INTEGRATED ENVIRONMENTAL MONITORING STATUS REPORT FOR FOURTH QUARTER 1999

2872

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

MARCH 2000

U.S. DEPARTMENT OF ENERGY

51350-RP-0009

REV. 0

FINAL

000001

2872

INTEGRATED ENVIRONMENTAL MONITORING STATUS REPORT FOR FOURTH QUARTER 1999

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

MARCH 2000

U.S. DEPARTMENT OF ENERGY

FINAL

000002

TABLE OF CONTENTS

1.0 Groundwater Remedy
- 1.1 Operational Assessment
  - 1.1.1 Aquifer Restoration System Summary
  - 1.1.2 Module-Specific Summaries
    - 1.1.2.1 South Field (Phase I) Extraction Module
    - 1.1.2.2 South Plume Module
    - 1.1.2.3 Re-Injection Demonstration Module
- 1.2 Aquifer Conditions
  - 1.2.1 Uranium Plume
    - 1.2.1.1 Total Uranium Plume
    - 1.2.1.2 Re-Injection Demonstration Cross-Sections
  - 1.2.2 Groundwater Elevations and Capture Assessment
    - 1.2.2.1 Groundwater Elevations and Capture Assessment
    - 1.2.2.2 South Plume Administrative Boundary
    - 1.2.2.3 Groundwater Model
  - 1.2.3 KC-2 Warehouse Well Monitoring

2.0 On-Site Disposal Facility Groundwater/Leak Detection and Leachate Monitoring
- 2.1 Cell 1
  - 2.1.1 Cell 1 Leak Detection System Volumes
  - 2.1.2 Analytical Status
- 2.2 Cell 2
  - 2.2.1 Cell 2 Leak Detection System Volumes
  - 2.2.2 Analytical Status
- 2.3 Cell 3
  - 2.3.1 Cell 3 Leak Detection System Volumes
  - 2.3.2 Analytical Status
- 2.4 Cell 4
  - 2.4.1 Cell 4 Analytical Status
- 2.5 Leachate Collection System Volumes

3.0 Surface Water and Treated Effluent
- 3.1 NPDES Permit Compliance
- 3.2 FFCA and OU5 ROD Compliance
- 3.3 Surveillance Monitoring

TABLE OF CONTENTS
(Continued)

2872

4.0 Air Monitoring
- 4.1 Radiological Air Particulate Monitoring
  - 4.1.1 Total Uranium, Total Particulate, and Thorium
  - 4.1.2 NESHAP Compliance
- 4.2 Radon Monitoring
  - 4.2.1 Environmental Radon
  - 4.2.2 Silo Head Space
- 4.3 Direct Radiation (TLD) Monitoring

5.0 Natural Resources

6.0 Meteorological
- 6.1 Monthly Precipitation
- 6.2 Wind Rose

LIST OF FIGURES

Figure 1-1 Groundwater Sampling Activities Covered in this Quarterly Report
Figure 1-2 IEMP Water Quality Monitoring Wells and Extraction Wells
Figure 1-3 Groundwater Elevation Monitoring Wells
Figure 1-4 Location of Active Aquifer Restoration Modules
Figure 1-5 Groundwater Sampling Activities Covered in the Next Quarterly Report
Figure 1-6 Total Groundwater Pumped vs. Groundwater Treated for Fourth Quarter 1999
Figure 1-7 Uranium Removal Indices by Module
Figure 1-8 Pumping Rates for South Field (Phase 1) Extraction Well 31550, 10/99 - 12/99
Figure 1-9 Pumping Rates for South Field (Phase 1) Extraction Well 31560, 10/99 - 12/99
Figure 1-10 Pumping Rates for South Field (Phase 1) Extraction Well 31561, 10/99 - 12/99
Figure 1-11 Pumping Rates for South Field (Phase 1) Extraction Well 31562, 10/99 - 12/99
Figure 1-12 Pumping Rates for South Field (Phase 1) Extraction Well 31563, 10/99 - 12/99
Figure 1-13 Pumping Rates for South Field (Phase 1) Extraction Well 31564, 10/99 - 12/99
Figure 1-14 Pumping Rates for South Field (Phase 1) Extraction Well 31565, 10/99 - 12/99
Figure 1-15 Pumping Rates for South Field (Phase 1) Extraction Well 31567, 10/99 - 12/99
Figure 1-16 Pumping Rates for South Field (Phase 1) Extraction Well 32276, 10/99 - 12/99
Figure 1-17 Weekly Total Uranium Concentrations for the South Field (Phase 1) Extraction Module
Figure 1-18 Pumping Rates for South Plume Extraction Well 3924, 10/99 - 12/99
Figure 1-19 Pumping Rates for South Plume Extraction Well 3925, 10/99 - 12/99
Figure 1-20 Pumping Rates for South Plume Extraction Well 3926, 10/99 - 12/99
Figure 1-21 Pumping Rates for South Plume Extraction Well 3927, 10/99 - 12/99
Figure 1-22 Pumping Rates for South Plume Extraction Well 32308, 10/99 - 12/99
Figure 1-23 Pumping Rates for South Plume Extraction Well 32309, 10/99 - 12/99
Figure 1-24 Weekly Total Uranium Concentrations for the South Plume Module
Figure 1-25 Total Uranium Concentrations in Injectate, 10/99 – 12/99
Figure 1-26 Re-Injection Rates for Re-Injection Well 22107, 10/99 - 12/99
Figure 1-27 Re-Injection Rates for Re-Injection Well 22108, 10/99 - 12/99
Figure 1-28 Re-Injection Rates for Re-Injection Well 22109, 10/99 - 12/99
Figure 1-29 Re-Injection Rates for Re-Injection Well 22111, 10/99 - 12/99
Figure 1-30 Re-Injection Rates for Re-Injection Well 22240, 10/99 - 12/99
Figure 1-31 Total Uranium Plume Map, Third Quarter 1999
Figure 1-32 Cross-Section G-G', Geoprobe Results for Total Uranium in Groundwater, Round F, September to November 1999
Figure 1-33 Cross-Section H-H', Geoprobe Results for Total Uranium in Groundwater, Round F, September to November 1999
Figure 1-34 Routine Groundwater Elevations for Type 2 Wells, October 1999
Figure 1-35 Routine Groundwater Elevations for Type 3 Wells, October 1999
Figure 1-36 Comparison of Modeled Groundwater Elevations with Interpreted Capture Zones
Figure 2-1 On-Site Disposal Facility Leak Detection Activities Covered in this Quarterly Report
Figure 2-2 On-Site Disposal Facility Well Locations
Figure 2-3 On-Site Disposal Facility Leak Detection Activities Covered in the Next Quarterly Report
Figure 2-4 On-Site Disposal Facility Cell 1 Leak Detection System (12338D) Rate of Accumulation (Gallons/Acre/Day), May 4, 1999 through December 11, 1999
Figure 3-1 Surface Water and Treated Effluent Sampling Activities Covered in this Quarterly Report
Figure 3-2 IEMP Surface Water and Treated Effluent Sample Locations

LIST OF FIGURES
(Continued)

Figure 3-3	Surface Water and Treated Effluent Sampling Activities Covered in the Next Quarterly Report
Figure 3-4	NPDES Permit Sample Locations
Figure 3-5	Pounds of Uranium Discharged to the Great Miami River from the Parshall Flume (PF 4001) in 1999
Figure 3-6	1999 Monthly Average Total Uranium Concentration in Water Discharged from the Parshall Flume (PF 4001) to the Great Miami River
Figure 3-7	Controlled Surface Water Areas and Uncontrolled Flow Directions for Fourth Quarter 1999
Figure 4-1	Air Sampling Activities Covered in this Quarterly Report
Figure 4-2	Air Sampling Activities Covered in the Next Quarterly Report
Figure 4-3	IEMP Air Monitoring Locations
Figure 4-4	Total Uranium and Particulate Concentrations in Air (AMS-2)
Figure 4-5	Total Uranium and Particulate Concentrations in Air (AMS-3)
Figure 4-6	Total Uranium and Particulate Concentrations in Air (AMS-4)
Figure 4-7	Total Uranium and Particulate Concentrations in Air (AMS-5)
Figure 4-8	Total Uranium and Particulate Concentrations in Air (AMS-6)
Figure 4-9	Total Uranium and Particulate Concentrations in Air (AMS-7)
Figure 4-10	Total Uranium and Particulate Concentrations in Air (AMS-8A)
Figure 4-11	Total Uranium and Particulate Concentrations in Air (AMS-9C)
Figure 4-12	Total Uranium and Particulate Concentrations in Air (AMS-22)
Figure 4-13	Total Uranium and Particulate Concentrations in Air (AMS-23)
Figure 4-14	Total Uranium and Particulate Concentrations in Air (AMS-24)
Figure 4-15	Total Uranium and Particulate Concentrations in Air (AMS-25)
Figure 4-16	Total Uranium and Particulate Concentrations in Air (AMS-26)
Figure 4-17	Total Uranium and Particulate Concentrations in Air (AMS-27)
Figure 4-18	Total Uranium and Particulate Concentrations in Air (AMS-28)
Figure 4-19	Total Uranium and Particulate Concentrations in Air (AMS-29)
Figure 4-20	Total Uranium and Particulate Concentrations in Air (AMS-12)
Figure 4-21	Total Uranium and Particulate Concentrations in Air (AMS-16)
Figure 4-22	Thorium-230 Concentrations in Air (WPTH-1)
Figure 4-23	Thorium-230 Concentrations in Air (WPTH-2)
Figure 4-24	Thorium-228 and Thorium-232 Concentrations in Air (WPTH-1)
Figure 4-25	Thorium-228 and Thorium-232 Concentrations in Air (WPTH-2)
Figure 4-26	Total Uranium and Particulate Concentrations in Air (STP-2)
Figure 4-27	NESHAP Stack Emission Monitoring Locations
Figure 4-28	Radon Monitoring - Continuous Alpha Scintillation Locations
Figure 4-29	Quarterly K-65 Silo Head Space Radon Concentrations, 1992-1999
Figure 4-30	Direct Radiation (thermoluminescent dosimeter) Monitoring Locations
Figure 4-31	Quarterly Direct Radiation (TLD) Measurements, 1994-1999 (K-65 Silos Fenceline Versus Background Average)
Figure 4-32	Quarterly Direct Radiation (TLD) Measurements, 1994-1999 (Location 6 Versus Background Average)
Figure 6-1	1999 FEMP Monthly Precipitation Data
Figure 6-2	Fourth Quarter 1999 Wind Rose Data, 10-Meter Height

LIST OF TABLES

Table 1-1	Aquifer Restoration System Operational Summary Sheet for Fourth Quarter (October through December 1999)
Table 1-2	South Field (Phase 1) Extraction Module Operational Summary Sheet for Fourth Quarter (October through December 1999)
Table 1-3	South Plume Module Operational Summary Sheet for Fourth Quarter (October through December 1999)
Table 1-4	Re-Injection Demonstration Module Operational Summary Sheet for Fourth Quarter (October through December 1999)
Table 1-5	Paddys Run Road Site Groundwater Summary Statistics
Table 1-6	KC-2 Warehouse Well 67 Summary Statistics (January 1993 through Third Quarter [August] 1999)
Table 2-1	On-Site Disposal Facility Cell 1 Data Summary for Constituents Detected During Third Quarter 1999
Table 2-2	On-Site Disposal Facility Cell 2 Data Summary for Constituents Detected During Third Quarter 1999
Table 2-3	On-Site Disposal Facility Cell 3 Data Summary for Constituents Detected During Third Quarter 1999
Table 3-1	1999 Treatment Bypass Events
Table 4-1	Total Uranium Particulate Concentrations in Air
Table 4-2	Total Particulate Concentrations in Air
Table 4-3	Fourth Quarter NESHAP Compliance Tracking
Table 4-4	Year-To-Date NESHAP Compliance Tracking
Table 4-5	NESHAP Stack Emission Monitoring Results
Table 4-6	Continuous Environmental Radon Monitoring Monthly Average Concentrations
Table 4-7	1999 Fourth Quarter Radon Concentrations 100 pCi/L Exceedances at the K-65 Silos 1 and 2 Exclusion Fence
Table 4-8	Radon Head Space Concentrations
Table 4-9	Direct Radiation (TLD) Measurements

LIST OF ACRONYMS

AMS	air monitoring station
amsl	above mean sea level
AWWT	Advanced Wastewater Treatment Facility
BRSR	Baseline Remedial Strategy Report
BTV	benchmark toxicity value
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
gpad	gallons per acre per day
gpm	gallons per minute
IEMP	Integrated Environmental Monitoring Plan
lbs	pounds
LCS	leachate collection system
LDS	leak detection system
mg/L	milligrams per liter
M gal	million gallons
mrem	millirem
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
OEPA	Ohio Environmental Protection Agency
OMMP	Operations and Maintenance Master Plan
OSDF	on-site disposal facility
pCi/L	picoCuries per liter
pCi/m^3	picoCuries per cubic meter
PRRS	Paddys Run Road Site
TLD	thermoluminescent dosimeter
WPRAP	Waste Pits Remedial Action Project
µg/L	micrograms per liter
µg/m^3	micrograms per cubic meter

2872

Introduction

INTEGRATED ENVIRONMENTAL MONITORING STATUS REPORT FOR FOURTH QUARTER 1999

The U.S. Department of Energy (DOE) has prepared this report to meet the quarterly reporting obligation defined in the Integrated Environmental Monitoring Plan (IEMP), Revision 1 (DOE 1999a) for the Fernald site. The IEMP quarterly status reports document the results of DOE's ongoing assessment of environmental conditions at and near the site as full-scale remediation of the Fernald site proceeds. The primary objectives of the report are to:

- Provide a current summary of key environmental data that serves as the basis for tracking and assessing the collective effectiveness of site emission controls
- Support Fernald stakeholders by providing a timely assessment of off-property impacts associated with implementation and operation of remedial actions at the Fernald site
- Document the performance of the groundwater remedy for the Great Miami Aquifer
- Document the status of natural resource impacts and restoration activities.

The information presented in the quarterly status report is primarily organized in summary data tables and graphics with minimal textual discussion. This reporting format provides an efficient means of summarizing the wide range of environmental and operational data that are collected each quarter. In addition, the emphasis on data tables and graphic data displays is designed to aid readers in interpreting the data relative to historical information and applicable regulatory standards. The information summarized in the quarterly status reports is presented in greater detail in Fernald's annual integrated site environmental report available June 1 of each year. The next IEMP quarterly status report will be submitted June 26, 2000.

2872

Groundwater Remedy

1.0 GROUNDWATER REMEDY

This section summarizes the fourth quarter 1999 operational data for the aquifer remedy and third quarter 1999 analytical data from groundwater monitoring. The material in this section satisfies the groundwater reporting requirements presented in the Integrated Environmental Monitoring Plan (IEMP), Revision 1 (DOE 1999a).

Figure 1-1 shows the sampling activities that contributed data to this section. Figure 1-2 identifies the IEMP groundwater monitoring wells by module/monitoring activity and Figure 1-3 shows the IEMP routine water-level (groundwater elevation) monitoring wells. Figure 1-4 shows the location of the active aquifer restoration modules and extraction/re-injection wells.

Figure 1-5 shows the groundwater monitoring activities to be summarized in the next IEMP quarterly status report to be submitted in June of 2000. The report will contain operational data and the plume capture assessment from January through March 2000 (first quarter). However, the remaining analytical results from the groundwater monitoring sampling activities conducted from October through December 1999 (fourth quarter) will be provided in the 1999 Integrated Site Environmental Report to be submitted June 1, 2000.

1.1 OPERATIONAL ASSESSMENT

1.1.1 AQUIFER RESTORATION SYSTEM SUMMARY

Table 1-1 summarizes the operational data from the three active restoration modules for the fourth quarter of 1999. The South Plume and South Field (Phase I) Extraction Modules pumped a total of 400.570 million gallons of groundwater and removed 175.03 pounds of uranium during this reporting period. The Re-Injection Demonstration Module re-injected 105.147 million gallons of treated groundwater back into the aquifer for a net total extraction of 295.423 million gallons. To date, 5.637 billion gallons of groundwater have been pumped and 1,537.60 pounds of uranium have been removed from the aquifer. During the fourth quarter of 1999, re-injection returned 4.28 pounds of uranium back into the aquifer. Figure 1-6 depicts the total groundwater pumped versus groundwater treated during the fourth quarter. Figure 1-7 shows the uranium removal indices for the South Field (Phase I) Extraction and South Plume Modules.

1.1.2 MODULE-SPECIFIC SUMMARIES

1.1.2.1 SOUTH FIELD (PHASE I) EXTRACTION MODULE

The module target pumping rate for the combined nine active extraction wells was 1500 gallons per minute (gpm). For the majority of the period, all active extraction wells in the module were pumped at or above the rates specified in the Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1) (DOE 1997a). The monthly average pumping rate at Extraction Well 31564 was significantly lower in December than in October and November due to maintenance activities and restoration of the pump's variable frequency drive. Additionally, in November, operations personnel were notified that the pumping rate at Extraction Well 31567 could be adjusted from 100 to 300 gpm as needed to use available treatment capacity. This is known as the swing well concept, which allows the pumping rate at Extraction Well 31567 to increase as additional capacity to treat groundwater becomes available at the site's water treatment facilities during periods of low storm water flow. While the concentration of total uranium in Extraction Well 31567 does not provide justification to increase this well's pumping rate, the following reasons do:

- The water levels observed during April and July 1999 in the vicinity of Extraction Well 31567 are slightly higher than the surrounding area, indicating that additional pumping is needed to provide the desired drawdown of the aquifer in this area.
- This is the closest extraction well down gradient of the plume emanating from the former inactive flyash pile area. If the pumping rate is increased, then the plume may be drawn to it more quickly.

Accordingly, the pumping rate at Extraction Well 31567 was increased to 150 gpm on November 5, 1999, and increased again to 200 gpm on November 8, 1999.

Table 1-2 provides operational details for this module. Daily pumping rate figures, which identify operational percentages for each well and outages lasting longer than 24 hours, can be viewed by going to Table 1-2 and selecting the appropriate well number. Figure 1-17 provides the weekly total uranium concentrations for each extraction well in this module.

In response to the newly defined area of uranium contamination found in the aquifer beneath the southeastern portion of the South Field area (described in the Integrated Environmental Monitoring Status Report for Third Quarter 1999 [DOE 1999b]), two new extraction wells have been installed as shown on Figure 1-4 (Monitoring Wells 32446 and 32447). The new extraction wells are located as discussed with the U.S. Environmental Protection Agency (EPA) and the Ohio Environmental Protection Agency (OEPA) during a conference call on May 18 1999 (reference Facsimile Number F:SWP[ARWWP]:990008, dated May 17 1999). It is anticipated that the new wells will begin pumping during the first quarter of 2000.

1.1.2.2 SOUTH PLUME MODULE

The South Plume Module target pumping rate was 2000 gpm. For the majority of the period, the six wells were pumped at or above the rates specified in the Baseline Remedial Strategy Report. The monthly average pumping rate for Extraction Well 3926 was significantly lower in December than in October or November because the well underwent rehabilitation activities during the last half of the month. The monthly average pumping rate for Extraction Well 3927 was significantly lower in November than in October or December because the well underwent rehabilitation activities during the last half of the month. The monthly average pumping rates for Extraction Wells 32308 and 32309 were significantly lower in November than in October or December because the re-injection wells were shut down more frequently in November. Per the Operations and Maintenance Master Plan, Extraction Wells 32308 and 32309 are to be shut down when the Re-Injection Wells are shut down.

Table 1-3 provides operational details for the South Plume Module. Daily pumping rate figures, which identify operational percentages for each well and outages lasting longer than 24 hours, can be viewed by going to Table 1-3 and selecting the appropriate well number. Figure 1-24 depicts the weekly total uranium concentrations for each well in this module.

1.1.2.3 RE-INJECTION DEMONSTRATION MODULE

The target re-injection rate for this module was 1000 gpm. Groundwater was re-injected through the five wells near the rates specified in the Baseline Remedial Strategy Report for the majority of the period. The entire re-injection well system was shutdown for significant periods of time in the latter portion of November and early December. As noted on the daily pumping rate figures for each of the wells, these shutdowns were due to construction tie-ins and maintenance activities. The monthly average module re-injection rate at Re-Injection Well 22108 was significantly lower in December than in October or November because the well underwent rehabilitation activities during the last half of the month.

Total uranium concentrations in the injectate source water significantly decreased in November and December due to successful regeneration of the ion exchange resins in the Advanced Wastewater Treatment Facility Expansion plant, the source for injection water. Figure 1-25 displays the injectate concentrations for the fourth quarter. During the fourth quarter, total uranium concentrations in the injectate were reduced from a monthly average of 9.6 micrograms per liter (μg/L) in October to 1.1 μg/L in December. Daily pumping rate figures, which identify operational percentages for each well and outages lasting longer than 24 hours, can be viewed by going to Table 1-4 and selecting the appropriate well number.

1.2 AQUIFER CONDITIONS

1.2.1 URANIUM PLUME

1.2.1.1 TOTAL URANIUM PLUME

The total uranium plume map shown in Figure 1-31 was modified in the following areas to account for higher total uranium concentrations reported for the third quarter of 1999:

- Monitoring Well 2385, which is located east of the inactive flyash pile
- Monitoring Well 2049, which is located in the South Field area.

Monitoring Well 2385 had a total uranium concentration of approximately 355 µg/L in September of 1999. This well was previously shown on the total uranium plume map just inside the 200 µg/L concentration contour. The 500 µg/L concentration contour line has been redrawn so that it extends closer to Monitoring Well 2385. Concentrations have trended upward at this well since the South Field (Phase I) Extraction Module began operating in July 1998. This trend is probably due to the effect of pumping Extraction Well 31567, which lies to the east and down gradient of both Monitoring Well 2385 and the uranium plume underlying the former inactive flyash pile.

Monitoring Well 2049 had a total uranium concentration of approximately 177 µg/L in September of 1999. The 200 µg/L concentration contour line has been redrawn so that it is closer to Monitoring Well 2049. This increase may be due to the effect of pumping Extraction Well 31563 which could be drawing the uranium plume back toward it from the east. Extraction Well 31563 is located about 300 feet west of Monitoring Well 2049. Continued sampling will determine whether the concentration trend continues to increase.

High turbidity in some groundwater samples collected during the third quarter resulted in measured total uranium concentrations that did not represent mobile uranium in the aquifer. During the sample preservation/preparation process, non-mobile uranium was being dissolved/digested along with the mobile uranium and biased the uranium results higher. The U.S. Department of Energy (DOE) is working with EPA and OEPA to modify the sampling protocol to include filtering the sample when the turbidity of the sample collected is greater than 5 nephelometric turbidity units (NTU). It is anticipated that the revised protocol will be established later this year.

Third quarter total uranium concentration results for Monitoring Wells 2546 and 2900 exemplified this issue. At Monitoring Wells 2546 and 2900, the uranium concentrations were 123 and 20 µg/L, and the turbidity of these samples was 999 and 49 NTU, respectively. These total uranium concentrations are shown on the map in Figure 1-31, but because the data are considered non-representative, the contours do not honor the data. Note that the second quarter 1999 total

uranium result for Monitoring Well 2546, 110 µg/L, was also associated with a high turbidity (>999 NTU) sample. Therefore, the current total uranium plume map, Figure 1-31, does not carry over the 20 µg/L circular contour found around Monitoring Well 2546 in the Integrated Environmental Monitoring Status Report for Third Quarter 1999.

In the Integrated Environmental Monitoring Status Report for Third Quarter 1999, a total uranium concentration of 180 µg/L in Monitoring Well 3027 (located in the waste storage area) was reported as suspect because it was much higher than previous total uranium results, which were generally below 20 µg/L. Additional efforts to determine the source of the unusually high total uranium concentration in Monitoring Well 3027 were undertaken during the fourth quarter of 1999. These efforts included:

- A camera survey of the well to determine if perched water may be leaking into the well
- Removing the dedicated pump and cleaning it
- Pumping the well to remove accumulated sediment
- Collecting samples with varying turbidity and analyzing them for total uranium.

Results of the camera survey indicated that the well was not leaking. Analyzing samples containing various turbidity levels indicated that there was a correlation of turbidity and high uranium results. Samples collected when the turbidity was high (i.e., >999 NTU) indicated uranium results in the 150 µg/L range, while samples with relatively low turbidity (i.e., 4-13 NTU) indicated total uranium concentrations in the range of 36 to 38 µg/L. This work was done in late October 1999. The dedicated sampling equipment has been re-installed and the well was sampled as part of the IEMP Waste Storage Area program in December. Preliminary results indicate the December sample had a total uranium concentration of about 42 µg/L and the turbidity was less than 5 NTU.

Pre-design sampling via direct push methodology is being conducted in the vicinity of Monitoring Well 3027. This sampling will further establish what the representative uranium concentrations are for this area. As the results of the pre-design sampling are obtained, they are being discussed with EPA and OEPA during the weekly site update teleconferences.

1.2.1.2 RE-INJECTION DEMONSTRATION CROSS-SECTIONS

A quarterly round of direct push groundwater sampling was conducted from September to November as part of the Re-Injection Demonstration at locations 12367, 12368, 12369, 12370, 12371, 12372, and 12373. This is Round F as described in the Re-Injection Demonstration Test Plan (DOE 1998b). Figure 1-32 profiles the total uranium concentrations from 12369, 12372, and 12373 in a cross section. Figure 1-33 profiles the total uranium concentrations from 12367, 12368, 12369, 12370, and 12371 in a cross section. The profiles will be used in the Re-Injection Demonstration Report to show how the plume is changing over the course of the demonstration at these locations. For reference, the screened interval depth of Re-Injection Well 22109 (located just upgradient from location 12369) is shown on the profile in Figure 1-32.

Round F data show that the depth of the base of the 20 μg/L uranium plume is consistent with the depth mapped in earlier sampling rounds. This indicates that the plume was not pushed into deeper regions of the aquifer by re-injection of treated groundwater. Round F data also show that the total uranium concentrations directly south of each re-injection well have dramatically decreased when compared to total uranium concentrations measured prior to the start of re-injection (Round A). Round A results were reported in the Integrated Environmental Monitoring Status Report for Third Quarter 1998 (DOE 1998a). A more detailed discussion of these direct-push sampling results will be provided in the Re-Injection Demonstration Report to be submitted June 30, 2000.

1.2.2 GROUNDWATER ELEVATIONS AND CAPTURE ASSESSMENT

1.2.2.1 GROUNDWATER ELEVATIONS AND CAPTURE ASSESSMENT

Groundwater elevation measurements for the fourth quarter of 1999 were collected from October 18 through October 21, 1999. The Type 2 and Type 3 measurements are contoured in Figure 1-34 and Figure 1-35, respectively. Both figures also contain some Type 6 measurements, which are posted to achieve better lateral coverage across the map area. Actual pumping rates for each module from October 18 through October 21 are posted on the figures to document the pumping conditions on these dates.

Past experience at the Fernald site has shown that with a large number of wells (181) being measured each quarter, some measurement, transcription, or data entry errors occur (typically less than five percent). These errors often become apparent when the data are posted to maps and the contouring process begins. When the errors are identified, the erroneous data points are removed from the data set to be contoured in order to produce a water level map that represents aquifer conditions. Only one measurement was not used in the October contour data set. This water level measurement was from Monitoring Well 62433, which is located in the South Field area. The measurement was removed because the elevation recorded (494.39 feet above mean sea level [amsl]) is approximately 20 feet lower than the average elevation of surrounding wells (approximately 514 feet amsl).

Capture of the main portion of the South Plume (north of Paddys Run Road Site [PRRS] above the 20 μg/L total uranium final remediation level [FRL]) continued during the fourth quarter of 1999 due to pumping of the South Plume Module (refer to Figure 1-34).

Figure 1-36 shows the predicted steady state groundwater elevations based on the groundwater model with the South Field (Phase 1) Extraction, Re-Injection Demonstration, and South Plume Modules operating as specified in the Baseline Remedial Strategy Report. For comparative purposes, the 10-year, uranium-based restoration footprint (capture zone), the maximum total uranium plume outline (updated with third quarter 1999 data), and the interpreted capture zones from the groundwater elevation map (Figure 1-34) are also shown on the figure. Note that the modeled capture zone and the capture zone derived from the October water level measurements appear to be in good agreement.

1.2.2.2 SOUTH PLUME ADMINISTRATIVE BOUNDARY

Analysis of the third quarter 1999 PRRS constituent concentration data for arsenic, phosphorous, potassium, and sodium indicates that capture of the total uranium plume is having a negligible influence on the PRRS plume. As shown in Table 1-5, most PRRS constituent concentrations were within the historical minimum-maximum range. Figure 1-2 identifies the well locations. No volatile organic compounds were detected in the monitoring wells used to sample for PRRS constituents.

1.2.2.3 GROUNDWATER MODEL

The groundwater flow model has been successfully recalibrated to an October 1998 groundwater elevation data set and has been validated against three other quarterly elevation data sets (April 1998, June 1999, and October 1999). A report on the recalibration effort is currently undergoing internal review and comment, and will be provided to EPA and OEPA later this year, after the internal review process is complete.

Phase II of the groundwater model upgrade project, which incorporates data fusion technology into the groundwater transport model has been completed. A draft report detailing Phase II of the project has been received from HydroGeoLogic, Inc., and is undergoing an internal review. Data fusion when coupled with the contaminant transport code provides a mechanism to allow the model to set transport parameters within pre-determined ranges to best match observed field data, thereby improving model predictions. Model output from data fusion also provides a quantitative measure of model uncertainty.

Phase III of the groundwater model upgrade project, which consists of an optimization package, will not be started until the Phase II report has been finalized. The final Phase II report will be provided to EPA and OEPA when it is finalized later this year. When completed, it is anticipated that Phase III of the model upgrade will provide a decision support system to optimize extraction/re-injection well locations for the aquifer remedy.

1.2.3 KC-2 WAREHOUSE WELL MONITORING

Sampling of this well (Well 67) in August 1999 indicated that concentrations of hazardous substance list metals were generally lower than routinely indicated by the average of previous sampling results. Concentrations of all constituents with an established FRL were below their respective FRL. Table 1-6 presents historical statistics as well as August 1999 results.

Well 67 is scheduled to be plugged and abandoned in Spring of 2000.

TABLE 1-1

AQUIFER RESTORATION SYSTEM OPERATIONAL SUMMARY SHEET

	Reporting Period					
	October 1999 through December 1999			August 1993 through December1999		
	Gallons Pumped/Re-Injected (M gal)	Total Uranium Removed/Re-Injected (lbs)	Uranium Removal Index[a] (lbs/M gal)	Gallons Pumped/Re-injected (M gal)	Total Uranium Removed/Re-Injected (lbs)	Uranium Removal Index[a] (lbs/M gal)
South Field (Phase1) Extraction Module	187.640	109.72	0.58	1,106.899	703.88	0.64
South Plume Module	212.930	65.31	0.31	4,530.124	833.72	0.18
Re-Injection Demonstration Module	105.147	4.28	NA	559.718	26.64	NA
Aquifer Restoration Systems Totals						
(Extraction Wells)	400.570	175.03	0.44	5,637.023	1,537.60	0.27
(Re-Injection Wells)	105.147	4.28	NA	559.718	26.64	NA
(net)	295.423	170.75	NA	5,077.305	1,510.96	NA

[a]NA = not applicable

TABLE 1-2

**SOUTH FIELD (PHASE 1) EXTRACTION MODULE
OPERATIONAL SUMMARY SHEET FOR FOURTH QUARTER
(OCTOBER 1999 THROUGH DECEMBER 1999)**

Extraction Well	31565	31564	31566[a,b]	31563	31567	31550[b]	31560	31561	31562	32276
	Baseline Remedial Strategy Report Target Pumping Rates (gpm)									
	200	200	200	200	100	100	100	100	100	200
	Average Pumping Rates (gpm)									
October	203	201	NA	203	101	101	101	102	202	302
November	201	199	NA	172	185	78	89	91	178	262
December	187	63[c]	NA	186	172	88	88	89	175	239
Quarterly Average	197	154	NA	187	153	89	93	94	185	268
	Average Total Uranium Concentrations (µg/L)									
October	12.5	14.3	NA	25.7	42.5	65.1[d]	97.6	42.6	114.7	174.2
November	11.7	14.1	NA	24.6	41.5	66.7	97.3	44.5	105.0	165.2
December	11.4	13.5	NA	26.4	39.4	63.6	94.0	45.5	106.5	161.2
Quarterly Average	11.9	14.0	NA	25.6	41.1	65.1	96.3	44.2	108.7	166.9
	Uranium Removal Index (Pounds of Total Uranium Removed/Million Gallons Pumped)									
October	0.10	0.12	NA	0.21	0.35	0.54	0.81	0.36	0.96	1.45
November	0.10	0.12	NA	0.21	0.35	0.56	0.81	0.37	0.88	1.38
December	0.10	0.11	NA	0.22	0.33	0.53	0.78	0.38	0.89	1.34
Quarterly Average	0.10	0.12	NA	0.21	0.34	0.54	0.80	0.37	0.91	1.39

	Average Module Pumping Rate (gpm)	Water Pumped by Module (M gal)	Total Uranium Concentration from Module[e] (µg/L)
October	1,515	67.529	73.5
November	1,453	62.148	66.7
December	1,287	57.963	69.7
Quarterly Average	1,418	Total 187.640	Quarterly Average 70.0

[a]Extraction Well 31566 was shut down in October, November, and December.
[b]NA = not applicable
[c]Low pumping rate due to variable frequency drive malfunctioning.
[d]Sampling port plugged (value is fourth quarter average).
[e]Average is calculated from individual well total uranium concentrations and flow rates.

000025

TABLE 1-3

SOUTH PLUME MODULE
OPERATIONAL SUMMARY SHEET FOR FOURTH QUARTER
(OCTOBER 1999 THROUGH DECEMBER 1999)

Extraction Well	3924	3925	3926	3927	32308	32309
	Baseline Remedial Strategy Report Target Pumping Rates (gpm)					
	300	300	400	400	250	250
	Average Pumping Rates (gpm)					
October	294	295	370	463	221	220
November	276	273	344	193[a]	189[b]	188[b]
December	264	268	152[a]	375	227	226
Quarterly Average	278	279	289	344	212	211
	Average Total Uranium Concentrations (µg/L)					
October	40.3	32.1	23.1	1.6	75.7	77.5
November	40.6	30.2	24.6	1.5	73.2	77.7
December	40.7	31.9	23.6	2.1	71.5	75.6
Quarterly Average	40.5	31.4	23.8	1.7	73.5	76.9
	Uranium Removal Index (Pounds of Total Uranium Removed/Million Gallons Pumped)					
October	0.34	0.27	0.19	0.01	0.63	0.65
November	0.34	0.25	0.21	0.01	0.61	0.65
December	0.34	0.27	0.20	0.02	0.60	0.63
Quarterly Average	0.34	0.26	0.20	0.01	0.61	0.64

	Average Module Pumping Rate (gpm)	Water Pumped by Module (M gal)	Total Uranium Concentration from Module[c] (µg/L)
October	1,864	83.314	34.6
November	1,463	63.316	38.7
December	1,510	66.300	37.7
Quarterly Average	1,612	Total 212.930	Quarterly Average 37.0

[a]Low pumping rate due to well rehabilitation.
[b]Low pumping rate due to well being down for construction tie-ins.
[c]Average is calculated from individual well total uranium concentrations and flow rates.

TABLE 1-4

**RE-INJECTION DEMONSTRATION MODULE
OPERATIONAL SUMMARY SHEET FOR FOURTH QUARTER
(OCTOBER 1999 THROUGH DECEMBER 1999)**

Re-Injection Well	22107	22108	22109	22240	22111
	Baseline Remedial Strategy Report Target Re-Injection Rates (gpm)				
	200	200	200	200	200
	Average Re-Injection Rates (gpm)				
October	176	175	175	177	175
November	156	153	151	156	155
December	161	68[a]	168	169	164
Quarterly Average	164	132	165	167	165

	Average Module Re-Injection Rate (gpm)	Water Re-Injected By Module (M gal)	Total Uranium Concentration from Module (µg/L)
October	879	39.177	9.6
November	772	33.000	2.9
December	732	32.970	1.1
Quarterly Average	794	Total 105.147	Quarterly Average 4.5

[a]Low re-injection rate due to well rehabilitation.

000027

TABLE 1-5

PADDYS RUN ROAD SITE GROUNDWATER SUMMARY STATISTICS

		Sampling Period						
		January 1, 1988 through September 30, 1999					Results with Detections for Third Quarter 1999	
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)	Sample Result (mg/L)[e]	Validation Qualifier[f,g]
Arsenic	2128	210	0.00041	0.1876	0.013	0.022	0.00082	U
	2625	199	0.0048	0.05	0.012	0.008	NS	NA
	2636	171	0.01	0.0939	0.04	0.02	NS	NA
	2898	26	0.00035	0.0063	0.0015	0.0013	0.00082	U
	2899	25	0.00032	0.0032	0.0013	0.00082	0.0032	-
	2900	208	0.00032	0.0548	0.0051	0.0051	0.0013	-
	3128	28	0.00085	0.234	0.012	0.044	0.0027	U
	3636	27	0.0006	0.014	0.002	0.0025	0.0012	U
	3898	25	0.0006	0.0062	0.002	0.0012	0.0023	U
	3899	26	0.00032	0.003	0.0013	0.0008	0.00082	U
	3900	26	0.000395	0.0045	0.0023	0.0010	0.0026	U
Phosphorus	2128	36	0.04	16.2	2	3	0.41	-
	2625	24	0.307	12.3	3.38	3.24	NS	NA
	2636	23	9.6	170	95	50	NS	NA
	2898	27	0.005	1.05	0.08	0.2	0.05	U
	2899	24	0.005	0.11	0.04	0.03	0.05	U
	2900	25	0.07	0.96	0.45	0.26	0.4	-
	3128	35	0.005	13	0.4	2	0.05	-
	3636	26	0.00955	1.1	0.1	0.2	0.05	U
	3898	24	0.00955	1.24	0.128	0.255	0.05	U
	3899	25	0.00955	0.83	0.13	0.17	0.05	U
	3900	26	0.005	1.26	0.1	0.24	0.05	U
Potassium	2128	28	1.09	18	4.1	4.6	2.14	-
	2625	24	0.64	6.26	3.4	1.7	NS	NA
	2636	23	8.51	218	82.4	54.7	NS	NA
	2898	27	1.11	5.05	3.65	0.805	4.77	-
	2899	25	1.36	4.66	3.57	0.626	4.66	-
	2900	26	0.0095	6	1.8	1.2	3.5	-
	3128	28	1.09	3.7	2.5	0.62	1.93	-
	3636	26	1.09	4.24	2.51	0.588	2.15	-
	3898	25	0.61	3.93	2.3	0.71	2.7	-
	3899	26	1.335	3.22	2.44	0.331	2.69	-
	3900	26	0.975	3.19	1.90	0.510	1.93	-
Sodium	2128	28	22.9	75.2	38.7	12.6	34.1	-
	2625	24	16.5	50.7	33.8	7.88	NS	NA
	2636	23	23	79.9	47	16	NS	NA
	2898	27	4.945	29.2	18.1	4.81	14.9	-
	2899	25	11.2	22.9	17.0	3.16	15.5	-
	2900	26	0.01355	43.3	29	9.7	23	-
	3128	28	3.56	13.4	6.71	3.32	4.04	-
	3636	26	4.34	13	8.0	3.0	4.37	-
	3898	25	7.29	14.6	9.12	1.72	10.9	-
	3899	26	6.24	12.1	8.73	1.40	8.12	-
	3900	26	4.19	10.8	6.3	1.9	4.3	-

[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 1999 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 total number of samples, and the sample with the maximum concentration is used to determine the summary statistics (minimum, maximum, average, and standard deviation [SD]).
[c]Rejected data qualified with either a R or Z were not included in this count or the summary statistics.
[d]Where concentrations are below the detection limit, each result used in the summary statistics is set at half the detection limit.
[e]NS = not sampled due to well being dry.
[f]Validation qualifier codes are provided in Appendix D of the Sitewide CERCLA Quality Assurance Project Plan (DOE 1998c).
[g]NA = not applicable

TABLE 1 -6
KC-2 WAREHOUSE WELL 67 SUMMARY STATISTICS
(January 1993 through Third Quarter [August] 1999)

Constituent	Number of Samples[a,b]	FRL[c] (mg/L)	Min.[a,b,d,e] (mg/L)	Max.[a,b,d,e] (mg/L)	Avg.[a,b,d,e] (mg/L)	SD[a,b,d,e] (mg/L)	1999 Data Sample Result (mg/L); Validation Qualifier[f]
Aluminum	13	NA	0.0104	80	13	24	0.0104 -
Antimony	13	0.0060	0.000065	0.22	0.048	0.069	0.00062 U
Arsenic	13	0.050	0.00041	0.0873	0.015	0.029	0.00082 U
Barium	13	2.0	0.103	0.867	0.350	0.251	0.208 -
Beryllium	13	0.0040	0.00001	0.005	0.0013	0.0016	0.00002 U
Cadmium	13	0.014	0.00003	0.0671	0.01	0.02	0.00008 U
Calcium	13	NA	45.3	1310	318	434	45.3 -
Chromium	13	0.022[g]	0.000415	2.35	0.40	0.74	0.00083 U
Cobalt	13	0.17	0.000065	0.102	0.024	0.037	0.00013 U
Copper	13	1.3	0.000335	0.373	0.089	0.14	0.00077 U
Cyanide	5	NA	0.000985	0.005	0.0024	0.0016	0.01 U
Iron	13	NA	1.65	620	140	220	1.65 -
Lead	13	0.015	0.00026	3.8	0.74	1.3	0.00052 U
Magnesium	13	NA	33.9	322	98.4	102	36.5 -
Manganese	13	0.900	0.0363	8.52	1.89	3.03	0.0363 -
Mercury	13	0.0020	0.00005	0.0022	0.0003	0.0006	0.0001 U
Nickel	13	0.10	0.00039	1.21	0.23	0.39	0.00039 -
Potassium	12	NA	0.922	14.6	3.09	3.99	1.33 -
Selenium	13	0.050	0.00039	0.0099	0.0027	0.0028	0.00092 U
Silver	13	0.050	0.00025	0.0312	0.005	0.009	0.0008 -
Sodium	12	NA	17.5	23.9	20.4	1.83	20.8 -
Thallium	13	NA	0.000025	1.8	0.14	0.50	0.0013 -
Vanadium	13	0.038	0.000075	0.19	0.035	0.055	0.00015 U
Zinc	13	0.021	0.0061	1.79	0.36	0.57	0.0138 UJ
		(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
Uranium, Total	13	20	0.04	2400	200	700	0.08 U

[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 to determine 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]Where concentrations are below the detection limit, each result used in the summary statistics is set at half the detection limit.
[e]If the total number of samples is greater than or equal to four, then all of the summary statistics are reported. If the total number of samples is equal to three, then the minimum, maximum, and average are reported. If the total number of samples is equal to two, then the minimum and maximum are reported. If the total number of samples is equal to one, then the data point is reported as the minimum.
[f]Validation qualifier codes are provided in Appendix D of the Sitewide CERCLA Quality Assurance Project Plan.
[g]The FRL is based on chromium VI, from Operable Unit 5 Record of Decision, Table 9 -4; however, the sampling results are for total chromium.

FIGURE 1-1/1-5

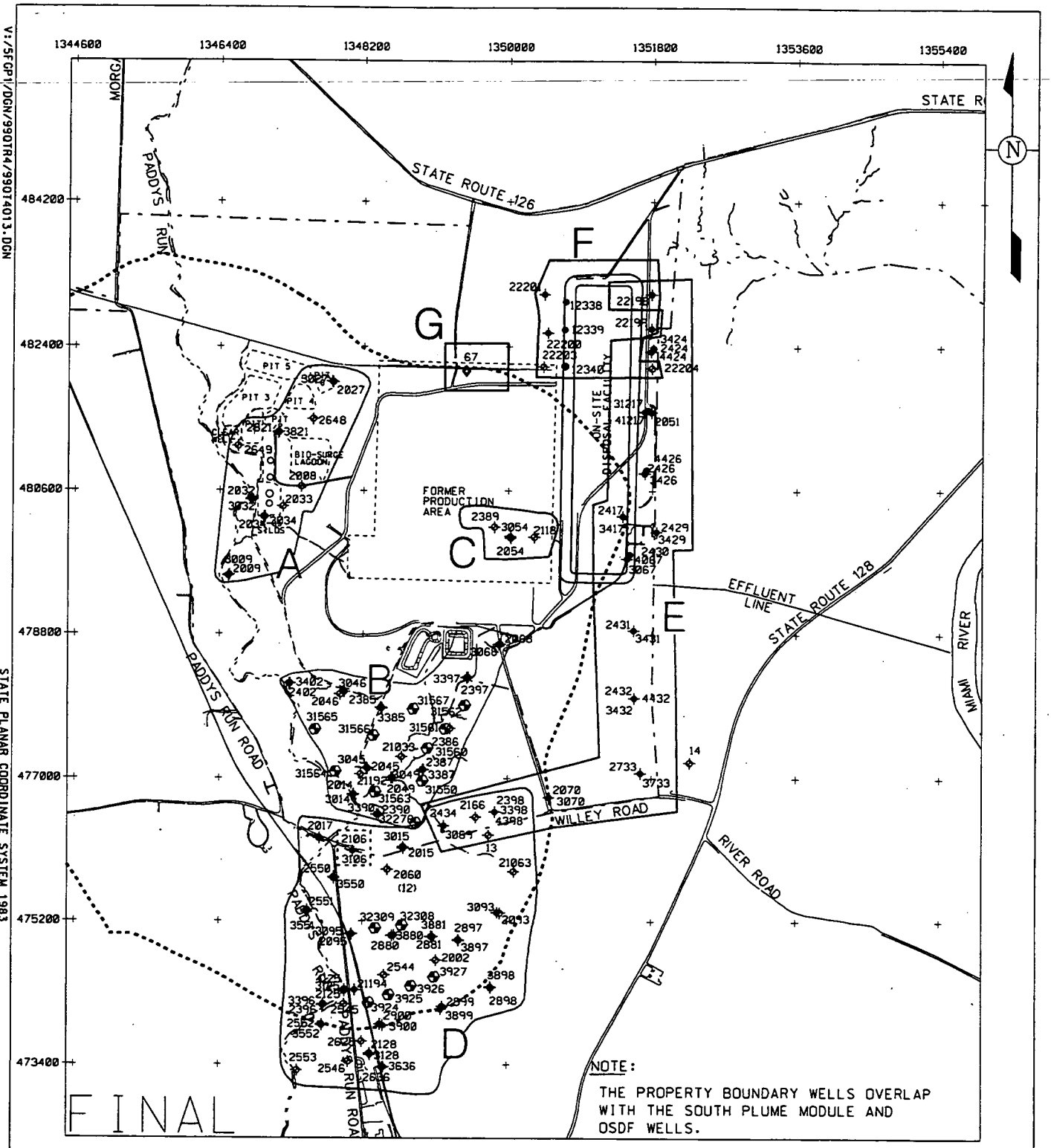
GROUNDWATER SAMPLING ACTIVITIES

	Quarter/Year											
	Third Quarter/1999			Fourth Quarter/1999			First Quarter/2000			Second Quarter/2000		
SAMPLING ACTIVITIES	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
South Plume Module:												
Operational				◆	◆	◆	⊠	⊠	⊠			
Aquifer Conditions [a]		◆										
South Field Extraction Module:												
Operational (Phase 1)				◆	◆	◆	⊠	⊠	⊠			
Aquifer Conditions [a]			◆									
Re-Injection Demonstration Module [b]												
Operational				◆	◆	◆	⊠	⊠	⊠			
Waste Storage Area Module:												
Aquifer Conditions [a]												
Plant 6 Area Module:												
Aquifer Conditions [a]												
Routine Water-Level/Flow Direction Monitoring				◆			⊠					
Property Boundary Monitoring [a]	◆											
Private Well Monitoring [a]	◆											
KC-2 Warehouse Well Monitoring [c]		◆										

◆ Data summarized/evaluated in this report
⊠ Data summarized/evaluated in the next report

FINAL

[a]Fourth quarter 1999 data will be included in the 1999 Integrated Site Environmental Report.
[b]Aquifer conditions for this module are being addressed in the Re-Injection Demonstration Report.
[c]This activity well be discontinued in 2000 due to dismantling of the KC-2 Warehouse and subsequent plugging and abandonment of the KC-2 Warehouse well.



