Sparton Technology, Inc.
Former Coors Road Plant
Remedial Program

2011 Annual Report

Σ²Π S.S. PAPADOPULOS & ASSOCIATES, INC.
Environmental & Water-Resource Consultants

June 29, 2012

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June 29, 2012

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Subject: Sparton Technology, Inc: Former Coors Road Plant Remedial Program 2011 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 former Coors Road Plant during the operation of the remedial systems in 2011, and evaluations of these data to assess the performance of the systems. This report was prepared by SSP&A. During the first five months of 2011, Metric Corporation (Metric) was responsible for the operation of the remedial systems, the collection of the data that form the basis of this report, and for other field activities; after the passing away of Gary Richardson of Metric in May of 2011, SSP&A took over the responsibility for these activities effective June 1, 2011.

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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, NAE
Founder & Senior Principal

cc: Secretary, Sparton Technology, Inc., c/o Mr. Joseph S. Lerczak
Mr. Gregory A. Slome, Senior Vice President and Chief Financial Officer of Sparton Corporation
Mr. Joseph S. Lerczak, Director of Treasury and Forecasting and Secretary of Sparton Corporation (3 copies)
Mr. James B. Harris, Thompson & Knight LLP
Mr. Tony Hurst, Hurst Engineering Services (2 copies)

Executive Summary

The former Coors Road Plant (Site) of Sparton Technology, Inc. (Sparton) is located at 9621 Coors Boulevard NW, Albuquerque, New Mexico. The Site is at an elevation of about 5,050 feet above mean sea level (ft MSL); the land slopes towards the Rio Grande on the east and rises to elevations of 5,150-5,200 ft MSL within a short distance to the west of the Site. The upper 1,500 feet of the fill deposits underlying the Site consist primarily of sand and gravel with minor amounts of silt and clay. The water table beneath the Site is at an elevation of 4,975-4,985 ft MSL and slopes towards the northwest to an elevation of about 4,960 ft MSL within about one-half mile of the Site. At an elevation of about 4,800 ft MSL a 2- to 3-foot clay layer, referred to as the 4800-foot clay unit, has been identified.

Investigations conducted at and around the Site in the 1980s revealed that soils beneath the Site and groundwater beneath and downgradient from the Site were contaminated. The primary contaminants were volatile organic compounds (VOCs), specifically trichloroethene (TCE), 1,1-dichloroethene (DCE), and 1,1,1-trichloroethane (TCA), and chromium. Remedial investigations that followed indicated that groundwater contamination was limited to the aquifer above the 4800-foot clay; current measures for groundwater remediation were, therefore, designed to address contamination within this depth interval.

Under the terms of a Consent Decree entered on March 3, 2000, Sparton agreed to implement a number of remedial measures. These remedial measures consisted of: (1) the installation and operation of an off-site containment system; (2) the installation and operation of a source containment system; and (3) the operation of an on-site, 400-cfm (cubic feet per minute) soil vapor extraction (SVE) system for an aggregate period of one year. The goals of these remedial measures are: (a) to control hydraulically the migration of the off-site plume; (b) to control hydraulically any potential source areas that may be continuing to contribute to groundwater contamination at the on-site area; (c) 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; and (d) in the long-term, restore the groundwater to beneficial use.

The installation of the off-site containment system began in late 1998 and was completed in early May 1999. The system consisted of: (1) a containment well near the leading edge of the plume, designed to pump at a rate of about 225 gallons per minute (gpm), (2) an off-site treatment system, (3) an infiltration gallery in the Arroyo de las Calabacillas, and (4) associated conveyance and monitoring components. The off-site containment well began operating on December 31, 1998; except for brief interruptions for maintenance activities or due to power outages, the well has operated continuously since that date. Based on an evaluation of the performance of the system and of alternative groundwater extraction systems, conducted in 2009, Sparton recommended and the regulatory agencies approved the increase of the pumping rate of this well to about 300 gpm to accelerate aquifer restoration; this rate increase was implemented on November 3, 2010. The year 2011 was the thirteenth full year of operation of this well.

The source containment system was installed during 2001 and began operating on January 3, 2002. This system consisted of: (1) a containment well immediately downgradient from the site, designed to pump at a rate of about 50 gpm, (2) an on-site treatment system, (3) six[a] on-site infiltration ponds, and (4) associated conveyance and monitoring components. The year 2011 was the tenth year of operation of this well.

The 400-cfm SVE system had operated for a total of about 372 days between April 10, 2000 and June 15, 2001 and thus met the length-of-operation requirements of the Consent Decree; monitoring conducted in the Fall of 2001 indicated that the system had also met its performance goals, and the system was dismantled in May 2002.

During 2011, considerable progress was made towards achieving the goals of the remedial measures:

- The off-site containment well continued to operate during the year at an average discharge rate of 284 gpm and maintained hydraulic containment of the off-site plume. The pumped water was treated and returned to the aquifer through the infiltration gallery. The concentrations of constituents of concern in the treated water met all the requirements of the Discharge Permit for the site.
- The source containment well continued to operate during the year at an average rate of 51 gpm, and to contain potential on-site source areas. The pumped water was treated and returned to the aquifer through the infiltration ponds. The concentrations of constituents of concern in the treated water met all the requirements of the Discharge Permit for the site.
- Groundwater monitoring was conducted as specified in the Groundwater Monitoring Program Plan (Monitoring Plan [Attachment A to the Consent Decree]) and the State of New Mexico Groundwater Discharge Permit DP-1184 (Discharge Permit). Water levels in all accessible wells and/or piezometers were measured quarterly. Samples were collected for water-quality analyses from monitoring wells at the frequency specified in the Monitoring Plan and analyzed for VOCs and total chromium.
- Samples were obtained from the influent and effluent of the treatment plants for the off-site and source containment systems, and the infiltration gallery and infiltration pond monitoring wells at the frequency specified in the Discharge Permit. All samples were analyzed for VOCs, total chromium, iron, and manganese.
- The groundwater flow and transport model that was developed in early 2000 to simulate the hydrogeologic system underlying the site and its vicinity, and which was revised several times during the past eleven years, was used to simulate TCE concentrations in the aquifer from start-up of the off-site containment well in December 1998 through December 2011, and to predict concentrations for December 2012.

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[a] The performance of the six on-site infiltration ponds between 2002 and 2004 indicated that four ponds are more than adequate for handling the water pumped by the source containment well. With the approval of the regulatory agencies, Sparton backfilled two of the six ponds in 2005 to put the land to other beneficial use.

The extent of groundwater contamination during 2011, as defined by the extent of the TCE plume, was essentially the same as during 2010. Of 56 wells sampled both in November 2010 and 2011, the 2011 concentrations of TCE were lower than in 2010 in 17 wells, higher in 13 wells, and remained the same in 26 wells (all below detection limits). Well MW-60, at 1,200 micrograms per liter (μg/L), continued to be the most contaminated off-site well. The corresponding results for DCE were 8 wells with lower, 6 wells with higher, and 42 wells with the same (all below detection limits) concentrations. The TCA plume ceased to exist in 2003, and this condition continued through 2011; the highest concentration of TCA during 2011 was 4.3 μg/L (also in well MW-60), significantly below the maximum allowable concentration of 60 μg/L set for groundwater by the New Mexico Water Quality Control Commission.

Changes in concentrations observed in monitoring wells since the implementation of the current remedial measures indicate that contaminant concentrations decreased significantly both in the on-site and off-site area. Data from 55 wells that were sampled both during 2011 and before, or soon after, the start of the remedial operations indicate that TCE concentrations decreased in 30 wells, increased in 6 and remained below detection limits in 19. Of the six wells where current concentrations are higher than they were prior to the start of the current remedial operations, the highest increase was at the off-site containment well CW-1. The concentrations of contaminants in the water pumped from CW-1 rapidly increased after the start of its operation and have remained high for several years before starting a declining trend in the mid-2000s. The high concentrations in this well and in well MW-60 indicated that areas of high concentration existed upgradient from both of these wells; however, most of the groundwater upgradient from these wells has been captured by CW-1 and concentrations both in CW-1 and MW-60 are expected to continue their declining trend.

Two of the three monitoring wells completed below the 4800-foot clay (in the Deep Flow Zone or the DFZ), well MW-67 and well MW-79, which was installed in 2006 to address the continuing presence of contaminants in the third DFZ monitoring well MW-71R, continued to be free of any site-related contaminants throughout 2011. Well MW-71R continued to be contaminated; however, TCE concentrations in the well declined from 210 μg/L in August 2003 to 51 μg/L in May 2009. After that, the TCE concentrations in the well began increasing again reaching 91 μg/L in May 2011 and then declining to 58 μg/L by the Fourth Quarter 2011 sampling event.

The off-site and source containment wells operated at a combined average rate of 335 gpm during 2011. A total of about 176 million gallons of water were pumped from the wells. The total volume of water pumped since the beginning of the current remedial operations on December 1998 is about 1.78 billion gallons and represents 158 percent of the initial volume of contaminated groundwater (pore volume).

A total of about 390 kilograms (kg) [850 pounds (lbs)] of contaminants consisting of about 350 kg (770 lbs) of TCE, 35 kg (77 lbs) of DCE, and 1.2 kg (2.7 lbs) of TCA were removed from the aquifer by the two containment wells during 2011. The total mass that was removed since the beginning of the of the current remedial operations through the end of 2011 is 6,600 kg (14,560 lbs) consisting of 6,170 kg (13,600 lbs) of TCE, 411 kg (905 lbs) of DCE, and 18 kg (40 lbs) of TCA. This represents about 84 percent of the total dissolved contaminant mass currently estimated to have been present in the aquifer prior to the testing and operation of the off-site containment well.

The containment systems were shut down several times during 2011 for routine maintenance activities, due to power and monitoring system failures, or due to the failure of other components of the systems. The downtime for these shutdowns ranged from 8 minutes to 96 hours. The longer shutdowns, of about four days each, were for pump replacement at the source and then at the off-site containment well. The rate of migration of contaminants during a shutdown (90 ft/yr) and the distance between the leading edge of the plume and the limit of the containment area of the systems (about 400 ft) indicate that shutdowns of this magnitude, or of even much longer duration, do not and will not allow the escape of any contaminants beyond the containment area of the systems.

Plans for next year include continuing the operation of the off-site and source containment systems, and the collection of monitoring data as required by the plans and permits controlling system operation, groundwater discharge, and air emissions. The plugging and abandonment of monitoring wells MW-47 and MW-58 and MW-61, and the installation of a replacement well MW-47R, which have been approved by the agencies, will be implemented during the summer of 2012.[b]

[b] The plugging and abandonment of wells MW-47, MW-58, and MW-61 was completed on June 18-19, 2012; Well MW-47R is expected to be installed in late July or early August 2012.

Sparton Technology, Inc.
Former Coors Road Plant
Remedial Program

2011 Annual Report

Prepared for:

Sparton Technology, Inc.
Schaumburg, Illinois

Prepared by:

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Environmental & Water-Resource Consultants

June 29, 2012

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List of Acronyms

µg/L	Micrograms per liter
3rdFZ	Third depth interval of the Lower Flow Zone
cfm	cubic feet per minute
Cis-12DCE	cis-1,2-Dichloroethene
cm^2/s	Centimeter squared per second
CMS	Corrective Measure Study
COA	City of Albuquerque
Cr	Chromium
DCE	1,1-Dichloroethylene
DFZ	Deep Flow Zone below the 4800 -- foot clay
DO	Dissolved Oxygen
ft	foot or feet
ft MSL	feet above Mean Sea Level
ft/d	feet per day
ft/yr	feet per year
ft^2	square feet
ft^2/d	feet squared per day
ft^3	cubic feet
g/cm^3	grams per cubic centimeter
gpd	gallons per day
gpm	gallons per minute
IM	Interim Measure
kg	Kilogram
lbs	Pounds
LLFZ	Lower Lower Flow Zone
MCL	Maximum Contaminant Level
Metric	Metric Corporation
mg/L	Milligrams per liter
mg/m^3	Milligrams per cubic meter
MSL	Mean Sea Level
mV	Millivolt
ND	Not Detected
NMED	New Mexico Environment Department
NMEID	New Mexico Environmental Improvement Division
NMWQCC	New Mexico Water Quality Control Commission
ORP	Oxidation/Reduction Potential
O/S	On-Site
ppmv	parts per million by volume
RFI	RCRA Facility Investigation
rpm	Revolutions per minute
Sparton	Sparton Technology, Inc.
SSP&A	S.S. Papadopulos & Associates, Inc.
SVE	Soil Vapor Extraction
TCA	1,1,1-Trichloroethane
TCE	Trichloroethylene

UFZ	Upper Flow Zone
ULFZ	Upper Lower Flow Zone
USEPA	United States Environmental Protection Agency
USF	Upper Santa Fe Group
USGS	United States Geological Survey
VC	Vinyl Chloride
VOC	Volatile Organic Compound

REPORT

Section 1
Introduction

The former Coors Road Plant of Sparton Technology, Inc. (Sparton) is located at 9621 Coors Boulevard NW (on the west side of the boulevard), Albuquerque, New Mexico, 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 on-site soils and groundwater were contaminated by volatile organic compounds (VOCs), primarily trichloroethene (TCE), 1,1,1-trichloroethane (TCA) and 1,1-dichloroethene (DCE), and by chromium, and 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. As a result, the system was shut down and permanently taken out of service on November 16, 1999.

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 (COA), Sparton agreed to implement a number of remedial measures and take certain actions, including: (1) the installation, testing, and continuous operation of an off-site extraction well designed to contain the contaminant plume; (2) 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; (3) the operation of a 400 cubic feet per minute (cfm) capacity on-site soil vapor extraction (SVE) system for a total operating time of one year over a period of eighteen months; (4) the implementation of a groundwater monitoring plan; (5) the assessment of aquifer restoration; and (6) the implementation of a public involvement plan. 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 Decree, 2000; S.S. Papadopulos & Associates, Inc. (SSP&A), 2000a; 2000b; 2000c; and Chandler, 2000].

The off-site containment well was installed and tested in late 1998. Based on the test results, a pumping rate of about 225 gpm was determined to be adequate for containing the off-site plume (SSP&A, 1998), and the well began operating at approximately this rate 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. In 2000, due to chromium concentrations that exceeded the permit requirements for the discharge of the treated water, a chromium reduction process was added to the treatment system and began operating on December 15, 2000; however, chromium concentrations declined in 2001 and the process was discontinued on October 31, 2001. In late 2009, Sparton recommended that the pumping rate of the off-site containment well be increased to 300 gpm to expedite aquifer restoration in the off-site plume area; this recommendation was approved by USEPA and the New Mexico Environment Department (NMED) on March 26, 2010[1] and implemented by Sparton on November 3, 2010. The year 2011 constitutes the thirteenth year of operation of the off-site containment system.

Sparton applied for and obtained approvals for the different permits and work plans required for the installation of the source-containment system in 1999 and 2000. The Construction Work Plan for the system was approved on February 20, 2001, and construction began soon after that date. The installation of the system was completed by the end of 2001, and the system began operating on January 3, 2002. Thus, the year 2011 constitutes the tenth year of operation of the source containment system.

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 required under the Consent Decree was installed in the spring of 2000 and operated for an aggregate of about 372 days between April 10, 2000 and June 15, 2001, meeting the one-year operation requirement of the Consent Decree. The performance of the system was evaluated by conducting two consecutive monthly sampling events of soil gas in September and October 2001, after a 3-month shut-off period. The results of these two sampling events, which were presented in the Final Report on the On-Site Soil Vapor Extraction System [Chandler and Metric Corporation (Metric), 2001] and on Table 4.7 of the 2001 Annual Report (SSP&A, 2002), indicated that TCE concentrations at all monitoring locations were considerably below the 10 parts per million by volume (ppmv) remediation goal of the Consent Decree. Based on these results, the operation of the SVE system was permanently discontinued by dismantling the system and plugging the vapor recovery well and vapor probes in May 2002.

In accordance with the requirements of the Consent Decree [Attachment D - Work Plan for the Assessment of Aquifer Restoration (SSP&A, 2000b)], a numerical groundwater flow and contaminant transport model of the aquifer system underlying the Sparton site and its vicinity was developed in 2000 and recalibrated each year until 2009. The initial development of this model is described in the 1999 Annual Report (SSP&A, 2001a), and major revisions to the model in the 2003 and 2008 Annual Reports (SSP&A, 2004; 2009a). In 2009, the model was deemed reliable for making future predictions and was used to evaluate the performance of the existing system and of several alternate groundwater extraction systems with respect to the time each system would take to restore the aquifer. The recommendation to increase the pumping rate of CW-1 to 300 gpm, made by Sparton and approved by USEPA and NMED, was based on the results of this evaluation (SSP&A, 2009b).[2]

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[1] Letter dated March 26, 2010 from John E. Kieling of NMED and Chuck Hendrickson of USEPA to Joseph S. Lerczak of Sparton, Re: Sentinel Well Installation Workplan Request, Sparton Technology, Inc., EPA ID No. NMD083212332.

[2] The report presenting the results of the evaluation (SSP&A, 2009b) was approved on July 9, 2010 (letter dated July 9, 2010 from John E. Kieling of NMED and Chuck Hendrickson of USEPA to Joseph S. Lerczak of Sparton, Re: 2007 & 2008 Annual reports Approval, Sparton Technology, Inc., EPA ID No. NMD083212332).

The purpose of this 2011 Annual Report is to:

- provide a brief history of the former Sparton plant and affected areas downgradient from the plant,
- summarize remedial and other actions taken in prior years and during 2011,
- present the data collected during 2011 from operating and monitoring systems, and
- provide interpretations of these data with respect to meeting remedial objectives.

This report was prepared by SSP&A on behalf of Sparton. During the first five months of 2011, Metric was responsible for the operation of the remedial systems, the collection of the data that form the basis of this report, and for other field activities; after the passing away of Gary Richardson of Metric in May of 2011, SSP&A took over the responsibility for these activities effective June 1, 2011. Background information on the site, the implementation of remedial actions, and initial site conditions as they existed prior to the implementation of the remedial actions agreed upon in the Consent Decree are discussed in Section 2; a brief summary of operations during 1999 through 2010 is included in this section. Issues related to the year-2011 operation of the off-site and source containment 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 interpretations of the data and discusses the results with respect to the performance and the goals of the remedial systems. A description of the site's groundwater flow and transport model and the results of evaluations made using the model are presented in Section 6. Section 7 summarizes the report and discusses future plans. References cited in the report are listed in Section 8.

Section 2
Background

2.1 Description of Facility

The site of Sparton's former Coors Road plant is approximately a 12-acre property located in northwest Albuquerque, on Coors Boulevard NW. The property is about one-quarter mile south of the Arroyo de las Calabacillas, about three-quarters of a mile north of the intersection of Coors Boulevard 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 (ft) 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. About one-quarter mile west of the property the land rises approximately 150 ft forming a hilly area with residential properties.

The plant consisted of a 64,000-square-foot manufacturing and office building and several other small structures that were used for storage or as workshops (see Figure 2.1). Manufacturing of electronic components, including printed-circuit boards, began at the plant in 1961 and continued until 1994. Between 1994 and the end of 1999, Sparton operated a machine shop at the plant in support of manufacturing at the company's Rio Rancho plant and other locations. The property was leased to Melloy Dodge in October 1999. During 2000 and early 2001, the tenant made modifications and renovations to the property to convert it to an automobile dealership and has been operating it as a dealership since April 23, 2001.

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 (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 (Figure 2.1) and wastewater that accumulated in the impoundment was periodically removed by a vacuum truck for off-site disposal at a permitted facility. Closure of the former impoundment and 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 ft thick. The deposits at the site have been characterized by more than 100 borings advanced for installing monitoring, production, and temporary wells, and soil vapor probes, and by a 1,520 ft deep boring (the Hunters Ridge Park 1 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 1,500 ft 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 ft of Quaternary (Holocene and Pleistocene) 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 (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-ft thick. Beneath the facility, and in an approximately 1,500 ft wide band trending north from the facility, a silty clay unit has been mapped between an elevation of about 4,965 ft above mean sea level (ft MSL) and 4,975 ft MSL. This unit, which is referred to as the 4970-foot silt/clay unit, represents Late-Pleistocene-age overbank deposits. The areal extent of the unit at and in the vicinity of the Sparton site is shown in Figure 2.3. Additional information on this unit is presented in Appendix A to both the 1999 and 2000 Annual Reports (SSP&A, 2001a; 2001b).) Holocene-age arroyo fan and terrace deposits, which are primarily sand and gravel, overlie this unit.

The Pliocene-age Upper Santa Fe Group (USF) deposits underlie the Quaternary alluvium. These USF deposits, to an elevation of 4,800 ft 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 assemblages 1 and 2 represent basin-floor alluvial deposits; assemblage 1 is primarily sand and gravel with lenses of silty clay, and assemblage 2 is primarily sand with lenses of pebbly sand and silty clay. Lithofacies assemblage 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 4,800 ft MSL, a 2- to 4-foot thick clay layer is encountered. This clay layer, referred to as the 4800-foot clay unit (Figure 2.2), likely represents lake deposits. The 4800-foot clay unit was encountered in borings for seven wells (MW-67, MW-71, MW-71R, MW-79, CW-1, OB-1, and OB-2) installed during site investigations and remedial actions. The unit was also encountered in the USGS Hunter Ridge Park 1 Boring which is located about 0.5 mile north of the Sparton Site on the north side of the Arroyo de las Calabacillas. The nature of the depositional environment (i.e. lake deposits), and the fact that the unit has been encountered in every deep well drilled in the vicinity of the site, as well as at the more distant USGS boring, indicate that the unit is areally extensive. The deposits of the Santa Fe Group immediately below the 4800-foot clay are similar to those above the clay. The USGS Hunter Ridge Park 1 Boring also indicates the presence of two other deeper clay units, a 15-foot thick unit between elevations 4,705 and 4,720 ft MSL, and a second 20-foot thick unit between elevations 4,520 and 4,540 ft MSL (see Figure 2.2).

The water table beneath the Sparton Site and between the Site and the Rio Grande lies within the Quaternary deposits; however, to the west and downgradient from the site the water table is within the USF deposits. A total of 91 wells were installed at the site and its vicinity to define hydrogeologic conditions and the extent and nature of groundwater contamination and to implement and monitor remedial actions. Of these 91 wells, 22 have been plugged and abandoned, leaving 69 wells that are currently active at the site. Four of the existing 69 wells (MW-14R, MW-37R, MW-52R, and MW-71R) are replacements for nearby wells that became dry and were plugged and abandoned, and two wells (MW-53D, and MW-57D) are wells that were deepened after becoming dry to continue to provide data.[3] The locations of existing wells are shown in Figure 2.3, and those of the plugged and abandoned wells are shown in Figure A-1 of Appendix A.

The off-site containment well, CW-1, and the two associated observation wells, OB-1 and OB-2, were drilled to the top of the 4800-foot clay unit and are screened across the entire saturated thickness of the aquifer above the clay unit. The source containment well, CW-2, was drilled to a depth of 130 ft and is equipped with a 50-foot screen from the water table to total depth. The monitoring wells have short screened intervals (5 to 30 ft) and were classified during their installation according to their depth and screened interval. Wells screened across, or within 15 ft of, the water table were referred to as Upper Flow Zone (UFZ) wells. Wells screened 15-45 and 45-75 ft below the water table were referred to as Upper Lower Flow Zone (ULFZ) and Lower Lower Flow Zone (LLFZ) wells, respectively.[4] Wells completed below the 4800-foot clay unit were referred to as Deep Flow Zone (DFZ) wells. Wells, which were installed at locations where an ULFZ or a LLFZ well already existed and which were screened at a deeper interval than the adjacent existing well, were referred to as LLFZ or Third Flow Zone (3rdFZ) wells, regardless of the depth of their screened interval with respect to the water table.[5] This classification, except for a few exceptions (see Footnote 5), has been maintained in this report.

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[3] The plugging and abandonment of two wells (MW-13 and MW-48) and the deepening of one well (MW-57D) occurred in June 2011.

[4] This classification was based on the height of the water table as it existed in 1998 and prior years. Since then, the water table in the off-site area has declined; the water-table declines range from about 4 ft to more than 7 ft and average about 5.5 ft. Because of these declines, some UFZ wells have become dry and the depth from the water table to the screened interval of ULFZ and LLFZ wells is smaller than specified in this classification.

[5] Because of this practice, the classification of three existing monitoring wells, MW-32, MW-49, and MW-70, was not consistent with the depth of their screened intervals; well MW-32, which was completed within the ULFZ, was classified as LLFZ, and MW-49 and MW-70, which were completed within the LLFZ, were classified as 3rd FZ wells. This inconsistency was corrected during the first (1999) Annual Report prepared under the Consent Decree (SSP&A, 2001a) and, since then, MW-32 has been referred to and treated as a ULFZ well and MW-49 and MW-70 as LLFZ wells.

The completion flow zone, location coordinates, and measuring point elevation of all existing wells are presented in Table 2.1; their diameters and screened intervals are summarized in Table 2.2. Similar information on wells that have been abandoned is presented on Tables A-1 and A-2 of Appendix A. In Figure 2.4, the screened interval of each existing 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 (MW-67, MW-71R, and MW-79), wells screened across the entire aquifer above the 4800-foot clay (CW-1, OB-1 and OB-2), and infiltration gallery monitoring wells (MW-74, MW-75, and MW-76) are not included in this figure.]

Data collected from these wells indicate that the thickness of the saturated deposits above the 4,800-foot clay ranges from about 180 ft at the Site to about 160 ft west of the Site and averages about 170 ft. Outside the area underlain by the 4970-foot silt/clay unit, groundwater occurs under unconfined conditions; however, in the area where this unit is present, it provides confinement to the underlying saturated deposits. The water table in this area occurs within the Late-Pleistocene-age arroyo fan and terrace deposits that overlie the 4970-foot silt/clay unit and is higher than the potentiometric surface of the underlying confined portion of the aquifer.

Analyses of data from aquifer tests conducted at the Site (Harding Lawson Associates, 1992; SSP&A, 1998; 1999b) indicate that the hydraulic conductivity of the aquifer is in the range of 25 to 30 ft per day (ft/d), corresponding to a transmissivity of about 4,000 to 5,000 ft squared per day (ft^2/d). A transmissivity of about 4,000 ft^2/d, corresponding to a hydraulic conductivity of about 25 ft/d, is also indicated by the response of water levels to long-term pumping from the off-site containment well CW-1. Analyses of the water levels measured quarterly in observation wells OB-1 and OB-2, and in monitoring wells within 1,000 ft of the off-site containment well, indicate that the response of these wells to the long-term pumping from CW-1 is best explained with a transmissivity of 4,000 ft^2/d; that is, a transmissivity of 4,000 ft^2/d produces the smallest residual between calculated and measured water levels in these wells.

Water-level data indicate that the general direction of groundwater flow is to the northwest with gradients that generally range from 0.0025 to 0.006; however, within the deposits that lie above the 4970-foot silt/clay unit at the Sparton Site, the direction of groundwater flow is to the west-southwest and the water table has a steeper gradient ranging from 0.010 to 0.016. Groundwater production from the deeper aquifers and a reduction in the extent of irrigated lands in the vicinity of the Site has resulted in a regional decline of water levels. Vertical flow is, therefore, downward with hydraulic gradients that change as rates of regional water-level decline change. During the 1990s the regional decline averaged about 0.65 foot per year (ft/yr) and the vertical hydraulic gradient was 0.002; this information was used in estimating the vertical hydraulic conductivity of the sand units above the 4800-foot clay unit (SSP&A, 2001a). The rate of regional water-level decline slowed down in the early 2000s and averaged about 0.3 ft/yr until 2007; the corresponding average hydraulic gradient was 0.0009. In early 2007, regional water levels rose by about one foot and then began declining again at rates that ranged between 0.47 ft/yr and 0.62 ft/yr and averaged 0.55 ft/yr (see well hydrographs presented in Figure 2.5 and Figure 6.3); the average vertical hydraulic gradient during these years was 0.0017.

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 indicated that the primary constituents of concern found in on-site soil and in both on-site and off-site groundwater were VOCs, primarily TCE, TCA and its abiotic transformation product DCE. Of these constituents, TCE had the highest concentrations and was the constituent used to define the extent of groundwater contamination. Concentrations of DCE in groundwater were lower relative to those of TCE, but it had the second largest plume extent. Groundwater contamination by TCA was primarily limited to the facility and its immediate vicinity. Various metals were also detected in both soil and groundwater samples; of these, chromium had 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 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 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 (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 delineate further 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 locations of the sampled off-site monitoring wells MW-48, MW-57, and MW-61 are shown on Figure 2.3. The fourth off-site monitoring well, MW-37, which became dry and was plugged in 2002, was located near its replacement well MW-37R. The area where TCE concentrations in soil-gas exceeded 10 ppmv was determined from the results of this investigation (Figure 2.7).

Following this investigation, a 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.

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 4,000 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 kilograms (kg) or 320 pounds (lbs).

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 total operating time of one year over a period of eighteen months.

Implementation of the off-site containment system, as originally planned, was completed in 1999. A chromium reduction process was added to the treatment component of the system in 2000. The chromium treatment process was discontinued in 2001 because the chromium concentration in the influent dropped below the New Mexico groundwater standard. The system currently consists of:

- a containment well (CW-1) installed near the leading edge of the TCE plume;
- an off-site treatment system for the water pumped by CW-1, consisting of an air stripper housed in a building;
- an infiltration gallery installed in the Arroyo de las Calabacillas for returning treated water to the aquifer;
- a pipeline for transporting the treated water from the treatment building to the gallery;
- a piezometer, PZG-1, with an horizontal screen placed near the bottom of the gallery, for monitoring the water level in the gallery; and
- three monitoring wells (MW-74, MW-75, and MW-76) for monitoring potential water-quality impacts of the gallery.

The locations 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 other components of the system (except the chromium reduction process) 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. Due to increases in chromium concentrations in the influent to, and hence in the effluent from, the air stripper, a chromium reduction process was added to the treatment system on December 15, 2000. Chromium concentrations, however, declined during 2001 and the chromium reduction process was removed on November 1, 2001. The pumping rate of the off-site containment well was increased to 300 gpm on November 3, 2010, and the system is now operating at approximately this rate with all system components functioning.

All permits and approvals required for the implementation of the source containment system were obtained between May 1999 and February 2001. The installation of the system began soon after the approval of the Construction Work Plan for the system in February 2001, and completed in December 2001. The system was tested in December 2001 and placed into operation on January 3, 2002. The system consists of:

- a source containment well (CW-2) installed immediately downgradient of the Site;
- an on-site treatment system for the water pumped by CW-2, consisting of an air stripper housed in a building;
- six on-site infiltration ponds for returning the treated water to the aquifer;
- pipelines for transporting the pumped water to the air stripper and the treated water to the ponds; and

- three monitoring wells (MW-17, MW-77, and MW-78) for monitoring the potential water-quality impacts of the ponds.

The layout of the system is shown in Figure 2.10. The chromium concentrations in the influent to, and hence in the effluent from, the air stripper meets the New Mexico water-quality standard for groundwater and, therefore, treatment for chromium is not necessary. Based on the first three years of operation of the system, Sparton concluded that four infiltration ponds were sufficient for returning to the aquifer the water treated by this system. Therefore, in April 2005 Sparton requested USEPA and NMED approval to backfill two of the six ponds (Ponds 5 and 6 in Figure 2.10), and upon approval of this request in June 2005, the two ponds were backfilled between August and December 2005.

An AcuVac SVE system was installed on vapor recovery well VR-1 (see Figure 2.6) in the spring of 1998 and operated between April 8 and October 20, 1998. Additional SVE operations at this location 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 was installed in 2000, and the SVE system was operated at 400 cfm between April 10, 2000 and June 15, 2001. The total operating time during this period, 371 days and 13 hours, and the results of the performance monitoring conducted after the shut-down of the system met the requirements of the Consent Decree for the termination of the SVE operations at the site. The system was, therefore, dismantled, and the recovery well and vapor probes associated with the system were plugged in May 2002.

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 and source containment systems, and the 1999-2001 operation of 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 implementation of the current remedial measures.

Water-level data from UFZ and ULFZ well pairs indicate that UFZ wells screened above or within the 4970-foot silt/clay unit (most of the UFZ wells on the Sparton Site) have a water level that is considerably higher than that in the adjacent ULFZ wells that are screened below this unit. These water-level differences range from less than one foot near the western and southwestern limit of the unit to more than 10 ft north and northeast of the Sparton site. Outside the area underlain by the 4970-foot silt/clay unit, however, the water-level difference between UFZ and ULFZ well pairs is 0.2 foot or less. This relationship between UFZ and ULFZ water levels is illustrated in the schematic cross-section shown in Figure 2.4 (see also Figure 5.14).

In early interpretations of water-level data, including those presented in the 1999 and 2000 Annual Reports (SSP&A, 2001a; 2001b), separate water-level maps were prepared using data from UFZ, ULFZ, and LLFZ wells without taking into consideration the above-discussed relationship between the water levels in UFZ and ULFZ wells. Since the 2001 Annual Report (SSP&A, 2002), however, this relationship has been taken into consideration, and water level conditions at the site and its vicinity are presented in three maps depicting: (1) the water table above the 4970-foot silt/clay unit underlying the Sparton site and at the area north of the site, based on water-level data from UFZ wells screened above or within the silt/clay unit (referred to as the "on-site water table"); (2) the combined UFZ/ULFZ water levels based on data from UFZ and ULFZ wells outside the area underlain by the silt/clay unit (using the average water level at UFZ/ULFZ well pair locations) and ULFZ wells screened below this unit; and (3) the LLFZ water levels based on data from LLFZ wells.

The elevation of the on-site water table in November 1998 is shown in Figure 2.11. The corresponding water-level elevations in the UFZ/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-site, the direction of flow is also northwesterly in both the UFZ/ULFZ and the LLFZ; however, the gradients are steeper, approximately 0.005 in the UFZ/ULFZ and 0.006 in the LLFZ. The on-site water table is affected by the on-site groundwater recovery system, which was operating during the November 1998 water-level measurements, and the presence of the 4970-foot silt/clay unit; the direction of flow changes from westerly north of the site to southwesterly on the site, with gradients that range from 0.01 to 0.016.

A discussion of water levels in the DFZ had not been included in the 2006 and earlier Annual Reports because data from only two monitoring wells (MW-67 and MW-71 or MW-71R) were available from this zone; these data indicated steep downward gradients across the 4,800-foot clay (water-level differences of about 6 feet between the LLFZ and the DFZ) but provided little information on the direction of groundwater flow in this zone. The installation of a third DFZ monitoring well (MW-79) in 2006, and the water-level data collected from the three DFZ wells between the installation of MW-79 and the end of 2008 indicate that the average direction of groundwater flow in the DFZ during this period was to the west-northwest (W 19.1° N) with an average gradient of about 0.00200 (see Figure 2.14). This direction of flow and gradient are similar to those observed in the flow zones above the 4800-foot clay.

The lower water levels in the DFZ are due to municipal and industrial pumping from the deeper horizons of the aquifer several miles to the north, west, and southwest of the Sparton site. These lower water levels and the resulting steep gradients across the 4800-foot clay unit create a potential for the downward migration of contaminants. The off-site containment well, which is fully penetrating the aquifer above the clay unit, is expected to create horizontal gradients that may counteract the downward migration potential across the clay unit.

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, CW-1, and the nearby observation wells, OB-1 and OB-2, and from temporary wells, TW-1 and TW-2, drilled in early 1998 at the current location of MW-73 and sampled on February 18 and 19, 1998, respectively. For each of the compounds reported on Table 2.5, concentrations that exceed the more stringent of its Maximum Contaminant Level (MCL) for drinking water or its maximum allowable concentration in groundwater set by the New Mexico Water Quality Control Commission (NMWQCC) are highlighted.

These concentration 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 2.15 and the extent of the DCE and TCA plumes is shown in Figures 2.16 and 2.17, respectively. This initial extent of the plumes forms a basis for comparing their extent during the years of operation of the remedial systems that have been implemented at the site and for evaluating the effectiveness of these remedial systems.

2.6.1.3 Pore Volume of Plume

TCE is the predominant contaminant at the Sparton site and has the largest plume. Calculation of the initial volume of water contaminated above MCLs, referred to as the pore volume of the plume, was, therefore, based on the horizontal and vertical extent of the TCE plume.

In preparing the plume maps presented in the previous section (Figures 2.15 through 2.17), the completion zone of 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 horizontal extent of the TCE plume shown in Figure 2.15 represents the envelope of the extent of contamination at different depths, rather than the extent of the plume at a specific depth within the aquifer.

To estimate the initial pore volume of the plume, three separate maps depicting the horizontal extent of the TCE plume were prepared using water-quality data from UFZ, ULFZ, and LLFZ monitoring wells. The concentrations measured in the fully-penetrating containment well CW-1 and observation wells OB-1 and OB-2 were assumed to represent average concentrations present in the entire aquifer above the 4800-foot clay, and these data were used in preparing all three maps. An estimate of the horizontal extent of TCE contamination at the top of the 4800-foot clay was also made by preparing a fourth plume map using the data from the containment well and the two observation wells, and data from two temporary wells that obtained samples from about 30-35 ft above the top of the clay during the construction of DFZ wells MW-67 (July 1996) and MW-71 (June 1998). [These four TCE plume maps were presented in Appendix B to both the 1999 and the 2000 Annual Reports (SSP&A, 2001a; 2001b).]

The extent of the plume based on UFZ wells was assumed to represent conditions at the water table; based on the elevation of the screened intervals in ULFZ and LLFZ wells (see Figure 2.4), the extent of the plume estimated from ULFZ wells was assumed to represent conditions at an elevation of 4,940 ft MSL, and that estimated from LLFZ wells conditions at an elevation of 4,900 ft MSL. The extent of the plume at the top of the clay was assumed to represent conditions at an elevation of 4,800 ft MSL. The area of the TCE plumes at each of these four horizons was calculated.[6] Using these areas, the thickness of the interval between horizons, and a porosity of 0.3, the pore volume was estimated to be approximately 150 million cubic ft (ft^3), or 1.13 billion gallons, or 3,450 acre-ft.

2.6.1.4 Dissolved Contaminant Mass

As discussed in both the 1999 and 2000 Annual Reports (SSP&A, 2001a; 2001b), calculations of the initial dissolved contaminant mass based on a plume-map approach, such as the one used above to estimate the initial pore volume (Section 2.6.1.3), significantly underestimate the dissolved contaminant mass present in the aquifer underlying the site. The calibration of the numerical transport model that was developed for the site and its vicinity (see Section 6.2.3) was, therefore, used to provide an estimate of the initial contaminant mass. During the calibration process of this model, the initial TCE concentration distribution within each model layer is adjusted, in a manner consistent with the initial concentrations observed in monitoring wells, until the computed concentrations of TCE in the water pumped from each containment well, and hence the computed TCE mass removal rates, closely match the observed concentrations and mass removal rates. Based on the calibration of the model against 1999 through 2009 water-quality data, the initial dissolved TCE mass is currently estimated to be (see Table 6.1) about 7,360 kg (16,230 lbs).[7] Using this estimate, and ratios of the removed TCE mass to the removed DCE and TCA mass, the initial masses of dissolved DCE and TCA are estimated to be approximately 460 kg (1,010 lbs) and 22 kg (48 lbs), respectively. Thus, the total initial mass of dissolved contaminants is currently estimated to be about 7,840 kg (17,290 lbs).

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 (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 2.18, with the approximate 10 ppmv TCE

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[6] The features of the commercially available mapping program Surfer 7.0 (copyright © 1999, Golden Software, Inc.) were used in generating the plume maps and in calculating plume areas.

[7] Comparison of mass removal rates and of containment-system influent concentrations during 2010 and 2011 with model predicted mass removal rates and influent concentrations (see Figure 6.8) indicates that this estimate of initial TCE mass continues to be valid.

plume limit delineated. The extent of the TCE plume presented in this figure represents the initial conditions prior to the resumption of soil vapor extraction remedial actions in 1999.

2.7 Summary of the 1999 through 2010 Operations

During 1999 through 2010, significant progress was made in implementing and operating the remedial measures Sparton agreed to implement under the terms of the Consent Decree entered on March 3, 2000. These remedial measures 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 through 2010 included the following:

- Between December 31, 1998 and April 14, 1999, and from May 6, 1999 through November 3, 2010, the off-site containment well was operated at a rate sufficient to contain the plume; the pumping rate of the well was increased on November 3, 2010 to accelerate aquifer restoration. The air stripper for treating the pumped water and the 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 chromium reduction process was added to the off-site treatment system on December 15, 2000, to control chromium concentrations in the air stripper effluent and thus meet discharge permit requirements for the infiltration gallery; the process was discontinued on November 1, 2001, after chromium concentrations in the influent decreased to levels that no longer required treatment.
- 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. A second 200-cfm Root blower was added to the system in the Spring of 2000, and the 400-cfm SVE system operated for a total of 372 days between April 10, 2000 and June 15, 2001 meeting the length-of-operation requirement of the Consent Decree. The results of the performance monitoring that was conducted in September and October 2001 indicated that the system had met the termination criteria specified in the Consent Decree, and the system was dismantled in May 2002.
- The source containment system, consisting of a containment well immediately downgradient from the site, an on-site treatment system, six on-site infiltration ponds, and associated conveyance and monitoring components, was installed and tested during 2001. Operation of the system began on January 3, 2002, and the system continued to operate through December 31, 2009 at a rate sufficient for containing any potential sources that may remain at the site. Two of the six infiltration ponds were backfilled in 2005 when an evaluation of the pond performance indicated that four ponds were sufficient for infiltrating the treated water.
- Groundwater monitoring was conducted as specified in the Groundwater Monitoring Program Plan, hereafter "Monitoring Plan," (Consent Decree, 2000, Attachment A) and in the State of New Mexico Groundwater Discharge Permit DP-1184 that controls the discharge of the treated water through the infiltration gallery and ponds, hereafter "Discharge Permit." Water levels in monitoring wells, containment wells, 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 Monitoring Plan and the Discharge Permit, and analyzed for TCE, DCE, TCA, and other constituents, as required by these documents.

- A groundwater flow and transport model of the hydrogeologic system underlying the site was developed in 2000. The model was calibrated against data available at the end of 1999, and again against data available at the end of each subsequent year, and used to simulate TCE concentrations in the aquifer from the start-up of the containment well in December 1998 through the end of 2009. After significant modifications in early 2009, during the preparation of the 2008 Annual Report, the model was deemed reliable for making predictions of future conditions, and was used in late 2009 to evaluate alternative groundwater extraction schemes for expediting aquifer restoration (SSP&A, 2009b). Based on this evaluation, and with the approval of the regulatory agencies, the pumping rate of the off-site containment well was increased to 300 gpm in November 2010.

A total of about 1.38 billion gallons of water, corresponding to an average rate of about 219 gpm, were pumped from the off-site containment well between the start of its operation and the end of 2010. An additional total of about 0.22 billion gallons of water, corresponding to an average rate of 48 gpm, were pumped by the source containment well between the start of its operation on January 3, 2002 and the end of 2010. The total volume of water pumped by both the off-site and source containment wells between the start of the off-site containment well operation and the end of 2010 was about 1.61 billion gallons, and represents about 142 percent of the initial volume of contaminated groundwater (pore volume). Evaluation of quarterly water-level data indicated that the off-site containment well maintained control of the off-site contaminant plume throughout each year, and that the source containment well developed a capture zone that contains potential on-site source areas that may be contributing to groundwater contamination.

The total mass of contaminants that was removed by the off-site containment well between the start of its operation and the end of 2010 was about 5,980 kg (13,200 lbs) and consisted of 5,620 kg (12,380 lbs) of TCE, 348 kg (767 lbs) of DCE, and 13.7 kg (30 lbs.) of TCA. An additional 230 kg (510 lbs) of contaminants consisting of about 200 kg (440 lbs) of TCE, 27.6 kg (61 lbs) of DCE, and 3.4 kg (7.4 lbs.) of TCA were removed from the aquifer by the source containment well. Thus, the total mass of contaminants removed from the aquifer by both wells between the start of the off-site containment well operation on December 1998 and the end of 2010 was about 6,210 kg (13,710 lbs) consisting of 5,820 kg (12,820 lbs) of TCE, 376 kg (830 lbs) of DCE, and 17.1 kg (38 lbs) of TCA. This removed mass represented about 79 percent of the contaminant mass currently estimated to have been present in the aquifer prior to the operation of the off-site containment well.

The operation of the soil vapor extraction systems at vapor recovery well VR-1 in 1999 and 2000 had a measurable impact on soil-gas concentrations at the site. The 1999 SVE operations had reduced TCE concentrations in soil gas below 10 ppmv at all but one of the monitored locations. Soil-gas was not monitored during the 2000 and 2001 operation of the

400-cfm system. The system was shut down on June 15, 2001; and performance monitoring was conducted near the end of 2001, three months after the shut-down. The results of this monitoring indicated that soil gas concentrations at all monitoring locations were considerably below the 10 ppmv termination criterion for the system, and the system was dismantled in May 2002.

The remedial systems were operated with only minor difficulties during 1999 through 2010. In 1999, the metering pump adding anti-scaling chemicals to the influent to the off-site air-stripper was not operating correctly. This problem was solved in December 1999 by replacing the pump. Also, chromium concentrations in the influent to, and hence in the effluent from, the air stripper increased from 20 μg/L at system start-up to 50 μg/L by May 1999, and fluctuated near this level, which is the discharge permit limit for the infiltration gallery, throughout the remainder of 1999 and during 2000. To solve this problem, a chromium reduction process was added to the treatment system on December 15, 2000; the process was discontinued on November 1, 2001, after chromium concentrations declined to levels that no longer required treatment. A new pump was installed in the off-site containment in October 2010 to accommodate the proposed new pumping rate of 300 gpm; however, after the pumping rate was increased on November 3, 2010, difficulties were encountered in maintaining this new pumping rate, and the pump was replaced on November 17, 2010.

In 2006, the discharge rate of the source containment well began declining during the latter half of the year; it was thought that this was due to the inefficiency of its pump and a new pump was installed in 2007. Further testing conducted when the new pump did not improve the flow rate indicated that the pipeline between the well and the air-stripper building was clogged with iron and manganese deposits; the pipeline was cleaned with acid in June 2007 to restore the capacity of the well.

Another issue of concern that developed during these years was the continuing presence of contaminants in the DFZ monitoring well MW-71. During 2001, an investigation was conducted on the well and the well was plugged. Based on the results of the investigation, a replacement well, MW-71R located about 30 ft south of the original well, was installed in February 2002. Samples collected from the replacement well between its installation and the end of 2003 indicated the continuing presence of contaminants in the Deep Flow Zone (TCE concentrations of 130 to 210 μg/L). In late 2003, USEPA/NMED and Sparton began negotiating potential approaches for addressing this problem; these negotiations led to the agreement in October 2004 of installing a DFZ monitoring/stand-by extraction well near CW-1, with the understanding that the decision to use this well as a monitoring or extraction well was to be based on whether the well is clean or contaminated. A Work Plan for the installation, testing, monitoring, and/or operation of this DFZ well was submitted to USEPA/NMED on December 6, 2004 and approved by USEPA/NMED on January 6, 2005. Difficulties in obtaining an easement agreement from the City of Albuquerque to provide access through a City owned park for moving a drilling rig to the proposed well location delayed the installation of the well until the beginning of 2006. The well was installed in February 2006, and the first samples from the well were obtained during its testing in April 2006. The analyses of these samples indicated that the well did not contain any site-related contaminants. Details on the installation, testing and sampling of the well were included in a letter-report[8] presented to USEPA/NMED in June 2006, and the results of the analysis of aquifer test data from the well were presented in Appendix E of the 2007 Annual Report (SSP&A, 2008). Based on the sampling results, the well was designated as monitoring well MW-79, and added to the Monitoring Plan under a semi-annual sampling schedule. Water-quality data collected from MW-79 and MW-71R until the end of 2010 indicated that MW-79 continued to remain free of contaminants, and that VOC concentrations in MW-71R began declining in 2005, from about 185 μg/L in November 2004 to about 77 μg/L in November 2007, and they remained in the 50-70 μg/L range since that time; the November 2010 concentrations in the well were 64 μg/L for TCE, 2.4 μg/L for DCE and <1.0 μg/L for TCA.

Six water table (UFZ) monitoring wells (MW-14, MW-15, MW-28, MW-37, MW-50, and MW-52) that became dry due to declining water levels were plugged during 2002 and 2003; three of these wells were replaced by wells with longer screens (MW-14R, MW-37R, and MW-52R) spanning both the UFZ and ULFZ. Three other water table monitoring wells that became dry during 2004 through 2006 (PW-1, MW-35, and MW-36) were plugged and abandoned in 2007. Well MW-53, which was dry in November 2005 and again in November 2007 and 2008, was deepened in December 2008; the well is now referred to as MW-53D. Well MW-33, which had been dry since 2006, was plugged and abandoned in July 2009.

In their comments on the 2003-2007 Annual Reports[9] USEPA and NMED requested that one or more wells or well clusters be installed "west to-northwest of MW-65 and OB-2." After negotiations between agency and Sparton representatives, Sparton agreed on March 30, 2009 to install one "sentinel" well (monitoring well MW-80) downgradient of the existing plume. Agreement on the location, and completion of such a sentinel well was reached in early 2010 (see SSP&A and Metric, 2010), and the well was installed in July-August 2010.

Other minor problems during the past years of operation included the occasional shutdown of the containment systems due to power failures, failures of the monitoring or paging systems, and failures of the discharge pumps or air-stripper blower motors. Appropriate measures were taken to address these problems.

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[8] Letter dated June 2, 2006 to USEPA and NMED representatives from Stavros S. Papadopulos of SSP&A and Gary L. Richardson of Metric with subject "Sparton Technology, Inc. Former Coors Road Plant Remedial Program - Transmittal of Data from the Installation, Testing, and Sampling of a new DFZ Well."

[9] Letter dated December 30, 2008 from Chuck Hendrickson of USEPA, Region 6 and John Kieling of NMED to Tony Hurst of Hurst Engineering Services, Re: 2003-2007 Annual Reports, Sparton Technology, Inc., Former Coors Road Plant, Sparton Technology, Inc., Consent Decree, Civil Action No. CIV 97 0206 LH/JHG, EPA ID No. NMD083212332, with enclosure on "EPA/NMED Comments on Sparton, Inc., Annual Reports for 2003-2007."

Section 3
System Operations - 2011

3.1 Monitoring Well System

During 2011, water levels were measured in and samples were collected from all monitoring wells that were not dry and had sufficient water during the measurement or sampling event. Water levels were measured quarterly and samples were collected from each well at the frequency specified either in the Monitoring Plan, or the Discharge Permit.

3.1.1 Upper Flow Zone

As in past years, the continuing water-level declines in the Albuquerque area affected the monitoring of some of the shallow monitoring wells (UFZ wells) during 2011. Monitoring wells MW-13, MW-48, and MW-57, which had been recommended and approved for abandonment (MW-13 and MW-48) or for deepening (MW-57)[10] continued to be dry during the first two quarters of 2011; water levels could not be measured in these wells, and MW-57, which is on a quarterly sampling schedule, could not be sampled during these two quarters. Wells MW-13 and MW-48 were plugged and abandoned in June 2011. Well MW-57 was deepened in late June and early July 2011 and a first sample was obtained from the deepened well (MW-57D) on July 8, 2011; water levels in the well were measured and samples were obtained from it during the scheduled Third and Fourth Quarter monitoring events. Well MW-61, which was dry during all four quarters of 2010, was also dry during the Second, Third, and Fourth Quarters of 2011 with the water level barely above the bottom of the screen during the First Quarter. In addition, water levels measured in wells MW-07, MW-09, MW-47, and MW-58, during all four quarters of 2011, were below the elevation of the screen bottom for these wells; that is, the measured water level was within blank casing below the screen and may not represent the water-level in the aquifer, unless the plug at the bottom of the blank casing is leaking. A similar situation existed with well MW-54, which was reported dry during the Third Quarter and had a water level below the screen bottom during the First and Fourth Quarters, and PZ-1, which had a below screen bottom water level during the Fourth Quarter. Because of these conditions, wells MW-07, MW-47, MW-58, and MW-61, which are scheduled for annual sampling, could not be sampled during the Fourth Quarter sampling event when wells scheduled for annual sampling are sampled.

In the 2010 Annual Report (SSP&A, 2011a), Sparton proposed that wells MW-58 and MW-61 be also plugged and abandoned, and that well MW-47 be deepened to continue providing water-level and water-quality data at its location. The USEPA and NMED approved this report, and hence the proposed well modifications, on September 23, 2011,[11] and requested

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[10] Letter dated September 28, 2010 from John E. Kieling of NMED and Chuck Hendrickson of USEPA to Joseph S. Lerczak of Sparton, Re: 2009 Annual Report Approval, Sparton Technology, Inc., EPA ID No. NMD083212332.

[11] Letter dated September 23, 2011 from John E. Kieling of NMED and Chuck Hendrickson of USEPA to Joseph S. Lerczak of Sparton, Re: 2010 Annual Report Approval with Modification, Sparton Technology Inc., EPA ID No.:NMD083212332.

that a Work Plan for implementing these modifications be submitted. Field inspection of the three wells to determine the best approach for implementing the agency approved modifications indicated, however, that the location of well MW-47 presented difficulties to its deepening, and that replacing the well at a nearby location would be more practical. A Work Plan proposing that all three wells be plugged and abandoned and a deeper replacement well (MW-47R) be installed near the original location of MW-47, and presenting a brief description of the procedures to be used in in implementing this work was prepared and submitted to the agencies on November 22, 2011 (SSP&A, 2011b). These monitoring well modifications will be implemented upon approval of this Work Plan.[12]

3.1.2 Deeper Flow Zones

There were no problems associated with the measurement of the water levels or with the sampling of any monitoring wells completed in the ULFZ, LLFZ, or the DFZ.

3.2 Containment Systems

3.2.1 Off-Site Containment System

The Off-Site Containment System operated for about 8,588 hours, or 98.0 percent of the 8,760 hours available during 2011. The system was down for about 172 hours due to 14 interruptions ranging in duration from 0.22 hour to about 96 hours. A summary of the downtime for the year is presented in Table 3.1 (a). These downtimes consisted of four shutdowns for routine maintenance, two shutdowns for well pump replacement, and eight shutdowns due to power failure.

3.2.2 Source Containment System

The Source Containment System operated for about 8,610 hours, or 98.3 percent of the 8,760 hours available during 2011. The system was down for about 150 hours due to 17 interruptions ranging in duration from 0.13 hour to about 90 hours. A summary of the downtime for the year is presented on Table 3.1 (b). These downtimes consisted of two shutdowns for cleaning up the pipeline between the CW-2 and the air stripper, three shutdowns for valve cleanup and adjustment, three shutdowns due to sump pump overload, five shutdowns due power failure, one shutdown for pump replacement, and three minor shutdowns due to various reasons.

The rapid infiltration ponds performed well during 2011. Ponds 1 and 4 were used during January, February, and March, and all four ponds were used in April. During the remainder of the year, except for September, three ponds were used each month. Ponds 1, 3, and 4 were used in May and June, ponds 2, 3, and 4 were used in July, October, and December, and ponds 1, 2, and 3 were used in August and November; two ponds, ponds 3 and 4, were used in

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[12] The Work Plan was approved by the agencies with some minor modifications on February 6, 2012 (letter from John E. Kieling of NMED and Chuck Hendrickson of USEPA to Joseph S. Lerczak of Sparton, Re: Approval with Modification, Work Plan for Plugging and Abandoning Three Monitoring Wells and for Installing a Replacement Well, Sparton Technology Inc., EPA ID No.:NMD083212332). Plugging and abandonment of wells MW-47, MW-58, and MW-16 was implemented on June 18-19, 2012; well MW-47R is expected to be installed in July 2012.

September. The amount of water evaporating from the ponds has been estimated to be about 1 percent of the discharged water, that is, about 0.5 gpm.

3.3 Problems and Responses

Since the increase of the off-site containment well pumping rate on November 3, 2010 difficulties were encountered in maintaining the pumping rate at about 300 gpm with the new pump that was installed at that time. The pump was replaced on November 17, 2010 but continued to need frequent flow rate adjustments during the remainder of 2010 and during 2011 until it failed on October 21, 2011. The system was shut down for about four days to replace the pump with a temporary pump pending the purchase of a new pump, and a new pump was installed in the well on November 7, 2011.

Difficulties were also encountered near the end of 2010 in maintaining the pumping rate of source containment well CW-2 at its design rate of 50 gpm; however, these difficulties were due to back-pressure from scale accumulation in the pipeline to the treatment plant rather than to the pump. The pipeline was cleaned on January 24-25, 2011 and the pumping rate of the well was restored to its design rate. A few weeks later, however, on February 14, 2011, the well pump failed and the system was shut down for about four days to replace the pump.

Section 4
Monitoring Results - 2011

The following data were collected in 2011 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:

- water-level and water-quality data from monitoring wells,
- data on containment well flow rates, and
- data on the quality of the influent to and effluent from the water-treatment systems.

4.1 Monitoring Wells

4.1.1 Water Levels

Water levels during 2011 were measured quarterly, in February, May, August and November, as it has been the case in past years.[13] During each round of measurements, the depth to water was measured in all monitoring wells that were not dry during the measurement round, the off-site and source containment wells, the two observation wells, and the piezometer installed in the infiltration gallery.[14] The corresponding elevations of the water levels during each of the four measurement rounds, calculated from these data, are summarized on Table 4.1.

4.1.2 Water Quality

Monitoring wells within and in the vicinity of the plume were sampled at the frequency specified in the Monitoring Plan and the Discharge Permit. The samples were analyzed for VOCs and for total chromium (unfiltered, and occasionally filtered, samples). During the Fourth Quarter sampling event conducted in November 2011, samples from a large number of the sampled wells (29 out of 57) were frozen in the laboratory due to a malfunction of their refrigeration system; 28 of these wells were re-sampled in December, and one (MW-39) which was inadvertently omitted in December, was re-sampled in January 2012.[15] The results of the analysis of the samples collected from monitoring wells during all sampling events conducted in 2011, and for all of the analyzed constituents, are presented in Appendix B-1. Data on TCE, DCE, and TCA concentrations in samples collected during the Fourth Quarter of 2011 are summarized on Table 4.2. Quarterly samples from the infiltration gallery monitoring wells

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[13] An exception was year 2010 when an additional round of water-level measurements was conducted in December to evaluate the effects of the increase in the CW-1 pumping rate from about 225 gpm to about 300 gpm.

[14] In past years, the water level was also measured in the Corrales Main Canal near the southeast corner of the Sparton property. The water level in the canal (when not dry) is more than 10 feet above the water table at the site, and hence these measurements were of no use in the interpretation of the local water table configuration; therefore, measurement of the canal level was discontinued effective the beginning of 2011,

[15] Although this Fourth Quarter sampling event spanned over a period of more than two months, it is often referred to as the November sampling event in this report.

(MW-74, MW-75, and MW-76) and from the infiltration pond monitoring wells (MW17, MW-77, and MW-78) were analyzed for VOCs, total chromium, iron, and manganese, as specified in the Discharge Permit. The results of the analysis of these samples are presented in Appendix B-2; data on TCE, DCE and TCA concentrations in the Fourth Quarter (November 2011) samples from these wells are also included on Table 4.2. For each of the compounds reported on Table 4.2 and in Appendix B, concentrations that exceed the more stringent of its MCL for drinking water or its maximum allowable concentration in groundwater set by NMWQCC are highlighted.

4.2 Containment Systems

4.2.1 Flow Rates

The volumes of groundwater pumped by the off-site and source containment wells during 2011 and the corresponding flow rates are summarized on Table 4.3. As shown on this table, a total of about 176.2 million gallons of water, corresponding to a combined flow rate of 335 gpm were pumped by the two containment wells. The volume and average flow rate of each well are discussed further below.

4.2.1.1 Off-Site Containment Well

The volume of the water pumped by the off-site containment well during 2011 was monitored with a totalizer meter that was read at irregular frequencies. The intervals between meter readings ranged from about 2.9 days to about 9.1 days, and averaged about 6.5 days. During each reading of the meter, the instantaneous flow rate of the well was calculated by timing the volume pumped over a specific time interval. The totalizer data collected from these flow meter readings and the calculated instantaneous discharge rate during each reading of the meter are presented in Appendix C-1. Also included in this appendix are the average discharge rate between readings and the total volume pumped between the start of continuous pumping on December 31, 1998 and the time of the measurement, calculated from the totalizer meter readings.

The average monthly discharge rate and the total volume of water pumped from the off-site containment well during each month of 2011, as calculated from the totalizer data, are summarized on Table 4.3. As indicated on this table, approximately 149.2 million gallons of water, corresponding to an average rate of 284 gpm, were pumped in 2011.

4.2.1.2 Source Containment Well

The volume of the water pumped by the source containment well during 2011 was also monitored with a totalizer meter that was also read at irregular frequencies. The intervals between meter readings ranged from about 1.7 days to about 8.9 days, and averaged 6.2 days. During each reading of the meter, the instantaneous flow rate of the well was calculated by timing the volume pumped over a specific time interval. The totalizer data collected from these flow meter readings and the calculated instantaneous discharge rate during each reading of the meter are presented in Appendix C-2. Also included in this appendix are the average discharge rate between readings and the total volume pumped between the start of continuous pumping on January 3, 2002, and the time of the measurement, calculated from the totalizer meter readings.

The average monthly discharge rate and the total volume of water pumped from the source containment well during each month of 2011, as calculated from the totalizer data, are summarized on Table 4.3. As indicated on this table, approximately 27.0 million gallons of water, corresponding to an average rate of 51 gpm, were pumped in 2011.

4.2.2 Influent and Effluent Quality

4.2.2.1 Off-Site Containment System

During 2011, the influent[16] to and effluent from the treatment plant for the off-site containment system was sampled monthly. These monthly samples were analyzed for VOCs, total chromium, iron, and manganese. The results of these influent and effluent sample analyses are presented in Appendix D-1. Concentrations of TCE, DCE, TCA, and total chromium in samples collected during 2011 are summarized on Table 4.4 (a). For each of the compounds shown on Table 4.4 (a), concentrations that exceed the more stringent of its MCL for drinking water or its maximum allowable concentrations in groundwater set by NMWQCC are highlighted. Data on TCE, DCE, and TCA concentrations for the November sample of influent are also included in Table 4.2, as the Fourth Quarter concentrations in CW-1, and were used in the preparation of the plume maps discussed in the next section.

4.2.2.2 Source Containment System

During 2011, the influent to and effluent from the treatment plant for the source containment system was sampled monthly. These monthly samples were analyzed for VOCs, total chromium, iron, and manganese. The results of these influent and effluent sample analyses are presented in Appendix D-2. Concentrations of TCE, DCE, TCA, and total chromium in samples collected during 2011 are summarized on Table 4.4 (b). For each of the compounds shown on Table 4.4 (b), concentrations that exceed the more stringent of its MCL for drinking water or its maximum allowable concentrations in groundwater set by NMWQCC are highlighted. Data on TCE, DCE, and TCA concentrations for the November sample of influent are also included in Table 4.2, as the Fourth Quarter concentrations in CW-2, and were used in the preparation of the plume maps discussed in the next section.

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[16] The "discharge from the containment wells" is the "influent" to the treatment systems; therefore, the two terms are used interchangeably in this report.

Section 5
Evaluation of Operations - 2011

The goal of the off-site containment system is to control hydraulically the migration of the plume in the off-site area and, in the long-term, restore the groundwater to beneficial use. The goal of the source containment system is to control hydraulically, within a short distance from the site, any potential source areas that may be continuing to contribute to groundwater contamination at the on-site area. This section presents the results of evaluations based on data collected during 2011 of the performance of the off-site and source containment systems with respect to their above-stated goals.

5.1 Hydraulic Containment

5.1.1 Water Levels and Capture Zones

The water-level elevation data presented in Table 4.1 were used to evaluate the performance of both the off-site and source containment wells with respect to providing hydraulic containment for the plume and potential on-site source areas. Maps of the elevation of the on-site water table and of the water levels in the UFZ/ULFZ and the LLFZ during each quarterly round of water-level measurements in 2011 are shown in Figures 5.1 through 5.12. Also shown on these water-level maps are: (1) the limit of the capture zones of the containment wells in the UFZ/ULFZ or the LLFZ, as determined from the configuration of the water levels; and (2) the extent of the TCE plume. The extent of the TCE plume shown in Figures 5.1 through 5.9 is based on previous year's (November 2010) water-quality data from monitoring wells; the extent of this plume is representative of the area that should have been contained between November 2010 and November 2011. The extent of the plume shown on the water-level maps for November 2011 (Figures 5.10 through 5.12), however, is based on the November 2011 water-quality data since this extent represents the area to be captured during the remainder of the year.

As shown in Figures 5.1, 5.4, 5.7, and 5.10, the pumping from the source containment well CW-2 has a relatively small effect on the on-site water table contours. Well CW-2 is screened between an elevation of 4,968.5 and 4,918.5 ft MSL. The sand-pack extends about 10 ft above the top of the screen, to an elevation of about 4,978.5 ft MSL. The top of the 4970-foot silt/clay at this location is also at an elevation of about 4,968.5 ft MSL. Most of the water pumped from the well, therefore, comes from the ULFZ and LLFZ underlying the 4970-foot silt/clay unit. The average pumping water level in CW-2 during 2011 was 4,950.4 ft MSL, about 18 ft below the top of the silt/clay unit; thus, the direct contribution of water from the aquifer above the silt/clay unit into the well is by leakage through the sand pack, and is controlled by the elevation of the top of the silt/clay unit at the well location. In preparing the water-table maps for the on-site area, the elevation of the water table at the location of CW-2 was, therefore, assumed to be near the top of the 4970-foot silt/clay, that is, at an elevation of 4,968.5 ft MSL. A similar condition exists at the location of infiltration pond monitoring wells MW-77 and MW-78. These two monitoring wells are equipped with 30-foot screens that span across the silt/clay unit, and thus allow water to flow from the on-site water table into the underlying ULFZ. The effects of this downward flow were also considered in preparing the water table maps.

The on-site water table maps (Figures 5.1, 5.4, 5.7, and 5.10) also indicate that the treated groundwater infiltrating from the infiltration ponds has created a water-table mound in the vicinity of the ponds. Comparisons of the water-level data collected before and after the start of the operation of CW-2 and of the infiltration ponds on January 3, 2002 indicate that soon after the start of the source containment system operation water levels rose in in response to the infiltrating water in all but seven of the wells completed above the 4970-foot silt/clay unit; the rise in the water level of the affected wells, between November 2001 and November 2002, ranged from 1.4 ft in well MW-22 to more than 8 ft in well MW-27 and averaged about 4.2 ft. After this initial rise, water levels resumed their declining trend due to regional effects, albeit at a smaller rate than the unaffected wells (see for example the hydrographs of wells MW-17 and MW-22 shown in Figure 2.5). The seven unaffected wells (MW-07, MW-09, MW-12, MW-13, MW-23, MW-26 and MW-33) are located near or along the southern limit of the silt/clay unit; water levels in these seven wells were not significantly affected by the infiltrating water, and continued to decline under the regional trends (see for example the hydrograph of well MW-12 in Figure 2.5). In fact, this regional decline caused two of the wells along the southern boundary of the 4970-foot silt/clay (wells MW-13 and MW-33) to go dry in recent years;[17] a similar situation started developing in well MW-07 during 2011. The lack of a response to the infiltrating water in the wells located along or near the southern boundary of the silt/clay unit suggests the presence of a low permeability barrier that isolates these wells from the effects of the water infiltrating from the ponds.

The quarterly water levels and the capture zones of the off-site and source containment wells within the UFZ/ULFZ are shown in Figures 5.2, 5.5, 5.8, and 5.11; those within the LLFZ are shown in Figures 5.3, 5.6, 5.9, and 5.12. As shown in these figures, at the new pumping rate of about 300 gpm the capture zone of the off-site containment well CW-1 extends well beyond the November 2010 or November 2011 extent of the TCE plume and provides a greater safety margin to the hydraulic containment of the off-site plume. The figures also indicate that the source containment well CW-2 continues to provide containment for any potential on-site source areas that may still be contributing to groundwater contamination.

Cross-sectional views of the November 2011 water table are shown on the schematic east-west (C-C') and north-south (D-D') cross-sections that are presented in Figure 5.13 (see Figures 5.10 through 5.12 for the location of these cross-sections). The cross-sections also show the water table that prevailed in November 1998, prior to the start of the off-site containment system. Other features shown on these cross-sections are: (1) the 4970-ft silt/clay unit, (2) the 4800-ft clay unit, (3) the screened intervals of the wells through which the cross-sections are passing (the deepest well at cluster locations), (3) the screened intervals of the DFZ wells, (4) the limits f the containment well capture zones, and (5) the pump intake elevation in the containment wells. The divergence of the water table from the ULFZ potentiometric surface in the area

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[17] Well MW-33 was plugged and abandoned in July 2009 and well MW-13 in June 2011.

underlain by the 4970-foot silt/clay is shown in greater detail, for both the 1998 and the 2011 conditions in Figure 5.14.

The direction of groundwater flow and the hydraulic gradient in the DFZ during each quarterly round of the 2011 water-level measurements in the three DFZ wells, MW-67, MW-71R, and MW-79, and for the average water level in these wells are shown in Figure 5.15. As shown in this figure, during 2011 the direction of groundwater flow in the DFZ ranged from W 21.0° N in November to W 26.7° N in August, and the hydraulic gradient from 0.00113 in August to 0.00243 in February. The average direction of groundwater flow in the DFZ during 2011 was W 22.6° N with an average hydraulic gradient of 0.00189.

5.1.2 Effects of Containment Well Shutdown on Capture

As discussed in Section 3, the containment systems are occasionally shut down for maintenance and repairs, and sometimes due to power or equipment failures. For example, during 2011 both the off-site and source containment systems were shut down for about four days to replace the well pumps. Longer shutdows ranging from more than five days at the source containment well (2007) to more than eight days at the off-site containment well (2010) have occurred in the past for pump replacement.

In their review of the 2007 Annual Report USEPA/NMED expressed some concern on whether these shutdowns may result in the escape of contaminants beyond the capture zones of these systems. The capture zone for the source containment well lies within the capture zone of the off-site containment well, and its downgradient limit is within the plume area. Any shutdown of this well would cause some contaminants to escape beyond its capture zone, but these contaminants will remain within the capture zone of the off-site containment well and eventually captured by this well.

Given the distance between the leading edge of the off-site plume and the limits of the capture zone of the off-site containment well, it is highly unlikely that any contaminants would escape beyond the capture zone of the well during a shutdown of limited duration. Under non-pumping conditions, the hydraulic gradient (see Figures 2.12 and 2.13) near the leading edge of the plume (see Figure 2.15) is about 0.003. The aquifer above the 4800-foot clay has a hydraulic conductivity of 25 ft/d and a porosity of 0.3. Thus, the rate at which groundwater, and hence contaminants, would move under non-pumping conditions is 0.25 ft/d or about 90 ft/yr. Prior to the increase of the pumping rate of the off-site containment well, the downgradient distance between the limit of its capture zone and the leading edge of the plume was at least 250 ft; the increase of the pumping rate to about 300 gpm increased this distance to more than 400 ft (see Figures 5.1 through 5.12). Thus, shutdowns of the length that have been experienced in the past, and of even much longer periods, could not cause any contaminants to escape beyond the capture zone of the well. Hydraulic containment of the plume has been, therefore, maintained during any past shutdowns of the off-site containment system, and will continue to be maintained during any future shutdowns of reasonable duration.

