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Final Phase I Report and Phase II Work Plan: QuickSite® Investigation, Adams, Nebraska

Environmental Research Division

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Final Phase I Report and Phase II Work Plan: QuickSite® Investigation, Adams, Nebraska

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Notation

AGEM	Applied Geosciences and Environmental Management
AMSL	above mean sea level
ASTM	American Society for Testing and Materials
BGL	below ground level
°C	degree(s) Celsius
CCC	Commodity Credit Corporation
CLP	Contract Laboratory Program
COC	chain of custody
cpm	count(s) per minute
DOE	U.S. Department of Energy
ECD	electron capture detector
ECPT	electronic cone penetrometer
EPA	U.S. Environmental Protection Agency
ESC	Expedited Site Characterization
ft	foot (feet)
g	gram(s)
gal	gallon(s)
GC-MS	gas chromatograph-mass spectrometer
gpd	gallon(s) per day
gpm	gallon(s) per minute
hr	hour(s)
IAEA	International Atomic Energy Agency
ICP	inductively coupled plasma
ID	inner diameter
in.	inch(es)
L	liter(s)
LUST	leaking underground storage tank
MCL	maximum contaminant level
µg/kg	microgram(s) per kilogram
µg/L	microgram(s) per liter
µS/cm	microsiemen(s) per centimeter
mg/L	milligram(s) per liter
mi	mile(s)
min	minute(s)

mL	milliliter(s)
MS/MSD	matrix spike/matrix spike duplicate
NAD	North American Datum
NAVD	North American Vertical Datum
NDEQ	Nebraska Department of Environmental Quality
NDH	Nebraska Department of Health (now Nebraska Health and Human Services, NHHS)
ng	nanogram(s)
NHHS	Nebraska Health and Human Services (formerly Nebraska Department of Health, NDH)
ppb	parts per billion
PRP	potentially responsible party
PVC	polyvinyl chloride
PWS	public water supply
QA	quality assurance
QC	quality control
RMS	root mean squared
RPD	relative percent difference
SDG	sample delivery group
sec	second(s)
TOC	top of casing
TU	tritium unit(s)
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
VOC	volatile organic compound
yr	year(s)

Key to symbols and colors used on maps, logs, and cross sections

Geologic Age

Young *Old*

- Pleistocene & Recent
- Permian

Lithology

- Topsoil
- Brown Clayey Silt (loess)
- Gray Sandy Silt and Clay
- Sand and Gravel
- Blue-gray Clayey Silt
- Limestone and Shale
- Gray Silt with trace Sand
- Sand
- Gravel
- Shale

Grain Size

- Gravel
- Coarse Sand
- Medium Sand
- Sand
- Silt
- Clay

Location Symbols

- Domestic Well
- Public Well
- Monitoring Well
- Irrigation Well
- Recovery Well
- Observation Well

ECPT/Geoprobe Activities

- Electronic Log
- Piezometer
- Log/Sample
- Piezometer/Sample
- Log/Sample/Piezometer

Drilling Activities

- Soil Boring

Aquifer Symbols

- Pleistocene Aquifer
- Water Level
- Piezometer Screen

Sampling Locations

- Vegetation Sample
- Soil & Vegetation Sample
- Proposed ECPT Sampling Location

Final Phase I Report and Phase II Work Plan: QuickSite® Investigation, Adams, Nebraska

1 Introduction

The Commodity Credit Corporation (CCC), an agency of the U.S. Department of Agriculture (USDA), operated a grain storage facility in Adams, Nebraska (Figure 1.1), from 1950 to 1975, as documented in the Phase I *Work Plan* (Argonne 2000). During this time, commercial grain fumigants containing carbon tetrachloride were in use by the CCC/USDA and the private grain storage industry to preserve grain in their facilities. In 1990, carbon tetrachloride was detected in a sampling event in one of Adams' three public water supply (PWS) wells during routine screening conducted by Nebraska Health and Human Services (NHHS), formerly the Nebraska Department of Health (NDH). Carbon tetrachloride was reportedly detected at 12.9 µg/L in a sample collected in February 1990 from the Adams municipal well PWS 64-1. This level exceeds the maximum contaminant level (MCL) of 5 µg/L promulgated by the U.S. Environmental Protection Agency (EPA) for drinking water. Carbon tetrachloride was again detected in the well at levels above the MCL (13.1 µg/L) in a follow-up sample collected from the well by NHHS in March 1990. The well was disconnected from the municipal water system in May 1991 because of the concentrations of carbon tetrachloride. Even though the well is no longer used for drinking, the village has continued to use it for other purposes. During the past several years, water from the well has been used extensively by road construction crews working in the area and by nearby farmers who have hauled the water for irrigation.

Initial sampling of well PWS 70-1 (Figure 1.2), conducted in February 1990 by NHHS, resulted in no detection of carbon tetrachloride. However, a sample collected from the well in October 1990 reportedly contained 0.4 µg/L. Two samples collected subsequently from the well in 1991 by NHHS resulted in no detection. Samples collected from the well later and from the treatment plant since 1991 have resulted in periodic detections of carbon tetrachloride, with all detections being well below the MCL. Well PWS 70-1 continues to serve as an active producing well for the village. Carbon tetrachloride has never been detected in the village's third well (PWS 79-1), which is located just north of the village limits (Figure 1.2). Because the carbon tetrachloride found in the wells might, in part, be linked to historical use of carbon tetrachloride-based grain fumigants at the former CCC/USDA facility, the CCC/USDA is conducting a remedial investigation to determine the source(s) and extent of the carbon tetrachloride contamination at the Adams site and to assess whether the contamination requires remedial

action. However, investigation of the possible contamination of public supply well PWS 64-1 by carbon tetrachloride emanating from the former CCC/USDA site could be complicated by the existence of other potentially responsible parties (PRPs) identified by the EPA in eastern Adams (Curry 2000).

The remedial investigation at Adams is being performed by the Environmental Research Division of Argonne National Laboratory with its QuickSite® characterization approach (formerly known as the Expedited Site Characterization [ESC] approach). Argonne is a nonprofit, multidisciplinary research center operated by the University of Chicago for the U.S. Department of Energy (DOE). The CCC/USDA has entered into interagency agreement with DOE, under which Argonne provides technical assistance to the CCC/USDA with environmental site characterization and remediation at its former grain storage sites.

At these sites, Argonne is applying its QuickSite® environmental site characterization methodology. QuickSite® is Argonne's proprietary implementation system for the ESC process (ASTM 1998). Argonne's Environmental Research Division developed the ESC process to optimize preremedial site characterization work at hazardous waste sites by obtaining and then exploiting a thorough understanding of a site's geology, hydrogeology, and hydrogeochemistry (e.g., Burton 1994). This approach is fundamental to successful site characterization, because the geology and hydrogeology of a site largely govern the mobility and fate of contaminants there. Throughout the ESC process, a conceptual model of a site's geology, hydrogeology, and hydrogeochemistry guides investigative work. The conceptual model is developed initially by appraising existing data from the site within a regional geologic, hydrogeologic, and hydrogeochemical framework. This preliminary conceptual model is tested and revised during the first phase of the ESC investigation. The revised conceptual model is then used to guide the second phase of investigation, which focuses primarily on delineation of contamination at the site. The results of the investigation provide a technically defensible basis for evaluating potential health risks and hence the possible remediation needs of the site. Argonne's QuickSite® methodology has been applied successfully at a number of former CCC/USDA sites in Nebraska and has been adopted by the American Society for Testing and Materials (ASTM 1998) as standard practice for environmental site characterization.

The preliminary conceptual model for Adams developed in the Phase I *Work Plan* (Argonne 2000) is summarized here for context. The geology of interest was predicted to be composed of Permian bedrock overlain by Pleistocene and Recent fluvial and glacial material

and eolian loess. The Pleistocene fluvial sands were expected to have a thickness of 27-42 ft near the former CCC/USDA site. Within the paleovalley north of Adams, the Pleistocene fluvial deposits increase in thickness to more than 113 ft and contain basal gravels. The Pleistocene fluvial deposits were predicted to be underlain by Pleistocene silt or by interbedded Permian shales and limestones of the Council Grove Group. A single Quaternary sand and gravel aquifer is the major water source for the community and for irrigation near Adams. All wells near the site are pumping groundwater from this aquifer. The flow direction of the groundwater at the former CCC/USDA site was anticipated to be from southwest to northeast, toward the Middle Branch of the Big Nemaha River.

The conceptual understanding of the site suggested one pathway by which carbon tetrachloride might have migrated from the former CCC/USDA site to PWS 70-1 and two potential pathways from the site to PWS 64-1, as follows:

1. Movement of carbon tetrachloride downward at the former CCC/USDA site until the contaminant reached the Quaternary aquifer, followed by easterly subhorizontal migration to well PWS 70-1 (near abandoned PWS 49-1). Potential variations of this pathway could result from southeasterly flow from the northern part of the site (pathway 1a) or northeasterly flow from the southern part of the site (pathway 1b). Pathway 1 terminates at PWS 70-1 and does not act as a source for well PWS 64-1.

2. Movement of carbon tetrachloride downward at the former CCC/USDA site until the contaminant reaches the Quaternary aquifer, followed by easterly subhorizontal migration passing through the location of PWS 70-1 (PWS 49-1) and on to well PWS 64-1. Potential variations of this pathway could bypass PWS 70-1/49-1 to the north (pathway 2a), to the south (pathway 2b), or both.

3. Movement of carbon tetrachloride downward at the former CCC/USDA site, followed by northeasterly subhorizontal migration of the contaminant in the Quaternary aquifer, to the north of the capture zone for PWS 70-1 (PWS 49-1), and then easterly migration through the location of abandoned well PWS 56-1 to well PWS 64-1.

These potential pathways are shown schematically in Figures 1.2 and 1.3. Figure 1.2 is a plan of the area showing all of the potential pathways and the location of cross section D-D´. Figure 1.3 is a west-to-east cross section (D-D´) running from the CCC/USDA site and through the location of PWS 70-1 to PWS 64-1, showing potential pathways 1 and 2 and their variations.

The Phase I investigation at Adams started on April 3, 2000. Field activities continued through May 5, 2000, and automated water level monitoring is ongoing. The objectives of the Phase I work were (1) testing and revision of the initial conceptual geologic-hydrogeologic-hydrogeochemical model as it relates to understanding and predicting contaminant distribution and migration and (2) identification of contaminant migration pathways.

This report documents the findings of the Phase I activities at Adams. Section 1 provides a brief history of the area and the QuickSite® process, a summary of the conceptual model, objectives of the Phase I investigation, and a brief description of the sections contained in this report. Section 2 describes the investigative methods used during the Phase I investigation. Section 3 presents all of the data obtained during the investigation. Section 4 describes the current understanding of the geology, hydrogeology, and hydrogeochemistry of the area, which is the revised conceptual model. Section 5 evaluates the effect of historical pumping on potential migration pathways identified in Phase I. Contaminant migration pathways in soil and groundwater are discussed in Section 6. Section 7 summarizes the findings and conclusions of Phase I and outlines recommendations for Phase II. To streamline the reporting process, material from the Phase I *Work Plan* (Argonne 2000) and relevant sections of the *Master Work Plan* (Argonne 1994) are not repeated in detail in this report. Consequently, *these documents must also be consulted* to obtain the complete details of the Phase I investigative program.

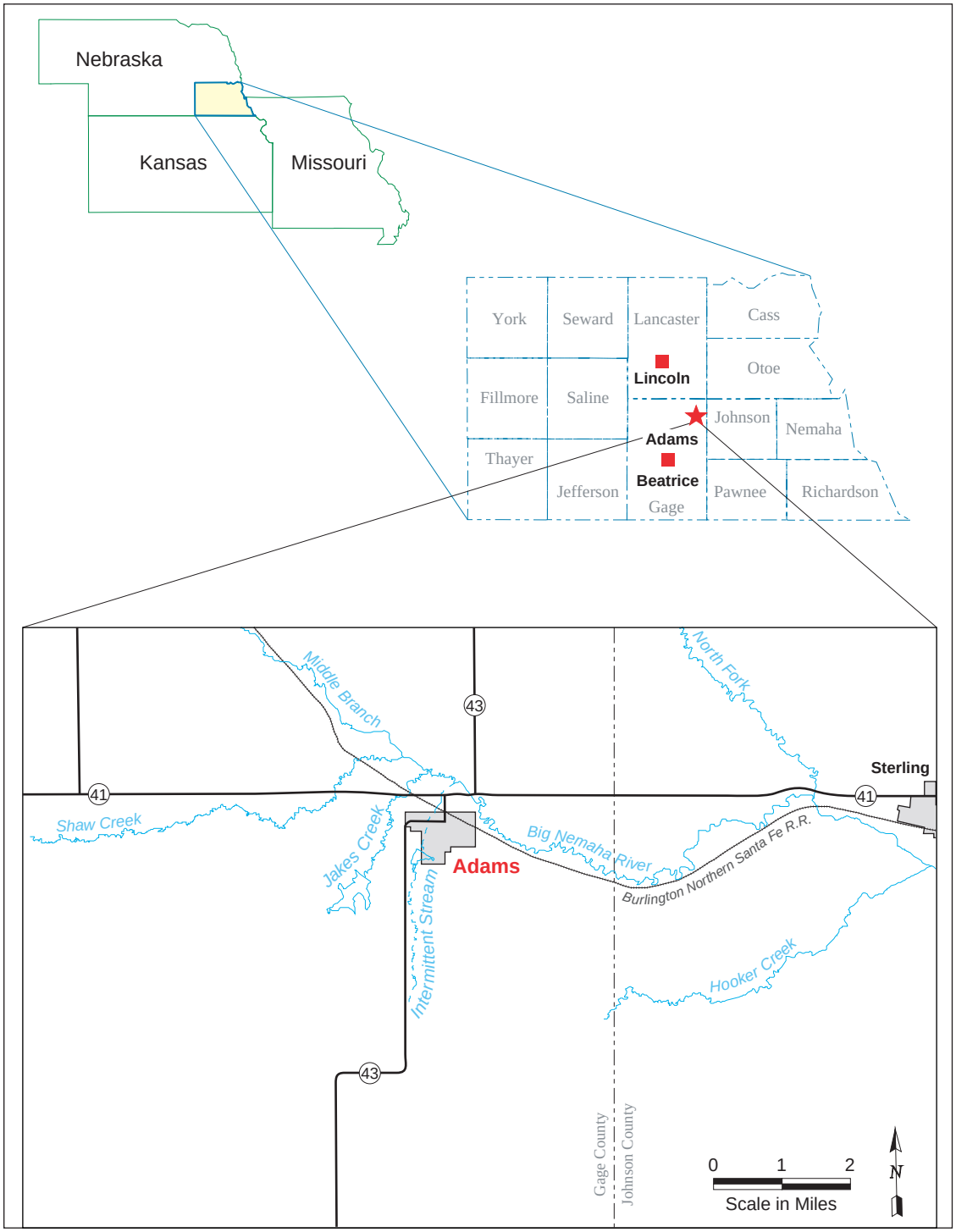

FIGURE 1.1 Map of Nebraska, Showing the Location of Gage County and the Village of Adams

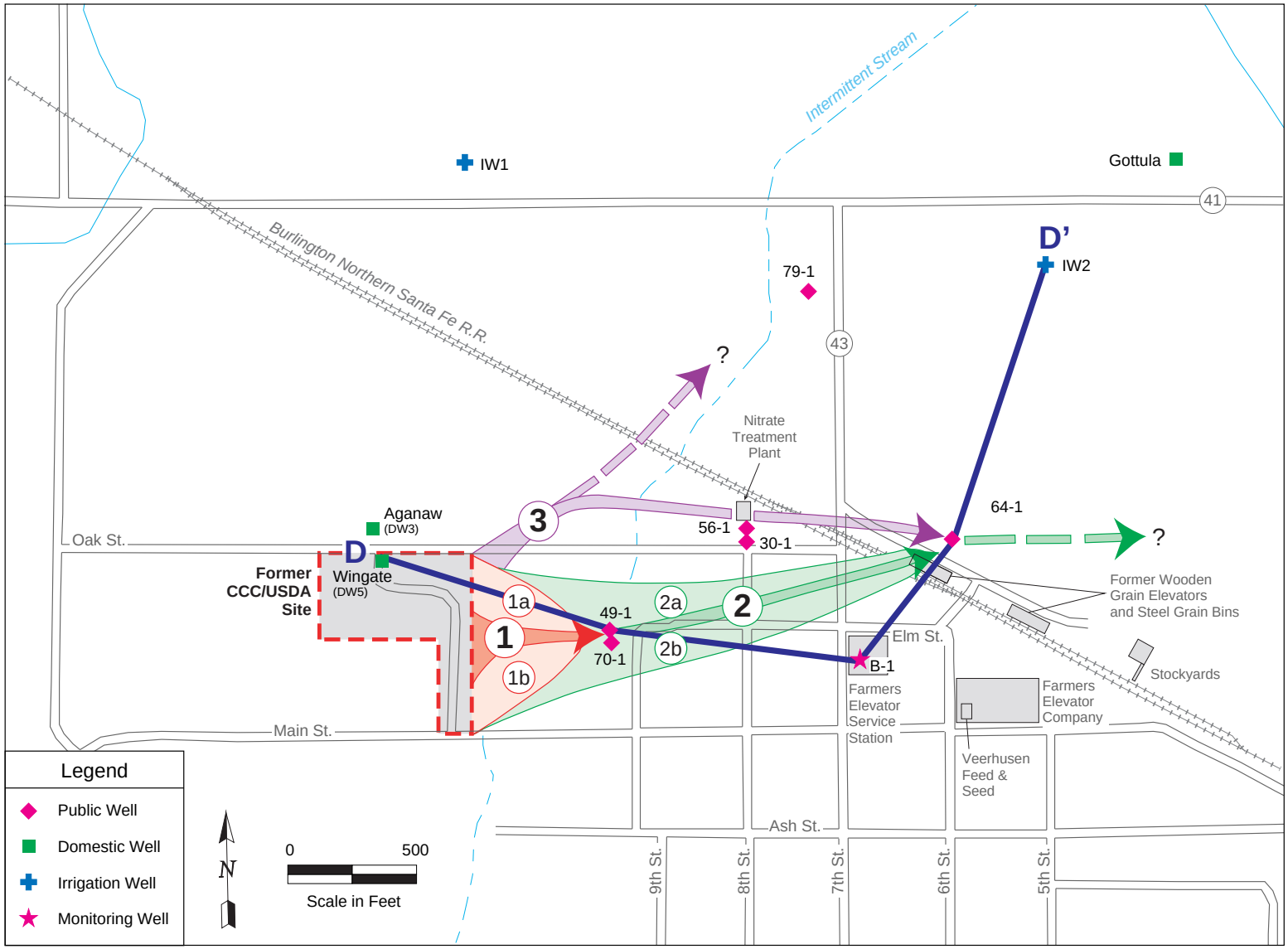

FIGURE 1.2 Map of Adams, Nebraska, Showing the Locations of the Former CCC/USDA Site; Other Potential Source Areas; Public, Domestic, Irrigation, and LUST Monitoring Wells; Interpretive Cross Section D-D´ from the Phase I *Work Plan* (Argonne 2000); and Potential Contaminant Migration Pathways

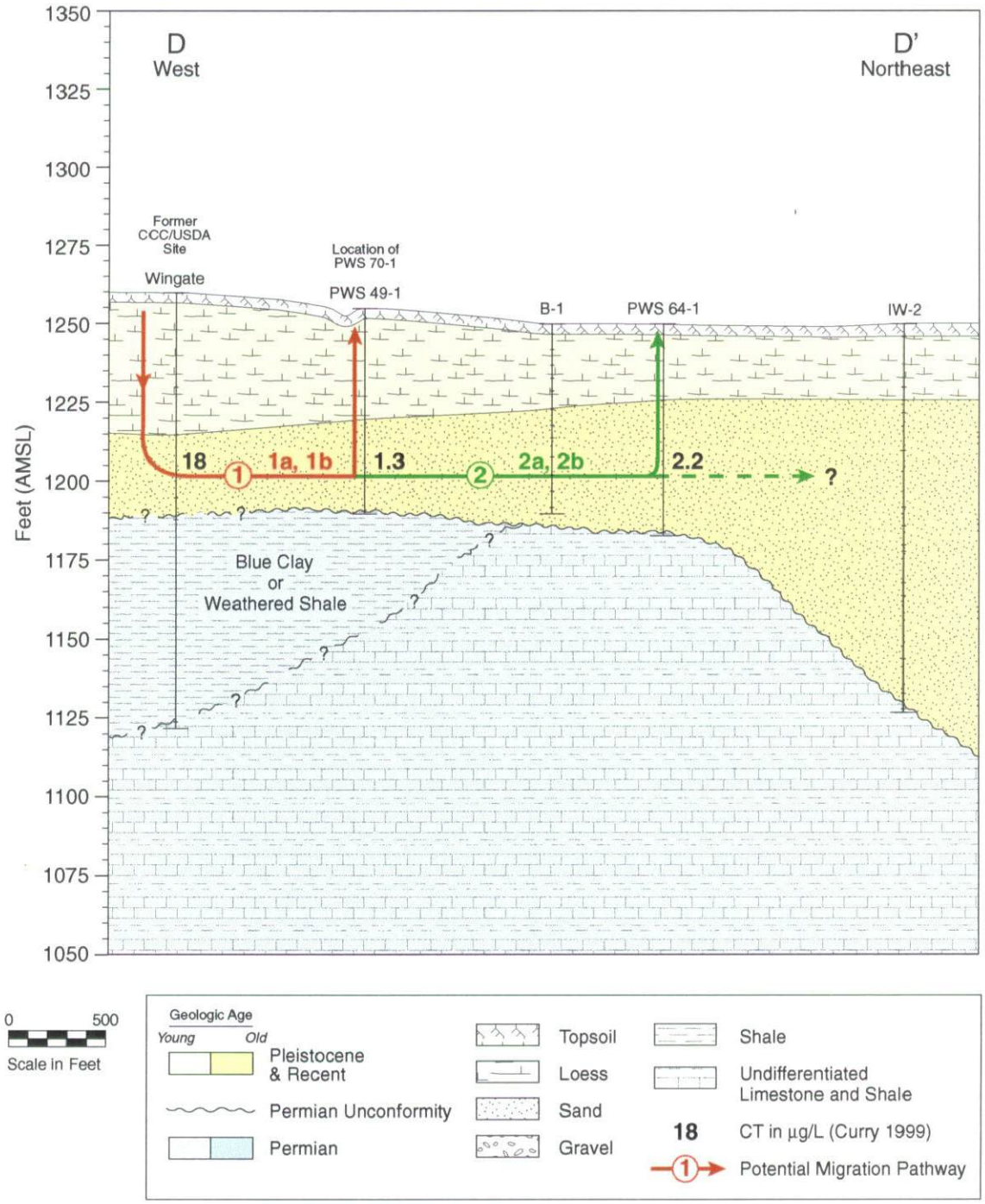

FIGURE 1.3 Geologic Cross Section D-D′, Showing the Potential Contaminant Migration Pathways Described in the Phase I *Work Plan* (Argonne 2000)

2 Investigation Methods

This section describes the objectives of the investigative program and the field and laboratory methods used during Phase I work to investigate the geology, hydrogeology, hydrogeochemistry, and distribution of carbon tetrachloride and chloroform in groundwater and soils in the Adams area. Detailed descriptions of the field and laboratory procedures associated with these methods are in the *Master Work Plan* (Argonne 1994).

2.1 Drilling Program

The Phase I drilling program was designed to (1) confirm the stratigraphic sequence inferred from regional and local data, (2) determine the detailed vertical stratigraphic sequence and its lateral variability along the potential migration pathway, (3) establish a basis for correlation of electronic cone penetrometer (ECPT) logs with core logs, and (4) collect lithologic samples to determine hydrogeologic properties (e.g., grain size and sorting). Two boreholes (SB01 and SB02, Figure 2.1) were drilled during Phase I by using the mud rotary continuous-coring method. Initially, the upper portion of borehole SB01 was drilled by using the hollow-stem auger continuous-coring method, but core recovery in the aquifer was hindered by the presence of flowing sands. Consequently, the mud rotary method was used to complete SB01 and to drill SB02 in an attempt to control the flowing sands and improve core recovery. During drilling, Argonne geologists prepared lithologic logs of each borehole by examining the cores. The Layne-Western Company of Omaha, Nebraska, performed the drilling. Drilling, sampling, and core logging procedures are described in the *Master Work Plan* (Argonne 1994). The geologic logs are in Appendix A.

To confirm the geologic log descriptions and allow for computation of preliminary hydraulic parameters, 30 samples collected from the cores from SB01 and SB02 were subjected to particle size analysis according to the procedure in the *Master Work Plan* (Argonne 1994). The soils were placed in sealed, labeled polyvinyl chloride (PVC) bags and shipped to HWS Consulting Group, Inc., Lincoln, Nebraska, for particle size analysis according to the procedure in ASTM Standard D 422–63 (ASTM 1994). The results are discussed in Section 3.1.3 and are displayed graphically on the geologic logs in Appendix A.

2.2 Electronic Cone Penetrometer Program

The objectives of the Phase I ECPT program at Adams were to (1) measure the geomechanical properties of the unconsolidated subsurface sediments, (2) collect sediment samples to determine the lithology and grain size distribution, (3) map the spatial and vertical distribution of the stratigraphic units by using ECPT sensor data correlated with lithologic core logs, (4) perform groundwater sampling for geochemical analyses to determine the hydrogeochemical character of each hydrostratigraphic unit, (5) collect water samples for analysis of carbon tetrachloride and chloroform to evaluate contaminant migration pathways, and (6) install piezometers for water level monitoring.

Fifteen locations (SB03-SB14, SB16, SB18, and SB20) were investigated by using the Argonne 40-ton ECPT vehicle (Figure 2.1). The ECPT operations were performed in accordance with procedures in the *Master Work Plan* (Argonne 1994).

Activities at the individual ECPT locations varied with location-specific objectives and subsurface conditions. Logs of tip and sleeve stress measurements were obtained at all 15 locations (SB03-SB14, SB16, SB18, and SB20). The ECPT logs were correlated with geology in nearby continuously cored soil borings (Section 2.1) or with split-spoon samples collected from selected depths with the ECPT and a MOSTAP sampler. Soil samples for lithologic logging were taken in SB03, SB04, SB05, SB06, SB13, SB14, SB16, SB18, and SB20 (Figure 2.1 and Appendix B). The ECPT sensor logs are in Appendix B.

A total of 26 soil samples were collected for grain size analysis by using the ECPT with the MOSTAP coring device, according to the procedure in the *Master Work Plan* (Argonne 1994). The soils were placed in sealed, labeled PVC bags and shipped to HWS Consulting Group, Inc., Lincoln, Nebraska, for particle size analysis according to the procedure in ASTM Standard D 422-63 (ASTM 1994). The results are discussed in Section 3.1.3 and are displayed graphically on the ECPT logs in Appendix B.

Groundwater samples were collected at 13 locations (SB03-SB11, SB13, SB14, SB16, and SB18) to obtain information on groundwater geochemistry and contaminant distribution (Figure 2.1). The groundwater sampling program is discussed further in Section 2.7.

Three temporary piezometers were installed with the ECPT at SB03, SB05, and SB14 (Figure 2.1). Piezometers were installed at ECPT locations SB12 and SB13 by using the Geoprobe™, as described in Section 2.3. The water level monitoring program is discussed further in Section 2.4.

2.3 Geoprobe™ Program

The objectives of the Geoprobe™ program were (1) to provide temporary water level monitoring capability at locations inaccessible to the 40-ton ECPT vehicle and adjacent to existing public water supply wells where well logs provided geologic control and (2) to collect groundwater samples at selected locations inaccessible by the 40-ton ECPT vehicle. Five piezometers were installed by using the Geoprobe™ at SB12, SB13, SB15, SB17, and SB19 (Figure 2.1). The water level monitoring program is discussed further in Section 2.4. Groundwater samples were collected with the Geoprobe™ at SB12 and SB15. The groundwater sampling program is discussed further in Section 2.7.

2.4 Water Level Monitoring Program

The water level monitoring program was designed to (1) measure groundwater potential gradients and flow directions and (2) determine the impact of pumping wells on potential contaminant migration pathways within the aquifer penetrated by the Adams public water supply wells.

2.4.1 Installation of Piezometers

A total of eight temporary piezometers were installed: five at ECPT test locations SB03, SB05, SB12, SB13, and SB14 and three at Geoprobe™ locations SB15, SB17, and SB19. The purpose was to measure water levels in the unconsolidated Pleistocene sediments (Figure 2.2). The ECPT and Geoprobe™ piezometers were installed by using a direct-push method in which a string of 1-in.-ID threaded PVC casing and 0.010-in. slotted screen were attached to a sacrificial tip and advanced to the desired depth inside 2.25-in. cone penetrometer or 2-in. Geoprobe™ rods. The rods were then withdrawn, leaving the sacrificial tip, screen, and casing in place. As the rods were withdrawn, a sand filter pack was placed across the screen interval, and the

remainder of the annular space was filled with 100% bentonite slurry pumped into the annulus through a tremie pipe. The piezometers were then secured with a locking cap and a 9-in. steel flush-mount. The piezometer screen intervals are given in Appendix B, Table B.1.

2.4.2 Water Level Measurements

Water levels in the network of piezometers and temporary monitoring wells were measured to determine potential gradients and directions of groundwater flow in the aquifer. At the conclusion of the initial phase of the field program, one set of water level measurements was made by hand with an electronic water level meter, to the nearest 0.01 ft from a surveyed mark at the top of the casing. To evaluate the effect of pumping wells on the water levels, transducers connected to data recorders were installed in the piezometers, PWS 70-1, and leaking underground storage tank (LUST) monitoring well B12.

2.5 Surveying

Wehling Engineers of Beatrice, Nebraska, performed the surveying. At the conclusion of field operations, the piezometers, borehole, and ECPT test hole locations were surveyed to provide horizontal and vertical control for stratigraphic correlation, water level monitoring, and hydrogeologic mapping. The locations and elevations of LUST monitoring wells B12 and B17 and domestic wells DW5 (Wingate) and DW3 (Aganaw) were also surveyed. The locations of the public water supply wells and the remaining domestic wells from which water samples were collected were estimated from aerial photography (USGS 1993) and from the USGS topographic map of the area (USGS 1965).

2.6 Soil and Vegetation Sampling

Vegetation was sampled in Phase I to guide deeper subsurface soil sampling in Phase II. Soil samples were collected at two near-surface depths: at about 1 ft below ground level (BGL) (within topsoil) and at about 6 ft BGL (at the lower depth of frost penetration). Soil analysis data will be used for risk calculations for soil.

2.6.1 Vegetation Sampling and Analysis

Fifty-two vegetation samples were collected at the former CCC/USDA site (Figure 2.3). A background sample was collected 0.3 mi east of the site. Brome grass samples were placed in 40-mL vials, preserved with dry ice, transported to the Applied Geosciences and Environmental Management (AGEM) Laboratory in the Environmental Research Division at Argonne National Laboratory, and analyzed for carbon tetrachloride and chloroform.

The analytical method used is a modification of the protocol for EPA Method 5021 ("Volatile Organic Compounds in Soils and Other Solid Matrices Using Equilibrium Headspace Analysis"). Approximately 0.5-1.0 g of a vegetation sample was placed in a tare-weighted 20-mL headspace vial with a high-temperature Teflon-faced septum seal. Sample weights were determined to an accuracy of 0.01 g, and the vials were placed in an autosampler. The analytical protocol was modified by raising the equilibration temperature to 95°C for 120 min to ensure reliable volatilization of the carbon tetrachloride and chloroform within the sample. Standards were prepared by using known quantities of carbon tetrachloride, chloroform, and tetrachloroethene. The gas chromatograph (GC) system, which contained an electron capture detector (ECD), was calibrated on the basis of the masses of the spike components detected in the standard. This method has high precision and gives reproducible patterns of contaminant distribution.

2.6.2 Near-Surface Soil Sampling and Analysis

A total of 96 near-surface soil samples were collected, representing 48 locations (Figure 2.3). Samples collected at 0.8-1.2 ft BGL were organic-rich, predominantly loam topsoil. Most samples collected at 5.5-6 ft BGL were clay or clayey loam, frequently displaying humic staining. Three additional samples were taken at intermediate depths where topsoil was buried by local fill. A background sample was collected 0.3 mi east of the site.

Samples were recovered by using a hand (ESP™) or power-driven (Geoprobe™) sleeved coring device. Samples were placed in jars, preserved on dry ice, and transported to the AGEM Laboratory for carbon tetrachloride and chloroform analyses. Analysis was conducted with a gas chromatograph-mass spectrometer (GC-MS) according to EPA Method 8260B. Headspace GC-ECD analyses were also performed on soil, according to the procedure described in Section 2.6.1 for vegetation.

2.7 Collection and Analysis of Groundwater Samples

Groundwater sampling was performed during the Phase I field program at Adams to quantify groundwater hydrogeochemistry in the water-saturated units. Groundwater samples were collected from 5 private wells, 2 LUST monitoring wells, 3 public water supply wells, 2 Geoprobe™ locations, and 13 ECPT locations (Figure 2.1) by using several sampling techniques. Sampling and analytical methods are described below.

2.7.1 Water Samples Collected with the Cone Penetrometer

The ECPT vehicle was used to collect 70 groundwater samples from multiple depths at 13 ECPT boring locations (SB03-SB11, SB13, SB14, SB16, and SB18). Samples were collected by using the procedure in the *Master Work Plan* (Argonne 1994), in which groundwater passes through a disposable tip-and-filter system attached directly to the cone penetrometer push rods. A Teflon bailer inserted through the rod was used to retrieve the groundwater sample.

2.7.2 Water Samples Collected with the Geoprobe™

The Geoprobe™ was used to collect two water samples from piezometer locations SB12 and SB15. The procedure for collecting Geoprobe™ samples was the method used for the ECPT, described in the *Master Work Plan* (Argonne 1994). Groundwater passing through a disposable tip-and-filter system attached directly to the Geoprobe™ push rods was sampled by using a Teflon bailer inserted through a 1-in. PVC riser attached to the filter screen.

2.7.3 Water Samples from Domestic Wells

Five samples were collected from privately owned domestic wells (Figure 2.1). Sampling was conducted as described in the *Master Work Plan* (Argonne 1994).

2.7.4 Water Samples from LUST Monitoring Wells

Two samples were collected from LUST monitoring wells B12 and B17 (Figure 2.1), installed during investigations at the Farmers Elevator Company service station (Coranco 1990). Sampling was conducted as described in the *Master Work Plan* (Argonne 1994).

2.7.5 Water Samples from Public Supply Wells

Samples were collected from public supply wells 64-1, 70-1, and 79-1 (Figure 2.1) as described in the *Master Work Plan* (Argonne 1994).

2.7.6 Analysis of Groundwater Samples

Groundwater samples collected during Phase I field activities were analyzed for volatile organic compounds (VOCs) including carbon tetrachloride and chloroform, inorganic materials, and tritium, according to analytical procedures in the *Master Work Plan* (Argonne 1994).

Groundwater samples collected for analysis of VOCs including carbon tetrachloride and chloroform were shipped immediately to the AGEM Laboratory for analysis with EPA Method 524.2. Analytical results for carbon tetrachloride and chloroform in groundwater samples are discussed in Section 3.6.2. The quality control groundwater samples collected, including replicate and split groundwater samples shipped to Clayton Laboratory in Novi, Michigan, for verification VOC analysis with EPA Contract Laboratory Program (CLP) methodology, are discussed in Section 2.8.

Groundwater geochemistry was characterized by inorganic analysis of the groundwater samples collected. After collection, the samples were shipped immediately to Severn-Trent Laboratory in Colchester, Vermont, for filtration, preservation, and analysis. The analyses included dissolved anion concentrations (chloride, sulfate, nitrate, and phosphate) by EPA Method 300, ammonia nitrogen by EPA Method 350, and metals (aluminum, calcium, iron, magnesium, manganese, phosphorus, potassium, silicon, sodium, and zinc) by EPA Method 6010.

To aid in characterization of the groundwater geochemistry, selected groundwater samples were analyzed for tritium isotopes. The tritium analyses were run at the Tritium Laboratory at the University of Miami in Miami, Florida.

2.7.7 Field Measurement

Field parameters (temperature, pH, and conductivity) were measured in the field during groundwater sampling by using a Checkmate Field Meter system after calibration with the appropriate standard solutions. Titrimetric techniques with commercial kits manufactured by CHEMetric, Inc., were used to determine alkalinity, dissolved oxygen, and nitrate concentrations.

2.8 Quality Control for Sample Collection, Handling, and Analysis

The quality assurance/quality control (QA/QC) procedures for sample collection, handling, and analysis followed during Adams Phase I activities are described in detail in the *Master Work Plan* (Argonne 1994). Significant points include the following:

- Sample integrity throughout the collection, shipping, and analysis activities was tracked by the documentation of samples as they were collected and the use of custody seals and chain-of-custody records.

- Rinsates of decontaminated ECPT sampling bailers and rods were collected periodically according to decontamination procedures defined in the *Master Work Plan* (Argonne 1994). Disposable equipment was used during collection of other sample types.

- Field blanks and trip blanks were collected to verify that samples for organic analysis were not contaminated during collection, handling, and shipment. Laboratory method blanks were analyzed to verify that contamination was not introduced within the laboratory.

- Vegetation and soil samples were analyzed for VOCs including carbon tetrachloride and chloroform at AGEM Laboratory by using a modification of the protocol in EPA Method 5021 (headspace analysis by GC-ECD) to achieve the low detection limits required. For comparison, the soil samples were also analyzed for carbon tetrachloride and chloroform by using EPA Method 8260B (purge-and-trap method by GC-MS).

- Groundwater samples were analyzed for VOCs including carbon tetrachloride and chloroform at AGEM Laboratory by using EPA Method 524.2 (purge-and-trap method). Blind replicate samples and blind analytical standards were collected, and other samples were selected by the laboratory for duplicate analyses, as one measure of the analytical precision achieved by the laboratory. In addition, replicate samples were sent to Clayton Laboratory for verification analysis with EPA CLP methodology.

- Groundwater samples for inorganic analysis were collected and shipped immediately to Severn-Trent Laboratory for filtration, preservation, and analysis. Analyses included dissolved anion concentrations (chloride, sulfate, nitrate, and phosphate) by EPA Method 300, ammonia nitrogen by EPA Method 350, and metals (aluminum, calcium, iron, magnesium, manganese, phosphorus, potassium, silicon, sodium, and zinc) by EPA Method 6010.

- Selected groundwater samples were analyzed for tritium at the University of Miami Tritium Laboratory. Tritium concentrations were reported on the basis of the National Institute of Science and Technology tritium water standard #4926, measured on September 3, 1961, and again on September 3, 1978, with a half-life of 12.43 yr.

2.9 Waste Characterization, Handling, and Disposal

Potentially contaminated waste soil and water derived during drilling and development of temporary wells SB01 and SB02 installed at Adams were accumulated in large roll-off containers at each drilling site and sampled prior to disposal. Composite samples representative of the waste material were collected from each container.

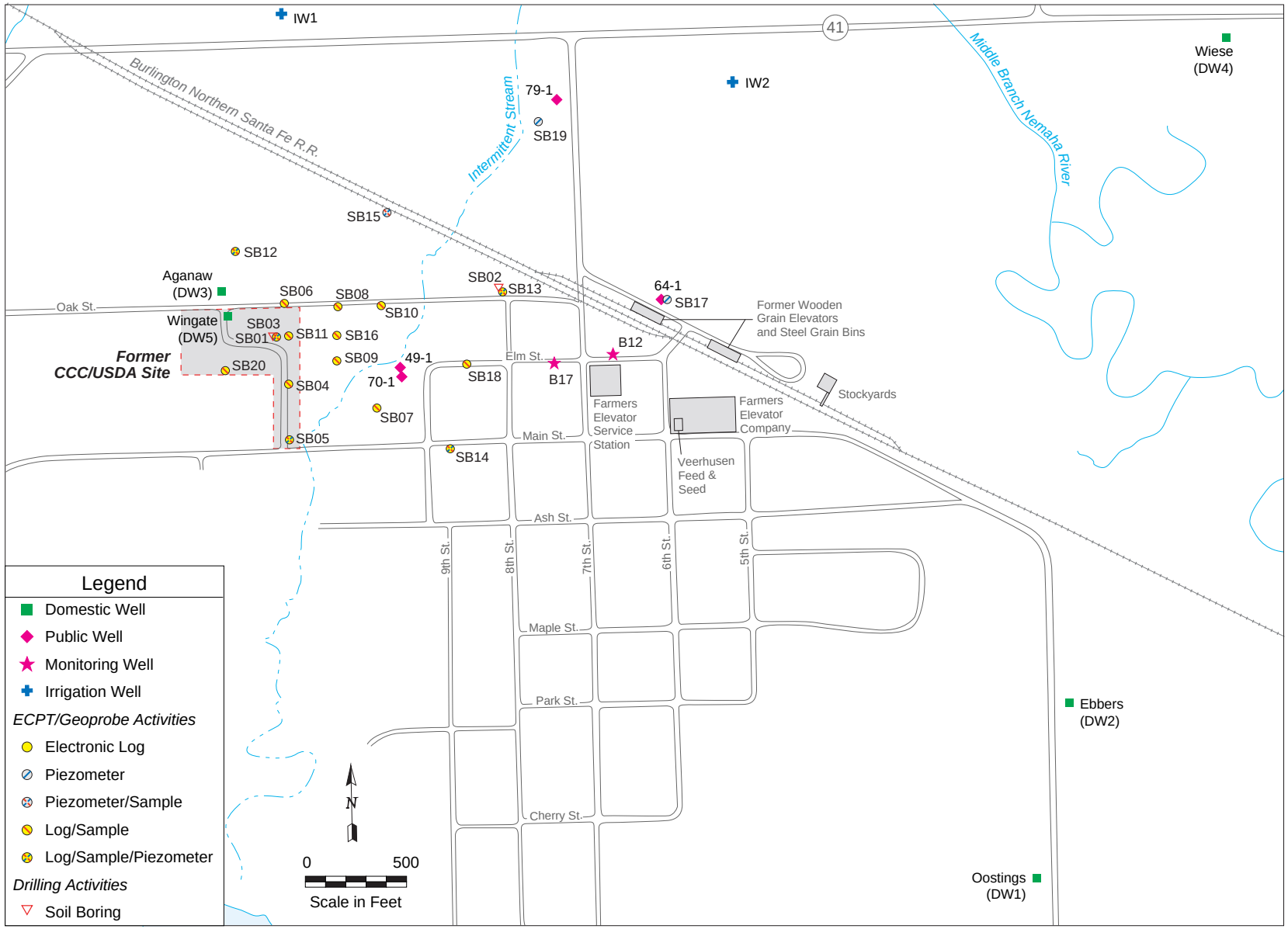

FIGURE 2.1 Map of Adams, Nebraska, Showing the Locations of the Former CCC/USDA Site; Other Potential Source Areas; Public, Domestic, Irrigation, and LUST Monitoring Wells; and Phase I Investigative Activities

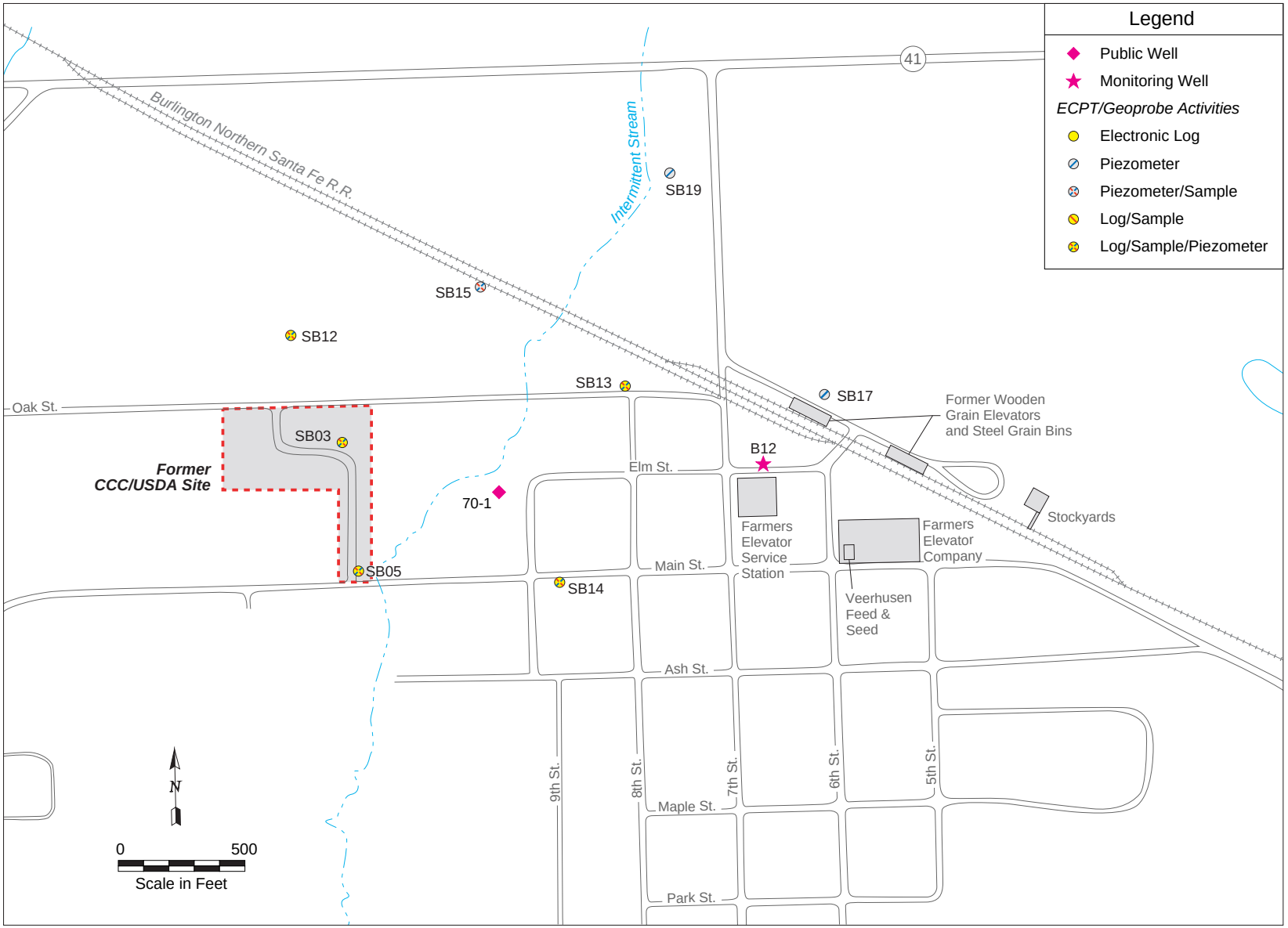

FIGURE 2.2 Map of Adams, Nebraska, Showing the Locations of the Former CCC/USDA Site, Other Potential Source Areas, and Automated Water Level Monitoring Activities in Phase I

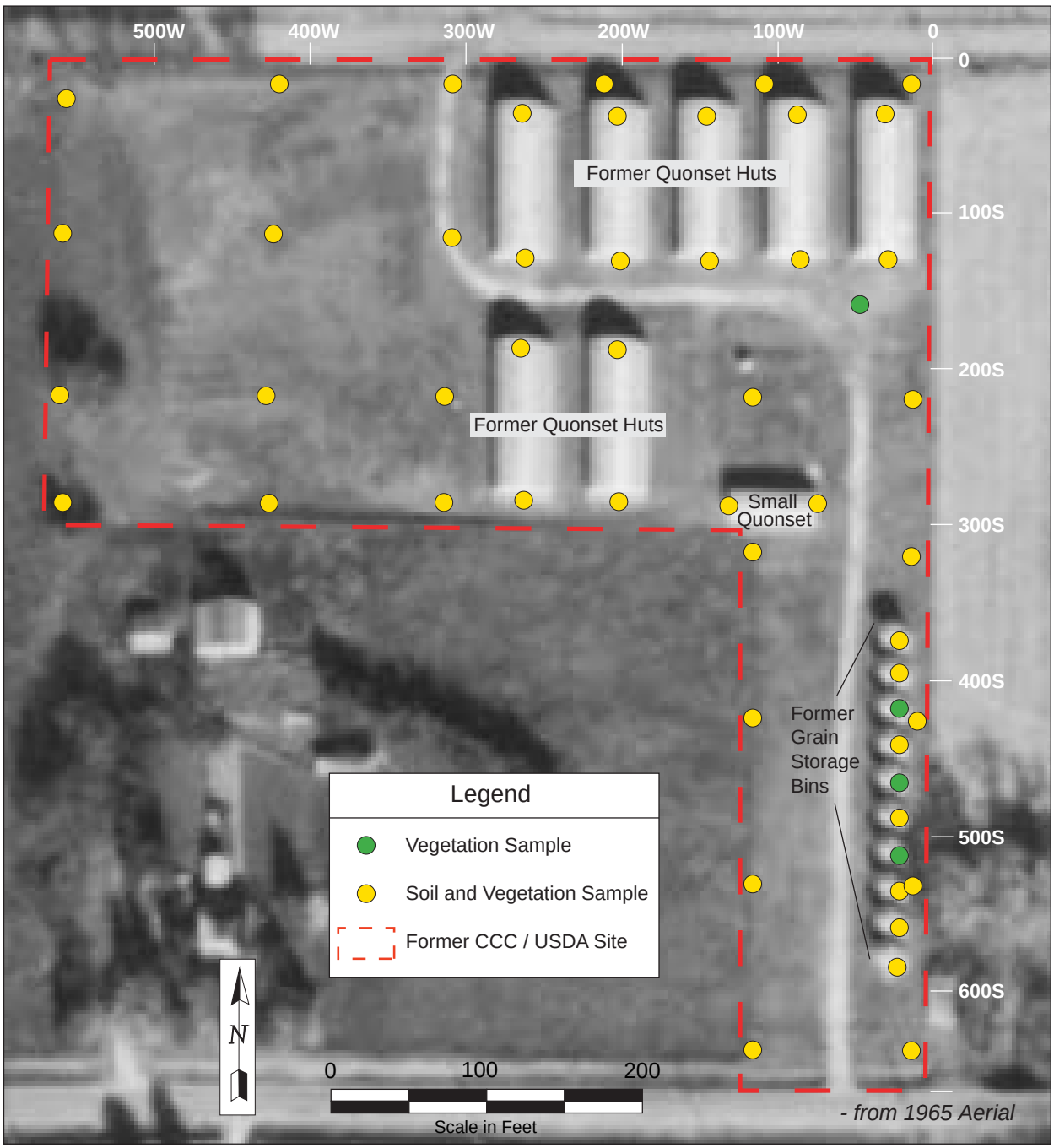

FIGURE 2.3 Aerial Photograph of the Former CCC/USDA Site at Adams, Showing Locations of Quonset Huts and Grain Bins in 1965 (USDA 1965), along with Locations of Vegetation and Near-Surface Soil Sampling in Phase I

3 Field and Laboratory Data

This section presents the field and Laboratory data generated during the Phase I work at Adams. The methods used to acquire these data are described in Section 2, and field and laboratory procedures followed during the investigation are described in the *Master Work Plan* (Argonne 1994).

3.1 Geologic Data

The geologic data obtained during the Phase I investigation include soil boring logs, soil samples collected with the ECPT, grain size analyses of samples and cores, and ECPT sensor logs. The following sections present these data in detail.

3.1.1 Soil Boring Logs

To accomplish the objectives of the drilling program described in Section 2.1, two soil borings were drilled at Adams as stratigraphic test holes (Figure 2.1). Test hole SB01 was drilled to establish the Recent and Pleistocene geologic section at the former CCC/USDA site. The hole was drilled with a hollow-stem auger rig to a depth of 34 ft BGL. A complete core was recovered in the silts and clays above 31 ft BGL, but at 34 ft BGL, in the underlying fluvial sand and gravel unit, flowing sand entered the core barrel, making it impossible to recover a soil core. As a result, the hole was drilled again by using a continuous-coring mud rotary rig in an attempt to recover core samples from the flowing sands. However, the mud rotary rig also met with limited success in the sand and gravel unit, because the core barrel was frequently blocked by coarse gravel cobbles that became wedged in the shoe, preventing recovery of a soil core. The mud rotary drilling penetrated the sand and gravel unit from 31 to 73 ft BGL with recovery of fine, medium, and coarse grained sand and gravel. The hole was completed in a dense blue-gray Pleistocene silt at a total depth of 83 ft BGL. The geologic log for SB01 is in Appendix A.

Soil boring SB02 was drilled with the continuous-coring mud rotary rig to a depth of 75 ft BGL (Figure 2.1). The soil boring was drilled to evaluate the sand and gravel unit along the potential contaminant migration pathway between the former CCC/USDA site and contaminated well PWS 64-1. Silt and clay were recovered from surface to 30 ft BGL, but core recovery from the sand and gravel unit at 30-69 ft BGL was limited. The occurrence of gravel at 31-35 ft BGL

in this hole occasionally restricted core recovery from lower levels, because cobbles falling from the gravel zone tended to become wedged in the core barrel. Sand samples recovered from SB02 below the gravel zone tended toward a finer grain size than those from the same interval in SB01. Below the sand and gravel unit, a complete core of dense, blue-gray Pleistocene silt was recovered at 70-75 ft BGL. The geologic log for SB02 is in Appendix A.

3.1.2 Electronic Cone Penetrometer Data

The ECPT was used at Adams to (1) obtain sensor data (primarily tip and sleeve stress), (2) obtain samples to evaluate the geologic section, (3) retrieve a vertical profile of water samples, and (4) install temporary piezometers for water level monitoring. Sensor data were obtained with the ECPT from SB03-SB14, SB16, SB18, and SB20 (Figure 2.1 and Appendix B). Soil samples for lithologic logging were taken from selected split-spoon cuttings to confirm the sensor response in SB03, SB04, SB05, SB06, SB13, SB14, SB16, SB18, and SB20 (Figure 2.1 and Appendix B). Groundwater samples (discussed in Section 3.6) were collected at SB03-SB11, SB13, SB14, SB16, and SB18 (Figure 2.1). Three temporary piezometers were installed with the ECPT at SB03, SB05, and SB14 (Figure 2.1 and Table B.1, Appendix B).

The ECPT sensor data obtained from SB03 and SB13, collected adjacent to cored soil borings SB01 and SB02, respectively, serve as an example of the results obtained. The sensor data for SB03 are shown in Figure 3.1, along with the geologic log of SB01 obtained by continuous coring as described in Section 3.1, the results of grain size analyses of SB01 core samples, and the vertical locations of the water samples retrieved from SB03. In the general pattern of the tip and sleeve stresses and the ratio sleeve:tip, the topsoil and clayey silt (loess) are characterized by a relatively low tip stress and a low but variable sleeve stress. The underlying sandy silt and clay unit also shows low tip and sleeve stresses, but the ratio is highly variable and spiky. The relatively high tip and sleeve stresses and low sleeve:tip ratios recorded at 32-72 ft BGL are characteristic of the sand and gravel unit. Below 72 ft BGL, the blue-gray clayey silt unit that underlies the sand and gravel is characterized by a relatively flat, intermediate tip stress, a relatively high sleeve stress, and a high sleeve:tip ratio. The off-scale tip and sleeve stress records at the bottom of the hole are associated with push refusal interpreted as the top of bedrock. (A sample collected from SB09 at refusal recovered limestone.)

The sensor data for SB13 are shown in Figure 3.2, along with the geologic log of SB02 obtained by continuous coring as described in Section 3.1, the results of grain size analyses of SB02 core samples, and the vertical locations of the water samples retrieved from SB03. In the general pattern of the tip and sleeve stresses and the ratio sleeve:tip, the topsoil and clayey silt (loess) are characterized by a relatively low tip stress and a low but variable sleeve stress. The underlying sand and gravel unit has relatively high tip and sleeve stresses and low ratios throughout. The blue-gray clayey silt unit that underlies the sand and gravel is recognized by a relatively flat, intermediate tip stress, a relatively high sleeve stress, and a high ratio immediately below the contact with the sand and gravel unit. Below 82 ft BGL, the sleeve stress declines. The off-scale tip and sleeve stress records at the bottom of the hole are associated with push refusal interpreted as the top of bedrock.

The lithologic classifications (sand, clay, silt, etc.) used to describe these units are shown in Figures 3.1 and 3.2 next to the ECPT sensor patterns. These examples of typical sensor response at core holes SB01 and SB02 and adjacent ECPT holes SB03 and SB13 were used as a general guide to the vertical distribution of the lithologic units throughout the area of investigation. Where the sensor response was questionable, geologic samples were collected with the ECPT at the depth of interest to confirm the assigned lithologic classification and for particle size analysis. Use of this method identified an additional stratigraphic unit through sampling at SB05 and SB20 that found gray silt with traces of sand. This unit was characterized by a relatively low tip stress with a highly variable and erratic sleeve stress. (See logs for SB05 and SB20, Appendix B.)

3.1.3 Particle Size Data

A total of 56 soil samples were collected for grain size analysis. Of these samples, 30 were obtained from the cores collected from SB01 and SB02, and the remaining 26 were collected with the ECPT and the MOSTAP coring device, according to the procedure described in the *Master Work Plan* (Argonne 1994). The results are in Tables C.3 and C.4, Appendix C, and are graphically displayed on the geologic and ECPT logs in Appendixes A and B, respectively.

3.2 Hydrogeologic Data

A temporary monitoring well network was installed to measure groundwater levels in the Pleistocene aquifer. The network consists of eight piezometers and LUST monitoring wells B12 and B17. All of the piezometers and wells are screened in the Pleistocene fluvial aquifer except for SB05, which is used to monitor the water level in the saturated glacial silt unit. Figure 2.2 shows the locations of all piezometers and wells in the network. A complete set of water level data was measured by hand on May 11, 2000. The name of the well or piezometer, the screened interval, the depth to groundwater, the elevation of the top of the well, and the groundwater elevation are summarized in Table 3.1.

To evaluate the effect of pumping wells on the groundwater flow system, pressure transducers connected to data recorders were installed in all of the piezometers, PWS 70-1, and LUST well B12. The data loggers were programmed to record water level measurements at 2-min intervals on May 2-11 and July 6-20, 2000, and at 4-hr intervals from May 11 to July 6, 2000. The data recorded at SB05, SB15, and B12 during the initial period (May 2-11, 2000) show a “square-wave” appearance that is due to poor resolution. The data loggers at these wells were replaced with new units supplied by the manufacturer. Data collected at these wells after May 11, 2000, were of good quality. All groundwater levels and elevations recorded during the investigation are in Appendix D.

TABLE 3.1 Hand-Measured Water Levels on May 11, 2000

Well	Screen Interval (ft BGL)	Time	Depth to Groundwater (ft BGL)	Elevation (ft AMSL)	
				Reference	Water Level
SB03	67-72	11:40	25.86	1257.54	1231.68
SB05	2.6-42.6	11:08	14.12	1261.60	1247.48
SB12	2.3-39.3	15:31	22.65	1254.56	1231.91
SB13	32-42	14:58	20.22	1250.18	1229.96
SB14	31-36	12:54	25.46	1256.08	1230.62
SB15	33.3-43.3	12:05	20.87	1251.67	1230.80
SB17	38-51	14:12	16.48	1245.24	1228.76
SB19	31.3-43.3	14:45	19.87	1249.36	1229.49
B12	30-45	12:34	16.27	1245.48	1229.21
B17	15-30	13:56	18.89	1248.51	1229.62

3.3 Survey Coordinates

Wehling Engineers of Beatrice, Nebraska, performed the surveying. At the conclusion of the Phase I field operations, the piezometer, borehole, and ECPT test hole locations were surveyed to provide horizontal and vertical control for stratigraphic correlation, water level monitoring, and hydrogeologic mapping. The locations and elevations of LUST monitoring wells B12 and B17 and domestic wells DW5 (Wingate) and DW3 (Aganaw) were also surveyed. The locations of the public water supply wells and the remaining domestic wells from which water samples were collected were estimated from aerial photography (USGS 1993) and from the USGS topographic map of the area (USGS 1965). Survey data from Phase I are in Appendix E.

3.4 Vegetation Sample Data

Brome grass samples were collected at 52 locations on the former CCC/USDA site and at one background location (Figure 3.3). Trace concentrations of carbon tetrachloride (< 0.1 μg/kg) were detected in most of the grass samples. Concentrations of carbon tetrachloride > 0.04 μg/kg appear to be significantly associated with former grain storage structures. Contaminant distributions are shown and discussed in Section 6.

3.5 Soil Sample Data

Ninety-six near-surface soil samples were collected at 48 locations in the pasture that now occupies the former CCC/USDA site. These samples represented organic-rich loamy soil at 0.8-1.2 ft BGL and clay or clayey loam at 5.5-6 ft BGL (Figure 3.3). Buried topsoil noted at intermediate depths was additionally sampled at three locations.

Topsoil covered most of the site to a depth of approximately 2-3 ft BGL. Underlying subsoil was generally uniform, grading mostly between clayey loam and clay and typically showing humic staining to 6 ft BGL. Table C.2 in Appendix C lists analytical results for soil. Soil sample descriptions are in Table C.1.

Carbon tetrachloride was not detected above a quantitation limit of 10 µg/kg after methanol extraction and GC-MS analysis. The presence of carbon tetrachloride at trace concentrations < 10 µg/kg was indicated at a number of locations in headspace analysis by GC-ECD. The contaminant distribution in soils correlated well with the distribution in vegetation.

3.6 Analytical Data for Groundwater Samples

Groundwater samples collected during the Phase I field activities were analyzed for carbon tetrachloride, chloroform, and dissolved inorganic materials (cations and anions). Selected samples were analyzed for tritium. All samples were analyzed by following procedures described in the *Master Work Plan* (Argonne 1994). Details about groundwater samples collected, including locations, date sampled, and sample depths, are in Table F.1 in Appendix F.

3.6.1 Field Measurements

Field measurements provide immediate results and sometimes give indications of groundwater chemistry that can aid in evaluating groundwater zones and patterns and can assist in site evaluation and decision making in the field. For example, nitrate concentrations determined in the field are often useful as indicators of surface recharge to shallow groundwater aquifers. The results of the field measurements are in Table F.2 in Appendix F.

3.6.2 Contaminants

All 25 groundwater sampling locations are shown in Figure 3.4. Carbon Tetrachloride and chloroform were the only organic contaminants found at the site. Carbon Tetrachloride contamination was found in groundwater at 10 locations (Figure 3.5), at concentrations of < 5-59 µg/L (Appendix F, Table F.3). (Values reported as < 5 µg/L indicate that the compound was present but could not be quantified.) The highest concentration was found at SB11 at the eastern boundary of the former CCC/USDA facility. Chloroform contamination was found in groundwater at 5 locations (Figure 3.6), at concentrations of < 5-20 µg/L (Appendix F, Table F.3). The highest chloroform concentration was also found in SB11, but at a shallower depth than the highest carbon tetrachloride value.

All organic analytical results for groundwater samples are shown in Table F.3 in Appendix F. These results are discussed in Section 6. The QA/QC results, including results for samples analyzed with EPA CLP methodology, are discussed in Appendix G.

3.6.3 Major Elements

Results of inorganic analyses of the groundwater samples were used to characterize the groundwater chemistry. The analytical results for major cations (calcium, magnesium, sodium, and potassium) and major anions (chloride, sulfate, and bicarbonate) and interpretations are in Section 4.4.2.

Nitrate concentrations in groundwater samples ranged from 0.21 to 34.3 mg/L. At a nitrate concentration of 16.3 mg/L, Adams well PWS 79-1 exceeded the EPA-promulgated MCL for nitrate in drinking water of 10 mg/L, and two domestic wells, DW03 (Aganaw) and DW05 (Wingate), also exceeded the MCL at 11.6 and 13.3 mg/L, respectively. The inorganic analytical results are shown in detail in Table F.4 in Appendix F and are discussed in Section 4.4.2.

3.6.4 Tritium Isotopes

To aid in characterizing variations in the hydrostratigraphy, groundwater samples representing different locations and depths were analyzed for tritium. The analytical results are shown in detail in Table F.5 in Appendix F, and the results are discussed in Section 4.4.3.

Tritium is a short-lived isotope of hydrogen (with a half-life of 12.43 yr) that is produced naturally by solar radiation. However, during the atmospheric testing of thermonuclear weapons that took place in 1951-1980, vastly greater quantities of tritium were released to the atmosphere (Clark and Fritz 1997). As a result, precipitation and therefore recharge to groundwater was enriched in tritium during this period. Low tritium values in groundwater (< 1 TU [1 TU = 1 atom of tritium per 10^{18} atoms of hydrogen]) suggest that the water originated prior to 1951. Therefore, the presence of tritium in groundwater is an indicator of modern (post-1951) groundwater recharge. Tritium was detected in all of the groundwater samples collected at Adams.

3.7 Results of Quality Control Activities

The QA/QC report for sample collection, handling, and analysis activities, including an evaluation of the analytical data generated, is in Appendix G. Significant results include the following:

- Sample integrity throughout the collection, shipping, and analysis activities was tracked by the documentation of samples as they were collected and the use of custody seals and chain-of-custody records. Minor discrepancies in sample identification numbers for some samples, as listed on chain-of-custody records and on the sample containers, were resolved by comparison of the various documentation records. Samples were received at appropriate temperature. All samples were analyzed within required holding times.

- Rinsates of decontaminated ECPT sampling bailers and rods contained no carbon tetrachloride or chloroform, indicating that decontamination procedures for that reusable sampling equipment were properly followed. Disposable equipment was used during collection of other sample types.

- Field blanks and trip blanks contained no carbon tetrachloride or chloroform, indicating the environmental samples collected were not contaminated during collection, handling, and shipment. The lack of contamination in laboratory method blanks verified that contamination was not introduced within the laboratory.

- Vegetation and soil samples were analyzed for carbon tetrachloride and chloroform at AGEM Laboratory by using a modification of the protocol in EPA Method 5021 (headspace analysis by GC-ECD) to achieve the low detection limits required. Typical detection limits achieved were 0.060 µg/kg (micrograms per kilogram or parts per billion) for carbon tetrachloride and 0.750 µg/kg for chloroform. A limitation of the chloroform analysis is the presence of chloroform (at very low concentrations) in the methanol solvent used in standard preparation. An 11-point calibration of the GC system was established on the basis of the mass of known quantities of carbon tetrachloride and chloroform in the range 0.125-4.000 ng (nanograms). The

analytical data are acceptable qualitatively for determination of contaminant distribution. For comparison, the soil samples were also analyzed for carbon tetrachloride and chloroform by using EPA Method 8260B, with all results below the quantitation limit of 10 µg/kg for this purge-and-trap method using methanol extraction followed by GC-MS.

- Groundwater samples were analyzed for VOCs including carbon tetrachloride and chloroform at AGEM Laboratory by using EPA Method 524.2 (purge-and-trap method). The concentration of each component was calculated by comparison of the MS response for the quantitation ion to the response on corresponding calibration curves, for internal standards, or both. The internal standard recovery limits were 80-120%. If the internal standard was outside these limits, the sample was analyzed again (if sample volume permitted), or the data were flagged accordingly. Calibration checks with each sample delivery group were required to be within ±20%. As one measure of the analytical precision achieved by the laboratory, blind replicate samples were submitted for analysis, and other samples were selected by the laboratory for duplicate analysis. Blind analytical standards were submitted to the laboratory as another measure of precision. In addition, replicate samples were sent to Clayton Laboratory for verification analysis with EPA CLP methodology. Accuracy and precision limits were met for the analyses (described in detail in Appendix G), and the organic analytical data from AGEM Laboratory are accepted.

- Groundwater samples for inorganic analysis were collected and shipped immediately to Severn-Trent Laboratory for filtration, preservation, and analysis. Analyses included dissolved anion concentrations (chloride, sulfate, nitrate, and phosphate) by EPA Method 300, ammonia nitrogen by EPA Method 350, and metals (aluminum, calcium, iron, magnesium, manganese, phosphorus, potassium, silicon, sodium, and zinc) by EPA Method 6010. The QC procedures followed during inorganic analyses included instrument calibration through analysis of spiked calibration check standards and the verification of interelement and background correction factors through the analysis of interference check samples for inductively coupled plasma (ICP) samples. Accuracy in the analytical methodology followed was measured by

the analysis of laboratory control samples with each sample delivery group. The inorganic data from Severn-Trent Laboratory are accepted. Because the recovery of phosphate in laboratory control samples analyzed with two groundwater samples (ADDW04-W-11314 and ADMWB12-W-11317) was above the QC limit, the reported phosphate results for the two samples are qualified (Table G.9, Appendix G, and Table F.4, Appendix F).

- Selected groundwater samples were analyzed for tritium at the University of Miami Tritium Laboratory. Tritium concentrations were reported on the basis of the National Institute of Science and Technology tritium water standard #4926, as measured on September 3, 1961, and again on September 3, 1978, with a half-life of 12.43 yr. The reported concentrations were corrected for cosmic intensity, gas pressure, and other parameters to account for variances in counter efficiency and background. The isotopic data from the University of Miami Tritium Laboratory are accepted.

3.8 Results of Waste Characterization, Handling, and Disposal

Potentially contaminated waste soil and water derived during drilling and development of temporary wells SB01 and SB02 installed at Adams were accumulated in large roll-off containers at each drilling site and sampled prior to disposal. Representative composite samples were collected from each container (Table G.1, Appendix G). Neither carbon tetrachloride nor chloroform was present (Table G.2, Appendix G). The drilling waste was placed in the Industrial Services, Inc., landfill in Lincoln, Nebraska.

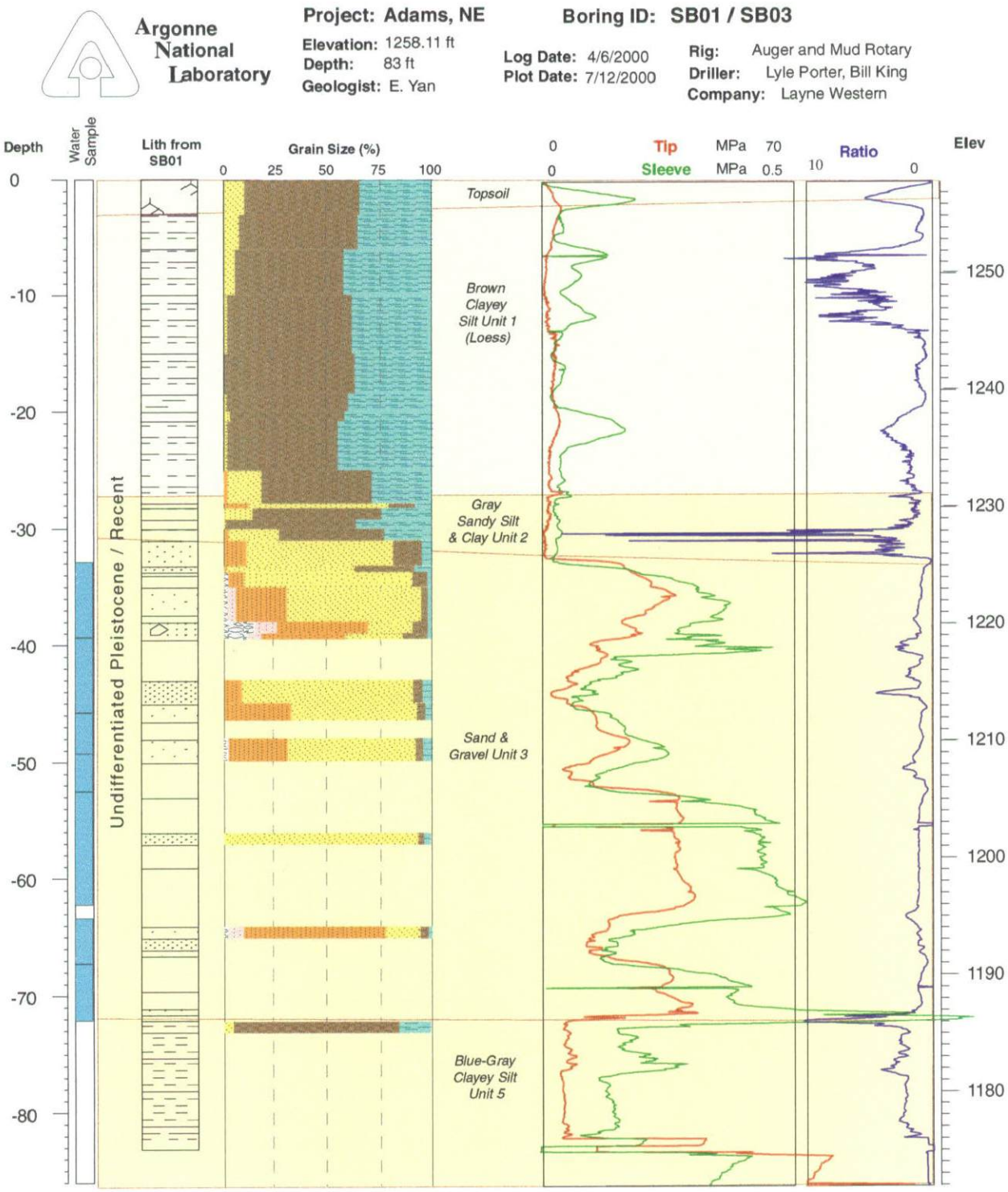

FIGURE 3.1 Geologic Log of SB01, Showing the Pleistocene and Recent Stratigraphic Sequence with the Grain Size Distribution of the Sediments and the Characteristic Cone Penetrometer Sensor Response at Adjacent Location SB03 at Adams, Nebraska

Argonne National Laboratory

Project: Adams, NE **Boring ID: SB02 / SB13**

Elevation: 1250.1 ft
Depth: 75 ft
Geologist: Yan/Meyer
Location: Nitrate Treatment Facility
Log Date: 4/07/2000
Plot Date: 7/12/2000
Rig: Mud Rotary
Driller: Bill King
Company: Layne Western

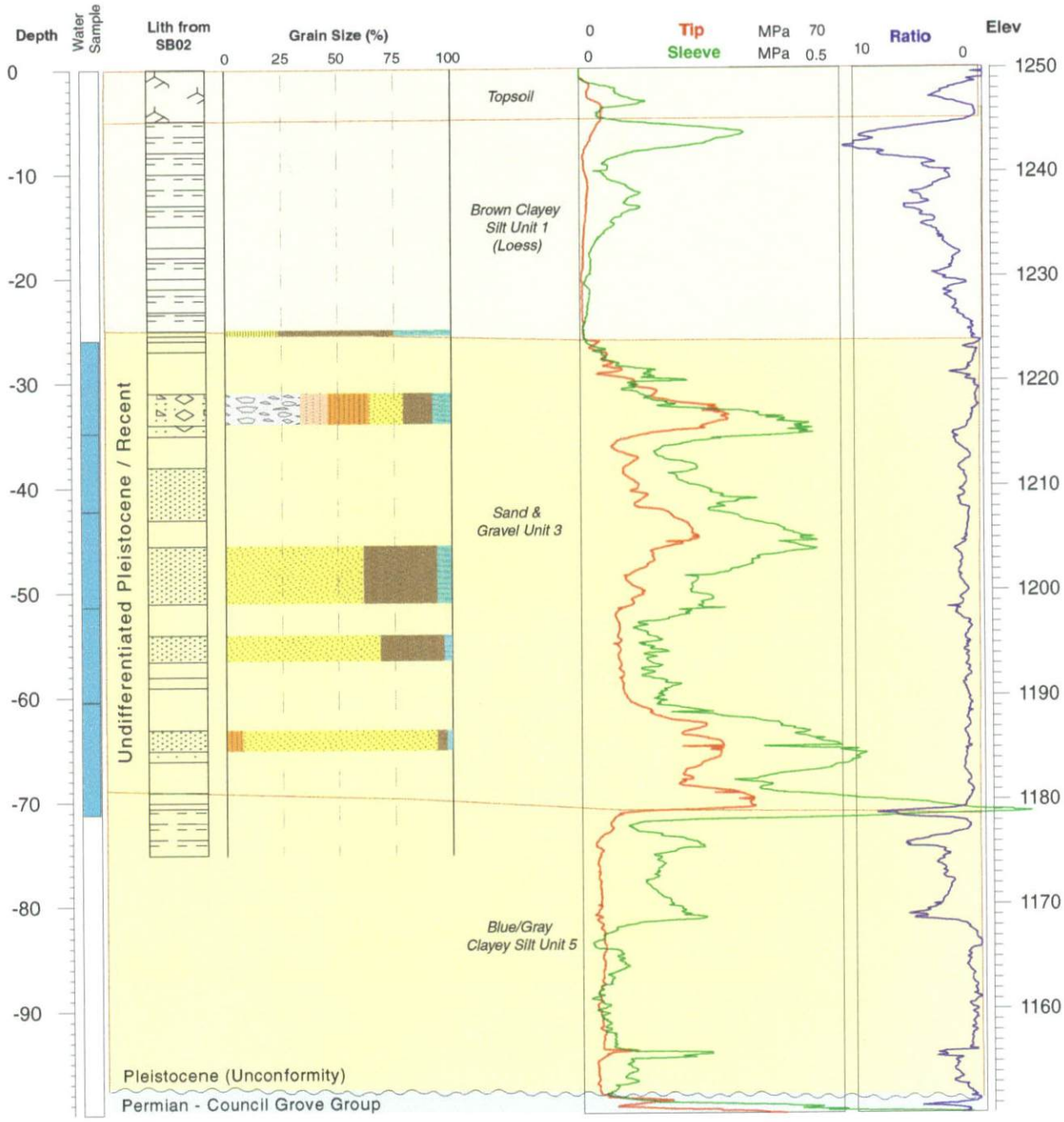

FIGURE 3.2 Geologic Log of SB02, Showing the Pleistocene and Recent Stratigraphic Sequence with the Grain Size Distribution of the Sediments and the Characteristic Cone Penetrometer Sensor Response at Adjacent Location SB13 at Adams, Nebraska

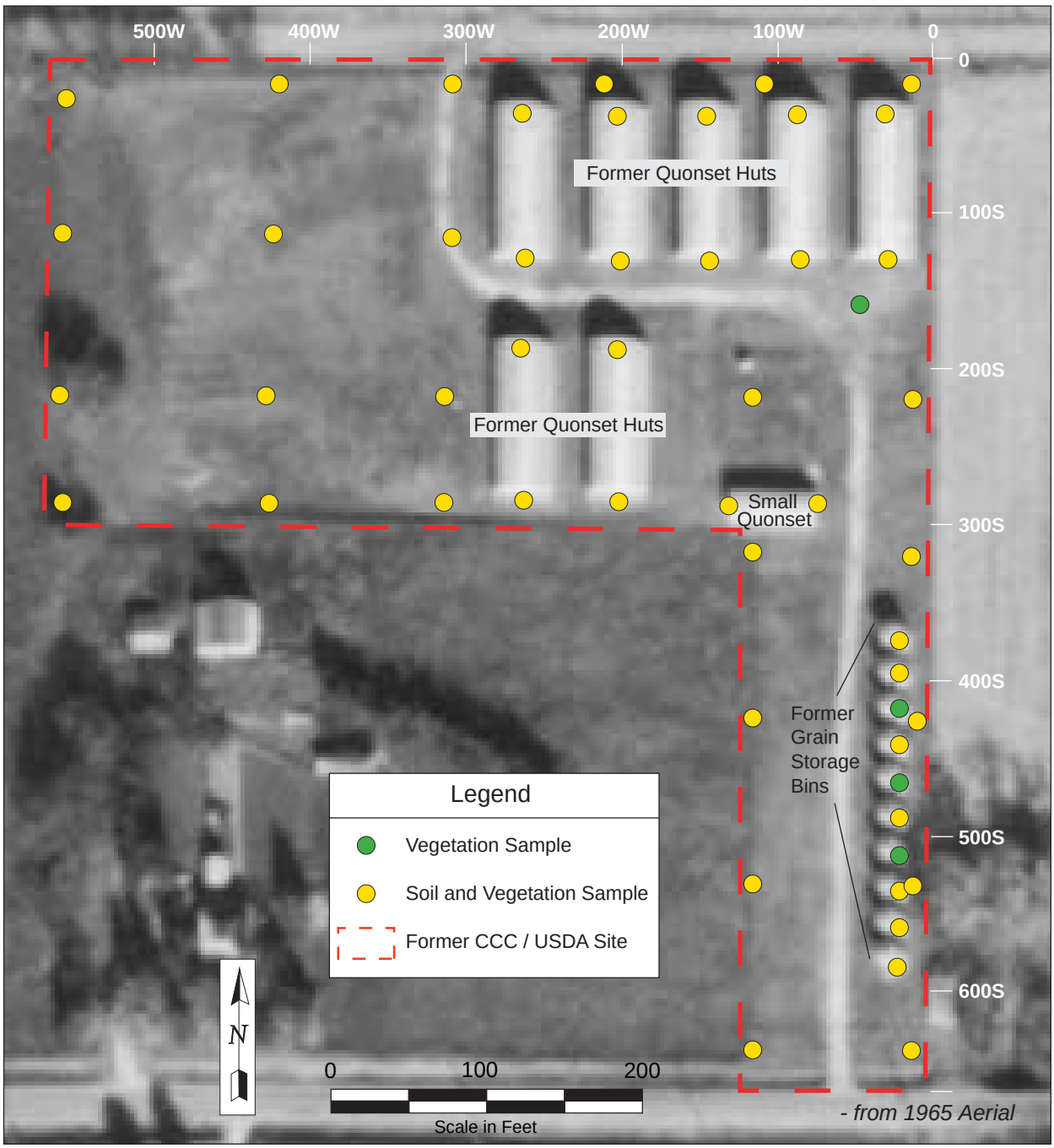

FIGURE 3.3 Aerial Photograph of the Former CCC/USDA Site at Adams (USDA 1965), Showing Locations of Vegetation and Near-Surface Soil Sampling in Phase I

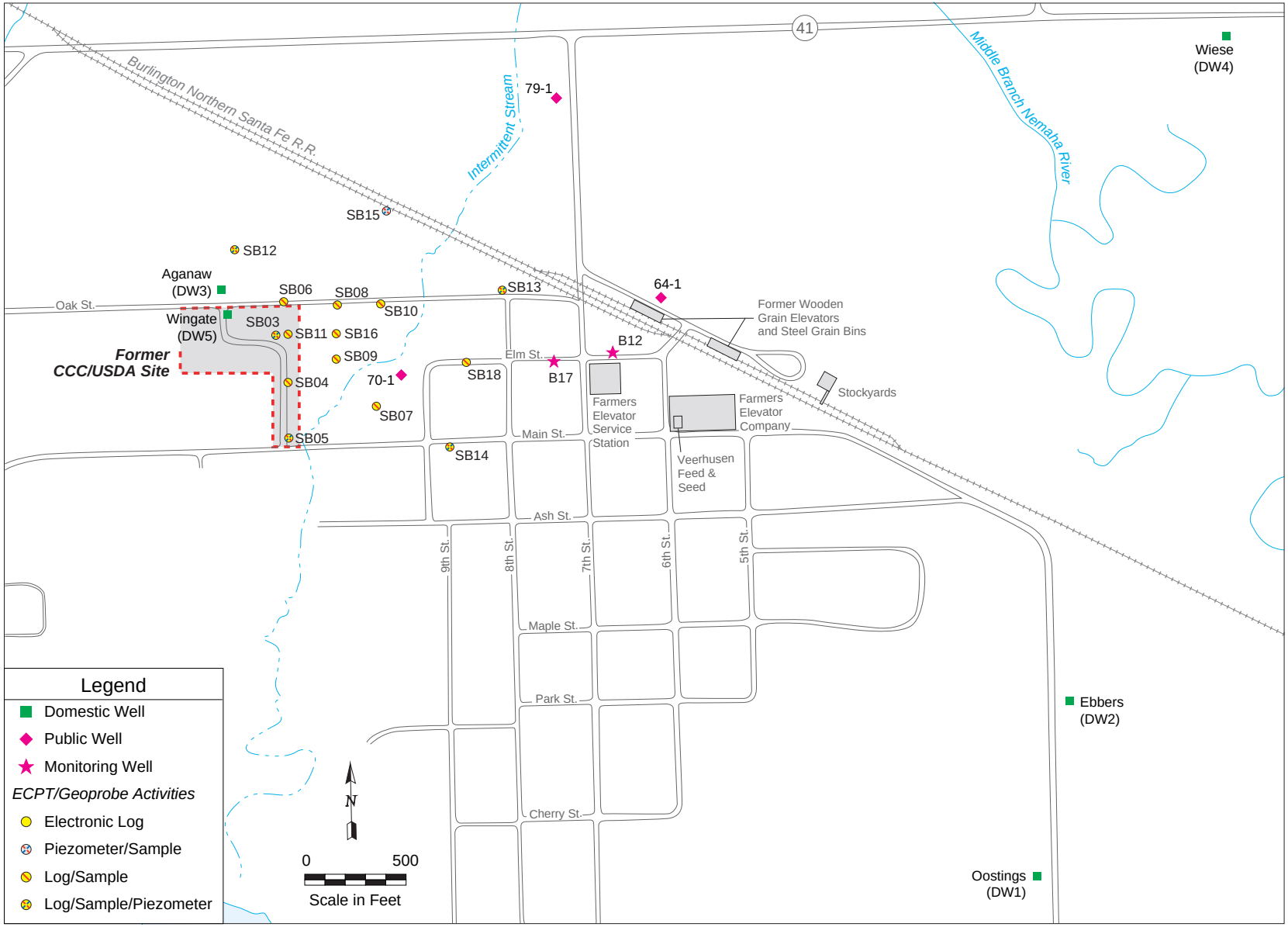

FIGURE 3.4 Map of Adams, Nebraska, Showing the Locations of the Former CCC/USDA Site, Other Potential Source Areas, and Groundwater Samples

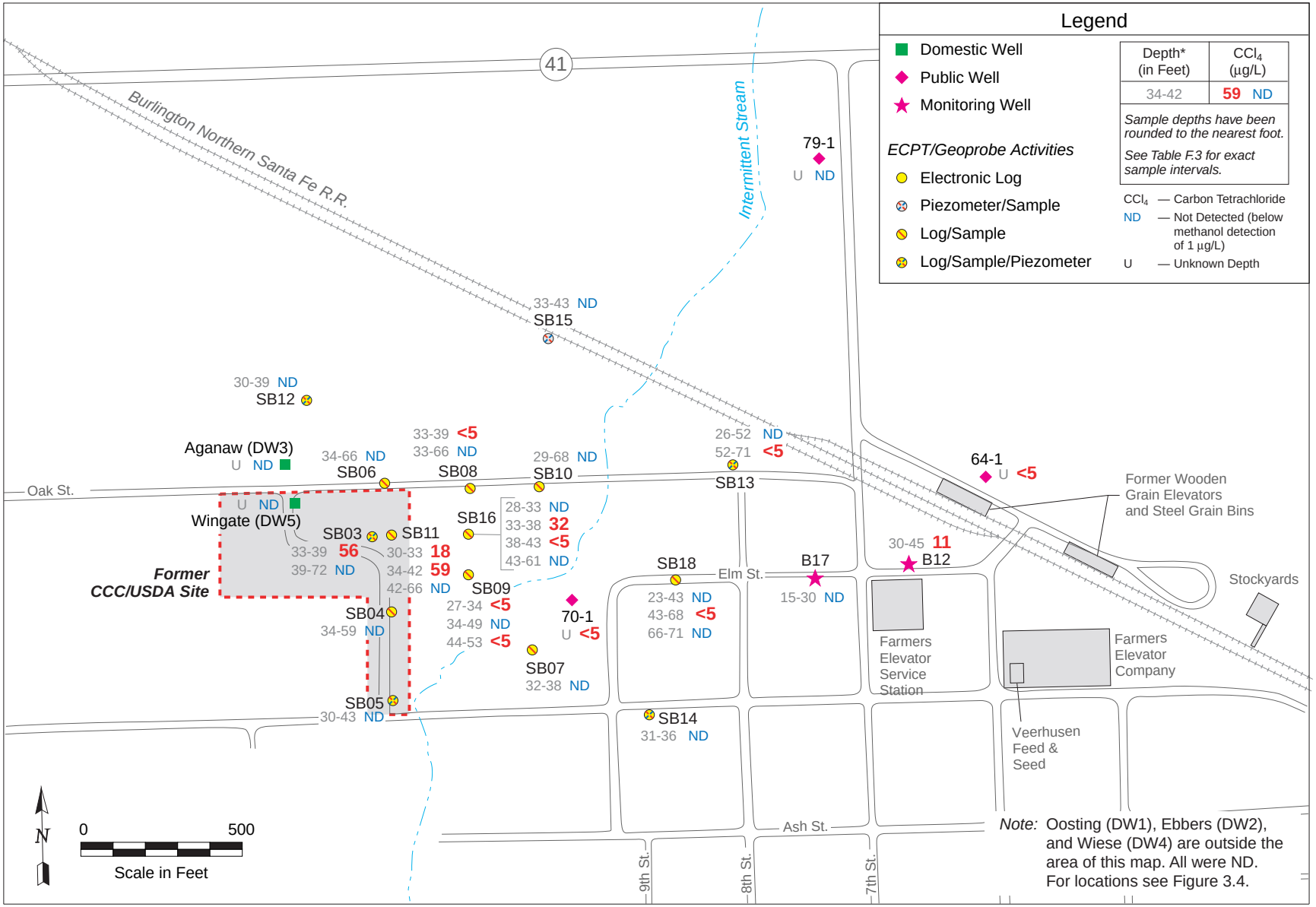

FIGURE 3.5 Map of Adams, Nebraska, Showing the Locations of the Former CCC/USDA Site, Other Potential Source Areas, and Groundwater Samples, with the Results of Analyses of These Samples for Carbon Tetrachloride

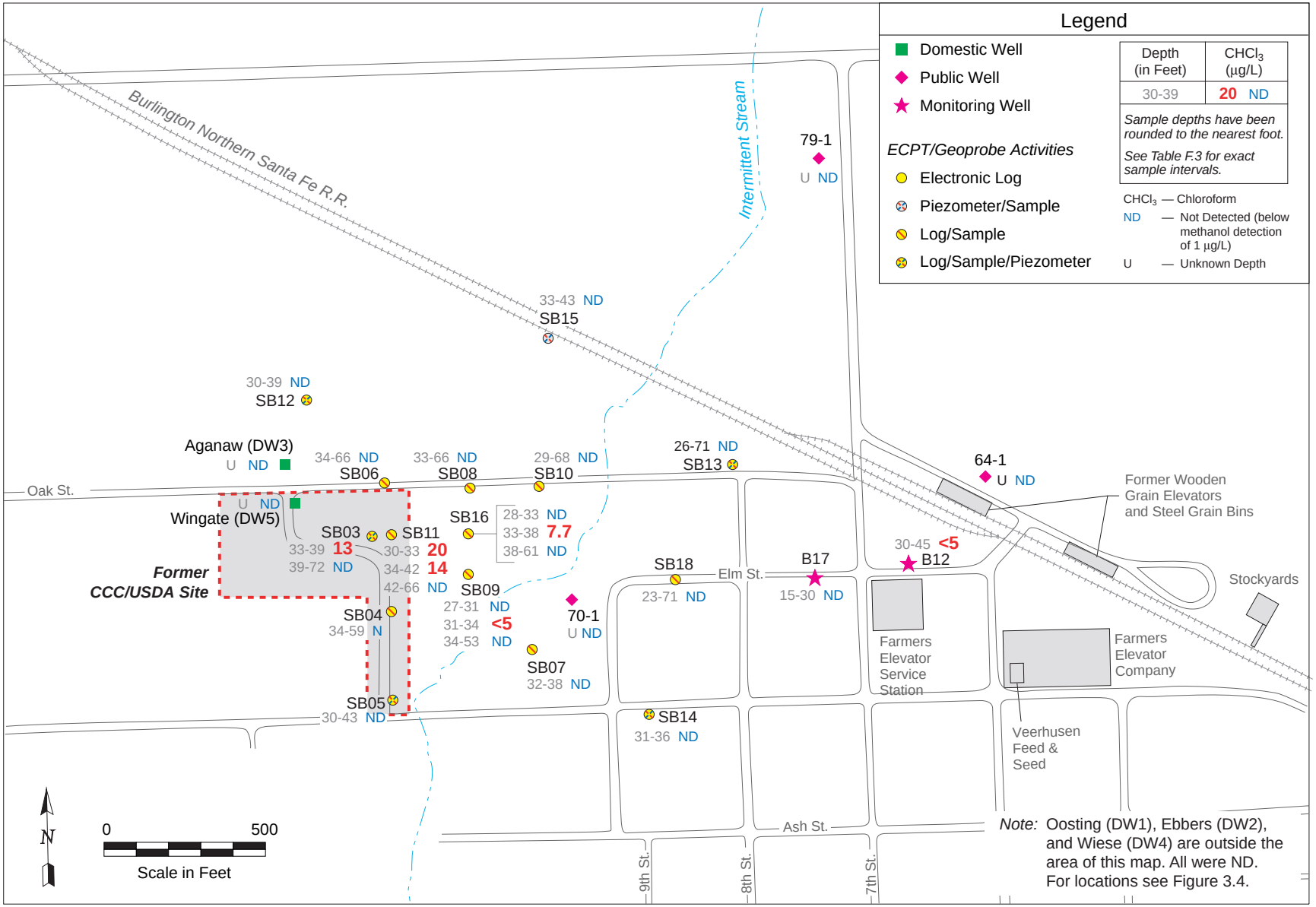

FIGURE 3.6 Map of Adams, Nebraska, Showing the Locations of the Former CCC/USDA Site, Other Potential Source Areas, and Groundwater Samples, with the Results of Analyses of These Samples for Chloroform

4 Interpretation of Field and Laboratory Data

4.1 Introduction

A preliminary conceptual model of the geology, hydrogeology, and hydrogeochemistry of the Adams area was developed in the Phase I *Work Plan* (Argonne 2000). This section describes the updated area model established from the Phase I investigation.

