1998 INTEGRATED SITE ENVIRONMENTAL REPORT

E-2272

1998 ENVIRONMENTAL SUMMARY
(Appendices A through E)

VOLUME I

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

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U.S. DEPARTMENT OF ENERGY
FERNALD AREA OFFICE

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1998 ENVIRONMENTAL SUMMARY

VOLUME I

(Appendices A through E)

Appendix A

APPENDIX A

SUPPLEMENTAL GROUNDWATER INFORMATION

TABLE OF CONTENTS

LIST OF ACRONYMS

AMSL	above mean sea level
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FEMP	Fernald Environmental Management Project
FRL	final remediation level
gpd	gallons per day
gpm	gallons per minute
IEMP	Integrated Environmental Monitoring Plan
lbs/M gal	pounds per million gallons
mg/L	milligrams per liter
mgpd	millions of gallons per day
μmhos/cm	micromhos per centimeter
OEPA	Ohio Environmental Protection Agency
PRRS	Paddys Run Road Site
μg/L	micrograms per liter

APPENDIX A

Appendix A presents additional groundwater data and analysis in support of Chapter 3 of this 1998 Integrated Site Environmental Report. This appendix consists of six attachments as follows:

- Attachment A.1 provides operational data for the Re-Injection Demonstration Module, the South Field (Phase I) Extraction Module, and the South Plume/South Plume Optimization Module for 1998. The attachment evaluates system performance with respect to the two-part objective to prevent further southward movement of the total uranium plume without adverse impact to the Paddys Run Road Site (PRRS) plumes.

- Attachment A.2 provides total uranium data and plume maps for all four quarters of 1998 with statistical trend results. The summary statistics and Mann-Kendall test for trend are based on unfiltered samples from the Operable Unit 5 remedial investigation/feasibility study data set (1988 through 1993) and 1994 through 1998 groundwater data, except for the new modules, whose statistics and trends are based on 1998 data alone.

- Attachment A.3 evaluates the capture zone of the Aquifer Restoration System by analyzing groundwater flow directions based on groundwater elevation data and well-specific flow direction data. It includes groundwater elevation maps from all four quarters of 1998 and borescope and hydrograph analyses of specific wells around the South Plume/South Plume Optimization and the South Field (Phase I) Extraction Modules.

- Attachment A.4 provides an analysis of the 1998 non-uranium FRL exceedances both inside and outside of the 10-year, uranium-based restoration footprint.

- Attachment A.5 provides detailed data from the miscellaneous, compliance-based monitoring activities in 1998 (i.e., the KC-2 Warehouse Monitoring Program and the Coal Pile Basin Runoff Monitoring Program).

- Attachment A.6 presents 1998 monitoring results associated with the On-Site Disposal Facility Monitoring Program.

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Attachment A.1

ATTACHMENT A.1

OPERATIONAL ASSESSMENT

ATTACHMENT A.1

In 1998 three new aquifer restoration modules began operating. The first new aquifer restoration module to come on line in 1998 was the South Field (Phase I) Extraction Module. This module encompasses Extraction Wells 31550, 31560, 31561, 31562, 31563, 31564, 31565, 31566, 31567, and 32276, which encircle the southern waste unit excavations in the South Field area of the Fernald Environmental Management Plan (FEMP) from Paddys Run to just west of the South Access Road. The pumping capacity of the South Plume Module, previously referred to as the South Plume Removal Action System and comprised of Extraction Wells 3924, 3925, 3926, and 3927, was optimized by the addition of the South Plume Optimization Module, the second new aquifer restoration module to come on line in 1998. This module contains Extraction Wells 32308 and 32309, and is located north of the four original extraction wells and south of Willey Road. Together, these six wells are known as the South Plume/South Plume Optimization Module. The third new aquifer restoration module to come on line in 1998 was the Re-Injection Demonstration Module. Comprised of Re-Injection Wells 22107, 22018, 22109, 22111, and 22240, this module stretches along the southern border of the FEMP to just north of Willey Road. Figure A.1-1 depicts these modules and identifies monitoring wells near each module. Table A.1-1 provides a summary of gallons pumped, total uranium removed, and system efficiency data for 1998 and for August 1993 through 1998.

<u>South Field (Phase I) Extraction Module</u>

The South Field (Phase I) Extraction Module came on line July 13, 1998. The module operated at 1,500 gallons per minute (gpm) in 1998 except for shutdowns for maintenance events and the December 1998 temporary shutdown to meet the 20 micrograms per liter (µg/L) total uranium discharge limit at the Parshall Flume.

Extraction Well 31566 was shut off on August 7, 1998, to mitigate the potential for creating a recalcitrant zone of uranium contamination. When this well was installed, it was noted in the drilling logs that the aquifer material in the immediate area of the screen was much finer grained than at other extraction well locations in the South Field (Phase I) Extraction Module. However, sediment grain size has been observed to change abruptly in a braided stream deposit such as the Great Miami Aquifer. Unless the extent of the fine-grained material in the aquifer is known, it is very difficult to predict how much it will effect pumping. Based on the information gained from an area-specific pumping test and what was known about the general prolific nature of the wells completed in the Great Miami Aquifer, the decision was made to install Extraction Well 31566 in the finer grained sediment rather than re-drilling in an attempt to complete it in a coarser grained section of the aquifer. During system operation testing, drawdown inside of the well was observed to be close to the downhole pump. During the first three weeks of operation, pumping rates for the well decreased from the initial set point of 200 to 150 gpm to maintain adequate submergence of the downhole equipment. After three weeks of operation, resulting in the extraction of over five million gallons of water, the pumping water level in the well was not improving, indicating that the fine-grained sediments were more extensive than anticipated. It was hoped that the extent of the tight sediment would have been such that a preferential pathway would establish itself and sufficiently high water levels could be maintained in order to sustain the design pumping rate. However, this did not occur. Furthermore, it became a concern that continued pumping would draw uranium contamination into an extensive low porosity "clean zone", thereby potentially creating a future "recalcitrant zone".

To compensate for the shut down of this well, and to increase module efficiency, the pumping rate was increased from 100 to 200 gpm at Extraction Well 31562 and from 200 to 300 gpm at Extraction Well 32276. Both of these wells are in areas of relatively high total uranium concentrations as shown in Figure A.2-5. The U.S. Environmental Protection Agency (EPA) and the Ohio Environmental Protection Agency (OEPA) were informed of these changes through the weekly site status conference calls.

During the six months of 1998 when the module was operational, 353.7 million gallons of groundwater were pumped by the 10 wells in the South Field (Phase I) Extraction Module.

Tables A.1-2 through A.1-11 provide individual extraction well performance data for the South Field (Phase I) Extraction Module. The footnotes explain individual extraction well or system outages of greater than 24 hours.

South Plume/South Plume Optimization Module

The South Plume Module operated in the four-well, 1,500 gpm target pumping configuration from January to August 9, 1998. The South Plume Optimization Module began pumping on August 9, 1998, and operated in the two-well, 500 gpm target pumping configuration so that the combined flow from the six-well South Plume/South Plume Optimization Module increased to 2,000 gpm. A short-term change in pumping rates was made after start-up to increase the South Plume/South Plume Optimization Module efficiency and to determine if the maximum extent of the eastern edge of the capture zone imposed by the six extraction wells remained sufficient under the revised pumping scenario.

During 1998, 772.4 million gallons of groundwater were pumped by the six wells in the South Plume/South Plume Optimization Module (672.9 million gallons were pumped from the four wells in the South Plume Module) and 185.2 pounds of total uranium were removed from the Great Miami Aquifer. The South Plume Module continued to meet the primary objective of preventing further southward movement of the total uranium plume and, in the process, the main lobe of the South Plume was within the capture zone imposed by the system. The primary objective for the South Plume Optimization wells is accelerated cleanup of the off-property plume as the South Plume Optimization wells are located in the area of the off-property plume with the highest total uranium concentrations. Attachment A.3 presents additional details concerning the capture zone, along with supporting data.

Tables A.1-12 through A.1-17 provide individual extraction well performance data for the South Plume/South Plume Optimization Module. Table A.1-1 provides a summary of gallons pumped, total uranium removed, and system efficiency data for 1998 and for August 1993 through 1998. The footnotes explain individual extraction well or system outages of greater than 24 hours.

In 1998, as in previous years, PRRS constituents of concern (arsenic, phosphorus, potassium, sodium, and volatile organic compounds) were monitored at 12 monitoring well locations immediately south of the South Plume Extraction Module to ensure that the operation of the system does not adversely impact the PRRS plume. The 12 wells monitored are 2128, 2548, 2625, 2636, 2898, 2899, 2900, 3128, 3636, 3898, 3899, and 3900 (refer to Figure A.1-1).

Consistent with previous reporting, the Mann-Kendall test for trend was run on PRRS data collected from these wells since the South Plume Extraction Module began operating in 1993. The Mann-Kendall test evaluates trends in the data by examining time-ordered data pairs then assigning a value of -1, 0, or 1 for decreases in concentrations, no change in concentrations, or increases in concentrations, respectively. The assigned values are summed for all time pairs to determine if any trend is present in the data and if so, whether the trend is up or down.

The significance of the up or down trend is evaluated by considering the probability of such an arrangement of data points occurring by random chance. A probability of 0.05 or less that the time-ordered data pairs could have occurred by chance is designated as a significant trend (up or down). A probability greater than 0.05 but less than or equal to 0.10 is designated as a marginal trend. A data set with a probability greater than 0.10 is designated as showing no trend.

As indicated in Table A.1-18, two wells monitored for PRRS constituents of concern had Up, Significant trends based on the Mann-Kendall test for trend:

- Monitoring Well 2625 had an Up, Significant trend for potassium with a concentration increasing from 4.46 milligrams per liter (mg/L) in the second quarter to 5.88 mg/L in the third quarter, as shown in Figure A.1-18. The well was not sampled in the fourth quarter because it was dry. Even so, this result remains less than the maximum historical potassium concentration observed at Monitoring Well 2625, which was 6.26 mg/L in the second quarter of 1996.

- An Up, Significant trend for arsenic in Monitoring Well 2548 (refer to Figure A.1-19) should have been reported in the 1997 Integrated Site Environmental Report (DOE 1998a). This well was not sampled in 1997 or 1998 because of access problems. Last year, non-validated data were inadvertently omitted from the data set upon which the Mann-Kendall test was performed. In 1998 non-validated data were restored to the data set; therefore, a trend was calculable. The average arsenic concentration of 0.027 mg/L at this well is almost half the groundwater final remediation level (FRL) of 0.050 mg/L. Due to unsurmountable access restrictions, this well has been dropped from the 1999 PRRS sampling program and will not be included in the 1999 Integrated Site Environmental Report. However, Monitoring Wells 2128 and 2900, located north of Monitoring Well 2548 (refer to Figure A.1-1), had Down, Significant trends for 1998, indicating that arsenic-contaminated groundwater is not migrating north. Therefore, with the continued monitoring of Monitoring Wells 2128 and 2900, the loss of access to Monitoring Well 2548 should not adversely affect the reliability of the monitoring network in the area between Extraction Wells 3924, 3925, 3926, 3927 and the PRRS plume program.

Although the monitoring activity for PRRS constituents of concern also included volatile organic compounds, no volatile organic compounds were detected in 1998.

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Re-Injection Demonstration Module

The Re-Injection Demonstration Module came on line September 2, 1998. The module operated in the five-well, 1,000 gpm design configuration in 1998 except for shutdowns for maintenance events and the December 1998 temporary shutdown to meet the 20 µg/L total uranium discharge limit at the Parshall Flume (PF 4001). The EPA and OEPA were notified of the December 1998 shutdown event.

During 1998, 150.9 million gallons of groundwater were re-injected back into the aquifer. An assessment of the module's effect on aquifer restoration will occur at the end of this re-injection demonstration project.

Tables A.1-19 through A.1-23 contain individual re-injection well performance data for the Re-Injection Demonstration Module. Table A.1-1 provides a summary of gallons pumped for 1998. The footnotes explain individual re-injection well or system outages of greater than 24 hours.

Total Uranium Data

The total uranium concentration data for each South Plume/South Plume Optimization or South Field (Phase I) Extraction Module extraction well since start-up through the end of 1998 are shown in Figures A.1-2 through A.1-17.

Since daily pumping rate data for each extraction well were presented in IEMP quarterly status reports for each quarter of 1998, those plots have not been repeated here.

Operating highlights for 1998 included:

- Construction was completed in the first quarter of 1998 on the expansion of the advanced wastewater treatment facility, adding 1,800 gpm of capacity dedicated to groundwater treatment. The facility began treating groundwater in April 1998 in accordance with the schedule established in the Remedial Action Work Plan for Aquifer Restoration at Operable Unit 5 (DOE 1997e). The 1998 monthly groundwater pumping rates versus treatment rates on Figure A.1-20 graphically depict the increase in available groundwater treatment capacity provided by the advanced wastewater treatment expansion facility.

- Significant system outages of the South Plume Module were experienced during the second quarter of 1998 due to construction activities associated with the pipeline distribution system for the South Plume Optimization and South Field (Phase I) Extraction Modules. The South Plume Module was taken out of service for tie-ins and while pressure testing was being conducted on the combined South Plume/South Plume Optimization and South Field (Phase I) Extraction Module pipelines and the South Plume bypass/treatment headers.

- The South Field (Phase 1) Extraction Module began operating ahead of schedule on July 13, 1998. All 10 extraction wells in the system were operating at the pumping rates specified in the Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1) (DOE 1997a). The module target pumping rate at start-up from the combined 10 pumping wells was 1,500 gpm.

- The South Plume Optimization Module began operating ahead of schedule on August 9, 1998. The two optimization wells were operating at the pumping rates specified in the Baseline Remedial Strategy Report. The combined South Plume/South Plume Optimization Module target pumping rate is 2,000 gpm (1,500 gpm from the existing four extraction wells comprising the South Plume Module and 500 gpm from the two extraction wells comprising the South Plume Optimization Module).

- The Re-Injection Demonstration Module began operating ahead of schedule on September 2, 1998. The five re-injection wells were operating at the re-injection rates specified in the Baseline Remedial Strategy Report. The target re-injection rate for this module is 1,000 gpm.

As shown in Table A.1-24, different pumping rates are applied at various times during the year as precipitation decreases, resulting in additional treatment capacity becoming available for groundwater. As additional operational experience is gained with these three active restoration modules, additional pumping rate changes are anticipated, to maximize the efficiency of each module. These rate changes will be made within the constraints imposed by the FEMP's 20 μg/L uranium discharge limit to the Great Miami River. During dry seasons when more treatment capacity is available and/or during the latter portions of months where the 20 μg/L total uranium limit is not in danger of being exceeded, pumping rates for extraction wells in areas of high total uranium concentrations may be increased (refer to Table A.1-24). When storm events require that treatment capacity be diverted to treating surface water runoff, well pumping rates may be reduced to meet the 20 μg/L total uranium discharge limit to the Great Miami River. Pumping rate changes will be documented in future IEMP quarterly status reports.

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TABLE A.1-1

AQUIFER RESTORATION SYSTEM OPERATIONAL SUMMARY SHEET (JANUARY 1 THROUGH DECEMBER 31, 1998)

	Gallons Pumped/Re-Injected this Reporting Period (M gal)	Total Uranium Removed/Re-Injected this Reporting Period[a] (lbs)	Average System Efficiency this Reporting Period[a] (lbs/M gal)	Gallons Pumped/Re-Injected from August 1993 to December 1998 (M gal)	Total Uranium Removed/Re-Injected from August 1993 to December 1998[a] (lbs)	System Efficiency from August 1993 to December 1998[a] (lbs/M gal)
South Field (Phase 1) Extraction Module	353.7	239.7	0.68	353.8	239.7	NA
South Plume/South Plume Optimization Module	770.8	185.2	0.24	3,583.334	574.61	0.16
Re-Injection Demonstration Module	150.9	NA	NA	150.891	NA	NA
Aquifer Restoration System Totals (pumped)	1,126.1	424.9	0.38	3,937.0	814.34	0.21
(re-injected)	150.9	NA	NA	150.9	NA	NA
(net)	975.2	424.9	NA	3,786.1	814.34	NA

[a]NA = not applicable

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TABLE A.1-2

EXTRACTION WELL 31550
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet AMSL) - 572.1 (top of well)
Northing Coordinate ('83) - 477,018.5
Easting Coordinate ('83) - 1,348,980

Hours in reporting period - 4,161
Hours not pumped - 134
Hours pumped - 4,027
Operational percent - 96.8
Target pumping rate - 100 gpm

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Uranium Concentration (μg/L)	Well Efficiency (lbs/M gal)
1/98[a]	NA	NA	NA	NA
2/98[a]	NA	NA	NA	NA
3/98[a]	NA	NA	NA	NA
4/98[a]	NA	NA	NA	NA
5/98[a]	NA	NA	NA	NA
6/98[a]	NA	NA	NA	NA
7/98[a]	94	2.8	106.1	0.88
8/98[b]	89	4.0	91.0	0.76
9/98	101	4.4	85.5	0.71
10/98[c]	92	4.1	87.6	0.73
11/98[d]	133	5.8	79.9	0.67
12/98	124	5.5	76.3	0.64
	Average 106	Total 26.6	Average 87.7	Average 0.73

[a]Extraction well did not become operational until July 13, 1998.
[b]Extraction well was out of service for three days due to a storm related electrical outage.
[c]Extraction well was out of service for two days due to a scheduled power outage.
[d]Extraction well was out of service for four days due to chlorination.

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TABLE A.1-3

EXTRACTION WELL 31560
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet above mean sea level [AMSL] - 574.93 (top of well)
Northing Coordinate ('83) - 477,403.1
Easting Coordinate ('83) - 1,349,029

Hours in reporting period - 4,144
Hours not pumped - 63
Hours pumped - 4,081
Operational percent - 98.5
Target pumping rate - 100 gpm

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Uranium Concentration (μg/L)	Well Efficiency (lbs/M gal)
1/98[a]	NA	NA	NA	NA
2/98[a]	NA	NA	NA	NA
3/98[a]	NA	NA	NA	NA
4/98[a]	NA	NA	NA	NA
5/98[a]	NA	NA	NA	NA
6/98[a]	NA	NA	NA	NA
7/98[a]	94	2.7	165.3	1.38
8/98[b]	89	4.0	144.0	1.20
9/98	101	4.4	146.9	1.23
10/98[c]	94	4.2	146.4	1.22
11/98[d]	152	6.5	138.2	1.15
12/98	118	5.2	138.2	1.15
	Average 108	Total 27.0	Average 147	Average 1.22

[a]Extraction well did not become operational until July 13, 1998.
[b]Extraction well was out of service for three days due to a storm related electrical outage.
[c]Extraction well was out of service for two days due to a scheduled power outage.
[d]Extraction well was out of service for two days due to chlorination.

TABLE A.1-4

EXTRACTION WELL 31561
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet above mean sea level [AMSL] - 578.77 (top of well)
Northing Coordinate ('83) - 477,660.8
Easting Coordinate ('83) - 1,349,255

Hours in reporting period - 4,161
Hours not pumped - 91
Hours pumped - 4,070
Operational percent - 97.8
Target pumping rate - 100 gpm

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Uranium Concentration (μg/L)	Well Efficiency (lbs/M gal)
1/98[a]	NA	NA	NA	NA
2/98[a]	NA	NA	NA	NA
3/98[a]	NA	NA	NA	NA
4/98[a]	NA	NA	NA	NA
5/98[a]	NA	NA	NA	NA
6/98[a]	NA	NA	NA	NA
7/98[a]	99	2.9	53.4	0.45
8/98[b]	90	4.0	62.9	0.52
9/98	101	4.4	50.5	0.42
10/98[c]	94	4.2	50.3	0.42
11/98	101	4.4	45.9	0.38
12/98	98	4.4	46.9	0.39
	Average 97	Total 24.3	Average 51.7	Average 0.43

[a]Extraction well did not become operational until July 13, 1998.
[b]Extraction well was out of service for three days due to a storm related electrical outage.
[c]Extraction well was out of service for two days due to a scheduled power outage.

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TABLE A.1-5

EXTRACTION WELL 31562
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet above mean sea level [AMSL] - 576.21 (top of well)
Northing Coordinate ('83) - 477,953.1
Easting Coordinate ('83) - 1,349,500

Hours in reporting period - 4,161
Hours not pumped - 79
Hours pumped - 4,082
Operational percent - 98.1
Target pumping rate - 200 gpm

Monthly Measurements at Wellfield

Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Uranium Concentration (μg/L)	Well Efficiency (lbs/M gal)
1/98[a]	NA	NA	NA	NA
2/98[a]	NA	NA	NA	NA
3/98[a]	NA	NA	NA	NA
4/98[a]	NA	NA	NA	NA
5/98[a]	NA	NA	NA	NA
6/98[a]	NA	NA	NA	NA
7/98[a]	94	2.7	141.6	1.18
8/98[b]	156	7.0	104.3	0.87
9/98	200	8.7	115.0	0.96
10/98[c]	187	8.3	114.1	0.95
11/98	209	9.1	113.7	0.95
12/98	194	8.7	116.4	0.97
	Average 173	Total 44.5	Average 117.5	Average 0.98

[a]Extraction well did not become operational until July 13, 1998.
[b]Extraction well was out of service for three days due to a storm related electrical outage.
[c]Extraction well was out of service for two days due to a scheduled power outage.

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TABLE A.1-6

EXTRACTION WELL 31563
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet above mean sea level [AMSL] - 544.36 (top of well)
Northing Coordinate ('83) - 477,066.4
Easting Coordinate ('83) - 1,348,330

Hours in reporting period - 4,160
Hours not pumped - 597
Hours pumped - 3,563
Operational percent - 85.6
Target pumping rate - 200 gpm

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Uranium Concentration (µg/L)	Well Efficiency (lbs/M gal)
1/98[a]	NA	NA	NA	NA
2/98[a]	NA	NA	NA	NA
3/98[a]	NA	NA	NA	NA
4/98[a]	NA	NA	NA	NA
5/98[a]	NA	NA	NA	NA
6/98[a]	NA	NA	NA	NA
7/98[a]	185	5.4	34.5	0.29
8/98	198	8.9	52.7	0.44
9/98	196	8.5	53.6	0.48
10/98[b]	181	8.1	49.3	0.41
11/98[c]	88	3.9	40.3	0.34
12/98[c]	162	7.2	40.0	0.33
	Average 168	Total 42.0	Average 45.1	Average 0.38

[a]Extraction well did not become operational until July 13, 1998.
[b]Extraction well was out of service for two days due to a scheduled power outage.
[c]Extraction well was out of service for 22 days due to an outage necessitated by the replacement of a logic board in the variable speed drive.

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TABLE A.1-7

EXTRACTION WELL 31564
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet above mean sea level [AMSL] - 538.65 (top of well)
Northing Coordinate ('83) - 477,124.7
Easting Coordinate ('83) - 1,347,880

Hours in reporting period - 4,160
Hours not pumped - 150
Hours pumped - 4,010
Operational percent - 96.4
Target pumping rate - 200 gpm

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Uranium Concentration (μg/L)	Well Efficiency (lbs/M gal)
1/98[a]	NA	NA	NA	NA
2/98[a]	NA	NA	NA	NA
3/98[a]	NA	NA	NA	NA
4/98[a]	NA	NA	NA	NA
5/98[a]	NA	NA	NA	NA
6/98[a]	NA	NA	NA	NA
7/98[a]	186	5.4	14.2	0.12
8/98	198	8.9	12.8	0.11
9/98	200	8.7	10.4	0.09
10/98[b]	187	8.3	13.8	0.12
11/98[c]	133	5.8	12.3	0.10
12/98	181	8.1	15.0	0.13
	Average 181	Total 45.2	Average 13.1	Average 0.11

[a]Extraction well did not become operational until July 13, 1998.
[b]Extraction well was out of service for two days due to a scheduled power outage.
[c]Extraction well was out of service for three days due to chlorination.

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TABLE A.1-8

EXTRACTION WELL 31565
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet above mean sea level [AMSL] - 540.72 (top of well)
Northing Coordinate ('83) - 477,648
Easting Coordinate ('83) - 1,347,603

Hours in reporting period - 4,160
Hours not pumped - 103
Hours pumped - 4,057
Operational percent - 97.5
Target pumping rate - 200 gpm

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Uranium Concentration (μg/L)	Well Efficiency (lbs/M gal)
1/98[a]	NA	NA	NA	NA
2/98[a]	NA	NA	NA	NA
3/98[a]	NA	NA	NA	NA
4/98[a]	NA	NA	NA	NA
5/98[a]	NA	NA	NA	NA
6/98[a]	NA	NA	NA	NA
7/98[a]	187	5.5	12.0	0.10
8/98	198	8.9	9.6	0.08
9/98	201	8.7	7.9	0.07
10/98[b]	182	8.1	12.4	0.10
11/98	139	6.0	12.9	0.11
12/98	182	8.1	14.8	0.12
	Average 182	Total 45.3	Average 11.6	Average 0.10

[a]Extraction well did not become operational until July 13, 1998.
[b]Extraction well was out of service for two days due to a scheduled power outage.

000025

2272

TABLE A.1-9

EXTRACTION WELL 31566
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet above mean sea level [AMSL] - 575.16 (top of well)
Northing Coordinate ('83) - 477,576.1
Easting Coordinate ('83) - 1,348,361

Hours in reporting period - 1,938
Hours not pumped - 0
Hours pumped - 1,938
Operational percent - 100.0
Target pumping rate - 200 gpm

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Uranium Concentration (μg/L)	Well Efficiency (lbs/M gal)
1/98[a]	NA	NA	NA	NA
2/98[a]	NA	NA	NA	NA
3/98[a]	NA	NA	NA	NA
4/98[a]	NA	NA	NA	NA
5/98[a]	NA	NA	NA	NA
6/98[a]	NA	NA	NA	NA
7/98[a]	162	4.7	5.4	0.05
8/98[b]	29	1.3	4.7	0.04
9/98[b]	NA	NA	4.8[c]	NA
10/98[b]	NA	NA	6.6	NA
11/98[b]	NA	NA	26.5[d]	NA
12/98[b]	NA	NA	20.9[d]	NA
	Average 96	Total 6.0	Average 11.5	Average 0.05

[a]Extraction well did not become operational until July 13, 1998.
[b]Extraction well was shut off on August 7, 1998 due to low total uranium recovery efficiency, excessive drawdown at the target pumping rate, and concerns regarding the creation of a recalcitrant zone.
[c]Extraction well is sampled weekly to track total uranium concentrations.
[d]The unusually high total uranium concentrations are being investigated.

000026

TABLE A.1-10

EXTRACTION WELL 31567
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet above mean sea level [AMSL] - 574.84 (top of well)
Northing Coordinate ('83) - 477,905.5
Easting Coordinate ('83) - 1,348,854

Hours in reporting period - 4,160
Hours not pumped - 82
Hours pumped - 4,078
Operational percent - 98.0
Target pumping rate - 100 gpm

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Uranium Concentration (μg/L)	Well Efficiency (lbs/M gal)
1/98[a]	NA	NA	NA	NA
2/98[a]	NA	NA	NA	NA
3/98[a]	NA	NA	NA	NA
4/98[a]	NA	NA	NA	NA
5/98[a]	NA	NA	NA	NA
6/98[a]	NA	NA	NA	NA
7/98[a]	93	2.7	63.4	0.53
8/98	100	4.5	41.0	0.34
9/98	101	4.3	34.8	0.29
10/98[b]	94	4.2	35.1	0.29
11/98	97	4.2	36.9	0.31
12/98	100	4.5	37.2	0.31
	Average 98	Total 24.4	Average 41.4	Average 0.35

[a]Extraction well did not become operational until July 13, 1998.
[b]Extraction well was out of service for two days due to a scheduled power outage.

000027

TABLE A.1-11

2272

EXTRACTION WELL 32276 OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet above mean sea level [AMSL] - 567.143 (top of well)
Northing Coordinate ('83) - 476,447.3
Easting Coordinate ('83) - 1,348,857

Hours in reporting period - 4,160
Hours not pumped - 74
Hours pumped - 4,086
Operational percent - 98.2
Target pumping rate - 300 gpm

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Uranium Concentration (μg/L)	Well Efficiency (lbs/M gal)
1/98[a]	NA	NA	NA	NA
2/98[a]	NA	NA	NA	NA
3/98[a]	NA	NA	NA	NA
4/98[a]	NA	NA	NA	NA
5/98[a]	NA	NA	NA	NA
6/98[a]	NA	NA	NA	NA
7/98[a]	187	5.5	268.2	2.24
8/98	279	12.5	230.0	1.92
9/98	294	12.7	206.5	1.72
10/98[b]	275	12.3	205.8	1.72
11/98	293	12.7	195.1	1.63
12/98	300	13.4	194.6	1.62
	Average 271	Total 69.1	Average 216.7	Average 1.81

[a]Extraction well did not become operational until July 13, 1998.
[b]Extraction well was out of service for two days due to a scheduled power outage.

000028

TABLE A.1-12

EXTRACTION WELL 3924
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet above mean sea level [AMSL]) - 533.51 (top of well)
Northing Coordinate ('83) - 474,219.7
Easting Coordinate ('83) - 1,348,314.26

Hours in reporting period - 8,757
Hours not pumped - 1,303
Hours pumped - 7,454
Operational percent - 85.1
Target pumping rate - 300 gpm

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Uranium Concentration (μg/L)	Well Efficiency (lbs/M gal)
1/98	297	13.3	46.0	0.38
2/98	294	11.8	46.3	0.39
3/98	290	12.9	50.6	0.42
4/98[a]	127	5.5	40.4	0.34
5/98[a,b,c,d]	156	7.0	36.5	0.30
6/98[a,b]	196	8.5	34.8	0.29
7/98[e]	238	10.6	41.7	0.35
8/98	287	12.8	36.2	0.30
9/98	282	12.2	33.6	0.28
10/98[f]	273	12.1	37.4	0.31
11/98	299	12.9	41.2	0.34
12/98	291	13.0	46.2	0.39
	Average 253	Total 132.6	Average 40.9	Average 0.34

[a]Extraction well was out of service for 17 days in April; eight days in May; and three days in June due to construction and connection activities on the pipeline distribution system for the South Plume Optimization and South Field Extraction (Phase 1) Modules.
[b]Extraction well was out of service for two days in May and five days in June due to a malfunctioning flow controller and a flow indicator/transmitter.
[c]Extraction well was out of service for three days due to a storm related electrical outage.
[d]Extraction well was out of service for two days due to an electrical malfunction.
[e]Extraction well was out of service for two days for installation of lightning arrestors.
[f]Extraction well was out of service for two days due to a scheduled power outage.

000029

2272

TABLE A.1-13

EXTRACTION WELL 3925
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet AMSL) - 542.01 (top of well)
Northing Coordinate ('83) - 474,319.65
Easting Coordinate ('83) - 1,348,565.4

Hours in reporting period - 8,757
Hours not pumped - 1,108
Hours pumped - 7,649
Operational percent - 87.3
Target pumping rate - 300 gpm

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Uranium Concentration (μg/L)	Well Efficiency (lbs/M gal)
1/98	288	12.9	31.7	0.26
2/98	297	11.9	24.5	0.20
3/98	291	13.0	31.7	0.26
4/98[a]	130	5.6	32.6	0.27
5/98[b]	193	8.6	30.3	0.25
6/98	242	10.4	33.1	0.28
7/98	256	11.4	35.9	0.30
8/98	260	11.6	31.1	0.26
9/98	299	12.9	31.4	0.26
10/98[c]	285	12.7	34.3	0.29
11/98	299	12.9	33.6	0.28
12/98[d]	271	12.1	35.3	0.29
	Average 259	Total 136.0	Average 32.1	Average 0.27

[a]Extraction well was out of service for 17 days in April; eight days in May; and three days in June due to construction and connection activities on the pipeline distribution system for the South Plume Optimization and South Field Extraction (Phase 1) Modules.
[b]Extraction well was out of service for three days in May due to a storm related electrical outage.
[c]Extraction well was out of service for two days due to a scheduled power outage.
[d]Extraction well was out of service for three days due to chlorination.

000030

TABLE A.1-14

EXTRACTION WELL 3926
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet AMSL) - 586.73 (top of well)
Northing Coordinate ('83) - 474,428.56
Easting Coordinate ('83) - 1,348,837.52

Hours in reporting period - 8,757
Hours not pumped - 1,086
Hours pumped - 7,671
Operational percent - 87.6
Target pumping rate - 400 gpm

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Uranium Concentration (μg/L)	Well Efficiency (lbs/M gal)
1/98	402	18.0	13.9	0.12
2/98	369	14.8	15.2	0.13
3/98	382	17.0	17.0	0.14
4/98[a]	175	7.6	16.1	0.13
5/98[a,b]	260	11.6	14.8	0.12
6/98[a,c]	319	13.8	16.3	0.14
7/98	376	16.8	17.7	0.15
8/98[d]	361	16.1	13.0	0.11
9/98	381	16.5	12.5	0.10
10/98[e]	372	16.6	15.8	0.13
11/98	343	14.8	15.0	0.13
12/98	367	16.4	17.6	0.15
	Average 342	Total 180.0	Average 15.4	Average 0.13

[a]Extraction well was out of service for 17 days in April; eight days in May; and three days in June due to construction and connection activities on the pipeline distribution system for the South Plume Optimization and South Field Extraction (Phase 1) Modules.
[b]Extraction well was out of service for two days due to a storm related electrical outage.
[c]Extraction well was out of service for two days due to a pressure indicator/transmitter malfunction.
[d]Extraction well was out of service for two days due to chlorination and installation of new control valves.
[e]Extraction well was out of service for two days due to a scheduled power outage.

000031

2272

TABLE A.1-15

EXTRACTION WELL 3927
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet AMSL) - 591.84 (top of well)
Northing Coordinate ('83) - 474,541.83
Easting Coordinate ('83) - 1,349,127.27

Hours in reporting period - 8,757
Hours not pumped - 1,136
Hours pumped - 7,621
Operational percent - 87.0
Target pumping rate - 500 gpm

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Uranium Concentration (μg/L)	Well Efficiency (lbs/M gal)
1/98	505	22.6	1.3	0.01
2/98	460	18.5	1.5	0.01
3/98	474	21.2	1.1	0.01
4/98[a]	214	9.2	0.8	0.01
5/98[a,b]	327	14.6	1.2	0.01
6/98[a]	425	18.4	1.3	0.01
7/98	468	20.9	1.2	0.01
8/98	490	21.9	1.2	0.01
9/98[c]	410	17.7	1.4	0.01
10/98[d]	456	20.3	1.1	0.01
11/98	438	18.9	1.2	0.01
12/98[e]	447	19.9	1.0	0.01
	Average 426	Total 224.1	Average 1.2	Average 0.01

[a]Extraction well was out of service for 17 days in April; eight days in May; and three days in June due to construction and connection activities on the pipeline distribution system for the South Plume Optimization and South Field Extraction (Phase 1) Modules.
[b]Extraction well was out of service for three days due to a storm related electrical outage.
[c]Extraction well was out of service for four days due to replacement of a process control station.
[d]Extraction well was out of service for two days due to a scheduled power outage.
[e]Extraction well was out of service for two days due to chlorination.

TABLE A.1-16

EXTRACTION WELL 32308
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet AMSL) - 582.05 (top of casing)
Northing Coordinate ('83) - 475,078.83
Easting Coordinate ('83) - 1,348,693.88

Hours in reporting period - 3,465
Hours not pumped - 102
Hours pumped - 3,363
Operational percent - 97.1
Target pumping rate - 250 gpm

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Uranium Concentration (μg/L)	Well Efficiency (lbs/M gal)
1/98[a]	NA	NA	NA	NA
2/98[a]	NA	NA	NA	NA
3/98[a]	NA	NA	NA	NA
4/98[a]	NA	NA	NA	NA
5/98[a]	NA	NA	NA	NA
6/98[a]	NA	NA	NA	NA
7/98[a]	NA	NA	NA	NA
8/98[a]	183	8.2	84.2	0.70
9/98	251	10.8	72.3	0.60
10/98[b]	236	10.5	73.4	0.61
11/98	307	13.3	71.2	0.59
12/98[c]	159	7.1	75.4	0.63
	Average 227	Total 49.9	Average 75.3	Average 0.63

[a]Extraction well did not become operational until August 9, 1998.
[b]Extraction well was out of service for two days due to a scheduled power outage.
[c]Extraction well was out of service for nine days due to an effort to mitigate the high total uranium concentration from the Storm Water Retention Basin bypass event.

000033

TABLE A.1-17

2272

EXTRACTION WELL 32309
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet AMSL) - 581.73 (top of casing)
Northing Coordinate ('83) - 475,109.60
Easting Coordinate ('83) - 1,348,366.34

Hours in reporting period - 3,465 | Hours pumped - 3,366 | Target pumping rate - 250 gpm
Hours not pumped - 99 | Operational percent - 97.1

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Uranium Concentration (μg/L)	Well Efficiency (lbs/M gal)
1/98[a]	NA	NA	NA	NA
2/98[a]	NA	NA	NA	NA
3/98[a]	NA	NA	NA	NA
4/98[a]	NA	NA	NA	NA
5/98[a]	NA	NA	NA	NA
6/98[a]	NA	NA	NA	NA
7/98[a]	NA	NA	NA	NA
8/98[a]	172	7.7	101.0	0.84
9/98	249	10.7	87.7	0.73
10/98[b]	234	10.4	90.1	0.75
11/98	307	13.3	82.2	0.69
12/98[c]	169	7.5	79.4	0.66
	Average 226	Total 49.6	Average 88.1	Average 0.73

[a]Extraction well did not become operational until August 9, 1998.
[b]Extraction well was out of service for two days due to a scheduled power outage.
[c]Extraction well was out of service for nine days due to an effort to mitigate the high total uranium concentration from the Storm Water Retention Basin bypass event.

TABLE A.1-18

PADDYS RUN ROAD SITE GROUNDWATER SUMMARY STATISTICS AND TREND ANALYSIS

Constituent	Monitoring Well	Number of Samples[a,b,c]	Min.[a,b,c,d] (mg/L)	Max.[a,b,c,d] (mg/L)	Avg.[a,b,c,d] (mg/L)	SD[a,b,c,d] (mg/L)	Trend[a,b,c,d]
Arsenic	2128	207	0.0006	0.1876	0.013	0.02	Down, Significant
	2548[e]	103	0.00065	0.35	0.027	0.040	Up, Significant
	2625	197	0.0048	0.05	0.012	0.008	Down, Significant
	2636	169	0.01	0.0939	0.04	0.02	Down, Significant
	2898	23	0.00035	0.0063	0.0016	0.0013	No Significant Trend
	2899	22	0.00035	0.003	0.0013	0.0007	No Significant Trend
	2900	205	0.0007	0.0548	0.005	0.005	Down, Significant
	3128	25	0.00085	0.234	0.013	0.046	No Significant Trend
	3636	24	0.00075	0.014	0.0021	0.0026	No Significant Trend
	3898	22	0.00095	0.0062	0.0022	0.0012	No Significant Trend
	3899	23	0.00035	0.003	0.0014	0.0008	No Significant Trend
	3900	23	0.00105	0.0045	0.0024	0.00098	Down, Significant
Phosphorus	2128	33	0.04	16.2	2	3	Down, Significant
	2548	12	0.0855	5.4	1.7	1.5	Down, Marginal
	2625	22	0.307	12.3	3.25	3.31	No Significant Trend
	2636	21	9.6	170	90	50	No Significant Trend
	2898	24	0.005	1.05	0.09	0.2	No Significant Trend
	2899	21	0.005	0.11	0.04	0.03	No Significant Trend
	2900	22	0.07	0.96	0.5	0.27	Down, Significant
	3128	32	0.005	13	0.5	2.3	No Significant Trend
	3636	23	0.0125	1.1	0.11	0.22	No Significant Trend
	3898	21	0.02	1.24	0.14	0.26	No Significant Trend
	3899	22	0.025	0.83	0.15	0.18	Down, Significant
	3900	23	0.005	1.26	0.11	0.26	No Significant Trend
Potassium	2128	25	1.09	18	4.3	4.9	Down, Significant
	2548	12	1.36	40	10	10	No Significant Trend
	2625	22	0.64	6.26	3.4	1.7	Up, Significant
	2636	21	8.51	218	80.9	57.0	Down, Significant
	2898	24	2.5	5.05	3.7	0.61	No Significant Trend
	2899	22	1.36	4.42	3.50	0.611	No Significant Trend
	2900	23	0.711	6	1.8	1.2	Down, Significant
	3128	25	1.09	3.7	2.5	0.61	Down, Significant
	3636	23	1.09	4.24	2.55	0.614	Down, Marginal
	3898	22	0.61	3.93	2.3	0.69	Down, Marginal
	3899	23	1.335	3.22	2.43	0.345	Down, Significant
	3900	23	0.975	3.19	1.90	0.542	No Significant Trend

000035

2272

TABLE A.1-18
(Continued)

Constituent	Monitoring Well	Number of Samples[a,b,c]	Min.[a,b,c,d] (mg/L)	Max.[a,b,c,d] (mg/L)	Avg.[a,b,c,d] (mg/L)	SD[a,b,c,d] (mg/L)	Trend[a,b,c,d]
Sodium	2128	25	22.9	75.2	38.6	13.1	No Significant Trend
	2548	12	18.2	35	25	5.1	No Significant Trend
	2625	22	16.5	50.7	33.9	8.24	Down, Significant
	2636	21	23	79.9	49	16	Down, Significant
	2898	24	12.3	29.2	19.0	4.07	Down, Significant
	2899	22	11.2	22.9	17.2	3.32	No Significant Trend
	2900	23	18.1	43.3	30.4	8.06	No Significant Trend
	3128	25	3.75	13.4	7.06	3.35	Down, Significant
	3636	23	4.65	13	8.5	2.9	Down, Significant
	3898	22	7.29	14.6	8.90	1.72	No Significant Trend
	3899	23	6.24	12.1	8.80	1.46	Down, Significant
	3900	23	4.45	10.8	6.43	1.89	Down, Marginal

[a]The data are based on unfiltered samples from the Operable Unit 5 remedial investigation/feasibility study data set (1988 through 1993) and 1994 through 1998 groundwater data. However, the Mann-Kendall test for trend was performed on data from samples taken between August 1993 and the end of 1998 in order to determine the effect of the south plume pumping system.
[b]If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the total number of samples, and the sample with the maximum concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation [SD]) and Mann-Kendall test for trend.
[c]Rejected data qualified with either a R or Z were not included in this count, the summary statistics, or Mann-Kendall test for trend.
[d]For results where the concentrations are below the detection limit, the results used in the summary statistics and Mann-Kendall test for trend are each set at half the detection limit.
[e]Although the well was not sampled during 1998, the trend was updated with nonvalidated data.

TABLE A.1-19

RE-INJECTION WELL 22107
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet above mean sea level [AMSL] - 540.6 (top of well)
Northing Coordinate ('83) - 476,196.2
Easting Coordinate ('83) - 1,347,978.2

Hours in reporting period - 2,908
Hours not re-injected - 619
Hours re-injected - 2,289
Operational percent - 78.7
Target re-injection rate - 200 gpm

Monthly Measurements at Wellfield		
Month	Monthly Average Re-Injection Rate (gpm)	Million Gallons Re-Injected
1/98[a]	NA	NA
2/98[a]	NA	NA
3/98[a]	NA	NA
4/98[a]	NA	NA
5/98[a]	NA	NA
6/98[a]	NA	NA
7/98[a]	NA	NA
8/98[a]	NA	NA
9/98[a]	196	8.2
10/98[b,c]	130	5.8
11/98	196	8.5
12/98[d,e]	128	5.8
	Average 163	Total 28.3

[a]Re-injection well did not become operational until September 2, 1998.
[b]Re-injection well was out of service for two days due to a scheduled power outage.
[c]Re-injection well was out of service for eight days due to chlorination.
[d]Re-injection well was out of service for two days due to treatment plant maintenance.
[e]Re-injection well was out of service for 10 days due to an effort to mitigate the high total uranium concentrations from the Storm Water Retention Basin bypass event.

000037

TABLE A.1-20

2272

RE-INJECTION WELL 22108
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet above mean sea level [AMSL] - 578.555 (top of well)
Northing Coordinate ('83) - 476,255.7
Easting Coordinate ('83) - 1,348,384

Hours in reporting period - 2,901
Hours not re-injected - 390
Hours re-injected - 2,511
Operational percent - 86.6
Target re-injection rate - 200 gpm

Monthly Measurements at Wellfield		
Month	Monthly Average Re-Injection Rate (gpm)	Million Gallons Re-Injected
1/98[a]	NA	NA
2/98[a]	NA	NA
3/98[a]	NA	NA
4/98[a]	NA	NA
5/98[a]	NA	NA
6/98[a]	NA	NA
7/98[a]	NA	NA
8/98[a]	NA	NA
9/98[a]	196	8.2
10/98[b]	186	8.3
11/98	197	8.5
12/98[c,d]	127	5.7
	Average 177	Total 30.7

[a]Re-injection well did not become operational until September 2, 1998.
[b]Re-injection well was out of service for two days due to a scheduled power outage.
[c]Re-injection well was out of service for two days due to treatment plant maintenance.
[d]Re-injection well was out of service for nine days due to an effort to mitigate the high total uranium concentrations from the Storm Water Retention Basin bypass event.

TABLE A.1-21

RE-INJECTION WELL 22109
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet above mean sea level [AMSL] - 577.53 (top of well)
Northing Coordinate ('83) - 476,175.6
Easting Coordinate ('83) - 1,348,861

Hours in reporting period - 2,901
Hours not re-injected - 391
Hours re-injected - 2,510
Operational percent - 86.5
Target re-injection rate - 200 gpm

Monthly Measurements at Wellfield

Month	Monthly Average Re-Injection Rate (gpm)	Million Gallons Re-Injected
1/98[a]	NA	NA
2/98[a]	NA	NA
3/98[a]	NA	NA
4/98[a]	NA	NA
5/98[a]	NA	NA
6/98[a]	NA	NA
7/98[a]	NA	NA
8/98[a]	NA	NA
9/98[a]	195	8.1
10/98[b]	186	8.3
11/98	196	8.5
12/98[c,d]	128	5.7
	Average 176	Total 30.6

[a]Re-injection well did not become operational until September 2, 1998.
[b]Re-injection well was out of service for two days due to a scheduled power outage.
[c]Re-injection well was out of service for two days due to treatment plant maintenance.
[d]Re-injection well was out of service for nine days due to an effort to mitigate the high total uranium concentrations from the Storm Water Retention Basin bypass event.

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TABLE A.1-22

RE-INJECTION WELL 22111
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet above mean sea level [AMSL] - 583.62 (top of well)
Northing Coordinate ('83) - 476,518.6
Easting Coordinate ('83) - 1,350,105

Hours in reporting period - 2,902
Hours not re-injected - 404
Hours re-injected - 2,498
Operational percent - 86.1
Target re-injection rate - 200 gpm

Monthly Measurements at Wellfield		
Month	Monthly Average Re-Injection Rate (gpm)	Million Gallons Re-Injected
1/98[a]	NA	NA
2/98[a]	NA	NA
3/98[a]	NA	NA
4/98[a]	NA	NA
5/98[a]	NA	NA
6/98[a]	NA	NA
7/98[a]	NA	NA
8/98[a]	NA	NA
9/98[a]	195	8.4
10/98[b]	186	8.3
11/98	197	8.5
12/98[c,d]	126	5.6
	Average 176	Total 30.8

[a]Re-injection well did not become operational until September 2, 1998.
[b]Re-injection well was out of service for two days due to a scheduled power outage.
[c]Re-injection well was out of service for two days due to treatment plant maintenance.
[d]Re-injection well was out of service for nine days due to an effort to mitigate the high total uranium concentrations from the Storm Water Retention Basin bypass event.

TABLE A.1-23

RE-INJECTION WELL 22240
OPERATIONAL SUMMARY SHEET FOR 1998

Reference Elevation (feet above mean sea level [AMSL] - 577.61 (top of well)
Northing Coordinate ('83) - 476,422.8
Easting Coordinate ('83) - 1,349,387

Hours in reporting period - 2,902
Hours not re-injected - 387
Hours re-injected - 2,515
Operational percent - 86.7
Target re-injection rate - 200 gpm

Monthly Measurements at Wellfield		
Month	Monthly Average Re-Injection Rate (gpm)	Million Gallons Re-Injected
1/98[a]	NA	NA
2/98[a]	NA	NA
3/98[a]	NA	NA
4/98[a]	NA	NA
5/98[a]	NA	NA
6/98[a]	NA	NA
7/98[a]	NA	NA
8/98[a]	NA	NA
9/98[a]	202	8.4
10/98[b]	186	8.3
11/98	197	8.5
12/98[c,d]	127	5.7
	Average 178	Total 30.9

[a]Re-injection well did not become operational until September 2, 1998.
[b]Re-injection well was out of service for two days due to a scheduled power outage.
[c]Re-injection well was out of service for two days due to treatment plant maintenance.
[d]Re-injection well was out of service for nine days due to an effort to mitigate the high total uranium concentrations from the Storm Water Retention Basin bypass event.

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TABLE A.1-24

1998 EXTRACTION WELL TARGET PUMPING RATES

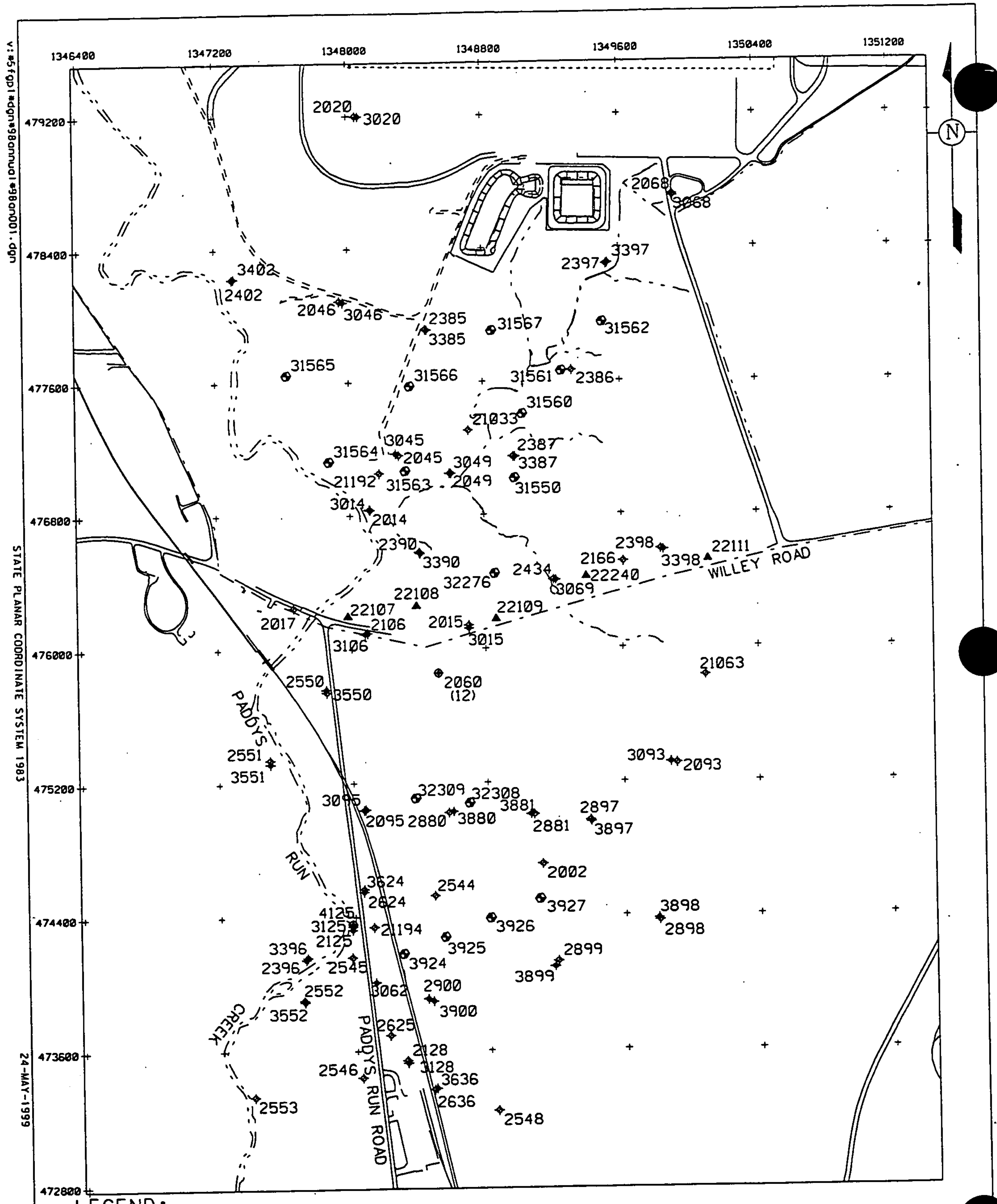
Module	Extraction Well	Initial Rates[a]	Target Pumping Rates as of August 7, 1998 Nominal Rates[b] (gpm)	Aggressive Rates[c] (gpm)
South Plume	3924	300	300	300
	3925	300	300	300
	3926	400	400	300
	3927	500	500	400
Sub-Total		1500	1500	1300
South Plume Optimization	32308	250	250	350
	32309	250	250	350
Sub-Total		500	500	700
South Field (Phase 1) Extraction	31550	100	100	200
	31560	100	100	200
	31561	100	100	100
	31562	100	200	200
	31563	200	200	200
	31564	200	200	100
	31565	200	200	100
	31566[d]	200	0	0
	31567	100	100	100
	32276	200	300	300
Sub-Total		1500	1500	1500
Total Pumping		3500	3500	3500

[a]With the exception of the pumping rate for Extraction Well 3927, these pumping rates are identical to the design pumping rates presented in Table 5-1 of the Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration. Pumping rates for Extraction Well 3927 were increased from 400 to 500 gpm on November 6, 1997 to maximize the extent of the eastern edge of the capture zone in this area.

[b]The nominal pumping rates are used when significant portions of the site's water treatment capacity is required to treat storm water. Rates for some wells are different from the Baseline Remedial Strategy Report pumping rates shown in the first column and were changed based on operational experience with the extraction system. These rates were established on August 7, 1998 when Extraction Well 31566 was shut down and Extraction Wells 31562 and 32276 were increased.

[c]The aggressive pumping rates are used when all, or nearly all the site's water treatment capacity is available for treating groundwater and the average monthly uranium discharge is well below the 20 μg/L limit.

[d]This well was shut off on August 7, 1998 after operational experience demonstrated its continued operation may have been detrimental in meeting system objectives. Pumping rates for Extraction Wells 31562 and 32276 were increased at that time to compensate for the shut down of Extraction Well 31566.



LEGEND:

- — - — FEMP BOUNDARY
- ◆ ◈ ✦ MONITORING WELL
- ⊗ EXTRACTION WELL
- ▲ RE-INJECTION WELL

SCALE

800 400 0 800 FEET

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FIGURE A.1-1. WELL LOCATIONS FOR SOUTH PLUME, SOUTH FIELD, RE-INJECTION AND PADDYS RUN ROAD SITE MONITORING ACTIVITES

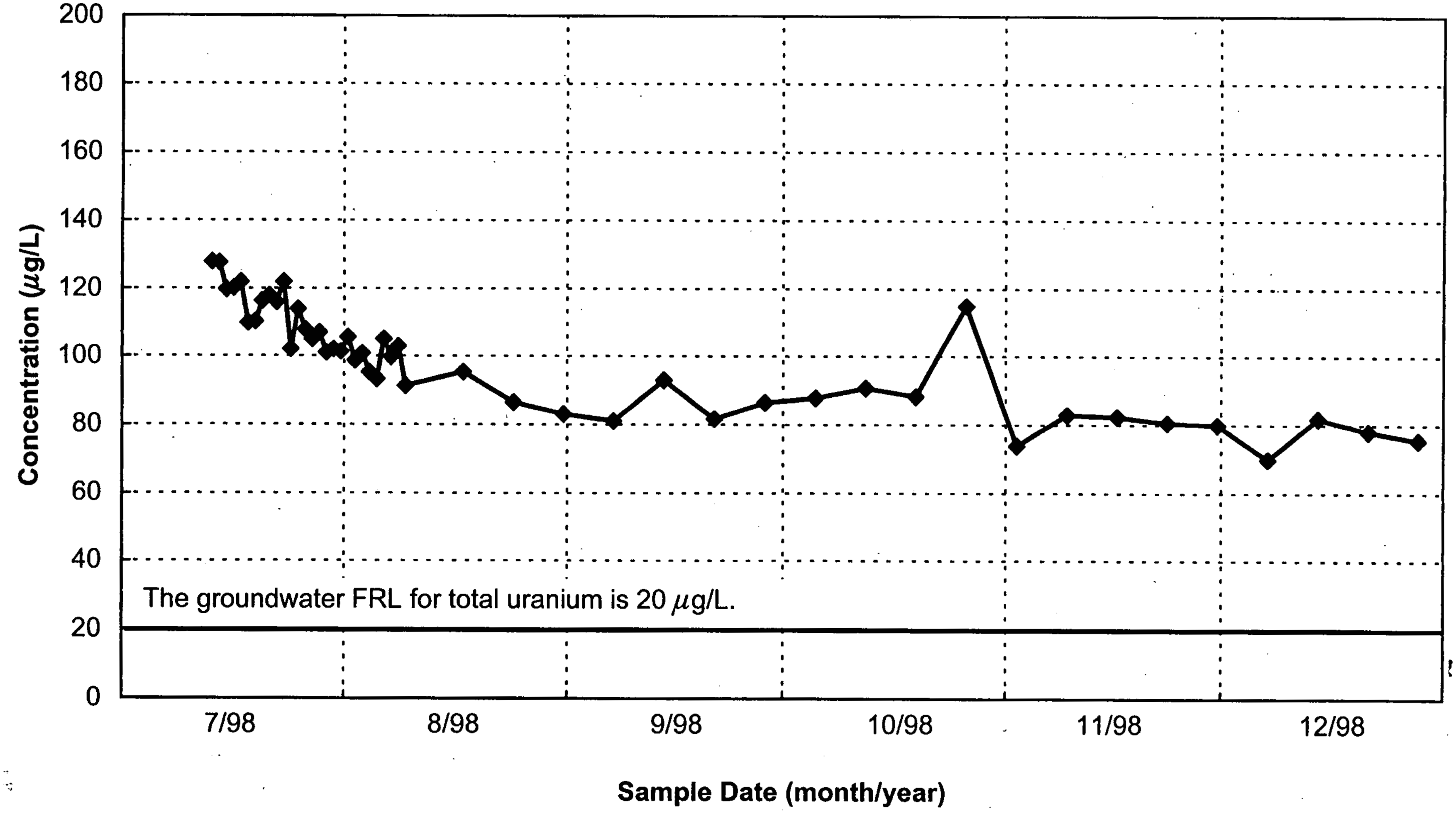

FIGURE A.1-2. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 31550

Modeled Concentration = 16.9 μg/L

Developed Concentration = 130 μg/L

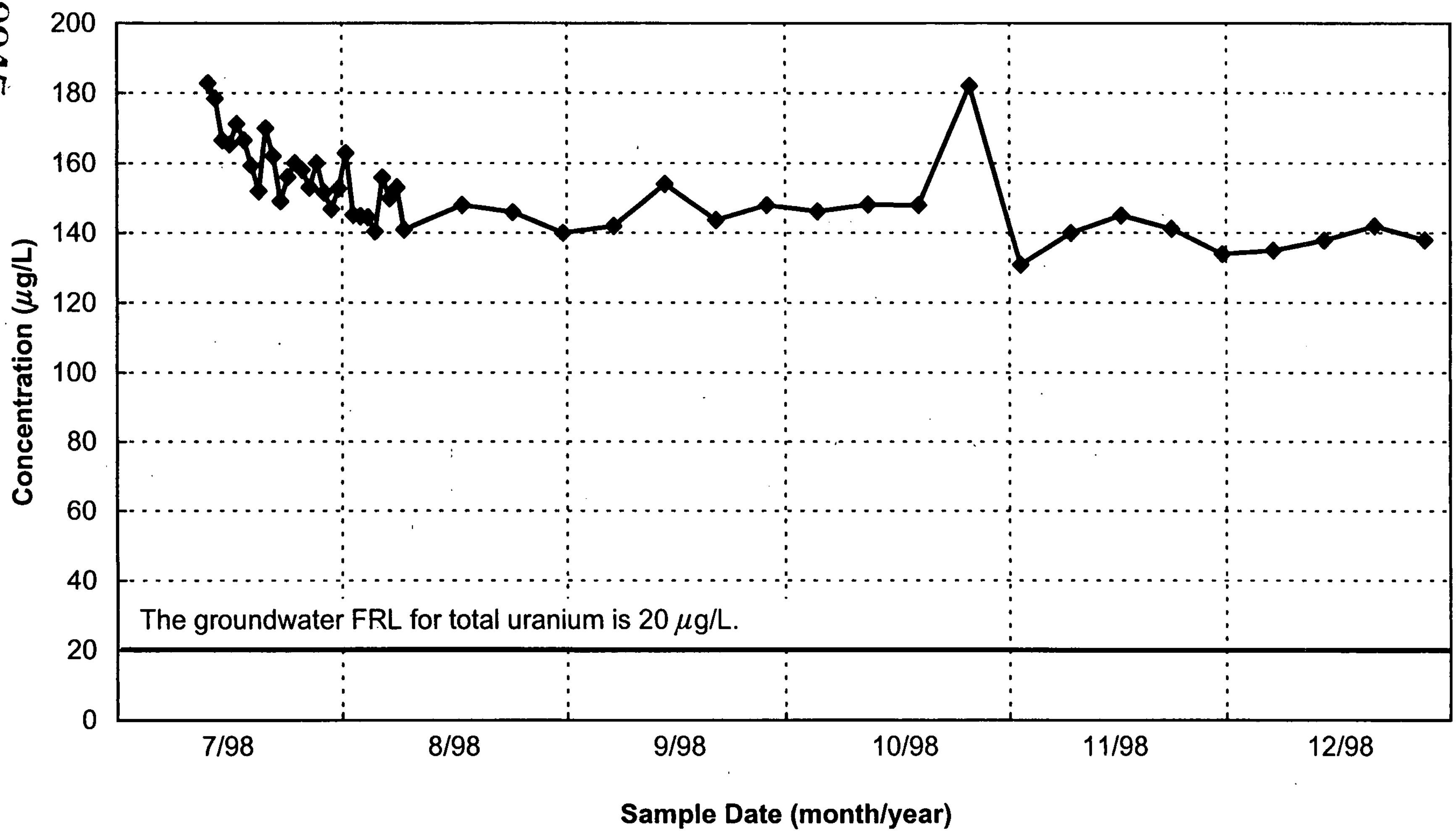

FIGURE A.1-3. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 31560

Modeled Concentration = 62.7 µg/L
Developed Concentration = 217 µg/L

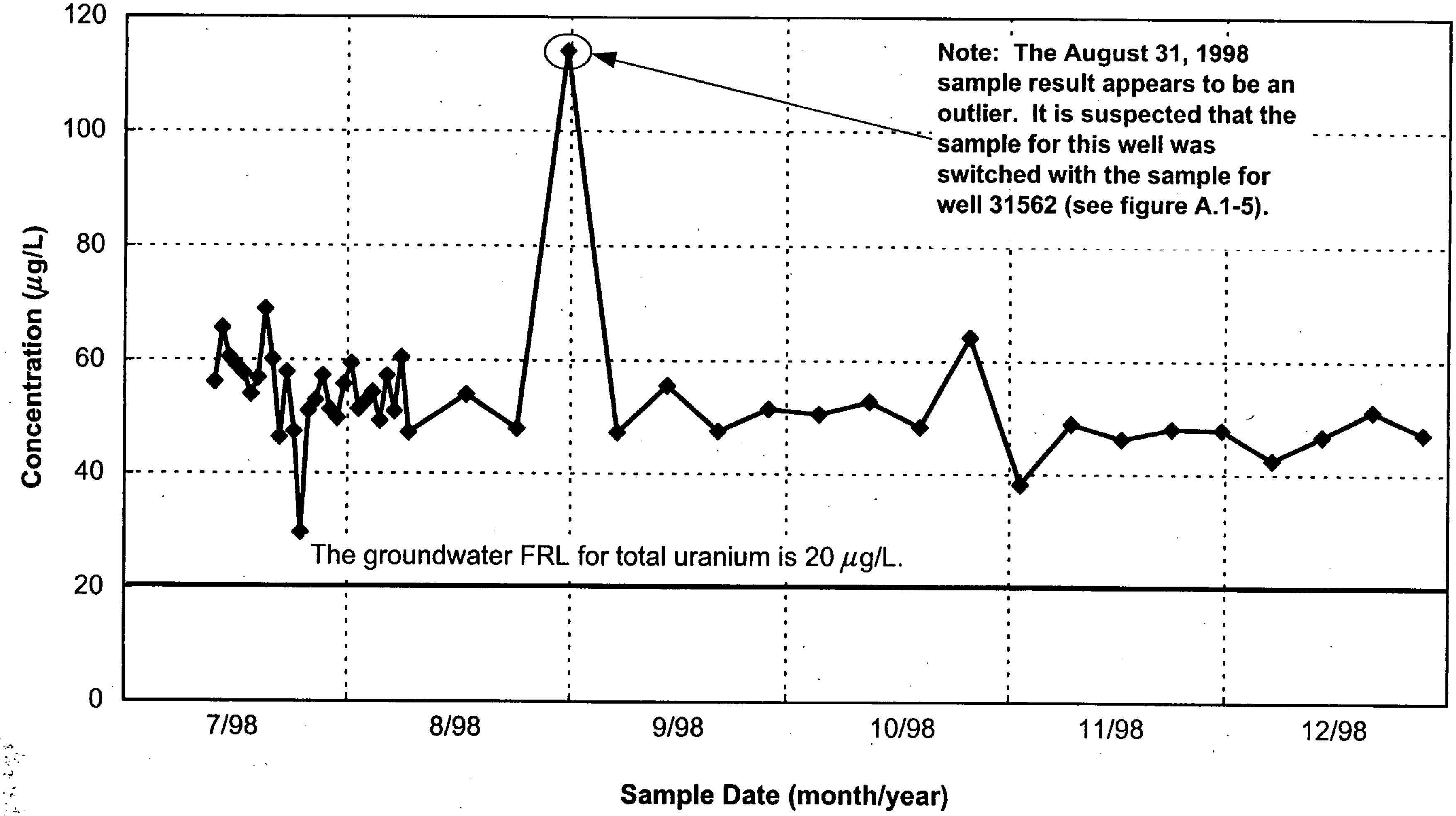

FIGURE A.1-4. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 31561

Modeled Concentration = 64.8 µg/L
Developed Concentration = 49 µg/L

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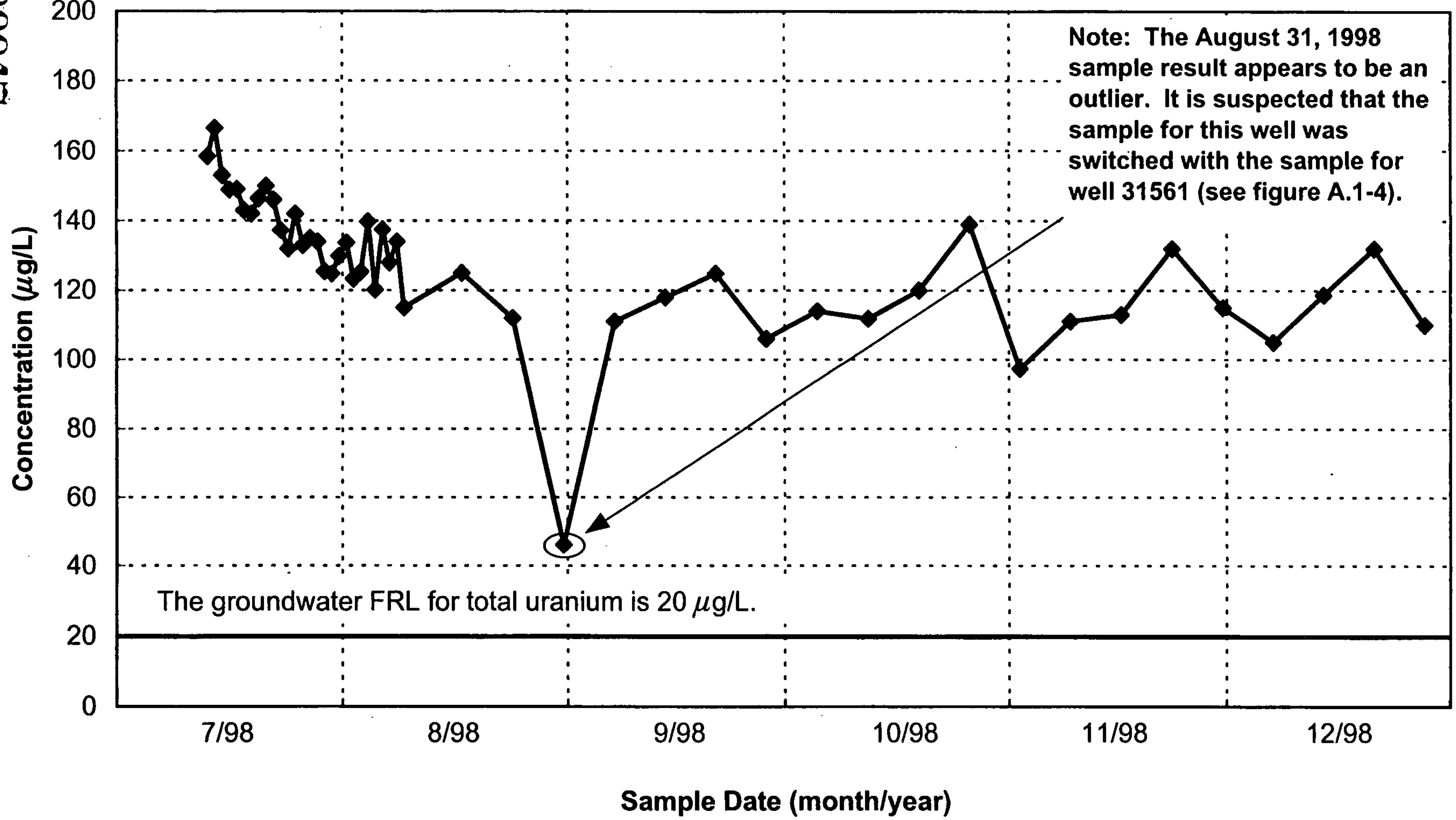

FIGURE A.1-5. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 31562

Modeled Concentration = 231.4 µg/L

Developed Concentration = 177 µg/L

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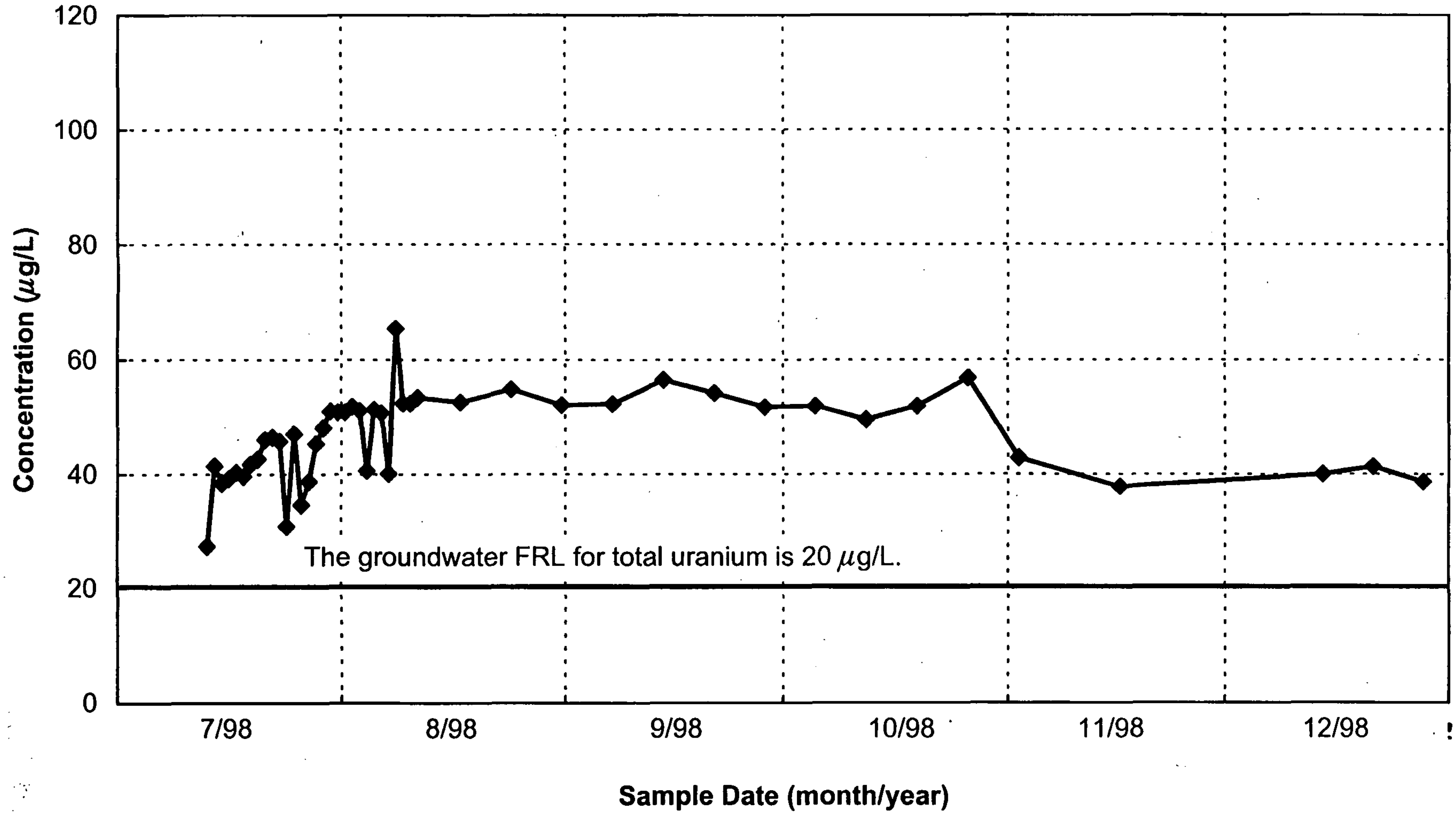

FIGURE A.1-6. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 31563

Modeled Concentration = 79.8 µg/L
Developed Concentration = 30 µg/L

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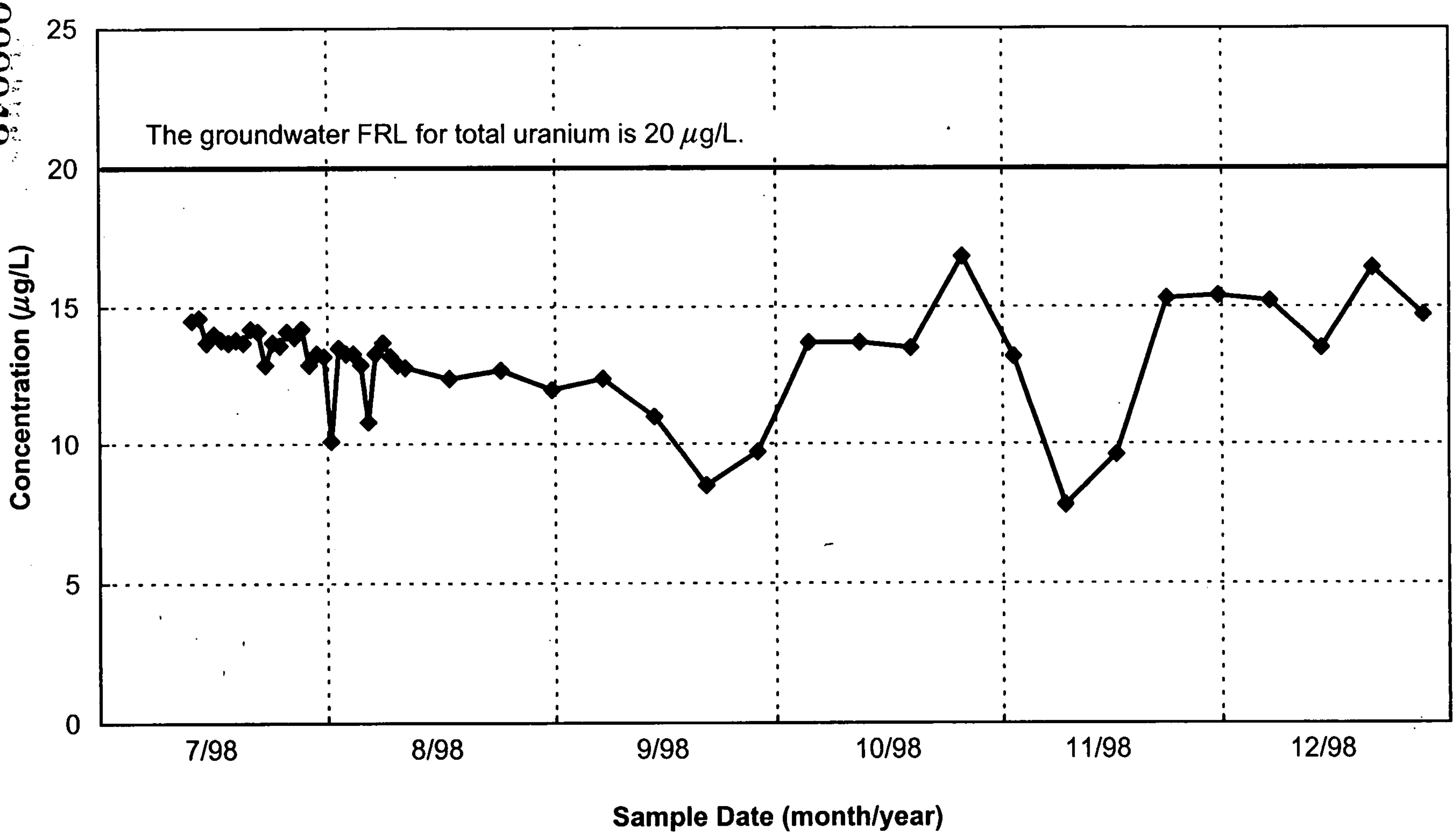

FIGURE A.1-7. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 31564

Modeled Concentration = 11.9 μg/L

Developed Concentration = 18 μg/L

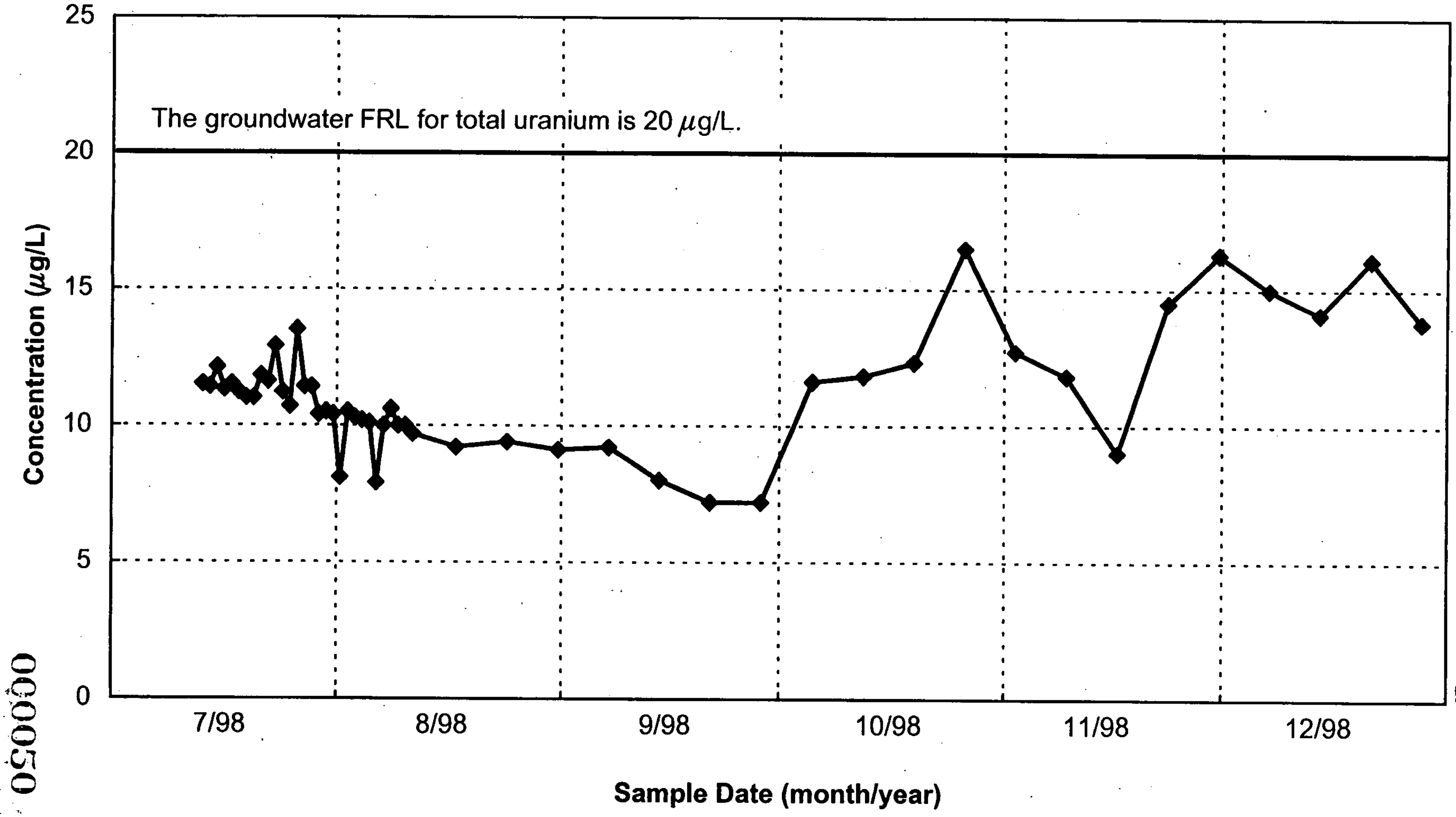

FIGURE A.1-8. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 31565

Modeled Concentration = 139.2 μg/L
Developed Concentration = 15 μg/L

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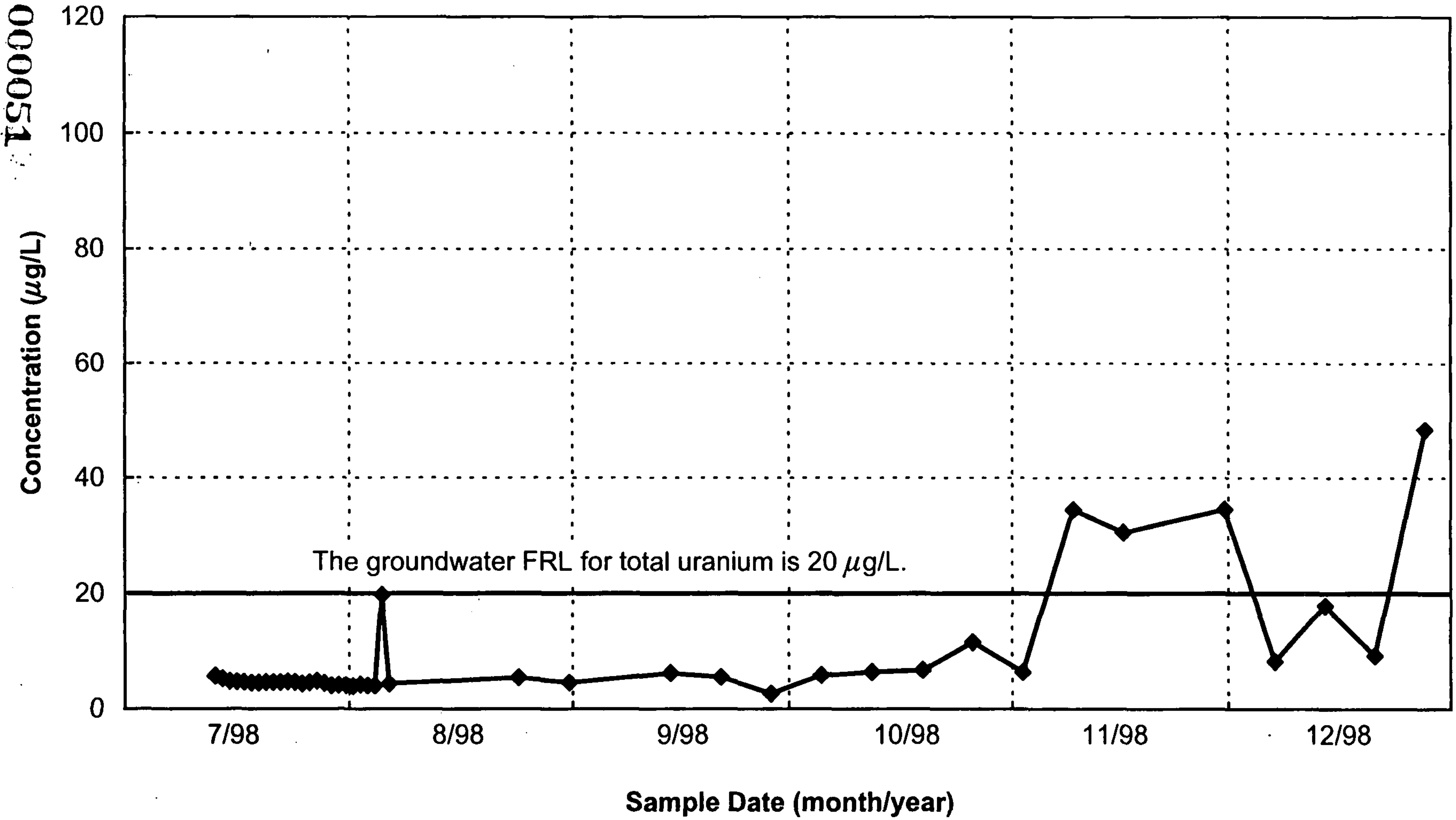

FIGURE A.1-9. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 31566

Modeled Concentration = 63.3 μg/L

Developed Concentration = 4.8 μg/L

000051

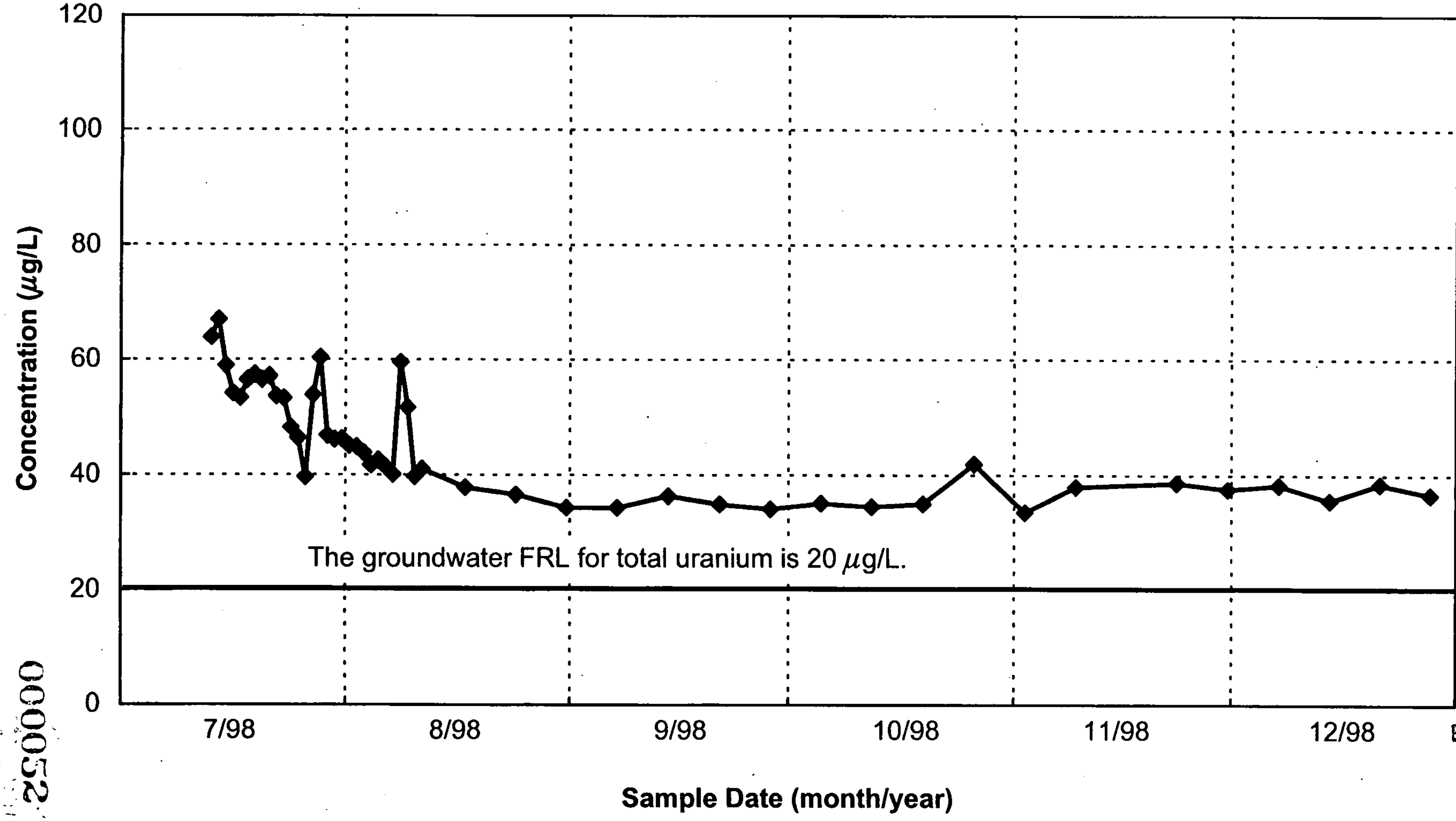

FIGURE A.1-10. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 31567

Modeled Concentration = 9.6 µg/L

Developed Concentration = 14 µg/L

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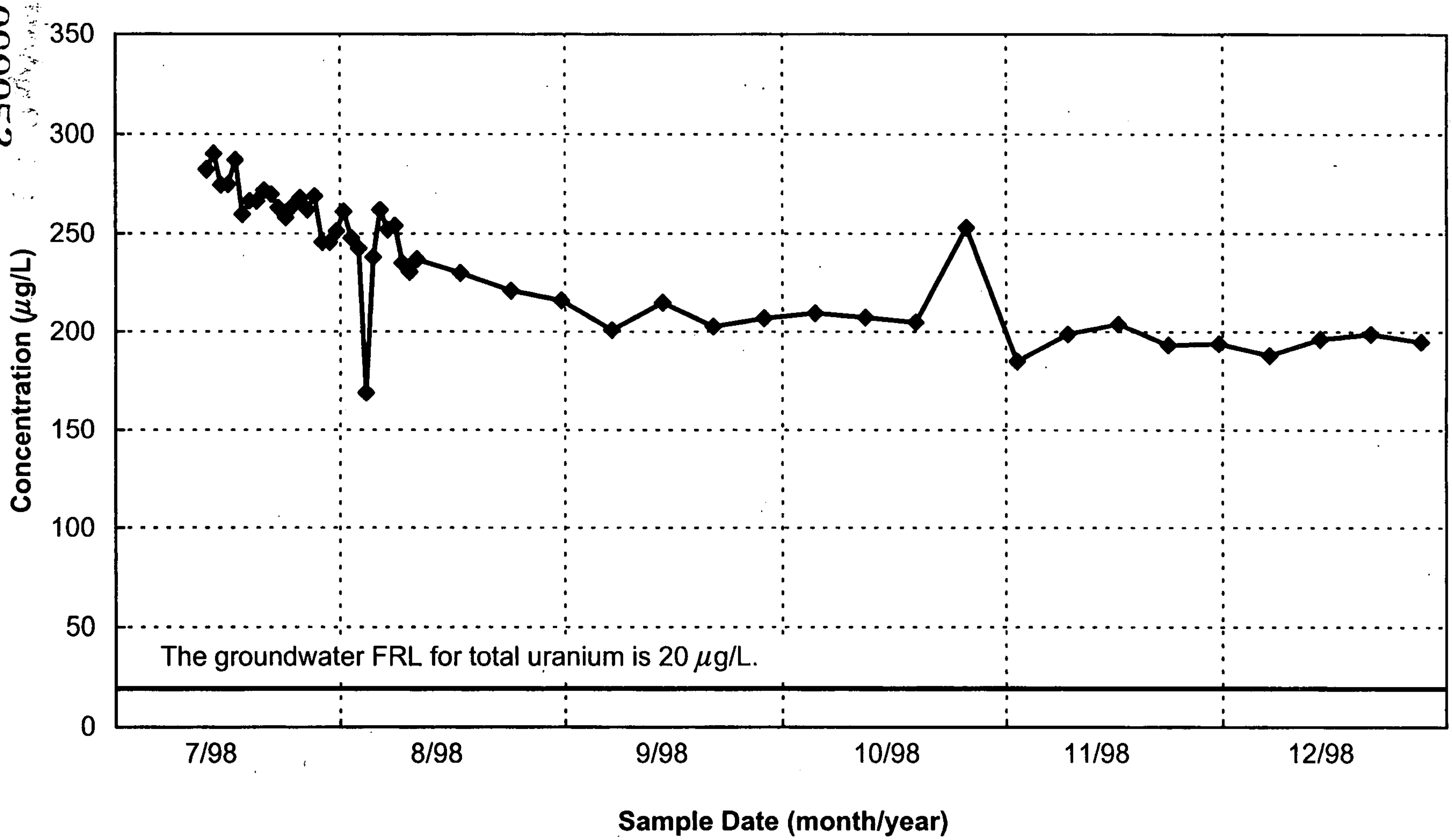

FIGURE A.1-11. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 32276

Modeled Concentration = 239.4 μg/L

Developed Concentration = 400 μg/L

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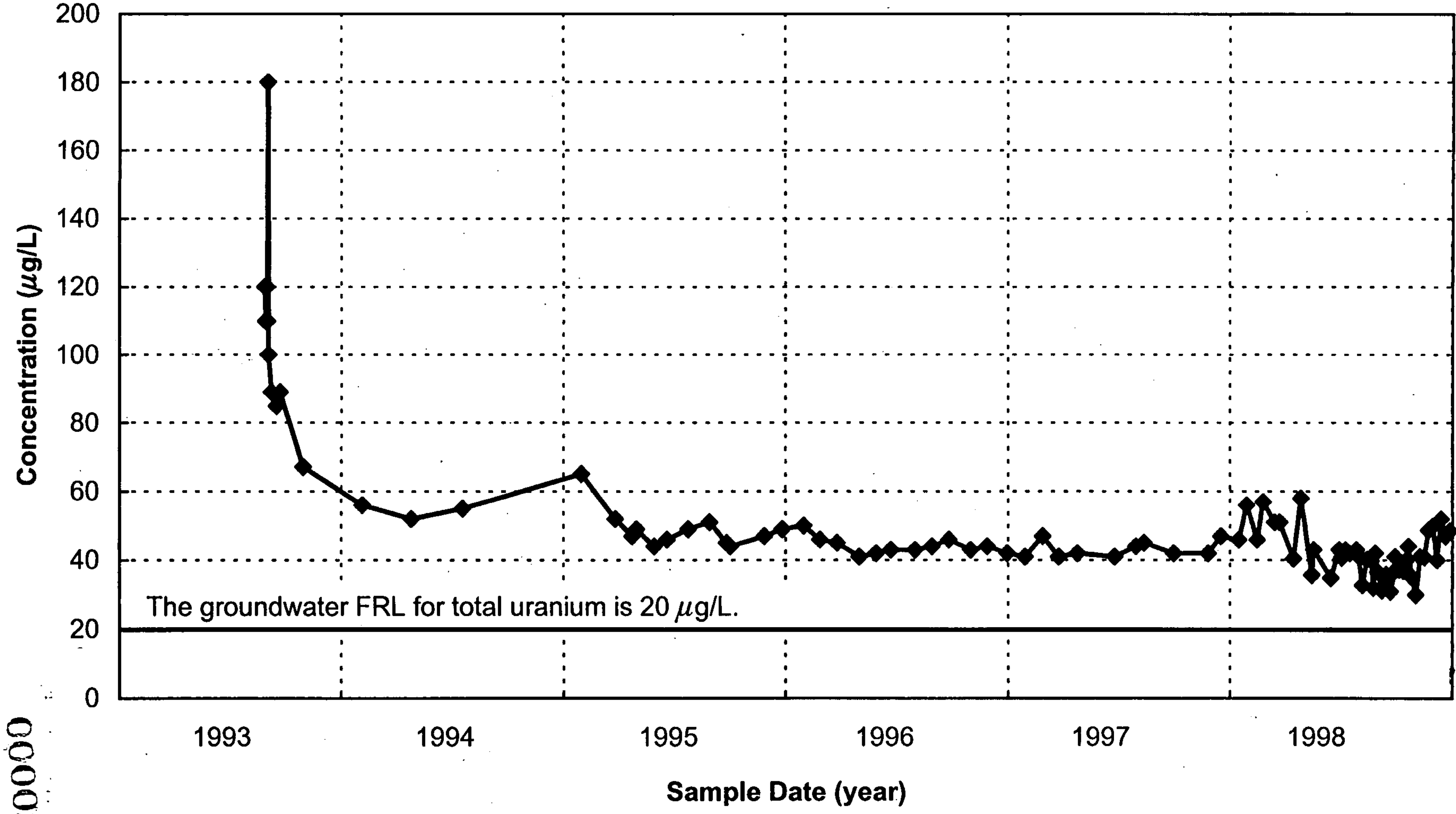

FIGURE A.1-12. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 3924

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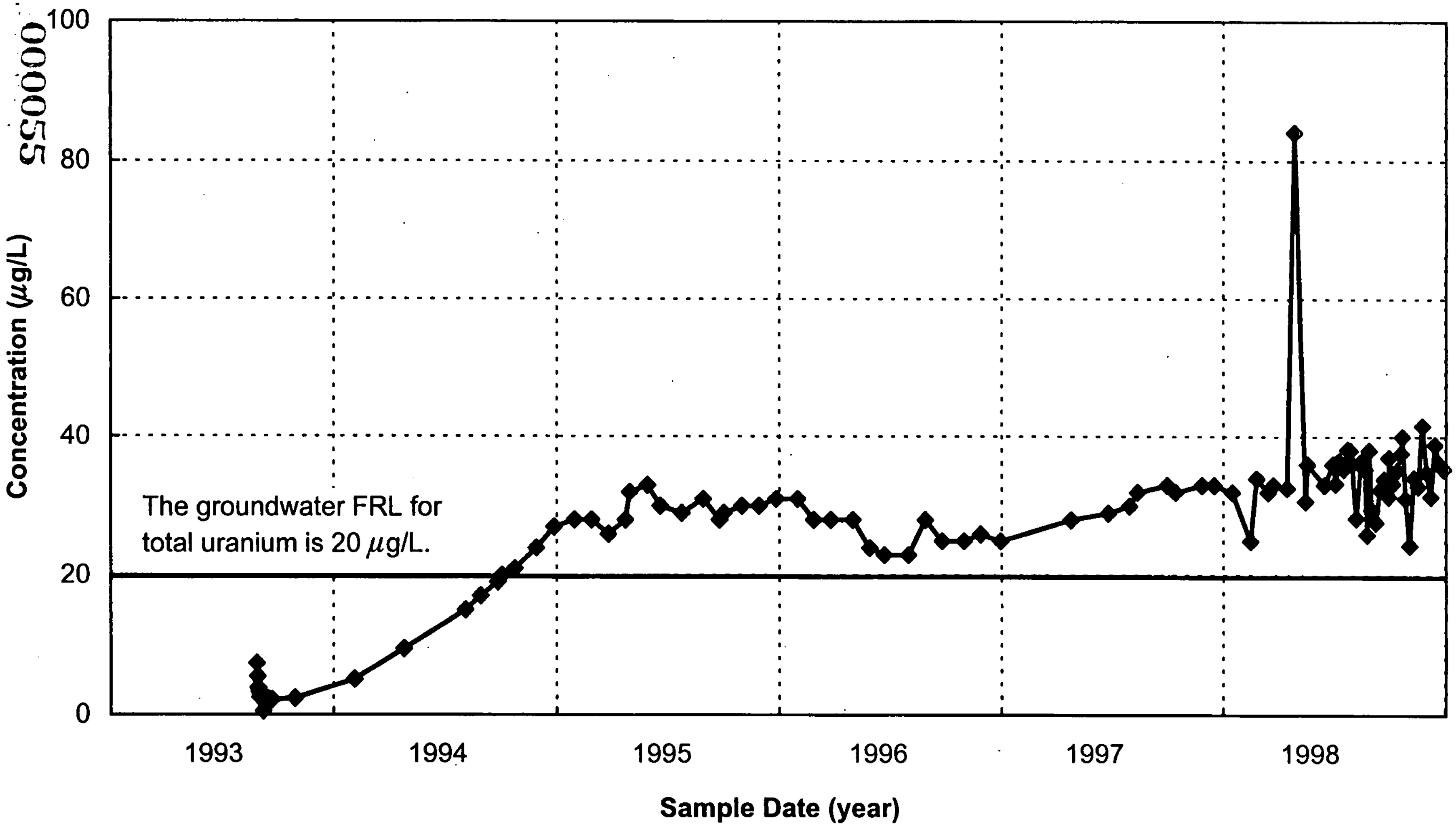

FIGURE A.1-13. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 3925

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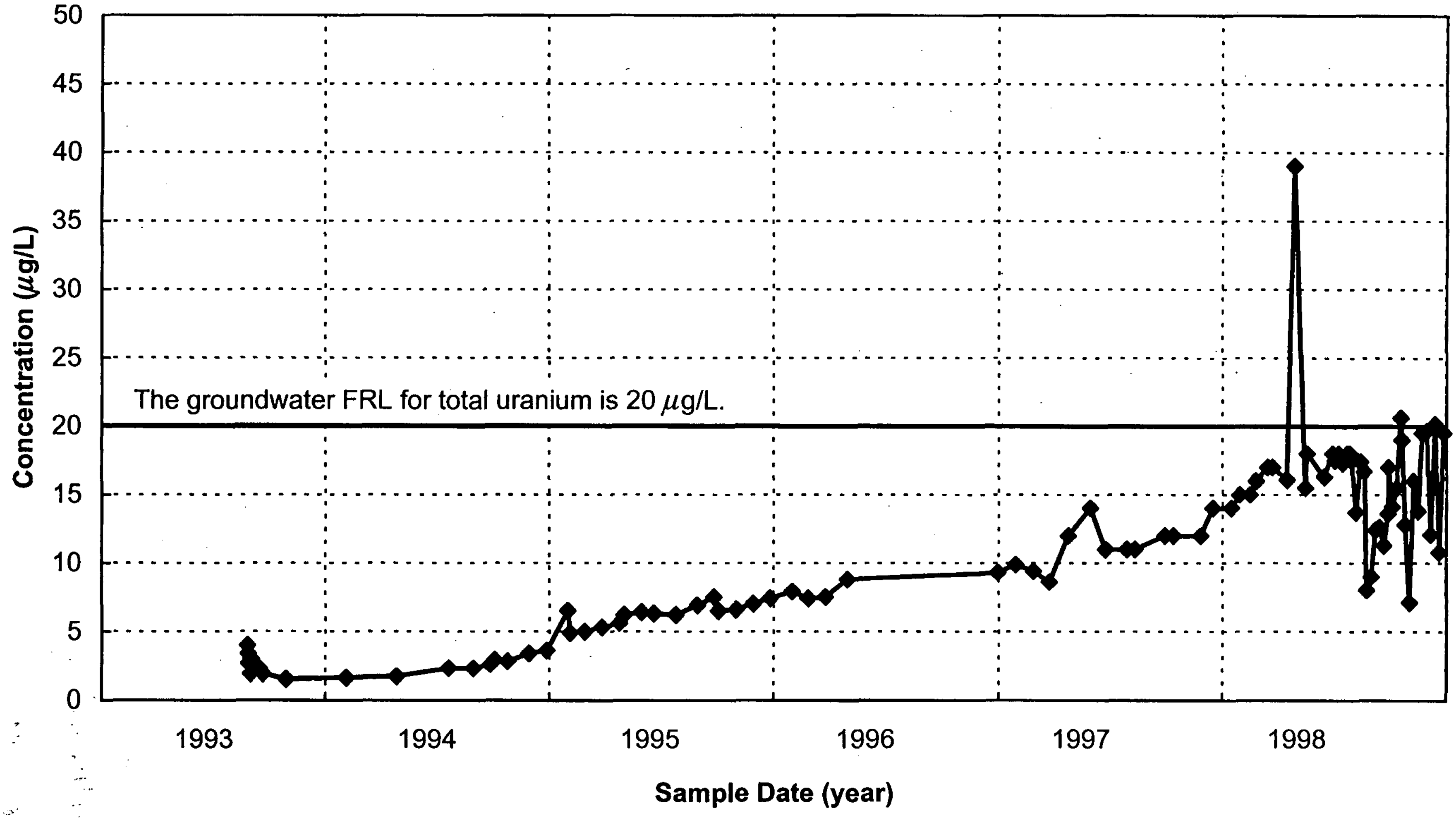

FIGURE A.1-14. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 3926

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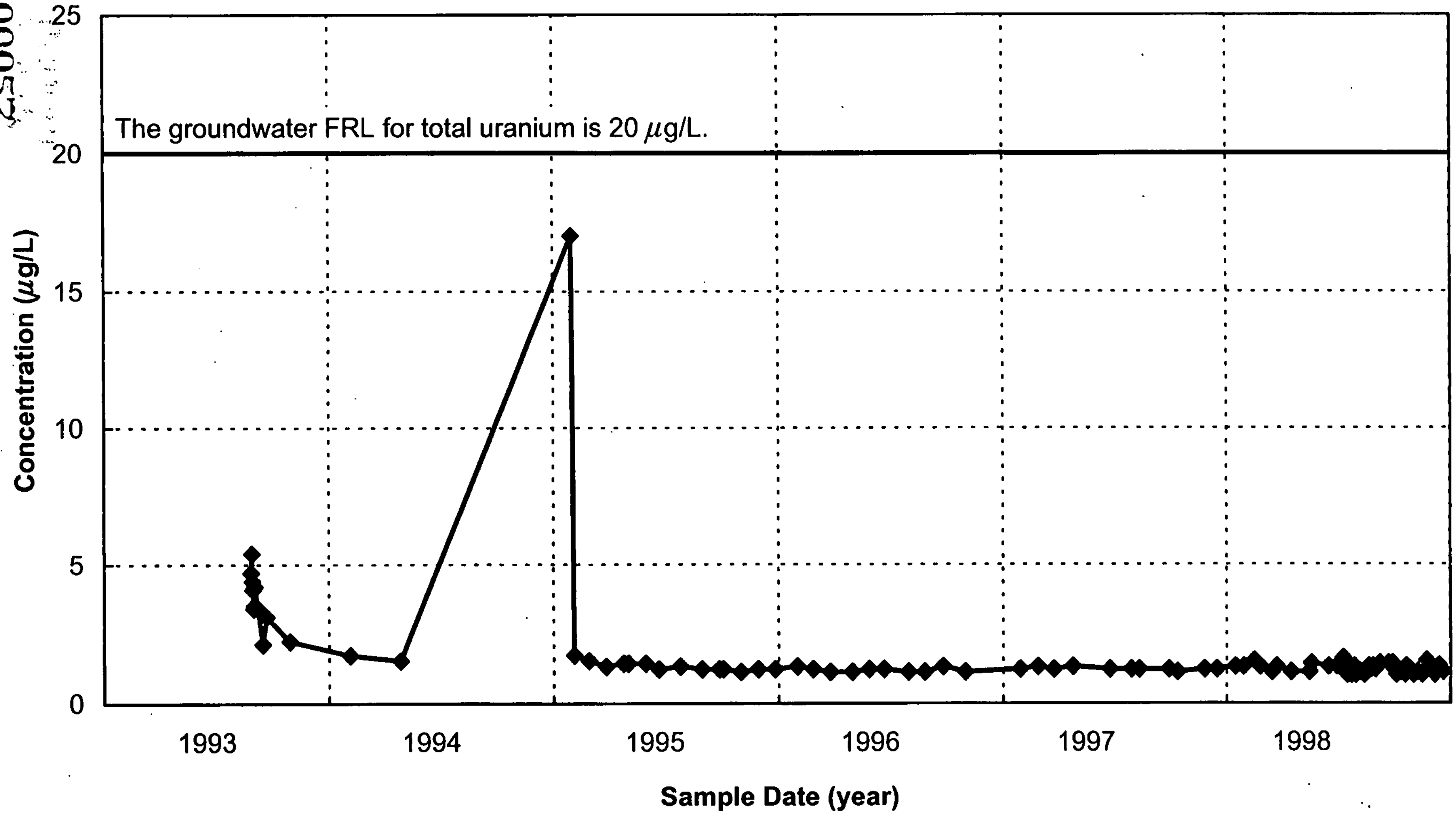

FIGURE A.1-15. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 3927

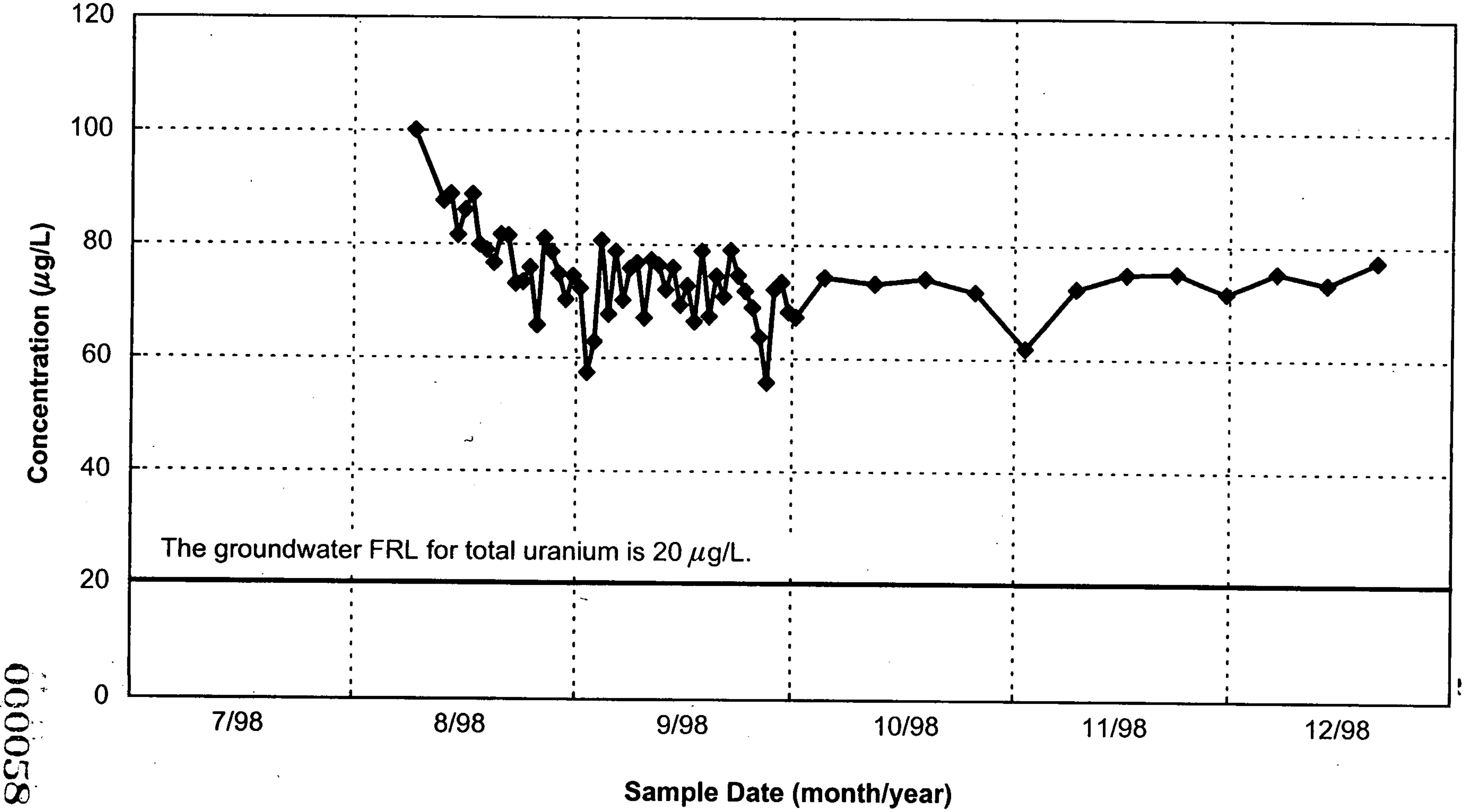

FIGURE A.1-16. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 32308

Modeled Concentration = 27.8 μg/L

Developed Concentration = 123 μg/L

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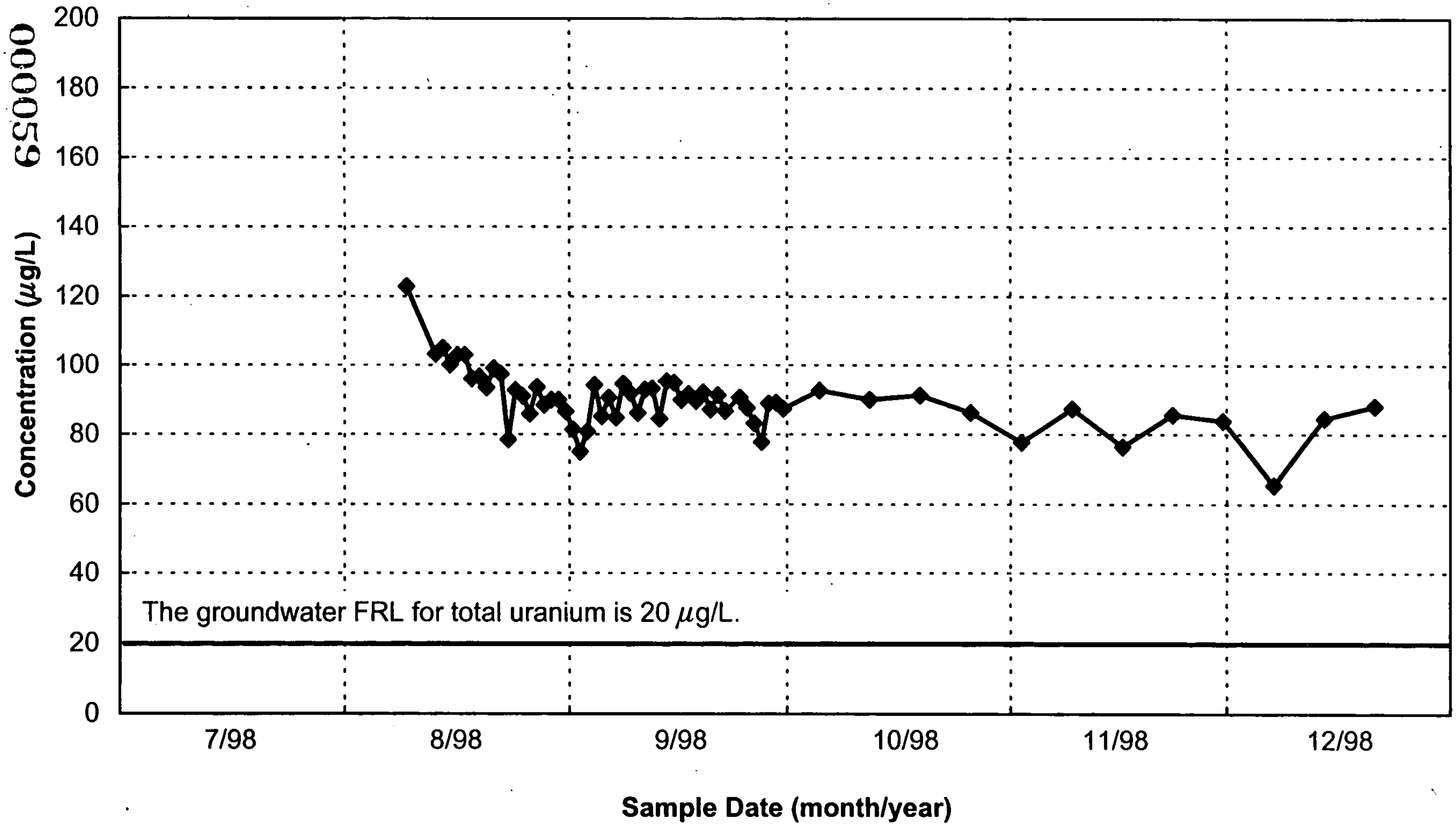

FIGURE A.1-17. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 32309

Modeled Concentration = 45.6 µg/L

Developed Concentration = 143 µg/L

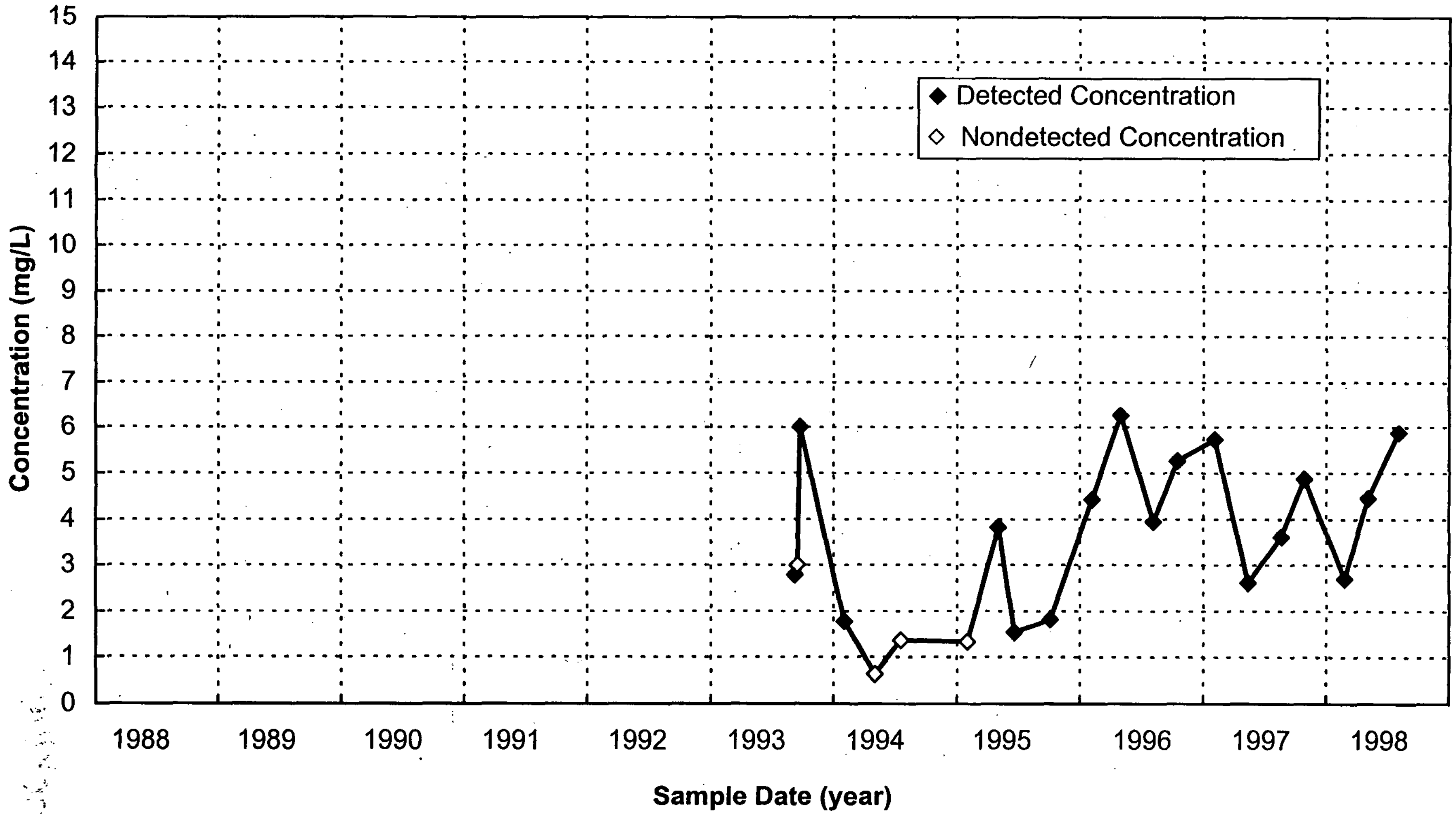

FIGURE A.1-18. POTASSIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2625

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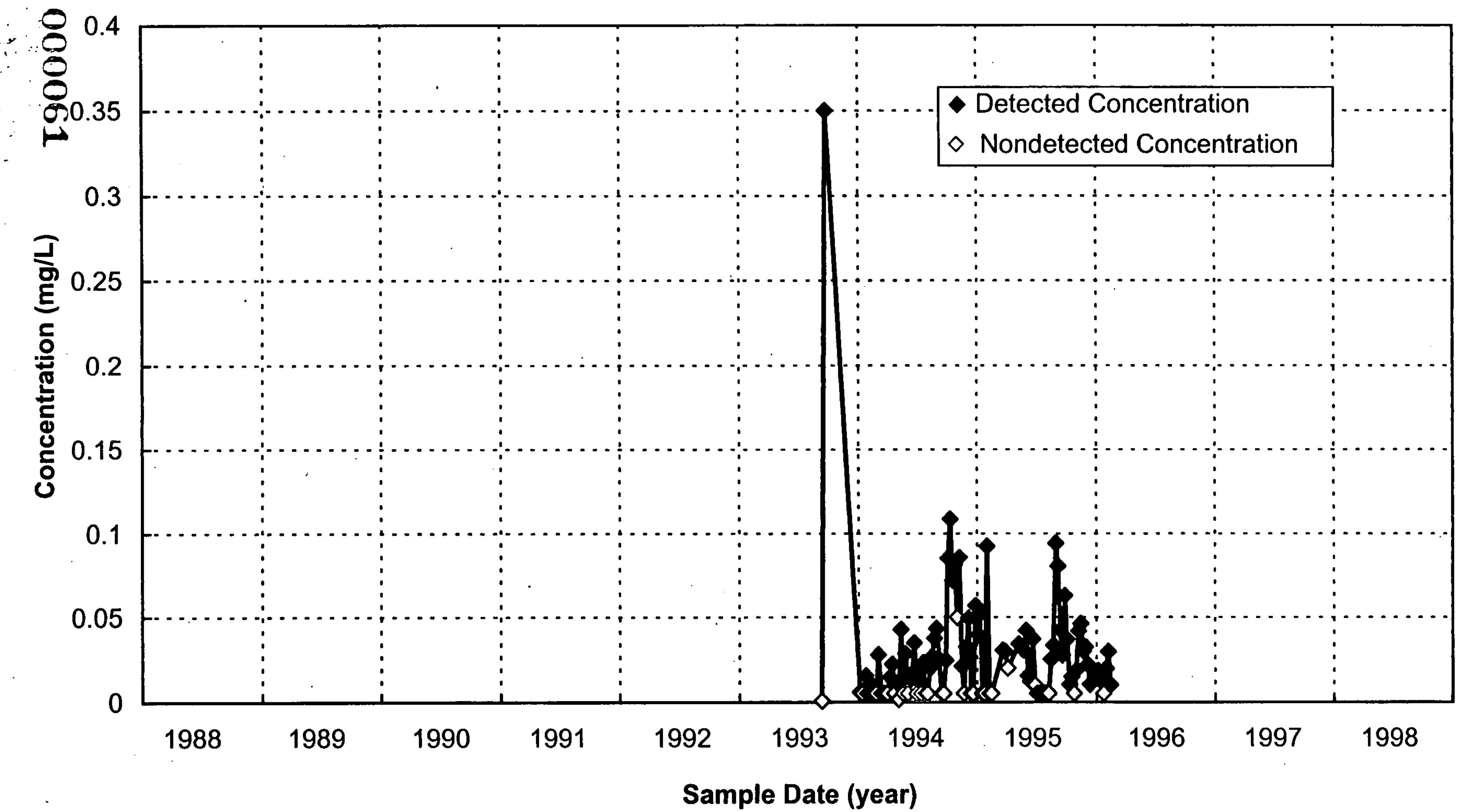

FIGURE A.1-19. ARSENIC CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2548

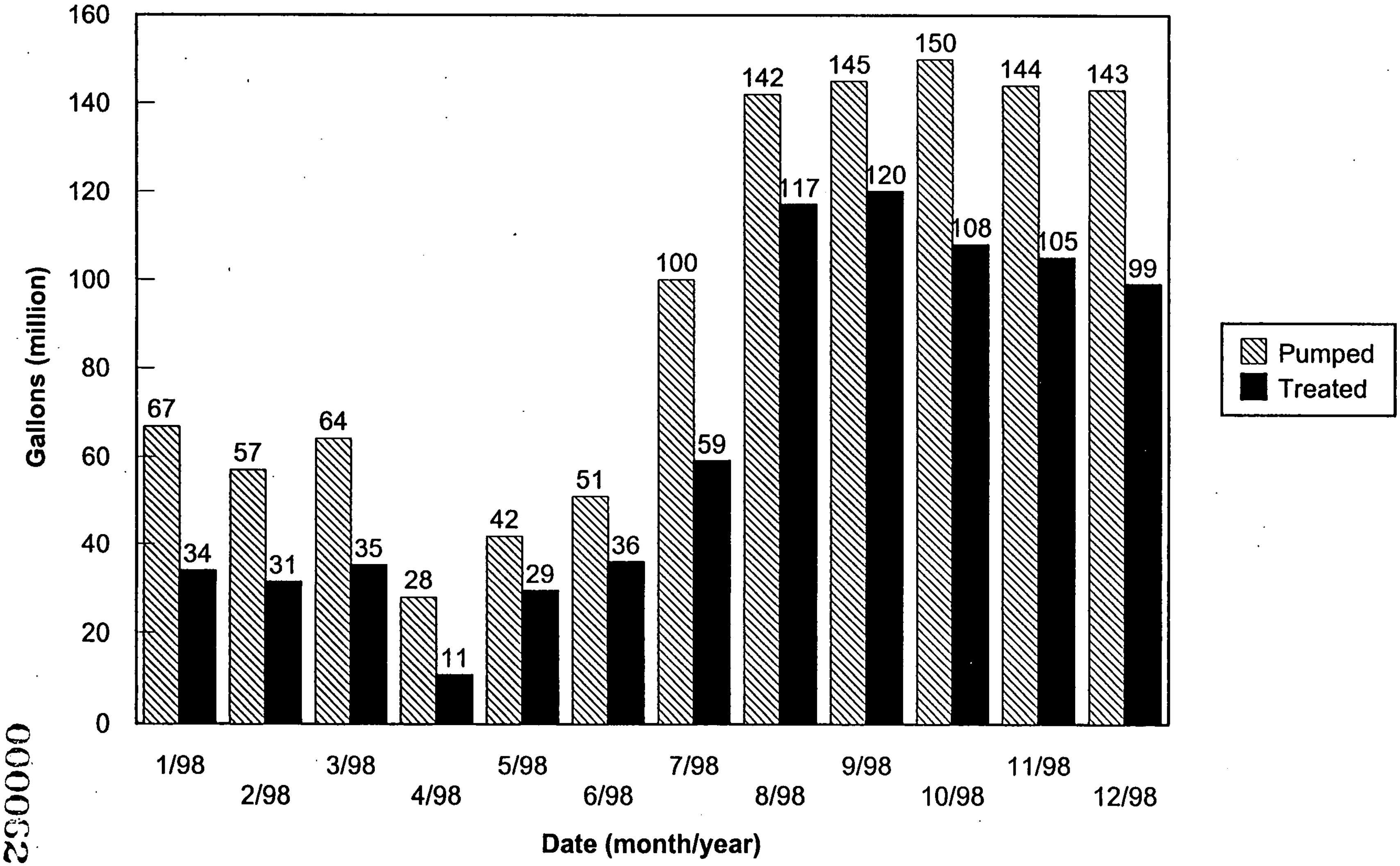

FIGURE A.1-20. TOTAL GROUNDWATER PUMPED VS. GROUNDWATER TREATED FOR 1998

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Attachment A.2

ATTACHMENT A.2

ASSESSMENT OF TOTAL URANIUM RESULTS

ATTACHMENT A.2

Tables A.2-1 and A.2-2 list the monitoring wells and extraction wells, respectively, where total uranium concentrations exceeded the 20 μg/L FRL during 1998. Included in the table are statistical summaries for total uranium concentrations at each well and a calculated statistical trend for the data. Monitoring well locations are shown in Figure A.2-1 and listed in Table A.2-3 with the area designations from the map in Figure A.2-1.

All the monitoring wells presented in Table A.2-1 with confirmed total uranium FRL exceedances for 1998 lie within the 10-year, uranium-based restoration footprint.

Total uranium concentrations are contoured on the maps in Figures A.2-2 through A.2-5, which depict the maximum total uranium plume for each quarter's data. Groundwater data collected with a Geoprobe® for the re-injection demonstration were incorporated into the maps. Groundwater data were collected via Geoprobe® prior to start-up of the South Field (Phase I) Extraction Module and prior to start-up of the Re-Injection Demonstration Module. Geoprobe® data collected in December 1998 and January 1999 will be presented in the 1999 Integrated Site Environmental Report. Data from the second and fourth quarters were used to update the waste storage area and Plant 6 area plume maps (refer to Figures A.2-2 and A.2-5, respectively).

A comparison of the four figures shows that the interpretation of the total uranium plume in the South Field and South Plume changed somewhat in shape and concentration in 1998. As detailed below, groundwater data collected with the Geoprobe® have increased the accuracy of the total uranium concentration contours.

- From the first to the second quarter of 1998, the total uranium plume interpretation changed in the vicinity of Extraction Wells 31565 and 31566, and Monitoring Well 21033. The plume configuration in the vicinity of the South Field shown in the first quarter 1998 map (Figure A.2-2) was based on Kriged groundwater results because the data were too sparse to achieve an accurate contour. The contours were redrawn to more accurately reflect the known maximum total uranium concentrations in this area. Since the second quarter of 1998, monitored uranium concentrations in this area have not changed significantly (refer to Figure A.2-3 through A.2-5).

- During the second quarter of 1998, our interpretation of the shape of the plume changed and the size decreased in the area immediately south of the inactive flyash pile. Data collected during the remedial investigation, and during the installation and subsequent operation of the South Field (Phase I) extraction wells indicated a narrow east-west trending zone located just south of the inactive flyash pile area where total uranium concentrations were below 20 μg/L.

- The concentration of the plume increased just south of Monitoring Well 3069 (along Willey Road) based on data collected via Geoprobe® at location 12370 as part of the Re-Injection Demonstration, which revealed a total uranium concentration of 131 μg/L. In addition, during April 1998, Integrated Environmental Monitoring Plan (IEMP) monitoring data collected at Extraction Wells 3925 and 3926 indicated total uranium concentrations of 84 and 39 μg/L, respectively. These concentrations are considered to be inaccurate when compared with concurrent operational data collected from the same two wells in April and reported in the Integrated Environmental Monitoring Status Report for Second Quarter 1998 (DOE 1998b). Operational sampling of these same two wells in April showed total uranium concentrations of 32.6 and 16.1 μg/L, respectively. The suspect IEMP April data from these two extraction wells are posted on the map, but the contours have not been adjusted at these two well locations (refer to Figure A.2-3).

During the second quarter of 1998, additional uranium profile data were collected using a Geoprobe® at seven locations (12367A, 12368A, 12369A, 12370A, 12371A, 12372A, and 12373A) prior to the start-up of the South Field (Phase I) Extraction Module on July 13, 1998. The data were used to create two cross-sections, A-A' and B-B'. Cross-Section A-A', shown in Figure A.2-6, consists of five locations, one location downgradient of each re-injection well. This cross-section will serve as the "benchmark" for the plume shape in front of each re-injection well prior to the start of the active remediation in this area. At the end of the one-year Re-Injection Demonstration, Geoprobe® samples will be collected from the same five locations to determine the effect that one year of active pumping and re-injection in this area has had on the plume. Cross-Section B-B', shown in Figure A.2-7, consists of three locations, immediately east, west, and downgradient of Re-Injection Well 22109. Re-Injection Well 22109 is located in an area of the total uranium plume that has total uranium concentrations over 400 μg/L. This cross-section will serve as a benchmark for the plume's shape around Re-Injection Well 22109 prior to the start of the active remediation in this area. These three locations will be re-sampled using the Geoprobe® on a quarterly basis during the Re-Injection Demonstration to determine what effect re-injection and pumping is having on the plume. The next round of Geoprobe® sampling at these three locations started in December of 1998 and was completed in January of 1999, and will be presented in the Integrated Environmental Monitoring Status Report for First Quarter 1999.

During the third quarter of 1998, the total uranium plume map shown in Figure A.2-4 was revised in the South Field area around Extraction Well 31561 and Monitoring Wells 2049 and 2385, and in the South Plume area around Extraction Well 3926. The plume was re-contoured in the South Field area to honor higher total uranium values than those presented in the Integrated Environmental Monitoring Status Report for Second Quarter 1998. The change to the South Plume area was a result of the plume being drawn toward Extraction Well 3926 which had a third quarter total uranium concentration of 18 μg/L.

In support of the Re-Injection Demonstration, additional total uranium plume profile data were collected using a Geoprobe® at locations 123769B, 12372B, and 12373B during the third quarter of 1998. Cross-Section C-C', shown in Figure A.2-8, consists of data collected at three locations, immediately east, west, and south (downgradient) of Re-Injection Well 22109 before starting re-injection. Re-Injection Well 22109 is located in an area of the total uranium plume that has total uranium concentrations over 400 μg/L. These three locations will be re-sampled using the Geoprobe® on a quarterly basis during the Re-Injection Demonstration to determine what effect re-injection and pumping is having on the plume. The third round of Geoprobe® sampling at these three locations was initiated in late December 1998 and continued through early January 1999; these data will be reported in the Integrated Environmental Monitoring Status Report for First Quarter 1999.

As indicated in Tables A.2-1 and A.2-2 and Figure A.2-9, 12 wells with total uranium FRL exceedances had Up, Significant trends based on the Mann-Kendall test for trend. All wells with exceedances and Up, Significant trends were within the 10-year, uranium-based restoration footprint:

- Monitoring Well 2900 is located south of the four South Plume extraction wells and lies outside the administrative boundary presented in the Feasibility Study Report for Operable Unit 5 (DOE 1995a). The total uranium concentration was 20.3 µg/L in fourth quarter 1998, whereas the first quarter 1999 concentration was 9.7 µg/L.

- Monitoring Wells 2398 and 3069 are located near the northeastern lobe of the plume. The Up, Significant trends in both wells were reported in the 1997 Integrated Site Environmental Report and indicate a continued slow, eastward expansion of the plume. However, these two wells are within the capture zone and flow in the area of these wells has been reversed toward the South Field extraction wells.

- Monitoring Wells 2386 and 2397 are located on the east side of the South Field plume. As in 1997, when these wells were also trended as Up, Significant, the 1998 Up, Significant trend indicates a continued slow eastward expansion of the plume as a result of the regional groundwater flow in this area. However, these two wells are within the capture zone and flow in the area of these wells has been altered such that it is now toward the South Field extraction wells.

- Monitoring Well 2648 showed an increase in total uranium concentration from 48.4 μg/L in fourth quarter 1997 to 57.3 μg/L in fourth quarter 1998. It was determined in early 1999 that surface water runoff was periodically entering the well and may have contributed to the increased total uranium concentration. Corrective actions were taken and will be discussed in upcoming IEMP reports.

- Extraction Wells 3925 and 3926 are South Plume extraction wells; the Up, Significant trends indicate that contamination was being drawn to the wells from the higher concentrations in the central portion of the plume to the north. As Up, Significant trends were calculated for Monitoring Wells 2544 and 3095, which are situated north of Extraction Well 3925, this may indeed be the case. Although it was anticipated that operation of the South Plume Optimization extraction wells would diminish total uranium concentrations in Extraction Well 3925, this has not happened yet. However, the total uranium concentration of approximately 40 μg/L in fourth quarter 1998 is not much higher than the total uranium concentration of 33.0 μg/L detected in this well during the fourth quarter of 1997. In addition, the concentration at Extraction Well 3926 for fourth quarter 1998 hovered a fraction over the 20 μg/L FRL compared to approximately 15 μg/L in the fourth quarter of 1997.

- Extraction Wells 31563 and 31566 are South Field extraction wells; the Up, Significant trend indicates that contamination was being drawn to the wells. The graphs for the wells are provided in Attachment 1, Figures A.1-12 and A.1-15, respectively and the highest total uranium concentrations were 65.5 and 48.4 μg/L, respectively. The trend in Extraction Well 31566 will be watched closely in 1999 since this well was shut down in August 1998 because of lower than expected uranium concentrations and water yields.

As remediation progresses, it will become increasingly important to follow Down, Significant trends as well. In 1998, nine monitoring wells with total uranium FRL exceedances displayed Down, Significant trends (refer to Table A.2-1). These wells are located in the South Plume and South Field areas (Figure A.2-9), where active groundwater restoration pumping began in 1998. Down, Significant trends were also observed at 11 extraction wells (Table A.2-2) in the South Field and South Plume areas (Figure A.2-9). Trending of uranium concentrations in monitoring wells and extraction wells will continue as remediation progresses. These trends will be useful in tracking the progress of the groundwater restoration as well as assisting in identifying areas of the aquifer remediation where operational changes may be required.

Figures A.2-10 through A.2-134 present total uranium concentration versus time plots for all IEMP monitoring wells. Only unfiltered, detected results were plotted.

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TABLE A.2-1

SUMMARY STATISTICS AND TREND ANALYSIS OF MONITORING WELLS FOR TOTAL URANIUM WITH 1998 RESULTS ABOVE FINAL REMEDIATION LEVEL

Well	No. of Samples Since 1988[a,b,c]	Minimum[a,b,c,d] (μg/L)	Maximum[a,b,c,d] (μg/L)	Average[a,b,c,d] (μg/L)	Standard Deviation[a,b,c,d] (μg/L)	Trend[a,b,c,d]
13	13	29	64	44	11	No Significant Trend
2008	14	5	25.4	18	5	No Significant Trend
2009	10	13.6	39.2	23.8	7.44	No Significant Trend
2015	37	1.3	290	150	43	Down, Significant
2033	6	3.3	89.732	55	33	No Significant Trend
2045	18	51.4	462	271	94.5	Down, Significant
2046	17	165	907	429	251	Down, Significant
2049	16	3	175	80	50	Up, Marginal
2054	11	2.84	58.8	23.1	15.6	No Significant Trend
2060 (12)	43	8.4	332	79	75	Down, Significant
2095	29	27	208	140	41	No Significant Trend
21033	7	24.8	43.2	32.5	7.09	No Significant Trend
2106	33	6.059	88.6	50.7	17.6	Down, Significant
2166	17	48	95.1	70	12	Up, Marginal
2385	10	76.648	242	146	57.4	No Significant Trend
2386	10	6.67	43.431	23.9	12.1	**Up, Significant**
2387	10	68.7	492	189	138	Down, Significant
2390	9	79.296	163	102	26.7	Down, Marginal
2397	11	212	500.937	328	74.5	**Up, Significant**
2398	27	0.663	35.697	15.7	10.0	**Up, Significant**
2544	22	0.4	521	30	100	**Up, Significant**
2545	24	7.6	106	33	22	Down, Significant
2550	22	59	120	78	15	Down, Significant
2551	20	7.5	90	31	18	No Significant Trend
2552	21	12	25	19	3.8	Down, Significant
2648	10	9.61	57.3	27.2	15.0	**Up, Significant**
2821	5	25.9	32.6	29.0	2.77	No Significant Trend
2900	23	0.4	20.271	5	4	**Up, Significant**
3069	35	0.5	333.716	104	93	**Up, Significant**
3095	30	2	94	15	17	**Up, Significant**
3125	27	19.3	82	51	16	No Significant Trend
3390	8	81.7	110	93	11	No Significant Trend

[a]Summary statistics and Mann-Kendall test for trend are based on unfiltered samples from the Operable Unit 5 remedial investigation/feasibility study data set (1988 through 1993) and 1994 through 1998 groundwater data.
[b]If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the number of samples, and the sample with the maximum concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation [SD]) and Mann-Kendall test for trend.
[c]Rejected data qualified with either a R or Z were not included in this count, the summary statistics, or Mann-Kendall test for trend.
[d]For results where the concentrations are below the detection limit, the results used in the summary statistics and Mann-Kendall test for trend are each set at half the detection limit.

TABLE A.2-2

SUMMARY STATISTICS AND TREND ANALYSIS OF EXTRACTION WELLS WITH 1998 RESULTS ABOVE FINAL REMEDIATION LEVEL

Well	No. of Samples Since 1988[a,b]	Minimum[a,b,c] (μg/L)	Maximum[a,b,c] (μg/L)	Average[a,b,c] (μg/L)	Standard Deviation[a,b,c] (μg/L)	Trend[a,b,c]
South Plume Module (August 27, 1993 through December 31, 1998)						
3924	90	29.9	180	52	24	Down, Significant
3925	96	0.5	84	30	12	Up, Significant
3926	94	1.5	39	11	6.5	Up, Significant
3927	88	1	17	1.7	2	Down, Significant
South Plume Optimization Module (August 9, 1998 through December 31, 1998)						
32308	63	55.8	100.1	74.3	7.35	Down, Significant
32309	61	65.4	122.8	89.9	8.40	Down, Significant
South Field (Phase I) Extraction Module (July 13, 1998 through December 31, 1998)						
31550	48	70	127.9	99	15	Down, Significant
31560	48	131	182.8	152	12.3	Down, Significant
31561	48	29.6	114[d]	53.6	11.2	Down, Significant
31562	48	46.1[e]	166.5	127	19.3	Down, Significant
31563	46	27.3	65.4	46.5	7.48	Up, Significant
31564	50	7.8	16.8	13	1.8	Down, Significant
31565	50	7.2	16.5	11	2.2	No Significant
31566	42	2.6	48.4	8.8	10	Up, Significant
31567	49	33.4	67	45	9.3	Down, Significant
32276	50	169.1	290.2	236.4	31.91	Down, Significant

[a]If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the number of samples, and the sample with the maximum concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation [SD]) and Mann-Kendall test for trend.
[b]Rejected data qualified with either a R or Z were not included in this count, the summary statistics, or Mann-Kendall test for trend.
[c]For results where the concentrations are below the detection limit, the results used in the summary statistics and Mann-Kendall test for trend are each set at half the detection limit.
[d]This result (sampled 8/31/98) appears to be an outlier. It is suspected that the sample for this well was switched with the sample for Extraction Well 31562 (refer to Figures A.1-4 and A.1-5).
[e]This result (sampled 8/31/98) appears to be an outlier. It is suspected that the sample for this well was switched with the sample for Extraction Well 31561 (refer to Figures A.1-4 and A.1-5).

000070

TABLE A.2-3

LISTING OF IEMP GROUNDWATER WELLS

Well ID	Well Location[a]	Monitoring Activity
13	D,E,F	Private Well Monitoring
14	NA[b]	Private Well Monitoring
67	H	KC-2 Warehouse
2002	D	South Plume Module
2008	A	Waste Storage Area Module
2009	A	Waste Storage Area Module
2014	B	South Field Extraction System Module
2015	D,E	South Plume Module Injection Demonstration Module
2017	D,E	South Plume Module Injection Demonstration Module
2027	A	Waste Storage Area Module
2032	A	Waste Storage Area Module
2033	A	Waste Storage Area Module
2034	A	Waste Storage Area Module
2045	B	South Field Extraction System Module
2046	B	South Field Extraction System Module
2049	B	South Field Extraction System Module
2051	F	RCRA Boundary Monitoring
2054	C	Plant 6 Area Module
2060 (12)	D,E	South Plume Module Injection Demonstration Module
2068	B	South Field/ Extraction System Module
2070	E,F	RCRA Boundary Monitoring Injection Demonstration Module
2093	D	South Plume Module
2095	D	South Plume Module
2106	D,E,F	South Plume Module RCRA Boundary Monitoring Injection Demonstration Module
2118	C	Plant 6 Area Module
2125	D	South Plume Module
2128	D	South Plume Module
2166	D,E,F	South Plume Modules RCRA Boundary Monitoring Injection Demonstration Module
2385	B	South Field Extraction System Module
2386	B	South Field Extraction System Module
2387	B	South Field Extraction System Module
2389	C	Plant 6 Area Module
2390	B	South Field Extraction System Module
2396	D	South Plume Module
2397	B	South Field Extraction System Module

TABLE A.2-3
(Continued)

Well ID	Well Location[a]	Monitoring Activity
2398	D,E,F	South Plume Module RCRA Boundary Monitoring Injection Demonstration Module
2402	B	South Field Extraction System Module
2417	F	RCRA Boundary Monitoring
2424	F	RCRA Boundary Monitoring
2426	F	RCRA Boundary Monitoring
2429	F	RCRA Boundary Monitoring
2430	F	RCRA Boundary Monitoring
2431	F	RCRA Boundary Monitoring
2432	F	RCRA Boundary Monitoring
2434	D,E,F	South Plume Module RCRA Boundary Monitoring Injection Demonstration Module
2544	D	South Plume Module
2545	D	South Plume Module
2546	D	South Plume Module
2548	D	South Plume Module
2550	D	South Plume Module
2551	D	South Plume Module
2552	D	South Plume Module
2553	D	South Plume Module
2624	D	South Plume Module
2625	D	South Plume Module
2636	D	South Plume Module
2648	A	Waste Storage Area Module
2649	A	Waste Storage Area Module
2733	F	RCRA Boundary Monitoring
2821	A	Waste Storage Area Module
2880	D	South Plume Module
2881	D	South Plume Module
2897	D	South Plume Module
2898	D	South Plume Module
2899	D	South Plume Module
2900	D	South Plume Module
3009	A	Waste Storage Area Module
3014	B	South Field Module
3015	D,E	South Plume Module Injection Demonstration
3027	A	Waste Storage Area Module
3032	A	Waste Storage Area Module
3034	A	Waste Storage Area Module
3045	B	South Field Extraction System Module
3046	B	South Field Extraction Module

000072

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TABLE A.2-3
(Continued)

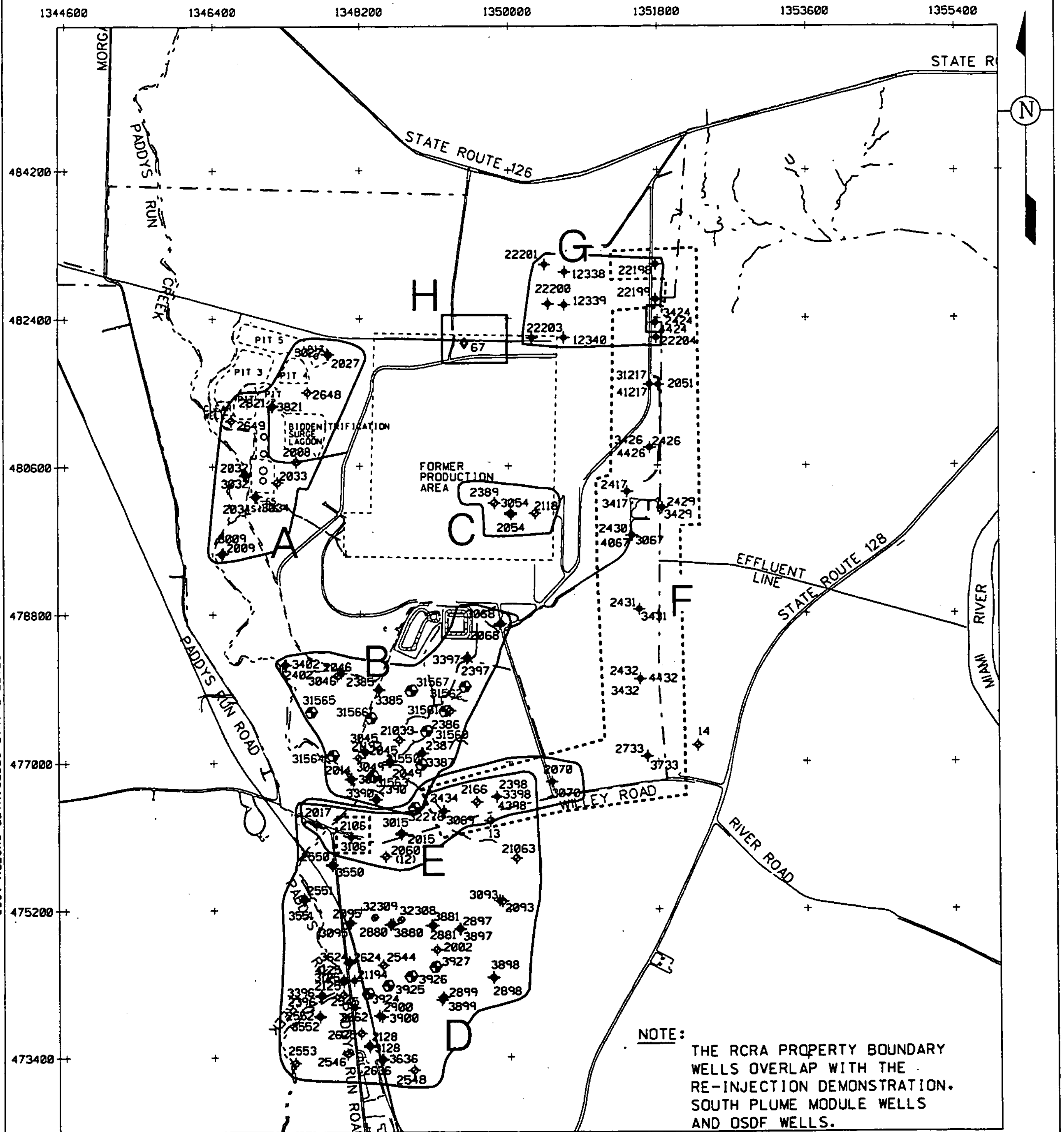
Well ID	Well Location[a]	Monitoring Activity
3049	B	South Field Extraction System Module
3054	C	Plant 6 Area Module
3062	D	South Plume Module
3067	F	RCRA Boundary Monitoring
3068	B	South Field Extraction System Module
3069	D,E,F	South Plume Module RCRA Boundary Monitoring Injection Demonstration Module
3070	E,F	RCRA Boundary Monitoring Injection Demonstration Module
3093	D	South Plume Module
3095	D	South Plume Module
3106	D,E,F	South Plume Module RCRA Boundary Monitoring Injection Demonstration Module
3125	D	South Plume Module
3128	D	South Plume Module
3385	B	South Field Extraction System Module
3387	B	South Field Extraction System Module
3390	B	South Field Extraction System Module
3396	D	South Plume Module
3397	B	South Field Extraction System Module
3398	D,E,F	South Plume Module RCRA Boundary Monitoring Injection Demonstration Module
3402	B	South Field Extraction System Module
3417	F	RCRA Boundary Monitoring
3424	F	RCRA Boundary Monitoring
3426	F	RCRA Boundary Monitoring
3429	F	RCRA Boundary Monitoring
3431	F	RCRA Boundary Monitoring
3432	F	RCRA Boundary Monitoring
3550	D	South Plume Module
3551	D	South Plume Module
3552	D	South Plume Module
3624	D	South Plume Module
3636	D	South Plume Module
3733	F	RCRA Boundary Monitoring
3821	A	Waste Storage Area Module
3880	D	South Plume Module
3881	D	South Plume Module
3897	D	South Plume Module
3898	D	South Plume Module
3899	D	South Plume Module
3900	D	South Plume Module

TABLE A.2-3
(Continued)

Well ID	Well Location[a]	Monitoring Activity
3924	D	South Plume Module
3925	D	South Plume Module
3926	D	South Plume Module
3927	D	South Plume Module
4067	F	RCRA Boundary Monitoring
4125	D	South Plume Module
4398	D,E,F	South Plume Module RCRA Boundary Monitoring Injection Demonstration Module
4424	F	RCRA Boundary Monitoring
4426	F	RCRA Boundary Monitoring
4432	F	RCRA Boundary Monitoring
21033	B	South Field Extraction System Module
21063	D	South Plume Module
21192	B	South Field Extraction System
21194	D	South Plume Module
22198	F	RCRA Boundary Monitoring
31217	F	RCRA Boundary Monitoring
32308	D	South Plume Optimization Module
32309	D	South Plume Optimization Module
31550	B	South Field Extraction (Phase I) Module
31560	B	South Field Extraction (Phase I) Module
31561	B	South Field Extraction (Phase I) Module
31562	B	South Field Extraction (Phase I) Module
31563	B	South Field Extraction (Phase I) Module
31564	B	South Field Extraction (Phase I) Module
31565	B	South Field Extraction (Phase I) Module
31566	B	South Field Extraction (Phase I) Module
31567	B	South Field Extraction (Phase I) Module
32276	B	South Field Extraction (Phase I) Module
41217	F	RCRA Boundary Monitoring

[a]Well location refers to Figure A.2-1.
[b]NA = not applicable. This well is located near the southeast corner of the FEMP.

000074



LEGEND:

A – WASTE STORAGE AREA
B – SOUTH FIELD EXTRACTION AREA
C – PLANT 6 AREA
D – SOUTH PLUME AREA
E – RE-INJECTION DEMONSTRATION AREA
F – RCRA PROPERTY BOUNDARY WELLS
G – OSDF MONITORING WELLS
H – KC-2 WAREHOUSE WELL

–·–·– FEMP BOUNDARY
✦✧ MONITORING WELL
⊛ EXTRACTION WELL

SCALE
1800 900 0 1800 FEET

v:\5fgp1\dgn\98annual\98an002.dgn

STATE PLANAR COORDINATE SYSTEM 1983

25-MAY-1999

000075

FIGURE A.2-1. IEMP WATER QUALITY MONITORING WELLS AND EXTRACTION WELLS

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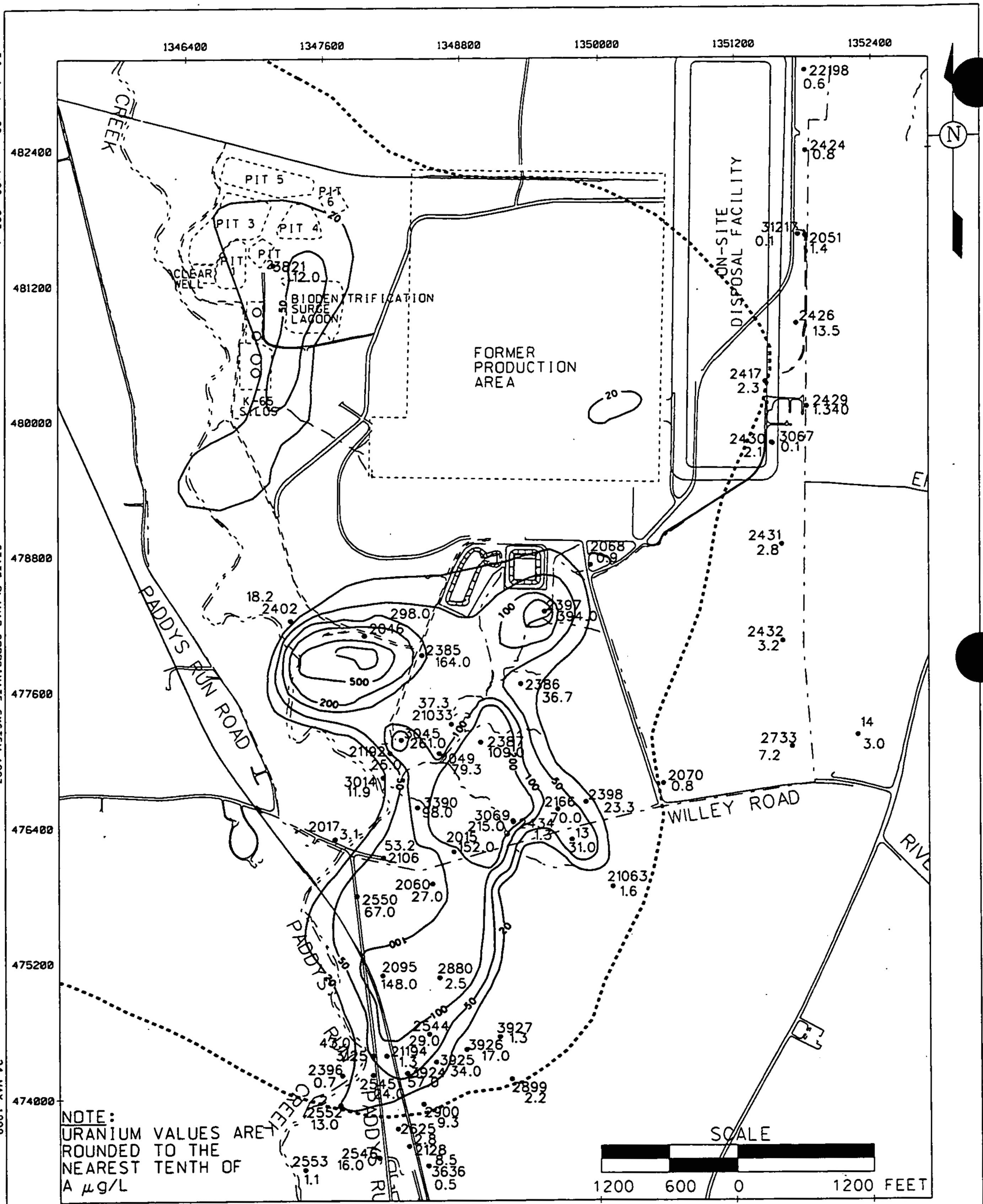
STATE PLANAR COORDINATE SYSTEM 1927

24-MAY-1999



LEGEND:

2553 • MONITORING WELL LOCATION

0.9 MAXIMUM TOTAL URANIUM CONCENTRATION UPDATED THROUGH FIRST QUARTER IN μg/L

— · — · — FEMP BOUNDARY

TOTAL URANIUM CONTOUR IN μg/L

.... 10-YEAR, URANIUM-BASED RESTORATION FOOTPRINT

000076

FIGURE A.2-2. TOTAL URANIUM PLUME MAP, FIRST QUARTER 1998

2272

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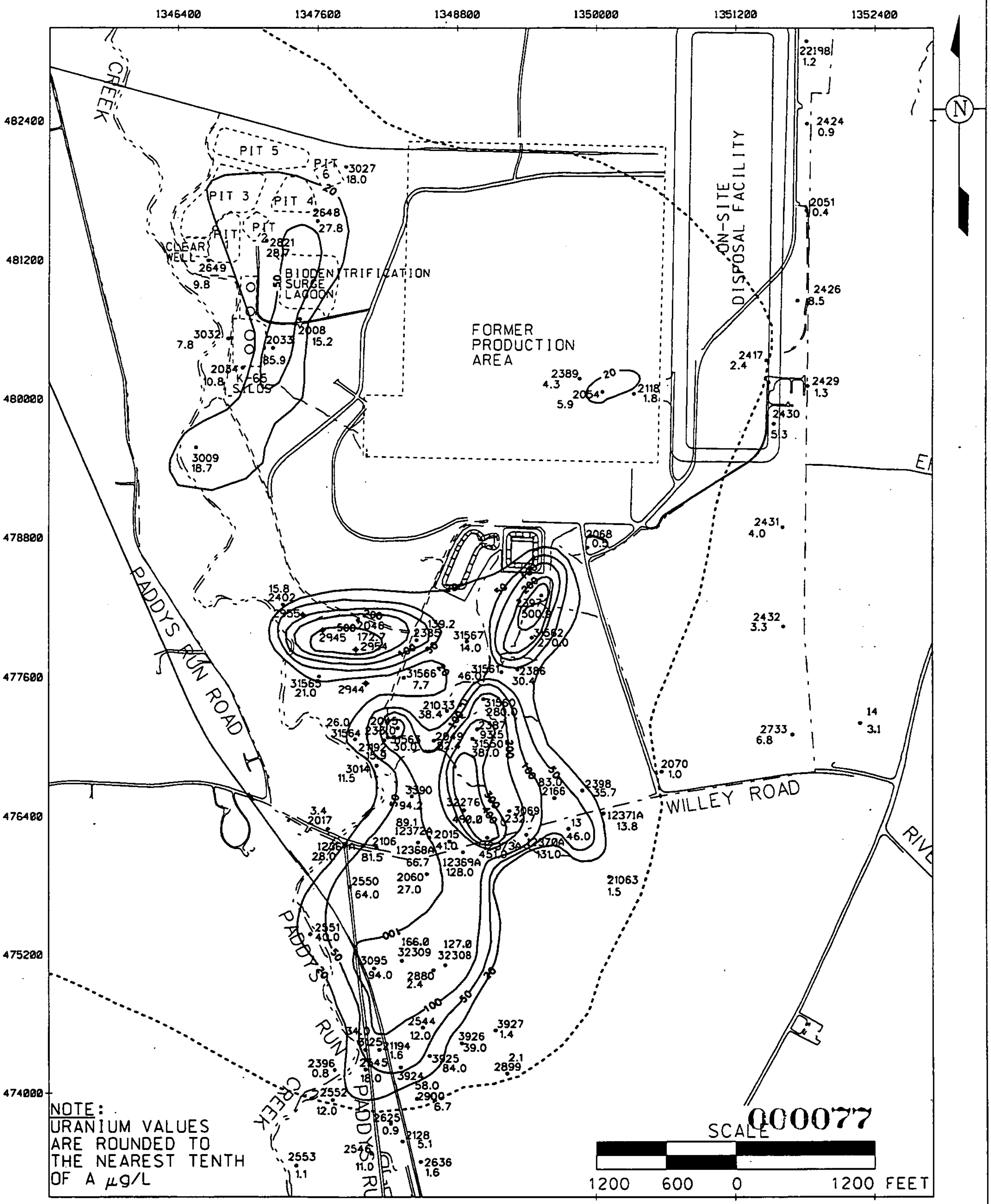
STATE PLANAR COORDINATE SYSTEM 1927

24-MAY-1999



000077

LEGEND:

2553 • MONITORING WELL LOCATION

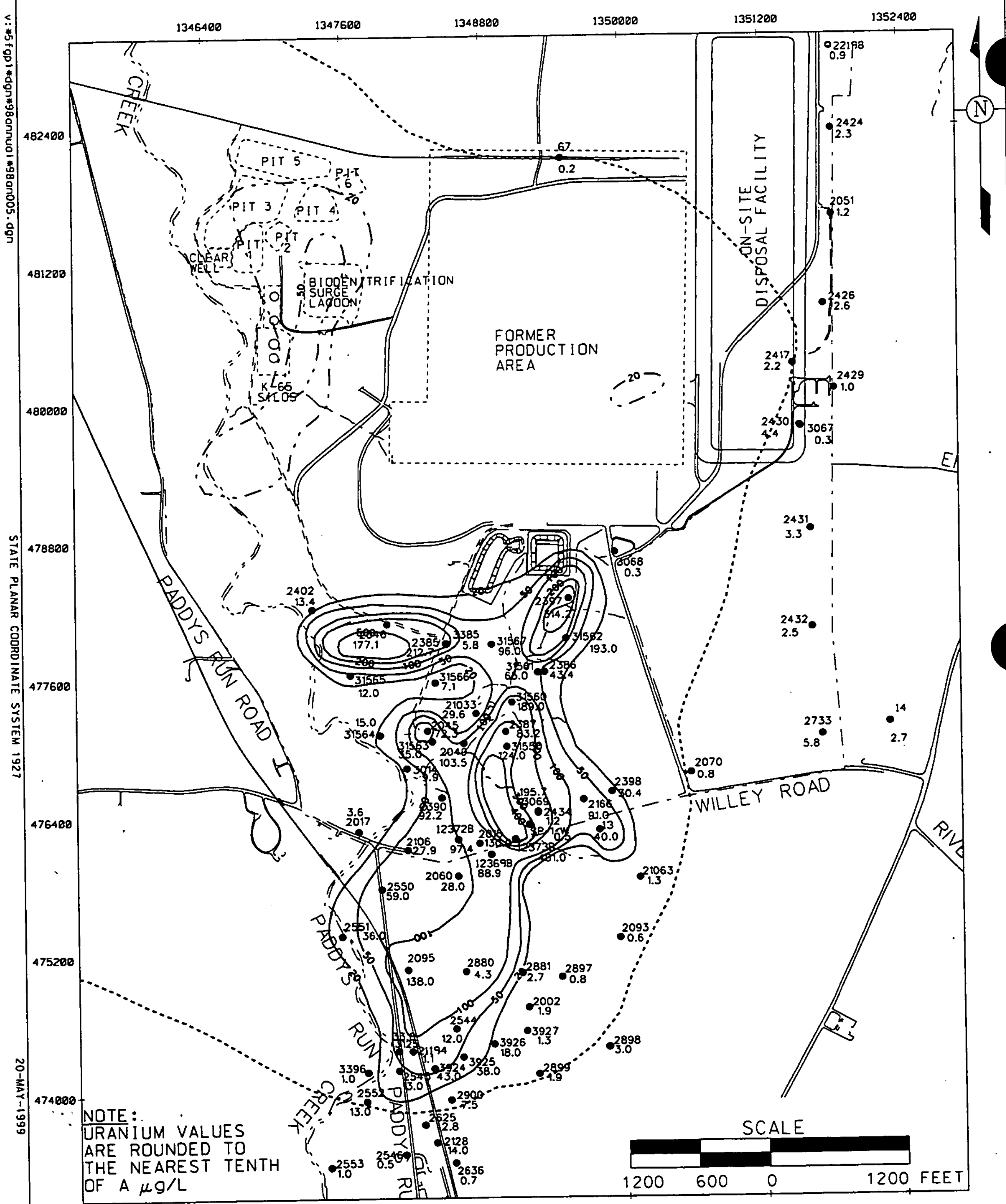
5.1 MAXIMUM TOTAL URANIUM CONCENTRATION UPDATED THROUGH SECOND QUARTER 1998 IN μg/L

— · — · — FEMP BOUNDARY

TOTAL URANIUM CONTOUR IN μg/L

- - - - - - - - 10-YEAR, URANIUM-BASED RESTORATION FOOTPRINT

FIGURE A.2-3. TOTAL URANIUM PLUME MAP, SECOND QUARTER 1998

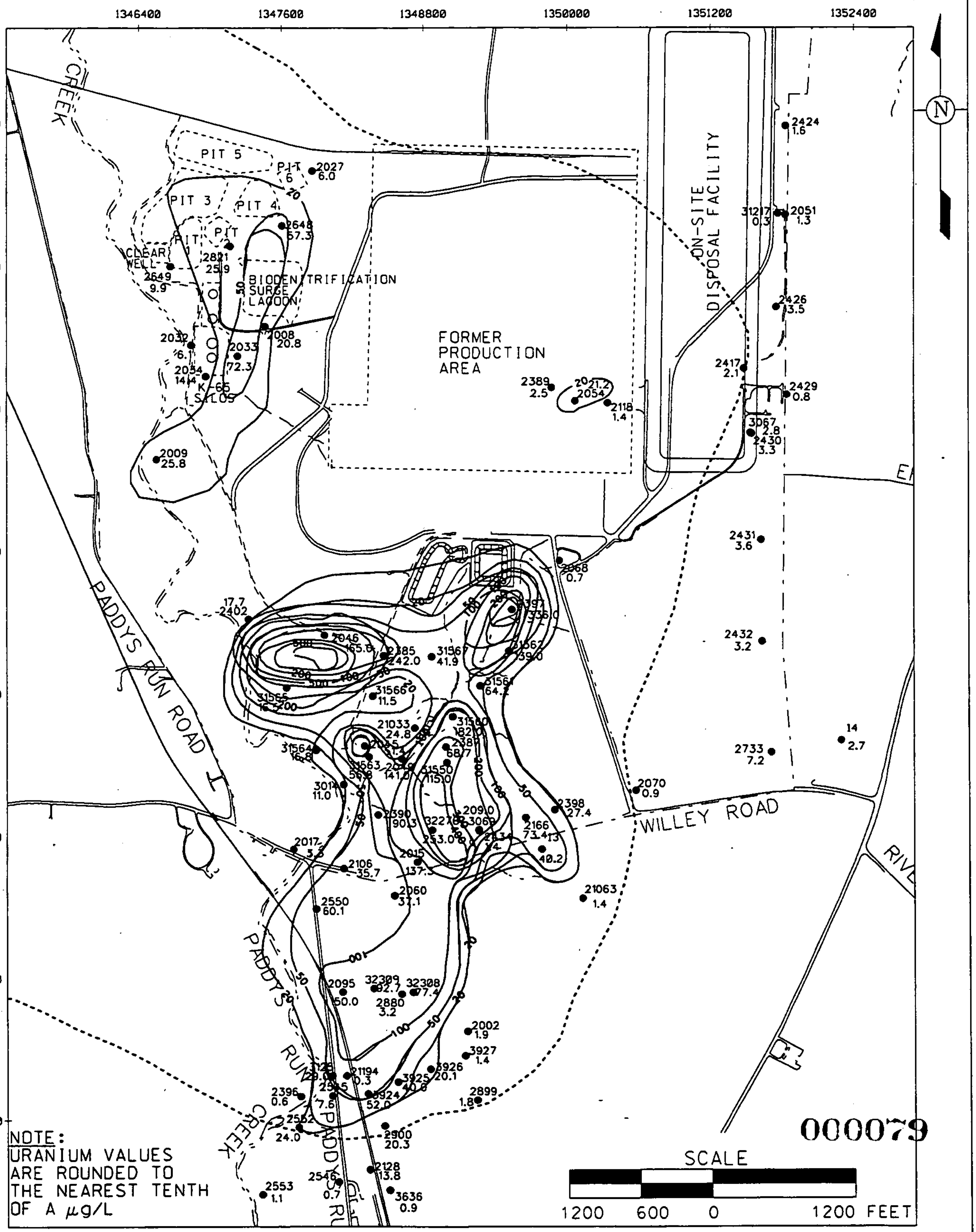


LEGEND:

- 2553● MONITORING WELL LOCATION
- 5.1 MAXIMUM TOTAL URANIUM CONCENTRATION UPDATED THROUGH THIRD QUARTER 1998
- — - - — PLUME SEGMENT FROM SECOND QUARTER STATUS REPORT
- — - — FEMP BOUNDARY
- TOTAL URANIUM CONTOUR IN μg/L
- .... 10-YEAR, URANIUM-BASED RESTORATION FOOTPRINT

000078

FIGURE A.2-4. TOTAL URANIUM PLUME MAP, THIRD QUARTER 1998 v:\5fgp1\dgn\98annual\color\98anplum.dgn



STATE PLANAR COORDINATE SYSTEM 1983

24-MAY-1999

LEGEND:

2553● MONITORING WELL LOCATION

5.1 MAXIMUM TOTAL URANIUM CONCENTRATION UPDATED THROUGH FOURTH QUARTER 1998

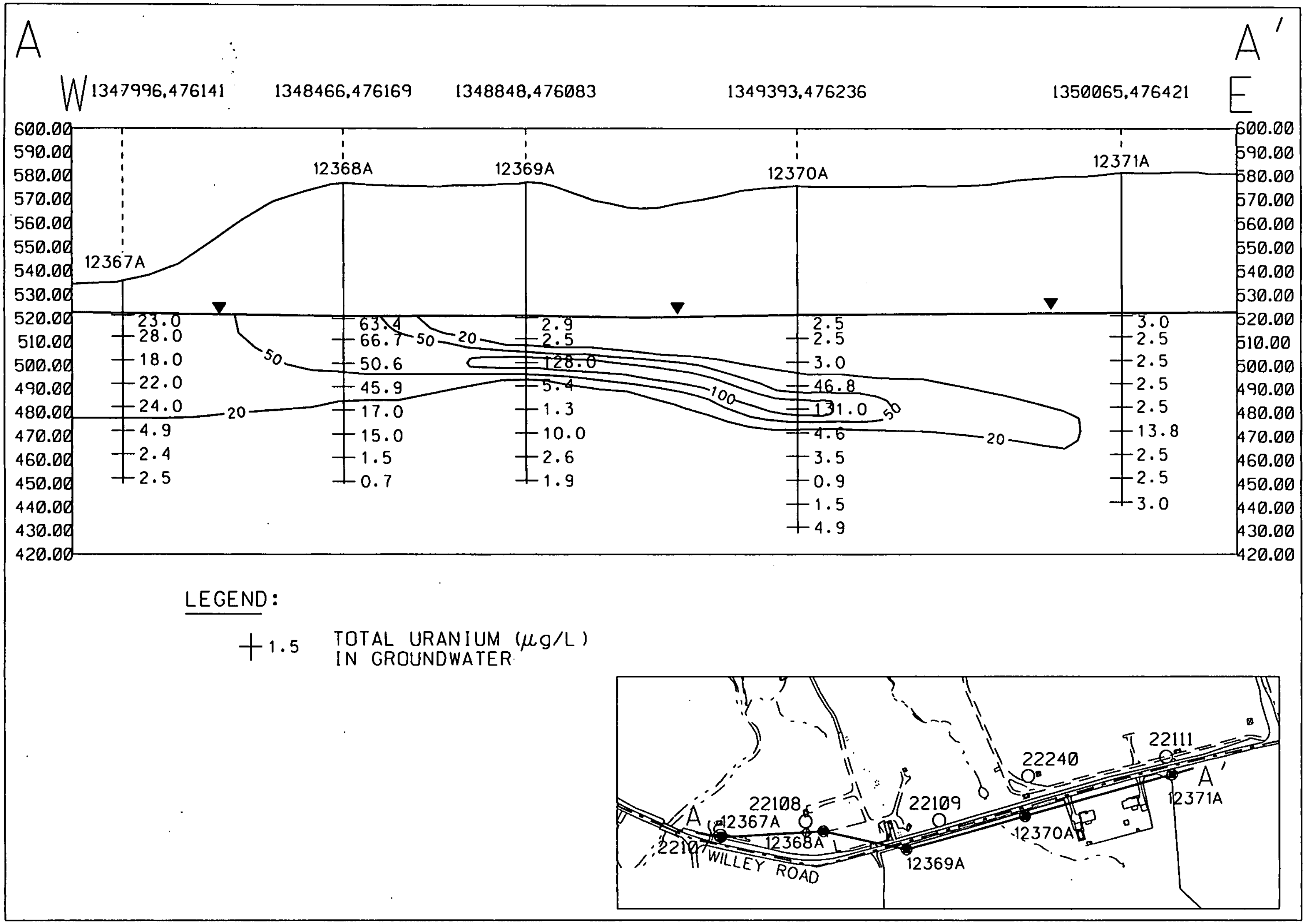
— · — · — FEMP BOUNDARY

TOTAL URANIUM CONTOUR IN µg/L

.... 10-YEAR, URANIUM-BASED RESTORATION FOOTPRINT

FIGURE A.2-5. TOTAL URANIUM PLUME MAP, FOURTH QUARTER 1998

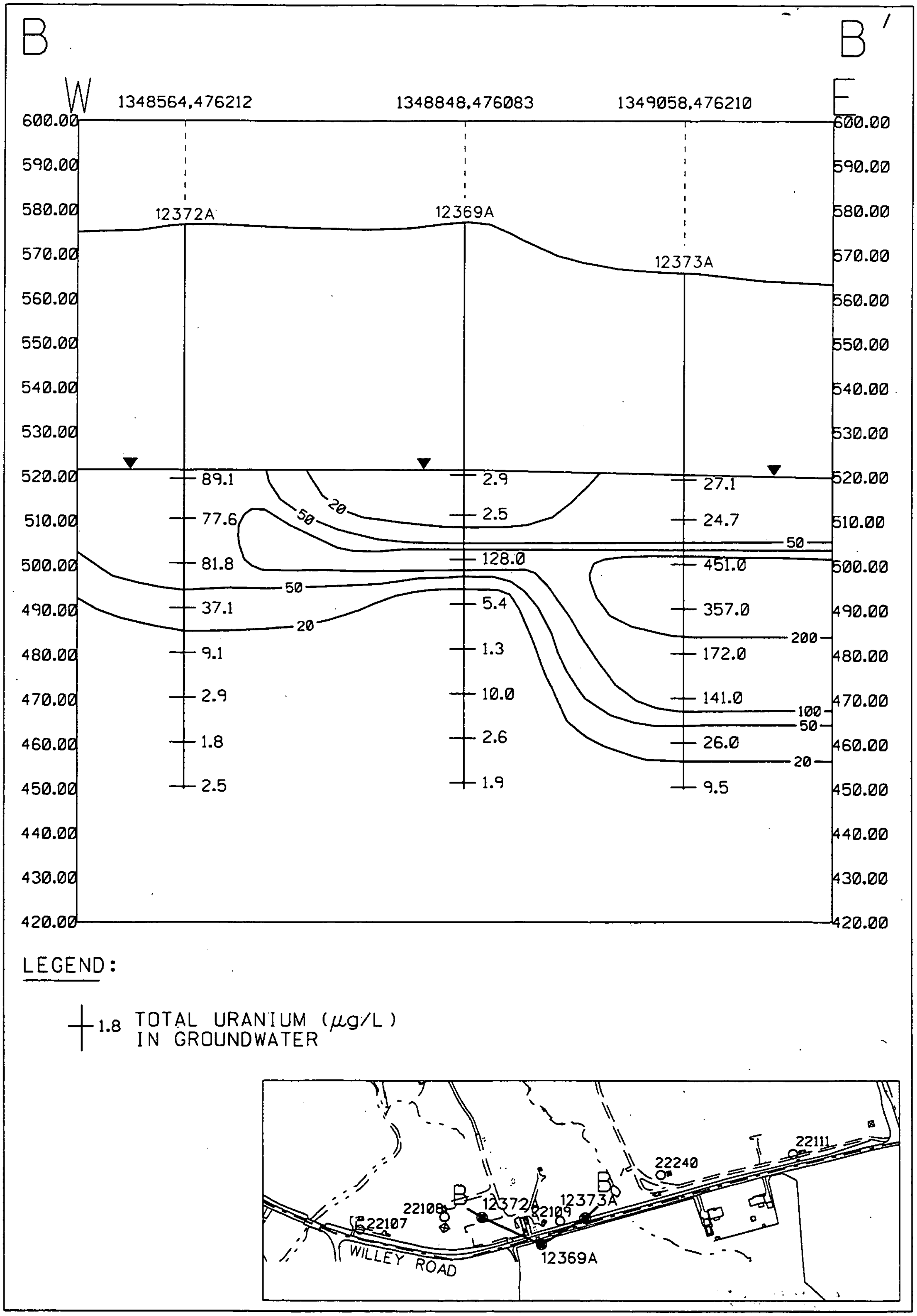
080000



v:*5fgp1*dgn*98annual*98an007.dgn
STATE PLANAR COORDINATE SYSTEM 1983

17-MAY-1999

FIGURE A.2-6. CROSS SECTION A-A', GEOPROBE RESULTS FOR TOTAL URANIUM IN GROUNDWATER



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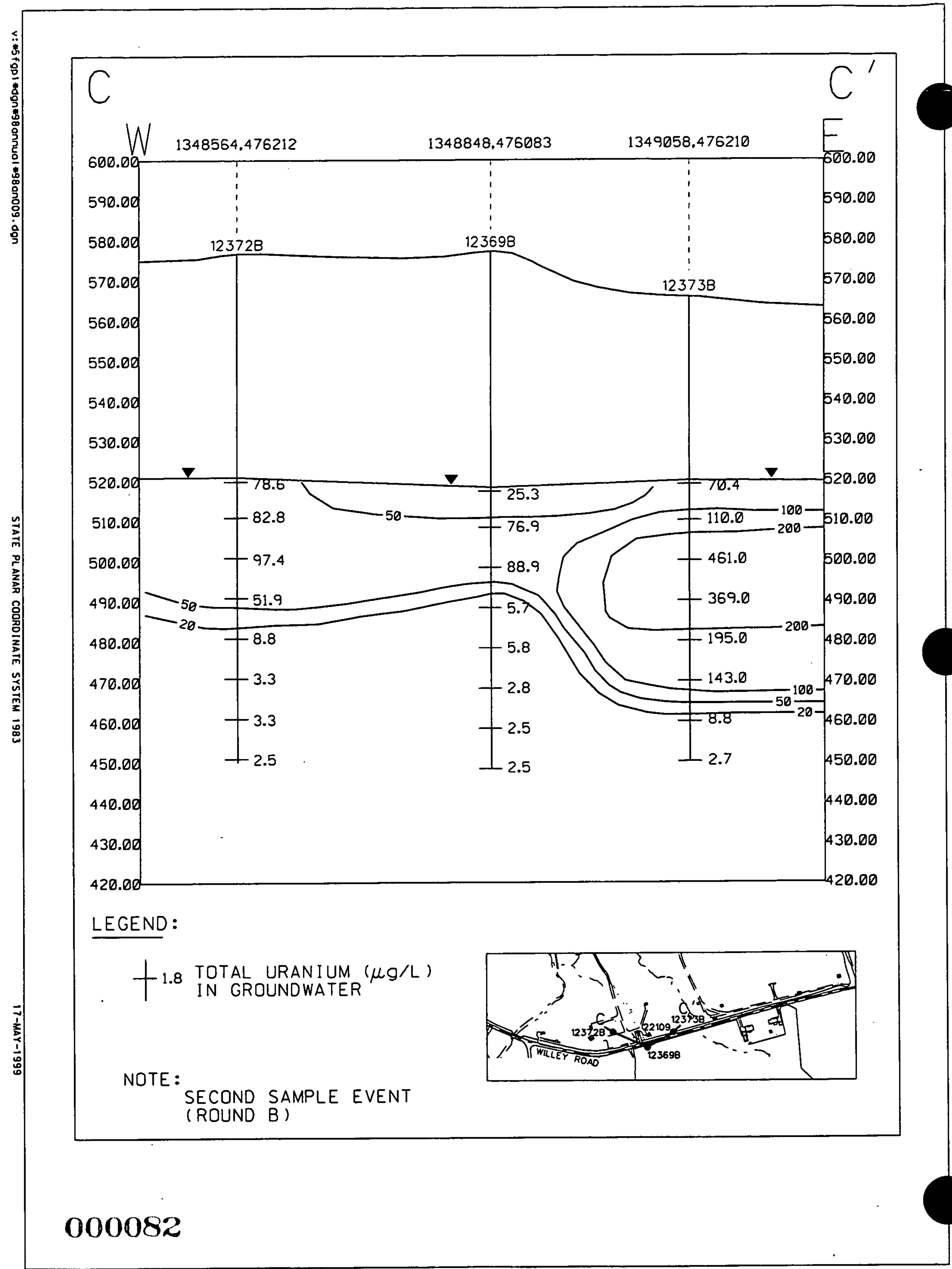
STATE PLANAR COORDINATE SYSTEM 1983

17-MAY-1999

FIGURE A.2-7. CROSS SECTION B-B′, GEOPROBE RESULTS FOR TOTAL URANIUM IN GROUNDWATER



000082

FIGURE A.2-8. CROSS SECTION C-C', GEOPROBE RESULTS FOR TOTAL URANIUM IN GROUNDWATER

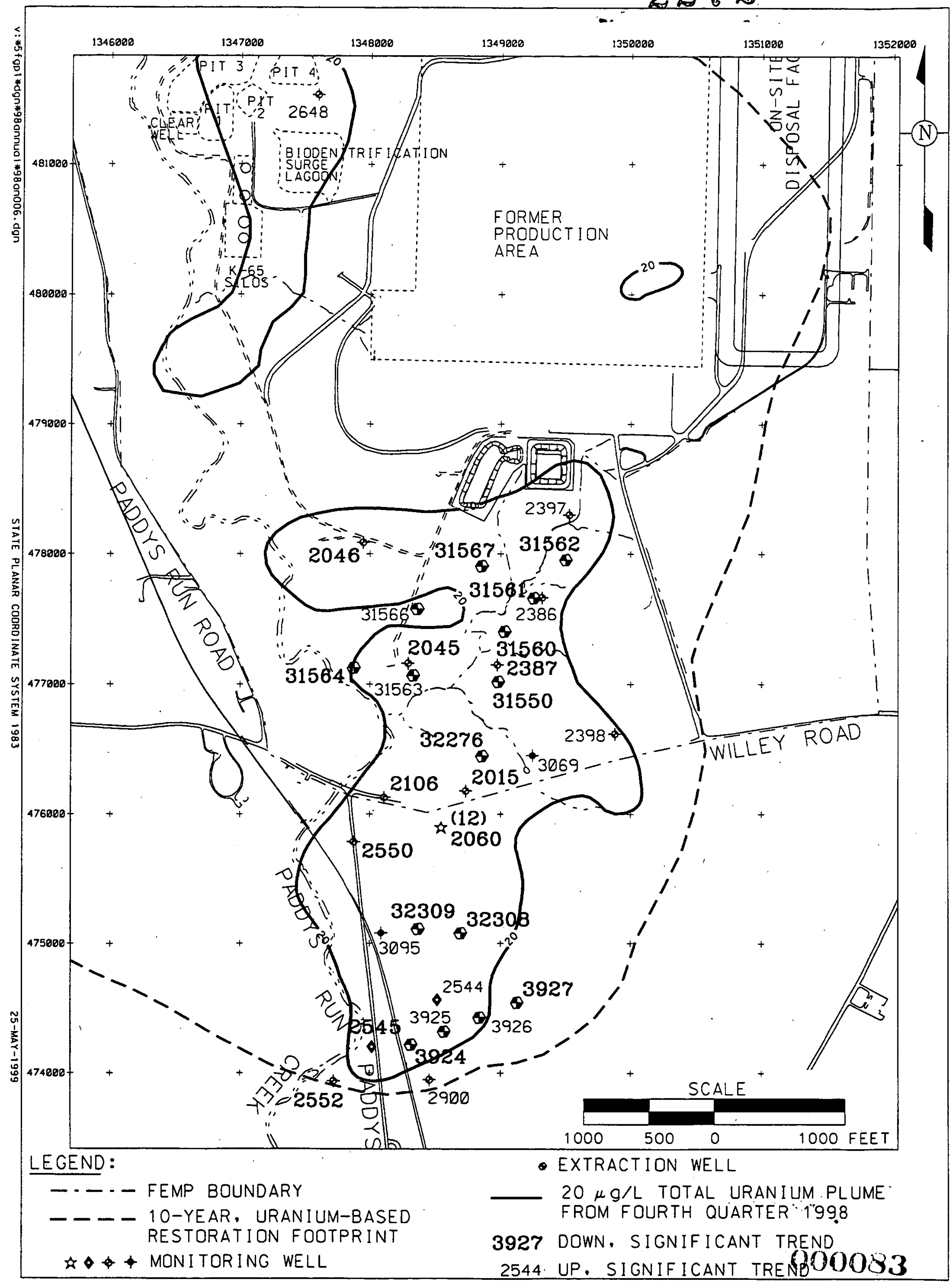


FIGURE A.2-9. WELLS WITH 1998 FRL EXCEEDANCES FOR TOTAL URANIUM WITH UP, SIGNIFICANT AND DOWN, SIGNIFICANT TRENDS

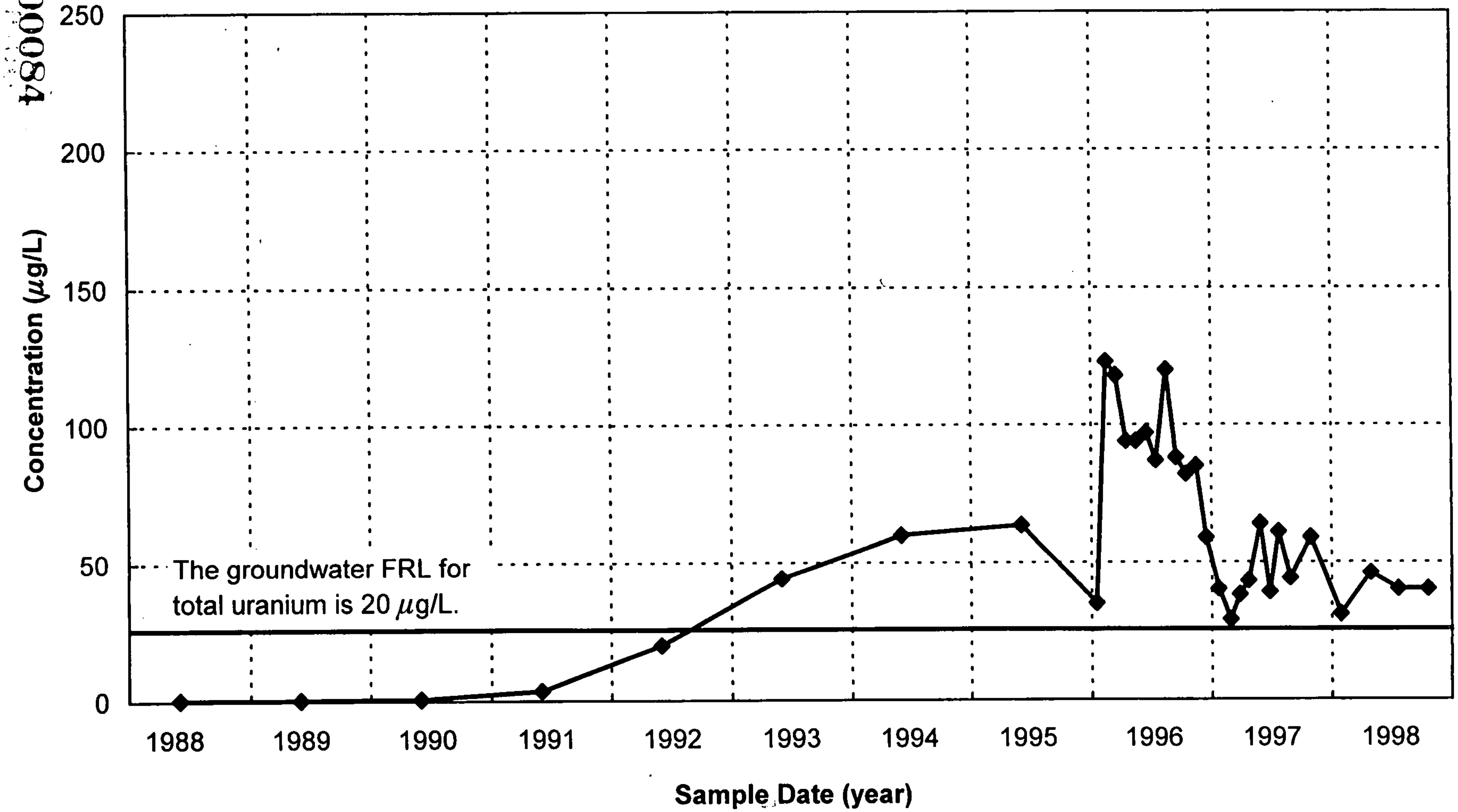


FIGURE A.2-10. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 13

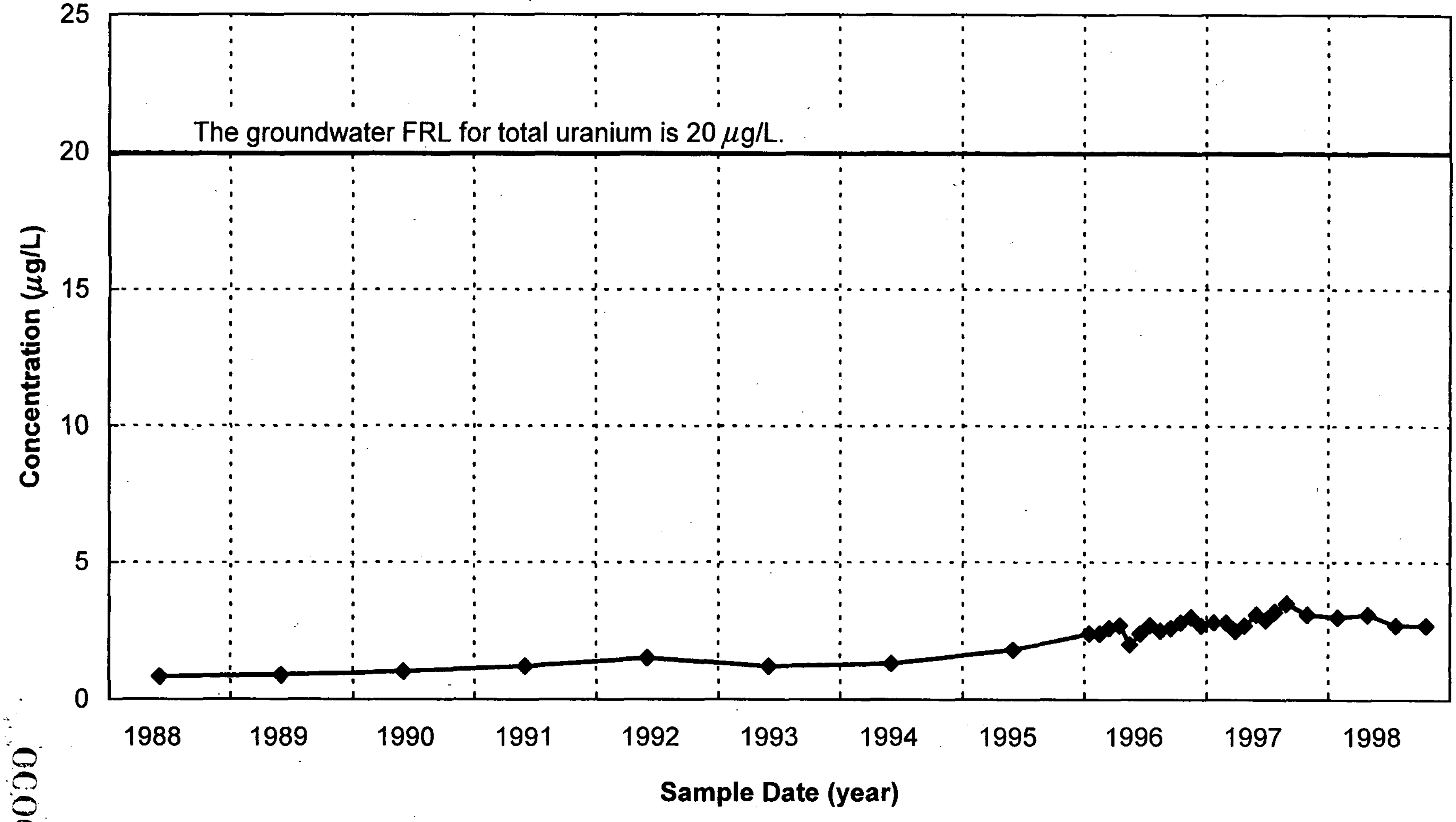


FIGURE A.2-11. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 14

000085

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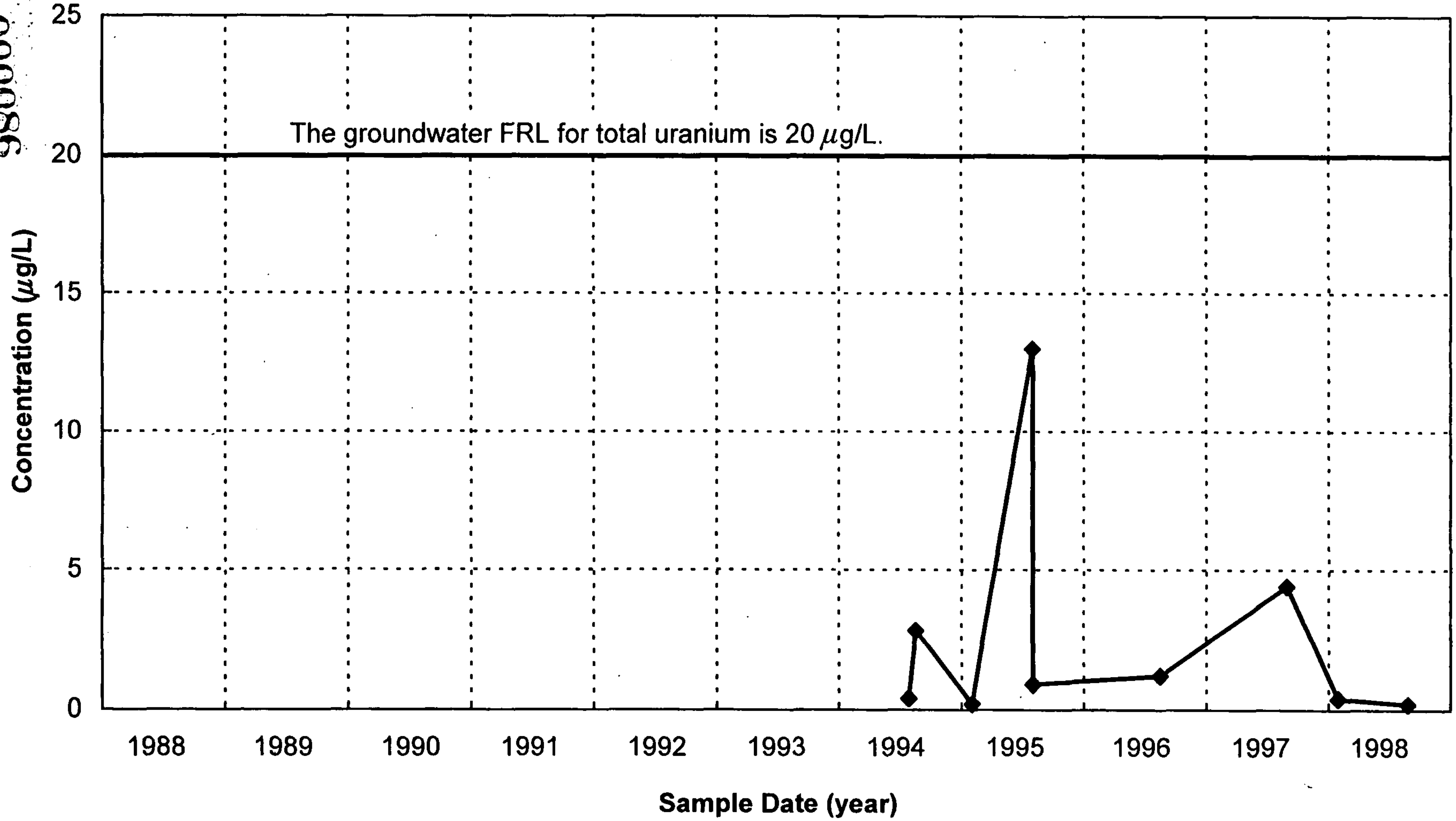

FIGURE A.2-12. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 67

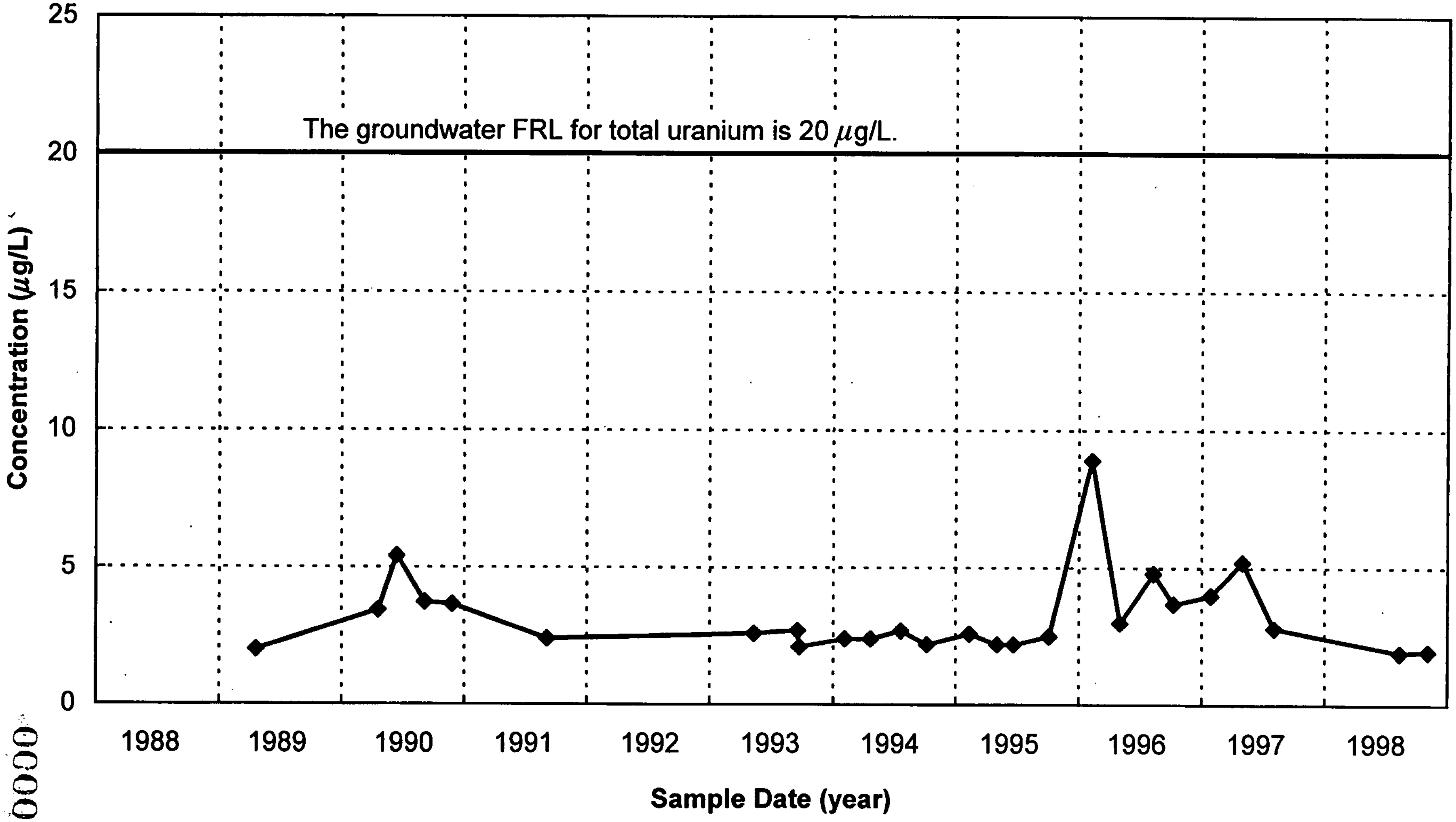

FIGURE A.2-13. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2002

000087

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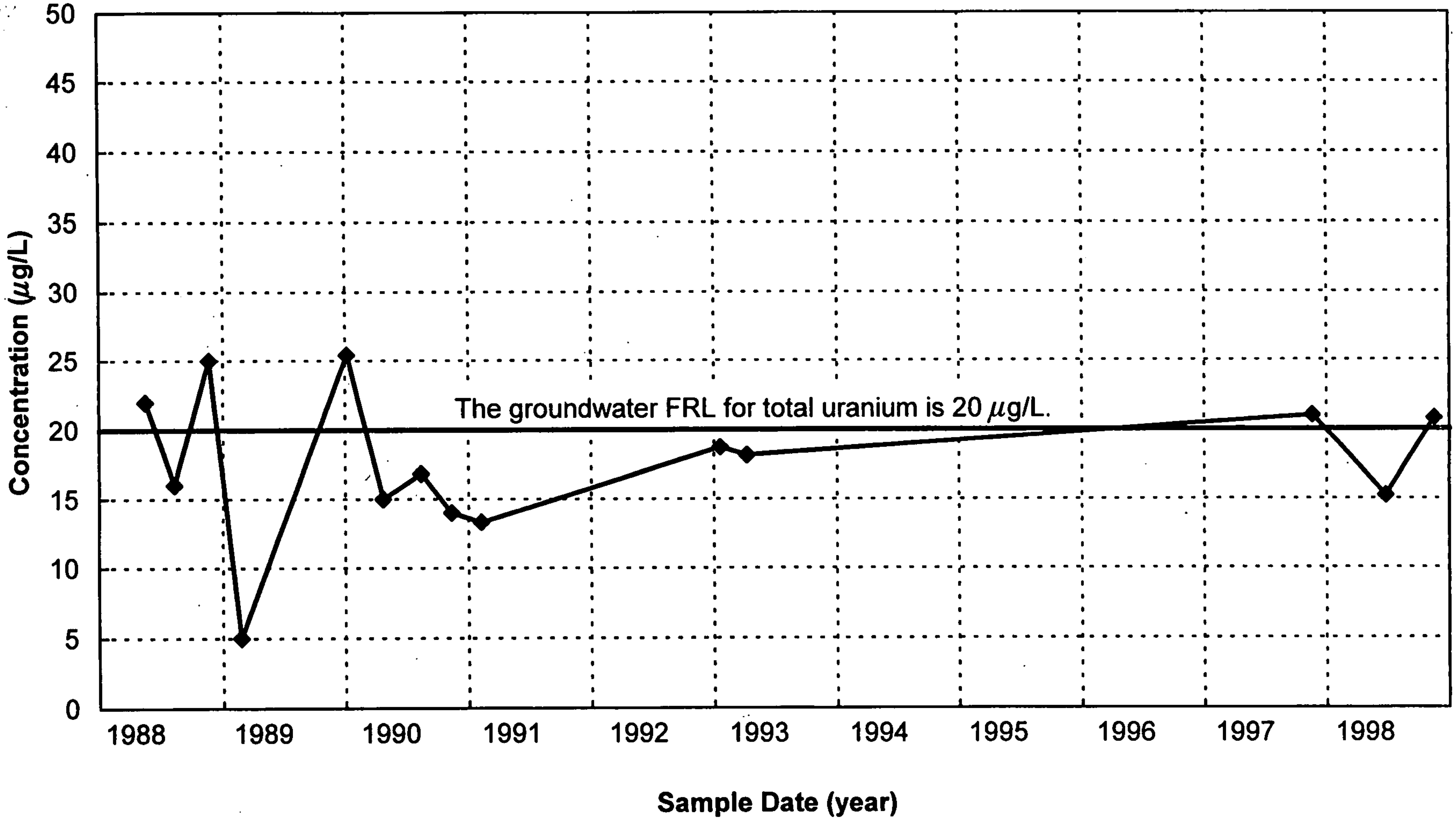

