S. S. PAPADOPULOS & ASSOCIATES, INC.
ENVIRONMENTAL & WATER-RESOURCE CONSULTANTS

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June 1, 2000

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Subject: Sparton Technology, Inc. Coors Road Plant Remedial Program
1999 Annual Report

Gentlemen:

On behalf of Sparton Technology, Inc. (Sparton), S. S. Papadopulos & Associates, Inc. (SSP&A) is pleased to submit the subject report. The report presents data collected at Sparton's Coors Road Plant during the operation of the remedial systems in 1999, and evaluations of these data to assess the performance of the systems. This document was prepared by SSP&A in cooperation with Metric Corporation, Inc. and Pierce L. Chandler, Jr., PE.

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I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based upon my inquiry of either the person or persons who manage the system and/or the person or persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I further certify, to the best of my knowledge and belief, that this document is consistent with the applicable requirements of the Consent Decree entered among the New Mexico Environment Department, the U.S. Environmental Protection Agency, Sparton Technology, Inc., and others in connection with Civil Action No. CIV 97 0206 LH/JHG, United States District Court for the District of New Mexico. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

If you have any questions concerning the report, please contact me.

Sincerely,

S. S. PAPADOPULOS & ASSOCIATES, INC.

Stavros S. Papadopulos, PhD, PE
Chairman, Board of Directors

cc: Secretary, Sparton Technology, Inc., w/ 1 copy
Mr. R. Jan Appel, w/1 copy
Mr. James B. Harris, w/1 copy
Mr. Tony Hurst, w/2 copies
Mr. Gary L. Richardson, w/1 copy
Mr. Pierce L. Chandler, Jr., w/1 copy

Sparton Technology, Inc.
Coors Road Plant
Remedial Program

1999 Annual Report

Prepared For:

Sparton Technology, Inc.
Rio Rancho, New Mexico

Prepared By:

$\Sigma^2\Pi$ S.S. PAPADOPULOS & ASSOCIATES, INC.
Bethesda, Maryland

In Association with:

Metric Corporation, Albuquerque, New Mexico
Pierce L. Chandler, Jr., P.E., Rockwall, Texas

June 1, 2000

Executive Summary

Sparton Technology, Inc. (Sparton) agreed to implement a number of remedial measures at its Coors Road Plant in Albuquerque, New Mexico under the terms of a consent decree entered on March 3, 2000. In 1999, significant progress was made in implementing and operating these remedial measures. These remedial measures have resulted in the containment of the plume at the site, the removal of a significant amount of mass from the plume of groundwater contamination, and a significant reduction in soil-gas concentrations in the on-site source areas.

The remedial measures undertaken in 1999 included the following:

- Between December 31, 1998 and April 14, 1999, and from May 6 through December 1999, the off-site containment well was operated at a rate sufficient to contain the plume. An air stripper for treating the pumped water and an infiltration gallery for returning the treated water to the aquifer were constructed in the spring of 1999. These systems were connected to the containment well and tested between April 14 and May 6, 1999.

- A 50-cfm AcuVac SVE system was operated at vapor recovery well VR-1 from May 12 through June 23, 1999, and a 200-cfm Root blower system was operated at this well from June 28 to August 25, 1999.

- Planning for the source containment system continued. A preliminary design of the system was completed, and applications were filed for the necessary permits, licenses, and approvals. The system, as currently designed, will consist of a source containment well to be located immediately downgradient from the Sparton plant, an air stripper, six infiltration ponds, three monitoring wells, and connecting pipelines. This system will replace the current on-site recovery system that was permanently shutdown on November 16, 1999 due to low recovery rates.

- Groundwater monitoring was conducted as specified in Attachment A to the Consent Decree. Water levels in accessible monitoring wells, the containment well, observation wells, piezometers, and the Corrales Main Canal were measured quarterly. Samples were collected for water-quality analyses from monitoring wells and from the influent and effluent of the air stripper at the frequency specified in the Consent Order. Water samples were analyzed for TCE, DCE, TCA and total and hexavalent chromium.

- A groundwater flow and transport model of the hydrogeologic system underlying the site was developed. The model was calibrated and used to simulate TCE concentrations in the aquifer from start-up of the containment well in December 1998 through November 2000. Several assumptions were made with respect to the TCE concentration distribution in the aquifer in order to simulate the observed TCE concentrations at the containment well and the mass removal of TCE at this well during the first year of well operation. Calibration and improvement of the model will continue next year.

A total of 115 million gallons were pumped at the off-site containment well during 1999. This pumped water represents about 10 percent of the volume of contaminated groundwater based on analysis of October 1998 water-quality data. Approximately 360 kg of TCE and 15 kg of DCE were removed from the aquifer by operation of the containment well. This represents about 17 percent of the total TCE mass (estimated using the flow and transport model) to be dissolved in the aquifer prior to operation of the containment well, and a similar percentage of the DCE mass.

The operation of the soil vapor extraction systems at vapor recovery well VR-1 in 1999 had a measurable impact on soil-gas concentrations in the vicinity of VR-1. Soil-gas concentrations decreased to less than 5 ppmv in monitoring wells in the vicinity of VR-1 (which had concentrations greater than 10 ppmv at the beginning of 1999). The total mass of TCE removed by the soil vapor extraction systems was about 4.5 kg in 1999. The only soil-gas monitoring location that had TCE soil-gas concentrations greater than 10 ppmv at the end of 1999 was at MW-18. A TCE concentration of 27 ppmv was measured at this location on August 31, 1999. The TCE in the soil-gas at this location is likely the result of volatilization of TCE from the water table; shallow groundwater at this location had a TCE concentration of 980 μg/L in the Fourth Quarter of 1999.

The volume of contaminated groundwater did not change significantly during 1999. Based on TCE data, the off-site portion of the plume has shifted slightly to the north, with a decrease in the contaminated area to the southwest of the containment well. The water-quality data indicate that TCE concentrations increased in an area adjacent to and northeast of the containment well. The data also indicate a significant increase in DCE concentrations in the vicinity of the containment well, indicating that the well is effectively capturing the leading edge of the DCE plume. Overall concentrations of the contaminants of concern declined on-site. These changes in on-site and off-site concentrations are directly attributable to the operation of the soil vapor extraction systems and the containment well.

The remedial systems were operated with only minor difficulties during 1999. One problem was the incorrect operation of a metering pump by adding anti-scaling chemicals to water from the containment well. The metering pump was replaced in December. A potential problem with the containment well was a steady increase in chromium concentrations from 0.02 mg/L at system start-up to near 0.05 mg/L from May through December. A more frequent sampling program was initiated to monitor the chromium concentrations.

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List of Acronyms

3rdFZ	Third Flow Zone
cfm	cubic feet per minute
CMS	Corrective Measure Study
DCE	1,1-dichloroethylene
DFZ	Deep Flow Zone
ft/d	feet per day
ft/yr	feet per year
ft^2/d	feet squared per day
gpm	gallons per minute
IM	Interim Measure
lbs	Pounds
LLFZ	Lower Lower Flow Zone
MCLs	Maximum Contaminant Levels
mg/m^3	milligrams per cubic meter
MSL	Mean Sea Level
NMED	New Mexico Environmental Department
NMEID	New Mexico Environmental Improvement Division
ppmv	parts per million by volume
RFI	RCRA Facility Investigation
SVE	site soil vapor extraction
SVE	Soil Vapor Extraction
TCA	1,1,1-trichloroethane
TCE	trichloroethylene
UFZ	Upper Flow Zone
ULFZ	Upper Lower Flow Zone
USEPA	U.S. Environmental Protection Agency
USF	Upper Santa Fe Group
USGS	U.S. Geological Survey

REPORT

Section 1
Introduction

The Sparton Technology, Inc. (*Sparton*) Coors Road Plant in Albuquerque, New Mexico is located at 9621 Coors Blvd. NW (the west side of Coors Road), north of Paseo del Norte and south of the Arroyo de las Calabacillas (see Figure 1.1). Investigations conducted between 1983 and 1987 at and around the plant revealed that contaminated groundwater had migrated beyond the boundaries of the facility to downgradient, off-site areas.

In 1988, the United States Environmental Protection Agency (*USEPA*) and Sparton negotiated an Administrative Order on Consent, which became effective on October 1, 1988. Under the provisions of this Order, Sparton implemented in December 1988 an Interim Measure (*IM*) that consisted of an on-site, eight-well groundwater recovery and treatment system. The initial average recovery rate of the system was about 1.5 gallons per minute (*gpm*); however, the recovery rate began declining within a few years due to a regional decline in water levels.

In 1998 and 1999, during settlement negotiations associated with lawsuits brought by the USEPA, the State of New Mexico, the County of Bernalillo, and the City of Albuquerque, Sparton agreed to implement a number of remedial measures and take certain actions, including: (a) the installation, testing, and continuous operation of an off-site extraction well designed to contain the contaminant plume; (b) the replacement of the on-site groundwater recovery system by a source containment well designed to address the release of contaminants from potential on-site source areas; (c) the operation of a 400 cubic feet per minute (*cfm*) capacity on-site soil vapor extraction (*SVE*) system for one year; (d) the implementation of a groundwater monitoring plan; and (e) the assessment of aquifer restoration. Work Plans for the implementation of the measures and actions agreed upon by the parties were developed and included in a Consent Decree entered by the parties on March 3, 2000 (Consent Order, 2000; SSP&A, 2000a, 2000b, 2000c; and P. Chandler, 2000).

The off-site containment well was installed and tested in late 1998, and began operating at a rate to contain the plume on December 31, 1998. An air stripper for treating the pumped water and an infiltration gallery for returning the treated water to the aquifer were constructed in the spring of 1999, and the well was connected to these facilities in late April 1999. SVE systems of different capacities were operated at the Sparton facility between April and October 1998, and between May and August 1999. The 400 cfm SVE system was installed and began operating in April 2000.

The purpose of this 1999 Annual Report is to:

- provide a brief history of the Sparton plant and affected areas downgradient from the plant,
- summarize remedial and other actions taken by the end of 1999,
- present data collected from operating and monitoring systems, and
- provide the interpretations of these data with respect to meeting remedial objectives.

This report was prepared on behalf of Sparton by S. S. Papadopulos & Associates, Inc. (SSP&A) in cooperation with Metric Corporation (Metric) and Pierce L. Chandler, Jr. Background information on the site, the implementation of remedial actions, and initial site conditions, as they existed prior to the implementation of the remedial action agreed upon in the Consent Decree, are discussed in Section 2. Issues related to the operation of the implemented remedial systems are discussed in Section 3. Data collected to evaluate system performance and to satisfy permit or other requirements are presented in Section 4. Section 5 presents the interpretations of the data and discusses the results with respect to the performance and the goals of the remedial systems. The development of the site's groundwater flow and transport model and predictions based on this model are presented in Section 6. Section 7 discusses future plans. References cited in the report are listed in Section 8.

Section 2
Background

2.1 Description of Facility

The Sparton Coors Road plant is an approximately 12-acre property located in northwest Albuquerque, on Coors Blvd. NW. The property is about one-quarter mile south of the Arroyo de las Calabacillas, about three-quarters of mile north of the intersection of Coors Blvd. and Paseo del Norte, and about one-half mile west of the Rio Grande (see Figure 1.1). The property sits on a terrace about 60 feet above the Rio Grande floodplain. An irrigation canal, the Corrales Main Canal, is within a few hundred feet from the southeast corner of the property. Irrigated agriculture occurs in the area southeast of the property and east of the canal. About one-quarter mile west of the property, the land rises approximately 250 feet forming a hilly area that in recent years has been developed into residential properties.

The plant consists of a 64,000-square-foot manufacturing and office building and of several other small structures that were used for storage or as workshops (see Figure 2.1). Electronic components, including printed-circuit boards, were manufactured at the plant. Since 1994, Sparton has operated a machine shop at the plant in support of manufacturing at the company's Rio Rancho plant and other locations.

2.2 Waste Management History

The manufacturing processes at the plant generated two waste streams that were managed as hazardous wastes: a solvent waste stream and an aqueous metal-plating waste stream. Waste solvents were accumulated in an on-site concrete sump (see Figure 2.1) and allowed to evaporate. In October 1980, Sparton discontinued using the sump and closed it by removing remaining wastes and filling it with sand. After that date, Sparton began to accumulate the waste solvents in drums and disposed of them off-site at a permitted facility.

The plating wastes were stored in a surface impoundment (see Figure 2.1), and wastewater that accumulated in the ponds was periodically removed by a vacuum truck for off-site disposal at a permitted facility. Closure of the impoundment and the former sump area occurred in December 1986 under a New Mexico State-approved closure plan. The impoundment was backfilled, and an asphaltic concrete cap was placed over the entire area to divert rainfall and surface-water run on, and thus to minimize infiltration of water into the subsurface through this area.

2.3 Hydrogeologic Setting

The Sparton site lies in the northern part of the Albuquerque Basin. The Albuquerque Basin is one of the largest sedimentary basins of the Rio Grande rift, a chain of linked basins that extend south from central Colorado into northern Mexico. Fill deposits in the basin are as much as 15,000 feet thick. The deposits at the site have been characterized by borings advanced for 82 monitoring and production wells, and by a 1505-foot-deep boring advanced by the U.S. Geological Survey (USGS) about 0.5 mile north of the facility on the north side of the Arroyo de las Calabacillas (Johnson and others, 1996).

The fill deposits in the upper 1500 feet of the subsurface consist primarily of sand and gravel with minor amounts of silt and clay. The near-surface deposits consist of less than 200 feet of Quaternary alluvium associated with terrace, arroyo fan, and channel and floodplain deposits. These deposits are saturated beneath the facility and to the east of the facility toward the Rio Grande, but are generally unsaturated to the west of the site. Two distinct geologic units have been mapped in the saturated portion of these deposits: Recent Rio Grande deposits, and a silt/clay unit (see Figure 2.2). The Recent Rio Grande deposits occur to the east of the facility adjacent to the Rio Grande. These deposits consist primarily of pebble to cobble gravel and sand, and sand and pebbly sand. These deposits are Holocene-age and are up to 70-feet thick. Beneath the facility, and in an approximately 1500-foot-wide band trending north from the facility, a silty/clay unit has been mapped between an elevation of about 4965 feet MSL and 4975 feet MSL. This unit, which is referred to as the 4970-foot silt/clay unit, represents Late-Pleistocene-age overbank deposits. Holocene-age arroyo fan and terrace deposits, which are primarily sand and gravel, overlie this unit.

The water table over much of the site occurs within the deposits of the Pliocene-age Upper Santa Fe Group (USF). These deposits, to an elevation of 4800-feet MSL, consist primarily of sand with lenses of sand and gravel and silt and clay. The lithologic descriptions of these deposits are variable, ranging from "sandy clay," to "very fine to medium sand," to "very coarse sand, to small pebble gravel." Most of the borings into this unit were advanced using the mud-rotary drilling technique, and as a result, it has not been possible to map the details of the geologic structure. The sand and gravel unit is primarily classified as USF2 lithofacies assemblages 2 and 3 (Hawley, 1996). Locally, near the water table, in some areas, the sands and gravels are classified as USF4 lithofacies assemblages 1 and 2. Lithofacies 2 represents basin-floor alluvial deposits that are primarily sand with lenses of pebble sand and silty clay. Lithofacies 3 represents basin-floor, overbank, and playa and lake deposits that are primarily interbedded sand and silty clay with lenses of pebbly sand.

At an elevation of approximately 4800 feet MSL, an areally extensive 2- to 3-foot thick clay layer is encountered. This clay, which is referred to as the 4800-foot clay unit (see Figure 2.2), likely represents lake deposits. This clay unit was encountered in borings for five wells (MW-67, MW-71, CW-1, OB-1, and OB-2) installed during site investigations and remedial actions. The deposits of the Santa Fe Group immediately below the 4800-foot clay are similar to those above the clay.

A total of 82 wells were installed at the site to define hydrogeologic conditions and the extent and nature of groundwater contamination and to implement and monitor remedial actions. Of these wells, 9 have been plugged and abandoned; the locations of the remaining 73 wells are shown in Figure 2.3.

The off-site containment well, CW-1, and two associated observation wells, OB-1 and OB2, were drilled to the top of the 4800-foot clay unit and were screened across the entire saturated thickness of the aquifer above the clay unit. The monitoring wells have short screened intervals (5 to 30 feet) and, during past investigations, were classified according to their depth and screened interval. Wells screened across, or within 15 feet of, the water table are referred to as Upper Flow Zone (*UFZ*) wells; wells screened 15 to 45 and 45 to 75 feet below the water table are referred to as Upper Lower Flow Zone (*ULFZ*) and Lower Lower Flow Zone (*LLFZ*) wells, respectively. At cluster well locations where an LLFZ well already existed, wells screened at a somewhat deeper interval are referred to as Third Flow Zone (*3rdFZ*) wells. Wells completed below the 4800-foot clay unit are referred to as Deep Flow Zone (*DFZ*) wells.

The completion flow zone, location coordinates, and measuring point elevation of all existing wells are presented on Table 2.1; their screened intervals are summarized in Table 2.2. In Figure 2.4, the screened interval of each monitoring well is projected onto a schematic cross-section through the site to show its position relative to the flow zones defined above. (Monitoring wells screened in the DFZ or across multiple flow zones are not been included in this figure.) The screened intervals in three of the monitoring wells shown on Figure 2.4 are inconsistent with the completion flow zones listed on Table 2.1, which were defined at the time of well construction. These monitoring wells are: MW-32, which is listed in Table 2.1 as a LLFZ well but is shown on Figure 2.4 as a ULFZ well; and MW-49 and MW-70 which are listed on Table 2.1 as 3rdFZ wells but are shown on Figure 2.4 as LLFZ wells. In the evaluations of water-level data for the flow zones, MW-32 was assumed to be a ULFZ well, and MW-49 and MW-70 were assumed to be LLFZ wells.

Data collected from these wells indicate that the saturated thickness of the aquifer above the 4800-foot clay is approximately 170 feet. Groundwater in the aquifer occurs under unconfined conditions; however, in the areas where the 4970-foot silt/clay is present below the water table, it provides a degree of confinement to underlying saturated deposits. Analyses of data from aquifer tests conducted at the Site (Harding Lawson Associates, 1992; SSP&A, 1998, 1999) and the response of water levels to the long-term operation of the off-site containment well, indicate that the hydraulic conductivity of the aquifer is in the range of 25 to 30 feet per day (*ft/d*), corresponding to a transmissivity of about 4200 to 5000 feet squared per day (ft^2/d) for the 170-foot saturated thickness of the aquifer above the clay.

Water-level data indicate that the general direction of groundwater flow is to the northwest with gradients that range 0.0025 to 0.006. Vertical flow is downward with a gradient of about 0.002. The pumpage from the deeper aquifers and a reduction in the extent of irrigated lands in the vicinity of the Site have resulted in a regional decline of water levels. This regional decline, which is reflected in the hydrographs of site monitoring wells (see Figure 2.5), is about 0.65 feet per year (*ft/yr*).

2.4 Site Investigations and Past Remedial Actions

In 1983, several groundwater monitoring wells were installed around the impoundment and sump area to determine whether there had been a release of constituents of concern from the impoundment or the sump. Analytical results from groundwater samples taken from these wells indicated concentrations of several constituents above New Mexico State standards.

Since this initial finding in 1983, several investigations were conducted to define the nature and extent of the contamination, and to implement remedial measures; these investigations continued through 1999. The results of the investigations indicate that the primary constituents of concern found in on-site soils and in both on-site and off-site groundwater are trichloroethene (*TCE*), 1,1,1-trichloroethane (*TCA*) and its abiotic transformation product 1,1-dichloroethene (*DCE*). Of these constituents, TCE has the highest concentrations and is the constituent that has been used to define the extent of groundwater contamination. DCE has been detected at low concentrations relative to TCE in groundwater, but it has the second largest plume extent. Groundwater contamination by TCA is primarily limited to the facility and its immediate vicinity. Various metals have also been detected in both soil and groundwater samples. Historically, chromium has the highest frequency of occurrence at elevated concentrations.

During the period 1983 to 1987, Sparton worked closely with the New Mexico Environmental Improvement Division (*NMEID*), the predecessor to the New Mexico Environment Department (*NMED*). Several investigations were conducted during this period (Harding and Lawson Associates, 1983; 1984; 1985). In 1987, when it became apparent that contaminants had migrated beyond plant boundaries, the USEPA commenced negotiations with Sparton to develop an Administrative Order on Consent. This Order was signed and became effective on October 1, 1988. Under the provisions of this Order, Sparton implemented an Interim Measure (*IM*) in December 1988. The IM consisted of groundwater recovery through eight on-site wells (PW-1, MW-18, and MW-23 through MW-28), and treatment of the recovered water in an on-site air stripper (see Figure 2.1). The purpose of this IM was to remove contaminants from areas of high concentration in the UFZ. Due to the regional decline of water levels, the total discharge rate from the IM system dropped to less than 0.25 gpm by November 1999. As a result, the system was shut-down and taken permanently out of service on November 16, 1999. Groundwater production from this system, during its 11-year operation, is summarized on Table 2.3. A total of 4.4 million gallons of water were recovered during the 11-year operation period, as shown on this table.

From 1988 through 1990, horizontal and vertical delineation of the groundwater plume continued under the October 1, 1988 Order on Consent. On July 6, 1990, the first draft of the RCRA Facility Investigation (*RFI*) report was submitted to USEPA; the final RFI was issued on May 20, 1992 (Harding Lawson Associates, 1992) and approved by USEPA on July 1, 1992. A draft Corrective Measures Study (*CMS*) report was submitted to USEPA on November 6, 1992. The report was revised in response to USEPA comments, and a draft Final CMS was issued on May 13, 1996; the draft was approved, subject to some additional revisions, by USEPA on June 24, 1996. The Revised Final CMS was issued on March 14, 1997 (HDR Engineering, Inc., 1997) . Nine additional monitoring wells (MW-65 through MW-73) were installed between 1996 and 1999 to further delineate the groundwater plume.

The investigations conducted at the site included several soil-gas surveys to determine the extent of groundwater contamination and to characterize vadose zone soil contamination and its potential impacts on groundwater quality. The results of soil-gas surveys conducted in 1984, 1985, 1987, and 1991 were reported in the RFI and the CMS. Additional soil-gas investigations to characterize vadose zone contamination were conducted between April 1996 and February 1997 (Black & Veatch, 1997). This work included the installation and sampling of a six-probe vertical vapor probe cluster in the source area, five vapor sampling probes at various radial distances from the former sump area, and vapor sampling of nine on-site and four off-site UFZ monitoring wells that are screened across the water table. The locations of the vapor probes (VP-1-6 and VR-1 through VR-5) and of the sampled on-site monitoring wells are shown in Figure 2.6; the sampled off-site monitoring wells (MW-37, MW-48, MW-57, and MW-61) are shown on Figure 2.3. The area where TCE concentrations in soil-gas exceeded 10 parts per million by volume (*ppmv*) was determined from the results of this investigation (see Figure 2.7).

Following this investigation, a soil vapor extraction (*SVE*) pilot test was conducted on February 27 and 28, 1997 (Black & Veatch, 1997). The test was conducted on vapor recovery well VR-1 using an AcuVac System operating at a flow of 65 cfm at a vacuum of 5 inches of water. The results of the tests indicated a radius of influence of 175 to 200 feet.

Based on the results of this pilot test, an AcuVac System was installed at the site in the spring of 1998 and operated at a flow rate of 50 cfm on vapor recovery well VR-1 from April 8, 1998 to October 20, 1998 (195 days). Influent and effluent concentrations measured during the operation of the system are shown in Figure 2.8. As shown in this figure, influent TCE concentrations dropped from about 18,000 milligrams per cubic meter (mg/m^3), or about 4000 ppmv, during the first day of operation, to about 150 mg/m^3 (34 ppmv) in about 120 days. Trend lines determined by analysis of the data (see Figure 2.8) indicate that influent TCE concentration was probably as low as 75 mg/m^3 (17 ppmv) prior to the shut-down of the system after 195 days of operation. The mass of TCE removed during this operation of the SVE system was calculated to be about 145 kg.

2.5 Implementation of Current Remedial Actions

Based on settlement negotiations that led to the March 3, 2000 Consent Decree, Sparton agreed to implement the following remedial measures: (a) installation and operation of an off-site containment system designed to contain the contaminant plume; (b) replacement of the on-site groundwater recovery system by a source containment system designed to address the release of contaminants from potential on-site source areas; and (c) operation of a robust SVE system for a limited period.

Implementation of the off-site containment system was completed in 1999. The system consists of:

1. A containment well (CW-1);
2. A water treatment system with an air stripper that treats groundwater pumped by the well;
3. An infiltration gallery installed in the Arroyo de las Calabacillas for returning treated water to the aquifer;
4. A pipeline for transporting the treated water from the treatment building to the gallery;
5. A piezometer, with an horizontal screen placed near the bottom of the gallery, for monitoring the water level in the gallery; and
6. Three monitoring wells (MW-74, MW-75, and MW-76) for monitoring potential water-quality impacts of the gallery.

The location of these components of the off-site containment system are shown in Figure 2.9.

The containment well was installed in August 1998, and aquifer tests were conducted on the well and evaluated in December (SSP&A, 1998). The well began operating at a design rate of 225 gpm on December 31, 1998. During the testing of the well and during its continuous operation between December 31, 1998 and April 14, 1999, the groundwater pumped from the well was discharged into a sanitary sewer without treatment. Installation of the air stripper, the infiltration gallery, and the other components of the system was completed in early April, 1999. The containment well was shut-down on April 14, 1999 to install a permanent pump and to connect the well to the air stripper. Between April 14 and May 6, 1999, the well operated intermittently to test the air stripper and other system components. The tests were completed on May 6, 1999, and the well was placed into continuous operation with all system components functioning.

The source containment system has not yet been implemented. The system will consist of:

1. A source containment well to be installed immediately downgradient of the Site;
2. An on-site air stripper, housed in a building, for treating the pumped water;
3. Six on-site infiltration ponds for returning the treated water to the aquifer;
4. Three monitoring wells (one existing and two new) for monitoring the potential water-quality impacts of the ponds; and
5. Pipelines for transporting the pumped water to the air stripper and the treated water to the ponds.

The proposed layout of the system is shown in Figure 2.10.

An AcuVac SVE system was installed at the site in the spring of 1998 and operated between April 8 and October 20, 1998. Additional SVE operations with the AcuVac system at 50 cfm and with a 200 cfm Roots blower occurred in 1999 between May 12 and June 23 and between June 28 and August 25, respectively. An additional 200 cfm Roots blower has been installed, and the SVE system has been operating at 400 cfm since April 10, 2000.

2.6 Initial Site Conditions

Initial site conditions as referred to in this report represent hydrogeologic and soil-gas conditions as they existed prior to the implementation of the current remedial measures(the installation and operation of the off-site containment well and the 1999 operation of the SVE systems).

2.6.1 Hydrogeologic Conditions

2.6.1.1 Groundwater Levels

The elevation of water levels in monitoring wells, based on measurements made in November 1998, is presented on Table 2.4. These data were used to prepare maps showing the configuration of the water levels at the site prior to the beginning of pumping from the off-site containment well. The elevation of the water table, based on wells screened across the water table (UFZ wells), is shown in Figure 2.11. The water-level elevations in the ULFZ and LLFZ are shown in Figures 2.12 and 2.13, respectively. These water-level maps indicate that in the off-site areas downgradient from the site, the direction of groundwater flow is generally to the northwest with a gradient of approximately 0.0025. On the site, the direction of flow is northwesterly in the ULFZ and the LLFZ; however, the gradients are steeper, approximately 0.005 in the ULFZ and 0.006 in the LLFZ. The water table on the site is affected by the on-site groundwater recovery system, which was operating during the November 1998 water-level measurements, and by the presence of the 4970-foot silt/clay unit (see Figures 2.2 and 6.3); the effects of this silt/clay unit also extend to the north of the property (see Figure 2.11). The direction of flow changes from westerly north of the site to southwesterly on the site, with gradients in the 0.01 to 0.02 range. It is also possible that water levels in wells completed above the silt/clay unit represent a perched water table where the direction of flow and gradient are different than the above interpretation, which is based on data from all UFZ wells.

2.6.1.2 Groundwater Quality

The concentrations of TCE, DCE, and TCA in groundwater samples obtained from monitoring wells during the Fourth Quarter 1998 sampling event are summarized on Table 2.5. Also included on this table are data obtained on September 1, 1998 from the off-site containment well and the nearby observation wells, OB-1 and OB-2, and from a temporary well, TW-1/2, drilled in early 1998 at the current location of MW-73 and sampled on February 18 and 19, 1998. These data were used to prepare maps showing the horizontal extent of the TCE, DCE and TCA plumes as they existed in November 1998, prior to the beginning of pumping from the off-site containment well. The procedures presented in the Work Plan for the Off-Site Containment System were used in preparing these maps (SSP&A, 2000a).

The horizontal extent of the TCE plume (in November 1998) is shown in Figure 2.14 and the extent of the DCE and TCA plumes is shown in Figures 2.15 and 2.16, respectively. The extent of these plumes forms a basis for evaluating the effectiveness of the remedial actions that have been or are about to be implemented at the site.

2.6.1.3 Pore Volume of Plume

In preparing the plume maps shown in previous section, the completion zone of the monitoring wells was not considered; that is, data from an UFZ well at one location was combined with data from an ULFZ or LLFZ well at another location. At well cluster locations, the well with the highest concentration was used, regardless of its completion zone. As such, the plumes shown in Figures 2.14 through 2.16 represent the areal extent of contamination based on the highest concentration observed at any depth.

To estimate the mass of dissolved contaminants within each plume and the pore volume of the plume, separate maps were prepared for the UFZ, the ULFZ and LLFZ using data only from wells completed within each of these zones. An estimate of the extent of contamination above the 4800-foot clay was also made based on concentrations data from temporary wells which were sampled during the installation of DFZ wells MW-67 and MW-71. The aquifer was then divided into the following three intervals:

- The interval between the water table to an elevation of 4940 ft, having a concentration distribution equal to the average of the UFZ and ULFZ;
- The interval between elevations 4940 and 4900 ft, having a concentration distribution equal to the average of the ULFZ and LLFZ; and
- The interval between elevations 4900 and 4800 ft, having a concentration distribution equal to the average of the LLFZ and the estimated distribution above the 4800-foot clay.

Calculation of the volume of water contaminated above Maximum Contaminant Levels (*MCLs*), referred to as the pore volume of the plume, was based on the TCE plume which is the largest plume. Using the average areal extent of the TCE plume within each of the three intervals mentioned above and a porosity of 0.3, the pore volume was estimated to be approximately 150 million cubic feet (ft^3), or 1.13 billion gallons, or 3450 acre-ft.

2.6.2 Soil Gas Conditions

A supplemental vadose zone characterization was conducted between March 15 and May 5, 1999, which included installation and sampling of eight additional vapor probes, VP-7 through VP-14 (see Figure 2.6) and resampling of 15 vapor monitoring points that had exhibited soil-gas concentrations greater than 10 ppmv during the initial characterization. The results of the supplemental investigation are presented in Figure 2.17, with the approximate 10 ppmv TCE plume limit delineated. The extent of the TCE plume presented in this figure represents the initial conditions prior to 1999 soil vapor extraction remedial actions.

Section 3
System Operations - 1999

3.1 Off-Site Containment System

The off-site containment well CW-1 operated at a rate designed to contain the plume from December 31, 1998 to April 14, 1999, and from May 6 through December 1999. During the period April 14, 1999 to May 6, 1999, the system was shut-down to install a permanent pump in the well, to connect the well to the air stripper and infiltration gallery, and to test the air stripper and system components. At no other time during 1999 was the system out of operation for more than one day. Several power outages and routine maintenance activities caused short-duration shutdowns of the system.

3.2 Source Containment System

The on-site source containment was not in operation in 1999. Work is in progress on designing the system, and securing the necessary permits, licenses, and approvals. The status of the necessary permits, licenses and approvals to construct and operate the source containment system was are follows:

▪ Authority-to-Construct (City Air Permit)	Approved May 6, 1999
▪ Groundwater Discharge Permit Modification Application (NMED DP-1184 modifications for rapid infiltration ponds)	Submitted Dec. 7, 1999
▪ Deed to tract B-2 (location of source containment well)	Filed Dec. 8, 1999
▪ Application to appropriate groundwater (water rights for source containment well)	Submitted Feb. 7, 2000
▪ Contract to lease water rights from Village of Los Lunas (water rights for source containment well)	Submitted Feb. 7, 2000
▪ Zoning for source containment well and air stripper building	Approved Mar. 3, 2000
▪ License agreement for source containment well and pipeline to encroach on City of Albuquerque easement	Submitted April 6, 2000
▪ License agreement for source pipeline to encroach on New Mexico Utilities, Inc. easement	Approved April 19, 2000
▪ License agreement for source containment pipeline to encroach on AMAFCA easement	Submitted April 6, 2000

3.3 Soil Vapor Extraction System

After a six-month suspension of operation, the 50-cfm AcuVac SVE system at recovery well VR-1 was restarted on May 12, 1999 and operated through June 23, 1999. Monitoring data indicated that influent constituent concentrations had dropped to the range where treatment was no longer required. The AcuVac system at VR-1 was replaced by a 200-cfm Roots blower in late June, and this SVE system was operated between June 28 and August 25, 1999. Continued monitoring of the blower effluent confirmed that direct discharge to the atmosphere was well within city/county emission requirements.

3.4 Problems and Responses

The treatment process for the off-site containment system includes a feed pump that is designed to add anti-scaling chemicals to the water at a steady rate of 15 gallons per day (*gpd*). The purpose of these chemicals is to prevent calcium carbonate precipitation in the infiltration gallery. During 1999, the only problems encountered with the off-site containment system were associated with this chemical feed pump maintaining a steady flow rate of 15 gpd. The original pump, installed in May 1999, was replaced twice during the year, with a different model each time. The final replacement pump, installed in December 1999, has proven reliable.

During their operating periods in 1999, both the AcuVac and the 200-cfm Roots blower SVE systems operated without significant problems.

Section 4
Monitoring Results - 1999

Data collected in 1999 to evaluate the performance of the operating remedial systems and to meet the requirements of the Consent Decree and of the permits for the site are presented in this section.

4.1 Off-Site Containment System

The following data were collected to evaluate the performance of the off-site containment system:

- Water levels;
- Containment well flow rate; and
- Water quality.

4.1.1 Water Levels

The depth to water was measured quarterly during 1999 in all accessible monitoring wells, the off-site containment well, the two observation wells, the piezometer installed in the infiltration gallery, and the Corrales Main Canal near the southeast corner of the Sparton property. The quarterly elevations of the water levels, calculated from these data, are summarized on Table 4.1.

4.1.2 Containment Well Flow Rate

The flow rate of the off-site containment well was monitored with a totalizer meter which also measured the instantaneous flow rate of the well. During the first few days after the December 31, 1998 initiation of continuous operation of the well, the meter was read at intervals of about 6 hours. After these first few days, the meter was read at least daily until the April 14, 1999 shut-down of the well for permanent pump installation and connection to the air stripper. A new totalizer meter was also installed at the beginning of this period, and several readings were made during the testing of the air stripper. After the resumption of the continuous operation on May 6, the meter continued to be read daily until early June. Between June and the end of 1999, the frequency of meter readings was daily, most of the time, to once every few days near the end of the year.

The totalizer and instantaneous discharge rate data collected from these flow meter readings are presented in Appendix A. Also included in this appendix are the average discharge rate between readings and the total volume pumped between the start of operations and the time of the measurement, calculated from the totalizer meter readings. The average monthly discharge rate and the total volume of water pumped during each month of 1999, as calculated from the totalizer data, are summarized on Table 4.2. As indicated on this table, approximately 115 million gallons of water, corresponding to an average rate of 219 gpm, were pumped in 1999.

4.1.3 Water Quality

During 1999, samples were collected for water-quality analyses from monitoring wells, from the discharge of the off-site containment well (influent[1]), and from the effluent from the air stripper.

4.1.3.1 Monitoring Wells

Monitoring wells were sampled at the frequency specified in the Groundwater Monitoring Program Plan (Attachment A to Consent Order). The samples were analyzed for TCE, DCE, and TCA, and for total and hexavalent chromium (both filtered and unfiltered samples). The results of monitoring well sample analyses performed in 1999 are presented in Appendix B. Data on TCE, DCE and TCA concentrations, in samples collected during the Fourth Quarter of 1999 (November 1999), are summarized on Table 4.3.

4.1.3.2 Influent and Effluent

Sampling of the influent began upon the completion of the containment well in late August 1998. Samples were collected at the end of well development and during the testing of the well in December 1998. In 1999, several samples were collected during the 30-day feasibility test of the well (the first 30 days of operation at a rate intended to contain the plume). After the end of this test, the influent was not sampled until the testing of the air stripper during the last week of April 1999. Several samples of the influent to and the effluent from the stripper were collected during this week. After the resumption of pumping on May 6, 1999, the influent to and the effluent from the air stripper were sampled frequently until mid-June. At the beginning of July 1999, the sampling frequency of the influent and effluent became monthly. The results of the analyses of these samples are presented in Appendix C. Data on TCE and DCE concentrations in samples collected during 1999 are summarized on Table 4.4. Because

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[1] In the remainder of this report the term "influent" will be used interchangeably with "discharge from the containment well."

concentrations of TCA in influent samples have been below detection limits throughout 1999, TCA is not reported in Appendix C or in Table 4.4.

4.2 SVE Monitoring Results

Flow rate, operating pressure, and influent concentration data for the 1999 SVE operations are presented in the following sections.

4.2.1 Flow Rates

The AcuVac system was operated from May 12 to June 23, 1999 (42 days) at 50 cfm. The Roots blower system was operated from June 28 to August 25, 1999 (58 days) at 200 cfm.

4.2.2 Operating Pressures

The AcuVac system operated at a vacuum of 6.0 inches of water, and the Roots blower operated at 24.5 inches of water.

4.2.3 Influent Concentration

During the 42-day operational period of the AcuVac system in 1999, the influent TCE concentration varied from 40 mg/m^3 at the beginning to an estimated 7.5 mg/m^3 at the end.

During the 58 day operational period of the Roots 200 cfm blower in 1999, the influent TCE concentration varied from 30 mg/m^3 at the beginning to 6.4 mg/m^3 at the end.

Section 5
Evaluation of Operations - 1999

The goal of the off-site containment well is to hydraulically control the migration of the plume and, in the long-term, restore the groundwater to beneficial use. The goal of the SVE system is to reduce contaminant concentrations in vadose-zone soils in the on-site area and thereby reduce the likelihood that these soils remain a source of groundwater contamination. This section presents an evaluation of the performance of these remedial systems in relation to these goals based on data collected in 1999.

5.1 Off-Site Containment System

5.1.1 Hydraulic Containment

The quarterly water-level elevation data presented in Table 4.1 was used to evaluate the performance of the off-site containment well with respect to providing hydraulic containment for the plume. Maps of the water table (UFZ) and of the water levels in the ULFZ and LLFZ during each of the four rounds of water-level measurements are shown in Figures 5.1 through 5.12. Also shown in these figures are the limit of the capture zone of the containment well, as determined from the configuration of the water levels within each flow zone, and the November 1998 analytical results indicating the extent of the TCE plume.

These water level maps indicate that, except for the May 13, 1999 water-level measurements, the containment well achieved the goal of hydraulically containing the contaminant plume. The May 13 water-level measurements were made only one week after the well had resumed pumping following a three-week shutdown. Water levels had not yet fully responded to the resumption of pumping, and the capture zone had not yet fully developed. On February 16, a small area located on the south side of the leading edge of the November 1998 recorded plume remains outside the ULFZ capture zone of the well (see Figure 5.2), and on August 12^{th} outside of the LLFZ capture zone (see Figure 5.9). It should be noted that the November 1998 extent of the plume in this area was controlled by the November 1998 detection of TCE at 13 μg/L in LLFZ well MW-65; the UFZ well in this area (MW-52) has not shown contamination. Since November 1998, TCE concentrations in well MW-65 have declined: 7 μg/L on February 17, 1999, 2 μg/L on May 17, 1999, and below the detection limit of 1 μg/L on August 23 and November 4, 1999; well MW-52 continued to remain clean throughout 1999 (see Appendix B).

5.1.2 Flow Rates

Based on the total volume of water pumped from the containment well in 1999 (approximately 115 million gallons), the average discharge rate was calculated as 219 gpm. The discharge rate was higher during December 31, 1998 to April 14, 1999 and May 6 to December 31, 1999, when the well was continuously operating. The average discharge rates during these periods were 239 gpm and 224 gpm, respectively. Thus, since the May 6, 1999 start-up of the complete off-site containment system, the well has been pumping very close to its design rate of 225 gpm.

In addition to the 115 million gallons pumped in 1999, an additional 1.7 million gallons were pumped during the testing of the well and the first day of operation, December 31, 1998. Thus, the total volume of water pumped from the well since its installation is close to 117 million gallons. This represents approximately 10 percent of the plume pore volume reported in Subsection 2.6.1.3 of this report

5.1.2 Water Quality

5.1.2.1 Influent and Effluent Quality

The 1999 concentrations of TCE and DCE in the influent to and effluent from the air stripper are presented on Table 4.4. As shown on this table, except for a few detections of TCE at less than 1 µg/L, the concentrations of TCE and DCE in the air stripper effluent have been below detection limits of 0.3 and 0.2 µg/L, respectively, throughout the period of operation of the air stripper.

The concentration of TCE and DCE in the influent, however, increased considerably during the year. A plot of the 1999 TCE and DCE data is presented in Figure 5.13. As shown in this figure and Table 4.4, the influent concentration of TCE remained below 200 µg/L through February 1, 1999. When the influent was sampled again in late April, the TCE concentration was close to 1000 µg/L and remained in the 800 to 1200 µg/L range through the remainder 1999. The concentration of DCE also followed a similar pattern, increasing from less than 5 µg/L at the beginning of 1999 to about 40 µg/L in April, and remained at 40 to 50 µg/L through the end of 1999, with one exception of 73 µg/L reported in September.

The mass of TCE and DCE removed by the off-site containment system each month, and during the entire 1999 operating year, were estimated using these influent concentration data and the monthly discharge volumes presented on Table 4.1. These estimates, which are summarized on Table 5.1, indicate that the off-site containment system removed approximately 375 kg

(825 lbs) of contaminants, consisting of approximately 360 kg (790 lbs) of TCE and 15 kg (35 lbs) of DCE.

5.1.2.2 Groundwater Quality

Plots of TCE, DCE, and TCA concentrations were prepared for a number of on-site and off-site wells to evaluate long-term water-quality changes at the Sparton site. Plots for on-site wells are shown in Figure 5.14a and plots for off-site wells in Figure 5.14b. The concentrations in the on-site wells (Figure 5.14a) indicate a general decreasing trend; in fact, the data from wells MW-9 and MW-16, which have the longest record, suggest that this decreasing trend may have started before 1983. A significant decrease in concentrations occurred in wells MW-16 and MW-21 during the last year and a half. These two wells are located near the area of the SVE system operations and it is apparent that they have been influenced by the 1998 and 1999 SVE operations.

A plot for well MW-72 is also included in Figure 5.14a. Well MW-72 (see Figure 2.3 for well location) was installed in late February 1999 to provide a means for assessing whether source areas exist outside the capture zone of the source containment well that will be installed downgradient from the Sparton property. The well was sampled three times, in March, May, and November 1999; the TCE concentrations were 1800, 1800, and 1200 μg/L, respectively. With these limited data, it is premature to reach any conclusions concerning the potential presence of unknown sources on the Sparton property.

The concentrations in most off-site wells (see Figure 5.14b) also had a decreasing trend during the last three to five years. Concentrations in wells MW-55, MW-56, MW-58 and MW-61 appear to have peaked between 1995 and 1997, and are declining currently. Concentrations in well MW-60, however, increased significantly during the last seven years. The concentration of TCE in this well increased from low μg/L levels in 1993 to 11,000 μg/L in November 1999. Although the concentrations of all three constituents, TCE, DCE, and TCA, in this well appear to be leveling off, the well may have not yet reached its peak concentration.

The Fourth Quarter 1999 water-quality data presented in Table 4.3 were used to prepare concentration distribution maps showing conditions near the end of 1999. The horizontal extent of the TCE, DCE and TCA plumes, and the concentration distribution within the plumes in November 1999 are shown in Figures 5.15, 5.16, and 5.17, respectively. Changes in concentrations between November 1998 (Figures 2.14, 2.15 and 2.16) and November 1999 are shown in Figures 5.18, 5.19, and 5.20. Also shown on these figures is the trace of the November 1998 extent of the plumes. The change in concentration maps show that concentrations of all three constituents have decreased on the Sparton facility. Concentrations of TCE and DCE also appear to have decreased near the center of the plume (in the off-site area, TCA does not occur above MCLs). The absence of TCE in well MW-65, causes the leading edge of the 1999 TCE plume to be narrower, well within the capture zone of the off-site containment system. Increases in TCE and DCE concentration have occurred downgradient from the Sparton facility and in the vicinity of well MW-60 and the containment well.