V:\5FGP1\DGN\990TR4\990T4013.DGN

STATE PLANAR COORDINATE SYSTEM 1983

11-23-99

000031

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

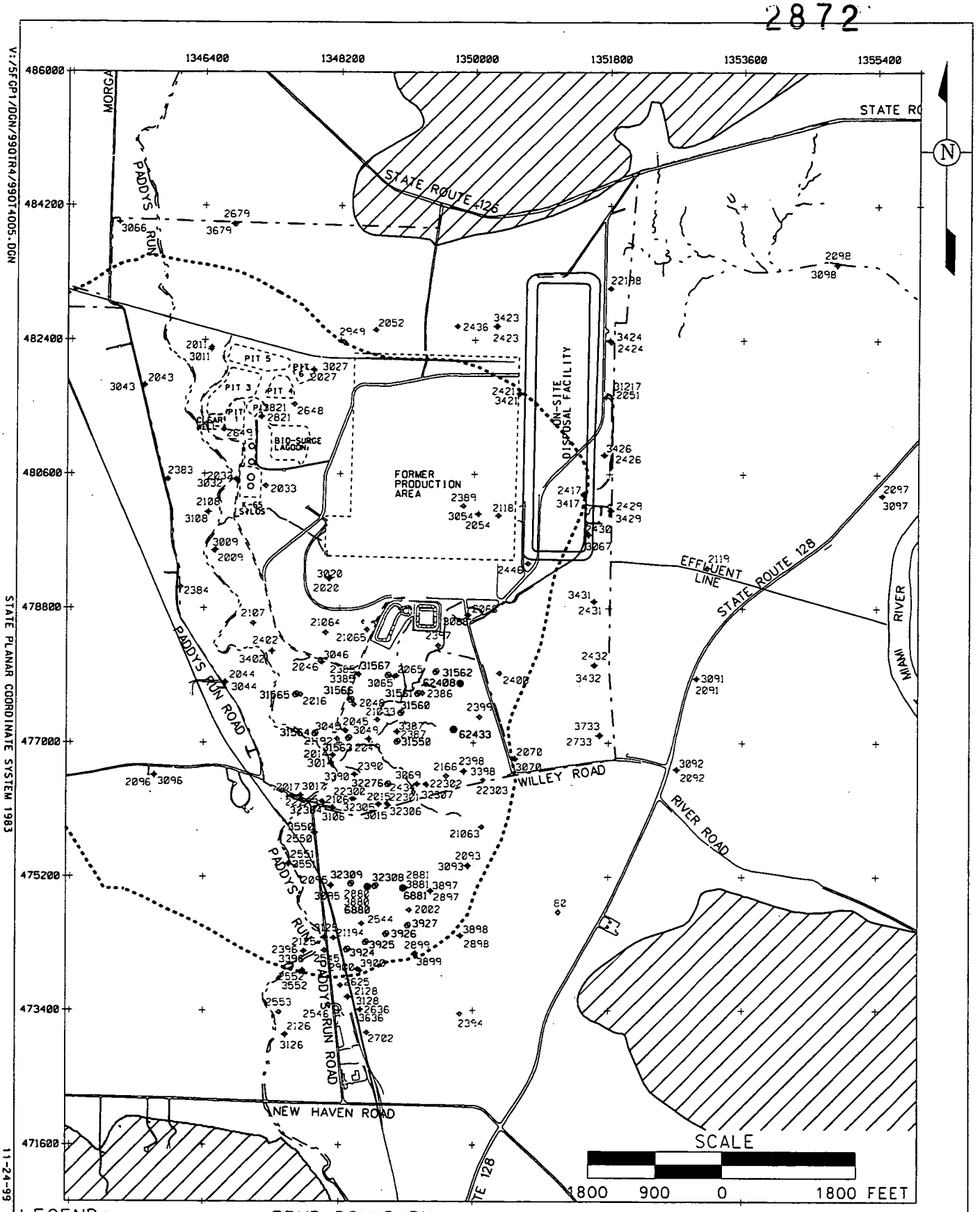


FIGURE 1-3. GROUNDWATER ELEVATION MONITORING WELLS

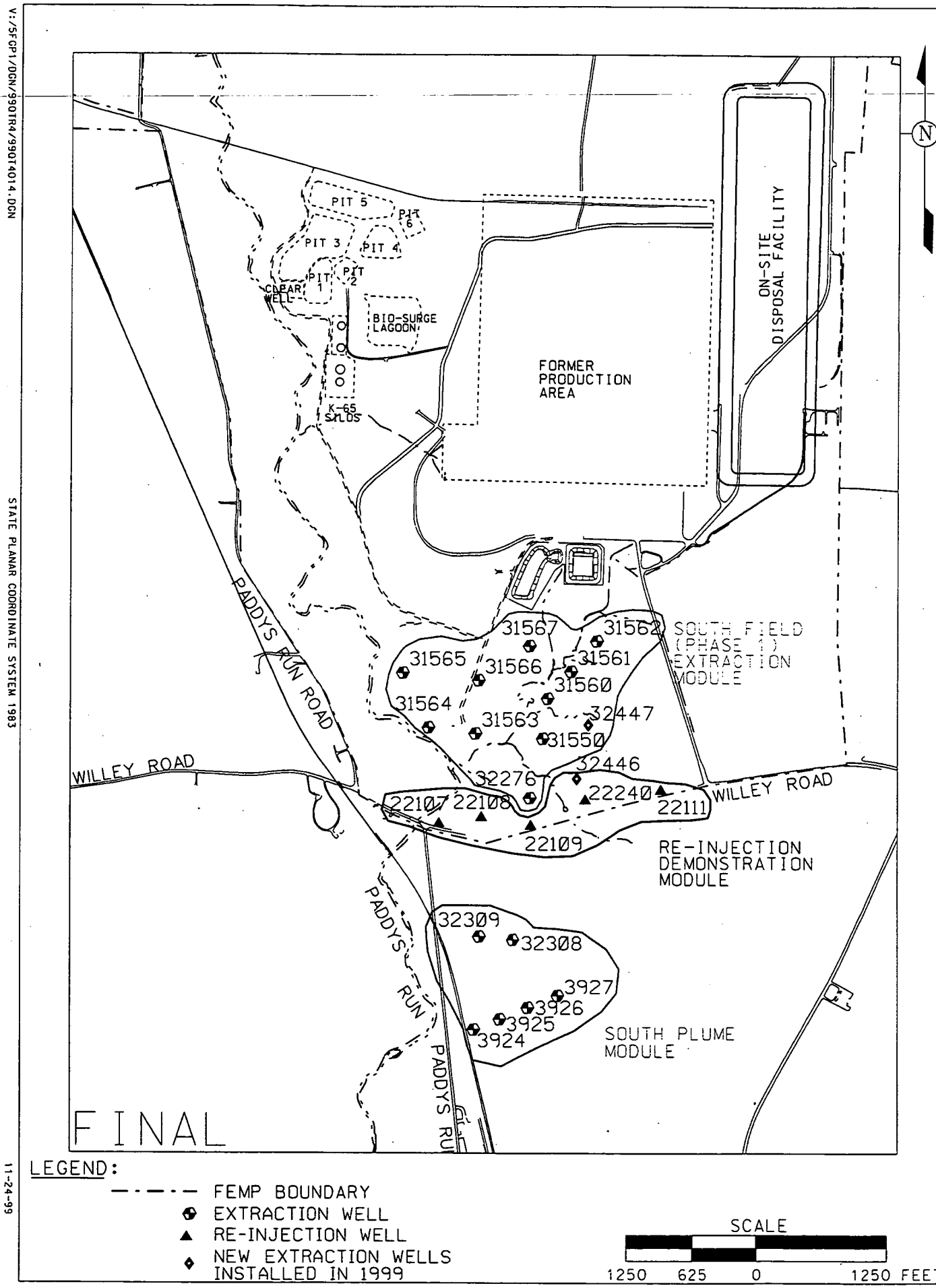


FIGURE 1-4. LOCATION OF ACTIVE AQUIFER RESTORATION MODULES

V:/5FCP1/DGN/99OTR4/99OT4014.DGN

STATE PLANAR COORDINATE SYSTEM 1983

11-24-99

FIGURE 1-1/1-5

GROUNDWATER SAMPLING ACTIVITIES

	Quarter/Year											
	Third Quarter/1999			Fourth Quarter/1999			First Quarter/2000			Second Quarter/2000		
SAMPLING ACTIVITIES	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
South Plume Module:												
Operational				◆	◆	◆	⊠	⊠	⊠			
Aquifer Conditions [a]		◆										
South Field Extraction Module:												
Operational (Phase 1)				◆	◆	◆	⊠	⊠	⊠			
Aquifer Conditions [a]			◆									
Re-Injection Demonstration Module [b]												
Operational				◆	◆	◆	⊠	⊠	⊠			
Waste Storage Area Module:												
Aquifer Conditions [a]												
Plant 6 Area Module:												
Aquifer Conditions [a]												
Routine Water-Level/Flow Direction Monitoring				◆			⊠					
Property Boundary Monitoring [a]	◆											
Private Well Monitoring [a]	◆											
KC-2 Warehouse Well Monitoring [c]		◆										

◆ Data summarized/evaluated in this report
⊠ Data summarized/evaluated in the next report

FINAL

[a]Fourth quarter 1999 data will be included in the 1999 Integrated Site Environmental Report.
[b]Aquifer conditions for this module are being addressed in the Re-Injection Demonstration Report.
[c]This activity well be discontinued in 2000 due to dismantling of the KC-2 Warehouse and subsequent plugging and abandonment of the KC-2 Warehouse well.

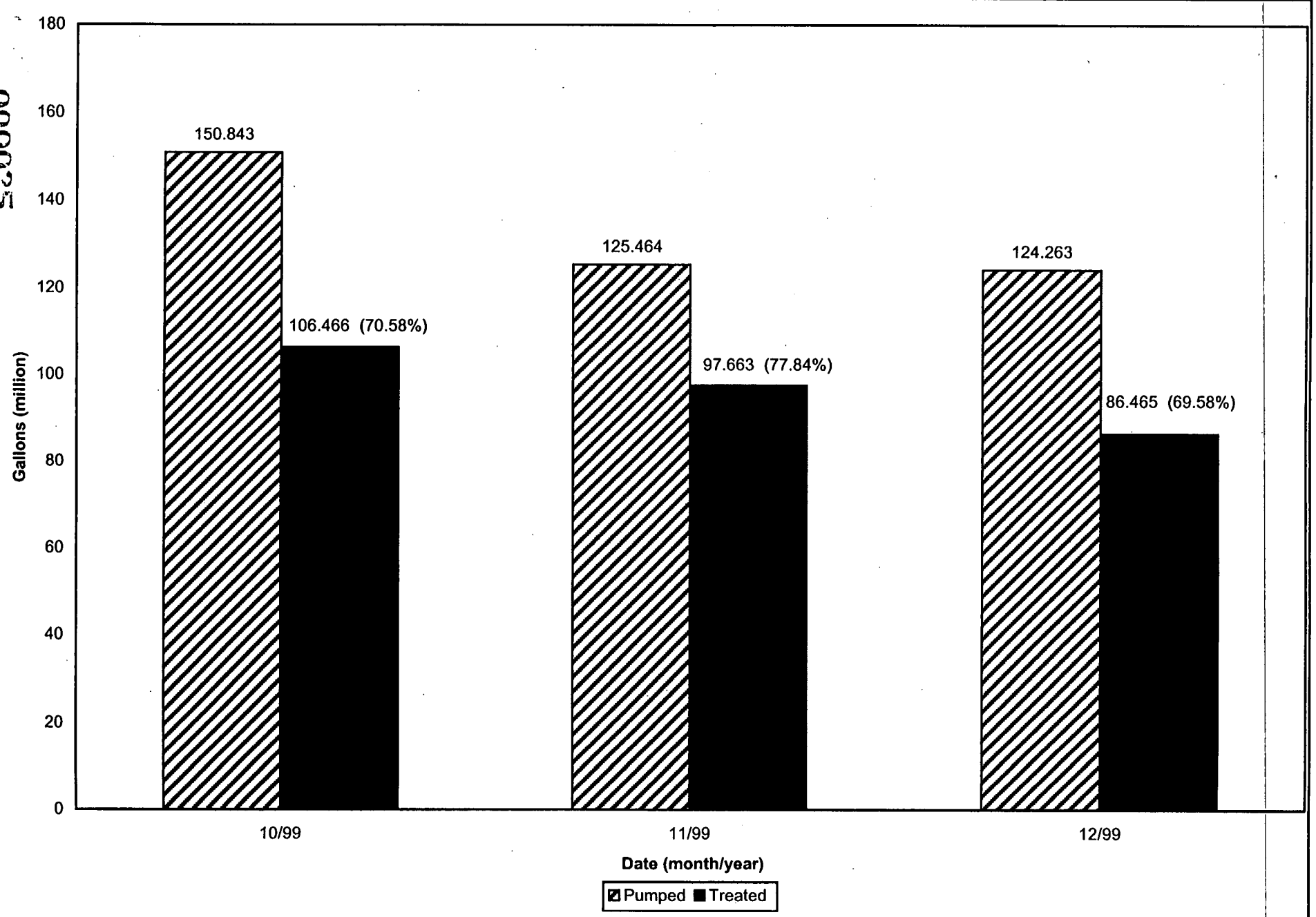


FIGURE 1-6. TOTAL GROUNDWATER PUMPED VS. GROUNDWATER TREATED FOR FOURTH QUARTER 1999

FINAL

S20000

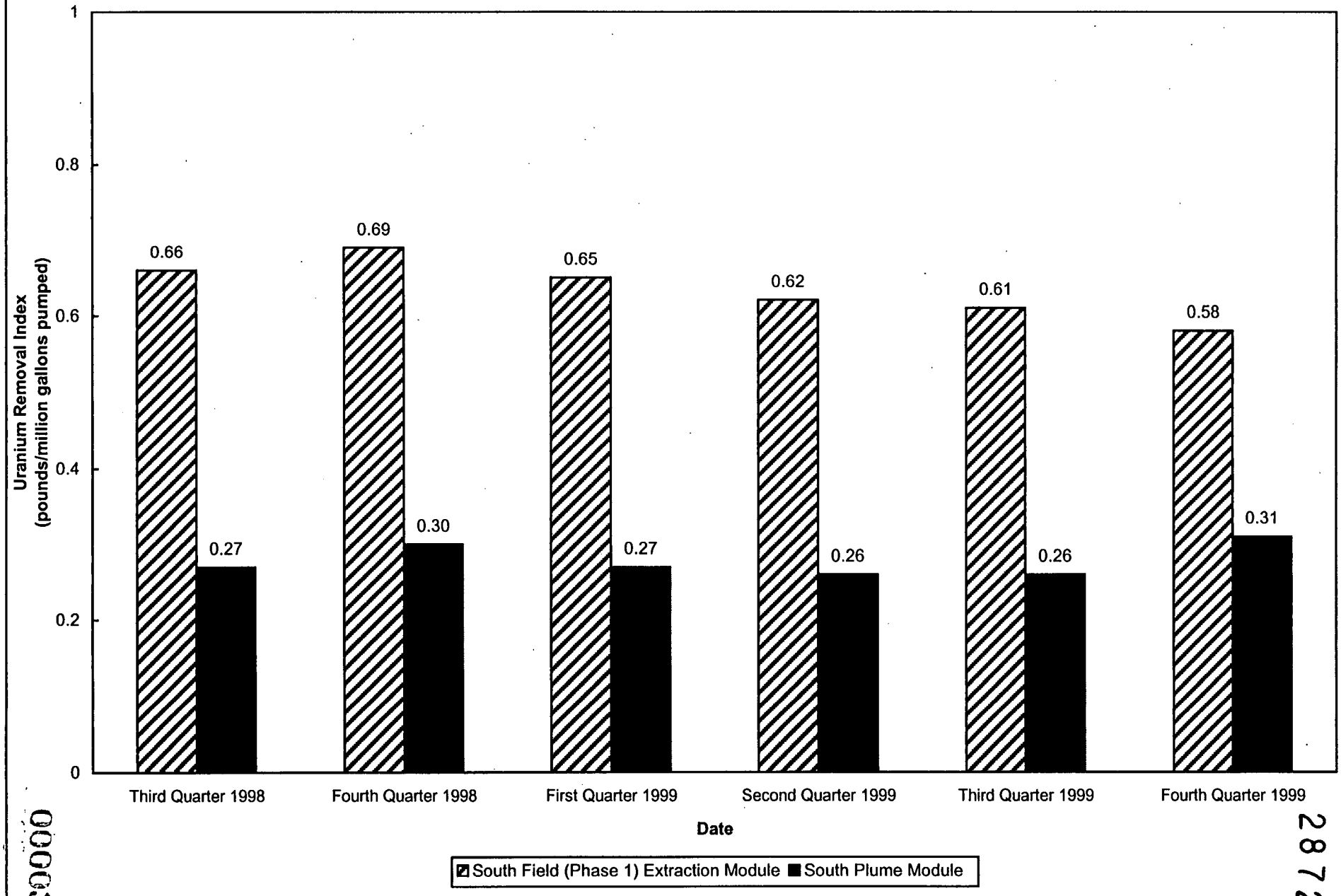


FIGURE 1-7. URANIUM REMOVAL INDICES BY MODULE

FINAL

000026

28 72

000027

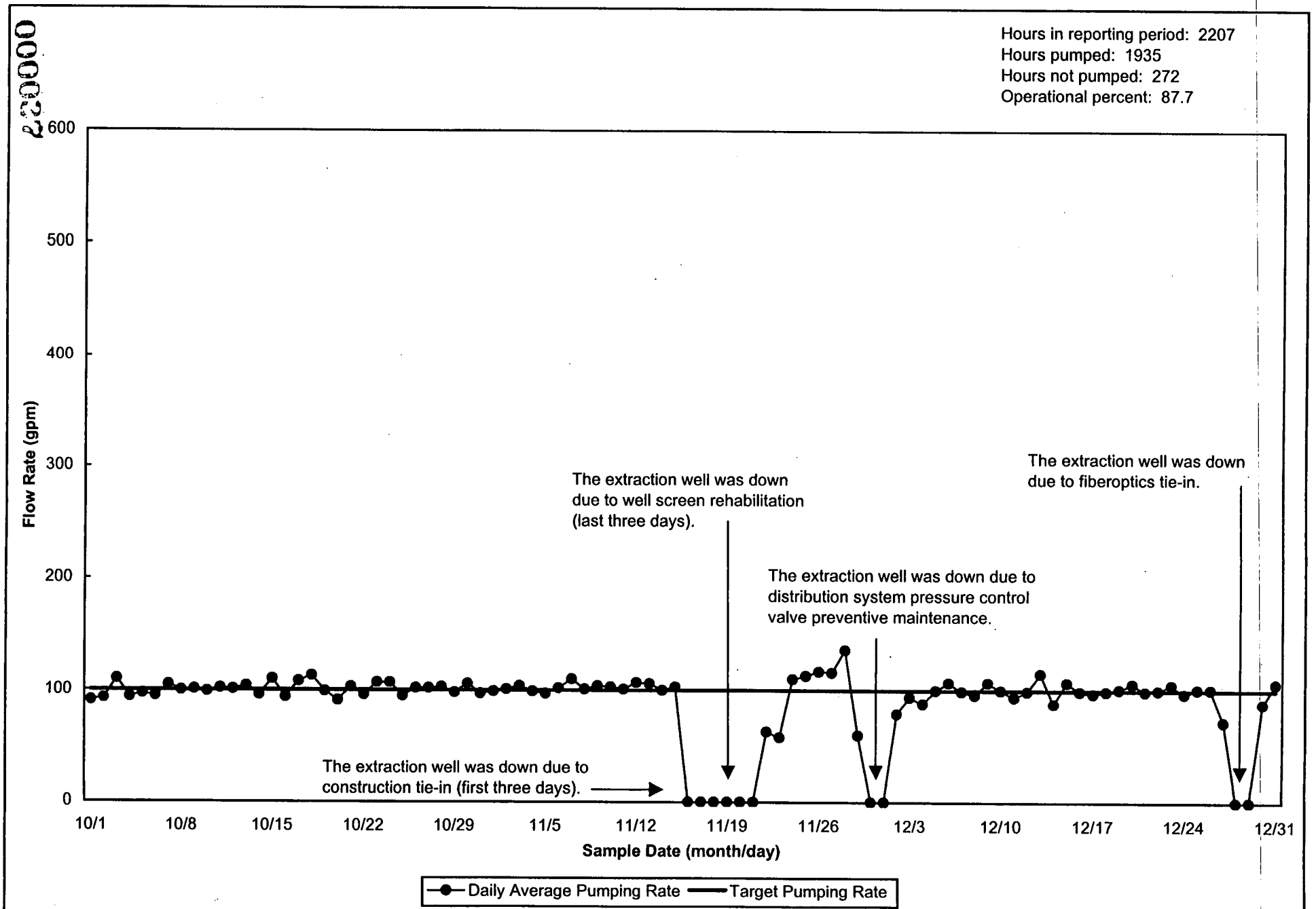
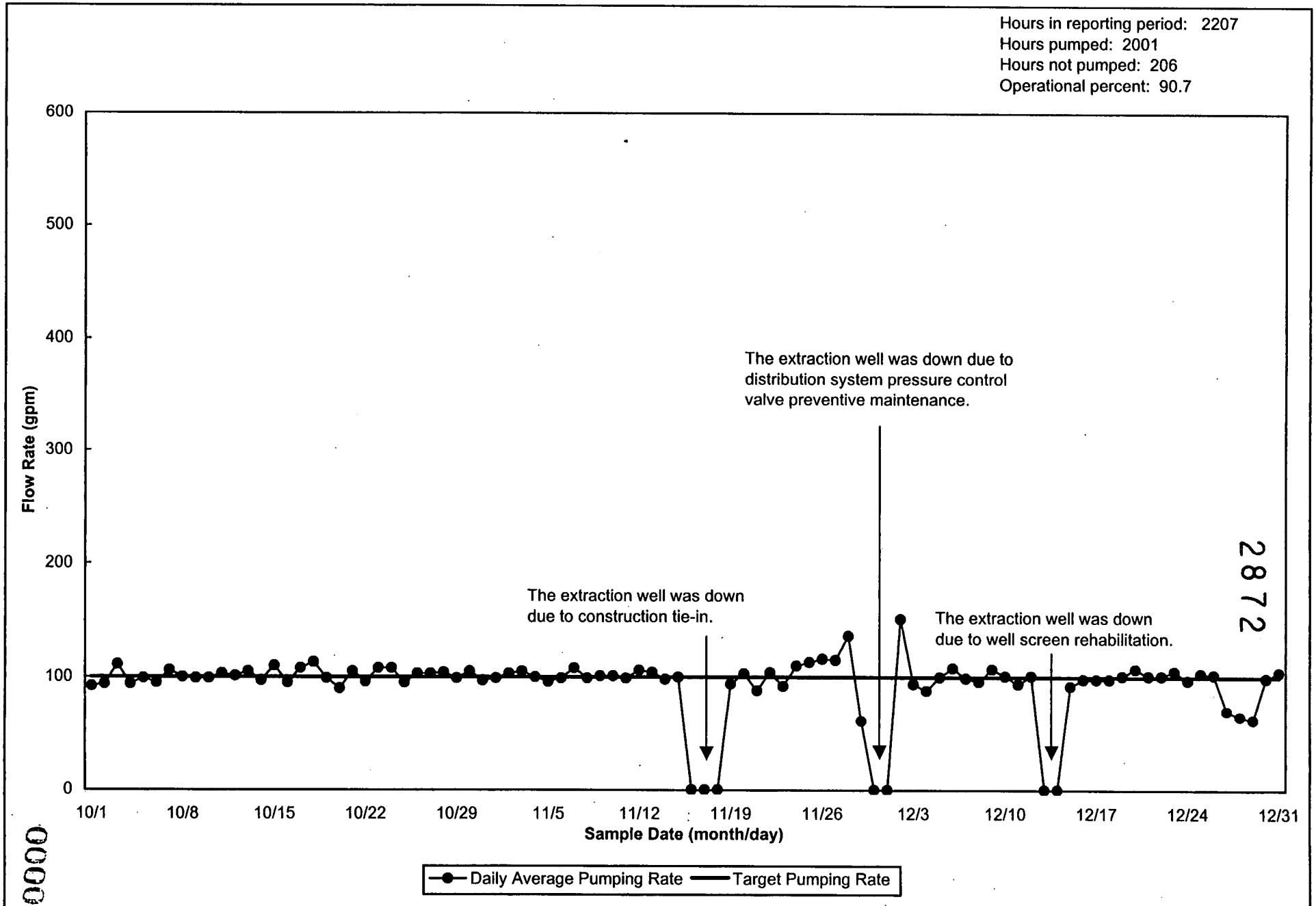


FIGURE 1-8. PUMPING RATES FOR SOUTH FIELD (PHASE 1) EXTRACTION WELL 31550, 10/99 - 12/99

FINAL



2872

000028

FINAL

FIGURE 1-9. PUMPING RATES FOR SOUTH FIELD (PHASE 1) EXTRACTION WELL 31560, 10/99 - 12/99

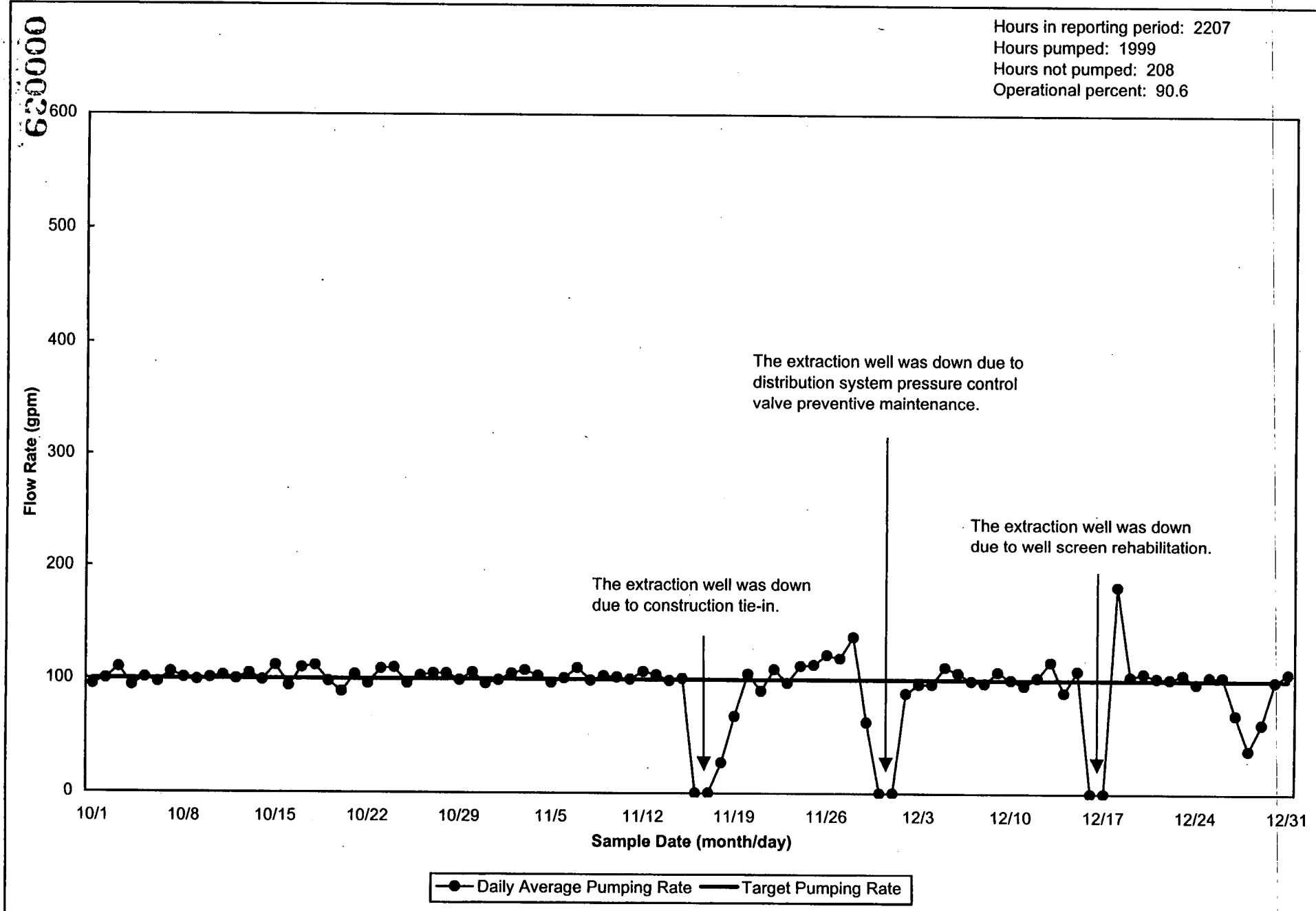


FIGURE 1-10. PUMPING RATES FOR SOUTH FIELD (PHASE 1) EXTRACTION WELL 31561, 10/99 - 12/99

FINAL

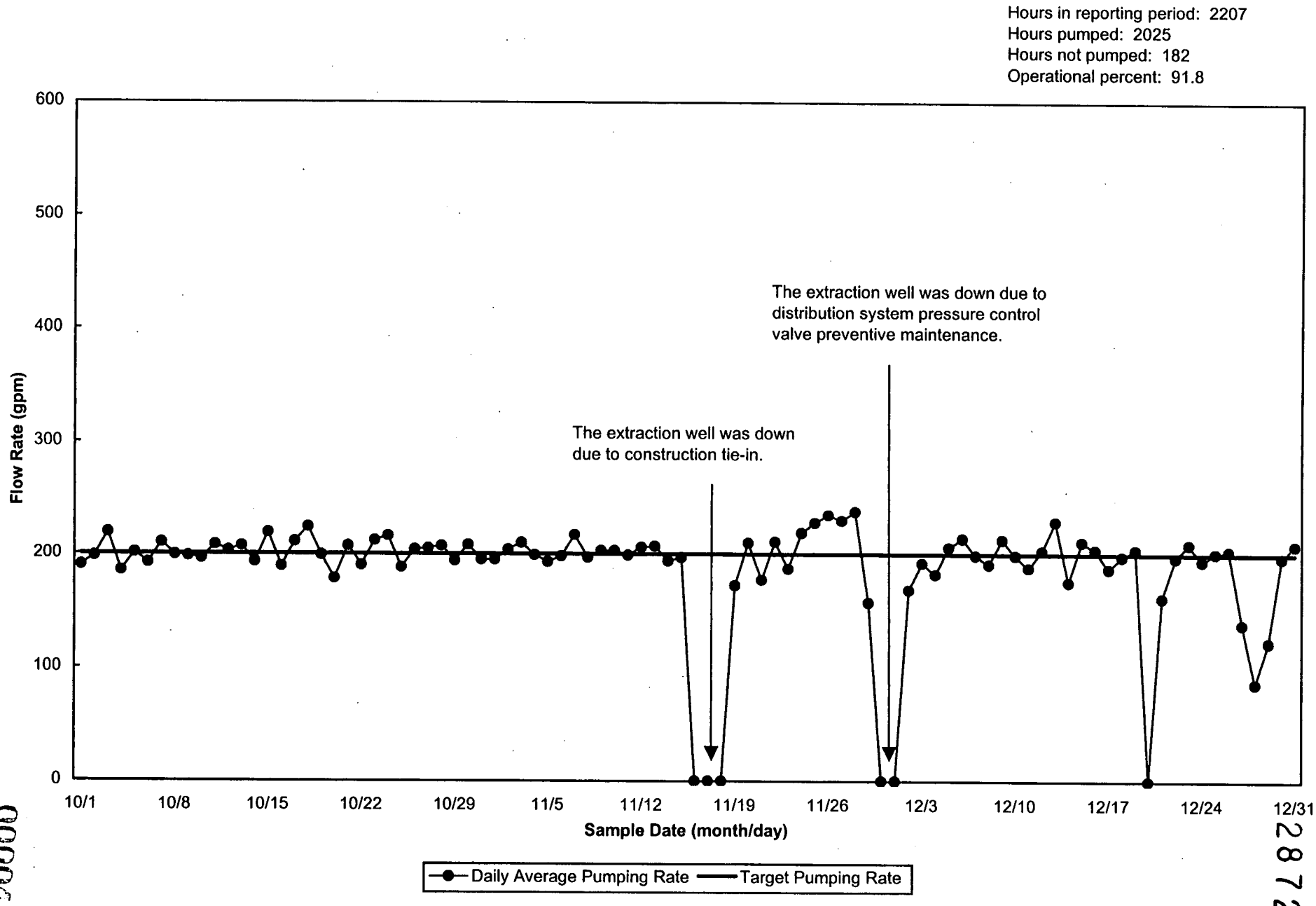
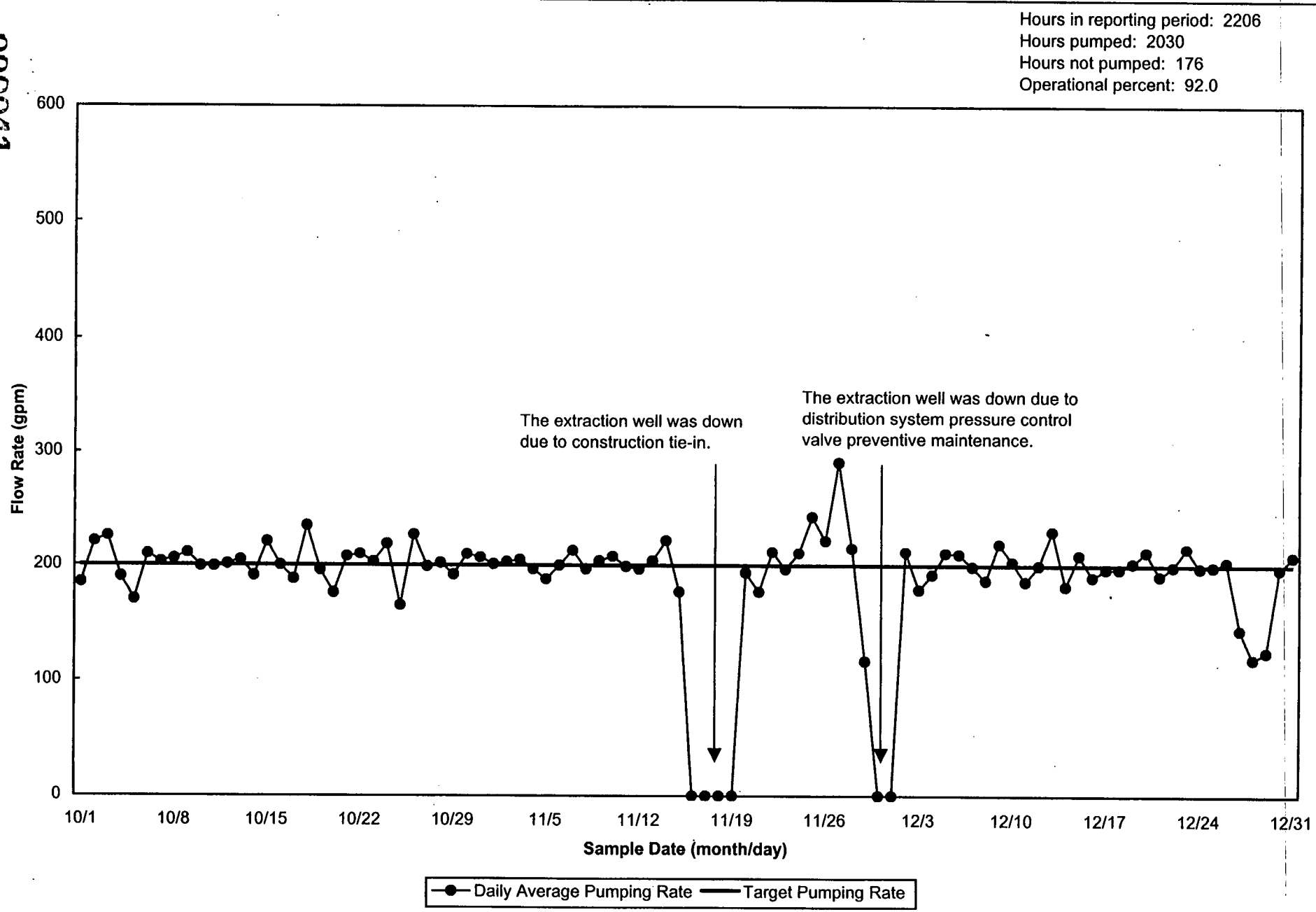


FIGURE 1-11. PUMPING RATES FOR SOUTH FIELD (PHASE 1) EXTRACTION WELL 31562, 10/99 - 12/99

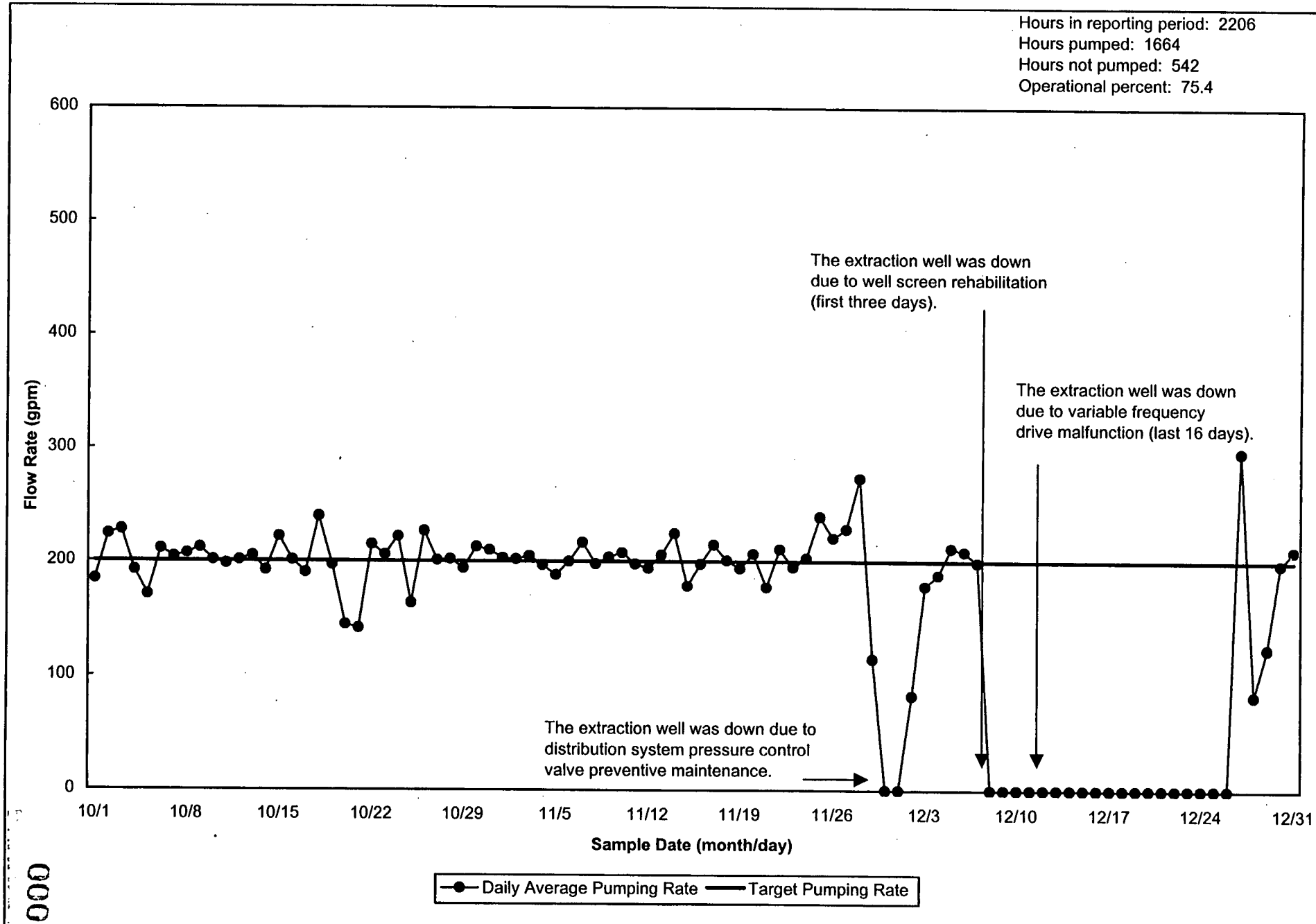
FINAL

000042



FINAL

FIGURE 1-12. PUMPING RATES FOR SOUTH FIELD (PHASE 1) EXTRACTION WELL 31563, 10/99 - 12/99



FINAL

FIGURE 1-13. PUMPING RATES FOR SOUTH FIELD (PHASE 1) EXTRACTION WELL 31564, 10/99 - 12/99

250000

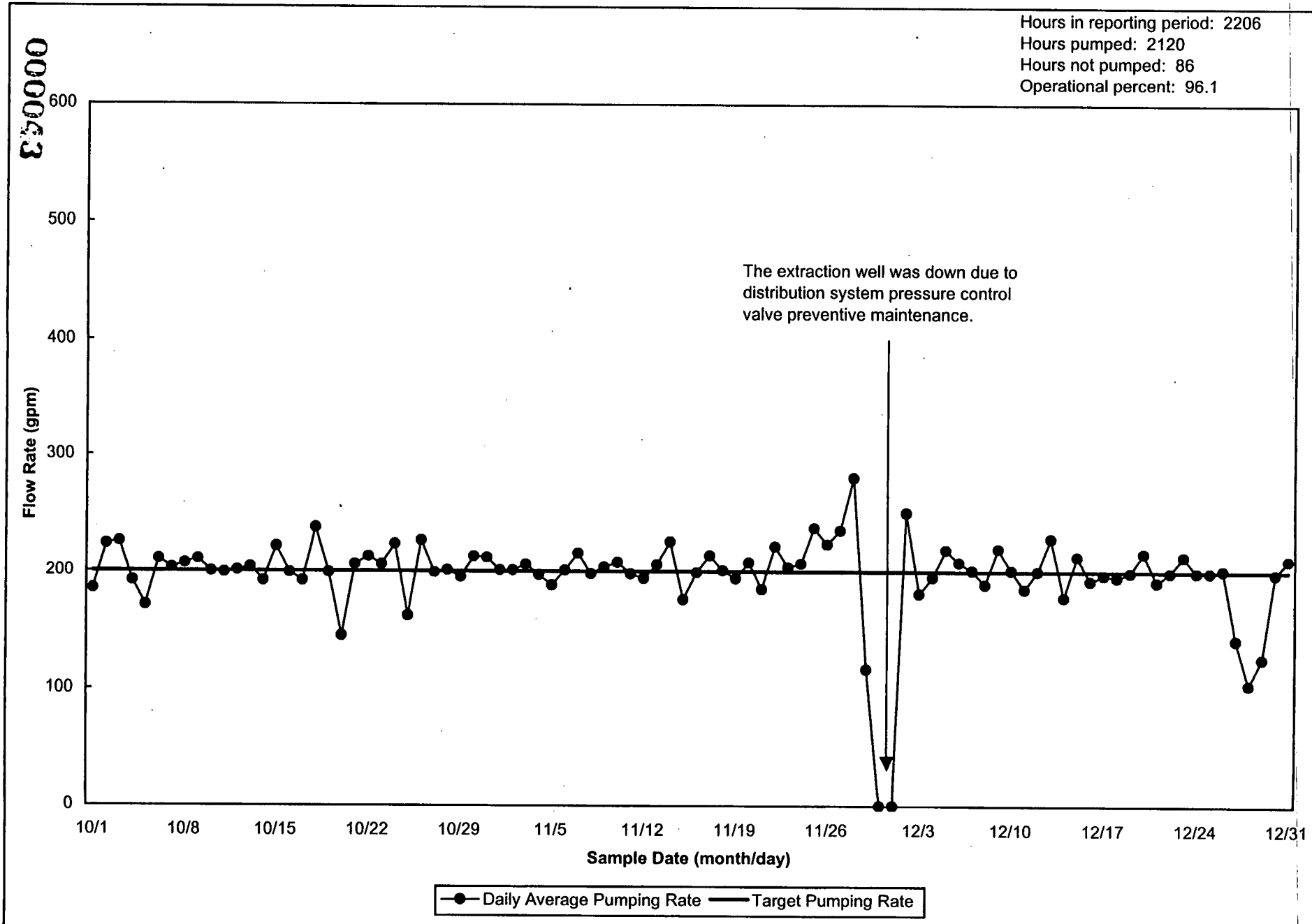
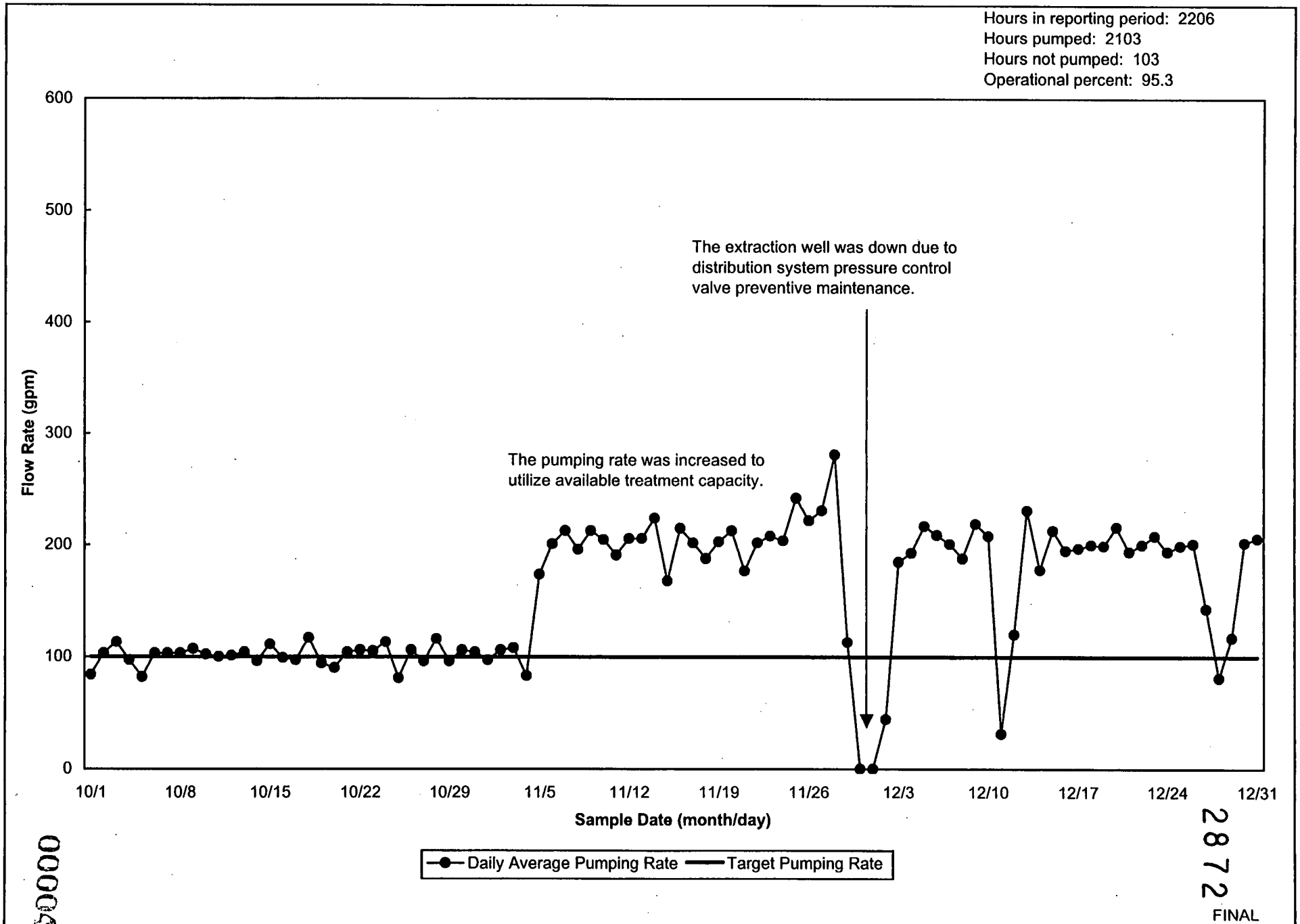


FIGURE 1-14. PUMPING RATES FOR SOUTH FIELD (PHASE 1) EXTRACTION WELL 31565, 10/99 - 12/99

FINAL

000043



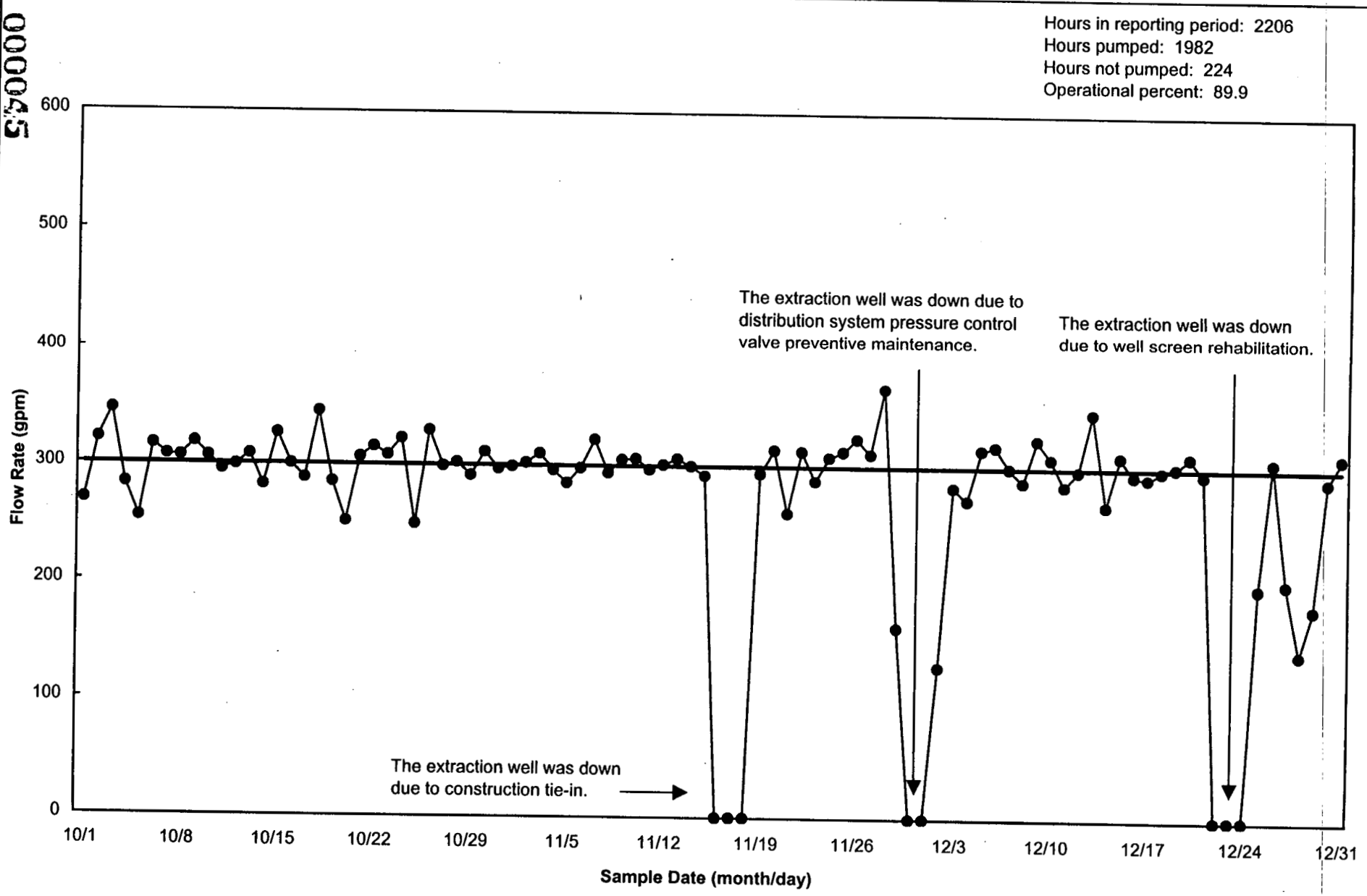
FINAL

28872

000041

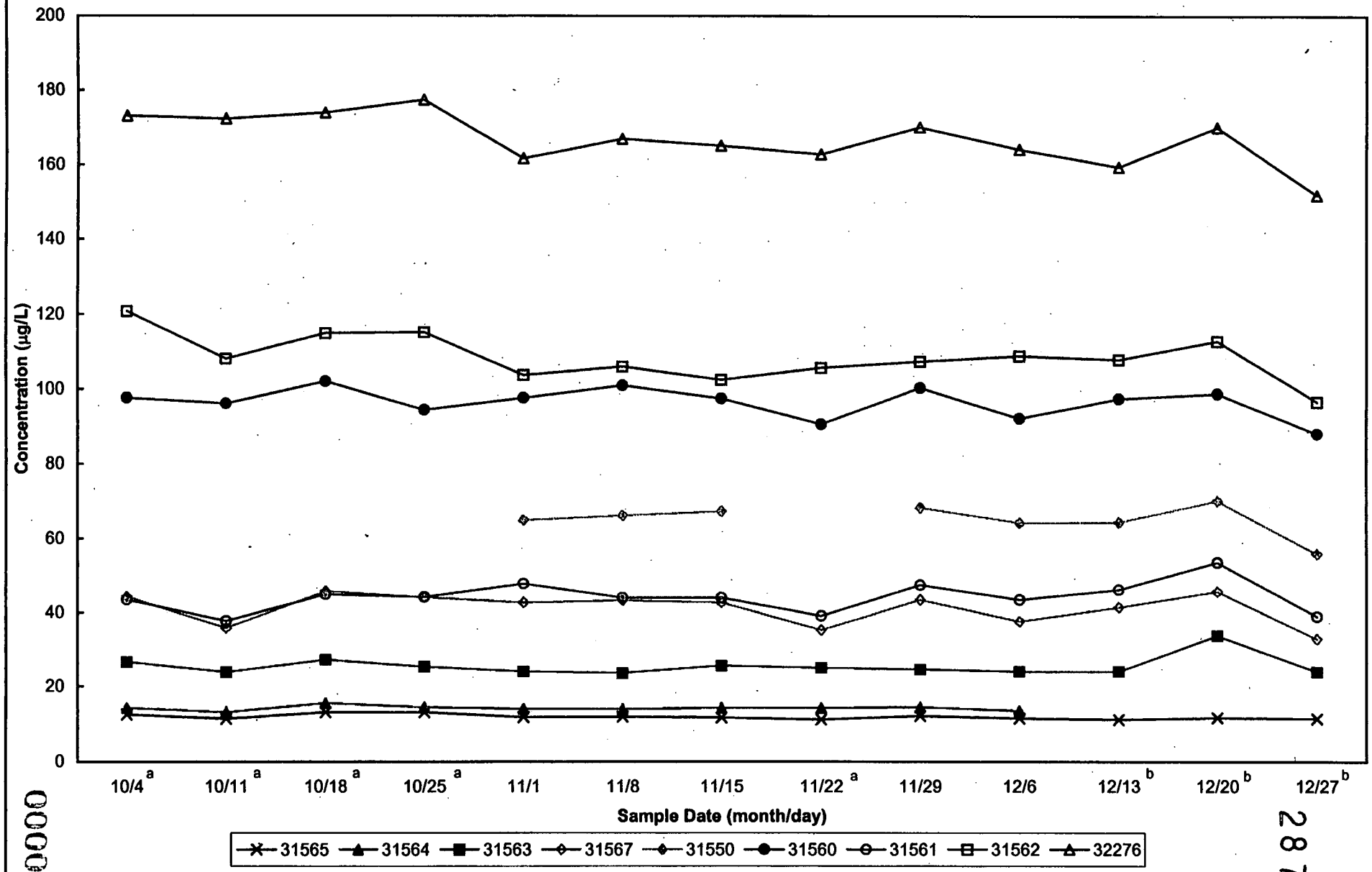
FIGURE 1-15. PUMPING RATES FOR SOUTH FIELD (PHASE 1) EXTRACTION WELL 31567, 10/99 - 12/99

550000



FINAL

FIGURE 1-16. PUMPING RATES FOR SOUTH FIELD (PHASE 1) EXTRACTION WELL 32276, 10/99 - 12/99



[a] A sample was not collected for Extraction Well 31550.