5.2 Groundwater Quality in Monitoring Wells

5.2.1 Concentration Trends

Plots showing temporal changes in the concentrations of TCE, DCE, and TCA 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 5.16 and plots for off-site wells in Figure 5.17. The concentrations in the on-site wells (Figure 5.16) 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 started before 1983. A significant decrease in concentrations occurred in well MW-16 during 1999 through 2001. This well is located near the area where the SVE system was operating during those years, and it is apparent that the SVE operations affected the concentrations in the well. The TCE concentrations in the well have been below 10 µg/L since November 2003; the November 2011 concentration was 2.1 µg/L. Since the termination of the SVE operations in 2001, low concentrations have been observed not only in this well but also in all other onsite wells completed above the 4970-foot silt/clay unit; in fact, only two out of eleven such wells that were sampled in 2011 had TCE concentrations above 5 µg/L (MW-12 at 13 µg/L and MW-26 at 7.3 µg/L). Note also, that wells MW-77 and MW-78, which are screened across the silt/clay unit and which reflect the water quality of groundwater above the unit due to downward leakage through the well casing, now have TCE concentrations below 5 µg/L (3.1µg/L at well MW-77 and <1 µg/L at well MW-78). This indicates that the cleanup of the unsaturated zone beneath the former Sparton plant area by the SVE system, and the flushing provided by the water infiltrating from the infiltration ponds of the source containment system has been very effective in reducing contaminant concentrations in the saturated sediments overlying the 4970-foot silt clay.

As shown in Figure 5.16, the TCE concentrations in on-site well MW-19, which is completed in the ULFZ below the 4970-foot silt/clay unit (see Figure 2.4), were in the several thousand µg/L level when the well was installed in 1986 and remained at that level for a few years before starting to decline. By November 1998, the TCE concentrations in the well had declined to a few µg/L levels. This declining trend reversed in November 2002 when the TCE concentration rose to 23 µg/L, and then to 630 µg/L by November 2003. The TCE concentrations in the well remained at the several hundred µg/L level until November 2008; however, they began declining again after that date, down to a concentration of 61µg/L by November 2010; the November 2011 TCE concentration in the well was at about the same level (64 µg/L). A similar pattern is also displayed in the DCE concentration in this well, albeit at lower levels. The concentration increases that occurred in this well soon after the start of the source containment system are attributed to an increase in the downward migration rate of contaminants present within the 4970-foot silt/clay unit that was caused by increased downward leakage rates across this unit; the increase in leakage rates were induced by the drawdowns below the unit caused by the pumping at CW-2 and the simultaneous increases in the water levels above the unit caused by seepage from the infiltration ponds.

The concentration plots of the six off-site monitoring wells shown in Figure 5.17 indicate that concentrations in most wells have declined and are much lower than their pre-remediation levels. There are some wells where concentrations have been increasing during the last few years (see for example the plots for MW-37/37R, MW-53/53D, and MW-55); this trend represents the passing of a slug of water with higher concentrations and is expected to reverse as it has been the case in some other monitoring wells (see for example the plot for MW-56. These temporary changes are consistent with the sporadic manner groundwater contamination occurred at the site and with the changes in groundwater flow patterns that resulted from the operation of the off-site containment system.

The concentrations in well MW-60 continued to be the highest observed in an off-site well, as it has been the case since the beginning of remedial operations. The concentrations of TCE in this well increased from low μg/L levels in 1993 to a high of 11,000 μg/L in November 1999 and then declined to 2,900 μg/L in November 2000. Then, they began increasing again reaching a second peak of 18,000 μg/L in November 2004; since then TCE concentrations in the well have declined to 1,200 μg/L in November 2011. The DCE and TCA concentrations in this well also declined from 830 μg/L and 59 μg/L in November 2004 to 140 μg/L and 4.3 μg/L, respectively, in November 2011. In general, the "rule-of-thumb" is that the presence of a contaminant at concentrations equal to or exceeding 1% of its solubility indicates the potential nearby presence of that contaminant as a free product (Newell and Ross, 1991; Pankow and Cherry, 1996) usually referred to as a non-aqueous phase liquid (NAPL). The solubility of TCE, a dense NAPL or DNAPL, is 1,100,000 μg/L; the concentrations of 11,000 μg/L and of 18,000 μg/L that were observed in MW-60 in November 1999 and 2004, respectively, meet the criteria of this rule-of-thumb. There are several factors, however, that preclude the presence of a DNAPL source near MW-60. First, the well is screened in the upper part of the aquifer and located almost 2,000 feet downgradient from the site; there is no plausible physical mechanism by which TCE could migrate to such a distance from the site as a DNAPL within a thick and fairly homogeneous aquifer. Second, although TCE concentrations above 10,000 μg/L and as high as 59,000 μg/L have been observed in several on-site wells in 1984 (Harding Lawson Associates, 1985), DNAPL has not been reported for any on-site boring or monitoring well. Finally, the gradual increase in the concentrations between 1993 and 1999, the occurrence of the high concentrations as two separate peaks with relatively lower concentrations in between, and the subsequent decrease in concentrations indicate that the contaminant concentrations in this well represent two slugs of highly contaminated groundwater that migrated from the site rather than a nearby DNAPL source. The migration of slugs of highly contaminated groundwater from the site is consistent with the high TCE concentrations that were observed at the site in 1984. It is of interest to note that Pankow and Cherry (1996, p. 459) state that "[t]he use of a 1% rule-of-thumb in any assessment of the spatial distribution of DNAPL zones must be performed cautiously, particularly in the downgradient direction. For example, the dissolved plume emitted from a very large DNAPL zone may exhibit dissolved concentrations above 1% of saturation for a substantial distance downgradient of the source zone."

Monitoring well MW-65, whose concentration trends are also shown in Figure 5.17, had low μg/L levels of TCE when first sampled after installation in 1996; TCE, at concentrations up to about 15 μg/L, was the only contaminant detected in this well before and at the start of the off-site containment system. The concentrations of TCE in the well declined rapidly after the start of the off-site containment system to "not detected" (at a detection limit of 1 μg/L) in August 1999, and remained "not detected" for almost two years. The well became contaminated again in 2001 but, as shown in Figure 5.17, this time the well contained not only TCE but also DCE and TCA with the dominant contaminant being DCE; the concentrations of these contaminants peaked around 2005 or 2006 and they have been declining since then. There are only two other wells, besides MW-65's post-2001 contamination, where the dominant contaminant is DCE; these are wells MW-62 and MW-52R. A plot of the contaminant concentrations in these two wells is presented in Figure 5.18; the plot for MW-65 is also repeated in this figure to provide for easy comparison. The dominant contaminant in all other wells associated with the Sparton Site is TCE (see for example the concentration plots of all the other wells shown in Figures 5.16 and 5.17). This indicates that the post-2001 contamination of MW-65 and that of MW-62 and MW-52R is due to a separate, DCE-dominated plume, although some mixing with the main plume may be occurring in the vicinity of MW-52R. During 2011, DCE continued to be the dominant contaminant in these three wells with concentrations of 29 μg/L, 6.9 μg/L, and 3.8 μg/L, in MW-52R, MW-65, and MW-62, respectively. Evaluations of the available data, including backward tracking from well MW-65 using water level data collected since 1992,[18] and review of historical water-quality data from monitoring wells MW-34 and MW-35,[19] which show that these wells were historically free of contaminants, indicate that the source of this separate plume lies somewhere south or southeast of wells MW-62 and MW-34, and that, therefore, this plume does not originate at the Sparton Facility.[20] Well MW-80, which was installed during 2010 to address agency concerns that this separate plume may have migrated beyond the capture zone of the off-site containment well, was free of the contaminants detected in wells MW-52R, MW-62, and MW-65, or of any other site-related contaminants, when it was first sampled on August 18, 2010, and remained free of these contaminants during three semi-annual sampling events conducted since then.

Of the three monitoring wells completed in the DFZ, well MW-67 of the MW-48/55/56/67 cluster had been clean since its installation in July 1996, and continued to be

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[18] See Attachment 3 to letter dated February 12, 2009 from Charles B. Andrews of SSP&A to Chuck Hendrickson of USEPA Region 6, and John Kieling of NMED, on the subject: Response to EPA/NMED comments on Sparton Technology, Inc., Former Coors Road Plant Remedial Program, 2003-2007 Annual Reports (including 5 attachments), with cc to Susan Widener, James B. Harris, Tony Hurst, and Gary L. Richardson.

[19] Well MW-35 became dry in 2002 and was plugged and abandoned in 2007; the well was located along Irving Boulevard, as shown in Figure A-1 of Appendix A..

[20] USEPA and NMED agree that the contaminants detected in MW-65 and MW-62 are due to a separate plume, but they disagree that this plume did not originate at the Sparton facility; the agencies were also concerned that contaminants that belong to this plume or that have not been captured by the off-site containment system, may be present outside the capture zone of the off-site containment well, and they requested the installation of a sentinel well northwest of MW-65 (see document in Footnote 9 and memorandum dated March 24, 2009 from Stavros S. Papadopulos of SSP&A to Charles Hendrickson of USEPA, Region 6, and John Kieling, Braid Swanson, and Brian Salem of NMED on the subject: Sparton Technology, Inc. Former Coors Road Plant Remedial Program, Minutes of Conference Call between Representatives of Sparton, USEPA and NMED [including 2 attachments], with cc to Richard Langley and Susan Widener of Sparton, James B. Harris of Thompson & Knight, Tony Hurst of Hurst Eng.'g Services, and Gary Richardson of Metric). Sparton agreed to install this well, and the well was installed in July-August 2010.

free of any contaminants in 2011. The second DFZ well, MW-71R, located about 30 ft south of the MW-60/61 cluster, was installed in February 2002 as a replacement for DFZ well MW-71 which was plugged and abandoned in October 2001 because of persistent contamination.[21] The first sample from MW-71R, obtained in February 2002, had a TCE concentration of 130 μg/L and the well has remained contaminated since then with TCE concentrations reaching a high of 210 μg/L in August 2003, and then declining to 51 μg/L in May 2009. After that, the TCE concentrations in the well began increasing again reaching 91 μg/L in May 2011 and then declining to 58 μg/L by the Fourth Quarter 2011 sampling event. The third DFZ well, MW-79, was installed near the off-site containment well CW-1 in February 2006 as a monitoring/stand-by extraction well to address the contamination detected in MW-71R; the decision on whether the well was to be a monitoring or an extraction well was to be based on the results of the initial sampling of the well. The initial sampling of the well showed the well to be free of site-related contaminants; therefore, the well was designated as a monitoring well, and added to the Monitoring Plan under a semi-annual sampling schedule. Samples collected from the well since then have been free of any site-related contaminants.

5.2.2 Concentration Distribution and Plume Extent

The Fourth Quarter 2011 TCE and DCE data presented in Table 4.2 were used to prepare concentration distribution maps showing conditions near the end of 2011. The horizontal extent of the TCE and DCE plumes and the concentration distribution within these plumes in November 2011, as determined from the monitoring well data, are shown on Figures 5.19 and 5.20, respectively.[22] In preparing these figures, the fact that wells MW-62, MW-65, and MW-52R are affected by a separate plume was taken into consideration. Concentrations of TCA in all monitoring and extraction wells have been below regulatory standards since 2003; in November 2011 only six of the 57 sampled wells contained TCA above the detection limit of 1 μg/L. The highest TCA concentrations were measured in well MW-60 (4.3 μg/L) and well MW-72 (3.3 μg/L); the concentrations in the other four wells where TCA was detected were 2 μg/L or less (see Table 4.2). Based on the low concentrations of TCA that have been observed since 2003, Sparton proposed in the 2008 Annual Report (SSP&A, 2009a) that evaluations of TCA data be discontinued, unless concentrations increase above regulatory standards; this proposal was approved by both USEPA[23] and NMED[24] in May 2010. A concentration distribution map for

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[21] See 1999 Annual Report (SSP&A, 2001a) for a detailed discussion of the history of well MW-71, and SSP&A and Metric (2002) for actions taken prior to its plugging and abandonment.

[22] At well cluster locations, the concentration shown in Figures 5.19 and 5.20 is that for the well with the highest concentration.

[23] E-mail dated May 11, 2010 from Charles Hendrickson of USEPA to Stavros Papadopulos of SSP&A with cc to Baird Swanson and Brian Salem of NMED on the subject "Re: Extension approval and Comments on 2008 Report," with an attachment titled "Annual Report 2008 draft comments" which included draft comments by C. Hendrickson, dated March 11, 2010.

[24] E-mail dated May 17, 2010 from John Kieling of NMED to Stavros Papadopulos of SSP&A with cc to Charles Hendrickson of USEPA, Baird Swanson and Brian Salem of NMED, Joe Lerczak of Sparton, James Harris of Thompson & Knight, Gary Richardson of Metric, and Tony Hurst of Hurst Engineering on the subject "Re: TCA valuation" indicating that NMED agrees to discontinuing TCA evaluations.

TCA or other evaluations of TCA data are not, therefore, included in this 2011 Annual Report; however, TCA concentrations in the off-site containment well are used in calculating mass removal by this well.

5.2.3 Changes in Concentrations

Fifty-six of the 57 wells sampled in November 2011 were also sampled in November 2010. In these 56 wells, the November 2011 TCE concentrations were lower than the November 2010 concentrations in 17 wells, higher in 13 wells, and remained the same in 26 wells (all below the detection limit of 1 μg/L). The largest decrease was in well MW-60 where the concentration of TCE decreased by 100 μg/L, from 1,300 μg/L in 2010 to 1,200 μg/L in 2011; the largest increase in a monitoring well was at MW-72 where the concentration of TCE increased by 440 μg/L, from 760 μg/L in 2010 to 1,200 μg/L in 2011. The corresponding numbers for DCE were 8 wells with lower, 6 wells with higher, and 42 wells with the same (all below the detection limit of 1 μg/L) concentrations. The largest decrease in DCE concentrations was in well MW-42 (11.4 μg/L), and the largest increase in well MW-72 (60 μg/L).

Of the 57 wells sampled in November 2011, 41 are wells that existed in November 1998 (prior to the implementation of the current remedial activities) and 6 are replacement or deepened version of wells that existed in November 1998. Another 5 of the sampled wells are wells that were installed in early 1999 (MW-72, MW-73, MW-74, MW-75, and MW-76) and 3 are wells that were installed in 2001 (MW-77, MW-78, and CW-2). Changes between the TCE and DCE concentrations measured in these wells in November 2011 and those measured in November 1998, or during their first sampling event, are summarized on Table 5.1. The concentrations of TCE increased in 30 of the 55 wells listed on Table 5.1, increased in 6, and remained unchanged in 19 (below detection limits during both sampling events). The corresponding number of wells where DCE concentrations decreased, increased, or remained unchanged are 26, 5, and 24, respectively. Twenty-three of the 55 wells listed on Table 5.1 are wells, or their replacements/deepened versions, that were used for defining both the November 1998 and the November 2011 plume; another 16 are wells that were used to define either the November 1998 or the November 2011 plume. Concentration changes in these 39 wells are presented in Figures 5.21, and 5.22 to show the distribution of concentration changes that occurred since the implementation of the off-site and source containment systems. Also shown on these figures is the extent of the plumes in November 1998 and November 2011. Among these 39 wells, TCE concentrations decreased in 27 wells, increased in 5 wells, and remained unchanged in 7 wells (below detection limits during both sampling events); the corresponding number of these wells where DCE concentrations decreased, increased, or remained unchanged are 23, 4, and 12.

The largest decreases in contaminant concentrations since the beginning of the current remedial operations occurred in on-site wells MW-23, MW-25 and MW-26, and in off-site well MW-60. Concentrations of TCE in on-site wells MW-23, MW-25, and MW-26 decreased by 6,197, 5,595, and 6,493 μg/L, respectively, from levels that were in the 5,500-6,500 μg/L range in 1998 to levels of less than 10 μg/L 2011; DCE concentrations in these three wells decreased by 400, 73, and 590 μg/L, to "not detected" (ND) since 2007 (since 2004 in MW-26). At off-site well MW-60, TCE concentrations decreased by 6,500 μg/L, from 7,700 μg/L in 1998 to 1,200 μg/L in November 2011); DCE concentrations in the well decreased by 210 μg/L from 350 μg/L in 1998 to 140 μg/L in 2011.

Of the five wells where the current (2011) TCE concentrations were larger than those in 1998, the largest increase occurred in the off-site containment well CW-1 (610 μg/L); this well also had the largest increase in DCE concentration (56 μg/L). These increases in the TCE and DCE concentrations in well CW-1 are based on concentrations observed in this well in September 1998 (140 μg/L and 2.9 μg/L, respectively), prior to the start of its operation on December 31, 1998, and those observed in the water pumped from the well on November 1, 2011 (750 μg/L and 59 μg/L, respectively). The concentration of TCE and DCE in the water pumped from this well increased rapidly after the start of its operation, rising to 900 μg/L and 38 μg/L, respectively, by April 23, 1999 and to 1,200 μg/L and 73 μg/L, respectively, by September 10, 1999. In the next several years concentrations in the well, except for a few outliers, fluctuated in the 1,200 μg/L to 1,400 μg/L range for TCE and in the 60 μg/L to 80 μg/L range for DCE, but started declining in the mid-2000s (see Figure 6.8 for historic TCE concentrations in this well). During 2011, TCE concentrations in the well ranged from 460 μg/L to 750 μg/L and averaged about 620 μg/L; DCE concentrations ranged from 53 μg/L to 69 μg/L and averaged 61 μg/L. Thus, even though comparison of current concentrations to pre-operational concentrations indicates an increase, as cited above, current concentration are considerably lower than those observed during its early years of operation.

The persistence of high concentrations in the off-site containment well CW-1, and in monitoring well MW--60 during the early years of the current remedial operations indicated that areas of high concentration existed upgradient from both of these wells. Most of the water in these upgradient areas, however, has been already captured and pumped out by the off-site containment well (see Figure 5.26), and concentrations both in MW-60 and CW-1 are declining (see Figures 5.17 and 6.8) and are expected to continue to decline.

5.3 Containment Systems

5.3.1 Flow Rates

A total of about 176 million gallons of water, corresponding to an average pumping rate of about 335 gpm, were pumped during 2011 from the off-site and source containment wells (see Table 4.3). The volume of water pumped during each year of the operation of the containment wells is summarized on Table 5.2. As shown on this table, the total volume pumped from both wells since the beginning of remedial pumping in December 1998 is about 1.78 billion gallons, and corresponds to an average rate of 261 gpm over the 13 years of operation. This volume represents approximately 158 percent of the initial plume pore volume reported in Subsection 2.6.1.3 of this report. The volume pumped from each well and the average flow rates are discussed below.

5.3.1.1 Off-Site Containment Well

The volume of water pumped from the off-site containment well during each month of 2011 is shown on Table 4.3; a plot of the monthly production is presented in Figure 5.23. Based on the total volume of water pumped during the year (approximately 149 million gallons), the average discharge rate for the year was 284 gpm. Due to downtimes (see Table 3.1), the well was operated 98.0 percent of the time available during the year, thus the average discharge rate of the well during its operating hours was about 290 gpm.

The volume of water pumped during each year of the operation of the well is summarized on Table 5.2. As shown on this table, the off-site containment well pumped a total of about 1.53 billion gallons of water from the aquifer since the beginning of its operation in December 1998. This represents approximately 136 percent of the initial plume pore volume reported in Subsection 2.6.1.3 of this report. A cumulative plot of the volume of water pumped from the off-site containment well is presented in Figure 5.24.

5.3.1.2 Source Containment Well

The volume of water pumped from the source containment well during each month of 2011 is shown on Table 4.3; a plot of the monthly production is presented in Figure 5.23. Based on the total volume of water pumped during the year (approximately 27 million gallons), the average discharge rate for the year was 51 gpm. The well was operated 98.3 percent of the time available during the year, thus the average discharge rate of the well during its operating hours was about 52 gpm.

The volume of water pumped during each year of the operation of the well is summarized on Table 5.2. As shown on this table, the source containment well pumped a total of about 251 million gallons of water from the aquifer since the beginning of its operation on January 3, 2002. This represents approximately 22 percent of the initial plume pore volume reported in Subsection 2.6.1.3 of this report. A cumulative plot of the volume of water pumped from the source containment well is presented in Figure 5.24. Also shown in Figure 5.24 is a cumulative plot of the total volume of water pumped by both containment wells.

5.3.2 Influent and Effluent Quality

5.3.2.1 Off-Site Containment System

The concentrations of TCE, DCE, TCA, and total chromium in the influent to and effluent from the off-site air stripper during 2011, as determined from samples collected at the beginning of each month, are presented on Table 4.4 (a). Plots of the TCE, DCE, and total chromium concentrations in the influent are presented in Figure 5.25.

The concentrations of TCE in the influent during 2011 ranged from a low of 460 μg/L in the September sample to a high of 750 μg/L in the November sample. The average concentration for the year was about 620 μg/L; this average concentration was 80 μg/L lower than the average concentration during 2010 (700 μg/L). The lowest (53 μg/L) and highest (69 μg/L) concentrations of DCE were detected in the December and April samples, respectively; the average concentration for the year was about 61 μg/L. Concentrations of TCA in the influent fluctuated within a relatively narrow range (1.7 μg/L to 2.4 μg/L) and averaged 2.1 μg/L. Throughout the year, total chromium concentrations in the influent were well below the 50 μg/L maximum allowable concentration in groundwater set by NMWQCC and averaged about 12 μg/L.

Except for the July (1.2 μg/L) and the August (1.1 μg/L) samples, the concentrations of TCE in the air stripper effluent were below the detection limit of 1 μg/L during the remaining months of 2011; the concentration of DCE and TCA in the effluent were below the detection limit of 1 μg/L throughout 2011. Total chromium concentrations in the effluent were essentially the same as those in the influent.

5.3.2.2 Source Containment System

The 2011 concentrations of TCE, DCE, TCA, and total chromium in the influent to and effluent from air stripper for the source containment system, as also determined from samples collected at the beginning of each month, are presented on Table 4.4 (b). Plots of the TCE, DCE, and total chromium concentrations in the influent are presented in Figure 5.25.

The concentrations of TCE in the influent during 2011 ranged from 31 μg/L in July and September 42 μg/L in January, and averaged about 35 μg/L. This average concentration was 16 μg/L lower than the average concentration during 2010 (51 μg/L). The concentrations of DCE fluctuated within a relatively narrow range during the year (3.5 μg/L to 5.0 μg/L) and averaged about 4.1 μg/L. The concentrations of TCA in the influent were below the detection limit of 1 μg/L throughout the year. Except for the January sample (78 μg/L) the total chromium concentrations during the remainder of 2011 were below the 50 μg/L maximum allowable concentration in groundwater set by NMWQCC; as discussed in the 2010 Annual Report[25] the concentration of 78 μg/L measured in the January sample is attributed to particulates from scaling in the pipeline leading to the treatment plant. After this pipeline was cleaned on January 25, 2011 chromium concentrations returned to the levels normally observed in the influent from CW-2. The average total chromium concentration for the year, including the January sample, was about 34 μg/L.

The concentrations of TCE, DCE, and TCA in the air stripper effluent were below detection limits throughout 2011, and chromium concentrations were at about the same level as those in the influent, except for the January 2011 sample that had a lower concentration than the influent, apparently because some of the particulates that caused the higher concentrations in the influent had settled in the air stripper.

5.3.3 Origin of the Pumped Water

The groundwater pumped from the off-site and the source containment wells is water that was originally (prior to the start of pumping) in storage around each well. The areal extent of the volume of the aquifer within which the water pumped during a particular period was originally

[25] See Footnote 22 in the 2010 Annual Report.

stored is referred to as the "area of origin" of the water pumped during that period. Particle tracking analysis (see Section 6.1.3) with the calibrated model of the site was used to determine the areas of origin of the water pumped from the off-site containment well during the last thirteen years and from the source containment well during the last ten years. The results of this analysis are presented in Figure 5.26. The areas from where the water pumped during different periods originated are shown in Figure 5.26 (a); the schematic cross-section of Figure 5.26 (b) shows the vertical extent of these areas of origin. The areas of origin of the water pumped by each of the two containment wells are discussed below.

5.3.3.1 Off-Site Containment Well

For the off-site containment well, which is fully penetrating the aquifer above the 4,800-foot clay, the area of origin of the water pumped during the first few years of its operation (1999-2002) is an almost circular area around the well, with the well off-centered on the down-gradient side of the area [Figure 5.26 (a)]. The areas of origin corresponding to subsequent years of operation form rings around this first area, which become more and more elliptical and more and more skewed towards the upgradient side (southeast) of the well. The shape and location of the areas of origin with respect to the containment well are controlled by the capture zone of the well. Since the capture zone is a limiting flow line, the areas of origin become narrower as they approach the downgradient (northwestern) limit of the capture zone and the stagnation point of the flow field. The area of origin of the water pumped until the end of 2009 had already reached this limit of the capture zone as it existed prior to the increase in the pumping rate of the off-site containment well; therefore, very little of the water pumped during 2010 had originated from this area [see Figure 5.29 (a) of the 2010 Annual Report]. As shown in Figure 5.26 (a), the increase in the pumping rate of CW-1 that was implemented in November 2010 has pushed the limit of the capture zone farther downgradient; therefore, some of the water pumped during 2011 originated from the area between the pre- and post-increase limit of the capture zone. This will also occur in the next few years until all water in this area has moved into CW-1 and the area of origin of the pumped water has reached the new downgradient limit of the capture zone. Note also that the area of origin of water pumped until 2010 and that of the water pumped during 2011 have a tail at their eastern extent, where these areas meet the capture zone of well CW-2. Since water within the capture zone of CW-2 is captured by CW-2, the water pumped by CW-1 has to come outside this area; since 2010, this water has been coming from the area north of the CW-2 capture zone and the aquifer beneath the 4970-foot silt/clay unit with some downward leakage through this unit. As pumping continues, the area of origin of the water pumped by CW-1 will also expand to the south of the CW-2 capture zone, surrounding the limit of this zone.

Since the well is fully penetrating, the areas of origin of the water pumped by this well remain essentially the same at different depths [see Figure 5.26 (b)], except that water derived from vertical drainage due to the decline of the water table reduces the areal extent of the area of origin in the upper horizons of the aquifer; the effect of vertical drainage was more pronounced during the early years of operation when the rapid decline of the water table in response to the start of pumping contributed a greater percentage of the pumped water than in later years.

5.3.3.2 Source Containment Well

Hydrogeologic conditions in the vicinity of the source containment well are different than in the vicinity of the off-site containment well because of the presence of the 4970-foot silt/clay unit, the presence of different deposits in the upper part of the aquifer between the Site and the Rio Grande (the Upper Sand Unit and the Recent Rio Grande deposits, as shown in Figure 2.2 and Figure 6.1), and the partial penetration of the aquifer by the source containment well. The screened interval of the well extends about 40 ft into the aquifer below the 4970-foot silt/clay unit; therefore, most of the water pumped by this well comes from the upper part of the aquifer where the well is screened with contributions from downward leakage through the silt/clay unit and from the Upper Sand Unit, from flow through the Recent Rio Grande deposits, and from upward leakage from horizons of the aquifer below the screened interval. The volume of groundwater that was originally stored in the upper part of the aquifer in the vicinity of the well and within the area which is now limited by the capture zone of the well is relatively small; by the mid-2000s most of this water had already moved into and pumped out by the well. This is reflected by the area of origin of the water pumped during 2003-2006 which, as shown in Figure 5.26 (a) extended very close to the downgradient (northwestern) limit of the capture zone; and by the end of 2010, the area of origin of all the water pumped from the well extended not only to the downgradient limit of the capture zone, but also to the southern limit and to the western part of the northern limit of the capture zone. Thus, the water pumped during 2011 originated from a narrow strip along the northern limit, and from the upgradient areas of the capture zone near the Corrales Main Canal [see Figure 5.26 (a)]. Since the areas of origin of the water pumped by the end of 2011 had essentially reached the downgradient, southern and northern limits of the capture zone, water to be pumped by CW-2 in future years would primarily originate from upgradient areas; eventually, however, the area of origin will stop expanding when a steady state is reached, that is, when the pumping rate of the well is balanced by leakage from above and below and by infiltration from the Rio Grande.

Because well CW-2 is partially penetrating the aquifer, the extent of the areas of origin of the water pumped by the well is different at different depths. As shown in Figure 5.26 (b), the areas of origin become smaller with depth, and do not extend below the upper half of the aquifer.

5.3.4 Contaminant Mass Removal

A total of about 390 kg (850 lbs) of contaminants, consisting of about 350 kg (770 lbs) of TCE, 35 kg (77 lbs) of DCE, and 1.2 kg (2.7 lbs) of TCA, were removed by the two containment wells during 2011 [see Table 5.3 (a)]. A plot of the TCE, DCE and total mass removed by the two containment wells during each month of 2011 is presented in Figure 5.27. The total mass of contaminants removed by the two containment wells during each year of their operation is summarized on Table 5.4 (a), and a plot of the cumulative TCE, DCE, and total mass removed by the wells is presented in Figure 5.28. As shown on Table 5.4 (a), the total mass removed by the containment wells, since the beginning of the current remedial operations in December 1998, is about 6,600 kg (14,560 lbs), consisting of about 6,170 kg (13,600 lbs) of TCE, 411 kg (905 lbs) of DCE, and 18 kg (40 lbs) of TCA. This represents about 84 percent of the total dissolved contaminant mass currently estimated to have been present in the aquifer prior to the testing and operation of the off-site containment system (see Section 2.6.1.4). The mass removal rates by each well are discussed below.

5.3.4.1 Off-Site Containment Well

The monthly mass removal rates of TCE, DCE, and TCA by the off-site containment well during 2011 were estimated using the monthly discharge volumes presented on Table 4.3 and the concentration of these compounds shown on Table 4.4 (a). These monthly removal rates are summarized on Table 5.3 (b); plots of the monthly TCE and DCE removal rates are presented in Figure 5.27. As shown on Table 5.3 (b), about 380 kg (850 lbs) of contaminants, consisting of about 350 kg (770 lbs) of TCE, 34 kg (76 lbs) of DCE, and 1.2 kg (2.6 lbs) of TCA were removed by the off-site containment well during 2011.

The mass of contaminants removed by this well during each year of its operation is summarized on Table 5.4 (b), and a plot showing the cumulative TCE, DCE, and total mass removal by the off-site containment well is presented in Figure 5.28. As shown on Table 5.4(b), by the end of 2011 the off-site containment well had removed a total of approximately 6.360 kg (14,040 lbs) of contaminants, consisting of approximately 5,960 kg (13,150 lbs) of TCE, 383 kg (843 lbs) of DCE, and 15 kg (33 lbs) of TCA. This represents about 81 percent of the total dissolved contaminant mass currently estimated to have been present in the aquifer prior to the testing and operation of the off-site containment system (see Section 2.6.1.4).

5.3.4.2 Source Containment Well

The monthly mass removal rates of TCE and DCE by the source containment well during 2011 were estimated using the monthly discharge volumes presented on Table 4.3 and the concentration of these compounds shown on Table 4.4 (b). These monthly removal rates are summarized on Table 5.3 (c) and plotted in Figure 5.27. As shown on Table 5.3 (c), about 4.0 kg (8.7 lbs) of contaminants, consisting of about 3.5 kg (7.8 lbs) of TCE and 0.41 kg (0.91 lbs) of DCE were removed by the source containment well during 2011. The TCA concentrations in the influent from this well have been below the detection limit of 1 μg/L since 2007. In past years, an upper limit for the removed TCA mass was estimated by assuming TCA concentrations to be at half the detection limit (0.5 μg/L); this practice is discontinued this year and estimates for the TCA mass removal rates are not included on Table 5.3 (c).

The mass of contaminants removed by this well during each year of its operation is summarized on Table 5.4 (c), and a plot showing the cumulative TCE, DCE, and total mass removal by the source containment well since the beginning of its operation on January 3, 2002 is presented in Figure 5.28. As shown on Table 5.4 (c) and Figure 5.28, the total mass of contaminants removed by the well by the end of 2011 was about 235 kg (517 lbs), consisting of 203 kg (447 lbs) of TCE, 28.0 kg (61.8 lbs) of DCE, and 3.4 kg (7. 4 lbs) of TCA. This represents about 3 percent of the total dissolved contaminant mass currently estimated to have been present in the aquifer prior to the testing and operation of the off-site containment system (see Section 2.6.1.4).

5.4 Site Permits

The infiltration gallery associated with the off-site containment system and the rapid infiltration ponds associated with the source containment system are operated under a Discharge Permit issued by the State of New Mexico (State of New Mexico Groundwater Discharge Permit DP-1184). This Discharge Permit was scheduled to expire at the end of 2011; an application for the renewal of the permit was submitted by Sparton on November 16, 2011, and an extension is expected to be approved soon by the Groundwater Bureau of the NMED.

The air stripper associated with the off-site containment system is operated under Air Quality Source Registration No. NM/001/00462/967, issued by the Air Quality Services Section, Air Pollution Control Division, Environmental Health Department, City of Albuquerque, and the source containment system air stripper is operated under Albuquerque/Bernalillo County Authority-to-Construct Permit No. 1203.

The performance of the off-site and source containment systems with respect to the requirements of these permits is discussed below.

5.4.1 Off-Site Containment System

Discharge Permit DP-1184 requires monthly sampling of the treatment system effluent, and the quarterly sampling of the infiltration gallery monitoring wells MW-74, MW-75 and MW-76. The samples are analyzed for TCE, DCE, TCA, chromium, iron, and manganese. The concentrations of these constituents must not exceed the maximum allowable concentrations for groundwater set by NMWQCC. As required by the current Discharge Permit, the analysis results of all samples collected during 2011 were reported to the NMED Groundwater Bureau in the 2011 Annual Monitoring Report for the permit submitted to the Bureau on June 20, 2012.[26] The sampling results met the permit requirements throughout the year.

The Air Quality Source Registration No. NM/001/00462/967, under which the off-site air stripper is operated, limits the hourly and annual VOC mass emitted by the stripper to 0.32 lbs/hr and 1.37 tons/yr. The emissions from the air stripper were calculated in June 1999, after the stripper had been put into continuous operation; the results of this calculation, which were reported to the agency that issued the registration, were in full compliance with the specified emission limits. Under the terms of the registration, further monitoring and/or reporting of the emissions from the air stripper was not required, and has not been carried out since that time. Based on the VOC mass removed by the off-site containment well during 2011 (380 kg or 850 lbs), and assuming that 100% of this mass was transferred to the air-stripped stack, the VOC mass emitted during the year averaged 0.10 lbs/hr or 0.43 tons/yr, well within the specified emission limits.

No violation notices were received during 2011 for activities associated with the operation of the off-site containment system.

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[26] Letter dated June 20, 2012 to Ms Naomi Davidson of the NMED Groundwater Bureau from Stavros S. Papadopulos of SSP&A on the subject: 2011 Annual Monitoring Report for Discharge Permit DP-1184.

5.4.2 Source Containment System

The rapid infiltration ponds associated with the source containment system are also subject to the above-stated requirements of Discharge Permit DP-1184. The monitoring wells for this system are MW-17, MW-77 and MW-78; the data collected from these wells met the requirements of the permit throughout 2011, and were also included in the 2011 Annual Monitoring Report for the permit.[26]

The Authority-to-Construct Permit No. 1203 specifies emission limits for total VOCs (TCE, DCE, and TCA) from the source containment system air stripper. Emissions from the air stripper are calculated annually and reported to the Albuquerque Environmental Health Department, Air Quality Division by March 15 every year as required by the permit. The calculated emissions for 2011, 0.0010 lbs/hr or 0.0045 tons/yr, which were reported to the Albuquerque Air Quality Division on February 15, 2012,[27] met the requirements of Permit No. 1203 throughout 2011.

No violation notices were received during 2011 for activities associated with operation of the source containment system.

5.5 Contacts

Under the terms of the Consent Decree,[28] Sparton is required to prepare an annual Fact Sheet summarizing the status of the remedial actions, and after approval by USEPA/NMED, distribute this Fact Sheet to property owners located above the plume and adjacent to the off-site treatment plant water discharge pipeline. Fact Sheets reporting on remedial activities during 1999 through 2009 were prepared by Sparton, approved by the regulatory agencies, and distributed to the property owners. After the approval of the 2010 Annual Report on September 23, 2011[29] Sparton prepared a 2010 Fact Sheet and submitted it to the USEPA/NMED for approval on November 14, 2011. The agencies requested some revisions to the Fact Sheet on December 23, 2011; a revised Fact Sheet was submitted on January 16, 2012 and approved by the agencies on February 3, 2012.[30] The approved 2010 Fact Sheet was distributed to the property owners located above the plume and adjacent to the off-site treatment plant water discharge pipeline on February 15, 2012.

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[27] Letter dated February 15, 2012 to Ms. Regan Eyerman of the Albuquerque Environmental Health Department, Air Quality Division from Stavros S. Papadopulos of SSP&A on the subject: Authority-to-Construct Permit#1203 – 2011 Annual Report on Air Emissions.

[28] Public Involvement Plan for Corrective Measure Activities. Attachment B to the Consent Decree in Albuquerque v. Sparton Technology, Inc., No. CV 07 0206 (D.N.M.),

[29] See document cited in Footnote 11.

[30] Letter dated February 3, 2012 from John E. Kieling of NMED and Chuck Hendrickson of USEPA to Joseph S. Lerczak of Sparton, Re: Approval, 2010 Fact Sheet with Revisions, Sparton Technology Inc., EPA ID No.:NMD083212332.

Section 6
Groundwater Flow and Transport Model

This section describes a numerical groundwater flow and contaminant transport model of the aquifer system underlying the Sparton site and its vicinity that has been used to evaluate water levels and TCE concentrations. This model was developed following the general outline described in Task 3 of the "Work Plan for the Assessment of Aquifer Restoration" (SSP&A, 2000b), which is incorporated as Attachment D in the Consent Decree. The development of the current version of the model is described in detail in the 2008 Annual Report (SSP&A, 2009a). The initial version of the model was described in the 1999 Annual Report (SSP&A, 2001) and the model has been updated and recalibrated several times since then as described in the 2008 Annual Report (SSP&A, 2009a) and in the 2009 report on the Evaluation of Alternative Systems for Aquifer Restoration (SSP&A, 2009b), hereafter "Alternatives Report." The groundwater flow model is based on MODFLOW-2000 (Harbaugh and others, 2000). The flow model is coupled with the solute transport simulation code MT3D (Zheng and SSP&A, 1999; Zheng, 2008) for the simulation of the movement of constituents of concern in the aquifer underlying the site, and the particle tracking codes PATH3D (Zheng, 1991) and MODPATH (Pollock, 1994; 2008) for the calculation of capture zones and of areas of origin, respectively. Flow and transport model simulations were performed using updated versions of these codes as developed by SSP&A to enhance their capabilities and address dry-cell issues in particular (Bedekar et al, 2011). The models have been used to simulate groundwater levels and TCE concentrations in the aquifer from start-up of the off-site containment well in December 1998 through December 2011, and to predict water levels and TCE concentrations through December 2012.

6.1 Groundwater Flow Model

6.1.1 Structure of Model

The model area and model grid are presented in Figure 6.1. The overall model dimensions are 15,000 ft by 9,500 ft. The model consists of 88 rows and 133 columns. The central part of the model covers a finely gridded area of 4,900 ft by 2,800 ft which includes the Site and the off-site plume; the grid spacing in this area is uniform at 50 ft. Outward from this central area, the grid spacing is gradually increased to as much as 1,000 feet at the limits of the model domain. The column axis of the model grid is aligned with the approximate direction of regional groundwater flow (W 25° N).

The model consists of 15 layers. The vertical discretization used in the model is shown in Figure 6.2. Layers 1 through 11 correspond to the surficial aquifer. Layer 1 is 15 ft thick, layer 2 is 5 ft thick, layers 3 through 7 are 10 ft thick, layers 8 and 9 are 20 ft thick, and layers 10 and 11 are 40 ft thick. Layer 12 is a 4-foot-thick unit that represents the 4800-foot clay unit. Layer 13 represents the 76-foot thick deep flow zone, layer 14 represents the 15-foot thick

4705-foot clay unit, and layer 15 represents the upper 165 ft of the deeper aquifer units.[31] The vertical discretization was selected to minimize vertical numerical dispersion.

6.1.1.1 Boundary Conditions

The eastern boundary of the model is a no-flow boundary located just east of the Rio Grande and oriented approximately parallel to the river. The northern and southern boundaries of the model are specified as no-flow boundaries along the eastern portion of these boundaries and as constant head boundaries along the western portion of these boundaries (see Figure 6.1). In the eastern portion of the model area, regional groundwater flow is away from the Rio Grande and approximately parallel to the northern and southern boundaries of the model and thus it is appropriate to specify these portions of the model boundaries as no-flow boundaries. In the western portion of the model area, however, regional groundwater pumping creates a divergence in groundwater flow directions. As a result, in the western portion of the model area the direction of regional groundwater flow is not parallel to the northern and southern model boundaries, and groundwater could flow in or out of the model boundaries; therefore, the western 5,000-foot portions of these boundaries were specified as constant-head boundaries to allow groundwater flow across these boundaries to be simulated (in or out of the model area). The western boundary of the model area is also simulated as a constant-head boundary.

The water levels on the constant head boundaries were estimated during model calibration. In the model calibration process the water-levels on the constant head boundaries were specified on the basis of five parameters. The five parameters were water levels in 1998 at the following locations: (1) in layer 1 at the eastern end of the constant-head segment of the northern boundary (4,959.47 ft MSL); (2) in layer 1 at the eastern end of the constant head segment of the southern boundary (4,950.63 ft MSL), (3) in layer 1 in the northwest corner of the model grid (4,954.37 ft MSL); (4) in layer 1 in the southwest corner of the model grid (4,948.04 ft MSL); and (5) in layer 1 in the center of the western model boundary (4,951.05 ft MSL). The locations of these constant-head boundary parameters are shown on Figure 6.1. Based on these five water levels, water levels were estimated at all constant-head boundary cells using the following algorithm:

1. The starting 1998 water levels along the constant-head boundaries in layer 1 were calculated by linear interpolation from the 5 water levels described above. Long-term hydrographs of monitoring wells (see Figures 2.5 and 6.3) indicate that water levels near the site are declining due to regional pumping effects. Therefore, during subsequent years the water levels along the model constant-head boundaries were reduced based on decline rates determined during model calibration. These calibrated decline rates were 0.4 foot for 1998 through 2007 and 2.0 feet for 2008 through 2012.
2. Water levels in constant-head boundary cells in layers 2 through 11 were calculated based on the water levels estimated in layer 1 and a specified vertical hydraulic

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[31] The units represented by Layers 13, 14, and 15 were identified from the log of the USGS Hunter Ridge Park 1 Boring (Johnson and others, 1996).

gradient of 0.002 ft/ft. This vertical hydraulic gradient was assumed to be constant through time.

3. Water levels in constant head cells in layers 12 and 13 were calculated based on the water levels estimated in layer 11 and a specified water-level change across the 4800-foot clay of 2.34 feet. This water-level change was determined in the model calibration process.
4. Water levels in constant head cells in layers 14 and 15 were calculated based on water levels estimated in layer 13 and a specified water-level change of 2.0 feet across the clay unit represented by layer 14. The water-level change was estimated from water-level data from the USGS monitoring well cluster at Hunter Ridge adjacent to Arroyo de las Calabacillas.

6.1.1.2 Hydraulic Properties

Five hydrogeologic zones are specified within the model domain:

- Holocene-aged channel and flood plain deposits, also referred to as Recent Rio Grande deposits;
- the 4970-foot silt/clay unit, which represents Late-Pleistocene-aged overbank deposits;
- sands of the Upper Santa Fe Group, Late-Pleistocene-aged channel and flood plain deposits, and Late-Pleistocene-aged and Holocene-aged arroyo fan and terrace deposits, collectively referred to as the sand unit; and
- the 4800-foot clay unit;
- the 4705-foot clay unit.

The sand unit, which is primarily classified as USF2 facies assemblages 2 and 3 (Hawley, 1996), was subdivided into six subzones for purposes of model calibration:

1. Sand unit above the 4970-foot silt/clay unit, except near the far southeastern of the silt/clay unit, which represent Late-Pleistocene-aged arroyo fan and terrace deposits (this zone was defined north of the simulated discontinuity shown on Figure 6.1);
2. Sand unit above the 4970-foot silt/clay unit near the far southeastern extent of this unit (this zone was defined south of the simulated discontinuity shown on Figure 6.1);
3. Sand unit in the region between the western extent of the Rio Grande deposits and the eastern extent of the 4970-foot silt/clay unit (This zone is shown as the "Upper Sand Unit" on Figure 6.1);
4. Sand unit above the 4800-foot clay unit except above and in vicinity of 4970-foot silt/clay unit;
5. Sand unit between the 4800-foot clay unit and the 4705-foot clay unit (model layer 13);

6. Sand unit below the 4705-foot clay unit (model layer 15).

The spatial extent of the Recent Rio Grande deposits, the 4970-foot silt/clay unit, and the Upper Sand Unit are shown in Figure 6.1. Also shown on Figure 6.1 is the location of a discontinuity in the sand unit above the 4970-silt/clay unit. This discontinuity was simulated with the MODFLOW horizontal flow barrier package. The horizontal conductance of the barrier was specified as 10^{-6} per day.

The hydraulic conductivity, specific yield and specific storage in each of the hydrogeologic zones in the calibrated groundwater model are listed on the table below.

Hydrogeologic Zone		Hydraulic Conductivity, ft/d		Specific Yield	Specific[32] Storage, ft^{-1}	Model Layers in which zone is present
		Horizontal	Vertical			
Recent Rio Grande deposits		150	0.025	0.2	2×10^{-6}	1-6
4970-foot silt/clay unit		0.0041	0.00003		2×10^{-6}	3
Sand unit	above 4970-foot silt/clay unit	40	0.2	0.2	2×10^{-6}	1
Sand unit	above 4970-foot silt/clay unit	99	0.5	0.2	2×10^{-6}	2
Sand unit	above 4970-foot silt/clay unit near SE extent	40	0.3	0.2	2×10^{-6}	1,2
Sand unit	between Recent Rio Grande deposits and eastern extent of 4970-foot silt/clay unit (Upper Sand Unit)	120	0.05	0.2	2×10^{-6}	1,2
Sand unit	above the 4800-foot clay unit	25	0.2	0.2	2×10^{-6}	3-11
Sand unit	in Layer 13	23	0.068		2×10^{-6}	13
Sand unit	in Layer 15	22	0.1		2×10^{-6}	15
4800-foot clay unit		0.0042	0.00053		2×10^{-6}	12
4705-foot clay unit		0.2	0.058		2×10^{-6}	14

6.1.1.3 Sources and Sinks

The groundwater sinks in the model domain are the off-site containment well CW-1, the source containment well CW-2, and eight on-site shallow wells (PW-1, MW-18, and MW-23 through MW-28) that were extraction wells for an IM that was implemented in 1988. The off-site containment well has been in operation since December 31, 1998 with a brief shut down in April 1999. The pumping capacity of CW-1 was 225 gpm prior to November 3, 2010 at which time the pumping capacity was increased to 300 gpm. The average annual pumping rate is less than the pumping capacity due to downtime related to system maintenance. The average pumping rate in 2011 was 284 gpm. The pumping at CW-1 is distributed across model layers 6

[32] The specific storage of all model units was specified at 2×10^{-6} ft^{-1} consistent with the value specified in the USGS model of the Albuquerque Basin (Kernodle, 1998). This value was not estimated during model calibration.

through 11 and is apportioned based on layer transmissivities.[33] The discharge from well CW-1 to the infiltration gallery is simulated using wells injecting into layer 2. The discharge is distributed across the area of the gallery and is specified at the same rate as the CW-1 pumping rate.

The source containment well, CW-2, began operation in January 2002. The well has operated at an average annual pumping rate of between 42 gpm and 52 gpm. The average pumping rate in 2011 was 51 gpm. The pumping at CW-2 is distributed across model layers 3 through 8.[33] Ninety-nine percent of the treated water from this well is assumed to infiltrate back to the aquifer from the six original or the current four[34] on-site infiltration ponds based on consumptive use calculations. Only some of the ponds are used for infiltration at any given time; during 2002 the treated discharge from the well was rotated among the six original ponds, in 2003 and 2004 only ponds 1 and 4 were used, and from 2004 to 2011 the discharge was rotated among ponds 1 through 4 (see Figure 2.10 for pond locations). In the model, the amount of water directed to each of the ponds was based upon operation records.

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 0.24 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 within the modeled area is specified to occur from the Rio Grande and the Arroyo de las Calabacillas. Infiltration from the Rio Grande was simulated with the MODFLOW river package. The water level in the Rio Grande was estimated from the USGS 7.5 minute topographic map for the Los Griegos, New Mexico quadrangle and the river-bed conductance was determined as part of the model calibration process. Recharge along the Arroyo de las Calabacillas was simulated with the MODFLOW recharge package. This recharge rate was determined during the model calibration process to be 0.2 ft/year.

6.1.2 Model Simulated Water Levels from 1999 through 2011

The groundwater model was used to simulate groundwater levels in the aquifer system underlying the former Sparton site and its vicinity from December 1998, just prior to the startup of containment well CW-1, until December 2011 for purposes of evaluating correspondence between model calculated and observed water levels. An initial steady-state stress period was used to simulate conditions prior to startup, and this was followed by a month-long stress period for December 1998, and annual stress periods for the years 1999 through 2011. The average annual pumping rates specified for the containment wells CW-1 and CW-2 are those specified on Table 5.2.

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[33] The production wells CW-1 and CW-2 are simulated in MODFLOW with the Multi-Node Well (MNW) package which dynamically allocates production to model layers based on water levels, hydraulic conductivity and layer thickness.

[34] As discussed in Section 2.5, Ponds 5 and 6 were backfilled during 2005.

A total of 916 water-level targets were used to evaluate the correspondence between model calculated and observed water levels. These targets were developed from average annual water levels for each year from 1998 to 2011 calculated from available water-level data for seventy-six monitoring wells at the Sparton site and four piezometers maintained by the USGS at the Hunters Ridge site located near the infiltration basin on the north side of the Arroyo de las Calabacillas.

The calculated water levels in December 2011 with the calibrated groundwater model for the water table (UFZ), ULFZ, and LLFZ[35] are shown in Figures 6.4, 6.5, and 6.6, respectively. These calculated water levels are similar to observed water levels. The correspondence between observed and model-calculated water levels was evaluated using both qualitative and quantitative measures. The qualitative measures included: (1) the preparation of scatter plots of observed versus calculated water levels to provide a visual comparison of the fit of model to the observed water level data; (2) plots of observed and calculated water levels for the period 1998 through 2011 for each of the monitoring wells and piezometers used for model calibration; (3) maps of the difference between observed and calculated water levels for each of the major aquifer units; and (4) evaluation of model water balance.

Scatter plots of observed water levels versus calculated water levels between 1998 and 2011 for all monitoring wells in the UFZ above the 4970-foot silt/clay unit (on-site UFZ wells), for all wells in the UFZ, ULFZ and LLFZ, except for those above the 4970-foot silt/clay unit, and for all wells in the DFZ are shown on Figure 6.7. In a model with good correspondence between calculated and observed water levels, the points on the scatter plot are random and closely distributed about the straight line that represents an exact match between the calculated and observed groundwater levels. The scatter plots shown in Figure 6.7 plot the average observed water level in each monitoring well during each year of the simulation against the average water level calculated for each well during each year of the simulation.[36] These scatter plots visually illustrate the excellent comparison between model calculated water levels and observed water levels in the UFZ/ULFZ/LLFZ and DFZ zones. In the on-site UFZ the correspondence between observed and calculated water levels is not as good as in the other zones. This is the result of significant heterogeneity in the sands above the 4970-foot silt/clay unit.

Plots of observed versus calculated water levels at all monitoring wells and piezometers used are shown in Appendix E on Figures E-1, E-2, and E-3. These plots indicate that the water-level trends in the observed and calculated water levels are very similar at almost all monitoring wells illustrating the close correspondence between observed and calculated water levels. The areal distribution of residuals in the on-site UFZ, the UFZ/ULFZ/LLFZ and the DFZ in 2011 are

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[35] The ULFZ water levels shown on Figure 6.5 are based on model calculated water levels in model Layer 5 and the LLFZ water levels shown on Figure 6.6 are based on model calculated water levels in model Layer 9.

[36] Observed water levels were compared to calculated water levels in the model layer corresponding to the location of the screened interval of the monitoring well. When the screened interval of a monitoring well spanned more than one model layer, the observed water levels were compared to the transmissivity weighted average of the calculated water levels in the layers penetrated by the well.

shown in Appendix E on Figures E-4, E-5 and E-6, respectively. An evaluation of these figures indicates that the spatial distribution of residuals is relatively random.

The model water balance was compiled for 1998, 2001, and 2011 to evaluate the reasonableness of groundwater flows within the model domain. The water balance consists of water inflows into the model domain, groundwater outflow from the model domain, and changes in groundwater storage within the model area. Water inflows consist of infiltration from the Rio Grande, recharge along the Arroyo de las Calabacillas, and infiltration from the infiltration gallery and the on-site infiltration ponds. Groundwater outflows consist of groundwater pumping from containment wells CW-1 and CW-2 and groundwater flow out of the model domain across the constant-head boundaries. The average annual water balances for 1998, 2001 and 2011 are summarized below[37]:

	Component	1998	2001	2011
Inflows, in gpm	Change in Storage (net)	0	80	361
	Infiltration from Gallery and Ponds	0	216	335
	River Infiltration	1,180	1,224	1,476
	Recharge	7	7	7
	Total Inflows	**1,187**	**1,526**	**2,180**
Outflows, in gpm	Containment Wells	0	216	335
	Constant Head (net)	1,187	1,314	1,844
	Total Outflows	**1,187**	**1,530**	**2,180**

The balance between total water inflows and outflows from the model area has a maximum error of 0.01 percent or less and is judged to be excellent. The increases through time in inflows from storage and the river and outflows from constant heads are the result of increasing regional pumping.

The quantitative evaluation of the model simulation consisted of examining the difference between the 916 average annual water levels observed in the monitoring wells and piezometers at the former Sparton site and its vicinity and the corresponding calculated water levels for these monitoring wells. The difference between an observed and a measured water level is called a residual. Three statistics were calculated for the residuals to quantitatively describe the model calibration: the mean of the residuals, the mean of the absolute value of the

[37] The calculated inflows and outflows in 1998 and 2001 are slightly different than those reported in the 2009 Annual Report. These differences are the result of using a new version of MODFLOW that handles dry cells more efficiently (Bedekar and others 2011).

residuals, and the root mean-squared error.[38] The mean of all the residuals is -0.28 ft, the mean of the absolute value of the residuals is 1.15 ft, and the root mean-squared error is 1.6. The minimum residual is -8.96 ft and the maximum residual is 5.99 ft, both for on-site monitoring wells. The absolute mean residual of 1.15 ft is considered acceptable since the observed water-level measurements applied as calibration targets have a total range of about 32.7 ft, and seasonal fluctuations of water levels are on the order of several feet. The quantitative statistics based on the monitoring wells in the major flow zones are listed below:

Flow Zone	Count	Mean Residuals	Absolute Mean Residual	Root-Mean-Squared Error	Minimum Residual	Maximum Residual
On-Site UFZ	220	-0.09	1.86	2.48	-8.96	5.99
UFZ/ULFZ/LLFZ	651	-0.40	0.94	1.25	-4.38	4.26
DFZ	45	0.56	0.82	1.26	-0.86	4.54

The differences between observed and calculated water levels at each monitoring well for the period 1998 through 2011 are presented in Appendix E, Tables E-1 through E-3. The qualitative and quantitative evaluations of the comparisons between observed and model calculated water levels indicate that the groundwater model is a reliable simulator of existing conditions.

6.1.3 Capture Zone Analysis

The capture zones of containment wells CW-1 and CW-2 at the water table (UFZ) , and in the ULFZ and LLFZ were calculated by applying particle tracking to the calculated average 2011 water levels in these horizons of the aquifer (Figures 6.4. 6.5, and 6.6), assuming that these water levels represented a steady-state condition. The particle tracking was carried out using the PATH3D computer code (Zheng, 1991), and by releasing particles at one-foot intervals along a line upgradient from both containment wells, and near and parallel to Rio Grande (along column 129 of the model grid shown in Figure 6.1). The calculated capture zones of containment wells CW-1 and CW-2 in the UFZ (water table), the ULFZ, and the LLFZ are presented in Figures 6.4, 6.5, and 6.6, respectively. Also shown in these figures is the extent of the TCE plume in November 2011.

Particle tracking analysis was also used to determine the aquifer area where the water extracted at CW-1 between 1999 and 2011 was located at the start of extraction in 1998 and where the water extracted at CW-2 between 2002 and 2011 was located at the start of extraction

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[38] The root mean-squared error is defined as $RMSE = \left[\frac{1}{N}\sum_{i=1}^{N} R_i^2\right]^{1/2}$ where N is the number of calibration targets, and R is the residual. The root mean-squared error is close to the standard deviation when the mean error is small and the number of targets is large.

in January 2002 (the "areas of origin"). This particle tracking analysis was carried out using the MODPATH computer code (Pollock 1994, 2008); particles were released on a twenty foot grid at the top of each model layer throughout the model domain, and keeping track of those particles that discharged at CW-1 and CW-2. The results of this analysis are discussed in Section 5 and are shown on Figure 5.26 in both map [Figure 5.26 (a)] and cross-section view [Figure 5.26 (b)]. The outlines of the areas of origin of the water pumped during different time periods [Figure 5.26 (a)] represent the outer boundary of the envelope of particle traces that discharged at each of the wells during that period.

The travel time from the center of the Sparton property (a point near monitoring well MW-26) to the source containment well CW-2, and the travel time from a point downgradient from and outside the capture zone of CW-2 to the off-site containment well CW-1 were estimated using the particle-tracking method. These travel times were calculated as 1.5 and 11 years, respectively.[39] This calculation assumed that both the off-site and the source containment wells are operating continuously at their current pumping rates (284 gpm at CW-1 and 51 gpm at CW-2) and that 2011 water level conditions exist throughout a 15-year period. The calculated travel time to the off-site containment well CW-1 was lower than the travel time reported last year as a result of the increased pumping rate at that well.

6.2 Solute Transport Model

A solute transport model is linked to the groundwater flow model to simulate the concentration of TCE in groundwater at the site. The three-dimensional contaminant transport simulation code MT3D (Zheng, 2008; Zheng and SSP&A, 1999) was applied for this study. The model was used to simulate TCE concentrations in the aquifer from December 1998 through December 2012.

Model input parameters were specified based on available data. 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 used only to predict TCE concentrations in the aquifer and no attempt was made to simulate DCE and TCA. Generally, DCE is detected at monitoring wells where TCE is detected, but DCE concentrations are much lower than TCE concentrations. During 2011, DCE was about 9 percent of the total mass of chlorinated volatile organic compounds extracted by CW-1 and 10 percent of that extracted by CW-2.

The other constituent of concern, TCA, had been historically detected at concentrations greater than the 60 μg/L maximum allowable concentration in groundwater set by the NMWQCC, primarily in monitoring wells at the facility; prior to 2003 TCA had been detected at levels above 60 μg/L in only one off-site well, MW-46. The concentrations of TCA have been below 60 μg/L since 2003; the maximum TCA concentration reported this year was 4.3 μg/L at MW-60. The limited distribution of TCA and the reduction in its concentrations are the result of the abiotic transformation of TCA to acetic acid and DCE; a transformation that occurs relatively

[39] This travel time is the travel time for ground water, and should not be construed as the time at which contaminants will migrate over the same distance; travel time for contaminants would be different due to dispersion and other factors that affect contaminant migration.

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). The current concentrations of TCA and DCE in monitoring wells indicate that the amount of TCA available for degradation has been greatly reduced and that, therefore, significant increases in DCE would not be expected to occur 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, bulk density, and dispersivity. The required chemical property is the retardation coefficient, which is a function of the fraction organic carbon, the organic-carbon partition coefficient for the organic compound being simulated, and the effective diffusion coefficient. The following table summarizes the transport parameters:

Transport Parameter	Geologic Unit	Value
Effective porosity	All	0.3
Longitudinal dispersivity	All	25 ft
Transverse horizontal dispersivity	All	0.25 ft
Transverse vertical dispersivity	All	0.025 ft
Retardation Coefficient	All	1

The rationale for choosing these transport parameters is described in the 2000 Annual Report (SSP&A, 2001b). The retardation coefficient for TCE was specified as unity in all geologic units. In previous years, a retardation coefficient of 4.3 was specified for the 4970-foot silt/clay unit. In the model calibration conducted last year, it was determined that the model with a retardation coefficient of unity provided just as good a calibration as with a retardation coefficient of 4.3; therefore, for simplicity a retardation coefficient of unity was also specified for this unit.

6.2.2 Initial Concentration Distribution and Model Calibration

The transport model has been calibrated for each annual report since 1999, except for the 2006 annual report, by adjusting the TCE concentrations in the aquifer in 1998 prior to startup of the groundwater remediation systems; these concentrations are referred to as the model's initial concentration distribution. The calibration process consisted of adjusting the initial TCE concentration distribution in the aquifer in a manner consistent with available data until a reasonable match was obtained between the calculated and measured TCE concentrations at containment wells CW-1 and CW-2, and the calculated and measured TCE mass removal by these two wells throughout their respective period of operation. The approach used in determining the initial concentration distribution has varied through time. In the last major recalibration of the transport model, which is described in the Alternatives Report, the initial concentration distribution was interpolated based on the November 1998 measured concentration data and a number of the pilot points along the center line of the plume using three-dimensional kriging. The parameter estimation program PEST (Doherty, 2002) was used to estimate TCE concentrations at the pilot points. A slight adjustment to the initial TCE concentration distribution at the on-site area, without affecting the initial mass, was made last year, during the preparation of the 2010 Annual Report, to provide a better representation of observed concentrations at CW-2. This calibration process resulted in good agreement between observed and calculated TCE mass removal from containment wells CW-1 and CW-2, and between observed and calculated TCE concentrations at these two wells, as shown in Figure 6.8. Further adjustments to the initial TCE concentration distribution were not necessary during the simulations carried out for this 2011 Annual Report.

The initial TCE mass in the aquifer, estimated from the initial TCE concentration distribution in the recalibrated model, is 7,360 kg (16,250 lbs). This estimated initial mass has remained the same since the 2009 recalibration of the model described in the Alternatives Report[40]. The distribution of this mass among the model layers, and the corresponding maximum TCE concentrations within each layer are summarized on Table 6.1.

6.2.3 Model Calculated TCE Mass Removal Rates and Concentration

The measured cumulative amount of TCE removed by operation of the on-site and off-site containment systems through the end of each year since 1999 and the model calculated amount of TCE removed are tabulated below:

Year	Cumulative TCE mass removed by both wells through end of year (kg)		Average Annual Concentration at CW-1 (µg/L)		Average Annual Concentration at CW-2 (µg/L)	
	Measured	Calculated	Measured	Calculated	Measured	Calculated
1999	360	480	829	1,107		
2000	820	970	1,055	1,131		
2001	1,340	1,470	1,205	1,160		
2002	1,940	2,020	1,225	1,099	723	691
2003	2,560	2,590	1,275	1,170	473	410
2004	3,160	3,170	1,317	1,280	301	268
2005	3,720	3,750	1,217	1,276	191	173
2006	4,230	4,270	1,166	1,190	153	123
2007	4,700	4,740	1,050	1,044	130	98
2008	5,130	5,150	982	908	90	85
2009	5,510	5,500	869	793	64	77
2010	5,820	5,810	703	698	52	73
2011	6,170	6,130	622	563	35	73

There is very good agreement between the observed and model calculated amount of TCE removed. The total TCE removed through the end of 2011 is about 6,170 kg; this amount is about 84 percent of the amount of TCE estimated to have been in the aquifer in 1998. The model calculated total TCE removal is about the same, 6,130 kg. Also listed on this table are the

[40] Initial mass estimates during nine previous model calibrations varied from 2,180 kg (4,810 lbs) in 1999 to 7,340 kg (16,780 lbs) in 2003 and averaged 5,290 kg (11,660 lbs).

average annual measured and model calculated concentrations in the water pumped from CW-1 and CW-2 from 1999 through 2011.

A comparison of calculated to observed concentrations of TCE at all monitoring wells for all samples analyzed between November 1998 and November 2011 is presented in Figure 6.9. Also presented in Figure 6.9 is a comparison of calculated to observed concentrations of TCE for only those samples analyzed in November 2011 on which the individual data points are labeled with the well number. The general agreement between observed and computed concentrations is reasonable given the uncertainty of the initial contaminant distribution. Plots of calculated and observed TCE concentrations at selected monitoring wells during the period 1998 through 2011 are shown in Appendix E on Figure E-7. The calibrated initial TCE plume (November 1998), and model calculated TCE plumes for November 2002, 2006, 2010, and 2011 are presented in Figure 6.10; the concentration contours shown on this figure are based on the maximum TCE concentration simulated in any layer.

6.3 Simulation of TCE Concentrations in 2012

The groundwater model was used to forecast TCE concentrations in the aquifer and the mass extracted from CW-1 and CW-2 from January through December 2012. The predicted TCE concentration distribution in December 2012, based on the maximum TCE concentration simulated in any layer, is presented in Figure 6.11. The predicted December 2012 TCE concentration at CW-1 is 401 µg/L, and that at CW-2 is 70 µg/L.

The predicted concentration at CW-2 in December 2012 is higher than the average concentration observed in the well in 2011, which was 35 µg/L. This indicates that the initial TCE concentrations specified in the 4970-foot silt/clay unit, and which act as a long-term source of contamination to the underlying aquifer units, may be overestimating the actual mass of TCE in this unit. If TCE concentrations at CW-2 continue to decline during 2012, adjustments will be made to the initial TCE concentrations in the 4970-foot silt/clay unit.

Section 7
Conclusions and Future Plans

7.1 Summary and Conclusions

Sparton's former Coors Road Plant is located at 9621 Coors Boulevard NW, Albuquerque, New Mexico. The Site is at an elevation of about 5,050 ft MSL; the land slopes towards the Rio Grande on the east and rises to elevations of 5,150-5,200 ft MSL within a short distance to the west of the Site. The upper 1,500 ft of the fill deposits underlying the Site consist primarily of sand and gravel with minor amounts of silt and clay. The water table beneath the Site is at an elevation of 4,975-4,985 ft MSL and slopes towards the northwest to an elevation of about 4,960 ft MSL within about one-half mile of the Site. At an elevation of about 4,800 ft MSL a 2- to 3-foot clay layer, referred to as the 4,800-foot clay unit, has been identified.

Investigations conducted at and around the Site in the 1980s revealed that soils beneath the Site and groundwater beneath and downgradient from the Site were contaminated. The primary contaminants were VOCs, specifically TCE, DCE, and TCA, and chromium. Remedial investigations that followed indicated that groundwater contamination was limited to the aquifer above the 4800-foot clay; current measures for groundwater remediation were, therefore, designed to address contamination within this depth interval.

Under the terms of a Consent Decree entered on March 3, 2000, Sparton agreed to implement a number of remedial measures. These remedial measures consisted of: (1) the installation and operation of an off-site containment system; (2) the installation and operation of a source containment system; and (3) the operation of an on-site, 400-cfm SVE system for an aggregate period of one year. The goals of these remedial measures are: (a) to control hydraulically the migration of the off-site plume; (b) to control hydraulically any potential source areas that may be continuing to contribute to groundwater contamination at the on-site area; (c) 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; and (d) in the long-term, restore the groundwater to beneficial use.

The installation of the off-site containment system began in late 1998 and was completed in early May 1999. The system consisted of: (1) a containment well near the leading edge of the plume, designed to pump at a rate of about 225 gpm, (2) an off-site treatment system, (3) an infiltration gallery in the Arroyo de las Calabacillas, and (4) associated conveyance and monitoring components. The off-site containment well began operating on December 31, 1998; except for brief interruptions for maintenance activities or due to power outages, the well has operated continuously since that date. Based on an evaluation of the performance of the system and of alternative groundwater extraction systems, conducted in 2009, Sparton recommended and the regulatory agencies approved the increase of the pumping rate of this well to about 300 gpm to accelerate aquifer restoration; this rate increase was implemented on November 3, 2010. The year 2011 was the thirteenth full year of operation of this well.

The source containment system was installed during 2001 and began operating on January 3, 2002. This system consisted of: (1) a containment well immediately downgradient from the site, designed to pump at a rate of about 50 gpm, (2) an on-site treatment system, (3) six[41] on-site infiltration ponds, and (4) associated conveyance and monitoring components. The year 2011 was the tenth year of operation of this well.

The 400-cfm SVE system had operated for a total of about 372 days between April 10, 2000 and June 15, 2001 and thus met the length-of-operation requirements of the Consent Decree; monitoring conducted in the Fall of 2001 indicated that the system had also met its performance goals, and the system was dismantled in May 2002.

During 2011, considerable progress was made towards achieving the goals of the remedial measures:

- The off-site containment well continued to operate during the year at an average discharge rate of 284 gpm and maintained hydraulic containment of the off-site plume. The pumped water was treated and returned to the aquifer through the infiltration gallery. The concentrations of constituents of concern in the treated water met all the requirements of the Discharge Permit for the site.
- The source containment well continued to operate during the year at an average rate of 51 gpm, and to contain potential on-site source areas. The pumped water was treated and returned to the aquifer through the infiltration ponds. The concentrations of constituents of concern in the treated water met all the requirements of the Discharge Permit for the site.
- Groundwater monitoring was conducted as specified in the Groundwater Monitoring Program Plan (Monitoring Plan [Attachment A to the Consent Decree]) and the State of New Mexico Groundwater Discharge Permit DP-1184 (Discharge Permit). Water levels in all accessible wells and/or piezometers were measured quarterly. Samples were collected for water-quality analyses from monitoring wells at the frequency specified in the Monitoring Plan and analyzed for VOCs and total chromium.
- Samples were obtained from the influent and effluent of the treatment plants for the off-site and source containment systems, and the infiltration gallery and infiltration pond monitoring wells at the frequency specified in the Discharge Permit. All samples were analyzed for VOCs, total chromium, iron, and manganese.
- The groundwater flow and transport model that was developed in early 2000 to simulate the hydrogeologic system underlying the site and its vicinity, and which was revised several times during the past eleven years, was used to simulate TCE concentrations in the aquifer from start-up of the off-site containment well in December 1998 through December 2011, and to predict concentrations for December 2012.

[41] The performance of the six on-site infiltration ponds between 2002 and 2004 indicated that four ponds are more than adequate for handling the water pumped by the source containment well. With the approval of the regulatory agencies, Sparton backfilled two of the six ponds in 2005 to put the land to other beneficial use.

The extent of groundwater contamination during 2011, as defined by the extent of the TCE plume, was essentially the same as during 2010. Of 56 wells sampled both in November 2010 and 2011, the 2011 concentrations of TCE were lower than in 2010 in 17 wells, higher in 13 wells, and remained the same in 26 wells (all below detection limits). Well MW-60, at 1,200 micrograms per liter (µg/L), continued to be the most contaminated off-site well. The corresponding results for DCE were 8 wells with lower, 6 wells with higher, and 42 wells with the same (all below detection limits) concentrations. The TCA plume ceased to exist in 2003, and this condition continued through 2011; the highest concentration of TCA during 2011 was 4.3 µg/L (also in well MW-60), significantly below the maximum allowable concentration of 60 µg/L set for groundwater by the NMWQCC.