5.2 Evaluation of SVE Operation

The AcuVac system was operated for 42 days in the spring of 1999 at a flow rate of 50 cfm. The initial influent concentration was 40 mg/m^3 and the final concentration was estimated to be 7.5 mg/m^3. The analysis of data from the period April - October 1998 (see Figure 2.8) indicates that the logarithm of the influent concentration varies linearly with the logarithm of time. A logarithmic plot of the initial and final concentrations was prepared, as shown in Figure 5.21, to estimate the average concentration during the system operation and to calculate the mass recovery by the system. The TCE mass removal was calculated to be about 1 kg. Since the influent concentrations during this operation of the system were sufficiently low, the AcuVac system was suspended in favor of the direct-discharge, higher capacity Roots blower system.

The 200 cfm Roots blower system was operated for 58 days in the summer of 1999 between June 28 and August 25. The initial influent concentration was 30 mg/m^3, and the final concentration was 6.4 mg/m^3. Using an approach similar to that described above (see Figure 5.22), the mass of TCE removed during the operation of this system was estimated to be about 4 kg.

The TCE mass removed by the 1998 operation of the AcuVac system was estimated to be about 145 kg (see Section 2.4). Thus, the total mass removal by SVE system operation in 1998 and 1999 was about 150 kg of TCE.

On August 31, 1999, subsequent to the AcuVac system and the 200-cfm Roots blower operation, a final characterization of the vadose zone plume was conducted. This included soil-gas sampling at VR-1, VR-2, VP-4, VP-9, VP-10 and MW-18, the locations that had exhibited soil-gas concentrations greater than 10 ppmv prior to the 1999 SVE operations. The results of this characterization are shown in Figure 5.23.

As shown on Figure 5.23, the only location where soil gas concentrations were above the remediation goal of 10 ppmv was monitoring well MW-18. The sample from this well was obtained from just above the water table and had a maximum constituent concentration of 27 ppmv of TCE;this soil-gas concentration is about 34 percent of the phase-equilibrium concentration based on the groundwater concentration of 980 μg/L at that same well. This suggests that the source of TCE detected in the soil gas at this location is volatilization from groundwater. (Under the terms of the Consent Order; however, another 200 cfm Roots blower was installed on the site in the spring of 2000 and a robust system began operating on April 10, 2000 at a flow rate of 400 cfm.)

5.3 Site Permits - Off-Site Containment System

The infiltration gallery associated with the off-site containment system is operated under State of New Mexico Groundwater Discharge Permit DP-1184, which specifies a total chromium concentration of 0.05 mg/L. During 1999, the total chromium concentration in the influent increased from about 0.02 mg/L in January to near 0.05 mg/L in May where it has remained through December 1999. Beginning in December 1999, more intense sampling for chromium was initiated. A chromium-reduction process will be added to the treatment system in 2000.

The air stripper associated with the off-site containment system is operated under City of Albuquerque Air Quality Source Registration No. 00442. The initial air stripper compliance testing indicated that TCE and DCE stack concentrations are sometimes slightly above those described in the registration. The slight increase in concentrations is due to a lower air to water ratio in the air striper than was predicted in the registration. In the final design of the air stripper, a lower air to water ratio was achieved (which saves electrical energy) by using a physically larger stripper with a smaller blower, and still meeting the effluent water-quality standards.

The mass emission rates from the air stripper are substantially lower than the predicted rates. The reason for these lower-than-predicted rates is because the system is treating 225 gpm rather than the predicted 600 gpm. These performance data were reported to the Albuquerque Air Quality Division in June 1999, and no modifications to the registration were requested.

5.4 Contacts

During 1999 Baird Swanson (NMED Groundwater Bureau) made several routine visits to the site to obtain split samples from the off-site containment system and from the SVE system.

Section 6
Groundwater Flow and Transport Model

This section describes the development of a numerical groundwater and contaminant transport model of the aquifer system underlying the Sparton site and its vicinity. This model was developed following the general outline described in Task 3 of the "Work Plan for the Assessment of Aquifer Restoration" (SSP&A, 1999), which has been incorporated as Appendix D in the Consent Order. The groundwater flow component of the model is based on the MODFLOW96 simulation code developed by the U.S. Geological Survey (Harbaugh and McDonald, 1996). This flow model has been calibrated to water-level data obtained from a period prior to the operation of the off-site containment well and to water-level data collected ten months after operation of the off-site containment well began operation. The flow model has been coupled with the solute transport simulation code $MT3D^{99}$ for the simulation of constituents of concern underlying the site. The model has been used to simulate TCE concentrations in the aquifer from start-up of the containment well in December 1998 through November 2000. The model closely simulates the observed TCE concentrations at the containment well and the mass removal of TCE at this well during the first year of well operation.

6.1 Groundwater Flow Model

6.1.1. Structure of Model

The model area and model grid are presented on Figure 6.1. The overall model dimensions are 8050 feet by 7300 feet. The model consists of 88 rows and 114 columns. The fine model area consists of uniform discretization of 50 feet, covering an area of 4100 feet by 2600 feet. The grid spacing is gradually increased to 200 feet towards the limits of model domain. The model grid is aligned with principal axes corresponding to the approximate groundwater flow direction and plume orientation (45° clockwise rotation).

The model consists of 13 layers. The vertical discretization used in the model is shown on Figure 6.2. Layers 1 through 11 correspond to the unconfined surficial aquifer. Layers 1 and 2 are 5 feet thick, layers 3 through 7 are 10 feet thick, layers 8 and 9 are 20 feet thick, and layers 10 and 11 are 40 feet thick. Layer 12 is a 4-foot-thick unit that represents the 4800-foot clay unit. Layer 13 represents the upper 10 feet of the aquifer underlying the 4800-foot clay unit. The vertical discretization was selected to minimize vertical numerical dispersion.

Boundary Conditions

The northwest and southeast model domain boundaries are constant head boundaries. The constant head boundaries were set by fitting a surface to the observed groundwater level measurements and extrapolating to the edges of the model domain. The northeast and southwest model boundaries are specified as no-flow boundaries (Figure 6.1).

The fitted water-level surface was calculated from water levels from monitoring wells screened approximately 30 feet below the water table, generally referred to as the ULFZ. This calculated water-level surface was assumed to represent heads in model layer 5 and was used to specify the constant-head boundaries in layer 5. The constant heads in layers 1 through 4 and 6 through 11 were calculated based on the constant heads specified in layer 5 and a downward vertical gradient of 0.002. This vertical gradient is the average observed vertical gradient prior to operation of the containment well. Constant heads in layer 12 were based on an assumed head drop of 6 feet across the 4800-foot silt/clay unit. The constant heads in layer 13 were calculated based on those in layer 12 and a downward vertical gradient of 0.002. Figure 6.2 presents a schematic of the vertical model layers and the specified vertical head change.

Hydraulic Properties

Four different zones of hydraulic conductivity were specified within the model domain:

- Holocene channel and flood plain deposits, also referred to as Recent Rio Grande deposits;
- The 4970-foot silt/clay unit;
- Sands of the Upper Santa Fe Group, Late-Pleistocene channel and flood plain deposits, and Late-Pleistocene and Holocene arroyo fan and terrace deposits, collectively referred to as the sand unit; and
- The 4800-foot clay unit.

The sand unit is primarily classified as USF2 facies assemblages 2 and 3 (Hawley, 1996). Locally, near the water table, in some areas, the sands and gravels are classified as USF4 facies assemblages 1 and 2. In areas where the 4970-foot silt/clay unit is present, the sands and gravels overlying this unit are Late-Pleistocene arroyo fan and terrace deposits. The 4970-foot silt/clay unit represents Late-Pleistocene overbank deposits. The 4800-foot clay unit is included in the USF2.

The spatial extent of the recent Rio Grande deposits and the 4970-foot silt/clay unit are shown on Figure 6.3. The following table summarizes the initial estimates of hydraulic conductivities and vertical extent:

Hydrogeologic Zone	Horizontal Hydraulic Conductivity (ft/d)	Vertical Hydraulic Conductivity (ft/d)	Present in Model Layers
Sand unit	25	0.114	1-11,13
Recent Rio Grande deposits	25	0.114	1-6
4970-foot silt/clay unit	0.085	0.00085	2.3
4800-foot clay unit	0.017	0.00017	12

The horizontal hydraulic conductivity of the sand unit is based on the transmissivity of 4250 ft^2/d, determined from an analysis of water-level data from October 1999 in the vicinity of the containment well (CW-1) and a unit saturated thickness of 170 feet. The vertical hydraulic conductivity of sand unit was estimated from the observed rate of water table decline (0.65 ft/yr), the observed vertical gradient (0.002), and a specific yield of 0.2.

The hydraulic conductivity of the Recent Rio Grande deposits was specified identical to that in the sand unit because the litholigies of the two units are similar and the constant head conditions specified at the edge of the model domain do not account for a change in hydraulic conductivity.

The vertical hydraulic conductivity of the 4970-foot silt/clay unit was specified as 8.5×10^{-4} ft/d. The vertical hydraulic conductivity of the 4800-foot clay unit was specified as 1.7×10^{-4} ft/d. This value is based upon the Darcy flux calculated from the vertical hydraulic conductivity of the surficial aquifer and a head loss of 5 feet across the clay unit. The horizontal hydraulic conductivity of both units was specified on the basis of $K_v/K_h = 0.01$.

Sources and Sinks

The groundwater sinks in the model domain are containment well CW-1 and eight on-site shallow wells (PW-1, MW-18, and MW-23 through MW-28) that are used for remedial extraction. The containment well has been in operation since December 31, 1998 with a brief shut down in April 1999. This well is set to pump at 225 gpm, and the average pumping rate between January and November 1999 was about 219 gpm. The pumping at CW-1 is distributed across model layers 5 through 12 and is apportioned based on layer transmissivities. The discharge from well CW-1 to the infiltration galleries is simulated using wells injecting into layer 2. The discharge flow is distributed across the area of the galleries.

The shallow extraction wells were operated from December 1988 to November 1999. Total extraction rates from the wells declined with time. The average pump rate was 0.26 gpm in 1999. Since discharge from the shallow extraction wells was to the city sewer, infiltration of this water was not simulated in the model.

Infiltration of precipitation is considered to be negligible due to high evapotranspiration and low precipitation. Recharge was assumed to occur from the Arroyo de las Calabacillas, the Corrales Main Canal, and irrigated fields. The recharge rate for the arroyo and the canal was estimated in the model calibration process described below. The calibrated recharge rate from the arroyo and the canal was 10 ft/yr. Recharge from the irrigated fields east of the Corrales Main Canal was simulated at a rate of 1 ft/yr. Recharge was applied to the highest layer active within the model.

The ratio of the arroyo and canal areas to the area of each finite-difference cell was calculated and applied as a multiplication factor to the recharge rate. The width of the arroyo, which is approximately 100 to 150 feet, was calculated from a topographic map. For the canal, a uniform width of 10 feet was used.

6.1.2 Model Calibration

The groundwater flow model was calibrated to two sets of groundwater levels. The model was calibrated to water levels prior to the start of pumping at well CW-1 (4th Quarter, November 1998, Table 2.4), and to water levels recorded 10 months after the start of pumping at well CW-1 (October 28, 1999, Table 4.1). The groundwater levels measured during these two time periods were applied as model calibration targets. The calibration targets were assigned to the model layer corresponding to the location of the screened interval of the monitoring well. When the screened interval spanned multiple model layers, the target layer was determined based on the midpoint of the screened interval.

Model calibration consisted of a systematic, iterative variation of the model input parameters within physically realistic bounds. The input parameters that were adjusted during model calibration included the hydraulic conductivity of the 4970-foot silt/clay unit and the 4800-foot clay unit, the head drop across the 4800-foot clay unit, and the recharge rate along the arroyo. These parameters were adjusted until a reasonable match between observed and calculated water levels was obtained for both calibration time periods.

The final calibrated model consists of the following hydraulic conductivity distribution (adjustments from initial estimates are indicated in bold text):

Unit	Horizontal Hydraulic Conductivity (ft/d)	Vertical Hydraulic Conductivity (ft/d)	Present in Model Layers
Sand unit	25	0.114	1-11,13
Recent Rio Grande deposits	25	0.114	1-6
4970-foot silt/clay	0.085	0.00085	2,3
4800-foot clay	0.0170	**0.000017**	12

In addition, the assumed head drop across the 4800-foot clay unit was increased from 5 feet to 6 feet.

Model calibration was evaluated using both qualitative and quantitative measures. The calculated water levels and groundwater flow directions were visually compared to observed groundwater levels and flow directions. The computed water levels for the October 1999 calibration simulation are presented on Figures 6.4, 6.5, and 6.6 for the UFZ, the ULFZ, and the LLFZ, respectively. The calculated water levels closely match the observed water levels shown on Figures 5.10, 5.11, and 5.12. The calculated water levels for the UFZ are based on calculated water levels in model layers 1 through 4 and represent the simulated water table. Calculated water levels for the ULFZ are based on average simulated water levels in model layers 5 and 6, representing an elevation of 4940 feet MSL. The calculated water levels for the LLFZ are based on average simulated water levels from model layers 8 and 9, representing an elevation of approximately 4900 feet MSL.

A scatter plot of observed versus calculated water levels also was used to provide a visual comparison of the fit of the calibrated model. For a calibrated model, the points on the scatter plot should be randomly and closely distributed about the straight line that represents an exact match between the calculated and observed groundwater levels. Scatter plots are shown on Figures 6.7 and 6.8 for the calibration simulations corresponding to November 1998 (pre-remedial pumping) and October 1999 (after initiation of remedial pumping), respectively. These scatter plots visually illustrate the excellent comparison between model calculated water levels and observed water levels.

The quantitative evaluation of the calibration consisted of examining the calibration target residuals. The calibration target residual is defined as the observed water level minus the calculated water level. To quantify calibration error, three statistics were calculated for the calibration residuals: the mean of the residuals, the mean of the absolute value of the residuals, and the sum of squared residuals. The calibration residuals and residual statistics are presented on Tables 6.1 and 6.2 for the November 1998 and October 1999 calibration simulations, respectively. The residual means are 0.05 feet and –0.17 feet for the November 1998 and October 1999 simulations, respectively. The near-zero value of the mean residuals demonstrates that there is no systematic bias in the calibration. The absolute residual means of 0.49 foot and 0.74 foot for the two simulations indicate that the mean calibration error is approximately 0.6 foot. This absolute error is considered acceptable since the observed water-level measurements applied as calibration targets have a total range of 21.58 feet and 22.68 feet for the November 1998 and October 1999 simulations, respectively, and seasonal fluctuations of water levels are on the order of 2 to 3 feet.

6.1.3 Capture Zone Analysis

The capture zone of well CW-1 was calculated with particle tracking simulations. The simulations were based on the steady-state October 1999 water-level simulations, which used a pumping rate of 225 gpm at well CW-1. The particle tracking was carried out using PATH3D (Zheng, 1991). The calculated particle tracks and capture zone for well CW-1 are presented on Figures 6.4, 6.5, and 6.6 for the UFZ, the ULFZ, and the LLFZ, respectively.

6.2 Solute Transport Model

A solute transport model was linked to the groundwater flow model to simulate the concentration of constituents of concern at the site. The three-dimensional contaminant transport simulation code MT3D^{99} (Zheng and S.S. Papadopulos & Associates, 1999) was applied for this study. The model has been used to simulate TCE concentrations in the aquifer from start-up of the containment well CW-1 in December 1998 through November 2000.

Model input parameters were specified based on available data, and the TCE concentrations in the model domain at the start of the simulation period were estimated from November 1998 measured concentration data. The model was calibrated by adjusting the initial TCE concentration distribution until a reasonable match was obtained between the calculated and measured TCE concentrations and TCE mass removal at the containment well, CW-1, between December 1998 and November 1999. Once the model was calibrated, the model was used to simulate TCE concentrations in the aquifer between November 1999 and November 2000.

No attempt was made to simulate DCE and TCA. DCE is generally detected at monitoring wells where TCE is detected, but DCE concentrations are much lower than TCE concentrations. Downgradient of the facility, between the facility and the containment well, DCE concentrations are typically only 3 to 6 percent of the TCE concentrations. In monitoring wells at the facility, the ratio of DCE to TCE concentrations is higher, but is typically less than 20 percent. Because DCE concentrations are generally very low relative to TCE concentrations, and because DCE represents only about 5 percent of the total mass of chlorinated volatile organic compounds extracted at the containment well, simulation of DCE concentrations in the aquifer at this time would not add significantly to the understanding of the system.

The other constituent of concern, TCA, has been detected at concentrations greater than its Maximum Contaminant Level of 200 μg/L, only in monitoring wells at the facility. The limited distribution of TCA is the result of the abiotic transformation of TCA to acetic acid and DCE; a transformation that occurs relatively rapidly when TCA is dissolved in water. Only about 20 percent of TCA degrades to DCE, the rest degrades to acetic acid (Vogel and McCarty, 1987). In the future, the degradation of TCA will be simulated along with the simulation of DCE, if such simulations are warranted by the evaluations of progress in aquifer restoration. However, the current concentrations of TCA and DCE in monitoring wells at the facility indicate that it is not likely that DCE concentrations will increase significantly in the future as the result of TCA degradation.

6.2.1 Transport Parameters

A number of aquifer and chemical properties are required as input parameters for the contaminant transport simulation. The required aquifer properties are porosity and dispersivity. The required chemical properties are: (1) the fraction organic carbon, (2) the organic-carbon partition coefficient for the organic compound being simulated, and (3) the effective diffusion coefficient.

An effective porosity of 0.3 was used, a typical value for sand and gravel aquifers. This value represents about 75 percent of the total porosity (Detmer, 1995).

A value of 25 feet was specified as the longitudinal dispersivity. This is consistent with the findings of Gelhar et al. (1992), which suggest that longitudinal dispersivity values tend to plateau at an approximate value of 30 feet as the plume length exceeds 300 to 500 feet. Values of 0.25 foot and 0.025 foot were specified for the transverse horizontal dispersivity and for the transverse vertical dispersivity, respectively. These relatively low transverse dispersivities are appropriate for a well-characterized flow system using a model that has an appropriate vertical resolution.

A fraction organic-carbon content of 0.01 percent was assumed, consistent with the surficial aquifer which is comprised primarily of sand and gravel. An organic-carbon partition coefficient of 97 was used for TCE (USEPA, 1996). The calculated retardation coefficient is 1.06, based on the values for the fraction organic-carbon content and the organic-carbon partition coefficient, and a porosity of 0.3. Because the fraction organic-carbon content was estimated and the calculated retardation coefficient is small, the initial simulations were made assuming a retardation coefficient of unity.

The effective diffusion coefficient is defined as:

$$D^* = \tau \times D_0$$

where D_0 is the free-solution diffusion coefficient, and τ is the tortuosity. A free-solution diffusion coefficient for TCE of 10^{-5} cm^2/sec (9.3×10^{-4} ft^2/day) was used based on Myrand et al. (1987) . A tortuosity of 0.25, as suggested by Johnson et al. (1989), was used.

6.2.2 Initial Concentration Distribution

The initial TCE distribution was generated based on the November 1998 measured concentration data. An interpolated concentration distribution was created for each flow zone and the base of the contaminated zone using linear kriging of the log values of concentration. The zones for which concentration distributions were generated are the following:

- the upper flow zone (UFZ), corresponding to concentrations at the water table;
- the upper lower flow zone (ULFZ), corresponding to concentrations at an elevation of 4940 feet MSL;
- the lower-lower flow zone (LLFZ), corresponding to an elevation of 4920 feet MSL at the facility and an elevation of 4900 feet MSL west of the facility; and
- the base of the contaminated zone, corresponding to top of 4800-foot clay west of facility and an elevation of 4910 feet MSL at the facility.

The concentration distributions generated for these four zones were used as the basis for specifying initial concentrations at each node in the model domain. The concentrations generated for a given flow zone were assumed to represent concentrations on an approximately horizontal surface. These surfaces generally did not coincide with the node centers of the model grid and, therefore, the initial concentration at a given node was calculated by vertical linear interpolation of the log values of concentration corresponding to the overlying and underlying surfaces.

The concentration distribution for the UFZ was assumed to represent concentration at the water table as estimated based on November 1998 water levels at wells screened within the UFZ. The concentration distribution for the ULFZ was assumed to represent concentrations on a horizontal surface at an elevation of 4940 feet MSL. The concentration distribution for the LLFZ was assumed to represent concentrations on a horizontal surface at an elevation of 4920 feet MSL at the facility and at an elevation of 4900 feet MSL west of the facility. The concentration distribution for the bottom zone was assumed to represent concentrations on a horizontal surface at an elevation of 4910 feet MSL at the facility and at an elevation of 4800 feet MSL west of the facility. The 4910 feet MSL elevation at the facility is based on no detections of TCE in monitoring wells MW-38, MW-39, MW-40, and MW-70. A processor was developed to generate one horizontal concentration distribution for each model layer, representing the initial contaminant distribution for the transport model.

The concentration distributions calculated with the procedures described above resulted in an underestimation of the total TCE mass extracted at well CW-1. The likely reason for the underestimation of the TCE mass is that the kriging procedure leads to an underestimation of TCE concentrations along the center line of the plume. The procedure was modified by adding a number of control points along the center line of the plume to the monitoring well data for use in estimating the concentration distributions in each flow zone. The concentrations specified at the control points were varied during the model calibration process. The calibrated initial concentration distribution specified in the model is as follows:

Layer	Approximate TCE Mass (kg)	Maximum Concentration (µg/L)
1	2.1	6540
2	9.9	5298
3	44.2	1360
4	205.6	4172
5	414.7	7589
6	465.2	9447
7	310.7	6720
8	364.1	4033

Layer	Approximate TCE Mass (kg)	Maximum Concentration (μg/L)
9	178.7	1987
10	137.8	1005
11	45.3	411
Total	2178.3	-

6.2.3 Model Calibration

The constant head boundary conditions developed for the steady-state groundwater flow model simulations were applied to create a transient flow field corresponding to the period between November 1998 and October 1999. A linear change over time is assumed for the boundary conditions. The pumping rates specified for well CW-1 and the eight extraction wells at the facility are listed in Table 6-3.

The transport model calibration consists of adjustment of the initial contaminant concentration distribution (via adjustment of control points) to achieve a reasonable match between calculated and observed TCE concentration and mass removal at the containment well CW-1. The TCE concentration at well CW-1 was 190 μg/L in December 31, 1998 prior to pumping of the wells, which agrees closely with the calculated initial TCE concentration at well CW-1 of 187 μg/L. The observed concentration at well CW-1 in October 1999 was 890 μg/L, and the calculated TCE concentration for this period is approximately 900 μg/L. The actual mass of TCE removed through the end of October 1999 at the containment well, was approximately 290 kg whereas the calculated removal through October 28, 1999 is 307 kg. A comparison of computed to observed concentrations of TCE for November 1999 is presented on Figure 6.9. The general agreement between observed and computed concentrations is reasonable given the uncertainty of the initial contaminant distribution.

6.2.4 Predictions of November 2000 Concentration

The groundwater transport model was applied to predict TCE concentrations in November 2000 after 23 months of pumping at well CW-1. A transient groundwater flow simulation was set up to correspond to the period between November 1999 and November 2000. The boundary conditions applied to the calibrated October 28, 1999 groundwater flow model are applied as starting conditions. A water-table decline of 0.65 ft/yr was used to calculate model boundary conditions for November 2000. The water levels were assumed to decline linearly over time. The containment well CW-1 was assumed to pump at an average rate of 225 gpm, and the shallow extraction wells at the facility were assumed to be shutdown. The TCE concentrations calculated for November 1999 are specified as the initial conditions for the predictive groundwater transport model.

The predicted TCE concentrations are presented on Figure 6.10. The concentration distribution is based on the maximum TCE concentration simulated within any given layer. A mass removal of 403 kg of TCE is predicted for the period of November 1999 to November 2000. The calculated TCE concentration at well CW-1 in November 2000 is 701 µg/L. The initial TCE concentration used in the transport model, and the calculated TCE concentrations after 10 and 23 months of operation of well CW-1, are compared on Figure 6-11.

6.3 Future Simulations

The accuracy of this first modeling effort will be evaluated during the next 12 months based on the concentrations measured at the containment well and the monitoring wells. As new data are collected, the initial conditions and parameters in the model will be adjusted to improve the model. It is anticipated that as improvements are made to the flow and transport model, the model will become a reliable tool for predicting future water-quality conditions and assessing aquifer restoration.

Section 7
Conclusions and Future Plans

7.1 Summary and Conclusions

Sparton Technology, Inc. agreed to implement a number of remedial measures at its Coors Road Plant in Albuquerque, New Mexico under the terms of a consent decree entered on March 3, 2000. In 1999, significant progress was made in implementing and operating these remedial measures. These remedial measures have resulted in the containment of the plume at the site, the removal of a significant amount of mass from the plume of groundwater contamination, and a significant reduction in soil-gas concentrations in the on-site source areas.

The remedial measures undertaken in 1999 included the following:

- Between December 31, 1998 and April 14, 1999, and from May 6 through December 1999, the off-site containment well was operated at a rate sufficient to contain the plume. An air stripper for treating the pumped water and an infiltration gallery for returning the treated water to the aquifer were constructed in the spring of 1999. These systems were connected to the containment well and tested between April 14 and May 6, 1999.

- A 50-cfm AcuVac SVE system was operated at vapor recovery well VR-1 from May 12 through June 23, 1999, and a 200-cfm Root blower system was operated at this well from June 28 to August 25, 1999.

- Planning for the source containment system continued. A preliminary design of the system was completed, and applications were filed for the necessary permits, licenses, and approvals. The system, as currently designed, will consist of a source containment well to be located immediately downgradient from the Sparton plant, an air stripper, six infiltration ponds, three monitoring wells, and connecting pipelines. This system will replace the current on-site recovery system that was permanently shutdown on November 16, 1999 due to low recovery rates.

- Groundwater monitoring was conducted as specified in Attachment A to the Consent Decree. Water levels in accessible monitoring wells, the containment well, observation wells, piezometers, and the Corrales Main Canal were measured quarterly. Samples were collected for water-quality analyses from monitoring wells and from the influent and effluent of the air stripper at the frequency specified in the Consent Order. Water samples were analyzed for TCE, DCE, TCA and total and hexavalent chromium.

- A groundwater flow and transport model of the hydrogeologic system underlying the site was developed. The model was calibrated and used to simulate TCE concentrations in the aquifer from start-up of the containment well in December 1998 through November 2000. Several assumptions were made with respect to the TCE concentration distribution in the aquifer in order to simulate the observed TCE concentrations at the containment well and the mass removal of TCE at this well during the first year of well operation. Calibration and improvement of the model will continue next year.

A total of 115 million gallons were pumped at the off-site containment well during 1999. This pumped water represents about 10 percent of the volume of contaminated groundwater based on analysis of October 1998 water-quality data. Approximately 360 kg of TCE and 15 kg of DCE were removed from the aquifer by operation of the containment well. This represents about 17 percent of the total TCE mass (estimated using the flow and transport model) to be dissolved in the aquifer prior to operation of the containment well, and a similar percentage of the DCE mass.

The operation of the soil vapor extraction systems at vapor recovery well VR-1 in 1999 had a measurable impact on soil-gas concentrations in the vicinity of VR-1. Soil-gas concentrations decreased to less than 5 ppmv in monitoring wells in the vicinity of VR-1 (which had concentrations greater than 10 ppmv at the beginning of 1999). The total mass of TCE removed by the soil vapor extraction systems was about 4.5 kg in 1999. The only soil-gas monitoring location that had TCE soil-gas concentrations greater than 10 ppmv at the end of 1999 was at MW-18. A TCE concentration of 27 ppmv was measured at this location on August 31, 1999. The TCE in the soil-gas at this location is likely the result of volatilization of TCE from the water table; shallow groundwater at this location had a TCE concentration of 980 μg/L in the Fourth Quarter of 1999.

The volume of contaminated groundwater did not change significantly during 1999. Based on TCE data, the off-site portion of the plume has shifted slightly to the north, with a decrease in the contaminated area to the southwest of the containment well. The water-quality data indicate that TCE concentrations increased in an area adjacent to and northeast of the containment well. The data also indicate a significant increase in DCE concentrations in the vicinity of the containment well, indicating that the well is effectively capturing the leading edge of the DCE plume. Overall concentrations of the contaminants of concern declined on-site. These changes in on-site and off-site concentrations are directly attributable to the operation of the soil vapor extraction systems and the containment well.

The remedial systems were operated with only minor difficulties during 1999. One problem was the incorrect operation of a metering pump by adding anti-scaling chemicals to water from the containment well. The metering pump was replaced in December. A potential problem with the containment well was a steady increase in chromium concentrations from

0.02 mg/L at system start-up to near 0.05 mg/L from May through December. A more frequent sampling program was initiated to monitor the chromium concentrations.

7.2 Future Plans

The off-site containment system will continue to operate at the current rate of approximately 225 gpm. The more intense influent sampling program that was initiated in December 1999 to monitor chromium concentrations will continue. A chromium reduction process will be added to the treatment system in 2000.

Sparton will continue to pursue obtaining of all necessary permits, contracts, and license agreements necessary for the construction and operation of the source containment system. Upon obtaining all necessary documents and approvals, Sparton will implement and begin operating the system.

Data collection will continue in accordance with the Groundwater Monitoring Program Plan and site permits and as necessary for the evaluation of the performance of the remedial systems. As additional data are being collected, calibration and improvement of the flow and transport model developed to assess aquifer restoration will continue.

The robust 400-cfm SVE system consisting of two 200-cfm Roots blowers, which began operating on April 10, 2000, will continue to be operated for a net operating time of one year as specified in the Consent Decree.

Regulatory agencies will be kept informed of any significant milestones or changes in remedial system operations. The goal of the systems will continue to be the return of the contaminated groundwater to beneficial use.

Section 8
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FIGURES

S. S. PAPADOPULOS & ASSOCIATES, INC.

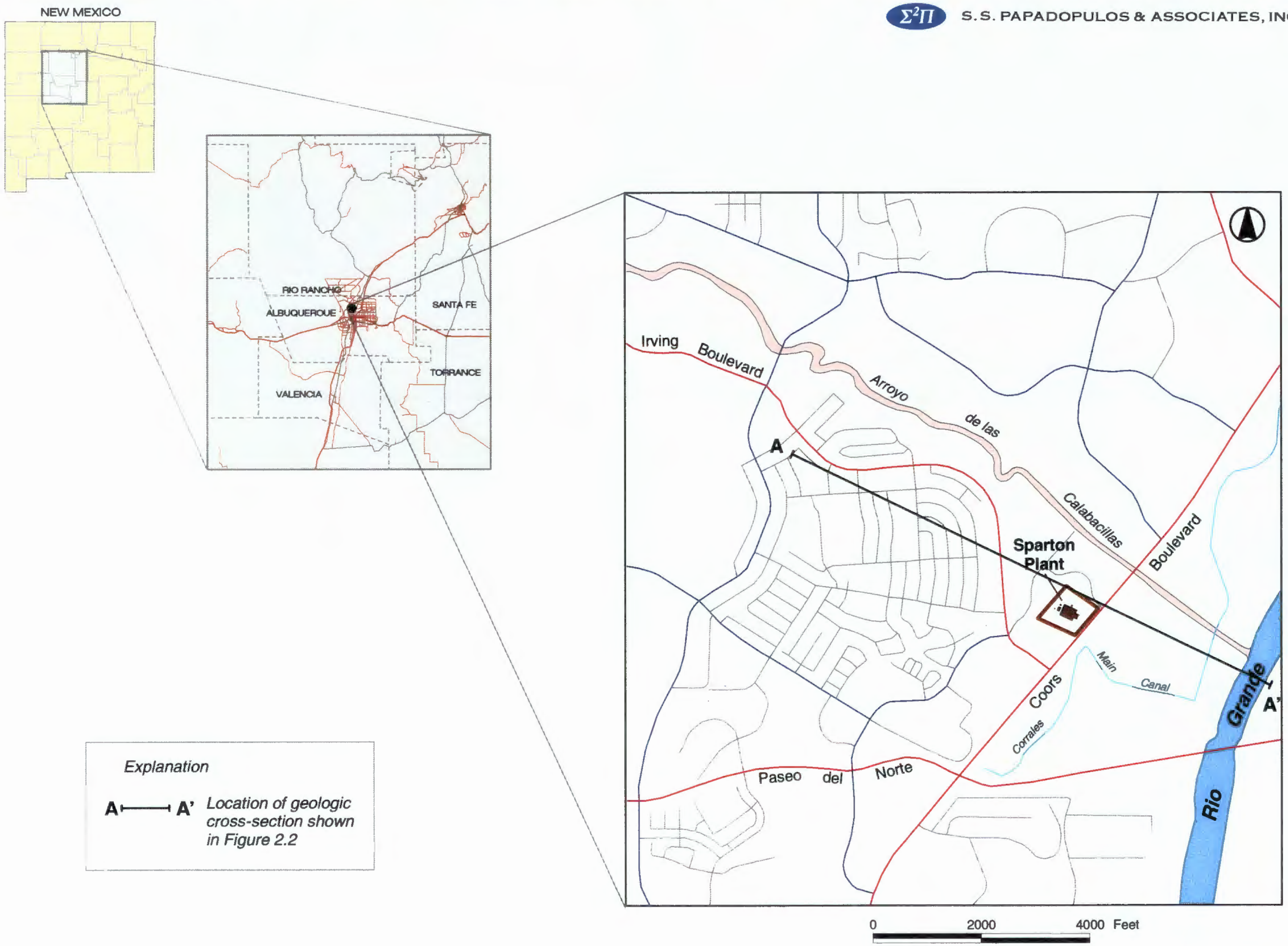


Figure 1.1 Location of the Sparton Coors Road Plant

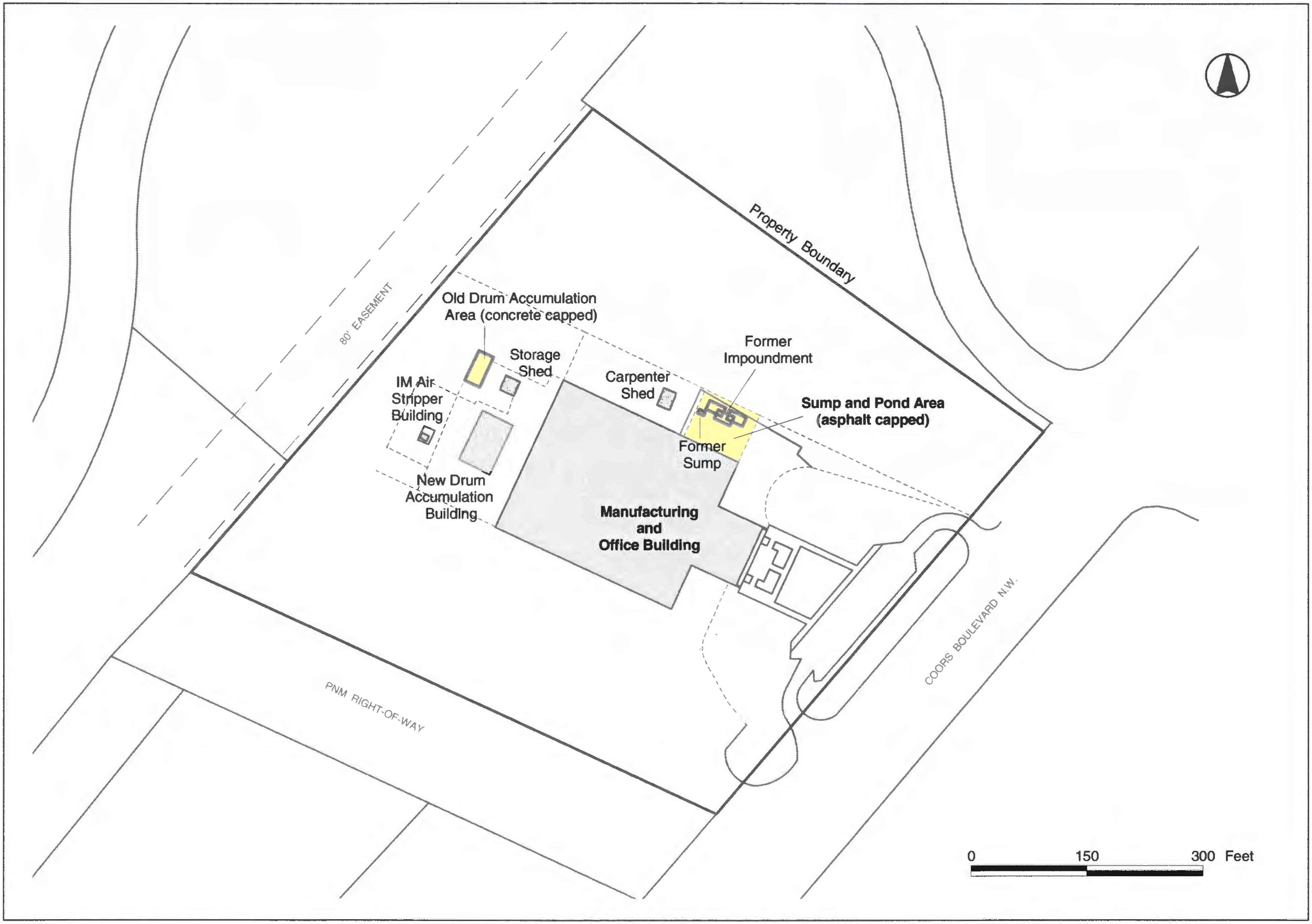
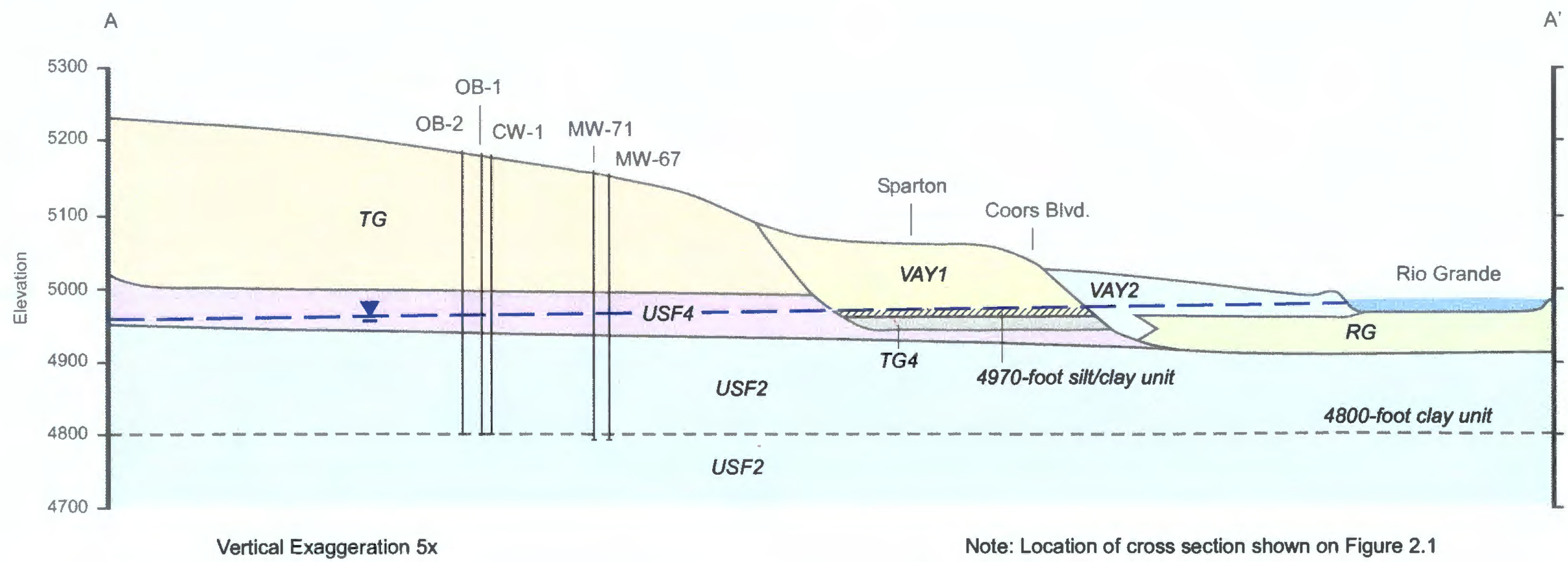


Figure 2.1 The Sparton Coors Road Plant



Explanation

RG	Holocene channel and flood plain deposits	*TG*	Middle Pleistocene undifferentiated deposits
VAY2	Holocene arroyo fan and terrace deposits	*USF4*	Pliocene Upper Santa Fe Group Western Basin fluvial facies
VAY1	Late Pleistocene arroyo fan and terrace deposits	*USF2*	Pliocene Upper Santa Fe Group Rio Grande facies
TG4	Late Pleistocene channel and flood plain deposits, upper portion is the 4970-foot silt/clay unit		