The updated area model reflects the local geologic, hydrogeologic, and hydrogeochemical characteristics pertinent to contaminant migration at Adams. The revision was based on (1) detailed information on the vertical sequence and the spatial distribution of Holocene and Pleistocene sediments and the configuration of the Permian bedrock surface and (2) detailed characterization and monitoring of the Pleistocene aquifer system involved in contaminant migration.

4.2 Interpretation of Geologic Data

The geologic conceptual model presented in the Phase I *Work Plan* (Argonne 2000) was based on regional and local geologic data from various sources, including well registration forms and drilling records for irrigation wells, irrigation and public water supply well test holes, and municipal wells. The Nebraska Water Survey compilations of test hole logs for Gage County (Burchett and Smith 1989) provided the primary source of subsurface geologic data for the Pleistocene. Data on the established stratigraphic section were also derived from reports covering southeastern Nebraska (Reed et al. 1965; Tanner and Steele 1989). Local geologic data included drillers' logs from irrigation and domestic wells, Adams municipal well PWS 79-1, and a test hole drilled for former municipal well PWS 64-1. Geologic logs were also obtained from a detailed LUST site assessment at a service station owned by the Farmers Elevator Company (Coranco 1990). Copies of the geologic and drillers' logs from Adams and the surrounding region are in Appendix A of the Phase I *Work Plan* (Argonne 2000).

The geologic sequence at the former CCC/USDA site was predicted to have a few feet of topsoil underlain by 30 ft of clayey silt loess. A 27- to 42-ft-thick unit of fine to medium grained Pleistocene sand was predicted to occur below the loess. Either interbedded shale and limestone of the Permian Council Grove Group at about 72 ft BGL, or possibly till from 72 to 136 ft BGL

("blue clay" in the Wingate well driller's log, which could be interpreted as glacial clay or weathered Permian shale) was predicted to underlie the sand unit.

The Phase I investigation was designed to address inadequacies in the quality and spatial coverage of the existing geologic data for the former CCC/USDA site. The detailed lithologic data obtained from this investigation are summarized in Section 3.1. Here we report results of data analysis and interpretation of the lithologic logs of soil borings (Appendix A), lithologic logs of soil samples collected with the ECPT (Appendix B), and ECPT electronic logs (Appendix B) in the context of the regional geologic framework.

4.2.1 Stratigraphic Interpretation

In general, the geology and stratigraphy predicted for the preliminary conceptual model (Argonne 2000) are in agreement with observations made during the Phase I investigation. The uncertainty over the interpretation of the thick sequence of "blue clay" recorded in the driller's log of the Wingate well was resolved when the "blue clay" was identified as a blue-gray clayey silt in core samples from SB01 on the Wingate property (formerly the CCC/USDA site). In addition, the fluvial sand and gravel unit predicted to occur uniformly beneath the former CCC/USDA site pinches out to the southwest; consequently, the Pleistocene aquifer sand and gravel does not underlie the entire site. The significance of this modification to the conceptual model and its potential influence on contaminant migration are discussed below and in Section 6.

Three geologic cross sections were interpreted and constructed for the Adams area by using a combination of data. The locations of the vertical sections are shown in Figure 4.1. Geologic cross section A-A´ runs from west to east, from the Wingate well in the northwest part of the former CCC/USDA site and along Oak Street to contaminated well PWS 64-1. The location of cross section A-A´ was selected to illustrate the distribution of the stratigraphic units along a potential contaminant migration pathway from the former CCC/USDA site to well PWS 64-1 (Figure 4.2). Geologic cross section B-B´ runs west to east, about 400 ft south of and parallel to section A-A´. Section B-B´ starts from the location of ECPT test hole SB20 in the southwest part of the former CCC/USDA site and runs along Elm Street to the location of LUST monitoring well B12. Cross section B-B´ was oriented to show the pinchout of the sand and gravel body at the former CCC/USDA site and the stratigraphic relationships along a potential contaminant migration pathway from the site to PWS 70-1 and beyond (Figure 4.3). Geologic cross section C-C´ runs south to north from the location of ECPT test hole SB05 in the southeast

part of the former CCC/USDA site to ECPT test hole SB12, 250 ft north of the site. The location of cross section C-C´ was selected to show the stratigraphic relationships perpendicular to the long axis of the sand and gravel body and to illustrate the pinchout of the sand unit in the southern part of the site (Figure 4.4).

Cross section A-A´ (Figure 4.2) was constructed from west to east by using control from the Wingate well driller's log; the continuous-core hole at SB01 and adjacent ECPT sensor log at SB03; ECPT sensor logs at SB11, SB16, and SB10; the continuous-core log at SB02 and adjacent ECPT sensor log at SB13; and the driller's log for the test hole at PWS 64-1. ECPT sensor logs were used only to map lithologic contacts where the material composition was known from geologic samples or nearby soil borings. Confirmatory soil samples were collected with the ECPT at SB03, SB16, and SB13. The continuous-core logs are in Appendix A, and the ECPT sensor and lithologic logs of ECPT samples are in Appendix B. The drillers' logs for the Wingate well and PWS 64-1 are also in Appendix A. A generalized stratigraphy for the area of the Phase I investigation is in Table 4.1.

Integrating the data from the drill holes, the ECPT sensor logs, and the ECPT soil samples, cross section A-A´ (Figure 4.2) shows the upper 70-140 ft of the geologic section to be composed of Pleistocene and Holocene silt, sand and gravel, and clay. The uppermost silt unit is a 25- to 30-ft-thick layer of loess of Holocene and Pleistocene age that is primarily wind blown in origin, forming a mantle over the older sediments (unit 1). The loess is described in the logs as a dry, brown to dark brown clayey silt that is about 55-65% silt and 30-40% clay, with the addition of 6-10% fine sand in the uppermost 10 ft of the unit at SB02 (see log in Appendix A and Tables C.3 and C.4 in Appendix C). Underlying the loess is a thin, gray to light brown sandy silt with silty clay and sand stringers (unit 2). This moist-dry unit is present at about 25-30 ft BGL at SB01, but it is not recognized elsewhere along section A-A´.

A saturated sand and gravel unit is found beneath the loess and sandy silt along the entire length of section A-A´ (unit 3). The fluvial sand and gravel was deposited by a Pleistocene river that occupied a paleovalley centered north of the present-day Middle Branch of the Nemaha River. The sand unit is about 35-45 ft thick, thinning slightly over the bedrock high shown on cross section A-A´ at SB16 (Figure 4.2). The sand body is made up of a series of upward-fining depositional sequences ranging from gravel and coarse sand at the base of each cycle, through

TABLE 4.1 Stratigraphy for Area of Phase I Investigation at Adams, Nebraska

Age	Rock Unit	Thickness (ft)	Physical Characteristics
Holocene	Topsoil	0-4.5	Dark brown-black silty loam to black loamy clay; abundant roots, high organic content, noncalcareous.
Holocene/ Pleistocene (Illinoian-Wisconsin Stage)	Loess (1)	25-30	Brown to dark brown clayey silt; minor iron oxide staining and manganese concretions, many root and worm holes, noncalcareous.
Pleistocene	Sandy silt with silty clay and sand stringers (2)	0-30	Gray and brown sandy silt and silty clay; sand stringers, some root tubules, iron oxide staining; dry.
	Sand and gravel (3)	0-45	Multiple upward-fining sequences of fluvial gravel, coarse sand, and medium grained and fine sand; gray-brown to red-brown; wet.
	Gray silt with trace sand (4)	0-40	Gray calcareous clayey silt with a trace of sand; damp to wet. Fine sand occurs in thin stringers.
	Blue-gray to olive silty clay (5)	0-65	Blue-gray to olive silty clay to clayey silt; massive, calcareous, dense, brittle fracture; dry.
Permian Council Grove Group	Shale and limestone (6)	Unknown	Gray limestone and calcareous shale.

medium sand, to fine grained sand (occasionally clayey) at the top. Because these upward-fining sequences form in river channels that follow a sinuous pattern and often cut across one another, it is difficult to correlate the lens-shaped bodies from one drill hole to the next. On the basis of the core holes at SB01 and SB02, gravel is common in the upper part of the sand and gravel unit at 30-40 ft BGL and again in a matrix of medium to coarse grained sand near the base of the unit at about 65 ft BGL in SB01. Fine silty sand is more prevalent in SB02, particularly in the zone at 45-60 ft BGL (Appendix A). The fluvial sand body overlies a dry, dense, blue-gray Pleistocene silt that ranges from 0 to 65 ft in thickness along section A-A´ (unit 5). The glacial silt was deposited on the eroded surface of the Permian bedrock. The bedrock surface occurs at 136 ft BGL in the Wingate well on the western edge of the area of investigation and rises to 63 ft BGL at SB16, where it forms a local bedrock high immediately to the east of the former CCC/USDA site. Bedrock (unit 6) is described as limestone in the drillers' logs from the Wingate well and PWS 64-1.

Cross section B-B´ was constructed from west to east by using control from the ECPT sensor logs for SB20, SB04, SB09, and SB18 and the geologic logs from split-spoon sampling at LUST wells B17 and B12 (Figure 4.3). Confirmatory soil samples were collected with the ECPT at SB20, SB04, SB09, and SB18. The ECPT sensor and lithologic logs of ECPT samples are in Appendix B. Geologic logs for LUST wells B17 and B12 are in Appendix A. Although the section passes through well PWS 70-1, only the well depth is shown because no record of the driller's log can be found.

Integrating the data from the ECPT sensor logs, the ECPT soil samples, and the geologic logs from the LUST wells, cross section B-B´ (Figure 4.3) shows the upper 57-120 ft of the geologic section to be composed of Pleistocene and Holocene silt, sand and gravel, and clay. The uppermost silt unit is a 15- to 30-ft thick layer of loess (unit 1). The loess is slightly thinner to the west of the intermittent stream, coinciding with thickening of the underlying sandy silt (unit 2). The sandy silt unit is 25 ft thick at SB20 but is not recognized at SB18.

The fluvial sand and gravel (unit 3) is found beneath the loess and sandy silt at and to the east of SB04 on the former CCC/USDA site. The sand and gravel unit is about 14 ft thick at SB04 and pinches out to the west. To the east, the sand and gravel body thickens to 25 ft at SB09, where it lies on a high in the bedrock surface and eventually reaches a thickness of 45 ft at SB18 (Figure 4.3). West of the pinchout, samples from SB20 show a change in lithology to gray clayey silt with traces of sand, with the fine sand often present in the form of stringers (unit 4).

Grain size analyses of samples from this unit show that they are composed of about 60% silt, 20% clay, and 20% fine sand (see log for SB20 in Appendix B and Table C.4 in Appendix C). The samples recovered at SB20 were damp to dry. An attempt to collect a water sample from the unit was unsuccessful. The underlying dry, blue-gray silt (unit 5) ranges from 0 to 35 ft in thickness along section B-B´. The bedrock surface occurs at 111 ft BGL at SB20 (refusal) and rises to form a high platform near SB09. At SB09, the ECPT recovered a fragment of limestone (unit 6) at the refusal depth.

Cross section C-C´ was constructed from south to north by using control from the ECPT sensor logs for SB05, SB04, and SB03 and the adjacent continuous core log for SB01, along with ECPT sensor logs for SB06 and SB12 (Figure 4.4). Confirmatory soil samples were collected with the ECPT at SB05, SB04, SB03, and SB06. The ECPT sensor logs and lithologic logs of ECPT samples are in Appendix B. The geologic log for SB01 is in Appendix A.

Integrating the data from the ECPT sensor logs, the ECPT soil samples, and the geologic log from SB01, cross section C-C´ (Figure 4.4) shows the upper 76-124 ft of the geologic section to be composed of Pleistocene and Holocene silt, sand and gravel, and clay. The uppermost silt unit is a 15- to 25-ft-thick layer of loess (unit 1) overlying a sandy silt and clay (unit 2). The sandy silt and clay unit is 5-10 ft thick.

The sand and gravel (unit 3) is found beneath the loess and sandy silt at and to the north of SB04 at the former CCC/USDA site. The saturated sand and gravel is about 14 ft thick at SB04 and pinches out to the south before it reaches SB05. To the north, the sand body thickens to 41 ft at SB01, where it forms a channel-like feature in cross section, thinning to the north at SB06 (33 ft) before it thickens once more toward the center of the paleovalley north of SB12 (Figure 4.4). South of the pinchout, a sample from SB05 at a depth of 34.67-36.7 ft BGL shows a change in lithology to gray clayey silt with a trace of sand (unit 4). Grain size analysis of this sample showed that the soil is composed of 80.3% silt, 15.3% clay, and 4.4% sand (see log for SB05 in Appendix B and Table C.4 in Appendix C). A small amount of water was recovered from this unit at SB05 by leaving the ECPT screen open overnight. However, insufficient water was recovered to allow for a full suite of chemical analyses. Unit 4 (gray silt with trace sand) was also identified by examination and grain size analysis of a soil sample collected from SB04 at a depth of 53-55 ft BGL (see log for SB04 in Appendix B and Table C.3 in Appendix C). The underlying dry blue-gray silt (unit 5) ranges from 15 ft to more than 55 ft in thickness along section C-C´. The bedrock surface occurs at 76 ft BGL at SB05 (refusal) at the southern end of

the former CCC/USDA site and deepens rapidly north of SB06, toward the center of the paleovalley.

4.2.2 Spatial Distribution of Significant Stratigraphic Units

The two stratigraphic units with hydrogeologic significance within the area of investigation at Adams are (1) the saturated and permeable fluvial sand and gravel (unit 3) and (2) the partially saturated low-permeability gray silt (unit 4). These units are significant because (1) the fluvial sand might provide a permeable pathway for potential contaminant migration from the former CCC/USDA grain storage facility and (2) the low-permeability silt that underlies part of the site is a source of recharge to the fluvial sand and gravel from the glacial sediments in the drift hills.

Before the Phase I investigation began, the conceptual understanding of the site suggested one pathway by which carbon tetrachloride might have migrated from the former CCC/USDA site to PWS 70-1 and two potential pathways from the site to PWS 64-1. All of these pathways involved movement of carbon tetrachloride downward at the former CCC/USDA site until the contaminant reached the Pleistocene aquifer sand and gravel (unit 3), followed by subhorizontal migration to the public water supply wells as described in Section 1 and in the Phase I *Work Plan* (Argonne 2000). The multiple pathways, postulated on the basis of the assumed northeast-to-easterly groundwater flow direction, considered the effects of long-term pumping of the public water supply wells.

Evaluating the potential migration pathways requires an understanding of the spatial configuration of the Pleistocene sand and gravel (unit 3) and the gray silt (unit 4) at the former CCC/USDA site and in the area between the site and the contaminated public water supply wells. The updated conceptual model can be illustrated by a series of planar or aerial views of the distribution of the lithologic units by constructing slice maps through the subsurface at selected elevations. Figure 4.5 is a slice map at an elevation of 1,225 ft AMSL (above mean sea level). This elevation was selected because it is near the top of the permeable sand and gravel unit (see cross section A-A´, Figure 4.2). Therefore, the map shows the areal distribution of the lithologies through which lateral contaminant migration will occur at and near the site.

The west-east elongation in the distribution of sand and gravel (unit 3) visible on the slice map (Figure 4.5) is the result of a slight thickening of unit 3 along the southern margin of the paleovalley. This slight thickening is accompanied by a shallow depression in the underlying silt (unit 5), as shown in cross section C-C´ at SB01 (Figure 4.4). This feature may have been formed by a fluvial channel that was incised into the underlying blue-gray silt by one of the many rivers that occupied the paleovalley during the Pleistocene. Coarser sediments deposited in this paleochannel might create a more permeable zone within the sand and gravel unit that would facilitate easterly contaminant migration along the channel. Lower-permeability loess or silt laterally confines the sand and gravel paleochannel at an elevation of 1,225 ft AMSL (Figure 4.5). The upper part of the sand and gravel body at SB01 also contains a high gravel content that could provide a zone for preferential migration (see log for SB01, Appendix A). Consequently, contaminants entering the saturated sand and gravel (unit 3) at the site might be constrained to move to the east along the relatively permeable zone coincident with the thickening at the top of the sand and gravel.

The slice map (Figure 4.5) also shows that the southern part of the former CCC/USDA site is underlain at the selected elevation by the low-permeability gray silt unit (unit 4) near the top of the fluvial aquifer. In this area, subhorizontal migration of contaminants could be retarded substantially.

A slice map of the distributions of the Pleistocene and Holocene sediments through the middle of the sand and gravel at an elevation of 1,200 ft AMSL (25 ft below the previous slice) is shown in Figure 4.6. This map shows the areal extent of the sand and gravel body (unit 3) extending north toward the center of the paleovalley and truncated to the south near the edge of the paleovalley. Subhorizontal migration of contaminants in the sand and gravel aquifer would be constrained by the low-permeability silts (units 4 and 5) along the southern boundary, but contaminants would be free to migrate to the east and northeast. At 1,200 ft AMSL, PWS 64-1 would be in the potential migration pathway, but PWS 70-1 lies just south of the permeable sand and gravel unit and is probably not screened at this elevation.

A planar view of the distributions of the Pleistocene and Holocene sediments and Permian bedrock is shown in the slice map at an elevation of 1,175 ft AMSL (Figure 4.7). This elevation was selected because it shows the configuration of the bedrock platform immediately east of the former CCC/USDA site. This bedrock high east of the site tends to contribute to a slight thinning of the overlying sand and gravel in this area. The slice map also shows that the

base of the sand and gravel (unit 3) moves progressively north at lower elevations, toward the deeper part of the paleovalley.

4.2.3 Summary of Geologic Data Interpretation

The primary stratigraphic units at Adams include (1) the overlying loess mantle of Holocene and Pleistocene age (unit 1); (2) the Pleistocene sandy silt and clay (unit 2); (3) the Pleistocene fluvial sand and gravel (unit 3); (4) the Pleistocene gray silt (unit 4); (5) the older Pleistocene blue-gray silt (unit 5); and (6) the Permian bedrock, consisting of limestone and shale of the Council Grove Group (unit 6).

The Holocene and Pleistocene sediments in the area of investigation were deposited on the southern edge of a major paleovalley cut into the Permian bedrock. Therefore, the former CCC/USDA site lies within a transitional zone between fluvial deposition to the north and glacial deposition to the south. The thickness of the Holocene and Pleistocene units varies between 70 ft and 150+ ft, becoming thicker to the north. A wind-blown loess mantle (unit 1) covers the underlying Pleistocene glacial and fluvial units. In the glacial zone, the uppermost unit immediately underlying the loess is sandy silt with clay (unit 2) that partly overlaps the southern edge of the fluvial valley fill.

In the fluvial zone, the sand and gravel (unit 3) at Adams represents the southern edge of the extensive fluvial sands and gravels that fill the paleovalley. The sand and gravel unit, about 35-45 ft thick, is made up of a series of upward-fining depositional sequences ranging from gravel and coarse sand at the base of each cycle, through medium sand, to fine grained sand (occasionally clayey) at the top. Because these upward-fining sequences form in river channels that follow a sinuous pattern and often cut across one another, it is difficult to correlate the lens-shaped bodies from one drill hole to the next. Gravel is common in the upper part of the sand and gravel unit at 30-40 ft BGL and again in a matrix of medium to coarse grained sand near the base of the unit at about 65 ft BGL. Fine silty sand is prevalent in the zone at 45-60 ft BGL.

Pleistocene glacial silts are found along the southern edge of the fluvial deposits at the northern boundary of the drift hills lying to the south. The sand and gravel body pinches out to the south and is replaced in the sequence by gray clayey silt with a trace of sand (unit 4). This unit may slowly contribute groundwater to the fluvial sand and gravel aquifer from the glacial

sediments that form the drift hills. Water sampling in the gray clayey silt was slow and sometimes unsuccessful because of the low permeability of the material. The older Pleistocene blue-gray silt (unit 5) was deposited directly on the bedrock surface prior to deposition of the fluvial sand and gravel. Sand and gravel are exposed to the Permian bedrock only in a limited area near ECPT location SB09.

The two stratigraphic units in the study area that have potential hydrostratigraphic significance are the Pleistocene sand and gravel (unit 3) and, to a lesser extent, the Pleistocene glacial gray silt (unit 4). These units might provide permeable pathways for potential contaminant migration. Whether these units actually do or do not provide pathways for contaminant migration is discussed more fully in Section 6.

4.3 Interpretation of Hydrogeologic Data

This section uses the updated geologic site model derived in Section 4.2 as the framework for analyzing and interpreting hydrogeologic data obtained during the Phase I investigation. The objectives of the hydrogeologic analysis are (1) to determine which of the geologic units, either individually or in combination, constitute aquifers or confining layers; (2) to evaluate the hydraulic character of each hydrostratigraphic unit that potentially transports (aquifer) or inhibits (confining layer) the movement of contaminants from the former CCC/USDA and other grain storage facilities; and (3) to evaluate the potential impact of multiple pumping scenarios on the groundwater flow system and thus the effect of these scenarios on contaminant migration.

4.3.1 Hydrostratigraphic Interpretation

Five primary stratigraphic units overlying Permian bedrock at Adams are identified in Section 4.2. The top two units are loess (unit 1) and sandy silt and clay (unit 2). Both units are unsaturated. The major water movement in these units is vertical infiltration of surface water. Carbon tetrachloride released from grain storage facilities will likewise move vertically downward through these units to reach the underlying saturated zone.

The Pleistocene aquifer is shown on geologic cross sections A-A´, B-B´, and C-C´ in Figures 4.8-4.10, respectively.

The Pleistocene fluvial sand and gravel (unit 3) underlying the loess and sandy silt units is fully saturated across most of the study area. This highly permeable unit is a major aquifer that produces most of the water from public, domestic, and irrigation wells at Adams. Groundwater flow in this unit is primarily from west to east.

The fluvial aquifer pinches out to the south, where it is in contact with glacial silts at the northern boundary of the drift hills. The glacial silt (unit 4) consists of gray silt and a trace of sand with relatively low overall permeability. The maximum hydraulic conductivity of this unit is estimated at 10^{-2} ft/d on the basis of the results of grain size analyses on samples collected at SB05 and SB20. The water level in the silt unit measured at SB05 is more than 15 ft above the water level in the adjacent fluvial aquifer (Figure 4.10). The large hydraulic gradient between the glacial silt (unit 4) and the fluvial sand and gravel (unit 3) aquifer provides the driving force for groundwater discharge from the glacial drift deposits into the fluvial aquifer, even though the glacial silt has a low hydraulic conductivity. The glacial silt (unit 4) acts as a very poor aquifer. Its ability to transmit groundwater lies somewhere between that of a typical aquitard and that of an aquifer.

The underlying blue-gray Pleistocene silt (unit 5) is dry and dense with a very low permeability, forming an aquiclude that confines the overlying fluvial aquifer (unit 3) and the saturated glacial silt (unit 4). This confining layer is laterally continuous at the former CCC/USDA site and thins over the bedrock high near SB09, where underlying limestone (unit 6) was recovered.

4.3.2 Pleistocene Fluvial Aquifer

The Pleistocene fluvial aquifer is completely saturated at most of the monitoring well locations, except for B17 (Figure 4.9). The aquifer is generally under a leaky confined condition. Unconfined conditions may occur in the aquifer near public water supply and irrigation wells because of drawdown of the water level due to heavy pumping. The fluvial aquifer was developed in a paleovalley that lies underneath the valley of the present-day Middle Branch Big Nemaha River. The aquifer at Adams represents the southern edge of the aquifer that fills the paleovalley. The thickness of the aquifer is about 35-45 ft at Adams, thickening to more than 100 ft near the Middle Branch Big Nemaha River north and northeast of Adams. The aquifer thins and pinches out to the south at the edge of the glacial drift hills (Figure 4.10).

The hydraulic conductivity of the aquifer, estimated from grain size analyses, ranges from a few to 100 ft/d. Hydraulic conductivity profiles at soil borings SB01/SB03 and SB02/SB13 indicate that the aquifer is more permeable at the top and bottom (up to 100 ft/d) and less permeable in the middle (less than 50 ft/d) (Figures 4.11 and 4.12). The upper part of aquifer provides a path for preferential migration for contaminants reaching the aquifer at the former CCC/USDA site. Laterally, the upper part of the aquifer increases in hydraulic conductivity toward the north and northeast, from maximum values of 63 ft/d at SB01/SB03 and 48 ft/d at SB14 to 99 ft/d at SB02/SB13.

The potentiometric surface of the Pleistocene fluvial aquifer, constructed with hand-measured water levels taken on May 11, 2000, is illustrated in Figure 4.13. Groundwater in the aquifer flows eastward to the Middle Branch Big Nemaha River with a gentle hydraulic gradient of 0.0016.

Hydrographs at eight piezometers and monitoring wells, illustrated in Figures 4.14 and 4.15, were recorded from May 2 to July 20, 2000. Groundwater level fluctuations at Adams are significant. As Figures 4.14 and 4.15 show, groundwater levels gradually declined during the monitoring period. Two significant drawdown events and a single periodic fluctuation were superimposed on the declining trend. The two major drawdown events occurred in all wells simultaneously, commencing on June 14 and July 10. Both drawdown episodes continued for 5-6 days in response to pumping at irrigation well IW1 (800 gpm). This well is located on the north side of State Route 41 and west of SB19 and PWS 79-1 (see Figure 4.13). Maximum recorded drawdown ranges from 1 to 4 ft, depending on proximity to the irrigation well. The influence of the radius of depression reached more than 2,500 ft from IW1 toward both the south (SB14) and the southeast (SB17 and B12).

A distinct fluctuation pattern with frequent periodic cycles of drawdown and rebound can be recognized at SB13, SB14, SB15, and SB19 (Figure 4.16). Figure 4.16 is an enlarged hydrograph recorded at 2-min intervals from July 6 to July 11, 2000. The fluctuations occurred four or five times per day and coincided with water level fluctuation at PWS 70-1 and at SB19 (adjacent to PWS 79-1). Therefore, the observed water level fluctuations were the result of simultaneous pumping of the two public water supply wells. The maximum-recorded fluctuations were about 0.5 ft at SB14, 0.3 ft at SB13, and 0.2 ft at SB15. Distances to SB13-SB15 are 400-800 ft from PWS 70-1 and more than 1,000 ft from PWS 79-1. The radius of influence from PWS 70-1 appears to be at least 800 ft.

Water levels in all piezometers and wells declined steadily by almost 1 ft from May 11 to June 9, 2000. This gradual drop in water levels is consistent with a threefold increase in the daily pumping rate of the public water supply wells during this period (Figure 4.14). No correlation is evident between the drop in water level and changes in precipitation (Figure 4.15). This general decrease of water level indicates that the groundwater system at Adams was under stress, with inadequate recharge to compensate for the routine pumping. The aquifer at Adams is located at the southern margin of the paleovalley. Groundwater flow to the aquifer from the drift hills through a low-permeability unit (gray silt) appears to be slow and limited. Because this slow recharge cannot immediately compensate for discharge from the fluvial aquifer due to usage, relatively large groundwater depressions were observed in response to pumping at Adams. Therefore, heavy pumping at Adams in the past might have affected the groundwater system and could have altered the course of contaminant migration, especially at locations where postulated contaminant migration pathways were close to pumping wells.

4.3.3 Summary of Hydrostratigraphic Interpretation

The Pleistocene fluvial aquifer is a major aquifer producing most of the water for public supply, domestic, and irrigation uses at Adams. The aquifer is semiconfined by the overlying loess (unit 1) and sandy silt unit (unit 2) and confined by the underlying older Pleistocene blue-gray silt (unit 5) and Permian limestone (unit 6). The aquifer is normally under a leaky and confined condition. The hydraulic conductivity of the aquifer is generally higher at the top and bottom and lower in the middle. The aquifer thickens to the north, toward the center of the paleovalley, and pinches out at the southern edge of the paleovalley. The pinchout occurs where the sand and gravel is in contact with unit 4, a gray silt aquitard (or poor aquifer) at the northern boundary of the drift hills.

A potentiometric surface of the Pleistocene fluvial aquifer, hand-measured from the monitoring network on May 11, 2000, indicates an eastward groundwater flow direction with a gentle hydraulic gradient of 0.0016. The fluvial aquifer at Adams is recharged primarily from precipitation falling over the broad upgradient region and recharged partially from glacial drift through the saturated gray silt aquitard. Minor local recharge occurs through infiltration of surface water.

A steady decline in groundwater level and superimposed drawdown events were observed in response to pumping at wells PWS 70-1 and 79-1 and irrigation well IW1. The

radius of influence was more than 2,500 ft for pumping at IW1 and about 800 ft for the public water supply wells. The water level was lowered by routine pumping because recharge of the Pleistocene fluvial aquifer was reduced due to a lack of rainfall in the Adams area. The slow inflow of groundwater from saturated glacial silt on the southern edge of paleovalley was insufficient to maintain the water level in the aquifer during the drought. Although the water level in the gray silt unit is 15 ft higher than the level in the adjacent fluvial aquifer, recharge from the south is slowed by the low permeability of the saturated glacial silt. Therefore, pumping at the public water supply wells significantly affects the groundwater flow system and, potentially, contaminant migration pathways near grain storage facilities at Adams.

4.4 Interpretation of Hydrogeochemical Data

This section uses the updated geologic-hydrogeologic area model discussed in Sections 4.2 and 4.3 as a framework for analyzing and interpreting the hydrogeochemical data acquired in the Phase I investigation. Geochemical data are used to further evaluate and document the presence or absence of hydraulic connections between aquifers and potential migration pathways for contaminants in groundwater. Detailed descriptions of the water samples and the analytical results are in Appendix F.

4.4.1 Tritium Isotopes

Tritium isotopes are often used in hydrology to distinguish the relative ages of groundwater masses. Tritium is the unstable isotope of hydrogen that has become enriched in precipitation in the years of atmospheric nuclear testing after 1951 (Clark and Fritz 1997). Water that formed in the atmosphere prior to nuclear weapons testing and fell to Earth as precipitation was not enriched with tritium. Groundwater derived from this older water has tritium values near zero, while groundwater derived from precipitation formed since 1951 has elevated tritium values. However, concentrations of tritium in precipitation are now largely back to natural, prenuclear-testing levels. By 1986, levels for tritium measured in precipitation at Lincoln, Nebraska, ranged from 13.3-14.9 TU, compared to 380-3,430 TU in 1963 (IAEA 2000). More recently, river water samples collected from the Big Blue River near Milford after two months of almost daily rain contained levels of 10.6 and 8.8 TU (Argonne 1999). These samples were interpreted as representing recent precipitation.

Tritium values measured in groundwater samples from wells, temporary piezometers, and ECPT samples in the area of investigation are plotted against sample depths in Figure 4.17. The depths are the distance from the top of the aquifer sand and gravel to the midpoint of the well or ECPT screen. For multiple vertical samples collected at the same location, the tritium values are connected by lines indicating the change in tritium concentration with depth in the aquifer. The analytical results are shown in detail in Table F.5 in Appendix F.

The tritium data show that the groundwater samples from the Pleistocene aquifer at Adams are the result of modern (post-1951) recharge, ranging from 6.47 to 16.3 TU. Most of the samples lie within the range of 6-12 TU (Figure 4.17), probably resulting from recharge within the past 20 yr. However, groundwater at SB14 contains 16.3 TU in a sample collected by bailing from a screen interval that bracketed the top of the aquifer sand and gravel. Two possible explanations for the relatively high concentration of tritium at SB14 are that (1) the groundwater is the product of very recent recharge of precipitation with a higher-than-expected tritium content or (2) precipitation took place when tritium levels were higher as the result of atmospheric nuclear testing. On the basis of the approximate range of natural tritium in precipitation from 1986 to the present (14.9-8.8 TU) as described above and considering the loss of tritium to radioactive decay after recharge, the second scenario seems more likely. Present-day values in the range of 15-30 TU in groundwater from continental regions are considered to have a component of bomb-derived tritium (Clark and Fritz 1997). Consequently, the groundwater at SB14, at the southern edge of the fluvial sand and gravel aquifer, may contain a tritium-enriched groundwater fraction that originated as precipitation in the drift hills south of Adams before 1980.

Vertical profiles of tritium in groundwater were obtained at SB03, SB13, and SB18 (Figure 4.17). The profile for SB03 suggests vertical recharge by precipitation, with a tritium concentration slightly greater than the value of 12.1 TU recorded in groundwater at the top of the sand and gravel aquifer. The tritium concentrations decline with depth, reaching a value of 7.2 TU at the base of the aquifer. This pattern is consistent with the conceptual model of infiltration of younger water at the top and the accumulation of older water at the base of the aquifer. The decline in tritium with depth can be attributed to the longer pathway, both vertical and horizontal, required for groundwater to reach these depths. The longer pathway results in a reduction in the original tritium content of the water due to radioactive decay over time.

The vertical profiles for SB13 and SB18 provide a substantially different picture than that observed at SB03 (Figure 4.17). In both SB13 and SB18, the uppermost groundwater has a lower tritium concentration than groundwater in the middle of the aquifer. Long-term pumping of well PWS 70-1 might have altered the normal distribution of groundwater ages, because both of these locations lie downgradient of the public water supply well. This finding suggests that long-term pumping of well PWS 70-1 might have also contributed to the downward movement of contamination in the aquifer to the east of the well (Section 6.3.2).

4.4.2 Ionic Composition

Major cations and anions were measured on groundwater samples from wells and the ECPT. The results (Table F.4, Appendix F) are plotted in a Piper diagram in Figure 4.18. The trilinear or Piper diagram (Piper 1944) is one way of comparing numerous water analyses (Freeze and Cherry 1979). The diagram shows the relative contributions of major cations and anions, on a charge-equivalent basis, to the total ion content of the water. Percentage scales along the sides of the diagram indicate the relative concentration, in milliequivalents per liter, of each major ion. Cations are shown in the left triangle, and anions are shown in the right triangle. The central diamond integrates the data.

In a study of the groundwater quality of aquifers in the Nemaha Natural Resources District, which includes the town of Adams, Tanner and Steele (1989) found that water samples from the shallow (sands in glacial till) and paleovalley alluvial aquifers were grouped closely together in the calcium bicarbonate area of the Piper diagram. In contrast, water from the bedrock aquifers had more of a magnesium sulfate character. The Piper plot of groundwater samples from the area of investigation at Adams (Figure 4.18) demonstrates that the waters are largely of the calcium bicarbonate type, characteristic of the shallow and paleovalley alluvial aquifers.

Three groundwater samples from the Phase I investigation plot are labeled as outliers on the Piper diagram (Figure 4.18). First, the greatest deviation from the calcium bicarbonate cluster is shown by the groundwater sample from DW02, the Ebbers domestic well. This sample has a calcium-magnesium-sulfate character, consistent with derivation from a bedrock aquifer. Well records are not available for this well, but the owner reported that the well penetrates limestone bedrock to an unknown depth. Second, the groundwater sample from contaminated well PWS 64-1 lies outside the normal range of groundwater chemistry for the area of investigation,

with a higher-than-normal chloride ion content. The presence of chloride ion could be the result of chlorination of the well in the past. Finally, sample 11449, from SB18 at a screened interval of 58-63 ft BGL, is isolated because of its low concentration of dissolved calcium. The lack of calcium gives rise to a strongly negative charge balance for the sample, which can be explained only by an excess of cations such as dissolved iron or manganese (Blackburn 1992) or by an erroneously high measurement of alkalinity. Erroneously high field measurements of alkalinity are often caused by the presence of acid-neutralizing particulate matter in unfiltered samples (Wilde and Radtke 1998). Field alkalinity analyses are conducted on unfiltered samples (Argonne 1994). Dissolved iron and manganese cannot account for the negative charge balance, because they are not present at higher-than-normal levels in sample 11449 (Table F.4, Appendix F).

Two of the public water supply wells (PWS 64-1 and 79-1) exceeded the MCL of 10 mg/L for nitrate in drinking water at 15.0 and 16.3 mg/L, respectively. Well PWS 64-1 is no longer connected to the distribution system. Groundwater from wells PWS 79-1 and 70-1 (with nitrate at 8.5 mg/L) is treated to remove nitrate before its enters the town water supply. Samples from private wells DW03 (Aganaw) and DW05 (Wingate) exceeded the MCL for nitrate at 11.6 and 13.3 mg/L.

Nitrate is present at levels above the MCL in most of the water samples collected with the ECPT. The analytical results are shown in detail in Table F.4 in Appendix F. The highest concentration of nitrate in groundwater (34.3 mg/L) was found at an intermediate depth in the sand and gravel aquifer at SB16, located in a cultivated field south of Oak Street, due east of the former CCC/USDA site. The only ECPT locations where water did not exceed the MCL for nitrate at any depth were SB04, SB14, and SB07. These three locations, at or near the southern limit of the sand and gravel aquifer, might receive a greater contribution of groundwater from the glacial sediments of the drift hills, as the tritium values suggest (see Section 4.4.1). Previous groundwater sampling in the region has shown that the paleovalley fluvial aquifers are enriched in nitrate relative to both the shallow aquifers of the drift hills and bedrock aquifers (Tanner and Steele 1989).

4.4.3 Summary of Hydrogeochemical Data Interpretation

The tritium data show that the groundwater samples from the Pleistocene aquifer at Adams are the result of modern (post-1951) recharge. Levels in most of the samples lie within

the range of 6-12 TU, probably resulting from recharge of the single aquifer within the past 20 yr. However, groundwater at the southern edge of the fluvial sand and gravel aquifer might contain a tritium-enriched groundwater component that originated as precipitation in the drift hills south of Adams before 1980.

The tritium concentrations decline with depth in the aquifer, consistent with the conceptual model of infiltration of younger water at the top and the accumulation of older water at the base of the aquifer. However, immediately east of PWS 70-1, the uppermost groundwater has a lower tritium concentration than groundwater in the middle of the aquifer. Long-term pumping of well PWS 70-1 could have altered the normal distribution of groundwater ages, because the locations involved lie downgradient of the public water supply well. This finding suggests that long-term pumping of well PWS 70-1 could also have contributed to the downward movement of contamination in the aquifer to the east of the well.

Groundwater samples from the sand and gravel aquifer at Adams are largely of the calcium bicarbonate type characteristic of the Pleistocene shallow and paleovalley alluvial aquifers of the region. The only significant exception was at DW02, the Ebbers domestic well, where water has a calcium-magnesium-sulfate character consistent with derivation from a bedrock aquifer. Well records are not available for this well, but the owner reported that the well penetrates limestone bedrock to an unknown depth.

Samples from the sand and gravel aquifer are nearly all contaminated with nitrate in excess of the MCL of 10 mg/L, including wells PWS 64-1 and PWS 79-1. Well PWS 64-1 is no longer connected to the distribution system, and groundwater from PWS 79-1 and PWS 70-1 is treated to remove nitrate before it enters the town water supply.

The highest concentration of nitrate in groundwater (34.3 mg/L) was found at an intermediate depth in the sand and gravel at SB16, located in a cultivated field south of Oak Street, due east of the former CCC/USDA site. The only ECPT locations where water did not exceed the MCL for nitrate at any depth were SB04, SB14, and SB07. These three locations, at or near the southern limit of the sand and gravel aquifer, might receive a substantial component of recharge from the glacial sediments of the drift hills, as the tritium results suggest. Previous groundwater sampling in the region has shown that the paleovalley fluvial aquifers are enriched in nitrate relative to both the shallow aquifers of the drift hills and the bedrock aquifers (Tanner and Steele 1989). Nitrate values tend to increase with depth in the sand and gravel aquifer.

4.5 Overall Summary of Data Interpretation

The Holocene and Pleistocene sediments in the area of investigation were deposited on the southern edge of a major paleovalley that was cut into the Permian bedrock during the Pleistocene. Consequently, the former CCC/USDA site lies within a transitional zone between fluvial sediments to the north and glacial sediments to the south. The total thickness of the Holocene and Pleistocene units varies between 70 ft and 150+ ft, becoming thicker to the north. The primary stratigraphic units at Adams include (1) the overlying loess mantle of Holocene and Pleistocene age (unit 1); (2) the Pleistocene sandy silt and clay unit (unit 2); (3) the Pleistocene fluvial sand and gravel (unit 3); (4) the Pleistocene gray silt (unit 4); (5) the older Pleistocene blue-gray silt (unit 5); and (6) the Permian bedrock (unit 6), consisting of limestone and shale of the Council Grove Group.

The two stratigraphic units in the study area that have potential hydrostratigraphic significance are the Pleistocene sand and gravel (unit 3) and, to a lesser extent, the Pleistocene gray silt (unit 4). The sand and gravel unit at Adams represents the southern edge of the extensive fluvial sands and gravels that fill the paleovalley. The sand unit, about 35-45 ft thick, is made up of a series of upward-fining depositional sequences ranging from gravel and coarse sand at the base of each cycle, through medium sand, to fine grained sand (occasionally clayey) at the top. Because these upward-fining sequences form in river channels that follow a sinuous pattern and often cut across one another, it is difficult to correlate the lens-shaped bodies from one drill hole to the next. Gravel is common in the upper part of the sand and gravel unit at 30-40 ft BGL and again in a matrix of medium to coarse grained sand near the base of the unit at about 65 ft BGL. Fine silty sand is prevalent in the zone at 45-60 ft BGL. The sand and gravel body pinches out to the south and is replaced by gray clayey silt with a trace of sand (unit 4). This unit may provide slow recharge of groundwater to the fluvial sand and gravel aquifer from the glacial sediments that form the drift hills. Water sampling in the gray clayey silt was slow and sometimes unsuccessful because of the low permeability of the material.

The Pleistocene aquifer, consisting of a fluvial sand and gravel unit, is semiconfined by the overlying loess and sandy silt units and confined by the underlying older Pleistocene blue-gray silt unit and Permian limestone. The aquifer normally is under a leaky and confined condition. The saturated gray silt (unit 4) that lies in direct contact with the southern edge of aquifer acts as an aquitard or poor aquifer, providing slow recharge to the fluvial sand and gravel. The hydraulic conductivity of the fluvial sand and gravel aquifer varies from a few to

100 ft/d. In general, the top and bottom of the aquifer have relatively higher hydraulic conductivities than the middle. The Pleistocene aquifer may provide pathways for contaminant migration, particularly the top of the aquifer in the northern part of the former CCC/USDA site. Groundwater in the Pleistocene fluvial aquifer at Adams flows eastward with a gentle hydraulic gradient of 0.0016.

The Pleistocene fluvial aquifer at Adams represents the southern edge of the aquifer that fills the paleovalley. Groundwater recharge from the glacial drift hills, south of the aquifer, is retarded by a low-permeability saturated unit (gray silt). Groundwater level fluctuations at Adams indicate that the aquifer at Adams is stressed by usage of water for the public distribution system and for domestic and irrigation wells. The water level was lowered by routine pumping when recharge of the Pleistocene fluvial aquifer decreased because of a lack of rainfall in the Adams area. The slow inflow of groundwater from saturated glacial silt on the southern edge of the paleovalley was insufficient to maintain the water level in the aquifer during the drought. Therefore, pumping at the public water supply and irrigation wells significantly affects the groundwater flow system and, potentially, contaminant migration pathways near grain storage facilities at Adams.

The tritium data show that the groundwater samples from the Pleistocene aquifer at Adams are the result of modern (post-1951) recharge. Most of the samples have tritium levels of 6-12 TU, probably resulting from recharge within the past 20 yr. However, groundwater at the southern edge of the fluvial sand and gravel aquifer could contain a tritium-enriched groundwater component that originated as precipitation in the drift hills south of Adams before 1980. The tritium concentrations decline with depth in the aquifer, consistent with the conceptual model of infiltration of younger water at the top and the accumulation of older water at the base of the aquifer. However, immediately east of PWS 70-1, the uppermost groundwater has a lower tritium concentration than groundwater in the middle of the aquifer. This finding suggests that long-term pumping of well PWS 70-1 could have contributed to the downward movement of contamination in the aquifer to the east of the well.

Groundwater samples from the sand and gravel aquifer at Adams are largely of the calcium bicarbonate type characteristic of the Pleistocene shallow and paleovalley alluvial aquifers of the region. The only significant exception was at DW02, the Ebbers domestic well, where water has a calcium-magnesium-sulfate character consistent with derivation from a

bedrock aquifer. Well records are not available for this well, but the owner reported that the well penetrates limestone bedrock to an unknown depth.

Samples from the sand and gravel aquifer are nearly all contaminated with nitrate in excess of the MCL of 10 mg/L. Previous groundwater sampling in the region has shown that the paleovalley fluvial aquifers are enriched in nitrate relative to both the shallow aquifers of the drift hills and the bedrock aquifers (Tanner and Steele 1989). Nitrate values tend to increase with depth in the sand and gravel aquifer. The only ECPT locations that did not produce groundwater samples with nitrate levels above the MCL were at or near the southern limit of the sand and gravel aquifer. These locations might receive a component of groundwater from the glacial sediments of the drift hills, as the tritium results suggest.

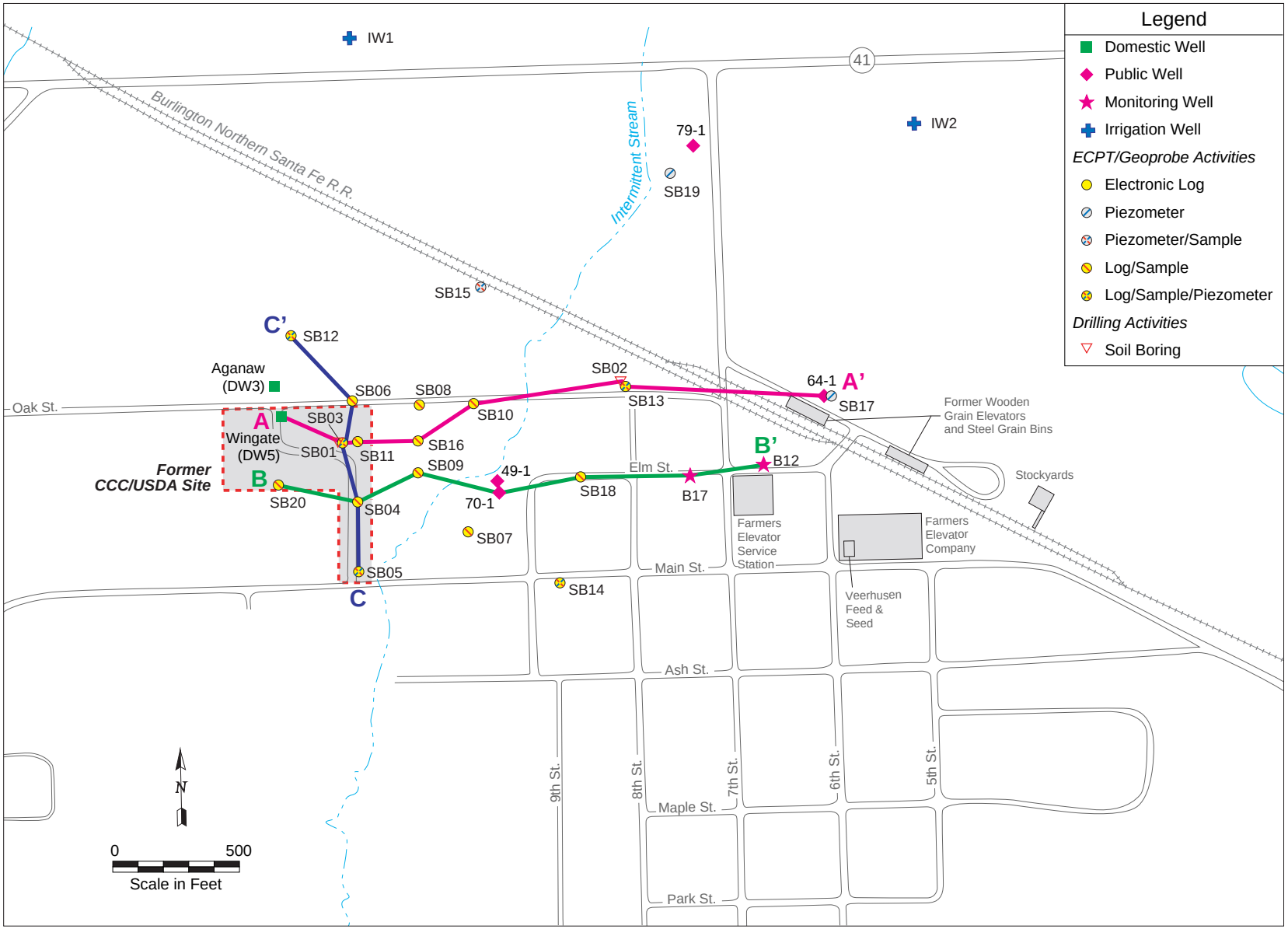

FIGURE 4.1 Map of Adams, Nebraska, Showing the Locations of the Former CCC/USDA Site; Other Potential Source Areas; Public, Domestic, Irrigation, and LUST Monitoring Wells; Phase I Investigative Activities; and Geologic Sections A-A´, B-B´, and C-C´

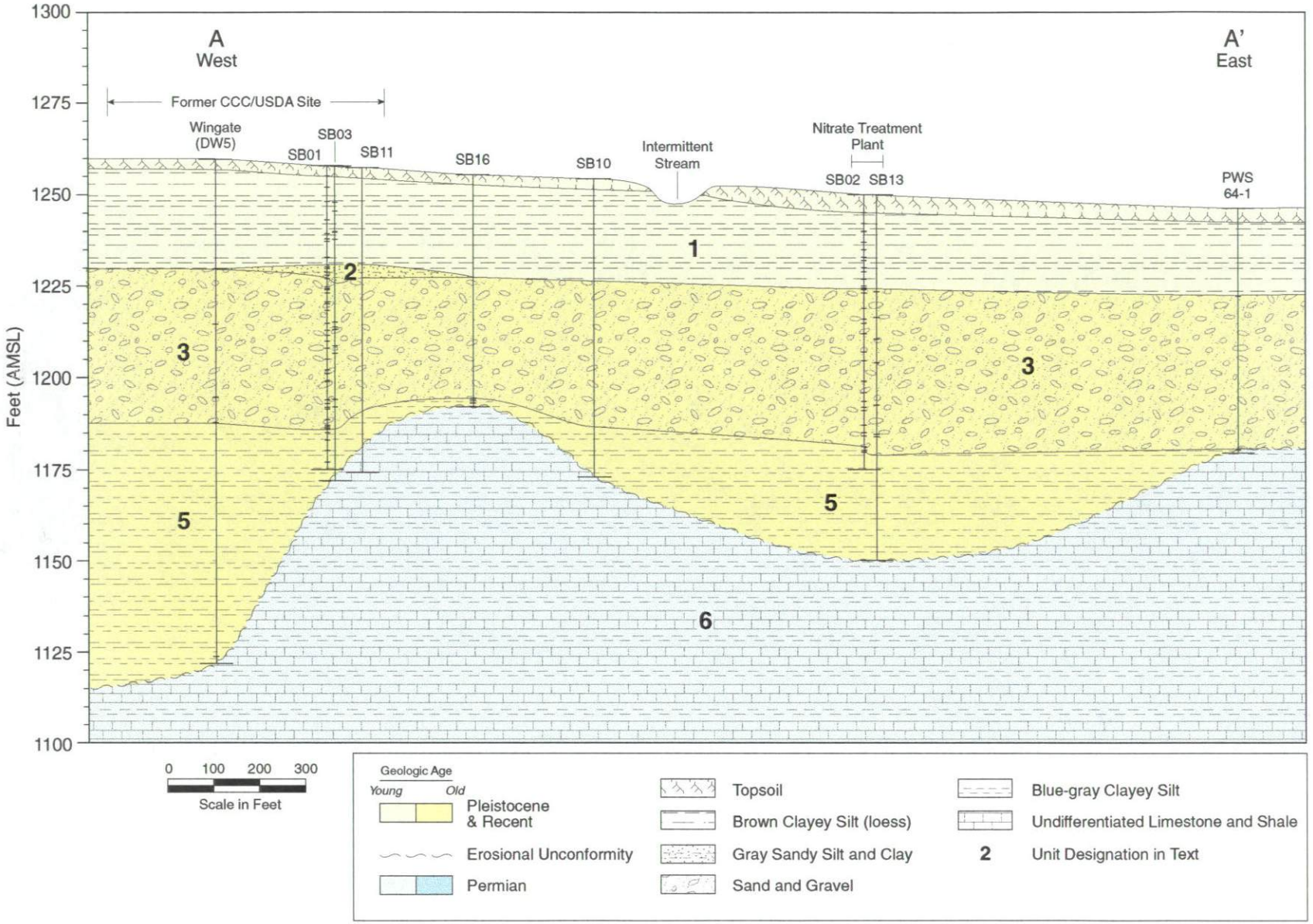

FIGURE 4.2 Interpretive West-to-East Geologic Cross Section A-A´, Showing the Stratigraphic Relationships from the Former CCC/USDA Site to PWS 64-1 at Adams, Nebraska

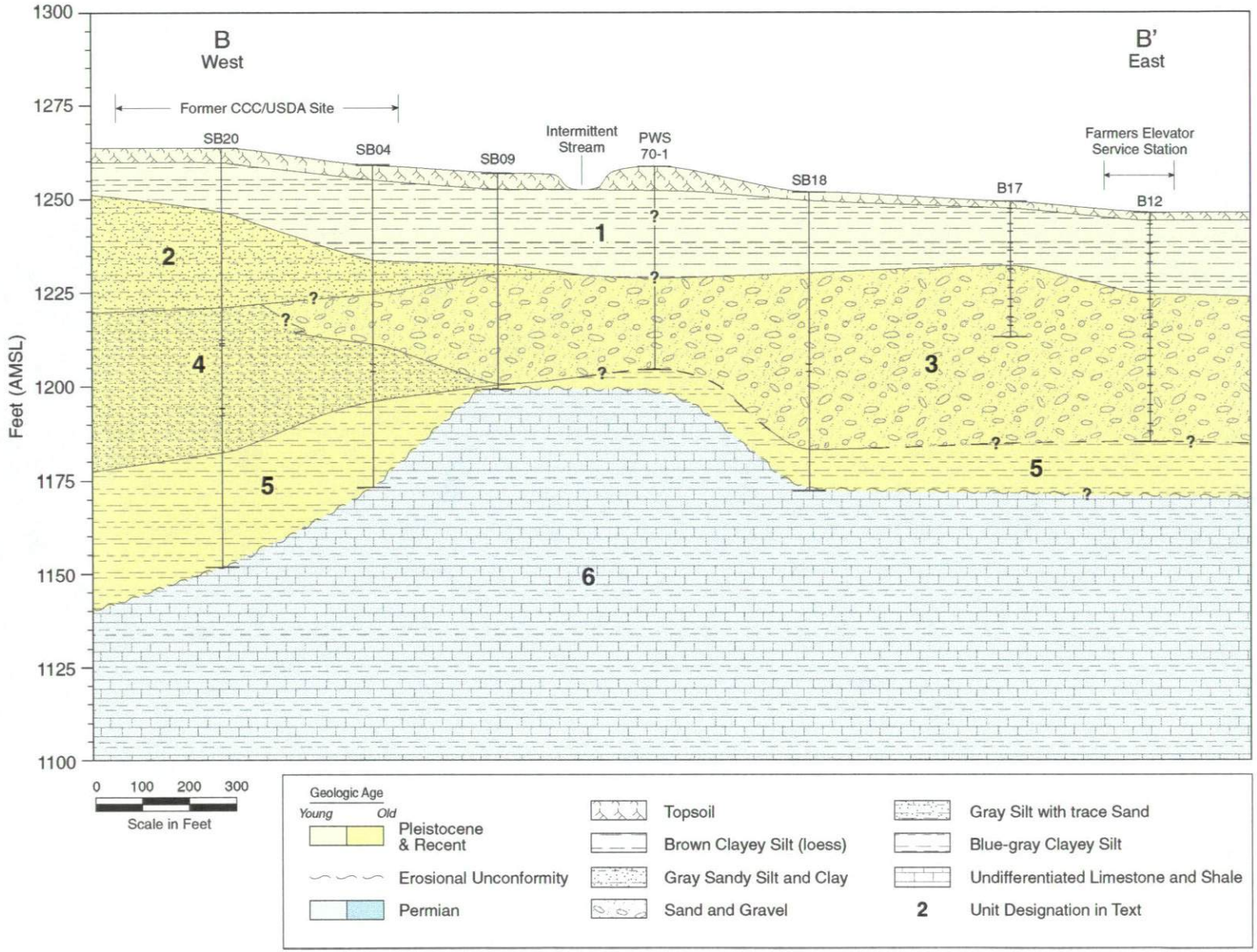

FIGURE 4.3 Interpretive West-to-East Geologic Cross Section B-B´, Showing Stratigraphic Relationships from the Former CCC/USDA Site to Monitoring Well B12 at Adams, Nebraska

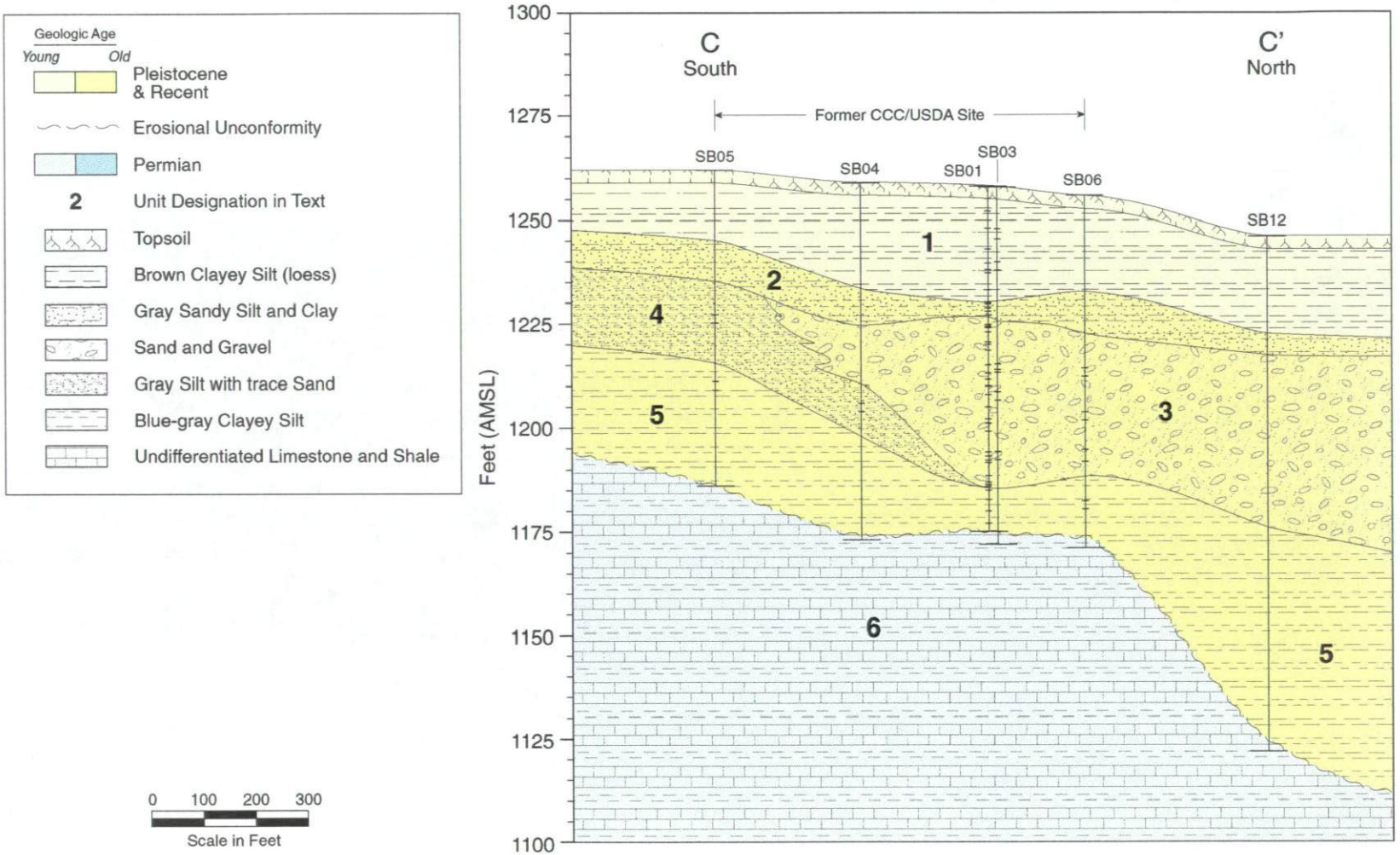

FIGURE 4.4 Interpretive South-to-North Geologic Cross Section C-C´, Showing Stratigraphic Relationships near the Former CCC/USDA Site at Adams, Nebraska

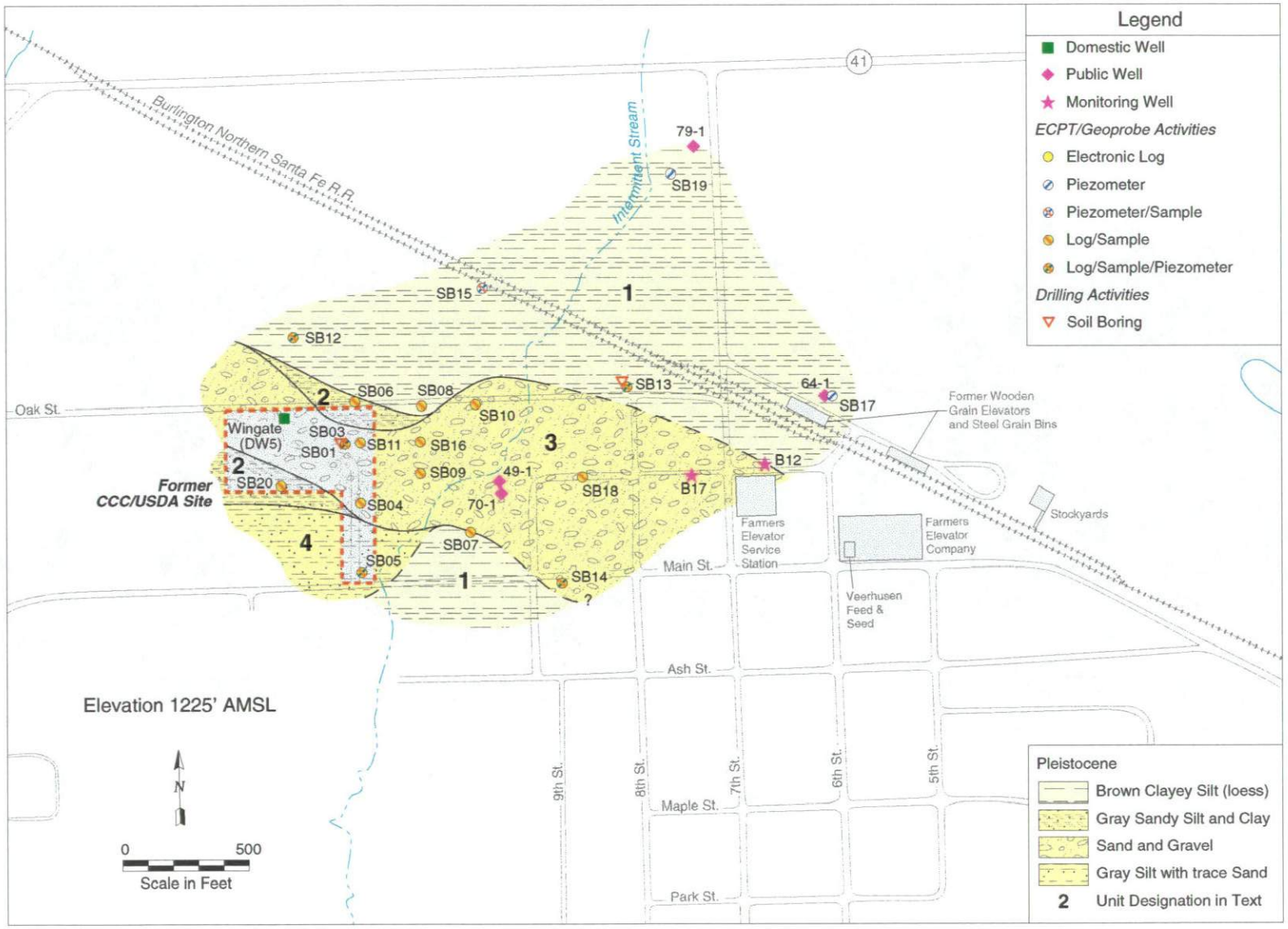

FIGURE 4.5 Horizontal Geologic Section (Slice Map) at an Elevation of 1,225 ft AMSL, Showing the Spatial Relationships among the Lithologic Units near the Top of the Pleistocene Fluvial Aquifer at Adams, and, Overlaid on the Geology, a Surface Map of Adams, Showing the Locations of the Former CCC/USDA Site and Other Potential Source Areas

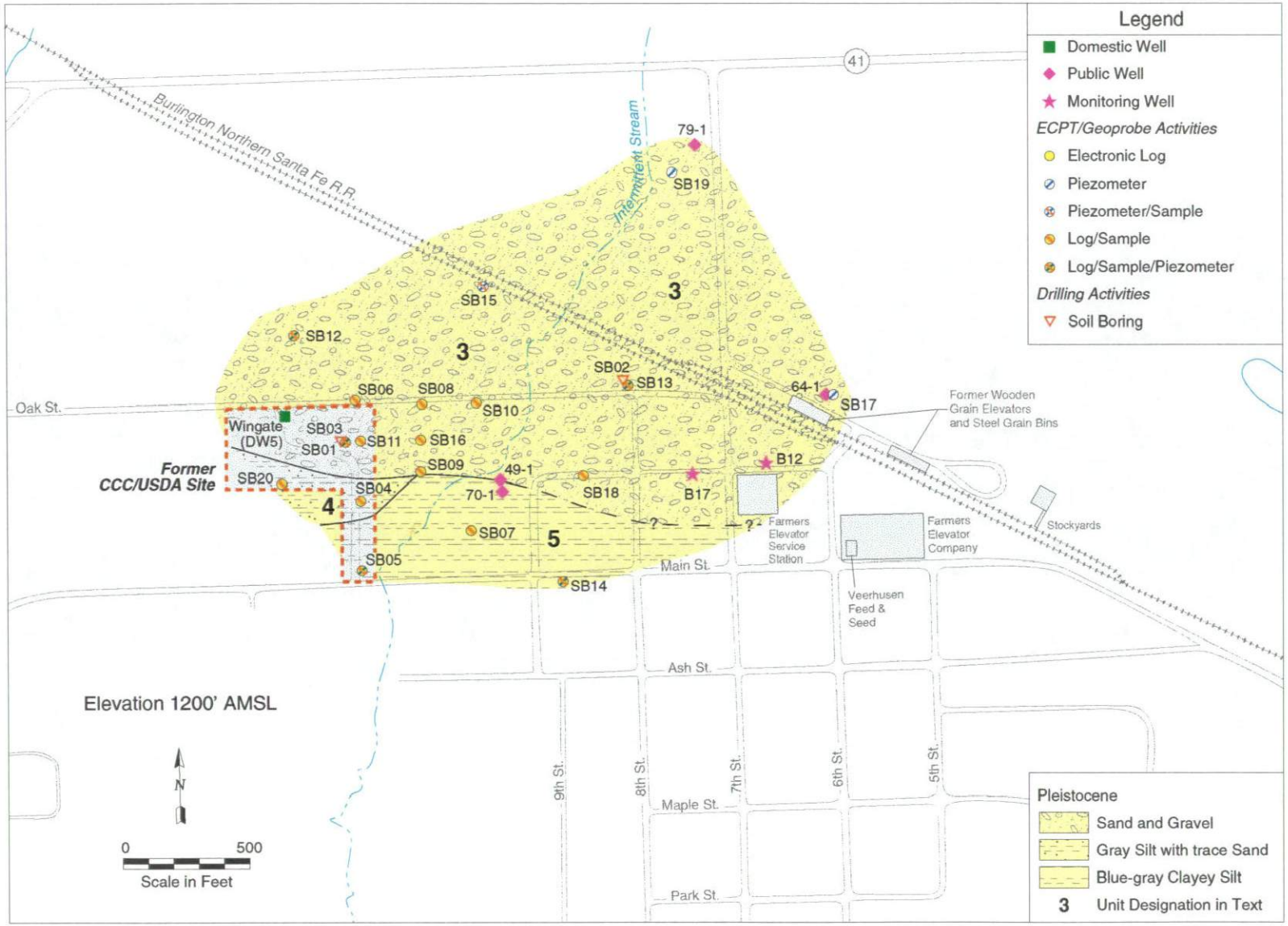

FIGURE 4.6 Horizontal Geologic Section (Slice Map) at an Elevation of 1,200 ft AMSL, Showing the Spatial Relationships among the Lithologic Units near the Middle of the Pleistocene Fluvial Aquifer at Adams, and, Overlaid on the Geology, a Surface Map of Adams, Showing the Locations of the Former CCC/USDA Site and Other Potential Source Areas

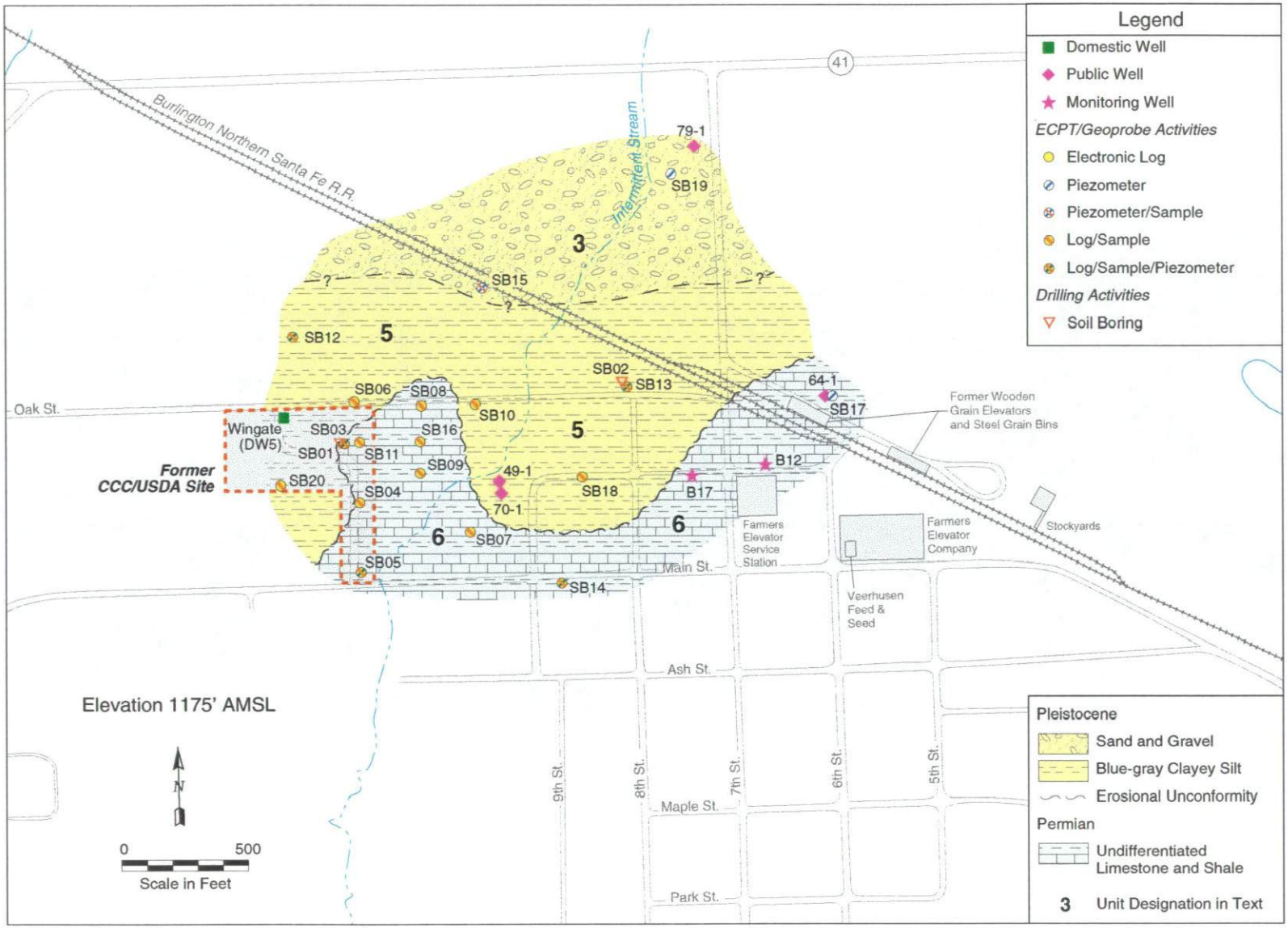

FIGURE 4.7 Horizontal Geologic Section (Slice Map) at an Elevation of 1,175 ft AMSL, Showing the Spatial Relationships among the Lithologic Units below the Pleistocene Aquifer at Adams, and, Overlaid on the Geology, a Surface Map of Adams, Showing the Locations of the Former CCC/USDA Site and Other Potential Source Areas

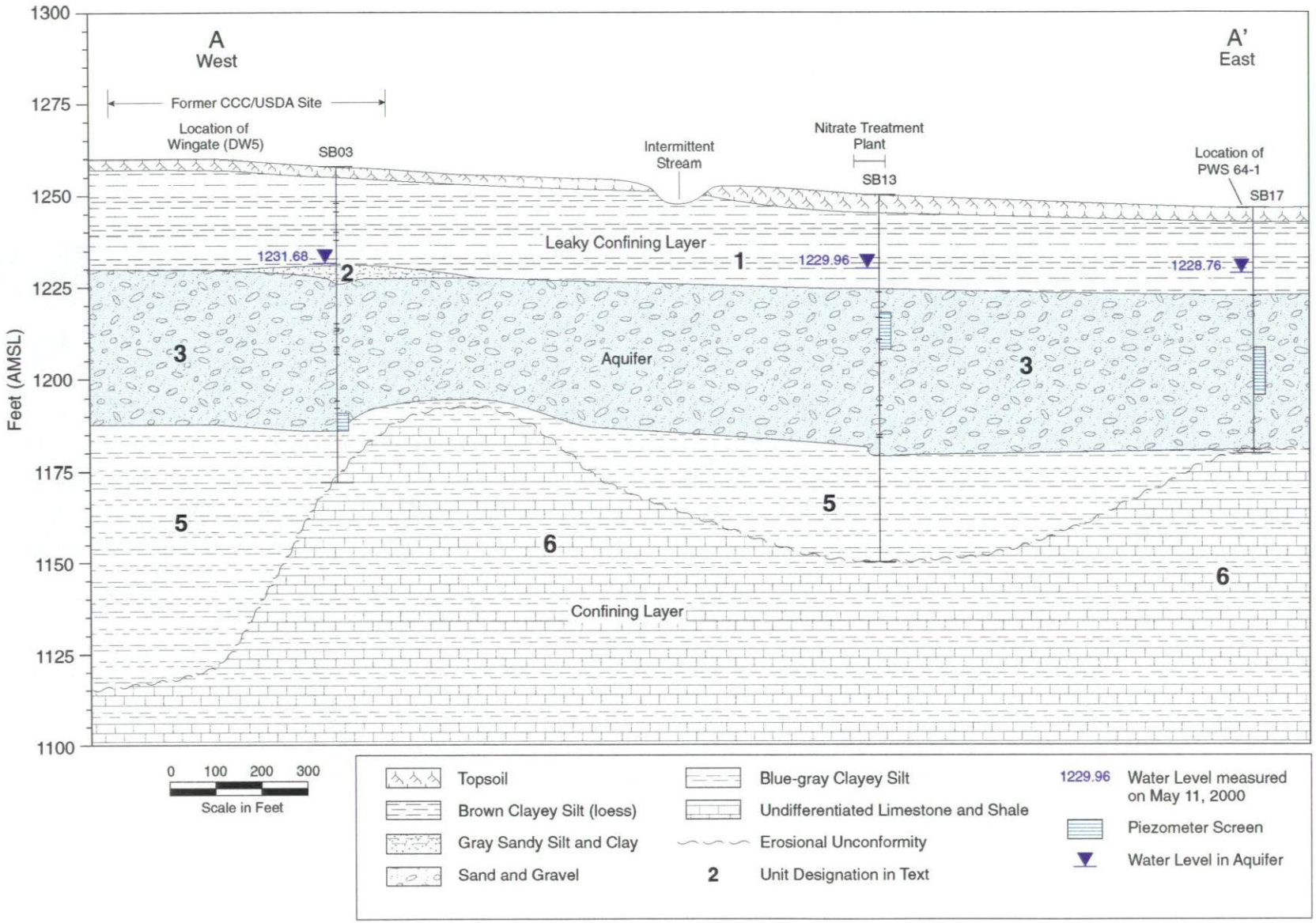

FIGURE 4.8 Interpretive West-to-East Geologic Cross Section A-A′, Showing the Pleistocene Aquifer from the Former CCC/USDA Site to PWS 64-1 at Adams, Nebraska

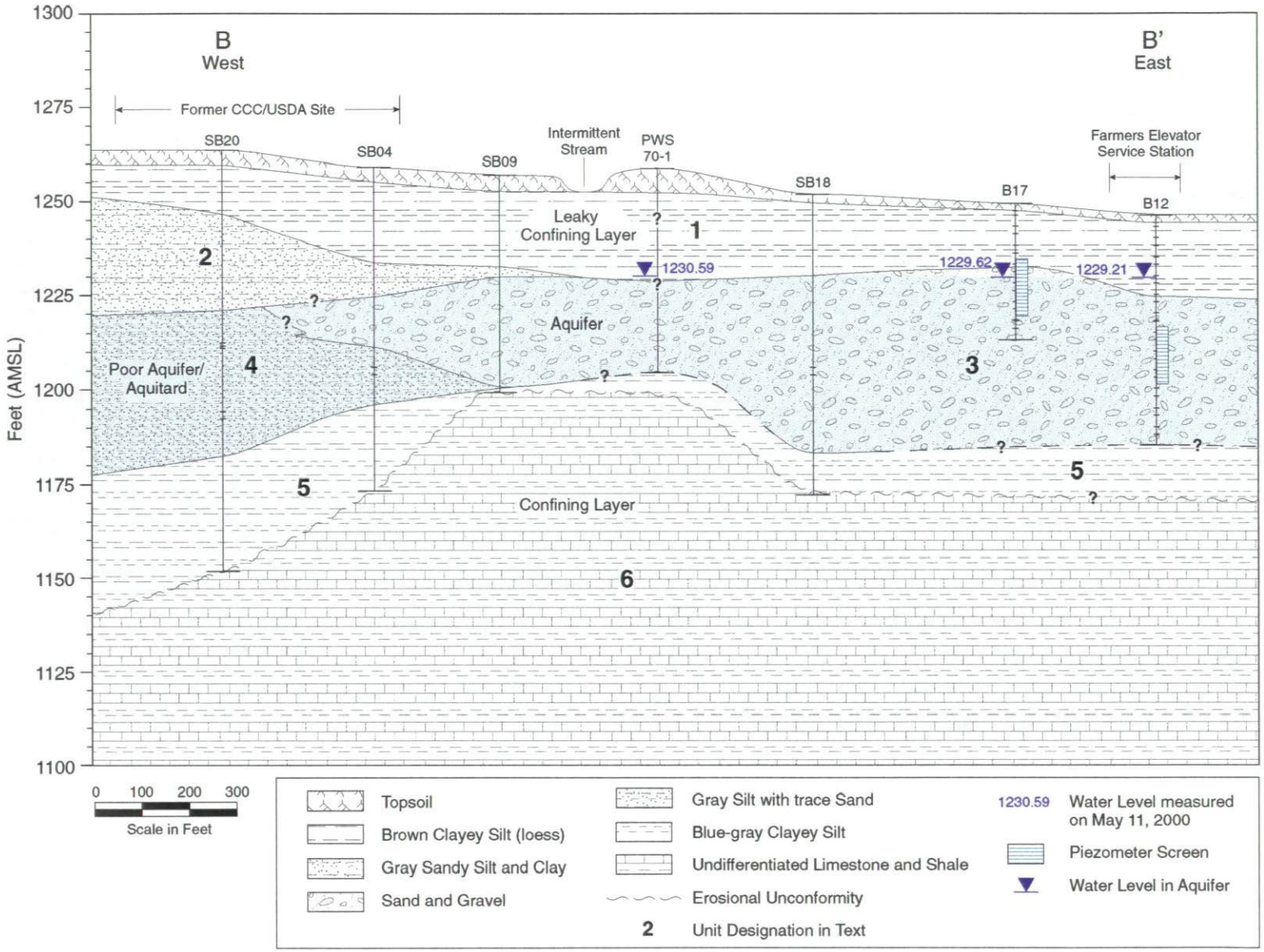

FIGURE 4.9 Interpretive West-to-East Geologic Cross Section B-B´, Showing the Pleistocene Aquifer from the Former CCC/USDA Site to Monitoring Well B12 at Adams, Nebraska

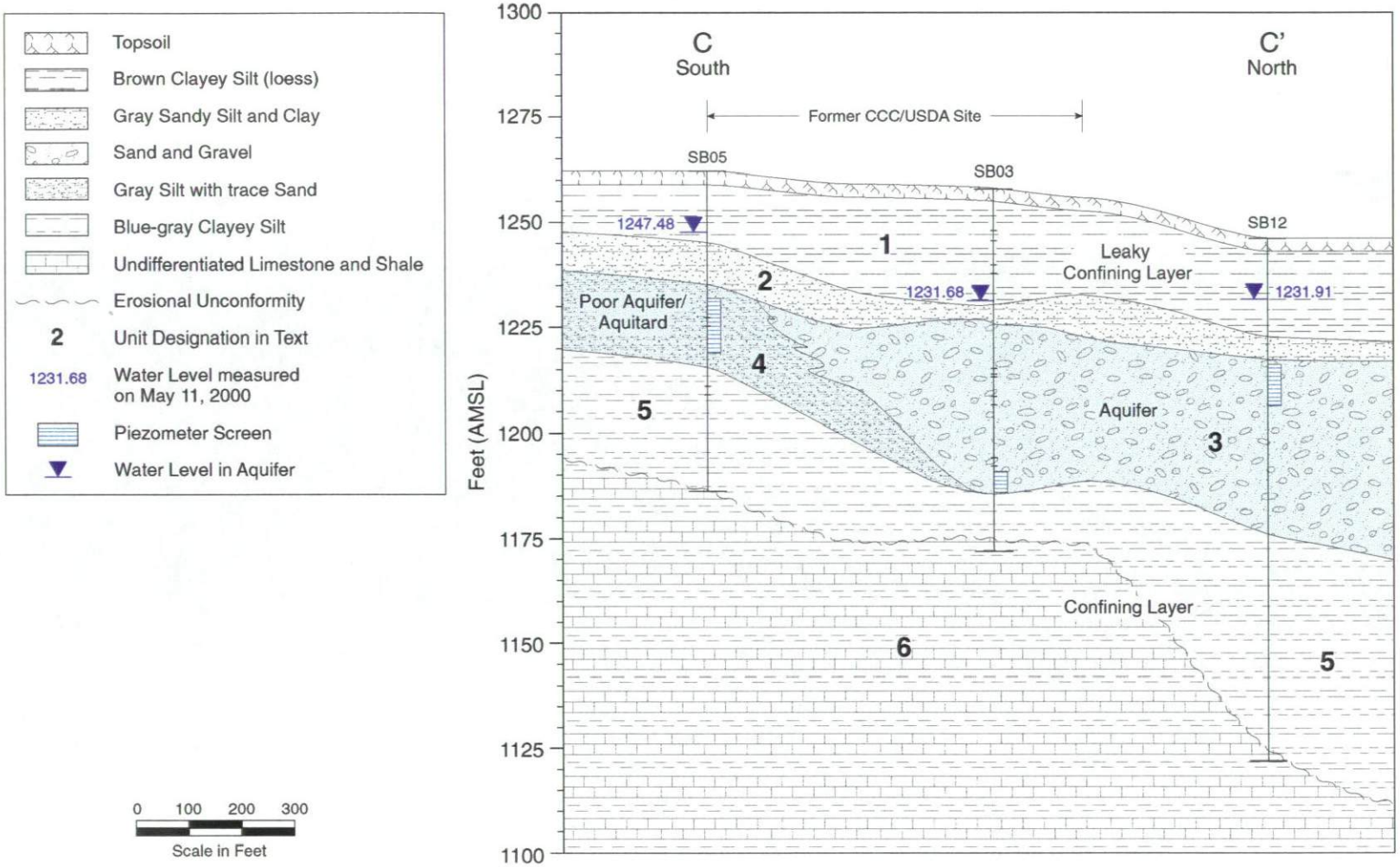

FIGURE 4.10 Interpretive South-to-North Geologic Cross Section C-C´, Showing the Pleistocene Aquifer near the Former CCC/USDA Site at Adams, Nebraska

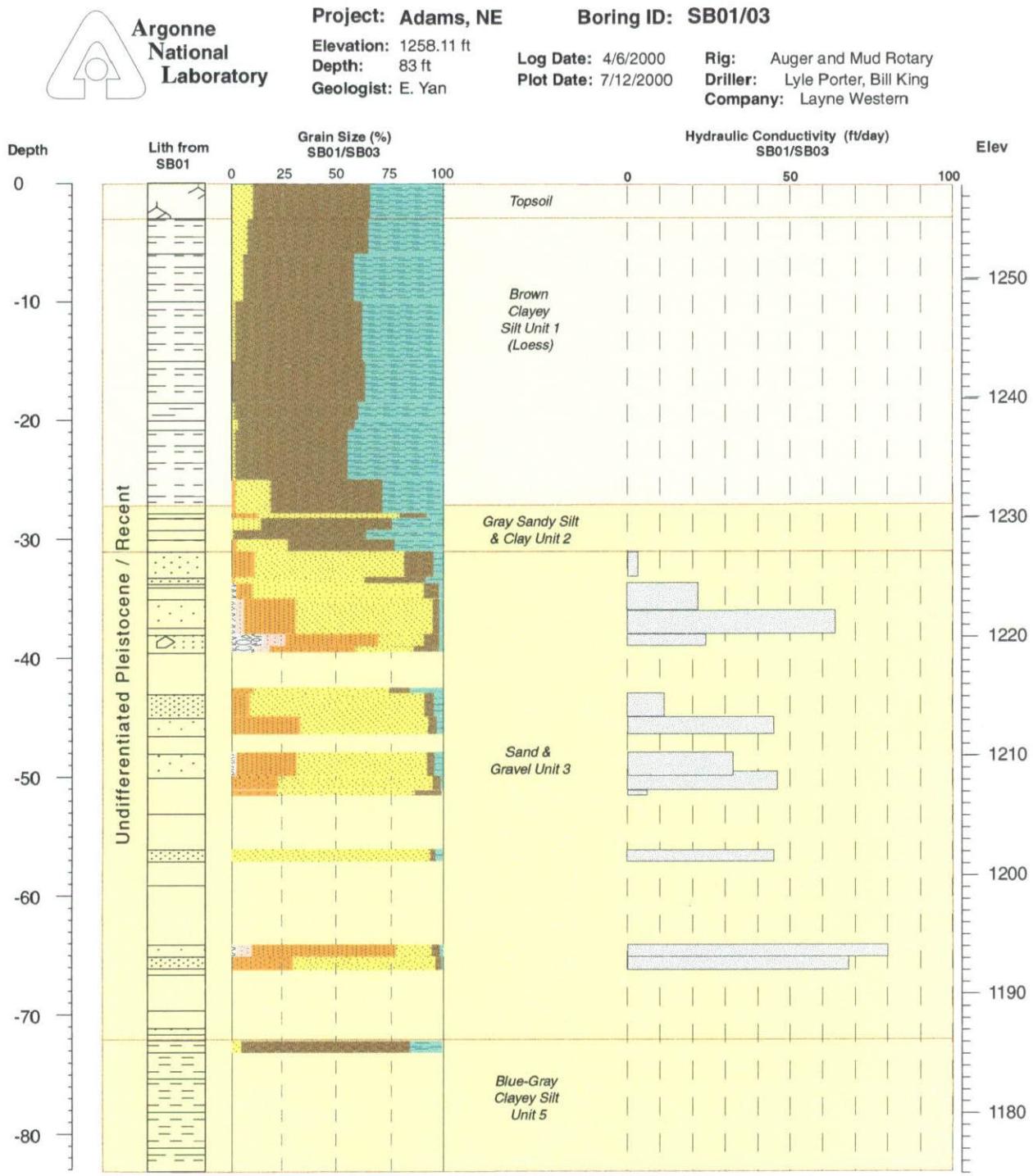

FIGURE 4.11 Geologic Log of SB01, Showing the Pleistocene and Recent Stratigraphic Sequence, the Grain Size Distribution of the Sediments, and the Hydraulic Conductivity of the Pleistocene Fluvial Aquifer at Adams, Nebraska

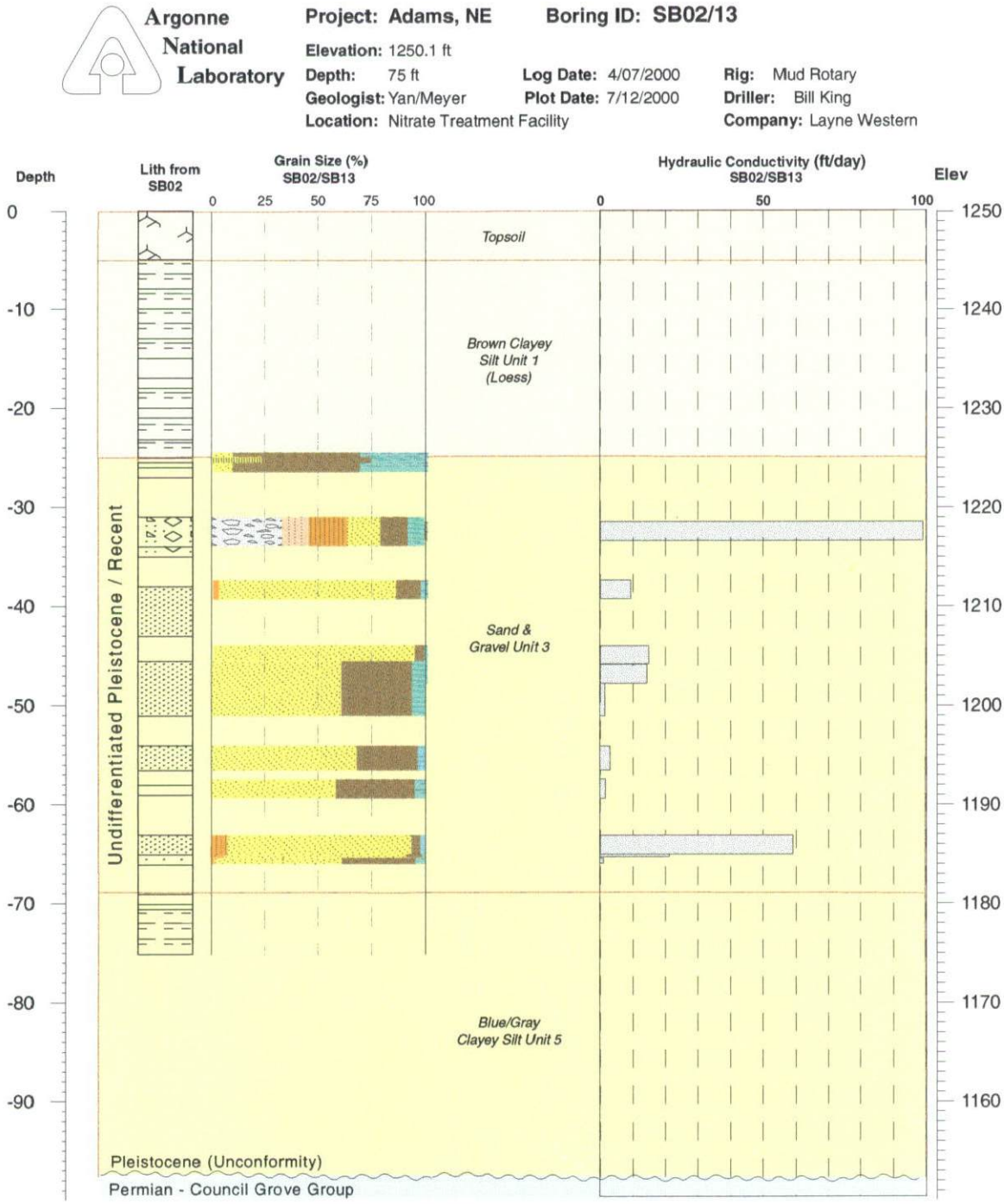

FIGURE 4.12 Geologic Log of SB02, Showing the Pleistocene and Recent Stratigraphic Sequence, the Grain Size Distribution of the Sediments, and the Hydraulic Conductivity of the Pleistocene Fluvial Aquifer at Adams, Nebraska