FIGURE A.2-14. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2008

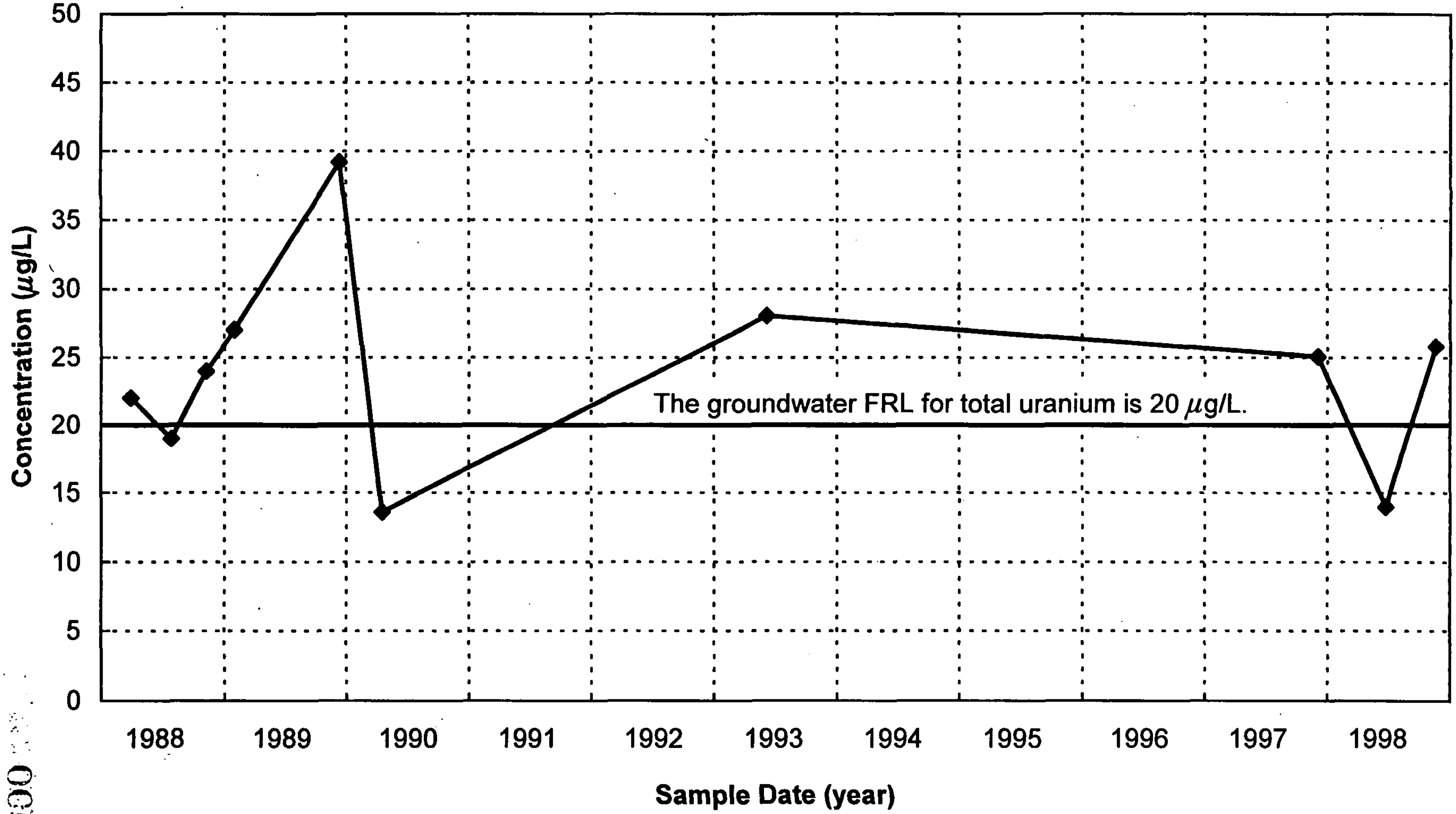

FIGURE A.2-15. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2009

000089

2272

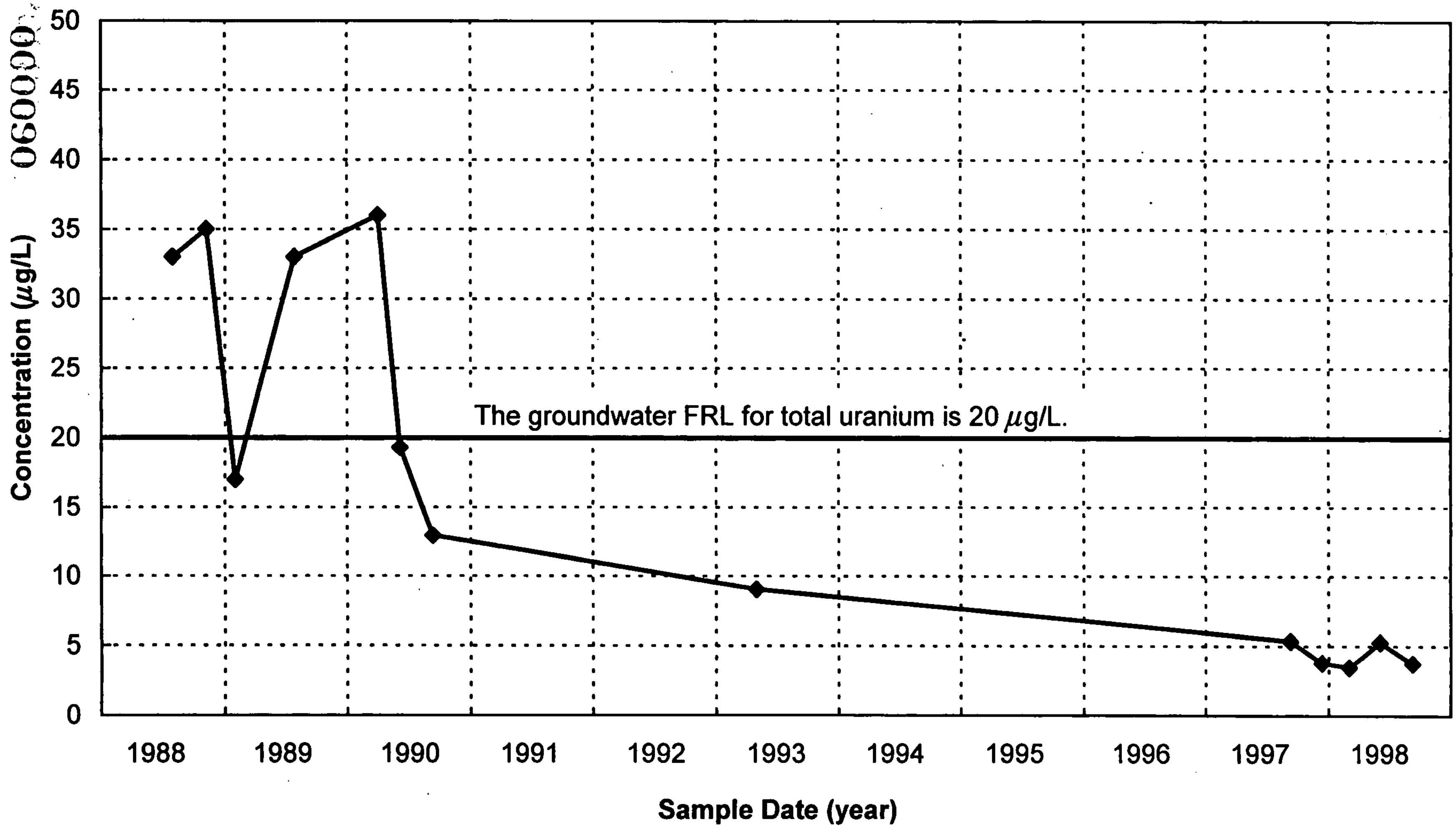

FIGURE A.2-16. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2014

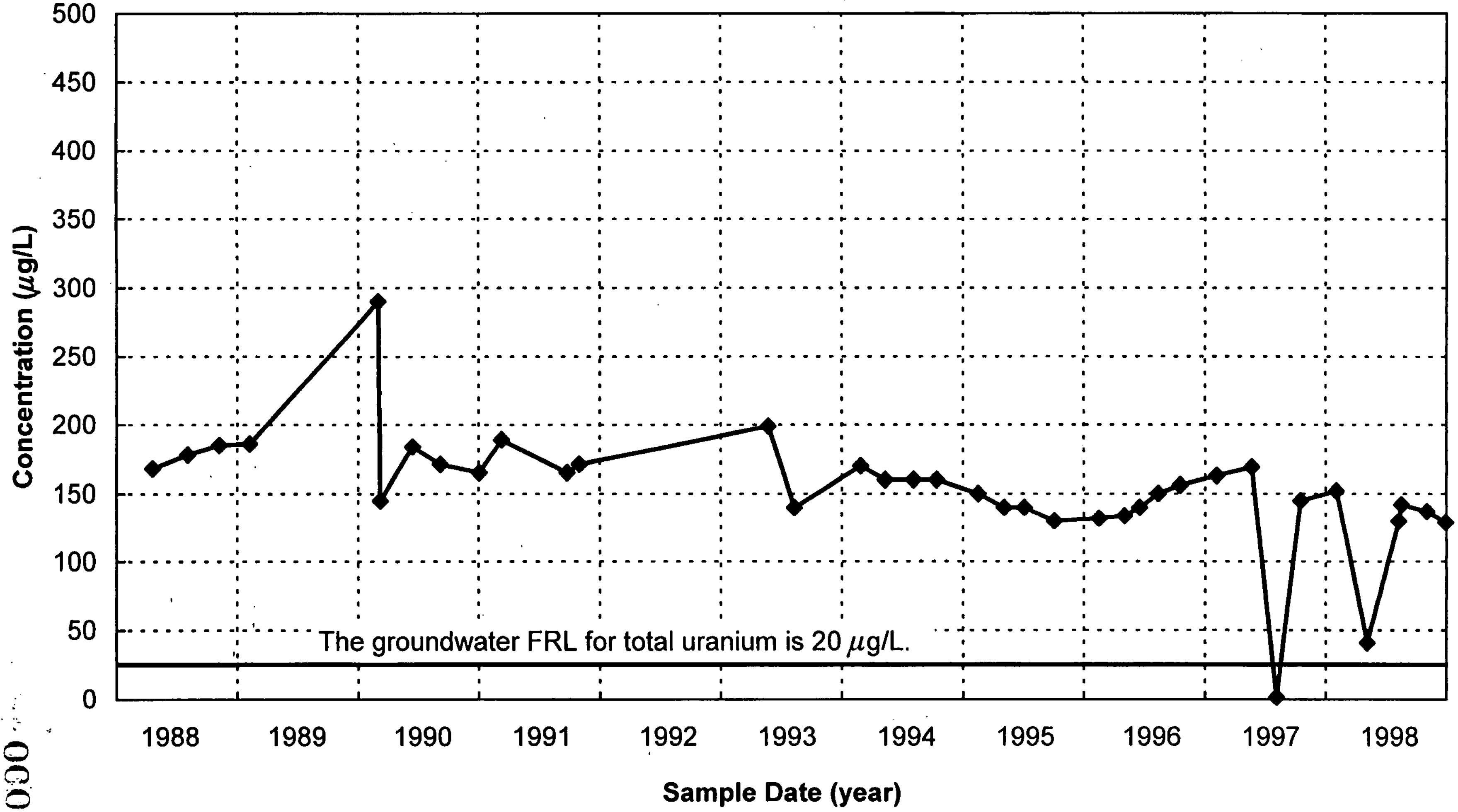

FIGURE A.2-17. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2015

000091

2272

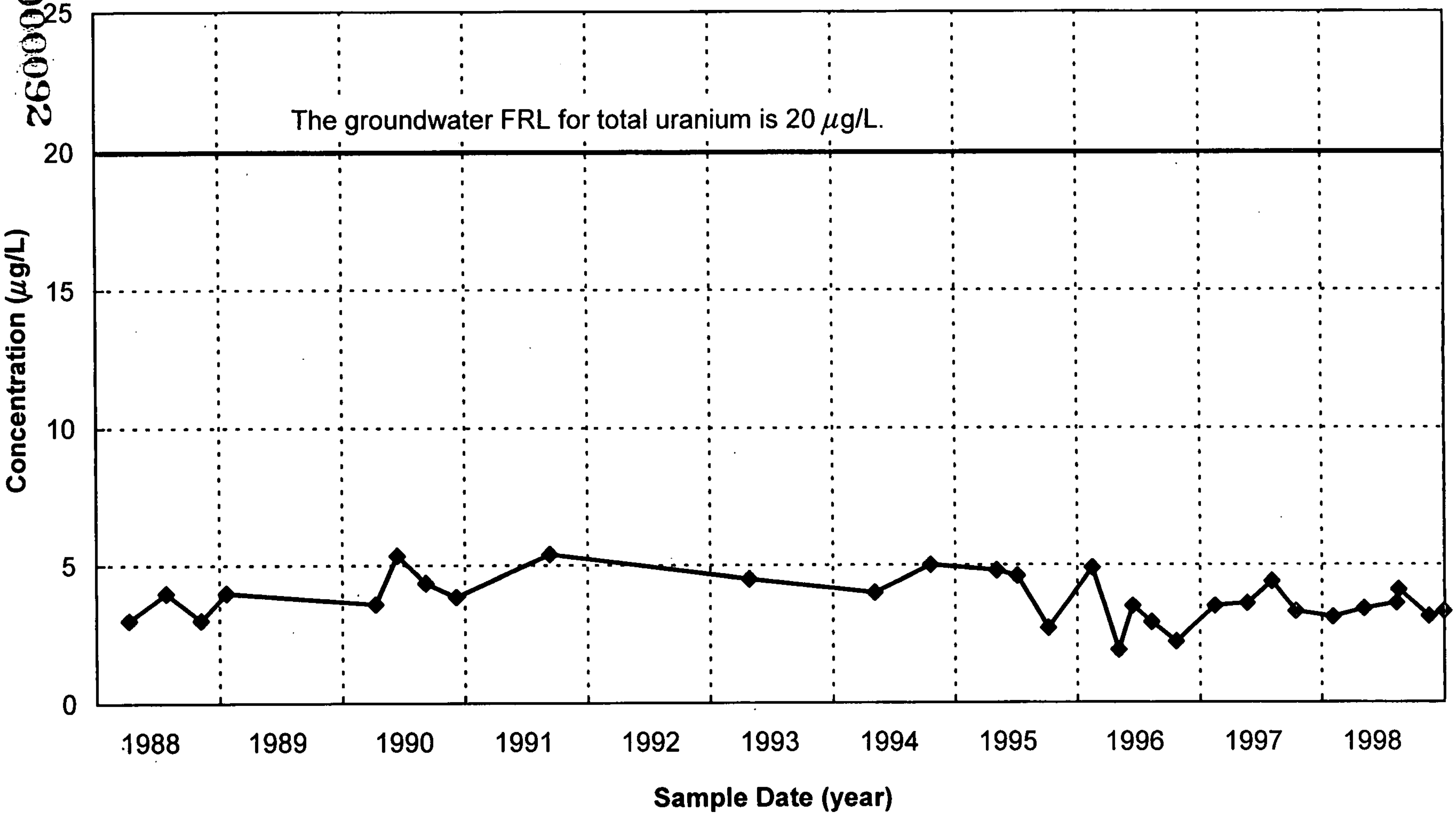

FIGURE A.2-18. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2017

000092

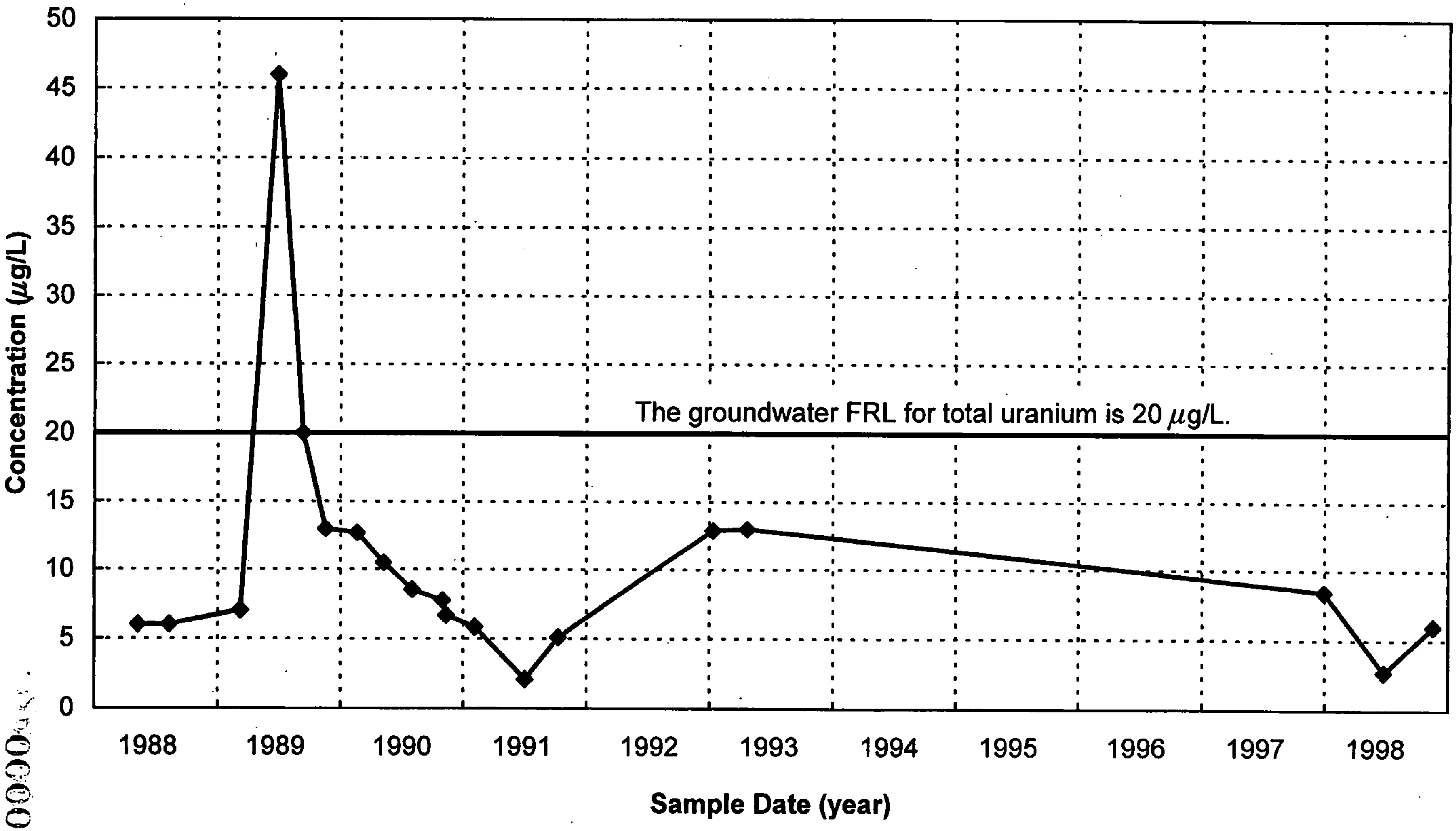

FIGURE A.2-19. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2027

000093

2272

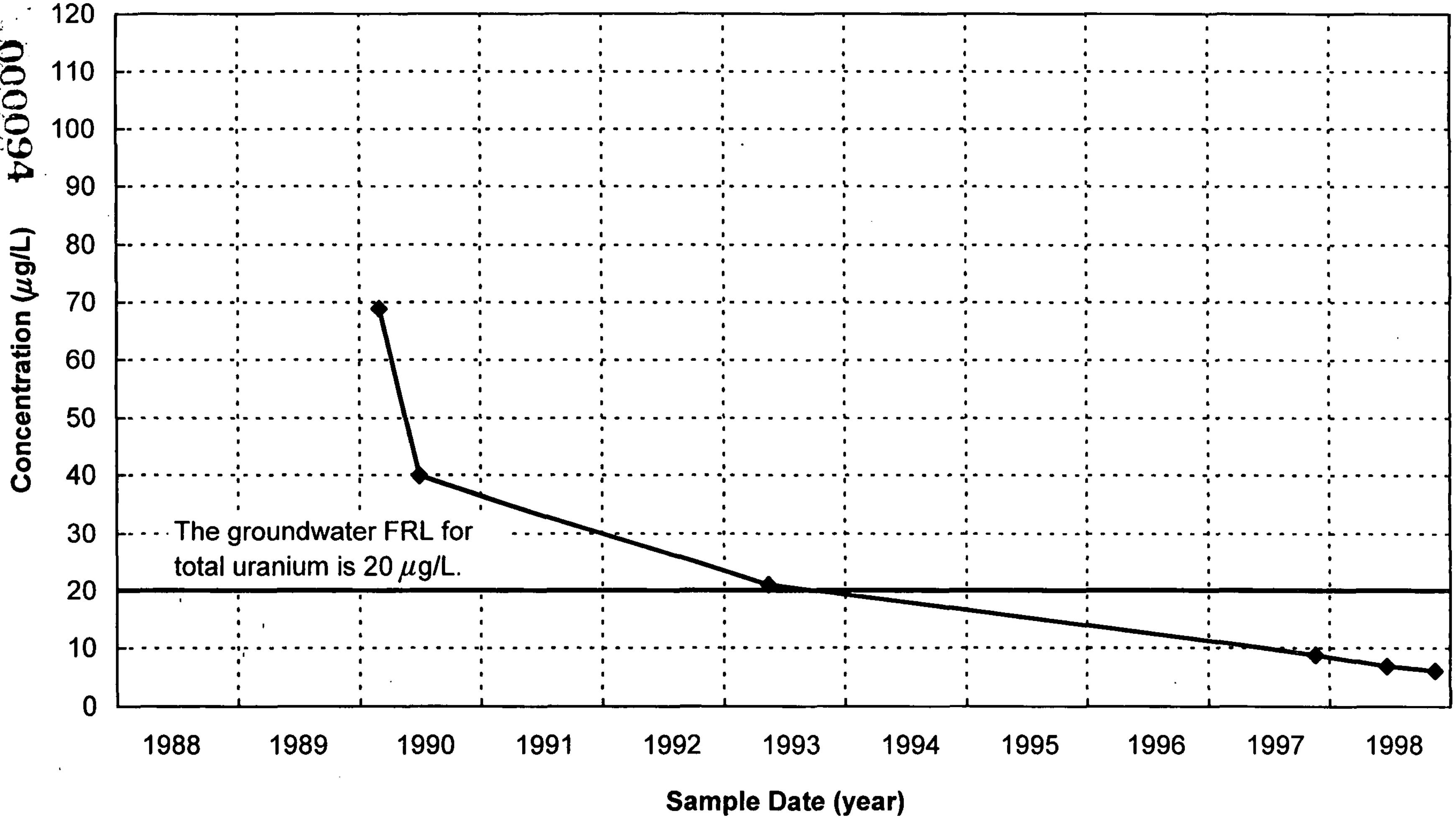

FIGURE A.2-20. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2032

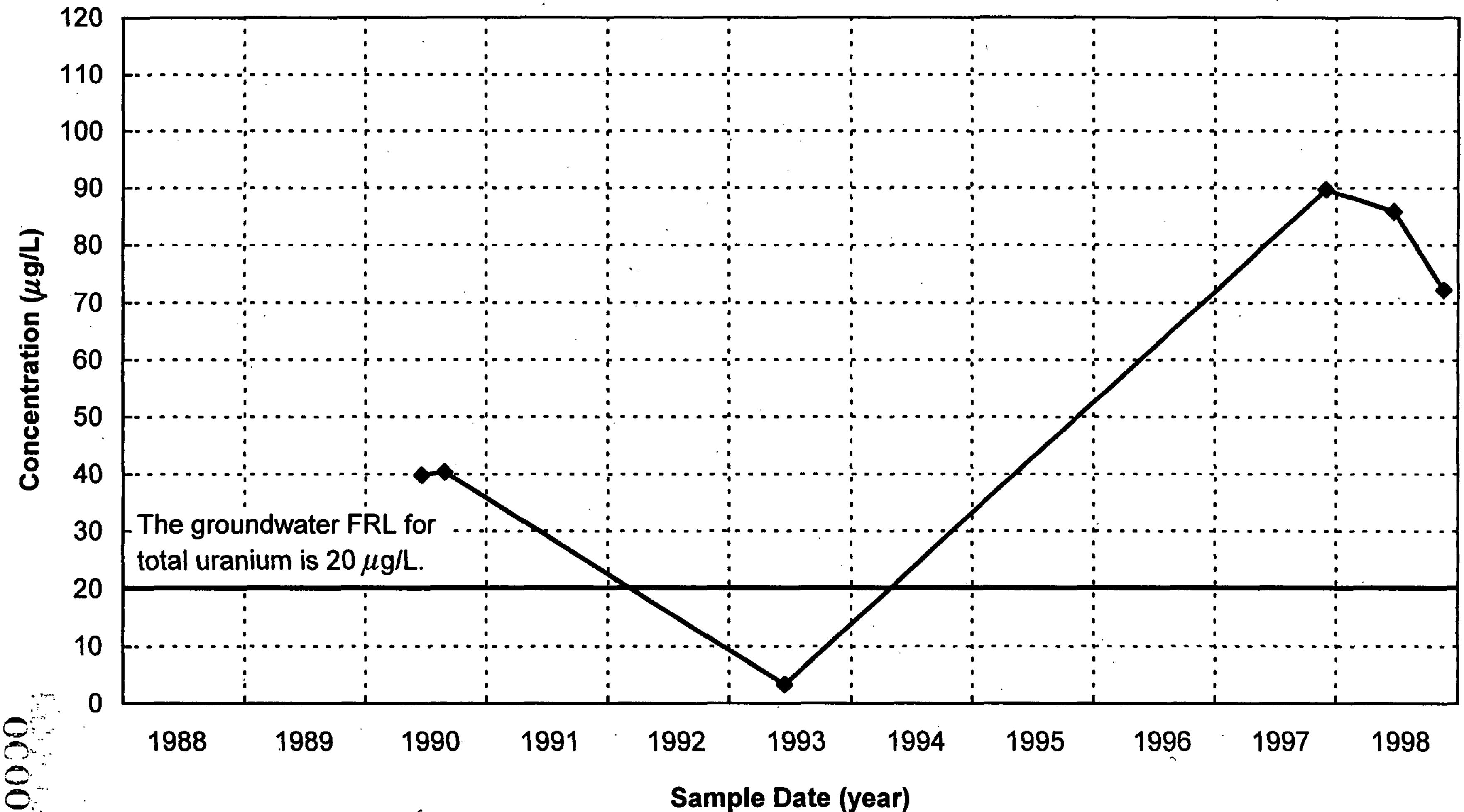

FIGURE A.2-21. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2033

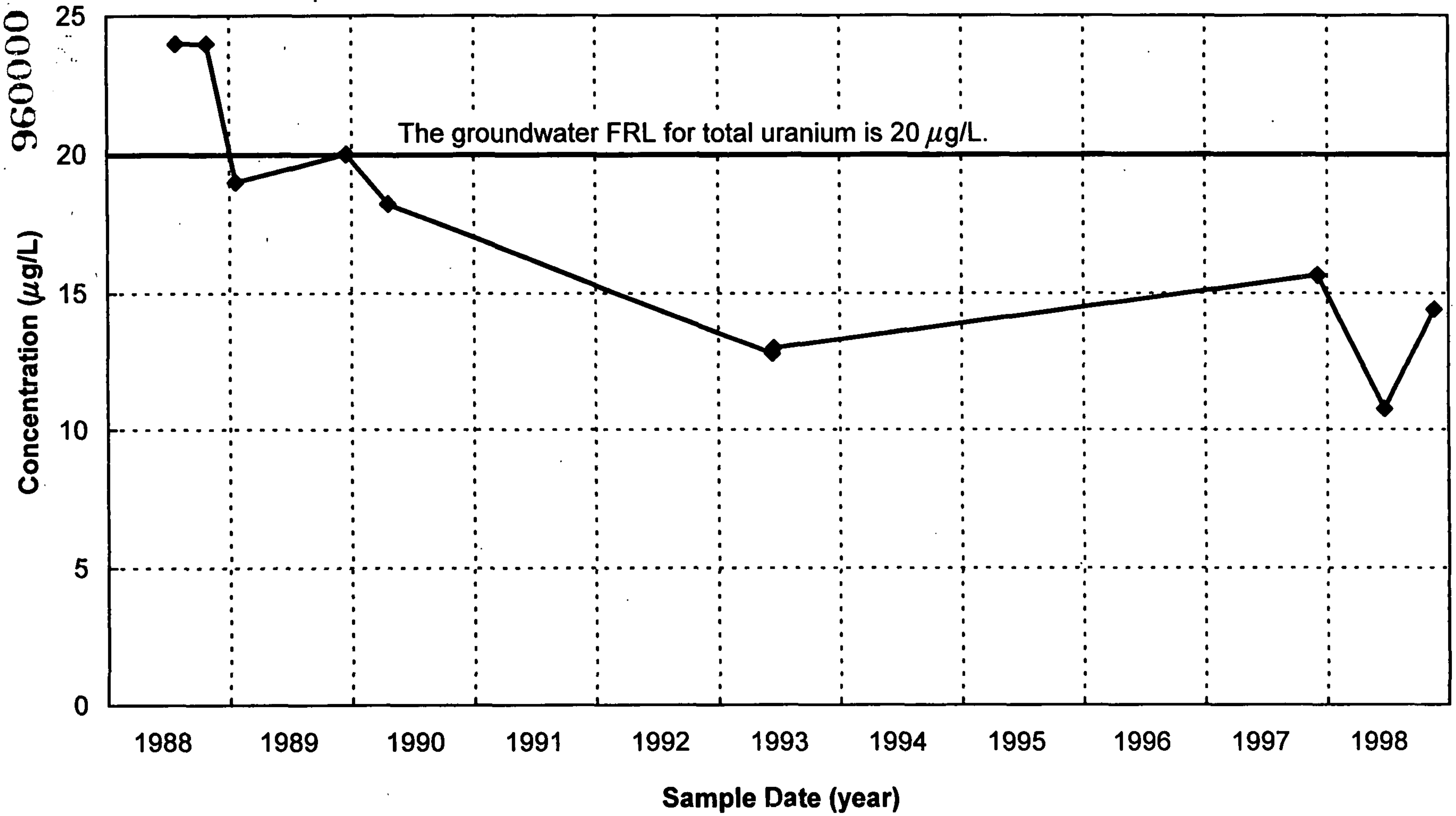

FIGURE A.2-22. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2034

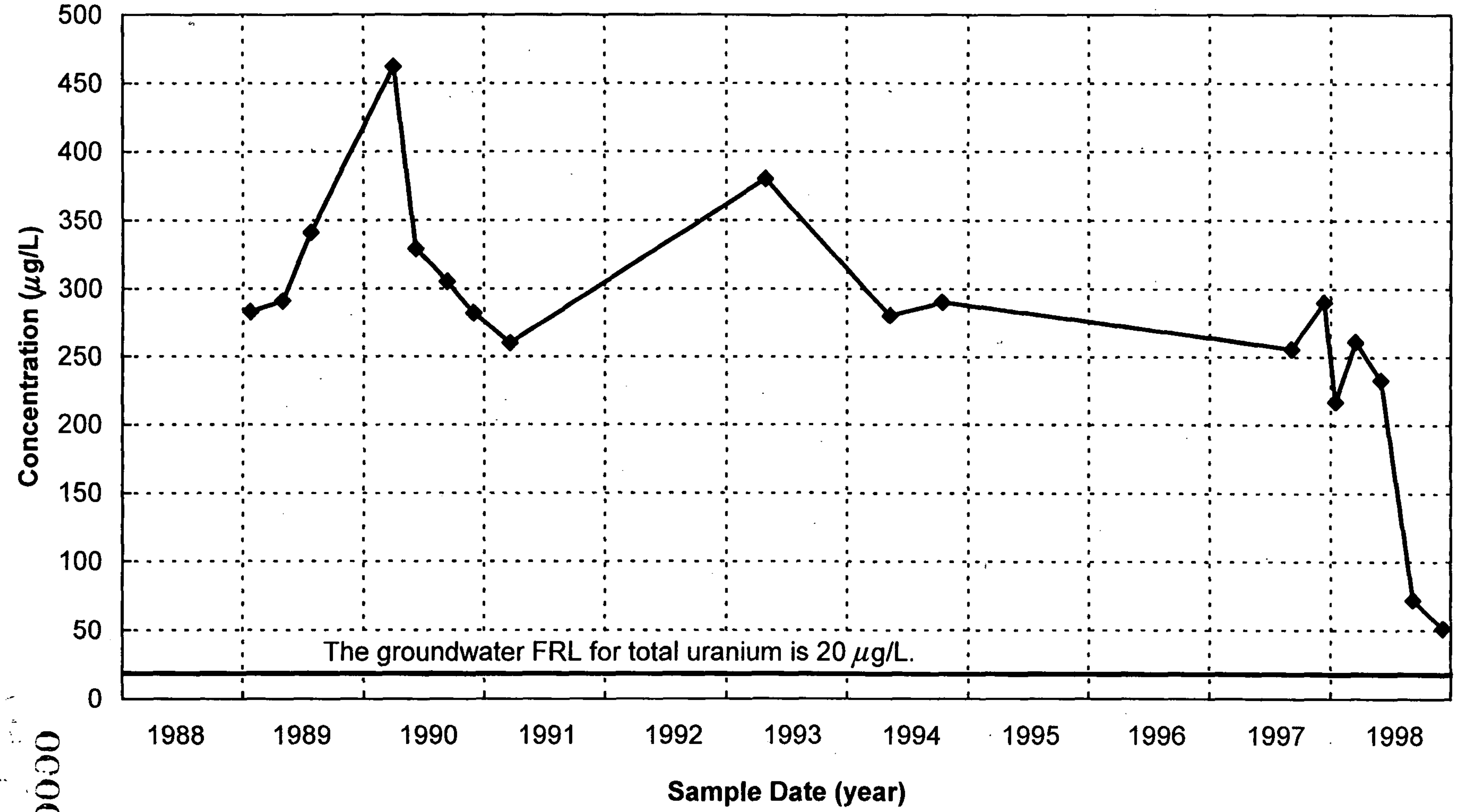

FIGURE A.2-23. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2045

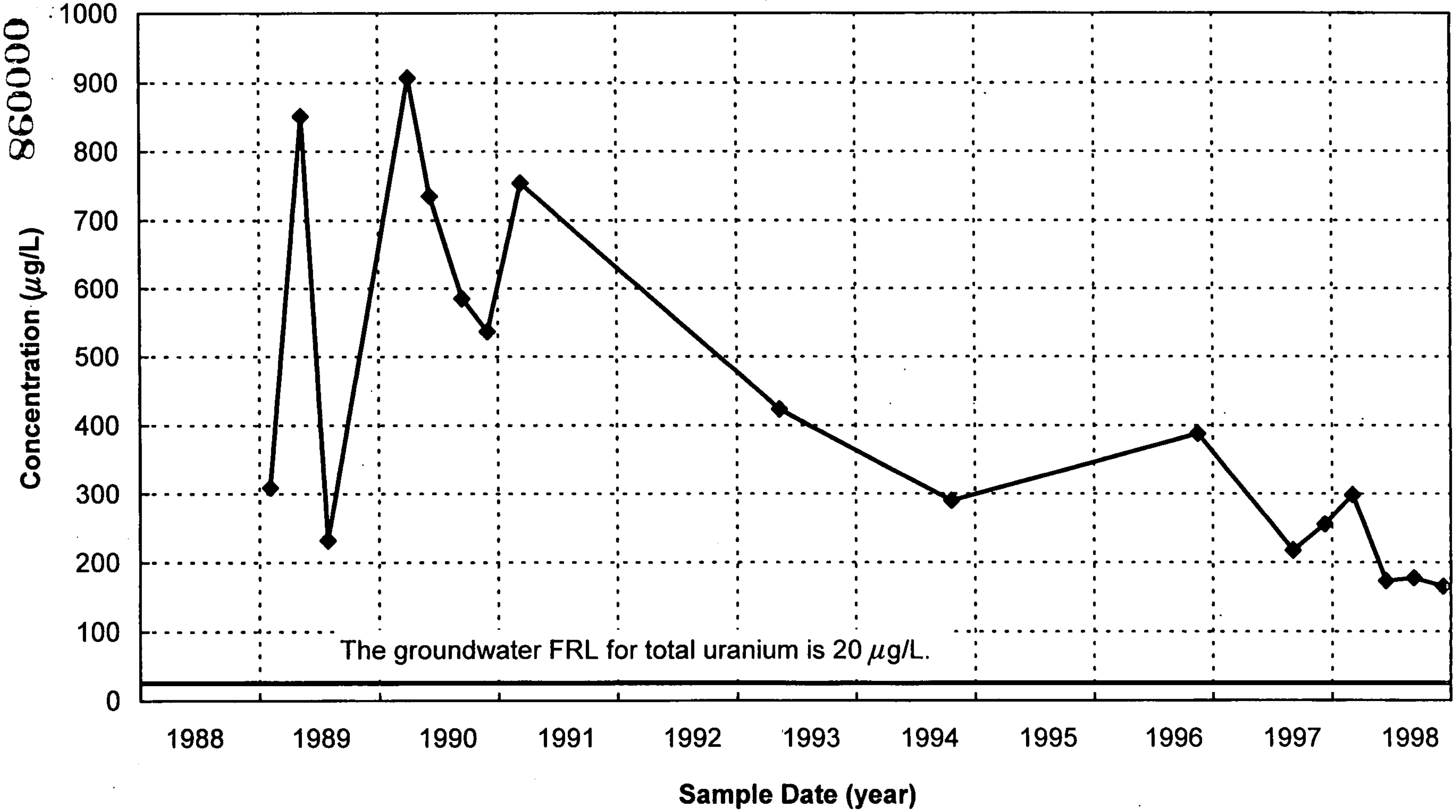

FIGURE A.2-24. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2046

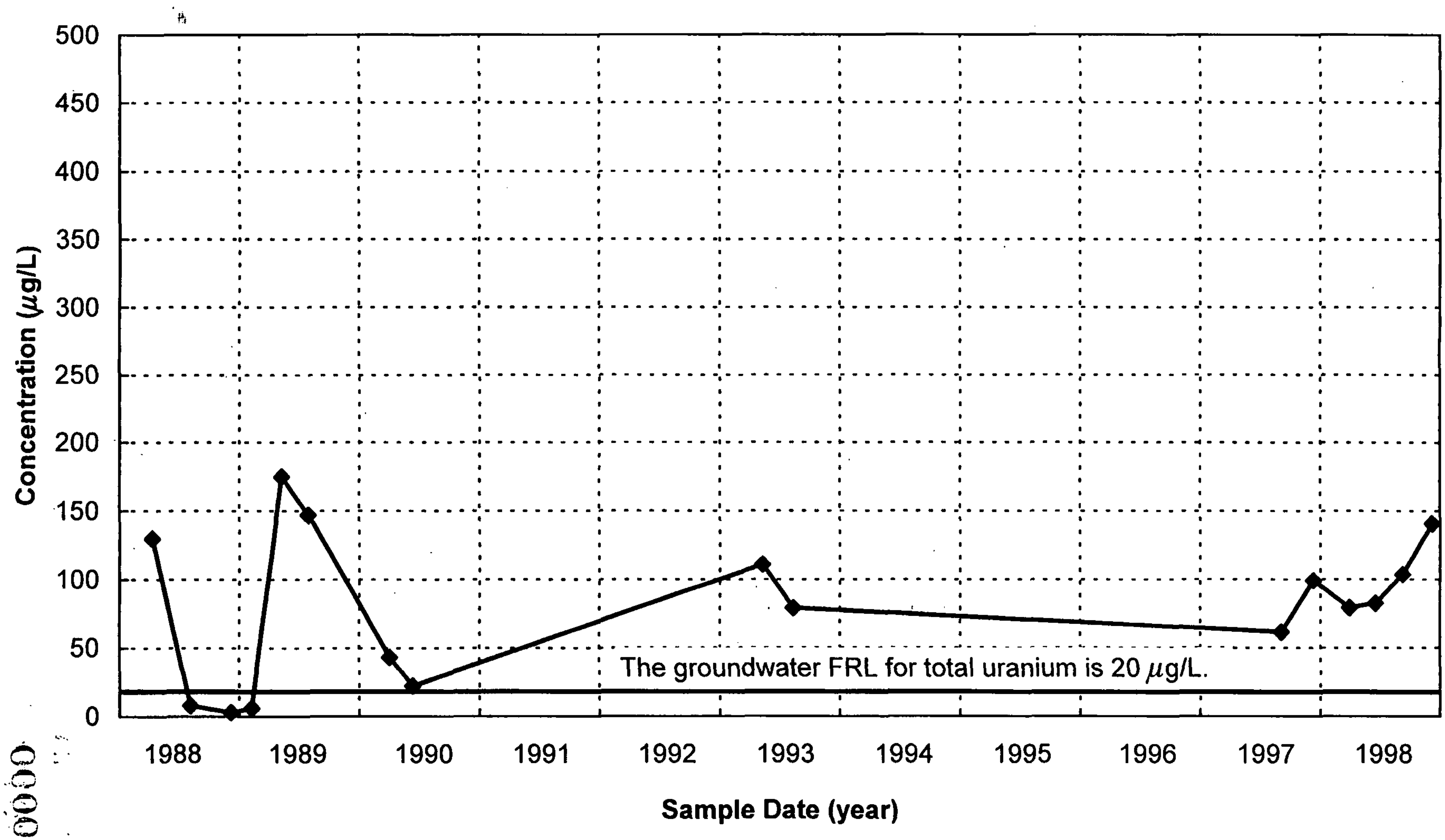

FIGURE A.2-25. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2049

000099

2272

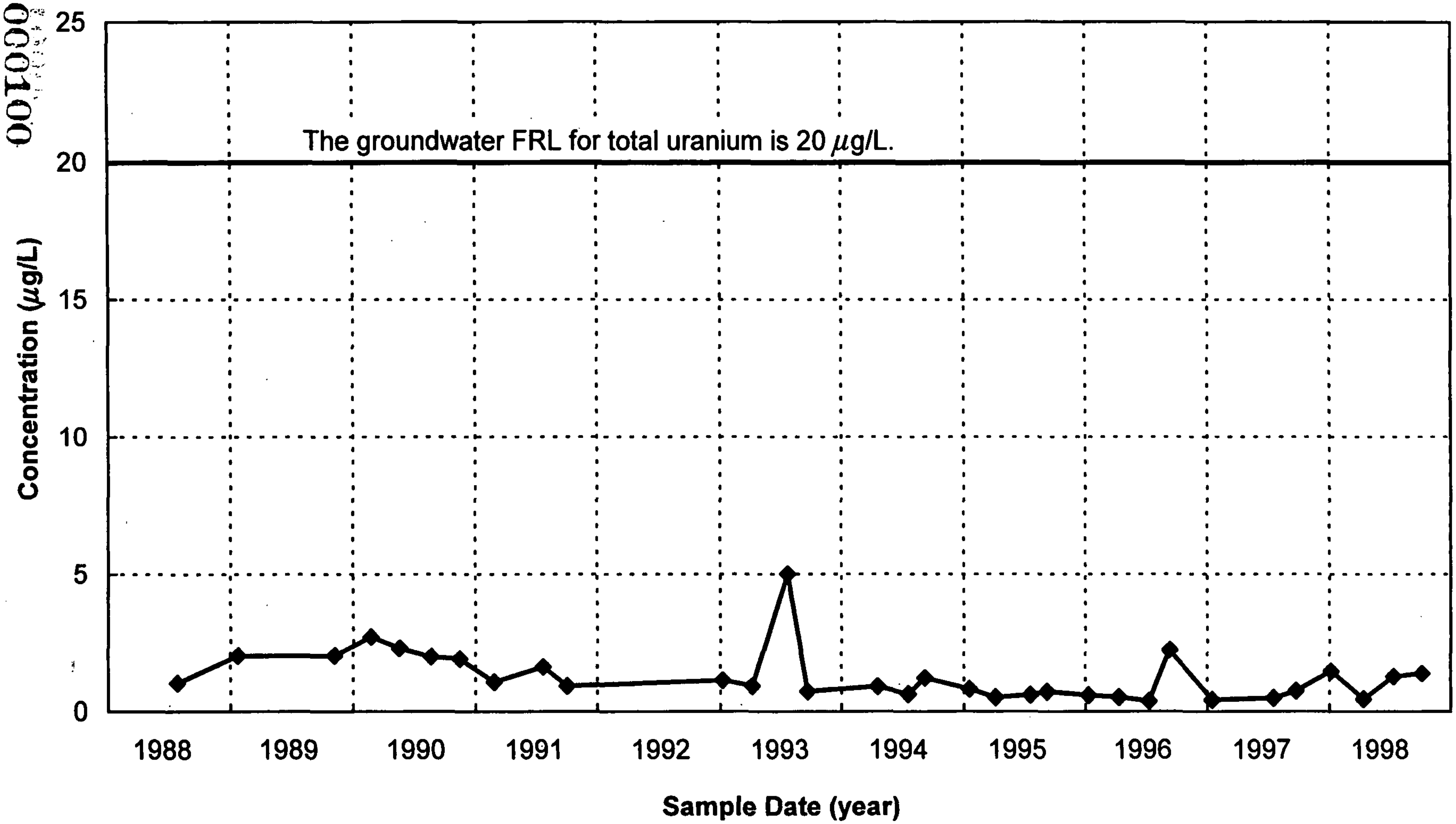

FIGURE A.2-26. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2051

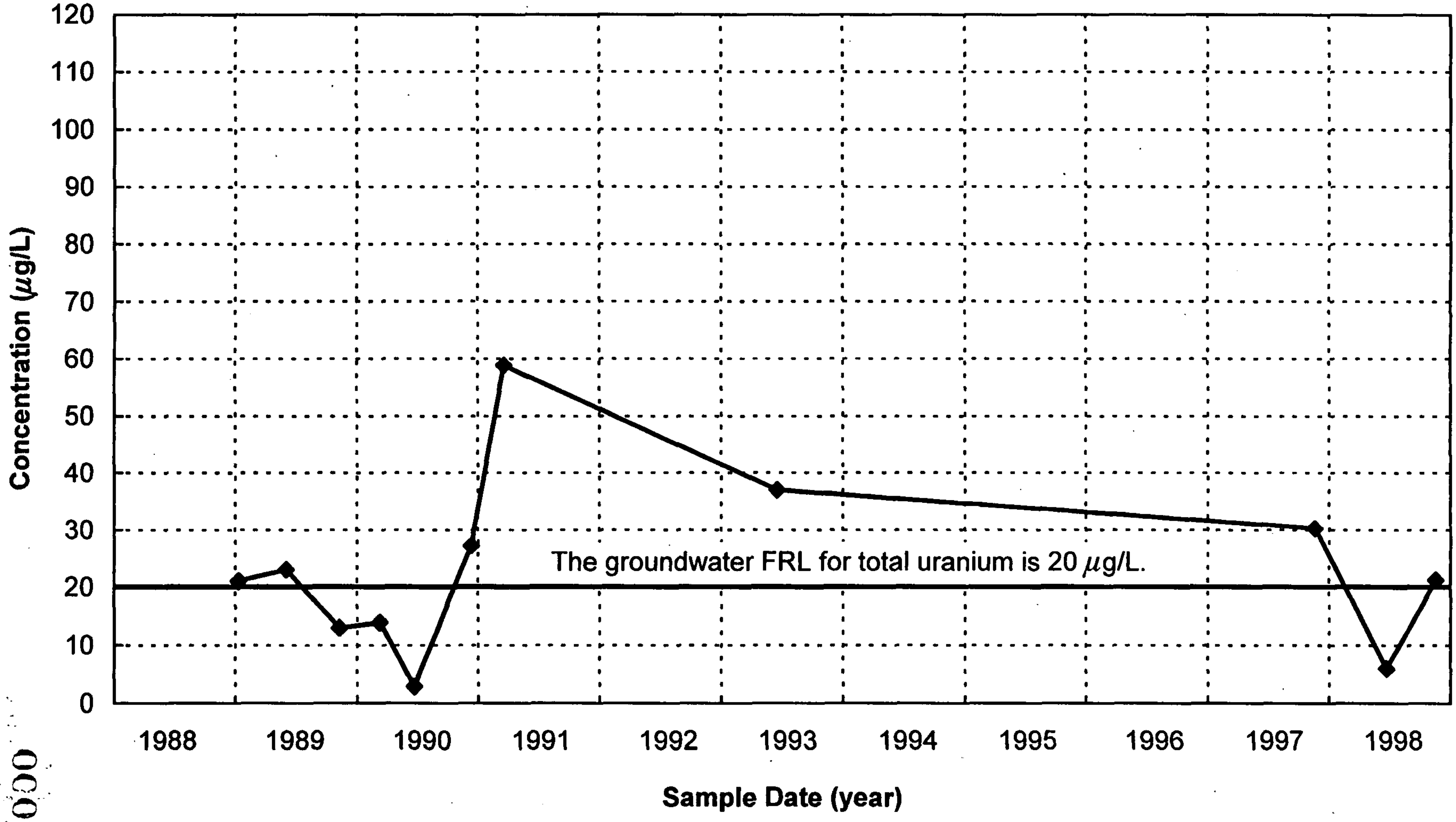

FIGURE A.2-27. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2054

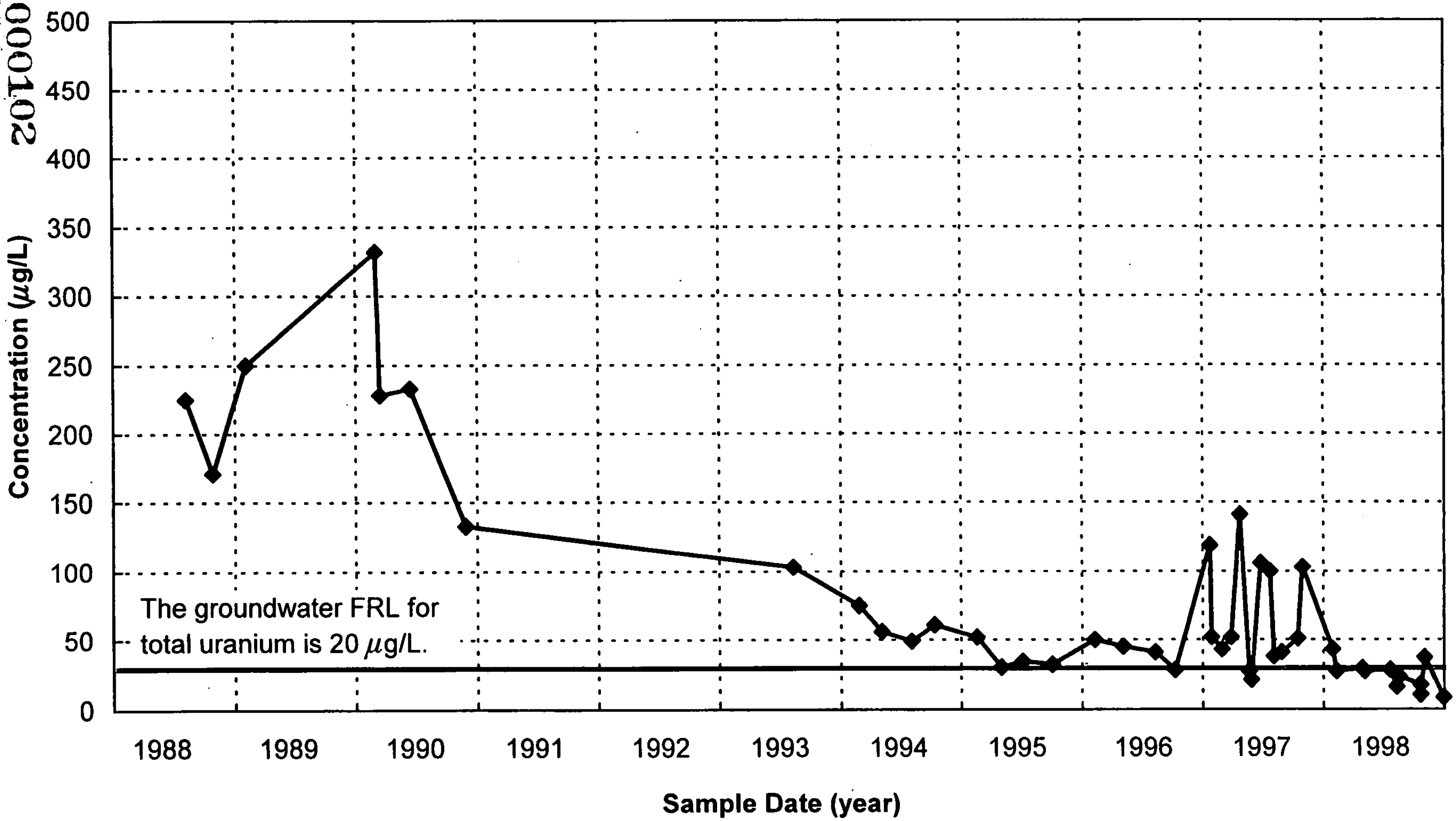

FIGURE A.2-28. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2060 (12)