Figure 2.2 Geologic Cross Section Showing Shallow Deposits

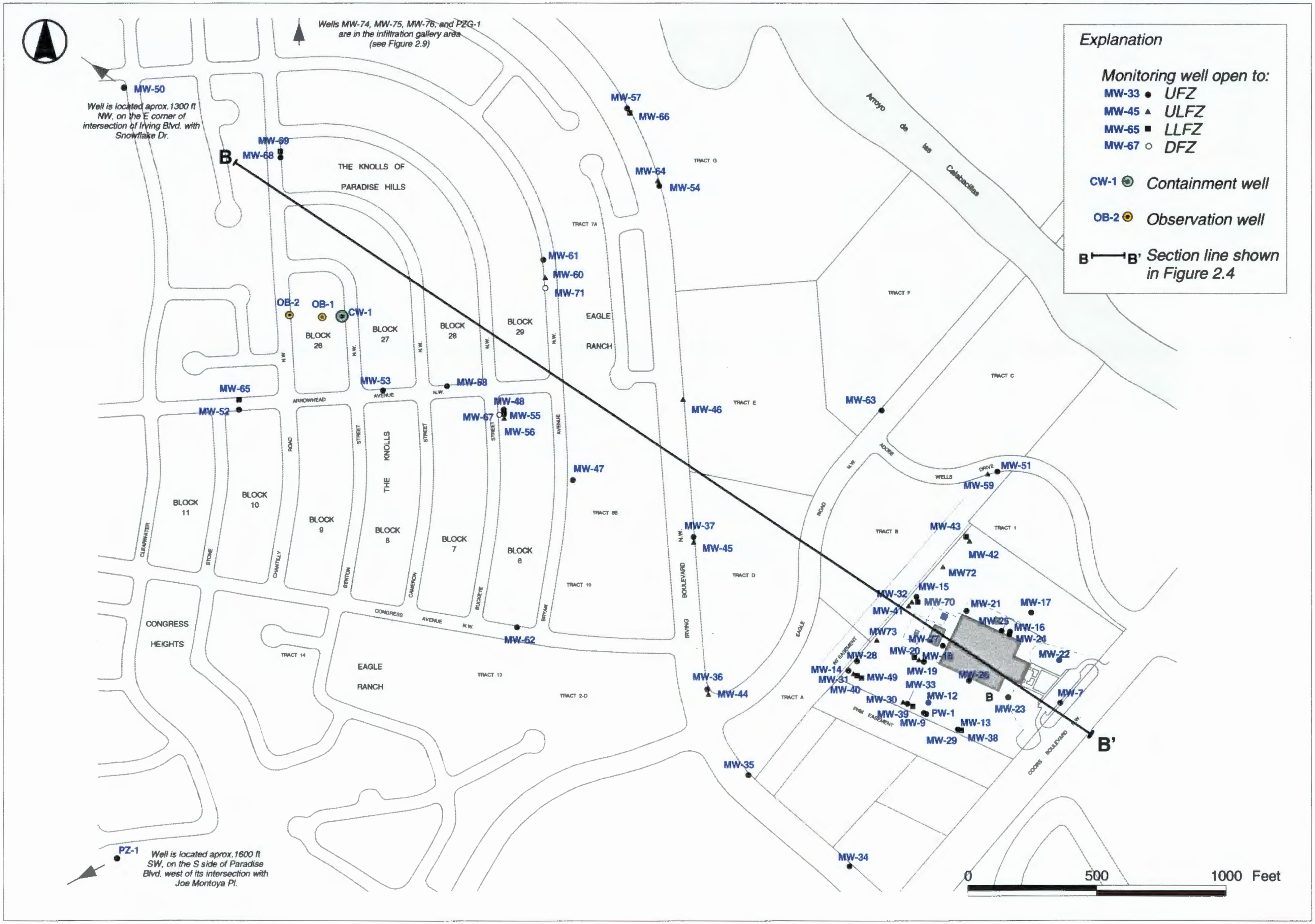


Figure 2.3 Location of Wells

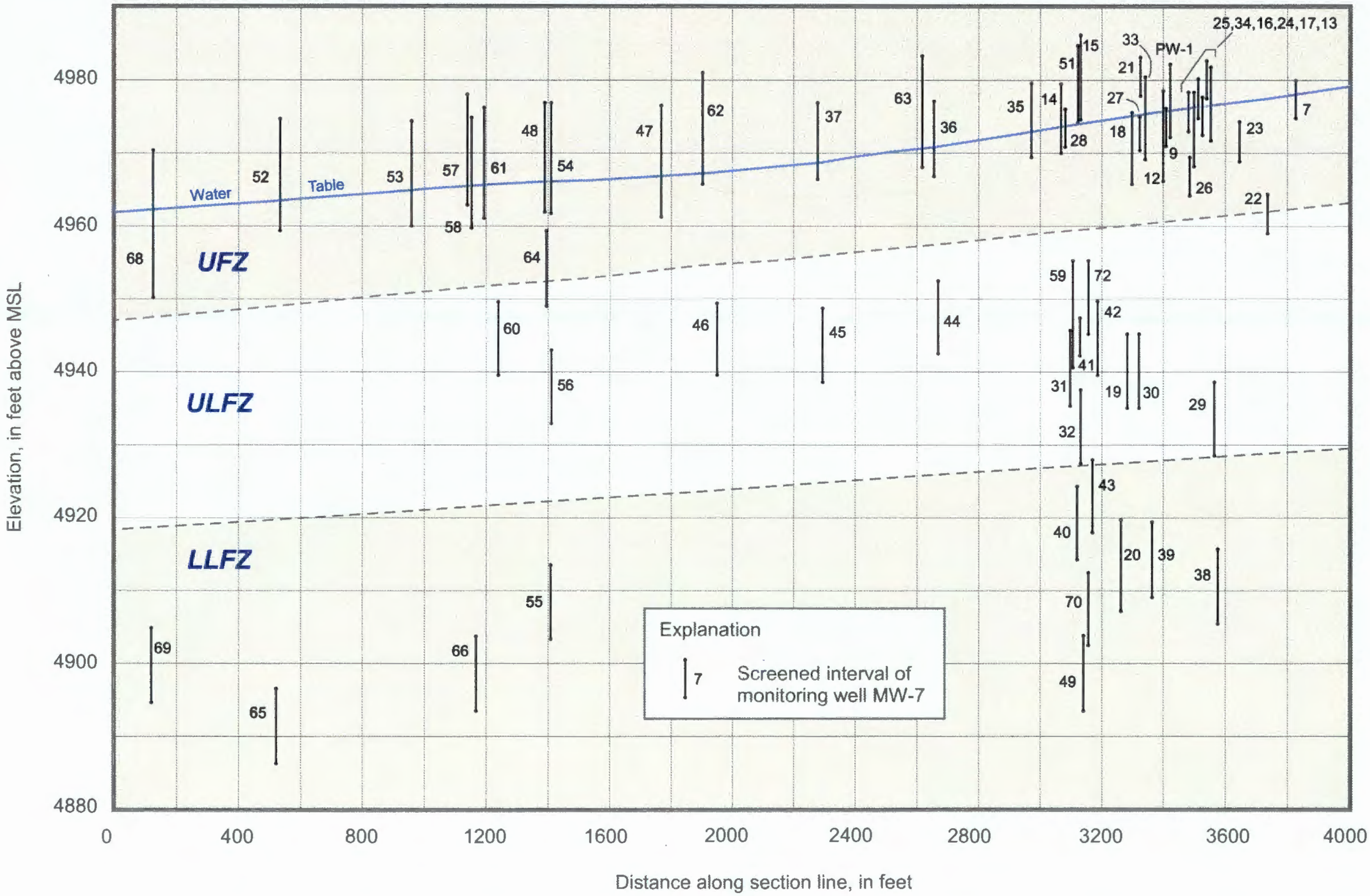


Figure 2.4 Screened Interval of Monitoring Wells and Relation to Flow Zones

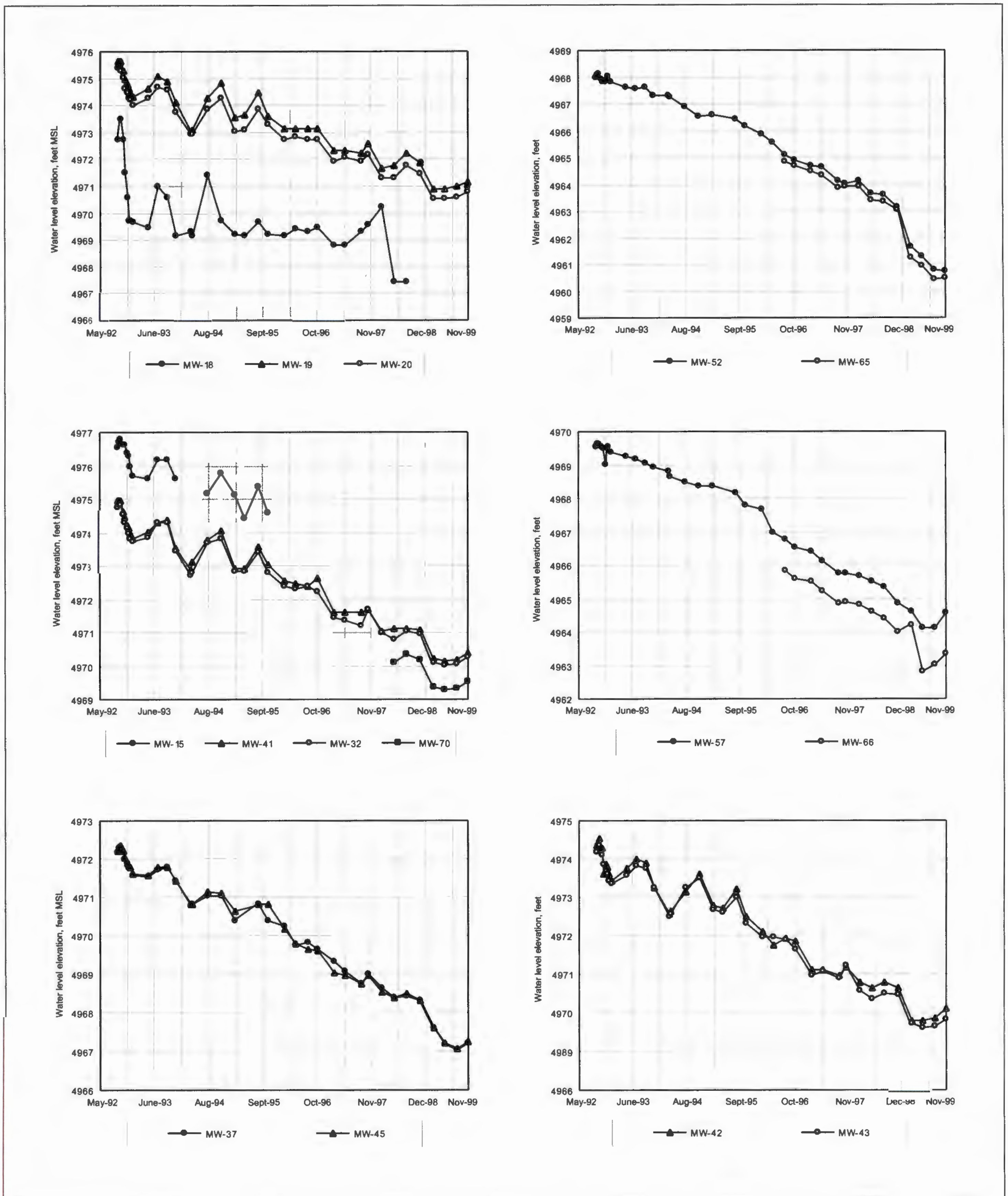


Figure 2.5 Monitoring Well Hydrographs

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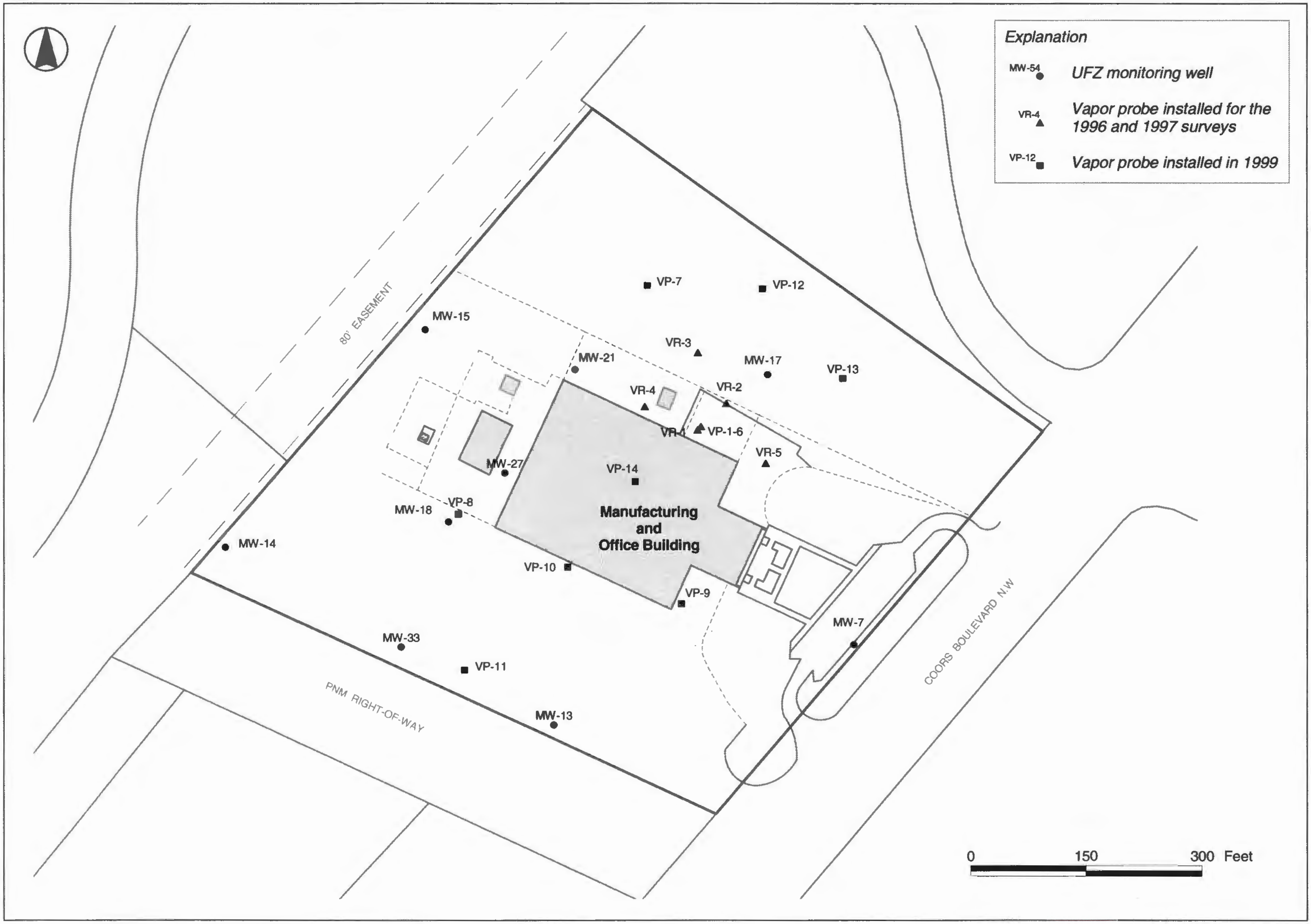

Figure 2.6 Location of Vapor Probes and On-Site Monitoring Wells Used in Vadose Zone Characterizations

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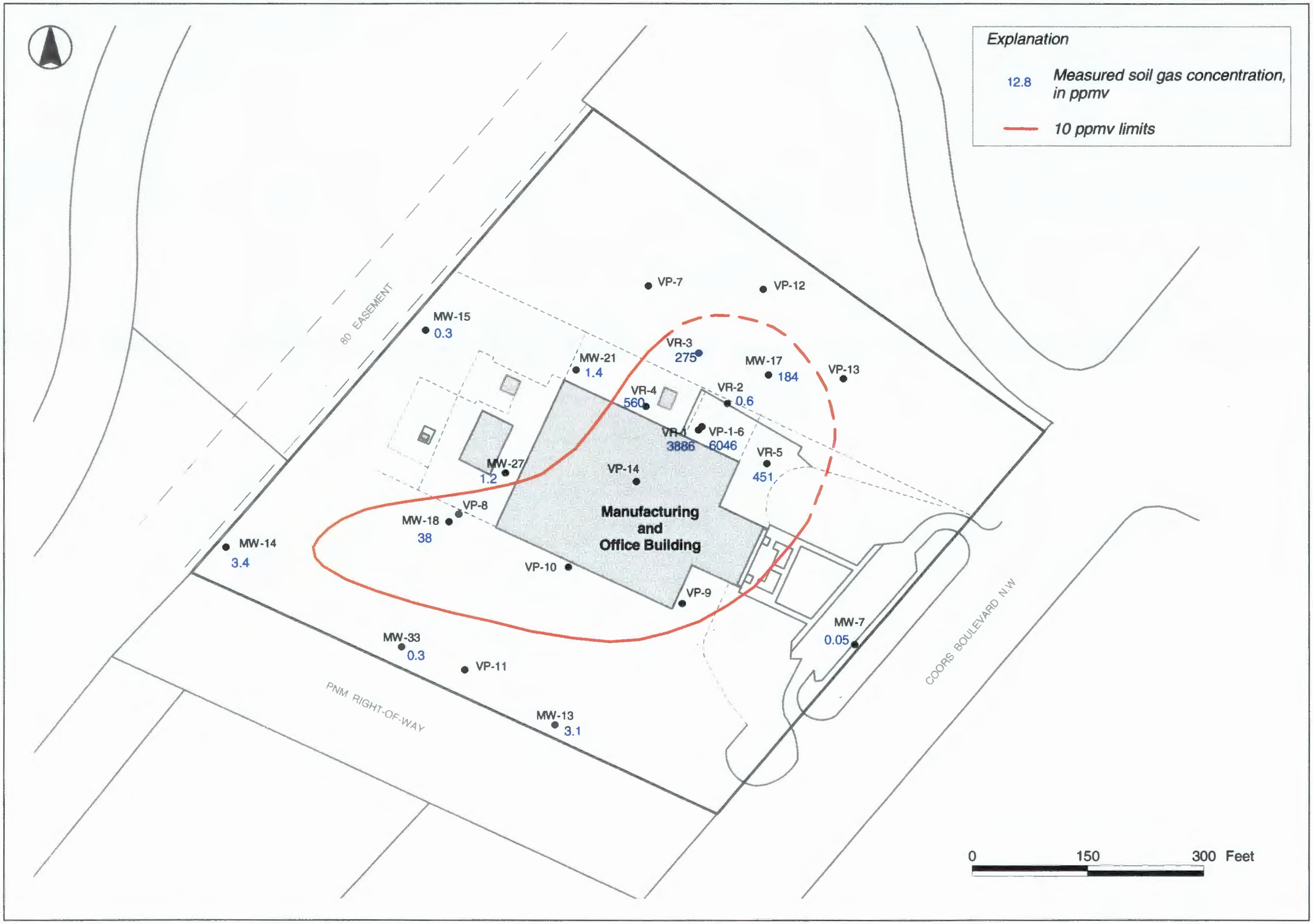

Figure 2.7 TCE Concentrations in Soil Gas - April 1996 - February 1997 Survey

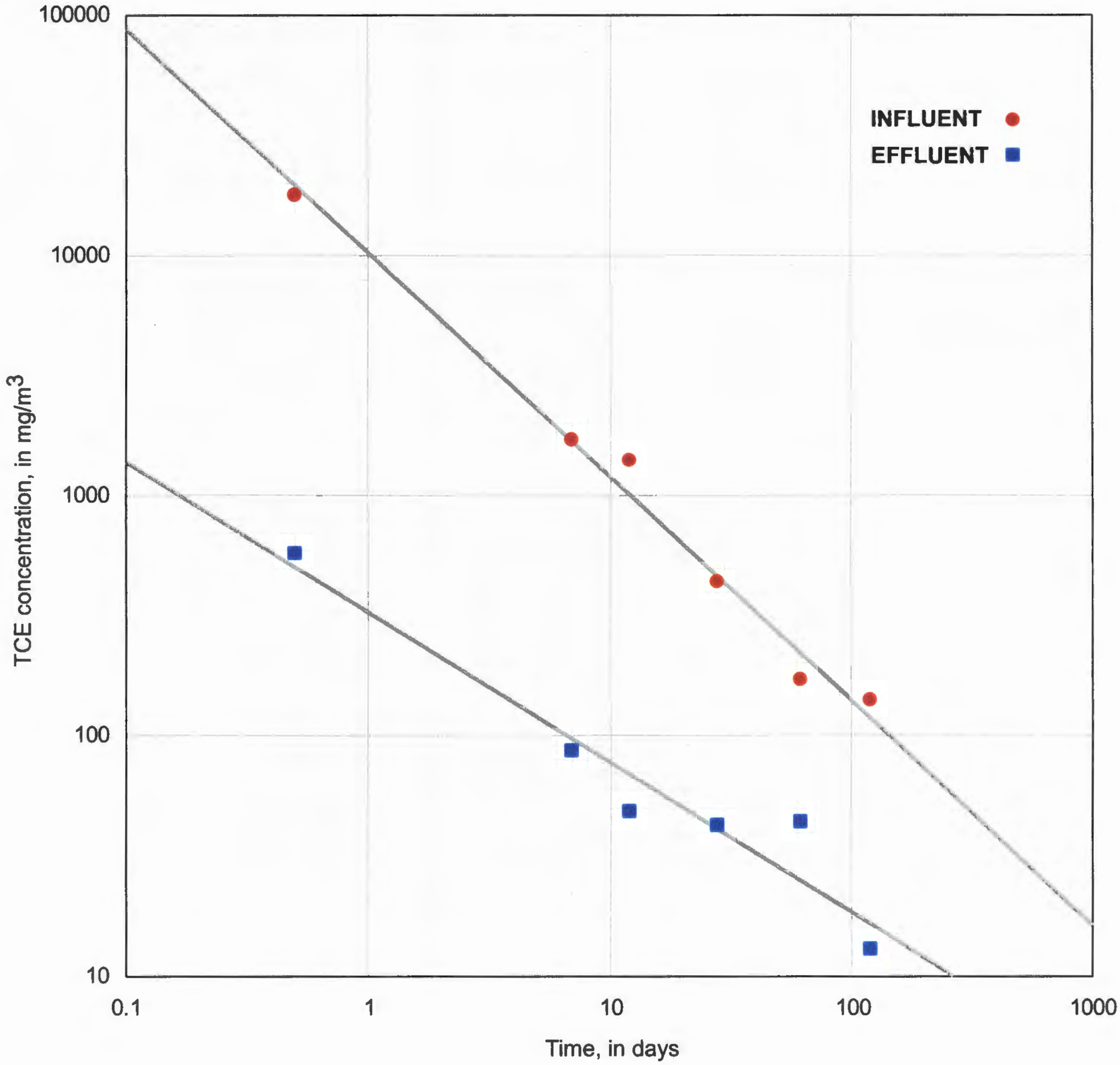

Figure 2.8 Influent and Effluent Concentrations - SVE Operation
April 8 - October 20, 1998

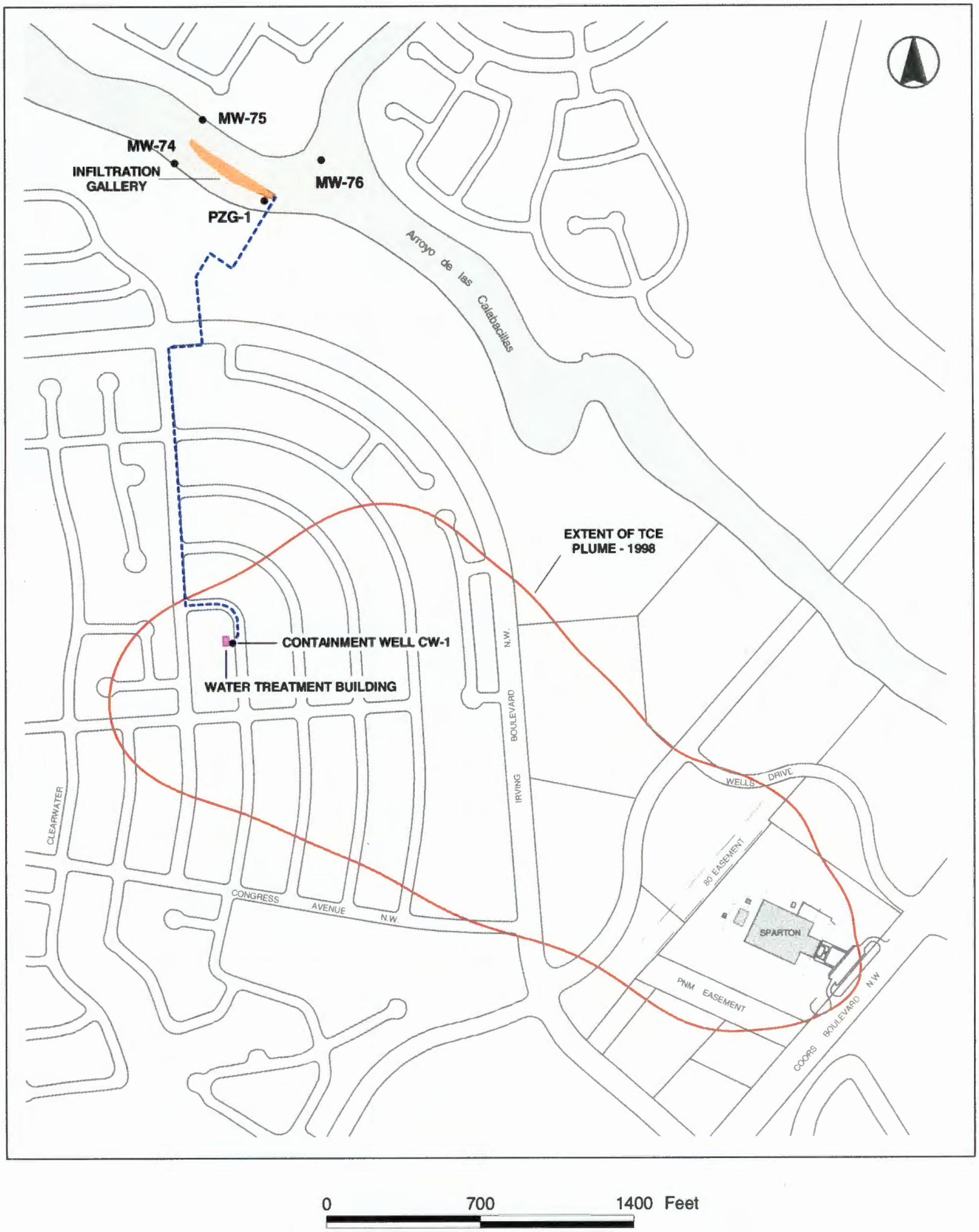

Figure 2.9 Location of the Off-Site Containment System Components

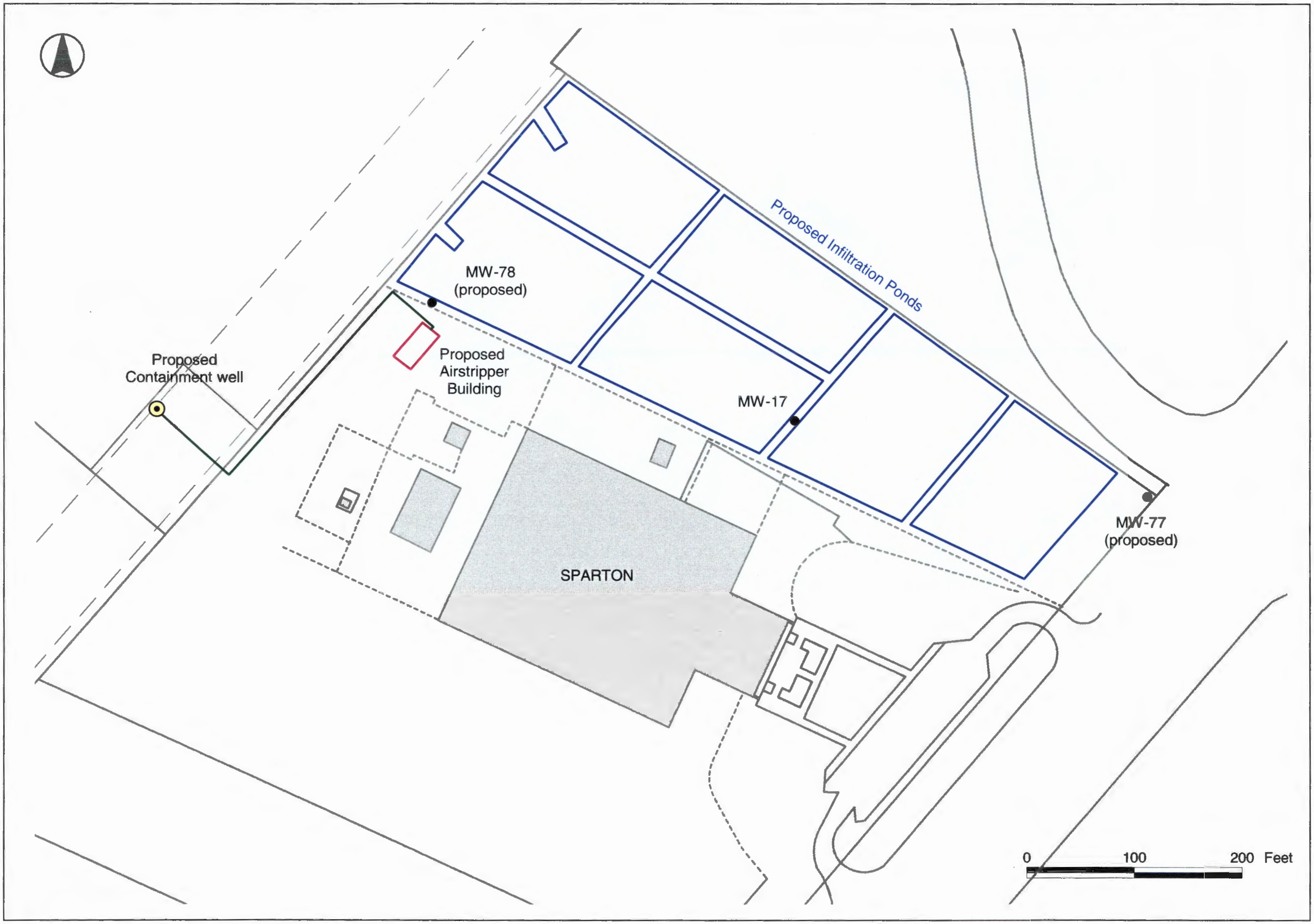

Figure 2.10 Proposed Layout of Source Containment System

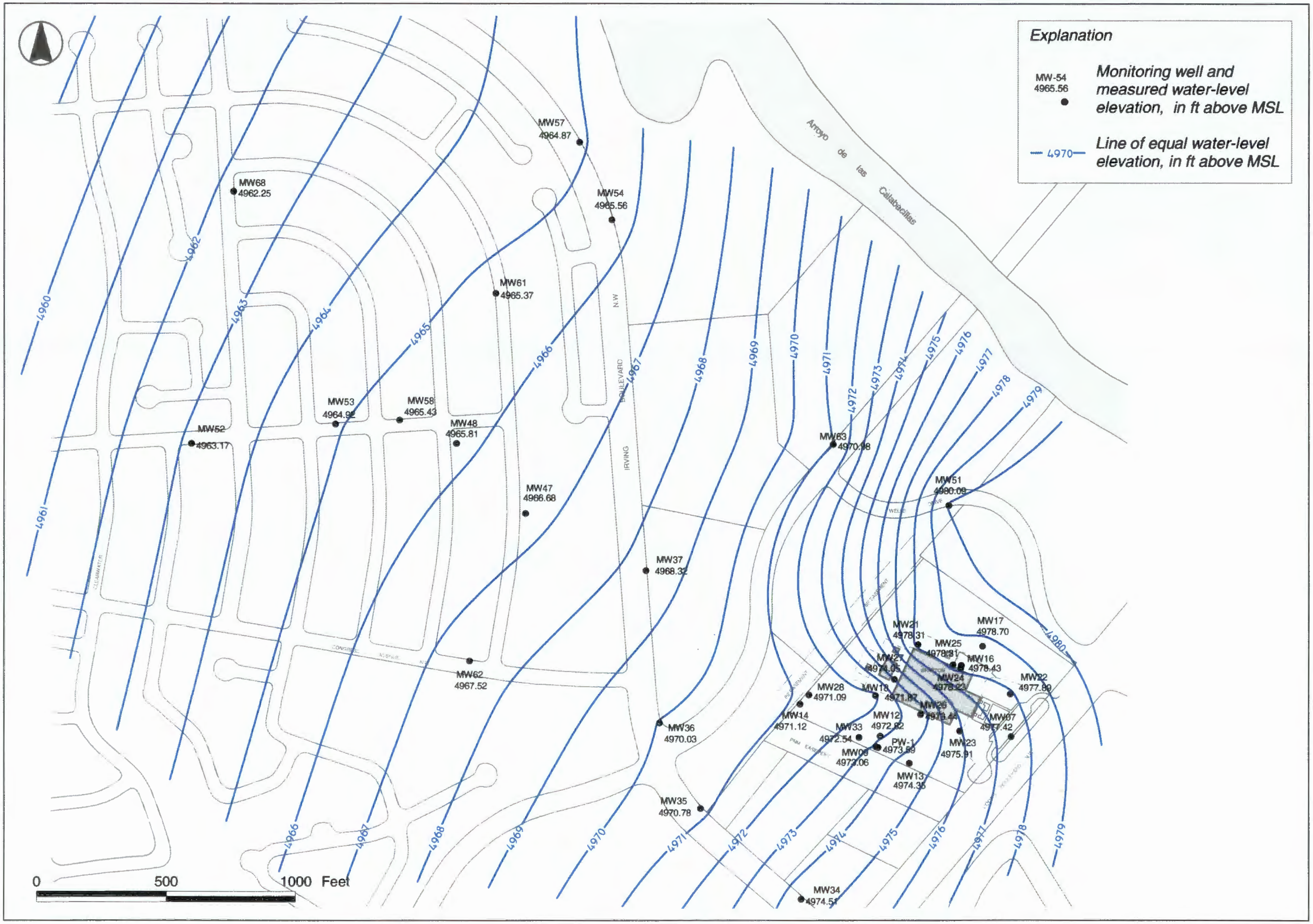

Figure 2.11 Elevation of the Water Table (UFZ) - November, 1998

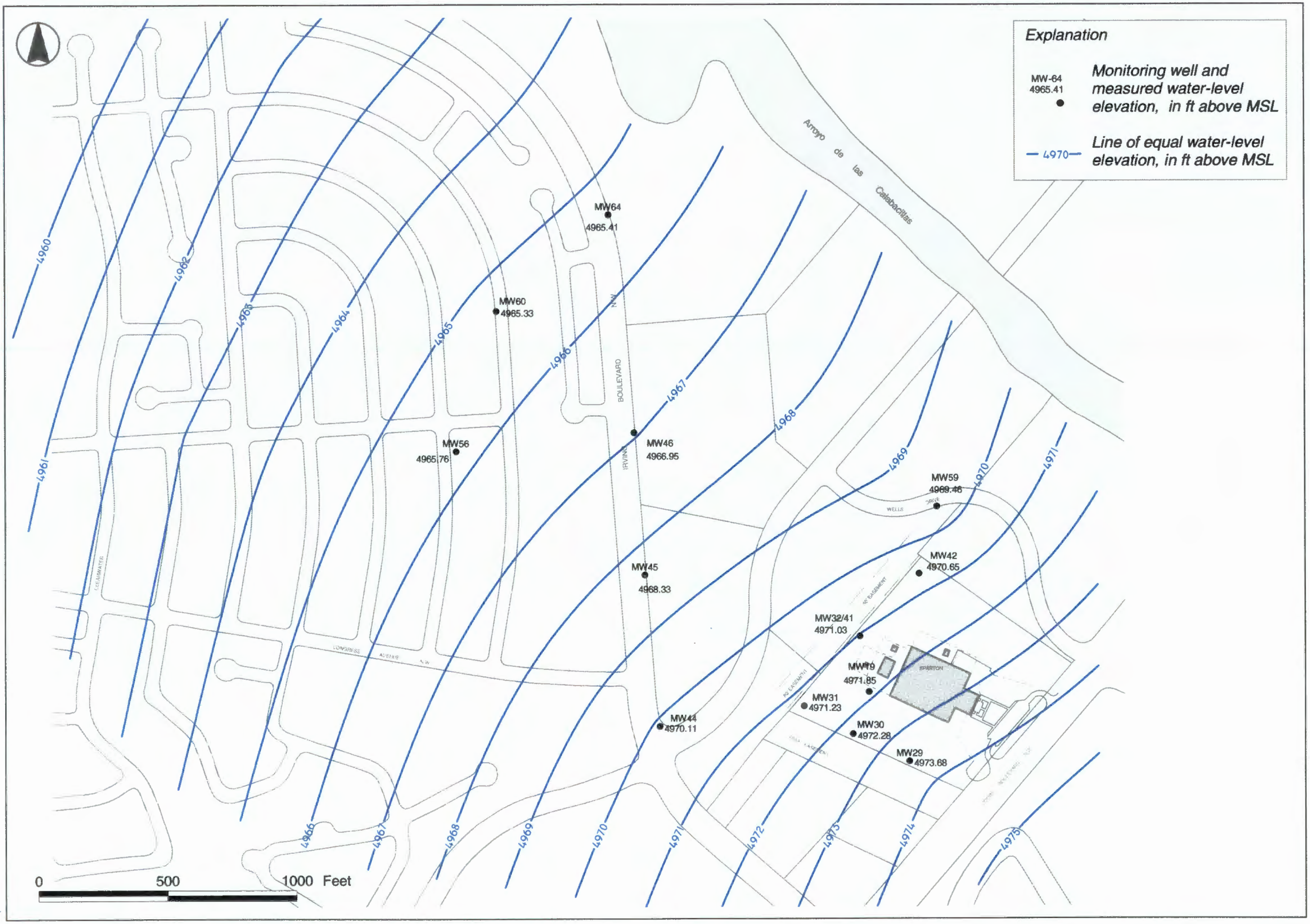

Figure 2.12 Elevation of the Water Level in the Upper Part of the Lower Flow Zone (ULFZ) - November, 1998

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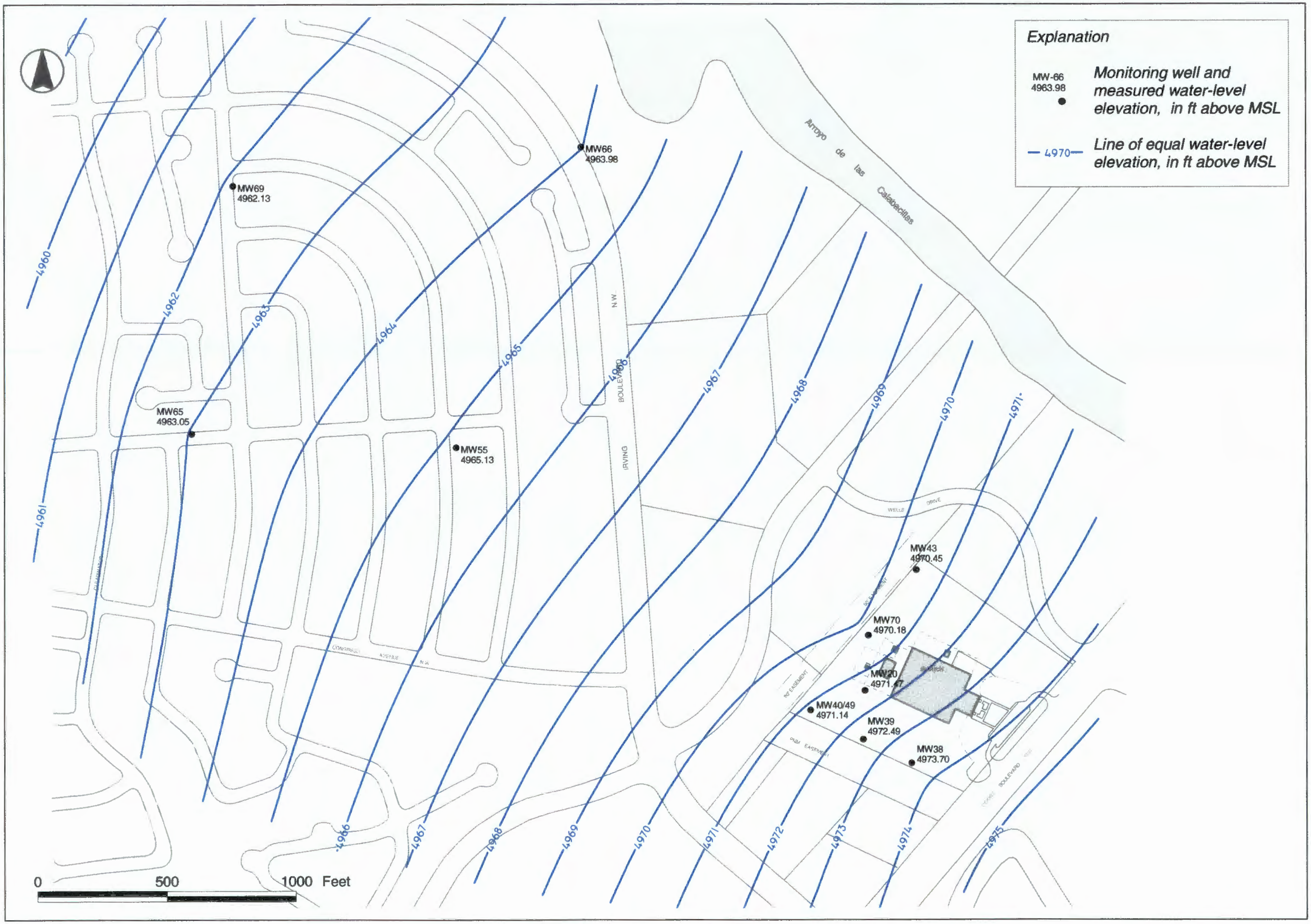

Figure 2.13 Elevation of the Water Level in the Lower Part of the Lower Flow Zone (LLFZ) - November, 1998