Changes in concentrations observed in monitoring wells since the implementation of the current remedial measures indicate that contaminant concentrations decreased significantly both in the on-site and off-site area. Data from 55 wells that were sampled both during 2011 and before, or soon after, the start of the remedial operations indicate that TCE concentrations decreased in 30 wells, increased in 6 and remained below detection limits in 19. Of the six wells where current concentrations are higher than they were prior to the start of the current remedial operations, the highest increase was at the off-site containment well CW-1. The concentrations of contaminants in the water pumped from CW-1 rapidly increased after the start of its operation and have remained high for several years before starting a declining trend in the mid-2000s. The high concentrations in this well and in well MW-60 indicated that areas of high concentration existed upgradient from both of these wells; however, most of the groundwater upgradient from these wells has been captured by CW-1 and concentrations both in CW-1 and MW-60 are expected to continue their declining trend.

Two of the three monitoring wells completed below the 4800-foot clay (in the Deep Flow Zone or the DFZ), well MW-67 and well MW-79, which was installed in 2006 to address the continuing presence of contaminants in the third DFZ monitoring well MW-71R, continued to be free of any site-related contaminants throughout 2011. Well MW-71R continued to be contaminated; however, TCE concentrations in the well declined from 210 µg/L in August 2003 to 51 µg/L in May 2009. After that, the TCE concentrations in the well began increasing again reaching 91 µg/L in May 2011 and then declining to 58 µg/L by the Fourth Quarter 2011 sampling event.

The off-site and source containment wells operated at a combined average rate of 335 gpm during 2011. A total of about 176 million gallons of water were pumped from the wells. The total volume of water pumped since the beginning of the current remedial operations on December 1998 is about 1.78 billion gallons and represents 158 percent of the initial volume of contaminated groundwater (pore volume).

A total of about 390 kilograms (kg) [850 pounds (lbs)] of contaminants consisting of about 350 kg (770 lbs) of TCE, 35 kg (77 lbs) of DCE, and 1.2 kg (2.7 lbs) of TCA were removed from the aquifer by the two containment wells during 2011. The total mass that was removed since the beginning of the of the current remedial operations through the end of 2011 is 6,600 kg (14,560 lbs) consisting of 6,170 kg (13,600 lbs) of TCE, 411 kg (905 lbs) of DCE, and 18 kg (40 lbs) of TCA. This represents about 84 percent of the total dissolved contaminant mass currently estimated to have been present in the aquifer prior to the testing and operation of the off-site containment well.

The containment systems were shut down several times during 2011 for routine maintenance activities, due to power and monitoring system failures, or due to the failure of other components of the systems. The downtime for these shutdowns ranged from 8 minutes to 96 hours. The longer shutdowns, of about four days each, were for pump replacement at the source and then at the off-site containment well. Evaluation of migration rates in the aquifer indicates that the systems could be down for significantly much longer periods without affecting the capture of the contaminant plume.

7.2 Future Plans

The off-site and source containment systems will continue to operate during 2012; their pumping rates will be closely monitored to maintain them as close a possible to their current design pumping rates (300 gpm for the off-site containment well and 50 gpm for the source containment well). Data collection will continue in accordance with the Monitoring Plan and the Discharge Permit, and as necessary for the evaluation of the performance of the remedial systems. As additional data are collected, they will compared to predictions made with the calibrated flow and transport model of the Site, and adjustments to the model will be made, if necessary.

The plugging and abandonment of monitoring wells MW-47 and MW-58 and MW-61, and the installation of a replacement well MW-47R, which have been approved by the agencies, will be implemented during the summer of 2012.[42] Data from well MW-7, whose water level was below the bottom of the screen during the 2011 measurement rounds and which could not be sampled in November because of insufficient water, will be carefully reviewed to assess whether this well should also be abandoned or replaced. After approval of this report, a Fact Sheet for 2011 will be prepared and submitted to the regulatory agencies for approval before distribution to the property owners located above the plume and adjacent to the off-site treatment plant water discharge pipeline.

The USEPA and the NMED will continue to 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.

[42] The plugging and abandonment of wells MW-47, MW-58, and MW-61 was completed on June 18-19, 2012; Well MW-47R is expected to be installed in late July or early August 2012.

Section 8
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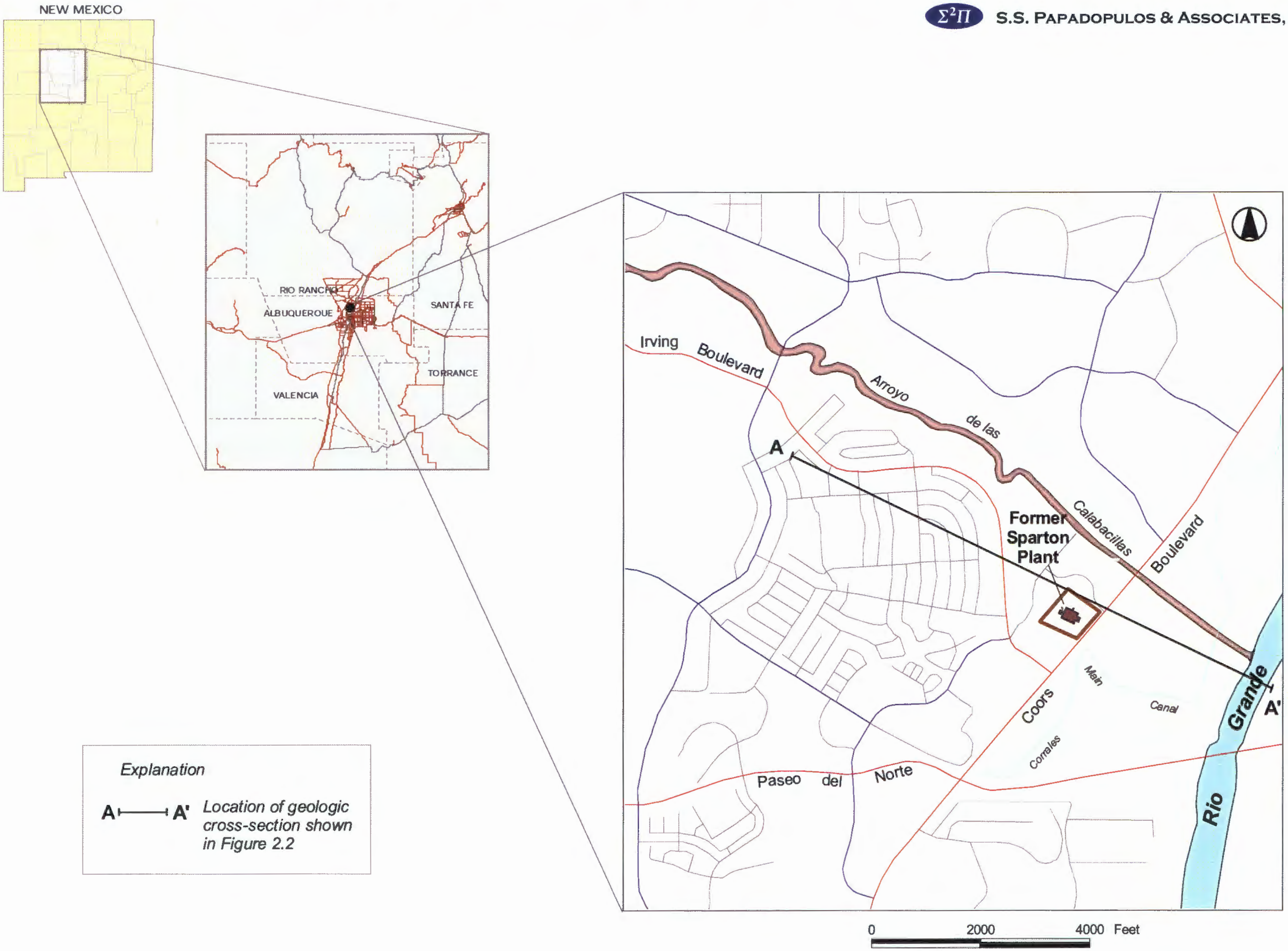
FIGURES



Explanation

A⊢—⊣A' *Location of geologic cross-section shown in Figure 2.2*

Figure 1.1 Location of the Former Sparton Coors Road Plant

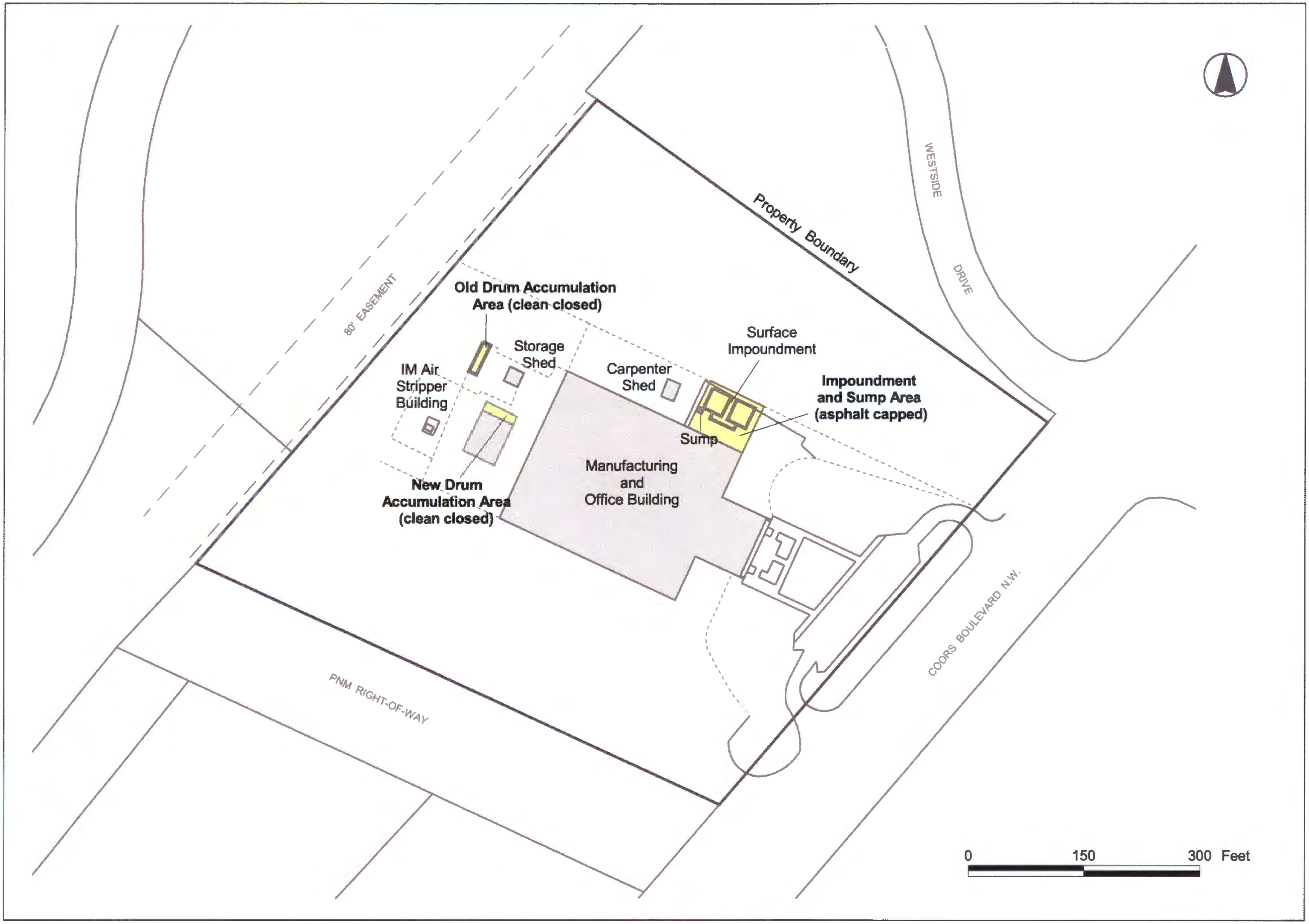
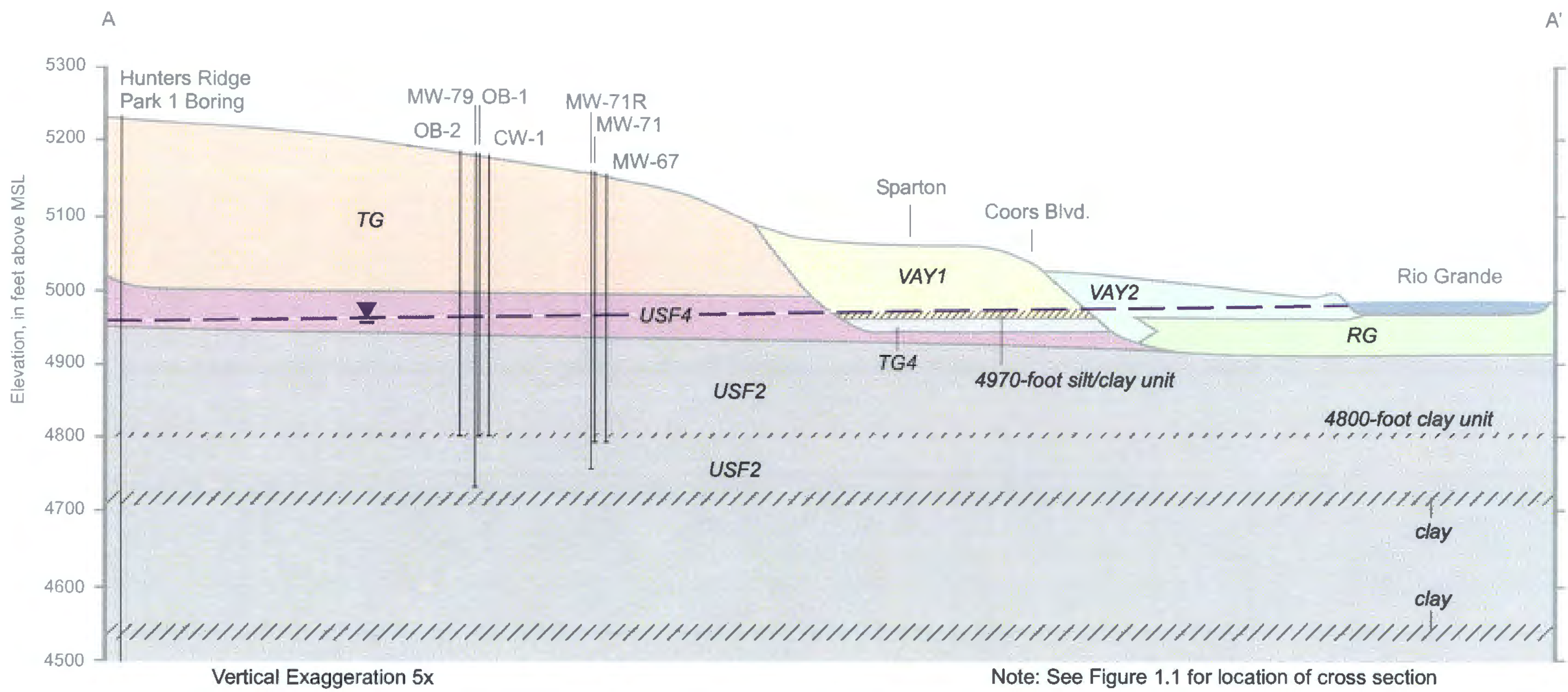


Figure 2.1 The Former Sparton Coors Road Plant



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

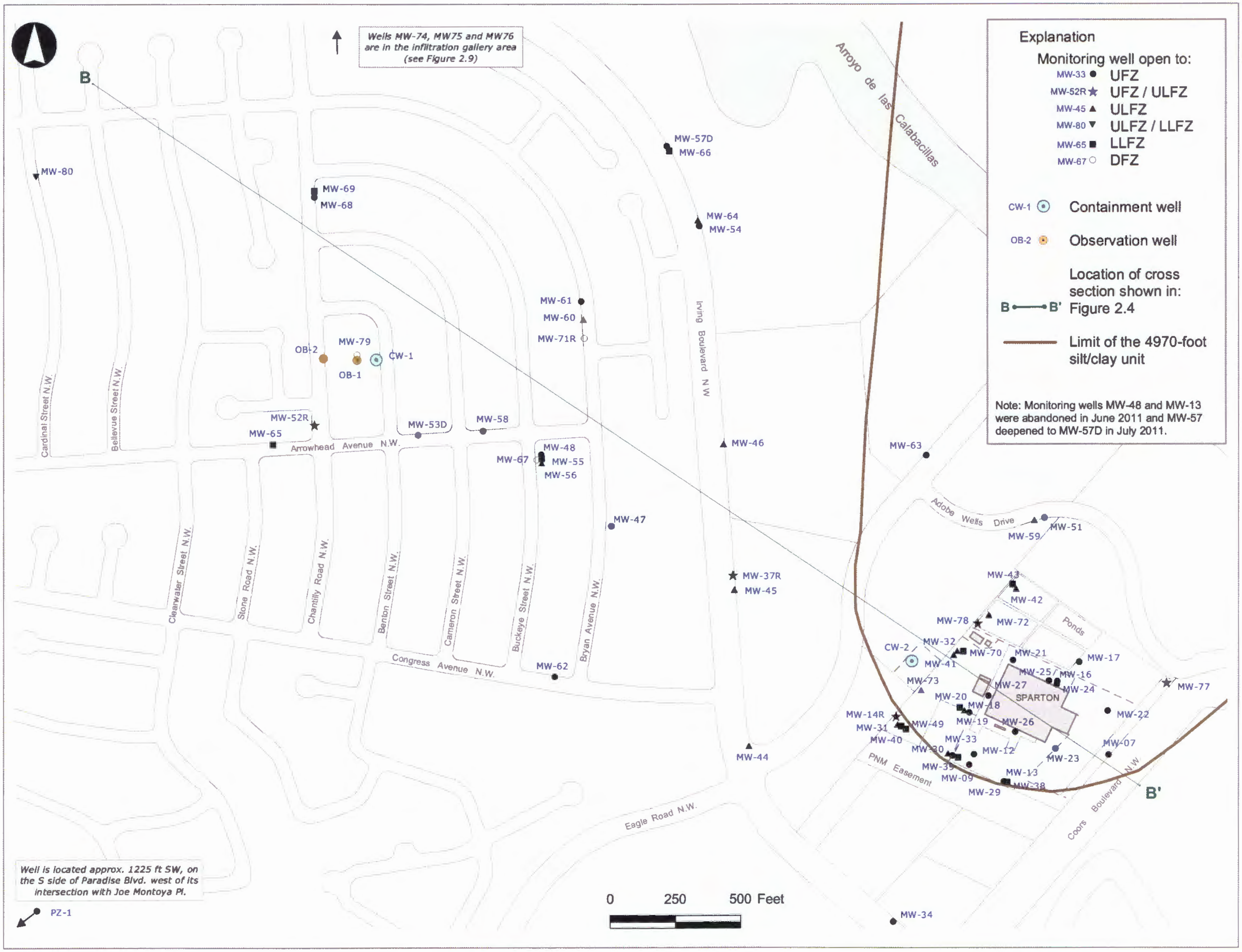


Figure 2.3 Location of Existing Wells

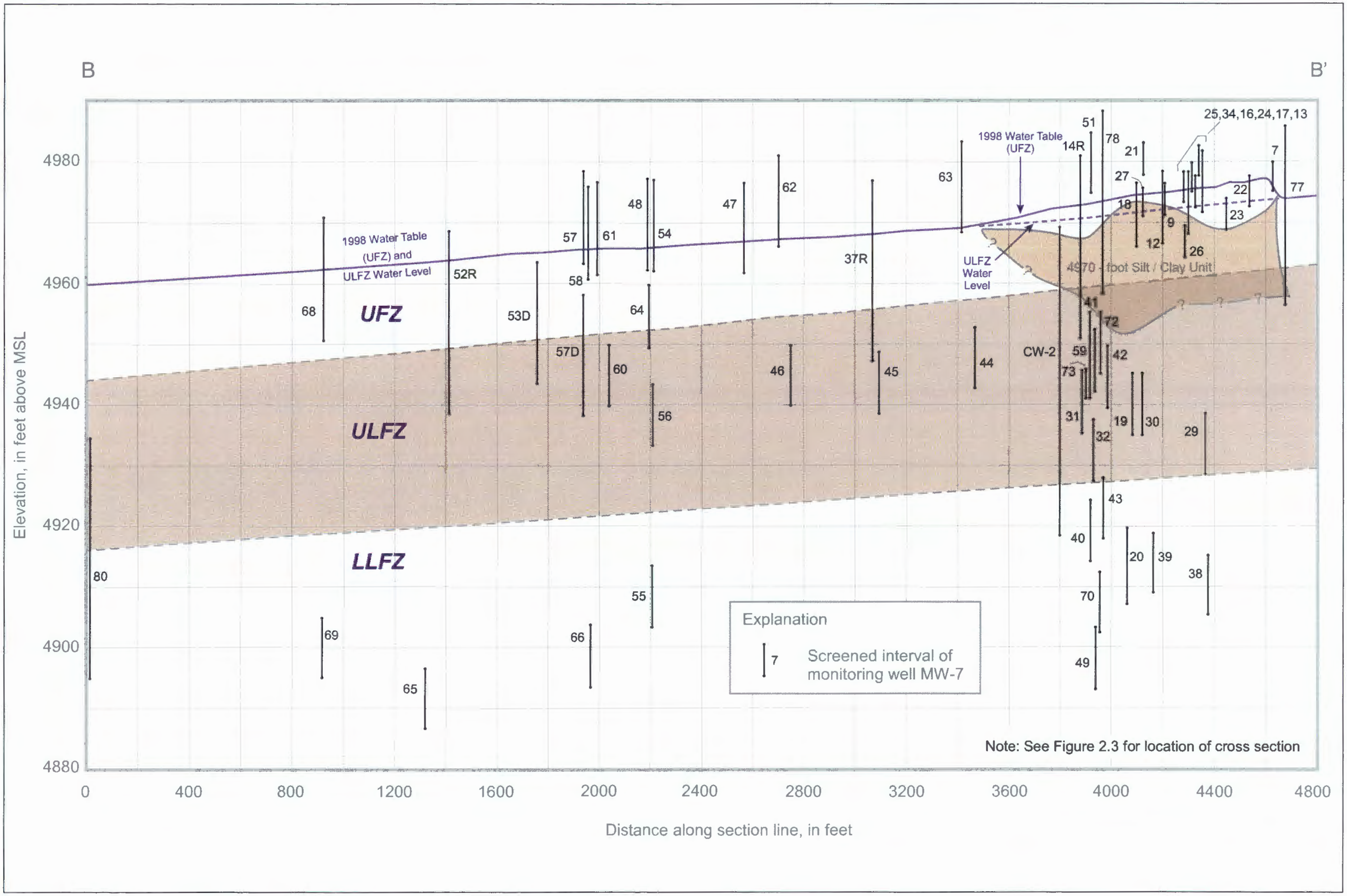


Figure 2.4 Schematic Cross-Section Showing Screened Interval of Monitoring Wells and Relation to Flow Zones

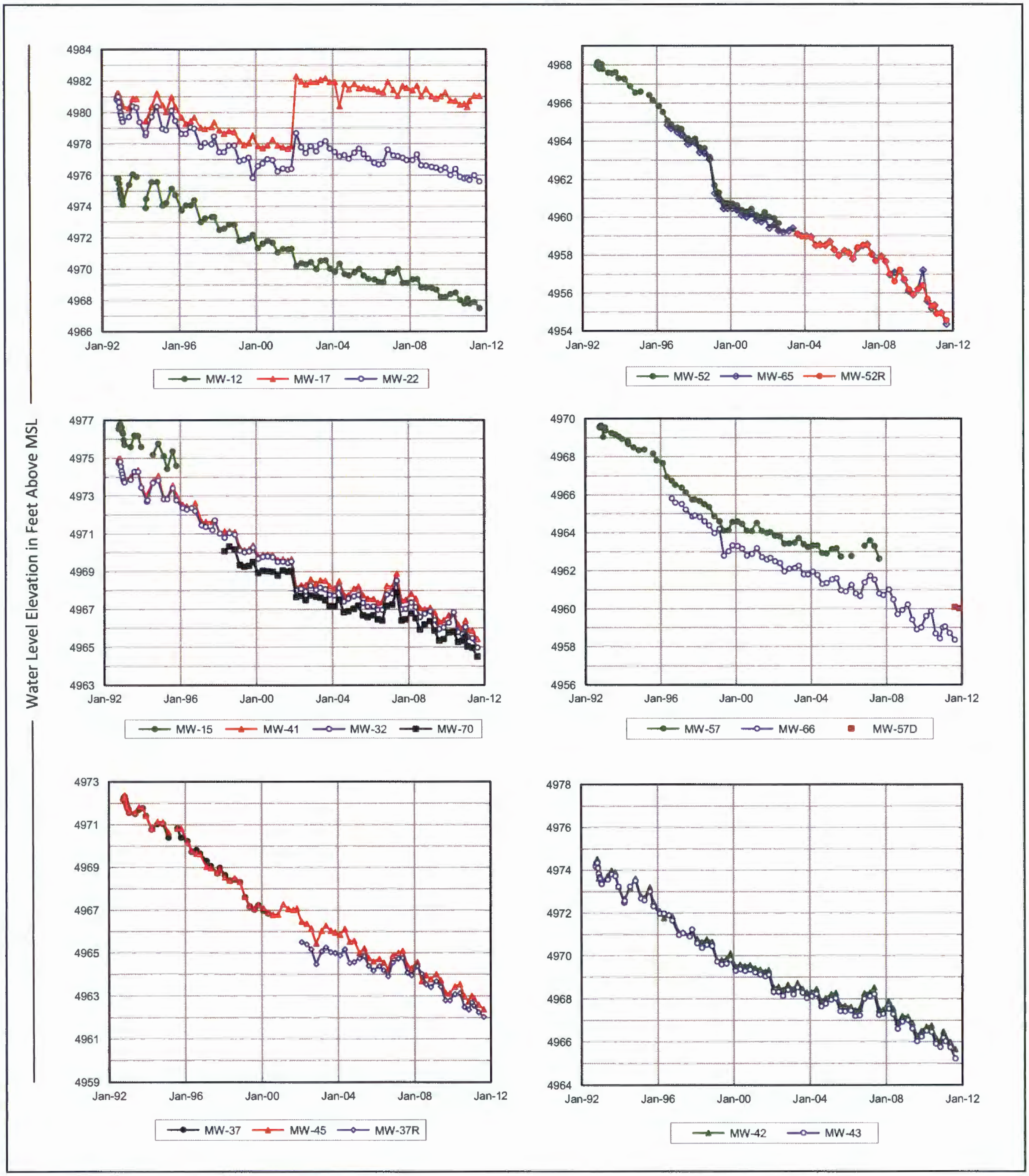


Figure 2.5 Monitoring Well Hydrographs

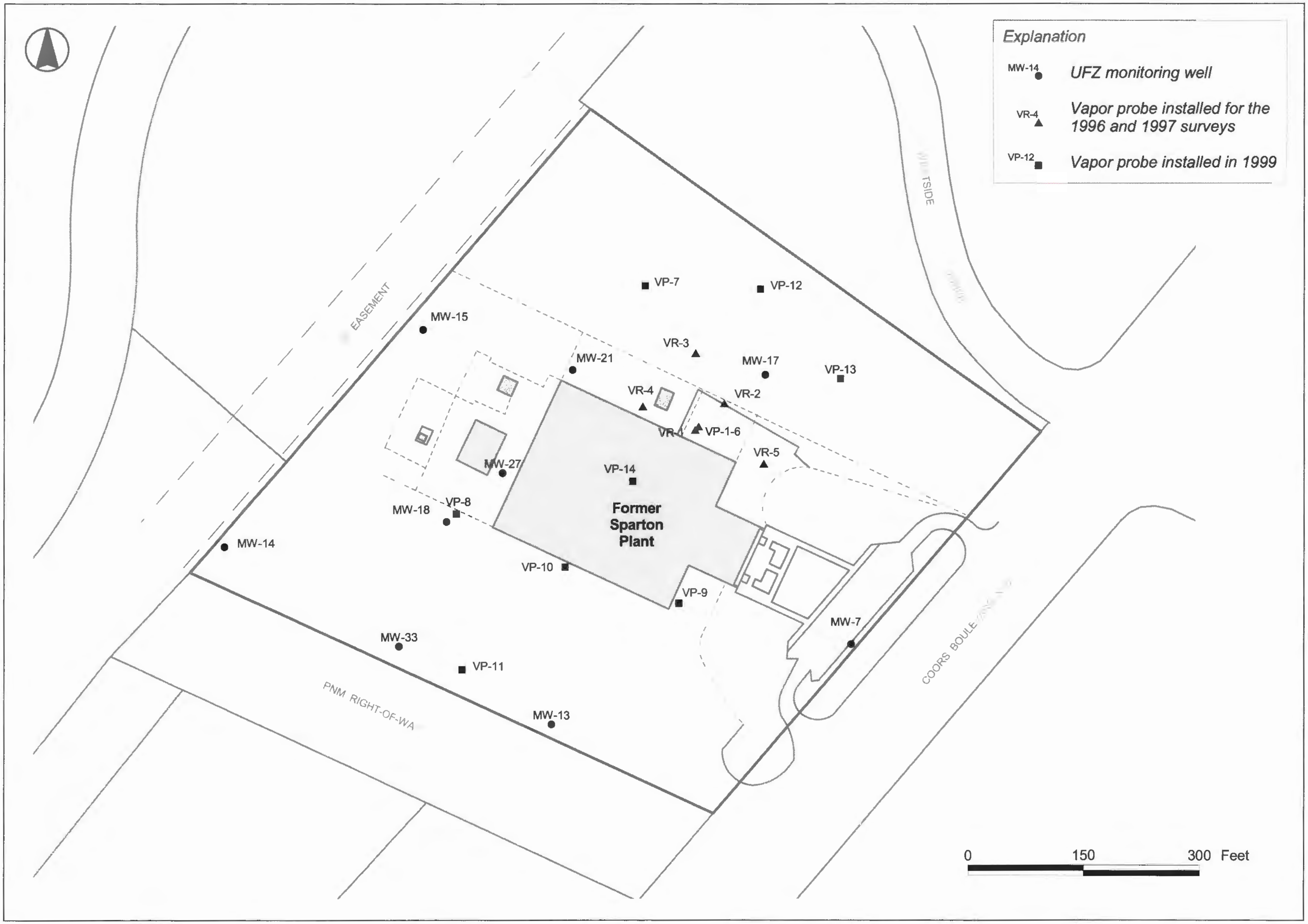


Figure 2.6 Location of Vapor Probes and On-Site Monitoring Wells Used in Vadose Zone Characterizations

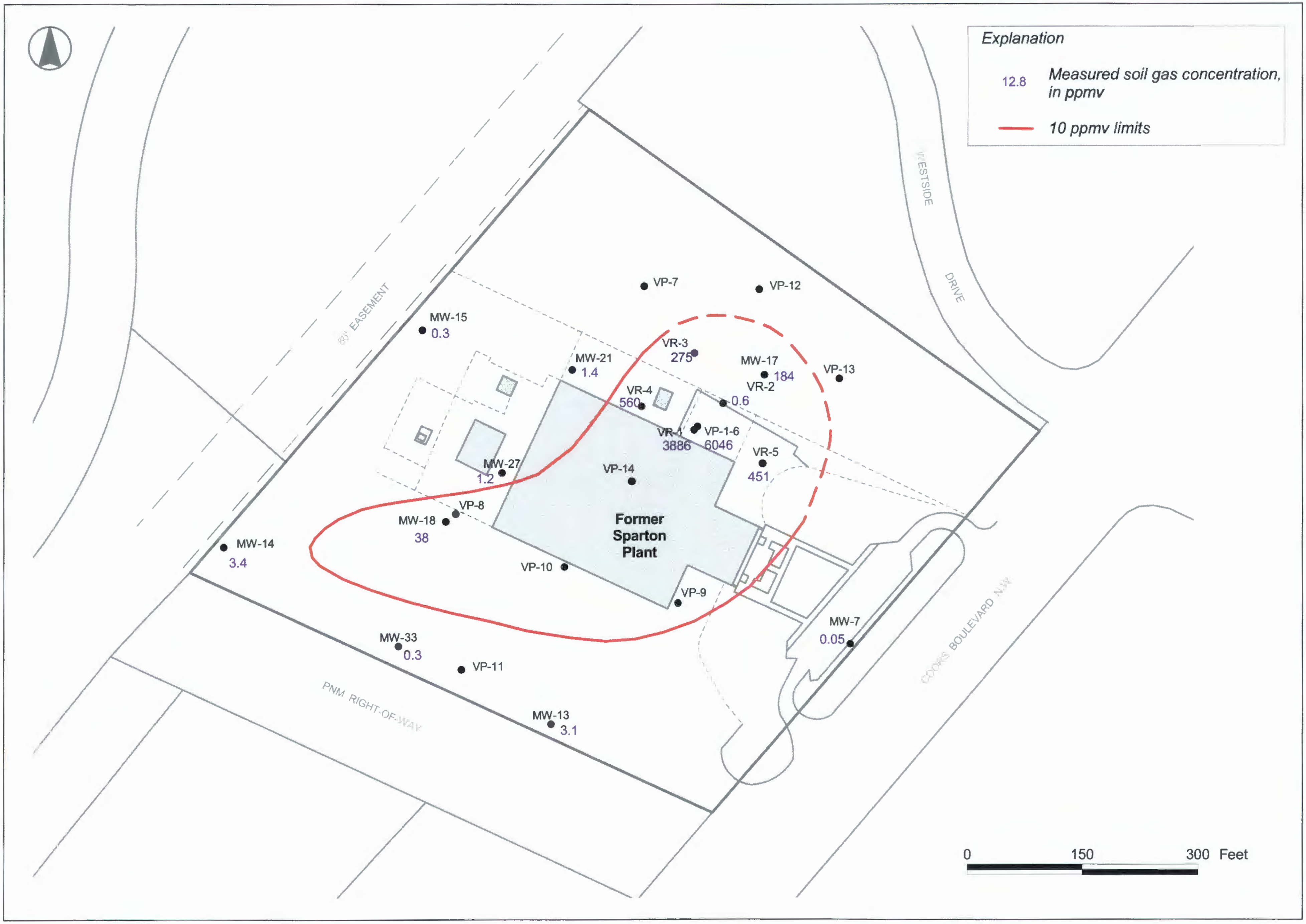


Figure 2.7 TCE Concentrations in Soil Gas - April 1996 - February 1997 Survey

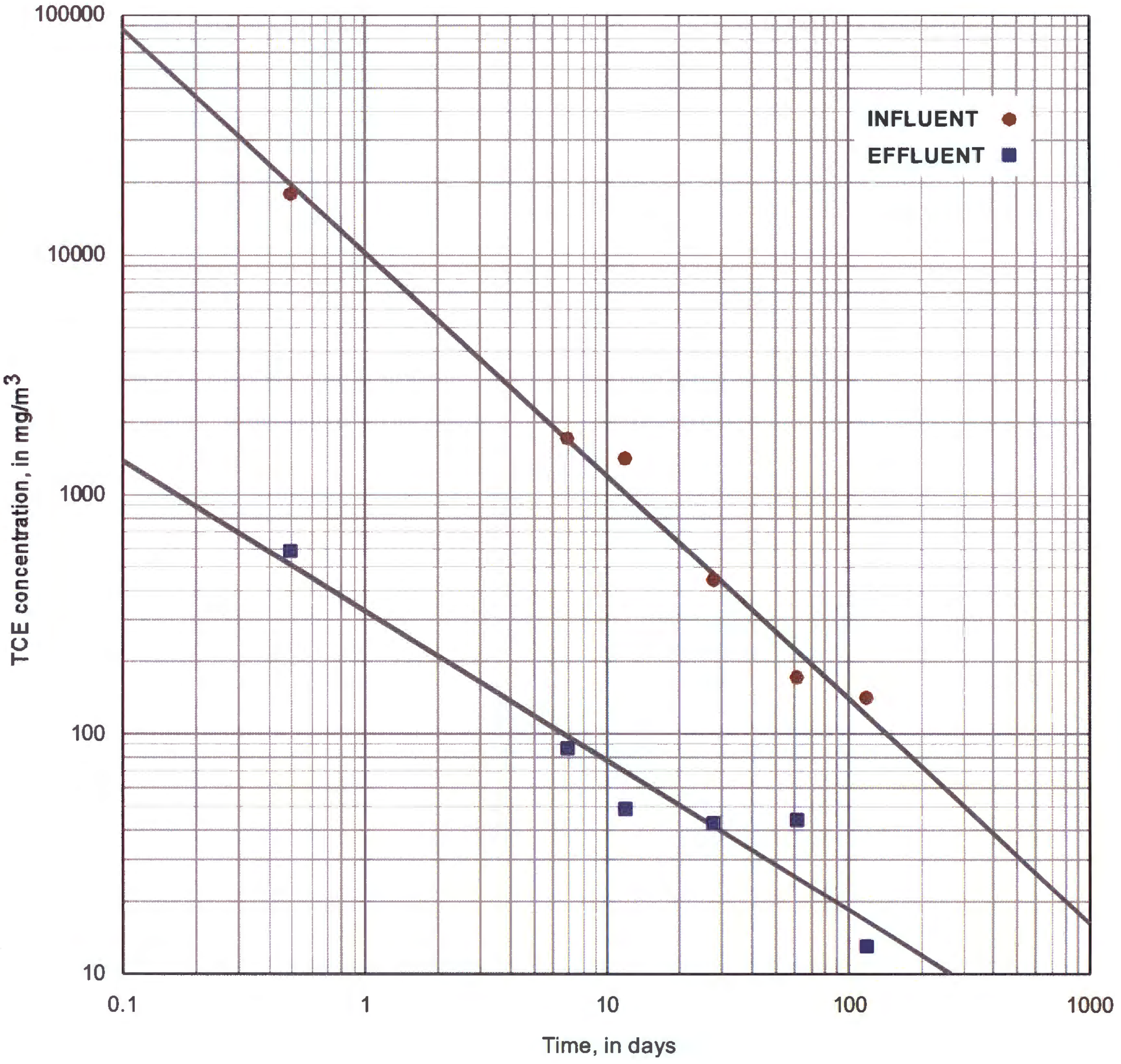


Figure 2.8 Influent and Effluent Concentrations - SVE Operation
April 8 - October 20, 1998

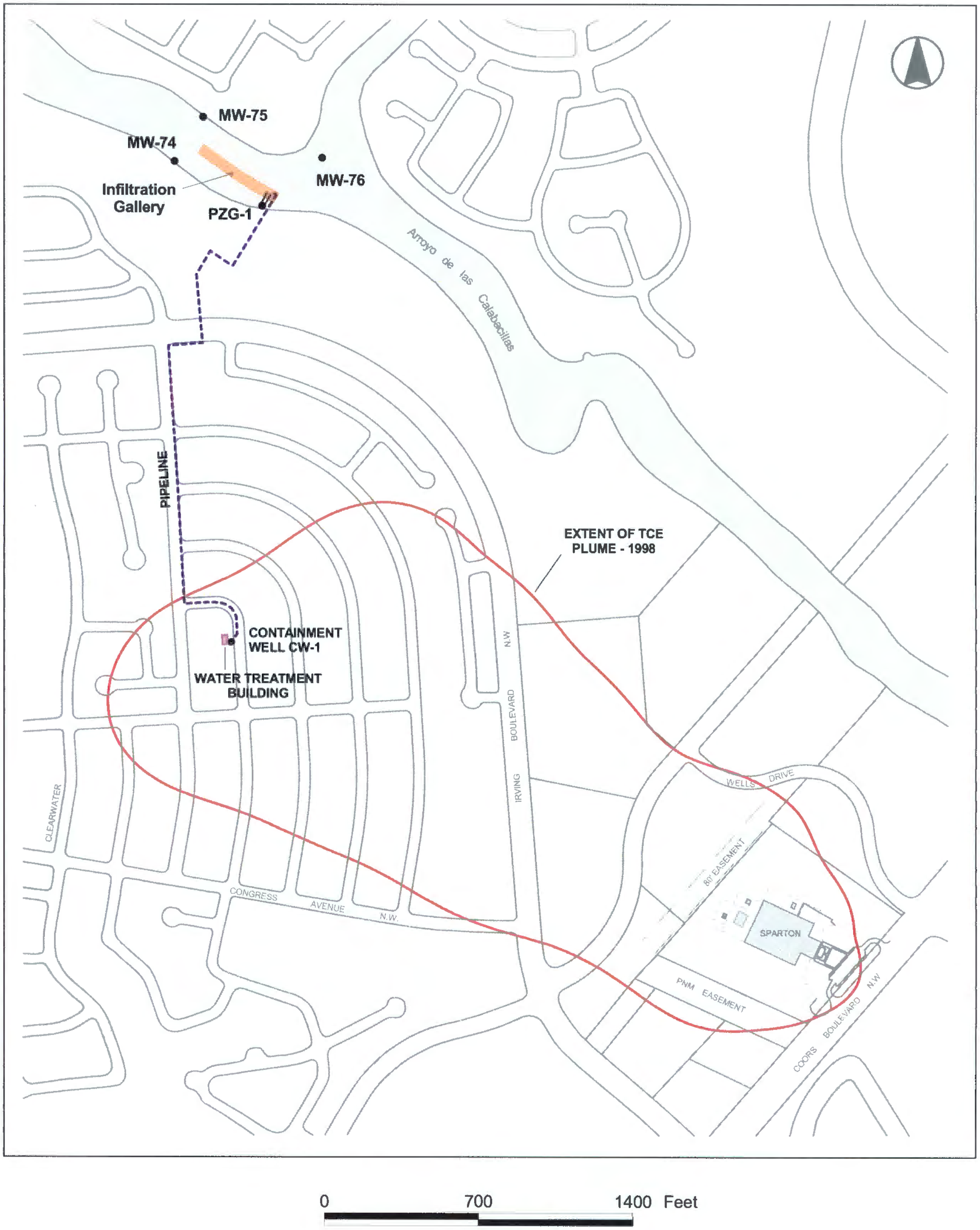


Figure 2.9 Layout of the Off-Site Containment System Components

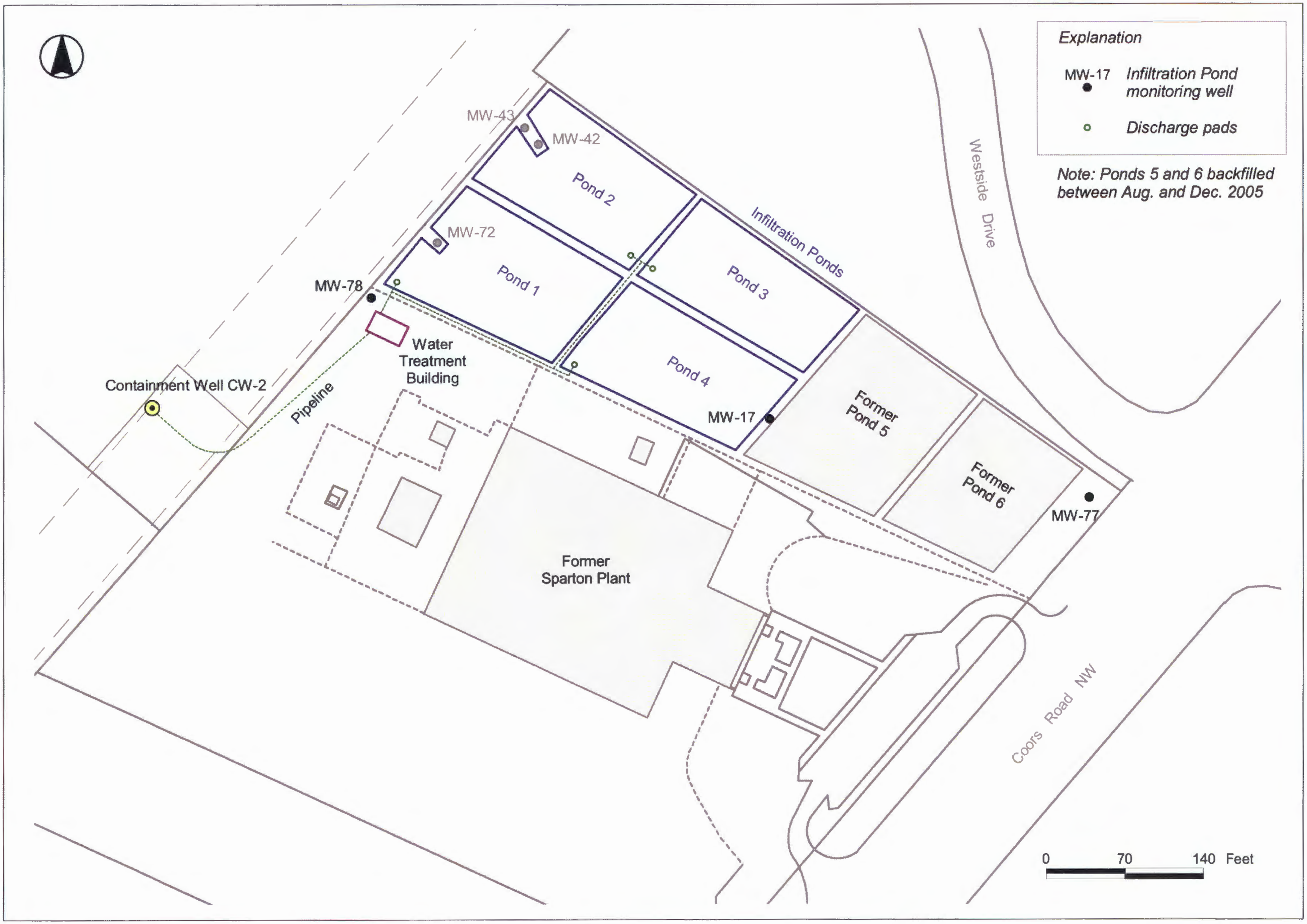


Figure 2.10 Layout of the Source Containment System Components

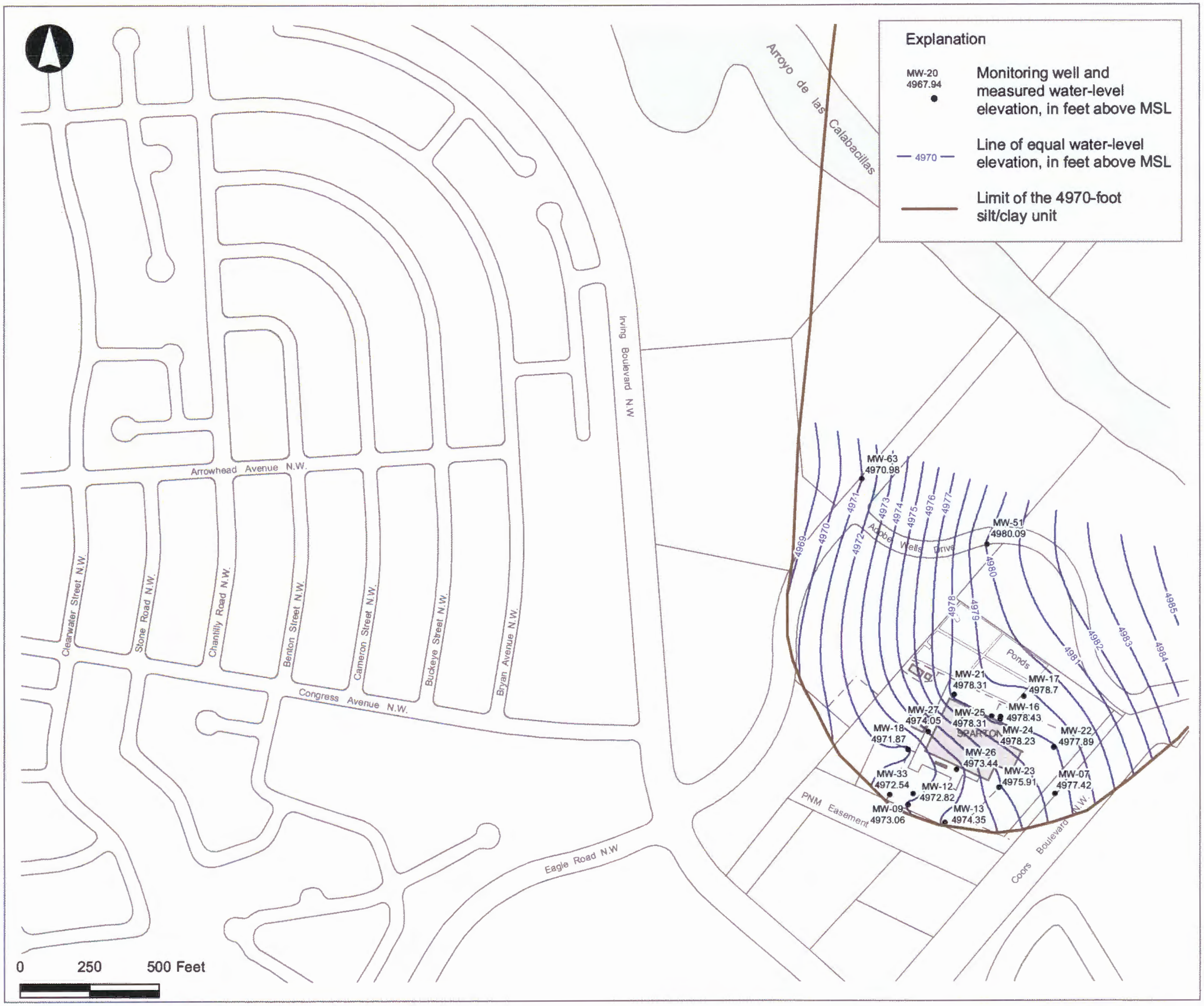


Figure 2.11 Elevation of the On-Site Water Table - November 1998

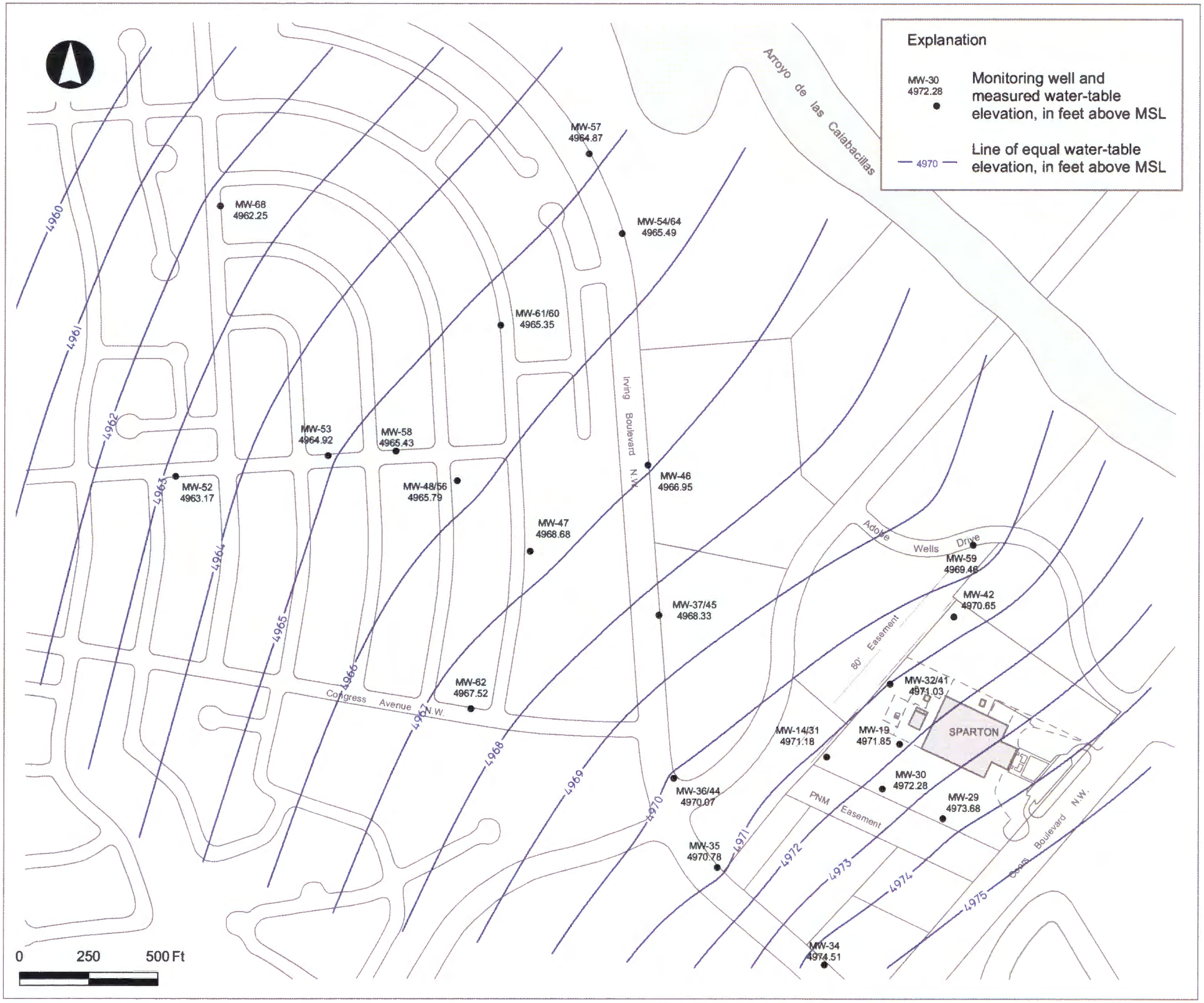


Figure 2.12 Elevation of the Water Levels in the UFZ/ULFZ - November 1998

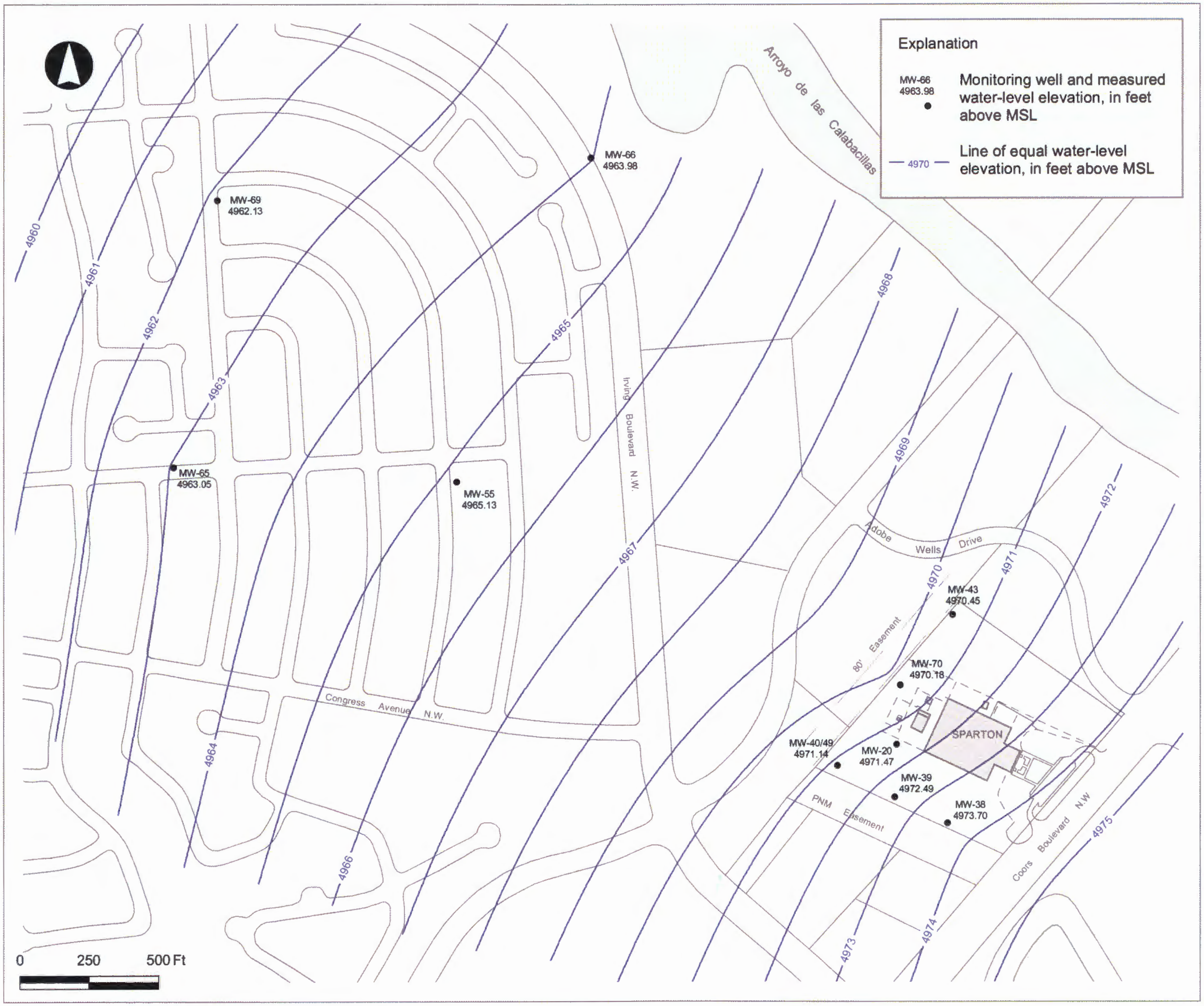


Figure 2.13 Elevation of the Water Levels in the LLFZ - November 1998

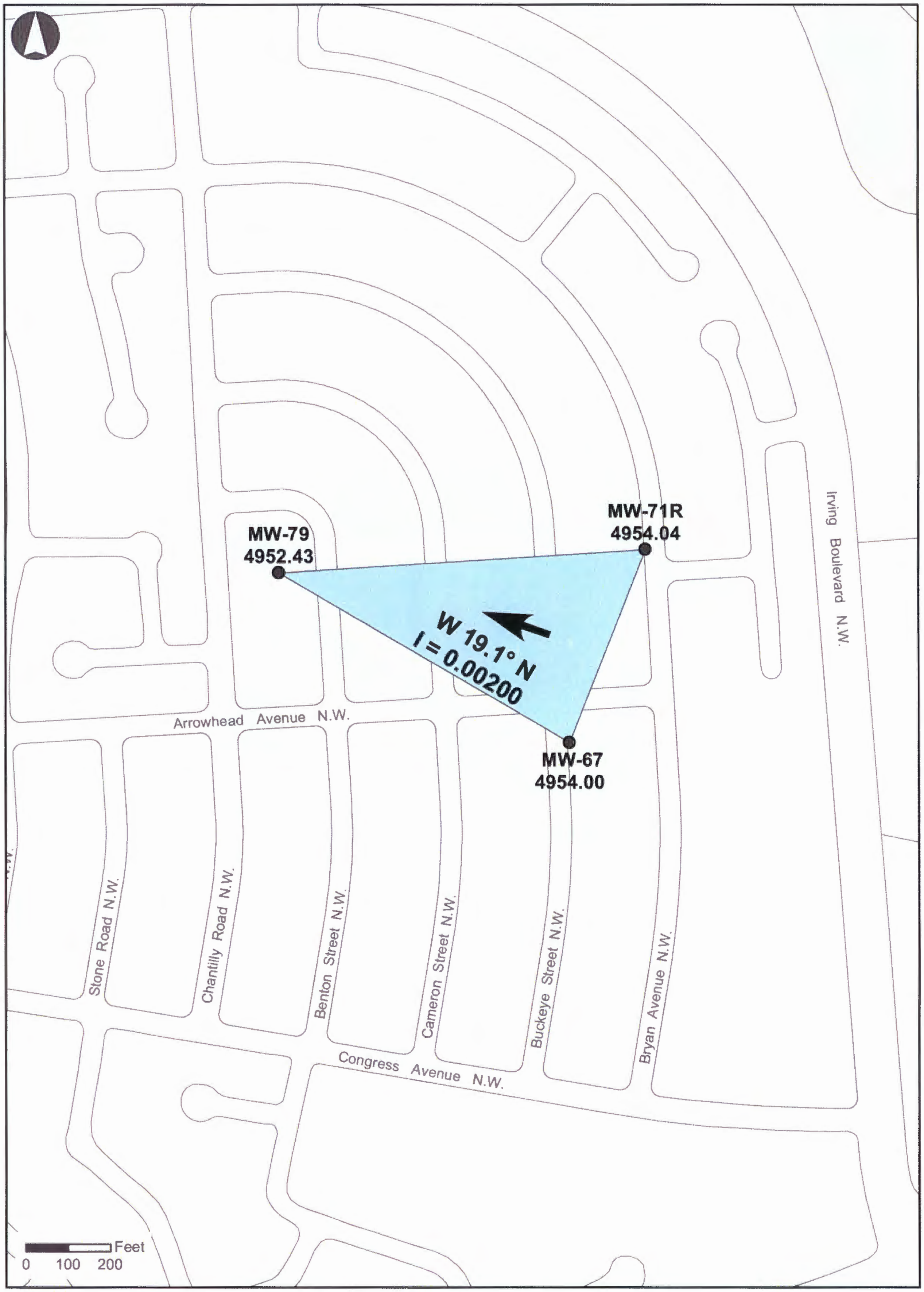


Figure 2.14 Average Direction of Groundwater Flow and Average Hydraulic Gradient in the DFZ (2006 - 2008)

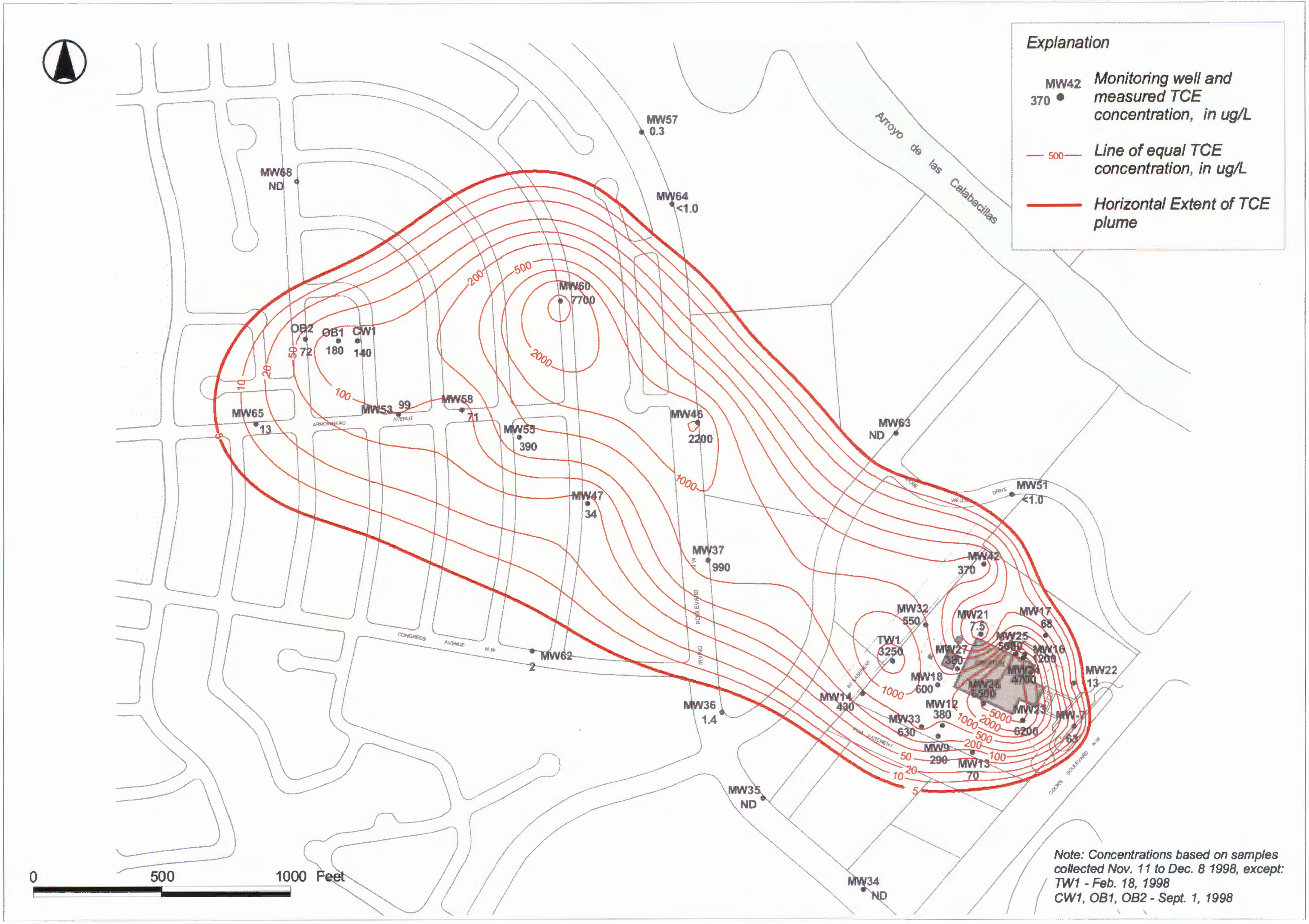


Figure 2.15 Horizontal Extent of TCE Plume - November 1998

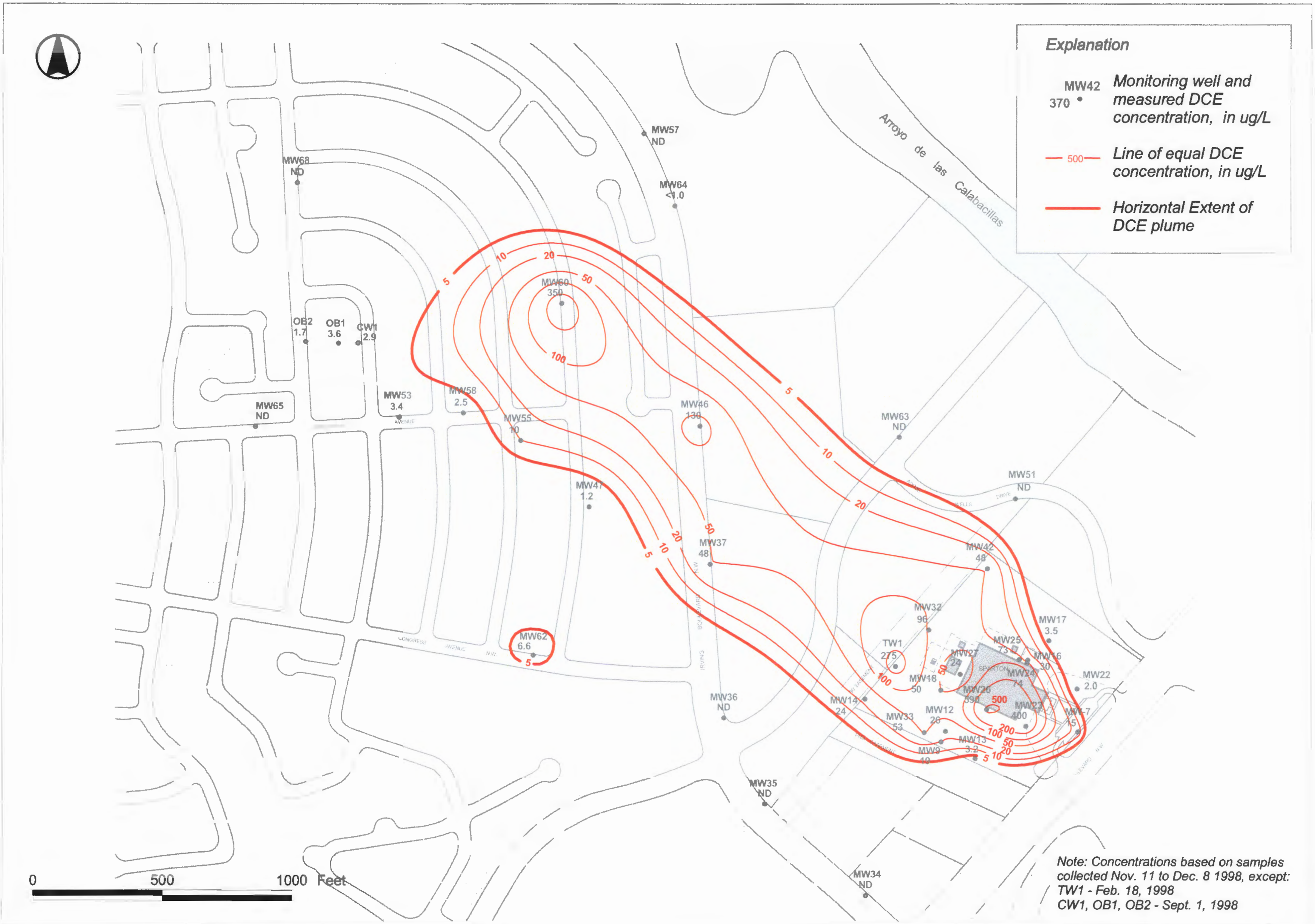


Figure 2.16 Horizontal Extent of DCE Plume - November 1998

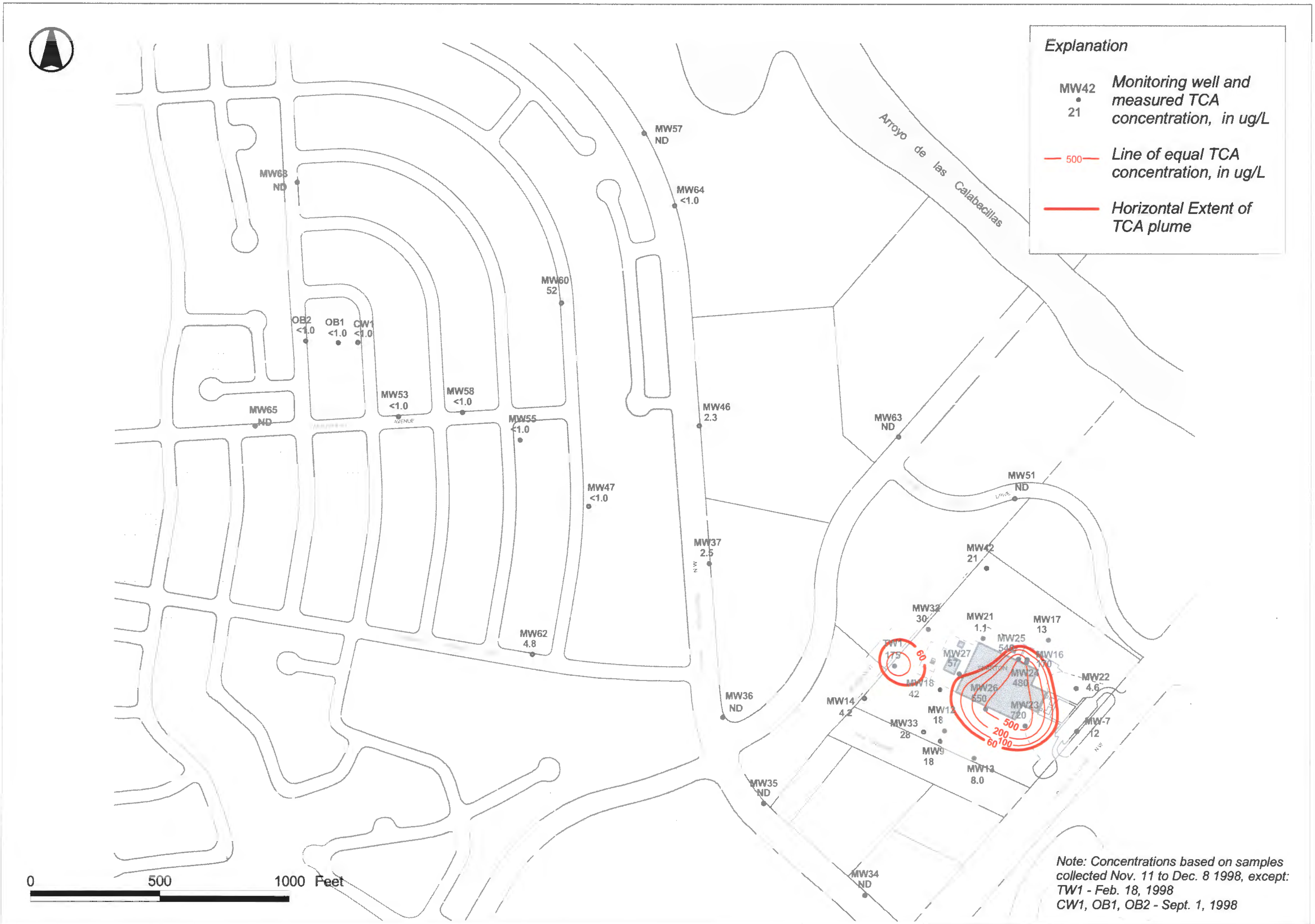


Figure 2.17 Horizontal Extent of TCA Plume - November 1998

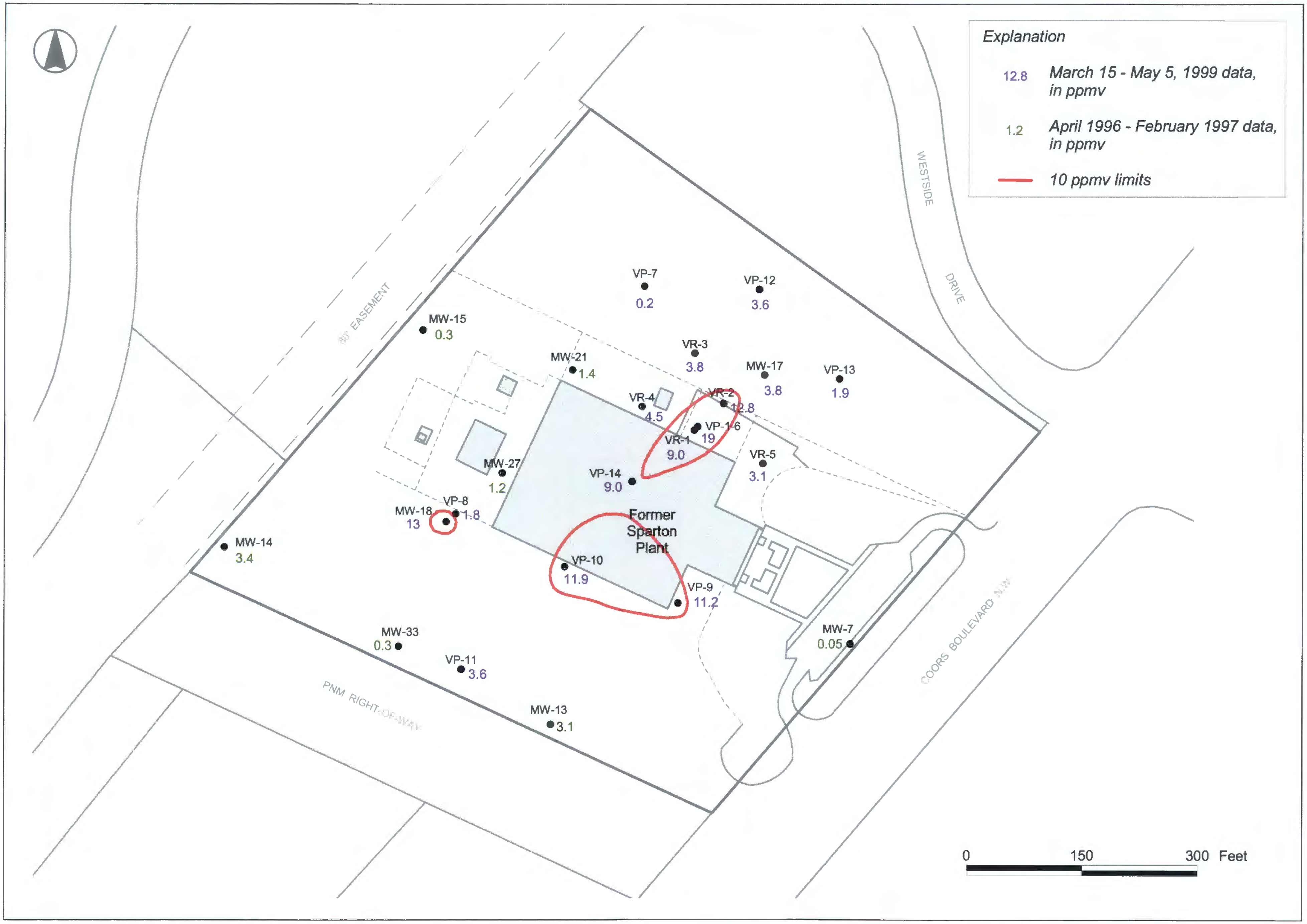


Figure 2.18 TCE Soil Gas Concentrations Prior to the 1999 Resumption of SVE System Operations