[b] A sample was not collected for Extraction Well 31564.

FIGURE 1-17. WEEKLY TOTAL URANIUM CONCENTRATIONS FOR THE SOUTH FIELD (PHASE 1) EXTRACTION MODULE

FINAL

000046
28 72

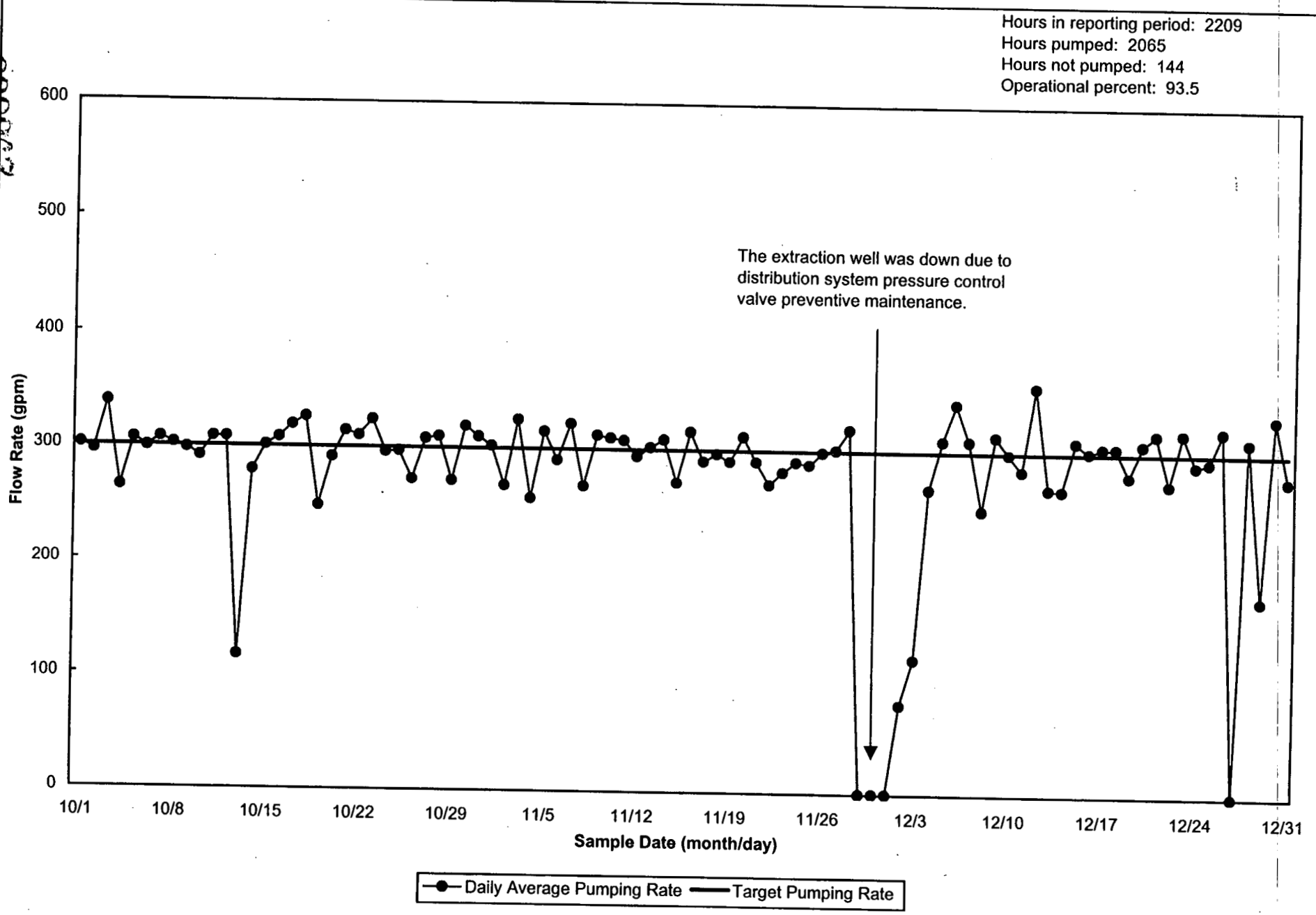


FIGURE 1-18. PUMPING RATES FOR SOUTH PLUME EXTRACTION WELL 3924, 10/99 - 12/99

FINAL

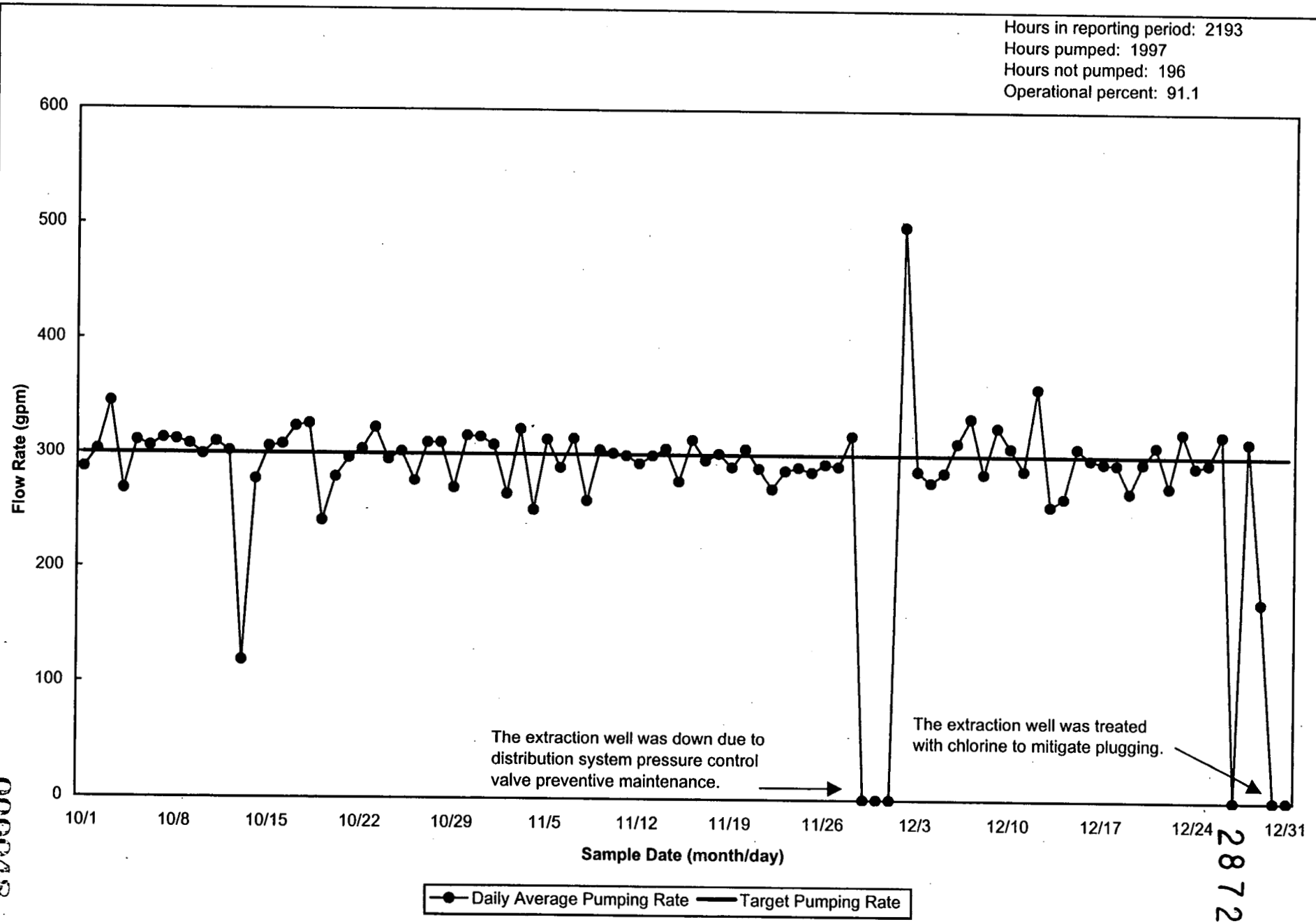


FIGURE 1-19. PUMPING RATES FOR SOUTH PLUME EXTRACTION WELL 3925, 10/99 - 12/99

FINAL

000028

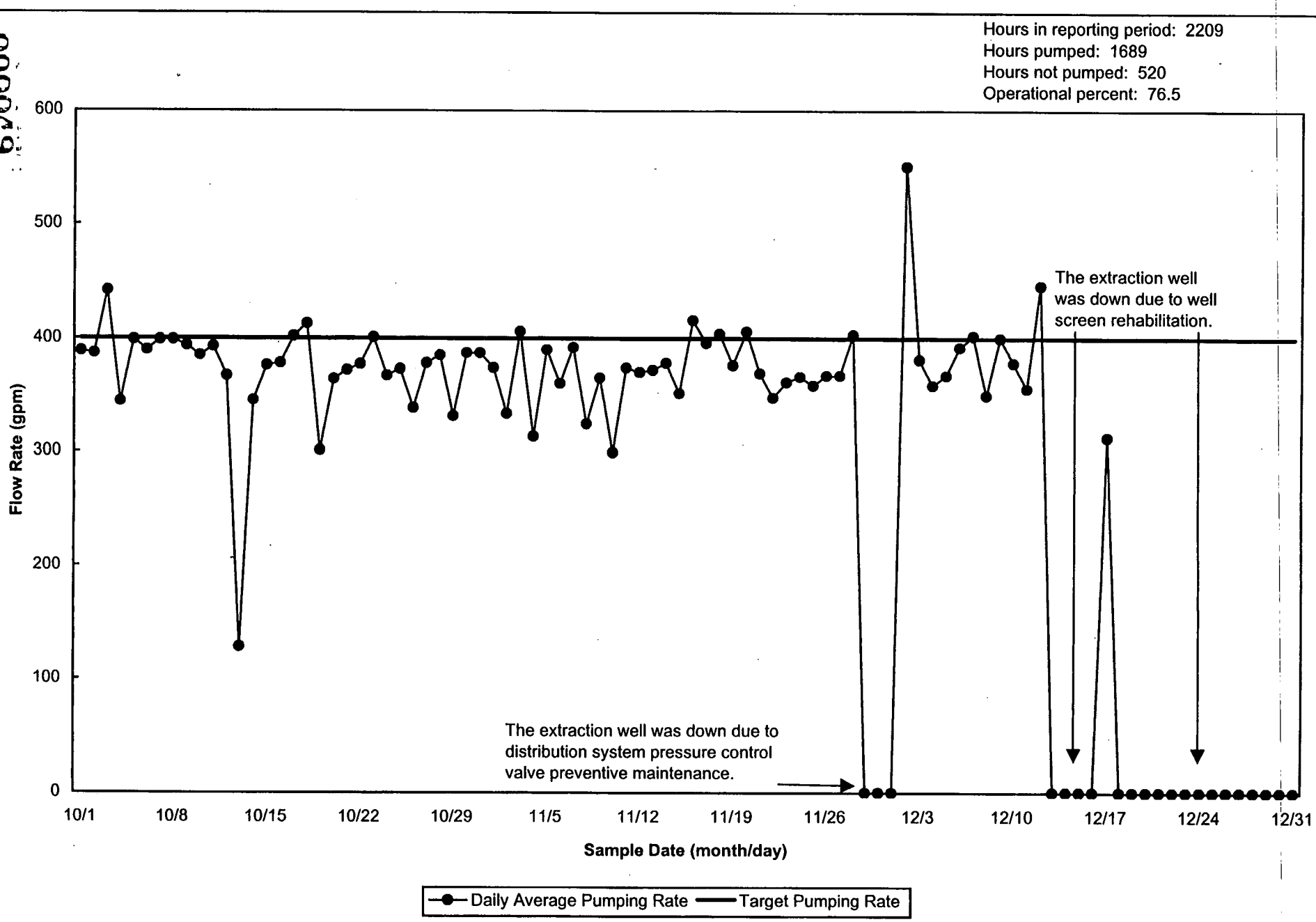


FIGURE 1-20. PUMPING RATES FOR SOUTH PLUME EXTRACTION WELL 3926, 10/99 - 12/99

FINAL

000049

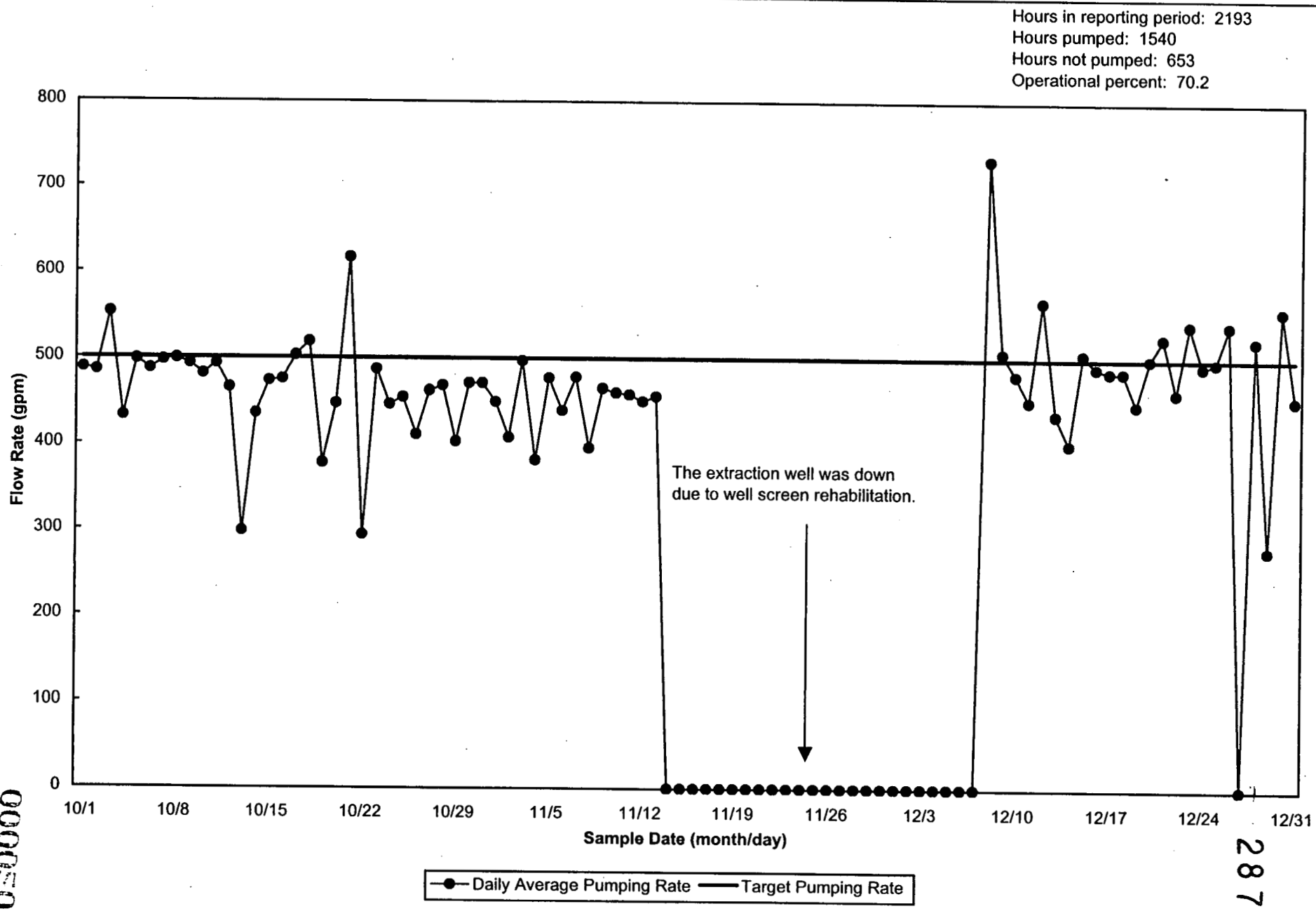
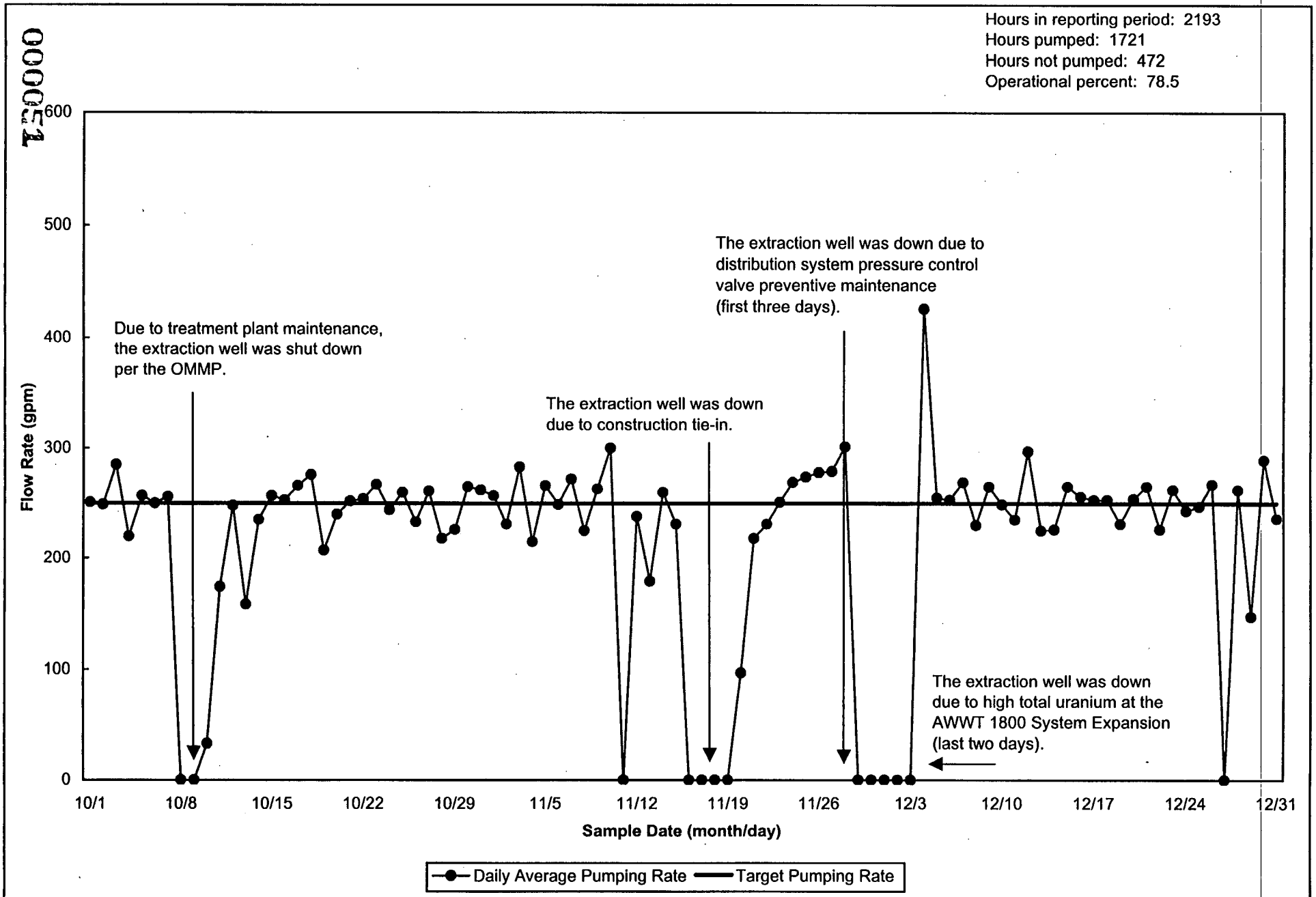


FIGURE 1-21. PUMPING RATES FOR SOUTH PLUME EXTRACTION WELL 3927, 10/99 - 12/99

000050

28 72
FINAL

000054



FINAL

FIGURE 1-22. PUMPING RATES FOR SOUTH PLUME EXTRACTION WELL 32308, 10/99 - 12/99

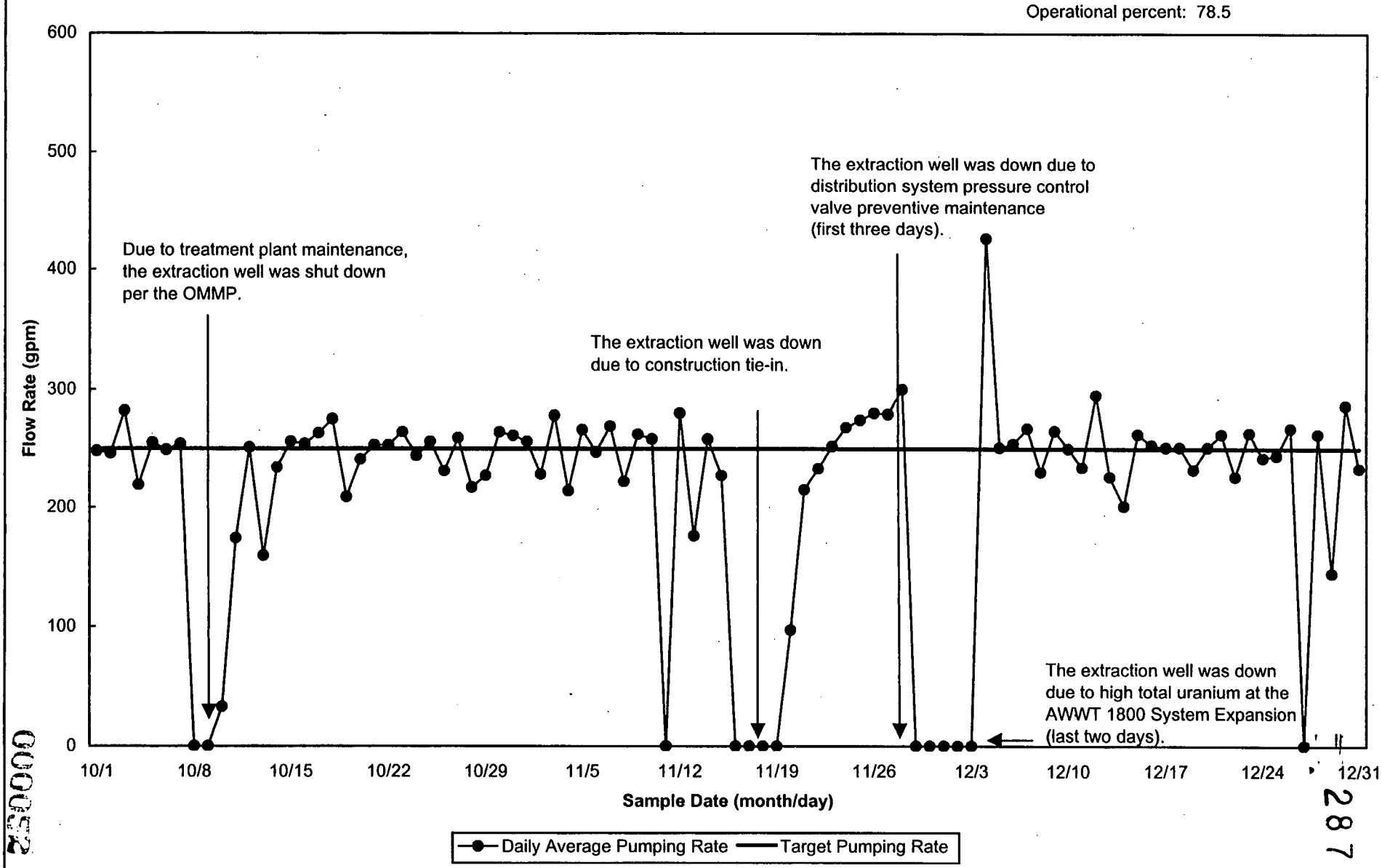
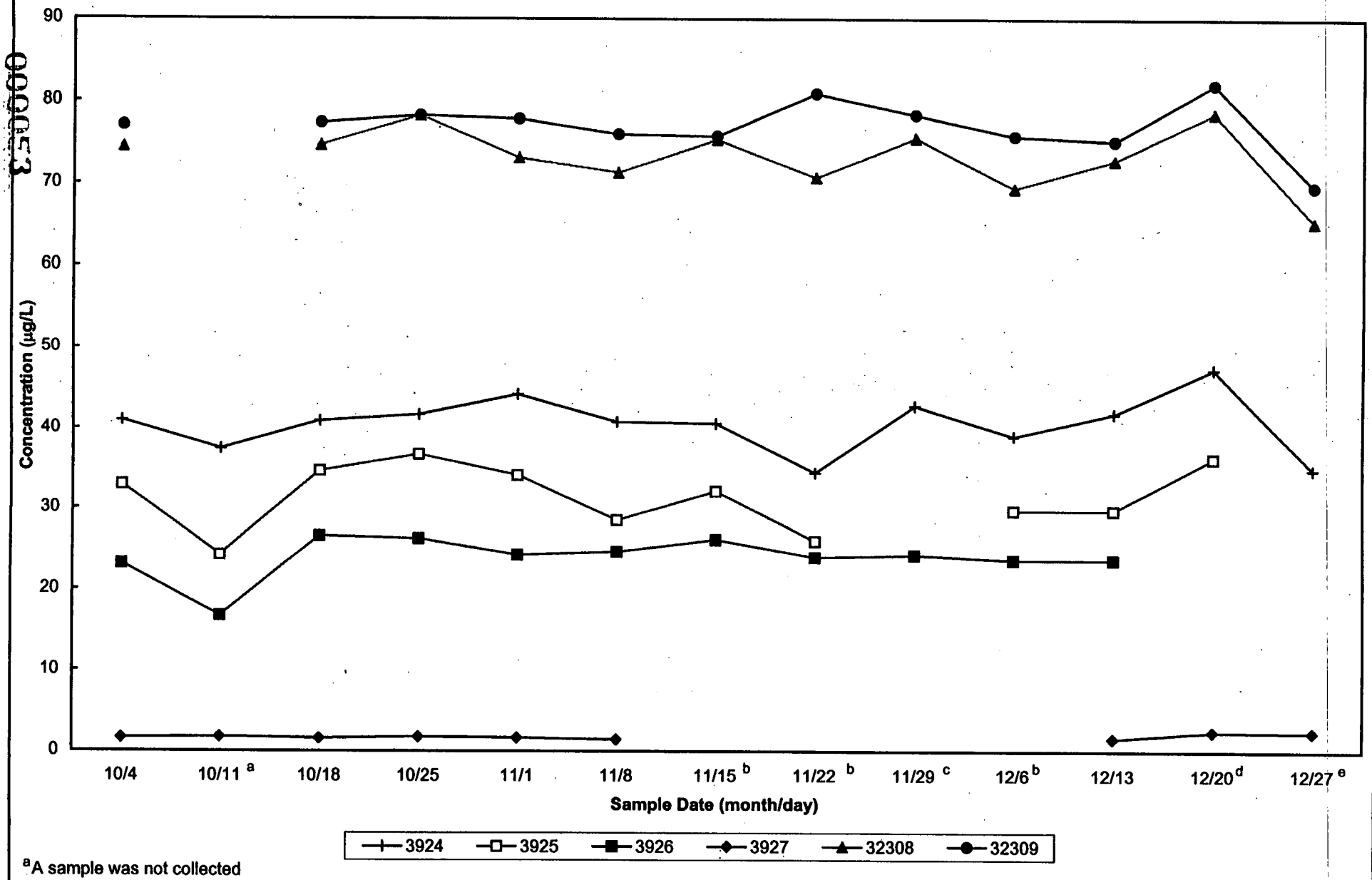


FIGURE 1-23. PUMPING RATES FOR SOUTH PLUME EXTRACTION WELL 32309, 10/99 - 12/99

FINAL

2872

000052



[a] A sample was not collected for Extraction Wells 32308 and 32309.

[b] A sample was not collected for Extraction Well 3927.

[c] A sample was not collected for Extraction Wells 3925 and 3927.

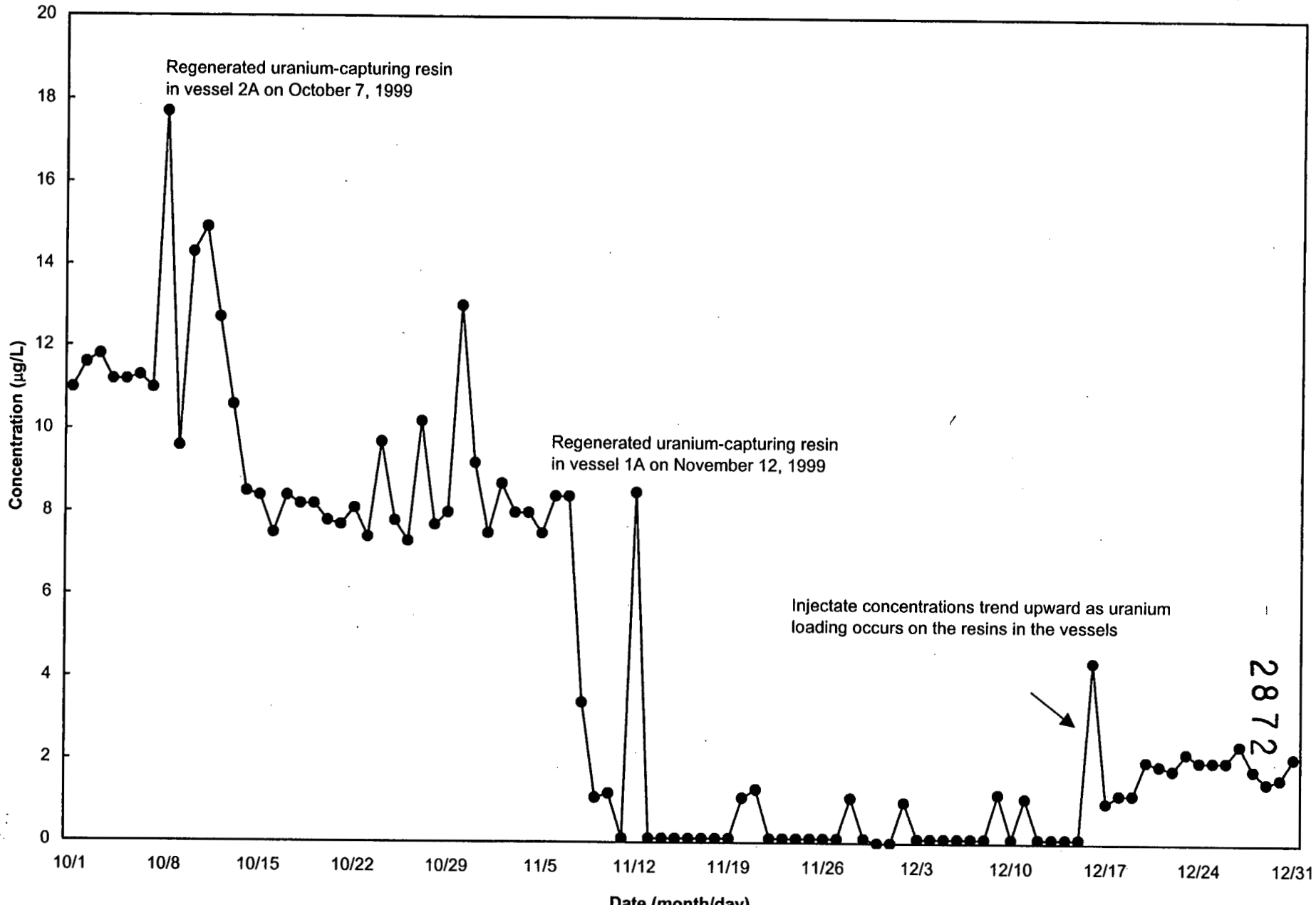
[d] A sample was not collected for Extraction Well 3926.

[e] A sample was not collected for Extraction Wells 3925 and 3926.

FIGURE 1-24. WEEKLY TOTAL URANIUM CONCENTRATIONS FOR THE SOUTH PLUME MODULE

FINAL

000053



Note: Total uranium concentration required to be less than 20 µg/L.

FIGURE 1-25. TOTAL URANIUM CONCENTRATIONS IN INJECTATE, 10/99 - 12/99

FINAL

28722

000054

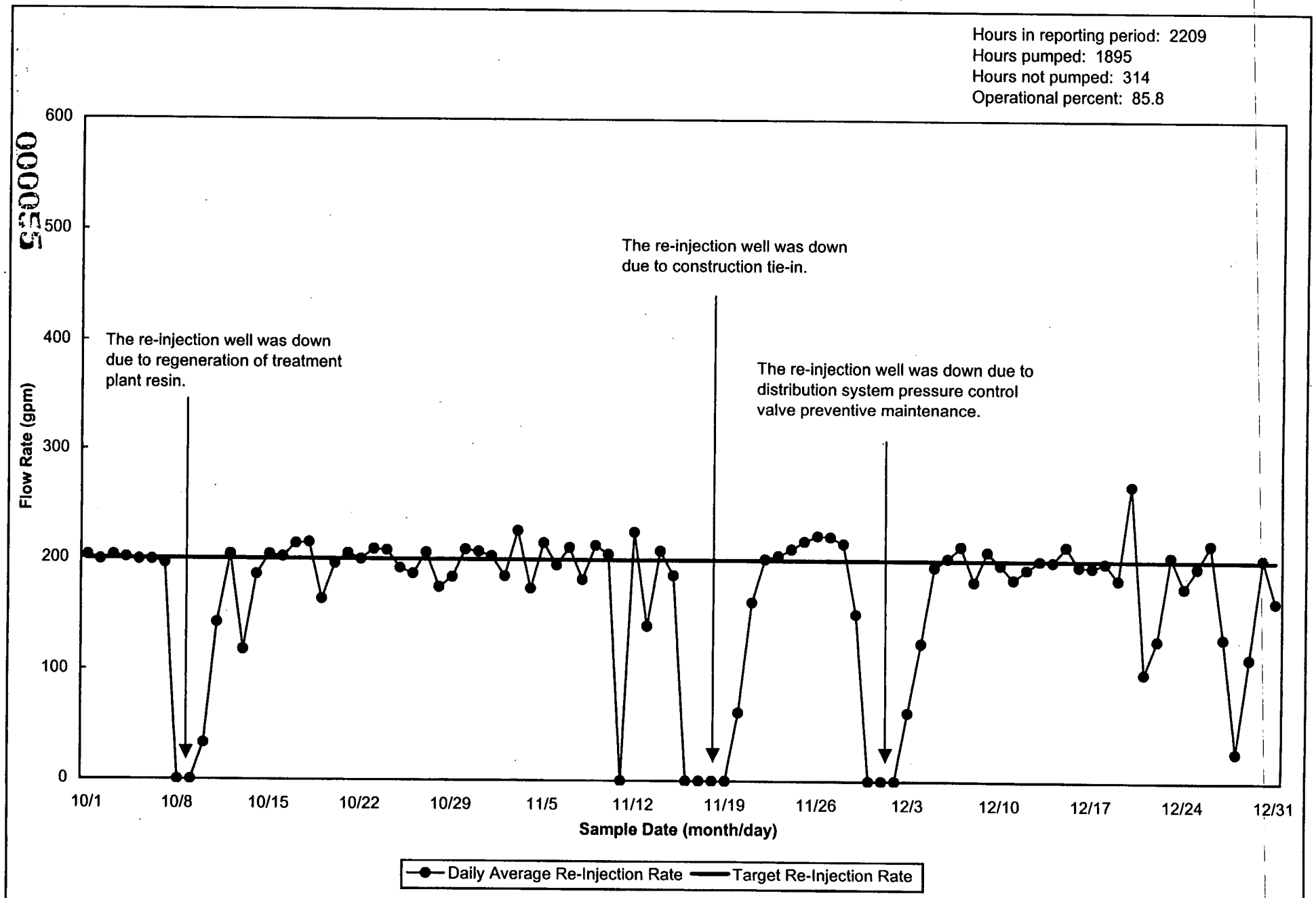
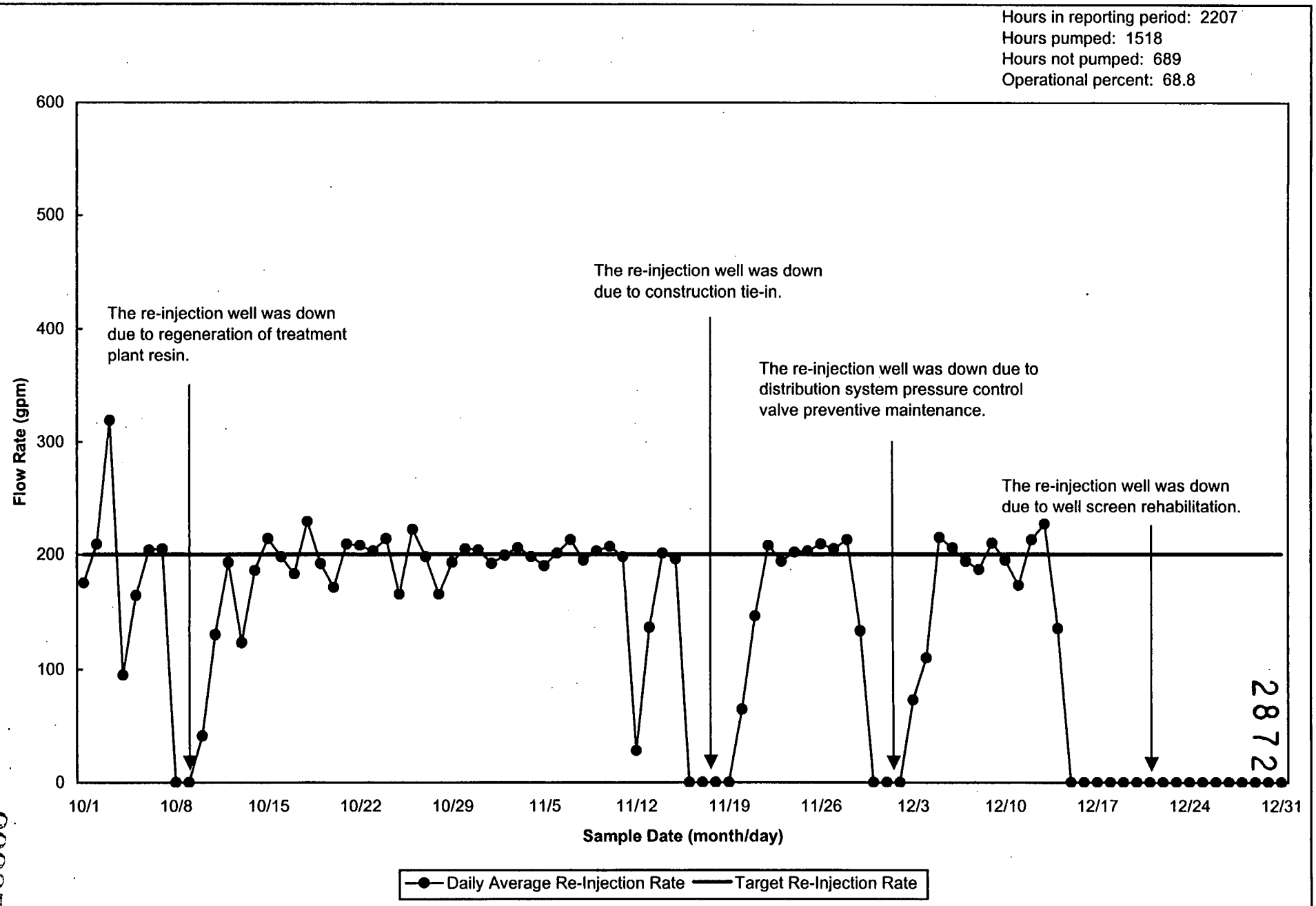


FIGURE 1-26. RE-INJECTION RATES FOR WELL 22107, 10/99 - 12/99

FINAL

530000

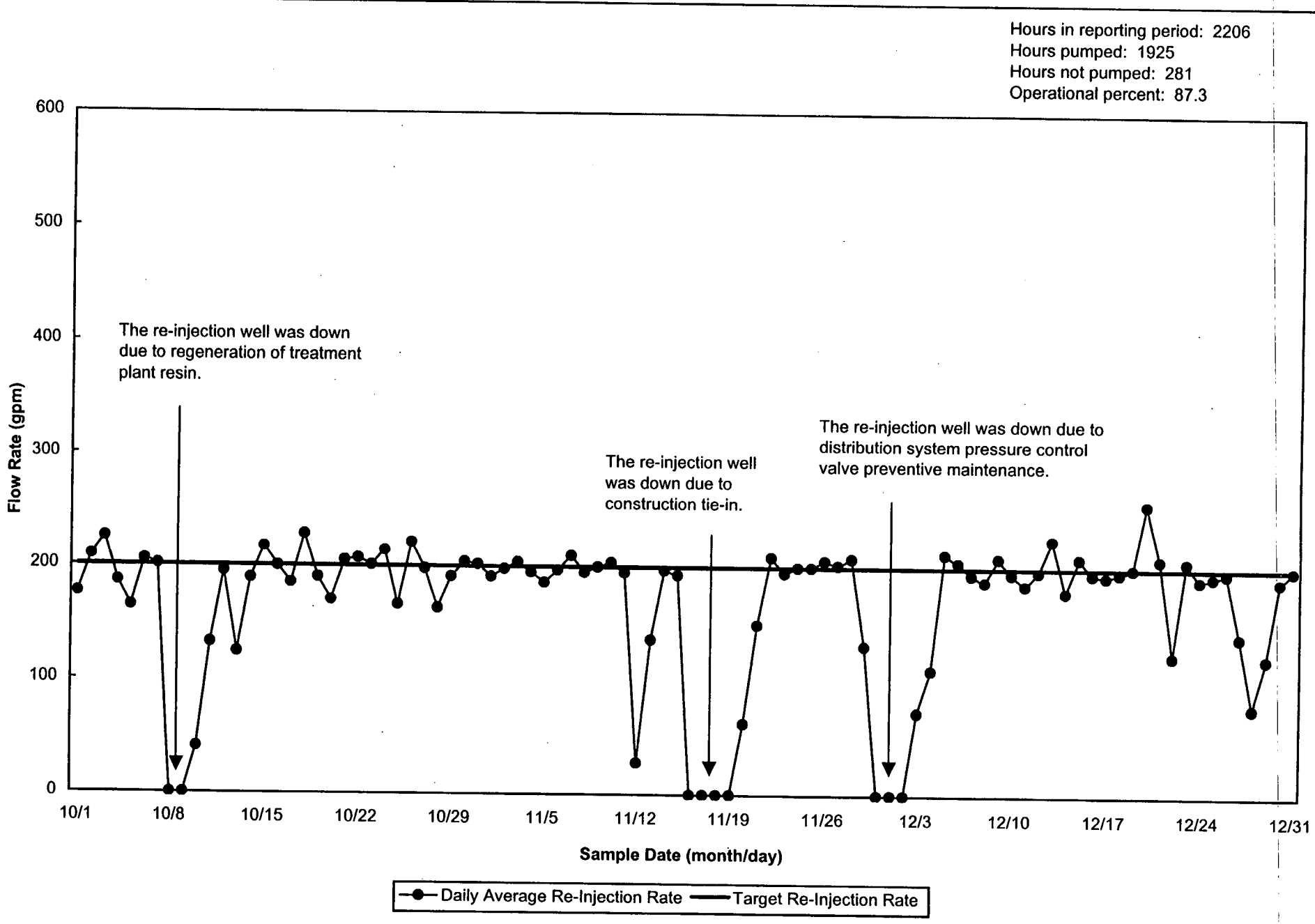


FINAL

FIGURE 1-27. RE-INJECTION RATES FOR WELL 22108, 10/99 - 12/99

28 72

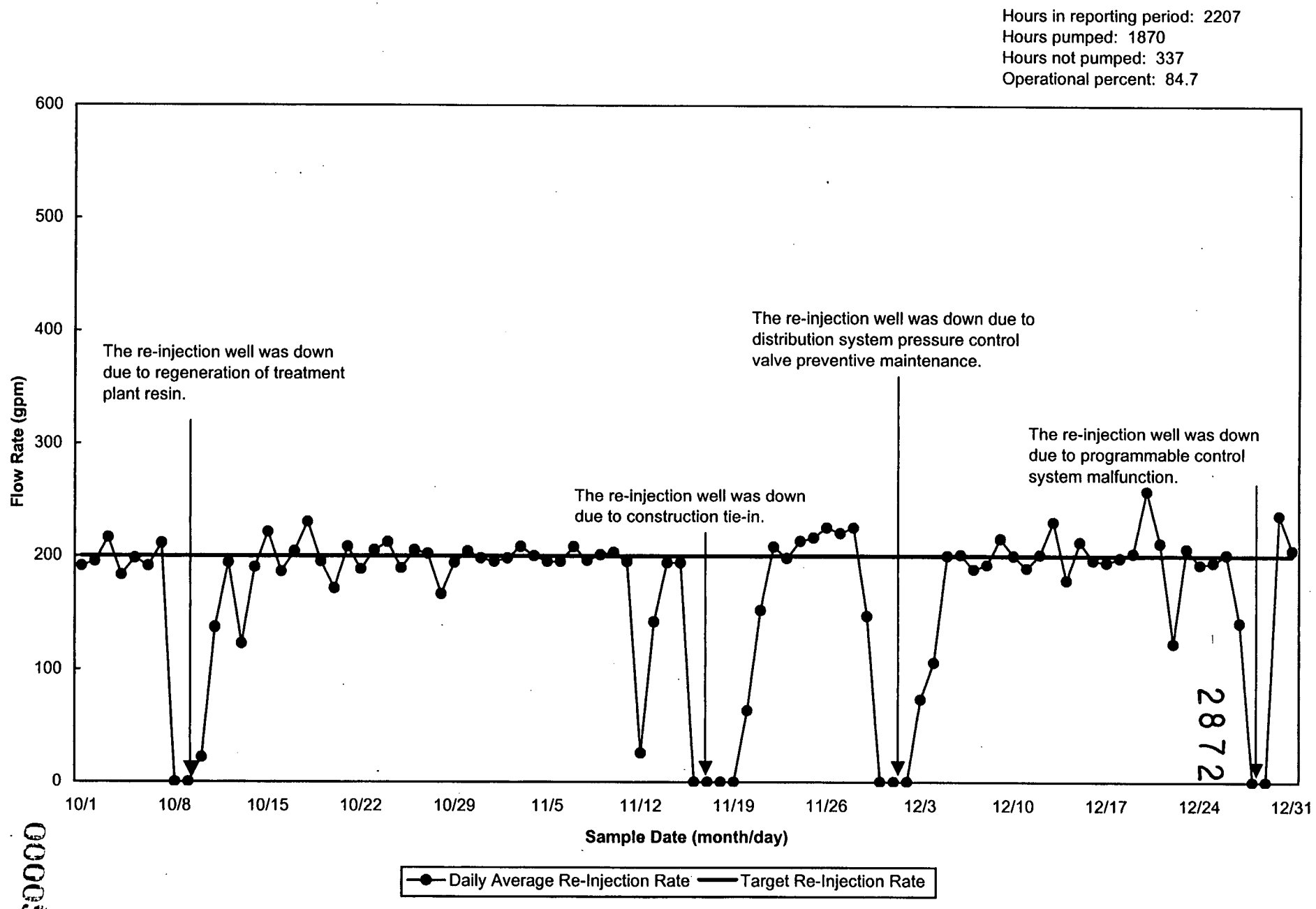
000052



FINAL

FIGURE 1-28. RE-INJECTION RATES FOR WELL 22109, 10/99 - 12/99

000037

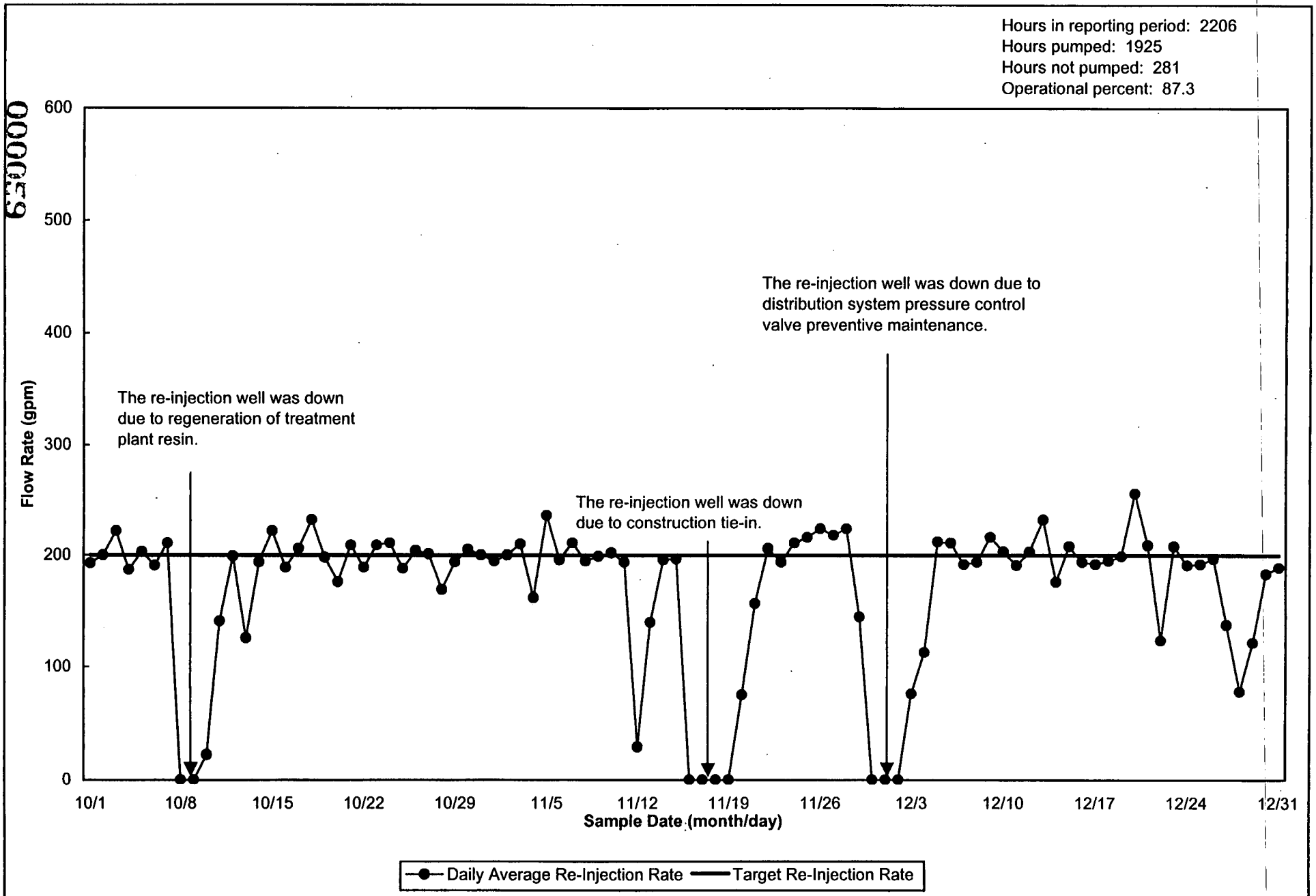


FINAL

FIGURE 1-29. RE-INJECTION RATES FOR WELL 22111, 10/99 - 12/99

28872

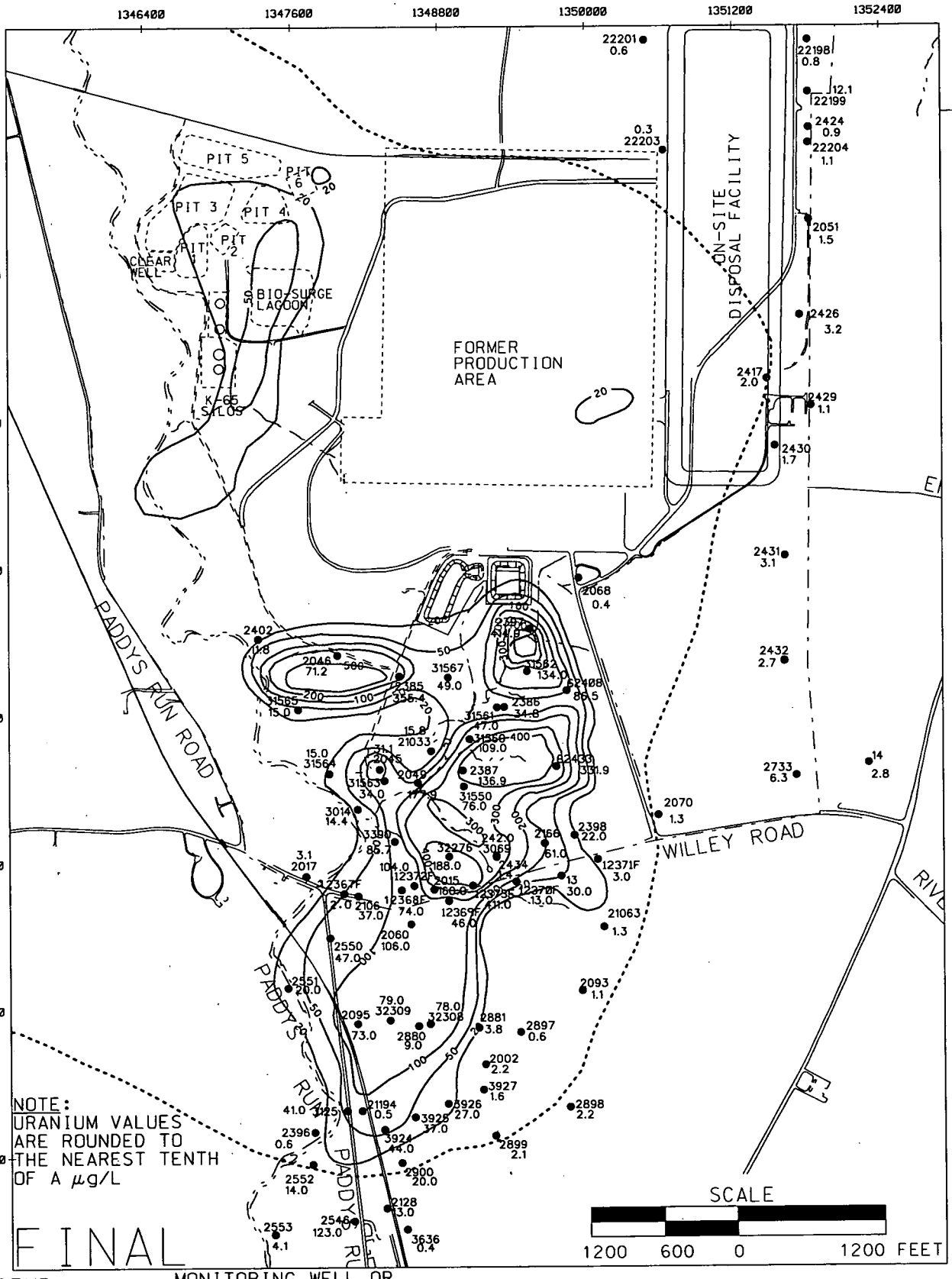
000038



FINAL

FIGURE 1-30. RE-INJECTION RATES FOR WELL 22240, 10/99 - 12/99

000059



LEGEND:

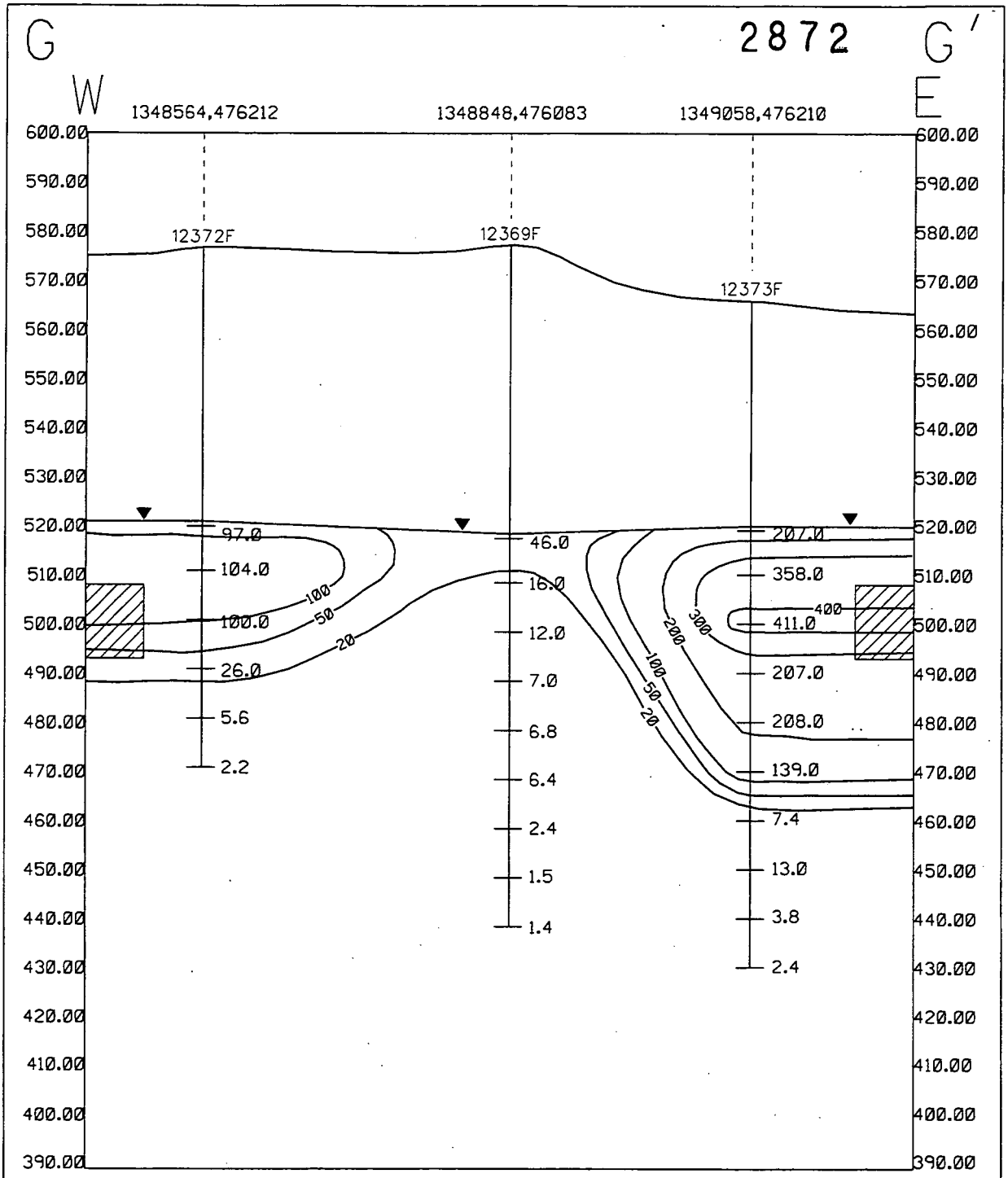
- 2553● MONITORING WELL OR GEOPROBE LOCATION
- 5.1 TOTAL URANIUM CONCENTRATION MEASURED IN THIRD QUARTER 1999
- CONTOUR CHANGES BASED ON NEW MAXIMUM THIRD QUARTER 1999 DATA
- FEMP BOUNDARY
- 50 MAX TOTAL URANIUM CONTOUR IN µg/L FROM BASELINE MODIFIED QUARTERLY
- 10-YEAR, URANIUM-BASED RESTORATION FOOTPRINT

V:/SFGP1/DGN/99QTR4/99QT4PLUM.DGN

STATE PLANAR COORDINATE SYSTEM 1983

11-23-99

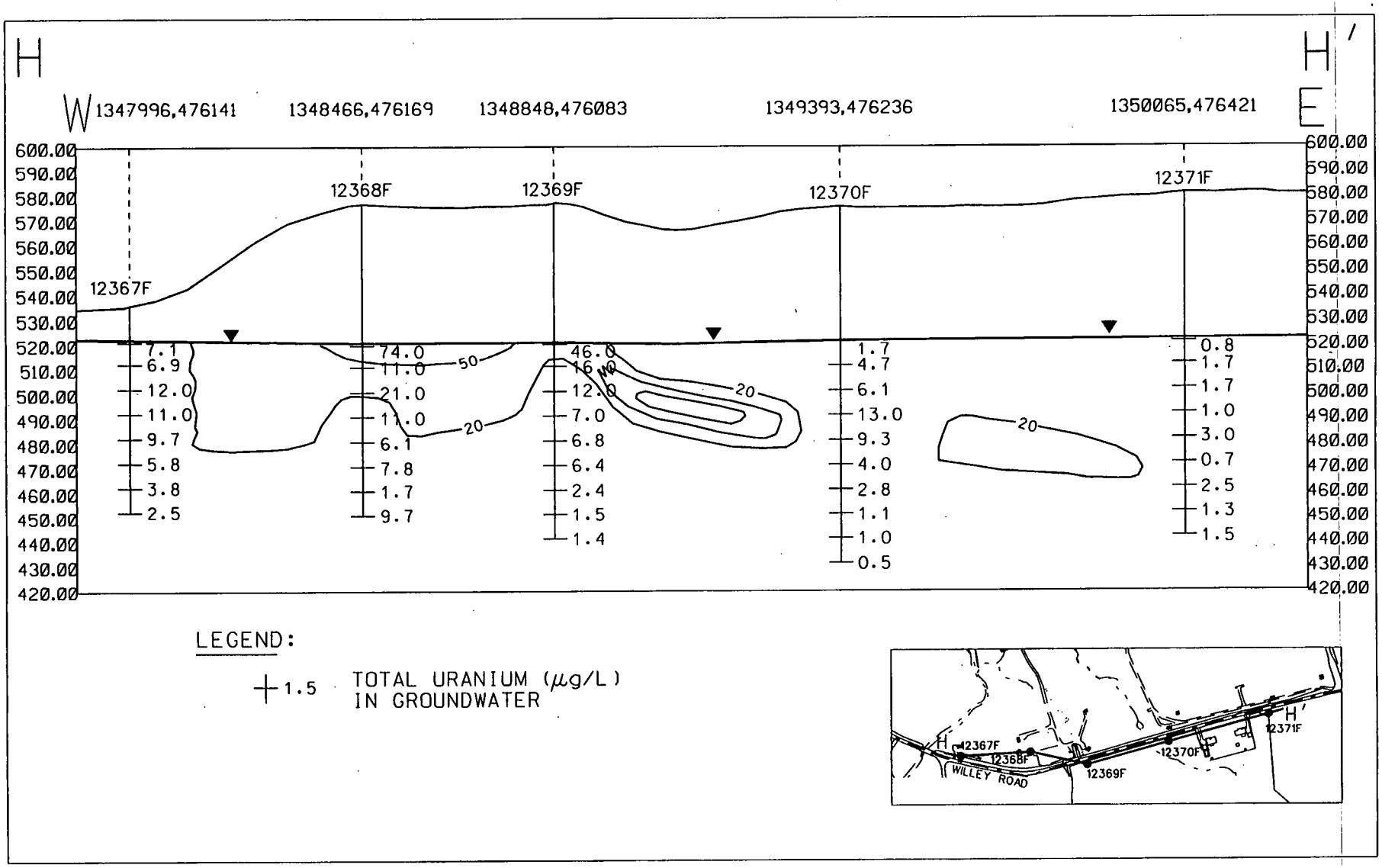
FIGURE 1-31. TOTAL URANIUM PLUME MAP, THIRD QUARTER 1999



FINAL

FIGURE 1-32. CROSS SECTION G-G', GEOPROBE RESULTS FOR TOTAL URANIUM IN GROUNDWATER, ROUND F, SEPTEMBER TO NOVEMBER 1999

v:\5fgp1\dgn\99qtr4\99qt4004.dgn
STATE PLANAR COORDINATE SYSTEM 1983
16-MAR-2000



FINAL

V:/5FGP1/DGN/99QTR4/99QT4003.DGN
STATE PLANAR COORDINATE SYSTEM 1983

13-MAR-2000

FIGURE 1-33. CROSS SECTION H-H', GEOPROBE RESULTS FOR TOTAL URANIUM IN GROUNDWATER, ROUND F, SEPTEMBER TO NOVEMBER 1999

230000

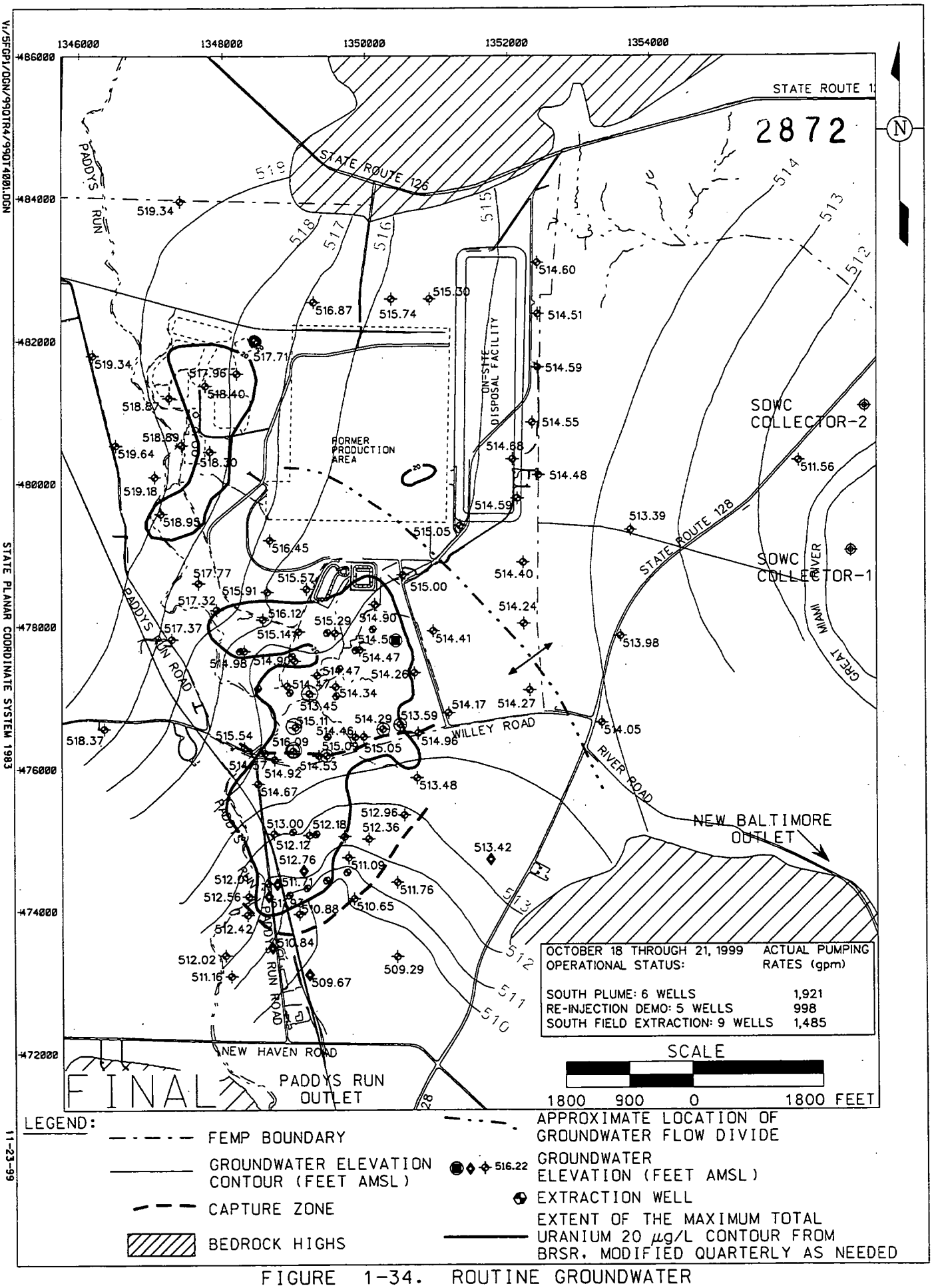
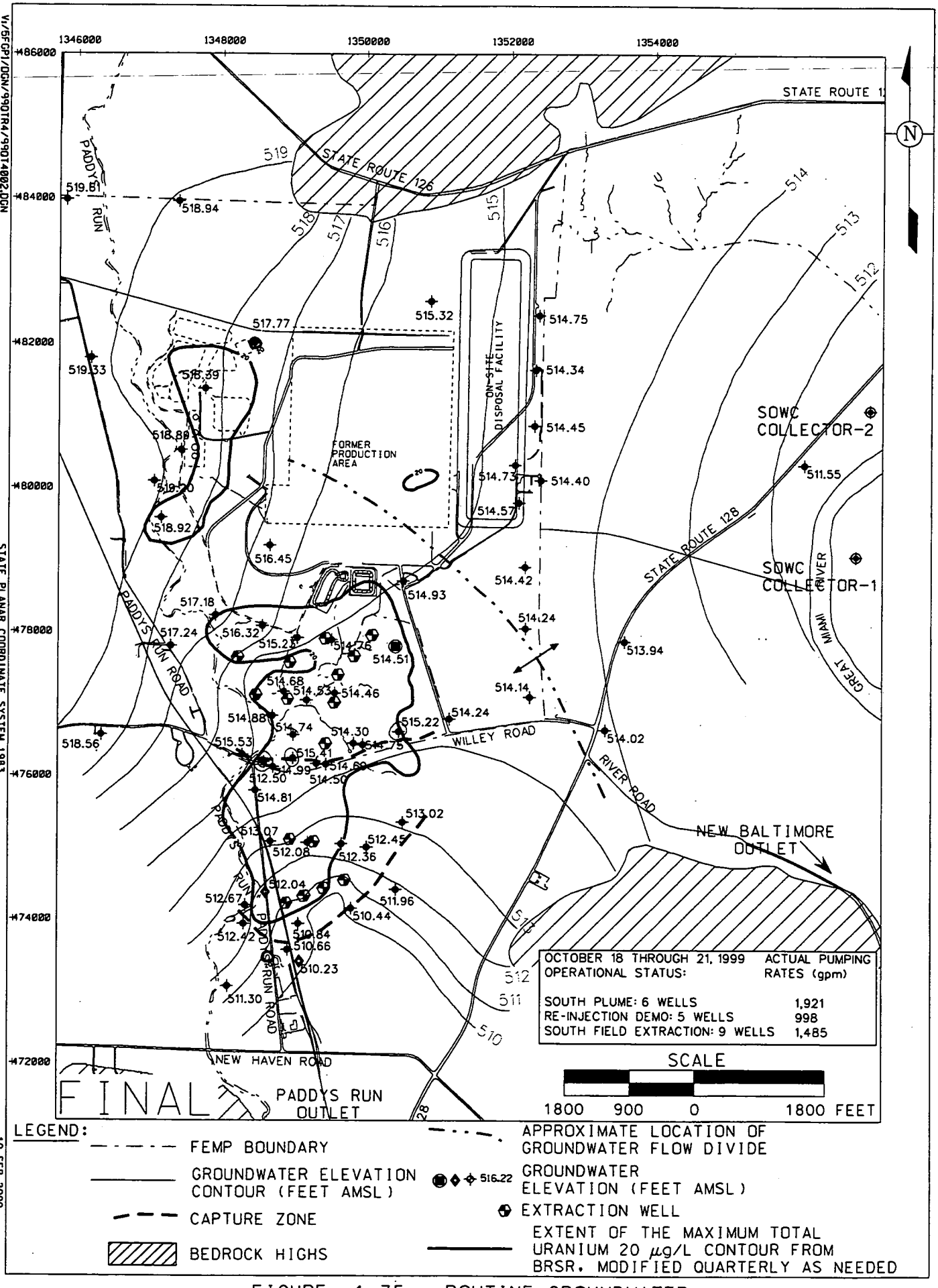
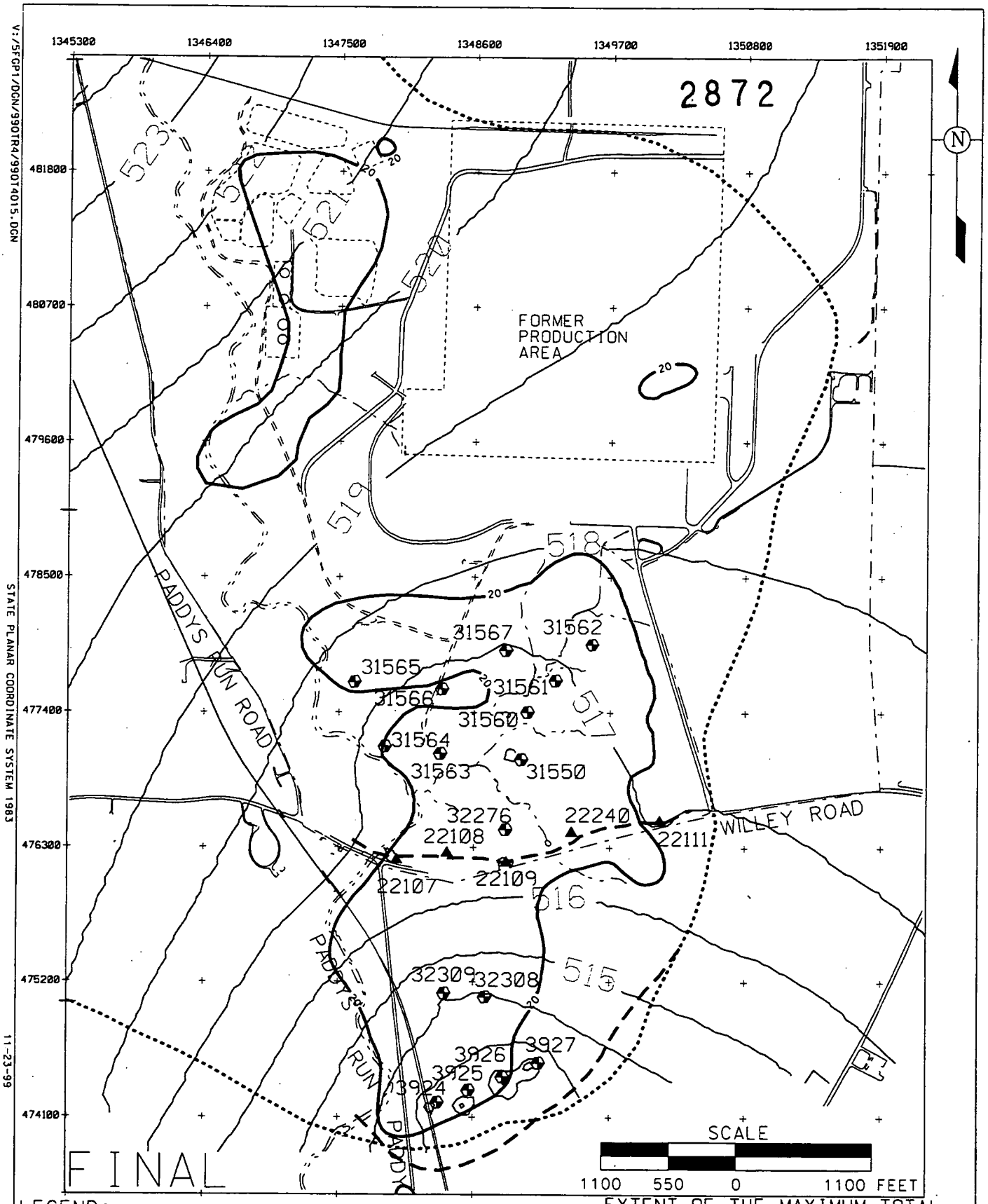


FIGURE 1-34. ROUTINE GROUNDWATER ELEVATIONS FOR TYPE 2 WELLS, OCTOBER 1999



000064

FIGURE 1-35. ROUTINE GROUNDWATER ELEVATIONS FOR TYPE 3 WELLS, OCTOBER 1999



LEGEND:

- FEMP BOUNDARY
- INTERPRETED CAPTURE ZONES, OCTOBER 1999
- 10-YEAR, URANIUM-BASED RESTORATION FOOTPRINT
- —20— EXTENT OF THE MAXIMUM TOTAL URANIUM 20 μg/L CONTOUR FROM BRSR, MODIFIED QUARTERLY AS NEEDED
- MODEL PREDICTED WATER LEVEL
- ▲ RE-INJECTION WELL
- EXTRACTION WELL

FIGURE 1-36. COMPARISON OF MODELED GROUNDWATER ELEVATIONS WITH INTERPRETED CAPTURE ZONES

2872

On-Site Disposal Facility Groundwater/Leak Detection and Leachate Monitoring

2.0 ON-SITE DISPOSAL FACILITY GROUNDWATER/LEAK DETECTION AND LEACHATE MONITORING

This section summarizes the fourth quarter 1999 leachate collection system (LCS) and leak detection system (LDS) volume data and third quarter 1999 analytical results for water samples collected from LCS, LDS, horizontal till well, and Great Miami Aquifer sampling locations associated with the on-site disposal facility leak detection monitoring. The material in this section satisfies the groundwater reporting requirements presented in the Integrated Environmental Monitoring Plan (IEMP), Revision 1 (DOE 1999a).

Figure 2-1 shows the sampling activities that contributed data to this section. Figure 2-2 identifies the well locations associated with the on-site disposal facility.

Figure 2-3 shows the on-site disposal facility leak detection monitoring activities to be summarized in the next IEMP quarterly status report to be submitted in June of 2000. The report will contain LCS and LDS volume data from January through March 2000 (first quarter). However, remaining analytical results from the on-site disposal facility leak detection sampling activities conducted from October through December 1999 (fourth quarter) will be provided in the 1999 Integrated Site Environmental Report to be submitted June 1, 2000.

2.1 CELL 1

2.1.1 CELL 1 LEAK DETECTION SYSTEM VOLUMES

Volumes pumped from the Cell 1 LDS for the fourth quarter of 1999 are as follows: October (79 gallons); November (0 gallons); and December (106 gallons).

Figure 2-4 depicts quantitative measurement of the LDS water accumulation rates along with summary statistics (minimum, maximum, and average) for the period from May 1999 (when quantitative measurements were initiated) through December 1999. The accumulation rates for the fourth quarter (0.36 and 0.26 gallons per acre per day [gpad]) were less than the May to December 1999 average accumulation rate (0.52 gpad) and showed a progressive decline from the rates measured during the third quarter. The most recent rate (0.26 gpad) determined from the December pump-out, indicates that the Cell 1 LDS is yielding about one quart of water per acre per day.

The ongoing accumulation rate measurements indicate that the liner system for Cell 1 continues to perform as designed in that these accumulation rates are far below (nearly two orders of magnitude) the on-site disposal facility design-established initial response leakage rate of 20 gpad. Note that this is the first quarter that the Cell 1 accumulation rate is greater than that of Cell 2. This is unexpected given that the stage of filling Cell 1 is much farther along than Cell 2. However, as noted above, the Cell 1 fourth quarter accumulation rates showed a continued decline and, moreover, are far below the noted initial response leakage rate.

Waste was placed in Cell 1 during each of the months comprising the fourth quarter of 1999. As of December 1999, Cell 1 was approximately 80 percent full.

2.1.2 CELL 1 ANALYTICAL STATUS

Sampling continues to be conducted in accordance with the On-Site Disposal Facility Groundwater/Leak Detection and Leachate Monitoring Plan (DOE 1997b) and follows agreements associated with that plan. Figure 2-2 identifies the well locations.

On July 22, 1999, the U.S. Department of Energy (DOE) transmitted responses to the second round of Ohio Environmental Protection Agency (OEPA) comments on the Draft Technical Memorandum for the On-Site Disposal Facility Cell 1 Baseline Groundwater Conditions. DOE briefly discussed the responses with OEPA during a meeting on July 27, 1999; however, a resolution to the comment pertaining to the timing and duration of the horizontal till well pre-waste placement baselining for the remaining cells was not reached until November 1999. DOE agreed with OEPA's recommendation "that for the remaining Cells the horizontal till wells be installed as soon as feasible in an effort to bracket the pre-waste placement water quality fluctuations" (reference letter "2nd Round RTC, Baseline Groundwater for OSDF" from OEPA to DOE, dated November 8, 1999).

For the third quarter of 1999, the following samples were collected: one sample each of leachate (location 12338C) and LDS water (location 12338D); two baseline sampling events for perched groundwater (Horizontal Till Well 12338), and quarterly samples from the upgradient Great Miami Aquifer Monitoring Well 22201, and downgradient Great Miami Aquifer Monitoring Well 22198. Table 2-1 provides detected results for the quarter along with a summary of previous data for those constituents. The following summarizes the types of information provided in the table:

- Constituents posted on Table 2-1 were detected during the reporting period (third quarter) in at least one of the four monitored horizons (i.e., LCS, LDS, horizontal till well, or one of the Great Miami Aquifer wells).
- For each monitored horizon and each constituent detected during the reporting period, the following four pieces of information are provided:
  - Row 1, Column 1, total number of samples with detections since sampling began at that monitoring point / total number of samples analyzed since sampling began at that monitoring point
  - Row 1, Column 2, range of results from monitoring point since sampling began at that monitoring point
  - Row 2, Column 1, total number of samples with detections for the reporting period
  - Row 2, Column 2, range of results from the monitoring point for the reporting period.

The data in Table 2-1 generally indicate, as expected, progressively decreasing concentrations of the detected constituents from the LCS to the LDS to the horizontal till well. These decreasing concentrations, in conjunction with the very low LDS accumulation rate (approximately one quart per acre per day as of December 1999) indicate that the Cell 1 liner system is functioning as designed.

Trend analysis will be performed annually on the analytical data collected from the LCS and LDS and will be provided in IEMP annual integrated site environmental reports. Horizontal till well results will continue to be reported quarterly and annually. Horizontal till well results will be provided annually on updated control charts once those charts are established in early 2001. The Great Miami Aquifer monitoring well results will continue to be reported quarterly as presented in this report and in IEMP annual integrated site environmental reports on updated control charts.

2872

2.2 CELL 2

2.2.1 CELL 2 LEAK DETECTION SYSTEM VOLUMES

During the fourth quarter of 1999, the accumulation rate into the Cell 2 LDS primary containment vessel continued to decline as observed in the latter portion of the third quarter. Due to the fourth quarter decline, the vessel did not fill to a point that required pumping; therefore, no water was pumped from the Cell 2 LDS during the fourth quarter. Since the accumulation rate decline was such that there were no pump-outs during the quarter, a figure depicting the quarterly accumulation rates was not necessary and is not included. However, accumulation rates were evaluated weekly and reported to the U.S. Environmental Protection Agency (EPA) and OEPA as part of the weekly site conference call. These weekly rates ranged from a high of 0.172 gpad to less than zero for some weeks. The negative rates are being attributed to evaporation rates inside the manhole being greater than accumulation rates. The fourth quarter maximum weekly rate (0.172 gpad) equates to somewhat less than one quart per acre per day. Note that the maximum fourth quarter weekly rate is less than five percent of the third quarter average of 3.8 gpad.

The ongoing accumulation rate measurements indicate that the liner system for Cell 2 continues to perform as designed, in that these accumulation rates are far below the on-site disposal facility design-established initial response leakage rate of 20 gpad. Note that this is the first quarter that the Cell 2 accumulation rate has declined to a point that it is less than that of Cell 1. This is unexpected given that the stage of filling Cell 1 is much farther along than Cell 2. However, the accumulation rates for both Cells 1 and 2 are far less than the initial response leakage rate of 20 gpad.

Waste was placed in Cell 2 during each of the months comprising the fourth quarter of 1999. As of December 1999, Cell 2 was approximately 40 percent full.

2.2.2 CELL 2 ANALYTICAL STATUS

Sampling continues to be conducted in accordance with the On-Site Disposal Facility Groundwater/Leak Detection and Leachate Monitoring Plan and follows agreements associated with that plan. Figure 2-2 identifies the well locations.

For the third quarter of 1999, the following samples were collected: one sample each of leachate (location 12339C) and LDS water (location 12339D); and baseline sampling events for perched groundwater (Horizontal Till Well 12339), upgradient Great Miami Aquifer Monitoring Well 22200, and downgradient Great Miami Aquifer Monitoring Well 22199. Table 2-2 provides detected results for the quarter along with a summary of previous data for those constituents. The following summarizes the types of information provided in the table:

- Constituents posted on Table 2-2 were detected during the reporting period (third quarter) in at least one of the four monitored horizons (i.e., LCS, LDS, horizontal till well, or one of the Great Miami Aquifer wells).
- For each monitored horizon and each constituent detected during the reporting period, the following four pieces of information are provided:
  - Row 1, Column 1, total number of samples with detections since sampling began at that monitoring point / total number of samples analyzed since sampling began at that monitoring point
  - Row 1, Column 2, range of results from monitoring point since sampling began at that monitoring point
  - Row 2, Column 1, total number of samples with detections for the reporting
  - Row 2, Column 2, range of results from the monitoring point for the reporting period.

The data in Table 2-2 generally indicate, as expected, decreasing concentrations of the detected constituents from the LCS to the horizontal till well. However, the concentrations generally appear to increase from the LCS to the LDS. This increase indicates residual contamination from the previously reported (1998 Integrated Site Environmental Report [DOE 1999]) leachate line malfunctions that occurred in December 1998 is still affecting the Cell 2 LDS. Note however that the LDS total uranium concentration (12 micrograms per liter [μg/L]) continues to decline from the December 1998 high of 71 μg/L. This indicates that the residual contamination from the water that backed up in the system is being flushed out.

The LCS to horizontal till well decreasing concentrations, in conjunction with the very low LDS accumulation rate (less than one quart per acre per day was the weekly maximum for the fourth quarter) indicate that the Cell 2 liner system is functioning as designed.

Trend analysis will be performed annually on the analytical data collected from the LCS and LDS and will be provided in IEMP annual integrated site environmental reports. Horizontal till well results will continue to be reported quarterly and annually. Horizontal till well results will be provided annually on control charts once those charts are established in early 2001. The Great Miami Aquifer monitoring well results will continue to be reported quarterly as presented in this report and in IEMP annual integrated site environmental reports. Note that the third quarter total uranium result for the downgradient Great Miami Aquifer Monitoring Well 22199 was 12.1 µg/L, a new maximum for this location. Previous results for this location indicate total uranium concentrations ranging from less than 1 µg/L to 11.8 µg/L, indicating that the baseline uranium concentrations at this location are elevated. Baseline control charts are scheduled to be established this year for the Cell 2 Great Miami Aquifer Monitoring. These charts may provide for a better understanding of the significance of these apparently elevated concentrations.

2.3 CELL 3

2.3.1 CELL 3 LEAK DETECTION SYSTEM VOLUMES

Quantitative measurement of Cell 3 LDS water accumulation rates began in early October 1999, just before waste placement was initiated. No water accumulated in the Cell 3 LDS primary containment vessel during the fourth quarter of 1999; therefore, the water accumulation rates for the entire quarter is zero.

Waste placement was initiated in Cell 3 during the fourth quarter of 1999. As of December 1999, Cell 3 was approximately 10 percent full.

2.3.2 CELL 3 ANALYTICAL STATUS

Sampling continues to be conducted in accordance with the On-Site Disposal Facility Groundwater/Leak Detection and Leachate Monitoring Plan and follows agreements associated with that plan. Figure 2-2 identifies the well locations.

For the third quarter of 1999, the following samples were collected: three baseline sampling events occurred for perched groundwater (Horizontal Till Well 12340); and three baseline sampling events occurred at upgradient Great Miami Aquifer Monitoring Well 22203, and downgradient Great Miami Aquifer Monitoring Well 22204. Table 2-3 provides detected results for the quarter along with a summary of previous data for those constituents. The following summarizes the types of information provided in the table:

- Constituents posted on Table 2-3 were detected during the reporting period (third quarter) in at least one of the two monitored horizons (i.e., horizontal till well or one of the Great Miami Aquifer wells).
- For each monitored horizon and each constituent detected during the reporting period, the following four pieces of information are provided:
  - Row 1, Column 1, total number of samples with detections since sampling began at that monitoring point/total number of samples analyzed since sampling began at that monitoring point
  - Row 1, Column 2, range of results from monitoring point since sampling began at that monitoring point
  - Row 2, Column 1, total number of samples with detections for the reporting period
  - Row 2, Column 2, range of results from the monitoring point for the reporting period.

2.4 CELL 4

2.4.1 CELL 4 ANALYTICAL STATUS

The downgradient Great Miami Aquifer Monitoring Well 22205 for Cell 4 was installed in August. Development of this well has been postponed till this spring due to unusually low water levels. DOE chose not to develop the well last fall for the following reasons:

- Due to the low water level in the well, it was estimated that it would take much more time (and therefore be more costly) to develop the well with low water levels than if we were to wait until the water levels came back up in the Spring.
- The viability of the development process (which includes airlifting) was determined to be questionable when the water levels were low.
- Sufficient time was available to delay the development of the well and still collect a year's worth of pre-waste placement baseline data, given that the schedule for waste placement in Cell 4 indicated that the cell would not become operational until at least late 2001.

Installation of a new well, to serve as the upgradient well for Cell 4, will not be required because Monitoring Well 2421 will be used. Baseline sampling of these two wells is scheduled to begin this summer.

2.5 LEACHATE COLLECTION SYSTEM VOLUMES

Volumes from the LCS for the fourth quarter of 1999 are as follows: October (307,084 gallons); November (221,509 gallons); and December (1,151,049 gallons).

TABLE 2-1

ON-SITE DISPOSAL FACILITY CELL 1 DATA SUMMARY FOR CONSTITUENTS DETECTED DURING THIRD QUARTER 1999

Note: Non-italicized pertains to total number of samples (including third quarter samples).
Italicized pertains to third quarter samples only.

Constituent (FRL)[a]	LCS[b,c,d,e] (12338C)		LDS[b,c,d,e] (12338D)		HTW[b,c,d,e] (12338)		Great Miami Aquifer: Upgradient[b,c,d] (22201)		Great Miami Aquifer: Downgradient[b,c,d] (22198)	
	No. of Samples with Detections / No. of Samples	Range	No. of Samples with Detections / No. of Samples	Range	No. of Samples with Detections / No. of Samples	Range	No. of Samples with Detections / No. of Samples	Range	No. of Samples with Detections / No. of Samples	Range
Total Organic Carbon	5/7	ND to 123	4/6	ND to 80.9	21/23	ND to 12.2	19/22	ND to 0.078	18/22	ND to 0.0526
	1/1	*19.6*	*1/1*	*11*	*2/2*	*1.19 to 5.23*	*0/1*	*ND*	*0/1*	*ND*
Total Organic Halogens (NA[f] mg/L)	6/7	ND to 0.204	5/6	ND to 0.0426	12/22	ND to 0.077	12/22	ND to 0.078	7/22	ND to 0.0526
	1/1	*0.204*	*1/1*	*0.0173*	*2/2*	*0.00668 to 0.0165*	*0/1*	*ND*	*0/1*	*ND*
Boron (0.33 mg/L)	8/8	0.0642 to 2.8	6/6	0.0296 to 0.321	18/23	ND to 0.685	17/22	ND to 0.142	23/30	ND to 0.116
	1/1	*0.856*	*1/1*	*0.273*	*2/2*	*0.0341 to 0.0418*	*1/1*	*0.0983*	*2/2*	*0.0503 to 0.0531*
Total Uranium (20 µg/L)	6/7	ND to 119	6/6	1.5 to 20.17	22/23	ND to 19	20/22	ND to 5.196	30/30	0.557 to 3.814
	1/1	*55.5*	*1/1*	*18.1*	*2/2*	*1.71 to 2.37*	*1/1*	*0.592*	*2/2*	*0.557 to 0.778*

[a]From Operable Unit 5 Record of Decision, Table 9-4
[b]If there was more than one sample result per day (e.g., a duplicate sample), then only the maximum sample concentration was counted and compared to the FRL.
[c]Rejected data qualified with either a R or Z were not used in this comparison.
[d]ND = not detected
[e]LCS = leachate collection system
LDS = leak detection system
HTW = horizontal till well
[f]NA = not applicable

000078

TABLE 2-2

ON-SITE DISPOSAL FACILITY CELL 2 DATA SUMMARY FOR CONSTITUENTS DETECTED DURING THIRD QUARTER 1999

Note: Non italicized pertains to total number of samples (including third quarter samples).
Italicized pertains to third quarter samples only.

Constituent (FRL)[a]	LCS[b,c,d,e] (12339C)		LDS[b,c,d,e] (12339D)		HTW[b,c,d,e] (12339)		Great Miami Aquifer: Upgradient[b,c,d] (22200)		Great Miami Aquifer: Downgradient[b,c,d] (22199)	
	No. of Samples with Detections / No. of Samples	Range	No. of Samples with Detections / No. of Samples	Range	No. of Samples with Detections / No. of Samples	Range	No. of Samples with Detections / No. of Samples	Range	No. of Samples with Detections / No. of Samples	Range
Total Organic Carbon (NA[f] mg/L)	3/4	ND to 3.51	3/4	ND to 26.1	18/21	ND to 4.22	15/17	ND to 47.6	13/17	ND to 51.8
	1/1	*0.929*	*1/1*	*26.1*	*0/1*	*ND*	*1/1*	*16.2*	*1/1*	*2.57*
Total Organic Halogens (NA[f] mg/L)	2/4	ND to 0.0292	3/4	ND to 0.0205	14/21	ND to 0.0612	8/17	ND to 0.124	8/17	ND to 0.0386
	1/1	*0.0292*	*1/1*	*0.015*	*0/1*	*ND*	*0/1*	*ND*	*1/1*	*0.0155*
Boron (0.33 mg/L)	4/5	ND to 0.915	4/4	0.408 to 2.22	13/21	ND to 0.0829	11/17	ND to 0.158	11/17	ND to 0.0569
	1/1	*0.207*	*1/1*	*0.408*	*1/1*	*0.0344*	*1/1*	*0.048*	*1/1*	*0.0428*
Total Uranium (20 µg/L)	4/4	4.51 to 22.022	4/4	12 to 71	21/22	ND to 3.607	12/17	ND to 1.11	17/17	0.259 to 12.1
	1/1	*4.51*	*1/1*	*12*	*1/1*	*2.29*	*0/1*	*ND*	*1/1*	*12.1*

[a]From Operable Unit 5 Record of Decision, Table 9-4
[b]If there was more than one sample result per day (e.g, a duplicate sample), then only the maximum sample concentration was counted and compared to the FRL.
[c]Rejected data qualified with either a R or Z were not used in this comparison.
[d]ND = not detected
[e]LCS = leachate collection system
LDS = leak detection system
HTW = horizontal till well
[f]NA = not applicable

TABLE 2-3

ON-SITE DISPOSAL FACILITY CELL 3 DATA SUMMARY FOR CONSTITUENTS DETECTED DURING THIRD QUARTER 1999

Note: Non italicized pertains to total number of samples (including third quarter samples).
Italicized pertains to third quarter samples only.

			Great Miami Aquifer			
	HTW[b,c,d,e] (12340)		Upgradient[b,c,d] (22203)		Downgradient[b,c,d] (22204)	
Constituent (FRL)[a]	No. of Samples with Detections / No. of Samples	Range	No. of Samples with Detections / No. of Samples	Range	No. of Samples with Detections / No. of Samples	Range
Total Organic Carbon (NA[f] mg/L)	8/16	ND to 2.91	4/14	ND to 3.51	5/14	ND to 5
	1/3	***ND to 2.91***	*1/3*	***ND to 2.17***	*2/3*	***ND to 1.2***
Total Organic Halogens (NA[f] mg/L)	13/16	ND to 0.0509	7/14	ND to 0.019	6/14	ND to 0.03
	3/3	***0.023 to 0.0509***	*1/3*	***ND to 0.019***	*1/3*	***ND to 0.0261***
Boron (0.33 mg/L)	13/16	ND to 0.197	9/14	ND to 0.0776	8/14	ND to 0.179
	3/3	***0.168 to 0.197***	*3/3*	***0.0377 to 0.0411***	*3/3*	***0.0433 to 0.179***
Total Uranium (20 µg/L)	14/16	ND to 9.14	9/14	ND to 0.559	13/14	ND to 2.995
	3/3	***4.45 to 4.68***	*1/3*	***ND to 0.277***	*3/3*	***0.66 to 1.06***

[a]From Operable Unit 5 Record of Decision, Table 9-4
[b]If there was more than one sample result per day (e.g., a duplicate sample), then only the maximum sample concentration was counted and compared to the FRL.
[c]Rejected data qualified with either a R or Z were not used in this comparison.
[d]ND = not detected
[e]HTW = horizontal till well
[f]NA = not applicable

000080

FIGURE 2-1/2-3

ON-SITE DISPOSAL FACILITY LEAK DETECTION ACTIVITIES

	Quarter/Year											
	Third Quarter/1999			Fourth Quarter/1999			First Quarter/2000			Second Quarter/2000		
LEAK DETECTION ACTIVITIES	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
Cell 1												
LDS Volumes				◆	◆	◆	⊠	⊠	⊠			
Analytical[a]	◆	◆										
Cell 2												
LDS Volumes				◆	◆	◆	⊠	⊠	⊠			
Analytical[a]		◆										
Cell 3												
LDS Volumes				◆	◆	◆	⊠	⊠	⊠			
Analytical[a]	◆	◆	◆									
LCS Volumes				◆	◆	◆	⊠	⊠	⊠			

◆ Data summarized/evaluated in this report
⊠ Data summarized/evaluated in the next report

FINAL

[a]Fourth Quarter 1999 data will be included in the 1999 Integrated Site Environmental Report.

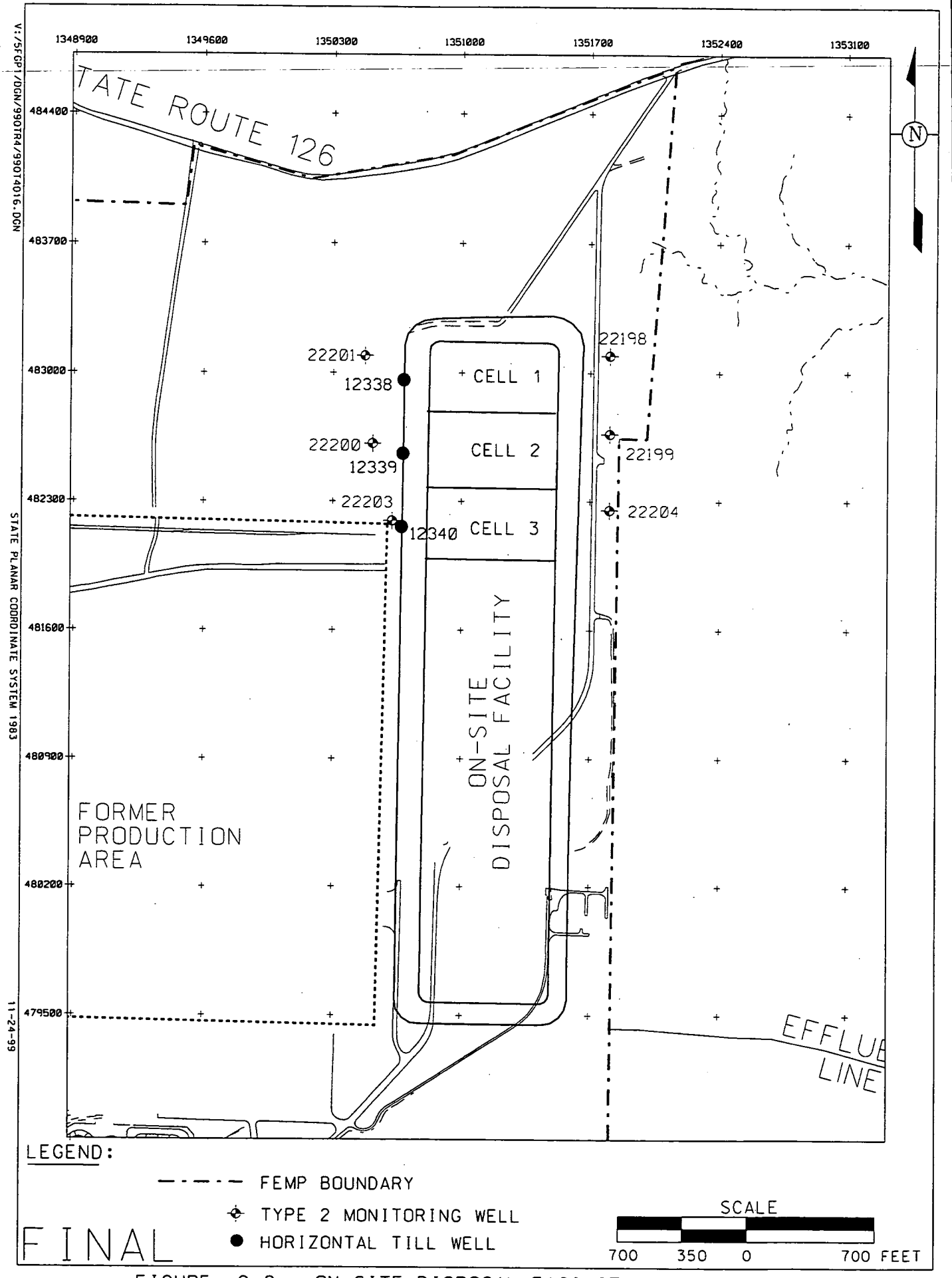


FIGURE 2-2. ON-SITE DISPOSAL FACILITY WELL LOCATIONS

FIGURE 2-1/2-3

ON-SITE DISPOSAL FACILITY LEAK DETECTION ACTIVITIES

	Quarter/Year											
	Third Quarter/1999			Fourth Quarter/1999			First Quarter/2000			Second Quarter/2000		
LEAK DETECTION ACTIVITIES	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
Cell 1												
LDS Volumes				◆	◆	◆	⊠	⊠	⊠			
Analytical[a]	◆	◆										
Cell 2												
LDS Volumes				◆	◆	◆	⊠	⊠	⊠			
Analytical[a]		◆										
Cell 3												
LDS Volumes				◆	◆	◆	⊠	⊠	⊠			
Analytical[a]	◆	◆	◆									
LCS Volumes				◆	◆	◆	⊠	⊠	⊠			

◆ Data summarized/evaluated in this report
⊠ Data summarized/evaluated in the next report

FINAL

[a]Fourth Quarter 1999 data will be included in the 1999 Integrated Site Environmental Report.