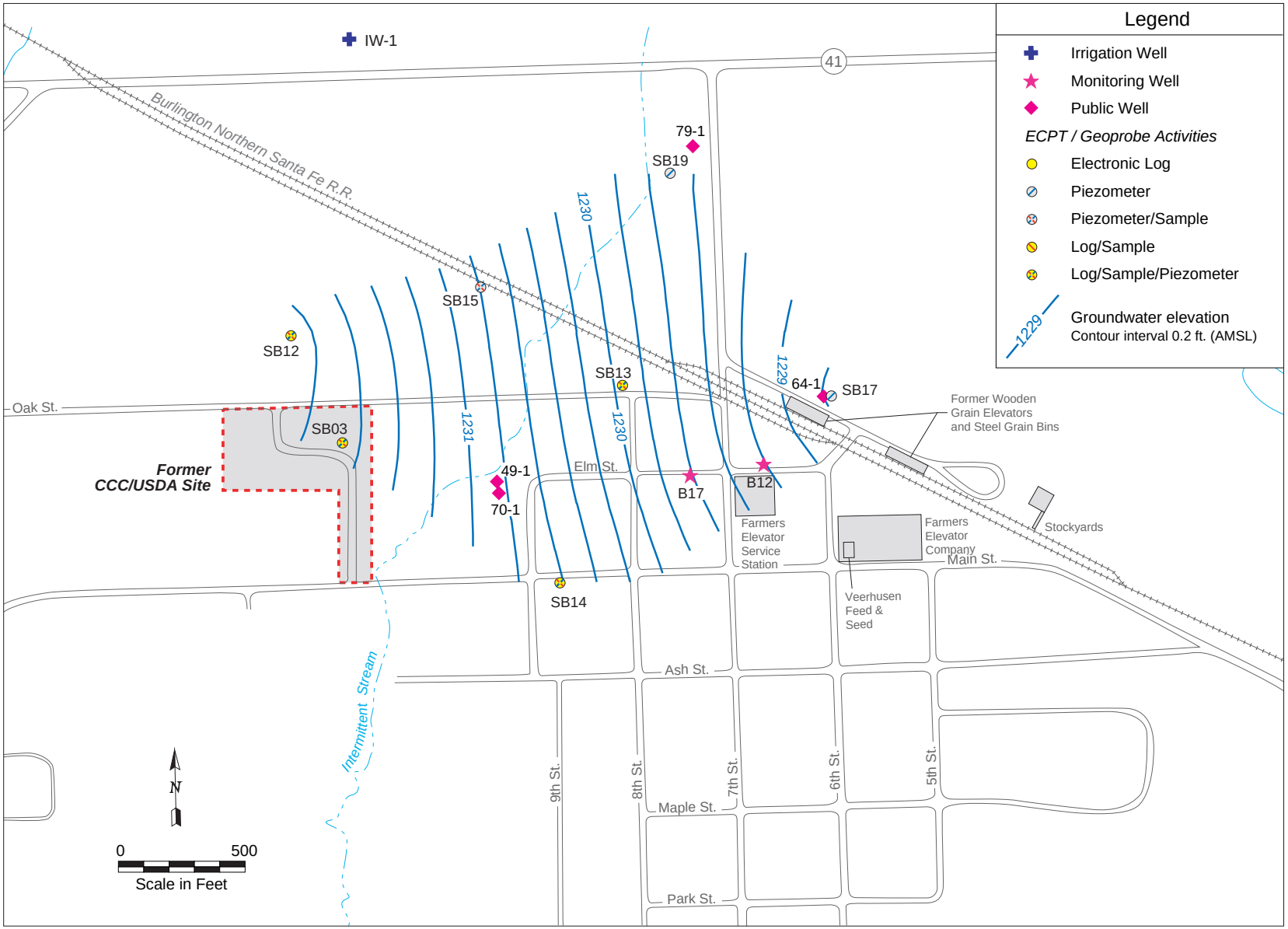

FIGURE 4.13 Map of Adams, Nebraska, Showing the Locations of the Former CCC/USDA Site and Other Potential Source Areas, with the Potentiometric Surface for the Pleistocene Fluvial Aquifer as Measured on May 11, 2000

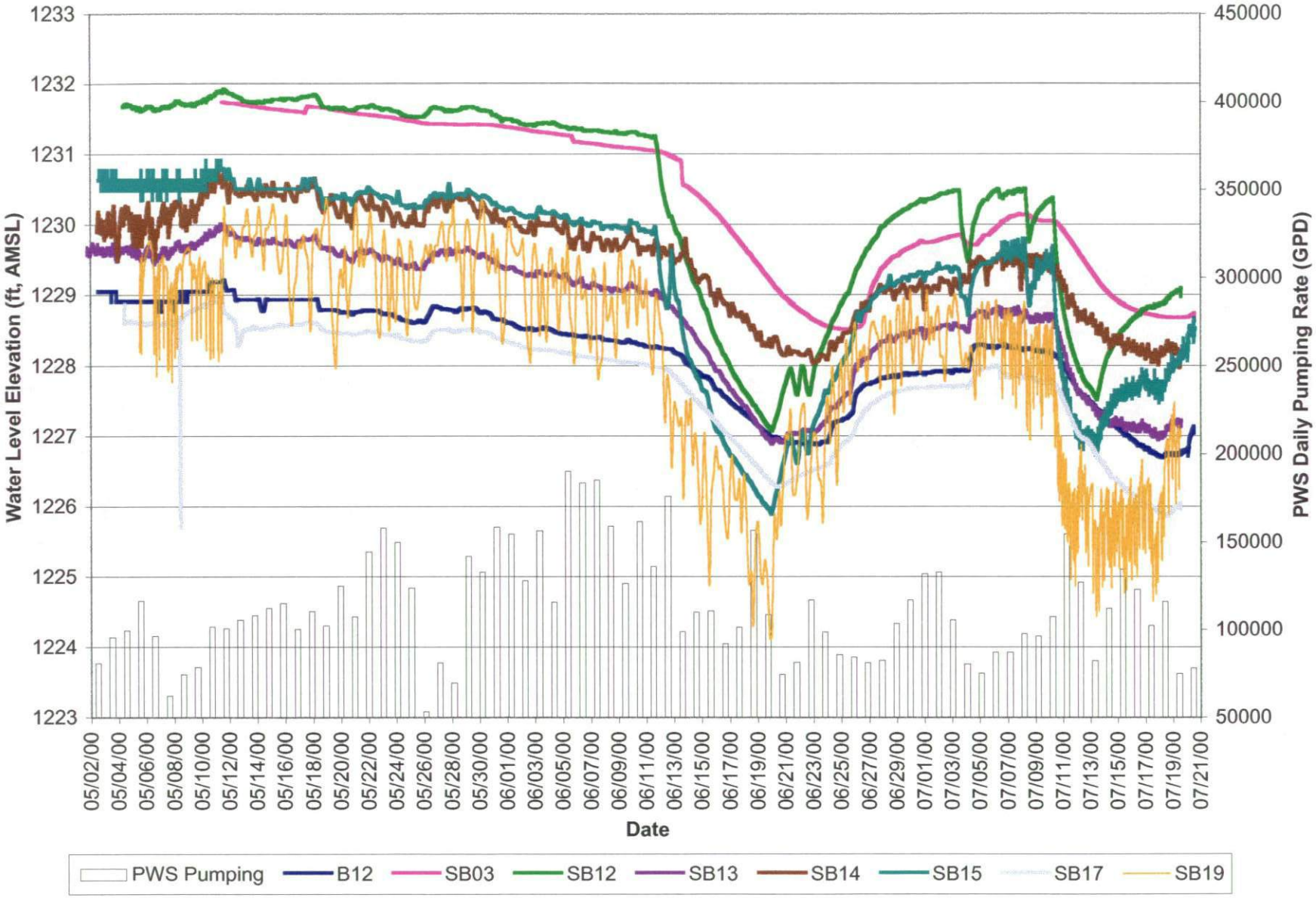

FIGURE 4.14 Hydrographs for Monitoring Wells from May 2 to July 20, 2000, with Pumping Rates for Public Water Supply Wells

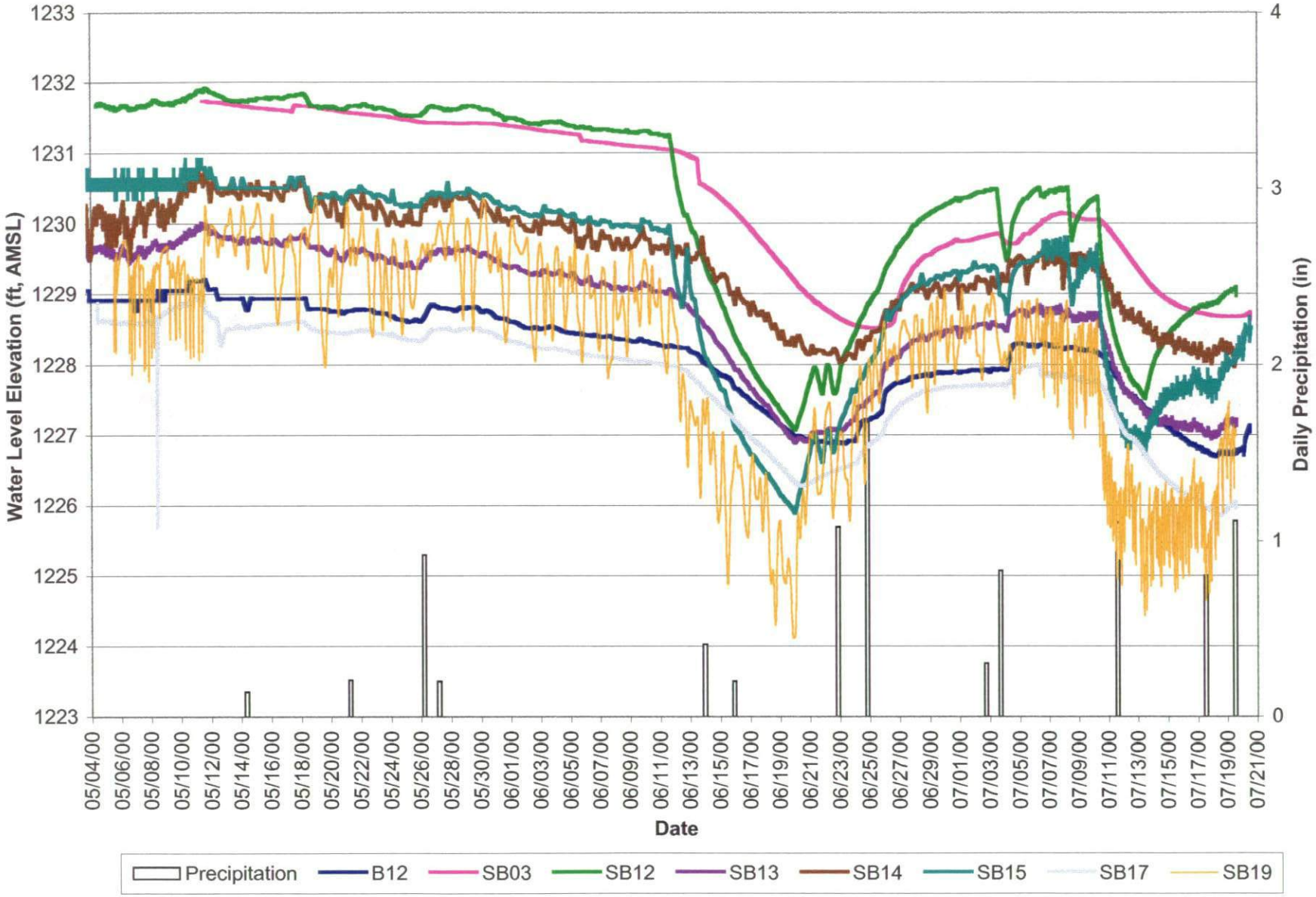

FIGURE 4.15 Hydrographs for Monitoring Wells from May 2 to July 20, 2000, with Daily Precipitation

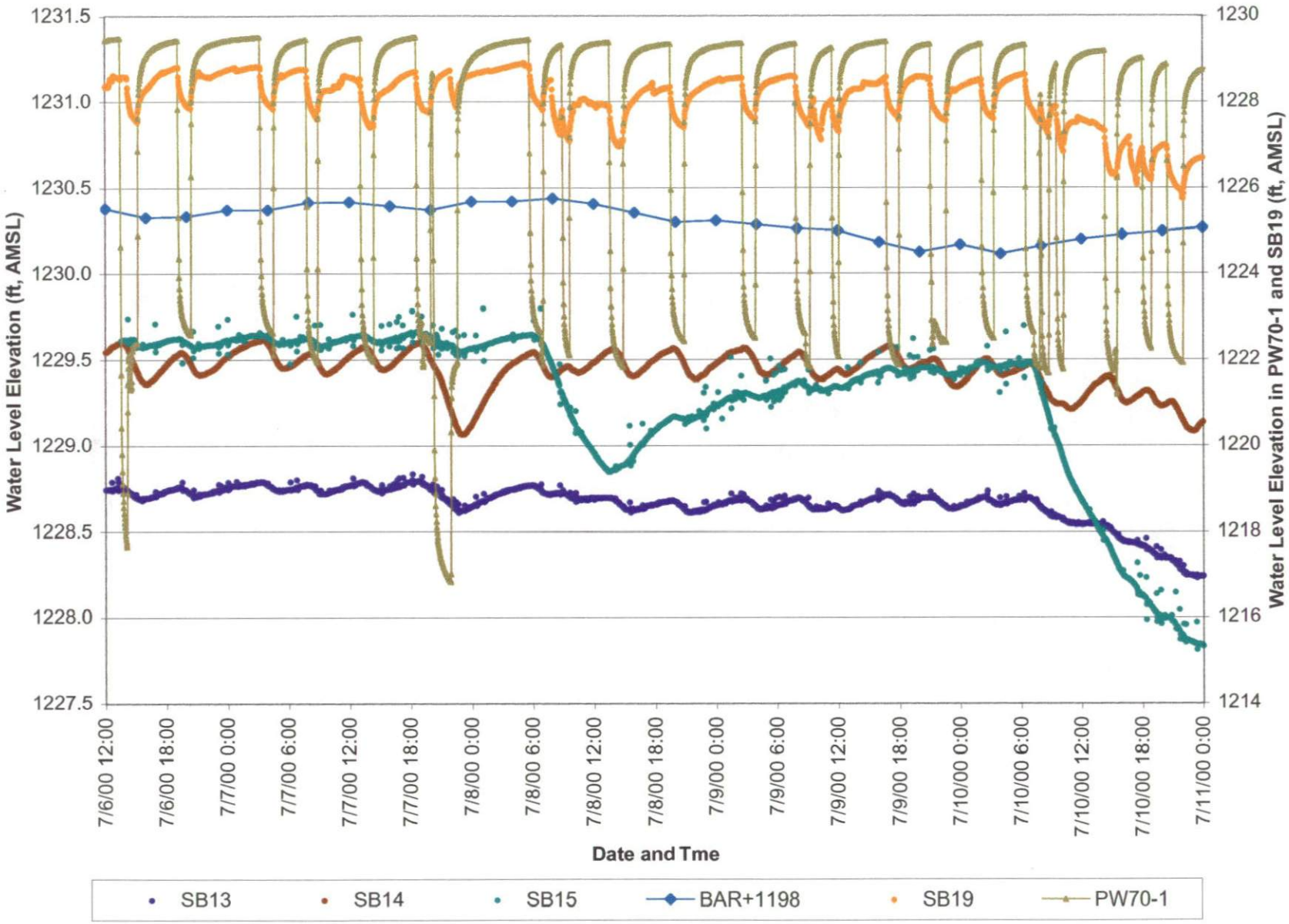

FIGURE 4.16 Hydrographs for Monitoring Wells from July 6 to July 11, 2000, at Two-Minute Intervals

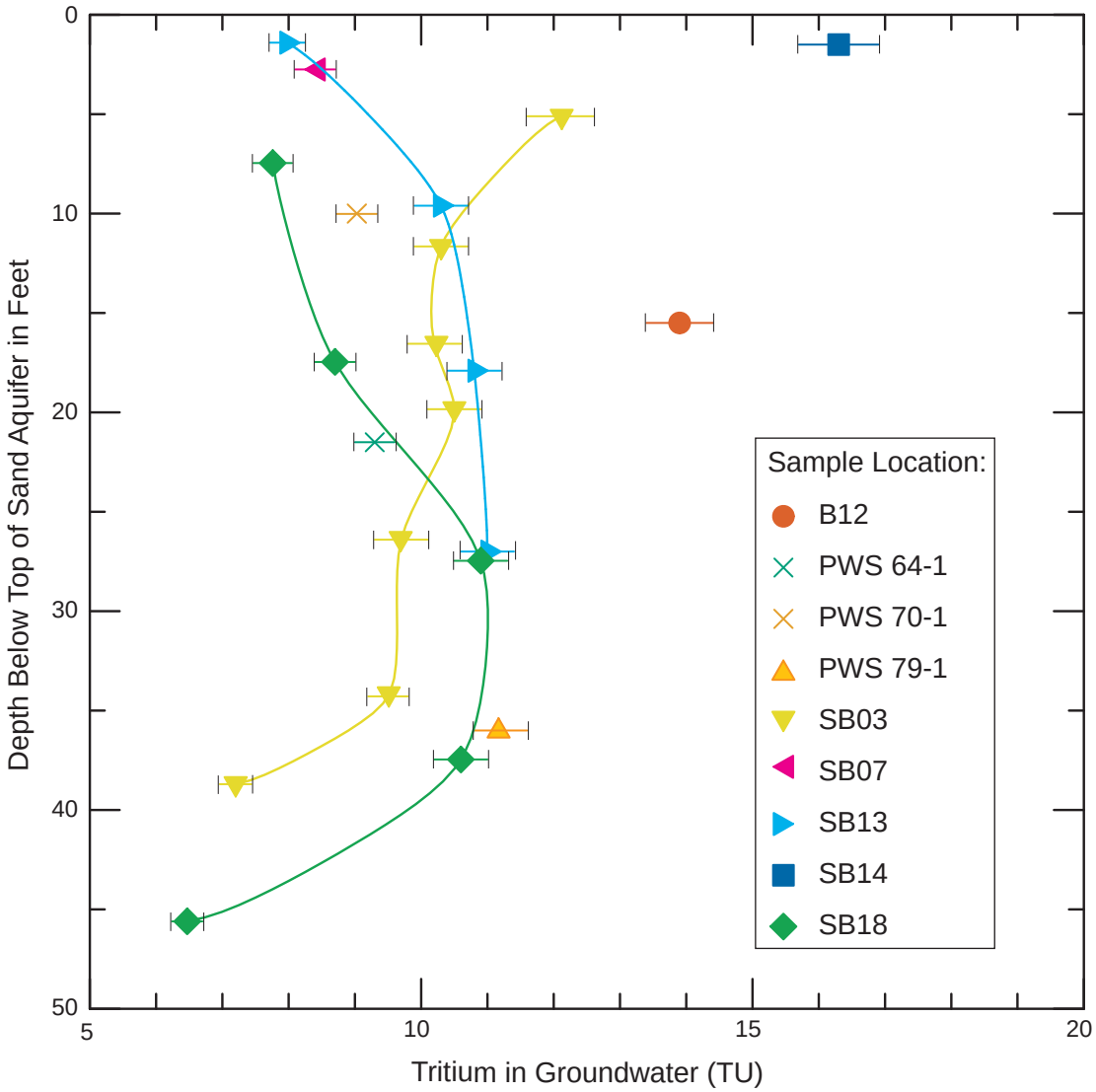

FIGURE 4.17 Tritium in Selected Groundwater Samples from Adams, Nebraska (Samples collected at the same location are connected to show the change in tritium with depth in the Pleistocene aquifer.)

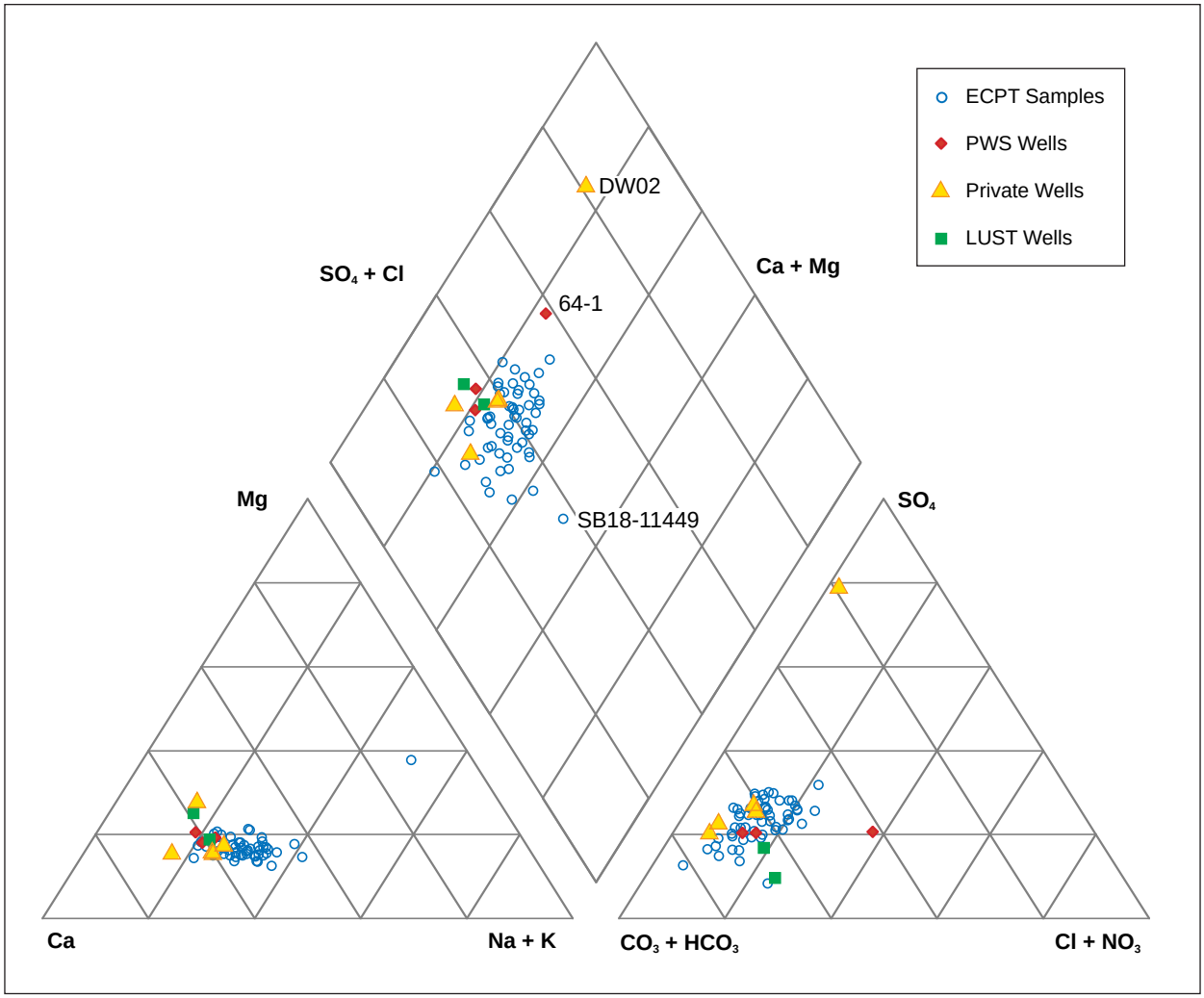

FIGURE 4.18 Piper Diagram Showing the Relative Contributions of Major Cations and Anions to the Total Ion Content of Groundwater Samples Collected at Adams, Nebraska

5 Evaluation of the Effect of Historic Pumping on Potential Contaminant Migration Pathways and Identification of Potentially Responsible Parties

This section evaluates the impact of historic pumping at various municipal, irrigation, and LUST remediation recovery wells on the groundwater flow system and potential contaminant migration. The evaluation was undertaken to determine whether the former CCC/USDA site is responsible for the carbon tetrachloride contamination of PWS 64-1 or whether a number of other PRPs in eastern Adams could be responsible for the contamination. More rigorous modeling using data from pump tests will be required to predict future groundwater flow and contaminant transport and for feasibility analysis.

The hydraulic analyses presented in Section 4.3 demonstrate that the groundwater flow system is significantly affected by long-term pumping at public water supply wells and by seasonal pumping at irrigation wells. These changes in the groundwater flow system could potentially alter migration pathways for contaminants. To investigate these effects, the updated geologic, hydrogeologic, and hydrogeochemical model presented in Section 4 was used to (1) study the dynamics of the groundwater flow field in and around the potential carbon tetrachloride source areas under the influence of various historic pumping schemes at Adams, (2) evaluate the potential roles and contributions of suspected source areas in the presence of carbon tetrachloride, and (3) assess the need for and scope of any further work required by the CCC/USDA to answer questions related to its role as a PRP.

The groundwater flow system at Adams has been affected by various municipal, irrigation, and LUST remediation recovery wells. In recent history, six wells (PWS 30-1, 49-1, 56-1, 64-1, 70-1, and 79-1) have served as public water supply wells at Adams. The effect of these wells on the dynamics of groundwater flow at Adams was complicated by the use of different combinations of wells at various times. Consequently, the currently observed groundwater flow field does not adequately represent the past. Identification of the potential source areas for contamination of PWS 64-1 requires a reconstruction of the history of groundwater flow at Adams. The analyses in this section were performed by using the particle tracking method to reconstruct groundwater flows corresponding to pumping scenarios derived from historic records. The resulting flow fields were used to identify the likely pathways of groundwater flow from potential contaminant source areas.

5.1 Groundwater Flow Model

To perform particle tracking analysis, a preliminary three-dimensional numerical model of groundwater flow was developed on the basis of the updated conceptual model of geology, hydrogeology, and hydrogeochemistry of the Adams area presented in Section 4. The detailed construction of the model is described in Appendix H.

Hydraulic analysis indicates that the groundwater system in the fluvial aquifer at Adams is stressed by routine pumping of the public water supply wells. Groundwater levels observed during the Phase I investigation represent the potentiometric surface of the aquifer as it has evolved from the original steady state under continued stress. Consequently, the observed groundwater level is lower than the water level anticipated under normal, stress-free conditions. Therefore, a flow model calibrated to the observed water level will underestimate aquifer production and overestimate the impact of pumping wells. To develop a flow model closer to the natural Adams flow system, the flow model was calibrated for the transient state under an equivalent constant stress lasting 20-70 yr, with water levels measured on May 11, 2000. The long-term-equivalent constant stress was estimated from the recorded daily production volume for the Adams public water supply from January to July 2000. No data are available on the length of time that the system has endured the current stress. In simulations of the stress time, a best fit was achieved by using calculated groundwater flows of 20-70 yr, in agreement with the observed groundwater flow at a standard error of the estimate of 0.066-0.091 ft (Appendix H). Parameters derived by calibration of the transient model with stress are more representative of the actual aquifer conditions than the calibrated aquifer parameters for the flow model with no stress. The detailed calibration process is documented in Appendix H.

Groundwater flow modeling was conducted by using the U.S. Geological Survey (USGS) modular, three-dimensional, finite-difference groundwater modeling code commonly referred to as MODFLOW (McDonald and Harbaugh 1988), as implemented in Visual MODFLOW (Waterloo 1999). For particle tracking analysis, MODPATH was used and also implemented in Visual MODFLOW.

5.2 Historic Pumping Schemes at Adams

Major pumping events at Adams include (1) long-term pumping of public water supply wells, (2) seasonal pumping for irrigation, and (3) continuous pumping of a LUST remediation system for a number of years. To evaluate the effect of these pumping events on the Adams flow regime, historic pumping schemes for each event were estimated on the basis of completion dates from well registration forms and drillers' logs for all municipal and irrigation wells. Previous reports (Jacobs 1992; NDEQ 1997; Coranco 1990, 1991, 1992) were also consulted.

5.2.1 Pumping Schemes at Municipal Wells

In recent history, the Adams municipal water supply system has used six wells (PWS 30-1, 49-1, 56-1, 64-1, 70-1, and 79-1). Existing wells PWS 64-1, 70-1, and 79-1 were connected to the system in 1965, 1971, and 1981, respectively. Well PWS 64-1 was disconnected in 1991, after the detection of carbon tetrachloride. The three older wells, PWS 30-1, 49-1, and 56-1, were installed in 1930, 1949, and 1956, respectively. Well PWS 30-1 was located near PWS 56-1, and 49-1 was near 70-1. Wells PWS 30-1 and 49-1 were probably replaced when PWS 56-1 and 70-1 were installed. The date for the abandonment of PWS 56-1 is unknown. However, all three of the older wells were abandoned before 1974. The estimated period of operation for each public supply well is as follows:

- PWS 79-1: 1981-present
- PWS 70-1: 1971-present
- PWS 64-1: 1965-1991
- PWS 56-1: 1956-1974 (?)
- PWS 49-1: 1949-1971
- PWS 30-1: 1930-1956

Carbon tetrachloride-based fumigants were commonly used by the CCC/USDA and the private grain storage industry from 1950 to 1975. Eventually, small amounts of the contaminant infiltrated through the leaky confining layer (loess unit) and reached groundwater, probably toward the end of this period. To evaluate the effect of municipal water supply pumping on the flow regime and migration pathways, pumping schemes from 1956 to the present were imposed on the calibrated model for the purpose of particle tracking analyses. The period from 1956 to the present was divided into five segments (Table 5.1).

Public supply wells PWS 79-1 and 70-1 are pumped intermittently at rates of about 230 gpm and 90 gpm, respectively. Well hydrograph data presented in Section 4 indicate that both wells are pumped simultaneously. Therefore, the amount of water withdraw daily from each well is in proportion only to the pumping rate at each well. The rate at PWS 49-1 can reasonably be estimated as the same as the rate for 70-1, which replaced 49-1 in 1971. The actual pumping rates for PWS 64-1 and 56-1 are unknown. However, the well logs indicate that PWS 64-1 and 56-1 have pumping capacities of about 230 and 160 gpm, respectively.

The current total pumping rate for the public water supply was estimated from the recent average daily water consumption for Adams (90,975 gpd [gallons per day]). The historic daily water consumption was probably higher, because the population of Adams has declined since 1911 from 700 to 472 (Daniel Freeman Public Schools 2001). To evaluate conservatively the historic pumping effect of the public wells, the current total pumping rate of 63 gpm (gallons per minute) was assigned uniformly to the period from 1956 to the present (Table 5.1). The present

TABLE 5.1 Pumping Schemes for Adams Public Water Supply System in 1956-2000

		Pumping Rate (gpm)					
		Well					
Scheme	Time Period	49-1	56-1	64-1	70-1	79-1	Total
1	1956-1965	23	40				63
2	1965-1971	12	21	30			63
	1971-1974		21	30	12		63
3	1974-1981			45	18		63
4	1981-1991			26	10	26	63
5	1991-2000				18	45	63

total pumping rate used in the model might represent the lowest rate in the history of the Adams water supply. Therefore, the pumping effects simulated by the model will reflect a conservative estimate of the effect of pumping on the groundwater flow system in the past.

With the total pumping rate set at 63 gpm for all operating public water supply wells in each time segment, the pumping rate at each supply well was allocated in proportion to the individual well pumping rate or capacity. For modeling purposes, all of the operating wells in each time segment are assumed to pump simultaneously in each time segment. Table 5.1 summarizes the Adams water supply pumping schemes used for the particle tracking analyses from 1956 to 2000.

5.2.2 Pumping Schemes at Irrigation Wells

Two irrigation wells located south of Middle Branch Big Nemaha River, IW1 and IW2, are close enough to affect the potentiometric surface at Adams. The wells have the same capacity and are pumped only during the irrigation season. During the Phase I investigation, IW1 was pumped at 800 gpm for several days, and the drawdown effect was observed at all wells in Argonne's monitoring network. In the particle tracking analyses, the following two scenarios were evaluated:

- IW1 pumping at 800 gpm for three months every year for the last 5 yr during the most recent 20 yr of pumping of the municipal wells.

- IW1 and IW2 both pumping at 800 gpm for three months every year for the last 5 yr during the most recent 20 yr of pumping of the municipal wells.

5.2.3 Pumping Scheme at LUST Recovery Wells

A pump-and-treat system was installed in February 1992 at the site of Farmers Elevator Company service station to remove both dissolved and free petroleum hydrocarbons released from LUSTs. The remediation system includes four recovery wells (RW01, RW02, RW03, and RW04) with pumping rates at 10, 30, 29, and 31 gpm, respectively. The pumping system commenced operation in February 1992. To evaluate the impact of the LUST remediation,

pumping of the recovery system for two years was simulated in conjunction with the municipal pumping scheme for 1991-2000.

5.3 Interpretation of Particle Tracking Results

Particle tracking is used to trace flow paths, or path lines, by tracking the movement of infinitely small imaginary particles placed in the flow field. Particle tracking is very helpful in visualizing groundwater flow and demonstrating available flow paths for contaminant migration when particles are placed at the potential source area. In this study, each particle tracking simulation was performed by placing water particles at the potential source areas with a release time at the start of the selected pumping scheme. In a few cases, for better visualization of pathways, water particles were released both before and at the start of the selected pumping scheme.

On the basis of known or suspected past use of carbon tetrachloride, the four most likely contaminant source areas are (1) the former CCC/USDA grain storage facility, (2) former wooden grain elevators of unknown ownership, (3) the Farmers Elevator Company, and (4) Veerhusen Feed and Seed (formerly Lloyd's Feed and Seed). To examine the available flow path lines from the potential source areas under various pumping schemes and scenarios, water particles were placed in aquifer layers 2 and 3 at the locations of the above four areas (Figure 5.1). A circle of 40 particles was placed around the area of contamination indicated by the presence of carbon tetrachloride in vegetation at the former CCC/USDA site (see Section 6). Two lines of water particles (10 each) were placed at the locations of former wooden grain elevators and steel grain bins, and 40 particles were placed around the boundary of the Veerhusen Feed and Seed and Farmers Elevator Company properties.

5.3.1 Impact of Municipal Pumping on Flow Paths and Contaminant Migration

A series of particle tracking simulations was conducted with the five schemes in Table 5.1. Results, plotted in Figures 5.2-5.6, are discussed below.

5.3.1.1 Simulation for 1956-1965

For pumping scheme 1, the continuous pumping rates for PWS 49-1 and 56-1 are 23 and 40 gpm, respectively. Figure 5.2 shows that groundwater flow distortion is greater around PWS 49-1 than at PWS 56-1, although PWS 56-1 pumps at the higher rate. Eastward flow path lines originating at the former CCC/USDA site are completely captured by PWS 49-1. Particles flowing toward the east from the Farmers Elevator Company, Veerhusen Feed and Seed, and the former wooden grain elevators are not affected by pumping of upgradient wells PWS 49-1 and 56-1. Particles from these downgradient source areas migrate to the east and discharge to the Middle Branch Big Nemaha River.

5.3.1.2 Simulation for 1965-1974

In 1965-1974, PWS 64-1 was installed, and PWS 49-1 was replaced by PWS 70-1 in 1971. Figure 5.3 illustrates the flow field when PWS 49-1/70-1, 56-1, and 64-1 pump simultaneously at rates of 12, 21, and 30 gpm, respectively. Flow path lines from the former CCC/USDA site are completely captured by well PWS 49-1/70-1, although the pumping rate at well PWS 49-1/70-1 is half that in the previous period. The new well (PWS 64-1) captures particles from the western wooden grain elevator, about 100 ft to the southwest. Particles from all other source areas flow eastward to the river.

5.3.1.3 Simulation for 1974-1981

Figure 5.4 illustrates the simulation results for pumping scheme 3. The pumping scheme uses rates of 18 gpm and 45 gpm for PWS 70-1 and 64-1, respectively. All flow path lines from the former CCC/USDA site are captured by PWS 70-1. Downgradient of PWS 70-1, pumping at PWS 64-1 has a significant effect on the groundwater flow. Particles from the eastern wooden grain elevator, the Farmers Elevator Company, and Veerhusen Feed and Seed are partially captured by PWS 64-1, and particles from the western wooden grain elevator are completely captured.

5.3.1.4 Simulation for 1981-1991

At the beginning of the period 1981-1991, a new well was installed at PWS 79-1, pumping at a modeled rate of 26 gpm. Pumping rates for PWS 64-1 and 70-1 are reduced to 26 and 10 gpm, respectively. Figure 5.5 shows that all simulated flow path lines from the former CCC/USDA site are captured by PWS 70-1. Most of the water particles originating at the eastern wooden grain elevator, the Farmers Elevator Company, and Veerhusen Feed and Seed migrate eastward to the river. However, PWS 64-1 still captures all particles from the western wooden grain elevator. Some of the water particles from the contaminant plume area developed during the previous pumping periods are also captured.

From 1965 to 1991, the simulated pumping at PWS 64-1 locally changes the flow field and continuously captures flow path lines from several of the potential source areas. Particle tracking results demonstrated in Figures 5.3-5.5 are consistent with the discovery of carbon tetrachloride at PWS 64-1 in 1990. Potential sources that might have contributed to the contamination of PWS 64-1 are (in the order in which particles were contributed) (1) the former wooden grain elevators, (2) Veerhusen Feed and Seed, (3) the Farmers Elevator Company, and (4) the former CCC/USDA site.

Particles from the former CCC/USDA site are entirely captured by PWS 70-1 during the simulation period 1981-1991, although the pumping rate is only 10 gpm. The results shown in Figures 5.2-5.5 suggest that PWS 49-1 and 70-1 captured all flow paths from the former CCC/USDA site from 1956 to 1991. This analysis is consistent with data from Argonne's Phase I investigation, showing that the concentration of carbon tetrachloride in groundwater between PWS 49-1/70-1 and Eighth Street, including SB13, SB18, and SB14, does not exceed 5 µg/L (Figure 3.5). The large capture zone created by PWS 49-1 and 70-1 was a result of their location close to the southern edge of aquifer.

5.3.1.5 Simulation for 1991-2000

In 1991, PWS 64-1 was disconnected from the municipal water system because of carbon tetrachloride contamination detected in the well in 1990, and the current pumping schedule was implemented (scheme 5). Wells PWS 79-1 and 70-1 are presently operated at 45 and 18 gpm, respectively. Simulation results (Figure 5.6) show that PWS 70-1 captures all flow path lines from the CCC/USDA site and that particles from all other source areas move eastward.

Contaminants captured by PWS 64-1 before 1991 also move to the east with the water particles. This scenario is consistent with the observed decrease in the concentration of carbon tetrachloride at PWS 64-1 from 13.1 µg/L in 1990 to < 5 µg/L at the present (Figure 3.5).

5.3.2 Impact of Irrigation Pumping on Flow Paths and Contaminant Migration

Two possible irrigation pumping scenarios were examined in this section: (1) IW1 pumping at 800 gpm for three months every year for the last 5 yr, during the most recent 20 yr of pumping of the municipal wells, and (2) IW1 and IW2 both pumping at 800 gpm for three months every year for the last 5 yr, during the most recent 20 yr of pumping of the municipal wells. Scenario 1 was designed to simulate summer 2000, with pumping only at IW1. Scenario 2 includes both irrigation wells IW1 and IW2 to evaluate the greatest drawdown that could be induced by pumping of the irrigation wells.

Figure 5.7 illustrates results simulated under scenario 1. The flow field shown in Figure 5.7 was produced at the end of the annual three-month pumping of IW1. The change in the groundwater flow is significant. However, this change does not alter the flow paths surrounding the potential source areas, although the rate of particle movement may have slowed. Well PWS 70-1 still captures all flow path lines from the former CCC/USDA site, and particles from the other source areas flow to the east. The flow field returns to the previously modeled conditions for the rest of the year after irrigation well IW1 stops pumping.

The results simulated under scenario 2 produce a greater change in the groundwater flow at the end of pumping season (Figure 5.8). Particles from the former wooden grain elevators, Veerhusen Feed and Seed, and the Farmers Elevator Company follow an oscillating flow pattern reflecting a seasonal northward component of movement induced by pumping of IW2. The general flow directions of the path lines change from eastward to northeastward. Particles from the western wooden grain elevator might pass through PWS 64-1 because of the effect of pumping at IW2. Flow path lines from the former CCC/USDA site experience no significant change in direction and are completely captured by PWS 70-1.

5.3.3 Impact of LUST Recovery System on Flow Paths and Contaminant Migration

In 1992, a remediation system including four recovery wells (RW1-RW4) began operating to remove petroleum hydrocarbons released from LUSTs at the Farmers Elevator Company service station. Recovery wells RW1-RW4 were pumped at 10, 30, 29, and 31 gpm, respectively. Figure 5.9 demonstrates results simulated for 1991-2000 (pumping scheme 5) with pumping at the four recovery wells incorporated. Pumping of the recovery system changes the flow field locally but significantly. All particles from the former wooden grain elevator, Veerhusen Feed and Seed, the Farmers Elevator Company, and contaminated well PWS 64-1 are captured by the recovery wells. The results are consistent with contamination found at monitoring well B12, about 100 ft northeast of RW4 (Figure 3.5). Pumping at the recovery wells does not affect the western part of Adams. Particles from the former CCC/USDA site are still captured by PWS 70-1.

5.4 Summary of Pumping Effects of Municipal, Irrigation, and LUST Wells

The potential contributions of the former CCC/USDA site and three other possible source areas were evaluated by particle tracking analysis for simulated historic groundwater conditions at Adams from 1956 to 2000. Simulated groundwater flow in the vicinity of the potential source areas was affected significantly by long-term pumping of the public water supply wells. From 1965 to 1991, contaminated well PWS 64-1 continuously captured groundwater flow particles from the three potential source areas in the eastern part of Adams. The contributions of these source areas, on the basis of captured water particles, are as follows, listed in declining order of possible contribution of water particles to PWS 64-1: (1) the former wooden grain elevators, (2) Veerhusen Feed and Seed, and (3) the Farmers Elevator Company. The water particles from the former CCC/USDA site were entirely captured by either PWS 49-1 or 70-1 in the western part of Adams. After 1991, the eastern part of Adams was not affected by pumping of municipal wells, and any contamination from the three eastern source areas and from contaminated well PWS 64-1 would have migrated to the east, discharging to the Middle Branch Big Nemaha River.

The expected impact of pumping of irrigation wells IW1 and IW2 on contaminant migration was limited, even though the flow field at Adams and the surrounding area was significantly changed during the seasonal pumping. Migration pathways from the former CCC/USDA site were still entirely captured by well PWS 70-1.

Simulated pumping of the four recovery wells in the LUST remediation system changed the local flow in the eastern part of Adams. Migration pathways from the former wooden grain elevator, Veerhusen Feed and Seed, the Farmers Elevator Company, and contaminated well PWS 64-1 were pulled into the LUST area. The recovery well pumping would have had no impact on the area of the former CCC/USDA site and PWS 70-1 in western Adams.

The results of the preliminary evaluation of the effects of historic pumping on past groundwater flow and contaminant transport at Adams indicate that the former CCC/USDA site is unlikely to be responsible for the carbon tetrachloride contamination of PWS 64-1. The analysis demonstrated that the contamination could have emanated from a number of other PRPs in eastern Adams. More rigorous modeling using data from pumping tests will be required to predict future groundwater flow and contaminant transport.

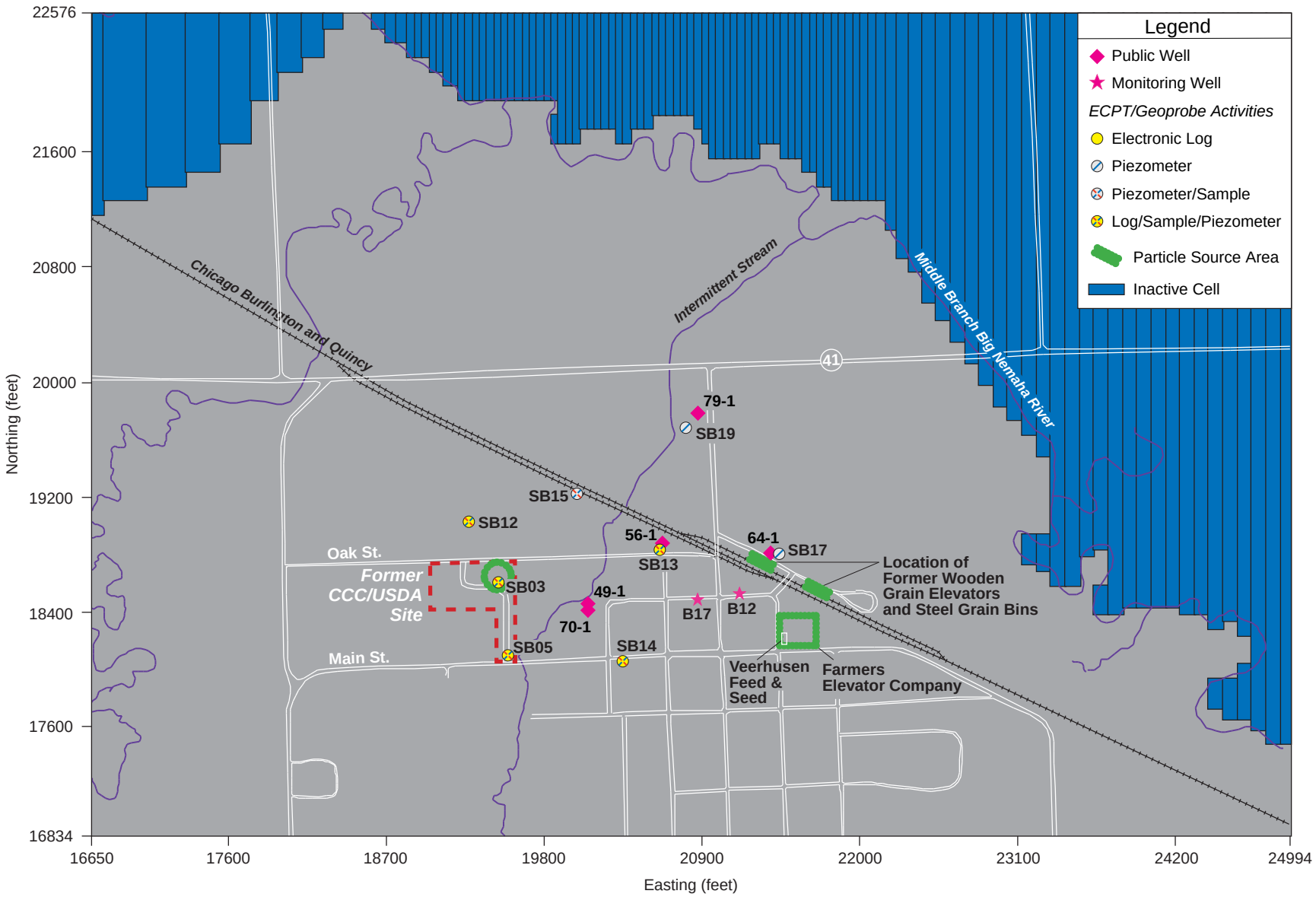

FIGURE 5.1 Map of Adams, Nebraska, Showing the Locations of the Former CCC/USDA Site and Other Potential Source Areas, with the Initial Particle Distribution for Numerical Modeling of the Pleistocene Fluvial Aquifer

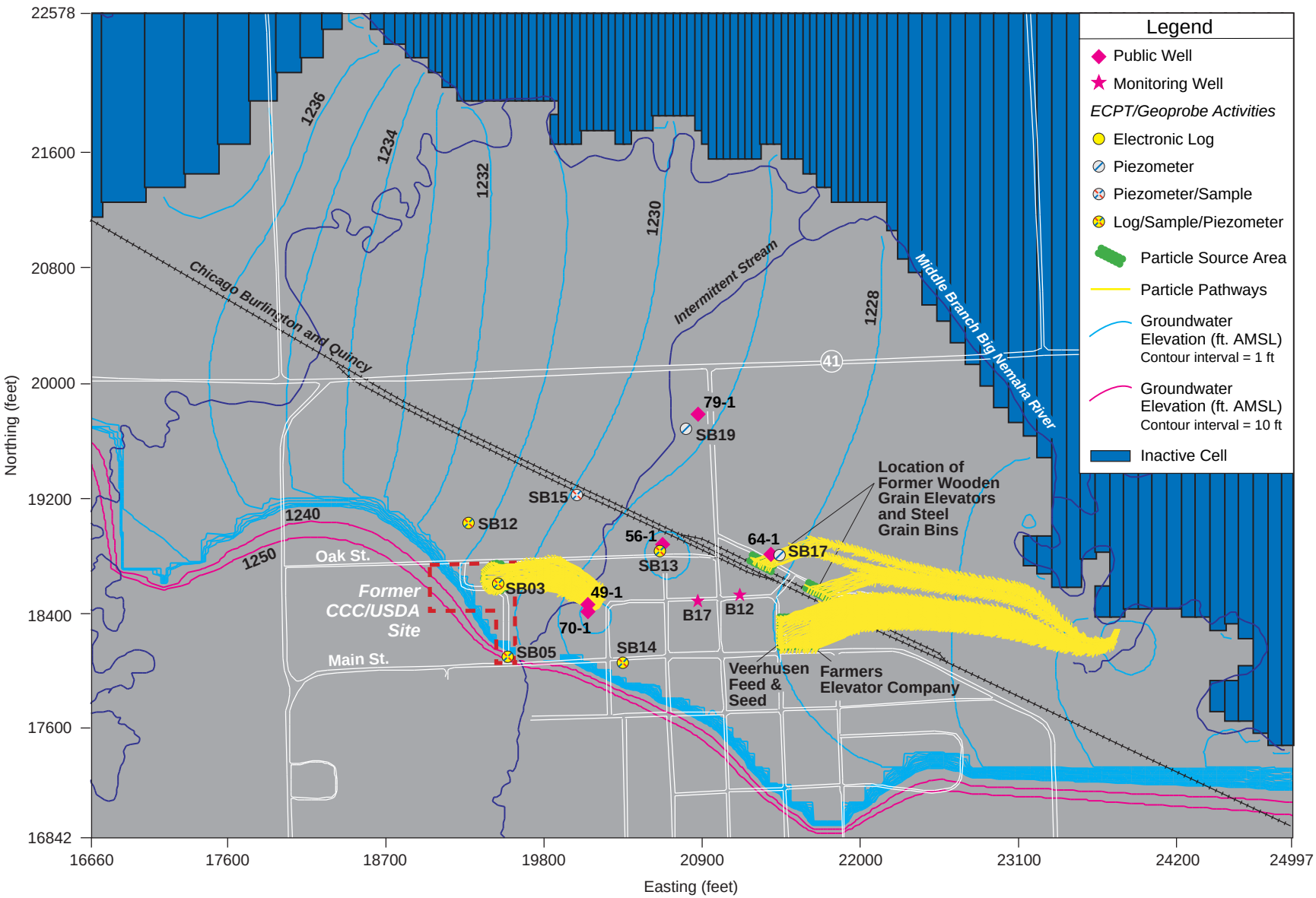

FIGURE 5.2 Map of Adams, Nebraska, Showing the Locations of the Former CCC/USDA Site and Other Potential Source Areas, with Particle Tracking Results for Pumping Scheme 1 (Table 5.1) in 1956-1965

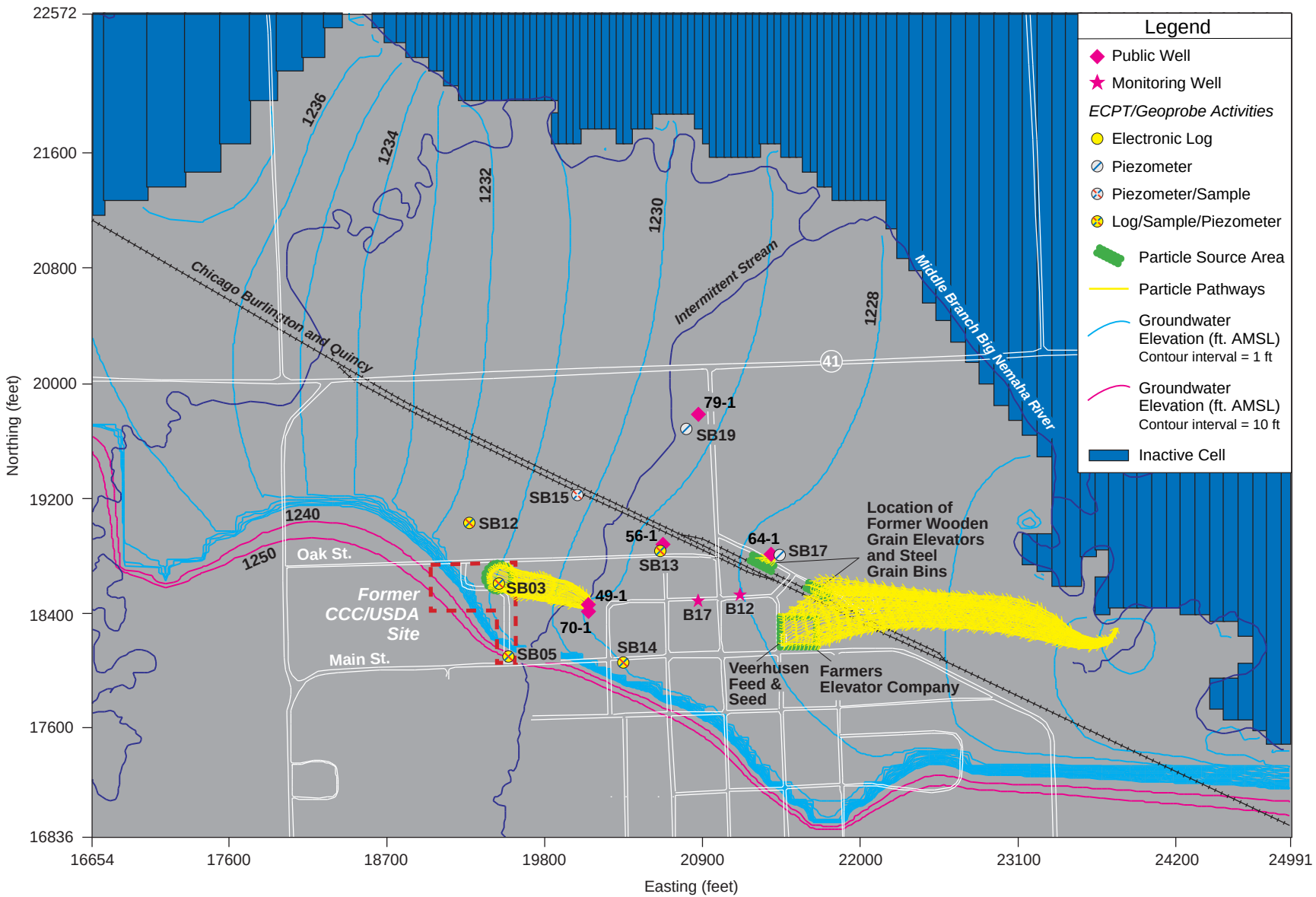

FIGURE 5.3 Map of Adams, Nebraska, Showing the Locations of the Former CCC/USDA Site and Other Potential Source Areas, with Particle Tracking Results for Pumping Scheme 2 (Table 5.1) in 1965-1974

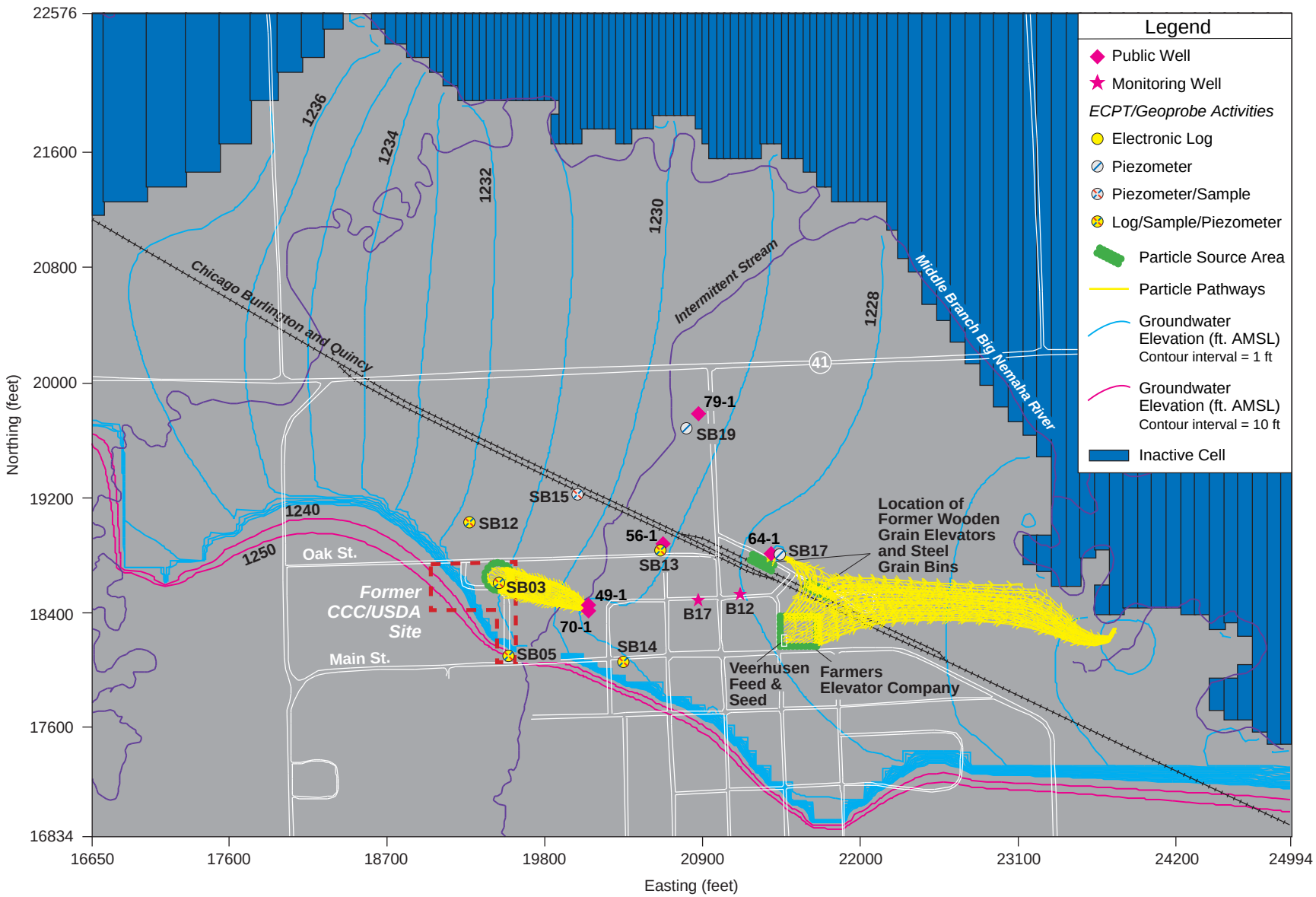

FIGURE 5.4 Map of Adams, Nebraska, Showing the Locations of the Former CCC/USDA Site and Other Potential Source Areas, with Particle Tracking Results for Pumping Scheme 3 (Table 5.1) in 1974-1981

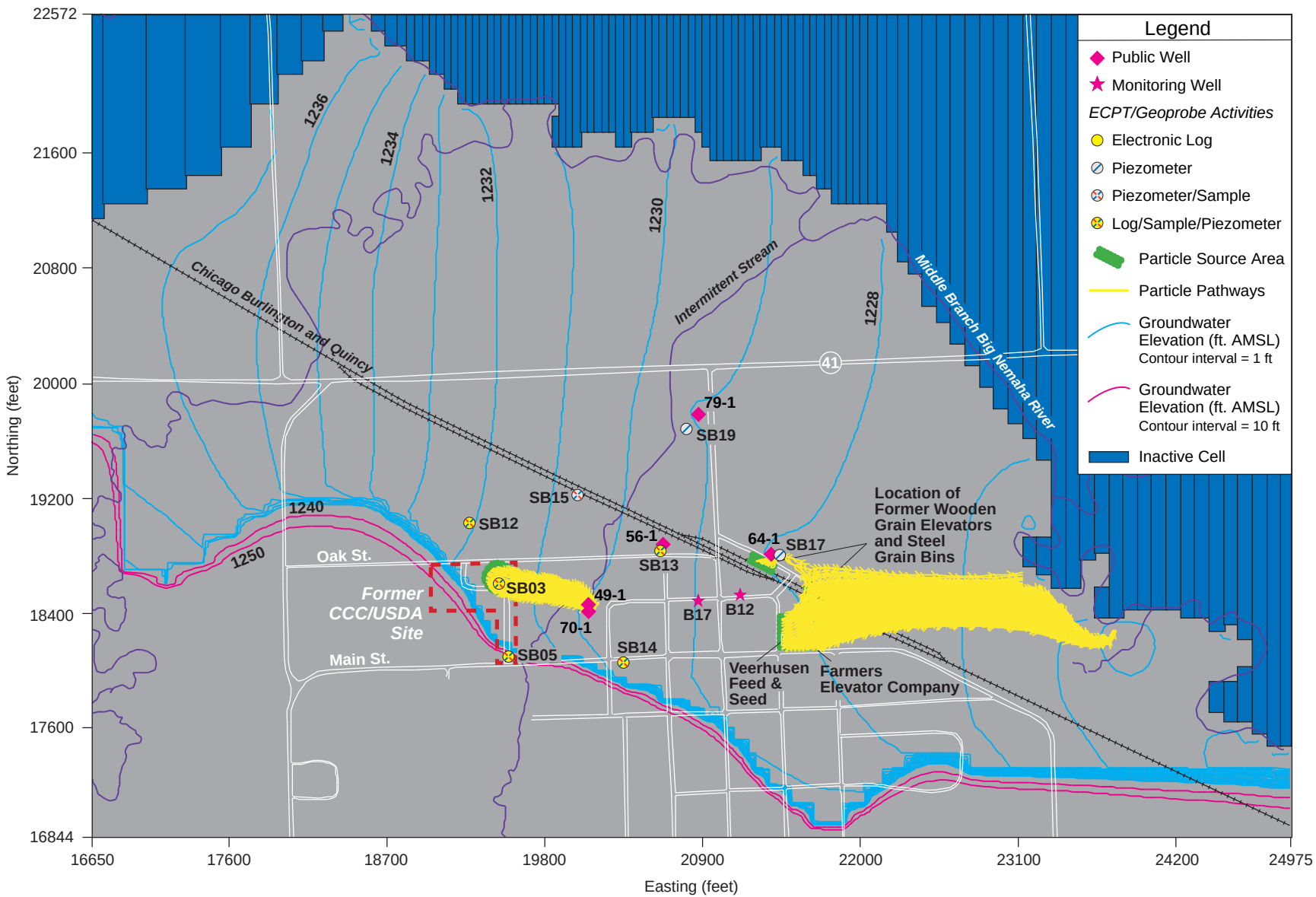

FIGURE 5.5 Map of Adams, Nebraska, Showing the Locations of the Former CCC/USDA Site and Other Potential Source Areas, with Particle Tracking Results for Pumping Scheme 4 (Table 5.1) in 1981-1991

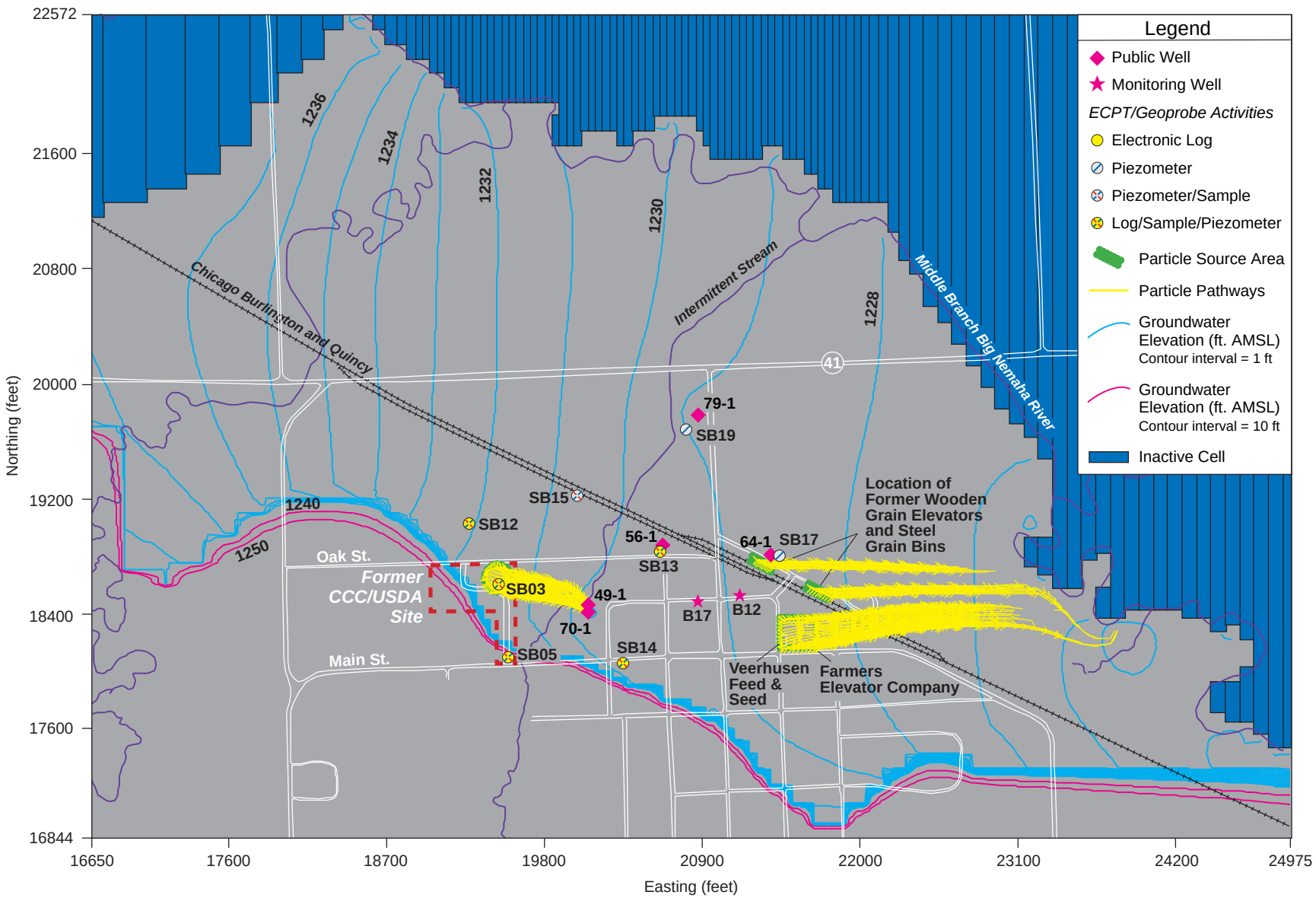

FIGURE 5.6 Map of Adams, Nebraska, Showing the Locations of the Former CCC/USDA Site and Other Potential Source Areas, with Particle Tracking Results for Pumping Scheme 5 (Table 5.1) in 1991-2000

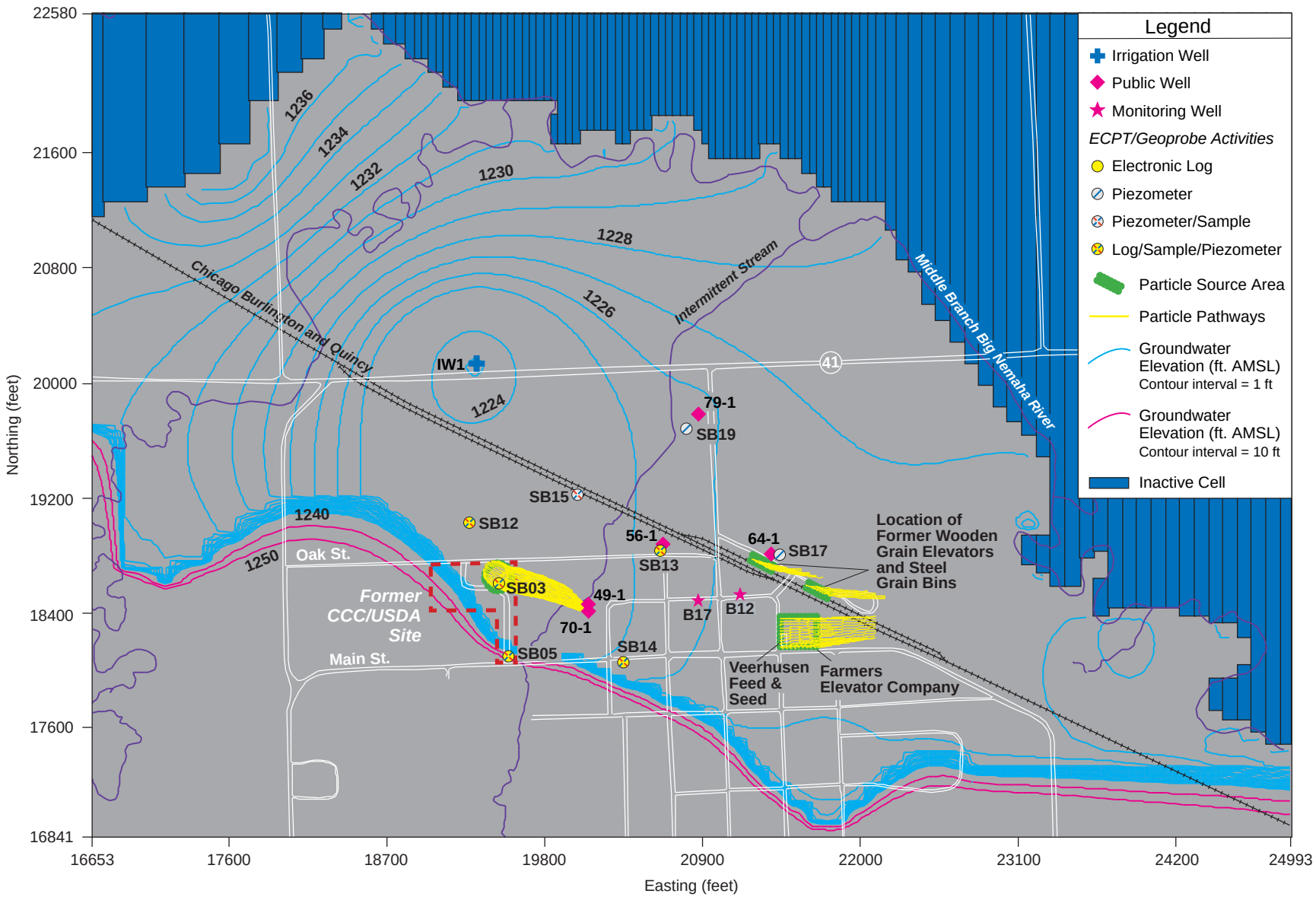

FIGURE 5.7 Map of Adams, Nebraska, Showing the Locations of the Former CCC/USDA Site and Other Potential Source Areas, with Particle Tracking Results for Pumping Scheme 5 (Table 5.1) in 1991-2000 and with Irrigation Well IW01 Pumping under Scenario 1 (Section 5.3.2)

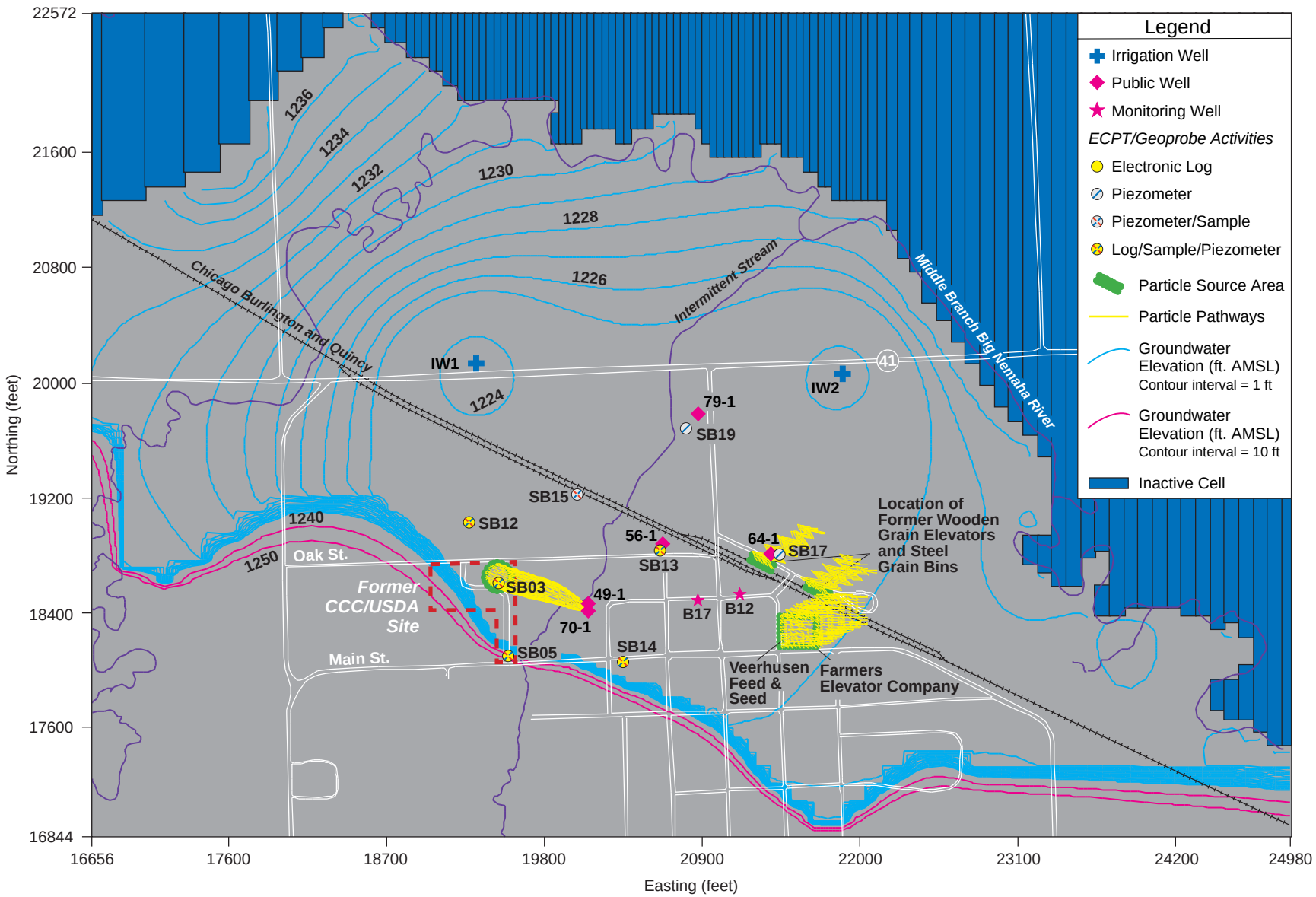

FIGURE 5.8 Map of Adams, Nebraska, Showing the Locations of the Former CCC/USDA Site and Other Potential Source Areas, with Particle Tracking Results for Pumping Scheme 5 (Table 5.1) in 1991-2000 and with Irrigation Wells IW01 and IW02 Pumping under Scenario 2 (Section 5.3.2)

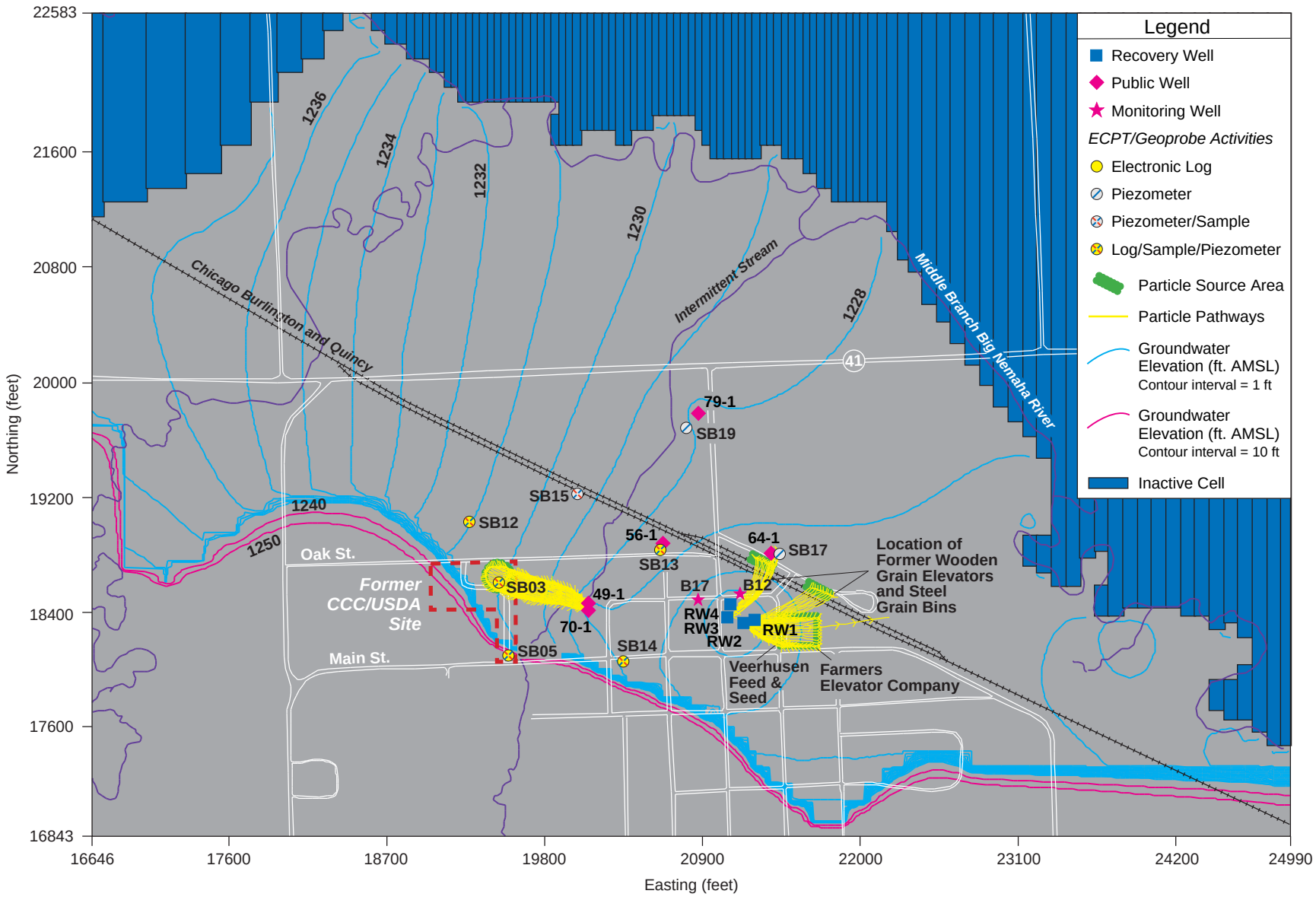

FIGURE 5.9 Map of Adams, Nebraska, Showing the Locations of the Former CCC/USDA Site and Other Potential Source Areas, with Particle Tracking Results for Pumping Scheme 5 (Table 5.1) in 1991-2000 and with LUST Monitoring Wells Pumping

6 Contaminant Distribution and Migration Pathways

6.1 Introduction

This section uses the integrated model of geology, hydrogeology, and hydrogeochemistry at Adams presented in Section 4, together with the results of preliminary groundwater flow modeling and particle tracking in Section 5, as a framework for analyzing the initial data obtained in the Phase I investigation on carbon tetrachloride and chloroform levels in vegetation, soils, and groundwater. The measurement and delineation of the contaminants carbon tetrachloride and chloroform are the primary focus of the Phase II investigation. Therefore, the data presented here from the Phase I investigation are used to (1) confirm that a problem exists to warrant the expenditure of additional resources for further investigation, (2) indicate areas that might warrant contaminant delineation, and (3) further define contaminant migration pathways.

At former CCC/USDA sites, contaminants have migrated from the surface of the source area through vadose zone infiltration into the groundwater system. To identify contaminant migration pathways, the analysis in this section includes (1) a determination of the contaminant distribution in vegetation and near-surface soils at the former CCC/USDA grain storage facility; (2) an evaluation of the evidence for contaminant infiltration into the vadose zone; (3) an evaluation of the potential for an ongoing source of contamination from subsurface soils to the groundwater; (4) the testing of postulated contaminant migration pathways in the groundwater system at Adams (Argonne 2000), and (5) an evaluation of the contaminant distribution in groundwater in relation to the postulated flow scenarios modeled in Section 5, as well as the locations of other PRPs identified by the EPA (Curry 2000).

6.2 Contaminant Distribution in Vegetation and Near-Surface Soils

6.2.1 Vegetation

Vegetation was sampled in Phase I to guide subsurface soil sampling that might be required in Phase II to locate buried residual contamination in vadose zone soils. As Figure 6.1 shows, contaminated grass was found in several portions of the site where grain storage

Quonsets huts or bins once stood. Contamination was also indicated at one isolated location at the southern end of the site.

6.2.2 Near-Surface Soil

Near-surface soils were sampled in Phase I as a basis for future risk calculations involving near-surface soil and to identify further potential locations for subsurface soil collection and analysis in Phase II. The GC-MS analyses of methanol-extracted samples failed to detect carbon tetrachloride above the quantitation limit of 10 μg/kg (Table C.2 in Appendix C).

Headspace GC-ECD analyses of the samples collected at 0.8-1.2 ft BGL and at 5.5-6 ft BGL indicated that carbon tetrachloride found in the soils correlated closely with the distribution of carbon tetrachloride in vegetation.

6.3 Migration Pathways in Groundwater

The conceptual understanding of the site in the Phase I *Work Plan* (Argonne 2000) suggested one pathway by which carbon tetrachloride might have migrated from the former CCC/USDA site to PWS 70-1 and two potential pathways from the site to PWS 64-1:

- Movement of carbon tetrachloride downward at the former CCC/USDA site until the contaminant reached the Quaternary aquifer, followed by easterly subhorizontal migration to municipal supply well PWS 70-1 (near abandoned PWS 49-1). Potential variations of this pathway could result from southeasterly flow from the northern part of the site (pathway 1a) or northeasterly flow from the southern part of the site (pathway 1b). This pathway terminates at PWS 70-1 and does not act as a source for well PWS 64-1.

- Movement of carbon tetrachloride downward at the former CCC/USDA site until the contaminant reaches the Quaternary aquifer, followed by easterly subhorizontal migration passing through the location of PWS 70-1 (PWS 49-1) and on to well PWS 64-1. Potential variations of this pathway

could bypass PWS 70-1/49-1 to the north (pathway 2a), the south (pathway 2b), or both.

- Movement of carbon tetrachloride downward at the former CCC/USDA site, followed by northeastward subhorizontal migration of the contaminant in the Quaternary aquifer, passing to the north of the capture zone for PWS 70-1 (PWS 49-1) and then easterly through the location of abandoned well PWS 56-1 to well PWS 64-1.

These potential pathways are shown schematically in Figures 1.2 and 1.3 in Section 1. Each migration pathway is evaluated below on the basis of the findings in Argonne's Phase I investigation, including changes to the aquifer as a result of the various historic pumping scenarios. Phase I groundwater sample locations are in Figure 6.2. Analytical results for carbon tetrachloride and chloroform in groundwater are in Figures 6.3 and 6.4, respectively. The results for carbon tetrachloride in groundwater are also plotted on hydrogeologic cross sections A-A´ and B-B´ in Figures 6.5 and 6.6, respectively. The locations of the cross sections are in Figure 4.1.

6.3.1 Migration Pathway 1

Pathway 1 assumes movement of carbon tetrachloride downward at the former CCC/USDA site until the contaminant reaches the Pleistocene fluvial aquifer. Carbon tetrachloride (56 µg/L) and chloroform (13 µg/L) were detected in groundwater at the top of the Pleistocene fluvial aquifer in the northeastern part of the site (SB03). This result indicates that downward contaminant movement has penetrated through the loess (unit 1) and sandy silt (unit 2) (see Figures 6.3-6.5). Carbon tetrachloride was identified in groundwater only beneath the site at location SB03 and downgradient from SB03 at SB11 (59 µg/L). Both of these locations are in the northeastern part of the site, in an area previously occupied by Quonset grain storage buildings. Analyses of groundwater samples from the Wingate well in the north-central part of the site, from SB04 at the northern end of the former line of grain bins along the eastern fence line, and from SB05 at the southern end of that line did not detect carbon tetrachloride (Figure 6.3). The Pleistocene fluvial aquifer pinches out in the southwestern part of the site, and no groundwater was recovered at SB20 (Figure 6.6).

Analyses of vegetation identified contaminated grass in several portions of the site where grain storage Quonsets huts or bins once stood (Figure 6.1). This result suggests that carbon tetrachloride infiltration might have occurred over a relatively broad area, but groundwater sampling in Phase I suggests otherwise. Phase II sampling will determine whether carbon tetrachloride and chloroform remain in the vadose zone in the areas outlined by the vegetation survey.

Migration pathway 1 postulated easterly subhorizontal migration to municipal supply well PWS 70-1 (near abandoned PWS 49-1) after the contaminants reached the Pleistocene aquifer. The analyses of groundwater from SB03, SB11, and SB16 clearly showed the plume extending due east from the northern part of the former CCC/USDA site (Figures 6.3 and 6.4). Results of the particle tracking simulation in Section 5 for the period from 1991 to 2000 (Figure 5.6) indicate that the eastward flow lines curve toward PWS 70-1 and that all contamination migrating in groundwater from the site is currently captured by the well. Significantly, the carbon tetrachloride values for PWS 70-1 have never exceeded the MCL in monitoring events from 1990 to the present (see Table 2.2, Phase I *Work Plan*, Argonne 2000). The low values of carbon tetrachloride (< 5 µg/L) that have occasionally been detected, including in this investigation (Figure 6.3), probably result from the dilution of a small volume of contaminated groundwater originating at the site with a large volume of uncontaminated water drawn from the remaining area of influence of the well. (Values reported as < 5 µg/L indicate that the compound was present but could not be quantified.) The quantifiable section of the plume (> 5 µg/L carbon tetrachloride) that moves east from the northeast part of the site is less than 200 ft wide and occupies only a thin vertical zone within the fluvial aquifer (Figure 6.5). At SB16, the sampling site in the plume that is closest to PWS 70-1, the plume is only 5 ft thick in an aquifer that is 32.8 ft thick. The carbon tetrachloride concentration in the plume at SB16 is 32 µg/L (Figure 6.5).

The Phase I *Work Plan* (Argonne 2000) considered that variations to the primary pathway could result from southeasterly flow from the northern part of the site (pathway 1a) or northeasterly flow from the southern part of the site (pathway 1b). Southeasterly flow from the northern part of the site (pathway 1a) is not supported by the maps of contaminant distribution in groundwater or the potentiometric surface of the fluvial aquifer (Figures 6.3 and 6.7). Both point to eastward flow from the northern part of the site.

Northeasterly flow from the southern part of the site (pathway 1b) could occur because of the capture by PWS 70-1 of eastward groundwater flow from the site. However, no contamination was found in groundwater samples from the southern part of the site, at SB04 and SB05 (Figure 6.3). Flow from this part of the site is probably restricted because the fluvial aquifer is thin at SB04 and gives way to saturated silt at SB05.

6.3.2 Migration Pathway 2

Pathway 2 assumes movement of carbon tetrachloride downward at the former CCC/USDA site until the contaminant reaches the fluvial aquifer. This part of the migration pathway is identical to that for migration pathway 1 (Section 6.3.1).

The Phase I *Work Plan* (Argonne 2000) postulated that contaminant infiltration at the former CCC/USDA site would be followed by easterly subhorizontal migration in the fluvial aquifer. This migration pathway would pass through the location of PWS 70-1 (PWS 49-1) and on to well PWS 64-1. Potential variations of this pathway could bypass PWS 70-1/49-1 to the north (pathway 2a), the south (pathway 2b), or both. Results of the particle tracking simulations for the conditions existing at present (Section 5, Figure 5.6) indicate that no contamination currently originating at the former CCC/USDA site will bypass PWS 70-1. Because the northern part of the site appears to contain the major current source of contamination, migration would most likely have occurred from west to east along the line of cross section A-A´, between the northern part of the site and PWS 64-1 (Figure 6.5). Cross section B-B´ shows the distribution of carbon tetrachloride between the center of the former CCC/USDA site and LUST well B12, directly east of PWS 70-1 (Figure 6.6).

The areal distributions of carbon tetrachloride and chloroform in groundwater along postulated pathway 2 are shown in Figures 6.3 and 6.4, respectively. Values for carbon tetrachloride or chloroform do not exceed 5 µg/L to the east of SB 16, located west of PWS 70-1 along the northern pathway (2a). However, carbon tetrachloride concentrations below 5 µg/L are found between PWS 70-1 and PWS 64-1 in the lower portion of the aquifer at SB13 (Figure 6.5) and at SB18 (Figure 6.6). The low values found at SB13 and SB18 might represent the diluted remnants of contamination that potentially escaped capture by PWS 49-1/70-1.

Farther to the east, carbon tetrachloride was found at 11 µg/L at LUST monitoring well B12 (Figure 6.6). Simulation of pumping of the four extraction wells at the LUST site indicated that the wells could have captured all contaminants originating from the potential source areas in eastern Adams. These are the former wooden grain elevators, Veerhusen Feed and Seed, and the Farmers Elevator Company (Figure 5.9). The contaminant plume drawn to well PWS 64-1 could also have been redirected to the LUST extraction wells. Consequently, the contamination at B12 could be due to past extraction of groundwater that has drawn carbon tetrachloride from a source or sources in the eastern part of Adams.

6.3.3 Migration Pathway 3

Migration pathway 3 suggested that movement of carbon tetrachloride downward at the former CCC/USDA site was followed by northeastward subhorizontal migration of the contaminant in the Pleistocene aquifer passing to the north of the capture zone for PWS 70-1 (PWS 49-1). The migration would then continue easterly through the location of abandoned well PWS 56-1 to well PWS 64-1. The Phase I investigation has eliminated this potential pathway, because an easterly flow direction in the aquifer has been established (Figure 6.7).

6.4 Summary

Analyses of vegetation in Phase I identified contaminated grass in several portions of the site where grain storage Quonset huts or bins once stood. This result suggests that carbon tetrachloride infiltration might have occurred over a relatively broad area, but groundwater sampling in Phase I suggests otherwise. Phase II soil sampling will determine whether carbon tetrachloride and chloroform remain in the vadose zone in the areas indicated by the vegetation survey.

Near-surface soils collected in a grid pattern over the previous locations of grain storage buildings were sampled as a basis for future risk calculations involving near-surface soil and to identify further areas of potential subsurface contamination. The GC-MS analyses of methanol-extracted samples failed to detect carbon tetrachloride above the quantitation limit of 10 µg/kg. Vadose zone samples will be collected in Phase II in the areas outlined by the vegetation survey to investigate the areas of potential subsurface contamination.

Contamination was detected at the top of the Pleistocene fluvial aquifer at two locations in the northeastern part of the site. Maximum carbon tetrachloride and chloroform values were 59 and 20 µg/L, respectively. The contamination occurs in an area previously occupied by Quonset grain storage buildings, probably indicating that downward movement of contamination has penetrated through the loess and sandy silt units overlying the Pleistocene fluvial aquifer at this location. Groundwater samples from the remainder of the site were free of contamination. The groundwater contamination extends due east from the northern part of the former CCC/USDA site. Results of particle tracking simulations indicate that the eastward flow lines leaving the site curve toward PWS 70-1 and that all contamination migrating in groundwater from the site is currently captured by the well. Significantly, the carbon tetrachloride values for PWS 70-1 have never exceeded the MCL in monitoring events from 1990 to the present. The low values of carbon tetrachloride found in samples from PWS 70-1 probably result from the dilution of a small volume of contaminated groundwater originating at the site with a large volume of uncontaminated water drawn from the area of influence of the well.

Farther to the east, carbon tetrachloride was found at 11 µg/L at LUST monitoring well B12. Simulation of the pumping of the four extraction wells at the LUST site indicated that the wells would have captured all contaminants originating from the former wooden grain elevator, Veerhusen Feed and Seed, and the Farmers Elevator Company. Therefore, the contamination at B12 could be the result of this pumping, with the source or sources located in the eastern part of Adams. Particle tracking also showed that well PWS 64-1 could have captured groundwater contamination from local sources in the eastern part of Adams in the past.

The particle tracking simulations for the conditions existing at present indicate that no contamination currently originating at the former CCC/USDA site will bypass PWS 70-1. Groundwater sampling to the east of PWS 70-1 found low levels of carbon tetrachloride (< 5 µg/L). These values could represent the remnants of contamination that potentially escaped capture by PWS 49-1/70-1. Consequently, the overall contribution that the former CCC/USDA site might have made to contamination at PWS 64-1 is questionable and could be small in comparison to the possible contribution from potential source areas near the well.