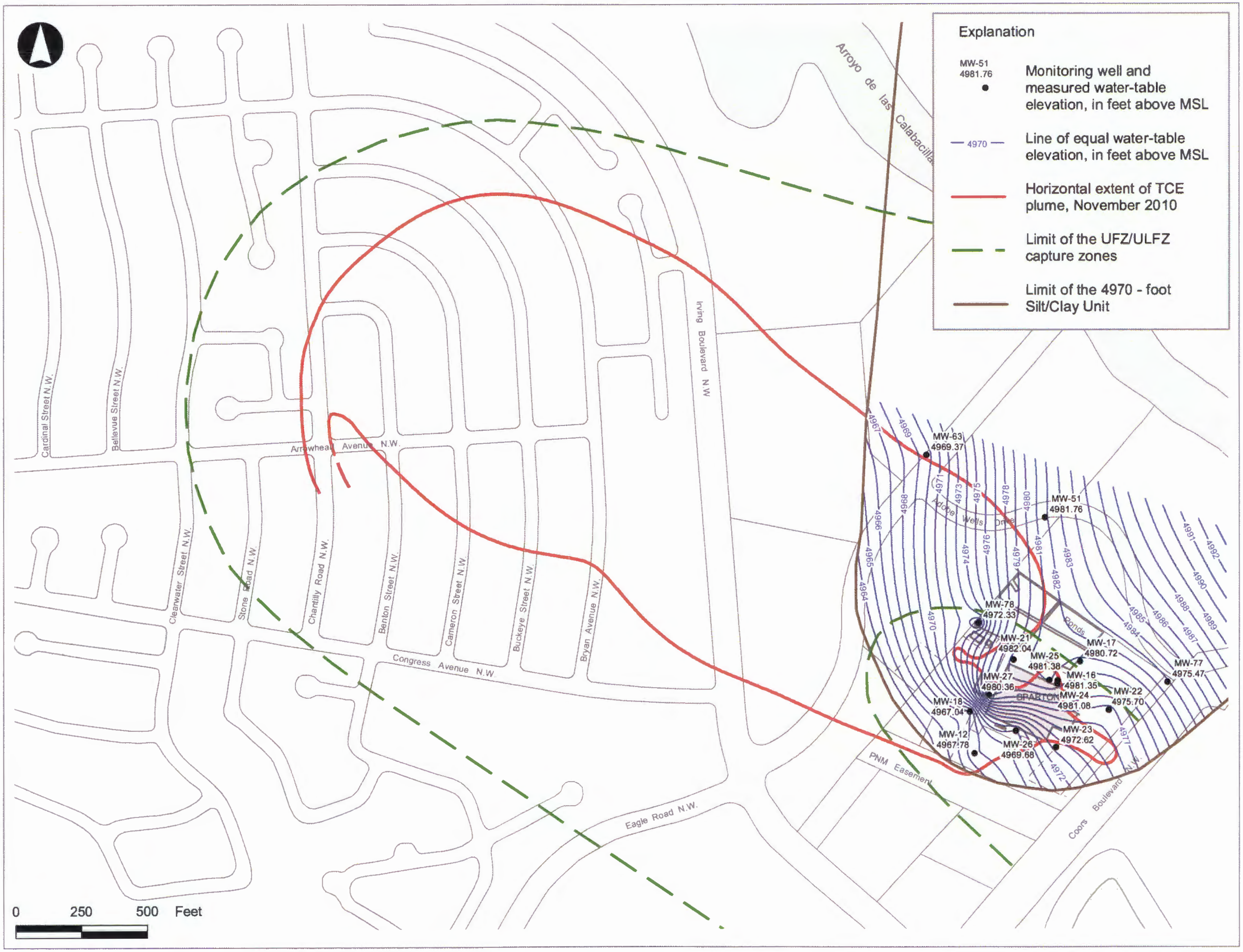


Figure 5.1 Elevation of the On-Site Water Table - February 8-9, 2011

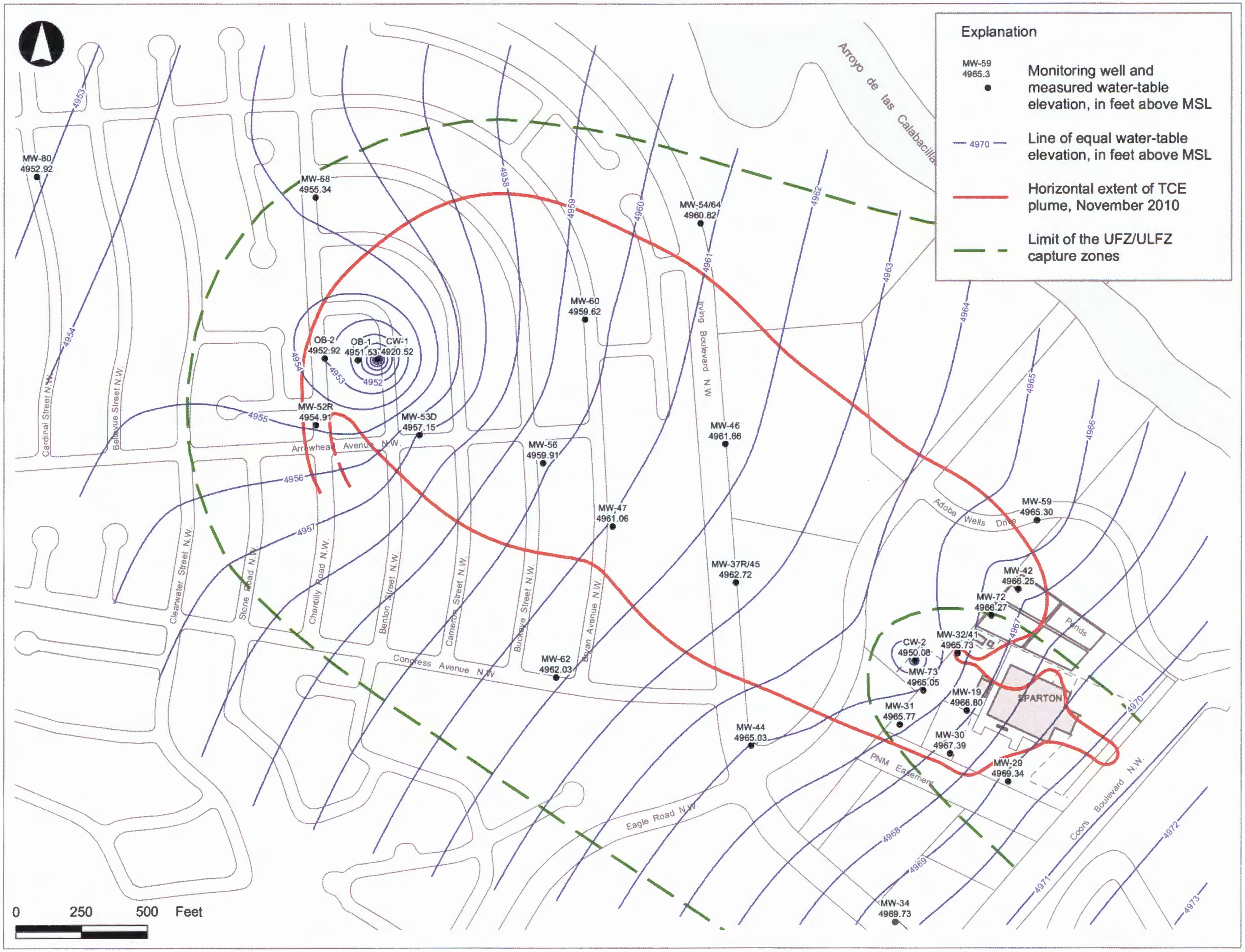


Figure 5.2 Elevation of Water Levels and Limits of Containment Well Capture Zones in the UFZ/ULFZ - February 8-9, 2011

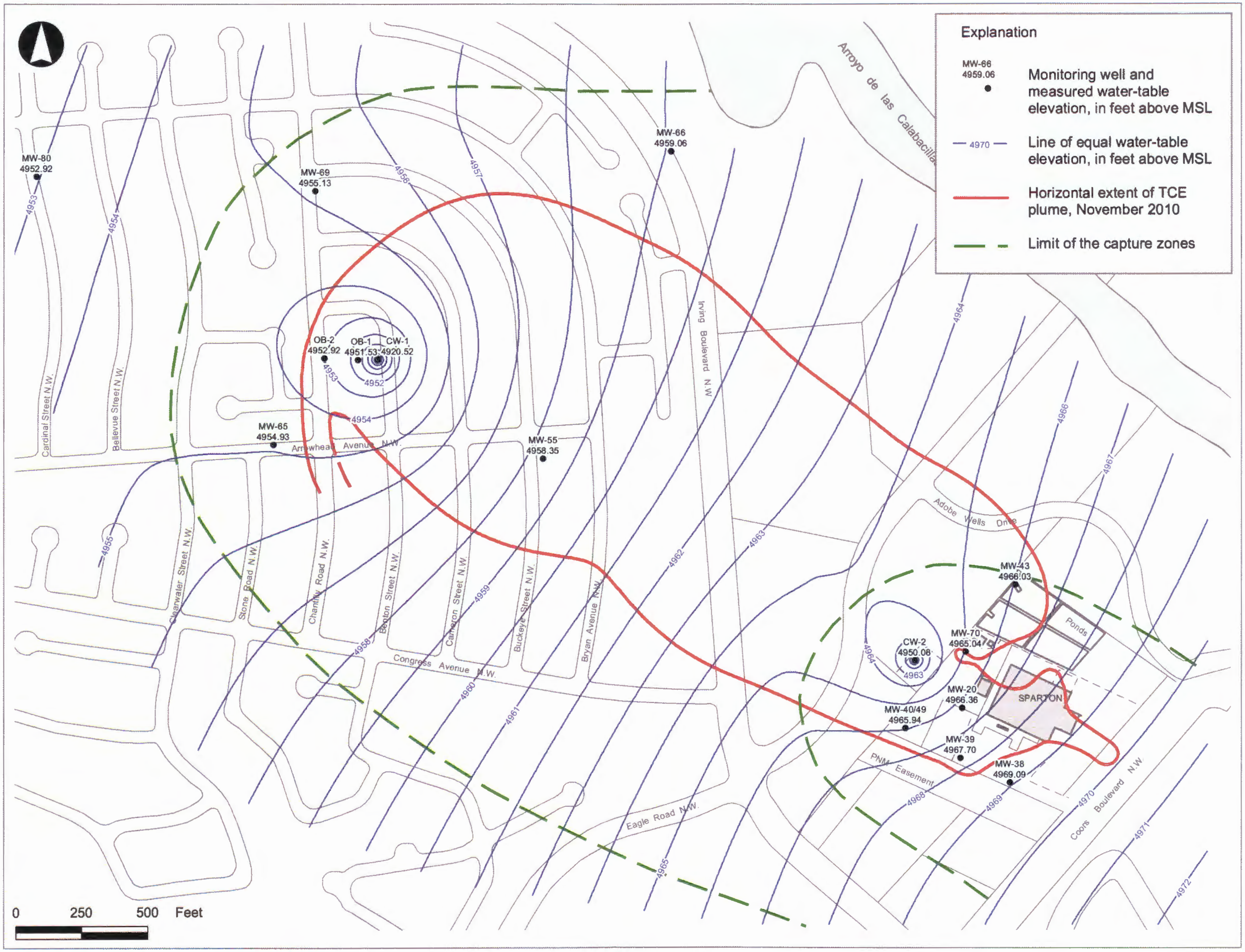


Figure 5.3 Elevation of Water Levels and Limits of Containment Well Capture Zones in the LLFZ - February 8-9, 2011

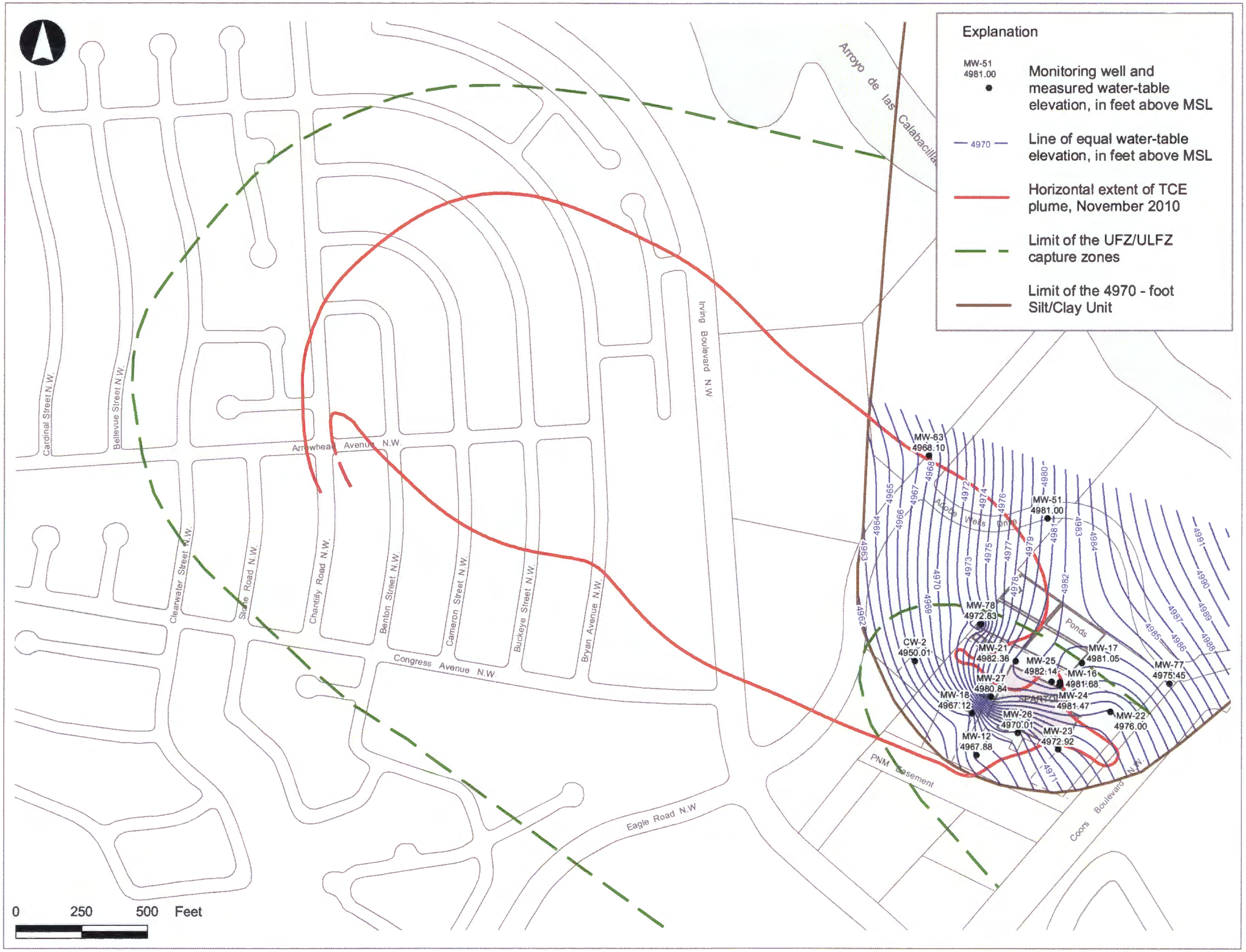


Figure 5.4 Elevation of the On-Site Water Table - May 10-11, 2011

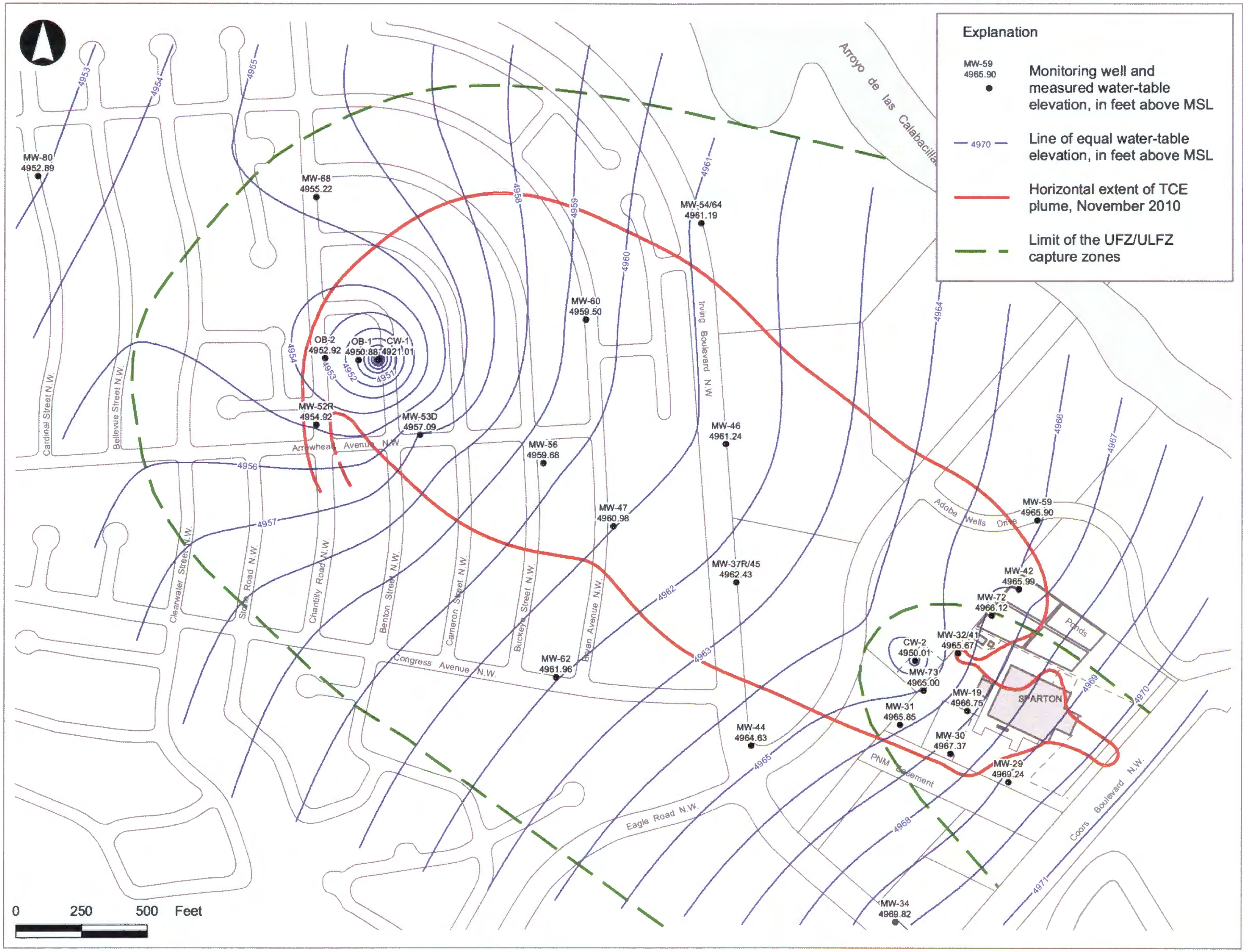


Figure 5.5 Elevation of Water Levels and Limits of Containment Well Capture Zones in the UFZ/ULFZ - May 10-11, 2011

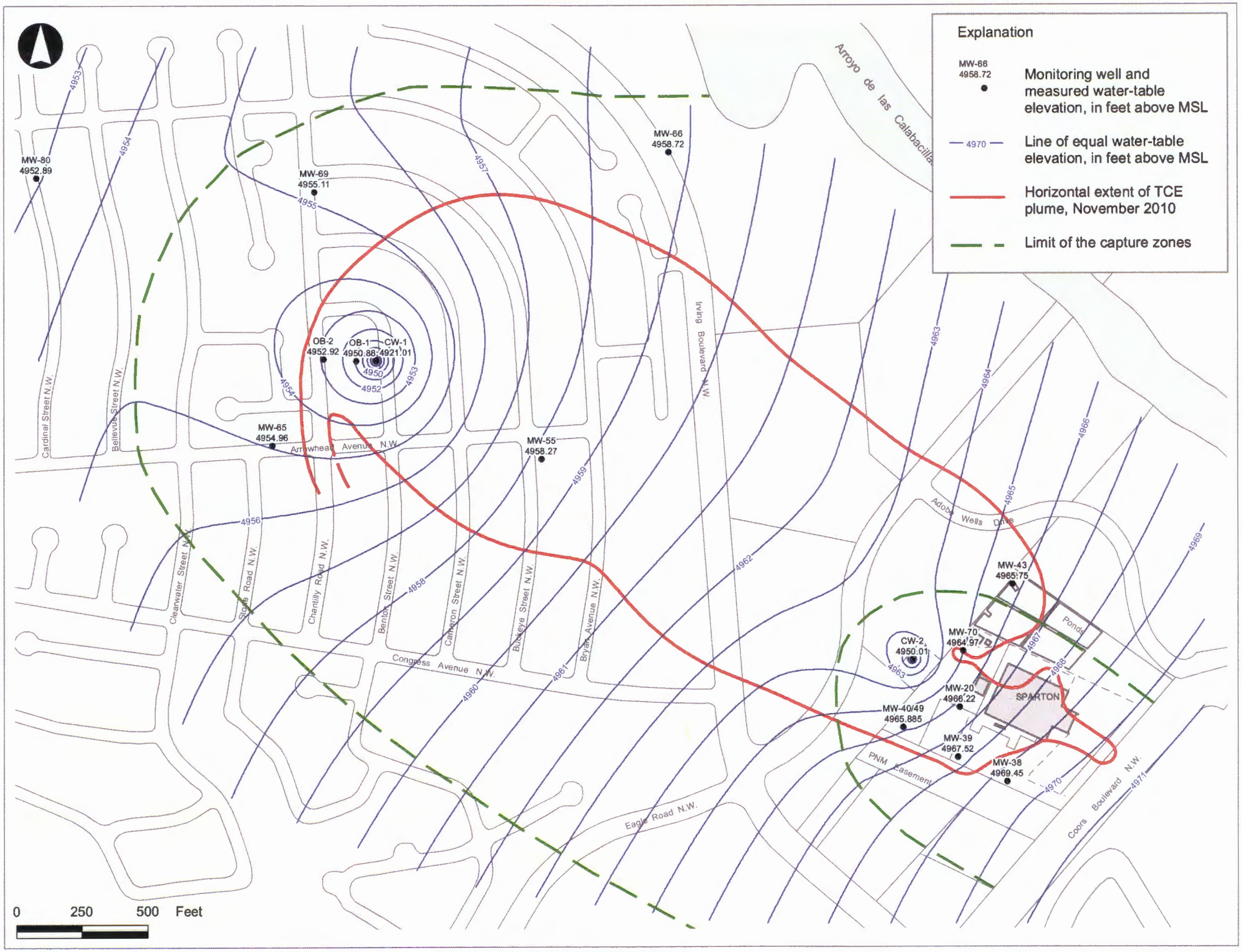


Figure 5.6 Elevation of Water Levels and Limits of Containment Well Capture Zones in the LLFZ - May 10-11, 2011

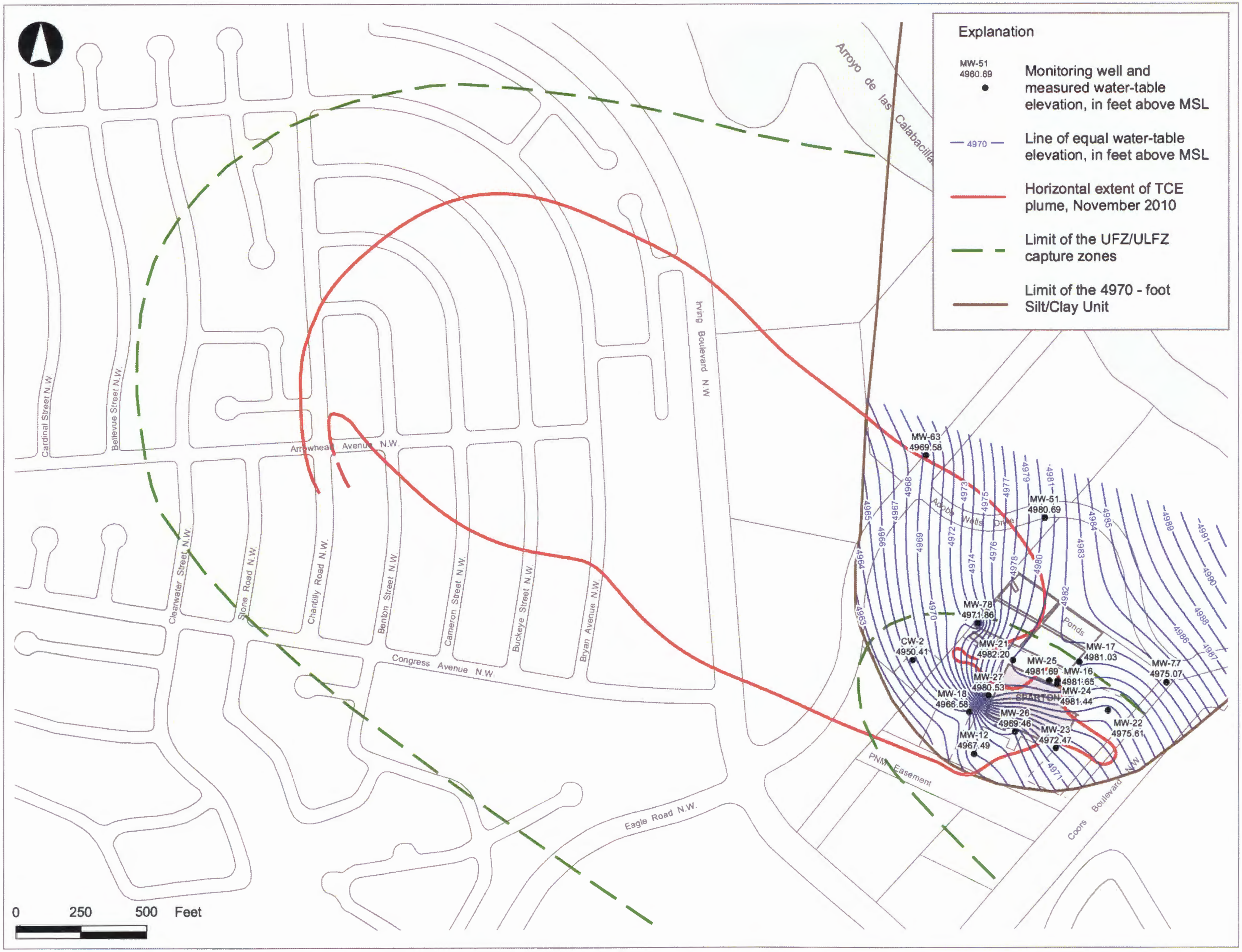


Figure 5.7 Elevation of the On-Site Water Table - August 16-17, 2011

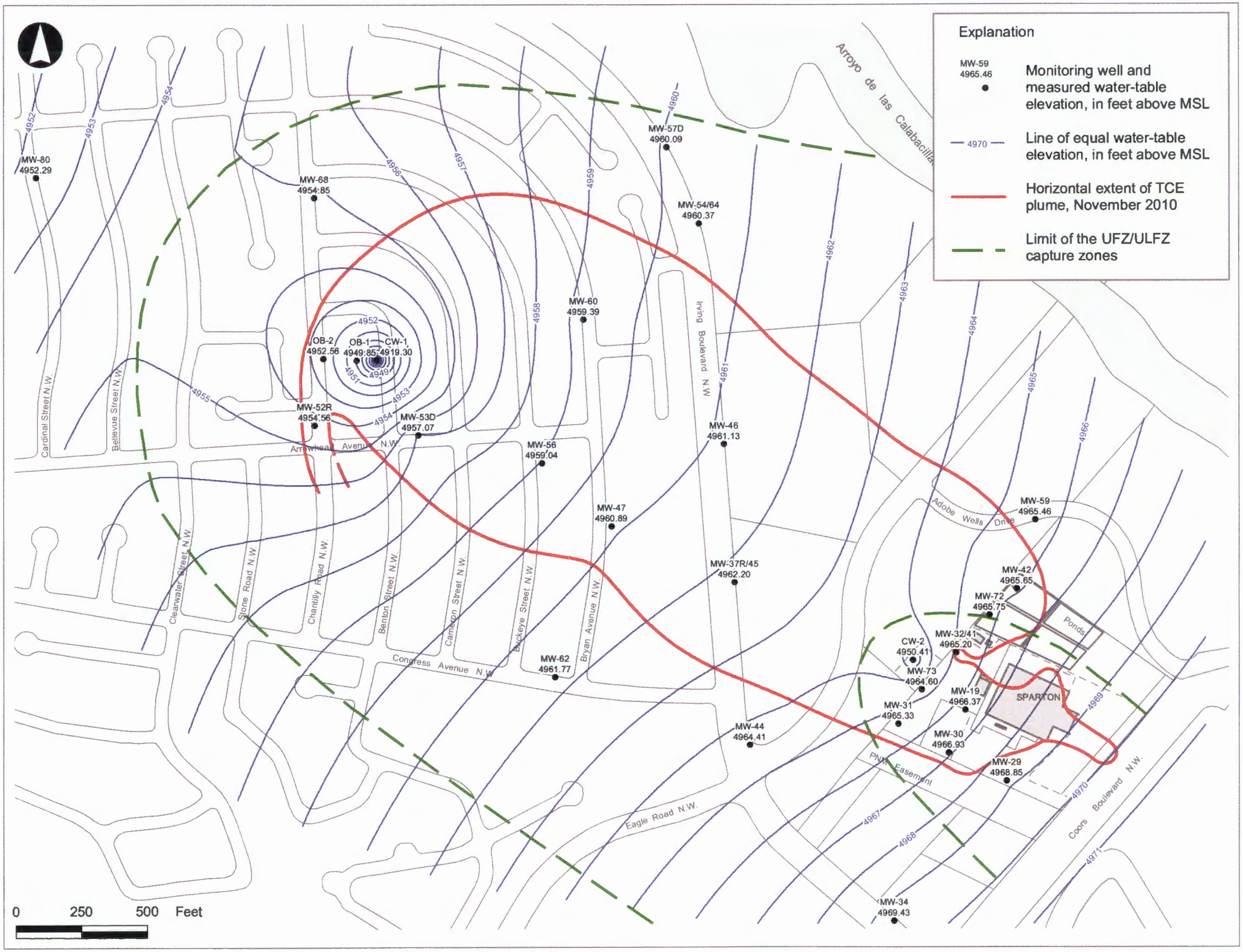


Figure 5.8 Elevation of Water Levels and Limits of Containment Well Capture Zones in the UFZ/ULFZ - August 16-17, 2011

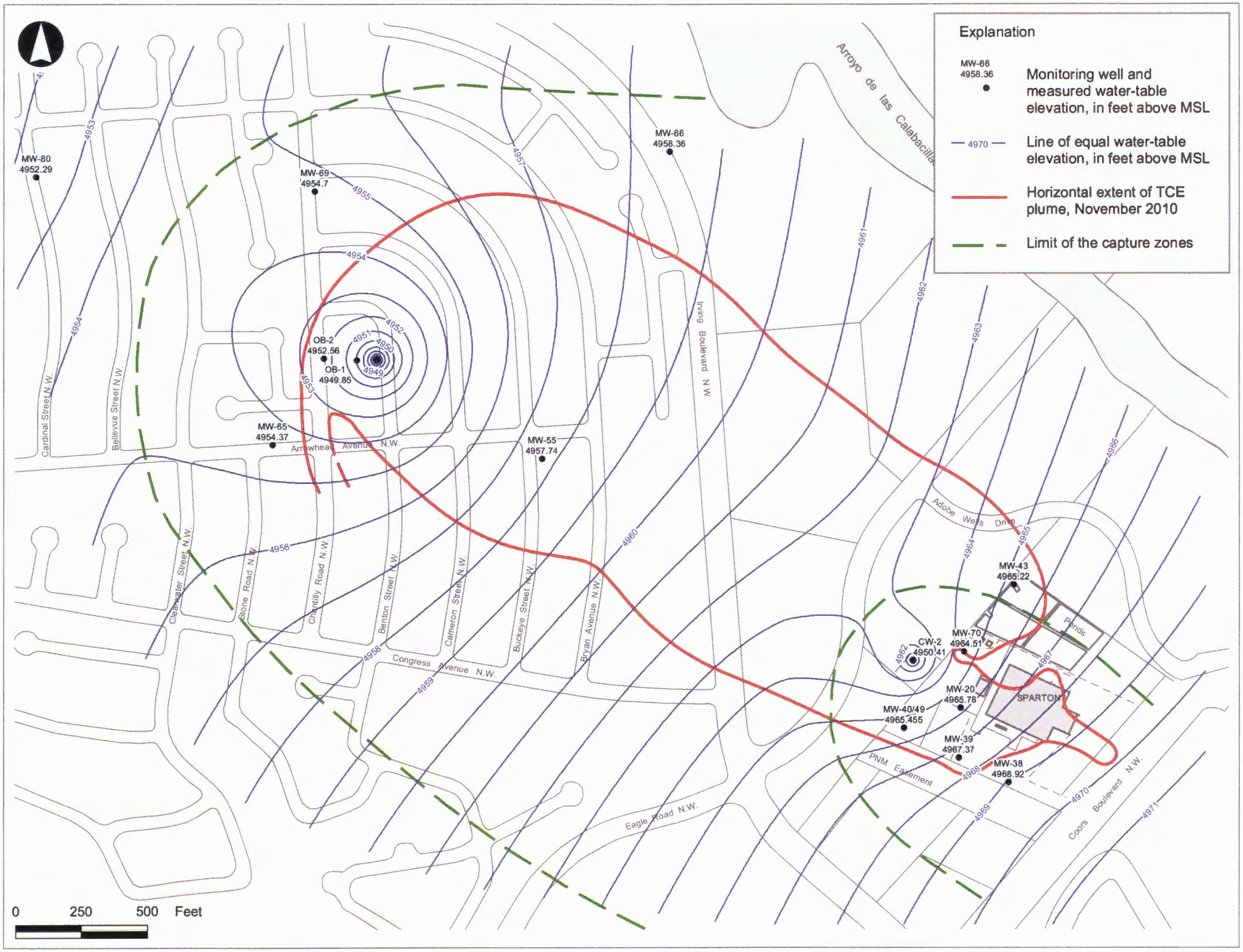


Figure 5.9 Elevation of Water Levels and Limits of Containment Well Capture Zones in the LLFZ - August 16-17, 2011

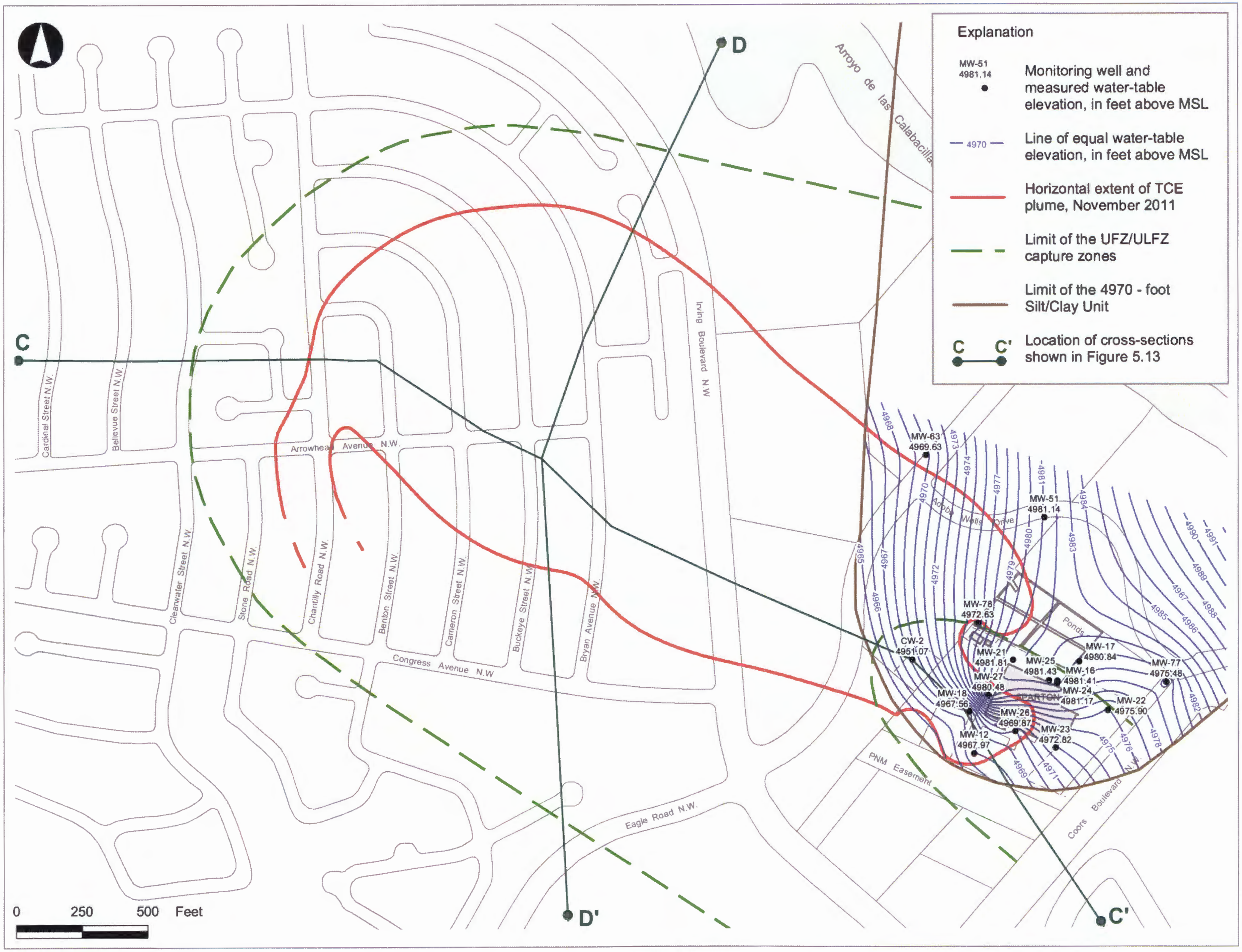


Figure 5.10 Elevation of the On-Site Water Table - November 15-16, 2011

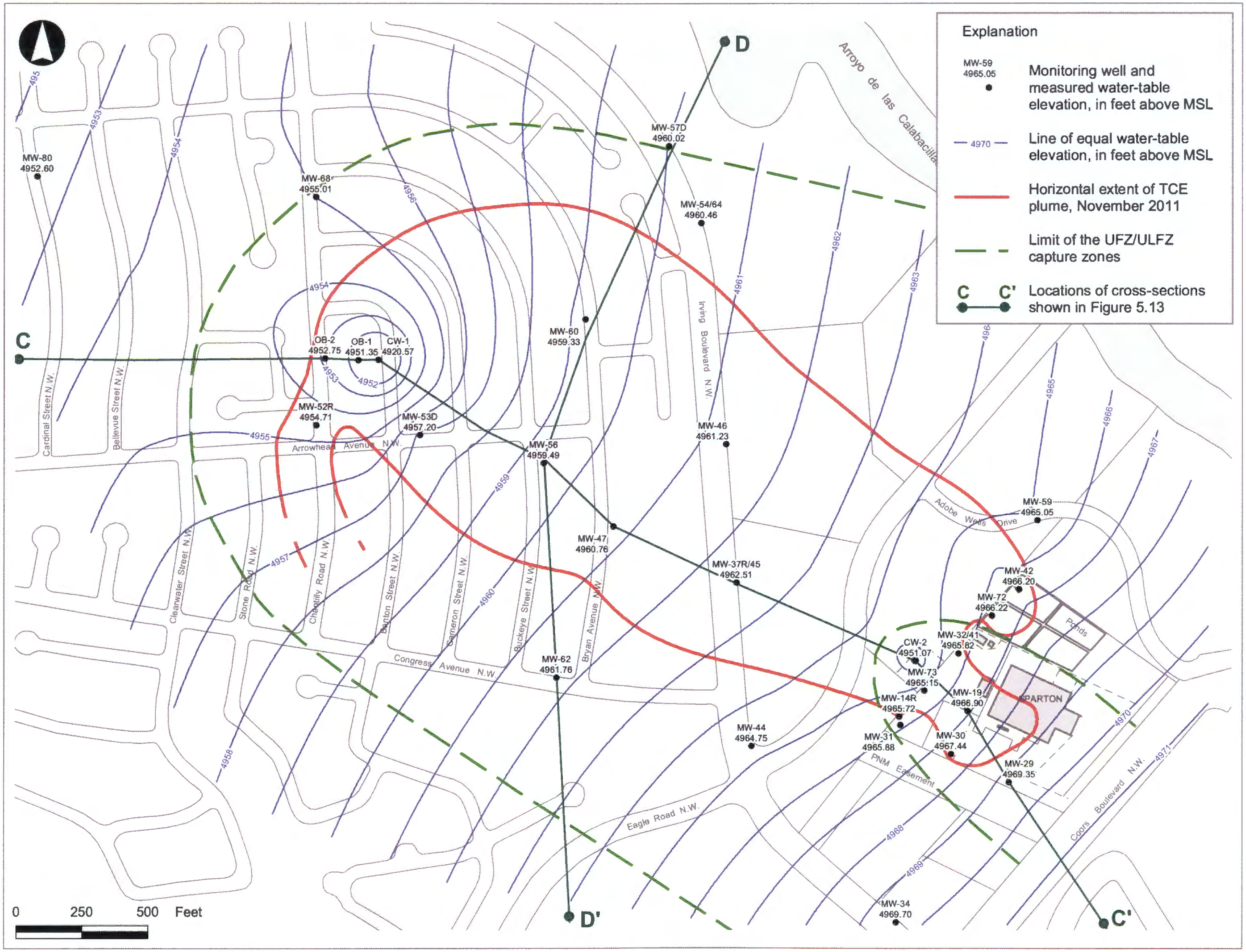


Figure 5.11 Elevation of Water Levels and Limits of Containment Well Capture Zones in the UFZ/ULFZ - November 15-16, 2011

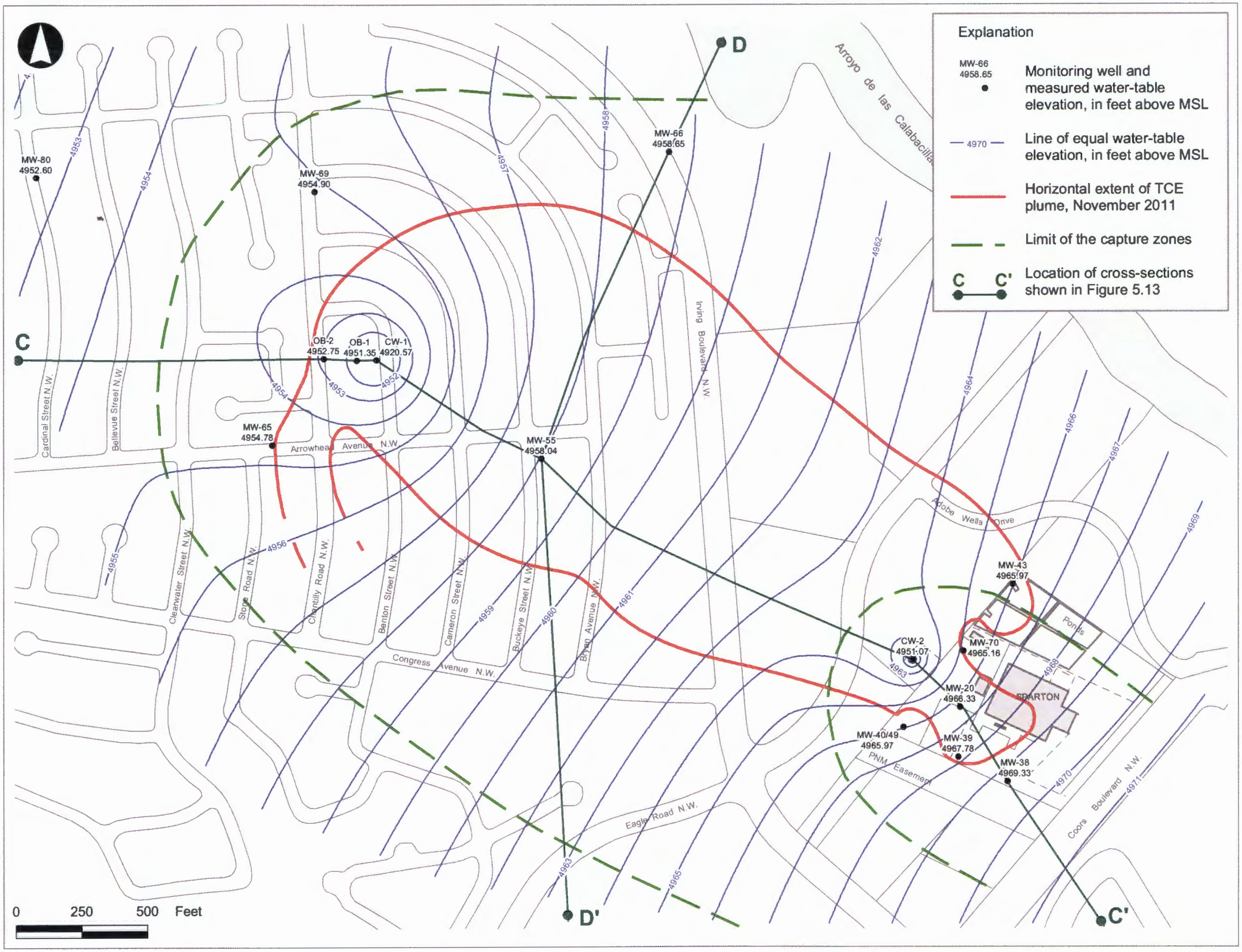


Figure 5.12 Elevation of Water Levels and Limits of Containment Well Capture Zones in the LLFZ - November 15-16, 2011

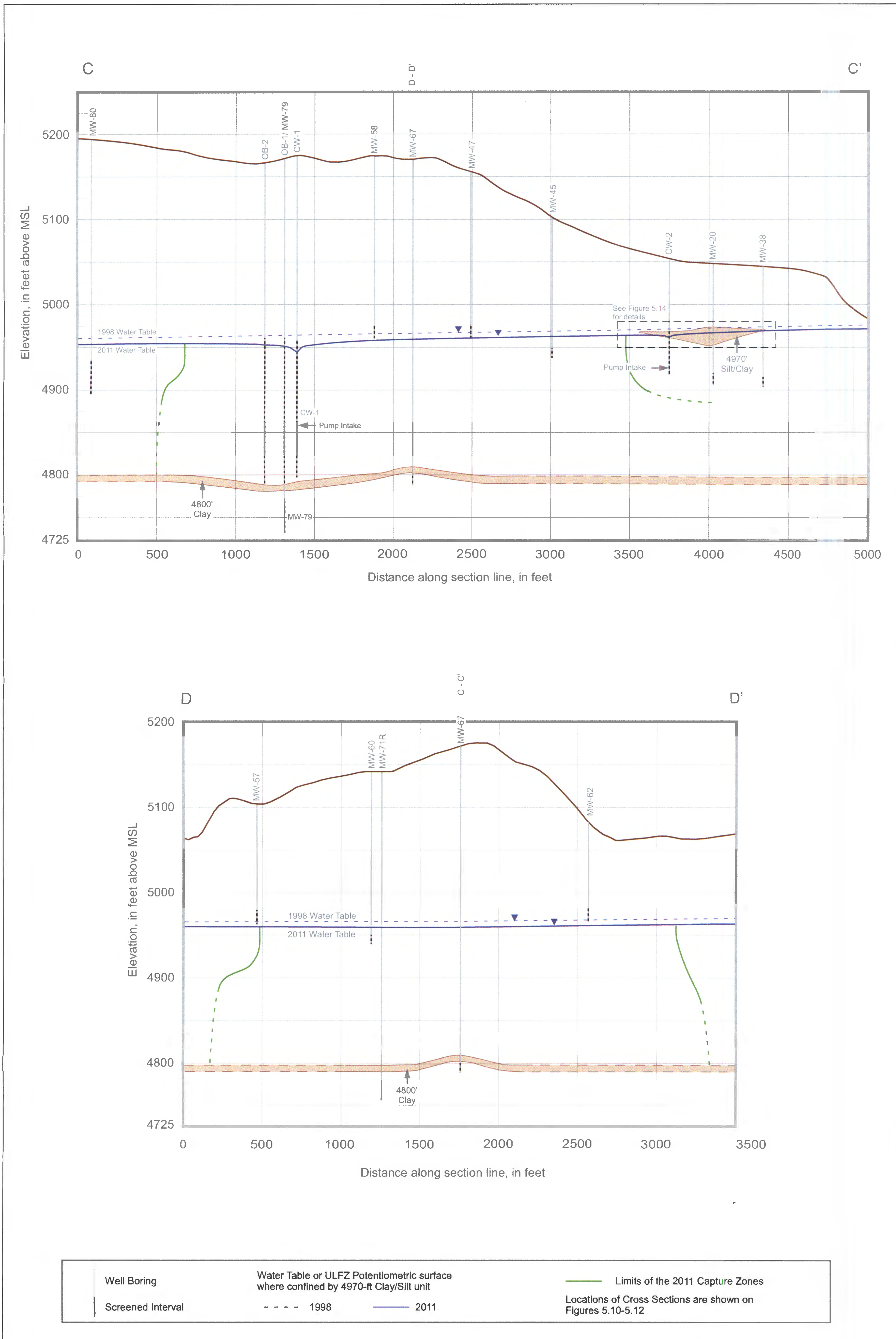


Figure 5.13 Schematic Cross-Sections Showing November 1998 and 2011 Water Levels and Containment Well Capture Zones

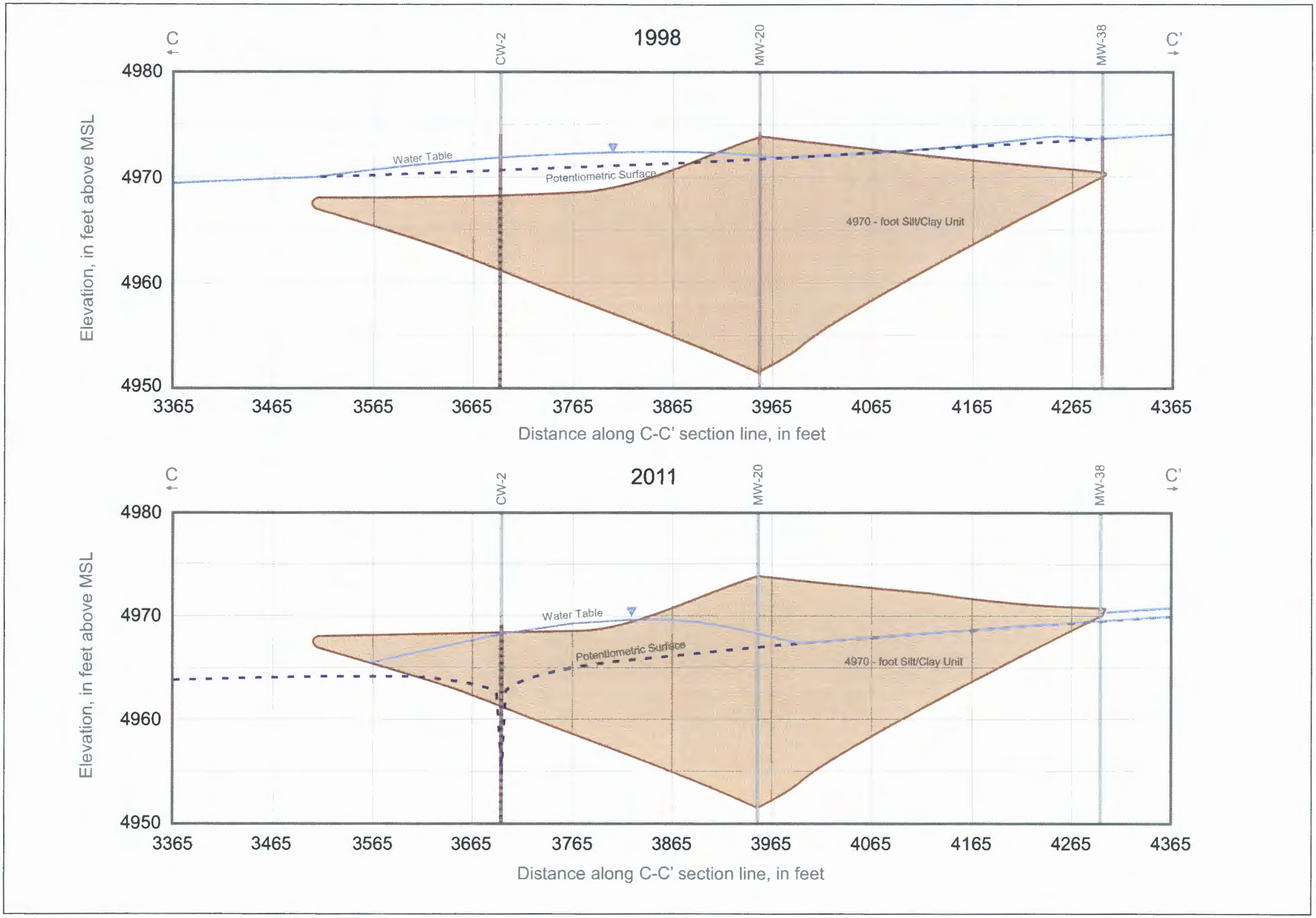


Figure 5.14 Details of Water Level Conditions at the Area Underlain by the 4970 - foot Silt/Clay Unit

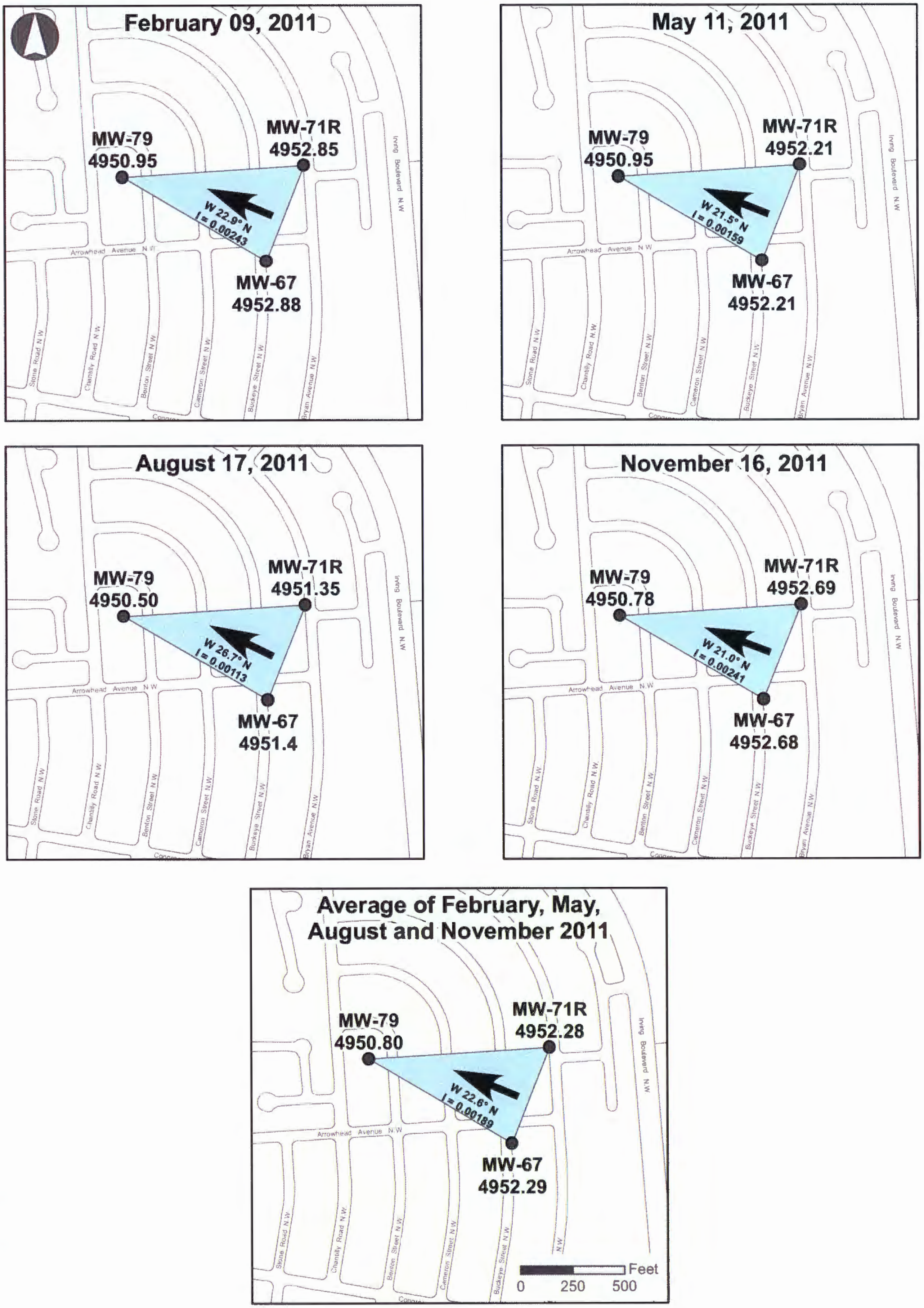
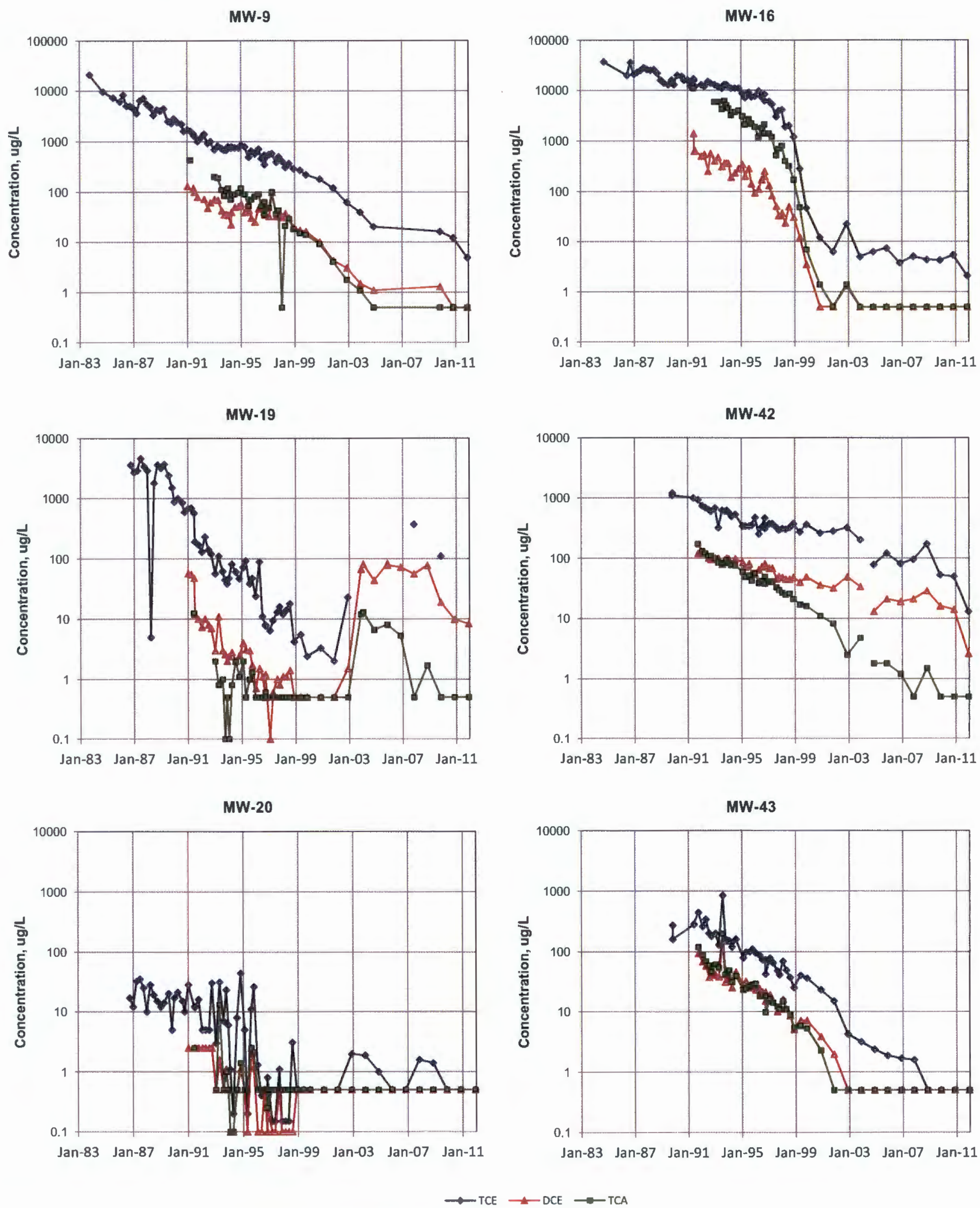
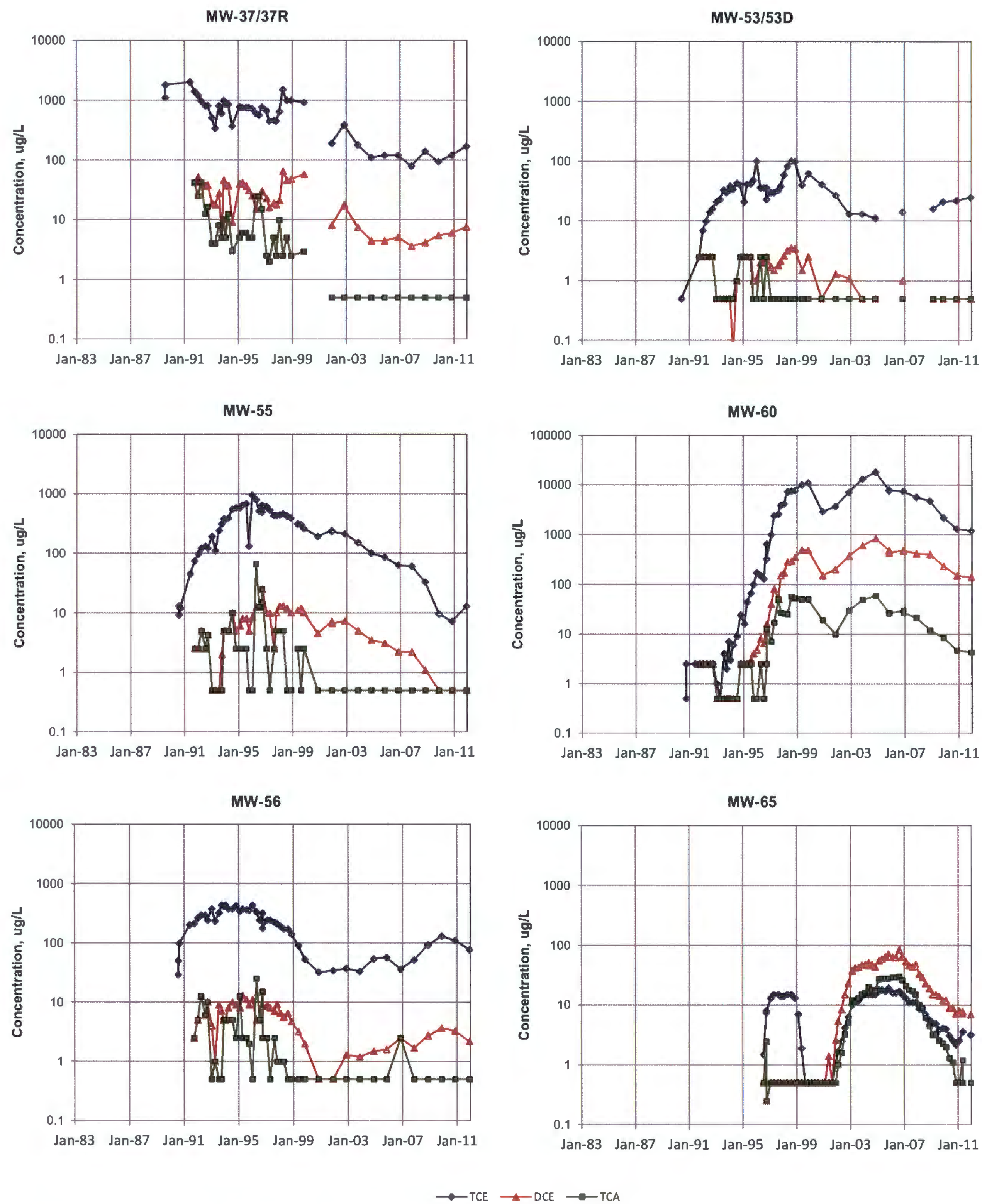


Figure 5.15 Groundwater Flow Direction and Hydraulic Gradient in the DFZ - 2011



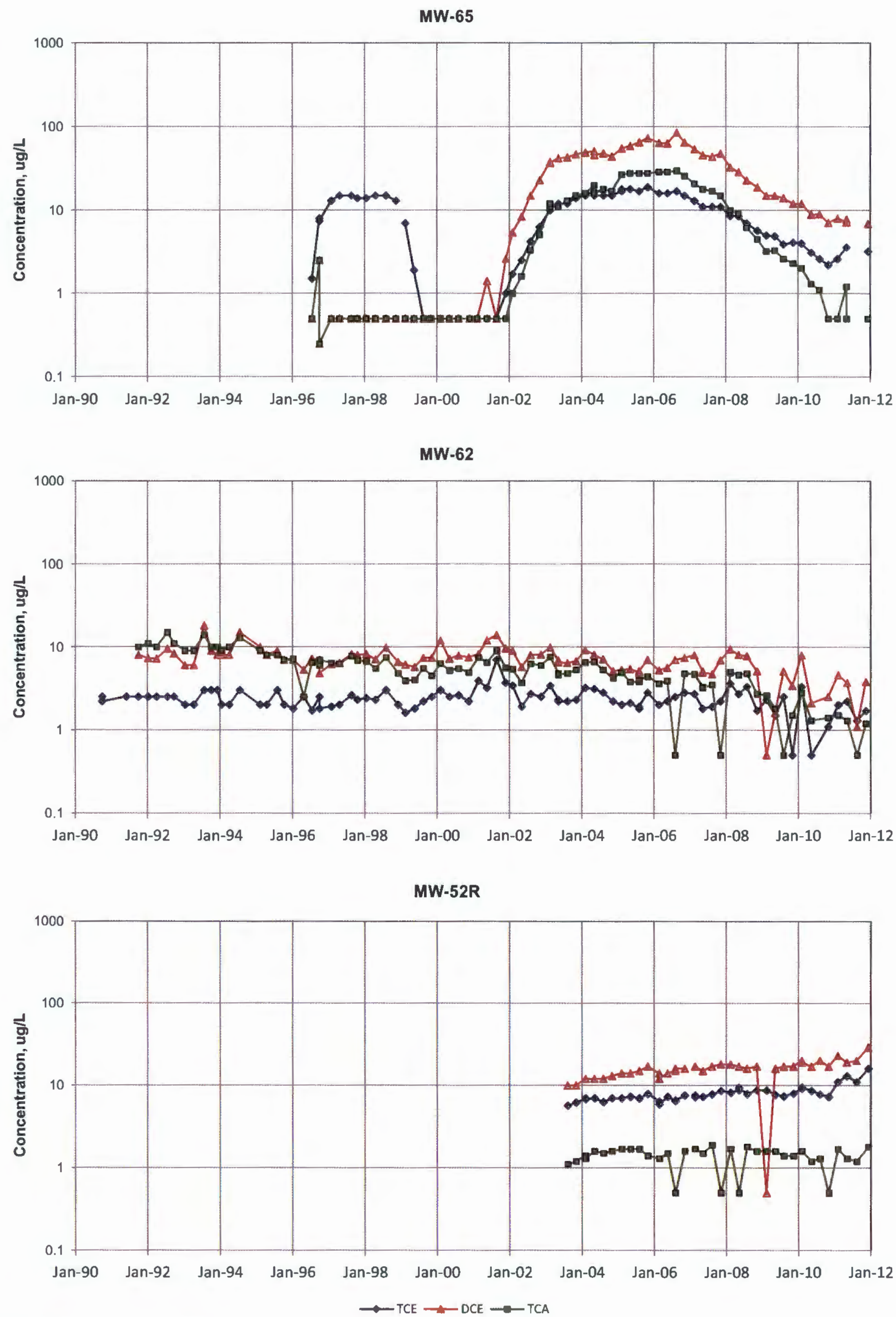
Note : Concentrations reported as less than the detection limit are plotted as 1/2 the detection limit.