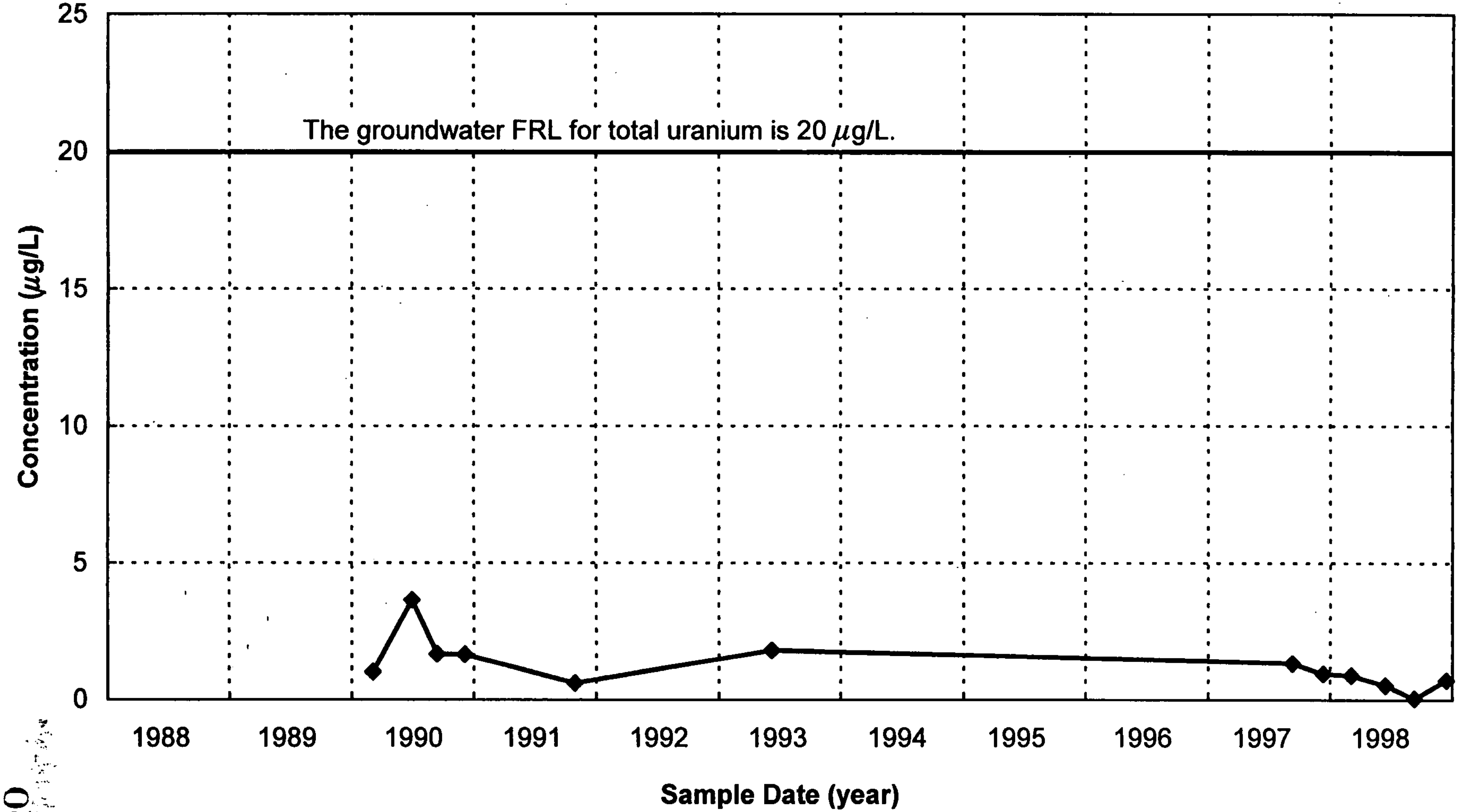

FIGURE A.2-29. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2068

000103

2272

000104

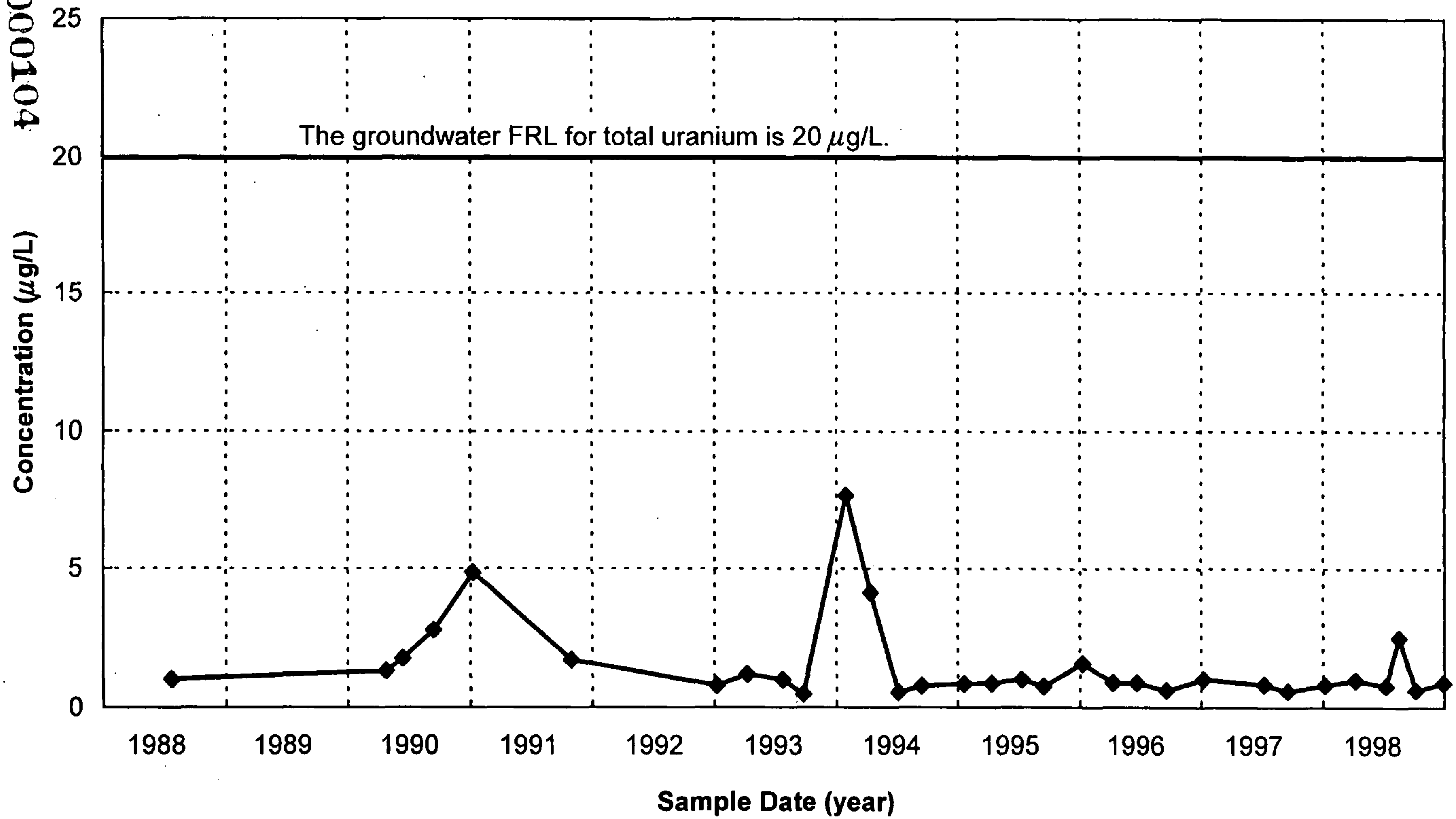

FIGURE A.2-30. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2070

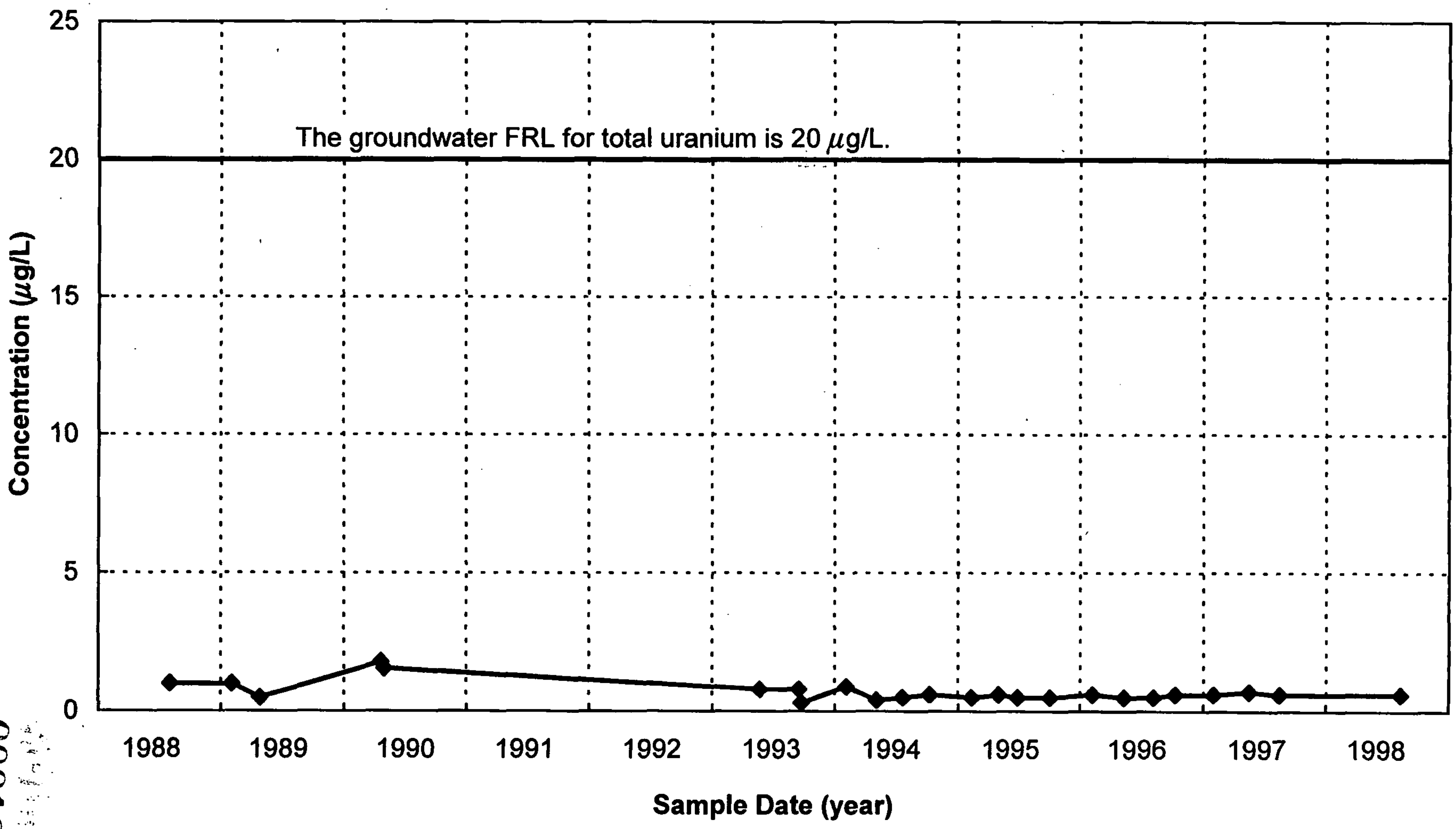

FIGURE A.2-31. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2093

000105

2272

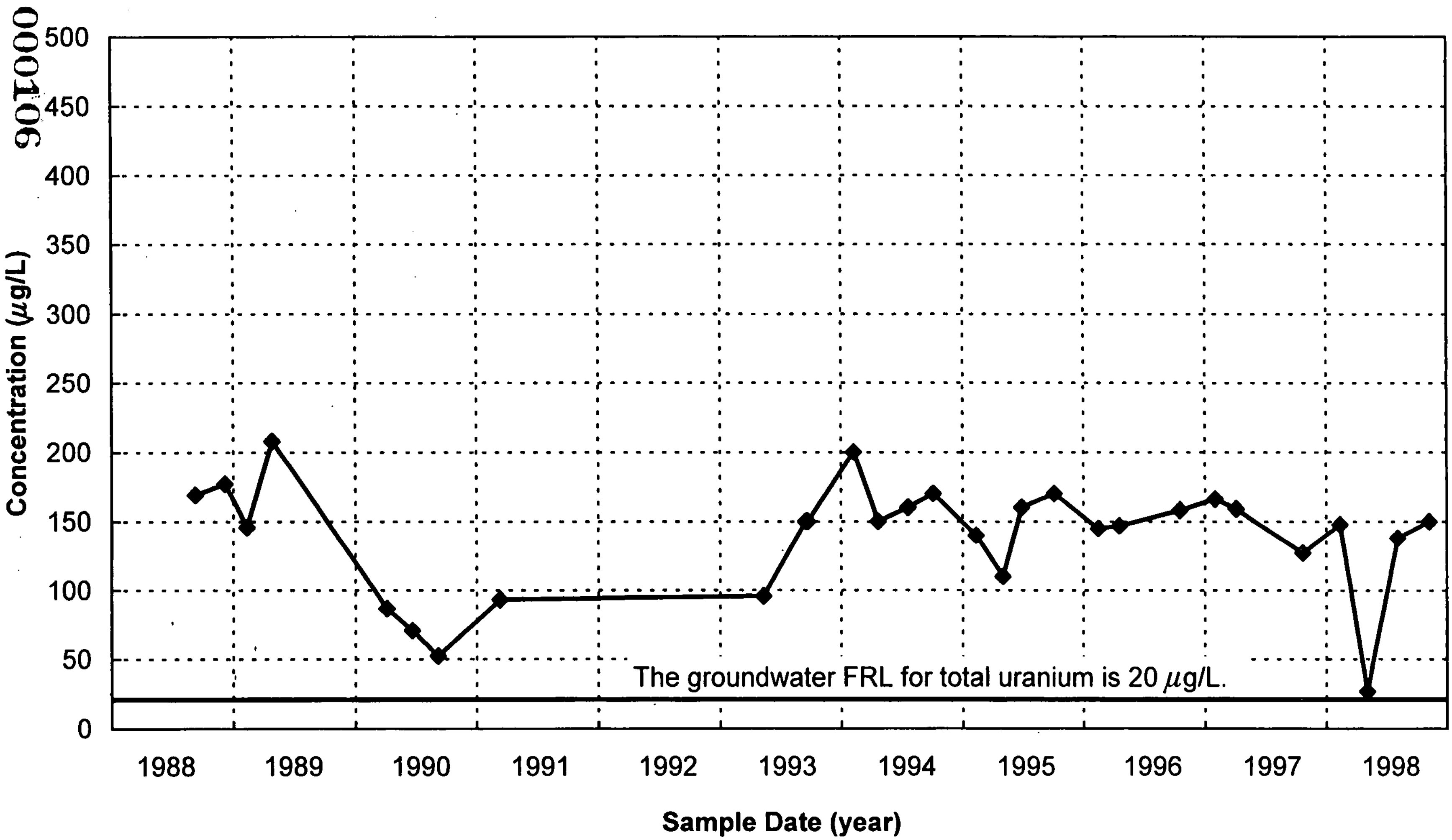

FIGURE A.2-32. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2095

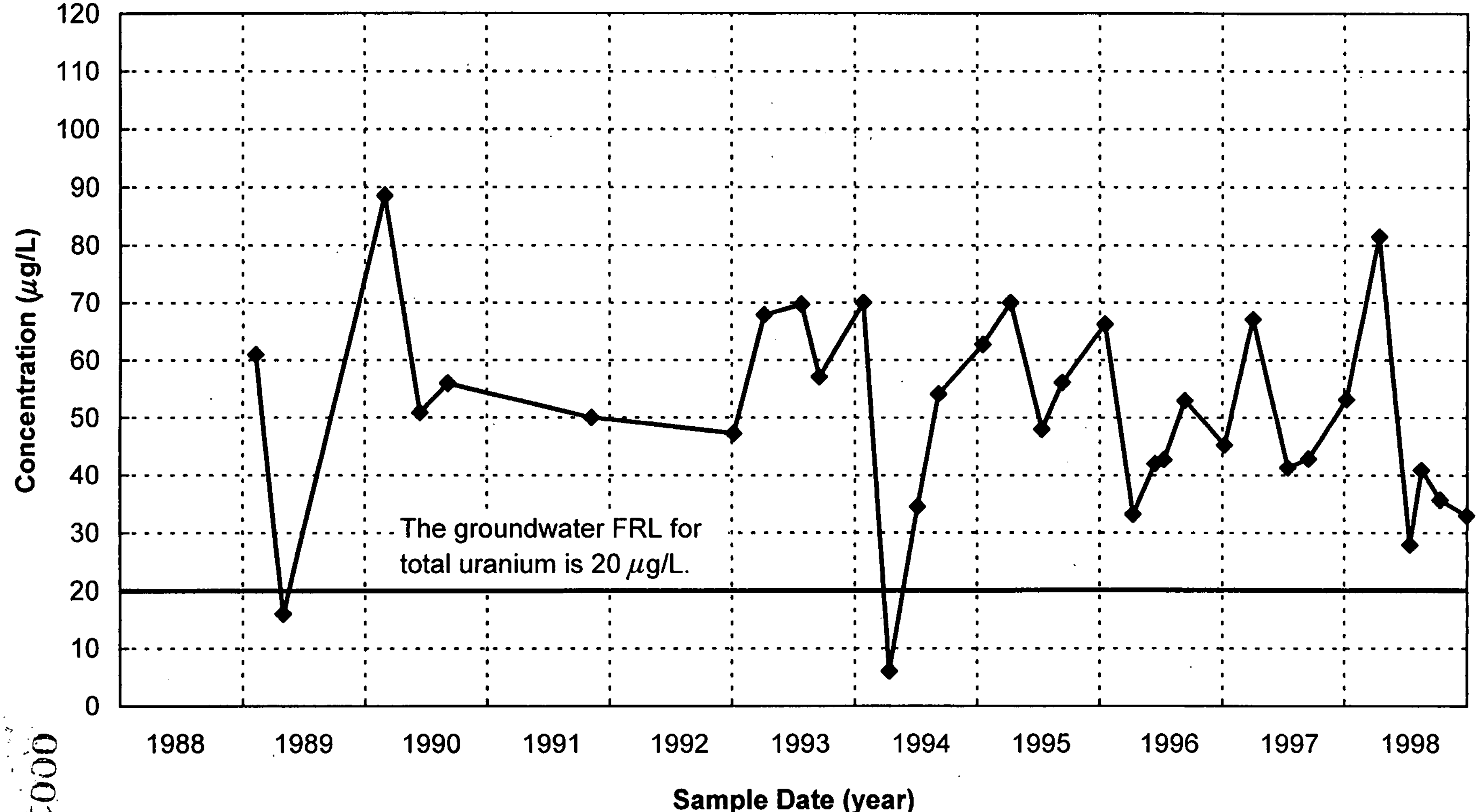

FIGURE A.2-33. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2106

000107

2272

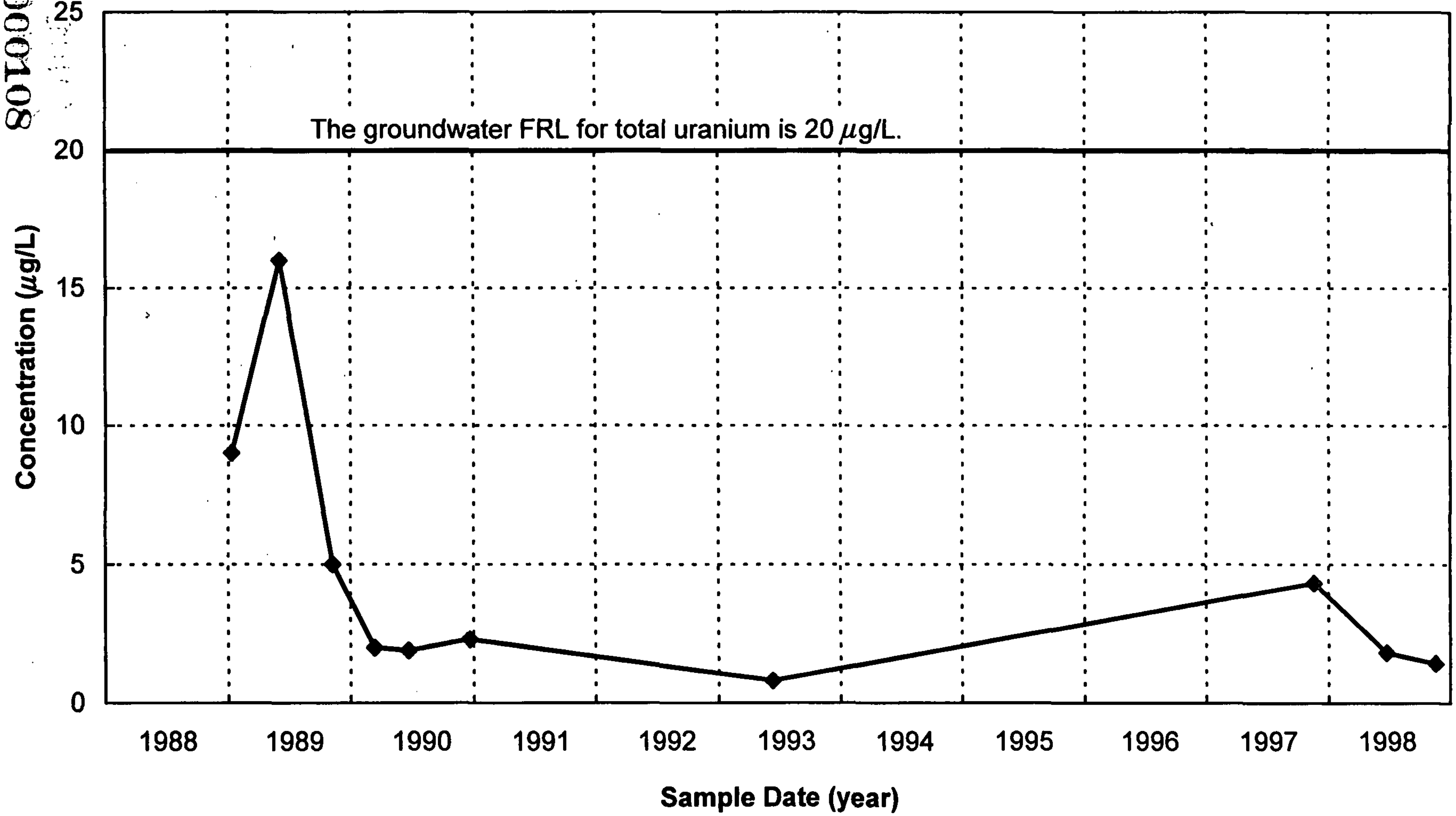

FIGURE A.2-34. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2118

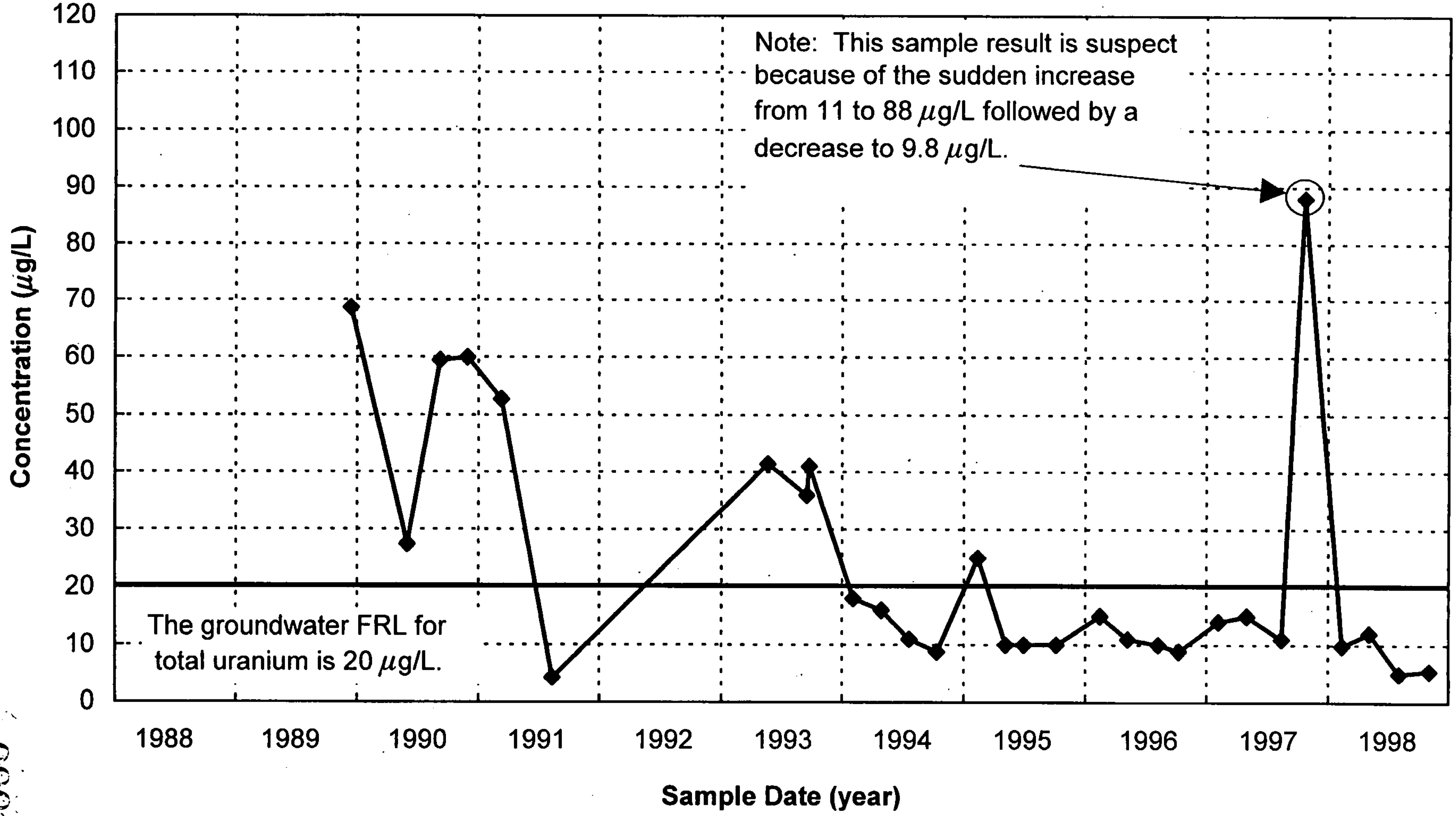

FIGURE A.2-35. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2125

000109

2272

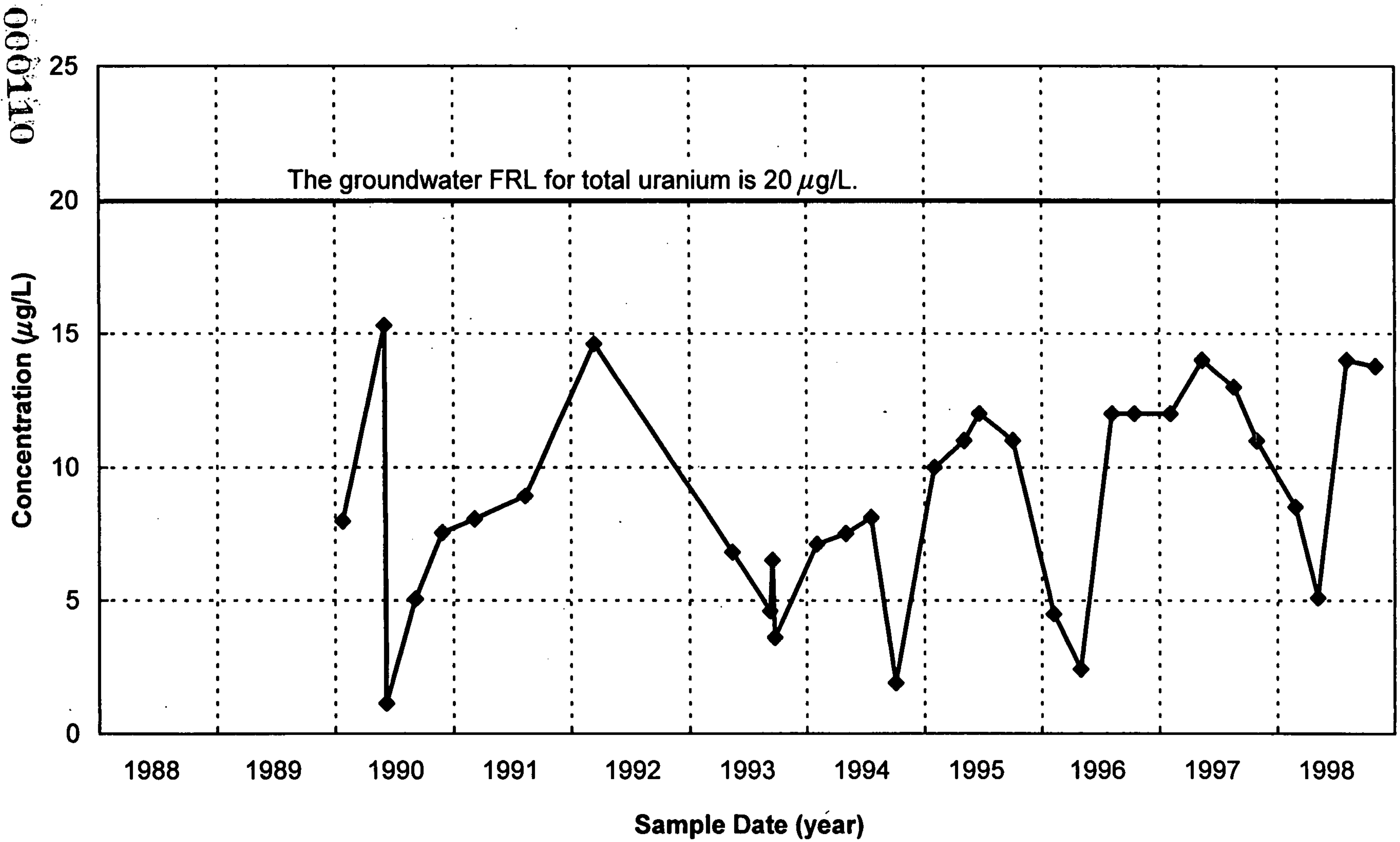

FIGURE A.2-36. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2128

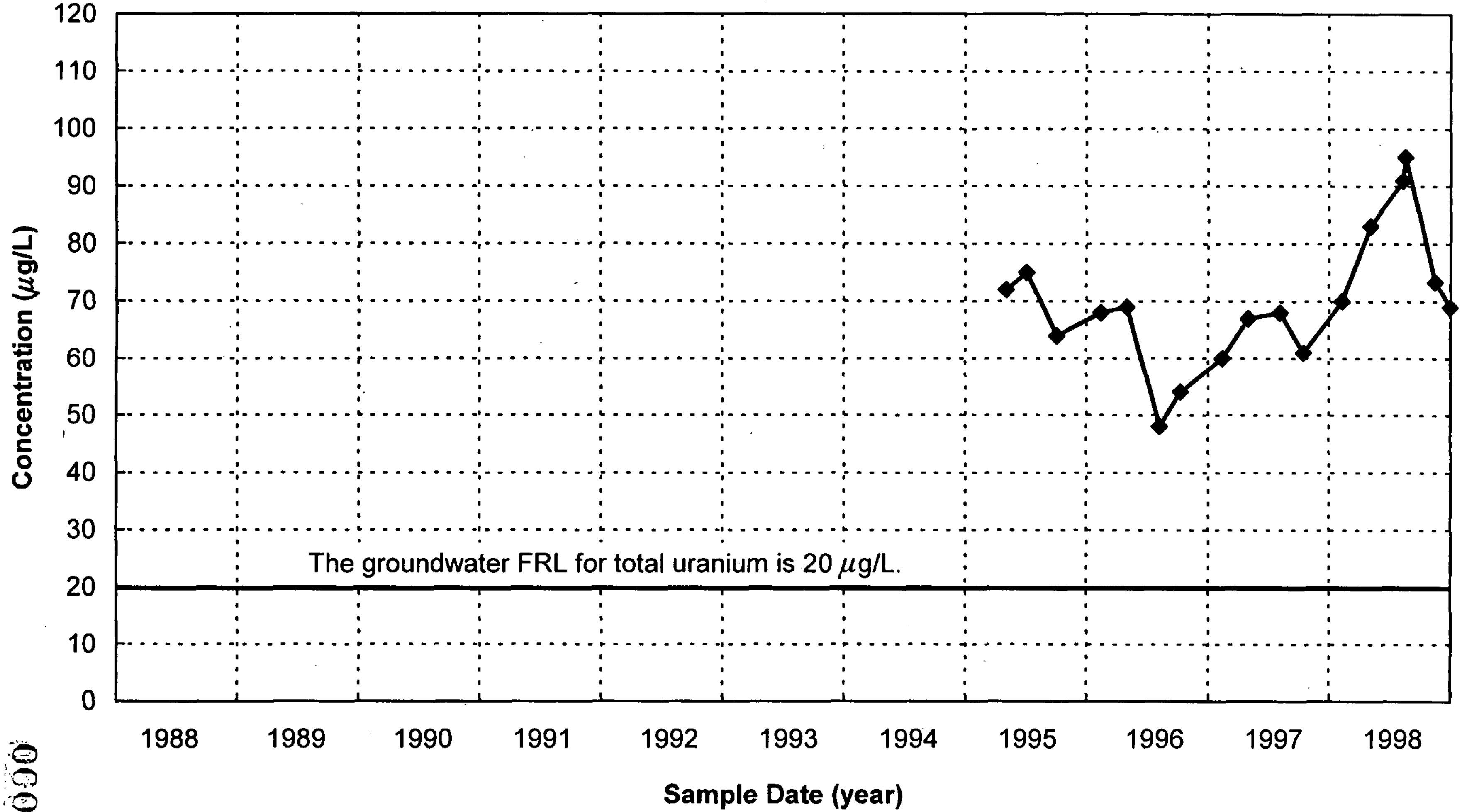

FIGURE A.2-37. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2166

000111

2272

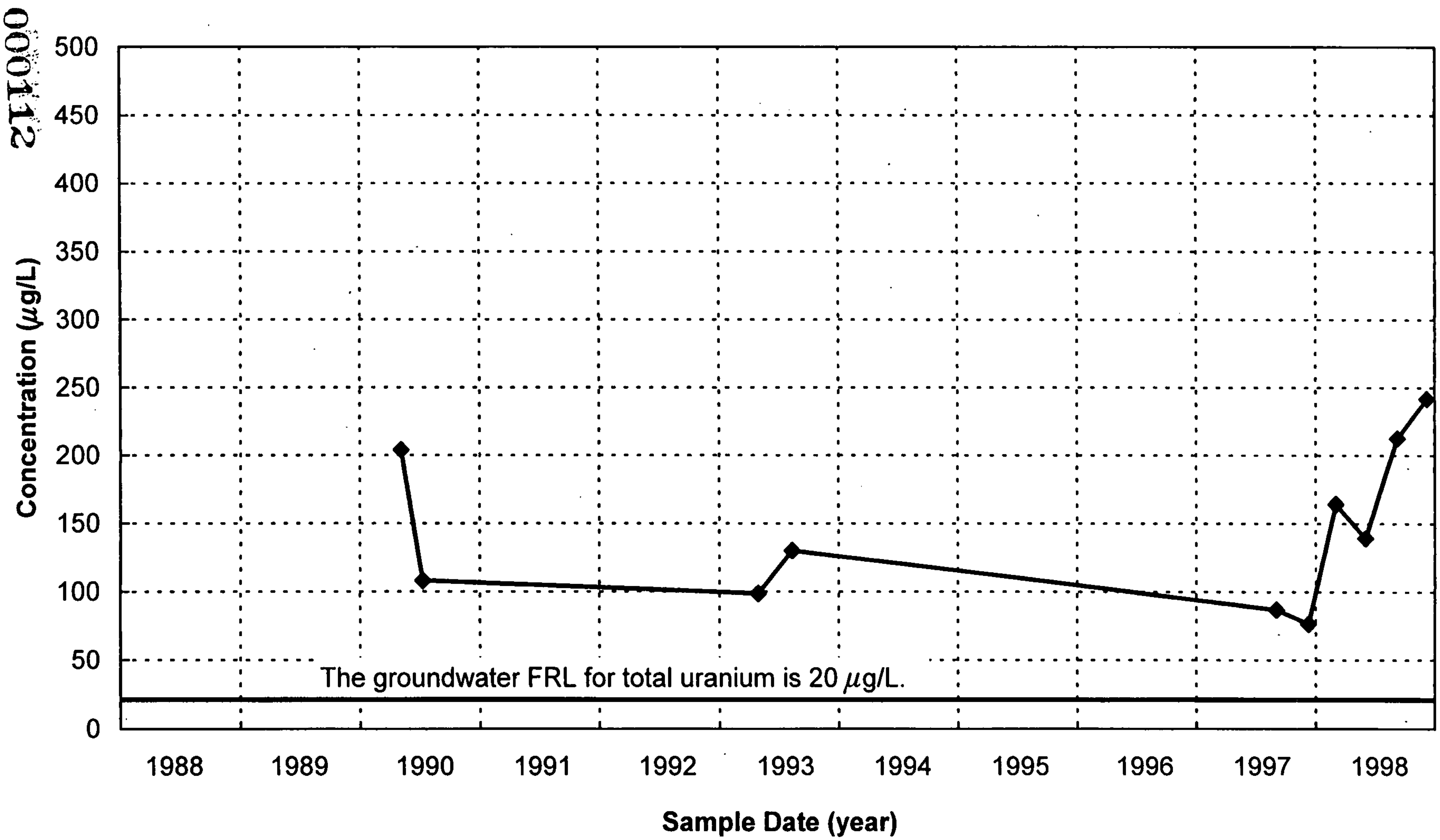

FIGURE A.2-38. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2385

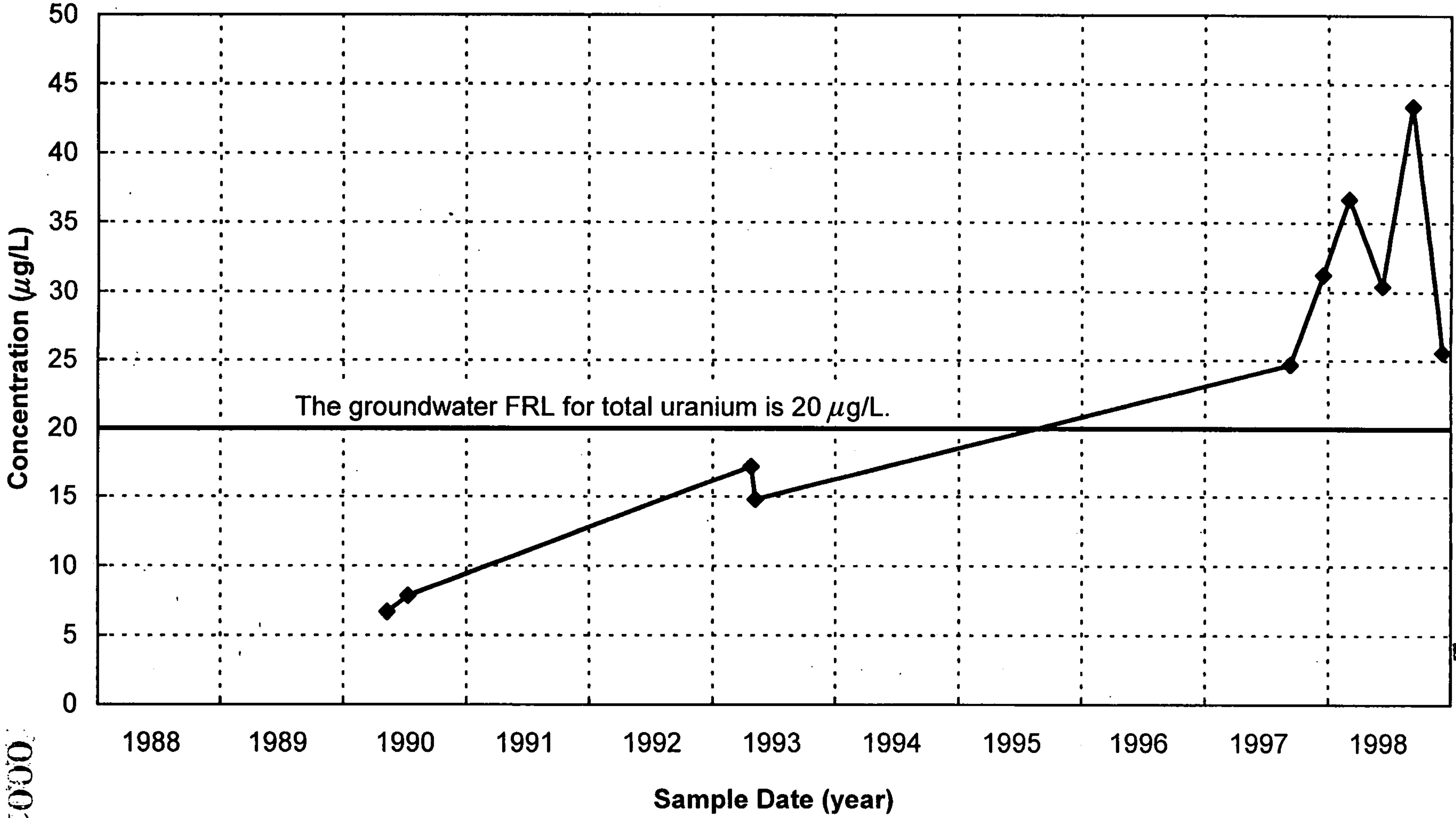

FIGURE A.2-39. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2386

000113

2272

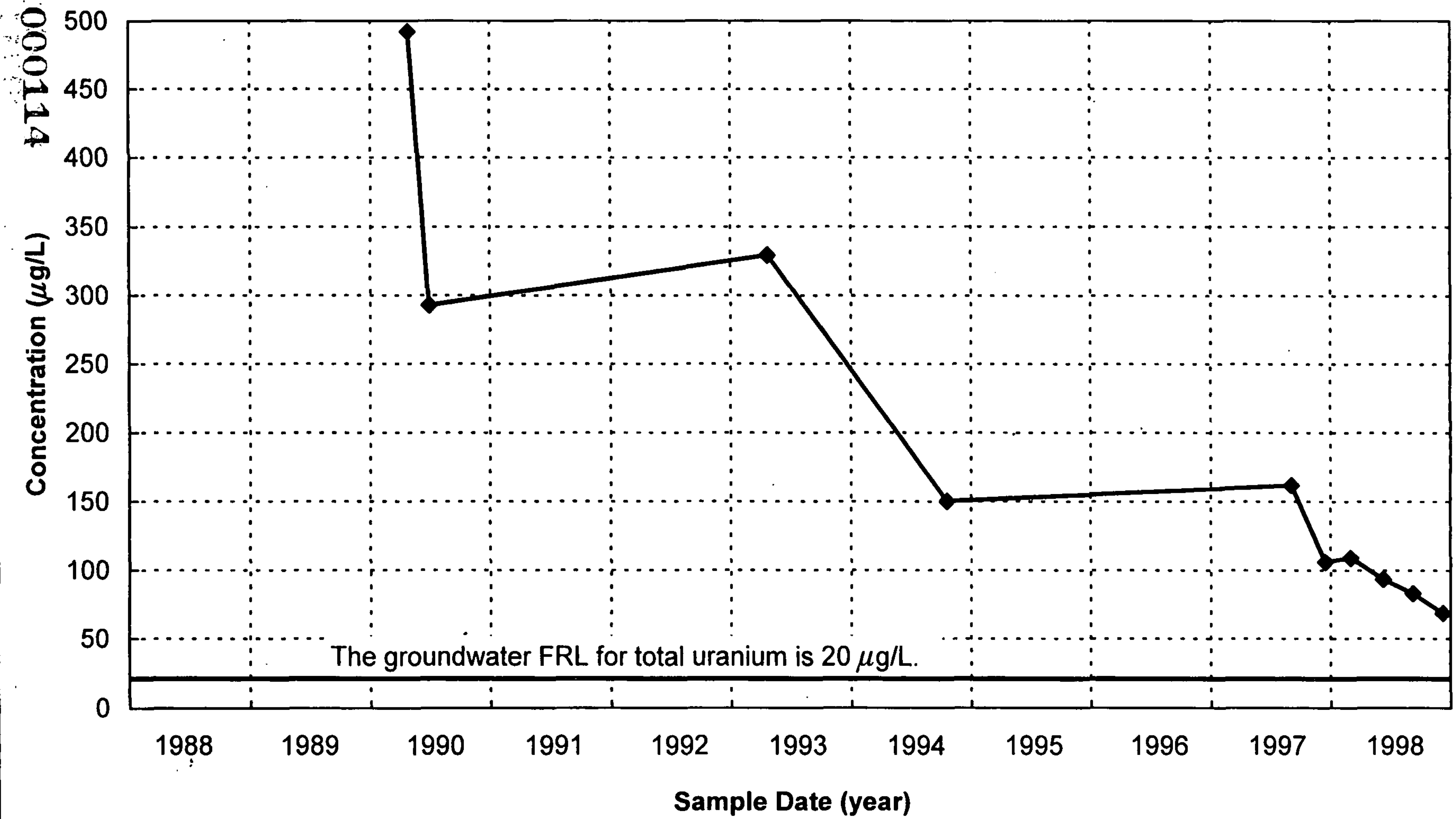

FIGURE A.2-40. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2387

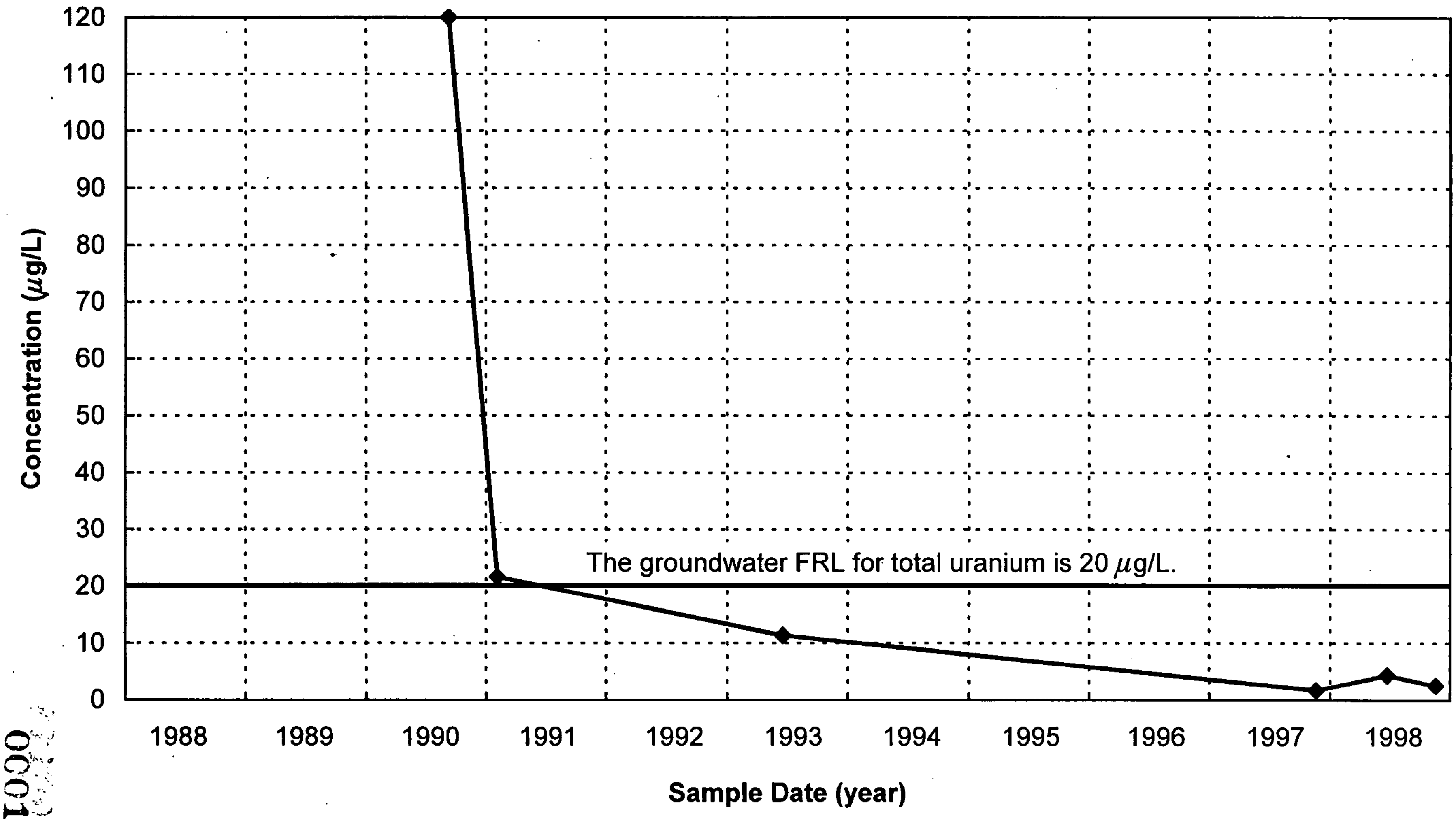

FIGURE A.2-41. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2389

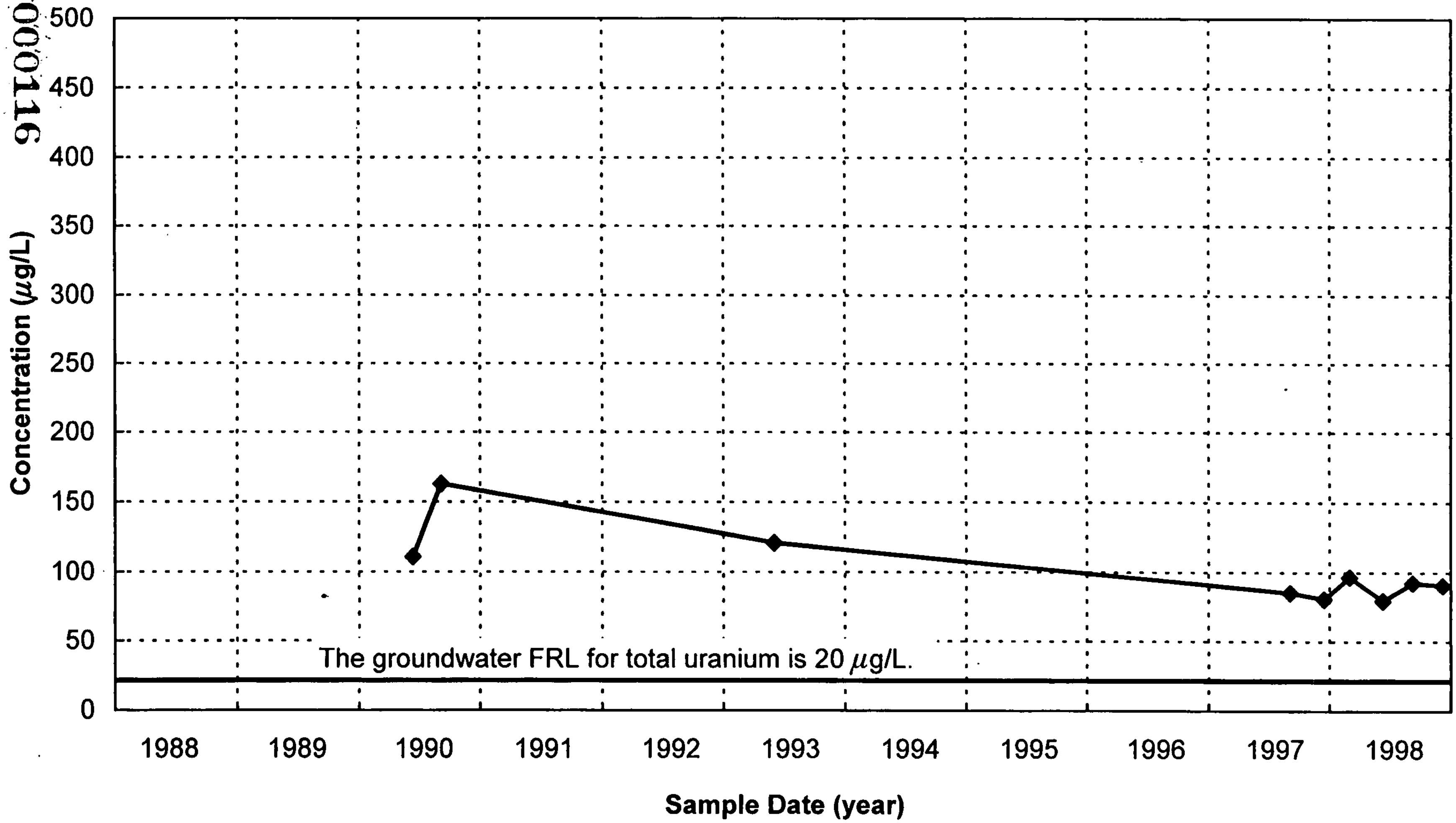

FIGURE A.2-42. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2390

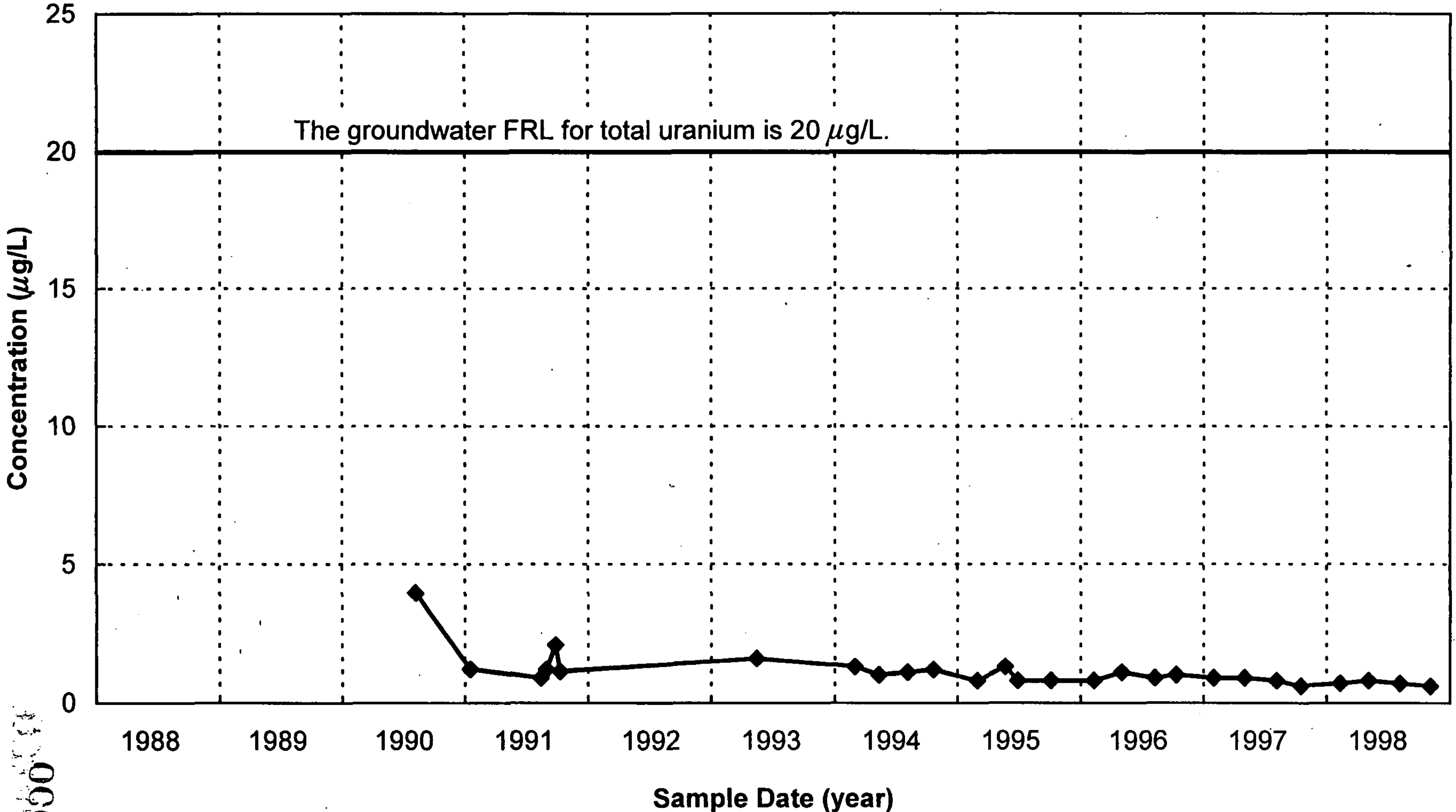

FIGURE A.2-43. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2396

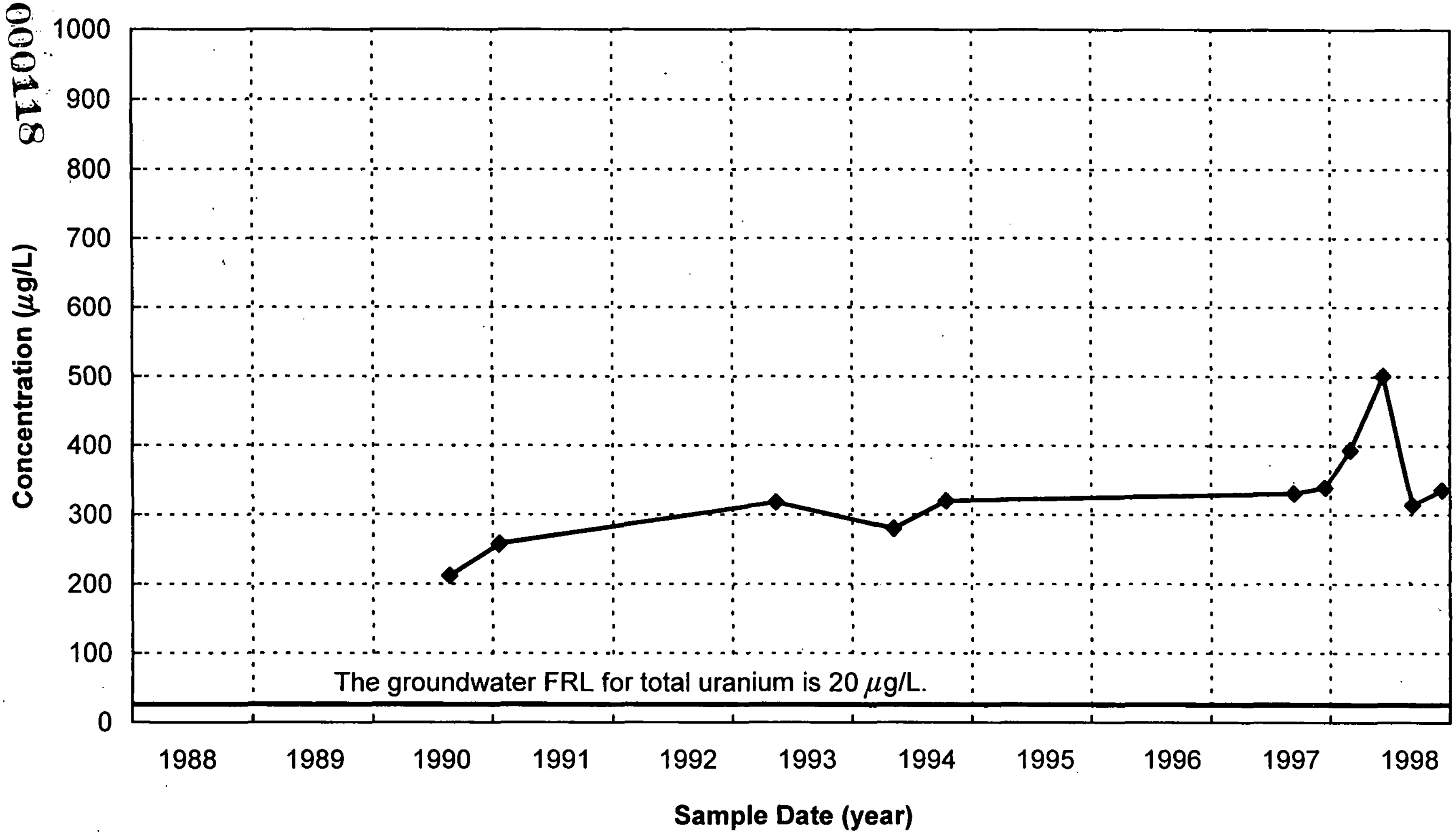

FIGURE A.2-44. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2397

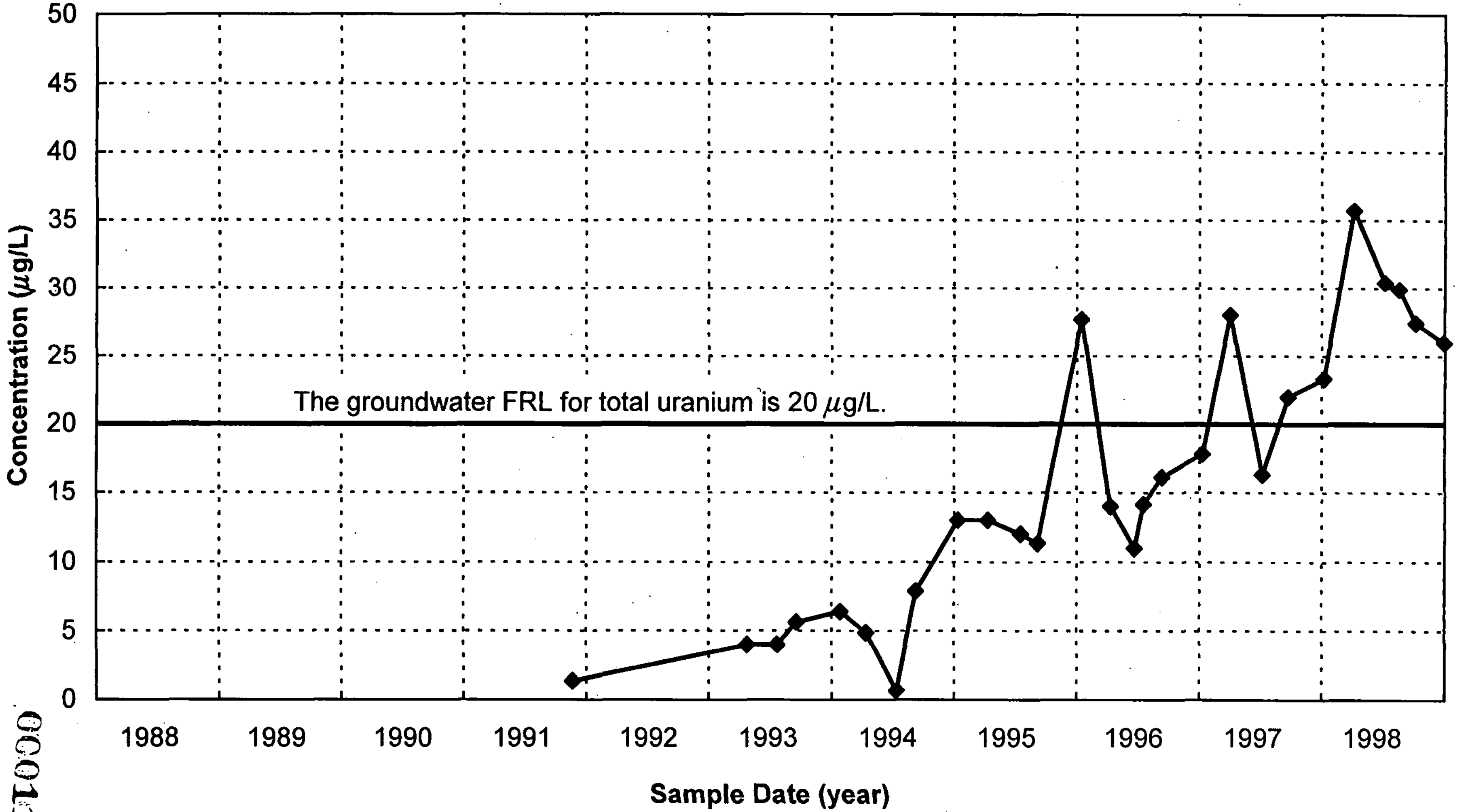

FIGURE A.2-45. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2398

000119

2272

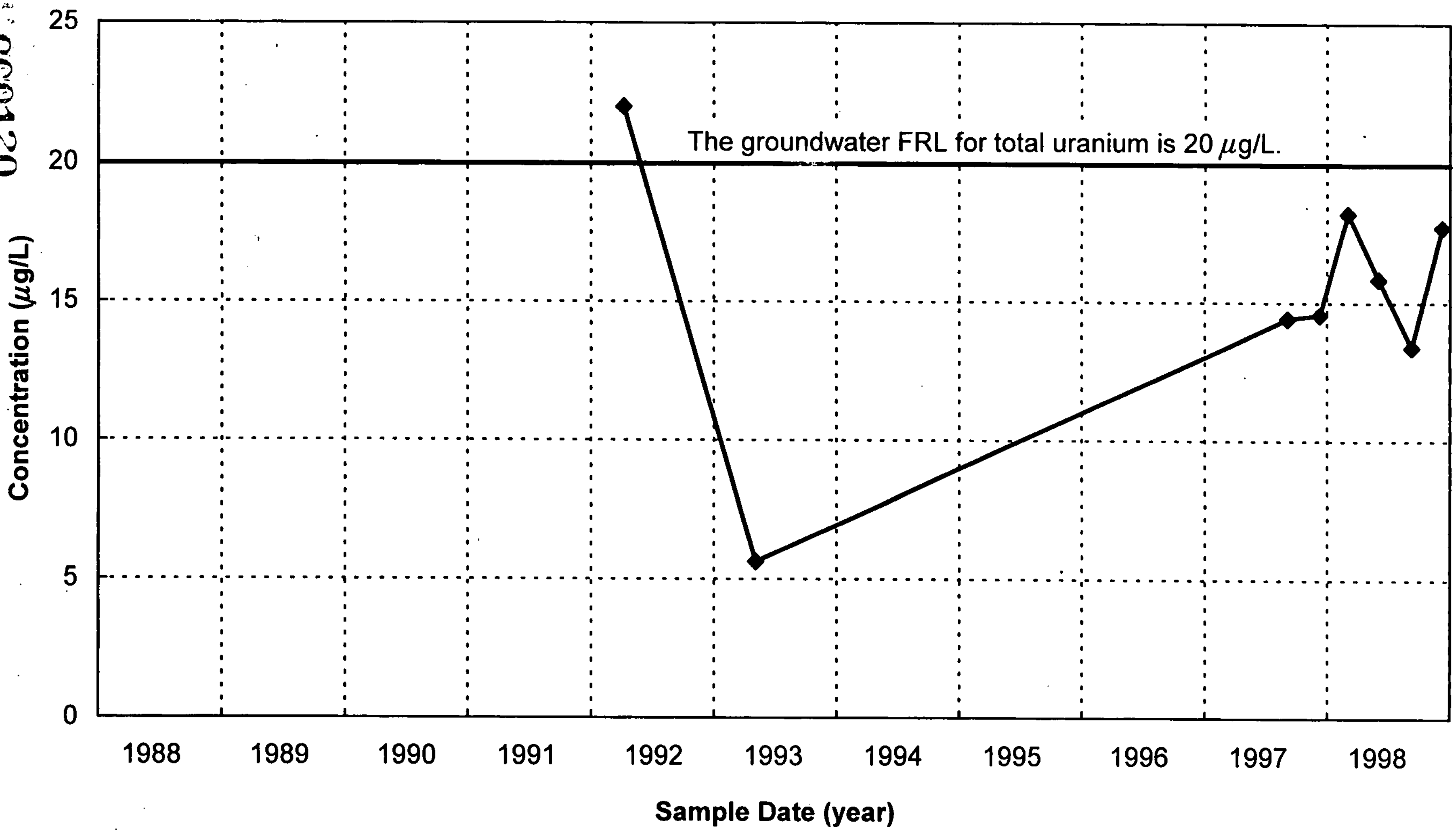

FIGURE A.2-46. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2402

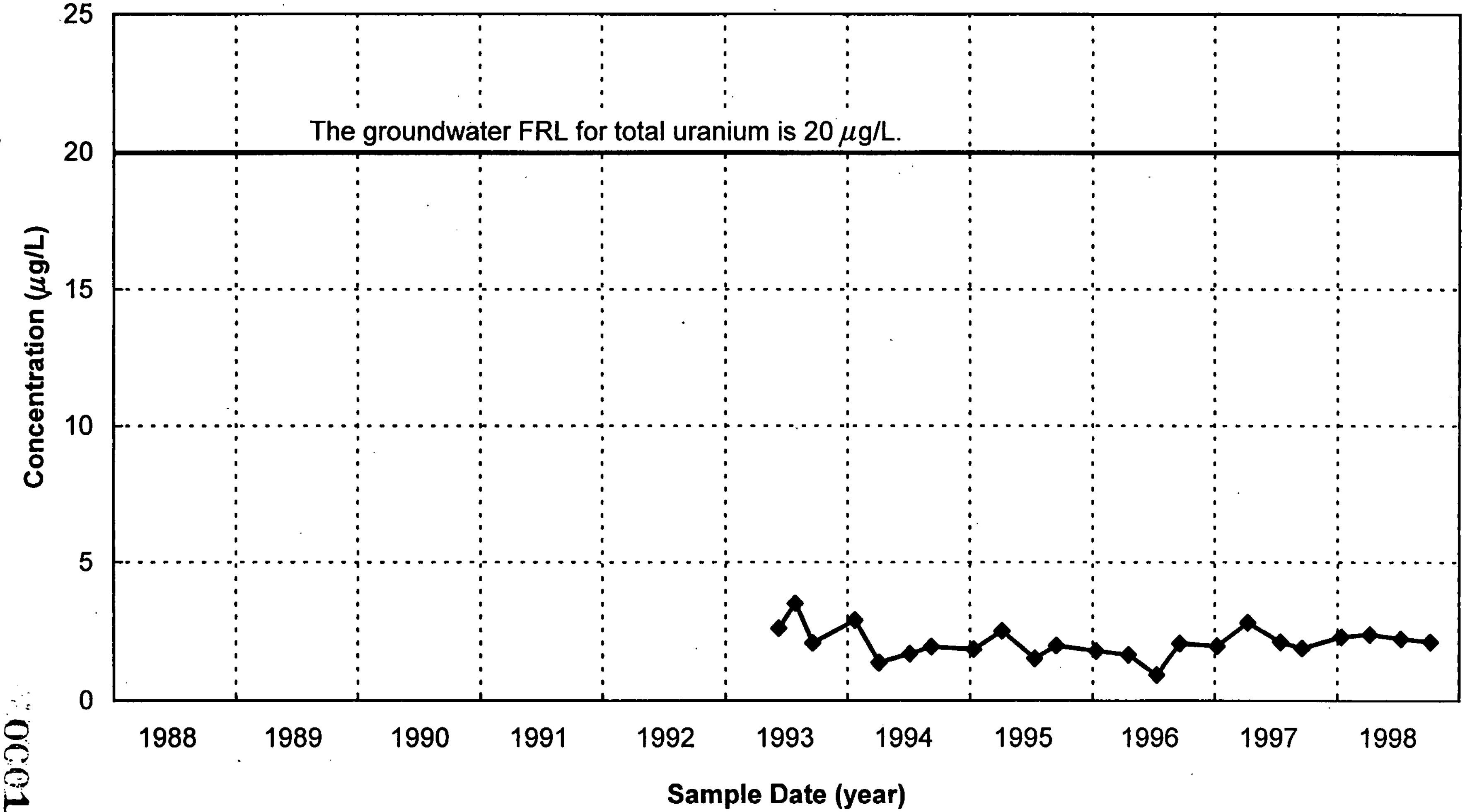

FIGURE A.2-47. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2417

000121

2272

000122

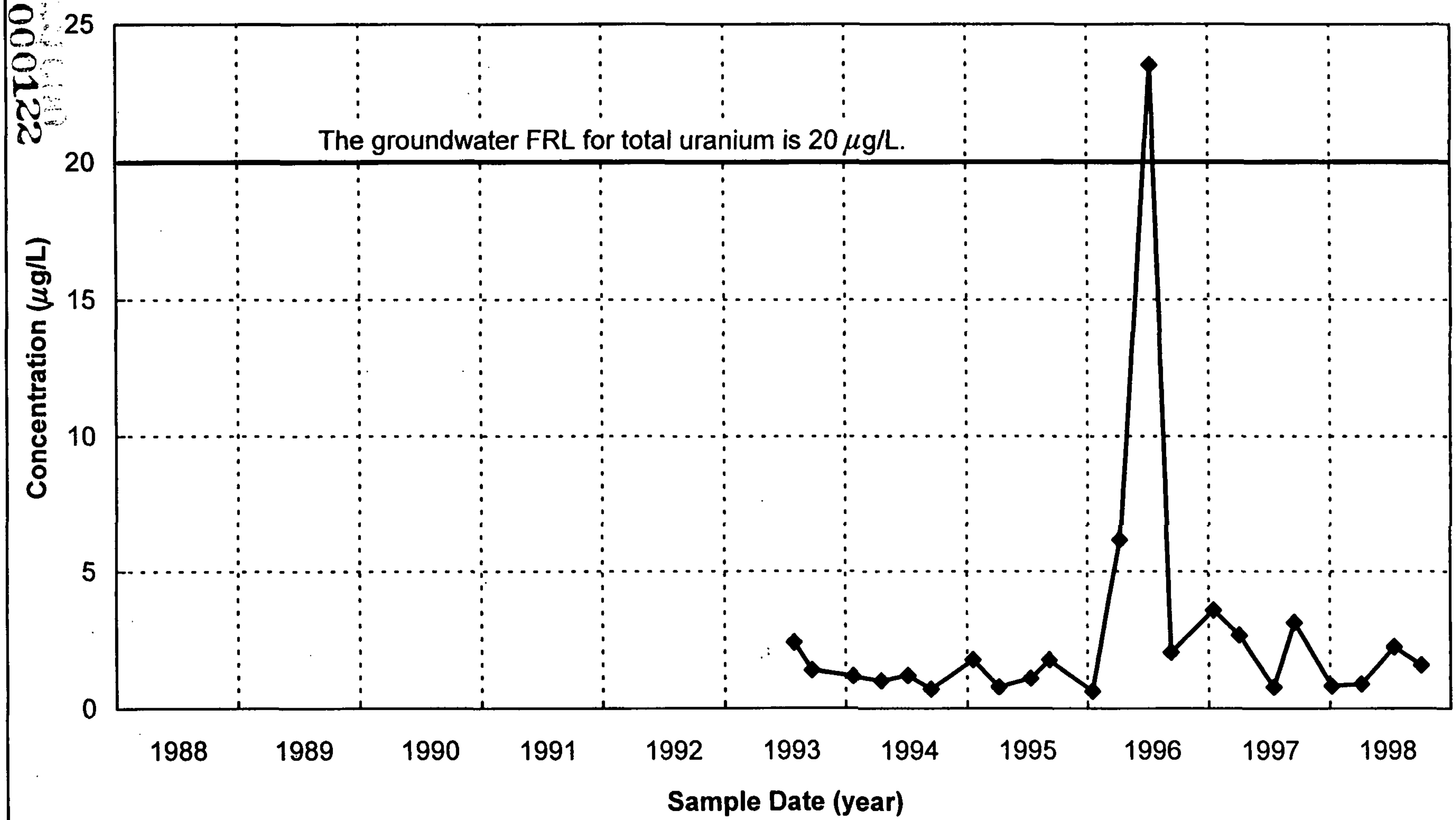

FIGURE A.2-48. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2424

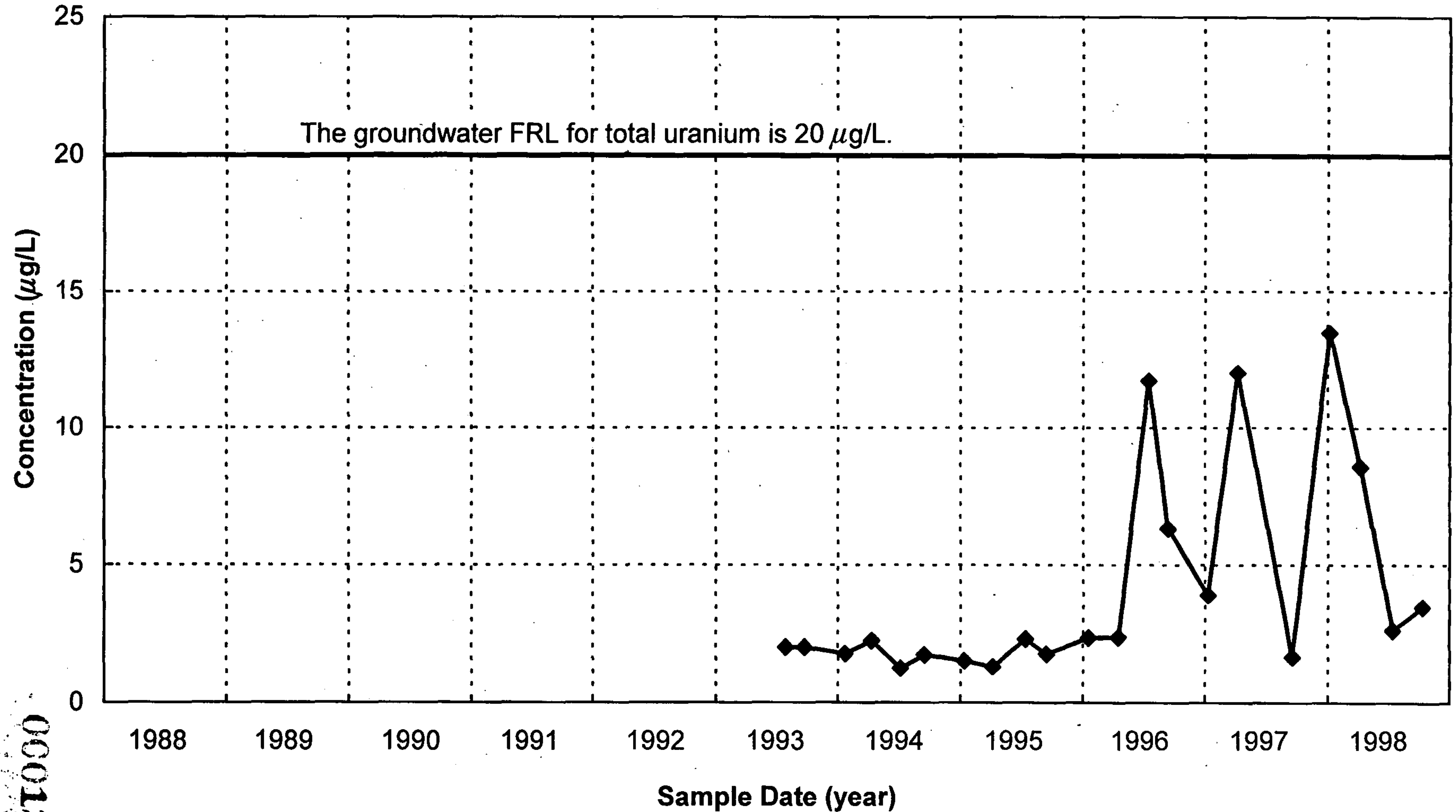

FIGURE A.2-49. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2426

000123

2272

000124

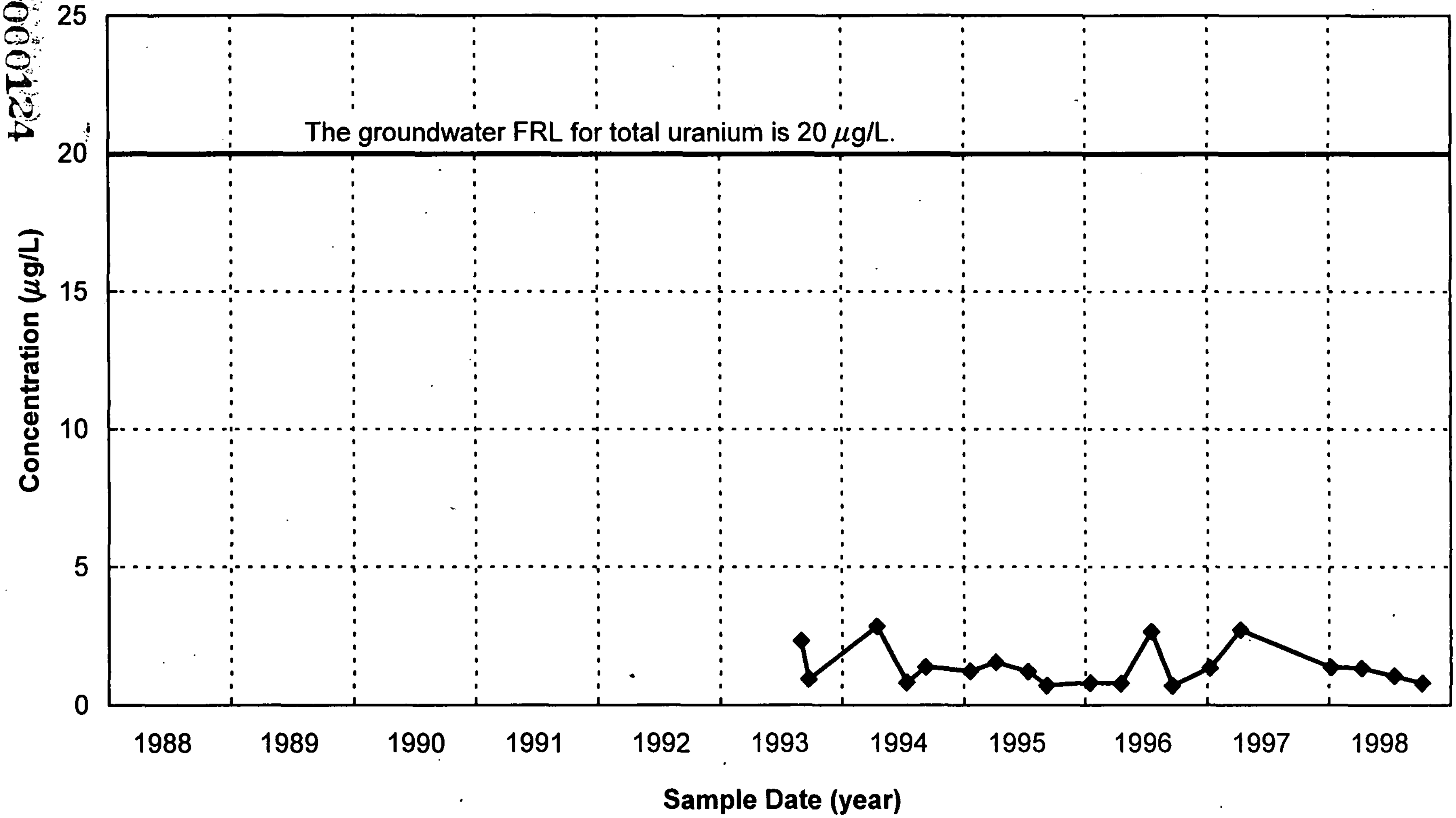

FIGURE A.2-50. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2429

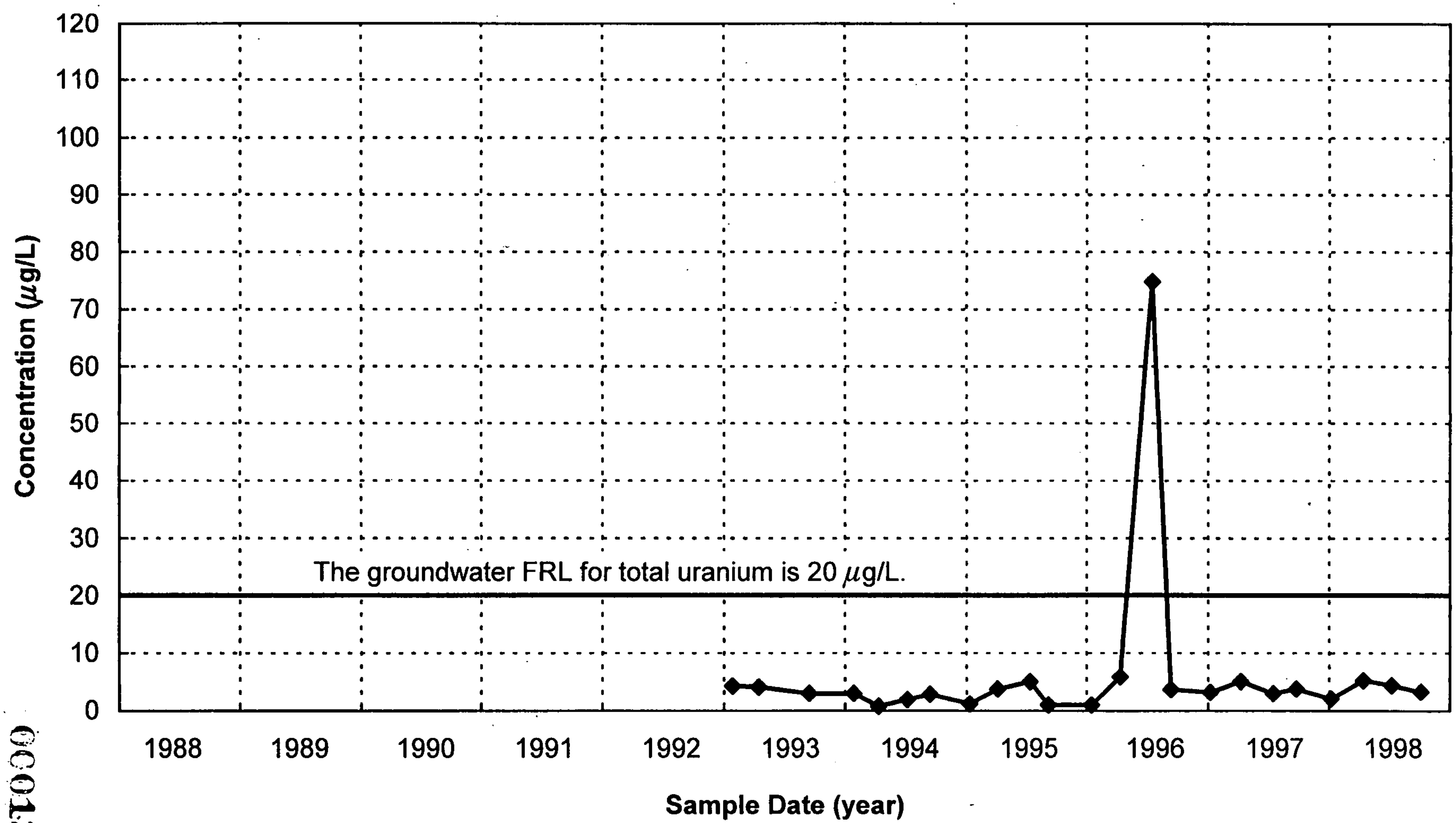

FIGURE A.2-51. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2430

000125

2272

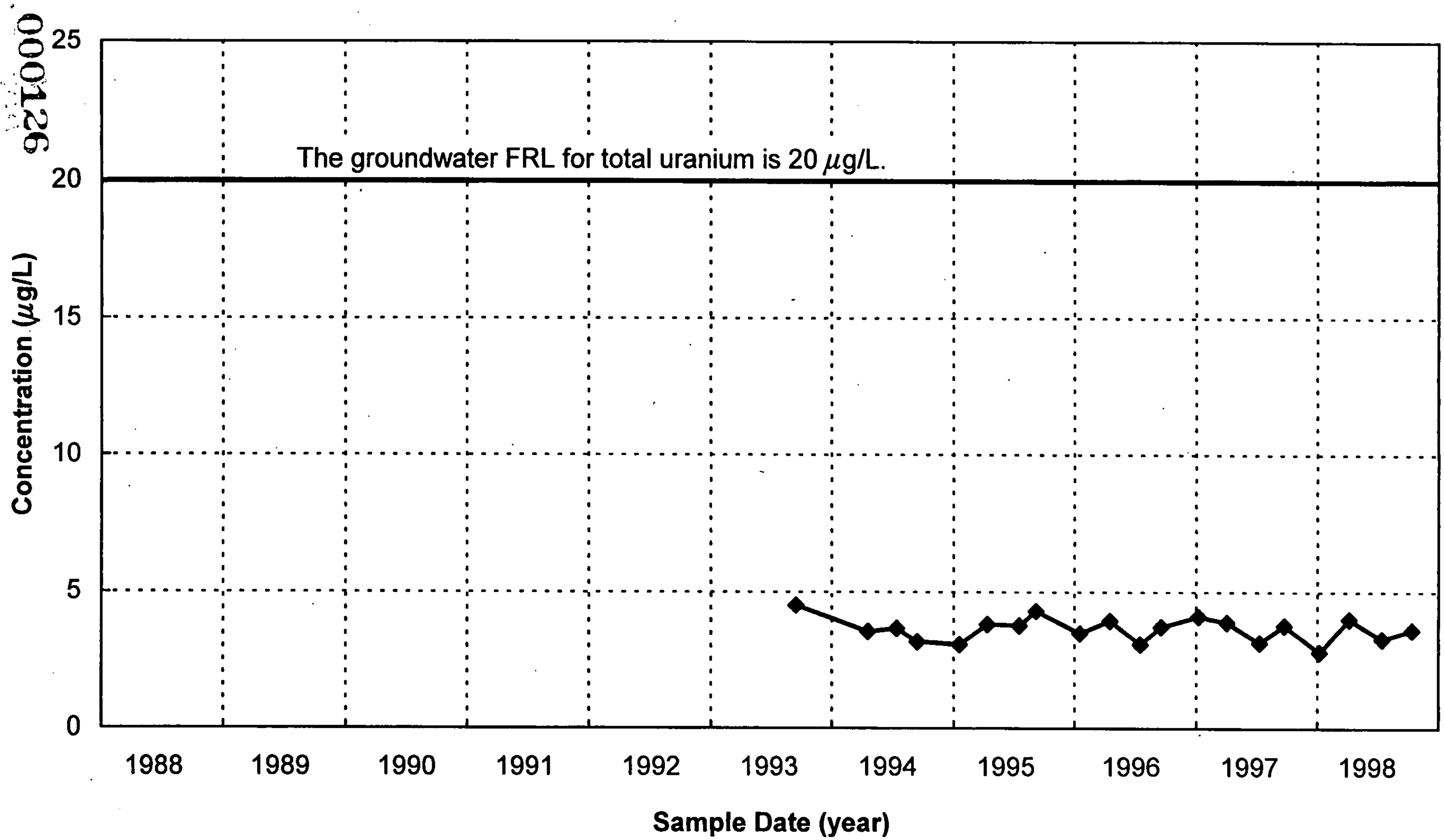

FIGURE A.2-52. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2431

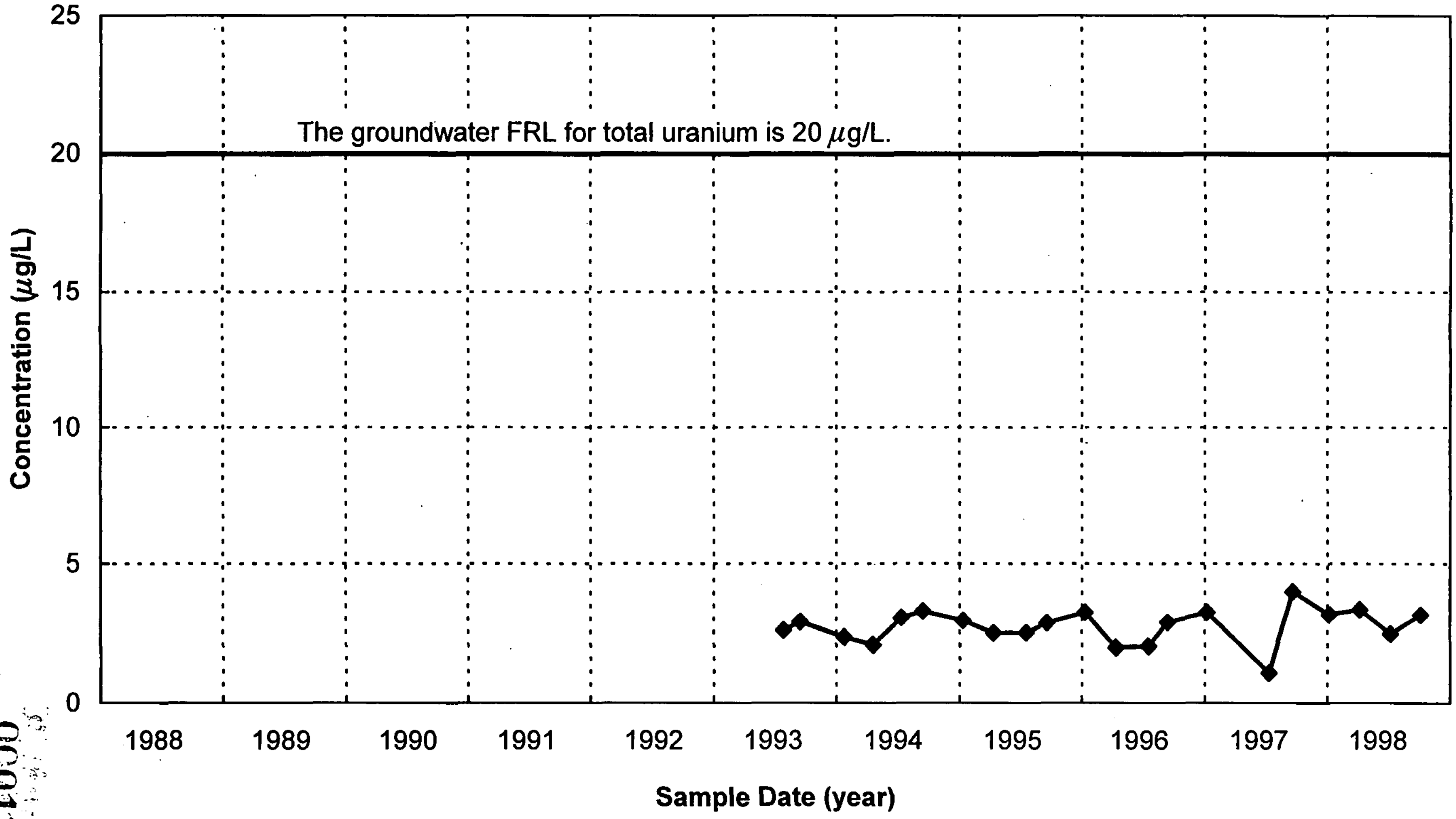

FIGURE A.2-53. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2432

000127

2272

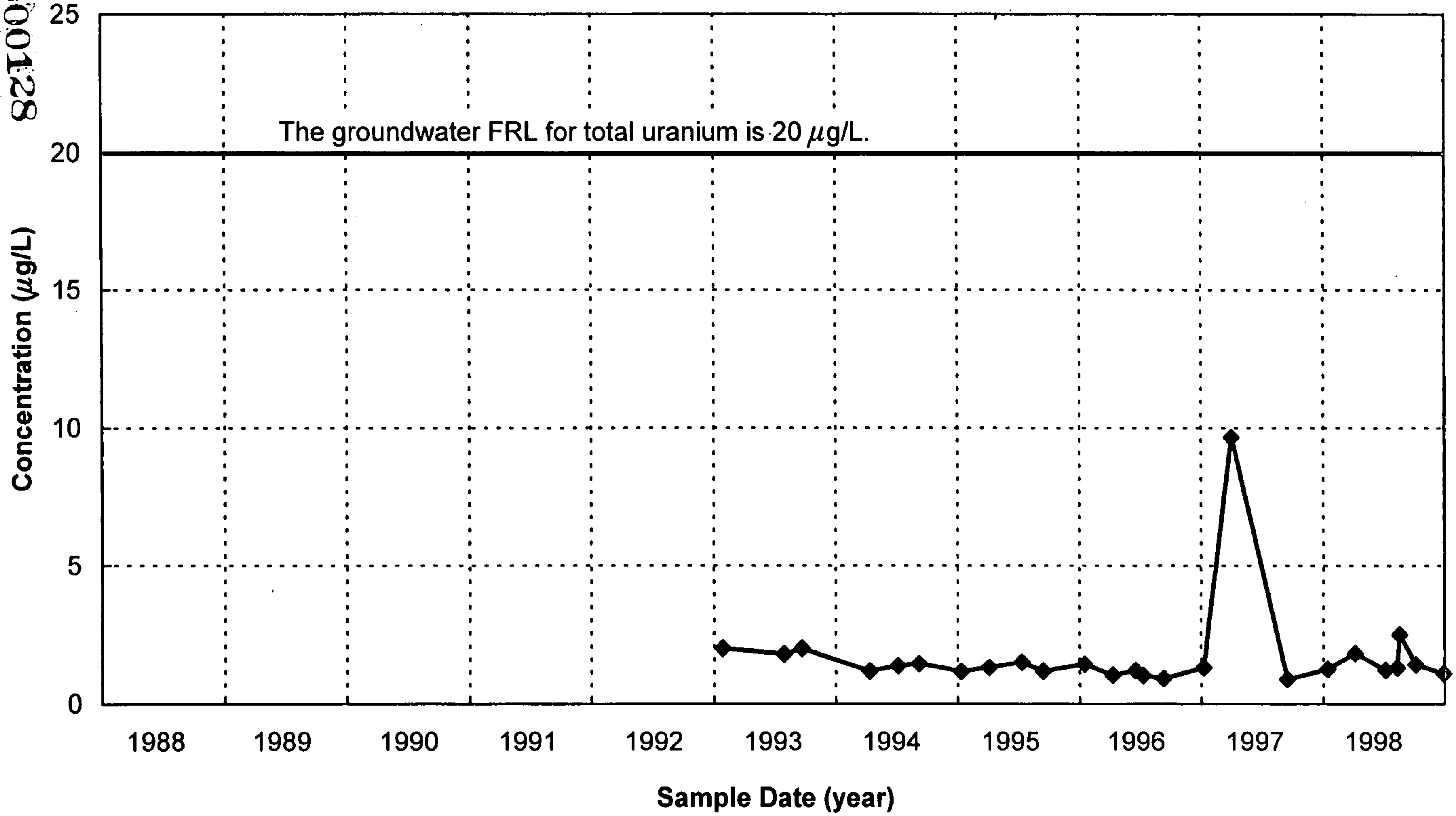

FIGURE A.2-54. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2434

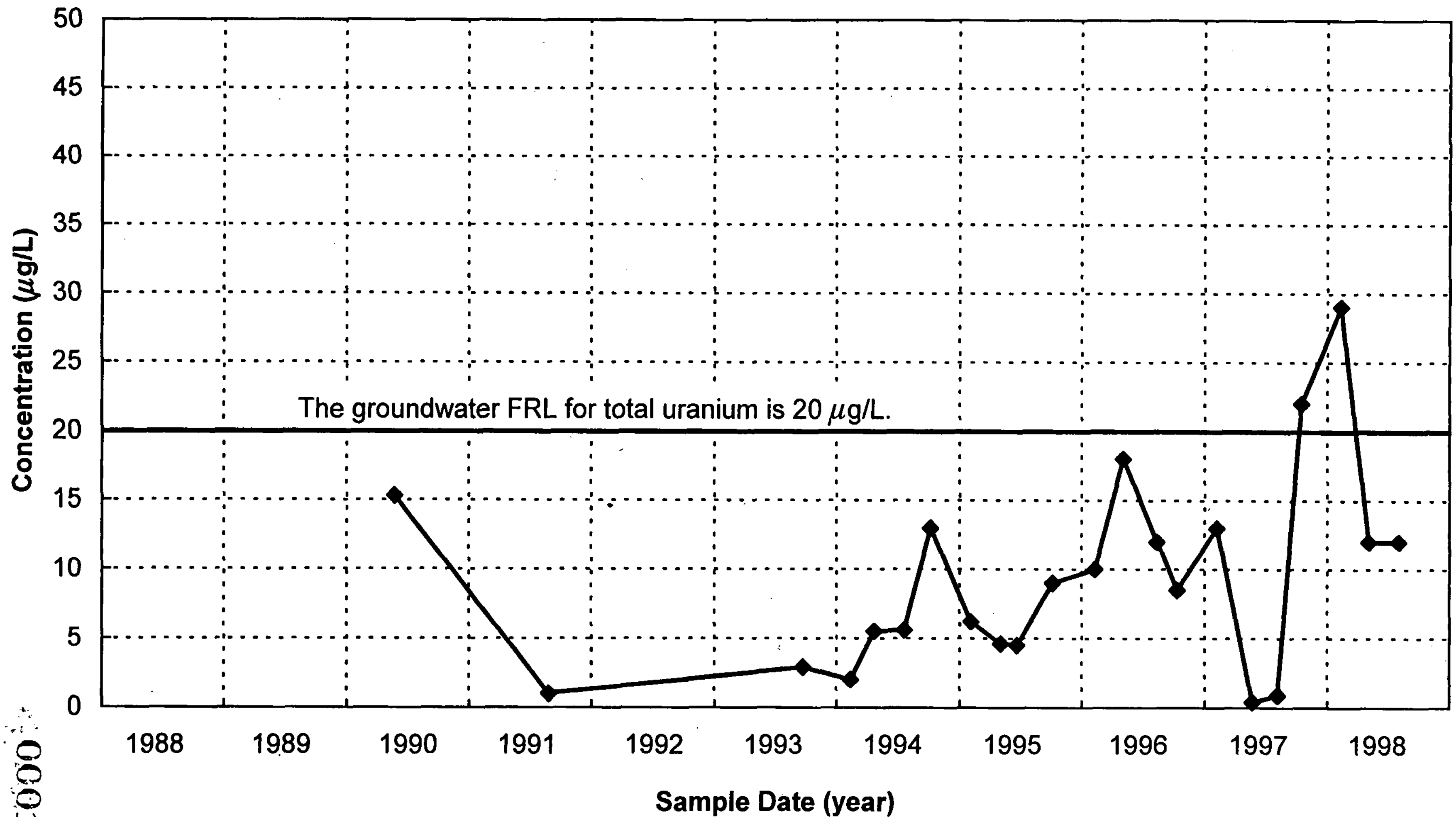

FIGURE A.2-55. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2544

000129

2272

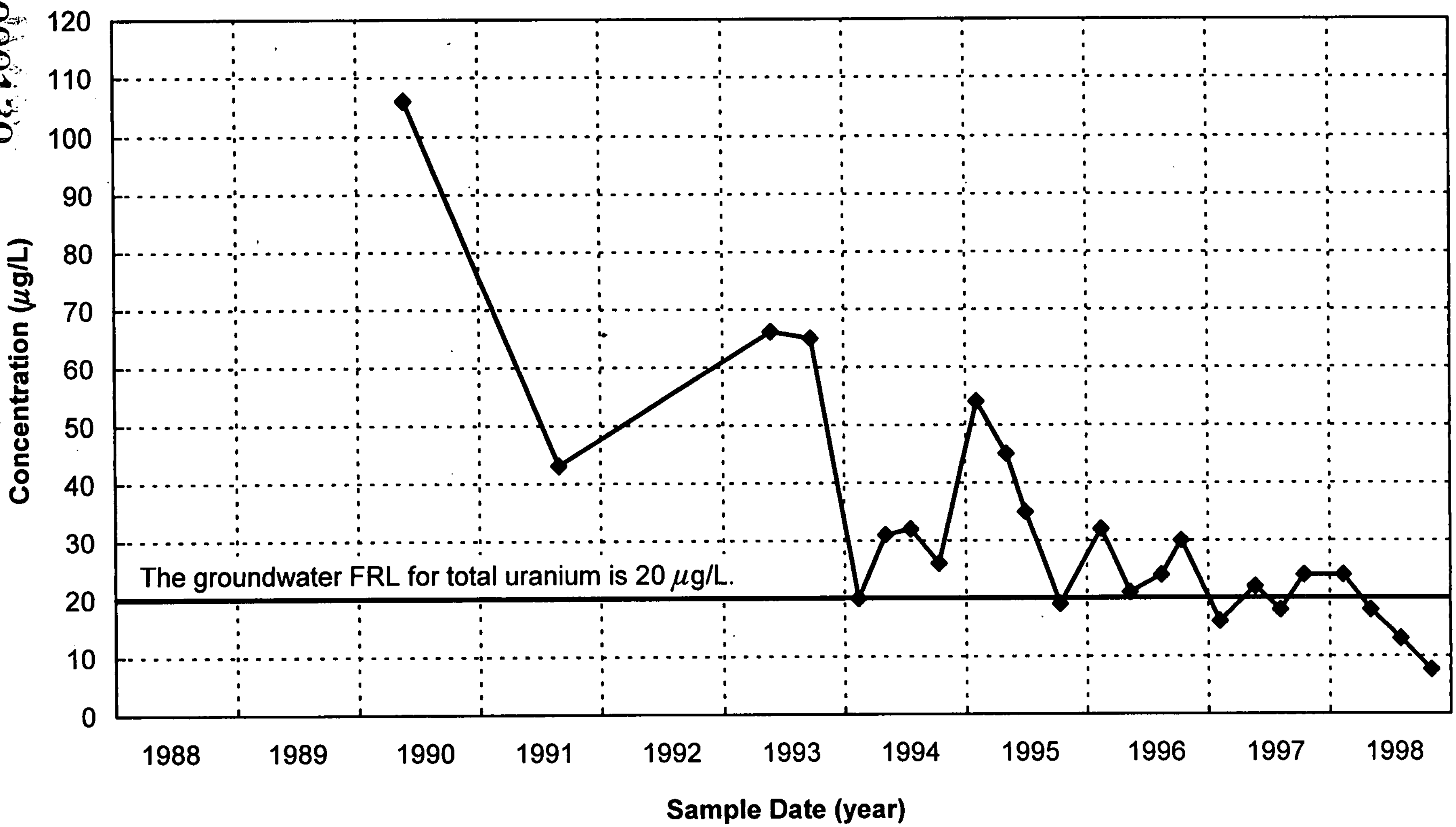

FIGURE A.2-56. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2545

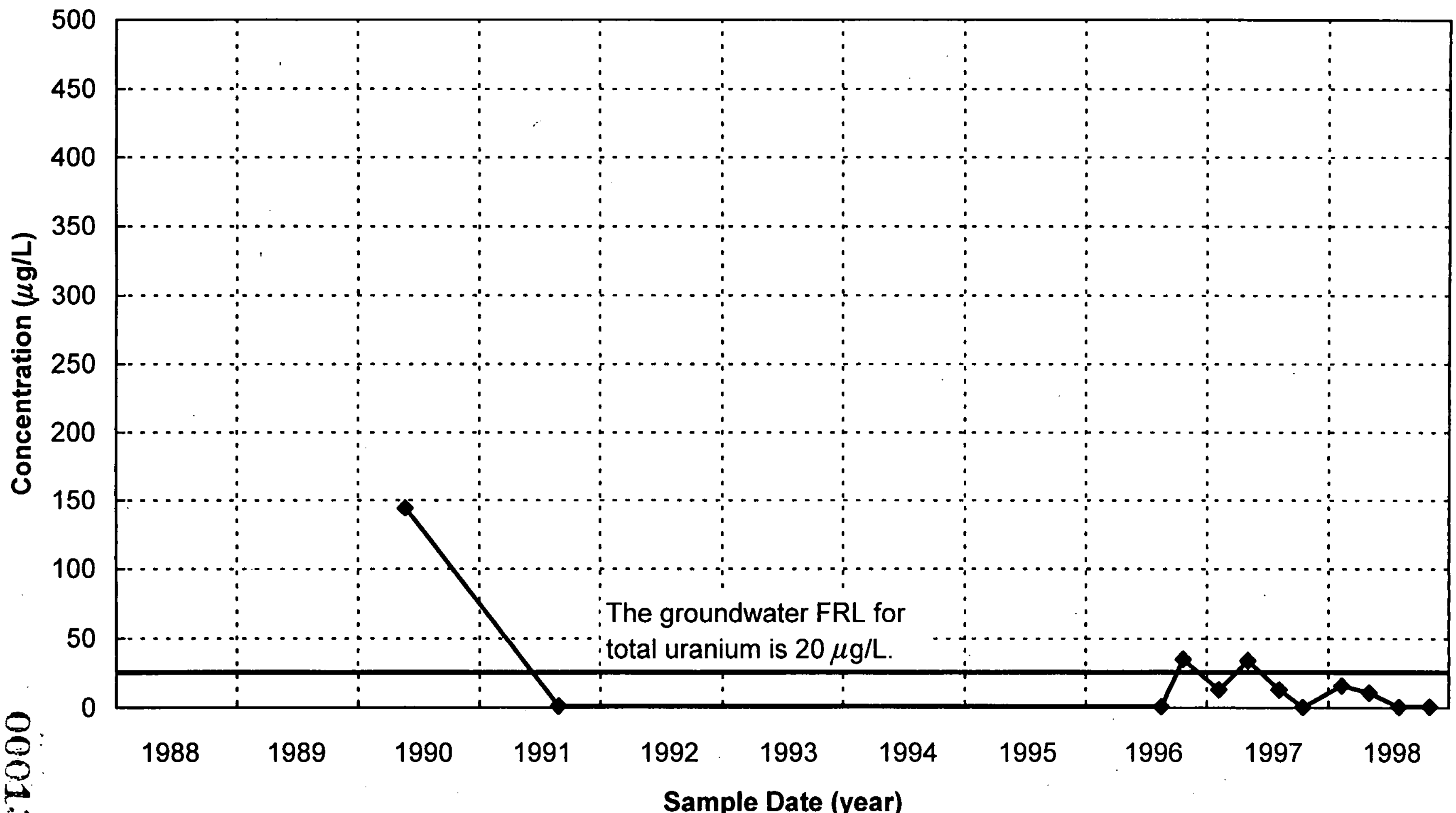

FIGURE A.2-57. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2546

000131

2272

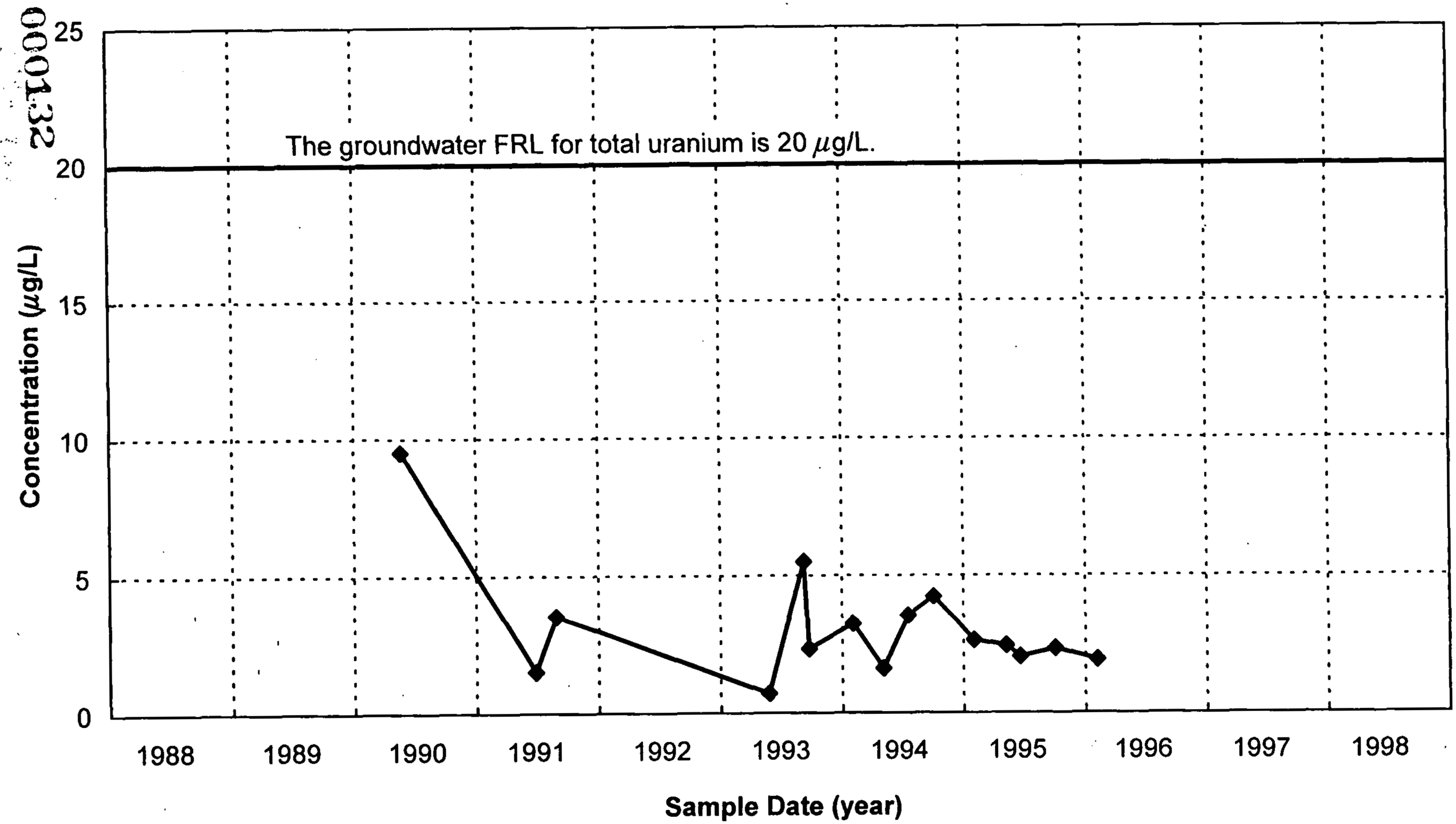

FIGURE A.2-58. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2548

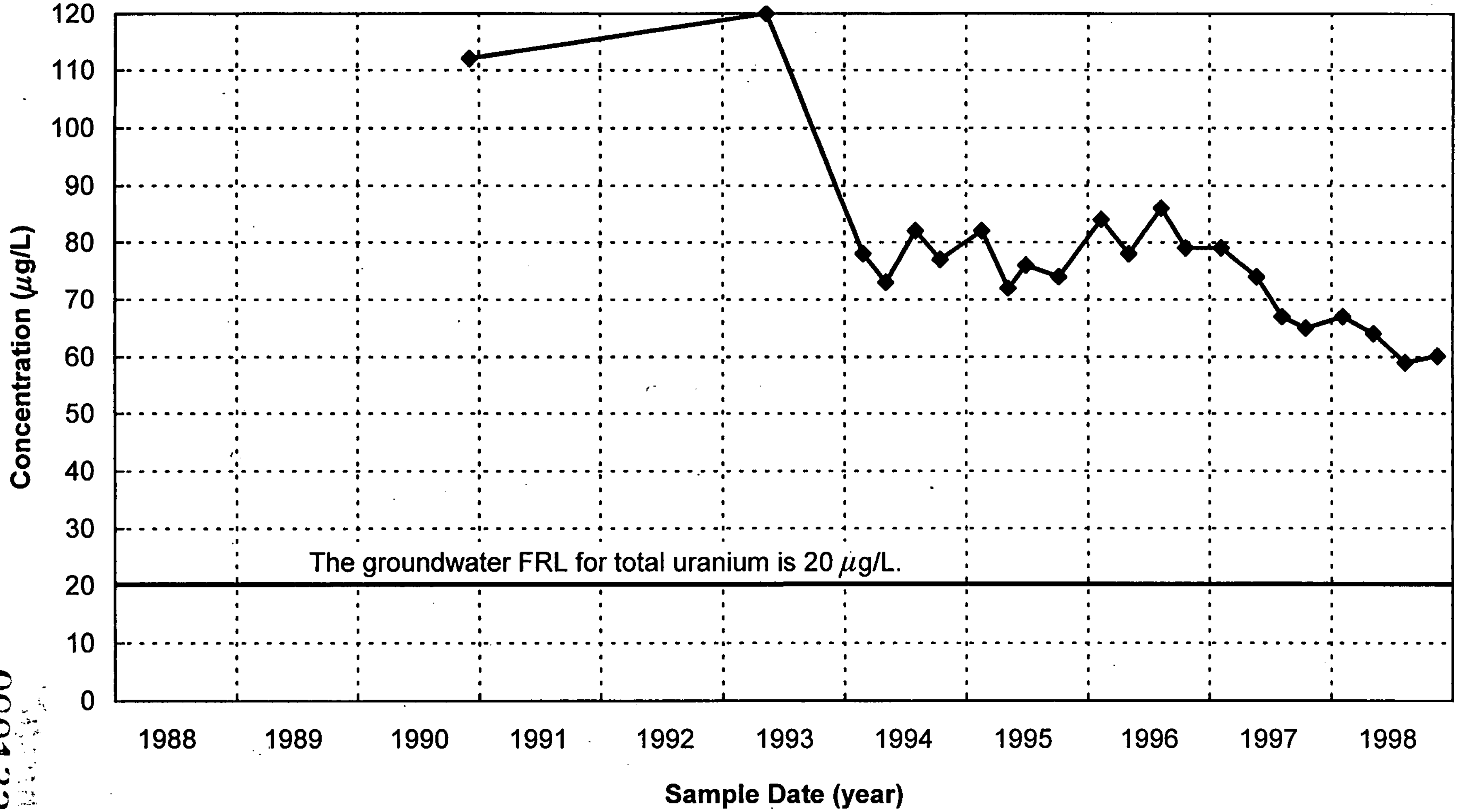

FIGURE A.2-59. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2550

000133

2272

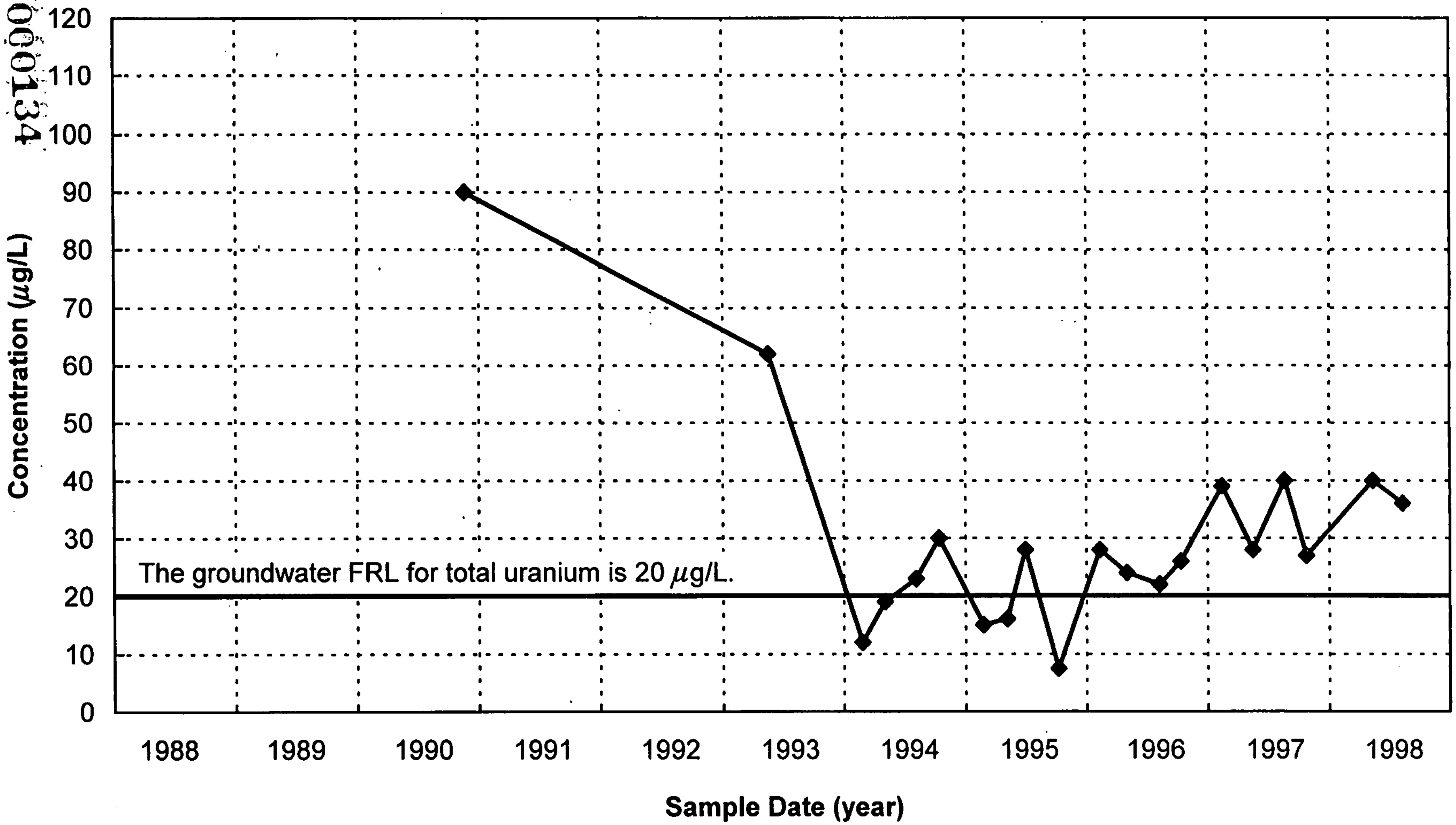

FIGURE A.2-60. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2551

000134

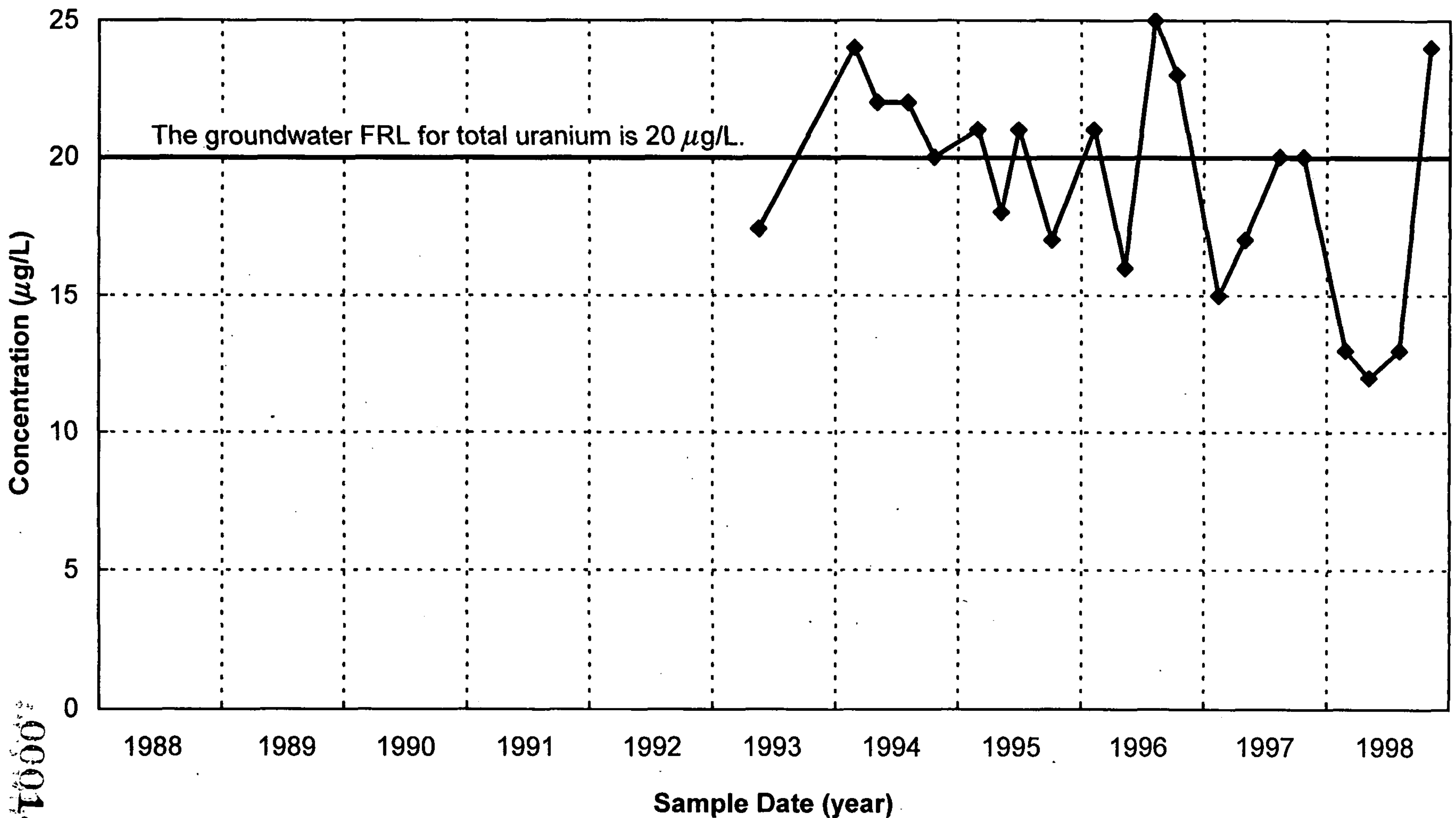

FIGURE A.2-61. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2552

000135

2272

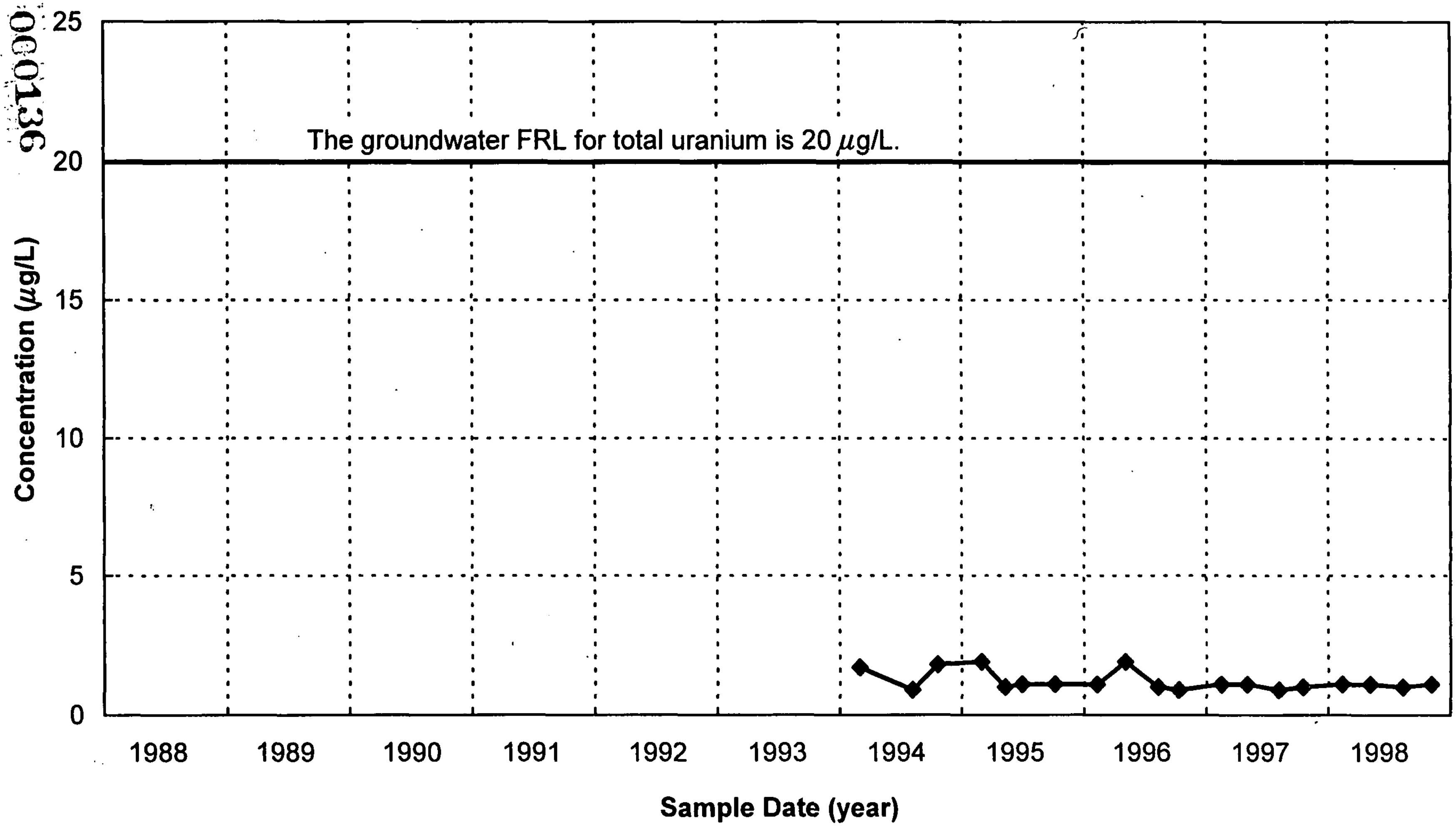

FIGURE A.2-62. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2553

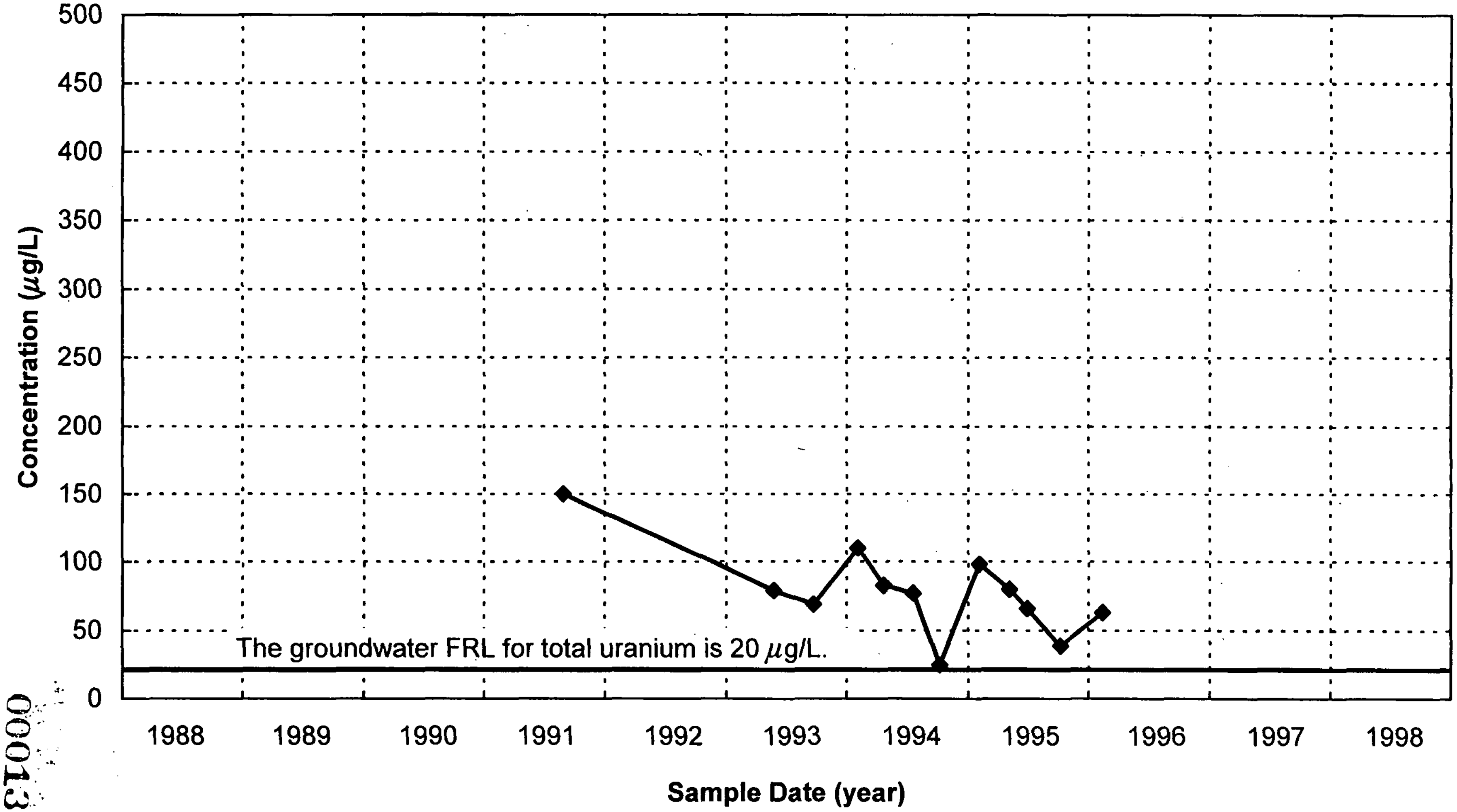

FIGURE A.2-63. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2624

000137

2272

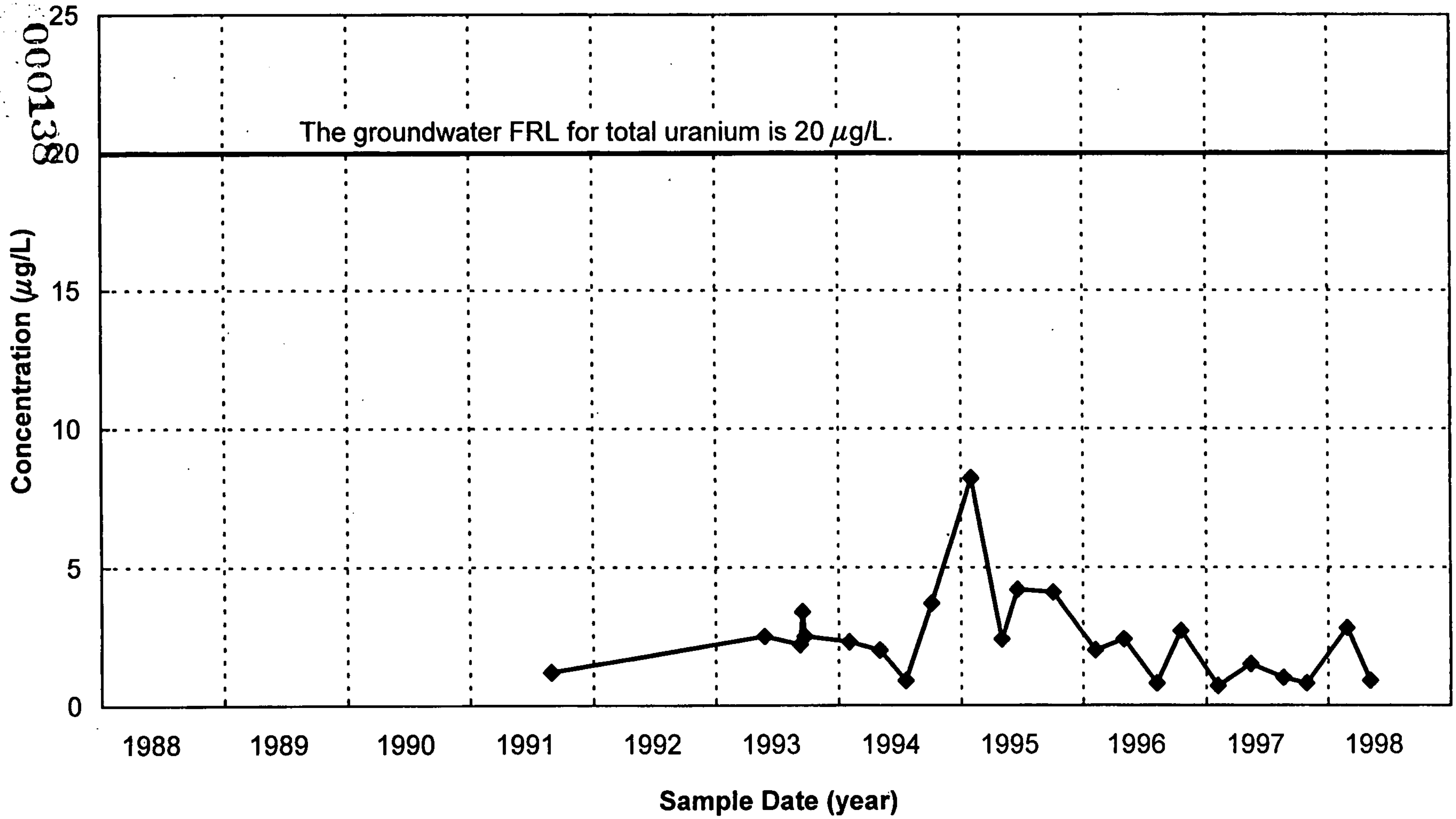

FIGURE A.2-64. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2625

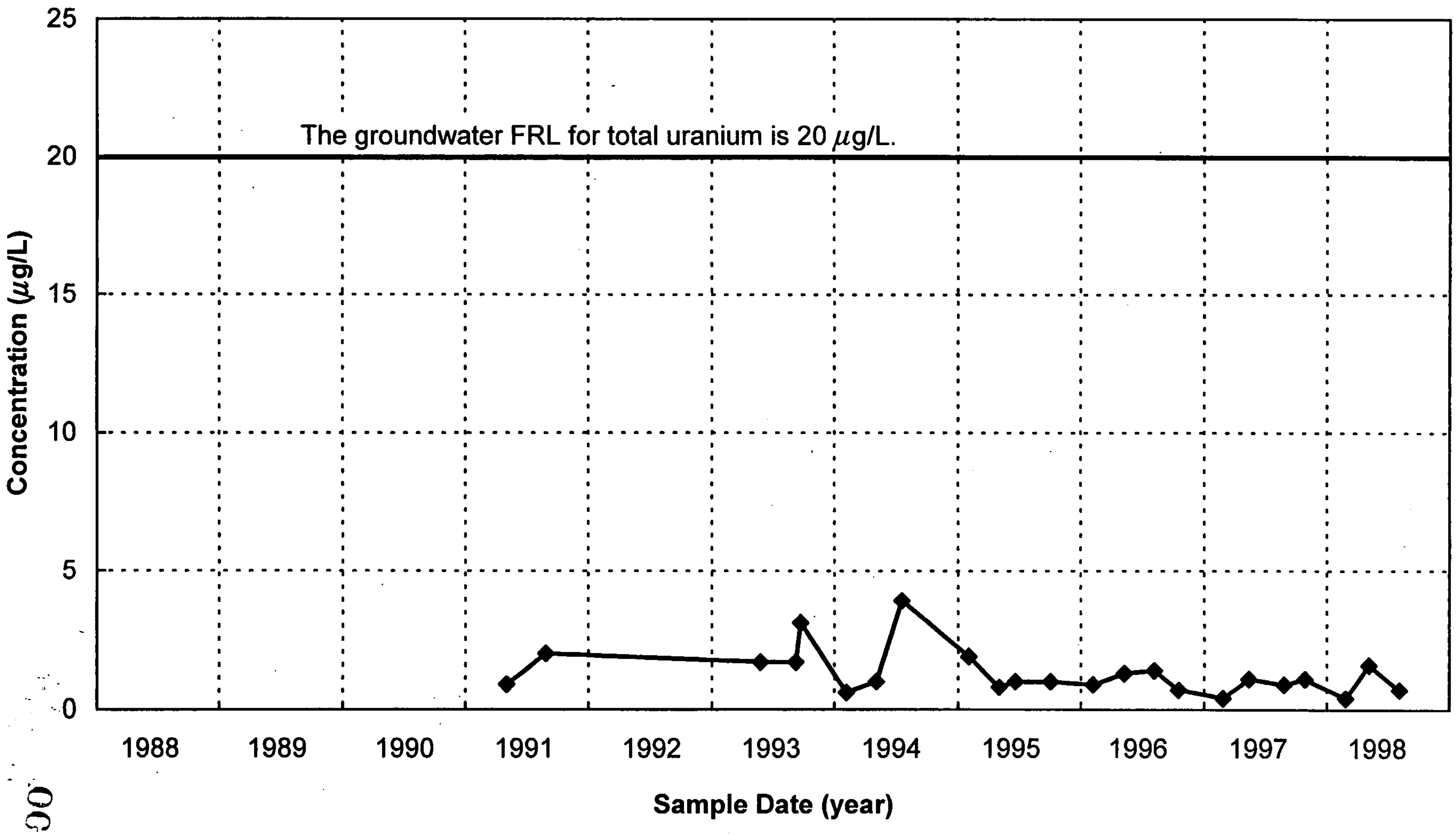

FIGURE A.2-65. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2636

000139

2272

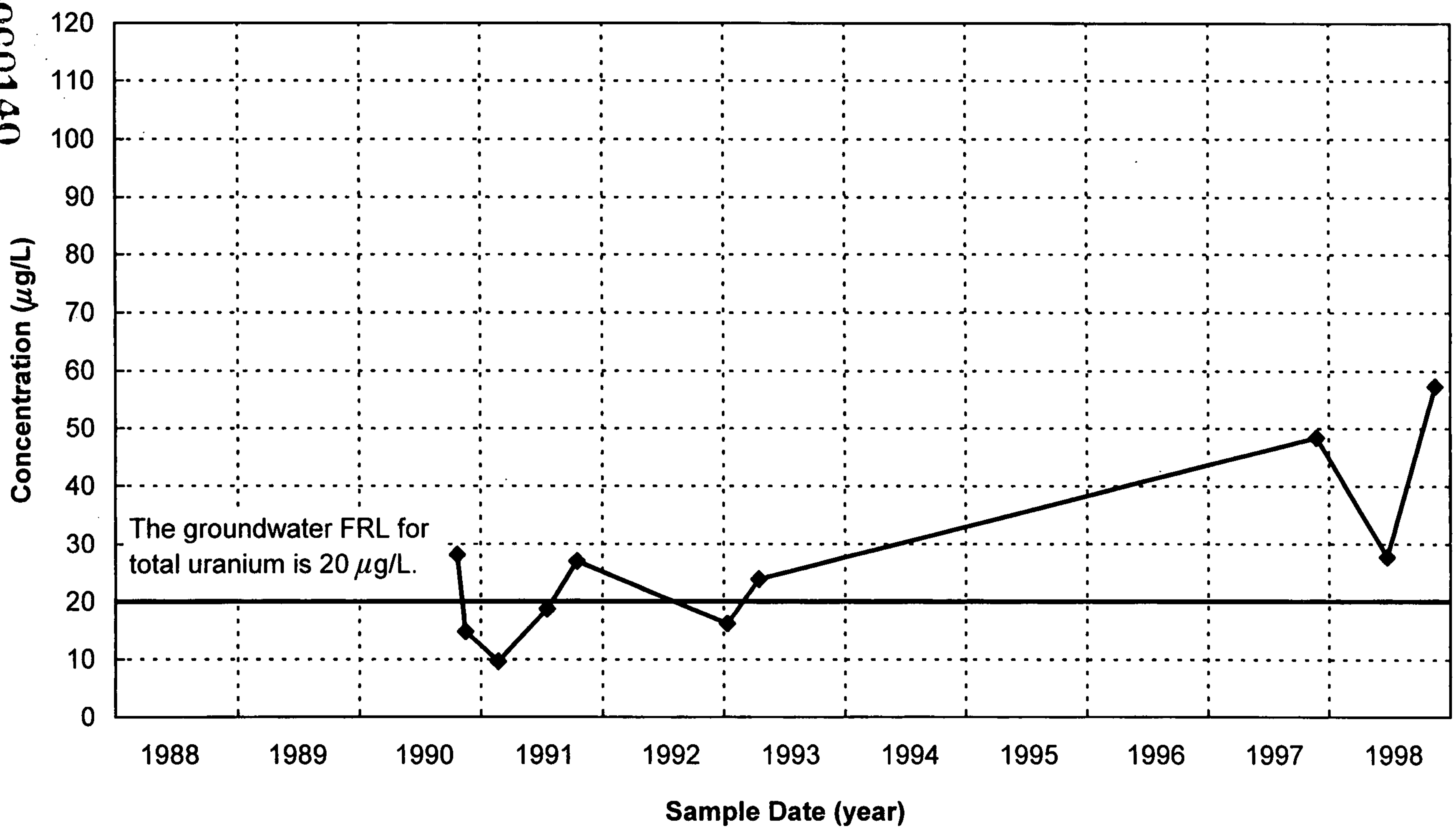

FIGURE A.2-66. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2648

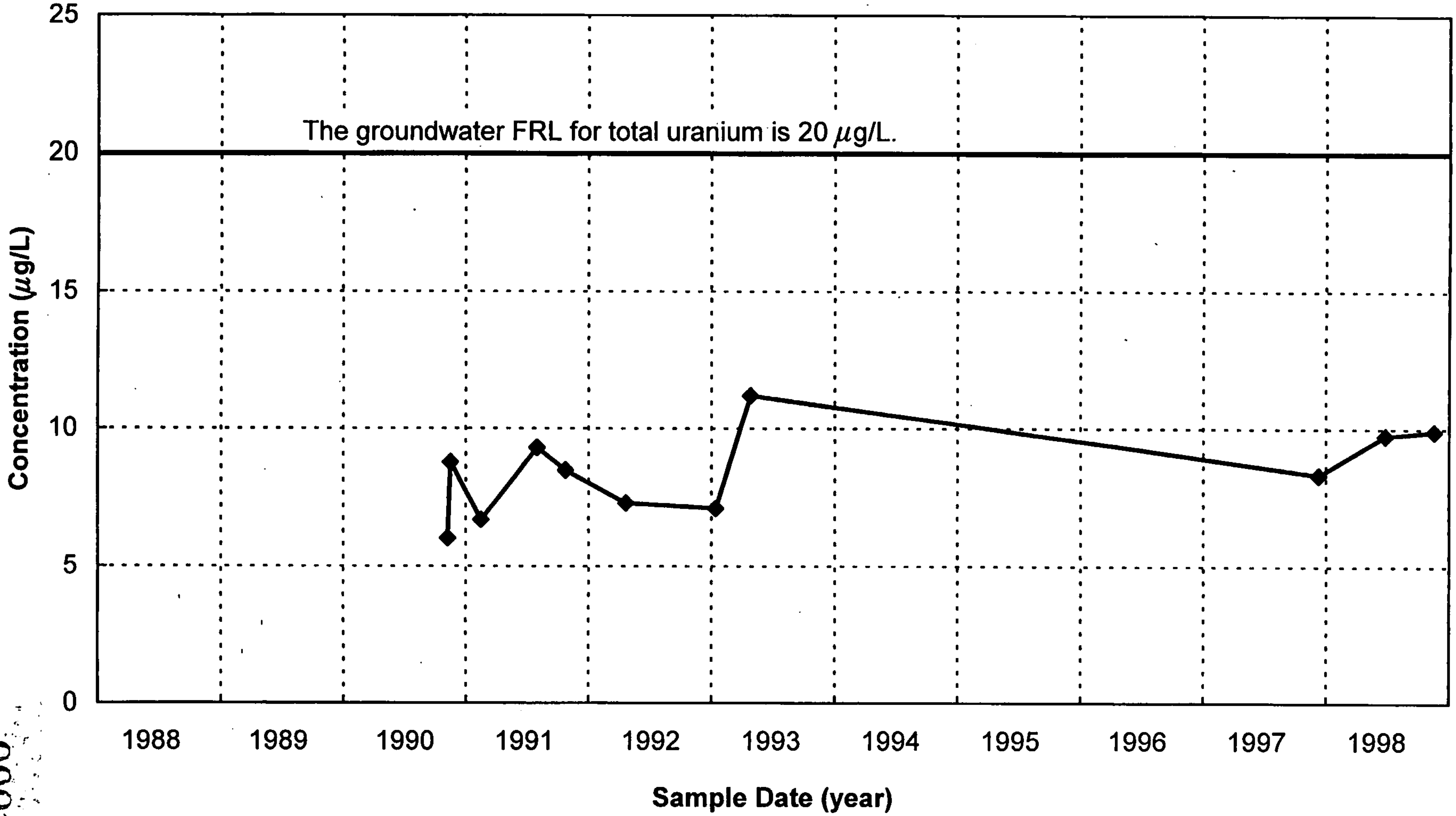

FIGURE A.2-67. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2649

000141

2272

000142

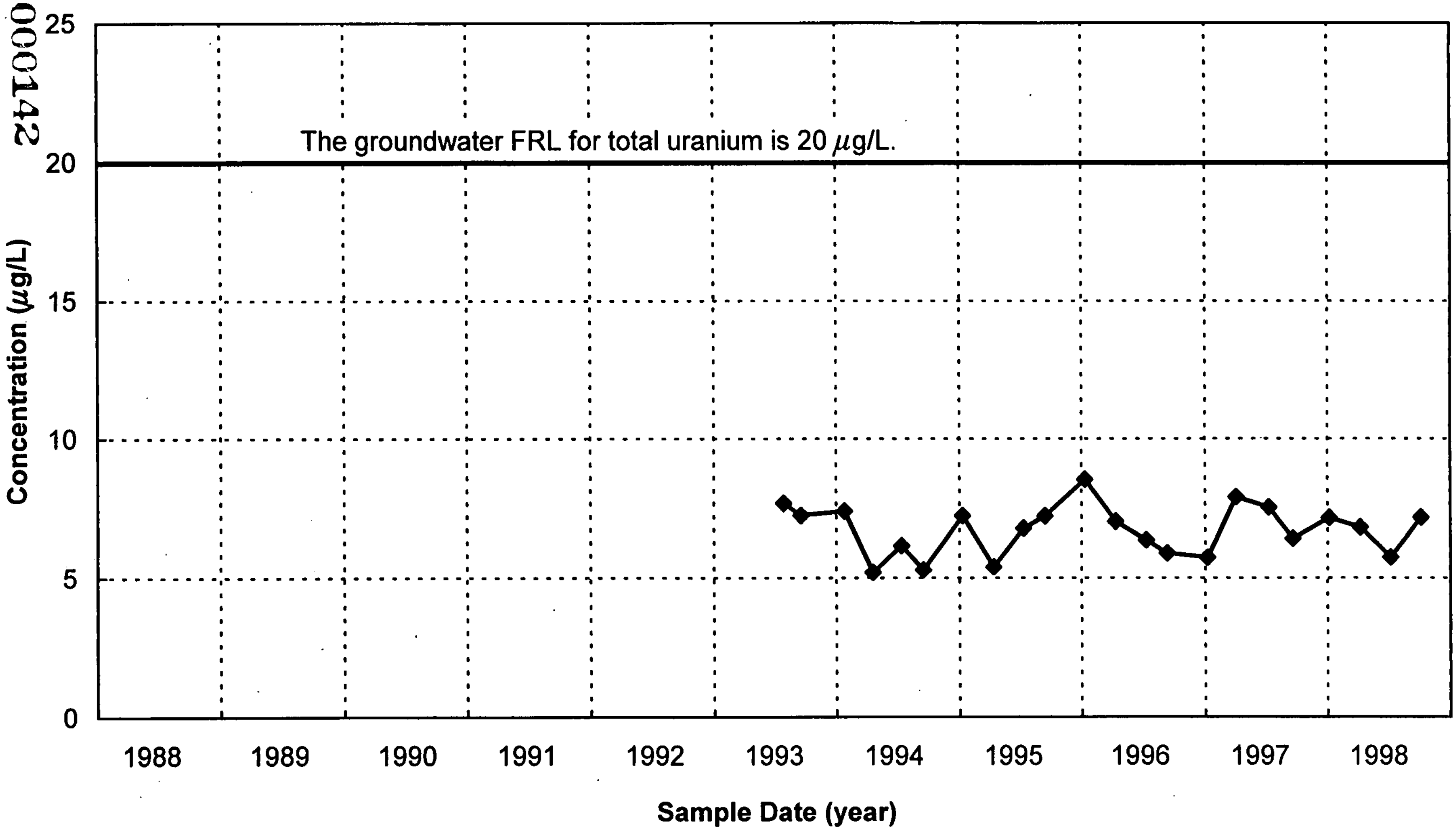

FIGURE A.2-68. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2733

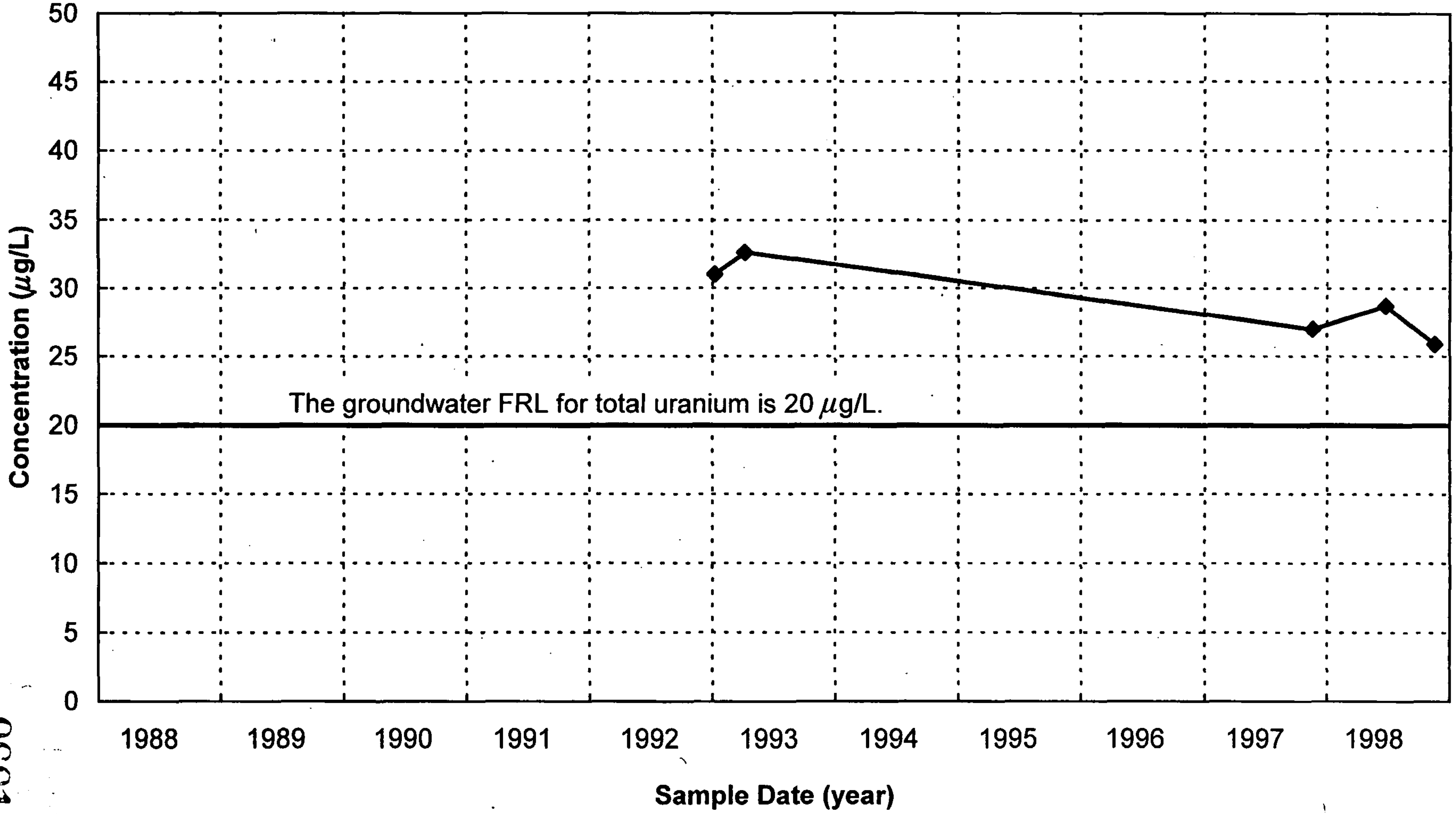

FIGURE A.2-69. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2821

000143

2272

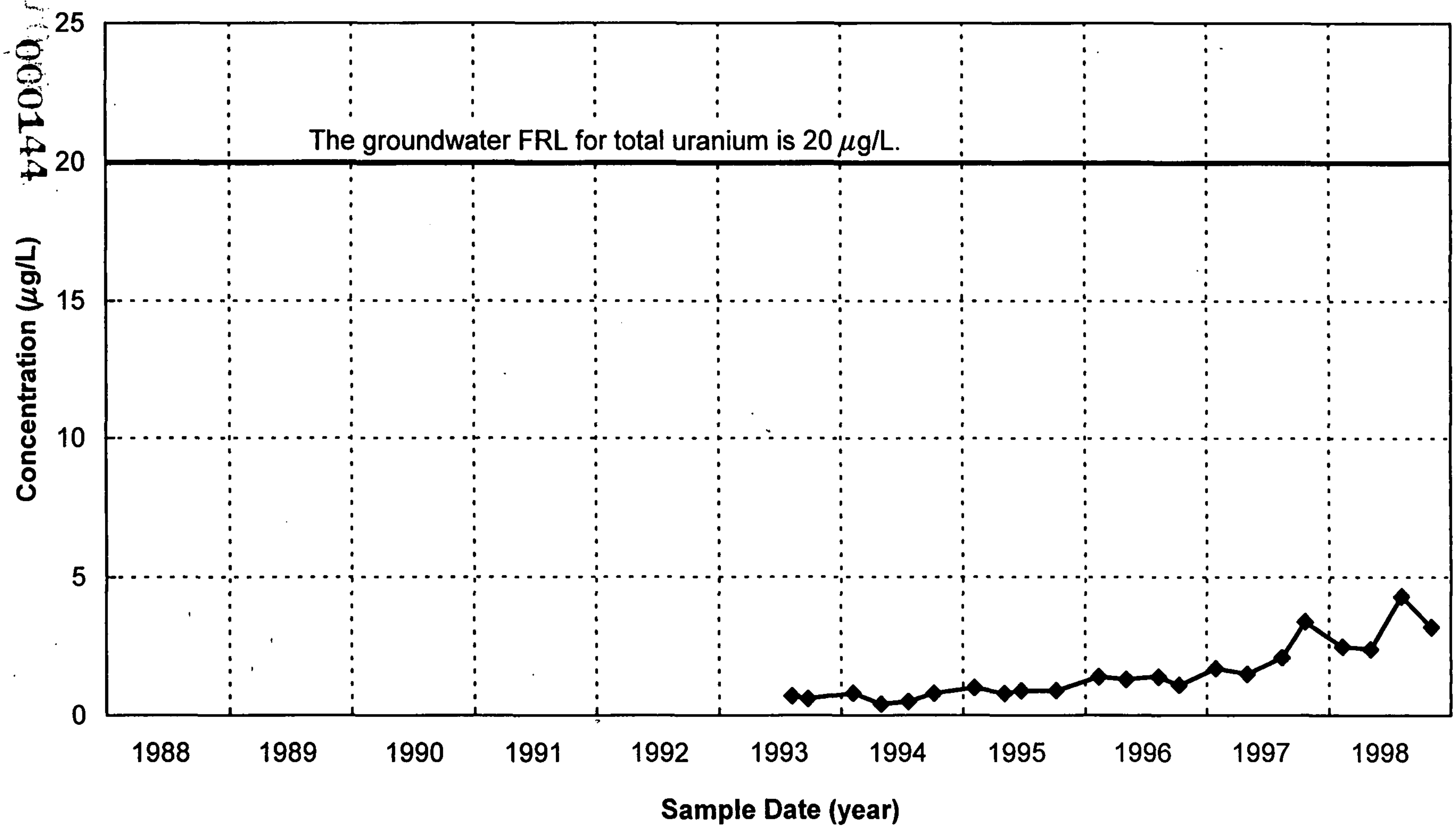

FIGURE A.2-70. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2880

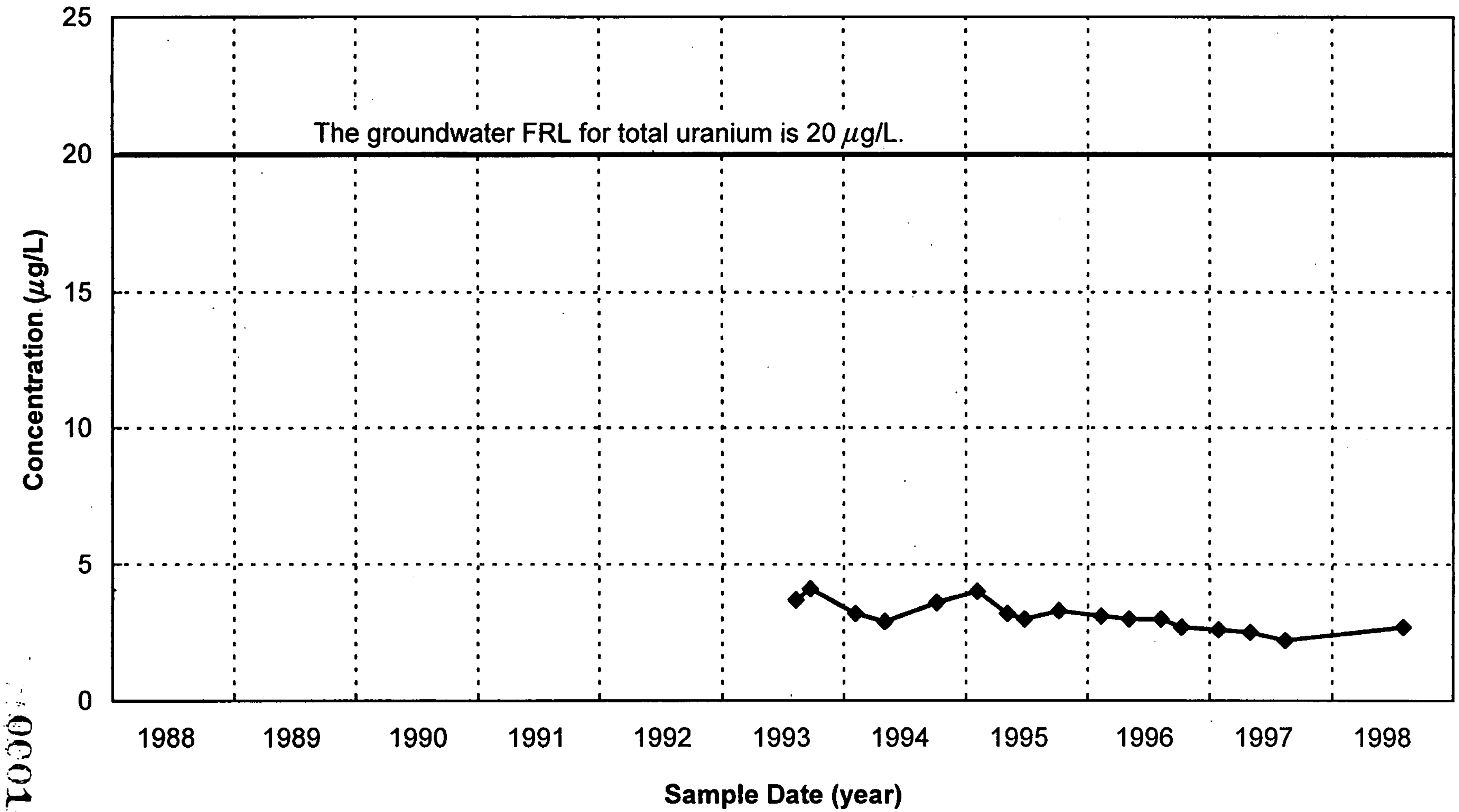

FIGURE A.2-71. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2881

000145

2272

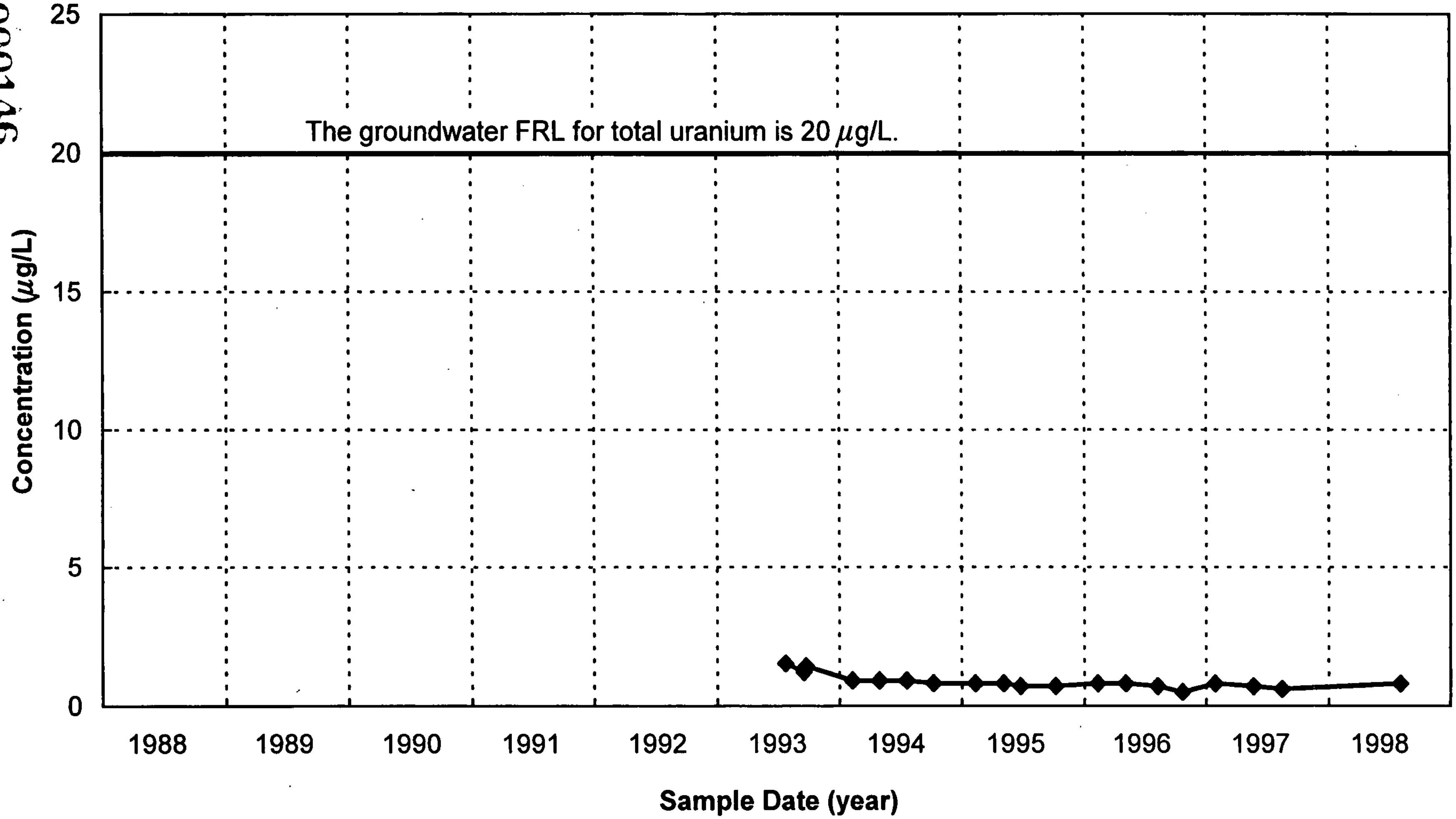

FIGURE A.2-72. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2897

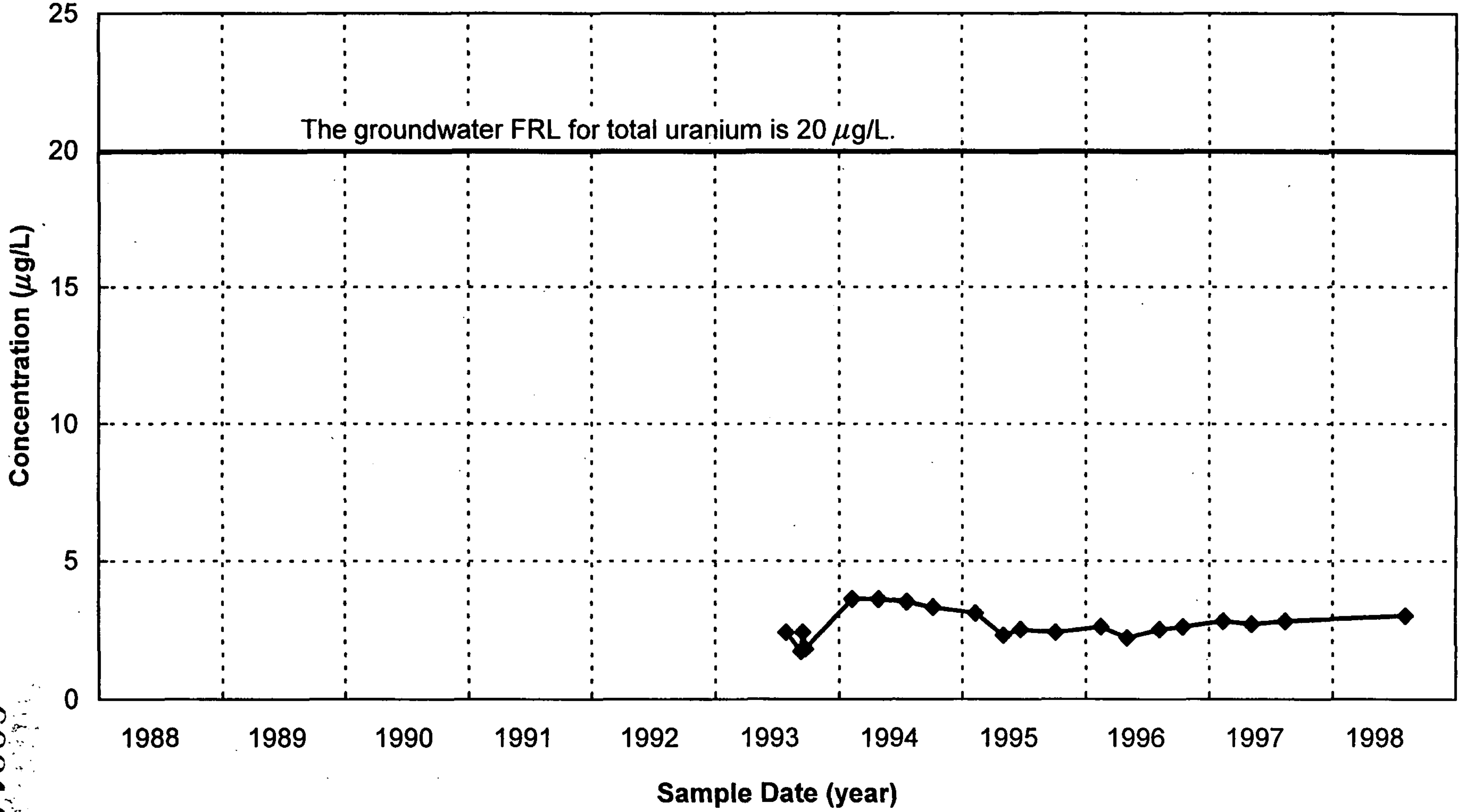

FIGURE A.2-73. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2898

000147

2272

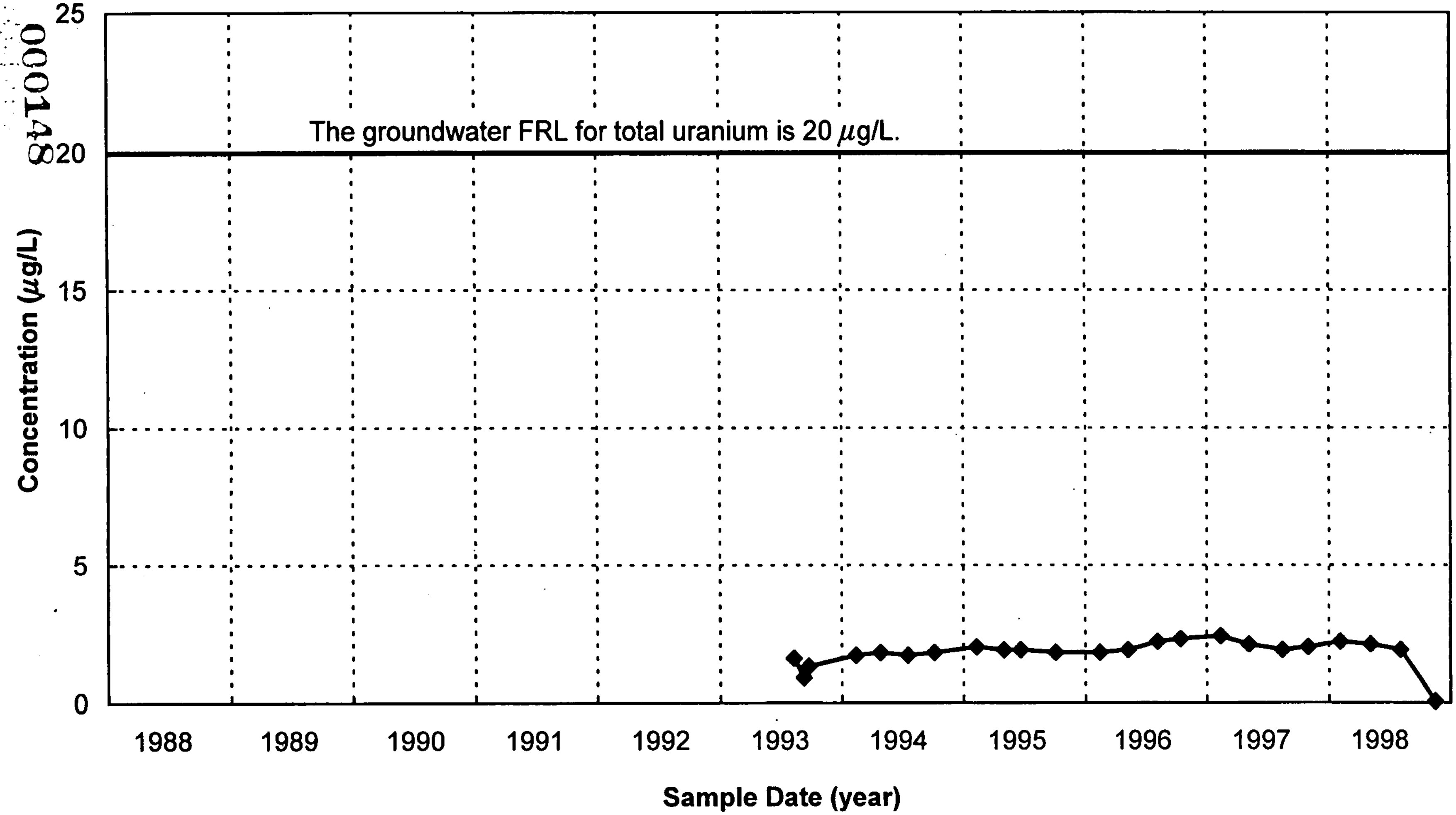

FIGURE A.2-74. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2899

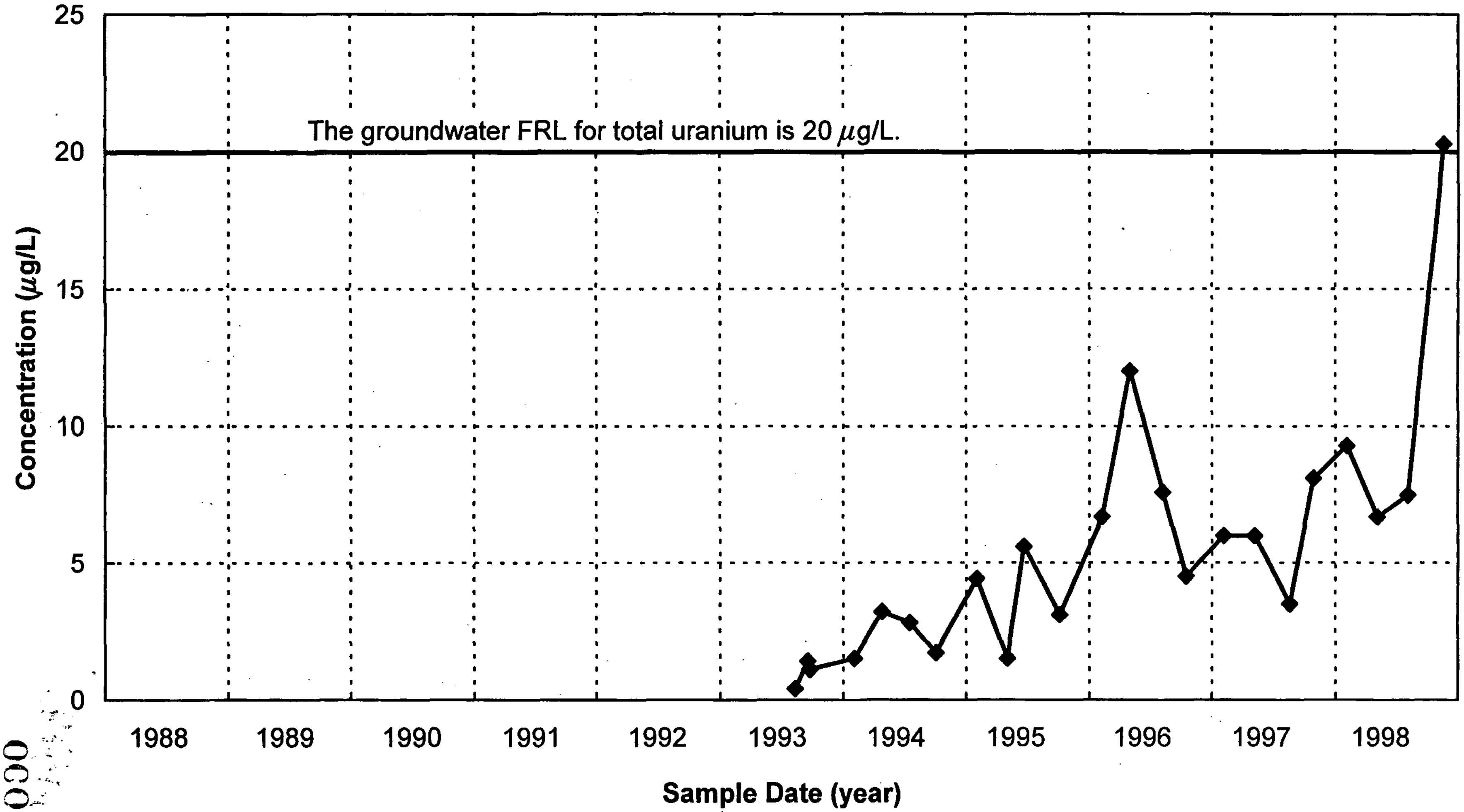

FIGURE A.2-75. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2900

000150

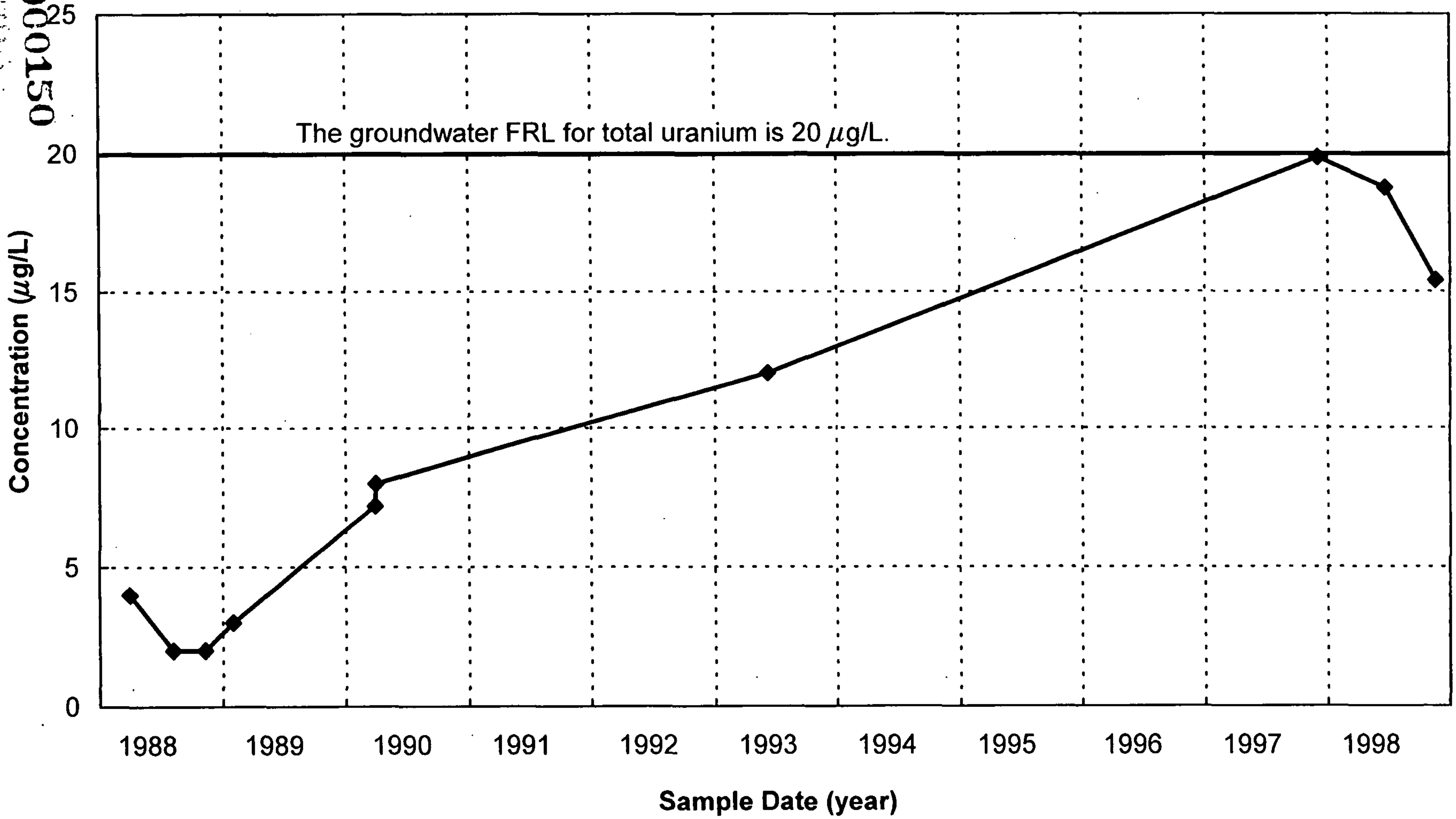

FIGURE A.2-76. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 3009

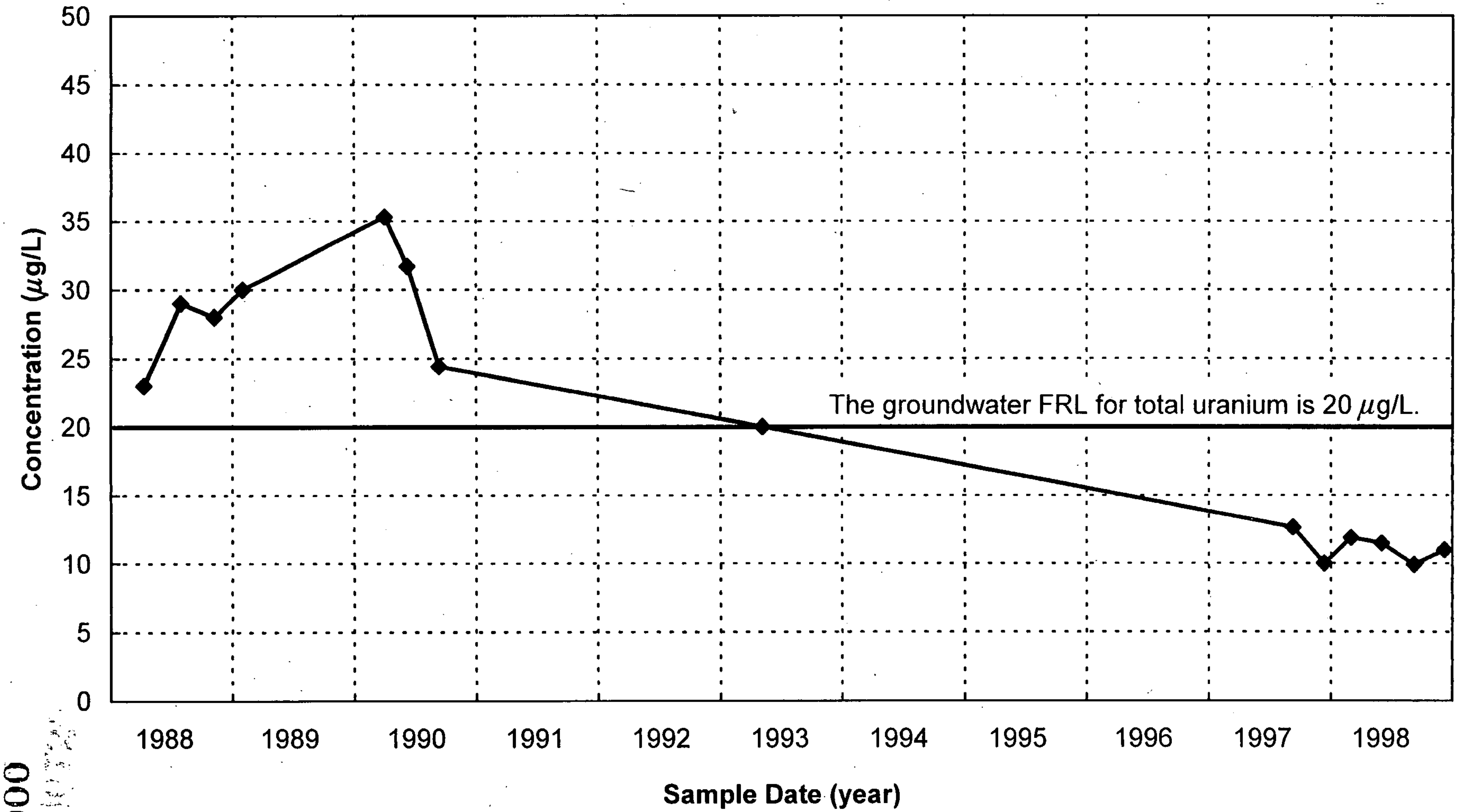

FIGURE A.2-77. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3014

000151

2272

000152

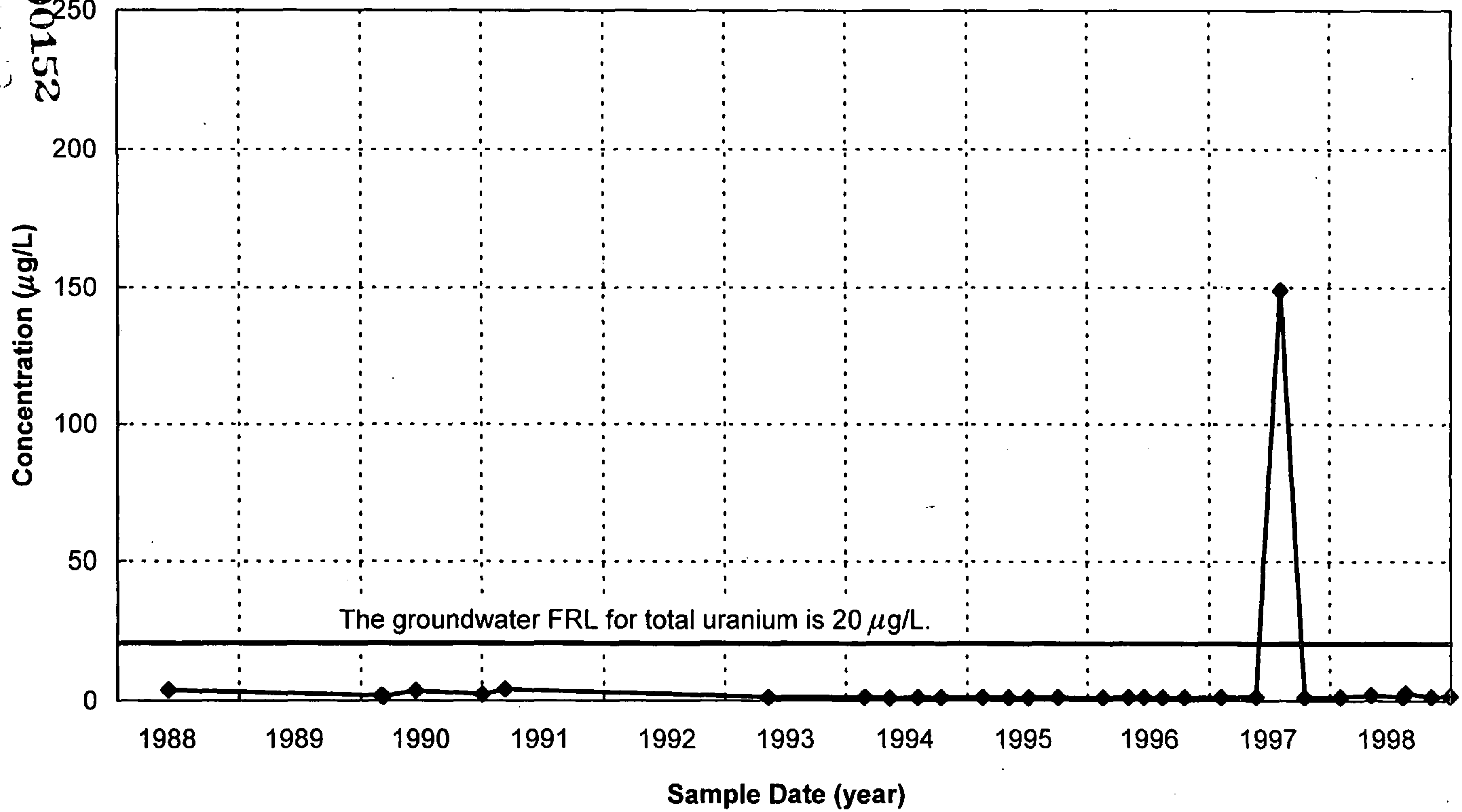

FIGURE A.2-78. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3015

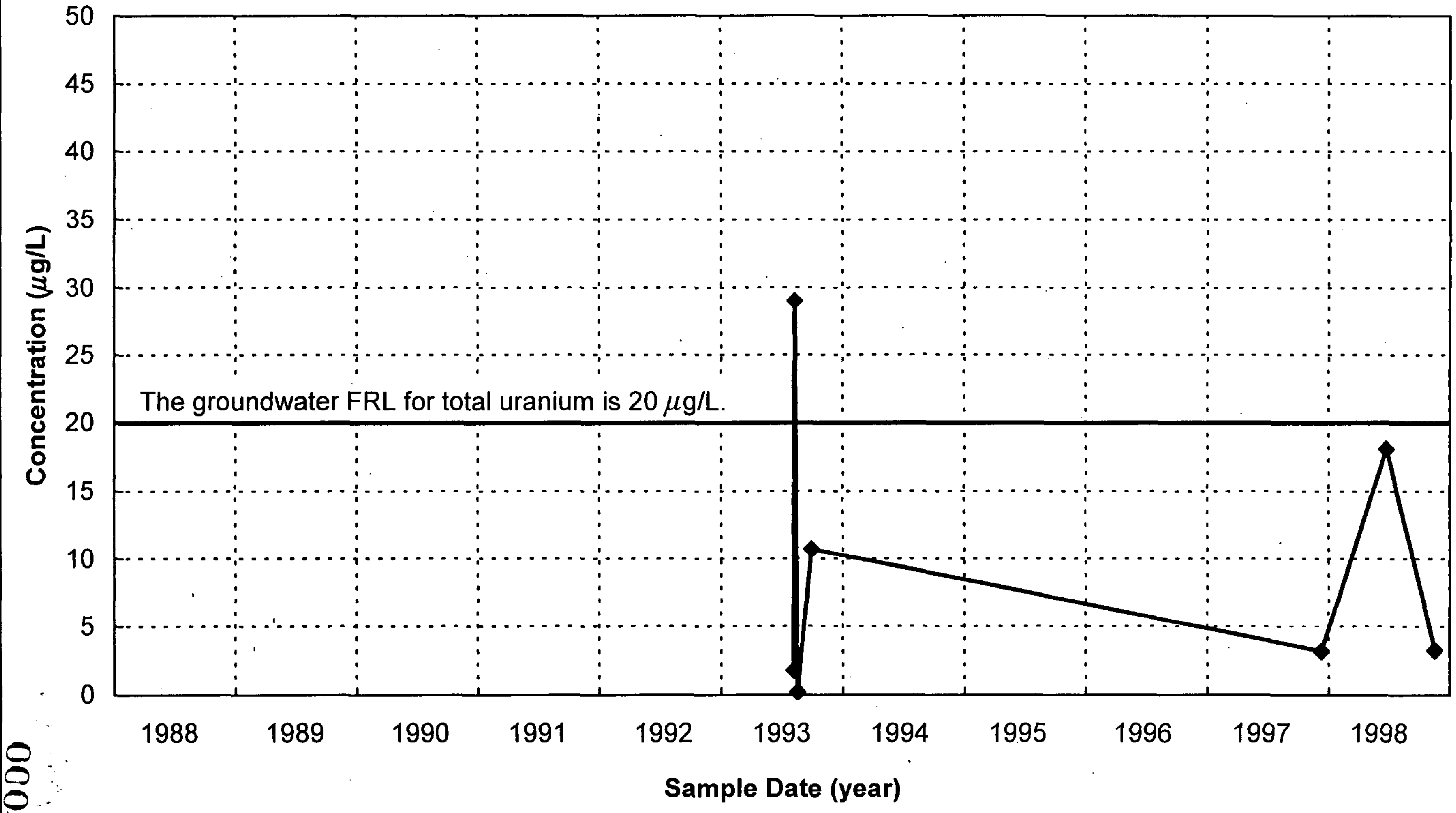

FIGURE A.2-79. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 3027

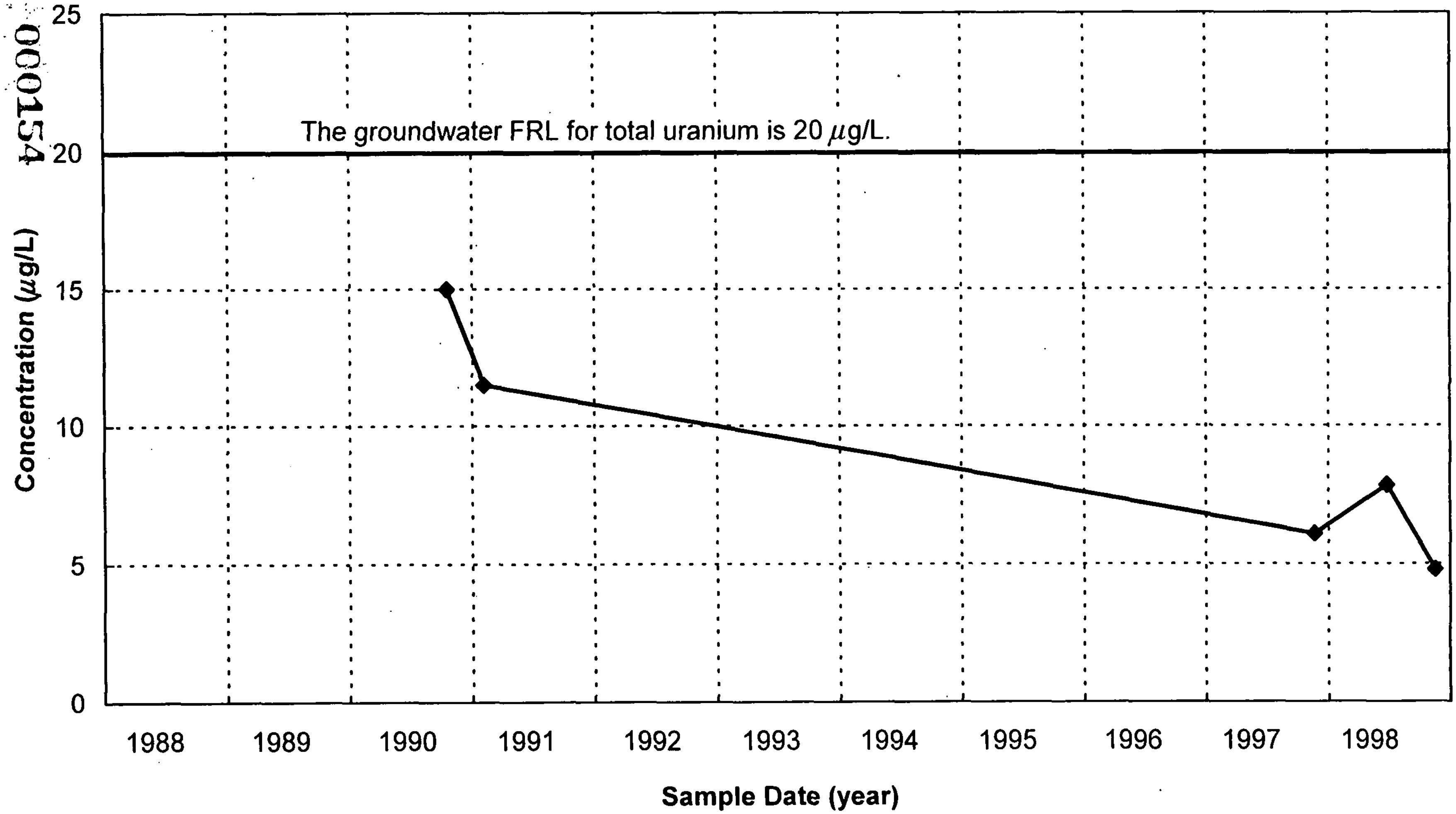

FIGURE A.2-80. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3032

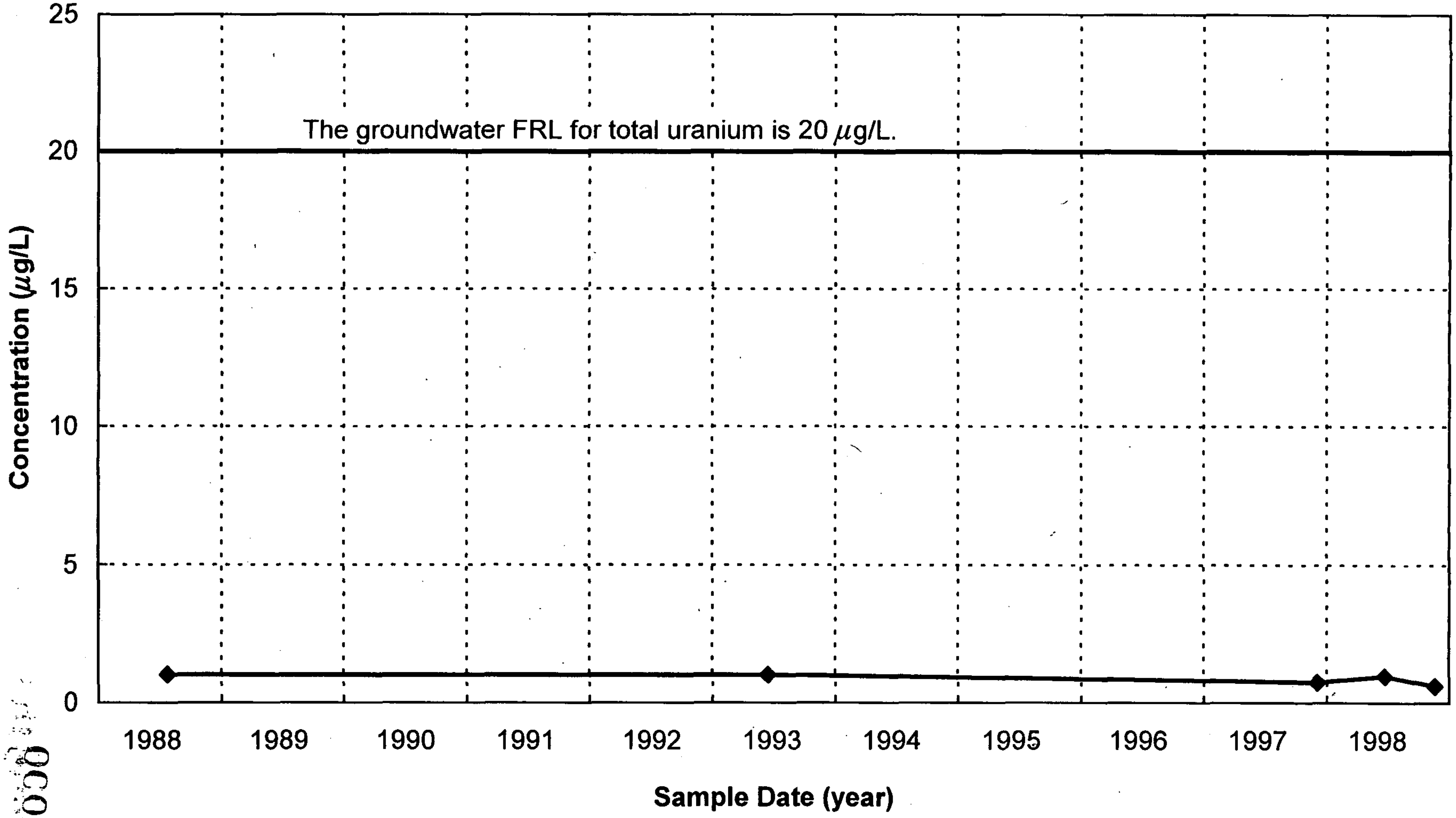

FIGURE A.2-81. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 3034

000155

2272

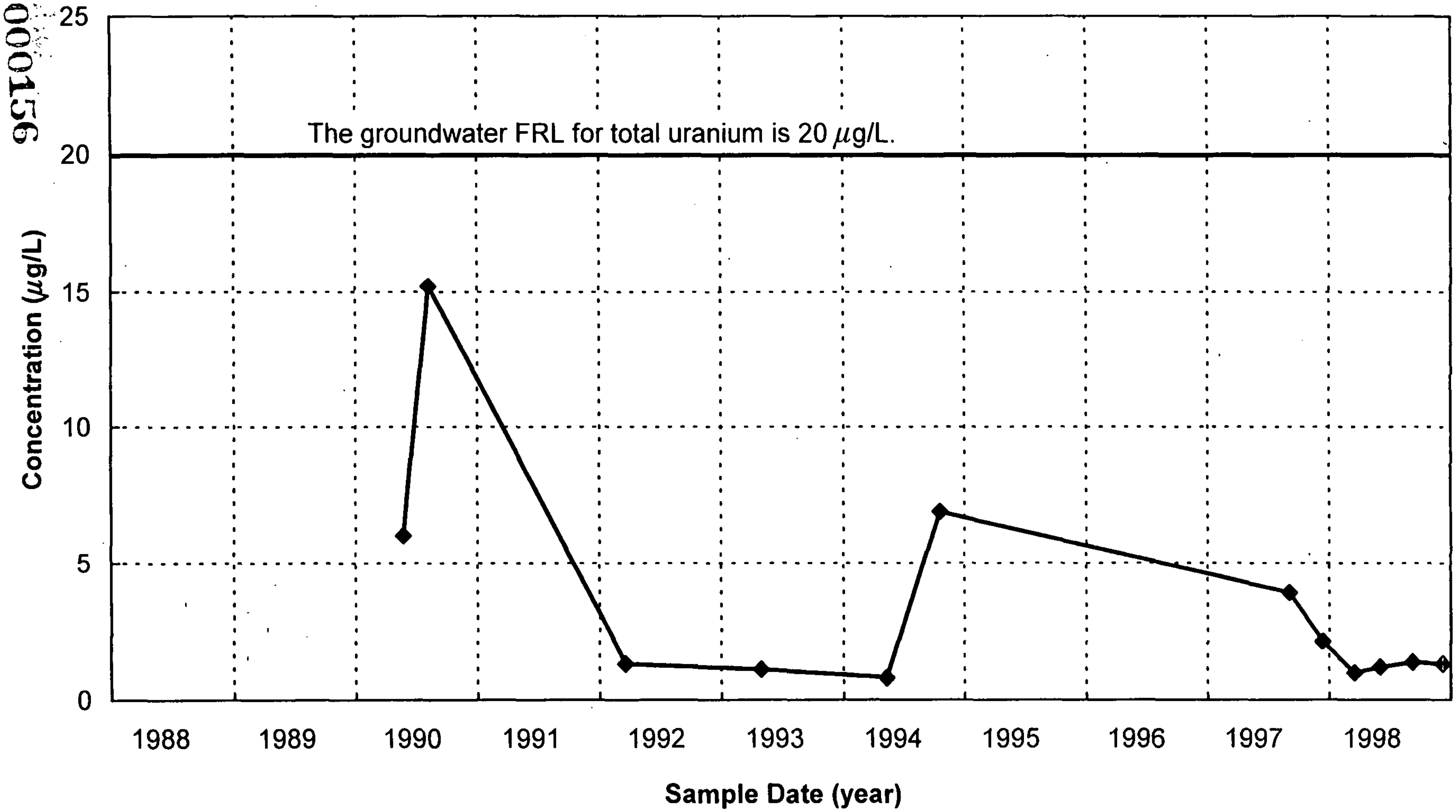

FIGURE A.2-82. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3045

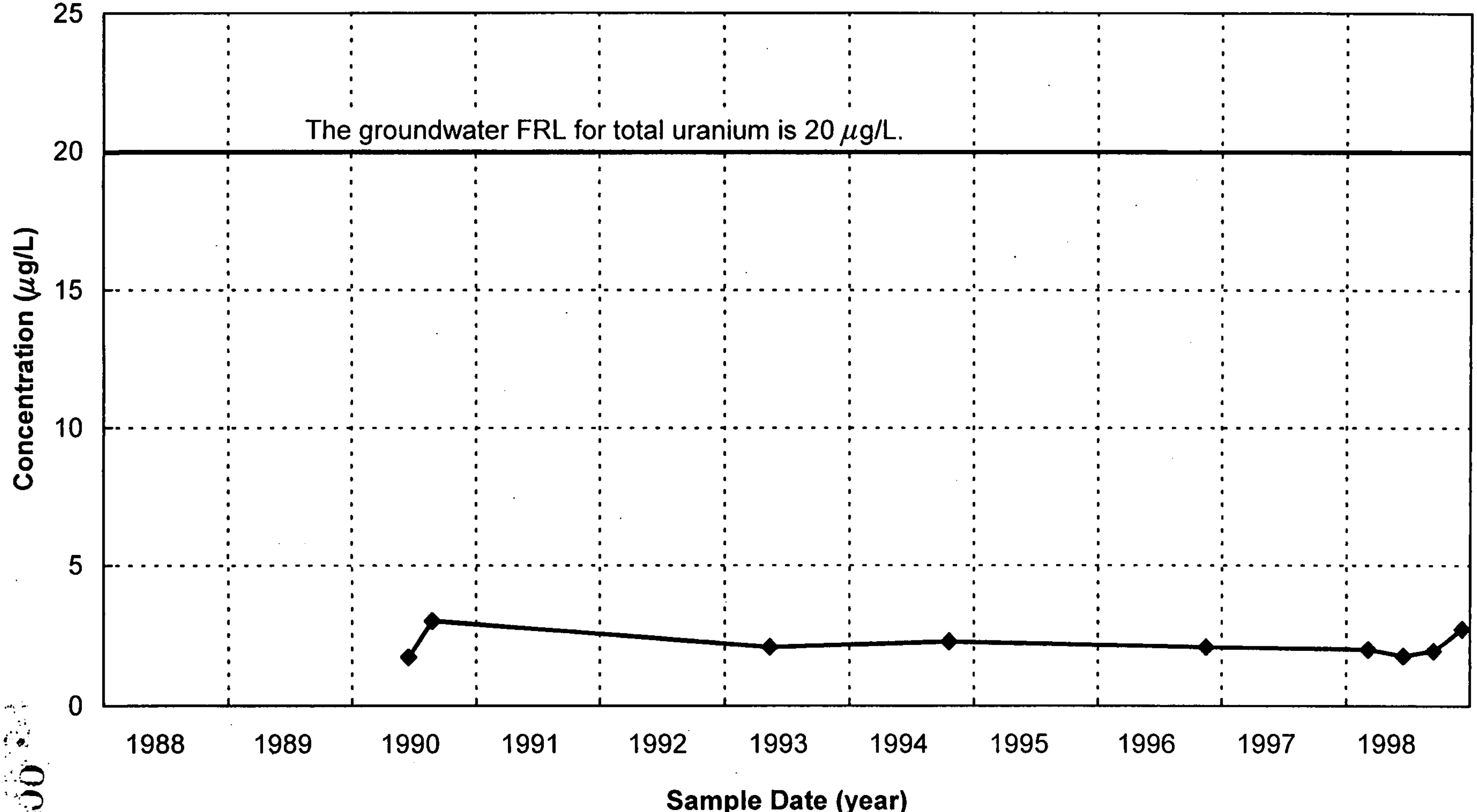

FIGURE A.2-83. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3046

000157

2272

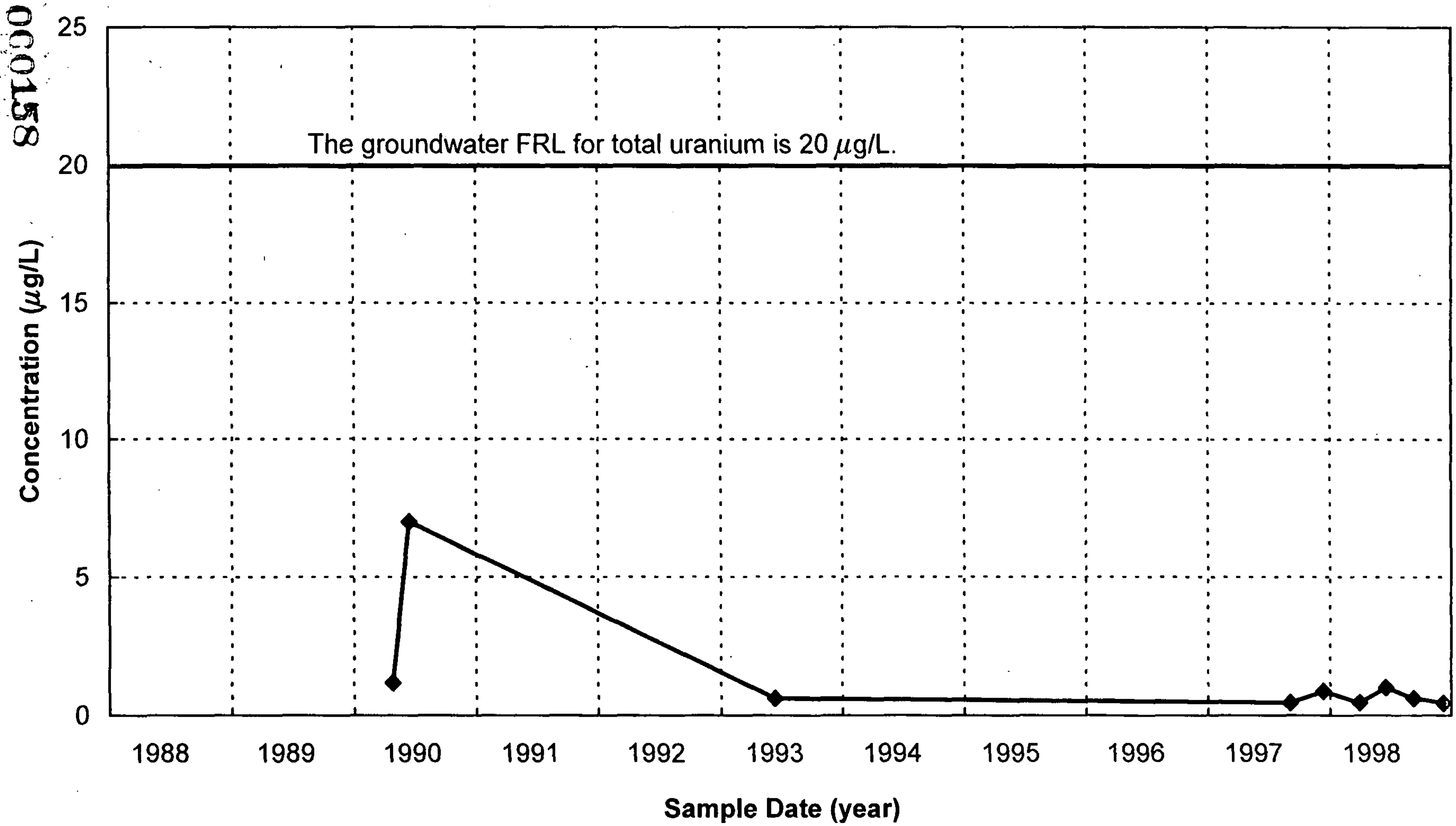

FIGURE A.2-84. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3049

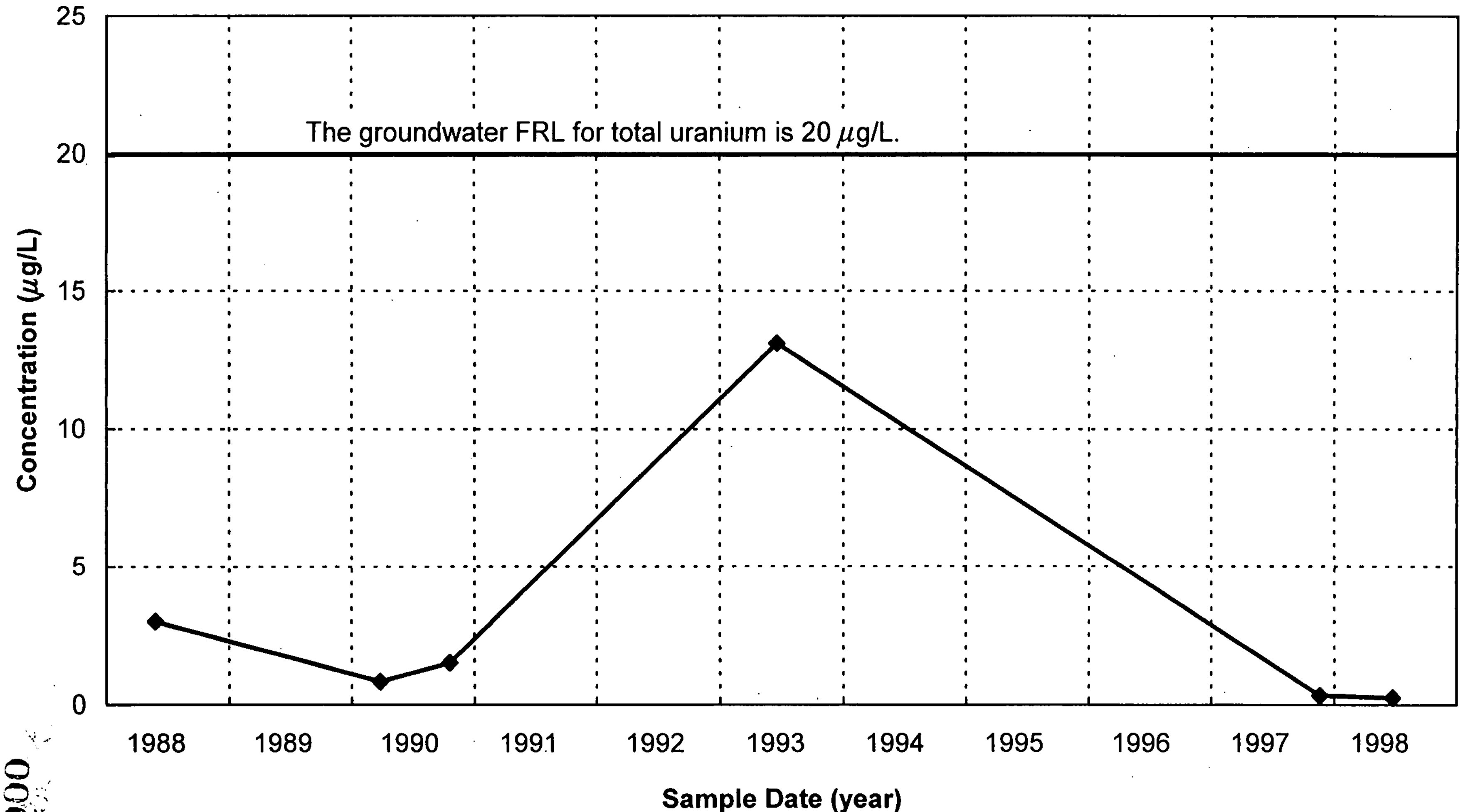

FIGURE A.2-85. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3054

000159

2272

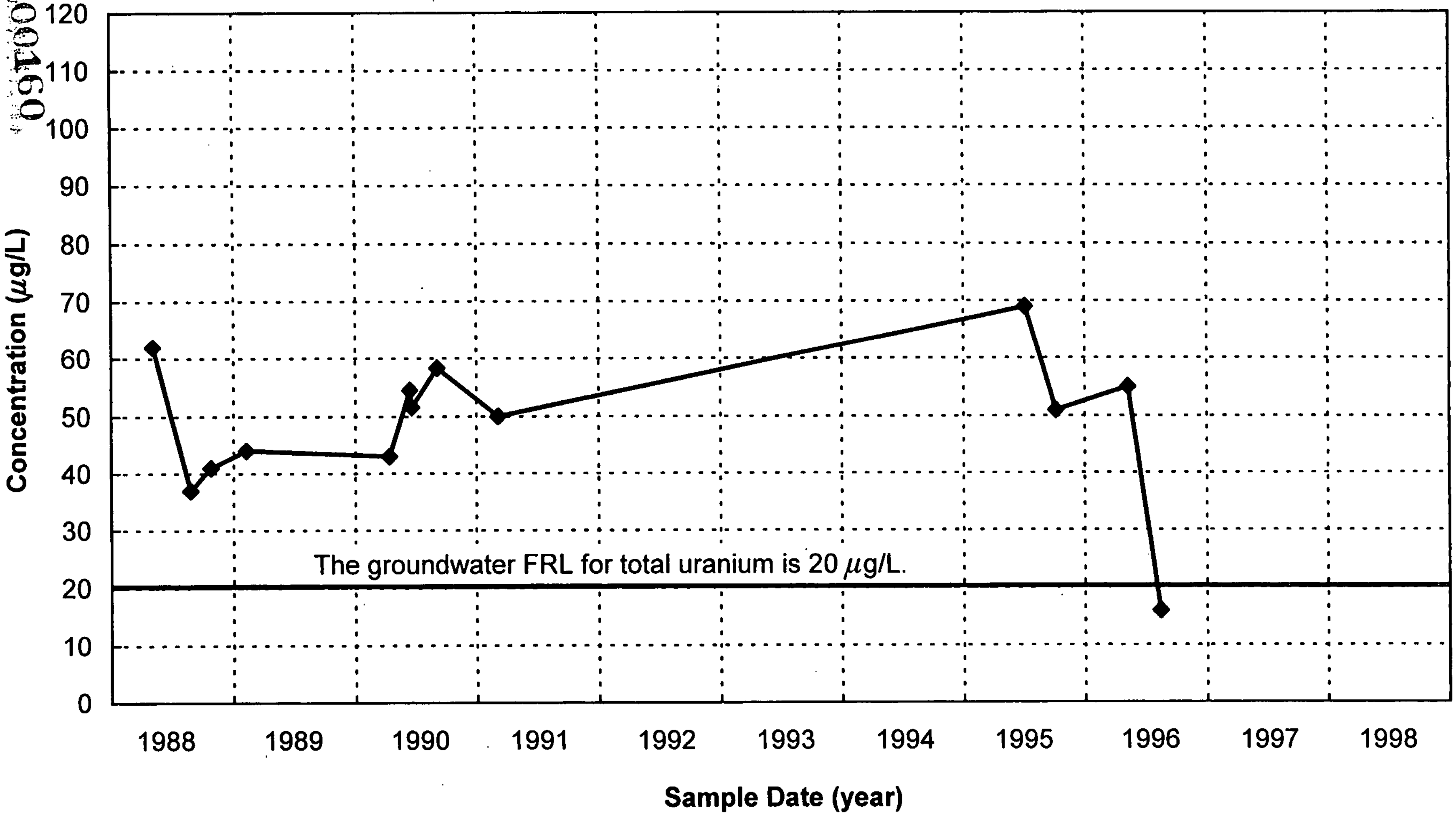

FIGURE A.2-86. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3062

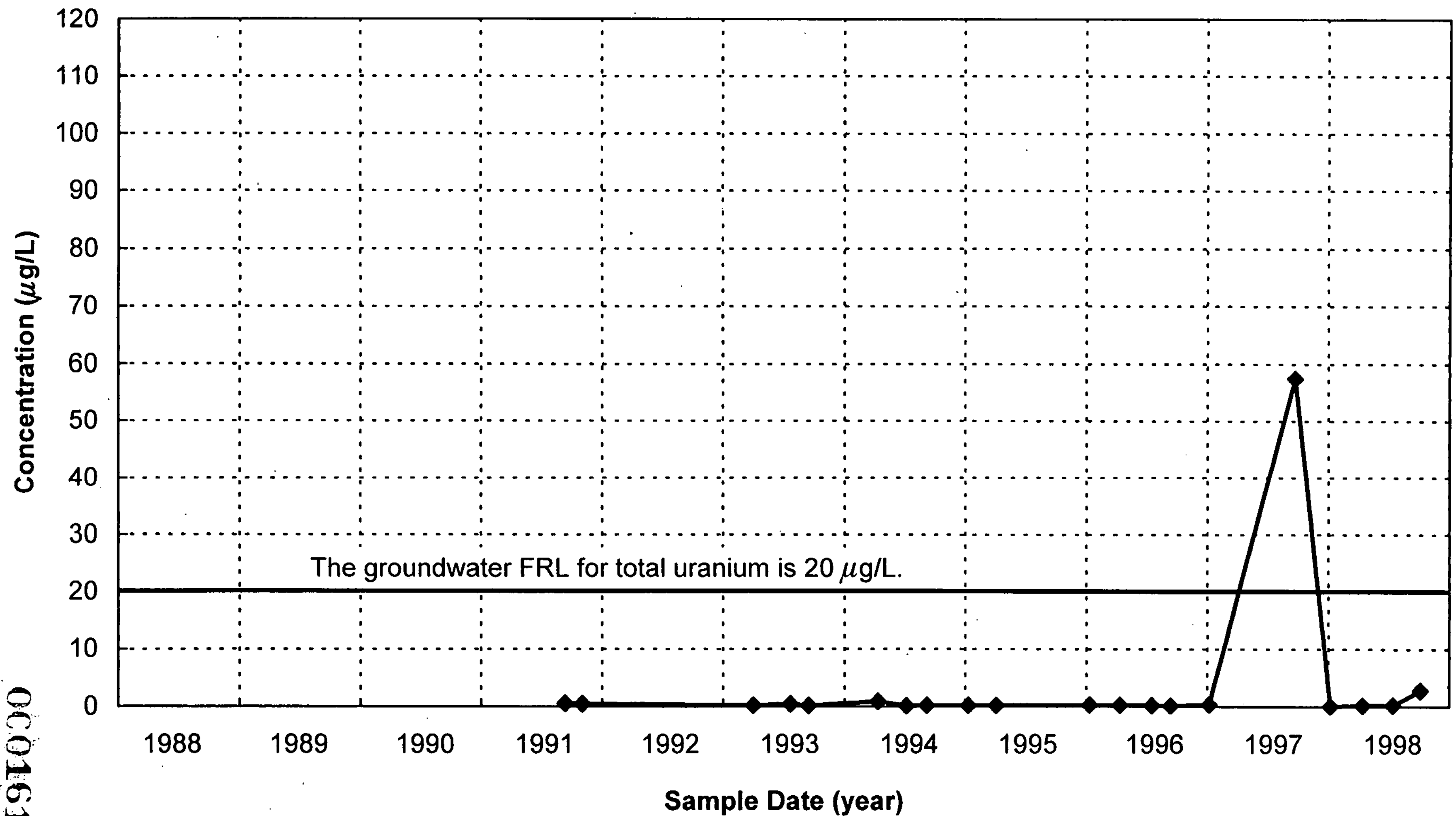

FIGURE A.2-87. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 3067

000161

2272

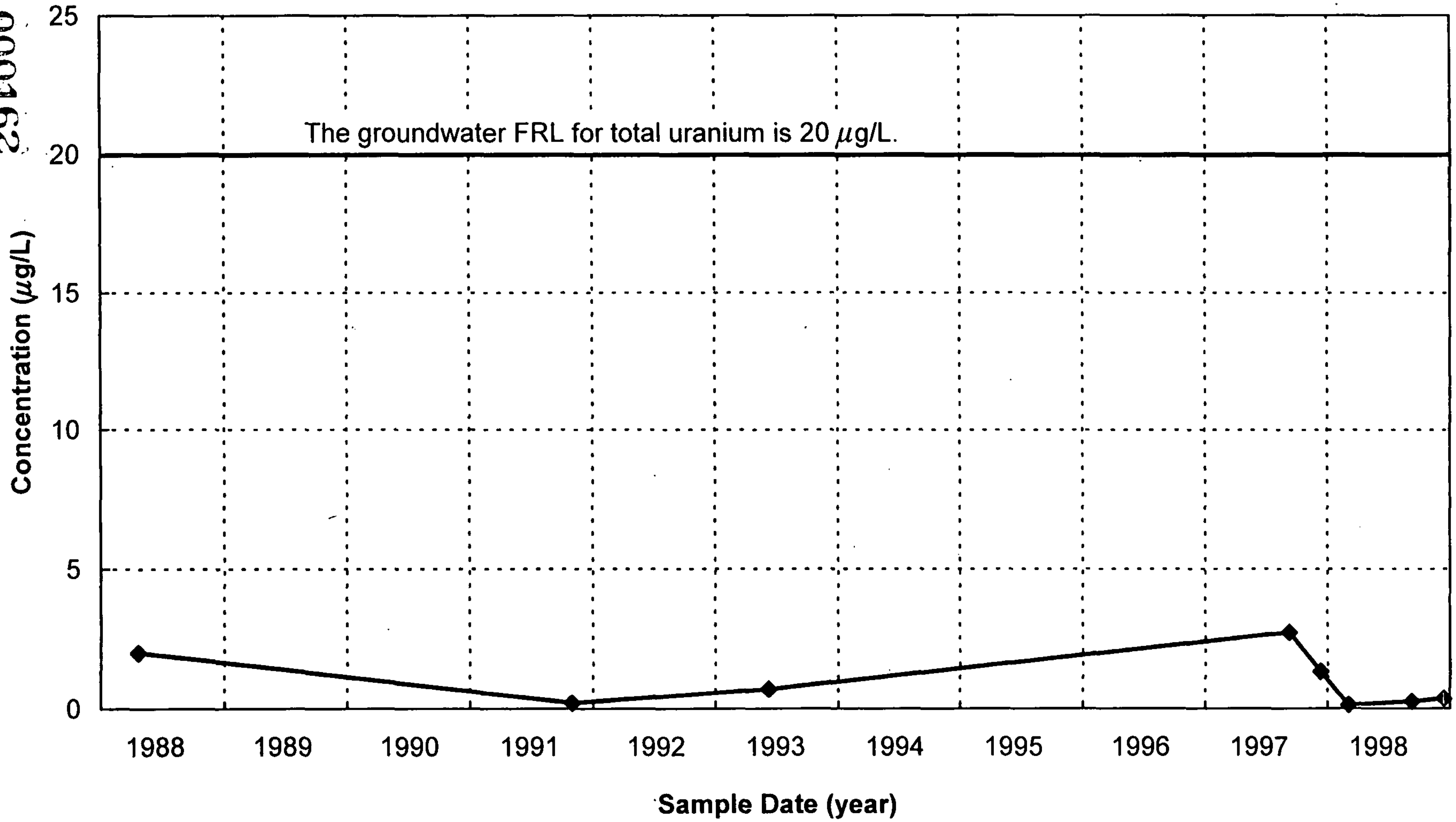

FIGURE A.2-88. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3068

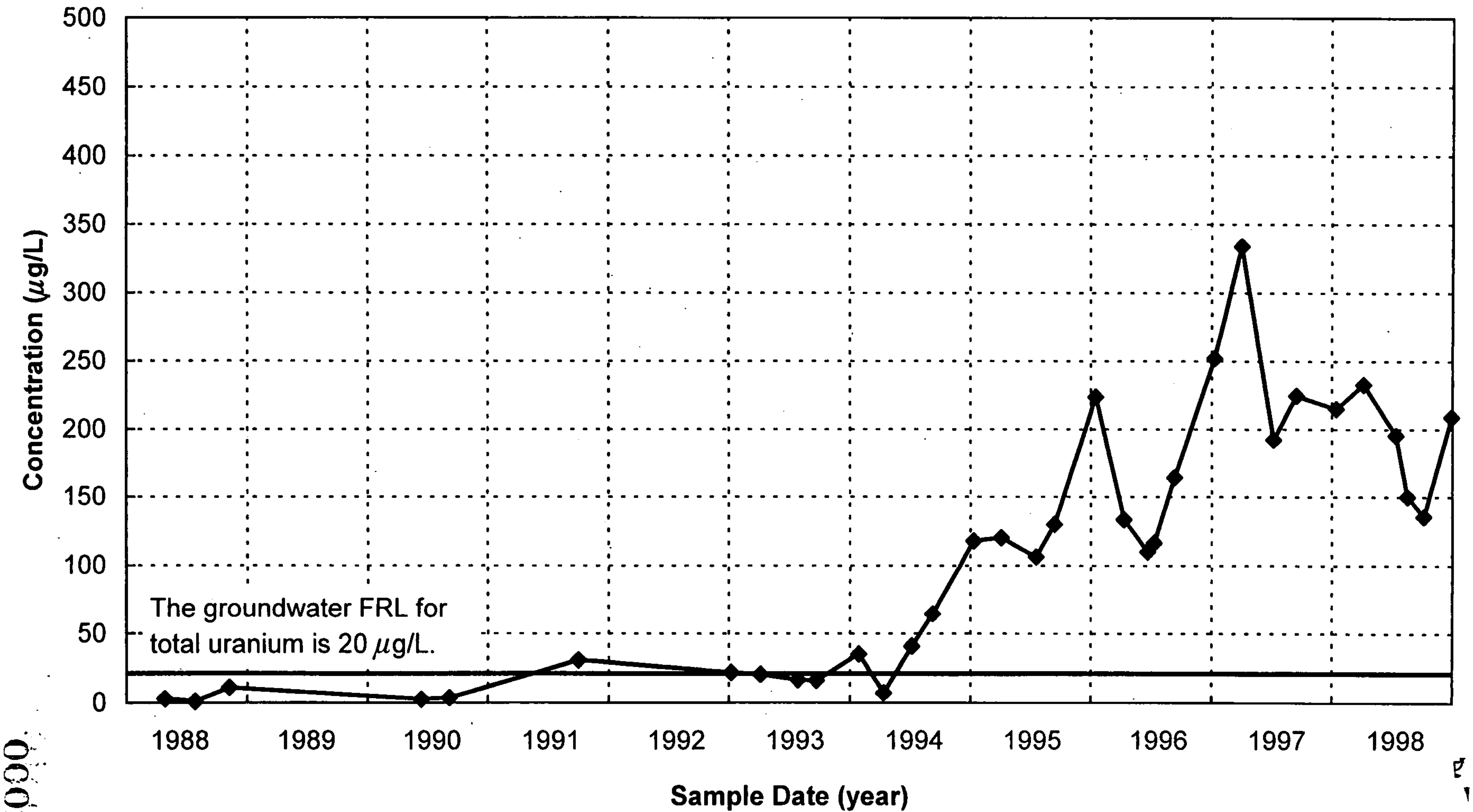

FIGURE A.2-89. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 3069

000163

2272

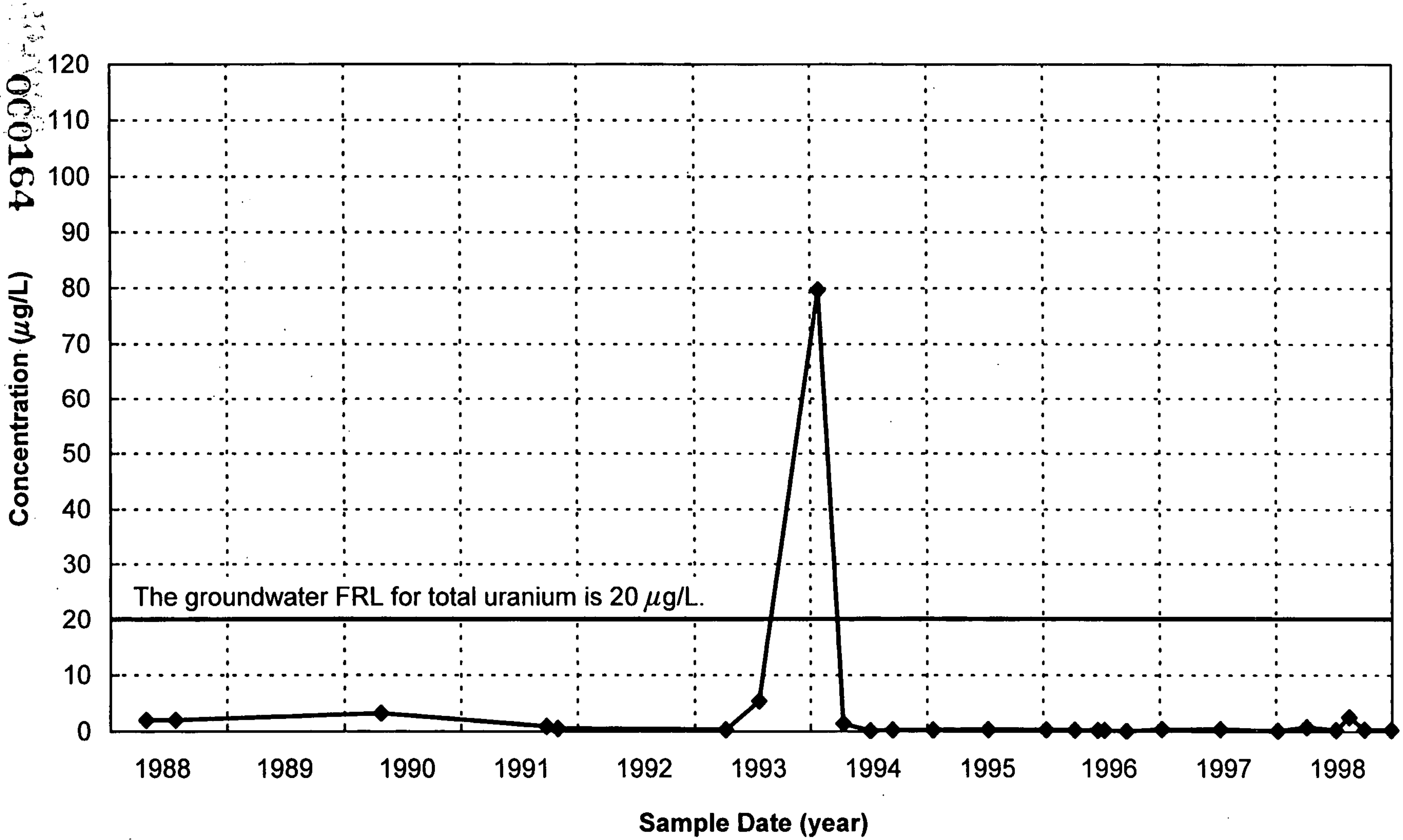

FIGURE A.2-90. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3070

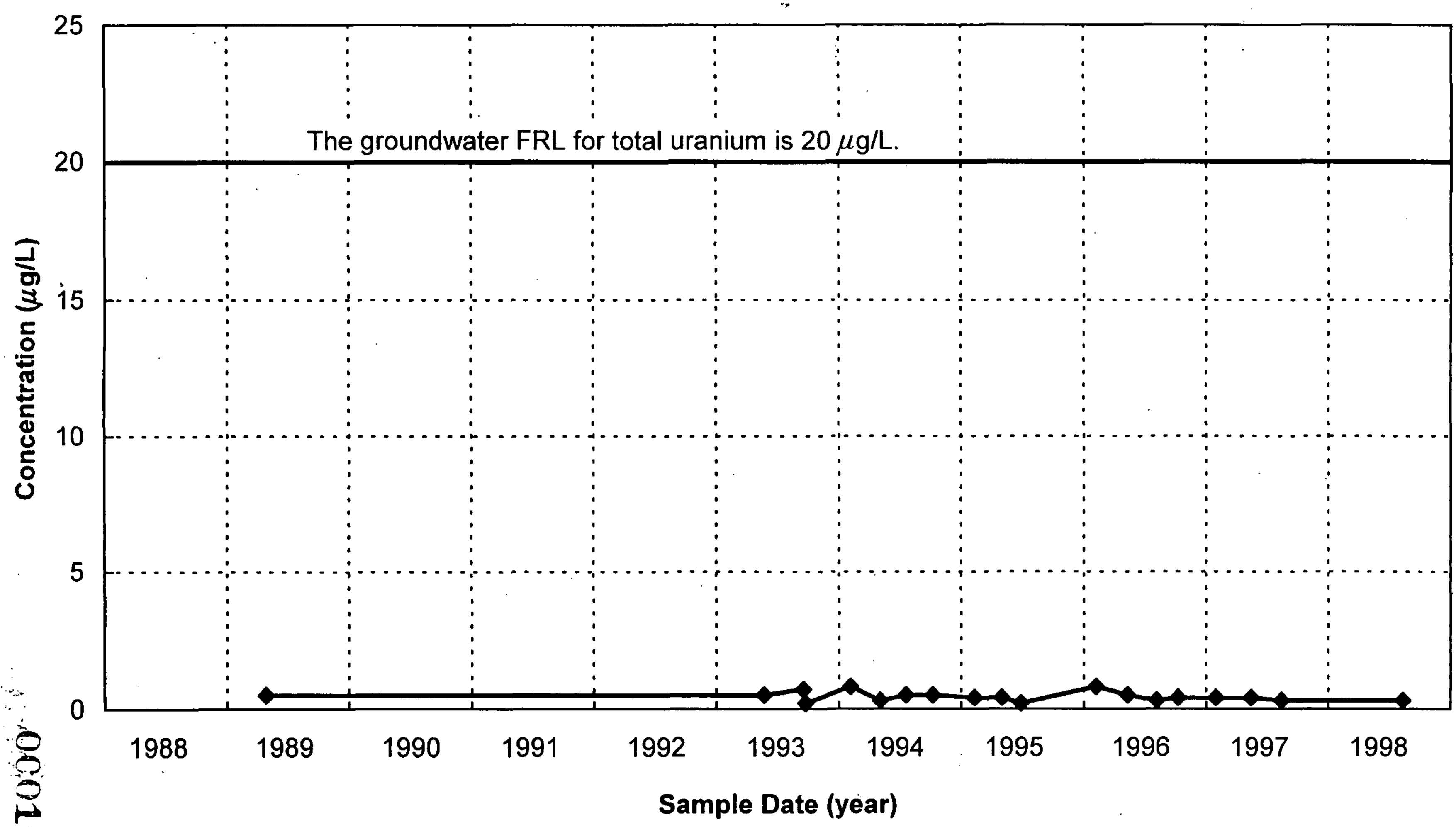

FIGURE A.2-91. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 3093

000165

2272

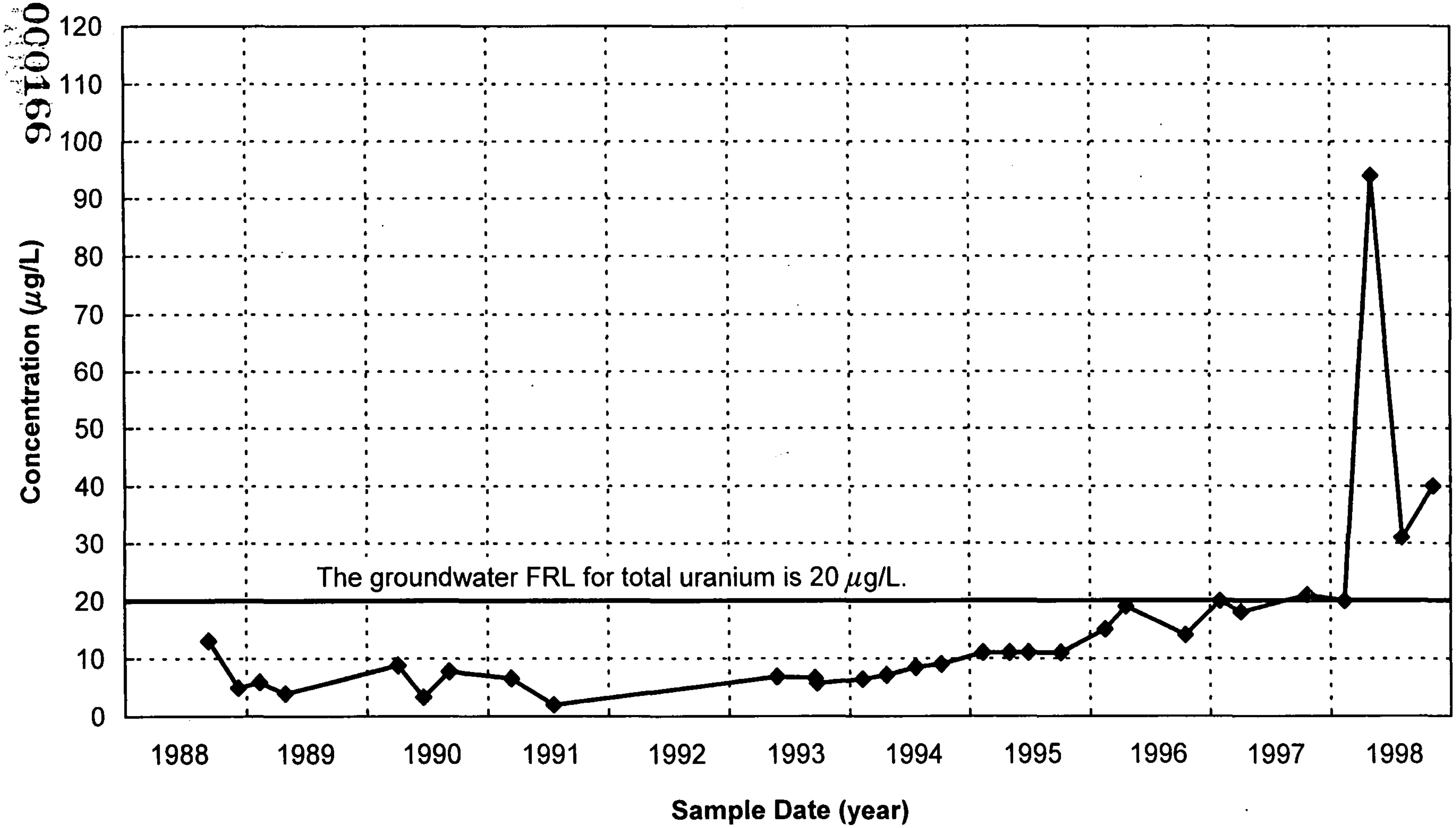

FIGURE A.2-92. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3095

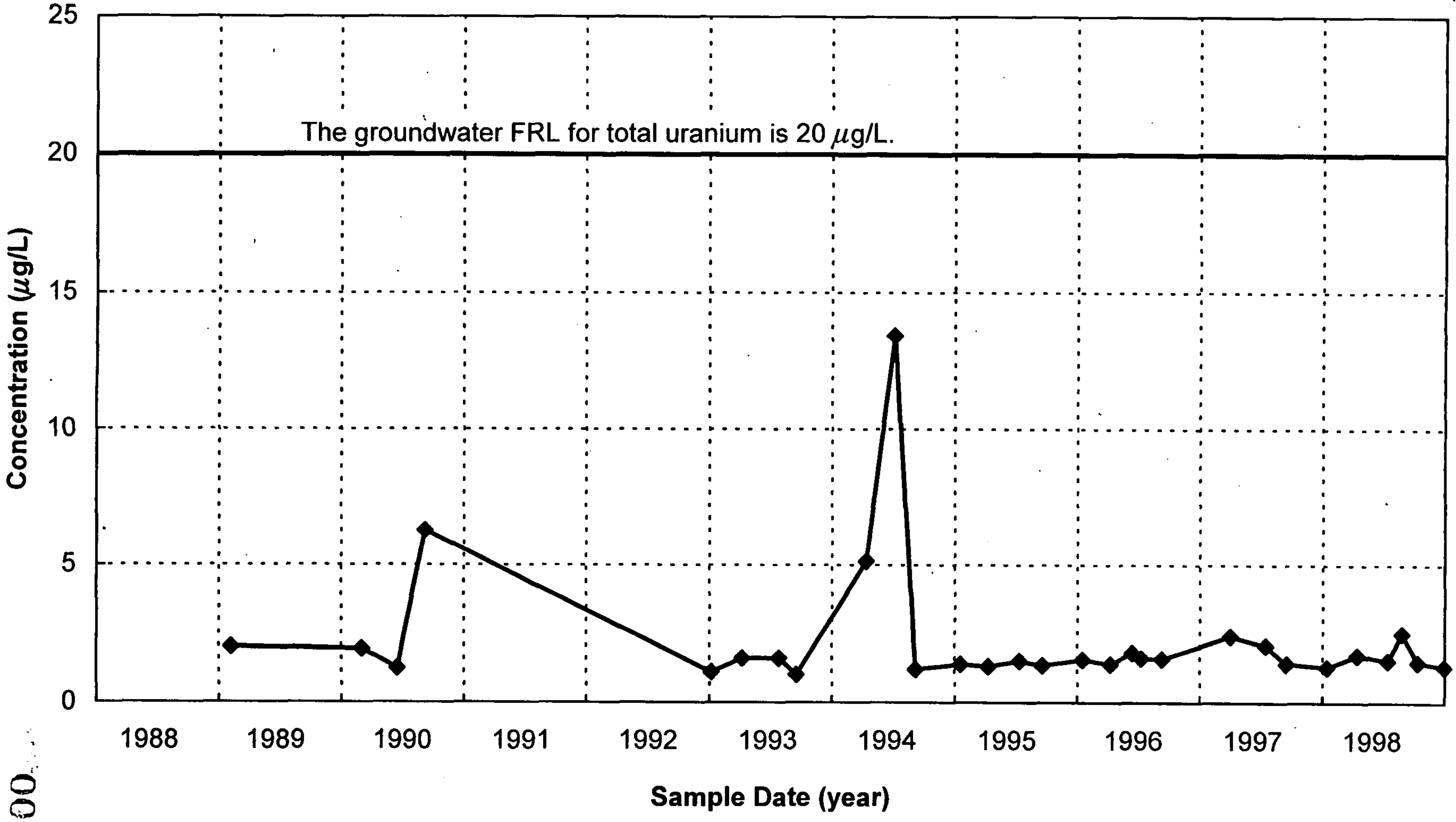

FIGURE A.2-93. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3106

000167

2272

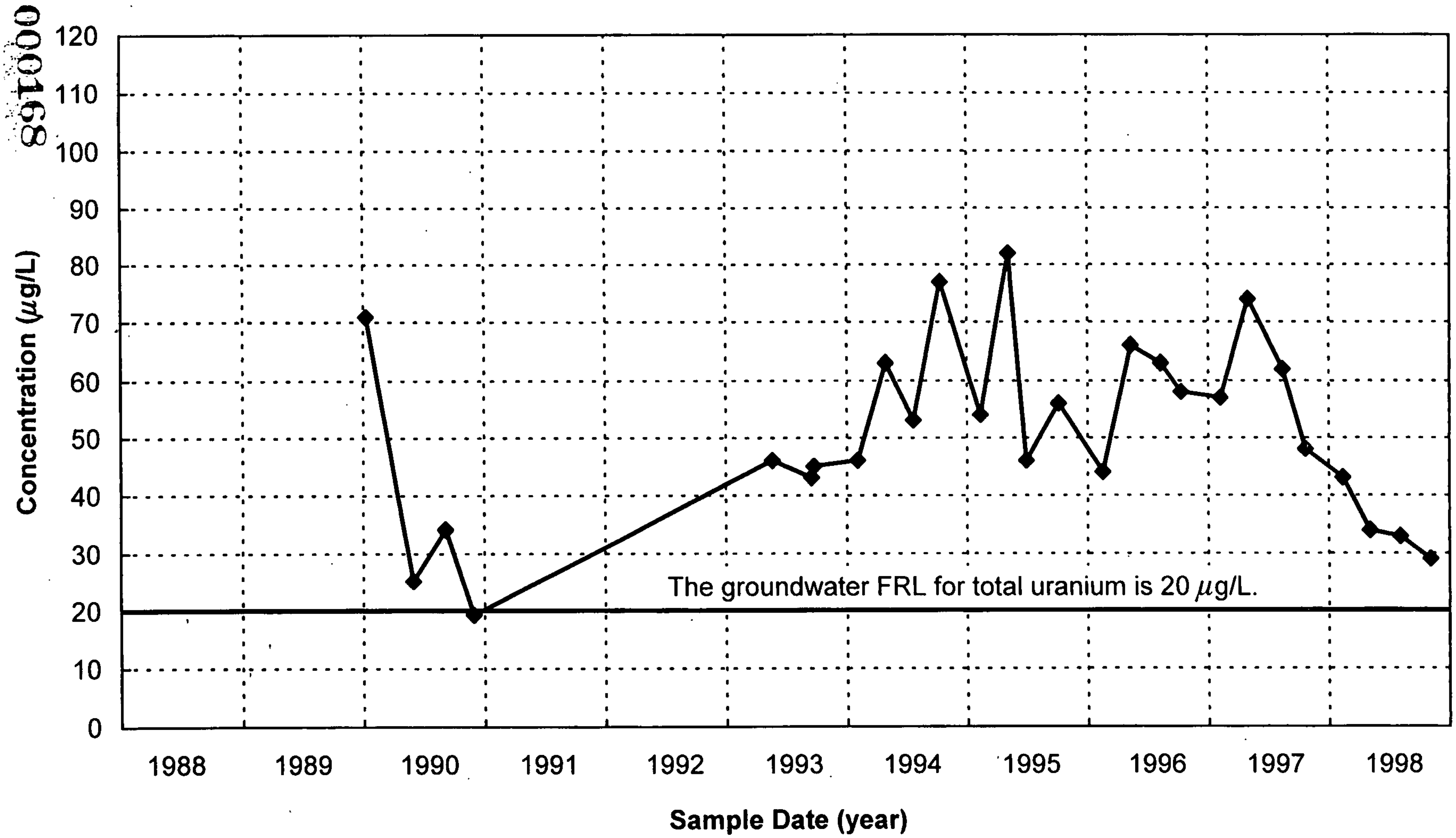

FIGURE A.2-94. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 3125

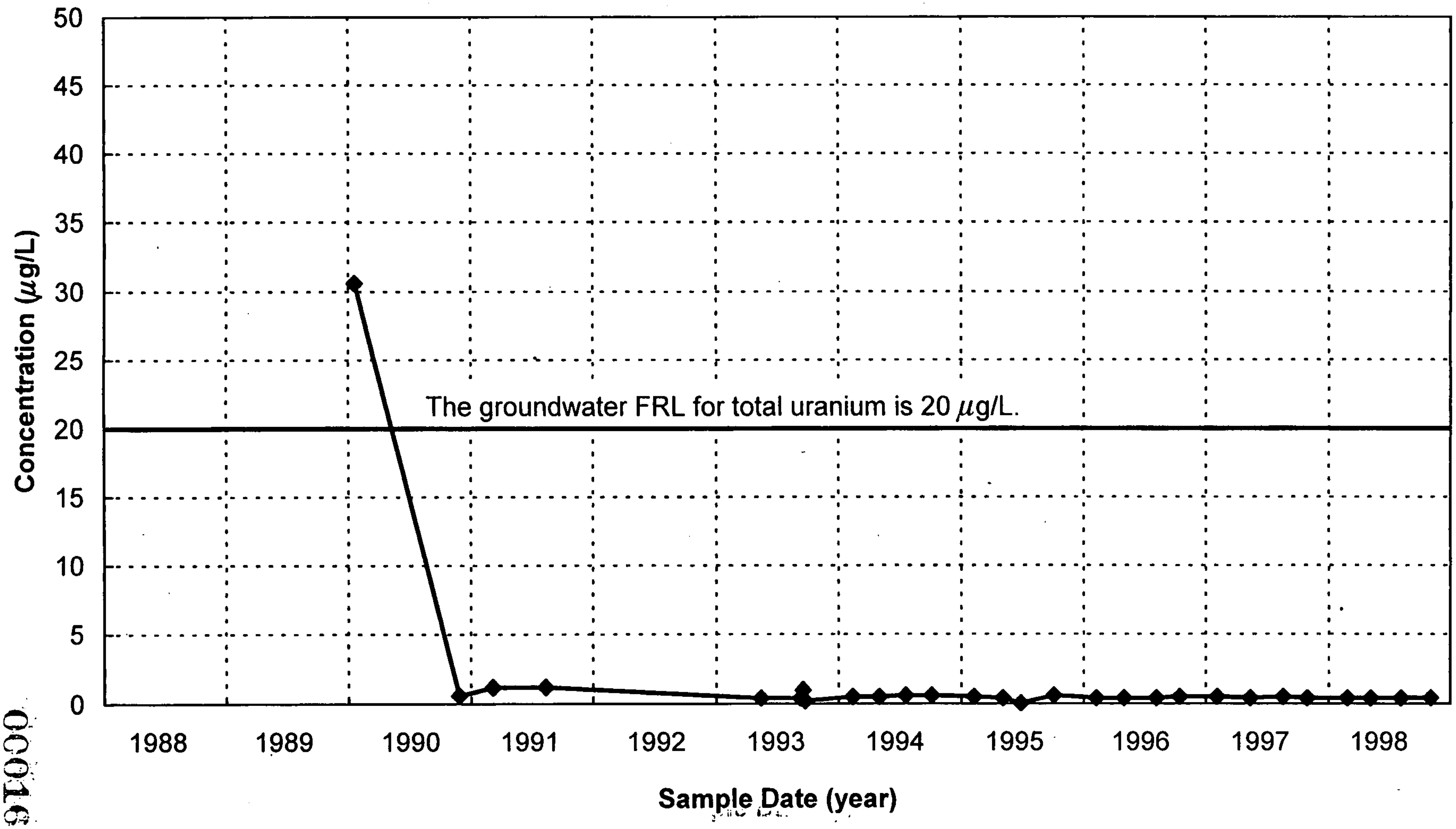

FIGURE A.2-95. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 3128

000169

2272

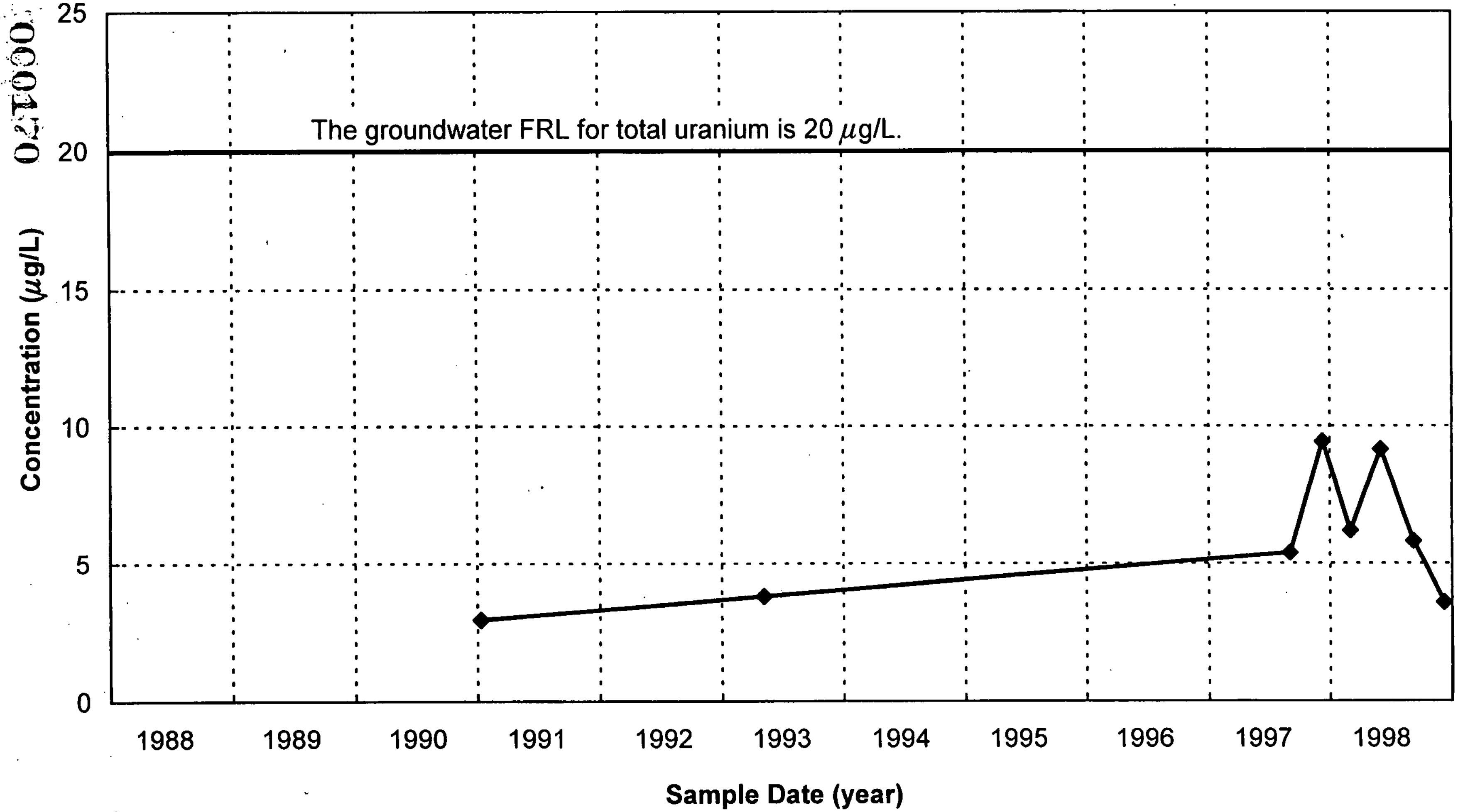

FIGURE A.2-96. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3385

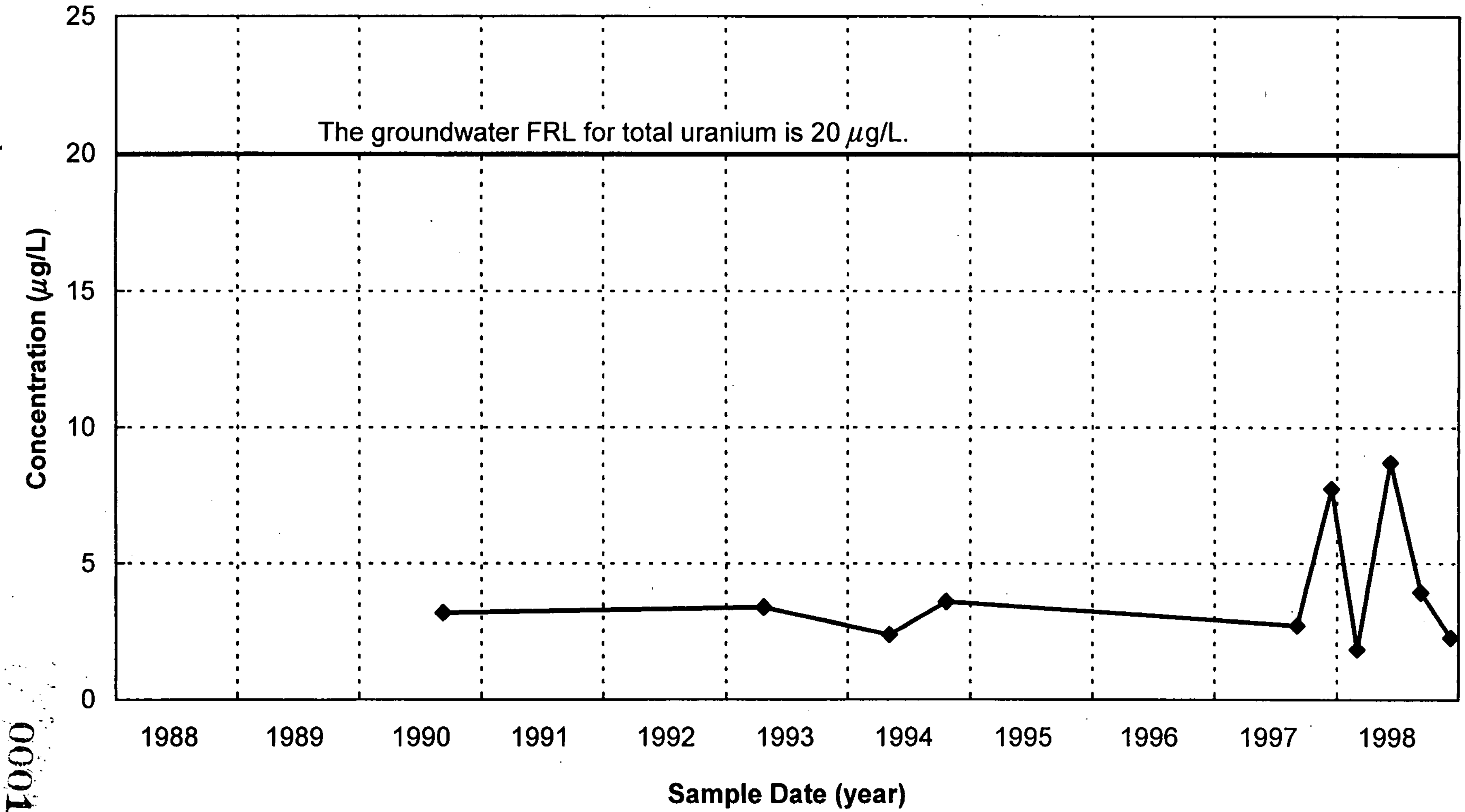

FIGURE A.2-97. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3387

000171

2272

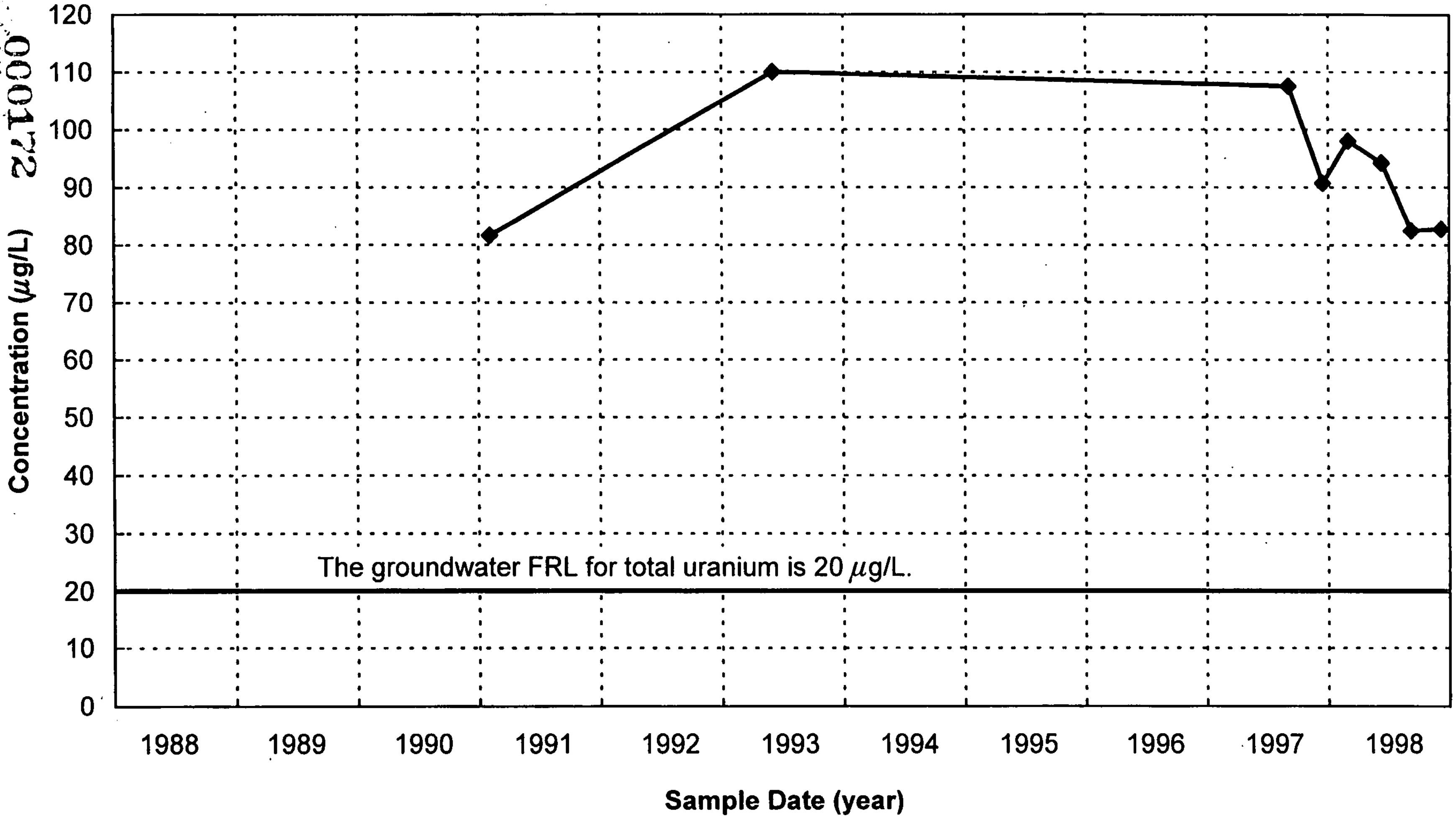

FIGURE A.2-98. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3390

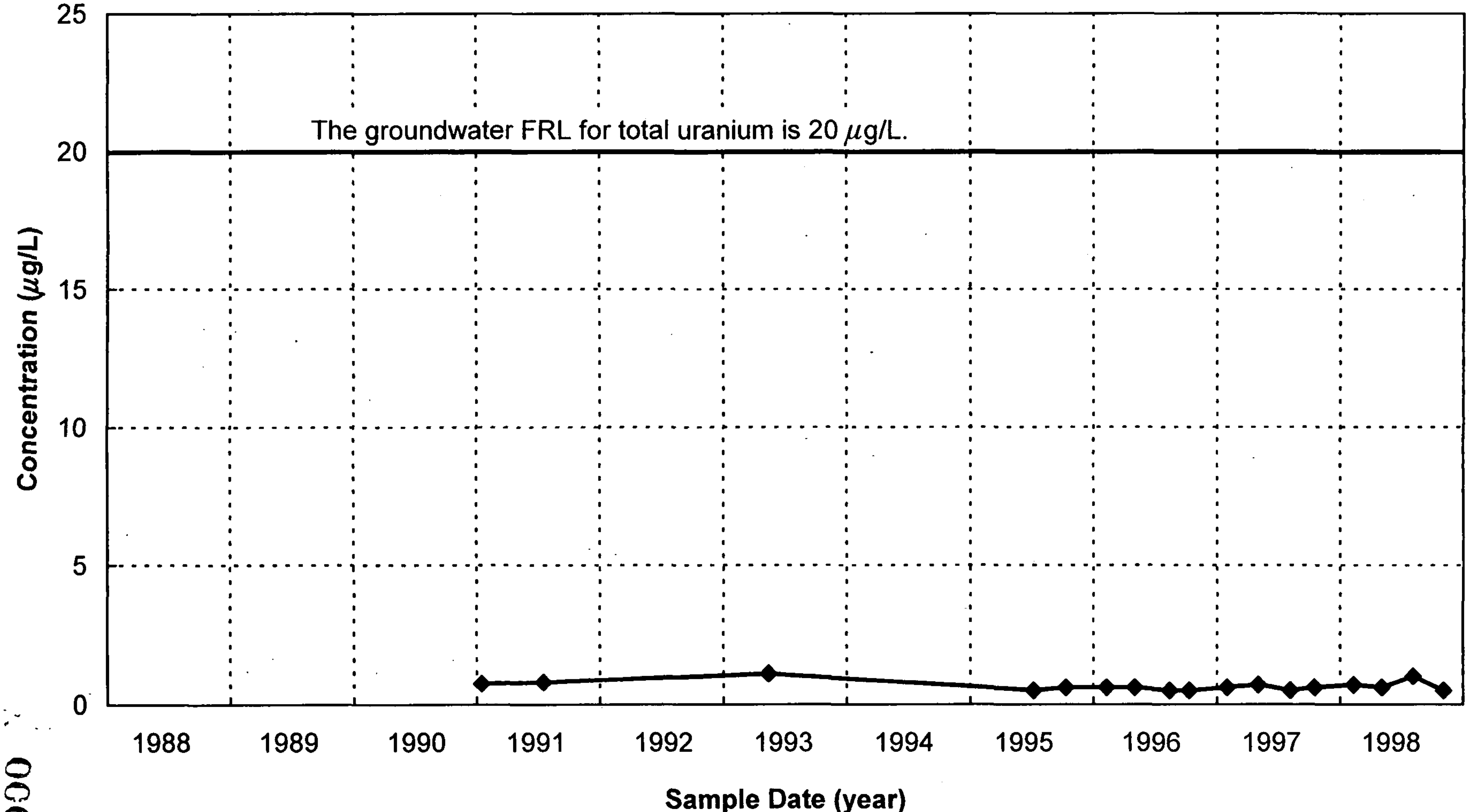

FIGURE A.2-99. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3396

000173

2272

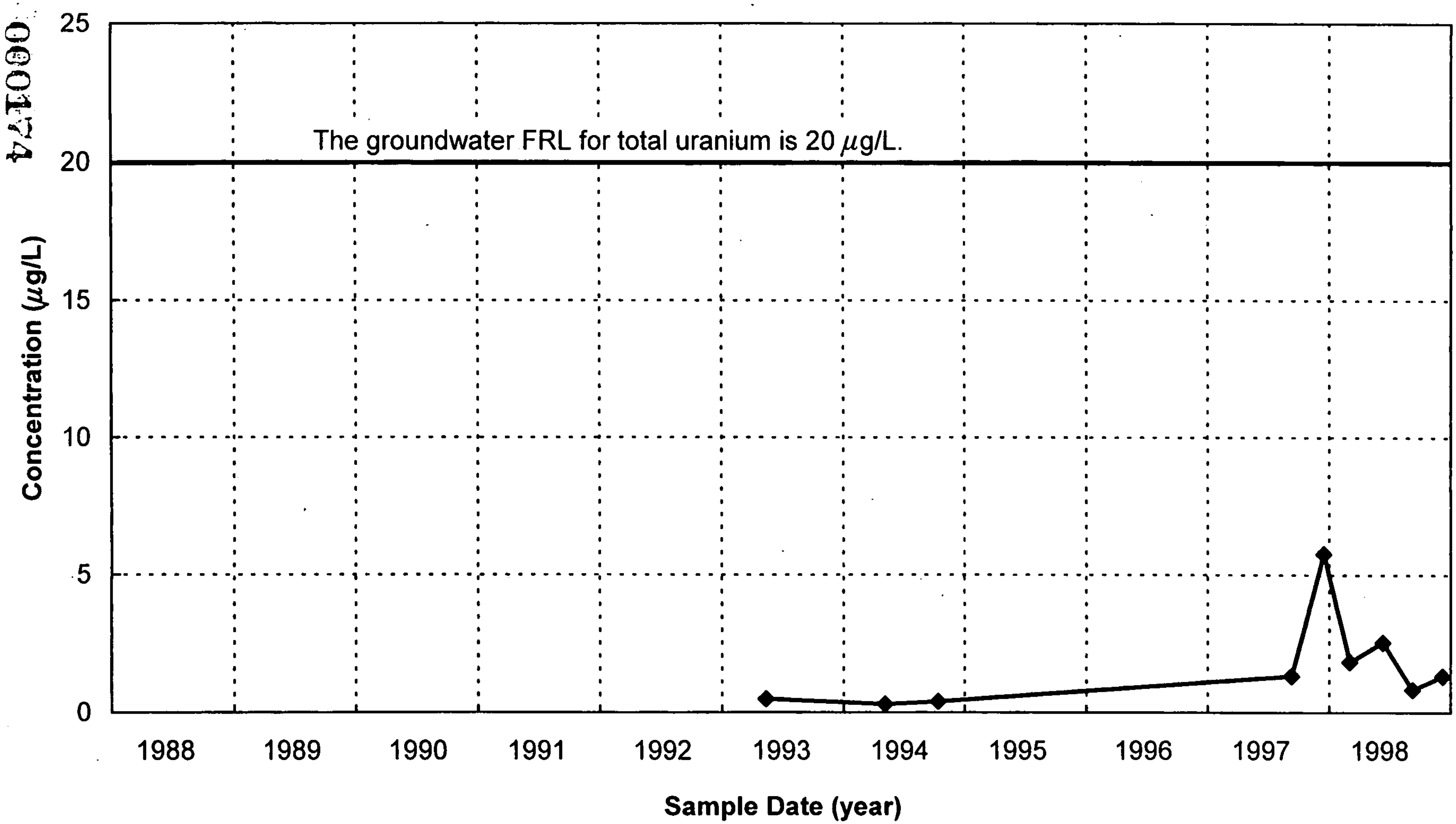

FIGURE A.2-100. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 3397

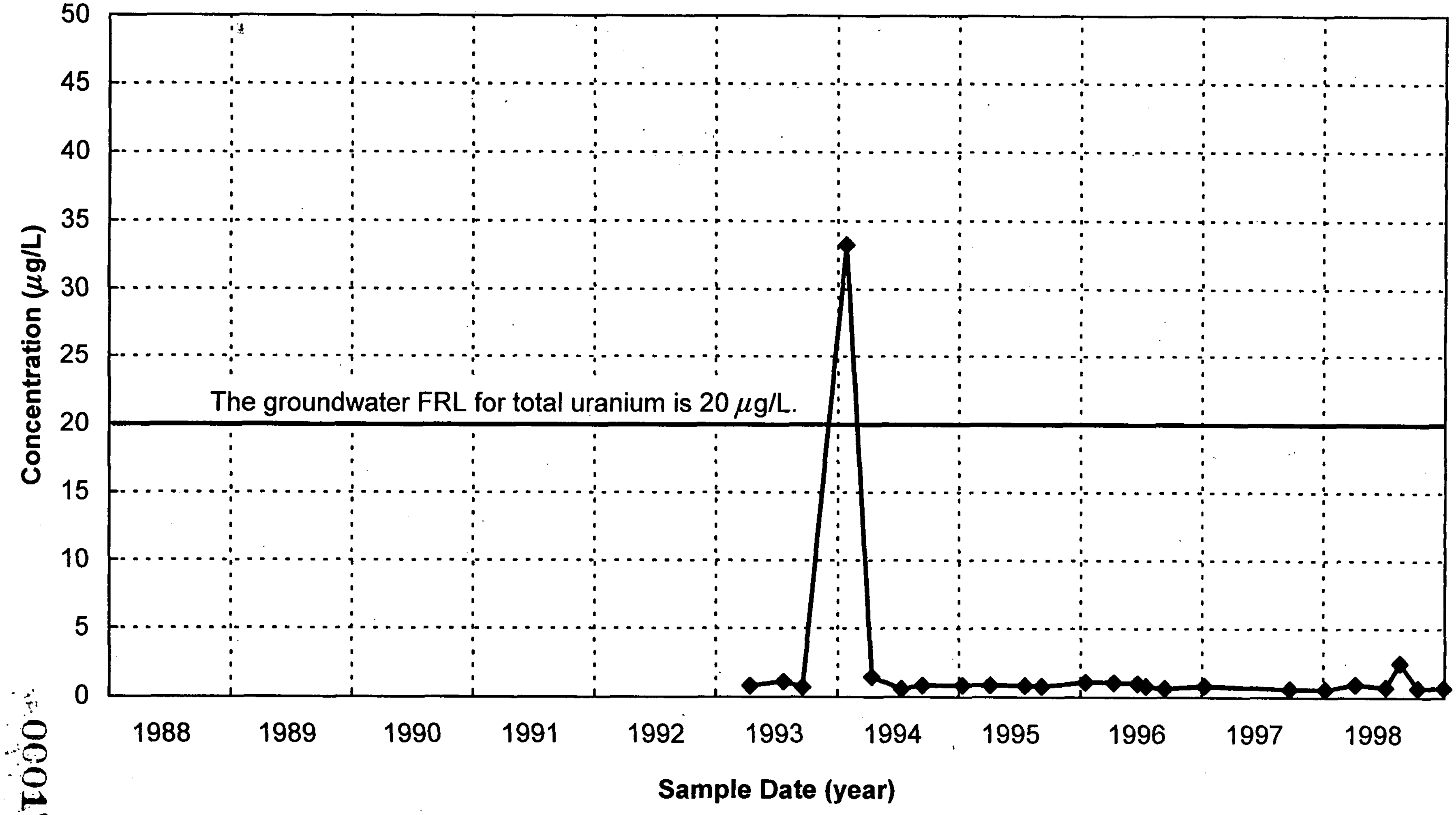

FIGURE A.2-101. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 3398

000175

2272

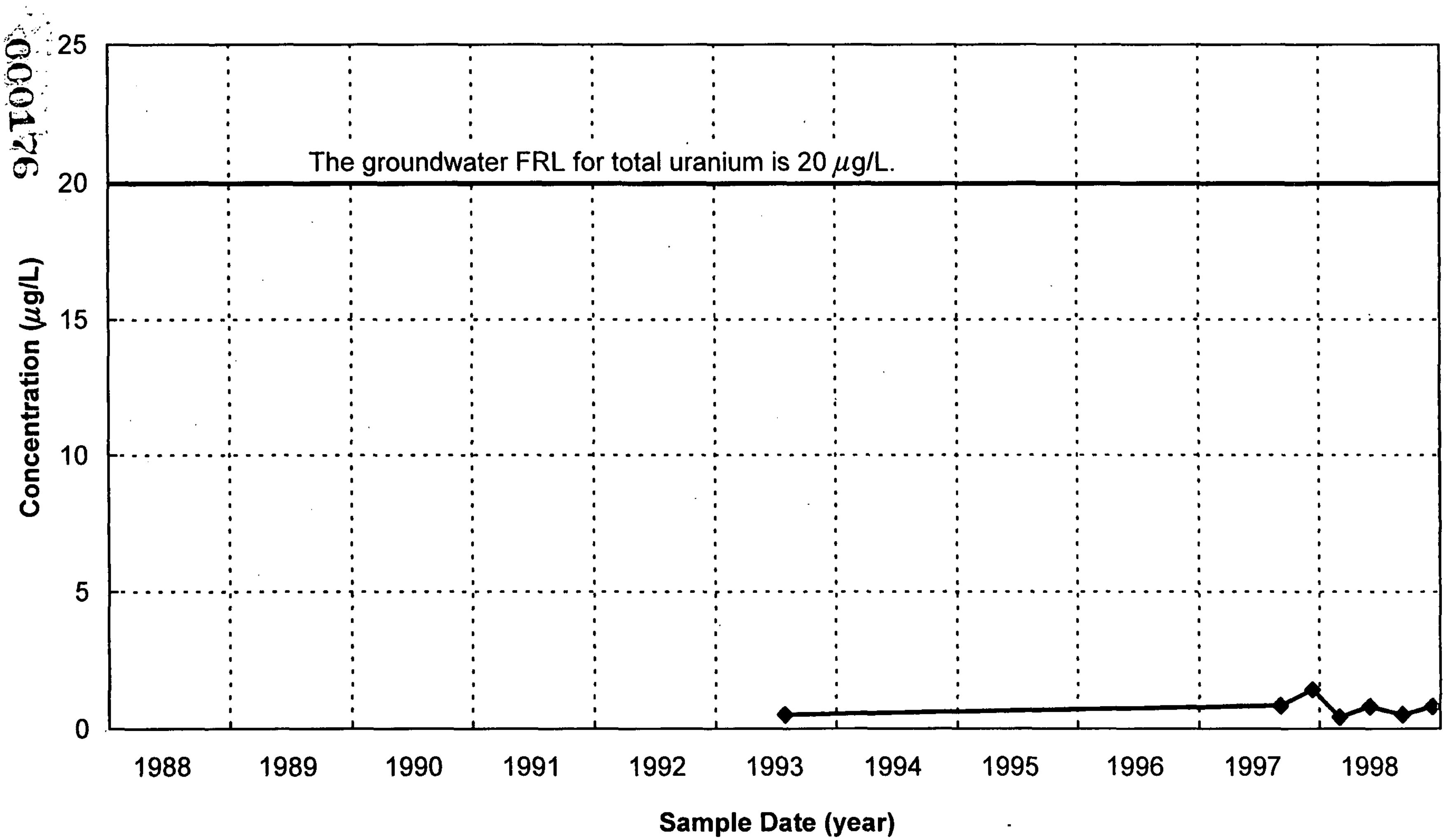

FIGURE A.2-102. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3402

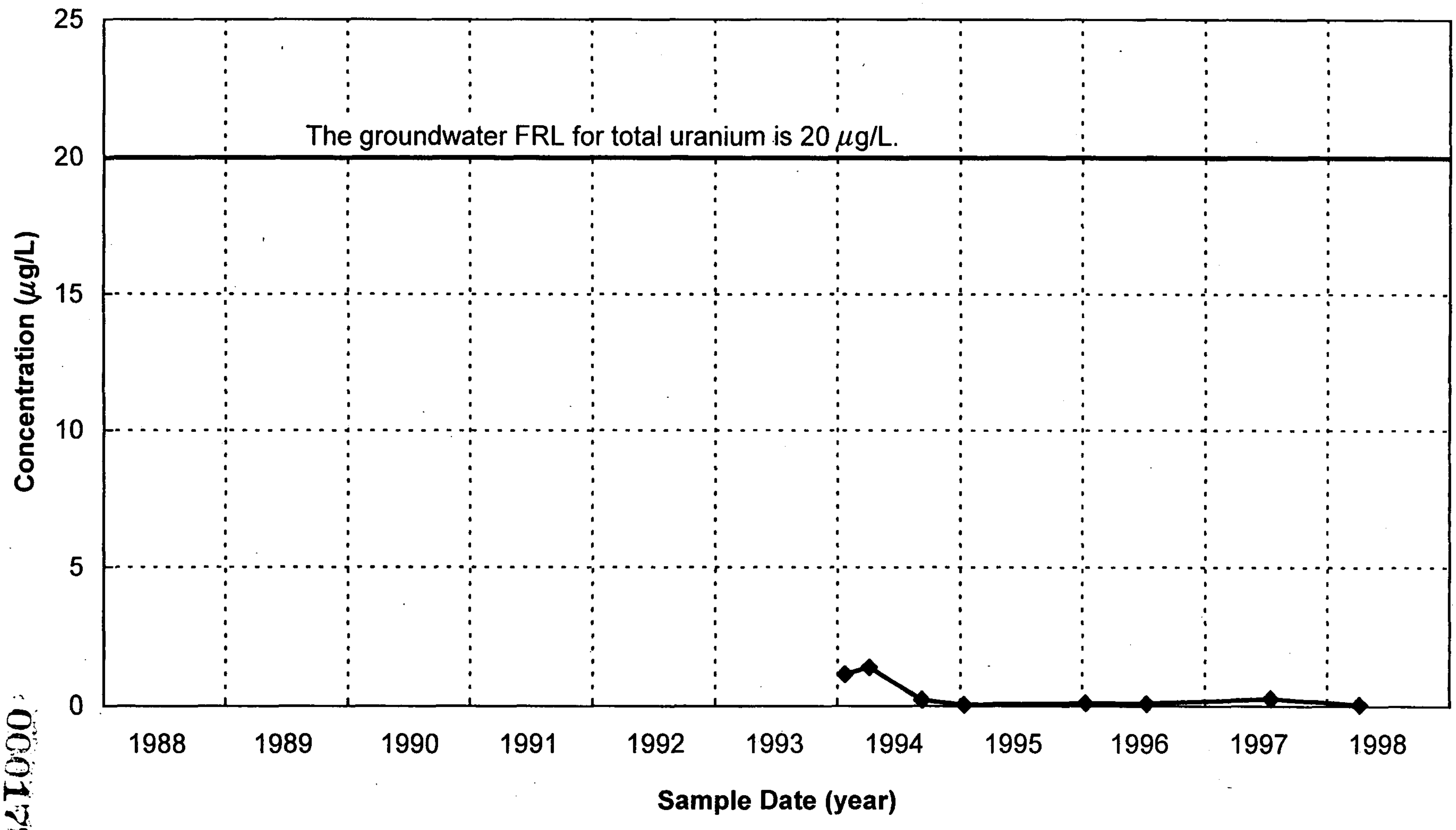

FIGURE A.2-103. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3417

000177

2272

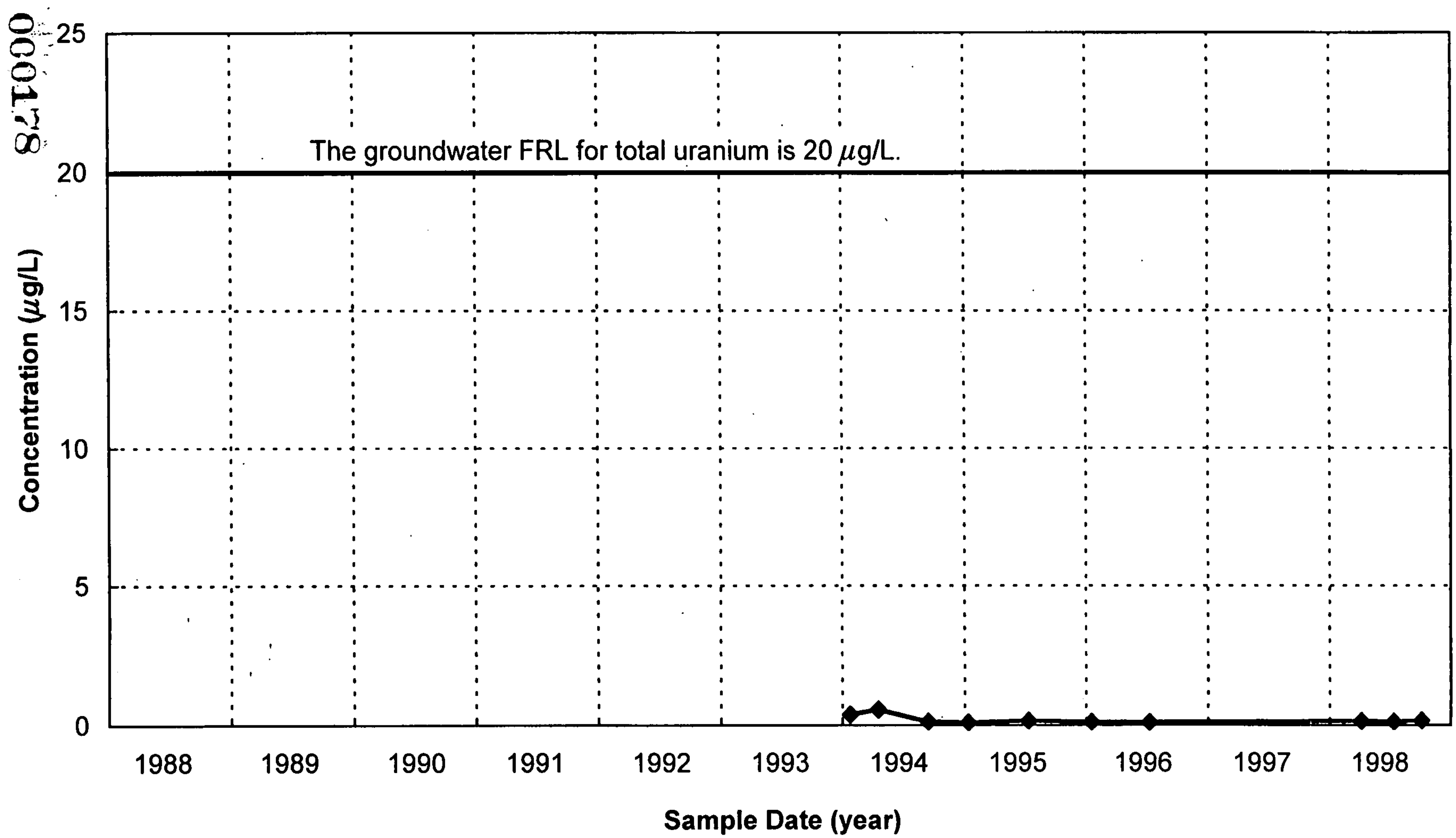

FIGURE A.2-104. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3424

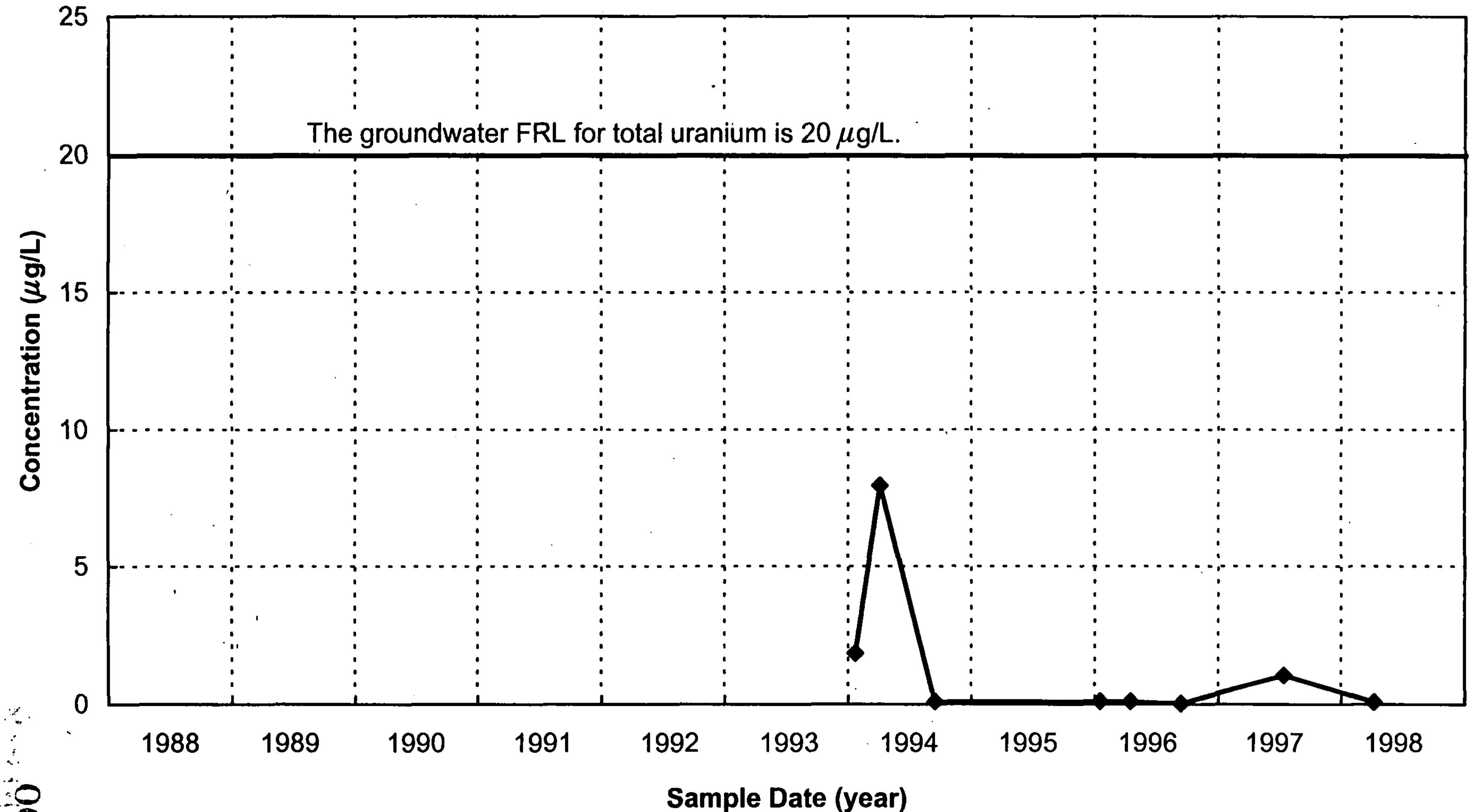

FIGURE A.2-105. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3426

000180

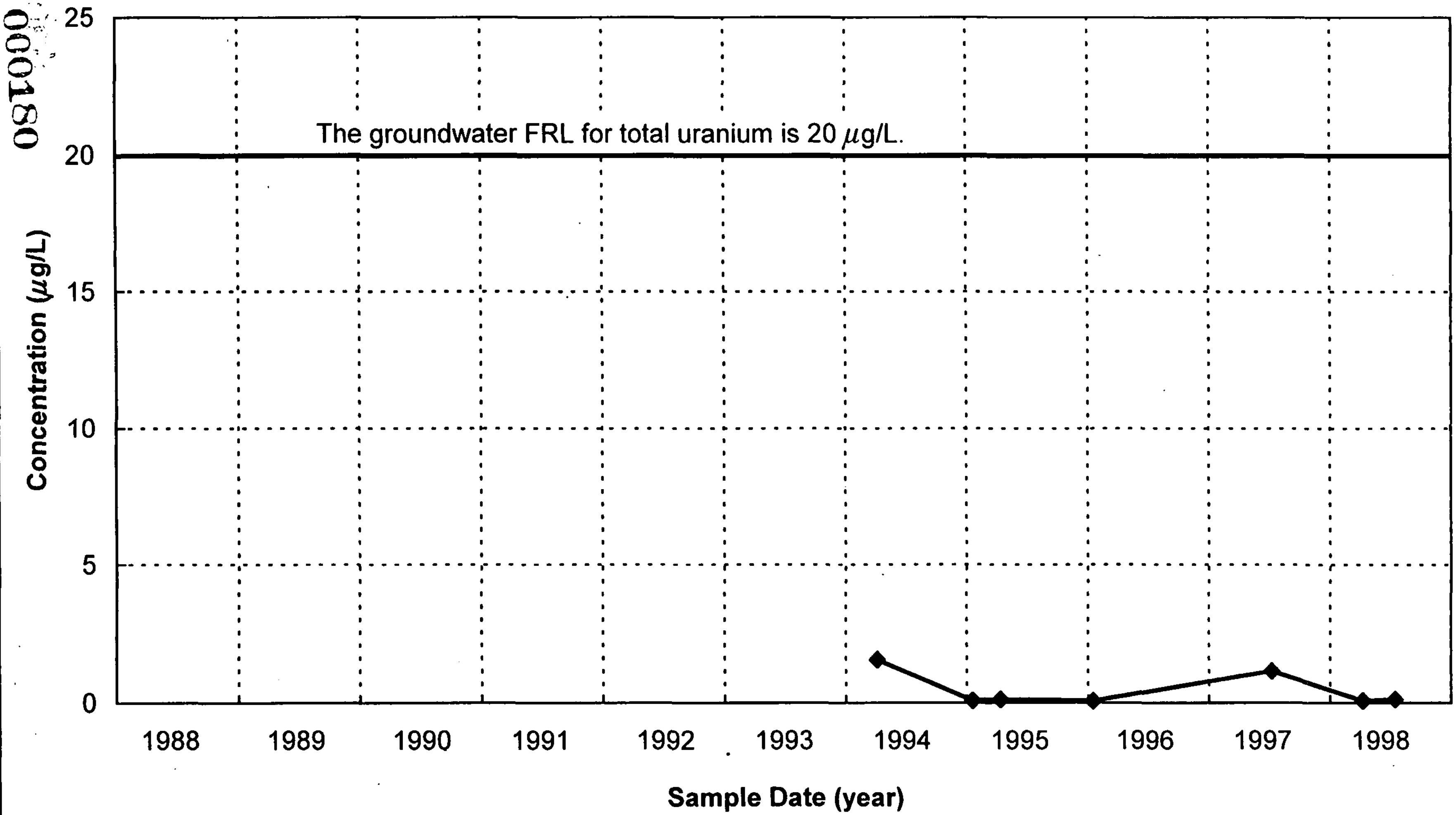

FIGURE A.2-106. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3429

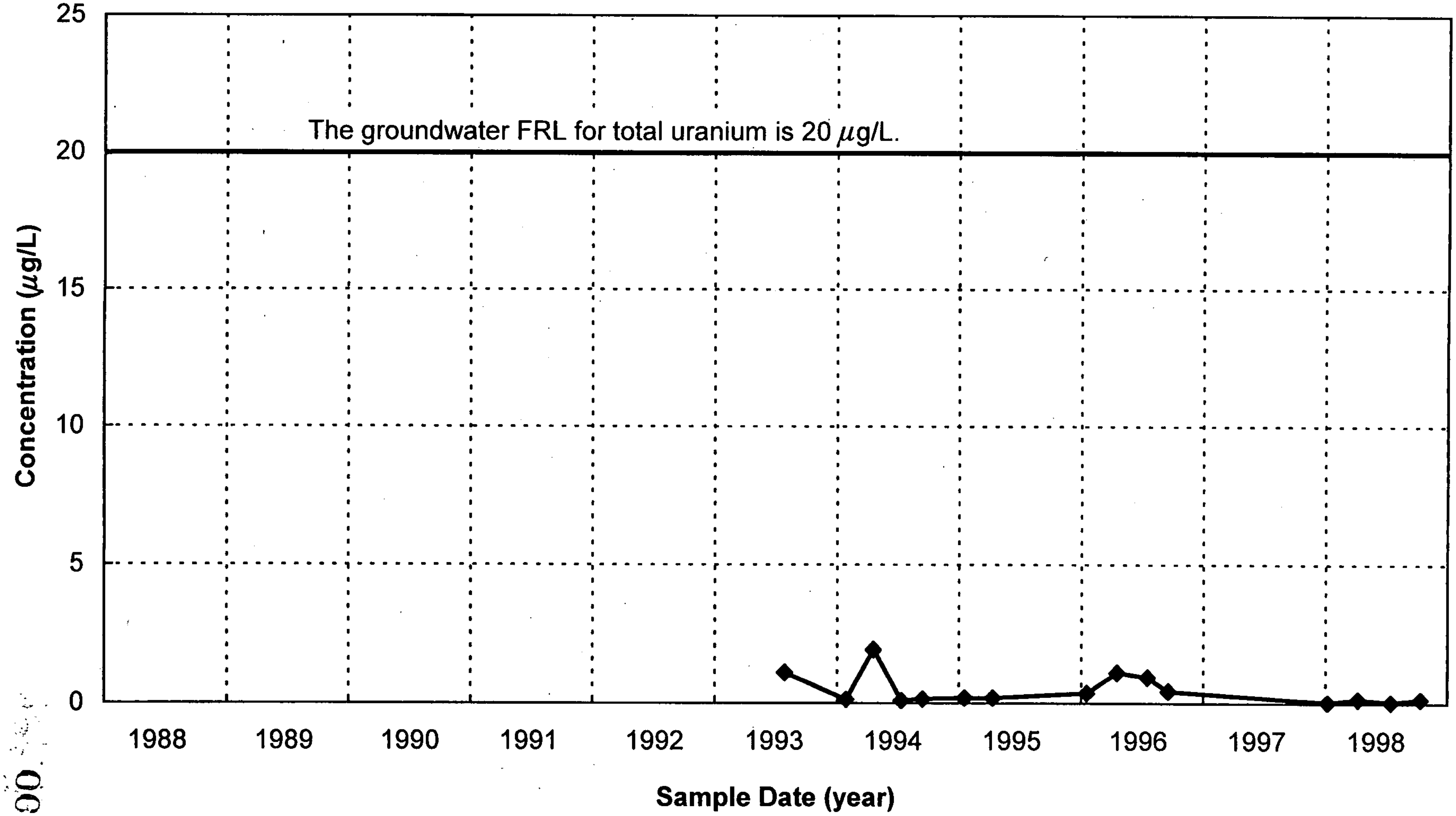

FIGURE A.2-107. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 3431

000182

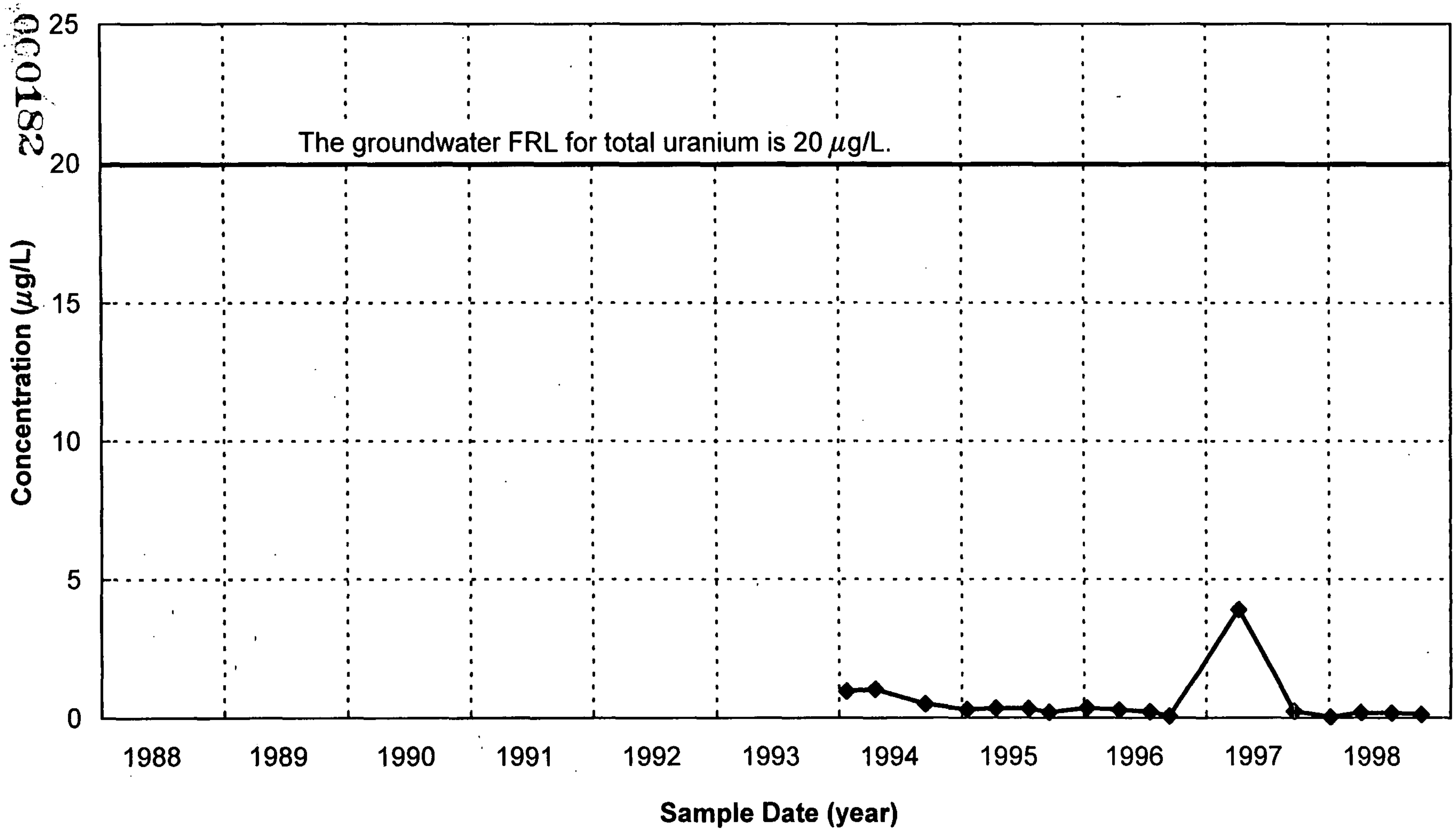

FIGURE A.2-108. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3432

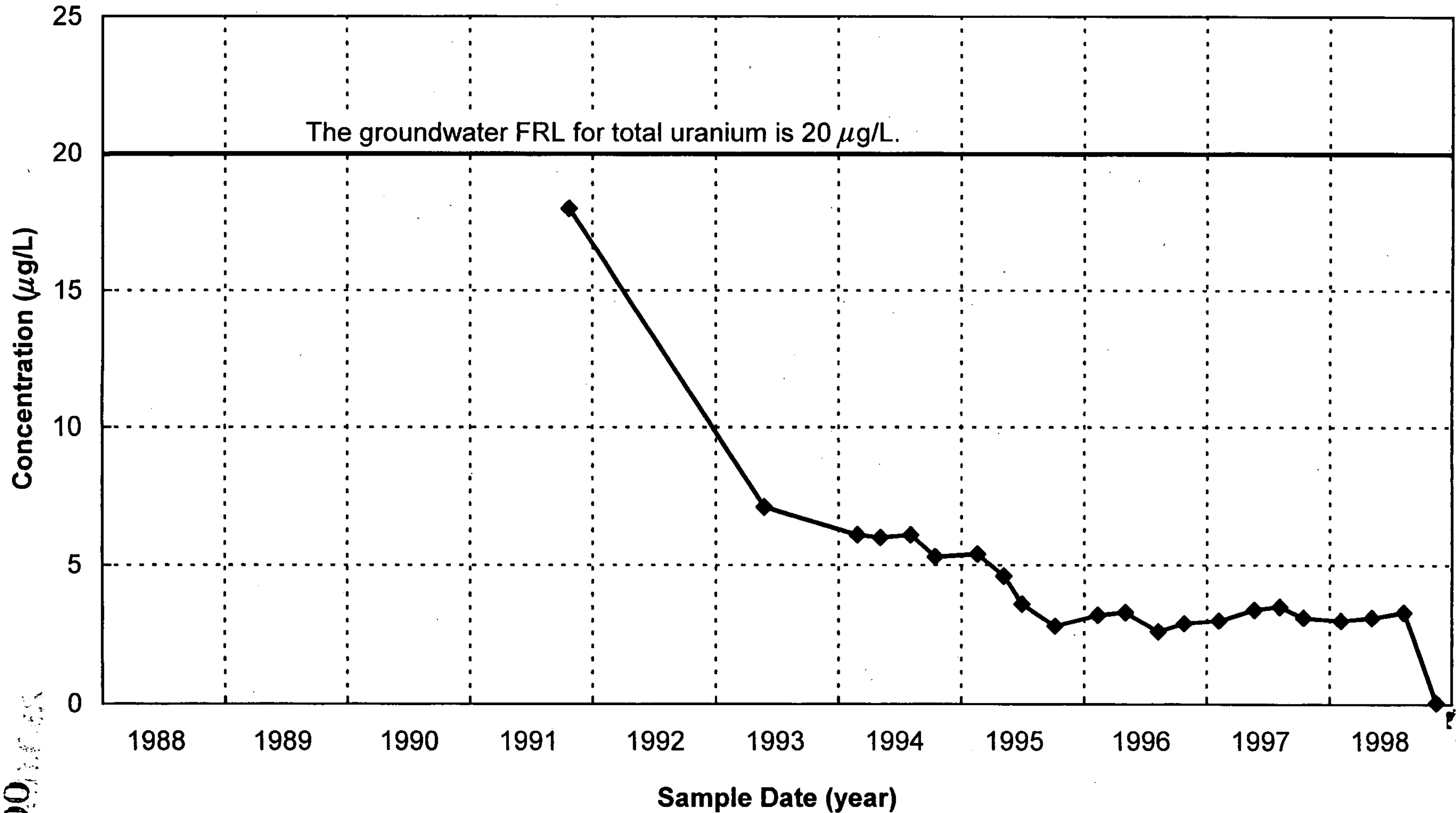

FIGURE A.2-109. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3550

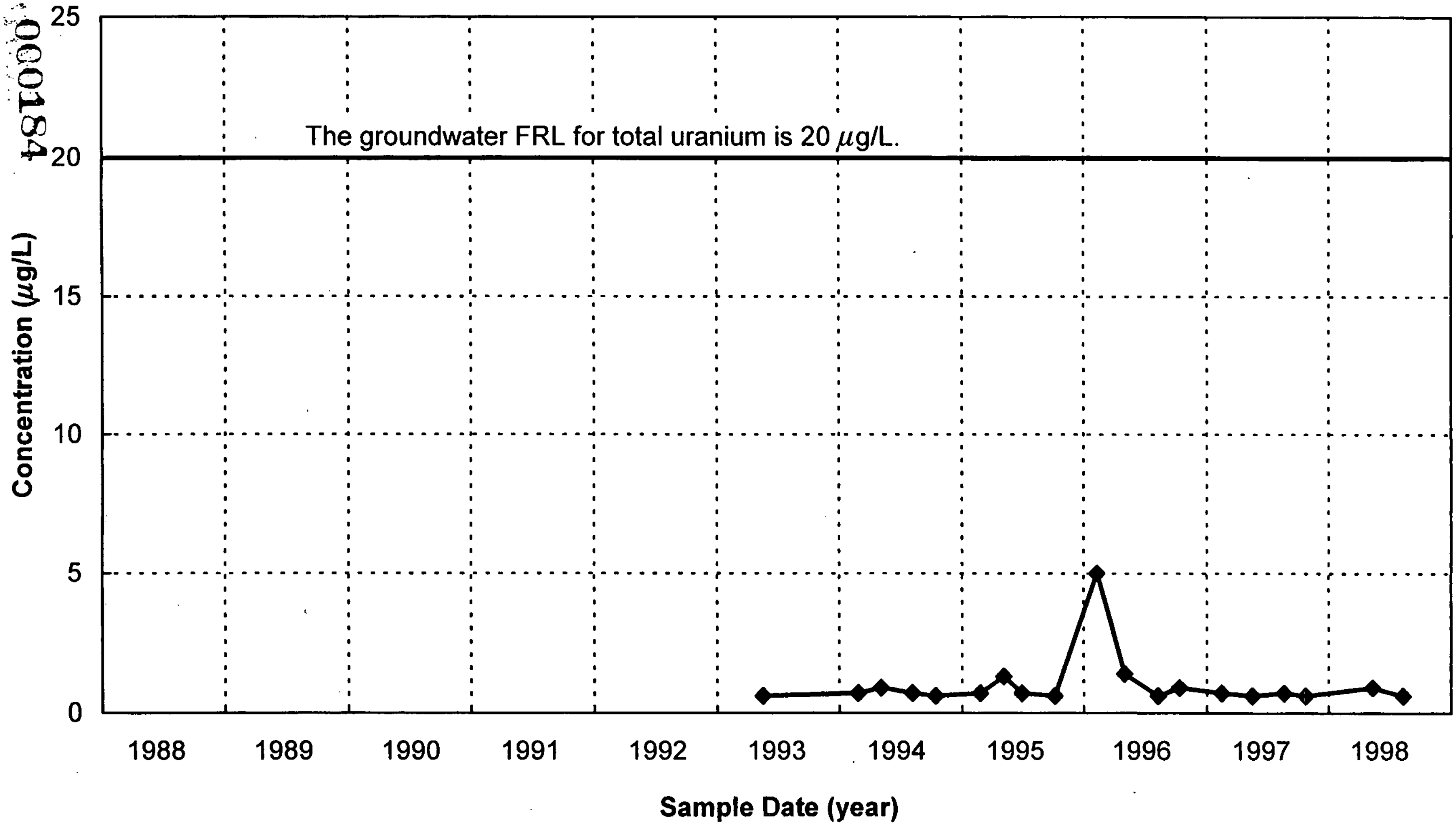

FIGURE A.2-110. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 3551

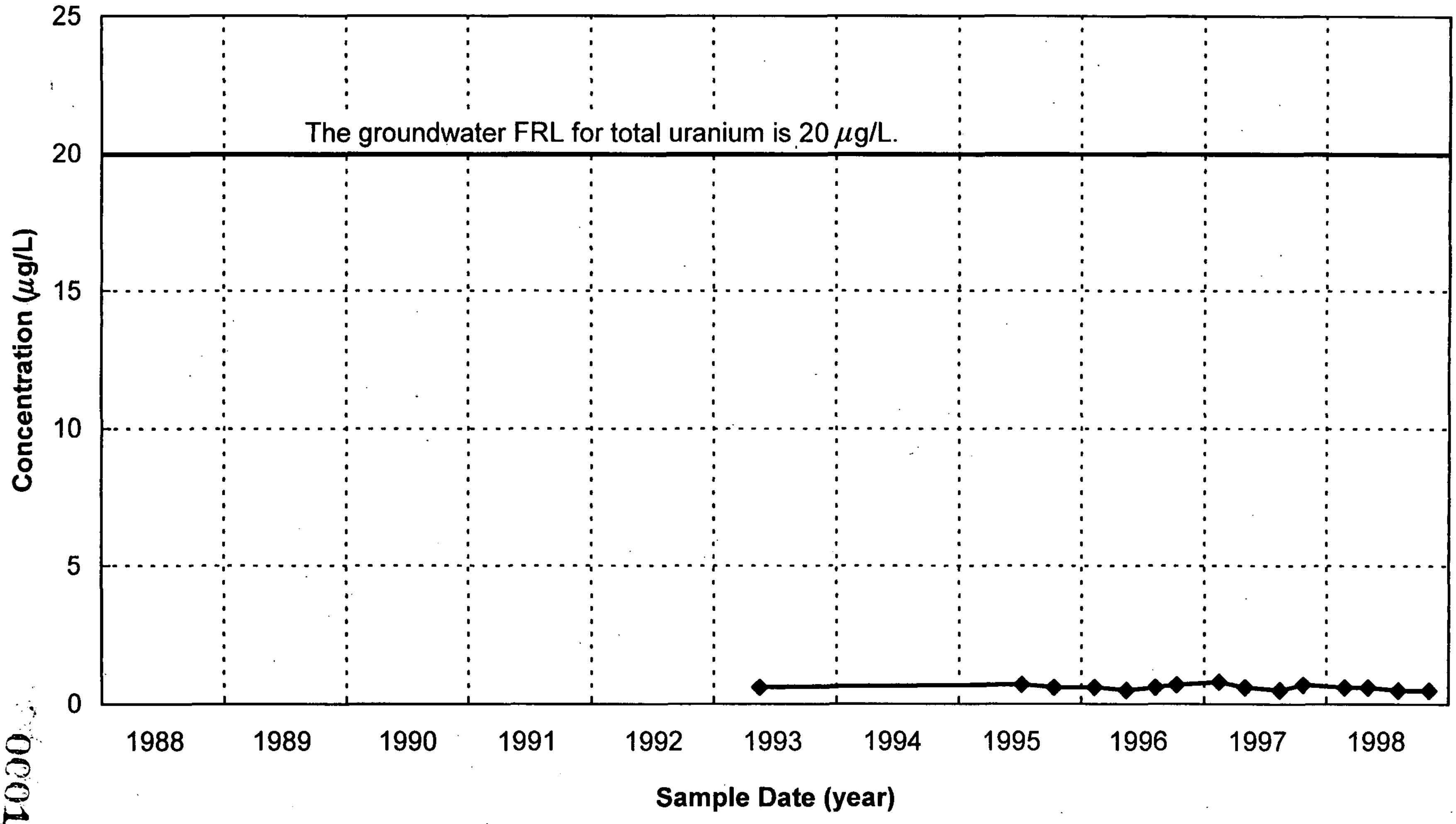

FIGURE A.2-111. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3552

000185

2272

000186

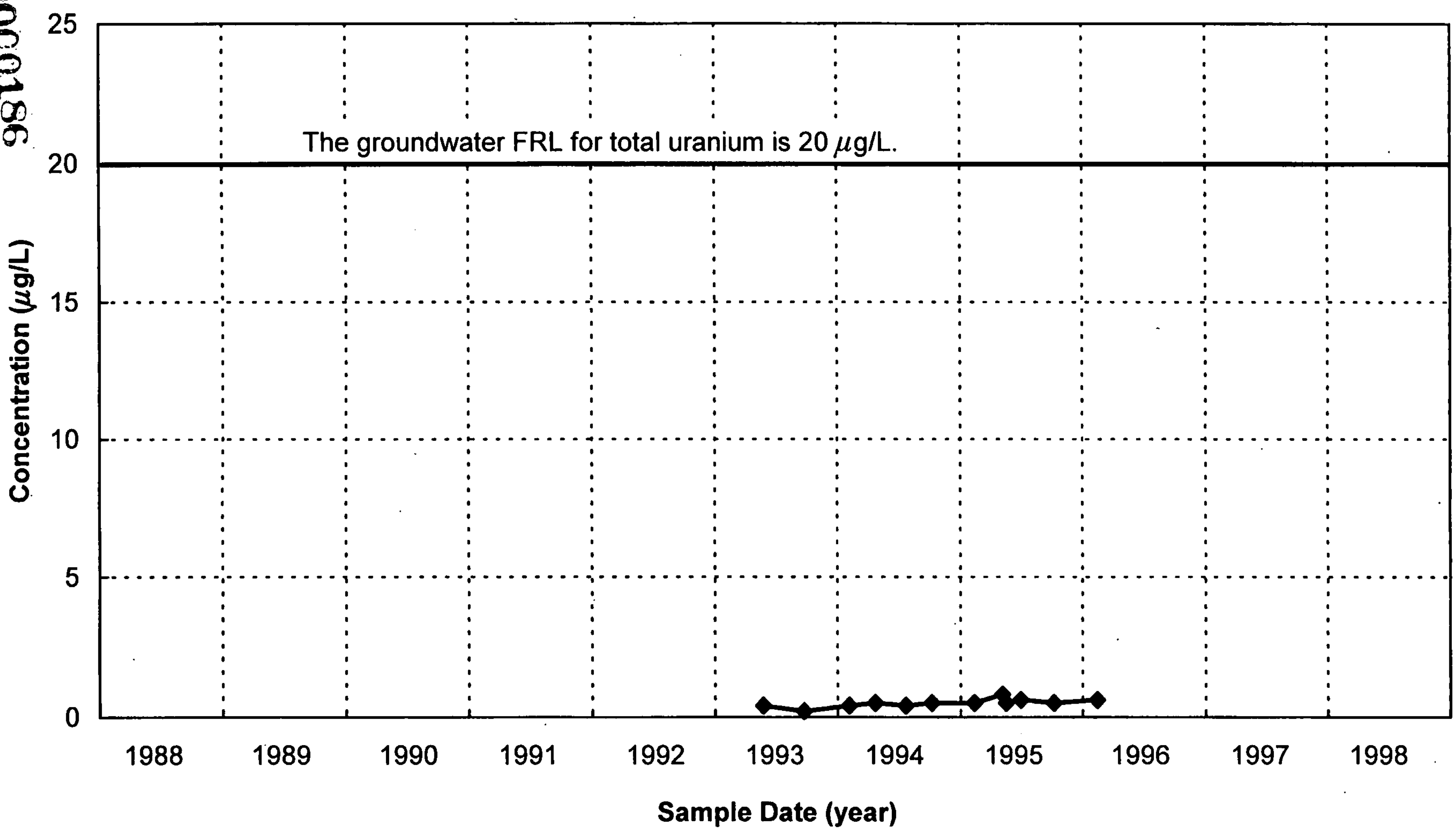

FIGURE A.2-112. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3624

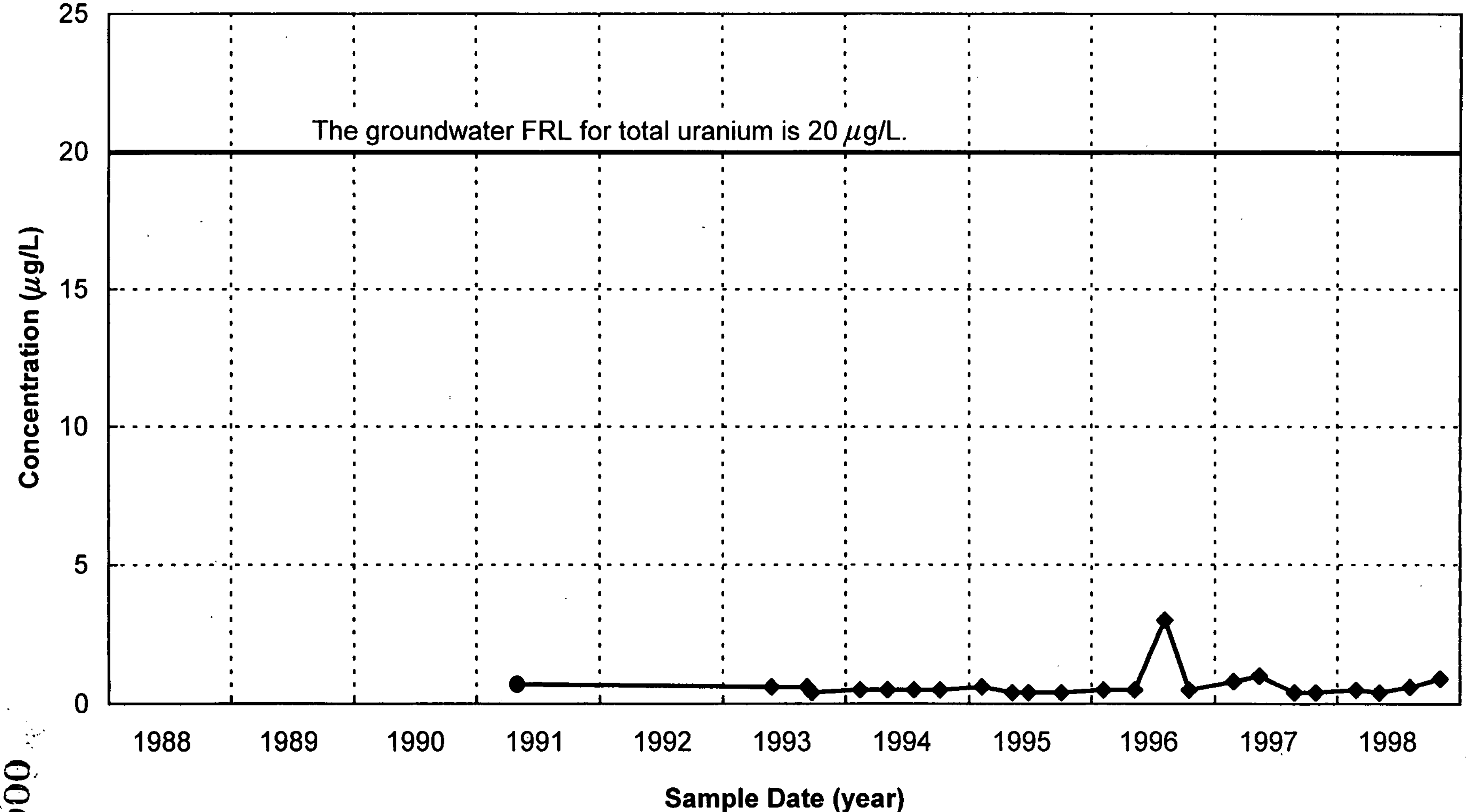

FIGURE A.2-113. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3636

000187

2272

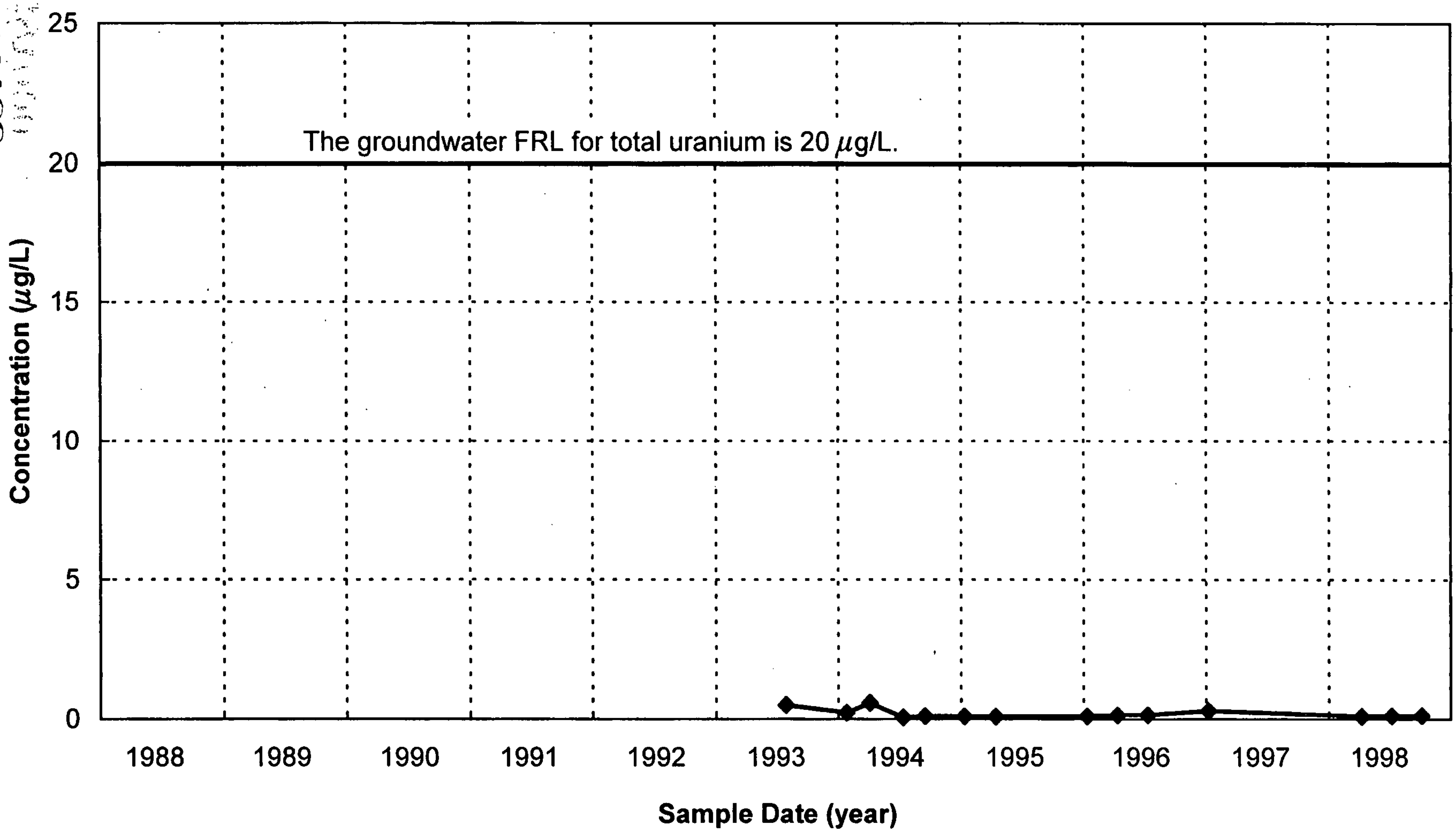

FIGURE A.2-114. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3733

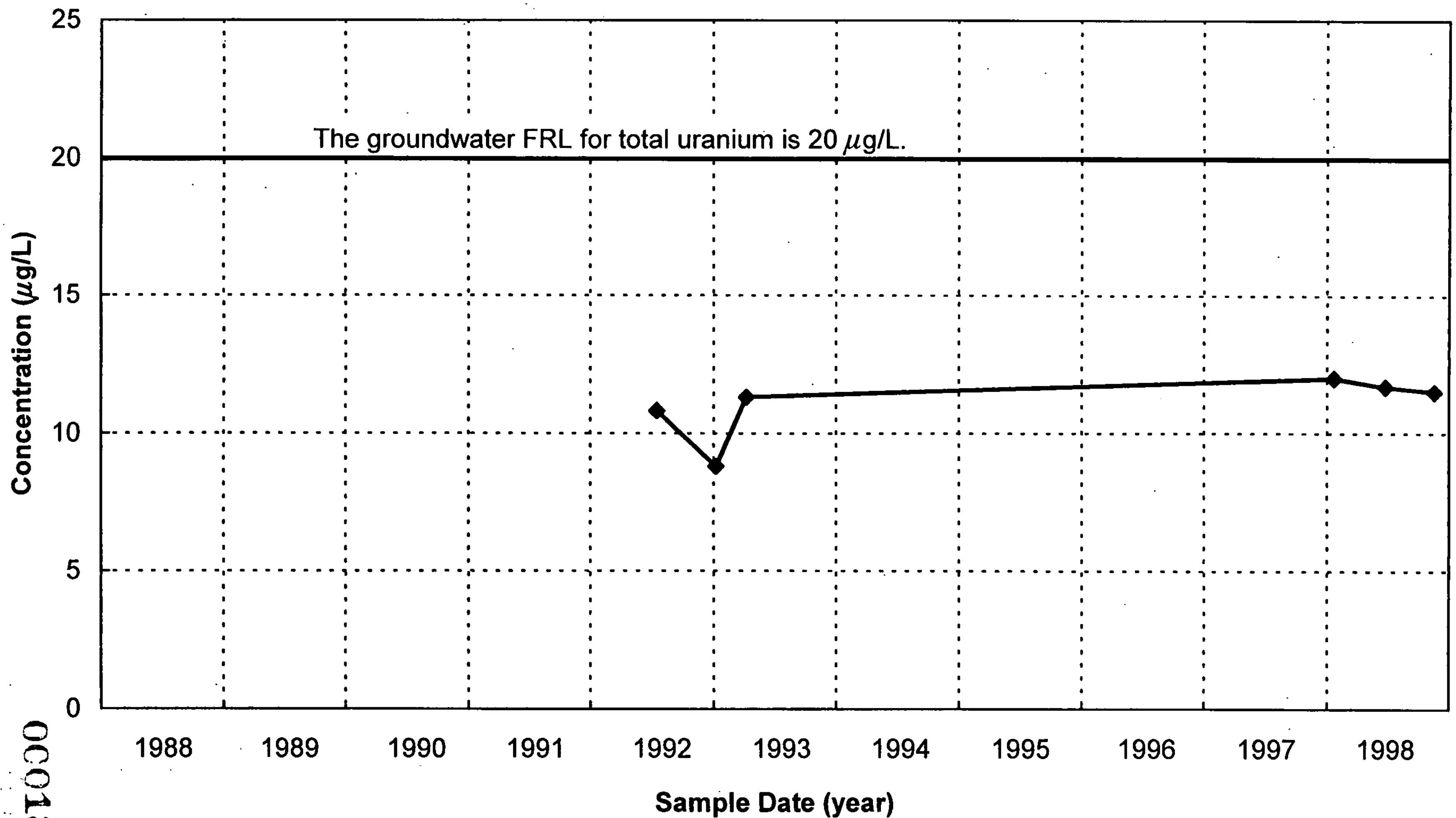

FIGURE A.2-115. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 3821

000189

2272

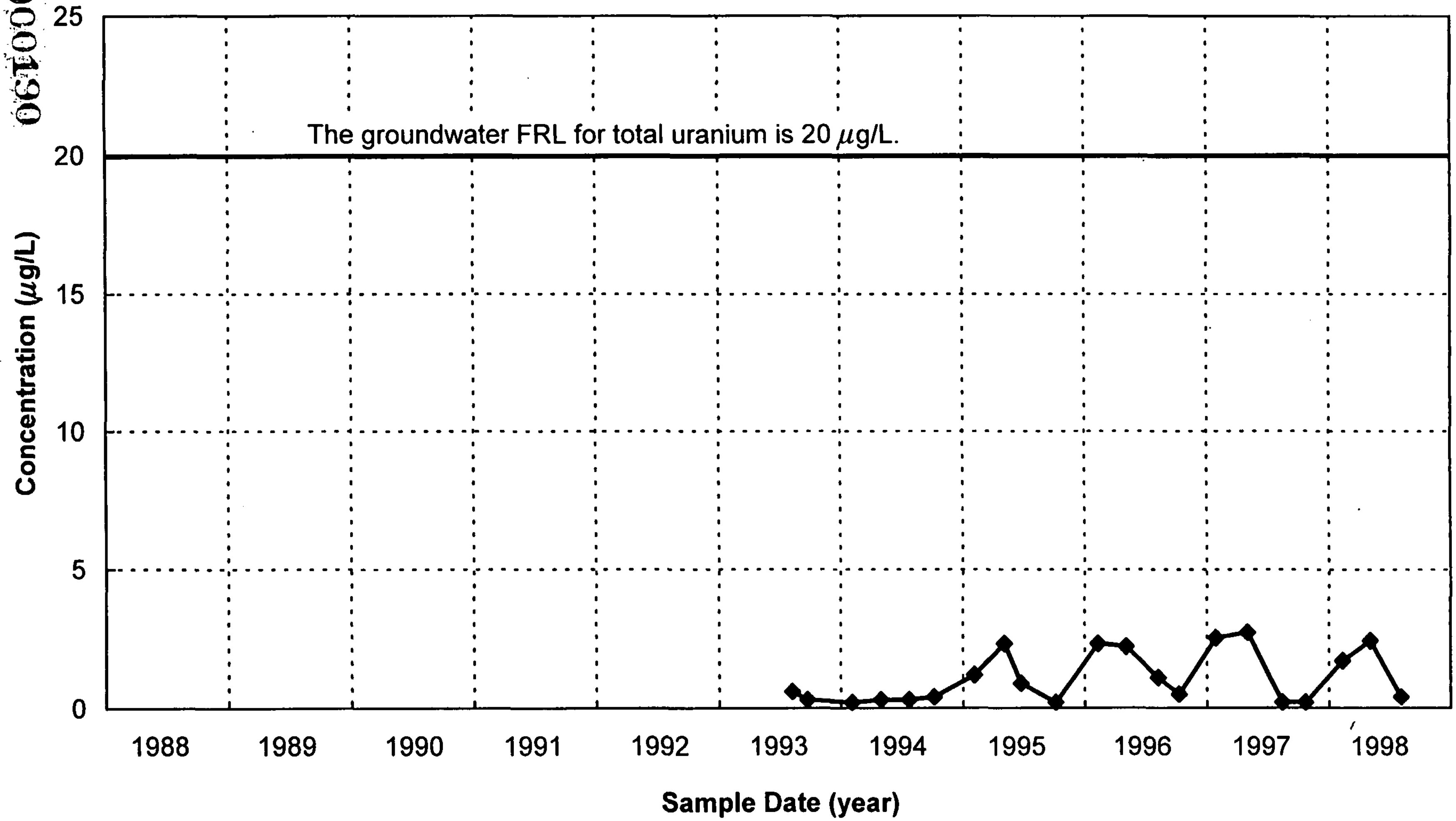

FIGURE A.2-116. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3880

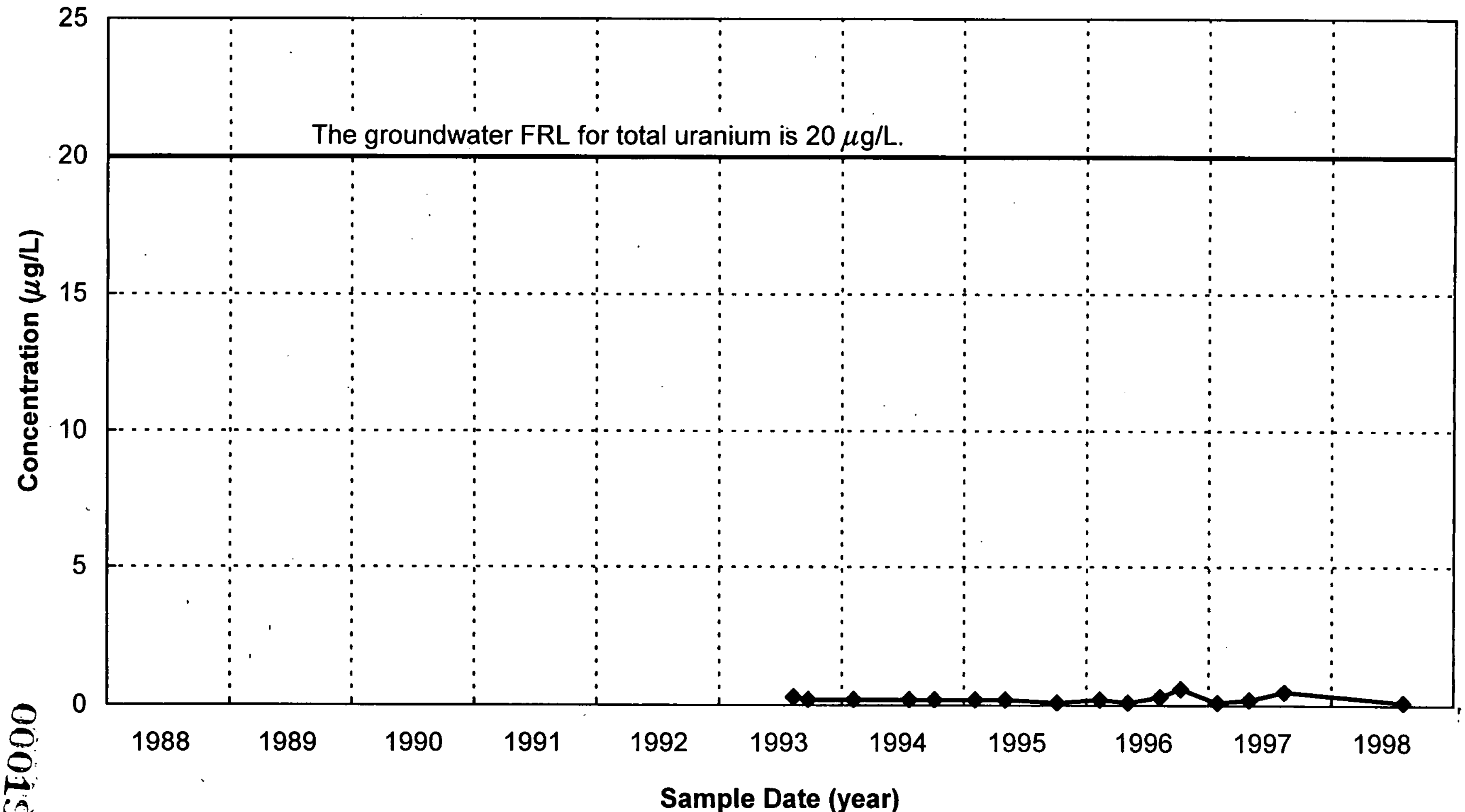

FIGURE A.2-117. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 3881

000191

2272

000192

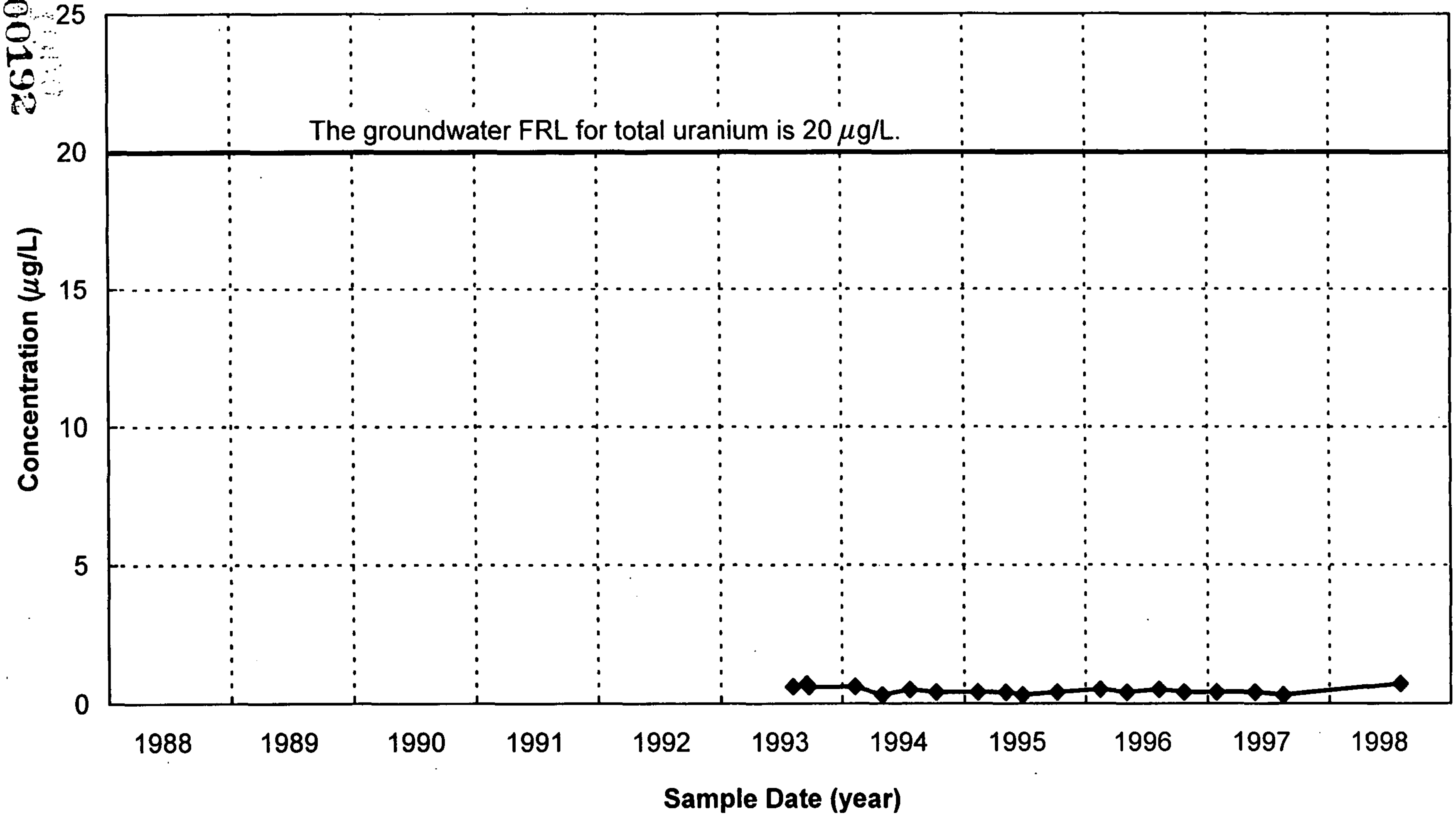

FIGURE A.2-118. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3897

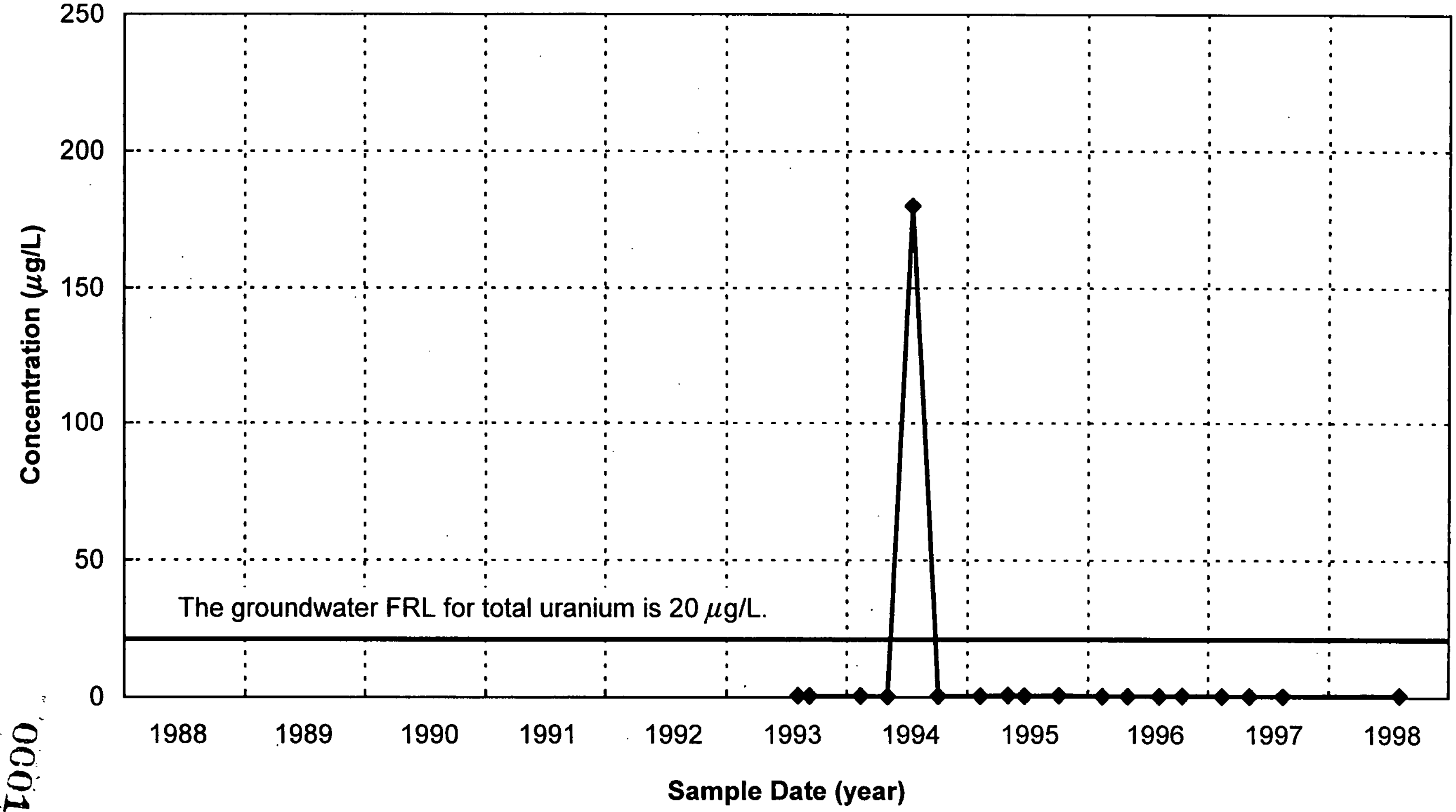

FIGURE A.2-119. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3898

000193

2272

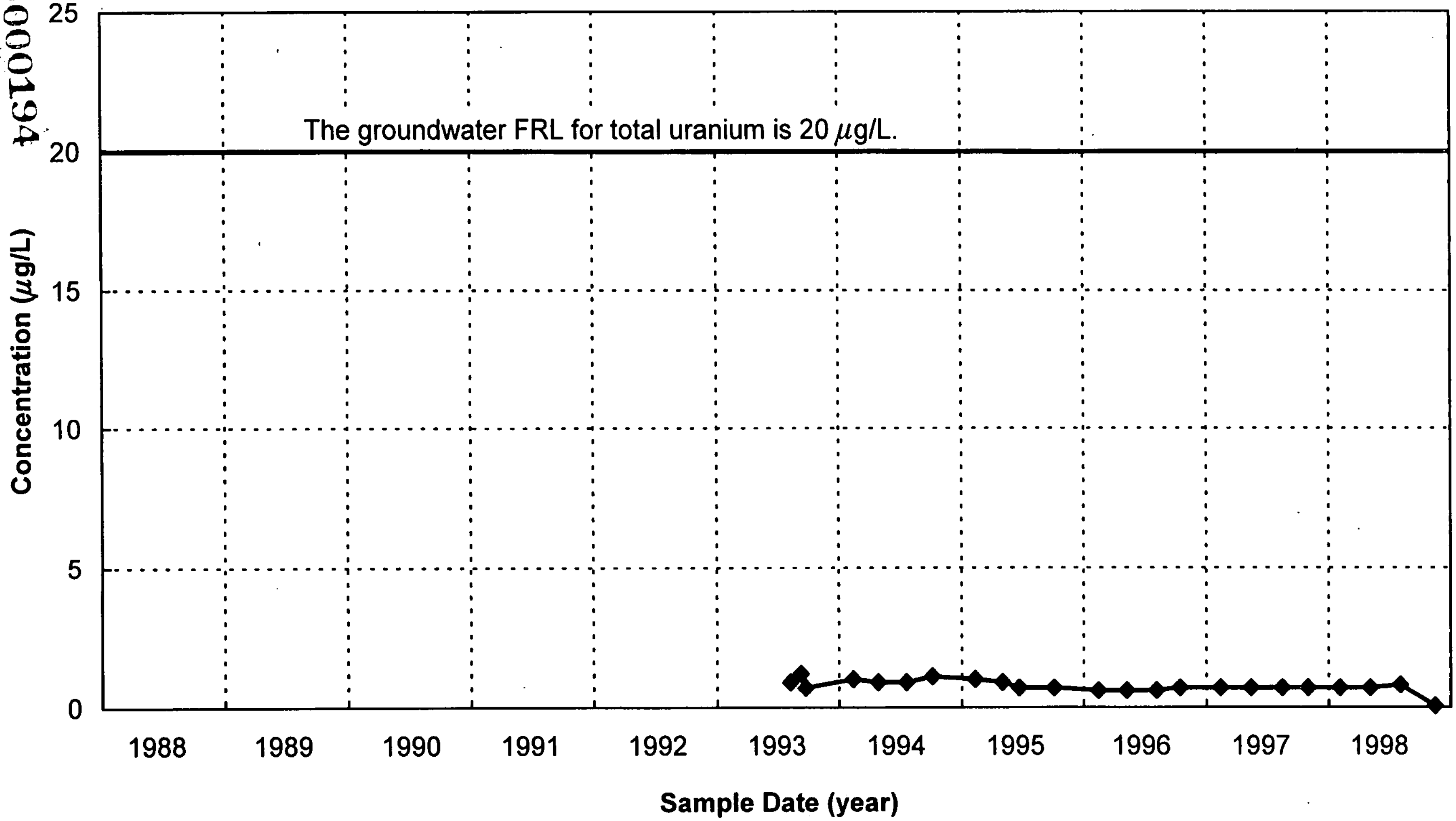

FIGURE A.2-120. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 3899

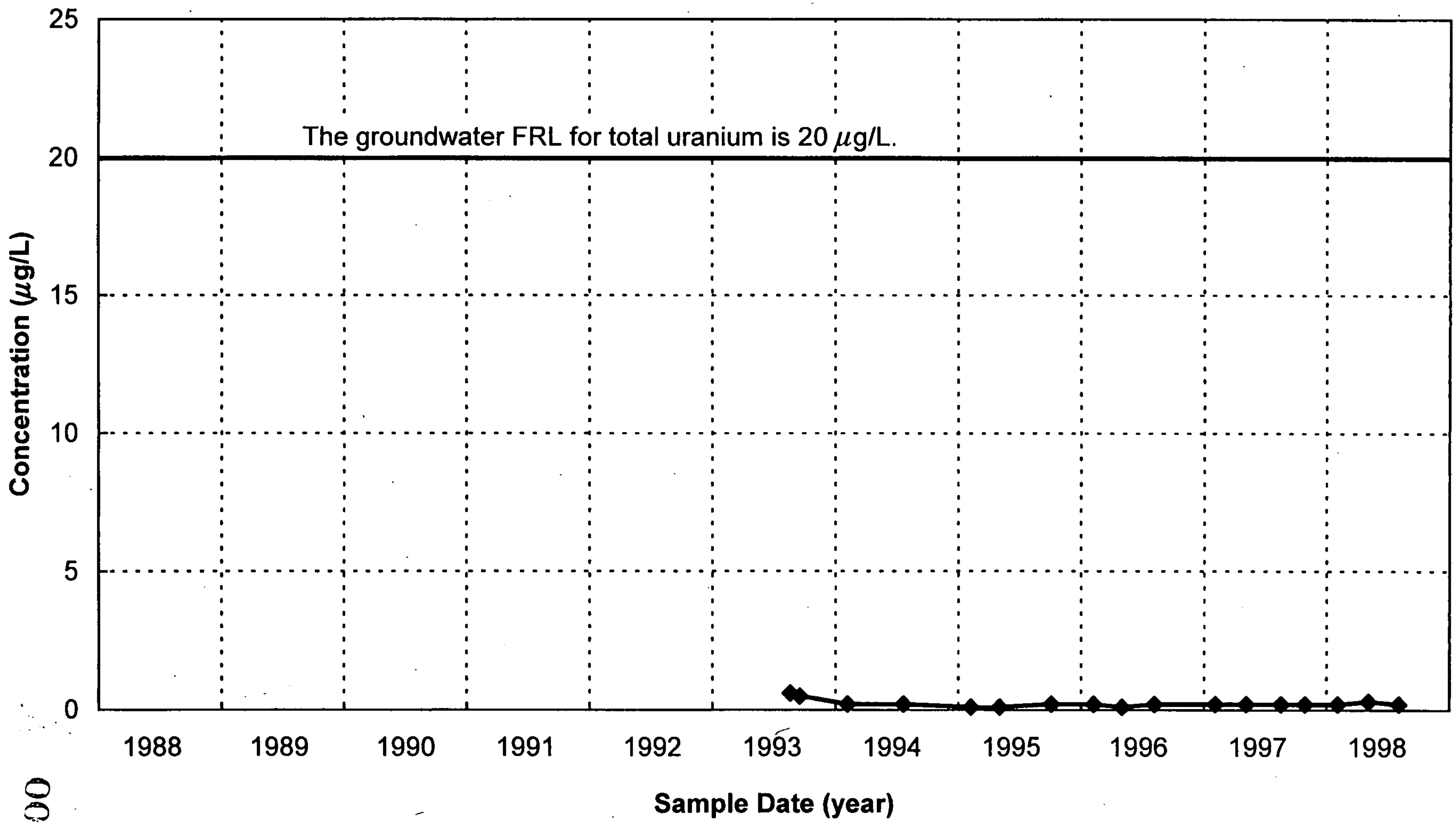

FIGURE A.2-121. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 3900

000195

2272

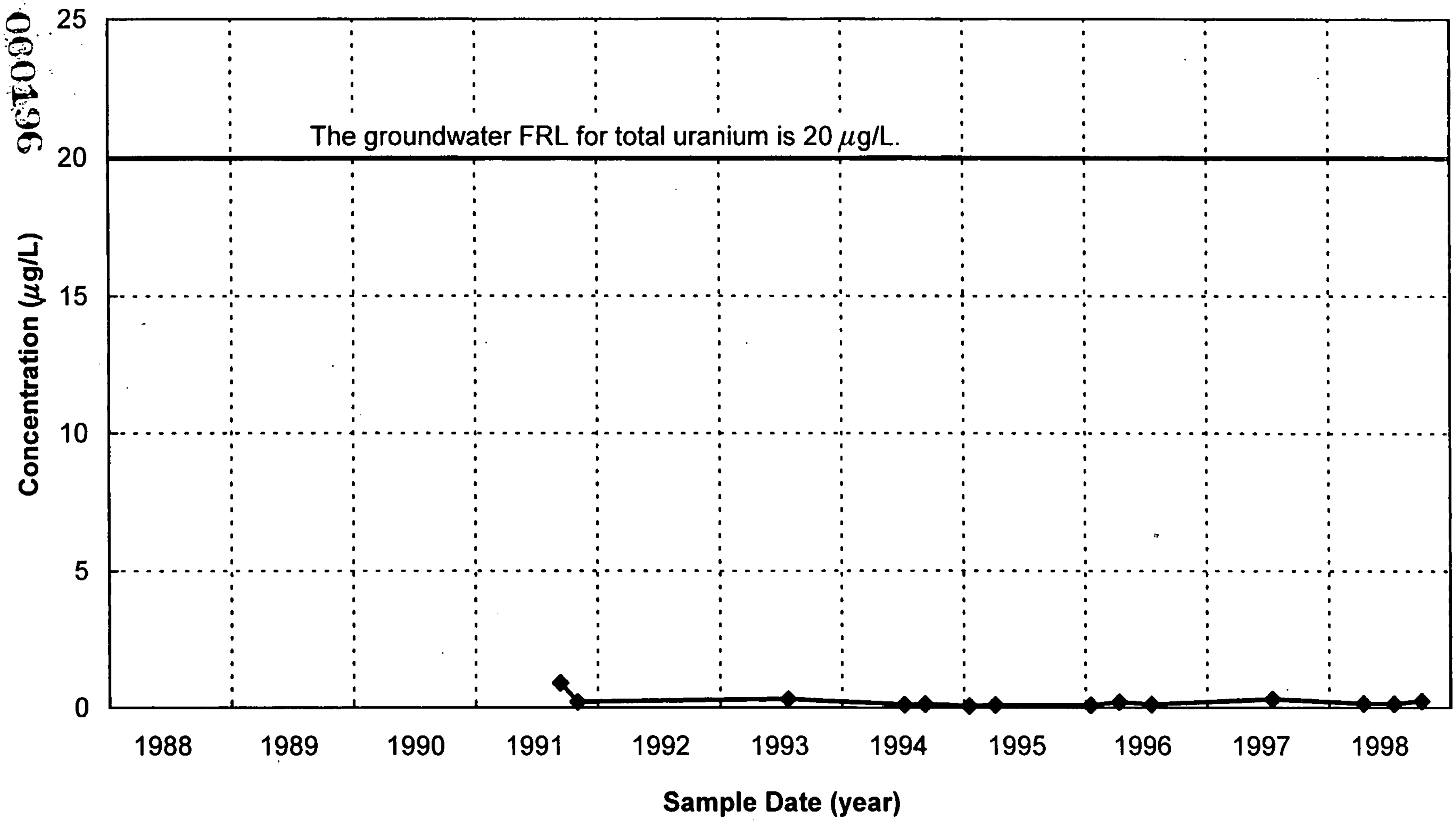

FIGURE A.2-122. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 4067

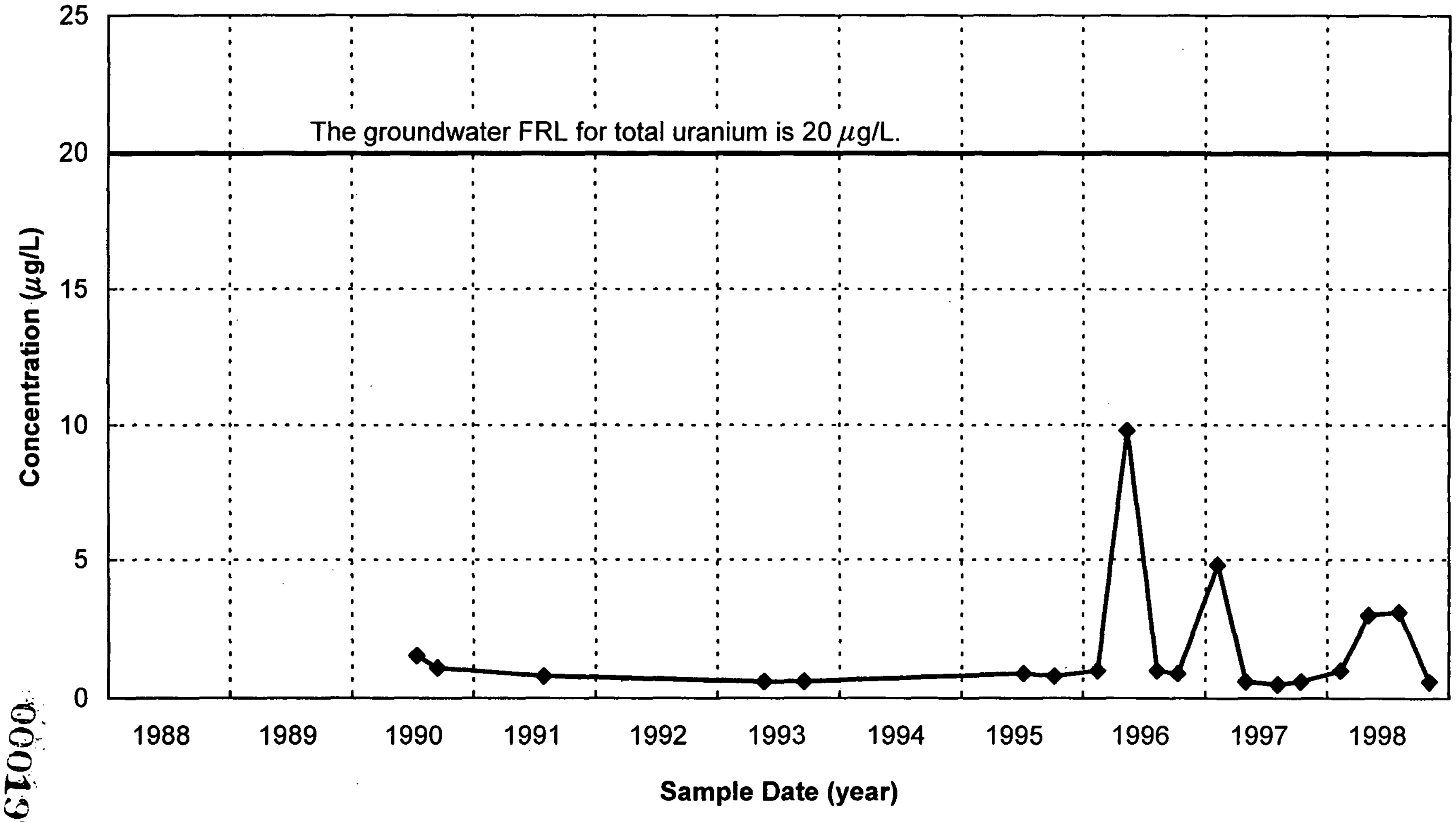

FIGURE A.2-123. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 4125

000197

2272

000198

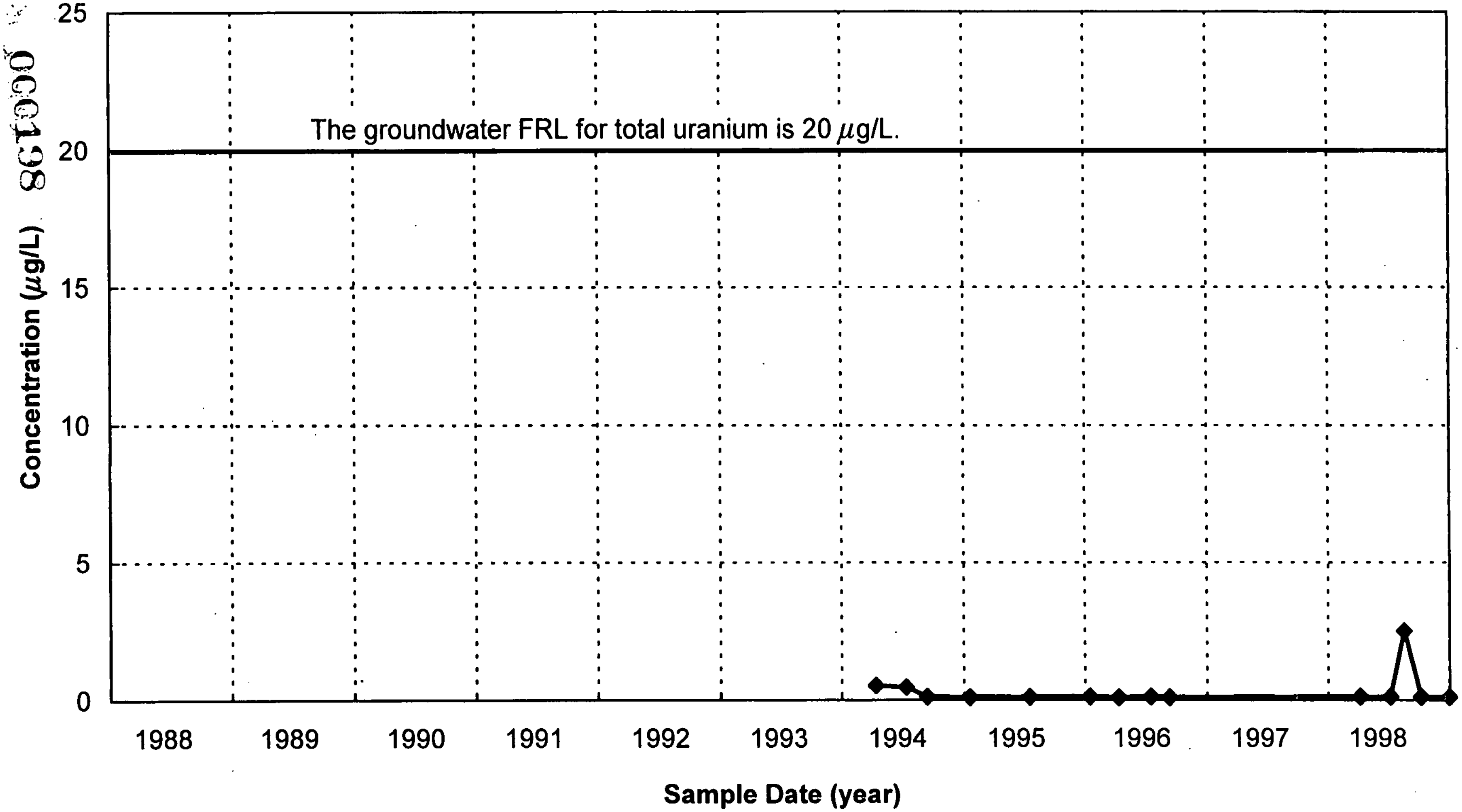

FIGURE A.2-124. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 4398

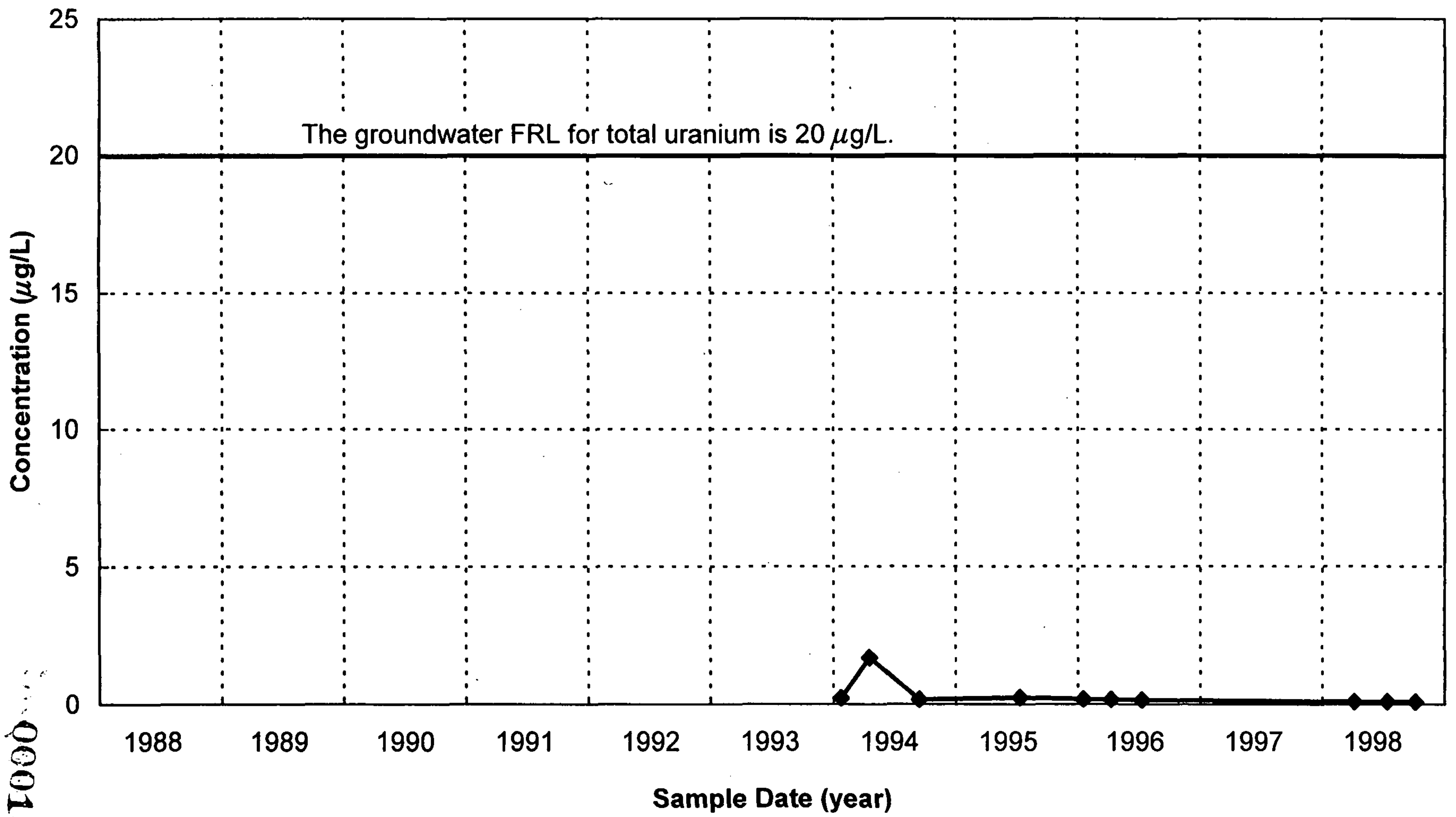

FIGURE A.2-125. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 4424

000199

2272

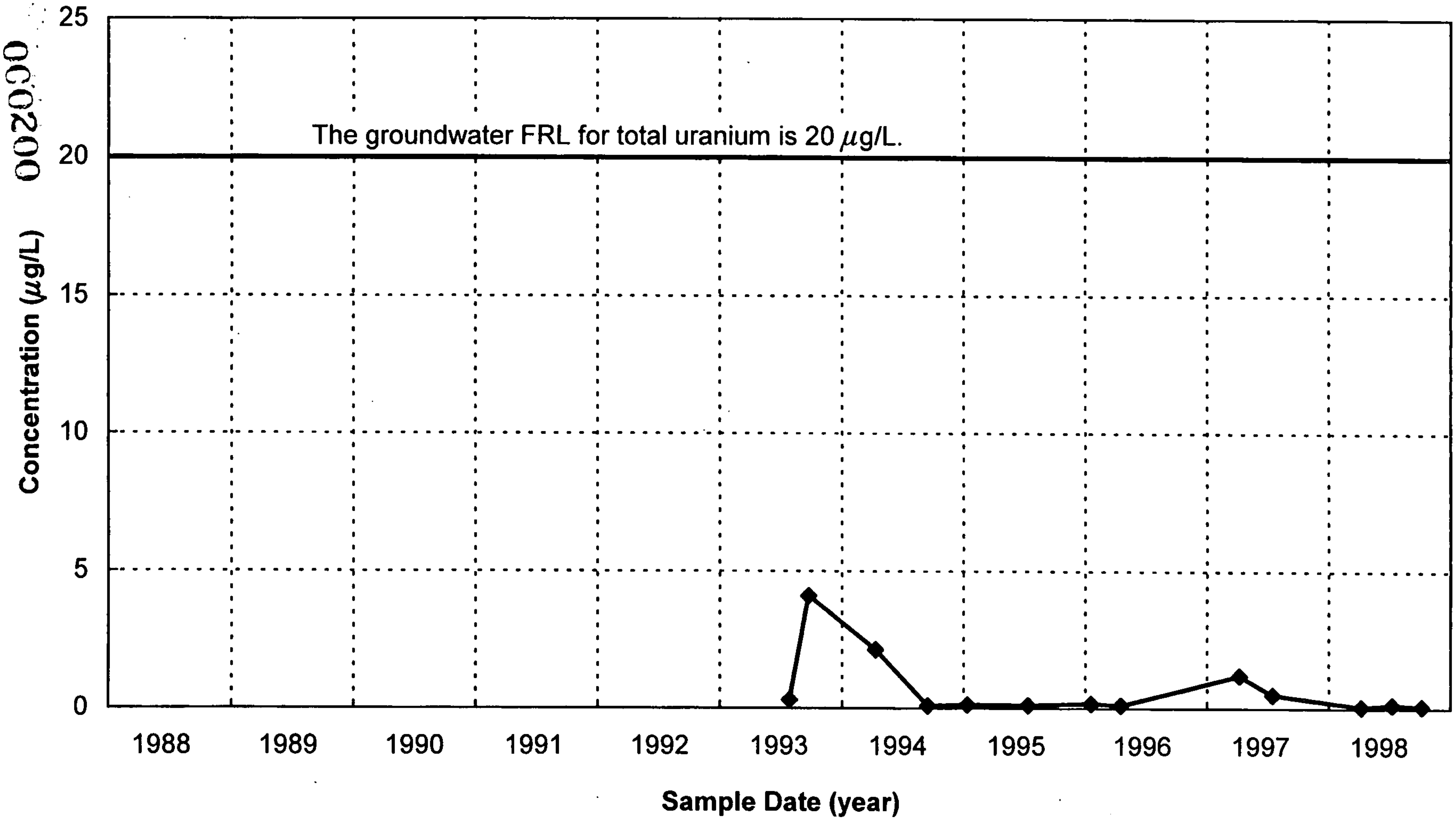

FIGURE A.2-126. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 4426

0002000

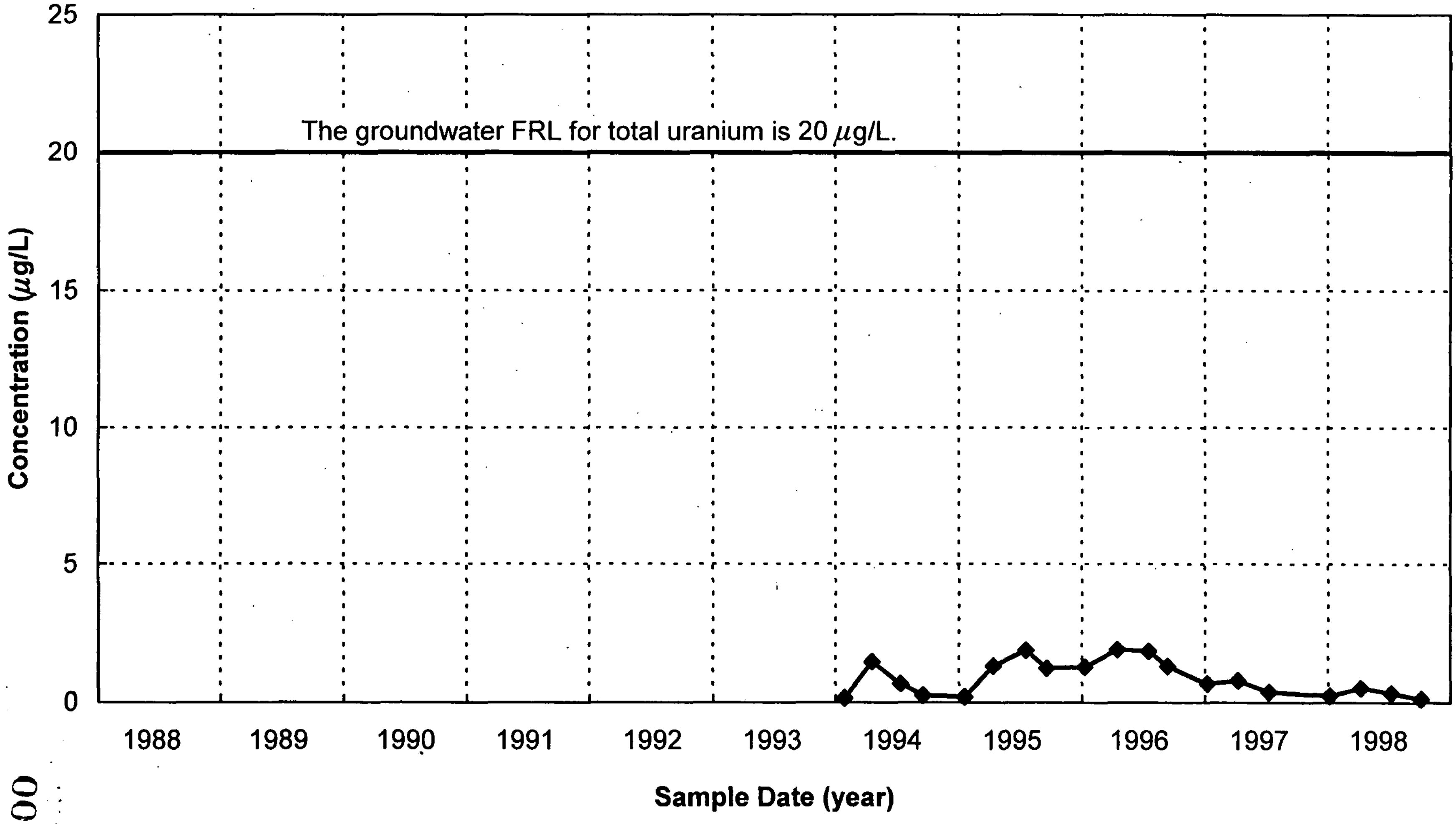

FIGURE A.2-127. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 4432

000201

2272

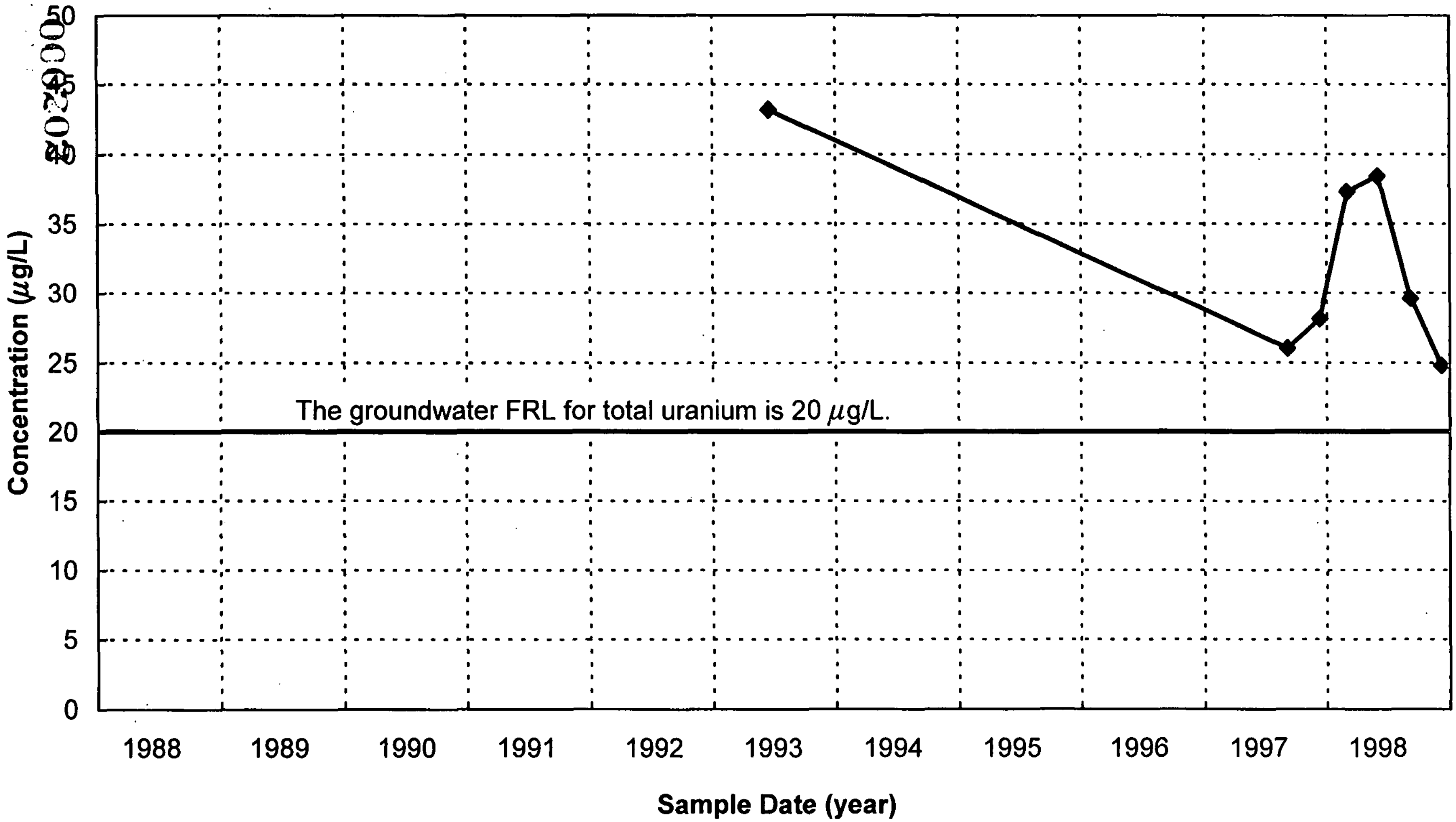

FIGURE A.2-128. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 21033

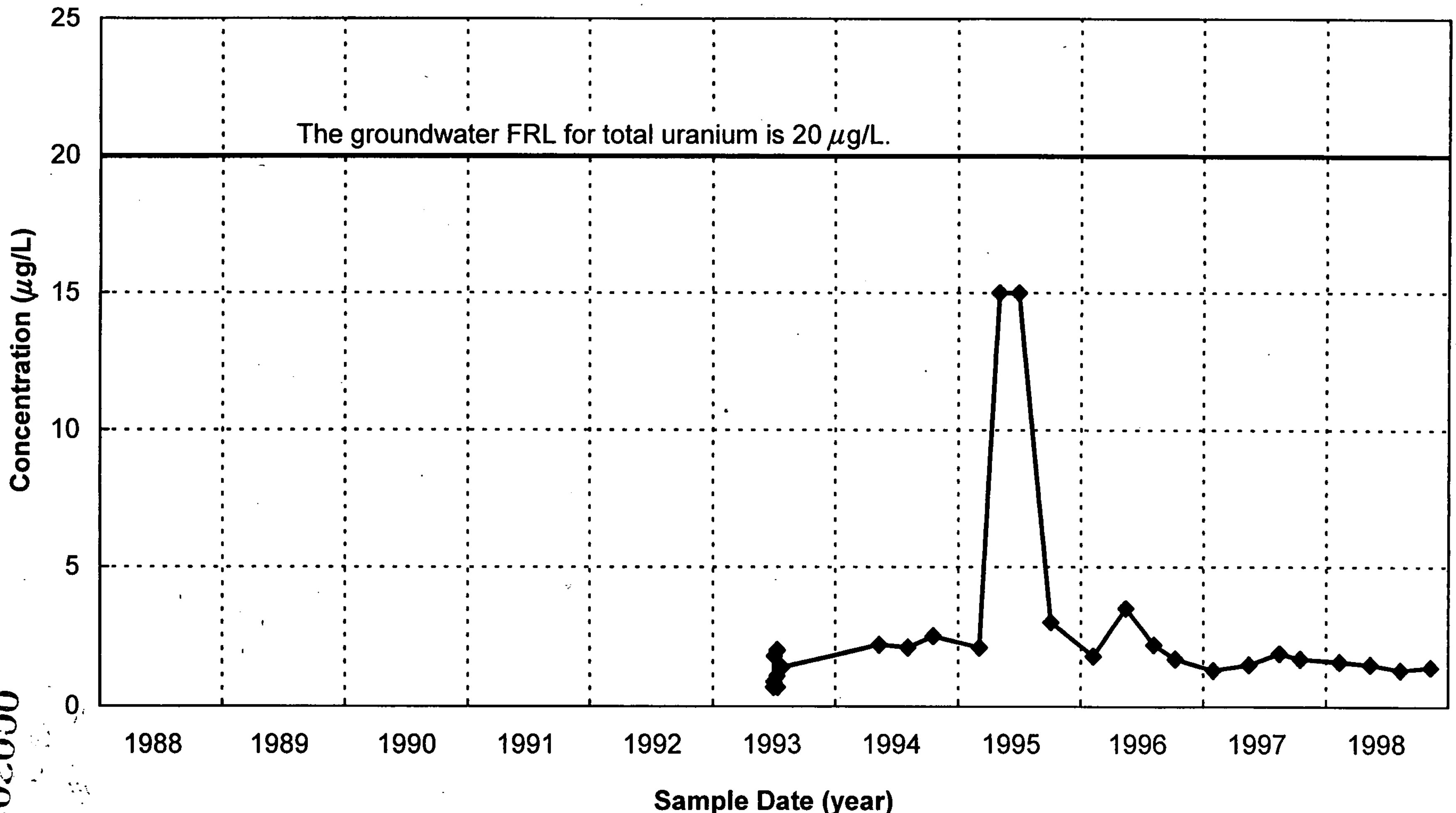

FIGURE A.2-129. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 21063

000203

2272

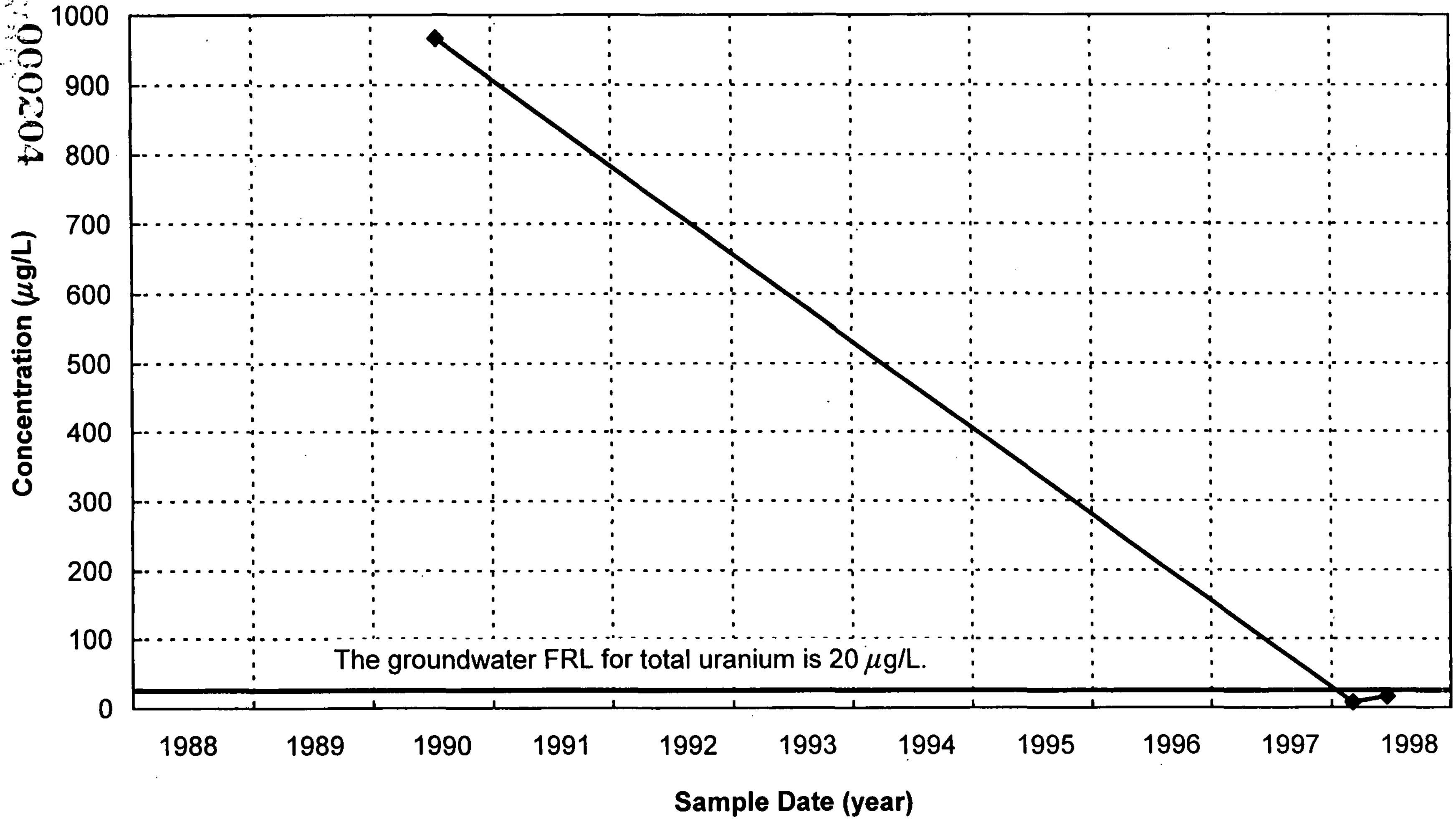

FIGURE A.2-130. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 21192

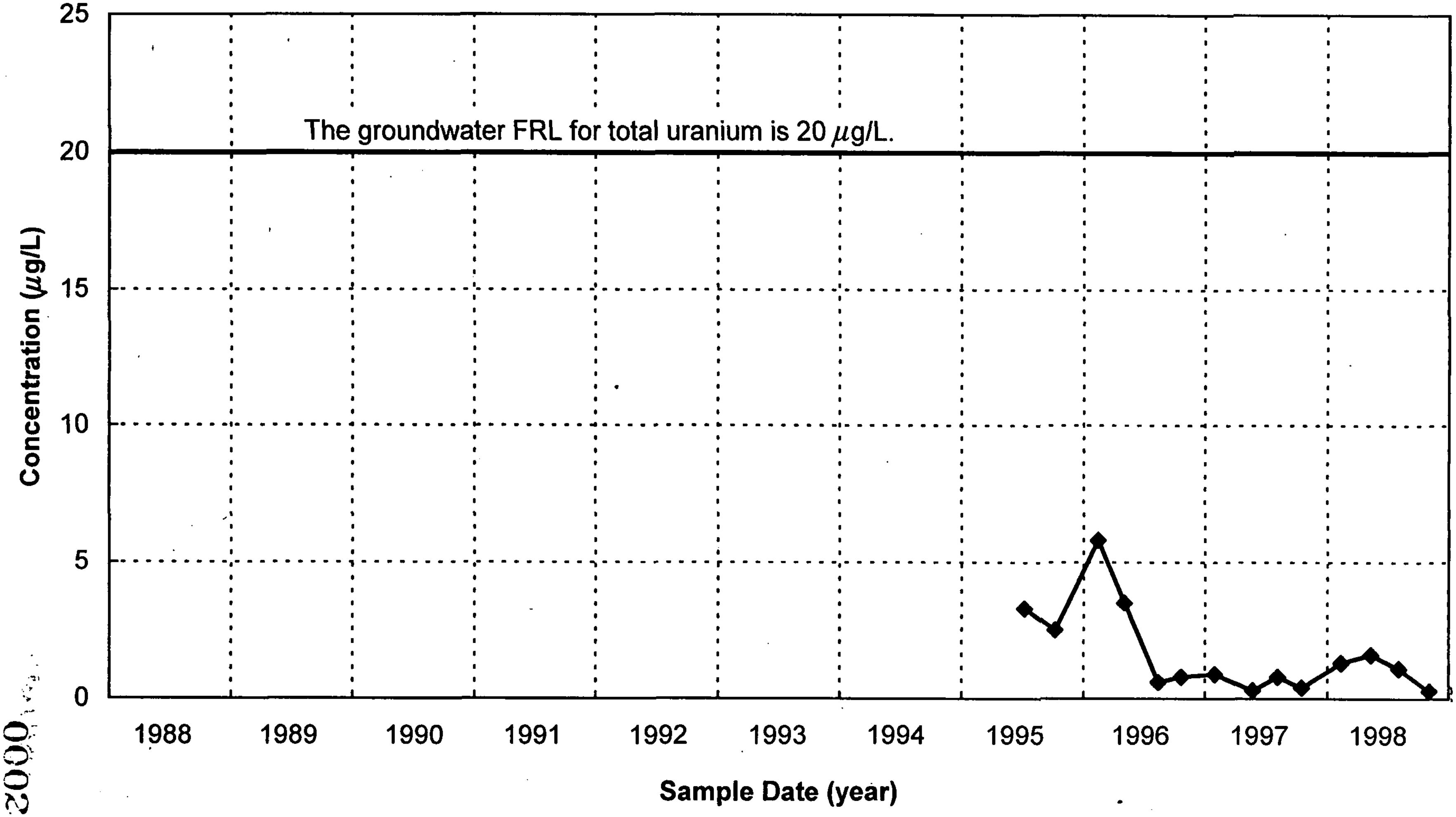

FIGURE A.2-131. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 21194

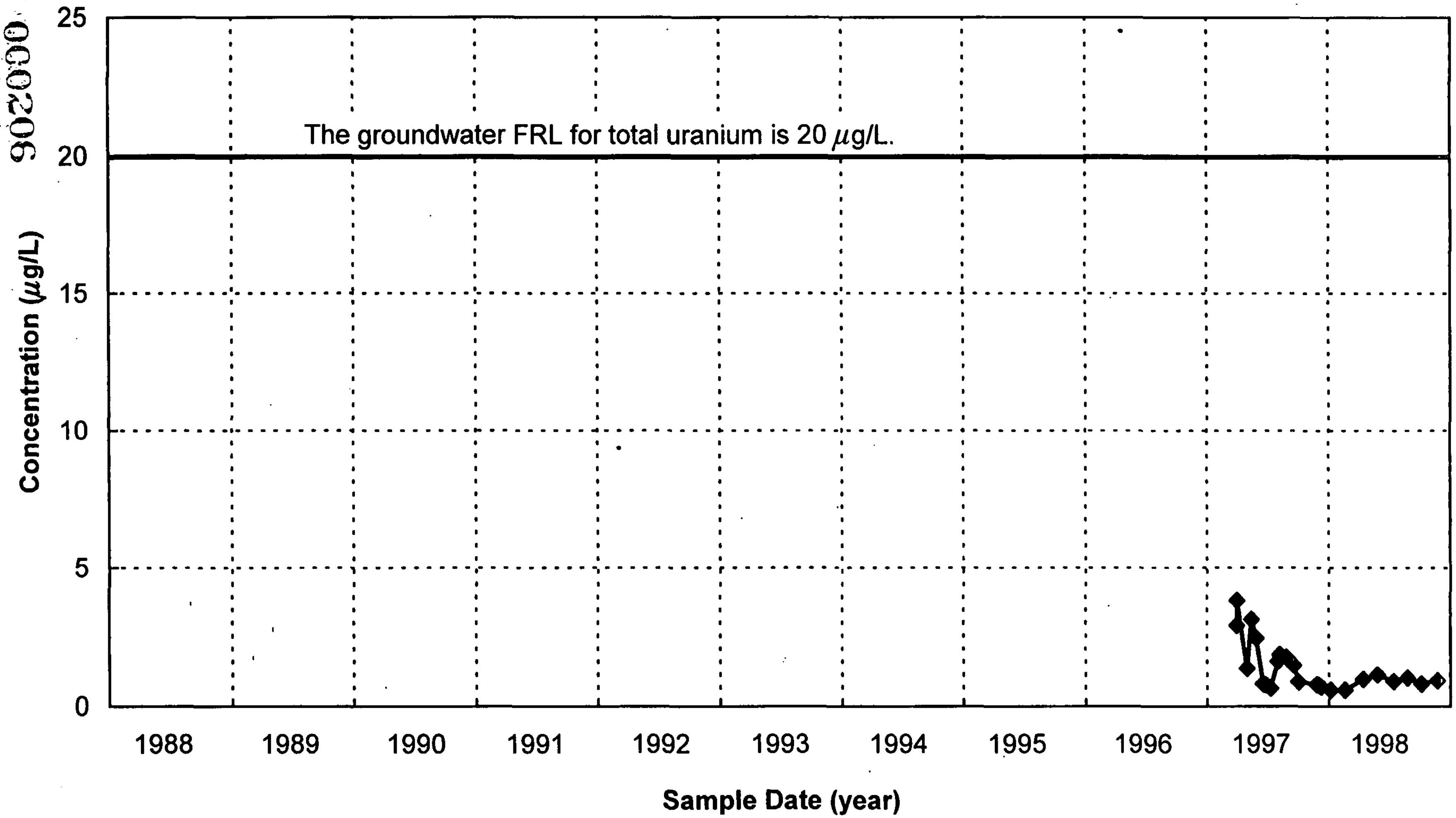

FIGURE A.2-132. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 22198

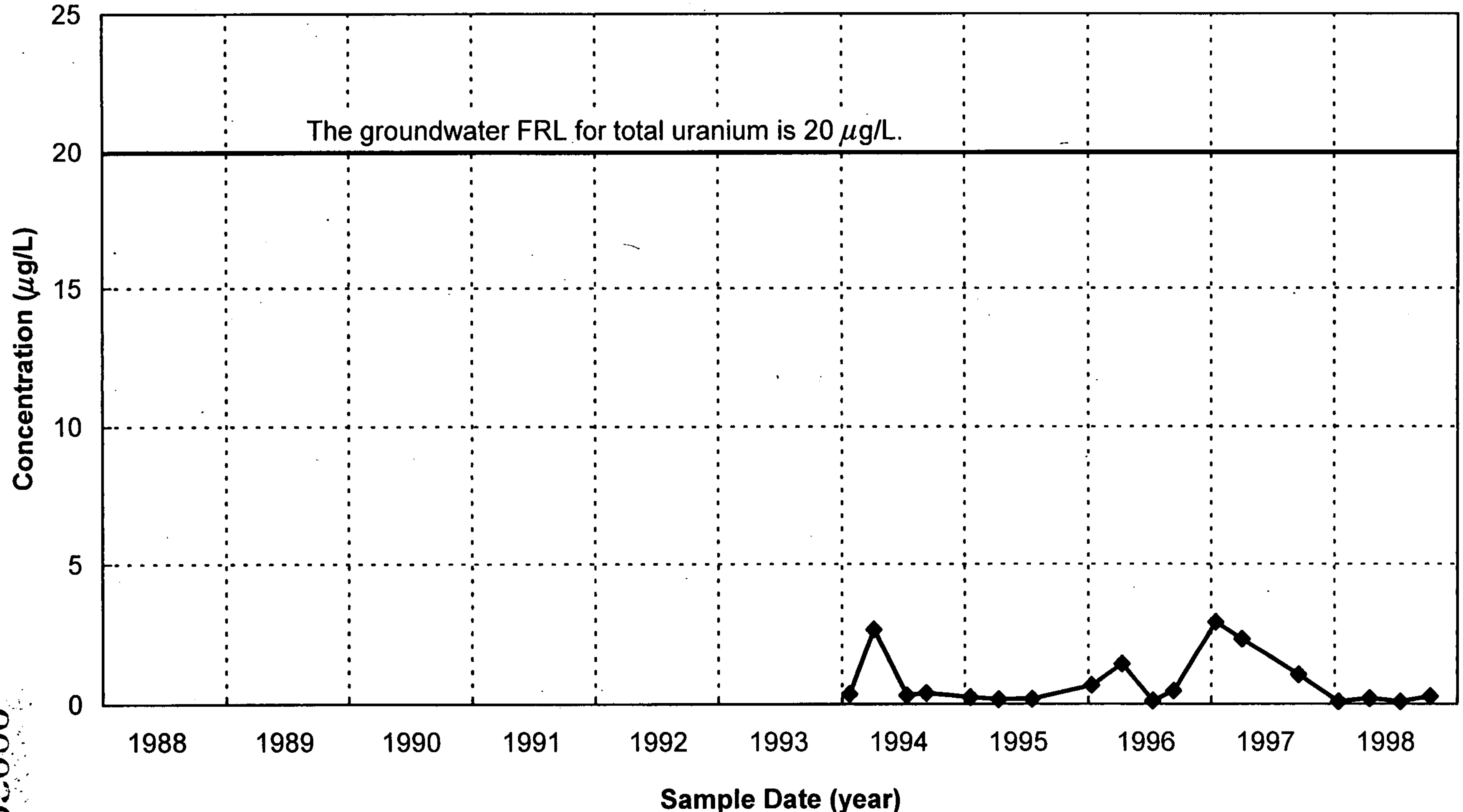

FIGURE A.2-133. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 31217

000208

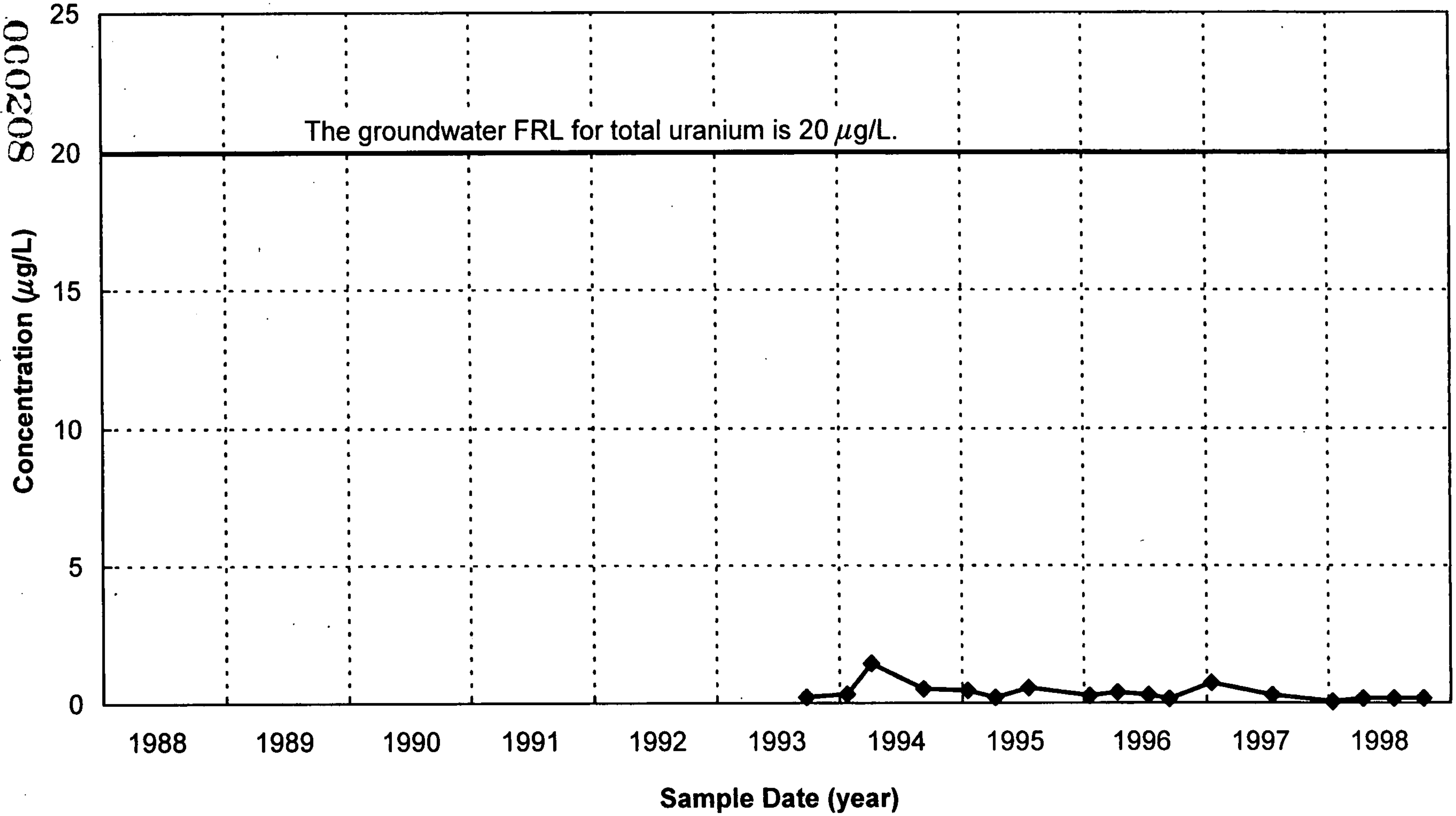

FIGURE A.2-134. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 41217

Attachment A.3

ATTACHMENT A.3

GROUNDWATER ELEVATIONS AND CAPTURE ASSESSMENT

ATTACHMENT A.3

Groundwater elevation maps are shown in Figures A.3-1 through A.3-8 for Type 2 and Type 3 groundwater monitoring wells for the four quarters of 1998. Each groundwater elevation map contains an interpreted capture zone for the respective time period made from the Type 2 elevation contours, then posted on both the Type 2 and Type 3 elevation maps. Also indicated on the maps are the bedrock highs and the major groundwater flow divide which separates groundwater exiting the New Haven Trough to the Great Miami River through the Paddys Run Outlet from groundwater exiting the New Haven Trough to the Great Miami River through the New Baltimore Outlet.

Figures A.3-9 through A.3-20 provide detailed groundwater elevation maps for the four quarters of 1998 and for the months during the second half of 1998 when the South Field (Phase I) Extraction, South Plume Optimization, and Re-Injection Demonstration Modules were being brought on line. Because the South Field (Phase I) Extraction Module began operating in July 1998, the detailed groundwater elevation figure formats from June 1998 to the end of the year have been expanded to include both the on-property South Field and off-property South Plume areas. All of these elevation maps were included in the 1998 IEMP quarterly status reports. For additional operational details on each module, see Attachment A.1.

Hydrographs for monitoring well clusters (Type 2 and Type 3 wells) are provided in Figures A.3-21 through A.3-36 to assess vertical groundwater gradients. For this reason, groundwater elevations from Type 2 and Type 3 wells at the same cluster were plotted on the same graph. The well clusters are identified by the last three digits of the monitoring wells (e.g., cluster 552 consists of Monitoring Wells 2552 and 3552). Figure A.1-1 identifies the well cluster locations.

Analysis of these hydrographs indicate that elevations in Type 2 and Type 3 monitoring wells within a cluster are almost always identical for each measurement time. An occasional difference can be seen in the hydrographs for clusters 897, 900, 068, and 106, but these differences display no systematic behavior and are attributed to measurement, transcription, or key-punch error when the data were processed. With the exception of cluster 398, a close examination of the hydrographs for the last two quarters of 1998 when the South Field (Phase I) Extraction and South Plume/South Plume Optimization Modules were operational shows no indications of vertical gradients between the Type 2 and Type 3 monitoring wells. Cluster 398 appears to show a two foot gradient during the last two quarters of 1998 with elevations in the Type 2 well (2398) being higher than elevations in the Type 3 well (3398). This may be due to the close proximity of this cluster to Re-Injection Well 22111 and will be investigated further in 1999.