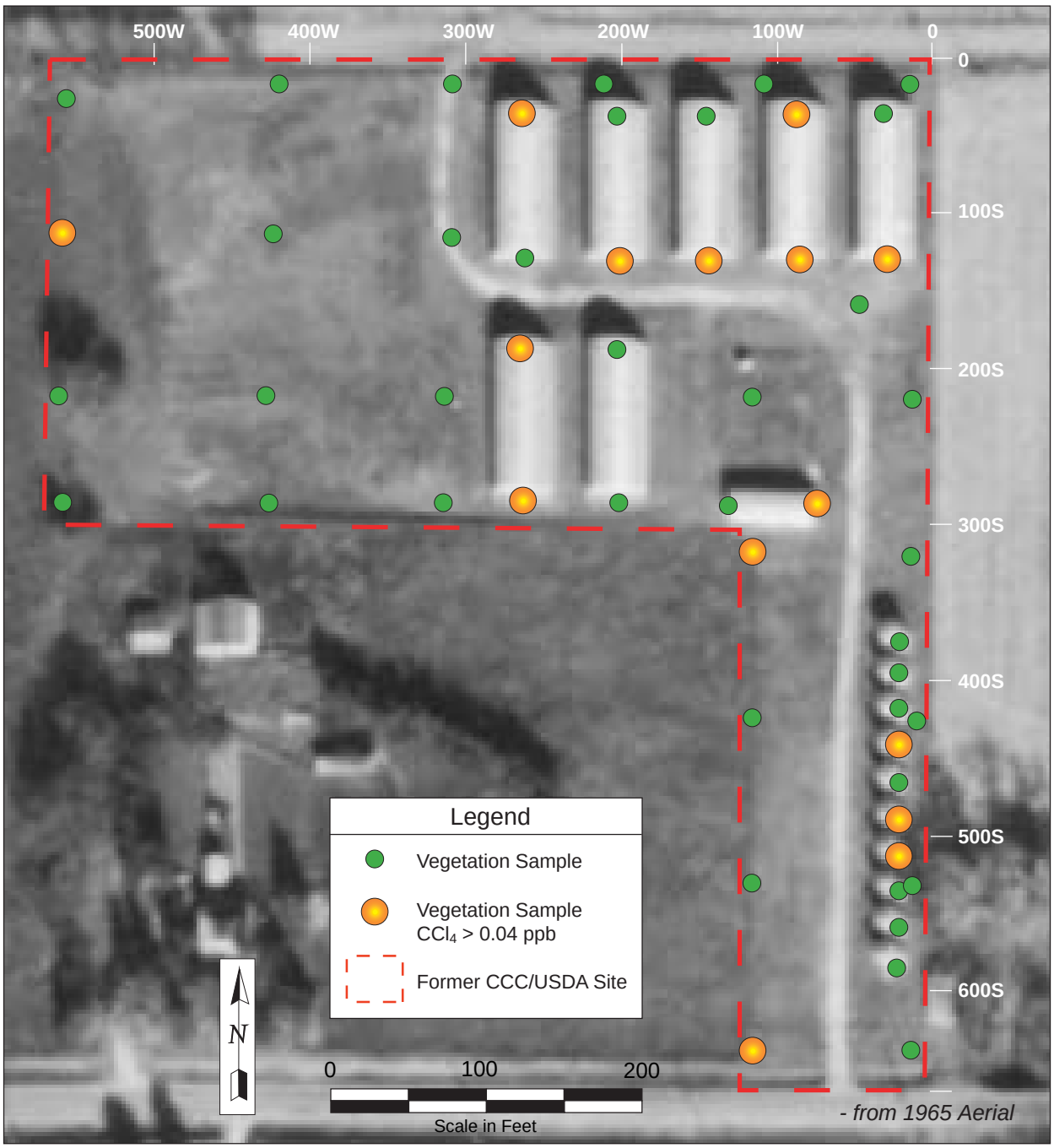

FIGURE 6.1 Aerial Photograph of the Former CCC/USDA Site at Adams (USDA 1965), Showing the Results of Analyses for Carbon Tetrachloride in Vegetation

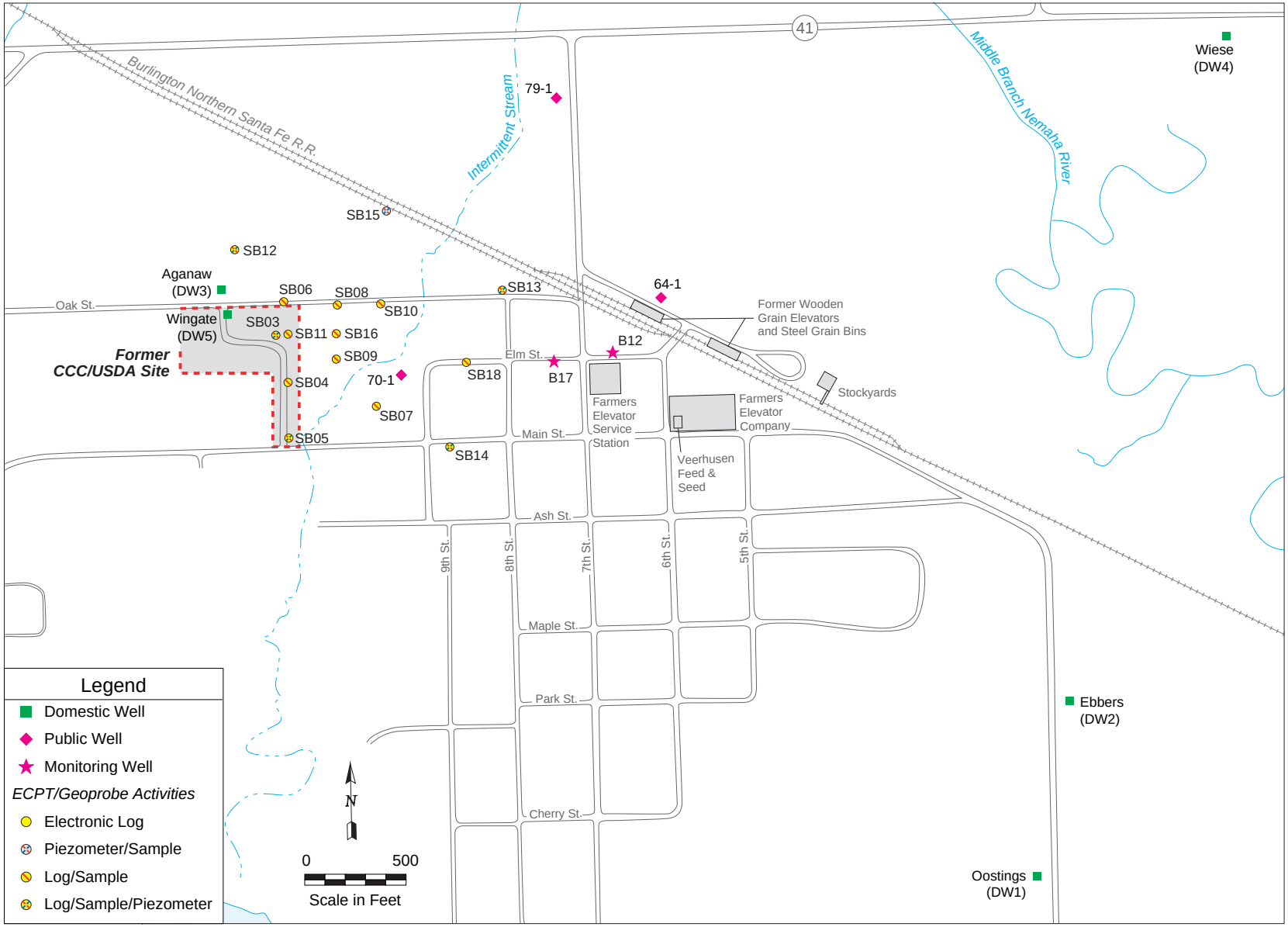

FIGURE 6.2 Map of Adams, Nebraska, Showing the Locations of the Former CCC/USDA Site and Other Potential Source Areas, with the Locations of Phase I Groundwater Samples

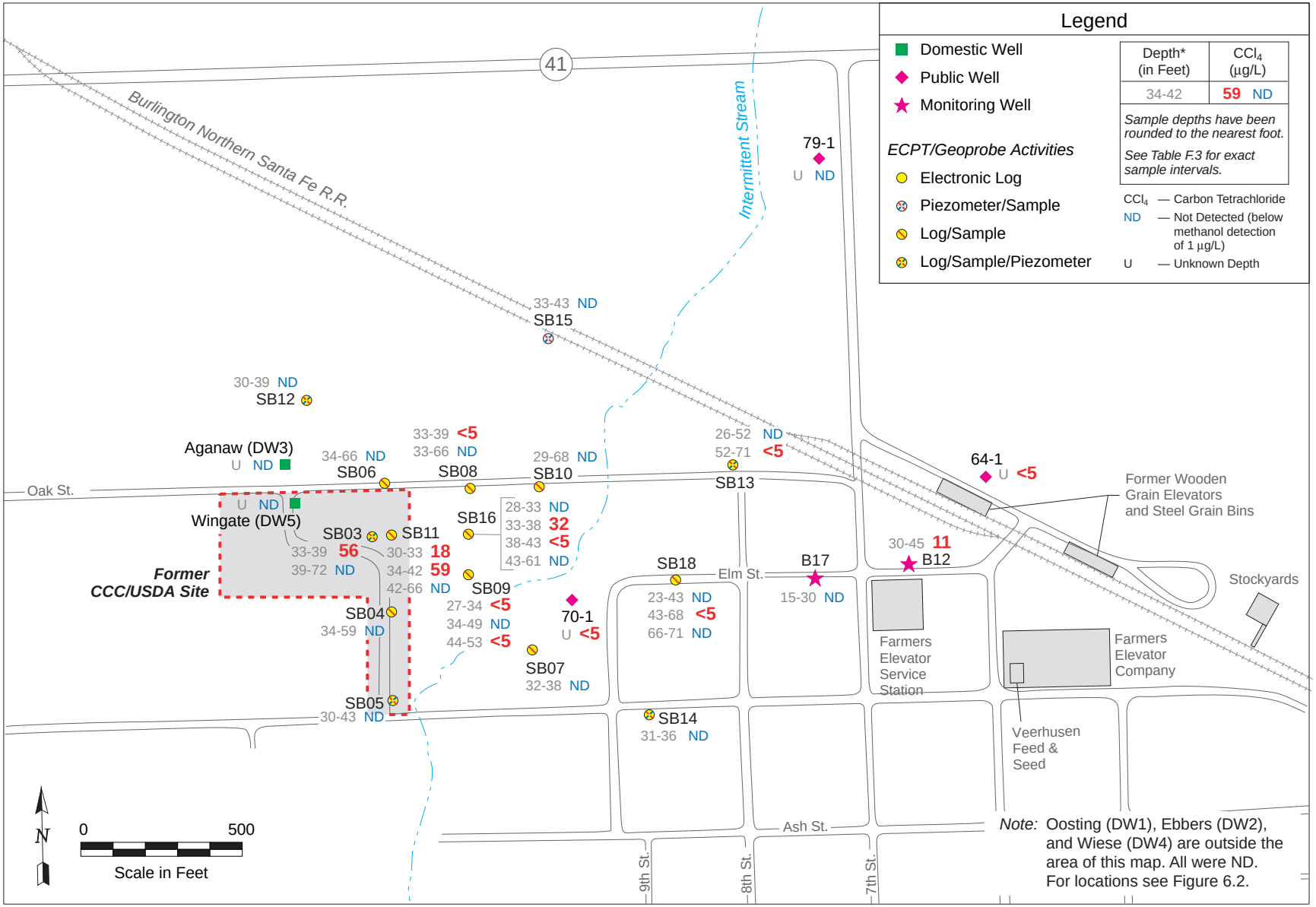

FIGURE 6.3 Map of Adams, Nebraska, Showing the Former CCC/USDA Site, the Locations of Groundwater Samples, and the Results of Analyses of These Samples for Carbon Tetrachloride

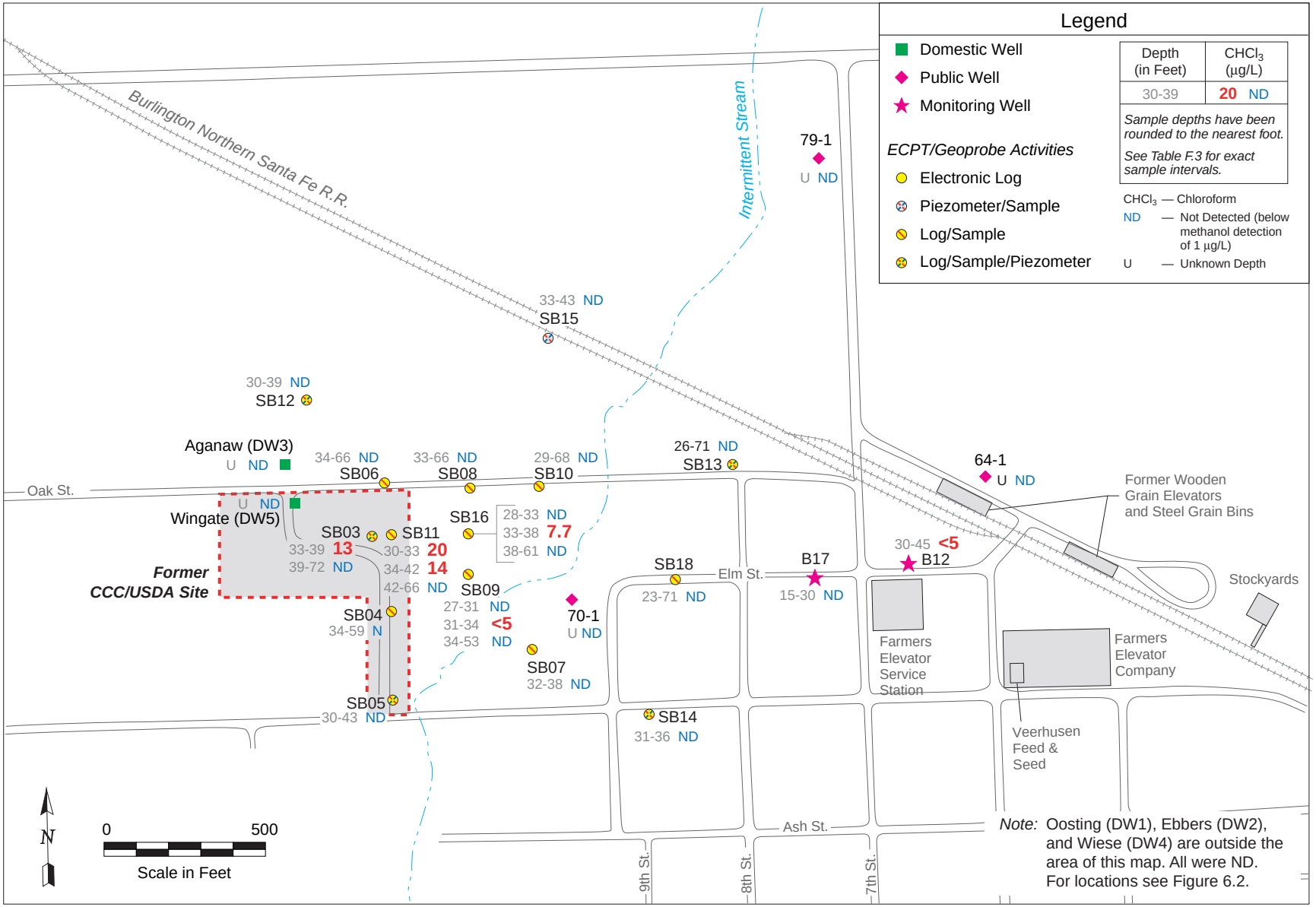

FIGURE 6.4 Map of Adams, Nebraska, Showing the Former CCC/USDA Site, the Locations of Groundwater Samples, and the Results of Analyses of These Samples for Chloroform

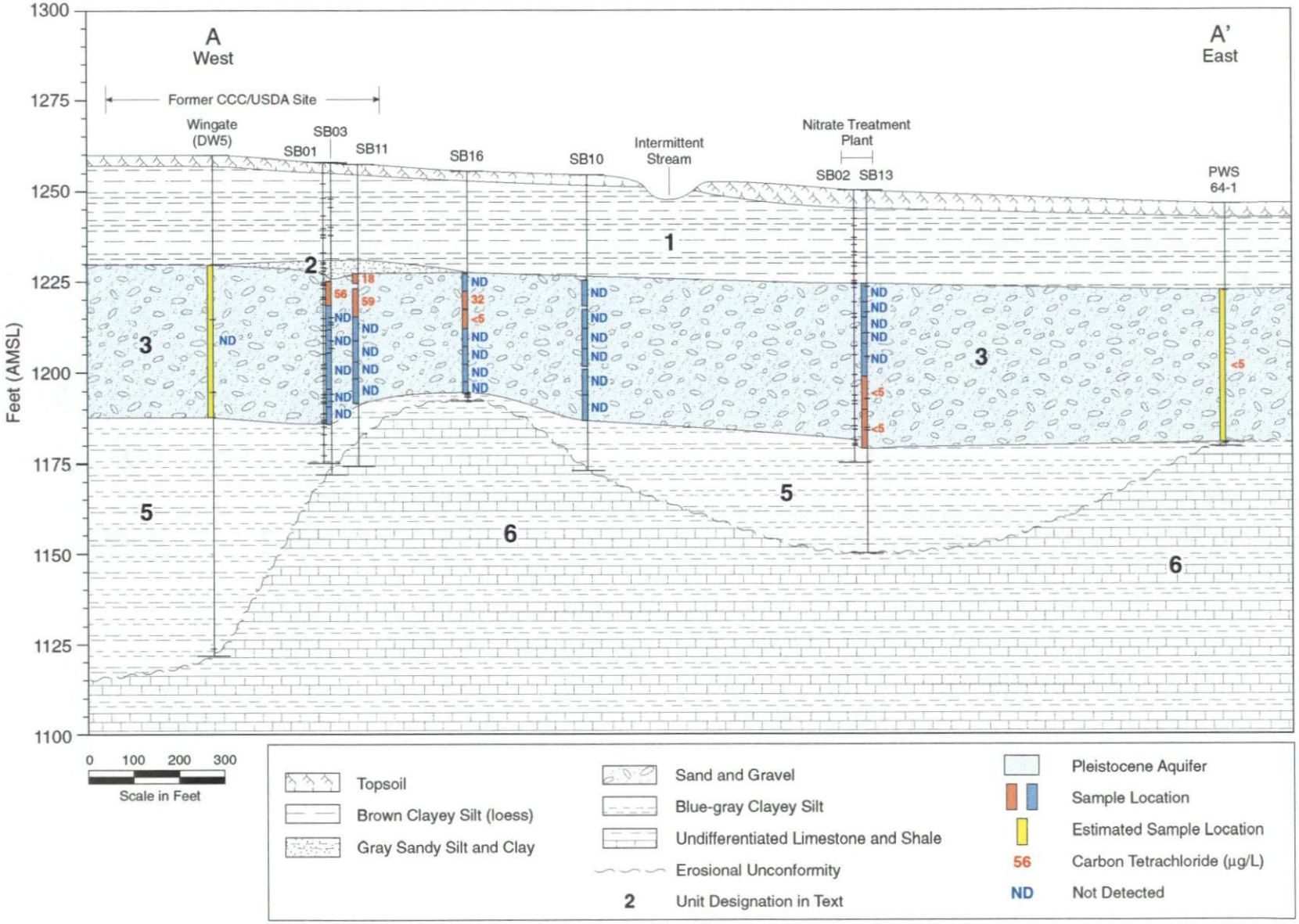

FIGURE 6.5 West-to-East Cross Section A-A´, Showing the Pleistocene Aquifer at Adams and the Distribution of Carbon Tetrachloride in Groundwater

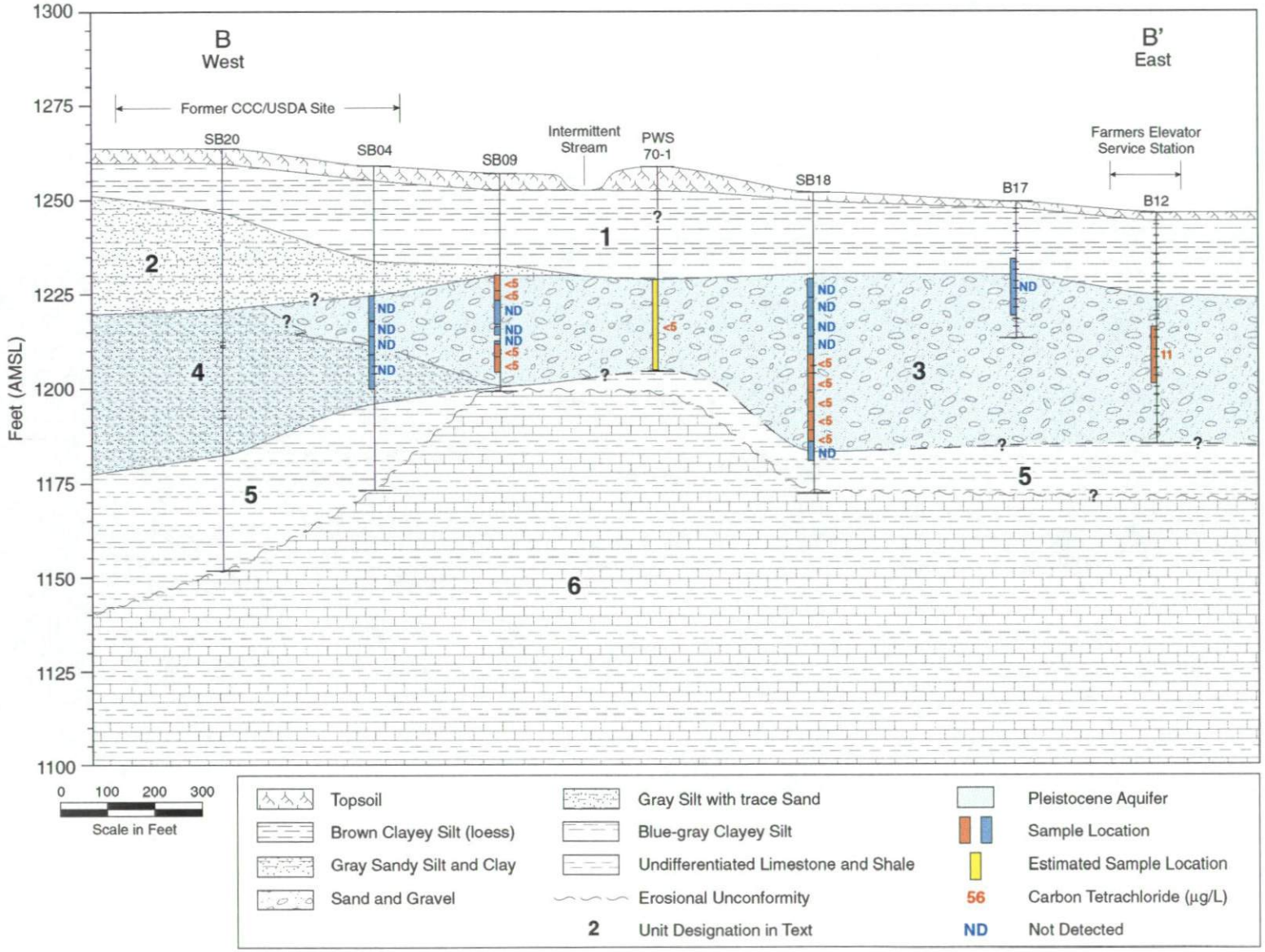

FIGURE 6.6 West-to-East Cross Section B-B´, Showing the Pleistocene Aquifer at Adams and the Distribution of Carbon Tetrachloride in Groundwater

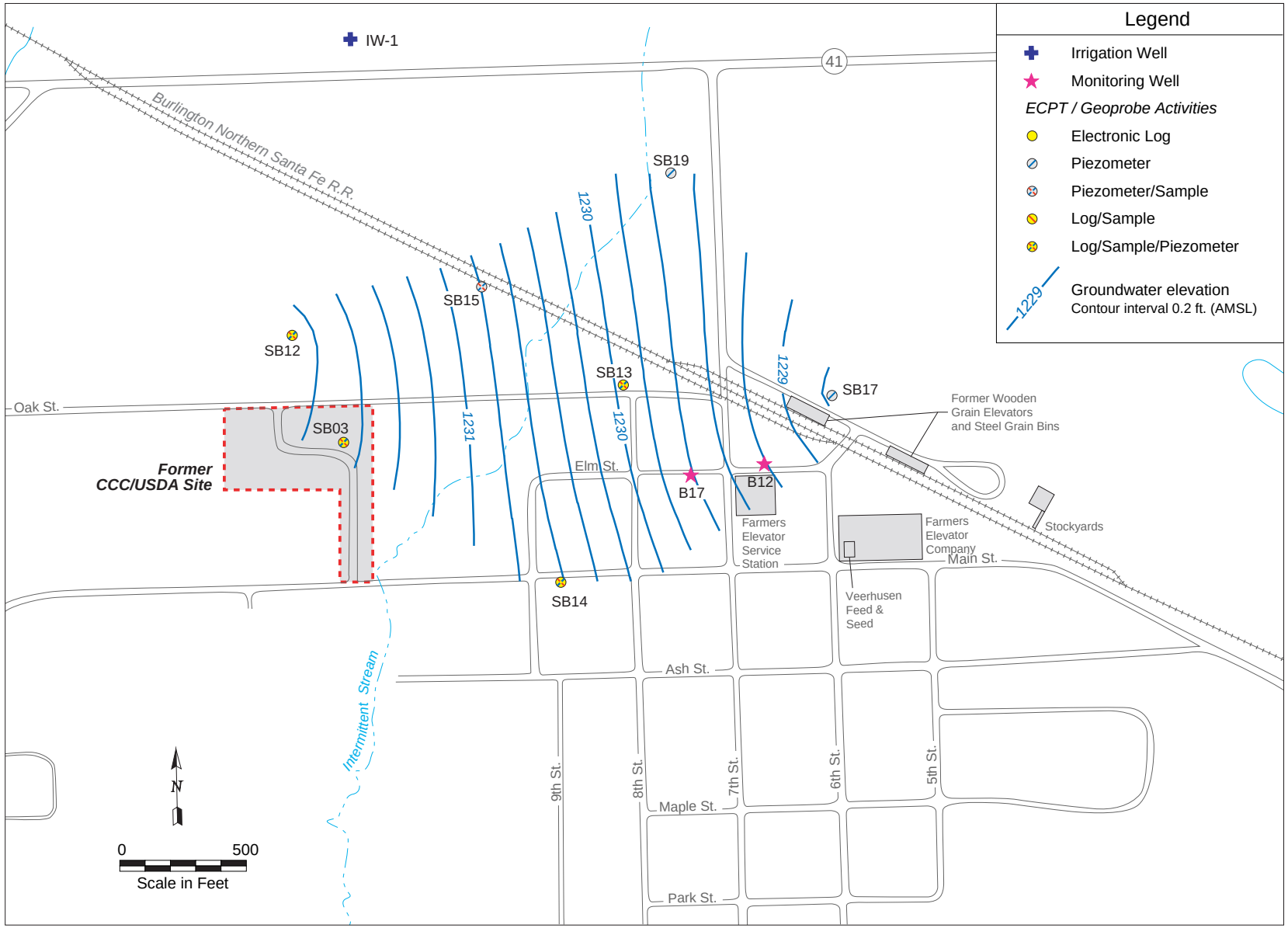

FIGURE 6.7 Potentiometric Surface for the Pleistocene Fluvial Aquifer at Adams, as Determined by Hand Measurements on May 11, 2000

7 Technical Conclusions

This section summarizes the findings of the Phase I QuickSite® investigation at Adams, Nebraska. The goals of the Phase I studies were (1) to obtain information required to test and refine the preliminary hydrogeologic model of the site presented in the Phase I *Work Plan* (Argonne 2000) and (2) to develop a preliminary understanding of the occurrence and migration of carbon tetrachloride within the vadose zone and the aquifer system at Adams. The Phase I studies were targeted to examine the key lithologic, stratigraphic, hydrostratigraphic, and hydrogeochemical relationships within the subsurface, which together define the groundwater flow system in the Adams area. The results of the Phase I investigation underpin the conceptual hydrogeologic model of the Pleistocene aquifer system that will be used to guide the Phase II investigation.

The following are the principal technical findings of Phase I of the QuickSite® investigation at Adams:

- The Recent and Pleistocene sediments in the area of investigation were deposited on the southern edge of a major paleovalley that was cut into the Permian bedrock during the Pleistocene. Consequently, the former CCC/USDA site lies within a transitional zone between fluvial sediments to the north and glacial sediments to the south. The thickness of the Recent and Pleistocene units varies between 70 and 150+ ft, becoming thicker to the north.

- The Pleistocene aquifer, consisting of a fluvial sand and gravel (unit 3), is semiconfined by the overlying loess (unit 1) and sandy silt (unit 2) and confined by the underlying older Pleistocene gray silt (unit 5) and Permian limestone (unit 6). Normally, the aquifer is under a leaky confined condition. Groundwater in the Pleistocene fluvial aquifer at Adams flows to the east with an hydraulic gradient of 0.0016. The saturated gray silt (unit 4) that lies in direct contact with the southern edge of the aquifer acts as an aquitard or poor aquifer, providing a slow discharge of groundwater to the fluvial aquifer from the south. The hydraulic conductivity of the fluvial aquifer varies from a few to 100 ft/d.

- Tritium analyses showed that groundwater from the Pleistocene aquifer at Adams is the result of modern (post-1951) recharge. Most of the samples represent recharge within the past 20 yr. However, groundwater at the southern edge of the fluvial sand and gravel aquifer may contain a tritium-enriched groundwater component that originated as precipitation in the drift hills south of Adams before 1980. The tritium concentrations decline with depth in the aquifer, consistent with the conceptual model of infiltration of younger water at the top and the accumulation of older water at the base of the aquifer. However, immediately east of well PWS 70-1, the uppermost groundwater has a lower tritium concentration than groundwater in the middle of the aquifer. Long-term pumping of well PWS 70-1 could have altered the normal distribution of groundwater ages downgradient of well PWS 70-1.

- Groundwater samples from the sand and gravel aquifer at Adams are largely of the calcium bicarbonate type that is characteristic of the Pleistocene shallow and paleovalley alluvial aquifers of the region. This geochemically distinct sand and gravel aquifer is the only groundwater system affected by carbon tetrachloride contamination at Adams.

- Samples from the sand and gravel aquifer are nearly all contaminated with nitrate in excess of the MCL of 10 mg/L. The ubiquitous presence of nitrate will have to be considered in developing plans for any aquifer cleanup.

- Analyses of vegetation identified contaminated grass in several portions of the former CCC/USDA grain storage site, where Quonsets huts or bins once stood. This result suggests that carbon tetrachloride contamination might have occurred over a relatively broad area, but analyses of near-surface soils failed to detect carbon tetrachloride above the quantitation limit of 10 µg/kg.

- Contamination was detected at the top of the Pleistocene fluvial aquifer at two locations in the northeast part of the site. Maximum carbon tetrachloride and chloroform values were 59 and 20 µg/L, respectively. The contamination occurs in an area previously occupied by Quonset grain storage buildings, probably indicating that downward movement of contamination has penetrated through the loess (unit 1) and sandy silt (unit 2) overlying the

Pleistocene fluvial aquifer at this location. Groundwater samples from the remainder of the site were free of contamination. The groundwater contamination extends due east from the northern part of the former CCC/USDA site.

- Groundwater level fluctuations at Adams indicate that the local groundwater flow system is significantly affected by pumping of the public water supply and irrigation wells.

- Groundwater flow beneath the former CCC/USDA grain storage facility is eastward toward PWS 70-1, and any contamination in groundwater originating from the site is currently captured by this well. Carbon tetrachloride concentrations detected at PWS 70-1 have never exceeded the MCL in monitoring events from 1990 to 2000. The low values of carbon tetrachloride found in samples from PWS 70-1 probably result from the dilution of a small volume of contaminated groundwater originating at the site with a large volume of uncontaminated water drawn from the area of influence of the well.

- Particle tracking simulations demonstrate that no contamination originating at the former CCC/USDA site could have bypassed PWS 70-1 and migrated farther east toward PWS 64-1. Consequently, it is unlikely that the former CCC/USDA site caused the contamination found at well PWS 64-1. It is more likely that groundwater at PWS 64-1 was contaminated by carbon tetrachloride from previously identified PRPs in eastern Adams (Curry 2000).

- Simulated pumping of the four extraction wells at the LUST site indicated that these wells could have affected carbon tetrachloride migration from potential source areas at the former wooden grain elevators, Veerhusen Feed and Seed, and the Farmers Elevator Company. Such pumping would have locally influenced the contaminant distribution in groundwater in the eastern part of Adams, near PWS 64-1, and might account for the carbon tetrachloride detected in one of the LUST monitoring wells.

- Particle tracking simulations showed that PWS 64-1 could also have captured groundwater contamination from local sources in the eastern part of Adams in the past. Carbon tetrachloride was detected by the EPA in groundwater from the Farmers Elevator Company property near PWS 64-1 (Curry 2000).

8 Recommended Actions and Phase II Work Plan

Two major results stem from the Phase I QuickSite® investigation at Adams, Nebraska. The data strongly indicate (1) that the former CCC/USDA site in the western part of Adams is not the source of the carbon tetrachloride contamination found in groundwater from PWS 64-1 in eastern Adams and (2) that the former CCC/USDA site is the source of groundwater contamination occasionally detected at levels below the MCL in PWS 70-1 in western Adams.

An additional finding of the Phase I investigation is that well PWS 70-1 serves to contain and extract dilute groundwater contamination originating at the former CCC/USDA site as long as it continues to be pumped regularly. Without the continued pumping of PWS 70-1, the contaminant plume would be free to migrate to the east, potentially affecting future development of the downgradient portion of the aquifer to supplement the existing public water supply. The occasional carbon tetrachloride values (maximum 1.3 µg/L) detected in PWS 70-1 have never exceeded the MCL in monitoring events from 1990 to 2000 (see Table 2.2, Phase I *Work Plan*, Argonne 2000). The low values of carbon tetrachloride result from the dilution of a small volume of contaminated groundwater originating at the site with a large volume of uncontaminated water drawn from the remaining area of influence of the well. The contaminated plume (with carbon tetrachloride > 5 µg/L) that moves eastward from the northeast part of the site is less than 200 ft wide and occupies only a thin vertical zone within the fluvial aquifer. At the sampling site in the plume that is closest to PWS 70-1, contaminated groundwater occupies only a 5-ft-thick zone in an aquifer that is 32.8 ft thick. The carbon tetrachloride concentration in the plume at this location is 32 µg/L, but dilution at the well effectively lowers the carbon tetrachloride concentration below the MCL. The water from PWS 70-1 is further diluted by mixing with water from PWS 79-1 before distribution to the public. Because the well provides a containment and remediation function for the carbon tetrachloride contamination, it would be prudent to continue pumping PWS 70-1 until an alternative plan for remediation of the plume is in effect or remediation of the former grain storage facility has been accomplished. Pumping should continue even if the well is disconnected from the distribution system.

Contamination of groundwater at PWS 64-1 probably originated from one or more of the PRPs identified by the EPA in eastern Adams (Curry 2000). Consequently, Phase II work to investigate groundwater contamination at Adams further will be restricted to the area of the former grain storage site and the contaminated groundwater between the site and PWS 70-1 in the western part of Adams.

The final planning for any work to follow the Phase II work proposed here will be done after the Phase II results are available, as will subsequent risk calculation for any present groundwater plume and contaminated soil that are related to the former CCC/USDA site near PWS 70-1. If the conceptual model is confirmed, final planning will proceed for the western area. If the results show that groundwater contamination from the CCC/USDA site might have affected PWS 64-1, final planning for work in the area near PWS 64-1 will be deferred. Any future work in this area must involve the other PRPs. Known nitrate and LUST contamination issues in eastern Adams will also have to be considered.

The conceptual hydrogeologic model for the Adams area established in the Phase I studies will serve as the guiding framework for Phase II of the site investigation. The proposed work will further delineate the lateral extent of the groundwater plume and its relationship to the PWS 70-1 capture zone downgradient from the former CCC/USDA site, assess whether a continuing soil source for groundwater contamination exists at the site, and delineate the extent of soil contamination.

Details of the proposed activities are as follows:

- Analyses of vegetation identified contaminated grass in several portions of the former CCC/USDA grain storage site where Quonset huts or storage bins once stood (Figure 6.1). The ECPT will be used to collect vadose zone samples from the areas outlined by the vegetation survey in Phase I, with highest priority along the edges of the former Quonset hut or storage bin locations. Proposed ECPT sampling locations are in Figure 8.1.

- The ECPT will be used to collect groundwater samples to the east of the former CCC/USDA site to refine the contaminant distribution in the area between the site and PWS 70-1. The results of the investigation will also determine whether any contaminants are currently bypassing the PWS 70-1 capture zone through sampling immediately to the northeast of PWS 70-1. Three proposed ECPT sampling locations are shown in Figure 8.2. Up to five additional locations in this general area will be sampled if needed to delineate the plume boundary accurately and determine whether contamination could bypass the PWS 70-1 capture zone.

- Groundwater samples will be collected with the ECPT from the upper 15 ft of the Pleistocene fluvial aquifer at the former CCC/USDA site if the vadose zone soil analyses identify soil source areas. These groundwater samples will be collected at and downgradient from all identified source areas to quantify the contribution of the contaminated soils to the carbon tetrachloride plume in groundwater.

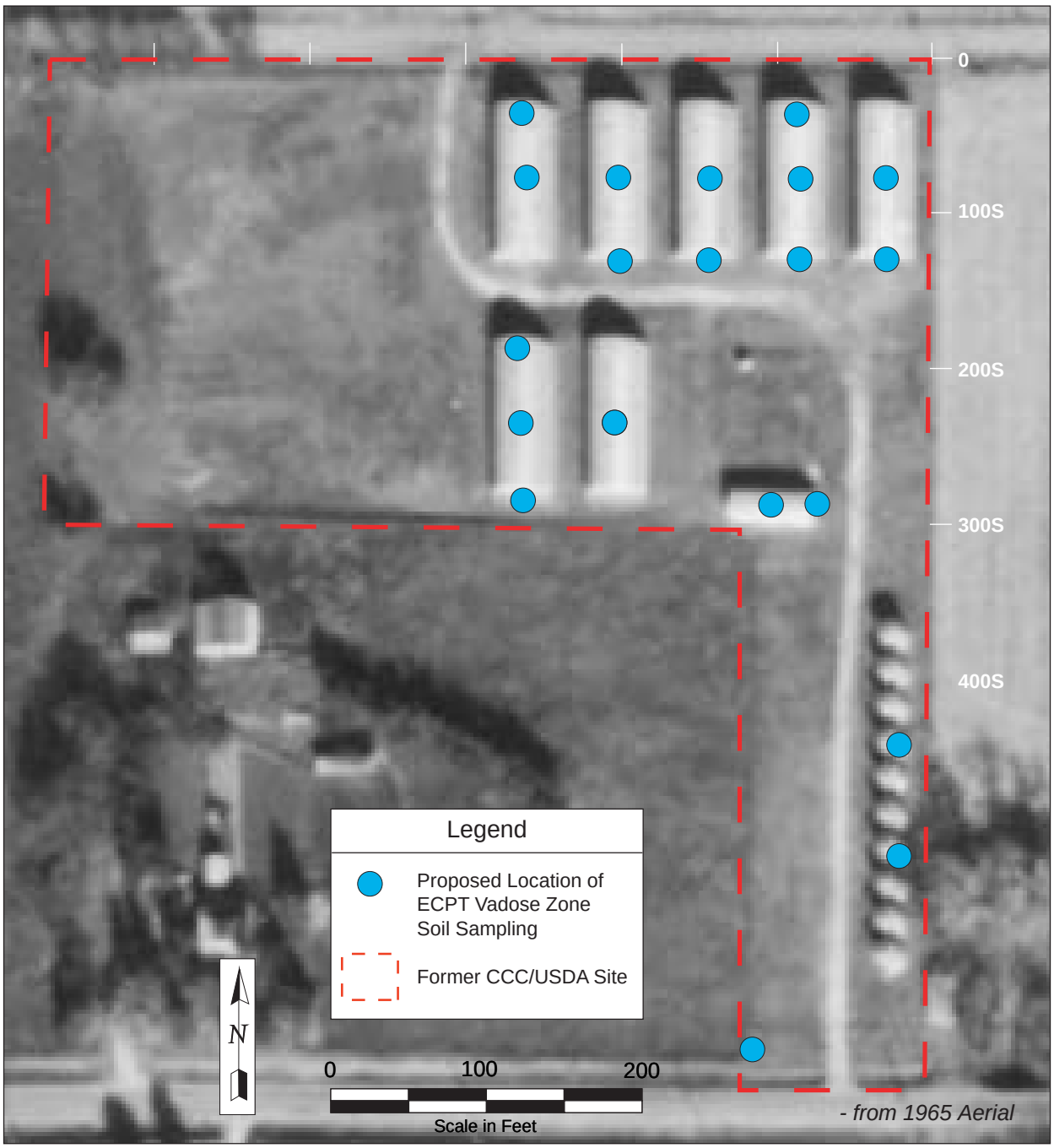

FIGURE 8.1 Historic Aerial Photograph of the Former CCC/USDA Site at Adams (USDA 1965), Showing the Proposed Locations for Vadose Zone Soil Sampling with the Cone Penetrometer in Phase II

FIGURE 8.2 Aerial Photograph of the Western Part of Adams, Nebraska (USGS 1993), Showing the Locations of Phase I Activities and the Proposed Locations for Phase II Groundwater Sampling with the Cone Penetrometer

9 References

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Appendix A:

Lithologic Logs of Soil Borings SB01 and SB02

Argonne National Laboratory

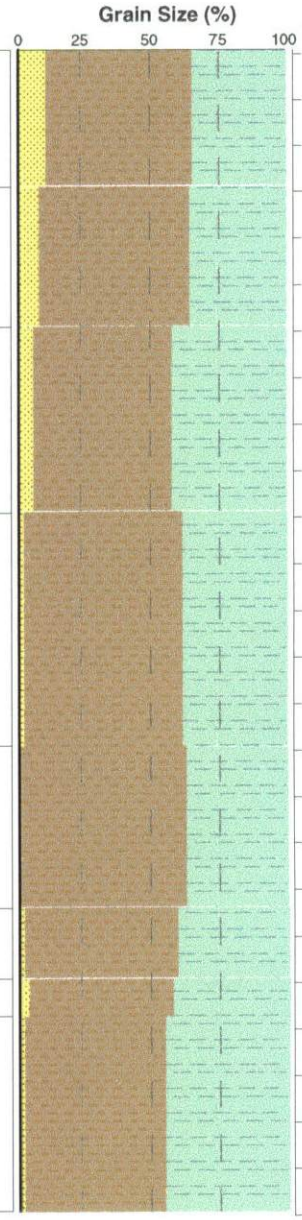
Project: Adams, NE **Boring ID: SB01**

Elevation: 1258.11 ft
Depth: 83 ft
Geologist: E. Yan
Location: Wingate Property

Log Date: 4/6/00
Plot Date: 4/7/00

Rig: Auger and Mud Rotary
Driller: Lyle Porter, Bill King
Company: Layne Western
Static Water: 28.95 ft

Depth	% Recovery	Lithology	Elev.
0		TOPSOIL: Clay, silty, dark brown, organic rich, with root fragments throughout, dry	
		SILT, CLAYEY: brown, black (organic) flakes throughout, dry	1255
-5		CLAY, SILTY: dark brown, silt content decreasing with depth, moderately plastic, dry	1250
-10		CLAY, SILTY: brown, some root cuts, silt content decreasing with depth, slightly moist at the bottom 2 ft	1245
-15		SILT, CLAYEY: brown, dry	1240
		CLAY: dark brown, moderately plastic, slightly moist at the bottom	
-20		SILT, CLAYEY: brown with dark brown mottling, dry	
		SILT, CLAYEY: light brown with gray mottling, some root tubules, FeOx stains present along fracture, dry	1235
-25			



SB01 p. 2

Depth	%	Lithology	Grain Size (%)	Elev.
		SILT, CLAYEY: as -20.8 to -25 ft, 0.5 inch sand string at -26.8 ft		
		SAND, MEDIUM: light brown, rounded-subrounded, moist		1230
		SILT, CLAYEY: gray, with FeOx staining along fractures		
		CLAY, SILTY: gray, dense, with some FeOx staining at the bottom, dry		
-30		CLAY, SILTY: gray, as above		
		SAND, MEDIUM: with a little gravel, light gray-brown, scattered black fines, subrounded to rounded, wet		
		SAND, FINE: light gray-brown, minor silt, wet		1225
		SAND, MEDIUM: light gray-brown, with some fines, wet		
-35		NO RECOVERY		
		SAND, COARSE: light gray-brown, with some gravel, subrounded, dominated by quartz with a few feldspar, fine black mineral throughout; gravel is subangular, max diam. 0.5". 2" coarse sand string with gravel present at 35 ft. FeOx stains throughtout the bottom 6", wet (start coring by mud rotary method)		
		NO RECOVERY		
		SAND, GRAVELLY: red-brown, med to coarse sand grains, poorly sorted, FeOx staining throughout. Gravels are subangular-angular, mainly quarzite; some cobbles with max diam. 2". Fine to med sands present at the bottom, wet		1220
-40		NO RECOVERY		
		SAND, FINE: brown, well sorted, subrounded- rounded, wet		1215
-45		SAND, FINE TO MEDIUM: light gray-brown, subrounded-rounded, some 2" shale cobbles with oxidized outer layer, wet		
		NO RECOVERY		
		SAND, FINE TO MEDIUM: brown, subrounded-rounded, wet		1210
-50		NO RECOVERY		
		NO RECOVERY: shoe was blocked by cobbles which dropped from the layer at -35 -43 ft		1205

SB01 p. 3

Depth
%
Lithology
Grain Size (%)
0
25
50
75
100
Elev.
-55
-60
-65
-70
-75
-80
1200
1195
1190
1185
1180
NO RECOVERY
SAND, FINE: light gray-brown, subrounded-rounded, well sorted, wet
NO RECOVERY
NO RECOVERY
SAND, COARSE: brown, mainly quartz with some feldspar, subrounded-subangular, poorly sorted, some gravel, wet
SAND, FINE: light gray-brown, subrounded-rounded, well sorted, wet
SAND, FINE TO MEDIUM: gravelly, light gray-brown, subrounded to rounded; gravel is mainly quartzite, granite, diorite etc., subangular-subrounded, wet
NO RECOVERY
NO RECOVERY
SAND, MEDIUM: brown, with some gravel, subrounded to rounded, wet
SAND, MED TO COARSE: gravelly, red-brown, subrounded, poorly sorted, FeOx stains throughtout; gravel is mainly quartzite, granite, diorite etc., subrounded to subangular, wet
SILT: (Weathered Siltstone) clayey, blue-gray, dense and massive,calcareous,dry
SILT: (Weathered Siltstone) as above
SILT: (Weathered Siltstone) clayey, blue-gray, brittle cleavage texture, calcareous, dry
SILT: (Weathered Siltstone) as -75.2 to -78 ft
CLAY, SILTY: (Weathered Mudstone) dark gray, dense and massive, non-calcareous, dry

Argonne National Laboratory

Project: Adams, NE **Boring ID: SB02**

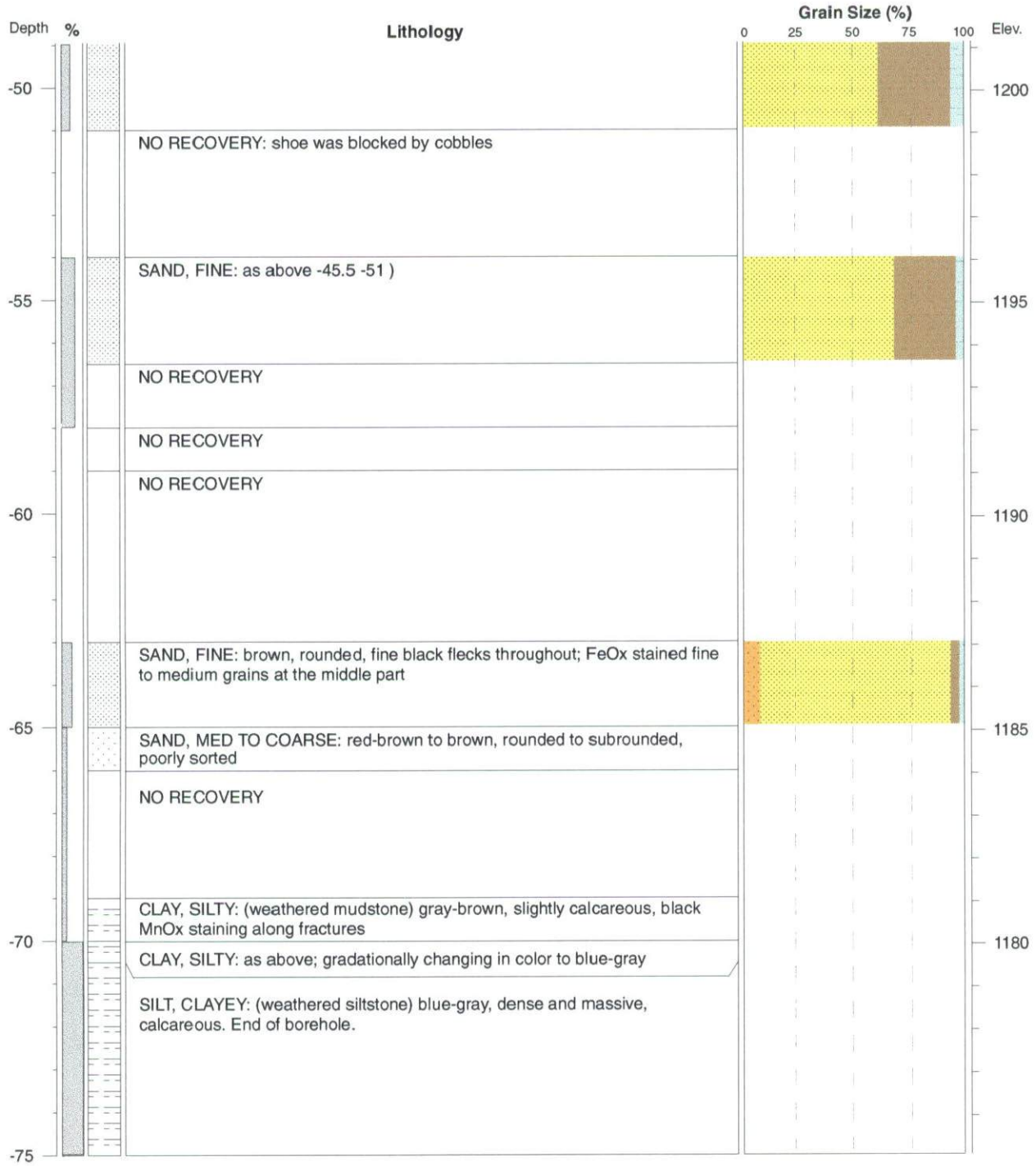
Elevation: 1250.1 ft
Depth: 75 ft
Geologist: Yan/Meyer
Location: Nitrate Treatment Facility
Log Date: 4/07/2000
Plot Date: 4/11/2000
Rig: Mud Rotary
Driller: Bill King
Company: Layne Western

Depth	% Recovery	Lithology	Grain Size (%) 0 25 50 75 100	Elev.
0		TOPSOIL: clay, silty; black, root fibers throughout, organic rich, dry (from chips)		1250
-5		CLAY, SILTY: dark brown, root fibers, dry (from chips)		1245
		SILT, CLAYEY: light gray with brown mottling, dry (from chips)		
-10		SILT, CLAYEY: brown, dry (from chips)		1240
		CLAY, SILTY: brown, moderately plastic, dry		
-15		NO RECOVERY		1235
		CLAY, SILTY: brown, moderately plastic, dry		
		SILT, CLAYEY: brown, dry		
-20		NO RECOVERY		1230
		CLAY, SILTY: brown, dry		

SB02 p. 2

Depth	%	Lithology	Grain Size (%) 0 25 50 75 100	Elev.
		SILT, CLAYEY: brown, FeOx stain along bedding, some gray mottles, dry		
-25		SILT: gray, some FeOx stain present, dry		1225
		NO RECOVERY		
		SILT, SANDY: gray, FeOx stains along fractures, moist		
		NO RECOVERY		
-30				1220
		SAND AND GRAVEL: brown; fine to coarse sand grains, subrounded, poorly sorted; gravel is mainly quartzite, granite, diorite etc. subrounded to subangular, max. diam. 2", wet		
		SAND AND GRAVEL: as above; brown fine sand present in the shoe		
-35		NO RECOVERY		1215
		SAND, FINE: brown, well sorted, subrounded to rounded, fine black flecks throughout; some gravels may drop from the above layer		
-40				1210
		NO RECOVERY: shoe was blocked by cobbles		
-45				1205
		SAND, FINE: brown, fine to very fine grains; rounded, well sorted, fine black flecks throughout		

SB02 p. 3


Depth
%
Lithology
Grain Size (%)
0
25
50
75
100
Elev.
-50
-55
-60
-65
-70
-75
1200
1195
1190
1185
1180
NO RECOVERY: shoe was blocked by cobbles
SAND, FINE: as above -45.5 -51)
NO RECOVERY
NO RECOVERY
NO RECOVERY
SAND, FINE: brown, rounded, fine black flecks throughout; FeOx stained fine to medium grains at the middle part
SAND, MED TO COARSE: red-brown to brown, rounded to subrounded, poorly sorted
NO RECOVERY
CLAY, SILTY: (weathered mudstone) gray-brown, slightly calcareous, black MnOx staining along fractures
CLAY, SILTY: as above; gradationally changing in color to blue-gray
SILT, CLAYEY: (weathered siltstone) blue-gray, dense and massive, calcareous. End of borehole.

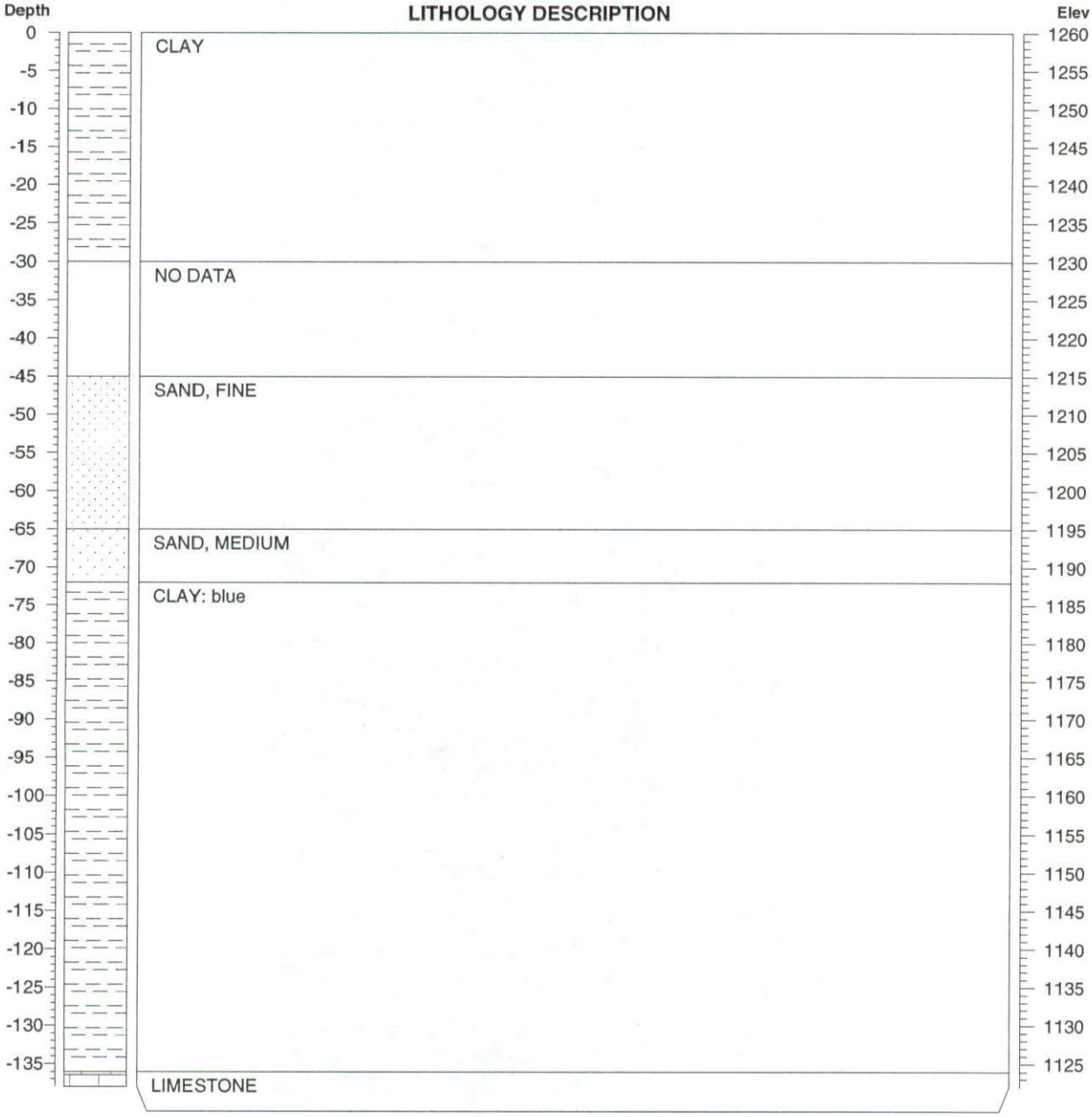
Argonne National Laboratory

Well ID: **Wingate**

Project: **Adams, NE**

Elevation: 1259.8 ft **Date:** N/A
Depth: 138 ft **Plot Date:** N/A

Drilling Company: Waymore Well Drilling



64-1

WATER WELL DATA SHEET

LOCATION: Just N of center NE¼ Sec. 27-6N-8E DATE: July 28, 1964 COUNTY: Gage

OWNER: Village of Adams

DRILLER: Boyd Reed

STATIC WATER LEVEL 15' ELEVATION:

Test @ N edge of city limits just N of depot.

24 - 66 Sand

66 - Rock Boyd believes this limestone

Adams plans to drill a well at site of test.

T. 6 N., R. 8E, Sec. 27

APPENDIX A SOIL BORING RECORD CoRanCo, Inc. JOB NO. 90074
PAGE 1 OF 2
EXPLORATION FOR: FARMER'S ELEVATOR COMPANY BORING NO.: B12-057-90Q
ADAMS, NEBRASKA

LOCATION:
NW 1/4, SW 1/4, NE 1/4, SEC. 27, T6N, R8E
DATE: 5-19-90
WEATHER: WARM & SUNNY
RECORDED BY: QAZI SALAHUDDIN
DRILL TYPE: 4" HOLLOW-STEM AUGER

SURFACE ELEV.: 96.6' Approx. Relative to Bench Mark
WATER LEVELS:
@ DRILLING: 74.6' Approx. Relative to Bench Mark
@ STATIC: 78.93' Relative to Bench Mark

SAMPLE NO.	SAMPLE TYPE	NO. OF BLOWS	DEPTH FEET	SOIL CHARACTERISTICS AND CLASSIFICATIONS	USCS	HNU (ppm)
				Silty clay, black, organic, moderately-plastic (topsoil).		
1	SS	Driven		#1 Silty clay, brown, highly-plastic, still, dry.	CH	< 1
			5			
2	SS	Driven		#2 Silty clay, brown, highly-plastic, stiff, dry.	CH	< 1
			10			
3	SS	Driven		#3 Silty clay, brown, highly-plastic, stiff, dry.	CH	< 1
			15			
4	SS	Driven		#4 Silty clay, brown, highly-plastic, scattered sand grains, moist at 19.2".	CH	< 1
			20			
5	SS	Driven		#5 Sand, gravelly, gray, medium to coarse-grained, gravel maximum (1.5 cm), well-graded.	SW	2
			25			
6	SS	Driven		#6 Sand, gravelly, gray, medium to coarse-grained, gravel maximum (1.5 cm), well-graded.	SW	< 1
			30			
7	SS	Driven		#7 Sand, yellowish-brown, fine-grained, poorly-graded, little fines.	SP	< 1
			35			
8	SS	Driven		#8 Sand, yellowish-brown, fine-grained, poorly-graded, little fines.	SP	< 1
			40			

NOTES: SS = SPLIT SPOON, * = FREE PRODUCT INFO.

REMARKS:

PAGE 2 OF 2

JOB NO. 90074

SOIL BORING RECORD CoRanCo, Inc.

BORING NO.: B12-057-90Q (cont'd)

SAMPLE NO.	SAMPLE TYPE	NO. OF BLOWS	DEPTH FEET	SOIL CHARACTERISTICS AND CLASSIFICATIONS	USCS	HNU (ppm)
9	SS	Driven	45	#9 Sand, light yellow, fine-grained, poorly-graded, few 1 cm clay balls? and clay lens (1").	SP	< 1
10	SS	Driven	50	#10 Sand, light yellow, fine to very fine-grained, poorly-graded, clay chips.	SP	< 1
11	SS	Driven	55	#11 Sand, light yellow, fine to very fine-grained, poorly-graded, clay chips.	SP	< 1
12	SS	Driven	60	#12 Sand. light yellow, fine-grained, poorly-graded, little fine.	SP	< 1
			65			
			70			
			75			
			80			
			85			

NOTE: SS = SPLIT SPOON, * = FREE PRODUCT INFO.

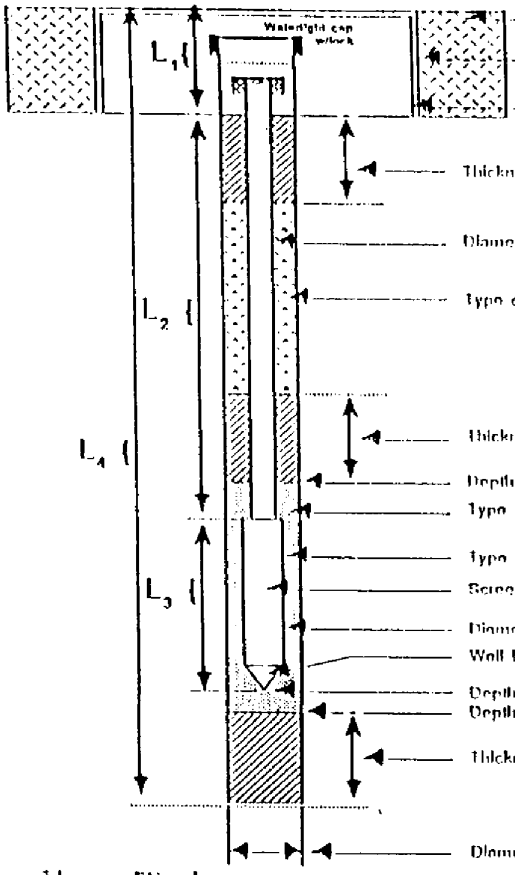
REMARKS:

Coranco, Inc.
ENVIRONMENTAL CONTRACTORS

INSTALLATION OF MONITORING WELLS

Project Name: Farmer's Elevator-Step 7 Monitoring Well No.: B12-057-90Q

Benchmark Height: 100' Ground Surface Elevation: 96.6' Top of Casing Elevation (With Cap Removed): 95.98'



Concrete pad diameter & thickness	2' x 8"
Manhole diameter and type	9" water tight, cast iron
Depth	12"
Protective Casing Diameter and Type	9", sheet metal
Total Length	12"
Thickness and type of seal	bentonite slurry
Diameter and type of blank casing	2" PVC SCH 40
Type of backfill around casing	bentonite slurry
Thickness and type of seal	2' granular bentonite
Depth to top of gravel pack	14'
Type of gravel pack around screen	12 x 70 pre-packaged sand
Type of monitoring well	NFG. PVC SCH. 40
Screen gauge or size of openings (Slot No.)	.010"
Diameter and length of screen	2" x 15'
Well bottom type	PVC point
Depth to bottom of monitoring well	45'
Depth to bottom of gravel pack	58'
Thickness and type of seal	none
Diameter of borehole	8.5"

1' Ft. = L_1
14' Ft. = L_2
30' Ft. = L_3
58' Ft. = L_4

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL (↓)	OBSERVATIONS
5-30-90		78.93'	

APPENDIX A SOIL BORING RECORD CoRanCo, Inc. JOB NO. 90074
PAGE 1 OF 1
EXPLORATION FOR: FARMER'S ELEVATOR COMPANY BORING NO.: B17-062-90Q
ADAMS, NEBRASKA

LOCATION:
NW 1/4, SW 1/4, NE 1/4, SEC. 27, T6N, R8E
DATE: 5-21-90
WEATHER: WARM & SUNNY
RECORDED BY: QAZI SALAHUDDIN
DRILL TYPE: 4" HOLLOW-STEM AUGER

SURFACE ELEV.: 99.73' Approx. Relative to Bench Mark
WATER LEVELS:
@ DRILLING: 77.73' Approx. Relative to Bench Mark
@ STATIC: 79.65' Relative to Bench Mark

SAMPLE NO.	SAMPLE TYPE	NO. OF BLOWS	DEPTH FEET	SOIL CHARACTERISTICS AND CLASSIFICATIONS	USCS	HNU (ppm)
			-	Silty clay, black, moderately-plastic.		
1	SS	Driven	-	#1 Silty clay, brownish-yellow, moderately-plastic.	CL	< 1
			5			
2	SS	Driven	-	#2 Silty clay, brownish-yellos, moderately-plastic.	CL	< 1
			10			
3	SS	Driven	-	#3 Silty clay, brown, moderately-plastic, scattered sand grains.	CL	< 1
			15			
4	SS	Driven	-	#4 Sand, brown, fine to medium grained, wet.	SP	< 1
			20			
5	SS	20	-	#5 Sand, gravelly, brown, medium to coarse, gravel maximum 1 cm, well-graded.	SW	< 1
			25			
6	SS	35	-	#6 Sand, gravelly, brown, medium to coarse, gravel maximum 1 cm, well-graded.	SW	< 1
			30			
7	SS	25	-	#7 Sand, gravelly, brown, medium to coarse, gravel maximum 1 cm, well-graded.	SW	< 1
			35			
			40			

NOTES: SS = SPLIT SPOON, * = FREE PRODUCT INFO.

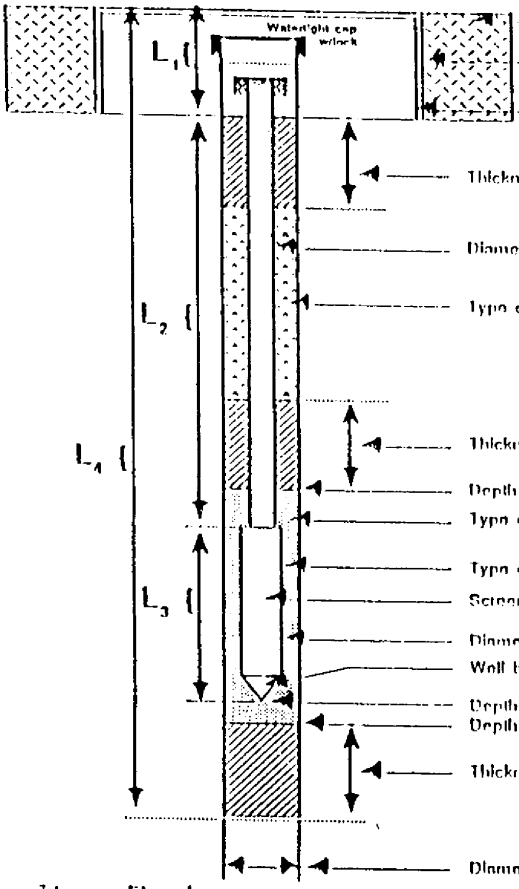
REMARKS:

Coranco, Inc.
ENVIRONMENTAL CONTRACTORS

INSTALLATION OF MONITORING WELLS

Project Name: Farmer's Elevator-Step 7 Monitoring Well No. B17-062-90Q

Benchmark Height: 100' Ground Surface Elevation: 99.73' Top of Casing Elevation (With Cap Removed): 99.04'



Concrete pad diameter & thickness	2' x 8"
Manhole diameter and type	9" water tight, cast iron
Depth	12"
Protective Casing Diameter and Type	9", sheet metal
Total Length	12"
Thickness and type of seal	bentonite slurry
Diameter and type of blank casing	2" PVC SCH 40
Type of backfill around casing	bentonite slurry
Thickness and type of seal	2' granular bentonite
Depth to top of gravel pack	14'
Type of gravel pack around screen	12 x 70
Type of monitoring well	pre-packaged sand MFG. PVC SCH. 40
Screen gauge or size of openings (Slot No.)	.010"
Diameter and length of screen	2" x 15'
Well bottom type	PVC point
Depth to bottom of monitoring well	30'
Depth to bottom of gravel pack	33'
Thickness and type of seal	none
Diameter of borehole	8.5"

1' Ft. = L_1
14' Ft. = L_2
15' Ft. = L_3
33' Ft. = L_4

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
5-30-90		79.65'	

Appendix B:

Electronic Cone Penetrometer Logs and Piezometer Specifications

TABLE B.1 Specifications for Piezometers

Well	Ground Surface Elevation (ft AMSL)	Reference Elevation[a] (ft AMSL)	Well Depth (ft BGL)	Screen Interval (ft BGL)
SB03	1257.93	1257.54	72	67-72
SB05	1262.00	1261.60	42.6	2.6-42.6
SB12	1255.06	1254.56	39.3	2.3-39.3
SB13	1250.61	1250.18	42	32-42
SB14	1256.37	1256.08	36	31-36
SB15	1252.10	1251.67	43.3	33.3-43.3
SB17	1245.62	1245.24	51	38-51
SB19	1249.62	1249.36	43.3	31.3-43.3

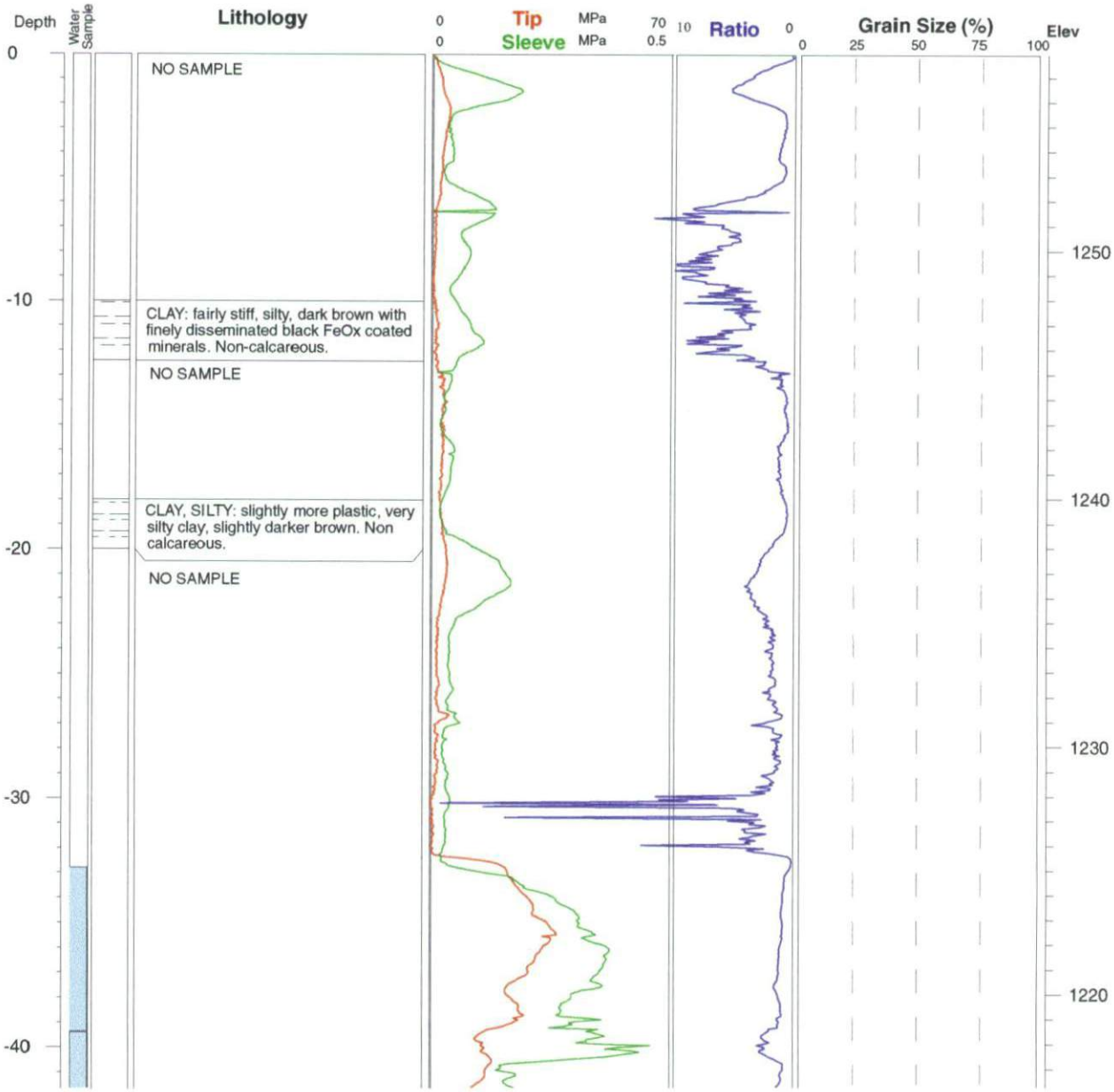
[a] Reference point for measuring water level depth.

Argonne National Laboratory

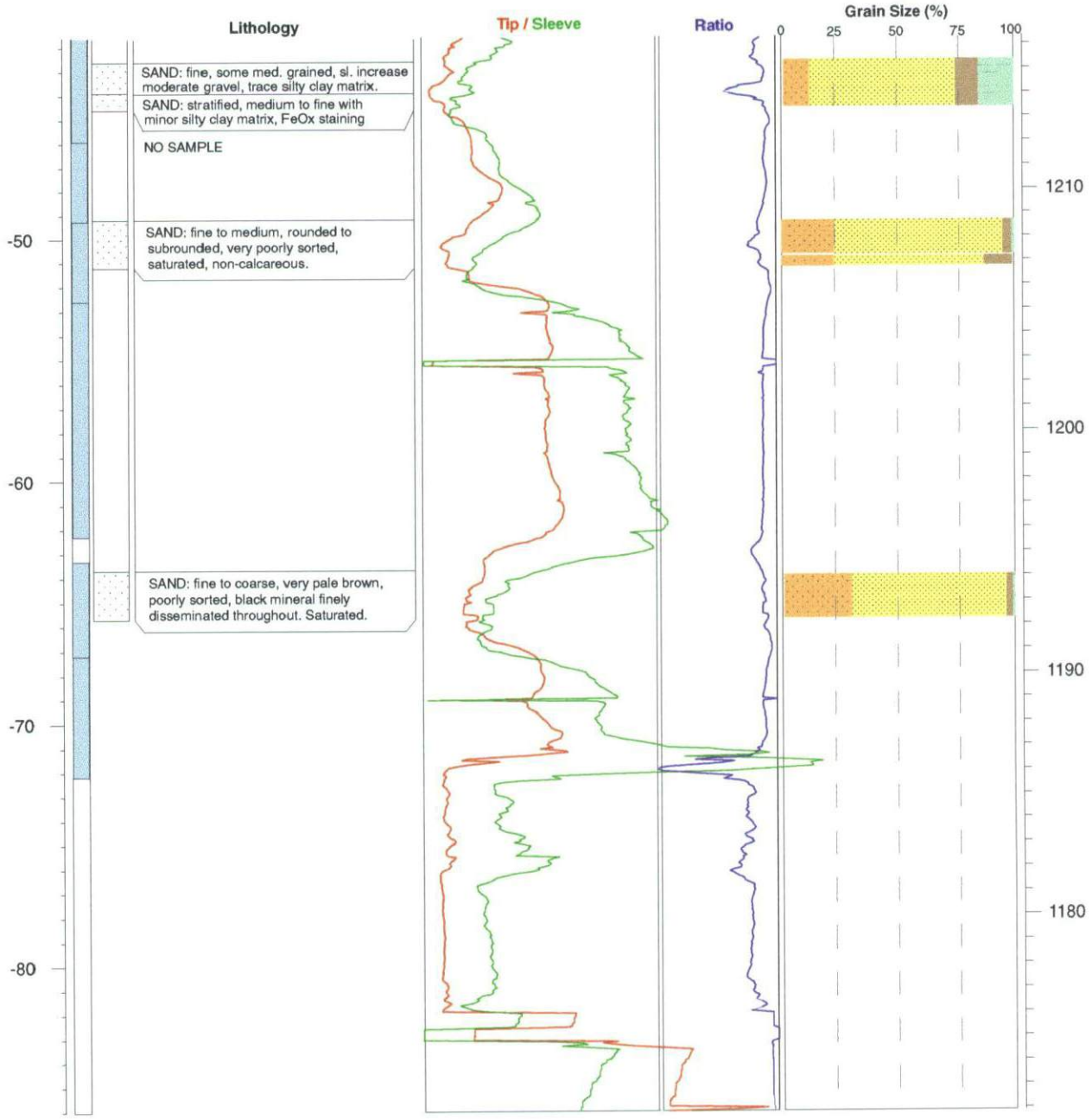
Project: Adams
Elevation: 1257.93 ft
Depth: 86.02 ft
Geologist: LaFreniere

Boring ID: SB03

Log Date: 4/15/00
Plot Date: 7/12/00
Rig: CPT
Driller: K. Spokas
Company: Argonne



SB03 p.2


Lithology
Tip / Sleeve
Ratio
Grain Size (%)
0
25
50
75
100
SAND: fine, some med. grained, sl. increase moderate gravel, trace silty clay matrix.
SAND: stratified, medium to fine with minor silty clay matrix, FeOx staining
NO SAMPLE
SAND: fine to medium, rounded to subrounded, very poorly sorted, saturated, non-calcareous.
SAND: fine to coarse, very pale brown, poorly sorted, black mineral finely disseminated throughout. Saturated.
-50
-60
-70
-80
1210
1200
1190
1180

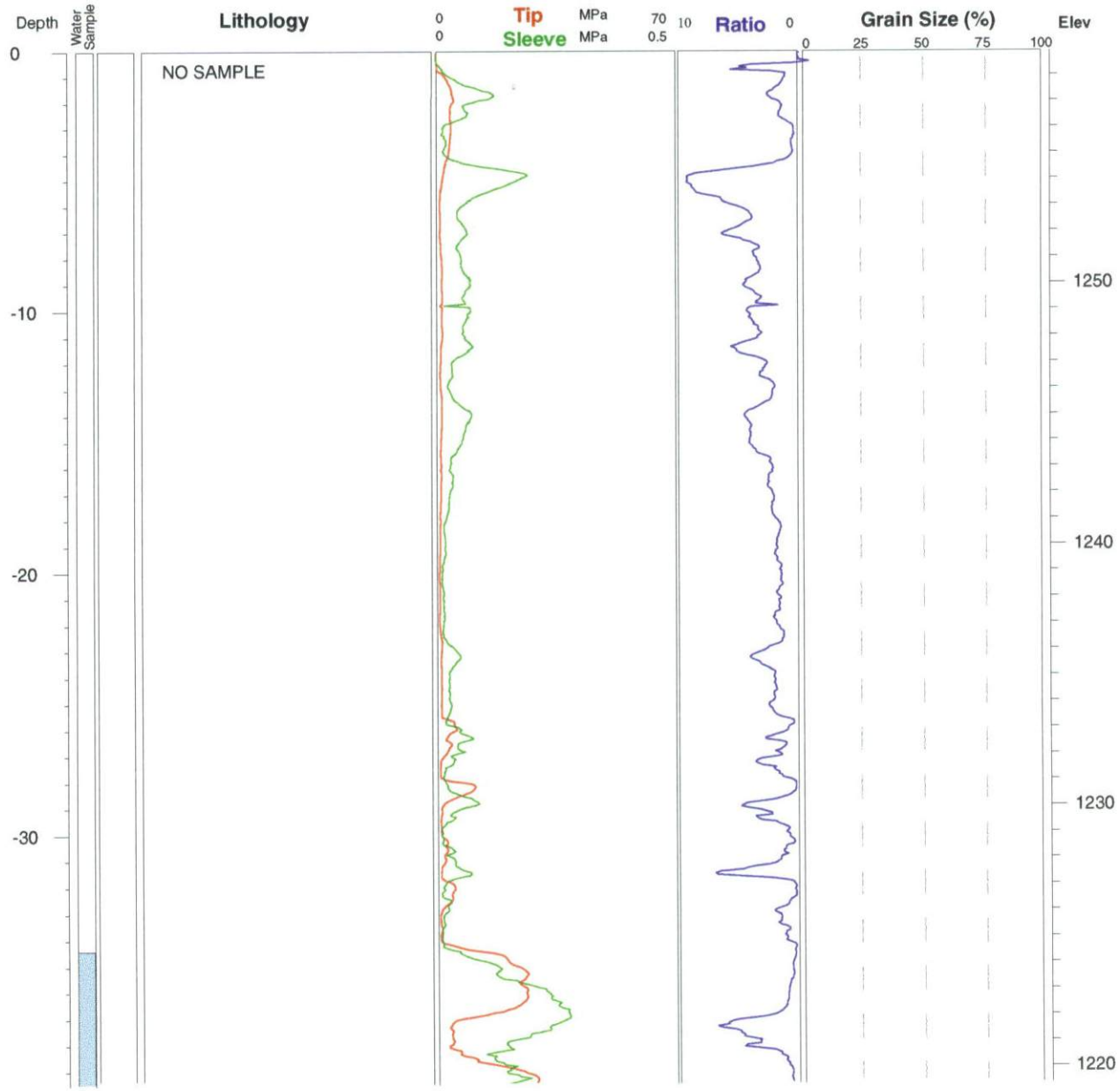
Argonne National Laboratory

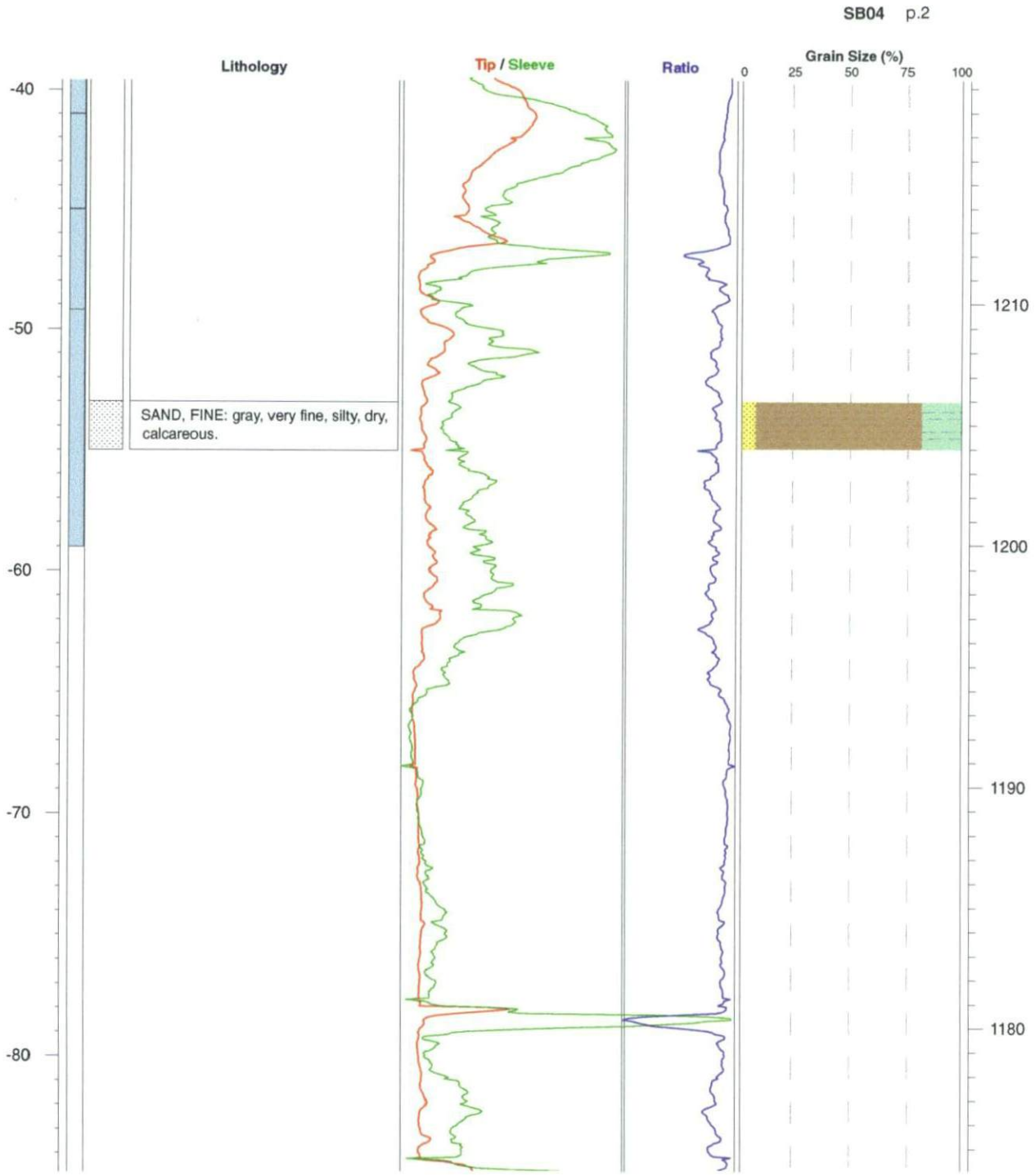
Project: Adams
Elevation: 1258.92 ft
Depth: 85.826 ft
Geologist: LaFreniere

Boring ID: SB04

Log Date: 4/18/00
Plot Date: 7/12/00

Rig: CPT
Driller: K. Spokas
Company: Argonne




SB04 p.2
Lithology
Tip / Sleeve
Ratio
Grain Size (%)
0
25
50
75
100
-40
-50
-60
-70
-80
1210
1200
1190
1180
SAND, FINE: gray, very fine, silty, dry, calcareous.

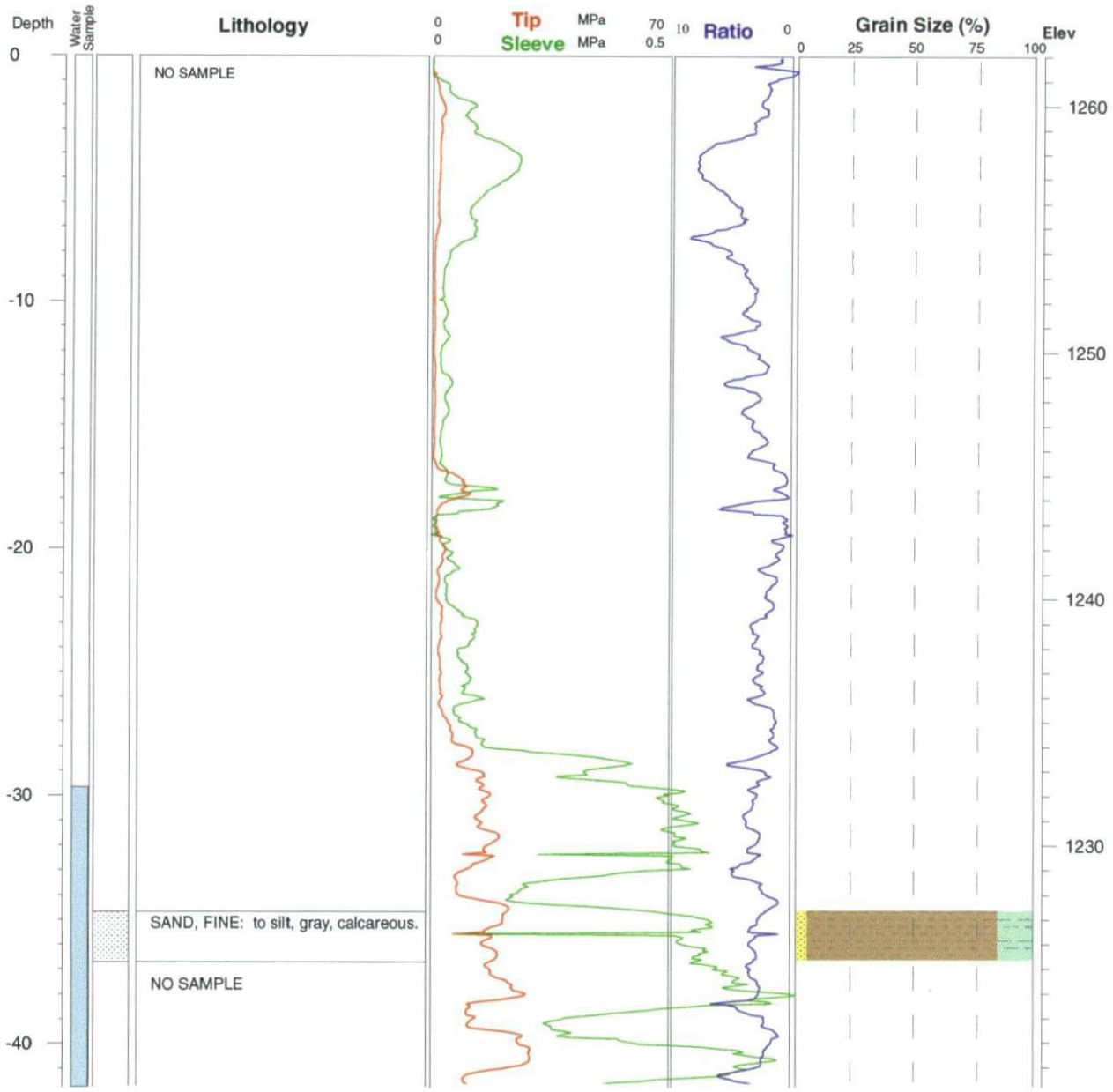
Argonne National Laboratory

Project: Adams
Elevation: 1262.0 ft
Depth: 75.72 ft
Geologist: LaFreniere

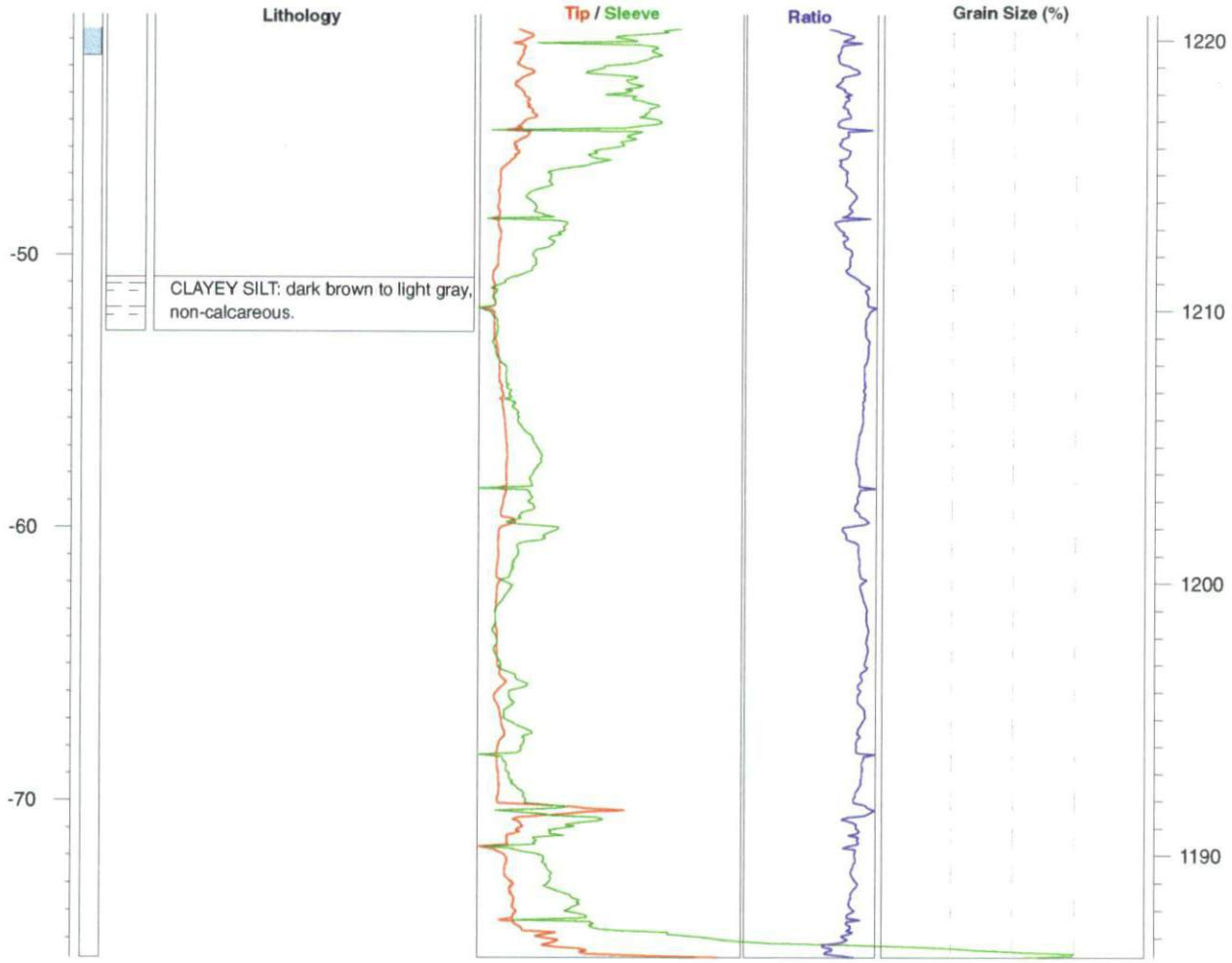
Boring ID: SB05

Log Date: 4/18/00
Plot Date: 7/12/00

Rig: CPT
Driller: K. Spokas
Company: Argonne



SB05 p.2


Lithology
Tip / Sleeve
Ratio
Grain Size (%)
-50
-60
-70
1220
1210
1200
1190
CLAYEY SILT: dark brown to light gray, non-calcareous.