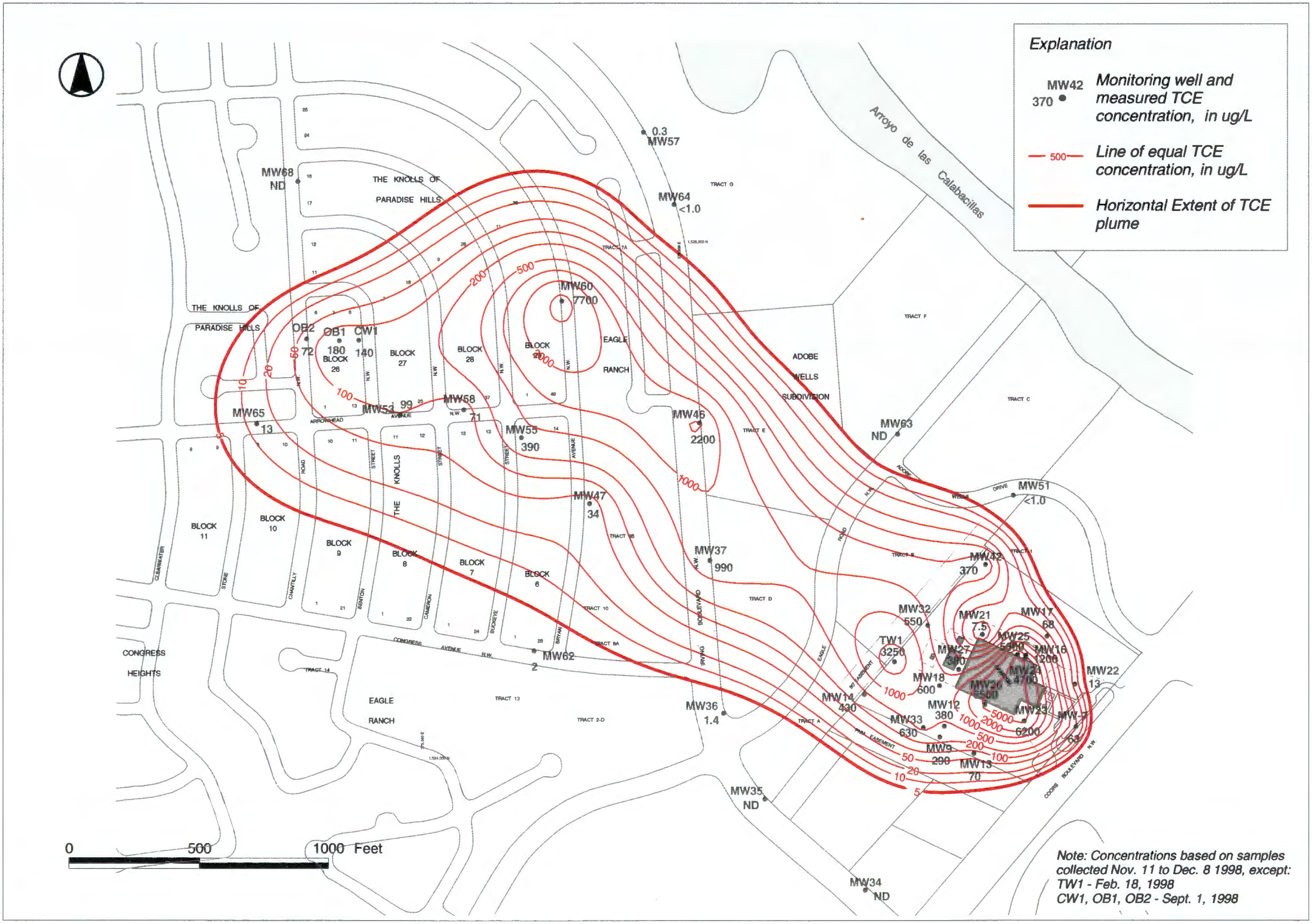

Figure 2.14 Horizontal Extent of TCE Plume - November, 1998

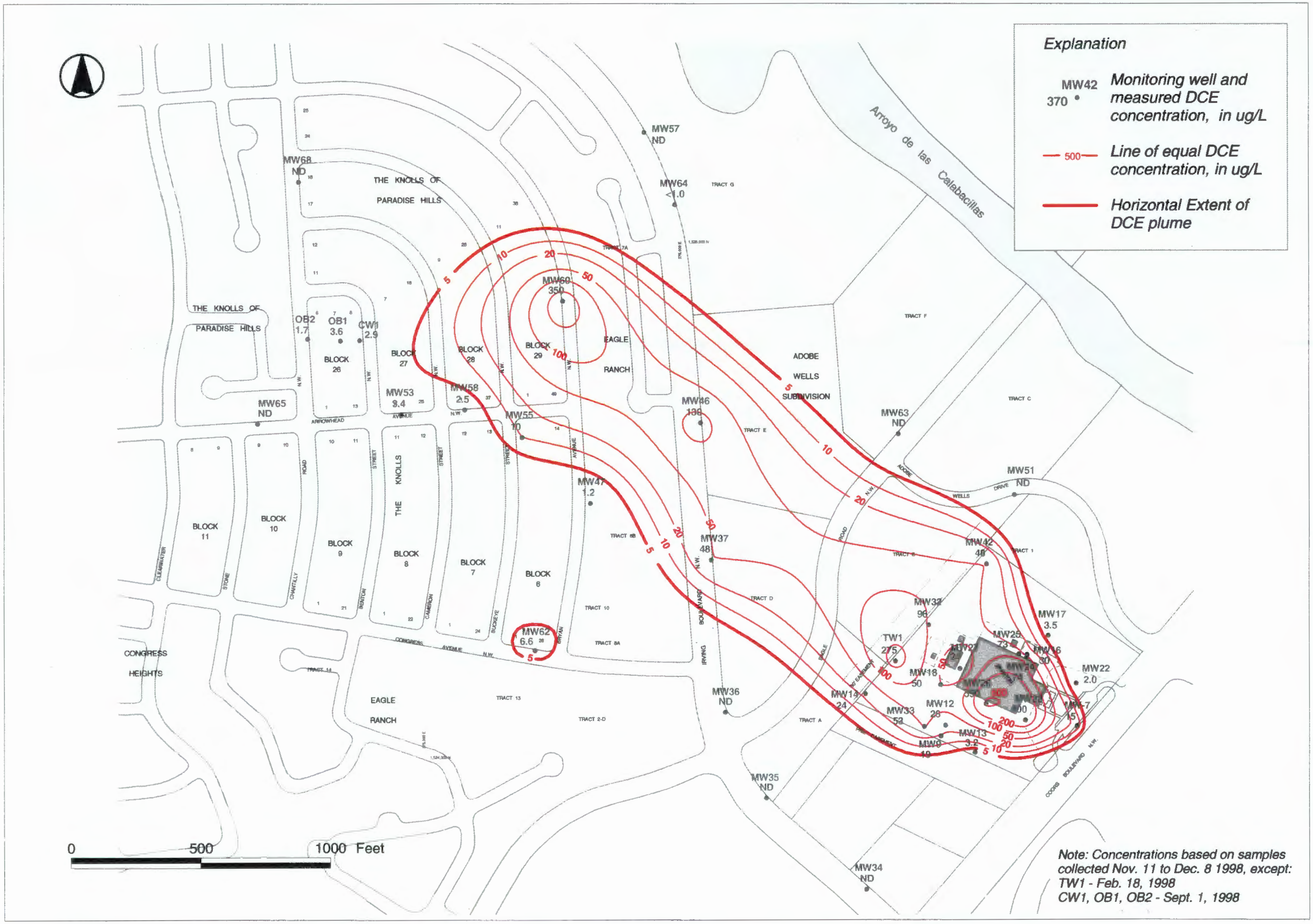

Figure 2.15 Horizontal Extent of DCE Plume - November, 1998

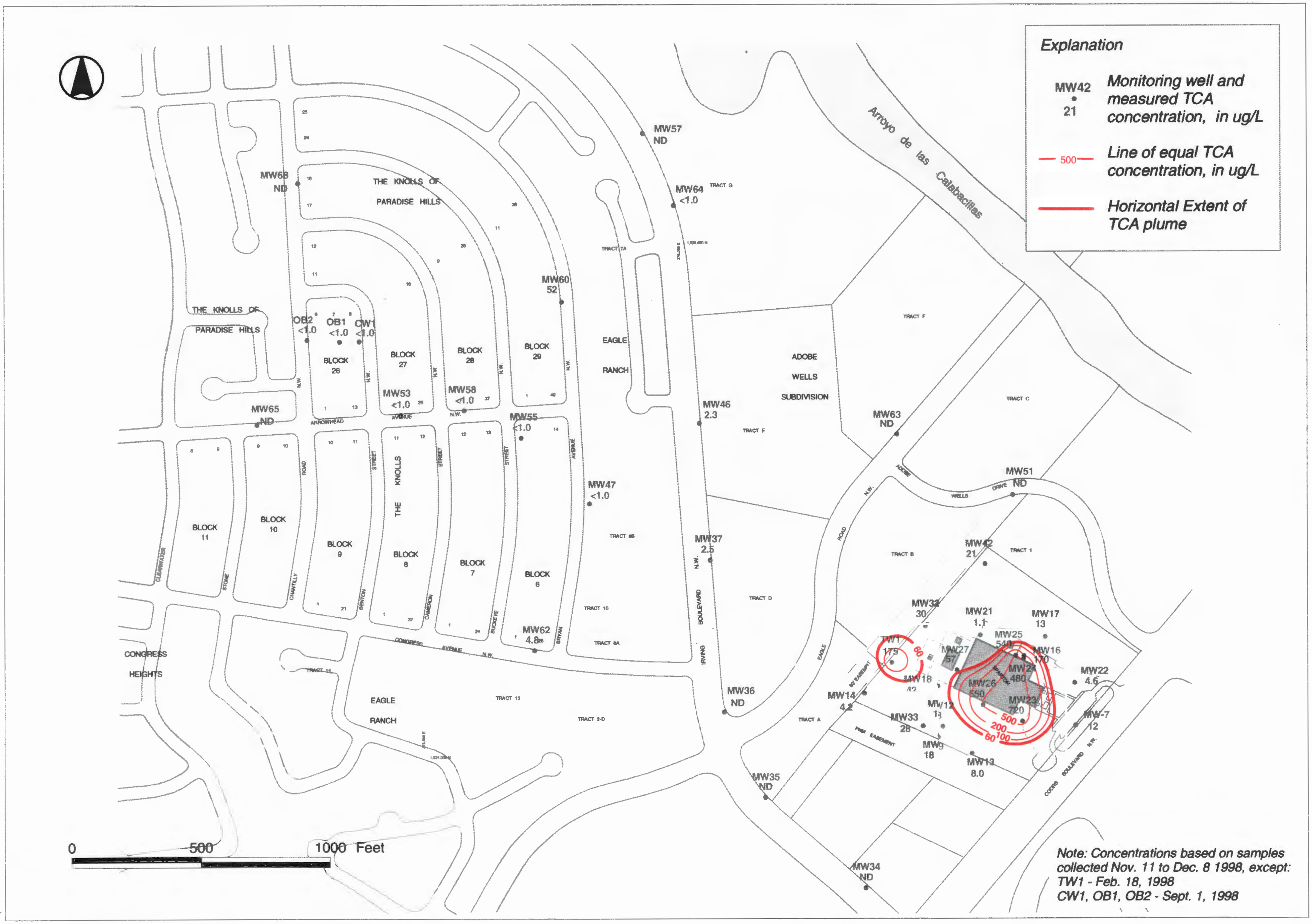

Figure 2.16 Horizontal Extent of TCA Plume - November, 1998

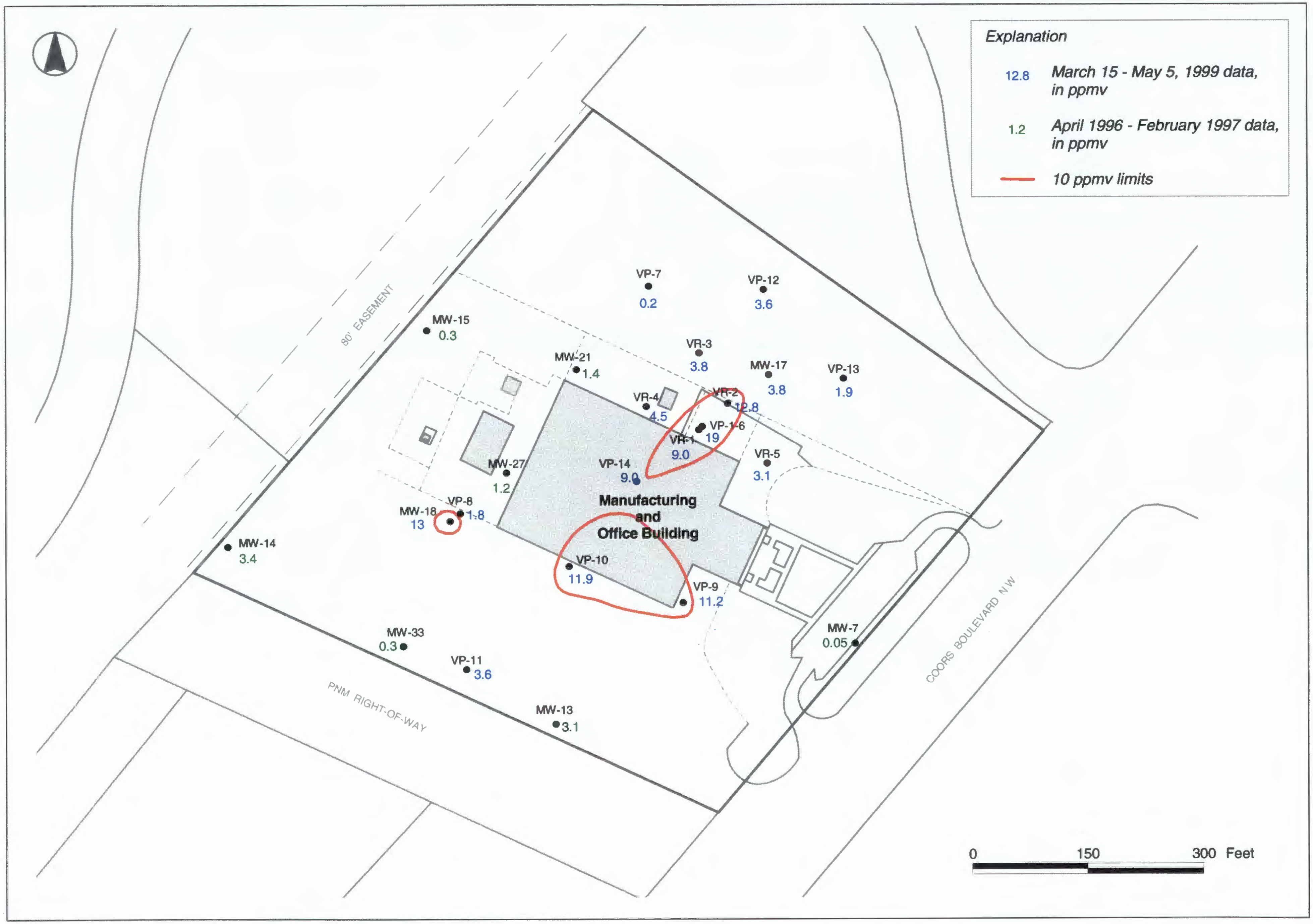

Figure 2.17 TCE Soil Gas Concentrations Prior to the 1999 Operation of SVE Systems

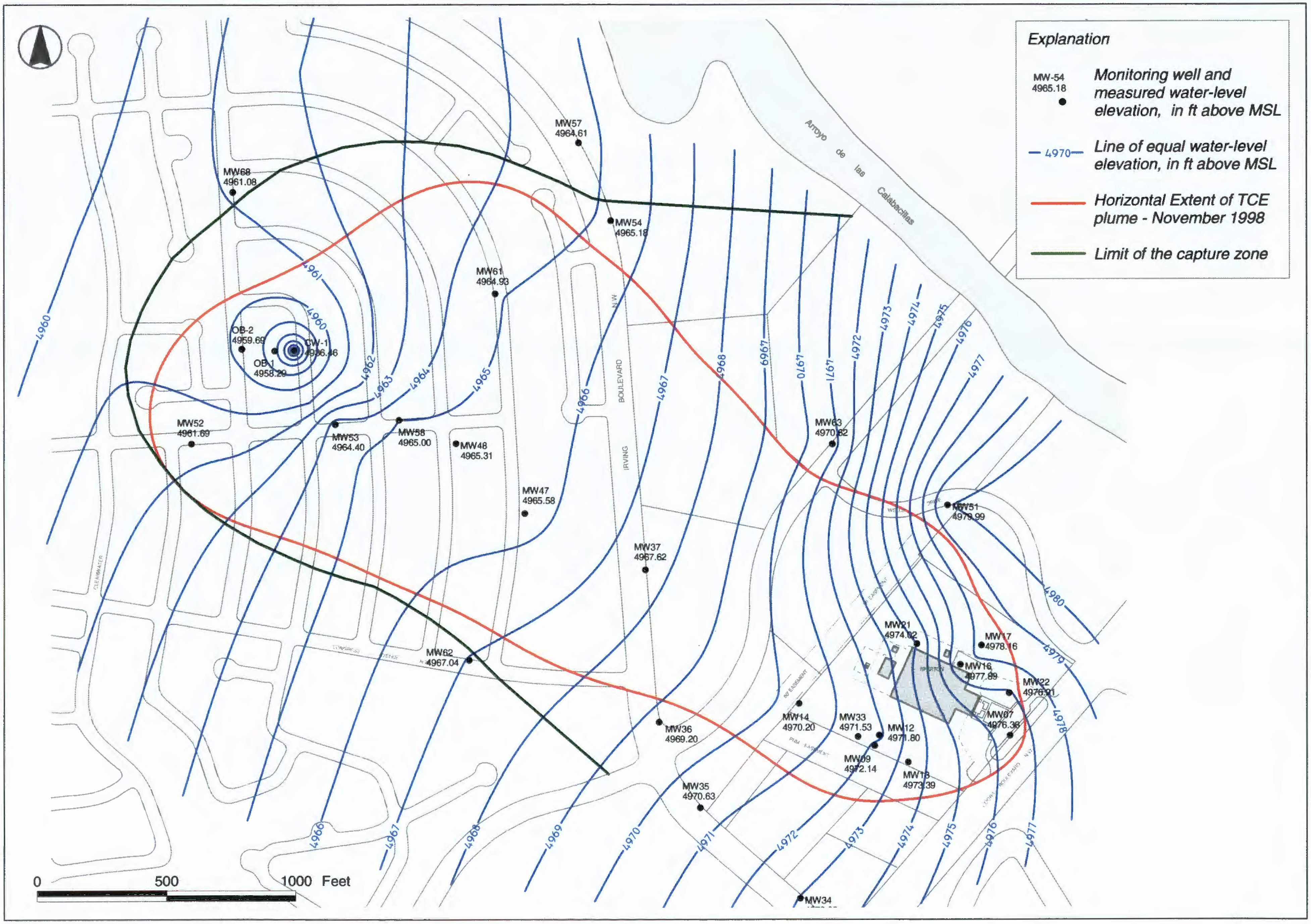

Figure 5.1 Elevation of the Water Table (UFZ) and Capture Zone of the Off-Site Containment Well - February 16, 1999

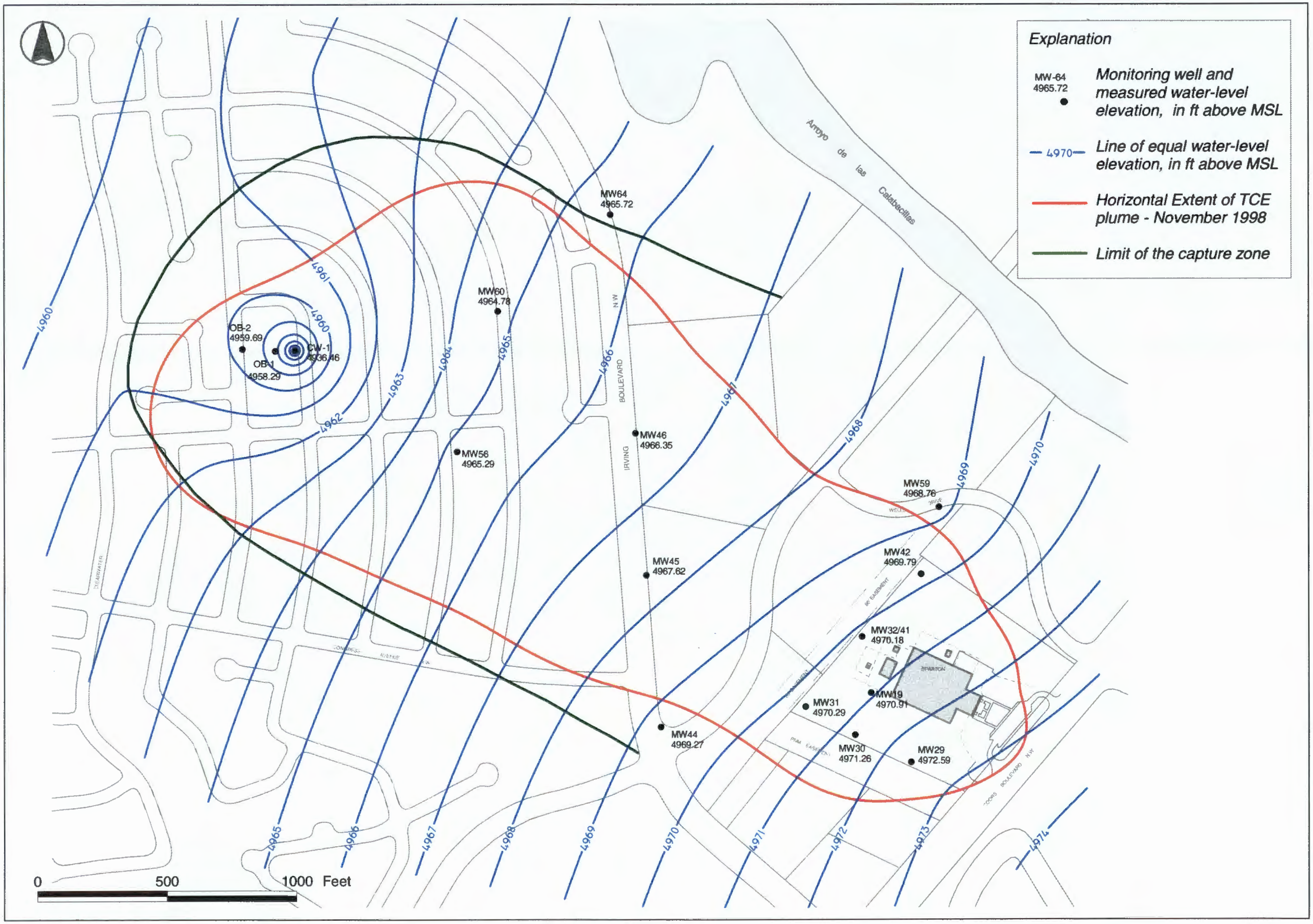

Figure 5.2 Elevation of the Water Level in the ULFZ and Capture Zone of the Off-Site Containment Well - February 16, 1999

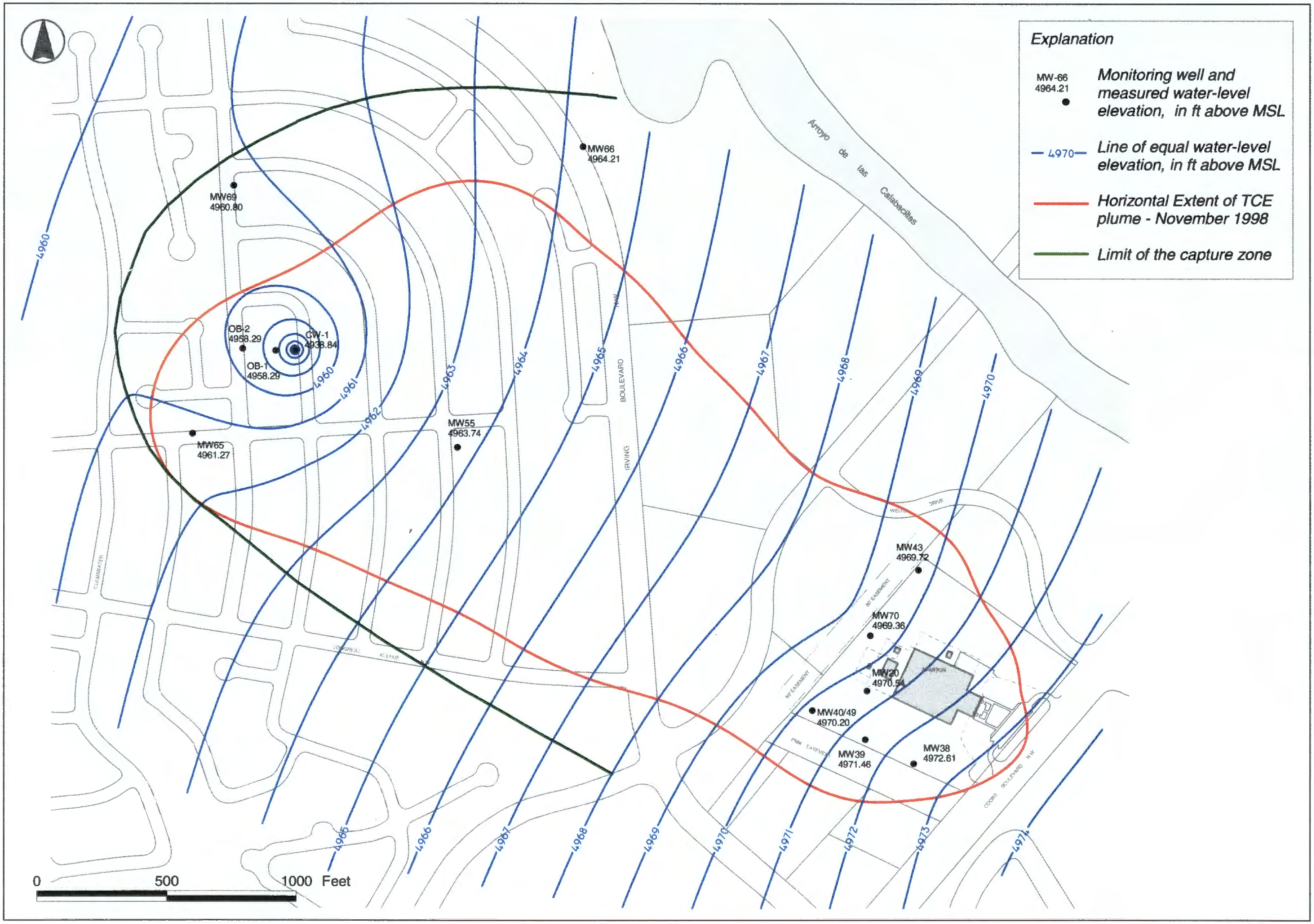

Figure 5.3 Elevation of the Water Level in the LLFZ and Capture Zone of the Off-Site Containment Well - February 16, 1999

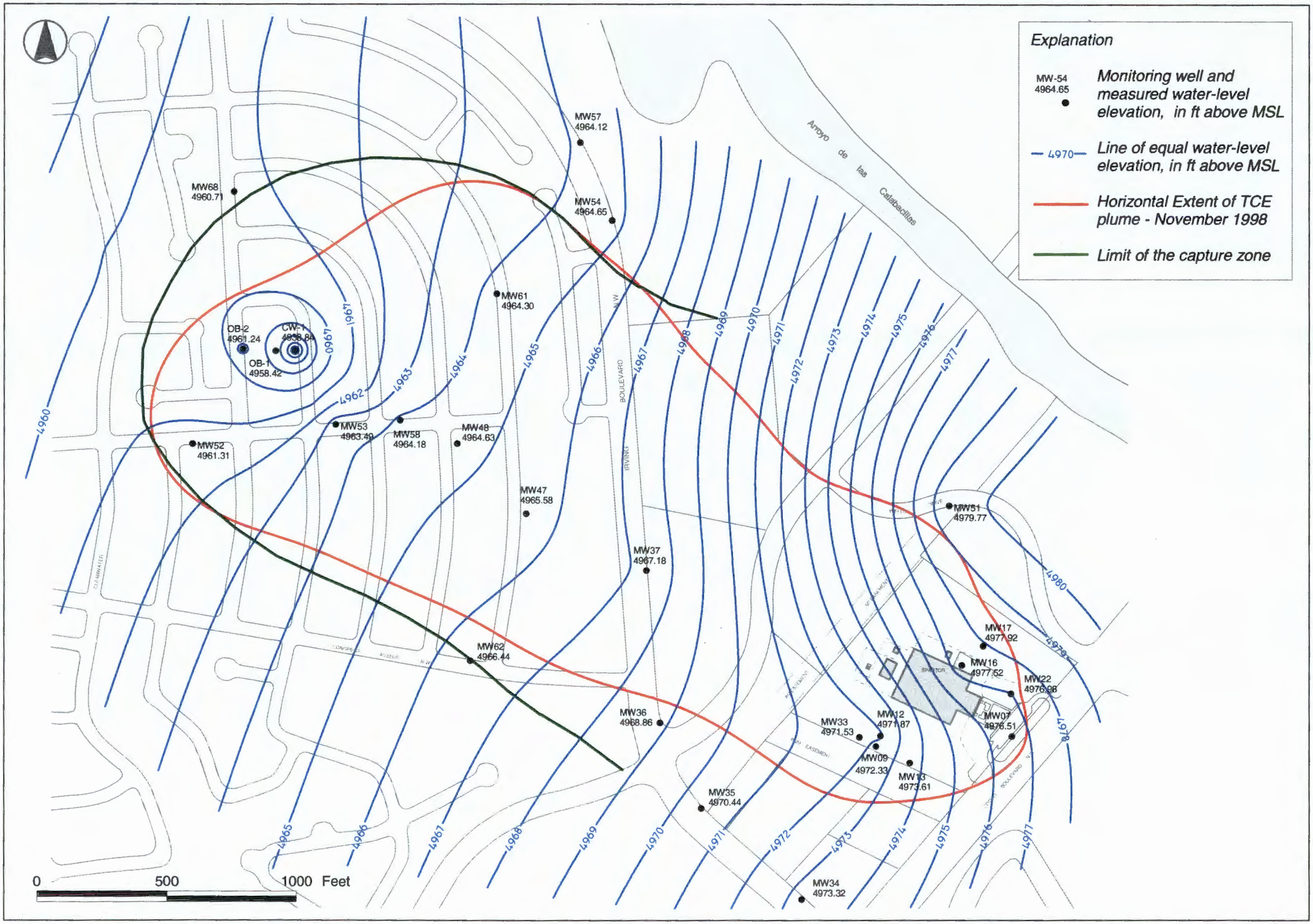

Figure 5.4 Elevation of the Water Table (UFZ) and Capture Zone of the Off-Site Containment Well - May 13, 1999

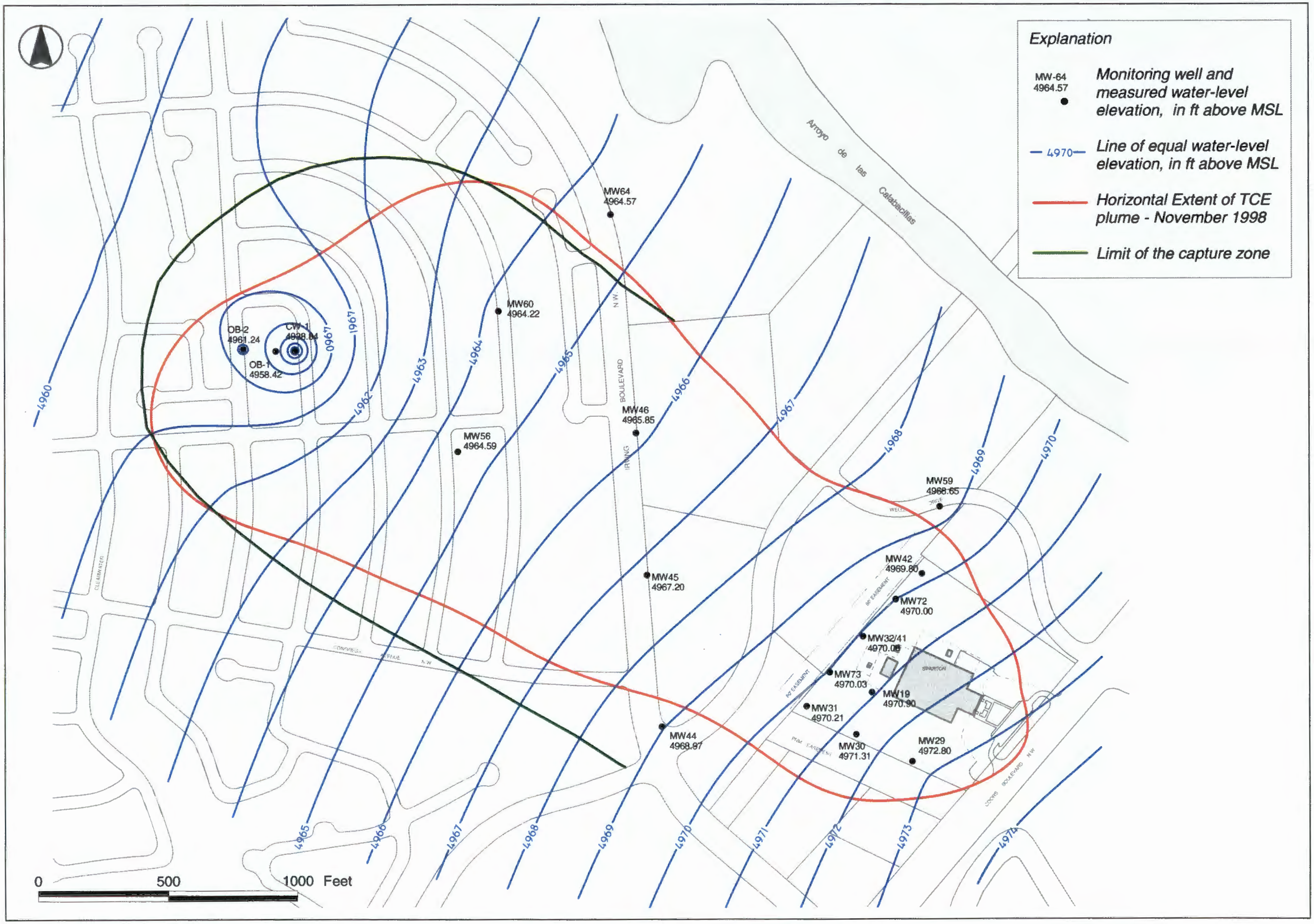

Figure 5.5 Elevation of the Water Level in the ULFZ and Capture Zone of the Off-Site Containment Well - May 13, 1999

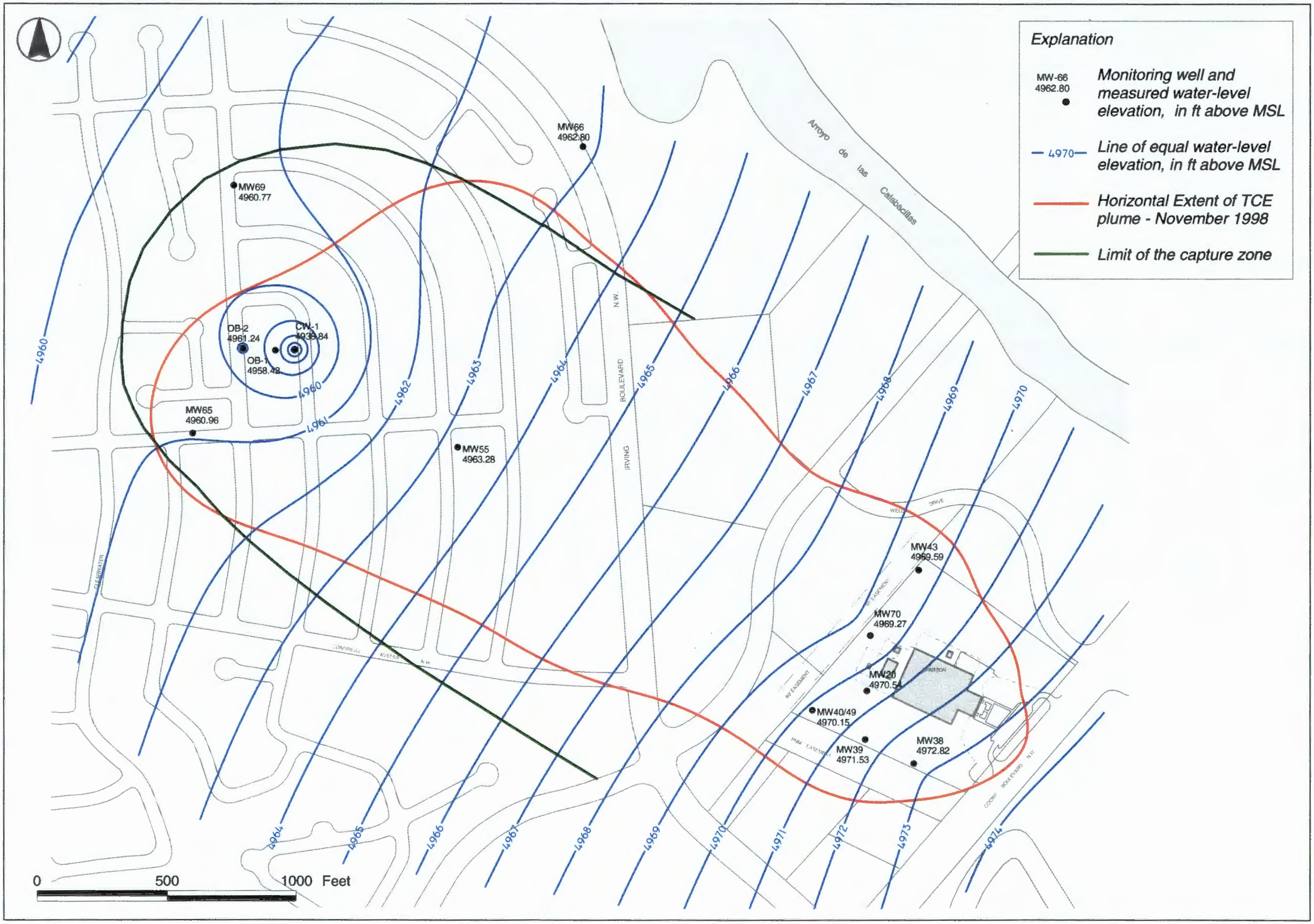

Figure 5.6 Elevation of the Water Level in the LLFZ and Capture Zone of the Off-Site Containment Well - May 13, 1999

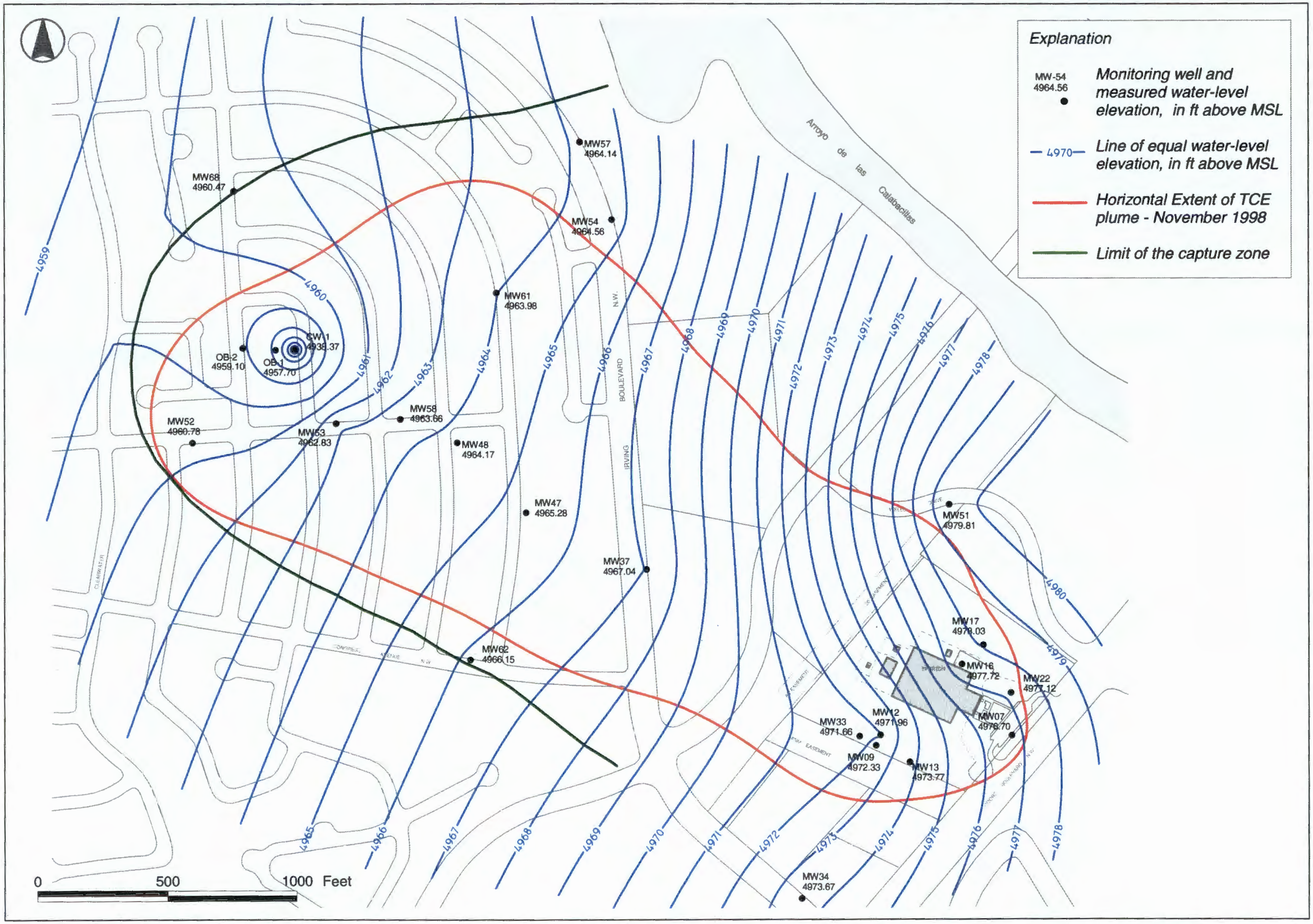

Figure 5.7 Elevation of the Water Table (UFZ) and Capture Zone of the Off-Site Containment Well - August 12, 1999

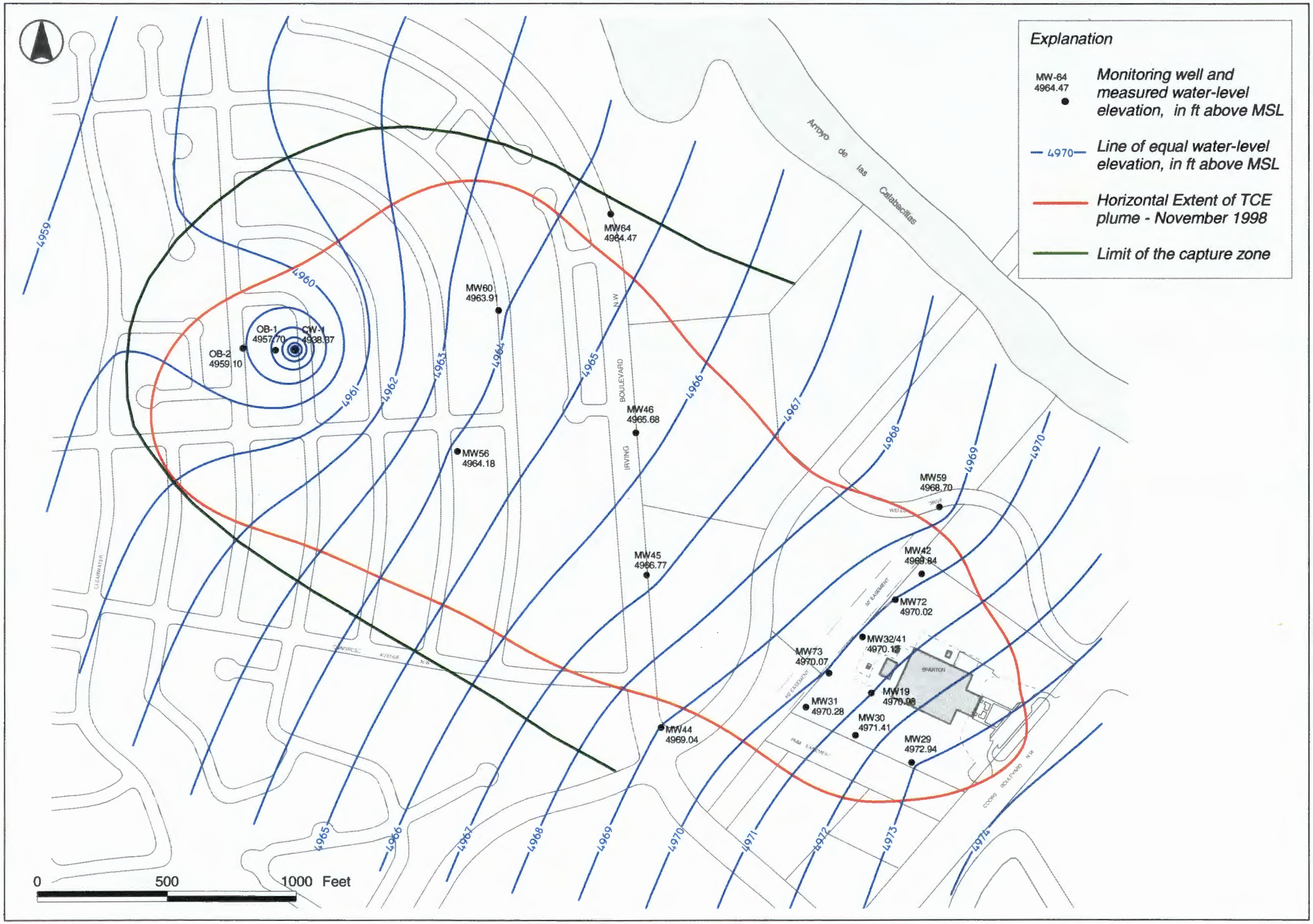

Figure 5.8 Elevation of the Water Level in the ULFZ and Capture Zone of the Off-Site Containment Well - August 12, 1999

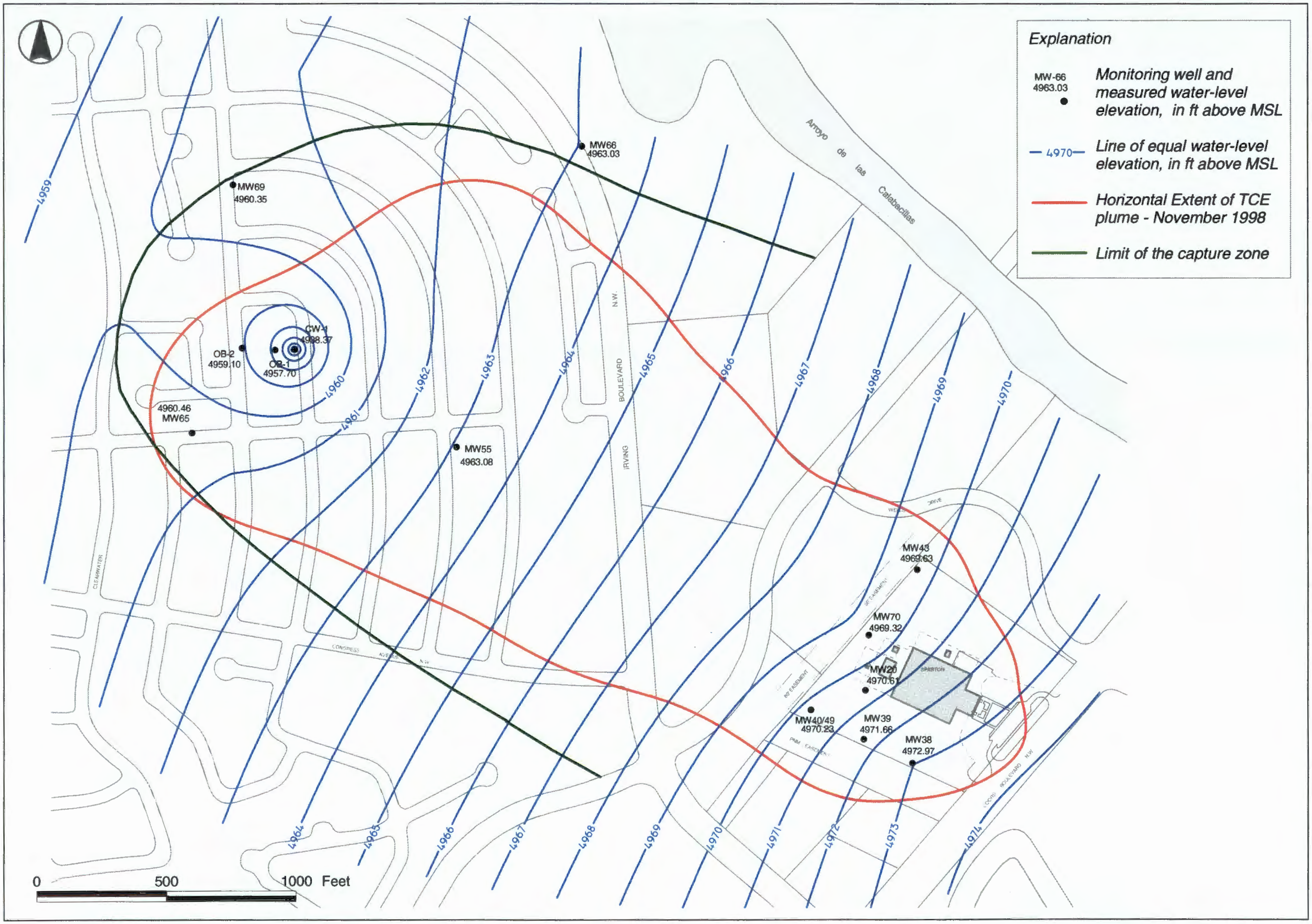

Figure 5.9 Elevation of the Water Level in the LLFZ and Capture Zone of the Off-Site Containment Well - August 12, 1999