The colloidal borescope was used in monitoring wells around the South Plume Extraction Module and in the area of the northeast lobe of the total uranium plume during 1998 to provide additional data on the location of the capture zone. These data are presented in Table A.3-1 and in four period-specific sets of figures from Figures A.3-37 through A.3-89. Each set of figures consists of a map and graphs showing the average groundwater flow direction for each well after statistical filtering. The uncertainty after filtering, plus or minus one standard deviation, is indicated on the map by a fan-shaped wedge at each well location. Each flow direction map is followed by graphs of flow direction versus time for those wells that were borescoped:

- Figures A.3-37 through A.3-50 represent data from the first quarter of 1998. As in previous reports, borescope flow directions are generally in agreement with interpreted capture zone data for the South Plume/South Plume Optimization Module.
- Figures A.3-51 through A.3-63 represent second quarter 1998 data. Flow directions are generally similar to those observed during the first quarter of 1998 with the exception of flow directions at cluster 900. Flow directions at these two wells during the first quarter of 1998 were observed to be east to northeast but were observed to be west to northwest during the second and third quarters.
- Figures A.3-64 through A.3-77 represent third quarter 1998 data. The observed flow directions during the third quarter of 1998 were generally consistent with those observed during the first half of 1998.
- Figures A.3-78 through A.3-89 represent fourth quarter 1998 data. The observed flow directions during the fourth quarter of 1998 were generally consistent with those observed during the first three quarters with the following three exceptions:
    - Flow at Monitoring Well 2093 shifted from southwest to southeast.
    - Flow at well cluster 898 shifted from south and southeast to east.
    - Flow at Monitoring Well 3899 shifted from southwest to north.

  These shifts in flow directions are believed to be due to changes in recharge conditions within the aquifer.

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The borescope flow directions are not always consistent with flow directions interpreted from groundwater elevation data because the borescope monitors local flow regimes within the aquifer, while groundwater elevation data tend to give results which are more regional in nature. Generally, however, the borescope data were consistent with the capture zones interpreted from groundwater elevation data.

Figure A.3-90 shows modeled particle tracks for operational wells in the South Plume/South Plume Optimization and the South Field (Phase I) Extraction Modules. The modeled flow directions agree with the flow directions interpreted from groundwater elevation data, except in the area of the northeast lobe of the total uranium plume. Model predictions in this area are being re-evaluated and compared to observed groundwater flows as part of the model upgrade project.

TABLE A.3-1

FLOW DIRECTION DATA FROM BORESCOPE OBSERVATIONS IN 1998

Monitoring Well	Date of Observation	Average Flow Direction[a,b] (degrees)	Standard Deviation[b] (degrees)
2093	3/16	212.2	25.1
	6/4	218	6.5
	8/4	211.4	6.1
	12/1	124.2	11.9
21063	3/16	142.6	12.7
	6/4	133.5	22.4
	8/4	83.9	27.3
	12/2	119.4	10.6
22111	3/10	89.8	4.4
22303	3/9	226.9	14.9
	3/9	196.3	4.6
	6/4	194.7	8.9
	8/3	186.3	2.0
	11/17	111.0	57.4
2551	6/1	89.6	3.8
	8/5	78.0	27.3
3551	8/5	130.7	38.6
2552	3/11	55.4	26.7
	6/3	81.5	10.6
	8/12	82.9	9.8
	12/1	102.6	4.5
3552	3/11	352.2	22.3
	6/3	2.2	14.7
	8/12	22.0	13.3
	11/25	36.8	11.0
2898	3/4	105.9	7.9
	5/19	115.2	12.0
	8/11	123.0	14.9
	11/19	104.25	4.1
3898	3/3	214.5	34.8
	5/20	225.4	12.9
	8/11	205.1	23.7
	11/19	73.5	16.1
2899	3/4	89.7	19.2
	5/20	151.5	10.5
	8/10	120.7	7.8
	11/18	96.5	8.2
3899	3/5	250.6	28.1
	5/26	238.6	15.5
	8/10	246.2	17.5
	11/18	6.5	19.8
2900	3/5	73.7	59.7
	5/28	307.1	4.6
	8/6	305.6	12.5
	11/16	320.7	5.5
3900	3/9	79.2	26.3
	5/28	276.9	27.6
	8/6	270.6	27.4
	11/16	77.9	47.9

[a] Average flow direction is measured clockwise in degrees from magnetic north.
[b] Values are calculated after statistical filtering to remove outliers.

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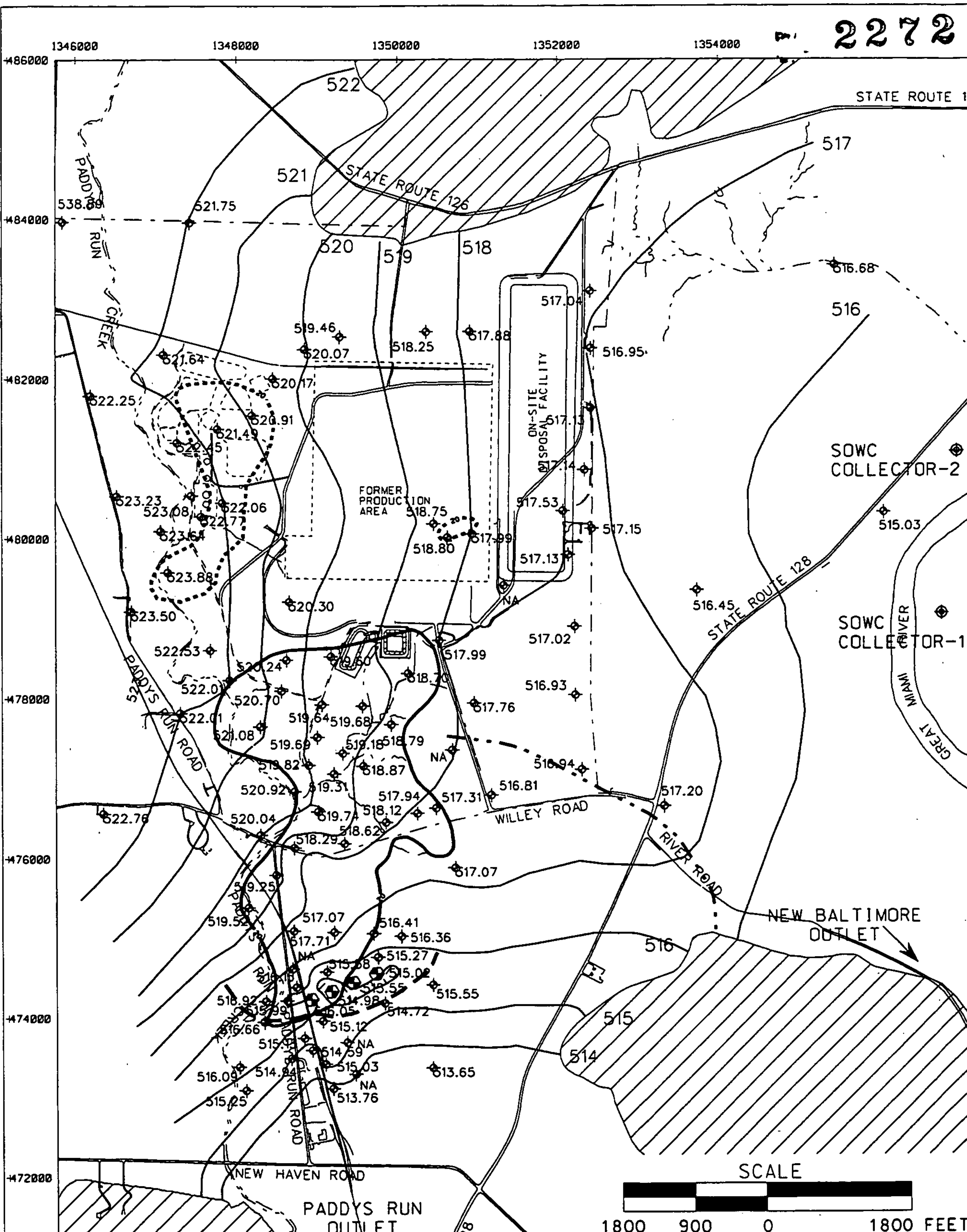

LEGEND:

- FEMP BOUNDARY
- GROUNDWATER ELEVATION CONTOUR (FEET AMSL)
- PLUME SEGMENT FROM FOURTH QUARTER 1997 DATA
- BEDROCK HIGHS
- CAPTURE ZONE
- APPROXIMATE LOCATION OF GROUNDWATER FLOW DIVIDE
- 516.22 GROUNDWATER ELEVATION (FEET AMSL)
- 20 µg/L TOTAL URANIUM PLUME FROM FIRST QUARTER 1998 DATA

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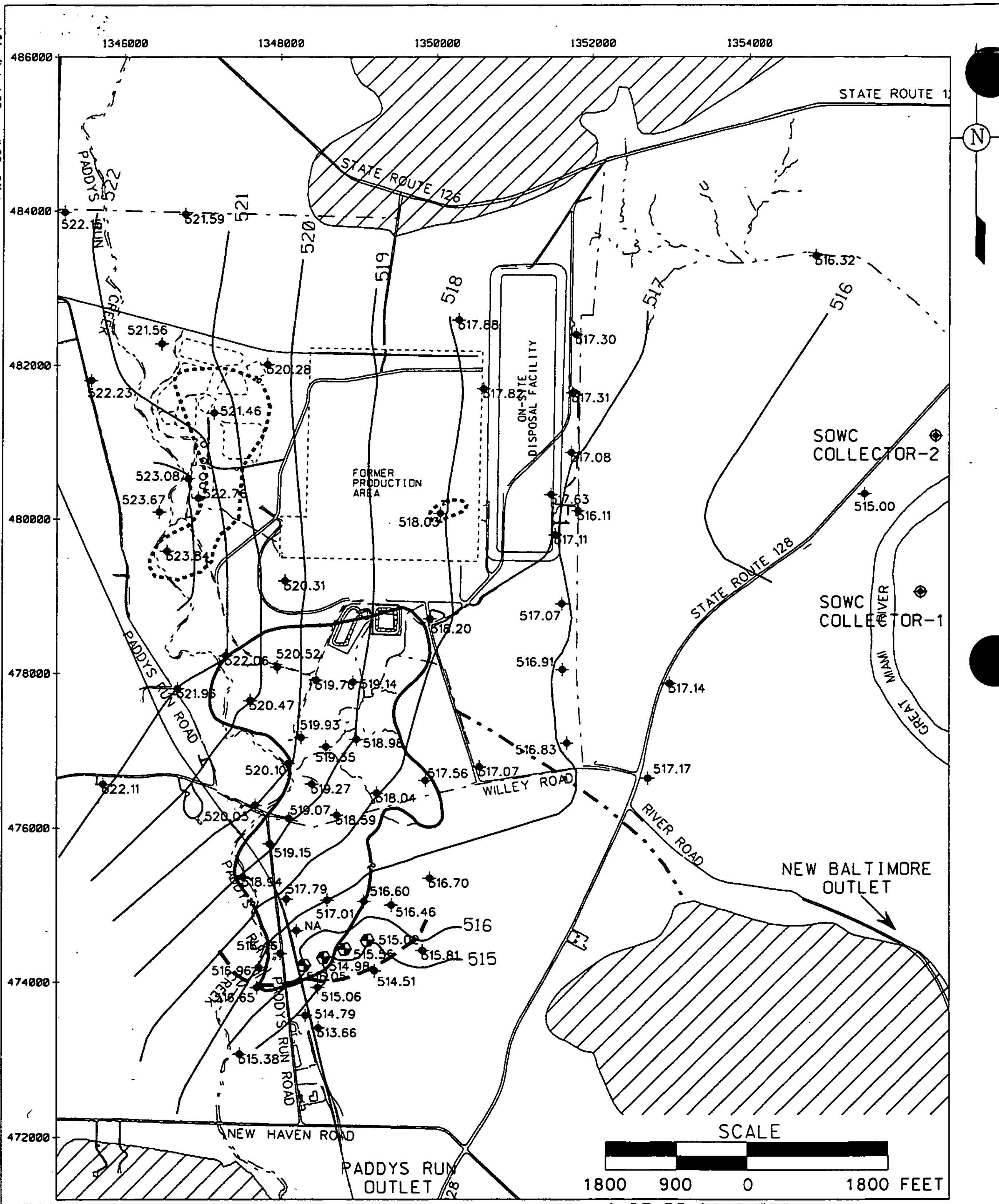
FIGURE A.3-1. GROUNDWATER ELEVATIONS FOR TYPE 2 WELLS, JANUARY 1998



LEGEND:

- FEMP BOUNDARY
- GROUNDWATER ELEVATION CONTOUR (FEET AMSL)
- PLUME SEGMENT FROM FOURTH QUARTER 1997 DATA
- BEDROCK HIGHS
- CAPTURE ZONE FROM TYPE 2 ELEVATION MAP
- APPROXIMATE LOCATION OF GROUNDWATER FLOW DIVIDE
- 516.22 GROUNDWATER ELEVATION (FEET AMSL)
- 20 μg/L TOTAL URANIUM PLUME FROM FIRST QUARTER 1998 DATA

FIGURE A.3-2. GROUNDWATER ELEVATIONS FOR TYPE 3 WELLS, JANUARY 1998

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25-MAY-1999

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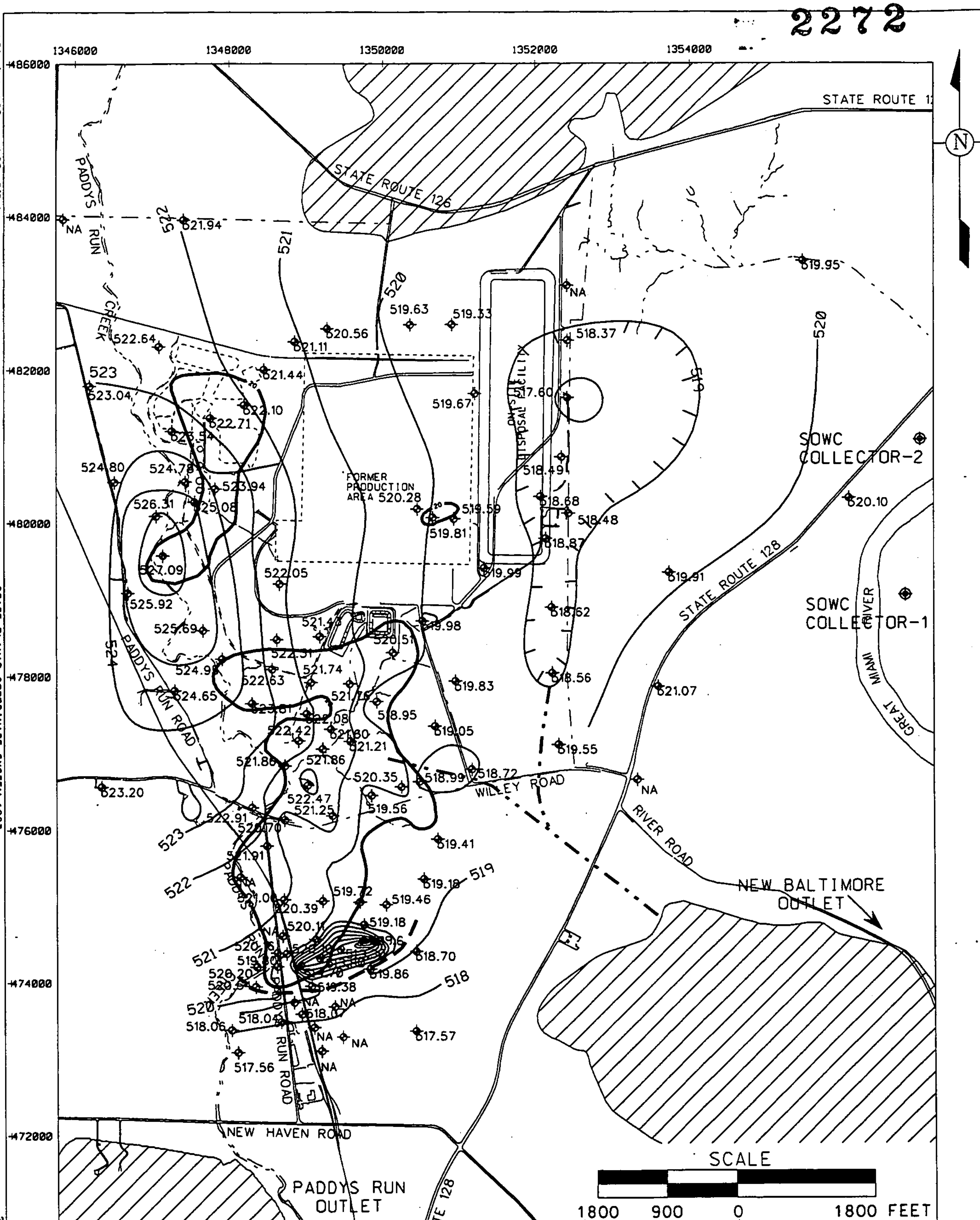

LEGEND:
- FEMP BOUNDARY
- GROUNDWATER ELEVATION CONTOUR (FEET AMSL)
- CAPTURE ZONE
- BEDROCK HIGHS
- APPROXIMATE LOCATION OF GROUNDWATER FLOW DIVIDE
- 516.22 GROUNDWATER ELEVATION (FEET AMSL)
- 20 μg/L TOTAL URANIUM PLUME FROM SECOND QUARTER 1998 DATA

FIGURE A.3-3. GROUNDWATER ELEVATIONS FOR TYPE 2 WELLS, APRIL 1998

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STATE PLANAR COORDINATE SYSTEM 1983

25-MAY-1999

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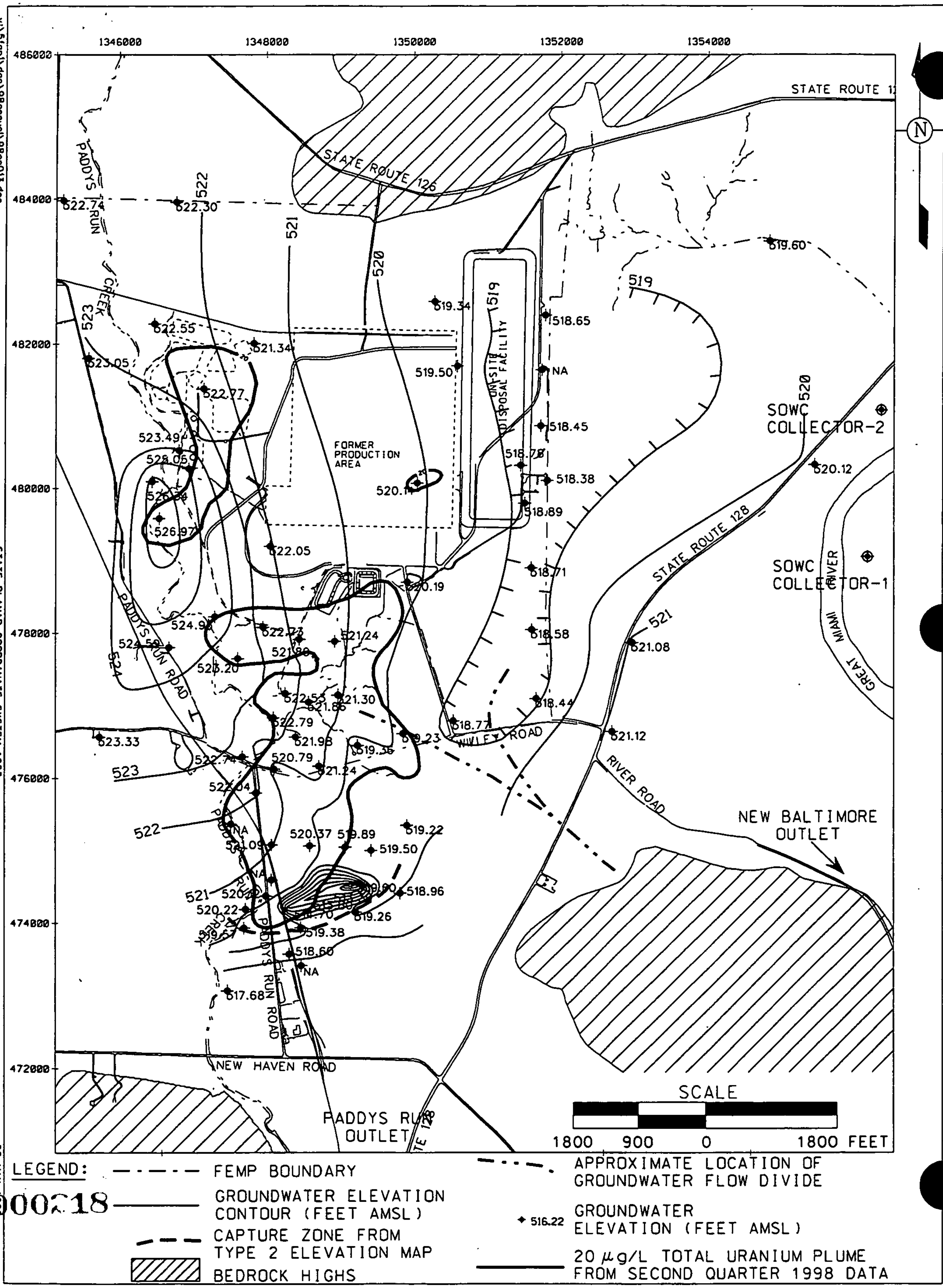

000218

FIGURE A.3-4. GROUNDWATER ELEVATIONS FOR TYPE 3 WELLS, APRIL 1998

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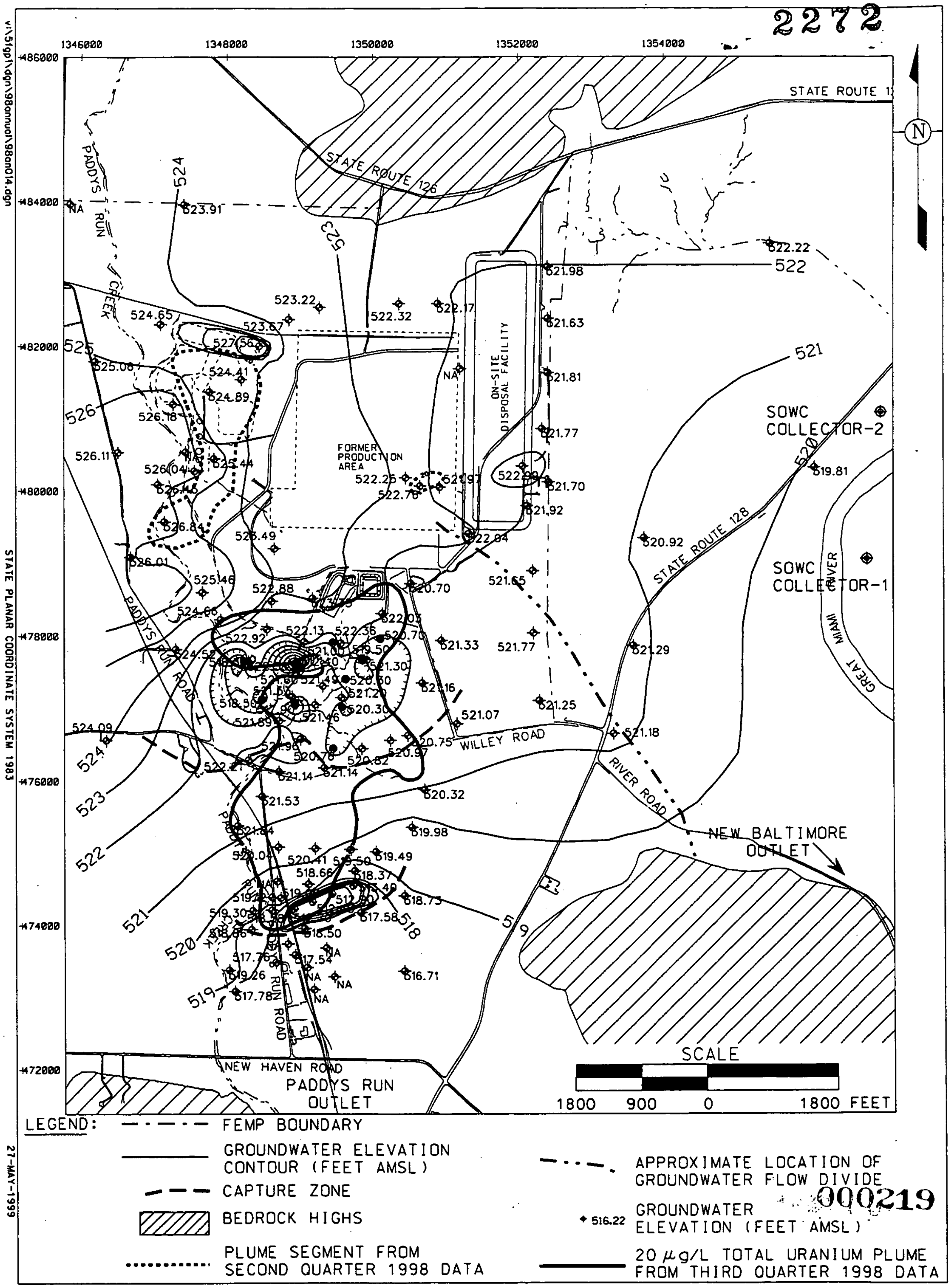
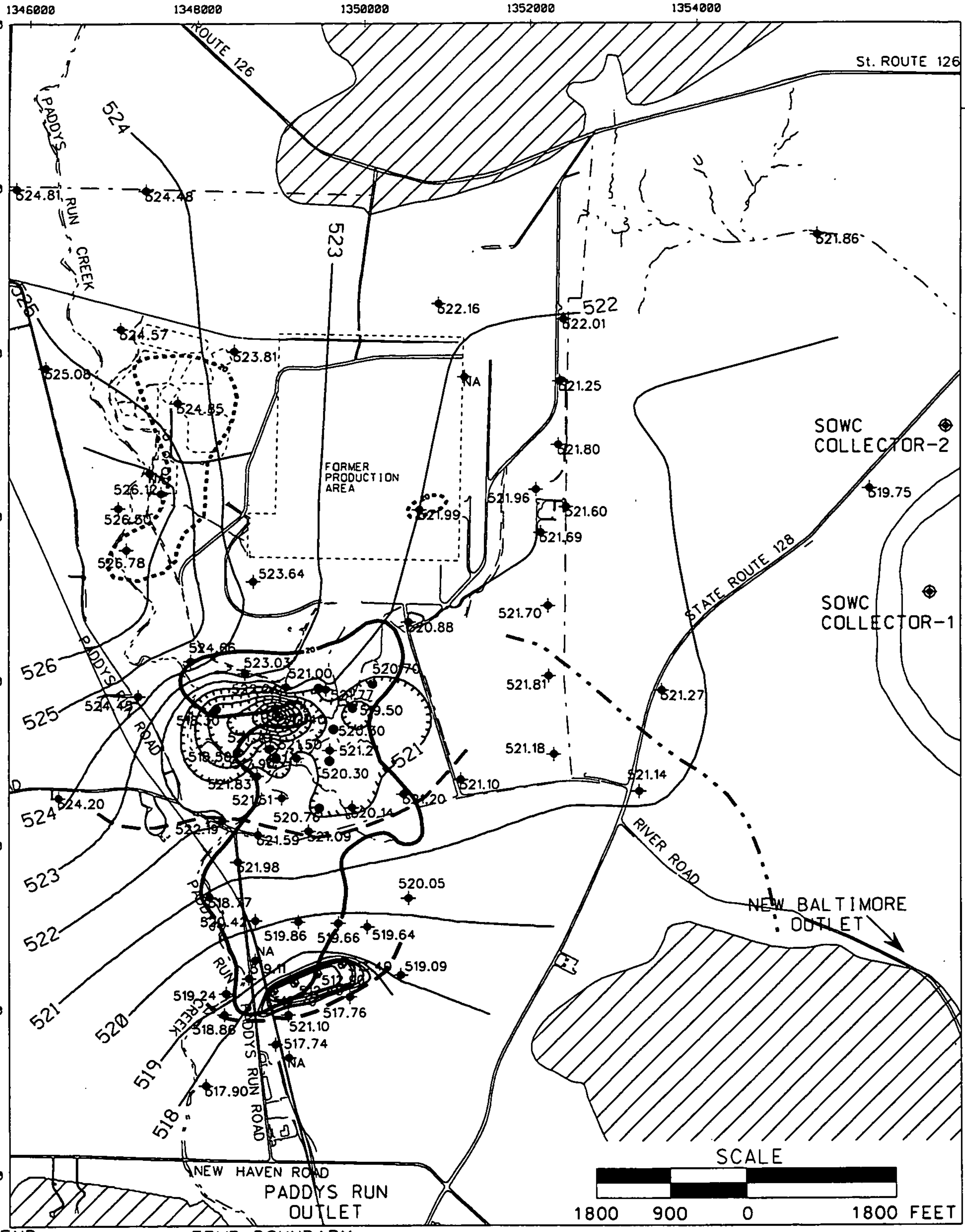


000219

FIGURE A.3-5. ROUTINE GROUNDWATER ELEVATIONS FOR TYPE 2 WELLS, JULY 1998



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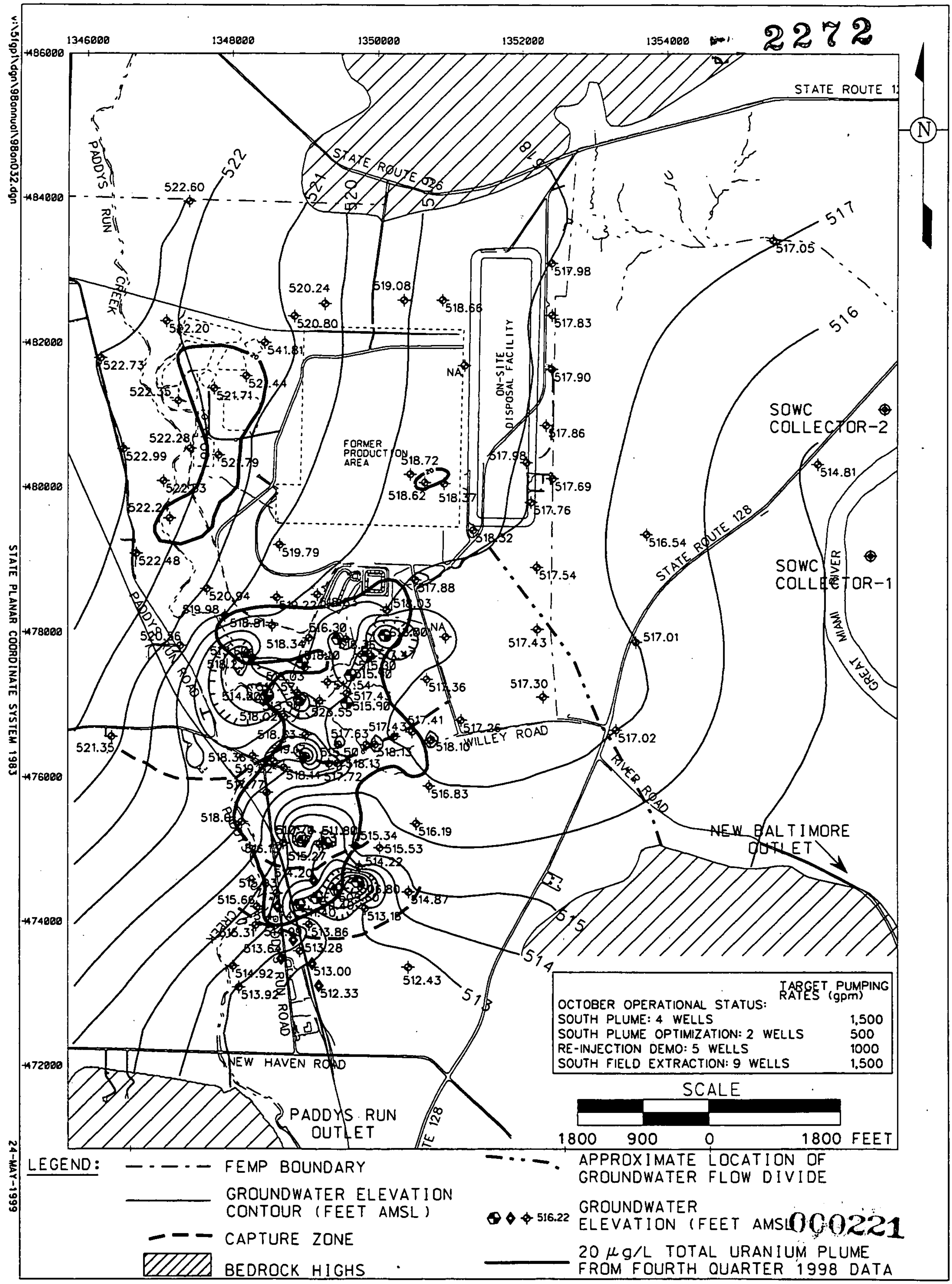
LEGEND:

- FEMP BOUNDARY
- GROUNDWATER ELEVATION CONTOUR (FEET AMSL)
- CAPTURE ZONE
- BEDROCK HIGHS
- PLUME SEGMENT FROM SECOND QUARTER 1998 DATA
- APPROXIMATE LOCATION OF GROUNDWATER FLOW DIVIDE
- ✦ 516.22 GROUNDWATER ELEVATION (FEET AMSL)
- 20 µg/L TOTAL URANIUM PLUME FROM THIRD QUARTER 1998 DATA

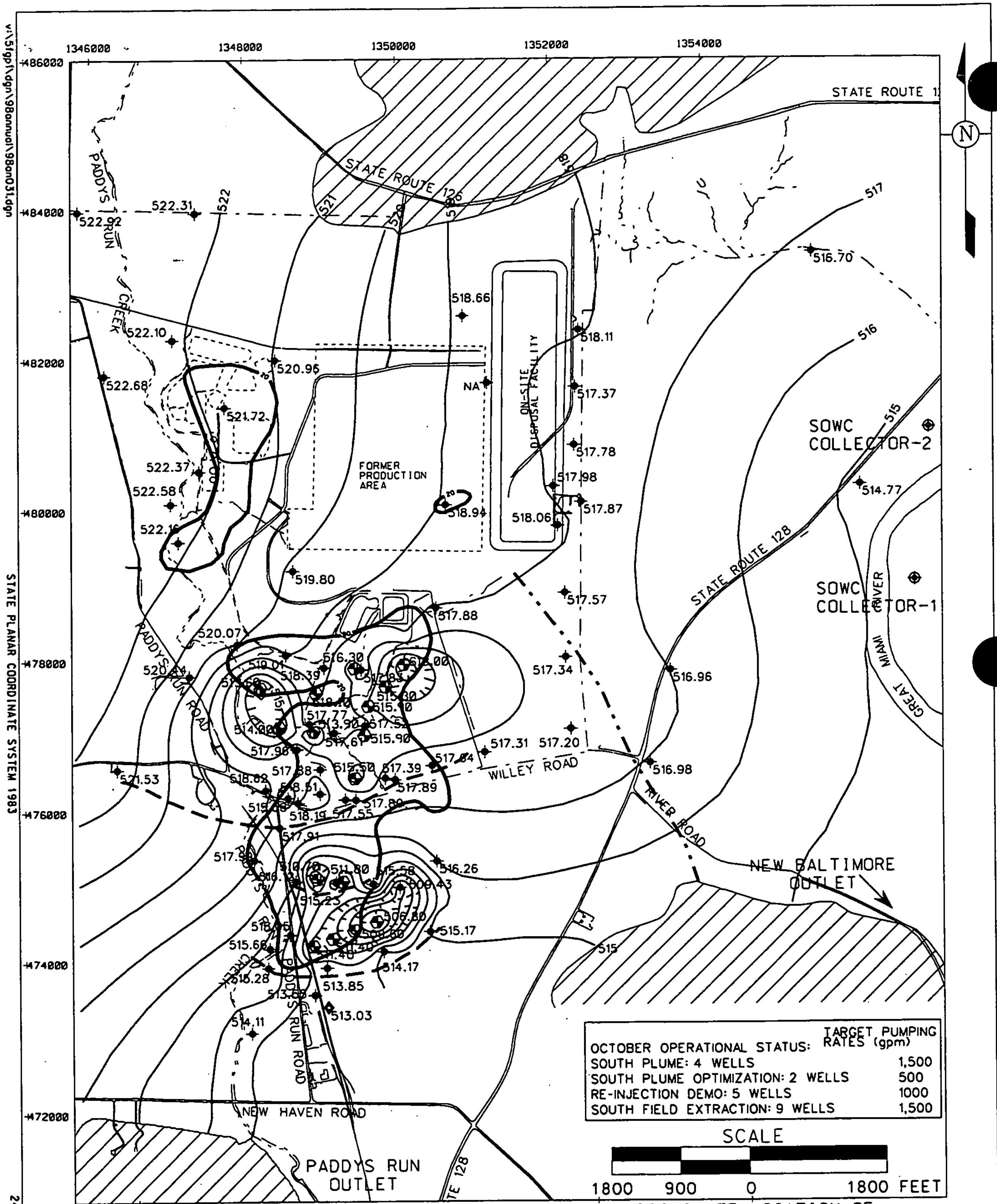
FIGURE A.3-6. ROUTINE GROUNDWATER ELEVATIONS FOR TYPE 3 WELLS, JULY 1998

2272



000221

FIGURE A.3-7. ROUTINE GROUNDWATER ELEVATIONS FOR TYPE 2 WELLS, OCTOBER 1998



LEGEND:

- FEMP BOUNDARY
- GROUNDWATER ELEVATION CONTOUR (FEET AMSL)
- CAPTURE ZONE
- BEDROCK HIGHS
- APPROXIMATE LOCATION OF GROUNDWATER FLOW DIVIDE
- 516.22 GROUNDWATER ELEVATION (FEET AMSL)
- 20 μg/L TOTAL URANIUM PLUME FROM FOURTH QUARTER 1998 DATA

STATE PLANAR COORDINATE SYSTEM 1983

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24-MAY-1999

FIGURE A.3-8. GROUNDWATER ELEVATIONS FOR TYPE 3 WELLS, OCTOBER 1998

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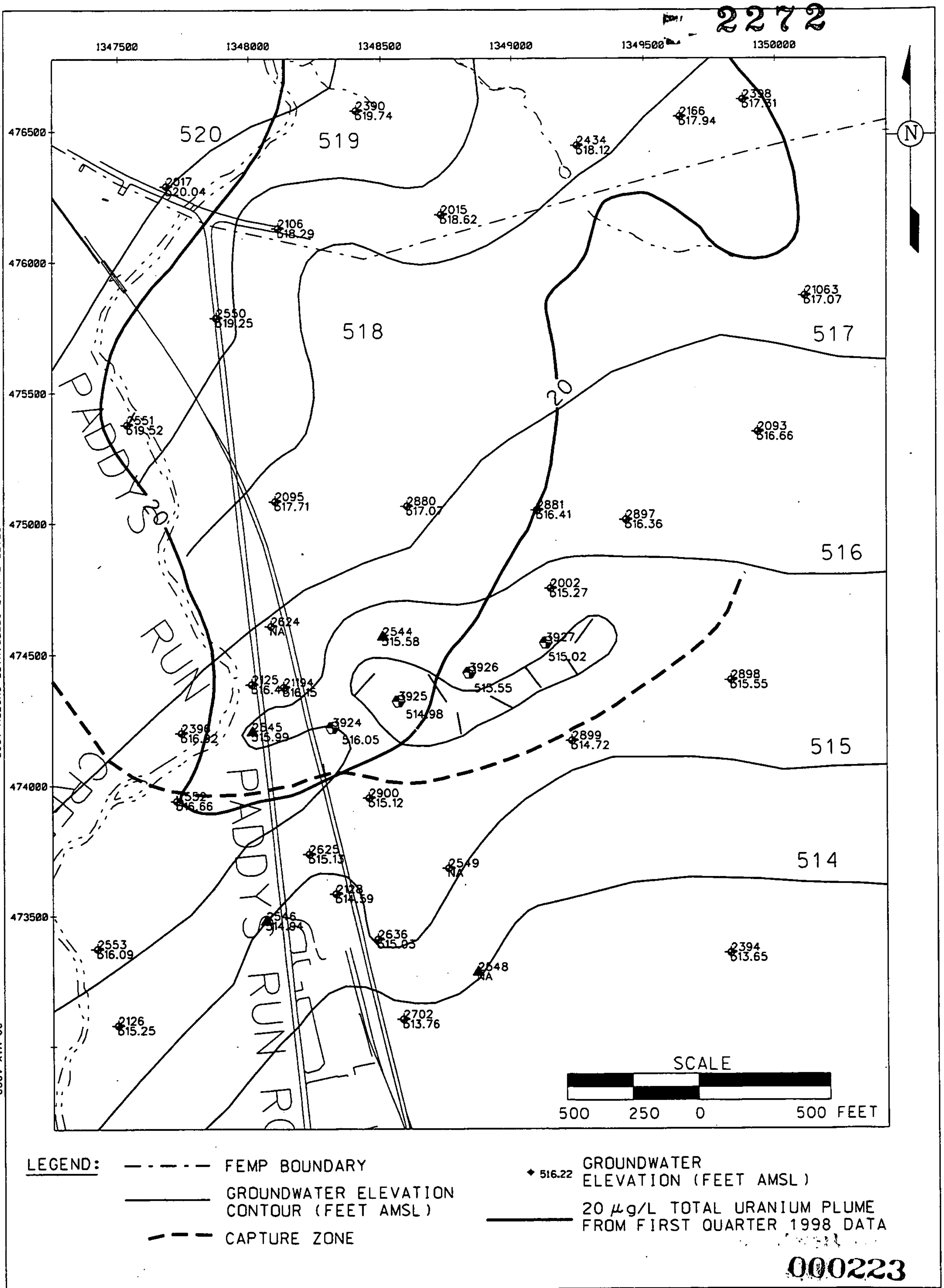

000223

FIGURE A.3-9. DETAILED GROUNDWATER ELEVATIONS IN SOUTH PLUME AREA FOR TYPE 2 WELLS, JANUARY 1998

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STATE PLANAR COORDINATE SYSTEM 1983

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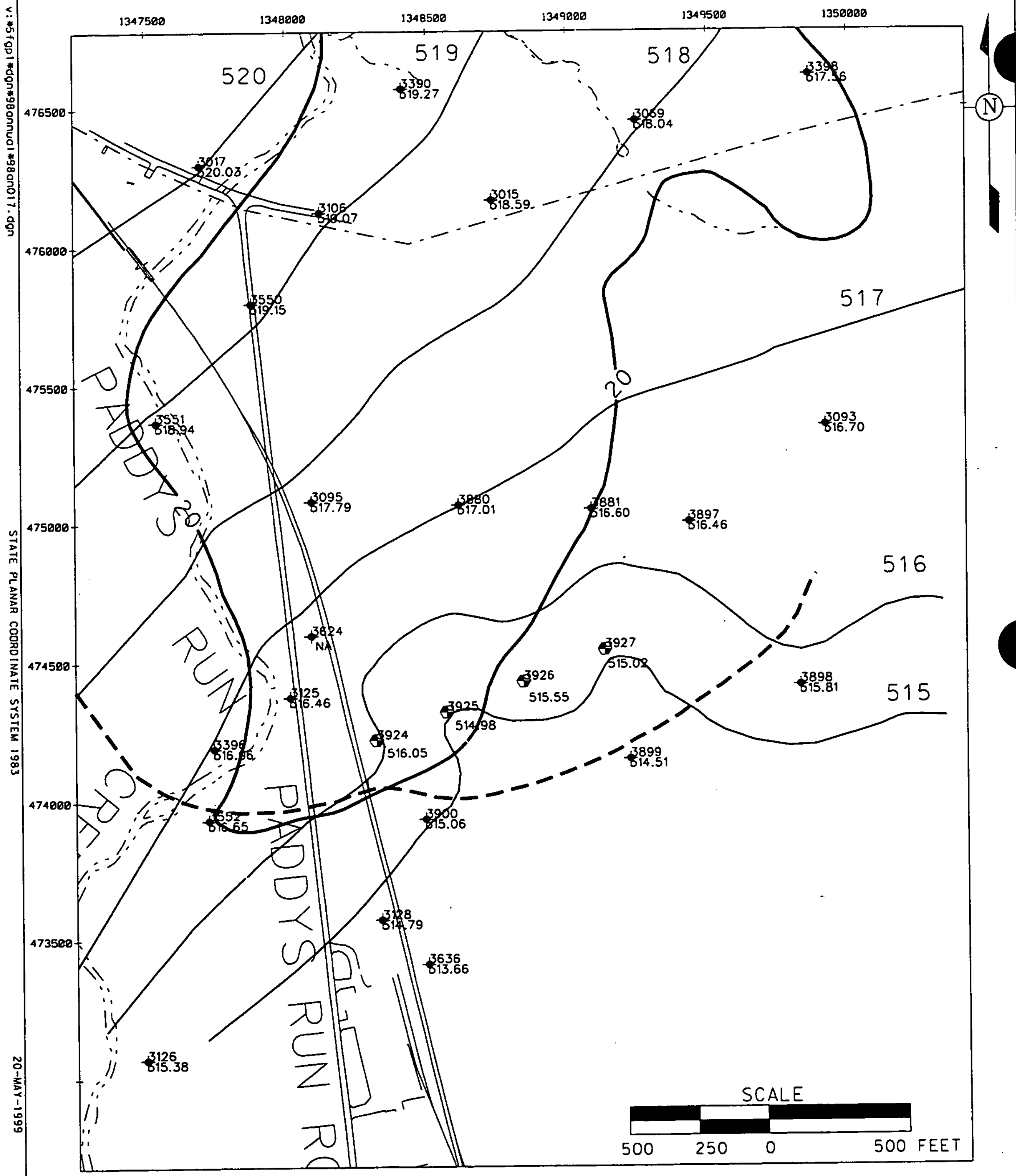

LEGEND:

- — · — · — FEMP BOUNDARY
- ———— GROUNDWATER ELEVATION CONTOUR (FEET AMSL)
- — — — CAPTURE ZONE
- ✦ 516.22 GROUNDWATER ELEVATION (FEET AMSL)
- ━━━━ 20 µg/L TOTAL URANIUM PLUME FROM FIRST QUARTER 1998 DATA

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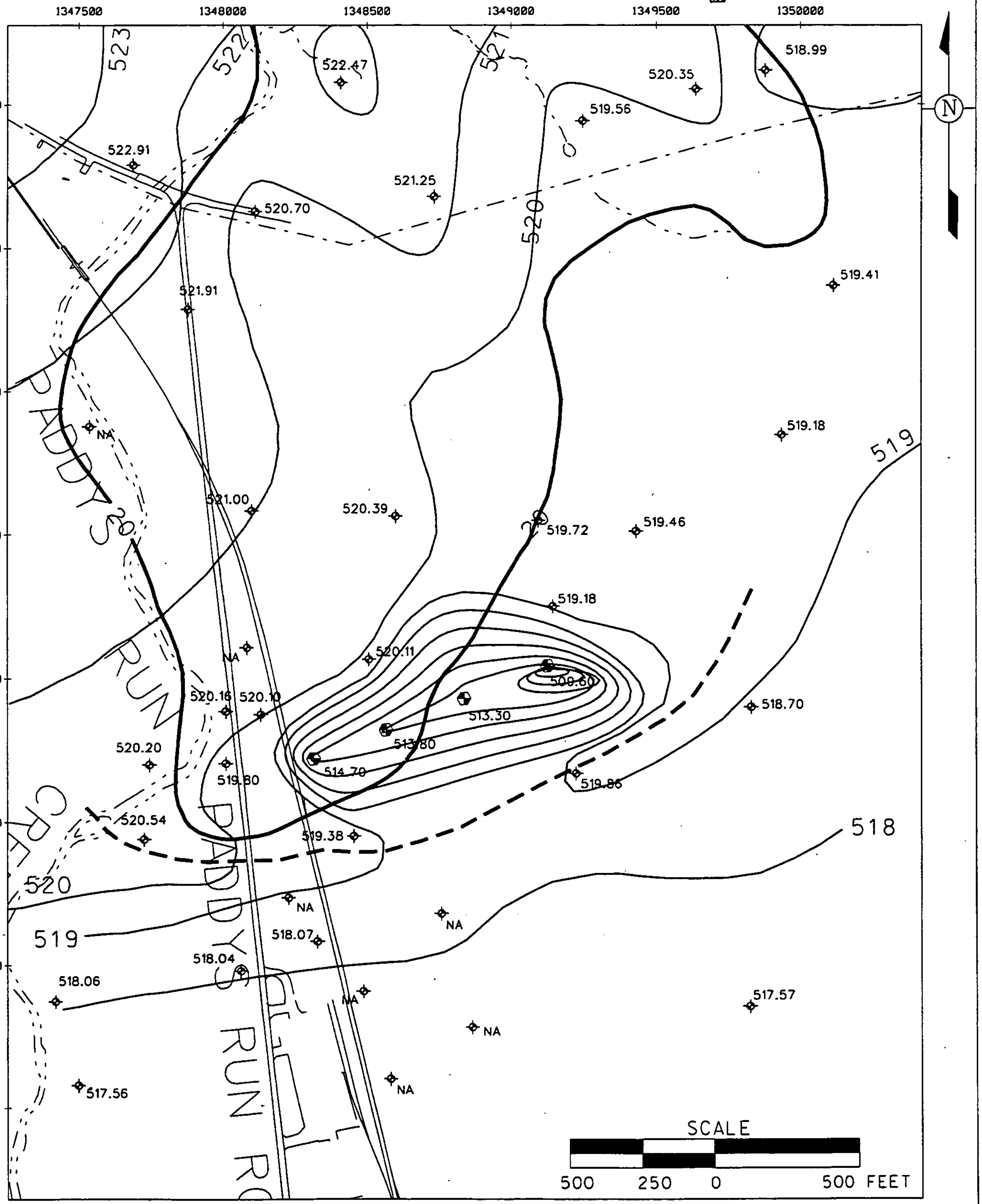
FIGURE A.3-10. DETAILED GROUNDWATER ELEVATIONS IN SOUTH PLUME AREA FOR TYPE 3 WELLS, JANUARY 1998



LEGEND:
- FEMP BOUNDARY
- GROUNDWATER ELEVATION CONTOUR (FEET AMSL)
- CAPTURE ZONE
- ✦ 516.22 GROUNDWATER ELEVATION (FEET AMSL)
- 20 µg/L TOTAL URANIUM PLUME FROM SECOND QUARTER 1998 DATA

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STATE PLANAR COORDINATE SYSTEM 1983

20-MAY-1999

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FIGURE A.3-11. DETAILED GROUNDWATER ELEVATIONS IN SOUTH PLUME AREA FOR TYPE 2 WELLS, APRIL 1998

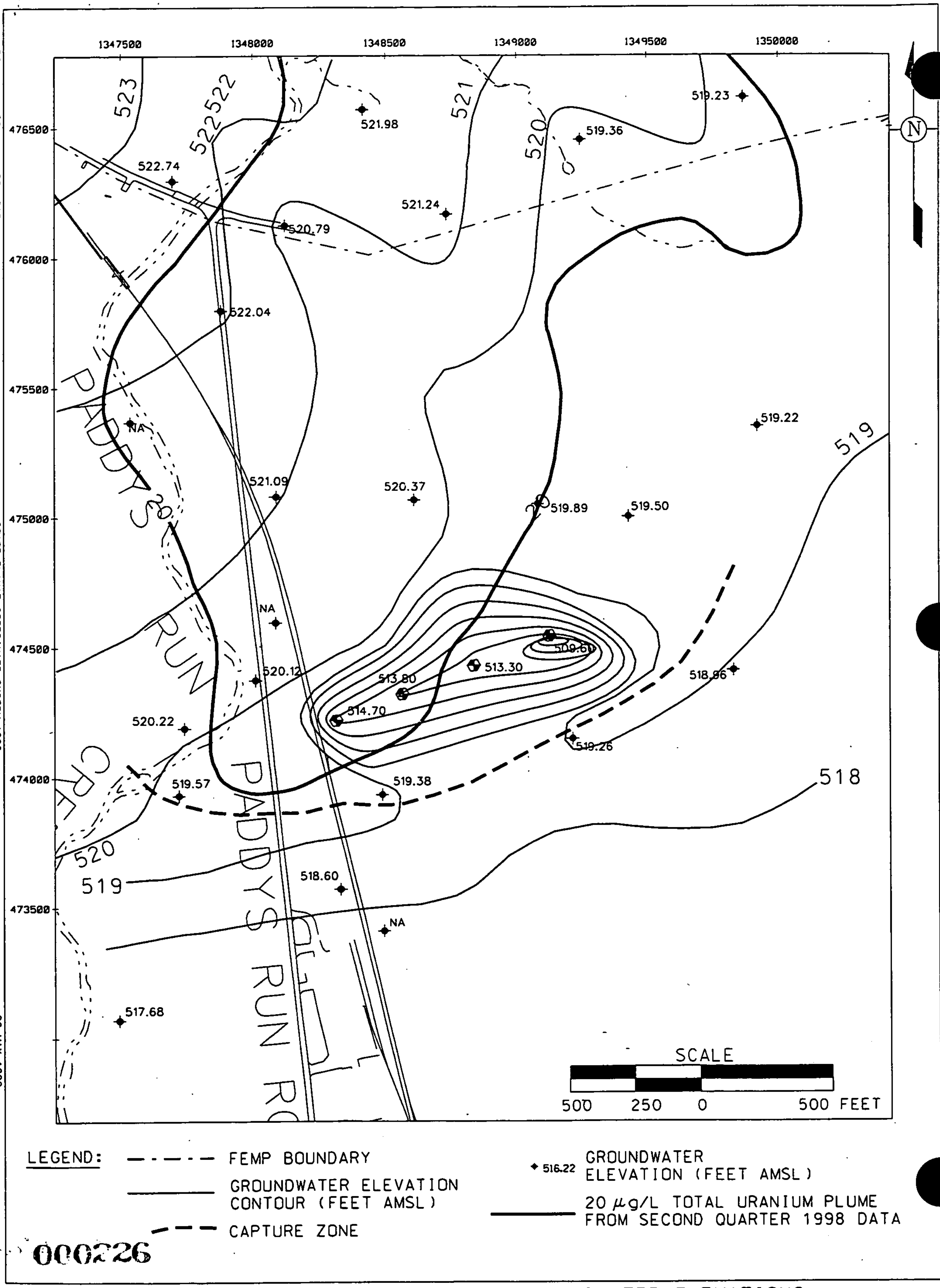

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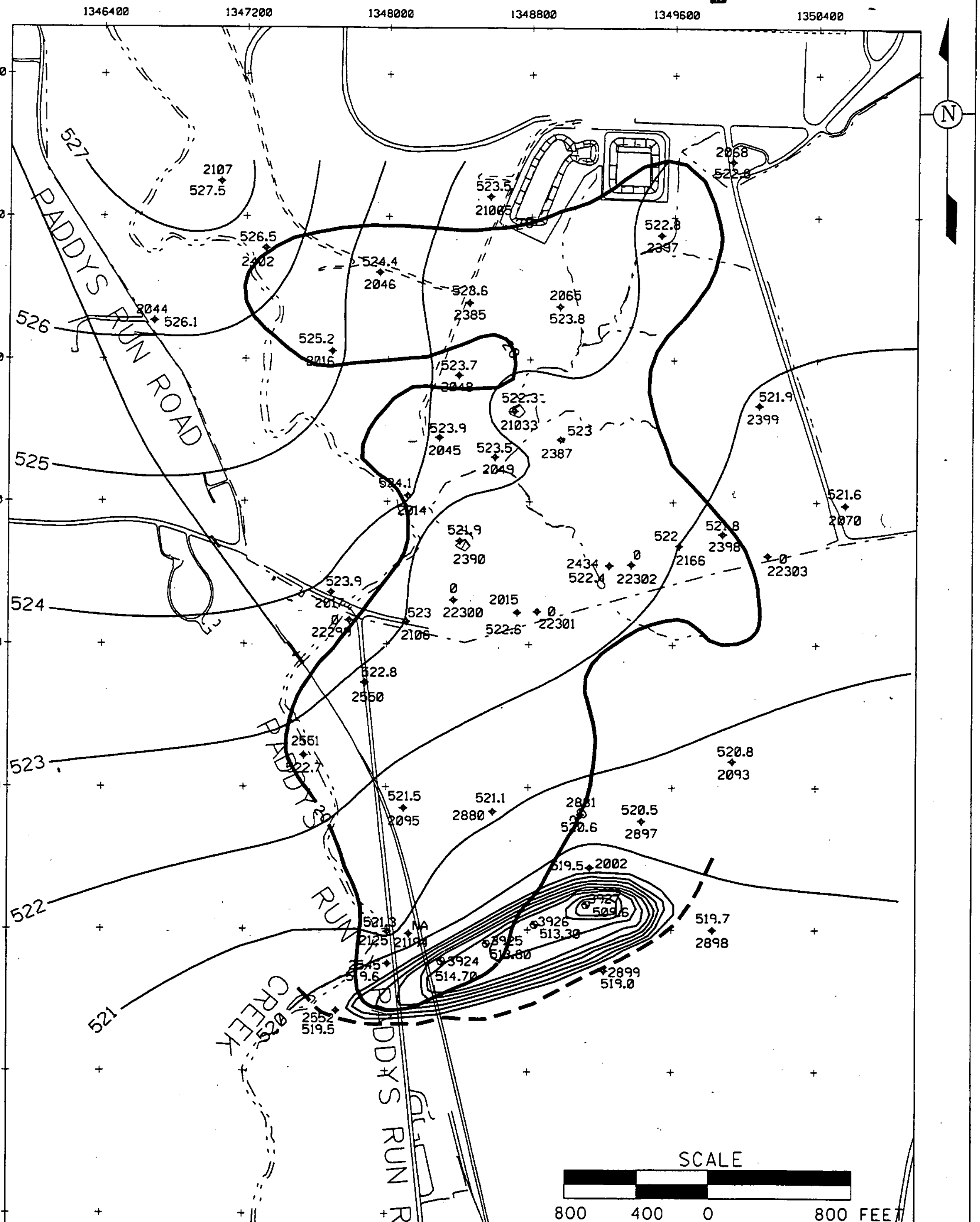
FIGURE A.3-12. DETAILED GROUNDWATER ELEVATIONS IN SOUTH PLUME AREA FOR TYPE 3 WELLS, APRIL 1998

2272

v:*5fgp1*dgn*98annual*98an020.dgn



STATE PLANAR COORDINATE SYSTEM 1927

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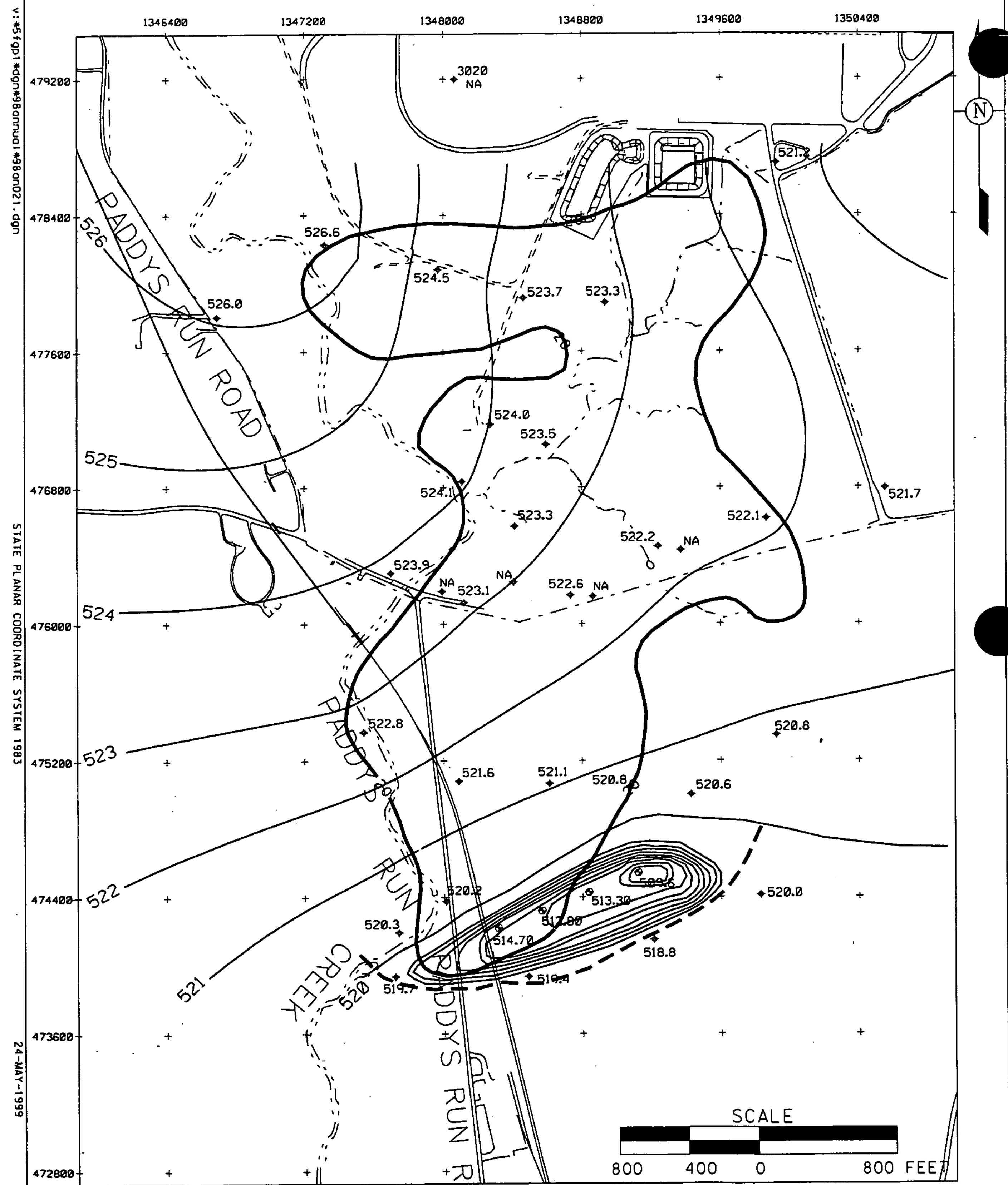
LEGEND:

- — - — FEMP BOUNDARY
- ———— GROUNDWATER ELEVATION CONTOUR (FEET AMSL)
- — — — CAPTURE ZONE
- 517.76 ✦ GROUNDWATER ELEVATION (FEET AMSL)
- ———— 20 µg/L TOTAL URANIUM PLUME FROM SECOND QUARTER 1998 DATA

000227

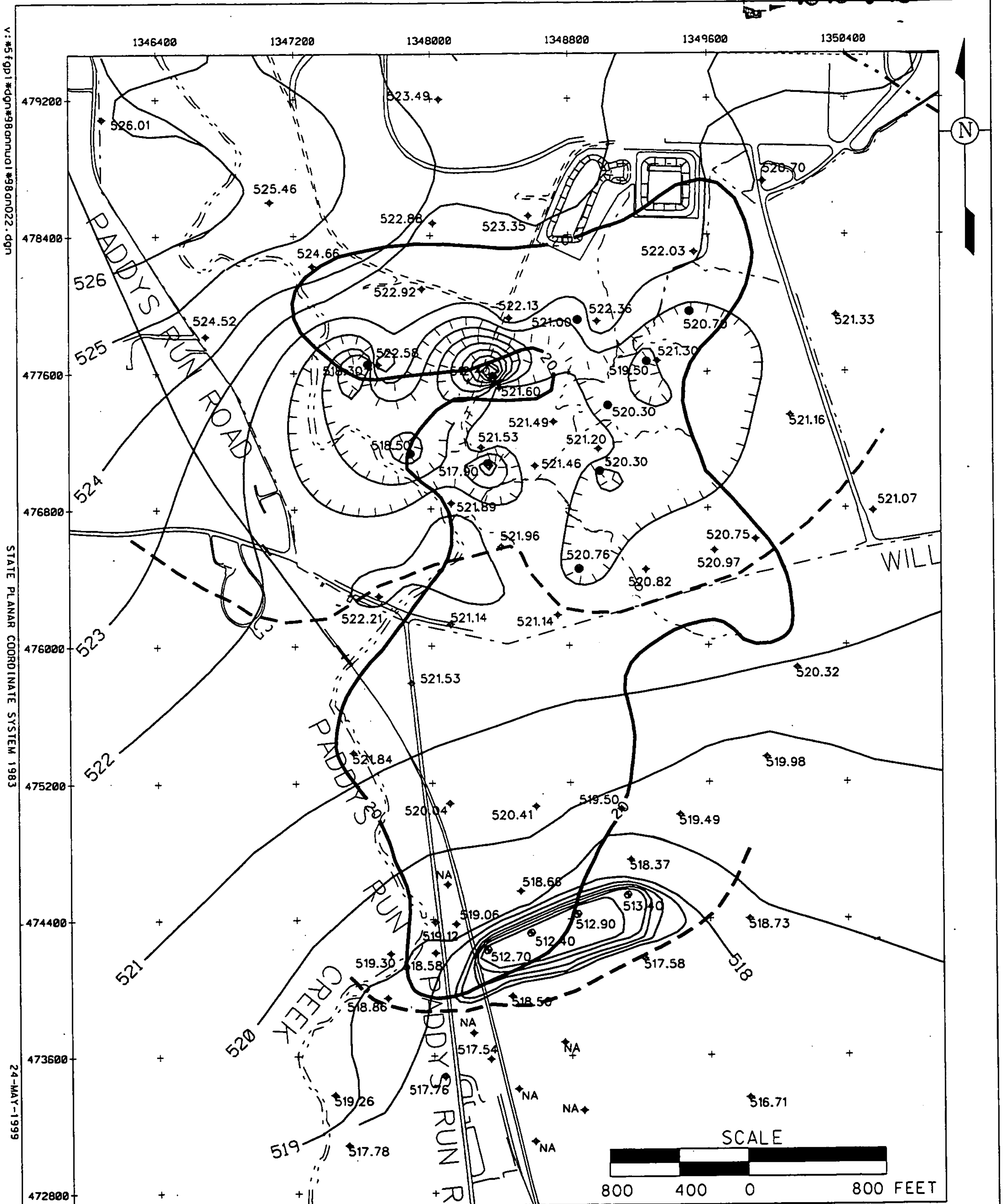
FIGURE A.3-13. DETAILED GROUNDWATER ELEVATIONS FOR TYPE 2 WELLS, JUNE 1998



LEGEND:

- —·—·— FEMP BOUNDARY
- ——— GROUNDWATER ELEVATION CONTOUR (FEET AMSL)
- – – – – CAPTURE ZONE
- 517.76 ✦ GROUNDWATER ELEVATION (FEET AMSL)
- ——— 20 μg/L TOTAL URANIUM PLUME FROM SECOND QUARTER 1998 DATA

FIGURE A.3-14. DETAILED GROUNDWATER ELEVATIONS FOR TYPE 3 WELLS, JUNE 1998 v:\5fgpl\dgn\98annual\98an022.dgn



STATE PLANAR COORDINATE SYSTEM 1983

24-MAY-1999

LEGEND:

—·—·—	FEMP BOUNDARY	✦516.71	GROUNDWATER ELEVATION (FEET AMSL)
———	GROUNDWATER ELEVATION CONTOUR (FEET AMSL)	━━━	20 µg/L TOTAL URANIUM PLUME FROM THIRD QUARTER 1998 DATA
— — —	CAPTURE ZONE		

FIGURE A.3-15. DETAILED GROUNDWATER ELEVATIONS FOR TYPE 2 WELLS, JULY 1998

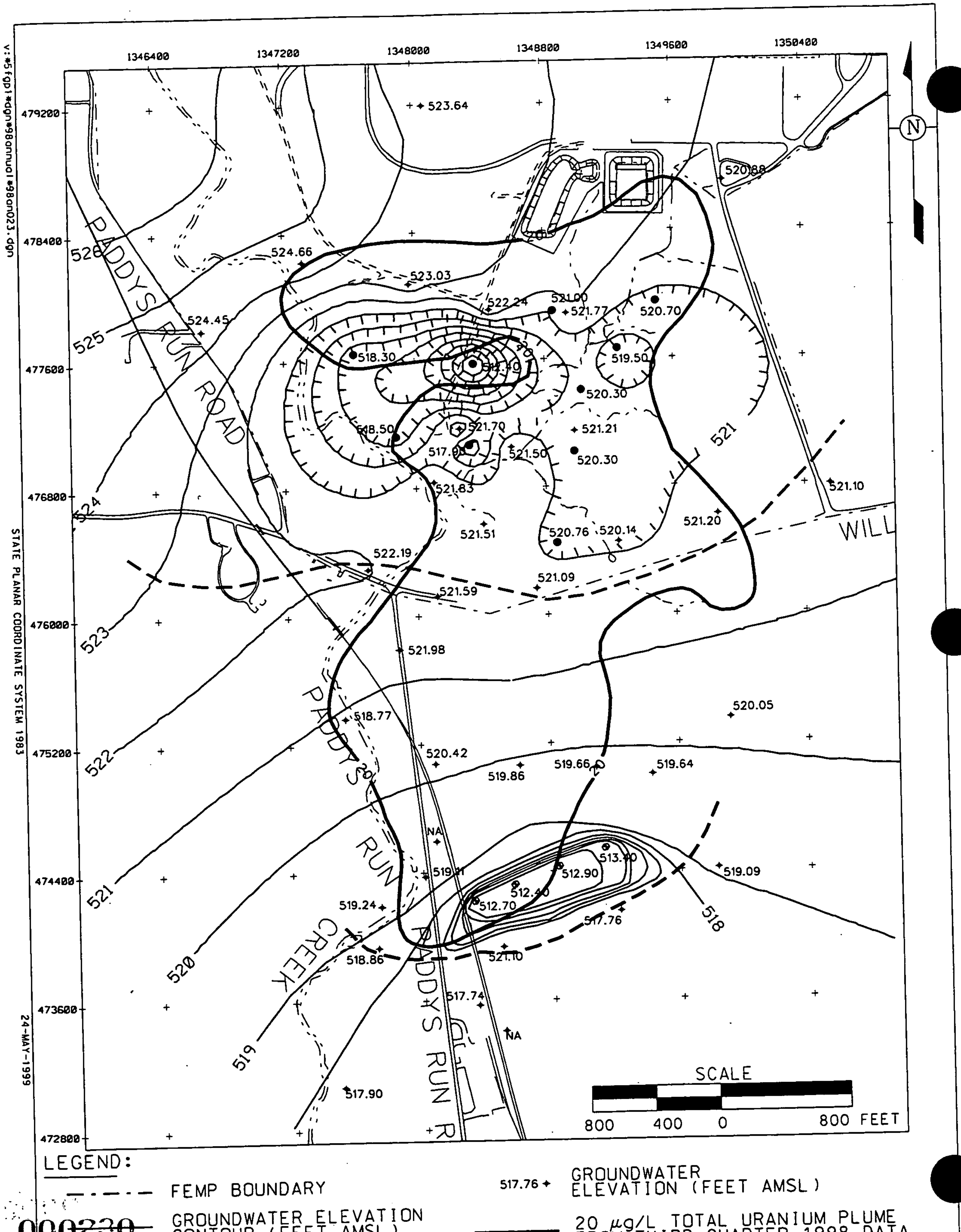


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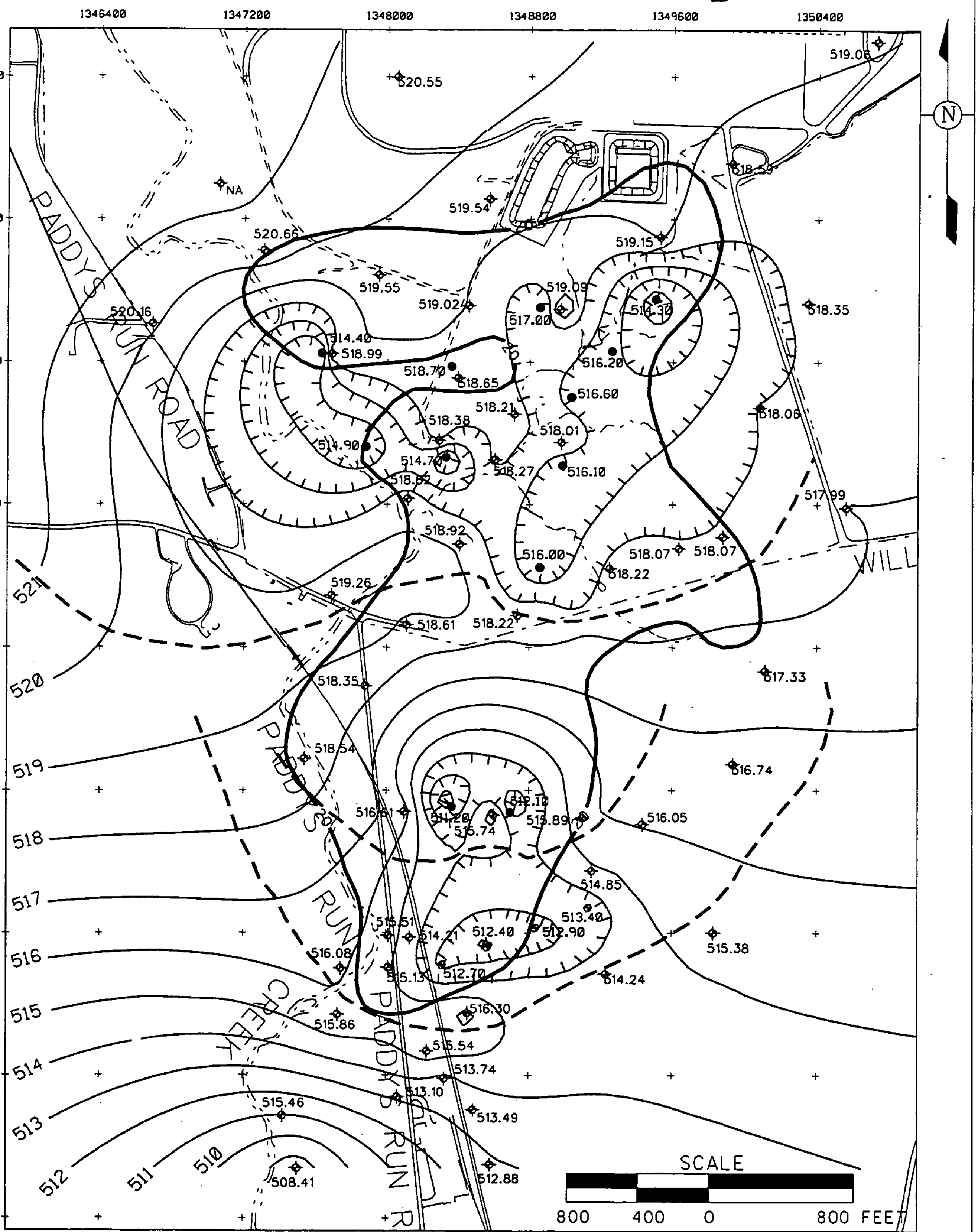
FIGURE A.3-16. DETAILED GROUNDWATER ELEVATIONS FOR TYPE 3 WELLS, JULY 1998



LEGEND:

- FEMP BOUNDARY
- GROUNDWATER ELEVATION CONTOUR (FEET AMSL)
- CAPTURE ZONE
- 517.76 ✦ GROUNDWATER ELEVATION (FEET AMSL)
- 20 µg/L TOTAL URANIUM PLUME FROM THIRD QUARTER 1998 DATA

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STATE PLANAR COORDINATE SYSTEM 1983

24-MAY-1999

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FIGURE A.3-17. DETAILED GROUNDWATER ELEVATIONS FOR TYPE 2 WELLS, SEPTEMBER 1998

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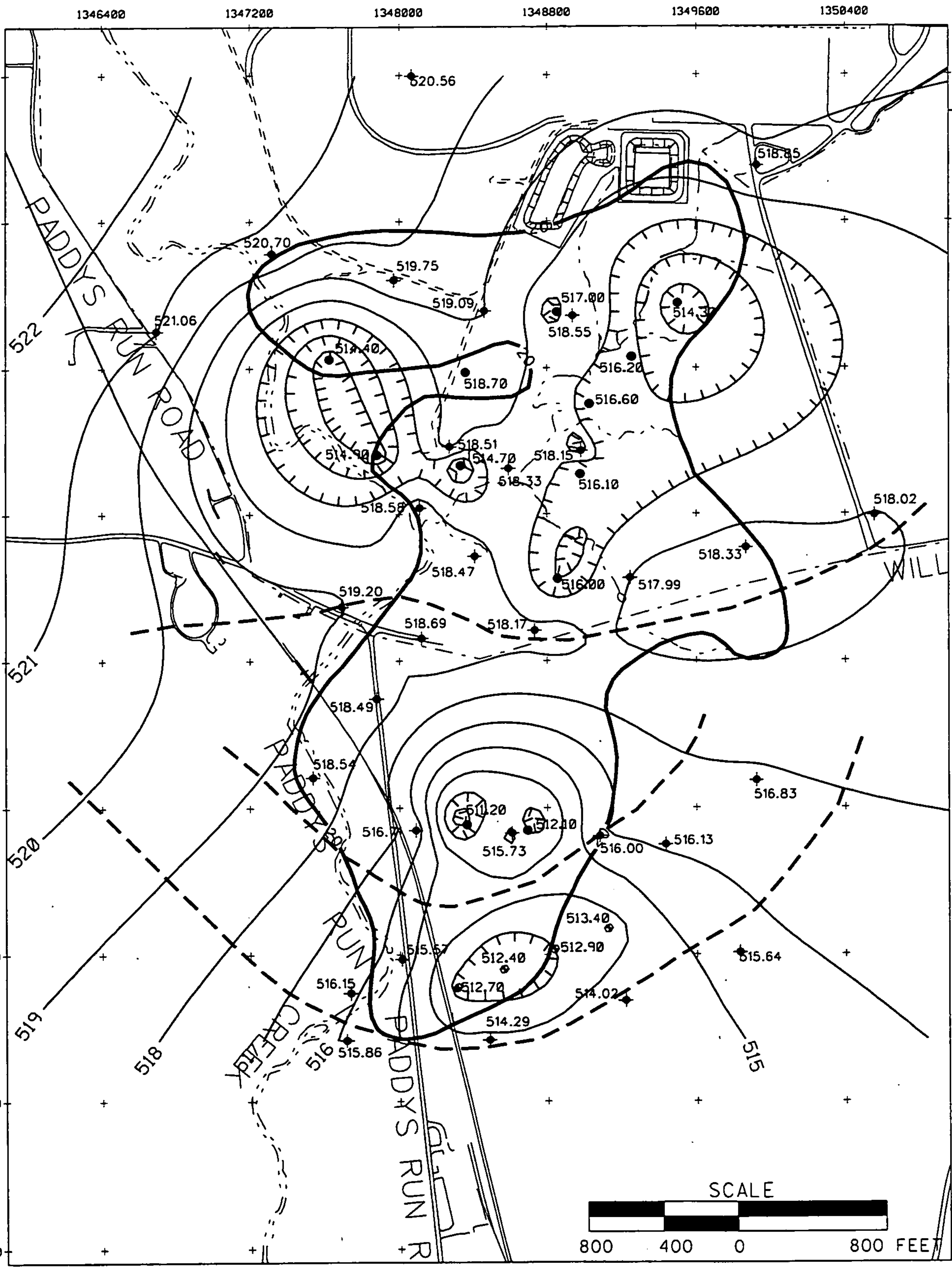

STATE PLANAR COORDINATE SYSTEM 1983

24-MAY-1999

LEGEND:

FEMP BOUNDARY

GROUNDWATER ELEVATION CONTOUR (FEET AMSL)

CAPTURE ZONE

517.76 ✦ GROUNDWATER ELEVATION (FEET AMSL)

20 µg/L TOTAL URANIUM PLUME FROM THIRD QUARTER 1998 DATA

000232

FIGURE A.3-18. DETAILED GROUNDWATER ELEVATIONS FOR TYPE 3 WELLS, SEPTEMBER 1998

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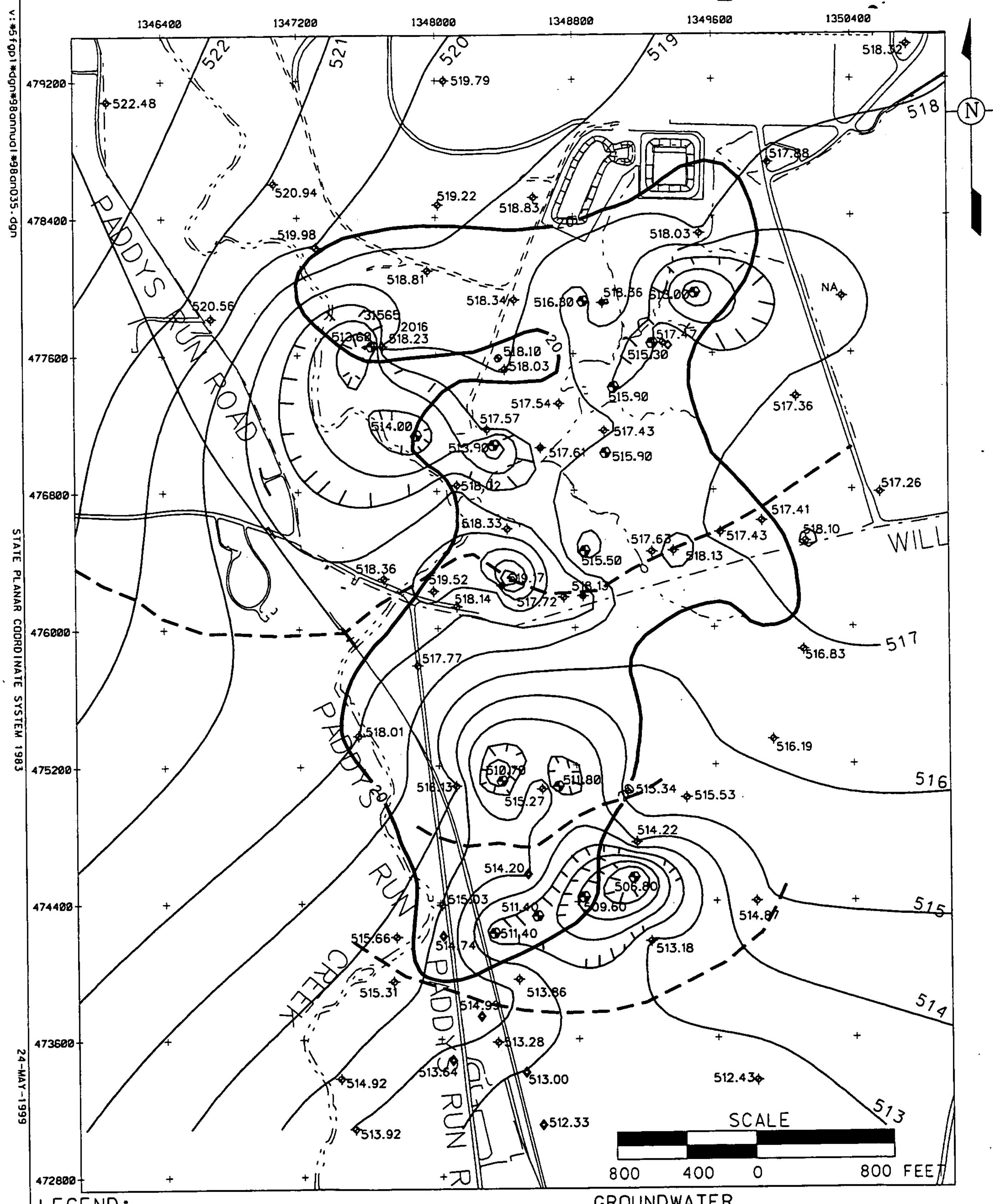


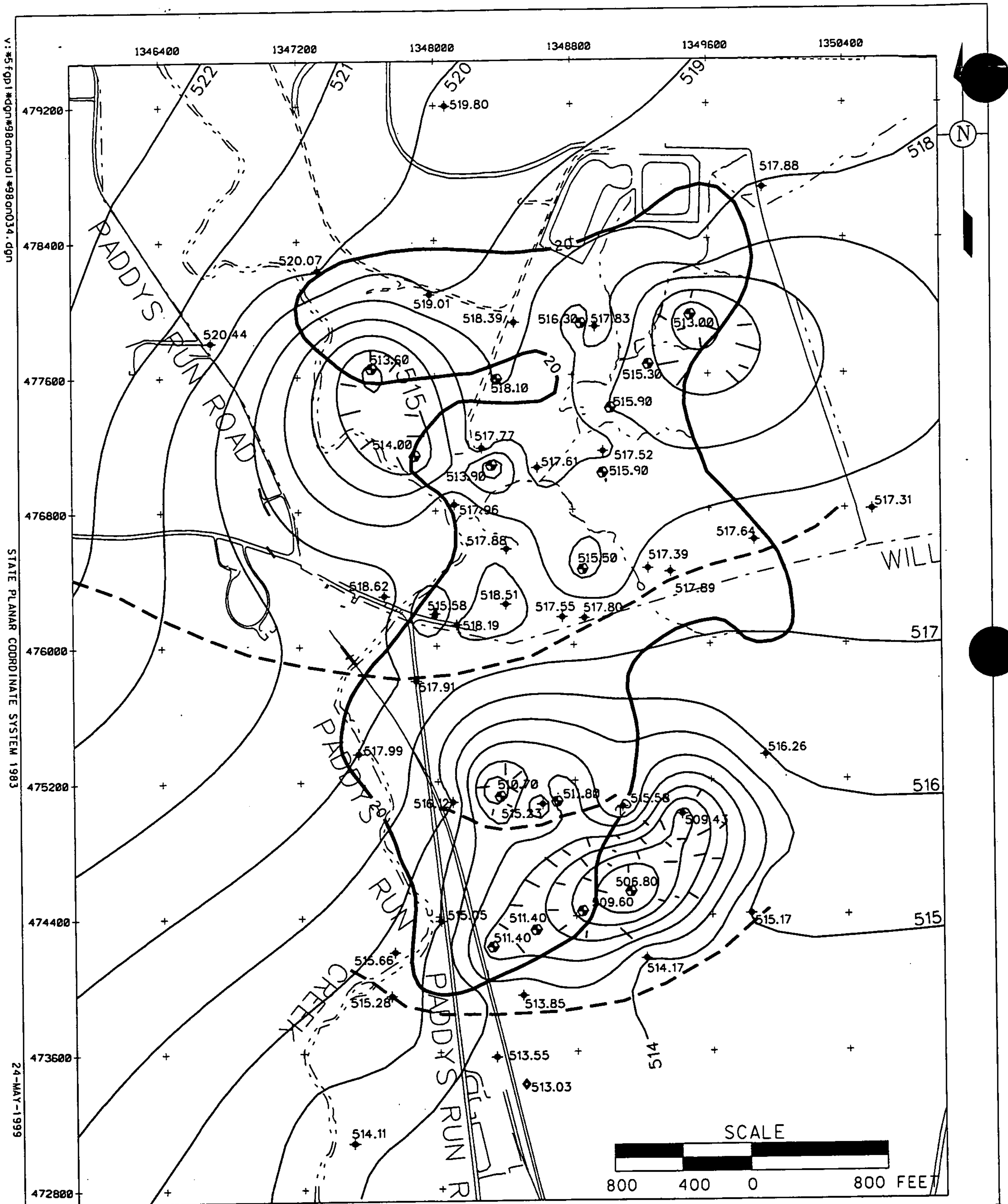
LEGEND:

- FEMP BOUNDARY
- GROUNDWATER ELEVATION CONTOUR (FEET AMSL)
- CAPTURE ZONE
- 517.76 GROUNDWATER ELEVATION (FEET AMSL)
- 20 $\mu g/L$ TOTAL URANIUM PLUME FROM FOURTH QUARTER 1998 DATA

FIGURE A.3-19. DETAILED GROUNDWATER ELEVATIONS FOR TYPE 2 WELLS, OCTOBER 1998

000233

v:*5fgp1*dgn*98annual*98an034.dgn



LEGEND:

—·—·— FEMP BOUNDARY

——— GROUNDWATER ELEVATION CONTOUR (FEET AMSL)

— — — CAPTURE ZONE

517.76 GROUNDWATER ELEVATION (FEET AMSL)

——— 20 µg/L TOTAL URANIUM PLUME FROM FOURTH QUARTER 1998 DATA

FIGURE A.3-20. DETAILED GROUNDWATER ELEVATIONS FOR TYPE 3 WELLS, OCTOBER 1998

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000234

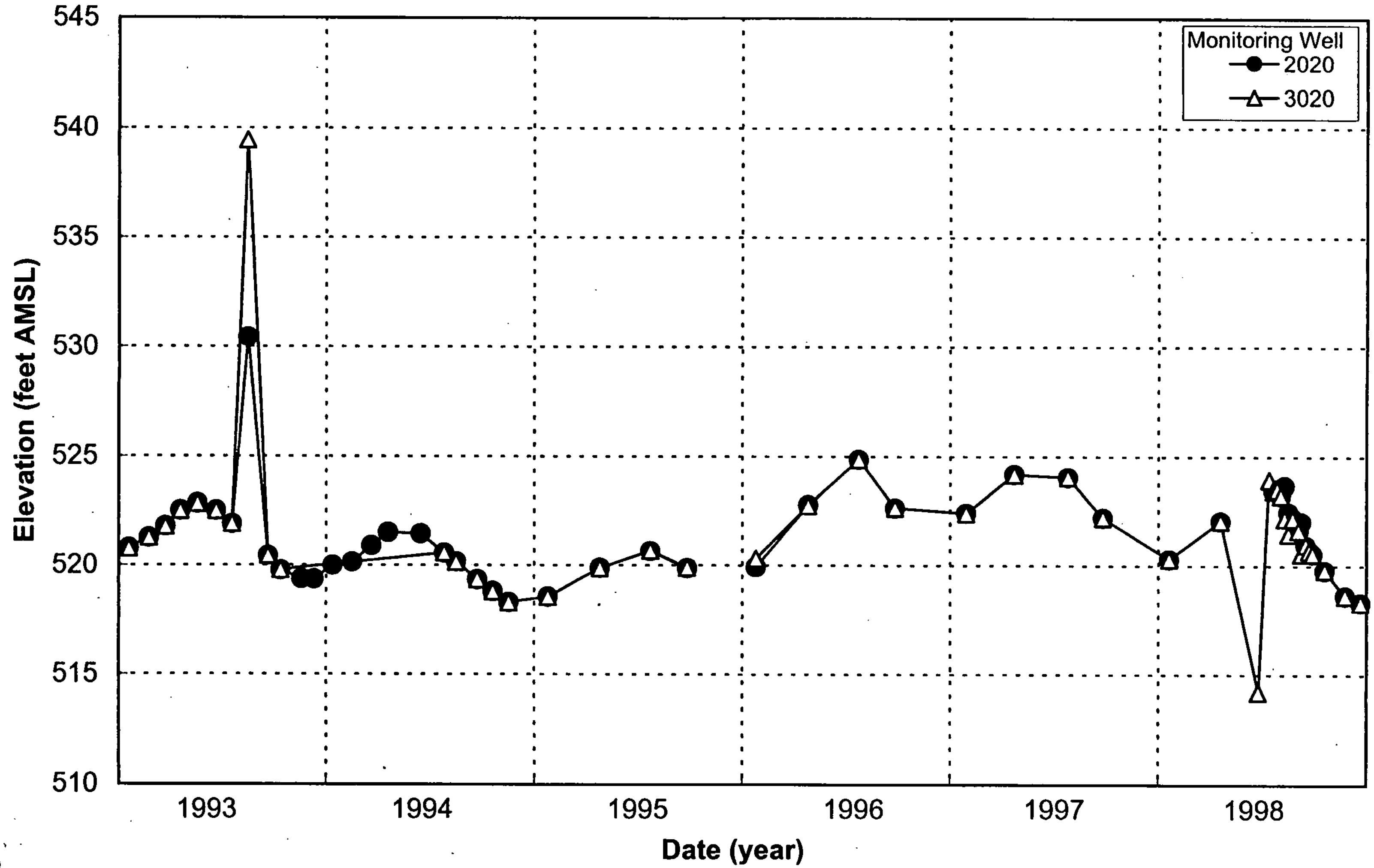

FIGURE A.3-21. HYDROGRAPH FOR WELL CLUSTER 020

000235

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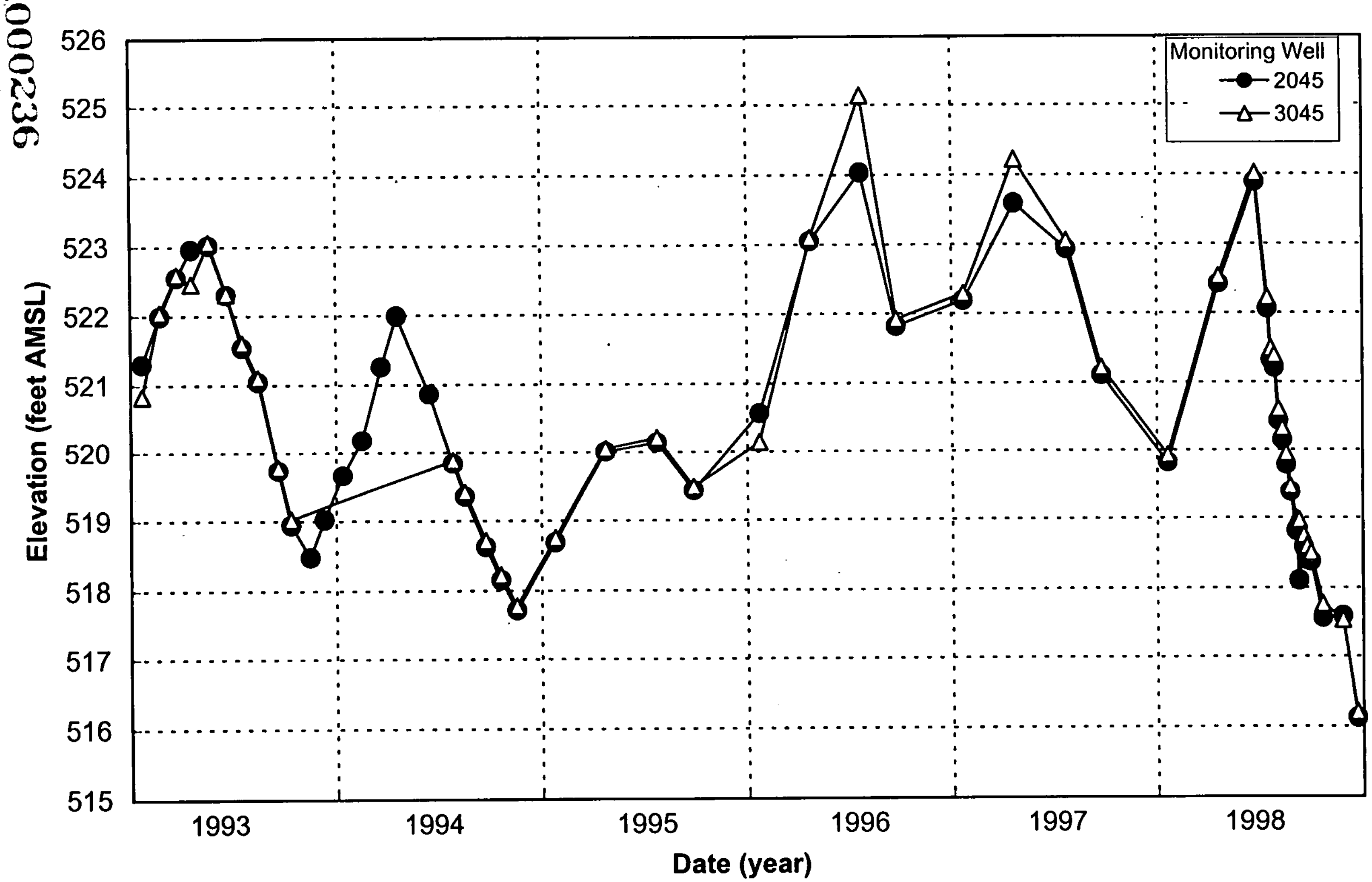

FIGURE A.3-22. HYDROGRAPH FOR WELL CLUSTER 045

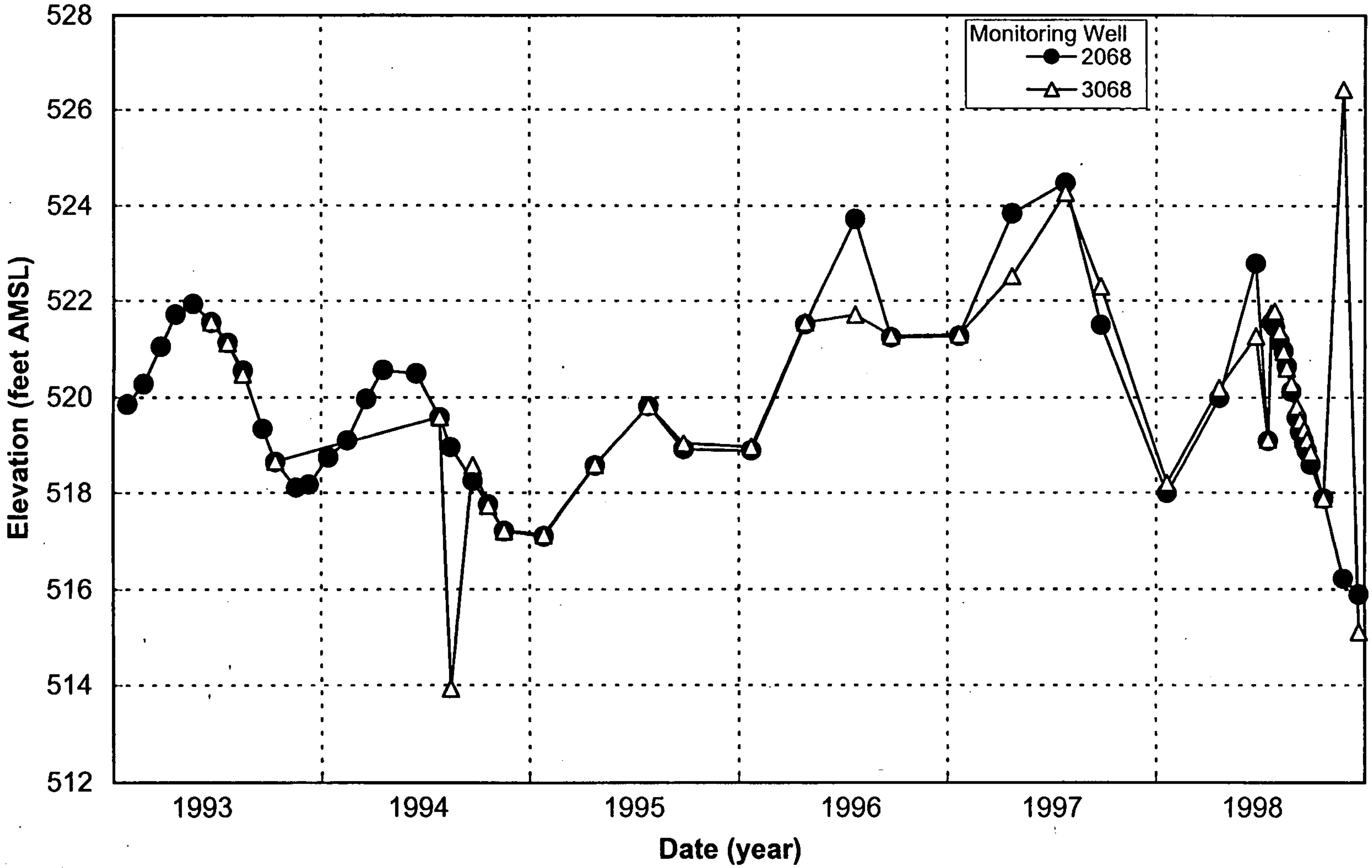

FIGURE A.3-23. HYDROGRAPH FOR WELL CLUSTER 068

000237

2272

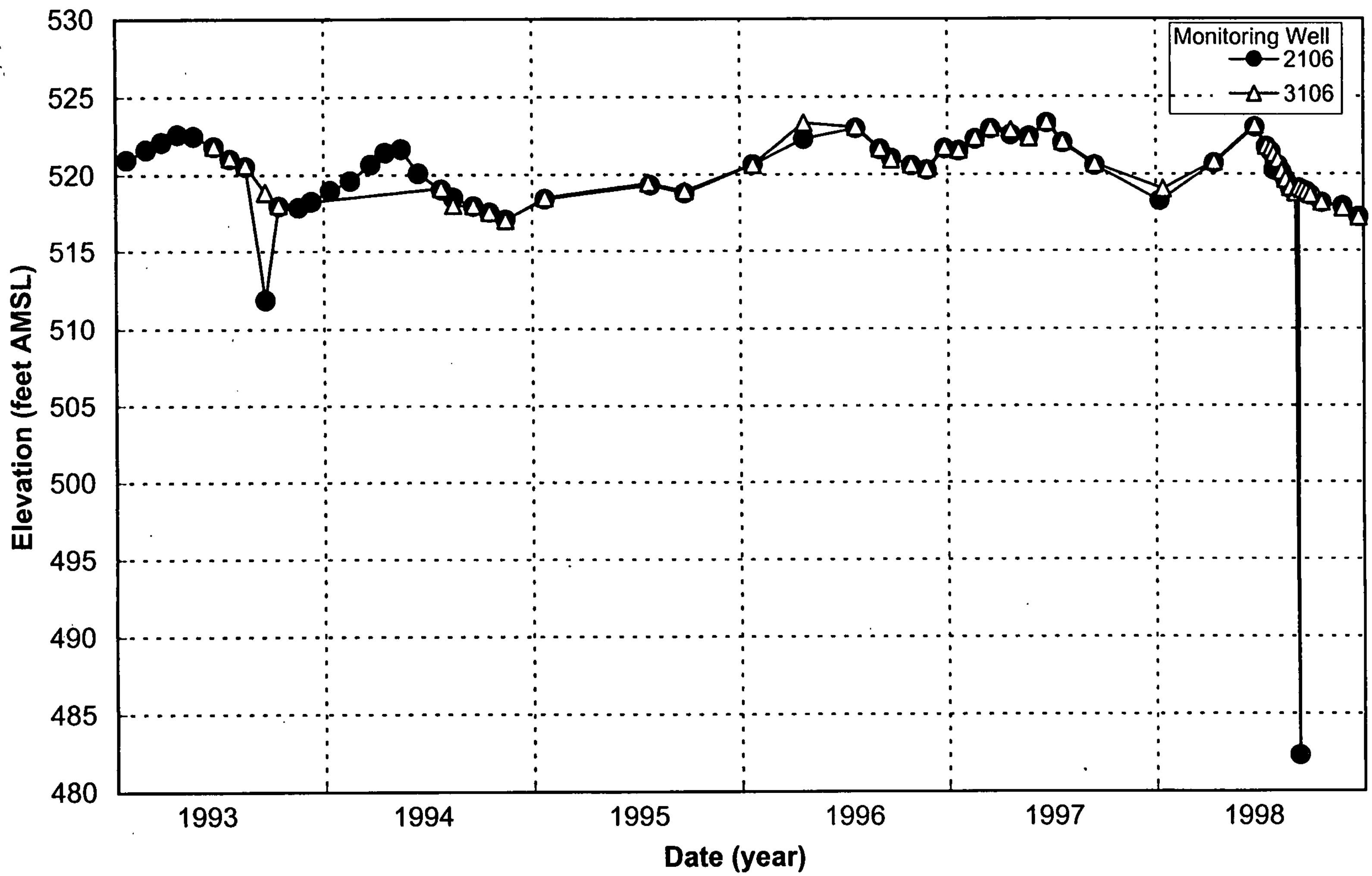

FIGURE A.3-24. HYDROGRAPH FOR WELL CLUSTER 106

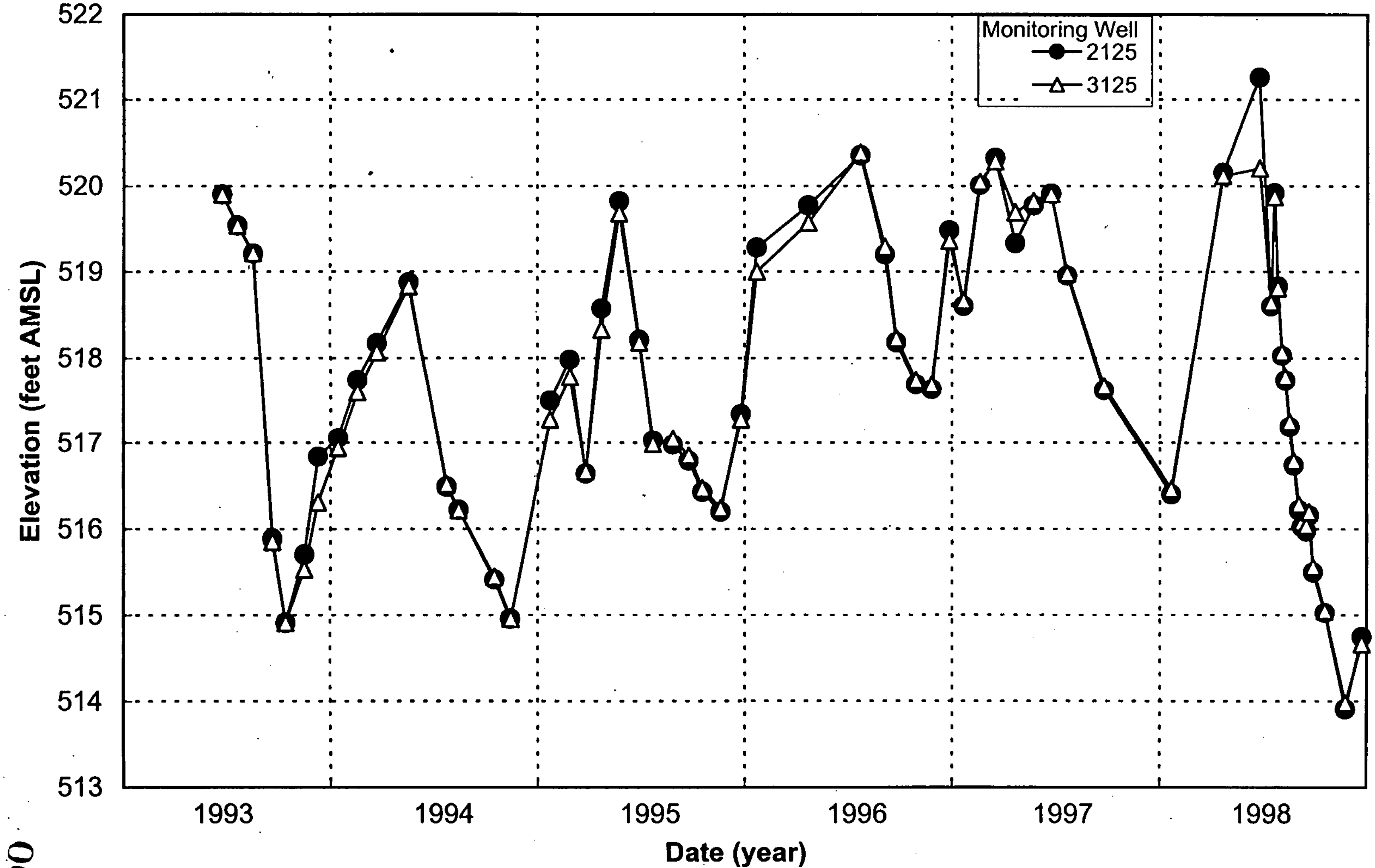

FIGURE A.3-25. HYDROGRAPH FOR WELL CLUSTER 125

000239

2272

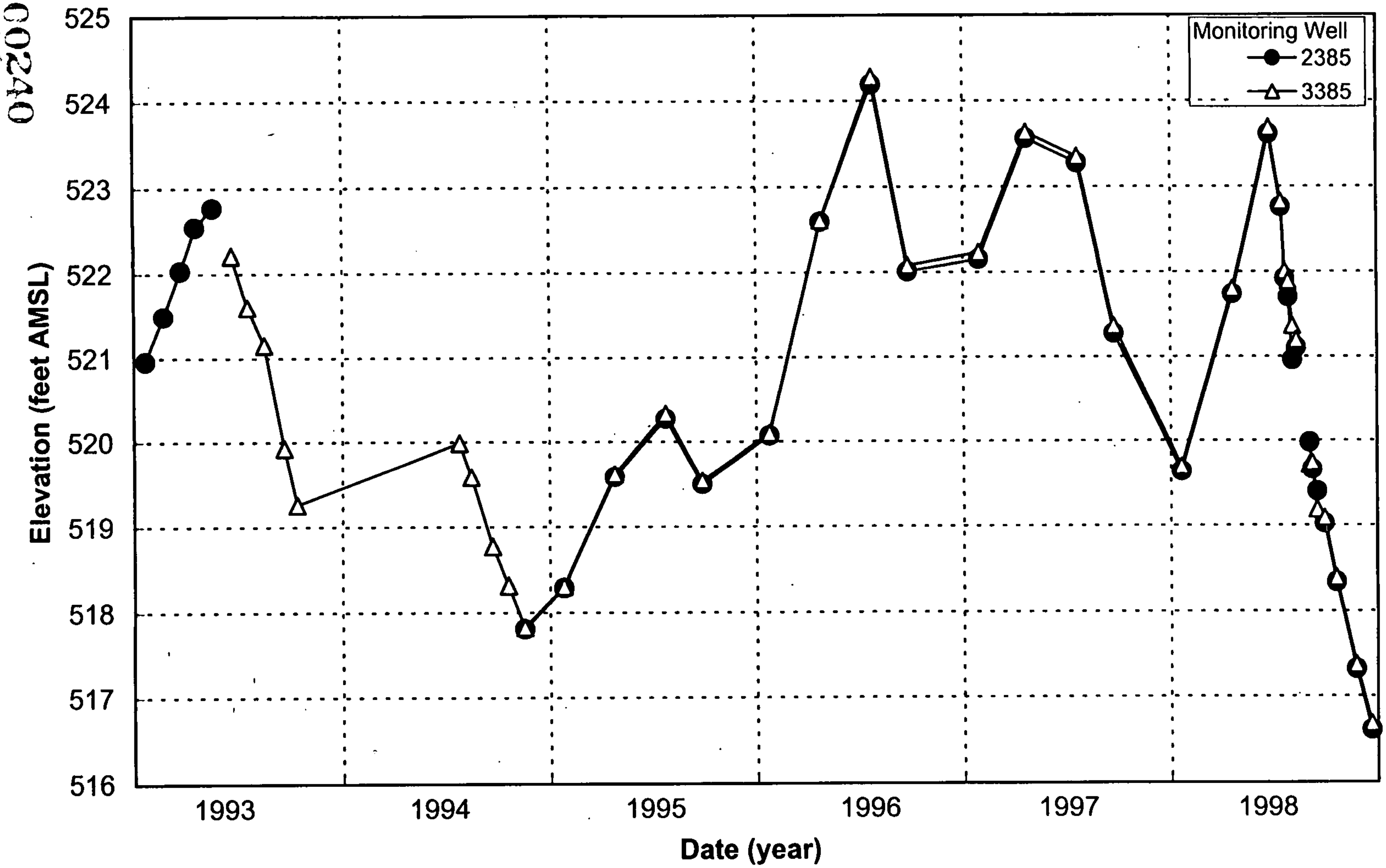

FIGURE A.3-26. HYDROGRAPH FOR WELL CLUSTER 385

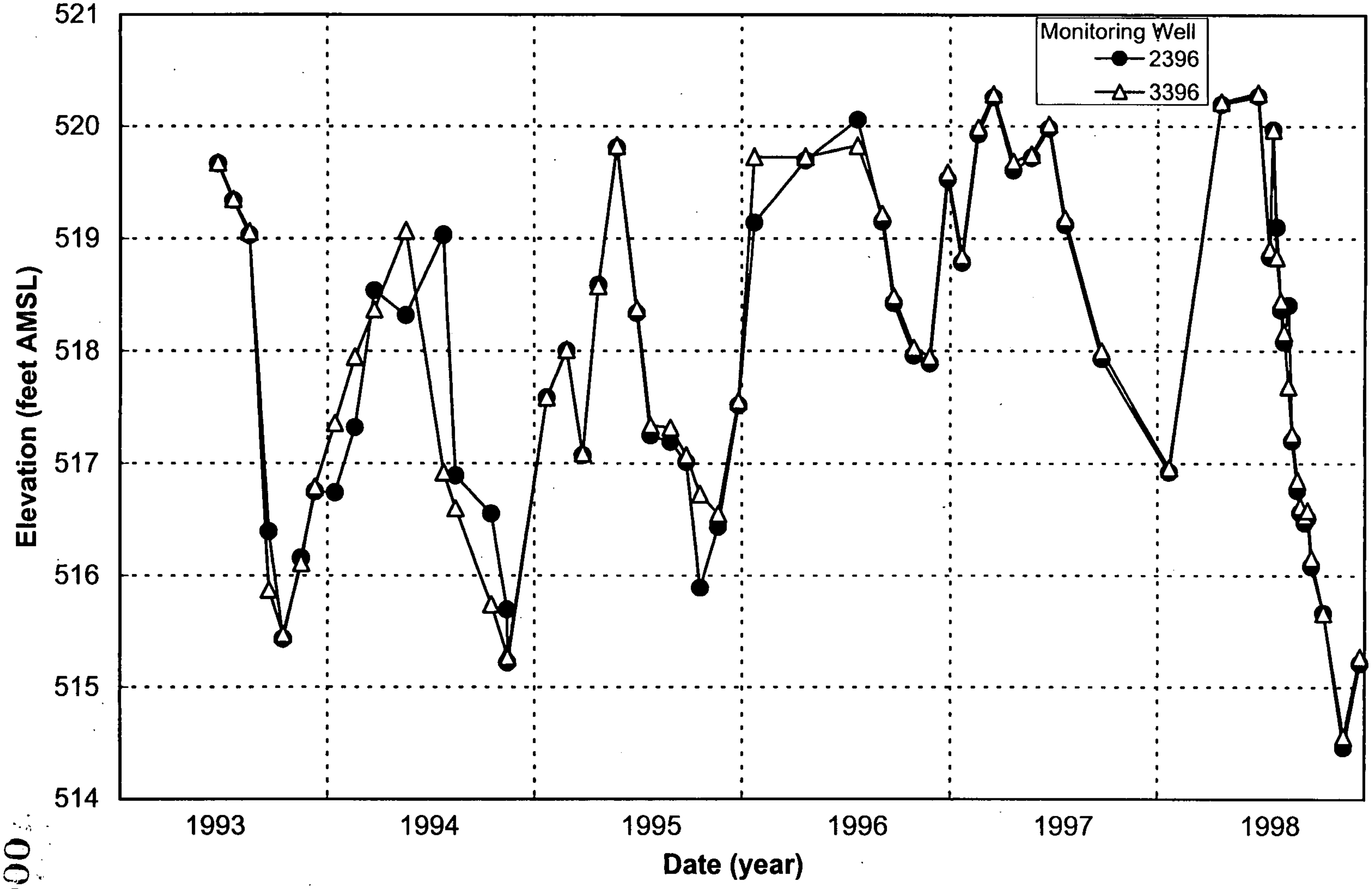

FIGURE A.3-27. HYDROGRAPH FOR WELL CLUSTER 396

000241

2272

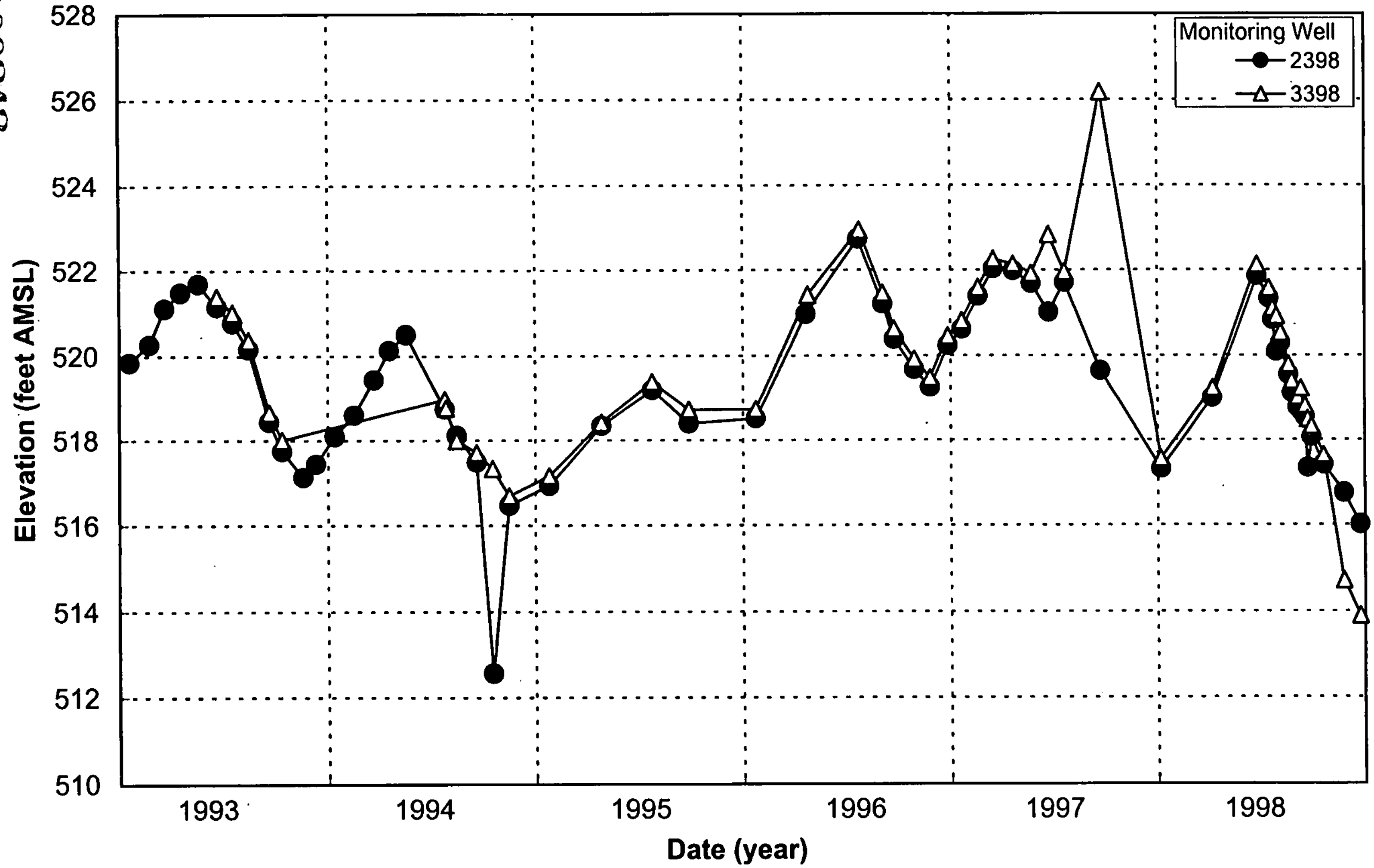

FIGURE A.3-28. HYDROGRAPH FOR WELL CLUSTER 398

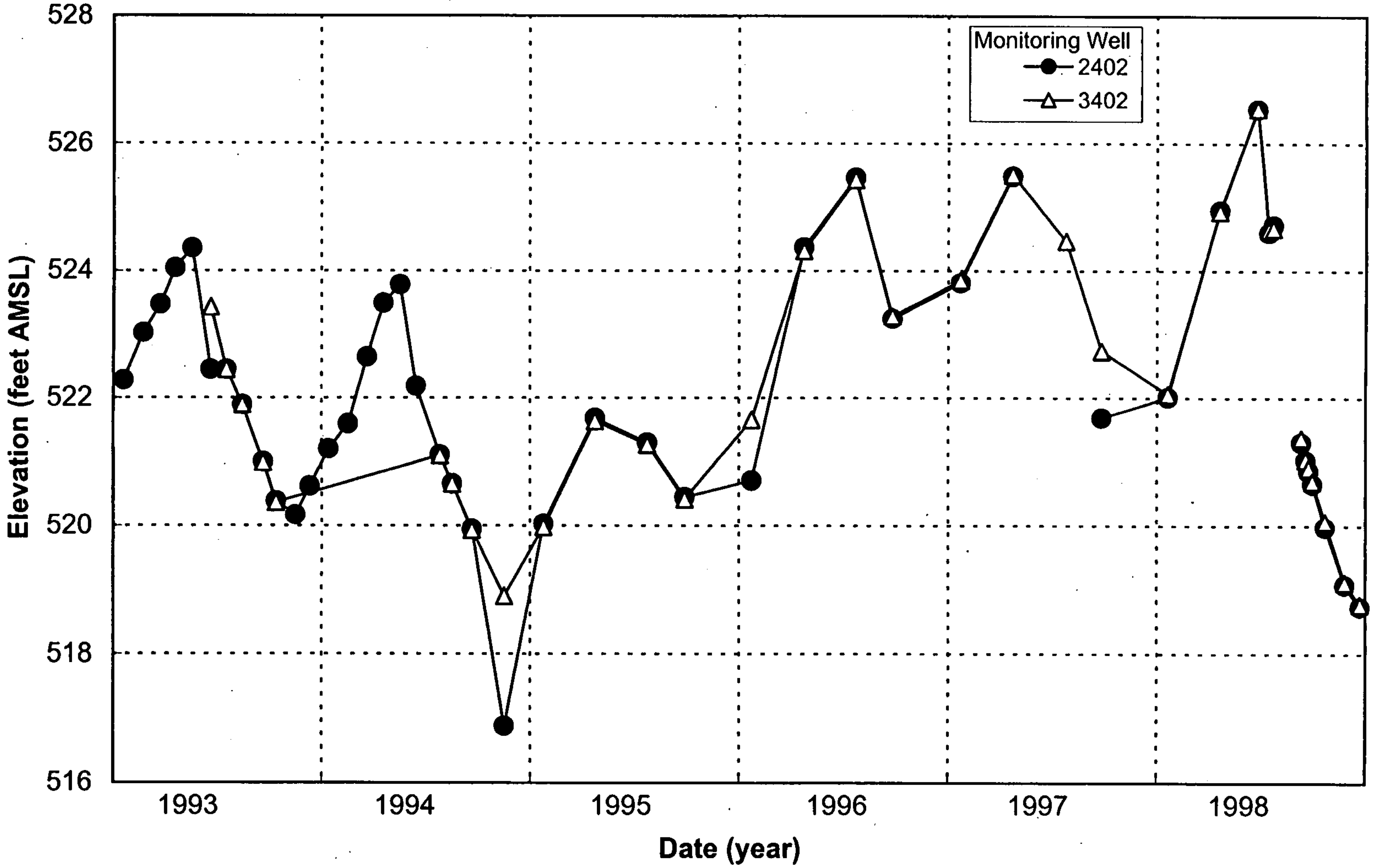

FIGURE A.3-29. HYDROGRAPH FOR WELL CLUSTER 402

000243

2272

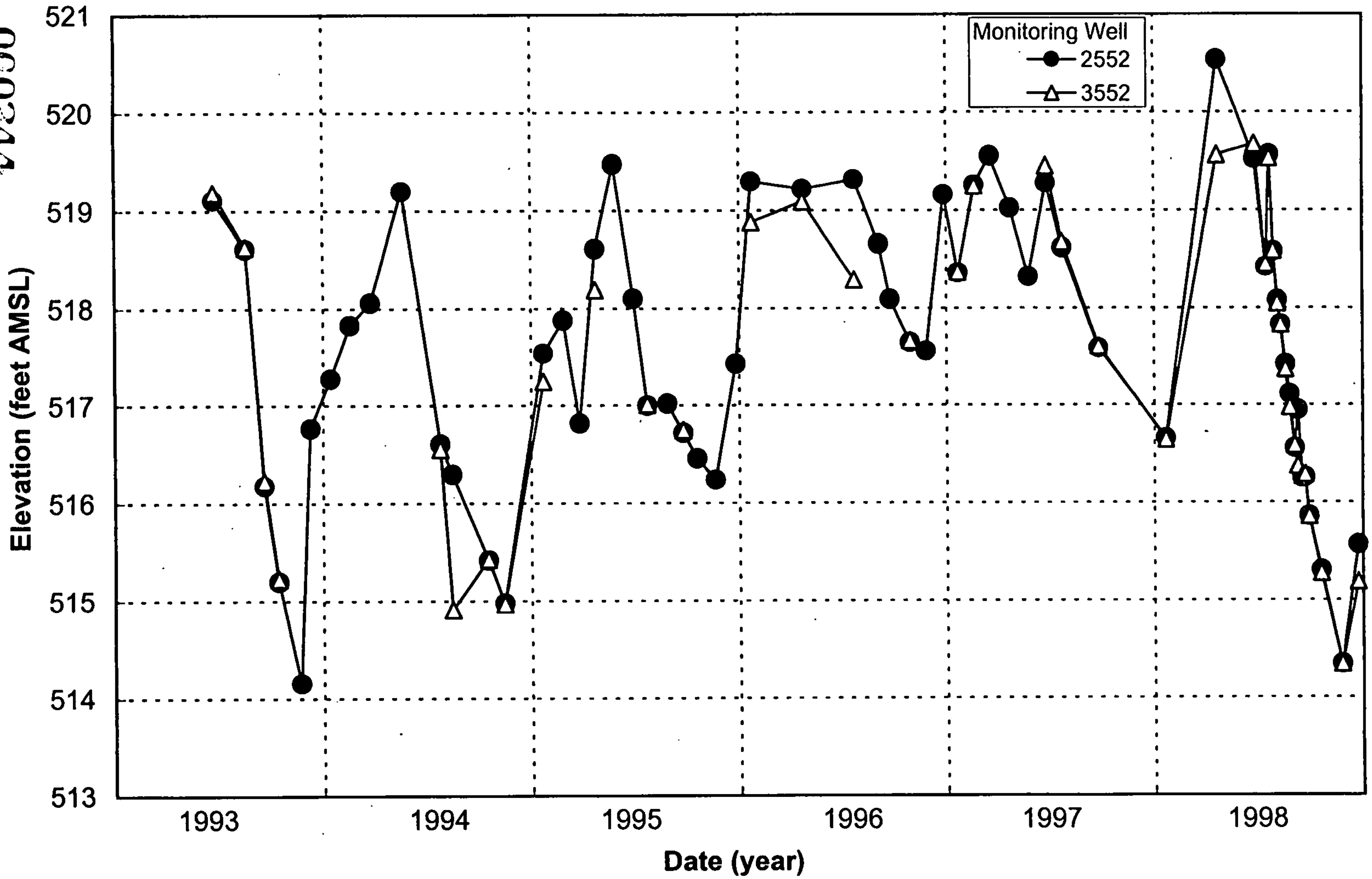

FIGURE A.3-30. HYDROGRAPH FOR WELL CLUSTER 552

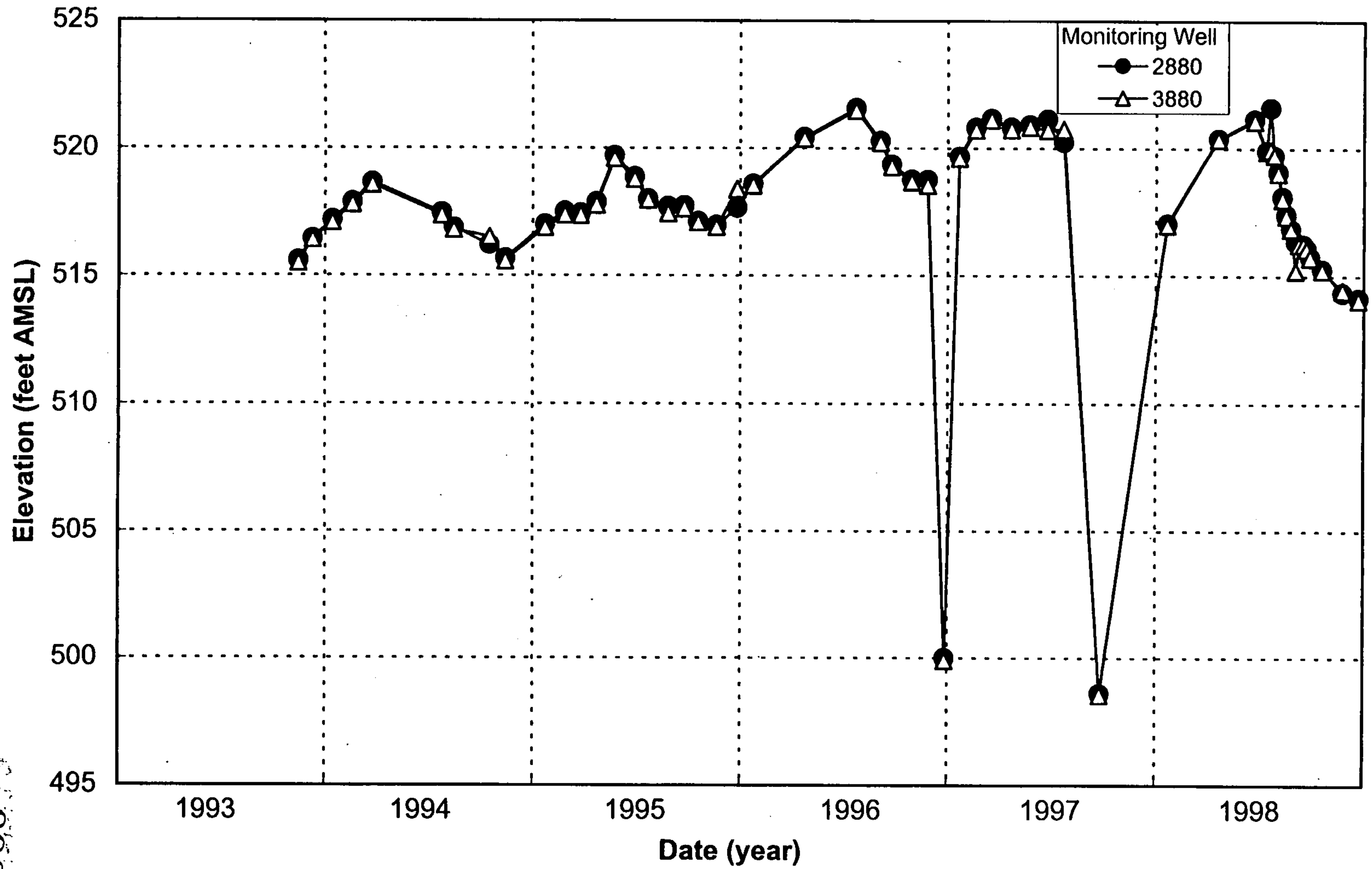

FIGURE A.3-31. HYDROGRAPH FOR WELL CLUSTER 880

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2272

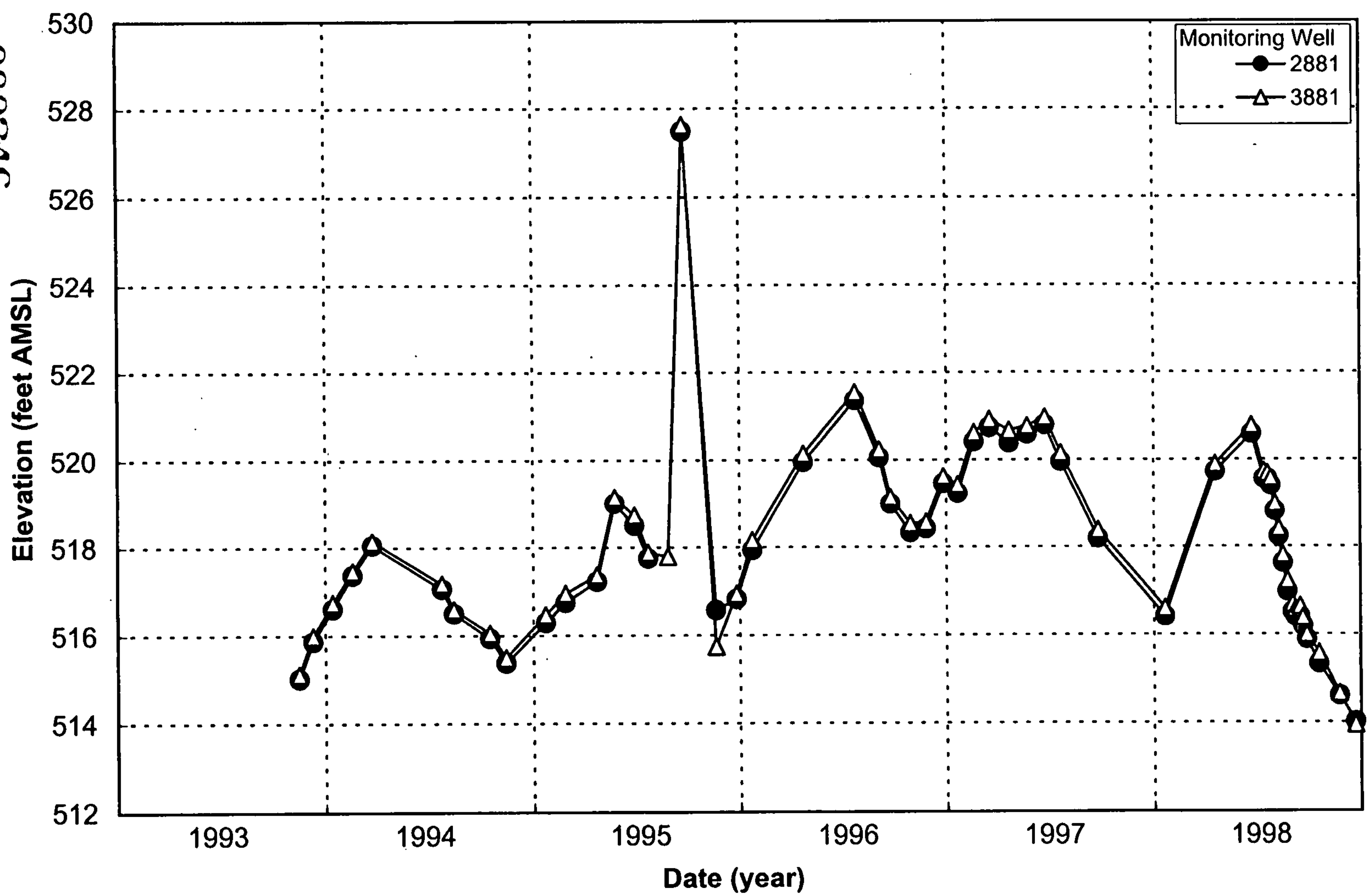

FIGURE A.3-32. HYDROGRAPH FOR WELL CLUSTER 881

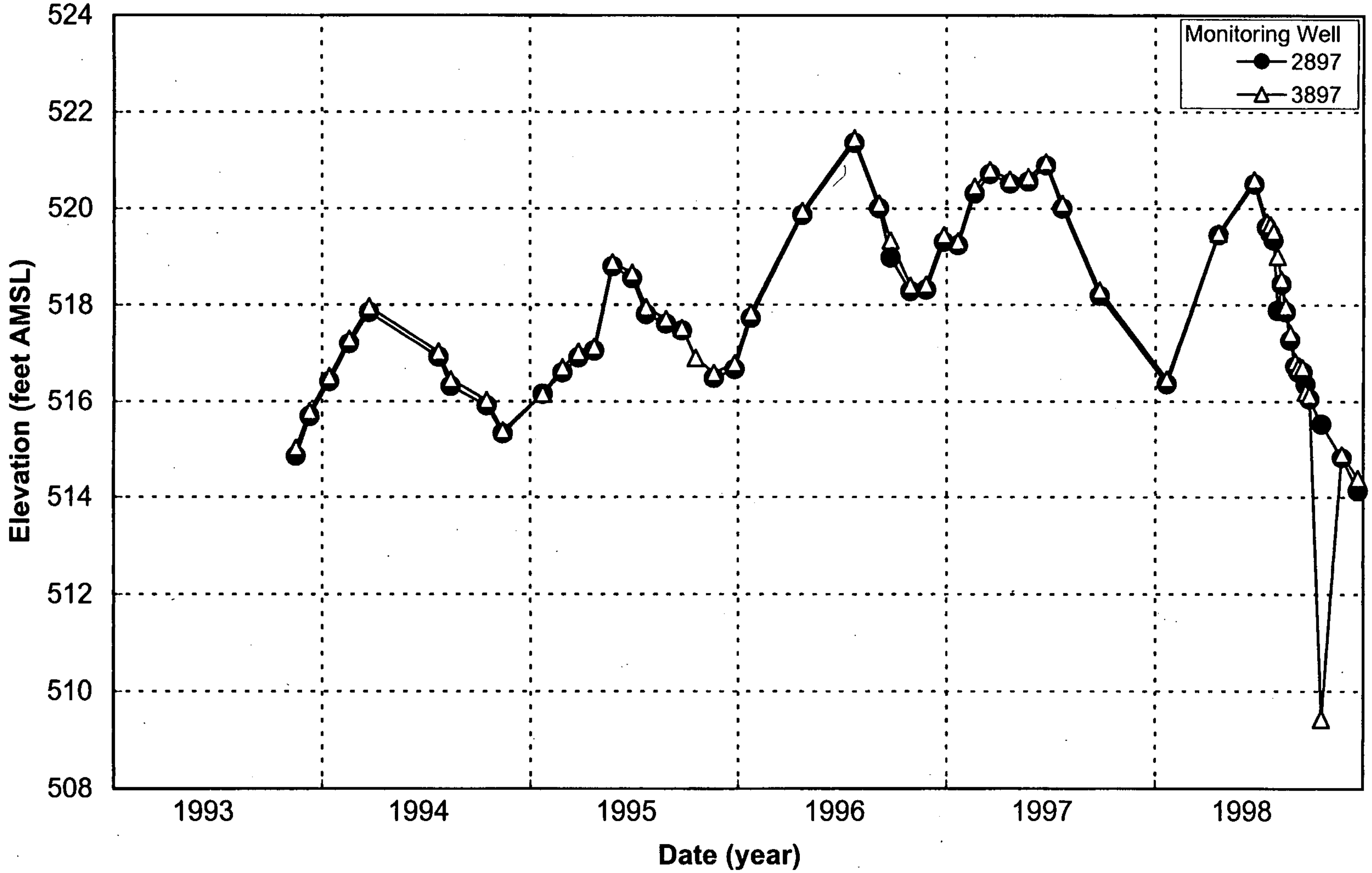

FIGURE A.3-33. HYDROGRAPH FOR WELL CLUSTER 897

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2272

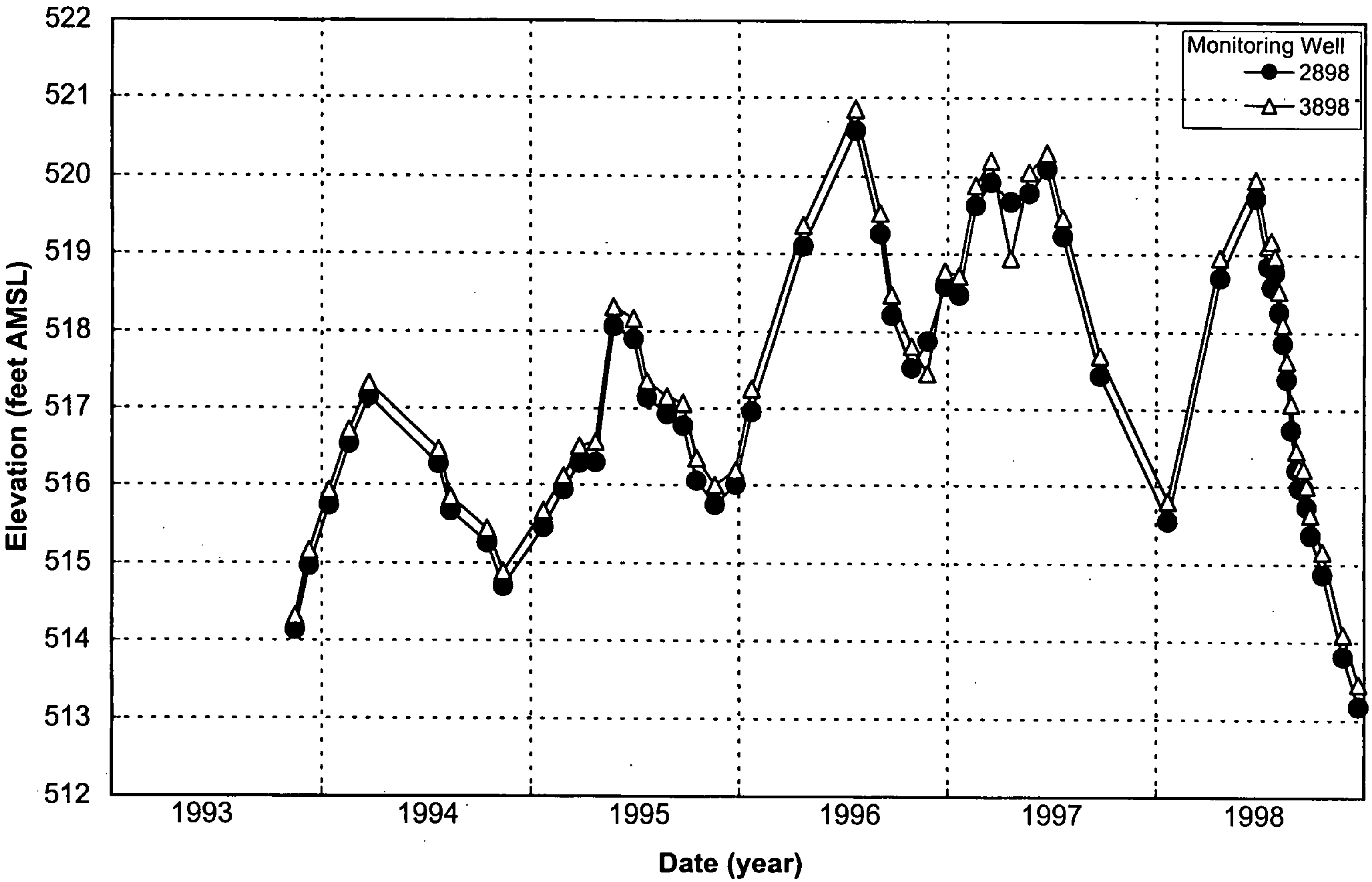

FIGURE A.3-34. HYDROGRAPH FOR WELL CLUSTER 898

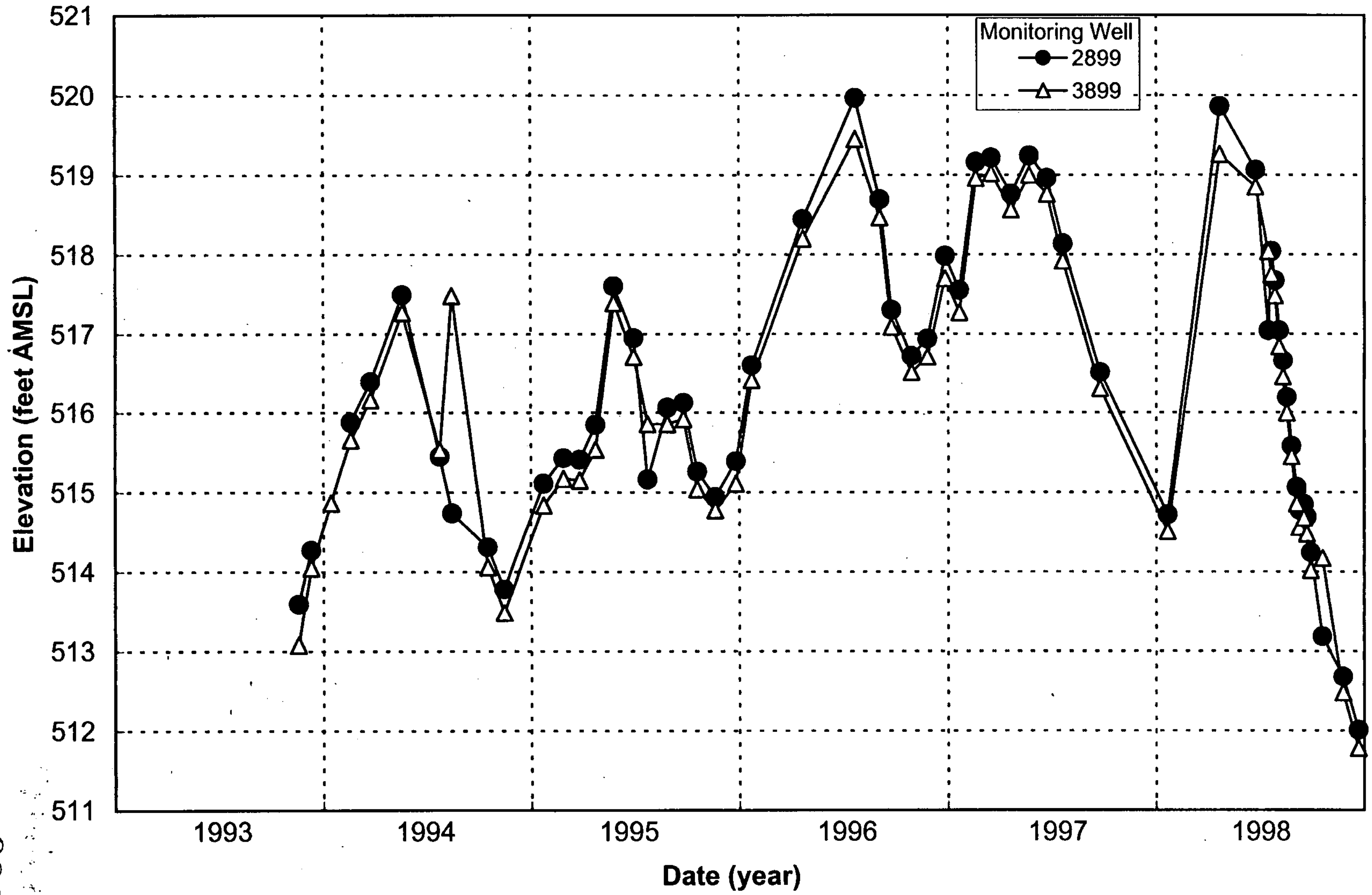

FIGURE A.3-35. HYDROGRAPH FOR WELL CLUSTER 899

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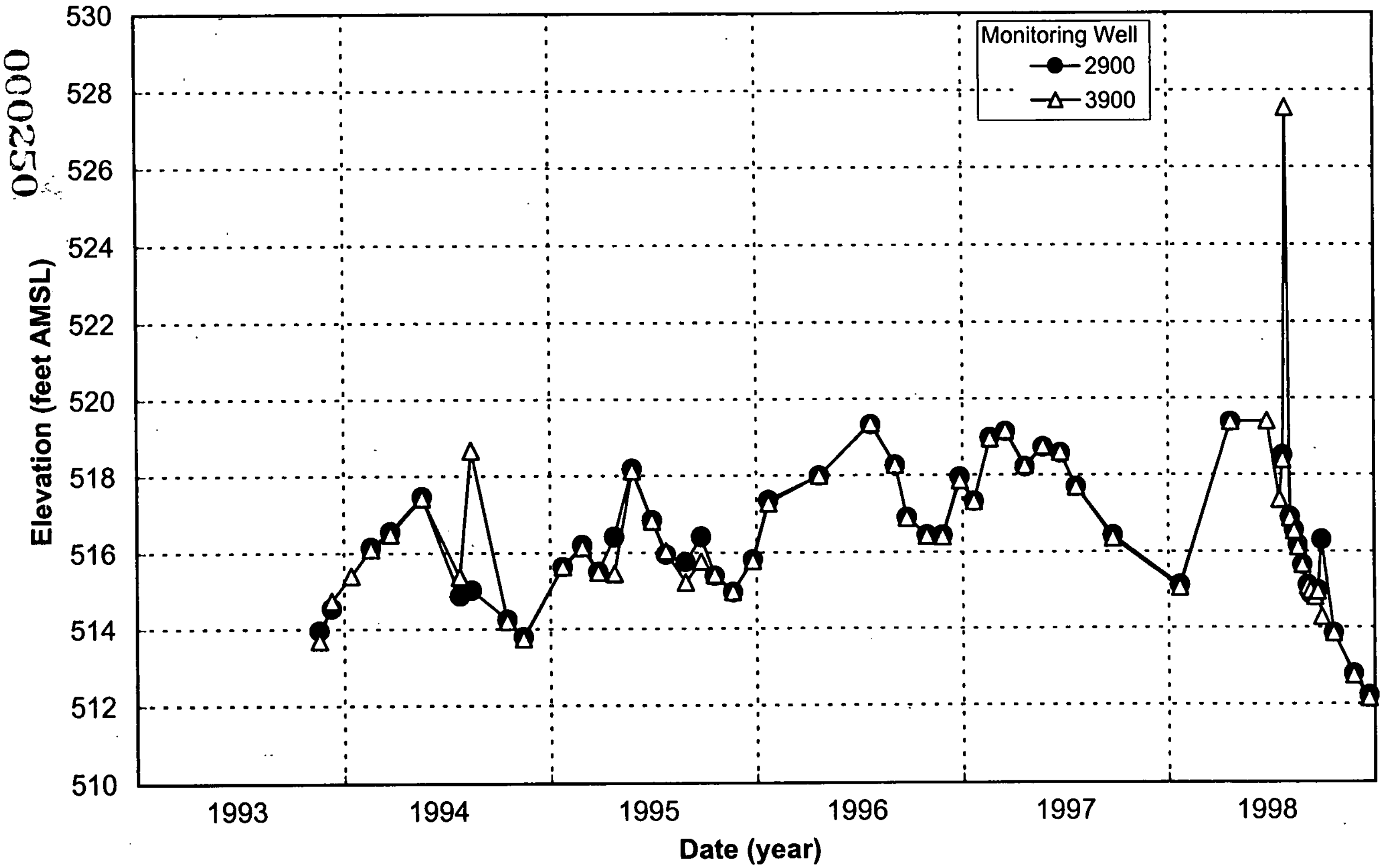
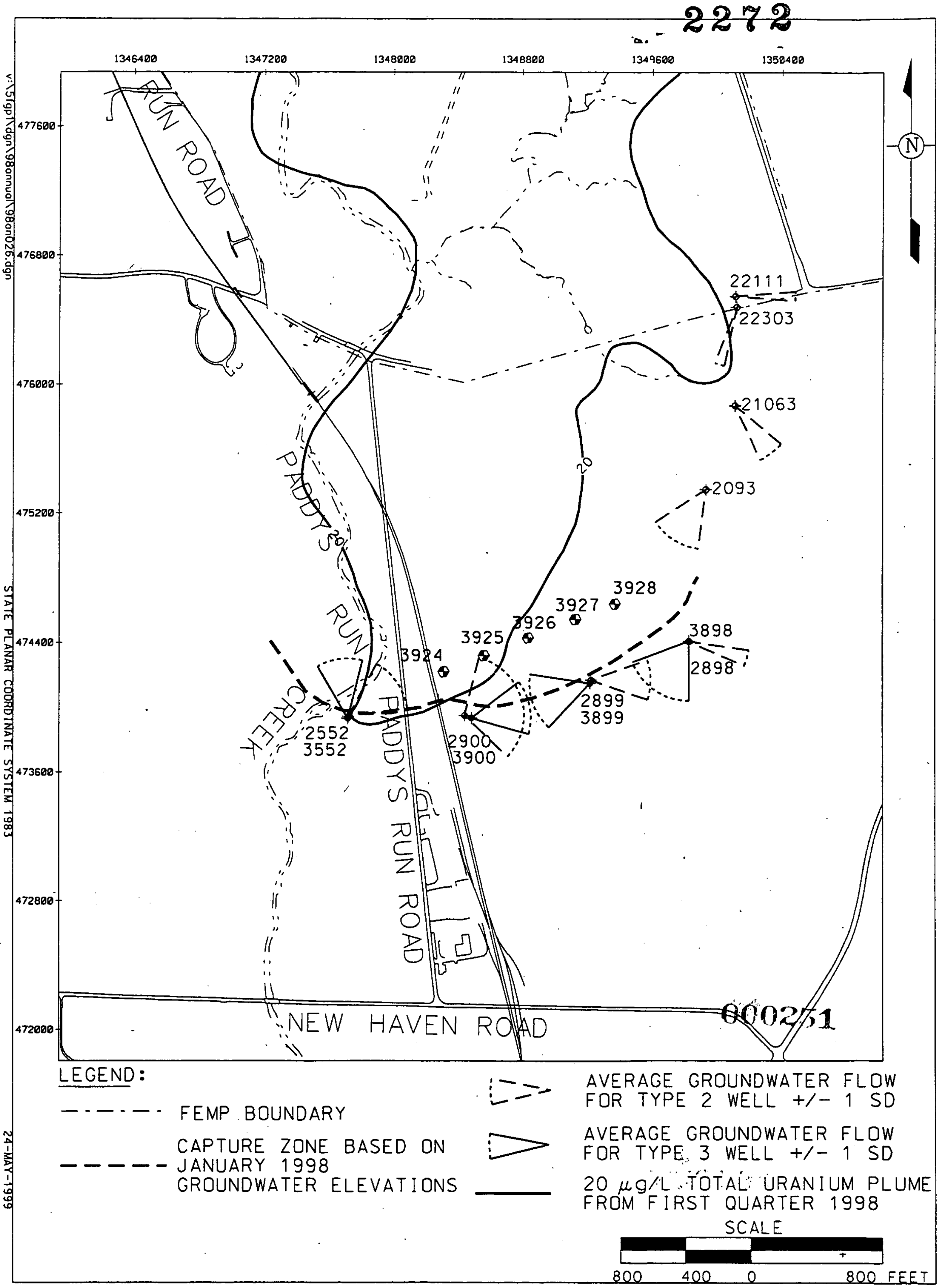


FIGURE A.3-36. HYDROGRAPH FOR WELL CLUSTER 900



000251

FIGURE A.3-37. HYDRAULIC CAPTURE ZONE AND COLLOIDAL BORESCOPE FLOW VECTORS FOR THE SOUTH PLUME EXTRACTION SYSTEM, FIRST QUARTER 1998

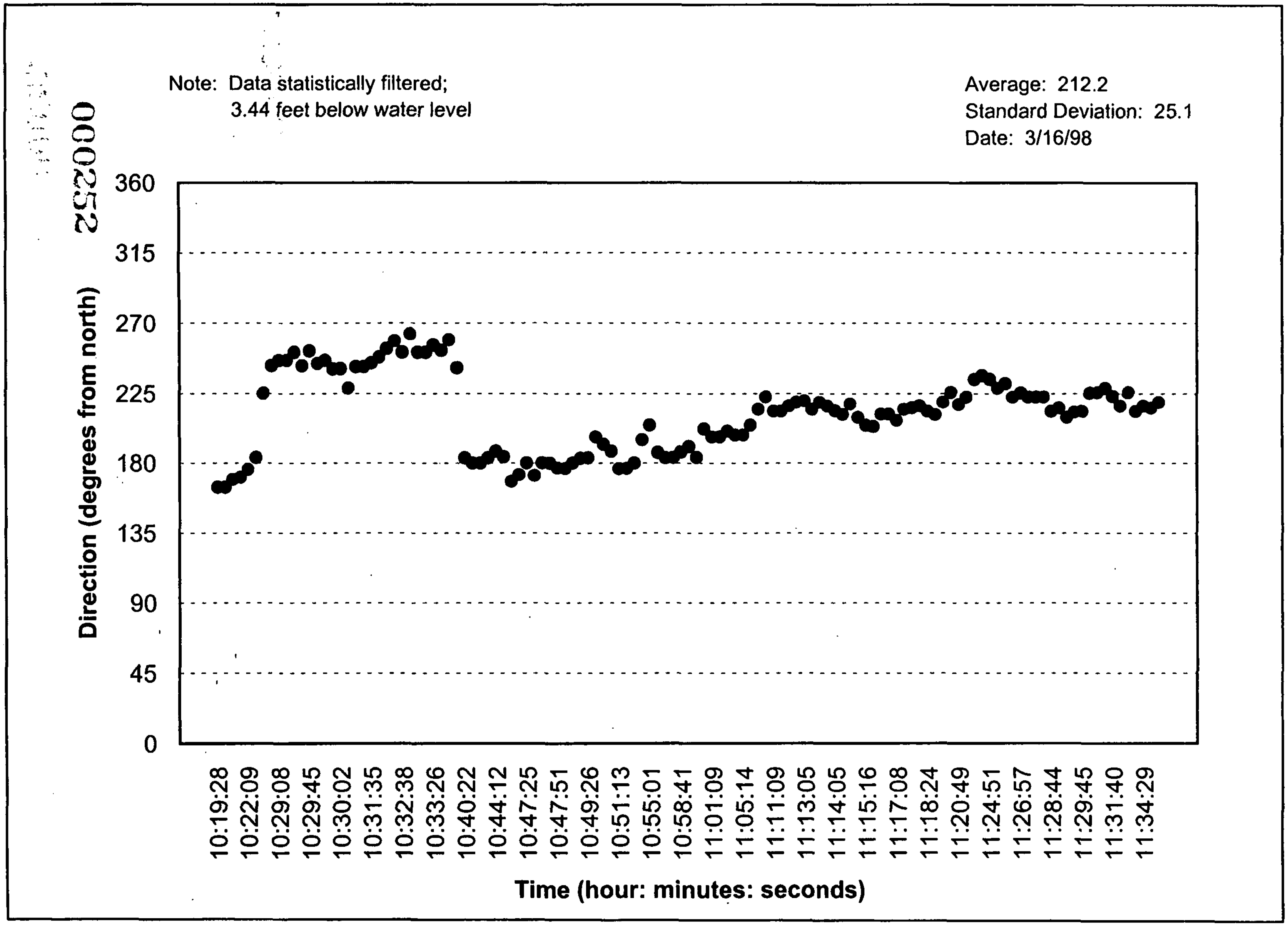


FIGURE A.3-38. FIRST QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2093 USING COLLOIDAL BORESCOPE

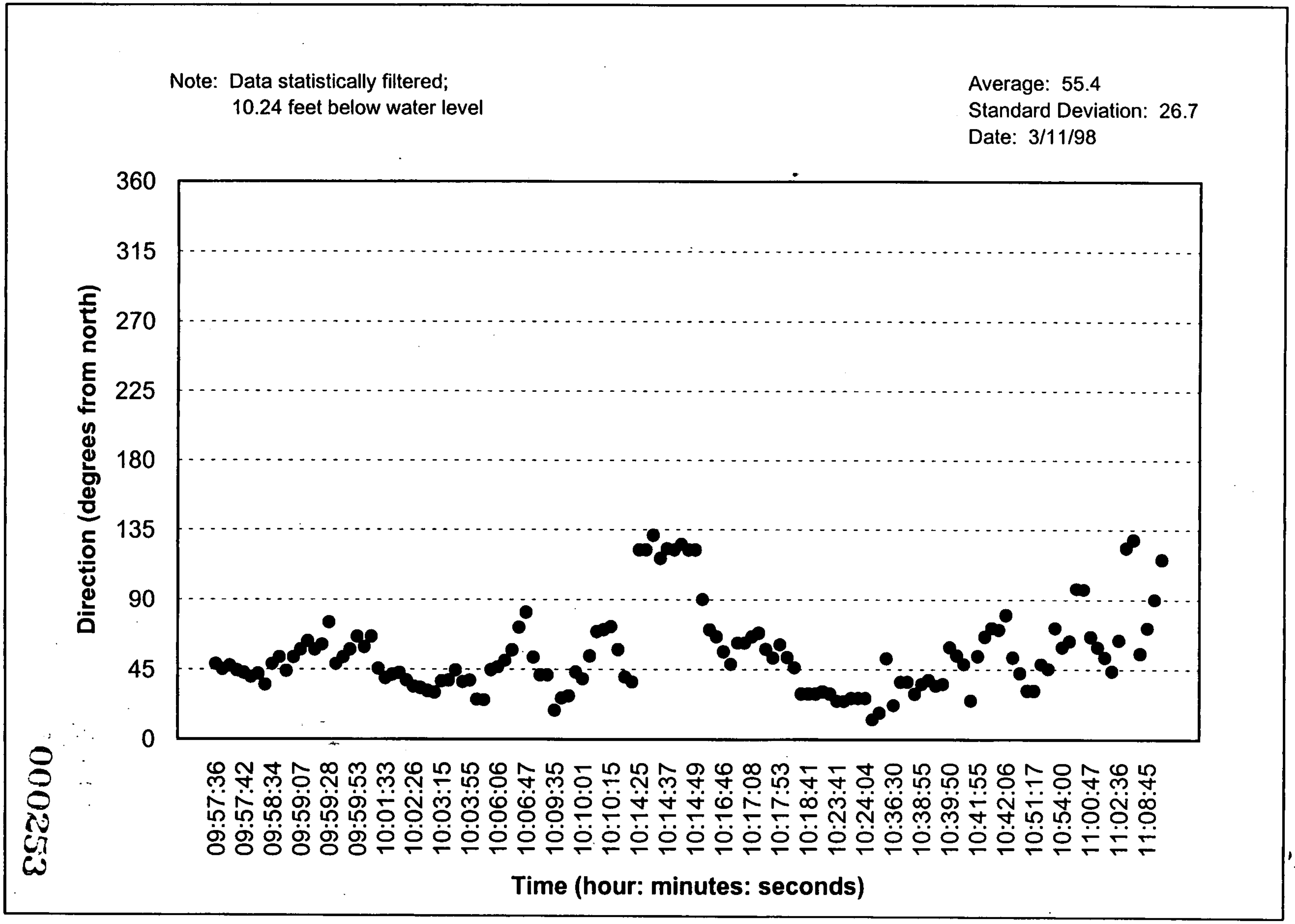


FIGURE A.3-39. FIRST QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2552 USING COLLOIDAL BORESCOPE

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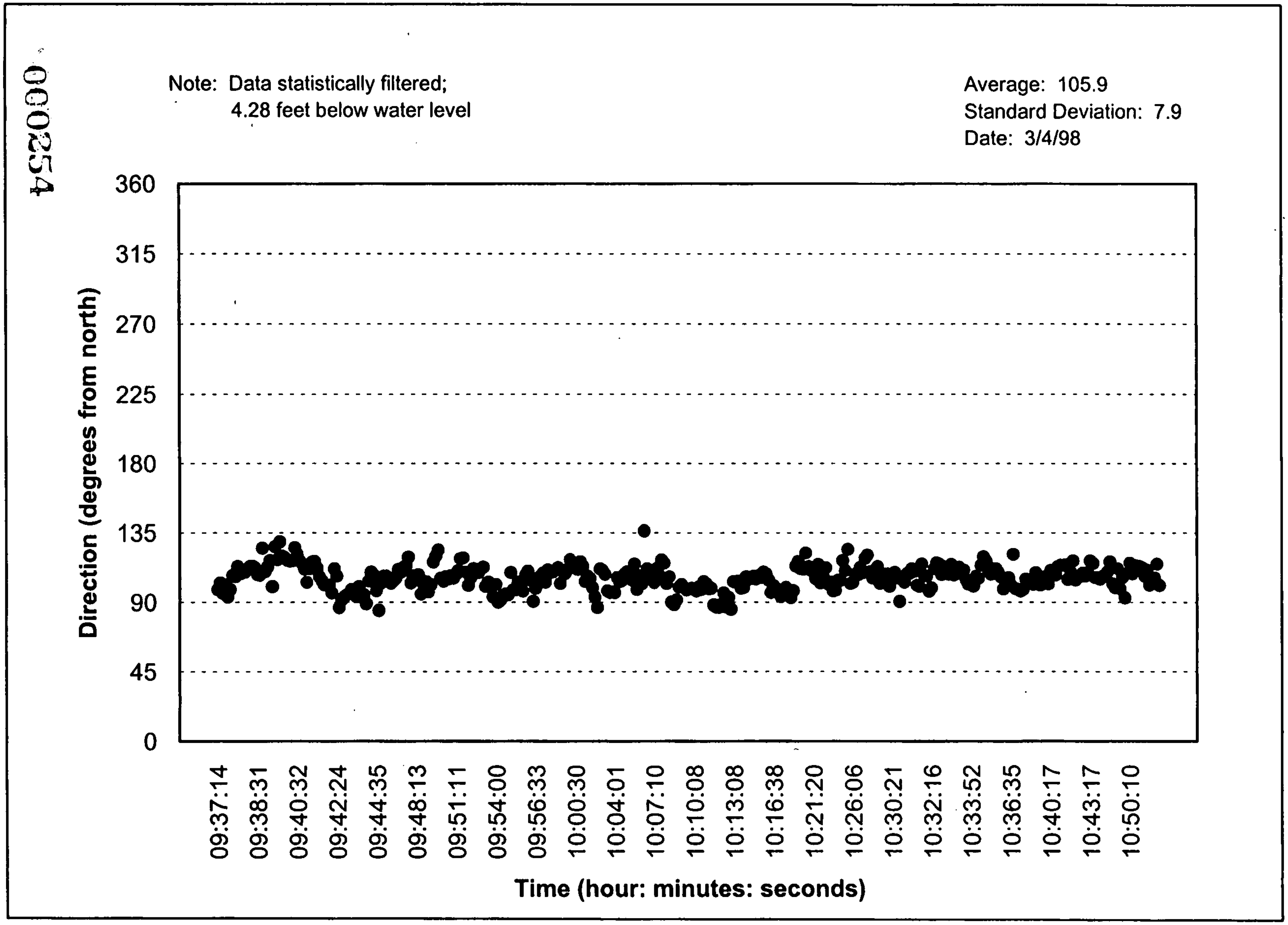

FIGURE A.3-40. FIRST QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2898 USING COLLOIDAL BORESCOPE

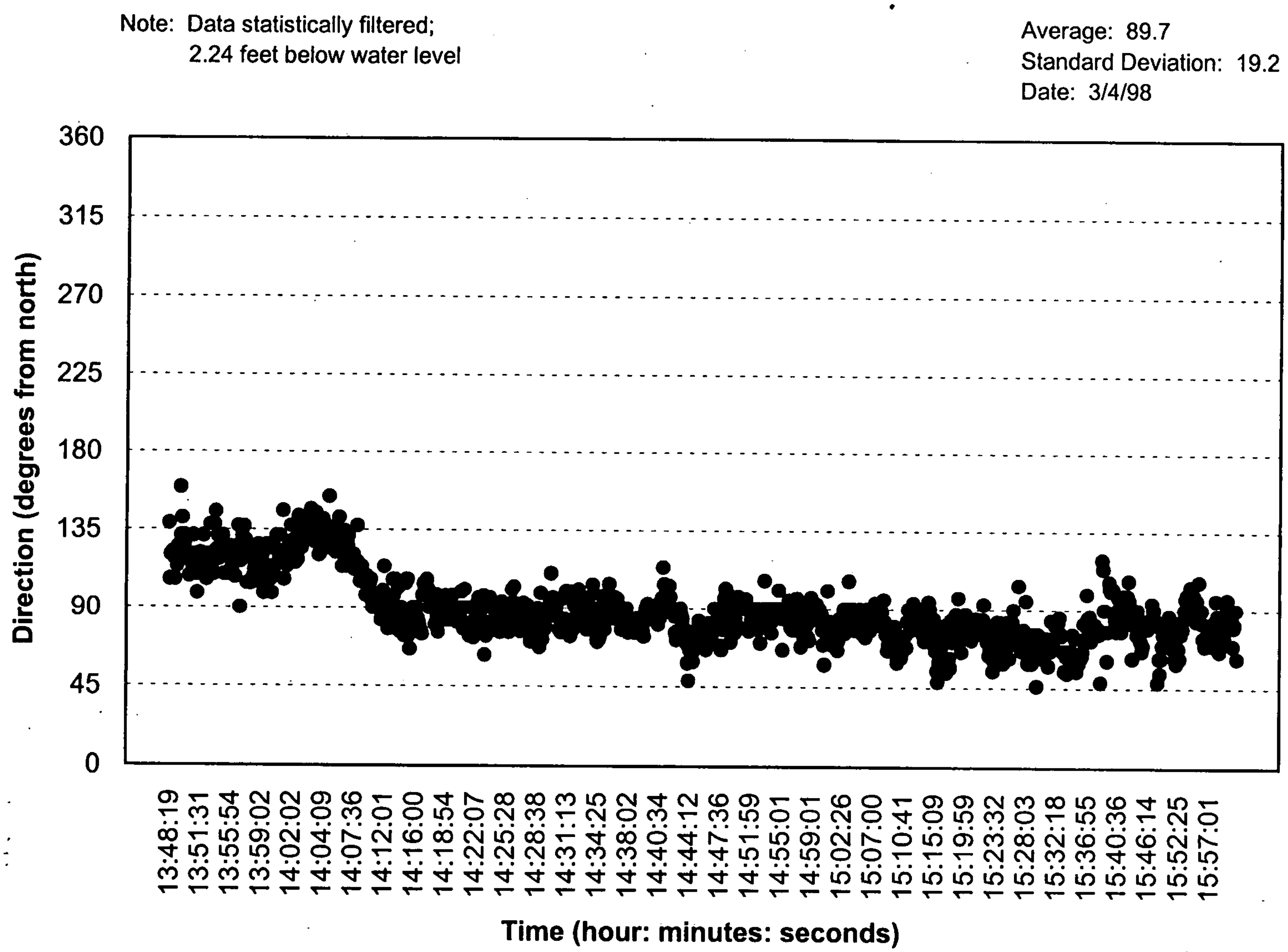

FIGURE A.3-41. FIRST QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2899 USING COLLOIDAL BORESCOPE

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0C0256

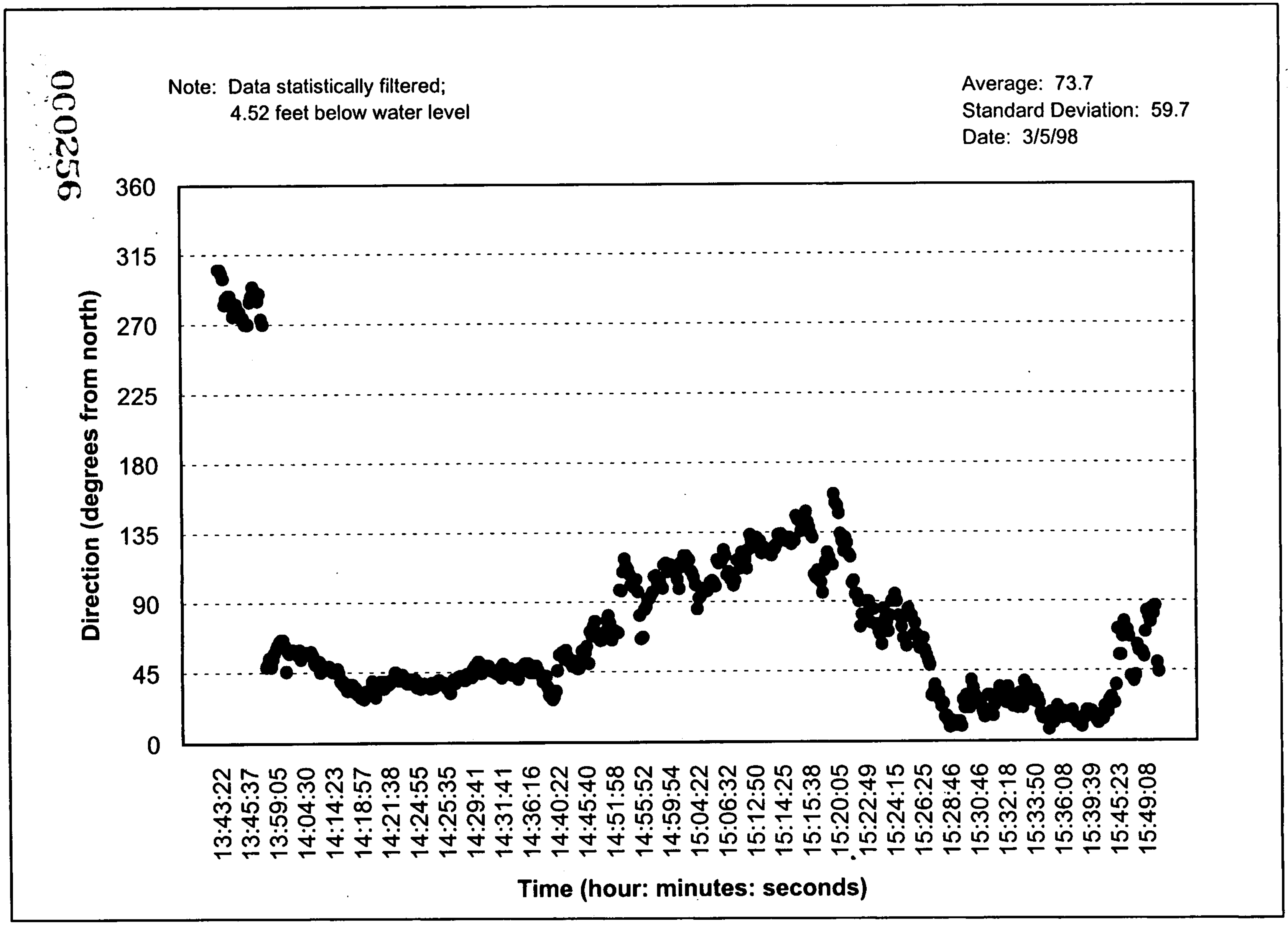

FIGURE A.3-42. FIRST QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2900 USING COLLOIDAL BORESCOPE

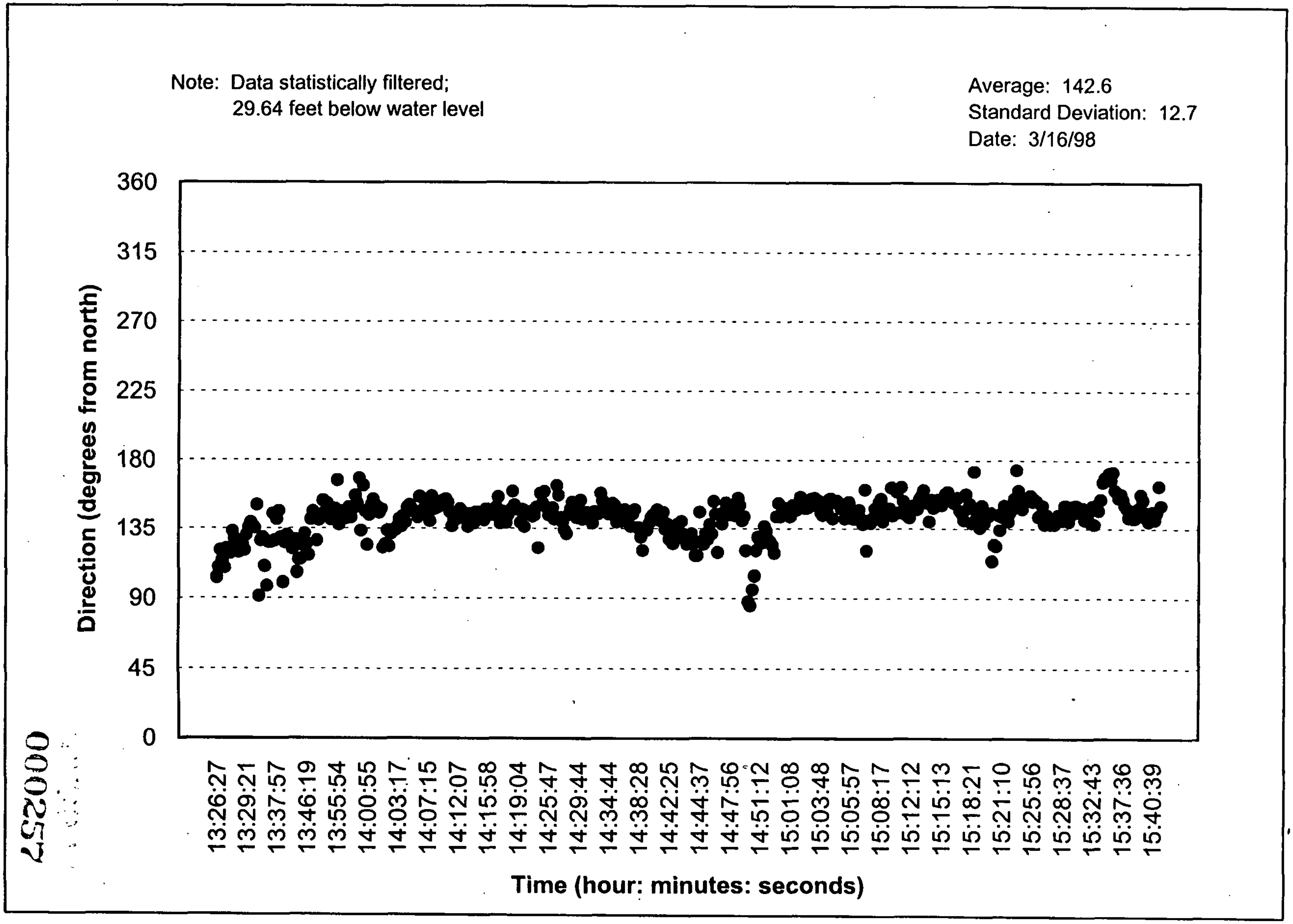

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FIGURE A.3-43. FIRST QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 21063 USING COLLOIDAL BORESCOPE

2272

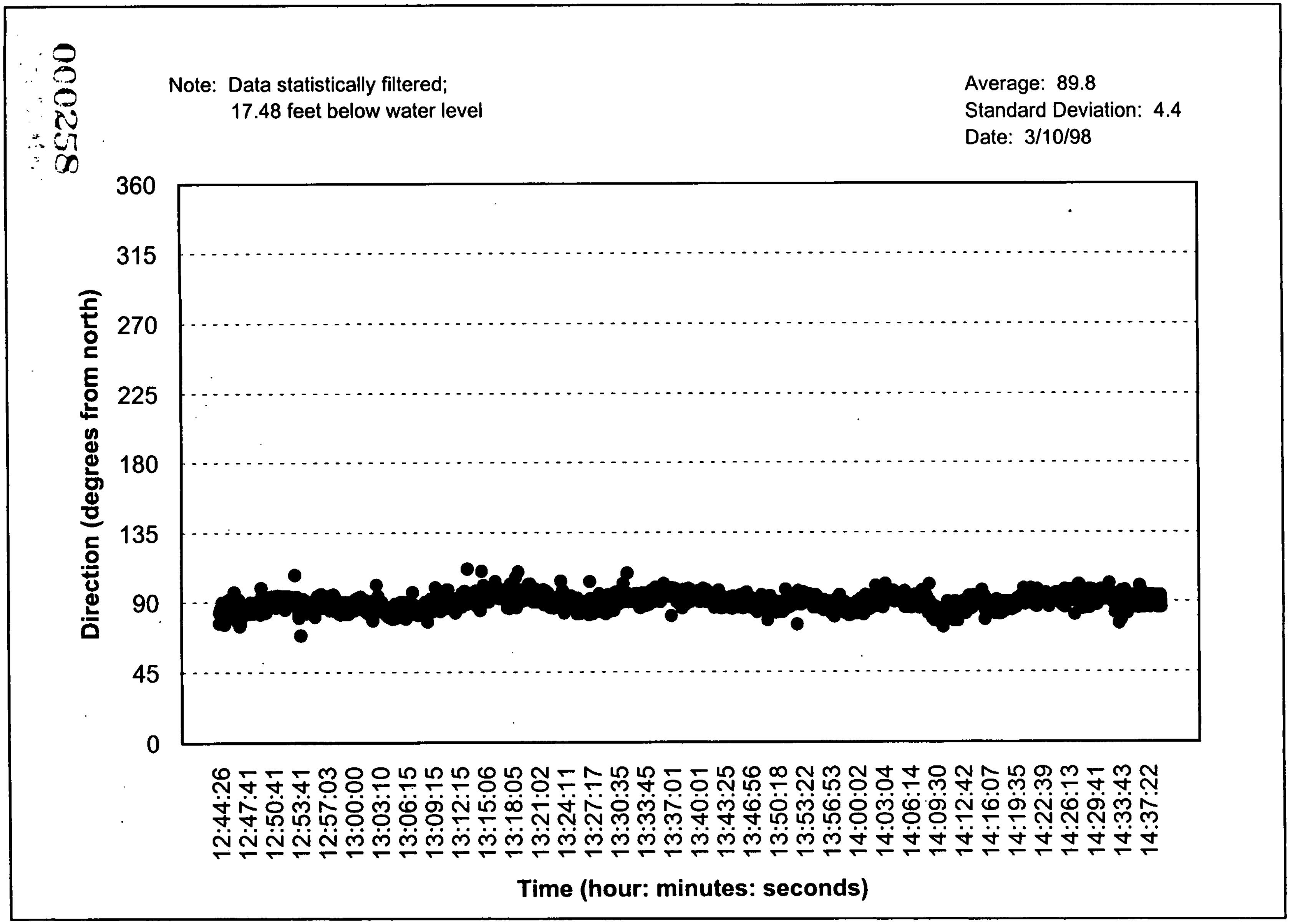


FIGURE A.3-44. FIRST QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 22111 USING COLLOIDAL BORESCOPE

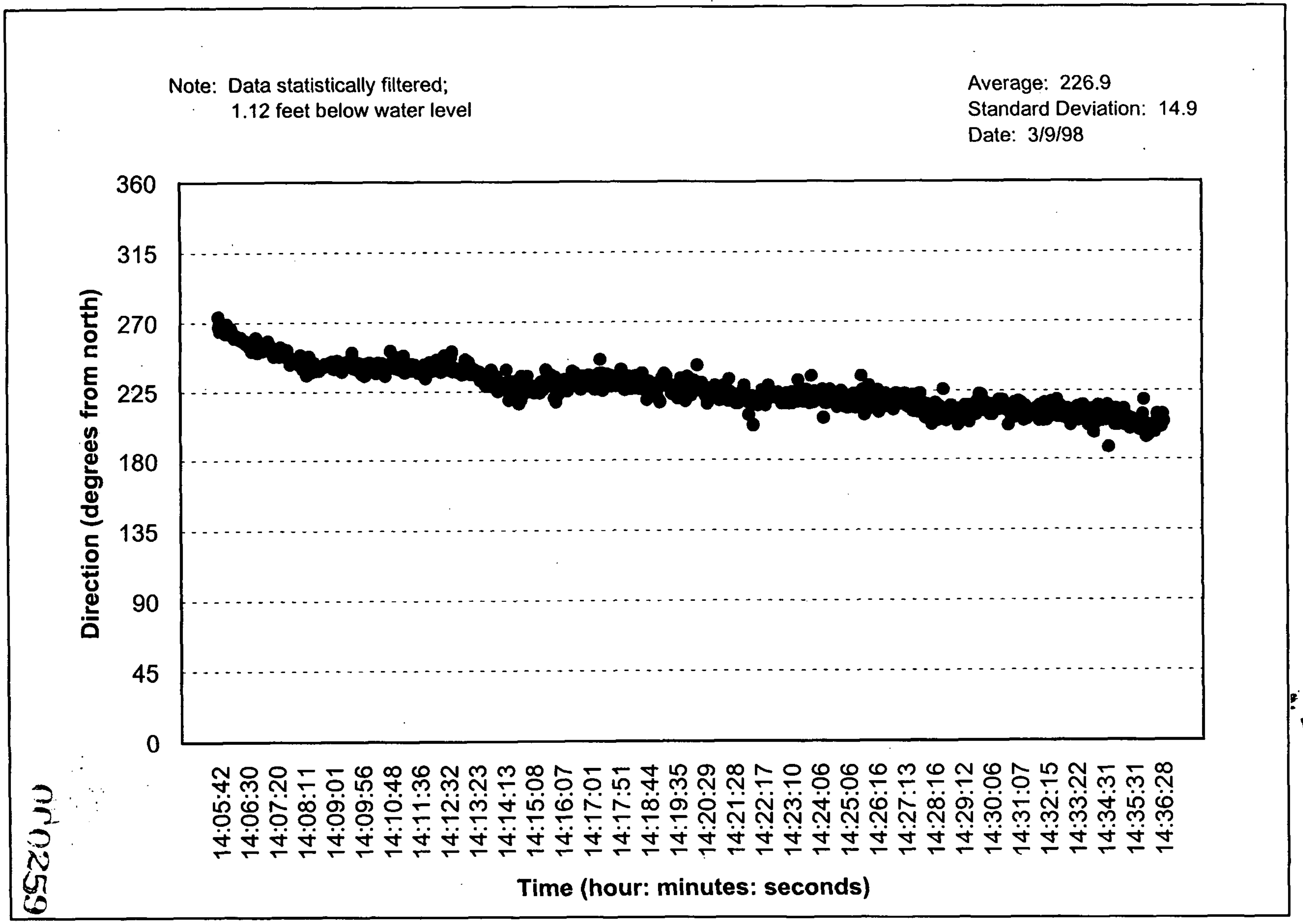


FIGURE A.3-45. FIRST QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 22303 USING COLLOIDAL BORESCOPE (2:05 TO 2:36 P.M.)