Figure 5.16 Contaminant Concentration Trends in On-Site Monitoring Wells



Note : Concentrations reported as less than the detection limit are plotted as 1/2 the detection limit.

Figure 5.17 Contaminant Concentration Trends in Off-Site Monitoring Wells



Note : Concentrations reported as less than the detection limit are plotted as 1/2 the detection limit.

Figure 5.18 Concentration Trends in Monitoring Wells with DCE Dominated Contamination

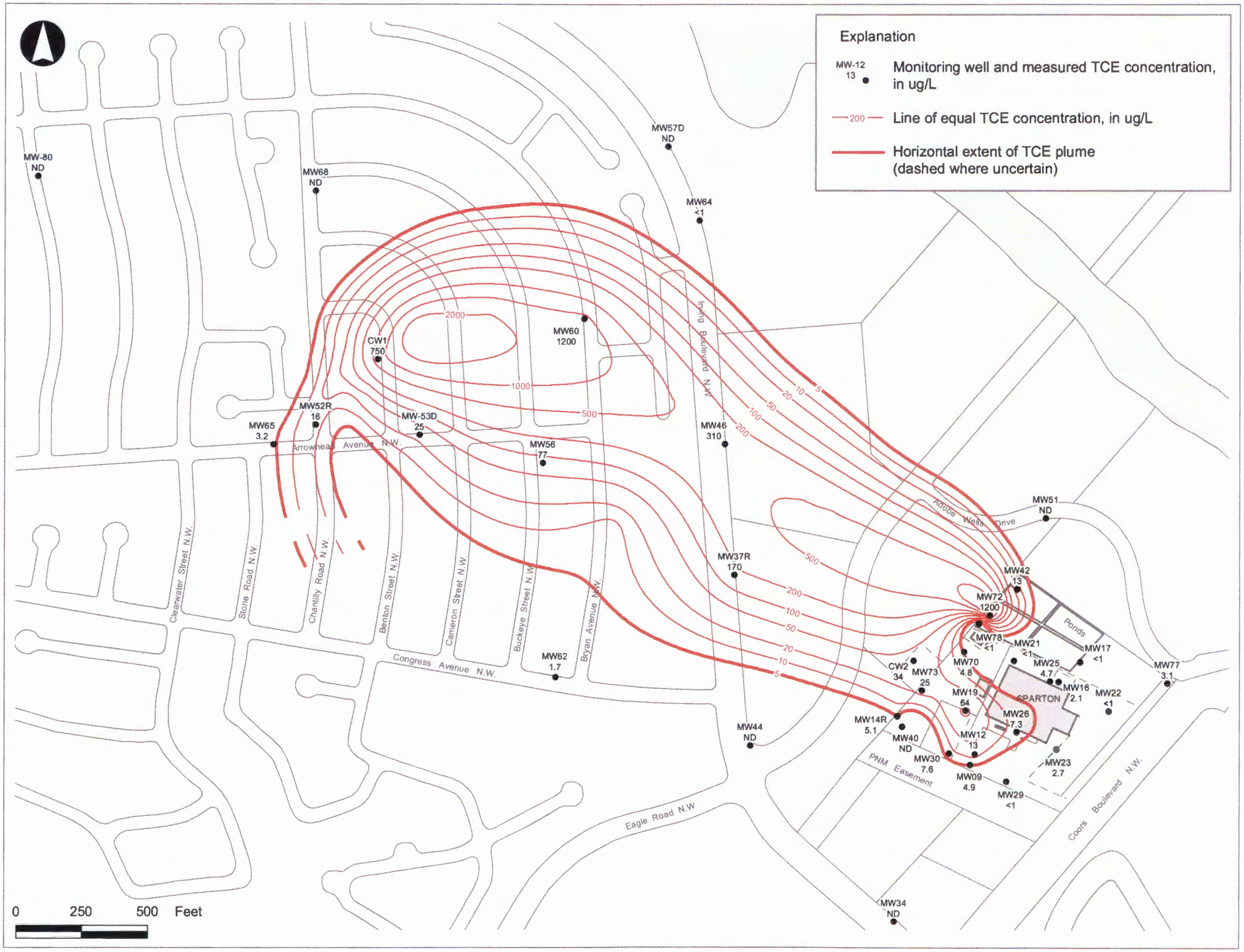


Figure 5.19 Horizontal Extent of TCE Plume - November 2011

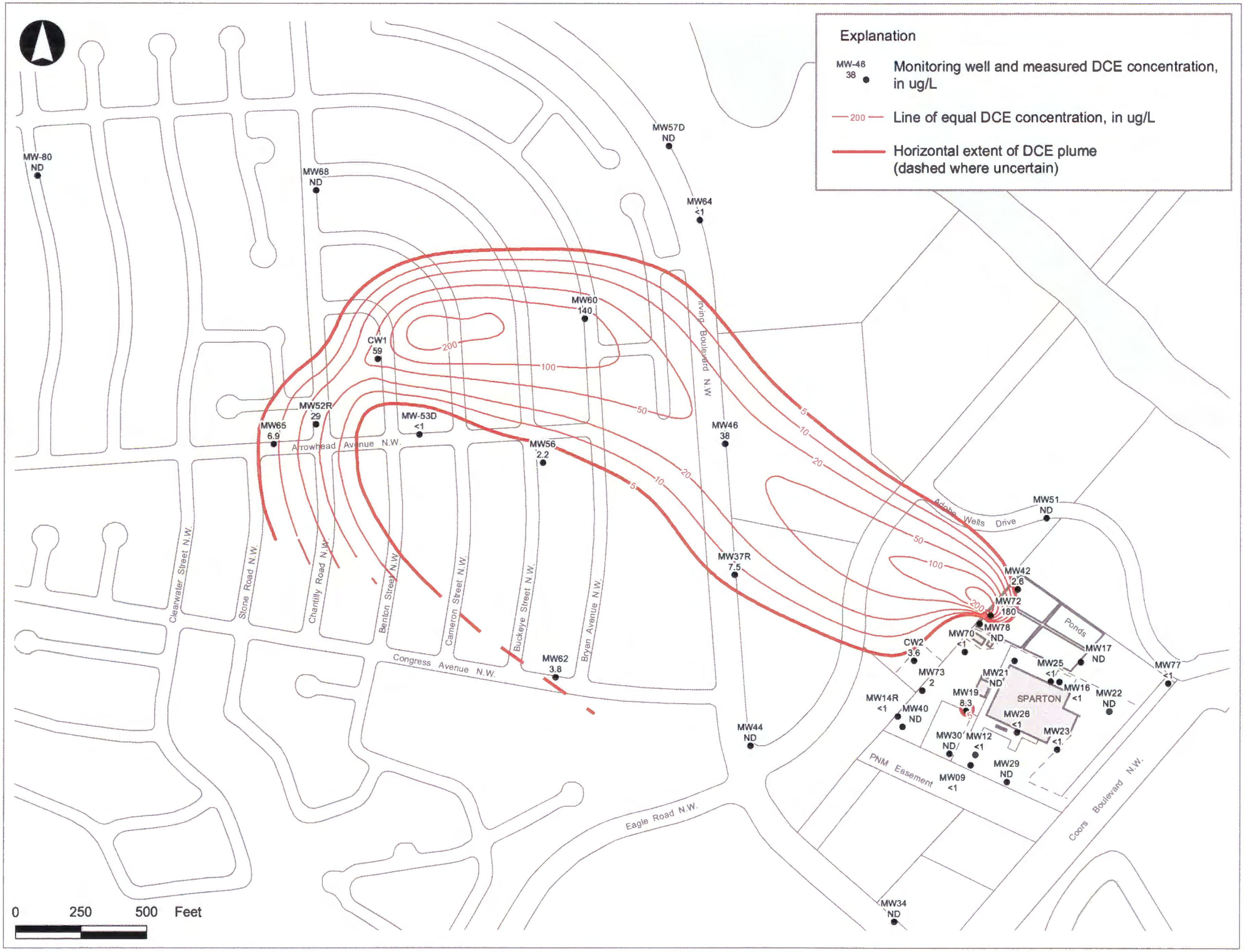


Figure 5.20 Horizontal Extent of DCE Plume - November 2011

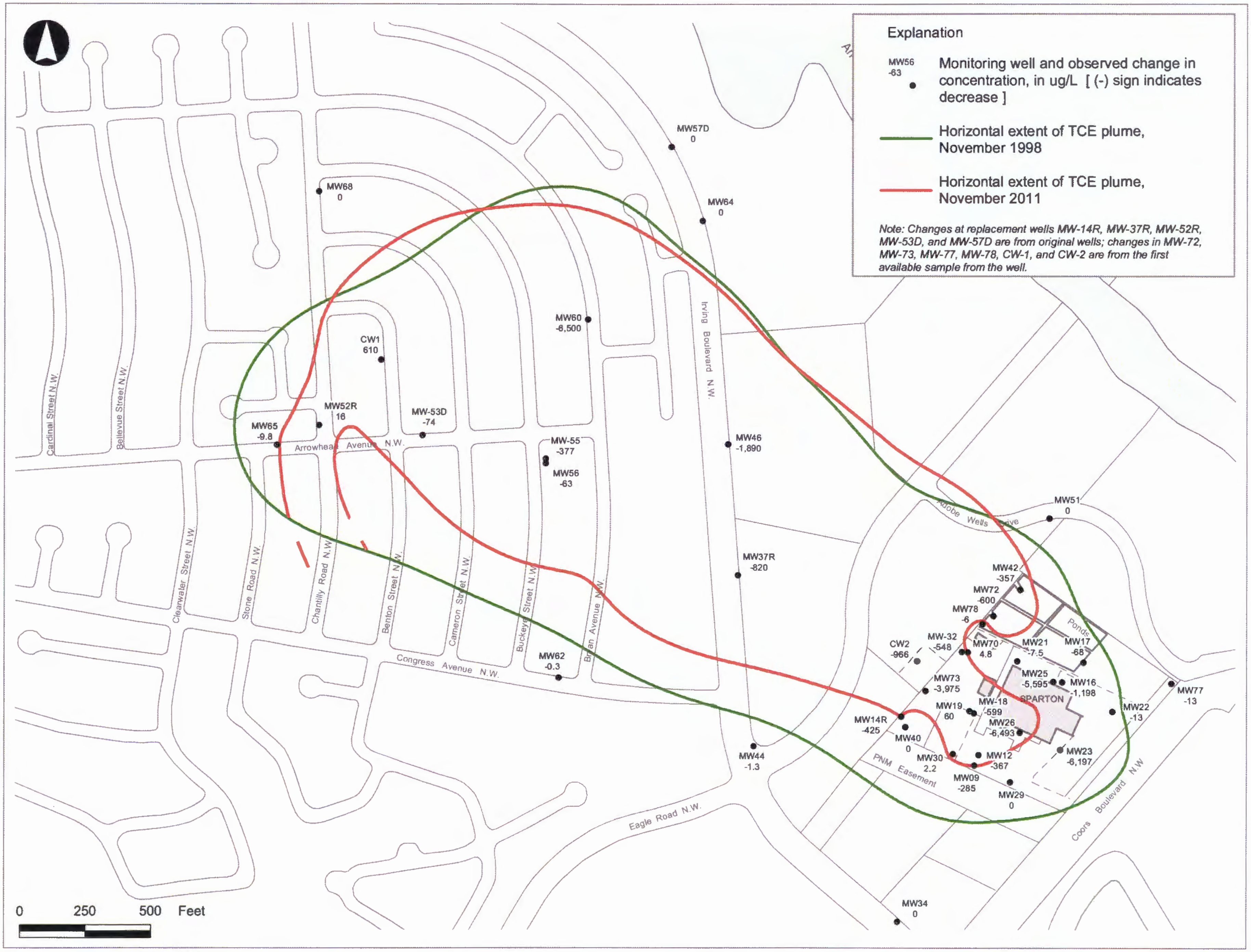


Figure 5.21 Changes in TCE Concentrations at Wells Used for Plume Definition - November 1998 to November 2011

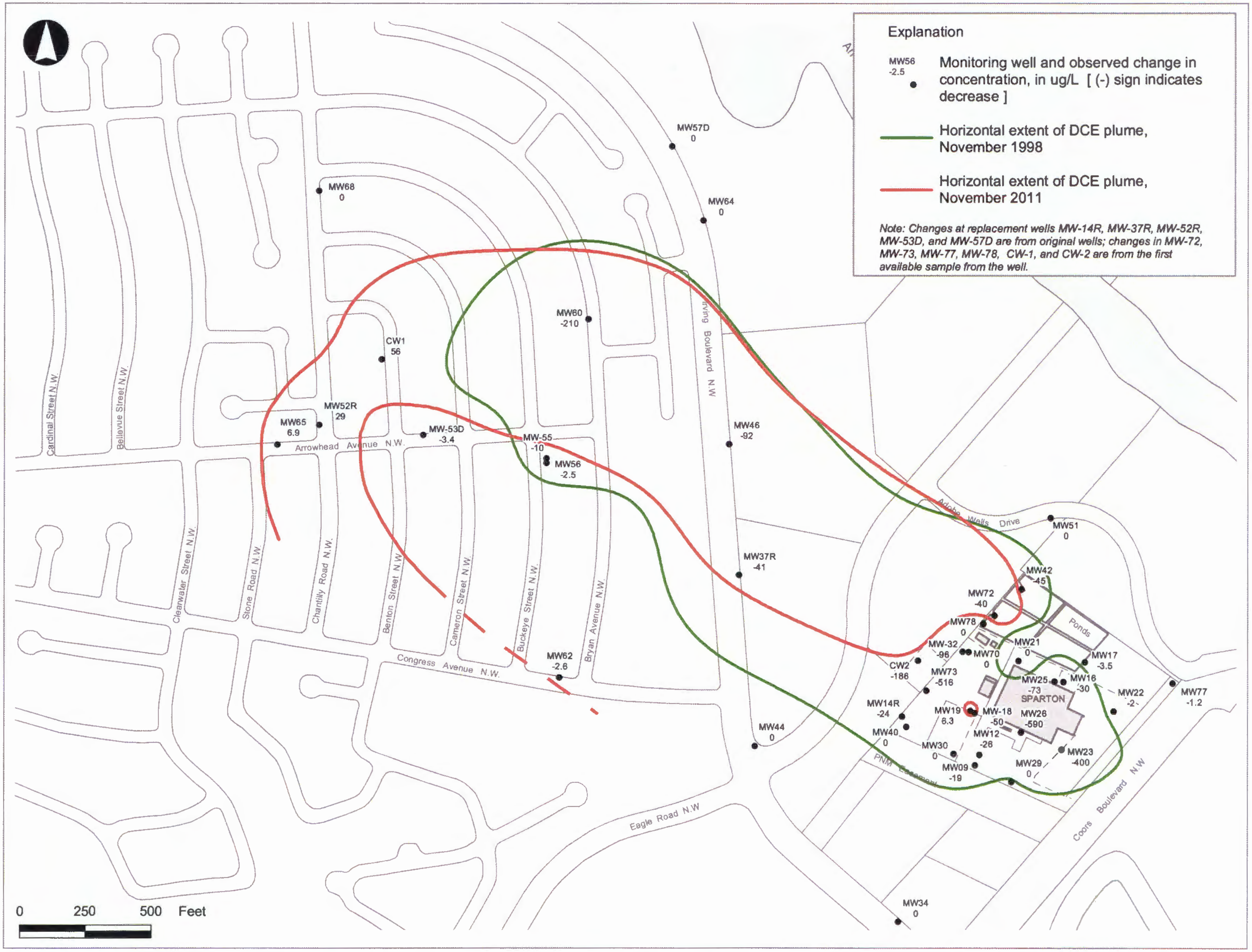


Figure 5.22 Changes in DCE Concentrations at Wells Used for Plume Definition - November 1998 to November 2011

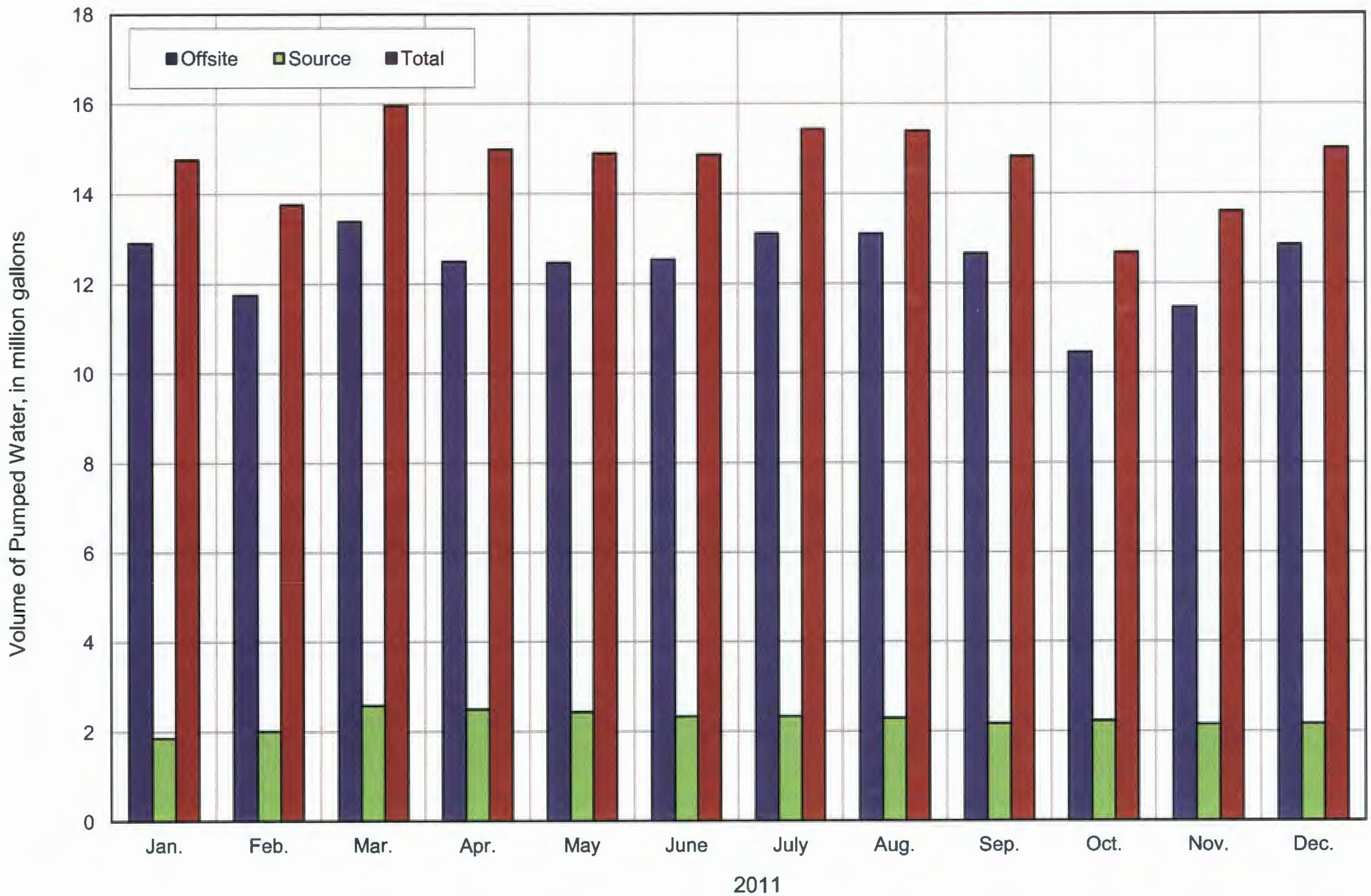


Figure 5.23 Monthly Volume of Water Pumped by the Containment Wells - 2011

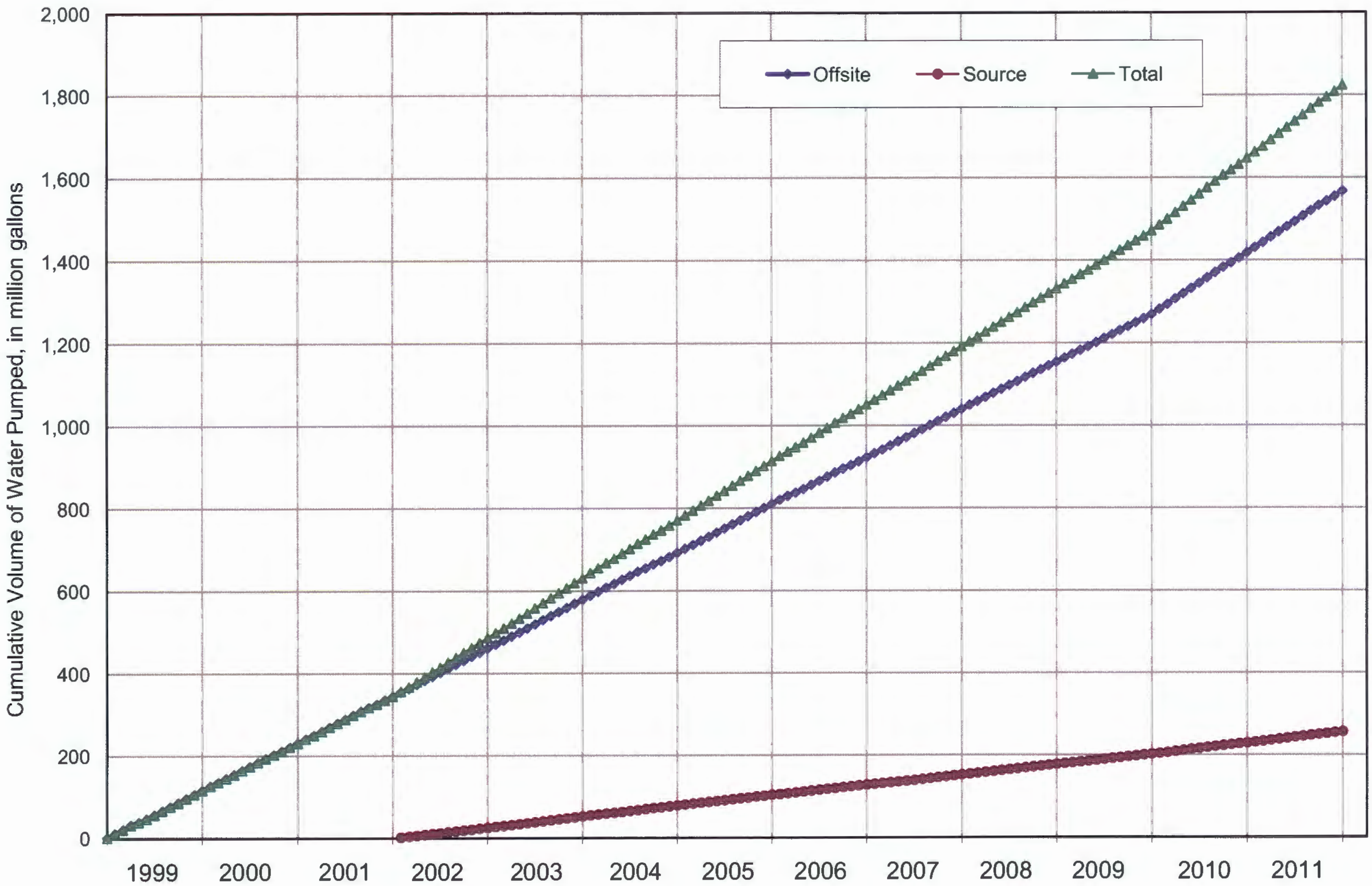


Figure 5.24 Cumulative Volume of Water Pumped by the Containment Wells

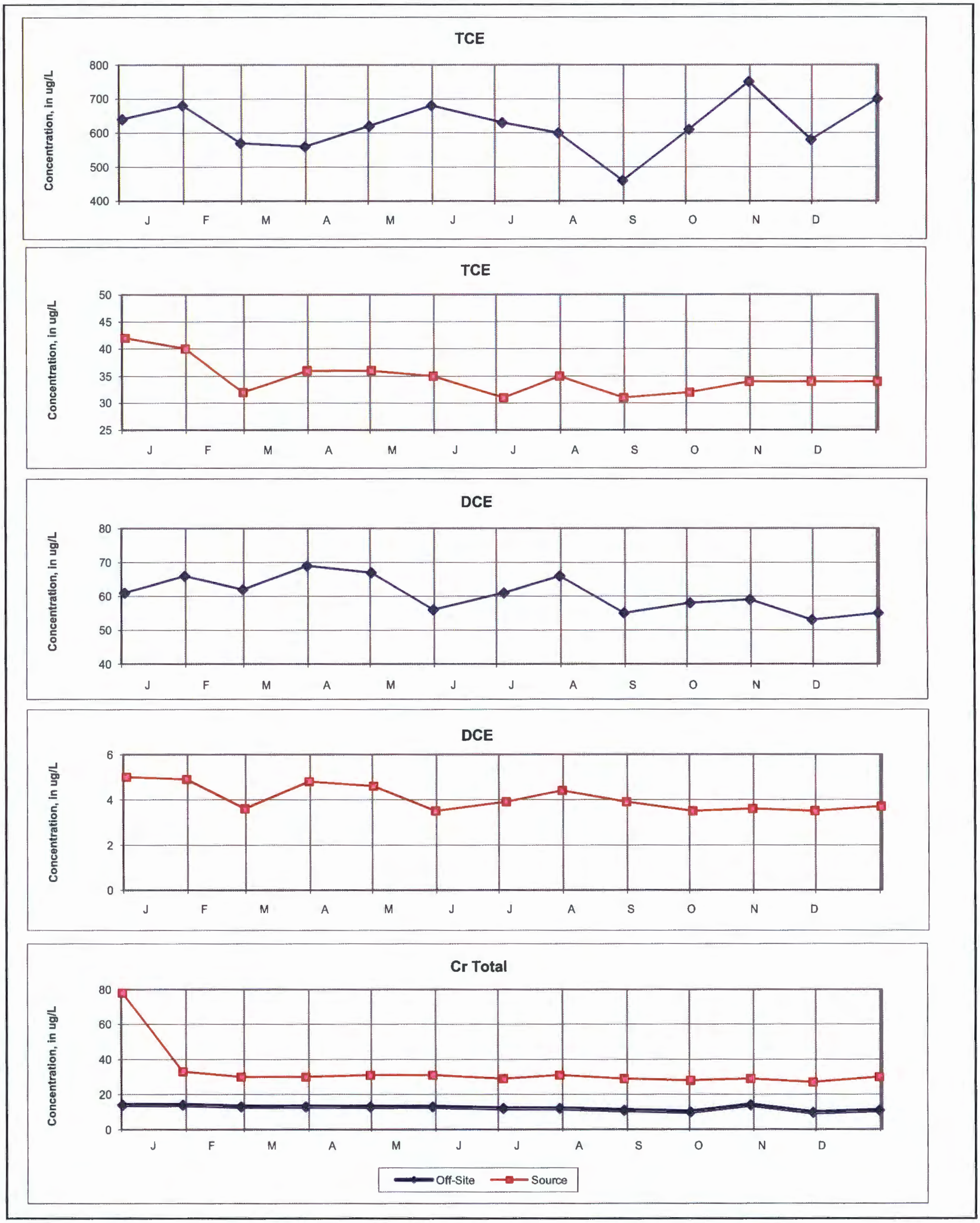


Figure 5.25 Off-Site and Source Containment Systems - TCE, DCE, and Total Chromium Concentrations in the Influent - 2011

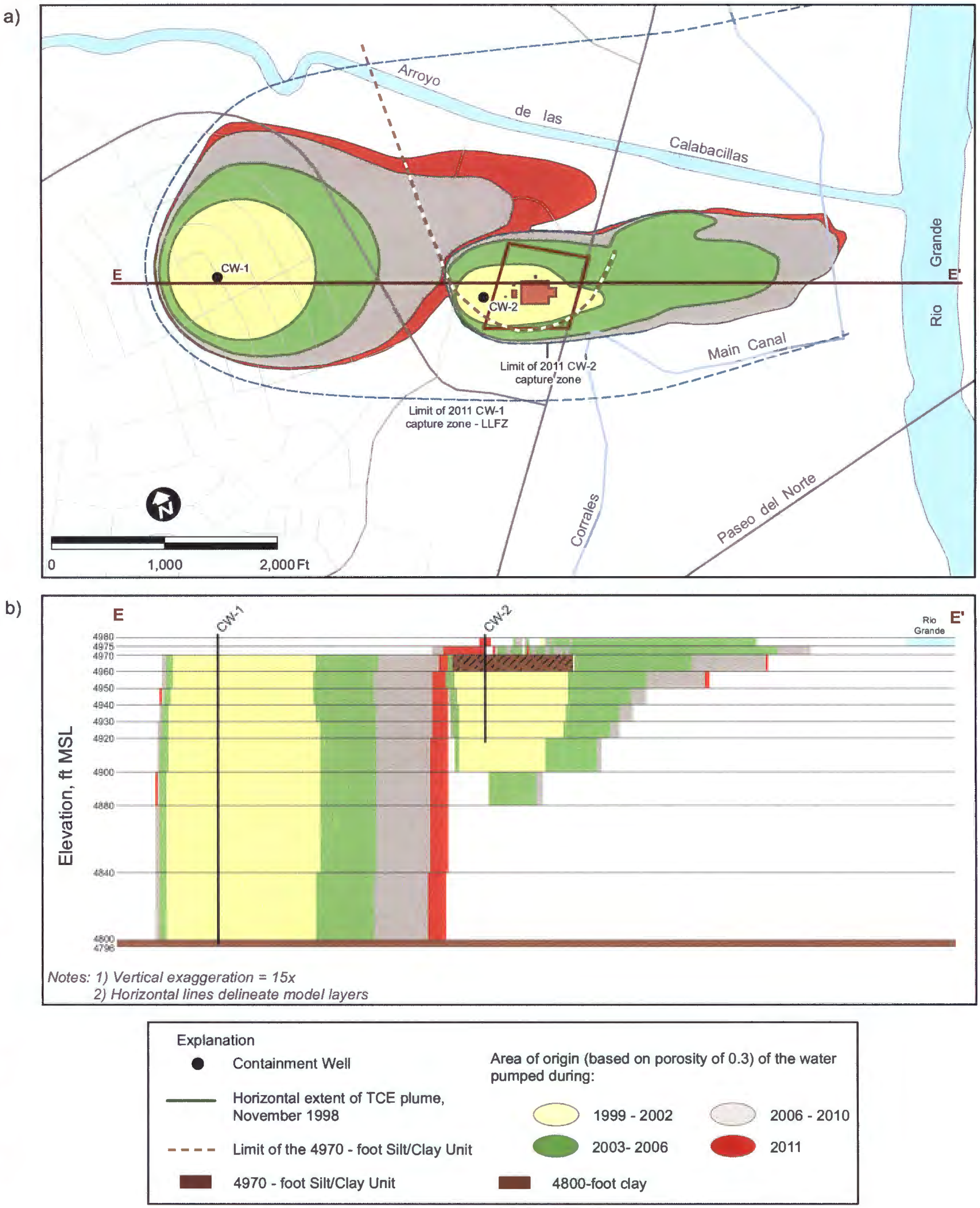


Figure 5.26 Areas of Origin of Water Pumped Since the Beginning of Remedial Operations

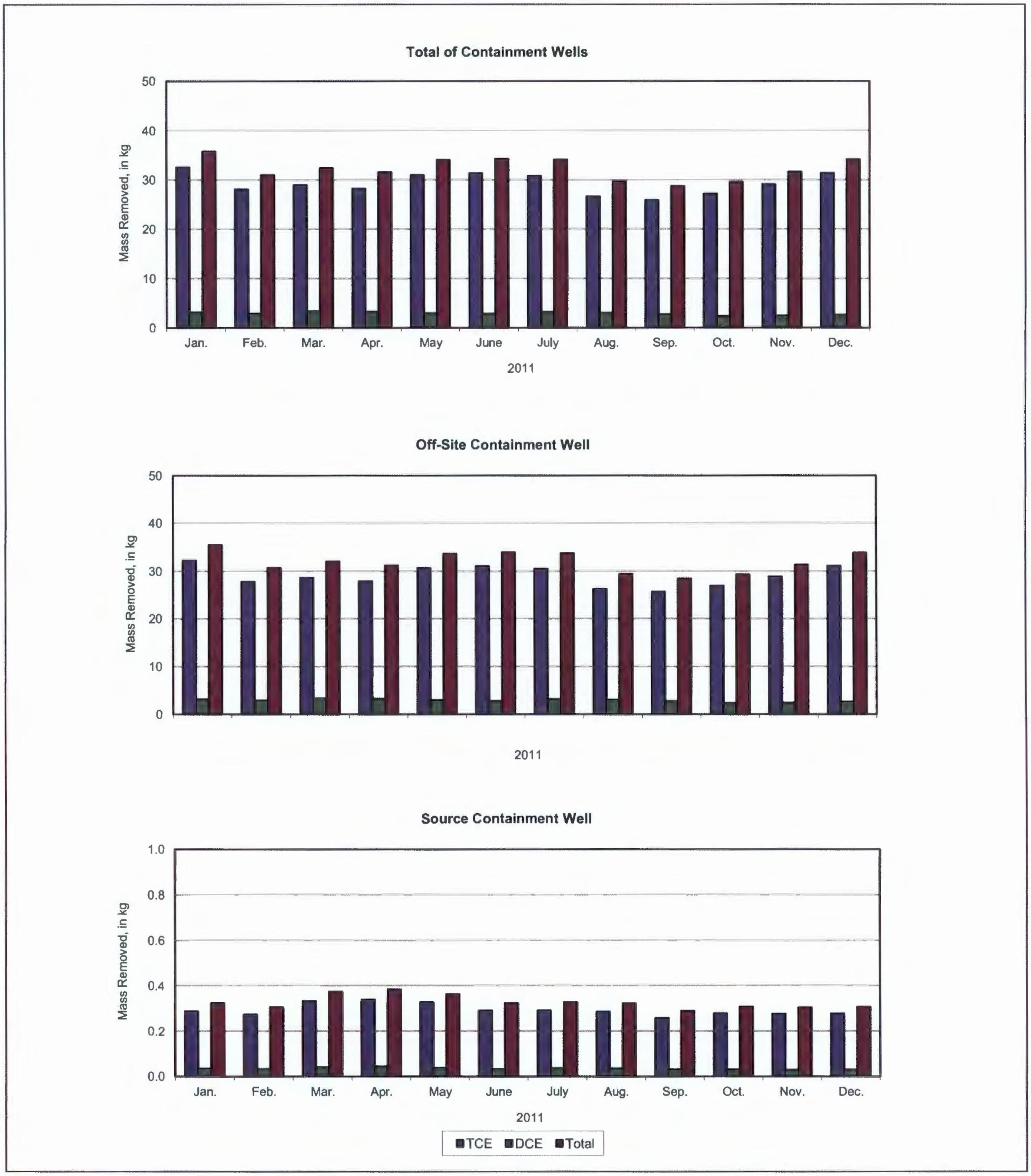


Figure 5.27 Monthly Contaminant Mass Removal by the Containment Wells - 2011

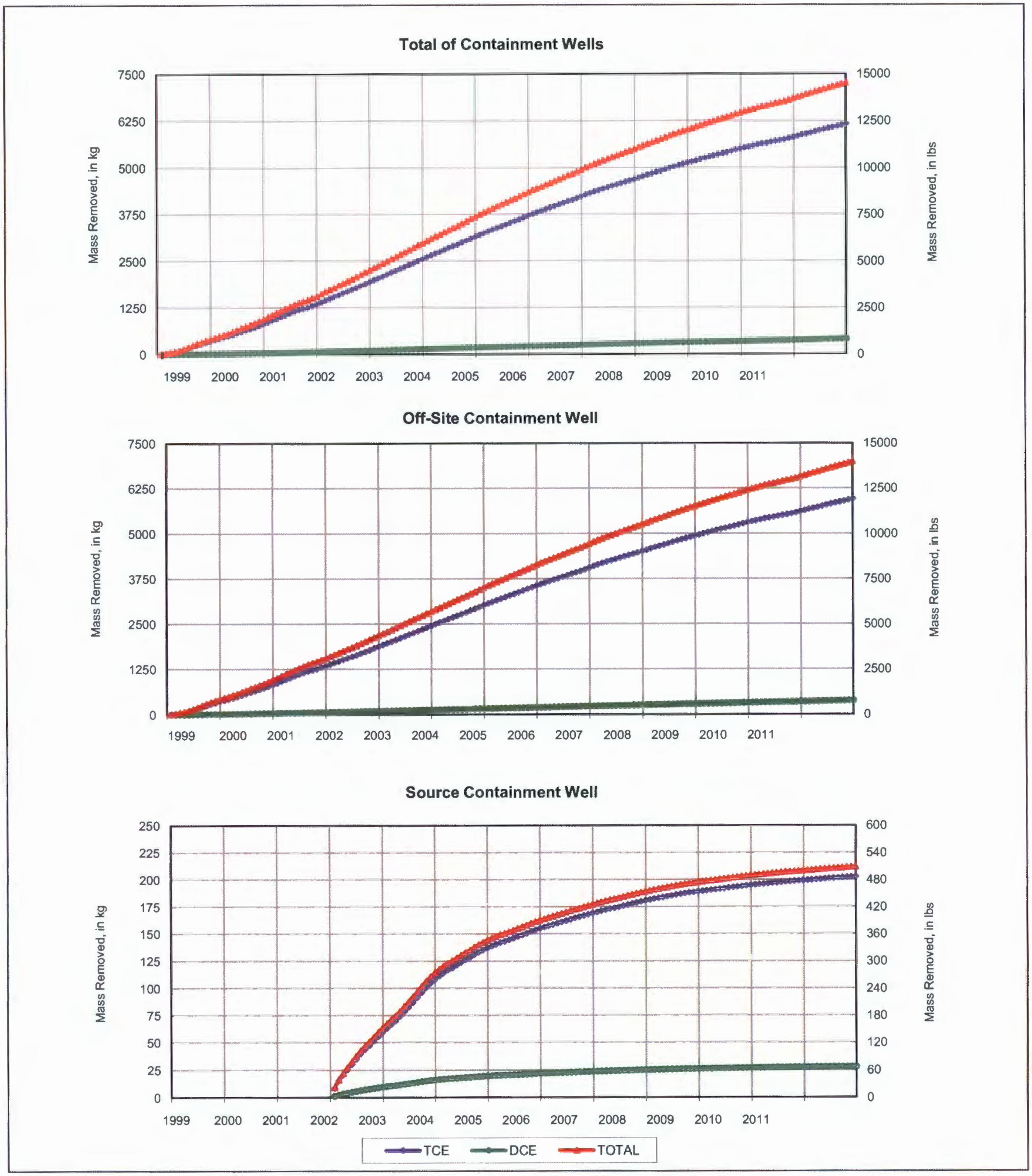


Figure 5.28 Cumulative Contaminant Mass Removal by the Containment Wells

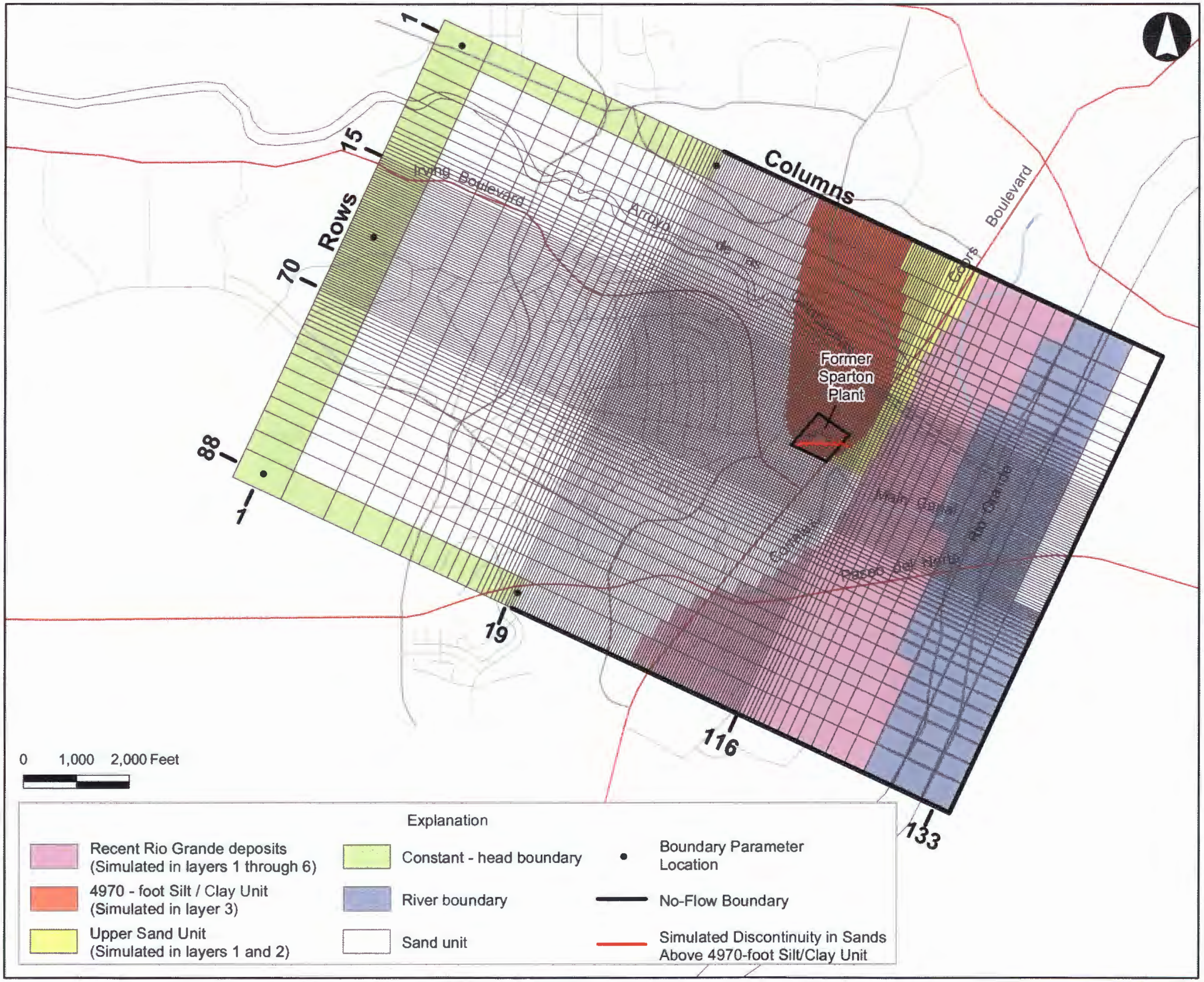


Figure 6.1 Model Grid, Hydraulic Property Zones and Boundary Conditions

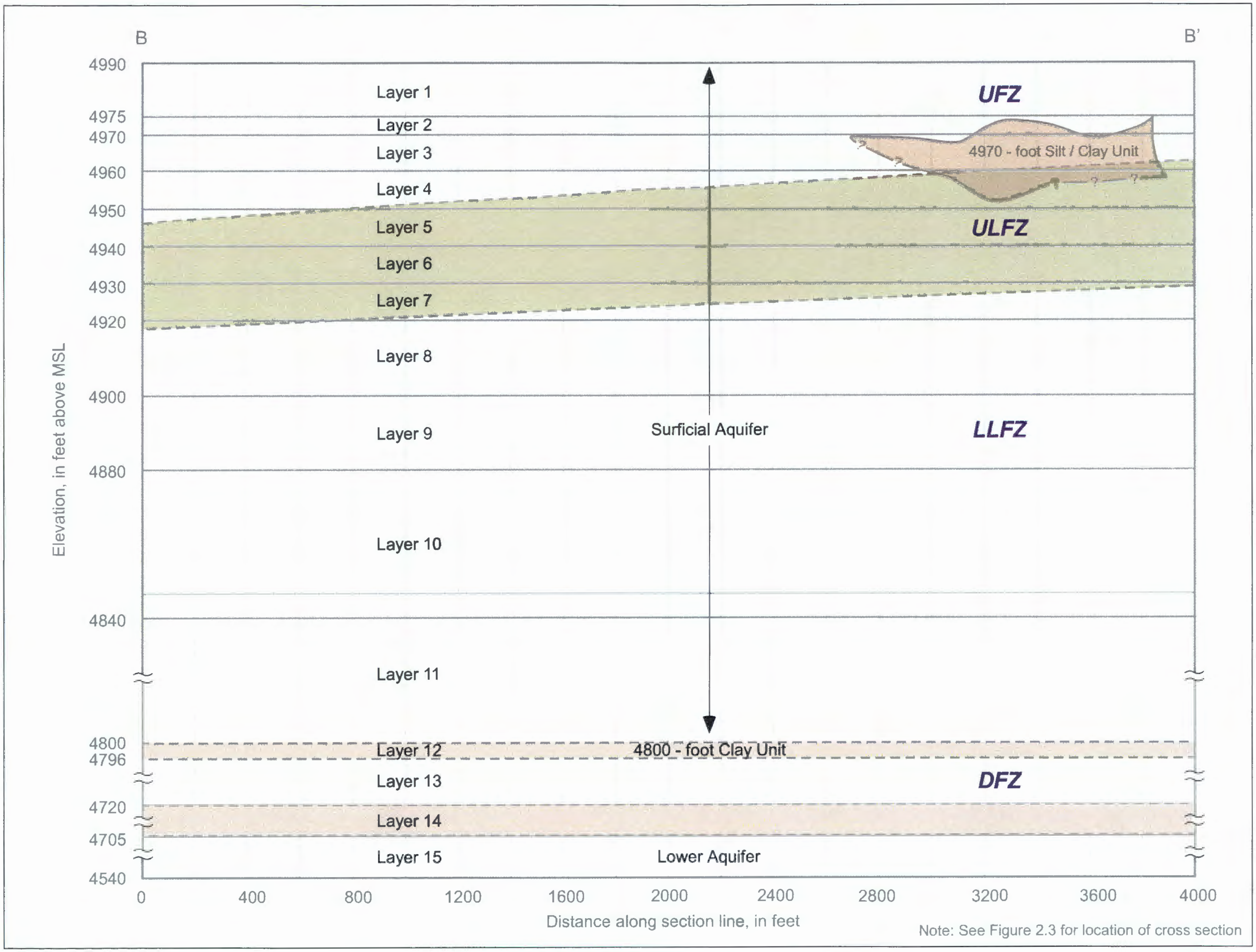


Figure 6.2 Model Layers

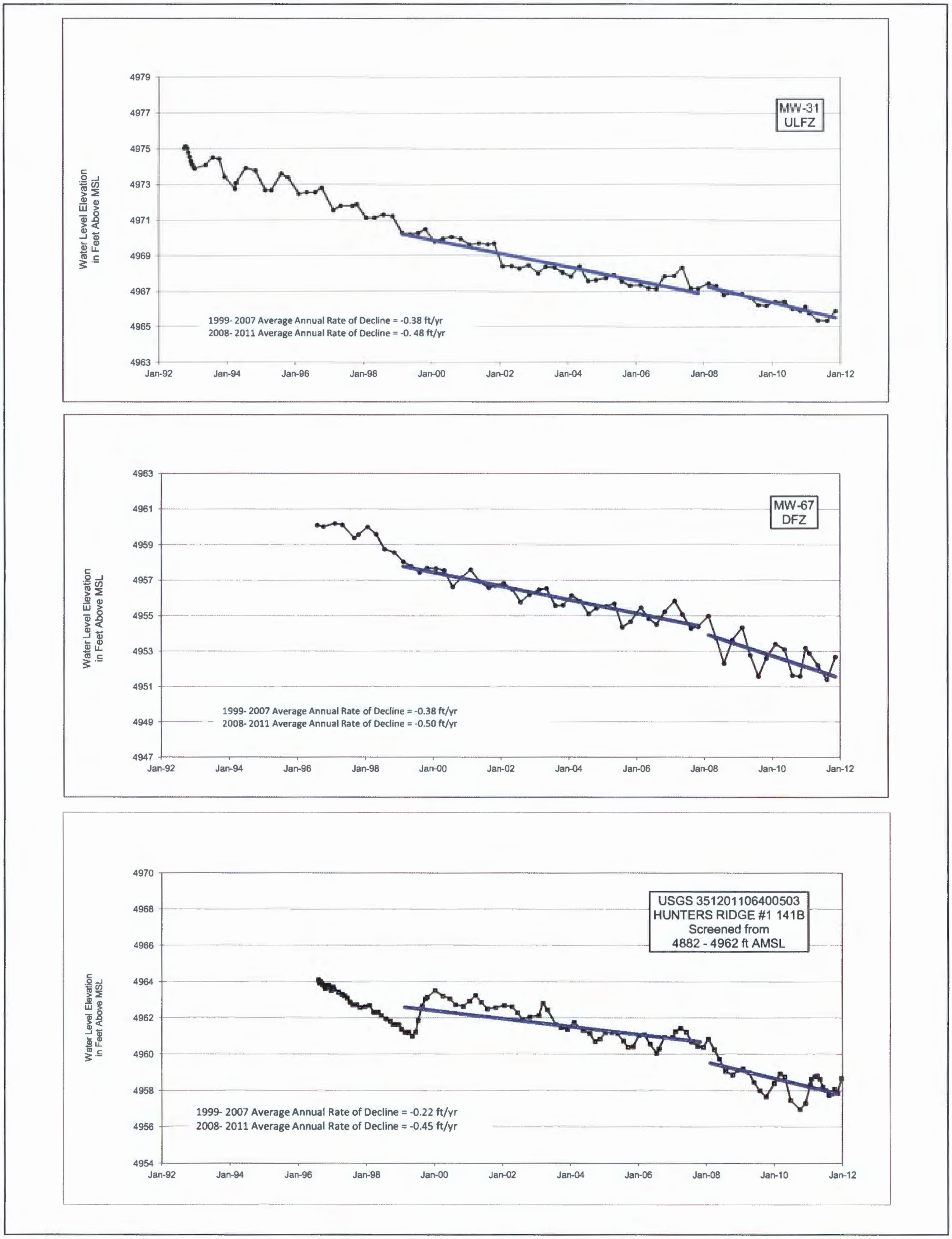
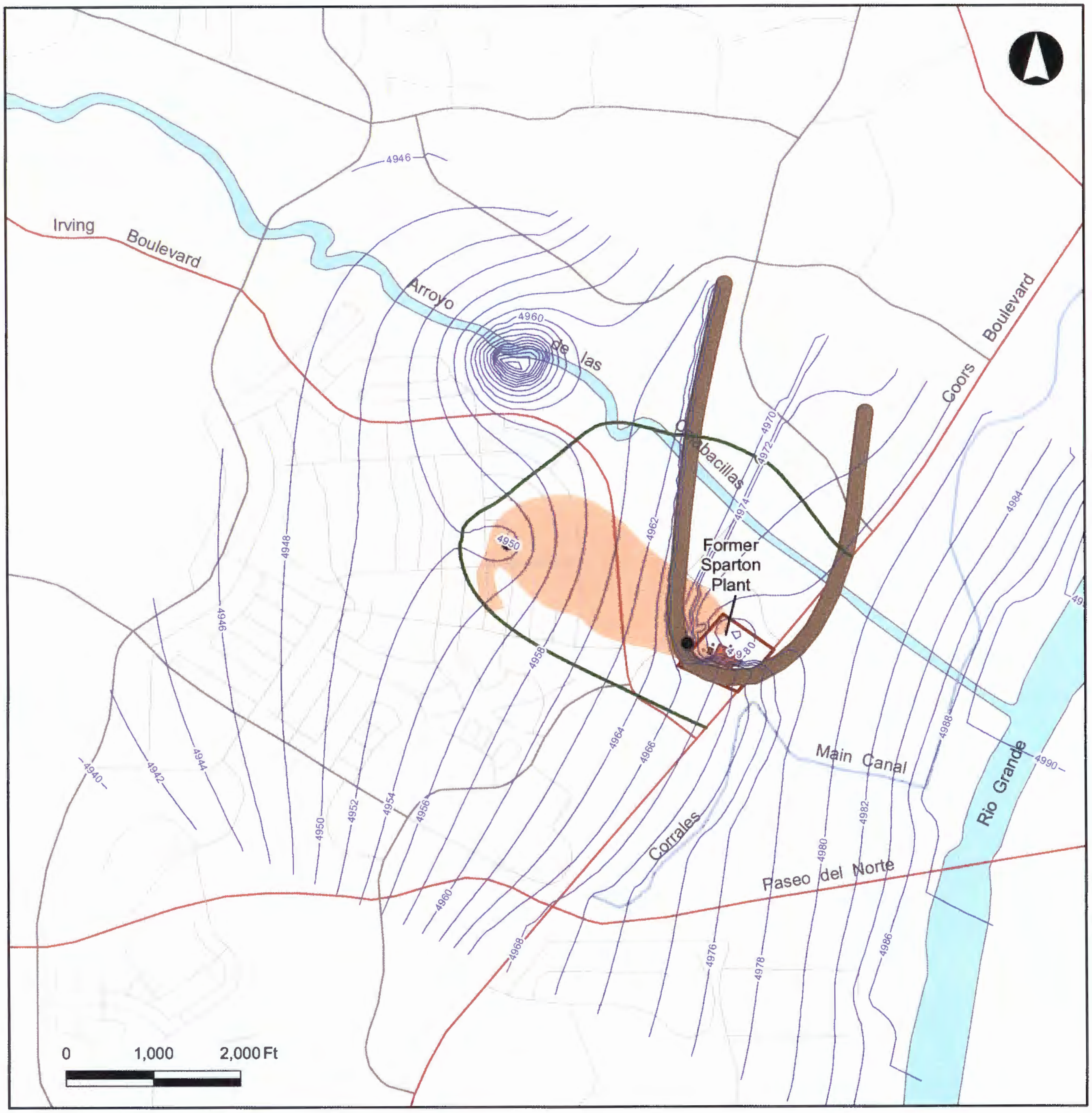


Figure 6.3 Regional Water - Level Trends



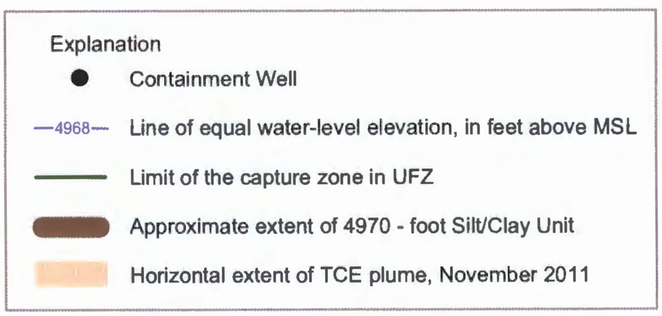


Figure 6.4 Calculated Water Table (UFZ) and Comparison of the Calculated Capture Zone to the TCE Plume Extent

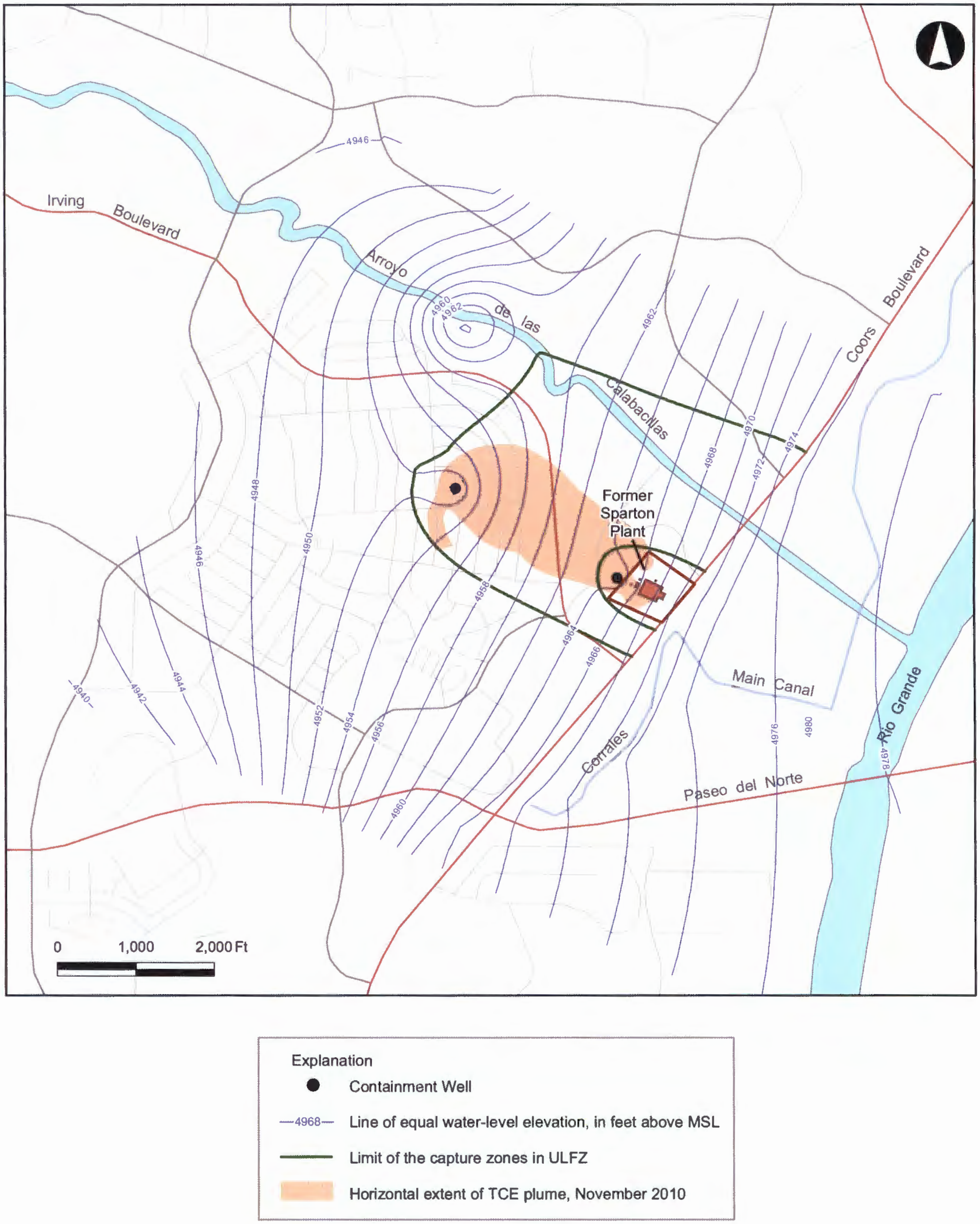


Figure 6.5 Calculated Water Levels in the ULFZ and Comparison of the Calculated Capture Zone to the TCE Plume Extent

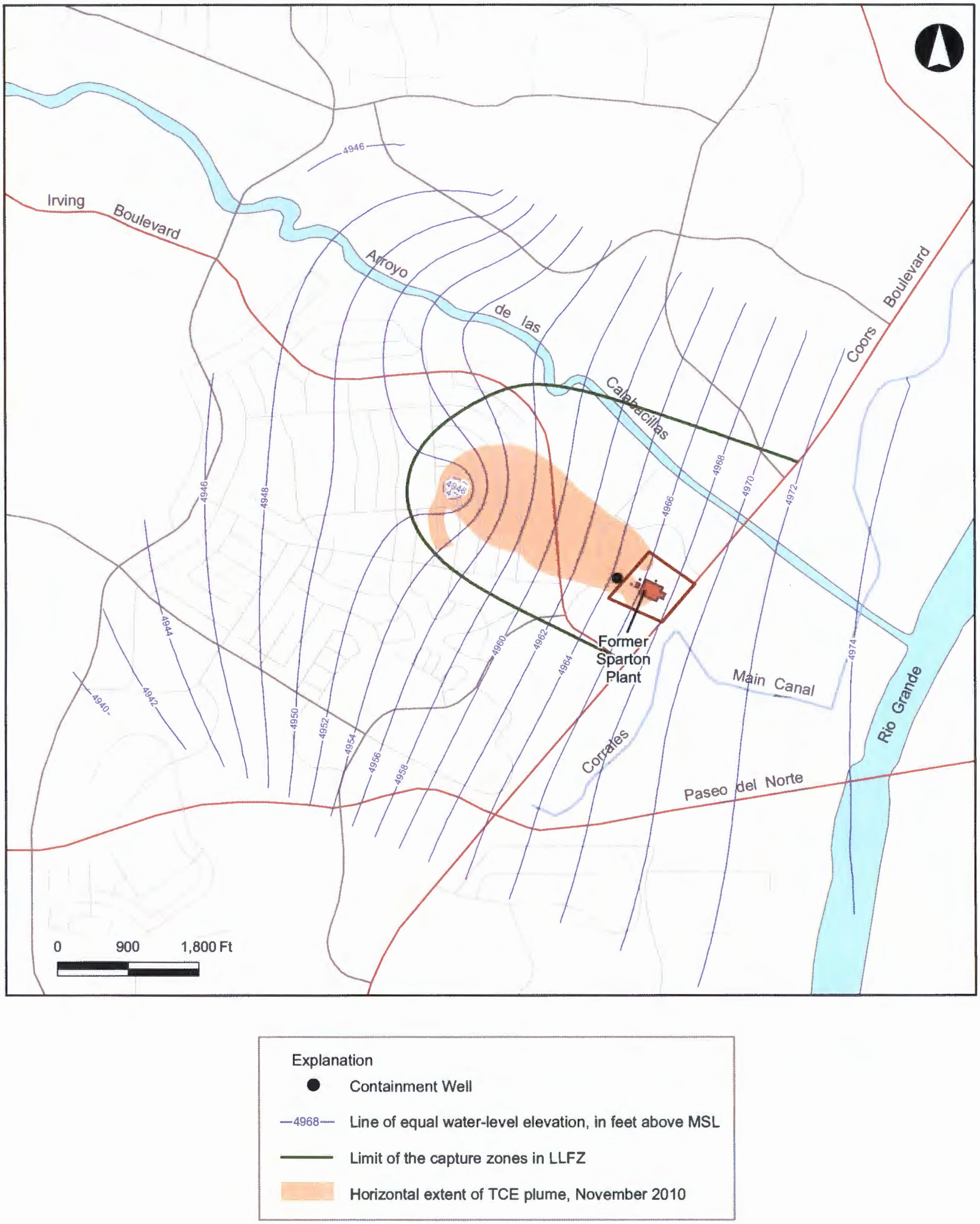


Figure 6.6 Calculated Water Levels in the LLFZ and Comparison of the Calculated Capture Zone to the TCE Plume Extent

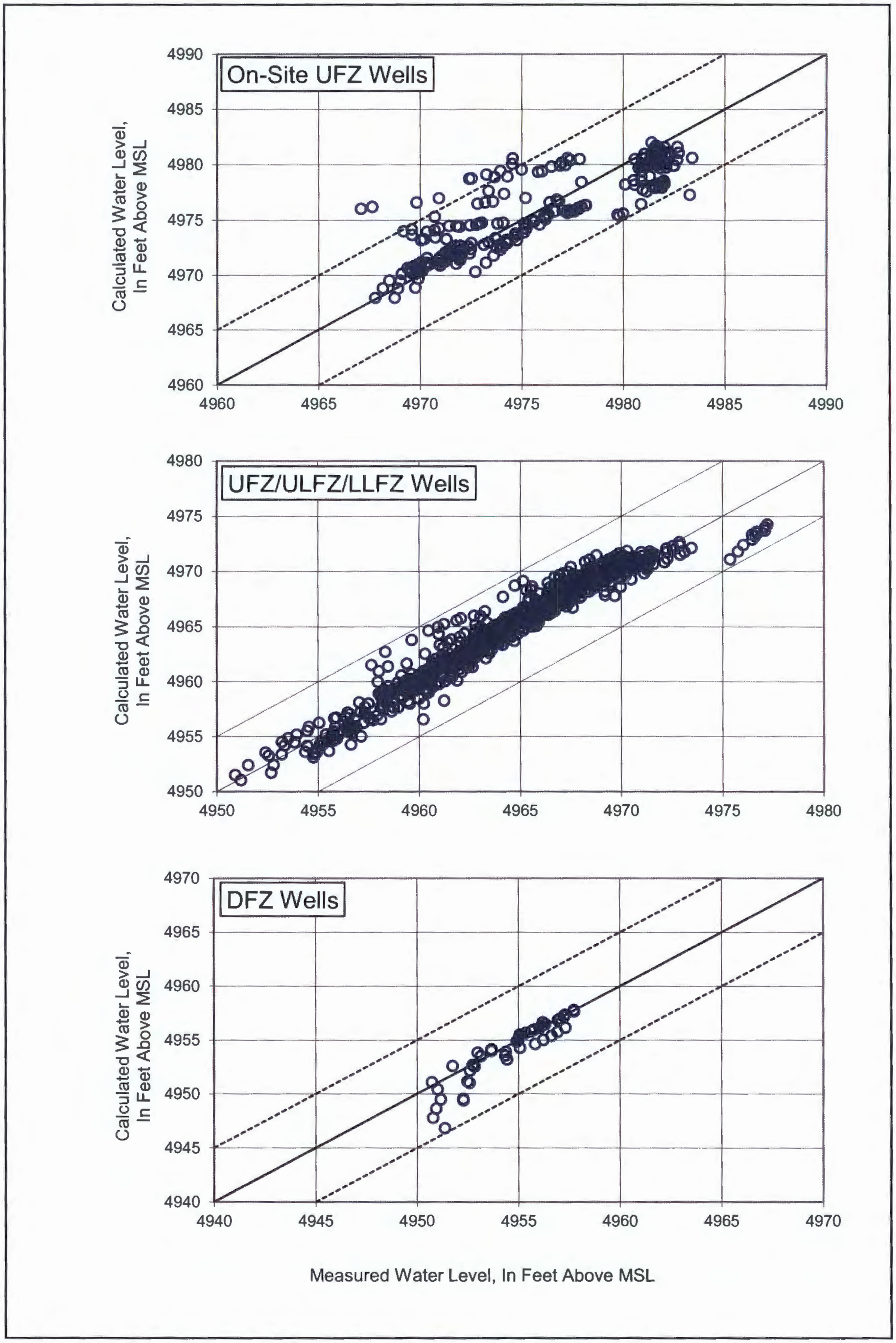


Figure 6.7 Comparison of Calculated to Observed Water Levels - November 1998 through November 2011

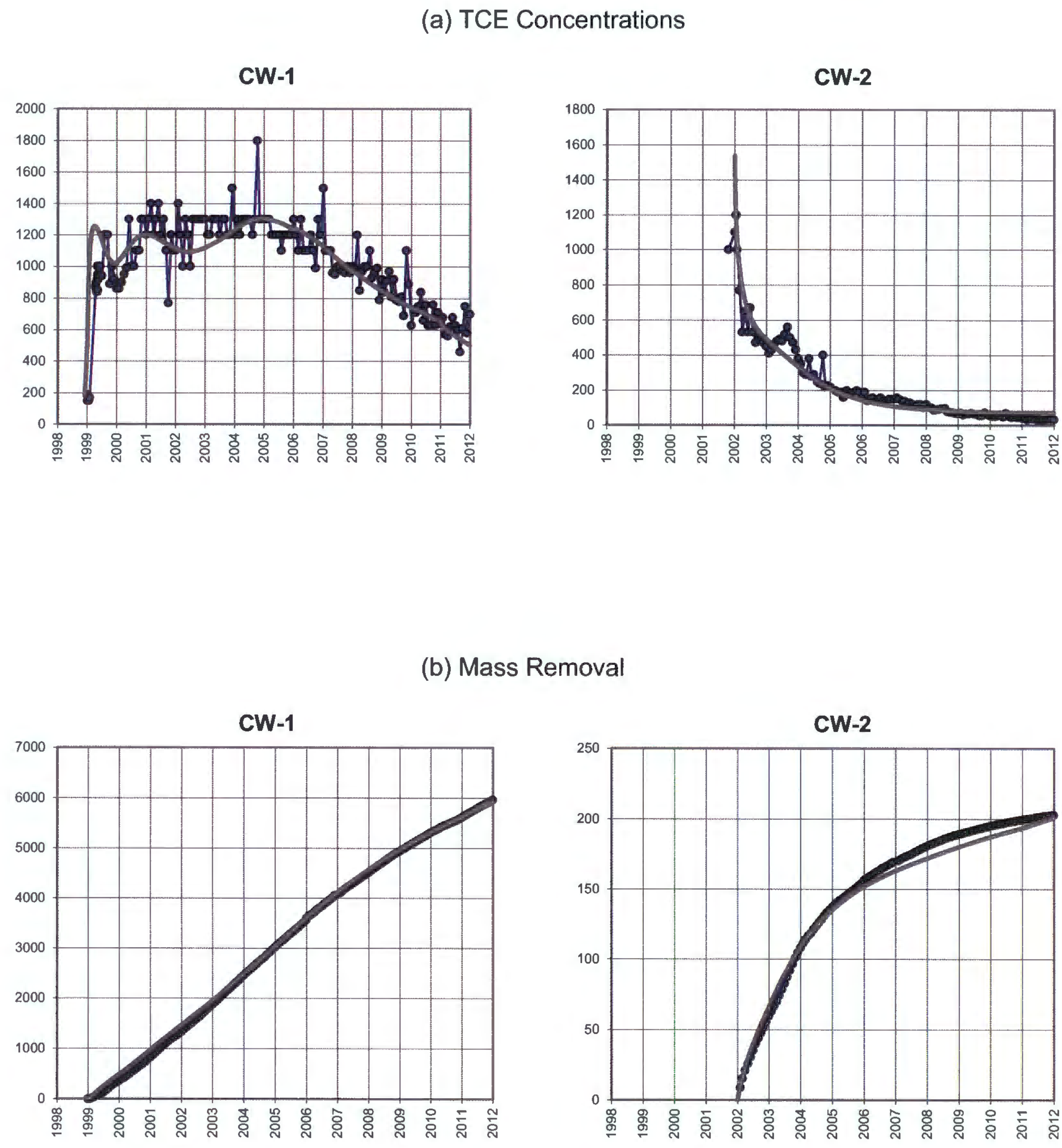
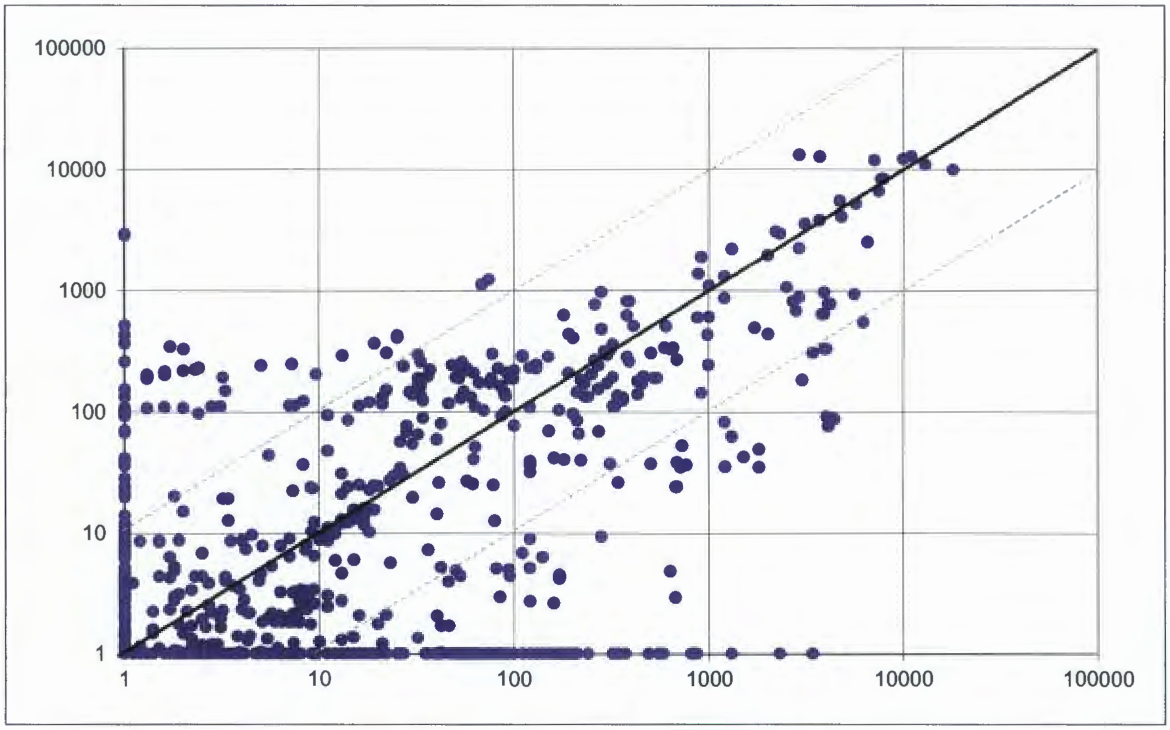