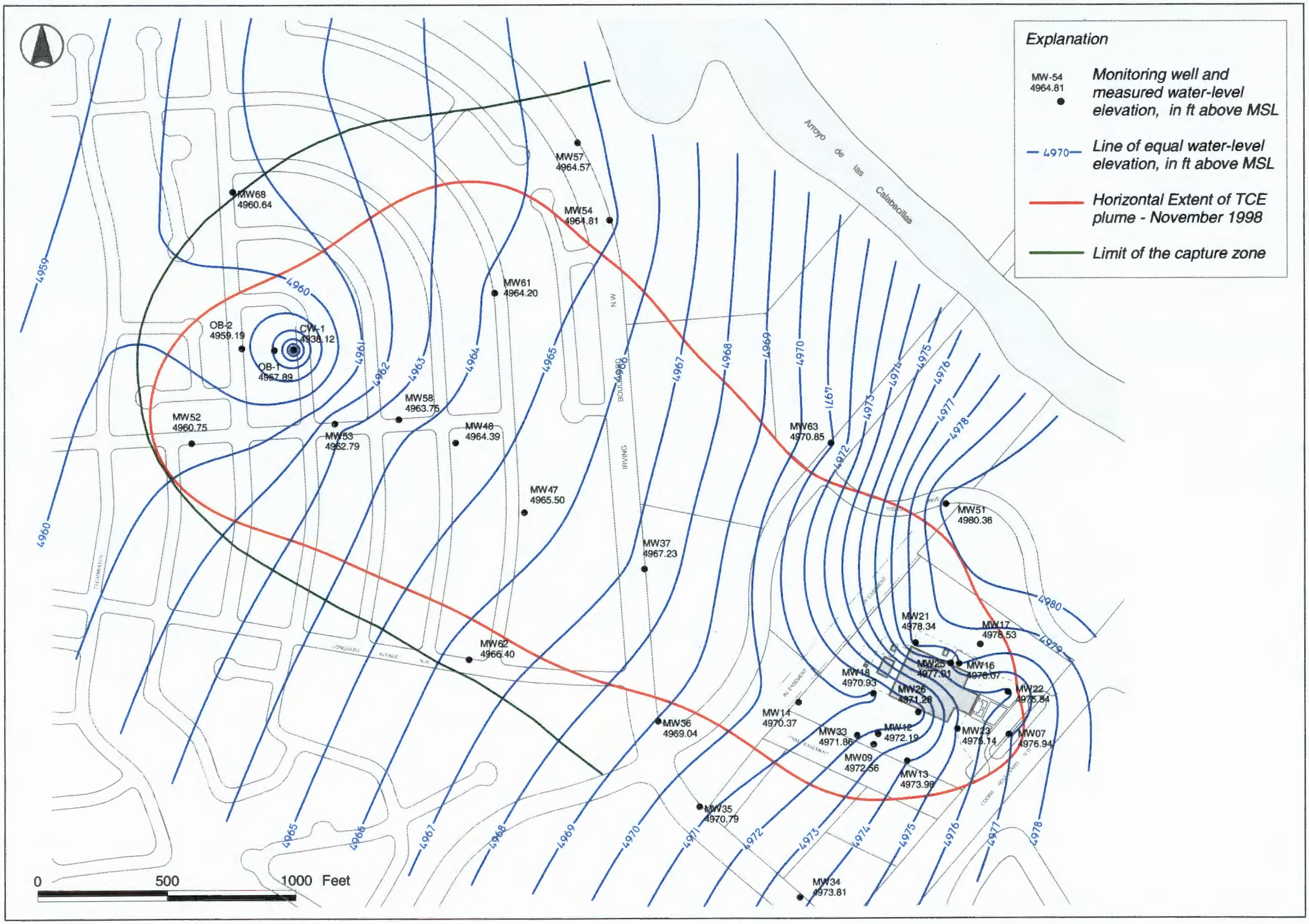

Figure 5.10 Elevation of the Water Table (UFZ) and Capture Zone of the Off-Site Containment Well - October 28, 1999

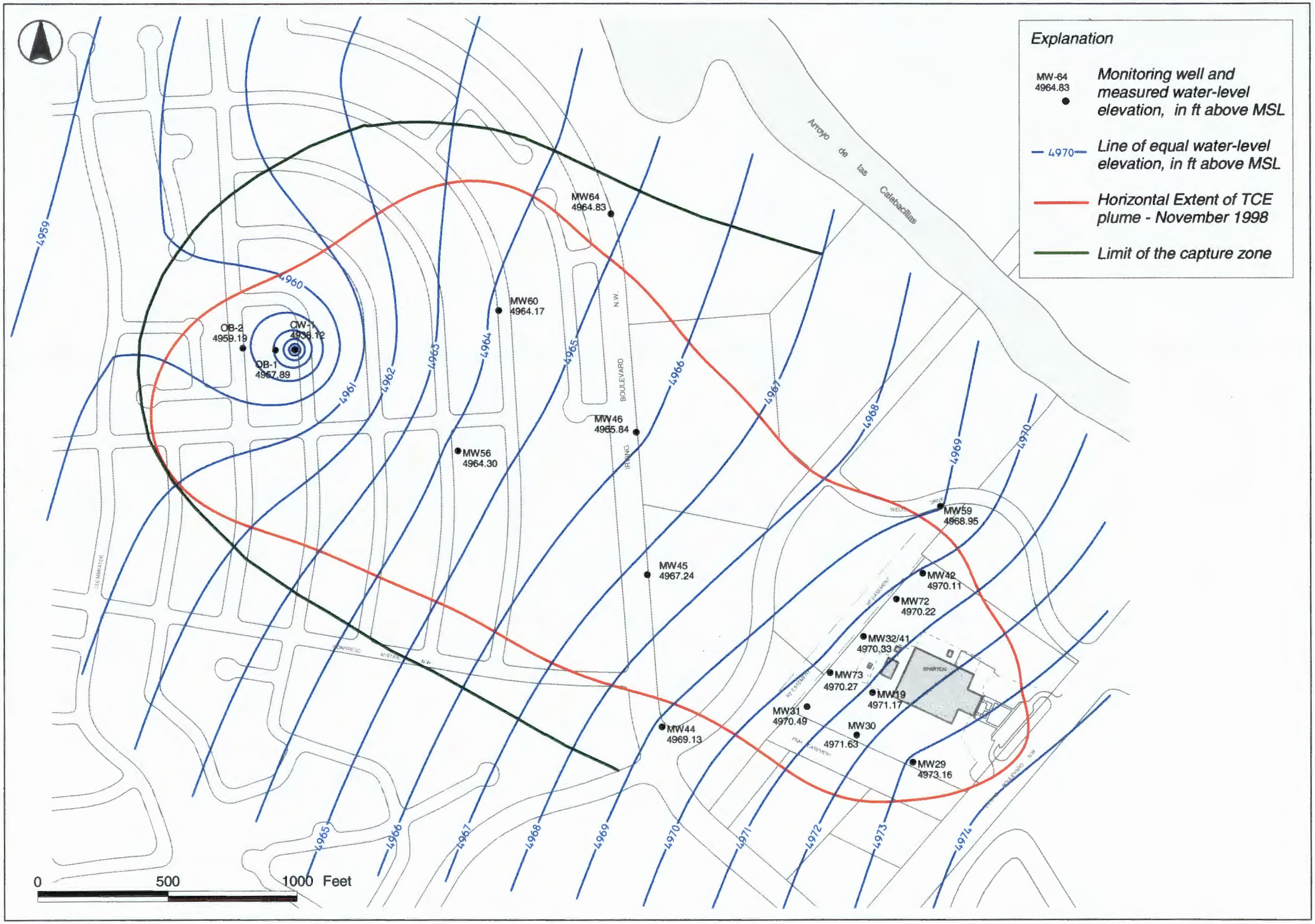

Figure 5.11 Elevation of the Water Level in the ULFZ and Capture Zone of the Off-Site Containment Well - October 28, 1999

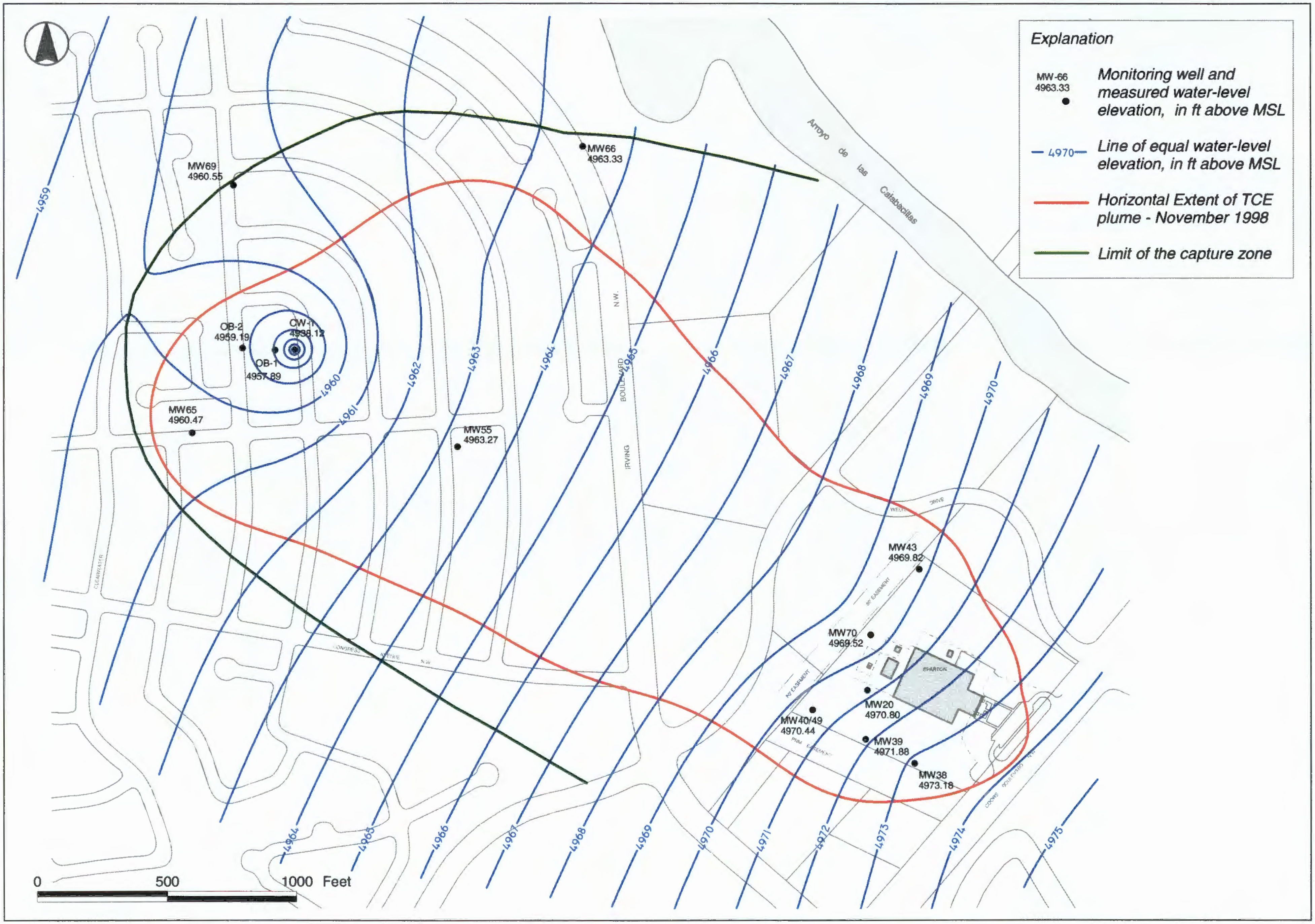

Figure 5.12 Elevation of the Water Level in the LLFZ and Capture Zone of the Off-Site Containment Well - October 28, 1999

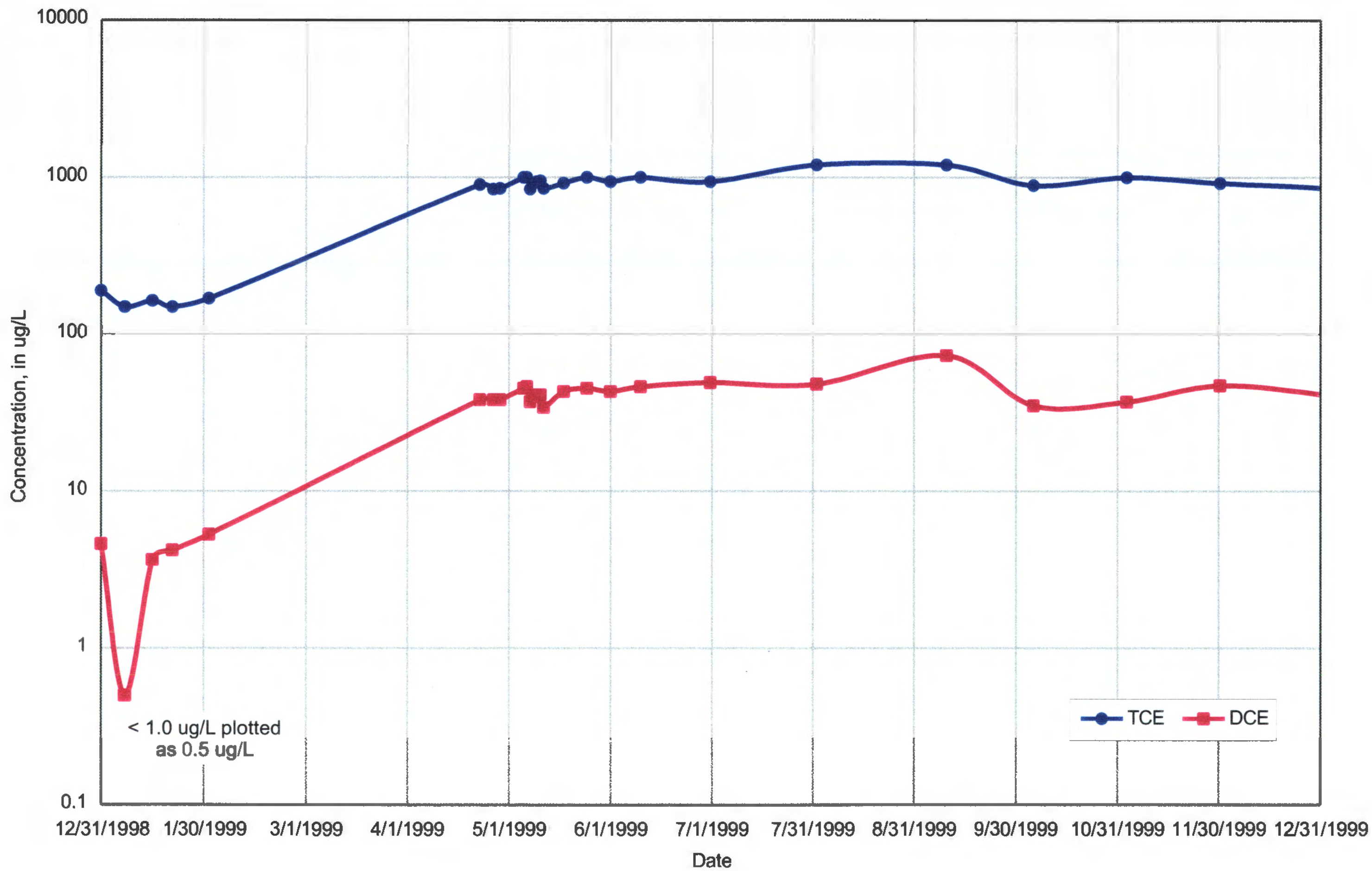

Figure 5.13 Off-Site Containment System - TCE and DCE Concentrations in the Influent, 1999

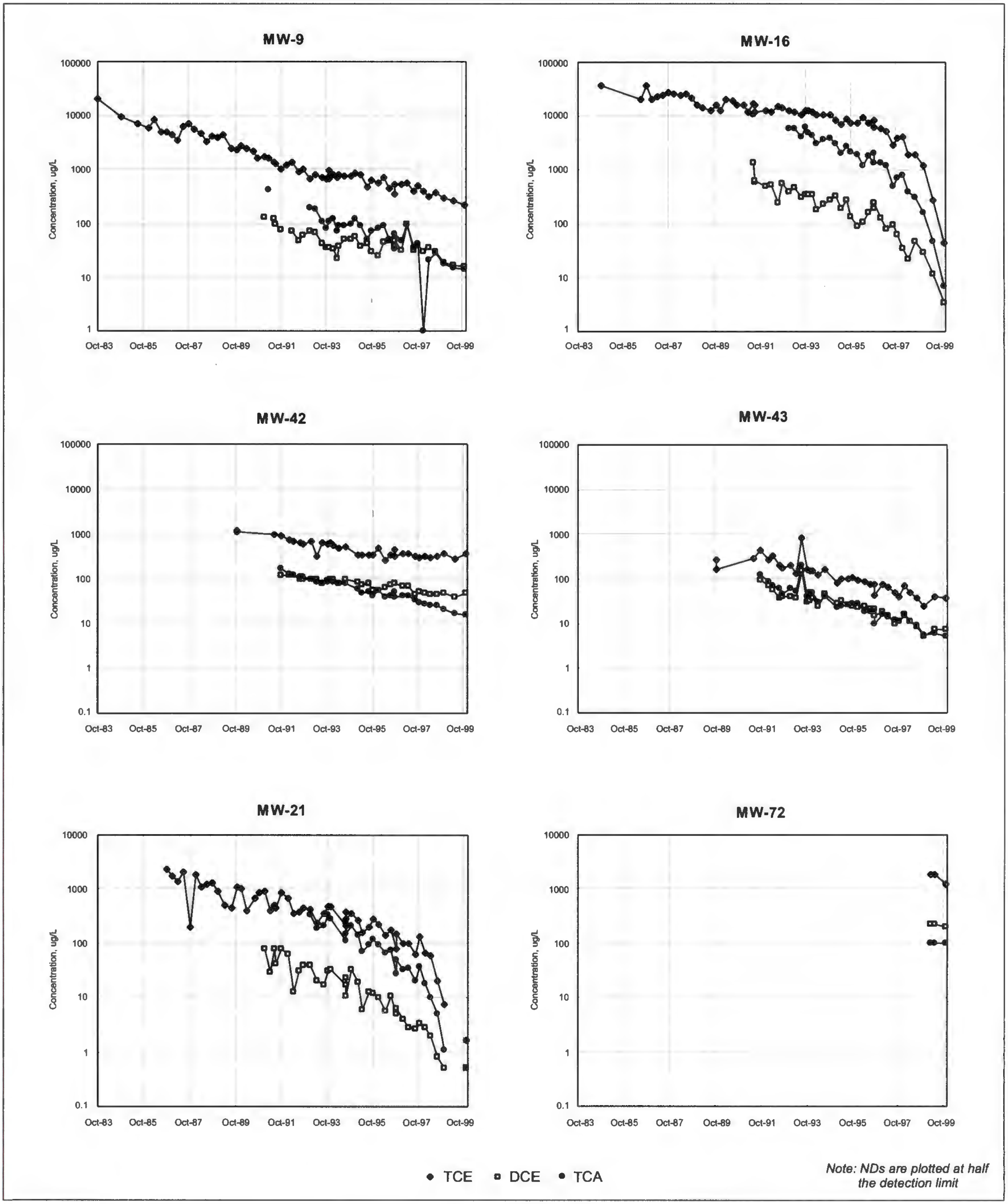

Figure 5.14a Contaminant Concentration Trends in On-Site Monitoring Wells

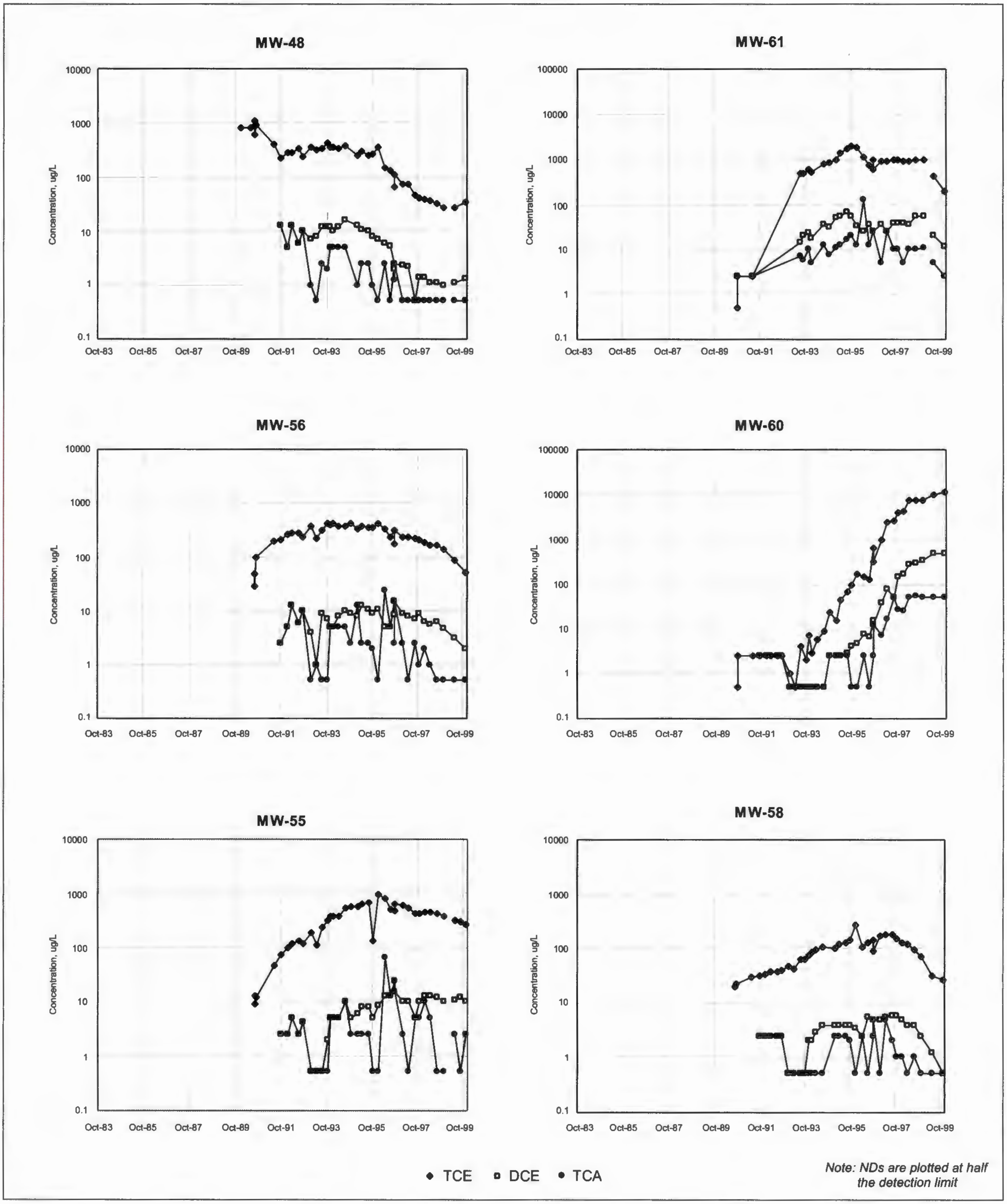

Figure 5.14b Contaminant Concentration Trends in Off-Site Monitoring Wells

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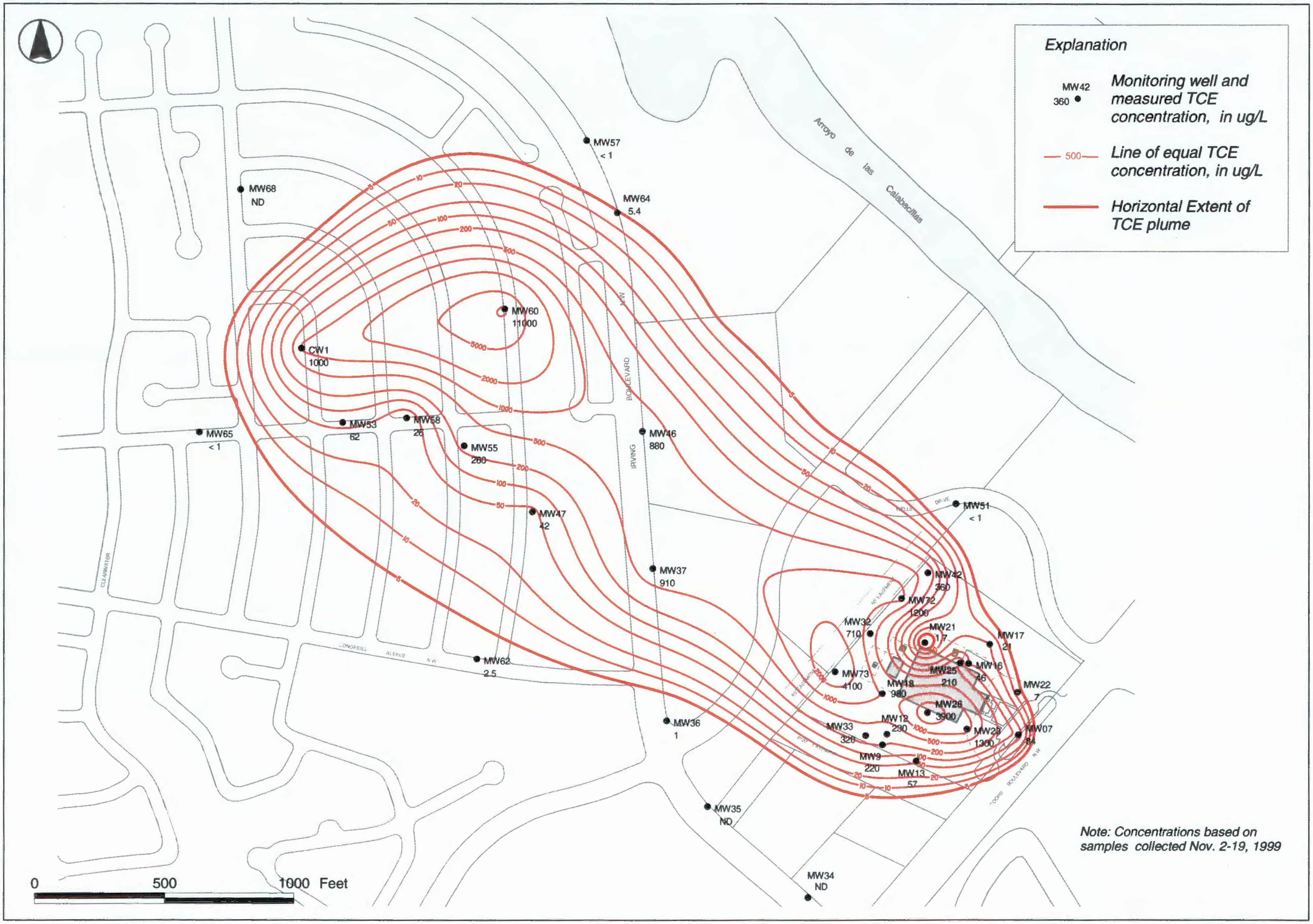