2272

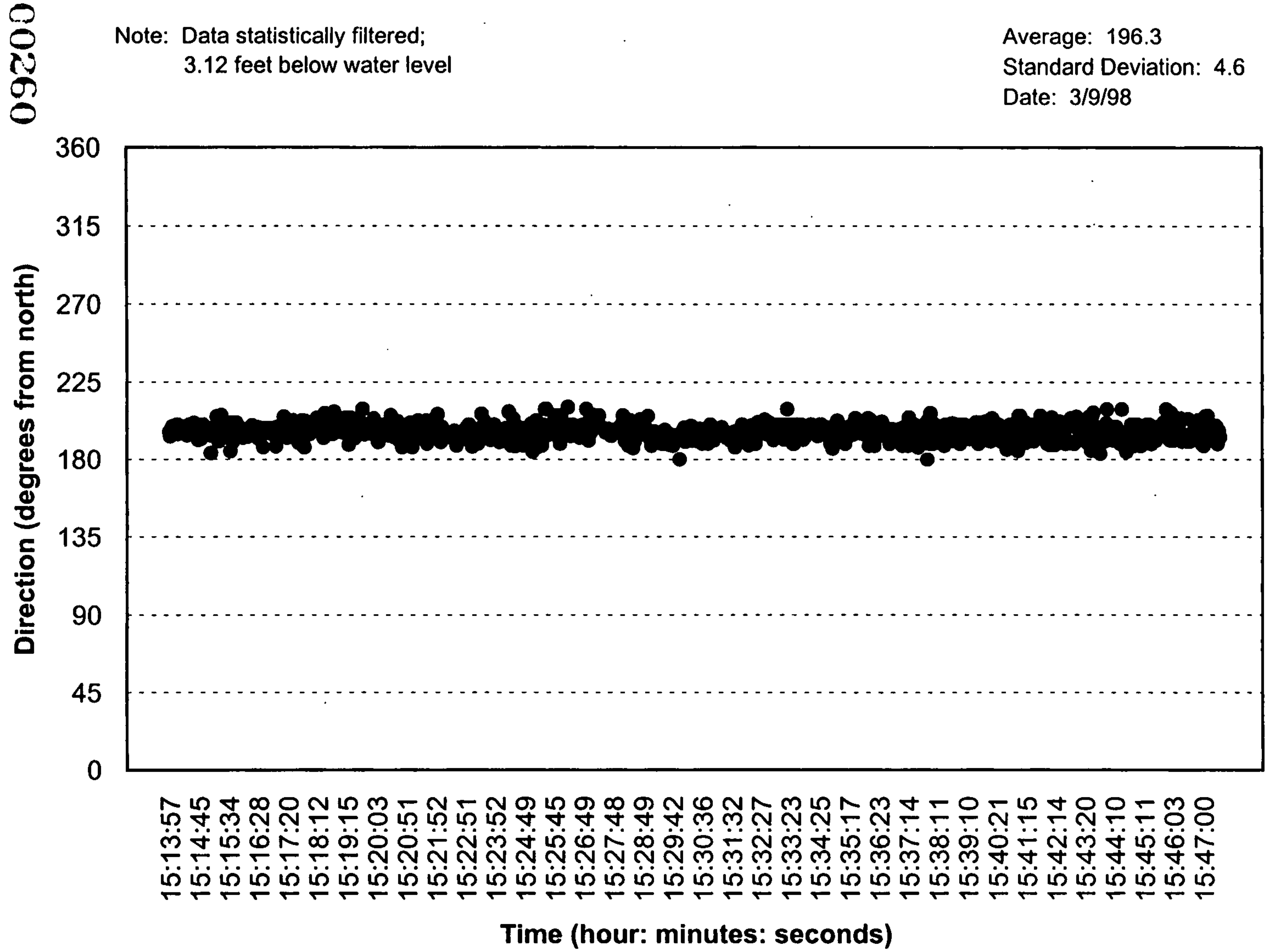


FIGURE A.3-46. FIRST QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 22303 USING COLLOIDAL BORESCOPE (3:13 TO 3:47 P.M.)

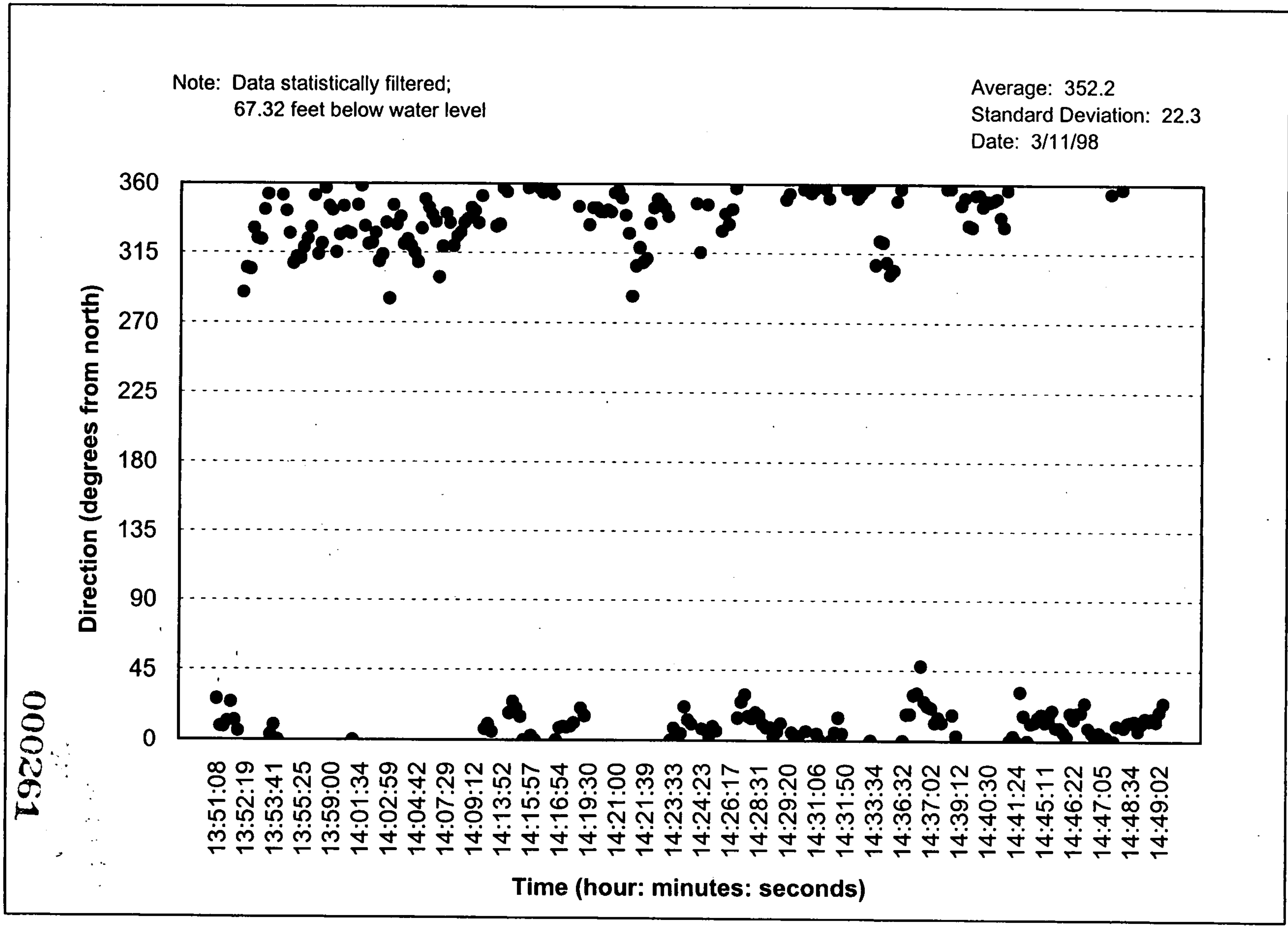


FIGURE A.3-47. FIRST QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 3552 USING COLLOIDAL BORESCOPE

000261

2272

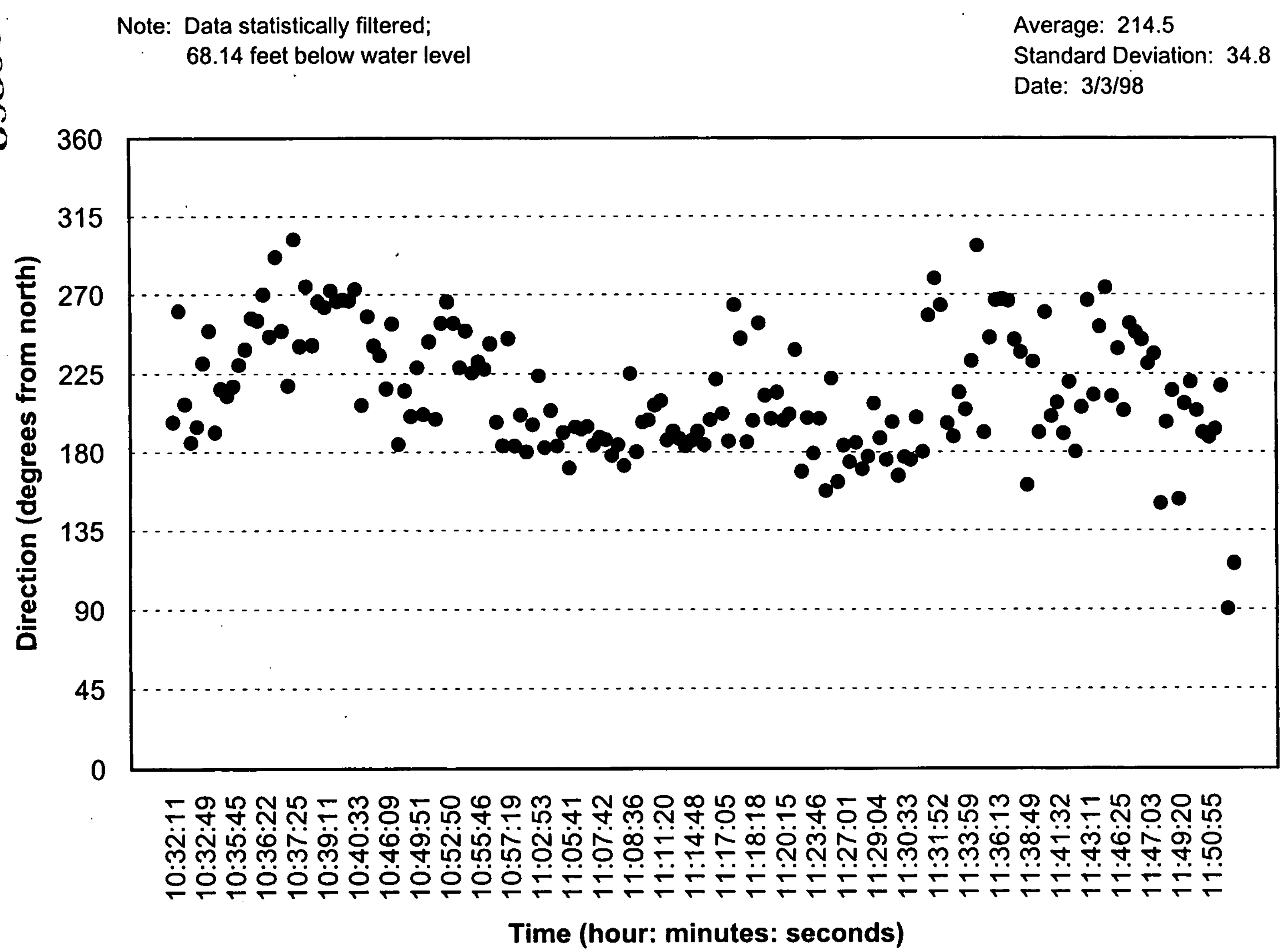


FIGURE A.3-48. FIRST QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 3898 USING COLLOIDAL BORESCOPE

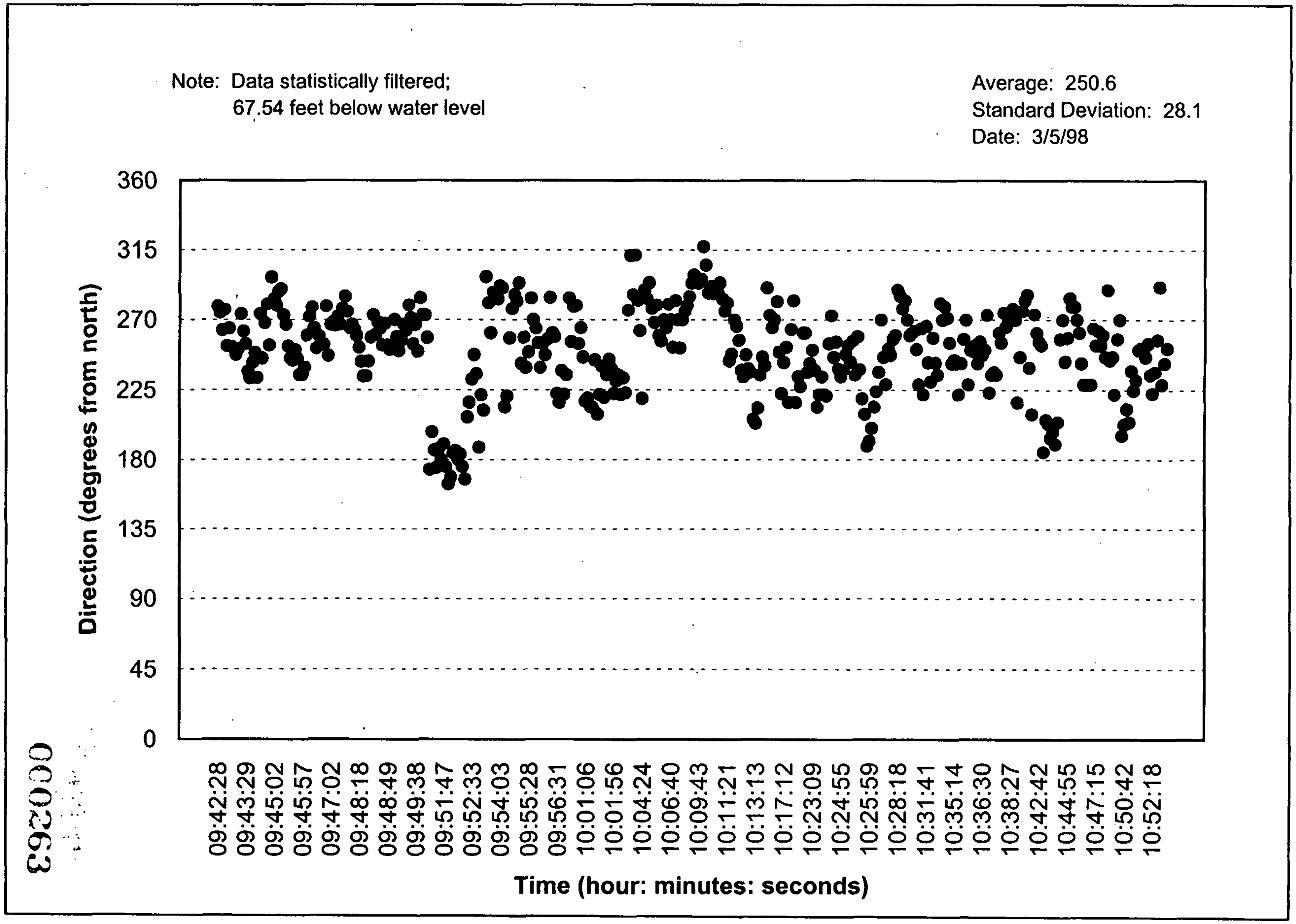


FIGURE A.3-49. FIRST QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 3899 USING COLLOIDAL BORESCOPE

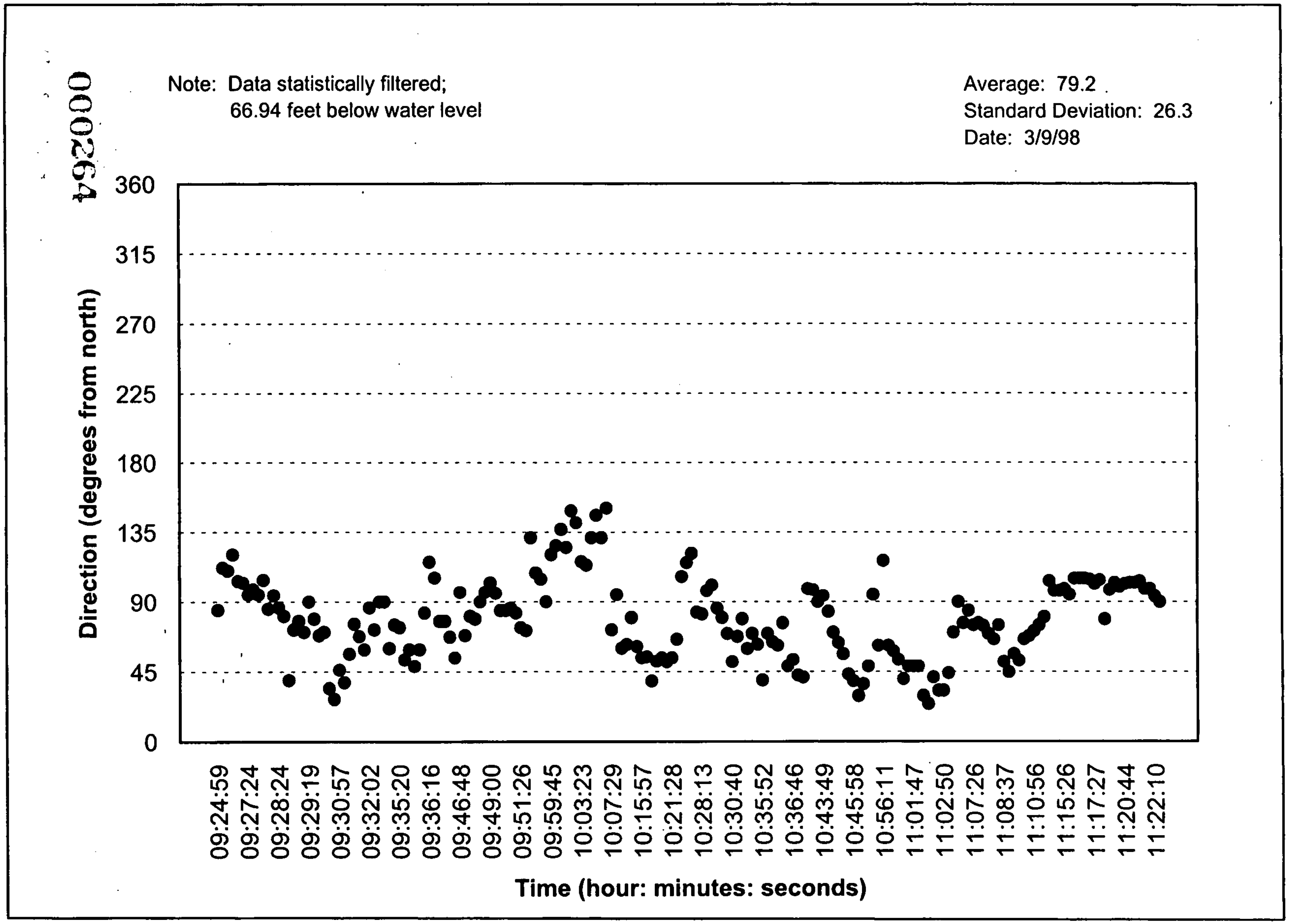
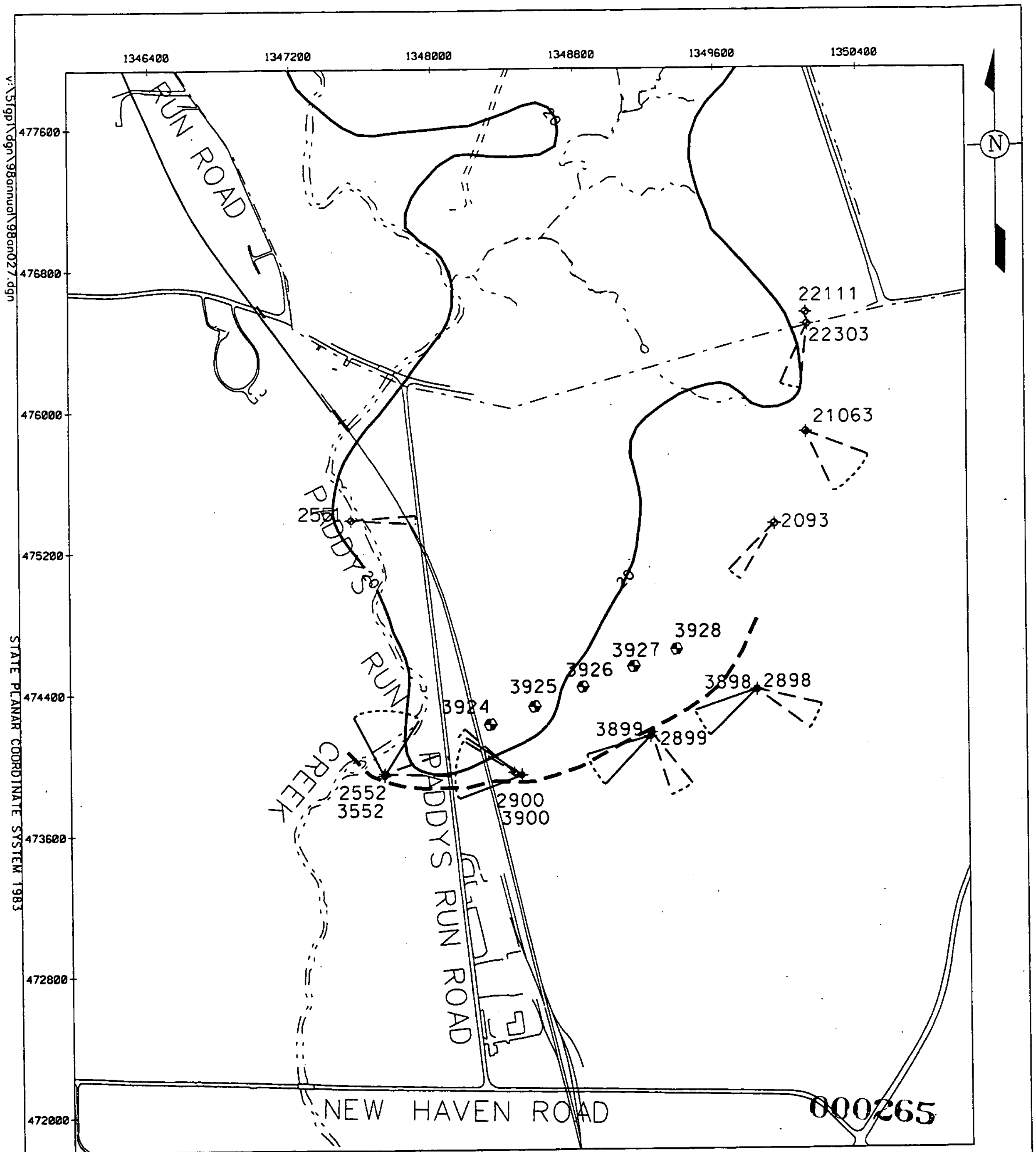


FIGURE A.3-50. FIRST QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 3900 USING COLLOIDAL BORESCOPE



LEGEND:

FEMP BOUNDARY

CAPTURE ZONE BASED ON APRIL 1998 GROUNDWATER ELEVATIONS

AVERAGE GROUNDWATER FLOW FOR TYPE 2 WELL +/- 1 SD

AVERAGE GROUNDWATER FLOW FOR TYPE 3 WELL +/- 1 SD

20 $\mu g/L$ TOTAL URANIUM PLUME FROM SECOND QUARTER 1998

SCALE

800 400 0 800 FEET

FIGURE A.3-51. HYDRAULIC CAPTURE ZONE AND COLLOIDAL BORESCOPE FLOW VECTORS FOR THE SOUTH PLUME EXTRACTION MODULE, SECOND QUARTER 1998

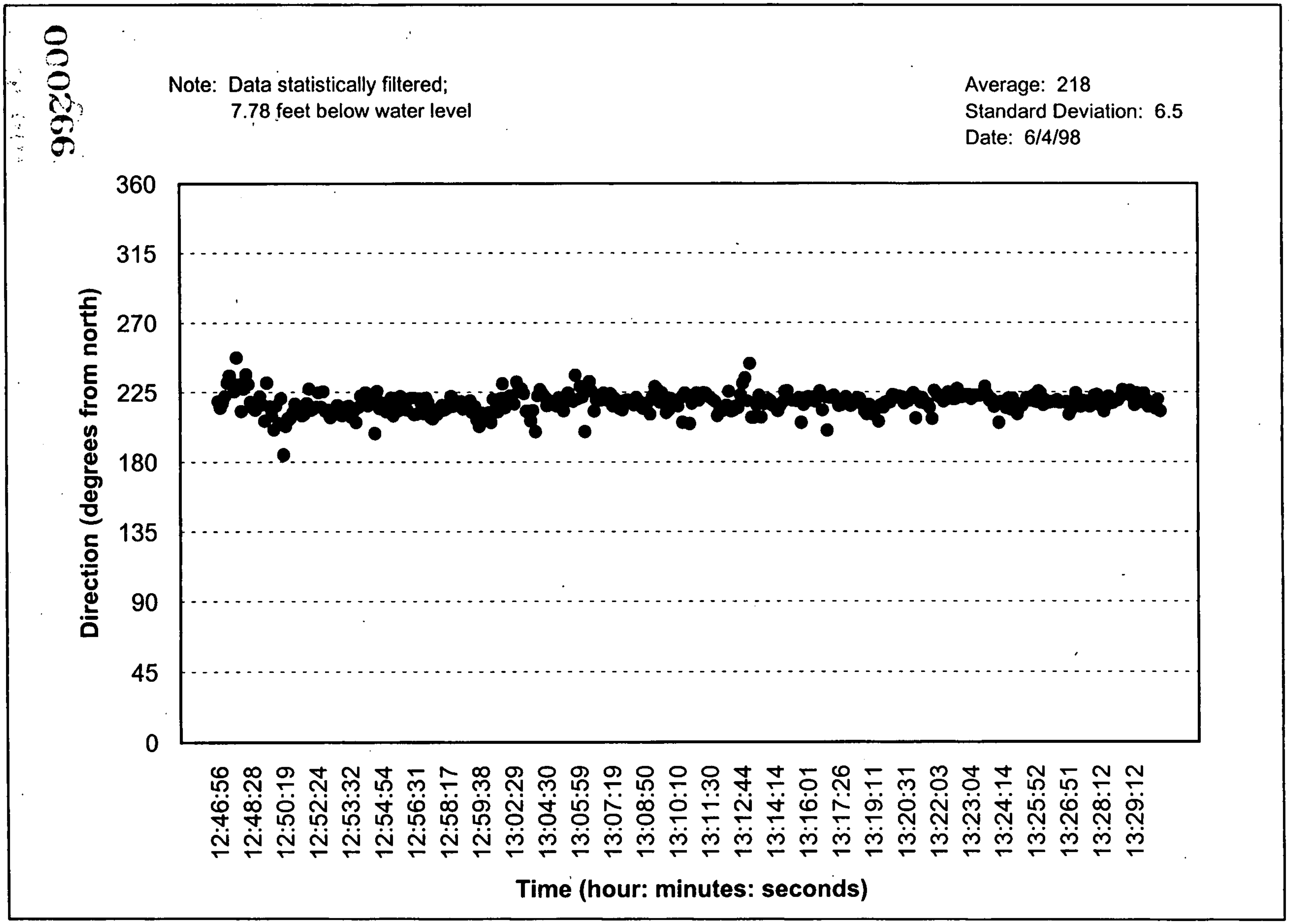


FIGURE A.3-52. SECOND QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2093 USING COLLOIDAL BORESCOPE

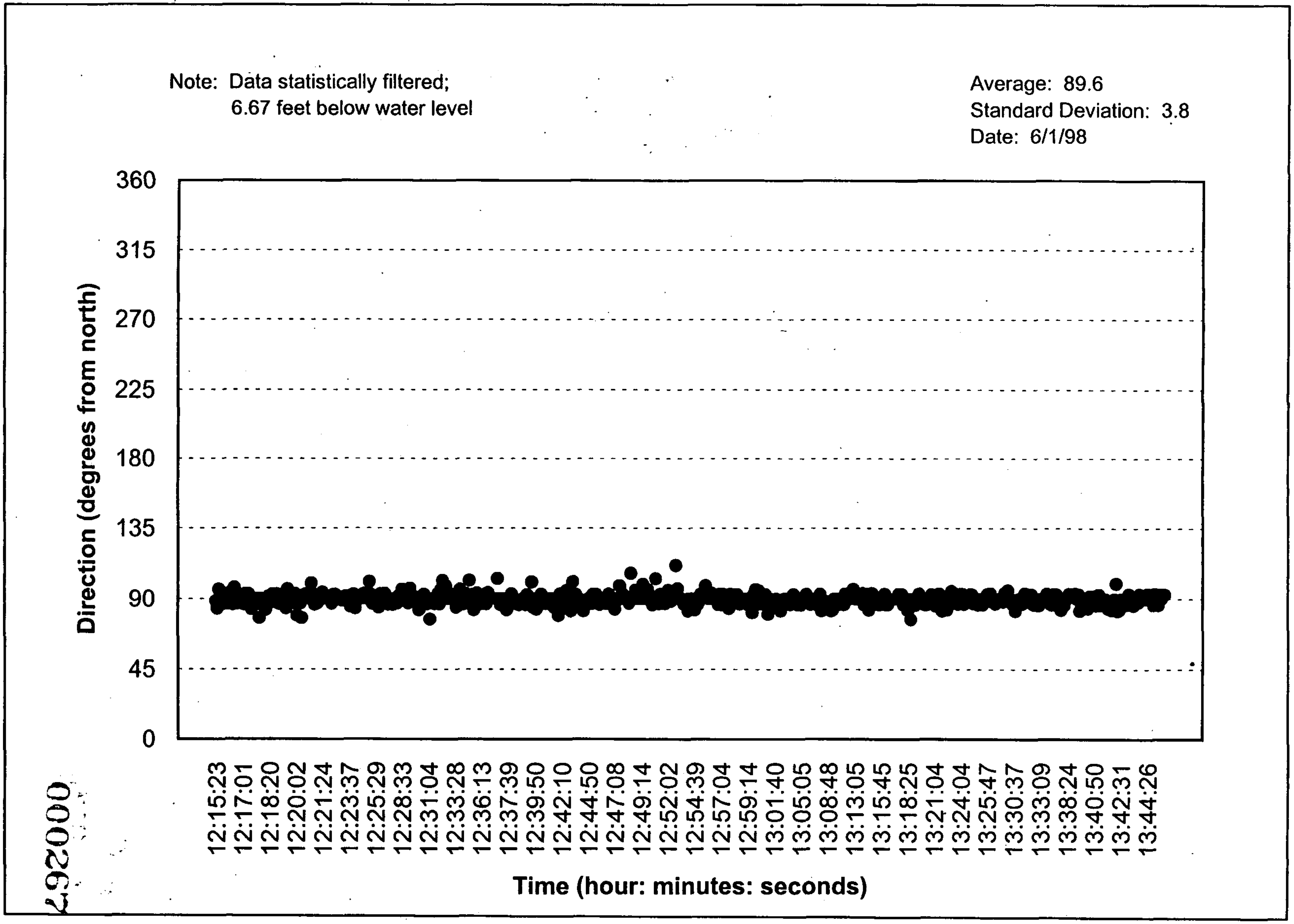


FIGURE A.3-53. SECOND QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2551 USING COLLOIDAL BORESCOPE

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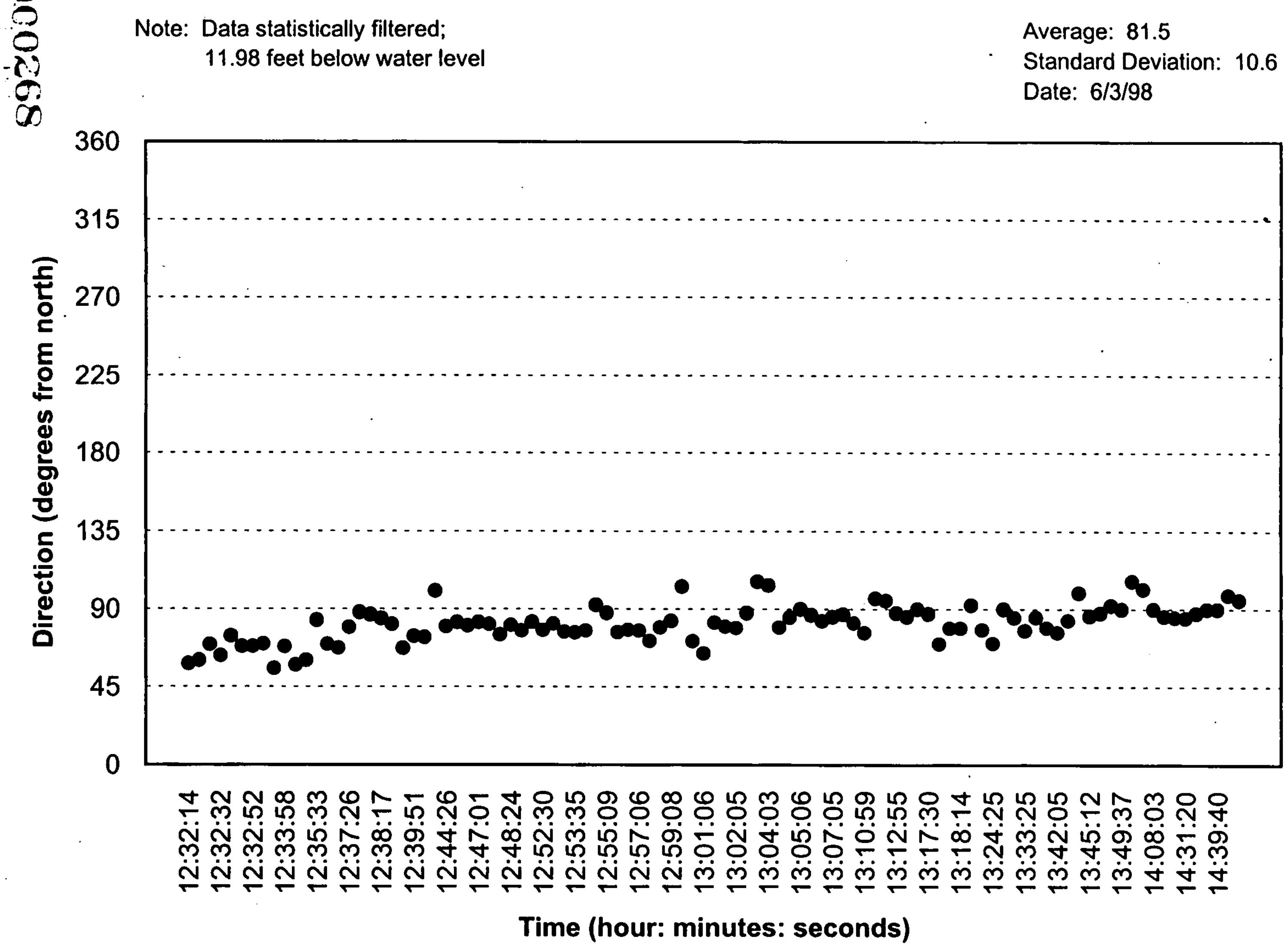

FIGURE A.3-54. SECOND QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2552 USING COLLOIDAL BORESCOPE

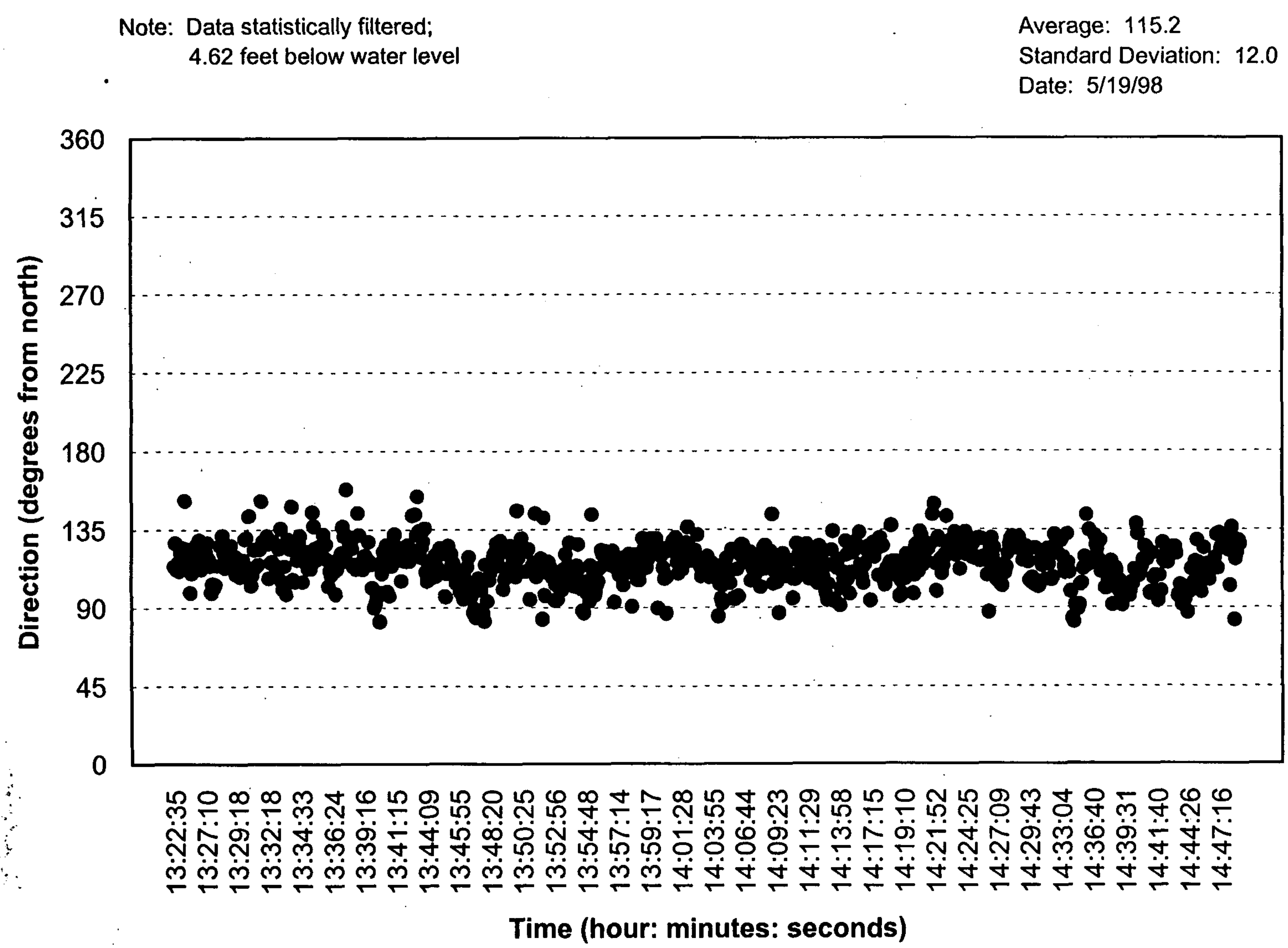

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FIGURE A.3-55. SECOND QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2898 USING COLLOIDAL BORESCOPE

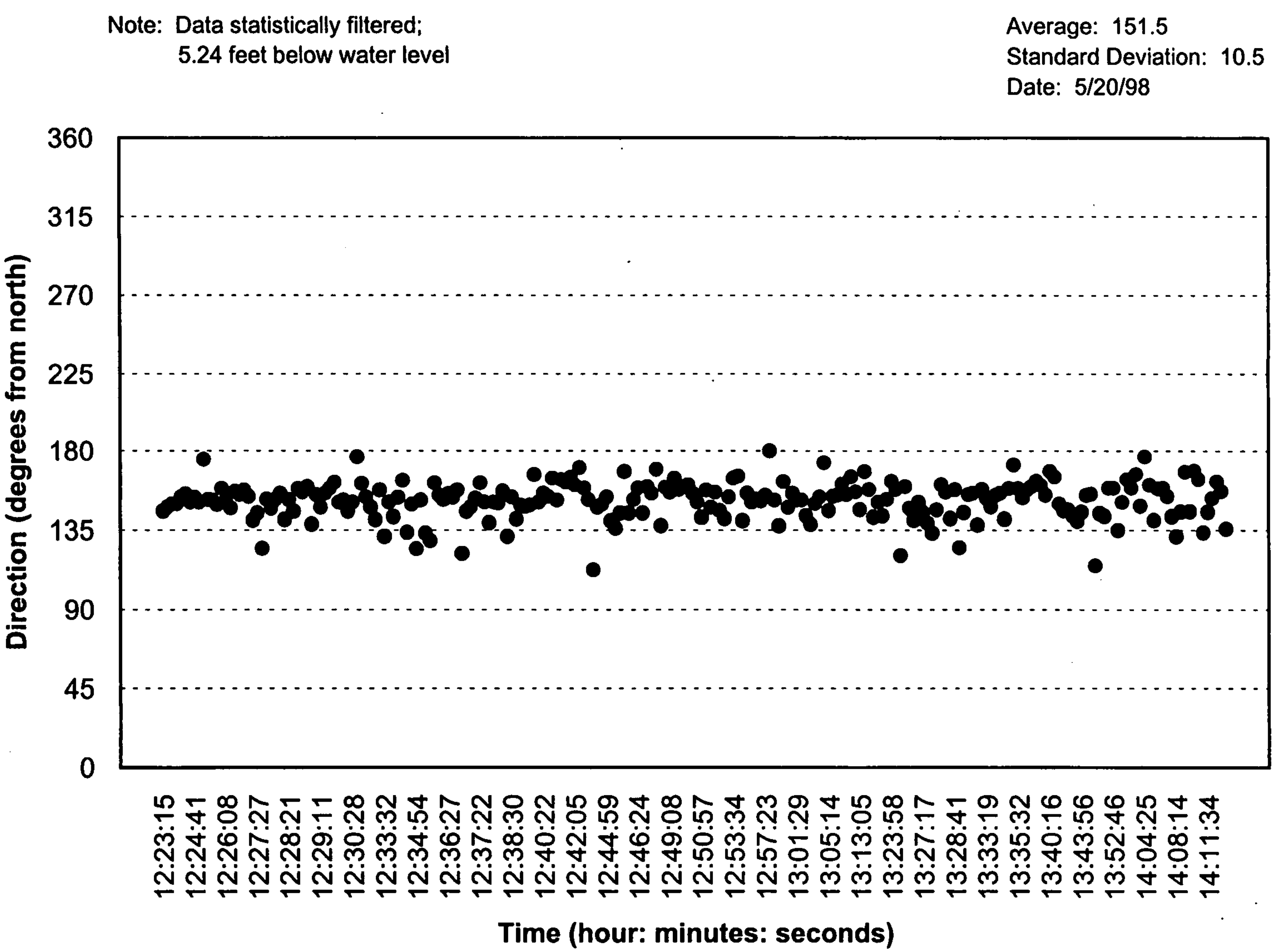

FIGURE A.3-56. SECOND QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2899 USING COLLOIDAL BORESCOPE

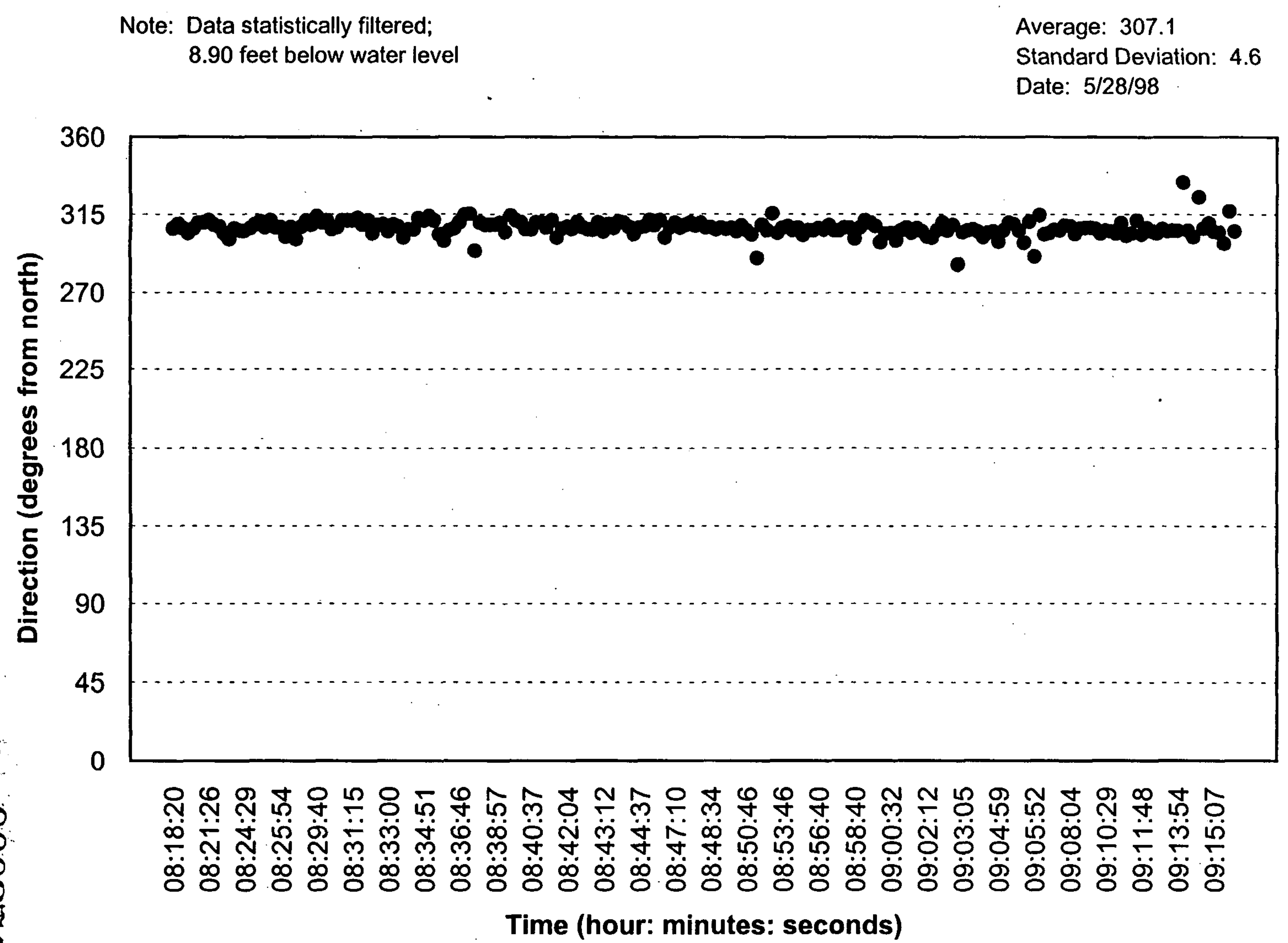

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FIGURE A.3-57. SECOND QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2900 USING COLLOIDAL BORESCOPE

2272

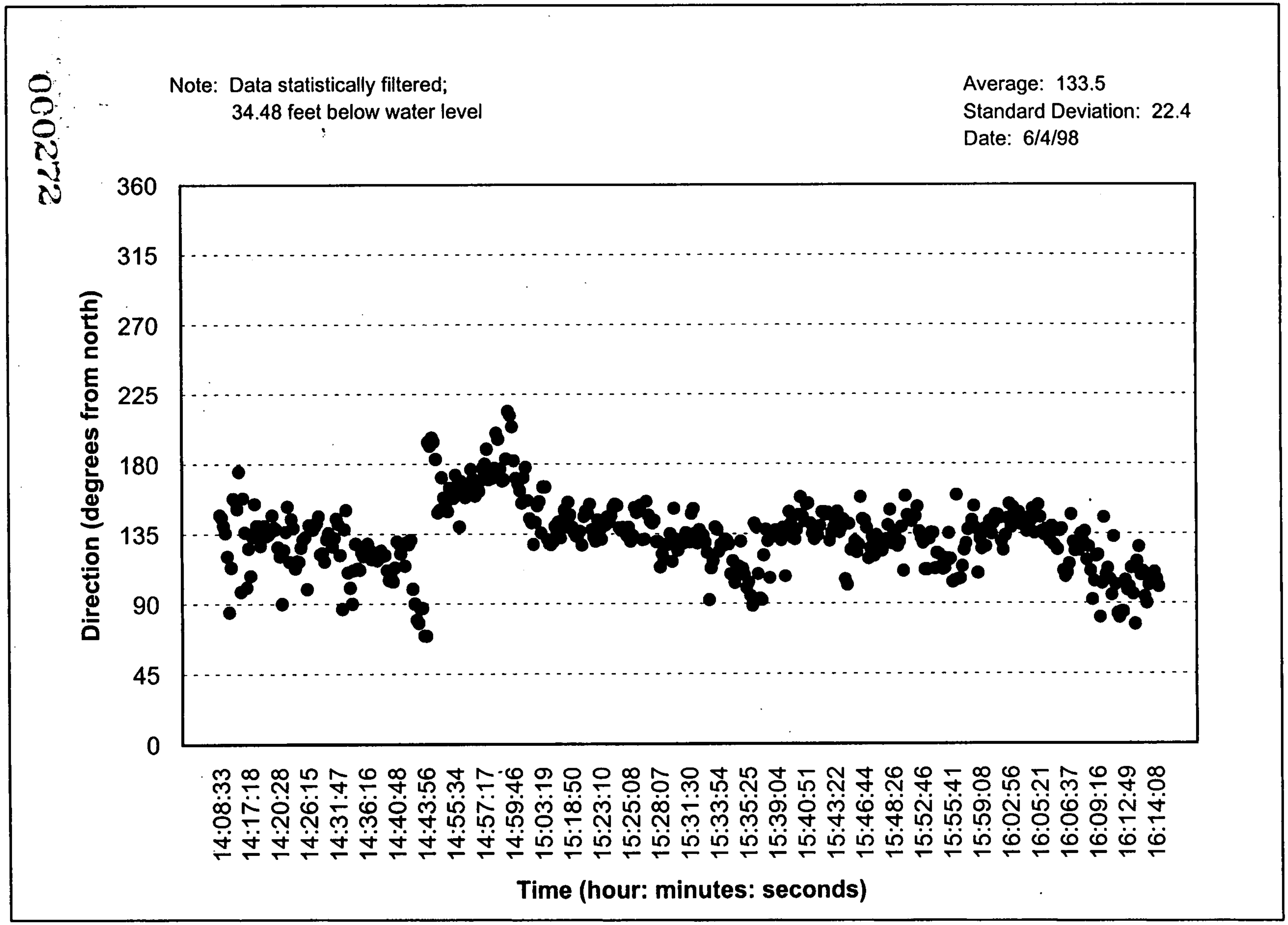

FIGURE A.3-58. SECOND QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 21063 USING COLLOIDAL BORESCOPE

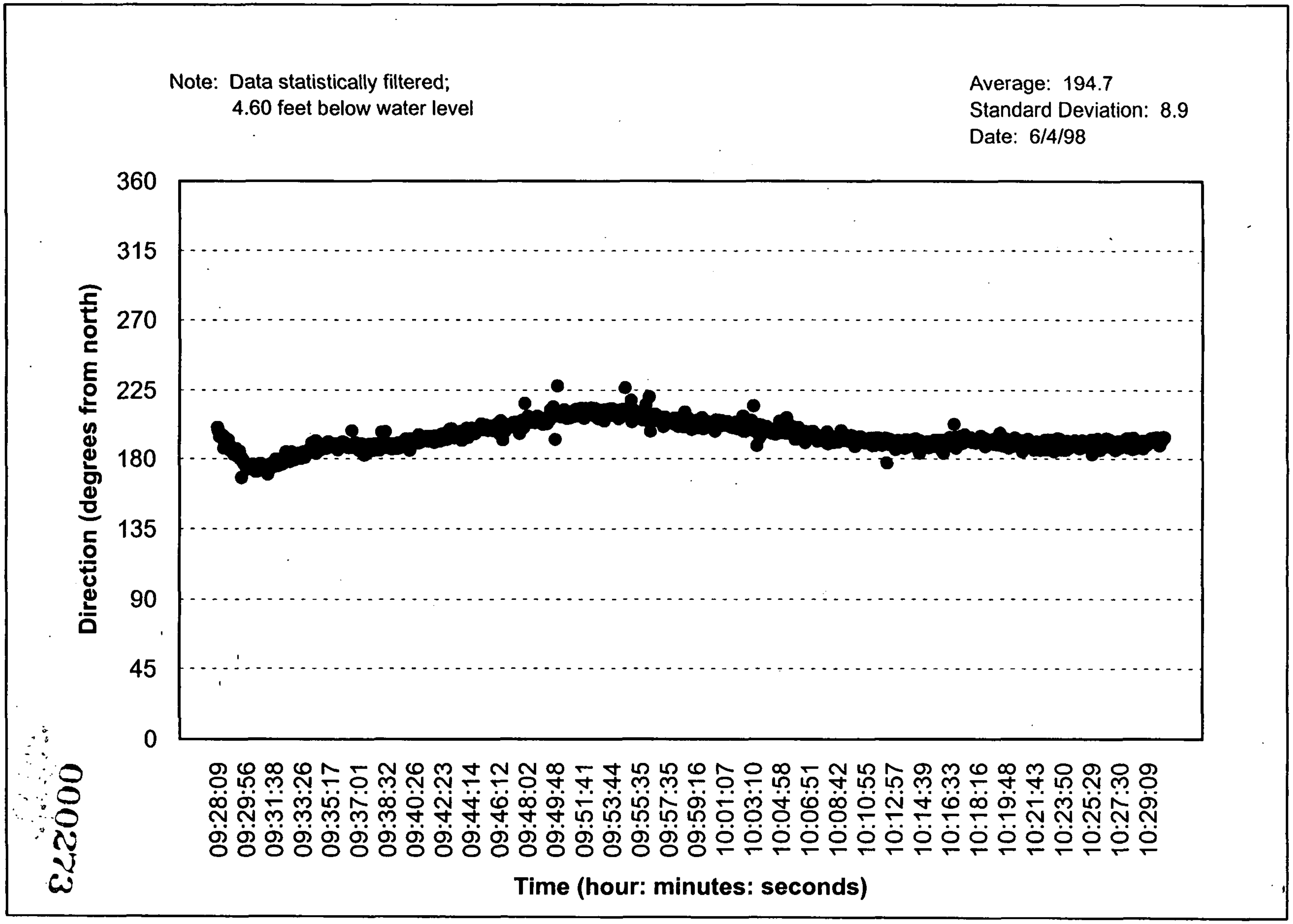

FIGURE A.3-59. SECOND QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 22303 USING COLLOIDAL BORESCOPE

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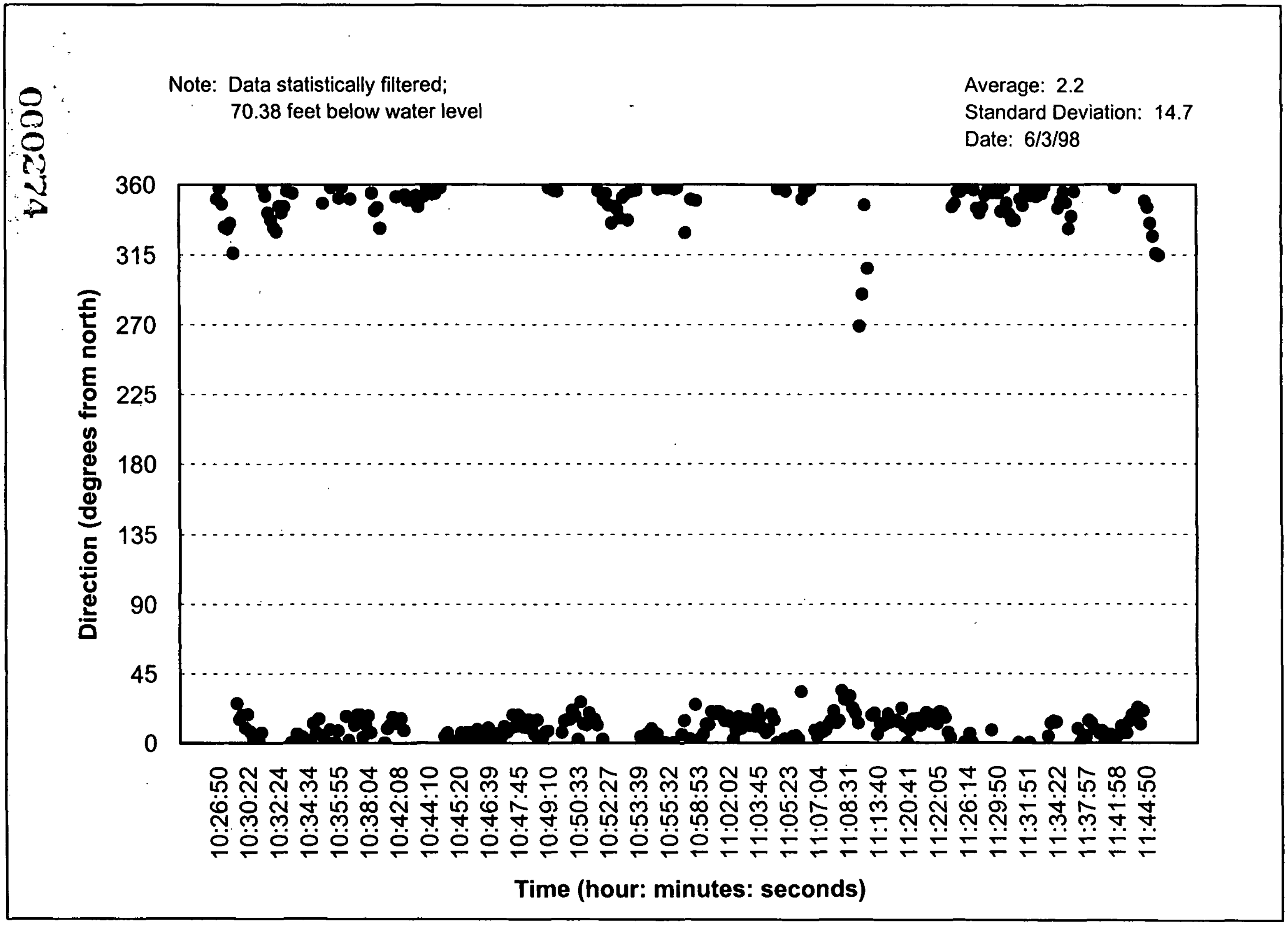

FIGURE A.3-60. SECOND QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 3552 USING COLLOIDAL BORESCOPE

000274

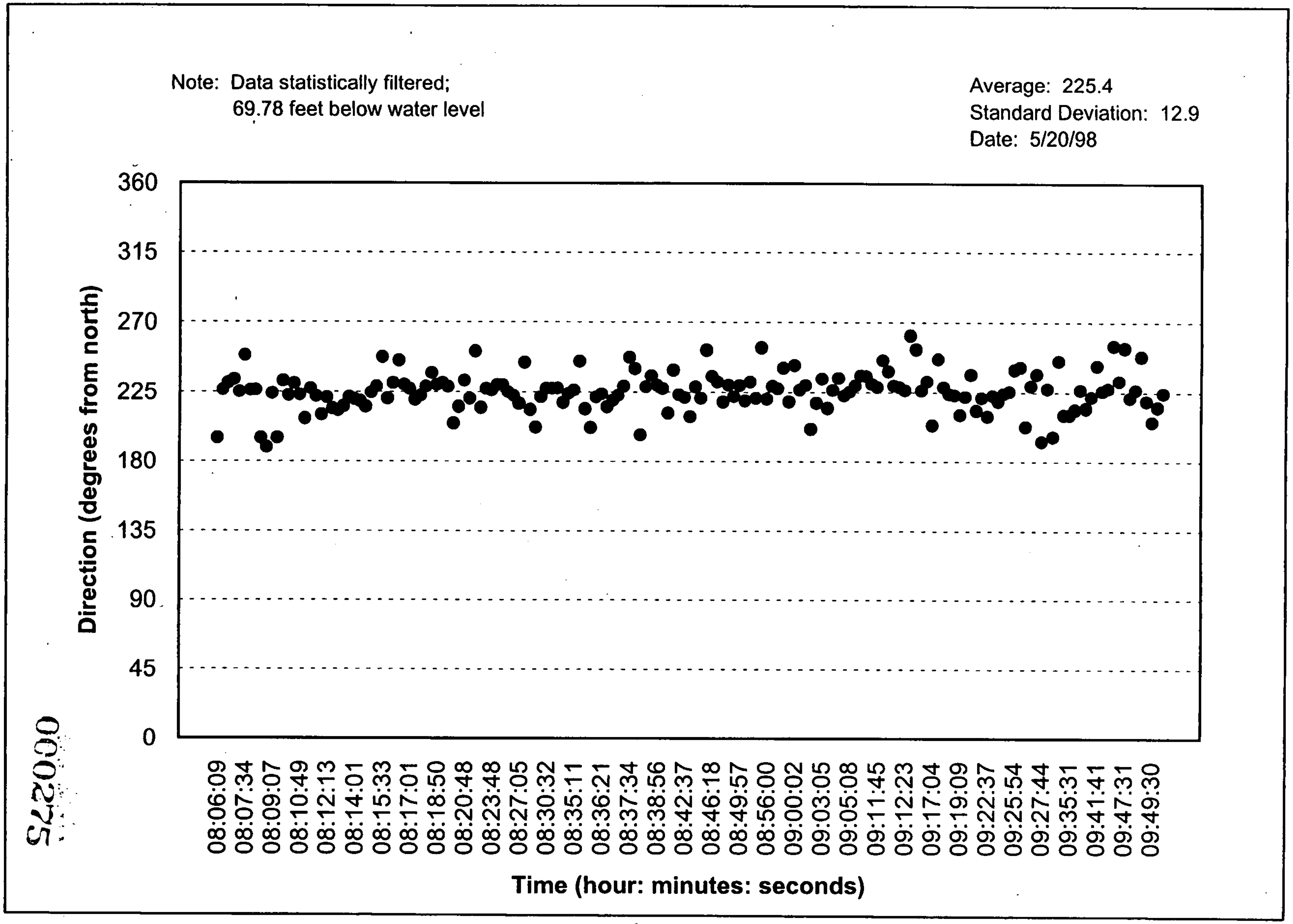

FIGURE A.3-61. SECOND QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 3898 USING COLLOIDAL BORESCOPE

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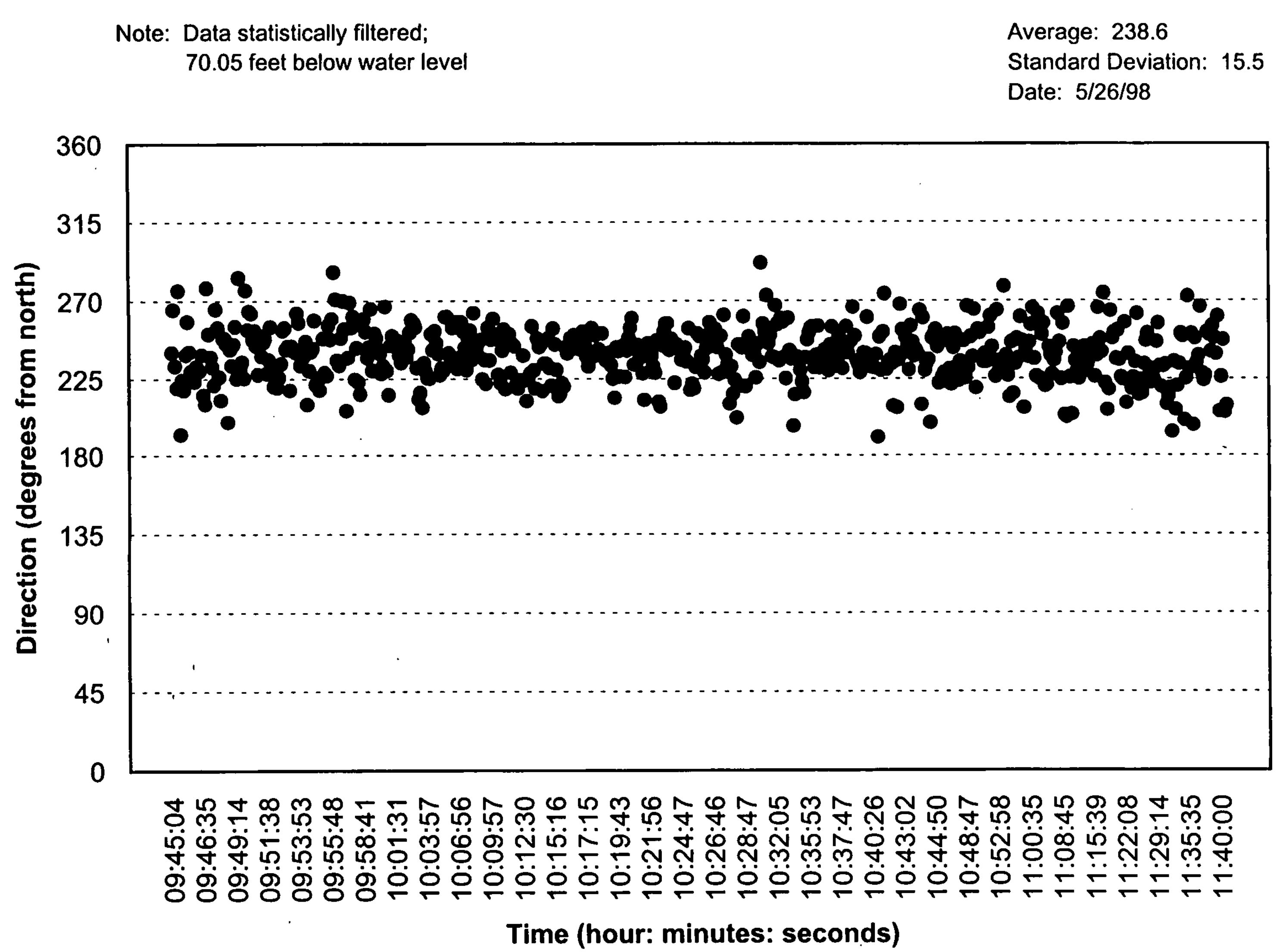

FIGURE A.3-62. SECOND QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 3899 USING COLLOIDAL BORESCOPE

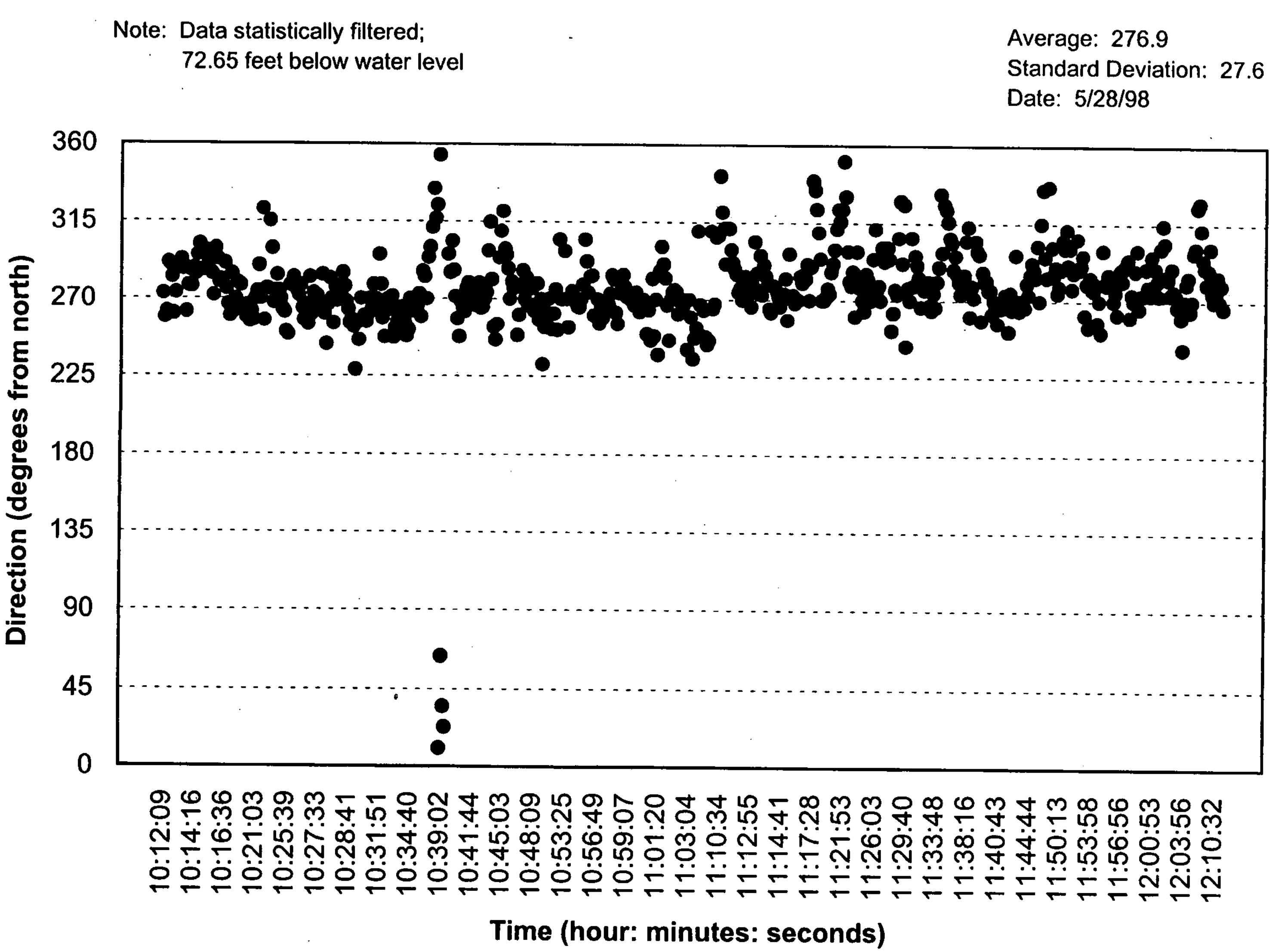

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FIGURE A.3-63. SECOND QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 3900 USING COLLOIDAL BORESCOPE

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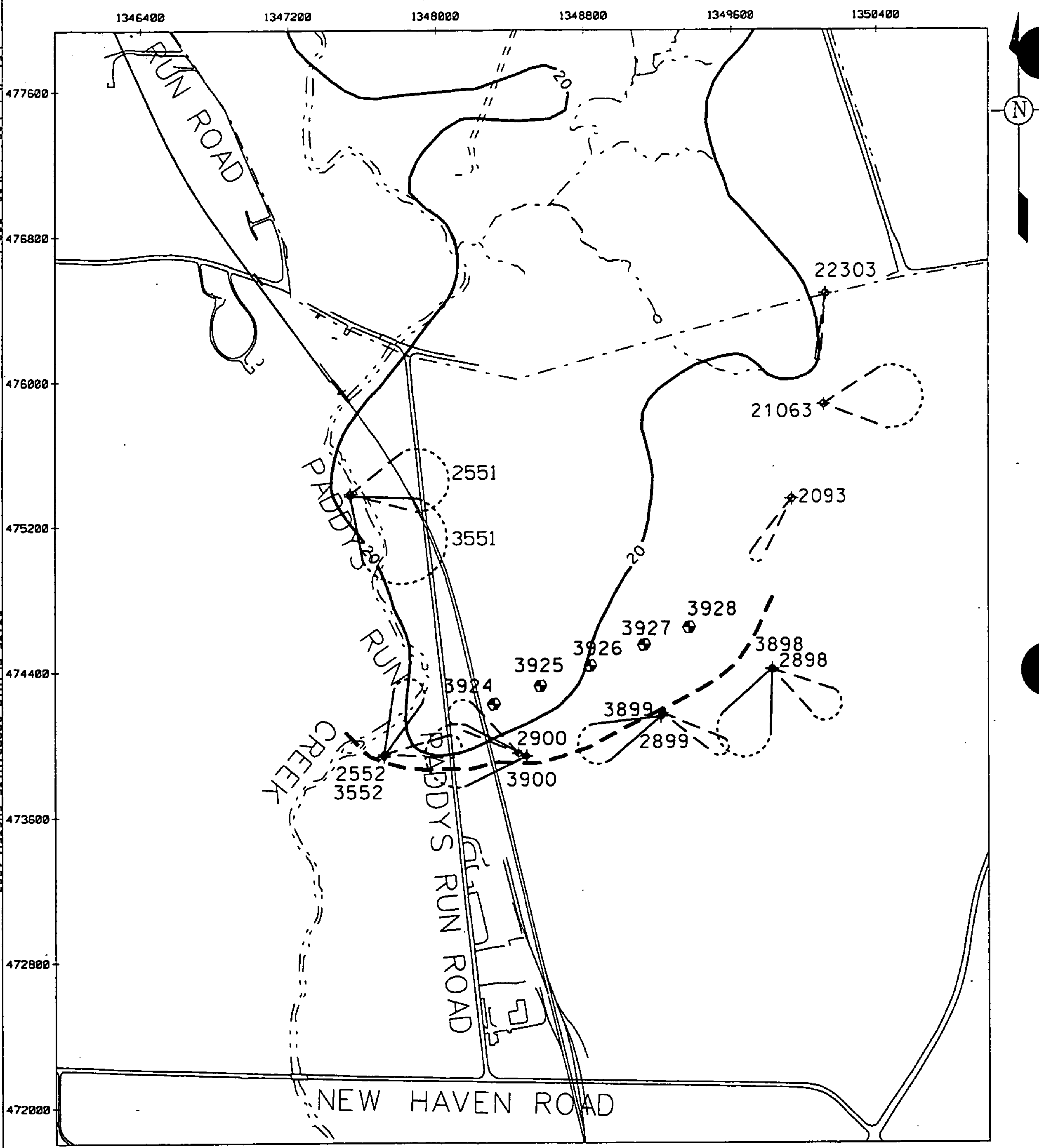

LEGEND:

FEMP BOUNDARY

CAPTURE ZONE BASED ON JULY 1998 GROUNDWATER ELEVATIONS

AVERAGE GROUNDWATER FLOW FOR TYPE 2 WELL +/- 1 SD

AVERAGE GROUNDWATER FLOW FOR TYPE 3 WELL +/- 1 SD

20 μg/L TOTAL URANIUM PLU[ME] FROM THIRD QUARTER 1998

SCALE

800 400 0 800 FEET

v:\5fgpi\dgn\98annual\98an028.dgn

STATE PLANAR COORDINATE SYSTEM 1983

24-MAY-1999

000278

FIGURE A.3-64. COLLOIDAL BORESCOPE FLOW VECTORS AT SOUTHERN EXTENT OF CAPTURE ZONE, THIRD QUARTER 1998

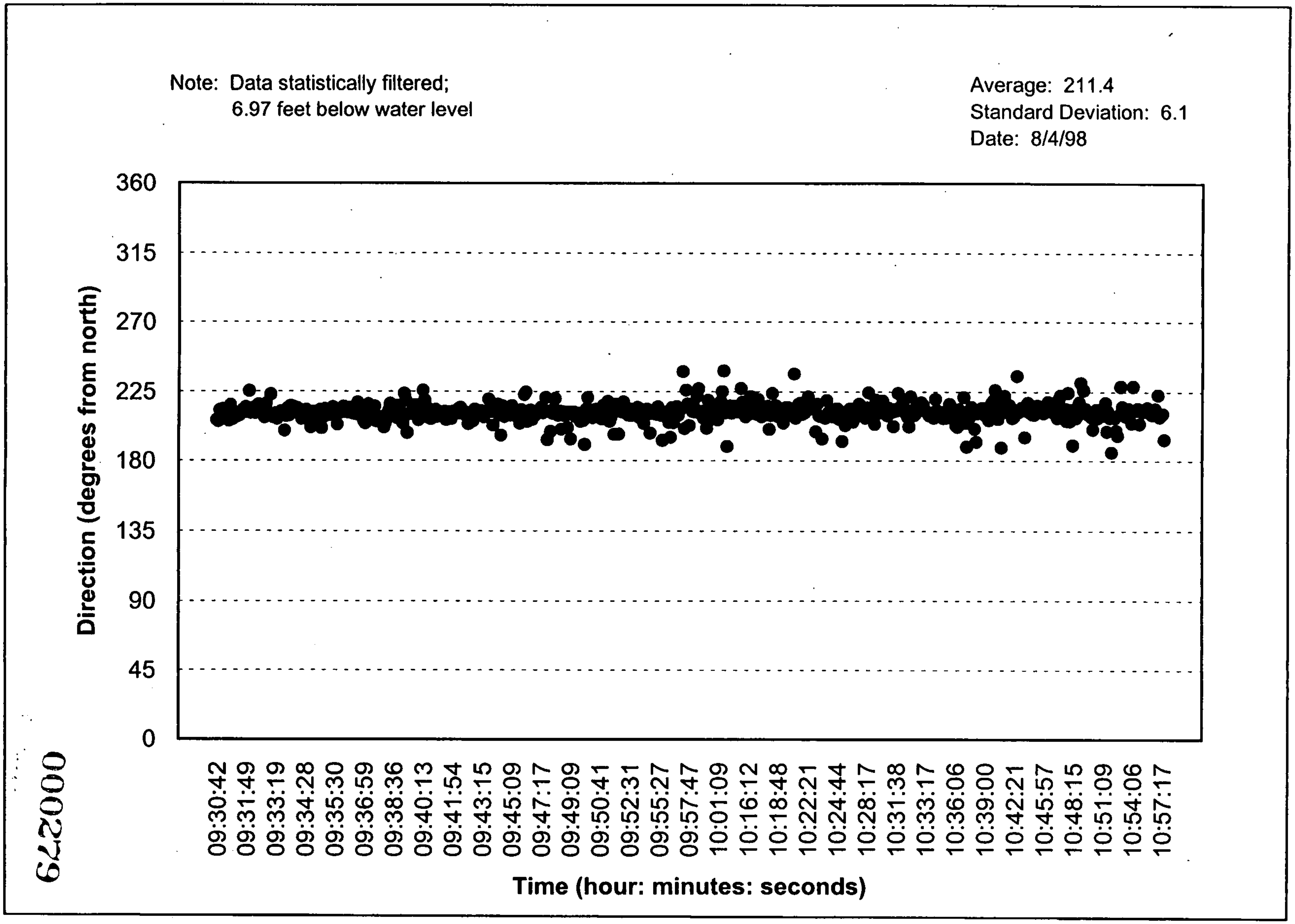

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FIGURE A.3-65. THIRD QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2093 USING COLLOIDAL BORESCOPE

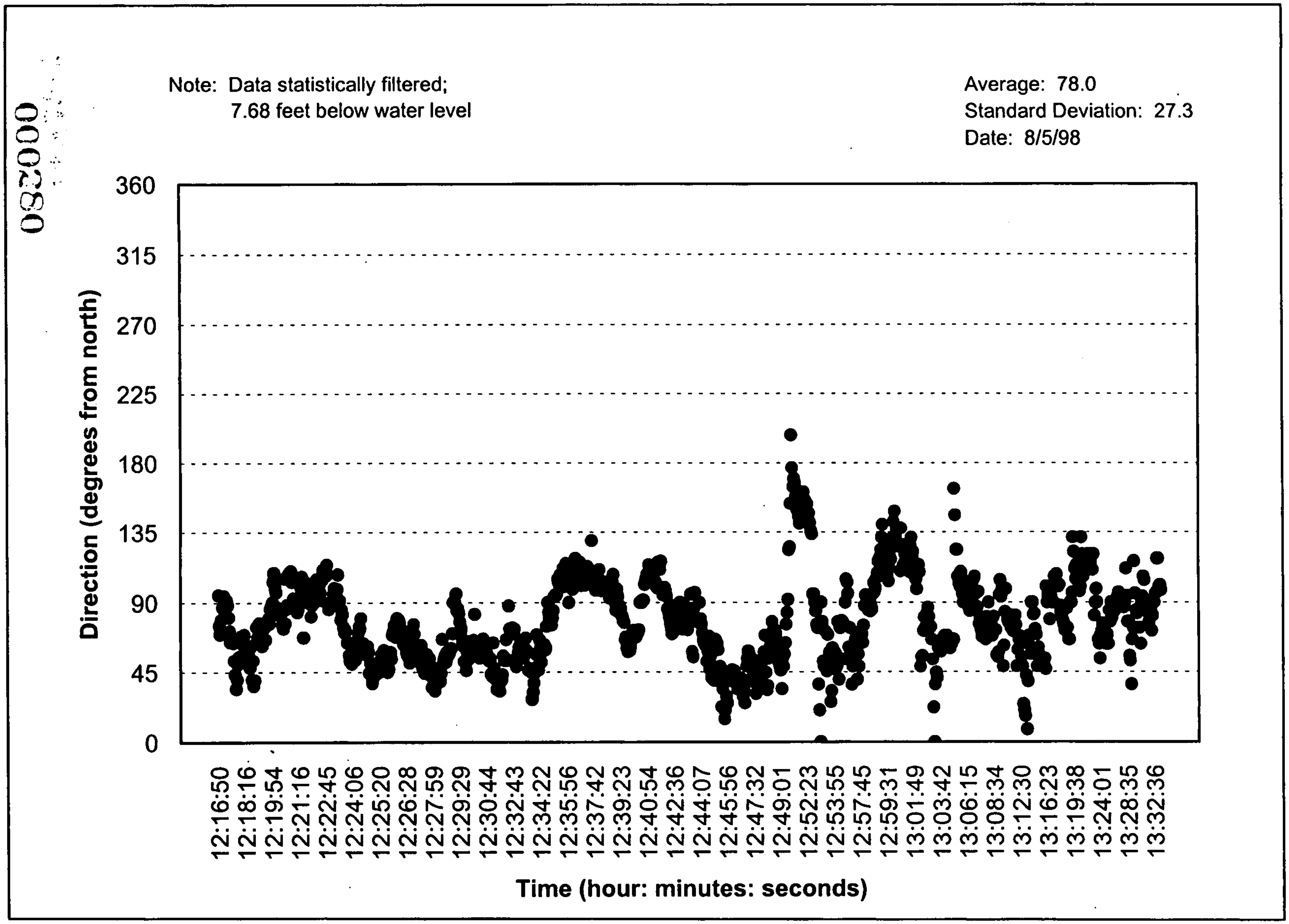

FIGURE A.3-66. THIRD QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2551 USING COLLOIDAL BORESCOPE

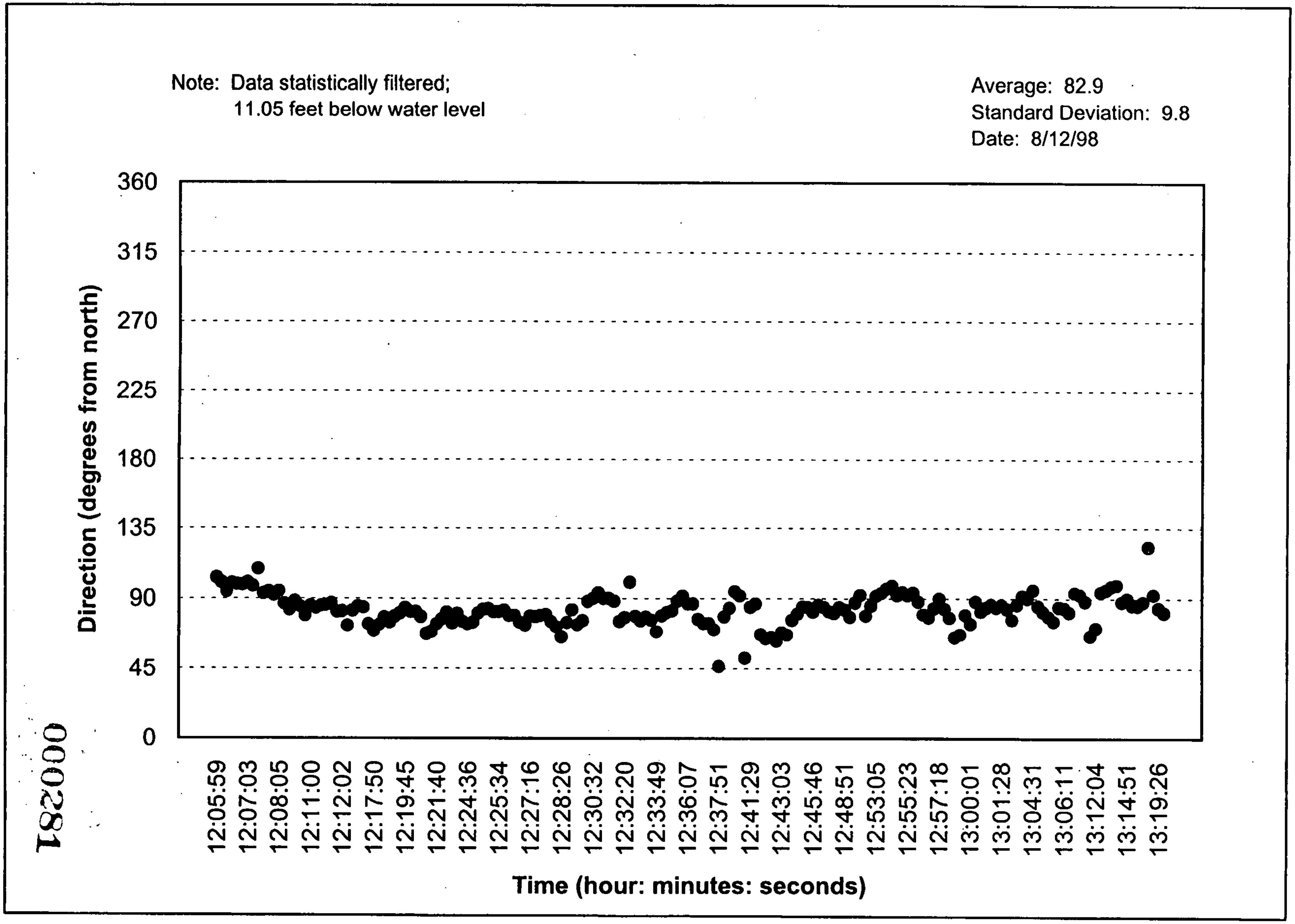

FIGURE A.3-67. THIRD QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2552 USING COLLOIDAL BORESCOPE

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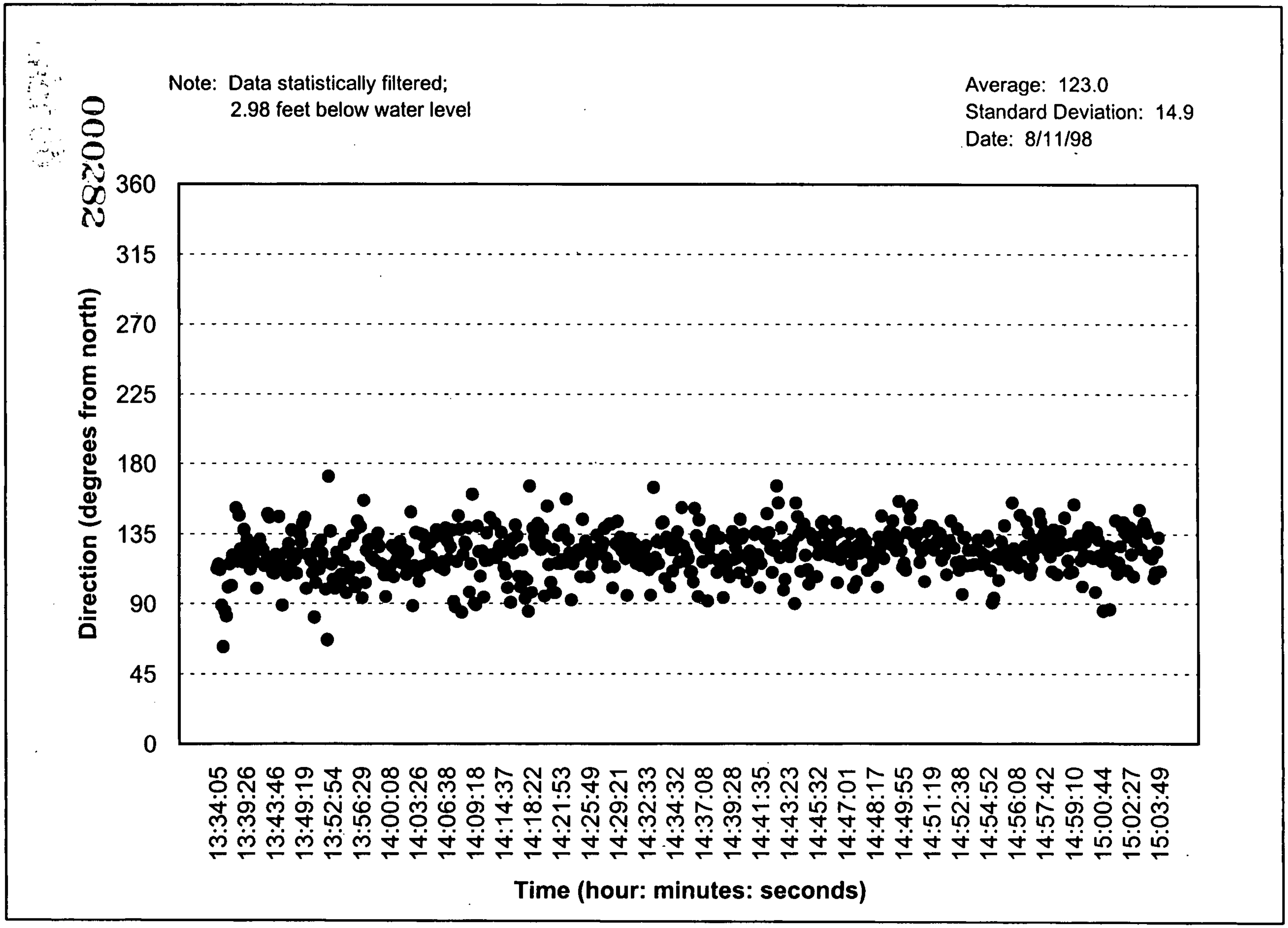

FIGURE A.3-68. THIRD QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2898 USING COLLOIDAL BORESCOPE

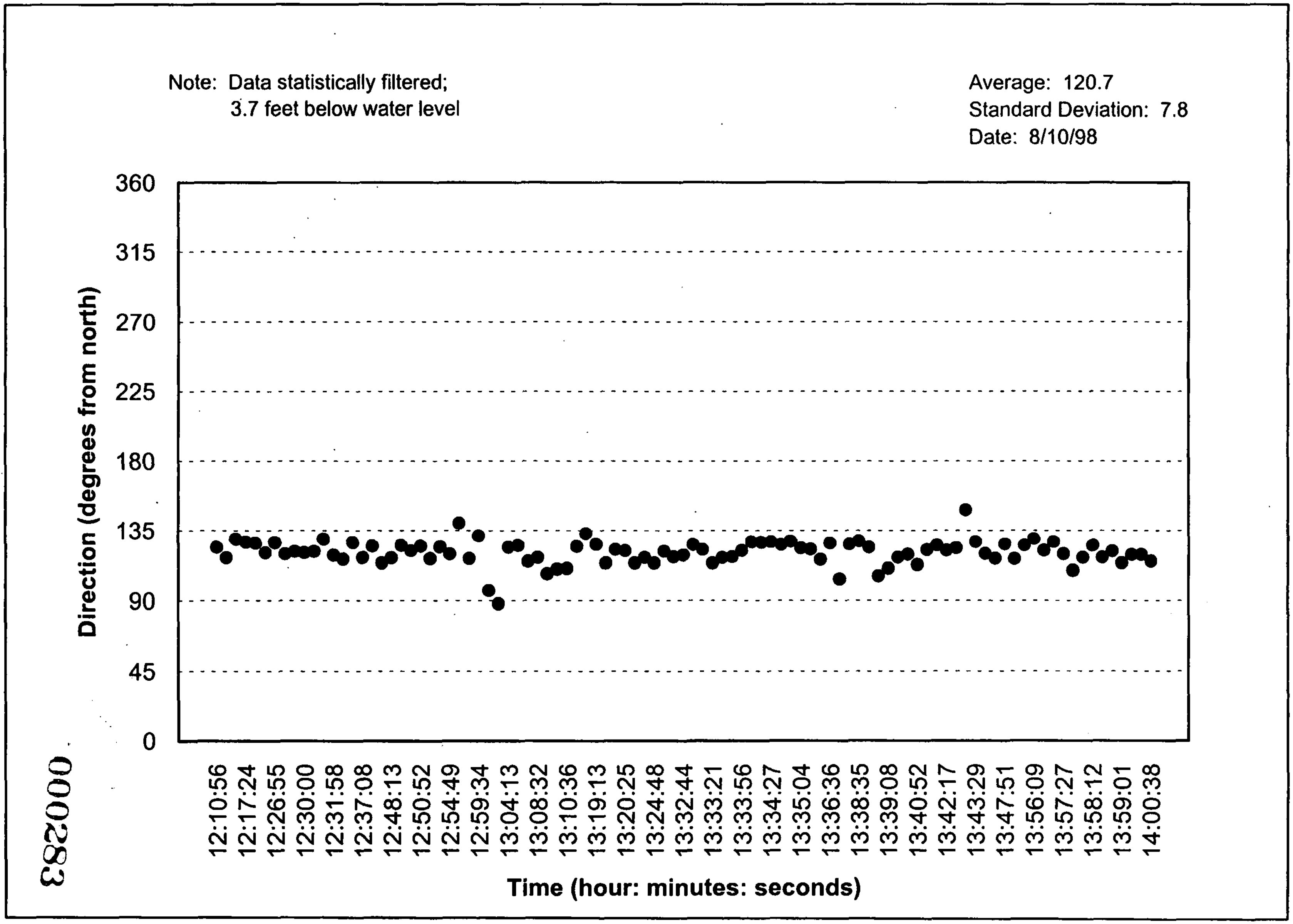

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FIGURE A.3-69. THIRD QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2899 USING COLLOIDAL BORESCOPE

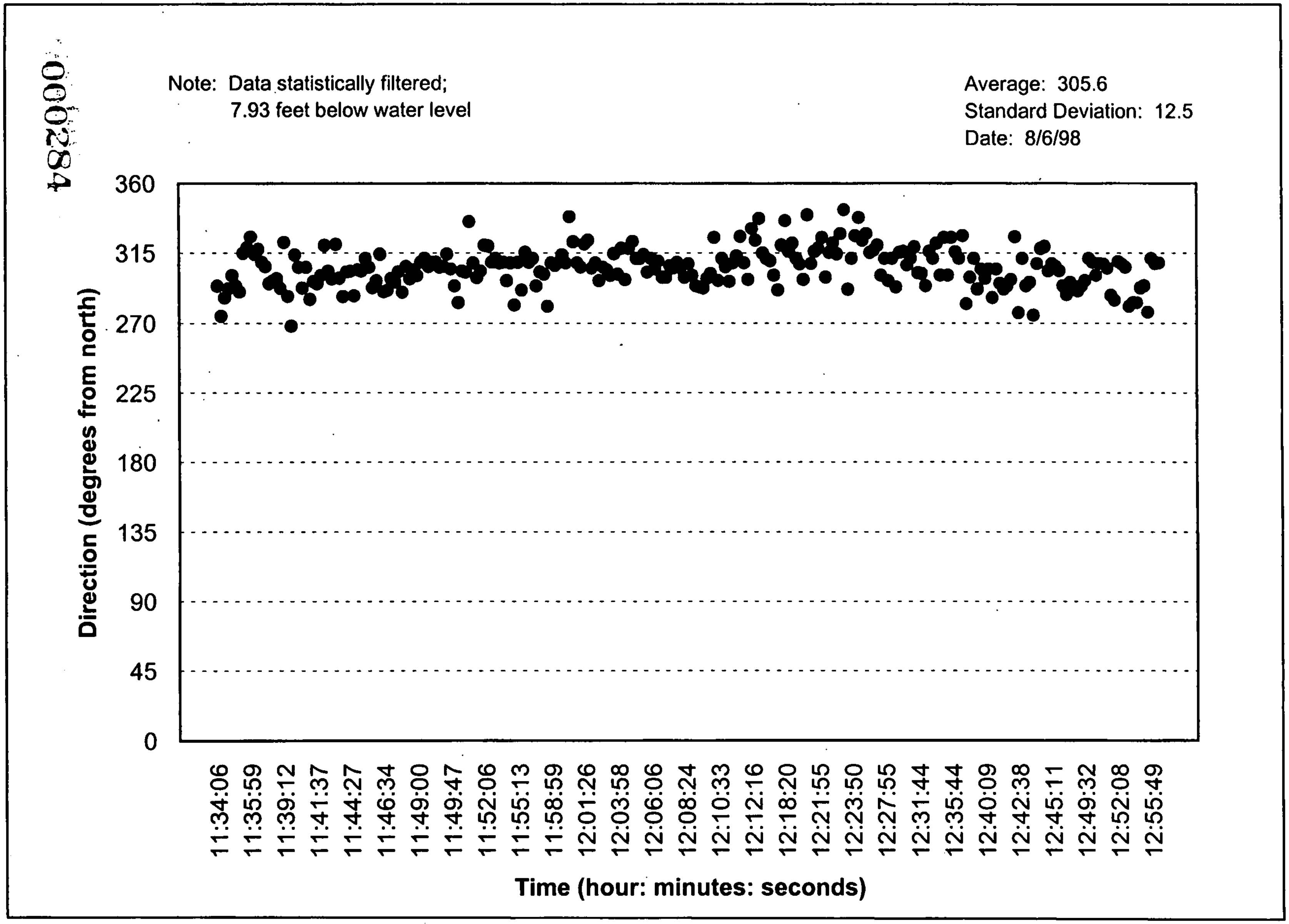

FIGURE A.3-70. THIRD QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2900 USING COLLOIDAL BORESCOPE

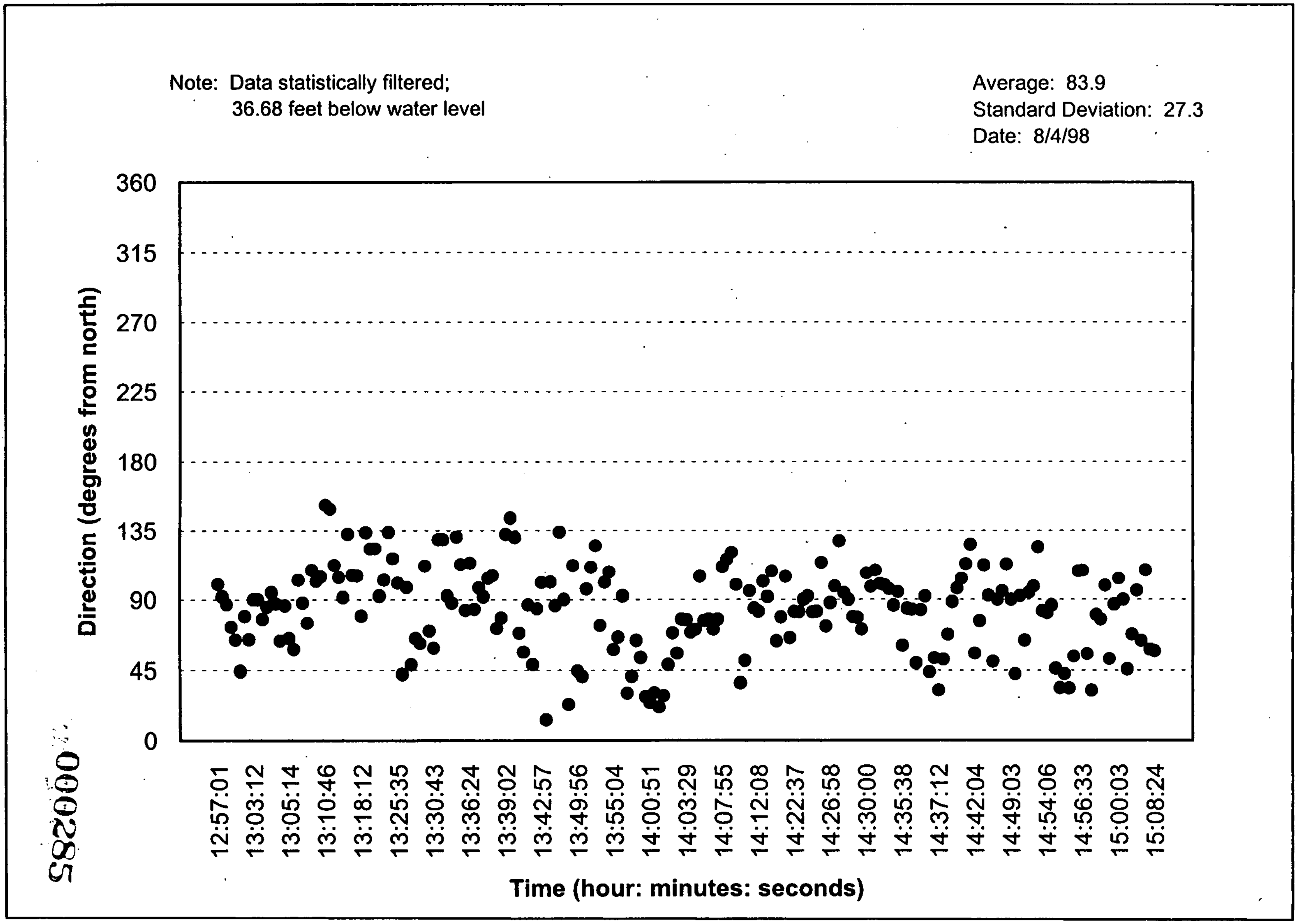

FIGURE A.3-71. THIRD QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 21063 USING COLLOIDAL BORESCOPE

000285

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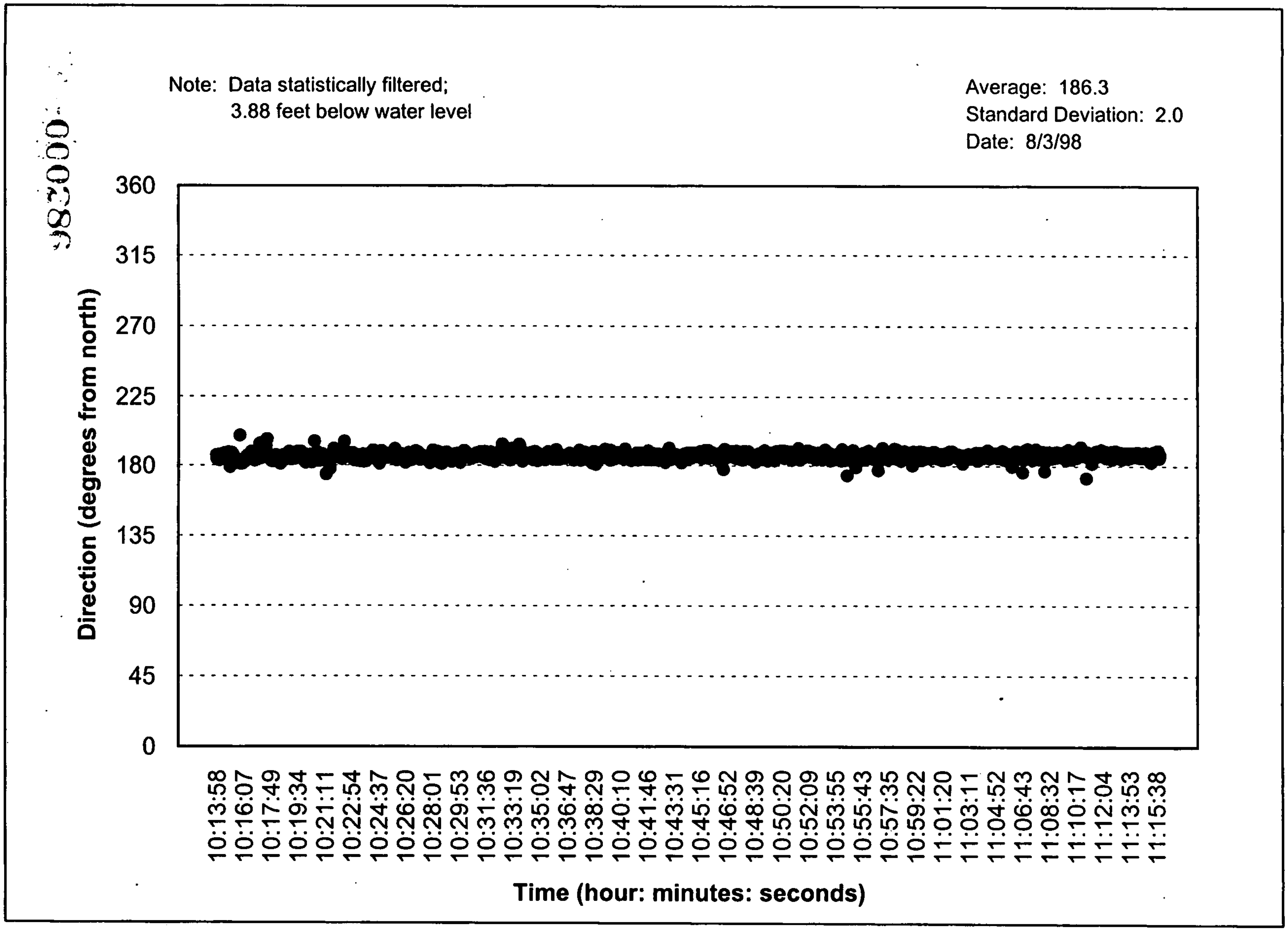

FIGURE A.3-72. THIRD QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 22303 USING COLLOIDAL BORESCOPE

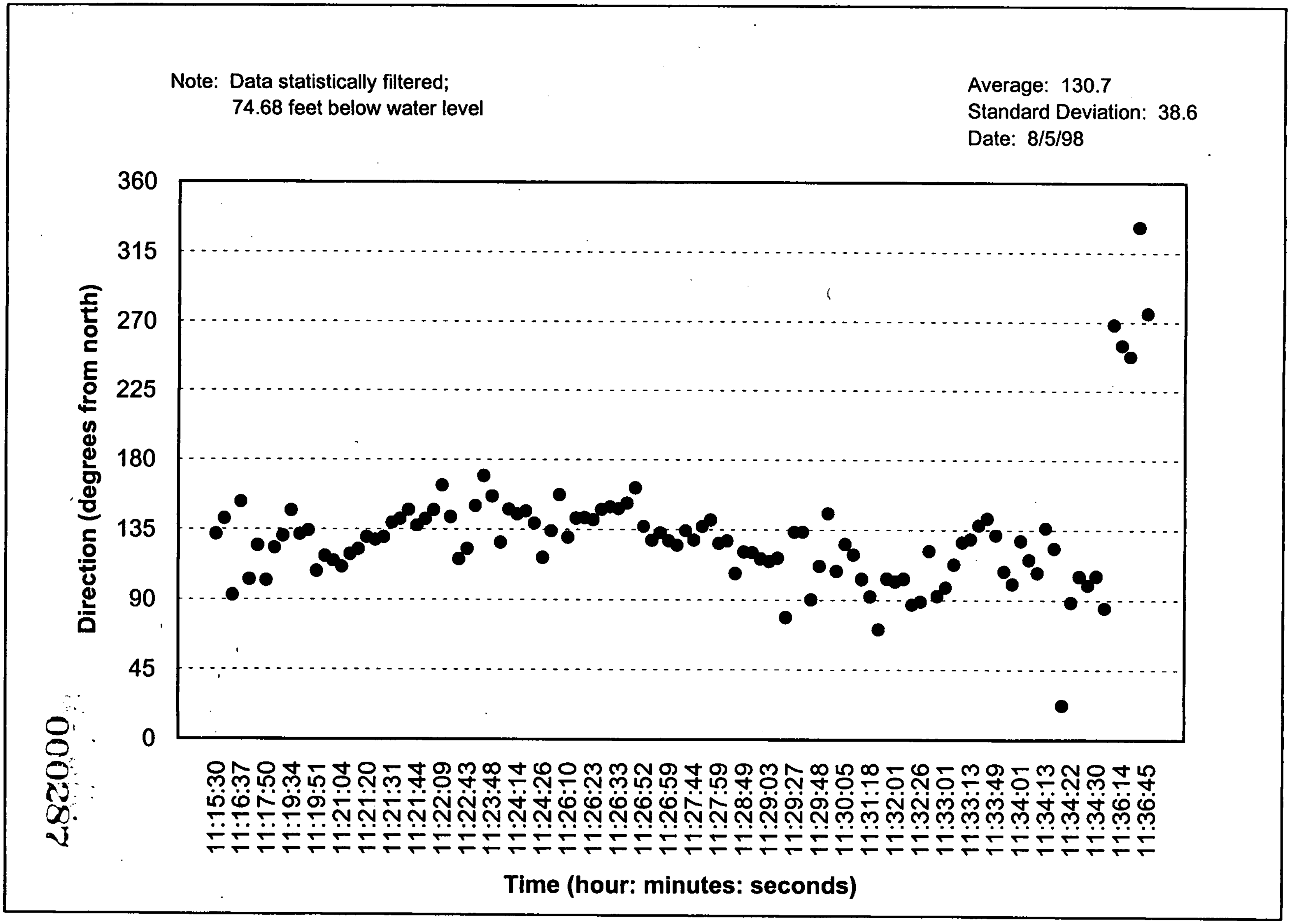

FIGURE A.3-73. THIRD QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 3551 USING COLLOIDAL BORESCOPE

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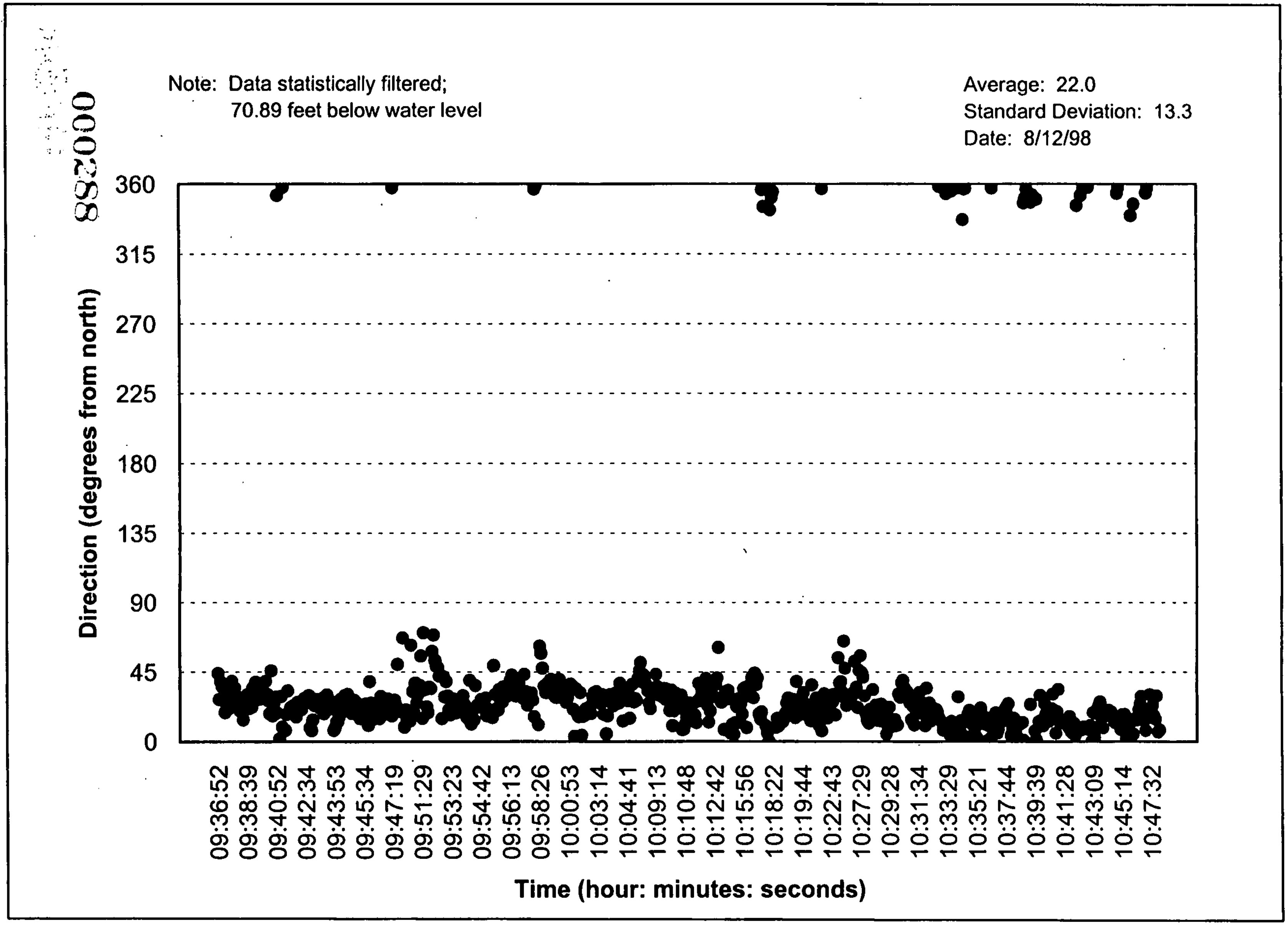

FIGURE A.3-74. THIRD QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 3552 USING COLLOIDAL BORESCOPE

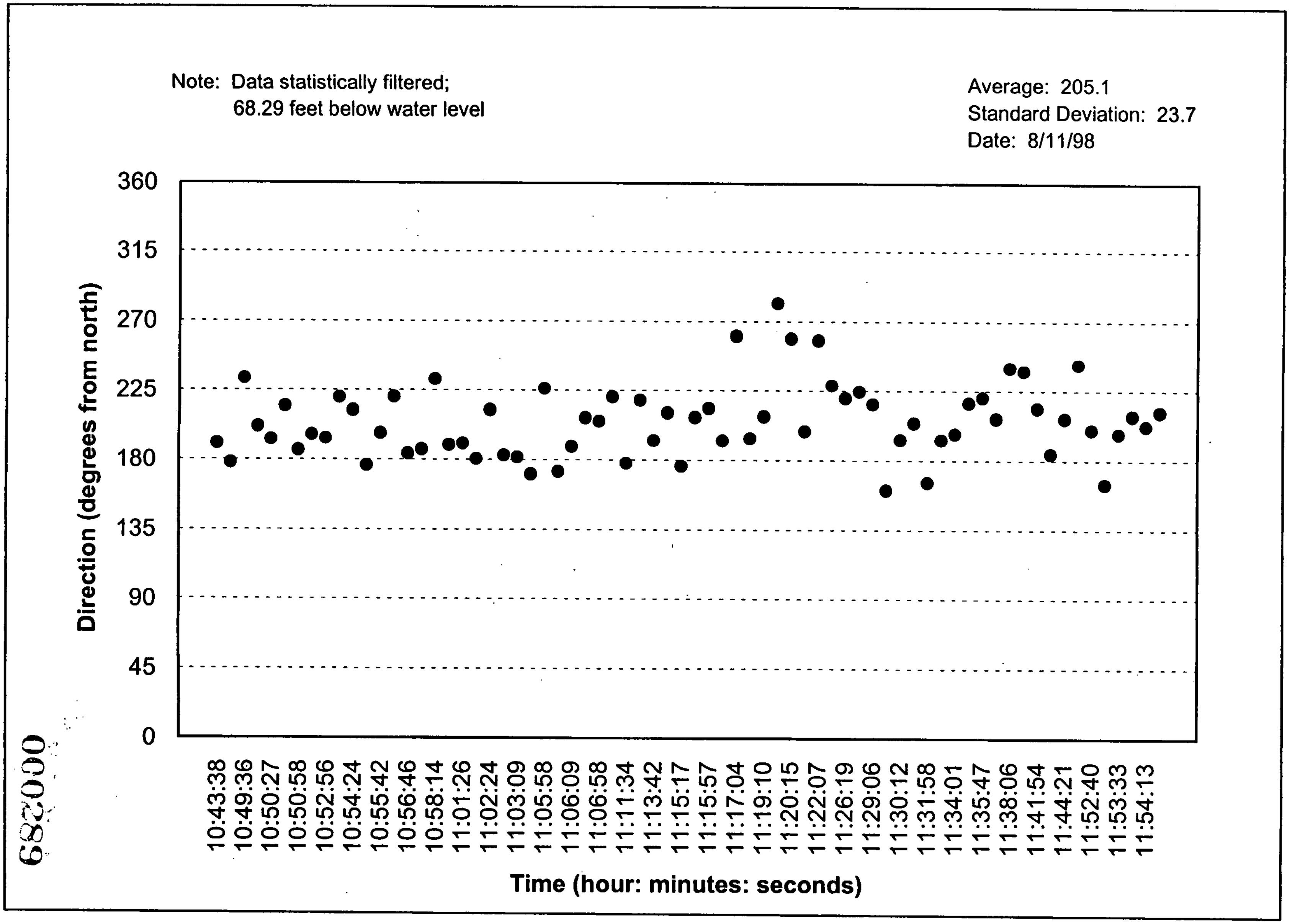

FIGURE A.3-75. THIRD QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 3898 USING COLLOIDAL BORESCOPE

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000630

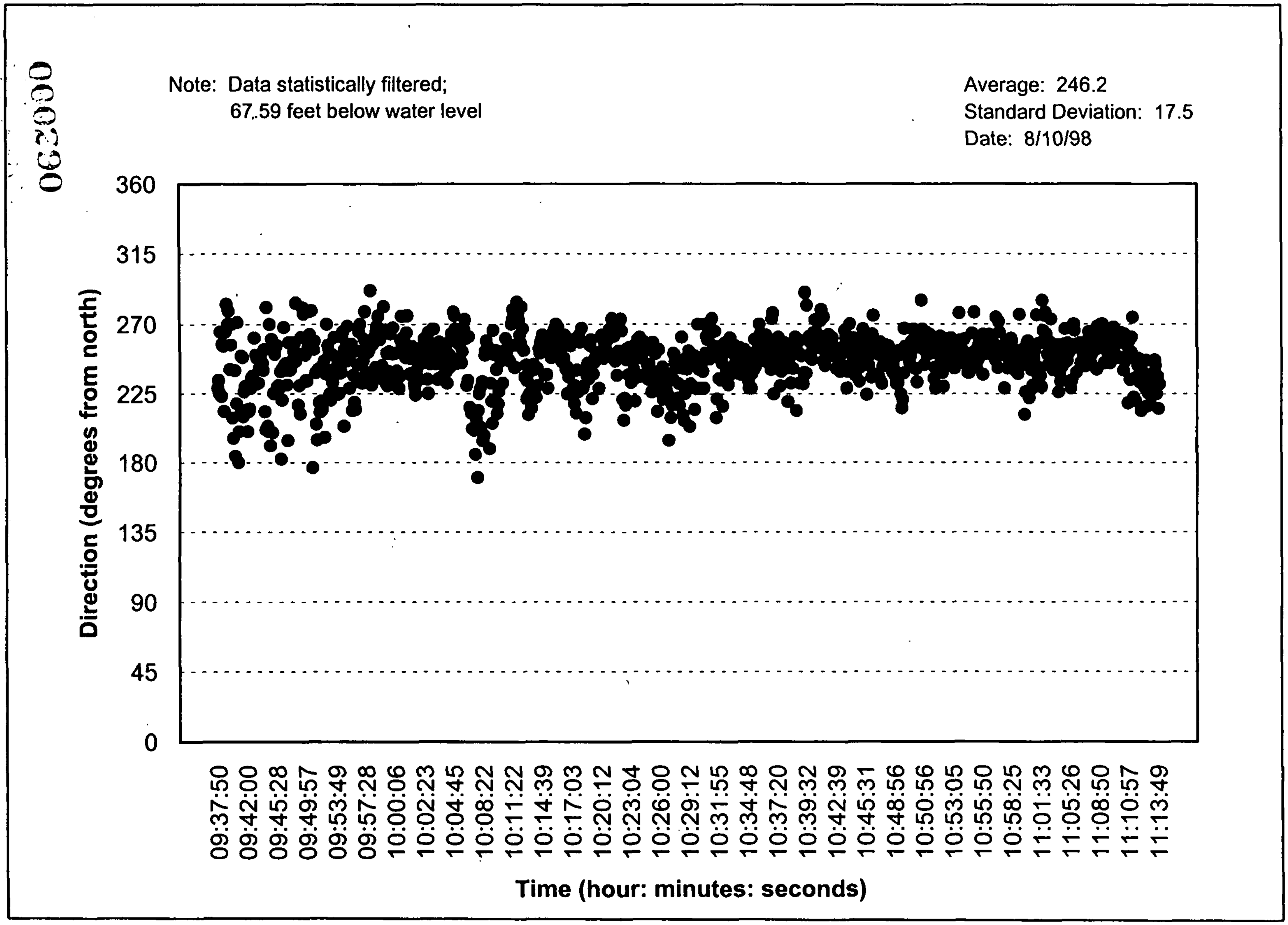

FIGURE A.3-76. THIRD QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 3899 USING COLLOIDAL BORESCOPE

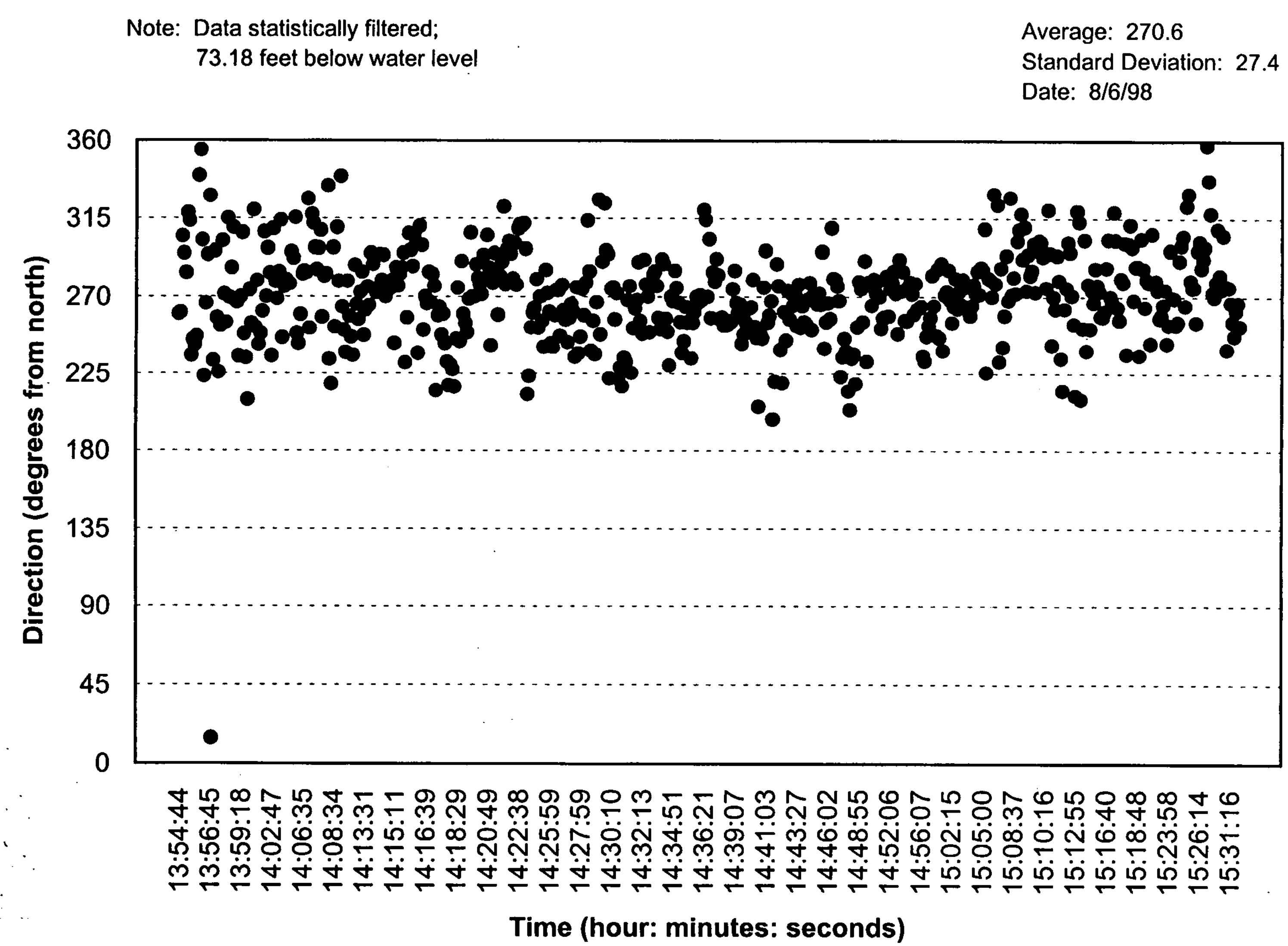

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FIGURE A.3-77. THIRD QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 3900 USING COLLOIDAL BORESCOPE

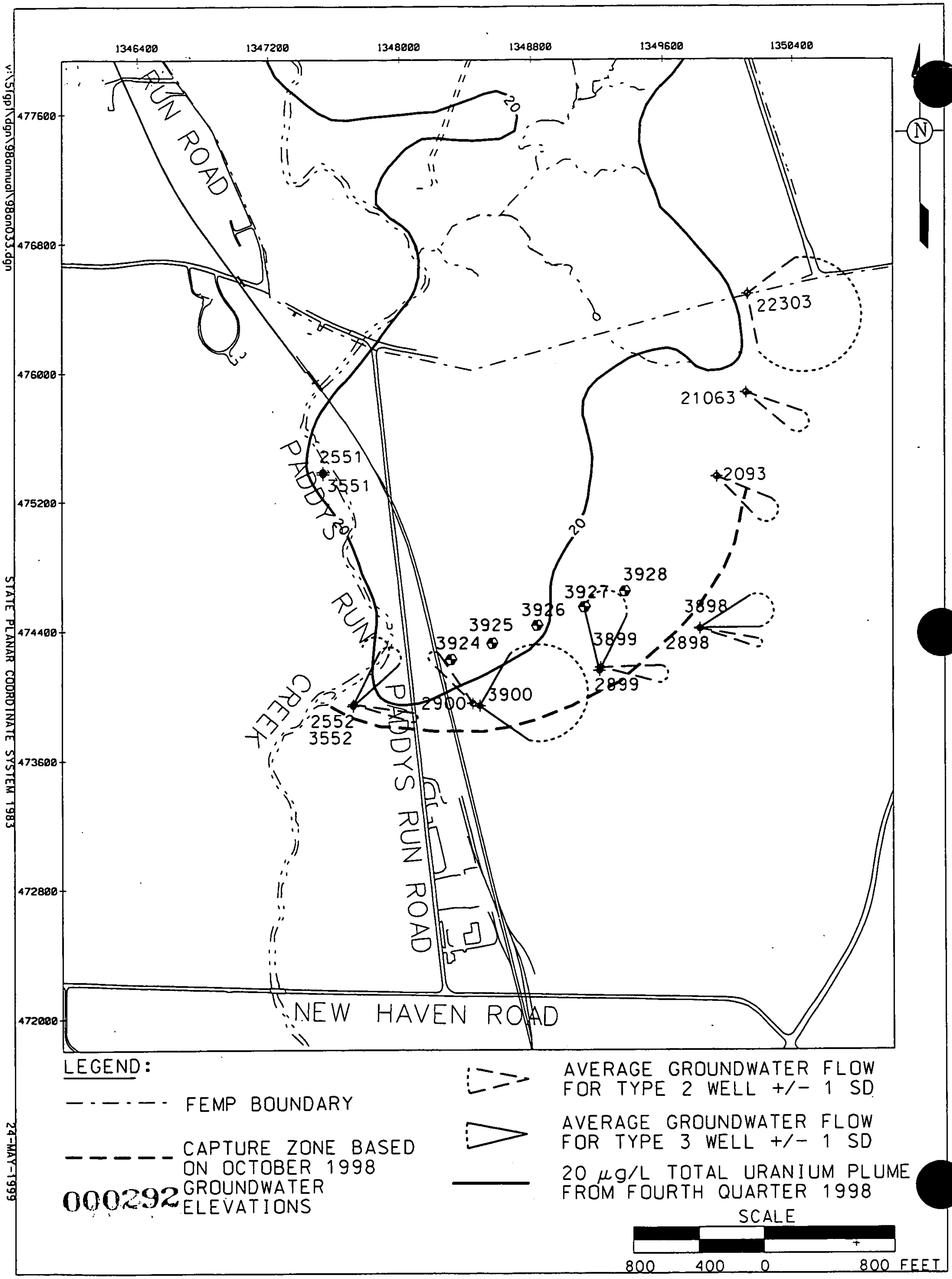

FIGURE A.3-78. COLLOIDAL BORESCOPE FLOW VECTORS AT SOUTHERN EXTENT OF CAPTURE ZONE, FOURTH QUARTER 1998

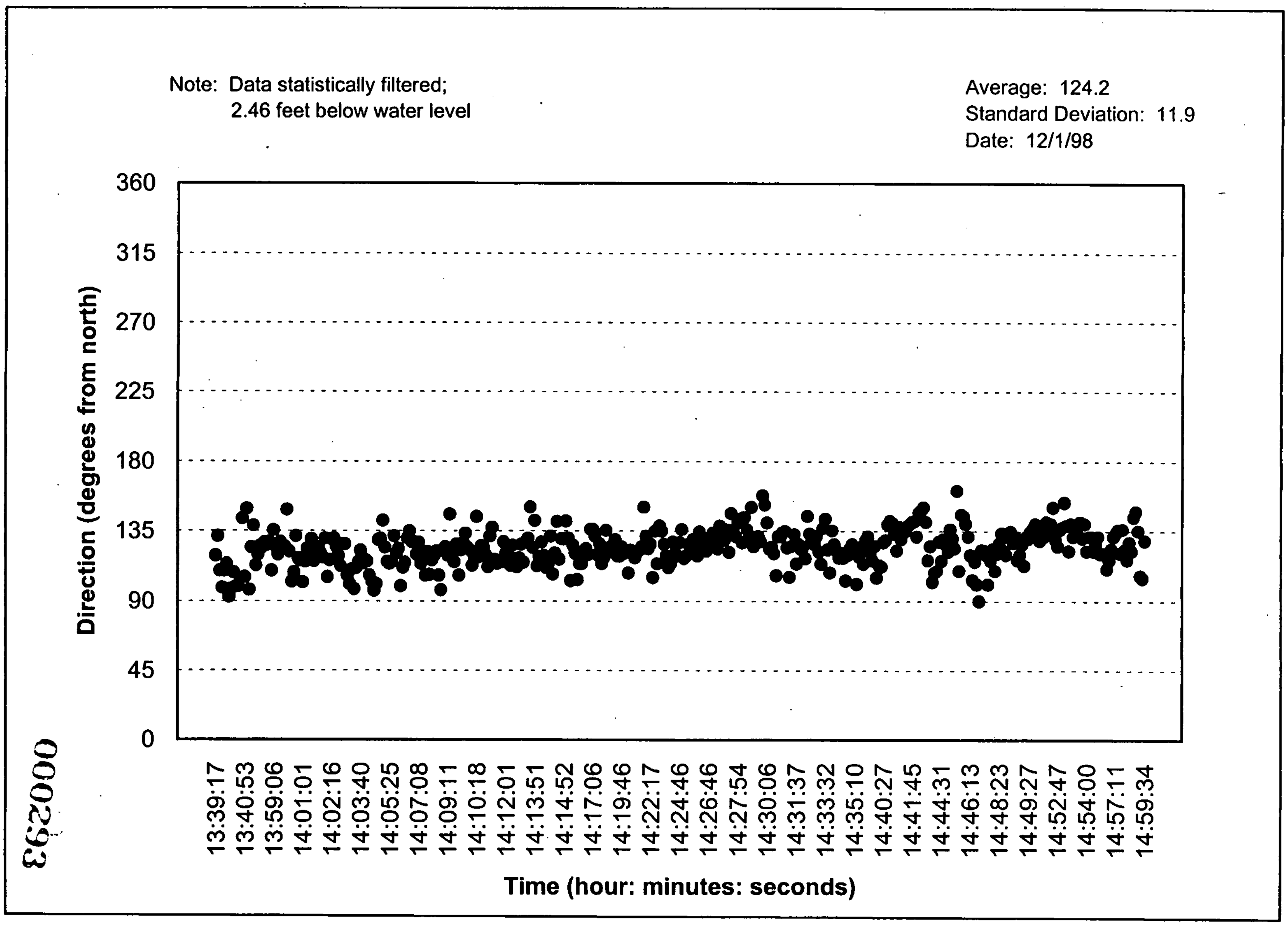

FIGURE A.3-79. FOURTH QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2093 USING COLLOIDAL BORESCOPE

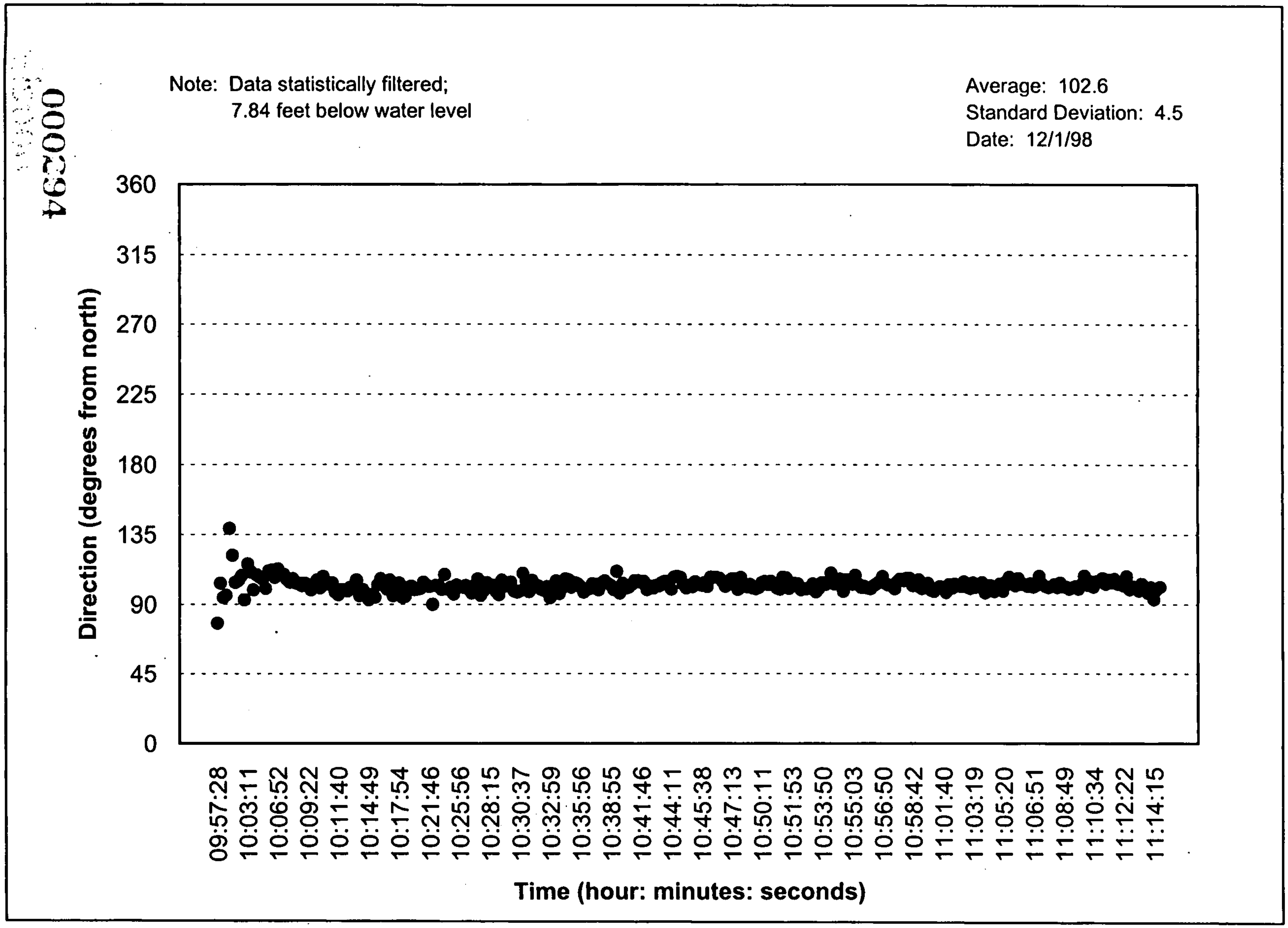

FIGURE A.3-80. FOURTH QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2552 USING COLLOIDAL BORESCOPE

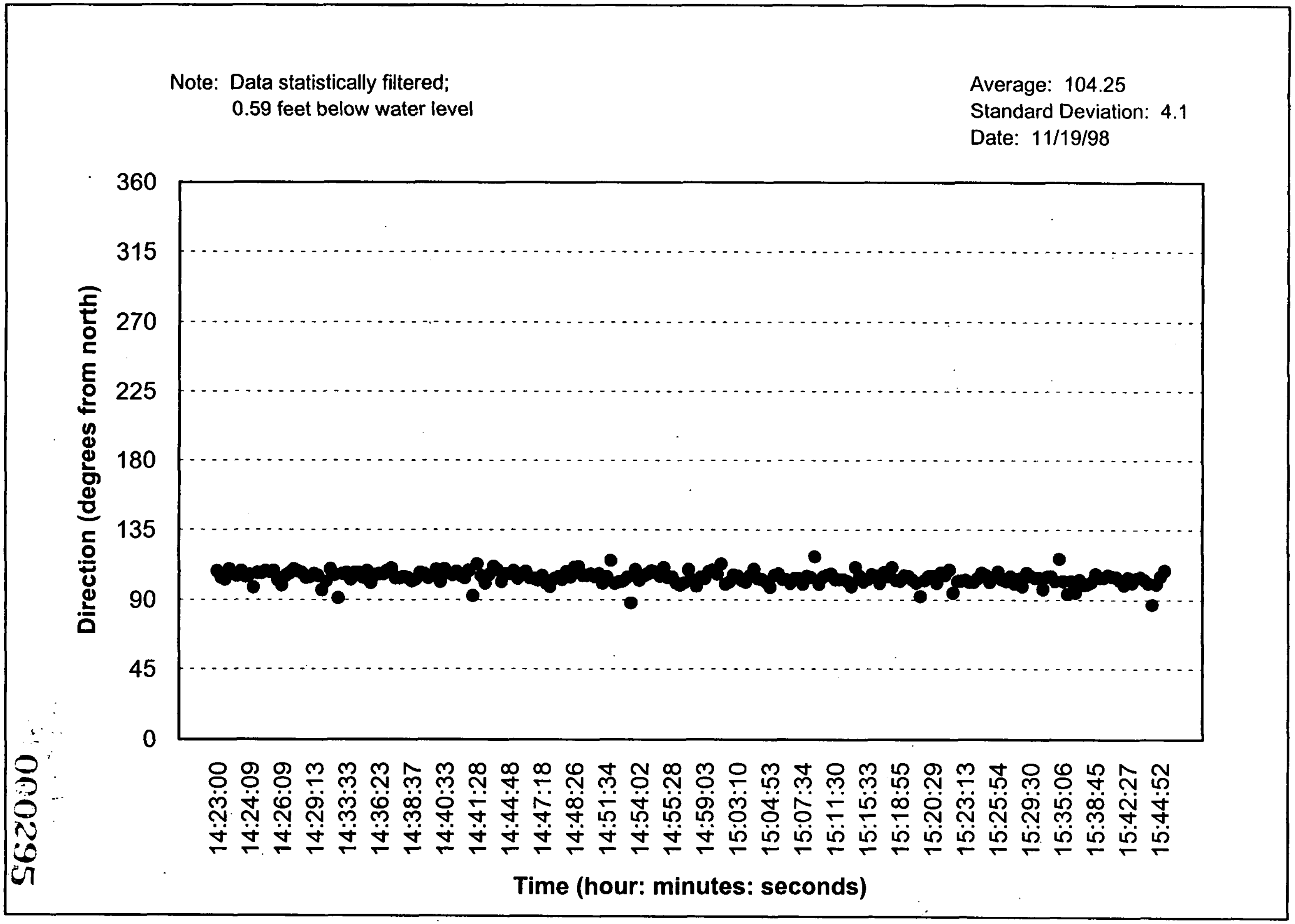

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FIGURE A.3-81. FOURTH QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2898 USING COLLOIDAL BORESCOPE

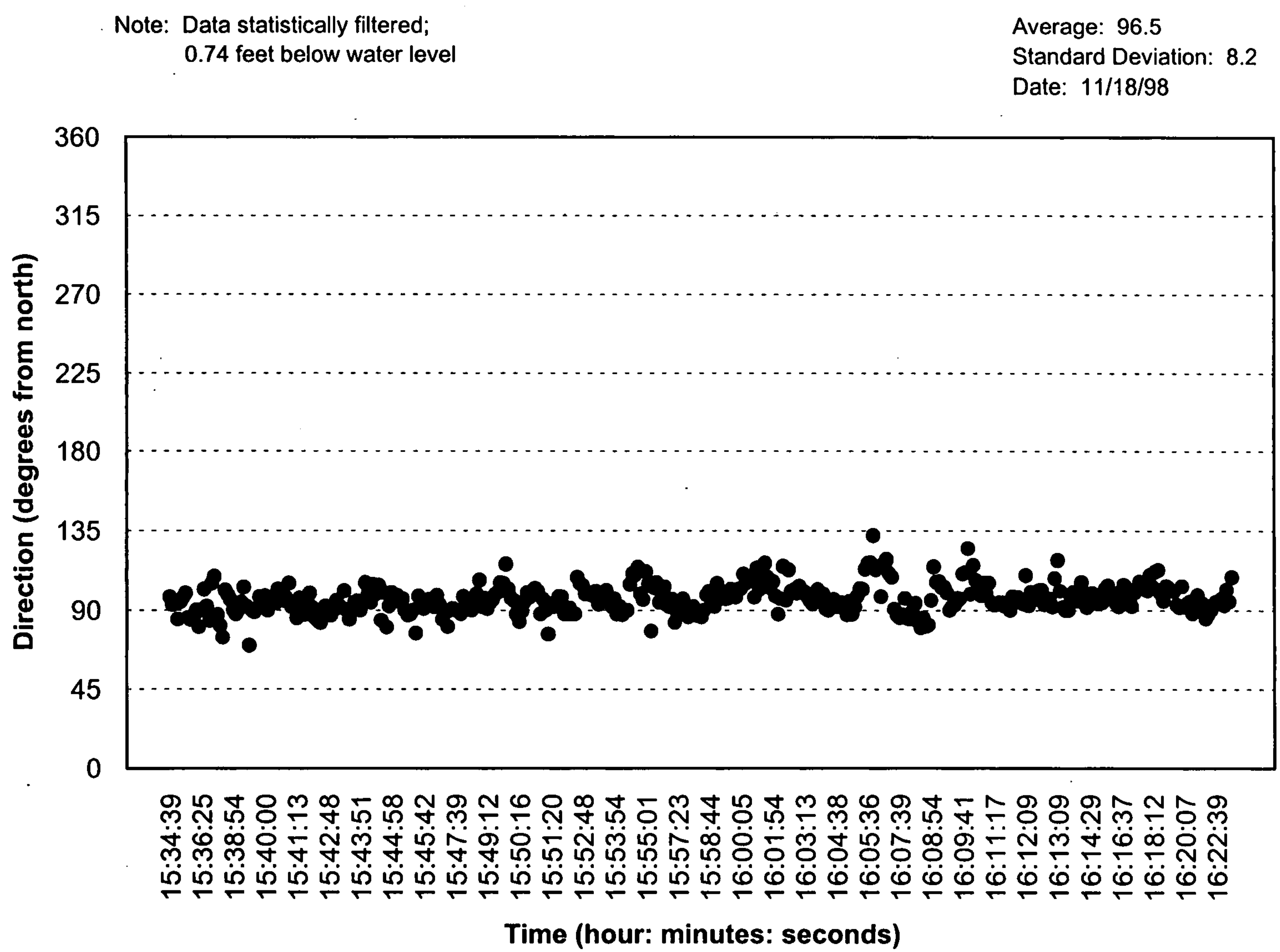

FIGURE A.3-82. FOURTH QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2899 USING COLLOIDAL BORESCOPE

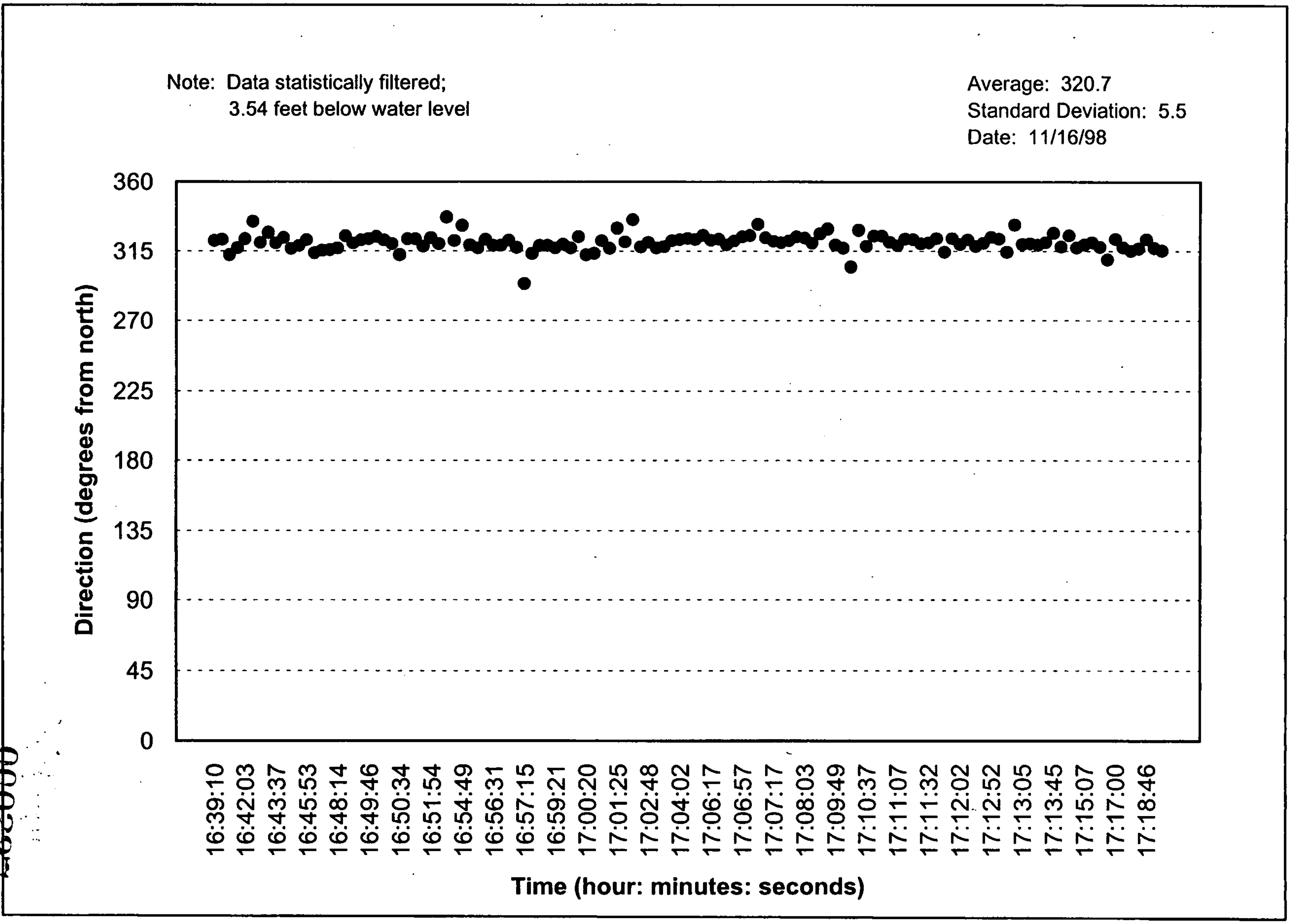

FIGURE A.3-83. FOURTH QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 2900 USING COLLOIDAL BORESCOPE

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Note: Data statistically filtered;
32.38 feet below water level

Average: 119.4
Standard Deviation: 10.6
Date: 12/2/98

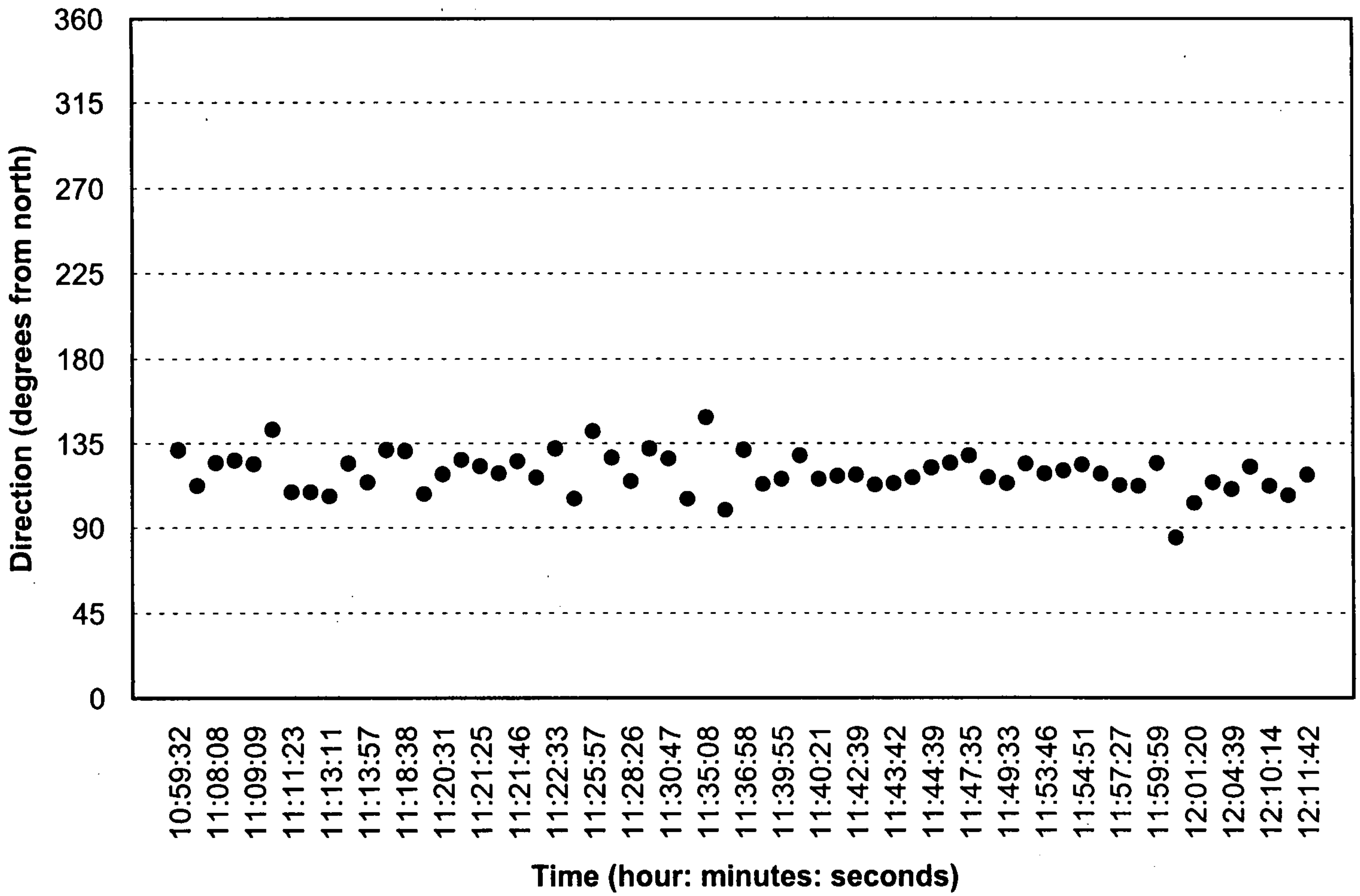
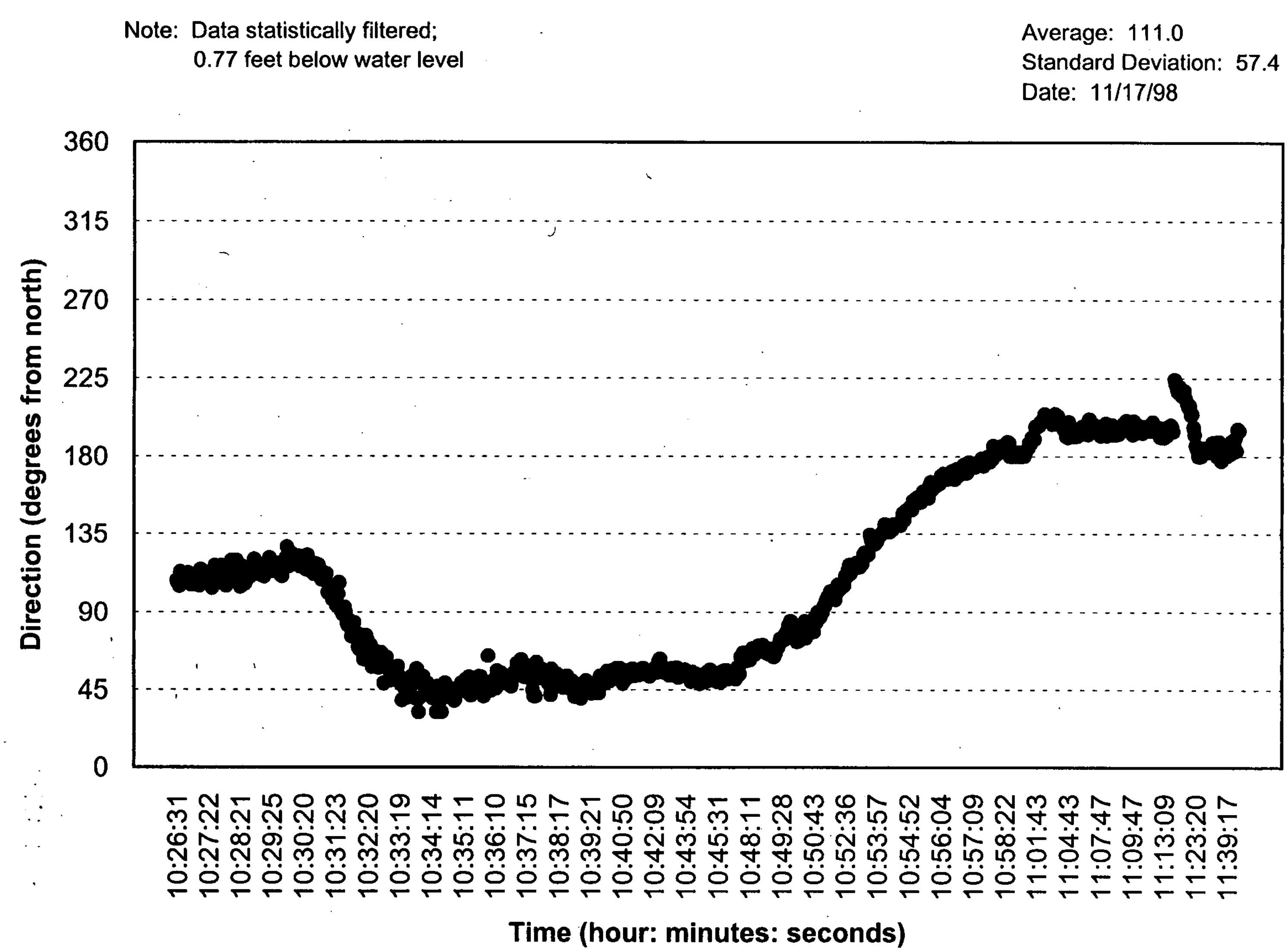


FIGURE A.3-84. FOURTH QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 21063 USING COLLOIDAL BORESCOPE



000299

FIGURE A.3-85. FOURTH QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 22303 USING COLLOIDAL BORESCOPE

2272

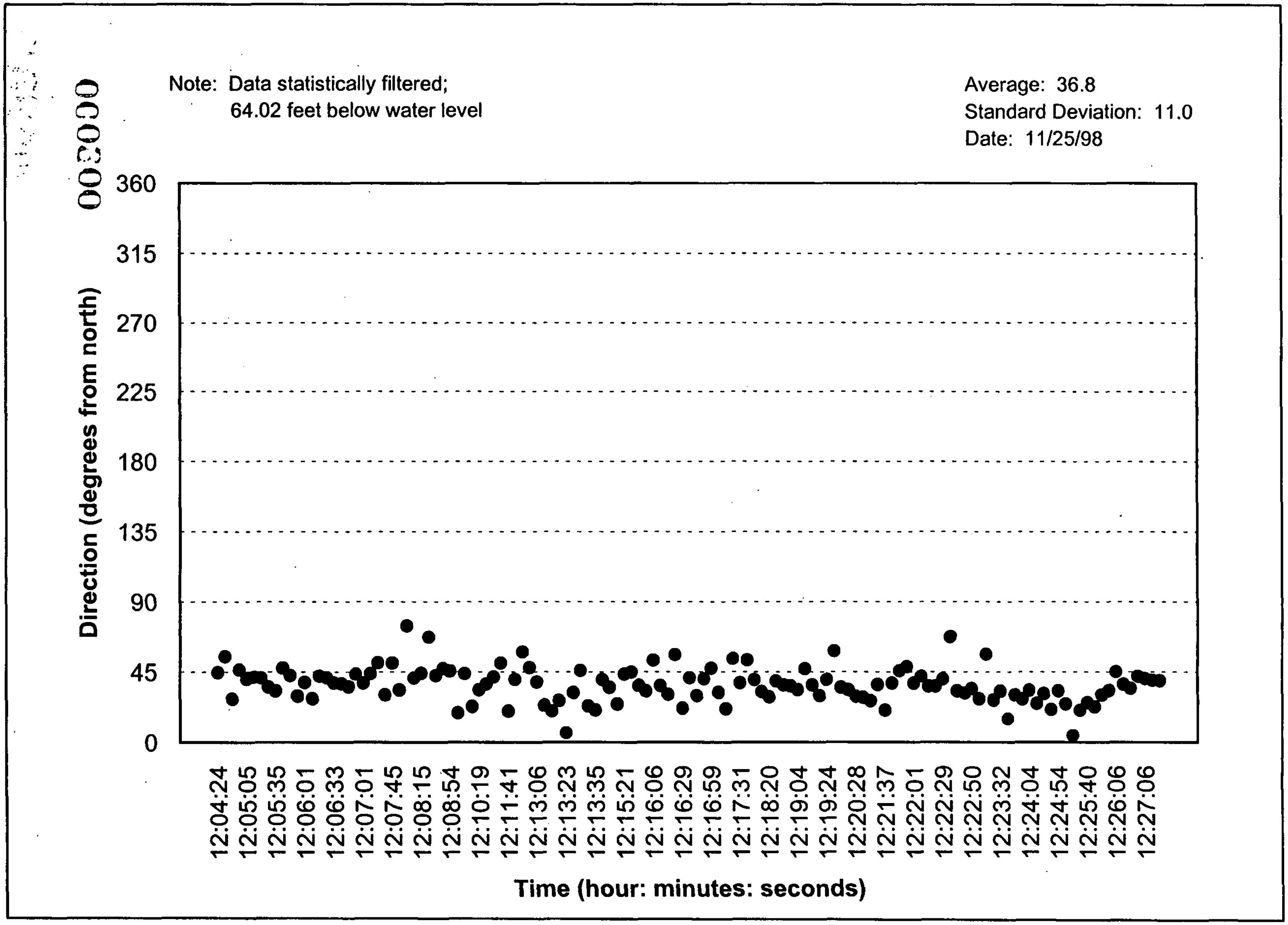


FIGURE A.3-86. FOURTH QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 3552 USING COLLOIDAL BORESCOPE

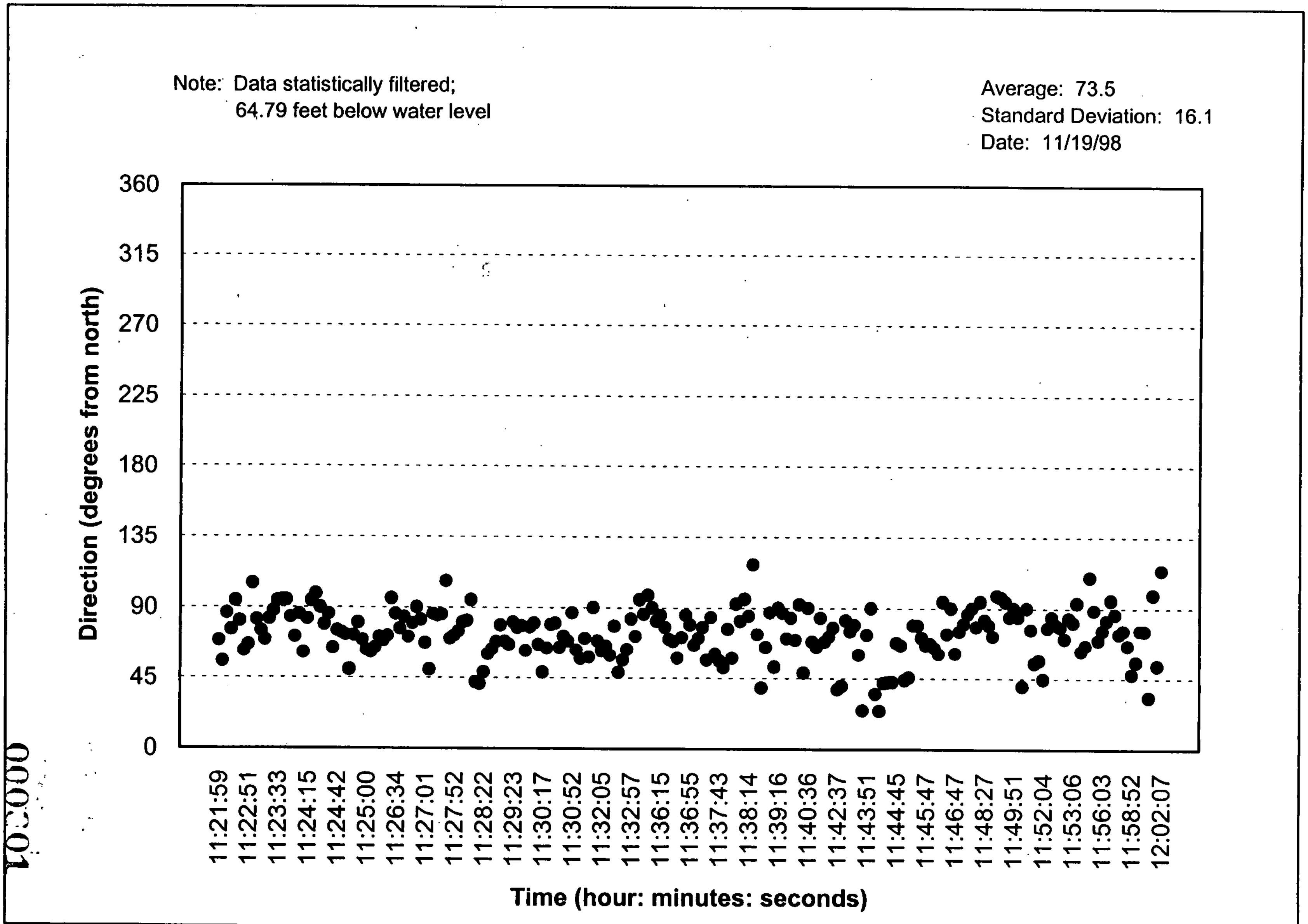


FIGURE A.3-87. FOURTH QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 3898 USING COLLOIDAL BORESCOPE

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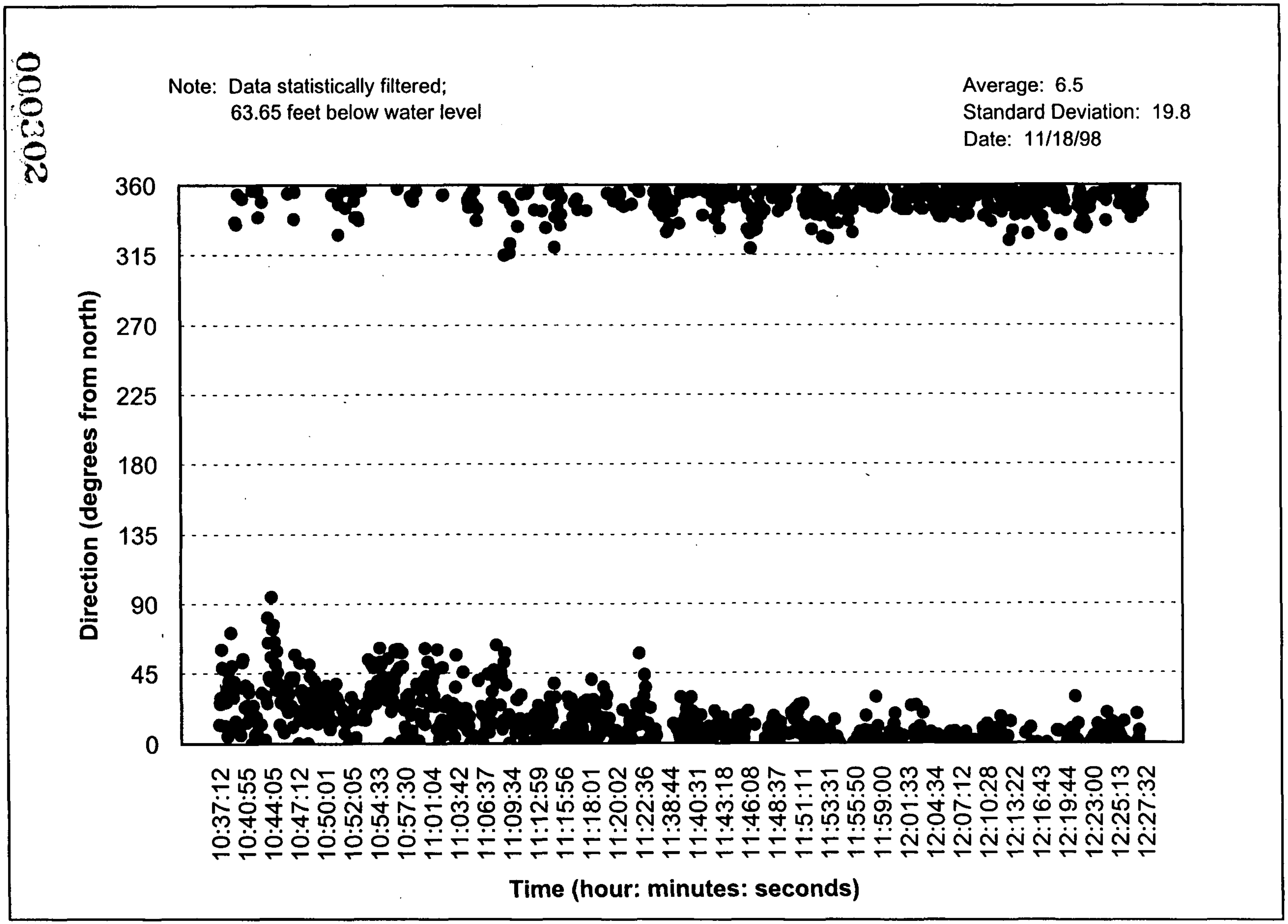

FIGURE A.3-88. FOURTH QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 3899 USING COLLOIDAL BORESCOPE

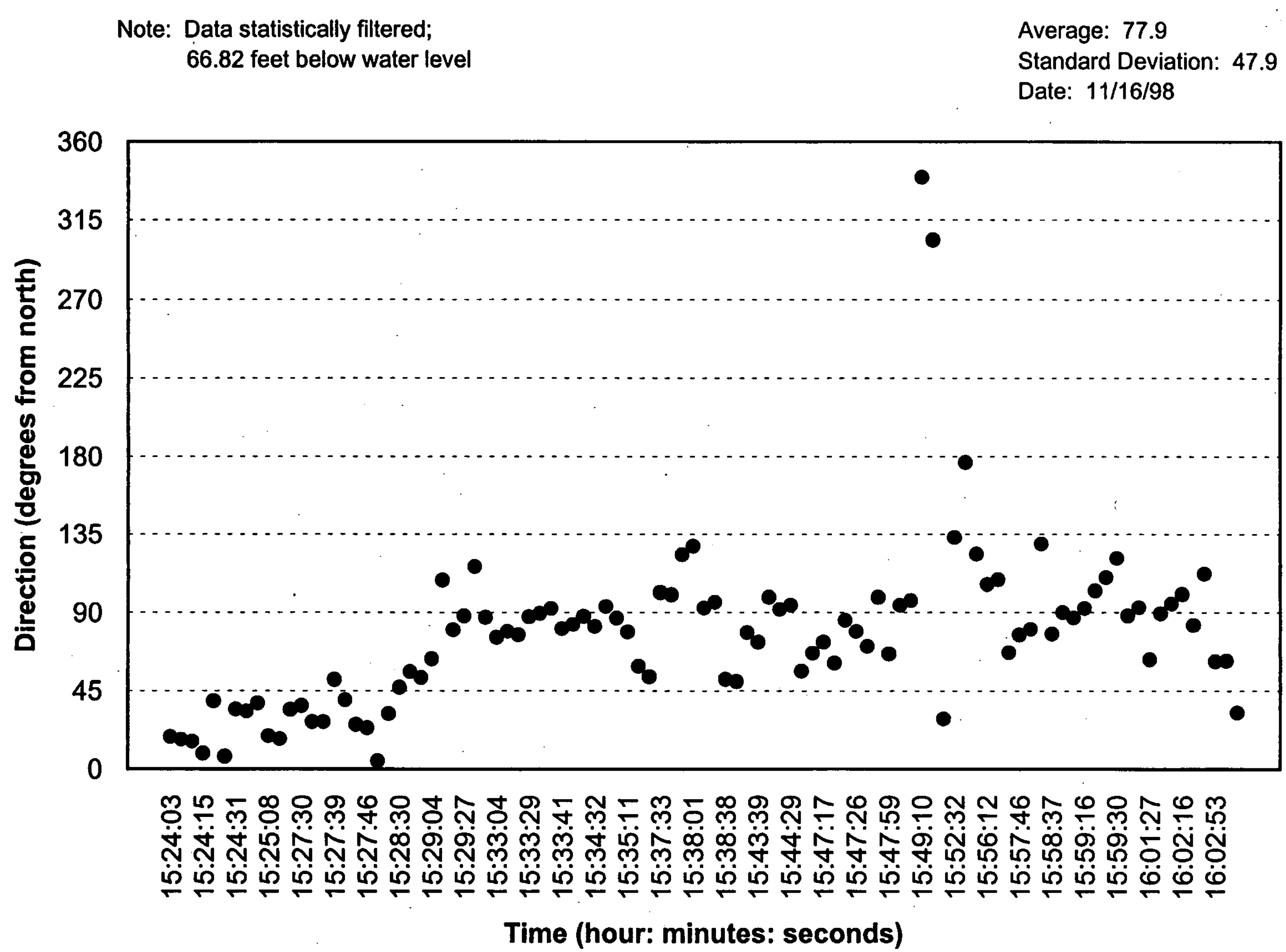

FIGURE A.3-89. FOURTH QUARTER GROUNDWATER FLOW DIRECTION IN MONITORING WELL 3900 USING COLLOIDAL BORESCOPE

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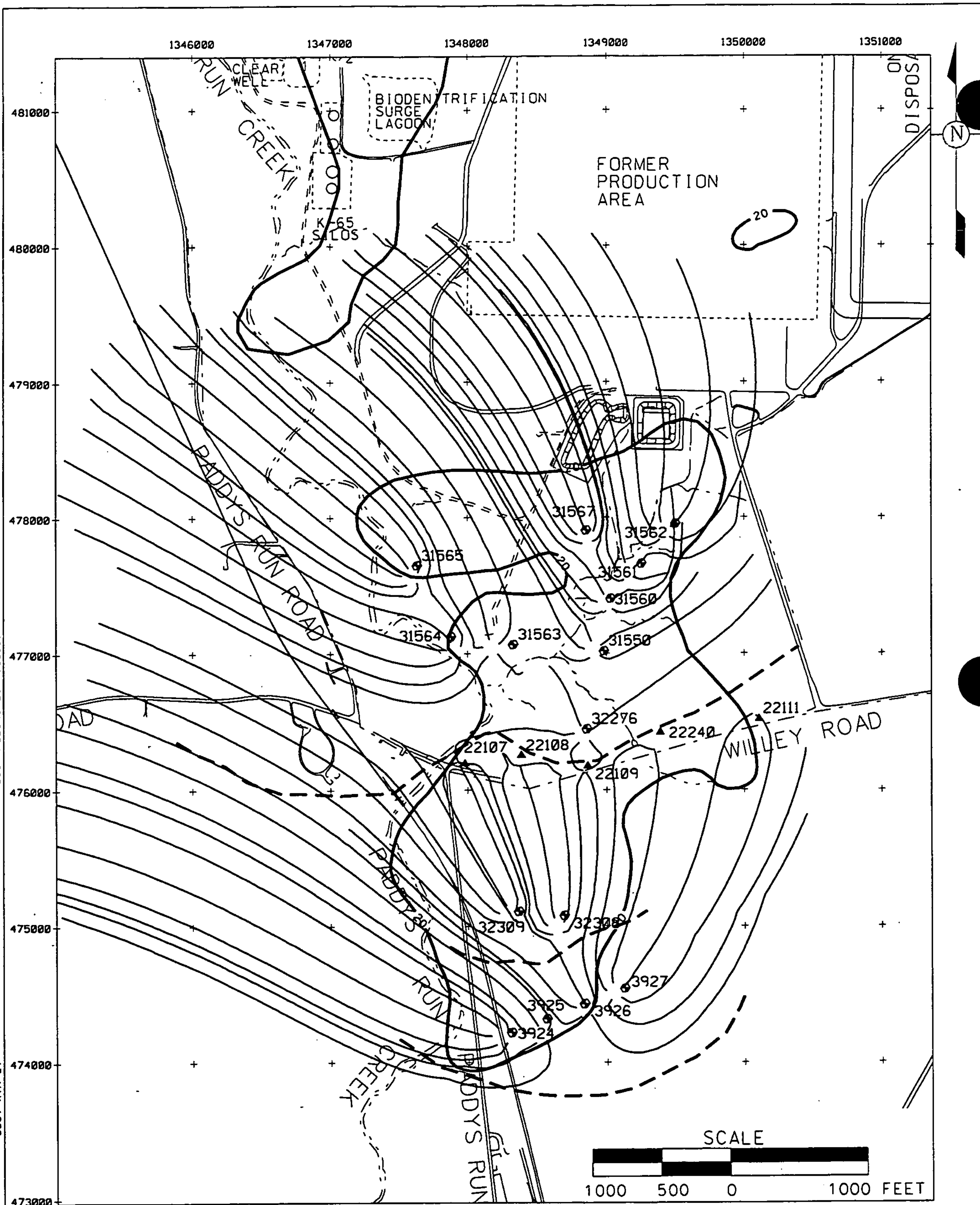

LEGEND:

FEMP BOUNDARY

EXTRACTION WELL

RE-INJECTION WELL

20 μg/L TOTAL URANIUM PLUME FROM FOURTH QUARTER 1998 DATA

INTERPRETED CAPTURE ZONES FROM TYPE 2 GROUNDWATER ELEVATIONS, FOURTH QUARTER 1998

v:\5fgp1\dgn\98annual\98an050.dgn

STATE PLANAR COORDINATE SYSTEM 1983

17-MAY-1999

000304

FIGURE A.3-90. MODELED PARTICLE TRACKS

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ATTACHMENT A.4

NON-URANIUM FRL EXCEEDANCES

ATTACHMENT A.4

This attachment to Appendix A evaluates non-uranium FRL exceedances which occurred in 1998. The purpose of the evaluation is to:

- Determine if 1998 non-uranium FRL exceedances result in the re-categorization of a constituent (Section A.4.1)
- Determine persistence of FRL exceedances outside of the 10-year, uranium-based restoration footprint (Section A.4.2)
- Summarize additional studies conducted in 1998 (i.e., identify correlations between specific constituent concentrations) (Section A.4.3)
- Identify conclusions (Section A.4.4).

A.4.1 RE-CATEGORIZATION OF NON-URANIUM FRL CONSTITUENTS BASED ON 1998 FRL EXCEEDANCES

Each year groundwater data are reviewed and monitoring constituent lists are evaluated to ensure that the sampling frequency for monitored constituents meets the criteria established for the program. The results of these evaluations are used to determine if the constituents should be re-categorized, which might change the monitoring frequency.

A.4.1.1 Background

Groundwater monitoring under the IEMP focuses on the 50 groundwater FRL constituents listed in the Record of Decision for Remedial Actions at Operable Unit 5 (DOE 1996). A detailed selection process was used to develop lists of constituents for groundwater monitoring of the aquifer restoration remedy. This process is presented in Appendix A of the IEMP (DOE 1997b).

For the purpose of modeling and monitoring, the aquifer was divided into different zones. A unique monitoring constituent list was initially developed for each zone, based on data collected from the aquifer from 1988 through 1995 and criteria defined in Appendix A of the IEMP.

Constituents were categorized based on whether or not they were mobile and persistent, and whether or not they had been detected above the FRL in the aquifer zone in question. The categories are defined as follows:

- >MP The constituent has been detected in the aquifer at concentrations greater than its established FRL and is considered "Mobile and Persistent". It has been predicted to be able to migrate vertically from the glacial overburden to the aquifer and has already caused an FRL exceedance in the aquifer.

- >N The constituent has been detected in the aquifer at concentrations greater than its established FRL but is "Not considered mobile and persistent". This constituent is not predicted to be able to migrate vertically through the glacial overburden, reach the aquifer, and create an unacceptable risk. Background conditions and/or surface water infiltrations may be the cause of the isolated FRL exceedances noted in the historical record.

- <MP The constituent has not been detected in the aquifer at concentrations greater than its established FRL, but is considered both "Mobile and Persistent". This constituent is predicted to be able to migrate vertically through the glacial overburden to the aquifer (if no source removal/control actions are taken), but as yet has not caused exceedances of its established FRL.

- <N The constituent has not been detected in the aquifer at concentrations greater than its established FRL and is "Not considered mobile and persistent".

If a new exceedance occurs in an aquifer zone for an FRL constituent, then the following criteria would trigger the need to re-categorize the constituent and increase its sampling frequency:

- For a <MP constituent, two consecutive FRL exceedances will result in re-categorization to a >MP constituent for the affected aquifer zone. An evaluation of each specific exceedance will be conducted to determine if re-sampling ahead of schedule is warranted.

- For a <N constituent, two consecutive FRL exceedances will result in re-categorization to a >N constituent for the affected aquifer zone. An evaluation of each specific exceedance will be conducted to determine if re-sampling ahead of schedule is warranted.

A.4.1.2 Evaluation

The criteria presented above were used to evaluate the non-uranium FRL constituents with exceedances in 1998 for re-categorization. Table A.4-1 lists the 1998 non-uranium FRL exceedances both inside and outside the 10-year, uranium-based restoration footprint and Figure A.4-1 identifies the location of these FRL exceedances. In 1998, 15 non-uranium FRL constituents had one or more FRL exceedances (Table A.4-1). As reported in Table A-2 of the IEMP, of the 15 constituents identified in

Table A.4-1, five (boron, chromium, fluoride, nitrate/nitrite as nitrogen, and technetium-99) have a "<" categorization (<MP) in one or more aquifer zones (note: <N constituents were not monitored in 1998 since they are only required to be monitored every five years). Correlation of the locations where the seven constituents had exceedances in 1998 with the aquifer zones defined in the IEMP indicate that only two constituents, chromium and fluoride, had FRL exceedances in aquifer zones currently categorized as <MP.

Figures A.4-2 through A.4-6 present the individual concentration versus time graphs for monitoring wells which had chromium and fluoride FRL exceedances in 1998 in an aquifer zone categorized as being <MP.

- FRL exceedances for chromium were detected in Aquifer Zone 0, in Monitoring Wells 2431 and 2733. Chromium is currently categorized as <MP in Aquifer Zone 0. The exceedance in Monitoring Well 2431 occurred in the fourth quarter of 1998. Data collected in 1999 are needed to decide if a categorization change from <MP to >MP is required. The exceedance in Monitoring Well 2733 occurred in the second quarter of 1998. Third and fourth quarter results from Monitoring Well 2733 indicate that the constituent does not need to be re-categorized.

- FRL exceedances for fluoride were detected in Aquifer Zone 0, in Monitoring Wells 2424 and 2431, and in Aquifer Zone 1, in Monitoring Well 3821. Fluoride is categorized as <MP in both aquifer zones. The exceedances at each well occurred in the fourth quarter of 1998. Data collected in 1999 are needed to decide if a categorization change from <MP to >MP in either aquifer zone is needed.

Re-categorization of the constituents to >MP for the affected aquifer zones is not required because two consecutive sampling rounds have not produced a FRL exceedance.

A.4.2 THE PERSISTENCE OF 1998 NON-URANIUM FRL EXCEEDANCES OUTSIDE THE 10-YEAR, URANIUM-BASED RESTORATION FOOTPRINT

The Restoration Area Verification Sampling Program Summary Report (DOE 1998d) states that any FRL exceedance outside the 10-year, uranium-based restoration footprint at the property boundary during routine monitoring would also be evaluated for persistence using the same conservative data evaluation method approved for the Restoration Area Verification Sampling Program, Project-Specific Plan (DOE 1997f) to determine if a change in the aquifer restoration remedy is required. This section presents an evaluation of the persistence of non-uranium FRL exceedances.

A.4.2.1 Background

Analytical data from samples collected immediately following an FRL exceedance are evaluated to determine if the detected exceedance is persistent. In accordance with the approved Restoration Area Verification Sampling method, if two or more sampling events following an FRL exceedance indicate that the concentration in question has decreased below the groundwater FRL, then the exceedance is not considered persistent.

If an FRL exceedance detected outside of the 10-year, uranium-based restoration footprint is determined to be not persistent, then no additional action is required above and beyond the routine groundwater monitoring specified in the IEMP. If an FRL exceedance is determined to be persistent, then the cause of the persistent exceedance needs to be identified, and its impact on the aquifer remedy design assessed. Ultimately, the cause needs to be addressed either through a modification of the aquifer remedy or by other means as applicable.