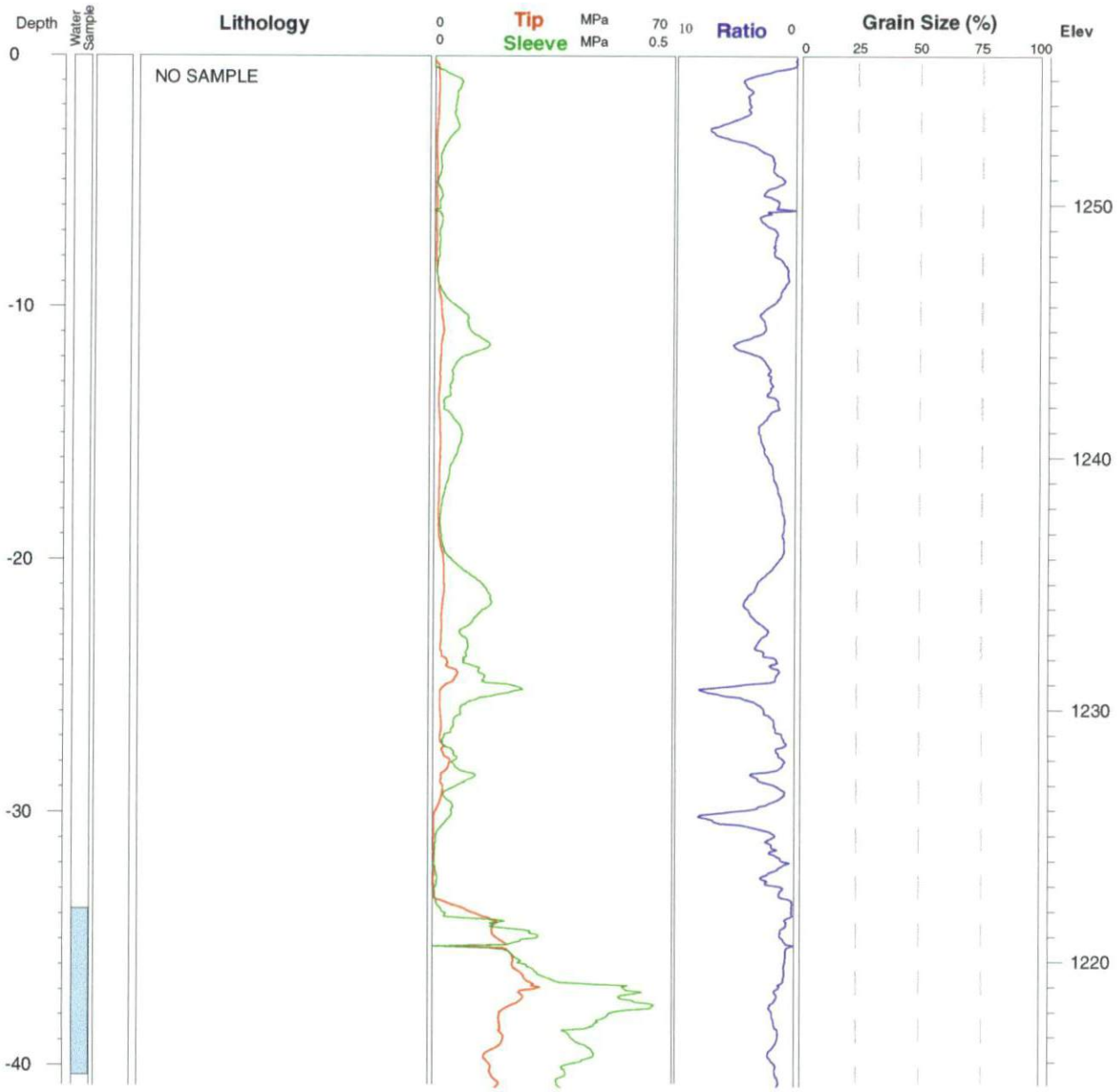
Argonne National Laboratory

Project: Adams
Elevation: 1255.95 ft
Depth: 84.90 ft
Geologist: LaFreniere

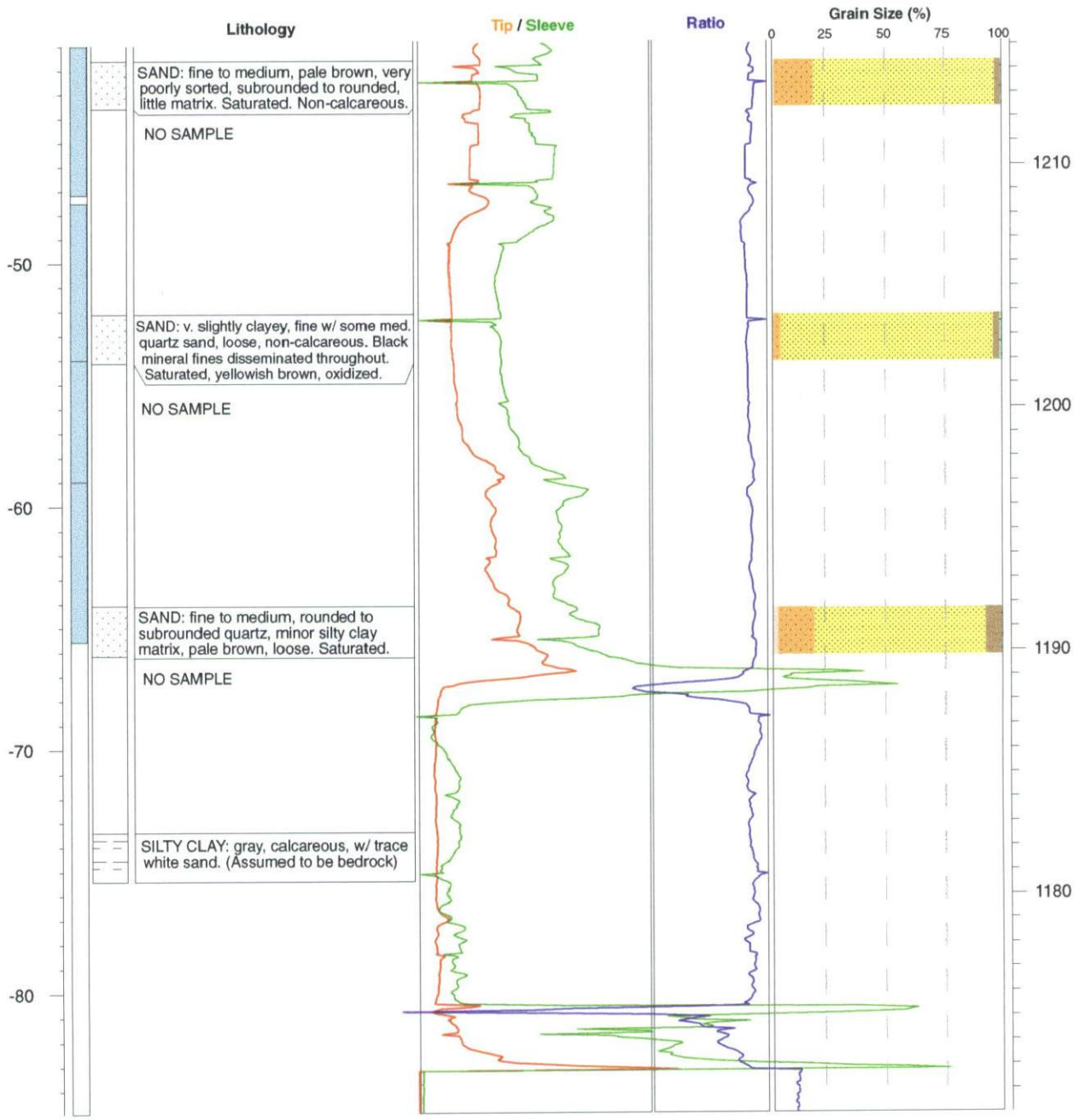
Boring ID: SB06

Log Date: 4/19/00
Plot Date: 7/12/00

Rig: CPT
Driller: K. Spokas
Company: Argonne



SB06 p.2

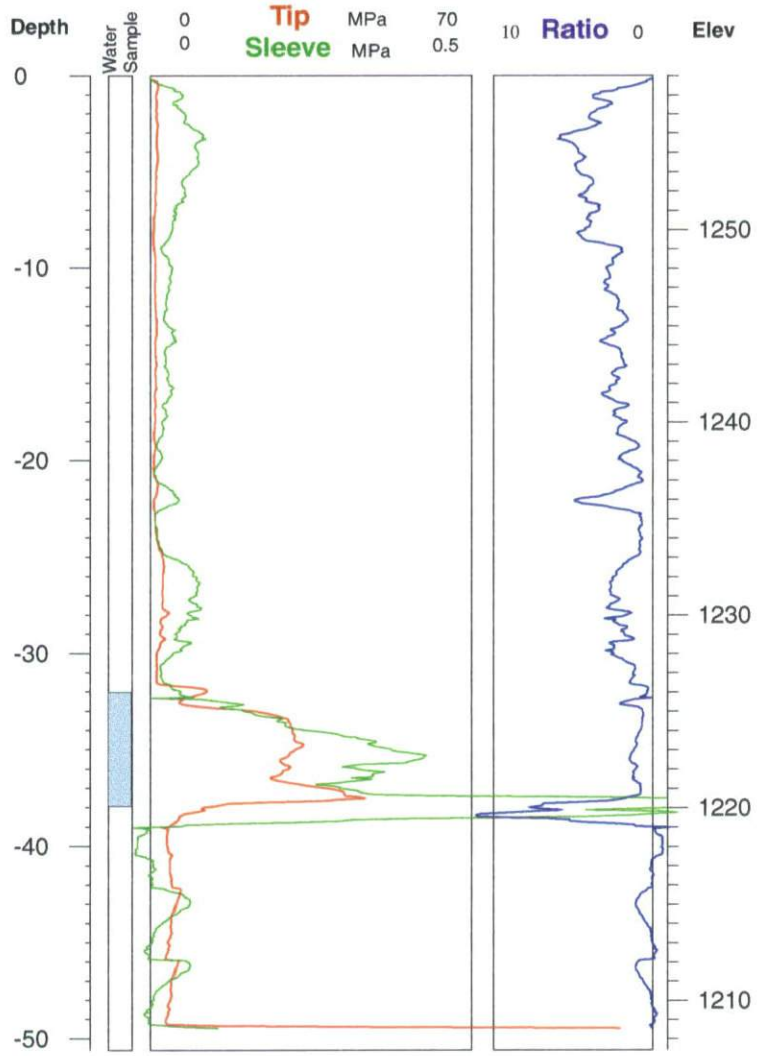

Lithology
Tip / Sleeve
Ratio
Grain Size (%)
0
25
50
75
100
SAND: fine to medium, pale brown, very poorly sorted, subrounded to rounded, little matrix. Saturated. Non-calcareous.
NO SAMPLE
SAND: v. slightly clayey, fine w/ some med. quartz sand, loose, non-calcareous. Black mineral fines disseminated throughout. Saturated, yellowish brown, oxidized.
NO SAMPLE
SAND: fine to medium, rounded to subrounded quartz, minor silty clay matrix, pale brown, loose. Saturated.
NO SAMPLE
SILTY CLAY: gray, calcareous, w/ trace white sand. (Assumed to be bedrock)
-50
-60
-70
-80
1210
1200
1190
1180

Argonne National Laboratory

Project: Adams
Elevation: 1258.03 ft
Depth: 49.475 ft
Geologist: La Freniere

Boring ID: SB07
Log Date:
Plot Date: 7/17/00

Rig: CPT
Driller: K. Spokas
Company: Argonne

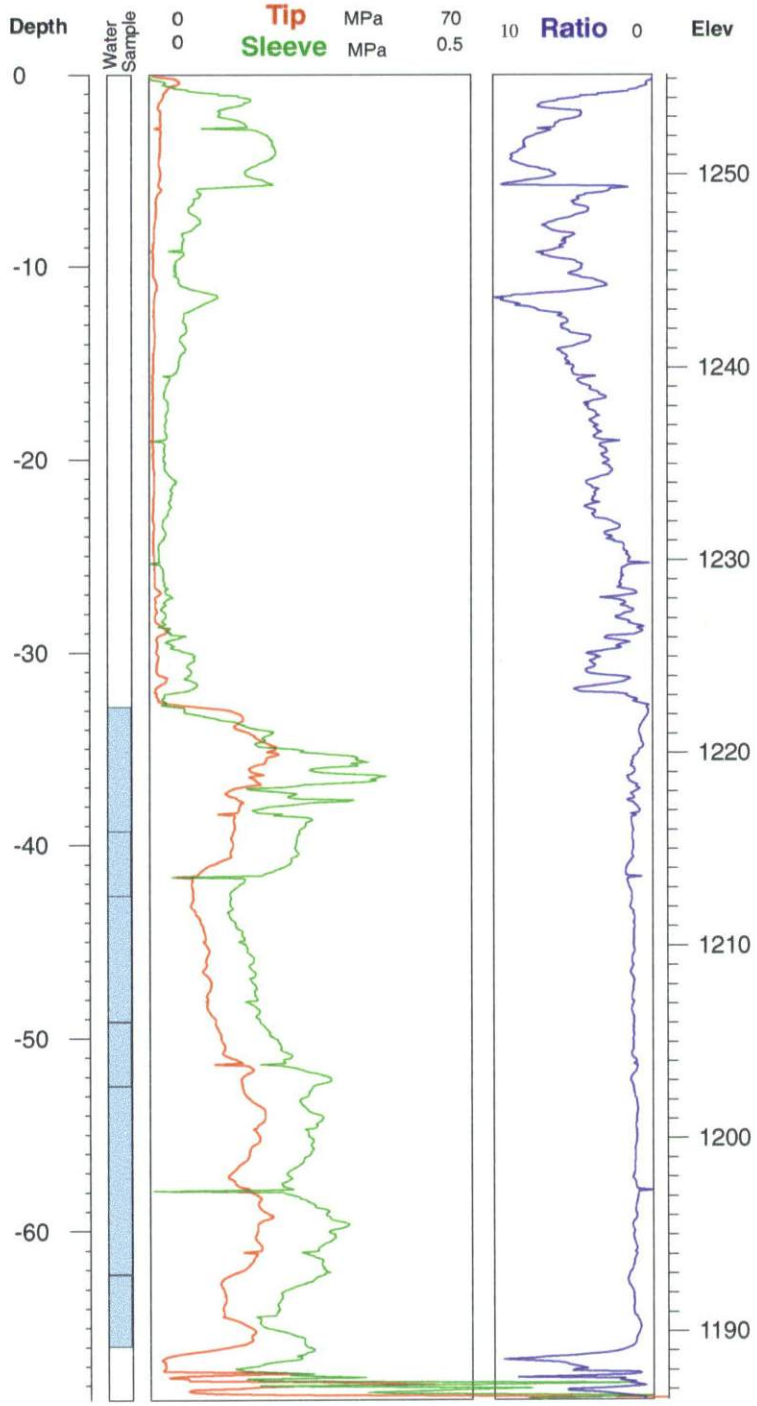


Argonne National Laboratory

Project: Adams
Elevation: 1255.24 ft
Depth: 68.766 ft
Geologist: L. LaFreniere

Boring ID: SB08
Log Date: 4/24/00
Plot Date: 7/17/00

Rig: CPT
Driller: K. Spokas
Company: Argonne

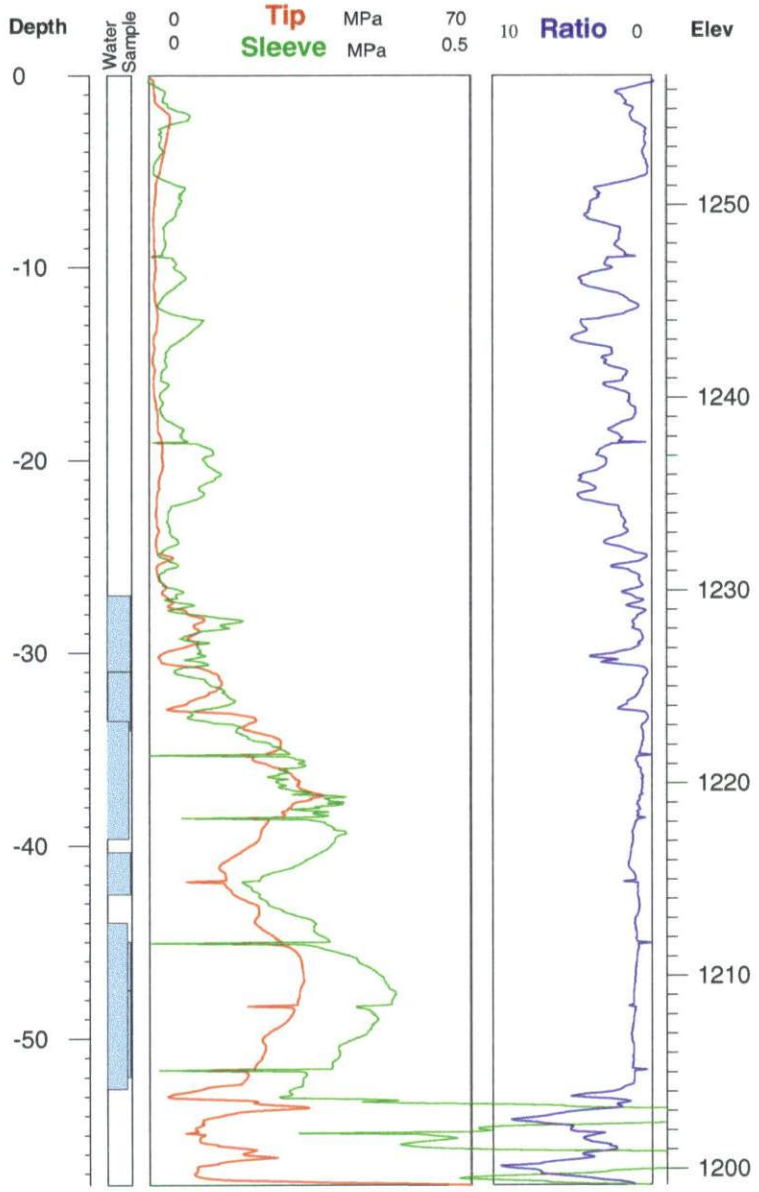


Argonne National Laboratory

Project: Adams
Elevation: 1256.78 ft
Depth: 57.61 ft
Geologist: LaFreniere

Boring ID: SB09
Log Date:
Plot Date: 7/17/00

Rig: CPT
Driller: K. Spokas
Company: Argonne



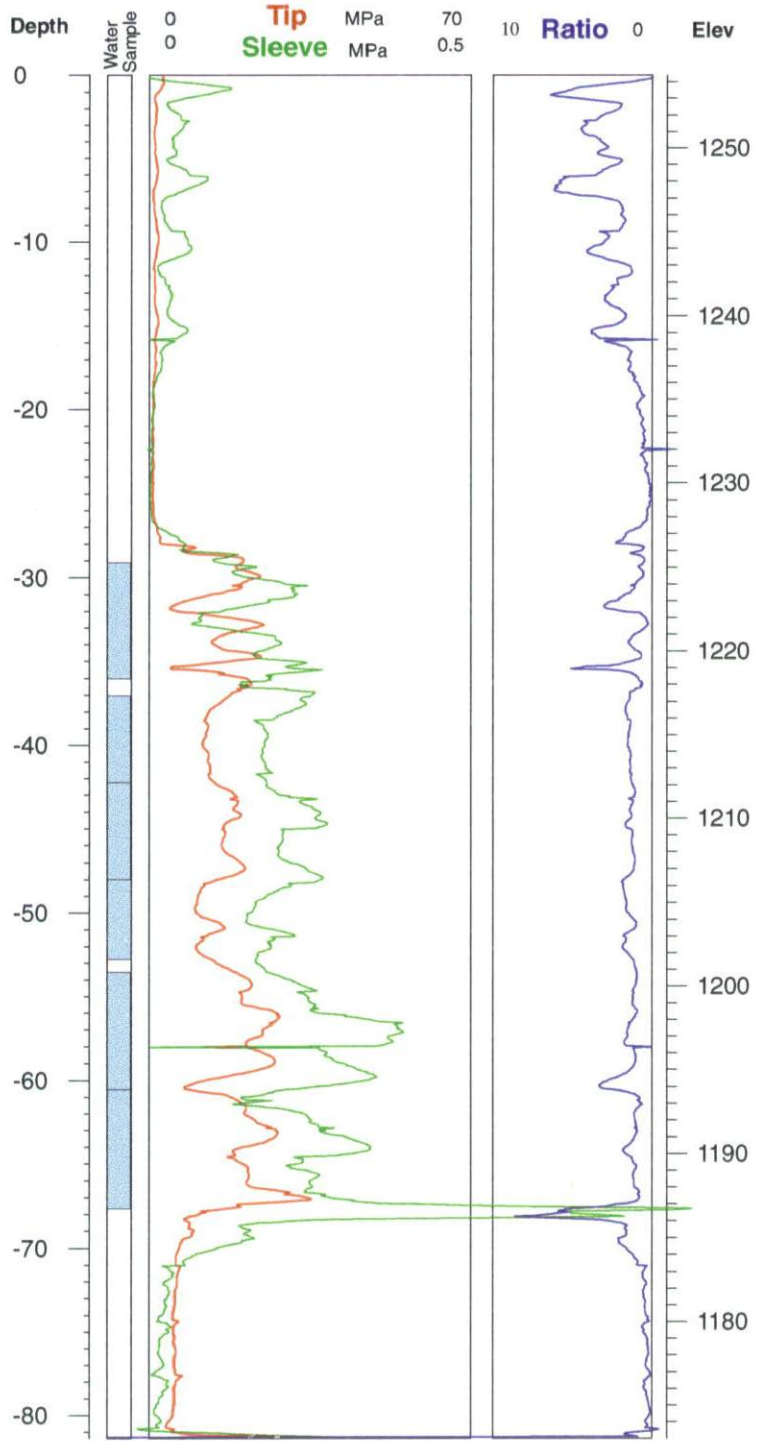
Argonne National Laboratory

Project: Adams **Boring ID: SB10**

Elevation: 1254.38
Depth: 81.36 ft
Geologist: LaFreniere

Log Date: 4/25/00 ft
Plot Date: 7/17/00

Rig: CPT
Driller: K. Spokas
Company: Argonne

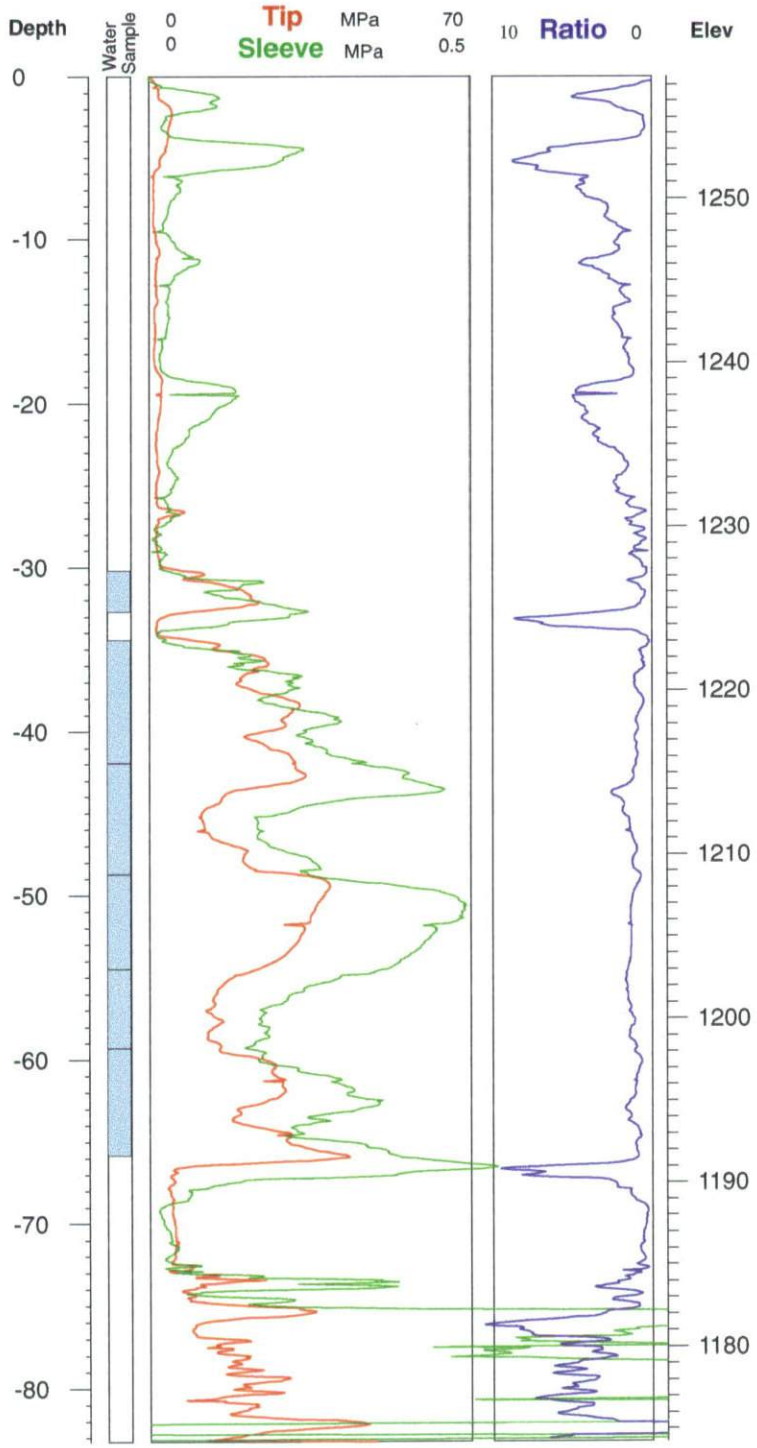


Argonne National Laboratory

Project: Adams
Elevation: 1257.5 ft
Depth: 83.267 ft
Geologist: LaFreniere

Boring ID: SB11
Log Date: 4/26/00
Plot Date: 7/17/00

Rig: CPT
Driller: K. Spokas
Company: Argonne

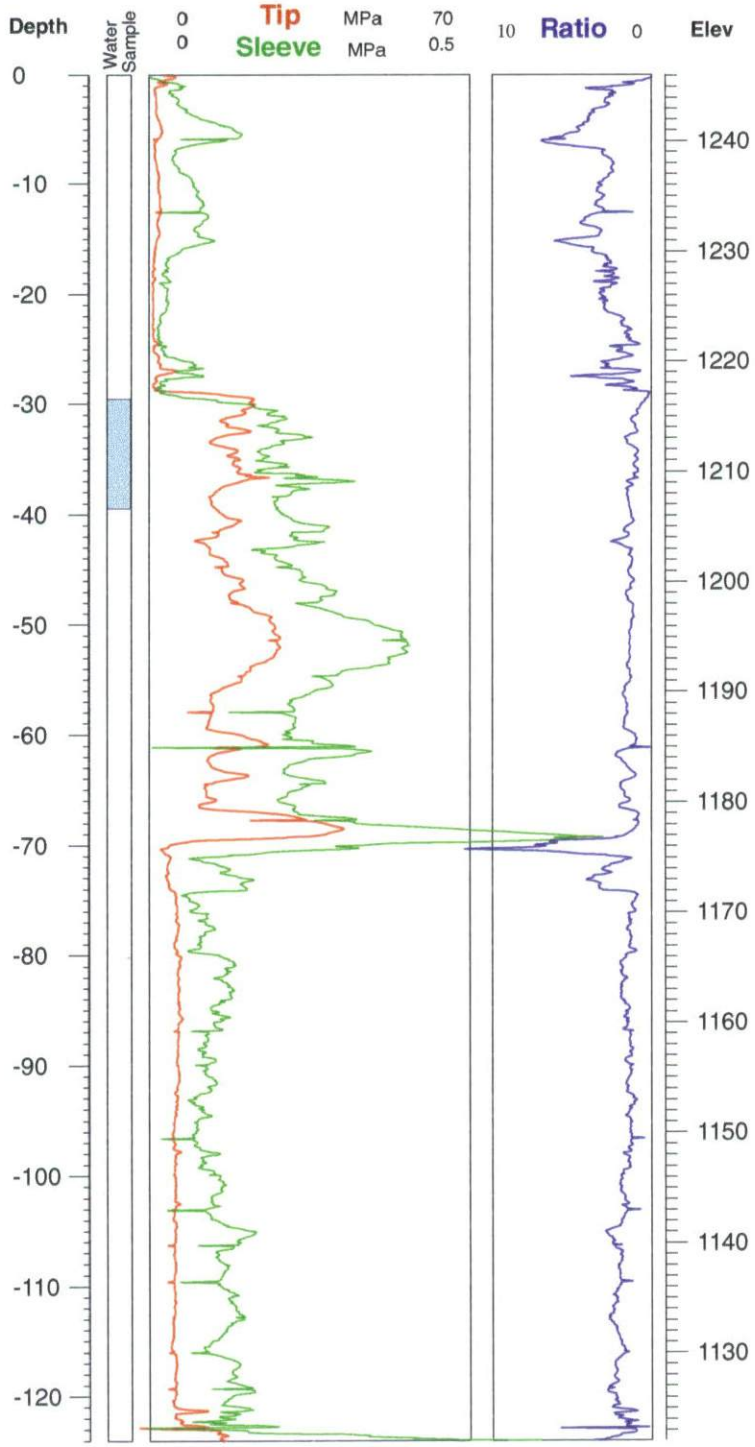


Argonne National Laboratory

Project: Adams
Elevation: 1246.08 ft
Depth: 124.015752 ft
Geologist: L. LaFreniere

Boring ID: SB12
Log Date: 4/30/00
Plot Date: 7/17/00

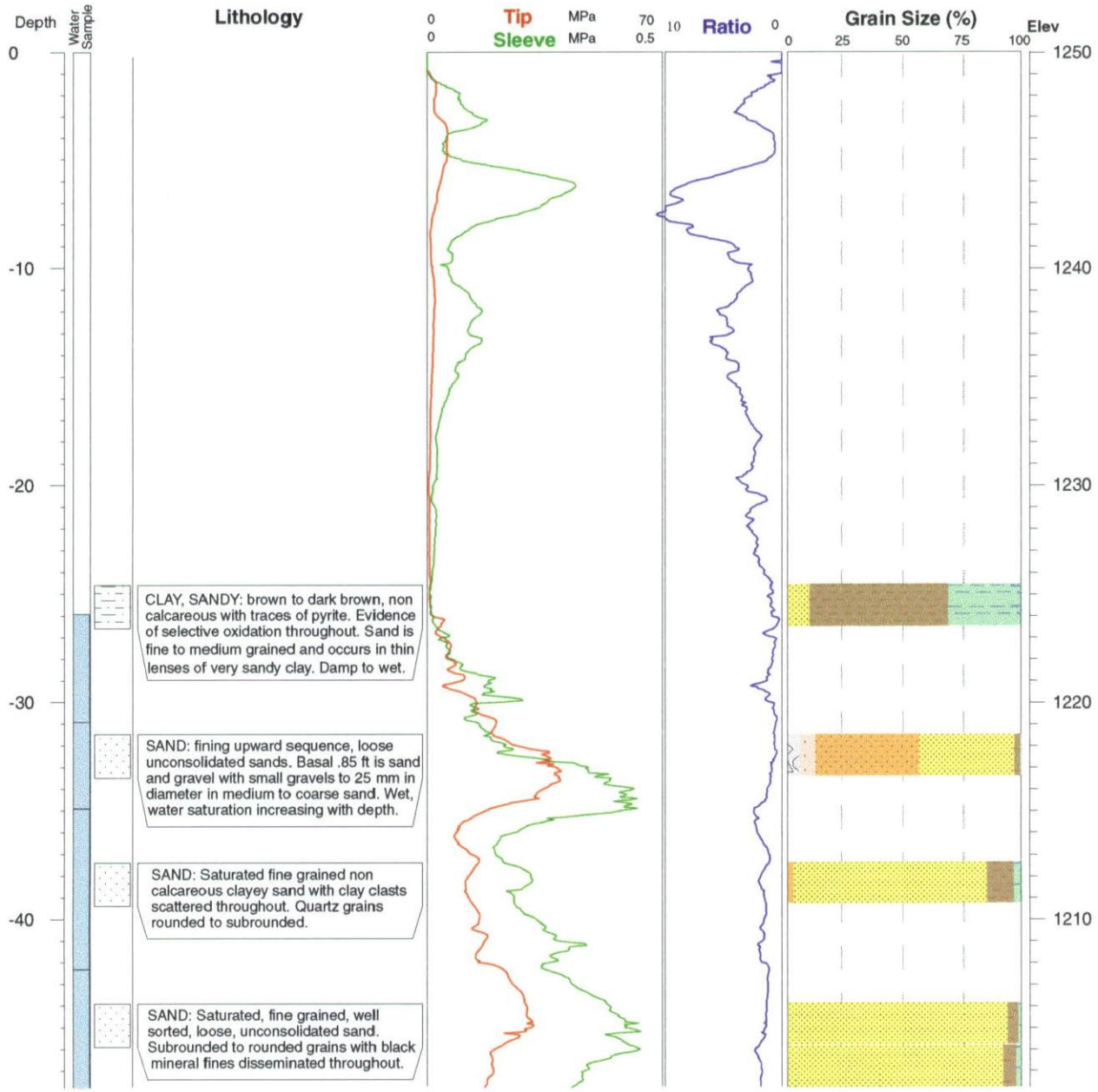
Rig: CPT
Driller: K. Spokas
Company: Argonne



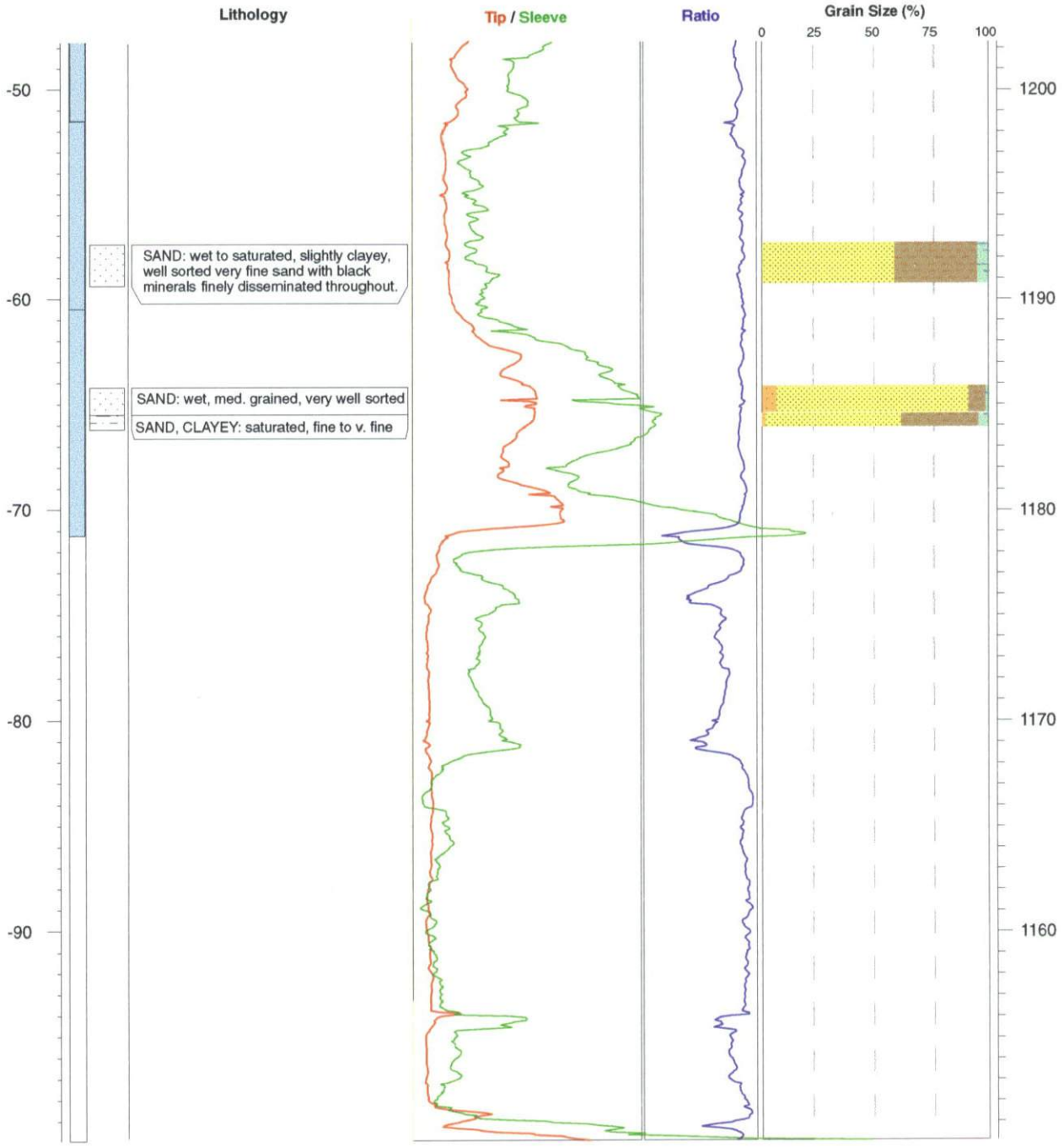
Argonne National Laboratory

Project: Adams
Elevation: 1250.05 ft
Depth: 99.93 ft
Geologist: LaFreniere

Boring ID: SB13
Log Date: 4/26/00
Plot Date: 7/12/00
Rig: CPT
Driller: K. Spokas
Company: Argonne



SB13 p.2


Lithology
Tip / Sleeve
Ratio
Grain Size (%)
0
25
50
75
100
-50
-60
-70
-80
-90
1200
1190
1180
1170
1160
SAND: wet to saturated, slightly clayey, well sorted very fine sand with black minerals finely disseminated throughout.
SAND: wet, med. grained, very well sorted
SAND, CLAYEY: saturated, fine to v. fine

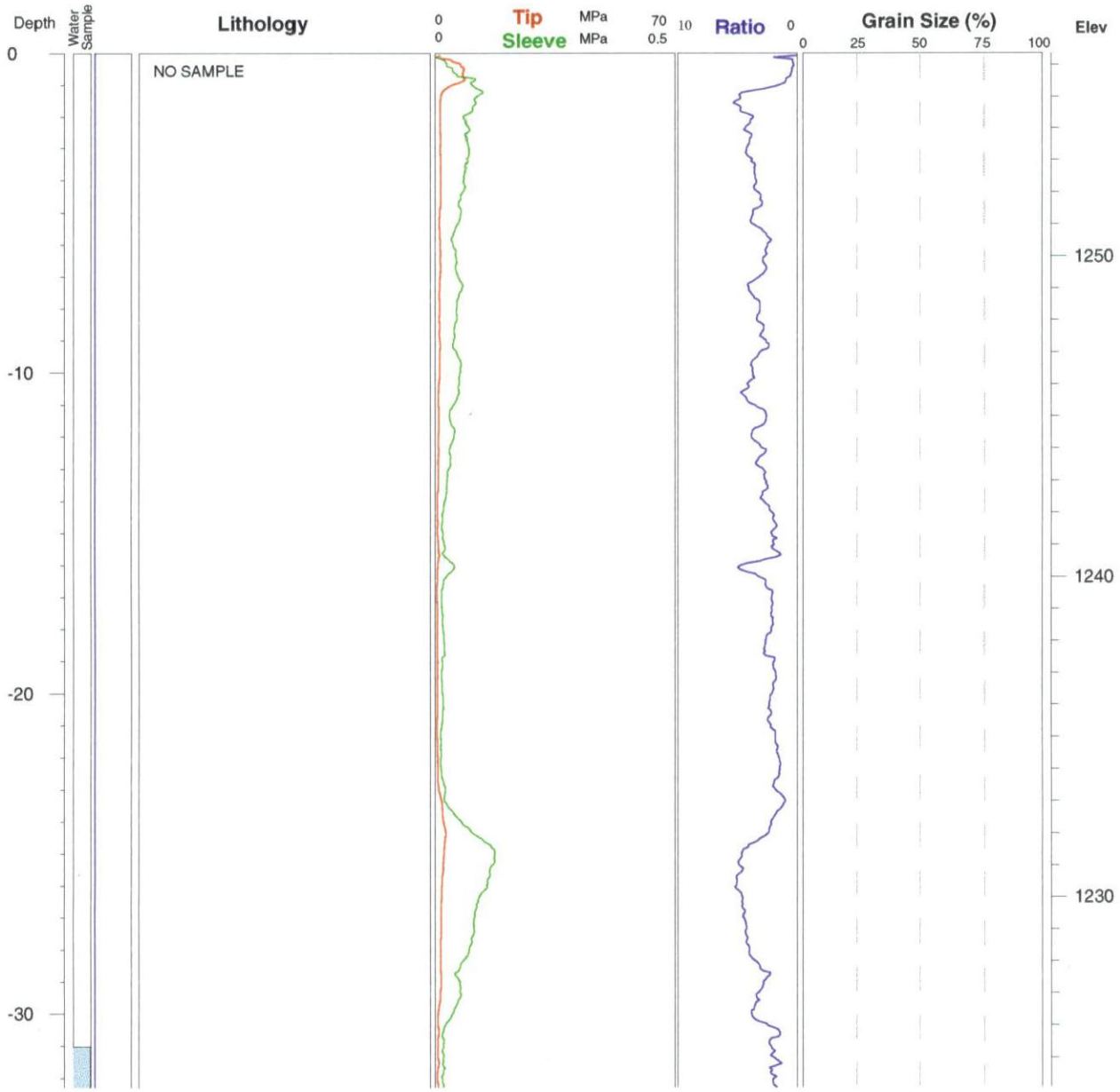
Argonne National Laboratory

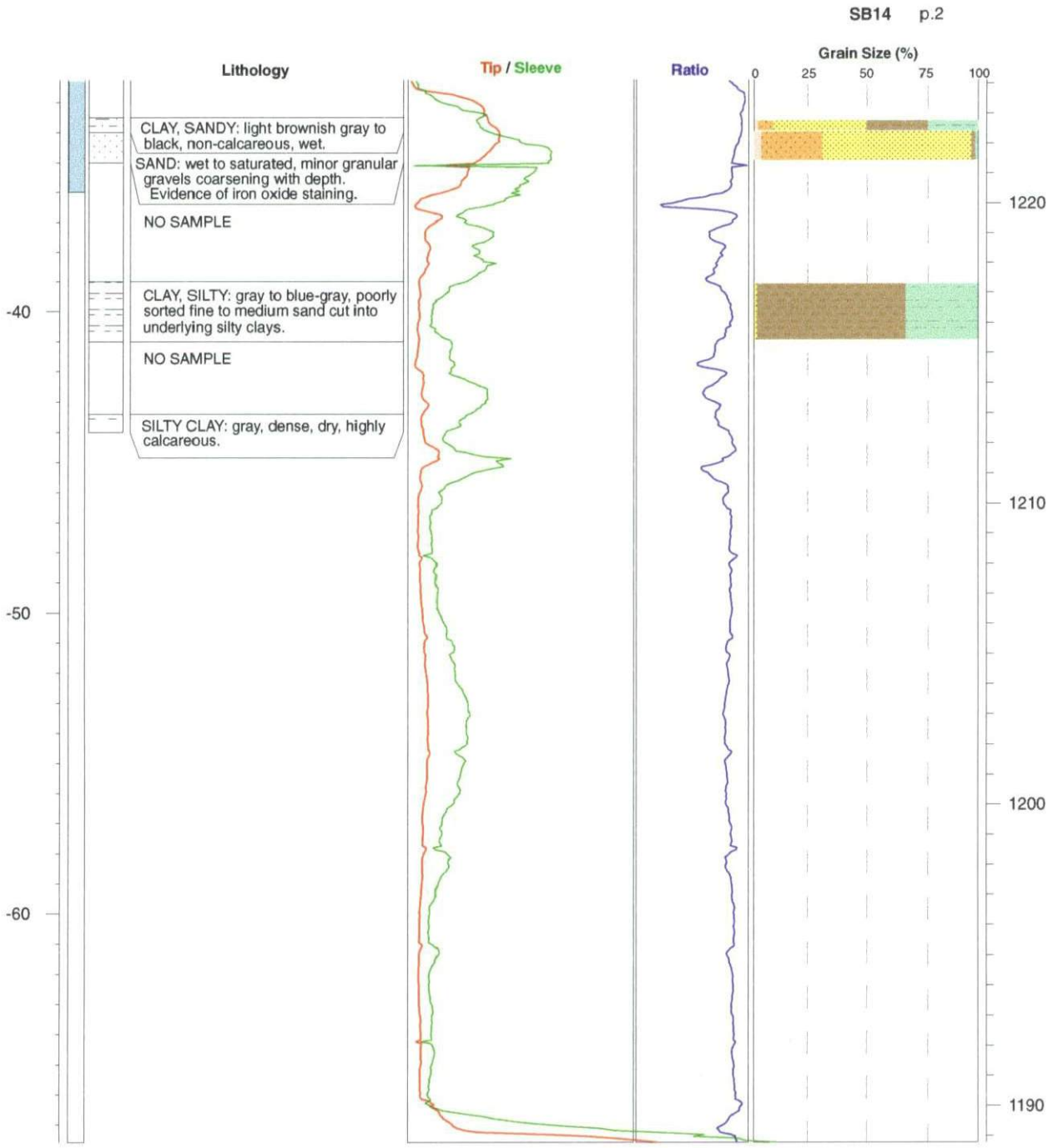
Project: Adams
Elevation: 1256.37 ft
Depth: 67.585 ft
Geologist: L. LaFreniere

Boring ID: SB14

Log Date: 4/28/00
Plot Date: 7/12/00

Rig: CPT
Driller: K. Spokas
Company: Argonne




SB14 p.2
Lithology
Tip / Sleeve
Ratio
Grain Size (%)
0
25
50
75
100
CLAY, SANDY: light brownish gray to black, non-calcareous, wet.
SAND: wet to saturated, minor granular gravels coarsening with depth. Evidence of iron oxide staining.
NO SAMPLE
CLAY, SILTY: gray to blue-gray, poorly sorted fine to medium sand cut into underlying silty clays.
NO SAMPLE
SILTY CLAY: gray, dense, dry, highly calcareous.
-40
-50
-60
1220
1210
1200
1190

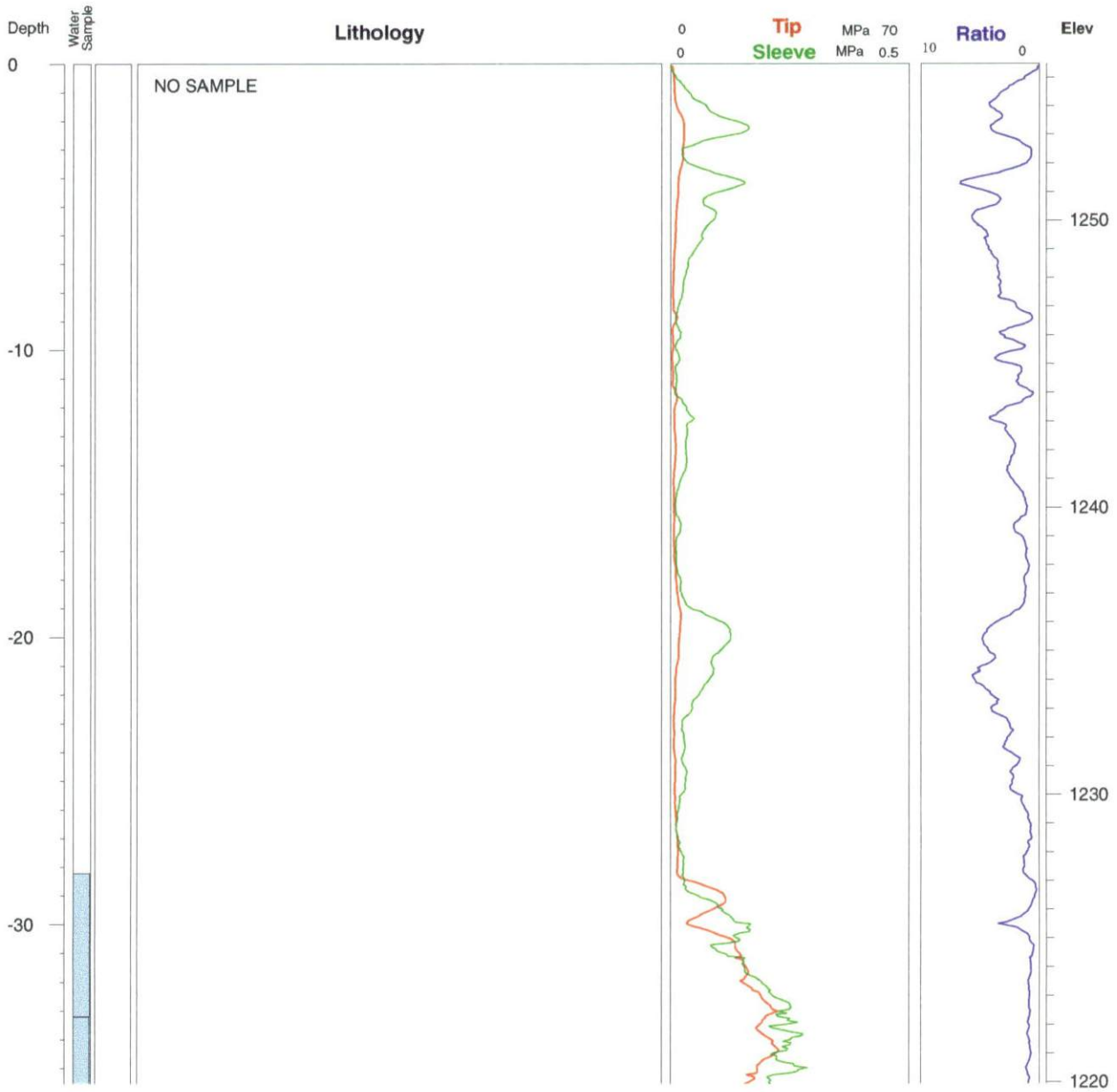
Argonne National Laboratory

Project: Adams
Elevation: 1255.48 ft
Depth: ~65 ft
Geologist: L. LaFreniere

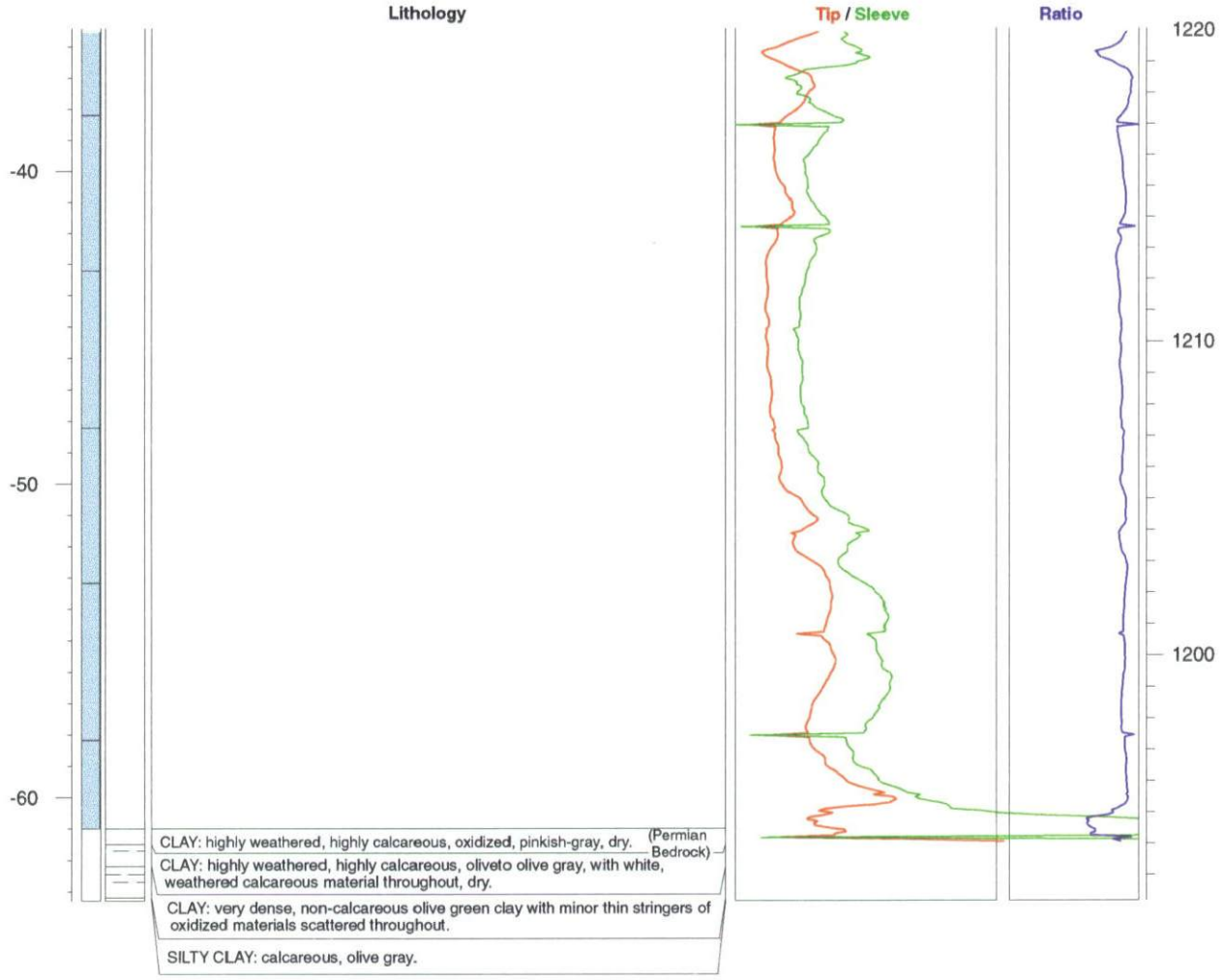
Boring ID: SB16

Log Date: 4/29/00
Plot Date: 5/2/00

Rig: CPT
Driller: K. Spokas
Company: Argonne



SB16 p.2

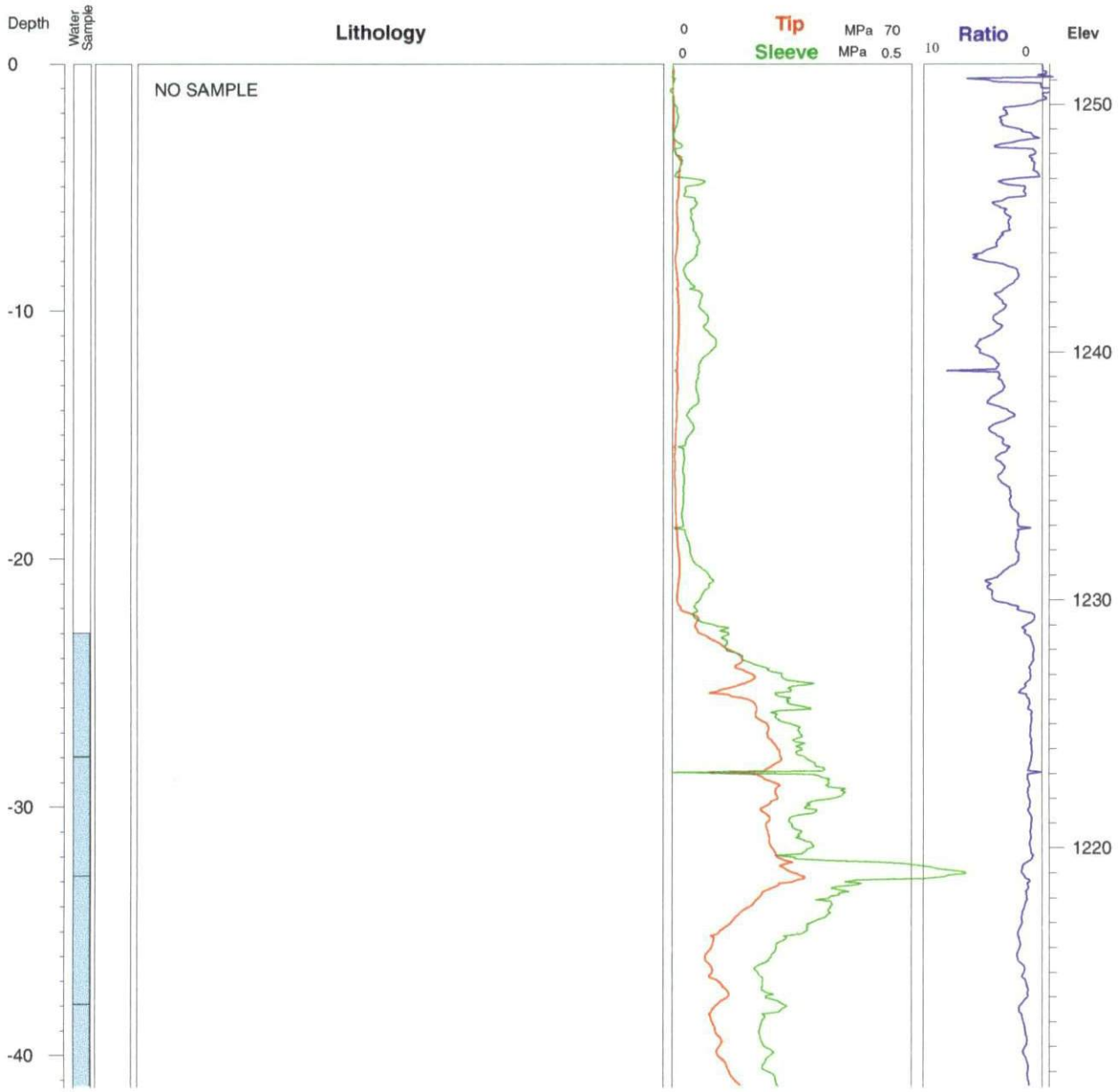

Lithology
Tip / Sleeve
Ratio
-40
-50
-60
1220
1210
1200
CLAY: highly weathered, highly calcareous, oxidized, pinkish-gray, dry.
(Permian Bedrock)
CLAY: highly weathered, highly calcareous, oliveto olive gray, with white, weathered calcareous material throughout, dry.
CLAY: very dense, non-calcareous olive green clay with minor thin stringers of oxidized materials scattered throughout.
SILTY CLAY: calcareous, olive gray.

Argonne National Laboratory

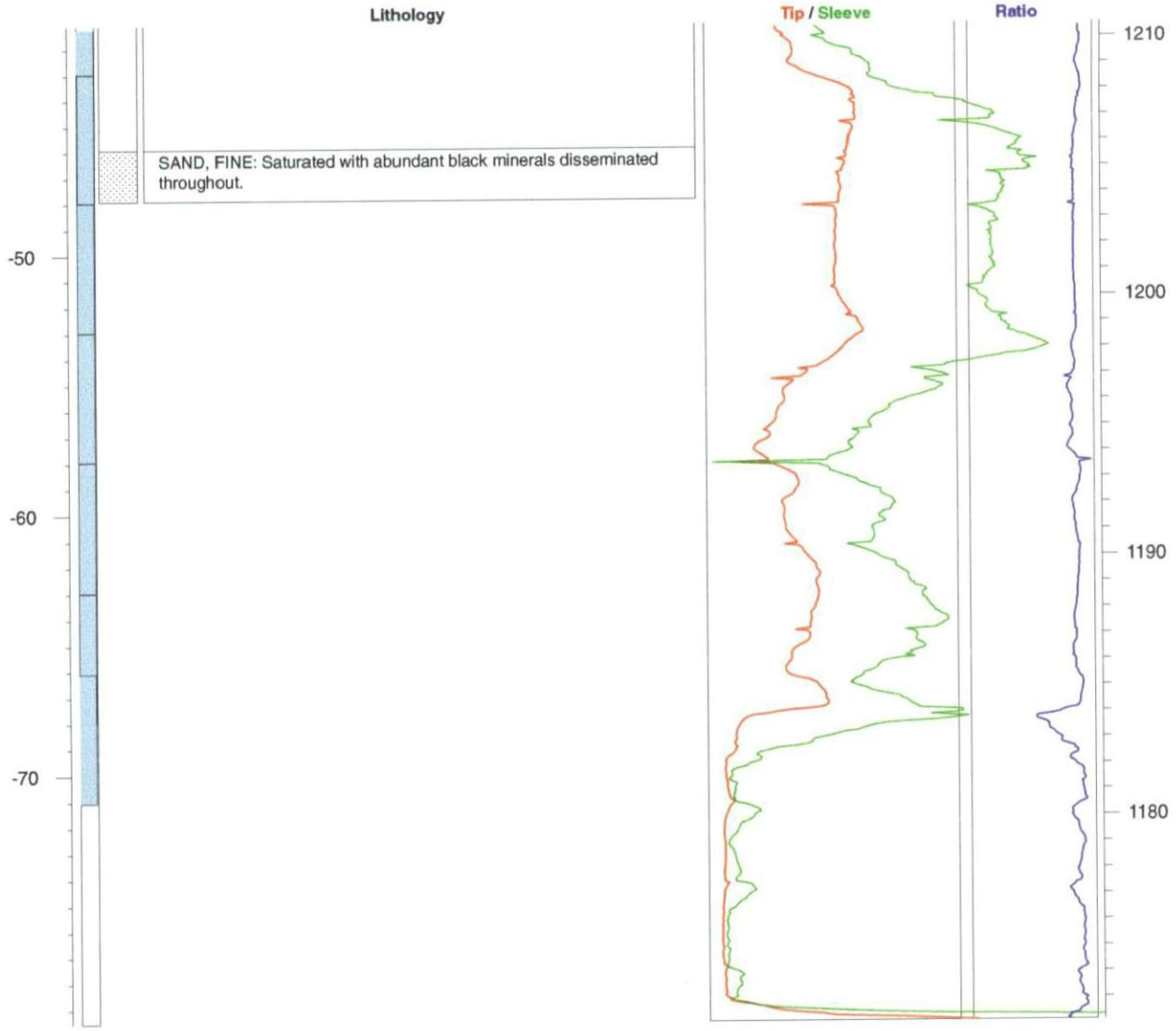
Project: Adams
Elevation: 1251.66 ft
Depth: 79.52 ft
Geologist: LaFreniere

Boring ID: SB18

Log Date: 5/2/00
Plot Date: 7/12/00
Rig: CPT
Driller: K. Spokas
Company: Argonne



SB18 p.2


Lithology
Tip / Sleeve
Ratio
SAND, FINE: Saturated with abundant black minerals disseminated throughout.
-50
-60
-70
1210
1200
1190
1180

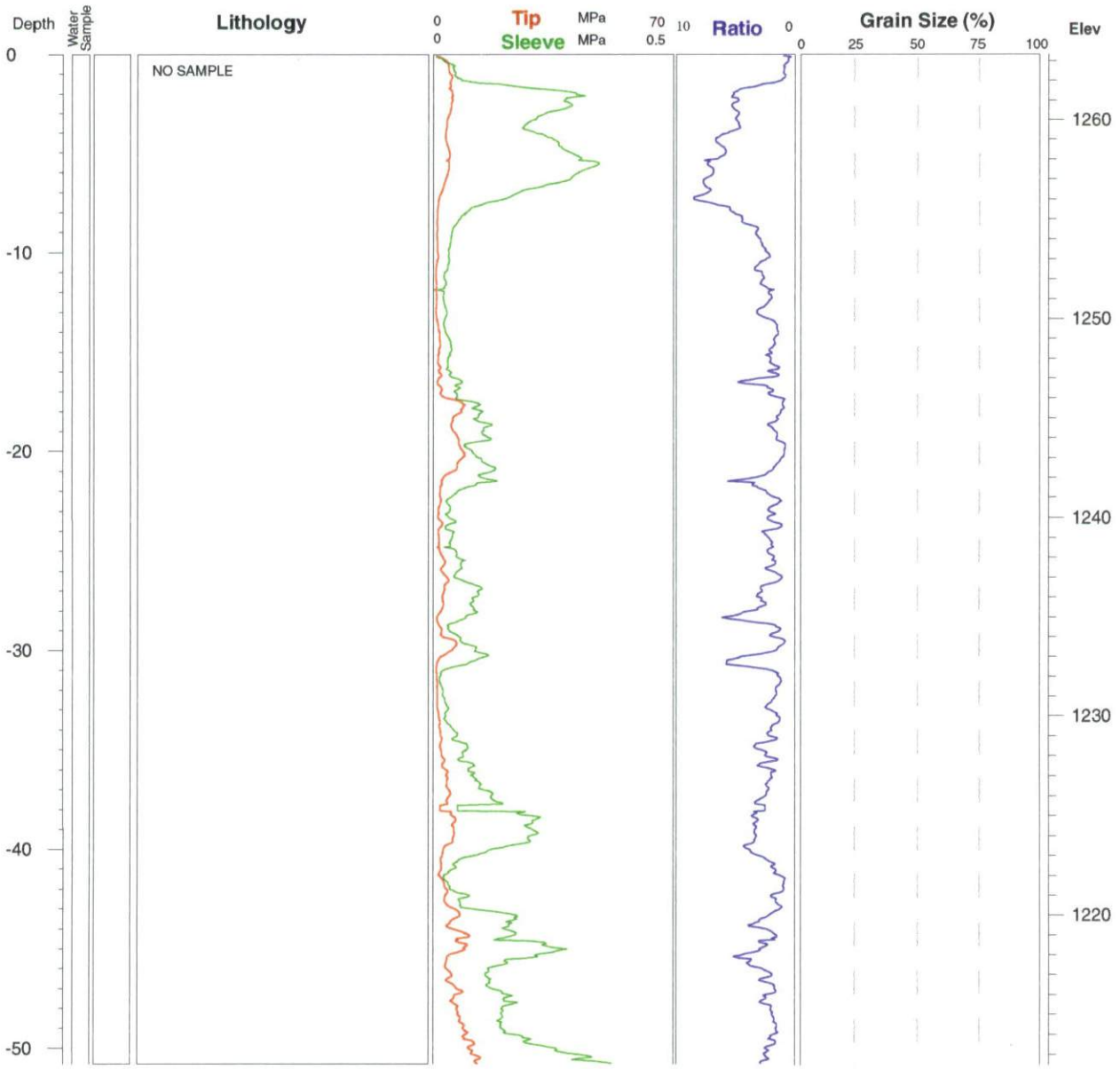
Argonne National Laboratory

Project: Adams
Elevation: 1263.34 ft
Depth: 111.48 ft
Geologist: LaFreniere

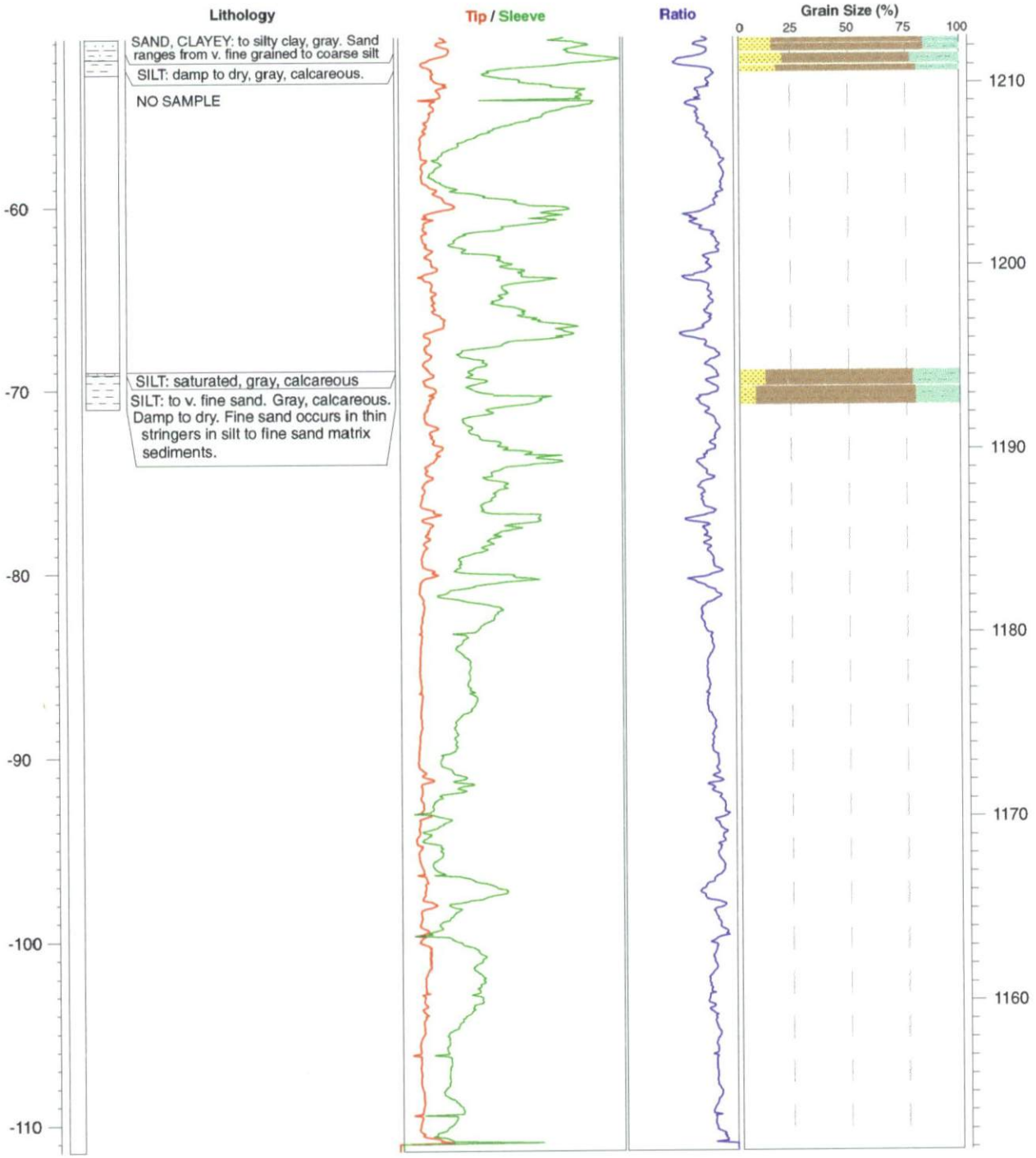
Boring ID: SB20

Log Date: 5/3/00
Plot Date: 7/12/00

Rig: CPT
Driller: K. Spokas
Company: Argonne



SB20 p.2


Lithology
Tip / Sleeve
Ratio
Grain Size (%)
0
25
50
75
100
SAND, CLAYEY: to silty clay, gray. Sand ranges from v. fine grained to coarse silt
SILT: damp to dry, gray, calcareous.
NO SAMPLE
SILT: saturated, gray, calcareous
SILT: to v. fine sand. Gray, calcareous. Damp to dry. Fine sand occurs in thin stringers in silt to fine sand matrix sediments.
-60
-70
-80
-90
-100
-110
1210
1200
1190
1180
1170
1160

Appendix C:

Soil Sample Data

TABLE C.1 Soil and Vegetation Samples Collected for Organic Analysis during the Phase I Investigation at Adams, Nebraska

Location	Sample	Depth (ft BGL)	Date	Sample Description
Near-Surface Soil Samples and Vegetation Samples				
B1	AD-B1-S-11621	0.8 -1.2	05/11/00	Very dark grayish brown silt loam; clay increases with depth.
B1	AD-B1-S-11622	5.8 -6	05/11/00	Brown clay.
B1	AD-B1-V-11529	NA[a]	05/10/00	Vegetation sample.
B2	AD-B2-S-11623	0.8 -1.2	05/11/00	Very dark grayish brown silt loam; clay increases with depth.
B2	AD-B2-S-11624	5.8 -6	05/11/00	Brown clay.
B2	AD-B2-V-11530	NA	05/10/00	Vegetation sample.
B3	AD-B3-V-11531	NA	05/10/00	Vegetation sample.
B4	AD-B4-S-11627	0.8 -1.2	05/11/00	Very dark grayish brown, highly organic silt loam.
B4	AD-B4-S-11628	5.8 -6	05/11/00	Clay with iron redox mottles.
B4	AD-B4-V-11532	NA	05/10/00	Vegetation sample.
B5	AD-B5-V-11553	NA	05/10/00	Vegetation sample.
B6	AD-B6-S-11631	0.8 -1.2	05/11/00	Very dark grayish brown organic silt loam.
B6	AD-B6-S-11632	5.8 -6	05/11/00	Clay (less redox than at B4 location).
B6	AD-B6-V-11554	NA	05/10/00	Vegetation sample.
B7	AD-B7-V-11555	NA	05/10/00	Vegetation sample.
B8	AD-B8-S-11635	0.8 -1.2	05/11/00	Very dark grayish brown silt loam.
B8	AD-B8-S-11636	5.8 -6	05/11/00	Dark yellowish brown to brown clay.
B8	AD-B8-V-11556	NA	05/10/00	Vegetation sample.
B9	AD-B9-S-11637	0.8 -1.2	05/11/00	Very dark grayish brown silt loam.
B9	AD-B9-S-11638	5.8 -6	05/11/00	Dark yellowish brown to brown clay.
B9	AD-B9-V-11557	NA	05/10/00	Vegetation sample.
B10	AD-B10-S-11639	0.8 -1.2	05/11/00	Very dark grayish brown silt loam.
B10	AD-B10-S-11640	5.8 -6	05/11/00	Brown clay.
B10	AD-B10-V-11558	NA	05/10/00	Vegetation sample.

TABLE C.1 (Cont.)

Location	Sample	Depth (ft BGL)	Date	Sample Description
Near-Surface Soil Samples and Vegetation Samples (Cont.)				
F1	AD-F1-S-11599	0.8 -1.1	05/11/00	Very dark gray clay loam.
F1	AD-F1-S-11600	5.8 -6	05/11/00	Brown silt with some clay and fine sand.
F1	AD-F1-V-11506	NA	05/09/00	Vegetation sample.
F2	AD-F2-S-11597	0.8 -1.1	05/11/00	Very dark gray clay loam.
F2	AD-F2-S-11598	5.9 -6	05/11/00	Very dark grayish brown loam to clay loam; occasional white inclusions.
F2	AD-F2-V-11505	NA	05/09/00	Vegetation sample.
F3	AD-F3-S-11595	0.8 -1.2	05/11/00	Very dark gray clay loam, similar to F4 location but with less staining.
F3	AD-F3-S-11596	5.5 -6	05/11/00	Brown clay.
F3	AD-F3-V-11504	NA	05/09/00	Vegetation sample.
F4	AD-F4-S-11593	0.8 -1.1	05/11/00	Very dark gray loam.
F4	AD-F4-S-11594	5.5 -6	05/11/00	Dark brown clay.
F4	AD-F4-V-11503	NA	05/09/00	Vegetation sample.
F5	AD-F5-S-11576	0.8 -1	05/10/00	Very dark grayish brown loam.
F5	AD-F5-S-11577	5.5 -6	05/10/00	Dark yellowish brown silt clay.
F5	AD-F5-V-11568	NA	05/10/00	Vegetation sample.
F6	AD-F6-S-11578	0.8 -1.2	05/10/00	Very dark gray loam topsoil.
F6	AD-F6-S-11579	5.5 -6	05/10/00	Dark brown loam.
F6	AD-F6-V-11569	NA	05/10/00	Vegetation sample.
F7	AD-F7-S-11580	0.8 -1.2	05/10/00	Very dark gray humic loam.
F7	AD-F7-S-11581	5.5 -6	05/10/00	Dark yellowish brown clay loam.
F7	AD-F7-V-11570	NA	05/10/00	Vegetation sample.
F8	AD-F8-S-11582	0.8 -1.2	05/10/00	Dark brown clay loam overwash.
F8	AD-F8-S-11584	2.2 -2.4	05/10/00	Very dark gray loam (buried topsoil).
F8	AD-F8-S-11583	5.5 -6	05/10/00	Slightly sandy brown clay, mottled with iron and manganese oxides.
F8	AD-F8-V-11571	NA	05/10/00	Vegetation sample.

TABLE C.1 (Cont.)

Location	Sample	Depth (ft BGL)	Date	Sample Description
Near-Surface Soil Samples and Vegetation Samples (Cont.)				
F9	AD-F9-S-11585	0.8 -1.2	05/10/00	Dark brown clay sand.
F9	AD-F9-S-11586	5.5 -6	05/10/00	Reddish brown clay sand with some carbonate flecks; some manganese and iron oxides.
F9	AD-F9-V-11572	NA	05/10/00	Vegetation sample.
F10	AD-F10-S-11587	0.2 -0.5	05/10/00	Dark brown clay with organic stain.
F10	AD-F10-S-11588	5.5 -6	05/10/00	Yellowish brown fine-medium sand.
F10	AD-F10-V-11573	NA	05/10/00	Vegetation sample.
F11	AD-F11-S-11619	0.8 -1.2	05/11/00	Dark brown clay loam.
F11	AD-F11-S-11620	5.8 -6	05/11/00	Dark brown clay with mottles; many grayish brown; few iron oxide and manganese oxide concretions.
F11	AD-F11-V-11563	NA	05/10/00	Vegetation sample.
F13	AD-F13-S-11617	0.8 -1.2	05/11/00	Very dark grayish brown loam.
F13	AD-F13-S-11618	5.8 -6	05/11/00	Yellowish brown silty clay loam with mottles.
F13	AD-F13-V-11528	NA	05/10/00	Vegetation sample.
F14	AD-F14-S-11615	0.8 -1.2	05/11/00	Dark grayish brown sandy loam.
F14	AD-F14-S-11616	5.8 -6	05/11/00	Yellowish brown mottled silt loam with yellowish brown to brown sand.
F14	AD-F14-V-11527	NA	05/10/00	Vegetation sample.
F15	AD-F15-S-11613	0.8 -1.2	05/11/00	Dark grayish brown sandy loam.
F15	AD-F15-S-11614	5.8 -6	05/11/00	Light brownish gray silt loam.
F15	AD-F15-V-11526	NA	05/10/00	Vegetation sample.
F16	AD-F16-S-11611	0.8 -1.2	05/11/00	Very dark grayish brown sandy loam.
F16	AD-F16-S-11612	5.8 -6	05/11/00	Mottled clay with sand.
F16	AD-F16-V-11525	NA	05/10/00	Vegetation sample.
F17	AD-F17-S-11609	0.8 -1.2	05/11/00	Very dark grayish brown to black loam.
F17	AD-F17-S-11610	5.8 -6	05/11/00	Brown clay.
F17	AD-F17-V-11524	NA	05/10/00	Vegetation sample.

TABLE C.1 (Cont.)

Location	Sample	Depth (ft BGL)	Date	Sample Description
Near-Surface Soil Samples and Vegetation Samples (Cont.)				
F18	AD-F18-S-11607	0.8 -1.2	05/11/00	Very dark grayish brown loam.
F18	AD-F18-S-11608	5.8 -6	05/11/00	Dark brown clay.
F18	AD-F18-V-11523	NA	05/09/00	Vegetation sample.
F19	AD-F19-S-11605	0.8 -1.2	05/11/00	Very dark grayish brown loam.
F19	AD-F19-S-11606	5.8 -6	05/11/00	Dark grayish brown clay.
F19	AD-F19-V-11520	NA	05/09/00	Vegetation sample.
F20	AD-F20-S-11603	0.8 -1.1	05/11/00	Very dark grayish brown fine sandy loam.
F20	AD-F20-S-11604	5.8 -6	05/11/00	Dark yellowish brown clay with gray clay skins.
F20	AD-F20-V-11519	NA	05/09/00	Vegetation sample.
F21	AD-F21-S-11601	0.8 -1.2	05/11/00	Very dark gray loam topsoil.
F21	AD-F21-S-11602	5.8 -6	05/11/00	Dark grayish brown sandy clay loam with oxides.
F21	AD-F21-V-11518	NA	05/09/00	Vegetation sample.
I1	AD-I1-S-11591	0.8 -1	05/10/00	Very dark grayish brown loam.
I1	AD-I1-S-11592	5.5 -6	05/10/00	Dark yellowish brown clay.
I1	AD-I1-V-11575	NA	05/10/00	Vegetation sample.
I2	AD-I2-S-11589	0.8 -1	05/10/00	Dark brown clay.
I2	AD-I2-S-11590	5.5 -6	05/10/00	Brown clay silt.
I2	AD-I2-V-11574	NA	05/10/00	Vegetation sample.
I3	AD-I3-S-11661	0.8 -1.2	05/11/00	Very dark gray silt loam.
I3	AD-I3-S-11662	5.8 -6	05/11/00	Dark yellowish brown clay; some humic stain.
I3	AD-I3-V-11512	NA	05/09/00	Vegetation sample.
I4	AD-I4-S-11663	0.8 -1.2	05/11/00	Very dark gray loam topsoil.
I4	AD-I4-S-11664	5.8 -6	05/11/00	Dark yellowish brown silty clay; some humic staining.
I4	AD-I4-V-11564	NA	05/10/00	Vegetation sample.

TABLE C.1 (Cont.)

Location	Sample	Depth (ft BGL)	Date	Sample Description
Near-Surface Soil Samples and Vegetation Samples (Cont.)				
I5	AD-I5-S-11669	0.8 -1.2	05/11/00	Very dark grayish brown silt loam topsoil.
I5	AD-I5-S-11670	5.8 -6	05/11/00	Dark yellowish brown clay with some humic staining.
I5	AD-I5-V-11567	NA	05/10/00	Vegetation sample.
Q1	AD-Q1-S-11649	0.8 -1.2	05/11/00	Very dark gray clay loam with red ferric stains.
Q1	AD-Q1-S-11650	5.8 -6	05/11/00	Dark yellowish brown loam.
Q1	AD-Q1-V-11507	NA	05/09/00	Vegetation sample.
Q2	AD-Q2-S-11647	0.8 -1.2	05/11/00	Very dark gray clay loam with red ferric stains.
Q2	AD-Q2-S-11648	5.8 -6	05/11/00	Dark yellowish brown silty clay loam.
Q2	AD-Q2-V-11508	NA	05/09/00	Vegetation sample.
Q3	AD-Q3-S-11645	0.8 -1.2	05/11/00	Very dark gray clay with red ferric stains.
Q3	AD-Q3-S-11646	5.8 -6	05/11/00	Dark brown silty clay loam.
Q3	AD-Q3-V-11509	NA	05/09/00	Vegetation sample.
Q4	AD-Q4-S-11643	0.8 -1.2	05/11/00	Very dark gray loam topsoil with red iron staining (previously under building).
Q4	AD-Q4-S-11644	5.8 -6	05/11/00	Brown clay; some humic staining.
Q4	AD-Q4-V-11510	NA	05/09/00	Vegetation sample.
Q5	AD-Q5-S-11641	0.8 -1.2	05/11/00	Very dark gray loam.
Q5	AD-Q5-S-11642	5.8 -6	05/11/00	Dark yellowish brown clay with heavy organic staining.
Q5	AD-Q5-V-11511	NA	05/09/00	Vegetation sample.
Q6	AD-Q6-S-11659	0.8 -1.2	05/11/00	Very dark gray clay loam with red iron stains.
Q6	AD-Q6-S-11660	5.8 -6	05/11/00	Dark yellowish brown silty clay loam with heavy organic stain.
Q6	AD-Q6-V-11514	NA	05/09/00	Vegetation sample.
Q7	AD-Q7-S-11657	0.8 -1.2	05/11/00	Very dark gray silty clay.
Q7	AD-Q7-S-11658	5.8 -6	05/11/00	Dark yellowish brown clay with light organic staining.
Q7	AD-Q7-V-11513	NA	05/09/00	Vegetation sample.

TABLE C.1 (Cont.)

Location	Sample	Depth (ft BGL)	Date	Sample Description
Near-Surface Soil Samples and Vegetation Samples (Cont.)				
Q8	AD-Q8-S-11655	0.8 -1.2	05/11/00	Very dark gray silty clay. (Sample collected above cultural disturbance.)
Q8	AD-Q8-S-11329	2.9 -3.1	05/11/00	Very dark grayish loam. (Sample collected above below cultural disturbance.)
Q8	AD-Q8-S-11656	5.8 -6	05/11/00	Dark yellowish brown clay with heavy organic staining to bottom.
Q8	AD-Q8-V-11515	NA	05/09/00	Vegetation sample.
Q9	AD-Q9-S-11653	0.8 -1.2	05/11/00	Very dark gray clay with high organic content and red iron stains.
Q9	AD-Q9-S-11654	5.8 -6	05/11/00	Dark brown silty clay loam.
Q9	AD-Q9-V-11516	NA	05/09/00	Vegetation sample.
Q10	AD-Q10-S-11667	0.8 -1.2	05/11/00	Sandy clay overwash (?). Atypical sample.
Q10	AD-Q10-S-11330	2.9 -3.1	05/11/00	Very dark gray topsoil (buried horizon).
Q10	AD-Q10-S-11668	5.8 -6	05/11/00	Very dark gray clay with high organic component.
Q10	AD-Q10-V-11566	NA	05/10/00	Vegetation sample.
Q11	AD-Q11-S-11665	1 -1.2	05/11/00	Silty clay loam.
Q11	AD-Q11-S-11666	5.8 -6	05/11/00	Silt loam.
Q11	AD-Q11-V-11565	NA	05/10/00	Vegetation sample.
Q12	AD-Q12-S-11651	0.8 -1.2	05/11/00	Very dark clay loam with pebbles and mixed with lighter subsoil. Disturbed.
Q12	AD-Q12-S-11652	5.8 -6	05/11/00	Brown silty clay loam. Fewer stains.
Q12	AD-Q12-V-11517	NA	05/09/00	Vegetation sample.
Q13	AD-Q13-S-11675	0.8 -1.2	05/11/00	Dark brown clay loam (topsoil gone, sample slightly stained).
Q13	AD-Q13-S-11676	5.8 -6	05/11/00	Dark yellowish brown clay loam with grayish brown mottles.
Q13	AD-Q13-V-11562	NA	05/10/00	Vegetation sample.
Q14	AD-Q14-S-11323	0.8 -1.2	05/11/00	Grayish brown loam.
Q14	AD-Q14-S-11324	5.8 -6	05/11/00	Dark yellowish brown clay loam.
Q14	AD-Q14-V-11561	NA	05/10/00	Vegetation sample.

TABLE C.1 (Cont.)

Location	Sample	Depth (ft BGL)	Date	Sample Description
Near-Surface Soil Samples and Vegetation Samples (Cont.)				
Q15	AD-Q15-S-11673	0.8 -1.2	05/11/00	Very dark grayish brown loam.
Q15	AD-Q15-S-11674	5.8 -6	05/11/00	Dark yellowish brown clay loam.
Q15	AD-Q15-V-11560	NA	05/10/00	Vegetation sample.
Q16	AD-Q16-S-11671	0.8 -1.2	05/11/00	Very dark grayish brown silt loam topsoil.
Q16	AD-Q16-S-11672	5.8 -6	05/11/00	Dark yellowish brown clay with some humic staining.
Q16	AD-Q16-V-11559	NA	05/10/00	Vegetation sample.
SB03	AD-SB03-V-11320	NA	05/11/00	Vegetation sample collected within 3 ft of SB03 piezometer.

[a] NA, depth not applicable.

TABLE C.2 Results of Organic Analyses by Purge-and-Trap Method on Soil Samples Collected during the Phase I Investigation at Adams, Nebraska

				Concentration (µg/kg)	
Location	Sample	Depth (ft BGL)	Sample Date	Carbon Tetrachloride	Chloroform
Near-Surface Soil Samples					
B1	AD-B1-S-11621	0.8 -1.2	5/11/00	ND[a]	ND
B1	AD-B1-S-11622	5.8 -6	5/11/00	ND	ND
B2	AD-B2-S-11623	0.8 -1.2	5/11/00	ND	< 10[b]
B2	AD-B2-S-11624	5.8 -6	5/11/00	ND	ND
B4	AD-B4-S-11627	0.8 -1.2	5/11/00	ND	ND
B4	AD-B4-S-11628	5.8 -6	5/11/00	ND	ND
B6	AD-B6-S-11631	0.8 -1.2	5/11/00	ND	ND
B6	AD-B6-S-11632	5.8 -6	5/11/00	ND	ND
B8	AD-B8-S-11635	0.8 -1.2	5/11/00	ND	ND
B8	AD-B8-S-11636	5.8 -6	5/11/00	ND	ND
B9	AD-B9-S-11637	0.8 -1.2	5/11/00	ND	ND
B9	AD-B9-S-11638	5.8 -6	5/11/00	ND	ND
B10	AD-B10-S-11639	0.8 -1.2	5/11/00	ND	ND
B10	AD-B10-S-11640	5.8 -6	5/11/00	ND	ND
F1	AD-F1-S-11599	0.8 -1.1	5/11/00	ND	ND
F1	AD-F1-S-11600	5.8 -6	5/11/00	NA[c]	NA
F2	AD-F2-S-11597	0.8 -1.1	5/11/00	ND	ND
F2	AD-F2-S-11598	5.9 -6	5/11/00	ND	ND
F3	AD-F3-S-11595	0.8 -1.2	5/11/00	ND	< 10
F3	AD-F3-S-11596	5.5 -6	5/11/00	ND	< 10
F4	AD-F4-S-11593	0.8 -1.1	5/11/00	ND	ND
F4	AD-F4-S-11594	5.5 -6	5/11/00	ND	ND
F5	AD-F5-S-11576	0.8 -1	5/10/00	ND	ND
F5	AD-F5-S-11577	5.5 -6	5/10/00	ND	< 10
F6	AD-F6-S-11578	0.8 -1.2	5/10/00	ND	ND
F6	AD-F6-S-11579	5.5 -6	5/10/00	ND	ND
F7	AD-F7-S-11580	0.8 -1.2	5/10/00	ND	ND
F7	AD-F7-S-11581	5.5 -6	5/10/00	ND	ND
F8	AD-F8-S-11582	0.8 -1.2	5/10/00	ND	ND
F8	AD-F8-S-11584	2.2 -2.4	5/10/00	ND	ND
F8	AD-F8-S-11583	5.5 -6	5/10/00	ND	ND
F9	AD-F9-S-11585	0.8 -1.2	5/10/00	ND	ND
F9	AD-F9-S-11586	5.5 -6	5/10/00	ND	ND
F10	AD-F10-S-11587	0.2 -0.5	5/10/00	ND	ND
F10	AD-F10-S-11588	5.5 -6	5/10/00	ND	< 10
F11	AD-F11-S-11619	0.8 -1.2	5/11/00	ND	ND
F11	AD-F11-S-11620	5.8 -6	5/11/00	ND	< 10
F13	AD-F13-S-11617	0.8 -1.2	5/11/00	ND	ND
F13	AD-F13-S-11618	5.8 -6	5/11/00	ND	ND
F14	AD-F14-S-11615	0.8 -1.2	5/11/00	ND	ND
F14	AD-F14-S-11616	5.8 -6	5/11/00	ND	ND

TABLE C.2 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Concentration (µg/kg) Carbon Tetrachloride	Chloroform
Near-Surface Soil Samples (Cont.)					
F15	AD-F15-S-11613	0.8 -1.2	5/11/00	ND	ND
F15	AD-F15-S-11614	5.8 -6	5/11/00	ND	ND
F16	AD-F16-S-11611	0.8 -1.2	5/11/00	ND	ND
F16	AD-F16-S-11612	5.8 -6	5/11/00	ND	ND
F17	AD-F17-S-11609	0.8 -1.2	5/11/00	ND	ND
F17	AD-F17-S-11610	5.8 -6	5/11/00	ND	ND
F18	AD-F18-S-11607	0.8 -1.2	5/11/00	ND	ND
F18	AD-F18-S-11608	5.8 -6	5/11/00	ND	ND
F19	AD-F19-S-11605	0.8 -1.2	5/11/00	ND	ND
F19	AD-F19-S-11606	5.8 -6	5/11/00	ND	ND
F20	AD-F20-S-11603	0.8 -1.1	5/11/00	ND	< 10
F20	AD-F20-S-11604	5.8 -6	5/11/00	ND	ND
F21	AD-F21-S-11601	0.8 -1.2	5/11/00	ND	< 10
F21	AD-F21-S-11602	5.8 -6	5/11/00	ND	ND
I1	AD-I1-S-11591	0.8 -1	5/10/00	ND	ND
I1	AD-I1-S-11592	5.5 -6	5/10/00	ND	< 10
I2	AD-I2-S-11589	0.8 -1	5/10/00	ND	ND
I2	AD-I2-S-11590	5.5 -6	5/10/00	ND	< 10
I3	AD-I3-S-11661	0.8 -1.2	5/11/00	ND	ND
I3	AD-I3-S-11662	5.8 -6	5/11/00	ND	ND
I4	AD-I4-S-11663	0.8 -1.2	5/11/00	ND	ND
I4	AD-I4-S-11664	5.8 -6	5/11/00	ND	ND
I5	AD-I5-S-11669	0.8 -1.2	5/11/00	ND	< 10
I5	AD-I5-S-11670	5.8 -6	5/11/00	ND	< 10
Q1	AD-Q1-S-11649	0.8 -1.2	5/11/00	ND	< 10
Q1	AD-Q1-S-11650	5.8 -6	5/11/00	ND	ND
Q2	AD-Q2-S-11647	0.8 -1.2	5/11/00	ND	ND
Q2	AD-Q2-S-11648	5.8 -6	5/11/00	ND	ND
Q3	AD-Q3-S-11645	0.8 -1.2	5/11/00	ND	ND
Q3	AD-Q3-S-11646	5.8 -6	5/11/00	ND	ND
Q4	AD-Q4-S-11643	0.8 -1.2	5/11/00	ND	ND
Q4	AD-Q4-S-11644	5.8 -6	5/11/00	ND	ND
Q5	AD-Q5-S-11641	0.8 -1.2	5/11/00	< 10	ND
Q5	AD-Q5-S-11642	5.8 -6	5/11/00	ND	ND
Q6	AD-Q6-S-11659	0.8 -1.2	5/11/00	< 10	< 10
Q6	AD-Q6-S-11660	5.8 -6	5/11/00	ND	< 10
Q7	AD-Q7-S-11657	0.8 -1.2	5/11/00	ND	ND
Q7	AD-Q7-S-11658	5.8 -6	5/11/00	ND	ND
Q8	AD-Q8-S-11655	0.8 -1.2	5/11/00	ND	ND
Q8	AD-Q8-S-11329	2.9 -3.1	5/11/00	ND	ND
Q8	AD-Q8-S-11656	5.8 -6	5/11/00	ND	ND

TABLE C.2 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Concentration (µg/kg) Carbon Tetrachloride	Chloroform
Near-Surface Soil Samples (Cont.)					
Q9	AD-Q9-S-11653	0.8 -1.2	5/11/00	ND	ND
Q9	AD-Q9-S-11654	5.8 -6	5/11/00	ND	ND
Q10	AD-Q10-S-11667	0.8 -1.2	5/11/00	ND	ND
Q10	AD-Q10-S-11330	2.9 -3.1	5/11/00	ND	ND
Q10	AD-Q10-S-11668	5.8 -6	5/11/00	ND	ND
Q11	AD-Q11-S-11665	1 -1.2	5/11/00	ND	< 10
Q11	AD-Q11-S-11666	5.8 -6	5/11/00	ND	< 10
Q12	AD-Q12-S-11651	0.8 -1.2	5/11/00	ND	ND
Q12	AD-Q12-S-11652	5.8 -6	5/11/00	ND	ND
Q13	AD-Q13-S-11675	0.8 -1.2	5/11/00	ND	< 10
Q13	AD-Q13-S-11676	5.8 -6	5/11/00	ND	ND
Q14	AD-Q14-S-11323	0.8 -1.2	5/11/00	ND	ND
Q14	AD-Q14-S-11324	5.8 -6	5/11/00	ND	ND
Q15	AD-Q15-S-11673	0.8 -1.2	5/11/00	ND	ND
Q15	AD-Q15-S-11674	5.8 -6	5/11/00	ND	< 10
Q16	AD-Q16-S-11671	0.8 -1.2	5/11/00	ND	< 10
Q16	AD-Q16-S-11672	5.8 -6	5/11/00	ND	ND
QC	AD-QCBG-S-11322	0.5 -0.7	5/11/00	ND	ND

[a] ND, contaminant not detected.