Figure 5.15 Horizontal Extent of TCE Plume - November, 1999

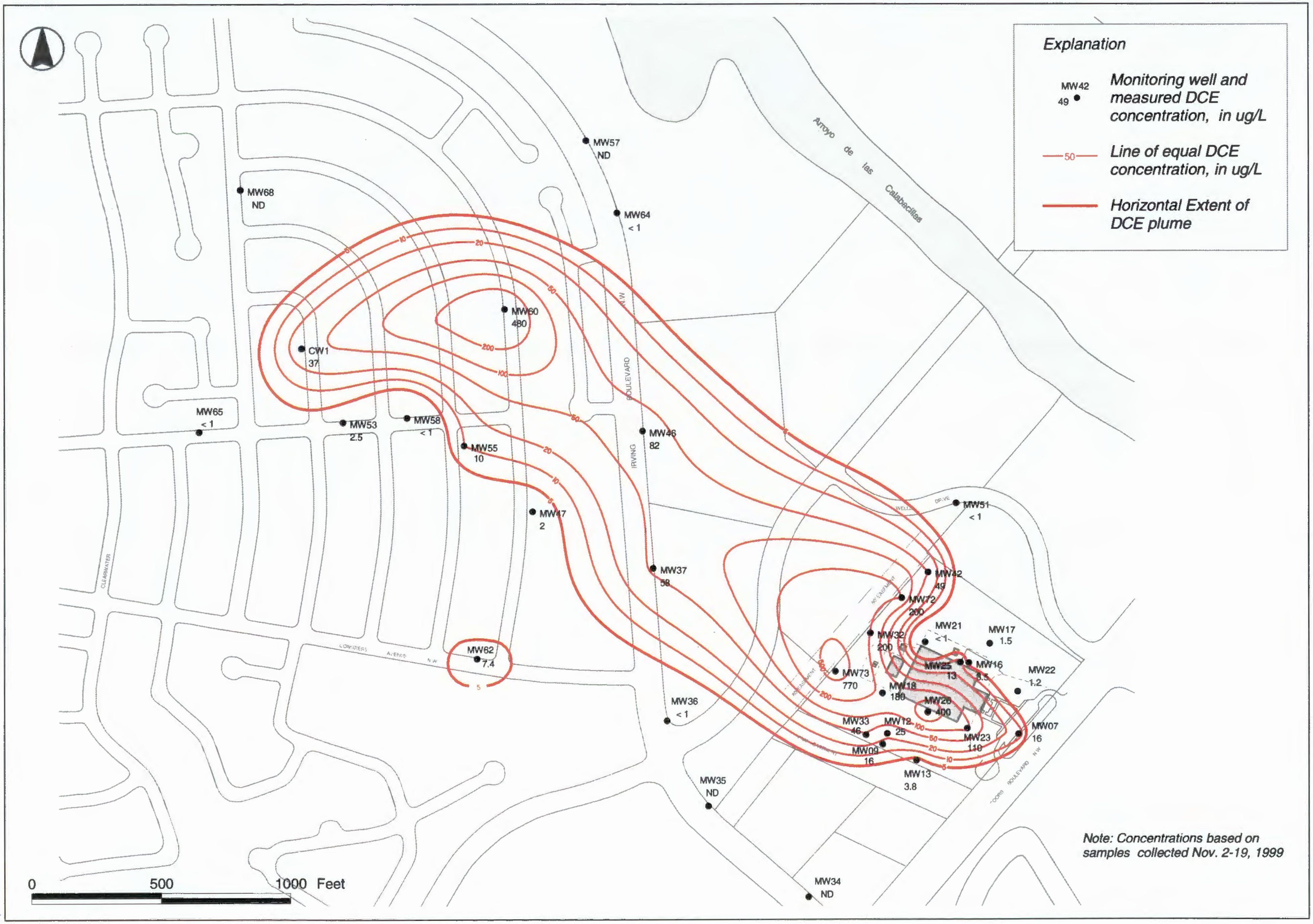

Figure 5.16 Horizontal Extent of DCE Plume - November, 1999

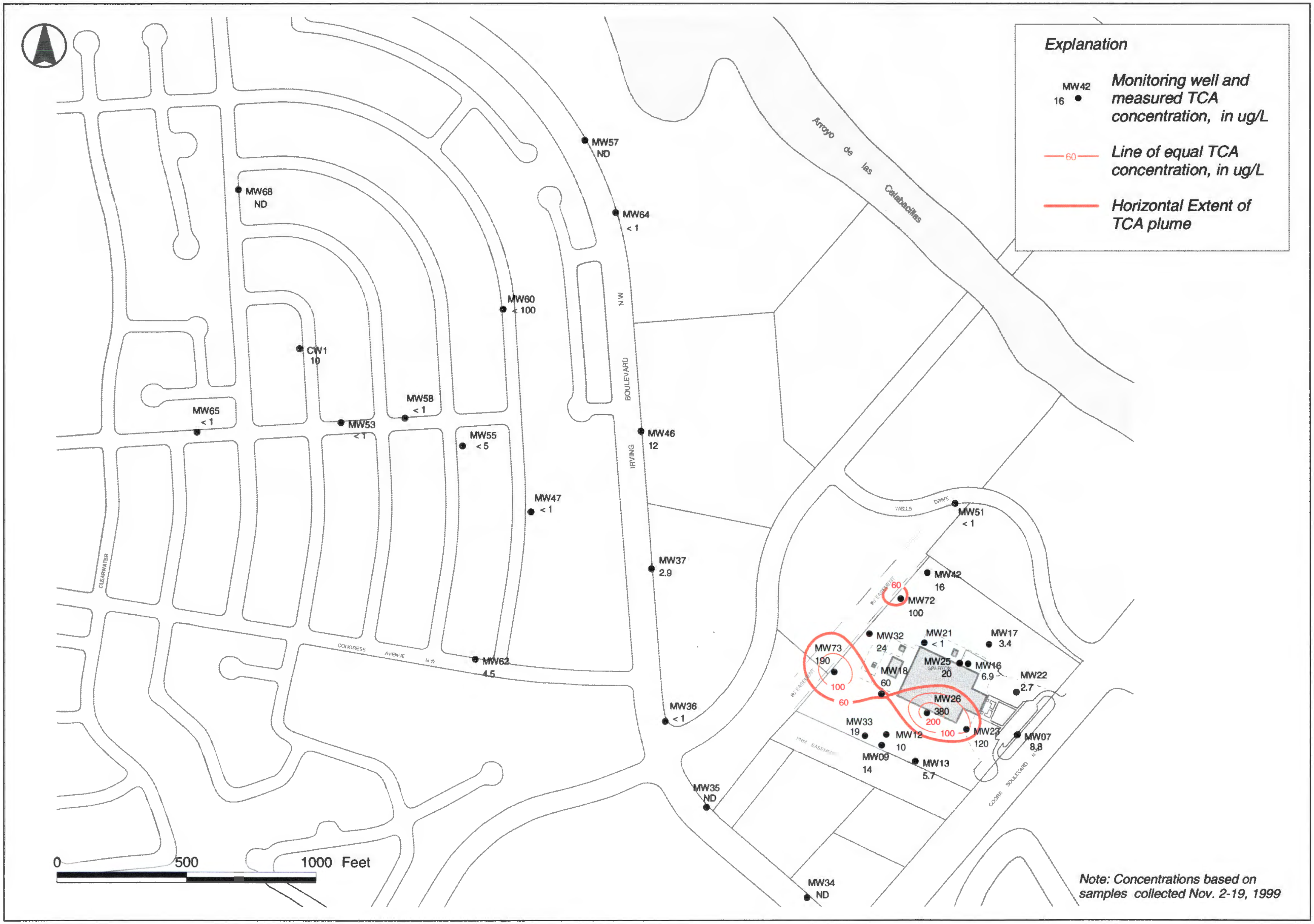

Figure 5.17 Horizontal Extent TCA Plume - November, 1999

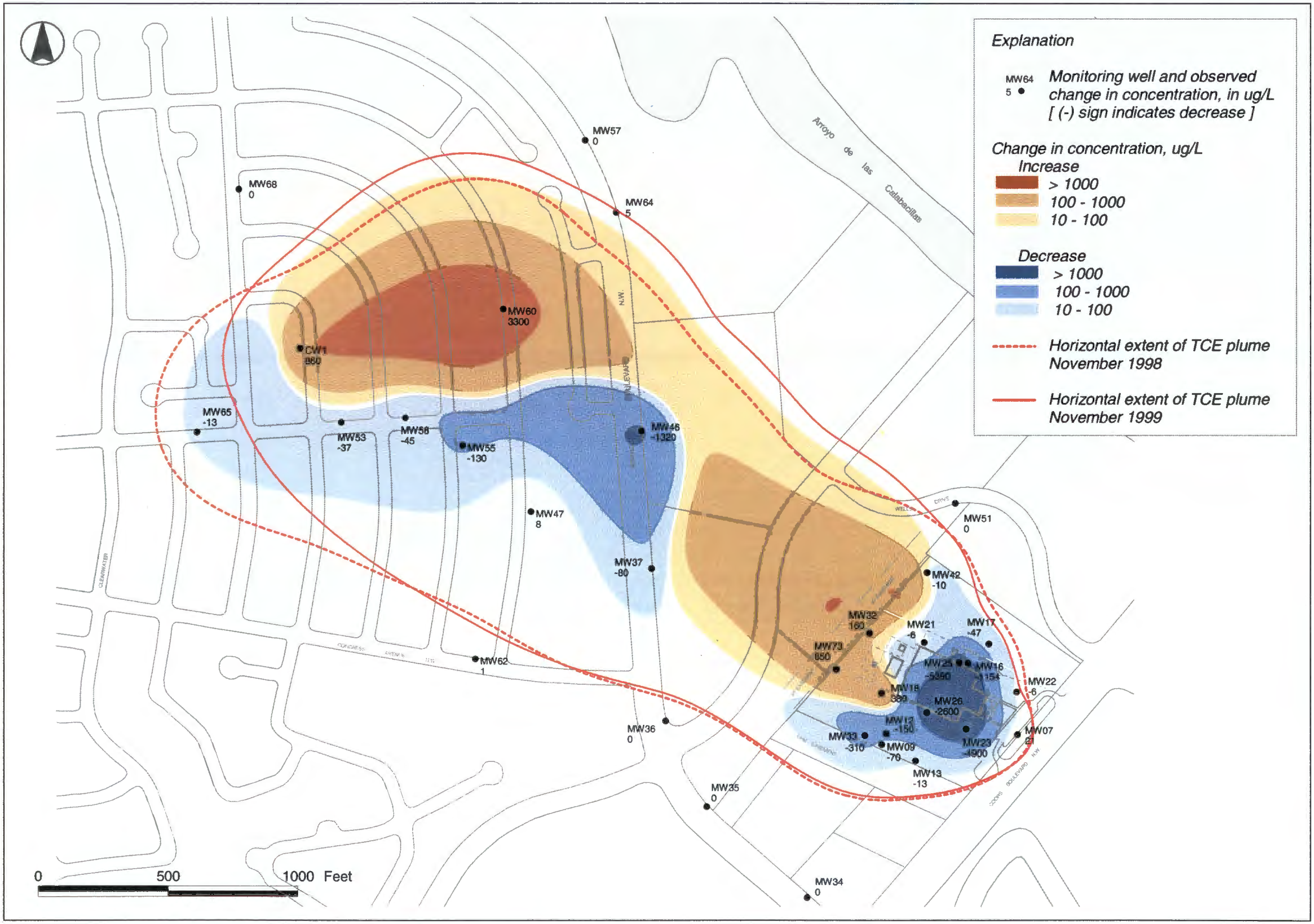

Figure 5.18 Change in TCE Concentrations - November 1998 to November 1999

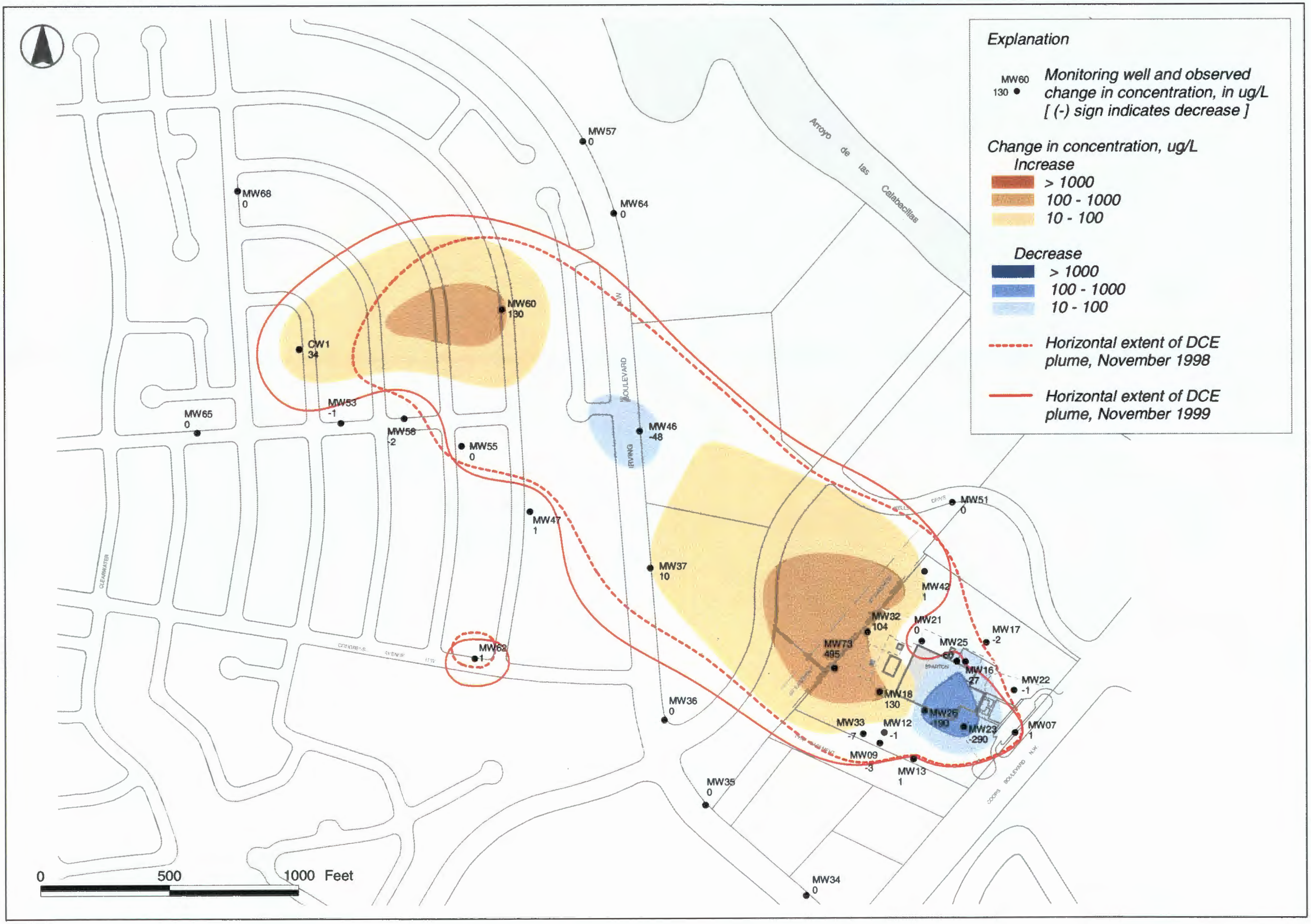

Figure 5.19 Change in DCE Concentrations - November 1998 to November 1999

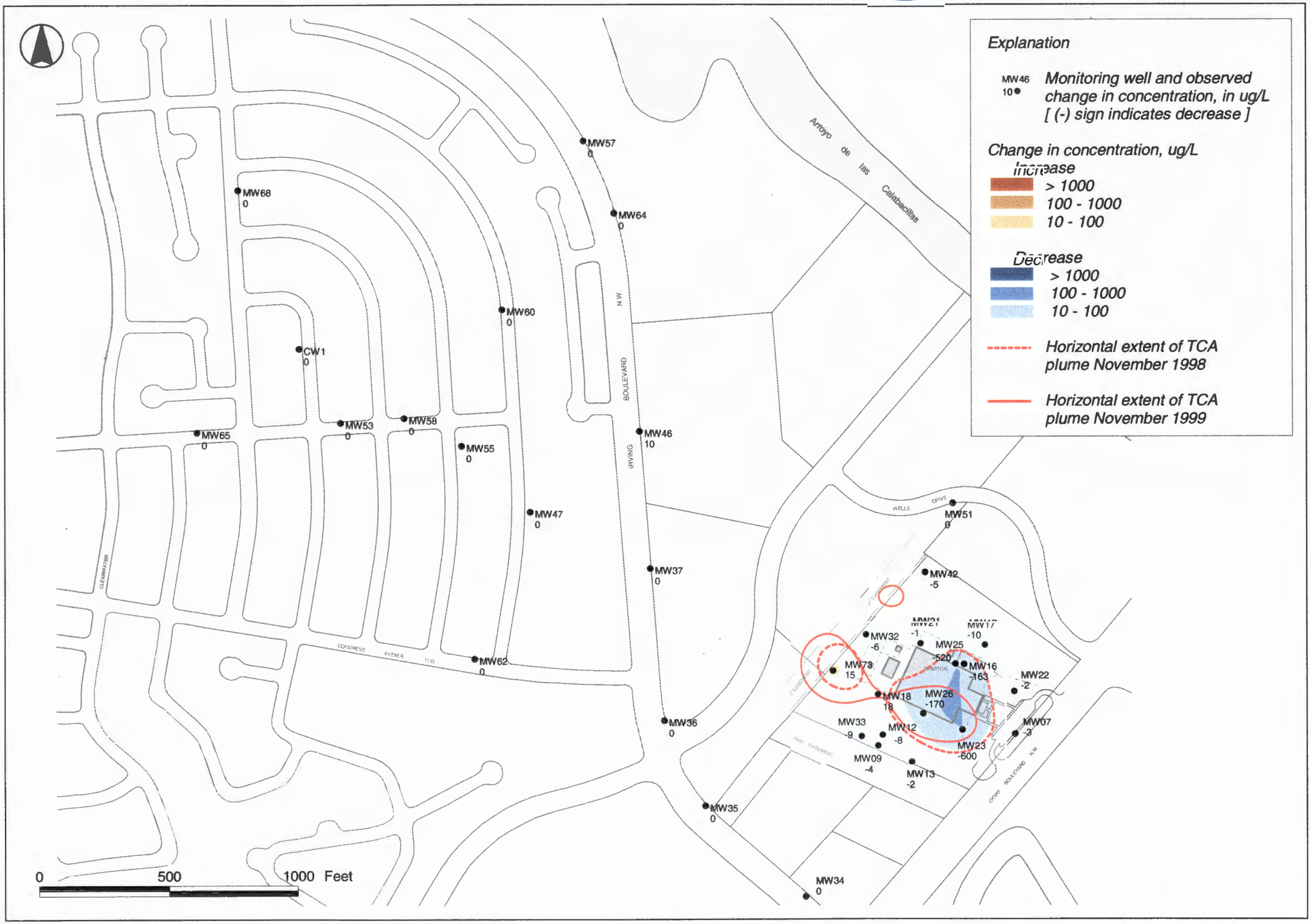

Figure 5.20 Change in TCA Concentrations - November 1998 to November 1999

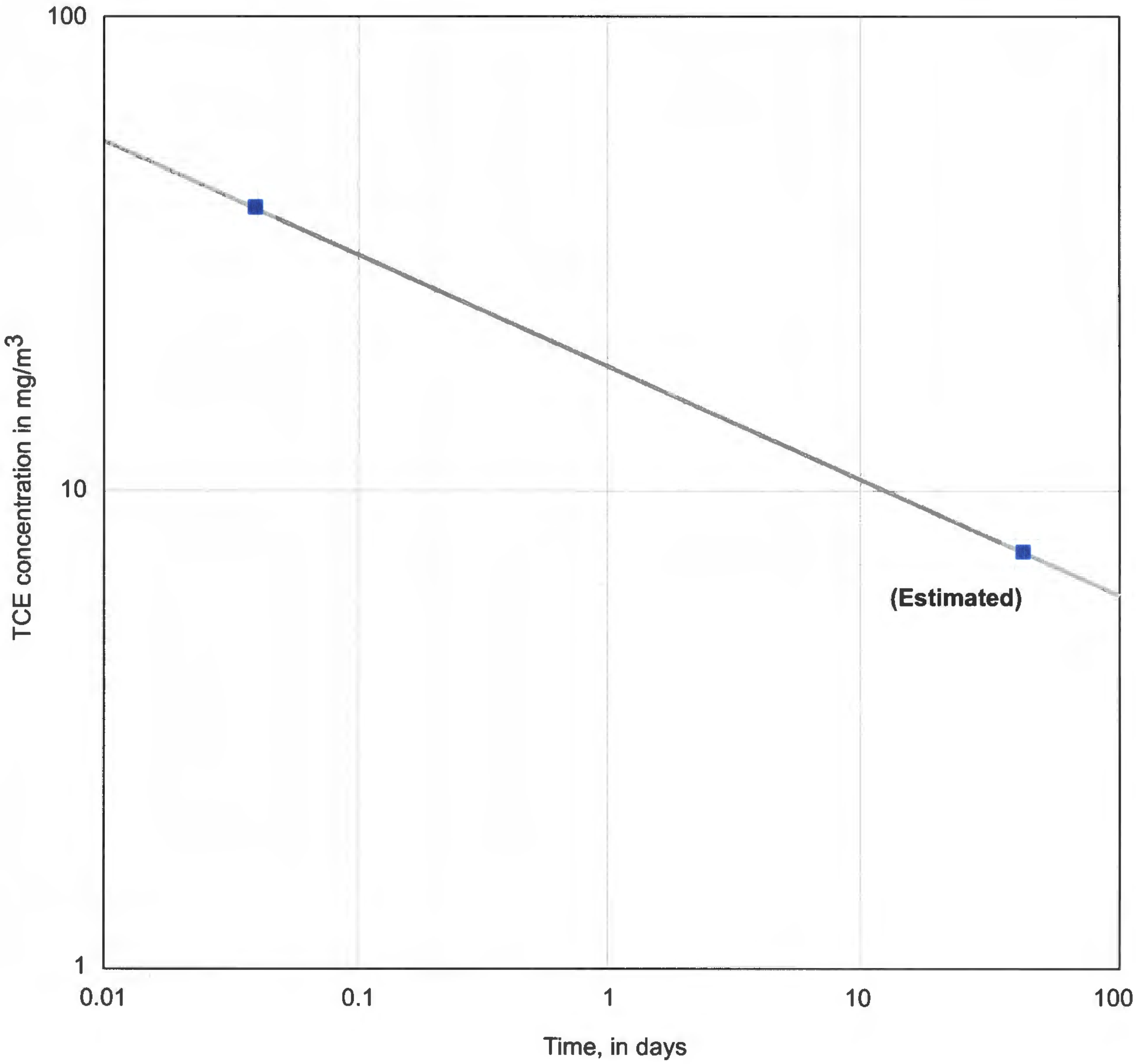

Figure 5.21 Influent Concentrations - SVE Operation - May 12 - June 23, 1999

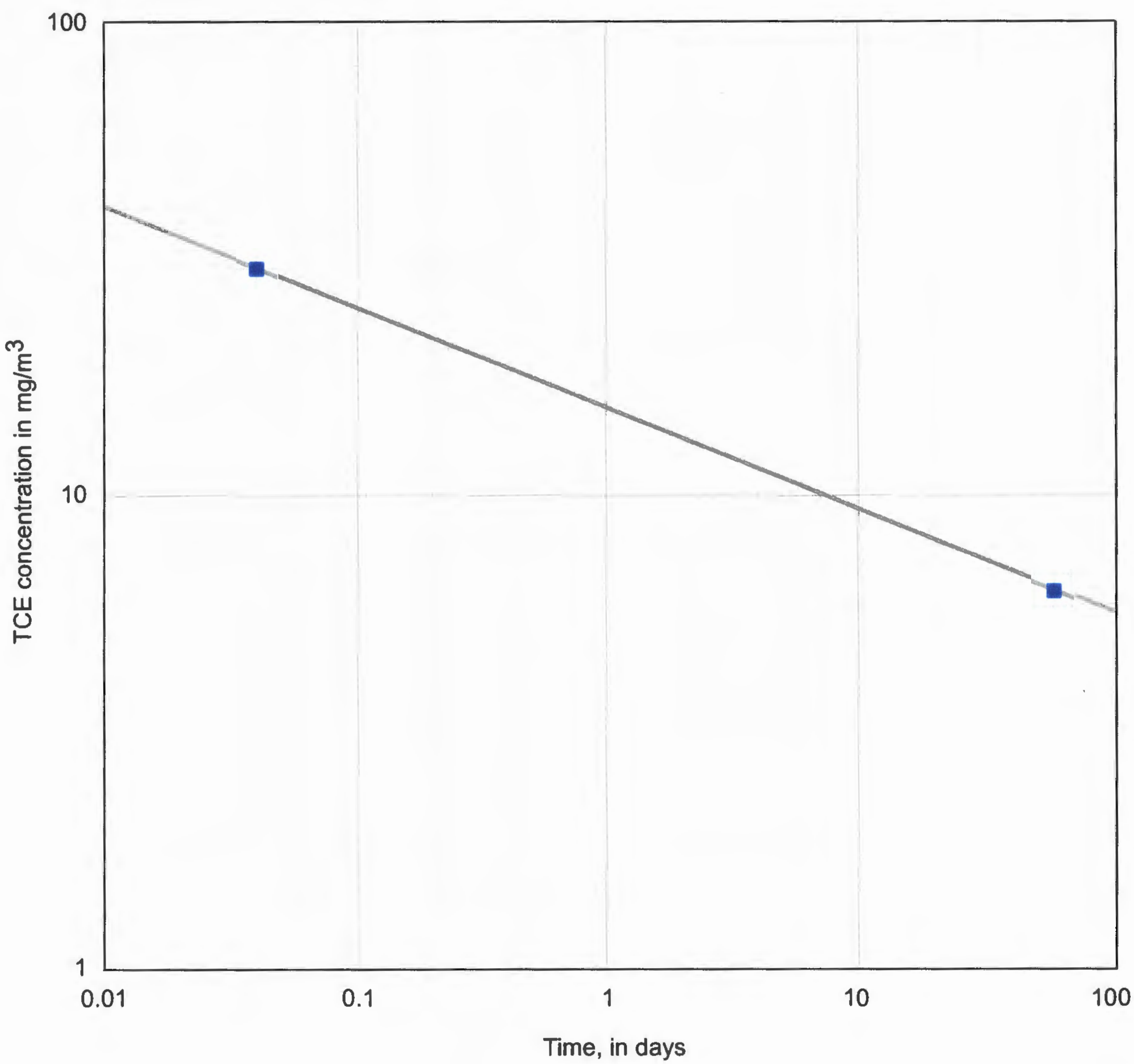

Figure 5.22 Influent Concentrations - SVE Operation - June 28 - August 25, 1999

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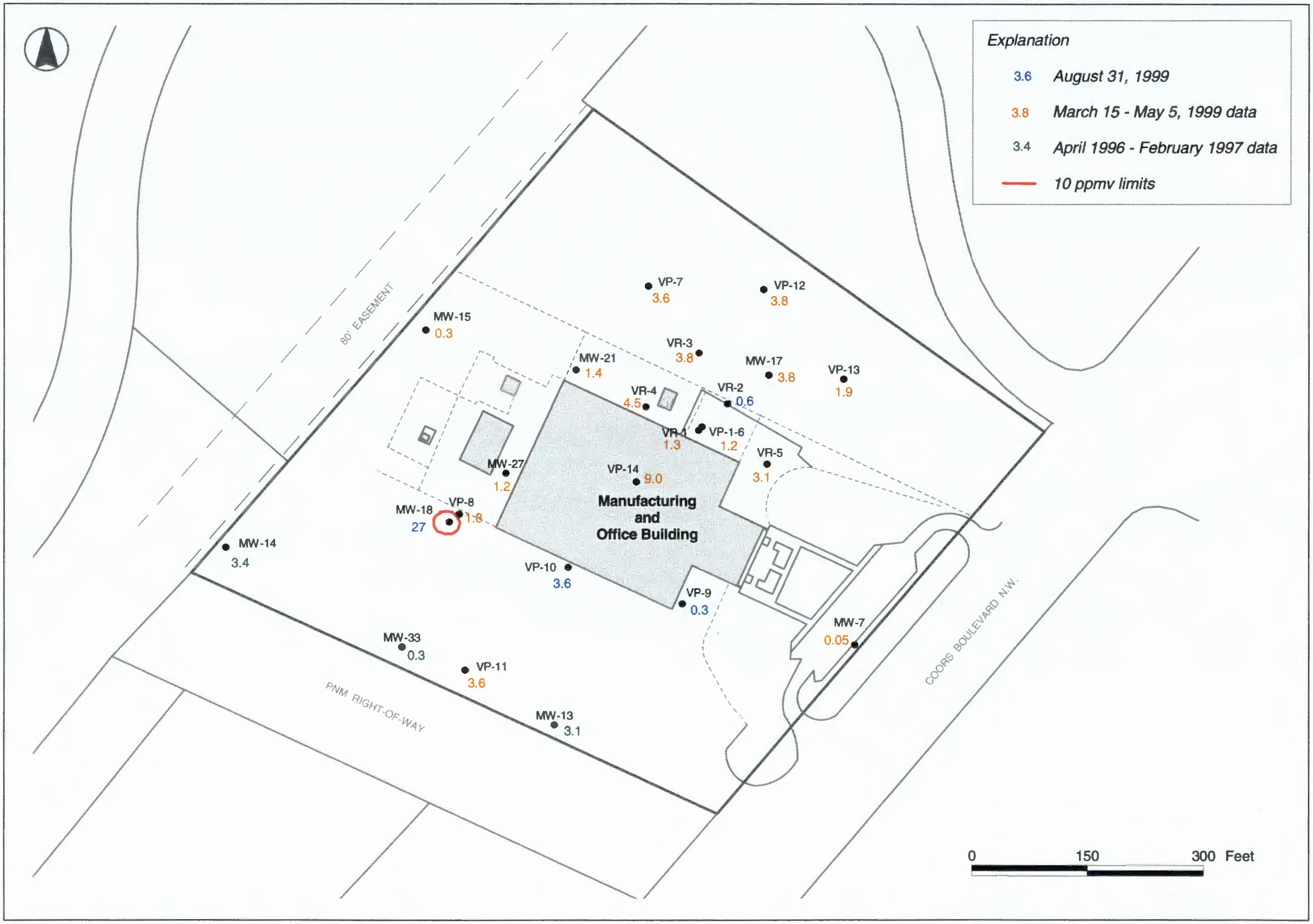


Figure 5.23 TCE Concentrations in Soil Gas After the 1999 SVE Operations

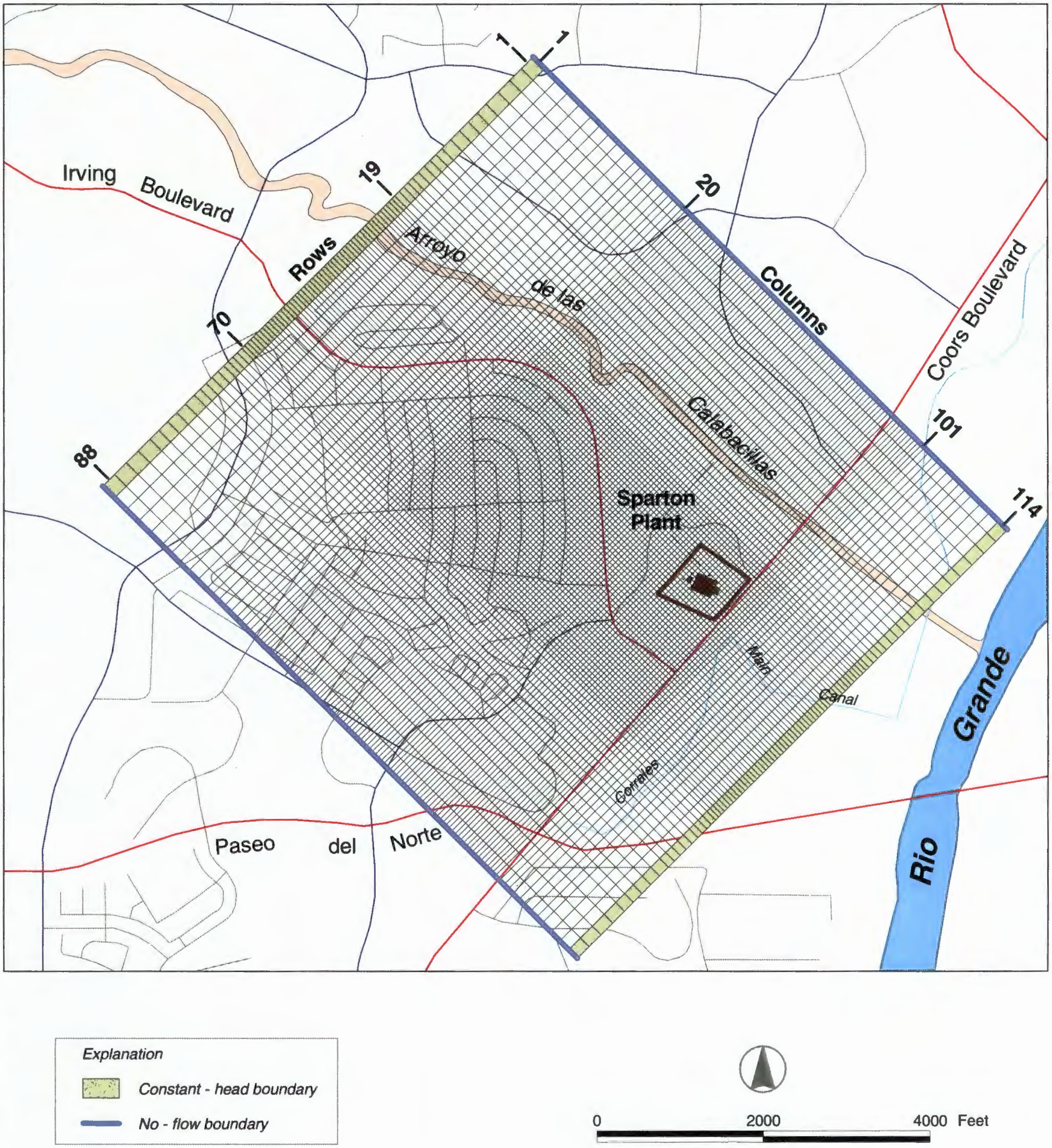


Figure 6.1 Model Grid and Boundary Conditions

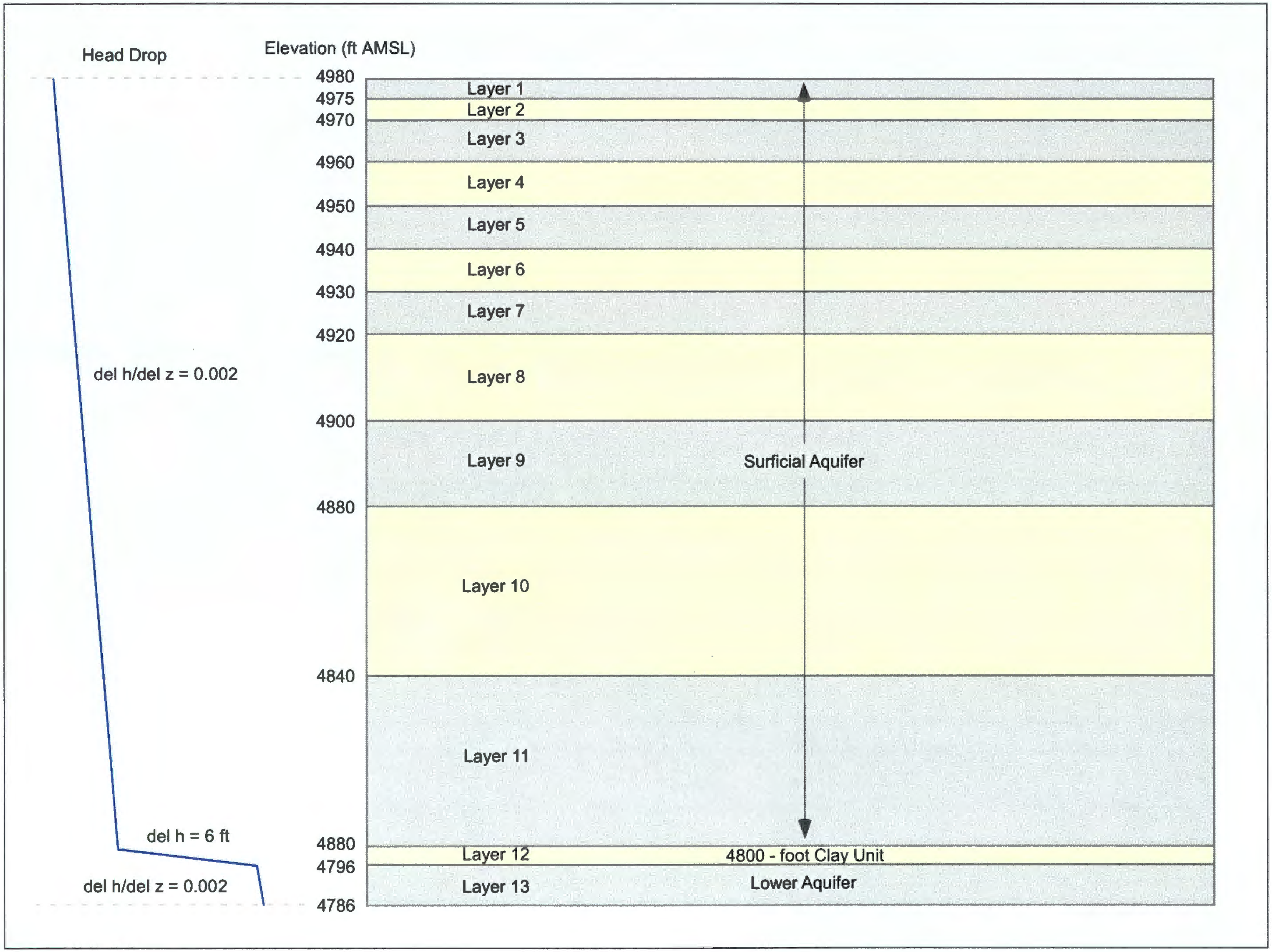


Figure 6.2 Model Layers

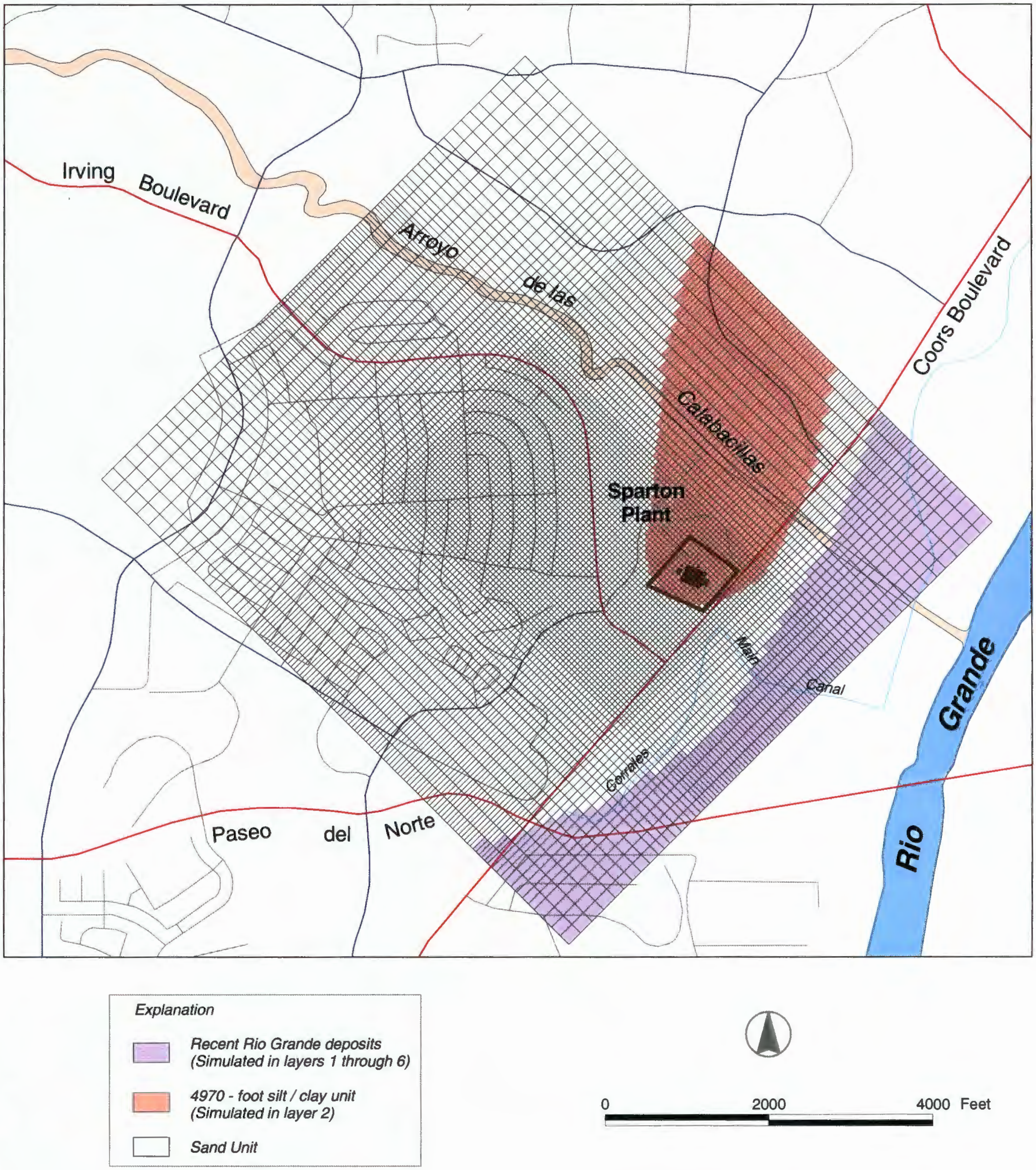
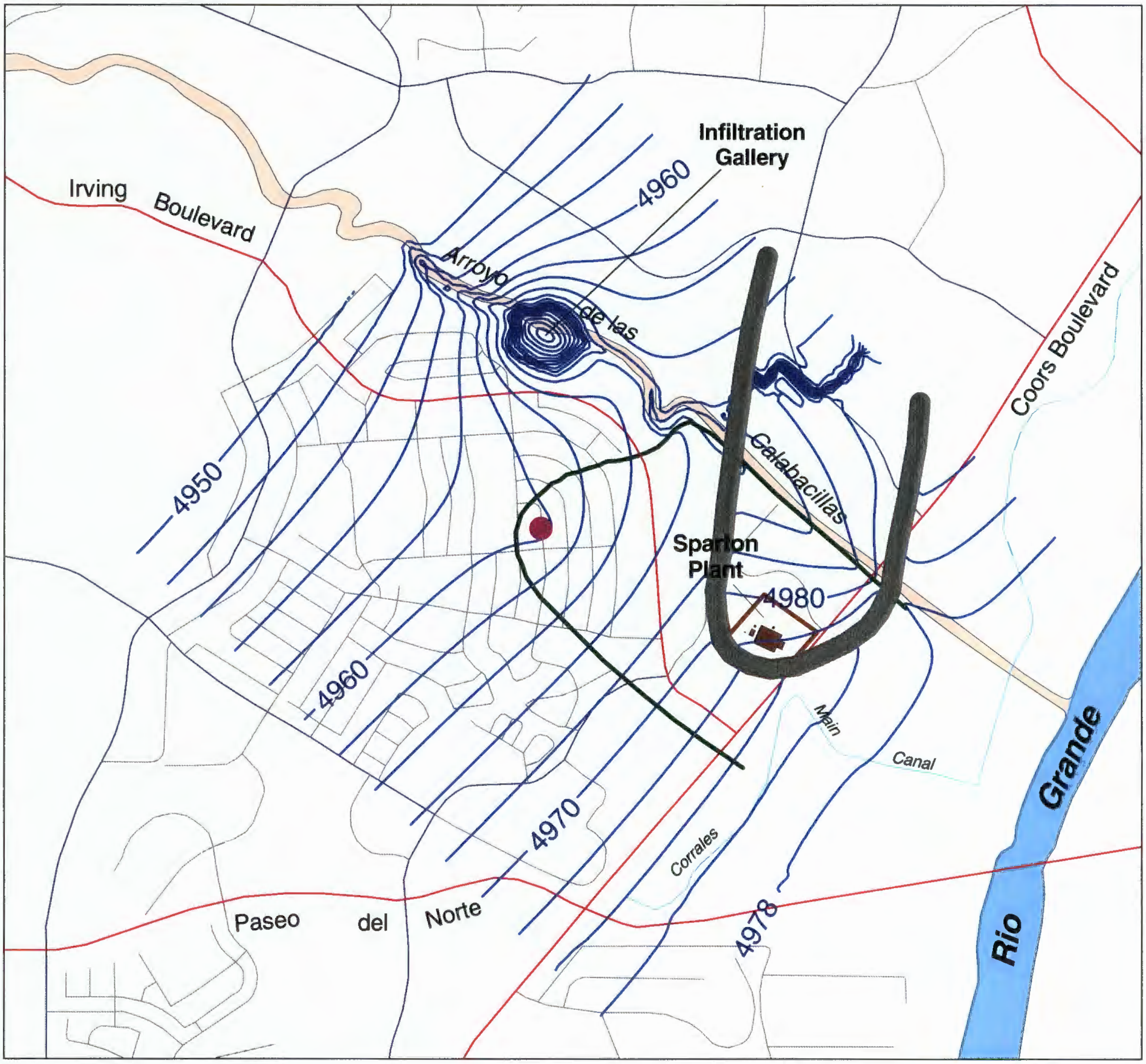


Figure 6.3 Hydraulic Property Zones



Explanation

- Containment Well
- –4978– Line of equal water - level elevation, in ft above MSL
- Limit of the capture zone
- Approximate extent of 4970 - foot silt/clay unit

0 2000 4000 Feet

Figure 6.4 Computed Water Levels and Capture Zone in the UFZ - October 1999

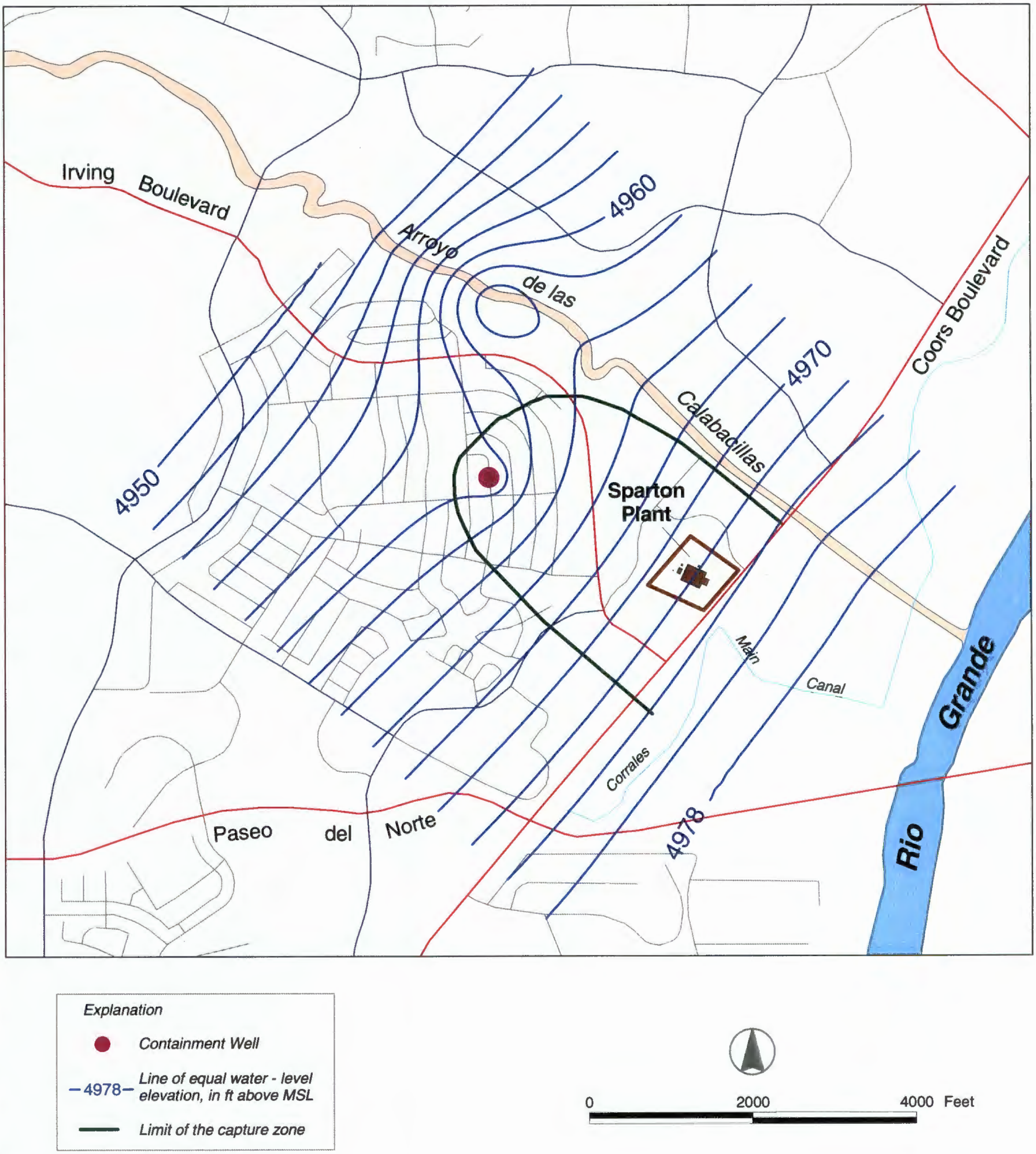


Figure 6.5 Computed Water Levels and Capture Zone in the ULFZ - October 1999

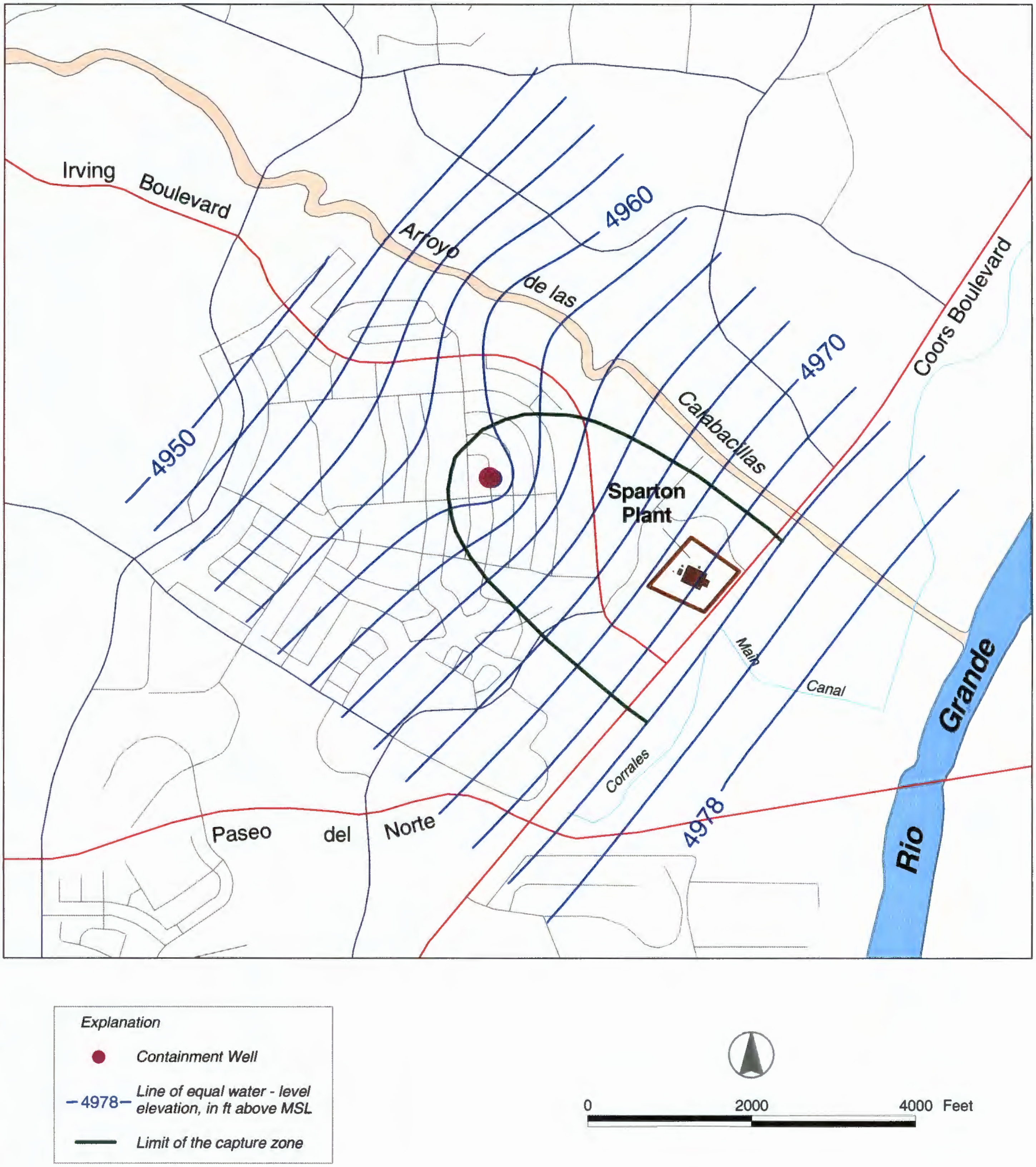


Figure 6.6 Computed Water Levels and Capture Zone in the LLFZ - October 1999

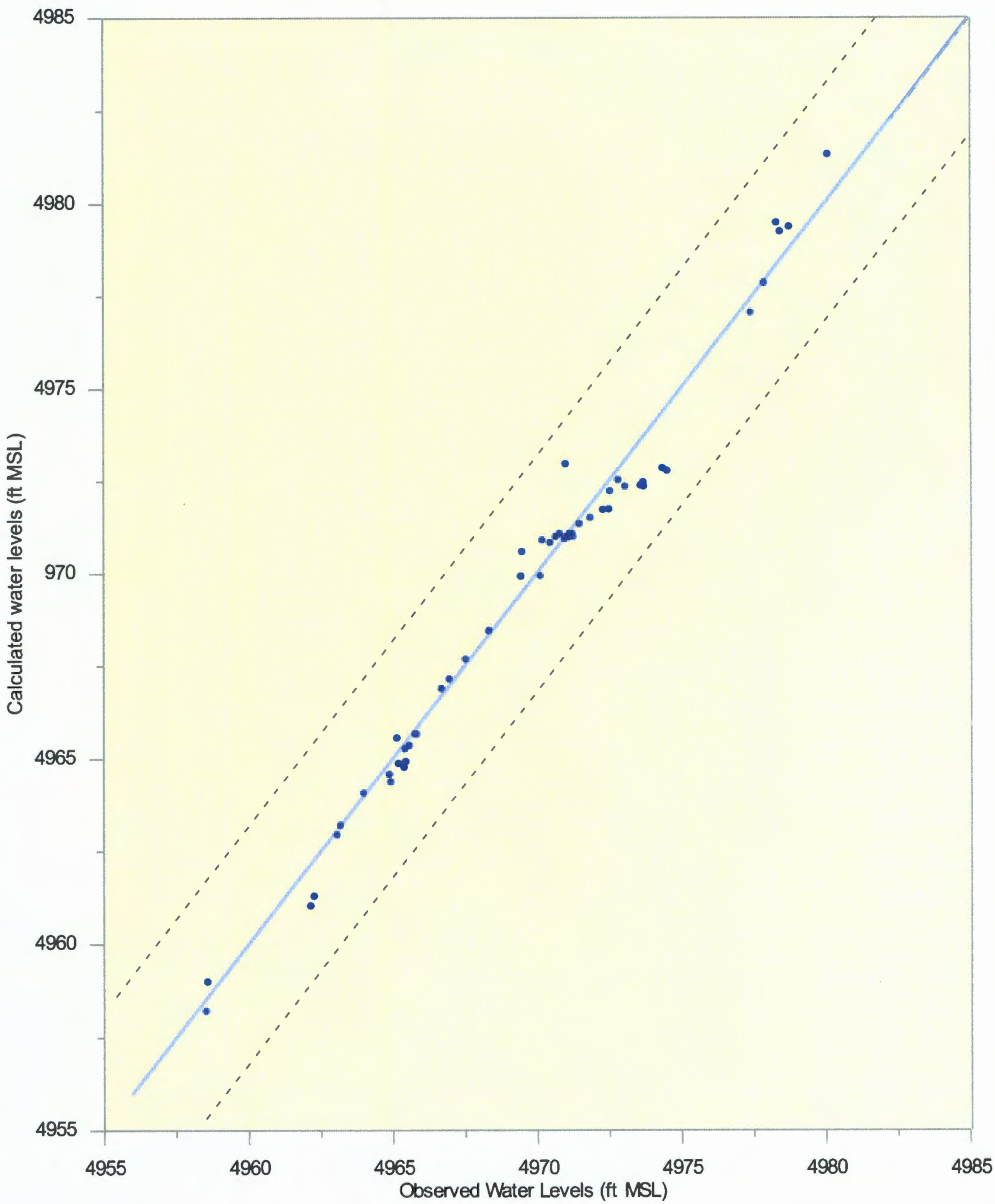


Figure 6.7 Comparison of Calculated to Observed Water Levels - November 1998

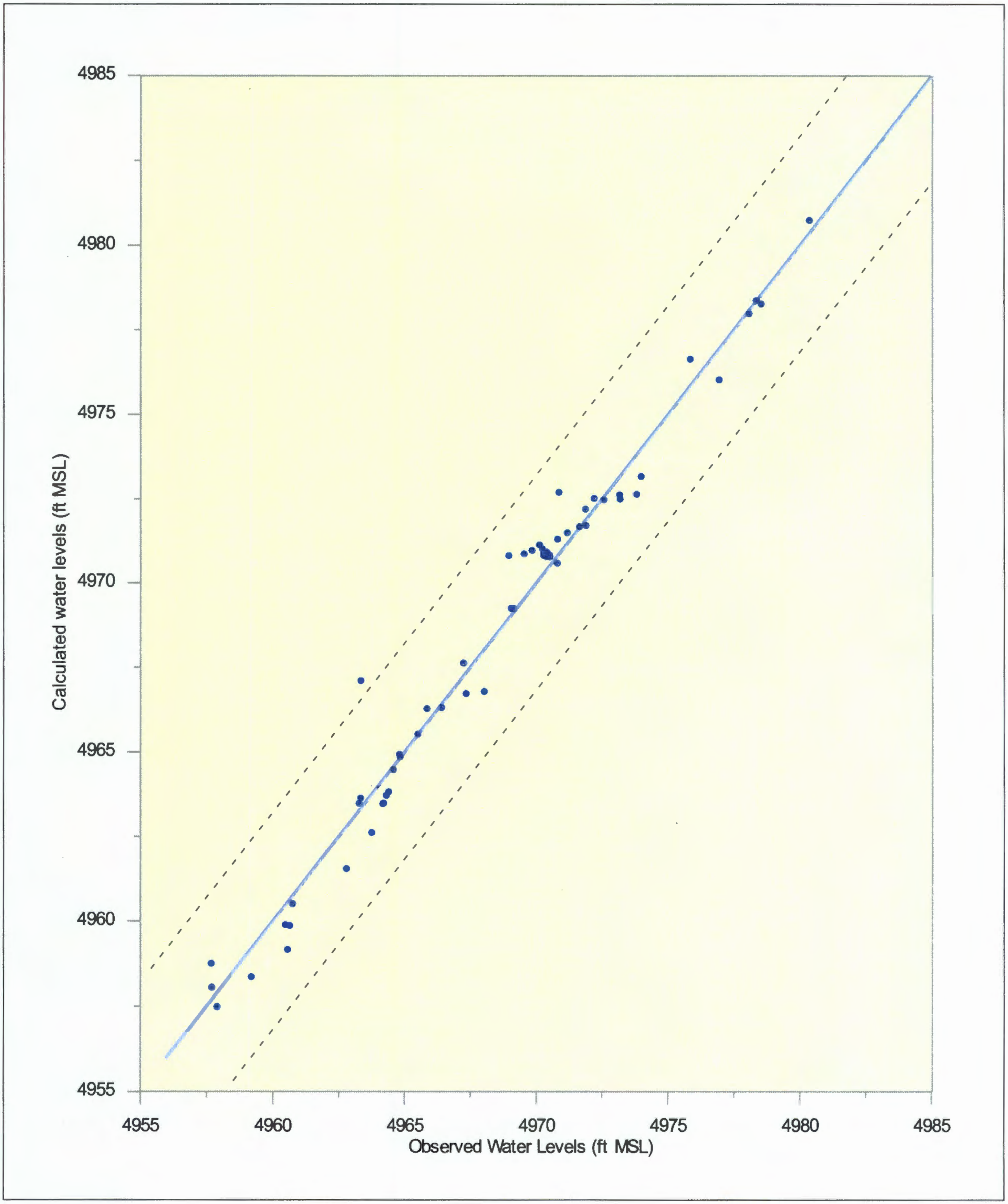


Figure 6.8 Comparison of Calculated to Observed Water Levels - October 1999

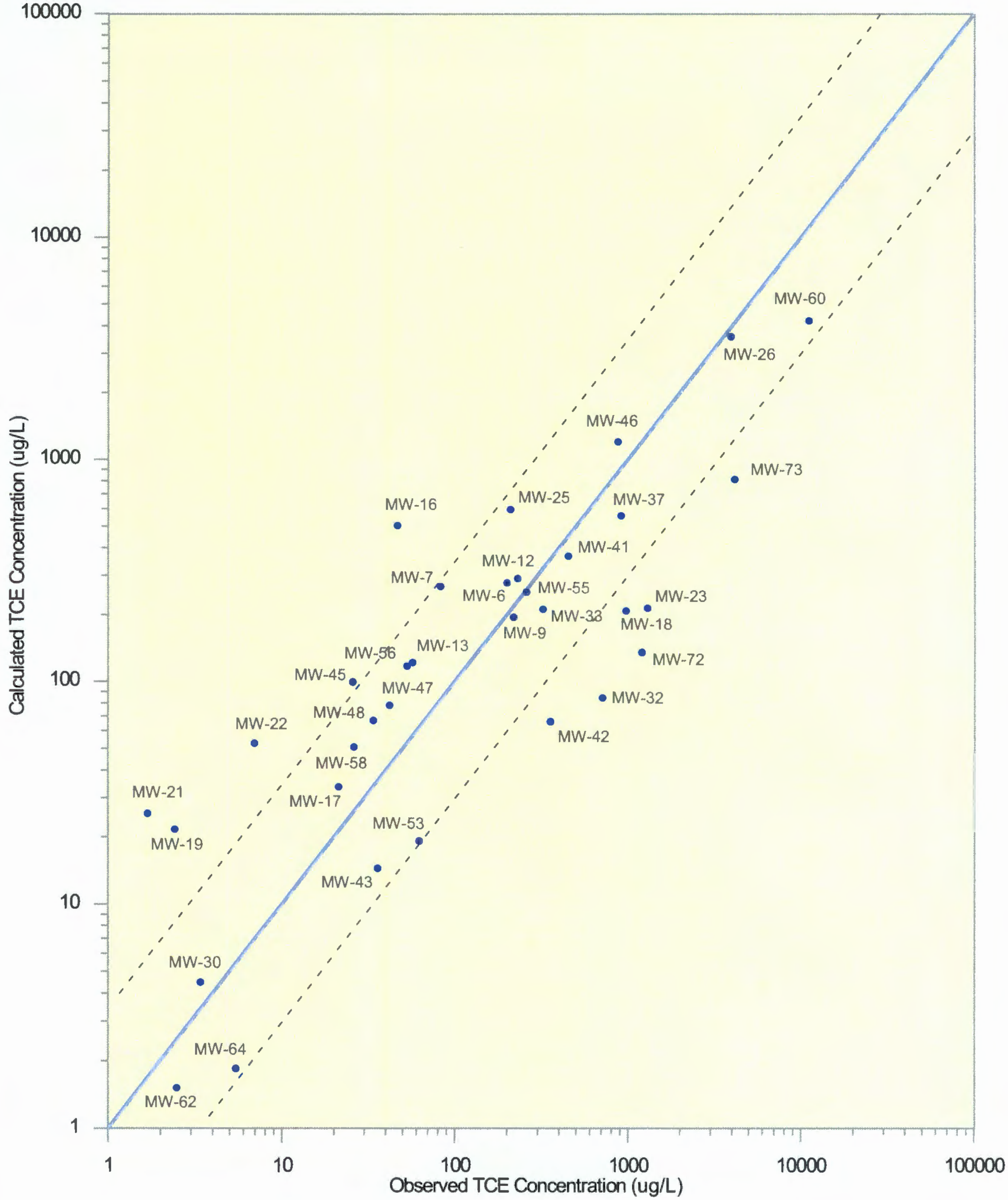


Figure 6.9 Comparison of Calculated to Observed Concentrations of TCE - November 1999