Results reported in Appendix A of the Restoration Area Verification Sampling Project-Specific Plan and the Restoration Area Verification Sampling Program Summary Report indicate that no persistent FRL exceedance was identified outside the 10-year, uranium-based restoration footprint. An evaluation of the data collected in 1997 for the IEMP, and reported in the 1997 Integrated Site Environmental Report, revealed three persistent FRL exceedances for manganese outside of the 10-year, uranium-based restoration footprint (Monitoring Wells 2426, 2430, and 2431), and possible persistent FRL exceedances for cadmium (Monitoring Well 2432), lead (Monitoring Well 3733), and zinc (Monitoring Wells 2426 and 3426). The 1998 non-uranium FRL exceedances along with these 1997 exceedances are addressed below.

A.4.2.2 Evaluation

Figure A.4-1 and Table A.4-1 identify the 1998 FRL exceedances. In 1998, six FRL constituents had one or more FRL exceedances at seven property boundary wells located outside the 10-year, uranium-based restoration footprint, as noted below:

Arsenic	Monitoring Well 2426
Chromium	Monitoring Well 2431, 2733, and 4067
Fluoride	Monitoring Well 2424, 2431, and 4067
Manganese	Monitoring Well 2426, 2430, and 2431
Vanadium	Monitoring Well 2426
Zinc	Monitoring Wells 2424, 2426, 2431, 4067, and 41217.

Table A.4-2 provides a summary of the 1998 FRL exceedances which occurred in the property boundary wells. Referring to Table A.4-2, no persistent FRL exceedances were identified outside of the 10-year, uranium-based restoration footprint using groundwater data collected in 1998. This includes confirmation of possible FRL exceedances detected in the later half of 1997 (also included in Table A.4-2). If two or more sampling events immediately following an FRL exceedance indicated that the concentration decreased below the FRL, then the exceedance was not identified as persistent.

- The following FRL exceedances detected in 1998 are not persistent:
  - Arsenic at Monitoring Wells 2426
  - Chromium at Monitoring Well 2733
  - Manganese at Monitoring Wells 2426, 2430, and 2431
  - Vanadium at Monitoring Well 2426
  - Zinc at Monitoring Well 2426.
- Data collected in 1999 are needed to determine the persistence of the following exceedances detected in 1998:
  - Chromium at Monitoring Wells 2431 and 4067
  - Fluoride at Monitoring Wells 2424, 2431, and 4067
  - Zinc at Monitoring Wells 2424, 2431, 2434, 4067, and 41217.
- The following FRL exceedances detected in 1997 are not persistent, based on 1998 monitoring data:
  - Cadmium at Monitoring Well 3432 during the second quarter of 1997
  - Lead at Monitoring Well 3733 during the third quarter of 1997
  - Zinc at Monitoring Well 2426 during the third quarter of 1997
  - Zinc at Monitoring Well 3426 during the second quarter of 1997.

Figures A.4-2 through A.4-5 (also used for the Section A.4.1 discussion) and A.4-7 through A.4-21 present individual concentration versus time graphs for all monitoring wells and constituents identified above. Additionally, FRL exceedances noted above for manganese, lead, and zinc could be associated with their trace concentrations in carbonate minerals.

A.4.2.3 <u>Discussion</u>

1998 marks the second year that an evaluation of the persistence of non-uranium FRL exceedances detected in property boundary wells located outside of the 10-year, uranium-based restoration footprint has been conducted as part of the IEMP. So far the evaluation has resulted in the identification of three persistent manganese FRL exceedances in 1997 at Monitoring Wells 2426, 2430, and 2431. However, data from 1998 indicate that the manganese concentrations in all three wells were again below the groundwater FRL for manganese. In other words, the FRL exceedances for manganese deemed persistent in the 1997 Integrated Site Environmental Report were not persistent in 1998.

Evaluating the data for persistence appears to be valuable in tracking changing conditions outside of the 10-year, uranium-based restoration footprint. Understanding why these manganese FRL exceedances are occurring will be helpful when efforts to certify the remedy as complete are initiated. So far, possibilities include:

- A contamination plume is present.
- The exceedances are due to natural concentrations in the aquifer.
- The exceedances are a combination of natural conditions and biofouling around the monitoring wells. Biofouling can elevate the manganese concentration around the well (Cullimore 1993).

First, a plume does not appear to be present. As explained in the 1997 Integrated Site Environmental Report, the FEMP is not a likely source for manganese contamination. Manganese or compounds with manganese were not used in operations at the FEMP, but according to the Remedial Investigation Report for Operable Unit 5 (DOE 1995b), manganese is a minor impurity (< 1 percent) in uranium ores and ore concentrates. Potential sources for manganese contamination at the FEMP were identified in the Feasibility Study Report for Operable Unit 5 as the waste pit area, flyash piles, South Field area, solid waste landfill, Plant 1 area, Plant 2/3 area, Plant 8 area, laboratory area, General Sump, and the Health and Safety Building. These potential source locations are not close to Monitoring Wells 2426, 2430, or 2431.

It is probable that the changing manganese concentrations in these three wells are natural. Unconsolidated glacial/alluvial aquifers in Ohio, like the Great Miami Aquifer, have relatively high manganese concentrations. Manganese is an impurity in shale and sandstone. Shale forms the floors and walls of the buried valley containing the sand and gravel comprising the Great Miami Aquifer beneath the FEMP. The FRL for manganese at the FEMP is based on the Great Miami Aquifer background value for the area of 0.9 mg/L. The persistent exceedances at Monitoring Wells 2426, 2430, and 2431 in 1997 were only slightly above background.

In 1998 the possibility that biofouling might have contributed to the elevated manganese concentrations was investigated. Metallic compounds are often bioaccumulated in a sequential manner around water wells. Iron and zinc concentrate very close to the well screen, while manganese accumulates further out (Cullimore 1993).

Monitoring Wells 2431, 2426, and 2430 were treated for biofouling on June 1, June 18, and October 29, 1998, respectively. Manganese concentrations before and after treatment are presented in Table A.4-3 and the data do not conclusively indicate that treating Monitoring Wells 2426, 2430, and 2431 for biofouling resulted in lower manganese concentrations. Figures A.4-10 through A.4-12 indicate the manganese concentration in Monitoring Wells 2426 and 2431 did decrease following treatment for biofouling, but the manganese concentration in Monitoring Well 2430 also decreased, and it had not yet been treated. Therefore, the liquid biofouling agent treatment, could have played a role in decreasing the manganese concentration at Monitoring Wells 2426 and 2431, but it could not have played a role in the decrease in manganese concentration at Monitoring Well 2430.

A.4.3 ADDITIONAL STUDIES

The following subsections provide discussions on the:

- Correlation of iron, manganese, and zinc concentrations
- Correlation of chloride, nickel, and chromium concentrations
- Correlation of hexavalent chromium and total chromium concentrations.

The commitments to perform these studies were identified in the 1997 Integrated Site Environmental Report.

A.4.3.1 Correlation of Iron, Manganese, and Zinc

It is thought that biofouling around well screens can lead to bioaccumulation of iron, manganese, and zinc (Cullimore 1993). Therefore, groundwater samples are being collected at the property boundary wells to determine if iron concentrations correlate with manganese and zinc concentrations. Analytical data will be used to determine if the wells should be redeveloped to address biofouling conditions. Although there are sufficient data for manganese and zinc, there are only two quarters of data available for iron (since sampling was not initiated for iron until the third quarter of 1998). Iron samples will continue to be collected at the property boundary wells in 1999, and the results will be reported in the 1999 Integrated Site Environmental Report.

A.4.3.2 Correlation of Chloride, Nickel, and Chromium Concentrations

In accordance with the 1997 Integrated Site Environmental Report, the U.S. Department of Energy (DOE) has reviewed historical data on chloride concentrations in monitoring wells with nickel and chromium exceedances to determine whether a correlation exists between chloride concentrations in the aquifer and the observed increase in nickel and chromium concentrations. Specifically, it was identified in the 1997 Integrated Site Environmental Report that chromium, nickel, and chloride concentrations were all increasing in Monitoring Well 2398. This well is not located near any known contaminant source, and there is no apparent reason for concentrations to increase in this well. Given the corrosive nature of chloride and the fact that nickel and chromium are both components of stainless steel, corrosion of the well casing was presented as a possibility for the increases.

Therefore, to determine if this situation was more widespread, chloride, nickel, and chromium data collected from 1988 through 1998 were reviewed and the Mann-Kendall statistical test for trend was used to determine the trends for chloride, nickel, and chromium concentrations at each well location. Out of all the groundwater monitoring wells at the FEMP, only Monitoring Well 2398 had an Up, Significant trend for all three constituents.

Discussions with site personnel revealed that corrosion of the stainless steel casing at Monitoring Well 2398, by the concentration of chlorides present, was very improbable. The cause of the simultaneous rise of chloride, nickel, and chromium concentrations in Monitoring Well 2398 is still unknown, but the rise in all three concentrations appears to be isolated to Monitoring Well 2398. Given that Monitoring Well 2398 is located within the 10-year, uranium-based restoration footprint, no additional actions beyond the scope of the current IEMP monitoring regime are required at this time.

A.4.3.3 Correlation of Hexavalent Chromium and Total Chromium Concentrations

Hexavalent chromium has a groundwater FRL of 0.022 mg/L. Because of the short laboratory holding times for hexavalent chromium, DOE is sampling for total chromium and making the conservative assumption that any exceedance for total chromium is an exceedance for hexavalent chromium. The following discusses the investigation of the valence state of chromium in groundwater at the FEMP to determine if hexavalent chromium is indeed present.

In 1998 groundwater data were collected at eight well locations at the FEMP to determine if hexavalent chromium was present in the Great Miami Aquifer, and if Eh-pH conditions would be supportive of the hexavalent chromium specie. Figure A.4-22 depicts the sample locations. The controlling document for the sampling program was the Project Specific Plan for Sampling Groundwater for Hexavalent Chromium (DOE 1998c). The locations sampled were selected because they had total chromium FRL exceedances in 1997 as reported in the 1997 Integrated Site Environmental Report.

A.4.3.3.1 Approach

Groundwater samples collected from the eight monitoring wells shown on Figure A.4-22 were analyzed for hexavalent chromium and total chromium (filtered and unfiltered) and compared to measured redox conditions (Eh-pH) taken at the same locations. Figure A.4-23 is an Eh-pH diagram for the system chromium, oxygen, and hydrogen at 25°C. At a pH of 7, the Eh needs to be 500 millivolts or more to form hexavalent chromium species (CrO_4^{2-}). Manganese samples (filtered and unfiltered) were also collected at each sample location. Manganese is relatively insoluble in the same Eh-pH range in which hexavalent chromium is stable. Therefore, dissolved manganese concentrations in the groundwater that exceeded 0.100 mg/L provide further supporting evidence that hexavalent chromium should not be present.

A.4.3.3.2 Evaluation

Hexavalent chromium, total chromium, and manganese concentrations (filtered and unfiltered) from this study are presented in Table A.4-4. The table also presents the maximum pH and Eh measured at each location, based on a minimum of 24 hours of measurements using a Hydrolab™ down-hole water quality probe. As identified in this table, hexavalent chromium was not detected in any of the groundwater samples and all the measured Eh-pH conditions indicate that groundwater is not oxidizing enough to support the presence of hexavalent chromium.

Figure A.4-24 is an Eh-pH diagram for the system chromium, oxygen, and hydrogen at 25°C. Results for Monitoring Wells 2386, 3045, 2398, 2648, and 2054 are posted on the figure based on the conditions measured at these locations. As the data indicate, all five locations are below the region of Eh-pH space that would be stable for hexavalent chromium.

Eh and pH conditions were not measured in Monitoring Well 41217 due to equipment limitations. However, the filtered manganese concentration measured at Monitoring Well 41217 was 0.136 mg/L, indicating that Eh-pH conditions were not oxidizing enough to support the presence of hexavalent chromium. The data collected to date in support of the re-injection demonstration indicate that Eh-pH conditions become more reduced with depth. Because hexavalent chromium requires oxidizing conditions it seems very unlikely that hexavalent chromium would be present at the depth of a Type 4 well screen.

Based on the data collected, it can be concluded that at the sampled locations, hexavalent chromium is not present in the aquifer and Eh-pH conditions measured in the aquifer are not oxidizing enough to support the presence of hexavalent chromium. Therefore, the total chromium concentrations measured and reported in the 1997 Integrated Site Environmental Report must be due to trivalent chromium.

A.4.4 CONCLUSIONS

From the above sections, the following conclusions can be made from review of the 1998 non-uranium FRL exceedance data:

- Re-categorization of FRL constituents is not required, and the sampling frequency used in 1998 to sample FRL constituents does not need to be changed.
- There are no new persistent FRL exceedances outside of the 10-year, uranium-based restoration footprint that would require a change in the design of the aquifer remedy at this time. Also, no change will be made to the aquifer remedy at this time to address the persistent manganese FRL exceedances detected in 1997 at Monitoring Wells 2426, 2430, and 2431. The manganese concentrations in these three wells will continue to be tracked.
- Samples will continue to be collected from the property boundary wells to determine if iron concentrations correlate with manganese and zinc concentrations. The data may be useful to evaluate whether monitoring wells should be redeveloped to address biofouling conditions. Results will be reported through IEMP reports.

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- There is no correlation between nickel, chromium, and chloride concentrations in the aquifer, with the exception of Monitoring Well 2398.
- Aquifer conditions at the FEMP do not support the presence of hexavalent chromium, rather they are supportive of the presence of trivalent chromium.

TABLE A.4-1

SUMMARY STATISTICS AND TREND ANALYSIS FOR NON-URANIUM CONSTITUENTS WITH 1998 RESULTS ABOVE FINAL REMEDIATION LEVELS

Constituent (FRL)[a]	Monitoring Well	No. of Samples[b,c,d]	No. of Samples Above FRL[b,c,d]	No. of Samples Above FRL for 1998[c,d]	Minimum[b,c,d,e,f] (mg/L)	Maximum[b,c,d,e,f,g] (mg/L)	Average[b,c,d,e,f,g] (mg/L)	Standard Deviation[b,c,d,e,f,g] (mg/L)	Trend[b,c,d,e,f,g]
Antimony (0.0060 mg/L)	2386	4	1	1	0.000025	0.0225	0.014	0.011	No Significant Trend
Arsenic (0.050 mg/L)	2426	22	3	2	0.00075	0.146	0.023	0.044	Up, Significant
Boron (0.33 mg/L)	2049	6	4	2	0.154	1.14	0.564	0.361	No Significant Trend
Carbon Disulfide (5.5 μg/L)	2649	5	1	1	0.3	7	3.5	2.6	No Significant Trend
Chromium (0.022 mg/L)[h]	2032	2	2	1	0.029	0.0478	NA	NA	NA
	2054	4	3	2	0.0025	0.0474	0.030	0.021	No Significant Trend
	2106	23	3	2	0.001	0.095	0.01	0.02	Up, Significant
	2118	4	2	1	0.0025	0.0582	0.029	0.024	No Significant Trend
	2386	4	2	1	0.002	8.51	2	4	Up, Significant
	2387	3	2	1	0.0021	0.0795	0.035	NA	NA
	2398	23	11	4	0.00145	0.212	0.0511	0.0656	Up, Significant
	2431	21	1	1	0.0007	0.0308	0.004	0.006	No Significant Trend
	2733	22	2	1	0.00135	0.0533	0.00749	0.0115	No Significant Trend
	3385	3	2	1	0.002	0.0367	0.02	NA	NA
	3387	3	1	1	0.002	0.128	0.05	NA	NA
	4067	23	1	1	0.001	0.0458	0.004	0.009	No Significant Trend
Fluoride (4 mg/L)	2424	22	1	1	0.22	5.3	0.77	1.1	No Significant Trend
	2431	21	1	1	0.08	12.3	0.9	2.6	No Significant Trend
	3821	4	1	1	0.19	5.76	1.6	2.8	No Significant Trend
	4067	24	1	1	0.08	11.3	0.8	2.3	No Significant Trend
Lead (0.015 mg/L)	3387	3	1	1	0.002	0.0437	0.02	NA	NA
Manganese (0.90 mg/L)	2385	3	2	1	0.384	9.15	3.58	NA	NA
	2386	4	1	1	0.0005	1.43	0.4	0.7	Up, Significant
	2426	22	6	2	0.326	4.55	1.09	1.07	Up, Significant
	2430	22	5	2	0.131	1.69	0.695	0.364	Up, Significant
	2431	21	5	2	0.237	5.52	0.880	1.20	Up, Significant
	2648	5	3	1	0.566	2.93	1.64	1.06	No Significant Trend
	3027	3	3	1	1.29	1.69	1.42	NA	NA
	3385	3	2	1	0.352	1.79	1.03	NA	NA
	3387	3	1	1	0.406	3.41	1.53	NA	NA
	3880	3	1	1	0.33	1.18	0.62	NA	NA

TABLE A.4-1
(Continued)

Constituent (FRL)[a]	Monitoring Well	No. of Samples[b,c,d]	No. of Samples Above FRL[b,c,d]	No. of Samples Above FRL for 1998[c,d]	Minimum[b,c,d,e,f]	Maximum[b,c,d,e,f,g]	Average[b,c,d,e,f,g]	Standard Deviation[b,c,d,e,f,g]	Trend[b,c,d,e,f,g]
Molybdenum (0.10 mg/L)	2649	4	4	1	0.359	0.69	0.54	0.14	No Significant Trend
Nickel (0.10 mg/L)	2386	4	1	1	0.0095	1.42	0.38	0.69	Up, Significant
	2387	3	1	1	0.0095	0.179	0.071	NA	NA
	2398	23	9	4	0.003	0.791	0.11	0.18	Up, Significant
	3387	3	1	1	0.0095	0.141	0.057	NA	NA
Nitrate/Nitrite (11 mg/L)[i]	2648	4	2	1	0.15	20	8.1	9.5	No Significant Trend
	2649	4	4	2	36	73.6	50	16	No Significant Trend
	3009	4	1	1	1.39	16.6	6.94	7.03	No Significant Trend
Technetium-99 (94 pCi/L)	2649	3	3	2	130.587	1207.77	825.908	NA	NA
Trichloroethene (5.0 μg/L)	2649	5	4	1	0.5	150	100	60	No Significant Trend
Vanadium (0.038 mg/L)	2426	22	1	1	0.0002	0.0664	0.007	0.015	No Significant Trend
Zinc (0.021 mg/L)	2385	3	1	1	0.0056	0.0223	0.013	NA	NA
	2398	22	1	1	0.00145	0.0304	0.00703	0.00656	No Significant Trend
	2424	23	7	2	0.00065	0.239	0.028	0.052	No Significant Trend
	2426	22	5	2	0.0008	0.047	0.012	0.014	No Significant Trend
	2431	21	3	2	0.00145	0.0917	0.0140	0.0227	No Significant Trend
	2434	22	2	1	0.0008	0.0385	0.007	0.009	No Significant Trend
	2648	5	4	1	0.003	0.127	0.06	0.05	No Significant Trend
	3106	23	2	1	0.001	0.0789	0.008	0.016	No Significant Trend
	3385	3	2	1	0.014	0.0656	0.045	NA	NA
	3387	3	2	1	0.0121	0.162	0.0704	NA	NA
	3397	3	2	1	0.0034	0.114	0.049	NA	NA
	3821	3	1	1	0.0029	0.0485	0.019	NA	NA
	4067	23	2	2	0.00085	13.6	0.61	2.8	Up, Marginal
	41217	21	2	1	0.002	0.0256	0.009	0.006	Down, Significant

Note: Highlighting indicates well is outside the 10-year, uranium-based restoration footprint.

[a]From Operable Unit 5 Record of Decision, Table 9-4

[b]Based on unfiltered samples from the Operable Unit 5 remedial investigation/feasibility study data set (1988 through 1993) and 1994 through 1998

[c]If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the number of samples, and the sample with the maximum concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation [SD]) and Mann-Kendall test for trend.

[d]Rejected data qualified with either a R or Z were not included in the count, the summary statistics, or Mann-Kendall test for trend.

[e]If the number of samples is greater than or equal to four, then the Mann-Kendall test for trend and all of the summary statistics are reported. If the number of samples is equal to three, then the minimum, maximum, and average are reported. If the number of samples is equal to two, then the minimum and maximum are reported. If the number of samples is equal to one, then the data point is reported as the minimum.

[f]For results where the concentrations are below the detection limit, the results used in the summary statistics and Mann-Kendall test for trend are each set at half the detection limit.

[g]NA = not applicable

[h]FRL based on hexavalent chromium, from Operable Unit 5 Record of Decision, Table 9-4; however, the sampling results are for total chromium.

[i]FRL based on nitrate, from Operable Unit 5 Record of Decision, Table 9-4

TABLE A.4-2

SUMMARY OF PERSISTENCE EVALUATION OF NON-URANIUM FRL EXCEEDANCES OUTSIDE OF THE 10-YEAR, URANIUM-BASED RESTORATION FOOTPRINT

Constituent	Monitoring Well	Pertinent 1997 Results	1998 FRL Exceedance				Evaluation Results for 1998	Figure No.
			First Qtr	Second Qtr	Third Qtr	Fourth Qtr		
Arsenic	2426		Y	Y	N	N	Not Persistent	A.4-7
Cadmium	3432	Third Quarter FRL Exceedance	N	N	N	N	Not Persistent	A.4-19
Chromium	2431		N	N	N	Y	Additional Data Required	A.4-2
	2733		N	Y	N	N	Not Persistent	A.4-3
	4067		N	N	Y	N	Additional Data Required	A.4-8
Fluoride	2424		N	N	N	Y	Additional Data Required	A.4-4
	2431		N	N	N	Y	Additional Data Required	A.4-5
	4067		N	N	N	Y	Additional Data Required	A.4-9
Lead	3733	Third Quarter FRL Exceedance	N	N	N	N	Not Persistent	A.4-20
Manganese	2426	Persistent Exceedance	Y	Y	N	N	Not Persistent	A.4-10
	2430	Persistent Exceedance	Y	Y	N	N	Not Persistent	A.4-11
	2431	Persistent Exceedance	Y	Y	N	N	Not Persistent	A.4-12
Vanadlum	2426		N	Y	N	N	Not Persistent	A.4-13
Zinc	2424		N	N	Y	N	Additional Data Required	A.4-14
	2426	Third Quarter FRL Exceedance	Y	Y	N	N	Not Persistent	A.4-15
	2431		N	N	Y	Y	Additional Data Required	A.4-16
	3426	Third Quarter FRL Exceedance	N	N	N	N	Not Persistent	A.4-21
	4067		N	N	Y	Y	Additional Data Required	A.4-17
	41217		N	N	Y	N	Additional Data Required	A.4-18

000320

TABLE A.4-3

MANGANESE RESULTS FOR THE TREATMENT OF MONITORING WELLS 2426, 2430, AND 2431 FOR BIOFOULING

Monitoring Well	Biofouling Treatment Date	Sample Date January 1998	April 1998	July 1998	October 1998
		(mg/L)	(mg/L)	(mg/L)	(mg/L)
2426	6/18/98	4.55	2.99	0.548	0.565
2430	10/29/98	1.69	1.28	0.131	0.608[a]
2431	6/1/98	5.52	2.09	0.241	0.742

[a]Sample was collected in October before well was re-habilitated.

TABLE A.4-4

Summary Table of Sampling Results for the Presence of Hexavalent Chromium in the Aquifer

Monitoring Well	Sample Date		Hexavalent Chromium[a]	Total Chromium[a]	Manganese[a]	pH[b]	Eh[b]
			(mg/L)	(mg/L)	(mg/L)		(mV)
2032	11/17/98	filtered	ND	ND	ND	8.25	333
		unfiltered	ND	0.0545	0.0133		
3032	11/17/98	filtered	ND	0.0068	0.0063	7.78	252
		unfiltered	ND	0.0153	0.205		
2648	11/17/98	filtered	ND	0.007	1.89	6.92	390
		unfiltered	ND	0.0139	1.94		
2054	11/18/98	filtered	ND	ND	0.418	7.2	128
		unfiltered	ND	0.0077	0.645		
3045	12/2/98	filtered	ND	ND	0.0106	7.28	323
		unfiltered	ND	ND	0.119		
2386	12/2/98	filtered	ND	ND	0.217	7.13	365
		unfiltered	ND	1.05	0.222		
2398	12/2/98	filtered	ND	ND	0.0071	7.47	375
		unfiltered	ND	0.0741	0.0138		
41217[c]	12/2/98	filtered	ND	ND	0.136	NS	NS
		unfiltered	ND	ND	0.139		

[a]ND = not detected. The detection limit for hexavalent chromium (filtered and unfiltered) was 0.006 mg/L. The detection limit for total chromium ranged from 0.0006 to 0.0107 mg/L (filtered) and 0.0033 to 0.004 mg/L (unfiltered). The detection limit for manganese (filtered) was 0.0043 mg/L.
[b]Maximum pH and Eh, based on a minimum of 24 hours of measurements using a Hydrolab™ down-hole water quality probe
[c]NS = not sampled due to equipment limitations.

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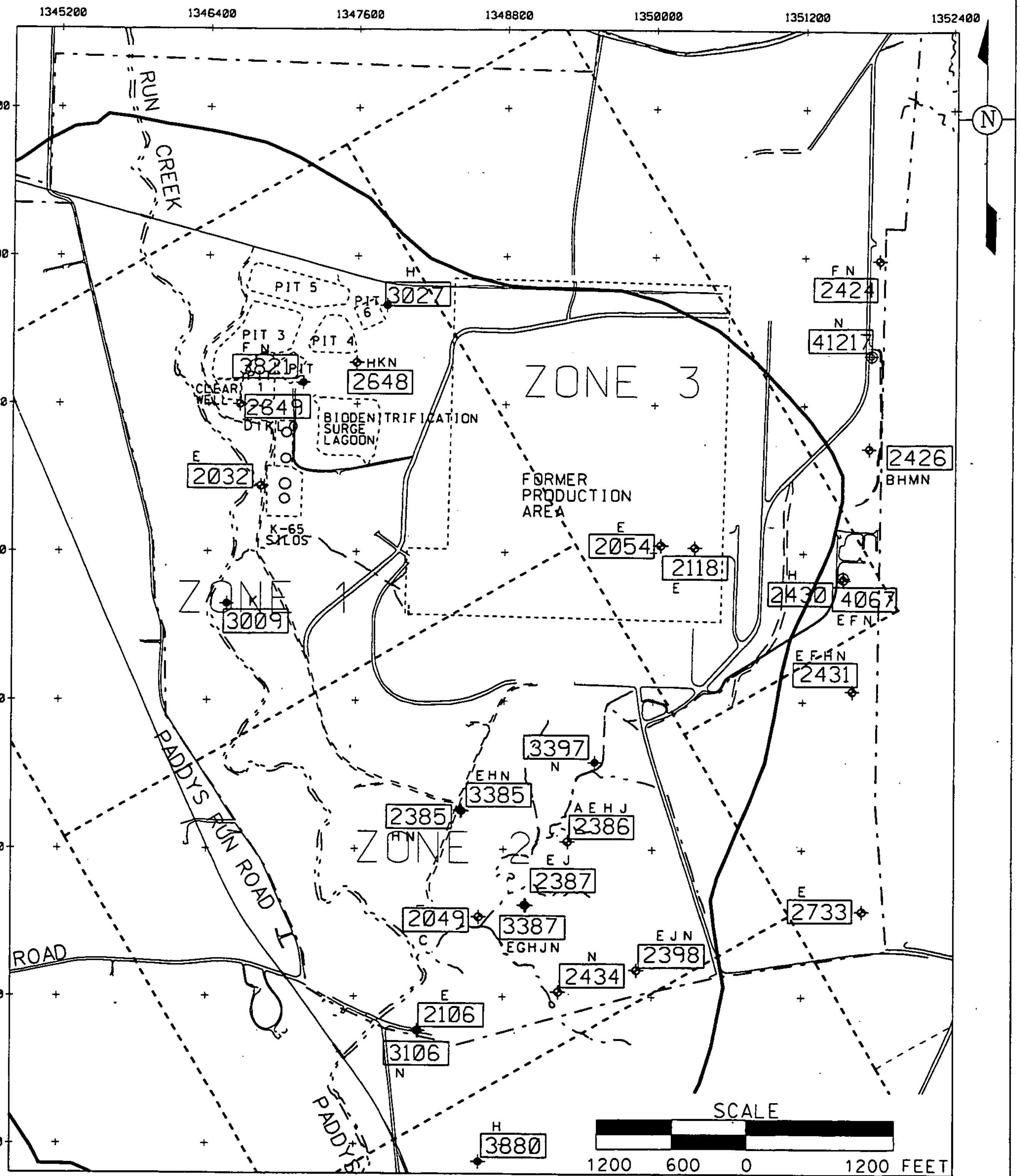
v:*5fgp1*dgn*98annual*98an030.dgn



STATE PLANAR COORDINATE SYSTEM 1983

05-MAY-1999

FRL EXCEEDANCE KEY:

A ANTIMONY
B ARSENIC
C BORON
D CARBON DISULFIDE
E CHROMIUM
F FLUORIDE
G LEAD
H MANGANESE
I MOLYBDENUM
J NICKEL
K NITRATE/NITRITE
L TRICHLOROETHENE
M VANADIUM
N ZINC
O TECHNETIUM-99

LEGEND:

- FEMP BOUNDARY
- MONITORING WELL LOCATIONS WITH FRL EXCEEDANCE
- 10-YEAR, URANIUM-BASED RESTORATION FOOTPRINT
- AQUIFER ZONE BOUNDARY

FIGURE A.4-1. NON-URANIUM CONSTITUENTS WITH 1998 RESULTS ABOVE FINAL REMEDIATION LEVELS

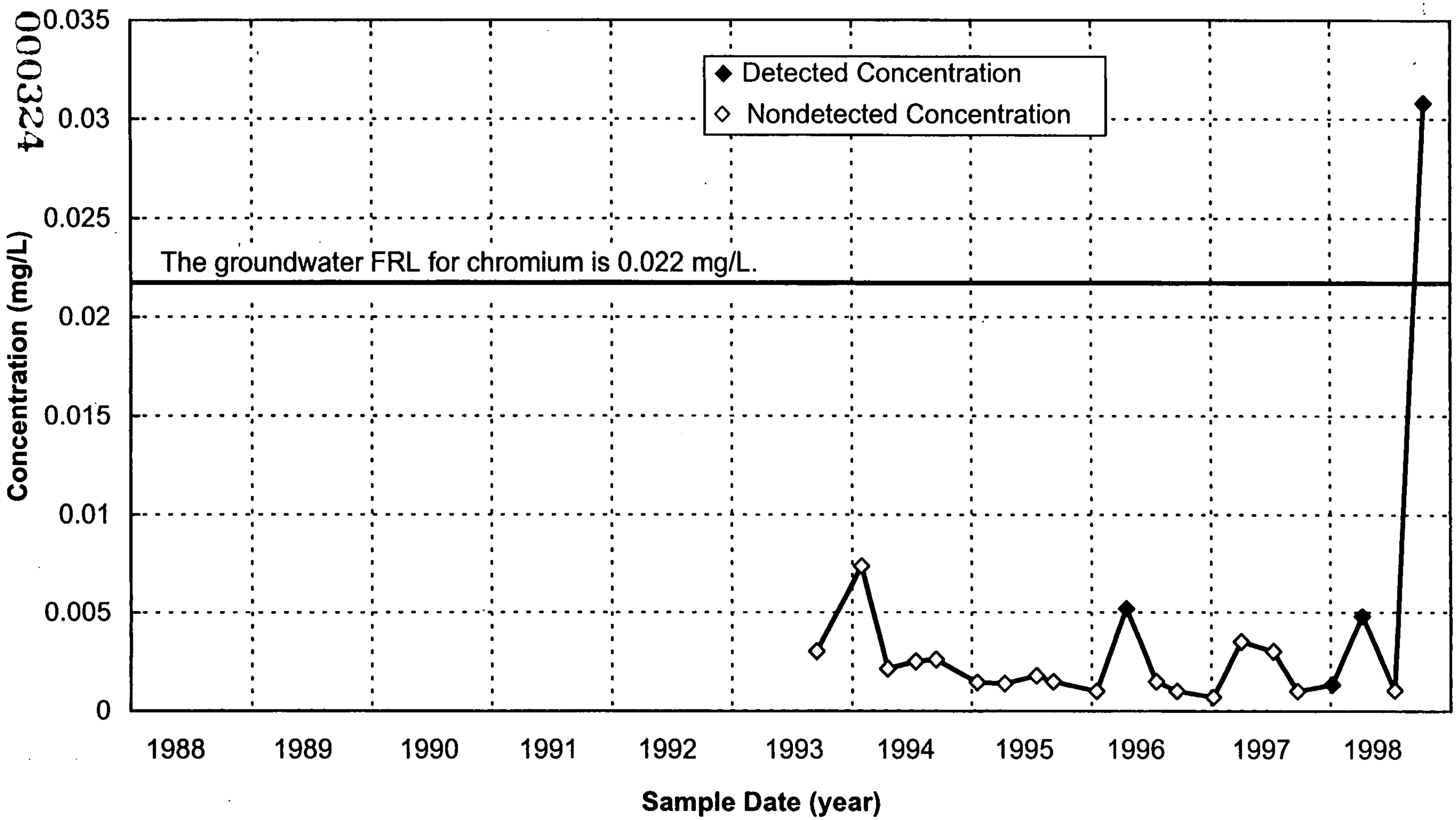


FIGURE A.4-2. CHROMIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2431

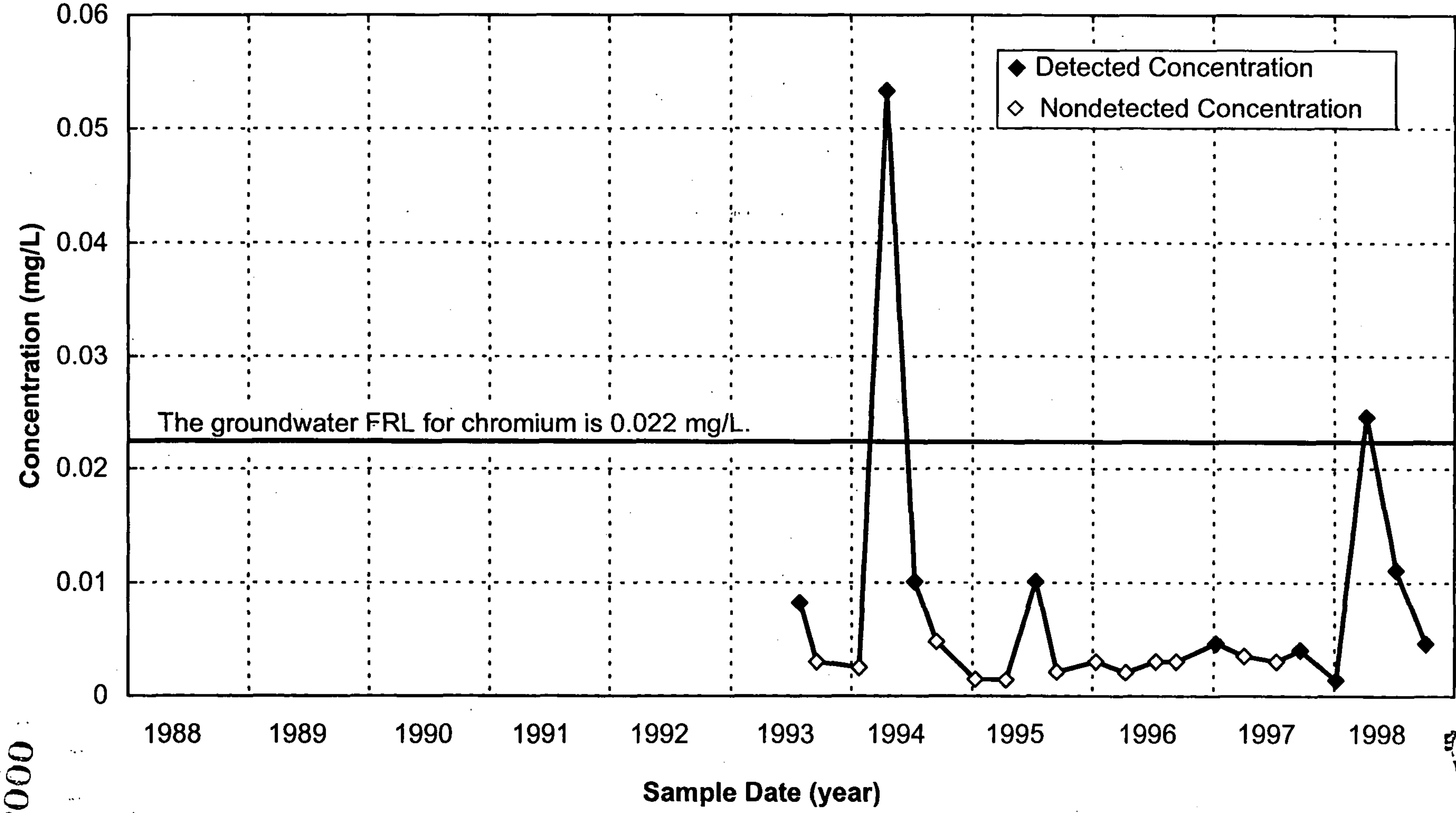


FIGURE A.4-3. CHROMIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2733

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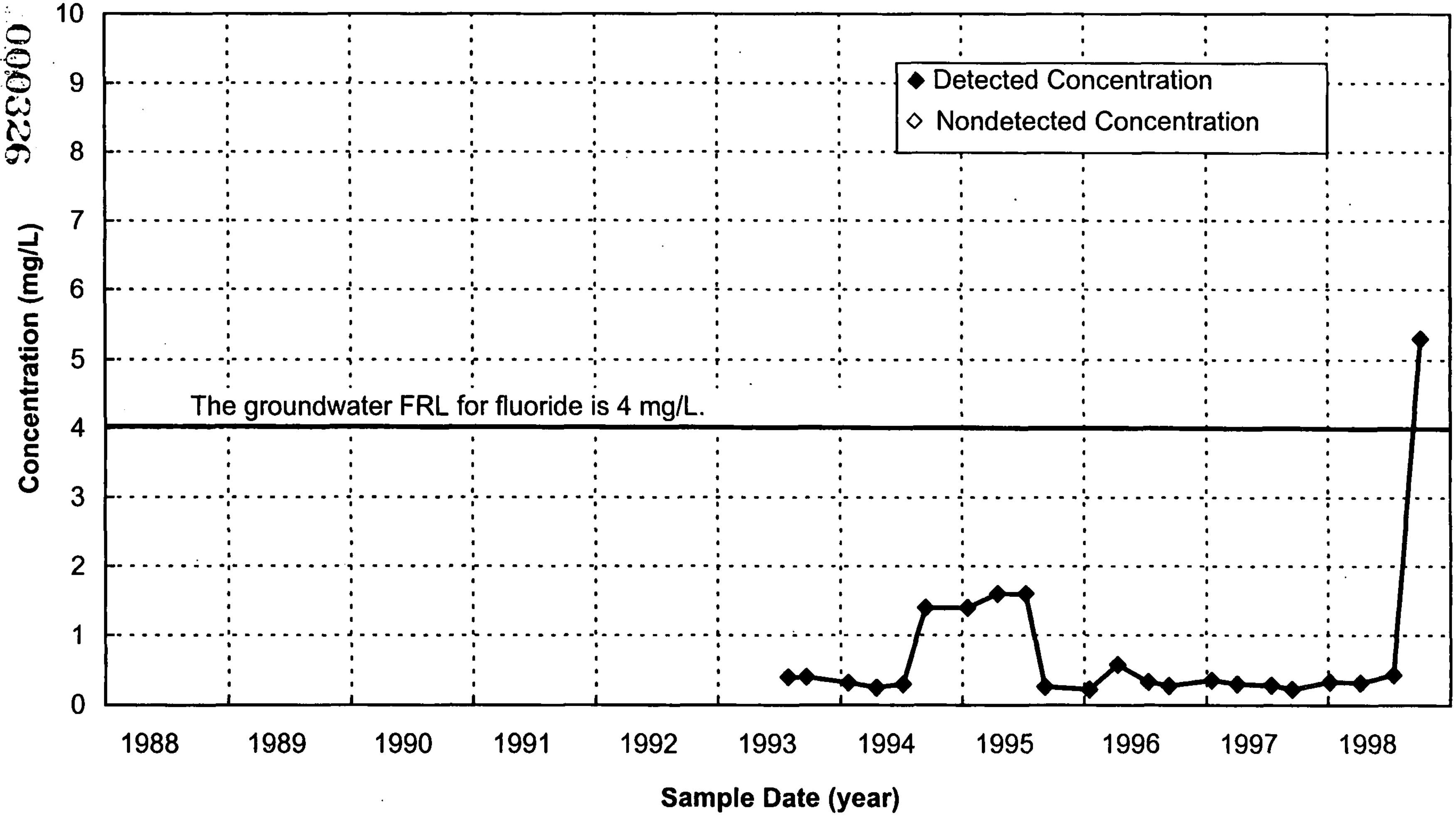


FIGURE A.4-4. FLUORIDE CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2424

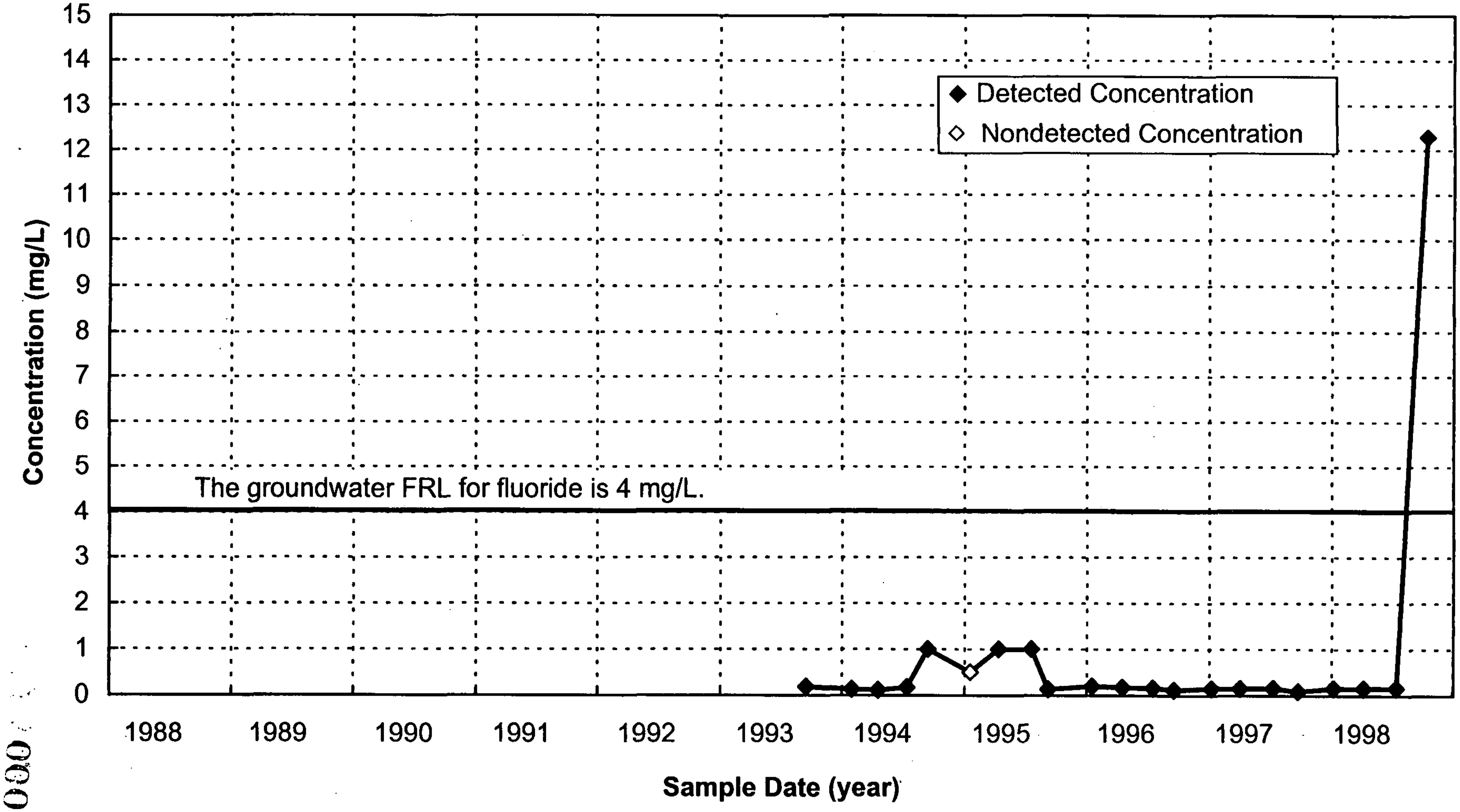


FIGURE A.4-5. FLUORIDE CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2431

000327

2272

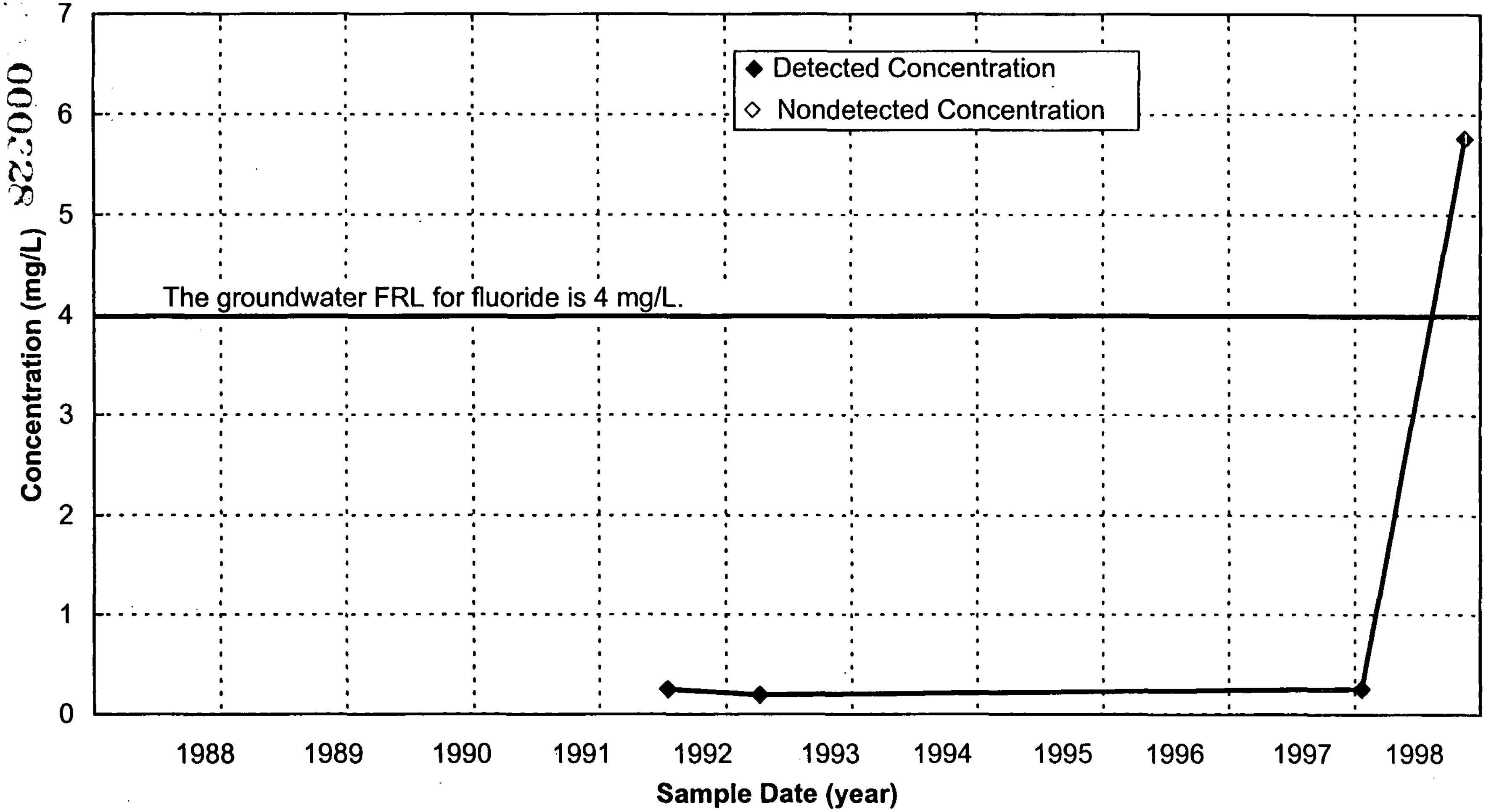


FIGURE A.4-6. FLUORIDE CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 3821

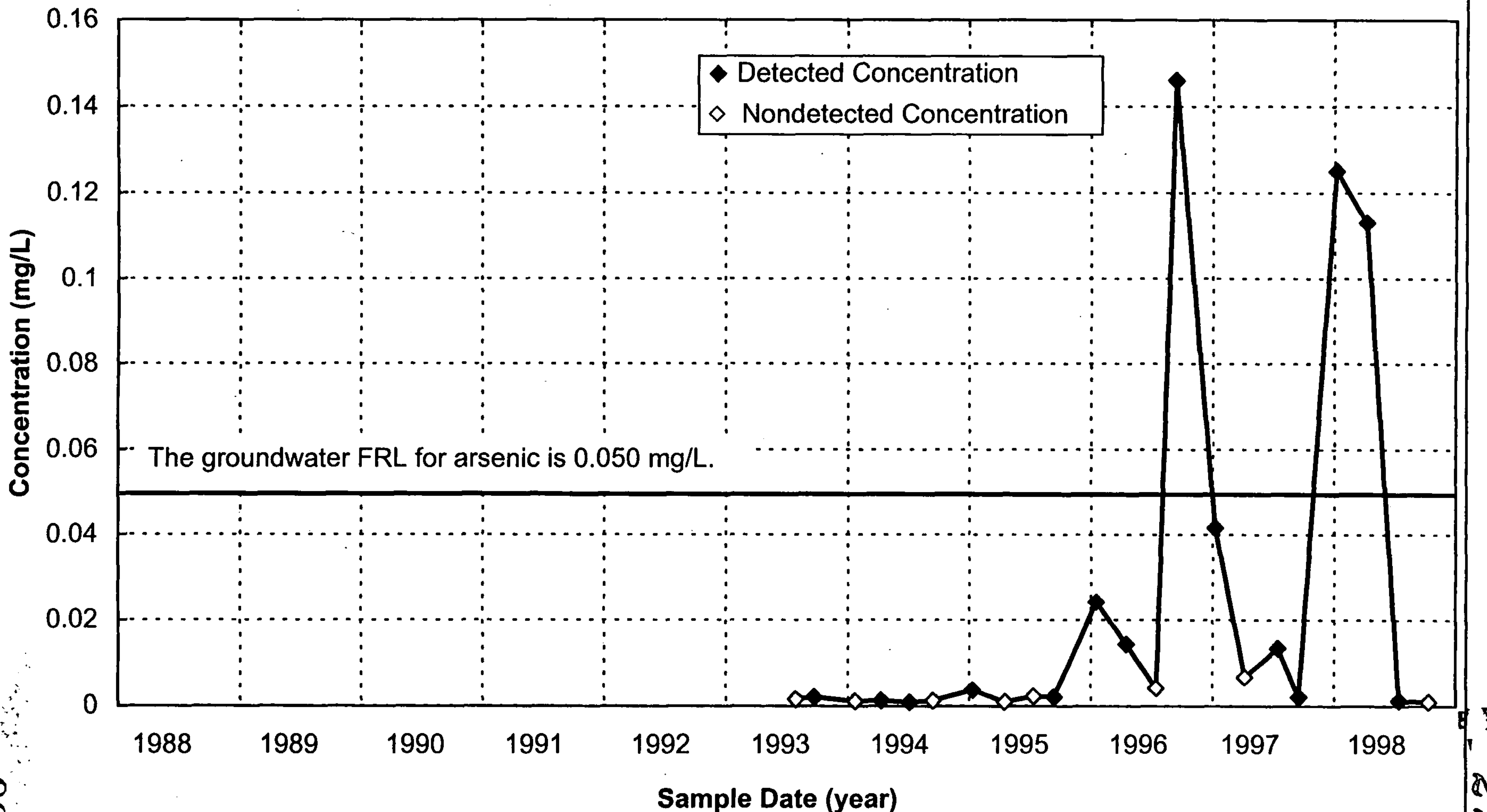


FIGURE A.4-7. ARSENIC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2426

000329

2272

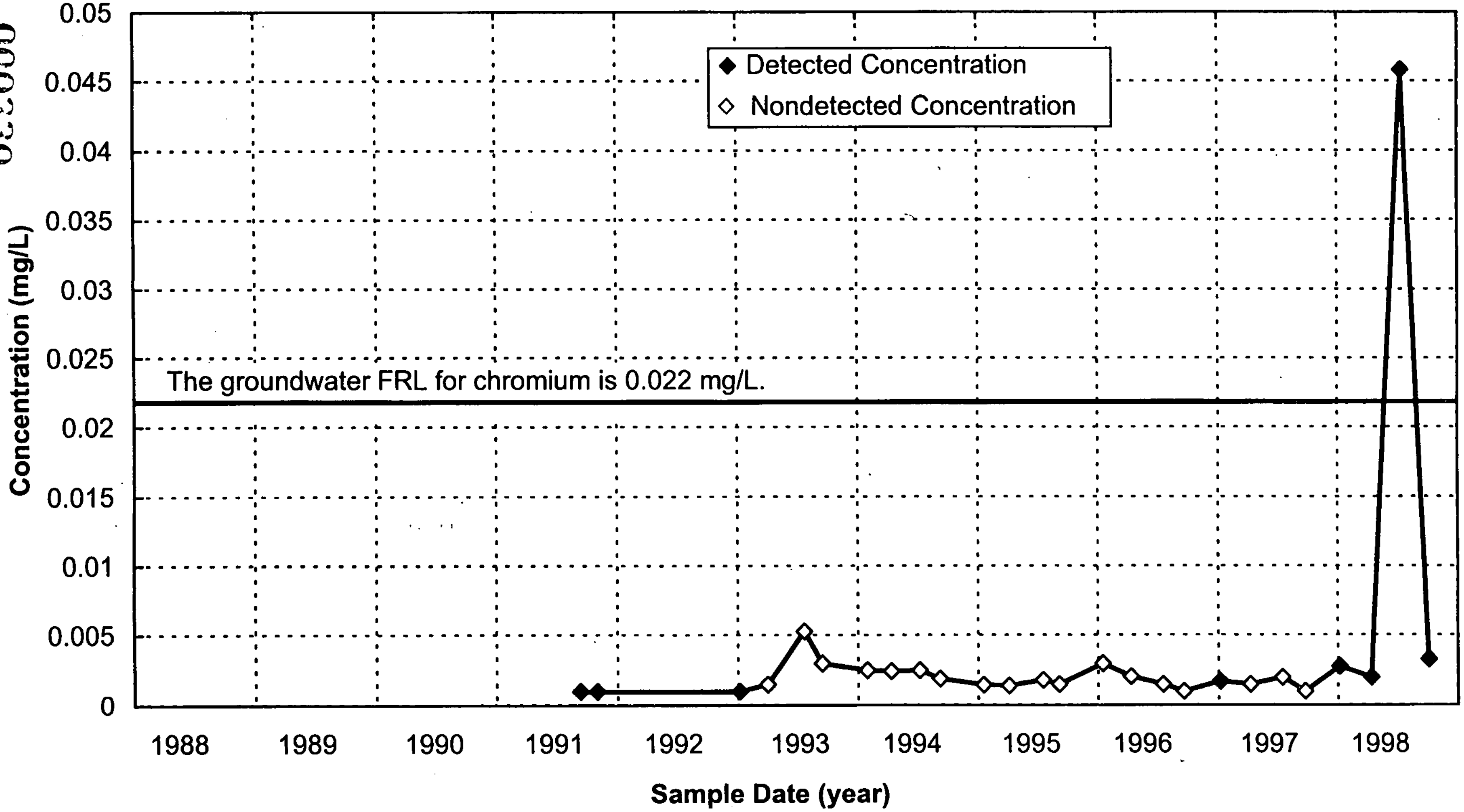


FIGURE A.4-8. CHROMIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 4067

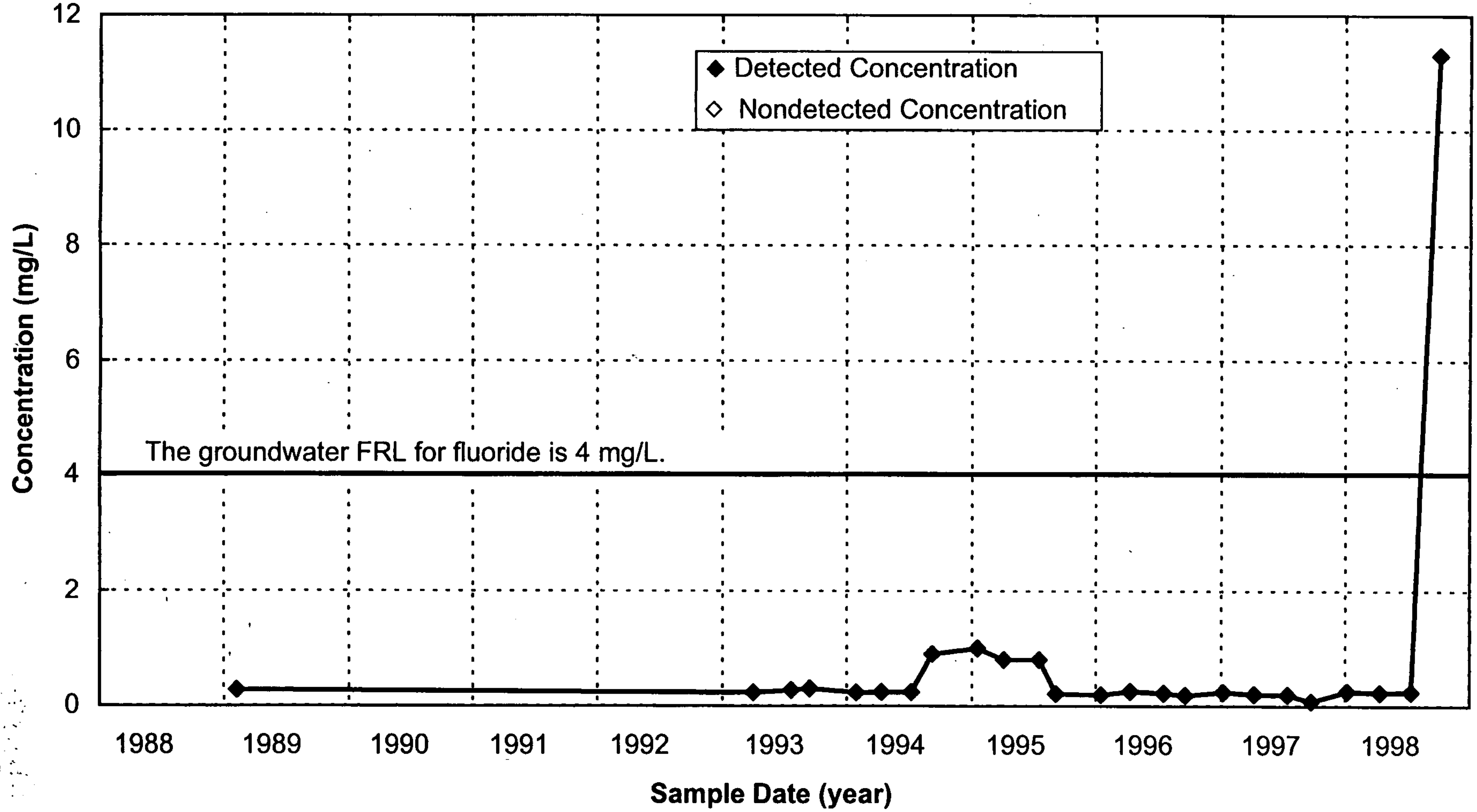


FIGURE A.4-9. FLUORIDE CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 4067

000331

2272

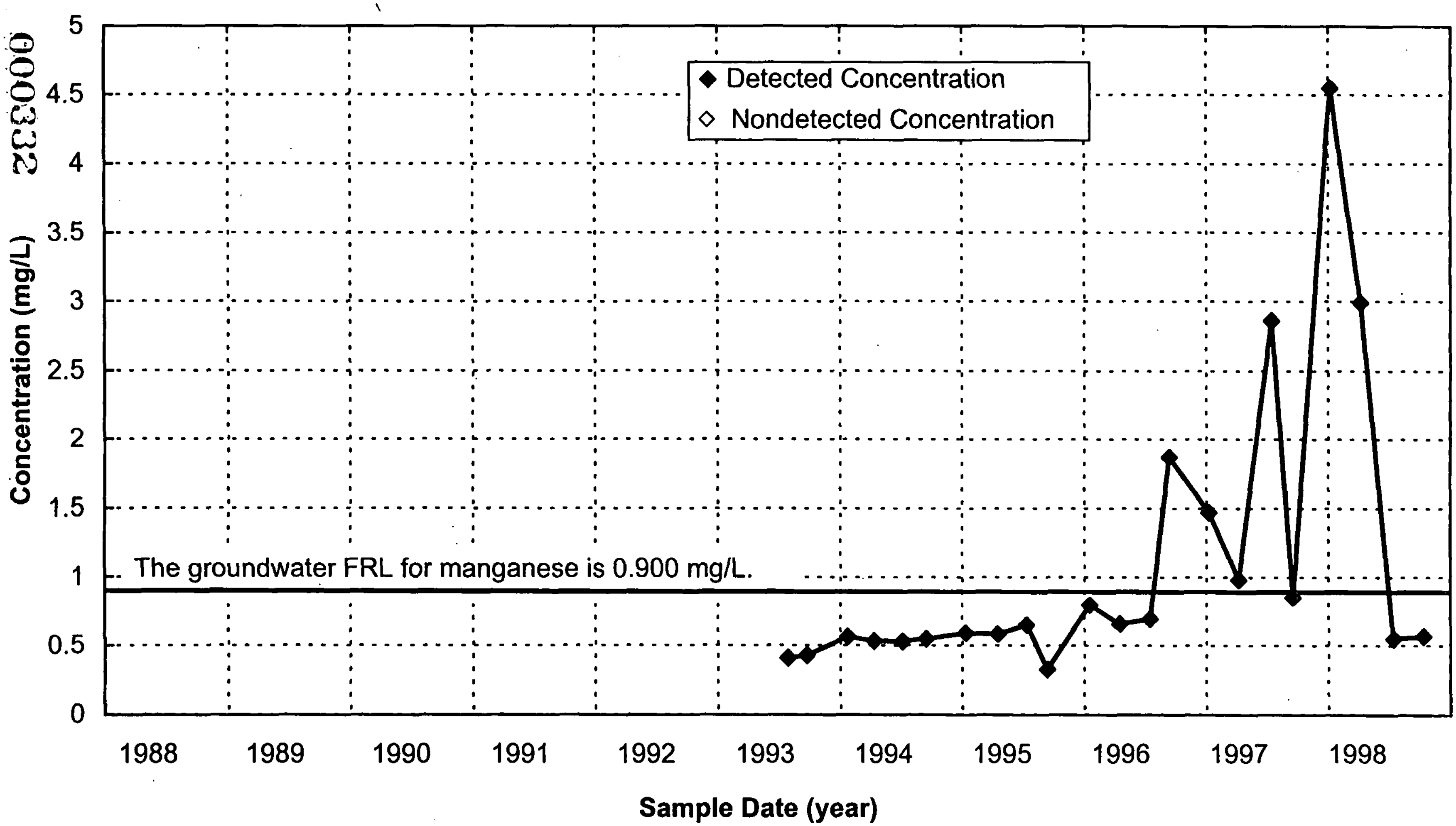


FIGURE A.4-10. MANGANESE CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2426

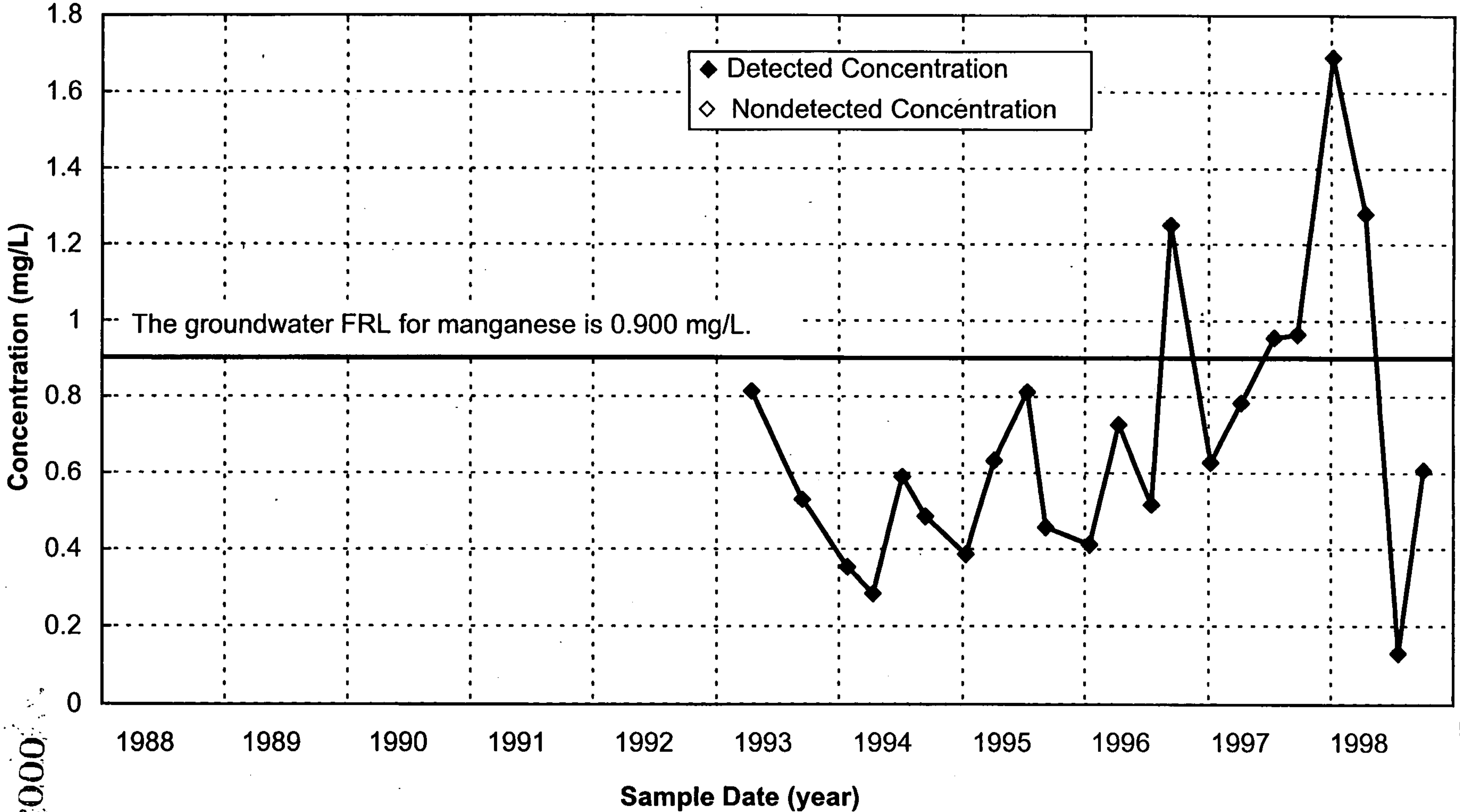


FIGURE A.4-11. MANGANESE CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2430

000333

2272

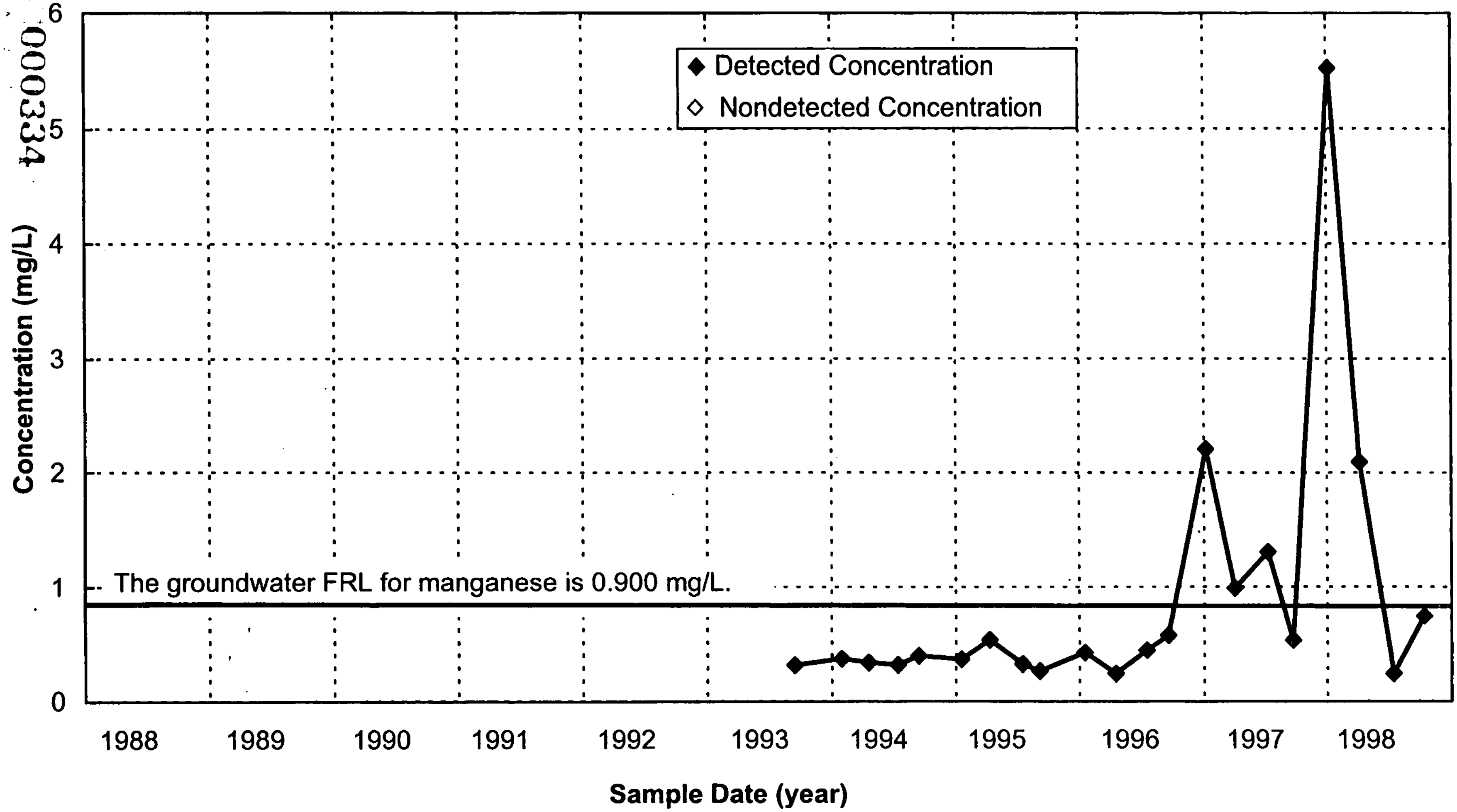


FIGURE A.4-12. MANGANESE CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2431

000334

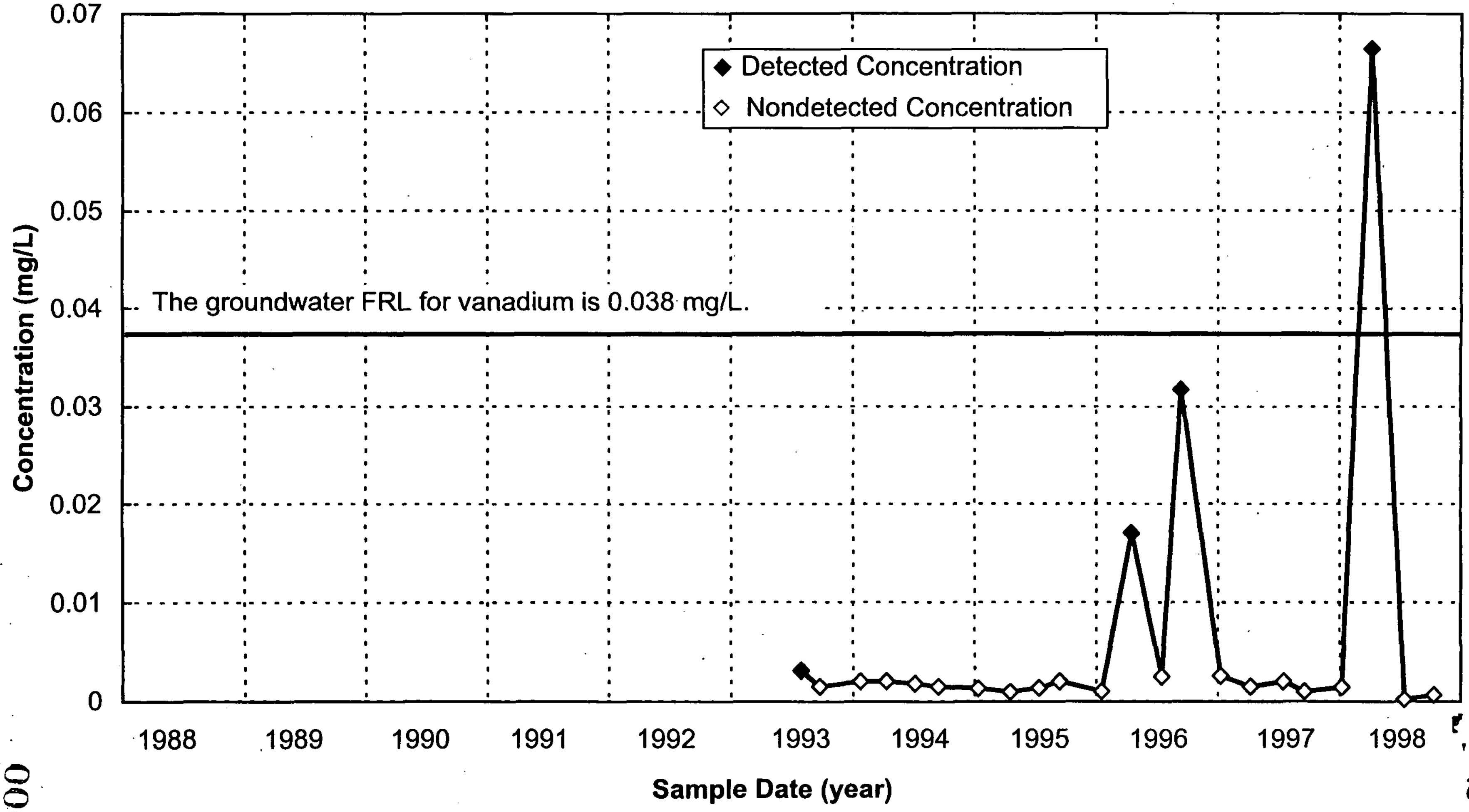


FIGURE A.4-13. VANADIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2426

000335

2272

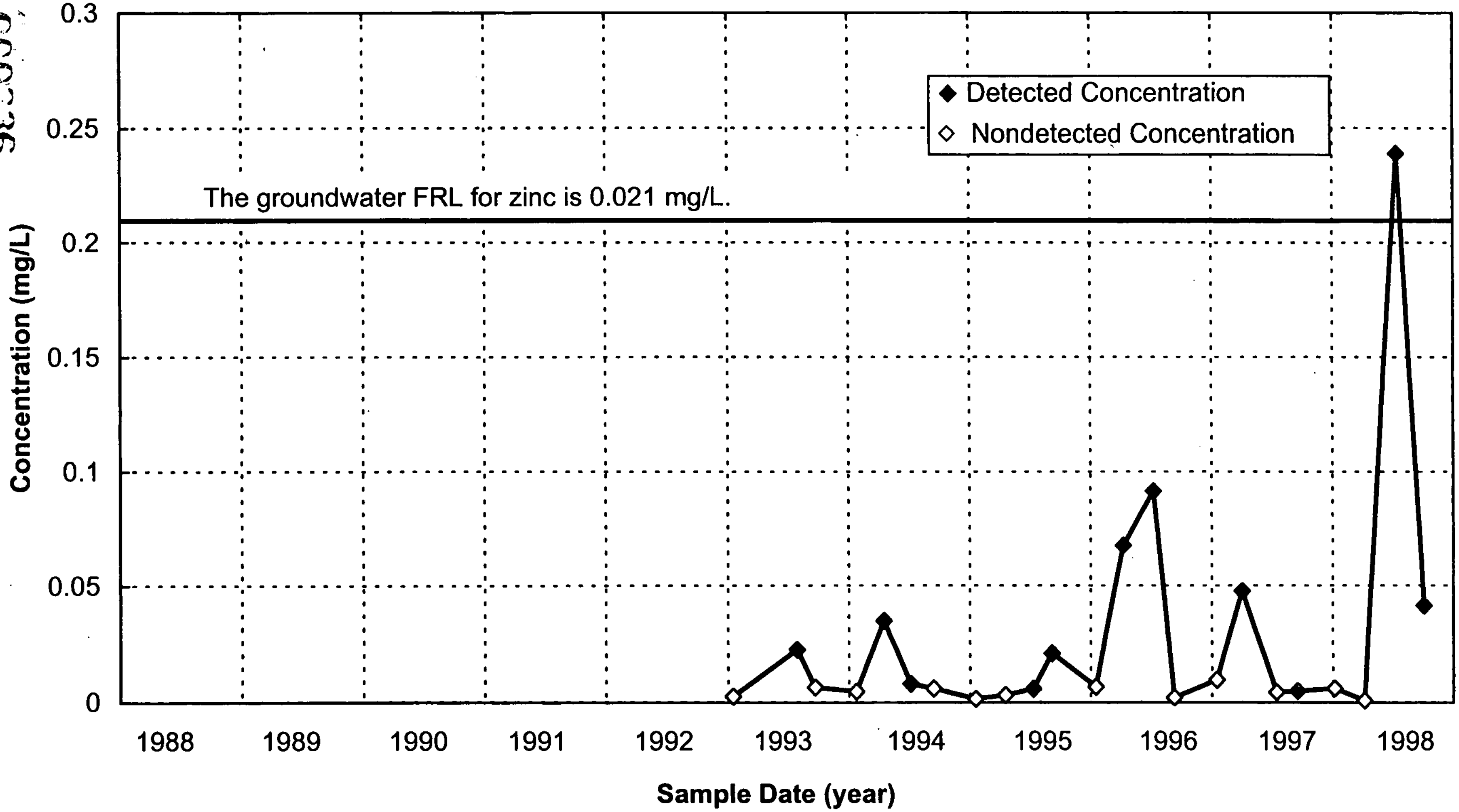


FIGURE A.4-14: ZINC CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2424

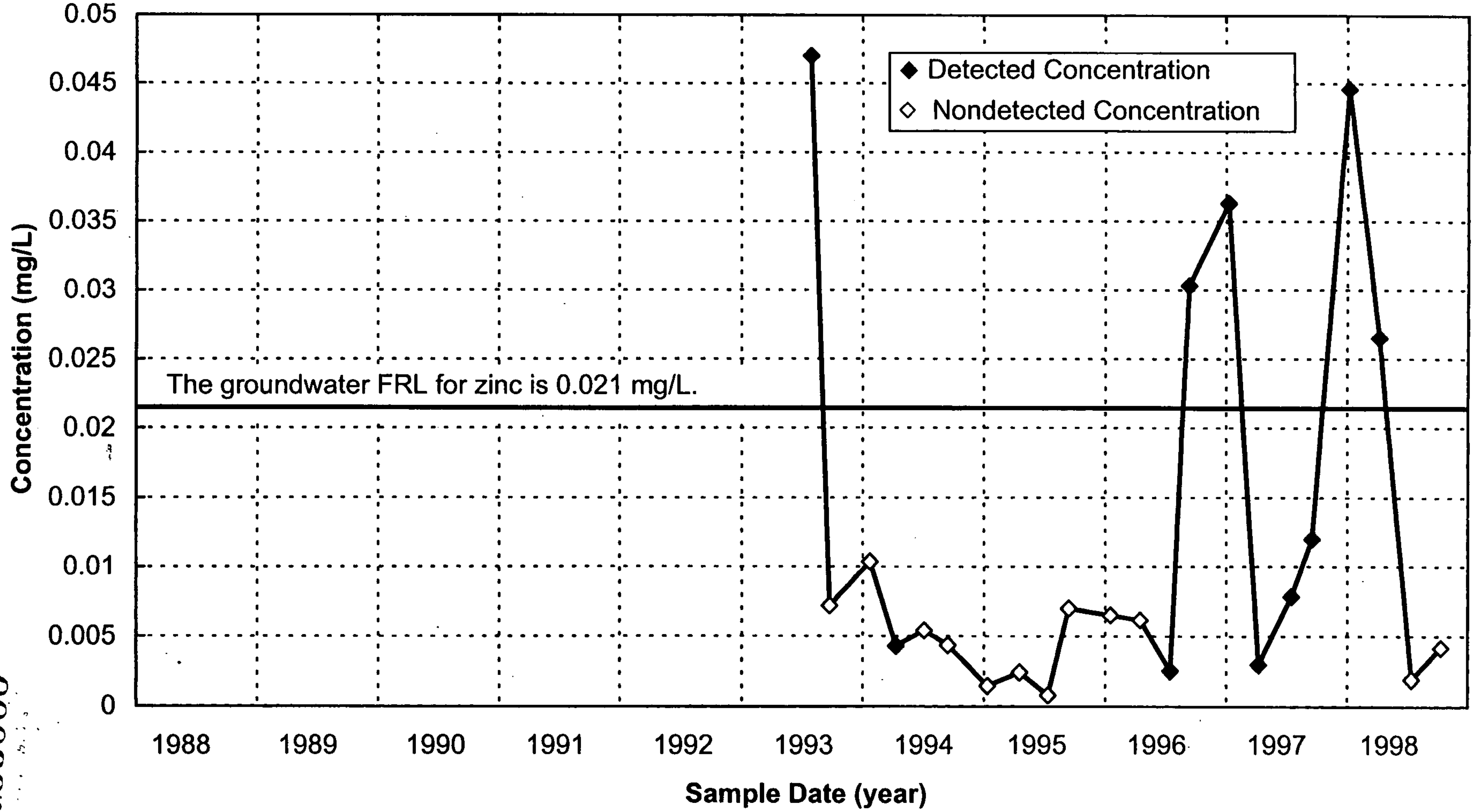


FIGURE A.4-15. ZINC CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 2426

000337

2272

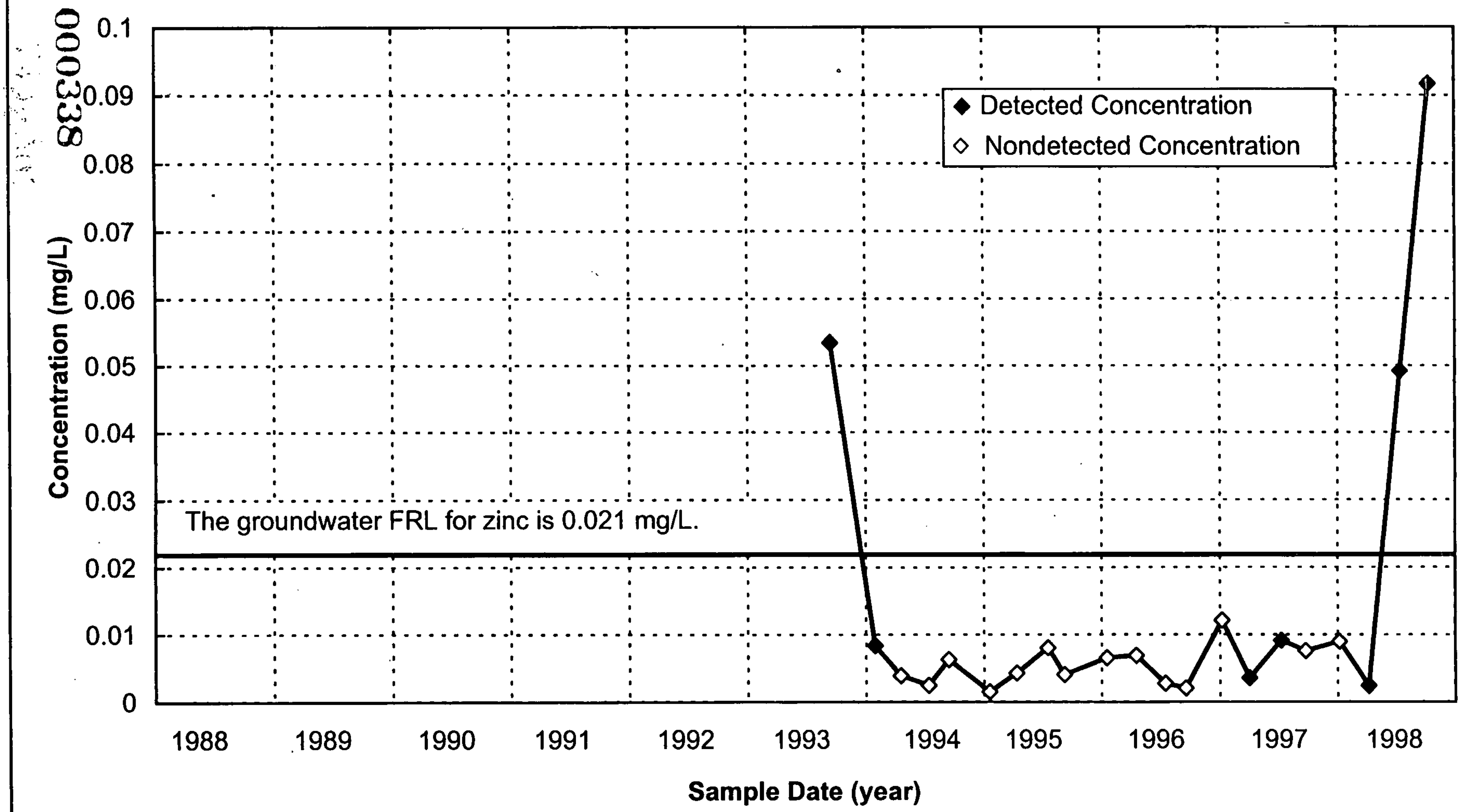


FIGURE A.4-16. ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2431

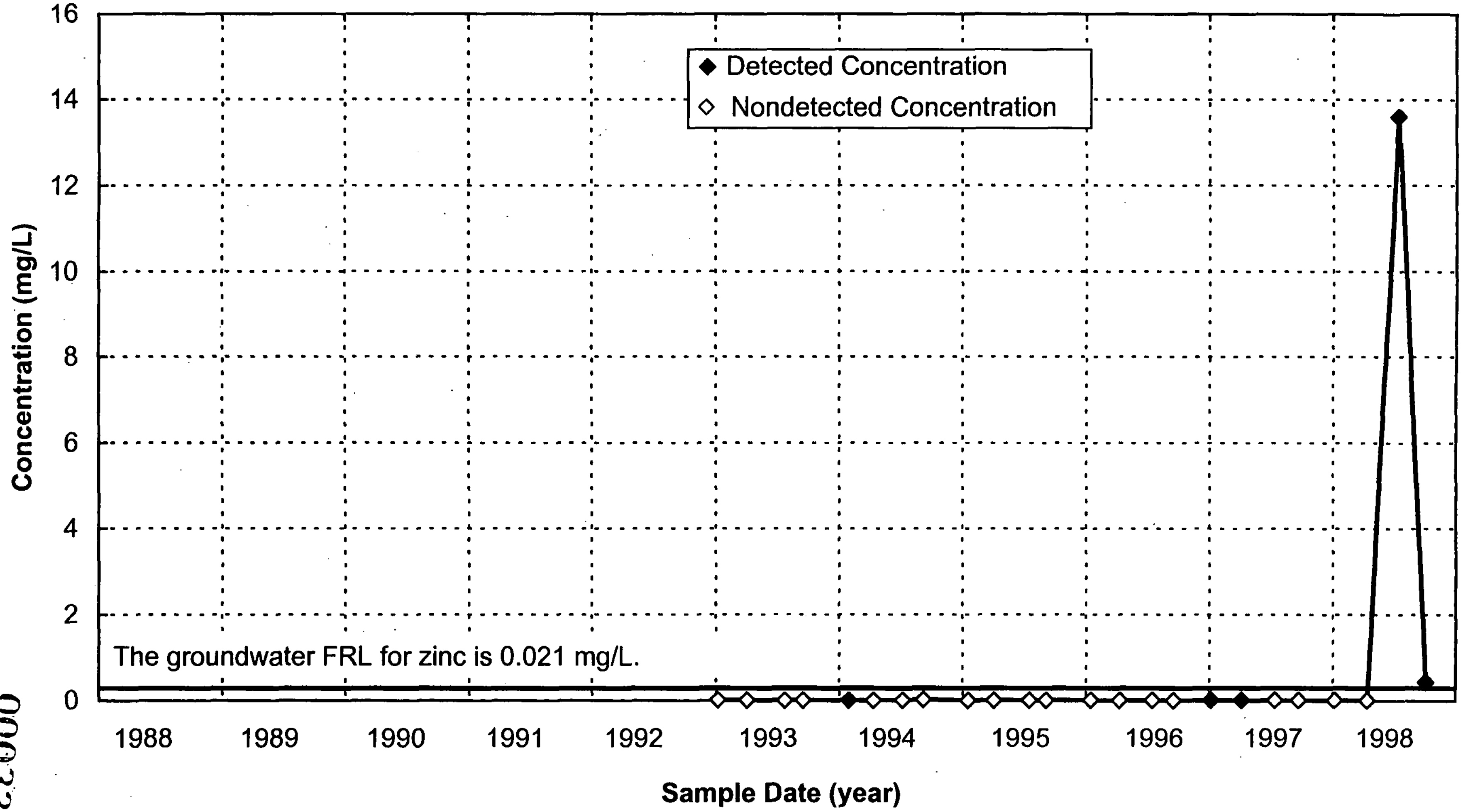


FIGURE A.4-17. ZINC CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 4067

000339

2272

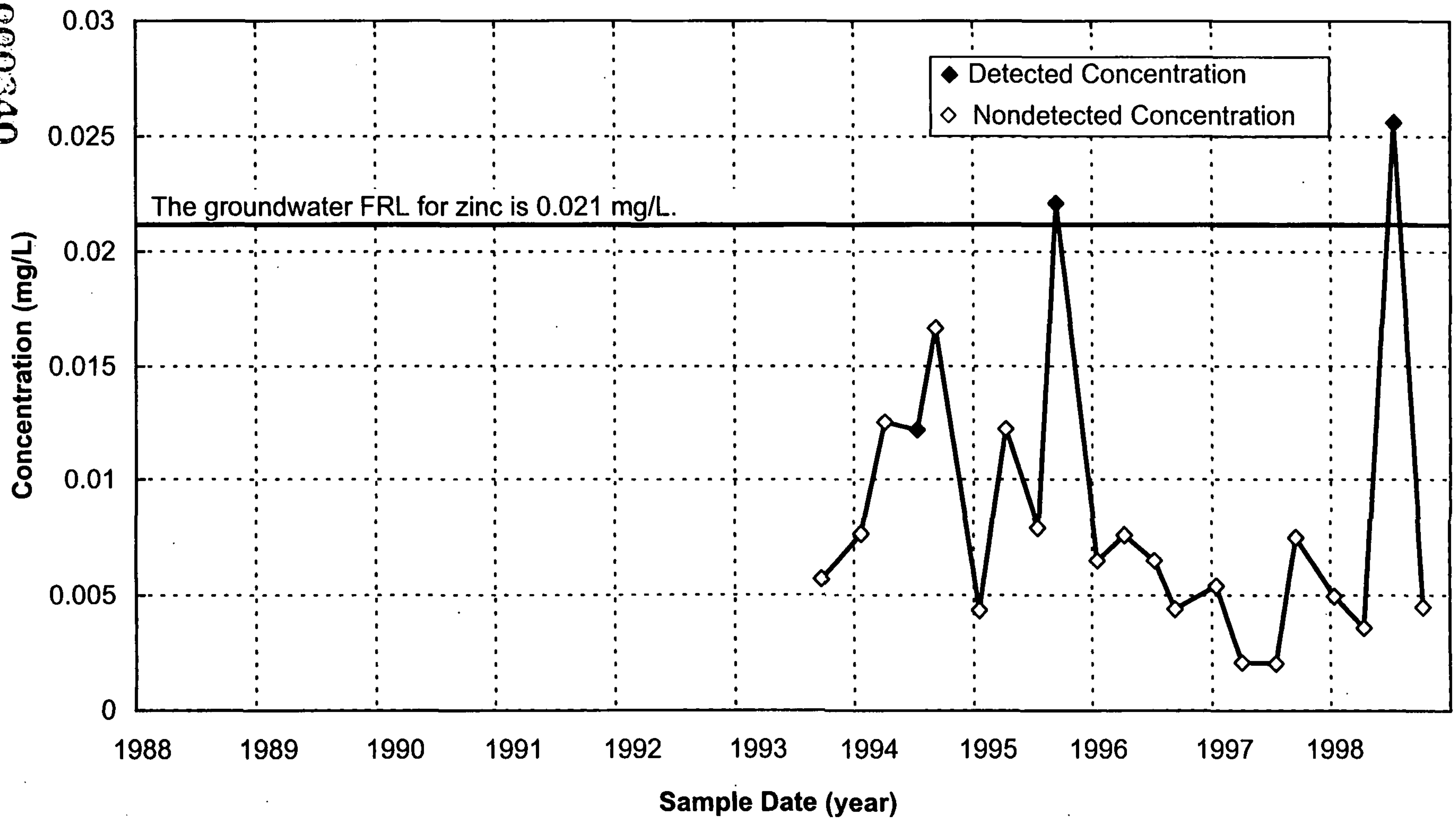


FIGURE A.4-18. ZINC CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 41217

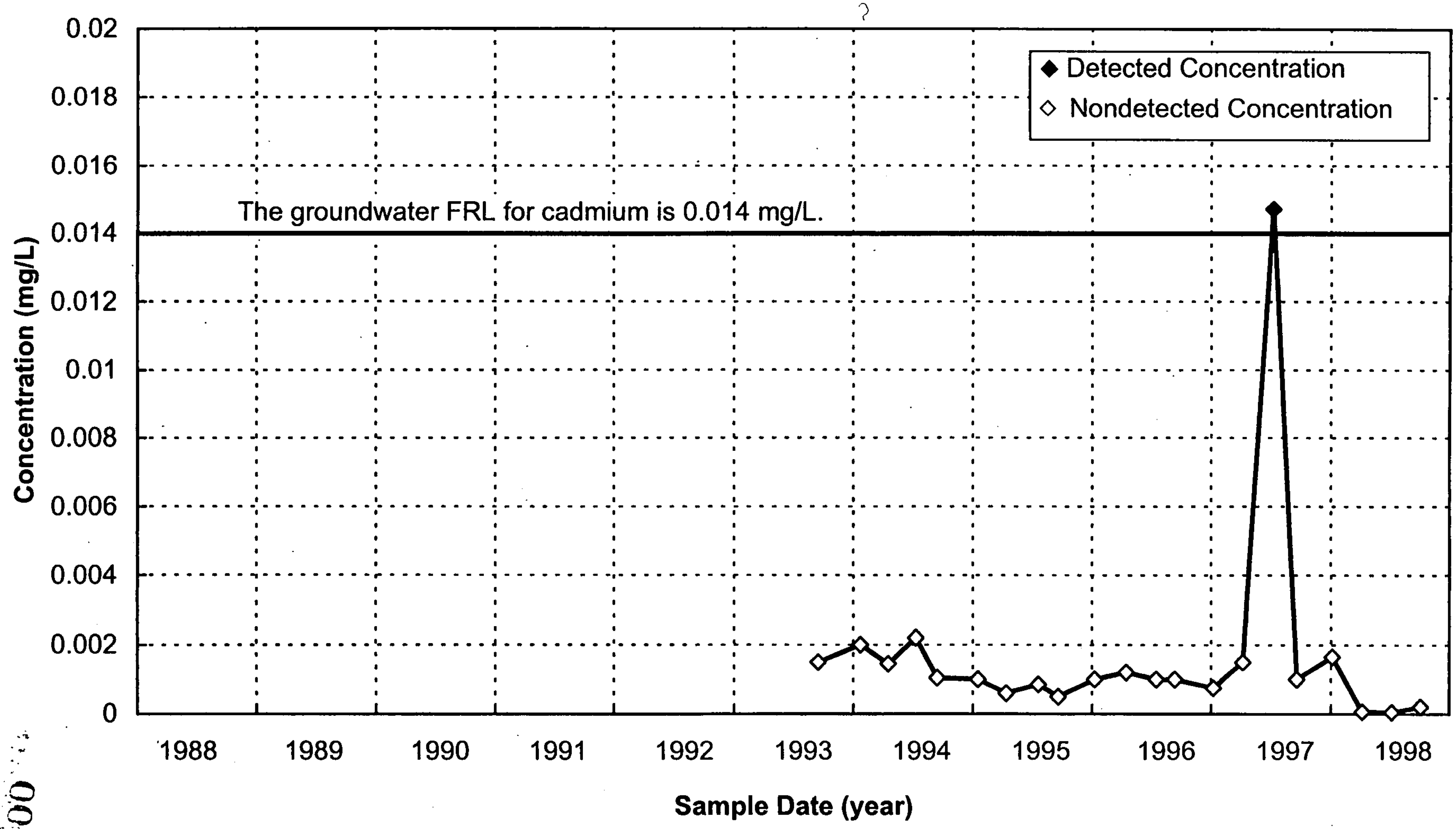


FIGURE A.4-19. CADMIUM CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 3432

000341

2272

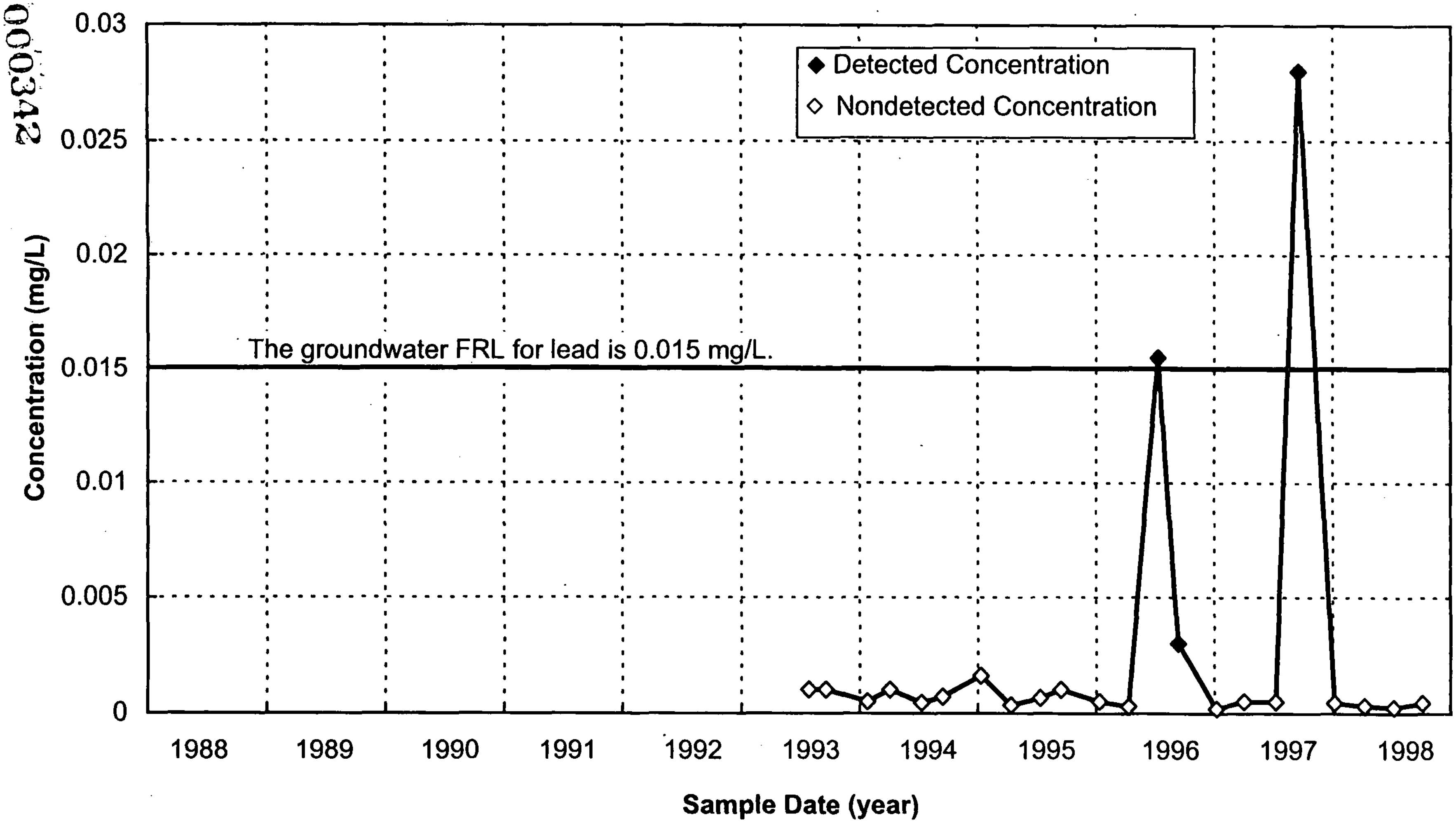


FIGURE A.4-20. LEAD CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3733

000342

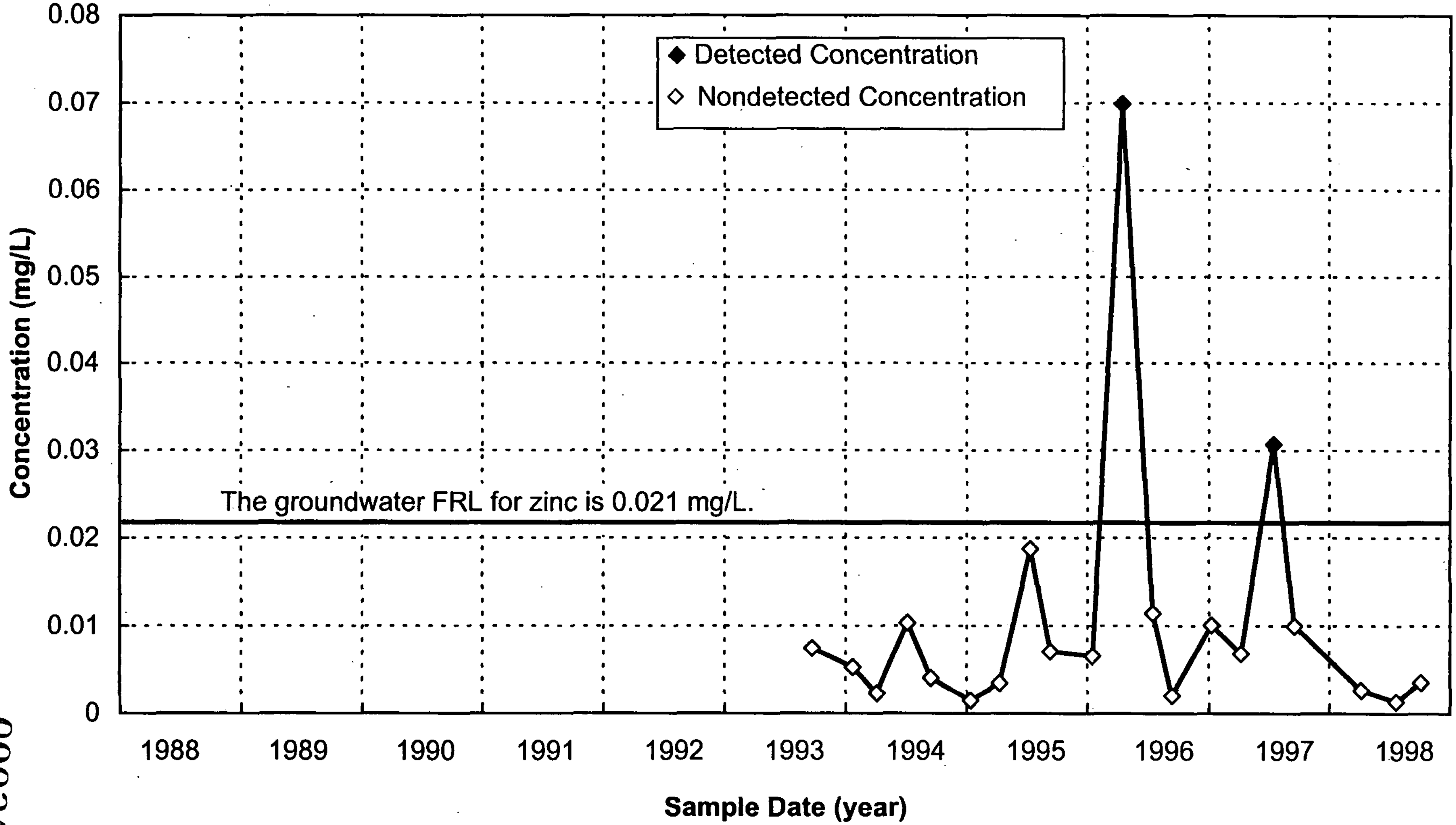
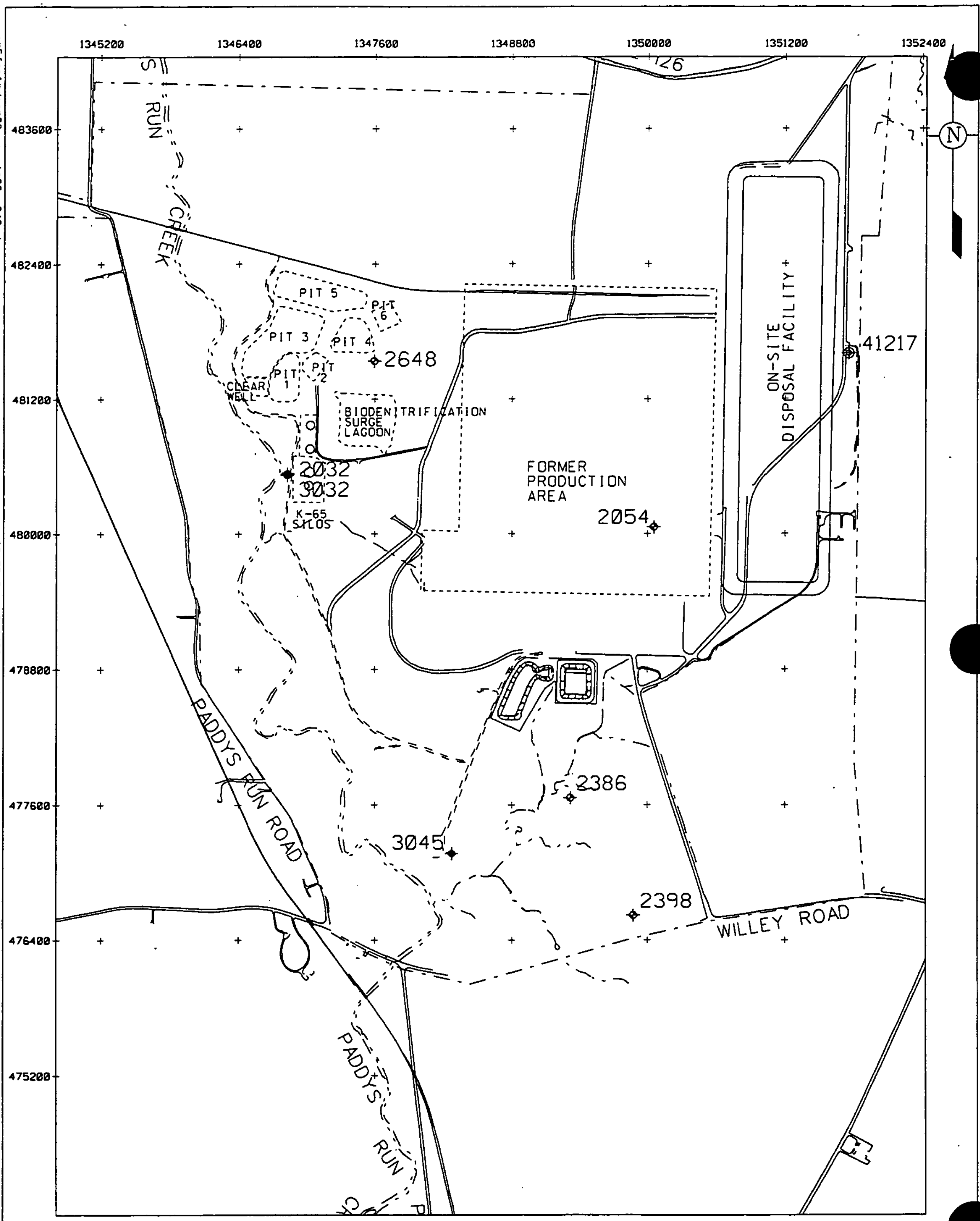


FIGURE A.4-21. ZINC CONCENTRATION VS. TIME PLOT
FOR MONITORING WELL 3426

000343

2272



LEGEND:

FEMP BOUNDARY

MONITORING WELL LOCATION

SCALE

1200 600 0 1200 FEET

FIGURE A.4-22. LOCATION MAP FOR MONITORING WELLS SAMPLED FOR CHROMIUM VI

000344

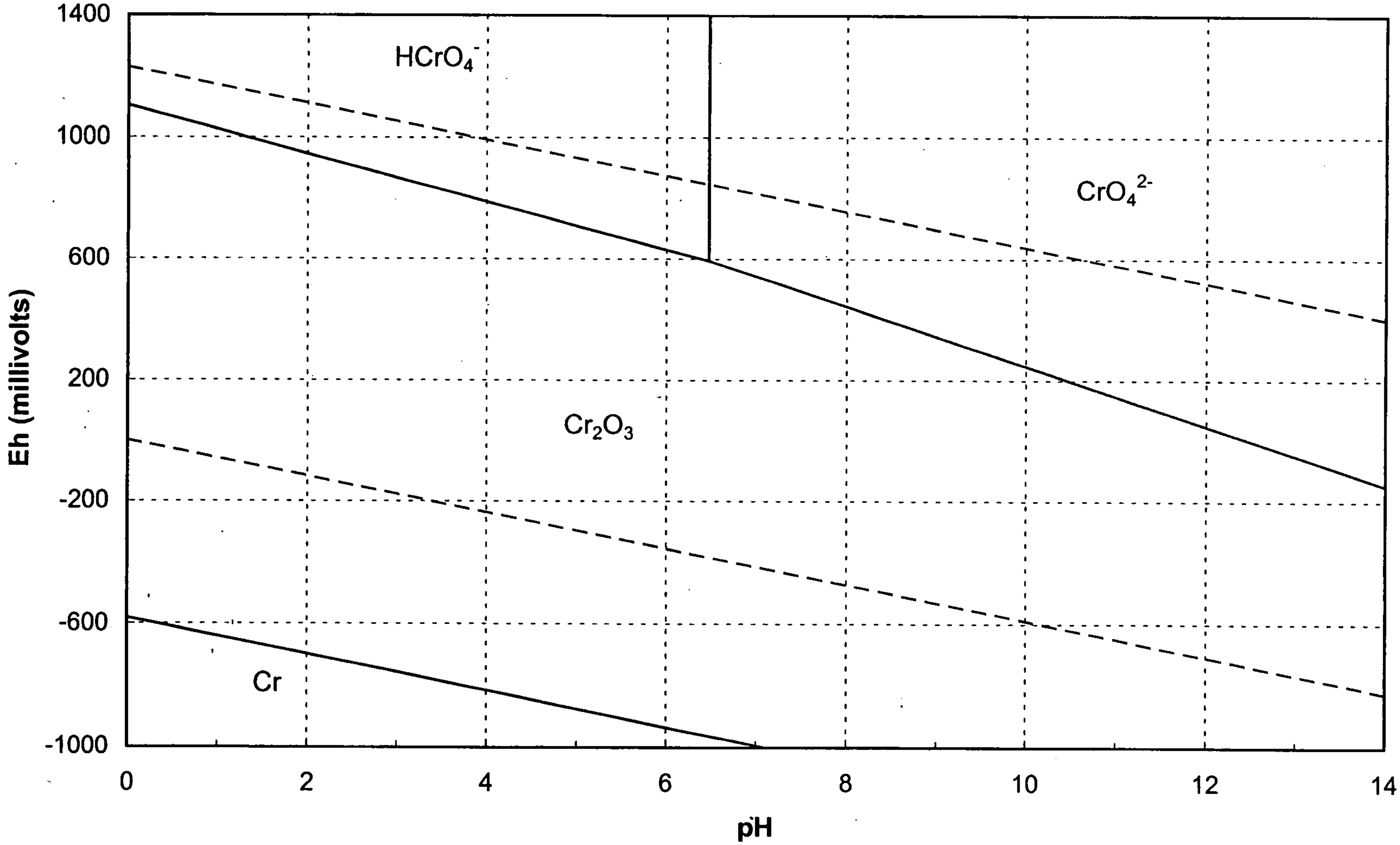


FIGURE A.4-23. Eh-pH DIAGRAM FOR CHROMIUM, OXYGEN, AND HYDROGEN AT 25 DEGREES CELSIUS

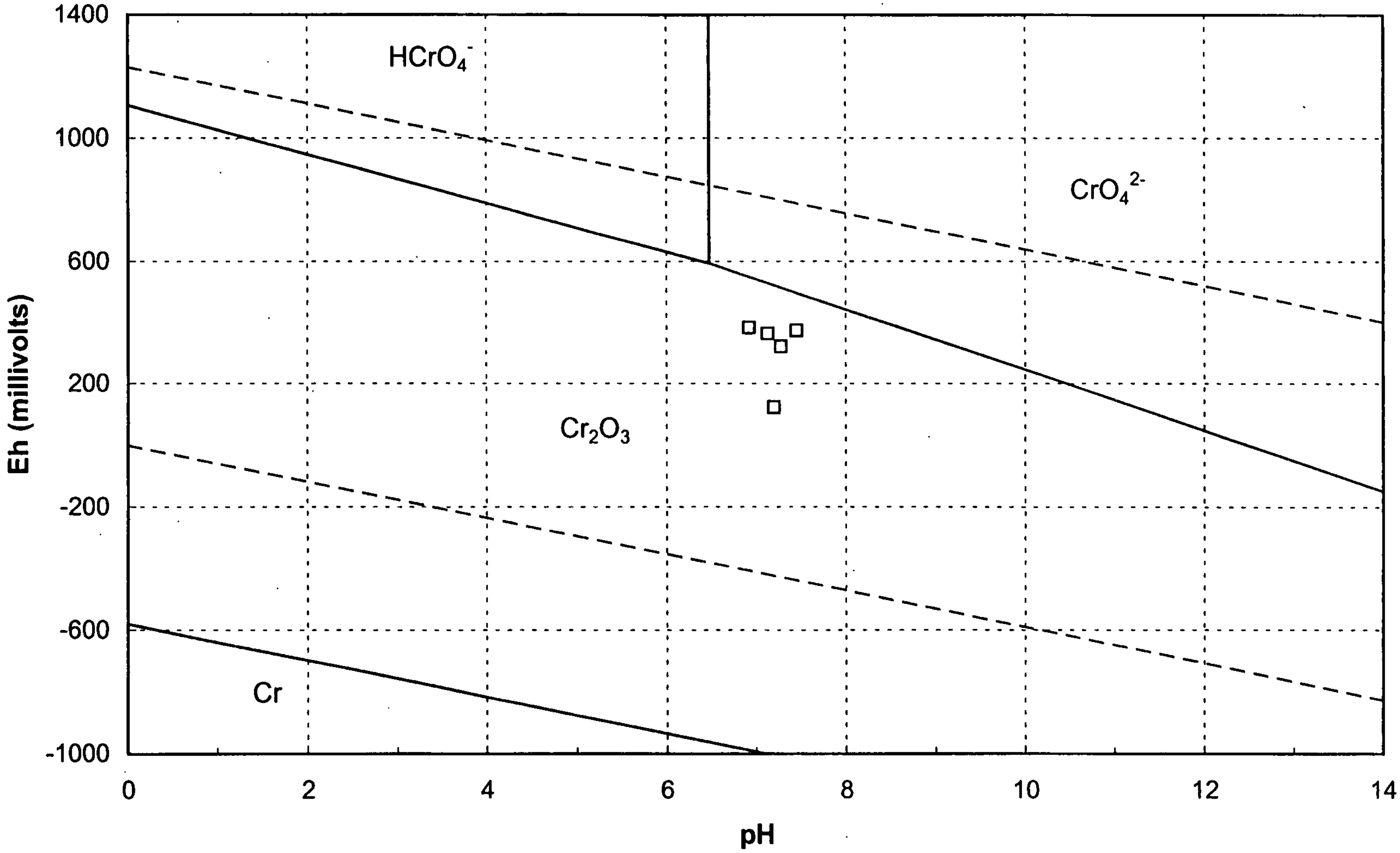


FIGURE A.4-24. Eh-pH DIAGRAM SHOWING RESULTS OF Eh-pH MONITORING

Attachment A.5

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ATTACHMENT A.5

MISCELLANEOUS MONITORING ACTIVITIES

ATTACHMENT A.5

KC-2 Warehouse Well Monitoring Activity

The KC-2 Warehouse well monitoring has also been included as part of the IEMP. Monitoring of this well (Well 67 in Figure A.5-1) is conducted on an annual basis and will continue until the warehouse is decommissioned and dismantled, at which time the well will be removed.

The August 1998 sampling event for the KC-2 Warehouse well (Table A.5-1) revealed lower concentrations of hazardous substance list metals than previous year's sampling results and all results were below the groundwater FRL.

Coal Pile Runoff Basin Monitoring

Monitoring Wells 1675 and 1676 (refer to Figure A.5-1) installed in the perched groundwater zone within the glacial overburden (till) have been used to monitor the Coal Pile Runoff Basin on a routine basis. Monitoring and reporting is conducted in accordance with Ohio Permit to Install No. 05-4172, issued and effective on September 13, 1990. As required by the Permit to Install, the monitoring data from the Coal Pile Runoff Basin for 1997 and 1998 are presented in Table A.5-2.

Monitoring of the two wells was only conducted during the first quarter of 1998; because in May, OEPA gave permission to cease monitoring of these wells primarily because the coal storage area which drained to the basin was no longer utilized for bulk coal storage and the useable coal had been removed (letter dated May 20, 1998, from OEPA's Office of Federal Facilities Oversight to DOE FEMP). The groundwater data that had been collected from these wells over the seven years of monitoring did not indicate a threat to human health and/or the environment.

TABLE A.5-1

KC-2 WAREHOUSE GROUNDWATER SUMMARY STATISTICS
(January 1993 through Third Quarter [August] 1998)

Constituent	Number of Samples[a,b]	FRL[c] (mg/L)	Min.[a,b,d] (mg/L)	Max.[a,b,d] (mg/L)	Avg.[a,b,d] (mg/L)	SD[a,b,d] (mg/L)	1998 Data Sample Result (mg/L); Validation Qualifier[e]
Aluminum	12	NA	0.01055	80	14	25	0.0211 U
Antimony	12	0.0060	0.000065	0.22	0.052	0.071	0.00013 U
Arsenic	12	0.050	0.00065	0.0873	0.016	0.030	0.0018 U
Barium	12	2.0	0.103	0.867	0.362	0.258	0.247 -
Beryllium	12	0.0040	0.00001	0.005	0.0014	0.0016	0.00002 U
Cadmium	12	0.014	0.00003	0.0671	0.01	0.02	0.00006 U
Calcium	12	NA	46.3	1310	340	445	58.1 J
Chromium	12	0.022[f]	0.0015	2.35	0.4	0.8	0.003 U
Cobalt	12	0.17	0.000105	0.102	0.026	0.038	0.00021 U
Copper	12	1.3	0.000335	0.373	0.096	0.15	0.00067 U
Cyanide	4	NA	0.000985	0.0025	0.0018	0.00081	0.00197 U
Iron	12	NA	3.18	620	150	230	4.19 -
Lead	12	0.015	0.00062	3.8	0.80	1.3	0.00062 -
Magnesium	12	NA	33.9	322	103	105	35.2 -
Manganese	12	0.900	0.053	8.52	2.0	3.1	0.053 -
Mercury	12	0.0020	0.00005	0.0022	0.00034	0.0006	0.0001 U
Nickel	12	0.10	0.0011	1.21	0.25	0.41	0.0022 U
Potassium	11	NA	0.922	14.6	3.25	4.15	1.11 -
Selenium	12	0.050	0.00039	0.0099	0.0029	0.0028	0.0023 U
Silver	12	0.050	0.00025	0.0312	0.005	0.009	0.0005 U
Sodium	11	NA	17.5	23.9	20.4	1.92	20.7 -
Thallium	12	NA	0.000025	1.8	0.15	0.52	0.00005 U
Vanadium	12	0.038	0.00075	0.19	0.038	0.056	0.0015 U
Zinc	12	0.021	0.0061	1.79	0.39	0.58	0.0122 U
		(μg/L)	(μg/L)	(μg/L)	(μg/L)	(μg/L)	(μg/L)
Uranium, Total	12	20	0.2	2400	200	200	0.2 NV

[a]If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the total number of samples, and the sample with the maximum concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation [SD]).
[b]Rejected data qualified with either a R or Z were not included in this count or the summary statistics.
[c]NA = not applicable
[d]Values where the concentrations are below the detection limit, the results used in the summary statistics are set at half the detection limit.
[e]Validation qualifier codes are provided in Appendix D of the Sitewide CERCLA Quality Assurance Project Plan (DOE 1998e).
[f]The FRL is based on hexavalent chromium, from Operable Unit 5 Record of Decision, Table 9-4; however, the sampling results are for total chromium.

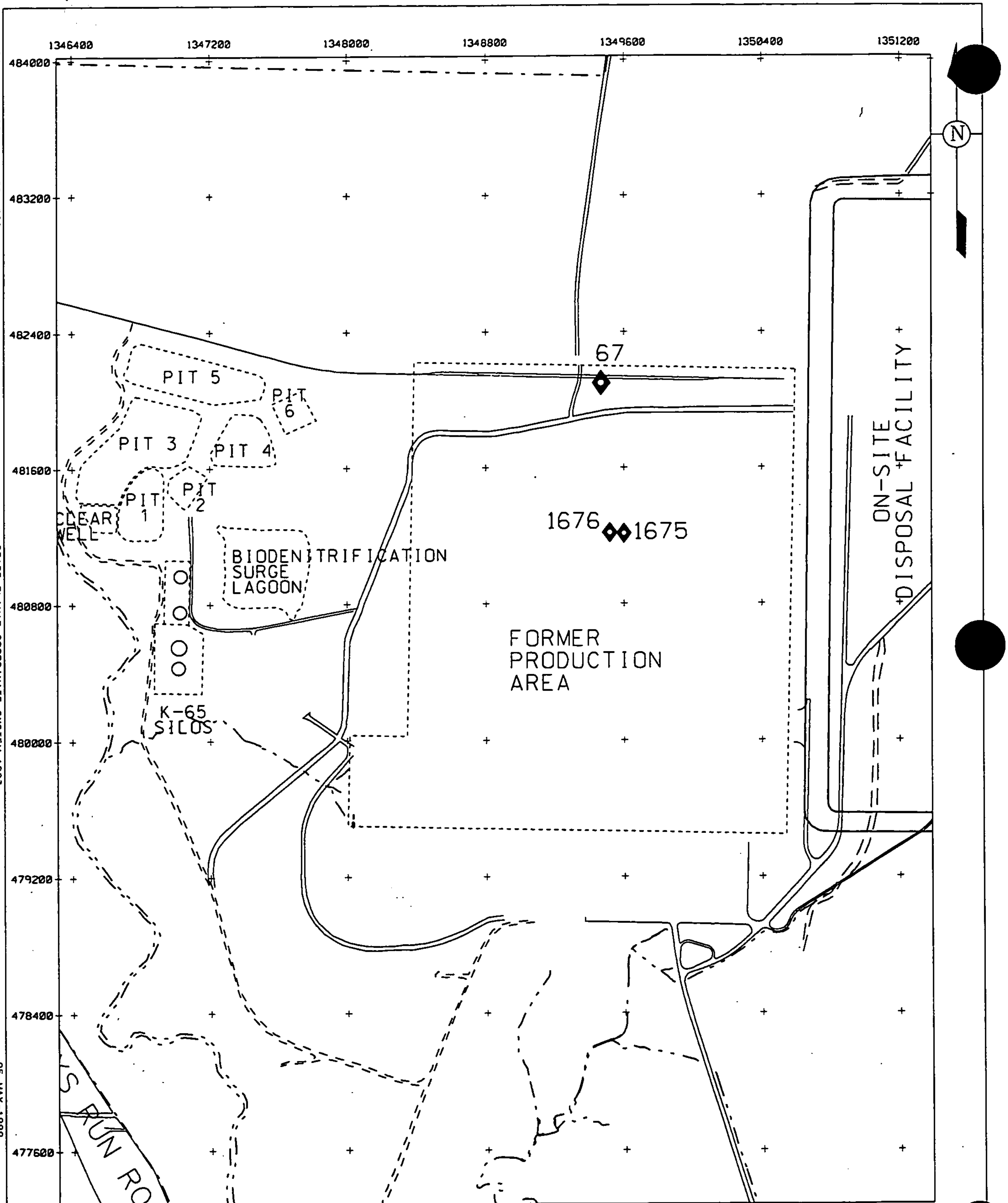
000350

TABLE A.5-2

COAL PILE RUNOFF BASIN SUMMARY STATISTICS FOR 1997 AND 1998 DATA

Monitoring Well	Constituent	No. of Samples[a,b]	Min.[a,b,c]	Max.[a,b,c]	Avg.[a,b,c]	SD[a,b,c]
			(mg/L)	(mg/L)	(mg/L)	(mg/L)
1675	Chloride	5	20	66	36	20
	Sulfate	5	265	395	349	49.9
	Total Dissolved Solids	5	957	1045	1015	34.73
			(Std. Units)	(Std. Units)	(Std. Units)	(Std. Units)
	pH	5	7.08	7.24	7.15	0.068
			(μmhos/cm)	(μmhos/cm)	(μmhos/cm)	(μmhos/cm)
	Specific Conductivity	5	1276	1361	1326	44.34
			(μg/L)	(μg/L)	(μg/L)	(μg/L)
	Total Uranium	5	2.5	35	9.9	14
			(mg/L)	(mg/L)	(mg/L)	(mg/L)
1676	Chloride	5	38	96	56	23
	Sulfate	5	220	387.5	288	63.5
	Total Dissolved Solids	5	719	1113	944	148
			(Std. Units)	(Std. Units)	(Std. Units)	(Std. Units)
	pH	5	7.1	7.3	7.2	0.083
			(μmhos/cm)	(μmhos/cm)	(μmhos/cm)	(μmhos/cm)
	Specific Conductivity	5	1234	1395	1330	70.24
			(μg/L)	(μg/L)	(μG/L)	(μg/L)
	Uranium, Total	5	9.7	64	25	22

[a]If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the total number of samples, and the sample with the maximum concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation [SD]).
[b]Rejected data qualified with either a R or Z were not included in this count or the summary statistics.
[c]For values where the concentrations are below the detection limit, the results used in the summary statistics are set at half the detection limit.



LEGEND:

FEMP BOUNDARY

MONITORING WELL LOCATION

SCALE

800 400 0 800 FEET

000352

FIGURE A.5-1. COAL PILE RUNOFF BASIN WELLS AND KC-2 WAREHOUSE WELL

Attachment A.6

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ATTACHMENT A.6

ON-SITE DISPOSAL FACILITY MONITORING RESULTS

ATTACHMENT A.6

The on-site disposal facility monitoring program fulfills two purposes: leak detection and leachate monitoring. It also meets the regulatory requirements for groundwater detection monitoring in the Great Miami Aquifer and perched groundwater system at the FEMP. The Final On-Site Disposal Facility Groundwater/Leak Detection and Leachate Monitoring Plan (DOE 1997d) presents the specific on-site disposal facility monitoring strategy for construction, closure, and post closure. The plan represents the first part of a three-tiered detection, assessment, and corrective action monitoring strategy required by EPA.

Final facility dimensions include: capacity of 2.5 million cubic yards, maximum height of approximately 65 feet, and an estimated areal coverage of 70 acres of the northeast area of the FEMP. Protection of the Great Miami Aquifer and the overlying perched groundwater system includes the following measures for each of the eight cells:

- Leachate collection system
- Leak detection system
- Multi-layer composite liner system
- Multi-layer composite cap.

The leachate collection system consists of a gravel layer installed beneath the waste to collect rainwater that comes in contact with the waste during cell construction, and additional moisture that drains from the waste following capping. The leak detection system is located beneath the leachate collection system and provides a mechanism for detecting leakage from the on-site disposal facility prior to any releases to the environment. Both systems drain to the west and extend beyond the synthetic liner systems where they become accessible through manholes. Horizontal till wells are set beneath each cell and provide verification of perched groundwater quality.

The following subsections provide information for each cell (Cells 1, 2, and 3) where monitoring was conducted during 1998. Figure A.6-1 identifies the well locations where monitoring occurred.

A.6.1 CELL 1

Sampling was initiated for Cell 1 in March 1997 to begin to establish baseline groundwater conditions. Waste placement commenced in December 1997; therefore, 1998 sampling was conducted during waste placement. During 1998 a draft technical memorandum was issued to discuss the baseline conditions for the horizontal till and Great Miami Aquifer wells. The EPA and OEPA issued comments on this technical memorandum in 1998 identifying that it would be necessary to extend sampling for the horizontal till wells in order to better establish baseline conditions. Approval of a strategy to establish baseline is anticipated in 1999.

Table A.6-1 presents the constituents detected in 1998 from the monitoring locations associated with Cell 1. Of the 16 constituents sampled, six constituents (total organic carbon, total organic halogens, boron, bromodichloromethane, technetium-99, and total uranium) were detected at least at one location. Monitoring results per location (leachate collection system, leak detection system, horizontal till well, and Great Miami Aquifer) are discussed below.

Leachate Collection System

Five of the six constituents (bromodichloromethane was not detected) identified in Table A.6-1 were detected in the leachate collection system. Total uranium concentrations ranged from 47 to 119 μg/L.

Furthermore, 67 additional Ohio Administrative Code 3745-27-10, Appendix I, constituents (general chemistry, inorganic, and organic) are sampled at the leachate collection system on an annual basis to determine if the constituents sampled quarterly are sufficient for leak detection purposes. This monitoring is identified in the Groundwater/Leak Detection and Leachate Monitoring Plan for the On-site Disposal Facility. New indicator constituents are to be added to the quarterly monitoring list if concentrations observed in the annual sample are much higher than the perched water concentrations at the FEMP. This annual sample was collected in December 1998. All detected constituent concentrations found in the annual leachate sample were within the range of FEMP perched water constituent concentrations as defined in the Operable Unit 5 Remedial Investigation Report, except for chemical oxygen demand, which was not sampled during the remedial investigation. The chemical oxygen demand concentration in the annual sample was 13.8 mg/L which is within the range of surface water chemical oxygen demand concentrations at the FEMP. Therefore, based on the results of the 1998 annual sample, no changes to the quarterly monitoring list are required.

The volume of water pumped from the leachate collection system is discussed in Section A.6.4.

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Leak Detection System

Five of the six constituents (technetium-99 was not detected) identified in Table A.6-1 were detected in the leak detection system. Also, bromodichloromethane was detected only once in the leak detection system at a concentration of 0.8 μg/L which is below the usual detection limit of 1 μg/L. Total uranium concentrations ranged from 1.5 to 13.744 μg/L.

Figure A.6-2 shows the volumes of water (monthly totals) pumped from the Cell 1 leak detection system. The volume of water removed from the leak detection system fluctuated over the year as the leak detection system was compressed and the water was squeezed out of the system by waste placement activities occurring in the cell above. The maximum and average monthly amount of water pumped from the leak detection system during 1998 was 1460 and 628 gallons, respectively. When the maximum and monthly averages are converted to daily rates, values of 48.7 and 20.9 gallons per day (gpd) are obtained. In the On-site Disposal Facility Final Design Calculation Package (DOE 1997c), it was concluded that an initial response leakage rate for individual cells would be 20 gallons per acre per day. Given that each cell covers an area of 6.4 acres, the initial response leakage rate for a given cell would be 128 gpd. The above noted maximum (48.7 gpd) and average (20.9 gpd) from Cell 1 are far below the initial response leakage rate of 128 gpd. Over time, with the capping and closure of the cell, the volume of water removed from the leak detection system is expected to stabilize and diminish. The volume of water removed from the leak detection system will be closely tracked over time to determine if the primary liner system continues to perform as expected.

Horizontal Till Well

Three of the six constituents identified in Table A.6-1 were detected at the horizontal till well. Total organic halogens, bromodichloromethane, and technetium-99 were not detected. Total uranium concentrations ranged from 1.106 to 19 μg/L; however, the total uranium concentration of 19 μg/L is considered anomolous because other concentrations in 1998 have been around 1 μg/L.

Great Miami Aquifer

Five of the six constituents (bromodichloromethane was not detected) identified in Table A.6-1 were detected in the Great Miami Aquifer wells. Total uranium concentrations ranged from not detectable to 3.08 μg/L. None of the constituents sampled and analyzed from the aquifer exceeded groundwater FRLs.

Trend analysis was performed on Great Miami Aquifer data. Of those detected constituents identified in Table A.6-1, only boron from Monitoring Well 22201 had an Up, Significant trend. The highest concentration for boron from this well during 1998 was 0.142 mg/L, which is well below the FRL of 0.33 mg/L.

A.6.2 CELL 2

Sampling was initiated for Cell 2 in June 1997 to begin to establish baseline groundwater conditions. Waste placement commenced in November 1998; therefore, for part of 1998, sampling was conducted prior to waste placement, and for part of 1998, sampling was conducted during waste placement. This is important for the fact that monitoring of the leachate collection and the leak detection systems are only initiated after waste placement in a cell. Only one sample from both the leachate collection and leak detection systems was collected during 1998, specifically in December. In order to evaluate the data associated with Cell 2, two tables were prepared (refer to Tables A.6-2 and A.6-3). Table A.6-2 presents constituents detected at the horizontal till well and aquifer wells prior to waste placement and Table A.6-3 presents constituents detected at the leachate collection system, leak detection system, horizontal till well, and aquifer wells after waste placement was initiated.

Leachate Collection System

Only one sample was collected from the Cell 2 leachate collection system. Four constituents (total organic carbon, total organic halogens, boron, and total uranium) were detected. The total uranium concentration was 17.1 μg/L.

Furthermore, 67 additional constituents (general chemistry, inorganic, and organic) are sampled at the leachate collection system on an annual basis. Consistent with the annual sample for Cell 1, the Cell 2 annual sample had no constituent concentrations that would require a change to the quarterly monitoring list.

The volume of water pumped from the leachate collection system is discussed in Section A.6.4.

Leak Detection System

During 1998, the leachate pipeline for the on-site disposal facility was found to be malfunctioning and is expected to be shutdown through the spring of 1999 to accommodate repairs. This pipeline is part of a system that connects the on-site disposal facility to the FEMP's advanced wastewater treatment facility for the subsequent treatment and discharge of collected leachate and contact stormwater runoff. During the period that the pipeline was not in service, a contingency plan for leachate collection was utilized to manually truck collected leachate from Cells 1 and 2 for delivery to the advanced wastewater treatment facility.

The malfunctions associated with the pipeline interrupted the FEMP's ability to obtain accurate water volume measurements and water quality monitoring data for the on-site disposal facility, most notably from the Cell 2 leak detection system. For this period, it became difficult during storm events to keep the various waters originating within the on-site disposal facility separate from one another, such that representative monitoring of each individual water source could be conducted. During this period, water originating within the Cell 1 leachate collection system periodically became mixed with water collected from the Cell 2 leak detection system, resulting in non-representative water quality data for the Cell 2 leak detection system. It was necessary to continue to collect data throughout the time that the pipeline was not functioning properly and under repair (to comply with existing monitoring plan requirements), but the results should not be considered as representative of the intended monitoring purpose (i.e., the monitoring of individual system flows) during this period.

All of the water quality results collected for the Cell 2 leak detection system during the IEMP reporting period are summarized in Table A.6-3, and those individual results that are not considered to be fully representative (because of the mixing of flows) are footnoted accordingly.

Figure A.6-3 shows the volume of water pumped from the Cell 2 leak detection system for the 1998 period after waste placement began (November and December). The volume of water removed from the system reflects a mixture of water that came from the Cell 2 leak detection system and water from the leachate pipeline, as discussed above. Therefore, an accurate determination of the volume of water associated solely with the Cell 2 leak detection system can not be made.

Once the repairs to the leachate pipeline are completed and the system is returned to service, flow and water quality sampling activities will again become representative of individual flows. Other than the problems with the pipeline and the accompanying difficulty in obtaining representative samples during a portion of the IEMP reporting period, the on-site disposal facility continues to function as designed. The resumption of representative sampling conditions in the summer of 1999, following successful repair of the pipeline, should continue to document this overall conclusion.

Horizontal Till Well

Seven constituents were detected prior to waste placement as identified in Table A.6-2. One of these constituents (bromodichloromethane) was only detected once at a concentration of 0.4 μg/L, which is below the usual detection limit of 1.0 μg/L. In regard to the sampling that occurred after waste placement was initiated, only three of the original seven constituents were detected, with boron, mercury, bromodichloromethane, and technetium-99 being the four constituents not detected after waste placement was initiated. The total uranium concentrations ranged from 1.53 to 3.607 μg/L.

Great Miami Aquifer

Four constituents (total organic carbon, total organic halogens, boron, and total uranium) identified in Tables A.6-2 and A.6-3 were detected in the Great Miami Aquifer wells. Total uranium concentrations ranged from not detectable to 11.826 μg/L. None of the constituents sampled and analyzed from the aquifer exceeded groundwater FRLs.

Trend analysis was performed on Great Miami Aquifer data. Of those detected constituents, only total organic halogens from both aquifer wells had an Up, Significant trend. The highest concentration for this constituent during 1998 was 0.124 mg/L. There is no FRL for total organic halogens.

A.6.3 <u>CELL 3</u>

Sampling was initiated for Cell 3 in July 1998, and continued throughout 1998, to establish baseline groundwater conditions. Waste placement is not anticipated until Fall 1999.

Table A.6-4 presents the number of samples with detections, the number of samples, and the range of all detected samples since baseline sampling was initiated. Of the 16 constituents sampled, four constituents (total organic carbon, total organic halogens, boron, and total uranium) were detected at the aquifer and horizontal till monitoring locations. At most, six samples have been collected from the monitoring locations. Table A.6-4 identifies that total uranium concentrations ranged from not detected to 9.14 μg/L for all locations monitored. The 9.14 μg/L total uranium concentration is from the horizontal till well. The maximum total uranium concentration in the aquifer was approximately 3 μg/L. None of the constituents sampled and analyzed from the aquifer exceeded groundwater FRLs.

A.6.4 LEACHATE COLLECTION SYSTEM VOLUMES

Leachate volumes are measured at a meter located at a manhole near the BioSurge Lagoon within the on-site disposal facility leachate conveyance system. The leachate volume measurements represent the collective leachate volume from all on-site disposal facility cells that contain waste materials. Leachate from Cells 1 and 2 contributed to the leachate volumes measured during 1998. During 1998 leachate was collected from Cell 1 for the entire year (since waste placement began in 1997) and from Cell 2 for November and December (since waste placement began in November). A total of just over six million gallons of leachate were collected and pumped to the BioSurge Lagoon for subsequent treatment at the advanced wastewater treatment Phase II facility. This leachate volume indicates that about 64 percent of the precipitation that fell on the controlled areas of Cells 1 and 2 (9,323,626 gallons) became leachate that was collected. The remaining 36 percent of the precipitation likely evaporated or is held up in the waste material. The six million gallons collected is considerably more than the 3.1 million gallons expected from design estimates; however, this is likely due to design assumptions such as precipitation rate and intensity differing from the actual conditions that occurred in 1998.

As presented in Figure A.6-4, leachate volumes fluctuated throughout the year. These fluctuations are expected during the active waste placement period of the on-site disposal facility (prior to final capping) because the leachate volumes during this period primarily reflect the amount of precipitation that falls on the active cells and is subsequently collected in the leachate collection systems. As the cells are capped, the leachate volumes are expected to stabilize and diminish over time.

TABLE A.6-1

1998 OSDF CELL 1 DETECTED CONSTITUENTS COMPARISON TABLE

Constituent (FRL)[a]	Quarter[b]	Leachate Collection System[c,e,f,g] (12338C)	Leak Detection System[c,d,e,f] (12338D)	Horizontal Till Well[c,e,f,h] (12338)	Great Miami Aquifer[c,e,f] Upgradient (22201)	Great Miami Aquifer[c,e,f] Downgradient[g] (22198)
Total Organic Carbon (NA mg/L)	First	26.3	1.04	9.72	1.98	ND
	Second	123	80.9	12.2	59.7	52.5
	Third	18.5	NS	3.93	7.72	4.7
	Fourth	9.99	2.06	1.1	2.18	ND
Total Organic Halogens (NA mg/L)	First	ND	ND	ND	0.026	ND
	Second	0.049	0.0216	ND	0.0138	0.0473
	Third	0.0308	NS	ND	ND	ND
	Fourth	0.022	0.0426	ND	0.0105	0.012
Boron (0.33 mg/L)	First	0.0642	0.0296	0.29	0.142	0.0412
	Second	0.128	0.321	ND	0.0915	0.0516
	Third	0.337	NS	0.0283	0.0759	0.0442
	Fourth	2.59[i]	0.197	ND	0.133	0.116
Bromodichloromethane (100 μg/L)	Fourth	ND	0.8	ND	ND	ND
Technetium-99 (94 pCi/L)	First	12	ND	ND	ND	14.8
	Second	18.28	ND	ND	ND	ND
	Third	ND	NS	ND	ND	12.18
Total Uranium (20 μg/L)	First	49.3	1.5	19	ND	0.579
	Second	70.006	13.744	1.106	0.087	1.13
	Third	47.018	NS	1.23	3.08	1.014
	Fourth	119	9.84	1.73	0.58	0.913

[a]From Operable Unit 5 Record of Decision, Table 9-4
[b]Waste placement was initiated in December 1997.
[c]ND = not detected
[d]NS = not sampled because the system was dry.
[e]If there was more than one sample collected per well per constituent per day (e.g., a duplicate sample), then only the maximum sample concentration was included in the table.
[f]Rejected data qualified with either a R or Z were not included.
[g]More than one sample was taken at this location per quarter, but the highest result for the quarter is included in the table.
[h]Purging of the well was not performed prior to sample collection; therefore, samples are not considered to be independent.
[i]There were two samples taken for this quarter at the leachate collection system. There was a high level of variability between the two samples with the lower concentration being 0.272 mg/L.

TABLE A.6-2

FREQUENCY AND RANGE OF PREWASTE PLACEMENT[a] CONSTITUENT DETECTIONS FOR OSDF CELL 2

	Horizontal Till Well[c,d,e] (12339)		Great Miami Aquifer[c,d] Upgradient (22200)		Great Miami Aquifer[c,d] Downgradient (22199)	
Constituent (FRL)[b]	Number of Samples with Detections/Number of Samples	Range	Number of Samples with Detections/Number of Samples	Range[f]	Number of Samples with Detections/Number of Samples	Range[f]
Total Organic Carbon (NA mg/L)	16/16	0.57 to 4.22	12/13	ND to 47.6	12/13	1.22 to 51.8
Total Organic Halogens (NA mg/L)	11/16	0.0107 to 0.0612	6/13	ND to 0.0181	5/13	0.0055 to 0.0386
Boron (0.33 mg/L)	9/16	0.0317 to 0.0829	7/13	ND to 0.158	8/13	0.0398 to 0.0569
Mercury (0.0020 mg/L)	1/15	0.00024	0/13	NA	0/13	NA
Bromodichloromethane (100 μg/L)	1/16	0.4	0/13	NA	0/13	NA
Technetium-99 (94 pCi/L)	5/17	4.93 to 12	0/12	NA	0/13	NA
Total Uranium (20 μg/L)	17/17	1.53 to 3.607	10/13	ND to 1.11	13/13	0.259 to 11.826

[a]Prior to November 12, 1998. NA = not applicable
[b]From Operable Unit 5 Record of Decision, Table 9-4
[c]If there was more than one sample collected per well per constituent per day (e.g., a duplicate sample), then only the maximum sample concentration was counted.
[d]Rejected data qualified with either a R or Z were not included in this count.
[e]Purging of the well was not performed prior to sample collection; therefore, samples are not considered to be independent.
[f]NA = not applicable
ND = not detected

TABLE A.6-3

1998[a] OSDF CELL 2 DETECTED CONSTITUENTS COMPARISON TABLE

Constituent (FRL)[b]	Leachate Collection System[c,d,e] (12339C)	Leak Detection System[c,d,f] (12339D)	Horizontal Till Well[c,d,g,h] (12339)	Great Miami Aquifer[c,d] Upgradient (22200)	Great Miami Aquifer[c,d] Downgradient[g] (22199)
Total Organic Carbon (NA mg/L)	2.44	4.23	1.14	1.04	ND
Total Organic Halogens (NA mg/L)	0.0119	0.0205	0.0253	0.124	0.00835
Boron (0.33 mg/L)	0.786	0.904	ND	0.0642	ND
Total Uranium (20 μg/L)	17.1	71	2.58	0.15	4.4

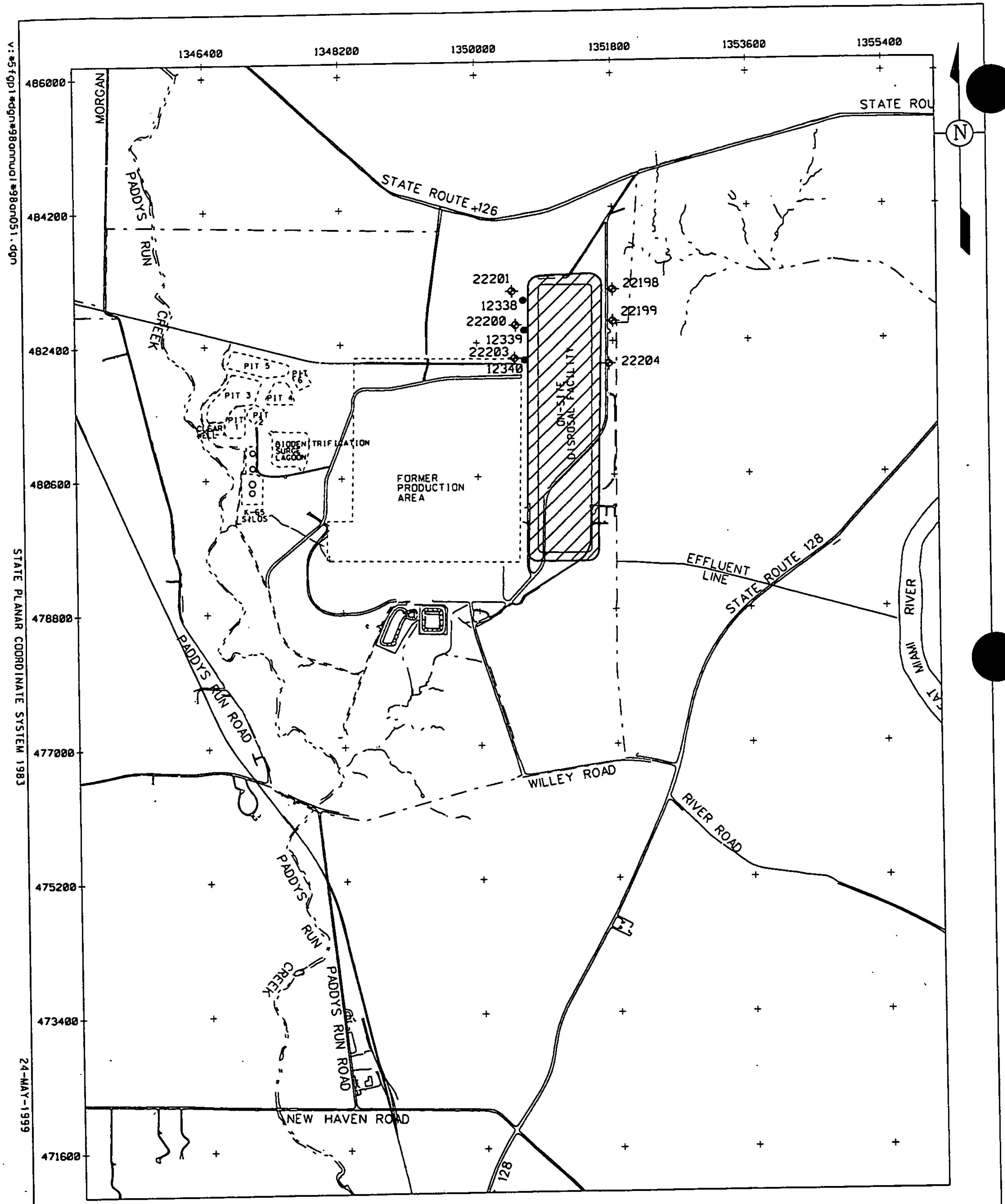
[a]Results are for fourth quarter 1998 after waste placement was initiated (after November 12, 1998). NA = not applicable
[b]From Operable Unit 5 Record of Decision, Table 9-4
[c]If there was more than one sample collected per well per constituent per day (e.g., a duplicate sample), then only the maximum sample concentration was included in the table.
[d]Rejected data qualified with either a R or Z were not included.
[e]More than one sample was taken at this location for the fourth quarter, but the highest result for the quarter is included in the table.
[f]Data not considered reliable due to malfunction in the leachate pipeline and the resultant mixing of individual flows.
[g]ND = not detected
[h]Purging of the well was not performed prior to sample collection; therefore, samples are not considered to be independent.

TABLE A.6-4

FREQUENCY AND RANGE OF BASELINE CONSTITUENT DETECTIONS FOR OSDF CELL 3

	Horizontal Till Well[b,c,d,e] (12340)		Great Miami Aquifer[b,c,e] Upgradient (22203)		Great Miami Aquifer[b,c,e] Downgradient (22204)	
Constituent (FRL)[a]	Number of Samples with Detections/Number of Samples	Range	Number of Samples with Detections/Number of Samples	Range	Number of Samples with Detections/Number of Samples	Range
Total Organic Carbon (NA mg/L)	5/6	ND to 2.79	3/5	ND to 3.51	3/5	ND to 5
Total Organic Halogens (NA mg/L)	4/6	ND to 0.0384	3/5	ND to 0.0171	2/5	ND to 0.014
Boron (0.33 mg/L)	3/6	ND to 0.0848	2/5	ND to 0.0776	1/5	0.0416
Total Uranium (20 μg/L)	5/6	ND to 9.14	5/5	0.266 to 0.559	5/5	0.481 to 2.995

[a]From Operable Unit 5 Record of Decision, Table 9-4. NA = not applicable
[b]If there was more than one sample collected per well per constituent per day (e.g., a duplicate sample), then only the maximum sample concentration was counted.
[c]Rejected data qualified with either a R or Z were not included in this count.
[d]Purging of the well was not performed prior to sample collection; therefore, samples are not considered to be independent.
[e]ND = not detected



LEGEND:

— - — - — FEMP BOUNDARY

⌖ OSDF MONITORING WELL IN GREAT MIAMI AQUIFER

• HORIZONTAL TILL WELL

SCALE

1800 900 0 1800 FEET

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FIGURE A.6-1. ON-SITE DISPOSAL FACILITY FOOTPRINT AND MONITORING WELL LOCATIONS

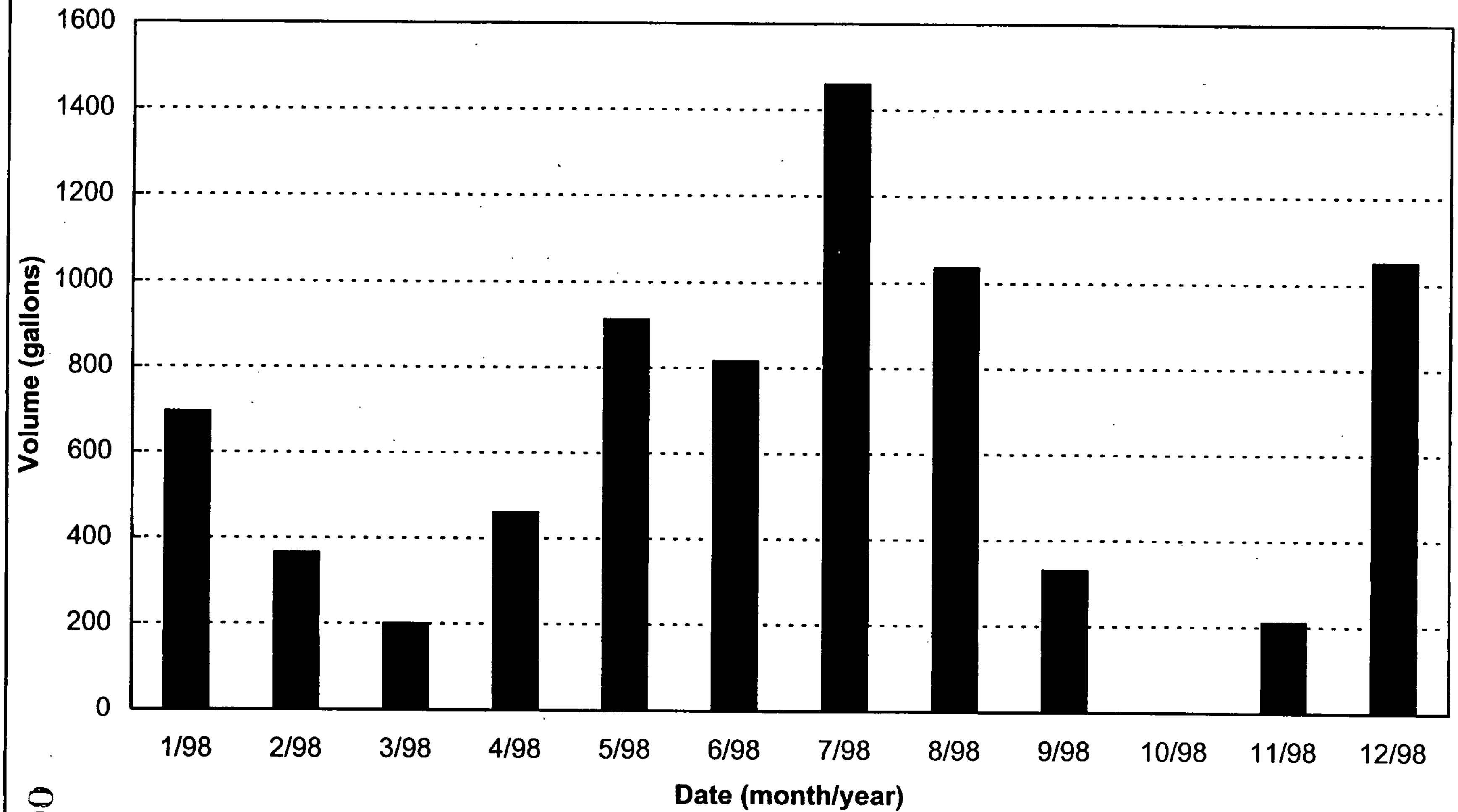

FIGURE A.6-2. 1998 LEAK DETECTION SYSTEM VOLUMES (MONTHLY TOTALS) FROM CELL 1 OF THE ON-SITE DISPOSAL FACILITY

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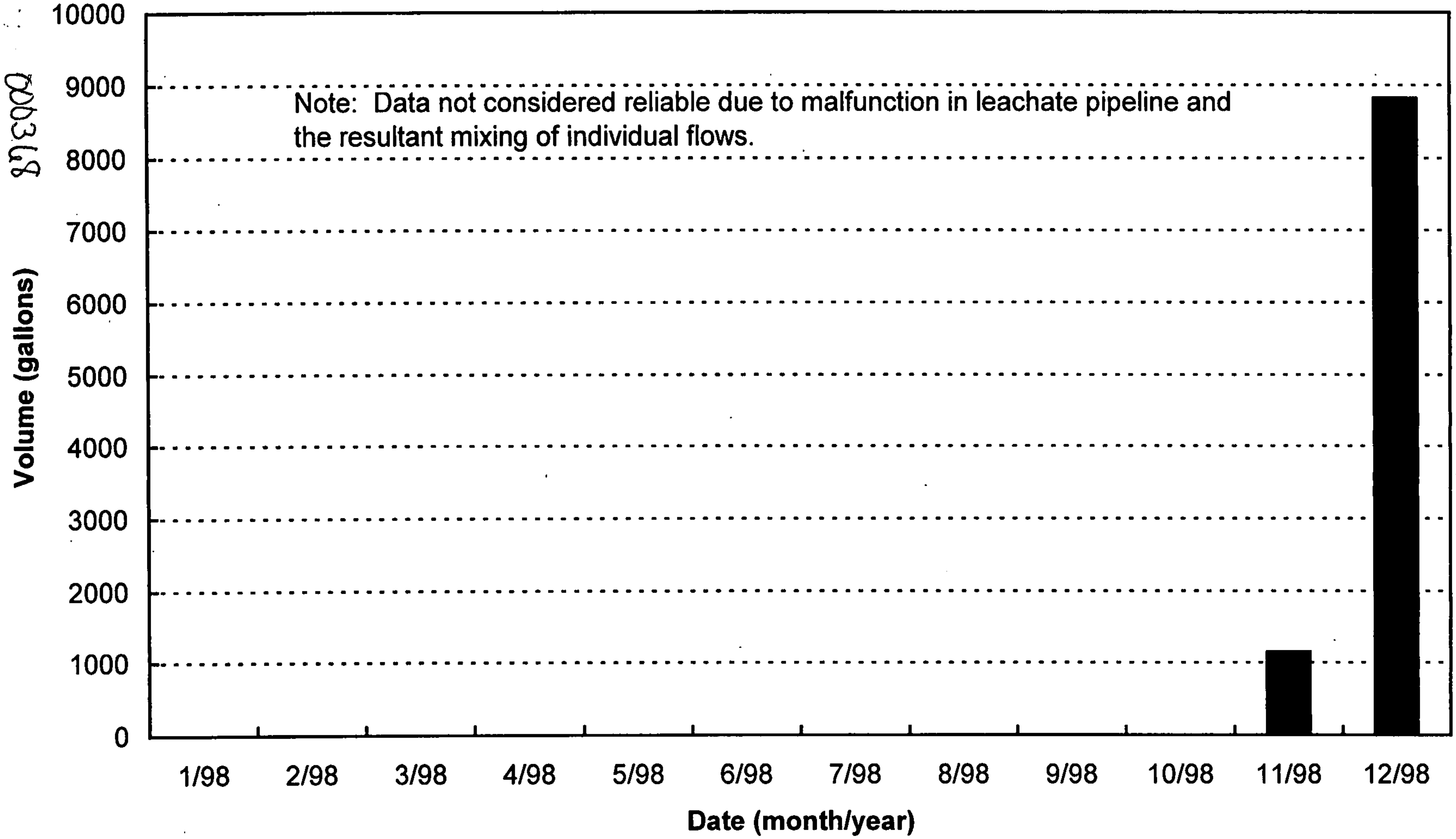

FIGURE A.6-3. 1998 LEAK DETECTION SYSTEM VOLUMES (MONTHLY TOTALS) FROM CELL 2 OF THE ON-SITE DISPOSAL FACILITY

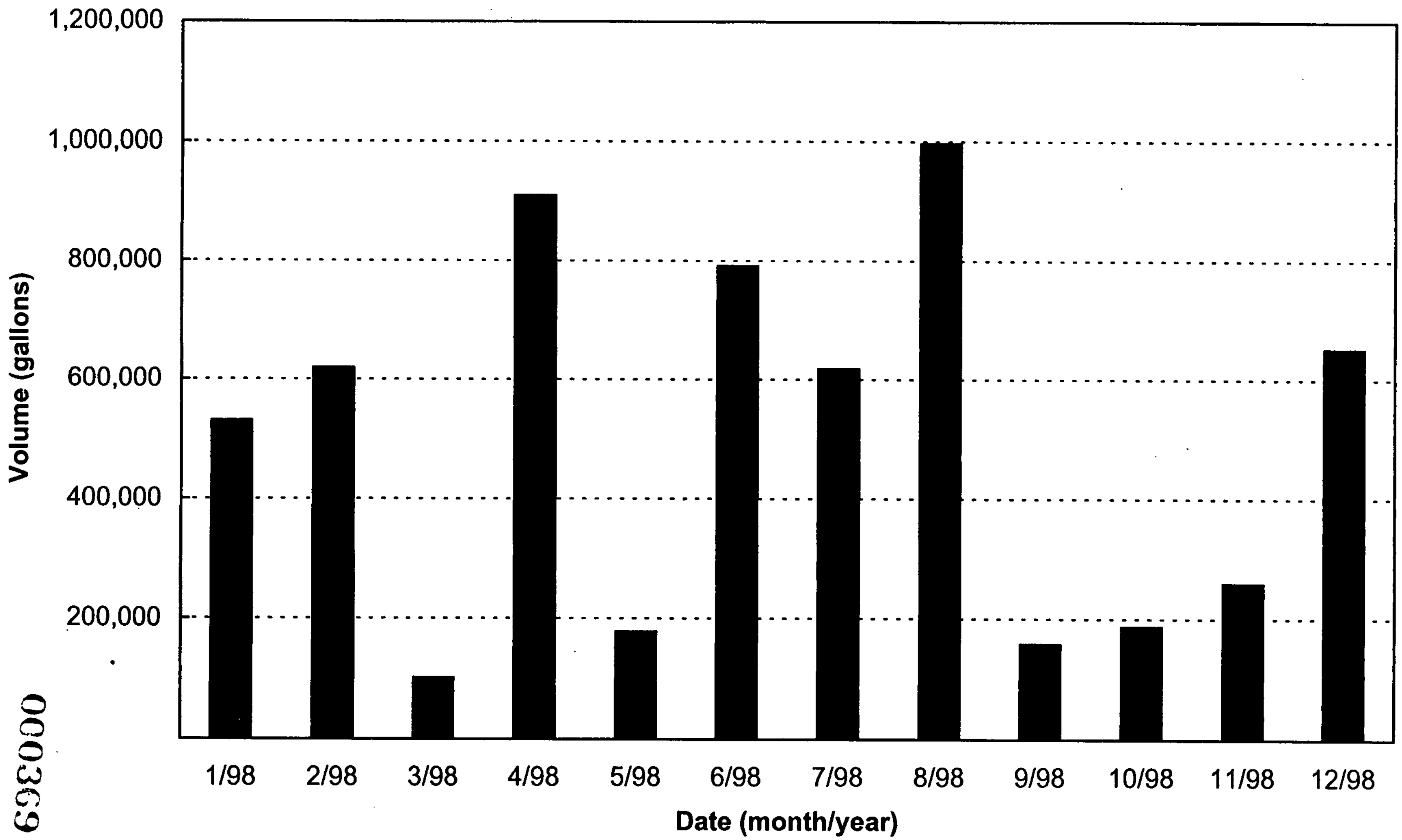

FIGURE A.6-4. 1998 LEACHATE COLLECTION SYSTEM VOLUMES FOR THE ON-SITE DISPOSAL FACILITY

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Appendix B

APPENDIX B

SUPPLEMENTAL SURFACE WATER AND TREATED EFFLUENT INFORMATION

TABLE OF CONTENTS

LIST OF ACRONYMS

BTV	benchmark toxicity value
cfs	cubic feet per second
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FEMP	Fernald Environmental Management Project
FFCA	Federal Facilities Compliance Agreement
FRL	final remediation level
IEMP	Integrated Environmental Monitoring Plan
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NPDES	National Pollutant Discharge Elimination System
OEPA	Ohio Environmental Protection Agency
WPRAP	Waste Pits Remedial Action Project
pCi/g	picoCuries per gram
pCi/L	picoCuries per liter
μg/L	micrograms per liter

APPENDIX B

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Appendix B presents additional surface water, treated effluent, and sediment data in support of Chapter 4 of this 1998 Integrated Site Environmental Report. This appendix consists of two attachments as follows:

- Attachment B.1 provides further evaluation of the final remediation levels (FRLs) and benchmark toxicity values (BTVs) exceedances for surface water and treated effluent including an assessment of potential cross-media impacts to the groundwater pathway. This attachment also provides detail on storm water-related bypasses pertaining to compliance with the Record of Decision for Remedial Actions at Operable Unit 5 (DOE 1996) total uranium treated effluent discharge limits.

- Attachment B.2 provides additional details pertaining to the 1998 sediment analytical results and historical results for comparison purposes.

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ATTACHMENT B.1

SURFACE WATER AND TREATED EFFLUENT

ATTACHMENT B.1

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During 1998 surface water and treated effluent samples were collected under the Integrated Environmental Monitoring Plan (IEMP) (DOE 1997a) and locations are presented in Figures B.1-1 and B.1-2. The following information is discussed in this attachment:

- Surveillance monitoring (Section B.1.1)
- Federal Facilities Compliance Agreement (FFCA)/Operable Unit 5 Record of Decision Compliance (Section B.1.2)
- Controlled and Uncontrolled Areas (Section B.1.3).

National Pollutant Discharge Elimination System (NPDES) is not discussed in this attachment as it is discussed in sufficient detail in Chapter 4 of this report.

B.1.1 SURVEILLANCE MONITORING

Surveillance monitoring is the comparison of surface water and treated effluent analytical results to the surface water FRLs and BTVs in order to determine effects of FEMP remediation activities on the surface water pathway. Surveillance monitoring also includes an assessment of the effects surface water may have on the groundwater pathway (referred to as cross-media impacts).

All 1998 data with the exception of the data collected from the sewage treatment plant (STP 4601) were compared to FRLs and BTVs. Results of treated effluent samples collected from the sewage treatment plant (STP 4601) are not used for surveillance monitoring because these samples are collected at an internal point prior to the sewage treatment plant treated effluent being discharged to the Parshall Flume (PF 4001). (Note: during 1998 the sewage treatment plant effluent comprised less than two percent of the combined effluent discharged to the Great Miami River.) Samples collected at the Parshall Flume (PF 4001) are used in the surveillance evaluation because this is the last point treated effluent is sampled prior to discharge to the Great Miami River.

Water discharges to the Great Miami River are required to be below the FRLs at the point where discharged water is completely mixed with water in the Great Miami River (i.e., outside the mixing zone). To make a determination of the concentration of each constituent at this point in the Great

Miami River for comparison to the FRLs, the following calculation was applied to data from the Parshall Flume (PF 4001):

$$C_{PF\,4001} = \frac{[Q_{10}][C_{GMR}] + [Q_{PF}][C_{PF}]}{[Q_{10}] + [Q_{PF}]}$$

where:

C_{PF4001}	=	Flow-weighted average concentration outside the mixing zone in the Great Miami River, picoCuries per liter (pCi/L) or milligrams per liter (mg/L)
Q_{10}	=	7-day, 10-year low flow, 583 cubic feet per second (cfs)
C_{GMR}	=	Background concentration in Great Miami River from the Remedial Investigation Report for Operable Unit 5 (DOE 1995), pCi/L or mg/L (0 was used when no background concentration was available)
Q_{PF}	=	Daily flow at Parshall Flume (PF 4001), cfs
C_{PF}	=	Daily concentration at Parshall Flume (PF 4001), pCi/L or mg/L

Note: In addition, flow conditions at the Hamilton Dam gauge are periodically reviewed to determine if there is a lower flow than the 7-day, 10-year low flow of 583 cfs. The lowest daily flow measured at the Hamilton Dam gauge (if lower than 583 cfs) will be used in the equation to see if an exceedance could potentially occur.

It is also important to note that several surface water sample locations were dry during 1998, and therefore there are no analytical data available during these periods. The locations that were dry are as follows: August (SWP-02, SWP-03, and SWD-01); September (SWP-02 and SWP-03); October (SWP-02, SWP-03, SWD-01, and SWD-02) and November (SWP-03).

B.1.1.1 Evaluation of Constituents Above FRLs for 1998

Table B.1-1 lists surface water FRL exceedances at corresponding sample locations and Figure B.1-3 shows the locations of these exceedances. The FRL exceedances that occurred in 1998 were generally sporadic as indicated by the small number of replicate exceedances and the fact that the exceedances did not occur at multiple locations during each sampling event. The following are general observations:

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- No exceedances occurred in the Great Miami River (using the mixing equation and Parshall Flume [PF 4001] concentrations). The lowest daily flow at the Hamilton Dam gauge during 1998 was 523 cfs. There were also no exceedances identified using this low flow value in the mixing equation.

- No exceedances occurred at the point where Paddys Run flows off property (SWP-03), with the exception of one mercury exceedance.

- No exceedances of the surface water FRL for total uranium occurred at any surface water sample location. Figure B.1-4 shows the total uranium concentrations at SWP-03 (Paddys Run at downstream property boundary).

In addition, as noted on Table B.1-1, the copper FRL (0.012 mg/L) exceedances appear to be more prevalent than the remaining FRL exceedances. During 1998 copper was sampled biannually in the drainages to Paddys Run (STRM 4003, STRM 4004, STRM 4005, and STRM 4006) and during overflows of the Storm Water Retention Basin (SWRB 4002O) to comply with the NPDES permit. It was also sampled at other drainages on a more frequent basis. The copper FRL was exceeded in six samples during 1998; however, the exceedances were only slightly above the FRL and the copper FRL was not exceeded at the property boundary location in Paddys Run during 1998. It is important to note that the highest copper exceedance during 1998 (0.0273 mg/L) was at the Great Miami River background location SWR-01 and that there are no significant trends associated with any of the copper exceedances. Copper exceedances will continue to be monitored as established in the NPDES permit and in the IEMP to determine their significance.

Chromium FRL (0.010 mg/L) exceedances occurred at four locations, with the highest concentration (0.0267 mg/L) again being at the Great Miami River background location (SWR-01). The FRL for chromium is actually associated with hexavalent chromium; however, due to short laboratory holding times, in most cases total chromium is analyzed rather than hexavalent chromium. Comparing total chromium concentrations against the hexavalent chromium FRL is conservative because hexavalent chromium is a component of total chromium. There are no significant trends associated with the chromium exceedances.

The FRL for zinc (0.11 mg/L) was exceeded in only one of the monthly samples collected from the northeast drainage ditch location SWD-01 during 1998. The zinc exceedance concentration was 0.261 mg/L. However, trend analysis indicates a Down, Significant trend in the data. Recognizing that a portion of the drainage area (Area 1, Phase I) feeding the northeast drainage has been certified as meeting soil FRLs specified in the Record of Decision for Remedial Actions at Operable Unit 5, zinc concentrations in this drainage will continue to be monitored and tracked over time to determine the significance of these exceedances.

In addition to the exceedances discussed above, there also was an additional exceedance of lead at the Great Miami background location SWR-01. This was the only location were a lead FRL exceedance occurred.

The exceedances of lead, copper, and chromium at the background location suggest that the background developed during the remedial investigation/feasibility study will need to be revisited. Although the trend analysis presented in Table B.1-1 does not suggest an increasing trend, the analysis was performed utilizing data collected from 1997 and 1998. The FRLs were established using the limited data set from samples collected from 1988 through 1993. It appears that a significant increase in background concentrations for these constituents may have occurred over the past five years. Therefore, selected surface water FRLs will need to be re-evaluated.

B.1.1.2 Evaluation of Cross-Media Impacts for 1998

Another objective of the IEMP surveillance monitoring program is to provide an ongoing assessment of the potential for cross-media impacts from surface water to the underlying Great Miami Aquifer. To conduct this assessment, sample locations were selected to evaluate contaminant concentrations in surface water just upstream from those areas where site drainages have eroded through the protective glacial overburden (i.e., the Storm Sewer Outfall Ditch and certain reaches of Paddys Run). In areas where the overburden is absent, a direct pathway exists for contaminants to reach the aquifer. Total uranium is used as an indicator to evaluate the impact of surface water on the Great Miami Aquifer because it is the primary contaminant at the site. A conservative assumption is used in this assessment, which considers the total uranium concentration (and all other constituent concentrations) in the surface water to be at the same concentration when the water reaches the Great Miami Aquifer through infiltration. However, the most likely scenario is that the total uranium concentration (and all other

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constituent concentrations) would decrease, because dilution and adsorption occur as the water infiltrates through the ground and is mixed with the groundwater in the Great Miami Aquifer.

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As shown in Table B.1-2, the results of the cross-media impact assessment for 1998 indicate occasional exceedances of the groundwater total uranium FRL (20 micrograms per liter [μg/L]) in the areas where surface water is directly infiltrating into the Great Miami Aquifer. Key sample locations associated with these areas of direct infiltration are SWP-02, SWD-02, and the Storm Water Retention Basin overflow (SWRB 4002O). Figures B.1-5 through B.1-7 present the total uranium concentrations along with the results from trend analysis (from Mann-Kendall test for trend) for these locations. Two of these locations (SWD-02 and 4002O) had total uranium groundwater FRL exceedances. However, based on these exceedances, it is not likely that there were any significant cross-media impacts to the underlying Great Miami Aquifer. Moreover, trend analysis indicates that there was no significant trend at either SWP-02 or SWD-02. (There are not enough samples to evaluate trend at the Storm Water Retention Basin.) In addition, it should be noted that the design of the groundwater remediation systems has accounted for this potential contaminant pathway by installing extraction wells downgradient of these areas where direct infiltration can occur. No other surface water constituent concentrations at the three locations exceeded any groundwater FRLs. Surface water monitoring under the IEMP will continue to focus on assessing the potential for cross-media impacts to the groundwater pathway throughout the remediation process.

B.1.1.3 Evaluation of Constituents Above BTVs for 1998

Based on the results of the BTV screening process presented in the approved Sitewide Excavation Plan (DOE 1998), three constituents (barium, cadmium, and silver) will be evaluated against surface water BTVs. BTV exceedances for 1998 were limited to three locations (one constituent per each location). Table B.1-3 lists BTV exceedances at corresponding sample locations and Figure B.1-3 shows the locations of these exceedances. Only one sample for each constituent exceeded during 1998. These concentrations were minimally above the BTVs and there were no significant trends.

B.1.1.4 Conclusions

Based on the sporadic nature of these FRL and BTV exceedances, continued monitoring is recommended to determine their significance. The data will continue to be used to document exceedances, provide statistical analysis, assess the cross-media impacts, and determine if additional

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administrative or engineered controls are required to protect the surface water pathway. At this time no additional controls are warranted.

B.1.2 FFCA/OPERABLE UNIT 5 RECORD OF DECISION COMPLIANCE

The Operable Unit 5 Record of Decision stipulates compliance with a monthly flow-weighted average total uranium concentration of 20 μg/L at the Great Miami River via the Parshall Flume (PF 4001) beginning on January 1, 1998. Additionally, the Operable Unit 5 Record of Decision stipulates that the total mass discharged during a year is limited to 600 pounds. During 1998 the Fernald Environmental Management Project (FEMP) monitored total uranium concentrations at the Parshall Flume (PF 4001) on a daily basis to demonstrate compliance with these limitations.

The FEMP was in compliance with the total mass limitation as uranium discharges totaled 216 pounds, which is well below the 600 pound limitation. The FEMP was in compliance with the 20 μg/L limitation every month except July and December. The 20 μg/L limitation was not met during these months due to storm water bypasses experienced during heavy rainfall events as detailed in the following subsections.

B.1.2.1 Storm Water-related Bypasses

The Operable Unit 5 Record of Decision allows the FEMP to directly discharge water collected in the Storm Water Retention Basin to the Great Miami River during periods of "significant precipitation". These are referred to as bypass events (storm water bypassing treatment directly to the Great Miami River). As noted in Figure B.1-8, the Operable Unit 5 Record of Decision allows the FEMP to eliminate the flow-weighted concentration for these bypass days due to "significant precipitation" (up to 10 days each year) in order to comply with the 20 μg/L total uranium limit. The definition of significant precipitation and the manner in which these days are accounted for in the calculation demonstrating compliance with the 20 μg/L limitation was established in the Operations and Maintenance Master Plan for Aquifer Restoration and Wastewater Treatment Project (Section 3.6.2) (DOE 1997b). The Operations and Maintenance Master Plan was approved by the U.S. Environmental Protection Agency (EPA) and the Ohio Environmental Protection Agency (OEPA) in October and

November 1997, respectively. In summary, "significant precipitation" bypass days are to be accounted for as follows:

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- Each day(s) when bypassing for less than 12 hours occurs is (are) to be counted only as necessary to achieve the 20 $\mu g/L$ monthly average total uranium limit.
- Each day when bypassing for 12 or more hours occurs is to be counted as a full bypass day.

The flow-weighted concentration and flow rate for each bypass day are eliminated from the calculation for the month.

Based on the approved definition, the FEMP experienced 14 significant precipitation bypass days of which only 10 were allowed to be deducted from the calculation during 1998 to comply with the limit. Table B.1-4 identifies the significant precipitation bypass days and Figure B.1-8 shows that the FEMP complied with the limit for 10 of the 12 months during 1998 except for July (20.7 $\mu g/L$) and December (23.6 $\mu g/L$). Section B.1.2.3 discusses the reasons for these exceedances. Figure B.1-8 shows how the monthly flow-weighted average concentration at the Parshall Flume (PF 4001) drops as each allowable bypass day is utilized.

B.1.2.2 <u>Maintenance Related Bypasses</u>

Bypassing during scheduled treatment plant maintenance is permissible under the Operable Unit 5 Record of Decision provided prior notice is given to EPA and OEPA. The uranium concentration for those days when a maintenance activity was performed can be eliminated from the uranium concentration calculation. The FEMP had two such days in December 1998 as identified in Table B.1-4 . The Advanced Wastewater Treatment Phase I, Phase II, and Expansion systems were shut down on December 18 through December 19 while required maintenance activities were performed. The south plume interim treatment facility and the interim advanced wastewater treatment plant remained in full operation treating groundwater during this time.

However, even with eliminating these days from the calculation for December, the FEMP still exceeded the 20 $\mu g/L$ limitation for that month due to the significant precipitation and associated storm water bypassing.

B.1.2.3 1998 Exceedances of the 20 μg/L Total Uranium Limitation

This section discusses the circumstances surrounding the two exceedances of the 20 μg/L total uranium limitation which occurred in July and December 1998.

The limit was not met in July 1998 because the monthly average total uranium concentration was 20.7 μg/L after eliminating the remaining allowable significant precipitation bypass day. According to the Operable Unit 5 Record of Decision, storm water bypass days exceeding the 10 allowed per year must be included in the calculation of the monthly average total uranium concentration in water discharged to the Great Miami River. Although the system was bypassed for four days in July 1998, only one allowable significant precipitation bypass day could be utilized to calculate the monthly average uranium concentration for July. For this reason, the remaining three days were included in the monthly uranium average. (Table B.1-4 presents the details concerning these bypasses.)

The U.S. Department of Energy (DOE) notified the EPA and OEPA of the exceedance in a letter transmitted on August 6, 1998, (letter [DOE-1063-98], dated August 6, 1998) and identified a corrective action. Specifically in July 1998, it was determined that the frequency and extent of the bypasses were caused by both high precipitation and because clean water from construction related runoff from Cells 2 and 3 of the on-site disposal facility was unnecessarily diverted to the Storm Water Retention Basin. The duration of the storm water bypass in July was exacerbated because storm water runoff from the construction of on-site disposal facility Cells 2 and 3 was mistakenly pumped to the FEMP's storm sewer system and subsequently delivered to the Storm Water Retention Basin during this period. These waters did not require treatment because no impacted material had been placed in Cells 2 and 3. A corrective action was initiated at the end of July to stop any further storm water flows from Cells 2 and 3 in order to ensure that the Storm Water Retention Basin's design capacity would not be exceeded according to the August 6, 1998 letter referenced above.

The average concentration for December was 23.6 μg/L after eliminating from the monthly average those concentrations observed during the two bypass days associated with treatment plant maintenance. Since the 10 allowable significant precipitation days had occurred by July, the discharge concentration from the one significant precipitation bypass day experienced in December 1998 was included in the monthly average total uranium calculation. Further discussions of the events leading to the December concentration limit exceedance were presented in a facsimile (letter [SWP(ARWWP):99-0003], dated

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February 1, 1999, from Fluor Daniel Fernald to EPA and OEPA). (Table B.1-4 presents the details concerning these bypasses.)

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The December 1998 bypass event was largely due to not having completely implemented corrective actions discussed with the EPA and OEPA in October 1998. Corrective actions discussed at this meeting consisted of operational changes that were summarized in a facsimile (letter [SWP(ARWWP):99-0001], dated January 11, 1999, from Fluor Daniel Fernald to EPA and OEPA) and include:

- Operating the Storm Water Retention Basin as a detention basin rather than a retention basin, thereby allowing flow to be pumped from the basin while it fills as opposed to waiting until after a storm event ends

- Maximizing the Storm Water Retention Basin capacity by operating the basins at the lowest possible level

- Raising the level at which storm water bypassing to the river begins and ends by one foot

- Stop pumping the storm water from the Southern Waste Unit Basins to the Storm Water Retention Basin when the water levels are such that the east and west chambers of the Storm Water Retention Basin become common. Pumping from the Southern Waste Unit Basins is not to resume until the water levels in the basins are such that the chambers of the Storm Water Retention Basin can be differentiated.

Some of these operational changes were largely initiated during the fourth quarter of 1998. The significant precipitation bypass on December 21 through 23, 1998, was due in part to not having fully implemented all of the changes identified above. Specifically, storm water from the Southern Waste Unit Basins continued to be sent to the Storm Water Retention Basin after the above noted "stop pumping" level had been reached. The bypass probably could not have been completely avoided because of the heavy rainfall. Nonetheless, it is likely that the duration of the bypass event would have been shortened if the flow of storm water from the Southern Waste Unit Basins had been curtailed prior to bypassing. It is important to note that after this bypass occurred, the operational modification identified above pertaining to the southern waste units was implemented. In addition, it was identified to EPA and OEPA during a conference call on December 22, 1998, that a number of groundwater extraction wells were shut down and the aquifer re-injection water (treated groundwater) was re-routed in an effort to mitigate the high total uranium concentrations from the Storm Water Retention Basin bypass event.

Additional discussions continue with EPA and OEPA to status the effectiveness and implementation of the operational changes. Corrective actions that have resulted from these discussions will continue to be reported through IEMP reports and will also be documented in the revised Operations and Maintenance Master Plan for the Aquifer Restoration and Wastewater Treatment Project to be issued in Spring 1999.

B.1.3 CONTROLLED AND UNCONTROLLED AREAS

There were a number of acres, previously uncontrolled, that were added to the FEMP controlled storm water system in 1998 (Figure B.1-9). These areas included Cells 1 and 2 of the on-site disposal facility, the southern waste units excavation area, and the Waste Pits Remedial Action Project (WPRAP) facility area. These changes added approximately 50.5 acres of previously uncontrolled area to the controlled storm sewer system. The following identifies for each specific area where storm water runoff is collected, how it is controlled, the reason why the area is now controlled, and the amount of area controlled:

- Storm water runoff associated with Cells 1 and 2 of the on-site disposal facility are collected by the leachate collection system and is sent to the Bio-Surge Lagoon and then to the advanced wastewater treatment facility. This area is controlled because waste placement is occurring within both of these cells, although, waste placement was not initiated until the latter part of 1998 for Cell 2. Thus, storm water runoff from Cell 2 was controlled before it was necessary (as discussed in Section B.1.2.3). The area controlled is seven acres per cell for a total of 14 acres.

- Storm water runoff associated with the southern waste units is collected by three engineered basins which became operational in July 1998. The water from these basins is transferred to the Storm Water Retention Basin and then to the advanced wastewater treatment facility. This area is controlled due to the excavation of contaminated soil and waste material. The area controlled is 26 acres.

- Storm water runoff associated with the WPRAP facility area is collected by the Storm Water Management Pond and is then sent to the Bio-Surge Lagoon and then to the advanced wastewater treatment facility. This area is controlled due to the construction activities and anticipated excavation activities in the Operable Unit 1 area. The area controlled is 10.5 acres. It is important to note that DOE has initiated negotiations with OEPA concerning acceptable sampling strategies and pollutant thresholds below which pumping the Storm Water Management Pond directly to Paddys Run would be acceptable.

The areas that are controlled/uncontrolled is expected to continue to change throughout remediation because areas with potential contamination will be added to the controlled system and areas that have been remediated will be removed from the controlled system. This information will continue to be provided in IEMP reports.

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TABLE B.1-1

SUMMARY STATISTICS AND TREND ANALYSIS FOR CONSTITUENTS WITH 1998 RESULTS ABOVE FINAL REMEDIATION LEVELS

Location[a]	Constituent	No. of Samples for 1997 and 1998[b,c]	No. of Samples Above FRL for 1997 and 1998[b,c]	No. of Samples Above FRL for 1998[b,c]	FRL[d] (mg/L)	Min.[b,c,e,f] (mg/L)	Max.[b,c,e,f] (mg/L)	Avg.[b,c,e,f] (mg/L)	SD[b,c,e,f,g] (mg/L)	Trend[b,c,e,f,g]
SWR-01 (Great Miami River Background)	Chromium	6	1	1	0.010[h]	0.0013	0.0267	0.0066	0.010	No Significant Trend
	Copper	12	2	2	0.012	0.0043	0.0273	0.011	0.0082	No Significant Trend
	Lead	6	1	1	0.01	0.0008	0.0222	0.005	0.008	No Significant Trend
SWP-02 (Paddys Run)	Chromium	13	2	1	0.010[h]	0.0003	0.181	0.016	0.05	No Significant Trend
	Copper	13	2	1	0.012	0.0011	0.269	0.024	0.074	No Significant Trend
SWP-03 (Paddys Run at Downstream Property Boundary)	Mercury	11	1	1	0.0002	0.000015	0.00027	0.000067	0.000068	No Significant Trend
SWD-01 (Northeast Drainage)	Zinc	15	4	1	0.11	0.0089	0.366	0.10	0.12	Down, Significant
SWD-03 (Waste Storage Area)	Copper	16	1	1	0.012	0.0007	0.0259	0.0033	0.006	No Significant Trend
SWRB 4002O (Storm Water Retention Basin Overflow)	Chromium	3	1	1	0.010[h]	0.003	0.0128	0.007	NA	NA
	Copper	3	2	1	0.012	0.0116	0.0156	0.0131	NA	NA
STRM 4004 (Paddys Run Drainage Ditch Near Inactive Flyash Pile)	Chromium	4	2	1	0.010[h]	0.003	0.0288	0.012	0.012	No Significant Trend
	Copper	4	3	1	0.012	0.0081	0.0293	0.017	0.0088	No Significant Trend

[a]Refer to Figure B.1-3
[b]If more than one sample is collected per surface water location per day (e.g., duplicate, grab, composite), then only one sample is counted for the number of samples, and the sample with the maximum concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation [SD]), Mann-Kendall test for trend, and in determining FRL exceedances.
[c]Rejected data qualified with either a R or Z were not included in the count, the summary statistics, or Mann-Kendall test for trend.
[d]From Operable Unit 5 Record of Decision, Table 9-5
[e]If the number of samples is greater than or equal to four, then the Mann-Kendall test for trend and all of the summary statistics are reported. If the number of samples is equal to three, then the minimum, maximum, and average are reported. If the number of samples is equal to two, then the minimum and maximum are reported. If the number of samples is equal to one, then the data point is reported as the minimum.
[f]For results where the concentrations are below the detection limit, the results used in the summary statistics and Mann-Kendall test for trend are each set at half the detection limit.
[g]NA = not applicable
[h]FRL based on hexavalent chromium, from Operable Unit 5 Record of Decision, Table 9-5; however, the sampling results are for total chromium.

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TABLE B.1-2

SUMMARY STATISTICS AND TREND ANALYSIS OF 1998 TOTAL URANIUM GROUNDWATER FINAL REMEDIATION LEVELS EXCEEDANCE FOR CROSS-MEDIA IMPACTS[a]

Location[b]	No. of Samples for 1997 and 1998[c,d]	No. of Samples Above FRL for 1997 and 1998[c,d]	No. of Samples Above FRL for 1998[c,d]	Min.[c,d,e,f,g] (μg/L)	Max.[c,d,e,f,g] (μg/L)	Avg.[c,d,e,f,g] (μg/L)	SD[c,d,e,f,g] (μg/L)	Trend[c,d,e,f,g]
SWD-02 (Storm Sewer Outfall Ditch)	16	7	5	0.599	73	23	18	No Significant Trend
SWRB 4002O (Storm Water Retention Basin Overflow)	3	3	2	104	314	196	NA	NA

[a]Groundwater total uranium FRL is 20 μg/L.
[b]Refer to Figure B.1-1 for sample locations
[c]If more than one sample is collected per surface water location per day (e.g., duplicate, grab, composite), then only one sample is counted for the number of samples, and the sample with the maximum concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation [SD]) and in determining FRL exceedances.
[d]Rejected data qualified with either a R or Z were not included in the count, the summary statistics, or Mann-Kendall test for trend.
[e]If the number of samples is greater than or equal to four, then the Mann-Kendall test for trend and all of the summary statistics are reported. If the number of samples is equal to three, then the minimum, maximum, and average are reported. If the number of samples is equal to two, then the minimum and maximum are reported. If the number of samples is equal to one, then the data point is reported as the minimum.
[f]For results where the concentrations are below the detection limit, the results used in the summary statistics and Mann-Kendall test for trend are each set at half the detection limit.
[g]NA = not applicable

TABLE B.1-3

SUMMARY STATISTICS AND TREND ANALYSIS FOR CONSTITUENTS WITH 1998 RESULTS ABOVE BENCHMARK TOXICITY VALUE

Location[a]	Constituent	No. of Samples for 1997 and 1998[b,c]	No. of Samples Above BTV for 1997 and 1998[b,c]	No. of Samples Above BTV for 1998[b,c]	BTV (mg/L)	Min.[b,c,d,e] (mg/L)	Max.[b,c,d,e] (mg/L)	Avg.[b,c,d,e] (mg/L)	SD[b,c,d,e] (mg/L)	Trend[b,c,d,e]
SWR-01 (Great Miami River Background)	Barium	6	1	1	0.145	0.0823	0.172	0.106	0.0335	No Significant Trend
SWP-02 (Paddys Run)	Cadmium	13	2	1	0.0035	0.00005	0.0105	0.0013	0.003	No Significant Trend
STRM 4004 (Paddys Run Drainage Ditch Near Inactive Flyash Pile	Silver	4	1	1	0.0013	0.00045	0.005	0.0025	0.002	No Significant Trend

[a]Refer to Figure B.1-3
[b]If more than one sample is collected per surface water location per day (e.g., duplicate, grab, composite), then only one sample is counted for the number of samples, and the sample with the maximum concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation [SD]) and in determining BTV exceedances.
[c]Rejected data qualified with either a R or Z were not included in the count, the summary statistics, or Mann-Kendall test for trend.
[d]If the number of samples is greater than or equal to four, then the Mann-Kendall test for trend and all of the summary statistics are reported. If the number of samples is equal to three, then the minimum, maximum, and average are reported. If the number of samples is equal to two, then the minimum and maximum are reported. If the number of samples is equal to one, then the data point is reported as the minimum.
[e]For results where the concentrations are below the detection limit, the results used in the summary statistics and Mann-Kendall test for trend are each set at half the detection limit.

TABLE B.1-4

1998 STORM WATER RETENTION BASIN OVERFLOWS AND TREATMENT BYPASS EVENTS

Event	Duration (hours)	Number of Bypass Days[a,b]	Cumulative Number of Bypass Days[b]	Total Uranium Discharged (pounds)	Total Water Discharged (millions of gallons)
Overflows				(to Paddys Run)	(to Paddys Run)
April 16	15.9	NA	NA	1.99	1.39
July 20	8.25	NA	NA	0.48	0.55
Significant Precipitation Bypasses				(to Great Miami River)	(to Great Miami River)
January 7 through January 9	53.8	2	2	7.82	3.19
April 16 through April 19	76.8	3	5	9.78	6.09
June 11 through June 14	80.0	3	8	11.16	5.72
June 16 through June 17	22.8	0	8	2.48	1.43
June 19 through June 20	24.0	1	9	3.17	2.01
July 20 through July 23	83.8	4[c]	13	6.45	6.17
December 21 through December 23	34.7	1[d]	14	4.92	2.04
Treatment Plant Maintenance Bypasses					
December 18 through December 19	48.0	2	2	3.81	9.75

[a]Days are counted according to the definition provided in the Operations and Maintenance Master Plan for the Aquifer Restoration and Wastewater Treatment Project.
[b]NA = not applicable
[c]The duration of the storm water bypass for this event was exacerbated because storm water runoff from the construction of on-site disposal facility Cells 2 and 3 was mistakenly pumped to the site's storm sewer system and subsequently delivered to the Storm Water Retention Basin during this period. These waters did not require treatment because no impacted material had been placed in Cells 2 and 3. A corrective action was initiated in the third quarter of 1998 to stop any further storm water runoff from on-site disposal facility Cells 2 and 3 prior to waste placement.
[d]The significant precipitation bypass on December 21 through December 23, 1998, was due in part to storm water from the southern waste units which continued to be sent to the Storm Water Retention Basin after the bypass event had been initiated.