Figure 6.8 Comparison of Calculated to Observed TCE Concentrations in and Mass Removal by the Containment Wells



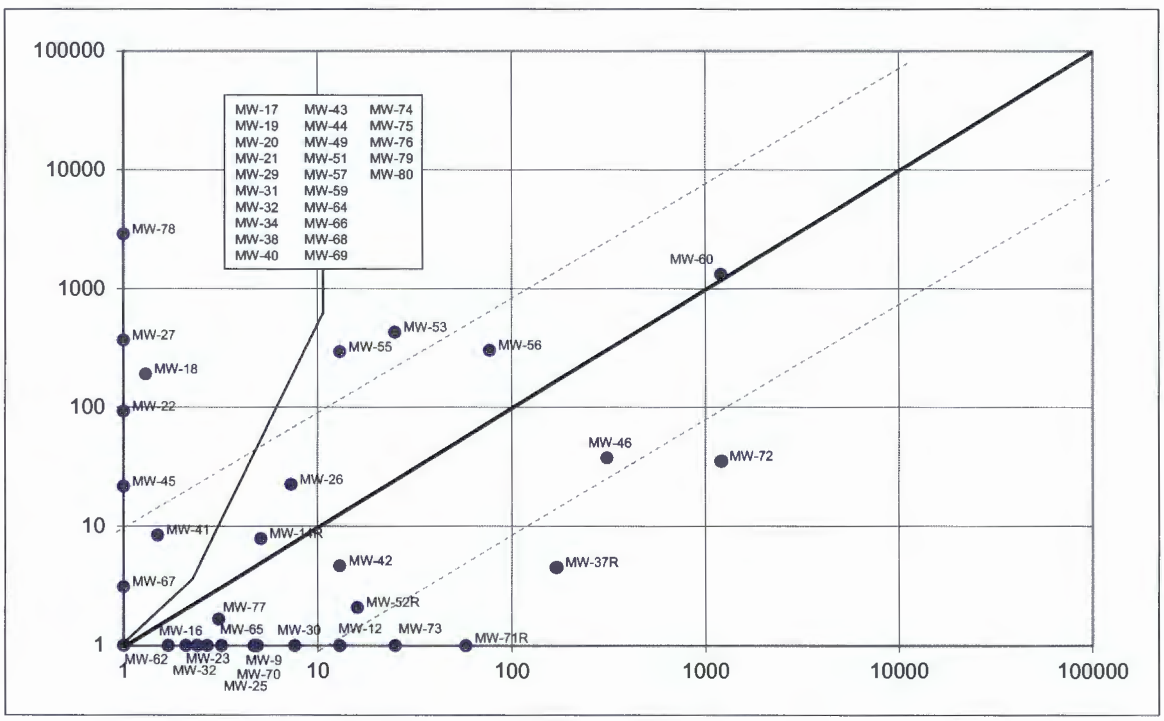


Figure 6.9 Comparisons of Calculated to Observed TCE Concentrations in Monitoring Wells

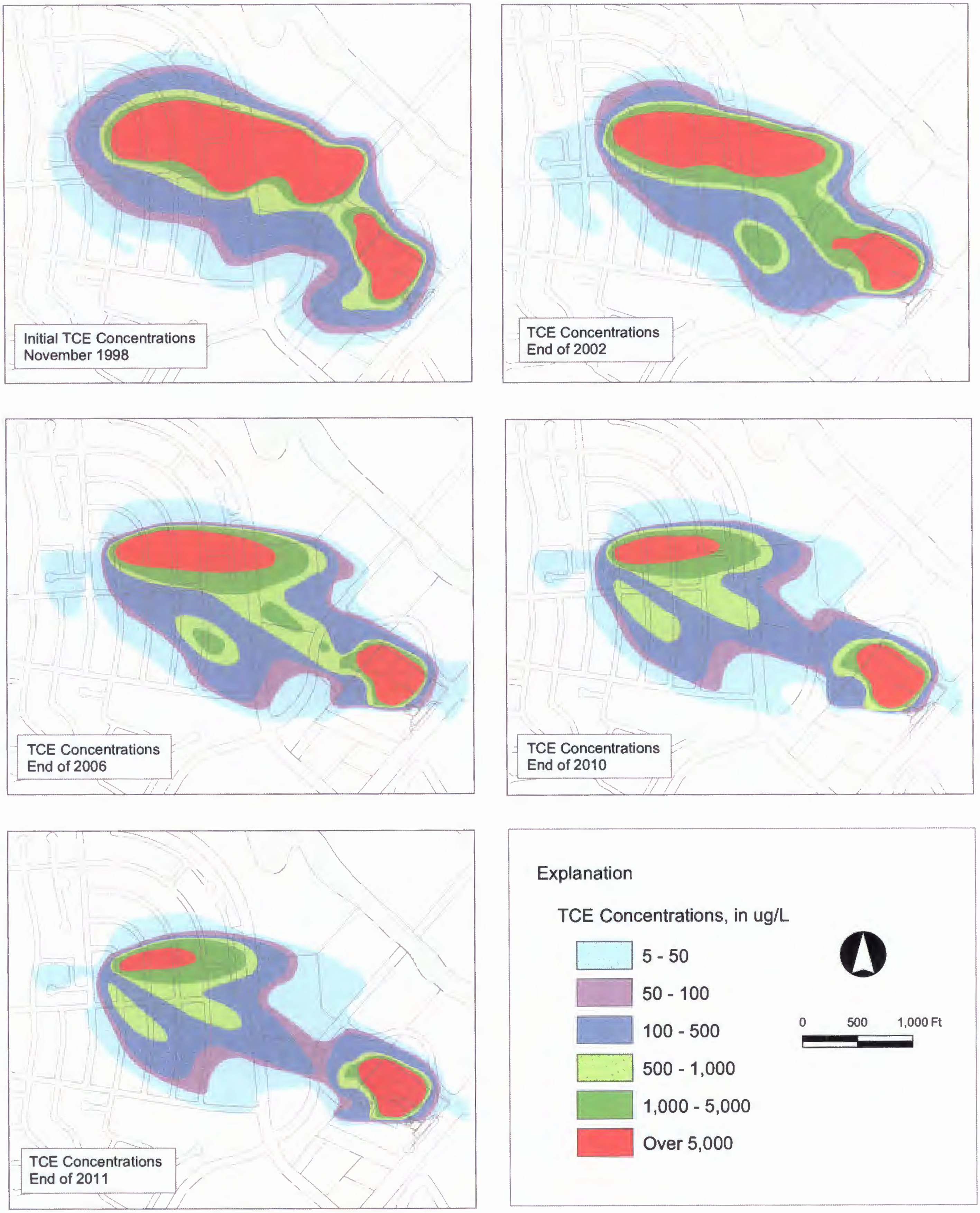
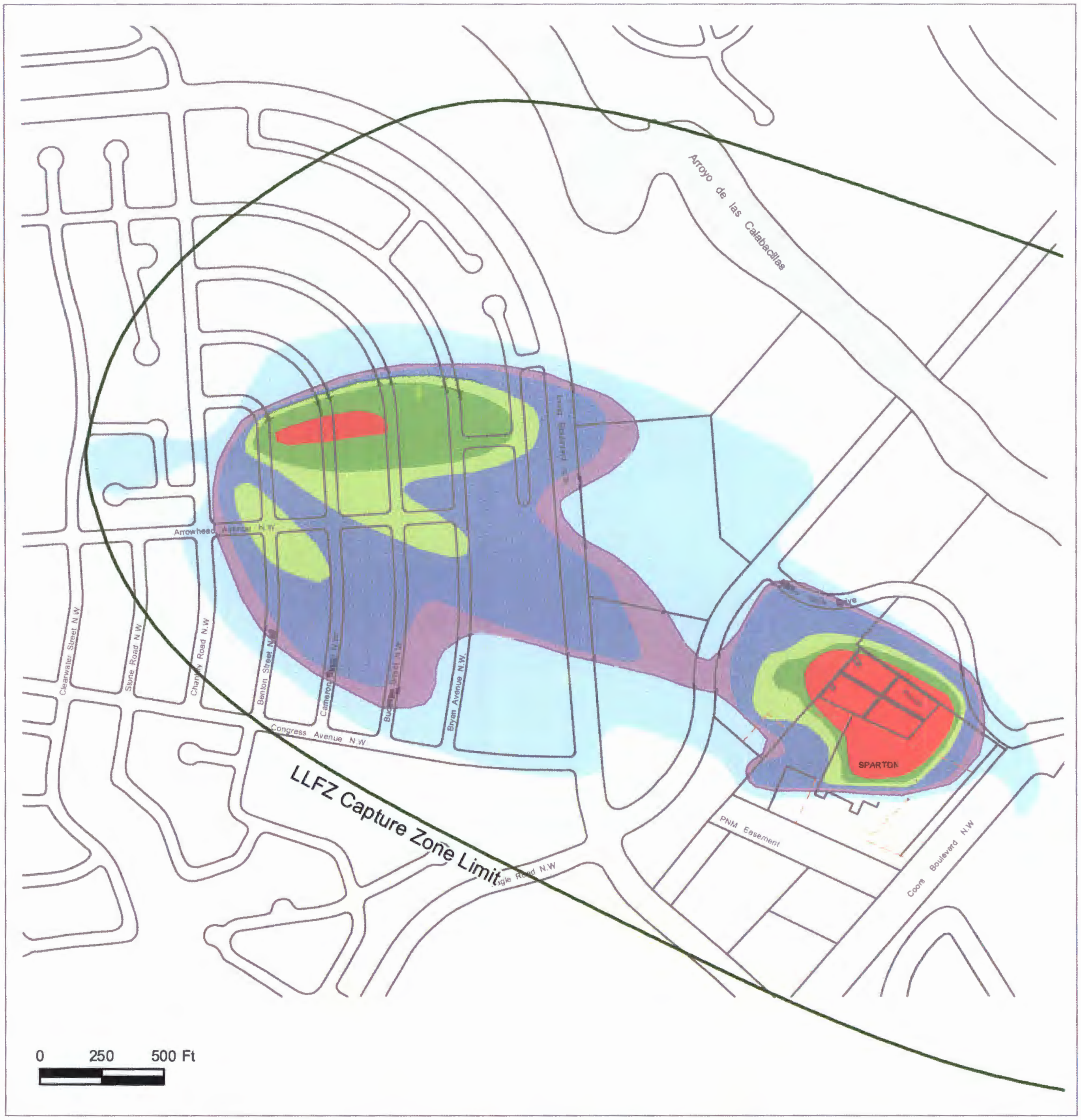


Figure 6.10 Horizontal Extent of Calibrated Initial TCE Plume and Model Calculated TCE Plumes for Later Years



TCE Concentrations in ug/L	
5 - 50	100 - 500
1,000 - 5,000	50 - 100
500 - 1,000	Over 5,000

Figure 6.11 Horizontal Extent of Model Predicted TCE Plume in December 2011

TABLES

Table 2.1

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

Well ID	Flow Zone[a]	Easting[b]	Northing[b]	Elevation[c]
CW-1	UFZ&LFZ	374740.43	1525601.48	5168.02
CW-2	UFZ-LLFZ	376788.70	1524459.40	5045.61
OB-1	UFZ&LFZ	374665.16	1525599.52	5169.10
OB-2	UFZ&LFZ	374537.98	1525606.65	5165.22
PZ-1	UFZ	372283.60	1523143.31	5147.36[e]
MW-7	UFZ	377535.41	1524101.14	5043.48
MW-9	UFZ	377005.75	1524062.25	5042.46
MW-12	UFZ	377023.27	1524102.56	5042.41
MW-13	UFZ	377137.23	1523998.34	5041.98
MW-14R	UFZ/ULFZ	376727.10	1524246.40	5040.92
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	5043.38
MW-19	ULFZ	376986.52	1524269.27	5043.30
MW-20	LLFZ	376967.98	1524277.98	5043.20
MW-21	UFZ	377171.22	1524458.71	5045.78
MW-22	UFZ	377531.77	1524267.24	5044.73
MW-23	UFZ	377333.63	1524123.03	5045.74
MW-24	UFZ	377338.05	1524367.39	5048.70
MW-25	UFZ	377307.91	1524380.40	5046.17
MW-26	UFZ	377180.89	1524187.40	5045.37
MW-27	UFZ	377078.91	1524323.46	5046.04
MW-29	ULFZ	377144.48	1523998.74	5041.88
MW-30	ULFZ	376924.12	1524105.15	5042.12
MW-31	ULFZ	376731.49	1524215.04	5041.38
MW-32	ULFZ	376958.37	1524494.18	5045.29
MW-34	UFZ	376715.25	1523469.17	5034.33[d]
MW-37R	UFZ/ULFZ	376104.50	1524782.90	5093.15[d]
MW-38	LLFZ	377150.52	1523995.17	5041.70
MW-39	LLFZ	376961.13	1524088.17	5042.30
MW-40	LLFZ	376745.33	1524207.40	5041.44
MW-41	ULFZ	376945.67	1524479.28	5044.56
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	5058.63[d]
MW-45	ULFZ	376108.80	1524726.75	5089.50[d]

Well ID	Flow Zone[a]	Easting[b]	Northing[b]	Elevation[c]
MW-46	ULFZ	376067.09	1525279.84	5118.86[d]
MW-47	UFZ	375638.14	1524967.74	5121.16
MW-48	UFZ	375369.75	1525239.86	5143.44
MW-49	LLFZ	376763.40	1524197.32	5041.44
MW-51	UFZ	377291.45	1525000.02	5060.34
MW-52R	UFZ/ULFZ	374504.50	1525353.60	5156.37
MW-53D	UFZ/ULFZ	374899.50	1525314.41	5148.62
MW-54	UFZ	375974.55	1526106.27	5097.69[d]
MW-55	LLFZ	375370.70	1525224.15	5143.45
MW-56	ULFZ	375371.31	1525207.68	5141.45
MW-57D	UFZ	375849.02	1526406.98	5103.62[d]
MW-58	UFZ	375148.43	1525330.73	5146.40
MW-59	ULFZ	377253.38	1524991.51	5060.65
MW-60	ULFZ	375530.19	1525753.61	5134.40
MW-61	UFZ	375523.16	1525821.65	5134.74
MW-62	UFZ	375421.24	1524395.94	5073.69
MW-63	UFZ	376840.50	1525236.52	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	5103.19[d]
MW-67	DFZ	375352.47	1525220.38	5142.21
MW-68	UFZ	374503.81	1526216.71	5168.54
MW-69	LLFZ	374502.80	1526239.55	5167.79
MW-70	LLFZ	376981.33	1524492.75	5046.74
MW-71R	DFZ	375534.49	1525681.93	5134.12
MW-72	ULFZ	377079.68	1524630.73	5056.25
MW-73	ULFZ	376821.45	1524346.08	5051.08
MW-74	UFZ/ULFZ	374484.30	1527810.76	5094.80
MW-75	UFZ/ULFZ	374613.33	1528009.97	5113.74
MW-76	UFZ/ULFZ	375150.41	1527826.10	5108.32
MW-77	UFZ/ULFZ	377754.90	1524374.20	5045.64
MW-78	UFZ/ULFZ	377038.50	1524599.30	5052.91
MW-79	DFZ	374662.64	1525626.72	5168.50
MW-80	ULFZ/LLFZ	373445.75	1526294.35	5203.31
PZG-1	Infilt. Gall.	374871.44	1527608.15	5090.90

[a] UFZ denotes the Upper Flow Zone; ULFZ and LLFZ denote the upper and lower, 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).

[d] Elevation effective February 1, 2005.

[e] Elevation effective March 12, 2008.

Table 2.2

Well Screen Data

Well ID[a]	Flow Zone	Diameter (in)	Elevation (ft above MSL)			Depth below Ground Surface(ft)		Screen Length (ft)
			Ground Surface	Top of Screen	Bottom of Screen	Top of Screen	Bottom of Screen	
CW-1	UFZ&LFZ	8	5166.4	4957.5	4797.5	208.9	368.9	160.0
CW-2	UFZ-LLFZ	4	5048.5	4968.5	4918.5	80.0	130.0	50.0
OB-1	UFZ&LFZ	4	5166.2	4960.3	4789.8	205.9	376.4	170.5
OB-2	UFZ&LFZ	4	5164.8	4960.3	4789.7	204.5	375.1	170.6
PZ-1	UFZ	2	5141.3	4961.5	4951.3	179.8	190.0	10.2
MW-7	UFZ	2	5043.0	4979.7	4974.7	63.3	68.3	5.0
MW-9	UFZ	2	5042.4	4975.8	4970.8	66.6	71.6	5.0
MW-12	UFZ	4	5042.3	4978.2	4966.2	64.1	76.1	12.0
MW-13[b]	UFZ	2	5041.9	4981.5	4971.6	60.4	70.3	9.9
MW-14R	UFZ/ULFZ	2	5040.8	4980.5	4950.5	60.3	90.3	30.0
MW-16	UFZ	2	5046.2	4979.7	4974.7	66.5	71.5	5.0
MW-17	UFZ	2	5047.5	4982.3	4977.3	65.2	70.2	5.0
MW-18	UFZ	4	5042.9	4976.0	4966.0	66.9	76.9	10.0
MW-19	ULFZ	4	5042.9	4944.8	4934.8	98.1	108.1	10.0
MW-20	LLFZ	4	5042.8	4919.2	4906.8	123.6	136.0	12.4
MW-21	UFZ	2	5045.7	4982.8	4977.8	62.9	67.9	5.0
MW-22	UFZ	2	5044.6	4977.2	4972.2	67.4	72.4	5.0
MW-23	UFZ	4	5045.6	4973.8	4968.8	71.8	76.8	5.0
MW-24	UFZ	4	5046.2	4977.5	4972.5	68.7	73.7	5.0
MW-25	UFZ	4	5046.1	4977.9	4972.9	68.2	73.2	5.0
MW-26	UFZ	2	5045.4	4969.1	4964.1	76.3	81.3	5.0
MW-27	UFZ	2	5045.8	4975.4	4970.4	70.4	75.4	5.0
MW-29	ULFZ	4	5041.9	4938.3	4928.3	103.6	113.6	10.0
MW-30	ULFZ	4	5041.7	4944.8	4934.8	96.9	106.9	10.0
MW-31	ULFZ	4	5040.9	4945.2	4935.2	95.7	105.7	10.0
MW-32	ULFZ	4	5044.8	4937.3	4927.3	107.5	117.5	10.0
MW-34	UFZ	2	5034.4	4978.0	4968.0	56.4	66.4	10.0
MW-37R	UFZ/ULFZ	2	5093.0	4976.6	4946.6	116.4	146.4	30.0
MW-38	LLFZ	4	5041.6	4915.0	4905.0	126.6	136.6	10.0
MW-39	LLFZ	4	5042.2	4918.7	4908.7	123.5	133.5	10.0
MW-40	LLFZ	4	5040.0	4923.9	4913.9	116.1	126.1	10.0
MW-41	ULFZ	4	5044.1	4952.1	4942.1	92.0	102.0	10.0
MW-42	ULFZ	4	5054.8	4949.3	4939.3	105.5	115.5	10.0
MW-43	LLFZ	4	5055.2	4927.7	4917.7	127.5	137.5	10.0
MW-44	ULFZ	4	5058.8	4952.4	4942.4	106.4	116.4	10.0
MW-45	ULFZ	4	5090.1	4948.5	4938.5	141.6	151.6	10.0
MW-46	ULFZ	4	5118.5	4949.4	4939.4	169.1	179.1	10.0

Table 2.2

Well Screen Data

Well ID[a]	Flow Zone	Diameter (in)	Elevation (ft above MSL)			Depth below Ground Surface(ft)		Screen Length (ft)
			Ground Surface	Top of Screen	Bottom of Screen	Top of Screen	Bottom of Screen	
MW-47	UFZ	4	5120.7	4976.4	4961.4	144.3	159.3	15.0
MW-48[b]	UFZ	4	5143.0	4976.9	4961.9	166.1	181.1	15.0
MW-49	LLFZ	4	5041.0	4903.2	4893.2	137.8	147.8	10.0
MW-51	UFZ	2	5059.9	4984.5	4974.5	75.4	85.4	10.0
MW-52R	UFZ/ULFZ	4	5156.2	4968.5	4938.5	187.0	217.0	30.0
MW-53D	UFZ/ULFZ	2	5148.6	4963.6	4943.6	185.0	205.0	20.0
MW-54	UFZ	4	5097.2	4976.8	4961.8	120.4	135.4	15.0
MW-55	LLFZ	4	5143.1	4913.1	4903.1	230.0	240.0	10.0
MW-56	ULFZ	4	5141.0	4942.9	4932.9	198.1	208.1	10.0
MW-57D	UFZ	4	5103.1	4958.1	4938.1	145.0	165.0	20.0
MW-58	UFZ	4	5146.4	4975.4	4960.4	171.0	186.0	15.0
MW-59	ULFZ	4	5060.2	4954.9	4944.4	105.3	115.8	10.5
MW-60	ULFZ	4	5134.4	4949.5	4939.5	184.9	194.9	10.0
MW-61	UFZ	4	5134.8	4976.2	4961.2	158.6	173.6	15.0
MW-62	UFZ	2	5073.7	4975.1	4960.1	98.6	113.6	15.0
MW-63	UFZ	2	5063.1	4983.1	4968.1	80.0	95.0	15.0
MW-64	ULFZ	4	5097.4	4959.3	4949.1	138.1	148.3	10.2
MW-65	LLFZ	4	5156.5	4896.4	4886.4	260.1	270.1	10.0
MW-66	LLFZ	4	5102.6	4903.3	4893.3	199.3	209.3	10.0
MW-67	DFZ	4	5142.2	4798.1	4788.1	344.1	354.1	10.0
MW-68	UFZ	4	5168.5	4970.5	4950.5	198.0	218.0	20.0
MW-69	LLFZ	4	5167.8	4904.7	4894.7	263.1	273.1	10.0
MW-70	LLFZ	2	5046.3	4912.1	4902.1	134.2	144.2	10.0
MW-71R	DFZ	4	5134.2	4761.5	4756.5	372.7	377.7	5.0
MW-72	ULFZ	2	5053.7	4955.0	4945.0	98.7	108.7	10.0
MW-73	ULFZ	2	5050.6	4945.5	4940.5	105.1	110.1	5.0
MW-74	UFZ/ULFZ	2	5092.4	4969.2	4939.2	123.2	153.2	30.0
MW-75	UFZ/ULFZ	2	5111.6	4971.2	4941.2	140.4	170.4	30.0
MW-76	UFZ/ULFZ	2	5105.5	4972.4	4942.4	133.1	163.1	30.0
MW-77	UFZ/ULFZ	2	5045.5	4985.9	4955.9	59.6	89.6	30.0
MW-78	UFZ/ULFZ	2	5050.5	4988.1	4958.1	62.4	92.4	30.0
MW-79	DFZ	6	5166.7	4767.7	4752.7	399.0	414.0	15.0
				4747.7	4732.7	419.0	434.0	15.0
MW-80	ULFZ/LLFZ	4	5203.3	4934.3	4894.3	269.0	309.0	40.0

[a] The letter R after the number in the Well ID indicates that the well is a new and deeper replacement well installed near the original well location; the letter D after the number in the Well ID indicates that the well has been deepened.

[b] Well plugged and abandoned in July, 2011.

Table 2.3

Production History of the Former On-Site Groundwater Recovery System

Year	Volume of Recovered Water (gal)	Average Discharge Rate (gpm)
1988[a]	25,689	1.05
1989	737,142	1.40
1990	659,469	1.25
1991	556,300	1.06
1992	440,424	0.84
1993	379,519	0.72
1994	370,954	0.71
1995	399,716	0.76
1996	306,688	0.58
1997	170,900	0.33
1998	232,347	0.44
1999[b]	137,403	0.26
Total Recovered Volume (gal)	**4,416,550**	
Average Discharge Rate (gpm)		**0.77**

[a] System began operating on December 15, 1988.

[b] System operations were terminated on November 16, 1999.

Table 2.4

Water-Level Elevations - Fourth Quarter 1998[a]

Well ID	Flow Zone	Elevation (ft above MSL)
PW-1	UFZ	4973.59
PZ-1	UFZ	4956.59
MW-7	UFZ O/S [b]	4977.42
MW-9	UFZ O/S	4973.06
MW-12	UFZ O/S	4972.82
MW-13	UFZ O/S	4974.35
MW-14	UFZ	4971.12
MW-15	UFZ	Dry
MW-16	UFZ O/S	4978.43
MW-17	UFZ O/S	4978.70
MW-18	UFZ O/S	4971.87
MW-19	ULFZ	4971.85
MW-20	LLFZ	4971.47
MW-21	UFZ O/S	4978.31
MW-22	UFZ O/S	4977.89
MW-23	UFZ O/S	4975.91
MW-24	UFZ O/S	4978.23
MW-25	UFZ O/S	4978.31
MW-26	UFZ O/S	4973.44
MW-27	UFZ O/S	4974.05
MW-28	UFZ O/S	4971.09
MW-29	ULFZ	4973.68
MW-30	ULFZ	4972.28
MW-31	ULFZ	4971.23
MW-32	ULFZ [c]	4970.96
MW-33	UFZ O/S	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	4973.70
MW-39	LLFZ	4972.49

Well	Flow Zone	Elevation (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 [c]	4971.03
MW-50	UFZ	Dry
MW-51	UFZ O/S	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 O/S	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 [d]	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.

[b] UFZ O/S denotes UFZ wells, mostly on-site, which are screened above or within the 4970-foot silt/clay.

[c] Previously classified as LLFZ.

[d] Previously classified as 3rdFZ.

Table 2.5

Water-Quality Data - Fourth Quarter 1998[a]

Well ID	Sampling Date	Concentration (µg/L)		
		TCE	DCE	TCA
CW-1	09/01/98	140	2.9	<20
OB-1	09/01/98	180	3.6	<20
OB-2	09/01/98	72	1.7	<20
PW-1	12/04/98	48	1.0	2.2
MW-7	12/01/98	63	15	12
MW-9	12/03/98	290	19	18
MW-12	12/07/98	380	26	18
MW-13	12/01/98	70	3.2	8.0
MW-14	12/01/98	430	24	4.2
MW-16	12/08/98	1200	30	170
MW-17	12/01/98	68	3.5	13
MW-18	12/02/98	600	50	42
MW-19	11/23/98	4.2	<1.0	<1.0
MW-20	11/23/98	<1.0	<1.0	<1.0
MW-21	12/02/98	7.5	<1.0	1.1
MW-22	11/19/98	13	2.0	4.6
MW-23	12/03/98	6200	400	720
MW-24	12/08/98	4700	74	480
MW-25	12/08/98	5600	73	540
MW-26	12/03/98	6500	590	550
MW-27	12/02/98	380	24	90
MW-29	11/19/98	<1.0	<1.0	<1.0
MW-30	11/23/98	5.4	<1.0	<1.0
MW-31	11/23/98	<1.0	<1.0	<1.0
MW-32	11/30/98	550	96	30
MW-33	12/02/98	630	53	28
MW-34	11/18/98	<1.0	<1.0	<1.0
MW-35	12/08/98	<1.0	<1.0	<1.0
MW-36	12/07/98	1.4	<1.0	<1.0
MW-37	12/03/98	990	48	<5
MW-38	11/19/98	<1.0	<1.0	<1.0
MW-39	11/23/98	<1.0	<1.0	<1.0
MW-40	11/30/98	<1.0	<1.0	<1.0
MW-41	11/19/98	170	26	<15
MW-42	11/19/98	370	48	21
MW-43	11/19/98	25	5.1	5.4
MW-44	11/18/98	1.3	<1.0	<1.0
MW-45	11/18/98	40	1.7	<1.0
MW-46	11/19/98	2200	130	2.3
MW-47	11/17/98	34	1.2	<1.0
MW-48	11/17/98	28	1.0	<1.0
MW-49	11/23/98	<1.0	<1.0	<1.0
MW-51	11/18/98	<1.0	<1.0	<1.0
MW-52	11/30/98	<1.0	<1.0	<1.0
MW-53	11/16/98	99	3.4	<1.0
MW-55	11/16/98	390	10	<1.0
MW-56	11/16/98	140	4.7	<1.0
MW-57	12/08/98	<1.0	<1.0	<1.0
MW-58	11/16/98	71	2.5	<1.0
MW-59	11/18/98	<1.0	<1.0	<1.0
MW-60	11/17/98	7700	350	52
MW-61	12/07/98	1000	54	11
MW-62	12/07/98	2.0	6.6	4.8
MW-63	12/02/98	<1.0	<1.0	<1.0
MW-64	11/17/98	<1.0	<1.0	<1.0
MW-65	11/16/98	13	<1.0	<1.0
MW-66	11/17/98	<1.0	<1.0	<1.0
MW-67	11/17/98	<1.0	<1.0	<1.0
MW-68	11/12/98	<1.0	<1.0	<1.0
MW-69	11/12/98	<1.0	<1.0	<1.0
MW-70	11/23/98	<1.0	<1.0	<1.0
MW-71	11/17/98	56	1.6	<1.0
TW-1	02/18/98	3100	280	180
	02/18/98	3400	270	170
TW-2	02/19/98	18	<1.0	<1.0
	02/19/98	16	<1.0	<1.0

[a] Includes February 18, 1998 data from temporary well TW-1/2 which was drilled at the current location of well MW-73, and September 1, 1998 data from the containment well CW-1 and observation wells OB-1 and OB-2.

(Yellow shading) Concentration exceeds MCLs based on the more stringent of the drinking water standards or the maximum allowable concentrations in groundwater set by the NMWQCC (5 mg/L for TCE and DCE, and 60 mg/L for TCA).

Table 3.1

Downtime in the Operation of the Containment Systems - 2011

(a) Off-Site Containment System

Date of Downtime		Duration	Cause
From	To	(hours)	
1/24/11 15:37	1/24/11 18:00	2.38	Flow rate adjustment
1/25/11 17:16	1/25/11 18:40	1.40	Flow rate adjustment
2/7/11 17:58	2/7/11 18:25	0.45	Valve replacement
4/11/11 9:10	4/12/11 8:30	23.33	Building power outage
5/5/11 18:00	5/6/11 6:30	12.50	Building power outage
5/9/11 14:10	5/9/11 15:50	1.67	Building power outage
7/6/11 14:20	7/6/11 16:30	2.17	Flow rate adjustment
10/21/11 15:36	10/25/11 15:10	95.57	Pump failure, Replace with temporary pump
11/1/11 2:04	11/1/11 8:48	6.73	Building power outage
11/7/11 9:50	11/7/11 14:50	5.00	Replace pump
11/21/11 13:23	11/21/11 14:23	1.00	Building power outage
11/21/11 21:20	11/22/11 7:20	10.00	Building power outage
11/29/11 16:02	11/29/11 16:15	0.22	No data recorded, power outage to logger
11/21/11 21:20	11/22/11 7:20	10.00	Building power outage
Total Downtime		**172.42**	

(b) Source Containment System

Date of Downtime		Duration	Cause
From	To	(hours)	
1/24/11 10:40	1/24/11 14:50	4.17	Clean-up pipe line from CW-2 to air stripper
1/25/11 9:10	1/25/11 15:40	6.50	Clean-up pipe line from CW-2 to air stripper
1/27/11 1:45	1/27/11 2:00	0.25	Alarm reset
2/14/11 14:47	2/14/11 14:55	0.13	Pump motor start and stop
2/14/11 17:39	2/18/11 12:00	90.35	Replace pump
5/5/11 18:20	5/6/11 7:00	12.67	Building power outage
5/12/11 17:00	5/13/11 13:50	20.83	Sump pump overload
7/26/11 10:10	7/26/11 10:20	0.17	Building power outage
8/27/11 5:15	8/27/11 8:49	3.57	Sump pump overload
8/29/11 16:10	8/29/11 17:20	1.17	Building power outage
9/1/11 11:50	9/1/11 12:20	0.50	Building power outage
9/19/11 11:20	9/19/11 16:17	4.95	Clean valve
9/20/11 7:20	9/20/11 8:10	0.83	Building power outage
9/21/11 9:00	9/21/11 10:40	1.67	Clean valve
9/22/11 8:30	9/22/11 10:10	1.67	Clean valve
10/6/11 9:36	10/6/11 9:45	0.15	Low discharge volume
12/9/11 16:18	12/9/11 16:30	0.20	Waste water overload
Total Downtime		**149.77**	

Table 4.1
Quarterly Water-Level Elevations - 2011

Well ID	Flow Zone	Elevation (feet above MSL) Feb. 8-9, 2011	May 10-11, 2011	Aug. 16-17, 2011	Nov. 15-16, 2011
CW-1	UFZ&LFZ	4920.52	4921.01	4919.30	4920.57
CW-2	UFZ&LFZ	4950.08	4950.01	4950.41	4951.07
OB-1	UFZ&LFZ	4951.53	4950.88	4949.85	4951.35
OB-2	UFZ&LFZ	4952.92	4952.92	4952.56	4952.75
PZ-1	UFZ	4951.46	4951.40	4951.57	4950.81
MW-7	UFZ O/S	4973.69	4973.95	4973.51	4973.84
MW-9	UFZ O/S	4968.56	4968.70	4968.94	4968.76
MW-12	UFZ O/S	4967.78	4967.88	4967.49	4967.97
MW-13	UFZ O/S	Dry	Dry	P&A	P&A
MW-14R	UFZ/ULFZ	4965.71	4965.63	4965.25	4965.72
MW-16	UFZ O/S	4981.35	4981.68	4981.65	4981.41
MW-17	UFZ O/S	4980.72	4981.05	4981.03	4980.84
MW-18	UFZ O/S	4967.04	4967.12	4966.58	4967.56
MW-19	ULFZ	4966.80	4966.75	4966.37	4966.90
MW-20	LLFZ	4966.36	4966.22	4965.78	4966.33
MW-21	UFZ O/S	4982.04	4982.36	4982.20	4981.81
MW-22	UFZ O/S	4975.70	4976.00	4975.61	4975.90
MW-23	UFZ O/S	4972.62	4972.92	4972.47	4972.82
MW-24	UFZ O/S	4981.08	4981.47	4981.44	4981.17
MW-25	UFZ O/S	4981.38	4982.14	4981.69	4981.43
MW-26	UFZ O/S	4969.68	4970.01	4969.46	4969.87
MW-27	UFZ O/S	4980.36	4980.84	4980.53	4980.48
MW-29	ULFZ	4969.34	4969.24	4968.85	4969.35
MW-30	ULFZ	4967.39	4967.37	4966.93	4967.44
MW-31	ULFZ	4965.77	4965.35	4965.33	4965.88
MW-32	ULFZ	4965.54	4965.47	4964.97	4965.61
MW-34	UFZ	4969.73	4969.82	4969.43	4969.70
MW-37R	UFZ/ULFZ	4962.55	4962.25	4962.03	4962.34
MW-38	LLFZ	4969.09	4969.45	4968.92	4969.33
MW-39	LLFZ	4967.70	4967.52	4967.37	4967.78
MW-40	LLFZ	4965.92	4965.88	4965.47	4965.92
MW-41	ULFZ	4965.92	4965.86	4965.42	4966.04
MW-42	ULFZ	4966.25	4965.99	4965.65	4966.20
MW-43	LLFZ	4966.03	4965.75	4965.22	4965.97
MW-44	ULFZ	4965.03	4964.63	4964.41	4964.75
MW-45	ULFZ	4962.90	4962.60	4962.38	4962.68

Well ID	Flow Zone	Elevation (feet above MSL) Feb. 8-9, 2011	May 10-11, 2011	Aug. 16-17, 2011	Nov. 15-16, 2011
MW-46	ULFZ	4961.66	4961.24	4961.13	4961.23
MW-47	UFZ	4961.06	4960.98	4960.89	4960.76
MW-48	UFZ	Dry	Dry	P&A	P&A
MW-49	LLFZ	4965.96	4965.89	4965.44	4966.01
MW-51	UFZ O/S	4981.76	4981.00	4980.69	4981.14
MW-52R	UFZ/ULFZ	4954.91	4954.92	4954.56	4954.71
MW-53D	UFZ/ULFZ	4957.15	4957.09	4957.07	4957.20
MW-54	UFZ	4961.31	4961.81	Dry	4961.70
MW-55	LLFZ	4958.35	4958.27	4957.74	4958.04
MW-56	ULFZ	4959.91	4959.68	4959.04	4959.49
MW-57	UFZ	Dry	Dry	Deepened	Deepened
MW-57D	UFZ	NI	NI	4960.09	4960.02
MW-58	UFZ	4960.20	4960.17	4960.30	4960.17
MW-59	ULFZ	4965.30	4964.90	4965.46	4965.05
MW-60	ULFZ	4959.62	4959.50	4959.39	4959.33
MW-61	UFZ	4961.24	Dry	Dry	Dry
MW-62	UFZ	4962.03	4961.96	4961.77	4961.76
MW-63	UFZ O/S	4969.37	4968.10	4969.58	4969.63
MW-64	ULFZ	4960.82	4960.56	4960.37	4960.46
MW-65	LLFZ	4954.93	4954.96	4954.37	4954.78
MW-66	LLFZ	4959.06	4958.72	4958.36	4958.65
MW-67	DFZ	4952.88	4952.21	4951.40	4952.68
MW-68	UFZ	4955.34	4955.22	4954.85	4955.01
MW-69	LLFZ	4955.13	4955.11	4954.70	4954.90
MW-70	LLFZ	4965.04	4964.97	4964.51	4965.16
MW-71R	DFZ	4952.85	4952.21	4951.35	4952.69
MW-72	ULFZ	4966.27	4966.12	4965.75	4966.22
MW-73	ULFZ	4965.05	4964.90	4964.60	4965.15
MW-74	UFZ/ULFZ	4958.43	4958.36	4957.77	4957.46
MW-75	UFZ/ULFZ	4964.54	4964.68	4964.28	4962.97
MW-76	UFZ/ULFZ	4966.07	4965.98	4965.93	4964.09
MW-77	UFZ/ULFZ	4975.47	4975.45	4975.07	4975.48
MW-78	UFZ/ULFZ	4972.33	4972.83	4971.86	4972.63
MW-79	DFZ	4950.95	4950.95	4950.50	4950.78
MW-80	ULFZ/LLFZ	4952.92	4952.89	4952.29	4952.60
PZG-1	Infilt. Gall.	5067.40	5067.90	5067.52	5067.58

(Yellow) Measured water level is at or below bottom of screen.

P&A Well is plugged and abandoned.

NI Well has not been yet installed.

Table 4.2

Water-Quality Data - Fourth Quarter 2011

Well ID	Sampling Date	Concentration (mg/L)		
		TCE	DCE	TCA
CW1	11/1/2011	750	59	2
CW2	11/1/2011	34	3.6	<1.0
MW-7[a]	11/16/11	NS	NS	NS
MW-9	11/23/11	4.9	<1.0	<1.0
MW-12	11/23/11	13	<1.0	<1.0
MW-14R	11/21/11	5.1	<1.0	<1.0
MW-16	11/18/11	2.1	<1.0	<1.0
MW-17	11/22/11	<1.0	<1.0	<1.0
MW-18	11/23/11	1.3	<1.0	<1.0
MW-19	12/09/11	64	8.3	<1.0
MW-20	12/10/11	<1.0	<1.0	<1.0
MW-21	11/18/11	<1.0	<1.0	<1.0
MW-22	11/28/11	<1.0	<1.0	<1.0
MW-23	11/22/11	2.7	<1.0	<1.0
MW-25	11/19/11	4.7	<1.0	<1.0
MW-26	11/19/11	7.3	<1.0	<1.0
MW-29	12/09/11	<1,0	<1.0	<1.0
MW-30	11/23/11	7.6	<1.0	<1.0
MW-31	11/21/11	<1.0	<1.0	<1.0
MW-32	11/28/11	2.4	<1.0	<1.0
MW-34	11/23/11	<1.0	<1.0	<1.0
MW-37R	12/14/11	170	7.5	<1.0
MW-38	12/08/11	<1.0	<1.0	<1.0
MW-39	01/10/12	<1.0	<1.0	<1.0
MW-40	11/23/11	<1.0	<1.0	<1.0
MW-41	12/08/11	1.5	<1.0	<1.0
MW-42	12/17/11	13	2.6	<1.0
MW-43	12/16/11	<1.0	<1.0	<1.0
MW-44	12/12/11	<1.0	<1.0	<1.0
MW-45	12/14/11	<1.0	<1.0	<1.0
MW-46	12/14/11	310	38	1.2

Well ID	Sampling Date	Concentration (mg/L)		
		TCE	DCE	TCA
MW-47[a]		NS	NS	NS
MW-49	12/07/11	<1.0	<1.0	<1.0
MW-51	12/10/11	<1.0	<1.0	<1.0
MW-52R	12/15/11	16	29	1.8
MW-53D	12/07/11	25	<1.0	<1.0
MW-55	12/09/11	13	<1.0	<1.0
MW-56	12/07/11	77	2.2	<1.0
MW-57D	12/16/11	<1.0	<1.0	<1.0
MW-58[a]		NS	NS	NS
MW-59	12/10/11	<1.0	<1.0	<1.0
MW-60	12/15/11	1200	140	4.3
MW-61[a]		NS	NS	NS
MW-62	11/22/11	1.7	3.8	1.2
MW-64	12/14/11	<1.0	<1.0	<1.0
MW-65	12/15/11	3.2	6.9	<1.0
MW-66	12/14/11	<1.0	<1.0	<1.0
MW-67	12/08/11	<1.0	<1.0	<1.0
MW-68	11/30/11	<1.0	<1.0	<1.0
MW-69	11/29/11	<1.0	<1.0	<1.0
MW-70	11/28/11	4.8	<1.0	<1.0
MW-71R	12/27/11	58	2.2	<1.0
MW-72	11/30/11	1200	180	3.3
MW-73	12/16/11	25	2	<1.0
MW-74	11/27/11	<1.0	<1.0	<1.0
MW-75	11/27/11	<1.0	<1.0	<1.0
MW-76	11/27/11	<1.0	<1.0	<1.0
MW-77	11/28/11	3.1	<1.0	<1.0
MW-78	11/28/11	<1.0	<1.0	<1.0
MW-79	12/19/11	<1.0	<1.0	<1.0
MW-80	12/20/11	<1.0	<1.0	<1.0

[a] Well not sampled (NS) because it was dry or did not have sufficient water for sampling.

(Yellow shading) Concentration exceeds MCLs based on the more stringent of the drinking water standards or the maximum allowable concentrations in groundwater set by the NMWQCC (5 mg/L for TCE and DCE, and 60 mg/L for TCA).

Table 4.3

Flow Rates - 2011

Month	Off-Site Containment Well		Source Containment Well		Total	
	Volume Pumped (gal)	Average Rate (gpm)	Volume Pumped (gal)	Average Rate (gpm)	Volume Pumped (gal)	Average Rate (gpm)
Jan.	12,909,211	289	1,857,038	42	14,766,248	331
Feb.	11,751,755	291	2,006,574	50	13,758,329	341
Mar.	13,385,240	300	2,577,731	58	15,962,971	358
Apr.	12,497,633	289	2,491,086	58	14,988,719	347
May	12,465,507	279	2,429,555	54	14,895,062	334
June	12,535,357	290	2,329,202	54	14,864,559	344
July	13,106,984	294	2,327,828	52	15,434,812	346
Aug.	13,104,418	294	2,285,936	51	15,390,354	345
Sep.	12,659,856	293	2,163,092	50	14,822,948	343
Oct.	10,450,797	234	2,225,782	50	12,676,579	284
Nov.	11,453,886	265	2,141,644	50	13,595,530	315
Dec.	12,851,115	288	2,154,313	48	15,005,428	336
Total or Average	**149,171,757**	**284**	**26,989,781**	**51**	**176,161,538**	**335**

Table 4.4

Influent and Effluent Quality - 2011[a]

(a) Off-Site Containment System

Sampling Date	Concentration (µg/L)							
	Influent				Effluent			
	TCE	DCE	TCA	Cr Total	TCE	DCE	TCA	Cr Total
01/03/11	640	61	2.2	14	<1.0	<1.0	<1.0	14
02/01/11	680	66	2.1	14	<1.0	<1.0	<1.0	14
03/01/11	570	62	1.9	13	<1.0	<1.0	<1.0	13
04/01/11	560	69	2.2	13	<1.0	<1.0	<1.0	13
05/02/11	620	67	2.4	13	<1.0	<1.0	<1.0	13
06/01/11	680	56	1.7	13	<1.0	<1.0	<1.0	13
07/01/11				12				11
07/05/11	630	61	2.0		1.2	<1.0	<1.0	
08/01/11	600	66	2.2	12	1.1	<1.0	<1.0	12
09/01/11	460	55	2.1	11	<1.0	<1.0	<1.0	11
10/03/11	610	58	1.9	10	<1.0	<1.0	<1.0	10
11/01/11	750	59	2.0	14	<1.0	<1.0	<1.0	13
12/01/11	580	53	2.2	9.7	<1.0	<1.0	<1.0	10
01/02/12	700	55	1.8	11	<1.0	<1.0	<1.0	12

(b) Source Containment System

Sampling Date	Concentration (µg/L)							
	Influent				Effluent			
	TCE	DCE	TCA	Cr Total	TCE	DCE	TCA	Cr Total
01/03/11	42	5.0	<1.0	78	<1.0	<1.0	<1.0	43
02/01/11	40	4.9	<1.0	33	<1.0	<1.0	<1.0	32
03/01/11	32	3.6	<1.0	30	<1.0	<1.0	<1.0	31
04/01/11	36	4.8	<1.0	30	<1.0	<1.0	<1.0	30
05/02/11	36	4.6	<1.0	31	<1.0	<1.0	<1.0	30
06/01/11	35	3.5	<1.0	31	<1.0	<1.0	<1.0	30
07/01/11				29				29
07/05/11	31	3.9	<1.0		<1.0	<1.0	<1.0	
08/01/11	35	4.4	<1.0	31	<1.0	<1.0	<1.0	30
09/01/11	31	3.9	<1.0	29	<1.0	<1.0	<1.0	30
10/03/11	32	3.5	<1.0	28	<1.0	<1.0	<1.0	28
11/01/11	34	3.6	<1.0	29	<1.0	<1.0	<1.0	29
12/01/11	34	3.5	<1.0	27	<1.0	<1.0	<1.0	27
01/02/12	34	3.7	<1.0	30	<1.0	<1.0	<1.0	28

[a] Data from January 2, 2012 has been included to show conditions at the end of the year.

(Yellow shading) Concentration exceeds MCLs based on the more stringent of the drinking water standards or the maximum allowable concentrations in groundwater set by the NMWQCC (5 mg/L for TCE and DCE, and 60 mg/L for TCA and 50 ug/L for total chromium).

Table 5.1

Concentration Changes in Monitoring Wells - 1998 to 2011

Well ID	Change in Concentration (mg/l) TCE	DCE
CW-1[a]	610	56
CW-2	-966	-186
MW-09	-285	-19
MW-12	-367	-26
MW-14R[b]	-425	-24
MW-16	-1198	-30
MW-17	-68	-3.5
MW-18	-599	-50
MW-19	60	8.3
MW-20	0[c]	0
MW-21	-7.5	0
MW-22	-13	-2.0
MW-23	-6197	-400
MW-25	-5595	-73
MW-26	-6493	-590
MW-29	0	0
MW-30	2.2	0
MW-31	0	0
MW-32	-548	-96
MW-34	0	0
MW-37R[b]	-820	-41
MW-38	0	0
MW-39	0	0
MW-40	0	0
MW-41	-169	-26
MW-42	-357	-45
MW-43	-25	-5.1
MW-44	-1.3	0

Well ID	Change in Concentration (mg/l) TCE	DCE
MW-45	-40	-1.7
MW-46	-1890	-92
MW-49	0	0
MW-51	0	0
MW-52R[b]	16	29
MW-53D[b]	-74	-3.4
MW-55	-377	-10
MW-56	-63	-2.5
MW-57D[b]	0	0
MW-59	0	0
MW-60	-6500	-210
MW-62	-0.3	-2.8
MW-64	0	0
MW-65	-9.8	6.9
MW-66	0	0
MW-67	0	0
MW-68	0	0
MW-69	0	0
MW-70	4.8	0
MW-71R[b]	2.0	0.6
MW-72[a]	-600	-40
MW-73[a]	-3975	-518
MW-74	0	0
MW-75	0	0
MW-76	0	0
MW-77[a]	-13	-1.2
MW-78[a]	-6.0	0

[a] Change from concentration in first available sample.

[b] Change from concentration in original well.

[c] "0" indicates concentration below detection limits during both sampling events.

(yellow) Well used both in the original and the current plume definition

(green) Well used either in the original or in the current plume definition

Table 5.2

Summary of Annual Flow Rates - 1998 to 2011

Year	Off-Site Containment Well		Source Containment Well		Total	
	Volume Pumped (gal)	Average Rate (gpm)	Volume Pumped (gal)	Average Rate (gpm)	Volume Pumped (gal)	Average Rate (gpm)
1998[a]	1,694,830				1,694,830	
1999	114,928,700	219			114,928,700	219
2000	114,094,054	216			114,094,054	216
2001	113,654,183	216			113,654,183	216
2002	116,359,389	221	25,403,490	49	141,762,879	270
2003	118,030,036	225	27,292,970	52	145,323,006	277
2004	113,574,939	215	26,105,202	50	139,680,141	265
2005	118,018,628	225	25,488,817	48	143,507,445	273
2006	112,213,088	213	24,133,264	46	136,346,352	259
2007	117,098,422	223	23,983,802	46	141,082,224	269
2008	114,692,635	218	25,432,013	48	140,124,648	266
2009	114,752,782	218	24,524,740	47	139,277,522	264
2010	114,720,233	218	22,062,857	42	136,783,091	260
2011	149,171,757	284	26,989,781	51	176,161,538	335
Total or Average	**1,533,003,676**	**224**	**251,416,936**	**48**	**1,784,420,613**	**261**

[a] Volume pumped during the testing of the well in early December, and during the first day of operation on December 31, 1998.

Table 5.3
Contaminant Mass Removal - 2011

(a) Total

	Mass Removed	(kg)	(lbs)
2011	TCE	352	774
	DCE	34.8	76.7
	TCA	1.2	2.6
	Total	387	854

(b) Off-Site Containment Well

Month	Mass Removed						Total	
	TCE		DCE		TCA			
	(kg)	(lbs)	(kg)	(lbs)	(kg)	(lbs)	(kg)	(lbs)
Jan.	32.3	71.1	3.10	6.84	0.1051	0.232	35.5	78.2
Feb.	27.8	61.3	2.85	6.28	0.0890	0.196	30.7	67.8
Mar.	28.6	63.1	3.32	7.32	0.1039	0.229	32.1	70.7
Apr.	27.9	61.5	3.22	7.09	0.1088	0.240	31.2	68.9
May	30.7	67.6	2.90	6.40	0.0967	0.213	33.7	74.2
June	31.1	68.5	2.78	6.12	0.0878	0.194	33.9	74.8
July	30.5	67.3	3.15	6.95	0.1042	0.230	33.8	74.5
Aug.	26.3	58.0	3.00	6.62	0.1067	0.235	29.4	64.8
Sep.	25.6	56.5	2.71	5.97	0.0958	0.211	28.4	62.7
Oct.	26.9	59.3	2.31	5.10	0.0771	0.170	29.3	64.6
Nov.	28.8	63.6	2.43	5.35	0.0911	0.201	31.4	69.1
Dec.	31.1	68.6	2.63	5.79	0.0973	0.214	33.9	74.6
Total	**348**	**766**	**34.4**	**75.8**	**1.16**	**2.57**	**383**	**845**

(c) Source Containment Well

Month	Mass Removed				Total	
	TCE		DCE			
	(kg)	(lbs)	(kg)	(lbs)	(kg)	(lbs)
Jan.	0.288	0.64	0.035	0.077	0.32	0.72
Feb.	0.273	0.60	0.032	0.071	0.31	0.67
Mar.	0.332	0.73	0.0410	0.090	0.37	0.82
Apr.	0.339	0.75	0.0443	0.098	0.38	0.85
May	0.326	0.72	0.0372	0.082	0.36	0.80
June	0.291	0.64	0.0326	0.072	0.32	0.71
July	0.291	0.64	0.0366	0.081	0.33	0.72
Aug.	0.286	0.63	0.0359	0.079	0.32	0.71
Sep.	0.258	0.57	0.0303	0.067	0.29	0.64
Oct.	0.278	0.61	0.0299	0.066	0.31	0.68
Nov.	0.276	0.61	0.0288	0.063	0.30	0.67
Dec.	0.277	0.61	0.0294	0.065	0.31	0.68
Total	**3.52**	**7.75**	**0.41**	**0.91**	**3.93**	**8.66**

Table 5.4

Summary of Contaminant Mass Removal - 1998 to 2011

(a) Total

Year	Mass Removed							
	TCE		DCE		TCA		Total	
	kg	lbs	kg	lbs	kg	lbs	kg	lbs
1998[a]	1.31	2.89	0.030	0.066	0.00	0.00	1.34	2.95
1999	358	789	16.2	35.7	0.00	0.00	374	825
2000	463	1,020	23.3	51.4	0.00	0.00	486	1,070
2001	519	1,140	26.6	58.6	0.00	0.00	546	1,200
2002	603	1331	40.6	89.4	3.66	8.07	647	1,426
2003	617	1,360	38.1	84.1	3.05	6.72	658	1,454
2004	596	1,310	35.3	77.7	2.42	5.34	634	1,403
2005	558	1,230	34.7	76.4	2.01	4.43	595	1,315
2006	513	1,130	34.3	75.5	1.66	3.67	549	1,215
2007	468	1,040	33.0	72.9	1.03	2.27	502	1,109
2008	433	955	32.5	71.8	1.08	2.39	467	1,031
2009	378	836	32.0	70.5	1.23	2.72	412	908
2010	309	682	29.2	64.4	0.97	2.13	339	749
2011	352	774	34.8	76.7	1.16	2.57	387	854
Total	**6,170**	**13,600**	**411**	**905**	**18.3**	**40.3**	**6,600**	**14,560**

(b) Off-Site Containment Well

Year	Mass Removed							
	TCE		DCE		TCA		Total	
	kg	lbs	kg	lbs	kg	lbs	kg	lbs
1998[a]	1.31	2.89	0.030	0.066	0.000	0.000	1.34	2.95
1999	358	789	16.2	35.7	0.000	0.000	374	825
2000	463	1,020	23.3	51.4	0.000	0.000	486	1,070
2001	519	1,140	26.6	58.6	0.000	0.000	546	1,200
2002	543	1,200	30.9	68.1	2.05	4.52	576	1,270
2003	568	1,250	31.6	69.7	2.06	4.54	602	1,330
2004	567	1,250	31.7	69.9	1.96	4.32	601	1,330
2005	540	1,190	32.4	71.4	1.79	3.95	574	1,270
2006	499	1,100	32.5	71.6	1.57	3.46	533	1,180
2007	456	1,010	31.6	69.7	1.03	2.27	489	1,080
2008	425	937	31.5	69.5	1.08	2.39	458	1,010
2009	372	821	31.2	68.8	1.23	2.72	405	892
2010	305	673	28.6	63.1	0.97	2.13	335	738
2011	348	766	34.4	75.8	1.16	2.57	383	845
Total	**5,960**	**13,150**	**383**	**843**	**14.9**	**32.9**	**6,360**	**14,040**

(c) Source Containment Well

Year	Mass Removed							
	TCE		DCE		TCA		Total	
	kg	lbs	kg	lbs	kg	lbs	kg	lbs
2002	59.6	131	9.66	21.3	1.61	3.55	70.9	156
2003	48.7	107	6.53	14.4	0.989	2.18	56.2	124
2004	29.0	63.9	3.55	7.83	0.464	1.02	33.1	72.8
2005	18.1	39.9	2.28	5.03	0.218	0.481	20.6	45.4
2006	13.8	30.4	1.76	3.88	0.093	0.206	15.7	34.5
2007	11.5	25.4	1.44	3.17	<0.05	<0.1	13.0	28.6
2008	8.42	18.6	1.04	2.29	<0.05	<0.1	9.51	21.0
2009	6.14	13.5	0.79	1.75	<0.05	<0.1	6.98	15.4
2010	4.30	9.50	0.57	1.26	<0.05	<0.1	4.87	10.7
2011	3.52	7.75	0.41	0.91	--	--	3.98	8.77
Total	**203**	**447**	**28.0**	**61.8**	**3.37**	**7.44**	**235**	**517**

[a] Mass removed during the testing of the off-site well in early December, and during the first day of operation on December 31, 1998.

Table 6.1
Initial Mass and Maximum Concentration of TCE in Model Layers

Model Layer	Approximate Mass (kg)	Approximate Mass (lbs)	Maximum Concentration (µg/L)
1	0.6	1.3	1000
2	40	90	12000
3	540	1190	150000
4	680	1500	25000
5	1130	2490	40000
6	990	2180	40000
7	880	1940	30000
8	1550	3420	37000
9	1310	2890	25000
10	240	530	1100
11	0.9	2.0	7.2
12	0.0	0.0	0.0
13	0.0	0.0	0.0
14	0.0	0.0	0.0
15	0.0	0.0	0.0
Total Mass	**7,361**	**16,233**	

APPENDIX A

Appendix A

Data on Abandoned, Replaced, or Deepened Wells

Figure A-1: Location of Abandoned, Replaced, or Deepened Wells

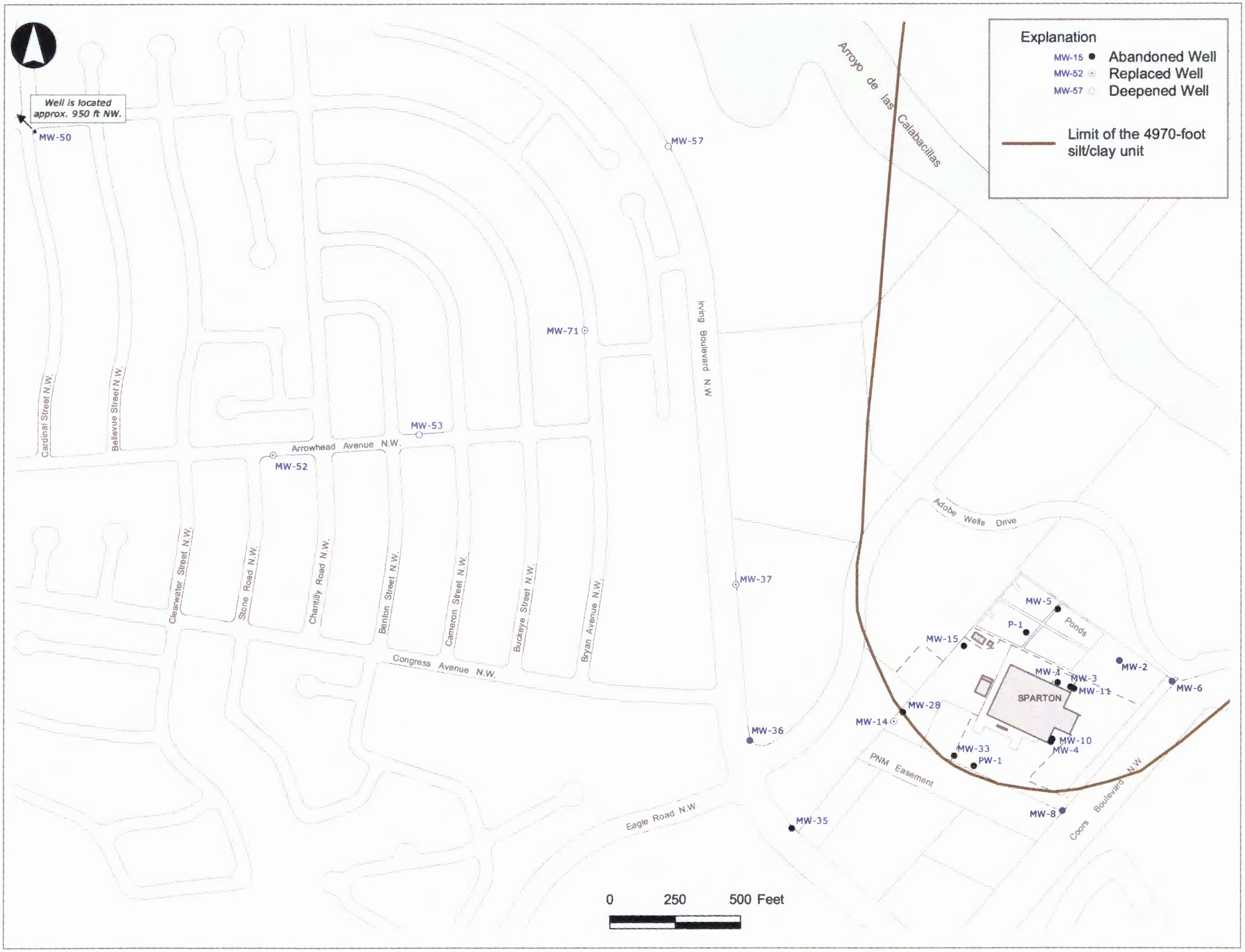


Figure A-1 Location of Abandoned, Replaced, or Deepened Wells

Table A-1: Completion Flow Zone, Location Coordinates, and Measuring Point Elevations for Abandoned, Replaced, or Deepened Wells

Table A-1

Completion Flow Zone, Location Coordinates, and Measuring Point Elevations for Abandoned, Replaced, or Deepened Wells

Well ID	Flow Zone	Easting	Northing	Elevation	Remark
MW-1	UFZ	377333.82	1524375.09	5047.84	P&A
MW-2	UFZ	377567.16	1524459.46	5050.26	P&A
MW-3	UFZ	377381.22	1524358.94	5047.22	P&A
MW-4	UFZ	377307.78	1524150.61	5047.61	P&A
MW-5	UFZ	377333.30	1524654.26	5054.52	P&A
MW-6	UFZ	377767.16	1524379.78	5046.39	P&A
MW-8	UFZ	377351.53	1523889.67	5042.62	P&A
MW-10	LLFZ	377312.93	1524159.79	5046.80	P&A
MW-11	LLFZ	377394.44	1524351.71	5046.31	P&A
MW-14	UFZ	376711.05	1524226.84	5043.04	Replaced
MW-15	UFZ	376976.13	1524514.13	5047.49	P&A
MW-28	UFZ	376745.76	1524262.70	5041.31	P&A
MW-33	UFZ	376940.80	1524097.74	5042.20	P&A
MW-35	UFZ	376322.45	1523822.39	5042.50	P&A
MW-36	UFZ	376161.85	1524154.66	5059.46	P&A
MW-37	UFZ	376108.17	1524746.78	5090.85	Replaced
MW-50	UFZ	372810.17	1527180.09	5211.51	P&A
MW-52	UFZ/ULFZ	374343.43	1525239.45	5156.79	Replaced
MW-53	UFZ	374899.50	1525314.41	5148.62	Deepened
MW-57	UFZ	375849.02	1526406.98	5103.54	Deepened
MW-71	DFZ	375530.63	1525711.81	5134.59	Replaced
P-1	UFZ	377213.50	1524565.70	5048.80	P&A
PW-1	UFZ	377014.90	1524058.50	5144.20	P&A

Table A-2: Screen Data for Abandoned, Replaced, or Deepened Wells

Table A-2

Screen Data for Abandoned, Replaced, or Deepened Wells

Well ID	Flow Zone	Diameter (in)	Elevation (ft above MSL)			Depth below Ground (ft)		Screen Length (ft)	Remark
			Ground Surface	Top of Screen	Bottom of Screen of Screen	Top of Screen	Bottom of Screen of Screen		
MW-01	UFZ		5046.1	4977.1	4957.1	69.0	89.0	20.0	P&A
MW-02	UFZ		5048.6	4979.6	4959.6	69.0	89.0	20.0	P&A
MW-03	UFZ		5045.5	4980.5	4960.5	65.0	85.0	20.0	P&A
MW-04	UFZ		5045.9	4975.9	4955.9	70.0	90.0	20.0	P&A
MW-05	UFZ	2	5052.3	4984.3	4974.3	68.0	78.0	10.0	P&A
MW-06	UFZ	2	5044.6	4983.1	4978.1	61.5	66.5	5.0	P&A
MW-08	UFZ	2	5040.4	4982.4	4977.4	58.0	63.0	5.0	P&A
MW-10	UFZ	2	5045.3	4910.3	4905.3	135.0	140.0	5.0	P&A
MW-11	UFZ	2	5044.4	4910.4	4905.4	134.0	139.0	5.0	P&A
MW-14	UFZ		5040.4	4979.4	4913.4	61.0	127.0	66.0	Replaced
MW-15	UFZ		5045.6	4985.6	4921.1	60.0	124.5	65.0	P&A
MW-28	UFZ	2	5040.9	4975.9	4970.9	65.0	70.0	5.0	P&A
MW-33	UFZ	2	5042.1	4980.1	4969.1	62.0	73.0	11.0	P&A
MW-35	UFZ	2	5042.5	4979.3	4969.3	63.2	73.2	10.0	P&A
MW-36	UFZ	2	5059.3	4977.0	4967.0	82.3	92.3	10.0	P&A
MW-37	UFZ	2	5091.7	4976.7	4966.7	115.0	125.0	10.0	Replaced
MW-50	UFZ	4	5210.8	4975.8	4960.8	235.0	250.0	15.0	P&A
MW-52	UFZ	4	5165.4	4974.6	4959.4	190.8	206.0	15.2	Replaced
MW-53	UFZ	2	5164.0	4974.0	4960.0	190.0	204.0	14.0	Deepened
MW-57	UFZ	4	5103.1	4977.1	4962.1	126.0	141.0	15.0	Deepened
MW-71	DFZ	4	5134.1	4786.1	4781.1	348.0	353.0	5.0	Replaced
P-1	UFZ		5048.8	4978.8	4958.8	70.0	90.0	10.0	P&A
PW-1	UFZ		5042.9	4982.9	4905.9	60.0	137.0	77.0	P&A

APPENDIX B

Appendix B

2011 Groundwater Quality Data

B-1: Groundwater Monitoring Program Wells 2011 Analytical Results

B-2: Infiltration Gallery and Pond Monitoring Wells 2011 Analytical Results

B-1: Groundwater Monitoring Program Wells 2011 Analytical Results

Appendix B-1
Groundwater Monitoring Program Wells
2011 Analytical Results[a]

	Sample Date	TCE ug/L	1,1-DCE ug/L	1,1,1-TCA ug/L	Cr Total, mg/L Unfiltered	Cr Total, mg/L Filtered	Other
MW-7	11/16/11						
MW-9	11/23/11	4.9	<1.0	<1.0	<0.0060	<0.0060	
MW-12	11/23/11	13	<1.0	<1.0	0.033	<0.0060	
MW-14R	11/21/11	5.1	<1.0	<1.0	0.190	NA	
MW-16	11/18/11	2.1	<1.0	<1.0	0.230	0.110	
MW-18	11/23/11	1.3	<1.0	<1.0	0.028	0.027	
MW-19	12/09/11	64	8.3	<1.0	0.031	NA	
MW-20	12/10/11	<1.0	<1.0	<1.0	<0.0060	NA	
MW-21	11/18/11	<1.0	<1.0	<1.0	0.100	0.028	
MW-22	11/28/11	<1.0	<1.0	<1.0	0.037	NA	
MW-23	11/22/11	2.7	<1.0	<1.0	0.250	0.120	
MW-25	11/19/11	4.7	<1.0	<1.0	0.210	0.071	
MW-26	11/19/11	7.3	<1.0	<1.0	0.620	0.078	
MW-27	11/22/11	<1.0	<1.0	<1.0	0.037	0.028	
MW-29	12/09/11	<1,0	<1.0	<1.0	<0.0060	NA	
MW-30	11/23/11	7.6	<1.0	<1.0	<0.0060	NA	
MW-31	11/21/11	<1.0	<1.0	<1.0	0.012	NA	
MW-32	11/28/11	2.4	<1.0	<1.0	0.019	NA	
MW-34	11/23/11	<1.0	<1.0	<1.0	0.110	<0.0060	
MW-37R	12/14/11	170	7.5	<1.0	0.084	NA	
MW-38	12/08/11	<1.0	<1.0	<1.0	<0.0060	NA	
MW-39	02/14/11	NA	NA	NA	<0.0060	<0.0060	
	01/10/12	<1.0	<1.0	<1.0	<0.0060	NA	
MW-40	11/23/11	<1.0	<1.0	<1.0	<0.010	NA	
MW-41	12/08/11	1.5	<1.0	<1.0	0.028	NA	
MW-42	12/17/11	13	2.6	<1.0	0.027	NA	
MW-43	12/16/11	<1.0	<1.0	<1.0	<0.0060	NA	
MW-44	12/12/11	<1.0	<1.0	<1.0	<0.0060	NA	
MW-45	12/14/11	<1.0	<1.0	<1.0	0.069	NA	
MW-46	12/14/11	310	38	1.2	0.043	NA	PCE:2.9
MW-49	12/07/11	<1.0	<1.0	<1.0	<0.0060	NA	
MW-51	12/10/11	<1.0	<1.0	<1.0	0.028	NA	

Appendix B-1
Groundwater Monitoring Program Wells
2011 Analytical Results[a]

	Sample Date	TCE ug/L	1,1-DCE ug/L	1,1,1-TCA ug/L	Cr Total, mg/L Unfiltered	Cr Total, mg/L Filtered	Other
MW-52R	02/10/11	11	23	1.7	0.008	NA	
	05/12/11	13	19	1.3	0.007	NA	
	08/18/11	11	20	1.2	0.008	NA	
	12/15/11	16	29	1.8	<0.0060	NA	
MW-53D	12/07/11	25	<1.0	<1.0	0.027	0.027	
MW-55	12/09/11	13	<1.0	<1.0	0.011	NA	
MW-56	12/07/11	77	2.2	<1.0	0.015	NA	
MW-57D	07/08/11	<1.0	<1.0	<1.0	0.025	0.014	Toluene 3.8, Acetone 28, 4-Isopropytoluene 1.5
	08/24/11	<1.0	<1.0	<1.0	0.017	<0.0060	
	12/16/11	<1.0	<1.0	<1.0	<0.0060	<0.0060	
MW-59	12/10/11	<1.0	<1.0	<1.0	0.027	NA	
MW-60	12/15/11	1200	140	4.3	0.045	0.028	1-1 DCA 1.4, PCE 12
MW-62	02/15/11	2.0	4.6	1.5	0.023	<0.0060	
	05/16/11	2.2	3.7	1.3	0.028	<0.0060	
	08/25/11	1.3	1.1	<1.0	0.016	<0.0060	
	11/22/11	1.7	3.8	1.2	0.018	<0.0060	
MW-64	12/14/11	<1.0	<1.0	<1.0	<0.0060	NA	
MW-65	02/10/11	2.6	8.0	<1.0	<0.0060	NA	
	05/12/11	3.6	7.2	1.2	<0.0060	NA	
	05/12/11	3.6	7.8	<1.0	<0.0060	NA	
	08/16/11						Broken Pump
	12/15/11	3.2	6.9	<1.0	<0.0060	NA	
MW-66	02/10/11	<1.0	<1.0	<1.0	<0.0060	NA	
	05/17/11	<1.0	<1.0	<1.0	<0.0060	NA	
	08/19/11	<1.0	<1.0	<1.0	<0.0060	NA	
	12/14/11	<1.0	<1.0	<1.0	<0.0060	NA	
MW-67	05/13/11	<1.0	<1.0	<1.0	<0.0060	NA	
	12/08/11	<1.0	<1.0	<1.0	<0.0060	NA	
MW-68	02/09/11	<1.0	<1.0	<1.0	<0.0060	NA	
	05/12/11	<1.0	<1.0	<1.0	<0.0060	NA	
	08/19/11	<1.0	<1.0	<1.0	<0.0060	NA	
	11/30/11	<1.0	<1.0	<1.0	<0.0060	NA	
MW-69	02/09/11	<1.0	<1.0	<1.0	<0.0060	NA	
	05/12/11	<1.0	<1.0	<1.0	<0.0060	NA	
	08/19/11	<1.0	<1.0	<1.0	<0.0060	NA	
	11/29/11	<1.0	<1.0	<1.0	<0.0060	NA	

Appendix B-1
Groundwater Monitoring Program Wells
2011 Analytical Results[a]

	Sample Date	TCE ug/L	1,1-DCE ug/L	1,1,1-TCA ug/L	Cr Total, mg/L Unfiltered	Cr Total, mg/L Filtered	Other
MW-70	11/28/11	4.8	<1.0	<1.0	<0.0060	NA	
MW-71R	02/10/11	81	3.1	<1.0	<0.0060	NA	
	02/10/11	85	3.1	<1.0	<0.0060	NA	
	05/17/11	91	2.0	<1.0	<0.0060	NA	
	08/23/11	82	2.8	<1.0	<0.0060	NA	
	08/23/11	79	2.9	<1.0	<0.0060	NA	
	12/27/11	58	2.2	<1.0	<0.0060	NA	
MW-72	11/30/11	1200	180	3.3	0.110	NA	PCE: 13, 1,1,2-TCA 1.6, Chlor 3.5
MW-73	12/16/11	25	2	<1.0	0.048	NA	
MW-79	05/23/11	<1.0	<1.0	<1.0	<0.0060	NA	
	10/21/11	<1.0	<1.0	<1.0	<0.0060	NA	
	12/19/11	<1.0	<1.0	<1.0	<0.0060	NA	
MW-80	08/26/11	<1.0	<1.0	<1.0	<0.0060	NA	
	12/20/11	<1.0	<1.0	<1.0	<0.0060	NA	

[a] VOCs by EPA Method 8260

NA Not analyzed

(Highlighted) Concentration exceeds MCLs based on the more stringent of the drinking water standards or the maximum allowable concentrations in groundwater set by the NMWQCC (5 mg/L for TCE and DCE, and 60 mg/L for TCA and 50 ug/L for total chromium).