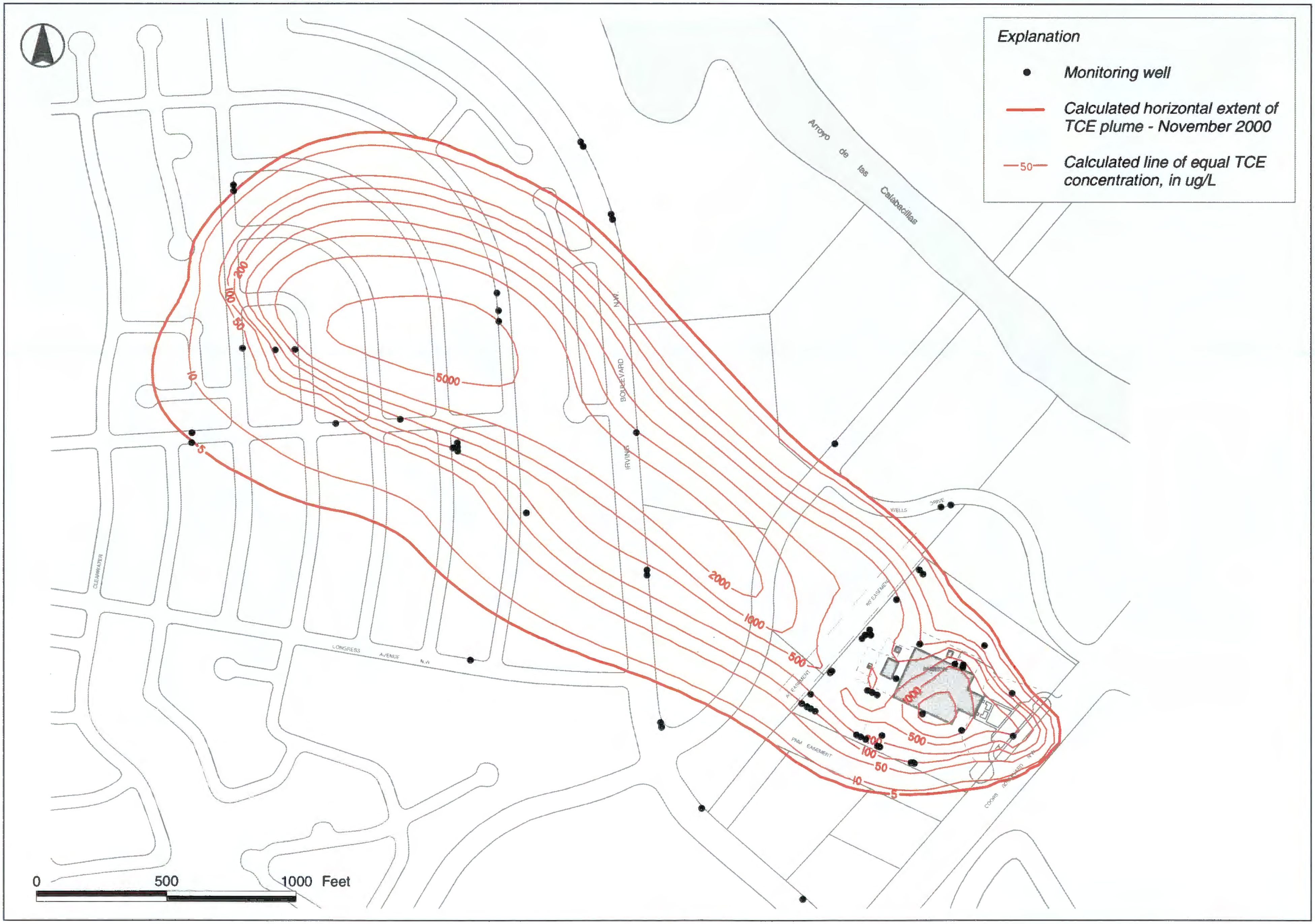


Figure 6-10 Calculated Extent of TCE Plume - November, 2000

Figure 6.11 TCE Concentrations Calculated with the Groundwater Flow and Transport Model

TABLES

Table 2.1

Completion Flow Zone, Location Coordinates, and Measuring Point Elevation of Wells

Well ID	Flow Zone[a]	Easting[b]	Northing[b]	Elevation[c]
CW-1	UFZ&LFZ	374740.43	1525601.48	5166.68
				5168.02*
OB-1	UFZ&LFZ	374665.16	1525599.52	5166.62
				5169.10*
OB-2	UFZ&LFZ	374537.98	1525606.65	5165.28
				5165.26*
PW-1	UFZ	377014.89	1524058.48	5044.54
				5043.84**
PZ-1	UFZ	372283.60	1523143.31	5142.17
MW-7	UFZ	377535.41	1524101.14	5044.80
MW-9	UFZ	377005.75	1524062.25	5044.11
MW-12	UFZ	377023.27	1524102.56	5042.58
MW-13	UFZ	377137.23	1523998.34	5043.25
MW-14	UFZ	376711.05	1524226.84	5043.04
MW-15	UFZ	376976.13	1524514.13	5047.49
MW-16	UFZ	377340.57	1524378.38	5047.50
MW-17	UFZ	377423.18	1524452.68	5049.28
MW-18	UFZ	377005.22	1524260.58	5045.58
				5045.32**
MW-19	ULFZ	376986.52	1524269.27	5046.25
MW-20	LLFZ	376967.98	1524277.98	5045.79
MW-21	UFZ	377171.22	1524458.71	5048.36
MW-22	UFZ	377531.77	1524267.24	5048.06
MW-23	UFZ	377333.63	1524123.03	5048.51
MW-24	UFZ	377338.05	1524367.39	5048.70
MW-25	UFZ	377307.91	1524380.40	5049.00
MW-26	UFZ	377180.89	1524187.40	5045.71
MW-27	UFZ	377078.91	1524323.46	5045.50
MW-28	UFZ	376745.76	1524262.70	5042.69
MW-29	ULFZ	377144.48	1523998.74	5044.51
MW-30	ULFZ	376924.12	1524105.15	5044.70
MW-31	ULFZ	376731.49	1524215.04	5043.53
MW-32	LLFZ	376958.37	1524494.18	5048.05
MW-33	UFZ	376940.80	1524097.74	5044.29
MW-34	UFZ	376715.25	1523469.17	5034.49
MW-35	UFZ	376322.45	1523822.39	5042.50
MW-36	UFZ	376161.85	1524154.66	5059.46
MW-37	UFZ	376108.17	1524746.78	5090.85
MW-38	LLFZ	377150.52	1523995.17	5044.32
MW-39	LLFZ	376961.13	1524088.17	5044.06
MW-40	LLFZ	376745.33	1524207.40	5043.35

[a] UFZ denotes the Upper Flow Zone; ULFZ, LLFZ and 3rdFZ denote the upper, lower, and deeper intervals of the Lower Flow Zone (LFZ); DFZ denotes a deeper flow zone separated from the Lower Flow Zone by a continuous clay layer that causes significant head differences between LFZ and DFZ.

[b] New Mexico "Modified State Plane" coordinates, in feet

[c] In feet above mean sea level (MSL)

Well ID	Flow Zone[a]	Easting[b]	Northing[b]	Elevation[c]
MW-41	ULFZ	376945.67	1524479.28	5046.77
MW-42	ULFZ	377183.28	1524730.69	5057.33
MW-43	LLFZ	377169.66	1524747.27	5057.74
MW-44	ULFZ	376166.14	1524136.09	5058.75
MW-45	ULFZ	376108.80	1524726.75	5089.65
MW-46	ULFZ	376067.09	1525279.84	5118.98
MW-47	UFZ	375638.14	1524967.74	5155.83
MW-48	UFZ	375369.75	1525239.86	5168.31
MW-49	3rdFZ	376763.40	1524197.32	5043.67
MW-50	UFZ	372810.17	1527180.09	5211.21
MW-51	UFZ	377291.45	1525000.02	5058.94
				5060.31***
MW-52	UFZ	374343.43	1525239.45	5156.79
MW-53	UFZ	374899.50	1525314.41	5164.24
MW-54	UFZ	375974.55	1526106.27	5097.64
MW-55	LLFZ	375370.70	1525224.15	5168.61
MW-56	ULFZ	375371.31	1525207.68	5168.61
MW-57	UFZ	375849.02	1526406.98	5103.54
MW-58	UFZ	375148.43	1525330.73	5168.89
MW-59	ULFZ	377253.38	1524991.51	5059.18
				5060.61***
MW-60	ULFZ	375530.19	1525753.61	5134.87
MW-61	UFZ	375523.16	1525821.65	5135.23
MW-62	UFZ	375421.24	1524395.94	5075.00
MW-63	UFZ	376840.50	1525236.52	5065.74
				5063.10****
MW-64	ULFZ	375968.81	1526127.81	5097.84
MW-65	LLFZ	374343.87	1525277.92	5156.45
MW-66	LLFZ	375859.24	1526389.09	5103.03
MW-67	DFZ	375352.47	1525220.38	5169.21
MW-68	UFZ	374503.81	1526216.71	5165.53
MW-69	LLFZ	374502.80	1526239.55	5165.46
MW-70	3rdFZ	376981.33	1524492.75	5046.65
MW-71	DFZ	375530.63	1525711.81	5134.59
MW-72	ULFZ	377079.68	1524630.73	5056.25
MW-73	ULFZ	376821.45	1524346.08	5045.07
MW-74	UFZ	374484.30	1527810.76	5094.80
MW-75	UFZ	374613.33	1528009.97	5113.74
MW-76	UFZ	375150.41	1527826.10	5108.32
PZG-1	Infilt. Gall.	374871.44	1527608.15	5090.90
Canal				4996.07

* Elevation effective May 6, 1999
** Elevation effective late November, 1999
*** Elevation effective June 4, 1999
**** Elevation effective October 28, 1999

Table 2.2

Well Screen Data

Well ID	Flow Zone	Elevation, in ft above MSL			Depth below Ground, in ft		Screen Length in ft
		Ground Surface	Top of Screen	Bottom of Screen	Top of Screen	Bottom of Screen	
CW-1	UFZ&LFZ	5164.5	4957.5	4797.5	207.0	367.0	160.0
OB-1	UFZ&LFZ	5164.1	4961.1	4790.6	203.0	373.5	170.5
OB-2	UFZ&LFZ	5164.8	4960.8	4790.2	204.0	374.6	170.6
PW-1	UFZ	5042.2	4982.2	4972.2	60.0	70.0	10.0
PZ-1	UFZ	5141.7	4958.9	4948.7	182.8	193.0	10.2
MW-7	UFZ	5043.9	4980.4	4975.4	63.5	68.5	5.0
MW-9	UFZ	5042.2	4979.7	4974.7	62.5	67.5	5.0
MW-12	UFZ	5042.4	4978.4	4966.4	64.0	76.0	12.0
MW-13	UFZ	5041.5	4981.5	4971.6	60.0	69.9	9.9
MW-14	UFZ	5040.4	4979.4	4970.0	61.0	70.4	9.4
MW-15	UFZ	5045.6	4985.6	4973.9	60.0	71.7	11.7
MW-16	UFZ	5045.8	4977.8	4972.8	68.0	73.0	5.0
MW-17	UFZ	5047.5	4980.5	4975.5	67.0	72.0	5.0
MW-18	UFZ	5043.5	4975.5	4965.5	68.0	78.0	10.0
MW-19	ULFZ	5043.0	4945.4	4935.4	97.6	107.6	10.0
MW-20	LLFZ	5043.3	4918.0	4905.6	125.3	137.7	12.4
MW-21	UFZ	5044.9	4980.4	4975.4	64.5	69.5	5.0
MW-22	UFZ	5045.2	4963.7	4958.7	81.5	86.5	5.0
MW-23	UFZ	5045.5	4974.0	4969.0	71.5	76.5	5.0
MW-24	UFZ	5046.3	4978.8	4973.8	67.5	72.5	5.0
MW-25	UFZ	5045.9	4977.4	4972.4	68.5	73.5	5.0
MW-26	UFZ	5043.7	4969.1	4964.1	74.6	79.6	5.0
MW-27	UFZ	5043.8	4975.3	4970.3	68.5	73.5	5.0
MW-28	UFZ	5040.9	4975.9	4970.9	65.0	70.0	5.0
MW-29	ULFZ	5041.8	4938.5	4928.5	103.3	113.3	10.0
MW-30	ULFZ	5041.9	4944.9	4934.9	97.0	107.0	10.0
MW-31	ULFZ	5040.9	4944.4	4934.4	96.5	106.5	10.0
MW-32	LLFZ	5045.1	4937.6	4927.6	107.5	117.5	10.0
MW-33	UFZ	5042.0	4980.0	4969.0	62.0	73.0	11.0
MW-34	UFZ	5034.5	4978.0	4968.0	56.5	66.5	10.0
MW-35	UFZ	5042.5	4979.3	4969.3	63.2	73.2	10.0
MW-36	UFZ	5059.3	4977.0	4967.0	82.3	92.3	10.0
MW-37	UFZ	5091.7	4976.7	4966.7	115.0	125.0	10.0
MW-38	LLFZ	5041.7	4915.2	4905.2	126.5	136.5	10.0
MW-39	LLFZ	5042.1	4919.1	4909.1	123.0	133.0	10.0
MW-40	LLFZ	5041.0	4924.0	4914.0	117.0	127.0	10.0

Table 2.2

Well Screen Data

(continued)

Well ID	Flow Zone	Elevation, in ft above MSL: Ground Surface	Elevation, in ft above MSL: Top of Screen	Elevation, in ft above MSL: Bottom of Screen	Depth below Ground, in ft: Top of of Screen	Depth below Ground, in ft: Bottom of Screen	Screen Length in ft
MW-41	ULFZ	5044.3	4952.3	4947.3	92.0	97.0	5.0
MW-42	ULFZ	5054.8	4949.8	4939.8	105.0	115.0	10.0
MW-43	LLFZ	5055.2	4928.2	4918.2	127.0	137.0	10.0
MW-44	ULFZ	5058.7	4952.7	4942.7	106.0	116.0	10.0
MW-45	ULFZ	5090.1	4947.7	4937.7	142.4	152.4	10.0
MW-46	ULFZ	5118.5	4948.5	4938.5	170.0	180.0	10.0
MW-47	UFZ	5155.4	4975.4	4960.4	180.0	195.0	15.0
MW-48	UFZ	5167.9	4975.9	4960.9	192.0	207.0	15.0
MW-49	3rdFZ	5041.2	4904.0	4894.0	137.2	147.2	10.0
MW-50	UFZ	5210.8	4975.8	4960.8	235.0	250.0	15.0
MW-51	UFZ	5058.5	4983.5	4973.5	75.0	85.0	10.0
MW-52	UFZ	5165.4	4974.6	4959.4	190.8	206.0	15.2
MW-53	UFZ	5164.0	4974.0	4960.0	190.0	204.0	14.0
MW-54	UFZ	5097.2	4976.2	4961.2	121.0	136.0	15.0
MW-55	LLFZ	5168.2	4913.2	4903.2	255.0	265.0	10.0
MW-56	ULFZ	5168.2	4943.2	4933.2	225.0	235.0	10.0
MW-57	UFZ	5103.1	4977.1	4962.1	126.0	141.0	15.0
MW-58	UFZ	5168.4	4974.4	4959.4	194.0	209.0	15.0
MW-59	ULFZ	5058.7	4954.2	4943.7	104.5	115.0	10.5
MW-60	ULFZ	5133.2	4948.2	4938.2	185.0	195.0	10.0
MW-61	UFZ	5133.5	4975.5	4960.5	158.0	173.0	15.0
MW-62	UFZ	5074.6	4979.6	4964.6	95.0	110.0	15.0
MW-63	UFZ	5065.7	4982.7	4967.7	83.0	98.0	15.0
MW-64	ULFZ	5097.4	4958.6	4948.4	138.8	149.0	10.2
MW-65	LLFZ	5156.0	4896.0	4886.0	260.0	270.0	10.0
MW-66	LLFZ	5102.6	4902.6	4892.6	200.0	210.0	10.0
MW-67	DFZ	5168.8	4798.8	4788.8	370.0	380.0	10.0
MW-68	UFZ	5165.1	4971.1	4951.1	194.0	214.0	20.0
MW-69	LLFZ	5165.0	4905.0	4895.0	260.0	270.0	10.0
MW-70	3rdFZ	5044.3	4911.3	4901.3	133.0	143.0	10.0
MW-71	DFZ	5134.1	4786.1	4781.1	348.0	353.0	5.0
MW-72	ULFZ	5053.7	4954.7	4944.7	99.0	109.0	10.0
MW-73	ULFZ	5042.2	4945.2	4940.2	97.0	102.0	5.0
MW-74	UFZ/ULFZ	5092.4	4969.4	4939.4	123.0	153.0	30.0
MW-75	UFZ/ULFZ	5111.6	4970.6	4940.6	141.0	171.0	30.0
MW-76	UFZ/ULFZ	5105.5	4972.5	4942.5	133.0	163.0	30.0

Table 2.3

Production History of the On-Site, Eight-Well Groundwater Recovery System

Date		Volume of Recovered Water, in gal		Average Discharge Rate, in gpm	
Year	Month	Monthly	Annual	Monthly	Annual
1988	Jan.				
	Feb.				
	Mar.				
	Apr.				
	May				
	June				
	July				
	Aug.				
	Sep.				
	Oct.				
	Nov.				
	Dec.	25,689	25,689	1.05[a]	1.05[a]
1989	Jan.	53,911		1.21	
	Feb.	32,100		0.80	
	Mar.	55,424		1.24	
	Apr.	36,676		0.85	
	May	50,600		1.13	
	June	73,235		1.70	
	July	75,765		1.70	
	Aug.	78,300		1.75	
	Sep.	84,290		1.95	
	Oct.	66,810		1.50	
	Nov.	78,300		1.81	
	Dec.	51,731	737,142	1.16	1.40
1990	Jan.	51,369		1.15	
	Feb.	47,900		1.19	
	Mar.	46,113		1.03	
	Apr.	53,888		1.25	
	May	57,900		1.30	
	June	53,323		1.23	
	July	56,677		1.27	
	Aug.	67,471		1.51	
	Sep.	53,529		1.24	
	Oct.	67,200		1.51	
	Nov.	61,688		1.43	
	Dec.	42,413	659,469	0.95	1.25

Date		Volume of Recovered Water, in gal		Average Discharge Rate, in gpm	
Year	Month	Monthly	Annual	Monthly	Annual
1991	Jan.	39,400		0.88	
	Feb.	42,200		1.05	
	Mar.	37,900		0.85	
	Apr.	40,000		0.93	
	May	45,091		1.01	
	June	47,209		1.09	
	July	59,300		1.33	
	Aug.	57,115		1.28	
	Sep.	53,485		1.24	
	Oct.	49,200		1.10	
	Nov.	43,355		1.00	
	Dec.	42,045	556,300	0.94	1.06
1992	Jan.	42,334		0.95	
	Feb.	36,866		0.88	
	Mar.	34,100		0.76	
	Apr.	33,100		0.77	
	May	33,200		0.74	
	June	37,800		0.88	
	July	37,388		0.84	
	Aug.	39,712		0.89	
	Sep.	39,300		0.91	
	Oct.	40,300		0.90	
	Nov.	36,600		0.85	
	Dec.	29,724	440,424	0.67	0.84
1993	Jan.	29,676		0.66	
	Feb.	23,800		0.59	
	Mar.	25,700		0.58	
	Apr.	25,313		0.59	
	May	26,688		0.60	
	June	27,700		0.64	
	July	30,806		0.69	
	Aug.	28,794		0.65	
	Sep.	32,400		0.75	
	Oct.	48,500		1.09	
	Nov.	43,600		1.01	
	Dec.	36,542	379,519	0.82	0.72

[a] Average for December 15 - 31, 1988.

Table 2.3

Production History of the On-Site, Eight-Well Groundwater Recovery System

(continued)

Date		Volume of Recovered Water, in gal		Average Discharge Rate, in gpm	
Year	Month	Monthly	Annual	Monthly	Annual
1994	Jan.	29,858		0.67	
	Feb.	23,600		0.59	
	Mar.	23,615		0.53	
	Apr.	24,985		0.58	
	May	27,100		0.61	
	June	33,600		0.78	
	July	37,000		0.83	
	Aug.	36,300		0.81	
	Sep.	33,094		0.77	
	Oct.	36,406		0.82	
	Nov.	34,300		0.79	
	Dec.	31,097	370,954	0.70	0.71
1995	Jan.	25,803		0.58	
	Feb.	27,700		0.69	
	Mar.	25,927		0.58	
	Apr.	23,373		0.54	
	May	23,100		0.52	
	June	40,147		0.93	
	July	44,353		0.99	
	Aug.	44,900		1.01	
	Sep.	38,903		0.90	
	Oct.	38,097		0.85	
	Nov.	36,800		0.85	
	Dec.	30,613	399,716	0.69	0.76
1996	Jan.	27,088		0.61	
	Feb.	22,400		0.54	
	Mar.	20,100		0.45	
	Apr.	22,100		0.51	
	May	25,270		0.57	
	June	24,930		0.58	
	July	29,200		0.65	
	Aug.	36,636		0.82	
	Sep.	24,064		0.56	
	Oct.	26,500		0.59	
	Nov.	26,419		0.61	
	Dec.	21,981	306,688	0.49	0.58
1997	Jan.	13,272		0.30	
	Feb.	9,428		0.23	
	Mar.	25,000		0.56	
	Apr.	5,500		0.13	
	May	17,922		0.40	
	June	16,478		0.38	
	July	15,100		0.34	
	Aug.	14,822		0.33	
	Sep.	3,778		0.09	
	Oct.	17,942		0.40	
	Nov.	15,858		0.37	
	Dec.	15,800	170,900	0.35	0.33
1998	Jan.	11,555		0.26	
	Feb.	11,045		0.27	
	Mar.	12,200		0.27	
	Apr.	12,800		0.30	
	May	13,200		0.30	
	June	15,060		0.35	
	July	21,550		0.48	
	Aug.	52,010		1.17	
	Sep.	39,850		0.92	
	Oct.	33,383		0.75	
	Nov.	9,247		0.21	
	Dec.	447	232,347	0.01	0.44
1999	Jan.	9,783		0.22	
	Feb.	12,350		0.31	
	Mar.	13,100		0.29	
	Apr.	12,930		0.30	
	May	13,360		0.30	
	June	13,380		0.31	
	July	13,766		0.31	
	Aug.	14,224		0.32	
	Sep.	14,450		0.33	
	Oct.	10,230		0.23	
	Nov.	9,830		0.23[b]	
	Dec.	0	137,403	0.00	0.26[c]

Total Recovered Volume, in gal	**4,416,550**
Average Discharge Rate, in gpm	**0.77**

[b] Average for November 1 - 16, 1999.

[c] Average for January 1 - November 16, 1999.

Table 2.4

Water-Level Elevations - Fourth Quarter 1998[a]

Well ID	Flow Zone	Elevation, in ft above MSL
PW-1	UFZ	4973.59
PZ-1	UFZ	4956.59
MW-7	UFZ	4977.42
MW-9	UFZ	4973.06
MW-12	UFZ	4972.82
MW-13	UFZ	4974.35
MW-14	UFZ	4971.12
MW-15	UFZ	Dry
MW-16	UFZ	4978.43
MW-17	UFZ	4978.7
MW-18	UFZ	4971.87
MW-19	ULFZ	4971.85
MW-20	LLFZ	4971.47
MW-21	UFZ	4978.31
MW-22	UFZ	4977.89
MW-23	UFZ	4975.91
MW-24	UFZ	4978.23
MW-25	UFZ	4978.31
MW-26	UFZ	4973.44
MW-27	UFZ	4974.05
MW-28	UFZ	4971.09
MW-29	ULFZ	4973.68
MW-30	ULFZ	4972.28
MW-31	ULFZ	4971.23
MW-32	ULFZ *	4970.96
MW-33	UFZ	4972.54
MW-34	UFZ	4974.51
MW-35	UFZ	4970.78
MW-36	UFZ	4970.03
MW-37	UFZ	4968.32
MW-38	LLFZ	4973.7
MW-39	LLFZ	4972.49

Well	Flow Zone	Elevation, in ft above MSL
MW-40	LLFZ	4971.25
MW-41	ULFZ	4971.09
MW-42	ULFZ	4970.65
MW-43	LLFZ	4970.45
MW-44	ULFZ	4970.11
MW-45	ULFZ	4968.33
MW-46	ULFZ	4966.95
MW-47	UFZ	4966.68
MW-48	UFZ	4965.81
MW-49	LLFZ **	4971.03
MW-50	UFZ	Dry
MW-51	UFZ	4980.09
MW-52	UFZ	4963.17
MW-53	UFZ	4964.92
MW-54	UFZ	4965.56
MW-55	LLFZ	4965.13
MW-56	ULFZ	4965.76
MW-57	UFZ	4964.87
MW-58	UFZ	4965.43
MW-59	ULFZ	4969.46
MW-60	ULFZ	4965.33
MW-61	UFZ	4965.37
MW-62	UFZ	4967.52
MW-63	UFZ	4970.98
MW-64	ULFZ	4965.41
MW-65	LLFZ	4963.05
MW-66	LLFZ	4963.98
MW-67	DFZ	4958.56
MW-68	UFZ	4962.25
MW-69	LLFZ	4962.13
MW-70	LLFZ **	4970.18
MW-71	DFZ	4958.51

[a] Water levels were measured on November 10, 1998, except for wells PW-1, MW-18, and MW-23 through MW-28 which were measured on November 25, 1998.

* Previously classified as LLFZ

** Previously classified as 3rdFZ

Table 2.5

Water-Quality Data - Fourth Quarter 1998[a]

Well ID	Sampling Date	Concentration, in µg/L TCE	DCE	TCA
CW1	9/1/98	140	2.9	<20
OB1	9/1/98	180	3.6	<20
OB2	9/1/98	72	1.7	<20
PW1	12/4/98	48	1	2.2
MW7	12/1/98	63	15	12
MW9	12/3/98	290	19	18
MW12	12/7/98	380	26	18
MW13	12/1/98	70	3.2	8
MW14	12/1/98	430	24	4.2
MW16	12/8/98	1200	30	170
MW17	12/1/98	68	3.5	13
MW18	12/2/98	600	50	42
MW19	11/23/98	4.2	<1.0	<1.0
MW20	11/23/98	<1.0	<1.0	<1.0
MW21	12/2/98	7.5	<1.0	1.1
MW22	11/19/98	13	2	4.6
MW23	12/3/98	6200	400	720
MW24	12/8/98	4700	74	480
MW25	12/8/98	5600	73	540
MW26	12/3/98	6500	590	550
MW27	12/2/98	380	24	90
MW29	11/19/98	<1.0	<1.0	<1.0
MW30	11/23/98	5.4	<1.0	<1.0
MW31	11/23/98	<1.0	<1.0	<1.0
MW32	11/30/98	550	96	30
MW33	12/2/98	630	53	28
MW34	11/18/98	<1.0	<1.0	<1.0
MW35	12/8/98	<1.0	<1.0	<1.0
MW36	12/7/98	1.4	<1.0	<1.0
MW37	12/3/98	990	48	<5
MW38	11/19/98	<1.0	<1.0	<1.0
MW39	11/23/98	<1.0	<1.0	<1.0
MW40	11/30/98	<1.0	<1.0	<1.0
MW41	11/19/98	170	26	<15
MW42	11/19/98	370	48	21
MW43	11/19/98	25	5.1	5.4
MW44	11/18/98	1.3	<1.0	<1.0
MW45	11/18/98	40	1.7	<1.0
MW46	11/19/98	2200	130	2.3
MW47	11/17/98	34	1.2	<1.0
MW48	11/17/98	28	1	<1.0
MW49	11/23/98	<1.0	<1.0	<1.0
MW51	11/18/98	<1.0	<1.0	<1.0
MW52	11/30/98	<1.0	<1.0	<1.0
MW53	11/16/98	99	3.4	<1.0
MW55	11/16/98	390	10	<1.0
MW56	11/16/98	140	4.7	<1.0
MW57	12/8/98	<1.0	<1.0	<1.0
MW58	11/16/98	71	2.5	<1.0
MW59	11/18/98	<1.0	<1.0	<1.0
MW60	11/17/98	7700	350	52
MW61	12/7/98	1000	54	11
MW62	12/7/98	2	6.6	4.8
MW63	12/2/98	<1.0	<1.0	<1.0
MW64	11/17/98	<1.0	<1.0	<1.0
MW65	11/16/98	13	<1.0	<1.0
MW66	11/17/98	<1.0	<1.0	<1.0
MW67	11/17/98	<1.0	<1.0	<1.0
MW68	11/12/98	<1.0	<1.0	<1.0
MW69	11/12/98	<1.0	<1.0	<1.0
MW70	11/23/98	<1.0	<1.0	<1.0
MW71	11/17/98	56	1.6	<1.0
TW1	2/18/98	3100	280	180
TW1 Dup.		3400	270	170
TW2	2/19/98	18	<1.0	<1.0
TW2 Dup.		16	<1.0	<1.0

[a] Includes 2/18/98 data from temporary well TW1/2 which was drilled at the current location of well MW73, and 9/1/98 data from the containment well CW1, and observation wells OB1 and OB2.

Table 4.1

Quarterly Water-Level Elevations - 1999

Well ID	Flow Zone	Elevation, in feet above MSL			
		Feb. 16	May 13	Aug. 12	Oct. 28
CW-1	UFZ&LFZ	4936.46	4938.84	4938.37	4938.12
OB-1	UFZ&LFZ	4958.29	4958.42	4957.70	4957.89
OB-2	UFZ&LFZ	4959.69	4961.24	4959.10	4959.19
PW-1	UFZ	NA[a]	NA[a]	NA[a]	NA[a]
PZ-1	UFZ	4956.95	4956.62	4956.14	4956.15
MW-7	UFZ	4976.36	4976.51	4976.70	4976.94
MW-9	UFZ	4972.14	4972.33	4972.33	4972.56
MW-12	UFZ	4971.80	4971.87	4971.96	4972.19
MW-13	UFZ	4973.39	4973.61	4973.77	4973.98
MW-14	UFZ	4970.20	Dry	Dry	4970.37
MW-15	UFZ	Dry	Dry	Dry	Dry
MW-16	UFZ	4977.89	4977.52	4977.72	4978.07
MW-17	UFZ	4978.16	4977.92	4978.03	4978.53
MW-18	UFZ	NA[a]	NA[a]	NA[a]	4970.93
MW-19	ULFZ	4970.91	4970.90	4970.98	4971.17
MW-20	LLFZ	4970.54	4970.54	4970.61	4970.80
MW-21	UFZ	4974.02	Dry	Dry	4978.34
MW-22	UFZ	4976.91	4976.98	4977.12	4975.84
MW-23	UFZ	NA[a]	NA[a]	NA[a]	4975.14
MW-24	UFZ	NA[a]	NA[a]	NA[a]	NA[a]
MW-25	UFZ	NA[a]	NA[a]	NA[a]	4977.01
MW-26	UFZ	NA	NA	NA	4971.28
MW-27	UFZ	NA[a]	NA[a]	NA[a]	NA[a]
MW-28	UFZ	Dry	Dry	Dry	Dry
MW-29	ULFZ	4972.59	4972.80	4972.94	4973.16
MW-30	ULFZ	4971.26	4971.31	4971.41	4971.63
MW-31	ULFZ	4970.29	4970.21	4970.28	4970.49
MW-32	ULFZ *	4970.12	4970.02	4970.07	4970.27
MW-33	UFZ	4971.53	4971.53	4971.66	4971.86
MW-34	UFZ	4973.03	4973.32	4973.67	4973.81
MW-35	UFZ	4970.63	4970.44	Dry	4970.79
MW-36	UFZ	4969.20	4968.86	Dry	4969.04
MW-37	UFZ	4967.62	4967.18	4967.04	4967.23
MW-38	LLFZ	4972.61	4972.82	4972.97	4973.18
MW-39	LLFZ	4971.46	4971.53	4971.66	4971.88
MW-40	LLFZ	4970.32	4970.25	4970.33	4970.51
MW-41	ULFZ	4970.24	4970.13	4970.17	4970.39

Well ID	Flow Zone	Elevation, in feet above MSL			
		Feb. 16	May 13	Aug. 12	Oct. 28
MW-42	ULFZ	4969.79	4969.80	4969.84	4970.11
MW-43	LLFZ	4969.72	4969.59	4969.63	4969.82
MW-44	ULFZ	4969.27	4968.97	4969.04	4969.13
MW-45	ULFZ	4967.62	4967.20	4966.77	4967.24
MW-46	ULFZ	4966.35	4965.85	4965.68	4965.84
MW-47	UFZ	4965.58	4965.58	4965.28	4965.50
MW-48	UFZ	4965.31	4964.63	4964.17	4964.39
MW-49	LLFZ **	4970.07	4970.05	4970.12	4970.37
MW-50	UFZ	Dry	Dry	Dry	Dry
MW-51	UFZ	4979.99	4979.77	4979.81	4980.36
MW-52	UFZ	4961.69	4961.31	4960.78	4960.75
MW-53	UFZ	4964.40	4963.49	4962.83	4962.79
MW-54	UFZ	4965.18	4964.65	4964.56	4964.81
MW-55	LLFZ	4963.74	4963.28	4963.08	4963.27
MW-56	ULFZ	4965.29	4964.59	4964.18	4964.30
MW-57	UFZ	4964.61	4964.12	4964.14	4964.57
MW-58	UFZ	4965.00	4964.18	4963.66	4963.75
MW-59	ULFZ	4968.76	4968.65	4968.70	4968.95
MW-60	ULFZ	4964.78	4964.22	4963.91	4964.17
MW-61	UFZ	4964.93	4964.30	4963.98	4964.20
MW-62	UFZ	4967.04	4966.44	4966.15	4966.40
MW-63	UFZ	4970.62	Well damaged	MPE not avail.	4970.85
MW-64	ULFZ	4965.72	4964.57	4964.47	4964.83
MW-65	LLFZ	4961.27	4960.96	4960.46	4960.47
MW-66	LLFZ	4964.21	4962.80	4963.03	4963.33
MW-67	DFZ	4958.05	4957.78	4957.44	4957.68
MW-68	UFZ	4961.08	4960.71	4960.47	4960.64
MW-69	LLFZ	4960.80	4960.77	4960.35	4960.55
MW-70	LLFZ **	4969.36	4969.27	4969.32	4969.52
MW-71	DFZ	4958.02	4957.72	4957.46	4957.70
MW-72	ULFZ	NI[b]	4970.00	4970.02	4970.22
MW-73	ULFZ	NI[b]	4970.03	4970.07	4970.27
MW-74	UFZ/ULFZ	NI[b]	4960.16	4962.63	4963.34
MW-75	UFZ/ULFZ	NI[b]	4960.89	4966.30	4967.32
MW-76	UFZ/ULFZ	NI[b]	4961.85	4966.89	4968.02
PZG-1	Infilt. Gall.	NI[b]	Dry	Dry	Dry
Canal[c]		Not measured	4991.57	4991.20	4991.32

[a] On-site recovery well, not accessible to measurement on that date.
[b] Well was not installed on date of measurement.
[c] Measured near the SE corner of Sparton property.

* Previously classified as LLFZ
** Previously classified as 3rdFZ

Table 4.2

Production from the Off-Site Containment Well - 1999

Month	Volume of Pumped Water, in gal.		Average Discharge Rates, in gpm	
	Monthly	**Annual**	**Monthly**	**Annual**
Jan.	10,555,600		236	
Feb.	9,345,550		232	
Mar.	10,855,470		243	
Apr.	6,866,620		159	
May	8,236,630		185	
June	9,679,620		224	
July	9,991,460		224	
Aug.	9,478,760		212	
Sep.	9,803,380		227	
Oct.	10,192,610		228	
Nov.	9,845,360		228	
Dec.	10,077,640	**114,928,700**	226	**219**

Table 4.3

Water-Quality Data - Fourth Quarter 1999

Well ID	Sampling Date	Concentration, in µg/L		
		TCE	DCE	TCA
CW1	11/3/99	1000	37	<20
MW7	11/16/99	84	16	8.8
MW9	11/5/99	220	16	14
MW12	11/18/99	230	25	10
MW13	11/15/99	57	3.8	5.7
MW16	11/18/99	46	3.5	6.9
MW17	11/16/99	21	1.5	3.4
MW18	11/19/99	980	180	60
MW19	11/8/99	2.4	<1.0	<1.0
MW20	11/8/99	<1.0	<1.0	<1.0
MW21	11/18/99	1.7	<1.0	<1.0
MW22	11/9/99	7	1.3	2.7
MW23	11/18/99	1300	110	120
MW25	11/19/99	210	13	20
MW26	11/19/99	3900	400	380
MW29	11/5/99	<1.0	<1.0	<1.0
MW30	11/8/99	3.4	<1.0	<1.0
MW31	11/9/99	<1.0	<1.0	<1.0
MW32	11/10/99	710	200	24
MW33	11/16/99	320	46	19
MW34	11/4/99	<1.0	<1.0	<1.0
MW35	11/16/99	<1.0	<1.0	<1.0
MW36	11/15/99	1	<1.0	<1.0
MW37	11/16/99	910	58	2.9
MW38	11/5/99	<1.0	<1.0	<1.0
MW39	11/8/99	<1.0	<1.0	<1.0
MW40	11/9/99	<1.0	<1.0	<1.0
MW41	11/10/99	450	100	25
MW42	11/10/99	360	49	16
MW43	11/9/99	36	7.2	5.3
MW44	11/4/99	<1.0	<1.0	<1.0
MW45	11/4/99	26	<1.0	<1.0
MW46	11/4/99	880	82	12
MW47	11/3/99	42	2	<1.0
MW48	11/3/99	34	1.3	<1.0
MW49	11/10/99	<1.0	<1.0	<1.0
MW51	11/9/99	<1.0	<1.0	<1.0
MW52	11/12/99	<1.0	<1.0	<1.0
MW53	11/12/99	62	2.5	<1.0
MW55	11/2/99	260	10	<5
MW56	11/2/99	53	2	<1.0
MW57	11/15/99	<1.0	<1.0	<1.0
MW58	11/15/99	26	<1.0	<1.0
MW59	11/10/99	<1.0	<1.0	<1.0
MW60	11/3/99	11000	480	<100
MW61	11/3/99	200	12	<5
MW62	11/12/99	2.5	7.4	4.5
MW64	11/4/99	5.4	<1.0	<1.0
MW65	11/4/99	<1.0	<1.0	<1.0
MW66	11/4/99	<1.0	<1.0	<1.0
MW67	11/3/99	<1.0	<1.0	<1.0
MW68	11/2/99	<1.0	<1.0	<1.0
MW69	11/2/99	<1.0	<1.0	<1.0
MW70	11/9/99	<1.0	<1.0	<1.0
MW71	11/3/99	65	1.8	<1
MW72	11/9/99	1200	200	100
MW73	11/9/99	4100	770	190

Table 4.4

Off-Site Containment System Influent and Effluent Quality - 1999[a]

Sampling Date	Concentration, in µg/L				Remarks
	Influent		Effluent		
	TCE	DCE	TCE	DCE	
12/31/98	190	4.6			Beginning of 30-day Feasibility Test
1/7/99	150	<1			During 30-day Feasibility Test
1/15/99	164	3.65			During 30-day Feasibility Test
1/21/99	150	4.2			During 30-day Feasibility Test
2/1/99	170	5.3			End of 30-day Feasibility Test
4/23/99	900	38	<1.0	<1.0	Air Stripper testing
4/27/99	840	38	<1.0	<1.0	Air Stripper testing
4/29/99	850	38	<1.0	<1.0	Air Stripper testing
5/6/99	1000	45	<0.3	<0.2	Beginning of complete system operation
5/7/99	1000	46	<0.3	<0.2	System operation
5/8/99	840	37	0.3	<0.2	System operation
5/9/99	920	40	0.4	<0.2	System operation
5/10/99	940	41	0.3	<0.2	System operation
5/11/99	950	41	<0.3	<0.2	System operation
5/12/99	850	34	<0.3	<0.2	System operation
5/18/99	920	43	0.4	<0.2	System operation
5/25/99	1000	45	0.3	<0.2	System operation
6/1/99	940	43	<0.3	<0.2	System operation
6/10/99	1000	46	<0.3	<0.2	System operation
7/1/99	940	49	<0.3	<0.2	System operation
8/2/99	1200	48	<0.3	<0.2	System operation
9/10/99	1200	73	<0.3	<0.2	System operation
10/6/99	890	35	<0.3	<0.2	System operation
11/3/99	1000	37	0.7	<0.2	System operation
12/1/99	920	47	0.5	<0.2	System operation
1/3/00	860	41	0.4	<0.2	System operation

[a] Note that data from 12/31/98 and 1/3/00 has been included to show conditions at the beginning and end of the year.