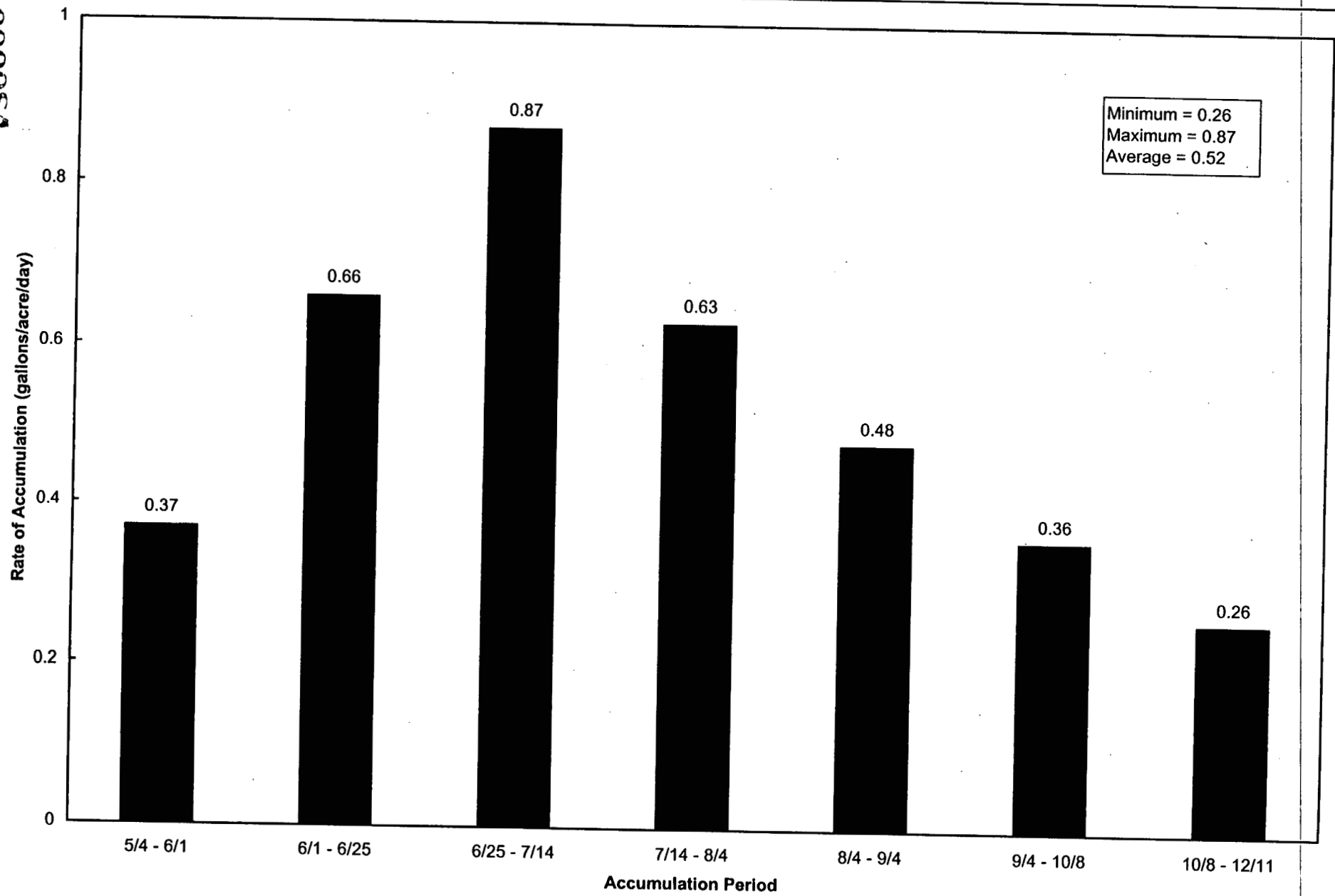


FIGURE 2-4. ON-SITE DISPOSAL FACILITY CELL 1 LEAK DETECTION SYSTEM (12338D)
RATE OF ACCUMULATION (GALLONS/ACRE/DAY), MAY 4, 1999 THROUGH DECEMBER 11, 1999

FINAL

000064

2872

Surface Water and Treated Effluent

2872

3.0 SURFACE WATER AND TREATED EFFLUENT

This section provides a status of the surface water and treated effluent monitoring for the fourth quarter of 1999. Figure 3-1 shows the data included in this section. Figure 3-2 identifies the surface water and treated effluent sample locations. Analytical results from the following routine monitoring program elements were utilized to complete the reporting requirements identified in Section 4.6.2 of the Integrated Environmental Monitoring Plan (IEMP), Revision 1 (DOE 1999a):

- National Pollutant Discharge Elimination System (NPDES) permit (data obtained from October through December 1999)
- Federal Facilities Compliance Agreement (FFCA) requirements (data obtained from October through December 1999)
- IEMP Characterization Program results (data obtained from July through September 1999).

Figure 3-3 shows the data from the surface water and treated effluent sampling activities that will be included in the next IEMP quarterly status report to be submitted in June of 2000. The report will contain NPDES and FFCA data from January through March 2000 (first quarter). However, the remaining analytical data from the IEMP Characterization Program from October through December 1999 (fourth quarter) will be presented in the 1999 Integrated Site Environmental Report to be submitted June 1, 2000.

3.1 NPDES PERMIT COMPLIANCE

Figure 3-4 identifies the surface water and treated effluent sample locations associated with NPDES compliance monitoring. Wastewater and storm water discharges from the Fernald site were in compliance 100 percent of the time during the fourth quarter of 1999. It should be noted that the December NPDES sample at STRM 4004 was not collected as identified in a letter from the U.S. Department of Energy (DOE) to the Ohio Environmental Protection Agency (OEPA) on January 13, 2000 (letter no. C:SWP[ARWWP]:2000-0001).

Discussions on the new NPDES permit continued during the fourth quarter of 1999. This permit (1IO00004*FD) significantly expands the sampling frequency and constituents sampled at the Parshall Flume (PF 4001) and adds two new monitoring points (4801 and 4902) representing ambient monitoring points within the Great Miami River upstream and down stream of Fernald site effluent. Sampling frequencies at the five storm water outfalls to Paddys Run (SWRB 4002O, STRM 4003, STRM 4004, STRM 4005, and STRM 4006) remain the same, with a reduction in constituents sampled. The sampling frequency of the sewage treatment plant effluent (STP 4601) also remains the same, except that the biannual sampling of metals has been eliminated. Also, the sewage sludge monitoring point (4589) has been eliminated from the renewed permit. March 1, 2000 will be the date the new permit becomes effective.

The data associated with NPDES will continue to be reported in the IEMP quarterly status reports, including the modifications associated with the new permit. The modifications associated with the new NPDES permit will be incorporated into the new IEMP, Revision 2, which will be completed later in 2000.

2872

3.2 FFCA AND OU5 ROD COMPLIANCE

Figure 3-5 shows that a cumulative total of 233 pounds of uranium were discharged to the Great Miami River in effluent from January through December 1999. The Record of Decision for Remedial Actions at Operable Unit 5 (DOE 1996) established an annual discharge limit to the Great Miami River of 600 pounds for total uranium.

Uncontrolled runoff also contributes to the amount of total uranium entering the environment. Previous estimates of uncontrolled runoff have been calculated using a loading term of 6.25 pounds of uranium discharged to Paddys Run for every inch of rainfall. The loading term has been revised to 2.6 pounds of uranium discharged per inch of rainfall (letters [DOE-0087-00 and DOE-0282-00] from DOE to the U.S. Environmental Protection Agency and OEPA, dated November 1, 1999, and January 7, 2000, respectively). Figure 6-1 shows that precipitation during the fourth quarter of 1999 was 7.95 inches; therefore, the mass of total uranium discharged to Paddys Run through uncontrolled runoff from October through December 1999 (using the 2.6 value) is estimated to be 20.67 pounds.

Figure 3-6 illustrates that the monthly average total uranium concentration limit of 20 micrograms per liter (μg/L) for water discharged to the Great Miami River was met each month during the fourth quarter of 1999. There were no changes to Table 3-1 because no treatment plant maintenance or significant precipitation bypass events occurred during the second, third, or fourth quarter of 1999.

Figure 3-7 presents controlled and uncontrolled surface water flow areas for the fourth quarter of 1999. As identified in previous IEMP quarterly status reports, an evaluation of controlled areas is to occur at least quarterly in order to help ensure that the appropriate areas are being controlled. Changes during the fourth quarter involved the catchment area associated with Cell 3 of the on-site disposal facility. This area is now controlled through the leachate collection system.

3.3 SURVEILLANCE MONITORING

The third quarter of 1999 was exceptionally dry and precipitation during this quarter was significantly below the 50-year average (refer to Figure 6-1). The dryness of this period impacted the number of locations in which samples were collected. Specifically, quarterly samples for SWD-01, SWD-03, SWP-01, SWP-02, and SWP-03 were not collected during the third quarter. Through review of the field paperwork, it became apparent that sampling crews did not attempt to collect samples during the first two months of the quarter. During September, these locations were dry. Additionally, quarterly total uranium samples at STRM 4004 and STRM 4006 were not collected and the July and September monthly total uranium samples were not collected at SWD-03. Although these samples were not collected, there is no reason to believe that any unmonitored discharges were significantly different in character from previous discharges based on the site activities occurring during the third quarter.

Meetings with the management of the sampling crews have been held to emphasize that the crews must be ready to sample at the beginning of a quarter to ensure the necessary samples are collected, especially due to the intermittent nature of flow at these locations. The procedure governing these sampling activities is being revised to require the sampling crews be ready to sample at the beginning of the quarter. It should also be noted that during the fourth quarter, required samples were collected at all of the locations with the exception of STRM 4004 (discussed in the NPDES subsection).

For those locations that were monitored, there were no final remediation level (FRL) or benchmark toxicity value (BTV) exceedances. Therefore, there were no FRL or BTV exceedances attributable to the Fernald site in the Great Miami River. In addition, there were no exceedances of the 530 μg/L surface water total uranium FRL.

The following activities occurred during the fourth quarter of 1999 that could have potentially impacted the water quality at various surface water sample locations (identified in parentheses):

- Limited activities in the on-site disposal facility borrow area (SWD-02 and STRM 4003)
- Construction activities associated with on-site disposal facility Cell 3 (SWD-02 and STRM 4003) and initiation of placement of impacted materials into Cell 3 (PF 4001).
- Stabilization activities (seeding) and construction completion activities in Area 1, Phase II (SWD-02, STRM 4003, and PF 4001)
- Excavation of southern waste unit material and hauling of excavated materials to the on-site disposal facility via the impacted material haul road (STRM 4004, STRM 4005, and PF 4001)
- Construction activities associated with South Field Extraction Wells 32446 and 32447 in the South Field area (STRM 4003)

2872

- Initiation of full scale operations, excavation of materials from Waste Pits 3 and 5, and general waste pit area activities in support of the Waste Pits Remedial Action Project (WPRAP) (PF 4001)
- Loading and shipping of contaminated material in support of the WPRAP activities (STRM 4005, PF 4001, SWD-03, and SWP-02)
- Rail yard activities in support of the loading and shipping of trains (STRM 4006 and SWP-02).

Review of the surface water and treated effluent data available for this report indicate that these activities have not caused any FRL or BTV exceedances. However, data will continue to be evaluated in light of ongoing remediation activities to assess impacts to the surface water pathway.

TABLE 3-1

1999 TREATMENT BYPASS EVENTS

Event	Duration (hours)	Number of Bypass Days[a]	Cumulative Number of Bypass Days	Total Uranium Discharged (pounds) (to Great Miami River)	Total Water Discharged (millions of gallons) (to Great Miami River)
Treatment Plant Maintenance Bypasses					
March 15 through March 17	72	3	3	3.29	13.767

[a]Days are counted according to the definition provided in the Operations and Maintenance Master Plan for the Aquifer Restoration and Wastewater Treatment Project (DOE 1997c).

000091

2872

FIGURE 3-1/3-3

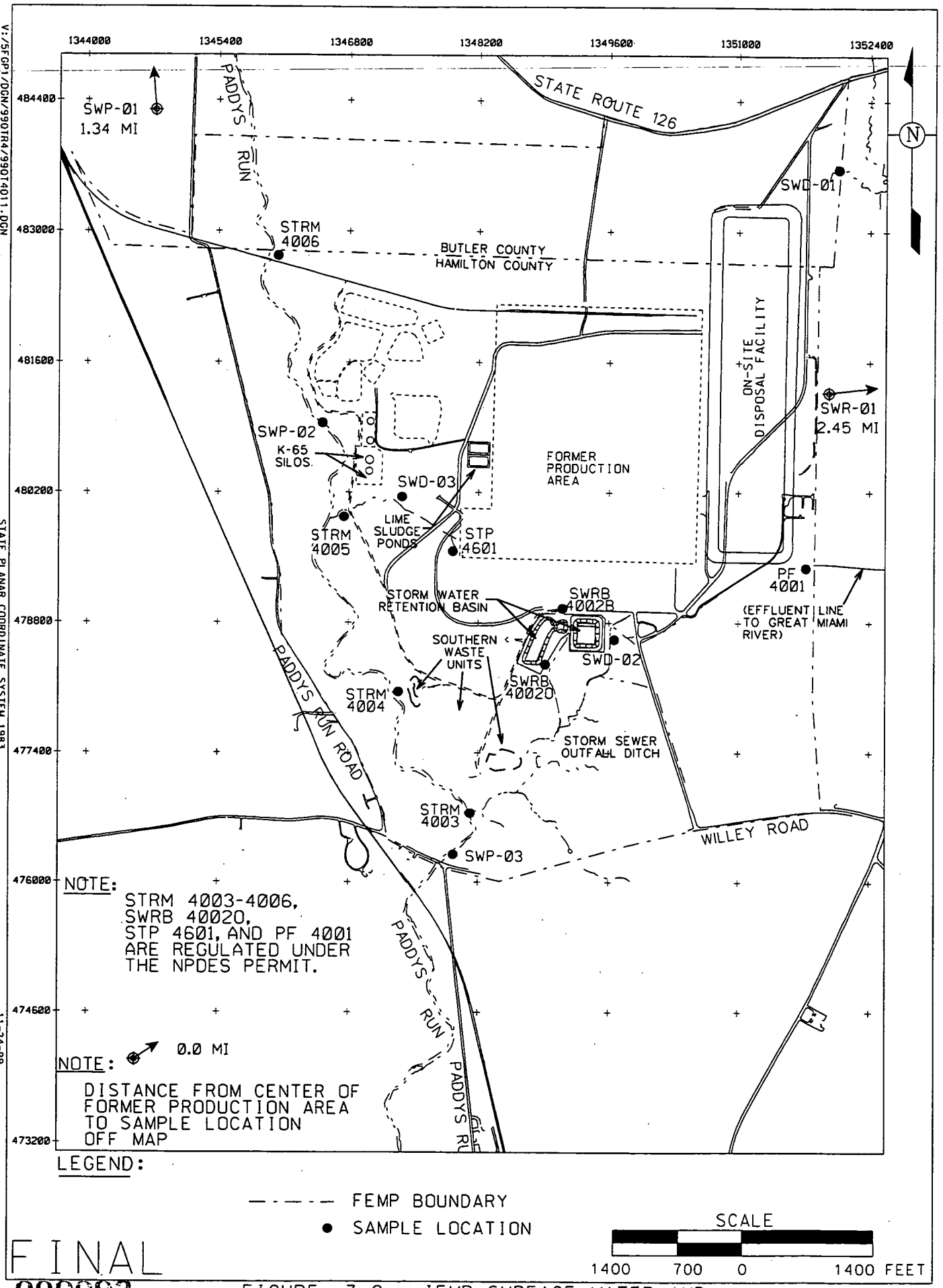
SURFACE WATER AND TREATED EFFLUENT SAMPLING ACTIVITIES

	Quarter/Year											
	Third Quarter/1999			Fourth Quarter/1999			First Quarter/2000			Second Quarter/2000		
SAMPLING ACTIVITIES	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
NPDES				◆	◆	◆	⊠	⊠	⊠			
FFCA				◆	◆	◆	⊠	⊠	⊠			
IEMP Characterization[a]	◆	◆	◆									

◆ Data summarized/evaluated in this report
⊠ Data summarized/evaluated in the next report

FINAL

[a]Fourth quarter 1999 data will be included in the 1999 Integrated Site Environmental Report.



000093

FIGURE 3-2. IEMP SURFACE WATER AND TREATED EFFLUENT SAMPLE LOCATIONS

FIGURE 3-1/3-3

SURFACE WATER AND TREATED EFFLUENT SAMPLING ACTIVITIES

	Quarter/Year											
	Third Quarter/1999			Fourth Quarter/1999			First Quarter/2000			Second Quarter/2000		
SAMPLING ACTIVITIES	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
NPDES				◆	◆	◆	⊠	⊠	⊠			
FFCA				◆	◆	◆	⊠	⊠	⊠			
IEMP Characterization[a]	◆	◆	◆									

◆ Data summarized/evaluated in this report
⊠ Data summarized/evaluated in the next report

FINAL

[a]Fourth quarter 1999 data will be included in the 1999 Integrated Site Environmental Report.

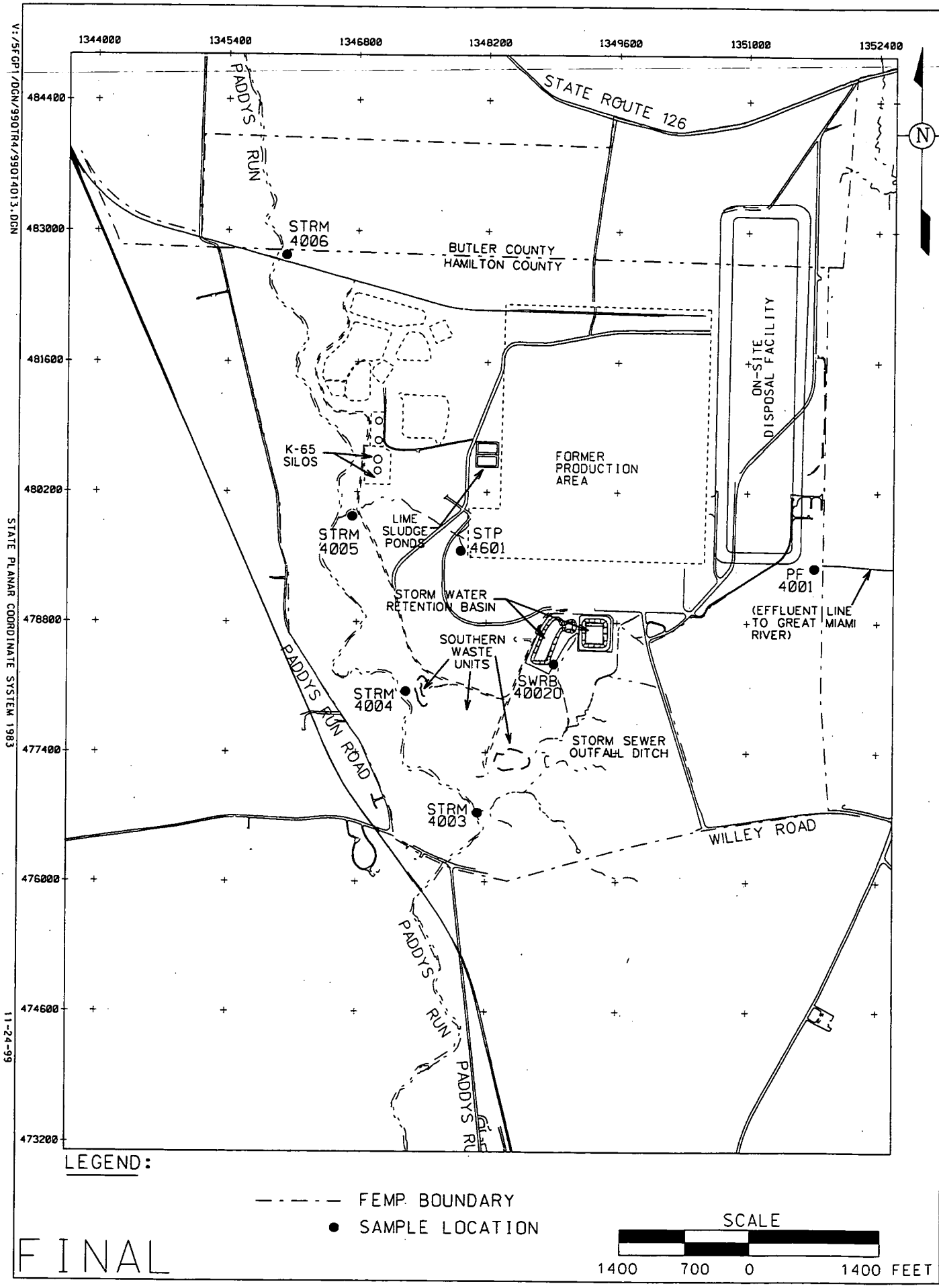
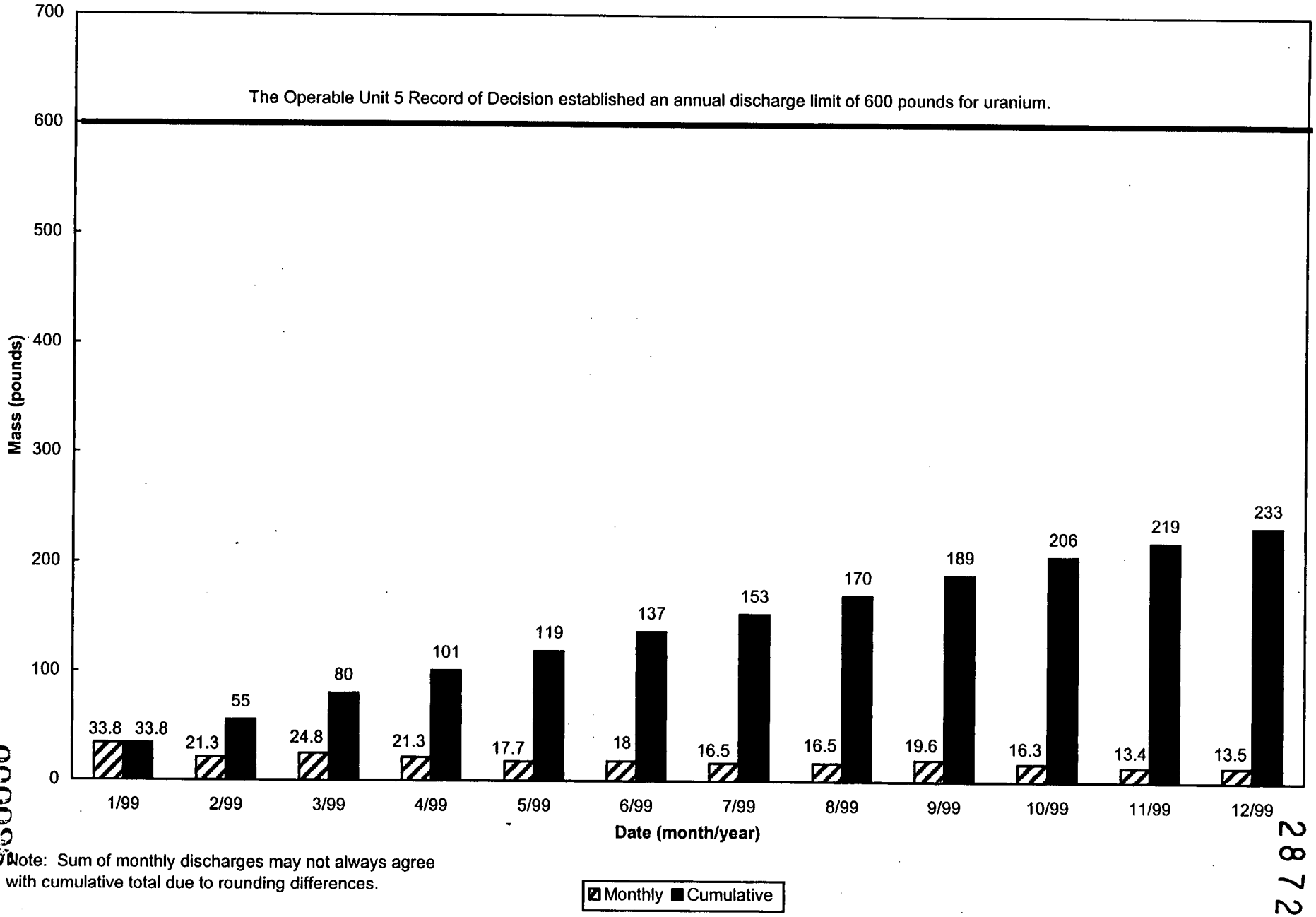
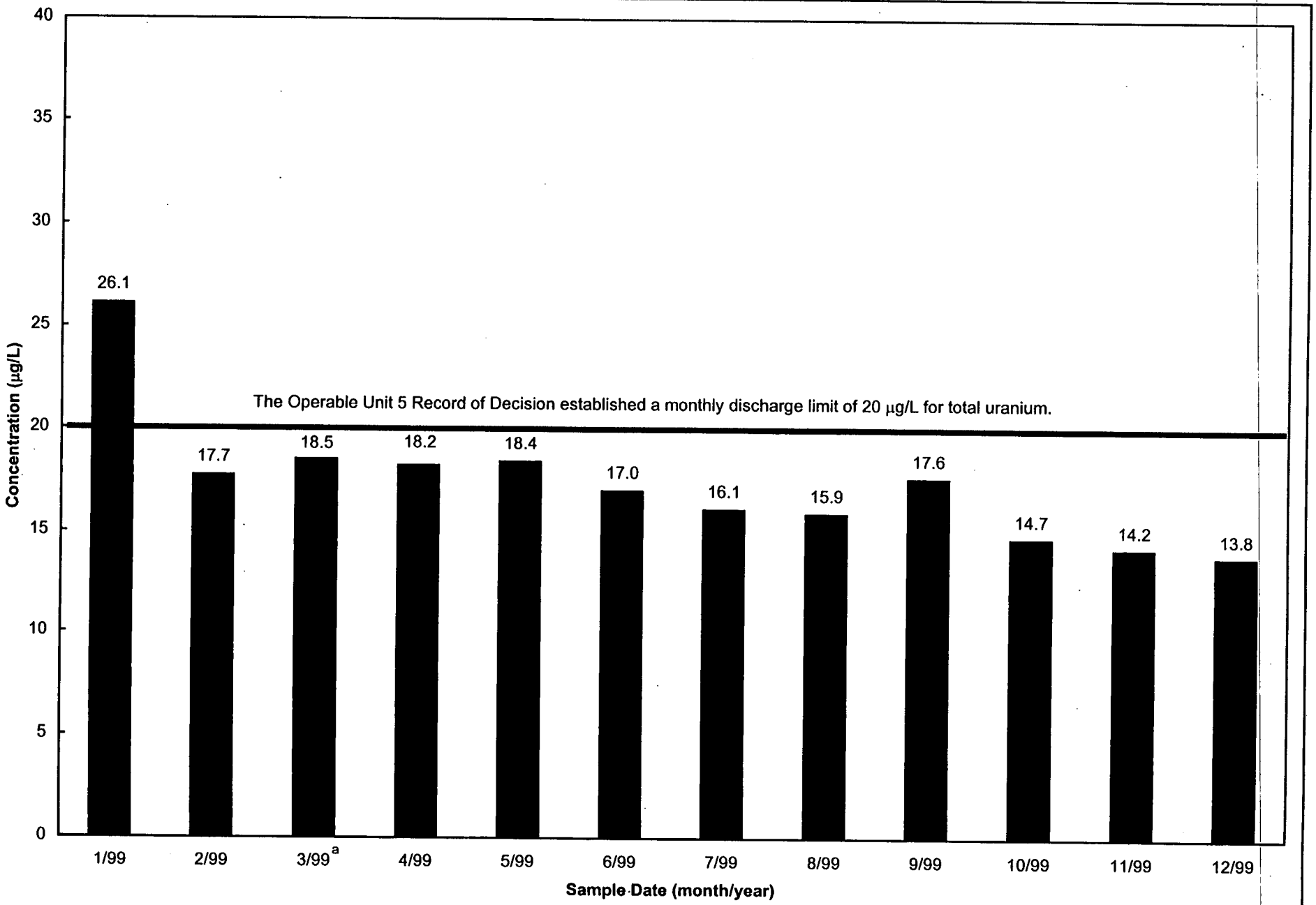


FIGURE 3-4. NPDES PERMIT SAMPLE LOCATIONS



Note: Sum of monthly discharges may not always agree with cumulative total due to rounding differences.

FIGURE 3-5. POUNDS OF URANIUM DISCHARGED TO THE GREAT MIAMI RIVER FROM THE PARSHALL FLUME (PF 4001) IN 1999

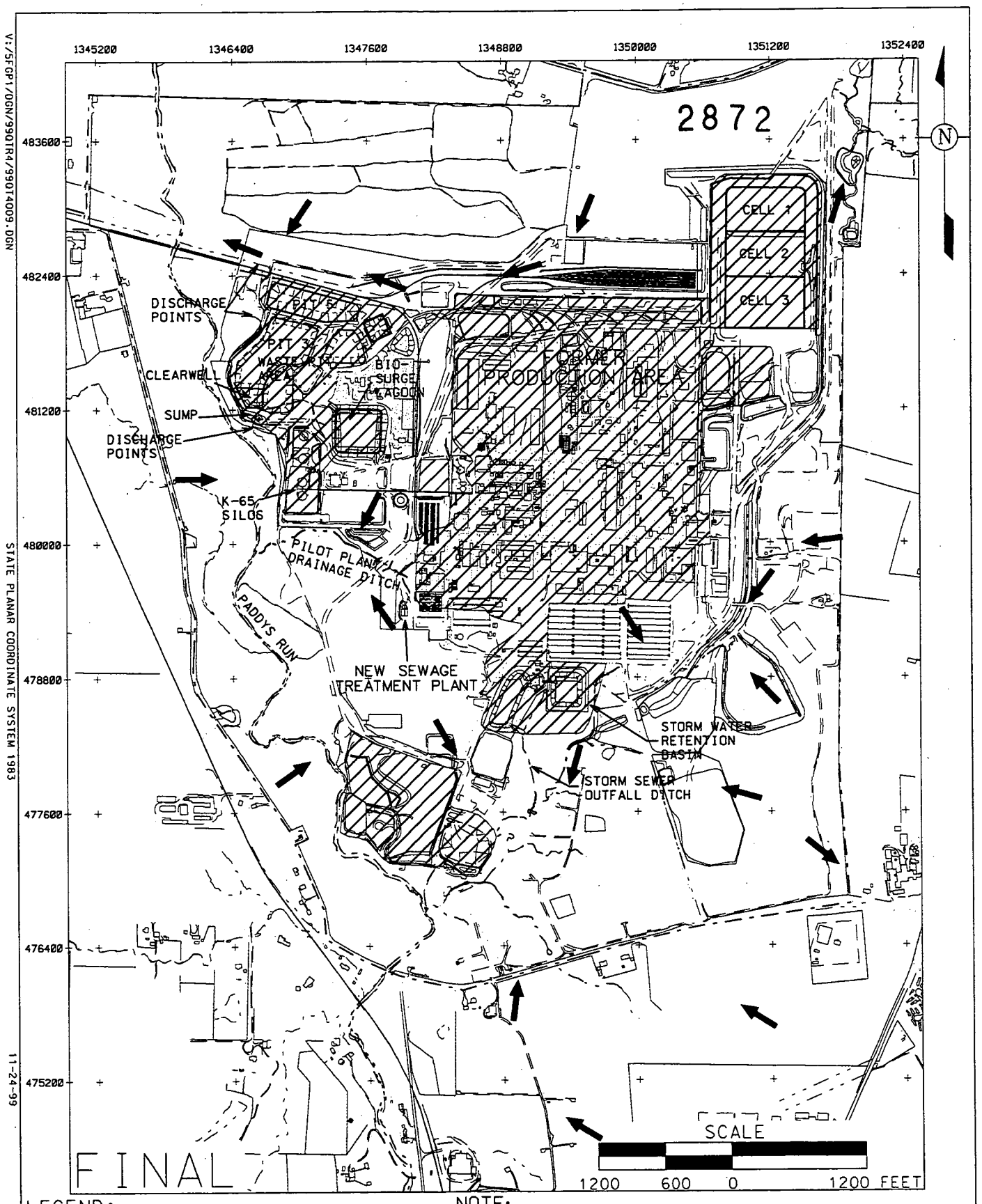


[a] Actual concentration was 19.4 µg/L. Eliminating the three "treatment plant maintenance" bypass days reduces average to 18.5 µg/L.

FIGURE 3-6. 1999 MONTHLY AVERAGE TOTAL URANIUM CONCENTRATION IN WATER DISCHARGED FROM THE PARSHALL FLUME (PF 4001) TO THE GREAT MIAMI RIVER

FINAL

000037



LEGEND:

- FEMP BOUNDARY
- CONTROLLED AREA
- UNCONTROLLED RUNOFF FLOW DIRECTION

NOTE:

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

WATER TREATED IF TOTAL URANIUM RESULT IS >20 µg/L

FIGURE 3-7. CONTROLLED SURFACE WATER AREAS AND UNCONTROLLED FLOW DIRECTIONS FOR FOURTH QUARTER 1999

2872

Air Monitoring

000093

2872

4.0 AIR MONITORING

This section provides a summary of the fourth quarter 1999 monitoring activities and analytical results for the Integrated Environmental Monitoring Plan (IEMP) air monitoring program. Figure 4-1 shows the data included in this section. Analytical results from the following routine air monitoring program elements and project-specific air monitoring activities covered in this section include:

- Radiological Air Particulate Monitoring:
  - National Emissions Standards for Hazardous Air Pollutants (NESHAP) Compliance
  - Monitoring Thorium Emissions from the Waste Pits Remedial Action Project (WPRAP)
  - Project-Specific Air Monitoring at the Sewage Treatment Plant Complex
- NESHAP Stack Emissions Monitoring
- Radon Monitoring:
  - Continuous Alpha Scintillation Monitoring - Silo Head Space and Environmental Data
- Direct Radiation Monitoring (via thermoluminescent dosimeters [TLDs]).

Figure 4-2 shows the data from the air monitoring activities that will be included in the next IEMP quarterly status report to be submitted in June of 2000. The report will contain data from air monitoring activities from January through March 2000 (first quarter). Monitoring activities defined under the IEMP for radiological particulate, stack, radon, and direct radiation monitoring will continue as planned during the first quarter of 2000.

4.1 RADIOLOGICAL AIR PARTICULATE MONITORING

4.1.1 TOTAL URANIUM, TOTAL PARTICULATE AND THORIUM

Airborne uranium particulate concentrations measured during the fourth quarter of 1999 were higher than concentrations observed during the fourth quarter of 1998; however, these concentrations exhibited a pattern consistent with the continuation of field remediation activities. Relative to the third quarter, an increase in the quarterly average total uranium concentrations was observed at 12 of the 16 fenceline air particulate monitoring locations during the fourth quarter of 1999. The generally higher total uranium concentrations reflect the continuation of earth moving, waste hauling, and waste placement operations into December as well as the excavation of the waste pits, which was initiated during the fourth quarter. While the overall fourth quarter averages were higher, decreases in the average total uranium concentrations were observed at AMS-3, AMS-7, AMS-8A, and AMS-9C. Three of these monitors (AMS-3, AMS-8A, and AMS-9C) are along the east fenceline and measured lower total uranium concentrations due, in part, to the completion of the Sewage Treatment Plant decontamination and dismantling project in mid-October. The decrease in average total uranium concentration at AMS-7, located in the northwest corner of the Fernald site, is not considered to be significant since it remains comparable to the average concentration measured during the third quarter of 1999. Figure 4-3 identifies the location of the air monitoring stations. Table 4-1 provides a summary of fourth quarter, 1999 year-to-date, and historical total uranium concentrations.

There were three notable temporary increases of total uranium concentrations in individual samples collected at AMS-6, AMS-25, and AMS-28. These temporary increases lasted for one sampling period (two weeks) and are attributed to fugitive emissions from the overall remediation of the Fernald site. Relatively high winds during these sampling periods are the likely cause of the increased amount of fugitive emissions. In the sampling period following the temporary increases, uranium concentrations returned to typical levels. Fourth quarter and historical total uranium concentration graphs for each location can be viewed by going to Table 4-1 and selecting the appropriate location.

Relative to 1998 annual average total uranium concentrations, 1999 annual average total uranium concentrations were lower at 10 of the 16 fenceline monitoring locations. The exceptions to the general decrease in total uranium concentrations were observed at AMS-6, AMS-8A, AMS-22, AMS-23, AMS-25 and AMS-28. As noted above, there were short-term peaks in total uranium concentrations at AMS-6, AMS-25, and AMS-28 that significantly increased the annual average uranium concentration at these monitors. The increase in the annual average concentration at AMS-8A is most likely attributable to emissions from the remediation of the Sewage Treatment Plant Complex Project. The increase in the annual average concentrations at AMS-22 and AMS-23 are not considered to be significant because they represent only a three and 11 percent increase over 1998 annual average concentrations, respectively.

Table 4-2 provides a summary of fourth quarter, year-to-date, and historical total particulate concentrations. Fourth quarter and historical total particulate concentration graphs for each location can be viewed by going to Table 4-2 and selecting the appropriate location. As indicated by the graphs, particulate concentrations at fenceline and background locations during the fourth quarter of 1999 are, in general, comparable to fourth quarter 1998 particulate concentrations.

The waste pit monitors (refer to Figure 4-3 for WPTH-1 and WPTH-2 locations) were installed to address potential increases in airborne thorium concentrations, specifically thorium-230, that may result from fugitive emissions from the excavation of the waste pits. As noted in the Integrated Environmental Monitoring Status Report for Third Quarter 1999 (DOE 1999b), cross-contamination occurred in the laboratory that processes the WPTH-1 and WPTH-2 samples. Cross-contamination affected the first biweekly samples of the fourth quarter also, but the samples were re-analyzed. The laboratory re-analyzed all samples except the WPTH-1 sample collected on October 5, 1999. This sample could not be re-analyzed because of insufficient sample volume. The original October 5 result from WPTH-1 was considered invalid and is not plotted on Figure 4-22.

Late in the fourth quarter, the biweekly thorium-230 concentrations measured at WPTH-1 and WPTH-2 (refer to Figure 4-22 and Figure 4-23, respectively) increased when compared to third quarter 1999 biweekly concentrations. This increase is attributed to the excavation of the waste pits and the startup of WPRAP dryer operations. Thorium concentrations at WPTH-1 and WPTH-2 will continue to be monitored biweekly in order to assess the impact of these excursions above the baseline concentrations measured prior to the excavation of the waste pits and startup of the WPRAP dryer operations. The thorium-230 concentration increases identified on Figure 4-22 and Figure 4-23 were relatively short in duration. Early in the first quarter of 2000, thorium-230 concentrations at WPTH-1 and WPTH-2 returned to levels comparable to concentrations measured during the early part of the fourth quarter of 1999.

Figure 4-24 and Figure 4-25 are plots of thorium-228 and thorium-232 concentrations at WPTH-1 and WPTH-2, respectively. As indicated by the plots, the airborne concentrations of thorium-228 and thorium-232 at the monitors are comparable to background and have generally remained consistent throughout the fourth quarter. This fenceline data reflects the fact that, in comparison to thorium-230, the concentrations of thorium-228 and thorium-232 in the waste pit material are relatively low. WPRAP operations are not expected to significantly impact the fenceline concentrations of thorium-228 and thorium-232.

The Below-Grade Excavations/Remediation of the Sewage Treatment Plant Complex Project were completed early in the fourth quarter (October 15, 1999). Project-specific monitoring (designated as STP-2 on Figure 4-3) continued for the remainder of the quarter. The average fourth quarter 1999 total uranium concentrations at STP-2 indicated a decrease of

approximately 37 percent when compared to average third quarter 1999 total uranium concentrations. Average particulate concentrations during the fourth quarter also indicated a 43 percent decrease from the previous quarter. Refer to Table 4-1 and Table 4-2 for STP-2 total uranium and total particulate concentrations, respectively. In addition, Figure 4-26 contains this information graphically for STP-2. It should be noted that a graph for STP-1 is not provided as it was not sampled during the fourth quarter of 1999 (STP-2 replaced this location).

4.1.2 NESHAP COMPLIANCE

The maximum fourth quarter dose equivalent, calculated from fourth quarter air composite data, was 0.10 millirem (mrem) and occurred at AMS-8A. Table 4-3 contains the fourth quarter doses for each air monitoring station and the fractional contribution of each radionuclide to the total dose. Uranium contributed the largest fraction of dose at the three fenceline monitors (AMS-3, AMS-8A, and AMS-9C) with the highest air inhalation dose equivalent for the fourth quarter. These three monitors are along the eastern fenceline of the site and generally downwind of the major remediation activities. For the fourth quarter, the results indicate that uranium contributed 66 percent of the dose at AMS-8A, 59 percent of the dose at AMS-3, and 43 percent of the dose at AMS-9C.

The maximum year-to-date dose equivalent, calculated from the sum of four quarterly air composites, was 0.29 mrem which occurred at AMS-3. This maximum year-to-date fenceline dose represents 2.9 percent of the 10 mrem NESHAP Subpart H standard. Table 4-4 contains the year-to-date doses for each air monitoring station and the fractional contribution of each radionuclide to the total dose. Three of the 16 fenceline monitors (AMS-3, AMS-8A, and AMS-9C) have year-to-date dose equivalents greater than two percent of the NESHAP standard. As noted above, these monitors are along the eastern fenceline of the site and generally downwind of the major remediation activities. On average, uranium contributed approximately 57 percent of the dose at these monitors (AMS-3, AMS-8A, and AMS-9C) and approximately 45 percent of the dose at the fenceline monitors overall. These uranium contributions to the dose equivalent are lower than historical dose contribution data, which indicate uranium typically contributes greater than 62 percent of the dose based on an evaluation of fenceline monitoring results from 1990 to 1998. Although the dose contribution from uranium in 1999 was less than most historical values, uranium is still the major contributor to dose, particularly at the fenceline locations where the maximum annual dose occurs.

NESHAP STACK EMISSIONS MONITORING

Table 4-5 includes the NESHAP stack emissions monitoring results and Figure 4-27 shows the NESHAP stack emissions monitoring locations. Fourth quarter 1999 results for the Laundry and Building 71 stacks are within expected ranges. Typically, post production (1991 to present) stack monitoring results are near or below the minimum detectable concentration levels for all isotopes monitored. No significant changes in the source operations associated with either stack were noted during the fourth quarter.

The WPRAP dryer stack began operations late in the fourth quarter of 1999. During the initial startup and operation of the dryer, there were a series of false alarms at the stack monitor. In response to each alarm, the monitoring system was inspected. The sample filter in the stack monitoring system was replaced, as necessary (e.g., in response to the alarm). The stack filters that were collected were analyzed as a composite sample. The WPRAP stack also contains a continuous

radon (i.e., radon-220 and radon-222) monitor. During dryer operations, the maximum daily release of radon (radon-220 and radon-222) from the dryer stack was 3,224 μCi, which is below the estimated maximum hourly release rate of 13,000 μCi/hr for radon-222. Although radon stack monitoring is not required per the NESHAP Subpart H regulations, Table 4-5 includes a summary of the results from the stack radon monitor.

4.2 RADON MONITORING

4.2.1 ENVIRONMENTAL RADON

Environmental radon concentrations are strongly influenced by seasonal meteorological conditions and patterns. Meteorological conditions known as inversions have the largest influence on radon concentrations. During an inversion, a layer of stable, cooler air is trapped near the earth's surface by an upper layer of warmer air. There is relatively little circulation and mixing within this layer of cooler air and, as a result, the concentration of radon (which is emitted from both the soil and the K-65 Silos) in this layer increases. Inversions are classified based on the gradient, or rate of increase, in air temperature with increasing elevation. Since the strongest inversions (i.e., the largest temperature gradients) are experienced in the early morning hours and are more prevalent during the fourth quarter, maximum radon concentrations can be expected to occur during this time of the year. Table 4-6 summarizes data from the fourth quarter of 1999, with ranges of monthly average concentrations for all of 1999 and all of 1998. Annual averages for all boundary locations (refer to Figure 4-28) were below the 3 picoCuries per liter (pCi/L) above background annual average radon concentration limit at the facility boundary for 1999. Maximum monthly averages are consistent with previous years' data. As expected, the highest continuous environmental radon monitoring results were recorded at the K-65 exclusion fence. Over time, there has been a gradual increase in radon levels recorded at the K-65 exclusion fence corresponding to increasing radon concentrations within the two K-65 Silos. The maximum monthly average was 14.3 pCi/L and was recorded at location KNE in the prevailing wind direction from the silos.

Following the re-sealing of the silo domes (completed on June 4, 1999), radon data from the K-65 Silo area has been closely monitored in order to gauge the effectiveness in reducing radon emissions. In general, fourth quarter 1999 radon levels at the four K-65 exclusion fence monitors are lower than during the same monthly periods in 1998. Comparing the 1999 and 1998 fourth quarter average radon concentrations at the KNE and KSE exclusion fence monitors (chosen because of prevailing wind directions) provides some measure of the effectiveness of the re-sealing activities. The fourth quarter 1999 combined average radon concentration for the KNE and KSE monitors was approximately 70 percent lower than the fourth quarter 1998 average, suggesting the re-sealing activities contributed to a substantial reduction in radon concentrations at the K-65 Silo area.

A review of meteorological data provides further support for the effectiveness of the re-sealing activities. The number of strong inversion hours (as defined by a temperature gradient of greater than 1.5 degrees Celsius per 100 meters in elevation) recorded during fourth quarter 1999 was very similar to fourth quarter 1998 (987 hours in 1999 compared to 985 hours in 1998). However, approximately 20 percent more of the strongest "G" class inversion hours (temperature gradient of greater than 4 degrees Celsius per 100 meters in elevation) were recorded for fourth quarter 1999. Given the larger and stronger inversions during the fourth quarter of 1999, radon concentrations at the K-65 exclusion fence monitors should have been greater during fourth quarter 1999 had the re-sealing activity been ineffective.

During the fourth quarter of 1999, there were 12 exceedances of the U.S. Department of Energy (DOE) Order 5400.5 100 pCi/L radon limit. Table 4-7 lists the exceedances chronologically with their duration in hours, affected monitoring locations, and the maximum hourly concentration. A majority of the exceedances occurred exclusively at the KNW monitor, in contrast to past years when most exceedances occurred at the KNE monitor. A review of activities occurring around the K-65 Silos indicated that the cause of the exceedances at the KNW monitor was related to the pumping of contaminated water from the K-65 Decant Sump, which collects contaminated water from the K-65 Silos. Annually, water in the sump is pumped out and temporarily held in a tanker truck, temporarily located near the KNW monitor. The water in the tanker truck and the residual water and sludge at the bottom of the sump are sources of radon. Since the pumping activities occurred during periods of strong inversions, radon emissions from the sump and the tanker were concentrated at relatively high levels on the western side of the K-65 Silos near the KNW monitor, and contributed to the exceedances.

In addition to increased radon levels from the pumping of the K-65 Decant Sump during the fourth quarter of 1999, part of the increased average radon concentrations at the KNW monitor are attributable to relocating the monitor about 15 feet closer to the K-65 Silos in May 1999. The relocation of the KNW monitor was necessary due to road construction activities for the Accelerated Waste Retrieval Project. Because the monitor was moved closer to the silos, radon levels recorded by this monitor were expected to be higher.

4.2.2 SILO HEAD SPACE

K-65 Silo head space radon concentrations fluctuate seasonally due to changes in meteorological parameters (e.g., temperature, barometric pressure, humidity, etc.). To account for the seasonal variations, concentrations are summarized quarterly (from the daily average concentrations) in order to compare data collected under similar meteorological conditions. The monthly average continuous monitoring results for K-65 Silo 1 during the fourth quarter of 1999 ranged between 14.4 and 14.8 million pCi/L. The quarterly average concentration increased approximately 6.1 percent over the quarterly average concentration during the same period in 1998 and is approximately 56 percent of the pre-bentonite concentration level (~26 million pCi/L). Fourth quarter 1999 monthly average continuous monitoring results for K-65 Silo 2 ranged between 8.68 and 11.0 million pCi/L. The quarterly average concentration decreased approximately 12 percent from the average concentration during the same period in 1998 and is approximately 33 percent of the pre-bentonite concentration level (~30 million pCi/L). Figure 4-29 shows the quarterly silo head space radon concentrations and Table 4-8 presents the monthly average silo head space radon concentrations.

After reviewing historical data from the last two years, differences were found between K-65 Silo head space radon concentrations calculated by the continuous monitoring system and confirmatory grab sample measurements. Specifically, the continuous monitoring system has consistently recorded concentrations that are approximately 70 to 80 percent of grab sample measurements. The grab sample is considered to be a better measurement of head space radon concentrations because radon daughter equilibrium is established prior to counting the sample. Within the continuous system, radon daughter equilibrium is assumed to exist during the measurement process. This equilibrium assumption is an influential factor in the calculation of head space radon concentrations.

A series of tests were run to determine whether equilibrium truly exists within the continuous sampling system. The results of the tests indicated the radon daughters are not in complete equilibrium within the continuous system. The experimentally determined equilibrium ratios were 0.80 for Silo 1 and 0.76 for Silo 2. Given the confirmation of non-equilibrium conditions within the system, DOE is planning to apply multiplication factors that correct for the non-equilibrium conditions when calculating and reporting radon concentrations measured by the continuous monitoring system. The net effect of applying the correction factors will be an approximate 20 to 25 percent increase in calculated head space radon concentrations. DOE is planning to apply the correction factors to the K-65 Silo headspace measurements beginning in January 2000.

It is important to note that the data recorded by environmental radon monitors at other on site locations and at the Fernald site boundary utilize a different sampling technique and do not rely on the assumption of equilibrium. No correction factors need to be applied to environmental radon concentrations.

4.3 DIRECT RADIATION (TLD) MONITORING

All monitoring results from direct radiation measurements for the fourth quarter of 1999 were within historical ranges. Figure 4-30 depicts the monitoring locations and direct radiation measurements are shown in Table 4-9. As noted in previous IEMP quarterly status reports, a positive trend in the immediate area of the K-65 Silos (locations 22 through 26) has been identified and will continue to be monitored (refer to Figure 4-31). This trend is attributed to a corresponding increase in radon and radon-progeny concentrations observed in the K-65 Silo head space. The increase in direct radiation measurements adjacent to the silos is still well below the levels observed prior to the addition of bentonite to the silos in 1991.

During the fourth quarter, a 33 percent increase in direct radiation levels was measured at TLD location 22. For comparison, there was an average two percent increase in radiation levels at the other TLD locations (locations 23, 24, 25, and 26) in the K-65 Silo area. The increase at location 22 has been attributed to the relocation of a radioactive material storage trailer within the K-65 Silo area. This is an acceptable and appropriate practice inside a radiologically controlled area. The trailer was relocated in close proximity to TLD location 22 and direct radiation from materials in the trailer produced the majority of the increase in radiation levels measured at TLD location 22. Given the influence of the radioactive material storage trailer on the radiation levels at TLD location 22, data from location 22 are no longer useful for monitoring the effect of K-65 Silo radon head space concentrations. Therefore, TLD location 22 data are not included in the K-65 Silo fenceline average as reported in Figure 4-31.

As discussed in previous reports, a slight positive trend in direct radiation measurements at the site fenceline nearest the K-65 Silos (location 6) has been identified. Although the 1999 year-to-date results are slightly lower than the 1998 results for this location, this trend will continued to be monitored. The increase is associated with the increasing direct radiation levels at the K-65 Silos, as discussed above. Figure 4-32 shows the slight positive trend at location 6.

TABLE 4-1

TOTAL URANIUM PARTICULATE CONCENTRATIONS IN AIR

	Fourth Quarter 1999 Results[a,b] (pCi/m³ x 1E-6)				1999 Summary Results[a] (pCi/m³ x 1E-6)				1990 through 1998 Summary Results[a,b] (pCi/m³ x 1E-6)	
Location	No. of Samples	Min.	Max.	Avg.	No. of Samples	Min.	Max.	Avg.	Min.	Max.
Fenceline										
AMS-2	7	9.5	269	88	25	9.5	269	57	0	3500
AMS-3	7	12	362	157	26	12	585	146	0	17000
AMS-4	7	6.2	109	37	26	0	109	29	0	2300
AMS-5	7	3.5	72	46	26	0	72	25	0	4400
AMS-6	7	5.0	453	116	26	3.2	453	55	0	3200
AMS-7	7	2.1	50	30	26	0	83	24	0	7800
AMS-8A	7	16	320	118	26	0	1135	130	7.9	900
AMS-9C[c]	7	9.2	266	120	26	9.2	409	102	0	562
AMS-22	7	9.3	89	50	26	0	89	35	0	101
AMS-23	7	14	202	93	26	0	202	49	9.0	194
AMS-24	7	2.5	112	40	26	0	112	24	0	65
AMS-25	7	2.3	402	77	26	0	402	33	0	79
AMS-26	7	2.6	171	58	26	0	171	31	0	98
AMS-27	7	0	101	41	26	0	101	30	0	64
AMS-28	7	10	445	102	26	0	445	40	0	216
AMS-29	7	0	199	70	26	0	199	41	0	121
Background										
AMS-12	7	0	11	3.8	26	0	45	8.1	0	480
AMS-16	7	0	37	14	26	0	37	16	0	350
Project-Specific										
STP-1[d,e]	0	NA	NA	NA	11	20	143	56	38	891
STP-2[e]	7	23	339	163	16	5.4	380	181	NA	NA

[a]For blank corrected concentrations less than or equal to 0.0 pCi/m³, the concentration is set as 0.0 pCi/m³.
[b]NA = not applicable
[c]Summary results for 1990 through 1998 include AMS-9B/C data.
[d]Project-specific monitor was not in operation prior to 1997.
[e]STP-1 was relocated to STP-2 on May 25, 1999.