B-2: Infiltration Gallery and Pond Monitoring Wells 2011 Analytical Results

Appendix B-2

Infiltration Gallery and Pond Monitoring Wells
2011 Analytical Results[a]

Well	Sample Date	TCE (ug/l)	1,1DCE (ug/l)	1,1,1TCA (ug/l)	Cr(total) (mg/l)	Fe(total) (mg/l)	Mn(total) (mg/l)	Cr(diss) (mg/l)	Fe(diss) (mg/l)	Mn(diss) (mg/l)
MW-17	02/16/11	<1.0	<1.0	<1.0	0.046	4.6	0.16	0.030	<0.0050	<0.0020
	05/17/11	<1.0	<1.0	<1.0	0.077	12	0.46	0.029	0.026	<0.0020
	08/25/11	1.1	<1.0	<1.0	0.041	6.2	0.19	0.029	<0.020	<0.0020
	11/22/11	<1.0	<1.0	<1.0	0.080	18	0.0020	0.029	0.036	0.0020
MW-74	02/18/11	<1.0	<1.0	<1.0	0.013	0.071	0.010			
	05/13/11	<1.0	<1.0	<1.0	0.012	<0.050	0.0028			
	08/22/11	<1.0	<1.0	<1.0	0.011	<0.020	<0.0020			
	11/27/11	<1.0	<1.0	<1.0	0.010	<0.050	0.0047			
MW-75	02/18/11	<1.0	<1.0	<1.0	0.012	<0.020	<0.0020			
	05/16/11	<1.0	<1.0	<1.0	0.013	<0.050	0.0024			
	08/22/11	<1.0	<1.0	<1.0	0.011	<0.020	<0.0020			
	11/27/11	<1.0	<1.0	<1.0	0.010	<0.050	<0.0020			
MW-76	02/18/11	<1.0	<1.0	<1.0	0.013	0.026	0.0021			
	05/13/11	<1.0	<1.0	<1.0	0.013	<0.050	<0.0020			
	08/22/11	1.2	<1.0	<1.0	0.011	<0.020	<0.0020			
	11/27/11	<1.0	<1.0	<1.0	0.010	<0.050	<0.0020			
MW-77	02/14/11	2.1	<1.0	<1.0	<0.0060	<0.050	1.1	<0.0060		
	05/17/11	6.1	<1.0	<1.0	<0.0060	0.470	6.4	<0.0060	<0.020	0.490
	08/23/11	7.9	<1.0	<1.0	<0.0060	0.340	4.9	<0.0060	<0.020	0.350
	11/28/11	3.1	<1.0	<1.0	<0.0060	0.400	9.2	<0.0060	<0.020	0.450
MW-78	2/9/11	<1.0	<1.0	<1.0	0.035	1.0	0.058	NA		
	5/13/11	<1.0	<1.0	<1.0	0.029	0.540	0.031	0.028	<0.005	<0.020
	8/23/11	<1.0	<1.0	<1.0	0.028	0.130	0.011	0.028	<0.020	0.013
	11/28/11	<1.0	<1.0	<1.0	0.027	0.086	0.005	0.028	<0.020	<0.0020

[a]VOCs by EPA Method 8260

NA Not analyzed

(yellow) Concentration exceeds MCLs based on the more stringent of the drinking water standards or the maximum allowable concentrations in groundwater set by the NMWQCC (5 mg/L for TCE and DCE, and 60 mg/L for TCA and 50 ug/L for total chromium).

APPENDIX C

Appendix C

2011 Flow Rate Data from Containment Well

C-1: Off-Site Containment Well

C-2: Source Containment Well

C-1: Off-Site Containment Well

Appendix C-1

Off-Site Containment Well
2011 Flow Rate Data

Date	Time	Instantaneous Discharge (gpm)	Totalizer Reading (gallons)	Average Discharge (gpm)	Total Volume (gallons)a
12/27/2010	7:20	296.7	24,964,500		1,380,684,100
				293	
1/3/2011	8:05	295.9	27,934,700		1,383,654,300
				295	
1/10/2011	8:30	293.5	30,913,300		1,386,632,900
				293	
1/17/2011	7:55	294.5	33,859,300		1,389,578,900
				294	
1/24/2011	7:45	292.3	36,816,000		1,392,535,600
				275	
2/1/2011	13:25	294.1	40,078,200		1,395,797,800
				294	
2/7/2011	8:45	295.4	42,537,800		1,398,257,400
				289	
2/14/2011	9:10	288.7	45,460,000		1,401,179,600
				288	
2/21/2011	9:15	--	48,366,400		1,404,086,000
				296	
3/1/2011	9:00	295.8	51,768,200		1,407,487,800
				298	
3/7/2011	8:55	301;51	54,343,600		1,410,063,200
				300	
3/14/2011	8:40	300.6	57,361,600		1,413,081,200
				300	
3/21/2011	8:05	302.3	60,379,900		1,416,099,500
				301	
3/28/2011	16:00	301.1	63,552,500		1,419,272,100
				300	
4/1/2011	8:00	298.7	65,137,900		1,420,857,500
				299	
4/4/2011	7:35	298.5	66,420,560		1,422,140,160
				299	
4/11/2011	7:52	299.5	69,437,500		1,425,157,100
				258	
4/18/2011	9:30	299.1	72,060,100		1,427,779,700
				299	
4/25/2011	8:12	300.5	75,055,100		1,430,774,700
				299	
5/2/2011	7:58	300.0	78,064,900		1,433,784,500

Appendix C-1

Off-Site Containment Well
2011 Flow Rate Data

Date	Time	Instantaneous Discharge (gpm)	Totalizer Reading (gallons)	Average Discharge (gpm)	Total Volume (gallons)a
				196	
5/9/2011	12:10	292.7	80,090,100		1,435,809,700
				371	
5/16/2011	7:30	289.6	83,724,600		1,439,444,200
				271	
5/23/2011	7:33	263.0	86,457,600		1,442,177,200
				280	
6/1/2011	8:50	282.0	90,105,200		1,445,824,800
				281	
6/8/2011	8:50	280.8	92,934,600		1,448,654,200
				293	
6/17/2011	7:45	293.1	96,710,600		1,452,430,200
				294	
6/24/2011	7:45	293.6	99,676,400		1,455,396,000
				293	
7/1/2011	8:20	296.3	102,638,700		1,458,358,300
				290	
7/8/2011	13:13	292.3	105,650,900		1,461,370,500
				294	
7/15/2011	8:20	295.5	108,524,500		1,464,244,100
				294	
7/22/2011	9:30	294.0	111,511,000		1,467,230,600
				296	
7/25/2011	12:15	293.5	112,836,800		1,468,556,400
				294	
8/1/2011	8:15	294.4	115,726,800		1,471,446,400
				294	
8/8/2011	8:45	294.1	118,698,600		1,474,418,200
				294	
8/15/2011	9:35	295.0	121,674,800		1,477,394,400
				294	
8/22/2011	8:40	291.8	124,619,600		1,480,339,200
				294	
8/29/2011	10:15	294.0	127,606,600		1,483,326,200
				296	
9/1/2011	11:00	293.5	128,899,100		1,484,618,700
				292	
9/6/2011	8:15	295.4	130,951,400		1,486,671,000
				294	

Appendix C-1

Off-Site Containment Well
2011 Flow Rate Data

Date	Time	Instantaneous Discharge (gpm)	Totalizer Reading (gallons)	Average Discharge (gpm)	Total Volume (gallons)a
9/12/2011	7:40	295.0	133,478,200		1,489,197,800
				293	
9/19/2011	8:48	293.7	136,455,700		1,492,175,300
				293	
9/26/2011	11:50	293.6	139,463,900		1,495,183,500
				293	
10/3/2011	8:00	291.9	142,347,000		1,498,066,600
				293	
10/10/2011	13:33	294.1	145,395,900		1,501,115,500
				292	
10/17/2011	8:45	291.7	148,258,100		1,503,977,700
				171	
10/24/2011	15:30	201.0	150,052,300		1,505,771,900
				120	
10/29/2011	11:18	201.0	150,887,300		1,506,606,900
				255	
11/1/2011	9:50	205.7	151,964,500		1,507,684,100
				207	
11/7/2011	7:50	--	153,726,300		1,509,445,900
				274	
11/14/2011	9:08	291.0	156,507,300		1,512,226,900
				297	
11/21/2011	10:05	300.4	159,519,500		1,515,239,100
				267	
11/28/2011	11:20	286.5	162,227,900		1,517,947,500
				286	
12/1/2011	9:24	286.3	163,429,400		1,519,149,000
				287	
12/9/2011	9:05	286.9	166,726,000		1,522,445,600
				286	
12/15/2011	11:08	287.5	169,228,900		1,524,948,500
				287	
12/22/2011	9:40	293.4	172,094,400		1,527,814,000
				291	
12/30/2011	9:08	291.0	175,439,800		1,531,159,400
				291	
1/2/2012	10:42	291.8	176,726,000		1,532,445,600

[a]Total pumpage since December 31, 1998

C-2: Source Containment Well

Appendix C-2

Source Containment Well
2011 Flow Rate Data

Date	Time	Instantaneous Discharge (gpm)	Totalizer Reading (gallons)	Average Discharge (gpm)	Total Volume (gallons)
12/27/2010	7:55		40,044,200		224,271,219
				38.9	
1/3/2011	9:00	38.99	40,438,400		224,665,419
				37.6	
1/10/2011	9:15	37.06	40,818,000		225,045,019
				37.5	
1/17/2011	8:10	37.63	41,193,700		225,420,719
				37.1	
1/24/2011	9:00	36.36	41,569,600		225,796,619
				41.8	
1/26/2011	8:30	59.10	41,688,600		225,915,619
				58.3	
2/1/2011	14:10	58.10	42,212,100		226,439,119
				57.6	
2/7/2011	8:30	59.60	42,690,400		226,917,419
				57.9	
2/14/2011	10:30	56.80	43,280,700		227,507,719
				25.3	
2/21/2011	8:20	58.70	43,532,000		227,759,019
				57.8	
3/1/2011	10:05	58.10	44,204,100		228,431,119
				57.8	
3/7/2011	8:27	57.50	44,698,200		228,925,219
				57.5	
3/14/2011	9:00	56.50	45,280,000		229,507,019
				57.8	
3/21/2011	8:20	57.50	45,860,600		230,087,619
				57.8	
3/28/2011	16:40	57.80	46,471,900		230,698,919
				57.8	
4/1/2011	9:20	57.55	46,779,200		231,006,219
				57.9	
4/4/2011	7:55	57.62	47,024,600		231,251,619
				57.8	
4/11/2011	8:20	57.60	47,608,200		231,835,219
				57.7	
4/18/2011	9:29	58.49	48,193,300		232,420,319
				57.6	
4/25/2011	8:40	58.15	48,771,200		232,998,219

Appendix C-2

Source Containment Well
2011 Flow Rate Data

Date	Time	Instantaneous Discharge (gpm)	Totalizer Reading (gallons)	Average Discharge (gpm)	Total Volume (gallons)
				57.5	
5/2/2011	8:40	57.30	49,350,600		233,577,619
				53.1	
5/9/2011	12:50	56.13	49,899,600		234,126,619
				54.9	
5/16/2011	8:40	56.90	50,439,000		234,666,019
				51.1	
5/23/2011	16:40	56.28	50,978,400		235,205,419
				57.6	
6/1/2011	9:45	55.75	51,701,200		235,928,219
				55.2	
6/8/2011	10:00	55.30	52,258,700		236,485,719
				54.0	
6/17/2011	8:58	53.50	52,955,500		237,182,519
				53.2	
6/24/2011	8:40	47.45	53,491,200		237,718,219
				52.9	
7/1/2011	9:35	53.15	54,027,100		238,254,119
				52.5	
7/8/2011	12:20	51.39	54,564,900		238,791,919
				52.2	
7/15/2011	8:35	52.45	55,079,300		239,306,319
				52.1	
7/22/2011	9:05	51.30	55,605,700		239,832,719
				51.9	
8/1/2011	9:05	51.42	56,352,800		240,579,819
				51.7	
8/8/2011	9:10	50.98	56,874,400		241,101,419
				51.7	
8/15/2011	8:08	52.20	57,392,200		241,619,219
				51.4	
8/22/2011	8:00	51.31	57,910,300		242,137,319
				50.2	
8/29/2011	9:27	50.82	58,420,611		242,647,630
				50.6	
9/1/2011	12:30	59.47	58,648,400		242,875,419
				51.0	
9/6/2011	8:30	57.56	59,003,700		243,230,719
				51.1	

Appendix C-2

Source Containment Well
2011 Flow Rate Data

Date	Time	Instantaneous Discharge (gpm)	Totalizer Reading (gallons)	Average Discharge (gpm)	Total Volume (gallons)
9/12/2011	8:30	59.38	59,444,800		243,671,819
				50.9	
9/19/2011	10:00	59.53	59,962,400		244,189,419
				47.4	
9/26/2011	12:15	59.69	60,446,400		244,673,419
				50.6	
10/3/2011	9:55	51.67	60,949,400		245,176,419
				50.4	
10/10/2011	13:50	59.22	61,469,400		245,696,419
				50.2	
10/17/2011	9:30	59.28	61,962,400		246,189,419
				50.0	
10/24/2011	10:00	60.81	62,467,700		246,694,719
				39.5	
10/29/2011	13:50	61.00	62,760,900		246,987,919
				68.3	
11/1/2011	10:45	59.59	63,043,400		247,270,419
				49.9	
11/7/2011	8:50	60.25	63,468,700		247,695,719
				48.5	
11/14/2011	13:00	61.34	63,969,800		248,196,819
				50.4	
11/21/2011	8:18	60.16	64,463,300		248,690,319
				49.2	
11/28/2011	13:27	62.32	64,974,100		249,201,119
				47.5	
12/1/2011	10:32	61.28	65,171,000		249,398,019
				48.6	
12/9/2011	10:34	62.02	65,731,300		249,958,319
				48.4	
12/15/2011	15:21	62.44	66,163,000		250,390,019
				48.2	
12/22/2011	10:02	63.75	66,633,500		250,860,519
				48.0	
12/30/2011	9:50	62.82	67,185,700		251,412,719
				47.9	
1/2/2012	11:42	61.31	67,397,800		251,624,819

APPENDIX D

Appendix D

2011 Influent/Effluent Quality Data

D-1: Off-Site Treatment System
2011 Analytical Results

D-2: Source Treatment System
2011 Analytical Results

D-1: Off-Site Treatment System 2011 Analytical Results

Appendix D-1

Off-Site Treatment System
2011 Analytical Results[a]

Sample Date	Influent TCE (ug/l)	Influent 1,1DCE (ug/l)	Influent 1,1,1TCA (ug/l)	Influent Cr(total) (mg/l)	Influent Fe(total) (mg/l)	Influent Mn(total) (mg/l)	Effluent TCE (ug/l)	Effluent 1,1DCE (ug/l)	Effluent 1,1,1TCA (ug/l)	Effluent Cr(total) (mg/l)	Effluent Fe(total) (mg/l)	Effluent Mn(total) (mg/l)
01/03/11	640	61	2.2	0.0140	<0.050	<0.0020	<1.0	<1.0	<1.0	0.0140	<0.050	<0.0020
02/01/11	680	66	2.1	0.0140	<0.050	<0.0020	<1.0	<1.0	<1.0	0.0140	<0.050	<0.0020
03/01/11	570	62	1.9	0.0130	<0.050	<0.0020	<1.0	<1.0	<1.0	0.0130	<0.050	<0.0020
04/01/11	560	69	2.2	0.0130	<0.050	<0.0020	<1.0	<1.0	<1.0	0.0130	<0.050	<0.0020
05/02/11	620	67	2.4	0.0130	<0.050	0.0025	<1.0	<1.0	<1.0	0.0130	<0.050	0.0024
06/01/11	680	56	1.7	0.0130	<0.050	0.0025	<1.0	<1.0	<1.0	0.0130	<0.050	<0.0020
07/01/11				0.0120	0.0360	<0.0020				0.0110	<0.020	<0.0020
07/05/11	630	61	2.0				1.2	<1.0	<1.0			
08/01/11	600	66	2.2	0.0120	<0.020	<0.0020	1.1	<1.0	<1.0	0.0120	<0.020	<0.0020
09/01/11	460	55	2.1	0.0110	<0.050	<0.0020	<1.0	<1.0	<1.0	0.0110	<0.050	<0.0020
10/03/11	610	58	1.9	0.0100	<0.050	<0.0020	<1.0	<1.0	<1.0	0.0100	<0.050	<0.0020
11/01/11	750	59	2.0	0.0140	0.2500	<0.0020	<1.0	<1.0	<1.0	0.0130	<0.050	<0.0020
12/01/11	580	53	2.2	0.0097	NA	<0.0020	<1.0	<1.0	<1.0	0.0098	NA	<0.0020
01/02/12	700	55	1.8	0.0110	<0.020	0.0000	<1.0	<1.0	<1.0	0.0120	0.0530	<0.0020

[a] Data from January 2, 2012 has been included to show conditions at the end of the year.

(Yellow box) Concentration exceeds MCLs based on the more stringent of the drinking water standards or the maximum allowable concentrations in groundwater set by the NMWQCC (5 mg/L for TCE and DCE, and 60 mg/L for TCA).

D-2: Source Treatment System 2011 Analytical Results

Appendix D-2

Source Treatment System
2011 Analytical Results[a]

Sample Date	Influent TCE (ug/l)	Influent 1,1DCE (ug/l)	Influent 1,1,1TCA (ug/l)	Influent Cr(total) (mg/l)	Influent Fe(total) (mg/l)	Influent Mn(total) (mg/l)	Effluent TCE (ug/l)	Effluent 1,1DCE (ug/l)	Effluent 1,1,1TCA (ug/l)	Effluent Cr(total) (mg/l)	Effluent Fe(total) (mg/l)	Effluent Mn(total) (mg/l)
01/03/11	42	5	<1.0	0.078	2.6	0.510	<1.0	<1.0	<1.0	0.043	0.4800	0.740
02/01/11	40	4.9	<1.0	0.033	<0.050	0.240	<1.0	<1.0	<1.0	0.032	0.0550	0.480
03/01/11	32	3.6	<1.0	0.030	<0.050	0.200	<1.0	<1.0	<1.0	0.031	<0.050	0.110
04/01/11	36	4.8	<1.0	0.030	<0.050	0.190	<1.0	<1.0	<1.0	0.030	<0.050	0.099
05/02/11	36	4.6	<1.0	0.031	<0.050	0.480	<1.0	<1.0	<1.0	0.030	<0.050	0.130
06/01/11	35	3.5	<1.0	0.031	<0.050	1.200	<1.0	<1.0	<1.0	0.030	<0.050	0.140
07/01/11	---	---	---	0.029	<0.020	0.120	---	---	---	0.029	<0.020	0.053
07/05/11	31	3.9	<1.0	---	---	---	<1.0	<1.0	<1.0	---	---	---
08/01/11	35	4.4	<1.0	0.031	<0.020	0.260	<1.0	<1.0	<1.0	0.030	<0.020	0.068
09/01/11	31	3.9	<1.0	0.029	<0.050	0.110	<1.0	<1.0	<1.0	0.030	<0.050	0.072
10/03/11	32	3.5	<1.0	0.028	<0.050	0.360	<1.0	<1.0	<1.0	0.028	<0.050	0.050
11/01/11	34	3.6	<1.0	0.029	<0.050	0.100	<1.0	<1.0	<1.0	0.029	<0.050	0.049
12/01/11	34	3.5	<1.0	0.027	NA	0.065	<1.0	<1.0	<1.0	0.027	NA	0.044
01/02/12	34	3.7	<1.0	0.030	<0.020	0.440	<1.0	<1.0	<1.0	0.028	<0.020	0.047

[a] Data from January 2, 2012 has been included to show conditions at the end of the year.

(Yellow shading) Concentration exceeds MCLs based on the more stringent of the drinking water standards or the maximum allowable concentrations in groundwater set by the NMWQCC (5 mg/L for TCE and DCE, and 60 mg/L for TCA and 50 ug/L for total chromium).

APPENDIX E

Appendix E

Observed and Calculated Water Levels and Concentrations – December 1998 to December 2011 Simulation

Figure E-1: Comparison of Observed and Calculated Water Levels in On-Site UFZ Wells

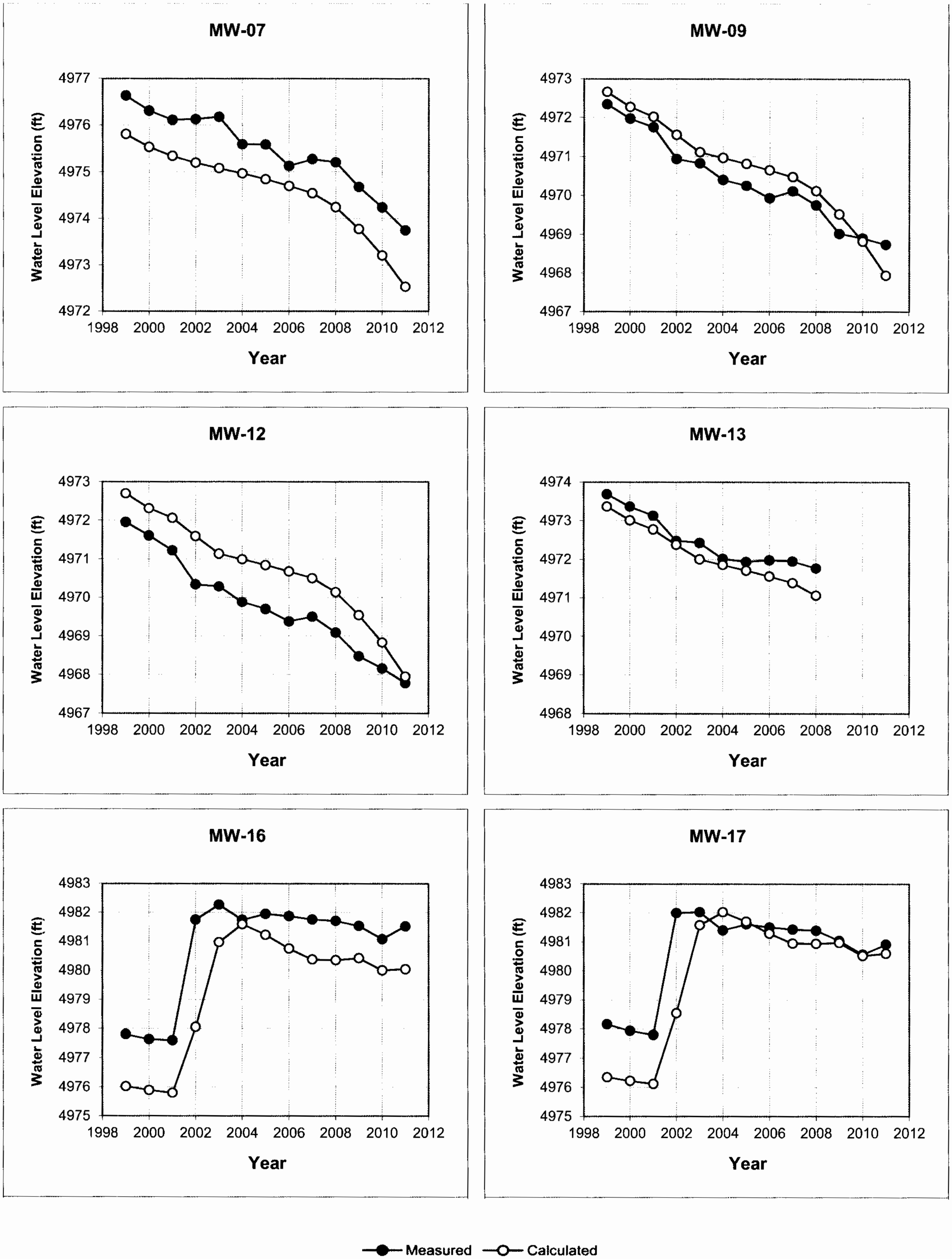


Figure E-1 Comparison of Observed and Calculated Water Levels in On-Site UFZ Wells

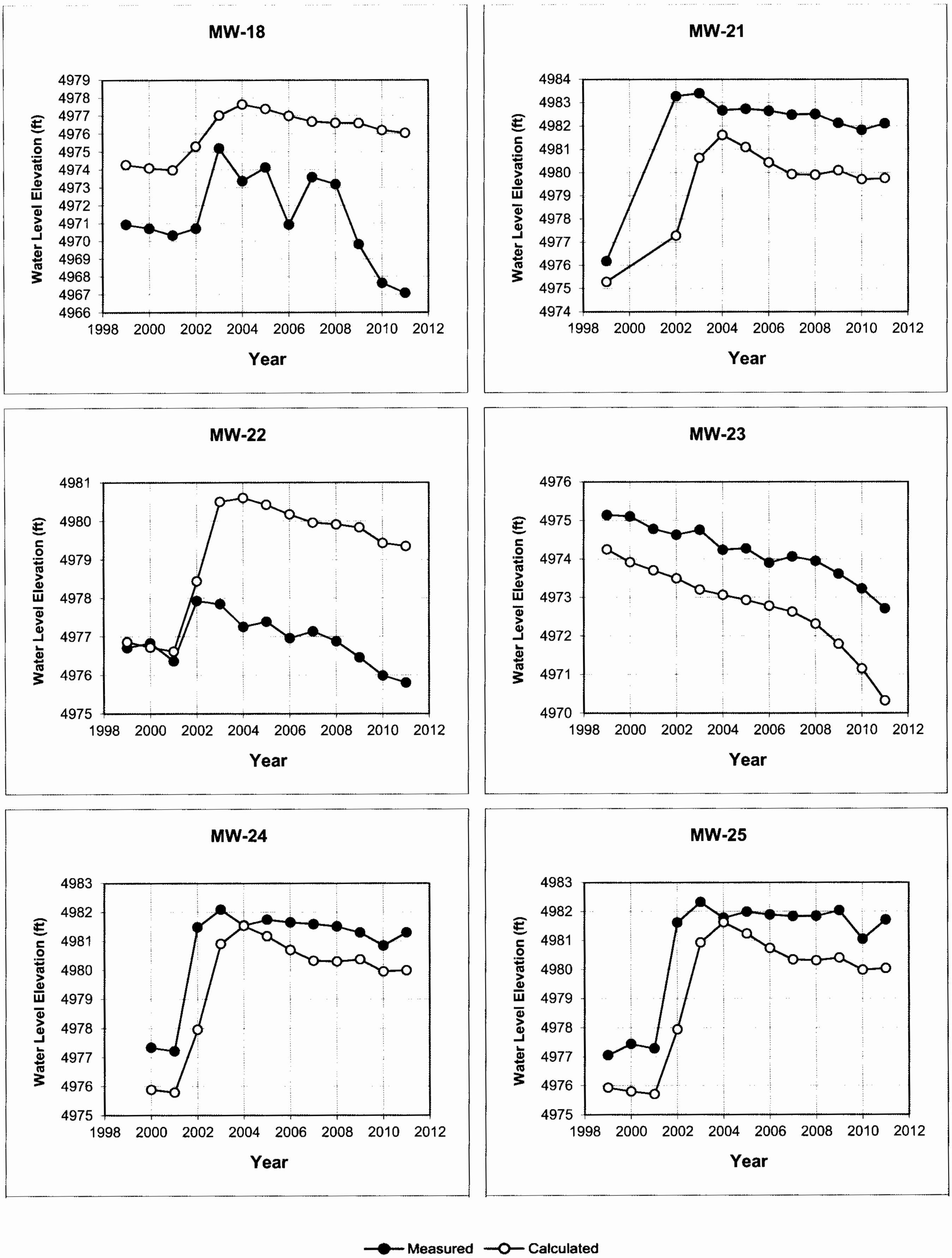


Figure E-1 Comparison of Observed and Calculated Water Levels in On-Site UFZ Wells

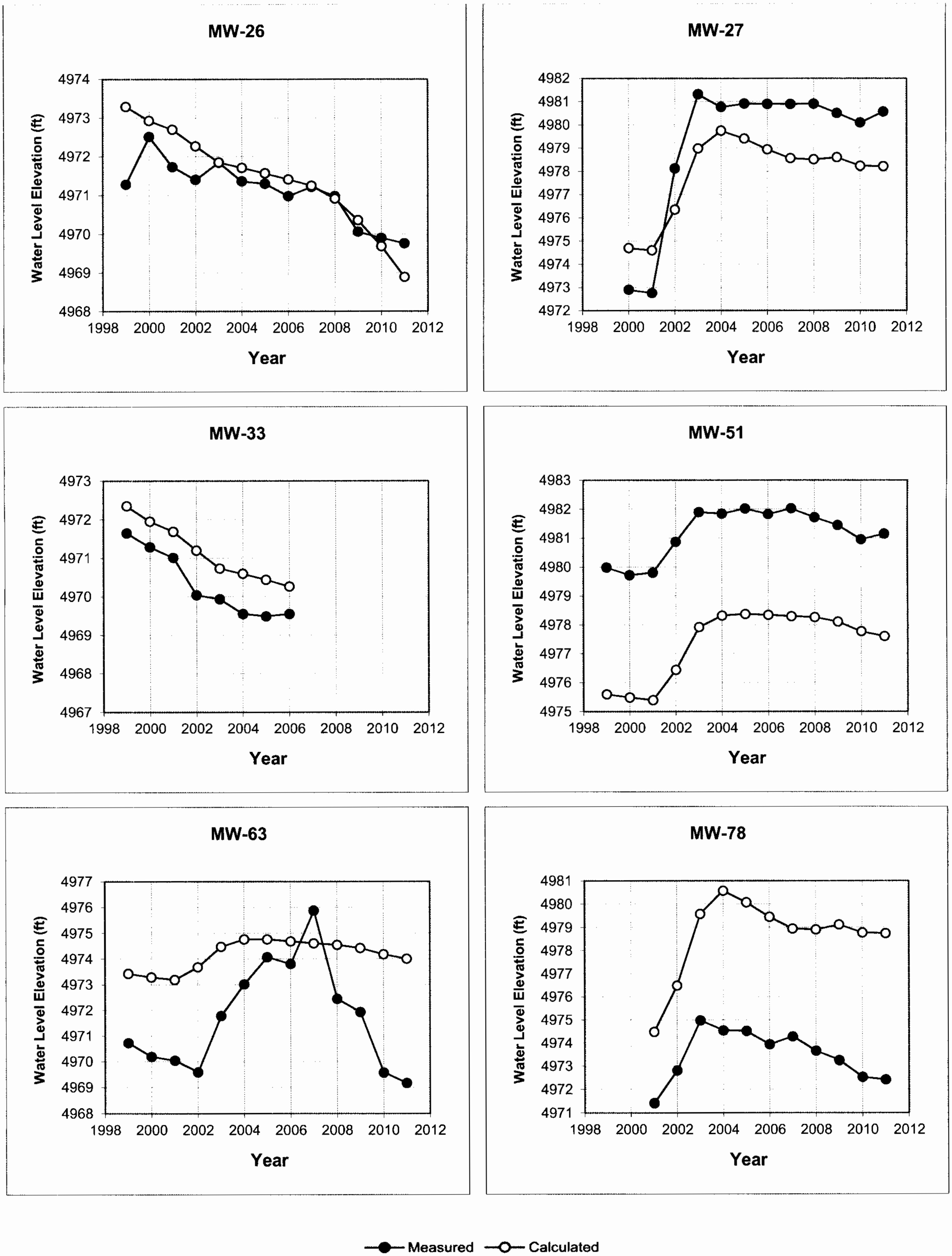


Figure E-1 Comparison of Observed and Calculated Water Levels in On-Site UFZ Wells
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Figure E-2: **Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells**

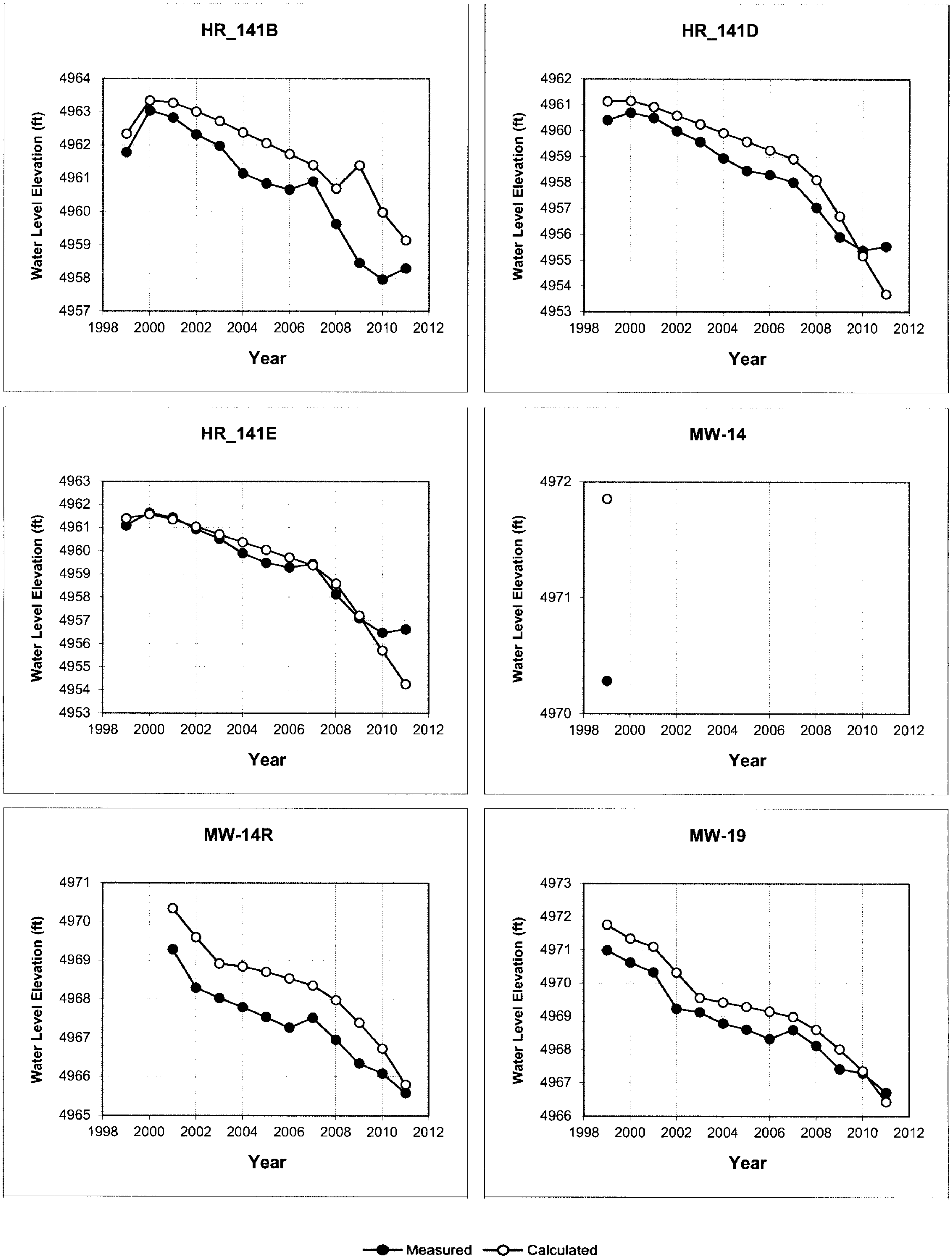

Figure E-2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells
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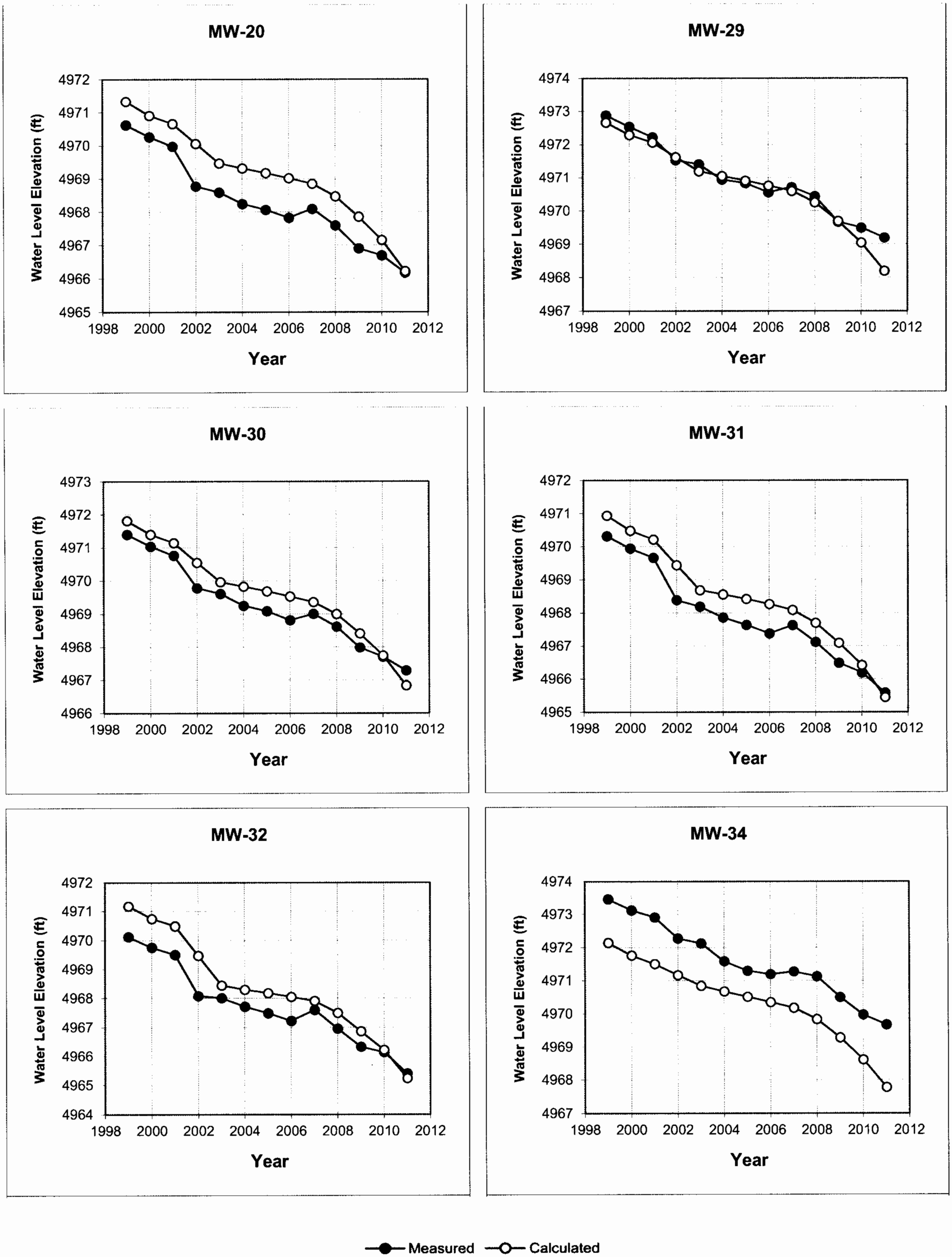


Figure E-2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells

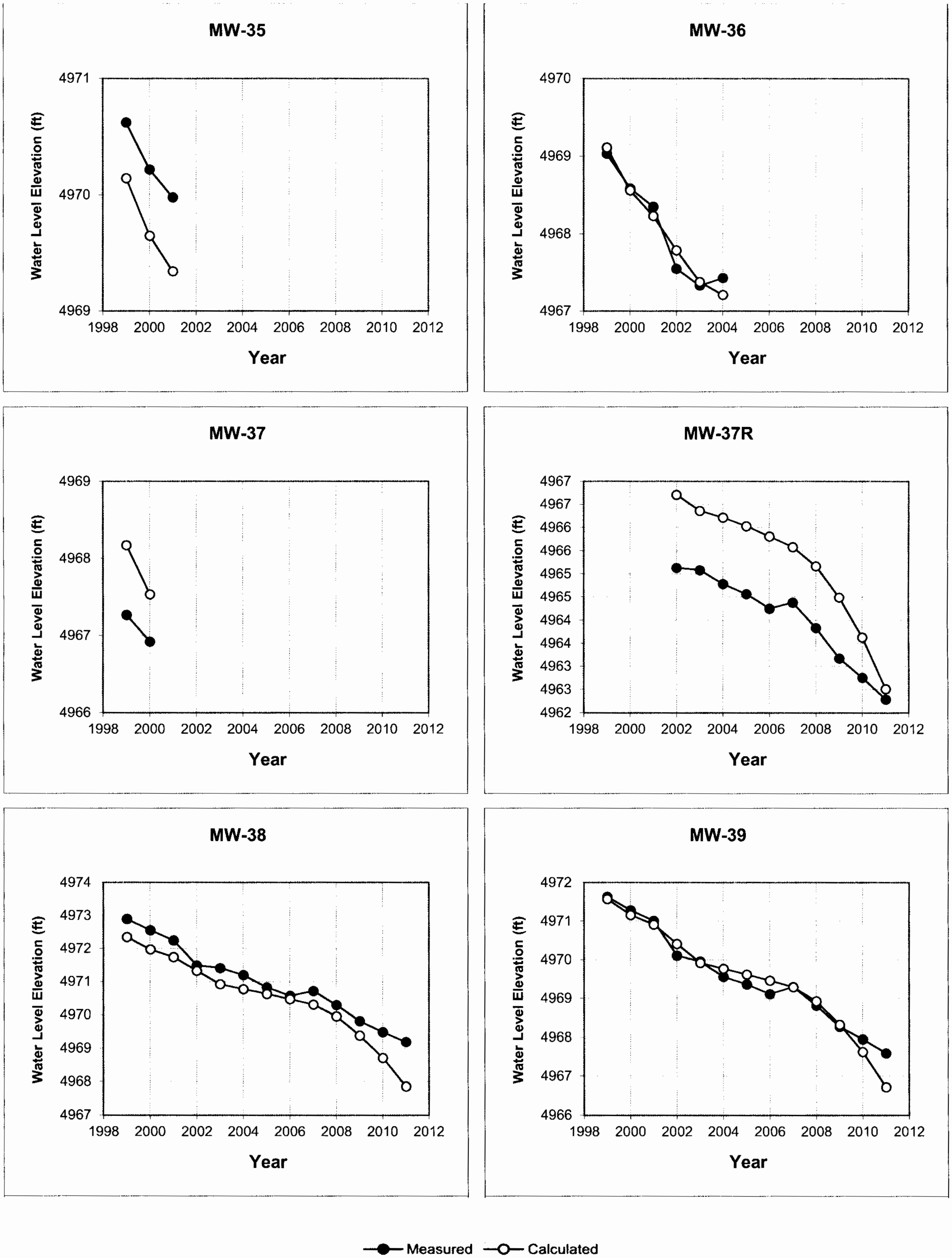


Figure E-2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells

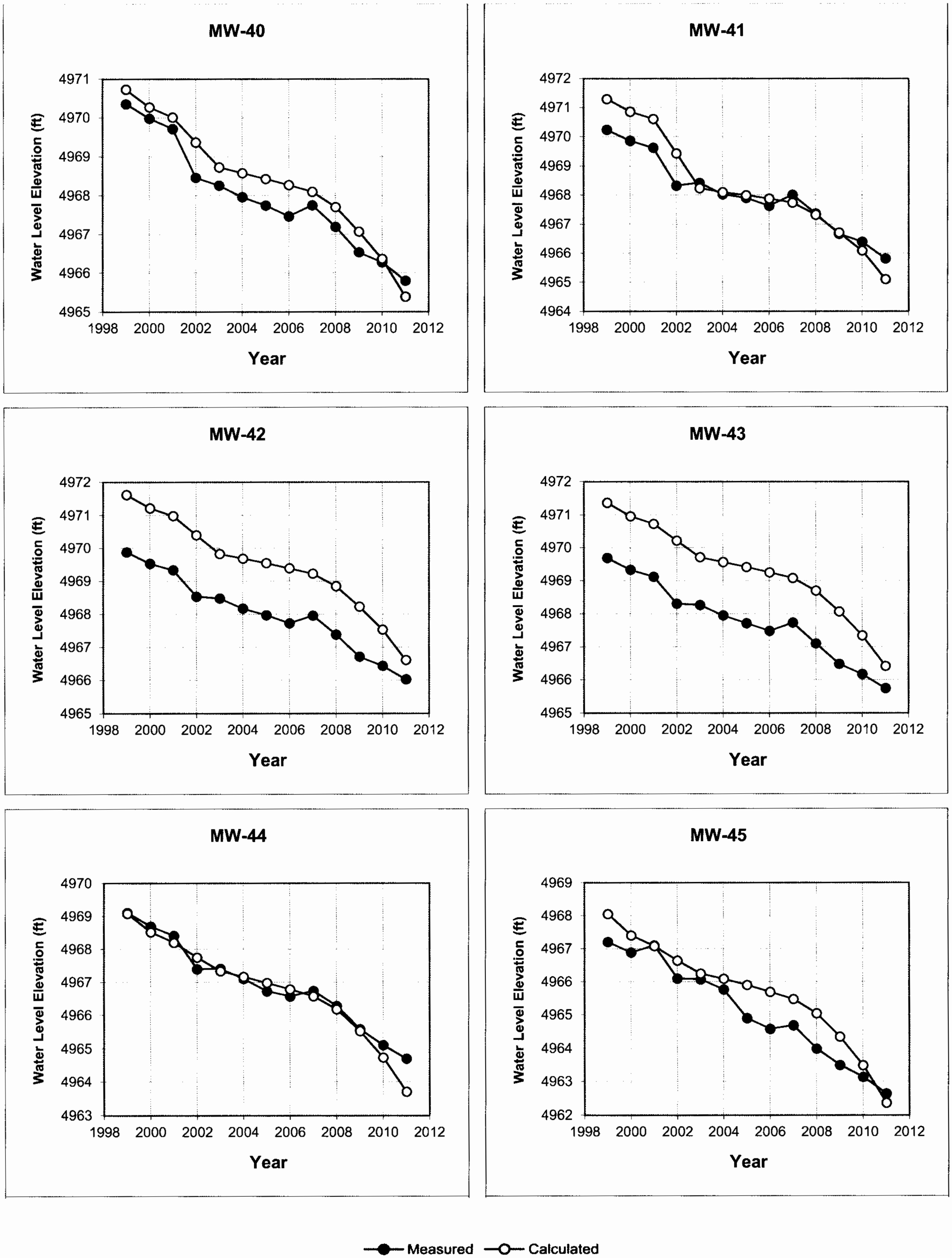


Figure E-2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells

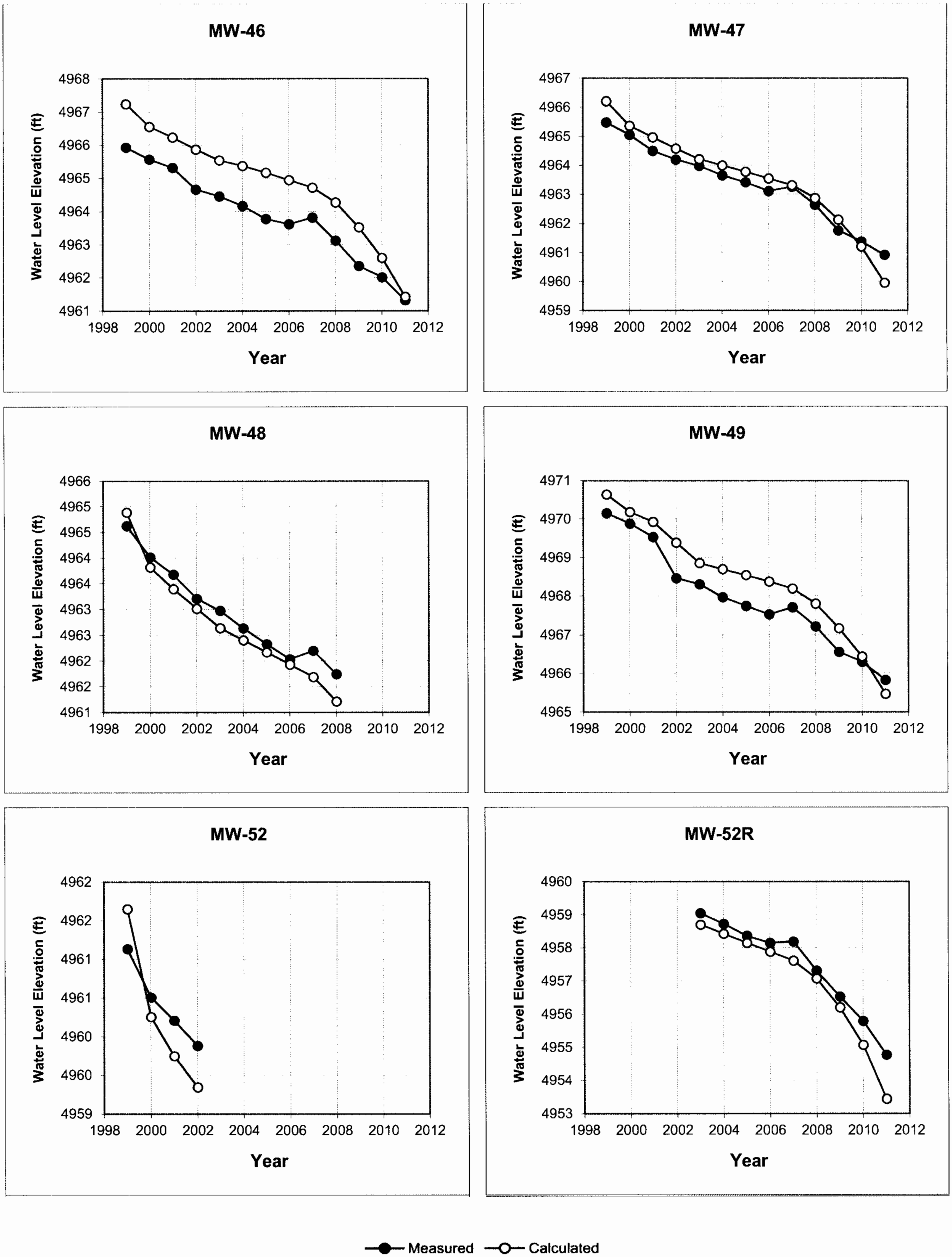


Figure E-2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells

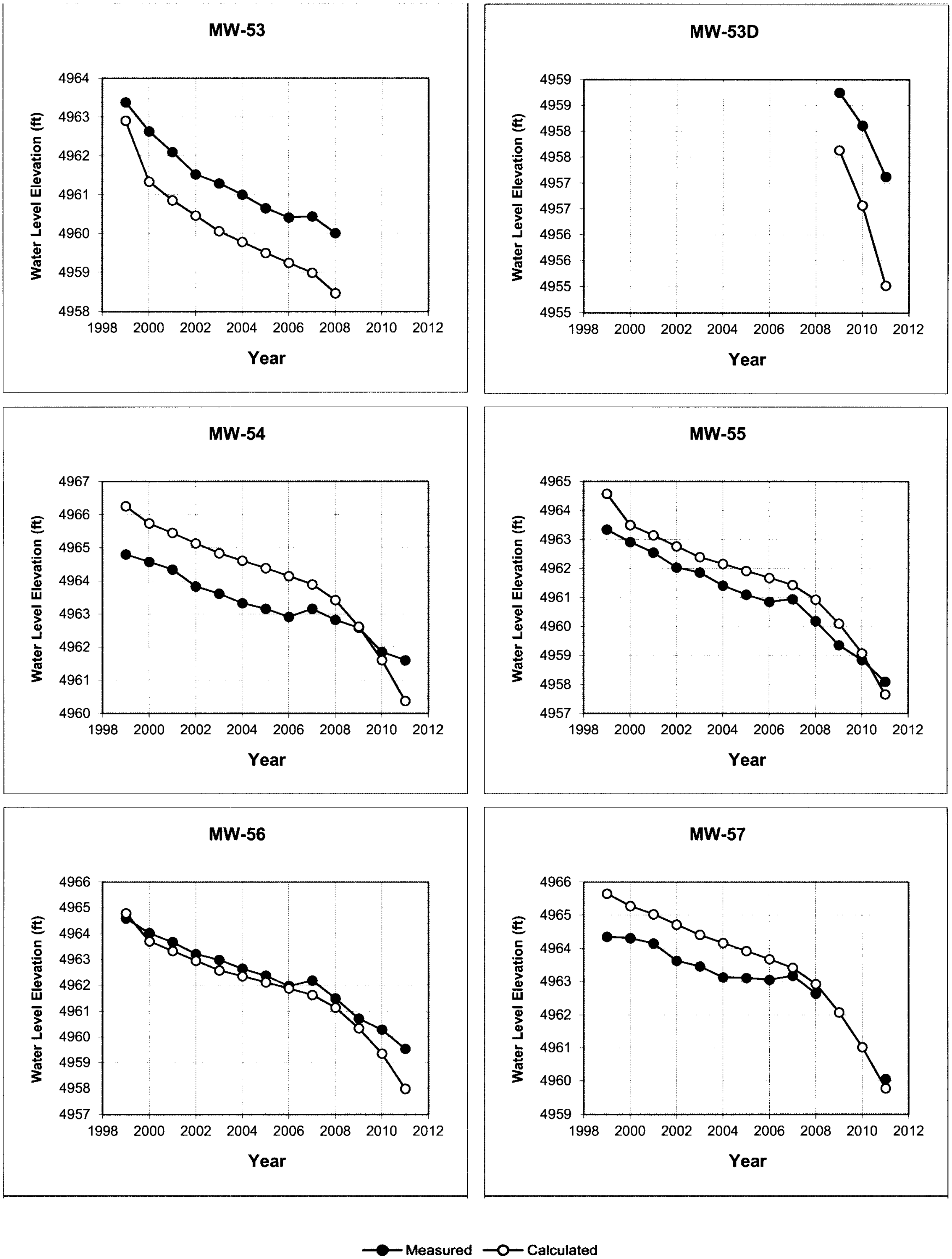


Figure E-2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells

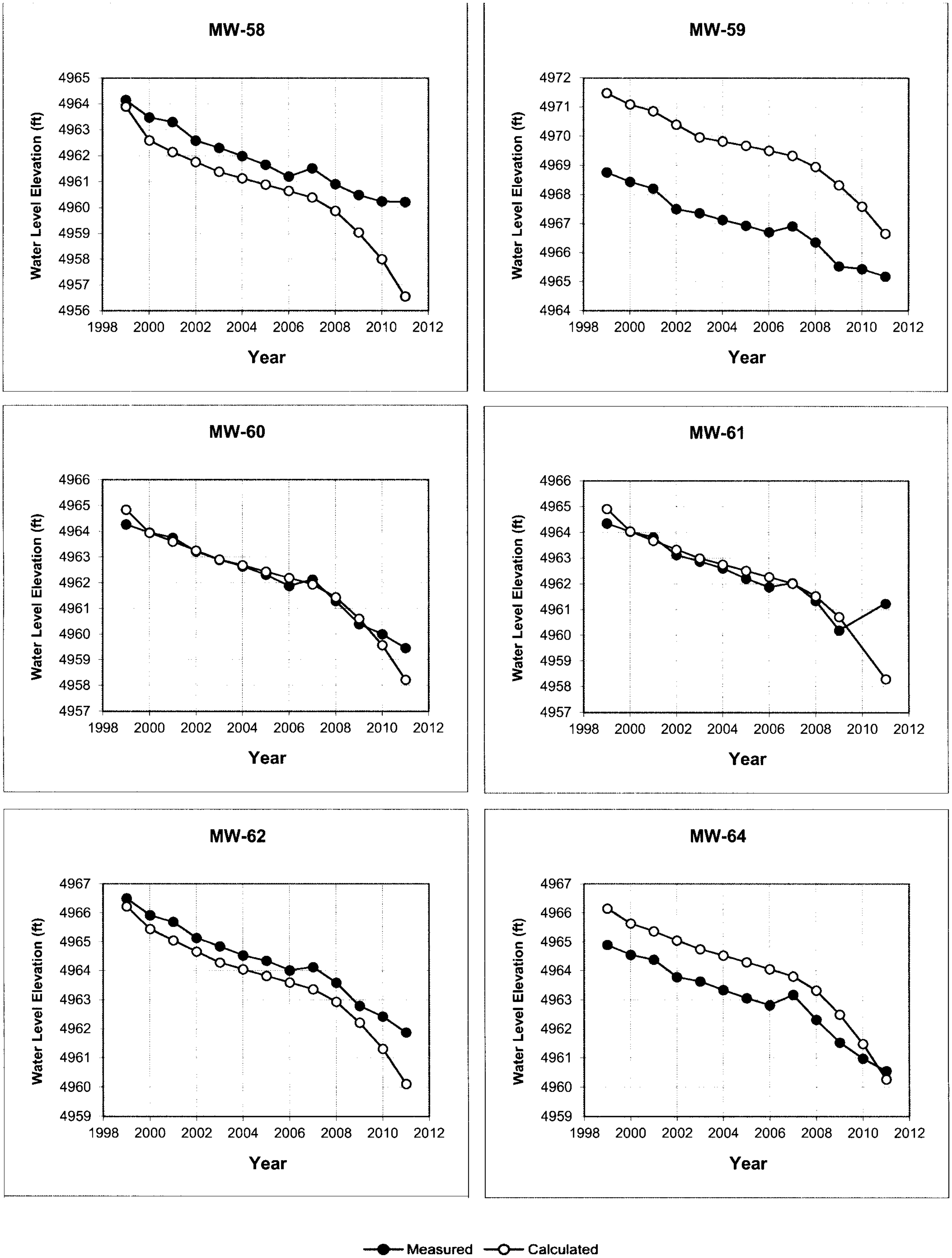


Figure E-2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells

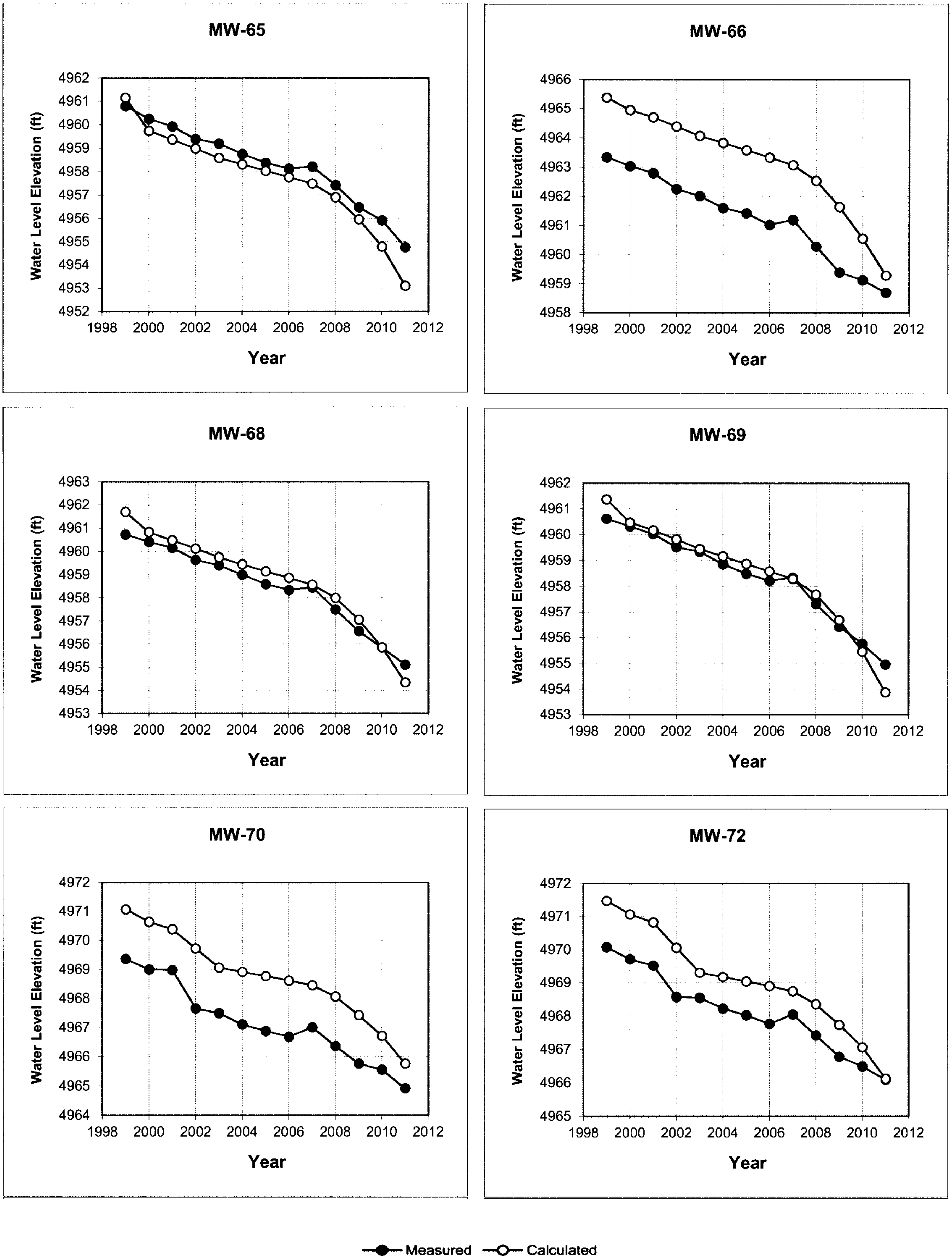


Figure E-2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells

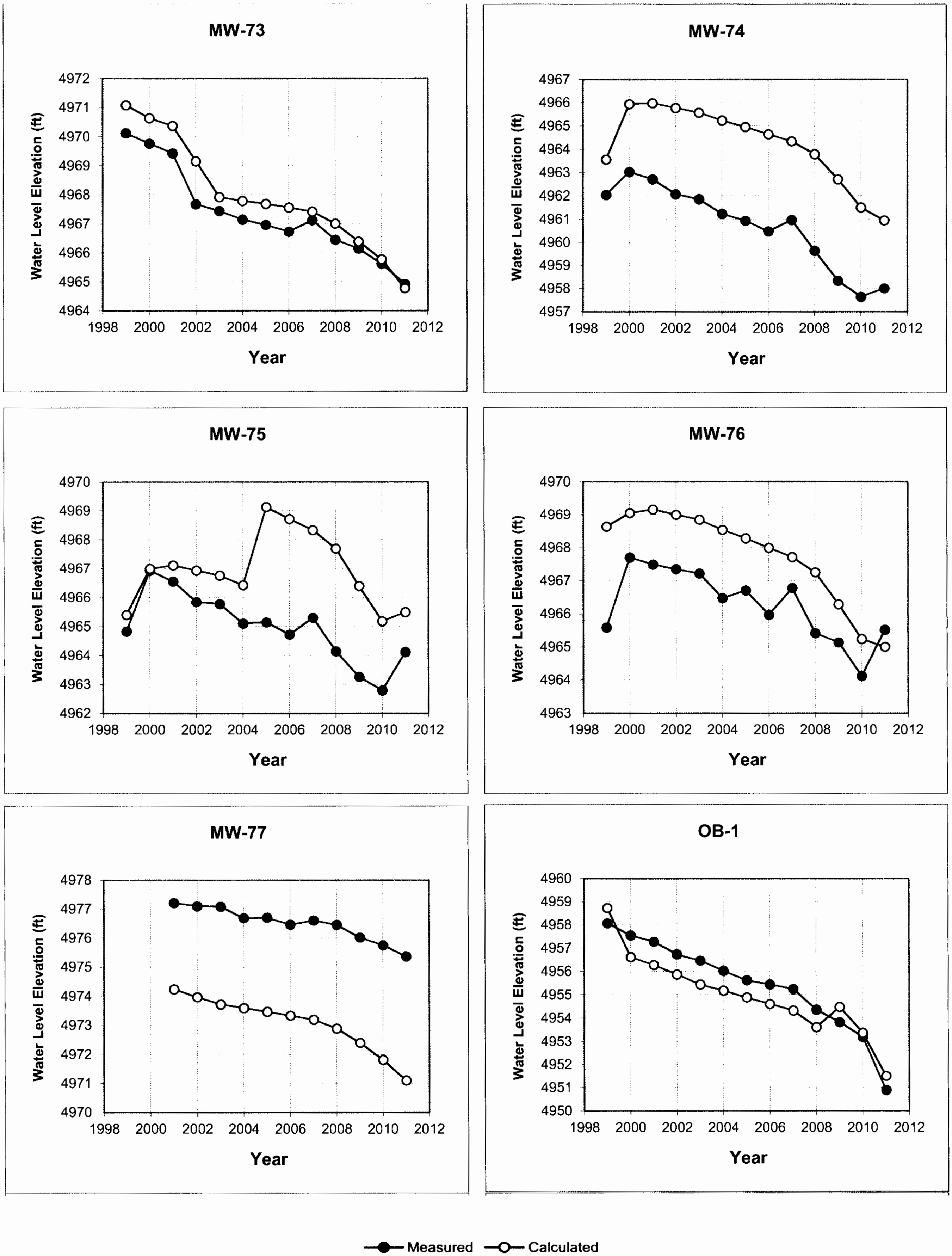
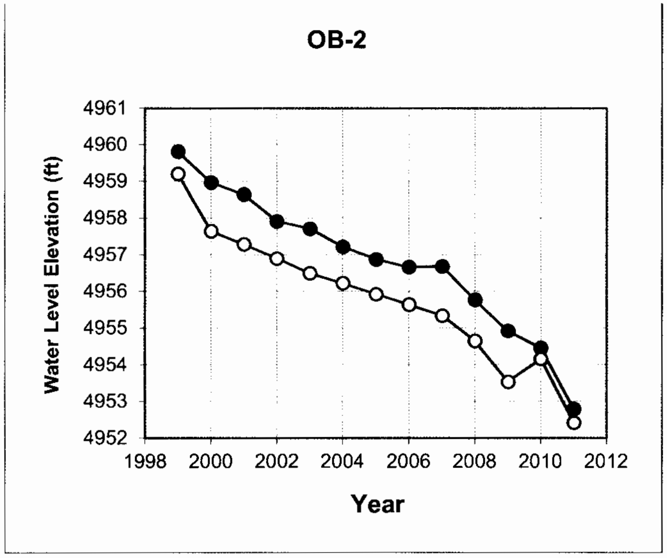
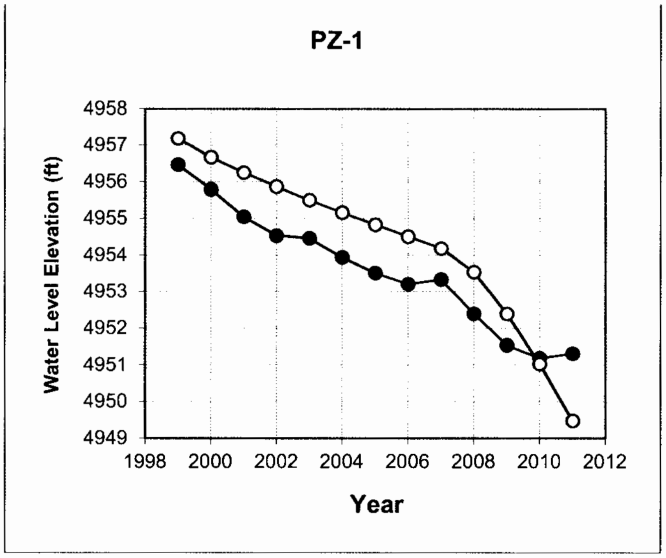