Table 5.1

Contaminant Mass Removal by the Off-Site Containment Well - 1999

Month	Mass of Removed TCE		Mass of Removed 1,1-DCE		Total Removed Mass	
	in kg	in lbs	in kg	in lbs	in kg	in lbs
Jan.	6.3	13.9	0.1	0.2	6.4	14.1
Feb.	18.5	40.8	0.8	1.8	19.3	42.6
Mar.	21.0	46.4	0.9	2.0	21.9	48.4
Apr.	16.3	36.0	0.7	1.5	17.0	37.5
May	28.5	62.9	1.3	2.9	29.8	65.8
June	35.5	78.4	1.7	3.8	37.2	82.2
July	40.4	89.2	1.8	4.0	42.2	93.2
Aug.	43.7	96.5	2.2	4.9	45.9	101.4
Sep.	39.9	88.1	2.0	4.4	41.9	92.5
Oct.	37.3	82.3	1.5	3.3	38.8	85.6
Nov.	35.5	78.4	1.5	3.3	37.0	81.7
Dec.	34.6	76.4	1.7	3.8	36.3	80.2
Total	**357.5**	**789.3**	**16.2**	**35.9**	**373.7**	**825.2**

Table 6.1

Calibration Target Residuals
November 1998 Simulation

Monitoring Well	Layer	Observed Groundwater Level (ft, MSL)	Simulated Hydraulic Head (ft, MSL)	Residual Difference (ft)
MW-07	1	4977.42	4976.14	1.28
MW-16	1	4978.43	4978.45	-0.02
MW-17	1	4978.75	4978.65	0.10
MW-21	1	4978.31	4978.86	-0.55
MW-51	1	4980.09	4981.04	-0.95
MW-09	2	4973.06	4972.47	0.59
MW-13	2	4974.35	4972.98	1.37
MW-14	2	4971.12	4971.19	-0.07
MW-22	2	4977.89	4976.84	1.05
MW-33	2	4972.54	4972.33	0.21
MW-34	2	4974.51	4972.89	1.62
MW-35	2	4970.78	4971.18	-0.40
PW-01	2	4973.59	4972.50	1.09
MW-12	3	4972.82	4972.61	0.21
MW-36	3	4969.43	4970.05	-0.62
MW-37	3	4968.32	4968.60	-0.28
MW-47	3	4966.68	4967.05	-0.37
MW-48	3	4965.81	4965.83	-0.02
MW-52	3	4963.17	4963.32	-0.15
MW-53	3	4964.92	4964.52	0.40
MW-54	3	4965.56	4965.70	-0.14
MW-57	3	4964.87	4964.95	-0.08
MW-58	3	4965.43	4965.09	0.34
MW-61	3	4965.37	4965.00	0.37
MW-62	3	4967.52	4967.81	-0.29
MW-63	3	4970.98	4972.96	-1.98
MW-64	4	4965.41	4965.61	-0.20
MW-68	4	4962.25	4961.46	0.79
MW-31	5	4971.23	4971.19	0.04
MW-41	5	4971.09	4971.11	-0.02
MW-42	5	4970.65	4971.14	-0.49
MW-44	5	4970.11	4970.05	0.06
MW-45	5	4968.33	4968.61	-0.28
MW-46	5	4966.95	4967.35	-0.40
MW-59	5	4969.46	4970.76	-1.30
MW-60	5	4965.18	4965.10	0.08
MW-19	6	4971.85	4971.63	0.22
MW-29	6	4973.68	4972.59	1.09
MW-30	6	4972.28	4971.85	0.43
MW-32	6	4970.96	4971.07	-0.11
MW-56	6	4965.76	4965.83	-0.07
MW-43	7	4970.45	4970.98	-0.53

Table 6.1

Calibration Target Residuals
November 1998 Simulation

Monitoring Well	Layer	Observed Groundwater Level (ft, MSL)	Simulated Hydraulic Head (ft, MSL)	Residual Difference (ft)
MW-20	8	4971.47	4971.46	0.01
MW-38	8	4973.70	4972.47	1.23
MW-39	8	4972.49	4971.86	0.63
MW-40	8	4971.25	4971.12	0.13
MW-55	8	4965.13	4965.72	-0.59
MW-70	8	4970.18	4971.03	-0.85
MW-49	9	4971.03	4971.11	-0.09
MW-65	9	4963.05	4963.06	-0.01
MW-66	9	4963.98	4964.29	-0.31
MW-69	9	4962.13	4961.18	0.95
MW-67	13	4958.56	4959.02	-0.46
MW-71	13	4958.51	4958.23	0.28

Residual Mean	0.05	ft
Residual Standard Deviation	0.67	ft
Sum of Squares	24.15	ft^2
Absolute Residual Mean	0.49	ft
Minimum Residual	-1.98	ft
Maximum Residual	1.62	ft
Head Range	21.58	ft
Residual Standard Deviation/Head Range	0.03	ft/ft

Table 6.2

Calibration Target Residuals
October 1999 Simulation

Monitoring Well	Layer	Observed Groundwater Level (ft, MSL)	Simulated Hydraulic Head (ft, MSL)	Residual Difference (ft)
MW-07	1	4976.94	4976.29	0.65
MW-16	1	4978.07	4978.70	-0.63
MW-17	1	4978.53	4978.89	-0.37
MW-21	1	4978.34	4979.13	-0.79
MW-51	1	4980.36	4981.33	-0.97
MW-09	2	4972.56	4972.38	0.18
MW-13	2	4973.98	4973.05	0.93
MW-14	2	4970.37	4970.78	-0.41
MW-22	2	4975.84	4977.07	-1.23
MW-33	2	4971.86	4972.19	-0.33
MW-34	2	4973.81	4972.64	1.17
MW-35	2	4970.79	4970.56	0.23
MW-12	3	4972.19	4972.53	-0.34
MW-36	3	4969.04	4969.21	-0.17
MW-37	3	4967.23	4967.59	-0.36
MW-47	3	4965.50	4965.43	0.07
MW-48	3	4964.39	4963.67	0.72
MW-52	3	4960.75	4960.24	0.51
MW-53	3	4962.79	4961.23	1.56
MW-54	3	4964.81	4965.14	-0.33
MW-57	3	4964.57	4964.79	-0.22
MW-58	3	4963.75	4962.39	1.36
MW-61	3	4964.20	4963.48	0.72
MW-62	3	4966.40	4966.20	0.20
MW-63	3	4970.85	4972.90	-2.05
MW-64	4	4964.83	4965.07	-0.24
MW-68	4	4960.64	4959.86	0.78
MW-74	4	4963.34	4968.50	-5.16
MW-75	4	4967.32	4968.20	-0.89
MW-76	4	4968.02	4968.03	-0.01
MW-31	5	4970.49	4970.84	-0.35
MW-41	5	4970.39	4970.95	-0.55
MW-42	5	4970.11	4971.19	-1.08
MW-44	5	4969.13	4969.21	-0.08
MW-45	5	4967.24	4967.58	-0.34
MW-46	5	4965.84	4966.27	-0.43
MW-59	5	4968.95	4970.88	-1.93
MW-60	5	4964.17	4963.43	0.74
MW-72	5	4970.22	4971.06	-0.84
MW-73	5	4970.27	4970.83	-0.56

Table 6.2

Calibration Target Residuals
October 1999 Simulation

Monitoring Well	Layer	Observed Groundwater Level (ft, MSL)	Simulated Hydraulic Head (ft, MSL)	Residual Difference (ft)
MW-19	6	4971.17	4971.52	-0.35
MW-29	6	4973.16	4972.64	0.52
MW-30	6	4971.63	4971.69	-0.06
MW-32	6	4970.27	4970.92	-0.65
MW-56	6	4964.30	4963.54	0.76
MW-43	7	4969.82	4971.02	-1.20
MW-20	8	4970.80	4971.32	-0.52
MW-38	8	4973.18	4972.51	0.67
MW-39	8	4971.88	4971.72	0.16
MW-40	8	4970.51	4970.77	-0.26
MW-55	8	4963.27	4963.28	-0.01
MW-70	8	4969.52	4970.89	-1.37
MW-49	9	4970.37	4970.77	-0.40
MW-65	9	4960.47	4959.56	0.91
MW-66	9	4963.33	4963.74	-0.41
MW-69	9	4960.55	4959.04	1.51
OB-1	10	4957.89	4956.73	1.16
OB-2	10	4959.19	4957.81	1.38
MW-67	13	4957.68	4958.75	-1.07
MW-71	13	4957.70	4958.05	-0.35

Residual Mean	-0.17	ft
Residual Standard Deviation	1.03	ft
Sum of Squares	65.71	ft^2
Absolute Residual Mean	0.74	ft
Minimum Residual	-5.16	ft
Maximum Residual	1.56	ft
Head Range	22.68	ft
Residual Standard Deviation/Head Range	0.05	ft/ft

Table 6.3

Simulated Pumping Rates (gpm)
November 1998 to October 1999

Well	Stress Period Number & Start Date										
	1 17-Nov-98	2 1-Dec-98	3 31-Dec-98	4 1-Feb-99	5 14-Apr-99	6 29-Apr-99	7 1-Jun-99	8 1-Jul-99	9 2-Aug-99	10 10-Sep-99	11 6-Oct-99
CW-1	0.0	39.2	233.5	239.1	96.1	175.5	224.1	224.0	216.6	226.2	229.7
PW-1	0.024	0.001	0.030	0.037	0.037	0.037	0.039	0.039	0.040	0.042	0.029
MW-18	0.024	0.001	0.030	0.037	0.037	0.037	0.039	0.039	0.040	0.042	0.029
MW-23	0.024	0.001	0.030	0.037	0.037	0.037	0.039	0.039	0.040	0.042	0.029
MW-24	0.024	0.001	0.030	0.037	0.037	0.037	0.039	0.039	0.040	0.042	0.029
MW-25	0.024	0.001	0.030	0.037	0.037	0.037	0.039	0.039	0.040	0.042	0.029
MW-26	0.024	0.001	0.030	0.037	0.037	0.037	0.039	0.039	0.040	0.042	0.029
MW-27	0.024	0.001	0.030	0.037	0.037	0.037	0.039	0.039	0.040	0.042	0.029
MW-28	0.024	0.001	0.030	0.037	0.037	0.037	0.039	0.039	0.040	0.042	0.029

Note: The pumping at the on-site remedial wells (PW-1, MW-18, and MW-23 through MW-28) is based on totalizer volumes for entire system.
Pumping is assumed to be distributed evenly among the eight wells.

APPENDIX A

Appendix A

Off-Site Containment Well Flow Rate Data

Appendix A

Off-Site Containment Well
Flow Rate Data

Date	Time	Instantaneous Discharge	Totalizer	Average Discharge	Total Gallons
12/31/98	14:00	219	14717200		0
				230	
12/31/98	14:05	218	14718350		1,150
				228	
12/31/98	14:15	217	14720625		3,425
				228	
12/31/98	14:30	218	14724050		6,850
				229	
12/31/98	15:00	217	14730925		13,725
				229	
12/31/98	17:12	219	14761200		44,000
				232	
12/31/98	20:54	225	14812700		95,500
				231	
01/01/99	02:53	224	14895750		178,550
				232	
01/01/99	08:40	224	14976100		258,900
				231	
01/01/99	14:00	219	15050025		332,825
				228	
01/01/99	20:45	228	15142500		425,300
				237	
01/02/99	02:50	228	15229050		511,850
				233	
01/02/99	08:50	222	15312900		595,700
				231	
01/02/99	14:53	220	15396875		679,675
				223	
01/02/99	20:58	228	15478300		761,100
				240	
01/03/99	02:45	237	15561750		844,550
				232	
01/03/99	09:08	226	15650500		933,300
				230	
01/03/99	15:10	220	15733875		1,016,675
				231	
01/04/99	15:58	220	16078100		1,360,900
				232	
01/05/99	15:56	220	16411325		1,694,125
				232	
01/06/99	14:43	218	16728100		2,010,900
				232	
01/07/99	15:28	221	17072450		2,355,250
				235	
01/08/99	14:58	225	17403600		2,686,400
				236	
01/09/99	15:31	222	17751875		3,034,675
				236	
01/10/99	13:32	219	18063175		3,345,975
				237	

Appendix A

Off-Site Containment Well
Flow Rate Data

Date	Time	Instantaneous Discharge	Totalizer	Average Discharge	Total Gallons
01/11/99	14:46	223	18421375		3,704,175
				237	
01/12/99	11:37	222	18718100		4,000,900
				235	
01/12/99	15:02	222	18766350		4,049,150
				238	
01/13/99	15:03	223	19109075		4,391,875
				238	
01/14/99	15:26	223	19456800		4,739,600
				238	
01/15/99	16:36	224	19816500		5,099,300
				239	
01/16/99	12:25	225	20100200		5,383,000
				238	
01/17/99	12:51	224	20449600		5,732,400
				238	
01/18/99	14:50	223	20820600		6,103,400
				239	
01/19/99	14:40	221	21162375		6,445,175
				238	
01/20/99	14:47	228	21506200		6,789,000
				239	
01/21/99	15:11	230	21856475		7,139,275
				237	
01/22/99	14:05	225	22182000		7,464,800
				237	
01/23/99	14:07	221	22523675		7,806,475
				237	
01/24/99	14:13	225	22865875		8,148,675
				237	
01/25/99	09:28	230	23139900		8,422,700
				175	
01/25/99	09:29	228	23140075		8,422,875
				239	
01/25/99	14:29	229	23211700		8,494,500
				239	
01/26/99	15:01	225	23562825		8,845,625
				239	
01/27/99	14:47	226	23903150		9,185,950
				239	
01/28/99	16:45	229	24275525		9,558,325
				239	
01/29/99	15:04	230	24595700		9,878,500
				239	
01/30/99	12:54	224	24908575		10,191,375
				225	
01/30/99	13:01	223	24910150		10,192,950
				239	
01/31/99	15:04	223	25283625		10,566,425
				238	
02/01/99	14:18	225	25615750		10,898,550
				239	

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Off-Site Containment Well Flow Rate Data

Date	Time	Instantaneous Discharge	Totalizer	Average Discharge	Total Gallons
02/02/99	14:21	228	25960625		11,243,425
				239	
02/03/99	14:28	225	26306200		11,589,000
				239	
02/05/99	12:22	227	26963300		12,246,100
				239	
02/06/99	14:23	227	27337075		12,619,875
				240	
02/07/99	17:46	225	27730600		13,013,400
				240	
02/08/99	14:11	225	28024300		13,307,100
				239	
02/09/99	14:51	250	28378600		13,661,400
				240	
02/10/99	08:09	233	28627400		13,910,200
				237	
02/10/99	14:19	221	28715250		13,998,050
				238	
02/11/99	13:08	228	29041300		14,324,100
				247	
02/12/99	13:13	225	29398925		14,681,725
				221	
02/13/99	14:50	225	29738575		15,021,375
				239	
02/14/99	18:52	230	30141250		15,424,050
				240	
02/15/99	14:45	228	30427625		15,710,425
				239	
02/16/99	13:40	228	30756350		16,039,150
				132	
02/17/99	09:35		30914500		16,197,300
				197	
02/17/99	12:46	225	30952100		16,234,900
				241	
02/19/99	10:06		31608800		16,891,600
				219	
02/19/99	16:38	230	31694600		16,977,400
				242	
02/20/99	16:04	230	32034300		17,317,100
				241	
02/21/99	16:46	225	32391275		17,674,075
				241	
02/22/99	13:51	225	32695750		17,978,550
				242	
02/23/99	14:54	230	33059700		18,342,500
				242	
02/24/99	14:10	230	33398025		18,680,825
				242	
02/25/99	14:28	220 - 250	33751400		19,034,200
				241	
02/26/99	15:23	228	34111550		19,394,350
				231	

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Off-Site Containment Well
Flow Rate Data

Date	Time	Instantaneous Discharge	Totalizer	Average Discharge	Total Gallons
02/27/99	15:40	225	34447900		19,730,700
				253	
02/28/99	11:33	225	34749900		20,032,700
				9	
03/01/99	10:44	233	34762900		20,045,700
				38	
03/01/99	15:08	230	34827350		20,110,150
				248	
03/02/99	12:03	230	35138350		20,421,150
				246	
03/02/99	14:43	220 - 260	35177725		20,460,525
				241	
03/03/99	14:35	231	35522600		20,805,400
				246	
03/04/99	14:57	232	35882550		21,165,350
				246	
03/05/99	14:45	230	36233625		21,516,425
				248	
03/06/99	16:36	235	36617850		21,900,650
				248	
03/07/99	17:05	235	36982300		22,265,100
				250	
03/08/99	15:58	238	37325400		22,608,200
				249	
03/09/99	17:14	236	37703175		22,985,975
				247	
03/10/99	08:51	238	37934850		23,217,650
				248	
03/10/99	15:10	235	38029000		23,311,800
				247	
03/11/99	17:00	240	38412500		23,695,300
				226	
03/13/99	16:29	235	39057500		24,340,300
				248	
03/14/99	11:44	235	39343600		24,626,400
				248	
03/15/99	20:08	235	39825150		25,107,950
				249	
03/16/99	14:01	233	40092300		25,375,100
				249	
03/18/99	16:37	250	40848250		26,131,050
				249	
03/20/99	17:13	235	41573625		26,856,425
				249	
03/21/99	21:38	240	41998250		27,281,050
				249	
03/23/99	13:20	235	42591450		27,874,250
				250	
03/24/99	14:52	235	42973725		28,256,525
				250	
03/25/99	13:57	235	43319300		28,602,100
				248	

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Off-Site Containment Well
Flow Rate Data

Date	Time	Instantaneous Discharge	Totalizer	Average Discharge	Total Gallons
03/27/99	11:30	235	43997900		29,280,700
				250	
03/28/99	12:52	235	44378000		29,660,800
				249	
03/29/99	14:37	235	44762850		30,045,650
				246	
03/30/99	14:21	235	45113800		30,396,600
				246	
03/31/99	14:30	235	45470900		30,753,700
				248	
04/01/99	15:04	240	45836700		31,119,500
				248	
04/02/99	12:21	240	46152800		31,435,600
				250	
04/03/99	11:16	240	46496975		31,779,775
				242	
04/04/99	15:40	240	46908850		32,191,650
				250	
04/05/99	17:08	240	47290200		32,573,000
				250	
04/06/99	14:49	235	47614800		32,897,600
				249	
04/07/99	14:40	240	47971800		33,254,600
				249	
04/08/99	14:48	235	48332700		33,615,500
				249	
04/09/99	15:11	235	48697200		33,980,000
				249	
04/10/99	11:13	240	48996500		34,279,300
				249	
04/11/99	12:51	240	49379400		34,662,200
				248	
04/12/99	14:46	235	49765800		35,048,600
				247	
04/13/99	11:33	235	50073800		35,356,600
				228	
04/14/99	11:30	shut down	50401900		35,684,700
INSTALL NEW METER					
04/20/99	12:00	-	2200		35,684,700
				15	
04/22/99	17:30	230	48900		35,731,400
				227	
04/27/99	17:02	225	1674500		37,357,000
				174	
04/29/99	07:46	224	2079000		37,761,500
				0.1	
05/03/99	12:50	225	2079700		37,762,200
				5	
05/06/99	11:20	224	2100200		37,782,700
				219	
05/07/99	13:07	223	2438800		38,121,300
				220	

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Off-Site Containment Well Flow Rate Data

Date	Time	Instantaneous Discharge	Totalizer	Average Discharge	Total Gallons
05/08/99	15:52	224	2791400		38,473,900
				223	
05/09/99	11:44	224	3057400		38,739,900
				224	
05/10/99	08:52	222	3341100		39,023,600
				224	
05/11/99	08:32	228	3659700		39,342,200
				225	
05/12/99	10:06	224	4004100		39,686,600
				224	
05/12/99	15:30	224	4076700		39,759,200
				213	
05/13/99	10:52	228	4324200		40,006,700
				226	
05/14/99	08:26	222	4616300		40,298,800
				226	
05/16/99	16:55	224	5383400		41,065,900
				225	
05/17/99	10:53	232	5626300		41,308,800
				226	
05/18/99	12:20	227	5970700		41,653,200
				225	
05/19/99	10:28	225	6270100		41,952,600
				225	
05/20/99	12:38	224	6623200		42,305,700
				225	
05/21/99	09:06	225	6899400		42,581,900
				225	
05/22/99	16:47	223	7326600		43,009,100
				225	
05/23/99	10:58	223	7571700		43,254,200
				225	
05/24/99	12:51	225	7921000		43,603,500
				222	
05/25/99	14:51	227	8267500		43,950,000
				225	
05/26/99	16:48	224	8617100		44,299,600
				225	
05/27/99	07:37	225	8817300		44,499,800
				144	
05/27/99	10:51	226	8845300		44,527,800
				225	
05/28/99	08:54	224	9143200		44,825,700
				225	
05/29/99	07:52	224	9453000		45,135,500
				225	
05/30/99	10:21	224	9810350		45,492,850
				225	
05/31/99	10:38	224	10138400		45,820,900
				221	
06/01/99	07:53	223	10420600		46,103,100
				228	

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Off-Site Containment Well
Flow Rate Data

Date	Time	Instantaneous Discharge	Totalizer	Average Discharge	Total Gallons
06/02/99	09:48	225	10774900		46,457,400
				226	
06/03/99	08:48	225	11086400		46,768,900
				215	
06/04/99	09:44	226	11408300		47,090,800
				229	
06/07/99	09:32	227	12394100		48,076,600
				225	
06/10/99	08:08	225	13349200		49,031,700
				216	
06/11/99	10:03	224	13685600		49,368,100
				225	
06/16/99	08:15	226	15279500		50,962,000
				225	
06/17/99	08:13	225	15602450		51,284,950
				224	
06/18/99	08:17	222	15926450		51,608,950
				224	
06/21/99	16:47	223	17010100		52,692,600
				224	
06/23/99	09:48	223	17561900		53,244,400
				224	
06/25/99	13:23	224	18255100		53,937,600
				224	
06/28/99	07:50	225	19149600		54,832,100
				191	
06/28/99	18:55	220	19276900		54,959,400
				231	
06/29/99	07:03	226	19445300		55,127,800
				224	
07/01/99	07:55	226	20101900		55,784,400
				223	
07/06/99	07:55	225	21707300		57,389,800
				223	
07/08/99	07:55	223	22349100		58,031,600
				222	
07/09/99	08:07	221	22671300		58,353,800
				223	
07/12/99	07:56	222	23631800		59,314,300
				222	
07/13/99	10:06	223	23980100		59,662,600
				223	
07/14/99	07:48	221	24270000		59,952,500
				222	
07/15/99	12:56	222	24658400		60,340,900
				223	
07/16/99	06:48	223	24897100		60,579,600
				222	
07/19/99	07:53	221	25869900		61,552,400
				224	
07/20/99	07:27	226	26187300		61,869,800
				230	

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Off-Site Containment Well
Flow Rate Data

Date	Time	Instantaneous Discharge	Totalizer	Average Discharge	Total Gallons
07/22/99	09:26	225	26875700		62,558,200
				214	
07/23/99	14:11	226	27244000		62,926,500
				227	
07/28/99	12:24	227	28850700		64,533,200
				227	
07/30/99	09:47	223	29468000		65,150,500
				226	
07/31/99	15:52	225	29876600		65,559,100
				226	
08/02/99	08:15	224	30424700		66,107,200
				226	
08/05/99	14:12	227	31482900		67,165,400
				80	
08/06/99	12:04	223	31587400		67,269,900
				225	
08/09/99	08:15	227	32506700		68,189,200
				226	
08/10/99	11:30	227	32875600		68,558,100
				40	
08/11/99	08:30	224	32926000		68,608,500
				225	
08/12/99	10:40	225	33278800		68,961,300
				211	
08/14/99	21:00	226	34017800		69,700,300
				201	
08/18/99	14:30		35099000		70,781,500
				226	
08/20/99	14:18	224	35746600		71,429,100
				226	
08/24/99	14:31	229	37053500		72,736,000
				227	
08/27/99	14:43	224	38035600		73,718,100
				226	
08/30/99	10:29		38954100		74,636,600
				227	
09/01/99	15:03	227	39671000		75,353,500
				228	
09/03/99	14:08	228	40315300		75,997,800
				228	
09/08/99	13:53	226	41955700		77,638,200
				228	
09/10/99	12:02	228	42587900		78,270,400
				229	
09/15/99	13:00	227	44249400		79,931,900
				229	
09/23/99	13:03	228	46883500		82,566,000
				220	
09/29/99	08:30	229	48724500		84,407,000
				230	
10/01/99	10:30	230	49413900		85,096,400
				229	

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Off-Site Containment Well Flow Rate Data

Date	Time	Instantaneous Discharge	Totalizer	Average Discharge	Total Gallons
10/06/99	10:15	229	51058500		86,741,000
				229	
10/07/99	12:56	228	51425700		87,108,200
				230	
10/12/99	12:42	229	53076200		88,758,700
				229	
10/13/99	12:57	229	53410000		89,092,500
				229	
10/14/99	09:45	226	53696300		89,378,800
				228	
10/18/99	12:26	227	55048800		90,731,300
				229	
10/20/99	12:52	228	55713700		91,396,200
				229	
10/21/99	13:27	228	56051200		91,733,700
				229	
10/22/99	11:04	227	56348200		92,030,700
				229	
10/25/99	13:52	228	57374200		93,056,700
				229	
10/26/99	11:08	229	57666200		93,348,700
				206	
10/27/99	14:23	229	58002800		93,685,300
				229	
10/28/99	13:51	228	58325000		94,007,500
				229	
10/29/99	09:33	227	58595100		94,277,600
				231	
11/01/99	13:53	228	59654400		95,336,900
				228	
11/03/99	14:44	228	60322000		96,004,500
				228	
11/09/99	16:16	229	62310700		97,993,200
				225	
11/11/99	11:16	228	62891600		98,574,100
				228	
11/12/99	16:20	229	63288700		98,971,200
				228	
11/17/99	09:16	228	64837000		100,519,500
				224	
11/19/99	16:49	227	65583400		101,265,900
				228	
11/22/99	14:12	226	66534100		102,216,600
				229	
11/29/99	10:10	230	68787000		104,469,500
				229	
12/01/99	10:32	229	69451900		105,134,400
				228	
12/07/99	12:18	228	71447400		107,129,900
				227	
12/10/99	17:10	225	72494600		108,177,100
				226	

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Off-Site Containment Well
Flow Rate Data

Date	Time	Instantaneous Discharge	Totalizer	Average Discharge	Total Gallons
12/14/99	13:41	223	73750400		109,432,900
				225	
12/15/99	11:18	225	74042100		109,724,600
				225	
12/16/99	12:08	225	74378000		110,060,500
				225	
12/17/99	11:55	225	74699700		110,382,200
				225	
12/20/99	08:37	224	75626700		111,309,200
				225	
12/22/99	14:17	223	76351000		112,033,500
				225	
12/24/99	13:15	223	76983900		112,666,400
				224	
12/27/99	15:55	225	77989100		113,671,600
				224	
12/29/99	08:17	223	78530900		114,213,400
				223	
12/31/99	10:38	223	79204700		114,887,200
				224	
01/03/00	08:21	225	80143700		115,826,200

APPENDIX B

Appendix B

Groundwater Monitoring Program 1999 Analytical Results

Appendix B

Groundwater Monitoring Program
1999 Analytical Results

Well ID	Sample Date	TCE ug/L	DCE ug/L	TCA ug/L	Unfiltered		Filtered	
					Cr Total mg/L	Cr +6 mg/L	Cr Total mg/L	Cr +6 mg/L
MW-7	11/16/99	84	16	9	0	NA	0	NA
MW-9	05/26/99	270	17	15	<0.05	<0.01		
	11/05/99	220	16	14	0	NA	NA	NA
MW-12	11/18/99	230	25	10	0	NA	0	NA
MW-13	11/15/99	57	4	6	0	NA	0	NA
MW-14	10/28/99	DRY						
MW-15	02/16/99	DRY						
	05/13/99	DRY						
	10/28/99	DRY						
MW-16	05/25/99	280	12	48	0	0	<0.005	0
	11/18/99	46	4	7	1	NA	0	NA
MW-17	11/16/99	21	2	3	0	NA	<0.005	NA
MW-18	11/19/99	980	180	60	0	NA	0	NA
MW-19	05/20/99	6	<1.0	<1.0	0	<0.01		
	11/08/99	2	<1.0	<1.0	<0.005	NA	NA	NA
MW-20	05/20/99	<1.0	<1.0	<1.0	0	<0.01		
	11/08/99	<1.0	<1.0	<1.0	0	NA	NA	NA
MW-21	05/13/99	DRY						
	11/18/99	2	<1.0	<1.0	0	NA	0	NA
MW-22	05/19/99	21	3	6	<0.005	<0.01	NA	NA
	11/09/99	7	1	3	<0.0050	NA	NA	NA
MW-23	11/18/99	1300	110	120	0	NA	0	NA
MW-25	11/19/99	210	13	20	0	NA	0	NA
MW-26	11/19/99	3900	400	380	0	NA	0	NA
MW-28	02/16/99	NA	NA	NA	NA	NA	NA	NA
	05/13/99	DRY						
MW-29	11/05/99	<1.0	<1.0	<1.0	<0.005	NA	NA	NA
MW-30	11/08/99	3	<1.0	<1.0	0	NA	NA	NA
MW-31	11/09/99	<1.0	<1.0	<1.0	0	NA	NA	NA
MW-32	11/10/99	710	200	24	<0.005	NA	NA	NA
MW-33	11/16/99	320	46	19	2	NA	0	NA
MW-34	02/18/99	NA	NA	NA	0	<0.01	<0.005	<0.01
	11/04/99	<1.0	<1.0	<1.0	0	NA	NA	NA
MW-35	11/16/99	<1.0	<1.0	<1.0	0	NA	0	NA
MW-36	11/15/99	1	<1.0	<1.0	0	NA	0	NA
MW-37	11/16/99	910	58	3	0	NA	0	NA
MW-38	11/05/99	<1.0	<1.0	<1.0	0	NA	NA	NA
MW-39	02/18/99	NA	NA	NA	0	0	0	0
	11/08/99	<1.0	<1.0	<1.0	0	NA	NA	NA
MW-40	11/09/99	<1.0	<1.0	<1.0	0	NA	NA	NA
MW-41	11/10/99	450	100	25	<0.005	NA	NA	NA
MW-42	05/19/99	270	40	17	<0.005	<0.01	NA	NA
	11/10/99	360	49	16	<0.005	NA	NA	NA
MW-43	05/19/99	40	7	6	<0.005	<0.01	NA	NA
	11/09/99	36	7	5	<0.005	NA	NA	NA
MW-44	11/04/99	<1.0	<1.0	<1.0	<0.005	NA	NA	NA
MW-45	11/04/99	26	<1.0	<1.0	0	NA	NA	NA
MW-46	05/18/99	2000	120	18	<0.005	<0.01	NA	NA
	11/04/99	880	82	12	0	NA	NA	NA
MW-47	11/03/99	42	2	<1.0	0	NA	NA	NA

Appendix B

Groundwater Monitoring Program
1999 Analytical Results

Well ID	Sample Date	TCE ug/L	DCE ug/L	TCA ug/L	Unfiltered		Filtered	
					Cr Total mg/L	Cr +6 mg/L	Cr Total mg/L	Cr +6 mg/L
MW-48	05/18/99	28	1	<1.0	0	0	NA	NA
	11/03/99	34	1	<1.0	0	NA	NA	NA
MW-49	11/10/99	<1.0	<1.0	<1.0	<0.005	NA	NA	NA
MW-50	10/28/99	DRY						
MW-51	11/09/99	<1.0	<1.0	<1.0	<0.0050	NA	NA	NA
MW-52	02/22/99	<1.0	<1.0	<1.0	0.035	0	0	<0.01
	05/24/99	<1.0	<1.0	<1.0	<0.05	<0.01	<0.005	0
	08/17/99	<1.0	<1.0	<1.0	0.072	<0.01	0	0
	11/12/99	<1.0	<1.0	<1.0	0	NA	0	NA
MW-53	05/25/99	40	2	<1.0	0	0	<0.05	0
	11/12/99	62	3	<1.0	0	NA	0	NA
MW-55	02/18/99	NA	NA	NA	0	0	0	0
	05/18/99	310	11	<5	<0.005	<0.01	NA	NA
	08/17/99	300	12	<1	0	0	NA	NA
	11/02/99	260	10	<5	0	NA	NA	NA
MW-56	05/19/99	90	3	<1.0	0	0	NA	NA
	11/02/99	53	2	<1.0	0	NA	NA	NA
MW-57	02/22/99	<1.0	<1.0	<1.0	0	0	<0.005	<0.01
	05/24/99	<1.0	<1.0	<1.0	<0.05	<0.01	<0.05	<0.01
	08/18/99	<1.0	<1.0	<1.0	0	<0.01	<0.005	<0.01
	11/15/99	<1.0	<1.0	<1.0	0	NA	<0.0050	NA
MW-58	05/25/99	32	1	<1.0	0	0	<0.05	0
	11/15/99	26	<1.0	<1.0	0	NA	0	NA
MW-59	11/10/99	<1.0	<1.0	<1.0	<0.0050	NA	NA	NA
MW-60	05/17/99	10000	490	<100	0	0	NA	NA
	11/03/99	11000	480	<100	0	NA	NA	NA
MW-61	02/19/99	NA	NA	NA	0	0	0	0
	05/17/99	410	20	<10	0	0	NA	NA
	11/03/99	200	12	<5	0	NA	NA	NA
MW-62	02/18/99	2	6	4	0	<0.01	0	<0.01
	05/24/99	2	6	4	<0.05	0	<0.05	<0.01
	08/19/99	2	7	6	0	<0.01	0	<0.01
	11/12/99	3	7	5	0	NA	0	NA
MW-63	02/22/99	NA	NA	NA	0	0	<0.005	<0.01
MW-64	05/17/99	2	<1.0	<1.0	<0.005	<0.01	NA	NA
	11/04/99	5	<1.0	<1.0	<0.005	NA	NA	NA
MW-65	02/17/99	7	<1.0	<1.0	<0.005	<0.01	NA	NA
	05/17/99	2	<1.0	<1.0	<0.005	<0.01	NA	NA
	08/23/99	<1.0	<1.0	<1.0	<0.005	<0.01	NA	NA
	11/03/99	<1.0	<1.0	<1.0	<0.005	NA	NA	NA
	11/04/99	<1.0	<1.0	<1.0	<0.005	NA	NA	NA
MW-66	02/17/99	<1.0	<1.0	<1.0	<0.005	<0.01	NA	NA
	05/18/99	<1.0	<1.0	<1.0	<0.005	<0.01	NA	NA
	08/23/99	<1.0	<1.0	<1.0	<0.005	<0.01	NA	NA
	11/04/99	<1.0	<1.0	<1.0	<0.005	NA	NA	NA
MW-67	02/18/99	<1.0	<1.0	<1.0	<0.005	<0.01	NA	NA
	05/18/99	<1.0	<1.0	<1.0	0	<0.01	NA	NA
	08/17/99	<1.0	<1.0	<1.0	<0.005	<0.01	NA	NA
	11/03/99	<1.0	<1.0	<1.0	<0.005	NA	NA	NA
MW-68	02/17/99	<1.0	<1.0	<1.0	<0.005	0	NA	NA
	05/17/99	<1.0	<1.0	<1.0	<0.005	0	NA	NA

Appendix B

Groundwater Monitoring Program
1999 Analytical Results

Well ID	Sample Date	TCE ug/L	DCE ug/L	TCA ug/L	Unfiltered Cr Total mg/L	Unfiltered Cr +6 mg/L	Filtered Cr Total mg/L	Filtered Cr +6 mg/L
	08/18/99	<1.0	<1.0	<1.0	<0.005	<0.01	NA	NA
	11/02/99	<1.0	<1.0	<1.0	<0.005	NA	NA	NA
MW-69	02/17/99	<1.0	<1.0	<1.0	<0.005	<0.01	NA	NA
	05/17/99	<1.0	<1.0	<1.0	<0.005	<0.01	NA	NA
	08/18/99	<1.0	<1.0	<1.0	<0.005	<0.01	NA	NA
	11/02/99	<1.0	<1.0	<1.0	<0.005	NA	NA	NA
MW-70	02/17/99	<1.0	<1.0	<1.0	<0.005	<0.01	NA	NA
	05/19/99	<1.0	<1.0	<1.0	<0.005	<0.01	NA	NA
MW-70	08/19/99	<1.0	<1.0	<1.0	<0.005	<0.01	NA	NA
	11/09/99	<1.0	<1.0	<1.0	<0.005	NA	NA	NA
MW-71	02/17/99	35	1	<1.0	<0.005	<0.01	NA	NA
	05/17/99	42	1	<1.0	<0.005	0	NA	NA
	08/19/99	46	1	<1.0	<0.005	<0.01	NA	NA
	11/03/99	65	2	<1.0	<0.005	NA	NA	NA
MW-72	03/05/99	1800	220	99	NA	NA	NA	NA
	05/19/99	1800	230	98	0	0	NA	NA
	11/09/99	1200	200	100	0	NA	NA	NA
MW-73	03/05/99	4000	520	240	NA	NA	NA	NA
	05/19/99	4400	780	220	0	0	NA	NA
	11/09/99	4100	770	190	0	NA	NA	NA
MW-74	11/04/99	0	<0.2	<1.0	0	NA	NA	NA
MW-75	11/04/99	1	<0.2	<1.0	0	NA	NA	NA
MW-76	11/04/99	1	<0.2	<1.0	0	NA	NA	NA

APPENDIX C

Appendix C

Off-Site Containment Well Water Quality Data

Appendix C

Off-Site Containment Well
Water Quality Summary

Sample	Date	TCE (ug/l)	1,1-DCE (ug/l)	Cr $^{(Total)}$ (mg/l)	Cr $^{+6}$ (mg/l)	Total Alkalinity (mg/l)	TDS (mg/l)	Arsenic (mg/l)	Hardness (mg/l)	Lead (mg/l)	Iron (mg/l)	Manganese (mg/l)
End Development	8/13/98	190	4.4	-	-	-	-	-	-	-	-	-
Official End Development	9/1/98	140	2.9	0.026	0.030	130	370	<.005	190	<.005	-	-
EPA Duplicate *	9/1/98	150	2.8	-	0.020	-	340	-	190	-	-	-
EPA Duplicate - 2 *	9/1/98	150	3.1	-	<0.20	-	340	-	190	-	-	-
Beginning Step Test	12/4/98	180	3.8	0.036	0.030	140	360	<.005	220	<.005	-	-
End Step Test	12/4/98	230	5.4	0.030	0.030	140	340	<.005	190	<.005	-	-
End 3-day Test	12/12/98	180	3.7	0.021	-	-	-	-	-	-	-	-
Beginning 30-day Test	12/31/98	190	4.6	0.023	-	140	350	<.005	190	<.005	-	-
Beginning 30-day Test	1/4/99	-	-	-	0.030	-	-	-	-	-	-	-
30-day Test	1/7/99	150	<1.0	0.023	-	130	340	<.005	190	<.005	-	-
30-day Test	1/11/99	-	-	-	0.020	-	-	-	-	-	-	-
30-day Test	1/15/99	164	3.65	0.024	-	140	320	<.005	190	<.005	-	-
30-day Test	1/18/99	-	-	-	0.030	-	-	-	-	-	-	-
30-day Test	1/21/99	150	4.2	0.024	-	150	340	<.005	170	0.060	-	-
30-day Test	1/26/99	-	-	-	0.030	-	-	-	-	-	-	-
30-day Test	2/1/99	170	5.3	0.035	0.040	160	340	<.005	200	0.0086	<0.02	<0.005
AIR STRIPPER TESTING												
Influent	4/23/99	900	38	-	-	-	-	-	-	-	-	-
Effluent	4/23/99	<1.0	<1.0	-	-	-	-	-	-	-	-	-
Influent	4/27/99	840	38	-	-	-	-	-	-	-	-	-
Effluent	4/27/99	<1.0	<1.0	-	-	-	-	-	-	-	-	-
Influent	4/29/99	850	38	-	-	-	-	-	-	-	-	-
Effluent	4/29/99	<1.0	<1.0	-	-	-	-	-	-	-	-	-

Appendix C

Off-Site Containment Well
Water Quality Summary

Sample	Date	TCE (ug/l)	1,1-DCE (ug/l)	Cr (Total) (mg/l)	Cr +6 (mg/l)	Total Alkalinity (mg/l)	TDS (mg/l)	Arsenic (mg/l)	Hardness (mg/l)	Lead (mg/l)	Iron (mg/l)	Manganese (mg/l)
SYSTEM OPERATION												
Influent	5/6/99	1000	45	-	-	-	-	-	-	-	-	-
Effluent	5/6/99	<0.3	<0.2	0.062	-	-	-	-	-	-	0.055	0.006
Influent	5/7/99	1000	46	-	-	-	-	-	-	-	-	-
Effluent	5/7/99	<0.3	<0.2	0.110	-	-	-	-	-	-	0.260	0.0097
Influent	5/8/99	840	37	-	-	-	-	-	-	-	-	-
Effluent	5/8/99	0.3	<0.2	0.049	-	-	-	-	-	-	0.030	<0.005
Influent	5/9/99	920	40	-	-	-	-	-	-	-	-	-
Effluent	5/9/99	0.4	<0.2	0.042	-	-	-	-	-	-	0.027	<0.005
Influent	5/10/99	940	41	-	-	-	-	-	-	-	-	-
Effluent	5/10/99	0.3	<0.2	0.037	-	-	-	-	-	-	0.077	<0.005
Influent	5/11/99	950	41	-	-	-	-	-	-	-	-	-
Effluent	5/11/99	<0.3	<0.2	0.049	-	-	-	-	-	-	<0.01	<0.005
Influent	5/12/99	850	34	-	-	-	-	-	-	-	-	-
Effluent	5/12/99	<0.3	<0.2	0.053	-	-	-	-	-	-	0.019	<0.005
Influent	5/18/99	920	43	-	-	-	-	-	-	-	-	-
Effluent	5/18/99	0.4	<0.2	0.056	-	-	-	-	-	-	0.021	<0.005
Influent	5/25/99	1000	45	-	-	-	-	-	-	-	-	-
Effluent	5/25/99	0.3	<0.2	<0.05	-	-	-	-	-	-	<0.1	<0.02
Influent	6/1/99	940	43	-	-	-	-	-	-	-	-	-
Effluent	6/1/99	<0.3	<0.2	0.049	-	-	-	-	-	-	0.050	<0.005
Influent	6/10/99	1000	46	-	-	-	-	-	-	-	-	-
Effluent	6/10/99	<0.3	<0.2	0.051	-	-	-	-	-	-	<0.025	0.0071
Influent	7/1/99	940	49	-	-	-	-	-	-	-	-	-
Effluent	7/1/99	<0.3	<0.2	0.049	-	-	-	-	-	-	0.013	<0.005

Appendix C

Off-Site Containment Well
Water Quality Summary

Sample	Date	TCE (ug/l)	1,1-DCE (ug/l)	Cr (Total) (mg/l)	Cr +6 (mg/l)	Total Alkalinity (mg/l)	TDS (mg/l)	Arsenic (mg/l)	Hardness (mg/l)	Lead (mg/l)	Iron (mg/l)	Manganese (mg/l)
Influent	7/28/99	-	-	0.048	-	-	-	-	-	-	-	-
Effluent	7/28/99	-	-	0.048	-	-	-	-	-	-	-	-
Influent	8/2/99	1200	48	0.048	-	-	-	-	-	-	0.020	<0.005
Effluent	8/2/99	<0.3	<0.2	0.049	-	-	-	-	-	-	0.016	<0.005
Influent	9/2/99	**	**	**	-	-	-	-	-	-	**	**
Effluent	9/2/99	**	**	**	-	-	-	-	-	-	**	**
Influent	9/10/99	1200	73	0.048	-	-	-	-	-	-	0.018	<0.005
Effluent	9/10/99	<0.3	<0.2	0.049	-	-	-	-	-	-	0.022	<0.005
Influent	10/6/99	890	35	0.049	-	-	-	-	-	-	0.013	<0.005
Effluent	10/6/99	<0.3	<0.2	0.044	-	-	-	-	-	-	0.013	<0.005
Influent	11/3/99	1000	37	0.052	-	-	-	-	-	-	0.015	<0.005
Effluent	11/3/99	0.7	<0.2	0.052	-	-	-	-	-	-	0.013	<0.005
Influent	12/1/99	920	47	0.081	-	-	-	-	-	-	1.200	<0.005
Effluent	12/1/99	0.5	<0.2	0.051	-	-	-	-	-	-	0.017	<0.005
Influent	1/3/00	860	41	-								
Effluent	1/3/00	0.4	<0.2	0.0534								

* From preliminary data summary

** Influent and effluent samples switched in the field. Resampled on 9/10/99