TABLE 4-2

TOTAL PARTICULATE CONCENTRATIONS IN AIR

Location	Fourth Quarter 1999 Results[a] (μg/m³)				1999 Summary Results (μg/m³)				1990 through 1998 Summary Results[a] (μg/m³)	
	No. of Samples	Min.	Max.	Avg.	No. of Samples	Min.	Max.	Avg.	Min.	Max.
Fenceline										
AMS-2	7	17	36	27	26	11	69	34	7.0	77
AMS-3	7	19	52	32	26	19	83	37	8.0	159
AMS-4	7	21	40	31	26	18	74	38	13	79
AMS-5	7	18	31	25	26	18	45	29	9.6	62
AMS-6	7	20	45	29	26	19	48	32	8.0	69
AMS-7	7	20	46	30	26	20	84	34	6.8	76
AMS-8A	7	21	55	33	26	20	63	37	13	89
AMS-9C[b]	7	19	50	34	26	19	66	38	7.1	136
AMS-22	7	23	39	31	26	16	53	37	13	57
AMS-23	7	18	31	24	26	18	57	30	15	51
AMS-24	7	24	54	42	26	13	57	38	18	79
AMS-25	7	21	38	32	26	17	45	31	21	69
AMS-26	7	19	32	26	26	19	52	31	15	51
AMS-27	7	16	92	50	26	16	92	50	24	86
AMS-28	7	16	46	26	26	15	51	28	12	49
AMS-29	7	19	40	29	26	18	52	33	11	62
Background										
AMS-12[c]	7	18	36	26	26	16	48	29	6.0	416
AMS-16[c]	7	29	61	42	26	26	61	44	18	84
Project-Specific										
STP-1[d,e]	0	NA	NA	NA	11	21	54	31	25	93
STP-2[e]	7	19	50	30	16	19	72	43	NA	NA

[a]NA = not applicable
[b]Summary results for 1990 through 1998 include AMS-9B/C data.
[c]Total particulate analysis was discontinued during 1994 and was reinstated for AMS-12 and AMS-16 in 1997.
[d]Project-specific monitor was not in operation prior to 1997.
[e]STP-1 was relocated to STP-2 on May 25, 1999.

000111

TABLE 4-3

FOURTH QUARTER NESHAP COMPLIANCE TRACKING

	40 CFR 61 (NESHAP) Subpart H Appendix E, Table 2; Net Ratios[a]													
Location	Ac-228[b]	Ra-224[b]	Ra-226	Ra-228[b]	Th-228	Th-230	Th-231[b]	Th-232	Th-234[b]	U-234	U-235 U-236	U-238	Ratio Totals	Dose[c] (mrem)
Fenceline														
AMS-2	-	-	9.5E-04	-	-	7.3E-04	1.3E-10	-	2.9E-06	5.7E-04	4.9E-06	7.7E-04	3.0E-03	0.030
AMS-3	-	-	1.4E-03	-	-	1.9E-03	2.7E-09	-	9.0E-06	2.3E-03	1.1E-04	2.4E-03	8.1E-03	0.081
AMS-4	-	-	8.3E-04	-	-	5.5E-04	-	-	1.8E-06	2.9E-04	-	4.8E-04	2.2E-03	0.022
AMS-5	-	-	6.3E-04	-	-	1.1E-03	4.1E-10	-	2.3E-06	5.2E-04	1.6E-05	6.0E-04	2.9E-03	0.029
AMS-6	-	-	9.0E-04	-	-	3.3E-03	2.3E-10	-	5.5E-06	4.0E-04	8.9E-06	1.5E-03	6.1E-03	0.061
AMS-7	-	-	8.2E-04	-	-	9.6E-05	7.7E-11	-	1.5E-06	9.1E-05	3.0E-06	3.9E-04	1.4E-03	0.014
AMS-8A	-	-	2.1E-03	-	-	1.3E-03	5.2E-09	-	1.3E-05	3.1E-03	2.1E-04	3.3E-03	1.0E-02	0.100
AMS-9C	-	-	2.1E-03	-	-	1.6E-03	1.0E-09	-	5.6E-06	1.2E-03	4.0E-05	1.5E-03	6.4E-03	0.064
AMS-22	-	-	1.4E-03	-	-	1.3E-03	6.8E-10	-	3.9E-06	4.2E-04	2.7E-05	1.0E-03	4.2E-03	0.042
AMS-23	-	-	-	-	-	8.9E-04	2.1E-09	-	5.6E-06	1.4E-03	8.1E-05	1.5E-03	3.9E-03	0.039
AMS-24	1.6E-07	3.9E-06	1.1E-03	9.8E-05	6.5E-05	1.1E-03	6.1E-10	9.3E-04	2.1E-06	4.8E-04	2.4E-05	5.7E-04	4.4E-03	0.044
AMS-25	-	-	-	-	-	1.2E-03	-	-	2.7E-06	2.5E-04	-	7.2E-04	2.2E-03	0.022
AMS-26	-	-	2.1E-05	-	-	4.4E-03	4.6E-10	-	3.0E-06	4.3E-04	1.8E-05	7.9E-04	5.6E-03	0.056
AMS-27	2.4E-08	5.9E-07	9.4E-04	1.5E-05	2.3E-05	1.3E-03	4.8E-10	1.4E-04	2.4E-06	2.6E-04	1.9E-05	6.3E-04	3.4E-03	0.034
AMS-28	-	-	-	-	-	2.8E-03	2.3E-10	-	5.6E-06	3.7E-04	8.8E-06	1.5E-03	4.7E-03	0.047
AMS-29	-	-	3.5E-05	-	-	1.7E-03	1.5E-09	-	6.0E-06	1.2E-03	5.9E-05	1.6E-03	4.5E-03	0.045
Background														
AMS-12	3.3E-07	8.3E-06	6.1E-04	2.1E-04	1.9E-04	7.4E-04	-	2.0E-03	9.0E-07	2.4E-04	-	2.4E-04	NA[d]	
AMS-16	9.0E-07	2.2E-05	1.4E-03	5.6E-04	8.7E-04	1.7E-03	7.1E-10	5.4E-03	1.8E-06	4.8E-04	2.8E-05	4.7E-04	NA[d]	
QA/QC														
Column Check[e]	0.000	0.000	0.132	0.001	0.001	0.253	0.000	0.011	0.001	0.132	0.006	0.192	NA[d]	0.73

Maximum Quarterly Ratio: 0.0100
Maximum Quarterly Dose (mrem): 0.100

[a]A "-" 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]NA = not applicable
[e]Column check is the sum of doses from each radionuclide, followed by the sum of doses (0.73) at all fenceline monitors.

TABLE 4-4

YEAR-TO-DATE NESHAP COMPLIANCE TRACKING

	40 CFR 61 (NESHAP) Subpart H Appendix E, Table 2; Net Ratios[a]													
Location	Ac-228[b]	Ra-224[b]	Ra-226[c]	Ra-228[b]	Th-228	Th-230	Th-231[b]	Th-232	Th-234[b]	U-234	U-235 U-236	U-238	Ratio Totals	Dose[d] (mrem)
Fenceline														
AMS-2	3.9E-07	9.5E-06	5.2E-03	2.4E-04	6.9E-04	2.2E-03	3.7E-09	2.3E-03	1.2E-05	2.8E-03	1.5E-04	3.2E-03	1.7E-02	0.17
AMS-3	2.2E-07	5.4E-06	9.5E-03	1.4E-04	4.8E-04	3.0E-03	8.8E-09	1.3E-03	2.7E-05	7.2E-03	3.5E-04	7.2E-03	2.9E-02	0.29
AMS-4	4.5E-07	1.1E-05	2.1E-03	2.8E-04	5.7E-03	2.5E-03	1.9E-09	2.7E-03	8.3E-06	1.8E-03	7.4E-05	2.2E-03	1.7E-02	0.17
AMS-5	-	-	-	-	-	1.3E-03	3.1E-10	-	3.3E-06	7.4E-04	1.2E-05	8.8E-04	3.0E-03	0.030
AMS-6	-	-	1.1E-03	-	-	3.6E-03	2.2E-09	-	1.0E-05	1.2E-03	8.6E-05	2.7E-03	8.7E-03	0.087
AMS-7	-	-	-	-	-	4.1E-04	5.4E-10	-	3.7E-06	6.2E-04	2.1E-05	9.9E-04	2.0E-03	0.020
AMS-8A	7.0E-08	1.7E-06	5.2E-03	4.4E-05	3.5E-05	2.3E-03	1.2E-08	4.2E-04	3.1E-05	8.0E-03	4.5E-04	8.1E-03	2.5E-02	0.25
AMS-9C	3.0E-07	7.4E-06	4.7E-03	1.9E-04	2.9E-04	3.2E-03	6.6E-09	1.8E-03	2.1E-05	5.2E-03	2.6E-04	5.6E-03	2.1E-02	0.21
AMS-22	5.2E-08	1.3E-06	8.1E-04	3.3E-05	1.4E-04	2.9E-03	2.4E-09	3.1E-04	8.6E-06	1.3E-03	9.2E-05	2.3E-03	7.9E-03	0.079
AMS-23	-	-	-	-	2.8E-03	9.6E-04	2.3E-09	-	1.1E-05	2.5E-03	8.8E-05	2.9E-03	9.2E-03	0.092
AMS-24	3.5E-07	8.6E-06	5.4E-03	2.2E-04	3.8E-04	2.2E-03	2.0E-09	2.1E-03	3.6E-06	8.9E-04	7.7E-05	9.6E-04	1.2E-02	0.12
AMS-25	-	-	-	-	-	1.2E-03	-	-	3.3E-06	2.2E-04	-	8.8E-04	2.3E-03	0.023
AMS-26	-	-	1.7E-03	-	-	4.4E-03	2.2E-09	-	5.8E-06	1.1E-03	8.7E-05	1.5E-03	8.8E-03	0.088
AMS-27	3.9E-07	9.6E-06	6.3E-03	2.4E-04	4.9E-04	2.5E-03	1.3E-09	2.3E-03	5.3E-06	9.0E-04	5.2E-05	1.4E-03	1.4E-02	0.14
AMS-28	-	-	-	-	-	3.0E-03	7.8E-10	-	6.0E-06	2.3E-04	3.1E-05	1.6E-03	4.9E-03	0.049
AMS-29	-	-	-	-	1.0E-03	2.5E-03	3.8E-09	-	9.8E-06	2.0E-03	1.5E-04	2.6E-03	8.4E-03	0.084
Background														
AMS-12	1.1E-06	2.6E-05	1.5E-03	6.7E-04	1.2E-03	1.9E-03	5.3E-10	6.3E-03	4.5E-06	1.3E-03	2.1E-05	1.2E-03	NA[e]	
AMS-16	2.5E-06	6.2E-05	7.6E-03	1.6E-03	2.8E-03	4.0E-03	1.3E-09	1.5E-02	6.1E-06	1.7E-03	5.0E-05	1.6E-03	NA[e]	
QA/QC														
Column Check[f]	0.000	0.001	0.418	0.014	0.120	0.383	0.000	0.132	0.002	0.368	0.020	0.450	NA[e]	1.91

Maximum Quarterly Ratio: 0.0293
Maximum Quarterly Dose (mrem): 0.293

[a]A "-" 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]First quarter 1999 radium-226 data were rejected and substituted with first quarter 1998 radium-226 data.
[d]Dose conversions are based on the NESHAP standard of 10 mrem per year.
[e]NA = not applicable
[f]Column check is the sum of doses from each radionuclide, followed by the sum of doses (1.91) at all fenceline monitors.

000113

TABLE 4-5

NESHAP STACK EMISSION MONITORING RESULTS

Analysis Performed	Fourth Quarter 1999 Results		1999 Year-to-Date Results		1998 Summary Results	
	No. of Samples[a,b]	Total Pounds[a,c,d]	No. of Samples[a]	Total Pounds[a,c,d]	No. of Samples[e]	Total Pounds[c,d,e]
Building 71 Stack						
Uranium, Total	2	3.6E-06	5	2.6E-05	5	1.3E-05
Thorium-232	2	ND	5	5.2E-05	5	8.6E-05
Thorium-230	2	2.8E-10	5	1.0E-09	5	1.2E-09
Total Particulate	1[f]	5.6E-01	3[f]	5.8E-01	1[f]	7.2E-02
Laundry Stack						
Uranium, Total	2	8.8E-06	9[g]	2.6E-05	10	7.0E-06
Thorium-232	2	7.1E-05	9[g]	5.8E-04	10	4.5E-04
Thorium-230	2	7.9E-10	9[g]	6.9E-09	10	5.8E-09
Total Particulate	1[f]	1.8E-01	7[f,g]	6.0E-01	8[f]	1.1E+00
WPRAP Dryer Stack						
Uranium-238	1	ND	1	ND	NA	NA
Uranium-235/236	1	ND	1	ND	NA	NA
Uranium-234	1	ND	1	ND	NA	NA
Thorium-232	1	ND	1	ND	NA	NA
Thorium-230	1	ND	1	ND	NA	NA
Thorium-228	1	ND	1	ND	NA	NA
Radium-226[h]	1	ND	1	ND	NA	NA
Total Particulate[i]	NS	NS	NS	NS	NA	NA

Analysis Performed	Fourth Quarter 1999 Results		
	Average Daily Release Rate (μCi)[j]	Maximum Daily Release Rate (μCi)[j]	Estimated Maximum Hourly Release Rate for Radon-222 (μCi/hr)
WPRAP Dryer Stack			
Radon-220/222	644	3,224	13,000

[a]ND = non-detectable
NS = not sampled
[b]WPRAP dryer stack sample consisted of 23 composited filters.
[c]Total pounds are only determined from detected results.
[d]Includes results from stack sample probe rinse
[e]NA = not applicable because WPRAP dryer stack was not in operation prior to 1999.
[f]Some particulate result(s) could not be determined due to a damaged filter(s).
[g]Includes previously unreported results from a second quarter 1999 sample
[h]Radium-226 is not required to be analyzed in WPRAP dryer stack samples, but is provided for informational purposes.
[i]Particulate emissions for 1999 will be calculated based on the results of stack performance testing to be conducted in early 2000.
[j]Reflects daily release rate information during period of operation from 12/17/99 to 12/22/99

TABLE 4-6

CONTINUOUS ENVIRONMENTAL RADON MONITORING MONTHLY AVERAGE CONCENTRATIONS[a]

	Fourth Quarter 1999 Monthly Results[b,c] (Instrument Background Corrected) (pCi/L)			1999 Summary Results[b] (Instrument Background Corrected) (pCi/L)			1998 Summary Results[b,c] (Instrument Background Corrected) (pCi/L)		
Location	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
Fenceline									
AMS-02	0.4	0.7	0.6	0.2	1.0	0.5	0.2	0.7	0.4
AMS-03	0.5	0.8	0.7	0.1	1.0	0.5	0.6	0.8	0.7
AMS-04	0.5	0.7	0.6	0.1	0.8	0.4	0.1	0.7	0.4
AMS-05	0.6	1.1	1.0	0.2	1.4	0.7	0.2	1.3	0.6
AMS-06	0.4	0.7	0.6	0.2	0.8	0.5	0.2	0.9	0.5
AMS-07	0.6	1.3	1.0	0.3	1.5	0.8	0.2	1.5	0.7
AMS-08A[d]	0.3	0.5	0.4	0.1	0.8	0.4	0.8	NA	NA
AMS-09C	0.3	0.7	0.6	0.2	0.8	0.5	0.2	0.9	0.6
AMS-22	0.4	0.4	0.4	0.1	0.5	0.3	0.2	0.7	0.4
AMS-23	0.4	0.5	0.4	0.1	0.6	0.3	0.4	0.5	0.4
AMS-24[d]	0.5	1.0	0.8	0.2	1.1	0.6	0.7	NA	NA
AMS-25[d]	0.4	0.7	0.6	0.2	0.8	0.5	0.6	NA	NA
AMS-26	0.4	0.7	0.6	0.2	0.8	0.5	0.2	0.8	0.6
AMS-27	0.4	1.1	0.8	0.2	1.1	0.6	0.2	1.1	0.7
AMS-28[d]	0.5	0.7	0.6	0.1	0.8	0.4	0.4	NA	NA
AMS-29[d]	0.6	0.7	0.7	0.1	0.8	0.4	0.7	NA	NA
Background									
AMS-12	0.2	0.4	0.3	0.1	0.5	0.2	0.1	0.6	0.3
AMS-16	0.3	0.5	0.4	0.1	0.5	0.3	0.2	0.6	0.4
On Site									
KNE	1.7	14.3	7.2	1.7	18.3	9.6	2.0	18.2	9.1
KNW	2.1	8.2	5.7	2.1	8.2	3.8	1.0	4.8	2.4
KSE	1.2	4.1	3.1	1.2	9.9	4.9	2.4	16.9	8.3
KSW	1.7	4.8	3.1	1.7	4.8	3.1	1.4	5.2	3.1
KTOP	3.4	5.3	4.5	3.4	15.8	8.4	7.2	24.6	13.0
Pilot Plant Warehouse	0.4	0.7	0.5	0.3	0.8	0.4	0.1	0.9	0.4
Rally Point 4	0.5	1.0	0.9	0.5	1.3	0.8	0.2	1.3	0.7
Surge Lagoon	0.5	0.9	0.8	0.4	1.0	0.7	0.3	1.3	0.7
T28	1.1	3.0	2.1	1.1	3.8	2.2	0.9	2.8	1.8
TS4[e]	0.3	0.9	0.6	0.2	0.9	0.5	NA	NA	NA
WP-17A	0.5	1.1	0.9	0.1	1.1	0.6	0.2	0.9	0.5

[a]Monthly average radon concentrations are calculated from daily average concentrations. Daily average concentrations are calculated by summing all hourly count data, treating the sum as a single daily measurement, and then converting the sum to a (daily average) concentration.
[b]Istrument background changes as monitors are replaced
[c]NA = not applicable
[d]Unit was placed in service in December 1998.
[e]Unit was placed in service in January 1999.

000115

2872

TABLE 4-7

1999 FOURTH QUARTER RADON CONCENTRATIONS
100 pCi/L EXCEEDANCES AT THE K-65 SILOS 1 AND 2 EXCLUSION FENCE

Exceedance Event Start Date	Duration of Exceedance (hours)	Maximum Recorded Hourly Radon Concentration (pCi/L)	Monitoring Location(s)[a]
10/5	2	112	KNE
10/12	4	200	KNE
10/20	2	172	KNE
10/27	3	172	KNW
10/28	3	169	KNW
10/29	3	135	KNW
10/31	6	318	KNW
11/1	5	334	KNW, KNE, KSW
11/7	1	101	KNW
11/8	2	184	KNW
11/21	1	115	KNW
12/2	3	108	KNW

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

NOTE: K-65 Decant Sump pumping activities occurred on October 13 through 15 and October 28 through 29. The tanker storing the water from the sump was stationed on the western side of the K-65 Silos near the KNW monitor from October 5 through November 4, 1999.

TABLE 4-8

RADON HEAD SPACE CONCENTRATIONS

	Radon Head Space Concentrations[a,b,c] (pCi/L)											
	Silo 1 1999			Silo 1 1998			Silo 2 1999			Silo 2 1998		
Month	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
January	1.24E+07	1.44E+07	1.34E+07	1.06E+07	1.18E+07	1.13E+07	8.78E+06	1.11E+07	9.95E+06	8.24E+06	1.01E+07	9.10E+06
February	1.27E+07	1.35E+07	1.32E+07	1.06E+07	1.18E+07	1.12E+07	8.70E+06	9.68E+06	9.20E+06	8.02E+06	9.48E+06	8.96E+06
March	1.25E+07	1.33E+07	1.29E+07	1.01E+07	1.17E+07	1.10E+07	8.66E+06	9.89E+06	9.30E+06	7.27E+06	9.19E+06	8.45E+06
April	1.22E+07	1.30E+07	1.25E+07	9.89E+06	1.09E+07	1.05E+07	7.74E+06	8.53E+06	8.10E+06	7.34E+06	8.87E+06	8.14E+06
May	1.21E+07	1.32E+07	1.26E+07	1.05E+07	1.20E+07	1.10E+07	7.77E+06	8.73E+06	8.21E+06	8.38E+06	8.99E+06	8.62E+06
June	1.25E+07	1.36E+07	1.30E+07	1.08E+07	1.22E+07	1.15E+07	8.04E+06	9.08E+06	8.50E+06	8.25E+06	9.05E+06	8.62E+06
July	1.26E+07	1.43E+07	1.36E+07	1.20E+07	1.41E+07	1.29E+07	8.40E+06	9.06E+06	8.69E+06	8.79E+06	9.44E+06	9.06E+06
August	1.34E+07	1.43E+07	1.37E+07	1.34E+07	1.43E+07	1.39E+07	8.29E+06	8.92E+06	8.58E+06	8.73E+06	9.08E+06	8.93E+06
September	1.28E+07	1.49E+07	1.40E+07	1.23E+07	1.42E+07	1.31E+07	8.20E+06	8.77E+06	8.52E+06	7.78E+06	8.79E+06	8.15E+06
October	1.41E+07	1.56E+07	1.48E+07	1.32E+07	1.43E+07	1.38E+07	8.20E+06	9.38E+06	8.68E+06	7.85E+06	8.94E+06	8.32E+06
November	1.40E+07	1.51E+07	1.45E+07	1.34E+07	1.43E+07	1.38E+07	9.28E+06	1.04E+07	9.67E+06	7.90E+06	9.30E+06	8.68E+06
December	1.41E+07	1.48E+07	1.44E+07	1.29E+07	1.43E+07	1.36E+07	1.04E+07	1.17E+07	1.10E+07	7.96E+06	1.09E+07	9.36E+06

[a]Minimum equals minimum recorded daily average radon concentration.
[b]Maximum equal maximum recorded daily average radon concentration.
[c]Average equals monthly average of recorded daily radon concentrations.

2872

TABLE 4-9

DIRECT RADIATION (TLD) MEASUREMENTS

Location	Direct Radiation (mrem)		
	Fourth Quarter 1999 Results[a]	1999 Year-to-Date Results[b]	1998 Summary Results[a]
Fenceline			
2	19	75	74
3	18	72	67
4	17	68	66
5	17	70	68
6	19	81	84
7	16	68	69
8A	18	74	75
9C	18	76	79
13	17	74	74
14	17	71	77
15	20	79	79
16	19	81	81
17	18	70[c]	73
34	19	75	75
35	17	71	70
36	16	64	65
37	19	76	77
38	15	63	63
39	19	79	79
40	16	68	67
41	18	72	73
Min.	**15**	**63**	**63**
Max.	**20**	**81**	**84**
On Site			
22	277	904	776
23[d,e]	NA	441	817
23A[d,e]	216	650	NA
24	201	707	632[f]
25	237	881	698
26	144	547	496
32	13	55	55
Min.	**13**	**55**	**55**
Max.	**277**	**904**	**817**
Background			
18	18	77	77
19	15	63	65
20	15	62	61
27	15	62	64
33	16	67	68
Min.	**15**	**62**	**61**
Max.	**18**	**77**	**77**

[a]NA = not applicable
[b]1999 summary result value may not always agree with quarterly results due to rounding differences.
[c]Estimated second quarter direct radiation levels
[d]Direct radiation levels for TLD locations 23 and 23A were extrapolated for second quarter results.
[e]TLD location 23 was relocated to TLD location 23A on May 26, 1999.
[f]Direct radiation value includes estimated second quarter results which were based on first quarter results.

FIGURE 4-1\4-2

AIR SAMPLING ACTIVITIES

	Quarter/Year											
	Third Quarter/1999			Fourth Quarter/1999			First Quarter/2000			Second Quarter/1999		
SAMPLING ACTIVITIES	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
Radiological Particulate Monitoring:				◆	◆	◆	☒	☒	☒			
NESHAP Quarterly Composite						◆			☒			
NESHAP Stack Emissions Monitoring				◆	◆	◆	☒	☒	☒			
Radon Monitoring – Continuous Alpha Scintillation Monitors				◆	◆	◆	☒	☒	☒			
Direct Radiation (TLD) Monitoring						◆			☒			

◆ Data summarized/evaluated in this report
☒ Data summarized/evaluated in the next report

FINAL

000119

2872

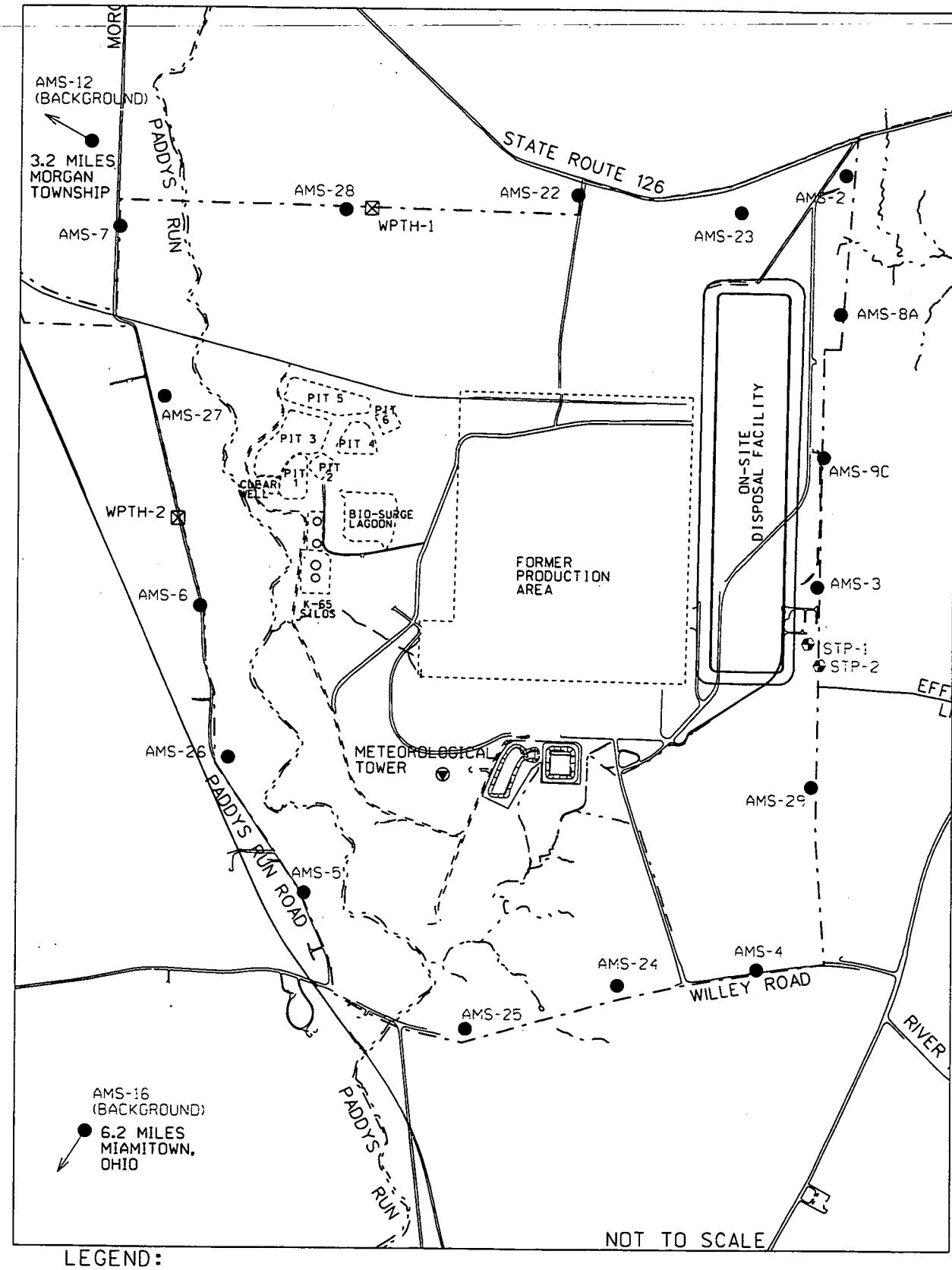
FIGURE 4-1\4-2

AIR SAMPLING ACTIVITIES

SAMPLING ACTIVITIES	Quarter/Year											
	Third Quarter/1999			Fourth Quarter/1999			First Quarter/2000			Second Quarter/1999		
	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
Radiological Particulate Monitoring:				◆	◆	◆	☒	☒	☒			
NESHAP Quarterly Composite						◆			☒			
NESHAP Stack Emissions Monitoring				◆	◆	◆	☒	☒	☒			
Radon Monitoring – Continuous Alpha Scintillation Monitors				◆	◆	◆	☒	☒	☒			
Direct Radiation (TLD) Monitoring						◆			☒			

◆ Data summarized/evaluated in this report
☒ Data summarized/evaluated in the next report

FINAL



LEGEND:

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

FINAL

FIGURE 4-3. IEMP AIR MONITORING LOCATIONS

V:/5FGP1/DGN/99OTR4/99OT4012.DGN

11-24-99

000121

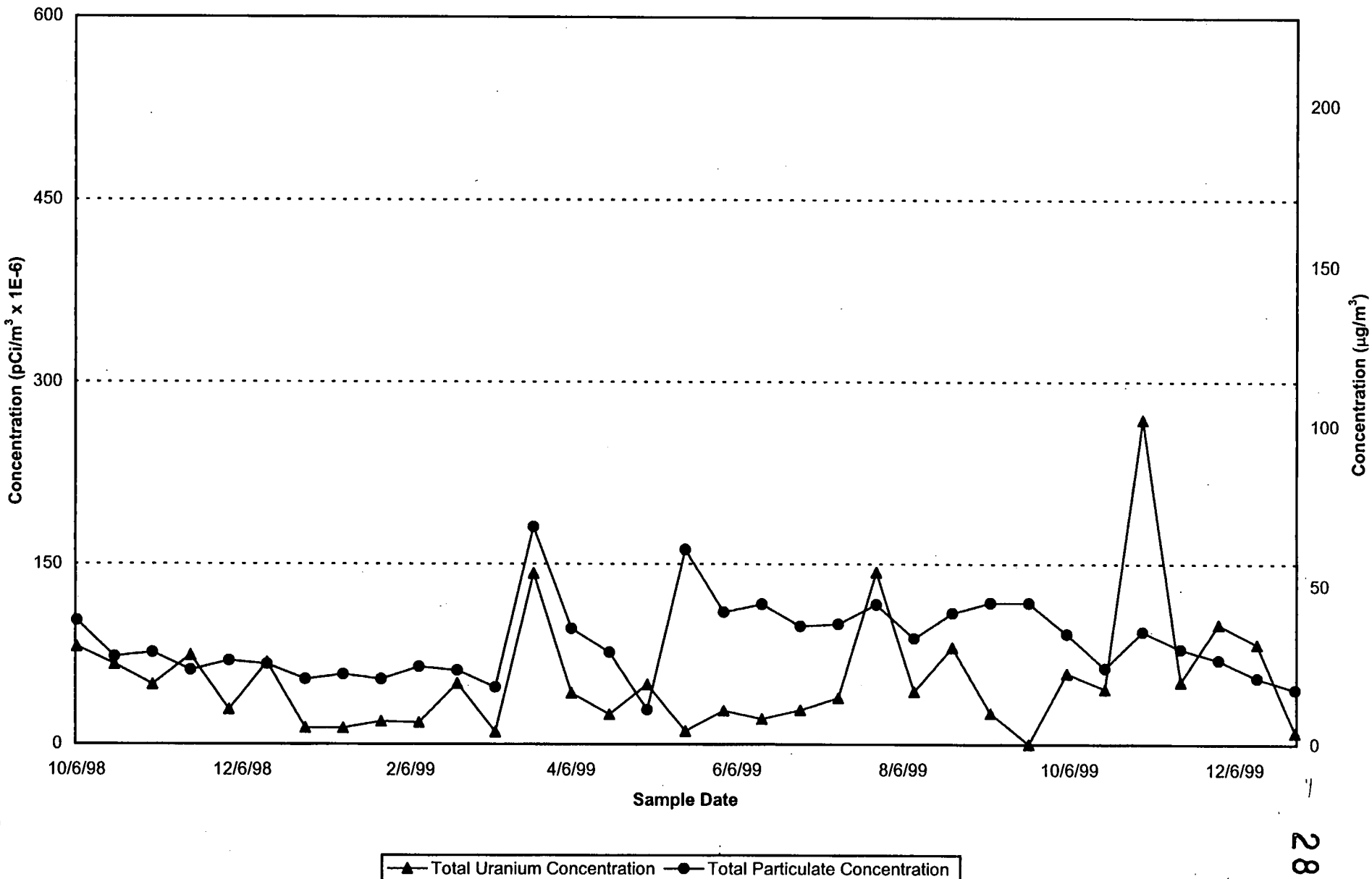


FIGURE 4-4. TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-2)

FINAL

28 72

000122

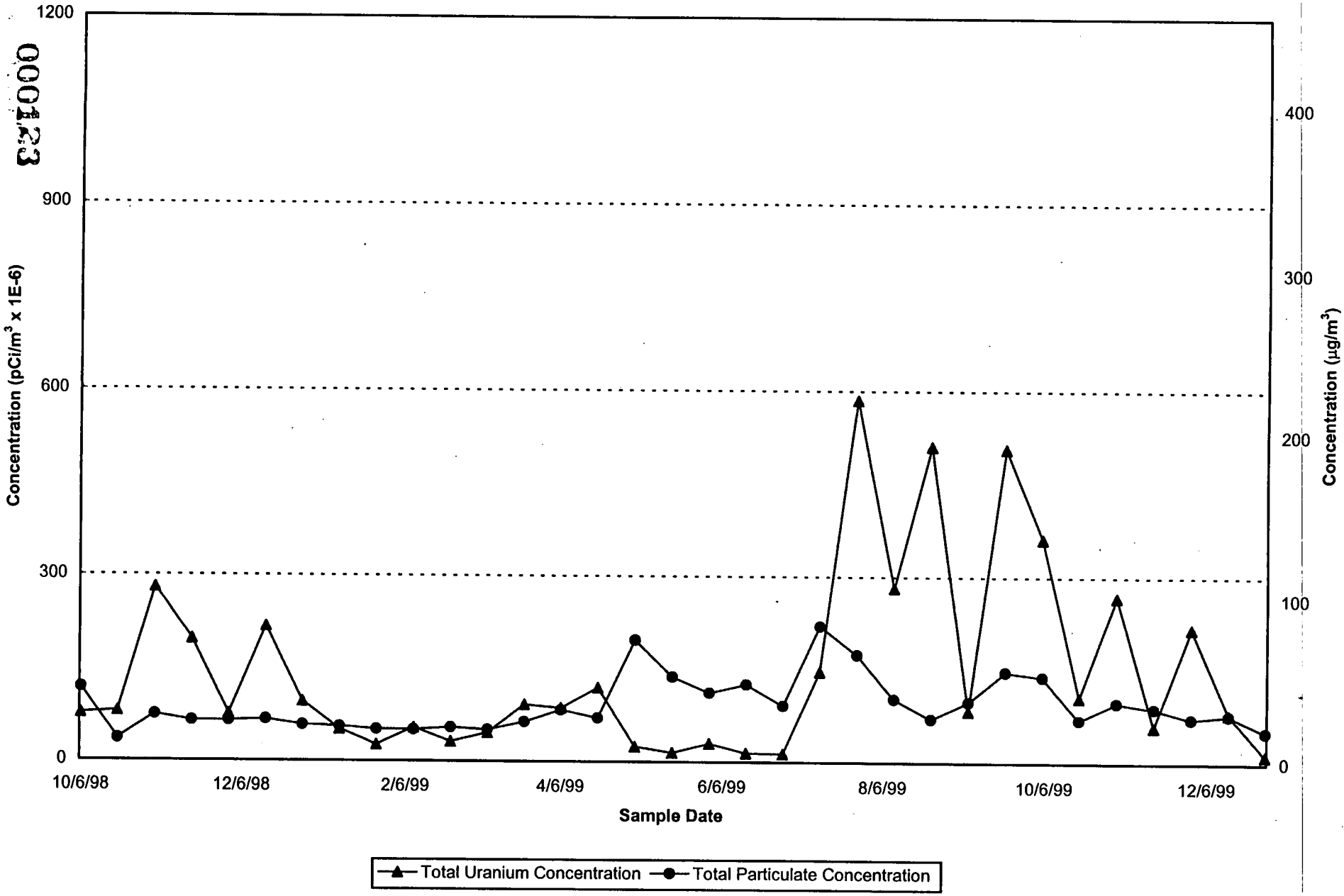


FIGURE 4-5. TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-3)

FINAL

000123

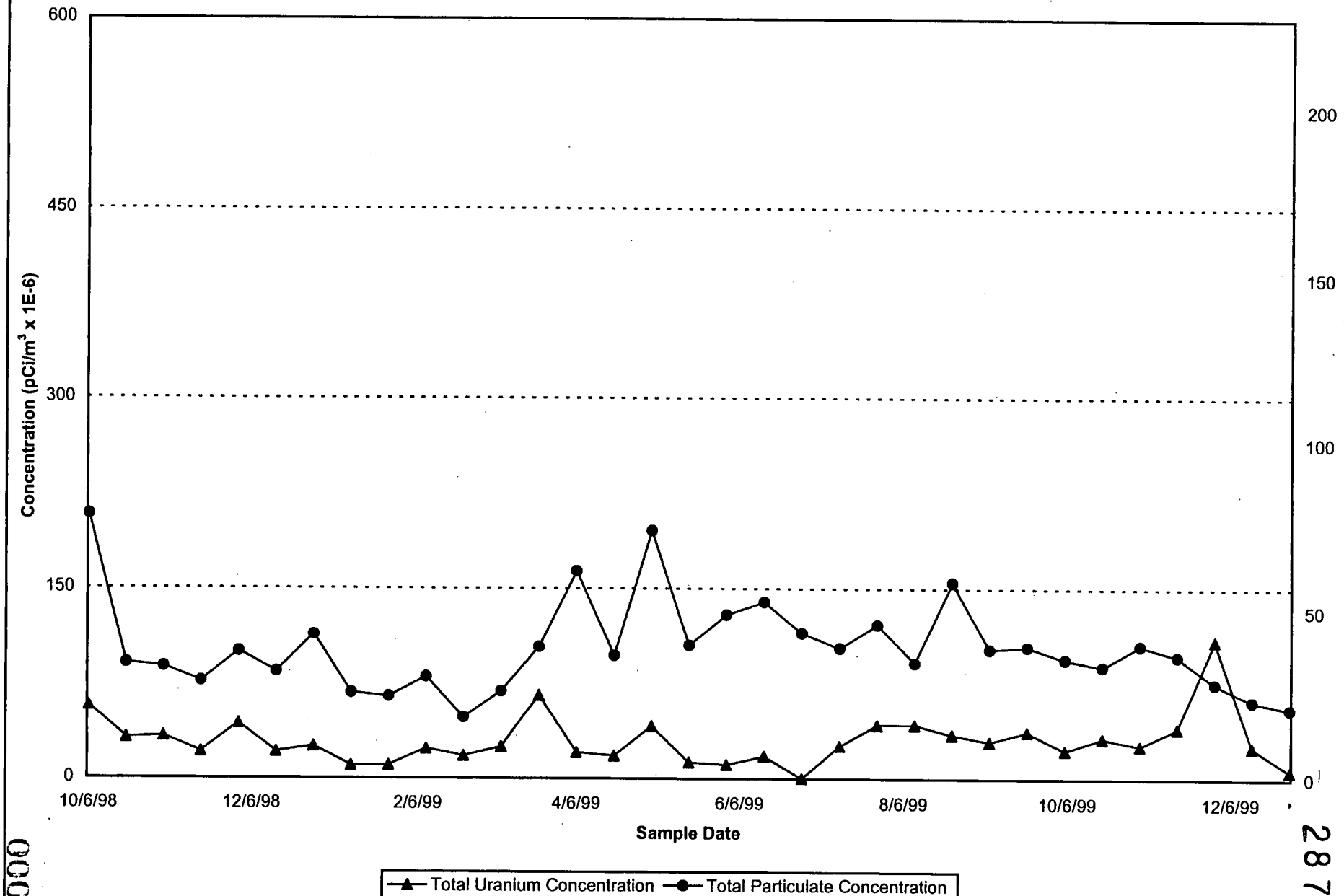


FIGURE 4-6. TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-4)

FINAL

28 872

000124

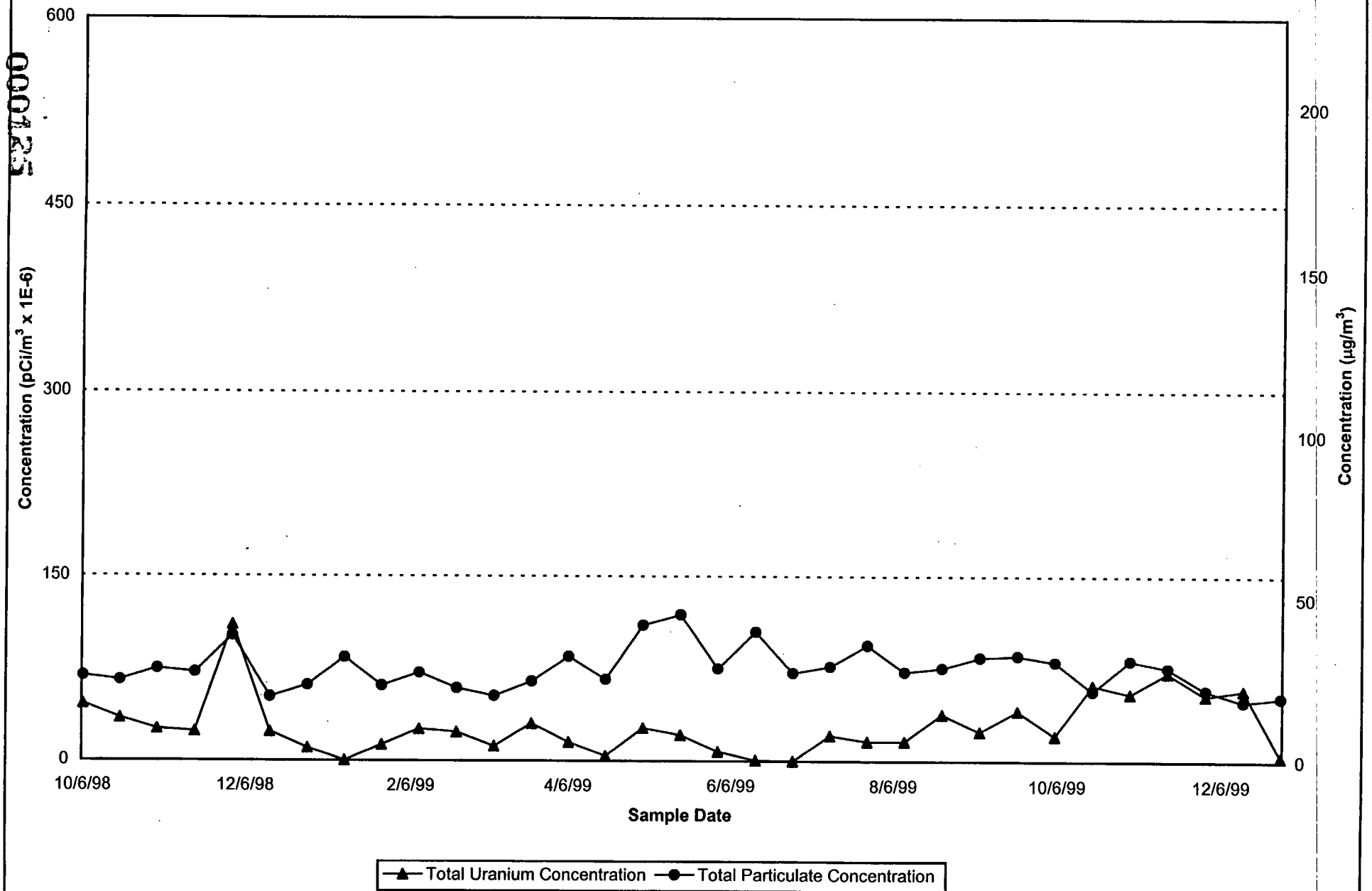


FIGURE 4-7. TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-5)

FINAL

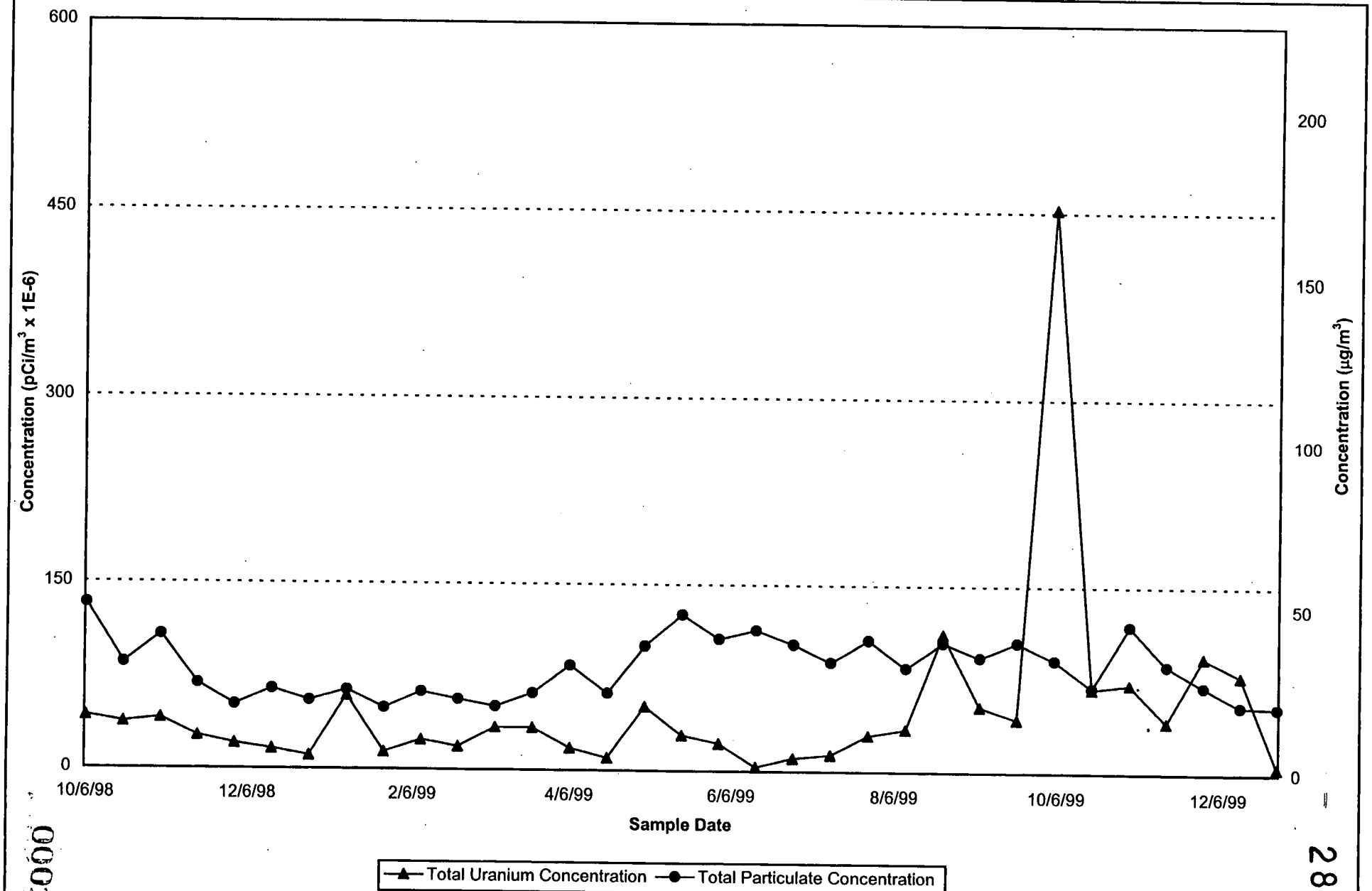


FIGURE 4-8. TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-6)

000428

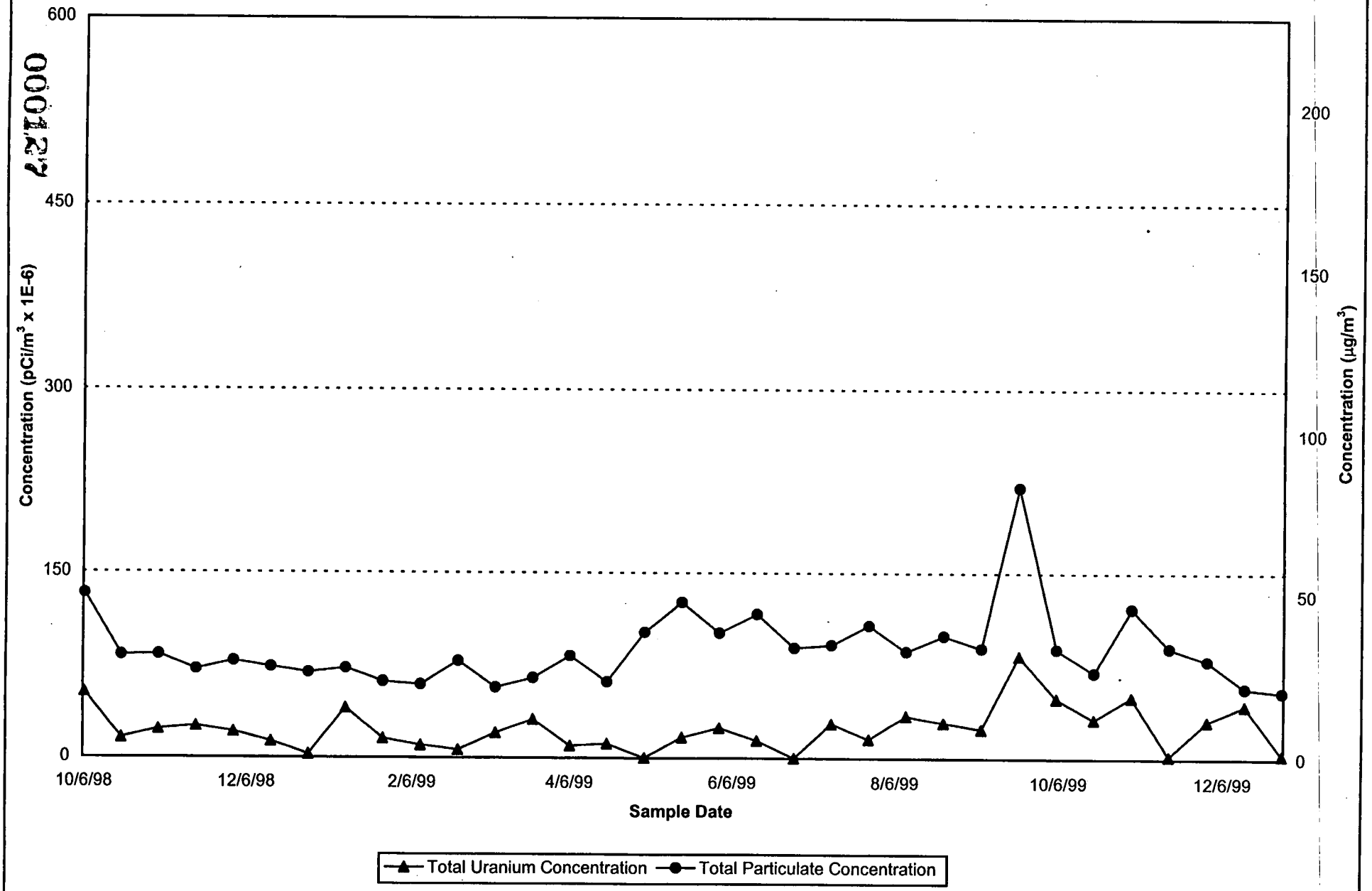


FIGURE 4-9. TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-7)