[b] < 10, contaminant detected at a concentration below the quantitation limit of 10 µg/kg.

[c] NA, sample not analyzed by purge-and-trap method.

TABLE C.3 Results of Particle Size Analyses on Subsurface Soil Samples Collected during the Phase I Field Investigation at Adams, Nebraska

Location	Depth (ft BGL)	Size (% passing through sieve size)														
		3/4 in.	1/2 in.	3/8 in.	#4	#10	#18	#20	#35	#40	#50	#60	#100	#140	#200	#270
SB01	0-3					100	100	100	100	99.9	99.3	98.9	96	92.1	89.6	87.9
SB01	3-6					100	99.9	99.9	99.8	99.8	99.5	99.3	97.7	94.8	92.3	90.8
SB01	6-10					100	100	100	100	99.9	99.9	99.8	99.4	97.5	93.9	91.4
SB01	10-15					100	100	100	100	99.9	99.9	99.9	99.5	98.9	98.1	97.5
SB01	15-18.5					100	100	100	100	99.9	99.9	99.9	99.7	99.4	99.1	98.9
SB01	18.5-20					100	100	99.9	99.9	99.8	99.6	99.6	99.1	98.8	98.4	98.1
SB01	20-21					100	99.7	99.7	99.2	99	98.6	98.4	97.7	97.2	96.6	95.8
SB01	21-25					100	100	100	99.9	99.8	99.4	99.2	98.9	98.5	98.1	97.4
SB01	25-27.8					100	99.7	99.7	99.1	98.6	97.8	97.4	93.7	87.1	81.5	79.5
SB01	27.8-28.2					100	98.4	97.7	91.9	88.1	74.7	64.8	33.8	24.1	20.8	19.8
SB01	28.2-29.2					100	100	100	100	99.9	99.9	99.8	99.3	94.6	85.6	79.8
SB01	29.2-30					100	100	100	100	99.9	99.9	99.9	99.8	99.5	98.7	97.8
SB01	30-31					100	99.9	99.8	98.9	98.1	95.5	93.9	89.2	81.1	73.2	70.5
SB01	31-33.2					100	99.4	99.1	94.3	89.2	72.6	61.7	29.5	22.1	18.6	17.4
SB01	33.2-33.7					100	100	99.9	99.6	99.4	97.8	95.9	73.4	51.2	37.5	31.8
SB01	33.7-36	100	100	100	97.9	97.3	96.6	96.3	93.5	90.7	73.1	59.5	22.1	12.8	9.4	8.1
SB01	36-38	100	100	100	98.6	94.7	90.7	89.6	78.9	70.1	45.4	34.9	12	6.9	5.6	5.2
SB01	38-39	100	99.1	93.1	85.4	74.2	57.3	54	36.6	31.4	23.1	20	12.1	10.2	9.2	8.7
SB01	39-39.5	100	98.1	94.1	88.9	82.5	71.1	68.2	49	42.2	32.2	29.1	19.5	15.9	14.2	13.2
SB01	43-45	100	100	100	100	100	99.4	99.2	95.6	91.6	72.8	60.9	20.3	11	9.2	8.5
SB01	45-46.5			100	100	100	98.9	98.4	83	67.6	36.2	28	10.2	7.8	7.2	6.8
SB01	48-50			100	98.5	98.3	97.1	95.9	77	69.5	54.3	42.4	13.6	8.7	7.7	7.3
SB01	56-57			100	100	100	99.9	99.9	99.7	99.5	89.4	68.2	10.2	6.9	6	5.7
SB01	64-65			99.4	98.2	91.2	71.4	66.5	32.4	23.4	14.9	12.4	8.2	7	6.3	5.9
SB01	72-73			100	100	100	100	100	99.7	99.4	98.1	97.2	95.4	95.1	94.5	90.6
SB02	25-25.5	100	100	100	100	100	100	99.9	99.9	99.9	99.5	99.2	94	82.8	75.8	71.8
SB02	31-34	93.5	92.1	86.2	78.2	66.8	55.5	52.7	40.9	37	30.7	28.7	24.2	22.1	20.7	19.9
SB02	46-51	100	100	100	100	100	99.9	99.8	99.8	99.7	99.7	99.6	94.4	67.3	38.4	26
SB02	54-56.5	100	100	100	100	100	99.9	99.9	99.8	99.7	99.6	99.5	90.9	56	30.9	23
SB02	63-65	100	100	100	100	100	99.7	99.5	96.5	93.1	62.4	36	8	6.3	5.3	4.8

TABLE C.3 (Cont.)

Location	Depth (ft BGL)	Size (% passing through sieve size)														
		3/4 in.	1/2 in.	3/8 in.	#4	#10	#18	#20	#35	#40	#50	#60	#100	#140	#200	#270
SB03	42.62-44.62					100	99.1	98.7	94.7	87.7	78.7	71.6	35.7	27	24.3	23.4
SB03	49.2-50.8					100	100	99.9	90.2	77.2	55.9	44.2	9.9	5.1	4.3	4.1
SB03	50.8-51.2					100	99.7	99.4	87.7	77	60.3	51.7	20.6	13.8	11.7	10.8
SB03	63.9-65.7					100	99.3	98.8	84.6	70	35.4	22.6	6.6	4.6	3.9	3.6
SB04	53-55					100	100	100	99.9	99.9	99.9	99.8	99.8	99.4	94.1	84.5
SB05	34.67-36.7					100	100	100	99.9	99.9	99.8	99.8	99.7	99.5	95.6	87.9
SB06	41.6-43.6					100	99.8	99.6	93	82.7	40.5	23.5	4.9	3.5	3.1	2.9
SB06	52.12-54.12					100	99.9	99.9	98.9	97	64	32.1	5.1	4.1	3.7	3.5
SB06	64.2-66.2					100	99	98.5	90.7	82.7	52.7	35.1	12.2	8.9	7.2	6.5
SB13	24.6-26.6					100	100	100	100	99.9	99.8	99.6	96.9	93.5	91	89.2
SB13	31.5-33.5	100	100	99.7	97.9	95.8	90.1	87.9	62.2	44.6	17.7	11.9	7.7	3.7	3.2	2.9
SB13	37.4-39.4					100	99.9	99.9	99.2	98.1	79.5	68.1	28.8	16.4	15	9.5
SB13	43.9-45.9					100	100	100	99.9	99.9	99.2	97.6	37	9.9	6.1	5.2
SB13	45.9-47.9					100	100	100	100	99.7	83.4	59.2	14.7	10.1	7.7	6.8
SB13	57.4-59.4					100	100	100	100	100	99.9	99.9	95.6	71.5	41.7	28.3
SB13	64.2-65.5					100	100	100	98.9	94.7	61	43.2	19.2	13.1	9.2	7.58
SB13	65.5-66.2					100	100	100	99.8	99.2	95.3	92.7	84.8	65.6	38.9	25.4
SB14	33.6-34.0					100	99.4	99.1	96	92.6	79.8	74.2	60.1	53.2	50	48.4
SB14	34-35					100	98.9	98.3	84.4	70.8	31.2	19.3	6.2	4	3.3	3
SB14	39-41					100	100	99.9	99.9	99.8	99.7	99.5	98.9	98.4	98.2	97.9
SB20	50.8-50.95					100	100	100	100	99.9	99.9	99.9	99.8	98.4	86.6	73.1
SB20	50.95-51.70					100	100	100	99.9	99.9	99.9	99.8	99.7	98.2	85.6	71.7
SB20	51.70-52.40					100	100	100	99.9	99.9	99.9	99.8	99.6	96.7	80.7	66.8
SB20	52.40-52.80					100	100	100	100	100	99.9	99.8	99.6	98.1	83.5	67.5
SB20	69-70					100	100	100	100	100	99.9	99.9	99.9	99.1	88.6	73.9
SB20	70-71					100	100	100	100	100	99.9	99.9	99.9	99.5	93.6	82.5

TABLE C.4 Composition of Subsurface Soil Samples Collected during the Phase I Field Investigation at Adams, Nebraska

Location	Depth (ft BGL)	Composition (%)				Location	Depth (ft BGL)	Composition (%)			
		Gravel	Sand	Silt	Clay			Gravel	Sand	Silt	Clay
SB01	0-3	0	10.4	54.8	34.8	SB03	42.62-44.62	0	75.7	8.7	15.6
SB01	3-6	0	7.7	56.5	35.8	SB03	49.2-50.8	0	95.7	2.9	1.4
SB01	6-10	0	6.1	51.2	42.7	SB03	50.8-51.2	0	88.3	8.1	3.6
SB01	10-15	0	1.9	59.2	38.9	SB03	63.9-65.7	0	96.1	2.8	1.1
SB01	15-18.5	0	0.9	61.8	37.3						
SB01	18.5-20	0	1.6	57.8	40.6	SB04	53-55	0	5.9	75.5	18.6
SB01	20-21	0	3.4	54.1	42.5						
SB01	21-25	0	1.9	53	45.1	SB05	34.67-36.7	0	4.4	80.3	15.3
SB01	25-27.8	0	18.5	52.5	29						
SB01	27.8-28.2	0	79.2	11	9.8	SB06	41.6-43.6	0	96.9	2.3	0.8
SB01	28.2-29.2	0	14.4	61	24.6	SB06	52.12-54.12	0	96.3	2.2	1.5
SB01	29.2-30	0	1.3	62.1	36.6	SB06	64.2-66.2	0	92.8	6.6	0.6
SB01	30-31	0	26.8	49.9	23.3						
SB01	31-33.2	0	81.4	13.3	5.3	SB13	24.6-26.6	0	9	59.5	31.5
SB01	33.2-33.7	0	62.5	27.6	9.9	SB13	31.5-33.5	2.1	94.7	2.6	0.6
SB01	33.7-36	2.1	88.5	6.7	2.7	SB13	37.4-39.4	0	85	11.6	3.4
SB01	36-38	1.4	93	2.9	2.7	SB13	43.9-45.9	0	93.9	4.4	1.7
SB01	38-39	14.6	76.2	6.4	2.8	SB13	45.9-47.9	0	92.3	5.5	2.2
SB01	39-39.5	11.1	74.7	9.8	4.4	SB13	57.4-59.4	0	58.3	36.3	5.4
SB01	43-45	0	90.8	4.1	5.1	SB13	64.2-65.5	0	90.8	7.4	1.8
SB01	45-46.5	0	92.8	3.5	3.7	SB13	65.5-66.2	0	61.1	33.6	5.3
SB01	48-50	1.5	90.8	2.9	4.8						
SB01	56-57	0	94	2.2	3.8	SB14	33.6-34.0	0	50	27.5	22.5
SB01	64-65	1.8	91.9	3.5	2.8	SB14	34-35	0	96.7	1.6	1.7
SB01	72-73	0	5.5	78.5	16	SB14	39-41	0	1.8	65.6	32.6
SB02	25-25.5	0	24.2	50.9	24.9	SB20	50.8-50.95	0	13.4	69.7	16.9
SB02	31-34	21.8	57.5	12.5	8.2	SB20	50.95-51.70	0	14.4	69.1	16.5
SB02	46-51	0	61.6	32.3	6.1	SB20	51.70-52.40	0	19.3	58.6	22.1
SB02	54-56.5	0	69.1	27.4	3.5	SB20	52.40-52.80	0	16.5	64.4	19.1
SB02	63-65	0	94.7	3.1	2.2	SB20	69-70	0	11.4	66.2	22.4
						SB20	70-71	0	6.4	73	20.6

Appendix D:

Water Level Data

TABLE D.1 Water Level Depth in Piezometers, Monitoring Well, and Municipal Well at Adams, Nebraska[a]

		Depth (ft BGL)									
Date	Time	SB03	SB05	SB12	SB13	SB14	SB15	SB17	SB19	B12	PWS 70-1
5/2/00	0:00				20.570						28.207
5/2/00	1:00				20.541						28.058
5/2/00	2:00				20.515						27.972
5/2/00	3:00				20.457						27.909
5/2/00	4:00				20.483						27.869
5/2/00	5:00				20.475						39.206
5/2/00	6:00				20.518						40.869
5/2/00	7:00				20.552						29.202
5/2/00	8:00				20.541						37.072
5/2/00	9:00				20.572						41.090
5/2/00	10:00				20.584						28.606
5/2/00	11:00				20.555						28.190
5/2/00	12:00				20.523	26.129					28.023
5/2/00	13:00				20.500	25.997					38.787
5/2/00	14:00				20.535	25.907				16.430	40.912
5/2/00	15:00				20.572	25.991	21.038			16.429	29.767
5/2/00	16:00				20.549	26.158	21.038			16.429	28.330
5/2/00	17:00				20.521	26.149	21.038			16.429	36.829
5/2/00	18:00	24.905	14.622		20.549	26.038	21.038			16.429	40.955
5/2/00	19:00	24.925	14.622		20.578	26.065	21.038			16.429	28.784
5/2/00	20:00	24.940	14.622		20.547	26.194	21.038			16.429	28.227
5/2/00	21:00	24.954	14.622		20.526	26.137	21.038			16.429	39.349
5/2/00	22:00	24.965	14.622		20.570	26.036	21.037			16.429	41.121
5/2/00	23:00	24.976	14.622		20.564	26.112	21.037			16.429	29.644
5/3/00	0:00	24.987	14.622		20.578	26.263	21.038			16.429	28.379
5/3/00	1:00	24.995	14.622		20.555	26.238	21.038			16.429	40.055
5/3/00	2:00	25.006	14.622		20.593	26.117	21.038			16.429	33.706
5/3/00	3:00	25.015	14.622		20.584	26.191	21.038			16.429	28.414
5/3/00	4:00	25.024	14.622		20.552	26.214	21.038			16.429	28.135
5/3/00	5:00	25.033	14.622		20.523	26.101	21.038			16.429	28.012
5/3/00	6:00	25.044	14.622		20.503	25.995	21.038			16.429	33.410
5/3/00	7:00	25.050	14.622		20.532	25.918	21.038			16.429	40.794
5/3/00	8:00	25.059	14.622		20.578	25.993	21.038			16.429	28.895
5/3/00	9:00	25.068	14.622		20.555	26.157	21.179			16.429	28.216
5/3/00	10:00	25.077	14.622		20.567	26.123	21.038			16.429	40.877
5/3/00	11:00	25.083	14.622		20.604	26.110	21.037			16.429	28.901
5/3/00	12:00	25.097	14.622		20.572	26.236	21.179			16.429	28.247
5/3/00	13:00	25.105	14.622		20.552	26.166	21.037			16.429	28.043
5/3/00	14:00	25.112	14.622		20.518	26.038	21.179			16.429	27.946
5/3/00	15:00	25.119	14.622		20.492	25.945	21.038			16.429	27.880
5/3/00	16:00	25.127	14.622		20.483	25.866	21.038			16.429	39.914
5/3/00	17:00	25.134	14.622		20.529	25.823	21.038			16.429	41.075
5/3/00	18:00	25.143	14.622		20.572	25.984	21.038			16.429	41.477
5/3/00	19:00	25.149	14.622		20.613	26.184	21.037			16.429	41.723
5/3/00	20:00	25.158	14.622		20.642	26.333	21.037			16.429	41.858
5/3/00	21:00	25.167	14.622		20.667	26.448	21.179			16.568	41.589
5/3/00	22:00	25.174	14.622		20.690	26.518	21.179			16.568	41.944
5/3/00	23:00	25.182	14.622		20.679	26.568	21.179			16.568	28.804

TABLE D.1 (Cont.)

		Depth (ft BGL)									
Date	Time	SB03	SB05	SB12	SB13	SB14	SB15	SB17	SB19	B12	PWS 70-1
5/4/00	0:00	25.191	14.622		20.644	26.536	21.179			16.568	28.376
5/4/00	1:00	25.200	14.622		20.610	26.378	21.179			16.568	28.193
5/4/00	2:00	25.209	14.622		20.581	26.220	21.179			16.568	28.084
5/4/00	3:00	25.215	14.622		20.558	26.099	21.179			16.568	28.009
5/4/00	4:00	25.222	14.621		20.541	26.008	21.179			16.568	27.957
5/4/00	5:00	25.231	14.621		20.523	25.945	21.037			16.568	27.912
5/4/00	6:00	25.237	14.621		20.515	25.893	21.037			16.568	36.697
5/4/00	7:00	25.244	14.622		20.538	25.860	21.037			16.568	38.790
5/4/00	8:00	25.251	14.622		20.567	25.950	21.179			16.568	28.434
5/4/00	9:00	25.257	14.622		20.544	26.085	21.179			16.568	28.069
5/4/00	10:00	25.266	14.621	22.890	20.526	26.026	21.179			16.568	27.983
5/4/00	11:00	25.270	14.621	22.878	20.509	25.945	21.179	16.636		16.567	27.886
5/4/00	12:00	25.277	14.621	22.873	20.498	25.875	21.179	16.627		16.567	37.609
5/4/00	13:00	25.284	14.621	22.875	20.544	25.821	21.037	16.624		16.568	30.008
5/4/00	14:00	25.290	14.621	22.867	20.532	25.929	21.179	16.621		16.568	28.132
5/4/00	15:00	25.297	14.621	22.867	20.509	25.968	21.179	16.616		16.568	27.929
5/4/00	16:00	25.303	14.621	22.864	20.500	25.893	21.037	16.619		16.568	37.821
5/4/00	17:00	25.310	14.621	22.858	20.503	25.832	21.038	16.619		16.567	38.426
5/4/00	18:00	25.314	14.621	22.861	20.541	25.860	21.179	16.616		16.567	40.866
5/4/00	19:00	25.321	14.621	22.867	20.581	25.961	21.179	16.619		16.568	28.898
5/4/00	20:00	25.328	14.621	22.870	20.561	26.137	21.179	16.621		16.568	28.196
5/4/00	21:00	25.334	14.621	22.870	20.538	26.112	21.179	16.627		16.568	28.009
5/4/00	22:00	25.339	14.621	22.870	20.518	26.020	21.179	16.627		16.568	38.426
5/4/00	23:00	25.345	14.621	22.875	20.547	25.927	21.179	16.624		16.568	40.920
5/5/00	0:00	25.350	14.621	22.887	20.587	26.008	21.038	16.633		16.568	41.416
5/5/00	1:00	25.358	14.621	22.901	20.613	26.193	21.179	16.630		16.568	41.646
5/5/00	2:00	25.365	14.621	22.904	20.595	26.335	21.179	16.627		16.568	28.540
5/5/00	3:00	25.372	14.621	22.904	20.555	26.342	21.179	16.633		16.568	28.196
5/5/00	4:00	25.378	14.621	22.901	20.521	26.209	21.179	16.633		16.568	28.041
5/5/00	5:00	25.385	14.621	22.890	20.495	26.076	21.179	16.636		16.567	27.955
5/5/00	6:00	25.389	14.621	22.893	20.515	25.979	21.179	16.633		16.568	40.748
5/5/00	7:00	25.394	14.621	22.901	20.572	26.013	21.179	16.636		16.568	40.083
5/5/00	8:00	25.402	14.621	22.916	20.598	26.198	21.179	16.624		16.568	41.330
5/5/00	9:00	25.409	14.621	22.922	20.639	26.340	21.179	16.636		16.568	28.672
5/5/00	10:00	25.416	14.621	22.927	20.613	26.376	21.179	16.639		16.568	28.250
5/5/00	11:00	25.422	14.621	22.919	20.584	26.243	21.179	16.639		16.568	28.081
5/5/00	12:00	25.427	14.621	22.910	20.555	26.105	21.179	16.641		16.568	27.975
5/5/00	13:00	25.433	14.621	22.907	20.575	25.990	21.179	16.633	21.025	16.568	38.801
5/5/00	14:00	25.438	14.621	22.916	20.618	26.002	21.179	16.641	20.105	16.568	40.889
5/5/00	15:00	25.444	14.621	22.916	20.665	26.139	21.179	16.641	19.894	16.568	41.454
5/5/00	16:00	25.449	14.621	22.942	20.676	26.277	21.179	16.639	21.014	16.568	29.059
5/5/00	17:00	25.455	14.621	22.942	20.662	26.383	21.179	16.639	19.965	16.568	28.356
5/5/00	18:00	25.464	14.621	22.933	20.633	26.290	21.179	16.647	20.357	16.567	28.147
5/5/00	19:00	25.468	14.621	22.922	20.607	26.157	21.179	16.647	20.207	16.568	28.038
5/5/00	20:00	25.475	14.621	22.922	20.624	26.047	21.179	16.653	20.083	16.568	40.685
5/5/00	21:00	25.479	14.621	22.930	20.656	26.058	21.179	16.659	19.981	16.568	28.632
5/5/00	22:00	25.486	14.621	22.927	20.624	26.196	21.179	16.656	19.900	16.568	28.187
5/5/00	23:00	25.490	14.621	22.922	20.598	26.135	21.179	16.661	19.835	16.568	28.035
5/6/00	0:00	25.495	14.621	22.916	20.578	26.038	21.179	16.659	19.785	16.568	27.955
5/6/00	1:00	25.501	14.621	22.904	20.558	25.954	21.179	16.656	19.749	16.568	27.891
5/6/00	2:00	25.506	14.621	22.896	20.500	25.884	21.179	16.633	19.724	16.568	27.846

TABLE D.1 (Cont.)

		Depth (ft BGL)									
Date	Time	SB03	SB05	SB12	SB13	SB14	SB15	SB17	SB19	B12	PWS 70-1
5/6/00	3:00	25.510	14.621	22.887	20.521	25.828	20.896	16.650	19.688	16.568	27.811
5/6/00	4:00	25.515	14.621	22.881	20.526	25.785	21.179	16.644	19.655	16.568	40.201
5/6/00	5:00	25.519	14.621	22.890	20.584	25.814	21.179	16.644	19.602	16.567	41.055
5/6/00	6:00	25.526	14.621	22.898	20.618	26.015	21.179	16.644	19.600	16.568	35.317
5/6/00	7:00	25.532	14.621	22.901	20.621	26.205	21.179	16.644	19.596	16.568	28.436
5/6/00	8:00	25.537	14.621	22.898	20.587	26.250	21.179	16.644	19.602	16.567	28.118
5/6/00	9:00	25.541	14.621	22.893	20.567	26.128	21.179	16.647	19.629	16.568	27.995
5/6/00	10:00	25.545	14.621	22.893	20.578	26.024	21.179	16.644	19.674	16.568	40.602
5/6/00	11:00	25.550	14.621	22.898	20.630	26.017	21.179	16.644	19.720	16.568	41.299
5/6/00	12:00	25.556	14.621	22.907	20.670	26.182	21.179	16.647	19.851	16.568	41.606
5/6/00	13:00	25.561	14.621	22.919	20.690	26.329	21.179	16.641	19.953	16.568	41.769
5/6/00	14:00	25.565	14.621	22.936	20.713	26.450	21.179	16.636	20.783	16.568	40.126
5/6/00	15:00	25.574	14.621	22.939	20.722	26.520	21.179	16.636	20.305	16.568	28.944
5/6/00	16:00	25.578	14.621	22.942	20.690	26.543	21.179	16.644	20.177	16.568	28.391
5/6/00	17:00	25.583	14.621	22.927	20.656	26.396	21.179	16.644	20.109	16.567	28.181
5/6/00	18:00	25.589	14.621	22.933	20.665	26.245	21.179	16.647	21.384	16.568	38.787
5/6/00	19:00	25.594	14.621	22.933	20.682	26.171	21.179	16.653	20.362	16.568	28.508
5/6/00	20:00	25.598	14.621	22.933	20.618	26.241	21.179	16.641	20.145	16.568	28.178
5/6/00	21:00	25.603	14.621	22.927	20.639	26.177	21.037	16.661	20.024	16.568	28.064
5/6/00	22:00	25.609	14.621	22.924	20.621	26.103	21.179	16.661	19.930	16.706	27.989
5/6/00	23:00	25.614	14.621	22.924	20.639	26.026	21.179	16.664	21.224	16.706	38.658
5/7/00	0:00	25.618	14.621	22.933	20.644	26.017	21.179	16.664	20.097	16.567	28.279
5/7/00	1:00	25.622	14.769	22.930	20.624	26.094	21.179	16.664	19.949	16.706	28.043
5/7/00	2:00	25.627	14.621	22.924	20.604	26.035	21.179	16.661	19.887	16.706	27.943
5/7/00	3:00	25.631	14.769	22.913	20.581	25.959	21.179	16.661	19.865	16.568	27.883
5/7/00	4:00	25.636	14.769	22.907	20.570	25.889	21.179	16.664	19.838	16.568	27.848
5/7/00	5:00	25.640	14.769	22.898	20.549	25.848	21.179	16.661	19.818	16.568	27.811
5/7/00	6:00	25.644	14.769	22.893	20.538	25.807	21.179	16.661	19.799	16.568	27.788
5/7/00	7:00	25.647	14.769	22.893	20.561	25.787	21.179	16.661	20.421	16.568	40.313
5/7/00	8:00	25.649	14.621	22.898	20.601	25.843	21.179	16.661	19.991	16.568	28.807
5/7/00	9:00	25.655	14.621	22.898	20.587	26.031	21.179	16.661	19.945	16.568	28.107
5/7/00	10:00	25.660	14.769	22.887	20.564	26.031	21.179	16.664	19.952	16.568	27.934
5/7/00	11:00	25.662	14.621	22.887	20.547	25.952	21.179	16.659	19.969	16.568	27.848
5/7/00	12:00	25.664	14.621	22.887	20.561	25.875	21.179	16.656	19.984	16.568	40.476
5/7/00	13:00	25.671	14.769	22.896	20.607	25.896	21.179	16.647	20.024	16.568	41.153
5/7/00	14:00	25.673	14.621	22.898	20.647	26.067	21.179	16.641	21.093	16.568	32.039
5/7/00	15:00	25.677	14.621	22.904	20.639	26.218	21.179	16.641	20.338	16.568	28.365
5/7/00	16:00	25.682	14.621	22.896	20.621	26.216	21.179	16.636	21.413	16.568	38.391
5/7/00	17:00	25.686	14.621	22.898	20.610	26.100	21.179	16.639	20.383	16.568	28.147
5/7/00	18:00	25.690	14.621	22.896	20.590	26.069	21.179	16.639	20.299	16.568	27.966
5/7/00	19:00	25.695	14.621	22.881	20.567	25.979	21.179	16.639	20.253	16.568	27.866
5/7/00	20:00	25.699	14.621	22.873	20.538	25.888	21.179	16.627	20.200	16.568	27.811
5/7/00	21:00	25.699	14.621	22.873	20.549	25.830	21.179	16.627	21.500	16.568	38.386
5/7/00	22:00	25.704	14.621	22.875	20.570	25.828	21.179	16.633	20.452	16.568	28.175
5/7/00	23:00	25.708	14.621	22.870	20.544	25.940	21.179	16.624	20.309	16.568	27.912
5/8/00	0:00	25.710	14.621	22.864	20.526	25.888	21.179	16.627	20.239	16.568	27.811
5/8/00	1:00	25.713	14.621	22.858	20.515	25.823	21.179	16.630	20.200	16.568	27.762
5/8/00	2:00	25.715	14.621	22.844	20.509	25.776	21.179	16.627	20.978	16.568	37.385
5/8/00	3:00	25.719	14.621	22.855	20.506	25.810	21.179	16.621	20.241	16.568	28.018
5/8/00	4:00	25.721	14.621	22.827	20.472	25.825	21.179	16.610	20.077	16.568	27.780
5/8/00	5:00	25.724	14.621	22.812	20.454	25.782	21.179	16.607	19.989	16.568	27.728

TABLE D.1 (Cont.)

		Depth (ft BGL)									
Date	Time	SB03	SB05	SB12	SB13	SB14	SB15	SB17	SB19	B12	PWS 70-1
5/8/00	6:00	25.726	14.621	22.806	20.472	25.758	21.179	16.598	20.966	16.568	33.381
5/8/00	7:00	25.730	14.621	22.812	20.463	25.767	21.179	16.590	20.077	16.568	27.894
5/8/00	8:00	25.732	14.621	22.809	20.449	25.814	21.179	16.578	20.034	16.568	27.760
5/8/00	9:00	25.735	14.621	22.809	20.443	25.778	21.179	16.567	19.974	16.568	27.705
5/8/00	10:00	25.739	14.621	22.815	20.440	25.751	21.179	16.561	19.926	16.568	38.191
5/8/00	11:00	25.741	14.621	22.827	20.477	25.719	21.179	17.701	19.926	16.568	40.485
5/8/00	12:00	25.743	14.621	22.835	20.526	25.825	21.179	16.687	19.962	16.568	41.024
5/8/00	13:00	25.748	14.621	22.838	20.526	26.022	21.179	16.633	19.995	16.568	28.276
5/8/00	14:00	25.750	14.621	22.835	20.509	26.089	21.179	16.590	19.966	16.568	39.220
5/8/00	15:00	25.754	14.621	22.850	20.547	26.006	21.179	16.573	20.187	16.568	29.331
5/8/00	16:00	25.757	14.621	22.850	20.541	26.073	21.179	16.561	19.920	16.568	28.147
5/8/00	17:00	25.763	14.621	22.852	20.512	26.076	21.179	16.553	19.850	16.568	27.943
5/8/00	18:00	25.763	14.621	22.847	20.486	25.990	21.179	16.535	19.811	16.568	27.831
5/8/00	19:00	25.765	14.621	22.847	20.475	25.884	21.179	16.527	19.778	16.429	38.179
5/8/00	20:00	25.768	14.621	22.850	20.506	25.825	21.179	16.515	19.750	16.429	40.651
5/8/00	21:00	25.772	14.621	22.873	20.555	25.916	21.179	16.510	19.734	16.429	34.030
5/8/00	22:00	25.776	14.621	22.867	20.549	26.091	21.179	16.504	19.723	16.429	28.293
5/8/00	23:00	25.779	14.621	22.864	20.523	26.143	21.037	16.501	19.710	16.429	28.015
5/9/00	0:00	25.781	14.621	22.858	20.495	26.049	21.179	16.490	19.710	16.429	27.869
5/9/00	1:00	25.783	14.621	22.855	20.498	25.916	21.179	16.490	19.687	16.429	39.983
5/9/00	2:00	25.787	14.621	22.864	20.535	25.891	21.179	16.484	19.680	16.429	29.363
5/9/00	3:00	25.790	14.621	22.861	20.523	26.022	21.179	16.475	19.678	16.429	28.147
5/9/00	4:00	25.792	14.621	22.858	20.503	26.051	21.179	16.472	19.925	16.429	27.943
5/9/00	5:00	25.796	14.621	22.858	20.483	25.972	21.179	16.472	19.904	16.429	27.840
5/9/00	6:00	25.801	14.621	22.850	20.463	25.893	21.179	16.467	19.889	16.429	27.777
5/9/00	7:00	25.803	14.621	22.844	20.437	25.819	21.037	16.461	20.257	16.429	37.144
5/9/00	8:00	25.805	14.621	22.852	20.486	25.746	21.037	16.464	20.084	16.429	40.522
5/9/00	9:00	25.807	14.621	22.858	20.495	25.855	21.179	16.452	20.014	16.429	28.207
5/9/00	10:00	25.809	14.621	22.861	20.472	25.965	21.179	16.452	20.079	16.429	27.909
5/9/00	11:00	25.814	14.621	22.852	20.457	25.907	21.179	16.447	20.119	16.429	38.609
5/9/00	12:00	25.816	14.621	22.858	20.489	25.828	21.179	16.441	19.939	16.429	40.680
5/9/00	13:00	25.818	14.621	22.867	20.509	25.916	21.179	16.435	20.005	16.429	28.391
5/9/00	14:00	25.820	14.621	22.867	20.480	26.037	21.037	16.435	20.084	16.429	27.986
5/9/00	15:00	25.825	14.621	22.855	20.460	25.967	21.037	16.430	20.122	16.429	27.846
5/9/00	16:00	25.827	14.621	22.850	20.451	25.868	21.037	16.427	20.901	16.429	35.831
5/9/00	17:00	25.827	14.621	22.844	20.469	25.805	21.037	16.418	20.401	16.429	28.485
5/9/00	18:00	25.831	14.621	22.838	20.454	25.855	21.179	16.418	20.074	16.429	27.894
5/9/00	19:00	25.834	14.621	22.829	20.440	25.843	21.179	16.412	19.965	16.429	27.774
5/9/00	20:00	25.836	14.621	22.827	20.428	25.780	21.037	16.412	19.893	16.429	27.714
5/9/00	21:00	25.838	14.621	22.829	20.414	25.726	21.037	16.415	19.840	16.429	27.682
5/9/00	22:00	25.840	14.621	22.824	20.405	25.692	21.037	16.412	20.030	16.429	32.257
5/9/00	23:00	25.842	14.621	22.824	20.428	25.656	21.037	16.401	20.908	16.429	35.575
5/10/00	0:00	25.845	14.621	22.827	20.431	25.699	21.179	16.407	20.214	16.429	27.998
5/10/00	1:00	25.847	14.621	22.824	20.426	25.787	21.179	16.412	20.077	16.429	27.768
5/10/00	2:00	25.849	14.621	22.815	20.397	25.735	21.179	16.398	20.014	16.429	27.673
5/10/00	3:00	25.849	14.621	22.809	20.385	25.665	21.037	16.395	19.974	16.429	27.630
5/10/00	4:00	25.851	14.621	22.804	20.374	25.618	21.037	16.392	19.945	16.429	27.590
5/10/00	5:00	25.853	14.620	22.795	20.354	25.571	21.037	16.387	19.909	16.429	27.576
5/10/00	6:00	25.853	14.621	22.789	20.351	25.553	21.037	16.389	19.893	16.429	27.562
5/10/00	7:00	25.856	14.621	22.804	20.339	25.541	21.037	16.384	19.910	16.429	27.544
5/10/00	8:00	25.856	14.621	22.783	20.339	25.528	21.037	16.381	20.953	16.429	35.283

TABLE D.1 (Cont.)

		Depth (ft BGL)									
Date	Time	SB03	SB05	SB12	SB13	SB14	SB15	SB17	SB19	B12	PWS 70-1
5/10/00	9:00	25.858	14.621	22.781	20.382	25.548	21.037	16.378	20.407	16.429	28.095
5/10/00	10:00	25.860	14.621	22.798	20.365	25.658	21.037	16.378	20.211	16.429	27.728
5/10/00	11:00	25.862	14.621	22.783	20.345	25.665	21.037	16.375	20.142	16.429	27.613
5/10/00	12:00	25.864	14.621	22.775	20.333	25.595	21.037	16.367	20.089	16.429	27.553
5/10/00	13:00	25.862	14.621	22.772	20.319	25.541	21.037	16.364	20.116	16.429	27.516
5/10/00	14:00	25.864	14.621	22.757	20.313	25.503	21.037	16.361	20.141	16.429	27.490
5/10/00	15:00	25.864	14.621	22.749	20.310	25.467	21.037	16.358	21.047	16.429	35.076
5/10/00	16:00	25.869	14.621	22.766	20.339	25.453	21.037	16.358	20.590	16.291	28.207
5/10/00	17:00	25.869	14.620	22.766	20.331	25.575	21.037	16.352	20.311	16.429	27.694
5/10/00	18:00	25.869	14.621	22.743	20.308	25.598	21.037	16.347	20.214	16.429	27.570
5/10/00	19:00	25.871	14.621	22.740	20.299	25.553	21.037	16.344	20.155	16.429	27.510
5/10/00	20:00	25.871	14.621	22.737	20.287	25.505	21.037	16.341	20.625	16.291	34.199
5/10/00	21:00	25.873	14.620	22.746	20.316	25.462	21.037	16.338	21.214	16.291	35.854
5/10/00	22:00	25.873	14.620	22.734	20.325	25.541	21.037	16.332	20.312	16.291	27.800
5/10/00	23:00	25.875	14.620	22.732	20.302	25.613	21.037	16.329	20.208	16.291	27.587
5/11/00	0:00	25.875	14.621	22.717	20.279	25.552	21.037	16.326	20.169	16.291	27.496
5/11/00	1:00	25.875	14.620	22.711	20.264	25.476	20.896	16.315	20.159	16.291	27.435
5/11/00	2:00	25.878	14.473	22.700	20.250	25.415	20.896	16.306	20.162	16.291	27.398
5/11/00	3:00	25.878	14.473	22.686	20.247	25.363	20.896	16.298	20.154	16.291	27.366
5/11/00	4:00	25.877	14.473	22.683	20.224	25.320	20.896	16.301	20.152	16.291	27.349
5/11/00	5:00	25.880	14.473	22.680	20.233	25.314	20.896	16.298	21.087	16.291	35.369
5/11/00	6:00	25.880	14.473	22.677	20.264	25.338	20.896	16.295	20.511	16.291	27.894
5/11/00	7:00	25.877	14.473	22.680	20.241	25.462	20.896	16.289	20.332	16.291	27.533
5/11/00	8:00	25.880	14.473	22.674	20.227	25.474	20.896	16.289	20.318	16.291	27.438
5/11/00	9:00	25.880	14.473	22.677	20.224	25.440	20.896	16.289	20.345	16.291	27.387
5/11/00	10:00	25.880	14.473	22.674	20.236	25.408	20.896	16.289	20.580	16.291	34.873
5/11/00	11:00	25.880	14.473	22.671	20.224	25.383	20.896	16.289	21.146	16.291	33.640
5/11/00	12:00	25.806	14.120	22.680	20.233	25.478	20.896	16.292	20.357	16.291	27.682
5/11/00	13:00			22.683	20.221			16.298	20.371		
5/11/00	14:00			22.683	20.227						
5/11/00	16:00	25.808	14.120	22.638	20.188	25.358	20.880	16.477	19.128	16.270	27.728
5/11/00	20:00	25.812	14.267	22.659	20.240	25.507	21.021	16.497	19.651	16.408	32.679
5/12/00	0:00	25.817	14.267	22.693	20.315	25.761	20.880	16.543	19.396	16.408	28.184
5/12/00	4:00	25.817	14.267	22.705	20.283	25.486	21.021	16.563	19.400	16.408	27.825
5/12/00	8:00	25.821	14.267	22.722	20.298	25.513	21.021	16.580	19.474	16.408	27.871
5/12/00	12:00	25.823	14.267	22.739	20.341	25.626	21.163	16.675	19.827	16.546	28.236
5/12/00	16:00	25.830	14.267	22.748	20.361	25.637	21.163	16.958	19.569	16.546	28.175
5/12/00	20:00	25.834	14.415	22.765	20.381	25.673	21.163	16.852	19.671	16.546	28.264
5/13/00	0:00	25.839	14.415	22.797	20.358	25.581	21.163	16.746	19.400	16.546	27.900
5/13/00	4:00	25.845	14.415	22.811	20.396	25.655	21.163	16.729	19.383	16.546	28.009
5/13/00	8:00	25.850	14.415	22.814	20.358	25.529	21.163	16.723	19.148	16.546	27.871
5/13/00	12:00	25.854	14.415	22.828	20.387	25.632	21.021	16.718	19.509	16.546	27.992
5/13/00	16:00	25.858	14.415	22.820	20.419	25.635	21.163	16.712	19.808	16.546	28.015
5/13/00	20:00	25.867	14.415	22.817	20.422	25.684	21.163	16.680	19.526	16.546	28.092
5/14/00	0:00	25.869	14.415	22.834	20.456	25.720	21.163	16.715	19.483	16.546	28.216
5/14/00	4:00	25.876	14.415	22.814	20.373	25.531	21.021	16.715	19.103	16.546	27.914
5/14/00	8:00	25.880	14.563	22.828	20.430	25.628	21.163	16.718	19.506	16.685	28.835
5/14/00	12:00	25.885	14.415	22.831	20.459	25.666	21.163	16.718	19.999	16.685	30.031
5/14/00	16:00	25.889	14.563	22.800	20.396	25.515	21.163	16.698	19.431	16.546	27.920
5/14/00	20:00	25.894	14.415	22.797	20.407	25.585	21.163	16.695	19.406	16.546	27.992
5/15/00	0:00	25.900	14.563	22.817	20.439	25.675	21.163	16.703	19.281	16.546	28.098

TABLE D.1 (Cont.)

		Depth (ft BGL)									
Date	Time	SB03	SB05	SB12	SB13	SB14	SB15	SB17	SB19	B12	PWS 70-1
5/15/00	4:00	25.902	14.563	22.788	20.375	25.481	21.163	16.692	19.073	16.546	27.886
5/15/00	8:00	25.907	14.415	22.785	20.410	25.619	21.163	16.678	19.247	16.546	28.121
5/15/00	12:00	25.909	14.415	22.782	20.436	25.666	21.163	16.675	19.752	16.546	28.434
5/15/00	16:00	25.913	14.415	22.788	20.439	25.655	21.163	16.660	20.055	16.546	28.436
5/15/00	20:00	25.916	14.415	22.774	20.450	25.682	21.163	16.660	19.870	16.546	28.594
5/16/00	0:00	25.922	14.415	22.797	20.465	25.727	21.163	16.666	19.505	16.546	28.204
5/16/00	4:00	25.924	14.415	22.771	20.393	25.504	21.163	16.669	19.257	16.546	27.920
5/16/00	8:00	25.927	14.415	22.768	20.410	25.565	21.163	16.660	20.367	16.546	36.516
5/16/00	12:00	25.931	14.415	22.774	20.445	25.644	21.163	16.658	20.786	16.546	36.267
5/16/00	16:00	25.933	14.415	22.782	20.476	25.714	21.163	16.655	20.311	16.546	28.735
5/16/00	20:00	25.938	14.415	22.794	20.485	25.743	21.163	16.658	20.101	16.546	28.614
5/17/00	0:00	25.942	14.415	22.774	20.410	25.542	21.163	16.658	19.611	16.546	27.929
5/17/00	4:00	25.944	14.415	22.765	20.424	25.612	21.163	16.649	19.689	16.546	28.095
5/17/00	8:00	25.946	14.415	22.745	20.364	25.461	21.021	16.640	19.502	16.546	27.845
5/17/00	12:00	25.949	14.415	22.751	20.387	25.567	21.021	16.635	19.722	16.546	27.963
5/17/00	16:00	25.867	14.415	22.748	20.396	25.599	21.163	16.629	19.873	16.546	28.026
5/17/00	20:00	25.869	14.415	22.733	20.381	25.522	21.021	16.615	20.866	16.546	36.421
5/18/00	0:00	25.872	14.415	22.736	20.375	25.542	21.021	16.635	19.628	16.546	27.903
5/18/00	4:00	25.872	14.415	22.713	20.327	25.420	21.021	16.620	19.472	16.546	27.794
5/18/00	8:00	25.872	14.562	22.736	20.384	25.596	21.163	16.649	19.430	16.546	27.946
5/18/00	12:00	25.876	14.563	22.794	20.465	25.783	21.163	16.686	19.699	16.685	28.089
5/18/00	16:00	25.880	14.563	22.866	20.514	25.860	21.304	16.726	19.439	16.685	28.150
5/18/00	20:00	25.885	14.562	22.895	20.519	25.903	21.446	16.723	19.314	16.685	28.336
5/19/00	0:00	25.891	14.562	22.895	20.499	25.706	21.304	16.752	18.980	16.685	28.043
5/19/00	4:00	25.896	14.562	22.897	20.545	25.801	21.304	16.763	19.269	16.685	28.376
5/19/00	8:00	25.900	14.562	22.929	20.505	25.664	21.304	16.763	20.428	16.685	36.051
5/19/00	12:00	25.909		22.906	20.548	25.781	21.304	16.766	21.087	16.685	36.562
5/19/00	16:00	25.916	14.448	22.900	20.589	25.853	21.258	16.763	21.368	16.689	36.479
5/19/00	20:00	25.922	14.446	22.903	20.617	25.961	21.285	16.769	20.397	16.702	28.741
5/20/00	0:00	25.929	14.458	22.926	20.620	25.973	21.300	16.781	20.000	16.723	28.462
5/20/00	4:00	25.933	14.447	22.903	20.548	25.711	21.229	16.781	20.240	16.713	35.271
5/20/00	8:00	25.938	14.453	22.918	20.580	25.785	21.249	16.786	19.669	16.726	28.181
5/20/00	12:00	25.944	14.452	22.938	20.663	26.031	21.320	16.789	20.645	16.726	28.815
5/20/00	16:00	25.951	14.449	22.938	20.663	25.948	21.302	16.789	20.316	16.710	28.720
5/20/00	20:00	25.957	14.451	22.935	20.709	26.121	21.389	16.798	19.946	16.754	28.763
5/21/00	0:00	25.964	14.451	22.946	20.649	25.871	21.313	16.804	19.354	16.726	28.261
5/21/00	4:00	25.968	14.444	22.918	20.586	25.706	21.243	16.789	19.077	16.713	28.118
5/21/00	8:00	25.973	14.448	22.892	20.557	25.664	21.216	16.786	19.942	16.715	35.931
5/21/00	12:00	25.977	14.449	22.897	20.522	25.716	21.205	16.778	19.568	16.704	28.098
5/21/00	16:00	25.979	14.442	22.895	20.568	25.772	21.212	16.775	19.953	16.695	28.201
5/21/00	20:00	25.982	14.444	22.889	20.589	25.831	21.225	16.763	19.732	16.693	28.330
5/22/00	0:00	25.986	14.448	22.900	20.563	25.869	21.139	16.743	19.492	16.702	28.330
5/22/00	4:00	25.990	14.453	22.877	20.534	25.657	21.185	16.761	19.196	16.693	28.066
5/22/00	8:00	25.993	14.444	22.869	20.571	25.808	21.212	16.758	19.823	16.697	28.505
5/22/00	12:00	25.997	14.451	22.892	20.597	25.860	21.227	16.763	19.781	16.700	28.322
5/22/00	16:00	25.999	14.451	22.903	20.609	25.828	21.236	16.766	20.827	16.697	35.785
5/22/00	20:00	26.004	14.449	22.906	20.655	25.885	21.276	16.772	20.948	16.710	36.430
5/23/00	0:00	26.010	14.460	22.935	20.689	26.018	21.305	16.798	19.816	16.745	28.520
5/23/00	4:00	26.012	14.453	22.926	20.620	25.770	21.256	16.795	19.444	16.741	28.170
5/23/00	8:00	26.017	14.462	22.918	20.632	25.821	21.269	16.795	20.018	16.747	29.696
5/23/00	12:00	26.021	14.463	22.926	20.658	25.882	21.287	16.804	20.870	16.754	34.219

TABLE D.1 (Cont.)

		Depth (ft BGL)									
Date	Time	SB03	SB05	SB12	SB13	SB14	SB15	SB17	SB19	B12	PWS 70-1
5/23/00	16:00	26.026	14.464	22.944	20.678	25.968	21.298	16.812	19.831	16.749	28.520
5/23/00	20:00	26.030	14.458	22.952	20.738	26.110	21.364	16.812	20.479	16.764	36.634
5/24/00	0:00	26.037	14.475	22.958	20.715	25.982	21.364	16.829	20.703	16.797	36.307
5/24/00	4:00	26.043	14.482	22.964	20.660	25.925	21.205	16.806	19.580	16.786	28.310
5/24/00	8:00	26.048	14.484	22.987	20.738	26.024	21.388	16.846	19.671	16.825	28.545
5/24/00	12:00	26.054	14.488	23.015	20.756	26.090	21.400	16.849	20.028	16.834	28.626
5/24/00	16:00	26.059	14.482	23.013	20.761	26.067	21.402	16.864	20.561	16.836	34.314
5/24/00	20:00	26.067	14.489	23.030	20.804	26.115	21.446	16.875	20.886	16.851	36.648
5/25/00	0:00	26.072	14.502	23.024	20.750	25.968	21.397	16.881	19.611	16.851	28.368
5/25/00	4:00	26.078	14.496	23.038	20.779	26.065	21.433	16.892	19.752	16.875	28.505
5/25/00	8:00	26.083	14.505	23.030	20.727	25.887	21.380	16.898	20.452	16.864	36.083
5/25/00	12:00	26.089	14.503	23.044	20.810	26.085	21.442	16.898	20.558	16.866	30.307
5/25/00	16:00	26.094	14.500	23.036	20.810	26.071	21.417	16.895	20.329	16.838	28.898
5/25/00	20:00	26.100	14.500	23.033	20.810	26.101	21.430	16.898	19.891	16.857	28.631
5/26/00	0:00	26.107	14.502	23.041	20.807	26.085	21.428	16.904	19.837	16.868	28.545
5/26/00	4:00	26.111	14.489	23.004	20.718	25.830	21.336	16.889	19.648	16.834	28.270
5/26/00	8:00	26.114	14.474	22.975	20.701	25.893	21.331	16.858	19.814	16.771	28.609
5/26/00	12:00	26.116	14.467	22.923	20.609	25.690	21.262	16.806	19.641	16.695	28.144
5/26/00	16:00	26.118	14.470	22.912	20.620	25.799	21.262	16.766	19.907	16.644	28.370
5/26/00	20:00	26.116	14.468	22.892	20.574	25.666	21.223	16.741	19.661	16.631	28.089
5/27/00	0:00	26.118	14.464	22.915	20.612	25.830	21.282	16.735	19.652	16.654	28.342
5/27/00	4:00	26.118	14.465	22.912	20.557	25.695	21.238	16.732	19.440	16.661	28.101
5/27/00	8:00	26.118	14.480	22.921	20.542	25.675	21.234	16.732	19.331	16.680	28.069
5/27/00	12:00	26.118	14.473	22.935	20.574	25.801	21.256	16.729	19.609	16.672	28.253
5/27/00	16:00	26.120	14.486	22.964	20.612	25.893	21.300	16.735	19.870	16.680	28.514
5/27/00	20:00	26.120	14.480	22.938	20.525	25.731	21.092	16.721	19.431	16.682	28.115
5/28/00	0:00	26.125	14.497	22.964	20.603	25.830	21.289	16.749	19.361	16.695	28.261
5/28/00	4:00	26.125	14.489	22.946	20.560	25.695	21.254	16.752	19.085	16.700	28.095
5/28/00	8:00	26.127	14.501	22.949	20.548	25.688	21.258	16.761	19.871	16.717	36.192
5/28/00	12:00	26.127	14.498	22.946	20.551	25.704	21.236	16.752	19.606	16.689	28.104
5/28/00	16:00	26.127	14.493	22.932	20.560	25.735	21.227	16.743	19.985	16.667	28.164
5/28/00	20:00	26.127	14.495	22.900	20.565	25.715	21.234	16.732	20.714	16.665	36.307
5/29/00	0:00	26.127	14.502	22.918	20.548	25.720	21.269	16.741	19.467	16.687	28.104
5/29/00	4:00	26.127	14.493	22.895	20.502	25.596	21.176	16.732	19.290	16.667	28.012
5/29/00	8:00	26.125	14.499	22.897	20.545	25.760	21.212	16.729	19.550	16.674	28.379
5/29/00	12:00	26.122	14.485	22.897	20.565	25.785	21.231	16.729	20.892	16.671	33.095
5/29/00	16:00	26.122	14.482	22.909	20.597	25.868	21.245	16.726	19.949	16.659	28.586
5/29/00	20:00	26.125	14.496	22.912	20.617	25.907	21.269	16.729	19.732	16.676	28.580
5/30/00	0:00	26.127	14.504	22.938	20.649	25.981	21.320	16.755	19.416	16.723	28.399
5/30/00	4:00	26.127	14.510	22.952	20.591	25.767	21.276	16.772	19.020	16.736	28.147
5/30/00	8:00	26.129	14.505	22.946	20.603	25.799	21.258	16.763	19.090	16.708	28.224
5/30/00	12:00	26.131	14.493	22.949	20.632	25.875	21.280	16.775	19.731	16.719	28.350
5/30/00	16:00	26.131	14.501	22.955	20.649	25.911	21.302	16.781	20.053	16.732	28.359
5/30/00	20:00	26.133	14.507	22.961	20.675	25.972	21.338	16.792	19.778	16.764	28.457
5/31/00	0:00	26.136	14.521	23.010	20.718	26.048	21.391	16.829	19.494	16.812	28.413
5/31/00	4:00	26.140	14.524	23.007	20.678	25.866	21.358	16.846	20.041	16.816	36.459
5/31/00	8:00	26.142	14.525	23.036	20.747	26.015	21.415	16.855	19.711	16.829	29.733
5/31/00	12:00	26.149	14.512	23.047	20.770	26.049	21.433	16.872	20.479	16.829	36.424
5/31/00	16:00	26.153	14.507	23.105	20.781	26.012	21.428	16.875	21.047	16.825	36.619
5/31/00	20:00	26.158	14.519	23.062	20.810	26.062	21.473	16.889	20.711	16.853	36.720
6/1/00	0:00	26.164	14.519	23.076	20.816	26.109	21.475	16.909	19.505	16.881	28.482

TABLE D.1 (Cont.)

		Depth (ft BGL)									
Date	Time	SB03	SB05	SB12	SB13	SB14	SB15	SB17	SB19	B12	PWS 70-1
6/1/00	4:00	26.166	14.528	23.067	20.793	26.003	21.444	16.915	19.318	16.874	28.419
6/1/00	8:00	26.171	14.528	23.073	20.787	25.994	21.442	16.918	19.631	16.887	28.413
6/1/00	12:00	26.175	14.520	23.102	20.802	25.997	21.473	16.935	19.692	16.900	28.399
6/1/00	16:00	26.177	14.528	23.096	20.839	26.100	21.512	16.950	19.790	16.926	28.474
6/1/00	20:00	26.186	14.533	23.110	20.848	26.107	21.510	16.955	19.783	16.939	35.145
6/2/00	0:00	26.191	14.552	23.136	20.859	26.159	21.537	16.967	19.669	16.961	28.520
6/2/00	4:00	26.195	14.546	23.139	20.882	26.175	21.545	16.984	19.566	16.957	28.766
6/2/00	8:00	26.202	14.554	23.151	20.899	26.184	21.570	16.990	20.564	16.969	29.564
6/2/00	12:00	26.206	14.547	23.154	20.908	26.186	21.572	16.998	21.062	16.967	29.879
6/2/00	16:00	26.213	14.550	23.145	20.879	26.053	21.539	17.004	21.298	16.950	36.556
6/2/00	20:00	26.217	14.540	23.142	20.899	26.121	21.563	17.007	19.900	16.961	28.649
6/3/00	0:00	26.224	14.557	23.162	20.914	26.218	21.579	17.018	19.626	16.978	28.778
6/3/00	4:00	26.228	14.555	23.136	20.842	25.981	21.497	17.018	19.976	16.965	28.422
6/3/00	8:00	26.232	14.542	23.131	20.856	26.096	21.422	17.018	20.938	16.959	28.884
6/3/00	12:00	26.237	14.543	23.136	20.874	26.060	21.512	17.021	19.940	16.957	28.548
6/3/00	16:00	26.239	14.528	23.125	20.882	26.069	21.492	17.013	20.478	16.935	28.586
6/3/00	20:00	26.243	14.535	23.125	20.911	26.100	21.521	17.015	21.009	16.950	36.588
6/4/00	0:00	26.248	14.539	23.128	20.888	26.067	21.508	17.024	19.798	16.963	28.522
6/4/00	4:00	26.252	14.539	23.133	20.897	26.099	21.517	17.027	19.688	16.974	28.557
6/4/00	8:00	26.256	14.538	23.113	20.845	25.975	21.483	17.033	20.258	16.987	35.925
6/4/00	12:00	26.261	14.540	23.136	20.885	26.092	21.521	17.041	19.929	17.011	28.508
6/4/00	16:00	26.265	14.544	23.156	20.914	26.146	21.552	17.047	20.858	17.017	36.338
6/4/00	20:00	26.270	14.551	23.168	20.925	26.164	21.565	17.053	20.330	17.028	35.899
6/5/00	0:00	26.276	14.559	23.185	20.937	26.191	21.583	17.067	19.837	17.036	28.609
6/5/00	4:00	26.281	14.563	23.174	20.885	26.031	21.532	17.070	20.352	17.032	36.166
6/5/00	8:00	26.283	14.550	23.191	20.917	26.119	21.559	17.076	19.649	17.043	28.545
6/5/00	12:00	26.290	14.559	23.211	20.989	26.408	21.647	17.064	20.622	17.052	29.793
6/5/00	16:00	26.296	14.546	23.208	21.009	26.286	21.634	17.090	20.836	17.039	30.229
6/5/00	20:00	26.371	14.547	23.188	21.046	26.428	21.682	17.093	21.312	17.047	37.609
6/6/00	0:00	26.375	14.564	23.211	20.994	26.275	21.636	17.101	20.023	17.067	28.697
6/6/00	4:00	26.380	14.554	23.220	21.006	26.254	21.638	17.113	19.806	17.071	28.709
6/6/00	8:00	26.382	14.553	23.203	20.948	26.094	21.585	17.113	20.423	17.065	36.533
6/6/00	12:00	26.389	14.559	23.231	21.058	26.421	21.671	17.118	20.379	17.077	29.022
6/6/00	16:00	26.393	14.554	23.237	21.046	26.340	21.649	17.118	20.303	17.060	28.953
6/6/00	20:00	26.397	14.547	23.234	21.092	26.457	21.700	17.121	20.933	17.080	37.474
6/7/00	0:00	26.400	14.559	23.237	21.069	26.319	21.685	17.130	21.143	17.088	37.351
6/7/00	4:00	26.406	14.559	23.231	21.015	26.200	21.629	17.133	19.995	17.086	28.672
6/7/00	8:00	26.408	14.554	23.234	21.041	26.288	21.640	17.139	20.099	17.088	28.821
6/7/00	12:00	26.413	14.548	23.231	21.055	26.258	21.654	17.136	21.527	17.080	36.826
6/7/00	16:00	26.415	14.545	23.243	21.066	26.270	21.656	17.147	21.353	17.077	36.918
6/7/00	20:00	26.422	14.549	23.246	21.118	26.405	21.736	17.144	21.267	17.097	37.600
6/8/00	0:00	26.426	14.554	23.260	21.101	26.441	21.709	17.153	19.913	17.116	28.881
6/8/00	4:00	26.430	14.556	23.254	21.081	26.301	21.691	17.161	20.718	17.118	37.594
6/8/00	8:00	26.433	14.556	23.257	21.095	26.328	21.698	17.167	20.641	17.123	37.035
6/8/00	12:00	26.439	14.543	23.274	21.136	26.452	21.724	17.170	20.395	17.127	29.188
6/8/00	16:00	26.448	14.554	23.277	21.101	26.353	21.696	17.173	20.736	17.125	28.941
6/8/00	20:00	26.448	14.556	23.249	21.089	26.290	21.687	17.179	21.223	17.131	37.414
6/9/00	0:00	26.450	14.562	23.280	21.118	26.437	21.722	17.187	19.891	17.149	28.893
6/9/00	4:00	26.455	14.563	23.280	21.124	26.394	21.718	17.193	19.745	17.151	28.987
6/9/00	8:00	26.459	14.563	23.274	21.133	26.401	21.729	17.199	20.462	17.157	29.816
6/9/00	12:00	26.461	14.549	23.289	21.115	26.337	21.722	17.204	20.300	17.155	28.809

TABLE D.1 (Cont.)

		Depth (ft BGL)									
Date	Time	SB03	SB05	SB12	SB13	SB14	SB15	SB17	SB19	B12	PWS 70-1
6/9/00	16:00	26.463	14.554	23.269	21.081	26.268	21.773	17.193	20.823	17.116	28.979
6/9/00	20:00	26.470	14.548	23.257	21.023	26.137	21.623	17.199	20.122	17.142	28.609
6/10/00	0:00	26.470	14.555	23.260	21.052	26.272	21.658	17.204	19.870	17.162	28.718
6/10/00	4:00	26.472	14.563	23.251	21.072	26.310	21.663	17.202	20.023	17.151	29.245
6/10/00	8:00	26.474	14.556	23.269	21.078	26.313	21.656	17.207	20.783	17.172	37.362
6/10/00	12:00	26.479	14.556	23.303	21.141	26.500	21.747	17.216	19.976	17.190	28.924
6/10/00	16:00	26.483	14.558	23.300	21.141	26.398	21.738	17.224	20.463	17.183	29.739
6/10/00	20:00	26.488	14.573	23.297	21.156	26.425	21.749	17.224	20.541	17.192	30.522
6/11/00	0:00	26.492	14.580	23.318	21.153	26.443	21.771	17.239	20.161	17.214	28.901
6/11/00	4:00	26.494	14.581	23.315	21.150	26.387	21.766	17.247	20.941	17.216	31.087
6/11/00	8:00	26.501	14.582	23.323	21.161	26.407	21.773	17.250	21.256	17.222	37.491
6/11/00	12:00	26.503	14.568	23.344	21.187	26.504	21.806	17.262	21.467	17.233	37.649
6/11/00	16:00	26.507	14.564	23.323	21.115	26.305	21.718	17.262	20.360	17.209	28.752
6/11/00	20:00	26.510	14.566	23.519	21.147	26.358	22.003	17.262	20.482	17.224	28.815
6/12/00	0:00	26.518	14.582	23.821	21.225	26.561	22.372	17.273	20.807	17.239	29.065
6/12/00	4:00	26.527	14.571	24.023	21.225	26.412	22.567	17.279	20.951	17.237	29.007
6/12/00	8:00	26.538	14.578	24.184	21.254	26.432	22.711	17.287	22.165	17.241	37.233
6/12/00	12:00	26.549	14.573	24.342	21.297	26.511	22.854	17.305	21.510	17.252	29.027
6/12/00	16:00	26.565	14.568	24.454	21.334	26.481	22.627	17.327	21.778	17.248	29.214
6/12/00	20:00	26.578	14.561	24.454	21.334	26.380	22.030	17.350	22.815	17.252	37.591
6/13/00	0:00	26.591	14.576	24.564	21.392	26.626	22.492	17.393	21.892	17.291	29.162
6/13/00	4:00	26.609	14.566	24.664	21.429	26.569	22.731	17.425	22.031	17.308	29.225
6/13/00	8:00	26.624	14.573	24.705	21.472	26.590	22.781	17.459	22.225	17.324	29.458
6/13/00	12:00	26.644	14.568	24.823	21.501	26.499	23.064	17.505	22.120	17.341	29.145
6/13/00	16:00	26.971	14.592	24.929	21.536	26.486	23.237	17.522	23.257	17.380	37.772
6/13/00	20:00	26.991	14.595	25.021	21.579	26.281	23.401	17.568	21.891	17.449	29.205
6/14/00	0:00	27.013	14.613	25.128	21.648	26.594	23.560	17.614	22.208	17.470	29.417
6/14/00	4:00	27.035	14.606	25.234	21.657	26.583	23.604	17.642	21.852	17.492	29.260
6/14/00	8:00	27.059	14.604	25.332	21.709	26.723	23.684	17.671	22.767	17.514	29.432
6/14/00	12:00	27.086	14.614	25.398	21.760	26.741	23.779	17.708	22.325	17.550	29.452
6/14/00	16:00	27.114	14.614	25.464	21.838	26.908	23.847	17.743	22.772	17.570	29.802
6/14/00	20:00	27.143	14.620	25.536	21.881	26.865	23.902	17.777	23.593	17.600	37.984
6/15/00	0:00	27.174	14.629	25.640	21.924	26.844	23.995	17.817	23.330	17.628	37.835
6/15/00	4:00	27.202	14.618	25.726	21.956	26.804	24.033	17.854	22.318	17.641	29.638
6/15/00	8:00	27.236	14.613	25.784	22.002	26.820	24.062	17.883	23.351	17.652	38.483
6/15/00	12:00	27.271	14.605	25.905	22.060	26.883	24.225	17.923	24.491	17.667	37.815
6/15/00	16:00	27.304	14.596	26.000	22.132	27.088	24.340	17.957	23.221	17.688	30.648
6/15/00	20:00	27.339	14.609	26.095	22.178	27.065	24.471	18.000	22.897	17.766	29.971
6/16/00	0:00	27.374	14.627	26.169	22.256	27.226	24.584	18.043	22.520	17.820	30.186
6/16/00	4:00	27.411	14.632	26.247	22.258	27.007	24.617	18.086	22.824	17.829	29.968
6/16/00	8:00	27.449	14.626	26.310	22.310	27.117	24.663	18.121	22.791	17.861	30.094
6/16/00	12:00	27.488	14.639	26.394	22.359	27.171	24.736	18.158	23.119	17.900	30.183
6/16/00	16:00	27.526	14.642	26.434	22.405	27.207	24.809	18.192	23.634	17.924	30.358
6/16/00	20:00	27.565	14.638	26.503	22.448	27.223	24.869	18.229	23.790	17.956	37.878
6/17/00	0:00	27.607	14.649	26.584	22.520	27.376	24.940	18.269	22.903	18.002	30.442
6/17/00	4:00	27.647	14.649	26.639	22.526	27.207	24.953	18.301	22.643	18.017	30.272
6/17/00	8:00	27.686	14.650	26.699	22.581	27.295	24.997	18.335	23.238	18.051	38.578
6/17/00	12:00	27.728	14.649	26.748	22.636	27.372	25.059	18.367	23.278	18.084	31.844
6/17/00	16:00	27.768	14.657	26.805	22.673	27.372	25.103	18.398	22.986	18.097	30.688
6/17/00	20:00	27.812	14.647	26.857	22.705	27.327	25.154	18.430	23.730	18.127	38.658
6/18/00	0:00	27.851	14.649	26.912	22.757	27.455	25.212	18.461	22.904	18.161	30.786

TABLE D.1 (Cont.)

		Depth (ft BGL)									
Date	Time	SB03	SB05	SB12	SB13	SB14	SB15	SB17	SB19	B12	PWS 70-1
6/18/00	4:00	27.895	14.656	26.955	22.765	27.358	25.231	18.501	23.472	18.185	30.519
6/18/00	8:00	27.937	14.644	27.007	22.831	27.471	25.298	18.536	24.469	18.215	38.850
6/18/00	12:00	27.977	14.651	27.056	22.889	27.575	25.342	18.573	24.291	18.241	30.829
6/18/00	16:00	28.021	14.637	27.116	22.926	27.514	25.395	18.610	25.051	18.263	39.272
6/18/00	20:00	28.063	14.651	27.142	22.978	27.627	25.450	18.647	23.755	18.300	30.946
6/19/00	0:00	28.105	14.647	27.208	23.042	27.719	25.517	18.684	23.592	18.339	31.213
6/19/00	4:00	28.149	14.657	27.254	23.065	27.606	25.552	18.725	24.332	18.364	39.817
6/19/00	8:00	28.190	14.643	27.306	23.142	27.791	25.616	18.765	24.476	18.399	39.335
6/19/00	12:00	28.234	14.646	27.364	23.174	27.762	25.645	18.808	24.124	18.427	31.001
6/19/00	16:00	28.278	14.642	27.410	23.226	27.811	25.689	18.842	24.439	18.457	31.118
6/19/00	20:00	28.318	14.643	27.450	23.243	27.708	25.731	18.879	25.243	18.483	39.722
6/20/00	0:00	28.362	14.643	27.490	23.298	27.821	25.780	18.913	25.201	18.516	39.888
6/20/00	4:00	28.404	14.620	27.401	23.240	27.692	25.614	18.945	23.507	18.494	30.946
6/20/00	8:00	28.446	14.619	27.292	23.226	27.687	25.461	18.954	23.826	18.503	39.361
6/20/00	12:00	28.483	14.615	27.174	23.258	27.827	25.331	18.962	23.155	18.531	31.061
6/20/00	16:00	28.520	14.614	27.050	23.286	27.890	25.198	18.951	23.631	18.544	31.603
6/20/00	20:00	28.556	14.609	26.915	23.269	27.929	25.052	18.934	22.921	18.567	31.368
6/21/00	0:00	28.586	14.630	26.805	23.220	27.933	24.906	18.922	22.348	18.585	31.110
6/21/00	4:00	28.617	14.628	26.696	23.145	27.820	24.754	18.902	22.415	18.587	37.847
6/21/00	8:00	28.646	14.631	26.613	23.165	27.922	24.670	18.879	22.004	18.593	31.414
6/21/00	12:00	28.670	14.639	26.696	23.142	27.879	24.782	18.862	23.196	18.593	33.416
6/21/00	16:00	28.696	14.629	26.883	23.139	27.892	24.948	18.830	23.188	18.580	31.118
6/21/00	20:00	28.723	14.631	26.967	23.163	27.890	25.048	18.816	22.873	18.572	31.374
6/22/00	0:00	28.749	14.649	26.736	23.139	27.931	24.778	18.805	22.175	18.600	31.024
6/22/00	4:00	28.773	14.643	26.578	23.122	27.935	24.619	18.790	21.961	18.598	31.239
6/22/00	8:00	28.795	14.643	26.636	23.091	27.937	24.659	18.770	21.909	18.596	31.052
6/22/00	12:00	28.817	14.653	26.880	23.122	27.913	24.915	18.759	23.503	18.589	33.413
6/22/00	16:00	28.842	14.651	26.975	23.096	27.863	24.860	18.750	23.179	18.580	30.912
6/22/00	20:00	28.866	14.648	26.866	23.119	27.955	24.634	18.727	22.688	18.583	31.067
6/23/00	0:00	28.890	14.660	26.664	23.134	28.057	24.510	18.725	22.315	18.604	31.121
6/23/00	4:00	28.910	14.665	26.523	23.122	28.021	24.422	18.710	22.360	18.591	31.724
6/23/00	8:00	28.927	14.650	26.426	23.091	28.016	24.353	18.705	22.950	18.611	39.309
6/23/00	12:00	28.945	14.655	26.354	23.039	27.940	24.243	18.690	23.023	18.583	38.931
6/23/00	16:00	28.960	14.649	26.302	23.021	27.937	24.181	18.673	23.569	18.567	38.532
6/23/00	20:00	28.971	14.655	26.204	22.978	27.951	24.033	18.653	22.205	18.567	30.875
6/24/00	0:00	28.985	14.649	26.132	22.975	27.994	24.062	18.647	21.802	18.570	30.906
6/24/00	4:00	28.996	14.640	26.040	22.823	27.784	23.982	18.613	22.466	18.453	38.463
6/24/00	8:00	29.002	14.630	25.942	22.765	27.748	23.885	18.541	21.394	18.345	30.611
6/24/00	12:00	29.011	14.619	25.890	22.782	27.863	23.863	18.493	21.822	18.298	30.803
6/24/00	16:00	29.015	14.614	25.824	22.759	27.768	23.794	18.447	23.055	18.276	37.944
6/24/00	20:00	29.018	14.608	25.729	22.690	27.693	23.703	18.410	21.548	18.267	30.522
6/25/00	0:00	29.022	14.613	25.689	22.676	27.741	23.661	18.381	21.292	18.265	30.548
6/25/00	4:00	29.022	14.623	25.634	22.633	27.619	23.597	18.352	22.024	18.241	38.245
6/25/00	8:00	29.022	14.615	25.568	22.590	27.621	23.542	18.327	21.018	18.233	30.421
6/25/00	12:00	29.020	14.616	25.539	22.564	27.605	23.473	18.301	21.504	18.207	30.404
6/25/00	16:00	29.020	14.598	25.464	22.552	27.605	23.431	18.258	21.891	18.177	30.674
6/25/00	20:00	29.015	14.598	25.364	22.368	27.484	23.268	18.232	21.022	18.138	30.054
6/26/00	0:00	29.009	14.590	25.254	22.235	27.371	23.142	18.138	20.759	17.917	30.071
6/26/00	4:00	28.998	14.576	25.171	22.166	27.308	22.910	18.043	21.442	17.844	37.265
6/26/00	8:00	28.985	14.583	25.119	22.192	27.382	23.038	18.003	21.166	17.812	30.172
6/26/00	12:00	28.949	14.581	25.047	22.123	27.206	22.943	17.952	21.239	17.779	29.891

TABLE D.1 (Cont.)

		Depth (ft BGL)									
Date	Time	SB03	SB05	SB12	SB13	SB14	SB15	SB17	SB19	B12	PWS 70-1
6/26/00	16:00	28.899	14.575	24.995	22.103	27.258	22.890	17.900	21.090	17.753	29.954
6/26/00	20:00	28.716	14.576	24.915	22.080	27.184	22.865	17.863	21.596	17.740	38.188
6/27/00	0:00	28.591	14.581	24.883	22.071	27.299	22.832	17.829	21.062	17.742	30.057
6/27/00	4:00	28.483	14.581	24.826	21.994	27.112	22.750	17.797	20.809	17.723	29.770
6/27/00	8:00	28.397	14.581	24.780	21.962	27.096	22.719	17.777	20.737	17.719	29.739
6/27/00	12:00	28.329	14.577	24.745	21.936	27.080	22.682	17.754	20.880	17.706	29.710
6/27/00	16:00	28.265	14.572	24.685	21.896	27.019	22.626	17.723	20.991	17.678	29.627
6/27/00	20:00	28.197	14.562	24.621	21.858	26.940	22.598	17.700	21.690	17.665	38.079
6/28/00	0:00	28.155	14.574	24.595	21.841	27.008	22.589	17.685	20.686	17.663	29.601
6/28/00	4:00	28.124	14.569	24.572	21.844	27.053	22.567	17.668	20.671	17.654	29.644
6/28/00	8:00	28.078	14.558	24.529	21.809	26.954	22.538	17.654	21.551	17.647	37.904
6/28/00	12:00	28.050	14.567	24.503	21.755	27.006	22.401	17.622	20.730	17.645	29.561
6/28/00	16:00	28.017	14.561	24.477	21.815	27.030	22.523	17.628	21.217	17.632	30.146
6/28/00	20:00	27.997	14.558	24.451	21.847	27.145	22.547	17.617	22.033	17.624	38.845
6/29/00	0:00	27.988	14.556	24.431	21.769	27.030	22.487	17.614	20.595	17.639	29.561
6/29/00	4:00	27.966	14.561	24.405	21.757	27.035	22.470	17.605	20.509	17.624	29.590
6/29/00	8:00	27.933	14.560	24.388	21.760	26.967	22.467	17.597	21.644	17.617	38.469
6/29/00	12:00	27.913	14.548	24.359	21.714	26.936	22.416	17.588	20.430	17.615	29.463
6/29/00	16:00	27.889	14.553	24.345	21.740	27.028	22.423	17.579	21.018	17.593	29.770
6/29/00	20:00	27.880	14.558	24.336	21.783	27.132	22.469	17.577	20.789	17.611	30.146
6/30/00	0:00	27.867	14.557	24.308	21.706	26.985	22.394	17.562	20.301	17.600	29.498
6/30/00	4:00	27.847	14.556	24.282	21.697	26.972	22.385	17.559	21.325	17.602	37.055
6/30/00	8:00	27.829	14.560	24.279	21.720	27.028	22.412	17.557	20.935	17.604	29.954
6/30/00	12:00	27.814	14.557	24.253	21.680	26.976	22.370	17.557	20.687	17.596	29.538
6/30/00	16:00	27.790	14.545	24.238	21.665	26.926	22.346	17.554	21.445	17.585	35.552
6/30/00	20:00	27.770	14.548	24.201	21.660	26.872	22.359	17.554	21.280	17.585	36.505
7/1/00	0:00	27.794	14.565	24.253	21.801	27.283	22.474	17.554	20.958	17.609	30.505
7/1/00	4:00	27.796	14.566	24.210	21.683	26.967	22.361	17.551	20.293	17.589	29.423
7/1/00	8:00	27.788	14.556	24.201	21.688	27.019	22.372	17.548	21.057	17.593	35.750
7/1/00	12:00	27.788	14.563	24.198	21.700	27.046	22.366	17.542	20.665	17.589	29.504
7/1/00	16:00	27.781	14.549	24.190	21.671	26.969	22.332	17.545	20.998	17.576	29.432
7/1/00	20:00	27.772	14.549	24.167	21.654	26.958	22.319	17.536	20.654	17.568	29.461
7/2/00	0:00	27.763	14.555	24.158	21.660	27.014	22.224	17.536	20.539	17.570	29.532
7/2/00	4:00	27.752	14.565	24.132	21.625	26.852	22.299	17.536	21.230	17.565	35.988
7/2/00	8:00	27.741	14.564	24.123	21.613	26.881	22.290	17.531	21.233	17.570	36.479
7/2/00	12:00	27.733	14.562	24.126	21.619	26.908	22.290	17.536	21.566	17.580	36.215
7/2/00	16:00	27.724	14.562	24.112	21.599	26.883	22.268	17.534	20.650	17.565	29.320
7/2/00	20:00	27.713	14.565	24.092	21.628	26.944	22.290	17.525	20.512	17.559	29.656
7/3/00	0:00	27.704	14.562	24.109	21.671	27.077	22.350	17.548	20.673	17.598	29.690
7/3/00	4:00	27.697	14.570	24.080	21.582	26.854	22.275	17.539	20.356	17.555	29.303
7/3/00	8:00	27.689	14.578	24.089	21.605	26.949	22.292	17.525	20.492	17.555	29.446
7/3/00	12:00	27.682	14.578	24.086	21.631	26.998	22.328	17.536	20.908	17.563	29.515
7/3/00	16:00	27.684	14.578	24.477	21.645	26.938	22.684	17.528	21.247	17.555	30.008
7/3/00	20:00	27.741	14.580	24.742	21.628	26.805	22.697	17.522	21.391	17.546	35.871
7/4/00	0:00	27.794	14.585	24.938	21.683	26.899	22.757	17.545	21.193	17.568	29.400
7/4/00	4:00	27.814	14.574	25.090	21.700	26.899	22.960	17.548	21.414	17.552	29.644
7/4/00	8:00	27.829	14.552	24.918	21.513	26.611	22.668	17.491	21.088	17.369	29.099
7/4/00	12:00	27.832	14.545	24.638	21.490	26.683	22.472	17.442	21.244	17.248	29.303
7/4/00	16:00	27.827	14.541	24.500	21.472	26.626	22.357	17.382	21.823	17.203	36.591
7/4/00	20:00	27.816	14.541	24.397	21.429	26.577	22.284	17.333	20.548	17.194	29.082
7/5/00	0:00	27.774	14.552	24.310	21.426	26.543	22.255	17.319	21.508	17.187	36.401

TABLE D.1 (Cont.)

		Depth (ft BGL)									
Date	Time	SB03	SB05	SB12	SB13	SB14	SB15	SB17	SB19	B12	PWS 70-1
7/5/00	4:00	27.739	14.543	24.262	21.406	26.586	22.222	17.299	20.475	17.187	29.073
7/5/00	8:00	27.693	14.550	24.218	21.426	26.620	22.235	17.270	21.412	17.196	36.097
7/5/00	12:00	27.689	14.550	24.215	21.501	26.942	22.231	17.282	20.528	17.218	29.684
7/5/00	16:00	27.684	14.553	24.172	21.438	26.721	22.204	17.276	20.472	17.226	29.165
7/5/00	20:00	27.651	14.556	24.135	21.438	26.678	22.222	17.265	20.955	17.200	29.876
7/6/00	0:00	27.623	14.558	24.103	21.386	26.581	22.155	17.253	21.206	17.205	36.295
7/6/00	4:00	27.596	14.550	24.080	21.377	26.619	22.162	17.270	20.438	17.237	29.070
7/6/00	8:00	27.565	14.550	24.063	21.346	26.504	22.122	17.259	21.028	17.209	35.963
7/6/00	11:00		14.547		21.453			17.400	21.003		
7/6/00	12:00	27.546		24.177	21.435	26.533	22.100	17.400	21.020	17.198	29.076
7/6/00	13:00	27.518	14.828	24.165	21.421	26.490		17.403	20.779	17.196	29.041
7/6/00	14:00	27.507	14.857	24.174	21.433	26.493	22.053	17.400	20.798	17.196	40.665
7/6/00	15:00	27.502	14.814	24.168	21.473	26.637	22.071	17.400	21.779	17.189	36.140
7/6/00	16:00	27.502	14.827	24.183	21.484	26.718	22.089	17.394	21.084	17.198	29.477
7/6/00	17:00	27.500	14.816	24.174	21.464	26.673	22.078	17.397	20.816	17.202	29.236
7/6/00	18:00	27.496	14.853	24.151	21.438	26.605	22.056	17.394	20.667	17.200	29.136
7/6/00	19:00	27.489	14.855	24.140	21.424	26.551	22.045	17.397	20.573	17.198	29.081
7/6/00	20:00	27.482	14.862	24.125	21.444	26.563	22.071	17.394	21.448	17.204	35.784
7/6/00	21:00	27.480	14.837	24.134	21.470	26.660	22.093	17.397	20.746	17.211	29.500
7/6/00	22:00	27.478	14.876	24.128	21.456	26.653	22.082	17.400	20.792	17.219	29.222
7/6/00	23:00	27.474	14.853	24.125	21.435	26.617	22.073	17.406	20.724	17.228	29.136
7/7/00	0:00	27.467	14.878	24.114	21.392	26.560	21.932	17.371	20.630	17.204	29.078
7/7/00	1:00	27.460	14.887	24.111	21.415	26.520	22.045	17.394	20.647	17.217	29.047
7/7/00	2:00	27.454	14.890	24.102	21.401	26.490	22.031	17.394	20.587	17.213	29.021
7/7/00	3:00	27.447	14.862	24.096	21.392	26.472	22.025	17.400	20.552	17.215	29.007
7/7/00	4:00	27.441	14.892	24.094	21.410	26.486	22.047	17.394	21.394	17.209	35.681
7/7/00	5:00	27.439	14.867	24.102	21.444	26.607	22.073	17.397	20.848	17.219	29.569
7/7/00	6:00	27.434	14.864	24.099	21.430	26.621	22.065	17.397	20.713	17.226	29.207
7/7/00	7:00	27.432	14.862	24.094	21.418	26.585	22.056	17.400	20.621	17.230	29.107
7/7/00	8:00	27.428	14.862	24.102	21.404	26.545	22.045	17.403	21.216	17.228	35.701
7/7/00	9:00	27.427	14.867	24.131	21.456	26.612	22.087	17.409	21.455	17.232	30.906
7/7/00	10:00	27.428	14.869	24.122	21.450	26.657	22.082	17.409	21.093	17.235	29.291
7/7/00	11:00	27.425	14.867	24.105	21.430	26.612	22.058	17.394	21.020	17.232	29.139
7/7/00	12:00	27.423	14.857	24.094	21.410	26.556	22.038	17.409	20.800	17.224	29.067
7/7/00	13:00	27.419	14.883	24.082	21.392	26.517	22.029	17.406	20.836	17.226	29.032
7/7/00	14:00	27.417	14.874	24.094	21.418	26.533	22.047	17.406	21.947	17.222	36.418
7/7/00	15:00	27.414	14.853	24.102	21.444	26.632	22.064	17.406	21.197	17.219	29.463
7/7/00	16:00	27.412	14.885	24.085	21.430	26.617	22.051	17.409	21.044	17.226	29.182
7/7/00	17:00	27.410	14.862	24.073	21.404	26.558	22.033	17.403	20.832	17.222	29.081
7/7/00	18:00	27.406	14.862	24.068	21.387	26.504	22.009	17.403	20.707	17.213	29.027
7/7/00	19:00	27.401	14.869	24.056	21.387	26.479	22.011	17.400	21.410	17.213	35.681
7/7/00	20:00	27.401	14.873	24.065	21.435	26.585	22.058	17.400	21.529	17.219	33.490
7/7/00	21:00	27.401	14.885	24.068	21.433	26.705	22.073	17.383	20.770	17.230	41.207
7/7/00	22:00	27.403	14.892	24.091	21.528	26.889	22.084	17.409	20.944	17.248	37.381
7/7/00	23:00	27.408	14.906	24.102	21.559	27.013	22.122	17.414	20.917	17.265	30.186
7/8/00	0:00	27.410	14.903	24.096	21.533	26.955	22.106	17.417	20.749	17.267	29.532
7/8/00	1:00	27.410	14.906	24.091	21.499	26.842	22.089	17.417	20.681	17.267	29.331
7/8/00	2:00	27.410	14.908	24.082	21.476	26.743	22.071	17.417	20.659	17.263	29.228
7/8/00	3:00	27.410	14.945	24.071	21.447	26.657	22.051	17.411	20.597	17.254	29.153
7/8/00	4:00	27.408	14.911	24.062	21.433	26.601	22.038	17.417	20.534	17.252	29.110
7/8/00	5:00	27.406	14.911	24.056	21.415	26.563	22.027	17.414	20.478	17.252	29.076

TABLE D.1 (Cont.)

		Depth (ft BGL)									
Date	Time	SB03	SB05	SB12	SB13	SB14	SB15	SB17	SB19	B12	PWS 70-1
7/8/00	6:00	27.403	14.938	24.050	21.410	26.535	22.025	17.417	21.110	17.252	35.234
7/8/00	7:00	27.406	14.913	24.071	21.453	26.614	22.078	17.414	21.541	17.256	36.530
7/8/00	8:00	27.403	14.940	24.217	21.458	26.677	22.217	17.417	21.357	17.256	29.357
7/8/00	9:00	27.406	14.908	24.347	21.458	26.632	22.389	17.423	21.736	17.252	33.673
7/8/00	10:00	27.408	14.911	24.471	21.487	26.643	22.529	17.420	21.616	17.247	29.635
7/8/00	11:00	27.410	14.901	24.577	21.490	26.641	22.630	17.426	21.292	17.254	29.256
7/8/00	12:00	27.414	14.926	24.675	21.493	26.596	22.717	17.429	21.431	17.254	29.173
7/8/00	13:00	27.421	14.922	24.761	21.484	26.546	22.794	17.429	21.432	17.248	29.139
7/8/00	14:00	27.425	14.894	24.761	21.496	26.517	22.803	17.431	22.232	17.245	36.168
7/8/00	15:00	27.432	14.889	24.730	21.551	26.621	22.776	17.434	21.858	17.250	30.610
7/8/00	16:00	27.439	14.892	24.689	21.553	26.673	22.708	17.440	21.321	17.256	29.425
7/8/00	17:00	27.443	14.896	24.646	21.536	26.625	22.635	17.443	21.084	17.254	29.273
7/8/00	18:00	27.447	14.906	24.606	21.519	26.573	22.577	17.440	21.169	17.250	29.213
7/8/00	19:00	27.452	14.903	24.574	21.507	26.537	22.531	17.440	21.053	17.250	29.179
7/8/00	20:00	27.456	14.903	24.542	21.507	26.522	22.502	17.446	21.739	17.252	35.644
7/8/00	21:00	27.460	14.917	24.531	21.562	26.628	22.527	17.449	21.597	17.260	30.573
7/8/00	22:00	27.465	14.956	24.514	21.559	26.691	22.504	17.451	21.137	17.280	29.443
7/8/00	23:00	27.469	14.929	24.494	21.556	26.652	22.493	17.460	20.980	17.278	29.294
7/9/00	0:00	27.471	14.961	24.471	21.525	26.603	22.436	17.454	20.875	17.278	29.225
7/9/00	1:00	27.474	14.963	24.447	21.505	26.555	22.398	17.457	20.851	17.271	29.179
7/9/00	2:00	27.476	14.943	24.427	21.482	26.528	22.378	17.457	20.825	17.273	29.156
7/9/00	3:00	27.478	14.966	24.410	21.496	26.517	22.363	17.460	21.511	17.273	35.517
7/9/00	4:00	27.478	14.966	24.404	21.542	26.612	22.387	17.460	21.395	17.278	30.544
7/9/00	5:00	27.482	14.966	24.393	21.542	26.668	22.378	17.466	20.935	17.286	29.397
7/9/00	6:00	27.485	14.945	24.378	21.525	26.632	22.354	17.469	20.848	17.289	29.256
7/9/00	7:00	27.487	14.933	24.364	21.505	26.585	22.325	17.469	20.790	17.286	29.190
7/9/00	8:00	27.487	14.929	24.347	21.484	26.540	22.297	17.466	21.266	17.278	34.932
7/9/00	9:00	27.489	14.931	24.347	21.525	26.605	22.328	17.472	21.881	17.286	36.601
7/9/00	10:00	27.491	14.924	24.341	21.551	26.693	22.336	17.469	22.030	17.286	29.537
7/9/00	11:00	27.493	14.922	24.332	21.542	26.673	22.367	17.474	21.414	17.293	29.305
7/9/00	12:00	27.493	14.947	24.318	21.545	26.639	22.328	17.480	22.040	17.291	36.412
7/9/00	13:00	27.496	14.913	24.312	21.551	26.664	22.319	17.480	21.154	17.289	29.394
7/9/00	14:00	27.496	14.940	24.304	21.519	26.619	22.281	17.477	21.068	17.284	29.233
7/9/00	15:00	27.496	14.945	24.292	21.496	26.567	22.257	17.477	20.948	17.280	29.164
7/9/00	16:00	27.496	14.945	24.281	21.484	26.528	22.246	17.477	20.934	17.280	29.130
7/9/00	17:00	27.496	14.922	24.263	21.467	26.499	22.219	17.474	21.405	17.273	35.899
7/9/00	18:00	27.496	14.924	24.266	21.513	26.580	22.252	17.472	21.715	17.273	33.610
7/9/00	19:00	27.496	14.956	24.252	21.476	26.637	22.146	17.457	20.879	17.260	29.380
7/9/00	20:00	27.496	14.938	24.243	21.487	26.605	22.219	17.466	20.788	17.278	29.219
7/9/00	21:00	27.496	14.943	24.237	21.476	26.585	22.115	17.472	20.829	17.284	29.167
7/9/00	22:00	27.496	14.947	24.235	21.510	26.614	22.239	17.483	21.718	17.297	35.959
7/9/00	23:00	27.498	14.989	24.237	21.548	26.718	22.259	17.480	21.183	17.299	29.830
7/10/00	0:00	27.498	14.963	24.232	21.536	26.727	22.252	17.489	21.035	17.310	29.377
7/10/00	1:00	27.496	14.996	24.223	21.510	26.666	22.221	17.489	20.927	17.308	29.239
7/10/00	2:00	27.496	14.993	24.212	21.487	26.598	22.193	17.483	20.855	17.295	29.170
7/10/00	3:00	27.498	14.993	24.209	21.502	26.598	22.213	17.483	21.713	17.293	35.905
7/10/00	4:00	27.496	14.966	24.209	21.522	26.673	22.217	17.477	20.992	17.293	29.497
7/10/00	5:00	27.496	14.989	24.197	21.505	26.655	22.197	17.483	20.826	17.301	29.273
7/10/00	6:00	27.493	14.966	24.191	21.493	26.632	22.197	17.489	20.755	17.319	29.205
7/10/00	7:00	27.493	14.963	24.186	21.493	26.607	22.193	17.489	21.514	17.317	35.724
7/10/00	8:00	27.493	14.996	24.327	21.551	26.711	22.365	17.500	21.405	17.323	30.352

TABLE D.1 (Cont.)