Figure E-2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells





Measured Calculated

Figure E-2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells

Figure E-3: Comparison of Observed and Calculated Water Levels in DFZ Wells

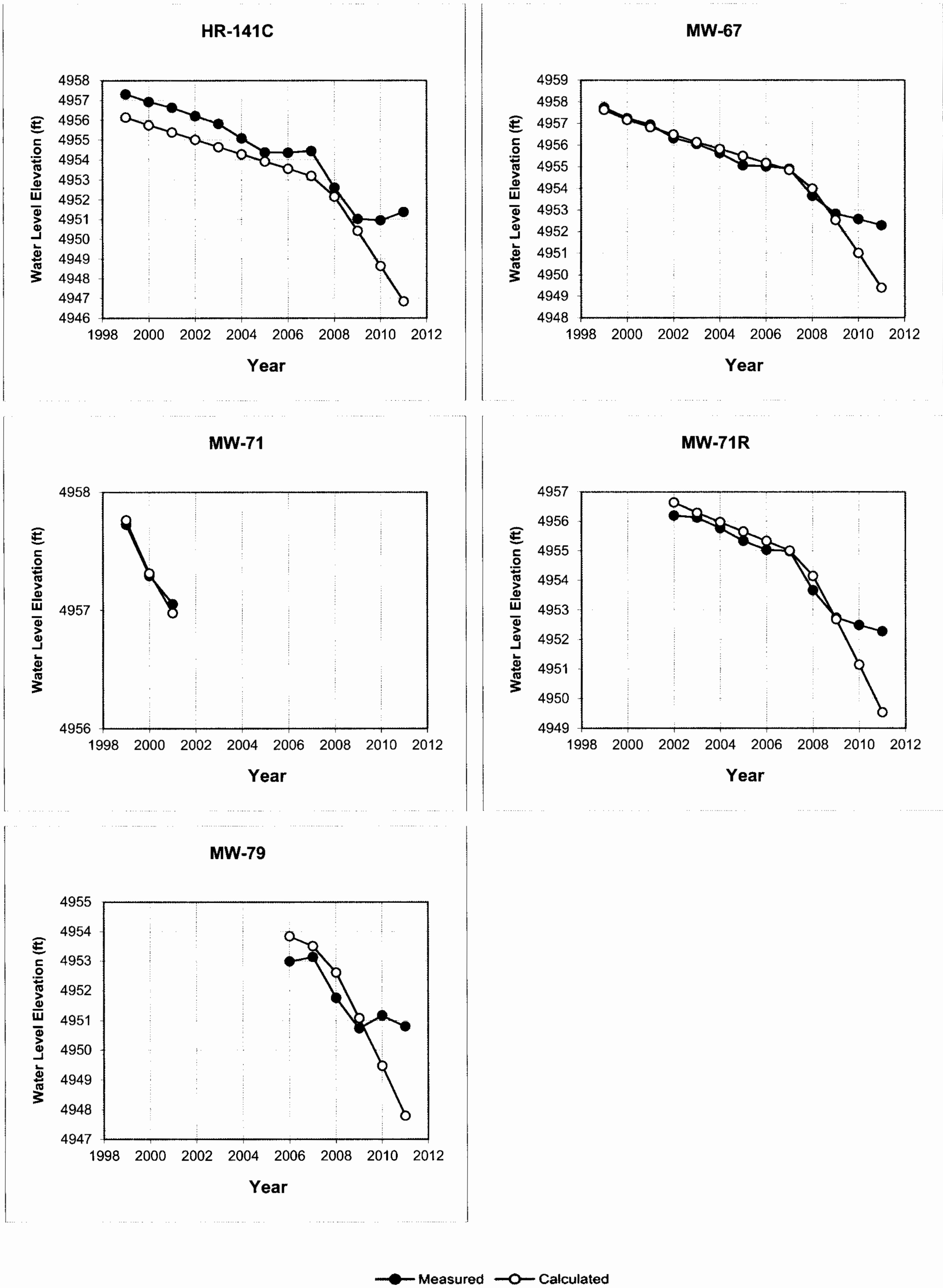


Figure E-3 Comparison of Observed and Calculated Water Levels in DFZ Wells
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Figure E-4: Residuals between Observed and Calculated 2011 Water Levels in UFZ Wells

Figure E-4 Residuals between Observed and Calculated 2011 Water Levels in On-Site UFZ Wells

Figure E-5: **Residuals between Observed and Calculated 2011 Water Levels in UFZ/ULFZ/LLFZ Wells**

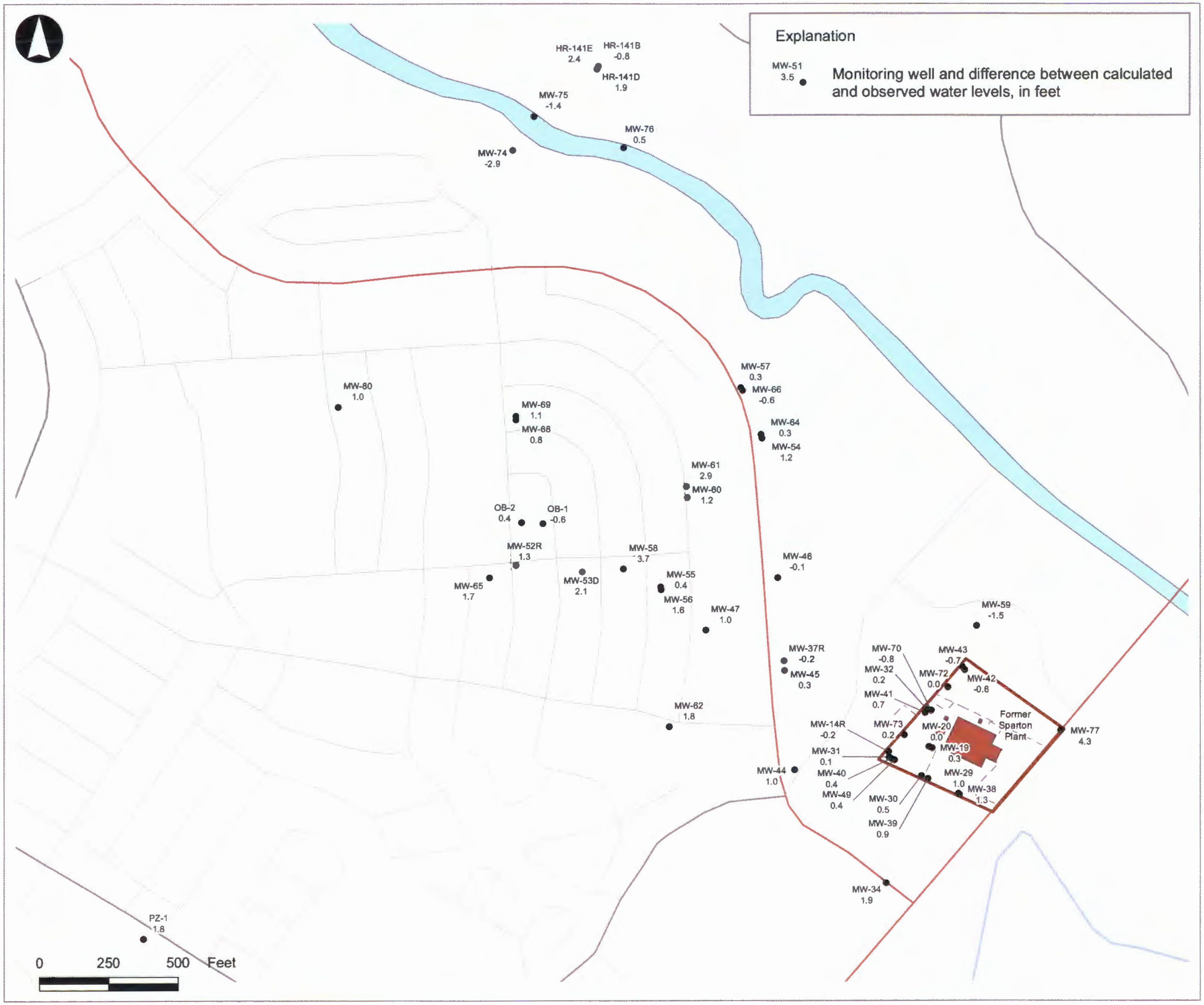

Figure E-5 Residuals between Observed and Calculated 2011 Water Levels in UFZ/UFLZ/LLFZ Wells

Figure E-6: **Residuals between Observed and Calculated 2011 Water Levels in DFZ Wells**

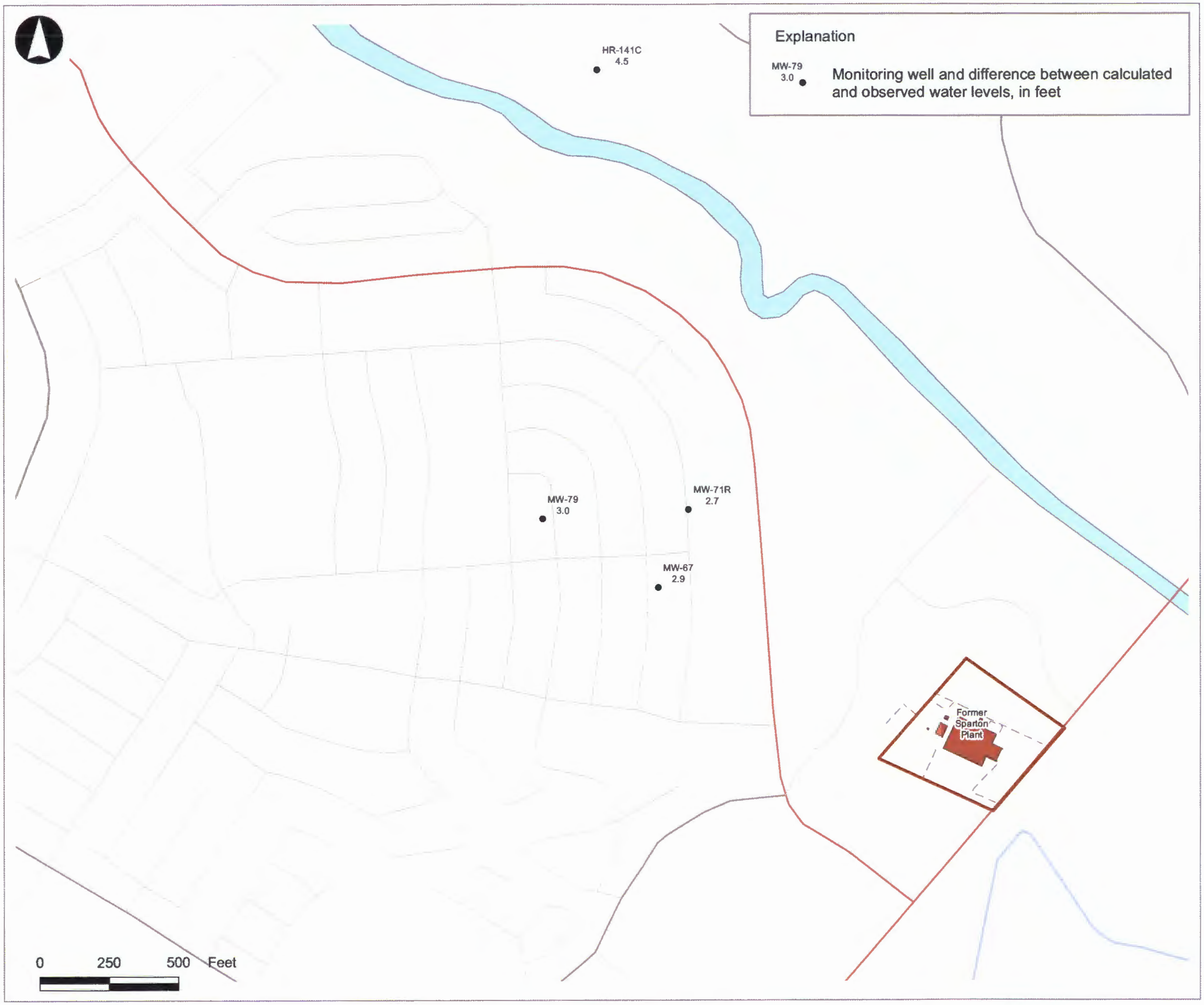

Figure E-6 Residuals between Observed and Calculated 2011 Water Levels in DFZ Wells

Figure E-7: **Comparison of Calculated to Observed TCE Concentrations in Select Monitoring Wells**

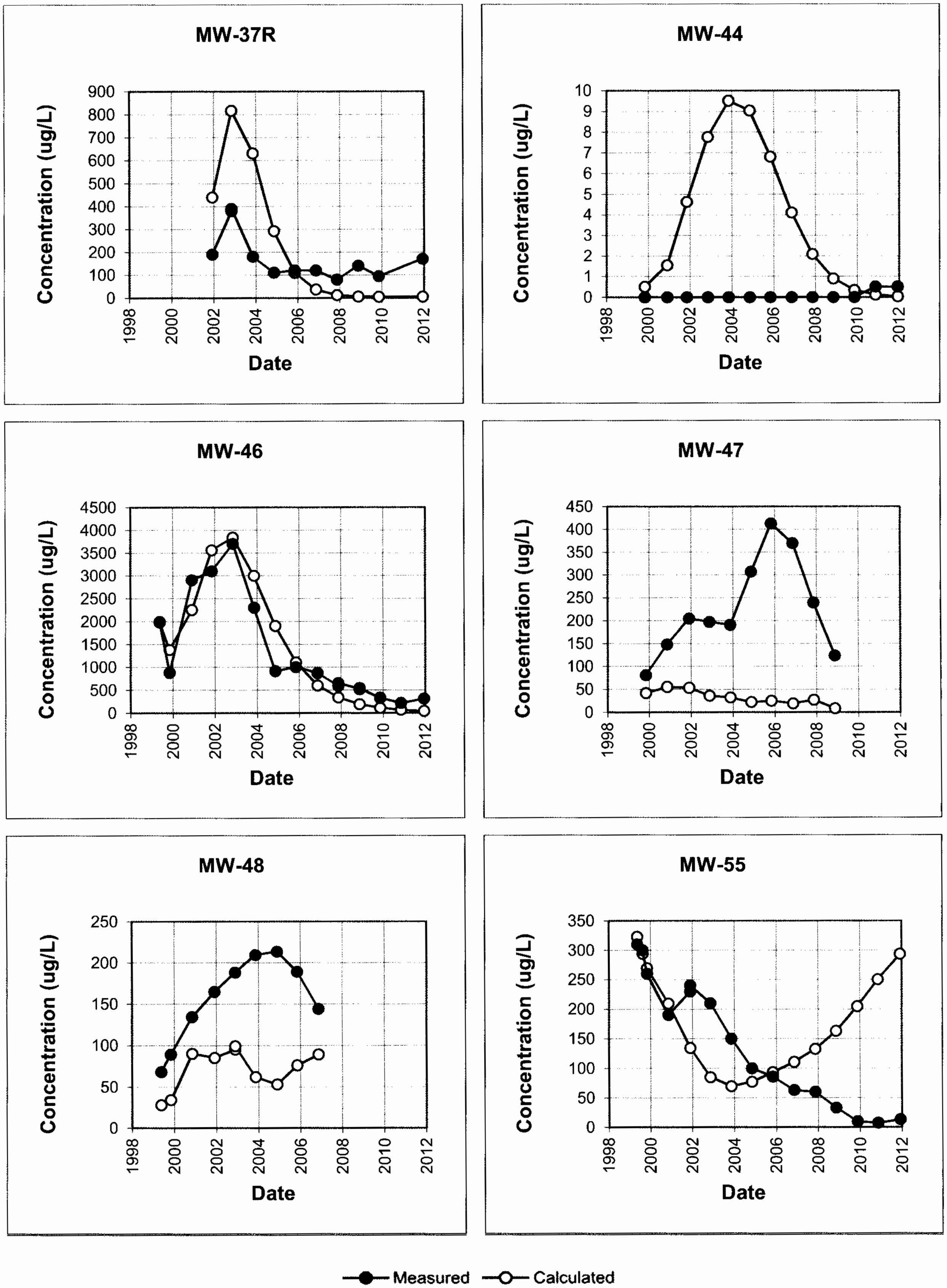

Figure E-7 Comparison of Calculated to Observed TCE Concentrations at Selected Monitoring Wells
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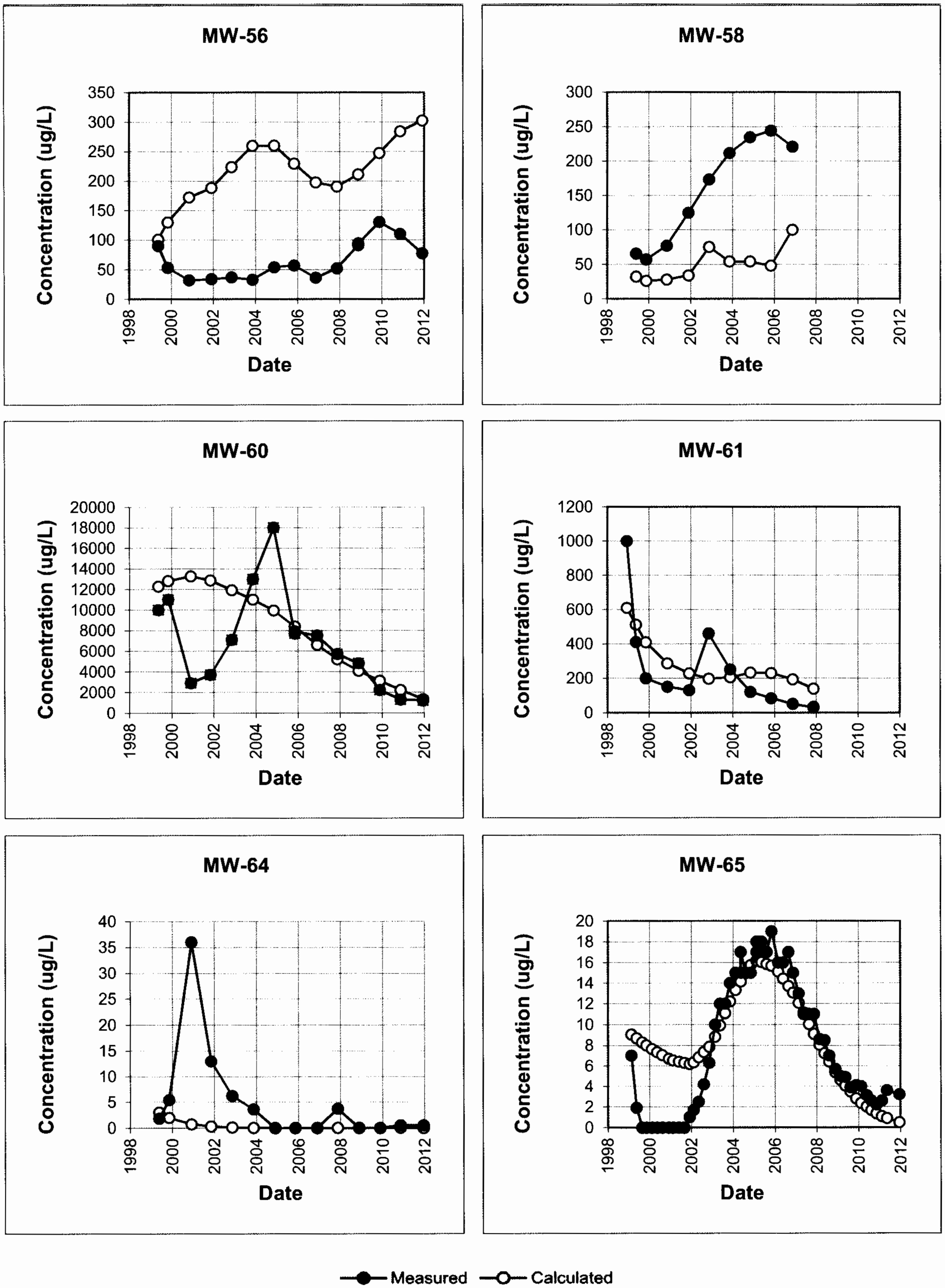

Figure E-7 Comparison of Calculated to Observed TCE Concentrations at Selected Monitoring Wells

Table E-1: Observed and Calculated Water Levels and Residuals in On-Site UFZ Wells – December 1998 to December 2011

Table E-1

Observed and Calculated Water Levels in On-Site UFZ Wells
December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-7	1999	4976.6	4975.8	0.8
MW-7	2000	4976.3	4975.5	0.8
MW-7	2001	4976.1	4975.3	0.8
MW-7	2002	4976.1	4975.2	0.9
MW-7	2003	4976.2	4975.1	1.1
MW-7	2004	4975.6	4975.0	0.6
MW-7	2005	4975.6	4974.8	0.7
MW-7	2006	4975.1	4974.7	0.4
MW-7	2007	4975.3	4974.5	0.7
MW-7	2008	4975.2	4974.2	1.0
MW-7	2009	4974.7	4973.8	0.9
MW-7	2010	4974.2	4973.2	1.0
MW-7	2011	4973.7	4972.5	1.2
MW-9	1999	4972.3	4972.7	-0.3
MW-9	2000	4972.0	4972.3	-0.3
MW-9	2001	4971.8	4972.0	-0.3
MW-9	2002	4970.9	4971.6	-0.6
MW-9	2003	4970.8	4971.1	-0.3
MW-9	2004	4970.4	4971.0	-0.6
MW-9	2005	4970.3	4970.8	-0.6
MW-9	2006	4969.9	4970.7	-0.7
MW-9	2007	4970.1	4970.5	-0.4
MW-9	2008	4969.7	4970.1	-0.4
MW-9	2009	4969.0	4969.5	-0.5
MW-9	2010	4968.9	4968.8	0.1
MW-9	2011	4968.7	4967.9	0.8
MW-12	1999	4972.0	4972.7	-0.7
MW-12	2000	4971.6	4972.3	-0.7
MW-12	2001	4971.2	4972.1	-0.8
MW-12	2002	4970.3	4971.6	-1.3
MW-12	2003	4970.3	4971.1	-0.9
MW-12	2004	4969.9	4971.0	-1.1
MW-12	2005	4969.7	4970.8	-1.1
MW-12	2006	4969.4	4970.7	-1.3
MW-12	2007	4969.5	4970.5	-1.0
MW-12	2008	4969.1	4970.1	-1.1
MW-12	2009	4968.5	4969.5	-1.1
MW-12	2010	4968.2	4968.8	-0.7
MW-12	2011	4967.8	4967.9	-0.2
MW-13	1999	4973.7	4973.4	0.3

Table E-1

Observed and Calculated Water Levels in On-Site UFZ Wells December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-13	2000	4973.4	4973.0	0.4
MW-13	2001	4973.1	4972.8	0.4
MW-13	2002	4972.5	4972.4	0.1
MW-13	2003	4972.4	4972.0	0.4
MW-13	2004	4972.0	4971.9	0.2
MW-13	2005	4971.9	4971.7	0.2
MW-13	2006	4972.0	4971.6	0.4
MW-13	2007	4972.0	4971.4	0.6
MW-13	2008	4971.8	4971.1	0.7
MW-16	1999	4977.8	4976.0	1.8
MW-16	2000	4977.6	4975.9	1.7
MW-16	2001	4977.6	4975.8	1.8
MW-16	2002	4981.7	4978.0	3.7
MW-16	2003	4982.3	4981.0	1.3
MW-16	2004	4981.7	4981.6	0.2
MW-16	2005	4981.9	4981.2	0.7
MW-16	2006	4981.9	4980.8	1.1
MW-16	2007	4981.8	4980.4	1.4
MW-16	2008	4981.7	4980.4	1.4
MW-16	2009	4981.5	4980.4	1.1
MW-16	2010	4981.1	4980.0	1.1
MW-16	2011	4981.5	4980.0	1.5
MW-17	1999	4978.2	4976.4	1.8
MW-17	2000	4977.9	4976.2	1.7
MW-17	2001	4977.8	4976.1	1.7
MW-17	2002	4982.0	4978.5	3.4
MW-17	2003	4982.0	4981.6	0.4
MW-17	2004	4981.4	4982.0	-0.6
MW-17	2005	4981.6	4981.7	-0.1
MW-17	2006	4981.5	4981.3	0.2
MW-17	2007	4981.4	4980.9	0.5
MW-17	2008	4981.4	4980.9	0.5
MW-17	2009	4981.0	4981.0	0.1
MW-17	2010	4980.6	4980.5	0.1
MW-17	2011	4980.9	4980.6	0.3
MW-18	1999	4970.9	4974.3	-3.3
MW-18	2000	4970.7	4974.1	-3.4
MW-18	2001	4970.3	4974.0	-3.6
MW-18	2002	4970.7	4975.3	-4.6
MW-18	2003	4975.2	4977.0	-1.8

Table E-1

Observed and Calculated Water Levels in On-Site UFZ Wells December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-18	2004	4973.4	4977.6	-4.3
MW-18	2005	4974.1	4977.4	-3.3
MW-18	2006	4970.9	4977.0	-6.1
MW-18	2007	4973.6	4976.7	-3.1
MW-18	2008	4973.2	4976.6	-3.4
MW-18	2009	4969.8	4976.6	-6.8
MW-18	2010	4967.6	4976.2	-8.6
MW-18	2011	4967.1	4976.0	-9.0
MW-21	1999	4976.2	4975.3	0.9
MW-21	2002	4983.3	4977.3	6.0
MW-21	2003	4983.4	4980.6	2.8
MW-21	2004	4982.7	4981.6	1.0
MW-21	2005	4982.7	4981.1	1.6
MW-21	2006	4982.6	4980.4	2.2
MW-21	2007	4982.5	4979.9	2.5
MW-21	2008	4982.5	4979.9	2.6
MW-21	2009	4982.1	4980.1	2.0
MW-21	2010	4981.8	4979.7	2.1
MW-21	2011	4982.1	4979.7	2.4
MW-22	1999	4976.7	4976.9	-0.1
MW-22	2000	4976.8	4976.7	0.1
MW-22	2001	4976.4	4976.6	-0.3
MW-22	2002	4977.9	4978.4	-0.5
MW-22	2003	4977.8	4980.5	-2.7
MW-22	2004	4977.3	4980.6	-3.4
MW-22	2005	4977.4	4980.4	-3.0
MW-22	2006	4977.0	4980.2	-3.2
MW-22	2007	4977.1	4980.0	-2.8
MW-22	2008	4976.9	4979.9	-3.0
MW-22	2009	4976.5	4979.8	-3.4
MW-22	2010	4976.0	4979.4	-3.4
MW-22	2011	4975.8	4979.3	-3.5
MW-23	1999	4975.1	4974.2	0.9
MW-23	2000	4975.1	4973.9	1.2
MW-23	2001	4974.8	4973.7	1.1
MW-23	2002	4974.6	4973.5	1.1
MW-23	2003	4974.8	4973.2	1.6
MW-23	2004	4974.2	4973.1	1.2
MW-23	2005	4974.3	4972.9	1.3
MW-23	2006	4973.9	4972.8	1.1

Table E-1

Observed and Calculated Water Levels in On-Site UFZ Wells December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-23	2007	4974.1	4972.6	1.4
MW-23	2008	4973.9	4972.3	1.6
MW-23	2009	4973.6	4971.8	1.8
MW-23	2010	4973.2	4971.1	2.1
MW-23	2011	4972.7	4970.3	2.4
MW-24	2000	4977.3	4975.9	1.5
MW-24	2001	4977.2	4975.8	1.4
MW-24	2002	4981.5	4978.0	3.5
MW-24	2003	4982.1	4980.9	1.2
MW-24	2004	4981.5	4981.5	0.0
MW-24	2005	4981.7	4981.2	0.6
MW-24	2006	4981.6	4980.7	0.9
MW-24	2007	4981.6	4980.3	1.3
MW-24	2008	4981.5	4980.3	1.2
MW-24	2009	4981.3	4980.4	0.9
MW-24	2010	4980.8	4979.9	0.9
MW-24	2011	4981.3	4980.0	1.3
MW-25	1999	4977.0	4975.9	1.1
MW-25	2000	4977.4	4975.8	1.6
MW-25	2001	4977.2	4975.7	1.6
MW-25	2002	4981.6	4977.9	3.7
MW-25	2003	4982.3	4980.9	1.4
MW-25	2004	4981.7	4981.6	0.2
MW-25	2005	4981.9	4981.2	0.8
MW-25	2006	4981.8	4980.7	1.2
MW-25	2007	4981.8	4980.3	1.5
MW-25	2008	4981.8	4980.3	1.5
MW-25	2009	4982.0	4980.4	1.6
MW-25	2010	4981.0	4979.9	1.1
MW-25	2011	4981.7	4980.0	1.7
MW-26	1999	4971.3	4973.3	-2.0
MW-26	2000	4972.5	4972.9	-0.4
MW-26	2001	4971.7	4972.7	-1.0
MW-26	2002	4971.4	4972.3	-0.9
MW-26	2003	4971.8	4971.8	0.0
MW-26	2004	4971.4	4971.7	-0.3
MW-26	2005	4971.3	4971.6	-0.3
MW-26	2006	4971.0	4971.4	-0.4
MW-26	2007	4971.2	4971.2	0.0
MW-26	2008	4971.0	4970.9	0.1

Table E-1

Observed and Calculated Water Levels in On-Site UFZ Wells
December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-26	2009	4970.1	4970.4	-0.3
MW-26	2010	4969.9	4969.7	0.2
MW-26	2011	4969.8	4968.9	0.9
MW-27	2000	4972.9	4974.7	-1.8
MW-27	2001	4972.8	4974.6	-1.8
MW-27	2002	4978.1	4976.4	1.8
MW-27	2003	4981.3	4979.0	2.3
MW-27	2004	4980.8	4979.7	1.0
MW-27	2005	4980.9	4979.4	1.5
MW-27	2006	4980.9	4978.9	2.0
MW-27	2007	4980.9	4978.6	2.3
MW-27	2008	4980.9	4978.5	2.4
MW-27	2009	4980.5	4978.6	1.9
MW-27	2010	4980.1	4978.2	1.9
MW-27	2011	4980.6	4978.2	2.4
MW-33	1999	4971.6	4972.3	-0.7
MW-33	2000	4971.3	4971.9	-0.7
MW-33	2001	4971.0	4971.7	-0.7
MW-33	2002	4970.0	4971.2	-1.2
MW-33	2003	4969.9	4970.7	-0.8
MW-33	2004	4969.6	4970.6	-1.0
MW-33	2005	4969.5	4970.4	-0.9
MW-33	2006	4969.6	4970.3	-0.7
MW-51	1999	4980.0	4975.6	4.4
MW-51	2000	4979.7	4975.5	4.2
MW-51	2001	4979.8	4975.4	4.4
MW-51	2002	4980.9	4976.4	4.4
MW-51	2003	4981.9	4977.9	4.0
MW-51	2004	4981.8	4978.3	3.5
MW-51	2005	4982.0	4978.4	3.7
MW-51	2006	4981.8	4978.3	3.5
MW-51	2007	4982.0	4978.3	3.7
MW-51	2008	4981.7	4978.3	3.5
MW-51	2009	4981.4	4978.1	3.3
MW-51	2010	4981.0	4977.8	3.2
MW-51	2011	4981.1	4977.6	3.5
MW-63	1999	4970.7	4973.4	-2.7
MW-63	2000	4970.2	4973.3	-3.1
MW-63	2001	4970.0	4973.2	-3.2
MW-63	2002	4969.6	4973.7	-4.1

Table E-1

Observed and Calculated Water Levels in On-Site UFZ Wells December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-63	2003	4971.8	4974.5	-2.7
MW-63	2004	4973.0	4974.8	-1.8
MW-63	2005	4974.1	4974.8	-0.7
MW-63	2006	4973.8	4974.7	-0.9
MW-63	2007	4975.9	4974.6	1.3
MW-63	2008	4972.5	4974.5	-2.1
MW-63	2009	4971.9	4974.4	-2.5
MW-63	2010	4969.6	4974.2	-4.6
MW-63	2011	4969.2	4974.0	-4.8
MW-78	2001	4971.4	4974.5	-3.1
MW-78	2002	4972.8	4976.5	-3.7
MW-78	2003	4975.0	4979.6	-4.6
MW-78	2004	4974.5	4980.6	-6.0
MW-78	2005	4974.5	4980.1	-5.6
MW-78	2006	4973.9	4979.5	-5.5
MW-78	2007	4974.3	4978.9	-4.7
MW-78	2008	4973.7	4978.9	-5.2
MW-78	2009	4973.3	4979.1	-5.9
MW-78	2010	4972.5	4978.8	-6.2
MW-78	2011	4972.4	4978.7	-6.3

Table E-2: Observed and Calculated Water Levels and Residuals in On-Site UFZ/ULFZ/LLFZ Wells – December 1998 to December 2011

Table E-2

Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells
December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
HR-141B	1999	4961.8	4962.3	-0.5
HR-141B	2000	4963.0	4963.3	-0.3
HR-141B	2001	4962.8	4963.3	-0.4
HR-141B	2002	4962.3	4963.0	-0.7
HR-141B	2003	4962.0	4962.7	-0.7
HR-141B	2004	4961.1	4962.4	-1.2
HR-141B	2005	4960.8	4962.1	-1.2
HR-141B	2006	4960.7	4961.7	-1.1
HR-141B	2007	4960.9	4961.4	-0.5
HR-141B	2008	4959.6	4960.7	-1.1
HR-141B	2009	4958.5	4961.4	-2.9
HR-141B	2010	4958.0	4960.0	-2.0
HR-141B	2011	4958.3	4959.1	-0.8
HR-141D	1999	4960.4	4961.1	-0.7
HR-141D	2000	4960.7	4961.2	-0.5
HR-141D	2001	4960.5	4960.9	-0.4
HR-141D	2002	4960.0	4960.6	-0.6
HR-141D	2003	4959.6	4960.2	-0.7
HR-141D	2004	4958.9	4959.9	-1.0
HR-141D	2005	4958.5	4959.6	-1.1
HR-141D	2006	4958.3	4959.3	-1.0
HR-141D	2007	4958.0	4958.9	-0.9
HR-141D	2008	4957.0	4958.1	-1.1
HR-141D	2009	4955.9	4956.7	-0.8
HR-141D	2010	4955.4	4955.2	0.2
HR-141D	2011	4955.5	4953.7	1.9
HR-141E	1999	4961.1	4961.4	-0.3
HR-141E	2000	4961.6	4961.6	0.1
HR-141E	2001	4961.4	4961.3	0.1
HR-141E	2002	4960.9	4961.0	-0.1
HR-141E	2003	4960.5	4960.7	-0.2
HR-141E	2004	4959.9	4960.4	-0.5
HR-141E	2005	4959.5	4960.0	-0.6
HR-141E	2006	4959.3	4959.7	-0.4
HR-141E	2007	4959.4	4959.4	0.1
HR-141E	2008	4958.1	4958.6	-0.5
HR-141E	2009	4957.1	4957.2	-0.1
HR-141E	2010	4956.5	4955.7	0.8
HR-141E	2011	4956.6	4954.3	2.4
MW-14	1999	4970.3	4971.9	-1.6

Table E-2

Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells
December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-14R	2001	4969.3	4970.3	-1.0
MW-14R	2002	4968.3	4969.6	-1.3
MW-14R	2003	4968.0	4968.9	-0.9
MW-14R	2004	4967.8	4968.8	-1.1
MW-14R	2005	4967.5	4968.7	-1.2
MW-14R	2006	4967.3	4968.5	-1.3
MW-14R	2007	4967.5	4968.4	-0.8
MW-14R	2008	4967.0	4968.0	-1.0
MW-14R	2009	4966.3	4967.4	-1.1
MW-14R	2010	4966.1	4966.7	-0.7
MW-14R	2011	4965.6	4965.8	-0.2
MW-19	1999	4971.0	4971.8	-0.8
MW-19	2000	4970.6	4971.3	-0.7
MW-19	2001	4970.3	4971.1	-0.8
MW-19	2002	4969.2	4970.3	-1.1
MW-19	2003	4969.1	4969.6	-0.4
MW-19	2004	4968.8	4969.4	-0.6
MW-19	2005	4968.6	4969.3	-0.7
MW-19	2006	4968.3	4969.1	-0.8
MW-19	2007	4968.6	4969.0	-0.4
MW-19	2008	4968.1	4968.6	-0.5
MW-19	2009	4967.4	4968.0	-0.6
MW-19	2010	4967.3	4967.4	-0.1
MW-19	2011	4966.7	4966.4	0.3
MW-20	1999	4970.6	4971.3	-0.7
MW-20	2000	4970.3	4970.9	-0.6
MW-20	2001	4970.0	4970.7	-0.7
MW-20	2002	4968.8	4970.1	-1.3
MW-20	2003	4968.6	4969.5	-0.9
MW-20	2004	4968.2	4969.3	-1.1
MW-20	2005	4968.1	4969.2	-1.1
MW-20	2006	4967.8	4969.0	-1.2
MW-20	2007	4968.1	4968.8	-0.8
MW-20	2008	4967.6	4968.5	-0.9
MW-20	2009	4966.9	4967.9	-1.0
MW-20	2010	4966.7	4967.2	-0.5
MW-20	2011	4966.2	4966.2	0.0
MW-29	1999	4972.9	4972.7	0.2
MW-29	2000	4972.5	4972.3	0.2
MW-29	2001	4972.2	4972.1	0.2

Table E-2

Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-29	2002	4971.5	4971.6	-0.1
MW-29	2003	4971.4	4971.2	0.2
MW-29	2004	4970.9	4971.1	-0.1
MW-29	2005	4970.8	4970.9	-0.1
MW-29	2006	4970.6	4970.8	-0.2
MW-29	2007	4970.7	4970.6	0.1
MW-29	2008	4970.4	4970.3	0.2
MW-29	2009	4969.7	4969.7	0.0
MW-29	2010	4969.5	4969.0	0.5
MW-29	2011	4969.2	4968.2	1.0
MW-30	1999	4971.4	4971.8	-0.4
MW-30	2000	4971.0	4971.4	-0.4
MW-30	2001	4970.8	4971.1	-0.4
MW-30	2002	4969.8	4970.5	-0.8
MW-30	2003	4969.6	4970.0	-0.4
MW-30	2004	4969.3	4969.8	-0.6
MW-30	2005	4969.1	4969.7	-0.6
MW-30	2006	4968.8	4969.5	-0.7
MW-30	2007	4969.0	4969.4	-0.4
MW-30	2008	4968.6	4969.0	-0.4
MW-30	2009	4968.0	4968.4	-0.4
MW-30	2010	4967.7	4967.7	0.0
MW-30	2011	4967.3	4966.8	0.5
MW-31	1999	4970.3	4970.9	-0.6
MW-31	2000	4969.9	4970.5	-0.5
MW-31	2001	4969.7	4970.2	-0.6
MW-31	2002	4968.4	4969.4	-1.1
MW-31	2003	4968.2	4968.7	-0.5
MW-31	2004	4967.9	4968.6	-0.7
MW-31	2005	4967.6	4968.4	-0.8
MW-31	2006	4967.4	4968.3	-0.9
MW-31	2007	4967.6	4968.1	-0.5
MW-31	2008	4967.1	4967.7	-0.6
MW-31	2009	4966.5	4967.1	-0.6
MW-31	2010	4966.2	4966.4	-0.2
MW-31	2011	4965.6	4965.4	0.1
MW-32	1999	4970.1	4971.2	-1.1
MW-32	2000	4969.8	4970.7	-1.0
MW-32	2001	4969.5	4970.5	-1.0
MW-32	2002	4968.1	4969.5	-1.4

Table E-2

Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-32	2003	4968.0	4968.4	-0.4
MW-32	2004	4967.7	4968.3	-0.6
MW-32	2005	4967.5	4968.2	-0.7
MW-32	2006	4967.2	4968.1	-0.8
MW-32	2007	4967.6	4967.9	-0.3
MW-32	2008	4967.0	4967.5	-0.5
MW-32	2009	4966.3	4966.9	-0.5
MW-32	2010	4966.1	4966.2	-0.1
MW-32	2011	4965.4	4965.2	0.2
MW-34	1999	4973.5	4972.1	1.3
MW-34	2000	4973.1	4971.8	1.4
MW-34	2001	4972.9	4971.5	1.4
MW-34	2002	4972.3	4971.2	1.1
MW-34	2003	4972.1	4970.8	1.3
MW-34	2004	4971.6	4970.7	0.9
MW-34	2005	4971.3	4970.5	0.8
MW-34	2006	4971.2	4970.3	0.8
MW-34	2007	4971.3	4970.2	1.1
MW-34	2008	4971.1	4969.8	1.3
MW-34	2009	4970.5	4969.3	1.2
MW-34	2010	4970.0	4968.6	1.4
MW-34	2011	4969.7	4967.8	1.9
MW-35	1999	4970.6	4970.1	0.5
MW-35	2000	4970.2	4969.7	0.6
MW-35	2001	4970.0	4969.3	0.6
MW-36	1999	4969.0	4969.1	-0.1
MW-36	2000	4968.6	4968.6	0.0
MW-36	2001	4968.4	4968.2	0.1
MW-36	2002	4967.6	4967.8	-0.2
MW-36	2003	4967.3	4967.4	0.0
MW-36	2004	4967.4	4967.2	0.2
MW-37	1999	4967.3	4968.2	-0.9
MW-37	2000	4966.9	4967.5	-0.6
MW-37R	2002	4965.1	4966.7	-1.6
MW-37R	2003	4965.1	4966.4	-1.3
MW-37R	2004	4964.8	4966.2	-1.4
MW-37R	2005	4964.6	4966.0	-1.5
MW-37R	2006	4964.3	4965.8	-1.6
MW-37R	2007	4964.4	4965.6	-1.2
MW-37R	2008	4963.8	4965.2	-1.3

Table E-2

Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-37R	2009	4963.2	4964.5	-1.3
MW-37R	2010	4962.8	4963.6	-0.9
MW-37R	2011	4962.3	4962.5	-0.2
MW-38	1999	4972.9	4972.4	0.5
MW-38	2000	4972.6	4972.0	0.6
MW-38	2001	4972.2	4971.7	0.5
MW-38	2002	4971.5	4971.3	0.2
MW-38	2003	4971.4	4970.9	0.5
MW-38	2004	4971.2	4970.8	0.4
MW-38	2005	4970.8	4970.6	0.2
MW-38	2006	4970.6	4970.5	0.1
MW-38	2007	4970.7	4970.3	0.4
MW-38	2008	4970.3	4970.0	0.3
MW-38	2009	4969.8	4969.4	0.4
MW-38	2010	4969.5	4968.7	0.8
MW-38	2011	4969.2	4967.9	1.3
MW-39	1999	4971.6	4971.6	0.1
MW-39	2000	4971.3	4971.2	0.1
MW-39	2001	4971.0	4970.9	0.1
MW-39	2002	4970.1	4970.4	-0.3
MW-39	2003	4970.0	4969.9	0.0
MW-39	2004	4969.6	4969.8	-0.2
MW-39	2005	4969.4	4969.6	-0.3
MW-39	2006	4969.1	4969.5	-0.4
MW-39	2007	4969.3	4969.3	0.0
MW-39	2008	4968.8	4968.9	-0.1
MW-39	2009	4968.3	4968.3	-0.1
MW-39	2010	4968.0	4967.6	0.3
MW-39	2011	4967.6	4966.7	0.9
MW-40	1999	4970.4	4970.7	-0.4
MW-40	2000	4970.0	4970.3	-0.3
MW-40	2001	4969.7	4970.0	-0.3
MW-40	2002	4968.5	4969.4	-0.9
MW-40	2003	4968.3	4968.7	-0.5
MW-40	2004	4968.0	4968.6	-0.6
MW-40	2005	4967.7	4968.4	-0.7
MW-40	2006	4967.5	4968.3	-0.8
MW-40	2007	4967.8	4968.1	-0.3
MW-40	2008	4967.2	4967.7	-0.5
MW-40	2009	4966.5	4967.1	-0.5

Table E-2

Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-40	2010	4966.3	4966.4	-0.1
MW-40	2011	4965.8	4965.4	0.4
MW-41	1999	4970.2	4971.3	-1.1
MW-41	2000	4969.9	4970.9	-1.0
MW-41	2001	4969.6	4970.6	-1.0
MW-41	2002	4968.3	4969.4	-1.1
MW-41	2003	4968.4	4968.2	0.2
MW-41	2004	4968.0	4968.1	-0.1
MW-41	2005	4967.9	4968.0	-0.1
MW-41	2006	4967.6	4967.9	-0.2
MW-41	2007	4968.0	4967.7	0.3
MW-41	2008	4967.4	4967.3	0.0
MW-41	2009	4966.7	4966.7	0.0
MW-41	2010	4966.4	4966.1	0.3
MW-41	2011	4965.8	4965.1	0.7
MW-42	1999	4969.9	4971.6	-1.7
MW-42	2000	4969.5	4971.2	-1.7
MW-42	2001	4969.3	4971.0	-1.6
MW-42	2002	4968.5	4970.4	-1.9
MW-42	2003	4968.5	4969.8	-1.3
MW-42	2004	4968.2	4969.7	-1.5
MW-42	2005	4968.0	4969.5	-1.6
MW-42	2006	4967.7	4969.4	-1.7
MW-42	2007	4968.0	4969.2	-1.3
MW-42	2008	4967.4	4968.8	-1.5
MW-42	2009	4966.7	4968.2	-1.5
MW-42	2010	4966.4	4967.5	-1.1
MW-42	2011	4966.0	4966.6	-0.6
MW-43	1999	4969.7	4971.4	-1.7
MW-43	2000	4969.3	4971.0	-1.6
MW-43	2001	4969.1	4970.7	-1.6
MW-43	2002	4968.3	4970.2	-1.9
MW-43	2003	4968.3	4969.7	-1.4
MW-43	2004	4967.9	4969.6	-1.6
MW-43	2005	4967.7	4969.4	-1.7
MW-43	2006	4967.5	4969.3	-1.8
MW-43	2007	4967.7	4969.1	-1.4
MW-43	2008	4967.1	4968.7	-1.6
MW-43	2009	4966.5	4968.1	-1.6
MW-43	2010	4966.2	4967.3	-1.2

Table E-2

Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells
December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-43	2011	4965.7	4966.4	-0.7
MW-44	1999	4969.1	4969.1	0.0
MW-44	2000	4968.7	4968.5	0.2
MW-44	2001	4968.4	4968.2	0.2
MW-44	2002	4967.4	4967.8	-0.4
MW-44	2003	4967.4	4967.3	0.1
MW-44	2004	4967.1	4967.2	-0.1
MW-44	2005	4966.7	4967.0	-0.3
MW-44	2006	4966.6	4966.8	-0.2
MW-44	2007	4966.7	4966.6	0.2
MW-44	2008	4966.3	4966.2	0.1
MW-44	2009	4965.6	4965.5	0.1
MW-44	2010	4965.1	4964.7	0.4
MW-44	2011	4964.7	4963.7	1.0
MW-45	1999	4967.2	4968.1	-0.8
MW-45	2000	4966.9	4967.4	-0.5
MW-45	2001	4967.1	4967.1	0.0
MW-45	2002	4966.1	4966.6	-0.5
MW-45	2003	4966.1	4966.2	-0.2
MW-45	2004	4965.8	4966.1	-0.3
MW-45	2005	4964.9	4965.9	-1.0
MW-45	2006	4964.6	4965.7	-1.1
MW-45	2007	4964.7	4965.5	-0.8
MW-45	2008	4964.0	4965.0	-1.1
MW-45	2009	4963.5	4964.4	-0.9
MW-45	2010	4963.1	4963.5	-0.4
MW-45	2011	4962.6	4962.4	0.3
MW-46	1999	4965.9	4967.2	-1.3
MW-46	2000	4965.6	4966.6	-1.0
MW-46	2001	4965.3	4966.2	-0.9
MW-46	2002	4964.7	4965.9	-1.2
MW-46	2003	4964.5	4965.5	-1.1
MW-46	2004	4964.2	4965.4	-1.2
MW-46	2005	4963.8	4965.2	-1.4
MW-46	2006	4963.6	4964.9	-1.3
MW-46	2007	4963.8	4964.7	-0.9
MW-46	2008	4963.1	4964.3	-1.1
MW-46	2009	4962.4	4963.5	-1.2
MW-46	2010	4962.0	4962.6	-0.6
MW-46	2011	4961.3	4961.4	-0.1

Table E-2

Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-47	1999	4965.5	4966.2	-0.7
MW-47	2000	4965.1	4965.4	-0.3
MW-47	2001	4964.5	4965.0	-0.5
MW-47	2002	4964.2	4964.6	-0.4
MW-47	2003	4964.0	4964.2	-0.2
MW-47	2004	4963.7	4964.0	-0.3
MW-47	2005	4963.4	4963.8	-0.4
MW-47	2006	4963.1	4963.5	-0.4
MW-47	2007	4963.3	4963.3	-0.1
MW-47	2008	4962.6	4962.9	-0.2
MW-47	2009	4961.8	4962.1	-0.4
MW-47	2010	4961.4	4961.2	0.2
MW-47	2011	4960.9	4960.0	1.0
MW-48	1999	4964.6	4964.9	-0.3
MW-48	2000	4964.0	4963.8	0.2
MW-48	2001	4963.7	4963.4	0.3
MW-48	2002	4963.2	4963.0	0.2
MW-48	2003	4963.0	4962.6	0.3
MW-48	2004	4962.6	4962.4	0.2
MW-48	2005	4962.3	4962.2	0.2
MW-48	2006	4962.0	4961.9	0.1
MW-48	2007	4962.2	4961.7	0.5
MW-48	2008	4961.7	4961.2	0.5
MW-49	1999	4970.2	4970.6	-0.5
MW-49	2000	4969.9	4970.2	-0.3
MW-49	2001	4969.5	4969.9	-0.4
MW-49	2002	4968.5	4969.4	-0.9
MW-49	2003	4968.3	4968.9	-0.6
MW-49	2004	4968.0	4968.7	-0.7
MW-49	2005	4967.7	4968.5	-0.8
MW-49	2006	4967.5	4968.4	-0.8
MW-49	2007	4967.7	4968.2	-0.5
MW-49	2008	4967.2	4967.8	-0.6
MW-49	2009	4966.6	4967.2	-0.6
MW-49	2010	4966.3	4966.4	-0.1
MW-49	2011	4965.8	4965.5	0.4
MW-52	1999	4961.1	4961.7	-0.5
MW-52	2000	4960.5	4960.3	0.3
MW-52	2001	4960.2	4959.7	0.5
MW-52	2002	4959.9	4959.3	0.5

Table E-2

Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-52R	2003	4959.0	4958.7	0.3
MW-52R	2004	4958.7	4958.4	0.3
MW-52R	2005	4958.4	4958.2	0.2
MW-52R	2006	4958.1	4957.9	0.3
MW-52R	2007	4958.2	4957.6	0.6
MW-52R	2008	4957.3	4957.1	0.2
MW-52R	2009	4956.5	4956.2	0.3
MW-52R	2010	4955.8	4955.1	0.7
MW-52R	2011	4954.8	4953.4	1.3
MW-53	1999	4963.4	4962.9	0.5
MW-53	2000	4962.6	4961.3	1.3
MW-53	2001	4962.1	4960.9	1.2
MW-53	2002	4961.5	4960.5	1.1
MW-53	2003	4961.3	4960.1	1.2
MW-53	2004	4961.0	4959.8	1.2
MW-53	2005	4960.7	4959.5	1.2
MW-53	2006	4960.4	4959.2	1.2
MW-53	2007	4960.4	4959.0	1.5
MW-53	2008	4960.0	4958.5	1.5
MW-53D	2009	4958.7	4957.6	1.1
MW-53D	2010	4958.1	4956.6	1.5
MW-53D	2011	4957.1	4955.0	2.1
MW-54	1999	4964.8	4966.3	-1.5
MW-54	2000	4964.6	4965.7	-1.2
MW-54	2001	4964.3	4965.5	-1.1
MW-54	2002	4963.8	4965.1	-1.3
MW-54	2003	4963.6	4964.8	-1.2
MW-54	2004	4963.3	4964.6	-1.3
MW-54	2005	4963.2	4964.4	-1.2
MW-54	2006	4962.9	4964.1	-1.2
MW-54	2007	4963.2	4963.9	-0.7
MW-54	2008	4962.8	4963.4	-0.6
MW-54	2009	4962.6	4962.6	0.0
MW-54	2010	4961.9	4961.6	0.2
MW-54	2011	4961.6	4960.4	1.2
MW-55	1999	4963.3	4964.6	-1.2
MW-55	2000	4962.9	4963.5	-0.6
MW-55	2001	4962.5	4963.1	-0.6
MW-55	2002	4962.0	4962.8	-0.7
MW-55	2003	4961.9	4962.4	-0.5

Table E-2

Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-55	2004	4961.4	4962.2	-0.8
MW-55	2005	4961.1	4961.9	-0.8
MW-55	2006	4960.9	4961.7	-0.8
MW-55	2007	4960.9	4961.4	-0.5
MW-55	2008	4960.2	4960.9	-0.7
MW-55	2009	4959.4	4960.1	-0.8
MW-55	2010	4958.8	4959.1	-0.2
MW-55	2011	4958.1	4957.7	0.4
MW-56	1999	4964.6	4964.8	-0.2
MW-56	2000	4964.0	4963.7	0.3
MW-56	2001	4963.7	4963.3	0.3
MW-56	2002	4963.2	4963.0	0.3
MW-56	2003	4963.0	4962.6	0.4
MW-56	2004	4962.6	4962.4	0.3
MW-56	2005	4962.4	4962.1	0.3
MW-56	2006	4962.0	4961.9	0.1
MW-56	2007	4962.2	4961.6	0.6
MW-56	2008	4961.5	4961.1	0.4
MW-56	2009	4960.7	4960.3	0.4
MW-56	2010	4960.3	4959.3	0.9
MW-56	2011	4959.5	4958.0	1.6
MW-57	1999	4964.4	4965.6	-1.3
MW-57	2000	4964.3	4965.3	-1.0
MW-57	2001	4964.2	4965.0	-0.9
MW-57	2002	4963.6	4964.7	-1.1
MW-57	2003	4963.5	4964.4	-1.0
MW-57	2004	4963.1	4964.2	-1.0
MW-57	2005	4963.1	4963.9	-0.8
MW-57	2006	4963.1	4963.7	-0.6
MW-57	2007	4963.2	4963.4	-0.2
MW-57	2008	4962.6	4962.9	-0.3
MW-57	2011	4960.1	4959.8	0.3
MW-58	1999	4964.1	4963.9	0.2
MW-58	2000	4963.5	4962.6	0.9
MW-58	2001	4963.3	4962.1	1.2
MW-58	2002	4962.6	4961.8	0.8
MW-58	2003	4962.3	4961.4	0.9
MW-58	2004	4962.0	4961.1	0.9
MW-58	2005	4961.7	4960.9	0.8
MW-58	2006	4961.2	4960.6	0.6

Table E-2

Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells
December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-58	2007	4961.5	4960.4	1.1
MW-58	2008	4960.9	4959.9	1.0
MW-58	2009	4960.5	4959.0	1.4
MW-58	2010	4960.2	4958.0	2.2
MW-58	2011	4960.2	4956.5	3.7
MW-59	1999	4968.8	4971.5	-2.7
MW-59	2000	4968.4	4971.1	-2.6
MW-59	2001	4968.2	4970.9	-2.7
MW-59	2002	4967.5	4970.4	-2.9
MW-59	2003	4967.4	4970.0	-2.6
MW-59	2004	4967.1	4969.8	-2.7
MW-59	2005	4966.9	4969.7	-2.7
MW-59	2006	4966.7	4969.5	-2.8
MW-59	2007	4966.9	4969.3	-2.4
MW-59	2008	4966.4	4968.9	-2.6
MW-59	2009	4965.5	4968.3	-2.8
MW-59	2010	4965.4	4967.6	-2.2
MW-59	2011	4965.2	4966.7	-1.5
MW-60	1999	4964.3	4964.8	-0.6
MW-60	2000	4964.0	4963.9	0.0
MW-60	2001	4963.8	4963.6	0.1
MW-60	2002	4963.2	4963.3	0.0
MW-60	2003	4962.9	4962.9	0.0
MW-60	2004	4962.6	4962.7	0.0
MW-60	2005	4962.3	4962.4	-0.1
MW-60	2006	4961.9	4962.2	-0.3
MW-60	2007	4962.1	4961.9	0.2
MW-60	2008	4961.3	4961.4	-0.1
MW-60	2009	4960.4	4960.6	-0.2
MW-60	2010	4960.0	4959.6	0.4
MW-60	2011	4959.5	4958.2	1.2
MW-61	1999	4964.4	4964.9	-0.6
MW-61	2000	4964.0	4964.0	0.0
MW-61	2001	4963.8	4963.7	0.1
MW-61	2002	4963.1	4963.3	-0.2
MW-61	2003	4962.9	4963.0	-0.1
MW-61	2004	4962.6	4962.8	-0.1
MW-61	2005	4962.2	4962.5	-0.3
MW-61	2006	4961.9	4962.3	-0.4
MW-61	2007	4962.0	4962.0	0.0

Table E-2

Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-61	2008	4961.3	4961.5	-0.2
MW-61	2009	4960.2	4960.7	-0.5
MW-61	2011	4961.2	4958.3	2.9
MW-62	1999	4966.5	4966.2	0.3
MW-62	2000	4965.9	4965.5	0.5
MW-62	2001	4965.7	4965.1	0.6
MW-62	2002	4965.1	4964.7	0.5
MW-62	2003	4964.8	4964.3	0.6
MW-62	2004	4964.5	4964.1	0.5
MW-62	2005	4964.3	4963.8	0.5
MW-62	2006	4964.0	4963.6	0.4
MW-62	2007	4964.1	4963.4	0.8
MW-62	2008	4963.6	4962.9	0.7
MW-62	2009	4962.8	4962.2	0.6
MW-62	2010	4962.4	4961.3	1.1
MW-62	2011	4961.9	4960.1	1.8
MW-64	1999	4964.9	4966.2	-1.3
MW-64	2000	4964.6	4965.6	-1.1
MW-64	2001	4964.4	4965.4	-1.0
MW-64	2002	4963.8	4965.1	-1.3
MW-64	2003	4963.6	4964.8	-1.1
MW-64	2004	4963.3	4964.5	-1.2
MW-64	2005	4963.1	4964.3	-1.2
MW-64	2006	4962.8	4964.1	-1.2
MW-64	2007	4963.2	4963.8	-0.6
MW-64	2008	4962.3	4963.3	-1.0
MW-64	2009	4961.5	4962.5	-1.0
MW-64	2010	4961.0	4961.5	-0.5
MW-64	2011	4960.6	4960.3	0.3
MW-65	1999	4960.8	4961.1	-0.4
MW-65	2000	4960.2	4959.7	0.5
MW-65	2001	4959.9	4959.4	0.6
MW-65	2002	4959.4	4959.0	0.4
MW-65	2003	4959.2	4958.6	0.6
MW-65	2004	4958.8	4958.3	0.4
MW-65	2005	4958.4	4958.0	0.3
MW-65	2006	4958.1	4957.8	0.4
MW-65	2007	4958.2	4957.5	0.7
MW-65	2008	4957.4	4956.9	0.5
MW-65	2009	4956.5	4956.0	0.5

Table E-2

Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells
December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-65	2010	4955.9	4954.8	1.1
MW-65	2011	4954.8	4953.1	1.7
MW-66	1999	4963.3	4965.4	-2.0
MW-66	2000	4963.0	4964.9	-1.9
MW-66	2001	4962.8	4964.7	-1.9
MW-66	2002	4962.2	4964.4	-2.1
MW-66	2003	4962.0	4964.1	-2.1
MW-66	2004	4961.6	4963.8	-2.2
MW-66	2005	4961.4	4963.6	-2.2
MW-66	2006	4961.0	4963.3	-2.3
MW-66	2007	4961.2	4963.1	-1.9
MW-66	2008	4960.3	4962.5	-2.3
MW-66	2009	4959.4	4961.6	-2.3
MW-66	2010	4959.1	4960.6	-1.4
MW-66	2011	4958.7	4959.3	-0.6
MW-68	1999	4960.7	4961.7	-1.0
MW-68	2000	4960.4	4960.8	-0.4
MW-68	2001	4960.2	4960.5	-0.3
MW-68	2002	4959.6	4960.1	-0.5
MW-68	2003	4959.4	4959.7	-0.3
MW-68	2004	4959.0	4959.4	-0.4
MW-68	2005	4958.6	4959.2	-0.6
MW-68	2006	4958.3	4958.9	-0.5
MW-68	2007	4958.5	4958.6	-0.1
MW-68	2008	4957.5	4958.0	-0.5
MW-68	2009	4956.6	4957.1	-0.5
MW-68	2010	4955.8	4955.9	0.0
MW-68	2011	4955.1	4954.3	0.8
MW-69	1999	4960.6	4961.4	-0.7
MW-69	2000	4960.3	4960.5	-0.2
MW-69	2001	4960.0	4960.2	-0.1
MW-69	2002	4959.5	4959.8	-0.3
MW-69	2003	4959.3	4959.4	-0.1
MW-69	2004	4958.9	4959.2	-0.3
MW-69	2005	4958.5	4958.9	-0.4
MW-69	2006	4958.2	4958.6	-0.4
MW-69	2007	4958.3	4958.3	0.0
MW-69	2008	4957.3	4957.7	-0.4
MW-69	2009	4956.4	4956.7	-0.3
MW-69	2010	4955.8	4955.5	0.3

Table E-2

Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-69	2011	4955.0	4953.9	1.1
MW-70	1999	4969.4	4971.1	-1.7
MW-70	2000	4969.0	4970.6	-1.6
MW-70	2001	4969.0	4970.4	-1.4
MW-70	2002	4967.7	4969.7	-2.1
MW-70	2003	4967.5	4969.1	-1.6
MW-70	2004	4967.1	4968.9	-1.8
MW-70	2005	4966.9	4968.8	-1.9
MW-70	2006	4966.7	4968.6	-1.9
MW-70	2007	4967.0	4968.5	-1.4
MW-70	2008	4966.4	4968.1	-1.7
MW-70	2009	4965.8	4967.4	-1.7
MW-70	2010	4965.5	4966.7	-1.2
MW-70	2011	4964.9	4965.8	-0.8
MW-72	1999	4970.1	4971.5	-1.4
MW-72	2000	4969.7	4971.1	-1.3
MW-72	2001	4969.5	4970.8	-1.3
MW-72	2002	4968.6	4970.1	-1.5
MW-72	2003	4968.5	4969.3	-0.8
MW-72	2004	4968.2	4969.2	-0.9
MW-72	2005	4968.0	4969.0	-1.0
MW-72	2006	4967.8	4968.9	-1.1
MW-72	2007	4968.1	4968.7	-0.7
MW-72	2008	4967.4	4968.4	-0.9
MW-72	2009	4966.8	4967.7	-1.0
MW-72	2010	4966.5	4967.1	-0.6
MW-72	2011	4966.1	4966.1	0.0
MW-73	1999	4970.1	4971.1	-1.0
MW-73	2000	4969.8	4970.6	-0.9
MW-73	2001	4969.4	4970.4	-0.9
MW-73	2002	4967.7	4969.2	-1.5
MW-73	2003	4967.5	4967.9	-0.5
MW-73	2004	4967.2	4967.8	-0.6
MW-73	2005	4967.0	4967.7	-0.7
MW-73	2006	4966.7	4967.6	-0.8
MW-73	2007	4967.1	4967.4	-0.3
MW-73	2008	4966.5	4967.0	-0.6
MW-73	2009	4966.1	4966.4	-0.2
MW-73	2010	4965.6	4965.8	-0.2
MW-73	2011	4964.9	4964.8	0.2

Table E-2

Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells
December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-74	1999	4962.0	4963.6	-1.5
MW-74	2000	4963.0	4965.9	-2.9
MW-74	2001	4962.7	4966.0	-3.3
MW-74	2002	4962.1	4965.8	-3.7
MW-74	2003	4961.9	4965.6	-3.7
MW-74	2004	4961.2	4965.2	-4.0
MW-74	2005	4960.9	4965.0	-4.0
MW-74	2006	4960.5	4964.6	-4.2
MW-74	2007	4961.0	4964.3	-3.4
MW-74	2008	4959.6	4963.8	-4.2
MW-74	2009	4958.3	4962.7	-4.4
MW-74	2010	4957.6	4961.5	-3.9
MW-74	2011	4958.0	4960.9	-2.9
MW-75	1999	4964.8	4965.4	-0.6
MW-75	2000	4966.9	4967.0	-0.1
MW-75	2001	4966.6	4967.1	-0.6
MW-75	2002	4965.8	4966.9	-1.1
MW-75	2003	4965.8	4966.8	-1.0
MW-75	2004	4965.1	4966.4	-1.3
MW-75	2005	4965.1	4969.1	-4.0
MW-75	2006	4964.7	4968.7	-4.0
MW-75	2007	4965.3	4968.3	-3.0
MW-75	2008	4964.1	4967.7	-3.6
MW-75	2009	4963.3	4966.4	-3.1
MW-75	2010	4962.8	4965.2	-2.4
MW-75	2011	4964.1	4965.5	-1.4
MW-76	1999	4965.6	4968.6	-3.1
MW-76	2000	4967.7	4969.1	-1.3
MW-76	2001	4967.5	4969.2	-1.7
MW-76	2002	4967.3	4969.0	-1.6
MW-76	2003	4967.2	4968.8	-1.6
MW-76	2004	4966.5	4968.5	-2.1
MW-76	2005	4966.7	4968.3	-1.6
MW-76	2006	4966.0	4968.0	-2.0
MW-76	2007	4966.8	4967.7	-0.9
MW-76	2008	4965.4	4967.3	-1.8
MW-76	2009	4965.1	4966.3	-1.2
MW-76	2010	4964.1	4965.2	-1.1
MW-76	2011	4965.5	4965.0	0.5
MW-77	2001	4977.2	4974.2	3.0

Table E-2

Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-77	2002	4977.1	4974.0	3.1
MW-77	2003	4977.1	4973.7	3.4
MW-77	2004	4976.7	4973.6	3.1
MW-77	2005	4976.7	4973.5	3.2
MW-77	2006	4976.5	4973.3	3.1
MW-77	2007	4976.6	4973.2	3.4
MW-77	2008	4976.5	4972.9	3.6
MW-77	2009	4976.0	4972.4	3.6
MW-77	2010	4975.8	4971.8	3.9
MW-77	2011	4975.4	4971.1	4.3
MW-80	2010	4952.6	4953.3	-0.7
MW-80	2011	4952.7	4951.7	1.0
OB-1	1999	4958.1	4958.7	-0.7
OB-1	2000	4957.6	4956.6	0.9
OB-1	2001	4957.3	4956.3	1.0
OB-1	2002	4956.7	4955.9	0.9
OB-1	2003	4956.5	4955.4	1.0
OB-1	2004	4956.0	4955.2	0.8
OB-1	2005	4955.6	4954.9	0.7
OB-1	2006	4955.4	4954.6	0.8
OB-1	2007	4955.2	4954.3	0.9
OB-1	2008	4954.4	4953.6	0.7
OB-1	2009	4953.8	4954.5	-0.6
OB-1	2010	4953.2	4953.4	-0.2
OB-1	2011	4950.9	4951.5	-0.6
OB-2	1999	4959.8	4959.2	0.6
OB-2	2000	4959.0	4957.6	1.3
OB-2	2001	4958.6	4957.3	1.4
OB-2	2002	4957.9	4956.9	1.0
OB-2	2003	4957.7	4956.5	1.2
OB-2	2004	4957.2	4956.2	1.0
OB-2	2005	4956.9	4955.9	1.0
OB-2	2006	4956.7	4955.6	1.0
OB-2	2007	4956.7	4955.3	1.3
OB-2	2008	4955.8	4954.6	1.1
OB-2	2009	4954.9	4953.5	1.4
OB-2	2010	4954.5	4954.2	0.3
OB-2	2011	4952.8	4952.4	0.4
PZ-1	1999	4956.5	4957.2	-0.7
PZ-1	2000	4955.8	4956.7	-0.9

Table E-2

Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells
December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
PZ-1	2001	4955.0	4956.3	-1.2
PZ-1	2002	4954.5	4955.9	-1.3
PZ-1	2003	4954.5	4955.5	-1.0
PZ-1	2004	4953.9	4955.2	-1.2
PZ-1	2005	4953.5	4954.8	-1.3
PZ-1	2006	4953.2	4954.5	-1.3
PZ-1	2007	4953.3	4954.2	-0.9
PZ-1	2008	4952.4	4953.5	-1.1
PZ-1	2009	4951.5	4952.4	-0.9
PZ-1	2010	4951.2	4951.0	0.2
PZ-1	2011	4951.3	4949.5	1.8

Table E-3: **Observed and Calculated Water Levels and Residuals in On-Site DFZ Wells – December 1998 to December 2011**

Table E-3

Observed and Calculated Water Levels in DFZ Wells December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
HR-141C	1999	4957.3	4956.1	1.2
HR-141C	2000	4956.9	4955.8	1.2
HR-141C	2001	4956.6	4955.4	1.2
HR-141C	2002	4956.2	4955.0	1.2
HR-141C	2003	4955.8	4954.6	1.2
HR-141C	2004	4955.1	4954.3	0.8
HR-141C	2005	4954.4	4953.9	0.5
HR-141C	2006	4954.4	4953.6	0.8
HR-141C	2007	4954.4	4953.2	1.3
HR-141C	2008	4952.6	4952.2	0.4
HR-141C	2009	4951.0	4950.4	0.6
HR-141C	2010	4950.9	4948.6	2.3
HR-141C	2011	4951.4	4946.8	4.5
MW-67	1999	4957.7	4957.6	0.1
MW-67	2000	4957.2	4957.2	0.1
MW-67	2001	4956.9	4956.8	0.1
MW-67	2002	4956.3	4956.5	-0.2
MW-67	2003	4956.0	4956.1	-0.1
MW-67	2004	4955.6	4955.8	-0.2
MW-67	2005	4955.1	4955.5	-0.4
MW-67	2006	4955.0	4955.2	-0.2
MW-67	2007	4954.9	4954.9	0.1
MW-67	2008	4953.7	4954.0	-0.3
MW-67	2009	4952.8	4952.5	0.3
MW-67	2010	4952.6	4951.0	1.6
MW-67	2011	4952.3	4949.4	2.9
MW-71	1999	4957.7	4957.8	0.0
MW-71	2000	4957.3	4957.3	0.0
MW-71	2001	4957.1	4957.0	0.1
MW-71R	2002	4956.2	4956.6	-0.4
MW-71R	2003	4956.1	4956.3	-0.2
MW-71R	2004	4955.8	4956.0	-0.2
MW-71R	2005	4955.3	4955.7	-0.3
MW-71R	2006	4955.0	4955.3	-0.3
MW-71R	2007	4955.0	4955.0	0.0
MW-71R	2008	4953.7	4954.1	-0.5
MW-71R	2009	4952.7	4952.7	0.1
MW-71R	2010	4952.5	4951.1	1.3
MW-71R	2011	4952.3	4949.5	2.7
MW-79	2006	4953.0	4953.8	-0.9

Table E-3

Observed and Calculated Water Levels in DFZ Wells December 1998 to December 2011

Monitoring Well	Year	Water Level Elevation in feet above MSL		Residual (ft)
		Observed	Calculated	
MW-79	2007	4953.1	4953.5	-0.4
MW-79	2008	4951.8	4952.6	-0.8
MW-79	2009	4950.7	4951.1	-0.3
MW-79	2010	4951.2	4949.5	1.7
MW-79	2011	4950.8	4947.8	3.0