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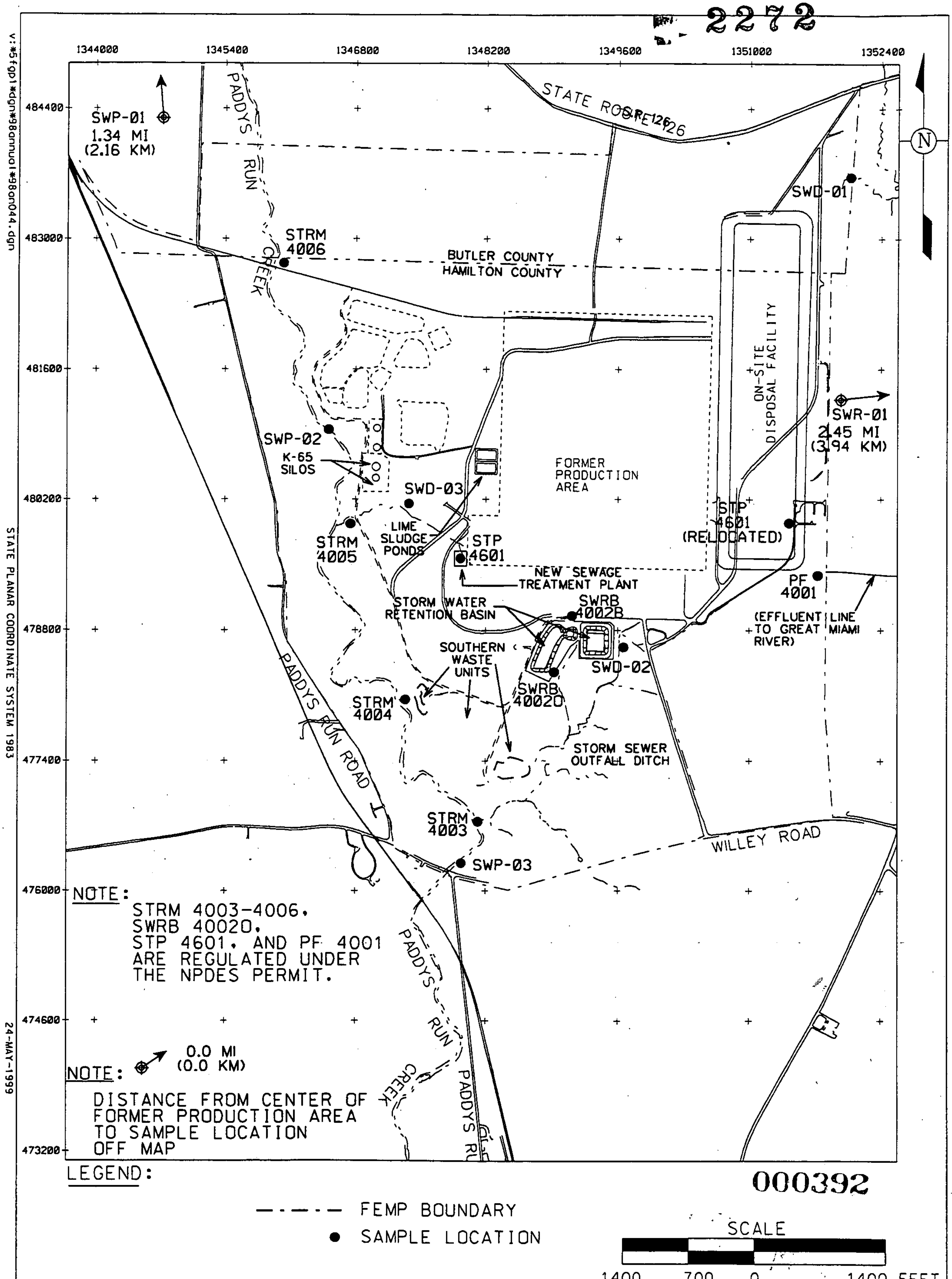

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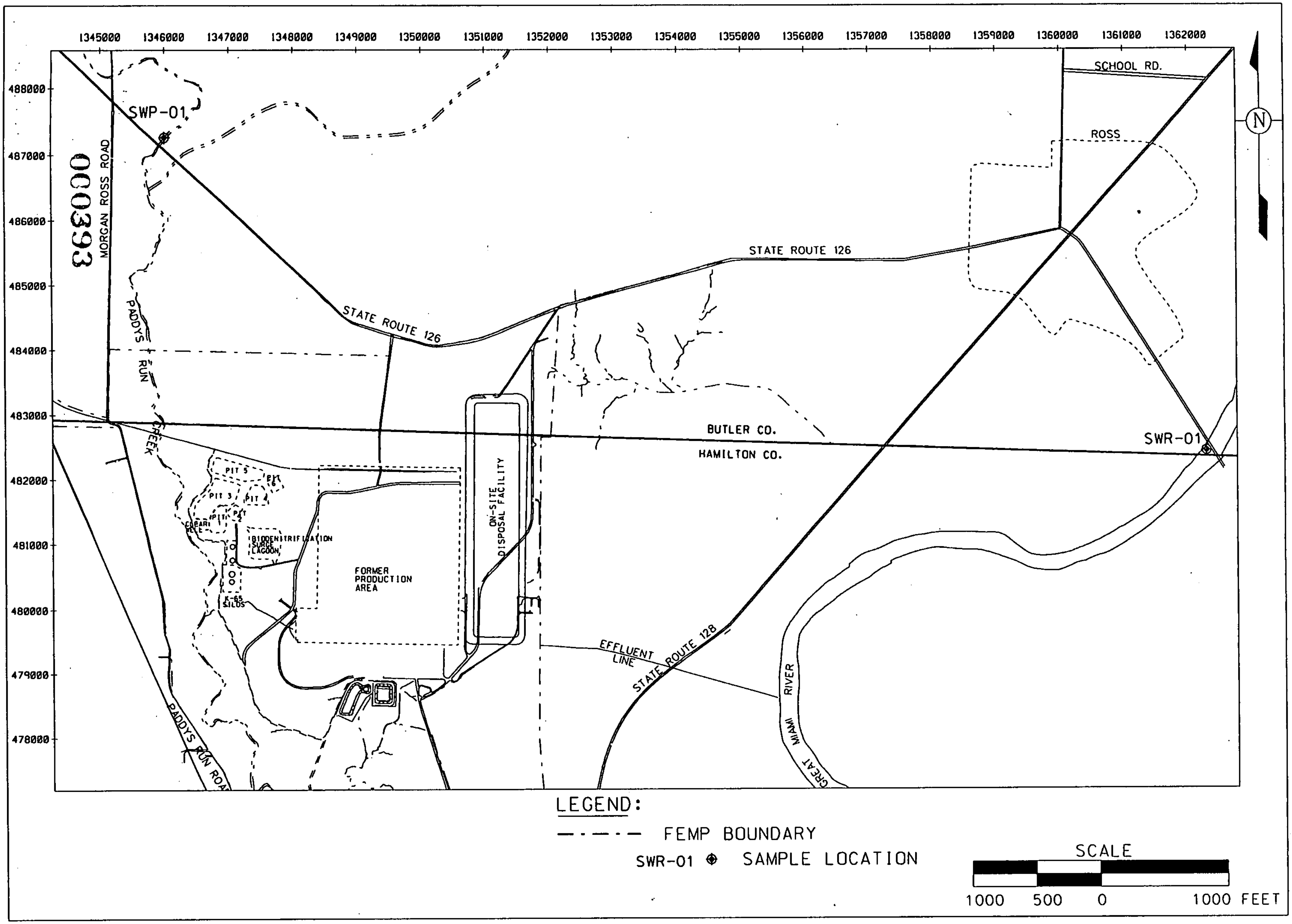
FIGURE B.1-1. IEMP SURFACE WATER AND TREATED EFFLUENT SAMPLE LOCATIONS



v:*5fgp1*dgn*98annual*98an046.dgn
STATE PLANAR COORDINATE SYSTEM 1983

24-MAY-1999

FIGURE B.1-2. IEMP BACKGROUND SURFACE WATER SAMPLE LOCATIONS

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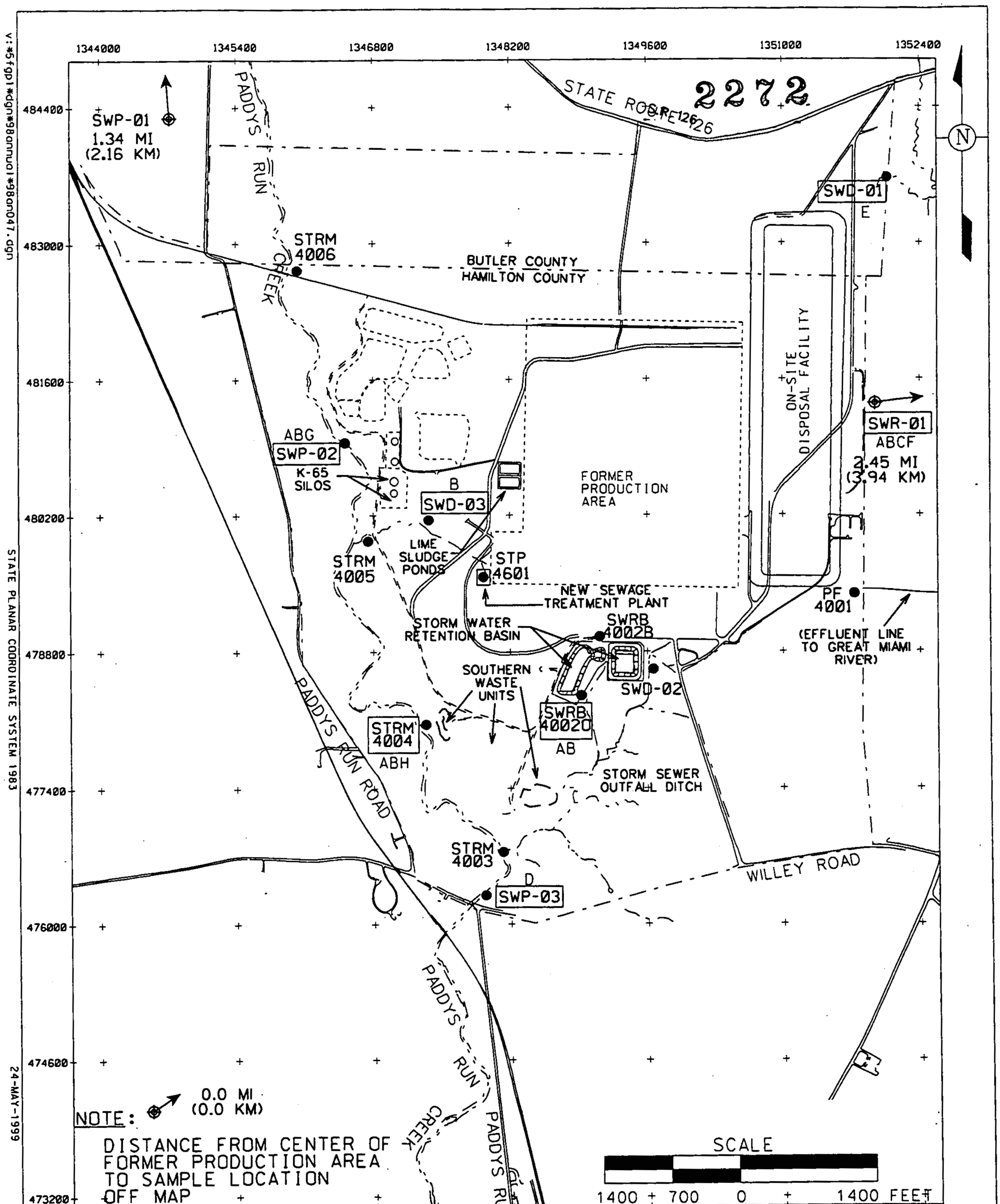

LEGEND:

- - FEMP BOUNDARY
- ● SAMPLE LOCATION

FRL EXCEEDANCE KEY:

A CHROMIUM
B COPPER
C LEAD
D MERCURY
E ZINC

BTV EXCEEDANCE KEY:

F BARIUM
G CADMIUM
H SILVER

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FIGURE B.1-3. CONSTITUENTS WITH 1998 RESULTS ABOVE FINAL REMEDIATION LEVELS AND/OR BENCHMARK TOXICITY VALUES

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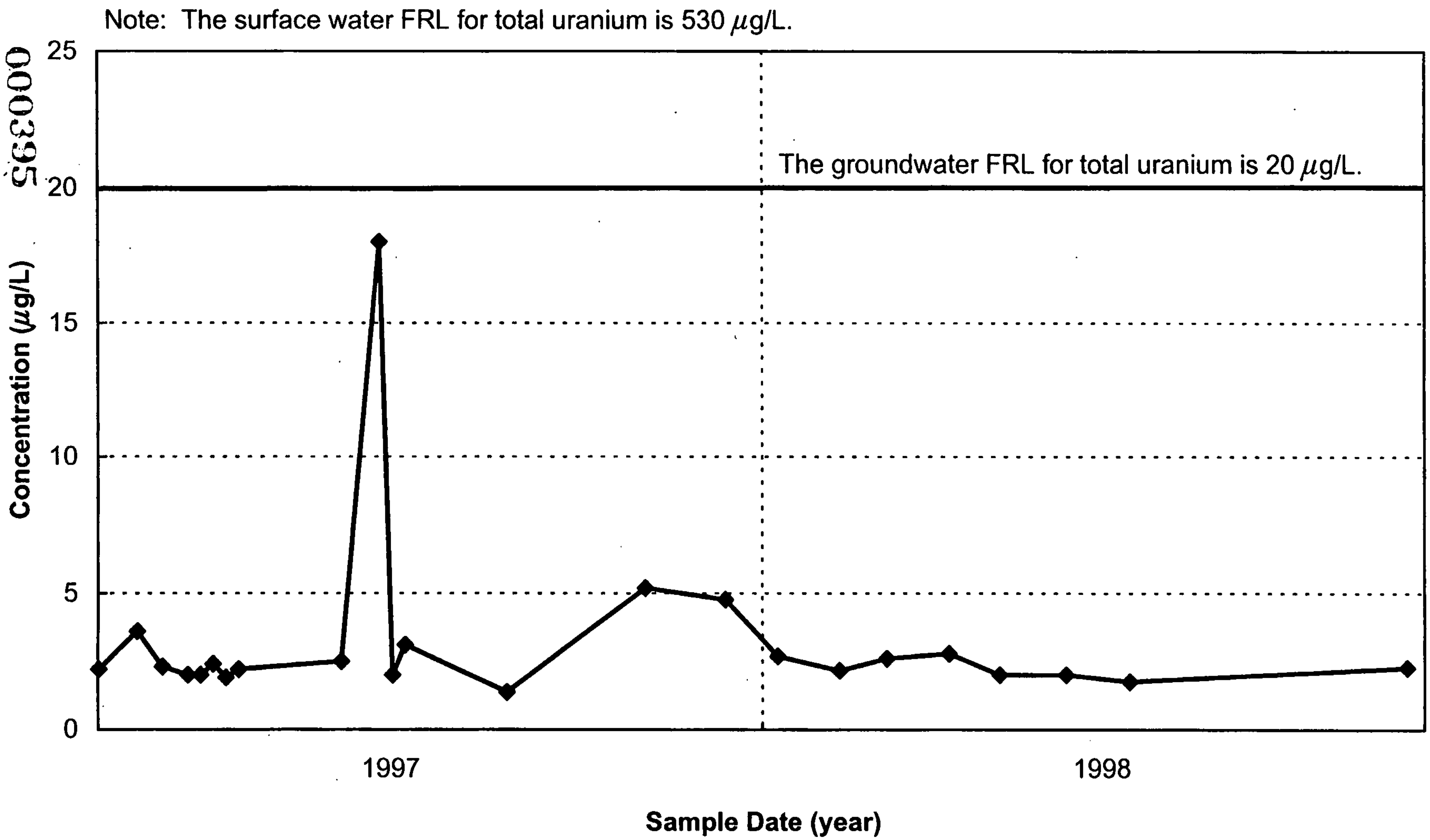

FIGURE B.1-4. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR LOCATION SWP-03
(PADDYS RUN AT DOWNSTREAM PROPERTY BOUNDARY)

No Trend

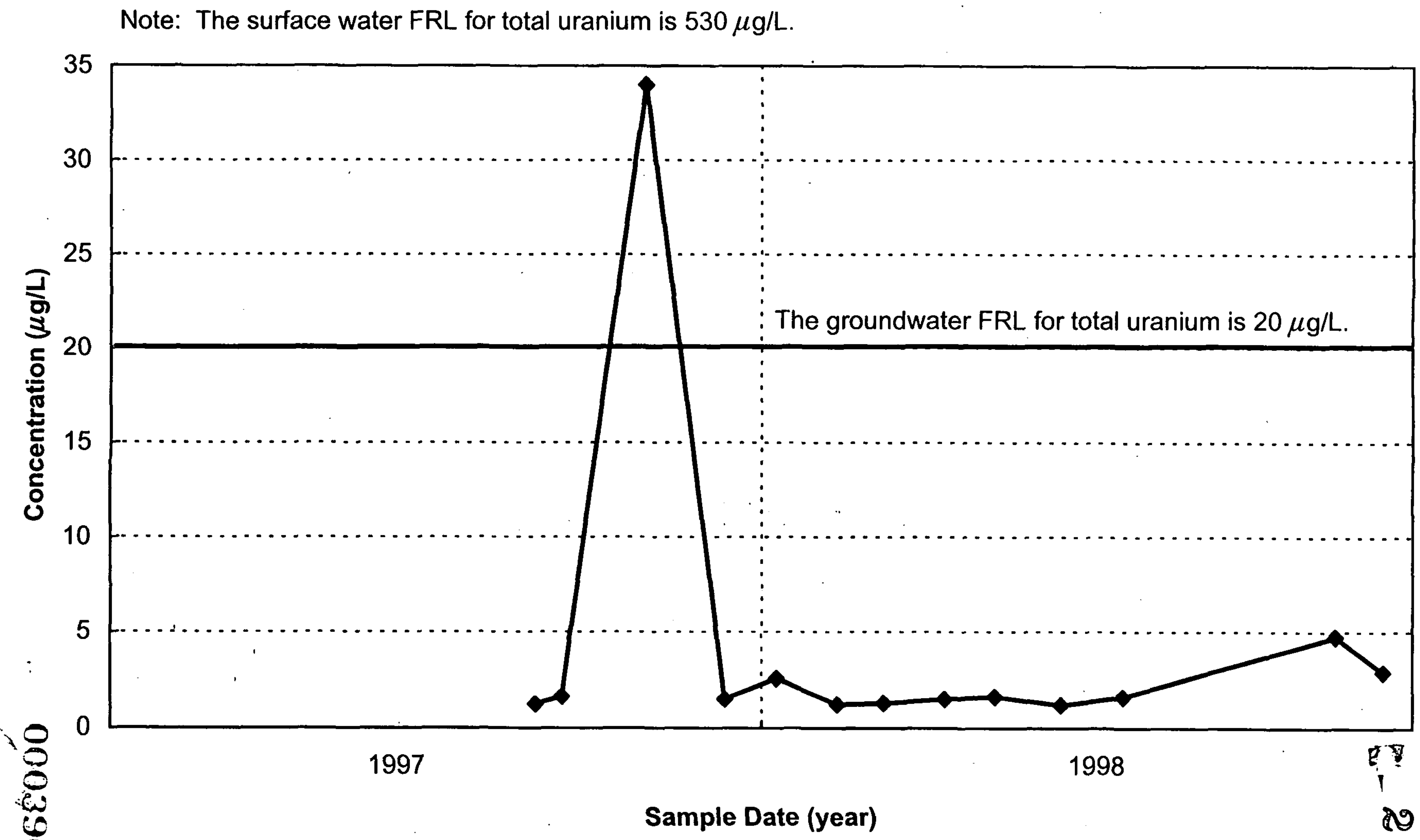

FIGURE B.1-5. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR LOCATION SWP-02 (PADDYS RUN)
FOR CROSS-MEDIA IMPACT EVALUATION

No Trend

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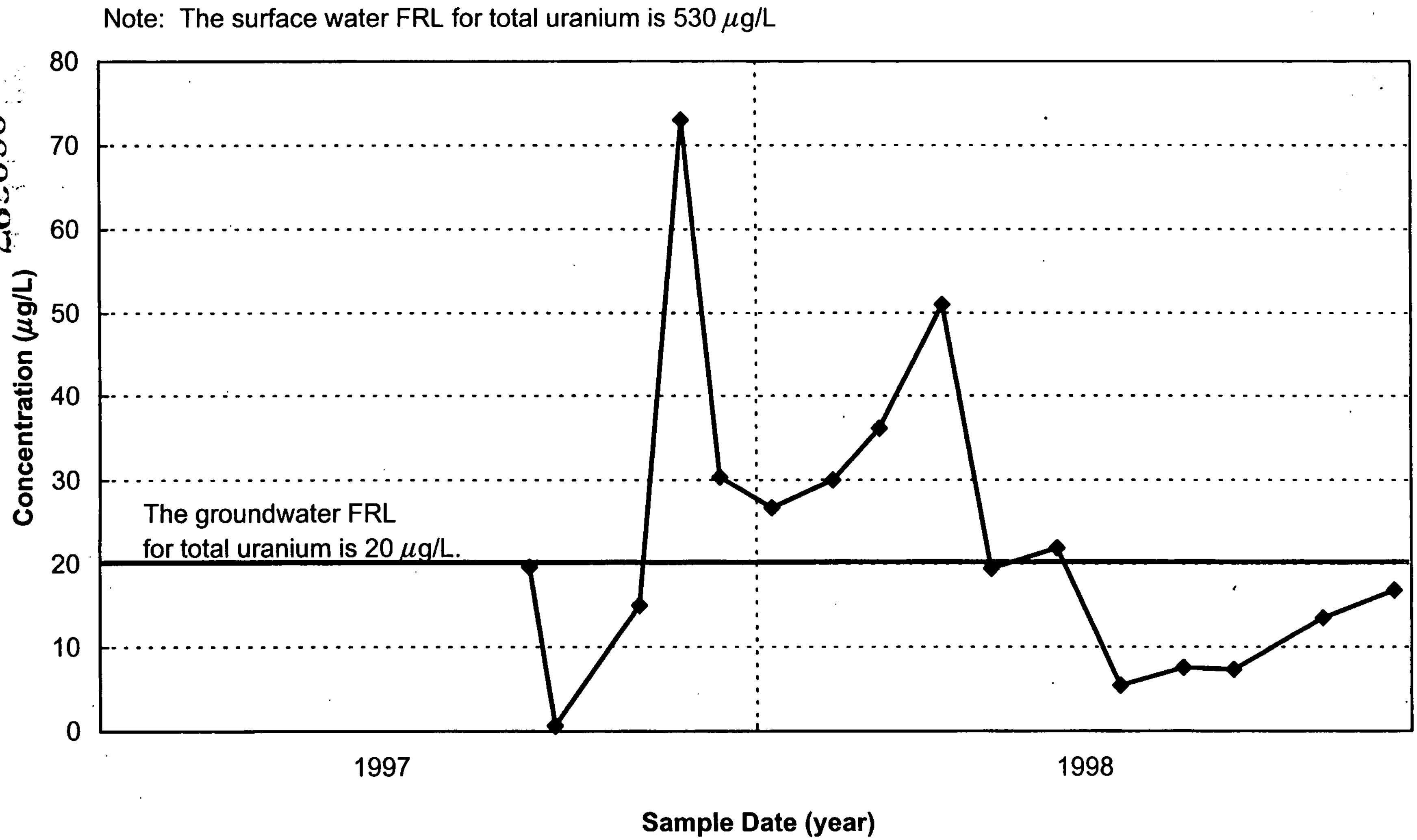
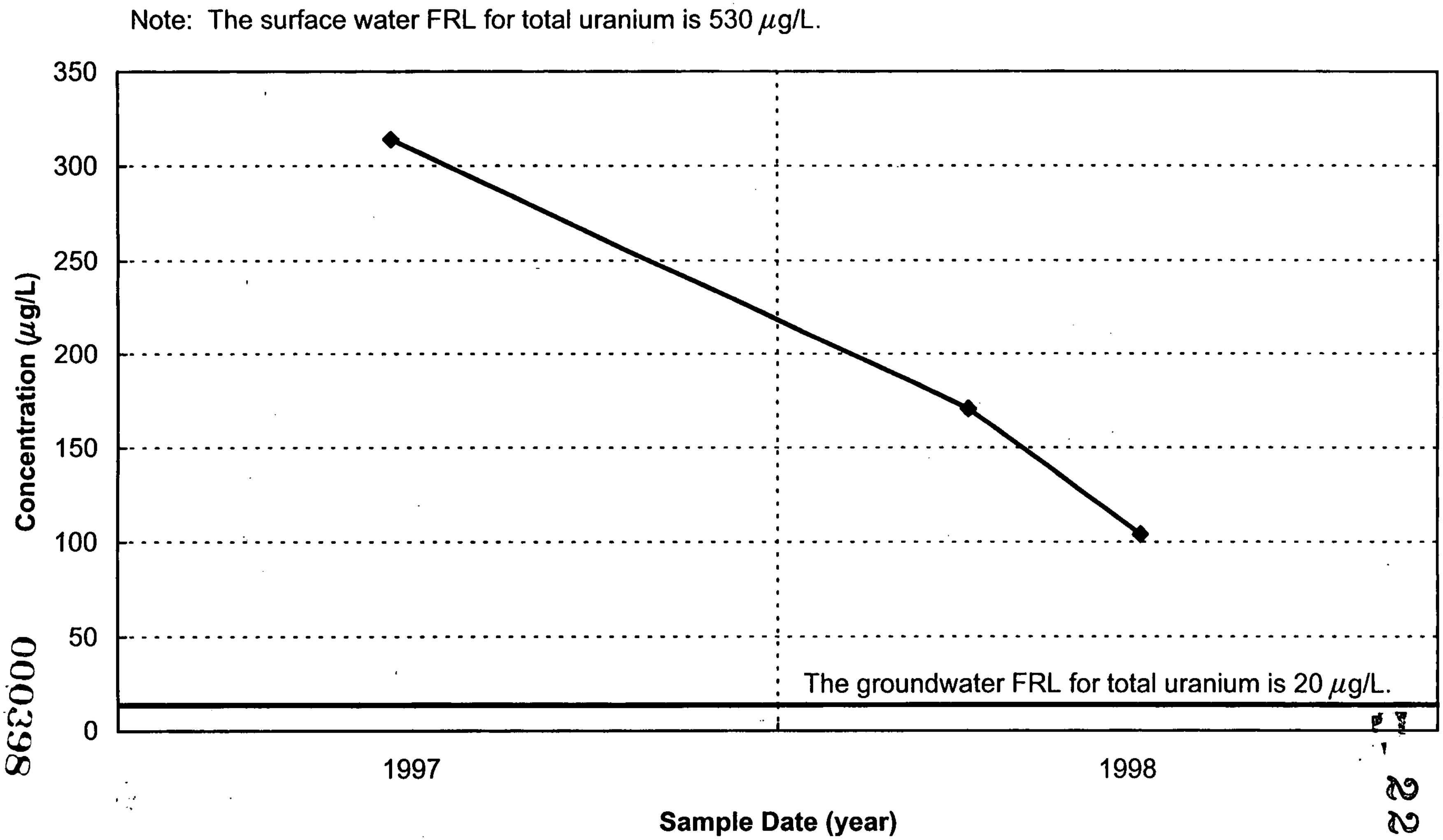


FIGURE B.1-6. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR LOCATION SWD-02 (STORM SEWER OUTFALL DITCH) FOR CROSS-MEDIA IMPACT EVALUATION

No Trend



Not enough samples to perform trend analysis.

FIGURE B.1-7. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR LOCATION SWRB 4002O (STORMWATER RETENTION BASIN OVERFLOW)
FOR CROSS-MEDIA IMPACT EVALUATION

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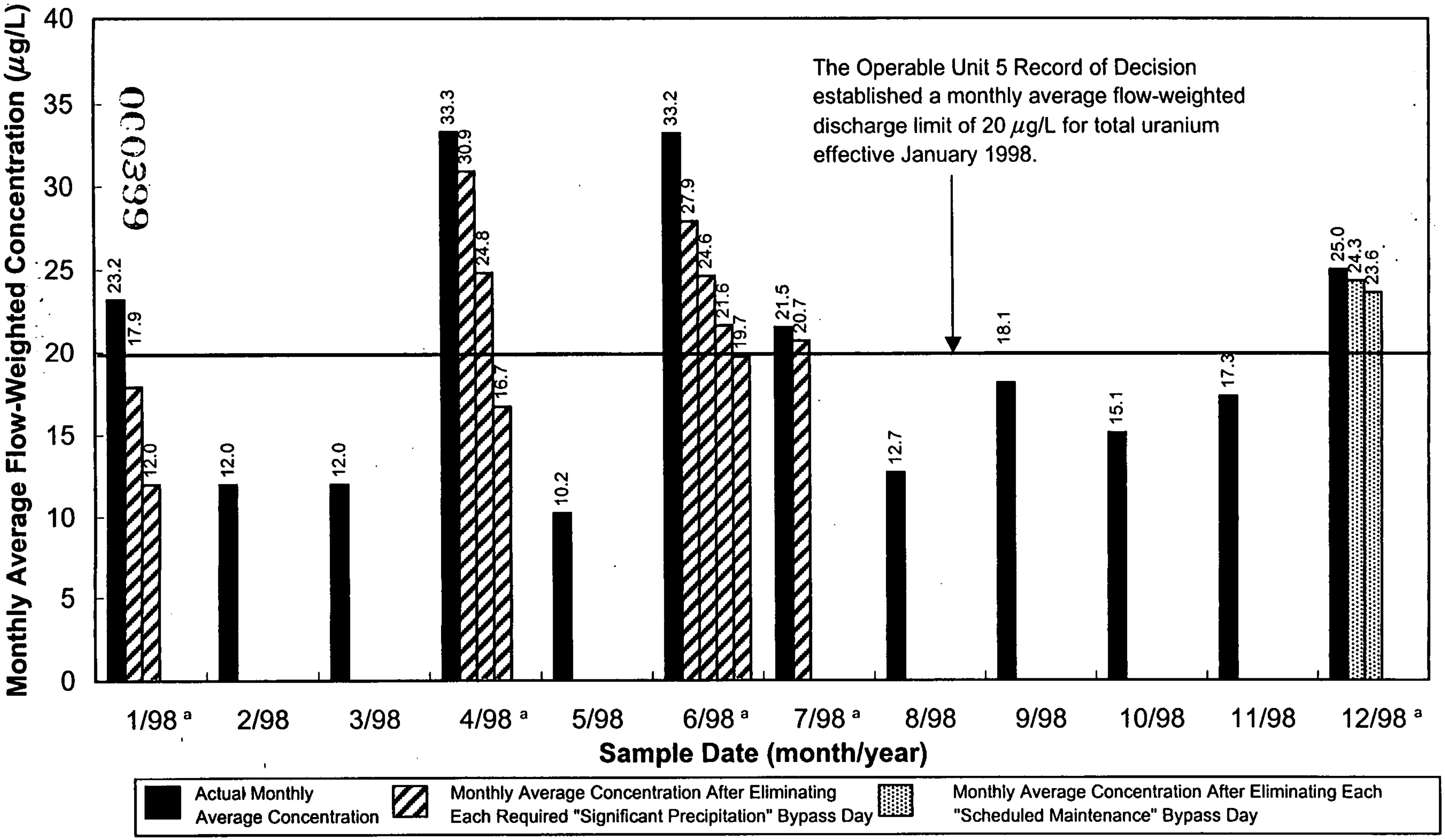
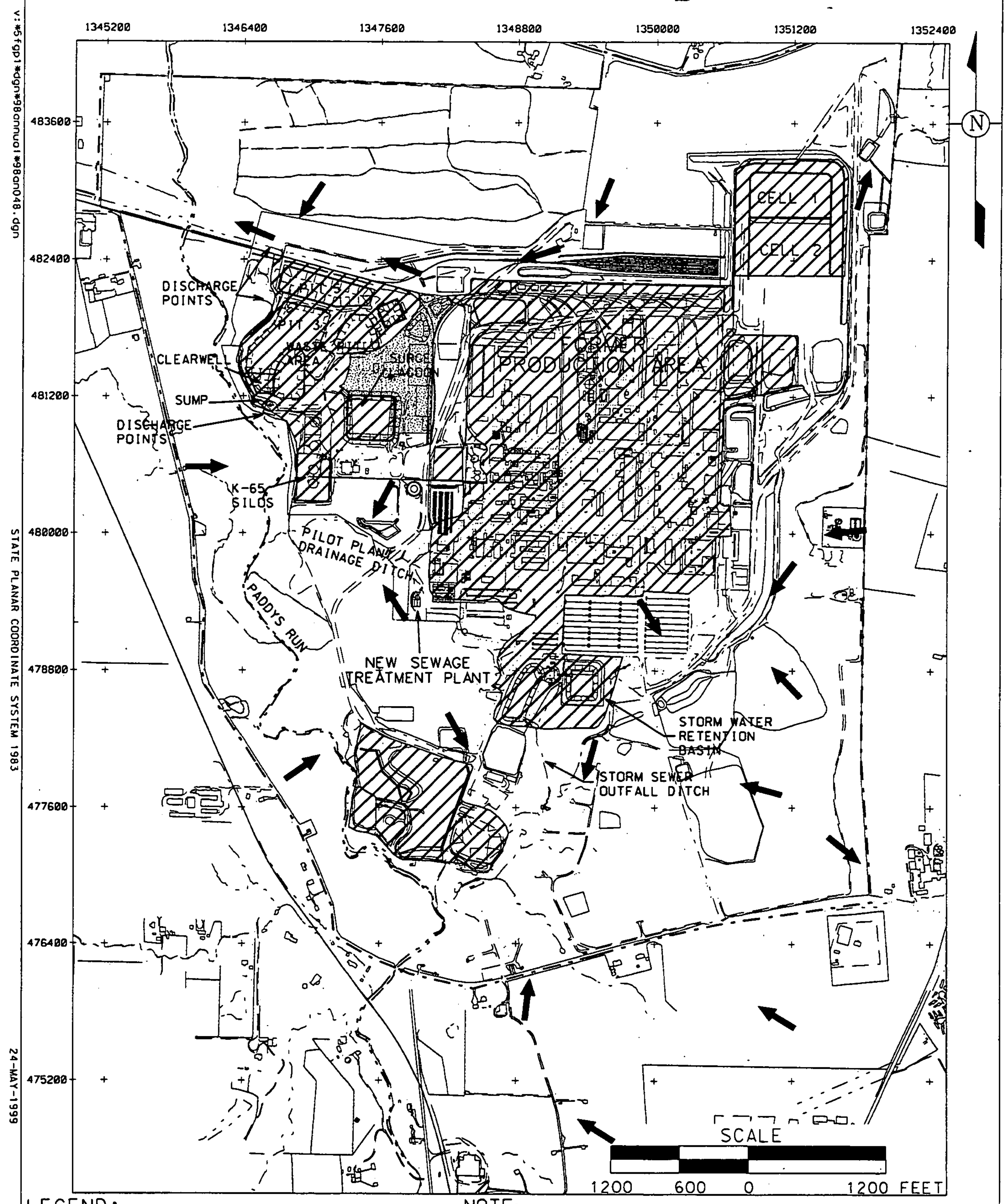


[a] For information regarding the length of the bypass event, see the "Duration" column of Table B.1-4.

FIGURE B.1-8. 1998 BYPASS ELIMINATION DETAIL FOR TOTAL URANIUM DISCHARGES FROM THE PARSHALL FLUME (PF 4001) TO THE GREAT MIAMI RIVER



LEGEND:

FEMP BOUNDARY

CONTROLLED AREA

UNCONTROLLED RUNOFF FLOW DIRECTION

WATER TREATED (AS OF THE FOURTH QUARTER)

NOTE: CONTROLLED MEANS WATER IS COLLECTED AND SENT FOR TREATMENT AT THE AWWT.

000400

FIGURE B.1-9. CONTROLLED SURFACE WATER AREAS AND UNCONTROLLED FLOW DIRECTIONS FOR FOURTH QUARTER 1998

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Attachment B.2

ATTACHMENT B.2

SEDIMENT

ATTACHMENT B.2

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Sediment is a secondary exposure pathway and is monitored annually to assess the impact of remediation activities on sediments deposited along surface water drainages. Sediment is collected at strategic locations to ensure that the most recently deposited sediment is collected. Sediment collected in 1998 marked the first year for implementing the sediment monitoring program contained in the IEMP. The sediment sample locations and analytical suite were comparable to previous years' sampling programs specified in the Environmental Monitoring Plan (FERMCO 1995).

Table B.2-1 summarizes the results of the 1998 sediment monitoring program. Figure B.2-1 identifies each sediment sample location. Analytical results of samples collected from the Storm Sewer Outfall Ditch, Paddys Run, and the Great Miami River were below the FRL for total uranium, isotopic thorium, and radium-226.

In general, the 1998 sample results indicate a decrease in concentrations from the samples collected from 1990 through 1997. Total uranium results for 1998 from Paddys Run were within the range of background levels. The average total uranium concentration in the Storm Sewer Outfall Ditch is slightly above background levels, but well below the FRL. Figures B.2-2 through B.2-6 present sediment data trends.

The overall 1998 analytical results indicate a decrease in concentrations compared to previous years. All sediment locations sampled in 1998 had results below the FRLs, whereas, one location sampled in 1997 slightly exceeded the thorium-232. Monitoring will continue to identify adverse impacts to the sediment pathway as remediation activities occur.

TABLE B.2-1

SUMMARY STATISTICS FOR SEDIMENT MONITORING PROGRAM

		1998 Results - Concentration (dry weight)							1997 Results						1990 - 1996 Results			
	No. of	Minimum[a,b,c]		Maximum[a,b,c]		Average[a,b,c]		No. of	Minimum[a,b,c]		Maximum[a,b,c]		Average[a,b,c]		Minimum[a,b,c]		Maximum[a,b,c]	
Radionuclide	Samples[a]	pCi/g	(mg/kg)	pCi/g	(mg/kg)	pCi/g	(mg/kg)	Samples[a]	pCi/g	(mg/kg)	pCi/g	(mg/kg)	pCi/g	(mg/kg)	pCi/g	(mg/kg)	pCi/g	(mg/kg)
Great Miami River, North of the Effluent Line																		
Uranium, Total	1	0.70	(1.04)	NA	NA	NA	NA	1	1.3	(1.9)	NA	NA	NA	NA	0.50	(0.74)	1.8	(2.7)
Great Miami River, South of the Effluent Line																		
Uranium, Total	3	0.46	(0.68)	1.13	(1.7)	0.83	(1.2)	4	1.0	(1.5)	1.2	(1.8)	1.1	(1.6)	0.30	(0.44)	2.6	(3.8)
Paddys Run Background, North of S.R. 126																		
Radium-226	1	0.57	NA	NA	NA	NA	NA	1	0.48	NA	NA	NA	NA	NA	0.00	NA	1.4	NA
Thorium-228	1	0.36	NA	NA	NA	NA	NA	1	0.41	NA	NA	NA	NA	NA	0.15	NA	1.2	NA
Thorium-230	1	0.48	NA	NA	NA	NA	NA	1	0.58	NA	NA	NA	NA	NA	0.22	NA	1.9	NA
Thorium-232	1	0.42	NA	NA	NA	NA	NA	1	0.34	NA	NA	NA	NA	NA	0.15	NA	1.1	NA
Uranium, Total	1	0.78	(1.2)	NA	NA	NA	NA	1	0.67	(1.0)	NA	NA	NA	NA	0.41	(0.61)	2.8	(4.1)
Paddys Run, North of the Storm Sewer Outfall Ditch																		
Radium-226	5	0.40	NA	0.52	NA	0.47	NA	5	0.54	NA	1.0	NA	0.78	NA	0.00	NA	3.7	NA
Thorium-228	5	0.33	NA	0.37	NA	0.34	NA	5	0.31	NA	0.47	NA	0.41	NA	0.25	NA	5.1	NA
Thorium-230	5	0.28	NA	0.67	NA	0.54	NA	5	0.47	NA	0.65	NA	0.58	NA	0.08	NA	9.8	NA
Thorium-232	5	0.24	NA	0.45	NA	0.35	NA	5	0.25	NA	0.43	NA	0.34	NA	0.19	NA	5.4	NA
Uranium, Total	5	0.66	(0.97)	1.26	(1.9)	0.89	(1.3)	5	0.77	(1.1)	1.1	(1.7)	0.77	(1.1)	0.55	(0.81)	8.7	(13)
Storm Sewer Outfall Ditch																		
Radium-226	5	0.46	NA	0.52	NA	0.48	NA	5	0.41	NA	0.98	NA	0.65	NA	0.00	NA	1.4	NA
Thorium-228	5	0.24	NA	0.39	NA	0.30	NA	5	0.31	NA	1.8	NA	0.76	NA	0.05	NA	1.9	NA
Thorium-230	5	0.49	NA	0.85	NA	0.64	NA	5	0.53	NA	1.7	NA	0.90	NA	0.02	NA	4.0	NA
Thorium-232	5	0.22	NA	0.41	NA	0.29	NA	5	0.21	NA	1.6	NA	0.64	NA	0.01	NA	2.1	NA
Uranium, Total	5	1.04	(1.5)	1.71	(2.5)	1.33	(2.0)	5	0.93	(1.4)	9.1	(14)	3.4	(5.1)	0.41	(0.61)	16	(23)
Paddys Run, South of the Storm Sewer Outfall Ditch																		
Uranium, Total	5	0.67	(0.99)	1.16	(1.7)	0.88	(1.3)	6	0.68	(1.0)	1.2	(1.8)	0.94	(1.4)	0.55	(0.81)	30	(44)

FRLs	mg/kg	pCi/g
Radium-226	-	2.9
Thorium-228	-	3.2
Thorium-230	-	18000
Thorium-232	-	1.6
Uranium, Total	210	-

[a]If more than one sample is collected per sample location (e.g., split or duplicate), then only one sample is counted for the number of samples, and the sample with the maximum concentration is used for determining the summary statistics (minimum, maximum, and average).
[b]If the number of samples is greater than or equal to three, then the minimum, maximum, and average are reported. If the number of samples is equal to two, then the minimum and maximum are reported. If the number of samples is equal to one, then the result is reported as the minimum.
[c]NA = not applicable

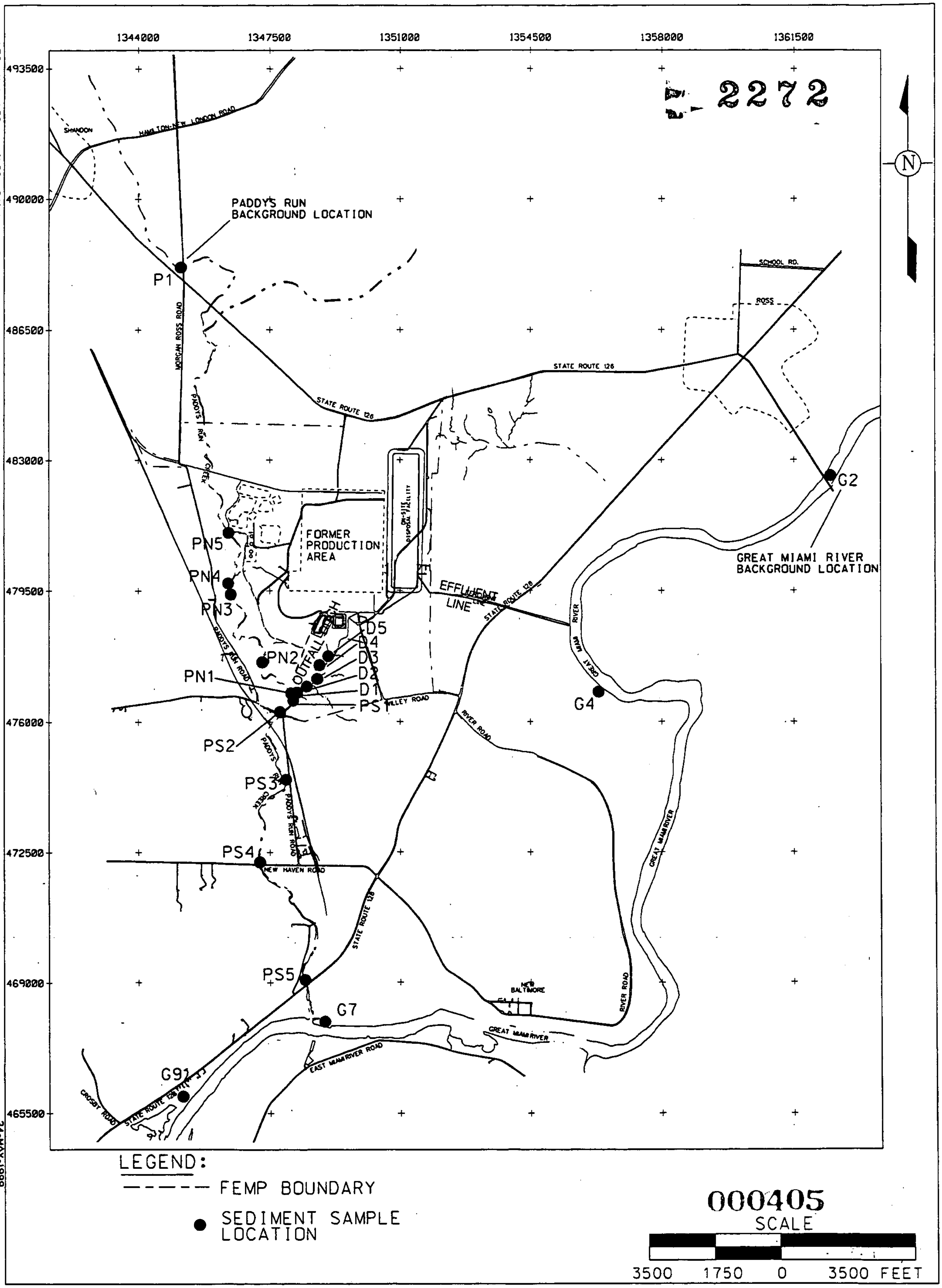

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FIGURE B.2-1. 1998 SEDIMENT SAMPLE LOCATIONS

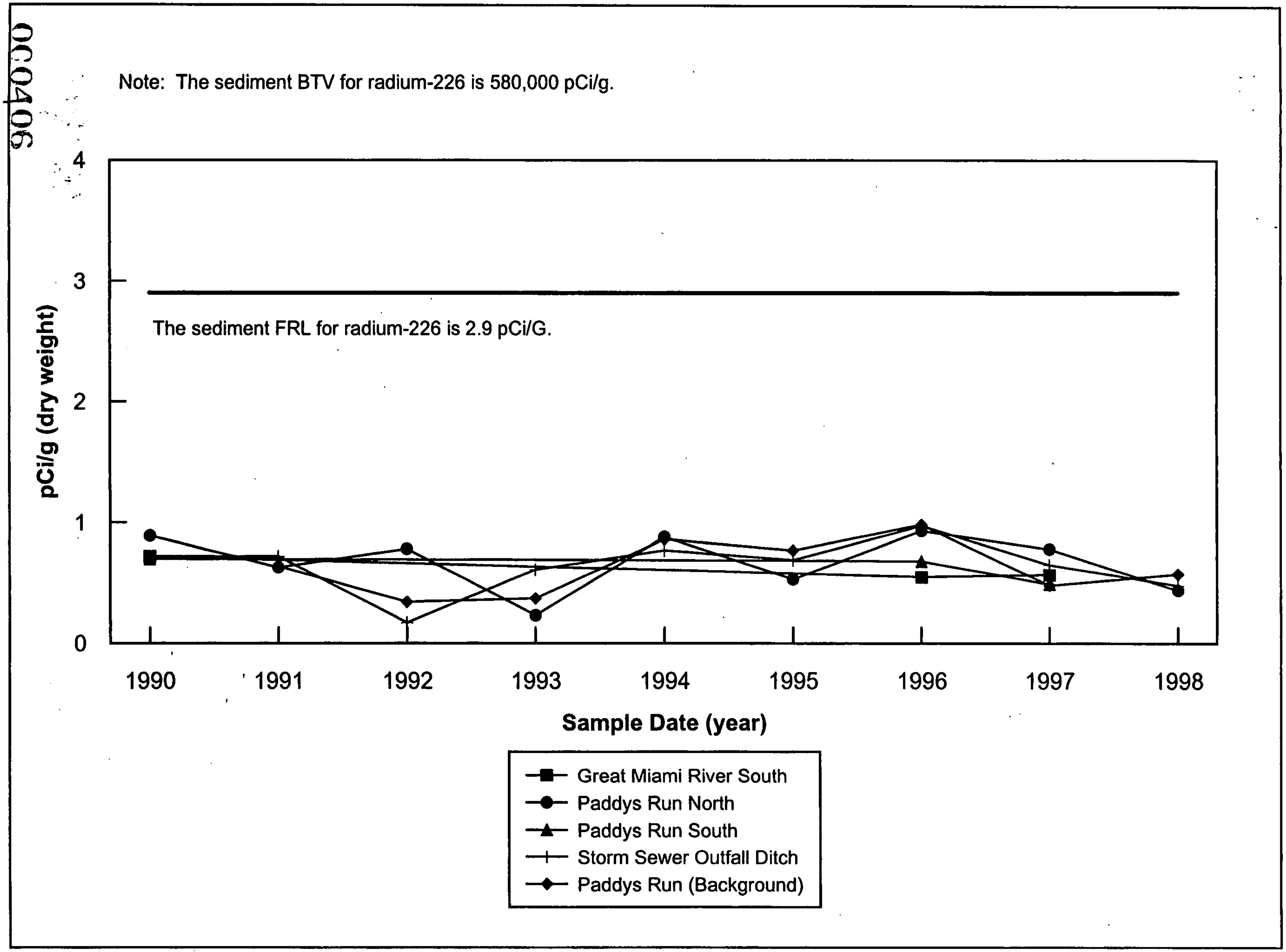

FIGURE B.2-2. RADIUM-226 CONCENTRATION VS. TIME PLOT FOR SEDIMENT

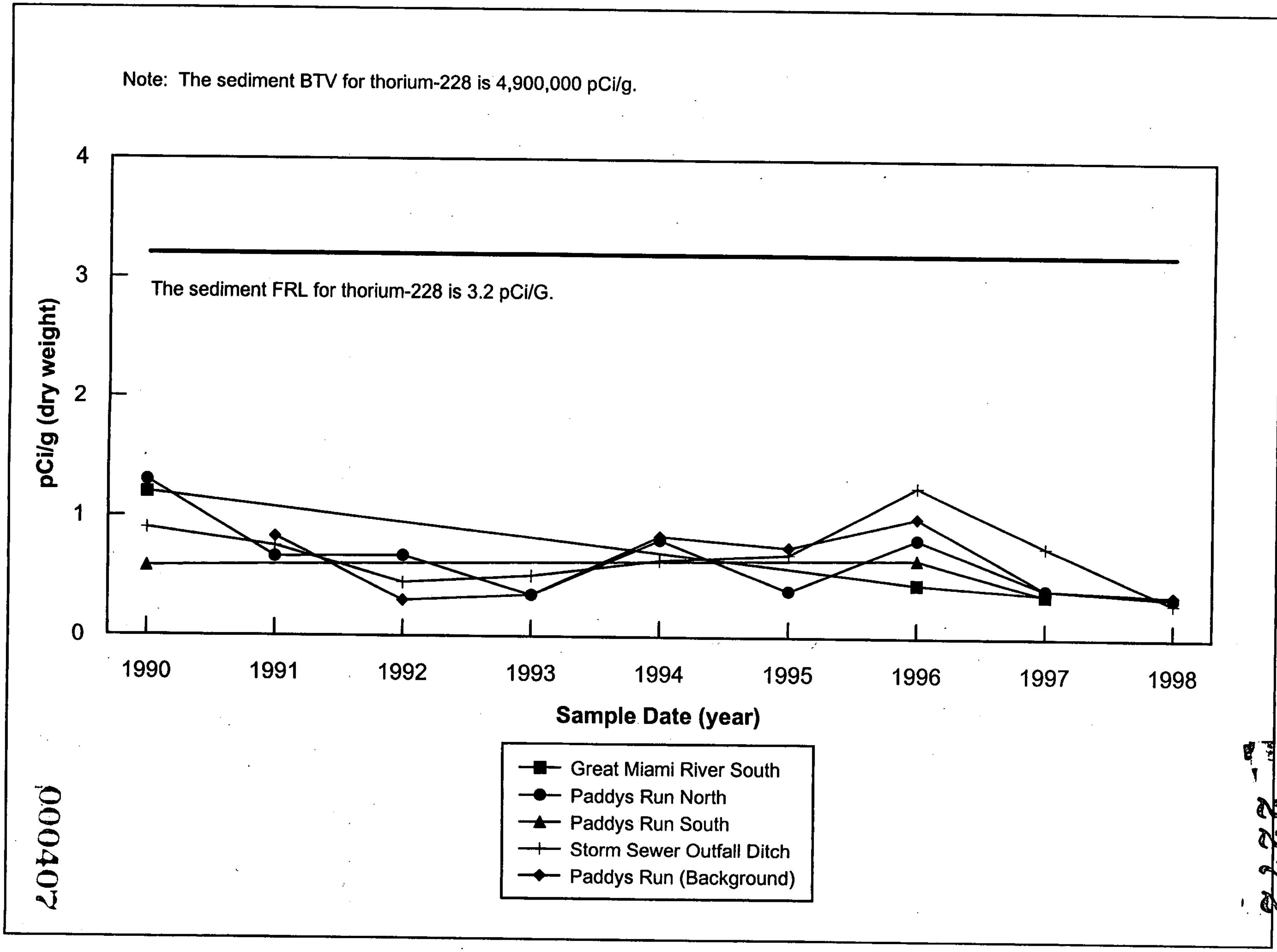

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FIGURE B.2-3. THORIUM-228 CONCENTRATION VS. TIME PLOT FOR SEDIMENT

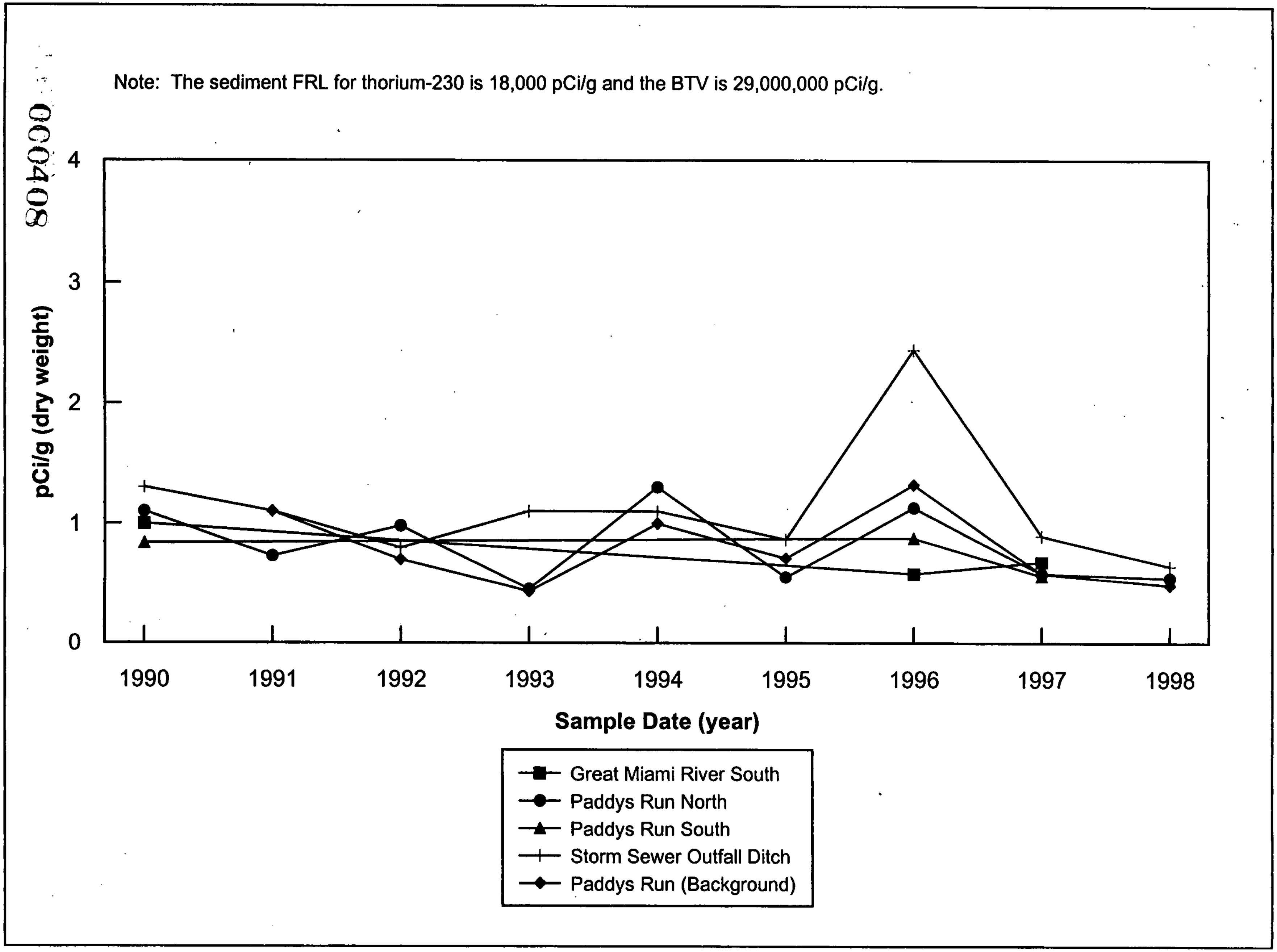

FIGURE B.2-4. THORIUM-230 CONCENTRATION VS. TIME PLOT FOR SEDIMENT

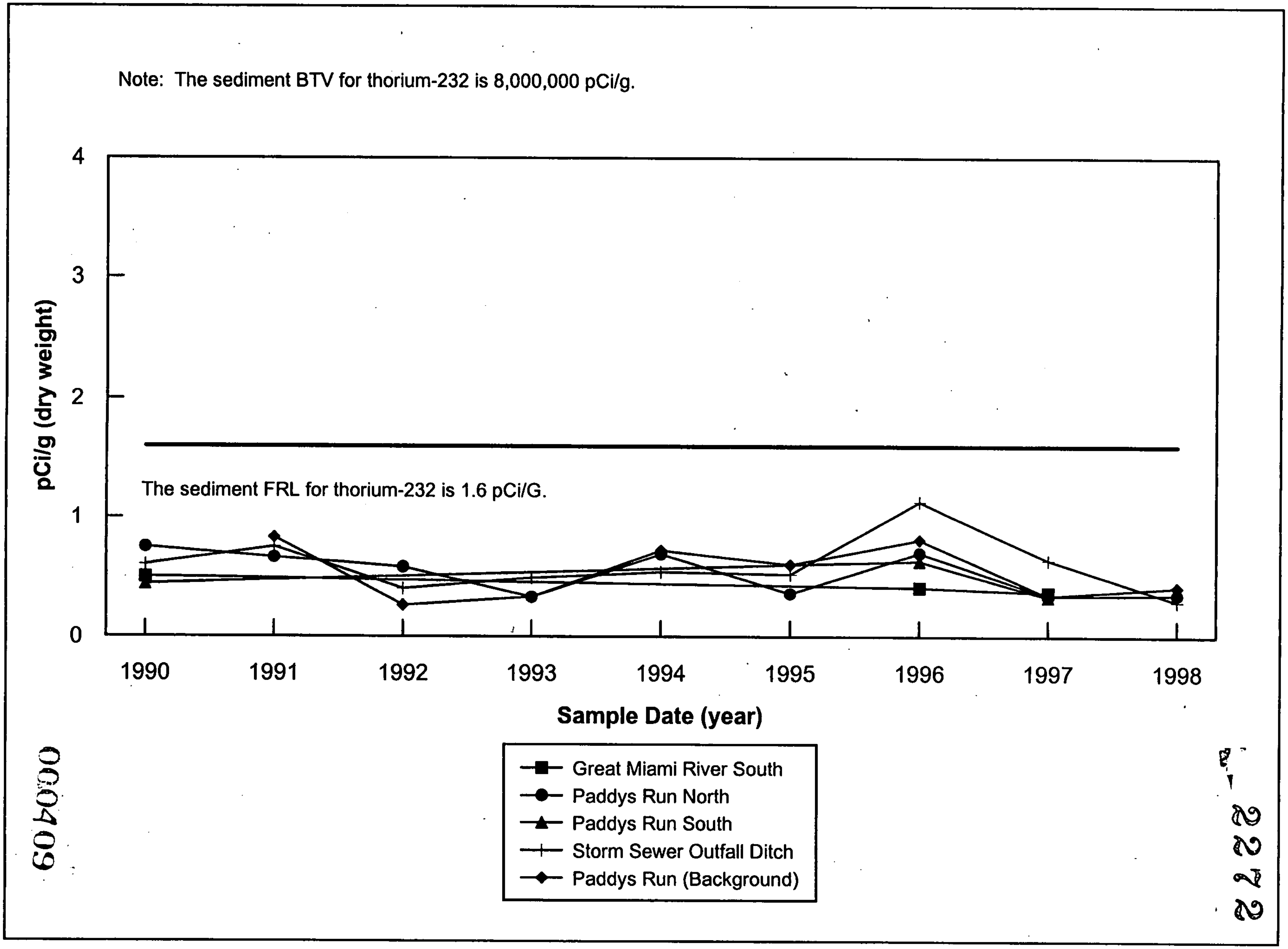

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FIGURE B.2-5. THORIUM-232 CONCENTRATION VS. TIME PLOT FOR SEDIMENT

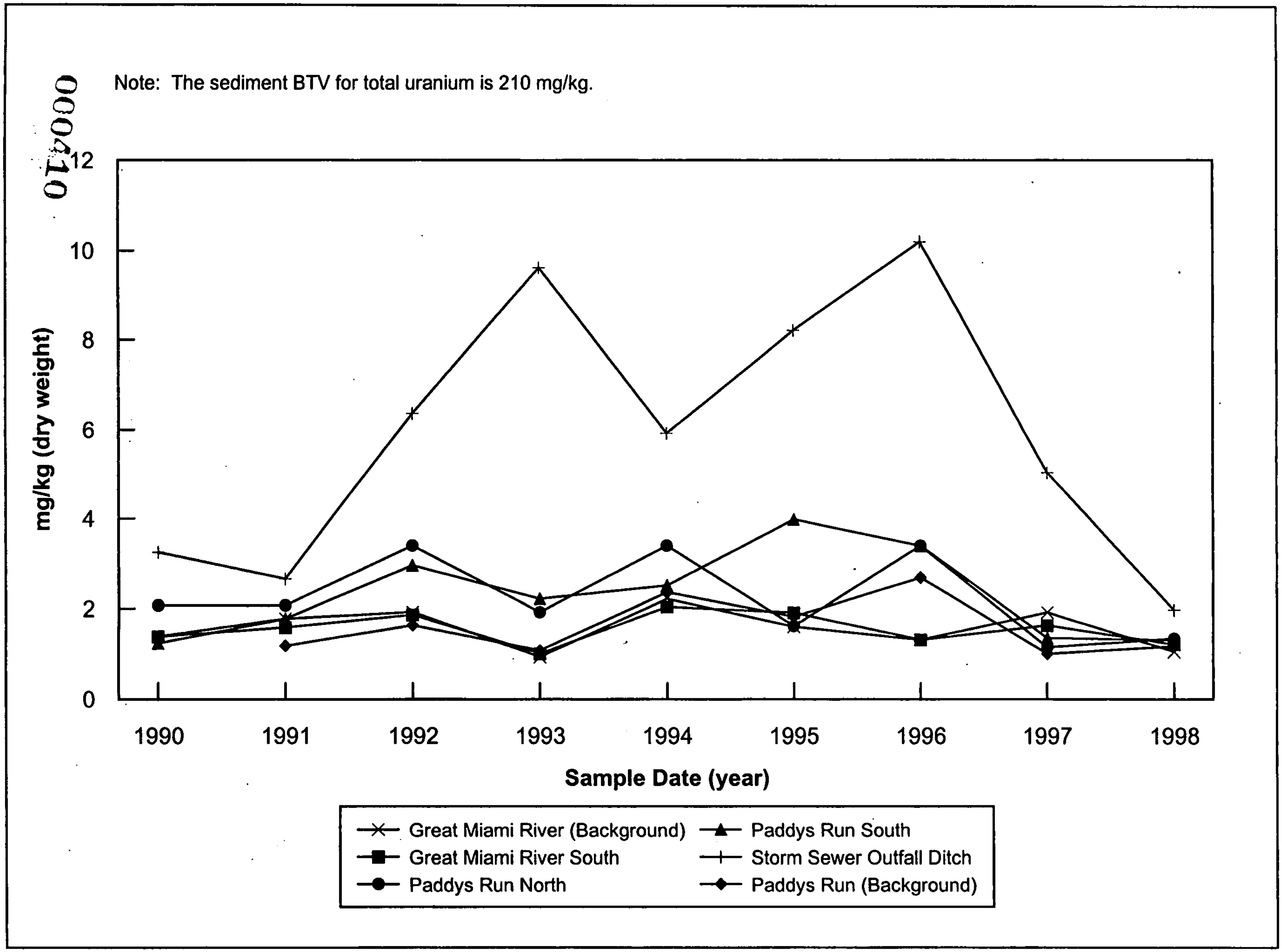

FIGURE B.2-6. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR SEDIMENT

Appendix C

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APPENDIX C

SUPPLEMENTAL AIR INFORMATION

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LIST OF ACRONYMS

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AMS	air monitoring station
°C	Centigrade
cm	centimeters
DOE	U.S. Department of Energy
°F	Fahrenheit
FEMP	Fernald Environmental Management Project
IEMP	Integrated Environmental Monitoring Plan
in	inches
kph	kilometers per hour
mph	miles per hour
mrem	millirem
mSv	milli Sievert
pCi/L	picoCuries per liter
pCi/m^3	picoCuries per cubic meter
TLD	thermoluminescent dosimeter
$\mu g/m^3$	micrograms per cubic meter

APPENDIX C

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Appendix C presents additional air monitoring data and analysis in support of Chapter 5 of the 1998 Integrated Site Environmental Report. This appendix consists of four attachments as follows:

- Attachment C.1 provides the results of the radiological air particulate monitoring program, including an assessment of 1998 results with respect to historical data, and provides concentration versus time plots of the total uranium and total particulate data for 1998.

- Attachment C.2 provides the results of the radon monitoring program, including an assessment of radon data relative to alpha track-etch cups and continuous radon monitors. This discussion focuses on the U.S. Department of Energy (DOE) standards contained in DOE Order 5400.5 and an evaluation of trends observed in the 1998 data.

- Attachment C.3 provides the results of the direct radiation monitoring program including an assessment of 1998 results with respect to historical data.

- Attachment C.4 provides a summary of the meteorological data measured at the site during 1998.

REFERENCES

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U.S. Dept. of Energy, 1998a, "Integrated Environmental Monitoring Status Report for Second Quarter 1998," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1998b, "Sewage Treatment Plant Complex Implementation Plan for Above-Grade Decontamination and Dismantlement," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

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Attachment C.1

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ATTACHMENT C.1

RADIOLOGICAL AIR PARTICULATE

ATTACHMENT C.1

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Appendix C.1 provides a detailed discussion of the radiological air particulate data for 1998. This information is used to assess the emissions of uranium, thorium, and radium from the Fernald Environmental Monitoring Project (FEMP) to the surrounding environment.

In 1998 the FEMP operated 18 air monitoring stations (AMS) 24 hours per day, seven days a week, as part of the Integrated Environmental Monitoring Plan (IEMP) Radiological Air Particulate Monitoring Program. Figure C.1-1 provides the location of air monitoring stations during 1998.

Table C.1-1 provides an operational summary for air monitoring stations in 1998. On average, the fenceline air monitors operated 98.7 percent of the time; and all monitors exceeded 95 percent operational time for the year. Routine maintenance and filter exchange combined with periodic electrical outages and equipment malfunctions create short periods of downtime for each monitor throughout the year and typically result in operation times of less than 100 percent.

During 1998 AMS-24 was relocated approximately 330 feet due east of its original location in order to address nearby property owner concerns regarding noise and electrical interferences. The air monitoring station was out of service between March 31 and April 3, 1998, due to this relocation. However, the monitor was still operational for more than 95 percent of the time for the year.

Air filters were exchanged every two weeks at all the monitoring locations during 1998. The filters were analyzed for total uranium and total particulates. The results of the biweekly total uranium analyses are summarized in Table C.1-2. Results from biweekly total particulate monitoring are summarized in Table C.1-3. Figures C.1-2 through C.1-20 provide graphical information on the total uranium and total particulate concentrations measured at each monitor during 1998.

The results for air monitoring in 1998 were consistent with the previous year's data and historical ranges. Temporary increases in total uranium and total particulate concentrations were observed along the eastern fenceline in August, September, and early October. These temporary increases were particularly evident at AMS-3, AMS-8A, AMS-9C, and STP-1 and are attributed to heightened levels of construction activities at the on-site disposal facility during this period.

An aliquot of each biweekly filter was maintained to provide a quarterly composite sample to be analyzed for isotopes of uranium, thorium, and radium-226. The annual average radionuclide concentrations were calculated from the quarterly composite sample data and are presented in Table C.1-4. The results indicate the radionuclide concentrations are well below the DOE guidelines.

All air monitoring data are reviewed and evaluated. The data evaluation focuses on tracking and trending data compared with historical data. Included in the evaluation is a review of the quality control measures utilized in the analysis of the samples. As a result of this data review process, some 1998 quarterly composite data were found to be suspect or rejected, as detailed below.

- As noted in the Integrated Environmental Monitoring Status Report for Second Quarter 1998 (DOE 1998a), evaluation of the analytical data associated with the second quarter AMS-25 composite sample indicated that the off-site laboratory experienced difficulties during the thorium analysis which may have contributed to unusually high thorium results. Specifically, the laboratory encountered reoccurring interferences during the thorium analysis resulting in low tracer recoveries. In adjusting the data for the low tracer recoveries, the thorium results may have been biased high, especially the thorium-230 results. While the thorium-230 data were not rejected through the validation process, they were qualified as "tentatively identified" indicating limited confidence in the results. The anomalously high second quarter thorium results are the reason thorium was the major contributor to annual dose at AMS-25.

- An unusually high radium-226 analytical result for the third quarter 1998 was detected at background monitor AMS-16. This data point was rejected because it was not considered reasonable based on historical background radium-226 levels. The use of this unusually high background data would have created a low bias in the net fenceline radium-226 results.

- During the data review and validation process, the following fourth quarter 1998 data were rejected based on performance problems with the off-site laboratory:

AMS-2: Isotopic thorium data were rejected due to low chemical recoveries.

AMS-8A: Isotopic thorium data were rejected due to low chemical recoveries.

AMS-12: Isotopic uranium and isotopic thorium data from this background monitor were rejected due to low chemical recoveries.

Evaluation of Isotopic Dose Contributions from FEMP Airborne Emissions 2272

Historically, uranium is the major contributor to the air inhalation dose from FEMP emissions. Uranium typically contributes greater than 62 percent of the effective dose equivalent based on an evaluation of monitoring results from 1990 through 1997 (post production era). In 1998 uranium isotopes (uranium-234, uranium-235/236, and uranium-238) contributed an average of 76 percent of the dose at the fenceline, while radium-226 contributed an average of 16 percent, and thorium isotopes (thorium-228, thorium-230, and thorium-232) contributed an average of eight percent. Figures C.1-21 through C.1-23 illustrate the percentage contribution to dose from uranium, thorium, and radium-226 at each fenceline and background monitor. To improve the presentation of information in Figures C.1-21 through C.1-23, only contributions from uranium, thorium, and radium are shown. Contributions from radionuclides which are assumed to be in equilibrium with their parent radionuclides were not included in the figures. At all fenceline locations, the contribution from radionuclides assumed to be in equilibrium with their parent radionuclides was less than 10 percent of the dose from airborne emissions.

The three highest fenceline doses were reported at AMS-3, AMS-8A, and AMS-9C (0.25, 0.17, and 0.26 millirem [mrem], respectively). Based on wind patterns in 1998, and the location of remediation activities, these monitoring locations are positioned downwind of most remediation activities. The average uranium contribution from these three monitors was 85 percent. Thorium represents eight percent, radium-226 represents six percent, while the remainder represents less than one percent of the dose contribution.

Non-typical air emission data were observed at monitors AMS-24 and AMS-25 during 1998. Based on annual wind patterns, these monitors are located upwind, therefore they are not expected to provide data which are representative of site emissions. Thorium isotopes contributed 41 and 65 percent of the annual dose components at AMS-24 and AMS-25, respectively. As noted in the Integrated Environmental Monitoring Status Report for Second Quarter 1998, an evaluation of the analytical data associated with the second quarter AMS-25 composite sample indicated that the off-site laboratory experienced difficulties during the thorium analysis which may have contributed to unusually high thorium results. Specifically, the laboratory encountered reoccurring interferences during the thorium analysis resulting in low tracer recoveries. In adjusting the data for the low tracer recoveries, the thorium results may have been biased high, especially the thorium-230 results. While the thorium-230 data were not rejected through the validation process, they were qualified as "tentatively identified" indicating limited confidence in the results. The anomalously high second quarter thorium results are the reason thorium was the major contributor to annual dose at AMS-25.

Because uranium continues to be the major contributor to dose from FEMP airborne emissions, biweekly uranium measurements remain an effective indicator of air emission patterns at the FEMP. The biweekly tracking will continue to be reported in IEMP quarterly status reports.

In late June 1998, project-specific environmental radiological air monitoring for the dismantlement of the sewage treatment plant complex began. This monitoring program, consisting of biweekly total uranium and total particulate measurements, is conducted under the Sewage Treatment Plant Complex Implementation Plan for Above-Grade Decontamination and Dismantlement (DOE 1998b). The project-specific air monitor, STP-1, was installed just south of the sewage treatment plant, between AMS-3 and AMS-29 (refer to Figure C.1-1).

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TABLE C.1-1

OPERATIONAL SUMMARY FOR AIR PARTICULATE MONITORING STATIONS IN 1998

Location	Number of Samples	Sample Start Date	Last Sample Collection Date	Operating Time (hours)	Percent of Operation
Fenceline					
AMS-2	26	12/30/97	12/29/98	8634	98.8
AMS-3	26	12/30/97	12/29/98	8483	97.1
AMS-4	26	12/30/97	12/29/98	8610	98.6
AMS-5	26	12/30/97	12/29/98	8734	100
AMS-6	26	12/30/97	12/29/98	8627	98.7
AMS-7	26	12/30/97	12/29/98	8704	99.6
AMS-8A	26	12/30/97	12/29/98	8666	99.2
AMS-9C	26	12/30/97	12/29/98	8597	98.4
AMS-22	26	12/30/97	12/29/98	8674	99.3
AMS-23	26	12/30/97	12/29/98	8669	99.2
AMS-24	26	12/30/97	12/29/98	8591	98.3
AMS-25	26	12/30/97	12/29/98	8506	97.4
AMS-26	26	12/30/97	12/29/98	8719	99.8
AMS-27	25	12/30/97	12/29/98	8313	95.2
AMS-28	26	12/30/97	12/29/98	8713	99.7
AMS-29	26	12/30/97	12/29/98	8685	99.4
Background					
AMS-12	26	12/30/97	12/29/98	8599	98.4
AMS-16	26	12/30/97	12/29/98	8609	98.5
Project-Specific					
STP-1	14	6/23/98	12/29/98	4399	97.0

TABLE C.1-2

TOTAL URANIUM PARTICULATE CONCENTRATIONS IN AIR

Location[a]	Summary of 1998 Results[b] (pCi/m³ x 1E-06)				Summary of 1997 Results[b,c,d] (pCi/m³ x 1E-06)				1990 through 1996 Summary Results[b,c,d] (pCi/m³ x 1E-06)	
	No. of Samples	Min.	Max.	Avg.	No. of Samples	Min.	Max.	Avg.	Min.	Max.
Fenceline										
AMS-2	26	11	168	62	28	0	247	51	0	3500
AMS-3	26	27	760	202	28	2.5	1167	186	0	17000
AMS-4	26	7.7	78	32	28	0	257	33	0	2300
AMS-5	26	0	118	42	28	0	220	27	0	4400
AMS-6	26	2.7	235	47	28	5.0	140	42	0	3200
AMS-7	26	2.4	105	36	28	0	146	36	0	7800
AMS-8A	26	7.9	338	116	28	10	234	82	13	900
AMS-9C[e]	26	5.7	562	129	28	0	431	111	NA	NA
AMS-22[f]	26	3.0	101	34	6	0	29	14	NA	NA
AMS-23[f]	26	9.0	194	44	6	9.8	53	29	NA	NA
AMS-24[f]	26	0	65	28	1	106	NA	NA	NA	NA
AMS-25[f]	26	0	79	30	6	6.7	30	19	NA	NA
AMS-26[f]	26	0	98	40	6	0	41	19	NA	NA
AMS-27[f]	25[g]	5.3	64	31	6	0	30	20	NA	NA
AMS-28[f]	26	2.6	216	30	6	0	29	13	NA	NA
AMS-29[f]	26	2.6	121	45	6	0	76	29	NA	NA
Background										
AMS-12	26	0	107	14	28	0	29	8.1	0	480
AMS-16	26	0	35	18	28	0	106	19	0	350
Project-Specific[h]										
STP-1	14	38	891	301	NA	NA	NA	NA	NA	NA

[a]See Figure C.1-1
[b]For blank corrected concentrations less than or equal to 0.0 pCi/m³, the concentration is set at 0.0 pCi/m³.
[c]If the total number of samples is equal to one, then the data point is reported as the minimum.
[d]NA = not applicable
[e]Summary results for 1997 include AMS-9B/C data.
[f]AMS location was not in operation prior to 1997.
[g]One data point was not obtained due to a damaged filter.
[h]Project-specific monitor was not in operaton prior to 1997.

TABLE C.1-3

TOTAL PARTICULATE CONCENTRATIONS IN AIR

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Location[a]	Summary of 1998 Results ($\mu g/m^3$)				Summary of 1997 Results[b,e] ($\mu g/m^3$)				1990 through 1996 Summary Results[b,e] ($\mu g/m^3$)	
	No. of Samples	Min.	Max.	Avg.	No. of Samples	Min.	Max.	Avg.	Min.	Max.
Fenceline										
AMS-2	25[c]	14	49	30	28	16	77	31	7	67
AMS-3	26	13	52	32	28	17	159	39	8	128
AMS-4	26	16	79	37	28	14	51	30	13	69
AMS-5	26	9.6	54	30	28	11	42	28	12	62
AMS-6	26	16	54	33	28	8	53	29	8	69
AMS-7	26	6.8	60	33	27	24	55	34	13	76
AMS-8A	26	13	64	34	28	18	89	35	19	53
AMS-9C[d]	26	15	65	36	28	7.1	136	42	NA	NA
AMS-22[f]	26	13	57	34	6	21	30	27	NA	NA
AMS-23[f]	26	15	51	30	6	22	28	25	NA	NA
AMS-24[f]	26	18	79	42	1	74	NA	NA	NA	NA
AMS-25[f]	26	21	69	40	6	26	40	33	NA	NA
AMS-26[f]	26	15	51	31	6	20	23	22	NA	NA
AMS-27[f]	26	24	86	46	6	33	49	38	NA	NA
AMS-28[f]	26	12	49	28	6	16	30	19	NA	NA
AMS-29[f]	26	11	62	32	6	19	30	25	NA	NA
Background										
AMS-12	26	12	47	28	14	18	41	27	6	416
AMS-16	26	18	84	50	14	27	79	46	22	59
Project-Specific[g]										
STP-1	14	25	93	43	NA	NA	NA	NA	NA	NA

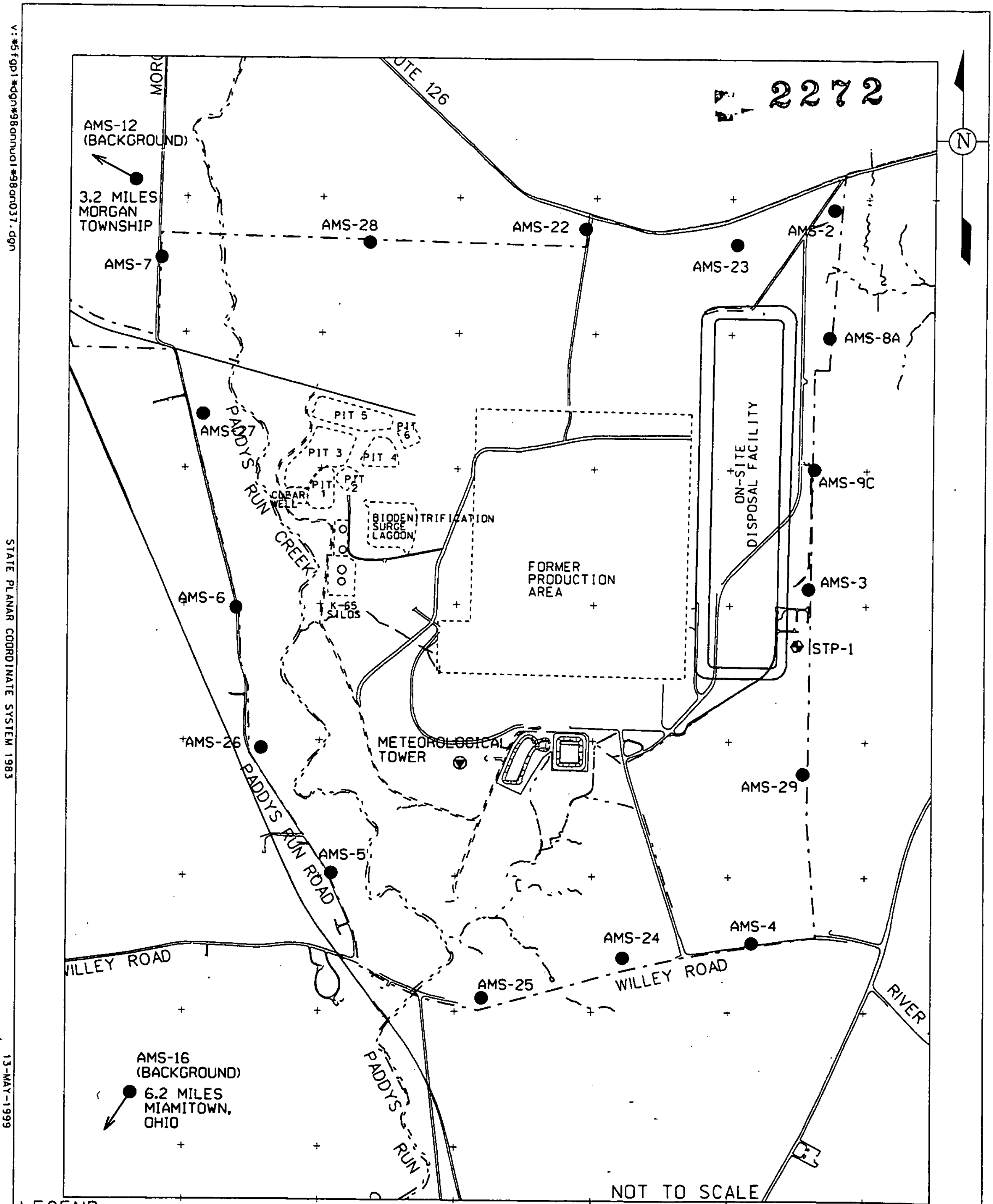
[a]See Figure C.1-1
[b]If the total number of samples is equal to one, then the data point is reported as the minimum.
[c]One data point was not obtained due to a damaged filter.
[d]Summary results for 1997 include AMS-9B/C data.
[e]NA = not applicable
[f]AMS location was not in operation prior to 1997.
[g]Project-specific monitor was not in operation prior to 1997.

TABLE C.1-4

RADIONUCLIDES IN AIR DURING 1998

	Gross Concentrations (pCi/m^3)											
Location[a]	Uranium-238	Uranium-234	Uranium-235/ Uranium-236	Thorium-228	Thorium-230	Thorium-232	Radium-226	Thorium-234[b]	Radium-228[b]	Actinium-228[b]	Radium-224[b]	Thorium-231[b]
Fenceline												
AMS-2	4.6E - 05	4.1E - 05	1.7E - 05	6.2E - 06	7.2E - 06	4.5E - 06	8.3E - 06	4.6E - 05	4.5E - 06	4.5E - 06	4.5E - 06	1.7E - 05
AMS-3	9.6E - 05	9.7E - 05	7.7E - 06	9.2E - 06	1.2E - 05	8.5E - 06	1.5E - 05	9.6E - 05	8.5E - 06	8.5E - 06	8.5E - 06	7.7E - 06
AMS-4	2.0E - 05	1.7E - 05	2.6E - 07	8.2E - 06	1.0E - 05	6.5E - 06	8.6E - 06	2.0E - 05	6.5E - 06	6.5E - 06	6.5E - 06	2.6E - 07
AMS-5	2.5E - 05	2.5E - 05	4.8E - 06	8.1E - 06	1.1E - 05	6.4E - 06	7.8E - 06	2.5E - 05	6.4E - 06	6.4E - 06	6.4E - 06	4.8E - 06
AMS-6	2.8E - 05	2.7E - 05	2.4E - 06	7.5E - 06	9.5E - 06	6.3E - 06	9.1E - 06	2.8E - 05	6.3E - 06	6.3E - 06	6.3E - 06	2.4E - 06
AMS-7	2.3E - 05	2.3E - 05	1.8E - 06	7.4E - 06	8.1E - 06	7.0E - 06	9.8E - 06	2.3E - 05	7.0E - 06	7.0E - 06	7.0E - 06	1.8E - 06
AMS-8A	7.3E - 05	7.4E - 05	7.2E - 06	5.3E - 06	7.6E - 06	5.4E - 06	9.4E - 06	7.3E - 05	5.4E - 06	5.4E - 06	5.4E - 06	7.2E - 06
AMS-9C	8.8E - 05	8.2E - 05	1.3E - 05	1.3E - 05	1.3E - 05	1.1E - 05	5.3E - 06	8.8E - 05	1.1E - 05	1.1E - 05	1.1E - 05	1.3E - 05
AMS-22	2.5E - 05	2.2E - 05	4.1E - 06	8.0E - 06	8.5E - 06	6.2E - 06	8.7E - 06	2.5E - 05	6.2E - 06	6.2E - 06	6.2E - 06	4.1E - 06
AMS-23	3.5E - 05	3.1E - 05	5.5E - 06	6.2E - 06	8.9E - 06	5.1E - 06	7.7E - 06	3.5E - 05	5.1E - 06	5.1E - 06	5.1E - 06	5.5E - 06
AMS-24	2.1E - 05	2.0E - 05	1.5E - 06	9.7E - 06	1.3E - 05	8.9E - 06	5.1E - 06	2.1E - 05	8.9E - 06	8.9E - 06	8.9E - 06	1.5E - 06
AMS-25	2.0E - 05	2.0E - 05	3.6E - 06	6.1E - 06	2.6E - 05	9.7E - 06	8.7E - 06	2.0E - 05	9.7E - 06	9.7E - 06	9.7E - 06	3.6E - 06
AMS-26	3.0E - 05	2.7E - 05	5.0E - 06	5.6E - 06	7.1E - 06	4.6E - 06	7.8E - 06	3.0E - 05	4.6E - 06	4.6E - 06	4.6E - 06	5.0E - 06
AMS-27	2.0E - 05	1.9E - 05	1.9E - 06	7.8E - 06	1.1E - 05	7.1E - 06	1.0E - 05	2.0E - 05	7.1E - 06	7.1E - 06	7.1E - 06	1.9E - 06
AMS-28	1.6E - 05	1.5E - 05	1.3E - 06	5.8E - 06	6.4E - 06	4.9E - 06	6.8E - 06	1.6E - 05	4.9E - 06	4.9E - 06	4.9E - 06	1.3E - 06
AMS-29	3.0E - 05	2.7E - 05	2.5E - 06	5.2E - 06	8.9E - 06	5.5E - 06	5.4E - 06	3.0E - 05	5.5E - 06	5.5E - 06	5.5E - 06	2.5E - 06
Background												
AMS-12	9.7E - 06	9.0E - 06	4.7E - 07	5.3E - 06	5.8E - 06	4.8E - 06	6.3E - 06	9.7E - 06	4.8E - 06	4.8E - 06	4.8E - 06	4.7E - 07
AMS-16	1.5E - 05	1.6E - 05	2.7E - 07	1.4E - 05	1.7E - 05	1.2E - 05	5.1E - 06	1.5E - 05	1.2E - 05	1.2E - 05	1.2E - 05	2.7E - 07
DCG[c]	1.0E - 01	9.0E - 02	1.0E - 01	4.0E - 02	4.0E - 02	7.0E - 03	1.0E + 00	4.0E + 02	3.0E + 00	4.0E + 01	4.0E + 00	1.0E + 04

[a]See Figure C.1-1 for sample locations
[b]Denotes isotopes assumed to be in equilibrium with their parents
[c]Derived concentration guidelines for air (μCi/ml · 1.0E + 12 pCi/m^3) from DOE Order 5400.5., Radiation Protection of the Public and the Environment, February 1990. Continuous inhalation of this concentration for one year will result in a committed effective dose equivalent of 100 mrem (1 mSv).



LEGEND:

- FEMP BOUNDARY
- AMS LOCATION
- DISTANCE FROM CENTER OF FORMER PRODUCTION AREA TO AMS LOCATION OFF MAP
- PROJECT-SPECIFIC LOCATION

FIGURE C.1-1. RADIOLOGICAL AIR MONITORING LOCATIONS

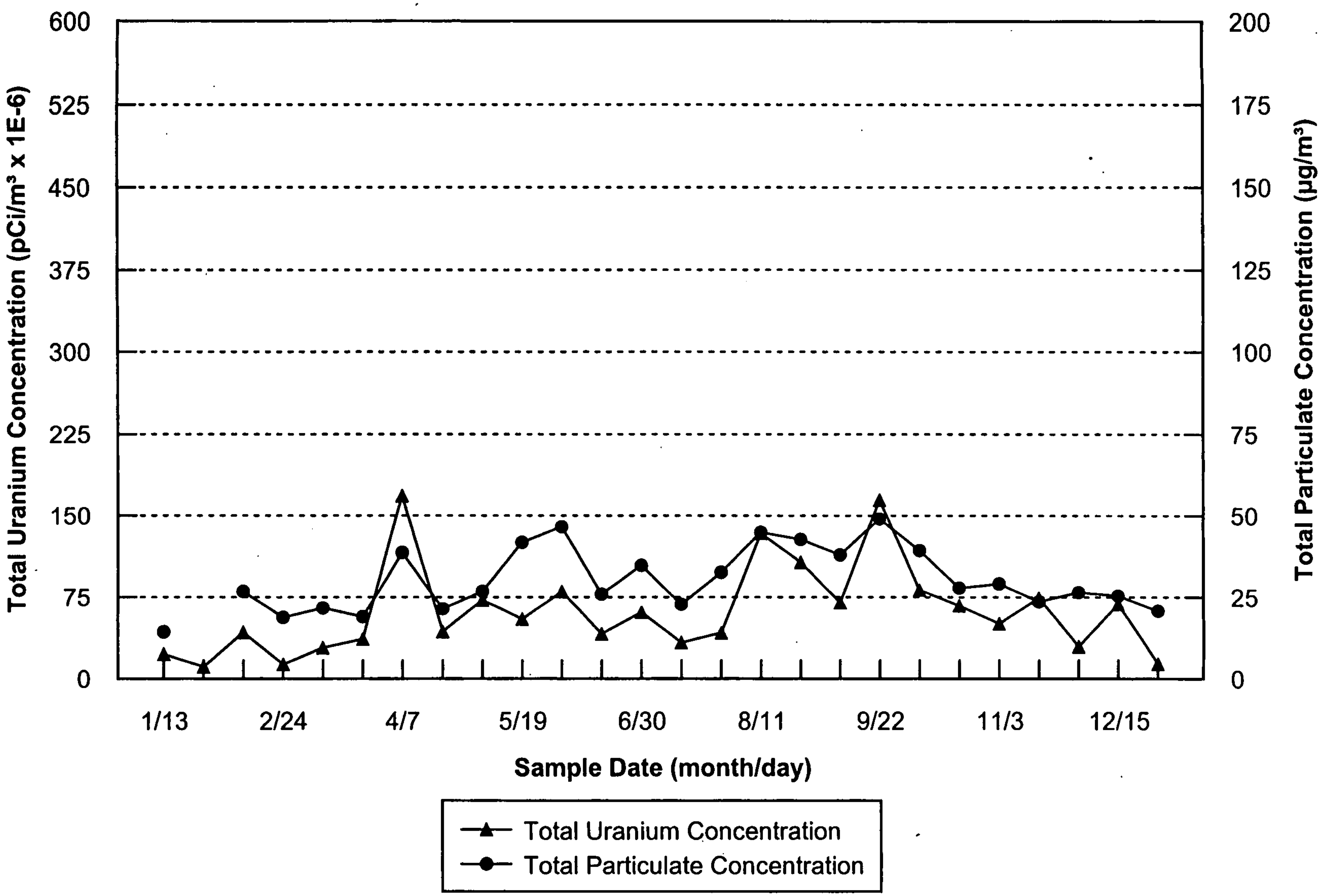


FIGURE C.1-2. 1998 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR FOR AMS-2

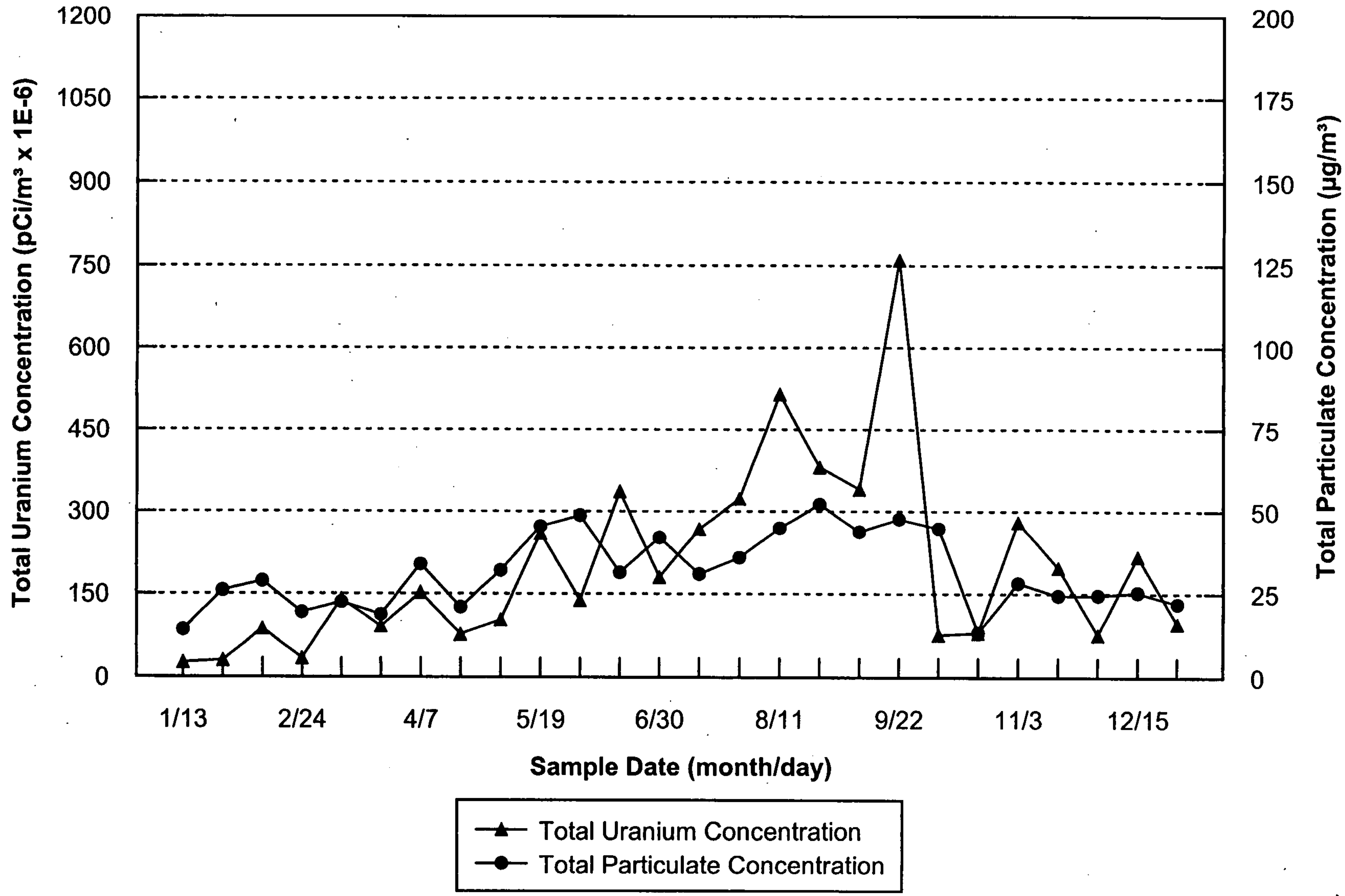


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FIGURE C.1-3. 1998 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR FOR AMS-3

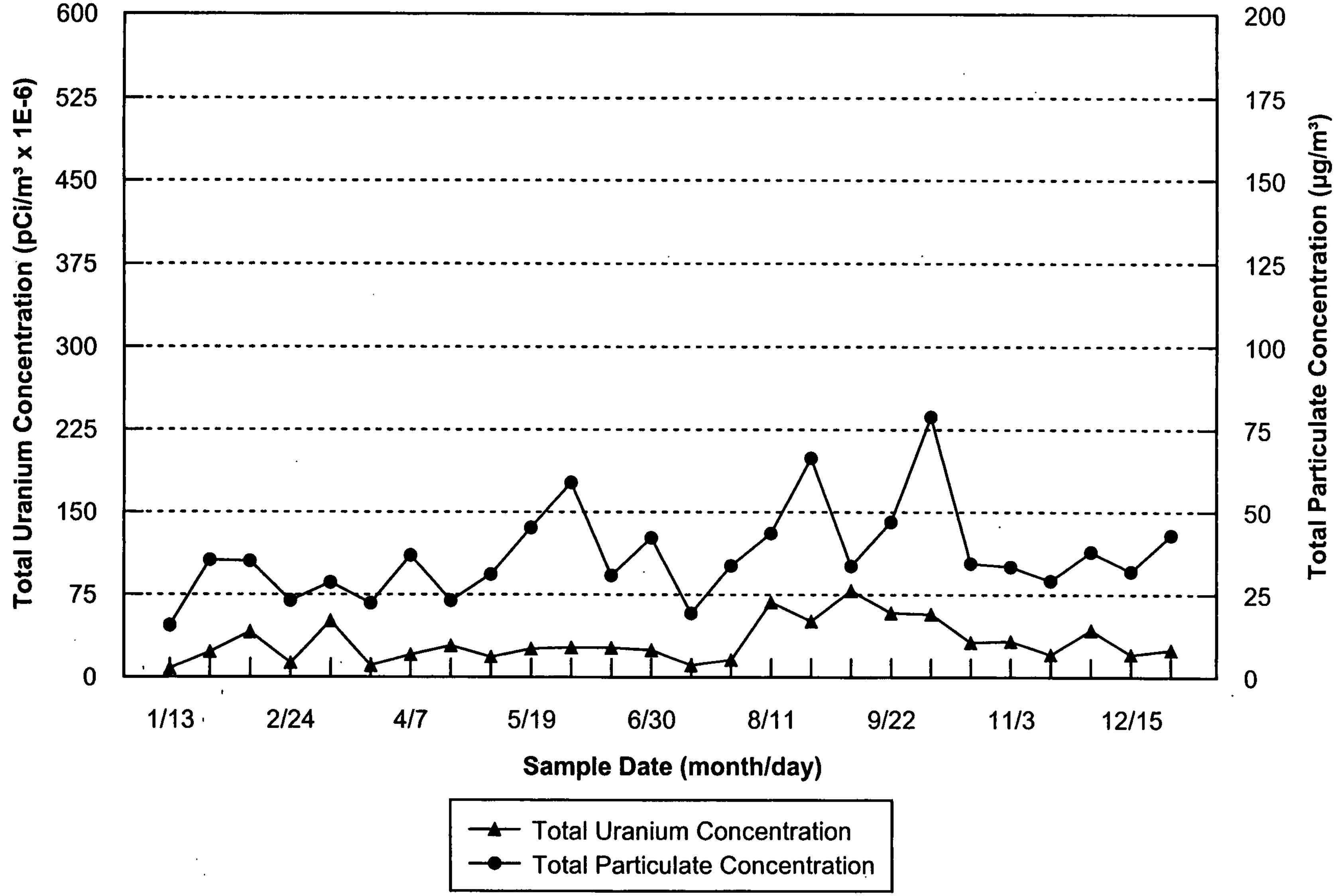

FIGURE C.1-4. 1998 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR FOR AMS-4

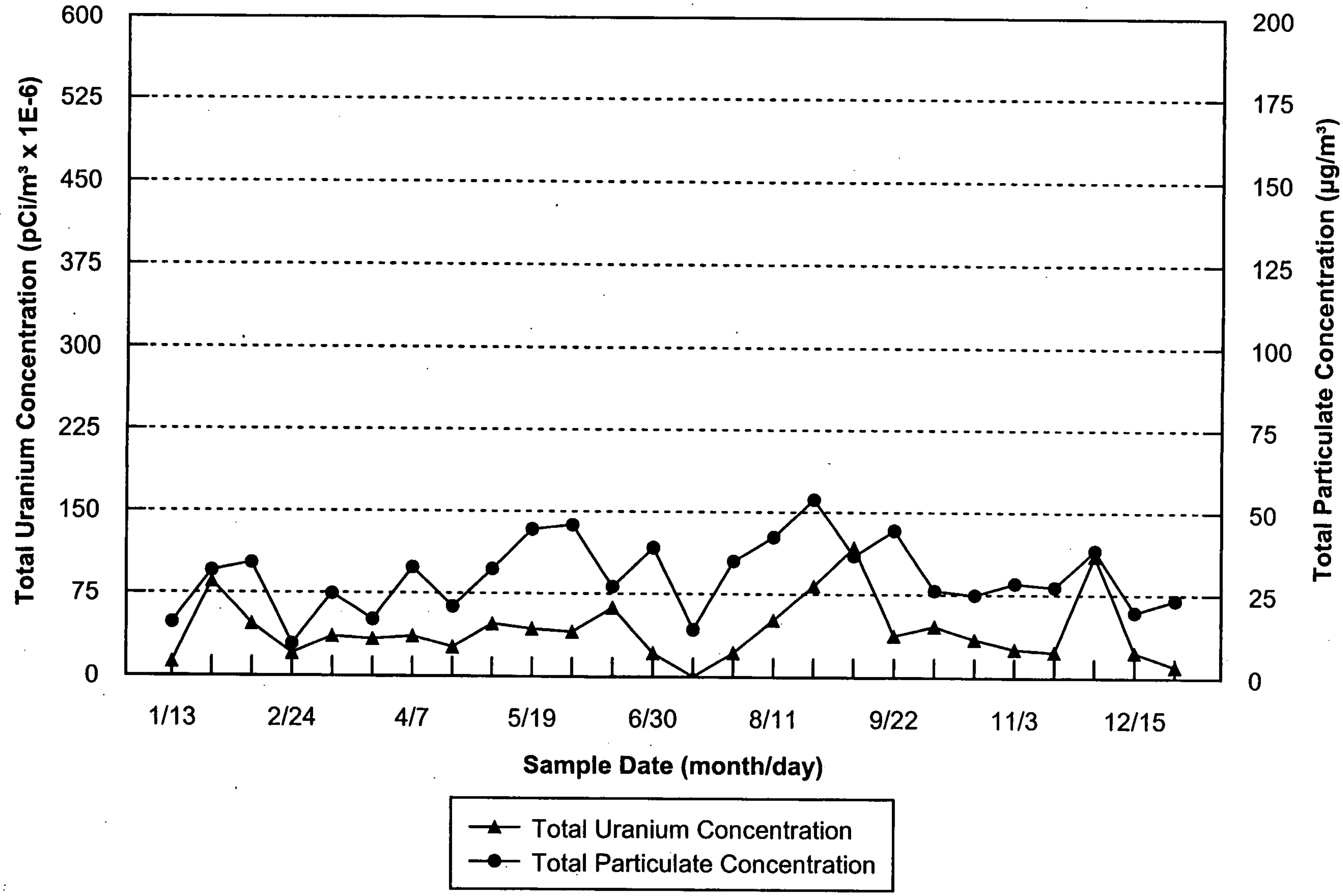

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FIGURE C.1-5. 1998 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR FOR AMS-5

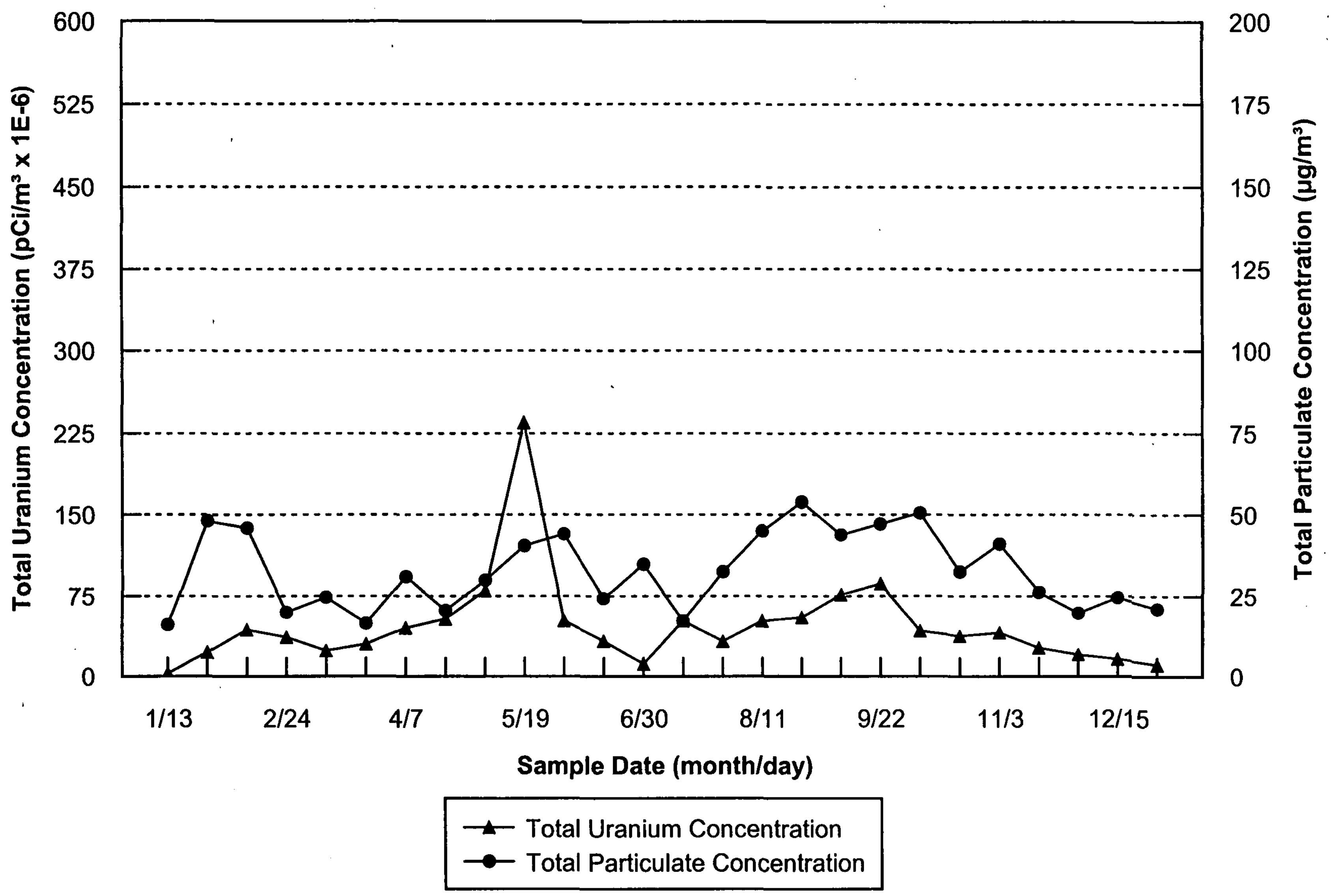

FIGURE C.1-6. 1998 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR FOR AMS-6

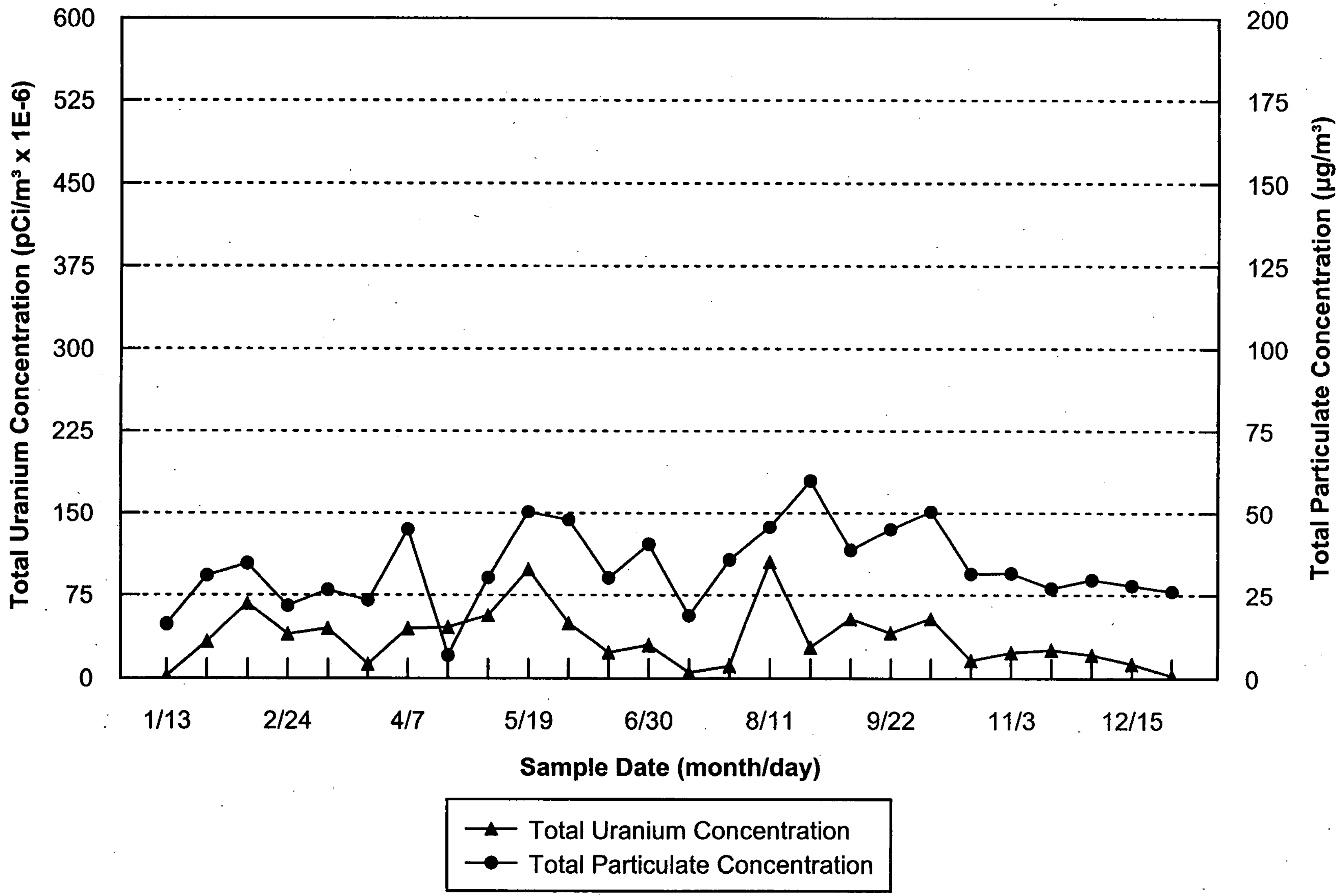

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FIGURE C.1-7. 1998 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR FOR AMS-7

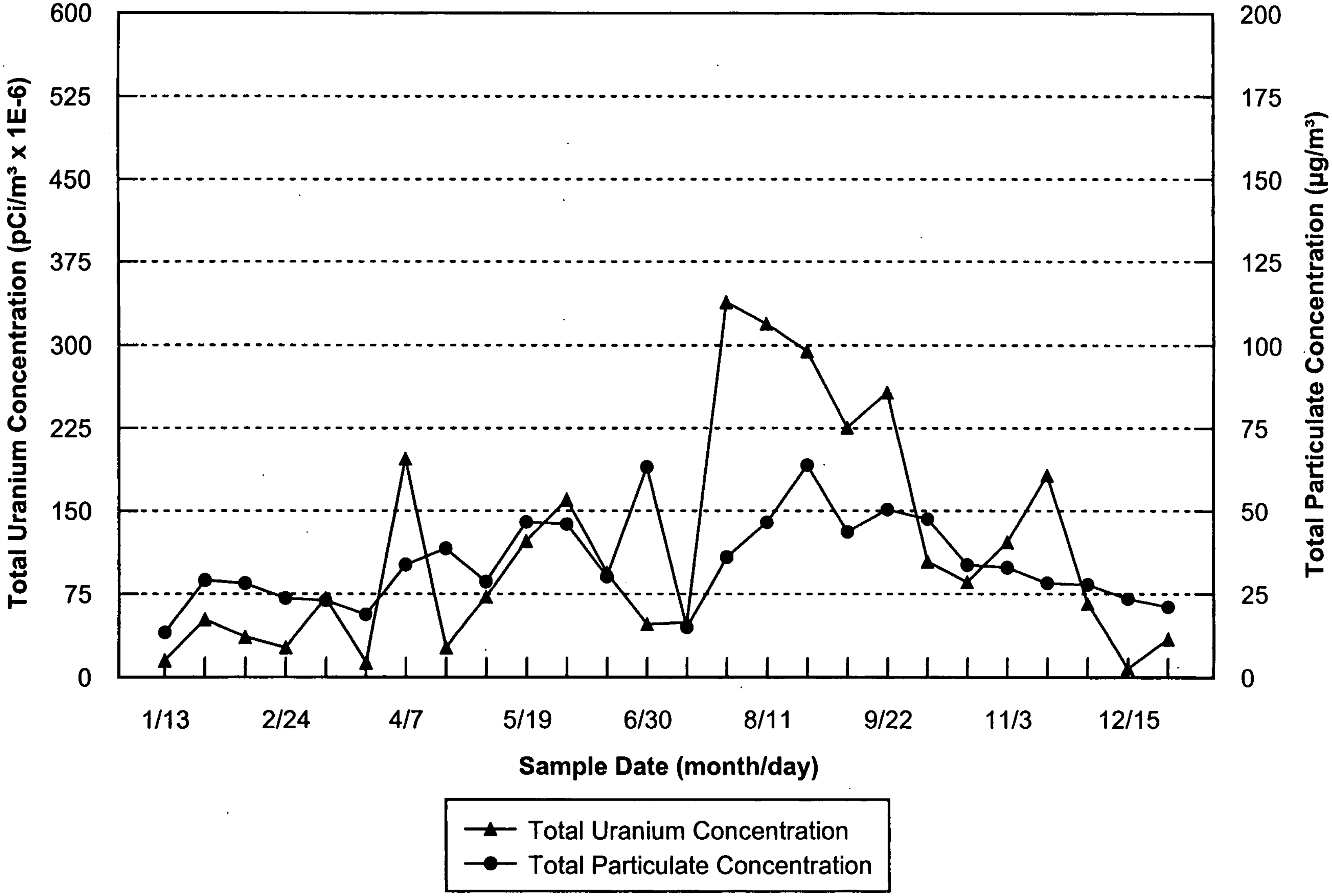

FIGURE C.1-8. 1998 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR FOR AMS-8A

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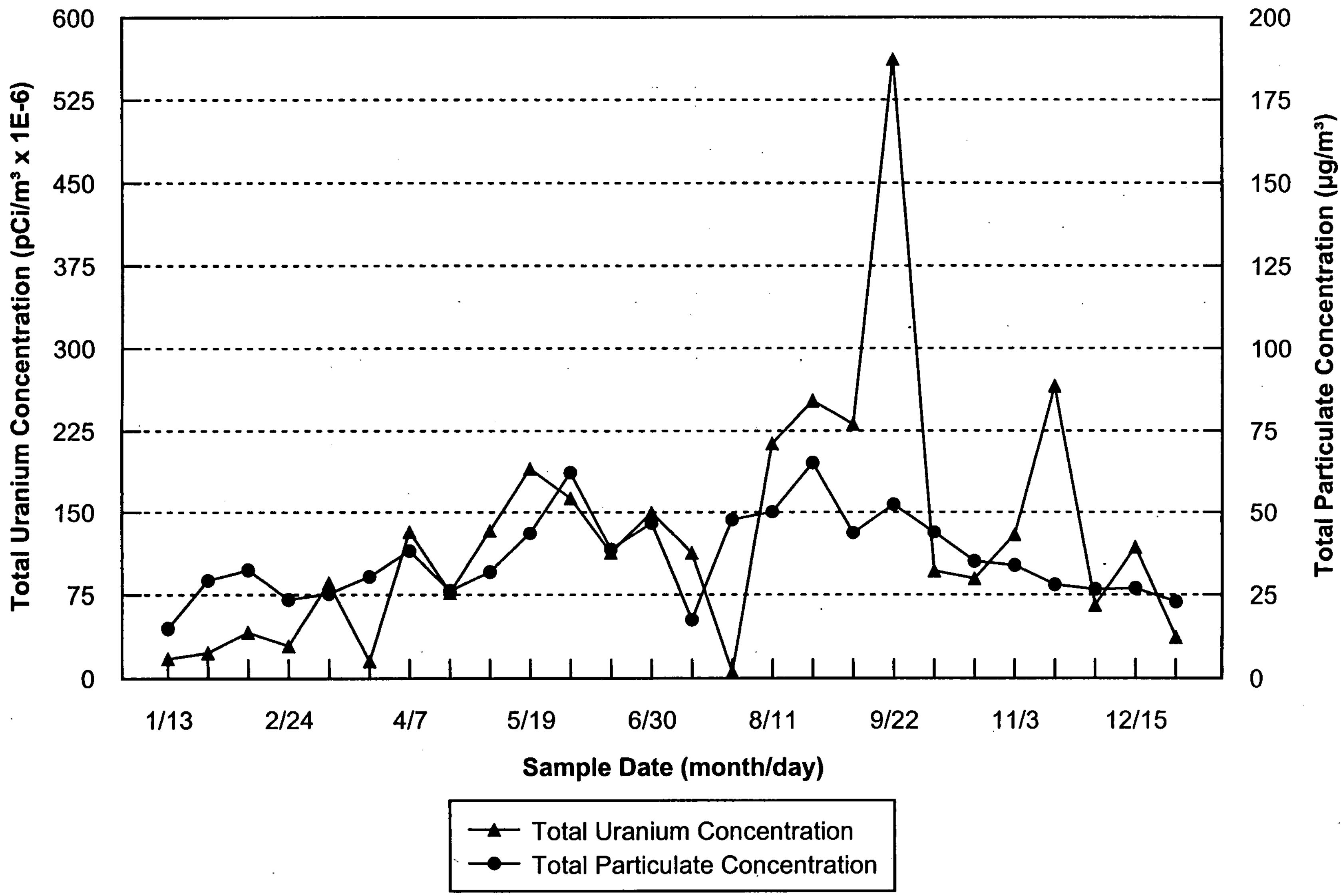

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FIGURE C.1-9. 1998 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR FOR AMS-9C

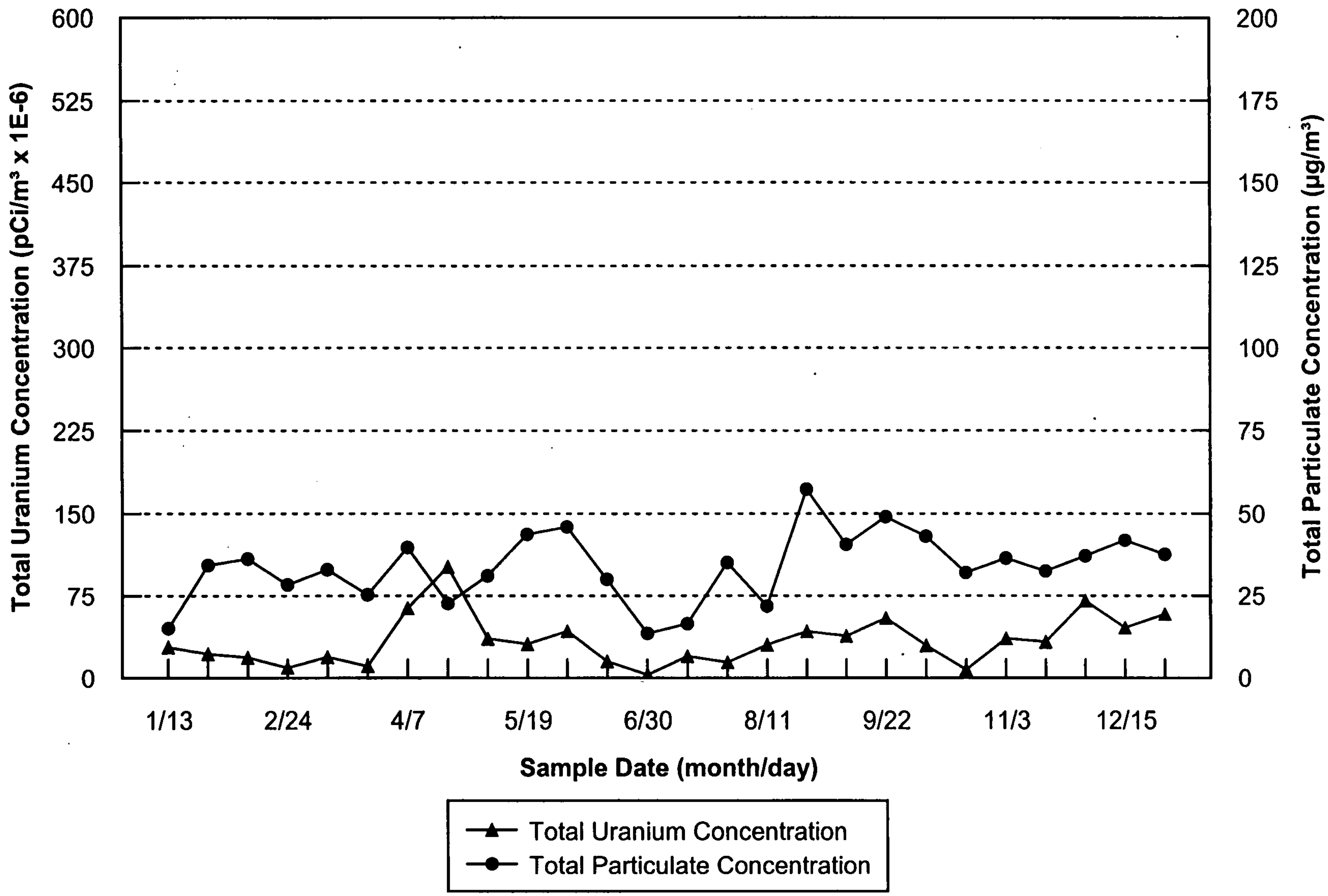

FIGURE C.1-10. 1998 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR FOR AMS-22

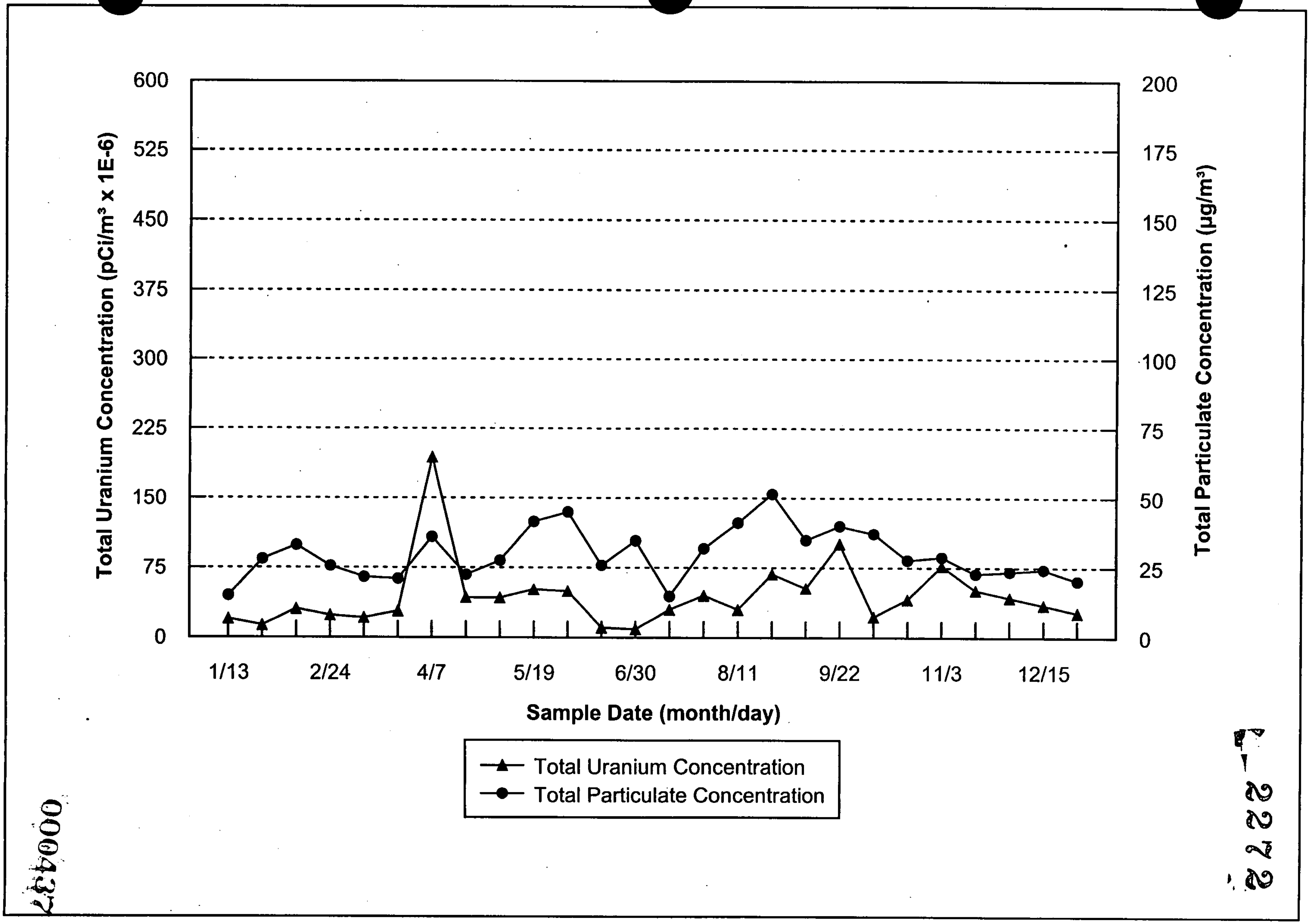

FIGURE C.1-11. 1998 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR FOR AMS-23

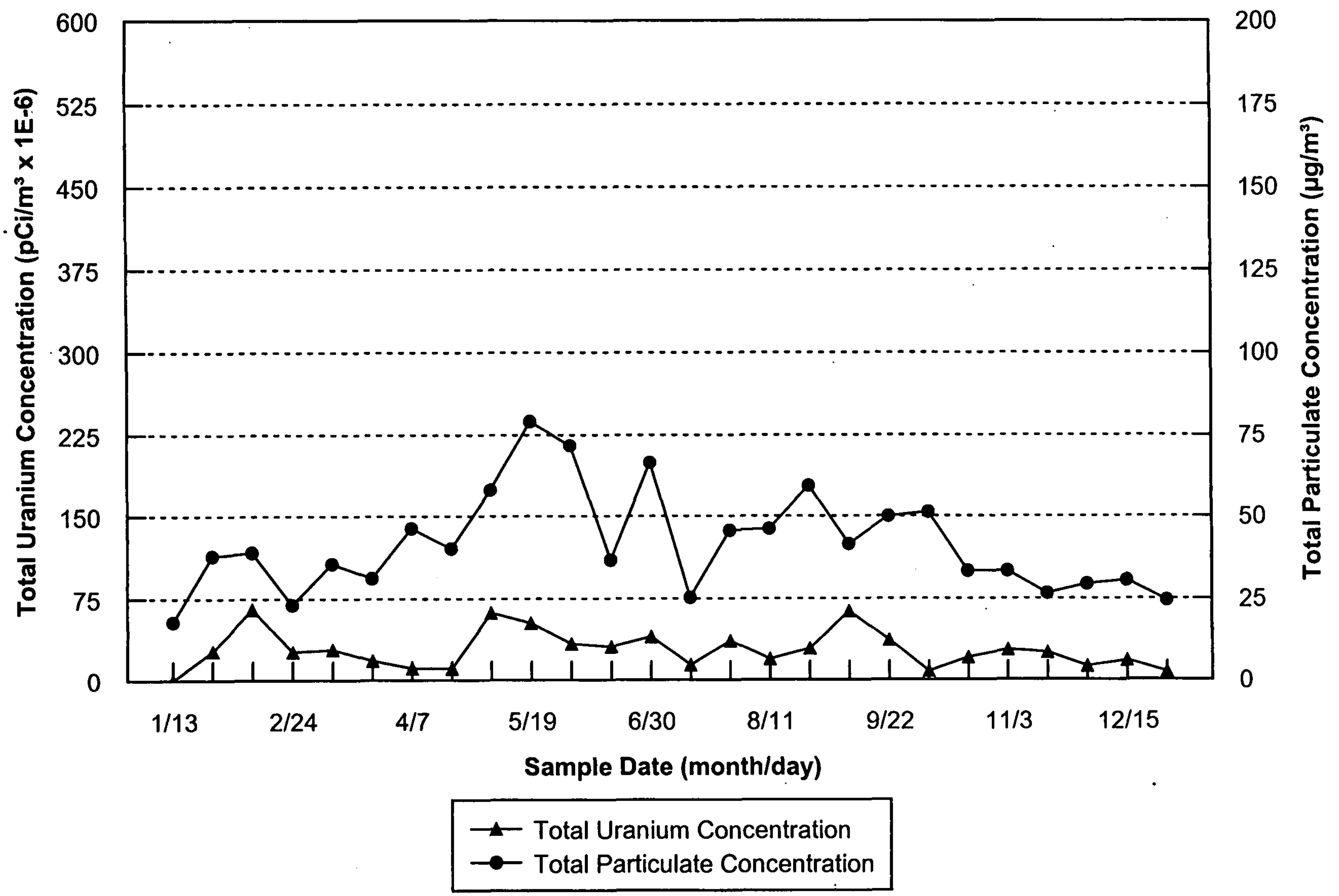

FIGURE C.1-12. 1998 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR FOR AMS-24

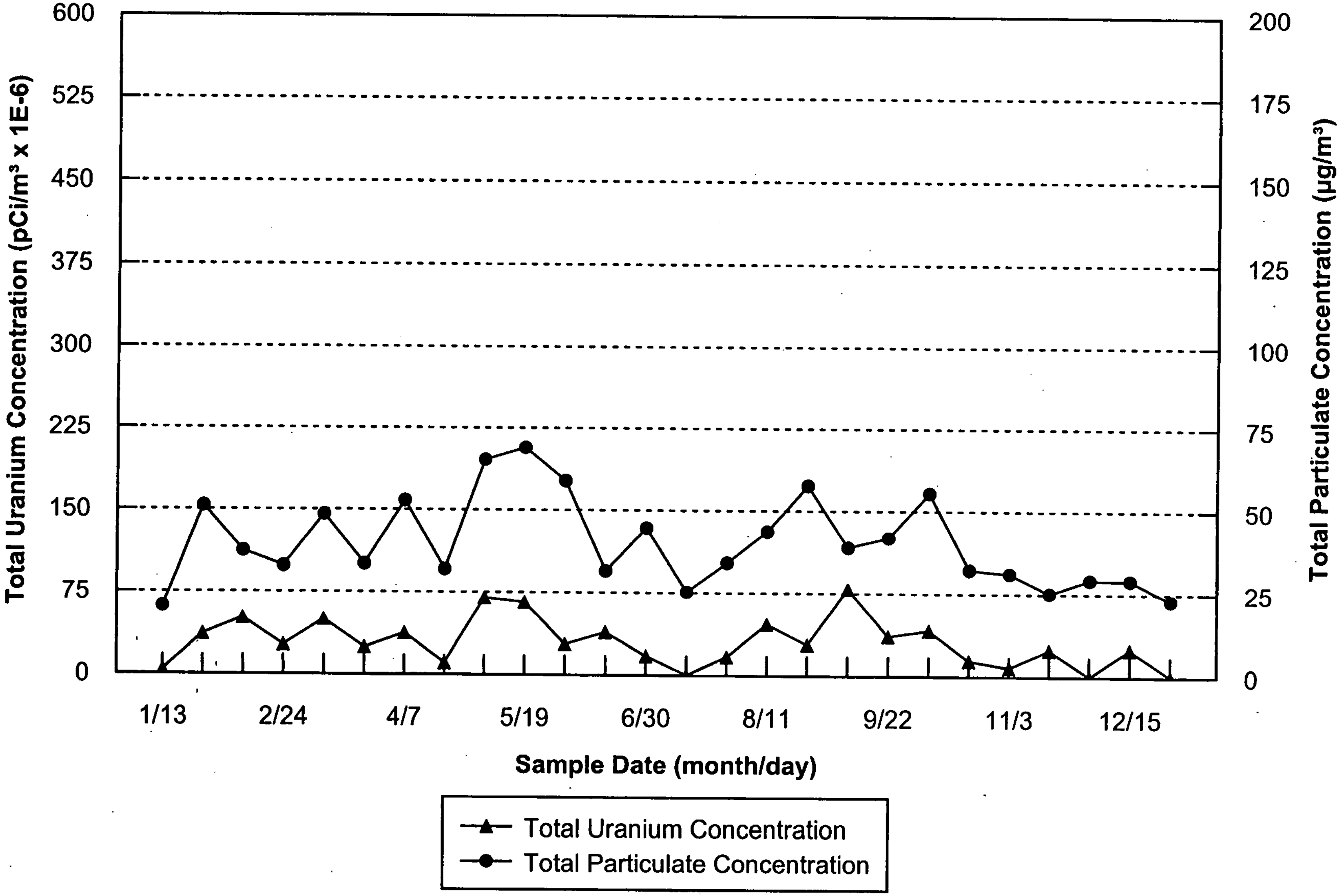

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FIGURE C.1-13. 1998 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR FOR AMS-25

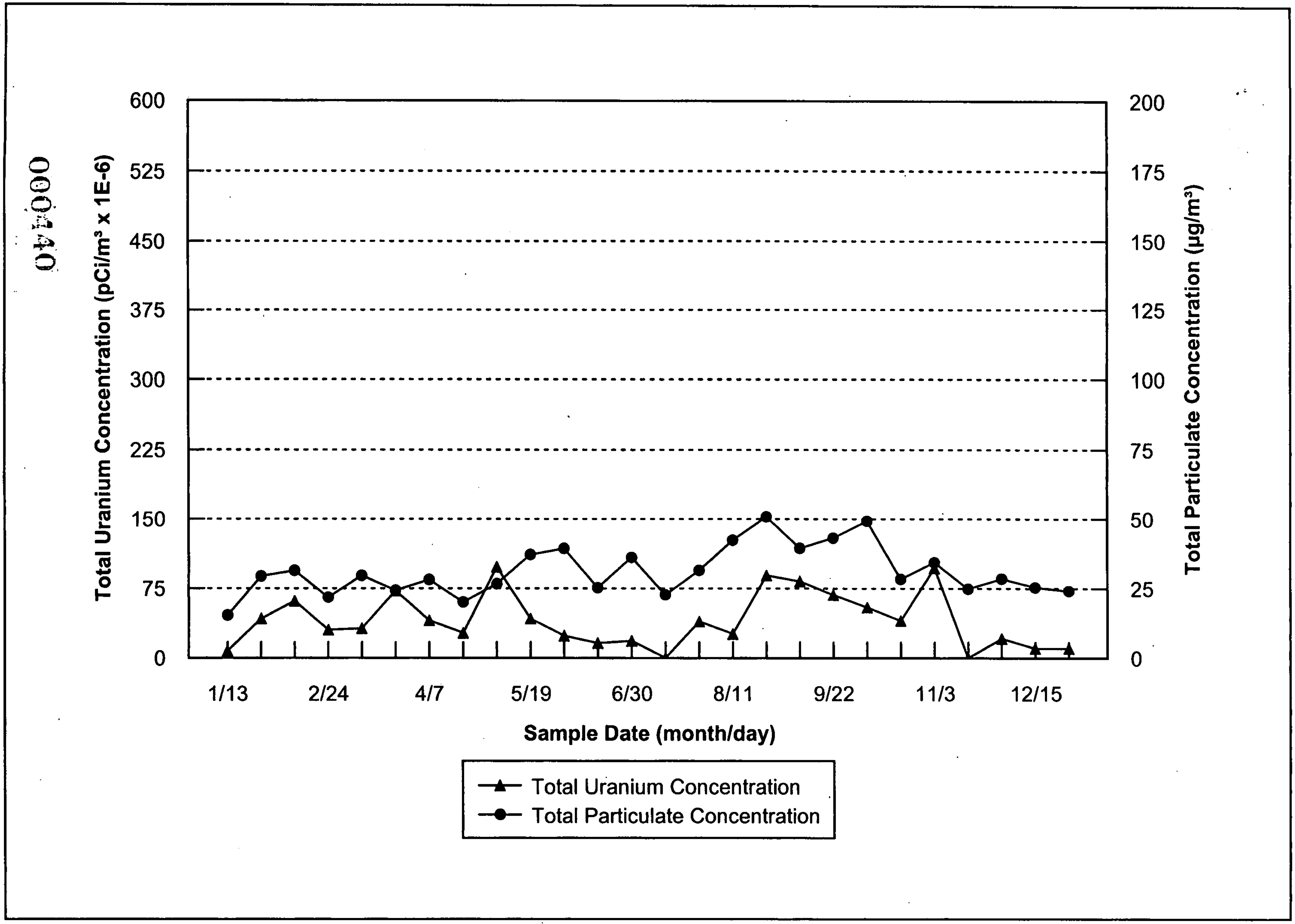

FIGURE C.1-14. 1998 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR FOR AMS-26

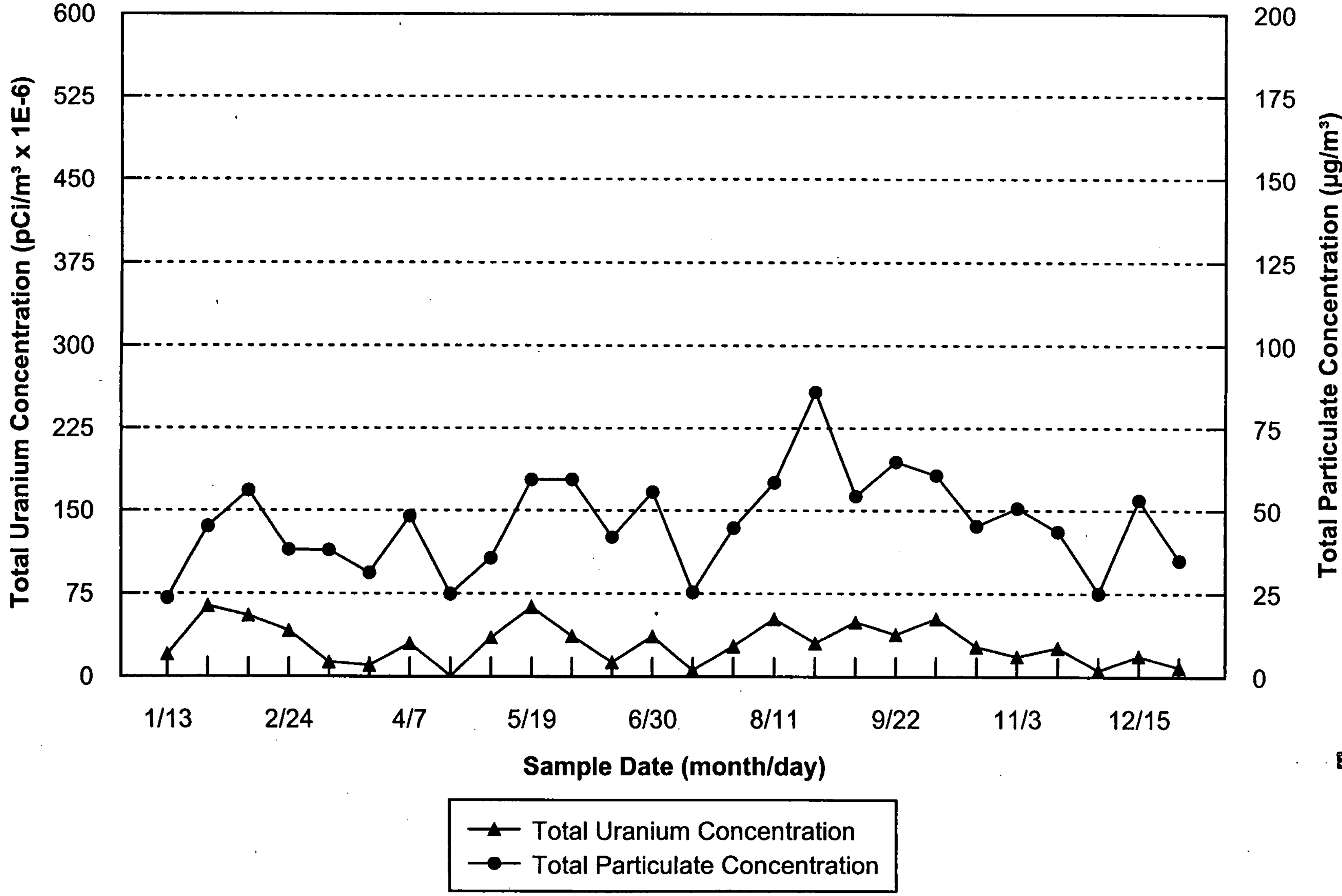

FIGURE C.1-15. 1998 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR FOR AMS-27

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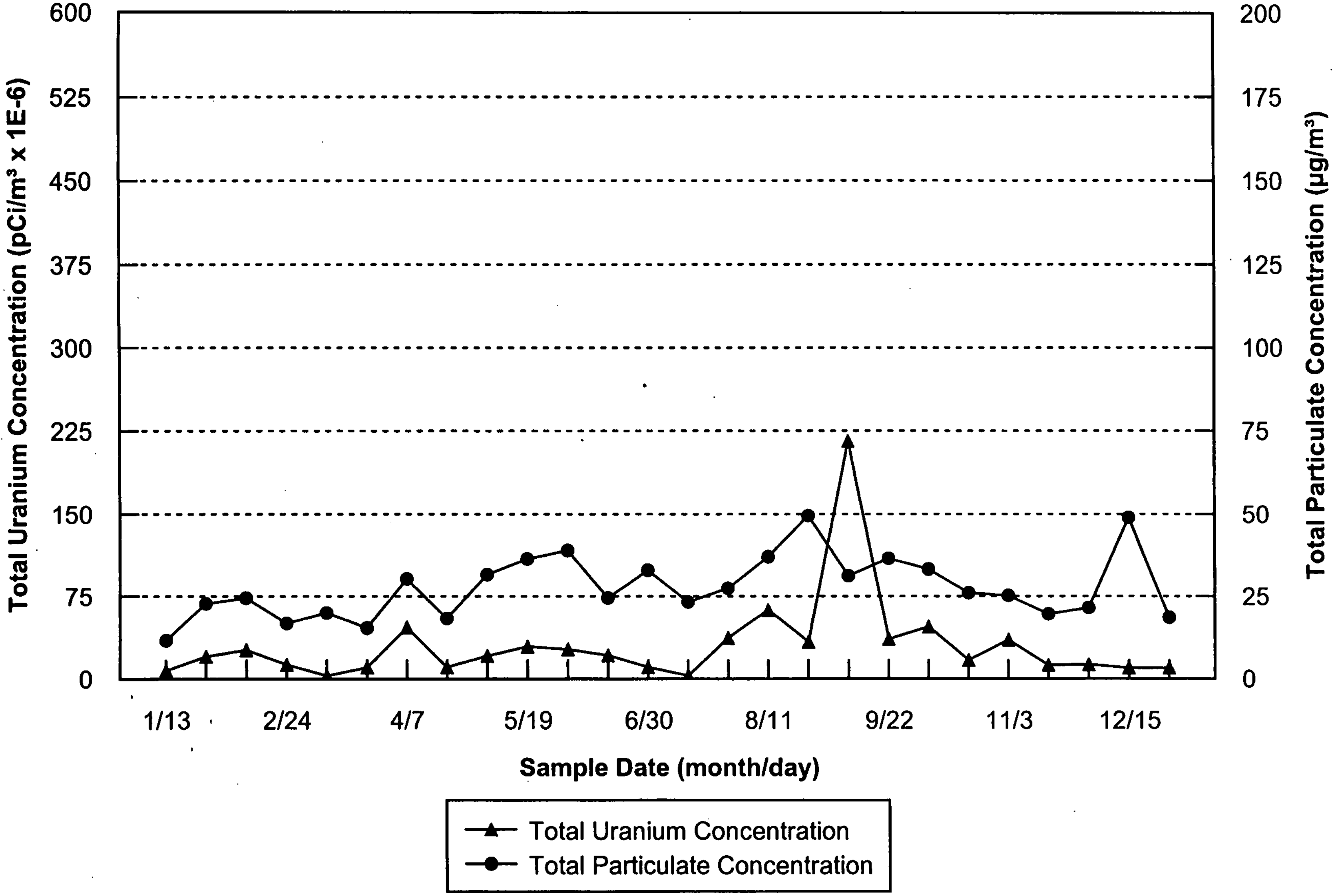

FIGURE C.1-16. 1998 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR FOR AMS-28

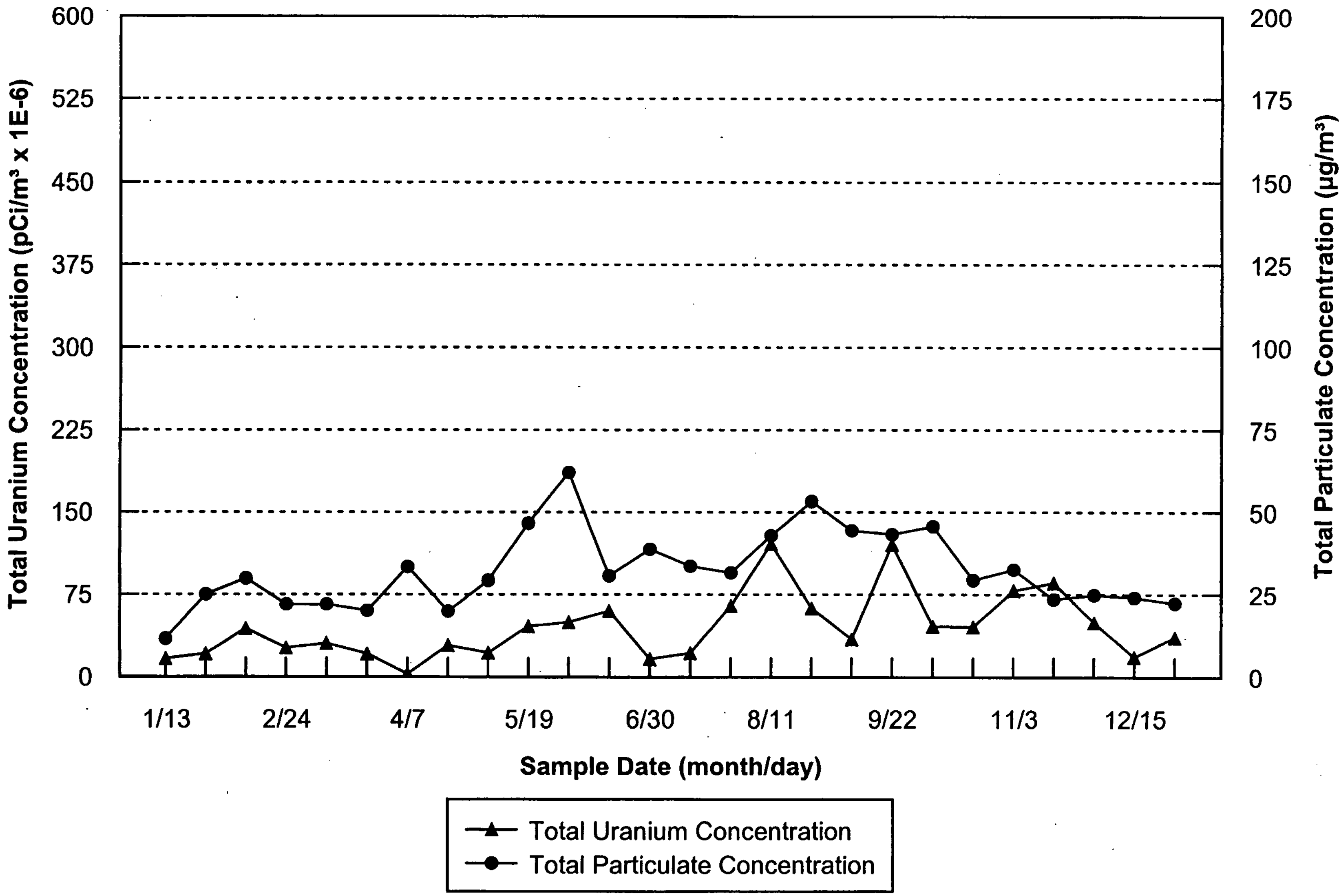

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FIGURE C.1-17. 1998 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR FOR AMS-29

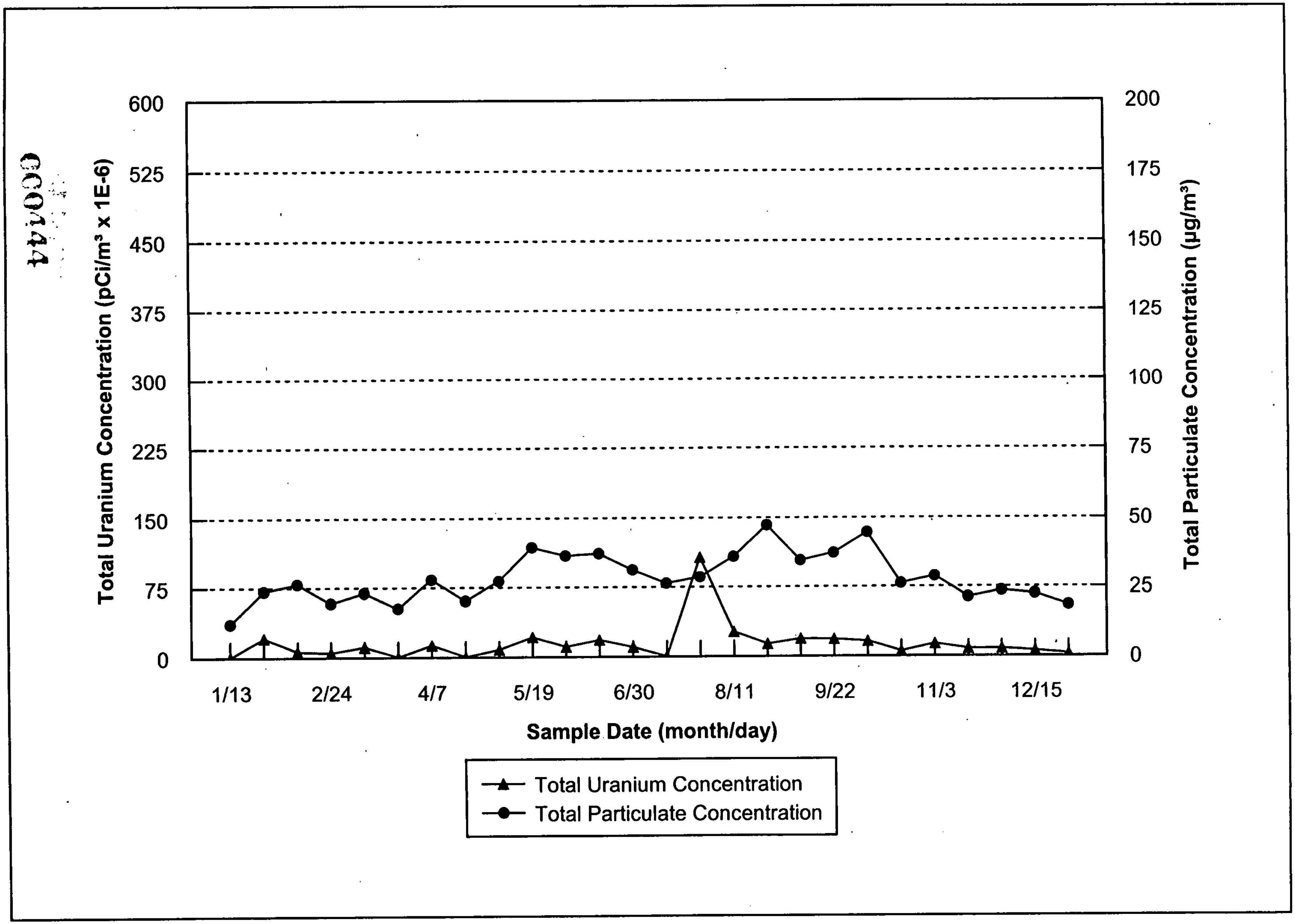

FIGURE C.1-18. 1998 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR FOR AMS-12

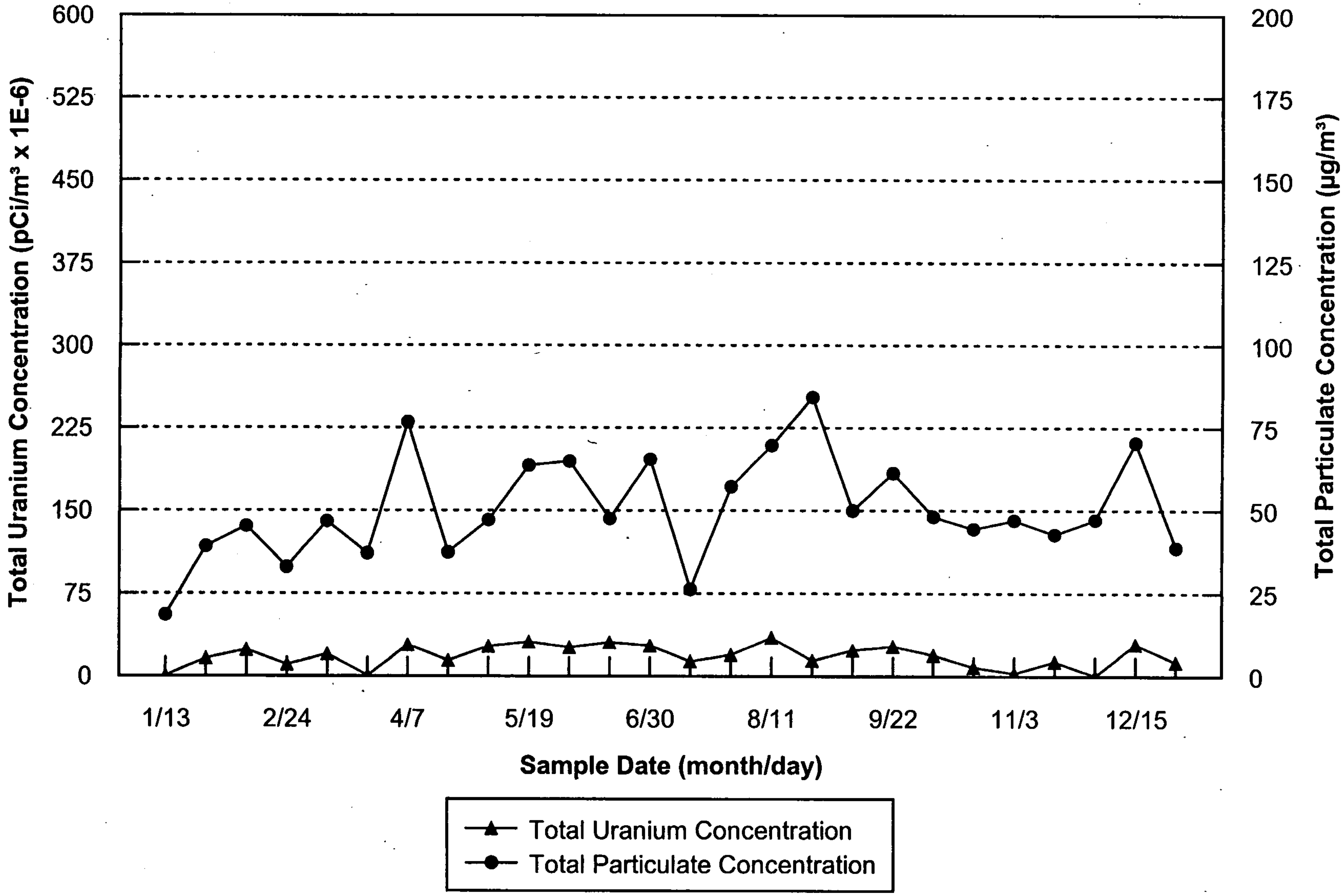

FIGURE C.1-19. 1998 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR FOR AMS-16

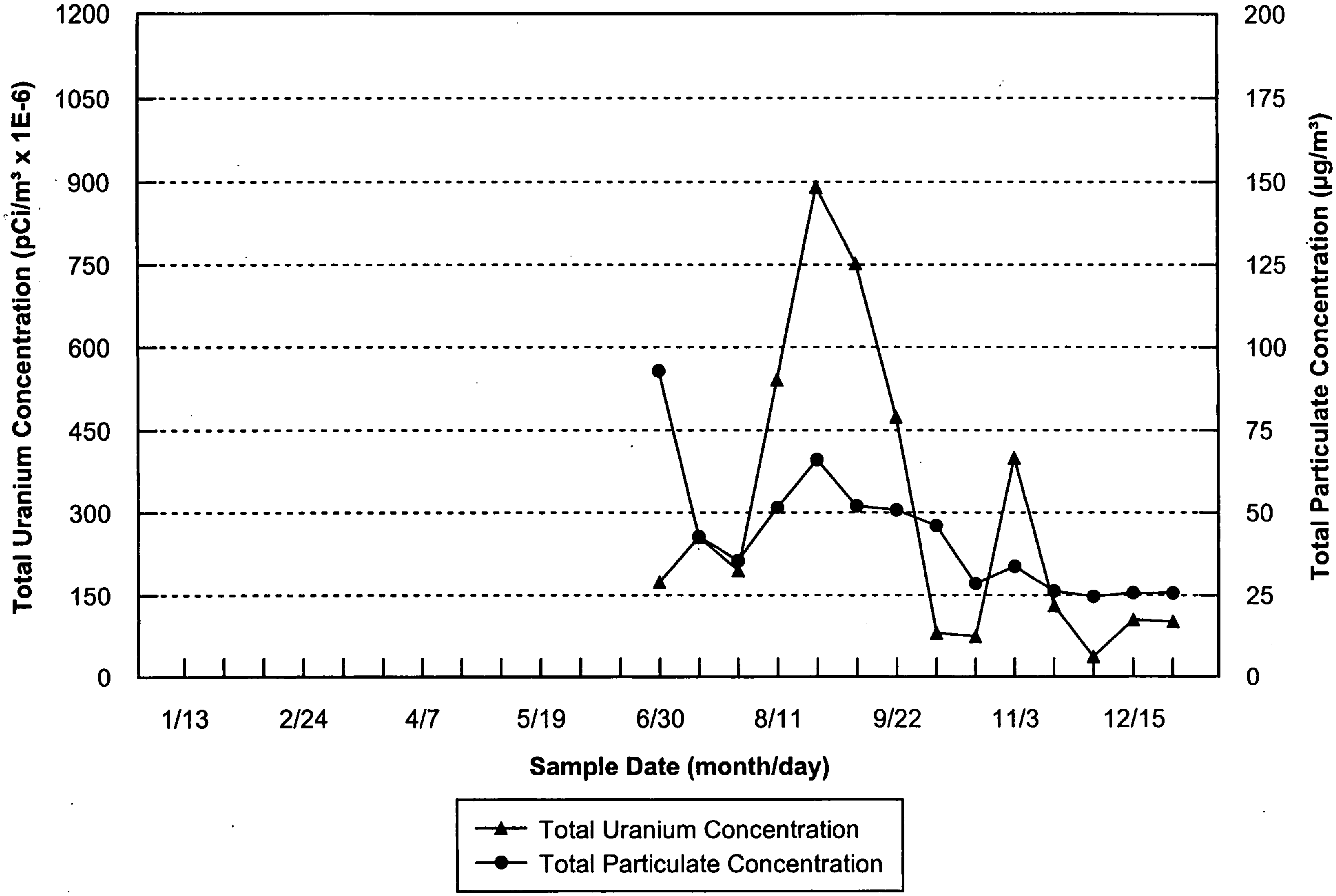

FIGURE C.1-20. 1998 TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR FOR STP-1

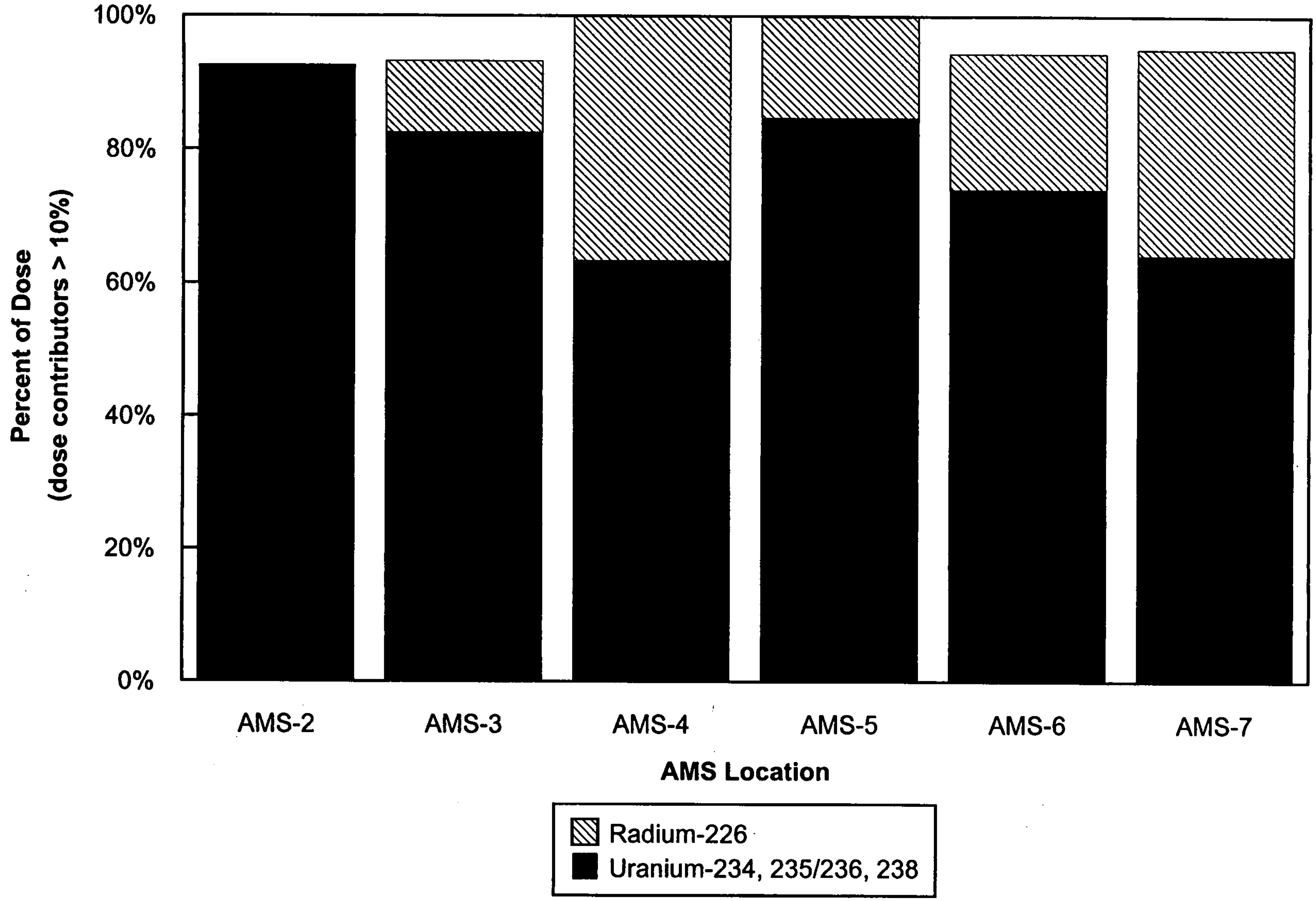

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FIGURE C.1-21. 1998 DOSE CONTRIBUTIONS PER AMS LOCATION

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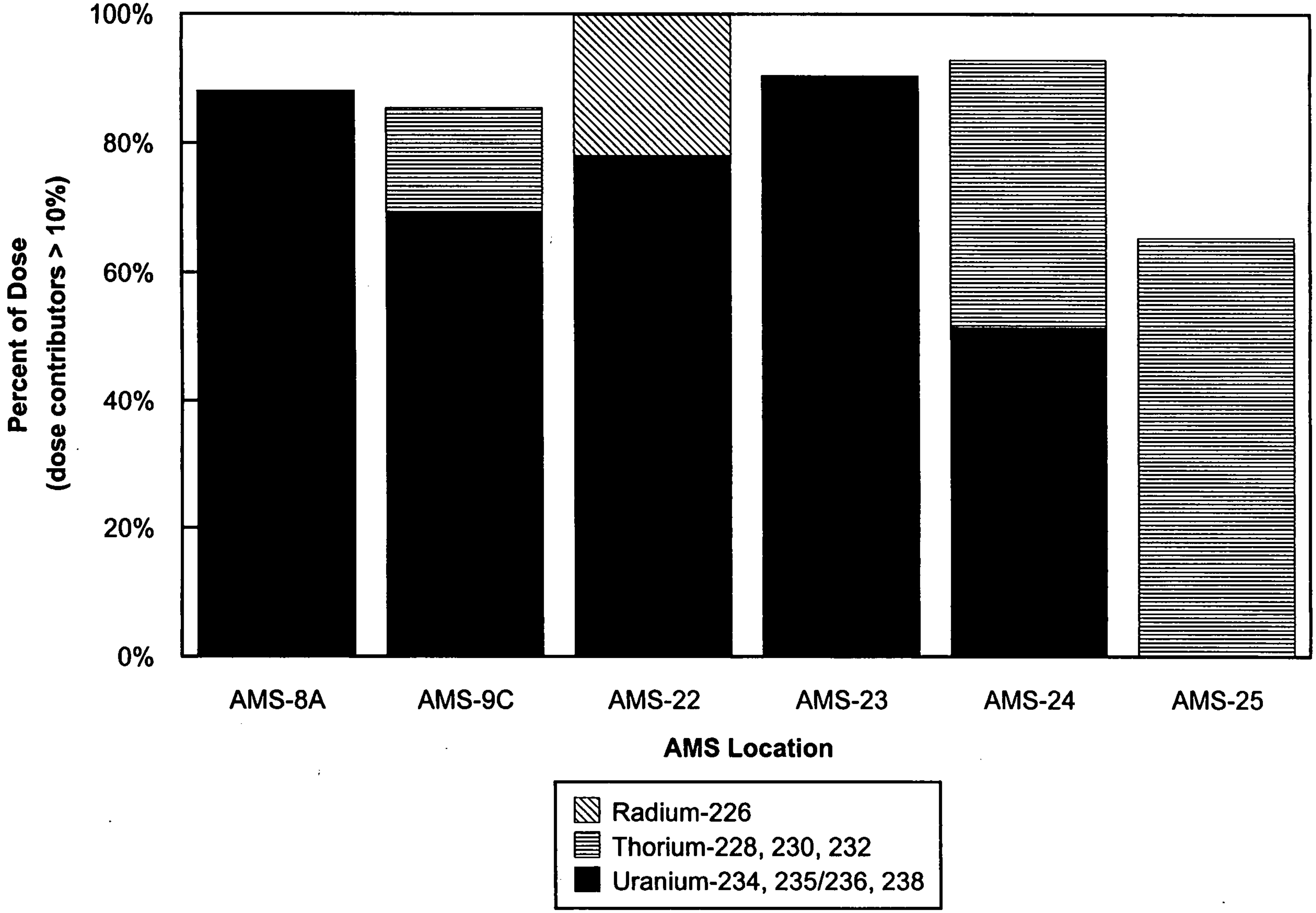

FIGURE C.1-22. 1998 DOSE CONTRIBUTIONS PER AMS LOCATION

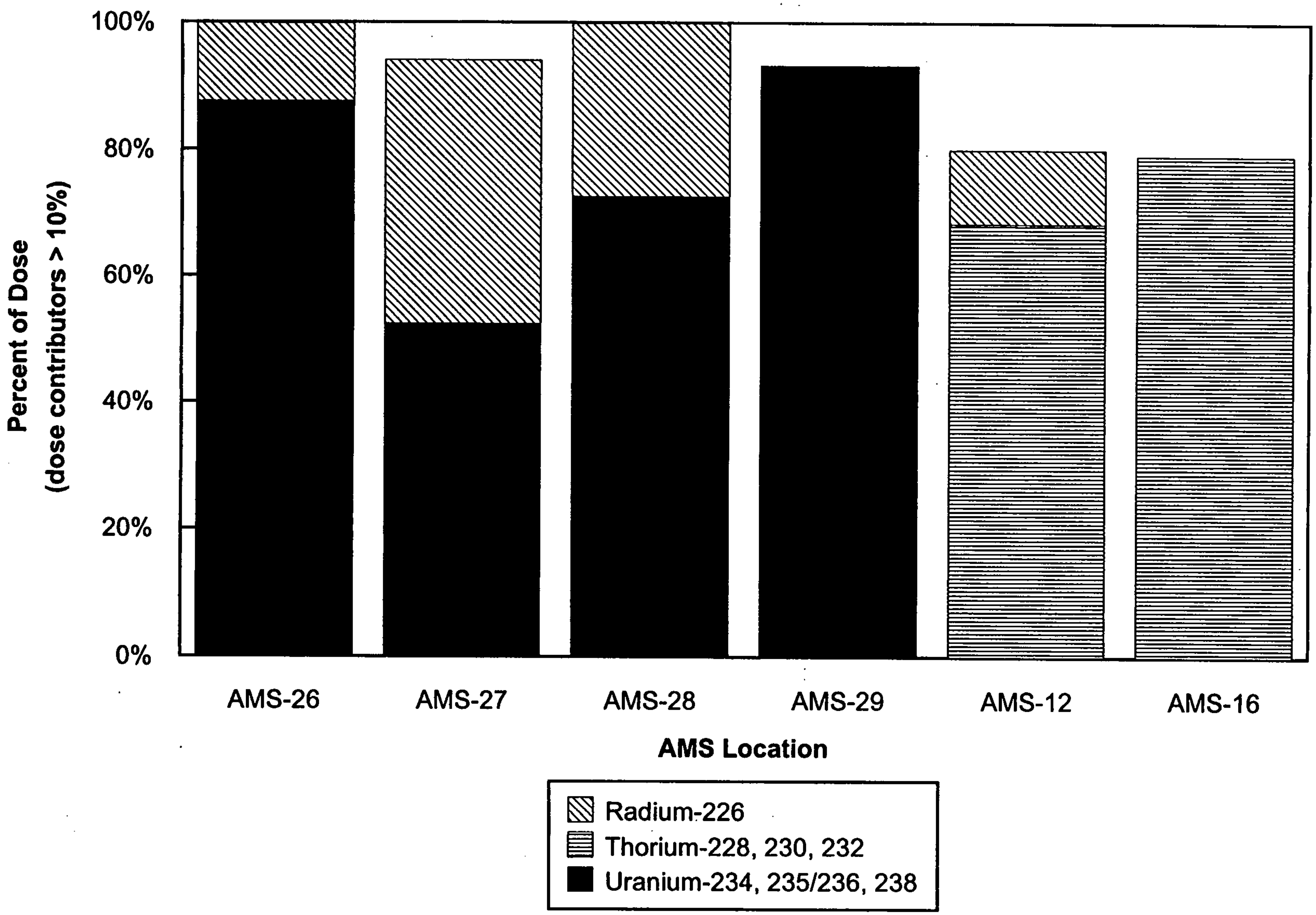

FIGURE C.1-23. 1998 DOSE CONTRIBUTIONS PER AMS LOCATION

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Attachment C.2

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ATTACHMENT C.2

RADON

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ATTACHMENT C.2

As discussed in Chapter 5 of the 1998 Integrated Site Environmental Report, the FEMP's radon monitoring program primarily focuses on assessing the effects of radon emissions from the K-65 Silos 1 and 2 on the surrounding environment. The radon data collected under the program are compared to the radon concentration standards contained in DOE Order 5400.5, Radiation Protection of the Public and the Environment. The pertinent standards and associated 1998 compliance status are provided below.

- The DOE annual average limit at and beyond the facility fenceline is 3.0 picoCuries per liter (pCi/L) above background; there were no exceedances in 1998.
- The DOE annual average limit over the facility is 30 pCi/L above background; there were no exceedances in 1998.
- The DOE limit measured at any point over the facility is 100 pCi/L; there were 24 exceedances during 1998.

Two monitoring devices are used at the FEMP to determine compliance with these limits and track changes in radon concentrations: 1) continuous monitors; and 2) long-term, time integrating monitors (alpha track-etch cups). The following sections summarize the findings from the radon monitoring program for 1998.

Continuous Monitoring Results

For 1998 the radon monitoring program operated 19 continuous environmental radon monitors for the entire year. The operational radon monitor run-time averaged approximately 97 percent for the 19 monitors. The three percent down-time was associated with downloading of instrument data, interruptions due to extreme cold temperatures, power interruptions, and/or routine maintenance activities. These monitors are primarily utilized to determine compliance with DOE Order 5400.5, 100 pCi/L radon limit, as well as track and evaluate fluctuations in environmental radon concentrations. Also, the Federal Facilities Agreement requires routine reporting of data from nine continuous monitors to assess short-term fluctuations associated with radon emissions from the K-65 Silos 1 and 2.

Data from the continuous environmental radon monitors are provided in this attachment in the following two formats:

- Table C.2-1 provides a detailed summary of 100 pCi/L exceedances. During 1998 there were 24 exceedances of the 100 pCi/L DOE limit.

- Figure C.2-1 identifies the location of continuous environmental radon monitoring locations in 1998. Figures C.2-2 through C.2-20 present the monthly average radon concentrations plotted over time for the 19 continuous environmental radon monitoring stations which operated throughout 1997 and 1998. The 3.0 pCi/L (fenceline and off site) and 30 pCi/L limits (on site) have been added as reference points to the appropriate graphs to assist in evaluating the data. The results for 1997 and 1998 have been corrected for instrument background. The practice of correcting measurements for instrument background was adopted by the FEMP in October 1997.

The noticeable increase in exceedances of the 100 pCi/L DOE limit at the K-65 Silo fenceline monitoring locations is attributed to both the increase in the radon concentrations in the silo head space as a result from the deterioration of bentonite layer overlying the waste materials within the silos and the leaks at the gasketed surfaces of manway flanges, sounding ports, and other silo penetrations (access port covers) that have been identified through radiological surveys of the silo domes. A radon treatment system included in the Accelerated Waste Retrieval Project for Silos 1 and 2 is forecasted to become fully operational in 2001 and will address the problems of radon emissions from the silos on a long-term basis. In the near-term, maintenance activities will be undertaken during 1999 to seal leaks in the silo domes.

In general, radon concentrations at all continuous radon monitoring locations including background locations increased during 1998. At the two highest K-65 Silo exclusion fence monitoring locations, the maximum monthly average concentration increased from 7.4 pCi/L in 1997 to 18.2 pCi/L at KNE and from 11.6 pCi/L in 1997 to 16.9 pCi/L at KSE in 1998.

During the biennial review of the IEMP, DOE proposed expanding the use of continuous environmental radon monitors at the FEMP. The expansion of the continuous monitoring network allows for frequent feedback to remediation projects, regulatory agencies and FEMP stakeholders on trends in ambient radon concentrations, while providing a sufficient radon monitoring network to ensure compliance with DOE Order 5400.5 requirements. Twelve continuous environmental radon monitor locations were added during 1998 and two monitoring locations were discontinued at the end of 1998 (monitoring location 11 and Waste Pit 5) following regulatory agency approval. This expands the network of continuous environmental radon monitors to 29. Data from the additional 12 monitors, will be reported beginning with the Integrated Environmental Monitoring Status Report for First Quarter 1999. Table C.2-3 provides a summary of monthly average radon concentrations for the continuous environmental radon monitoring stations operating in 1997 and 1998.

Long-term, Time Integrating Monitor Results

In addition to the continuous radon monitors, radon monitoring was conducted at 65 radon (alpha track-etch) cup locations during 1998. These detectors were collected at six month intervals and analyzed by at an off-site laboratory. The data from this monitoring effort are provided in Table C.2-2 for each six month sample collection period, as well as the annual average concentrations for 1998. For comparison, 1997 results are also included in the table. The radon cups are utilized primarily to determine compliance with the DOE Order 5400.5 standards of 3.0 pCi/L (above background) annual average at the fenceline and off-site locations and 30 pCi/L (above background) annual average over the facility. Data collected from the fenceline and off-site locations were all below the 3.0 pCi/L standard. Likewise, all on-site monitoring locations were below the 30 pCi/L standard. Figure C.2-21 identifies the radon alpha track-etch cup monitoring locations.

Beginning in 1997, new quality assurance methods were used to evaluate the alpha track-etch cup data. These methods were implemented to address analytical biases detected in the previous years' data. The process includes screening the data against quality assurance samples of a known radon exposure that are analyzed in conjunction with the field samples. The IEMP describes the detailed screening process for acceptable data, as well as the treatment to adjust the data. Radon data from alpha track-etch cups collected prior to 1997 have not been corrected for this bias.

For 1998 the analyses for the known exposure quality assurance samples for the first six month sampling period show a positive bias (i.e., analytical results were greater than the known exposure value). Therefore, the first six month alpha track-etch data were corrected downward to account for this bias.

No determination of the analytical bias is possible for the second six month sampling period due to vendor laboratory problems. During the spiking process of adding a known exposure to the quality control alpha track-etch detectors, an equipment malfunction in the spiking chamber occurred during off shift hours, preventing an accurate approximation of the known exposure. Therefore, no positive or negative bias factors were applied to the environmental radon exposure data for the second six month sampling period.

During the biennial review of the IEMP, DOE proposed eliminating the use of alpha track-etch detectors for measuring environmental radon concentrations at the FEMP. After gaining regulatory agency concurrence, the use of alpha track-etch detectors for environmental radon monitoring was discontinued at the end of 1998. Data from the expanded network of continuous monitors will be used during 1999 to determine compliance with the DOE Order 5400.5 limits.

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TABLE C.2-1

1998 RADON CONCENTRATIONS
100 pCi/L EXCEEDANCES AT THE K-65 SILOS 1 AND 2 EXCLUSION FENCE

Exceedance Event Start Date	Exceedance Duration (hours)	Maximum Recorded Hourly Radon Concentration (pCi/L)	Effected Monitoring Locations[a]
01/28	1	102.5	KNE
02/01	1	100.8	KNE
09/14	1	104.9	KSE
10/12	1	101.1	KSE
10/12	4	169.4	KSE
10/17	4	190.3	KNE
10/24	4	138.9	KNE, KSE
10/25	6	143.5	KNE, KSE
10/26	1	113.7	KNE
10/27	2	112.7	KNE, KSE
10/29	1	102.2	KNE
11/12	6	229.7	KNE, KSE
11/13	6	151.6	KNE, KSE
11/15	4	155.9	KNE, KSE
11/21	10	144.7	KNE, KSE
11/24	13	149.2	KNE, KNW, KSE, KSW
12/1	7	257.8	KNE, KSE
12/9	10	190.7	KNE, KSE
12/11	1	101.6	KNE
12/15	7	158.4	KNE, KSE
12/15	3	106.4	KNE, KSE
12/24	2	186.4	KNE
12/25	7	200.8	KSE, KNE, KNW
12/26	5	163.4	KNE, KNW, KSE, KSW

[a]The location listed first had the highest recorded concentration.

TABLE C.2-2

RADON MONITORING-ALPHA TRACK-ETCH CUPS, CONCENTRATION DATA FOR 1998

Location	Radon Concentration ± Precision[a] (pCi/L) First Half of Year 1998	Second Half of Year 1998	1998 Location Average	1997 Location Average
K-65 Silos 1 and 2 Exclusion Fence Locations				
K65A	1.2 ± 0.2	1.6 ± 0.3	1.4 ± 0.3	1.0 ± 0.4
K65B	1.5 ± 0.3	2.3 ± 0.1	1.9 ± 0.2	1.4 ± 0.6
K65C	2.3 ± 0.3	4.3 ± 1.2	3.3 ± 0.9	2.2 ± 0.4
K65D	3.7 ± 0.9	6.3 ± 0.7	5.0 ± 0.8	3.5 ± 0.8
K65E	3.3 ± 0.8	5.9 ± 0.7	4.6 ± 0.8	3.3 ± 0.3
K65F	3.3 ± 0.8	7.1 ± 0.6	5.2 ± 0.7	3.5 ± 0.8
K65G	2.3 ± 0.1	3.8 ± 0.4	3.1 ± 0.3	2.1 ± 0.5
K65H	1.6 ± 0.3	2.2 ± 0.3	1.9 ± 0.3	1.4 ± 0.4
K65I	1.3 ± 0.6	1.6 ± 0.4	1.5 ± 0.5	1.1 ± 0.4
K65J	0.9 ± 0.3	1.0 ± 0.1	1.0 ± 0.2	0.7 ± 0.2
K65K	1.1 ± 0.3	1.1 ± 0.4	1.1 ± 0.4	0.9 ± 0.2
K65L	2.2 ± 0.1	2.1 ± 0.3	2.2 ± 0.2	1.8 ± 0.7
K65M	2.5 ± 1.1	2.0 ± 0.3	2.3 ± 0.8	1.6 ± 0.5
K65N	2.1 ± 0.5	1.9 ± 0.8	2.0 ± 0.7	1.4 ± 0.3
K65O	1.2 ± 0.5	1.1 ± 0.4[b]	1.2 ± 0.5	0.9 ± 0.2
K65P	1.0 ± 0.2	1.3 ± 0.5	1.2 ± 0.4	0.8 ± 0.4
Minimum	**0.9 ± 0.3**	**1.0 ± 0.1**	**1.0 ± 0.2**	**0.7 ± 0.2**
Maximum	**3.7 ± 0.9**	**7.1 ± 0.6**	**5.2 ± 0.7**	**3.5 ± 0.8**
K-65 Silos 1 and 2 Dome Locations				
1-NE	15.4 ± 0.4	25.9 ± 2.1	20.7 ± 1.5	12.1 ± 0.3
1-NW	10.4 ± 0.2	17.4 ± 0.8	13.9 ± 0.6	6.4 ± 0.8
1-SE	7.6 ± 0.6	12.2[c]	9.9 ± 0.4	7.1 ± 0.6
1-SW	6.3 ± 0.5	4.5 ± 0.2	5.4 ± 0.4	4.1 ± 0.3
2-NE	20.4 ± 3.8	30.6 ± 4.8	25.5 ± 4.3	18.0 ± 1.6
2-NW	5.9 ± 0.1	4.9± 0.1	5.4± 0.1	3.8 ± 0.7
2-SE	21.0 ± 0.6	34.9 ± 0.2	28.0 ± 0.4	12.3 ± 1.0
2-SW	13.5[d]	8.2 ± 0.1	10.9 ± 0.1	7.6 ± 0.7
Minimum	**5.9 ± 0.1**	**4.5 ± 0.2**	**5.4 ± 0.1**	**3.8 ± 0.7**
Maximum	**21.0 ± 0.6**	**34.9 ± 0.2**	**28.0 ± 0.4**	**18.0 ± 1.6**
Fenceline Locations				
AMS-02	0.0 ± 0.1[e]	0.3 ± 0.1[f]	0.2 ± 0.1	0.2 ± 0.1
AMS-04	0.0 ± 0.1	0.3 ± 0.1[f]	0.2 ± 0.1	0.2 ± 0.2
AMS-06	0.1 ± 0.1[f]	0.4 ± 0.2	0.3 ± 0.2	0.3 ± 0.2
AMS-07	0.1 ± 0.1	0.5 ± 0.1	0.3 ± 0.1	0.3 ± 0.2
AMS-08A	0.0 ± 0.2[e]	0.4 ± 0.1	0.2 ± 0.2	0.2 ± 0.1
AMS-09B/C[g]	0.1 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.3 ± 0.1
A	0.4 ± 0.2	1.0 ± 0.4	0.7 ± 0.3	0.4 ± 0.2
B	0.0 ± 0.1	0.2 ± 0.1	0.1 ± 0.1	0.3 ± 0.2
C	0.0 ± 0.1[e]	0.2 ± 0.1	0.1 ± 0.1	0.3 ± 0.2
D	0.0 ± 0.1[e]	0.3 ± 0.3[e]	0.2 ± 0.2	0.2 ± 0.2
E	0.0 ± 0.1	0.3 ± 0.1	0.2 ± 0.1	0.3 ± 0.2
F	0.2 ± 0.1[f]	0.4 ± 0.1[f]	0.3 ± 0.1	0.2 ± 0.1
G	0.0 ± 0.1[b]	0.4 ± 0.2[e]	0.2 ± 0.2	0.3 ± 0.1
H	0.0 ± 0.1	0.5 ± 0.3[e]	0.3 ± 0.2	0.3 ± 0.2
I	0.2 ± 0.2	0.5 ± 0.1[b]	0.4 ± 0.2	0.3 ± 0.2

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TABLE C.2-2
(Continued)

Location	Radon Concentration ± Precision[a] (pCi/L)			
	First Half of Year 1998	Second Half of Year 1998	1998 Location Average	1997 Location Average
Fenceline Locations (Contd.)				
J	0.1 ± 0.1	0.5 ± 0.1[f]	0.3 ± 0.1	0.3 ± 0.1
K	0.1 ± 0.1	0.4 ± 0.1	0.3 ± 0.1	0.4 ± 0.1
L	0.5 ± 0.2	1.0 ± 0.3	0.8 ± 0.3	0.4 ± 0.2
M	0.2 ± 0.1	0.4 ± 0.1[b]	0.3 ± 0.1	0.4 ± 0.2
N	0.2 ± 0.2	0.4 ± 0.1	0.3 ± 0.2	0.4 ± 0.2
O	0.1 ± 0.1[f]	0.4 ± 0.2[e]	0.3 ± 0.2	1.0 ± 0.2
P	0.2 ± 0.1	0.6 ± 0.1	0.4 ± 0.1	0.4 ± 0.2
Minimum	**0.0 ± 0.1**	**0.2 ± 0.1**	**0.1 ± 0.1**	**0.2 ± 0.1**
Maximum	**0.5 ± 0.2**	**1.0 ± 0.4**	**0.8 ± 0.3**	**1.0 ± 0.2**
Background Locations				
AMS-12	0.0 ± 0.1[b]	0.2 ± 0.1	0.1 ± 0.1	0.1 ± 0.1
AMS-13	0.1 ± 0.2[e]	0.2 ± 0.1	0.2 ± 0.2	0.2 ± 0.2
AMS-16[h]	0.1 ± 0.1	0.3 ± 0.1[f]	0.2 ± 0.1	0.2 ± 0.1
BKGD-01	0.0 ± 0.1	0.2 ± 0.1	0.1 ± 0.1	0.1 ± 0.1
BKGD-02	0.0 ± 0.1[b]	0.3 ± 0.1	0.1 ± 0.1	0.2 ± 0.1
BKGD-04	0.0 ± 0.1[b]	0.2 ± 0.1	0.1 ± 0.1	0.2 ± 0.2
BKGD-05	0.1 ± 0.1[f]	0.4 ± 0.2[e]	0.3 ± 0.2	0.2 ± 0.1
BKGD-06	0.0 ± 0.1[i]	0.2[j]	0.1 ± 0.1	0.1 ± 0.1
Minimum	**0.0 ± 0.1**	**0.2 ± 0.1**	**0.1 ± 0.1**	**0.1 ± 0.1**
Maximum	**0.1 ± 0.2**	**0.4 ± 0.2**	**0.3 ± 0.2**	**0.2 ± 0.2**
Other On-Site Locations				
PERM-07	0.1[j]	0.4 ± 0.1[b]	0.3 ± 0.1	0.4 ± 0.1
PERM-09	0.1 ± 0.1	0.6 ± 0.3	0.4 ± 0.2	0.2 ± 0.1
65-6	0.2 ± 0.1	0.5 ± 0.1	0.4 ± 0.1	0.3 ± 0.2
65-7	0.2 ± 0.1	0.4 ± 0.1	0.3 ± 0.1	0.3 ± 0.1
65-8	0.2 ± 0.2[e]	0.6 ± 0.1	0.4 ± 0.2	0.3 ± 0.2
65-9	0.2 ± 0.1[f]	0.4 ± 0.1	0.3 ± 0.1	0.3 ± 0.1
AMS-01A	0.1 ± 0.1	0.6 ± 0.1[f]	0.4 ± 0.1	0.3 ± 0.1
Minimum	**0.1 ± 0.1**	**0.4 ± 0.1**	**0.3 ± 0.1**	**0.2 ± 0.1**
Maximum	**0.2 ± 0.2**	**0.6 ± 0.3**	**0.4 ± 0.2**	**0.4 ± 0.1**
Other Off-Site Locations				
AMS-10	0.1 ± 0.1[f]	0.4 ± 0.2	0.3 ± 0.2	0.3 ± 0.2
AMS-11	0.1 ± 0.2[e]	0.4 ± 0.1	0.3 ± 0.2	0.3 ± 0.1
RES-01	0.1 ± 0.1	0.4 ± 0.1[b]	0.3 ± 0.1	0.3 ± 0.2
RES-02	0.2 ± 0.1[f]	0.4 ± 0.1[c]	0.3 ± 0.1	0.3 ± 0.1
RES-03	0.2 ± 0.2	0.4 ± 0.1[b]	0.3 ± 0.2	0.4 ± 0.2
Minimum	**0.1 ± 0.1**	**0.4 ± 0.1**	**0.3 ± 0.1**	**0.3 ± 0.2**
Maximum	**0.2 ± 0.2**	**0.4 ± 0.2**	**0.3 ± 0.2**	**0.4 ± 0.2**

[a]± 2 standard deviations
[b]Data edited due to IEMP Screening Criteria III.
[c]Detectors missing; value supplied was estimated by multiplying first half average by 1.6 which is the average increase of east silo locations.
[d]Data was only available for one detector.
[e]Data edited due to IEMP Screening Criteria IV.
[f]Data was edited due to IEMP Screening Criteria II.
[g]Location is approximately 125 yards south of AMS-09B (1997 data).
[h]Previously referred to as BKGD-03
[i]Data was only available for two detectors.
[j]Detectors missing; value supplied is the minimum for the group (this effects previously published value for PERM-07).

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TABLE C.2-3

CONTINUOUS ENVIRONMENTAL RADON MONITORING MONTHLY AVERAGE CONCENTRATIONS

	1998 Summary Results[b,c] (Instrument Background Corrected) (pCi/L)			1997 Summary Results[b,c] (Instrument Background Corrected) (pCi/L)		
Location[a]	Min.	Max.	Avg.	Min.	Max.	Avg.
Fenceline						
AMS-02	0.2	0.7	0.4	0.3	0.7	0.5
AMS-03[d]	0.6	0.8	0.7	NA	NA	NA
AMS-04	0.1	0.7	0.4	0.1	0.7	0.4
AMS-05	0.2	1.3	0.6	0.1	1.2	0.5
AMS-06	0.2	0.9	0.5	0.2	0.8	0.4
AMS-07	0.2	1.5	0.7	0.1	1.2	0.5
AMS-08A[e]	0.8	NA	NA	NA	NA	NA
AMS-09C[f]	0.2	0.9	0.6	NA	NA	NA
AMS-22[f]	0.2	0.7	0.4	NA	NA	NA
AMS-23[d]	0.4	0.5	0.4	NA	NA	NA
AMS-24[e]	0.7	NA	NA	NA	NA	NA
AMS-25[e]	0.6	NA	NA	NA	NA	NA
AMS-26[f]	0.2	0.8	0.6	NA	NA	NA
AMS-27[f]	0.2	1.1	0.7	NA	NA	NA
AMS-28[e]	0.4	NA	NA	NA	NA	NA
AMS-29[e]	0.7	NA	NA	NA	NA	NA
Off Site						
AMS-11	0.1	1.0	0.4	0.1	0.9	0.4
Background						
AMS-12	0.1	0.6	0.3	0.0	0.5	0.2
AMS-16	0.2	0.6	0.4	0.1	0.4	0.2
On Site						
KNE	2.0	18.2	9.1	2.9	7.4	5.5
KNW	1.0	4.8	2.4	0.9	2.3	1.6
KSE	2.4	16.9	8.3	2.8	11.6	5.6
KSW	1.4	5.2	3.1	1.5	3.3	2.3
KTOP	7.2	24.6	13.0	6.0	13.5	9.9
Pilot Plant Warehouse	0.1	0.9	0.4	0.1	1.2	0.4
Pit 5	0.2	1.0	0.5	0.2	0.9	0.5
Rally Point 4	0.2	1.3	0.7	0.3	1.0	0.6
Surge Lagoon	0.3	1.3	0.7	0.3	1.3	0.7
T28	0.9	2.8	1.8	1.0	2.4	1.8
WP-17A	0.2	0.9	0.5	0.2	1.0	0.5

[a]See Figure C.2-1
[b]Instrument background changes as monitors are replaced.
[c]NA = not applicable
[d]Unit was placed in service in August 1998.
[e]Unit was placed in service in December 1998.
[f]Unit was placed in service in June 1998.