		Depth (ft BGL)									
Date	Time	SB03	SB05	SB12	SB13	SB14	SB15	SB17	SB19	B12	PWS 70-1
7/10/00	9:00	27.498	15.000	24.491	21.594	26.815	22.566	17.500	21.609	17.332	30.174
7/10/00	10:00	27.500	14.973	24.637	21.605	26.837	22.723	17.509	22.381	17.340	36.610
7/10/00	11:00	27.504	14.977	24.776	21.631	26.866	22.885	17.517	21.865	17.347	29.649
7/10/00	12:00	27.509	14.970	24.888	21.634	26.819	22.995	17.529	21.779	17.355	29.446
7/10/00	13:00	27.518	14.970	24.994	21.634	26.743	23.093	17.532	21.852	17.353	29.365
7/10/00	14:00	27.522	15.000	25.089	21.643	26.693	23.192	17.546	21.999	17.358	29.334
7/10/00	15:00	27.531	14.973	25.181	21.680	26.700	23.305	17.563	23.053	17.368	36.682
7/10/00	16:00	27.537	14.982	25.262	21.735	26.817	23.420	17.572	22.441	17.381	29.922
7/10/00	17:00	27.548	14.986	25.334	21.744	26.812	23.471	17.592	22.828	17.384	29.577
7/10/00	18:00	27.557	15.028	25.397	21.761	26.767	23.546	17.606	22.473	17.392	29.503
7/10/00	19:00	27.566	15.007	25.466	21.804	26.792	23.619	17.623	22.869	17.401	31.052
7/10/00	20:00	27.577	15.014	25.518	21.830	26.849	23.668	17.643	22.393	17.422	29.709
7/10/00	21:00	27.584	15.021	25.561	21.850	26.828	23.692	17.660	23.164	17.427	36.174
7/10/00	22:00	27.597	15.033	25.622	21.879	26.934	23.778	17.658	23.610	17.453	36.587
7/10/00	23:00	27.606	15.072	25.676	21.939	26.995	23.818	17.701	22.767	17.463	29.959
7/11/00	0:00	27.617	15.044	25.719	21.939	26.943	23.838	17.715	22.658	17.468	29.775
7/11/00	1:00	27.625	15.079	25.760	21.948	26.887	23.864	17.735	22.609	17.476	29.712
7/11/00	2:00	27.634	15.079	25.812	22.000	26.912	23.940	17.752	23.589	17.487	37.169
7/11/00	3:00	27.643	15.046	25.860	22.040	27.020	24.001	17.772	22.893	17.507	30.203
7/11/00	4:00	27.656	15.049	25.898	22.054	27.020	24.028	17.792	22.735	17.526	29.930
7/11/00	5:00	27.667	15.056	25.935	22.060	26.966	24.043	17.815	22.689	17.533	29.844
7/11/00	6:00	27.676	15.079	25.973	22.098	26.984	24.099	17.832	23.617	17.556	37.221
7/11/00	7:00	27.689	15.051	26.019	22.164	27.099	24.169	17.852	23.804	17.571	37.542
7/11/00	8:00	27.700	15.083	26.062	22.210	27.221	24.218	17.875	23.102	17.591	30.645
7/11/00	9:00	27.711	15.081	26.102	22.245	27.232	24.238	17.890	23.425	17.597	31.442
7/11/00	10:00	27.722	15.079	26.134	22.253	27.241	24.258	17.915	23.035	17.619	30.269
7/11/00	11:00	27.733	15.049	26.163	22.253	27.194	24.273	17.938	23.076	17.638	30.111
7/11/00	12:00	27.746	15.044	26.194	22.247	27.119	24.282	17.958	23.698	17.643	36.045
7/11/00	13:00	27.757	15.040	26.232	22.293	27.142	24.340	17.978	24.303	17.651	36.877
7/11/00	14:00	27.768	15.067	26.266	22.325	27.209	24.380	17.995	23.343	17.662	30.438
7/11/00	15:00	27.782	15.067	26.301	22.319	27.178	24.384	18.013	23.313	17.673	30.148
7/11/00	16:00	27.793	15.035	26.315	22.316	27.119	24.397	18.033	23.248	17.686	30.085
7/11/00	17:00	27.804	15.065	26.341	22.334	27.081	24.422	18.050	23.855	17.695	36.550
7/11/00	18:00	27.815	15.044	26.381	22.394	27.173	24.492	18.070	23.754	17.712	31.783
7/11/00	19:00	27.828	15.049	26.404	22.409	27.236	24.508	18.084	23.207	17.729	30.381
7/11/00	20:00	27.839	15.058	26.425	22.414	27.203	24.514	18.104	23.723	17.744	36.994
7/11/00	21:00	27.852	15.093	26.448	22.463	27.257	24.565	18.121	24.272	17.757	37.806
7/11/00	22:00	27.863	15.102	26.485	22.501	27.356	24.605	18.141	23.604	17.779	30.667
7/11/00	23:00	27.878	15.113	26.502	22.504	27.335	24.610	18.159	23.413	17.800	30.406
7/12/00	0:00	27.887	15.086	26.522	22.504	27.302	24.625	18.179	23.202	17.822	30.326
7/12/00	1:00	27.900	15.090	26.554	22.524	27.282	24.636	18.190	23.919	17.822	37.307
7/12/00	2:00	27.914	15.088	26.568	22.581	27.416	24.683	18.210	23.416	17.848	31.442
7/12/00	3:00	27.927	15.070	26.606	22.578	27.414	24.669	18.222	22.930	17.850	30.581
7/12/00	4:00	27.938	15.095	26.620	22.567	27.378	24.671	18.236	23.340	17.854	36.622
7/12/00	5:00	27.949	15.072	26.637	22.532	27.387	24.517	18.219	22.821	17.850	30.656
7/12/00	6:00	27.962	15.116	26.655	22.576	27.378	24.694	18.250	22.639	17.857	30.467
7/12/00	7:00	27.975	15.074	26.623	22.573	27.344	24.643	18.259	22.519	17.867	30.406
7/12/00	8:00	27.988	15.083	26.658	22.570	27.322	24.647	18.267	23.022	17.878	36.401
7/12/00	9:00	27.999	15.116	26.712	22.610	27.367	24.691	18.273	23.264	17.885	36.679
7/12/00	10:00	28.010	15.120	26.718	22.625	27.434	24.696	18.282	22.937	17.895	30.802
7/12/00	11:00	28.024	15.088	26.741	22.645	27.426	24.747	18.293	22.923	17.902	30.544

TABLE D.1 (Cont.)

		Depth (ft BGL)									
Date	Time	SB03	SB05	SB12	SB13	SB14	SB15	SB17	SB19	B12	PWS 70-1
7/12/00	12:00	28.037	15.118	26.753	22.622	27.380	24.707	18.287	23.009	17.906	30.464
7/12/00	13:00	28.048	15.118	26.764	22.616	27.344	24.698	18.290	23.159	17.913	30.424
7/12/00	14:00	28.059	15.081	26.778	22.613	27.313	24.685	18.296	22.801	17.915	30.398
7/12/00	15:00	28.072	15.077	26.793	22.636	27.313	24.696	18.299	23.685	17.919	37.057
7/12/00	16:00	28.085	15.083	26.816	22.676	27.423	24.722	18.308	23.410	17.930	31.098
7/12/00	17:00	28.096	15.083	26.825	22.685	27.448	24.711	18.310	23.773	17.934	37.571
7/12/00	18:00	28.107	15.120	26.833	22.702	27.484	24.709	18.322	23.134	17.943	30.774
7/12/00	19:00	28.123	15.125	26.845	22.694	27.448	24.678	18.328	23.423	17.947	30.579
7/12/00	20:00	28.134	15.134	26.850	22.722	27.459	24.687	18.339	23.574	17.956	31.000
7/12/00	21:00	28.147	15.109	26.856	22.722	27.480	24.669	18.350	23.306	17.971	30.650
7/12/00	22:00	28.158	15.125	26.859	22.728	27.471	24.676	18.362	23.231	17.990	30.576
7/12/00	23:00	28.171	15.162	26.871	22.728	27.441	24.680	18.373	23.168	17.999	30.541
7/13/00	0:00	28.180	15.176	26.879	22.725	27.408	24.691	18.382	23.119	18.001	30.510
7/13/00	1:00	28.195	15.143	26.891	22.725	27.388	24.709	18.396	23.088	18.008	30.498
7/13/00	2:00	28.204	15.176	26.908	22.717	27.369	24.691	18.405	23.059	18.012	30.487
7/13/00	3:00	28.217	15.143	26.917	22.731	27.353	24.736	18.416	23.326	18.016	35.403
7/13/00	4:00	28.228	15.169	26.940	22.774	27.410	24.786	18.428	24.048	18.021	38.067
7/13/00	5:00	28.239	15.171	26.954	22.792	27.512	24.718	18.439	23.746	18.029	30.880
7/13/00	6:00	28.250	15.139	26.966	22.803	27.509	24.817	18.451	23.618	18.049	30.690
7/13/00	7:00	28.263	15.166	26.983	22.800	27.468	24.817	18.459	23.572	18.053	30.613
7/13/00	8:00	28.274	15.164	26.991	22.797	27.450	24.828	18.479	23.618	18.064	30.587
7/13/00	9:00	28.285	15.141	27.006	22.843	27.473	24.870	18.496	24.640	18.079	37.536
7/13/00	10:00	28.299	15.150	27.032	22.887	27.586	24.904	18.505	24.474	18.090	31.640
7/13/00	11:00	28.310	15.171	27.037	22.892	27.627	24.899	18.516	24.209	18.105	30.880
7/13/00	12:00	28.323	15.134	27.014	22.884	27.590	24.859	18.534	23.664	18.113	30.739
7/13/00	13:00	28.334	15.130	26.954	22.878	27.538	24.769	18.539	23.800	18.116	30.670
7/13/00	14:00	28.345	15.167	26.917	22.898	27.541	24.649	18.554	24.831	18.124	37.456
7/13/00	15:00	28.356	15.127	26.888	22.933	27.628	24.718	18.565	23.797	18.129	31.164
7/13/00	16:00	28.369	15.162	26.873	22.918	27.624	24.667	18.579	23.661	18.137	30.825
7/13/00	17:00	28.380	15.132	26.810	22.907	27.570	24.621	18.591	23.435	18.142	30.716
7/13/00	18:00	28.389	15.137	26.773	22.892	27.520	24.581	18.602	23.261	18.144	30.656
7/13/00	19:00	28.400	15.134	26.741	22.884	27.491	24.530	18.614	23.757	18.152	36.877
7/13/00	20:00	28.409	15.171	26.707	22.938	27.568	24.543	18.622	24.502	18.165	38.170
7/13/00	21:00	28.420	15.178	26.675	22.947	27.649	24.526	18.634	23.634	18.178	30.992
7/13/00	22:00	28.431	15.189	26.640	22.933	27.640	24.499	18.648	23.491	18.193	30.794
7/13/00	23:00	28.439	15.194	26.609	22.959	27.631	24.517	18.662	24.309	18.200	38.150
7/14/00	0:00	28.448	15.171	26.589	22.993	27.723	24.501	18.671	23.770	18.215	31.611
7/14/00	1:00	28.459	15.203	26.563	22.979	27.732	24.459	18.683	23.413	18.221	30.951
7/14/00	2:00	28.468	15.171	26.531	22.961	27.680	24.422	18.697	23.294	18.226	30.791
7/14/00	3:00	28.477	15.208	26.502	22.941	27.626	24.386	18.705	23.205	18.232	30.713
7/14/00	4:00	28.486	15.201	26.473	22.930	27.590	24.362	18.720	23.135	18.243	30.673
7/14/00	5:00	28.492	15.171	26.450	22.936	27.572	24.348	18.725	23.893	18.247	37.895
7/14/00	6:00	28.501	15.178	26.433	23.005	27.676	24.435	18.743	23.617	18.260	31.884
7/14/00	7:00	28.510	15.169	26.422	22.993	27.723	24.353	18.748	23.170	18.275	30.940
7/14/00	8:00	28.516	15.199	26.399	22.996	27.712	24.340	18.763	23.945	18.284	37.445
7/14/00	9:00	28.527	15.169	26.387	23.036	27.786	24.364	18.777	24.219	18.293	37.720
7/14/00	10:00	28.534	15.203	26.378	23.036	27.831	24.346	18.788	23.542	18.295	31.106
7/14/00	11:00	28.543	15.199	26.355	23.013	27.782	24.313	18.794	23.571	18.312	30.863
7/14/00	12:00	28.549	15.196	26.338	23.010	27.739	24.306	18.817	24.414	18.323	37.290
7/14/00	13:00	28.558	15.157	26.327	23.042	27.771	24.267	18.817	24.481	18.319	37.631
7/14/00	14:00	28.565	15.187	26.309	23.028	27.811	24.256	18.823	23.622	18.327	31.049

TABLE D.1 (Cont.)

		Depth (ft BGL)									
Date	Time	SB03	SB05	SB12	SB13	SB14	SB15	SB17	SB19	B12	PWS 70-1
7/14/00	15:00	28.571	15.155	26.286	22.996	27.759	24.218	18.831	23.327	18.329	30.822
7/14/00	16:00	28.578	15.155	26.269	22.967	27.696	24.189	18.837	23.415	18.329	30.722
7/14/00	17:00	28.587	15.152	26.255	22.970	27.660	24.187	18.840	24.138	18.327	38.001
7/14/00	18:00	28.591	15.185	26.252	23.002	27.725	24.196	18.851	23.383	18.334	31.112
7/14/00	19:00	28.598	15.155	26.229	22.984	27.719	24.178	18.854	23.158	18.345	30.805
7/14/00	20:00	28.602	15.162	26.200	22.956	27.674	24.152	18.863	23.046	18.347	30.702
7/14/00	21:00	28.611	15.201	26.191	22.987	27.680	24.169	18.869	23.932	18.353	38.116
7/14/00	22:00	28.615	15.178	26.183	23.025	27.777	24.185	18.880	23.698	18.370	31.146
7/14/00	23:00	28.622	15.215	26.166	23.002	27.766	24.156	18.886	23.479	18.375	30.834
7/15/00	0:00	28.626	15.189	26.148	22.979	27.721	24.134	18.894	23.374	18.381	30.722
7/15/00	1:00	28.633	15.182	26.131	22.967	27.671	24.119	18.897	23.943	18.383	37.551
7/15/00	2:00	28.637	15.182	26.128	23.016	27.716	24.161	18.909	24.234	18.383	37.568
7/15/00	3:00	28.644	15.215	26.119	23.028	27.782	24.143	18.917	23.422	18.394	31.009
7/15/00	4:00	28.648	15.210	26.105	23.010	27.771	24.125	18.929	23.251	18.412	30.797
7/15/00	5:00	28.653	15.173	26.088	22.987	27.719	24.101	18.934	23.158	18.414	30.702
7/15/00	6:00	28.657	15.208	26.073	22.967	27.669	24.083	18.937	23.132	18.414	30.645
7/15/00	7:00	28.662	15.182	26.068	23.008	27.701	24.114	18.954	24.002	18.427	37.462
7/15/00	8:00	28.666	15.176	26.059	23.048	27.800	24.132	18.960	23.386	18.437	31.184
7/15/00	9:00	28.670	15.171	26.065	23.028	27.800	24.107	18.972	23.261	18.446	30.837
7/15/00	10:00	28.675	15.215	26.042	23.054	27.804	24.121	18.980	24.247	18.459	37.493
7/15/00	11:00	28.681	15.206	26.039	23.071	27.886	24.149	18.983	24.127	18.468	31.881
7/15/00	12:00	28.688	15.169	26.027	23.077	27.908	24.127	18.997	23.824	18.476	30.997
7/15/00	13:00	28.692	15.164	26.019	23.048	27.840	24.092	19.000	23.857	18.474	30.802
7/15/00	14:00	28.695	15.189	26.010	23.031	27.762	24.065	19.009	24.154	18.468	37.843
7/15/00	15:00	28.701	15.159	26.007	23.082	27.813	24.101	19.015	24.259	18.472	33.057
7/15/00	16:00	28.706	15.187	26.004	23.079	27.858	24.090	19.026	23.721	18.485	30.986
7/15/00	17:00	28.708	15.187	25.993	23.048	27.809	24.059	19.032	23.478	18.487	30.782
7/15/00	18:00	28.712	15.159	25.978	23.025	27.748	24.037	19.040	23.299	18.487	30.696
7/15/00	19:00	28.714	15.194	25.970	23.033	27.728	24.041	19.040	24.081	18.491	38.001
7/15/00	20:00	28.721	15.176	25.953	23.077	27.811	24.065	19.052	23.370	18.500	31.124
7/15/00	21:00	28.725	15.208	25.947	23.065	27.825	24.070	19.063	23.112	18.520	30.814
7/15/00	22:00	28.728	15.185	25.932	23.039	27.793	24.034	19.066	22.990	18.524	30.716
7/15/00	23:00	28.732	15.201	25.921	23.051	27.780	24.041	19.075	24.309	18.530	37.488
7/16/00	0:00	28.736	15.236	25.921	23.105	27.865	24.085	19.080	23.857	18.539	31.597
7/16/00	1:00	28.739	15.201	25.918	23.085	27.877	24.050	19.083	23.486	18.541	30.917
7/16/00	2:00	28.741	15.201	25.904	23.059	27.825	24.052	19.098	23.364	18.543	30.765
7/16/00	3:00	28.745	15.231	25.895	23.039	27.773	24.015	19.103	23.288	18.550	30.690
7/16/00	4:00	28.747	15.203	25.886	23.042	27.748	24.012	19.109	24.014	18.556	37.252
7/16/00	5:00	28.750	15.201	25.883	23.103	27.845	24.057	19.121	23.839	18.569	32.225
7/16/00	6:00	28.754	15.199	25.878	23.100	27.881	24.043	19.121	23.334	18.573	30.937
7/16/00	7:00	28.756	15.226	25.863	23.071	27.849	24.017	19.135	23.233	18.580	30.776
7/16/00	8:00	28.761	15.192	25.860	23.051	27.795	23.997	19.141	23.575	18.580	36.166
7/16/00	9:00	28.763	15.201	25.863	23.111	27.867	24.057	19.158	24.296	18.612	38.196
7/16/00	10:00	28.765	15.199	25.863	23.120	27.915	24.043	19.155	23.661	18.602	31.092
7/16/00	11:00	28.769	15.196	25.843	23.108	27.922	24.041	19.163	23.393	18.619	30.845
7/16/00	12:00	28.774	15.233	25.829	23.079	27.883	23.992	19.163	23.132	18.625	30.742
7/16/00	13:00	28.774	15.206	25.829	23.094	27.870	23.984	19.166	23.912	18.623	38.147
7/16/00	14:00	28.778	15.238	25.826	23.120	27.935	23.979	19.166	23.157	18.623	31.192
7/16/00	15:00	28.780	15.206	25.823	23.079	27.906	23.933	19.166	22.993	18.623	30.842
7/16/00	16:00	28.783	15.196	25.806	23.054	27.847	23.924	19.166	22.906	18.621	30.722
7/16/00	17:00	28.785	15.226	25.791	23.022	27.808	23.873	19.163	22.826	18.627	30.673

TABLE D.1 (Cont.)

		Depth (ft BGL)									
Date	Time	SB03	SB05	SB12	SB13	SB14	SB15	SB17	SB19	B12	PWS 70-1
7/16/00	18:00	28.787	15.201	25.777	23.010	27.804	23.864	19.163	22.712	18.640	30.645
7/16/00	19:00	28.789	15.206	25.768	23.025	27.804	23.869	19.166	23.757	18.636	38.061
7/16/00	20:00	28.791	15.206	25.780	23.068	27.896	23.906	19.163	23.270	18.638	31.293
7/16/00	21:00	28.794	15.219	25.765	23.062	27.921	23.908	19.169	23.115	18.649	30.851
7/16/00	22:00	28.796	15.215	25.754	23.045	27.892	23.908	19.178	23.066	18.658	30.733
7/16/00	23:00	28.798	15.224	25.754	23.085	27.917	23.948	19.178	23.932	18.671	37.522
7/17/00	0:00	28.800	15.254	25.760	23.126	27.984	23.973	19.186	23.382	18.666	31.385
7/17/00	1:00	28.802	15.224	25.754	23.114	27.973	23.966	19.195	23.152	18.671	30.900
7/17/00	2:00	28.805	15.226	25.754	23.082	27.903	23.933	19.204	23.086	18.664	30.754
7/17/00	3:00	28.807	15.222	25.740	23.065	27.849	23.924	19.204	23.046	18.669	30.685
7/17/00	4:00	28.807	15.222	25.734	23.054	27.813	23.917	19.212	22.999	18.671	30.645
7/17/00	5:00	28.809	15.224	25.725	23.045	27.793	23.915	19.218	22.970	18.679	30.622
7/17/00	6:00	28.813	15.252	25.725	23.082	27.824	23.948	19.221	23.899	18.679	37.493
7/17/00	7:00	28.811	15.252	25.731	23.134	27.933	23.990	19.232	23.234	18.697	31.132
7/17/00	8:00	28.813	15.217	25.725	23.120	27.946	23.979	19.235	23.076	18.703	30.831
7/17/00	9:00	28.818	15.252	25.719	23.108	27.910	23.970	19.238	23.720	18.707	37.714
7/17/00	10:00	28.820	15.229	25.731	23.157	27.966	24.012	19.244	24.134	18.714	38.322
7/17/00	11:00	28.820	15.224	25.731	23.177	28.036	24.021	19.258	23.395	18.716	31.152
7/17/00	12:00	28.822	15.221	25.737	23.154	28.000	24.004	19.264	23.974	18.723	37.195
7/17/00	13:00	28.827	15.249	25.740	23.186	28.014	24.004	19.269	24.700	18.725	38.319
7/17/00	14:00	28.827	15.219	25.742	23.189	28.036	24.032	19.275	23.939	18.725	31.046
7/17/00	15:00	28.829	15.254	25.722	23.157	27.978	24.004	19.284	23.965	18.727	30.837
7/17/00	16:00	28.831	15.217	25.722	23.140	27.930	23.995	19.289	23.918	18.731	30.756
7/17/00	17:00	28.831	15.245	25.705	23.128	27.876	23.979	19.295	23.789	18.735	30.699
7/17/00	18:00	28.833	15.249	25.705	23.172	27.892	24.010	19.304	24.593	18.738	37.556
7/17/00	19:00	28.835	15.226	25.717	23.195	27.966	24.028	19.309	23.796	18.744	31.078
7/17/00	20:00	28.835	15.231	25.705	23.172	27.953	24.010	19.312	23.601	18.751	30.834
7/17/00	21:00	28.838	15.266	25.705	23.209	27.969	24.046	19.321	24.408	18.759	37.617
7/17/00	22:00	28.840	15.247	25.714	23.238	28.057	24.079	19.327	23.800	18.766	31.528
7/17/00	23:00	28.842	15.252	25.711	23.218	28.054	24.057	19.332	23.465	18.770	30.980
7/18/00	0:00	28.844	15.254	25.705	23.206	27.982	24.068	19.350	23.334	18.766	30.825
7/18/00	1:00	28.844	15.254	25.699	23.175	27.924	24.010	19.344	23.284	18.768	30.754
7/18/00	2:00	28.846	15.254	25.694	23.160	27.887	24.001	19.352	23.248	18.777	30.711
7/18/00	3:00	28.844	15.249	25.688	23.149	27.849	23.986	19.358	23.184	18.777	30.673
7/18/00	4:00	28.846	15.277	25.688	23.172	27.854	24.004	19.364	23.988	18.779	37.433
7/18/00	5:00	28.849	15.233	25.694	23.218	27.939	24.034	19.370	23.429	18.781	31.293
7/18/00	6:00	28.851	15.212	25.691	23.195	27.937	24.017	19.375	23.181	18.783	30.863
7/18/00	7:00	28.851	15.201	25.682	23.169	27.894	23.999	19.381	23.102	18.779	30.728
7/18/00	8:00	28.853	15.194	25.676	23.149	27.842	23.975	19.384	23.681	18.764	37.668
7/18/00	9:00	28.853	15.194	25.676	23.186	27.917	24.017	19.387	23.032	18.766	31.238
7/18/00	10:00	28.855	15.187	25.671	23.157	27.905	23.959	19.387	22.684	18.746	30.817
7/18/00	11:00	28.855	15.189	25.659	23.126	27.863	23.917	19.384	22.562	18.740	30.711
7/18/00	12:00	28.857	15.180	25.653	23.079	27.808	23.774	19.381	22.496	18.714	30.647
7/18/00	13:00	28.855	15.210	25.639	23.091	27.799	23.862	19.384	22.450	18.738	30.622
7/18/00	14:00	28.857	15.208	25.622	23.065	27.766	23.827	19.378	22.427	18.733	30.587
7/18/00	15:00	28.857	15.201	25.627	23.045	27.743	23.802	19.372	22.433	18.731	30.561
7/18/00	16:00	28.857	15.164	25.607	23.054	27.754	23.802	19.364	23.339	18.729	37.932
7/18/00	17:00	28.859	15.162	25.607	23.097	27.854	23.822	19.355	22.775	18.729	31.273
7/18/00	18:00	28.860	15.185	25.604	23.077	27.885	23.793	19.341	22.493	18.738	30.791
7/18/00	19:00	28.859	15.157	25.587	23.051	27.858	23.769	19.347	22.384	18.742	30.667
7/18/00	20:00	28.862	15.162	25.576	23.028	27.815	23.745	19.335	22.272	18.738	30.604

TABLE D.1 (Cont.)

		Depth (ft BGL)									
Date	Time	SB03	SB05	SB12	SB13	SB14	SB15	SB17	SB19	B12	PWS 70-1
7/18/00	21:00	28.859	15.187	25.567	23.013	27.784	23.727	19.324	22.172	18.738	30.570
7/18/00	22:00	28.860	15.164	25.555	22.999	27.781	23.718	19.321	22.080	18.746	30.558
7/18/00	23:00	28.859	15.194	25.555	23.022	27.811	23.734	19.307	22.929	18.746	37.416
7/19/00	0:00	28.860	15.169	25.555	23.056	27.917	23.751	19.304	22.280	18.748	31.155
7/19/00	1:00	28.860	15.173	25.550	23.031	27.926	23.723	19.298	22.039	18.751	30.768
7/19/00	2:00	28.862	15.173	25.541	23.008	27.878	23.692	19.289	21.940	18.746	30.647
7/19/00	3:00	28.859	15.175	25.532	22.987	27.851	23.683	19.287	22.494	18.749	30.596
7/19/00	4:00	28.860	15.208	25.527	22.973	27.815	23.659	19.269	22.434	18.744	30.553
7/19/00	5:00	28.862	15.178	25.524	22.990	27.824	23.670	19.267	23.281	18.733	37.327
7/19/00	6:00	28.860	15.208	25.521	23.010	27.901	23.674	19.258	22.558	18.733	30.940
7/19/00	7:00	28.860	15.203	25.509	22.990	27.901	23.652	19.255	22.390	18.738	30.696
7/19/00	8:00	28.860	15.205	25.501	22.970	27.867	23.634	19.246	22.325	18.740	30.607
7/19/00	9:00	28.859	15.173	25.495	22.982	27.878	23.630	19.241	22.275	18.742	42.792
7/19/00	10:00	28.860	15.178	25.506	23.039	28.018	23.636	19.235	22.231	18.748	33.834
7/19/00	11:00	28.862	15.175	25.506	23.059	28.081	23.632	19.224	22.602	18.727	31.996
7/19/00	12:00	28.862	15.176	25.504	23.039	28.111	23.634	19.218	22.333	18.742	31.095
7/19/00	13:00	28.862	15.176	25.492	23.005	28.054	23.610	19.215	22.285	18.742	30.817
7/19/00	14:00	28.859	15.178	25.478	22.976	27.975	23.586			18.733	30.690
7/19/00	15:00	28.862	15.173			27.908	23.568			18.727	30.619
7/19/00	16:00	28.862	15.171				23.457			18.703	30.564
7/19/00	17:00	28.860	15.173				23.559			18.712	37.972
7/19/00	18:00	28.860	15.194				23.561			18.703	30.931
7/19/00	19:00	28.859	15.159				23.289			18.694	30.662
7/19/00	20:00	28.857	15.155				23.517			18.701	30.573
7/19/00	21:00	28.855	15.187				23.495			18.690	30.515
7/19/00	22:00	28.857	15.157				23.491			18.699	36.197
7/19/00	23:00	28.855	15.161				23.519			18.697	38.018
7/20/00	0:00	28.853	15.191				23.508			18.684	30.883
7/20/00	1:00	28.853	15.162				23.484			18.682	30.630
7/20/00	2:00	28.851	15.161				23.495			18.712	30.561
7/20/00	3:00	28.851	15.078				23.404			18.669	30.401
7/20/00	4:00	28.851	15.014				23.272			18.599	30.315
7/20/00	5:00	28.846	14.991				23.179			18.526	30.243
7/20/00	6:00	28.842	14.984				23.161			18.504	30.243
7/20/00	7:00	28.838	14.965				23.207			18.479	37.141
7/20/00	8:00	28.835	14.949				23.254			18.455	30.871
7/20/00	9:00	28.831	14.942				23.230			18.433	30.449
7/20/00	10:00	28.827	14.931				23.194			18.401	30.309
7/20/00	11:00	28.818	14.954				23.194			18.384	36.796
7/20/00	12:00	28.811	14.947				23.212			18.364	
7/20/00	13:00	28.807	14.942				23.185				
7/20/00	14:00		14.905				23.161				

[a] Water levels were collected at 2-min intervals on May 2-11 and July 6-20, 2000. The table shows hourly water levels as samples for these two periods.

Appendix E:

Survey Data

TABLE E.1 Survey Data for Sampling Locations in Adams, Nebraska

Location	Horizontal Location[a] (ft)		Elevation[b] (ft AMSL)	
	Northing	Easting	Representative Ground Surface	Reference
Public Wells				
49-1	303461.61	2831110.61	1256.96	-
64-1	303805.76	2832404.77	1246.36	-
70-1	303412.33	2831117.31	1256.53	1258.48
79-1	304794.82	2831879.21	1249.94	-
Private Wells				
DW01	-	-	-	-
DW02	-	-	-	-
DW03	303829.99	2830221.94	1257.73	1259.00
DW04	-	-	-	-
DW05	303711.91	2830255.95	1259.80	1260.89
IW1	305137.50	2830333.88	1250.66	1253.89
IW2	305062.57	2832870.95	1244.24	1248.36
Monitoring Wells				
MWB12	303534.78	2832167.76	1246.08	1245.48
MWB17	303409.21	2831119.97	1249.18	1248.51
Soil Borings				
SB01	303611.38	2830478.67	1258.11	-
SB02	303857.50	2831597.88	1250.10	-
Cone Penetrometer and Geoprobe Locations				
SB03	303611.69	2830494.45	1257.93	1257.54
SB04	303379.66	2830558.47	1258.92	-
SB05	303100.00	2830565.13	1262.00	1261.60
SB06	303775.78	2830533.41	1255.95	-
SB07	303261.37	2830995.32	1258.03	-
SB08	303761.82	2830798.18	1255.24	-
SB09	303496.75	2830797.21	1256.78	-
SB10	303768.78	2831015.82	1254.38	-
SB11	303613.54	2830555.54	1257.47	-
SB12	304031.06	2830287.73	1246.08	1245.48
SB13	303834.15	2831610.07	1250.61	1250.18
SB14	303059.60	2831360.95	1256.37	1256.08
SB15	304230.86	2831041.78	1252.10	1251.67
SB16	303619.28	2830796.83	1255.48	-
SB17	303807.51	2832432.73	1245.62	1245.24

TABLE E.1 (Cont.)

Location	Horizontal Location[a] (ft)		Elevation[b] (ft AMSL)	
	Northing	Easting	Representative Ground Surface	Reference
Cone Penetrometer and Geoprobe Locations (Cont.)				
SB18	303482.05	2831440.98	1251.66	-
SB19	304683.25	2831786.16	1249.62	1249.36
SB20	303443.40	2830241.82	1263.34	1263.34

[a] Horizontal coordinates are target location centers, not points selected to represent ground elevations. Northings and eastings are Nebraska State Plane Coordinates. Horizontal datum is North American Datum (NAD) 27.

[b] Vertical datum is National Geodetic Vertical Datum (NGVD) 29.

Appendix F:

Groundwater Sample Data

TABLE F.1 Groundwater Samples Collected during the Phase I Field Investigation at Adams, Nebraska

Location	Sample	Depth (ft BGL)	Sample Date	Sample Description
Public Wells				
64-1	ADPW64-1-W-11308	Unk[a] -70	4/12/00	Sample collected after purging at full capacity for 5 min. Sampled from spigot in pump house. Well currently used for construction purposes. Depth from well construction/registration form.
70-1	ADPW70-1-W-11306	Unk -54.15	4/12/00	Sampled from spigot in well house while well in production mode. Flow estimated by water department staff at 88-93 gpm. Depth of well measured at time of sampling.
79-1	ADPW79-1-W-11307	77.6 -105.2	4/12/00	Sampled from spigot in well house while well in production mode. Screen interval from well constuction/registration form.
Domestic Wells				
DW01	ADDW01-W-11309	Unk	4/12/00	Sample from Glen Oosting residence drinking water well, collected from spigot in garden after purging for 5 min at 4 gpm.
DW02	ADDW02-W-11312	Unk	4/13/00	Sample from Dennis Ebbers residence drinking water well, collected from spigot outside house after purging of approximately 12 gal (3 gpm for 4 min).
DW03	ADDW03-W-11313	Unk	4/13/00	Sample from BAP, Inc., construction company drinking water well, collected after purging of approximately 20 gal (4 gpm for 5 min).
DW04	ADDW04-W-11314	Unk	4/13/00	Sample from Eugene Weise drinking water well, collected from spigot inside livestock shed after purging of approximately 30 gal (5 gpm for 6 min).
DW05	ADDW05-W-11315	Unk	4/13/00	Sample from Bud Wingate residence drinking water well, collected after purging of approximately 14 gal (2 gpm for 7 min).
Monitoring Wells				
MWB12	ADMWB12-W-11317	30 -45	4/14/00	Depth to water from top of casing (TOC) = 16.65 ft. Depth of well = 44.65 ft. Sample collected after purging of 76.8 gal (2.4 gpm for 32 min) or approximately 16 well volumes.
MWB17	ADMWB17-W-11318	15 -30	4/14/00	Depth to water from TOC = 19.25 ft. Measured depth of well = 20.16 ft. Silting of well has occurred; well construction form shows depth at 30 ft. Sample collected after purging of 5.2 L by bailing.

TABLE F.1 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Sample Description
Cone Penetrometer and Geoprobe Locations				
SB03	ADSB03-W-11342	32.8 -39.4	4/17/00	Water entering at rate of 0.1 ft per 9 sec.
SB03	ADSB03-W-11343	39.4 -45.9	4/17/00	No description recorded.
SB03	ADSB03-W-11348	45.9 -49.2	4/18/00	Considerable sediment in water.
SB03	ADSB03-W-11341	49.2 -52.48	4/17/00	Water relatively clear, with little sediment. Abundant recovery, with level rising 1 ft every 18 sec. Purged.
SB03	ADSB03-W-11346	52.48 -62.32	4/18/00	Water rising at rate of 0.3 ft per 6 sec.
SB03	ADSB03-W-11349	63.32 -67.24	4/18/00	Water with little suspended sediment. Level rising at rate of 0.1 ft per 5 sec.
SB03	ADSB03-W-11350	67.24 -72.16	4/18/00	Rapid fill at 0.5 ft per 5 sec.
SB04	ADSB04-W-11353	34.44 -41	4/18/00	No description recorded.
SB04	ADSB04-W-11419	41 -45	4/28/00	Very slow recovery: 2.5 ft of water. Bailed sample.
SB04	ADSB04-W-11420	45 -50	4/28/00	No description recorded.
SB04	ADSB04-W-11358	49.2 -59.04	4/20/00	Clear water.
SB05	ADSB05-W-11354	29.64 -42.64	4/19/00	Low water recovery. Sample for metals analysis not collected.
SB06	ADSB06-W-11359	33.8 -40.4	4/20/00	Water entering very slowly (< 2 ft in 3 min). Bailed dry with very slow recharge. Note: A replicate of this sample collected as ADSB06-W-11361 was analyzed for dissolved anions. No sample was collected for metals analysis.
SB06	ADSB06-W-11383	41 -47.2	4/25/00	Return to SB06 sample location to obtain sample at interval now considered important. Water clear with little suspended sediement.
SB06	ADSB06-W-11362	47.5 -54	4/20/00	Rate of water infiltration = 0.1 ft per 10 sec. Bailed dry during sample collection.
SB06	ADSB06-W-11433	54 -59	5/1/00	No description recorded.
SB06	ADSB06-W-11363	59 -65.6	4/20/00	Deepest sand within section at SB06.
SB07	ADSB07-W-11366	31.8 -37.7	4/20/00	Slow-recharge zone. Sample collected for field measurements and organic analysis.
SB07	ADSB07-W-11367	31.8 -37.7	4/20/00	Slow recharge; rods left in place overnight to accumulate sufficient water for inorganic and tritium analyses. Five feet of water in the hole after 14 hr.
SB08	ADSB08-W-11436	33.2 -37.8	5/1/00	No description recorded.
SB08	ADSB08-W-11369	32.8 -39.36	4/21/00	No description recorded.
SB08	ADSB08-W-11440	37.8 -42.8	5/1/00	Slow water recovery.

TABLE F.1 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Sample Description
Cone Penetrometer and Geoprobe Locations (Cont.)				
SB08	ADSB08-W-11371	42.6 -49.2	4/21/00	Three feet of water immediately. Water clearer than shallower sample. Very, very slow infiltration of water into the hole.
SB08	ADSB08-W-11438	49.2 -52.5	5/1/00	Poor water, slow recovery.
SB08	ADSB08-W-11373	52.48 -63.2	4/24/00	Purged, relatively clear water.
SB08	ADSB08-W-11439	62.3 -66	5/1/00	No description recorded.
SB09	ADSB09-W-11425	27 -31	4/29/00	Slow recovery. Water very dark brown with heavy sediment. Purged prior to sampling.
SB09	ADSB09-W-11427	31 -34	4/28/00	Very slow recovery of water from this zone. Water carrying much suspended sediment. Collected only for VOC analysis because of low volume available.
SB09	ADSB09-W-11378	33.5 -39.7	4/24/00	Slightly milky in appearance. Good water recovery. Used Watera pump microflow system.
SB09	ADSB09-W-11380	40.3 -42.6	4/25/00	Low water recovery.
SB09	ADSB09-W-11428	45 -48.5	4/29/00	No description recorded.
SB09	ADSB09-W-11426	48.5 -52	4/29/00	Dark brown water with much suspended sediment. Purged-bailed.
SB09	ADSB09-W-11382	44.28 -52.5	4/25/00	Second push at sample location after low water recovery during first attempt. Purged with Watera pump. Water relatively clear. Low suspended sediments.
SB10	ADSB10-W-11385	29.08 -36.08	4/25/00	Very silty brown water. Raining hard just before sampling. Moderate recovery rate. Uppermost sand unit. (Research sample ADSB10-W-11386 collected for organic analysis by using Watera pump not reported.)
SB10	ADSB10-W-11387	37 -42.3	4/25/00	Sample from low tip-sleeve zone on ECPT sensor log. Probably clayey or silty, very fine grained sand. Sediment in sample settled quickly. Heavy rain prior to and during sampling. (Research sample ADSB10-W-11388 collected for organic analysis by using Watera pump not reported.)
SB10	ADSB10-W-11391	42.3 -48	4/25/00	Second sand unit with high tip-sleeve.
SB10	ADSB10-W-11389	48 -52.8	4/25/00	Cloudy sample with much suspended sediment, collected from low tip-sleeve zone on ECPT sensor log.
SB10	ADSB10-W-11392	53.5 -60.5	4/26/00	Collected from sand overlying basal sand. Water has some suspended sediment. No additional rain overnight. Purged with Watera pump.
SB10	ADSB10-W-11390	60.5 -67.7	4/25/00	Collected at zone of highest tip measurement; basal sand unit.
SB11	ADSB11-W-11393	30.17 -32.8	4/26/00	Possible perched upper aquifer interval.
SB11	ADSB11-W-11399	34.4 -41.9	4/26/00	Collected from interval for field measurements and inorganic analysis by using Watera pump.
SB11	ADSB11-W-11400	34.4 -41.9	4/26/00	Collected from interval by bailing for organic analysis.
SB11	ADSB11-W-11394	41.9 -48.7	4/26/00	Collected from interval for field measurements and inorganic analysis by using Watera pump.

TABLE F.1 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Sample Description
Cone Penetrometer and Geoprobe Locations (Cont.)				
SB11	ADSB11-W-11395	41.9 -48.7	4/26/00	Collected from interval by bailing for organic analysis.
SB11	ADSB11-W-11402	48.7 -54.5	4/26/00	Collected from interval for field measurements and inorganic analysis by using Watera pump.
SB11	ADSB11-W-11403	48.7 -54.5	4/26/00	Collected from interval by bailing for organic analysis.
SB11	ADSB11-W-11396	54.5 -59.3	4/26/00	No description recorded.
SB11	ADSB11-W-11404	59.3 -65.9	4/26/00	Collected from interval for field measurements and anions analysis by using Watera pump. Analysis for metals not conducted.
SB11	ADSB11-W-11405	59.3 -65.9	4/26/00	Collected from interval by bailing for organic analysis.
SB12	ADSB12-W-11398	29.6 -39.3	4/26/00	Sample collected from piezometer installed by using the Geoprobe, with the screen at the indicated depth. Sample collected after purging of two well volumes.
SB13	ADSB13-W-11412	25.9 -30.9	4/27/00	Good water recovery; water above screen immediately. Turbid with suspended sediment. Bailed sample.
SB13	ADSB13-W-11406	25.9 -34.9	4/27/00	Sample collected by bailing after purging. Much suspended sediment.
SB13	ADSB13-W-11413	30.9 -34.9	4/27/00	Recovery fair to moderate. Water slightly reddish in color (iron oxide?), turbid with suspended sediment.
SB13	ADSB13-W-11408	34.9 -42.3	4/27/00	Purged prior to sampling.
SB13	ADSB13-W-11407	42.3 -51.5	4/27/00	Purged prior to sampling. Water relatively clear.
SB13	ADSB13-W-11409	51.5 -60.5	4/24/00	No description recorded.
SB13	ADSB13-W-11410	60.5 -71.3	4/27/00	Very low water recovery. Sample collected for VOC analysis only.
SB14	ADSB14-W-11414	31 -36	4/28/00	Moderate water recovery. Collected from interval for field measurements and inorganic and tritium analyses by using Watera pump.
SB14	ADSB14-W-11418	31 -36	4/28/00	Collected from interval by bailing for organic analysis.
SB15	ADSB15-W-11417	33.3 -43.3	4/28/00	Sample collected from piezometer installed by using the Geoprobe, with the screen at the indicated depth. Turbid water with high sediment content.
SB16	ADSB16-W-11432	28.2 -33.2	4/30/00	Very dark, sediment-laden water. Sampler questions validity of sample for field measurements because of rain and turbidity of sample.
SB16	ADSB16-W-11424	33.2 -38.2	4/30/00	No description recorded.
SB16	ADSB16-W-11421	38.2 -43.2	4/29/00	Immediately 4 ft of water. Rising at 0.1 ft/min. Purged prior to sampling.
SB16	ADSB16-W-11429	43.2 -48.2	4/30/00	Little suspended sediment.

TABLE F.1 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Sample Description
Cone Penetrometer and Geoprobe Locations (Cont.)				
SB16	ADSB16-W-11422	48.2 -53.2	4/29/00	Good water recovery.
SB16	ADSB16-W-11430	53.2 -58.2	4/30/00	No description recorded.
SB16	ADSB16-W-11423	58.2 -61	4/29/00	Unit overlying bedrock. Purged prior to sampling.
SB18	ADSB18-W-11445	22.96 -27.96	5/2/00	No description recorded.
SB18	ADSB18-W-11450	27.96 -32.96	5/2/00	Poor water recovery from this zone, even with Watera pump. Bailed dry several times during collection of VOC samples.
SB18	ADSB18-W-11446	32.96 -37.96	5/2/00	Turbid water, dark brown.
SB18	ADSB18-W-11452	37.96 -42.96	5/2/00	Very slow recovery.
SB18	ADSB18-W-11447	42.96 -47.96	5/2/00	Brown water. Abundant water, 2.5 ft.
SB18	ADSB18-W-11448	47.96 -52.96	5/2/00	No description recorded.
SB18	ADSB18-W-11453	52.96 -57.96	5/2/00	Reddish brown water. Low recovery. Moderate sediment.
SB18	ADSB18-W-11449	57.96 -62.96	5/2/00	No description recorded.
SB18	ADSB18-W-11455	62.96 -67.96	5/2/00	Very clear water with a little suspended sediment. Average to good recovery.
SB18	ADSB18-W-11444	66.1 -71.1	5/2/00	Abundant water recovery, relatively clear water.

[a] Unk, sample depth unknown.

TABLE F.2 Field Measurements Made during Collection of Groundwater Samples at Adams, Nebraska

Location	Sample	Depth (ft BGL)	Sample Date	Temperature (°C)	pH	Conductivity (µS/cm)	Concentration (mg/L) Alkalinity	Ammonia-N	Dissolved Oxygen	Iron	Nitrate
Public Wells											
64-1	ADPW64-1-W-11308	Unk[a] -70	4/12/00	NA[b]	6.36	771	125	NA	NA	NA	50
70-1	ADPW70-1-W-11306	Unk -54.15	4/12/00	16.7	6.47	578	150	NA	NA	NA	50
79-1	ADPW79-1-W-11307	77.6 -105.2	4/12/00	15.3	6.34	522	125	NA	NA	NA	60
Domestic Wells											
DW01	ADDW01-W-11309	Unk	4/12/00	NA	6.97	753	250	NA	NA	NA	40
DW02	ADDW02-W-11312	Unk	4/13/00	12.3	7.1	1734	200	NA	NA	NA	0
DW03	ADDW03-W-11313	Unk	4/13/00	13.6	6.78	671	175	NA	NA	NA	5
DW04	ADDW04-W-11314	Unk	4/13/00	13.2	6.93	476	125	NA	NA	NA	3
DW05	ADDW05-W-11315	Unk	4/13/00	11.2	6.87	799	200	NA	NA	NA	10
Monitoring Wells											
MWB12	ADMWB12-W-11317	30 -45	4/14/00	13.9	6.64	688	175	NA	NA	NA	10
MWB17	ADMWB17-W-11318	15 -30	4/14/00	18.2	6.08	287	80	NA	NA	NA	< 0.5
Cone Penetrometer and Geoprobe Locations											
SB03	ADSB03-W-11342	32.8 -39.4	4/17/00	14.8	6.76	658	125	0	NA	0	25
SB03	ADSB03-W-11343	39.4 -45.9	4/17/00	15.4	6.84	941	200	0	NA	0	35
SB03	ADSB03-W-11348	45.9 -49.2	4/18/00	14.6	6.89	872	205	0	NA	0	35
SB03	ADSB03-W-11341	49.2 -52.48	4/17/00	14	6.8	865	250	0	NA	NA	25
SB03	ADSB03-W-11346	52.48 -62.32	4/18/00	13.4	7.03	895	225	0	NA	0	30
SB03	ADSB03-W-11349	63.32 -67.24	4/18/00	14.8	7.01	877	230	0	NA	0	30
SB03	ADSB03-W-11350	67.24 -72.16	4/18/00	15.5	7.06	815	250	0	NA	0	27
SB04	ADSB04-W-11353	34.44 -41	4/18/00	17.6	7	666	135	5	NA	0	25
SB04	ADSB04-W-11419	41 -45	4/28/00	16.9	7.17	693	190	NA	NA	1	25
SB04	ADSB04-W-11420	45 -50	4/28/00	16.2	7.12	619	175	NA	NA	1	10
SB04	ADSB04-W-11358	49.2 -59.04	4/20/00	14.3	7.73	701	250	0	NA	1.5	0

TABLE F.2 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Temperature (°C)	pH	Conductivity (µS/cm)	Concentration (mg/L) Alkalinity	Ammonia-N	Dissolved Oxygen	Iron	Nitrate
Cone Penetrometer and Geoprobe Locations (Cont.)											
SB05	ADSB05-W-11354	29.64 -42.64	4/19/00	17	7.72	735	285	NA	NA	NA	0
SB06	ADSB06-W-11359	33.8 -40.4	4/20/00	14.3	7	764	260	0	NA	0	27
SB06	ADSB06-W-11383	41 -47.2	4/25/00	16	6.99	820	200	0	NA	0	25
SB06	ADSB06-W-11362	47.5 -54	4/20/00	14.3	6.99	836	250	0	NA	1	30
SB06	ADSB06-W-11433	54 -59	5/1/00	14.1	7.16	851	250	NA	NA	0	10
SB06	ADSB06-W-11363	59 -65.6	4/20/00	14.1	7.13	849	220	0	NA	1	30
SB07	ADSB07-W-11366	31.8 -37.7	4/20/00	15.7	6.95	663	200	NA	NA	1	10
SB08	ADSB08-W-11436	33.2 -37.8	5/1/00	14.8	6.51	335	120	NA	NA	1	3
SB08	ADSB08-W-11369	32.8 -39.36	4/21/00	16	6.6	447	115	0	NA	3	10
SB08	ADSB08-W-11440	37.8 -42.8	5/1/00	15.4	6.88	740	250	NA	NA	0	7.5
SB08	ADSB08-W-11371	42.6 -49.2	4/21/00	17.3	7.1	843	180	NA	NA	0	25
SB08	ADSB08-W-11438	49.2 -52.5	5/1/00	14.7	6.94	813	345	NA	NA	1.5	10
SB08	ADSB08-W-11373	52.48 -63.2	4/24/00	14.9	7	836	175	0	NA	0	25
SB08	ADSB08-W-11439	62.3 -66	5/1/00	14.7	7.14	753	175	NA	NA	0	10
SB09	ADSB09-W-11425	27 -31	4/29/00	17	6.95	414	120	NA	NA	0	25
SB09	ADSB09-W-11427	31 -34	4/28/00	19.7	7.22	524	150	NA	NA	0	15
SB09	ADSB09-W-11378	33.5 -39.7	4/24/00	18.9	6.83	559	160	NA	NA	0	25
SB09	ADSB09-W-11380	40.3 -42.6	4/25/00	14.2	6.74	535	125	0	NA	2	25
SB09	ADSB09-W-11428	45 -48.5	4/29/00	18.4	7.04	596	160	NA	NA	2.5	25
SB09	ADSB09-W-11426	48.5 -52	4/29/00	16.7	7.21	699	250	NA	NA	1	10
SB09	ADSB09-W-11382	44.28 -52.5	4/25/00	14.4	6.81	563	105	NA	NA	1.5	17
SB10	ADSB10-W-11385	29.08 -36.08	4/25/00	17.2	6.79	430	125	0	NA	1	10
SB10	ADSB10-W-11387	37 -42.3	4/25/00	16.4	6.76	650	145	NA	NA	0	25
SB10	ADSB10-W-11391	42.3 -48	4/25/00	16.7	6.93	692	210	NA	NA	0	25
SB10	ADSB10-W-11389	48 -52.8	4/25/00	16.3	7.13	758	175	0	NA	1	27
SB10	ADSB10-W-11392	53.5 -60.5	4/26/00	13.7	7.15	863	175	0	NA	1	25
SB10	ADSB10-W-11390	60.5 -67.7	4/25/00	16.5	7.15	832	200	0	NA	0	35

TABLE F.2 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Temperature (°C)	pH	Conductivity (µS/cm)	Concentration (mg/L) Alkalinity	Ammonia-N	Dissolved Oxygen	Iron	Nitrate
Cone Penetrometer and Geoprobe Locations (Cont.)											
SB11	ADSB11-W-11393	30.17 -32.8	4/26/00	15	6.29	347	80	0	NA	0	25
SB11	ADSB11-W-11399	34.4 -41.9	4/26/00	18.5	6.81	697	200	NA	NA	1	25
SB11	ADSB11-W-11394	41.9 -48.7	4/26/00	17.9	6.92	858	200	0	NA	1	25
SB11	ADSB11-W-11402	48.7 -54.5	4/26/00	17.2	6.98	871	245	NA	NA	1	35
SB11	ADSB11-W-11396	54.5 -59.3	4/26/00	17.6	6.98	882	250	NA	NA	0	50
SB11	ADSB11-W-11404	59.3 -65.9	4/26/00	18.2	7.08	860	180	NA	NA	0	35
SB12	ADSB12-W-11398	29.6 -39.3	4/26/00	18.4	6.49	1165	250	NA	NA	2	45
SB13	ADSB13-W-11412	25.9 -30.9	4/27/00	14.5	6.78	574	80	NA	NA	0	50
SB13	ADSB13-W-11406	25.9 -34.9	4/27/00	13.7	6.75	536	125	NA	NA	0	50
SB13	ADSB13-W-11413	30.9 -34.9	4/27/00	15.2	7.01	546	135	NA	NA	0	20
SB13	ADSB13-W-11408	34.9 -42.3	4/27/00	15.9	6.87	517	135	NA	NA	1	25
SB13	ADSB13-W-11407	42.3 -51.5	4/27/00	13.9	6.92	654	120	NA	NA	1	35
SB13	ADSB13-W-11409	51.5 -60.5	4/24/00	15.5	6.92	783	200	NA	NA	2	27
SB13	ADSB13-W-11410	60.5 -71.3	4/27/00	16.1	7.13	771	200	NA	NA	NA	50
SB14	ADSB14-W-11414	31 -36	4/28/00	16.2	7.07	785	185	NA	NA	1	10
SB15	ADSB15-W-11417	33.3 -43.3	4/28/00	8.13	6.72	792	175	NA	NA	2.5	75
SB16	ADSB16-W-11432	28.2 -33.2	4/30/00	16.5	6.65	353	NA	NA	NA	0	10
SB16	ADSB16-W-11424	33.2 -38.2	4/30/00	15	6.84	763	200	NA	NA	3	50
SB16	ADSB16-W-11421	38.2 -43.2	4/29/00	16.9	6.85	919	190	NA	NA	0	50
SB16	ADSB16-W-11429	43.2 -48.2	4/30/00	15.5	6.99	1024	200	NA	NA	2	50
SB16	ADSB16-W-11422	48.2 -53.2	4/29/00	15.9	6.86	990	240	NA	NA	0	50
SB16	ADSB16-W-11430	53.2 -58.2	4/30/00	16.3	7.14	949	185	NA	NA	0	10
SB16	ADSB16-W-11423	58.2 -61	4/29/00	15.7	7.18	789	190	0	NA	2	25

TABLE F.2 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Temperature (°C)	pH	Conductivity (μS/cm)	Concentration (mg/L) Alkalinity	Ammonia-N	Dissolved Oxygen	Iron	Nitrate
Cone Penetrometer and Geoprobe Locations (Cont.)											
SB18	ADSB18-W-11445	22.96 -27.96	5/2/00	15.8	6.25	439	150	NA	NA	0	0
SB18	ADSB18-W-11450	27.96 -32.96	5/2/00	22	7.21	643	180	NA	NA	0	7.5
SB18	ADSB18-W-11446	32.96 -37.96	5/2/00	18.3	6.9	591	170	NA	NA	0	2.5
SB18	ADSB18-W-11452	37.96 -42.96	5/2/00	19.8	6.89	539	150	NA	NA	3	5
SB18	ADSB18-W-11447	42.96 -47.96	5/2/00	17	6.61	525	NA	NA	NA	0	5
SB18	ADSB18-W-11448	47.96 -52.96	5/2/00	19.3	6.66	537	165	NA	NA	1	10
SB18	ADSB18-W-11453	52.96 -57.96	5/2/00	18.3	7.04	814	120	NA	NA	1	10
SB18	ADSB18-W-11449	57.96 -62.96	5/2/00	18	6.98	935	275	NA	NA	0	13
SB18	ADSB18-W-11455	62.96 -67.96	5/2/00	17.8	7.1	918	225	NA	NA	0	7.5
SB18	ADSB18-W-11444	66.1 -71.1	5/2/00	15.7	7.13	827	190	NA	NA	0	10

[a] Unk, depth unknown.

[b] NA, not applicable.

TABLE F.3 Results of Organic Analyses on Groundwater Samples Collected at Adams, Nebraska

				Concentration (μg/L)	
Location	Sample	Depth (ft BGL)	Sample Date	Carbon Tetrachloride	Chloroform
Public Wells					
64-1	ADPW64-1-W-11308	Unk[a]-70	4/12/00	< 5[b]	ND[c]
70-1	ADPW70-1-W-11306	Unk-54.15	4/12/00	< 5	ND
79-1	ADPW79-1-W-11307	77.6-105.2	4/12/00	ND	ND
Domestic Wells					
DW01	ADDW01-W-11309	Unk	4/12/00	ND	ND
DW02	ADDW02-W-11312	Unk	4/13/00	ND	ND
DW03	ADDW03-W-11313	Unk	4/13/00	ND	ND
DW04	ADDW04-W-11314	Unk	4/13/00	ND	ND
DW05	ADDW05-W-11315	Unk	4/13/00	ND	ND
Monitoring Wells					
MWB12	ADMWB12-W-11317	30-45	4/14/00	11	< 5
MWB17	ADMWB17-W-11318	15-30	4/14/00	ND	ND
Cone Penetrometer and Geoprobe Locations					
SB03	ADSB03-W-11342	32.8-39.4	4/17/00	56	13
SB03	ADSB03-W-11343	39.4-45.9	4/17/00	ND	ND
SB03	ADSB03-W-11348	45.9-49.2	4/18/00	ND	ND
SB03	ADSB03-W-11341	49.2-52.48	4/17/00	ND	ND
SB03	ADSB03-W-11346	52.48-62.32	4/18/00	ND	ND
SB03	ADSB03-W-11349	63.32-67.24	4/18/00	ND	ND
SB03	ADSB03-W-11350	67.24-72.16	4/18/00	ND	ND
SB04	ADSB04-W-11353	34.44-41	4/18/00	ND	ND
SB04	ADSB04-W-11419	41-45	4/28/00	ND	ND
SB04	ADSB04-W-11420	45-50	4/28/00	ND	ND
SB04	ADSB04-W-11358	49.2-59.04	4/20/00	ND	ND
SB05	ADSB05-W-11354	29.64-42.64	4/19/00	ND	ND
SB06	ADSB06-W-11359	33.8-40.4	4/20/00	ND	ND
SB06	ADSB06-W-11383	41-47.2	4/25/00	ND	ND
SB06	ADSB06-W-11362	47.5-54	4/20/00	ND	ND
SB06	ADSB06-W-11433	54-59	5/1/00	ND	ND
SB06	ADSB06-W-11363	59-65.6	4/20/00	ND	ND
SB07	ADSB07-W-11366	31.8-37.7	4/20/00	ND	ND

TABLE F.3 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Concentration (μg/L) Carbon Tetrachloride	Chloroform
Cone Penetrometer and Geoprobe Locations (Cont.)					
SB08	ADSB08-W-11436	33.2 -37.8	5/1/00	ND	ND
SB08	ADSB08-W-11369	32.8 -39.36	4/21/00	< 5	ND
SB08	ADSB08-W-11440	37.8 -42.8	5/1/00	ND	ND
SB08	ADSB08-W-11371	42.6 -49.2	4/21/00	ND	ND
SB08	ADSB08-W-11438	49.2 -52.5	5/1/00	ND	ND
SB08	ADSB08-W-11373	52.48 -63.2	4/24/00	ND	ND
SB08	ADSB08-W-11439	62.3 -66	5/1/00	ND	ND
SB09	ADSB09-W-11425	27 -31	4/29/00	< 5	ND
SB09	ADSB09-W-11427	31 -34	4/28/00	< 5	< 5
SB09	ADSB09-W-11378	33.5 -39.7	4/24/00	ND	ND
SB09	ADSB09-W-11380	40.3 -42.6	4/25/00	ND	ND
SB09	ADSB09-W-11428	45 -48.5	4/29/00	ND	ND
SB09	ADSB09-W-11426	48.5 -52	4/29/00	< 5	ND
SB09	ADSB09-W-11382	44.28 -52.5	4/25/00	< 5	ND
SB10	ADSB10-W-11385	29.08 -36.08	4/25/00	ND	ND
SB10	ADSB10-W-11387	37 -42.3	4/25/00	ND	ND
SB10	ADSB10-W-11391	42.3 -48	4/25/00	ND	ND
SB10	ADSB10-W-11389	48 -52.8	4/25/00	ND	ND
SB10	ADSB10-W-11392	53.5 -60.5	4/26/00	ND	ND
SB10	ADSB10-W-11390	60.5 -67.7	4/25/00	ND	ND
SB11	ADSB11-W-11393	30.17 -32.8	4/26/00	18	20
SB11	ADSB11-W-11400	34.4 -41.9	4/26/00	59	14
SB11	ADSB11-W-11395	41.9 -48.7	4/26/00	ND	ND
SB11	ADSB11-W-11403	48.7 -54.5	4/26/00	ND	ND
SB11	ADSB11-W-11396	54.5 -59.3	4/26/00	ND	ND
SB11	ADSB11-W-11405	59.3 -65.9	4/26/00	ND	ND
SB12	ADSB12-W-11398	29.6 -39.3	4/26/00	ND	ND
SB13	ADSB13-W-11412	25.9 -30.9	4/27/00	ND	ND
SB13	ADSB13-W-11406	25.9 -34.9	4/27/00	ND	ND
SB13	ADSB13-W-11413	30.9 -34.9	4/27/00	ND	ND
SB13	ADSB13-W-11408	34.9 -42.3	4/27/00	ND	ND
SB13	ADSB13-W-11407	42.3 -51.5	4/27/00	ND	ND
SB13	ADSB13-W-11409	51.5 -60.5	4/24/00	< 5	ND
SB13	ADSB13-W-11410	60.5 -71.3	4/27/00	< 5	ND
SB14	ADSB14-W-11418	31 -36	4/28/00	ND	ND
SB15	ADSB15-W-11417	33.3 -43.3	4/28/00	ND	ND

TABLE F.3 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Concentration (μg/L) Carbon Tetrachloride	Chloroform
Cone Penetrometer and Geoprobe Locations (Cont.)					
SB16	ADSB16-W-11432	28.2 -33.2	4/30/00	ND	ND
SB16	ADSB16-W-11424	33.2 -38.2	4/30/00	32	7.7
SB16	ADSB16-W-11421	38.2 -43.2	4/29/00	< 5	ND
SB16	ADSB16-W-11429	43.2 -48.2	4/30/00	ND	ND
SB16	ADSB16-W-11422	48.2 -53.2	4/29/00	ND	ND
SB16	ADSB16-W-11430	53.2 -58.2	4/30/00	ND	ND
SB16	ADSB16-W-11423	58.2 -61	4/29/00	ND	ND
SB18	ADSB18-W-11445	22.96 -27.96	5/2/00	ND	ND
SB18	ADSB18-W-11450	27.96 -32.96	5/2/00	ND	ND
SB18	ADSB18-W-11446	32.96 -37.96	5/2/00	ND	ND
SB18	ADSB18-W-11452	37.96 -42.96	5/2/00	ND	ND
SB18	ADSB18-W-11447	42.96 -47.96	5/2/00	< 5	ND
SB18	ADSB18-W-11448	47.96 -52.96	5/2/00	< 5	ND
SB18	ADSB18-W-11453	52.96 -57.96	5/2/00	< 5	ND
SB18	ADSB18-W-11449	57.96 -62.96	5/2/00	< 5	ND
SB18	ADSB18-W-11455	62.96 -67.96	5/2/00	< 5	ND
SB18	ADSB18-W-11444	66.1 -71.1	5/2/00	ND	ND

[a] Unk, unknown depth.

[b] < 5, not detected above the EPA CLP quantitation limit of 5 μg/L.

[a] ND, not detected above the EPA Method 524.2 (purge-and-trap method) quantitation limit of 1 μg/L.

TABLE F.4 Results of Inorganic Analyses on Groundwater Samples Collected at Adams, Nebraska

Location	Sample	Depth (ft BGL)	Sample Date	Concentration (μg/L) Aluminum	Ammonia Nitrogen	Calcium	Chloride	Iron	Magnesium	Manganese	Nitrate
Public Wells											
64-1	ADPW64-1-W-11308	Unk[a] -70	4/12/00	< 200	40	101000	70900	< 100	20500	< 15	15000
70-1	ADPW70-1-W-11306	Unk -54.15	4/12/00	< 200	50	83400	16100	< 100	15000	< 15	8500
79-1	ADPW79-1-W-11307	77.6 -105.2	4/12/00	< 200	40	72300	12500	< 100	14800	< 15	16300
Domestic Wells											
DW01	ADDW01-W-11309	Unk	4/12/00	< 200	40	125000	13600	< 100	17700	< 15	8200
DW02	ADDW02-W-11312	Unk	4/13/00	< 200	920	270000	13700	< 100	80700	109	< 200
DW03	ADDW03-W-11313	Unk	4/13/00	< 200	100	91300	19300	< 100	15100	< 15	11600
DW04	ADDW04-W-11314	Unk	4/13/00	< 200	< 30	63300	5400	< 100	11900	< 15	5000
DW05	ADDW05-W-11315	Unk	4/13/00	< 200	< 30	108000	19600	< 100	17300	< 15	13300
Monitoring Wells											
MWB12	ADMWB12-W-11317	30 -45	4/14/00	< 200	30	93600	27500	< 100	18000	< 15	16000
MWB17	ADMWB17-W-11318	15 -30	4/14/00	< 200	40	38400	20900	103	9940	60.1	770
Cone Penetrometer and Geoprobe Locations											
SB03	ADSB03-W-11342	32.8 -39.4	4/17/00	< 200	NA[b]	77800	22100	< 100	16000	171	15200
SB03	ADSB03-W-11343	39.4 -45.9	4/17/00	< 200	NA	123000	41700	< 100	19800	260	22800
SB03	ADSB03-W-11348	45.9 -49.2	4/18/00	< 200	NA	114000	26600	< 100	17500	174	18100
SB03	ADSB03-W-11341	49.2 -52.48	4/17/00	< 200	NA	114000	19000	< 100	17300	161	16000
SB03	ADSB03-W-11346	52.48 -62.32	4/18/00	< 200	NA	115000	20800	< 100	18200	979	15900
SB03	ADSB03-W-11349	63.32 -67.24	4/18/00	< 200	NA	110000	22600	< 100	16700	392	14200
SB03	ADSB03-W-11350	67.24 -72.16	4/18/00	< 200	NA	118000	20800	< 100	18600	652	13000
SB04	ADSB04-W-11353	34.44 -41	4/18/00	< 200	NA	92200	28200	< 100	15700	192	9000
SB04	ADSB04-W-11419	41 -45	4/28/00	< 200	NA	85900	26100	< 100	15000	1060	9700
SB04	ADSB04-W-11420	45 -50	4/28/00	< 200	NA	87200	20800	< 100	15800	1030	6600
SB04	ADSB04-W-11358	49.2 -59.04	4/20/00	< 200	NA	99200	12000	< 100	18100	762	700

TABLE F.4 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Concentration (μg/L) Aluminum	Ammonia Nitrogen	Calcium	Chloride	Iron	Magnesium	Manganese	Nitrate
Cone Penetrometer and Geoprobe Locations (Cont.)											
SB05	ADSB05-W-11354	29.64 -42.64	4/19/00	NA	NA	NA	20800	NA	NA	NA	210
SB06	ADSB06-W-11361[c]	33.8 -40.4	4/20/00	NA	NA	NA	23600	NA	NA	NA	14700
SB06	ADSB06-W-11383	41 -47.2	4/25/00	< 200	NA	99900	26100	< 100	17900	293	14700
SB06	ADSB06-W-11362	47.5 -54	4/20/00	< 200	NA	108000	26300	< 100	18100	335	14400
SB06	ADSB06-W-11433	54 -59	5/1/00	< 200	NA	112000	23000	< 100	19700	640	14900
SB06	ADSB06-W-11363	59 -65.6	4/20/00	< 200	NA	109000	102000	< 100	18600	1030	13300
SB07	ADSB07-W-11367[d]	31.8 -37.7	4/21/00	< 200	NA	96200	16500	116	17100	1080	2700
SB08	ADSB08-W-11436	33.2 -37.8	5/1/00	< 200	NA	42800	6500	< 100	9230	93.6	5400
SB08	ADSB08-W-11369	32.8 -39.36	4/21/00	< 200	NA	90400	9400	< 100	12300	255	7500
SB08	ADSB08-W-11440	37.8 -42.8	5/1/00	< 200	NA	92400	21200	< 100	17500	277	13400
SB08	ADSB08-W-11371	42.6 -49.2	4/21/00	< 200	NA	103000	23800	< 100	19100	418	14900
SB08	ADSB08-W-11438	49.2 -52.5	5/1/00	< 200	NA	108000	22600	< 100	20200	287	15000
SB08	ADSB08-W-11373	52.48 -63.2	4/24/00	< 200	NA	88000	18700	< 100	18000	261	13400
SB08	ADSB08-W-11439	62.3 -66	5/1/00	< 200	NA	95400	14400	< 100	17200	382	13900
SB09	ADSB09-W-11425	27 -31	4/29/00	< 200	NA	49400	4400	< 100	11900	756	11800
SB09	ADSB09-W-11427[e]	31 -34	4/28/00	NA	NA	NA	NA	NA	NA	NA	NA
SB09	ADSB09-W-11378	33.5 -39.7	4/24/00	< 200	NA	82600	34500	818	12900	59.4	8100
SB09	ADSB09-W-11380	40.3 -42.6	4/25/00	< 200	NA	71600	23300	< 100	13500	43.1	8000
SB09	ADSB09-W-11428	45 -48.5	4/29/00	< 200	NA	76500	24800	< 100	13900	402	10000
SB09	ADSB09-W-11426	48.5 -52	4/29/00	< 200	NA	102000	27700	< 100	17500	908	9600
SB09	ADSB09-W-11382	44.28 -52.5	4/25/00	< 200	NA	74000	21200	< 100	12900	401	9800
SB10	ADSB10-W-11385	29.08 -36.08	4/25/00	< 200	NA	57400	11000	< 100	11200	162	9200
SB10	ADSB10-W-11387	37 -42.3	4/25/00	< 200	NA	85800	16600	< 100	16600	107	12400
SB10	ADSB10-W-11391	42.3 -48	4/25/00	< 200	NA	93100	13500	< 100	16000	258	14000

TABLE F.4 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Concentration (μg/L) Aluminum	Ammonia Nitrogen	Calcium	Chloride	Iron	Magnesium	Manganese	Nitrate
Cone Penetrometer and Geoprobe Locations (Cont.)											
SB10	ADSB10-W-11389	48 -52.8	4/25/00	< 200	NA	102000	14400	< 100	17200	865	19200
SB10	ADSB10-W-11392	53.5 -60.5	4/26/00	< 200	NA	103000	23800	< 100	17600	586	21500
SB10	ADSB10-W-11390	60.5 -67.7	4/25/00	< 200	NA	112000	22300	< 100	18000	635	21700
SB11	ADSB11-W-11393	30.17 -32.8	4/26/00	< 200	NA	40500	9200	< 100	10400	98.4	10900
SB11	ADSB11-W-11399[f]	34.4 -41.9	4/26/00	< 200	NA	89100	26200	< 100	17900	166	16300
SB11	ADSB11-W-11394[g]	41.9 -48.7	4/26/00	< 200	NA	116000	23000	< 100	16900	105	15800
SB11	ADSB11-W-11402[h]	48.7 -54.5	4/26/00	< 200	NA	120000	27800	< 100	18700	253	18400
SB11	ADSB11-W-11396	54.5 -59.3	4/26/00	< 200	NA	119000	22800	< 100	18800	134	19300
SB11	ADSB11-W-11404[i]	59.3 -65.9	4/26/00	NA	NA	NA	26000	NA	NA	NA	16600
SB12	ADSB12-W-11398	29.6 -39.3	4/26/00	< 200	NA	152000	57400	< 100	40100	402	23500
SB13	ADSB13-W-11412	25.9 -30.9	4/27/00	< 200	NA	68100	8600	< 100	15500	198	29100
SB13	ADSB13-W-11406	25.9 -34.9	4/27/00	< 200	NA	62000	9200	< 100	14200	81.2	22400
SB13	ADSB13-W-11413	30.9 -34.9	4/27/00	< 200	NA	64200	12400	< 100	13300	249	13300
SB13	ADSB13-W-11408	34.9 -42.3	4/27/00	< 200	NA	67200	11000	< 100	13000	109	15600
SB13	ADSB13-W-11407	42.3 -51.5	4/27/00	< 200	NA	82700	16500	< 100	14300	364	20800
SB13	ADSB13-W-11409	51.5 -60.5	4/24/00	< 200	NA	105000	20200	< 100	19100	330	22300
SB13	ADSB13-W-11410[e]	60.5 -71.3	4/27/00	NA	NA	NA	NA	NA	NA	NA	NA
SB14	ADSB14-W-11414[j]	31 -36	4/28/00	< 200	NA	103000	51900	< 100	22300	1150	7000
SB15	ADSB15-W-11417	33.3 -43.3	4/28/00	< 200	NA	97200	19700	138	21600	421	33500
SB16	ADSB16-W-11432	28.2 -33.2	4/30/00	< 200	NA	41000	3900	< 100	10200	49.5	13800
SB16	ADSB16-W-11424	33.2 -38.2	4/30/00	< 200	NA	90000	36500	< 100	20300	275	21800
SB16	ADSB16-W-11421	38.2 -43.2	4/29/00	< 200	NA	115000	33600	< 100	23700	600	28400
SB16	ADSB16-W-11429	43.2 -48.2	4/30/00	< 200	NA	133000	48400	< 100	22700	1170	34300

TABLE F.4 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Concentration (μg/L) Aluminum	Ammonia Nitrogen	Calcium	Chloride	Iron	Magnesium	Manganese	Nitrate
Cone Penetrometer and Geoprobe Locations (Cont.)											
SB16	ADSB16-W-11422	48.2 -53.2	4/29/00	< 200	NA	134000	43000	< 100	22100	921	30900
SB16	ADSB16-W-11430	53.2 -58.2	4/30/00	< 200	NA	125000	37400	< 100	20900	738	23100
SB16	ADSB16-W-11423	58.2 -61	4/29/00	< 200	NA	109000	19000	< 100	21000	630	10600
SB18	ADSB18-W-11445	22.96 -27.96	5/2/00	< 200	NA	53800	35600	< 100	13700	85.3	3000
SB18	ADSB18-W-11450	27.96 -32.96	5/2/00	< 200	NA	68800	25800	< 100	17000	88.3	5400
SB18	ADSB18-W-11446	32.96 -37.96	5/2/00	< 200	NA	77400	15700	< 100	16200	147	5000
SB18	ADSB18-W-11452	37.96 -42.96	5/2/00	< 200	NA	67600	18600	< 100	13800	56.4	11200
SB18	ADSB18-W-11447	42.96 -47.96	5/2/00	< 200	NA	67100	10500	< 100	13700	161	15500
SB18	ADSB18-W-11448	47.96 -52.96	5/2/00	< 200	NA	66800	10100	111	13700	202	15500
SB18	ADSB18-W-11453	52.96 -57.96	5/2/00	< 200	NA	110000	27900	< 100	21000	223	20500
SB18	ADSB18-W-11449	57.96 -62.96	5/2/00	< 200	NA	12800	36800	< 100	25300	203	27900
SB18	ADSB18-W-11455	62.96 -67.96	5/2/00	< 200	NA	120000	31600	< 100	23900	126	23400
SB18	ADSB18-W-11444	66.1 -71.1	5/2/00	< 200	NA	114000	22400	< 100	24300	237	17800

TABLE F.4 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Concentration (μg/L) Phosphate	Phosphorus	Potassium	Silicon	Sodium	Sulfate	Zinc
Public Wells										
64-1	ADPW64-1-W-11308	Unk -70	4/12/00	500	658	5880	20700	33400	59400	< 20
70-1	ADPW70-1-W-11306	Unk -54.15	4/12/00	400	496	< 5000	16600	27900	44100	< 20
79-1	ADPW79-1-W-11307	77.6 -105.2	4/12/00	700	828	< 5000	19000	20100	38200	23.9
Domestic Wells										
DW01	ADDW01-W-11309	Unk	4/12/00	< 200	< 250	< 5000	14500	29200	79100	23.6
DW02	ADDW02-W-11312	Unk	4/13/00	< 200	< 250	7770	10000	65600	807000	< 20
DW03	ADDW03-W-11313	Unk	4/13/00	< 200	< 250	< 5000	17700	36400	70800	60.1
DW04	ADDW04-W-11314	Unk	4/13/00	670[k]	635	< 5000	15500	26700	34200	31.8
DW05	ADDW05-W-11315	Unk	4/13/00	< 200	< 250	< 5000	16500	44800	86600	< 20
Monitoring Wells										
MWB12	ADMWB12-W-11317	30 -45	4/14/00	600[k]	633	5020	16500	29600	44000	< 20
MWB17	ADMWB17-W-11318	15 -30	4/14/00	< 200	< 250	< 5000	16000	6580	11300	< 20
Cone Penetrometer and Geoprobe Locations										
SB03	ADSB03-W-11342	32.8 -39.4	4/17/00	< 200	287	10300	19200	34300	63300	32.1
SB03	ADSB03-W-11343	39.4 -45.9	4/17/00	< 200	< 250	6250	16400	50700	93800	32.1
SB03	ADSB03-W-11348	45.9 -49.2	4/18/00	< 200	< 250	< 5000	16400	47500	86500	< 20
SB03	ADSB03-W-11341	49.2 -52.48	4/17/00	< 200	< 250	< 5000	16200	47900	93200	37.1
SB03	ADSB03-W-11346	52.48 -62.32	4/18/00	< 200	< 250	7560	15600	52200	91700	41
SB03	ADSB03-W-11349	63.32 -67.24	4/18/00	< 200	< 250	14400	15200	61300	93800	39.4
SB03	ADSB03-W-11350	67.24 -72.16	4/18/00	< 200	< 250	6280	15800	41400	90200	< 20
SB04	ADSB04-W-11353	34.44 -41	4/18/00	< 200	< 250	< 5000	16800	29600	57900	< 20
SB04	ADSB04-W-11419	41 -45	4/28/00	< 200	< 250	8900	16500	37400	59300	249
SB04	ADSB04-W-11420	45 -50	4/28/00	< 200	< 250	5800	16000	29600	56000	56.2
SB04	ADSB04-W-11358	49.2 -59.04	4/20/00	< 200	< 250	5670	14600	26600	37500	43.9

TABLE F.4 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Concentration (μg/L)						
				Phosphate	Phosphorus	Potassium	Silicon	Sodium	Sulfate	Zinc
Cone Penetrometer and Geoprobe Locations (Cont.)										
SB05	ADSB05-W-11354	29.64 -42.64	4/19/00	< 200	NA	NA	NA	NA	17100	NA
SB06	ADSB06-W-11361[c]	33.8 -40.4	4/20/00	< 200	NA	NA	NA	NA	65600	NA
SB06	ADSB06-W-11383	41 -47.2	4/25/00	< 200	< 250	12200	15600	50700	85200	69.9
SB06	ADSB06-W-11362	47.5 -54	4/20/00	< 200	< 250	6770	16000	44500	100000	35.5
SB06	ADSB06-W-11433	54 -59	5/1/00	< 200	< 250	9540	16300	50900	96600	174
SB06	ADSB06-W-11363	59 -65.6	4/20/00	< 200	< 250	10800	14500	46300	24900	40.6
SB07	ADSB07-W-11367[d]	31.8 -37.7	4/21/00	< 200	< 250	6240	10200	35900	77900	< 20
SB08	ADSB08-W-11436	33.2 -37.8	5/1/00	700	599	5880	25100	10500	25400	< 20
SB08	ADSB08-W-11369	32.8 -39.36	4/21/00	< 200	< 250	8200	23800	16900	31500	< 20
SB08	ADSB08-W-11440	37.8 -42.8	5/1/00	< 200	< 250	11700	17600	48000	77600	241
SB08	ADSB08-W-11371	42.6 -49.2	4/21/00	< 200	710	9540	16100	47500	92500	68.5
SB08	ADSB08-W-11438	49.2 -52.5	5/1/00	< 200	< 250	7100	16400	47200	88700	28.6
SB08	ADSB08-W-11373	52.48 -63.2	4/24/00	< 200	< 250	10700	17200	47400	85300	22.1
SB08	ADSB08-W-11439	62.3 -66	5/1/00	< 200	< 250	10500	16100	47600	84200	< 20
SB09	ADSB09-W-11425	27 -31	4/29/00	< 200	< 250	7000	19400	21700	27300	39.4
SB09	ADSB09-W-11427[e]	31 -34	4/28/00	NA	NA	NA	NA	NA	NA	NA
SB09	ADSB09-W-11378	33.5 -39.7	4/24/00	< 200	1670	9590	20200	29400	43900	< 20
SB09	ADSB09-W-11380	40.3 -42.6	4/25/00	< 200	< 250	5140	19200	22500	42300	20
SB09	ADSB09-W-11428	45 -48.5	4/29/00	< 200	< 250	9730	15200	29100	46700	35.9
SB09	ADSB09-W-11426	48.5 -52	4/29/00	< 200	< 250	6450	15200	29300	56200	33
SB09	ADSB09-W-11382	44.28 -52.5	4/25/00	< 200	< 250	7320	17500	24500	42600	< 20
SB10	ADSB10-W-11385	29.08 -36.08	4/25/00	< 200	< 250	9160	22800	22900	39300	< 20
SB10	ADSB10-W-11387	37 -42.3	4/25/00	< 200	< 250	6760	20200	33700	74200	< 20
SB10	ADSB10-W-11391	42.3 -48	4/25/00	< 200	< 250	6090	16300	41800	81500	< 20

TABLE F.4 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Concentration (μg/L)						
				Phosphate	Phosphorus	Potassium	Silicon	Sodium	Sulfate	Zinc
Cone Penetrometer and Geoprobe Locations (Cont.)										
SB10	ADSB10-W-11389	48 -52.8	4/25/00	< 200	< 250	7400	14700	47600	79200	< 20
SB10	ADSB10-W-11392	53.5 -60.5	4/26/00	< 200	< 250	11200	13900	50000	85400	73.6
SB10	ADSB10-W-11390	60.5 -67.7	4/25/00	< 200	< 250	9450	15000	42200	85400	< 20
SB11	ADSB11-W-11393	30.17 -32.8	4/26/00	< 200	277	6540	24700	11900	31800	< 20
SB11	ADSB11-W-11399[f]	34.4 -41.9	4/26/00	< 200	< 250	13600	19800	48400	72300	< 20
SB11	ADSB11-W-11394[g]	41.9 -48.7	4/26/00	< 200	< 250	8220	17500	50800	94000	< 20
SB11	ADSB11-W-11402[h]	48.7 -54.5	4/26/00	< 200	< 250	13700	17000	59000	94600	< 20
SB11	ADSB11-W-11396	54.5 -59.3	4/26/00	< 200	< 250	13700	17300	57300	93900	< 20
SB11	ADSB11-W-11404[i]	59.3 -65.9	4/26/00	< 200	NA	NA	NA	NA	97300	NA
SB12	ADSB12-W-11398	29.6 -39.3	4/26/00	< 200	< 250	12100	27500	35300	163000	517
SB13	ADSB13-W-11412	25.9 -30.9	4/27/00	< 200	< 250	6660	21400	24700	27600	41.5
SB13	ADSB13-W-11406	25.9 -34.9	4/27/00	< 200	327	7200	21400	23500	26500	< 20
SB13	ADSB13-W-11413	30.9 -34.9	4/27/00	< 200	< 250	9860	15000	27700	30700	< 20
SB13	ADSB13-W-11408	34.9 -42.3	4/27/00	< 200	< 250	8730	19300	26700	36300	< 20
SB13	ADSB13-W-11407	42.3 -51.5	4/27/00	< 200	< 250	9940	17800	37400	60400	< 20
SB13	ADSB13-W-11409	51.5 -60.5	4/24/00	< 200	< 250	8750	15700	31700	77500	135
SB13	ADSB13-W-11410[e]	60.5 -71.3	4/27/00	NA	NA	NA	NA	NA	NA	NA
SB14	ADSB14-W-11414[j]	31 -36	4/28/00	< 200	800	11000	15000	26300	74300	< 20
SB15	ADSB15-W-11417	33.3 -43.3	4/28/00	< 200	< 250	8800	16200	25500	61800	82.2
SB16	ADSB16-W-11432	28.2 -33.2	4/30/00	2100	974	7130	27000	15000	17200	< 20
SB16	ADSB16-W-11424	33.2 -38.2	4/30/00	< 200	< 250	12400	20300	41000	70000	< 20
SB16	ADSB16-W-11421	38.2 -43.2	4/29/00	< 200	< 250	7450	18500	53600	92200	< 20
SB16	ADSB16-W-11429	43.2 -48.2	4/30/00	< 200	< 250	9220	16100	58700	98400	< 20

TABLE F.4 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Concentration (μg/L)						
				Phosphate	Phosphorus	Potassium	Silicon	Sodium	Sulfate	Zinc
Cone Penetrometer and Geoprobe Locations (Cont.)										
SB16	ADSB16-W-11422	48.2 -53.2	4/29/00	< 200	< 250	5230	16800	53800	96200	136
SB16	ADSB16-W-11430	53.2 -58.2	4/30/00	< 200	< 250	11800	15800	53700	85600	< 20
SB16	ADSB16-W-11423	58.2 -61	4/29/00	< 200	< 250	9230	14700	41200	89000	165
SB18	ADSB18-W-11445	22.96 -27.96	5/2/00	600	762	6190	23600	21600	17800	< 20
SB18	ADSB18-W-11450	27.96 -32.96	5/2/00	< 200	< 250	14800	17700	38300	33600	< 20
SB18	ADSB18-W-11446	32.96 -37.96	5/2/00	< 200	< 250	11000	16000	36900	33200	< 20
SB18	ADSB18-W-11452	37.96 -42.96	5/2/00	< 200	< 250	16100	19700	39400	42700	< 20
SB18	ADSB18-W-11447	42.96 -47.96	5/2/00	< 200	< 250	6400	20200	28000	46200	< 20
SB18	ADSB18-W-11448	47.96 -52.96	5/2/00	< 200	< 250	6030	20400	26900	46700	31.6
SB18	ADSB18-W-11453	52.96 -57.96	5/2/00	< 200	< 250	12000	16000	42300	78900	< 20
SB18	ADSB18-W-11449	57.96 -62.96	5/2/00	< 200	< 250	11100	15700	40400	83900	< 20
SB18	ADSB18-W-11455	62.96 -67.96	5/2/00	< 200	< 250	14500	15100	44500	83600	< 20
SB18	ADSB18-W-11444	66.1 -71.1	5/2/00	< 200	< 250	6850	15300	35600	82500	< 20

[a] Unk, unknown depth.

[b] NA, not applicable.

[c] Sample ADSB06-W-11361 is a replicate of sample ADSB06-W-11359, analyzed for volatile organic compounds.

[d] Sample ADSB07-W-11367 is a replicate of sample ADSB07-W-11366, analyzed for volatile organic compounds.

[e] Sample collected only for organic analysis because of low water recovery.

[f] Sample ADSB11-W-11399 is a replicate of sample ADSB11-W-11400, analyzed for volatile organic compounds.

[g] Sample ADSB11-W-11394 is a replicate of sample ADSB11-W-11395, analyzed for volatile organic compounds.

[h] Sample ADSB11-W-11402 is a replicate of sample ADSB11-W-11403, analyzed for volatile organic compounds.

[i] Sample ADSB11-W-11404 is a replicate of sample ADSB11-W-11405, analyzed for volatile organic compounds.

[j] Sample ADSB14-W-11414 is a replicate of sample ADSB14-W-11418, analyzed for volatile organic compounds.

[k] The recovery of phosphate in the laboratory control sample analyzed with this sample was above the quality control limit of 120%.

TABLE F.5 Results of Tritium Analyses on Groundwater Samples Collected at Adams, Nebraska

Location	Sample	Depth (ft BGL)	Sample Date	Tritium (TU)
Public Wells				
64-1	ADPW64-1-W-11308	Unk[a]-70	4/12/00	9.3 ± 0.3
70-1	ADPW70-1-W-11306	Unk-54.15	4/12/00	9.03 ± 0.30
79-1	ADPW79-1-W-11307	77.6-105.2	4/12/00	11.2 ± 0.4
Monitoring Well				
MWB12	ADMWB12-W-11317	30-45	4/14/00	13.9 ± 0.5
Cone Penetrometer and Geoprobe Locations				
SB03	ADSB03-W-11342	32.8-39.4	4/17/00	12.1 ± 0.5
SB03	ADSB03-W-11343	39.4-45.9	4/17/00	10.3 ± 0.4
SB03	ADSB03-W-11348	45.9-49.2	4/18/00	10.2 ± 0.4
SB03	ADSB03-W-11341	49.2-52.48	4/17/00	10.5 ± 0.4
SB03	ADSB03-W-11346	52.48-62.32	4/18/00	9.7 ± 0.4
SB03	ADSB03-W-11349	63.32-67.24	4/18/00	9.5 ± 0.3
SB03	ADSB03-W-11350	67.24-72.16	4/18/00	7.2 ± 0.24
SB07	ADSB07-W-11367	31.8-37.7	4/21/00	8.4 ± 0.3
SB13	ADSB13-W-11406	25.9-34.9	4/27/00	7.98 ± 0.26
SB13	ADSB13-W-11408	34.9-42.3	4/27/00	10.3 ± 0.4
SB13	ADSB13-W-11407	42.3-51.5	4/27/00	10.8 ± 0.4
SB13	ADSB13-W-11409	51.5-60.5	4/24/00	11 ± 0.4
SB14	ADSB14-W-11414[b]	31-36	4/28/00	16.3 ± 0.6
SB18	ADSB18-W-11450	27.96-32.96	5/2/00	7.76 ± 0.29
SB18	ADSB18-W-11452	37.96-42.96	5/2/00	8.7 ± 0.3
SB18	ADSB18-W-11448	47.96-52.96	5/2/00	10.9 ± 0.4
SB18	ADSB18-W-11449	57.96-62.96	5/2/00	10.6 ± 0.4
SB18	ADSB18-W-11444	66.1-71.1	5/2/00	6.47 ± 0.23

[a] Unk, unknown depth.

[b] Sample ADSB14-W-11414 is a replicate of sample ADSB14-W-11418, which was analyzed for volatile organic compounds.

Appendix G:

Quality Control for Sample Collection, Handling, and Analysis

Appendix G:

Quality Control for Sample Collection, Handling, and Analysis

Soil, vegetation, and groundwater sampling was conducted during the Phase I investigation at Adams, Nebraska, to identify contaminant migration pathway(s) in the study area and to characterize the geology and hydrogeology of the stratigraphic units that compose these pathways. Quality assurance/quality control (QA/QC) samples were collected throughout the investigation to monitor sample collection, handling, and analysis activities. The QA/QC procedures for sample collection, handling, and analysis followed during the Phase I effort are described in detail in the *Master Work Plan* (Argonne 1994).

G.1 Sampling to Monitor Sampling Collection, Handling, and Analysis Procedures

Sample collection and handling activities were monitored by the documentation of samples as they were collected and the use of chain-of-custody (COC) forms and custody seals to ensure sample integrity during the handling and shipment of samples for analysis. Minor discrepancies in sample identification numbers for some samples, as listed on the COC records and sample containers, were resolved by comparison of the various documentation records. The COC records are on file at Argonne and are available upon request.

The QA/QC samples collected included field blanks, equipment rinsates, trip blanks, and blind analytical standards. Samples of the potentially contaminated waste soil/mud generated during drilling of temporary wells were collected prior to disposal. Background soil and vegetation samples were collected to provide a baseline for the vegetation and soil surveys. Replicate samples were collected, and other samples were selected for duplicate analyses as a measure of analytical precision. The QA/QC samples are listed in Table G.1. Analytical results for carbon tetrachloride and chloroform in QA/QC samples collected to monitor sample collection and handling activities are in Table G.2.

G.1.1 Field Blanks

Samples of (1) the water used during drilling and sampling activities and (2) the solvent and silicon used on ECPT rod connections showed no carbon tetrachloride or chloroform contamination.

G.1.2 Equipment Rinsates

Reusable sampling bailers were used during collection of groundwater samples by the ECPT vehicle. Rinsates from the decontaminated bailers and ECPT rods were collected periodically to ensure that cross-contamination of samples did not occur during sample collection. Disposable sampling equipment was used during collection of other samples.

G.1.3 Trip Blanks

Trip blanks were prepared and included in each shipment of soil, vegetation, or water samples for organic analysis as an indicator of cross-contamination of samples during shipment. Neither carbon tetrachloride or chloroform was detected in the trip blanks.

Air was present in both vials of trip blank ADTB17-W-11345, shipped with samples ADSB03-W-11341, ADSB03-W-11342, and ADSB03-W-11343 to AGEM Laboratory on April 17, 2000, under COC 1831. Carbon tetrachloride and chloroform were detected in sample ADSB03-W-11341 but not in the other two groundwater samples or in the trip blank.

G.1.4 Background Sampling

Background soil and vegetation samples were collected to establish a baseline for contamination detected in the soil and vegetation surveys. Neither carbon tetrachloride or chloroform was detected.

G.1.5 Blind Analytical Standards

Three blind analytical water standards were prepared and included in shipments of groundwater samples for organic analysis at AGEM Laboratory as a measure of analytical precision, with carbon tetrachloride concentrations ranging from 4.96 to 983 µg/L.