FINAL

001427

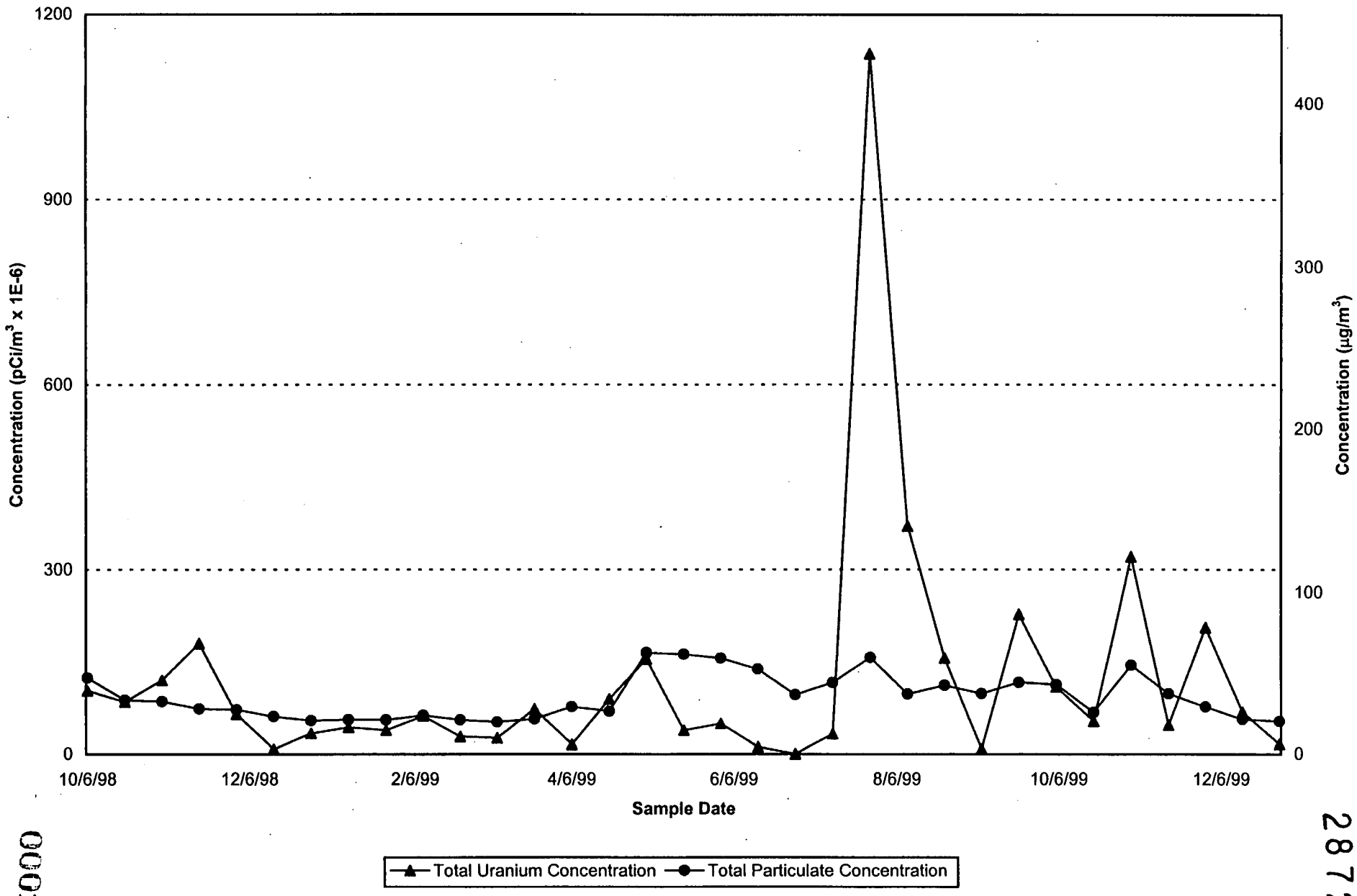


FIGURE 4-10. TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-8A)

FINAL

28 72

000428

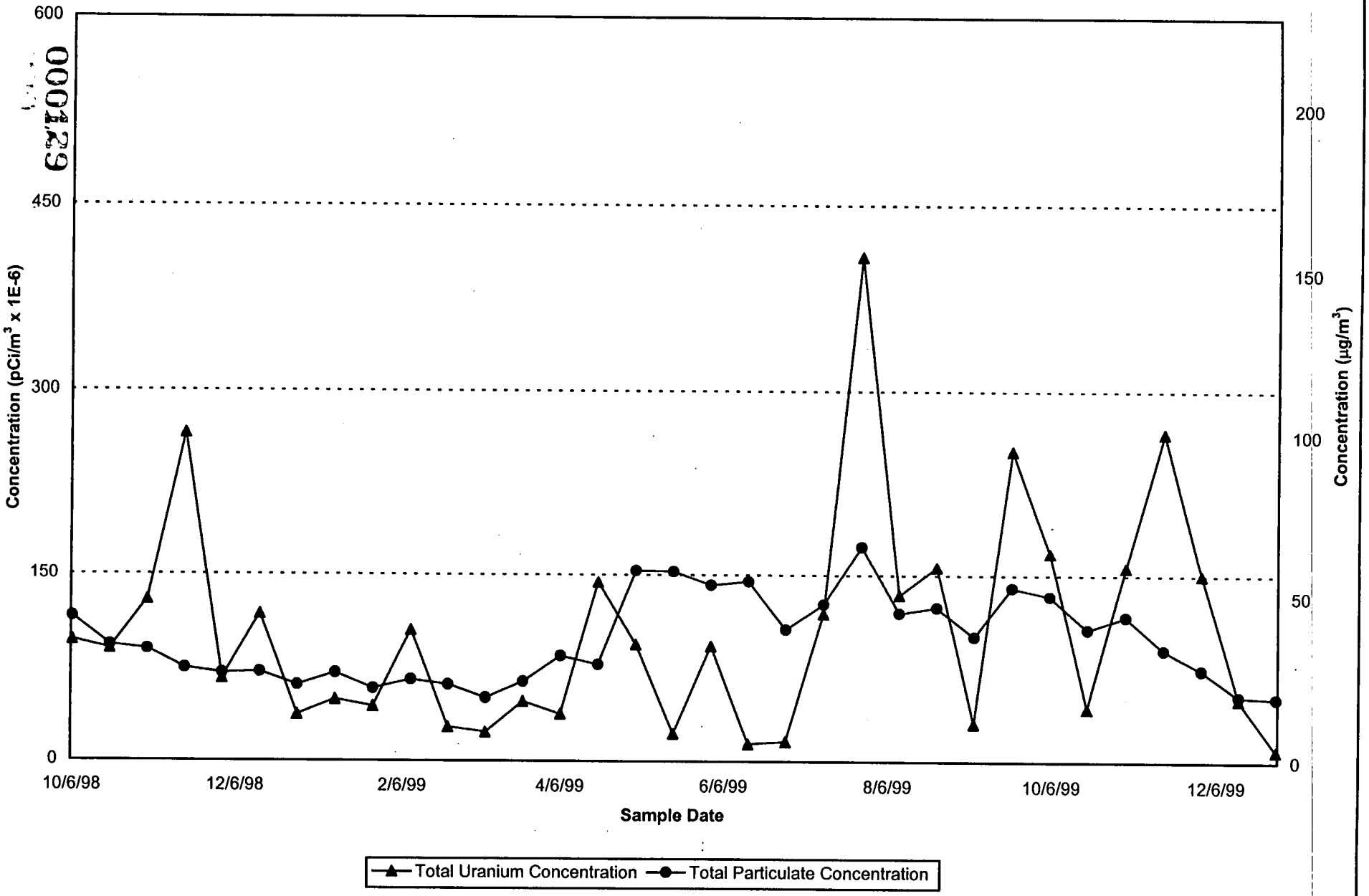


FIGURE 4-11. TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-9C)

FINAL

000429

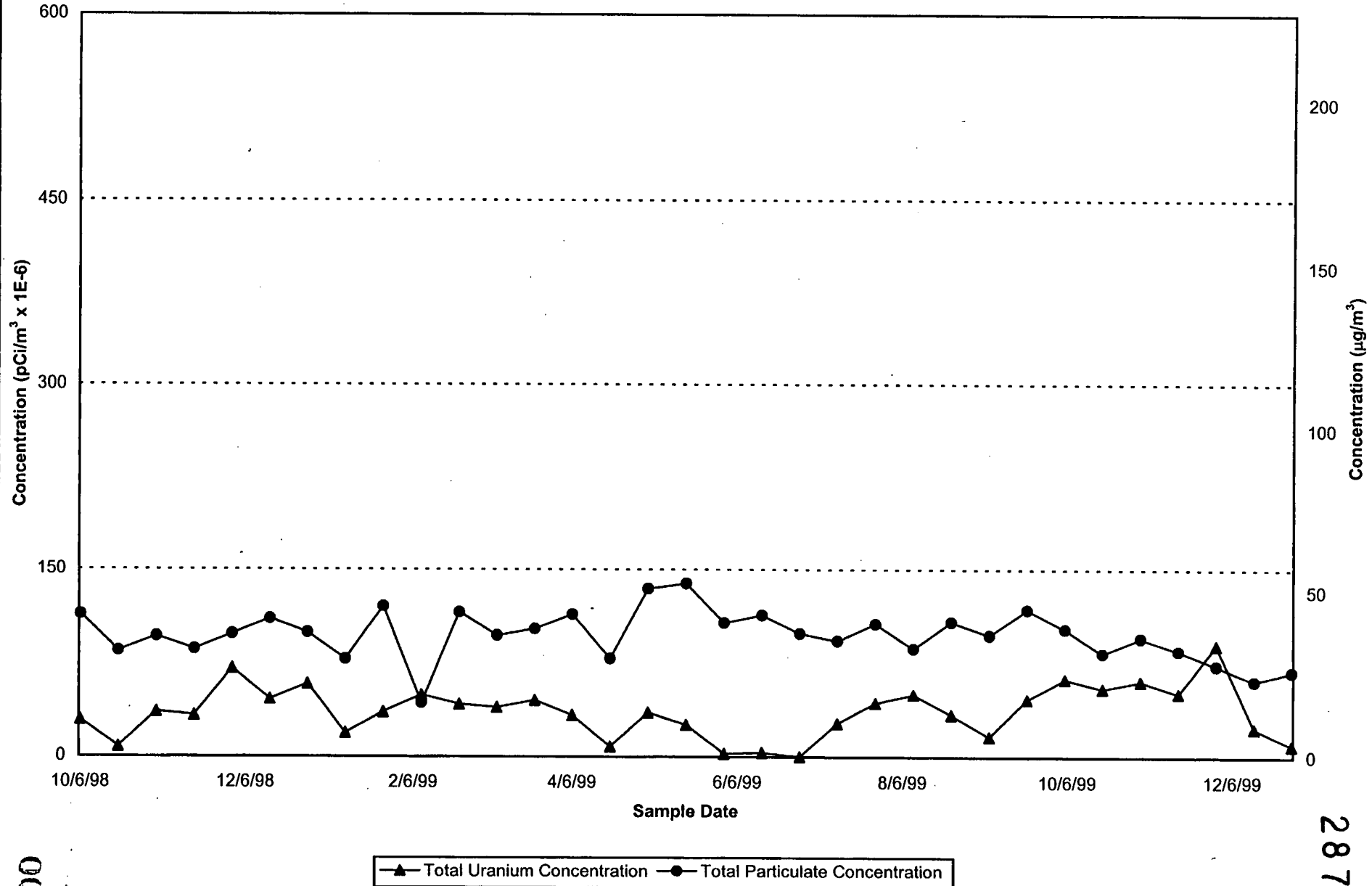


FIGURE 4-12. TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-22)

FINAL

2872

000120

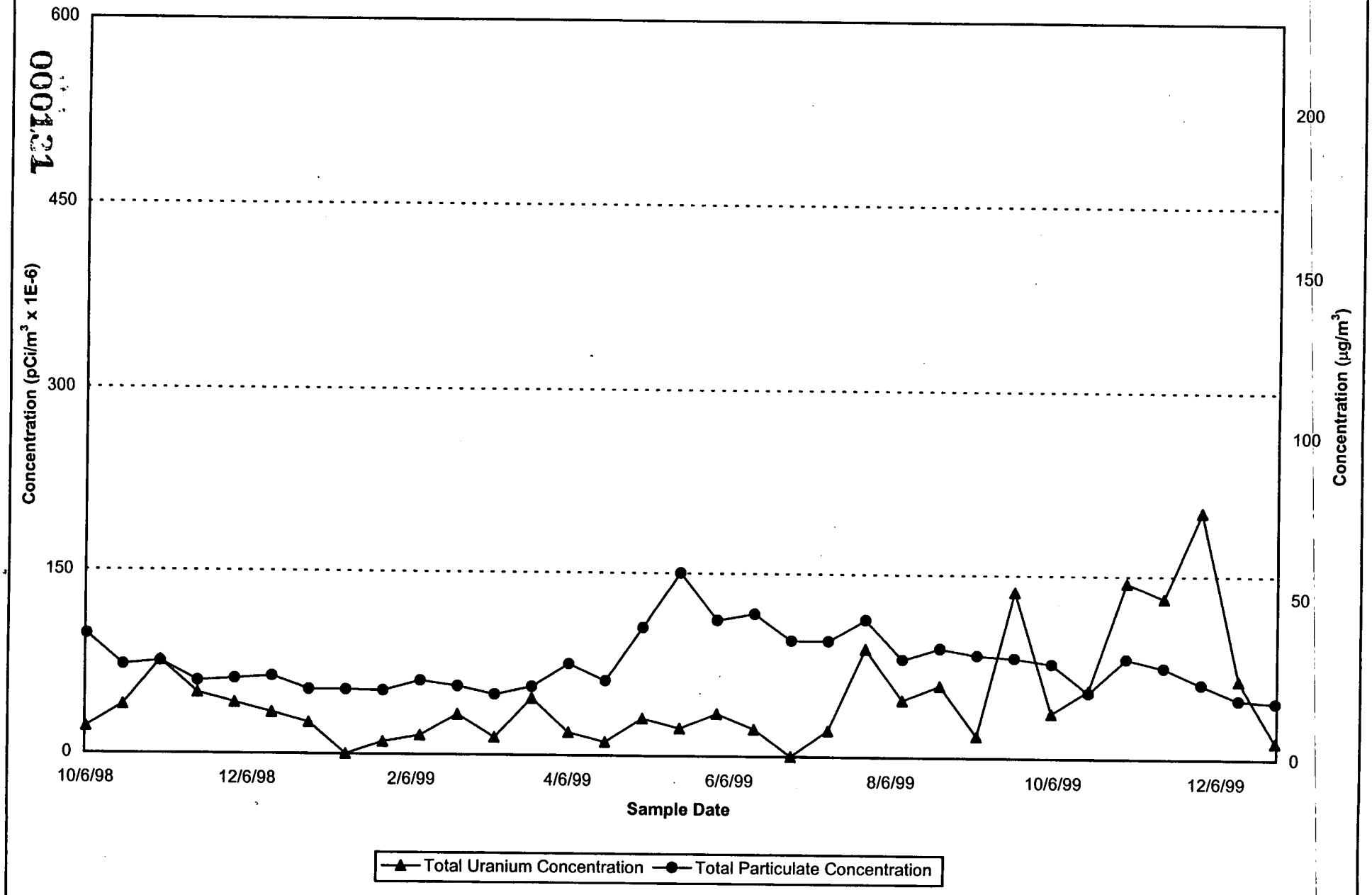


FIGURE 4-13. TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-23)

FINAL

000121

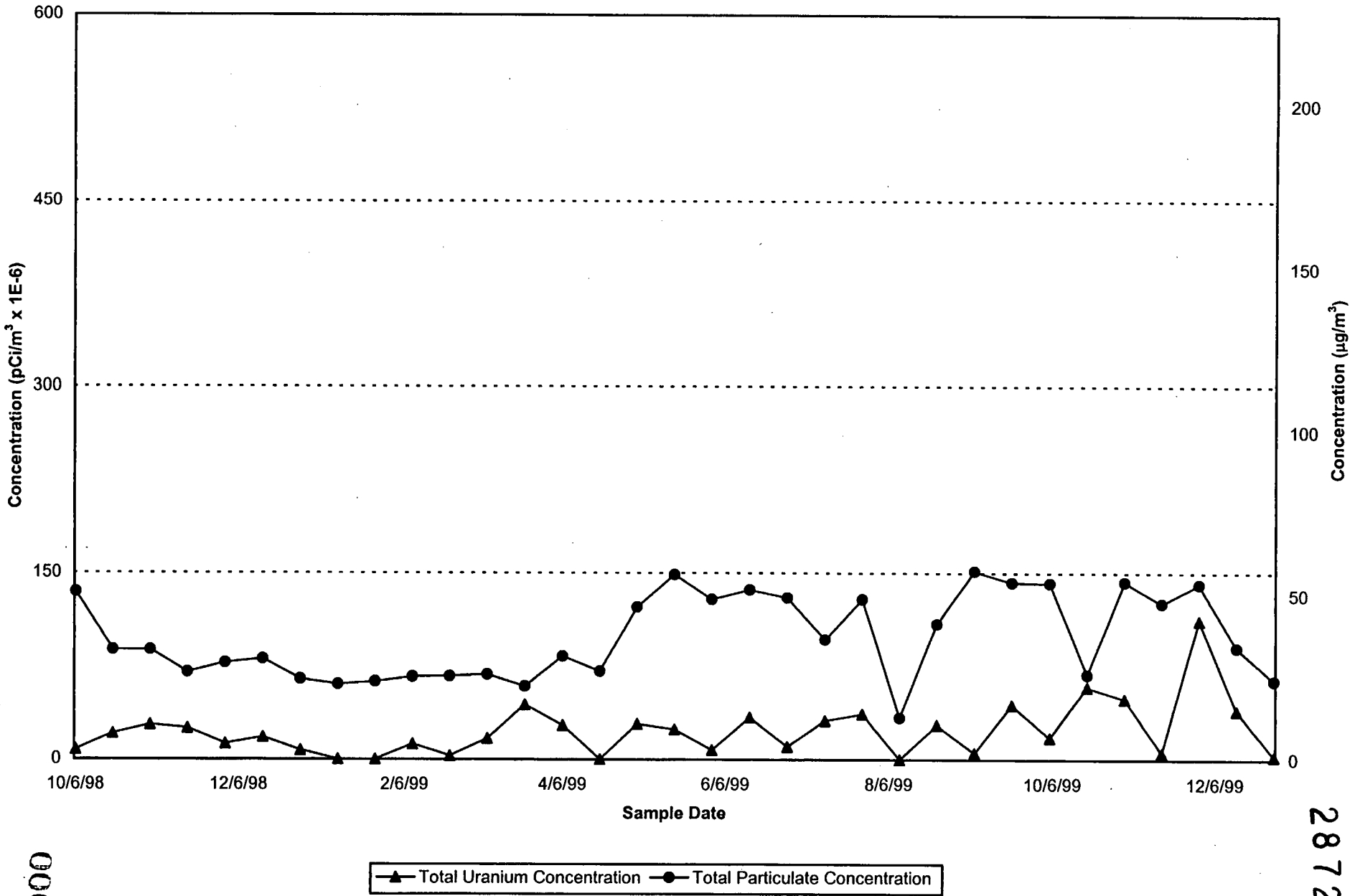


FIGURE 4-14. TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-24)

FINAL

2872

000122

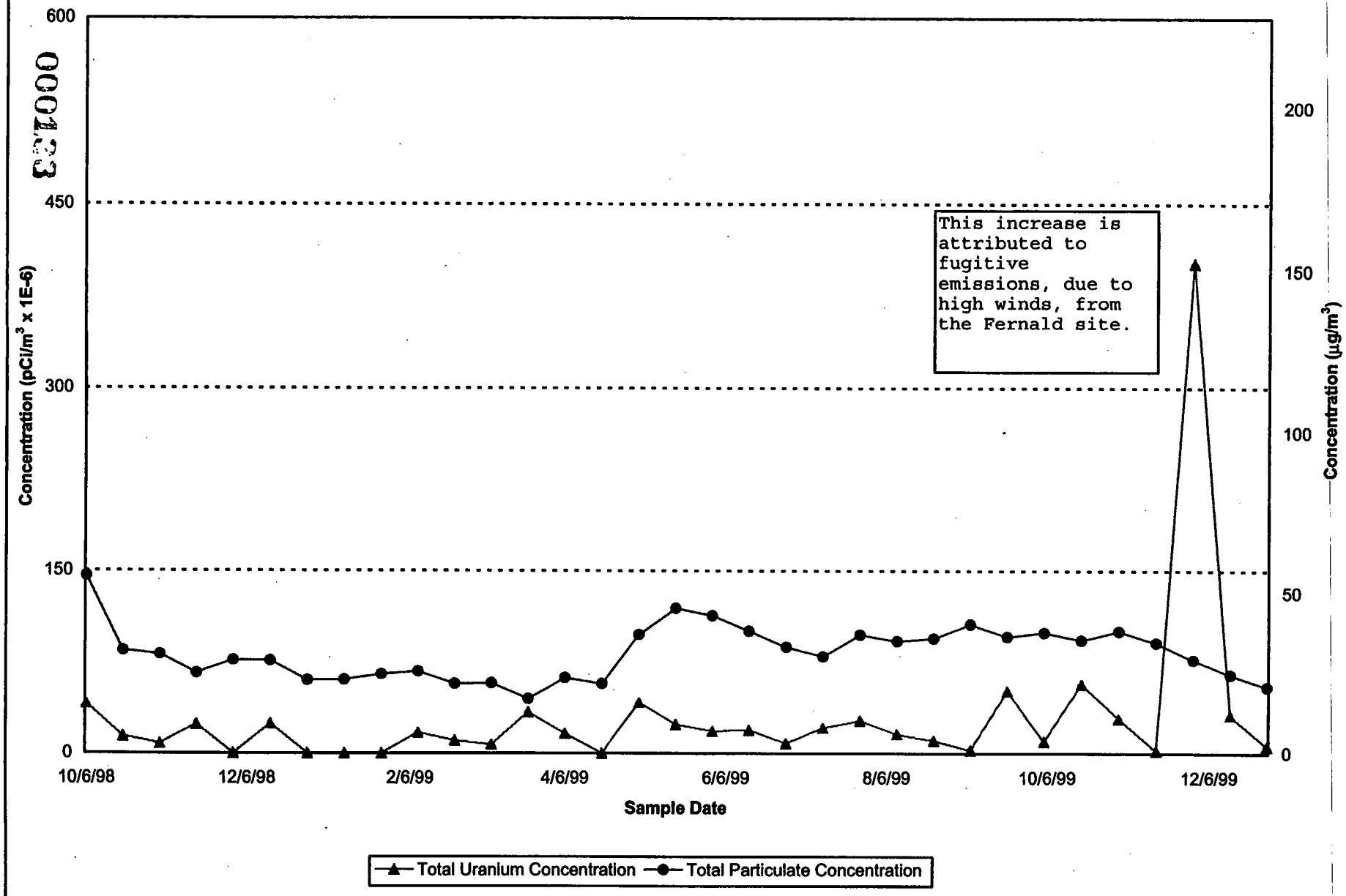


FIGURE 4-15. TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-25)

FINAL

000423

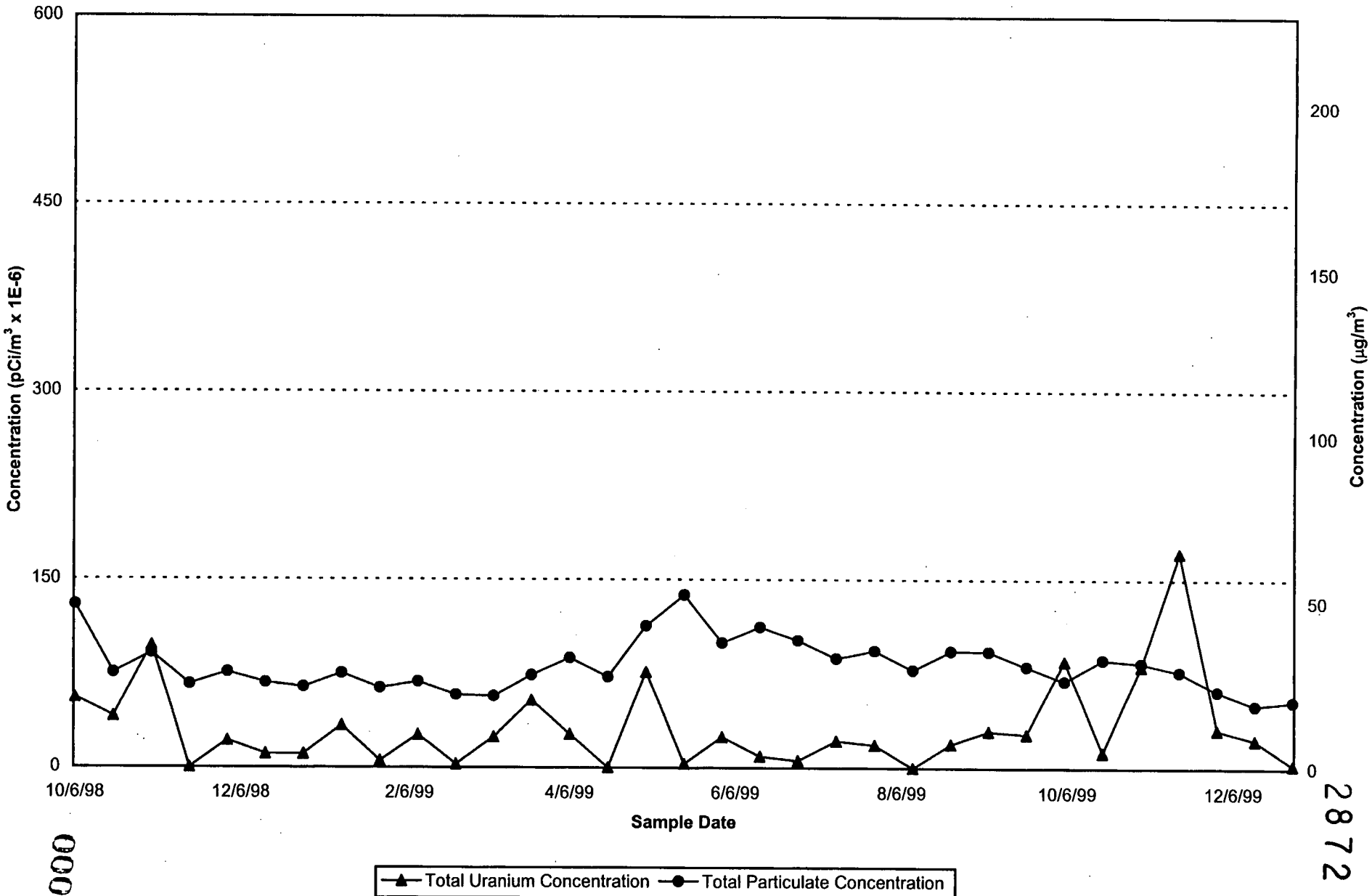


FIGURE 4-16. TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-26)

FINAL

000224

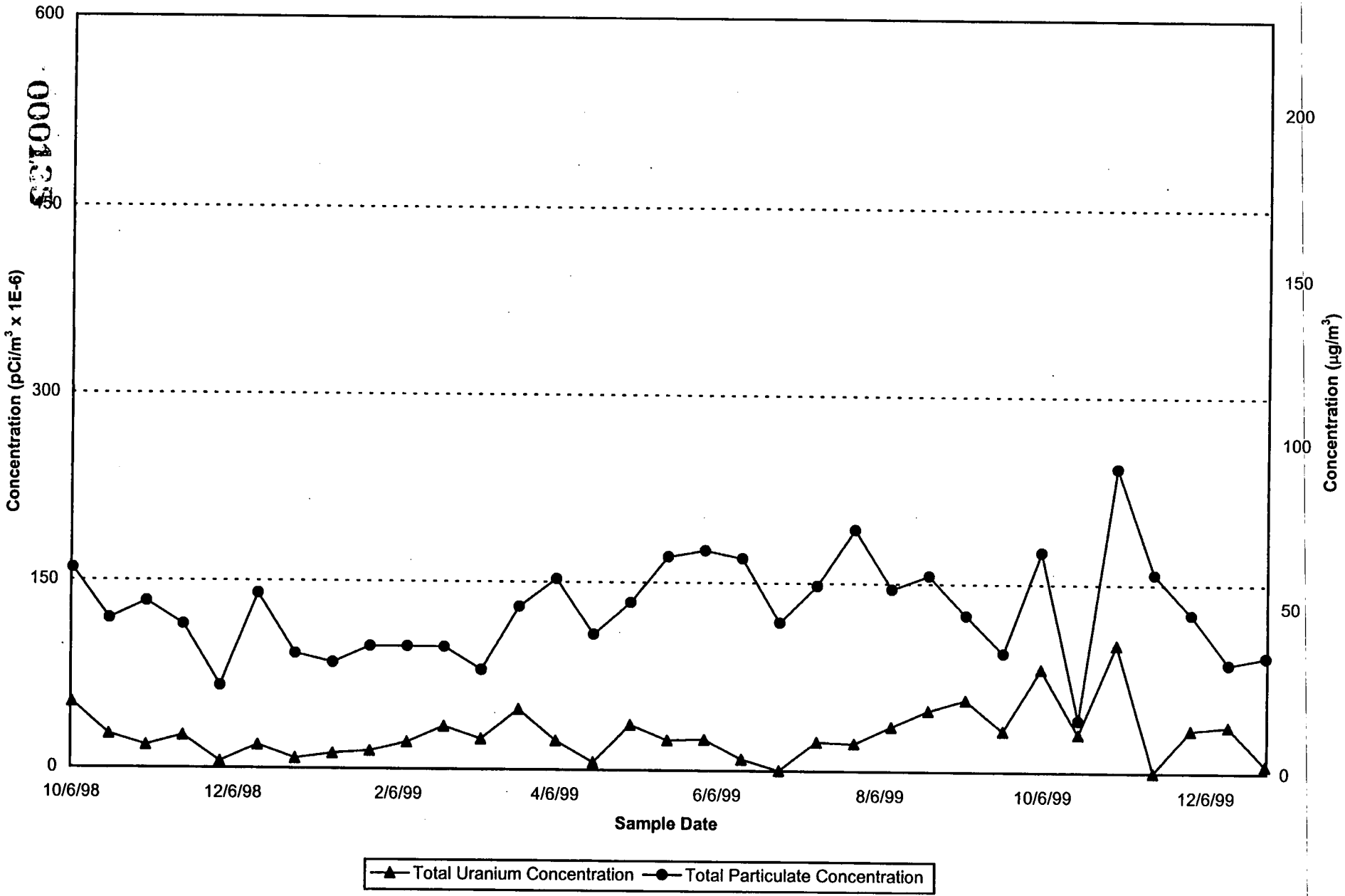


FIGURE 4-17. TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-27)

FINAL

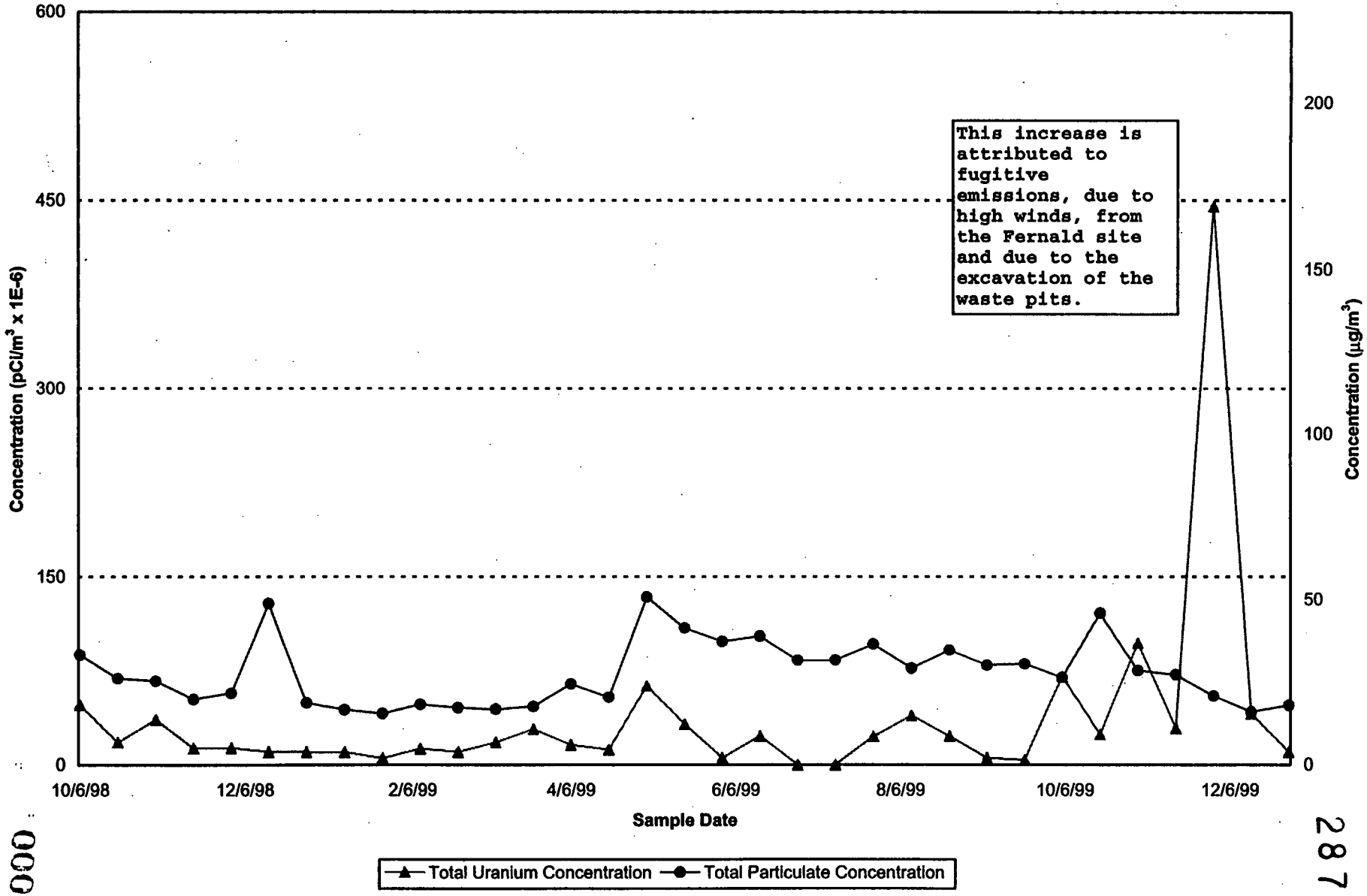


FIGURE 4-18. TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-28)

FINAL

000126

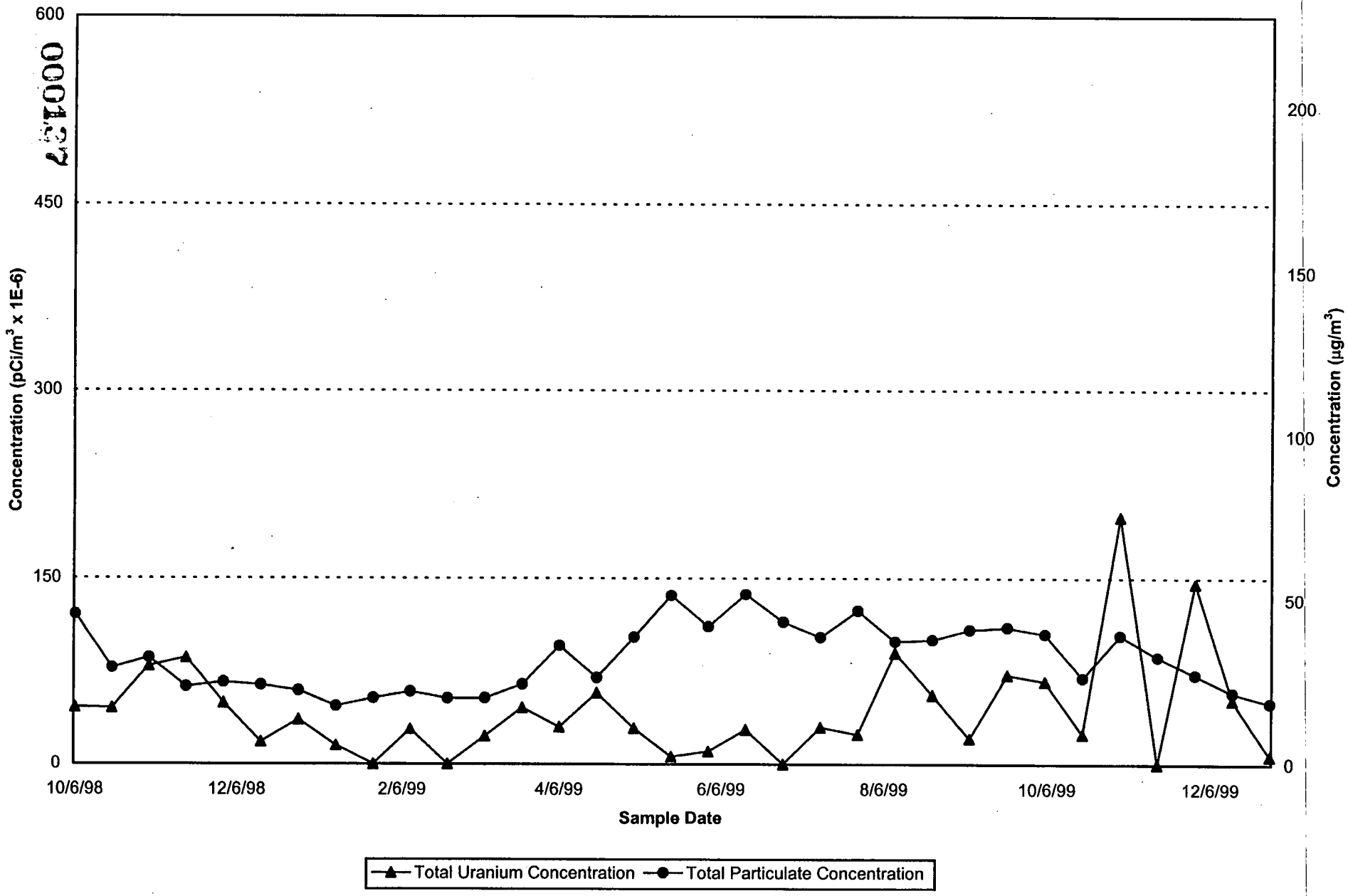


FIGURE 4-19. TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-29)

FINAL

000127

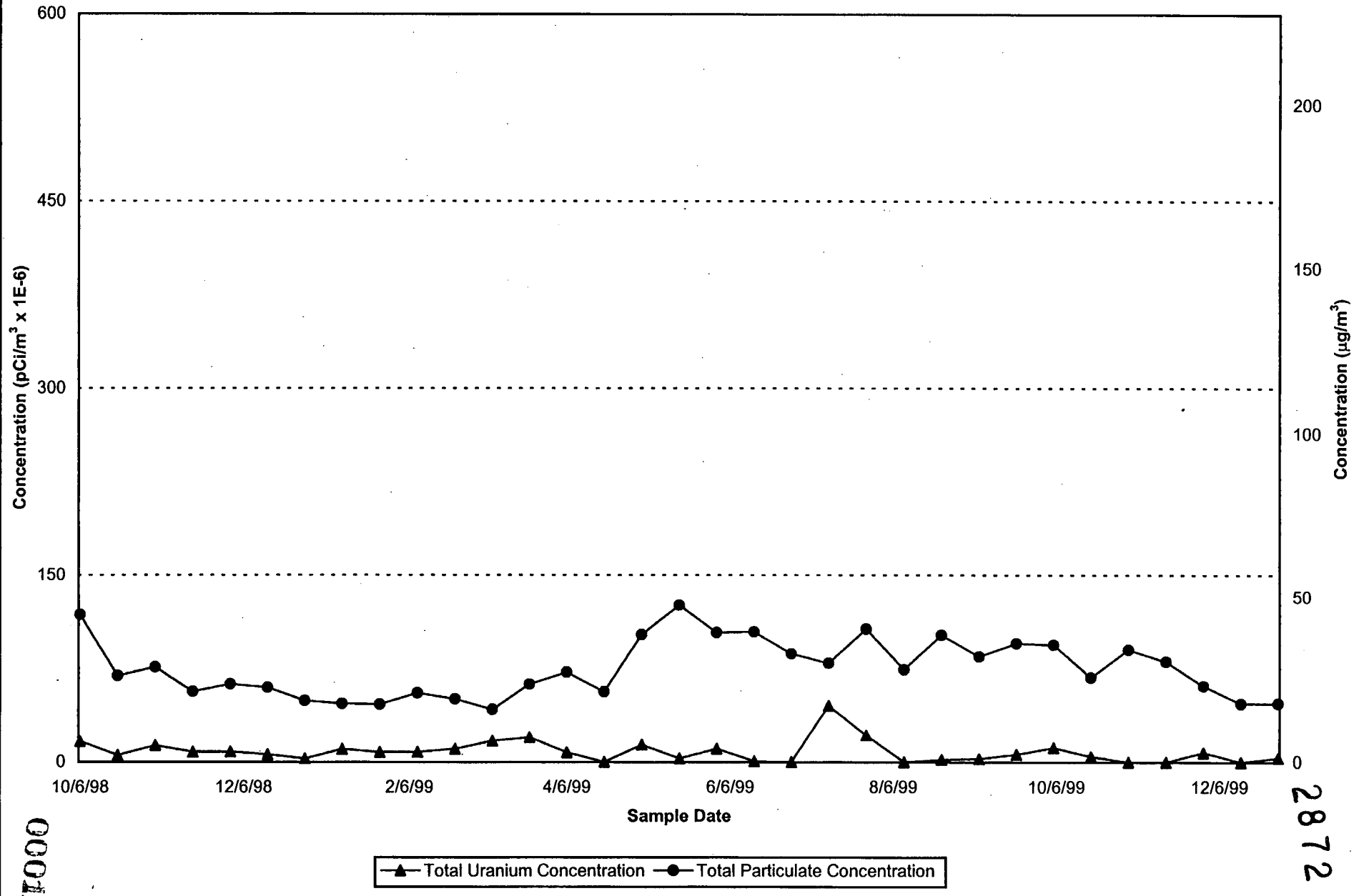


FIGURE 4-20. TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-12)

FINAL

000128

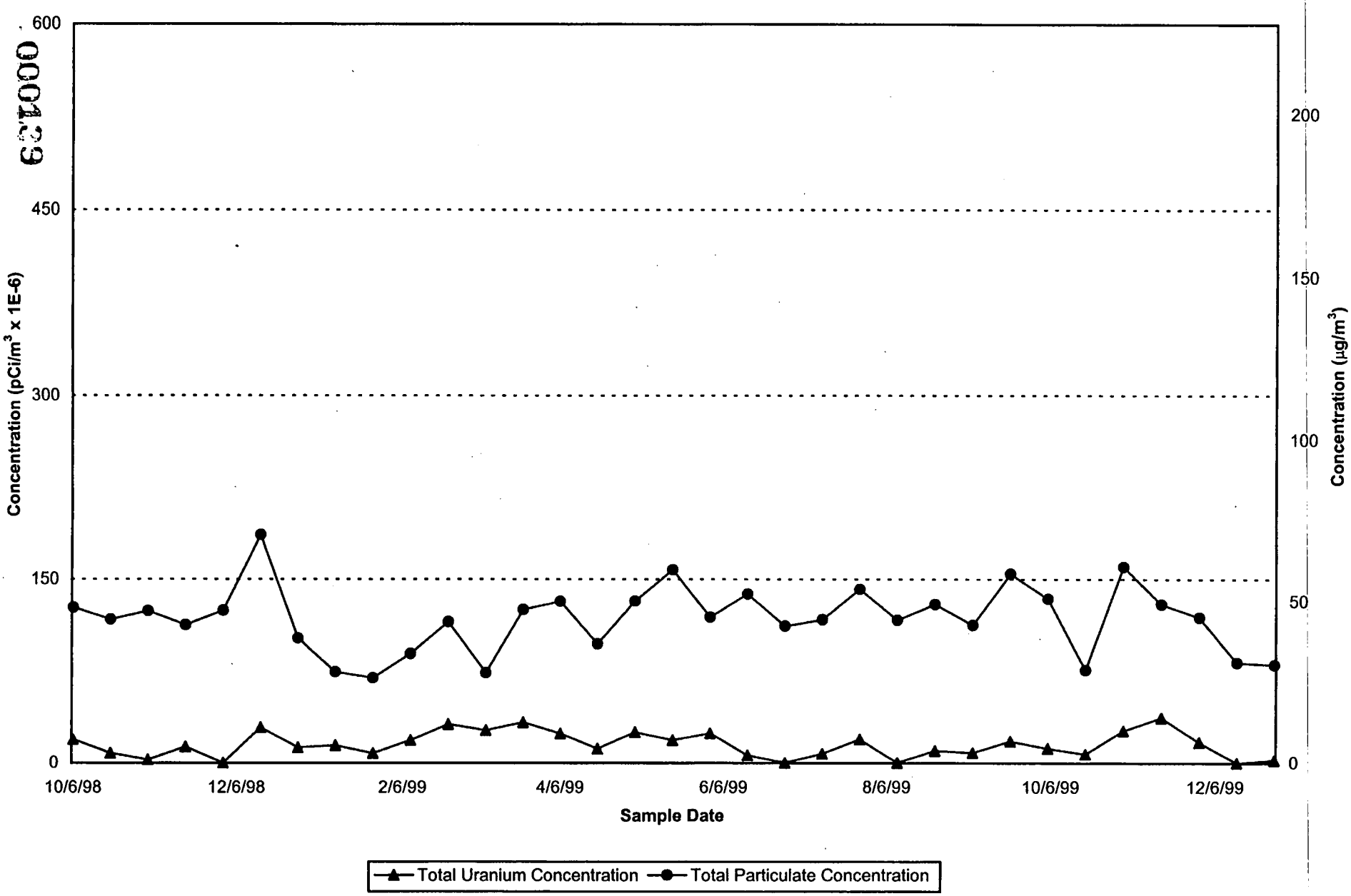


FIGURE 4-21. TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (AMS-16)

FINAL

000129

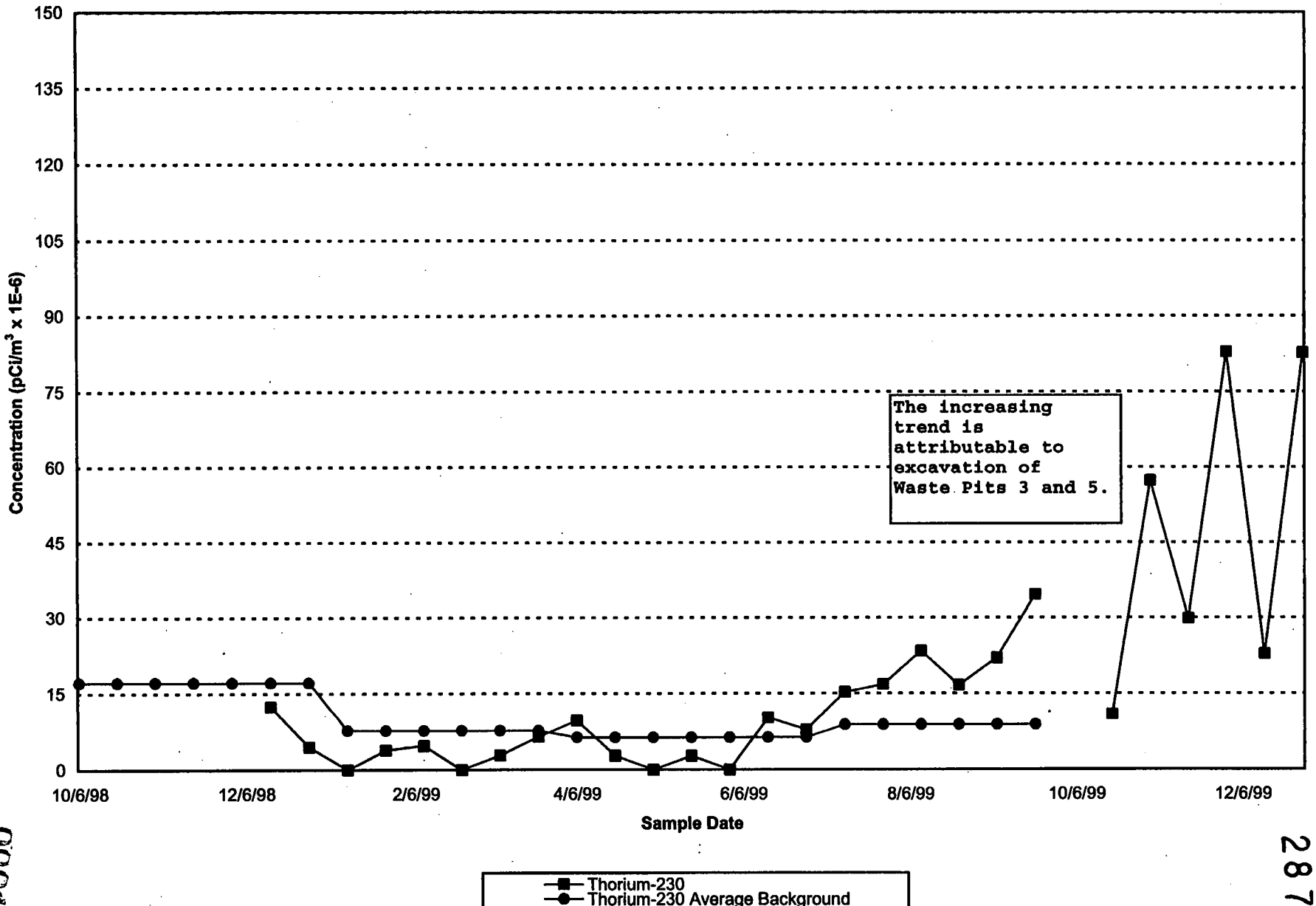


FIGURE 4-22. THORIUM-230 CONCENTRATIONS IN AIR (WPTH-1)