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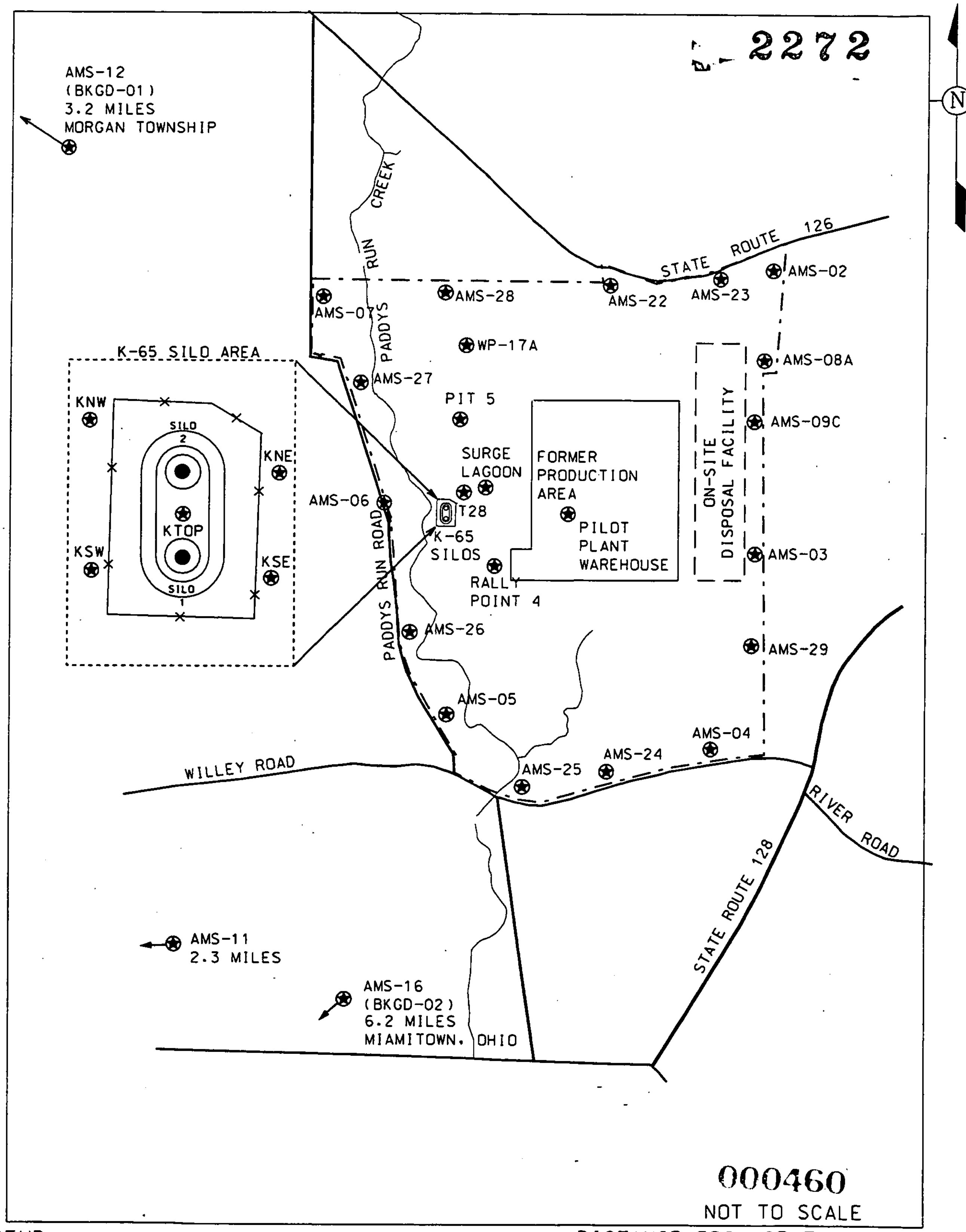

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LEGEND:

FEMP BOUNDARY

ENVIRONMENTAL RADON MONITORING - CONTINUOUS ALPHA SCINTILLATION LOCATION

DISTANCE FROM CENTER OF FORMER PRODUCTION AREA TO LOCATION OFF MAP

SILO HEAD SPACE RADON MONITORING - CONTINUOUS ALPHA SCINTILLATION LOCATION

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FIGURE C.2-1. 1998 RADON MONITORING - CONTINUOUS ALPHA SCINTILLATION LOCATIONS

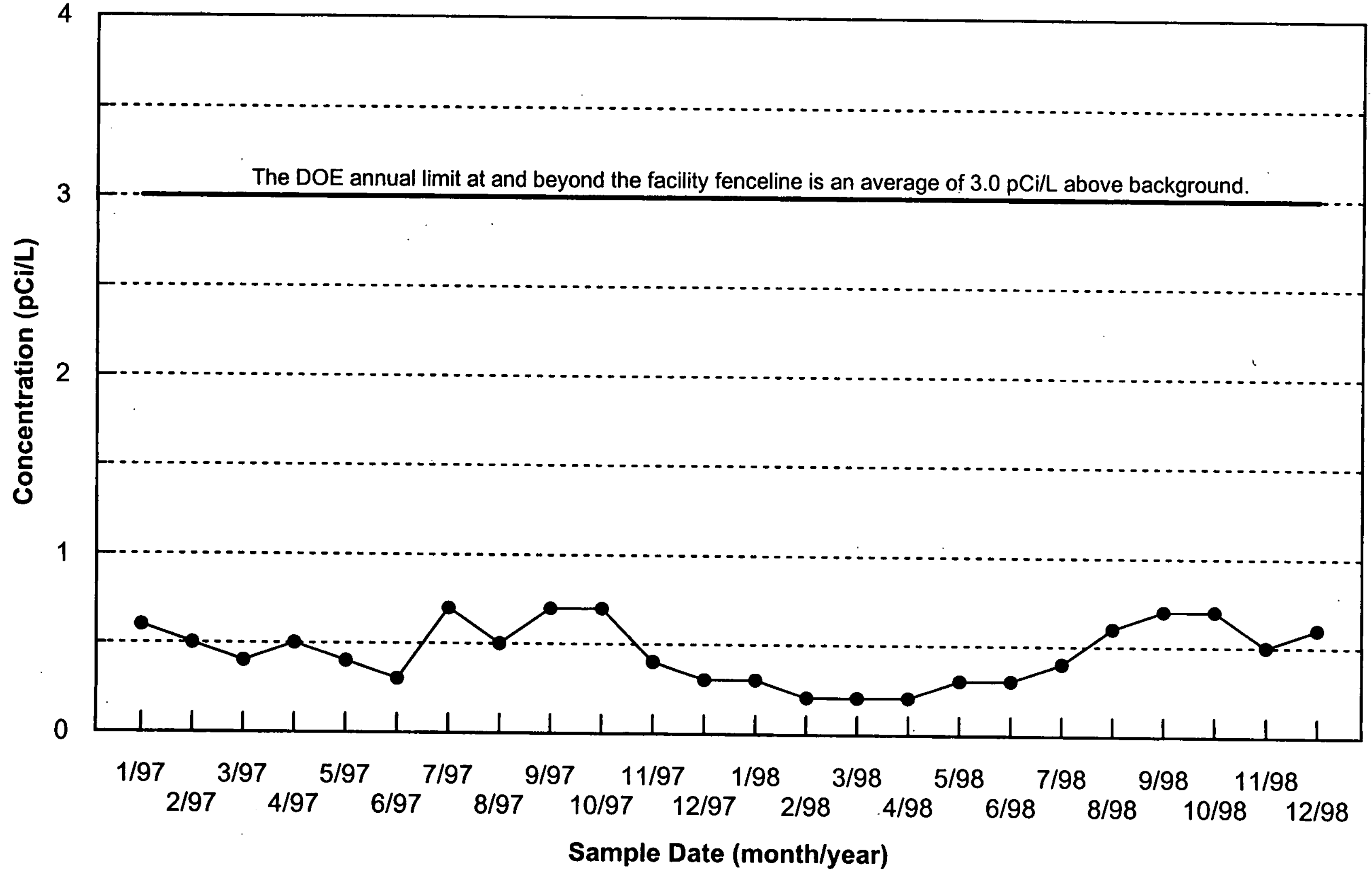

FIGURE C.2-2. 1997 AND 1998 MONTHLY AVERAGE RADON CONCENTRATION FOR AMS-02

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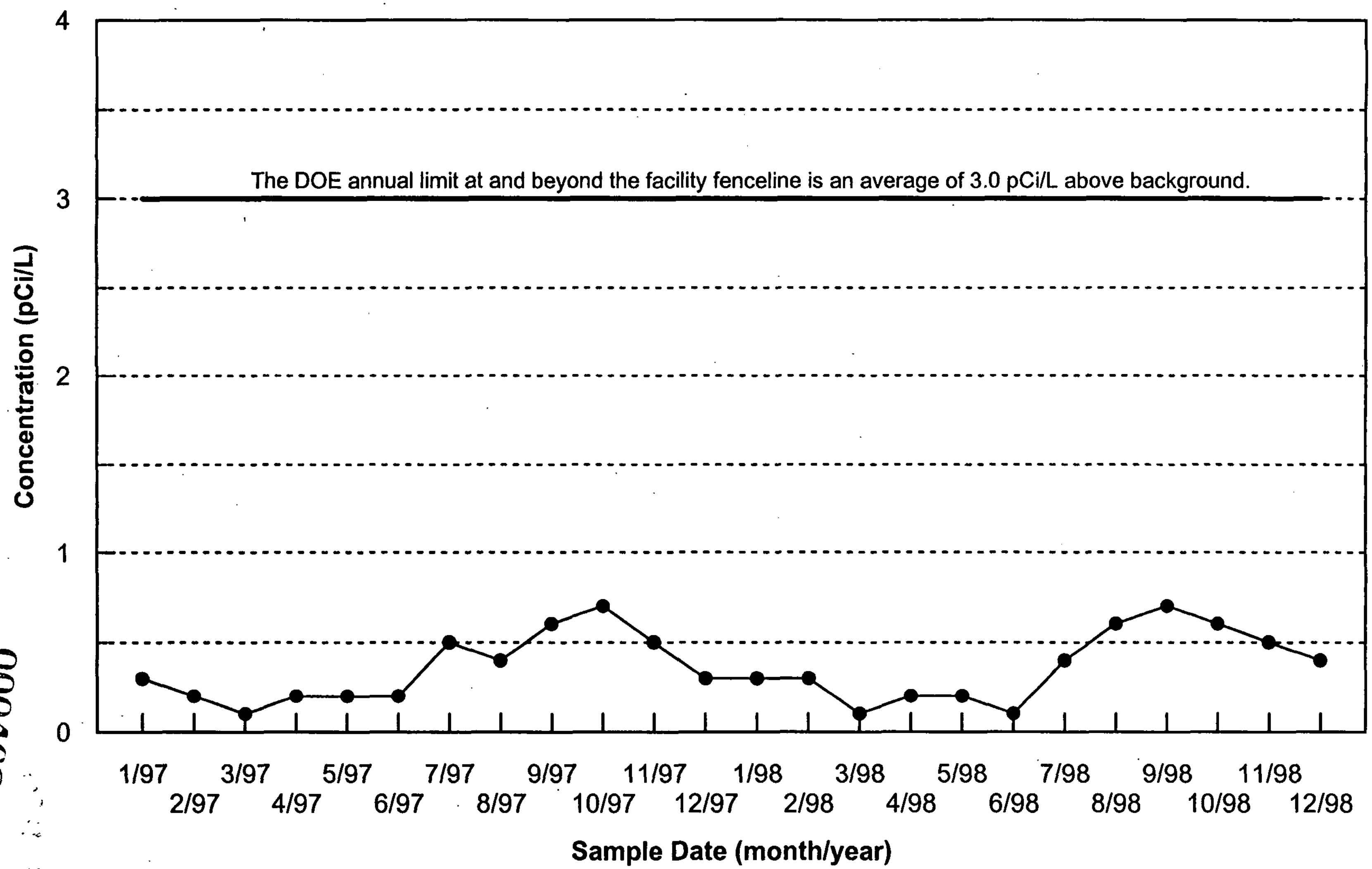

FIGURE C.2-3. 1997 AND 1998 MONTHLY AVERAGE RADON CONCENTRATION FOR AMS-04

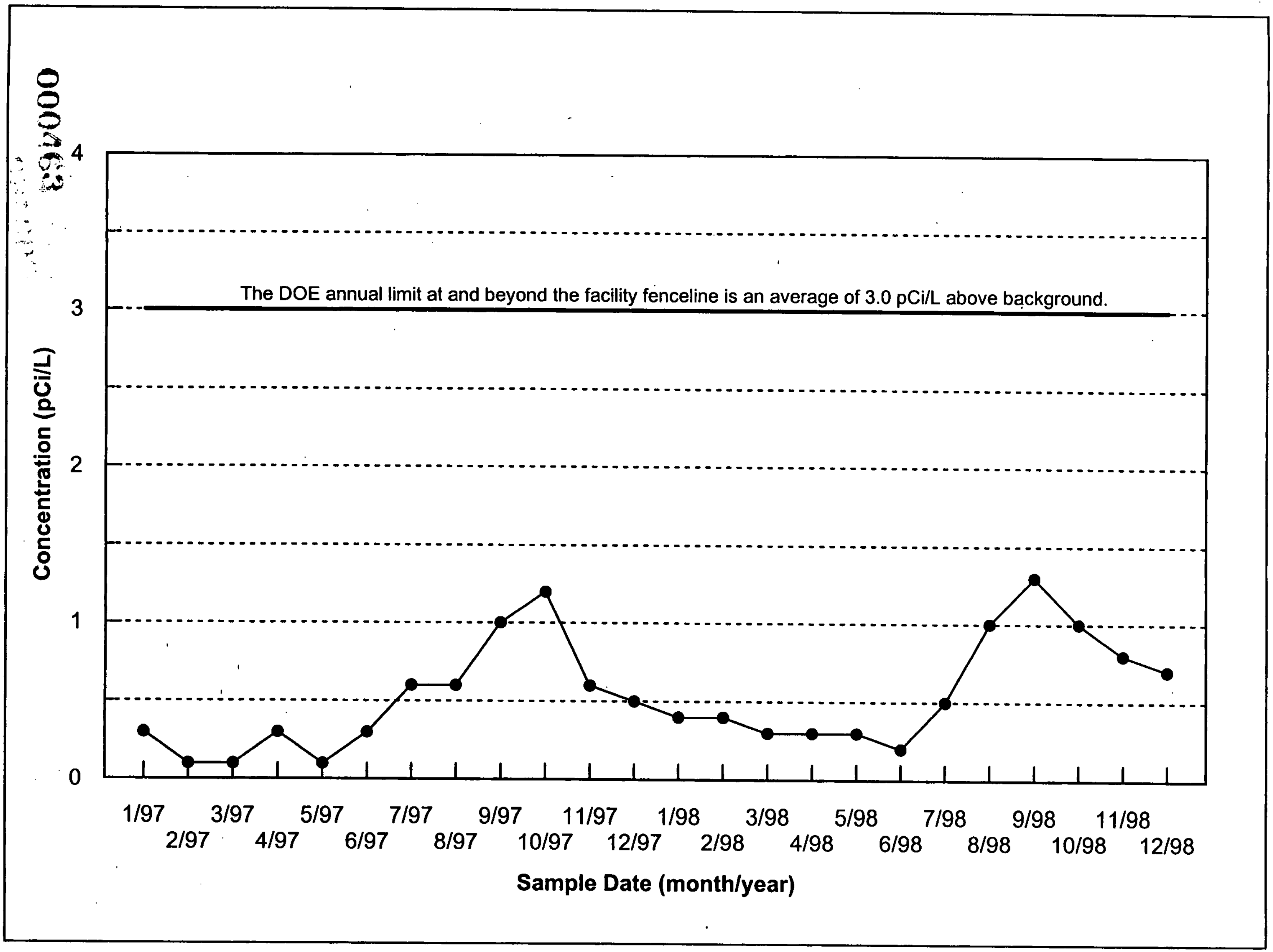

FIGURE C.2-4. 1997 AND 1998 MONTHLY AVERAGE RADON CONCENTRATION FOR AMS-05

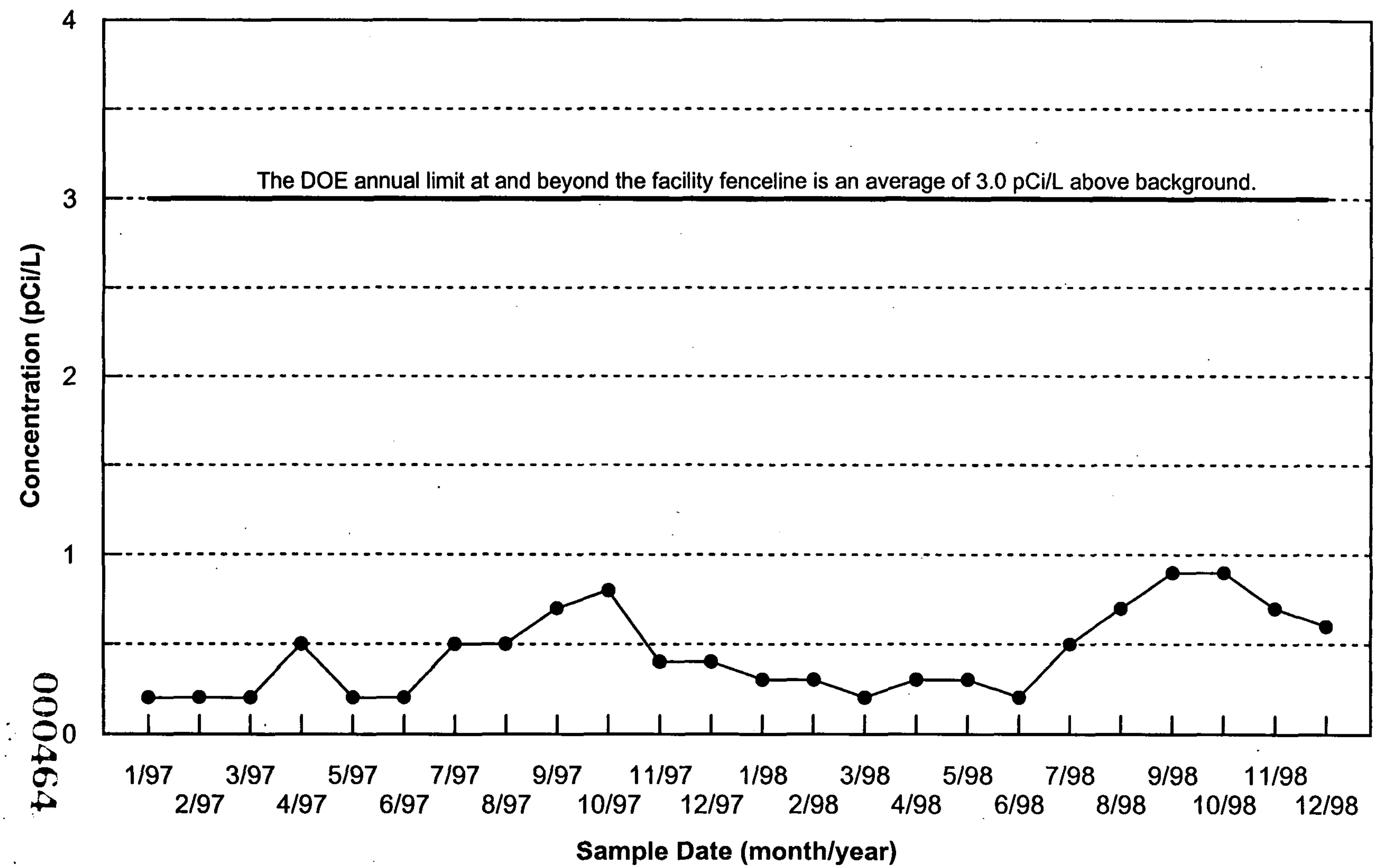

FIGURE C.2-5. 1997 AND 1998 MONTHLY AVERAGE RADON CONCENTRATION FOR AMS-06

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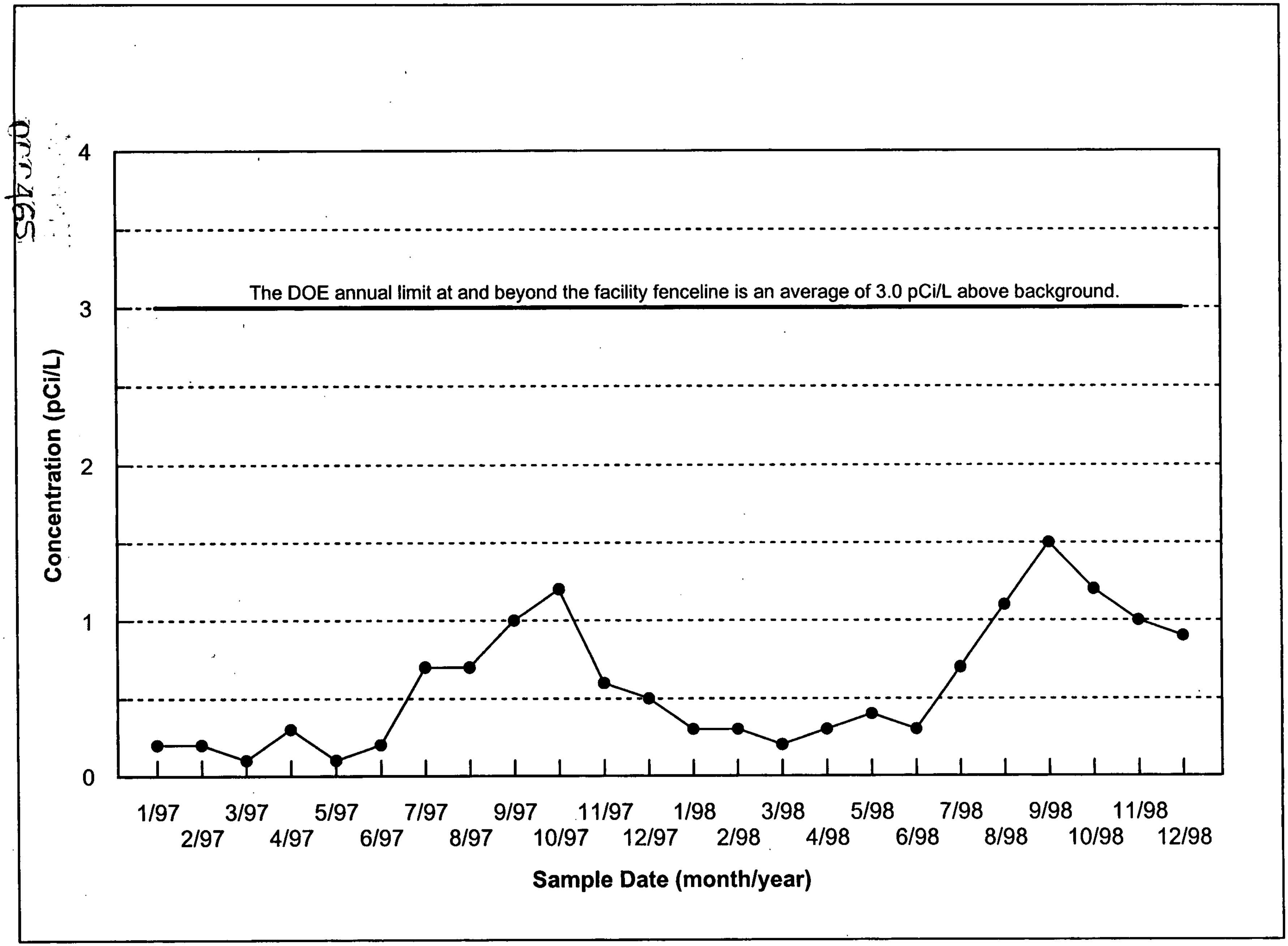

FIGURE C.2-6. 1997 AND 1998 MONTHLY AVERAGE RADON CONCENTRATION FOR AMS-07

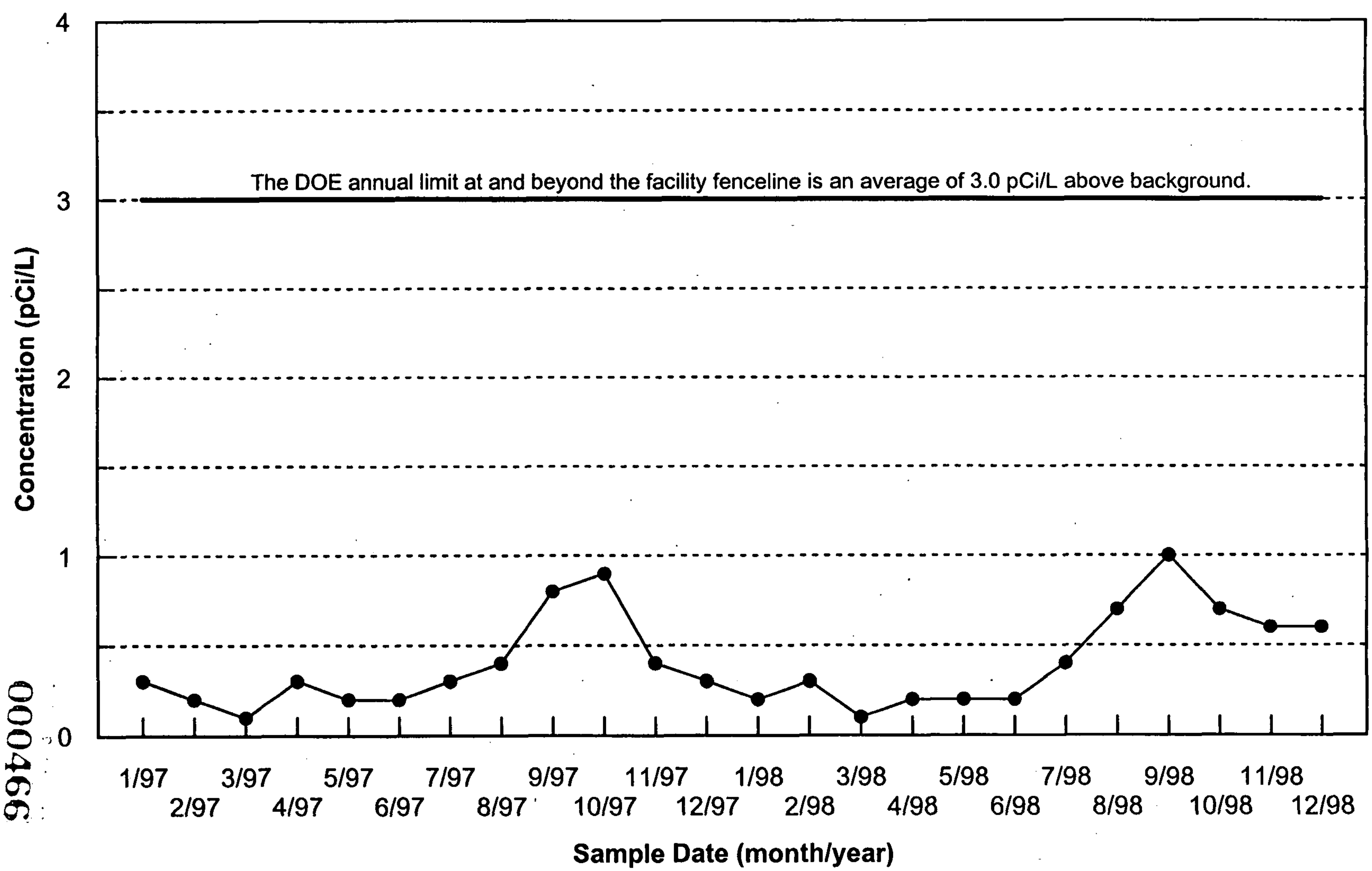

FIGURE C.2-7. 1997 AND 1998 MONTHLY AVERAGE RADON CONCENTRATION FOR AMS-11

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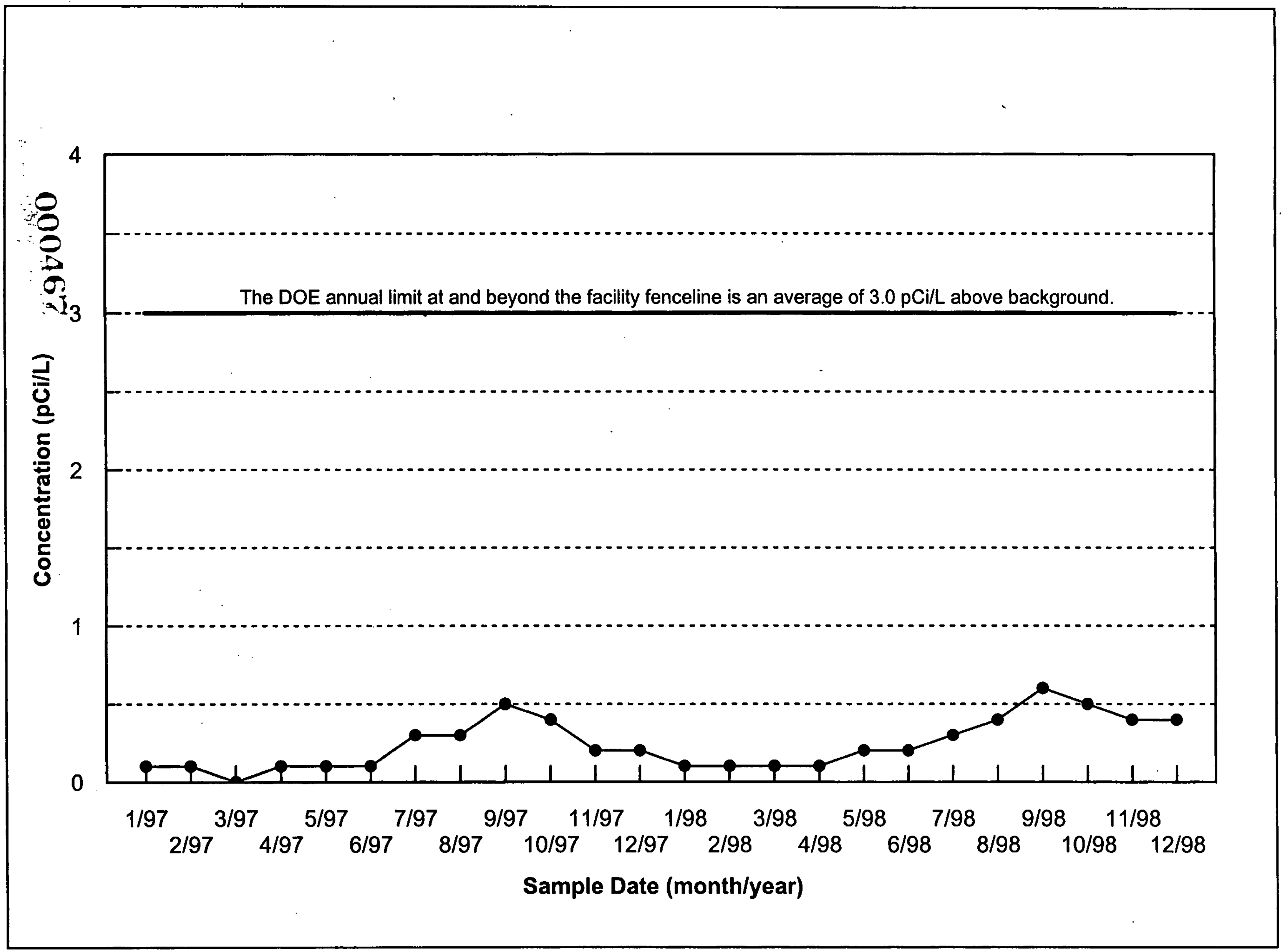

FIGURE C.2-8. 1997 AND 1998 MONTHLY AVERAGE RADON CONCENTRATION FOR AMS-12 (BKGD-01)

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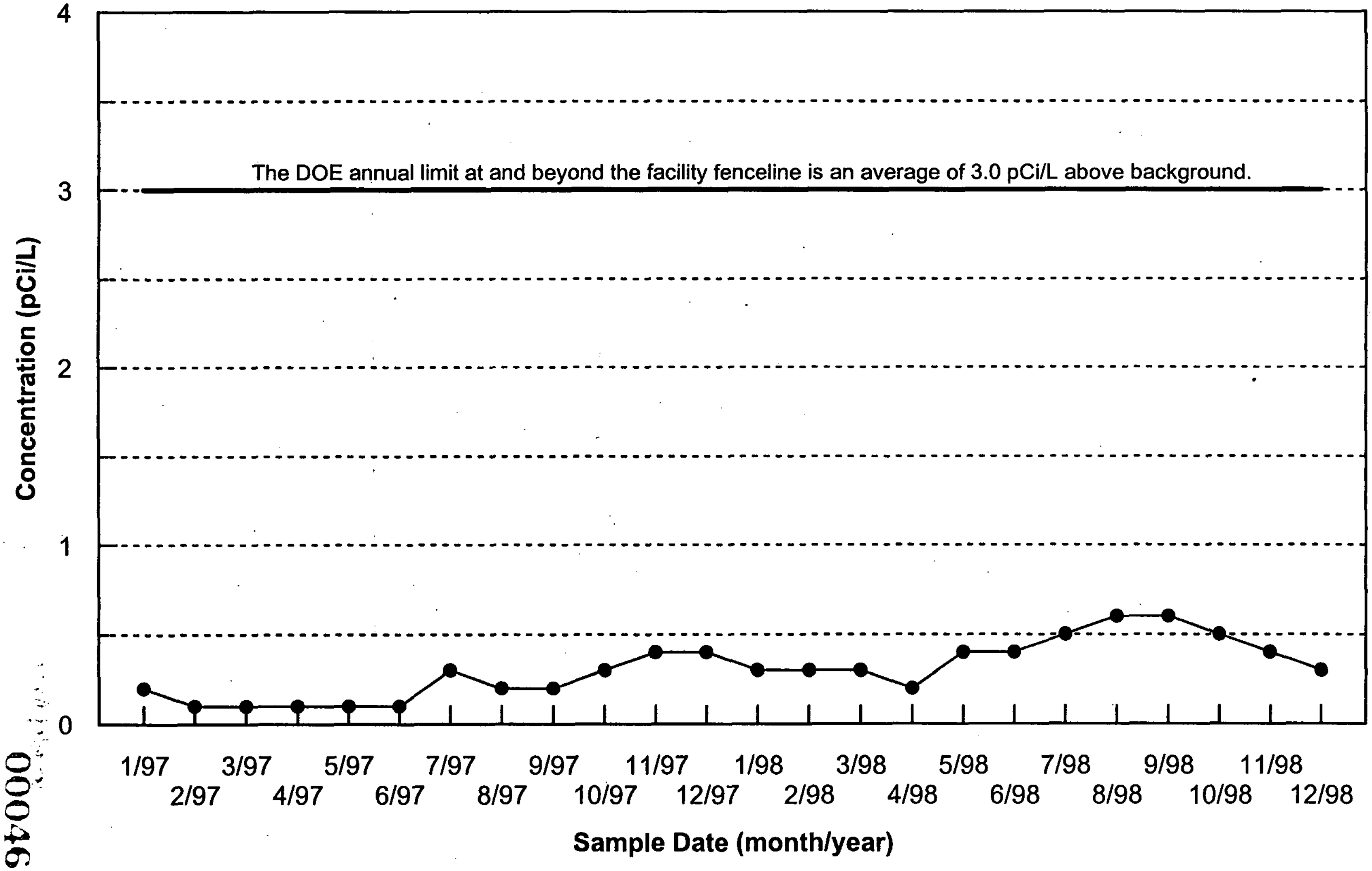

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FIGURE C.2-9. 1997 AND 1998 MONTHLY AVERAGE RADON CONCENTRATION FOR AMS-16 (BKGD-02)

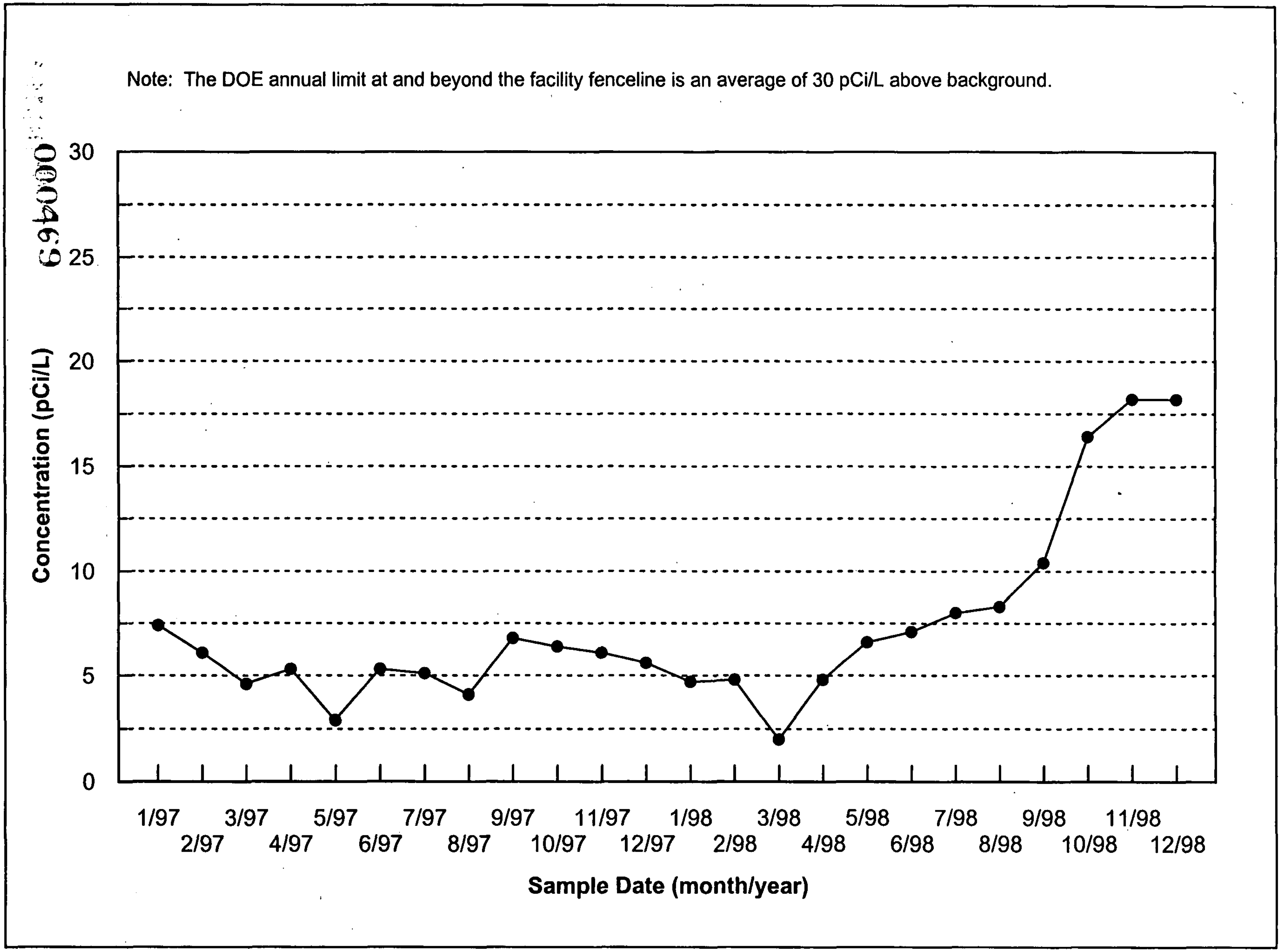

FIGURE C.2-10. 1997 AND 1998 MONTHLY AVERAGE RADON CONCENTRATION FOR KNE

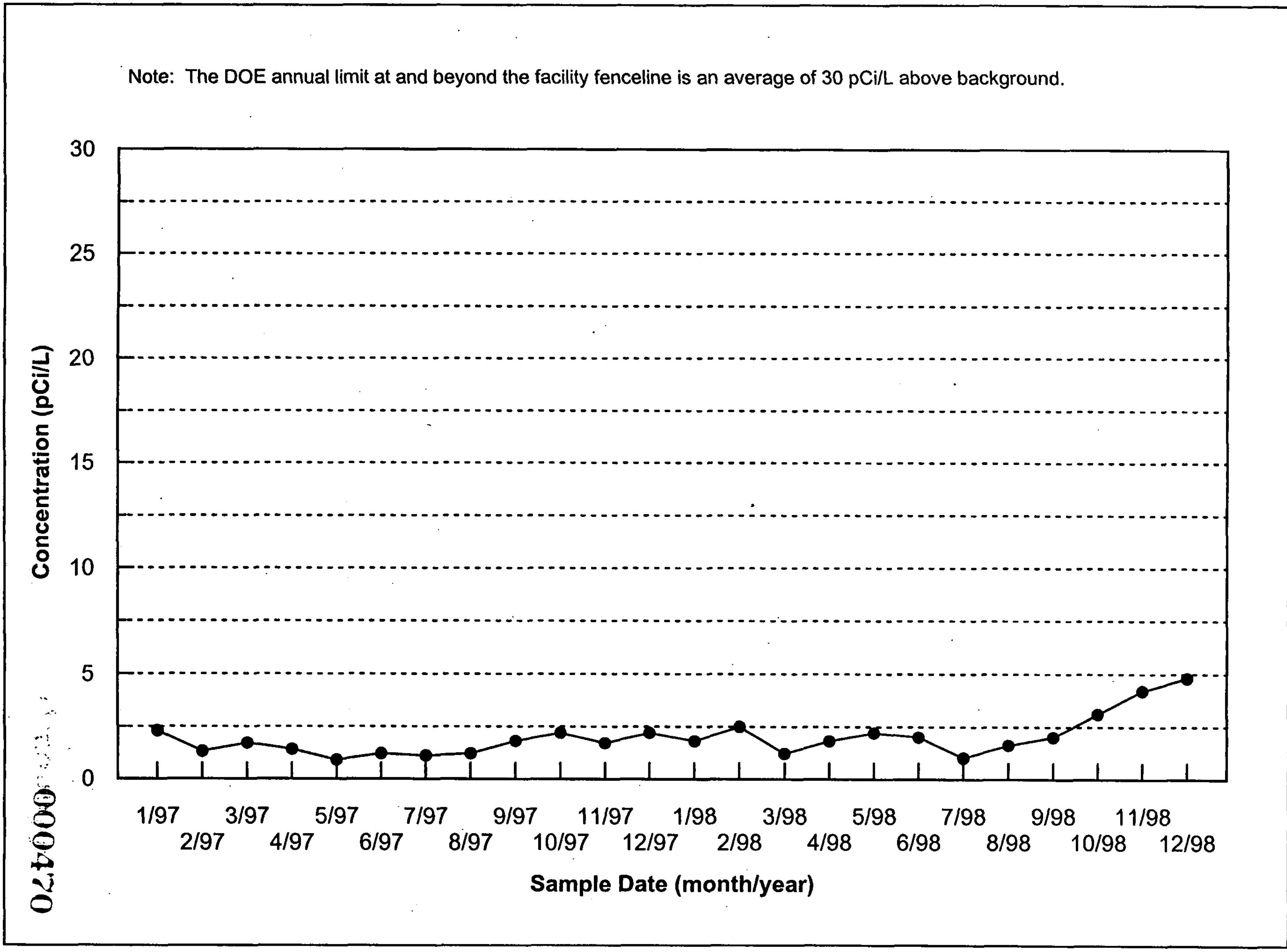

FIGURE C.2-11. 1997 AND 1998 MONTHLY AVERAGE RADON CONCENTRATION FOR KNW

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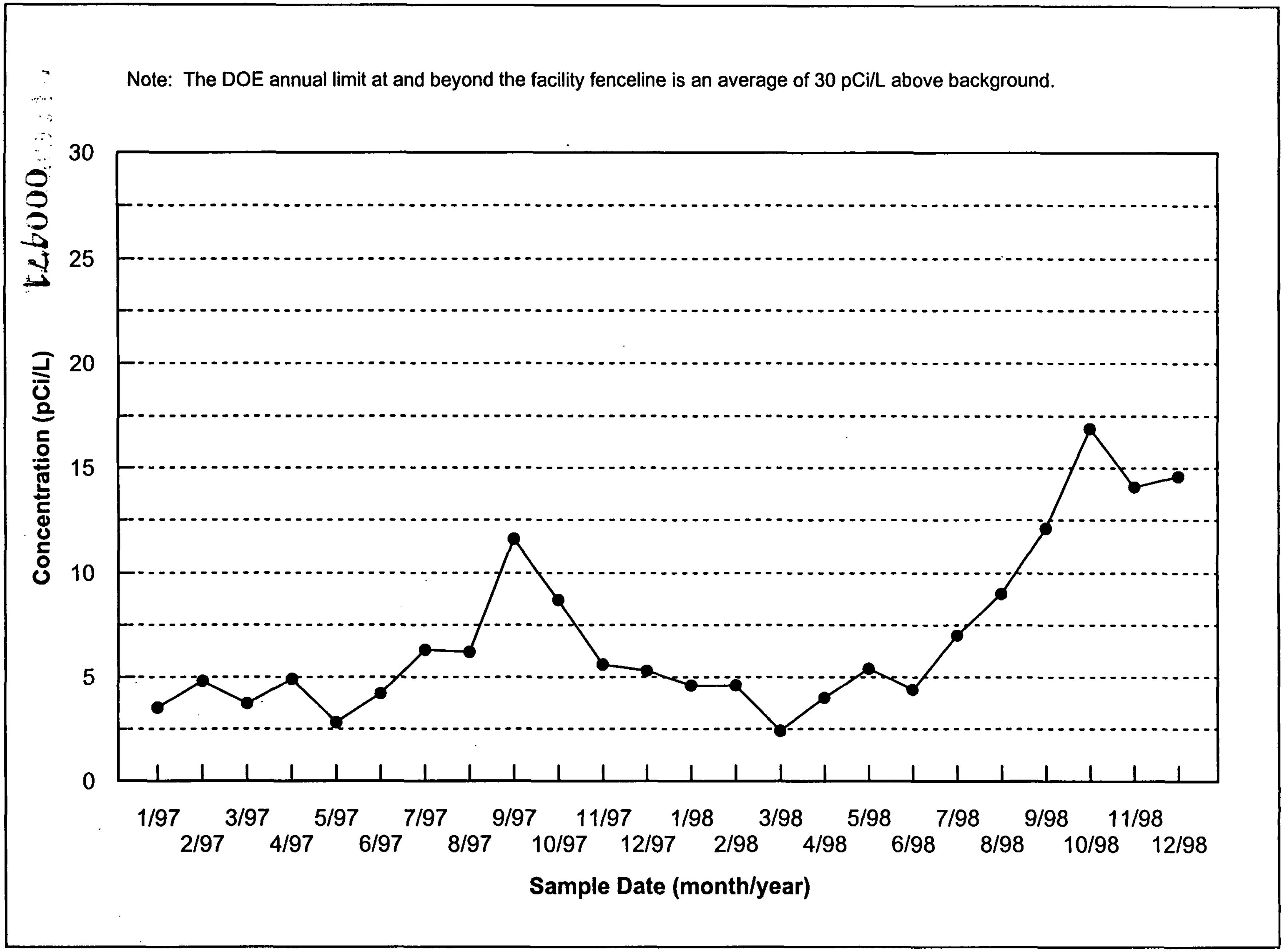

FIGURE C.2-12. 1997 AND 1998 MONTHLY AVERAGE RADON CONCENTRATION FOR KSE

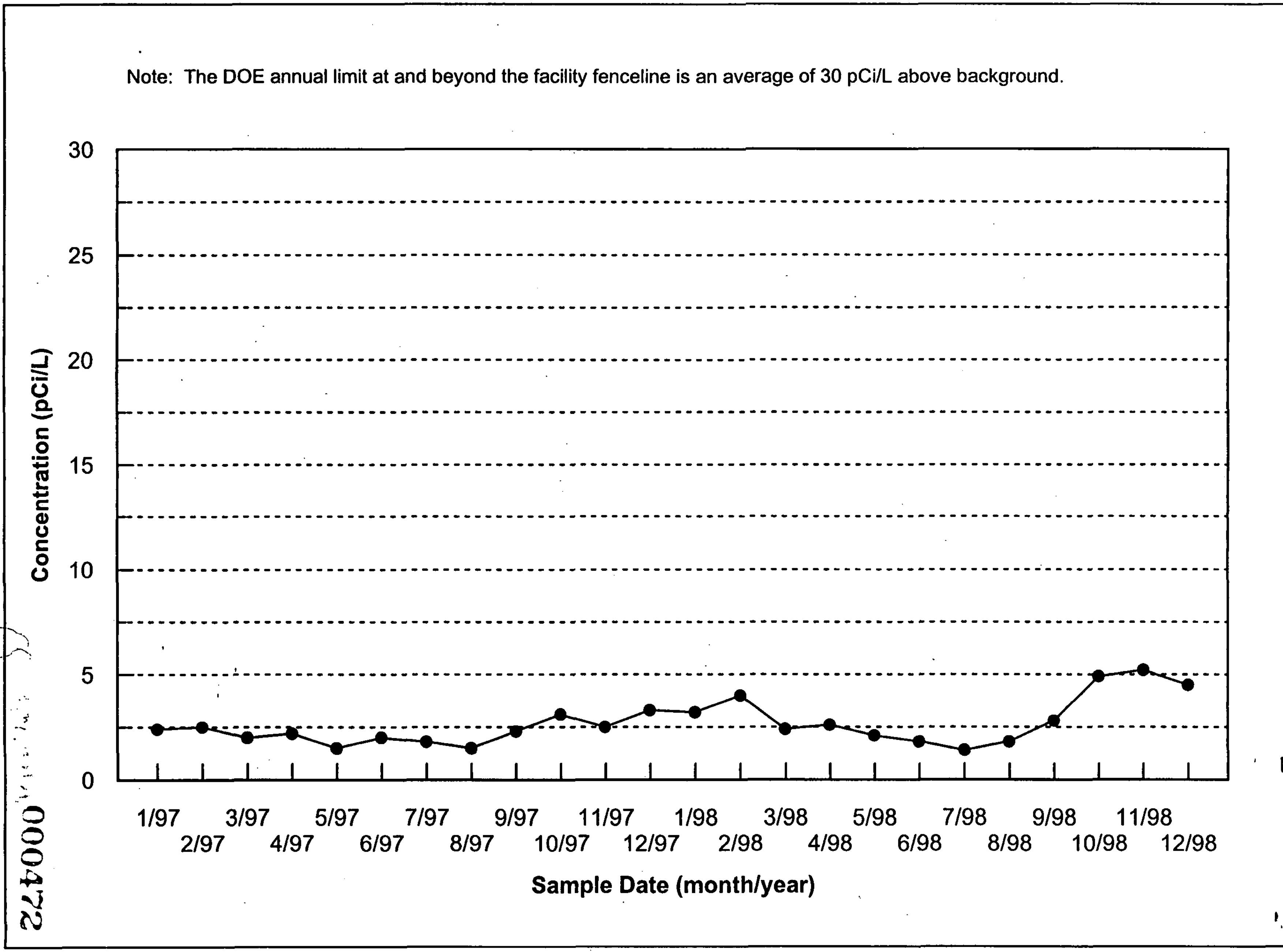

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FIGURE C.2-13. 1997 AND 1998 MONTHLY AVERAGE RADON CONCENTRATION FOR KSW

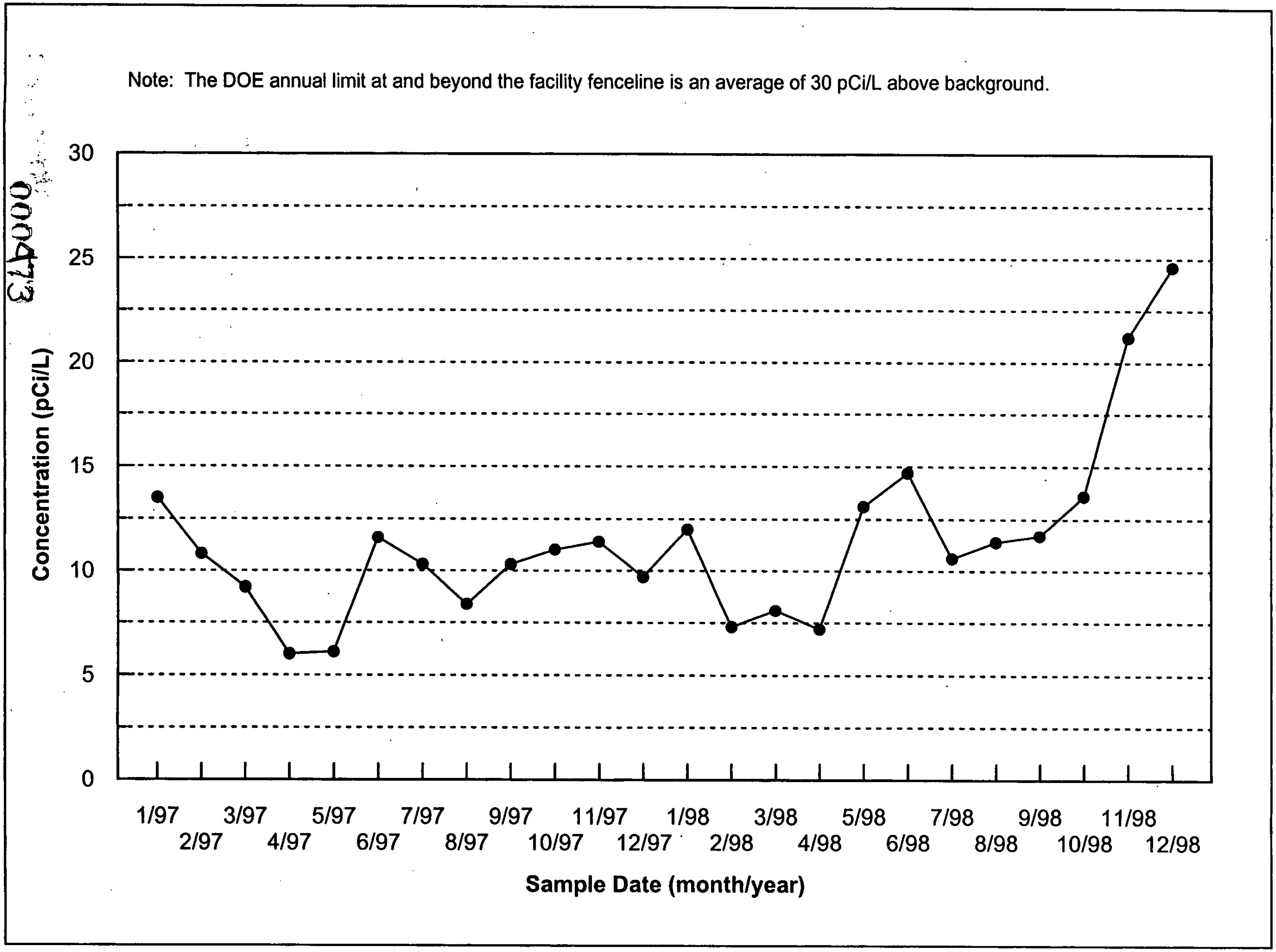

FIGURE C.2-14. 1997 AND 1998 MONTHLY AVERAGE RADON CONCENTRATION FOR KTOP

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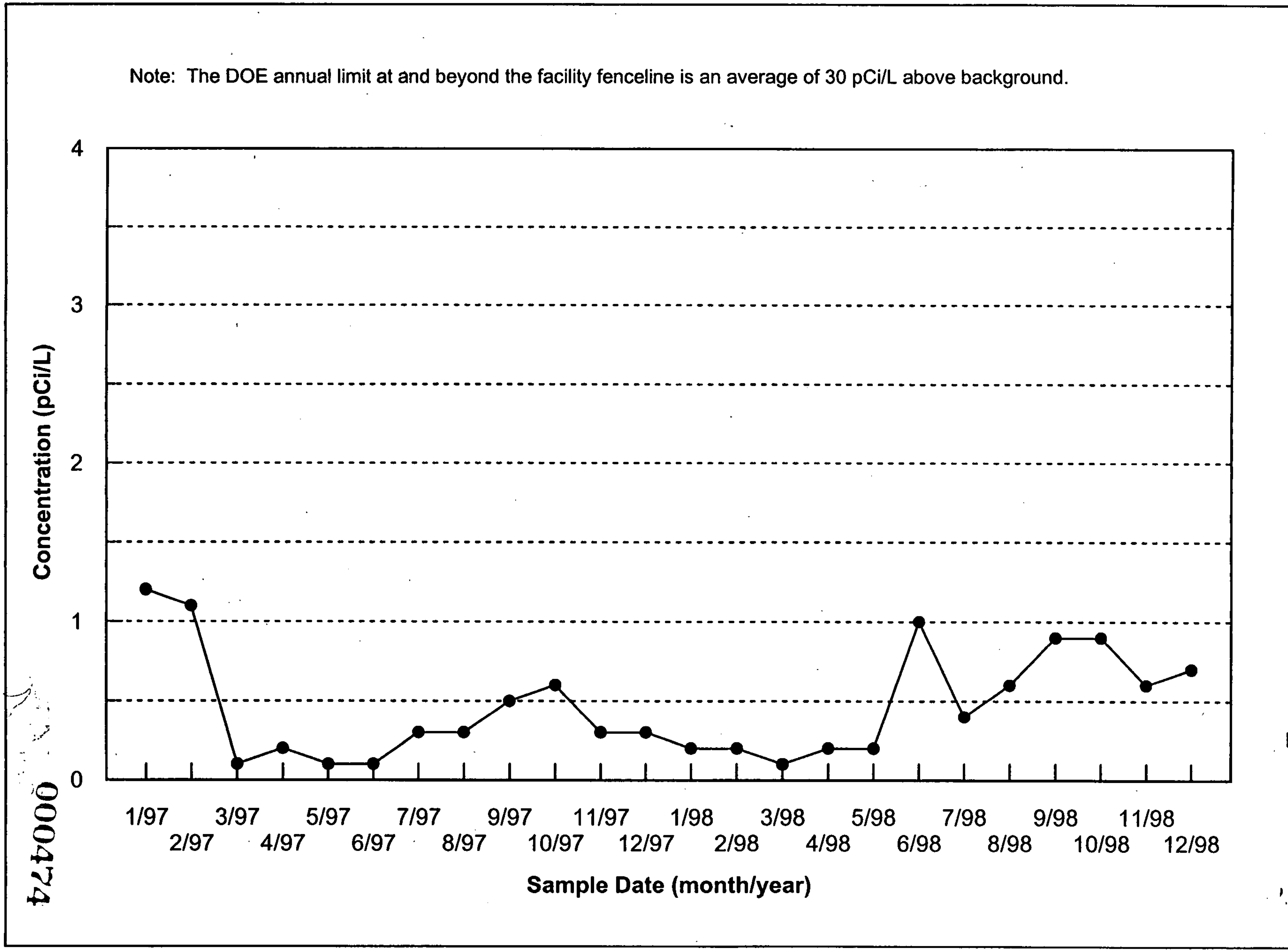

FIGURE C.2-15. 1997 AND 1998 MONTHLY AVERAGE RADON CONCENTRATION FOR PILOT PLANT WAREHOUSE

Note: The DOE annual limit at and beyond the facility fenceline is an average of 30 pCi/L above background.

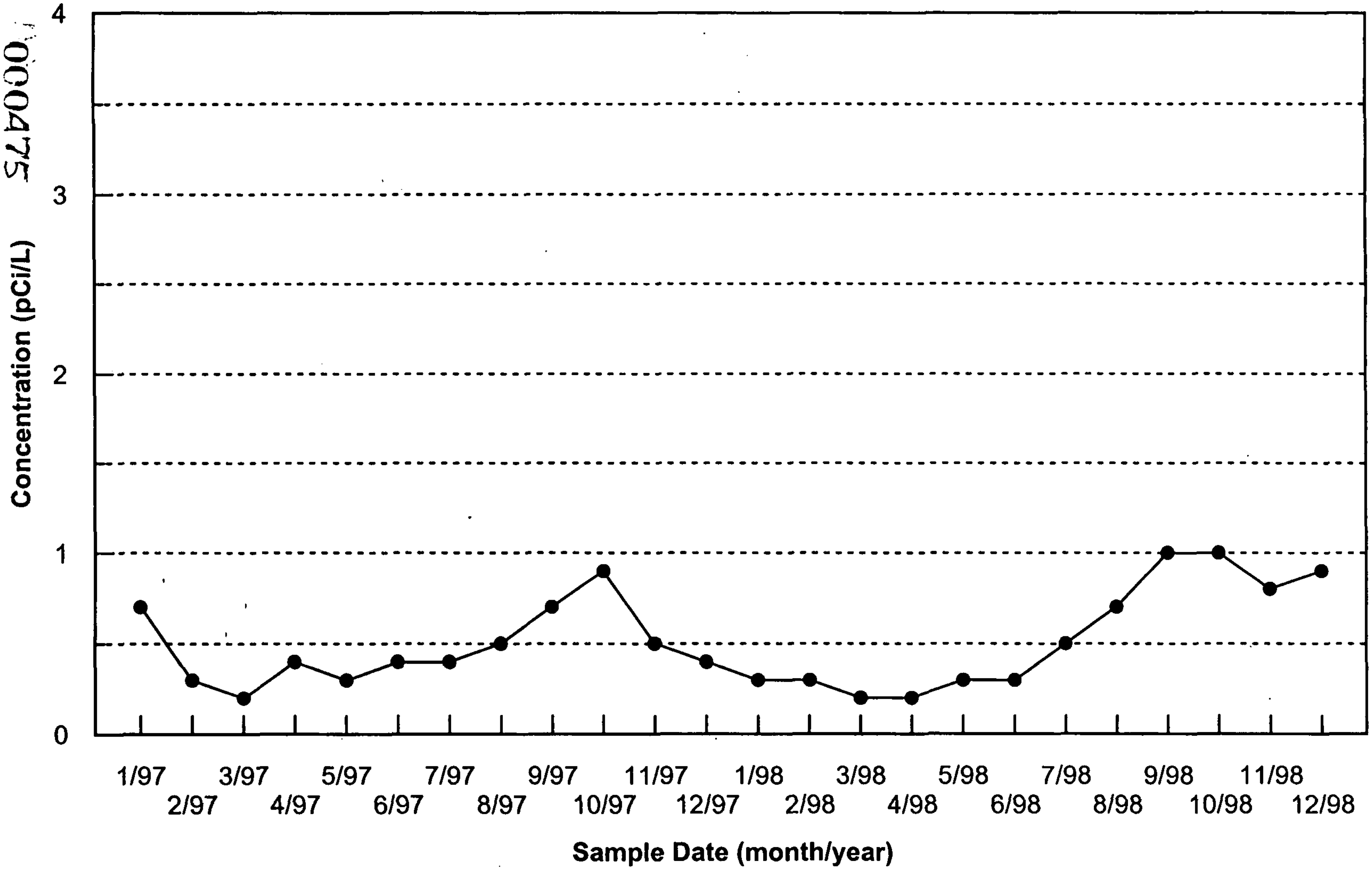

FIGURE C.2-16. 1997 AND 1998 MONTHLY AVERAGE RADON CONCENTRATION FOR PIT 5

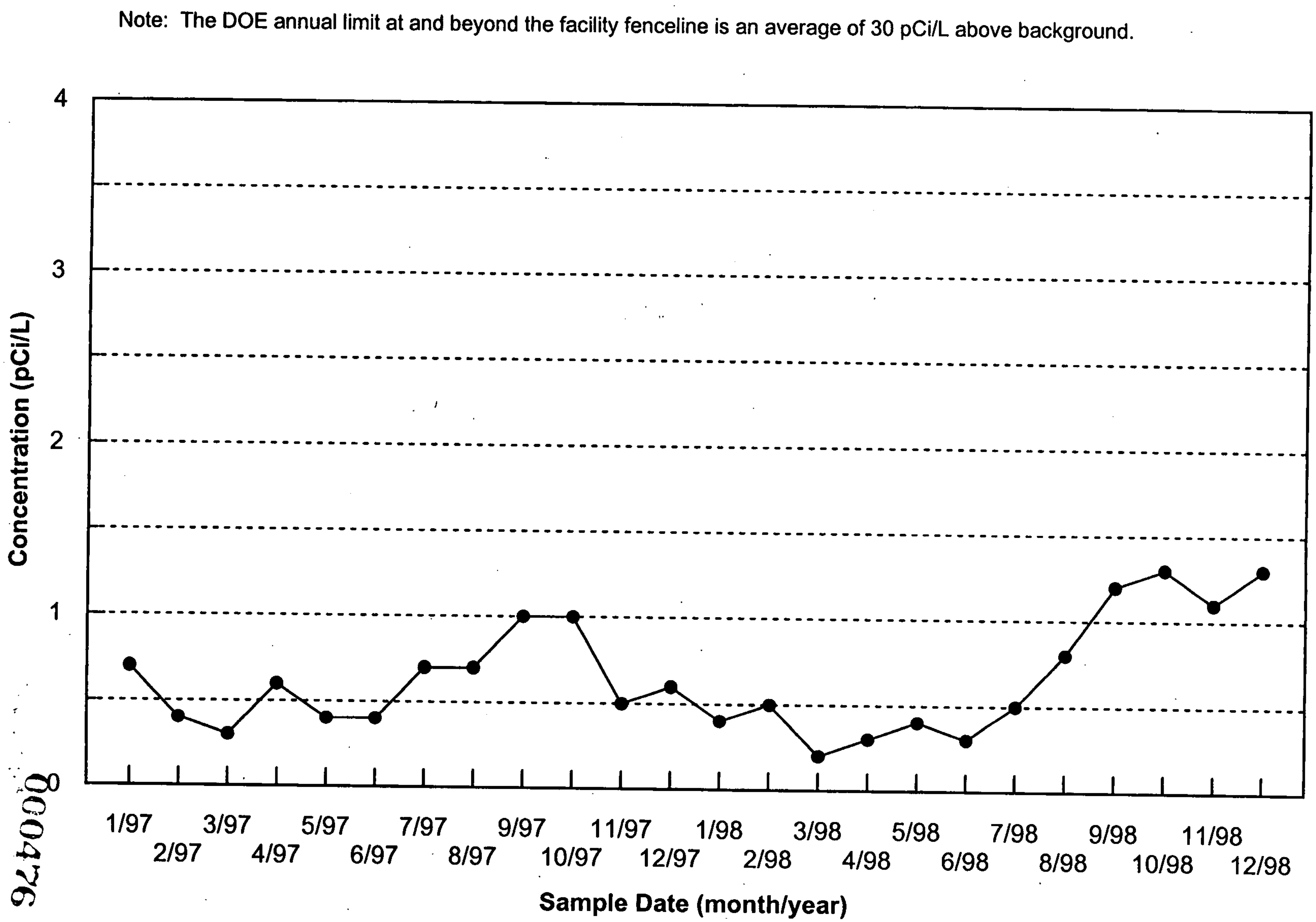

FIGURE C.2-17. 1997 AND 1998 MONTHLY AVERAGE RADON CONCENTRATION FOR RALLY POINT 4

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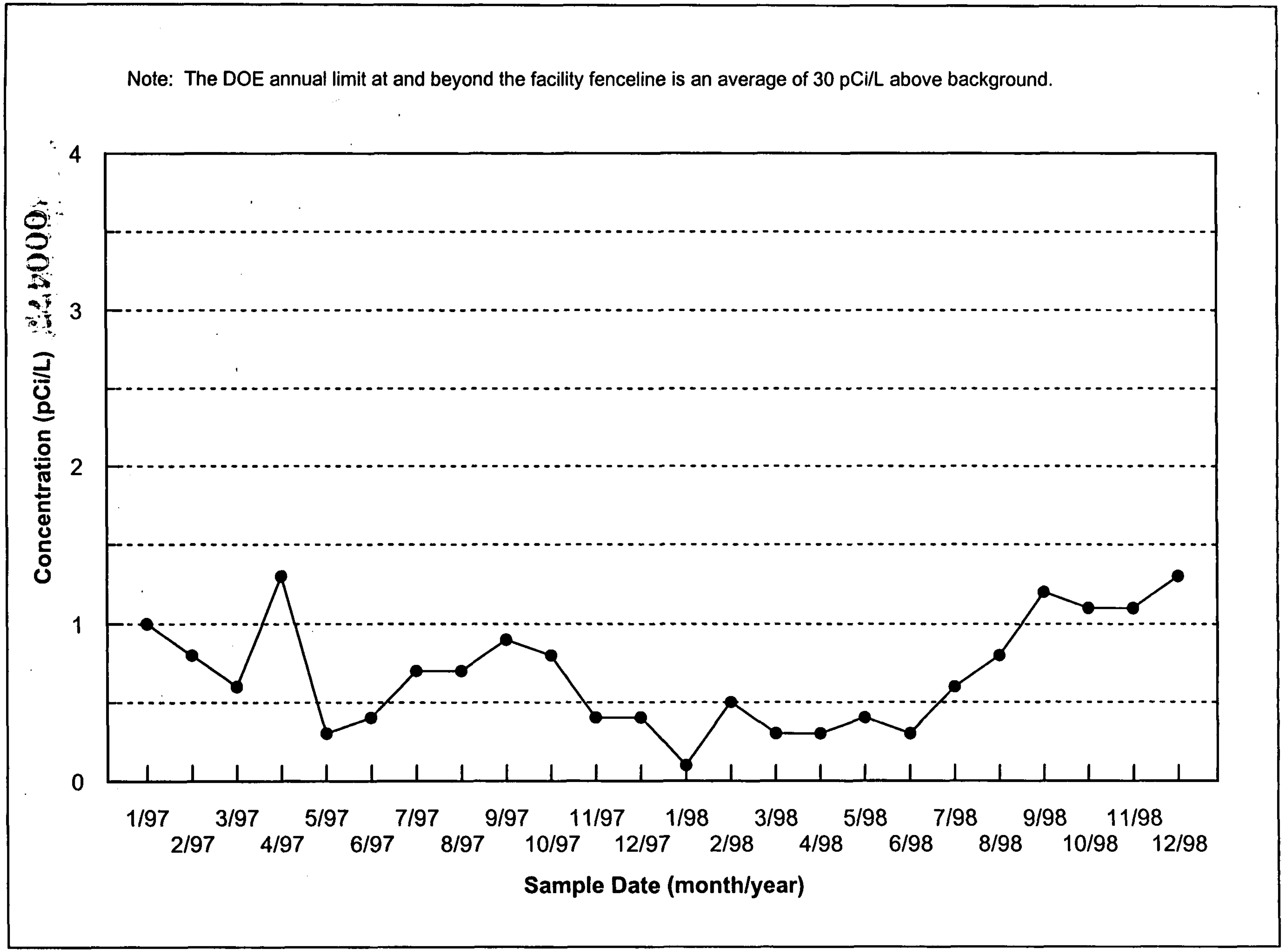

FIGURE C.2-18. 1997 AND 1998 MONTHLY AVERAGE RADON CONCENTRATION FOR THE SURGE LAGOON

Note: The DOE annual limit at and beyond the facility fenceline is an average of 30 pCi/L above background.

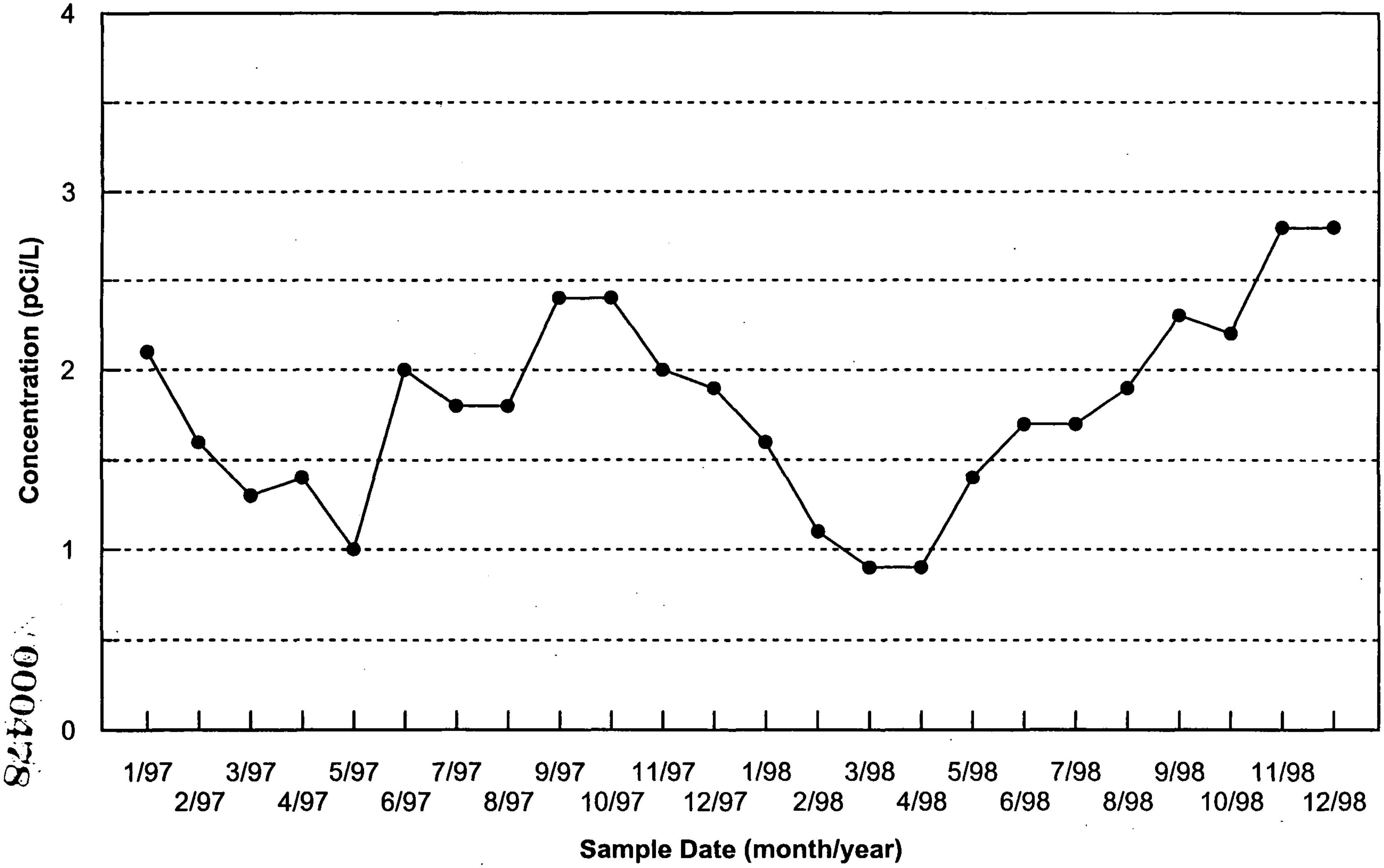

FIGURE C.2-19. 1997 AND 1998 MONTHLY AVERAGE RADON CONCENTRATION FOR T28

Note: The DOE annual limit at and beyond the facility fenceline is an average of 30 pCi/L above background.

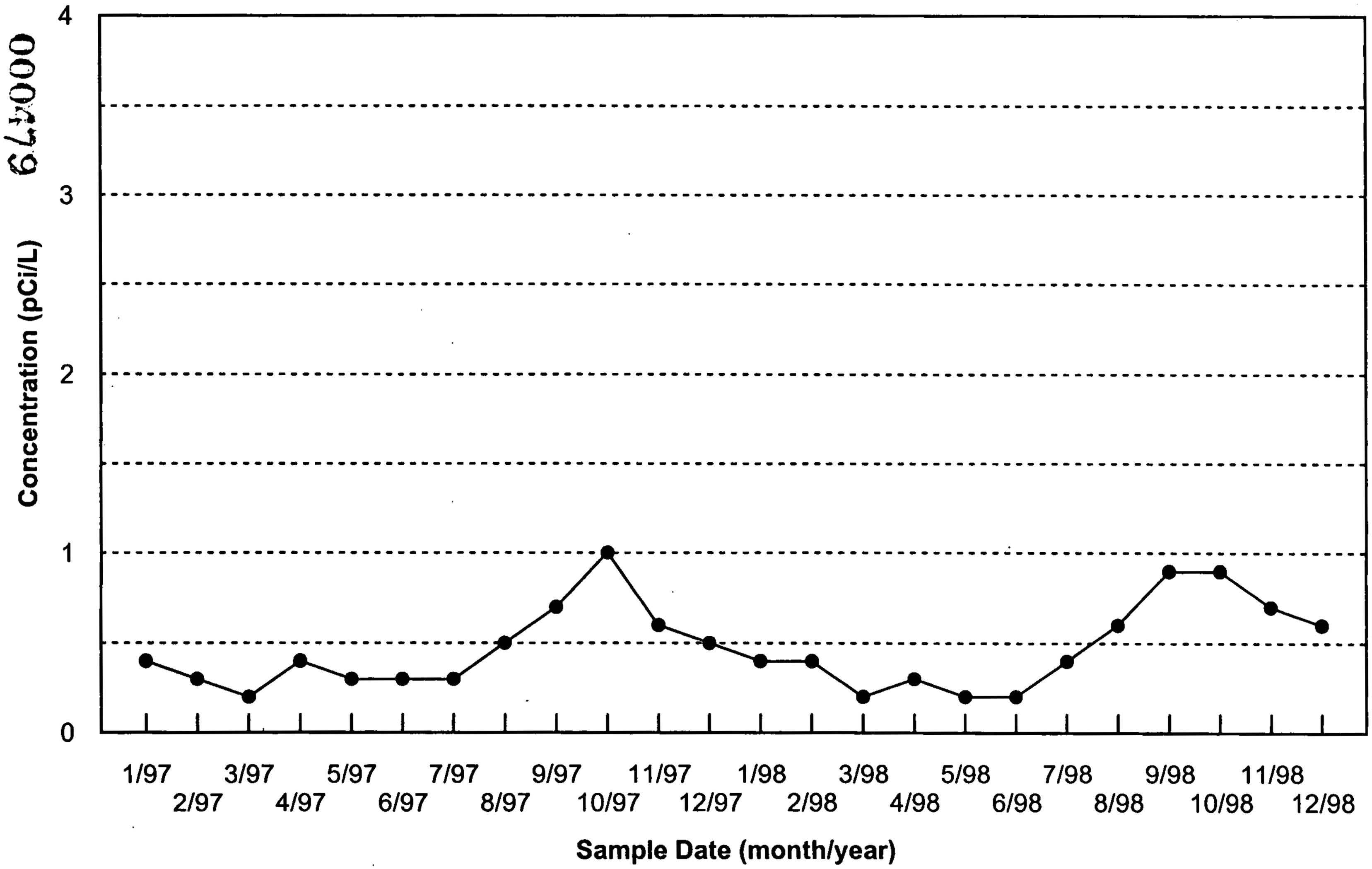

FIGURE C.2-20. 1997 AND 1998 MONTHLY AVERAGE RADON CONCENTRATION FOR WP-17A

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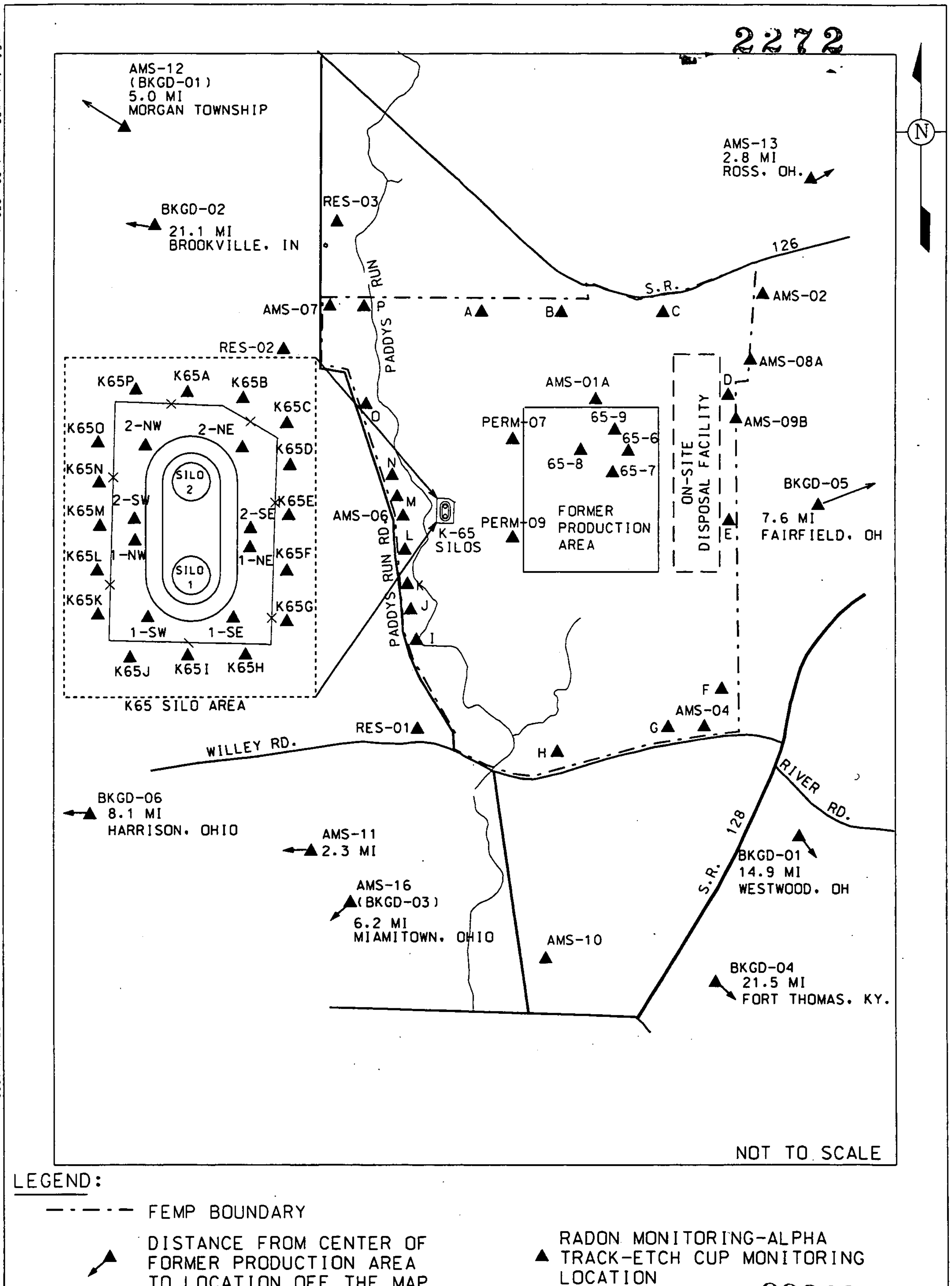

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FIGURE C.2-21. RADON MONITORING-ALPHA TRACK-ETCH CUP MONITORING LOCATIONS

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ATTACHMENT C.3

DIRECT RADIATION

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ATTACHMENT C.3

Direct radiation measurements were conducted at 38 locations using thermoluminescent dosimeters (TLDs) during 1998. Figure C.3-1 identifies all TLD locations for 1998. Three TLDs are deployed at each location and the measurements from each TLD are averaged on a quarterly basis. These measurements are used to track and evaluate environmental direct radiation levels at locations near the K-65 Silos, other selected on-site locations, at the site fenceline, and at off-site and background locations.

Table C.3-1 provides the data collected and averaged for four quarters in 1998. For comparison, annual average data collected during 1997 has been included. As discussed in Chapter 5 of this 1998 Integrated Site Environmental Report, an increasing trend has been identified at the locations around the K-65 Silos 1 and 2 exclusion fence (locations 22 through 26) as well as at the site fenceline near the K-65 Silos (location 6). The increasing direct radiation levels in these areas are the result of the increasing radon (and associated decay products) concentrations in head space of the K-65 Silos 1 and 2. While the 1998 results are still less than the levels observed prior to the addition of bentonite to the silos in 1991, these data are being considered in the design of the Advanced Waste Retrieval Project for K-65 Silos 1 and 2 which will address both radon and direct radiation concerns associated with the K-65 waste materials. The radon control system associated with this project is scheduled to be operational in 2001. Monitoring for direct radiation will continue during 1999 as specified in the IEMP.

TABLE C.3-1

DIRECT RADIATION (TLD) MEASUREMENTS

Location[a]	Direct Radiation ± Uncertainty[b] (mrem) Summary of 1998 Results[c]	Summary of 1997 Results
Fenceline		
2	74 ± 12	72 ± 10
3	67 ± 11	65 ± 9.0
4	66 ± 11	65 ± 9.1
5	68 ± 11	67 ± 9.3
6	84 ± 14	79 ± 11
7	69 ± 11	65 ± 9.0
8A	75 ± 12	74 ± 10
9C	79 ± 13	79 ± 11[d]
13	74 ± 12	71 ± 9.9
14	77 ± 12	70 ± 9.8
15	79 ± 13	74 ± 10
16	81 ± 13	77 ± 11
17	73 ± 12	70 ± 9.7
34[e]	75 ± 12	73 ± 14
35[e]	70 ± 11	67 ± 13
36[e]	65 ± 11	60 ± 12
37[e]	77 ± 12	75 ± 14
38[e]	63 ± 10	60 ± 11
39[e]	79 ± 13	76 ± 14
40[e]	67 ± 11	65 ± 12
41[e]	73 ± 12	70 ± 13
Min.	**63 ± 10**	**60 ± 12**
Max.	**84 ± 14**	**79 ± 11[d]**
On Site		
1B	89 ± 14	84 ± 12
22	776 ± 125	778 ± 108
23	817 ± 132	712 ± 99
24	632[f] ± 102	512 ± 71
25	698 ± 113	641 ± 89
26	496 ± 80	425 ± 59
32	55 ± 9.0	54 ± 7.5
Min.	**55 ± 9.0**	**54 ± 7.5**
Max.	**817 ± 132**	**778 ± 108**

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TABLE C.3-1
(Continued)

	Direct Radiation ± Uncertainty[b] (mrem)	
Location[a]	Summary of 1998 Results[c]	Summary of 1997 Results
Off Site		
10	56 ± 9.1	52 ± 7.3
11	69 ± 11	65 ± 9.1
12	62 ± 10	59 ± 8.2
30	62 ± 9.9	59 ± 8.2
Min.	**56 ± 9.1**	**52 ± 7.3**
Max.	**69 ± 11**	**65 ± 9.1**
Background		
18	77 ± 13	74 ± 10
19	65 ± 10	60 ± 8.4
20	61 ± 9.9	57 ± 8.0
21	69[g] ± 11	67 ± 9.4
27	64 ±10	60 ± 8.3
33	68 ± 11	65 ± 9.1
Min.	**61 ± 9.9**	**57 ± 8.0**
Max.	**77 ± 13**	**74 ± 10**

[a]See Figure C.3-1
[b]Associated laboratory uncertainty are estimates of accuracy and precision.
[c]Uncertainty terms for second quarter are based on average uncertainty from previous quarters. Due to an error in the laboratory, the TLDs used to determine the uncertainty were not processed.
[d]Locations 9B and 9C are combined to determine 1997 year-end results.
[e]1997 data for locations 34 through 41 are calculated from fourth quarter (October through December) measurements. These locations were established during the fourth quarter of 1997.
[f]Direct radiation and uncertainty value includes estimated second quarter results which were based on first quarter results.
[g]Direct radiation and uncertainty value includes estimated fourth quarter data based on the average of the previous three quarters.

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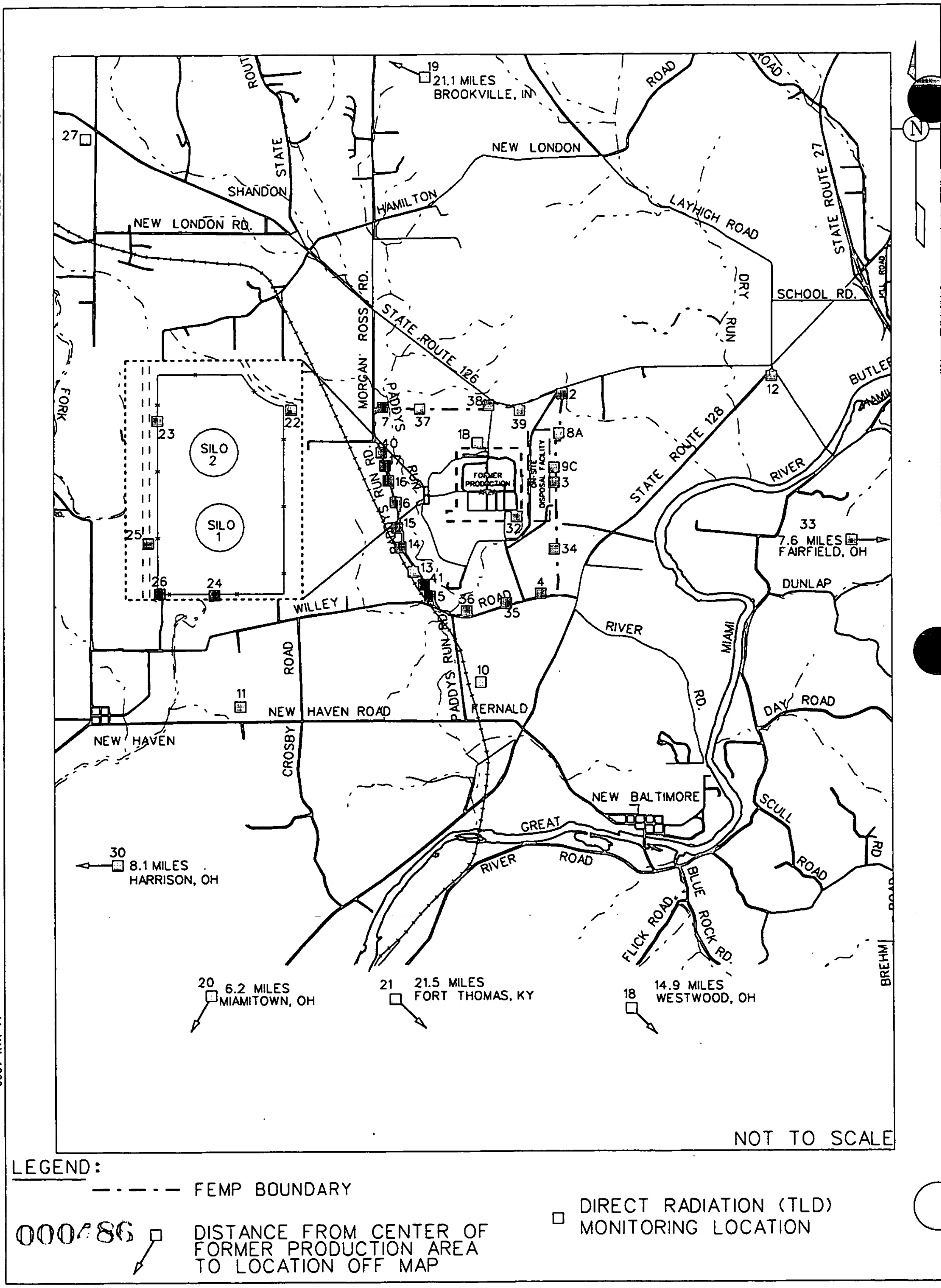

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FIGURE C.3-1. DIRECT RADIATION (THERMOLUMINESCENT DOSIMETERS) MONITORING LOCATIONS

Attachment C.4

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ATTACHMENT C.4

METEOROLOGICAL DATA

ATTACHMENT C.4

Meteorological data were recorded at the site meteorological station during 1998. Meteorological data recovery for 1998 was 99.6 percent. As shown in Table C.4-1, data from the 10-meter and 60-meter elevations are reported here as a monthly maximum hourly average and a monthly minimum hourly average. Ambient air temperature is provided which includes monthly average temperature, and daily maximum and minimum values per month. The precipitation totals include the monthly total and daily maximum values recorded during 1998. Table C.4-2 presents the 1998 average wind speed and percent of time from direction at the 10-meter and 60-meter elevations.

For 1998 the highest hourly average wind speed at the 10-meter elevation was measured at 24.8 miles per hour during March 1998. At the 60-meter elevation, the highest hourly average wind speed was measured at 38.0 miles per hour during June 1998. The prevailing winds were from directions west through south-southwest approximately 40 percent of the time at both elevations. The winds out of the southeast were least predominant, occurring less than three percent of the time.

Total precipitation for 1998 measured 48.43 inches which is 7.57 inches above the annual average precipitation of 40.86 inches for the period 1948 through 1997. For comparison, the total annual precipitation in 1997 was 40.1 inches. The highest amount of precipitation was measured during April 1998 (9.37 inches). The daily maximum amount of precipitation was recorded in July 1998 (3.83 inches).

The monthly average temperatures during 1998 ranged from 36.8 degrees Fahrenheit (°F) in January to 74.2°F in August. The coldest day was 6.9°F recorded in January and the warmest day was 93.2°F recorded in September.

TABLE C.4-1

1998 METEOROLOGICAL DATA

	Units	January	February	March	April	May	June	July	August	September	October	November	December
10-Meter Wind Speed													
Maximum hourly average	mph	14.2	14.9	24.8	19.1	13.9	22.8	11.9	13.2	14.6	13.5	18.8	17.1
	kph	22.9	24.0	39.9	30.7	22.4	36.7	19.2	21.2	23.5	21.7	30.3	27.5
Minimum hourly average	mph	0.8	0.6	0.7	0.7	0.5	0.6	0.6	0.4	0.4	0.2	0.4	0.2
	kph	1.3	1.0	1.1	1.1	0.8	1.0	1.0	0.6	0.6	0.3	0.6	0.3
60-Meter Wind Speed													
Maximum hourly average	mph	21.6	22.3	33.1	26.2	21.0	38.0	20.7	20.9	20.4	18.8	30.9	25.2
	kph	34.8	35.9	53.3	42.2	33.8	61.2	33.3	33.6	32.8	30.3	49.7	40.6
Minimum hourly average	mph	0.6	0.2	0.2	0.5	0.5	0.9	0.4	0.4	0.7	0.5	0.6	0.7
	kph	1.0	0.3	0.3	0.8	0.8	1.4	0.6	0.6	1.1	0.8	1.0	1.1
Ambient Air Temperature													
Average	°F	36.8	38.1	43.9	52.6	66.3	70.5	73.9	74.2	69.7	54.6	45.7	38.0
	°C	2.7	3.4	6.6	11.4	19.1	21.4	23.3	23.4	20.9	12.6	7.6	3.3
Maximum daily	°F	64.3	66.6	81.8	73.5	87.9	91.7	91.9	92.9	93.2	80.7	69.8	72.8
	°C	17.9	19.2	27.7	23.1	31.1	33.2	33.3	33.8	34.0	27.1	21.0	22.7
Minimum daily	°F	6.9	12.9	9.5	25.9	42.7	41.0	56.2	53.3	43.6	28.8	22.0	9.2
	°C	-13.9	-10.6	-12.5	-3.4	5.9	5.0	13.4	11.8	6.4	-1.8	-5.6	-12.7
Precipitation													
Monthly total	in	3.33	2.04	2.70	9.37	4.8	8.6	5.39	1.14	2.3	3.11	2.0	3.65
	cm	8.46	5.18	6.86	23.8	12.19	21.84	13.69	2.9	5.84	7.9	5.08	9.27
Daily maximum	in	1.96	0.54	0.62	2.49	1.39	1.74	3.83	0.38	1.28	1.25	0.63	3.0
	cm	4.98	1.37	1.57	6.32	3.53	4.42	9.73	0.97	3.25	3.18	1.60	7.62

TABLE C.4-2

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1998 AVERAGE WIND SPEED AND PERCENT OF TIME FROM DIRECTION AT TEN AND SIXTY METERS ABOVE GROUND LEVEL

Direction	Average 10-meter Wind Speed (mph)	Average 10-meter Wind Speed (kph)	Percent of Time from Direction	Average 60-meter Wind Speed (mph)	Average 60-meter Wind Speed (kph)	Percent of Time from Direction
N	5.5	8.8	3.7	7.9	12.7	4.6
NNE	6.1	9.8	4.3	7.7	12.4	5.6
NE	5.6	9.0	4.6	6.9	11.1	7.7
ENE	5.3	8.5	7.9	7.4	11.9	8.6
E	3.6	5.8	5.1	6.3	10.1	3.7
ESE	3.1	5.0	2.4	5.9	9.5	2.6
SE	3.2	5.1	2.2	6.4	10.3	2.4
SSE	3.7	6.0	3.2	6.6	10.6	3.2
S	5.2	8.4	5.3	8.7	14.0	6.4
SSW	6.4	10.3	10.6	10.1	16.3	11.5
SW	4.9	7.9	12.5	8.3	13.4	11.9
WSW	3.7	6.0	9.8	7.8	12.6	9.7
W	3.6	5.8	8.8	7.4	11.9	6.7
WNW	3.8	6.1	7.8	7.5	12.1	5.3
NW	4.0	6.4	7.1	7.6	12.2	5.7
NNW	4.8	7.7	4.9	7.7	12.4	4.5

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Appendix D

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APPENDIX D

1998 NATIONAL EMISSIONS STANDARDS FOR HAZARDOUS AIR POLLUTANTS (NESHAP)

ANNUAL REPORT FOR THE

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

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NATIONAL EMISSIONS STANDARDS FOR HAZARDOUS AIR POLLUTANTS (NESHAP) ANNUAL REPORT

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

MAY 1999

U.S. DEPARTMENT OF ENERGY
FERNALD AREA OFFICE

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NATIONAL EMISSIONS STANDARDS FOR HAZARDOUS AIR POLLUTANTS (NESHAP) ANNUAL REPORT

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

MAY 1999

U.S. DEPARTMENT OF ENERGY
FERNALD AREA OFFICE

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FINAL

U.S. Department of Energy
Radionuclide Air Emissions Annual Report
(under Subpart H of 40 CFR Part 61)
Calendar Year 1998

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Site Name: Fernald Environmental Management Project (FEMP), Fernald, Ohio

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Site Information

Operating Contractor: Fluor Daniel Fernald

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Cincinnati, Ohio 45253-8704 (mailing address)

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ALARA	As Low As Reasonably Achievable
AMS	air monitoring station
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FEMP	Fernald Environmental Management Project
IEMP	Integrated Environmental Monitoring Plan
mrem	millirem
NESHAP	National Emission Standards for Hazardous Air Pollutants

PREAMBLE

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On May 23, 1997, the U.S. Department of Energy (DOE) Fernald Environmental Management Project (FEMP) submitted a written request to the U.S. Environmental Protection Agency (EPA) for approval to use an alternate approach for demonstrating compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP), Subpart H requirements (DOE 1997b). The alternate approach utilizes environmental measurements of airborne radionuclide concentrations (as provided for under 40 Code of Federal Regulations [CFR] 61.93[b][5]) rather than air dispersion modeling to demonstrate that radionuclide emissions resulting from FEMP operations remain below the annual NESHAP Subpart H standard. The request for approval of the alternative approach was driven by the recognition that the dominant sources of radiological emissions at the FEMP had changed as the mission of the FEMP changed from uranium metal production (which ended in 1989) to environmental remediation. During production, the primary emission sources from the facility were point sources (stacks and vents); however, under the current mission of full scale environmental remediation, the dominant emission sources are fugitive emissions from diffuse sources (i.e., large scale excavations, wind erosion from stockpiled materials, and decontamination and dismantling projects, etc.). Because there is a high degree of uncertainty associated with modeling fugitive emissions, environmental measurements were proposed as an alternative to provide a more accurate assessment of FEMP emissions.

On August 11, 1997, the EPA granted approval to use environmental measurements as an alternative methodology for demonstrating NESHAP compliance (EPA 1997). 1998 was the first year the FEMP utilized environmental measurements for compliance purposes.

SUMMARY

For 1998, the maximum effective dose equivalent from emissions of radionuclides to the ambient air, based on radionuclide measurements at the FEMP fenceline, is estimated to be 0.26 millirem (mrem) (2.6E-03 mSv), which is in compliance with the Subpart H standard of 10 mrem. This estimation is based on the FEMP's radiological air particulate monitoring program which consists of a network of high volume air monitoring stations (AMS) operated continuously during the year at the FEMP facility fenceline and background locations.

SECTION I: FACILITY INFORMATION

A. Site Description

The FEMP is located on a 1,050 acre (425 hectare) area approximately 17 miles (27 km) northwest of Cincinnati, Ohio. The former production area covers approximately 136 acres (55 hectares) in the center of the FEMP. The facility is sited just north of the small farming community of Fernald, Ohio.

The area immediately surrounding the FEMP is primarily rural in nature, characterized by the predominance of agriculture, with some light industry and private residences. The FEMP is located on a relatively level plain, outside of the 500-year flood plain of the Great Miami River, in an ancestral river valley known as the New Haven Trough.

The climate is characterized as continental, with average temperatures ranging from approximately 29°F (-1.7°C) in January, to 76°F (24.4°C) in July. Average annual precipitation is approximately 41 inches (102 cm) per year. Prevailing wind flow is from the south-southwest.

For 37 years, the former Feed Materials Production Center (Fernald site) produced uranium metals for DOE and its predecessors. On July 10, 1989, uranium metals production was suspended. Management responsibilities of the Fernald site were transferred from the Defense Programs organization to the DOE's Office of Environmental Restoration and Waste Management.

Currently, most activities at the FEMP are conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). These activities include sample analysis, waste characterization, the management, treatment, storage, and disposal of hazardous, mixed, low-level and solid wastes, and the decontamination and cleanup of radioactively contaminated buildings, equipment, soils, and waters. The site also manages thorium wastes, and K-65 Silo waste material which contains radium and produces radon gas.

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B. Source Descriptions

The majority of the airborne emissions at the FEMP consist of uranium and uranium compounds. Thorium, radium-226, and the radioactive decay products of uranium and thorium form the balance of airborne emissions.

1998 radionuclide emission sources at the FEMP included:

- Plant 6*: Emissions from T-Hopper repackaging operations
- Plant 8: Shot blasting demonstrations
- Plant 9: Fugitive emissions generated from the Thorium/Plant 9 Complex above-grade decontamination and dismantlement project
- Building 11*: Emissions from the laundry facilities resulting from the processing of contaminated clothing used at the FEMP, and from the respirator washing facility located in the building
- Building 15*: Emissions from laboratory operations
- Building 51: Emissions from the advanced wastewater treatment facility
- Building 53: Emissions from laboratory operations
- Building 65: Emissions from thorium repackaging operations
- Building 68: Decontamination of steel rails, angle bar, and tie plates of existing railroad tracks
- Building 71*: Emissions from material sorting and repackaging operations
- Building 78: Emissions from repackaging operations
- Other sources: Fugitive emissions from the decontamination and demolition of the Sewage Treatment Plant Complex, Waste Pit Remedial Action Project, Waste Pit 5, on-site disposal facility cell excavations/ construction, on-site disposal facility Phase 2 borrow area excavations, on-site disposal facility Phase 2 option A borrow area excavations, and various stockpiles (i.e., Fly Ash pile, southern waste units) around the FEMP site, generated via wind erosion, earth moving equipment, and material handling operations.

Note: *Indicates 1998 point sources continuously monitored during process operations. Table D-1 provides a summary of data from point source monitors, and is included as supporting documentation and is not used to demonstrate 40 CFR 61.92 compliance.

All monitored stacks are equipped with a high efficiency particulate air (HEPA) filter used for effluent controls. HEPA filters are 99.97 percent efficient for particles of 0.3 microns or larger. Additionally, HEPA filtration systems are utilized throughout the FEMP in adhering to the As Low As Reasonably Achievable (ALARA) philosophy. In accordance with 40 CFR 61.94 (b)(5), some examples of HEPA used at the FEMP include: vacuum cleaner exhaust controls, negative pressure ventilation controls, venting glove bags and glove boxes, and in general decontamination efforts. Table D-2 is provided to comply with 40 CFR 61.94 (b)(6) which provides the distance from the points of release to the nearest residence, etc. This table is not used to demonstrate compliance with 40 CFR 61.92.

C. Radiological Air Particulate Monitoring Program Description

The FEMP's radiological air monitoring program is defined in the Integrated Environmental Monitoring Plan (IEMP) (DOE 1997a). The program design, as approved by the EPA, is summarized below:

Monitoring Equipment and Locations

- A network of 18 high volume environmental air samplers comprise the FEMP's radiological air particulate monitoring program. The monitors draw air continuously through an 8" × 10" filter at a rate of 40-50 cfm. The AMS contain a flow-rate chart recorder and an hour-meter which provides a record of the monitors operational run-time over the sampling period. Additionally, the samplers are equipped with a flow controller which maintains a constant air flow through the sampler by an electronic probe which automatically adjusts blower/motor speed to correct for variations in line voltage, temperature, pressure, or filter loading.

- The 18 air monitoring stations are divided among on site and background monitoring locations. Sixteen monitors are located on the FEMP fenceline corresponding to the 16 windrose sectors. Two monitors serve as background monitors, located in the predominant upwind directions of the Northwest (3.2 miles from the center of the FEMP) and the Southwest (6.2 miles from the center of the FEMP). The EPA siting criteria (40 CFR 58, Appendix E) were considered when selecting these locations (refer to Figure D-1 for monitoring locations).

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Analytical Regime and Sampling Frequency

The analytical regime and sampling frequency for this program was designed to account for the major contributors to dose as defined in 40 CFR 61.93(b)(5)(ii) for the purpose of demonstrating NESHAP Subpart H compliance.

- Filters are exchanged on a biweekly basis and analyzed for total uranium and total particulates. These data are used to track site emissions routinely throughout the year to ensure emission controls at the FEMP are operating effectively.
- A portion of each biweekly filter is retained and is used to form a quarterly composite sample. The composite sample is analyzed for the radionuclides expected to be the major contributors to dose from site emissions. The results of the quarterly data are used to track compliance against the NESHAP Subpart H standard during the year and for demonstrating compliance at the end of the year.

Isotopes which comprise the quarterly composite analysis were selected based on the following considerations:

- Radionuclides which are stored in large quantities at the FEMP and which will be handled or processed during the remediation effort (uranium, thorium-230, thorium-232, and radium-226)
- Radionuclides which have been the major contributors to dose based on environmental and stack filter measurements (uranium)
- Radionuclides which, due to their concentrations in waste and contaminated soil, will be the major contributors to dose (uranium, thorium-228, and thorium-230).

Uranium-238, thorium-232, and uranium-235 are initial radionuclides in the uranium, thorium, and actinide decay chains, respectively. The majority of uranium and thorium received and processed during the production era of the FEMP had been separated from its decay chain progeny prior to shipment to the FEMP. As a result, decay chain progeny products were not in equilibrium with the parent concentrations. Therefore, a number of progeny radionuclides can conservatively be considered to be present in equilibrium concentrations with their parents. These radionuclides (thorium-234, radium-228, actinium-228, radium-224, and thorium-231) are considered to be in equilibrium with their parent concentrations as measured in the quarterly composites. (Refer to Table D-3 for measured net air concentrations.)

Air Emission Data Reporting

In addition to this report, the biweekly and quarterly composite data associated with this program were tracked and reported to the EPA through IEMP quarterly status reports during 1998. In conjunction with the quarterly reports, all monitoring data were provided to the EPA via electronic media (data disc or CD-ROM) on a quarterly basis.

SECTION II: AIR EMISSIONS DATA

A. Air Monitoring Data Completeness Requirements

During 1998 operational AMS run-time averaged 98.7 percent for the 18 monitors. In general, interuptions in monitor operations that were encountered during 1998 were the result of power failures and/or equipment failures (refer to Table D-4). Other issues effecting data recovery and completeness are summarized below:

- AMS-24 and AMS-25 were modified during the year in an attempt to reduce ambient noise levels in consideration of FEMP stakeholders. The modification consisted of placing rubber mats on the fence around the monitor in order to dampen the noise from the air sampler motor. During a routine field inspection, the EPA determined the modification was unacceptable. The matting had been in place approximately three months. In a letter from the EPA dated December 7, 1998 (EPA 1998) (regarding unauthorized modifications to the two air monitoring stations) EPA stated that the data from the two monitors could not be used for the NESHAP Subpart H compliance demonstration based on the potential impact of the matting on the air monitors operation. Eliminating the AMS-24 and AMS-25 data will not adversely affect the compliance demonstration for the site because these monitors are located primarily upwind of FEMP remediation activities. Figure D-2 contains the 1998 wind rose data at the 10-meter height.

- An unusually high radium-226 analytical result for the third quarter of 1998 was detected at background monitor AMS-16. This data point was rejected because it was not considered reasonable based on historical background radium-226 levels. The use of this unusually high background data would have created a low bias in the net fenceline radium-226 results.

- During the data review and validation process, the following fourth quarter 1998 data were rejected based on performance problems with the off-site laboratory:

  AMS-2: Isotopic thorium (thorium 228, thorium-230, and thorium-232) data were rejected due to low chemical recoveries.

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AMS-8A: Isotopic thorium data were rejected due to low chemical recoveries.

AMS-12: Isotopic uranium (uranium-234, uranium-235/236, and uranium-238) and isotopic thorium data from this background monitor were rejected due to low chemical recoveries.

The effect of rejecting the thorium data from AMS-2 and AMS-8A on the NESHAP compliance demonstration was evaluated. The rejected data were found to have a minimal influence on the compliance demonstration for the following reasons:

- Fourth quarter thorium data at other monitoring locations were consistent with thorium results from the first three quarters of 1998. No significant increase in thorium emissions was detected during the fourth quarter at any other fenceline monitors.
- There were no significant changes in remediation activities conducted during the fourth quarter of 1998 that involved moving, repackaging, or processing thorium wastes.
- Based on 1998 and historical measurements, thorium does not contribute the majority of dose at the fenceline monitors and therefore would not be expected to be a major component of dose at AMS-2 or AMS-8A.
- If the maximum thorium levels measured at AMS-2 or AMS-8A in any of the first three quarters of 1998 were substituted for the (rejected) fourth quarter data, the location (AMS-9C) and value (0.26 mrem) of the maximum dose at the fenceline is unchanged.

The rejection of uranium and thorium data from background monitor AMS-12 does not impact the compliance demonstration because acceptable isotopic uranium and isotopic thorium background data were obtained at AMS-16 during the fourth quarter of 1998.

The maximum air inhalation effective dose equivalent was from AMS-9C, which was not affected by rejected data and therefore does not affect the FEMP's demonstration of NESHAP compliance.

SECTION III: DOSE ASSESSMENT

Based on the sum of the quarterly isotopic results and annual air volumes, the net measured concentrations for each radionuclide were calculated at each fenceline air monitor to determine annual average concentrations. The annual averages are compared to the values listed in Subpart H of 40 CFR 61, Appendix E, Table 2. (Refer to Table D-5 for the annual NESHAP compliance ratio report.)

At each fenceline air monitor, the sum of the fractions obtained by dividing each radionuclide concentration by the listed 40 CFR 61, Appendix E, Table 2 value was determined. The maximum value of the sum of the fractions was 0.026 and occurred at AMS-9C. AMS-9C operated 98.4 percent of the time during 1998 and no data from the monitor were rejected during the data validation process.

Assuming the values in 40 CFR 61, Appendix E, Table 2 represent the radionuclide concentration which correspond to a 10 mrem annual effective dose equivalent, the sum of the fractions at each monitor was converted to dose by multiplying the sum by 10. Using this assumption, the maximum effective dose equivalent at the fenceline (AMS-9C) is estimated to be 0.26 mrem (2.6E-03 mSv). Recognizing that the nearest residence is located approximately 2000 feet downwind from AMS-9C, the actual dose received by this receptor would be substantially lower than 0.26 mrem.

SECTION IV: COMPLIANCE ASSESSMENT

For 1998 the maximum effective dose equivalent from emissions of radionuclides to the ambient air, based on radionuclide measurements at the FEMP fenceline, is estimated to be 0.26 mrem (2.6E-03 mSv), which is in compliance with the Subpart H standard of 10 mrem.

SECTION V: ADDITIONAL INFORMATION

A. Meteorological Data

Refer to Figure D-2 for 1998 wind rose data.

B. Construction/Modifications at the FEMP

Three projects were completed in 1998 for which the requirements to apply to the EPA for approval to construct or modify were waived due to the provisions of 40 CFR 61.96. These projects were:

- Sewage treatment plant above-grade decontamination and dismantlement project.
- Building 68 decontamination of structural steel (steel rails, angle bars, and tie plates of existing railroad track)
- Plant 8 demonstration of shot blasting techniques to remove surface layers of contaminated floors.

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Refer to Appendix D.1 for CAP88-PC computer model runs as supporting documentation for the waivers.

C. Unplanned Releases of Radionuclides

For 1998 no unplanned releases of radionuclides were identified in a review of the 347 notifications received by the site's release evaluators.

TABLE D-1
NESHAP STACK EMISSIONS MONITORING RESULTS

1998 Annual Results		
Stack Location/ Analysis Performed	Number of Samples, (Including Rinsate)	Total Pounds
Building 71 Stack		
Uranium, Total	5	1.3E-05
Thorium-232	5	8.6E-05
Thorium-230	5	1.2E-09
Total Particulate	5	7.2E-02
Laboratory Stack		
Uranium, Total	5	1.0E-04
Thorium-232	5	4.2E-04
Thorium-230	5	5.1E-09
Total Particulate	5	1.2E+00
Laundry Stack		
Uranium, Total	10	7.0E-06
Thorium-232	10	4.5E-04
Thorium-230	10	5.8E-09
Total Particulate	10	1.1E+00
T-Hopper Stack		
Uranium, Total	6	5.9E-04
Thorium-232	6	4.5E-04
Thorium-230	6	5.2E-09
Total Particulate	6	8.0E-01

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TABLE D-2[a]
DISTANCE AND DIRECTION FROM POINTS OF RELEASE TO RECEPTORS

Source	Type of Control	Percent Efficiency[b]	Dist. and Direction to Nearest Off Site Receptor
Plant 6	HEPA	99.97	854m ESE
Plant 9	None	NA	959m ESE
Building 11			
Laundry Dryer Exhaust	HEPA	99.97	1016m WSW
Respirator Washing Facility	HEPA	99.97	1017m WSW
Building 15			
Perchloric Stacks	None	NA	921m WSW
HEPA Exhaust	HEPA	99.97	921m WSW
General Exhaust	None	NA	921m WSW
Building 51	None	NA	671m W
Building 53	None	NA	939m ESE
Building 65	HEPA	99.97	844m N
Building 71	HEPA	99.97	944m N
Building 78	HEPA	99.97	833m N

[a]Table D-2 is included to comply with 40 CFR 61.94 (b)(6) and not used to demonstrate compliance with 40 CFR 61.92.
[b]NA = not applicable

TABLE D-3
NET AIR CONCENTRATIONS[a]

	Uranium (pCi/m³)			Thorium (pCi/m³)			Radium (pCi/m³)
Location	234	235/236	238	228	230	232	226
Fenceline							
AMS-2	2.9E-05	1.7E-05	3.4E-05	0.0E+00	0.0E+00	0.0E+00	2.6E-06
AMS-3	8.4E-05	7.4E-06	8.3E-05	0.0E+00	7.9E-07	2.4E-07	9.0E-06
AMS-4	5.0E-06	0.0E+00	7.3E-06	0.0E+00	0.0E+00	0.0E+00	2.9E-06
AMS-5	1.2E-05	4.5E-06	1.3E-05	0.0E+00	0.0E+00	0.0E+00	2.2E-06
AMS-6	1.4E-05	2.0E-06	1.5E-05	0.0E+00	0.0E+00	0.0E+00	3.4E-06
AMS-7	1.0E-05	1.4E-06	1.0E-05	0.0E+00	0.0E+00	0.0E+00	4.1E-06
AMS-8A	6.2E-05	6.9E-06	6.1E-05	0.0E+00	0.0E+00	0.0E+00	3.7E-06
AMS-9C	7.0E-05	1.3E-05	7.5E-05	3.5E-06	1.6E-06	2.6E-06	0.0E+00
AMS-22	1.0E-05	3.7E-06	1.3E-05	0.0E+00	0.0E+00	0.0E+00	3.1E-06
AMS-23	1.9E-05	5.1E-06	2.3E-05	0.0E+00	0.0E+00	0.0E+00	2.0E-06
AMS-24	7.9E-06	1.2E-06	8.3E-06	0.0E+00	1.8E-06	6.8E-07	0.0E+00
AMS-25	7.8E-06	3.2E-06	7.5E-06	0.0E+00	1.5E-05	1.5E-06	3.1E-06
AMS-26	1.5E-05	4.6E-06	1.7E-05	0.0E+00	0.0E+00	0.0E+00	2.1E-06
AMS-27	6.8E-06	1.5E-06	7.6E-06	0.0E+00	0.0E+00	0.0E+00	4.7E-06
AMS-28	2.5E-06	9.5E-07	3.9E-06	0.0E+00	0.0E+00	0.0E+00	1.1E-06
AMS-29	1.5E-05	2.1E-06	1.7E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Background							
AMS-12	9.0E-06	4.7E-07	9.7E-06	5.3E-06	5.8E-06	4.8E-06	6.3E-06
AMS-16	1.6E-05	2.7E-07	1.5E-05	1.4E-05	1.7E-05	1.2E-05	5.1E-06

[a]Thorium-234, radium-228, actinium-228, radium-224, and thorium-231 are considered to be in equilibrium with their parent concentrations (i.e., uranium-238 pCi/m^3 = thorium-234 pCi/m^3, thorium-232 pCi/m^3 = radium-228, actinium-228, and radium-224 pCi/m^3, uranium-235 pCi/m^3 = thorium-231 pCi/m^3).

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TABLE D-4
OPERATIONAL SUMMARY FOR AIR PARTICULATE MONITORING STATIONS IN 1998

Location	Number of Samples	Sample Start Date	Last Sample Collection Date	Operating Time (hours)[a]	Percent of Operation
Fenceline					
AMS-2	26	12/30/97	12/29/98	8634	98.8
AMS-3	26	12/30/97	12/29/98	8483	97.1
AMS-4	26	12/30/97	12/29/98	8610	98.6
AMS-5	26	12/30/97	12/29/98	8734	100
AMS-6	26	12/30/97	12/29/98	8627	98.7
AMS-7	26	12/30/97	12/29/98	8704	99.6
AMS-8A	26	12/30/97	12/29/98	8666	99.2
AMS-9C	26	12/30/97	12/29/98	8597	98.4
AMS-22	26	12/30/97	12/29/98	8674	99.3
AMS-23	26	12/30/97	12/29/98	8669	99.2
AMS-24	26	12/30/97	12/29/98	8591	98.3
AMS-25	26	12/30/97	12/29/98	8506	97.4
AMS-26	26	12/30/97	12/29/98	8719	99.8
AMS-27	25	12/30/97	12/29/98	8313	95.2
AMS-28	26	12/30/97	12/29/98	8713	99.7
AMS-29	26	12/30/97	12/29/98	8685	99.4
Background					
AMS-12	26	12/30/97	12/29/98	8599	98.4
AMS-16	26	12/30/97	12/29/98	8609	98.5

[a]8736 available operating hours from December 30, 1997 through December 29, 1998

TABLE D-5

ANNUAL NESHAP COMPLIANCE RATIO REPORT

40 CFR 61 (NESHAP) Subpart H Appendix E, Table 2; Net Ratios[a]

Location	Actinium-228[b]	Radium-224[b]	Radium-226	Radium-228[b]	Thorium-228	Thorium-230	Thorium-231[b]	Thorium-232	Thorium-234[b]	Uranium-234	Uranium-235 Uranium-236	Uranium-238	Ratio Totals	Dose[c] (mrem)
Fenceline														
AMS-2	0.0E+00	0.0E+00	7.9E-04	0.0E+00	0.0E+00[d]	0.0E+00[d]	5.8E-08	0.0E+00[d]	1.5E-05	3.8E-03	2.3E-03	4.1-03	1.1E-02	.109
AMS-3	6.6E-08	1.6E-06	2.7E-03	4.2E-05	0.0E+00	2.3E-04	2.5E-08	4.0E-04	3.8E-05	1.1E-02	1.0E-03	1.0E-02	2.5E-02	.254
AMS-4	0.0E+00	0.0E+00	8.8E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.3E-06	6.5E-04	0.0E+00	8.8E-04	2.4E-03	.024
AMS-5	0.0E+00	0.0E+00	6.6E-04	0.0E+00	0.0E+00	0.0E+00	1.5E-08	0.0E+00	5.7E-06	1.6E-03	6.0E-04	1.5E-03	4.4E-03	.044
AMS-6	0.0E+00	0.0E+00	1.0E-03	0.0E+00	0.0E+00	0.0E+00	6.9E-09	0.0E+00	7.0E-06	1.9E-03	2.7E-04	1.9E-03	5.0E-03	.050
AMS-7	8.5E-09	0.0E+00	1.2E-03	0.0E+00	0.0E+00	0.0E+00	4.9E-09	0.0E+00	4.6E-06	1.3E-03	1.9E-04	1.2E-03	4.0E-03	.040
AMS-8A	0.0E+00	0.0E+00	1.1E-03	0.0E+00	0.0E+00[e]	0.0E+00	2.4E-08	0.0E+00[e]	2.8E-05	8.1E-03	9.3E-04	7.3E-03	1.7E-02	.175
AMS-9C	7.0E-07	1.7E-05	0.0E+00	4.4E-04	1.3E-03	4.8E-04	4.4E-08	4.2E-03	3.4E-05	9.1E-03	1.7E-03	9.0E-03	2.6E-02	.261
AMS-22	0.0E+00	0.0E+00	9.3E-04	0.0E+00	0.0E+00	0.0E+00	1.3E-08	0.0E+00	5.1E-06	1.3E-04	5.0E-04	1.5E-03	4.2E-03	.042
AMS-23	0.0E+00	0.0E+00	6.2E-04	0.0E+00	0.0E+00	0.0E+00	1.8E-08	0.0E+00	1.0E-05	2.5E-03	6.9E-04	2.7E-03	6.5E-03	.065
AMS-24[e]	1.8E-07	4.5E-06	0.0E+00	1.2E-04	2.3E-04	5.3E-04	4.0E-09	1.1E-03	3.8E-06	1.0E-04	1.6E-04	9.9E-04	3.9E-03	.039
AMS-25[e]	3.9E-07	9.7E-05	9.3E-04	2.5E-04	3.7E-04	4.4E-03	1.1E-08	2.3E-03	3.4E-06	1.0E-04	4.3E-04	9.0E-04	1.0E-02	.102
AMS-26	0.0E+00	0.0E+00	6.5E-04	0.0E+00	0.0E+00	0.0E+00	1.6E-08	0.0E+00	7.8E-06	2.0E-03	6.3E-04	2.1E-03	5.3E-03	.053
AMS-27	0.0E+00	0.0E+00	1.4E-03	0.0E+00	0.0E+00	0.0E+00	5.1E-09	0.0E+00	3.5E-06	8.8E-04	2.0E-04	9.1E-04	3.4E-03	.034
AMS-28	0.0E+00	0.0E+00	3.4E-04	0.0E+00	0.0E+00	0.0E+00	3.3E-09	0.0E+00	1.8E-06	3.3E-04	1.3E-05	4.6E-04	1.3E-03	.013
AMS-29	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.2E-09	0.0E+00	7.9E-06	1.9E-03	2.8E-04	2.1E-03	4.3E-03	.043
Background														
AMS-12	1.3E-06	3.2E-05	1.9E-03	8.1E-04	1.7E-03[d]	1.7E-03[d]	1.6E-09	7.7E-03[d]	4.4E-06	1.2E-03[d]	6.4E-05[d]	1.2E-03[d]	NA[f]	
AMS-16	3.2E-06	7.8E-05	1.5E-03[g]	2.0E-03	4.7E-03	4.9E-03	9.4E-10	1.9E-02	7.0E-06	2.0E-03	3.7E-05	1.9E-03	NA[f]	

Maximum Year-to-Date Ratio: 0.026 Maximum Year-to-Date Dose (mrem): 0.261

[a]A ratio of 0.0+00 indicates the filter results were less than or equal to the blank results, and/or the indicator concentrations were less than or equal to the average net background concentrations.
[b]Isotopes assumed to be in equilibrium with their parents.
[c]Dose conversions are based on the NESHAP standard of 10 mrem per year.
[d]Through the validation process, fourth quarter data were rejected due to low tracer recoveries. Rejected data were not used in dose calculations.
[e]Suspect data due to inflow disturbances caused by sound reduction matts.
[f]NA = not applicable
[g]The validated third quarter result was not considered representative of true background radium-226 concentrations at AMS-16. Therefore, the result was not used in dose calculations.

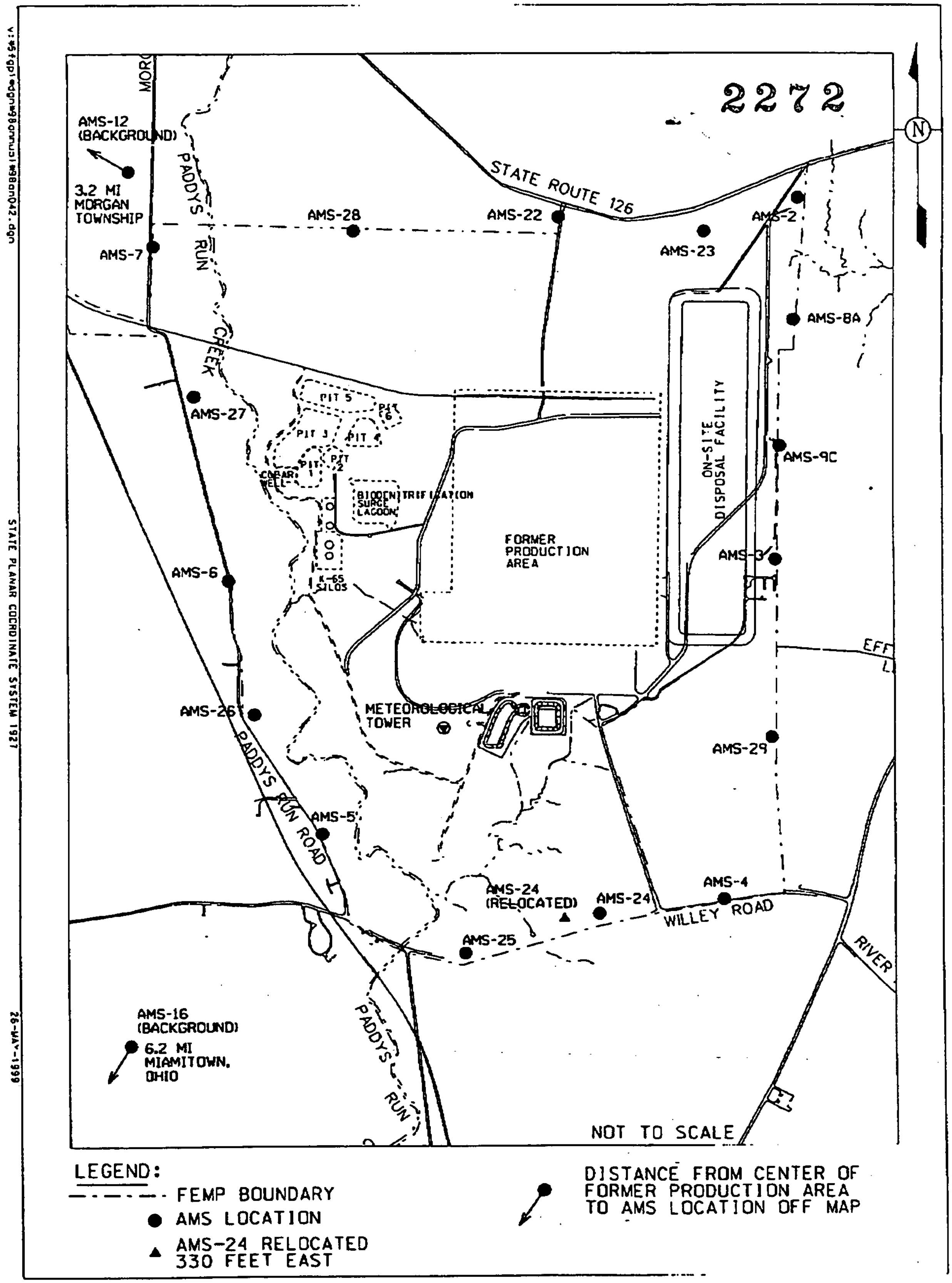

FIGURE D-1 RADIOLOGICAL AIR MONITORING STATION LOCATIONS

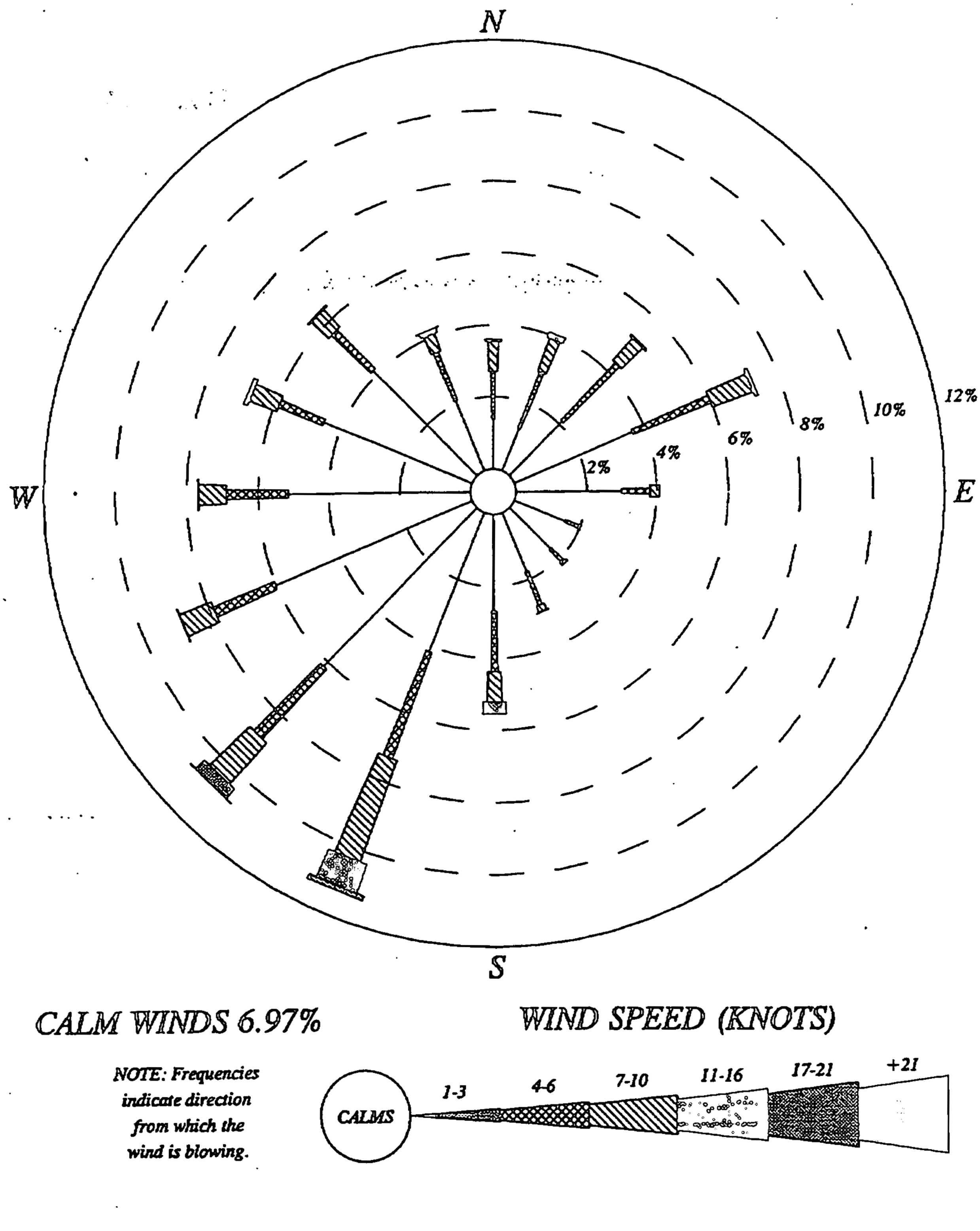

FIGURE D-16 1998 WIND ROSE DATA, 10-METER HEIGHT

000515

REFERENCES

U.S. Dept. of Energy, 1997a, "Integrated Environmental Monitoring Plan," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1997b, DOE-0980-97, Johnny Reising to James Saric and Michael Murphy, "Application for Approval to Use Environmental Measurements to Demonstrate Compliance with the National Emission Standards for Hazardous Air Pollutants Subpart H, "dated May 23, 1997.

U.S. Environmental Protection Agency, 1998, U.S. EPA, Michael Murphy to Johnny Reising, "DOE-0082-99; "Response to Issues Regarding National Emission Standards for Hazardous Air Pollutants Air Monitoring Stations," dated December 7, 1998.

U.S. Environmental Protection Agency, 1997, Jack Barnett to Johnny Reising, "Application for Approval to Use Environmental Measurements to Demonstrate Compliance with the National Emission Standards for Hazardous Air Pollutants Subpart H," dated August 11, 1997.

SECTION VI: CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment. (see 18 U.S.C. 1001).

Name: JACK R CRAIG

Signature: [signature] Date: 5/27/99

000517

P. 2272

Attachment D.1

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ATTACHMENT D.1

CAP88-PC COMPUTER MODEL RUNS AS SUPPORTING DOCUMENTATION FOR 40 CFR 61.96

000519

SEWER TREATMENT FACILITY - 39D

SEWER TREATMENT FACILITY- 39D
ESTIMATION OF EMISSIONS (FIXED + REMOVABLE) DURING DISMANTLING

ASSUMPTIONS:

1) Uranium is the only radionuclide present
2) All contamination is 1.25% enriched which is the highest routine enrichment processed during production of uranium metal.
3) Fixed + removable contamination will become airborned during dismantling/demolition activities.
4) Total area of building equals:
   floor: 60 ft x 15 ft or 18.3 m x 4.6 m = 84.2 m^2
   2 walls: 2(60 ft x 15 ft) or 2(84.2 m^2) = 168.4 m^2
   2 walls: 2(15 ft x 15 ft) or 2(21.2 m^2) = 42.4 m^2
   Total: 295 m^2 or 2,950,000 cm^2
5) Contamination is based on the radiological surveys done by technicians
6) Uranium contamination is released into the environment via a 2000 cfm HEPA filtration unit with a exit vent of 1 ft x 1 ft or 1 ft^2.
7) One-tenth of 1% of uranium contamination will be emitted into the environment during dismantling/demolition activities. (Conservative estimate based on 40 CFR 61 Appendix D)

Note: The survey report included beta-gamma dpm of loose (removable) contamination and beta-gamma of fixed + removable contamination. For estimating emissions from Building 39D, the maximum value of fixed + removable contamination was used. This is the most conservative estimate.

ISOTOPE	ASSAY %	HALF-LIFE (YRS)	LAMBDA λ, sec^{-1}
U-234	0.019%	2.45 E5	8.97 E-14
U-235	1.25%	7.04 E8	3.12 E-17
U-238	98.73%	4.47 E9	4.92 E-18

Lambda (λ) is the decay constant and equals 0.6931/half-life.

Activity, A = λN * (%Assay/100)
A = dps
λ = 1/sec
N = atoms = total grams of uranium * 1 g mole/238 g * 6.023 E23 atoms/g mole

A_{U-234} = 8.97 E-14 * (0. 00019 * N) = 43,130 * total U g

A_{U-235} = 3.12 E-17 * (0.0125 * N) = 987 * total U g

A_{U-238} = 4.92 E-18 * (0.9873 * N) = 12,293 * total U g

$A_{U-total}$ (dps) = (43,130 + 987 + 12,293) * total U g = 56,410 atoms/sec g * total U g

$A_{U-total}$ (dpm) = 3,384,600 atoms/min g * total U g

ALSO:

$A_{U\text{-total}}$ (dpm) = (maximum survey values/100cm^2) * (surface area/100) 100 cm^2

$A_{U\text{-total}}$ (dpm) = 2,400,000 dpm/100 cm^2 * 29,500 100 cm^2 = 7.08 E10 dpm

THEREFORE:

3,384,600 atoms/min g * total U grams = 7.08 E10 dpm

total U grams = 7.08 E10 dpm/ 3,384,600 atoms/min g

total U grams = 20,918.3 total U grams

ESTIMATED OF URANIUM ACTIVITY:

ISOTOPE	MASS, g	ACTIVITY, pCi/µg	ACTIVITIY, Ci
U-234	3.97	6246.1	0.0248
U-235	261.5	2.161	5.65 E-4
U-238	20,652.6	0.336	6.94 E-3

ESTIMATED OF EMISSIONS:

U-234: 0.1(0.01) * 0.0248 = 2.48 E-5 Ci

U-235: 0.1(0.01) * 5.65 E-4 = 5.65 E-7 Ci

U-238: 0.1(0.01) * 6.94 E-3 = 6.94 E-6 Ci

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S   R E P O R T

Non-Radon Individual Assessment
Feb 18, 1998   1:21 pm

Facility: FERNALD ENVIRONMENT MANAGEMENT PROJECT
Address: P.O. BOX 538704
7400 WILLEY ROAD
City: CINCINNATI
State: OH   Zip: 45253-8704

Effective Dose Equivalent
(mrem/year)

2.03E-03

At This Location: 714 Meters North Northeast

Source Category: STACK
Source Type: Stack
Emission Year: 1997

Comments: OFFSITE EDE FROM DISMANTLING/DEMOLITION OF SEWER TREATMENT FACILITY- 39D - FIXED+REMOVABLE

Dataset Name: SEWERTREAT3
Dataset Date: Feb 18, 1998   1:21 pm
Wind File: WNDFILES\FEMPSTD.WND

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 714 Meters North Northeast
Lifetime Fatal Cancer Risk: 2.63E-08

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Dose Equivalent (mrem/y)
GONADS	5.36E-06
BREAST	6.22E-06
R MAR	1.19E-04
LUNGS	1.60E-02
THYROID	5.22E-06
ENDOST	1.79E-03
RMNDR	1.56E-04
EFFEC	2.03E-03

Feb 18, 1998 1:21 pm

RADIONUCLIDE EMISSIONS DURING THE YEAR 1997

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
U-234	Y	1.00	2.5E-05	2.5E-05
U-235	Y	1.00	5.6E-07	5.6E-07
U-238	Y	1.00	6.9E-06	6.9E-06

SITE INFORMATION

Temperature:	12 degrees C
Precipitation:	102 cm/y
Mixing Height:	950 m

SOURCE INFORMATION

Source Number:	1
Stack Height (m):	1.00
Diameter (m):	0.34
Plume Rise Momentum (m/s): (Exit Velocity)	1.02E+01

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

1308	1323	2244	1975	1714	1435	1437	1446	1470	1550
1528	1435	1238	1203	1670	1099	731	714	1369	1483

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

D O S E   A N D   R I S K   E Q U I V A L E N T   S U M M A R I E S

Non-Radon Individual Assessment
Feb 18, 1998 1:21 pm

Facility: FERNALD ENVIRONMENT MANAGEMENT PROJECT
Address: P.O. BOX 538704
7400 WILLEY ROAD
City: CINCINNATI
State: OH Zip: 45253-8704

Source Category: STACK
Source Type: Stack
Emission Year: 1997

Comments: OFFSITE EDE FROM DISMANTLING/DEMOLITION OF SEWER TREATMENT FACILITY- 39D - FIXED+REMOVABLE (1/10 OF 1% RELEASED INTO THE ENVIRONMENT)

Dataset Name: SEWERTREAT3
Dataset Date: Feb 18, 1998 1:21 pm
Wind File: WNDFILES\FEMPSTD.WND

F:\WPW61\SEWTREAT\E.SUM

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)
GONADS	5.36E-06
BREAST	6.22E-06
R MAR	1.19E-04
LUNGS	1.60E-02
THYROID	5.22E-06
ENDOST	1.79E-03
RMNDR	1.56E-04
EFFEC	2.03E-03

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem/y)
INGESTION	1.13E-04
INHALATION	1.92E-03
AIR IMMERSION	2.56E-11
GROUND SURFACE	9.79E-07
INTERNAL	2.03E-03
EXTERNAL	9.79E-07
TOTAL	2.04E-03

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem/y)
U-234	1.60E-03
U-235	3.46E-05
U-238	3.99E-04
TOTAL	2.04E-03

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
LEUKEMIA	1.25E-10
BONE	9.46E-11
THYROID	1.17E-12
BREAST	1.38E-11
LUNG	2.56E-08
STOMACH	7.83E-12
BOWEL	1.04E-11
LIVER	7.58E-12
PANCREAS	5.20E-12
URINARY	3.38E-10
OTHER	6.36E-12
TOTAL	2.63E-08

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	5.80E-10
INHALATION	2.57E-08
AIR IMMERSION	5.96E-16
GROUND SURFACE	2.24E-11
INTERNAL	2.62E-08
EXTERNAL	2.24E-11
TOTAL	2.63E-08

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
U-234	2.06E-08
U-235	4.55E-10
U-238	5.18E-09
TOTAL	2.63E-08

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	1308	1323	2244	1975	1714	1435	1437
N	3.5E-04	3.4E-04	1.5E-04	1.8E-04	2.3E-04	3.0E-04	3.0E-04
NNW	1.5E-04	1.5E-04	6.6E-05	8.0E-05	9.9E-05	1.3E-04	1.3E-04
NW	1.3E-04	1.3E-04	5.9E-05	7.1E-05	8.8E-05	1.1E-04	1.1E-04
WNW	1.1E-04	1.1E-04	5.1E-05	6.1E-05	7.5E-05	9.8E-05	9.8E-05
W	1.7E-04	1.7E-04	7.4E-05	8.9E-05	1.1E-04	1.5E-04	1.5E-04
WSW	4.3E-04	4.2E-04	1.8E-04	2.2E-04	2.8E-04	3.7E-04	3.7E-04
SW	2.9E-04	2.8E-04	1.2E-04	1.5E-04	1.9E-04	2.5E-04	2.5E-04
SSW	3.7E-04	3.6E-04	1.5E-04	1.9E-04	2.4E-04	3.2E-04	3.2E-04
S	3.6E-04	3.5E-04	1.5E-04	1.8E-04	2.3E-04	3.1E-04	3.0E-04
SSE	3.4E-04	3.3E-04	1.4E-04	1.7E-04	2.2E-04	2.9E-04	2.9E-04
SE	3.3E-04	3.2E-04	1.4E-04	1.7E-04	2.1E-04	2.8E-04	2.8E-04
ESE	4.5E-04	4.4E-04	1.9E-04	2.3E-04	2.9E-04	3.9E-04	3.8E-04
E	3.2E-04	3.1E-04	1.3E-04	1.6E-04	2.0E-04	2.7E-04	2.7E-04
ENE	3.4E-04	3.3E-04	1.4E-04	1.7E-04	2.2E-04	2.9E-04	2.9E-04
NE	3.7E-04	3.7E-04	1.6E-04	1.9E-04	2.4E-04	3.2E-04	3.2E-04
NNE	7.1E-04	7.0E-04	2.9E-04	3.6E-04	4.6E-04	6.1E-04	6.1E-04

	Distance (m)						
Direction	1446	1470	1550	1528	1435	1238	1203
N	3.0E-04	2.9E-04	2.7E-04	2.7E-04	3.0E-04	3.8E-04	4.0E-04
NNW	1.3E-04	1.2E-04	1.2E-04	1.2E-04	1.3E-04	1.6E-04	1.7E-04
NW	1.1E-04	1.1E-04	1.0E-04	1.0E-04	1.1E-04	1.4E-04	1.5E-04
WNW	9.7E-05	9.5E-05	8.7E-05	8.9E-05	9.8E-05	1.2E-04	1.3E-04
W	1.4E-04	1.4E-04	1.3E-04	1.3E-04	1.5E-04	1.9E-04	1.9E-04
WSW	3.7E-04	3.6E-04	3.3E-04	3.3E-04	3.7E-04	4.7E-04	4.9E-04
SW	2.5E-04	2.4E-04	2.2E-04	2.2E-04	2.5E-04	3.2E-04	3.3E-04
SSW	3.1E-04	3.1E-04	2.8E-04	2.9E-04	3.2E-04	4.0E-04	4.2E-04
S	3.0E-04	2.9E-04	2.7E-04	2.8E-04	3.1E-04	3.9E-04	4.1E-04
SSE	2.9E-04	2.8E-04	2.5E-04	2.6E-04	2.9E-04	3.7E-04	3.9E-04
SE	2.8E-04	2.7E-04	2.5E-04	2.5E-04	2.8E-04	3.6E-04	3.8E-04
ESE	3.8E-04	3.7E-04	3.4E-04	3.5E-04	3.9E-04	4.9E-04	5.2E-04
E	2.7E-04	2.6E-04	2.4E-04	2.5E-04	2.7E-04	3.5E-04	3.6E-04

ENE	2.9E-04	2.8E-04	2.6E-04	2.6E-04	2.9E-04	3.7E-04	3.9E-04
NE	3.2E-04	3.1E-04	2.8E-04	2.9E-04	3.2E-04	4.1E-04	4.3E-04
NNE	6.0E-04	5.9E-04	5.4E-04	5.5E-04	6.1E-04	7.8E-04	8.1E-04

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)					
Direction	1670	1099	731	714	1369	1483
N	2.4E-04	4.7E-04	9.6E-04	1.0E-03	3.3E-04	2.9E-04
NNW	1.0E-04	2.0E-04	4.0E-04	4.2E-04	1.4E-04	1.2E-04
NW	9.1E-05	1.7E-04	3.5E-04	3.6E-04	1.2E-04	1.1E-04
WNW	7.8E-05	1.5E-04	3.0E-04	3.1E-04	1.1E-04	9.4E-05
W	1.2E-04	2.2E-04	4.6E-04	4.8E-04	1.6E-04	1.4E-04
WSW	2.9E-04	5.7E-04	1.2E-03	1.2E-03	4.0E-04	3.5E-04
SW	1.9E-04	3.8E-04	7.9E-04	8.2E-04	2.7E-04	2.4E-04
SSW	2.5E-04	4.9E-04	1.0E-03	1.1E-03	3.4E-04	3.0E-04
S	2.4E-04	4.7E-04	9.8E-04	1.0E-03	3.3E-04	2.9E-04
SSE	2.2E-04	4.5E-04	9.3E-04	9.8E-04	3.1E-04	2.7E-04
SE	2.2E-04	4.3E-04	8.9E-04	9.2E-04	3.0E-04	2.7E-04
ESE	3.0E-04	6.0E-04	1.2E-03	1.3E-03	4.2E-04	3.7E-04
E	2.1E-04	4.2E-04	8.6E-04	9.0E-04	2.9E-04	2.6E-04
ENE	2.3E-04	4.5E-04	9.3E-04	9.7E-04	3.1E-04	2.8E-04
NE	2.5E-04	5.0E-04	1.0E-03	1.1E-03	3.5E-04	3.0E-04
NNE	4.7E-04	9.4E-04	1.9E-03	2.0E-03	6.6E-04	5.8E-04

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	1308	1323	2244	1975	1714	1435	1437
N	4.4E-09	4.4E-09	1.8E-09	2.2E-09	2.8E-09	3.8E-09	3.8E-09
NNW	1.9E-09	1.8E-09	7.8E-10	9.6E-10	1.2E-09	1.6E-09	1.6E-09
NW	1.6E-09	1.6E-09	6.9E-10	8.5E-10	1.1E-09	1.4E-09	1.4E-09
WNW	1.4E-09	1.4E-09	5.9E-10	7.2E-10	9.0E-10	1.2E-09	1.2E-09
W	2.1E-09	2.1E-09	8.8E-10	1.1E-09	1.4E-09	1.8E-09	1.8E-09
WSW	5.5E-09	5.4E-09	2.2E-09	2.8E-09	3.5E-09	4.7E-09	4.7E-09
SW	3.7E-09	3.6E-09	1.5E-09	1.8E-09	2.3E-09	3.1E-09	3.1E-09
SSW	4.7E-09	4.6E-09	1.9E-09	2.4E-09	3.0E-09	4.0E-09	4.0E-09
S	4.5E-09	4.4E-09	1.8E-09	2.3E-09	2.9E-09	3.9E-09	3.8E-09
SSE	4.3E-09	4.2E-09	1.7E-09	2.1E-09	2.7E-09	3.6E-09	3.6E-09
SE	4.2E-09	4.1E-09	1.7E-09	2.1E-09	2.7E-09	3.6E-09	3.6E-09
ESE	5.7E-09	5.6E-09	2.3E-09	2.9E-09	3.6E-09	4.9E-09	4.9E-09
E	4.0E-09	3.9E-09	1.6E-09	2.0E-09	2.6E-09	3.4E-09	3.4E-09
ENE	4.3E-09	4.2E-09	1.8E-09	2.2E-09	2.7E-09	3.7E-09	3.7E-09
NE	4.7E-09	4.7E-09	1.9E-09	2.4E-09	3.0E-09	4.1E-09	4.0E-09
NNE	9.1E-09	8.9E-09	3.7E-09	4.6E-09	5.8E-09	7.8E-09	7.8E-09

	Distance (m)						
Direction	1446	1470	1550	1528	1435	1238	1203
N	3.8E-09	3.7E-09	3.4E-09	3.4E-09	3.8E-09	4.9E-09	5.1E-09
NNW	1.6E-09	1.5E-09	1.4E-09	1.4E-09	1.6E-09	2.0E-09	2.1E-09
NW	1.4E-09	1.4E-09	1.2E-09	1.3E-09	1.4E-09	1.8E-09	1.9E-09
WNW	1.2E-09	1.2E-09	1.1E-09	1.1E-09	1.2E-09	1.5E-09	1.6E-09
W	1.8E-09	1.7E-09	1.6E-09	1.6E-09	1.8E-09	2.3E-09	2.4E-09
WSW	4.6E-09	4.5E-09	4.1E-09	4.2E-09	4.7E-09	6.0E-09	6.3E-09
SW	3.1E-09	3.0E-09	2.8E-09	2.8E-09	3.1E-09	4.0E-09	4.2E-09
SSW	4.0E-09	3.9E-09	3.5E-09	3.6E-09	4.0E-09	5.1E-09	5.4E-09
S	3.8E-09	3.7E-09	3.4E-09	3.5E-09	3.9E-09	4.9E-09	5.2E-09
SSE	3.6E-09	3.5E-09	3.2E-09	3.3E-09	3.6E-09	4.7E-09	4.9E-09
SE	3.5E-09	3.4E-09	3.1E-09	3.2E-09	3.6E-09	4.6E-09	4.8E-09
ESE	4.8E-09	4.7E-09	4.3E-09	4.4E-09	4.9E-09	6.3E-09	6.6E-09
E	3.4E-09	3.3E-09	3.0E-09	3.1E-09	3.4E-09	4.4E-09	4.6E-09

ENE	3.6E-09	3.5E-09	3.2E-09	3.3E-09	3.7E-09	4.7E-09	4.9E-09
NE	4.0E-09	3.9E-09	3.6E-09	3.7E-09	4.1E-09	5.2E-09	5.5E-09
NNE	7.7E-09	7.5E-09	6.8E-09	7.0E-09	7.8E-09	1.0E-08	1.0E-08

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)					
Direction	1670	1099	731	714	1369	1483
N	3.0E-09	5.9E-09	1.2E-08	1.3E-08	4.1E-09	3.6E-09
NNW	1.3E-09	2.5E-09	5.2E-09	5.4E-09	1.7E-09	1.5E-09
NW	1.1E-09	2.2E-09	4.5E-09	4.6E-09	1.5E-09	1.3E-09
WNW	9.4E-10	1.8E-09	3.8E-09	4.0E-09	1.3E-09	1.1E-09
W	1.4E-09	2.8E-09	5.8E-09	6.1E-09	2.0E-09	1.7E-09
WSW	3.7E-09	7.3E-09	1.5E-08	1.6E-08	5.1E-09	4.5E-09
SW	2.4E-09	4.9E-09	1.0E-08	1.1E-08	3.4E-09	3.0E-09
SSW	3.1E-09	6.3E-09	1.3E-08	1.4E-08	4.3E-09	3.8E-09
S	3.0E-09	6.0E-09	1.3E-08	1.3E-08	4.2E-09	3.6E-09
SSE	2.8E-09	5.7E-09	1.2E-08	1.3E-08	3.9E-09	3.4E-09
SE	2.8E-09	5.5E-09	1.1E-08	1.2E-08	3.9E-09	3.4E-09
ESE	3.8E-09	7.7E-09	1.6E-08	1.7E-08	5.3E-09	4.6E-09
E	2.7E-09	5.4E-09	1.1E-08	1.2E-08	3.7E-09	3.2E-09
ENE	2.9E-09	5.8E-09	1.2E-08	1.3E-08	4.0E-09	3.5E-09
NE	3.1E-09	6.4E-09	1.3E-08	1.4E-08	4.4E-09	3.8E-09
NNE	6.1E-09	1.2E-08	2.5E-08	2.6E-08	8.4E-09	7.4E-09

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S   R E P O R T

Non-Radon Individual Assessment

Feb 18, 1998 12:59 am

Facility: FERNALD ENVIRONMENT MANAGEMENT PROJECT

000536

Address: P.O. BOX 538704

7400 WILLEY ROAD

City: CINCINNATI

State: OH Zip: 45253-8704

Effective Dose Equivalent
(mrem/year)

8.82E-04

At This Location: 1142 Meters North Northeast

Source Category: STACK

Source Type: Stack

Emission Year: 1997

Comments: OFFSITE EDE FROM DISMANTLING/DEMOLITION OF SEWER TREATMENT FACILITY- 39D PART 2- FIXED+REMOVABLE

Dataset Name: sewertreat4

Dataset Date: Feb 18, 1998 12:59 am

Wind File: WNDFILES\FEMPSTD.WND

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 1142 Meters North Northeast
Lifetime Fatal Cancer Risk: 1.14E-08

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Dose Equivalent (mrem/y)
GONADS	2.50E-06
BREAST	2.89E-06
R MAR	5.56E-05
LUNGS	6.90E-03
THYROID	2.43E-06
ENDOST	8.37E-04
RMNDR	7.28E-05
EFFEC	8.82E-04

RADIONUCLIDE EMISSIONS DURING THE YEAR 1997

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
U-234	Y	1.00	2.5E-05	2.5E-05
U-235	Y	1.00	5.6E-07	5.6E-07
U-238	Y	1.00	6.9E-06	6.9E-06

SITE INFORMATION

Temperature:	12 degrees C
Precipitation:	102 cm/y
Mixing Height:	950 m

SOURCE INFORMATION

Source Number:	1
Stack Height (m):	1.00
Diameter (m):	0.34
Plume Rise Momentum (m/s): (Exit Velocity)	1.02E+01

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

1215	1694	2479	1410	2112	2757	1956	1810	1142	1833
1902	1885	2817	2003	2244	2339	2299	2258	2291	1621

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

D O S E   A N D   R I S K   E Q U I V A L E N T   S U M M A R I E S

Non-Radon Individual Assessment
Feb 18, 1998 12:59 am

Facility: FERNALD ENVIRONMENT MANAGEMENT PROJECT
Address: P.O. BOX 538704
7400 WILLEY ROAD
City: CINCINNATI
State: OH Zip: 45253-8704

Source Category: STACK
Source Type: Stack
Emission Year: 1997

Comments: OFFSITE EDE FROM DISMANTLING/DEMOLITION OF SEWER TREATMENT FACILITY- 39D PART 2- FIXED+REMOVABLE (1/10 OF 1% RELEASED INTO THE ENVIRONMENT)

Dataset Name: sewertreat4
Dataset Date: Feb 18, 1998 12:59 am
Wind File: WNDFILES\FEMPSTD.WND

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)
GONADS	2.50E-06
BREAST	2.89E-06
R MAR	5.56E-05
LUNGS	6.90E-03
THYROID	2.43E-06
ENDOST	8.37E-04
RMNDR	7.28E-05
EFFEC	8.82E-04

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem/y)
INGESTION	5.28E-05
INHALATION	8.29E-04
AIR IMMERSION	1.11E-11
GROUND SURFACE	4.50E-07
INTERNAL	8.82E-04
EXTERNAL	4.50E-07
TOTAL	8.83E-04

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem/y)
U-234	6.95E-04
U-235	1.50E-05
U-238	1.73E-04
TOTAL	8.83E-04

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
LEUKEMIA	5.84E-11
BONE	4.42E-11
THYROID	5.41E-13
BREAST	6.39E-12
LUNG	1.11E-08
STOMACH	3.64E-12
BOWEL	4.83E-12
LIVER	3.52E-12
PANCREAS	2.42E-12
URINARY	1.58E-10
OTHER	2.96E-12
TOTAL	1.14E-08

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	2.71E-10
INHALATION	1.11E-08
AIR IMMERSION	2.57E-16
GROUND SURFACE	1.03E-11
INTERNAL	1.13E-08
EXTERNAL	1.03E-11
TOTAL	1.14E-08

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
U-234	8.92E-09
U-235	1.97E-10
U-238	2.24E-09
TOTAL	1.14E-08

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	1215	1694	2479	1410	2112	2757	1956
N	3.9E-04	2.3E-04	1.2E-04	3.1E-04	1.6E-04	1.0E-04	1.8E-04
NNW	1.6E-04	9.7E-05	5.4E-05	1.3E-04	6.8E-05	4.6E-05	7.7E-05
NW	1.4E-04	8.5E-05	4.8E-05	1.1E-04	6.1E-05	4.1E-05	6.8E-05
WNW	1.2E-04	7.3E-05	4.1E-05	9.7E-05	5.2E-05	3.5E-05	5.8E-05
W	1.9E-04	1.1E-04	6.0E-05	1.5E-04	7.7E-05	5.1E-05	8.6E-05
WSW	4.8E-04	2.8E-04	1.5E-04	3.8E-04	1.9E-04	1.3E-04	2.2E-04
SW	3.2E-04	1.9E-04	1.0E-04	2.5E-04	1.3E-04	8.5E-05	1.5E-04
SSW	4.1E-04	2.4E-04	1.3E-04	3.2E-04	1.7E-04	1.1E-04	1.9E-04
S	4.0E-04	2.3E-04	1.2E-04	3.1E-04	1.6E-04	1.0E-04	1.8E-04
SSE	3.8E-04	2.2E-04	1.2E-04	2.9E-04	1.5E-04	9.7E-05	1.7E-04
SE	3.7E-04	2.1E-04	1.1E-04	2.9E-04	1.5E-04	9.6E-05	1.7E-04
ESE	5.0E-04	2.9E-04	1.5E-04	3.9E-04	2.0E-04	1.3E-04	2.3E-04
E	3.5E-04	2.0E-04	1.1E-04	2.8E-04	1.4E-04	9.2E-05	1.6E-04
ENE	3.8E-04	2.2E-04	1.2E-04	3.0E-04	1.5E-04	9.9E-05	1.7E-04
NE	4.2E-04	2.4E-04	1.3E-04	3.3E-04	1.7E-04	1.1E-04	1.9E-04
NNE	8.0E-04	4.6E-04	2.5E-04	6.2E-04	3.2E-04	2.1E-04	3.6E-04

	Distance (m)						
Direction	1810	1142	1833	1902	1885	2817	2003
N	2.0E-04	4.3E-04	2.0E-04	1.9E-04	1.9E-04	9.9E-05	1.7E-04
NNW	8.7E-05	1.8E-04	8.5E-05	8.0E-05	8.2E-05	4.4E-05	7.4E-05
NW	7.7E-05	1.6E-04	7.5E-05	7.1E-05	7.2E-05	3.9E-05	6.6E-05
WNW	6.6E-05	1.4E-04	6.4E-05	6.1E-05	6.2E-05	3.4E-05	5.6E-05
W	9.8E-05	2.1E-04	9.6E-05	9.0E-05	9.2E-05	4.9E-05	8.3E-05
WSW	2.5E-04	5.4E-04	2.4E-04	2.3E-04	2.3E-04	1.2E-04	2.1E-04
SW	1.7E-04	3.6E-04	1.6E-04	1.5E-04	1.6E-04	8.2E-05	1.4E-04
SSW	2.1E-04	4.6E-04	2.1E-04	2.0E-04	2.0E-04	1.0E-04	1.8E-04
S	2.1E-04	4.4E-04	2.0E-04	1.9E-04	1.9E-04	1.0E-04	1.7E-04
SSE	1.9E-04	4.2E-04	1.9E-04	1.8E-04	1.8E-04	9.4E-05	1.6E-04
SE	1.9E-04	4.0E-04	1.9E-04	1.8E-04	1.8E-04	9.3E-05	1.6E-04
ESE	2.6E-04	5.6E-04	2.5E-04	2.4E-04	2.4E-04	1.3E-04	2.2E-04
E	1.8E-04	3.9E-04	1.8E-04	1.7E-04	1.7E-04	8.9E-05	1.5E-04

ENE	2.0E-04	4.2E-04	1.9E-04	1.8E-04	1.8E-04	9.6E-05	1.7E-04
NE	2.2E-04	4.6E-04	2.1E-04	2.0E-04	2.0E-04	1.1E-04	1.8E-04
NNE	4.1E-04	8.8E-04	4.0E-04	3.8E-04	3.9E-04	2.0E-04	3.5E-04

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)					
Direction	2244	2339	2299	2258	2291	1621
N	1.4E-04	1.3E-04	1.4E-04	1.4E-04	1.4E-04	2.4E-04
NNW	6.2E-05	5.8E-05	6.0E-05	6.2E-05	6.0E-05	1.0E-04
NW	5.5E-05	5.2E-05	5.3E-05	5.5E-05	5.4E-05	9.1E-05
WNW	4.7E-05	4.4E-05	4.6E-05	4.7E-05	4.6E-05	7.8E-05
W	7.0E-05	6.5E-05	6.7E-05	6.9E-05	6.7E-05	1.2E-04
WSW	1.8E-04	1.6E-04	1.7E-04	1.7E-04	1.7E-04	3.0E-04
SW	1.2E-04	1.1E-04	1.1E-04	1.2E-04	1.1E-04	2.0E-04
SSW	1.5E-04	1.4E-04	1.4E-04	1.5E-04	1.5E-04	2.6E-04
S	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04	2.5E-04
SSE	1.4E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	2.3E-04
SE	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	2.3E-04
ESE	1.8E-04	1.7E-04	1.7E-04	1.8E-04	1.8E-04	3.1E-04
E	1.3E-04	1.2E-04	1.2E-04	1.3E-04	1.2E-04	2.2E-04
ENE	1.4E-04	1.3E-04	1.3E-04	1.4E-04	1.3E-04	2.4E-04
NE	1.5E-04	1.4E-04	1.5E-04	1.5E-04	1.5E-04	2.6E-04
NNE	2.9E-04	2.7E-04	2.8E-04	2.9E-04	2.8E-04	4.9E-04

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

Direction	Distance (m) 1215	1694	2479	1410	2112	2757	1956
N	5.0E-09	2.9E-09	1.5E-09	3.9E-09	2.0E-09	1.3E-09	2.3E-09
NNW	2.1E-09	1.2E-09	6.5E-10	1.6E-09	8.4E-10	5.5E-10	9.5E-10
NW	1.8E-09	1.1E-09	5.7E-10	1.4E-09	7.4E-10	4.8E-10	8.4E-10
WNW	1.5E-09	9.0E-10	4.9E-10	1.2E-09	6.3E-10	4.1E-10	7.1E-10
W	2.4E-09	1.4E-09	7.3E-10	1.9E-09	9.4E-10	6.1E-10	1.1E-09
WSW	6.2E-09	3.5E-09	1.9E-09	4.8E-09	2.5E-09	1.6E-09	2.8E-09
SW	4.1E-09	2.4E-09	1.3E-09	3.2E-09	1.6E-09	1.0E-09	1.9E-09
SSW	5.3E-09	3.0E-09	1.6E-09	4.1E-09	2.1E-09	1.3E-09	2.4E-09
S	5.1E-09	2.9E-09	1.5E-09	4.0E-09	2.0E-09	1.3E-09	2.3E-09
SSE	4.8E-09	2.7E-09	1.4E-09	3.7E-09	1.9E-09	1.2E-09	2.1E-09
SE	4.7E-09	2.7E-09	1.4E-09	3.7E-09	1.9E-09	1.2E-09	2.1E-09
ESE	6.5E-09	3.7E-09	1.9E-09	5.0E-09	2.5E-09	1.6E-09	2.9E-09
E	4.5E-09	2.6E-09	1.4E-09	3.5E-09	1.8E-09	1.1E-09	2.0E-09
ENE	4.8E-09	2.8E-09	1.5E-09	3.8E-09	1.9E-09	1.2E-09	2.2E-09
NE	5.3E-09	3.1E-09	1.6E-09	4.2E-09	2.1E-09	1.4E-09	2.4E-09
NNE	1.0E-08	5.9E-09	3.1E-09	8.0E-09	4.1E-09	2.6E-09	4.6E-09

Direction	Distance (m) 1810	1142	1833	1902	1885	2817	2003
N	2.6E-09	5.6E-09	2.5E-09	2.4E-09	2.4E-09	1.2E-09	2.2E-09
NNW	1.1E-09	2.3E-09	1.1E-09	1.0E-09	1.0E-09	5.3E-10	9.1E-10
NW	9.5E-10	2.0E-09	9.3E-10	8.8E-10	8.9E-10	4.7E-10	8.1E-10
WNW	8.1E-10	1.7E-09	7.9E-10	7.4E-10	7.5E-10	4.0E-10	6.8E-10
W	1.2E-09	2.6E-09	1.2E-09	1.1E-09	1.1E-09	5.9E-10	1.0E-09
WSW	3.2E-09	6.9E-09	3.1E-09	2.9E-09	3.0E-09	1.5E-09	2.7E-09
SW	2.1E-09	4.6E-09	2.1E-09	1.9E-09	2.0E-09	1.0E-09	1.8E-09
SSW	2.7E-09	5.9E-09	2.6E-09	2.5E-09	2.5E-09	1.3E-09	2.3E-09
S	2.6E-09	5.6E-09	2.5E-09	2.4E-09	2.4E-09	1.2E-09	2.2E-09
SSE	2.4E-09	5.4E-09	2.4E-09	2.2E-09	2.3E-09	1.2E-09	2.1E-09
SE	2.4E-09	5.2E-09	2.4E-09	2.2E-09	2.2E-09	1.2E-09	2.0E-09
ESE	3.3E-09	7.2E-09	3.2E-09	3.0E-09	3.1E-09	1.6E-09	2.8E-09
E	2.3E-09	5.0E-09	2.3E-09	2.1E-09	2.2E-09	1.1E-09	1.9E-09

ENE	2.5E-09	5.4E-09	2.4E-09	2.3E-09	2.3E-09	1.2E-09	2.1E-09
NE	2.7E-09	5.9E-09	2.7E-09	2.5E-09	2.6E-09	1.3E-09	2.3E-09
NNE	5.3E-09	1.1E-08	5.2E-09	4.9E-09	4.9E-09	2.5E-09	4.5E-09

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)					
Direction	2244	2339	2299	2258	2291	1621
N	1.8E-09	1.7E-09	1.7E-09	1.8E-09	1.7E-09	3.1E-09
NNW	7.6E-10	7.1E-10	7.3E-10	7.5E-10	7.4E-10	1.3E-09
NW	6.7E-10	6.3E-10	6.5E-10	6.7E-10	6.5E-10	1.1E-09
WNW	5.7E-10	5.3E-10	5.5E-10	5.6E-10	5.5E-10	9.6E-10
W	8.6E-10	8.0E-10	8.2E-10	8.5E-10	8.3E-10	1.5E-09
WSW	2.2E-09	2.1E-09	2.1E-09	2.2E-09	2.1E-09	3.8E-09
SW	1.5E-09	1.4E-09	1.4E-09	1.5E-09	1.4E-09	2.5E-09
SSW	1.9E-09	1.8E-09	1.8E-09	1.9E-09	1.8E-09	3.3E-09
S	1.8E-09	1.7E-09	1.7E-09	1.8E-09	1.8E-09	3.1E-09
SSE	1.7E-09	1.6E-09	1.6E-09	1.7E-09	1.6E-09	2.9E-09
SE	1.7E-09	1.6E-09	1.6E-09	1.7E-09	1.6E-09	2.9E-09
ESE	2.3E-09	2.1E-09	2.2E-09	2.3E-09	2.2E-09	4.0E-09
E	1.6E-09	1.5E-09	1.5E-09	1.6E-09	1.6E-09	2.8E-09
ENE	1.7E-09	1.6E-09	1.7E-09	1.7E-09	1.7E-09	3.0E-09
NE	1.9E-09	1.8E-09	1.8E-09	1.9E-09	1.8E-09	3.3E-09
NNE	3.7E-09	3.4E-09	3.5E-09	3.7E-09	3.6E-09	6.3E-09

DECONTAMINATION OF STRUCTURAL STEEL

ATTACHMENT 1 - EMISSION INFORMATION
DECONTAMINATION OF STRUCTURAL STEEL

Radionuclide Emissions:

If steel from the Plant 1 Ore Silo Project is decontaminated then the calculations and modeling performed in the 1995 Permit Information Summary (Attachment 2) is sufficient to show continuous sampling is not required. This document will not duplicated those calcualtions in this document.

This document evaluates steel contaminated with uranium and not thorium. The average removable contamination levels on the steel beams will be less than 10,000/100 cm^2, and the average fixed levels will be less than 100,000/100 cm^2. 50 tons of steel will be decontaminated in FY-1997. The fixed contamination is considered removable for purposes of calculating the emissions from the uranium contaminated steel. In the 1995 PIS, it was determined 75 tons of steel has a total surface area of 15,000 ft^2. The calculated total activity on 50 tons of uranium contaminated steel is:

$$\frac{110{,}000\ dpm}{100\ cm^2} \left| \frac{6.45\ cm^2}{in^2} \right| \frac{144\ in^2}{ft^2} \left| \frac{50\ t}{yr} \right| \frac{4.5E\text{-}07\ \mu Ci}{dpm} \left| \frac{15{,}000\ ft^2}{75\ t} \right.$$

$$= 4597\ \frac{\mu Ci}{yr}$$

Under 40 CFR Part 61, Section 61.93, the release rate for each point source (stack or vent) shall be determined. There are two emission points for the grit blasting operation: the grit blaster, and the ventilation booth. 40 CFR Part 61 Appendix D protocols were used to estimate the potential (uncontrolled) emissions from the ventilation booth.

Potential emissions from the ventilation booth are:

4597 μCi / yr x 0.001 (Appendix D emission factor for particulate solids) = 4.6 μCi / yr

Potential emissions from the grit blaster were determined by assuming total emissions were controlled by 99%. The control being applied in this instance is the vacuum nature of the blaster which is inherent to the (normal) operation of the machine. The efficiency of the machines HEPA filter (99.97%) was not used.

4597 μCi / yr x (1 - .99) = 45.97 μCi / yr

Attachments 3 & 4 are the CAP88-PC model runs for the project point sources. The model indicates no continuous sampling is required for the grit blasting of 50 tons of uranium contaminated steel for either point source. If the project decides to continue this decontamination method past FY-1997, it could decontaminate 20 times (300,000 ft^2) this amount of uranium contaminated steel per calendar year and still not require continuous monitoring for either point source.

Lead Emissions:

For this project, it is assumed there is 25 grams of paint per ft^2 of steel and 10% of the paint by weight is lead. The grit blaster and the ventilation booth are equipped with HEPA filters.

$$\frac{10{,}000\ ft^2}{yr}\ \Big|\ \frac{25\ g}{ft^2}\ \Big|\ \frac{1\ lb\ pb}{10 lb\ paint}\ \Big|\ \frac{kg}{1000\ g}\ \Big|\ \frac{2.205\ lb}{kg}\ \Big|\ \underline{0.0003}$$

= 0.0165 lb. lead/year

The lead in structural paint at the FEMP is typically lead oxide but in some instances it is lead chromate. From the ACGIH Handbook for Threshold Limit Values, 1993- 1994, Table of Adopted Values, the TLV for lead chromate is 0.012 mg/m^3 and the TLV for inorganic lead compounds, from the Table of Intended Changes, is 0.05 mg/m^3.

The lead chromate would have the more conservative MAGLC.

$(0.012\ mg/m^3)/100 = 0.00012\ mg/m^3 = 0.12\ \mu g/m^3$

Maximum 1 hour emission rate of the lead paint from the activity is:

$$\frac{.0165 lb}{yr}\ \Big|\ \frac{1000 g}{2.205 lb}\ \Big|\ \frac{yr}{52 wk}\ \Big|\ \frac{wk}{5\ day}\ \Big|\ \frac{day}{24\ hr}\ \Big|\ \frac{hr}{60\ min}\ \Big|\ \frac{min}{60\ sec}\ \Big|$$

= 3.3 E-07 g/s

Other process inputs:

Flow rate of air filtration devices:	1000 cfm
Stack height:	2 m
Stack diameter:	0.4 m
Distance to fenceline:	423 m

The BEE-Line Screen3 model result is attached (Attachment 5). The model results show this activity as planned is under the MAGLC value (by approximately 180x). Therefore, no additional controls for Lead-emissions are necessary even if 300,000 ft^2 of steel is to be decontaminated.

Particulate Emissions:

Particulate emission estimates should be two-thirds those estimated in the 1995 PIS for the decontamination of Plant 1 Ore Silo steel (letter to Jack Craig from Terence Hagen dated June 30, 1995). These calculations will not be duplicated in this document.

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S   R E P O R T

Non-Radon Individual Assessment
June 19, 1997 10:30 am

Facility: Fernald Environmental Management Project
Address: P.O. Box 538704
7400 Willey Road
City: Cincinnati
State: OH Zip: 45253-8704

Effective Dose Equivalent
(mrem/year)

3.26E-03

At This Location: 815 Meters North Northeast

Source Category:
Source Type: Stack
Emission Year: 96

Comments: Grit blasting of contaminated steel for recycling/ reuse.

Dataset Name: 78-GBP
Dataset Date: June 19, 1997 10:27 am
Wind File: WNDFILES\FEMPSTD.WND

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 815 Meters North Northeast
Lifetime Fatal Cancer Risk: 4.28E-08

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Dose Equivalent (mrem/y)
GONADS	4.85E-06
BREAST	5.63E-06
R MAR	1.47E-04
LUNGS	2.61E-02
THYROID	4.75E-06
ENDOST	1.89E-03
RMNDR	1.70E-04
EFFEC	3.26E-03

RADIONUCLIDE EMISSIONS DURING THE YEAR 96

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
U-238	Y	0.30	4.6E-05	4.6E-05

SITE INFORMATION

Temperature:	20 degrees C
Precipitation:	146 cm/y
Mixing Height:	965 m

SOURCE INFORMATION

Source Number:	1
Stack Height (m):	2.00
Diameter (m):	0.47
Plume Rise Momentum (m/s): (Exit Velocity)	2.56E+01

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

815	918	1951	1779	1582	1538	1662	1793	1594	1482
951	1505	1812	1142	1129					

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

D O S E A N D R I S K E Q U I V A L E N T S U M M A R I E S

Non-Radon Individual Assessment
Jun 19, 1997 10:30 am

Facility: Fernald Environmental Management Project
Address: P.O. Box 538704
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Source Type: Stack
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reuse.

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Dataset Date: Jun 19, 1997 10:27 am
Wind File: WNDFILES\FEMPSTD.WND

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)
GONADS	4.85E-06
BREAST	5.63E-06
R MAR	1.47E-04
LUNGS	2.61E-02
THYROID	4.75E-06
ENDOST	1.89E-03
RMNDR	1.70E-04
EFFEC	3.26E-03

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem/y)
INGESTION	1.21E-04
INHALATION	3.14E-03
AIR IMMERSION	9.70E-13
GROUND SURFACE	1.95E-07
INTERNAL	3.26E-03
EXTERNAL	1.95E-07
TOTAL	3.26E-03

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem/y)
U-238	3.26E-03
TOTAL	3.26E-03

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
LEUKEMIA	1.84E-10
BONE	1.02E-10
THYROID	8.49E-13
BREAST	1.05E-11
LUNG	4.21E-08
STOMACH	6.81E-12
BOWEL	1.42E-11
LIVER	5.50E-12
PANCREAS	4.45E-12
URINARY	3.69E-10
OTHER	5.44E-12
TOTAL	4.28E-08

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	6.72E-10
INHALATION	4.22E-08
AIR IMMERSION	2.06E-17
GROUND SURFACE	4.11E-12
INTERNAL	4.28E-08
EXTERNAL	4.11E-12
TOTAL	4.28E-08

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
U-238	4.28E-08
TOTAL	4.28E-08

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	815	918	1951	1779	1582	1538	1662
N	1.6E-03	1.3E-03	3.9E-04	4.5E-04	5.5E-04	5.7E-04	5.0E-04
NNW	6.9E-04	5.6E-04	1.7E-04	2.0E-04	2.4E-04	2.5E-04	2.2E-04
NW	5.6E-04	4.6E-04	1.5E-04	1.7E-04	2.0E-04	2.1E-04	1.9E-04
WNW	4.8E-04	4.0E-04	1.3E-04	1.4E-04	1.7E-04	1.8E-04	1.6E-04
W	7.0E-04	5.8E-04	1.8E-04	2.1E-04	2.5E-04	2.6E-04	2.3E-04
WSW	2.0E-03	1.6E-03	4.8E-04	5.6E-04	6.7E-04	7.0E-04	6.2E-04
SW	1.3E-03	1.0E-03	3.2E-04	3.6E-04	4.4E-04	4.6E-04	4.1E-04
SSW	1.8E-03	1.5E-03	4.2E-04	4.8E-04	5.9E-04	6.1E-04	5.4E-04
S	1.6E-03	1.3E-03	3.9E-04	4.6E-04	5.5E-04	5.8E-04	5.1E-04
SSE	1.6E-03	1.3E-03	3.7E-04	4.3E-04	5.2E-04	5.5E-04	4.8E-04
SE	1.3E-03	1.1E-03	3.5E-04	4.0E-04	4.8E-04	5.1E-04	4.5E-04
ESE	2.0E-03	1.6E-03	4.9E-04	5.7E-04	6.9E-04	7.2E-04	6.3E-04
E	1.4E-03	1.1E-03	3.4E-04	4.0E-04	4.8E-04	5.0E-04	4.4E-04
ENE	1.6E-03	1.3E-03	3.8E-04	4.4E-04	5.3E-04	5.5E-04	4.9E-04
NE	1.8E-03	1.4E-03	4.1E-04	4.8E-04	5.8E-04	6.1E-04	5.4E-04
NNE	3.3E-03	2.7E-03	7.9E-04	9.2E-04	1.1E-03	1.2E-03	1.0E-03

	Distance (m)						
Direction	1793	1594	1482	951	1505	1812	1142
N	4.5E-04	5.4E-04	6.1E-04	1.2E-03	5.9E-04	4.4E-04	9.2E-04
NNW	1.9E-04	2.3E-04	2.6E-04	5.3E-04	2.5E-04	1.9E-04	3.9E-04
NW	1.7E-04	2.0E-04	2.2E-04	4.3E-04	2.2E-04	1.6E-04	3.3E-04
WNW	1.4E-04	1.7E-04	1.9E-04	3.7E-04	1.8E-04	1.4E-04	2.8E-04
W	2.1E-04	2.5E-04	2.8E-04	5.5E-04	2.7E-04	2.1E-04	4.1E-04
WSW	5.5E-04	6.6E-04	7.5E-04	1.5E-03	7.3E-04	5.4E-04	1.1E-03
SW	3.6E-04	4.3E-04	4.9E-04	9.8E-04	4.7E-04	3.5E-04	7.3E-04
SSW	4.8E-04	5.8E-04	6.5E-04	1.4E-03	6.4E-04	4.7E-04	1.0E-03
S	4.5E-04	5.4E-04	6.1E-04	1.3E-03	6.0E-04	4.4E-04	9.3E-04
SSE	4.3E-04	5.2E-04	5.8E-04	1.2E-03	5.7E-04	4.2E-04	8.9E-04
SE	4.0E-04	4.8E-04	5.3E-04	1.0E-03	5.2E-04	3.9E-04	7.9E-04
ESE	5.6E-04	6.8E-04	7.6E-04	1.6E-03	7.4E-04	5.5E-04	1.2E-03
E	3.9E-04	4.7E-04	5.3E-04	1.1E-03	5.2E-04	3.9E-04	8.0E-04
ENE	4.3E-04	5.2E-04	5.9E-04	1.2E-03	5.7E-04	4.2E-04	8.9E-04
NE	4.7E-04	5.7E-04	6.5E-04	1.3E-03	6.3E-04	4.7E-04	9.8E-0[illegible]
NNE	9.0E-04	1.1E-03	1.2E-03	2.5E-03	1.2E-03	8.9E-04	1.9E-03

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)
Direction	1129
N	9.4E-04
NNW	4.0E-04
NW	3.3E-04
WNW	2.8E-04
W	4.2E-04
WSW	1.2E-03
SW	7.4E-04
SSW	1.0E-03
S	9.5E-04
SSE	9.1E-04
SE	8.0E-04
ESE	1.2E-03
E	8.2E-04
ENE	9.1E-04
NE	1.0E-03
NNE	1.9E-03

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

Direction	815	918	1951	1779	1582	1538	1662
	Distance (m)						
N	2.1E-08	1.7E-08	5.0E-09	5.8E-09	7.1E-09	7.4E-09	6.5E-09
NNW	9.1E-09	7.3E-09	2.1E-09	2.5E-09	3.0E-09	3.1E-09	2.8E-09
NW	7.2E-09	5.9E-09	1.8E-09	2.1E-09	2.5E-09	2.7E-09	2.4E-09
WNW	6.3E-09	5.1E-09	1.6E-09	1.8E-09	2.2E-09	2.2E-09	2.0E-09
W	9.1E-09	7.5E-09	2.3E-09	2.7E-09	3.2E-09	3.4E-09	3.0E-09
WSW	2.6E-08	2.1E-08	6.2E-09	7.2E-09	8.7E-09	9.1E-09	8.1E-09
SW	1.7E-08	1.4E-08	4.0E-09	4.7E-09	5.7E-09	5.9E-09	5.2E-09
SSW	2.4E-08	1.9E-08	5.4E-09	6.2E-09	7.6E-09	8.0E-09	7.0E-09
S	2.1E-08	1.7E-08	5.1E-09	5.9E-09	7.1E-09	7.5E-09	6.6E-09
SSE	2.1E-08	1.7E-08	4.8E-09	5.6E-09	6.8E-09	7.1E-09	6.2E-09
SE	1.7E-08	1.4E-08	4.5E-09	5.2E-09	6.3E-09	6.5E-09	5.8E-09
ESE	2.6E-08	2.2E-08	6.3E-09	7.4E-09	8.9E-09	9.3E-09	8.2E-09
E	1.8E-08	1.5E-08	4.4E-09	5.1E-09	6.2E-09	6.5E-09	5.7E-09
ENE	2.1E-08	1.7E-08	4.8E-09	5.6E-09	6.8E-09	7.1E-09	6.3E-09
NE	2.3E-08	1.9E-08	5.3E-09	6.2E-09	7.5E-09	7.9E-09	6.9E-09
NNE	4.3E-08	3.5E-08	1.0E-08	1.2E-08	1.4E-08	1.5E-08	1.3E-08

Direction	1793	1594	1482	951	1505	1812	1142
	Distance (m)						
N	5.8E-09	7.0E-09	7.9E-09	1.6E-08	7.7E-09	5.7E-09	1.2E-08
NNW	2.4E-09	3.0E-09	3.3E-09	6.9E-09	3.2E-09	2.4E-09	5.1E-09
NW	2.1E-09	2.5E-09	2.8E-09	5.6E-09	2.7E-09	2.1E-09	4.2E-09
WNW	1.8E-09	2.1E-09	2.4E-09	4.8E-09	2.3E-09	1.7E-09	3.6E-09
W	2.6E-09	3.2E-09	3.6E-09	7.1E-09	3.5E-09	2.6E-09	5.3E-09
WSW	7.1E-09	8.6E-09	9.7E-09	2.0E-08	9.5E-09	7.0E-09	1.5E-08
SW	4.6E-09	5.6E-09	6.3E-09	1.3E-08	6.1E-09	4.6E-09	9.5E-09
SSW	6.2E-09	7.5E-09	8.5E-09	1.8E-08	8.3E-09	6.1E-09	1.3E-08
S	5.8E-09	7.0E-09	7.9E-09	1.6E-08	7.7E-09	5.7E-09	1.2E-08
SSE	5.5E-09	6.7E-09	7.5E-09	1.6E-08	7.3E-09	5.4E-09	1.2E-08
SE	5.2E-09	6.2E-09	6.9E-09	1.4E-08	6.8E-09	5.1E-09	1.0E-08
ESE	7.3E-09	8.8E-09	9.9E-09	2.0E-08	9.6E-09	7.1E-09	1.5E-08
E	5.1E-09	6.1E-09	6.9E-09	1.4E-08	6.7E-09	5.0E-09	1.0E-08
ENE	5.6E-09	6.7E-09	7.6E-09	1.6E-08	7.4E-09	5.5E-09	1.2E-08
NE	6.1E-09	7.4E-09	8.4E-09	1.7E-08	8.2E-09	6.0E-09	1.3E-08
NNE	1.2E-08	1.4E-08	1.6E-08	3.3E-08	1.6E-08	1.2E-08	2.4E-0[illegible]

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)
Direction	1129
N	1.2E-08
NNW	5.2E-09
NW	4.3E-09
WNW	3.6E-09
W	5.4E-09
WSW	1.5E-08
SW	9.7E-09
SSW	1.3E-08
S	1.2E-08
SSE	1.2E-08
SE	1.0E-08
ESE	1.5E-08
E	1.1E-08
ENE	1.2E-08
NE	1.3E-08
NNE	2.5E-08

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Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S   R E P O R T

Non-Radon Individual Assessment
June 19, 1997 10:30 am

Facility: Fernald Environmental Management Project
Address: P.O. Box 538704
7400 Willey Road
City: Cincinnati
State: OH   Zip: 45253-8704

Effective Dose Equivalent
(mrem/year)

3.26E-04

At This Location: 815 Meters North Northeast

Source Category:
Source Type: Stack
Emission Year: 96

Comments: Grit blasting of contaminated steel for recycling/ reuse.

Dataset Name: 78-GBFVB
Dataset Date: June 19, 1997 10:27 am
Wind File: WNDFILES\FEMPSTD.WND

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 815 Meters North Northeast
Lifetime Fatal Cancer Risk: 4.28E-09

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Dose Equivalent (mrem/y)
GONADS	4.85E-07
BREAST	5.63E-07
R MAR	1.47E-05
LUNGS	2.61E-03
THYROID	4.75E-07
ENDOST	1.89E-04
RMNDR	1.70E-05
EFFEC	3.26E-04

RADIONUCLIDE EMISSIONS DURING THE YEAR 96

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
U-238	Y	0.30	4.6E-06	4.6E-06

SITE INFORMATION

Temperature: 20 degrees C
Precipitation: 146 cm/y
Mixing Height: 965 m

SOURCE INFORMATION

Source Number:	1
Stack Height (m):	2.00
Diameter (m):	0.47
Plume Rise Momentum (m/s): (Exit Velocity)	2.56E+01

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

815	918	1951	1779	1582	1538	1662	1793	1594	1482
951	1505	1812	1142	1129					

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

D O S E   A N D   R I S K   E Q U I V A L E N T   S U M M A R I E S

Non-Radon Individual Assessment
Jun 19, 1997 10:30 am

Facility: Fernald Environmental Management Project
Address: P.O. Box 538704
7400 Willey Road
City: Cincinnati
State: OH Zip: 45253-8704

Source Category:
Source Type: Stack
Emission Year: 96

Comments: Grit blasting of contaminated steel for recycling/ reuse.

Dataset Name: 78-GBFVB
Dataset Date: Jun 19, 1997 10:29 am
Wind File: WNDFILES\FEMPSTD.WND

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)
GONADS	4.85E-07
BREAST	5.63E-07
R MAR	1.47E-05
LUNGS	2.61E-03
THYROID	4.75E-07
ENDOST	1.89E-04
RMNDR	1.70E-05
EFFEC	3.26E-04

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem/y)
INGESTION	1.21E-05
INHALATION	3.14E-04
AIR IMMERSION	9.70E-14
GROUND SURFACE	1.95E-08
INTERNAL	3.26E-04
EXTERNAL	1.95E-08
TOTAL	3.26E-04

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem/y)
U-238	3.26E-04
TOTAL	3.26E-04

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
LEUKEMIA	1.84E-11
BONE	1.02E-11
THYROID	8.49E-14
BREAST	1.05E-12
LUNG	4.21E-09
STOMACH	6.81E-13
BOWEL	1.42E-12
LIVER	5.50E-13
PANCREAS	4.45E-13
URINARY	3.69E-11
OTHER	5.44E-13
TOTAL	4.28E-09

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	6.72E-11
INHALATION	4.22E-09
AIR IMMERSION	2.06E-18
GROUND SURFACE	4.11E-13
INTERNAL	4.28E-09
EXTERNAL	4.11E-13
TOTAL	4.28E-09

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
U-238	4.28E-09
TOTAL	4.28E-09

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	815	918	1951	1779	1582	1538	1662
N	1.6E-04	1.3E-04	3.9E-05	4.5E-05	5.5E-05	5.7E-05	5.0E-05
NNW	6.9E-05	5.6E-05	1.7E-05	2.0E-05	2.4E-05	2.5E-05	2.2E-05
NW	5.6E-05	4.6E-05	1.5E-05	1.7E-05	2.0E-05	2.1E-05	1.9E-05
WNW	4.8E-05	4.0E-05	1.3E-05	1.4E-05	1.7E-05	1.8E-05	1.6E-05
W	7.0E-05	5.8E-05	1.8E-05	2.1E-05	2.5E-05	2.6E-05	2.3E-05
WSW	2.0E-04	1.6E-04	4.8E-05	5.6E-05	6.7E-05	7.0E-05	6.2E-05
SW	1.3E-04	1.0E-04	3.2E-05	3.6E-05	4.4E-05	4.6E-05	4.1E-05
SSW	1.8E-04	1.5E-04	4.2E-05	4.8E-05	5.9E-05	6.1E-05	5.4E-05
S	1.6E-04	1.3E-04	3.9E-05	4.6E-05	5.5E-05	5.8E-05	5.1E-05
SSE	1.6E-04	1.3E-04	3.7E-05	4.3E-05	5.2E-05	5.5E-05	4.8E-05
SE	1.3E-04	1.1E-04	3.5E-05	4.0E-05	4.8E-05	5.1E-05	4.5E-05
ESE	2.0E-04	1.6E-04	4.9E-05	5.7E-05	6.9E-05	7.2E-05	6.3E-05
E	1.4E-04	1.1E-04	3.4E-05	4.0E-05	4.8E-05	5.0E-05	4.4E-05
ENE	1.6E-04	1.3E-04	3.8E-05	4.4E-05	5.3E-05	5.5E-05	4.9E-05
NE	1.8E-04	1.4E-04	4.1E-05	4.8E-05	5.8E-05	6.1E-05	5.4E-05
NNE	3.3E-04	2.7E-04	7.9E-05	9.2E-05	1.1E-04	1.2E-04	1.0E-04

	Distance (m)						
Direction	1793	1594	1482	951	1505	1812	1142
N	4.5E-05	5.4E-05	6.1E-05	1.2E-04	5.9E-05	4.4E-05	9.2E-05
NNW	1.9E-05	2.3E-05	2.6E-05	5.3E-05	2.5E-05	1.9E-05	3.9E-05
NW	1.7E-05	2.0E-05	2.2E-05	4.3E-05	2.2E-05	1.6E-05	3.3E-05
WNW	1.4E-05	1.7E-05	1.9E-05	3.7E-05	1.8E-05	1.4E-05	2.8E-05
W	2.1E-05	2.5E-05	2.8E-05	5.5E-05	2.7E-05	2.1E-05	4.1E-05
WSW	5.5E-05	6.6E-05	7.5E-05	1.5E-04	7.3E-05	5.4E-05	1.1E-04
SW	3.6E-05	4.3E-05	4.9E-05	9.8E-05	4.7E-05	3.5E-05	7.3E-05
SSW	4.8E-05	5.8E-05	6.5E-05	1.4E-04	6.4E-05	4.7E-05	1.0E-04
S	4.5E-05	5.4E-05	6.1E-05	1.3E-04	6.0E-05	4.4E-05	9.3E-05
SSE	4.3E-05	5.2E-05	5.8E-05	1.2E-04	5.7E-05	4.2E-05	8.9E-05
SE	4.0E-05	4.8E-05	5.3E-05	1.0E-04	5.2E-05	3.9E-05	7.9E-05
ESE	5.6E-05	6.8E-05	7.6E-05	1.6E-04	7.4E-05	5.5E-05	1.2E-04
E	3.9E-05	4.7E-05	5.3E-05	1.1E-04	5.2E-05	3.9E-05	8.0E-05
ENE	4.3E-05	5.2E-05	5.9E-05	1.2E-04	5.7E-05	4.2E-05	8.9E-05
NE	4.7E-05	5.7E-05	6.5E-05	1.3E-04	6.3E-05	4.7E-05	9.8E-05
NNE	9.0E-05	1.1E-04	1.2E-04	2.5E-04	1.2E-04	8.9E-05	1.9E-04

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

Direction	Distance (m)
	1129
N	9.4E-05
NNW	4.0E-05
NW	3.3E-05
WNW	2.8E-05
W	4.2E-05
WSW	1.2E-04
SW	7.4E-05
SSW	1.0E-04
S	9.5E-05
SSE	9.1E-05
SE	8.0E-05
ESE	1.2E-04
E	8.2E-05
ENE	9.1E-05
NE	1.0E-04
NNE	1.9E-04

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	815	918	1951	1779	1582	1538	1662
N	2.1E-09	1.7E-09	5.0E-10	5.8E-10	7.1E-10	7.4E-10	6.5E-10
NNW	9.1E-10	7.3E-10	2.1E-10	2.5E-10	3.0E-10	3.1E-10	2.8E-10
NW	7.2E-10	5.9E-10	1.8E-10	2.1E-10	2.5E-10	2.7E-10	2.4E-10
WNW	6.3E-10	5.1E-10	1.6E-10	1.8E-10	2.2E-10	2.2E-10	2.0E-10
W	9.1E-10	7.5E-10	2.3E-10	2.7E-10	3.2E-10	3.4E-10	3.0E-10
WSW	2.6E-09	2.1E-09	6.2E-10	7.2E-10	8.7E-10	9.1E-10	8.1E-10
SW	1.7E-09	1.4E-09	4.0E-10	4.7E-10	5.7E-10	5.9E-10	5.2E-10
SSW	2.4E-09	1.9E-09	5.4E-10	6.2E-10	7.6E-10	8.0E-10	7.0E-10
S	2.1E-09	1.7E-09	5.1E-10	5.9E-10	7.1E-10	7.5E-10	6.6E-10
SSE	2.1E-09	1.7E-09	4.8E-10	5.6E-10	6.8E-10	7.1E-10	6.2E-10
SE	1.7E-09	1.4E-09	4.5E-10	5.2E-10	6.3E-10	6.5E-10	5.8E-10
ESE	2.6E-09	2.2E-09	6.3E-10	7.4E-10	8.9E-10	9.3E-10	8.2E-10
E	1.8E-09	1.5E-09	4.4E-10	5.1E-10	6.2E-10	6.5E-10	5.7E-10
ENE	2.1E-09	1.7E-09	4.8E-10	5.6E-10	6.8E-10	7.1E-10	6.3E-10
NE	2.3E-09	1.9E-09	5.3E-10	6.2E-10	7.5E-10	7.9E-10	6.9E-10
NNE	4.3E-09	3.5E-09	1.0E-09	1.2E-09	1.4E-09	1.5E-09	1.3E-09

	Distance (m)						
Direction	1793	1594	1482	951	1505	1812	1142
N	5.8E-10	7.0E-10	7.9E-10	1.6E-09	7.7E-10	5.7E-10	1.2E-09
NNW	2.4E-10	3.0E-10	3.3E-10	6.9E-10	3.2E-10	2.4E-10	5.1E-10
NW	2.1E-10	2.5E-10	2.8E-10	5.6E-10	2.7E-10	2.1E-10	4.2E-10
WNW	1.8E-10	2.1E-10	2.4E-10	4.8E-10	2.3E-10	1.7E-10	3.6E-10
W	2.6E-10	3.2E-10	3.6E-10	7.1E-10	3.5E-10	2.6E-10	5.3E-10
WSW	7.1E-10	8.6E-10	9.7E-10	2.0E-09	9.5E-10	7.0E-10	1.5E-09
SW	4.6E-10	5.6E-10	6.3E-10	1.3E-09	6.1E-10	4.6E-10	9.5E-10
SSW	6.2E-10	7.5E-10	8.5E-10	1.8E-09	8.3E-10	6.1E-10	1.3E-09
S	5.8E-10	7.0E-10	7.9E-10	1.6E-09	7.7E-10	5.7E-10	1.2E-09
SSE	5.5E-10	6.7E-10	7.5E-10	1.6E-09	7.3E-10	5.4E-10	1.2E-09
SE	5.2E-10	6.2E-10	6.9E-10	1.4E-09	6.8E-10	5.1E-10	1.0E-09
ESE	7.3E-10	8.8E-10	9.9E-10	2.0E-09	9.6E-10	7.1E-10	1.5E-09
E	5.1E-10	6.1E-10	6.9E-10	1.4E-09	6.7E-10	5.0E-10	1.0E-09
ENE	5.6E-10	6.7E-10	7.6E-10	1.6E-09	7.4E-10	5.5E-10	1.2E-09
NE	6.1E-10	7.4E-10	8.4E-10	1.7E-09	8.2E-10	6.0E-10	1.3E-09
NNE	1.2E-09	1.4E-09	1.6E-09	3.3E-09	1.6E-09	1.2E-09	2.4E-09

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)
Direction	1129
N	1.2E-09
NNW	5.2E-10
NW	4.3E-10
WNW	3.6E-10
W	5.4E-10
WSW	1.5E-09
SW	9.7E-10
SSW	1.3E-09
S	1.2E-09
SSE	1.2E-09
SE	1.0E-09
ESE	1.5E-09
E	1.1E-09
ENE	1.2E-09
NE	1.3E-09
NNE	2.5E-09

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PLANT 8 CONCRETE SHOT-BLASTING

EMISSION ESTIMATE
PLANT 8 CONCRETE SHOT-BLASTING DEMONSTRATION

1. Average Radionuclide Concentration for Building 8A Concrete Chips.

NOTE: Only one result (13 total) was used for each page of results. Highest result reported on each page for each radionuclide was used to calculate the concentration for each radionuclide. Therefore, the radionuclide concentration reported below is ~~actually~~ higher than the actual average. Values used will be included in PEAPR files.

Radionuclide	Concentration (pCi/g)
U^{238}	1623
U^{235}	177.5
U^{234}	1747
Th^{232}	18.5
Th^{230}	87.4
Th^{228}	18.5
Pb^{210}	2.6
Pu^{241}	5.3
Sr^{90}	0.23
Tc^{99}	597

2. Concrete Emission Estimate.

A. ASSUMPTIONS

- o 137 ft^3 of concrete will be removed.
- o Density of concrete is 4000 lb/yd^3 (from App. A of AP-42).
- o Efficiency of grit blast vacuum system is 99% (does not include filters).

Note: This is conservative. 40 CFR Part 61 Appendix D would allow use of 10^{-3} as an emission factor for particulate matter.

B. TOTAL CONCRETE EMISSIONS

137 ft^3	4000 lb	yd^3	1 - .99	kg	= 92.05
	yd^3	27 ft^3		2.205 lb	kg-concrete

EMISSION ESTIMATE
PLANT 8 CONCRETE SHOT-BLASTING
DEMONSTRATION

C. TOTAL CURIES PER YEAR

Formula: 92.05 kg x (1000g/kg) x ______ pCi/g x (1 Ci/1x10^{12}pCi)
= total activity per year for radionuclide

Radionuclide	Total Curies (Ci/yr)
U^{238}	1.49E-4
U^{235}	1.63E-5
U^{234}	1.61E-4
Th^{232}	1.70E-7
Th^{230}	8.05E-6
Th^{228}	1.70E-6
Pb^{210}	2.38E-7
Pu^{241}	4.85E-7
Sr^{90}	2.12E-8
Tc^{99}	1.06E-6 (Ci/wk)

3. Process Ventilation System

A. ASSUMPTIONS

- o 2750 cfm flowrate
- o 120" high
- o 8" diameter discharge (guess) (0.35 ft^2 area)

B. EXIT VELOCITY

2750 ft^3		minute	0.305 m	= 39.9 m/sec
minute	0.35 ft^2	60 seconds	ft	

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Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S   R E P O R T

Non-Radon Individual Assessment
Feb 10, 1998   9:44 am

Facility: FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
Address: P.O. BOX 538704
7400 WILLEY ROAD
City: CINCINNATI
State: OH   Zip: 45253-8704

Effective Dose Equivalent
(mrem / year)

1.87E-02

At This Location: 958 Meters North Northeast

Source Category: REMEDIATION SITE
Source Type: Stack
Emission Year: 1998

Comments: GRIT BLASTER BLDG 8 - CONCRETE REMOVAL DEMO
REFLECT ACTUAL MAXIMALLY EXPOSED INDIVIDUAL

Dataset Name: 98P8CONCRETE
Dataset Date: Feb 10, 1998   9:44 am
Wind File: WNDFILES\FEMPSTD.WND

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 958 Meters North Northeast
Lifetime Fatal Cancer Risk: 2.40E-07

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Dose Equivalent (mrem/y)
GONADS	4.40E-05
BREAST	4.98E-05
R MAR	1.71E-03
LUNGS	1.46E-01
THYROID	4.35E-05
ENDOST	2.25E-02
RMNDR	9.20E-04
EFFEC	1.87E-02

RADIONUCLIDE EMISSIONS DURING THE YEAR 1998

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
U-234	Y	0.30	1.6E-04	1.6E-04
U-235	Y	1.00	1.6E-05	1.6E-05
U-238	Y	0.30	1.5E-04	1.5E-04
TH-228	Y	0.30	1.7E-06	1.7E-06
TH-230	Y	0.30	8.1E-06	8.1E-06
TH-232	Y	0.30	1.7E-06	1.7E-06
SR-90	Y	1.00	2.1E-08	2.1E-08
TC-99	W	1.00	1.1E-06	1.1E-06
PB-210	Y	0.30	2.4E-07	2.4E-07
PU-241	Y	1.00	4.8E-07	4.8E-07

SITE INFORMATION

Temperature: 12 degrees C
Precipitation: 99 cm/y
Mixing Height: 950 m

SOURCE INFORMATION

Source Number:	1
Stack Height (m):	3.05
Diameter (m):	0.35
Plume Rise	
Momentum (m/s): (Exit Velocity)	3.99E+01

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

1192	1680	1539	1243	2258	958	1071	1141	1256	1255
1405	1206	2319	1736	1692	1255				

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

D O S E   A N D   R I S K   E Q U I V A L E N T   S U M M A R I E S

Non-Radon Individual Assessment
Feb 10, 1998   9:44 am

Facility: FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
Address: P.O. BOX 538704
7400 WILLEY ROAD
City: CINCINNATI
State: OH   Zip: 45253-8704

Source Category: REMEDIATION SITE
Source Type: Stack
Emission Year: 1998

Comments: GRIT BLASTER BLDG 8 - CONCRETE REMOVAL DEMO
REFLECT ACTUAL MAXIMALLY EXPOSED INDIVIDUAL

Dataset Name: 98P8CONCRETE
Dataset Date: Feb 10, 1998   9:44 am
Wind File: WNDFILES\FEMPSTD.WND

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)
GONADS	4.40E-05
BREAST	4.98E-05
R MAR	1.71E-03
LUNGS	1.46E-01
THYROID	4.35E-05
ENDOST	2.25E-02
RMNDR	9.20E-04
EFFEC	1.87E-02

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem/y)
INGESTION	6.54E-04
INHALATION	1.80E-02
AIR IMMERSION	3.75E-10
GROUND SURFACE	1.35E-05
INTERNAL	1.86E-02
EXTERNAL	1.35E-05
TOTAL	1.87E-02

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem/y)
U-234	9.24E-03
U-235	5.26E-04
U-238	7.61E-03
TH-228	1.80E-04
TH-230	8.31E-04
TH-232	2.55E-04
SR-90	2.42E-08
TC-99	1.75E-07
PB-210	1.28E-05
PU-241	6.82E-07
TOTAL	1.87E-02

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
LEUKEMIA	1.65E-09
BONE	1.09E-09
THYROID	1.17E-11
BREAST	1.24E-10
LUNG	2.35E-07
STOMACH	7.43E-11
BOWEL	8.21E-11
LIVER	1.04E-10
PANCREAS	4.57E-11
URINARY	1.96E-09
OTHER	5.59E-11
TOTAL	2.40E-07

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	3.43E-09
INHALATION	2.36E-07
AIR IMMERSION	8.73E-15
GROUND SURFACE	3.12E-10
INTERNAL	2.40E-07
EXTERNAL	3.12E-10
TOTAL	2.40E-07

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
U-234	1.21E-07
U-235	6.90E-09
U-238	1.00E-07
TH-228	3.65E-09
TH-230	6.97E-09
TH-232	1.45E-09
SR-90	5.00E-13
TC-99	6.43E-12
PB-210	1.63E-10
PU-241	2.60E-12
TOTAL	2.40E-07

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	1192	1680	1539	1243	2258	958	1071
N	6.6E-03	3.8E-03	4.4E-03	6.2E-03	2.4E-03	9.4E-03	7.9E-03
NNW	2.8E-03	1.7E-03	1.9E-03	2.7E-03	1.1E-03	4.0E-03	3.4E-03
NW	2.3E-03	1.4E-03	1.6E-03	2.2E-03	9.0E-04	3.2E-03	2.7E-03
WNW	2.0E-03	1.2E-03	1.4E-03	1.9E-03	7.7E-04	2.8E-03	2.3E-03
W	2.9E-03	1.7E-03	2.0E-03	2.7E-03	1.1E-03	4.0E-03	3.3E-03
WSW	8.2E-03	4.7E-03	5.4E-03	7.6E-03	2.9E-03	1.2E-02	9.7E-03
SW	5.2E-03	3.0E-03	3.5E-03	4.8E-03	1.9E-03	7.3E-03	6.1E-03
SSW	7.3E-03	4.2E-03	4.8E-03	6.8E-03	2.6E-03	1.1E-02	8.7E-03
S	6.6E-03	3.9E-03	4.4E-03	6.2E-03	2.4E-03	9.5E-03	7.9E-03
SSE	6.4E-03	3.7E-03	4.2E-03	6.0E-03	2.3E-03	9.3E-03	7.7E-03
SE	5.5E-03	3.3E-03	3.8E-03	5.1E-03	2.1E-03	7.5E-03	6.4E-03
ESE	8.2E-03	4.8E-03	5.5E-03	7.7E-03	3.0E-03	1.2E-02	9.7E-03
E	5.7E-03	3.3E-03	3.8E-03	5.3E-03	2.1E-03	8.0E-03	6.7E-0[illegible]
ENE	6.4E-03	3.7E-03	4.3E-03	6.0E-03	2.3E-03	9.2E-03	7.6E-0[illegible]
NE	7.1E-03	4.1E-03	4.7E-03	6.6E-03	2.5E-03	1.0E-02	8.4E-03
NNE	1.3E-02	7.7E-03	8.9E-03	1.2E-02	4.8E-03	1.9E-02	1.6E-02

	Distance (m)						
Direction	1141	1256	1255	1405	1206	2319	1736
N	7.1E-03	6.1E-03	6.1E-03	5.1E-03	6.5E-03	2.3E-03	3.6E-03
NNW	3.0E-03	2.6E-03	2.6E-03	2.2E-03	2.8E-03	1.0E-03	1.6E-03
NW	2.5E-03	2.1E-03	2.1E-03	1.8E-03	2.3E-03	8.7E-04	1.3E-03
WNW	2.1E-03	1.8E-03	1.8E-03	1.6E-03	2.0E-03	7.4E-04	1.1E-03
W	3.1E-03	2.6E-03	2.7E-03	2.2E-03	2.8E-03	1.1E-03	1.6E-03
WSW	8.8E-03	7.5E-03	7.5E-03	6.3E-03	8.0E-03	2.8E-03	4.5E-03
SW	5.5E-03	4.8E-03	4.8E-03	4.0E-03	5.1E-03	1.8E-03	2.9E-03
SSW	7.9E-03	6.7E-03	6.7E-03	5.6E-03	7.2E-03	2.5E-03	3.9E-03
S	7.1E-03	6.1E-03	6.1E-03	5.1E-03	6.5E-03	2.3E-03	3.7E-03
SSE	6.9E-03	5.9E-03	5.9E-03	4.9E-03	6.3E-03	2.2E-03	3.5E-03
SE	5.8E-03	5.1E-03	5.1E-03	4.3E-03	5.4E-03	2.0E-03	3.1E-03
ESE	8.8E-03	7.5E-03	7.6E-03	6.3E-03	8.0E-03	2.9E-03	4.5E-03
E	6.1E-03	5.2E-03	5.2E-03	4.4E-03	5.6E-03	2.0E-03	3.2E-03
ENE	6.9E-03	5.9E-03	5.9E-03	4.9E-03	6.3E-03	2.2E-03	3.5E-0[illegible]
NE	7.6E-03	6.5E-03	6.5E-03	5.4E-03	7.0E-03	2.4E-03	3.9E-[illegible]
NNE	1.4E-02	1.2E-02	1.2E-02	1.0E-02	1.3E-02	4.6E-03	7.3E-03

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)	
Direction	1692	1255
N	3.8E-03	6.1E-03
NNW	1.6E-03	2.6E-03
NW	1.4E-03	2.1E-03
WNW	1.2E-03	1.8E-03
W	1.7E-03	2.7E-03
WSW	4.7E-03	7.5E-03
SW	3.0E-03	4.8E-03
SSW	4.1E-03	6.7E-03
S	3.8E-03	6.1E-03
SSE	3.6E-03	5.9E-03
SE	3.3E-03	5.1E-03
ESE	4.7E-03	7.6E-03
E	3.3E-03	5.2E-03
ENE	3.7E-03	5.9E-03
NE	4.0E-03	6.5E-03
NNE	7.6E-03	1.2E-02

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

Direction	Distance (m) 1192	1680	1539	1243	2258	958	1071
N	8.5E-08	4.9E-08	5.6E-08	7.9E-08	3.0E-08	1.2E-07	1.0E-07
NNW	3.6E-08	2.1E-08	2.4E-08	3.4E-08	1.3E-08	5.1E-08	4.3E-08
NW	2.9E-08	1.7E-08	2.0E-08	2.7E-08	1.1E-08	4.1E-08	3.4E-08
WNW	2.5E-08	1.5E-08	1.7E-08	2.3E-08	9.3E-09	3.5E-08	3.0E-08
W	3.6E-08	2.2E-08	2.5E-08	3.4E-08	1.4E-08	5.0E-08	4.2E-08
WSW	1.0E-07	6.0E-08	6.9E-08	9.8E-08	3.7E-08	1.5E-07	1.2E-07
SW	6.6E-08	3.8E-08	4.4E-08	6.2E-08	2.4E-08	9.3E-08	7.8E-08
SSW	9.4E-08	5.3E-08	6.1E-08	8.7E-08	3.2E-08	1.3E-07	1.1E-07
S	8.5E-08	4.9E-08	5.6E-08	7.9E-08	3.0E-08	1.2E-07	1.0E-07
SSE	8.2E-08	4.7E-08	5.4E-08	7.7E-08	2.9E-08	1.2E-07	9.8E-08
SE	7.0E-08	4.2E-08	4.8E-08	6.6E-08	2.7E-08	9.6E-08	8.2E-08
ESE	1.0E-07	6.1E-08	7.0E-08	9.8E-08	3.8E-08	1.5E-07	1.2E-07
E	7.2E-08	4.2E-08	4.8E-08	6.8E-08	2.6E-08	1.0E-07	8.5E-0[illegible]
ENE	8.2E-08	4.7E-08	5.4E-08	7.7E-08	2.9E-08	1.2E-07	9.8E-0[illegible]
NE	9.1E-08	5.2E-08	6.0E-08	8.5E-08	3.2E-08	1.3E-07	1.1E-07
NNE	1.7E-07	9.9E-08	1.1E-07	1.6E-07	6.2E-08	2.4E-07	2.0E-07

Direction	Distance (m) 1141	1256	1255	1405	1206	2319	1736
N	9.1E-08	7.8E-08	7.8E-08	6.5E-08	8.3E-08	2.9E-08	4.6E-08
NNW	3.9E-08	3.3E-08	3.3E-08	2.8E-08	3.5E-08	1.2E-08	2.0E-08
NW	3.1E-08	2.7E-08	2.7E-08	2.3E-08	2.9E-08	1.1E-08	1.6E-08
WNW	2.7E-08	2.3E-08	2.3E-08	1.9E-08	2.5E-08	8.9E-09	1.4E-08
W	3.9E-08	3.3E-08	3.4E-08	2.8E-08	3.6E-08	1.3E-08	2.1E-08
WSW	1.1E-07	9.6E-08	9.6E-08	8.0E-08	1.0E-07	3.6E-08	5.7E-08
SW	7.0E-08	6.1E-08	6.1E-08	5.1E-08	6.5E-08	2.3E-08	3.6E-08
SSW	1.0E-07	8.6E-08	8.6E-08	7.1E-08	9.2E-08	3.1E-08	5.0E-08
S	9.1E-08	7.8E-08	7.8E-08	6.5E-08	8.3E-08	2.9E-08	4.6E-08
SSE	8.8E-08	7.5E-08	7.6E-08	6.3E-08	8.1E-08	2.7E-08	4.4E-08
SE	7.4E-08	6.5E-08	6.5E-08	5.5E-08	6.9E-08	2.6E-08	4.0E-08
ESE	1.1E-07	9.6E-08	9.6E-08	8.1E-08	1.0E-07	3.6E-08	5.8E-08
E	7.7E-08	6.7E-08	6.7E-08	5.6E-08	7.1E-08	2.5E-08	4.0E-08
ENE	8.8E-08	7.5E-08	7.5E-08	6.3E-08	8.0E-08	2.8E-08	4.5E-08
NE	9.7E-08	8.3E-08	8.3E-08	6.9E-08	8.9E-08	3.1E-08	4.9E-[illegible]
NNE	1.8E-07	1.6E-07	1.6E-07	1.3E-07	1.7E-07	5.9E-08	9.4E-[illegible]

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)	
Direction	1692	1255
N	4.8E-08	7.8E-08
NNW	2.1E-08	3.3E-08
NW	1.7E-08	2.7E-08
WNW	1.5E-08	2.3E-08
W	2.1E-08	3.4E-08
WSW	5.9E-08	9.6E-08
SW	3.8E-08	6.1E-08
SSW	5.2E-08	8.6E-08
S	4.8E-08	7.8E-08
SSE	4.6E-08	7.6E-08
SE	4.1E-08	6.5E-08
ESE	6.0E-08	9.6E-08
E	4.2E-08	6.7E-08
ENE	4.6E-08	7.5E-08
NE	5.1E-08	8.3E-08
NNE	9.8E-08	1.6E-07

Appendix E

APPENDIX E

SPLIT/CO-LOCATED SAMPLING COMPARISON WITH OEPA

TABLE OF CONTENTS

LIST OF ACRONYMS

DOE	U.S. Department of Energy
OEPA	Ohio Environmental Protection Agency
pCi/g	picoCuries per grams
pCi/L	picoCuries per liter
μg/L	micrograms per liter

APPENDIX E

Appendix E presents split/co-located sample data in support of Chapter 2 of this 1998 Integrated Site Environmental Report. The data reflect results from split/co-located samples for analysis between the U.S. Department of Energy (DOE) and the Ohio Environmental Protection Agency (OEPA) for groundwater, surface water, and sediment. The results are provided in Table E-1 and the sample locations for groundwater, surface water, and sediment are depicted in Figures E-1, E-2, and E-3, respectively.

The data from the split/co-located sampling program show close agreement between DOE and OEPA results for the groundwater (except at location 12 in October) and surface water samples. However, a greater degree of variability exists between DOE and OEPA results for sediment. This is not unusual for this type of sample matrix based on the potential variability within the samples themselves. In addition, variability in the sample results may be affected by incomplete sample homogenization in the field and differences in sample preparation methods at the analytical laboratories. DOE and OEPA have discussed these issues and will continue to work together to ensure the highest degree of quality in the split/co-located sampling program. Differences in DOE and OEPA sample results presented for 1998 do not impact the Fernald Environmental Management Project's compliance with federal or state regulations.

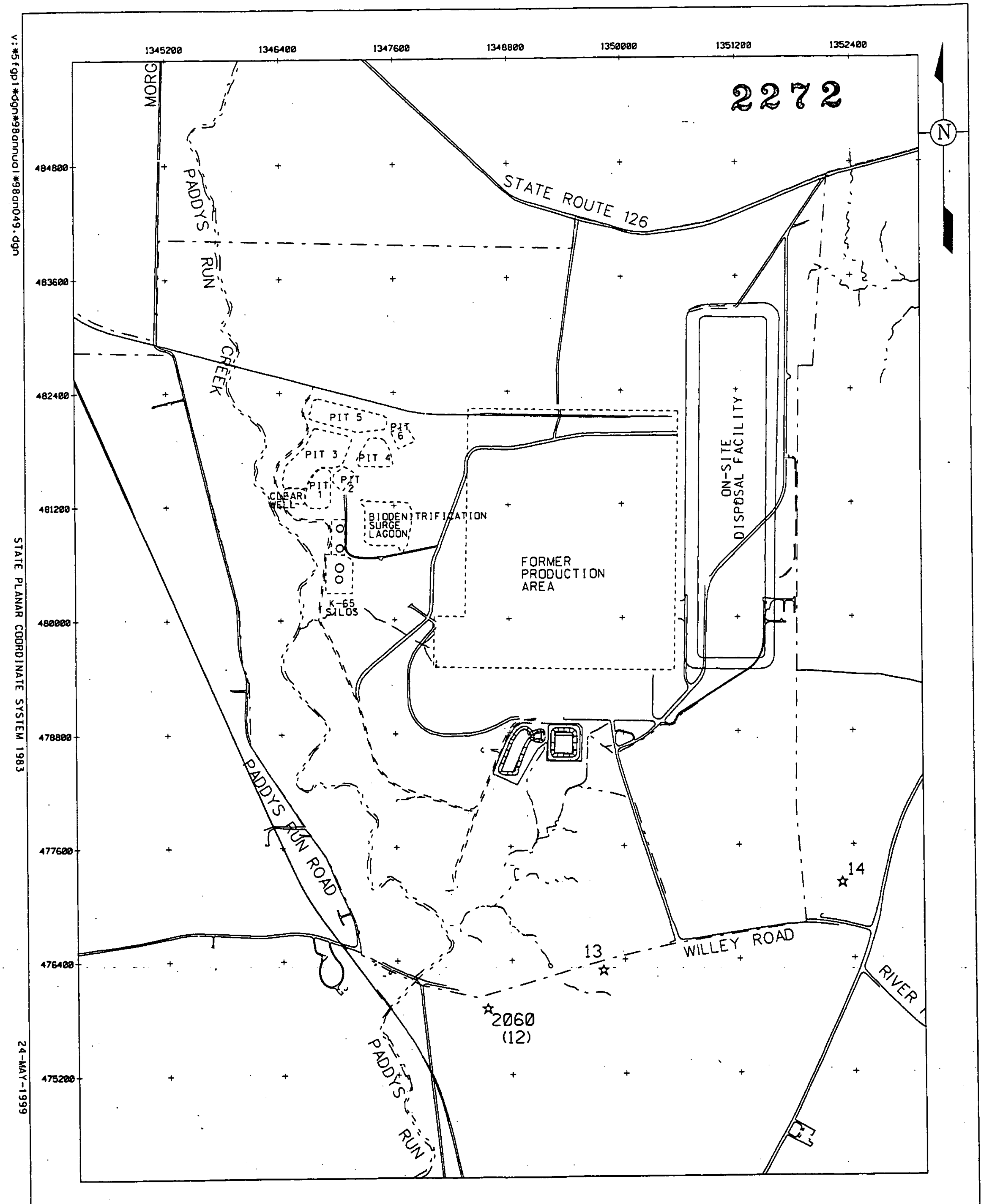
TABLE E-1

1998 FEMP DOE-OEPA SPLIT/CO-LOCATED SAMPLING COMPARISON

Media	Sample Location	Sample Date	Constituent	DOE Result	OEPA Result
Groundwater[a]				(μg/L)	(μg/L)
	12	January	Total Uranium	43	26
	12	April	Total Uranium	29	22
	12	July	Total Uranium	28	30
	12	October	Total Uranium	17.269	8.8
	13	January	Total Uranium	31	36
	13	April	Total Uranium	46	45
	13	July	Total Uranium	40	27
	13	October	Total Uranium	40.235	32
	14	January	Total Uranium	3	2.6
	14	April	Total Uranium	3.1	2.7
	14	July	Total Uranium	2.7	2.8
	14	October	Total Uranium	2.681	2.1
Surface Water[b]				(pCi/L)	(pCi/L)
	SWR-01	December	Radium-226	0.437	0.24
	SWR-01	December	Radium-228	0.505	<1.3
				(μg/L)	(μg/L)
	SWR-01	December	Total Uranium	1.53	1.6
Sediment[c,d]				(mg/kg)	(mg/kg)
	G7	July	Total Uranium	0.676	1.5
	PS5	July	Total Uranium	0.985	2.4
	PS2	July	Total Uranium	1.34	2.7
	P1	July	Total Uranium	1.16	0.76
	G2	July	Total Uranium	1.04	0.92

[a]See Figure E-1 for groundwater sample locations (splits)
[b]See Figure E-2 for surface water sample locations (co-located)
[c]See Figure E-3 for sediment sample locations (G7 split - the rest are co-located)
[d]Both DOE and OEPA samples were collected in July; however, G7 was the only location in which both samples were collected on the same day.

000600



LEGEND:

— - — - — FEMP BOUNDARY

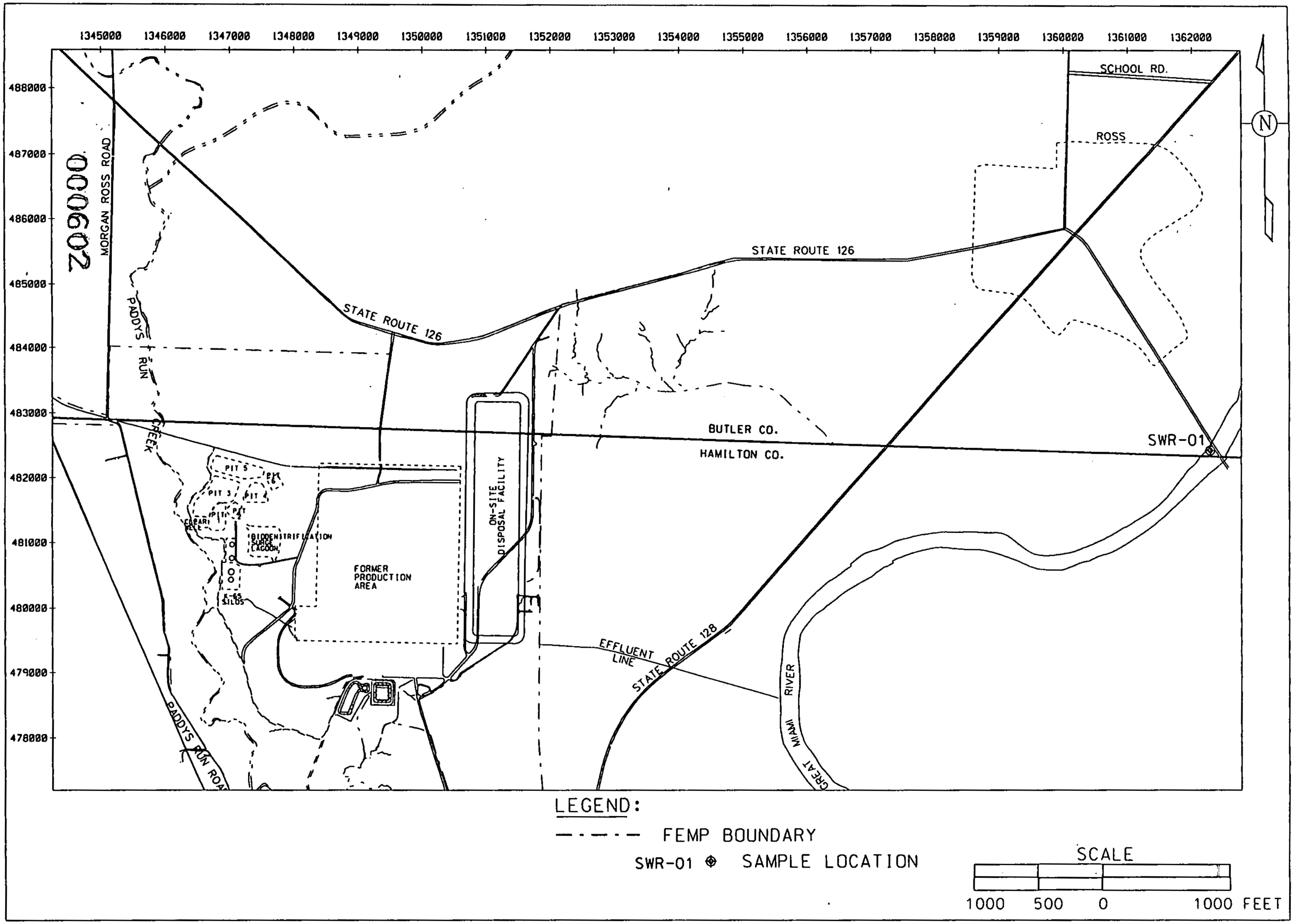
☆ SAMPLE LOCATION

SCALE

1200 600 0 1200 FEET

000601

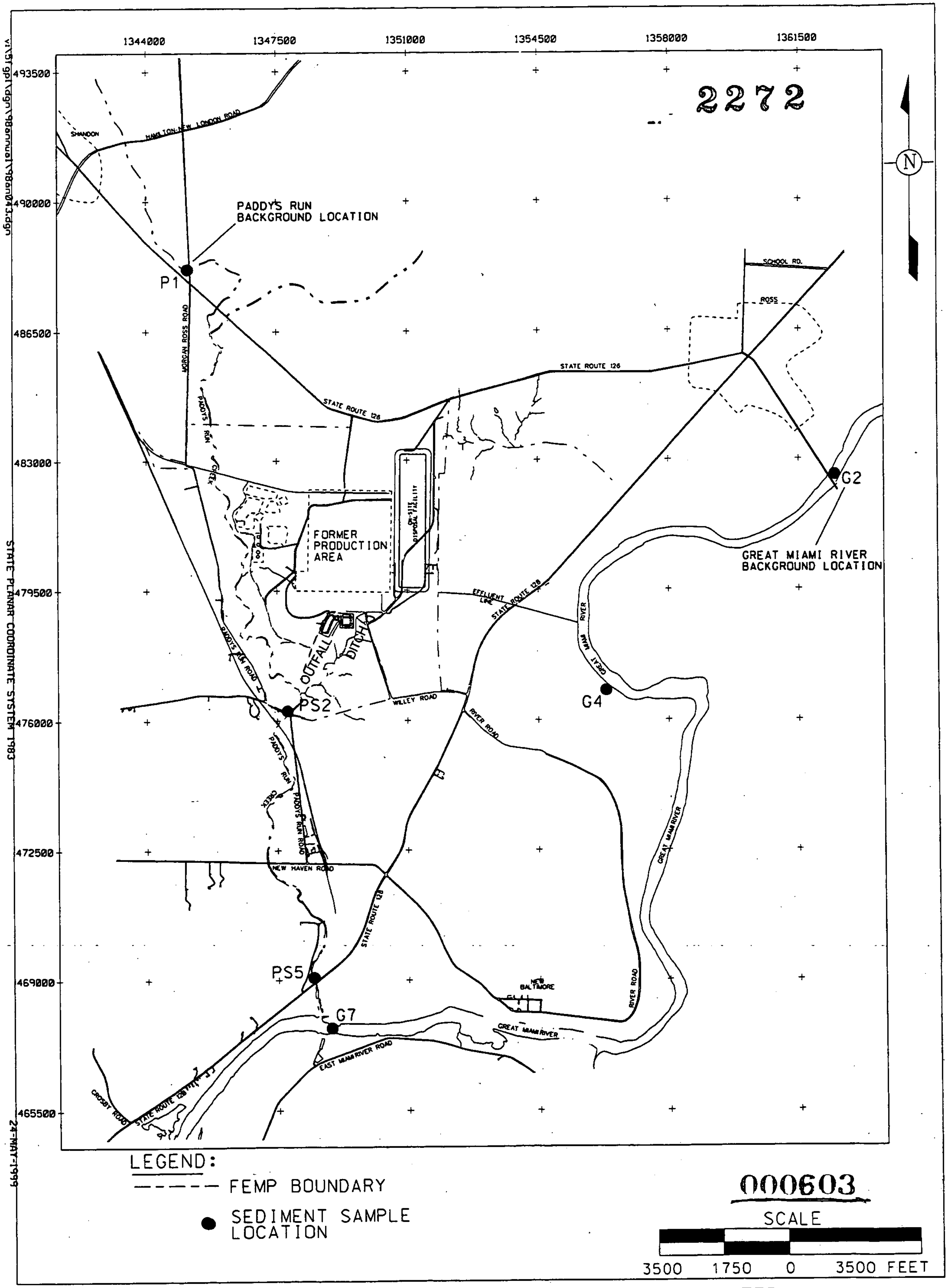
FIGURE E-1. 1998 OEPA AND FEMP SPLIT/CO-LOCATED GROUNDWATER SAMPLE LOCATIONS



v:#5fgp1#dgn#98annual#98an045.dgn
STATE PLANAR COORDINATE SYSTEM 1983

FIGURE E-2. 1998 OEPA AND FEMP SPLIT/CO-LOCATED SURFACE WATER SAMPLE LOCATION

2272



000603

FIGURE E-3. 1998 OEPA AND FEMP SPLIT/CO-LOCATED SEDIMENT SAMPLE LOCATIONS