FINAL

2872

000140

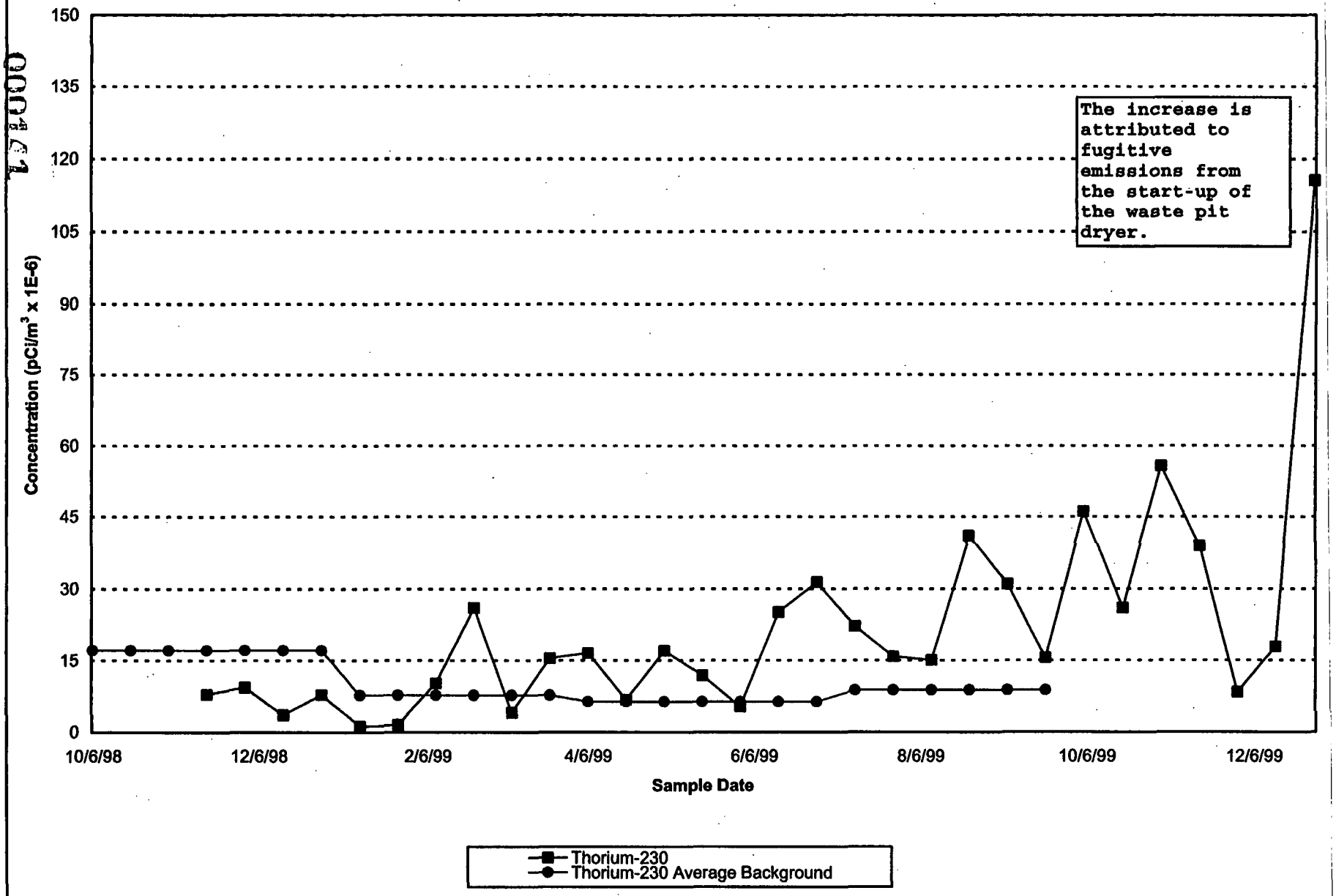


FIGURE 4-23. THORIUM-230 CONCENTRATIONS IN AIR (WPTH-2)

FINAL

000471

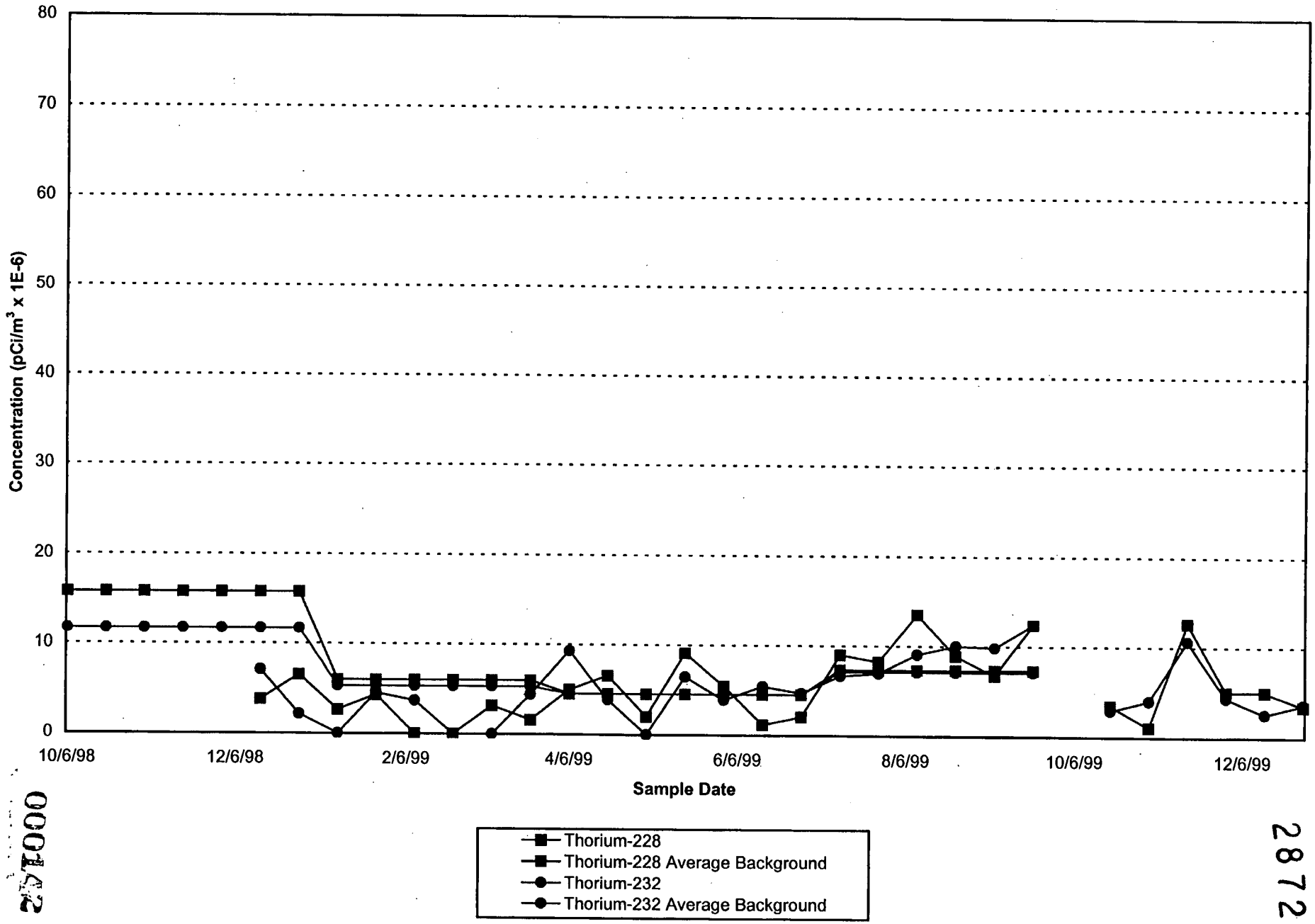


FIGURE 4-24. THORIUM-228 AND THORIUM-232 CONCENTRATIONS IN AIR (WPTH-1)

FINAL

2872

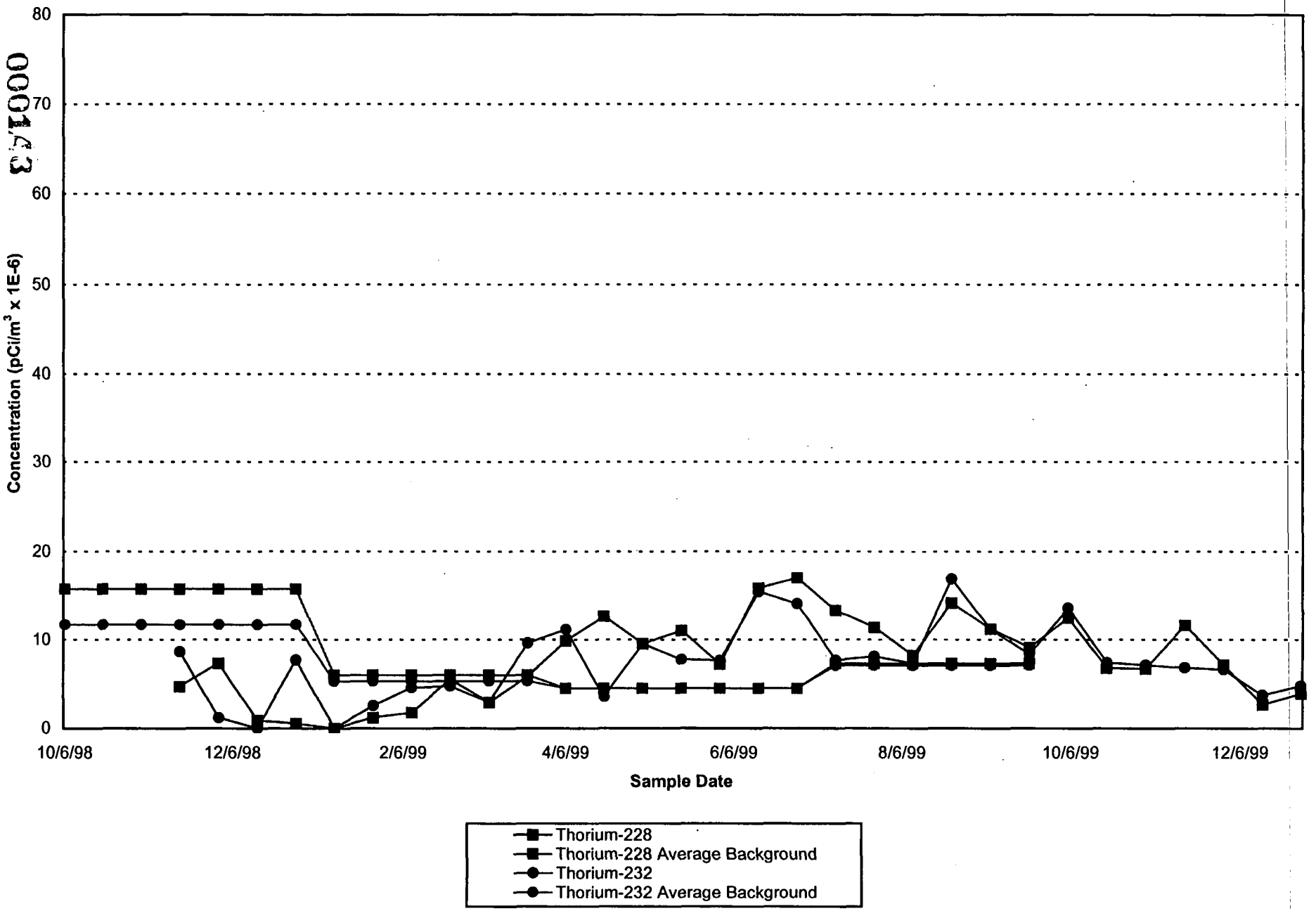


FIGURE 4-25. THORIUM-228 AND THORIUM-232 CONCENTRATIONS IN AIR (WPTH-2)

FINAL

000143

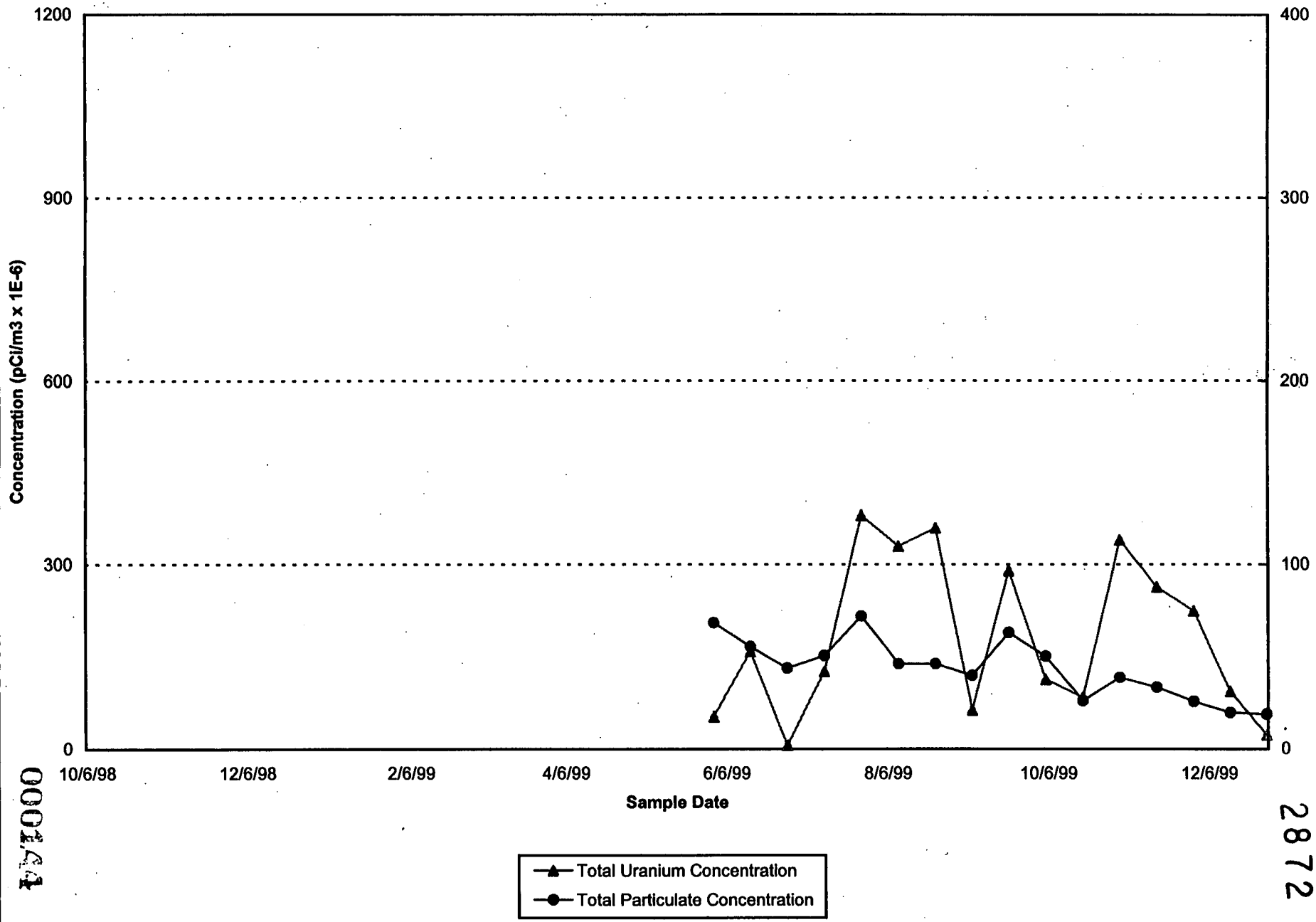


FIGURE 4-26. TOTAL URANIUM AND PARTICULATE CONCENTRATIONS IN AIR (STP-2)

FINAL

000141

2872

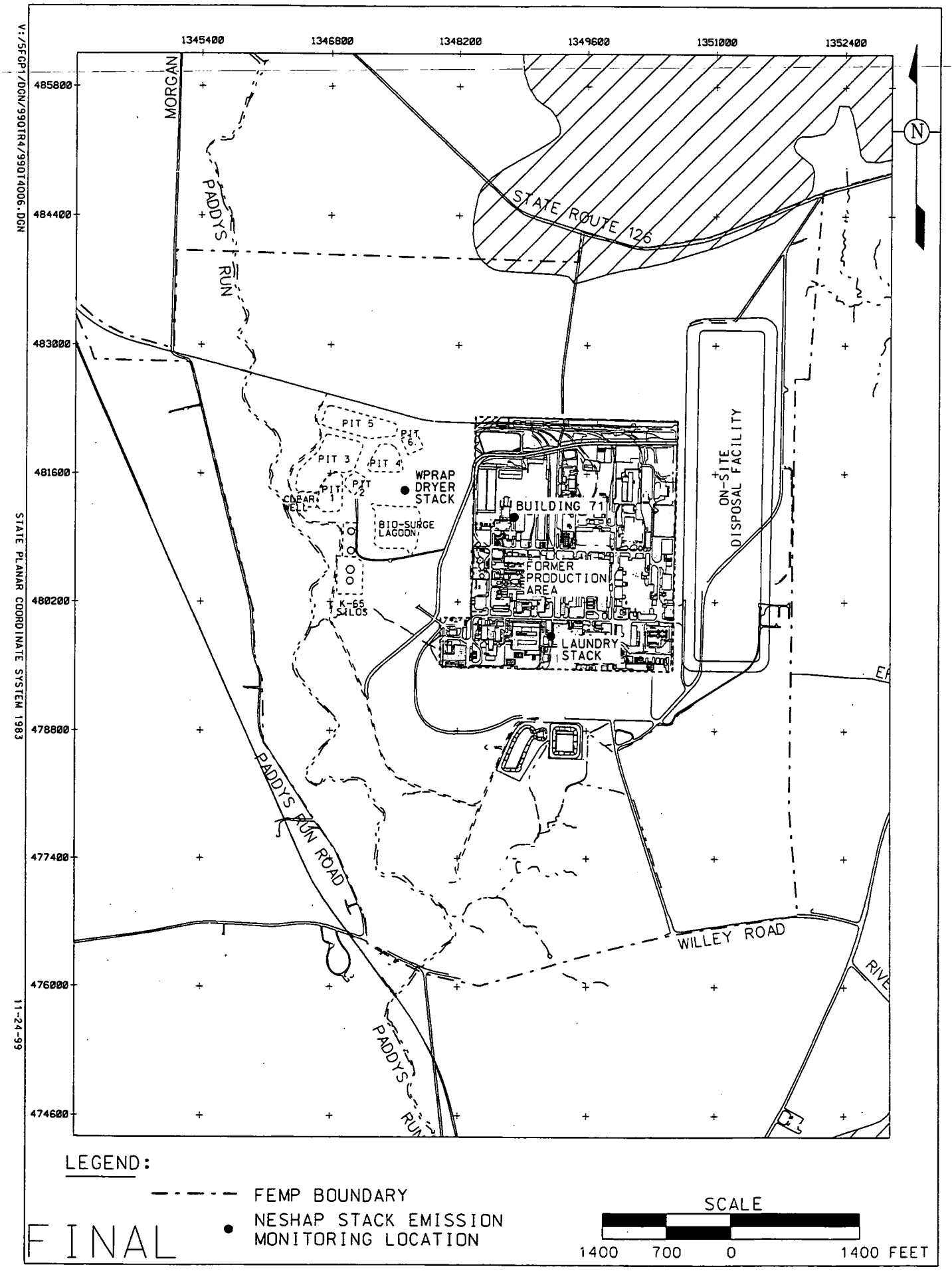


FIGURE 4-27. NESHAP STACK EMISSION MONITORING LOCATIONS

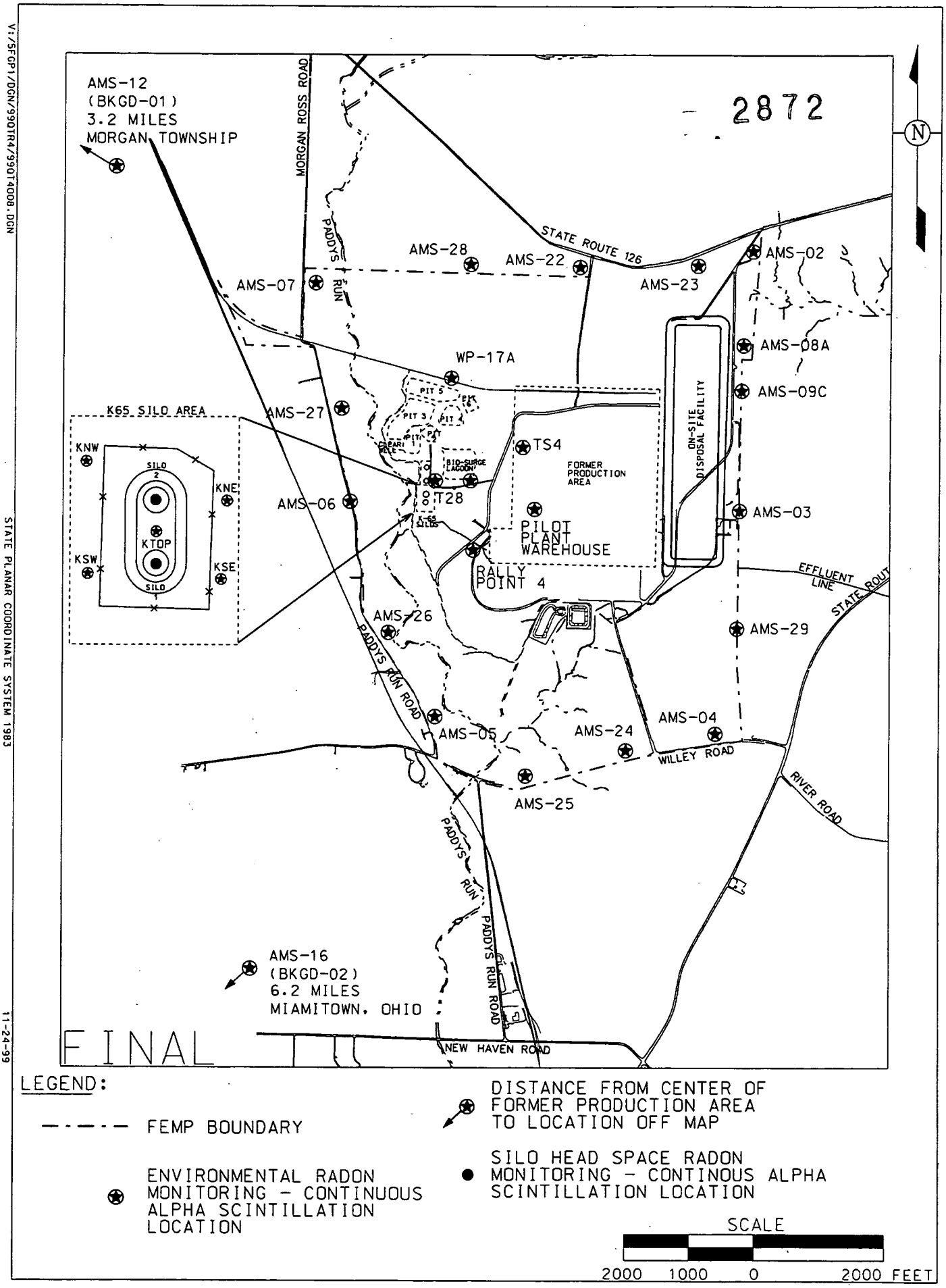
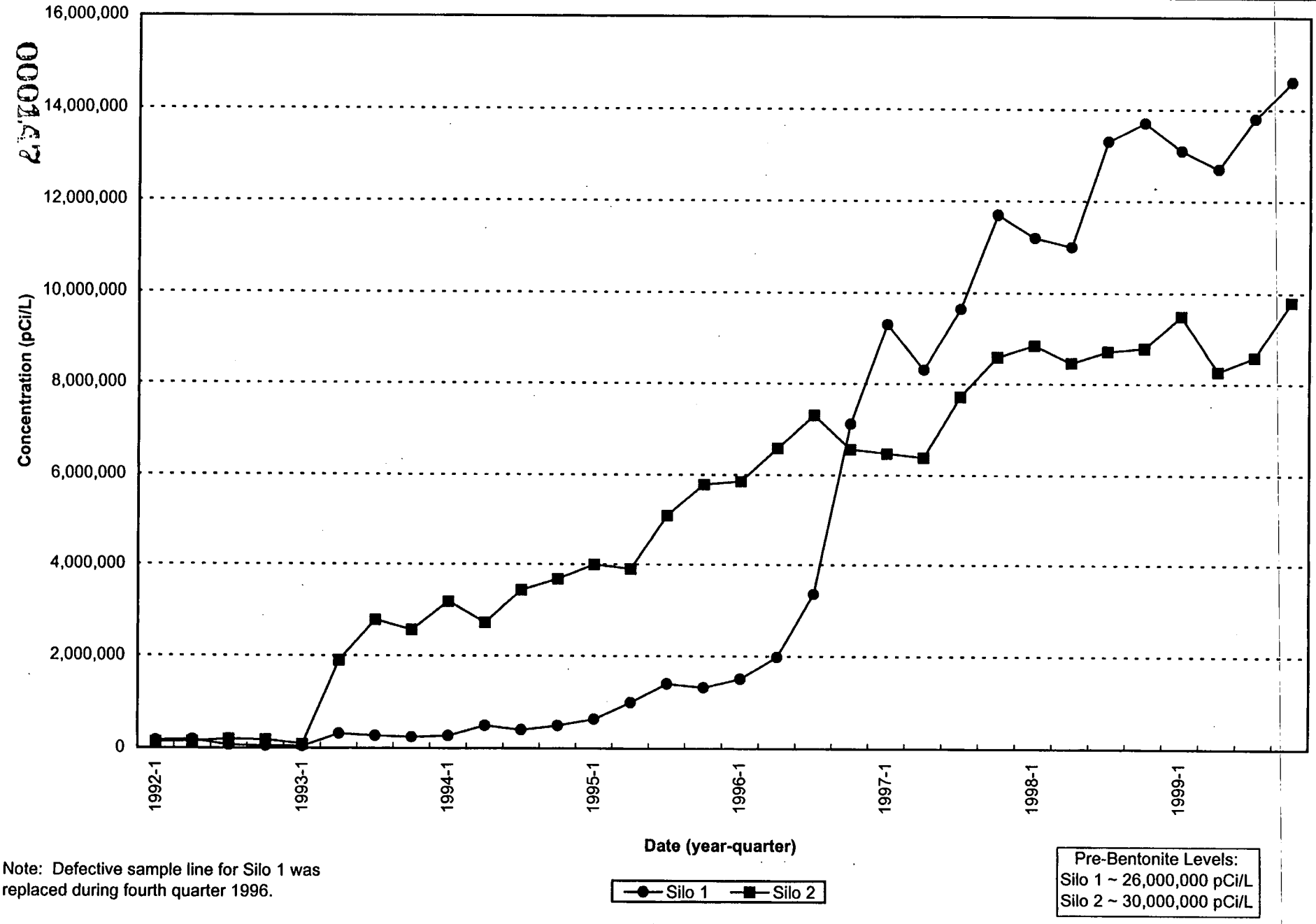


FIGURE 4-28. RADON MONITORING - CONTINOUS ALPHA SCINTILLATION LOCATIONS

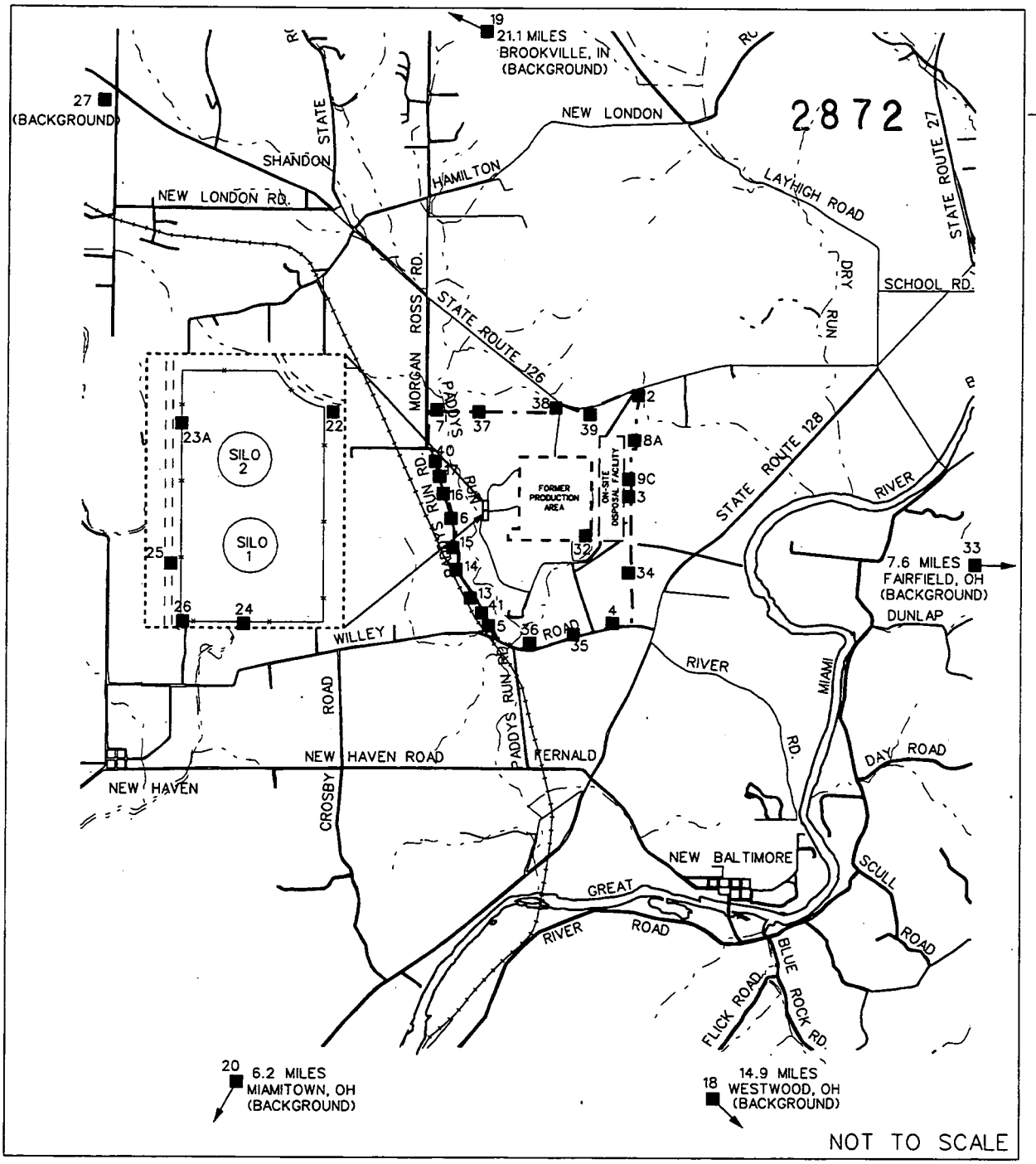


Note: Defective sample line for Silo 1 was replaced during fourth quarter 1996.

FIGURE 4-29. QUARTERLY K-65 SILO HEAD SPACE RADON CONCENTRATIONS, 1992 - 1999

FINAL

000427



LEGEND:

DISTANCE FROM CENTER OF FORMER PRODUCTION AREA TO SAMPLE LOCATIONS OFF MAP

FEMP BOUNDARY

DIRECT RADIATION (TLD) MONITORING LOCATION

FINAL

000148

FIGURE 4-30. DIRECT RADIATION (THERMOLUMINESCENT DOSIMETER) MONITORING LOCATIONS

V:/SFGP/DGN/999TR4/999T4007.DGN

11-24-99

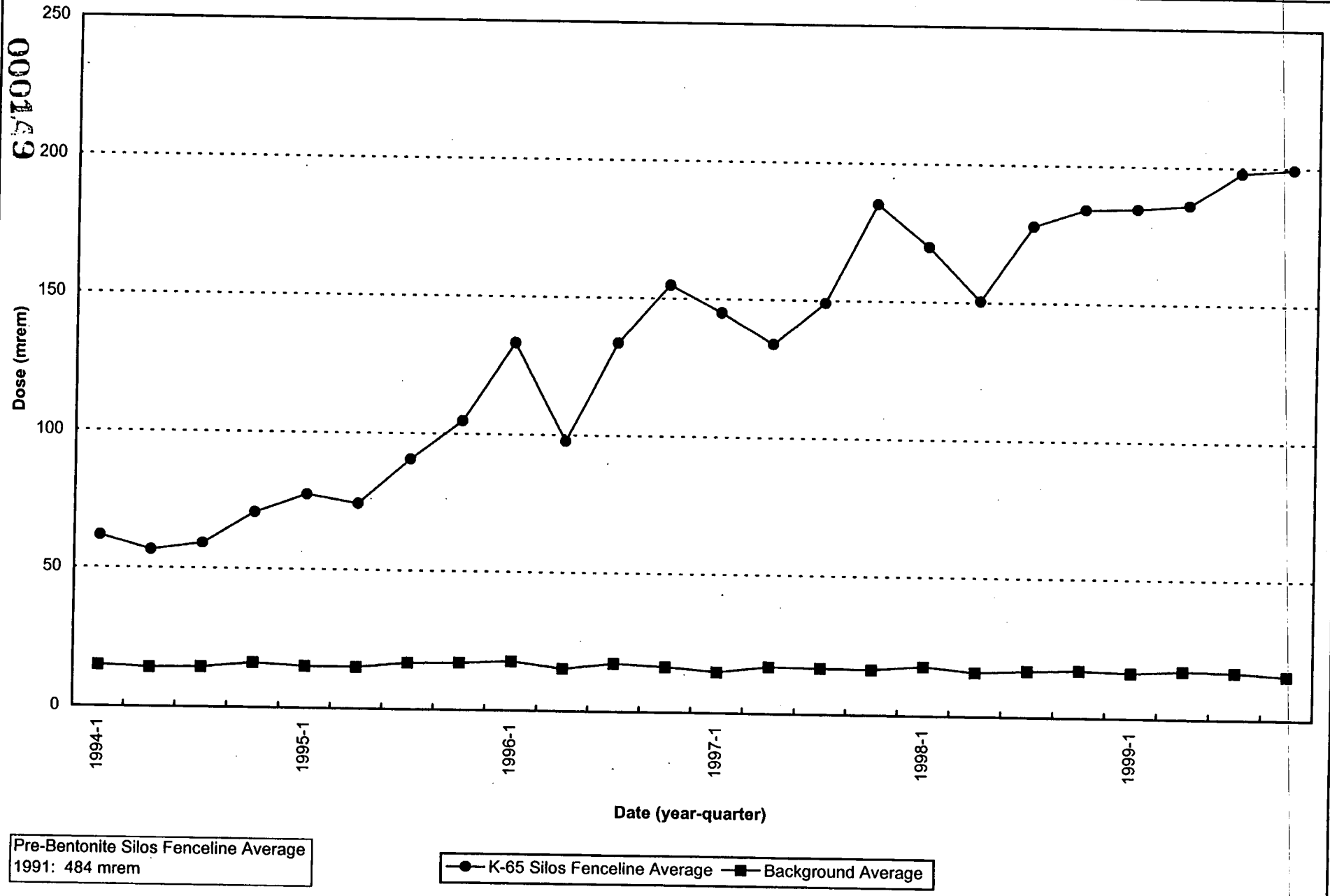


FIGURE 4-31. QUARTERLY DIRECT RADIATION (TLD) MEASUREMENTS, 1994 - 1999
(K-65 SILOS FENCELINE AVERAGE VERSUS BACKGROUND AVERAGE)

FINAL

000149

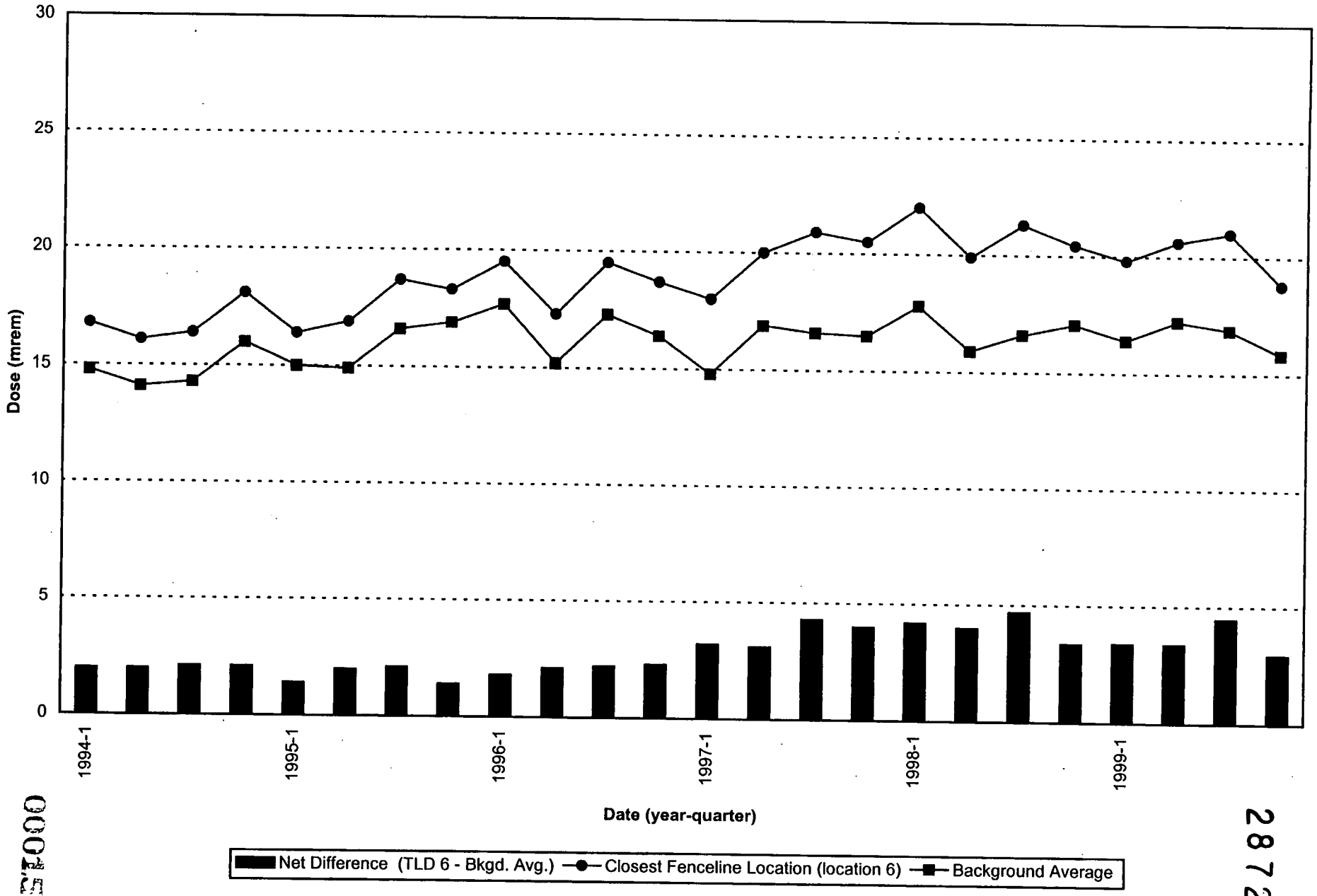


FIGURE 4-32. QUARTERLY DIRECT RADIATION (TLD) MEASUREMENTS, 1994 - 1999
(LOCATION 6 VERSUS BACKGROUND AVERAGE)

FINAL

00015 0
2872

2872

Natural Resources

5.0 NATURAL RESOURCES

This section provides a summary of newly impacted or ecologically restored areas, as well as a status of wetlands and endangered species at the Fernald site.

During the fourth quarter of 1999, habitat impacts occurred in Area 2, Phase I and Area 1, Phase III. Specifically, within Area 2, Phase I, approximately three acres of shrubs and small trees were removed in areas adjacent to the southern waste units prior to certification and potential remediation. Certain trees were marked for preservation prior to these removal activities. Within Area 1, Phase III, approximately three acres of shrubs and small trees were removed. The removal of the shrubs and small trees actually resulted in a positive habitat impact because most of the vegetation cleared consisted of non-native and aggressive bush honeysuckle (*Lonicera mackii*) and multiflora rose (*Rosa multiflora*).

Several ecological restoration projects in Area 1, Phase I, Area 1, Phase III, Area 8, Phase I, and Area 8, Phase II were initiated, continued, or completed during the fourth quarter of 1999. Construction of the Area 1, Phase I Wetland Mitigation Project was completed, which will trigger the start of a five-year wetland monitoring program in the spring of 2000. Over six acres of wetlands were created, and 3,200 trees and shrubs installed within this 12-acre project area. In addition, approximately 2,200 wetland plugs were planted, and the entire area was seeded either with a marsh, wet prairie, or upland prairie grass and wildflower mix. In Area 8, Phase I, hybrid American chestnuts (*Castanea dentata*) were planted within deer exclosure fencing as part of the American Chestnut Research Project. Approximately 85 seedlings and 85 seeds were planted in the 0.25-acre exclosure area. The majority of chestnuts planted were 7/8 American and 1/8 Chinese chestnut (which is resistant to the chestnut blight). Once the chestnuts reach sufficient size, they will be inoculated with the chestnut blight fungus. Seeds from surviving trees will be harvested for future research and restoration efforts. Monitoring and surveillance also continued during the fourth quarter for the Invasive Plant Control Research Project in Area 1, Phase III, as well as the Area 8, Phase I revegetation test plots. Lastly in Area 8, Phase II, construction of a 400-foot gravel access road was initiated. This effort represents the first phase of ecological restoration for Area 8, Phase II. In 2000 it is expected that approximately 18 acres of forest and savanna habitats will be enhanced and restored in Area 8, Phase II.

There were no unexpected conditions observed in Paddys Run during Sloan's crayfish monitoring in the fourth quarter of 1999. However, it should be noted that on December 10, 1999, turbid flow was observed from the northern drainage ditch following 0.66 inches of precipitation earlier in the day. Follow-up observations on the following Monday (December 13) revealed that there was no longer increased turbidity from the northern drainage ditch, and no immediate action was required. No other Fernald-induced increases in turbidity above ambient conditions were observed. Therefore, no Fernald site activities have adversely impacted the Sloan's crayfish population.

The December 10 observation was the second time during 1999 that increased turbidity was observed from the northern drainage ditch. As a result, the U.S. Department of Energy (DOE) is investigating the source of increased turbidity from the northern drainage ditch. At this point, no obvious cause can be determined. This was discussed with the Ohio Environmental Protection Agency (OEPA) during a meeting on February 16, 2000. It was also identified in this meeting that DOE would continue to monitor the northern drainage ditch following rain events and try to ascertain the cause of these isolated occurrences of increased turbidity. Any future turbid conditions in this channel will be immediately reported to OEPA via telephone and/or email. Corrective actions resulting from these monitoring activities will be discussed with and approved by OEPA prior to their implementation.

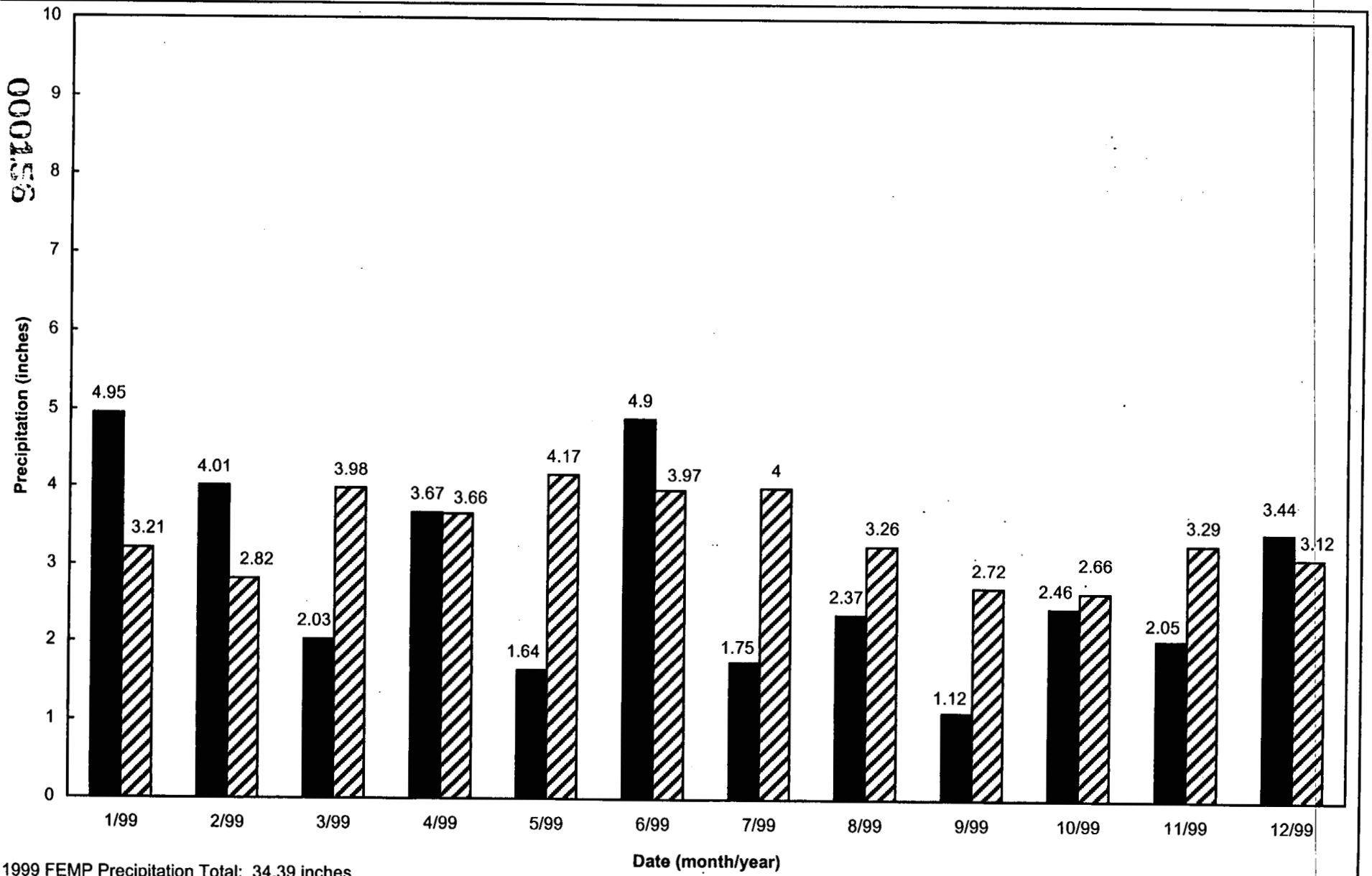
2872

Meteorological

000154

6.1 MONTHLY PRECIPITATION

This section provides the fourth quarter 1999 monitoring activities for the Integrated Environmental Monitoring Plan (IEMP) meteorological monitoring program. Figure 6-1 shows 1999 precipitation by month in the Fernald area compared to average precipitation by month from 1948 through 1997, based on data collected at the Greater Cincinnati/Northern Kentucky International Airport and at the Fernald site. This figure shows that precipitation during the fourth quarter of 1999 was 7.95 inches.



1999 FEMP Precipitation Total: 34.39 inches
Average Precipitation Total (1948 - 1997): 40.86 inches[a]

[a] Average precipitation is based on data collected at the Greater Cincinnati/Northern Kentucky International Airport.

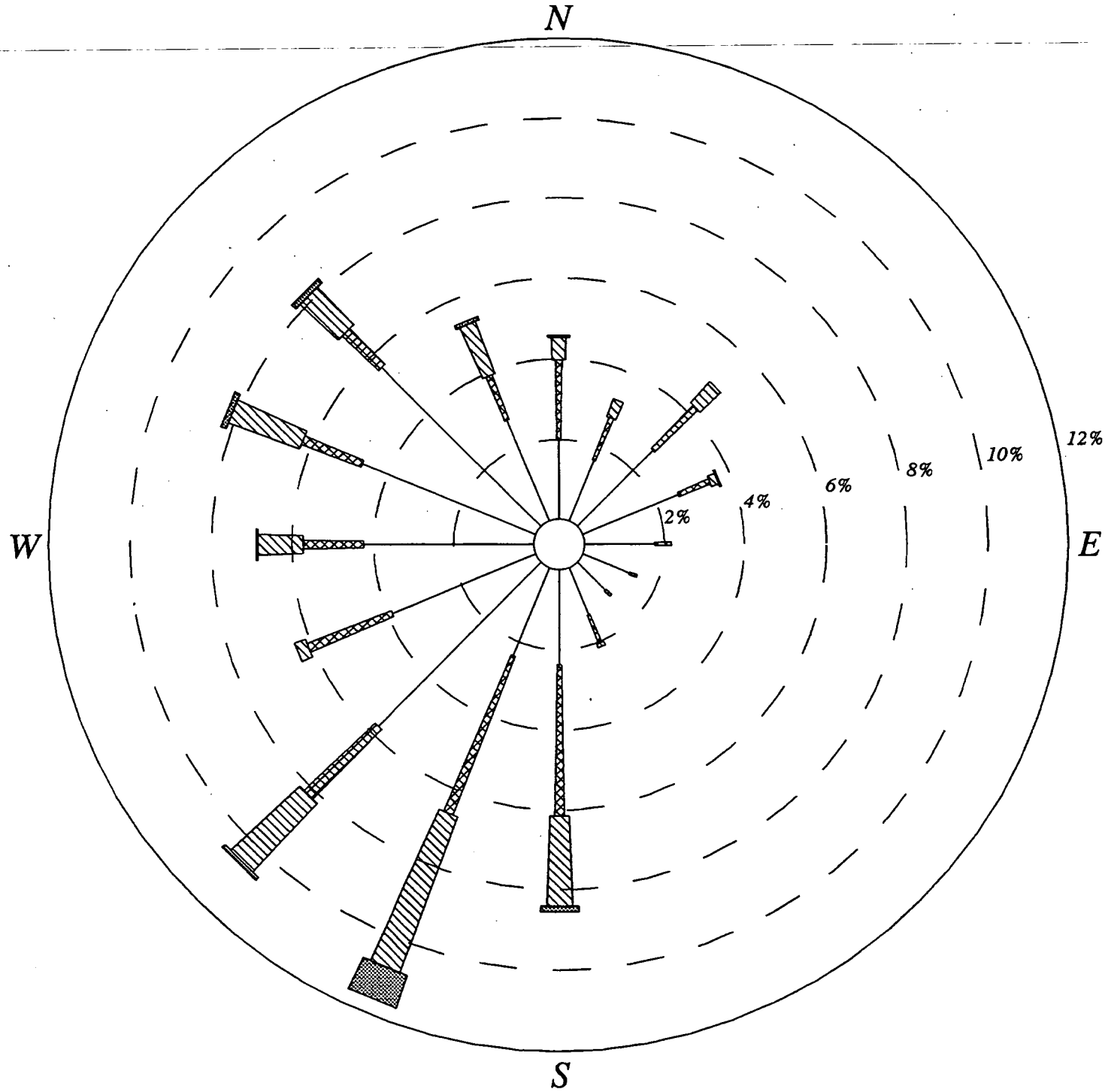
FIGURE 6-1. 1999 FEMP MONTHLY PRECIPITATION DATA

FINAL

000156

6.2 WIND ROSE

This section provides the fourth quarter 1999 monitoring activities for the IEMP meteorological monitoring program. The fourth quarter 1999 wind rose (Figure 6-2) indicates that the predominant wind directions were from the northwest and southwest quadrants. The wind rose indicates that airborne emissions from site remediation activities would be carried towards air monitors in the northeast and southeast quadrants of the site. Fourth quarter wind rose is generally consistent with annual wind rose data for the Fernald area which indicates the prevailing wind directions are from the southwest which includes south-southwest, southwest, and west-southwest sectors.



CALM WINDS 10.54%

WIND SPEED (KNOTS)

NOTE: Frequencies indicate direction from which the wind is blowing.

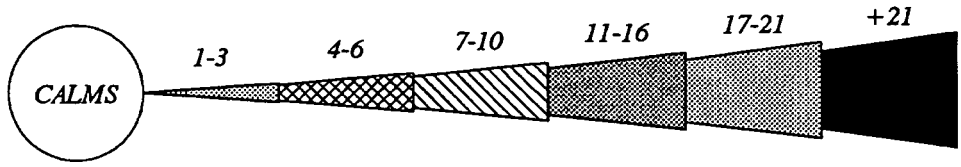


FIGURE 6-2. FOURTH QUARTER 1999 WIND ROSE DATA, 10-METER HEIGHT

References

2872

REFERENCES

U.S. Dept. of Energy, 1999, "1998 Integrated Site Environmental Report," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1999a, "Integrated Environmental Monitoring Plan, Revision 1," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1999b, "Integrated Environmental Monitoring Status Report for Third Quarter 1999," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Cincinnati, OH.

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

U.S. Dept. of Energy, 1998b, "Re-Injection Demonstration Test Plan," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1998c, "Sitewide CERCLA Quality Assurance Project Plan," Revision 1, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1997a, "Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1)," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1997b, "On-Site Disposal Facility Groundwater/Leak Detection and Leachate Monitoring Plan," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1997c, "Operations and Maintenance Master Plan for the Aquifer Restoration and Wastewater Treatment Project," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1996, "Record of Decision for Remedial Actions at Operable Unit 5," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.