G.1.6 Replicate Samples and Duplicate Analyses

As an indicator of the consistency of the sampling methodology followed and to provide a measure of analytical precision, blind replicate soil, vegetation, and groundwater samples were collected. In addition, samples were selected by AGEM Laboratory for duplicate organic analyses and by Severn-Trent Laboratory for duplicate inorganic analyses (Table G.1). To verify organic analytical results from AGEM Laboratory obtained with EPA Method 524.2 (purge-and-trap method), selected groundwater samples were analyzed at Clayton Laboratory according to EPA CLP protocols for organic analysis.

G.1.7 Waste Characterization Samples

During the Phase I investigation, samples of the waste soil/mud accumulated during the drilling and development of temporary wells SB01 and SB02 were collected for organic analysis at the AGEM Laboratory (Table G.1). Neither carbon tetrachloride or chloroform was detected (Table G.2).

G.1.8 Analyses of Research Samples

At several ECPT sampling locations (identified in Table F.1 in Appendix F), groundwater samples were collected for organic analysis by using the Watera pump and by bailing to compare the two sampling methods. Samples for organic analysis obtained with the Watera pump are considered research samples; only the analytical results for the ECPT groundwater samples collected by bailing are reported.

G.2 Quality Control for Organic Analysis of Vegetation Samples

A total of 57 vegetation samples (including 4 blind field replicates and 1 background sample) were analyzed for carbon tetrachloride and chloroform at AGEM Laboratory with a modification of the protocol in EPA Method 5021 (headspace analysis by GC-ECD) to achieve the low detection limits required. Typical detection limits achieved were 0.060 µg/kg for carbon tetrachloride and 0.750 µg/kg for chloroform. A limitation of the chloroform analysis is the presence of chloroform (at very low concentrations) in the methanol solvent used in standard preparation. An 11-point calibration of the GC system was established on the basis of the mass of known quantities of carbon tetrachloride and chloroform, in the range 0.125-4.000 ng. The analytical data are acceptable for qualitative determination of contaminant distribution.

G.3 Quality Control for Organic Analysis of Soil Samples

A total of 108 soil samples (including 99 near-surface soil samples, 8 blind field replicate near-surface soil samples, and 1 background near-surface soil sample) were collected for organic analysis. Under the EPA's CLP analytical method for soils collected without extractant, SOW 2/88 (EPA 1989), which uses GC-MS, detection limits are as high as 60 µg/kg for medium-level soils. Accordingly, the soil samples were analyzed at AGEM Laboratory by using EPA Method 8260B (purge-and-trap method), as referenced in the EPA's SW-846 (EPA 1986) to achieve lower detection limits. At the laboratory, the VOCs present in each soil sample were extracted with methanol from the sample matrix. An aliquot of the extract was purged, and the volatile species were transferred to a sorbent tube. After purging, the sorbent tube was heated and backflushed with an inert gas to desorb the components into the GC-MS system. The compounds eluting from the GC column were identified by retention time and by comparison with reference library spectra. The concentration of each component was calculated by comparison of the MS response for the quantitation ion to the response for internal standards.

Soil samples were analyzed at AGEM Laboratory with the purge-and-trap method in sample delivery groups (SDGs), as shown in Table G.3. The QA/QC procedures followed included initial and continuing calibration of instruments, the analysis of laboratory blanks,

monitoring of surrogate spike recovery, analysis of replicate samples, and duplicate analyses of selected samples. Significant results include the following:

- Soil samples were received with custody seals intact and at appropriate temperature. All samples were analyzed within required holding times.

- Contaminants of concern were not detected in the laboratory method blanks.

- For each SDG, the calibration of analytical instruments was monitored by the analysis of calibration check standards. Table G.3 shows the relative percent difference (RPD) values between the known and calculated concentrations of the standards. The concentrations of calibration check standards measured in all SDGs were within the acceptable limit of ±20%.

- Surrogate standard determinations were performed on the samples and blanks by using the surrogate spike compounds fluorobenzene, 4-bromofluorobenzene, and 1,2-dichlorobenzene-d_4. Table G.3 shows the percent recovery of these system-monitoring compounds for each of the analyses. In the analysis of eight soil samples (identified in Table G.3) the recoveries of one or more surrogate compounds were outside the specified range of 80-120%. Two of the samples were reanalyzed with surrogate recovery within QC limits. The other six samples were not reanalyzed.

- Replicates of 8 soil samples were collected in the field, and an additional 19 soil samples were selected by AGEM Laboratory for duplicate organic analyses by the purge-and-trap method. Contaminant concentrations were below the quantitation limit of 10 µg/kg for all samples and replicates analyzed with the purge-and-trap analytical method.

To achieve lower detection limits, the soil samples were also analyzed by using a modification of EPA Method 5021 (headspace analysis with GC-ECD) similar to that used for the analysis of the vegetation samples. Typical detection limits achieved were 0.060 µg/kg for carbon tetrachloride and 0.750 µg/kg for chloroform. A limitation of the chloroform analysis is the presence of chloroform (at very low concentrations) in the methanol solvent used in standard preparation. An 11-point calibration of the GC system was established on the basis of the mass

of known quantities of carbon tetrachloride and chloroform in the range 0.125-4.000 ng. The analytical data are acceptable for qualitative determination of contaminant distribution.

G.3 Quality Control for Organic Analysis of Water Samples

Groundwater samples (and associated QC samples) collected for carbon tetrachloride and chloroform analysis were shipped immediately to AGEM Laboratory for analysis with EPA Method 524.2. As one measure of the precision of the analytical process, samples were selected by the laboratory for duplicate analyses. To verify the accuracy of the analytical results obtained with EPA Method 524.2, replicate (split) samples were collected for verification analysis at Clayton Laboratory with CLP methodology. On the basis of the results obtained by AGEM Laboratory, selected replicate samples were subjected to verification analysis.

The following sections describe QC measures followed during analysis of groundwater samples and replicates and discuss the quality of the organic analytical data from each laboratory. Analytical data from AGEM Laboratory are discussed in Section G.3.1, and analytical data from Clayton Laboratory are discussed in Section G.3.2. The analytical results from the two laboratories are compared in Section G.3.3.

G.3.1 Analysis of Water Samples at AGEM Laboratory

Water samples shipped to the AGEM Laboratory were analyzed by the purge-and-trap method with a GC-MS system. For the purge-and-trap analyses, VOCs present in the groundwater sample were extracted (purged) from the sample matrix by bubbling an inert gas through the sample. The purged components were trapped in a specified sorbent tube. After purging, the sorbent tube was heated and backflushed with an inert gas to desorb the components into the GC-MS system. The compounds eluting from the GC column were identified by retention time and by comparison with reference library spectra. The concentration of each component was calculated by comparison of the MS response for the quantitation ion to the response for corresponding calibration curves and/or internal standards. The internal standard recovery limits were 80-120%. If the internal standard was outside these limits, the data were flagged accordingly. Calibration checks with each SDG were required to be within ±20% of the standard.

Water samples submitted to the AGEM Laboratory for organic analysis were analyzed in 14 SDGs. Table G.4 identifies the groundwater, surface water, and associated QA/QC samples analyzed in each SDG. The QA/QC procedures followed included analysis of instrument calibration check standards, analysis of laboratory blanks, monitoring of surrogate spike recovery, and duplicate laboratory analyses. Significant results include the following:

- Samples shipped to AGEM Laboratory were received with custody seals intact and at appropriate temperature. All samples were analyzed within required holding times.

- Contaminants of concern were not detected in field blanks, equipment rinsates, trip blanks shipped with the samples, or laboratory method blanks analyzed with the samples.

- For each SDG, analytical instrument calibration was monitored by the analysis of calibration check standards. Table G.4 shows the RPD between the known and calculated concentrations of the standards. The concentrations of calibration check standards measured in all SDGs were within the acceptable limit of ±20%.

- Surrogate standard determinations were performed on samples and blanks by using surrogate spike compounds fluorobenzene, 1,2-dichlorobenzene-d_4, and 4-bromofluorobenzene. Table G.4 shows the percent recovery of these system-monitoring compounds for each of the analyses. Analysis of the following two SDGs requires explanation:

  - SDG 00-4-25: In the analysis of field blanks of the solvent and silicon gel used to maintain proper fitting of the ECPT rods (samples ADSB09-W-11376, ADSB09-W-11377, and ADSB08-W-11374), the recovery of two surrogate compounds was extremely high. Neither carbon tetrachloride or chloroform was detected, and these samples were not reanalyzed. The data for these three samples are accepted without qualification.

  - SDG 00-4-27: In the initial analysis of sample ADSB10-11385, the recovery of surrogate compound fluorobenzene was below the specified

limit of 80%. In a second analysis of the sample in the same SDG, surrogate recoveries were within the limit of ±20%, and this second result is reported.

- Six blind replicate groundwater samples were collected for organic analysis at AGEM Laboratory. Eighteen samples (including one of the equipment rinsates and two of the replicates) were selected by AGEM Laboratory for duplicate organic analysis to provide a measure of the analytical precision. Contamination was not detected in any of the sample-replicate pairs. One sample selected for duplicate analysis (ADSB11-W-11400) contained carbon tetrachloride and chloroform. The RPD between the two analyses is acceptable. Carbon tetrachloride was measured at 59 µg/L and 44 µg/L, for an RPD between the sample and duplicate result of 29%. Chloroform was measured at 14 µg/L and 12 µg/L, for an RPD of 15%. The higher contaminant concentrations are reported.

- Three blind analytical standards were shipped to AGEM Laboratory to provide a measure of analytical precision (Table G.1). The RPD values between the actual and measured concentrations for the three standards indicate good analytical precision (Table G.5), with the RPD for carbon tetrachloride in the range 1.2-8.7% and the RPD for chloroform at 9.3-18.3%.

G.3.2 Analysis of Water Samples at Clayton Laboratory

In accordance with the QA/QC procedures defined in the *Master Work Plan* (Argonne 1994), replicates of groundwater samples analyzed at the AGEM Laboratory for carbon tetrachloride and chloroform with EPA Method 524.2 were collected for analysis with EPA-defined CLP methodology. On the basis of the results determined by AGEM Laboratory, replicate samples (identified in Table G.1) were selected for this verification analysis. The AGEM Laboratory and CLP analytical results for the replicate samples are compared in Section G.3.3. Below is a discussion of the quality of the organic analytical data obtained with CLP methodology.

Ten replicate groundwater samples were shipped to Clayton Laboratory for organic analysis with CLP methodology. The samples were sent in two shipments, with a trip blank in each. Complete CLP data packages were provided. The QA/QC procedures followed in the CLP

analyses included initial and continuing calibration of instruments, analysis of laboratory blanks, monitoring of surrogate spike recovery, and matrix spike/matrix spike duplicate (MS/MSD) analyses. Significant results include the following:

- Samples shipped to the CLP laboratory were received with custody seals intact and at appropriate temperature. All samples were analyzed within required holding times.

- Analytical instruments were properly tuned; initial and continuing calibration checks remained within the allowable limit.

- Contaminants of concern were not detected in trip blanks or laboratory method blanks.

- Surrogate standard determinations were performed on samples and blanks by using the surrogate spike compounds toluene-d_8, 4-bromofluorobenzene, and 1,2-dichloroethane-d_4. Table G.6 shows the percent recovery of the system-monitoring compounds for each of the CLP analyses. For all analyses, recovery of the surrogate spikes was within the acceptable range (identified in Table G.6) specific to each surrogate.

- The MS/MSD analyses were performed in accordance with CLP protocol by using matrix spike compounds 1,1-dichloroethene, trichloroethene, chlorobenzene, toluene, and benzene to evaluate the matrix effect of samples on the analytical methodology. Table G.7 shows the percent recovery of each spike compound in the two MS/MSD analyses, as well as the calculated RPD for the MS/MSD analytical results. The recovery of spike compounds was within QC limits for both MS/MSD analyses. The RPD values for four of the five spike compounds were outside control limits for the MS/MSD analysis conducted with SDG 40780-ARG65 and for all five spike compounds for the MS/MSD analysis conducted with SDG 41114-ARG66, resulting in qualification of the reported analytical data.

Organic analytical data from Clayton Laboratory for the replicate groundwater samples are acceptable for comparison to AGEM Laboratory data with the qualifications described.

G.3.3 Verification Analysis of Water Samples

In accordance with the QA/QC procedures defined in the *Master Work Plan* (Argonne 1994), selected replicates of the groundwater samples analyzed at AGEM Laboratory for carbon tetrachloride and chloroform with EPA Method 524.2 were subjected to verification analysis with EPA-defined CLP methodology. Ten of the 81 groundwater samples analyzed at AGEM Laboratory for carbon tetrachloride and chloroform (12% of the groundwater samples) were also analyzed according to CLP methodology. Table G.8 compares the analytical results for groundwater samples obtained by using EPA Method 524.2 and CLP methodology.

Analytical results for samples analyzed at AGEM Laboratory with EPA Method 524.2 compare favorably with the analytical results for replicate samples analyzed at Clayton Laboratory with EPA CLP methodology over the range of carbon tetrachloride and chloroform concentrations detected. Replicates of samples analyzed at AGEM Laboratory with no detection of carbon tetrachloride and/or chloroform were analyzed with CLP methodology with similar results. Comparable results were also obtained for the sample in which contamination was detected, with calculated RPD values between the purge-and-trap and CLP results of 21.7% for carbon tetrachloride and 8% for chloroform.

Analytical data from AGEM Laboratory, obtained with EPA Method 524.2, are supported by the data from Clayton Laboratory, obtained by using EPA CLP methodology.

G.4 Quality Control for Inorganic Analyses of Groundwater Samples

Groundwater samples collected during the Phase I investigation were collected for inorganic analysis to aid in geochemical characterization of the water-bearing zone. Groundwater samples collected for inorganic analysis were shipped immediately to Severn-Trent Laboratory for filtration, preservation, and analysis. The analyses included dissolved anion concentrations (chloride, sulfate, nitrate, and phosphate) by EPA Method 300, ammonia nitrogen by EPA Method 350, and dissolved metals (aluminum, calcium, iron, magnesium, manganese, phosphorus, potassium, silicon, sodium, and zinc) by EPA Method 6010.

Inorganic analysis of the groundwater samples was conducted in 13 SDGs. The QA/QC procedures followed included instrument calibration through analysis of spiked calibration check

standards, as well as verification of interelement and background correction factors through the analysis of ICP interference check samples. Significant points are the following:

- Initial and continuing calibration of analytical equipment was verified according to method protocol by the analysis of instrument check standards to determine instrument drift. Accuracy was measured by the percent recovery of known concentrations of the metals and anions of concern added to the calibration check standards. Percent recoveries of the spiked analytes of concern in the calibration check standards were within the range 90-110% for each SDG.

- Interelement and background correction factors for ICP analysis were determined through the analysis of ICP interference check samples, with results falling within the control limit of ±20% of the established mean value for each SDG.

- Accuracy in the analytical methodology followed was measured by the analysis of laboratory QC samples with each SDG. Except for phosphate, recovery of known concentrations of the metals and anions of concern in spiked laboratory QC samples, shown in Table G.9, was within the allowable limit of 80-120%. The recovery of phosphate was above the QC limit in the laboratory QC sample analyzed with 3 of the 13 SDGs. Phosphate was detected in 2 samples associated with these 3 SDGs: domestic well sample ADDW04-W-11314 (analyzed in SDG 77748) and monitoring well sample ADMWB12-W-11317 (analyzed in SDG 77772). Phosphate was not detected in other samples analyzed in the 3 SDGs of concern but was detected in samples analyzed in other SDGs with recovery of phosphate within QC limits. The phosphate results for the 2 samples in question are qualified (Table F.4, Appendix F).

- Precision was measured by duplicate analysis of selected samples. One blind replicate sample was submitted for analysis, and four samples were selected by the laboratory for duplicate analyses. Good precision in the inorganic analyses is indicated by the low RPD values between the initial and duplicate analyses (Table G.10).

The inorganic results for groundwater samples from Severn-Trent Laboratory are acceptable, on the basis of the recovery of known concentrations of the analytes of concern in laboratory QC samples analyzed with the groundwater samples and RPD values in duplicate analyses.

G.5 Quality Control for Isotope Analyses of Groundwater Samples

Selected groundwater samples were analyzed for tritium at the University of Miami Tritium Laboratory in Miami, Florida. Tritium concentrations were reported on the basis of the National Institute of Science and Technology tritium water standard #4926, as measured on September 3, 1961, and again on September 3, 1978, with a half-life of 12.43 yr. Concentrations were reported in tritium units (TU), equivalent to 3.193 picocuries per kilogram of water. Because counting efficiency and background concentration are different for each instrument, the reported concentrations were corrected for cosmic intensity and gas pressure. Typical efficiencies are equivalent to 1 count per minute (cpm) per TU. Background is about 0.3 cpm, known to ±0.02 cpm. The RPD values for duplicate analyses are typically < 5%.

TABLE G.1 Quality Control Samples Collected during the Phase I Investigation at Adams, Nebraska

Location	Sample	Depth (ft BGL)	Sample Date	Sample Description
Field Blanks				
QC	ADSB07-W-11365	NA[a]	04/20/00	Quality control test: distilled water/lithium.
QC	ADSB08-W-11374	NA	04/24/00	Field blank of silicon used on cone penetrometer rod connections.
QC	ADSB09-W-11376	NA	04/24/00	Field blank of solvent used on cone penetrometer rod connections.
QC	ADSB09-W-11377	NA	04/24/00	Field blank of silicon used on cone penetrometer rod connections.
QC	ADINIT-W-11435	NA	05/01/00	Field blank of water used during cone penetrometer investigation.
Equipment Rinsates				
QC	ADSB05-W-11355	NA	04/19/00	Rinsate of decontaminated cone penetrometer sampling bailer after collection of sample ADSB05-W-11354.
QC	ADSB09-W-11379	NA	04/24/00	Rinsate of cone penetrometer sampling bailer prior to collection of sample ADSB09-W-11378.
QC	ADSB14-W-11416	NA	04/28/00	Rinsate of cone penetrometer sampling bailer after collection of sample ADSB14-W-11414.
QC	ADBR30-W-11431	NA	04/30/00	Rinsate of cone penetrometer sampling bailer prior to collection of sample ADSB16-W-11432.
QC	ADBR08-W-11442	NA	05/01/00	Rinsate of cone penetrometer sampling bailer after collection of sample ADSB08-W-11440.
QC	ADRR01-W-11434	NA	05/01/00	Rinsate of cone penetrometer rod prior to collection of sample ADSB08-W-11436.
QC	ADRR08-W-11443	NA	05/01/00	Rinsate of cone penetrometer rod during sampling at SB18.
QC	ADBR2A-W-11456	NA	05/02/00	Rinsate of cone penetrometer sampling bailer after collection of sample ADSB18-W-11453.
QC	ADRR02-W-11457	NA	05/02/00	Rinsate of cone penetrometer rod during sampling at SB18.
QC	ADSB18-W-11451	NA	05/02/00	Rinsate of cone penetrometer sampling bailer after collection of sample ADSB18-W-11450.
Background Samples				
QC	AD-QCBG-V-11321	NA	05/11/00	Background vegetation sample.
QC	AD-QCBG-S-11322	0.5·0.7	05/11/00	Background surface soil sample. Black loam topsoil.

TABLE G.1 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Sample Description
Trip Blanks				
QC	ADTB01-W-11304	NA	04/10/00	Trip blank sent to AGEM Laboratory with samples listed on COC 1936.
QC	ADQCTB-W-11311	NA	04/12/00	Trip blank sent to AGEM Laboratory with samples listed on COC 1945.
QC	ADQCTB-W-11316	NA	04/13/00	Trip blank sent to AGEM Laboratory with samples listed on COC 1947.
QC	ADQCTB-W-11319	NA	04/14/00	Trip blank sent to AGEM Laboratory with samples listed on COC 1948.
QC	ADTB17-W-11345	NA	04/17/00	Trip blank sent to AGEM Laboratory with samples listed on COC 1831.
QC	ADTB18-W-11351	NA	04/18/00	Trip blank sent to AGEM Laboratory with samples listed on COC 1775 and to Clayton Laboratory with samples listed on COC 749.
QC	ADTB18-S-11352	NA	04/18/00	Soil trip blank sent to AGEM Laboratory with samples listed on COC 1830.
QC	ADSB06-W-11356	NA	04/19/00	Trip blank sent to AGEM Laboratory with samples listed on COC 1828.
QC	ADTB20-W-11364	NA	04/20/00	Trip blank sent to AGEM Laboratory with samples listed on COC 1826.
QC	ADTB21-W-11370	NA	04/21/00	Trip blank sent to AGEM Laboratory with samples listed on COC 1778.
QC	ADSB09-W-11375	NA	04/24/00	Trip blank sent to AGEM Laboratory with samples listed on COC 1779.
QC	ADTB25-W-11384	NA	04/25/00	Trip blank sent to AGEM Laboratory with samples listed on COC 1824.
QC	ADTB26-W-11401	NA	04/26/00	Trip blank sent to AGEM Laboratory with samples listed on COC 1783 and to Clayton Laboratory with samples listed on COC 750.
QC	ADTB27-W-11411	NA	04/27/00	Trip blank sent to AGEM Laboratory with samples listed on COC 1785.
QC	ADTB28-W-11415	NA	04/28/00	Trip blank sent to AGEM Laboratory with samples listed on COC 1821.
QC	ADTB08-W-11441	NA	05/01/00	Trip blank sent to AGEM Laboratory with samples listed on COC 1788.
QC	ADTB02-W-11454	NA	05/02/00	Trip blank sent to AGEM Laboratory with samples listed on COC 1789.
Blind Replicate Vegetation Samples				
F1	AD-QCDU-V-11332	NA	05/11/00	Replicate of vegetation sample AD-F1-V-11506.
F2	AD-QCDU-V-11331	NA	05/11/00	Replicate of vegetation sample AD-F2-V-11505.
F21	AD-QCDU-V-11521	NA	05/09/00	Replicate of vegetation sample AD-F21-V-11518.
Q9	AD-QCDU-V-11522	NA	05/09/00	Replicate of vegetation sample AD-Q9-V-11516.

TABLE G.1 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Sample Description
Blind Replicate Soil Samples				
F20	AD-QCDU-S-11680	0.8·1.1	05/11/00	Replicate of near-surface soil sample AD-F20-S-11603.
F20	AD-QCDU-S-11681	5.8·6	05/11/00	Replicate of near-surface soil sample AD-F20-S-11604.
F21	AD-QCDU-S-11678	0.8·1.1	05/11/00	Replicate of near-surface soil sample AD-F21-S-11601.
F21	AD-QCDU-S-11679	5.8·6	05/11/00	Replicate of near-surface soil sample AD-F21-S-11602.
Q2	AD-QCDU-S-11325	0.8·1.2	05/11/00	Replicate of near-surface soil sample AD-Q2-S-11647.
Q2	AD-QCDU-S-11326	5.8·6	05/11/00	Replicate of near-surface soil sample AD-Q2-S-11648.
Q12	AD-QCDU-S-11327	0.8·1.2	05/11/00	Replicate of near-surface soil sample AD-Q12-S-11651.
Q12	AD-QCDU-S-11328	5.8·6	05/11/00	Replicate of near-surface soil sample AD-Q12-S-11652.
Soil Samples Selected by AGEM Laboratory for Duplicate Organic Analysis by Purge-and-Trap Method				
B2	AD-B2-S-11623	0.8·1.2	05/11/00	Near-surface soil sample.
B8	AD-B8-S-11636	5.8·6	05/11/00	Near-surface soil sample.
F2	AD-F2-S-11598	5.9·6	05/11/00	Near-surface soil sample.
F6	AD-F6-S-11578	0.8·1.2	05/10/00	Near-surface soil sample.
F14	AD-F14-S-11616	5.8·6	05/11/00	Near-surface soil sample.
F17	AD-F17-S-11609	0.8·1.2	05/11/00	Near-surface soil sample.
F17	AD-F17-S-11610	5.8·6	05/11/00	Near-surface soil sample.
Q2	AD-Q2-S-11648	5.8·6	05/11/00	Near-surface soil sample.
Q3	AD-Q3-S-11646	5.8·6	05/11/00	Near-surface soil sample.
Q4	AD-Q4-S-11643	0.8·1.2	05/11/00	Near-surface soil sample.
Q4	AD-Q4-S-11644	5.8·6	05/11/00	Near-surface soil sample.
Q6	AD-Q6-S-11660	5.8·6	05/11/00	Near-surface soil sample.
Q9	AD-Q9-S-11653	0.8·1.2	05/11/00	Near-surface soil sample.
Q9	AD-Q9-S-11654	5.8·6	05/11/00	Near-surface soil sample.
Q12	AD-Q12-S-11651	0.8·1.2	05/11/00	Near-surface soil sample.
Q12	AD-Q12-S-11652	5.8·6	05/11/00	Near-surface soil sample.
Q16	AD-Q16-S-11672	5.8·6	05/11/00	Near-surface soil sample.

TABLE G.1 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Sample Description
Blind Replicate Groundwater Samples				
64-1	ADQCDU-W-11310	Unk·70	04/12/00	Replicate of public well sample ADPW64-1-W-11308.
SB03	ADSB03-W-11347	52.48·62.32	04/18/00	Replicate of cone penetrometer sample ADSB03-W-11346.
SB06	ADSB06-W-11361	33.8·40.4	04/20/00	Replicate of cone penetrometer sample ADSB06-W-11359.
SB08	ADSB08-W-11437	33.2·37.8	05/01/00	Replicate of cone penetrometer sample ADSB08-W-11436.
SB08	ADSB08-W-11372	42.6·49.2	04/21/00	Replicate of cone penetrometer sample ADSB08-W-11371.
SB11	ADSB11-W-11397	54.5·59.3	04/26/00	Replicate of cone penetrometer sample ADSB11-W-11396.
Groundwater Samples Selected by AGEM Laboratory for Duplicate Organic Analysis				
64-1	ADPW64-1-W-11308	Unk·70	04/12/00	Public well sample.
DW01	ADDW01-W-11309	Unk	04/12/00	Domestic well sample.
DW03	ADDW03-W-11313	Unk	04/13/00	Domestic well sample.
DW05	ADDW05-W-11315	Unk	04/13/00	Domestic well sample.
QC	ADSB05-W-11355	NA	04/19/00	Equipment rinsate.
SB03	ADSB03-W-11343	39.4·45.9	04/17/00	Cone penetrometer sample.
SB03	ADSB03-W-11346	52.48·62.32	04/18/00	Cone penetrometer sample.
SB04	ADSB04-W-11420	45·50	04/28/00	Cone penetrometer sample.
SB07	ADSB07-W-11366	31.8·37.7	04/20/00	Cone penetrometer sample.
SB08	ADSB08-W-11440	37.8·42.8	05/01/00	Cone penetrometer sample.
SB08	ADSB08-W-11371	42.6·49.2	04/21/00	Cone penetrometer sample.
SB09	ADSB09-W-11425	27·31	04/29/00	Cone penetrometer sample.
SB09	ADSB09-W-11378	33.5·39.7	04/24/00	Cone penetrometer sample.
SB10	ADSB10-W-11385	29.08·36.08	04/25/00	Cone penetrometer sample.
SB11	ADSB11-W-11400	34.4·41.9	04/26/00	Replicate of cone penetrometer sample ADSB11-W-11399.
SB11	ADSB11-W-11395	41.9·48.7	04/26/00	Replicate of cone penetrometer sample ADSB11-W-11394.
SB13	ADSB13-W-11409	51.5·60.5	04/24/00	Cone penetrometer sample.
SB18	ADSB18-W-11450	27.96·32.96	05/02/00	Cone penetrometer sample.

TABLE G.1 (Cont.)

Location	Sample	Depth (ft BGL)	Sample Date	Sample Description
Blind Analytical Standards for Organic Analysis at AGEM Laboratory				
QC	ADSB06-W-11357	NA	04/19/00	Quality control standard 0321-00-10.3 (VOC No. 5). CCl_4 = 983 ppb. $CHCl_3$ = 978 ppb. Duplicate analysis conducted.
QC	ADSB06-W-11360	NA	04/20/00	Quality control standard 0321-00-10.1 (VOC No. 1). CCl_4 = 9.93 ppb. $CHCl_3$ = 9.98 ppb.
QC	ADSB07-W-11368	NA	04/21/00	Quality control standard 0321-00-10.2 (VOC No. 3). CCl_4 = 4.96 ppb. $CHCl_3$ = 4.94 ppb. Duplicate analysis conducted.
Groundwater Samples Selected for Verification Analysis at Clayton Laboratory				
DW04	ADDW04-W-11314	Unk	04/13/00	Domestic well sample.
SB03	ADSB03-W-11342	32.8·39.4	04/17/00	Cone penetrometer sample.
SB03	ADSB03-W-11348	45.9·49.2	04/18/00	Cone penetrometer sample.
SB03	ADSB03-W-11346	52.48·62.32	04/18/00	Cone penetrometer sample.
SB04	ADSB04-W-11353	34.44·41	04/18/00	Cone penetrometer sample.
SB09	ADSB09-W-11380	40.3·42.6	04/25/00	Cone penetrometer sample.
SB10	ADSB10-W-11385	29.08·36.08	04/25/00	Cone penetrometer sample.
SB10	ADSB10-W-11389	48·52.8	04/25/00	Cone penetrometer sample.
SB11	ADSB11-W-11396	54.5·59.3	04/26/00	Cone penetrometer sample.
SB12	ADSB12-W-11398	29.6·39.3	04/26/00	Geoprobe sample.
Groundwater Samples Selected by Severn-Trent Laboratory for Duplicate Inorganic Analysis				
SB03	ADSB03-W-11349	63.32·67.24	04/18/00	Cone penetrometer sample.
SB04	ADSB04-W-11419	41·45	04/28/00	Cone penetrometer sample.
SB11	ADSB11-W-11399	34.4·41.9	04/26/00	Cone penetrometer sample.
SB18	ADSB18-W-11448	47.96·52.96	05/02/00	Cone penetrometer sample.
Waste Characterization Samples				
QC	ADRO-W-11303	NA	04/10/00	Composite of waste soil and water from drilling of SB01.
QC	ADDR-W-11305	NA	04/10/00	Composite of waste soil and water from drilling of SB02.

[a] NA, not applicable.

TABLE G.2 Results of Carbon Tetrachloride and Chloroform Analyses on Quality Control Samples Collected to Monitor Sample Collection and Handling Activities during the Phase I Investigation at Adams, Nebraska

Sample	Sample Date	Concentration (μg/L) Carbon Tetrachloride	Chloroform
Field Blanks			
ADSB07-W-11365	4/20/00	ND[a]	< 5[b]
ADSB08-W-11374	4/24/00	ND	< 5
ADSB09-W-11376	4/24/00	ND	< 5
ADSB09-W-11377	4/24/00	ND	< 5
ADINIT-W-11435	5/1/00	ND	ND
Equipment Rinsates			
ADSB05-W-11355	4/19/00	ND	< 5
ADSB09-W-11379	4/24/00	ND	< 5
ADSB14-W-11416	4/28/00	ND	ND
ADBR30-W-11431	4/30/00	ND	ND
ADBR08-W-11442	5/1/00	ND	ND
ADRR01-W-11434	5/1/00	ND	ND
ADRR08-W-11443	5/1/00	ND	ND
ADBR02-W-11456	5/2/00	ND	< 5
ADRR02-W-11457	5/2/00	ND	< 5
ADSB18-W-11451	5/2/00	ND	< 5
Trip Blanks			
ADTB01-W-11304	4/10/00	ND	ND
ADQCTB-W-11311	4/12/00	ND	ND
ADQCTB-W-11316	4/13/00	ND	ND
ADQCTB-W-11319	4/14/00	ND	ND
ADTB17-W-11345	4/17/00	ND	ND
ADTB18-W-11351-AGEM	4/18/00	ND	ND
ADTB18-W-11351-CLAYTN	4/18/00	< 5	ND
ADTB18-W-11352	4/18/00	NA[c]	NA
ADSB06-W-11356	4/19/00	ND	ND
ADTB20-W-11364	4/20/00	ND	ND
ADTB21-W-11370	4/21/00	ND	ND
ADSB09-W-11375	4/24/00	ND	ND
ADTB25-W-11384	4/25/00	ND	ND
ADTB26-W-11401-AGEM	4/26/00	ND	ND
ADTB26-W-11401-CLAYTN	4/26/00	< 5	ND
ADTB27-W-11411	4/27/00	ND	ND
ADTB28-W-11415	4/28/00	ND	ND
ADTB08-W-11441	5/1/00	ND	ND
ADTB02-W-11454	5/2/00	ND	ND

TABLE G.2 (Cont.)

Sample	Sample Date	Concentration (μg/L)	
		Carbon Tetrachloride	Chloroform
Waste Characterization Samples			
ADDR-W-11305	4/10/00	ND	< 5
ADRO-W-11303	4/10/00	ND	< 5

[a] ND, not detected above the EPA Method 524.2 quantitation limit of 1 μg/L.

[b] < 5, not detected above the EPA CLP quantitation limit of 5 μg/L.

[c] NA, soil trip blank not analyzed by purge-and-trap method.

TABLE G.3 Results of Organic Analyses on Quality Control Samples Collected to Monitor Soil Analyses at AGEM Laboratory by the Purge-and-Trap Method

	Recovery of Surrogate Compounds[a] (%)			Measured Values for Calibration Check Standards			
Sample	Fluoro-benzene	1,2-Dichloro-benzene-d_4	4-Bromo-fluorobenzene	CCl_4 (µg/kg)	RPD[b]	$CHCl_3$ (µg/kg)	RPD[b]
SDG 00-5-19, Analysis Date May 19, 2000							
Laboratory Blank	100	100	100				
AD-Q12-S-11652	93	83	90				
AD-QCDU-S-11325	80	66[c]	71[c]	Reanalyzed in SDG 00-6-23.			
AD-Q8-S-11329	90	88	92				
AD-Q4-S-11644	87	81	88				
AD-Q2-S-11648	92	86	91				
AD-Q3-S-11646	82	76[c]	81	Reanalyzed in SDG 00-6-23.			
AD-Q12-S-11651	95	88	91				
AD-Q9-S-11654	89	83	89				
20-µg/kg standard	106	97	100	22.72	12.7	22.59	12.2
SDG 00-5-22, Analysis Date May 22, 2000							
Laboratory Blank	89	89	89				
AD-Q9-S-11653	91	83	88				
AD-F17-S-11610	92	88	88				
AD-F17-S-11609	90	86	89				
AGEM methanol blank	92	85	89				
20-µg/kg standard	104	93	94	20.3	1.5	21.24	6
SDG 00-5-30, Analysis Date May 30, 2000							
Laboratory Blank	100	100	100				
AD-F2-S-11598	106	106	106				
AD-F2-S-11598DUP	102	106	102				
AD-QCDU-S-11680	99	100	98				
AD-F14-S-11616	90	97	96				
AD-F20-S-11603	97	97	97				
AD-F19-S-11606	97	100	100				
AD-F4-S-11594	95	100	99				
AD-Q14-S-11324	98	98	100				
AD-F11-S-11619	88	82	85				
AD-F1-S-11599	93	97	96				
AD-Q15-S-11673	105	107	108				

TABLE G.3 (Cont.)

Sample	Recovery of Surrogate Compounds[a] (%)			Measured Values for Calibration Check Standards			
	Fluoro-benzene	1,2-Dichloro-benzene-d_4	4-Bromo-fluorobenzene	CCl_4 (µg/kg)	RPD[b]	$CHCl_3$ (µg/kg)	RPD[b]
SDG 00-5-30, Analysis Date May 30, 2000 (Cont.)							
AD-Q5-S-11642	103	107	108				
AD-F9-S-11585	98	104	105				
AD-F21-S-11602	100	103	105				
AD-F20-S-11604	104	108	107				
20-µg/kg standard	100	100	100	20.89	4.3	20.63	3.1
SDG 00-6-1, Analysis Date June 1, 2000							
Laboratory Blank	89	83	85				
AD-F16-S-11611	112	110	107				
AD-F4-S-11593	112	111	109				
AD-F9-S-11586	112	106	110				
AD-F8-S-11582	111	106	108				
AD-Q5-S-11641	104	111	102				
AD-F6-S-11579	99	97	98				
AD-QCDU-S-11679	97	85	89				
AD-B10-S-11639	108	104	107				
AD-B4-S-11628	102	101	102				
AD-Q10-S-11330	102	99	101				
AD-B9-S-11637	103	101	101				
AD-B8-S-11636	100	98	99				
20-µg/kg standard	85	87	84	17.26	14.7	17.02	16.1
SDG 00-6-2, Analysis Date June 2, 2000							
Laboratory Blank	100	100	100				
AD-B1-S-11621	87	69[c]	75[c]	Not reanalyzed.			
AD-I4-S-11663	95	89	91				
AD-B8-S-11635	108	101	104				
AD-B4-S-11627	96	93	96				
AD-B8-S-11636DUP	98	93	97				
AD-B6-S-11632	98	93	97				

TABLE G.3 (Cont.)

Sample	Recovery of Surrogate Compounds[a] (%)			Measured Values for Calibration Check Standards			
	Fluoro-benzene	1,2-Dichloro-benzene-d_4	4-Bromo-fluorobenzene	CCl_4 (µg/kg)	RPD[b]	$CHCl_3$ (µg/kg)	RPD[b]
SDG 00-6-2, Analysis Date June 2, 2000 (Cont.)							
AD-I4-S-11664	88	86	87				
AD-B1-S-11622	96	89	95				
AD-Q10-S-11668	109	103	105				
AD-B10-S-11640	104	96	102				
AD-QCDU-S-11328	97	92	96				
20-µg/kg standard	105	105	106	23	13.9	22.83	13.2
SDG 00-6-5, Analysis Date June 5, 2000							
Laboratory Blank	100	100	100				
AD-Q16-S-11672	100	100	100				
AD-Q16-S-11672DUP	107	104	103				
AD-B6-S-11631	99	97	98				
AD-I3-S-11661	104	103	104				
AD-Q16-S-11671	105	101	101				
20-µg/kg standard	109	107	105	20.76	3.7	22.1	9.9
SDG 00-6-6, Analysis Date June 6, 2000							
Laboratory Blank	100	100	100				
AD-I5-S-11670	100	104	106				
AD-B2-S-11623	100	100	100				
20-µg/kg standard	107	102	104	20.58	2.8	21.23	5.9
SDG 00-6-9, Analysis Date June 9, 2000							
Laboratory Blank	100	100	100				
AD-B2-S-11624	6[c]	33[c]	25[c]	Not reanalyzed.			
AD-Q6-S-11659	92	85	90				
AD-Q7-S-11658	94	87	91				
AD-B9-S-11638	92	86	90				

TABLE G.3 (Cont.)

Sample	Recovery of Surrogate Compounds[a] (%)			Measured Values for Calibration Check Standards			
	Fluoro-benzene	1,2-Dichloro-benzene-d_4	4-Bromo-fluorobenzene	CCl_4 (µg/kg)	RPD[b]	$CHCl_3$ (µg/kg)	RPD[b]
SDG 00-6-9, Analysis Date June 9, 2000 (Cont.)							
AD-F19-S-11605	91	83	88				
AD-Q11-S-11666	94	84	91				
AD-F3-S-11595	91	88	93				
AD-F21-S-11601	92	85	90				
AD-Q10-S-11667	92	86	90				
AD-F5-S-11577	88	83	87				
AD-F18-S-11607	91	82	88				
AD-F18-S-11608	89	83	87				
AD-F15-S-11613	90	82	87				
20-µg/kg standard	101	98	99	20.72	3.5	20.98	4.8
SDG 00-6-13, Analysis Date June 13, 2000							
Laboratory Blank	100	100	100				
AD-F16-S-11612	96	91	92				
AD-F15-S-11614	102	96	96				
AD-F14-S-11616DUP	92	80	81				
AD-QCBG-S-11322	100	100	100				
AD-F13-S-11617	97	92	93				
AD-F13-S-11618	98	97	96				
AD-F5-S-11576	93	88	90				
AD-F7-S-11581	100	98	99				
AD-B2-S-11623DUP	97	94	97				
AGEM methanol blank-6/13	103	102	102				
AD-I1-S-11592	101	102	101				
AD-F3-S-11596	101	97	99				
AD-F8-S-11584	98	97	98				
AD-I2-S-11590	100	99	99				
AD-F8-S-11583	98	96	96				
20-µg/kg standard	97	89	92	18.42	8.2	20.98	4.8

TABLE G.3 (Cont.)

Sample	Recovery of Surrogate Compounds[a] (%)			Measured Values for Calibration Check Standards			
	Fluoro-benzene	1,2-Dichloro-benzene-d_4	4-Bromo-fluorobenzene	CCl_4 (µg/kg)	RPD[b]	$CHCl_3$ (µg/kg)	RPD[b]
SDG 00-6-14, Analysis Date June 14, 2000							
Laboratory Blank	100	100	100				
AGEM methanol blank-6/14	96	82	86				
AD-QCDU-S-11678	95	81	85				
AD-Q6-S-11660	94	82	85				
AD-Q13-S-11675	91	78[c]	82	Not reanalyzed.			
AD-I5-S-11669	97	84	86				
20-µg/kg standard	104	96	97	19.94	0.3	21.42	6.8
SDG 00-6-15, Analysis Date June 15, 2000							
Laboratory Blank	100	100	100				
AD-F10-S-11588	107	109	111				
AD-QCDU-S-11681	109	110	113				
AD-Q15-S-11674	109	108	114				
AD-F11-S-11620	102	112	109				
AD-Q1-S-11649	98	103	104				
AD-Q6-S-11660DUP	114	108	108				
AD-QCDU-S-11326	112	107	106				
AD-Q11-S-11665	99	88	89				
AD-I3-S-11662	114	112	111				
AD-Q14-S-11323	106	102	102				
AD-Q4-S-11643	109	105	106				
AD-Q4-S-11643DUP	94	92	90				
AD-Q8-S-11655	104	99	100				
AD-QCDU-S-11327	112	104	105				
20-µg/kg standard	97	109	105	17.83	11.5	19.19	4.1
SDG 00-6-16, Analysis Date June 16, 2000							
Laboratory Blank	100	100	100				
AD-I1-S-11591	115	114	117				
AD-Q8-S-11656	114	109	113				
AD-F6-S-11578	110	102	109				
AD-F7-S-11580	110	105	114				
AD-F10-S-11587	100	100	104				
AD-I2-S-11589	99	98	102				
20-µg/kg standard	101	105	107	16.98	16.3	19.19	4.1

TABLE G.3 (Cont.)

Sample	Recovery of Surrogate Compounds[a] (%)			Measured Values for Calibration Check Standards			
	Fluoro-benzene	1,2-Dichloro-benzene-d_4	4-Bromo-fluorobenzene	CCl_4 (µg/kg)	RPD[b]	$CHCl_3$ (µg/kg)	RPD[b]
SDG 00-6-17, Analysis Date June 17, 2000							
Laboratory Blank	100	100	100				
AD-F2-S-11597	84	78[c]	76[c]	Not reanalyzed.			
AD-Q2-S-11647	87	80	81				
AD-Q13-S-11676	87	79[c]	79[c]	Not reanalyzed.			
AD-Q3-S-11645	85	76[c]	77[c]	Not reanalyzed.			
20-µg/kg standard	101	99	95	20.41	2	22.38	11.2
SDG 00-6-23, Analysis Date June 23, 2000							
Laboratory Blank	100	100	100				
AD-QCDU-S-11325	103	103	106				
AD-F6-S-11578DUP	103	102	102				
AD-F17-S-11609DUP	102	100	100				
AD-F17-S-11610DUP	103	100	104				
AD-F14-S-11615	101	98	100				
AD-Q4-S-11644DUP	109	106	107				
AD-Q3-S-11646DUP	96	95	98				
AD-Q2-S-11648DUP	96	95	97				
AD-Q1-S-11650	89	85	85				
AD-Q12-S-11651DUP	104	102	105				
AD-Q12-S-11652DUP	98	97	99				
AD-Q9-S-11653DUP	97	98	98				
AD-Q9-S-11654DUP	95	98	99				
AD-Q7-S-11657	96	97	98				
20-µg/kg standard	97	107	102	22.83	13.2	22.7	12.6

[a] Quality control limit = 80-120%.

[b] Quality control limit = ±20%.

[c] Surrogate recovery outside QC limit.

TABLE G.4 Results of Organic Analyses on Quality Control Samples Collected to Monitor Water Analyses at AGEM Laboratory by the Purge-and-Trap Method

	Recovery of Surrogate Compounds[a] (%)			Measured Values for Calibration Check Standards			
Sample	Fluoro-benzene	1,2-Dichloro-benzene-d_4	4-Bromo-fluorobenzene	CCl_4 (µg/L)	RPD[b]	$CHCl_3$ (µg/L)	RPD[b]
SDG 00-4-10, Analysis Date April 10, 2000							
Laboratory Blank	100	100	100				
ADRO-W-11303	104	113	111				
ADDR-W-11305	109	117	115				
ADTB01-W-11304	97	101	100				
20-µg/L standard	99	98	99	17.64	12.5	19.14	4.4
SDG 00-4-13, Analysis Date April 13, 2000							
Laboratory Blank	100	100	100				
ADPW70-1-W-11306	109	113	113				
ADPW79-1-W-11307	98	100	99				
ADPW64-1-W-11308	97	101	102				
ADPW64-1-W-11308DUP	99	101	103				
ADDW01-W-11309	91	97	96				
ADDW01-W-11309DUP	83	89	91				
ADQCDU-W-11310	95	98	99				
ADQCTB-W-11311	85	92	93				
20-µg/L standard	99	94	97	18.02	10.4	19.84	0.8
SDG 00-4-14, Analysis Date April 14, 2000							
Laboratory Blank	100	100	100				
ADQCTB-W-11316	103	106	108				
ADDW02-W-11312	115	118	118				
ADDW03-W-11313	105	107	105				
ADDW03-W-11313DUP	104	108	108				
ADDW04-W-11314	104	104	106				
ADDW05-W-11315	108	110	110				
ADDW05-W-11315DUP	99	100	100				
20-µg/L standard	107	105	110	18.12	9.9	19.49	2.6

TABLE G.4 (Cont.)

Sample	Recovery of Surrogate Compounds[a] (%)			Measured Values for Calibration Check Standards			
	Fluoro-benzene	1,2-Dichloro-benzene-d_4	4-Bromo-fluorobenzene	CCl_4 (µg/L)	RPD[b]	$CHCl_3$ (µg/L)	RPD[b]
SDG 00-4-18, Analysis Date April 18, 2000							
Laboratory Blank	100	100	100				
ADSB03-W-11341	110	109	110				
ADSB03-W-11342	110	108	111				
ADSB03-W-11343	103	104	104				
ADSB03-W-11343DUP	105	105	108				
ADMWB17-W-11318	106	104	106				
ADMWB12-W-11317	107	105	107				
ADQCTB-W-11319	106	103	106				
ADTB17-W-11344	102	98	100				
20-µg/L standard	108	95	100	20.69	3.4	22.11	10
SDG 00-4-19, Analysis Date April 19, 2000							
Laboratory Blank	100	100	100				
ADSB03-W-11346	104	112	110				
ADSB03-W-11346DUP	102	109	109				
ADSB03-W-11347	101	108	107				
ADSB03-W-11348	102	110	107				
ADSB03-W-11349	100	111	109				
ADSB03-W-11350	100	111	109				
ADTB18-W-11351	101	107	106				
ADSB04-W-11353	99	107	104				
20-µg/L standard	99	100	101	18.9	5.6	20.45	2.2
SDG 00-4-20, Analysis Date April 20, 2000							
Laboratory Blank	100	100	100				
ADSB05-W-11354	107	112	114				
ADSB05-W-11355	101	108	108				
ADSB05-W-11355DUP	100	106	105				
ADSB06-W-11356	101	108	105				
ADSB06-W-11357	91	99	95				
ADSB06-W-11357DUP	103	113	110				
20-µg/L standard	100	99	101	18.42	8.2	20.11	0.5

TABLE G.4 (Cont.)

Sample	Recovery of Surrogate Compounds[a] (%)			Measured Values for Calibration Check Standards			
	Fluoro-benzene	1,2-Dichloro-benzene-d_4	4-Bromo-fluorobenzene	CCl_4 (µg/L)	RPD[b]	$CHCl_3$ (µg/L)	RPD[b]
SDG 00-4-21, Analysis Date April 21, 2000							
Laboratory Blank	100	100	100				
ADSB04-W-11358	96	97	92				
ADSB06-W-11359	102	102	101				
ADSB06-W-11360	98	98	96				
ADSB06-W-11361	97	100	98				
ADSB06-W-11362	95	97	98				
ADSB06-W-11363	95	97	96				
ADSB07-W-11365	94	94	94				
ADSB07-W-11366	93	94	96				
ADSB07-W-11366DUP	110	98	103				
ADTB20-W-11364	107	107	108				
20-µg/L standard	97	82	82	20	0	20.95	4.6
SDG 00-4-24, Analysis Date April 24, 2000							
Laboratory Blank	100	100	100				
ADSB07-W-11368	106	107	109				
ADSB08-W-11372	98	105	107				
ADSB08-W-11369	106	111	111				
ADSB08-W-11371	104	110	111				
ADSB08-W-11371DUP	88	101	99				
ADTB21-W-11370	103	103	106				
20-µg/L standard	104	101	104	17.57	12.9	19.43	2.9
SDG 00-4-25, Analysis Date April 25, 2000							
Laboratory Blank	100	100	100				
ADSB09-W-11375	101	106	101				
ADSB08-W-11373	97	103	94				
ADSB09-W-11379	99	102	101				
ADSB09-W-11378	95	100	97				
ADSB09-W-11378DUP	96	98	97				
ADSB07-W-11368DUP	98	99	98				
ADSB09-W-11376	98	250[c]	3887[c]	Solvent blank not reanalyzed.			
ADSB09-W-11377	92	129[c]	380[c]	Silicon blank not reanalyzed.			
ADSB08-W-11374	91	77[c]	181[c]	Silicon blank not reanalyzed.			
20-µg/L standard	104	102	101	18.35	8.6	18.3	8.8

TABLE G.4 (Cont.)

Sample	Recovery of Surrogate Compounds[a] (%)			Measured Values for Calibration Check Standards			
	Fluoro-benzene	1,2-Dichloro-benzene-d_4	4-Bromo-fluorobenzene	CCl_4 (µg/L)	RPD[b]	$CHCl_3$ (µg/L)	RPD[b]
SDG 00-4-27, Analysis Date April 27, 2000							
Laboratory Blank	100	100	100				
ADSB09-W-11380	97	105	101				
ADSB09-W-11382	99	107	104				
ADSB06-W-11383	99	108	102				
ADTB25-W-11384	97	104	103				
ADSB10-W-11385	75[c]	93	85	Initial analysis not reported.			
ADSB10-W-11385	92	101	95	Second analysis reported.			
ADSB10-W-11387	95	105	103				
ADSB10-W-11390	96	102	97				
ADSB10-W-11389	95	101	98				
ADSB10-W-11391	97	104	97				
ADSB10-W-11392	96	107	100				
ADSB11-W-11393	96	103	98				
ADSB11-W-11395	81	93	88				
ADSB11-W-11395DUP	95	103	96				
ADSB11-W-11400DUP	99	109	101				
ADTB26-W-11401	87	98	90				
ADSB11-W-11403	95	102	95				
ADSB11-W-11396	93	101	93				
ADSB11-W-11397	92	100	95				
ADSB12-W-11398	88	83	83				
20-µg/L standard	95	98	99	20.23	1.1	20.92	4.5
SDG 00-4-28, Analysis Date April 28, 2000							
Laboratory Blank	100	100	100				
ADSB11-W-11405	106	111	104				
ADSB13-W-11406	103	105	104				
ADSB13-W-11407	104	108	106				
ADSB13-W-11408	102	105	101				
ADSB13-W-11409	87	96	93				
ADSB13-W-11409DUP	97	99	95				
ADSB13-W-11410	99	98	94				
ADTB27-W-11411	98	88	89				
ADSB13-W-11412	99	101	97				
ADSB13-W-11413	101	103	102				
ADSB11-W-11400	100	103	101				
20-µg/L standard	105	104	102	19.39	3.1	21.27	6.2

TABLE G.4 (Cont.)

Sample	Recovery of Surrogate Compounds[a] (%)			Measured Values for Calibration Check Standards			
	Fluoro-benzene	1,2-Dichloro-benzene-d_4	4-Bromo-fluorobenzene	CCl_4 (µg/L)	RPD[b]	$CHCl_3$ (µg/L)	RPD[b]
SDG 00-5-1, Analysis Date May 1, 2000							
Laboratory Blank	100	100	100				
ADSB16-W-11432	102	103	105				
ADSB16-W-11423	101	103	106				
ADSB16-W-11421	99	103	106				
ADSB16-W-11430	100	103	106				
ADSB16-W-11429	99	103	104				
ADSB16-W-11422	93	99	101				
ADSB16-W-11424	94	98	101				
ADTB28-W-11415	94	96	98				
ADSB09-W-11427	91	81	89				
ADSB09-W-11428	90	99	101				
ADSB09-W-11425	91	98	100				
ADSB09-W-11425DUP	91	100	101				
ADSB09-W-11426	91	96	100				
ADSB15-W-11417	92	98	101				
ADBR30-W-11431	90	95	98				
ADSB14-W-11416	87	98	100				
ADSB14-W-11418	84	94	95				
ADSB04-W-11419	88	97	100				
ADSB04-W-11420	87	96	98				
ADSB04-W-11420DUP	87	95	96				
20-µg/L standard	100	99	102	21.06	5.2	21.46	7
SDG 00-5-2, Analysis Date May 2, 2000							
Laboratory Blank	100	100	100				
ADSB06-W-11433	109	113	111				
ADRR01-W-11434	102	108	107				
ADINIT-W-11435	107	110	108				
ADSB08-W-11436	108	111	110				
ADSB08-W-11437	106	109	107				
ADSB08-W-11438	105	108	109				
ADSB08-W-11439	102	105	105				
ADSB08-W-11440	104	106	107				
ADSB08-W-11440DUP	99	91	95				
ADTB08-W-11441	102	104	104				
ADBR08-W-11442	103	105	104				
ADRR08-W-11443	102	106	104				
20-µg/L standard	98	99	100	18.7	6.7	19.32	3.5

TABLE G.4 (Cont.)

Sample	Recovery of Surrogate Compounds[a] (%)			Measured Values for Calibration Check Standards			
	Fluoro-benzene	1,2-Dichloro-benzene-d_4	4-Bromo-fluorobenzene	CCl_4 (µg/L)	RPD[b]	$CHCl_3$ (µg/L)	RPD[b]
SDG 00-5-3, Analysis Date May 3, 2000							
Laboratory Blank	100	100	100				
ADSB18-W-11444	110	111	114				
ADSB18-W-11445	108	109	113				
ADSB18-W-11446	107	106	108				
ADSB18-W-11447	104	105	109				
ADSB18-W-11448	103	107	109				
ADSB18-W-11449	104	107	108				
ADSB18-W-11450	103	107	110				
ADSB18-W-11450DUP	102	104	107				
ADSB18-W-11451	100	89	94				
ADSB18-W-11452	101	101	104				
ADSB18-W-11453	102	101	105				
ADTB02-W-11454	100	101	105				
ADSB18-W-11455	100	104	108				
ADBR2A-W-11456	102	102	105				
ADRR02-W-11457	101	101	104				
20-µg/L standard	104	96	102	16.64	18.3	18.03	10.4

[a] Quality control limit = 80-120%.

[b] Quality control limit = ±20%.

[c] Surrogate recovery outside QC limit.

TABLE G.5 Results of Analyses of Carbon Tetrachloride and Chloroform Standards at AGEM Laboratory

Sample	Carbon Tetrachloride			Chloroform		
	Actual (μg/L)	Measured (μg/L)	RPD (%)	Actual (μg/L)	Measured (μg/L)	RPD (%)
ADSB06-W-11357	983	954	3	978	824	17.1
ADSB06-W-11357DUP	983	971	1.2	978	827	16.7
ADSB06-W-11360	9.93	9.1	8.7	9.98	8.3	18.3
ADSB07-W-11368	4.96	5.3	6.6	4.94	4.5	9.3
ADSB07-W-11368DUP	4.96	4.8	3.3	4.94	4.2	16.2

TABLE G.6 Recovery of System-Monitoring Compounds in Organic Analyses of Water Samples at Clayton Laboratory[a]

Sample	Analysis Date	Sample Delivery Group	Recovery[a] (%)		
			Toluene-d_8	Bromofluoro-benzene	1,2-Dichloro-ethane-d_4
VBLKAA	4/29/00	40780-ARG65	100	94	94
ADDW04-W-11314MSD	4/29/00	40780-ARG65	100	92	98
ADDW04-W-11314MSD	4/29/00	40780-ARG65	100	96	98
ADSB03-W-11342	4/29/00	40780-ARG65	98	94	100
ADSB03-W-11346	4/29/00	40780-ARG65	98	92	100
ADSB03-W-11348	4/29/00	40780-ARG65	98	96	100
ADTB18-W-11351	4/29/00	40780-ARG65	100	94	100
ADSB04-W-11353	4/29/00	40780-ARG65	100	94	96
ADDW04-W-11314	4/29/00	40780-ARG65	102	98	100
VHBLKAA	4/29/00	40780-ARG65	102	94	100
VBLKAE	5/4/00	41114-ARG66	102	98	104
ADSB09-W-11380	5/4/00	41114-ARG66	98	96	104
ADSB10-W-11385	5/4/00	41114-ARG66	102	98	106
ADSB10-W-11389	5/4/00	41114-ARG66	100	94	104
ADSB12-W-11398	5/4/00	41114-ARG66	102	98	102
ADTB26-W-11401	5/4/00	41114-ARG66	104	100	106
VBLKAF	5/5/00	41114-ARG66	100	100	98
ADSB11-W-11396	5/5/00	41114-ARG66	104	100	102
ADSB11-W-11396MS	5/5/00	41114-ARG66	100	100	100
ADSB11-W-11396MSD	5/5/00	41114-ARG66	100	100	102
VHBLKAA	5/5/00	41114-ARG66	100	98	102

[a] Quality control limits are as follows:

Compound	Recovery (%)
Toluene-d_8	88-110
Bromofluorobenzene	86-115
1,2-Dichloroethane-d_4	76-114

TABLE G.7 Recovery and Relative Percent Difference Values for Matrix Spike/Matrix Spike Duplicate Organic Analyses at Clayton Laboratory with CLP Methodology

Compound	Concentration (μg/L)				Recovery (%)			Relative Percent Difference	
	Sample	Spike Added	MS	MSD	MS	MSD	QC Limit	RPD	QC Limit
MS/MSD Analysis of ANDW04-W-11341 with SDG 40780-ARG65									
1,1-Dichloroethene	0	50	44	41	88	82	61-145	7	14
Benzene	0	50	57	46	114	92	76-127	21[a]	11
Trichloroethene	0	50	50	43	100	86	71-120	15[a]	14
Toluene	0	50	59	47	118	94	76-125	23[a]	13
Chlorobenzene	0	50	61	50	122	100	75-130	20[a]	13
MS/MSD Analysis of ANSB11-W-11396 with SDG 41114-ARG66									
1,1-Dichloroethene	0	50	32	44	64	88	61-145	32[a]	14
Benzene	0	50	43	55	86	110	76-127	24[a]	11
Trichloroethene	0	50	45	58	90	116	71-120	25[a]	14
Toluene	0	27	73	86	92	118	76-125	25[a]	13
Chlorobenzene	0	50	47	59	94	118	75-130	23[a]	13

[a] Value outside QC limit.

TABLE G.8 Relative Percent Difference in Carbon Tetrachloride and Chloroform Concentrations for Verification Analyses of Water Samples

				Carbon Tetrachloride			Chloroform		
Location	Sample	Depth (ft BGL)	Sample Date	AGEM (μg/L)	CLP[a] (μg/L)	RPD (%)	AGEM (μg/L)	CLP[a] (μg/L)	RPD (%)
DW04	ADDW04-W-11314	Unk	4/13/00	< 5[b]	< 5	-[c]	< 5	< 5	-
DW04	ADDW04-W-11314	Unk	4/13/00						
SB03	ADSB03-W-11342	32.8 -39.4	4/17/00	56	45	21.7	13	12	8
SB03	ADSB03-W-11342	32.8 -39.4	4/17/00						
SB03	ADSB03-W-11348	45.9 -49.2	4/18/00	< 5	< 5	-	< 5	< 5	-
SB03	ADSB03-W-11348	45.9 -49.2	4/18/00						
SB03	ADSB03-W-11346	52.48 -62.32	4/18/00	< 5	< 5	-	< 5	< 5	-
SB03	ADSB03-W-11346	52.48 -62.32	4/18/00						
SB04	ADSB04-W-11353	34.44 -41	4/18/00	< 5	< 5	-	< 5	< 5	-
SB04	ADSB04-W-11353	34.44 -41	4/18/00						
SB09	ADSB09-W-11380	40.3 -42.6	4/25/00	< 5	< 5	-	< 5	< 5	-
SB09	ADSB09-W-11380	40.3 -42.6	4/25/00						
SB10	ADSB10-W-11385	29.08 -36.08	4/25/00	< 5	< 5	-	< 5	< 5	-
SB10	ADSB10-W-11385	29.08 -36.08	4/25/00						
SB10	ADSB10-W-11389	48 -52.8	4/25/00	< 5	< 5	-	< 5	< 5	-
SB10	ADSB10-W-11389	48 -52.8	4/25/00						
SB11	ADSB11-W-11396	54.5 -59.3	4/26/00	< 5	< 5	-	< 5	< 5	-
SB11	ADSB11-W-11396	54.5 -59.3	4/26/00						
SB12	ADSB12-W-11398	29.6 -39.3	4/26/00	< 5	< 5	-	< 5	< 5	-
SB12	ADSB12-W-11398	29.6 -39.3	4/26/00						

[a] Relative percent difference for matrix spike/matrix spike duplicate analyses were outside the quality control limit.

[b] < 5, not detected above the EPA CLP quantitation limit of 5 μg/L.

[c] Analyte concentration below the quantitation limit in both the sample and replicate analyses.

TABLE G.9 Percent Recovery of Known Analyte Concentrations Obtained during Inorganic Analysis of Laboratory Quality Control Samples at Severn-Trent Laboratory, Colchester, Vermont[a]

	SDG						
Compound	77736	77748	77772	77779	77813	77830	77798
Chloride	98	98	98	100	100	102	93
Sulfate	100	98	98	100	100	102	100
Nitrate	93	95	95	95	98	99	97
Phosphate	95	142[b]	142[b]	142[b]	110	114	107
Ammonia nitrogen	99	99	99	NA[c]	NA	NA	NA
Aluminum	99	99	100	100	NA	100	96
Calcium	107	107	108	108	NA	108	108
Iron	101	101	102	102	NA	96	98
Magnesium	103	103	104	104	NA	104	104
Manganese	101	101	101	101	NA	101	104
Potassium	99	99	100	100	NA	100	100
Phosphorus	115	115	111	111	NA	111	111
Sodium	100	100	101	101	NA	101	101
Silicon	104	104	103	103	NA	103	103
Zinc	104	104	106	101	NA	101	94

	SDG					
Compound	77996	77857	77877	77905	77929	78013
Chloride	100	100	102	101	101	102
Sulfate	103	101	103	103	103	104
Nitrate	99	99	100	100	100	100
Phosphate	113	110	111	113	110	118
Ammonia nitrogen	NA	NA	NA	NA	NA	NA
Aluminum	NA	107	107	104	104	103
Calcium	NA	105	105	108	108	106
Iron	NA	105	105	105	110	107
Magnesium	NA	109	109	107	107	108
Manganese	NA	106	106	103	103	105
Potassium	NA	107	107	105	105	112
Phosphorus	NA	109	109	109	111	111
Sodium	NA	108	108	104	104	110
Silicon	NA	106	106	106	105	107
Zinc	NA	104	104	104	102	104

[a] Quality control limit for percent recovery = 80-120%.

[b] Outside quality control limit.

[c] NA, samples in this sample delivery group were not analyzed for this parameter.

TABLE G.10 Calculated Relative Percent Difference in Duplicate Inorganic Analyses of Groundwater Samples at Severn-Trent Laboratory

	Concentration (μg/L)		
Analyte	Sample Analysis	Duplicate Analysis	RPD
Analysis of Sample ADPW64-1-W-11308 and Replicate ADQCDU-W-11310 in SDG 77736			
Chloride	70900	66900	5.8
Sulfate	59400	57800	2.7
Nitrate	15000	14500	3.4
Phosphate	500	500	0
Ammonia nitrogen	40	70	54.5
Aluminum	< 200	< 200	-[a]
Calcium	101000	95000	6.1
Iron	< 100	< 100	-
Magnesium	20500	19300	6
Manganese	< 15	< 15	-
Potassium	5880	5500	6.7
Phosphorus	658	616	6.6
Sodium	33400	32600	2.4
Silicon	20700	19700	4.9
Zinc	< 20	< 20	-
Duplicate Laboratory Analysis of ADSB03-W-11349 in SDG 77798			
Chloride	22600	23500	3.9
Sulfate	93800	97400	3.8
Nitrate	14200	14200	0
Phosphate	< 200	< 200	-
Aluminum	< 200	< 200	-
Calcium	110000	113000	2.7
Iron	< 100	< 100	-
Magnesium	16700	17300	3.5
Manganese	392	382	2.6
Potassium	14400	14900	3.4
Phosphorus	< 250	< 250	-
Sodium	61300	63400	3.4
Silicon	15200	15800	3.9
Zinc	39.4	34.3	13.8

TABLE G.10 (Cont.)

Analyte	Concentration (μg/L) Sample Analysis	Duplicate Analysis	RPD
Duplicate Laboratory Analysis of ADSB11-W-11399 in SDG 77905			
Chloride	26200	25700	1.9
Sulfate	72300	72600	0.4
Nitrate	16300	16300	0
Phosphate	< 200	< 200	-
Aluminum	< 200	< 200	-
Calcium	89100	88700	0.4
Iron	< 100	< 100	-
Magnesium	17900	17700	1.1
Manganese	166	165	0.6
Potassium	13600	13400	1.5
Phosphorus	< 250	< 250	-
Sodium	48400	47500	1.9
Silicon	19800	19500	1.5
Zinc	< 20	< 20	-
Duplicate Laboratory Analysis of ADSB04-W-11419 in SDG 78013			
Chloride	26100	25700	1.5
Sulfate	59300	58800	0.8
Nitrate	9700	9700	0
Phosphate	< 200	< 200	-
Aluminum	< 200	< 200	-
Calcium	85900	84600	1.5
Iron	< 100	< 100	-
Magnesium	15000	14800	1.3
Manganese	1060	1040	1.9
Potassium	8900	8880	0.2
Phosphorus	< 250	< 250	-
Sodium	37400	37400	0
Silicon	16500	16200	1.8
Zinc	249	245	1.6

TABLE G.10 (Cont.)

Analyte	Concentration (μg/L) Sample Analysis	Duplicate Analysis	RPD
Duplicate Laboratory Analysis of ADSB18-W-11448 in SDG 78013			
Chloride	10100	10200	1.0
Sulfate	46700	44300	5.3
Nitrate	15500	15500	0
Phosphate	< 200	< 200	-
Aluminum	< 200	< 200	-
Calcium	66800	68200	2.1
Iron	111	146	27.2
Magnesium	13700	14000	2.2
Manganese	202	206	2
Potassium	6030	6150	2
Phosphorus	< 250	< 250	-
Sodium	26900	27600	2.6
Silicon	20400	20800	1.9
Zinc	31.6	31	1.9

[a] Analyte concentration below the quantitation limit in both the sample and duplicate analysis.

Appendix H:

Numerical Models

Appendix H:

Numerical Models

To facilitate the investigation of probable groundwater flow and contaminant migration pathways, a three-dimensional numerical model of groundwater flow was developed for the Pleistocene aquifer at Adams, Nebraska, by using advective transport (particle tracking) analyses. This section documents details of the conceptual model, numerical model design, model calibration, and model sensitivity analyses.

H.1 Summary of the Conceptual Hydrogeologic Model

An updated conceptual model of the geology, hydrogeology, and hydrogeochemistry of the Adams area was established from the Phase I investigation (Section 4). The conceptual model includes the following essential features that affect the groundwater flow at the Adams site, therefore providing constraints for the numerical aquifer model:

- The top two units, loess and sandy silt and clay, generally act as a leaky confining layer with a very low permeability. Vertical infiltration of surface water takes place by leakage through this layer.

- The Pleistocene sand and gravel unit at Adams represents the southern edge of the extensive fluvial sands and gravels that fill the paleovalley. The thickness of the unit is about 35-45 ft at Adams, increasing northward and northeastward to more than 100 ft near the Middle Branch Big Nemaha River. The sand and gravel unit is a semiconfined aquifer that is the major source of water for public, domestic, and irrigation requirements at Adams.

- At the present, groundwater in the fluvial sand and gravel aquifer flows eastward with a gentle hydraulic gradient of 0.0016. Groundwater locally enters the Pleistocene aquifer by seepage from glacial till through the saturated gray silt unit at the southern edge of the aquifer, as well as by rainwater infiltration through the overlying loess and sandy silt units.

- A saturated or partially saturated glacial silt unit is a very poor aquifer with a low permeability, located between the fluvial aquifer and the glacial till layer

in the glacial drift hills. Regional data indicate that the glacial till also has a low permeability and that sufficient water cannot be produced from this layer to supply a domestic well.

- Dry and dense blue-gray Pleistocene silt or limestone bedrock confines the overlying fluvial aquifer and the saturated to partially saturated glacial silt.

H.2 Numerical Model Design

A rectangular domain measuring 26,000 ft in the west-east direction by 24,000 ft in the south-north direction was constructed with 152 columns (west-east) and 137 rows (south-north). Figure H.1 shows the areal extent of the groundwater flow model at Adams and the surrounding area. Variable grid spacing was used to provide the highest model resolution ($\Delta x_{min} = \Delta y_{min} = 50$ ft) in areas of known groundwater contamination within the study area. The geographic limits of the model were chosen to coincide with boundaries of a natural watershed to eliminate the effect of artificially imposed boundaries on the model results. Middle Branch Big Nemaha River forms the northeastern boundary of the model, and watershed dividers along the middle ridge of the hill form the eastern, southern, western, and northwestern boundaries. To improve computation efficiency, the grid was coarsened toward the boundaries, away from the study area. The grid was constructed by using the Adams 7.5 minute quadrangle (USGS 1965) as a base.

The Adams groundwater flow model was vertically divided into three layers incorporating all stratigraphic units. The first layer includes the top two units, loess and sandy silt and clay. The second and third layers represent the upper and lower parts of fluvial aquifer and the gray silt unit, respectively. A dry, dense, blue-gray Pleistocene silt unit and bedrock define the lower no-flow boundary of the model. With a nonhorizontal layering approach (Harte 1994), the vertical structure of the model corresponds reasonably well to the geologic cross sections presented in Section 4. Figures H.2-H.4 show three model cross sections that compare favorably with Figures 4.8-4.10. Groundwater flow equations were based on the assumption that hydraulic properties are uniform within individual cells. This condition is more likely to be met when model layers are nonhorizontal and thus conform to the geometry of the hydrogeologic units.

The elevation of each model layer was determined from field and regional data and by interpolation or extrapolation where necessary. The elevation of the top of layer 1 (loess and sandy silt and clay), the land surface, was established by augmenting the USGS digital elevation

model for the Adams groundwater flow model domain with finer-spatial-scale data obtained in the field investigation. The elevation of the top of each subsequent layer was determined from the results of the Phase I investigation with interpolation between data points. Model layer elevation data for areas beyond the geographic limits of the Phase I investigation were extrapolated from regional data, in keeping with regional geologic trends.

The model boundaries were specifically designed to capture all influences on local groundwater flow at Adams. Constant-head boundaries were set along the Middle Branch Big Nemaha River and the northwest fluvial aquifer boundary for layers 2 and 3 (Figure H.1). The values of the constant head, based on estimated water levels along the river, were adjusted during calibration until a close match was achieved with the water levels measured in the aquifer during Phase I. All of the other external boundaries of the flow domain are no-flow boundaries along watershed divides.

A block-heterogeneous distribution of hydraulic properties was used to simulate the spatial variability of the lithologic characteristics within each model layer. Model layers 2 and 3 include the glacial silt unit and the fluvial aquifer. Hydraulic conductivities for these units were estimated on the basis of results of grain size analyses by using the Hazen equation for well-sorted grains and the Breyer equation for poorly sorted grains (Vukovic and Soro 1992). The estimated hydraulic conductivity for the glacial silt unit was 10^{-2} ft/d. The fluvial aquifer has higher hydraulic conductivities at its top and bottom (up to 100 ft/d) and lower values at its middle (less than 50 ft/d) (see Figures 4.11 and 4.12). Model layer 2 contains only the upper part of the fluvial aquifer, and model layer 3 includes both the middle and lower parts of the aquifer. Figures H.5 and H.6 show the hydraulic conductivity distributions for model layers 2 and 3, respectively. Hydraulic conductivity for the loess unit overlying the aquifer and for the glacial silt unit were initially determined from the literature (e.g., Heath 1984; de Marsily 1986; Anderson and Woessner 1992) and refined during calibration. The final calibrated hydraulic conductivities for each model layer are in Table H.1.

No direct measurements of storativity were made for the hydrogeologic units at Adams. Representative values from the literature were used. A specific yield of 0.02 ft^{-1} was used for model layer 1 (loess unit), and a specific storage of 10^{-6} ft^{-1} was used for model layers 2 and 3 (fluvial aquifer and glacial till unit) in the final calibrated flow model.

TABLE H.1 Hydraulic Conductivity Values for Adams Groundwater Flow Model

Model Layer	Stratigraphic Unit	Hydraulic Conductivity (ft/d)	
		Horizontal, K_h	Vertical, K_v
1	Loess and sandy silt	0.02	0.02
2a	Glacial silt	0.05	0.05
2b	Upper aquifer	40	40
2c	Upper aquifer	100	100
3a	Glacial silt	0.05	0.05
3b	Lower aquifer	60	60

Recharge has a major influence on model behavior, but it is difficult to estimate for several reasons. The conventional method of estimating recharge (i.e., precipitation minus evapotranspiration minus runoff, with allowances for changes in soil moisture storage) is very sensitive to measurement errors and frequently leads to underestimates of recharge (Howard and Lloyd 1979). Recharge is spatially variable and is usually limited over areas with high slopes. For the Adams flow model, recharge was assumed to occur over the flat areas in uplands and lowlands. Figure H.7 shows the recharge areas within the model domain where recharge was prescribed. Recharge was adjusted during model calibration to simulate a set of water level measurements taken on May 11, 2000, under both transient and quasi-steady-state conditions (see below). The final, calibrated, uniform recharge rates were 6.5 in./yr for the transit flow model and 0.67 in./yr for the steady-state flow model. The steady-state flow model did not consider the stresses imposed on the aquifer by pumping of the public water supply wells. Consequently, the calibrated recharge rate appears to be unrealistically low. The recharge rate for the transient flow model, which takes into consideration the effects of current pumping on the groundwater system, is reasonable when compared to calibrated rates for previously investigated sites in eastern Nebraska and northeastern Kansas (Argonne 1998, 1999).

H.3 Model Calibration and Testing

The Pleistocene fluvial aquifer at Adams represents the southern edge of the extensive sand and gravel unit that occupies the paleovalley. Groundwater monitoring during Phase I indicated that the groundwater system at Adams is significantly affected by routine pumping of the public water supply wells. During periods of low rainfall, the aquifer is under stress, because groundwater recharge to the aquifer from the drift hills cannot immediately compensate for

discharge from the fluvial aquifer due to pumping. Consequently, groundwater levels observed at Adams in Phase I reflect a lower water level than predicted for the unstressed (steady-state) aquifer, and steady-state flow models calibrated against these data underestimate aquifer production. To develop a flow model closer to the real Adams groundwater flow system, a transient flow model was calibrated against the observed water levels with pumping at wells PWS 70-1 and 79-1. The following assumptions or estimates have been made to limit the uncertainties:

1. Groundwater level measurements in the fluvial aquifer taken on May 11, 2000, were used as the calibration baseline. The locations of the observation wells are in Figure H.8. Well hydrograph records from May 2 through July 10, 2000 (Figures 4.14 and 4.15), indicate that the general hydraulic gradient and flow pattern remains constant, except during active pumping of the irrigation wells. The May 11 water levels represent a flow regime under long-term stress due to continuous pumping at PWS 70-1 and PWS 79-1.

2. The model calibration attempted to achieve good agreement between the measured water levels and simulated hydraulic heads in the aquifer over a period of 20-70 yr. However, no long-term (e.g., a year or more) set of observed groundwater levels was available as a calibration baseline for the transient model. The recent history of the public water system indicates that the first public supply well was registered in 1930 (PWS 30-1), and wells were added to the system in 1949, 1956, 1964, 1971, and 1981. For modeling, the assumption was that annual public water supply withdrawals have remained relatively constant at Adams over the past 20-70 yr.

3. The overall pumping rate for the public water supply system was estimated from the recent average daily water consumption of wells (90,975 gpd) recorded by the village of Adams (Village of Adams Water Department 2000), equivalent to an average pumping rate of 63 gpm.

Calibration was accomplished through a trial-and-error, iterative process of adjusting specific model parameters to achieve the best possible match to the measured water levels. This process was repeated until no significant improvement in the match of simulated hydraulic heads to measured water levels could be achieved. After 20 yr, the simulated hydraulic heads for the

Adams transient model show little change. The best match was quantified by the average of root mean squared (RMS) errors calculated for every 10-yr interval from 20 to 70 yr. During calibration, parameter adjustments were made heuristically. The following parameters, listed in their general order of consideration, were adjusted:

- Horizontal hydraulic conductivity, K_h, of the aquifer and glacial silt unit (layers 2 and 3)
- Hydraulic conductivity, K, of the loess unit (layer 1)
- Recharge rate
- Constant-head boundaries in the aquifer (layers 2 and 3)

The final calibrated model reached minimum RMS errors of 0.25-0.54 ft over the 20- to 70-yr simulation. The standard errors of the estimate were 0.066-0.091 ft. Figure H.9 shows the results of model calibration for 50 yr. Good agreement was achieved between measured water levels and simulated hydraulic heads in the final calibrated flow model. Figure H.10 shows the simulated potentiometric surface configuration at 50 yr.

For comparison, a steady-state flow model was calibrated against measured water levels for stress-free conditions (pumps turned off). The calibrated steady-state flow model suggests an unreasonably low recharge rate (0.67 ft/d) for the groundwater system at Adams, if all other parameters remain the same. This result underestimates recharge to the groundwater system as a direct consequence of the assumption (for this simulation) of no influence on the flow system due to pumping of the municipal wells.

H.4 Sensitivity Analyses

The purpose of sensitivity analysis is to address the uncertainty in the calibrated model caused by uncertainty in the estimates of parameters and boundary conditions (Anderson and Woessner 1992). Sensitivity testing of the Adams flow model consisted of systematic perturbation of the most significant model parameters (recharge, hydraulic conductivity in

layer 1, and constant-head boundaries). A simulation was computed for each perturbation, and the deviation from the measured water levels on May 11, 2000, was calculated.

To provide an unbiased, quantitative, comparative measure of model sensitivity for each sensitivity analysis simulation, the RMS errors were calculated for each parameter perturbation simulated for 20-70 yr at 10-yr intervals. The RMS error was calculated according to the equation

$$\mathrm{RMS} = \frac{1}{n}\sqrt{\sum_{i=1}^{n}(h_s - h_o)_i^2} \ , \qquad \text{(H.1)}$$

where h_o equals the calibrated water levels, h_s equals the simulated water level from the sensitivity analysis, and n equals the number of observation wells.

The sensitivity of the Adams flow model to change in recharge rate was tested by increasing and decreasing the calibrated rate by 25% while all other parameters remained at their calibration values. As expected, simulated hydraulic heads were sensitive to changes in recharge (Figures H.11). Both increasing and decreasing the recharge rate caused simulated hydraulic heads to deviate from the observed water levels and led to higher average RMS error for the 20- to 70-yr simulations (Figure H.12). Another test was conducted by increasing and decreasing the hydraulic conductivity of layer 1 by an order of magnitude from the calibrated value of 0.02 ft/d. Results indicate that simulated water levels are also sensitive to hydraulic conductivity in layer 1. Figures H.11 and H.12 show that the simulated heads are most sensitive to the imposed increase in the hydraulic conductivity of layer 1. Finally, two simulations were performed by raising and lowering the constant-head boundaries by 2 ft. As Figure H.11 shows, RMS errors increase or decrease by a similar amount with changes in constant-head boundaries. The average RMS error for the 20- to 70-yr simulation is about 1.8-1.9 ft (Figure H.12).

The sensitivity analyses conducted for the Adams transient flow model qualitatively suggest that the simulated water levels are highly sensitive to recharge, the hydraulic conductivity of layer 1, and the constant-head boundaries. Figures H.11 and H.12 demonstrate that parameters selected through a systematic calibration process (Section H.3) provide the best fit of the flow model to the measured data. However, this approach to sensitivity analysis does not address the combined effects of multiple changes in various hydrogeologic properties.

H.5 Summary

The results presented in this section demonstrate that the Adams numerical flow model, based on the updated conceptual model of the geology, hydrogeology, and hydrogeochemistry at the site, is consistent with site-specific geologic and hydrogeologic data, as well as with data from similar groundwater systems. The simulated groundwater flow pattern is in general quantitative agreement with the observed characteristics of the actual groundwater system at Adams. Therefore, the calibrated transient model is appropriate for particle tracking analysis to evaluate historical pumping effects on potential contaminant migration pathways in the Pleistocene fluvial aquifer.

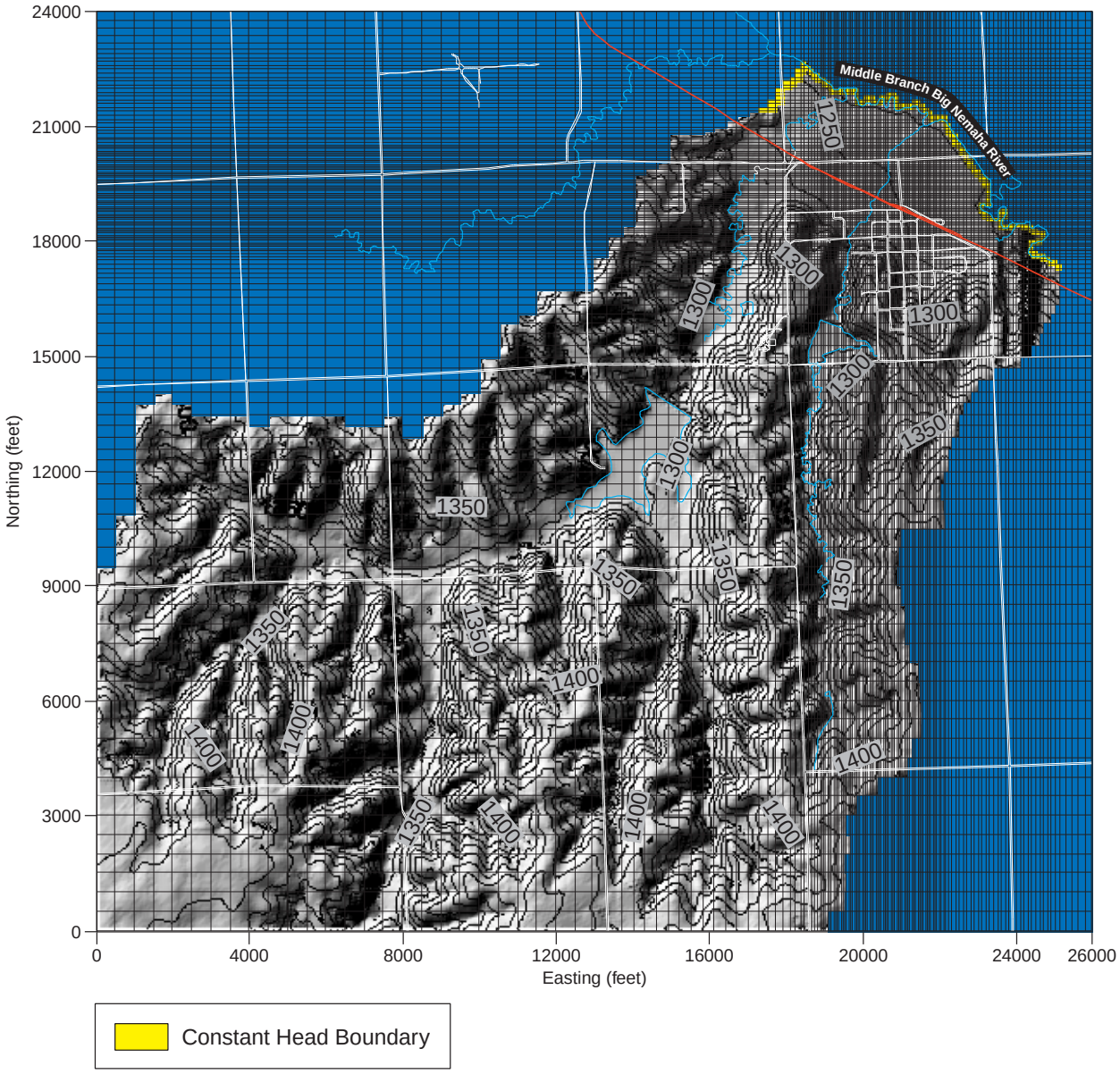


FIGURE H.1 Adams Groundwater Flow Model Domain, Showing the Grid Overlying the U.S. Geological Survey 7.5 Minute Topographic Map

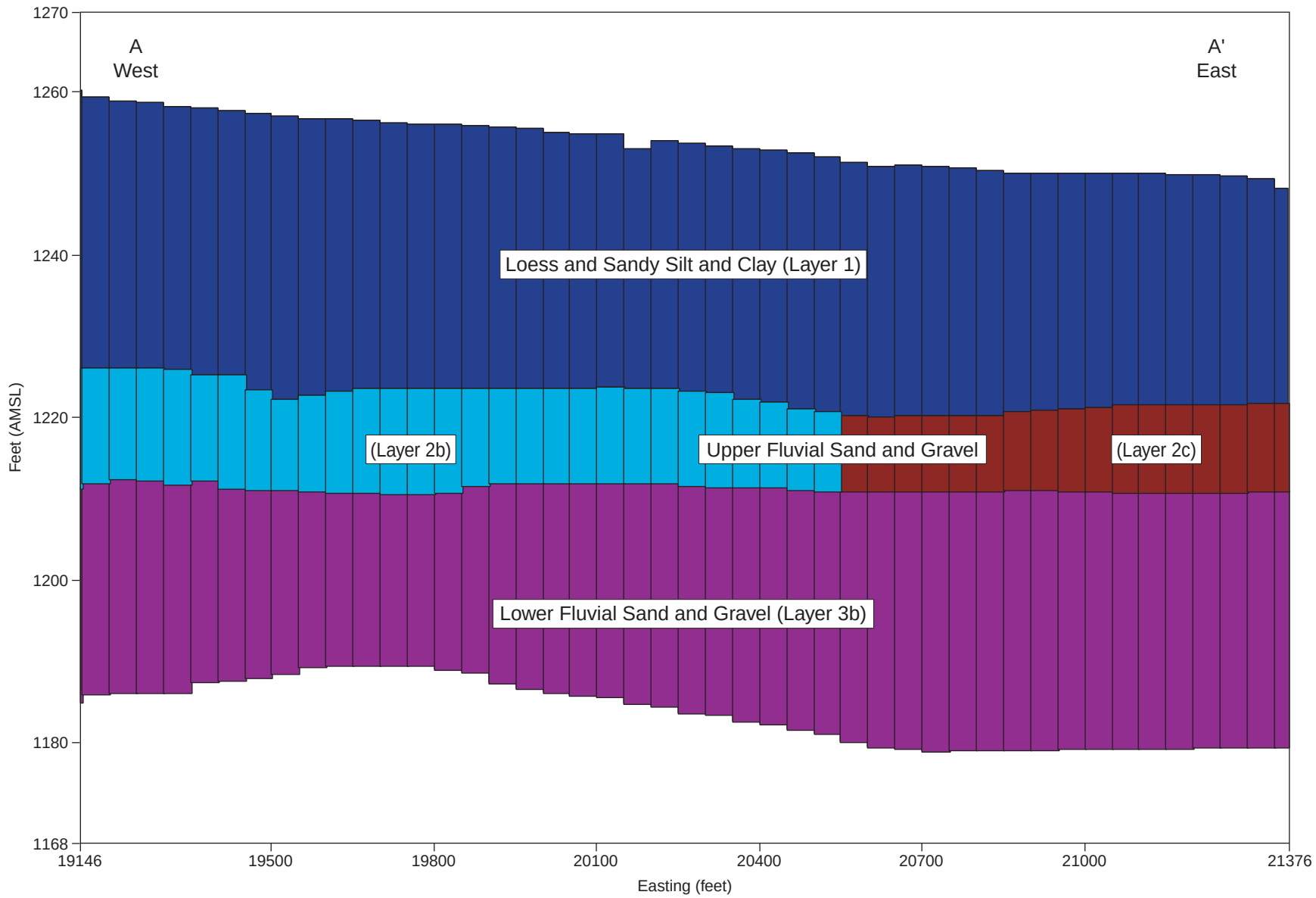


FIGURE H.2 Adams Groundwater Flow Model West-East Cross Section, Equivalent to Geologic Cross Section A-A´ Shown in Figure 4.8

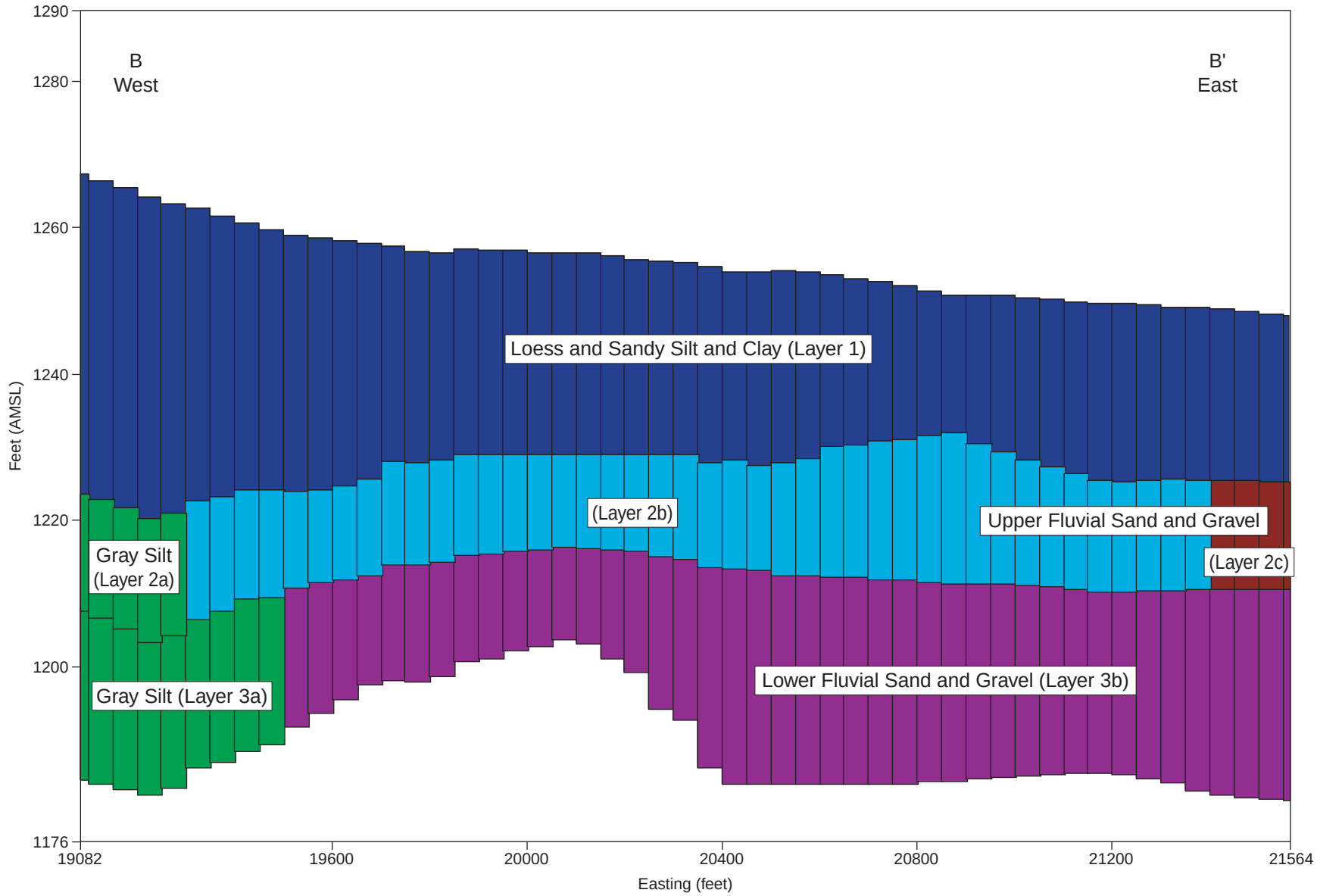


FIGURE H.3 Adams Groundwater Flow Model West-East Cross Section, Equivalent to Geologic Cross Section B-B´ Shown in Figure 4.9

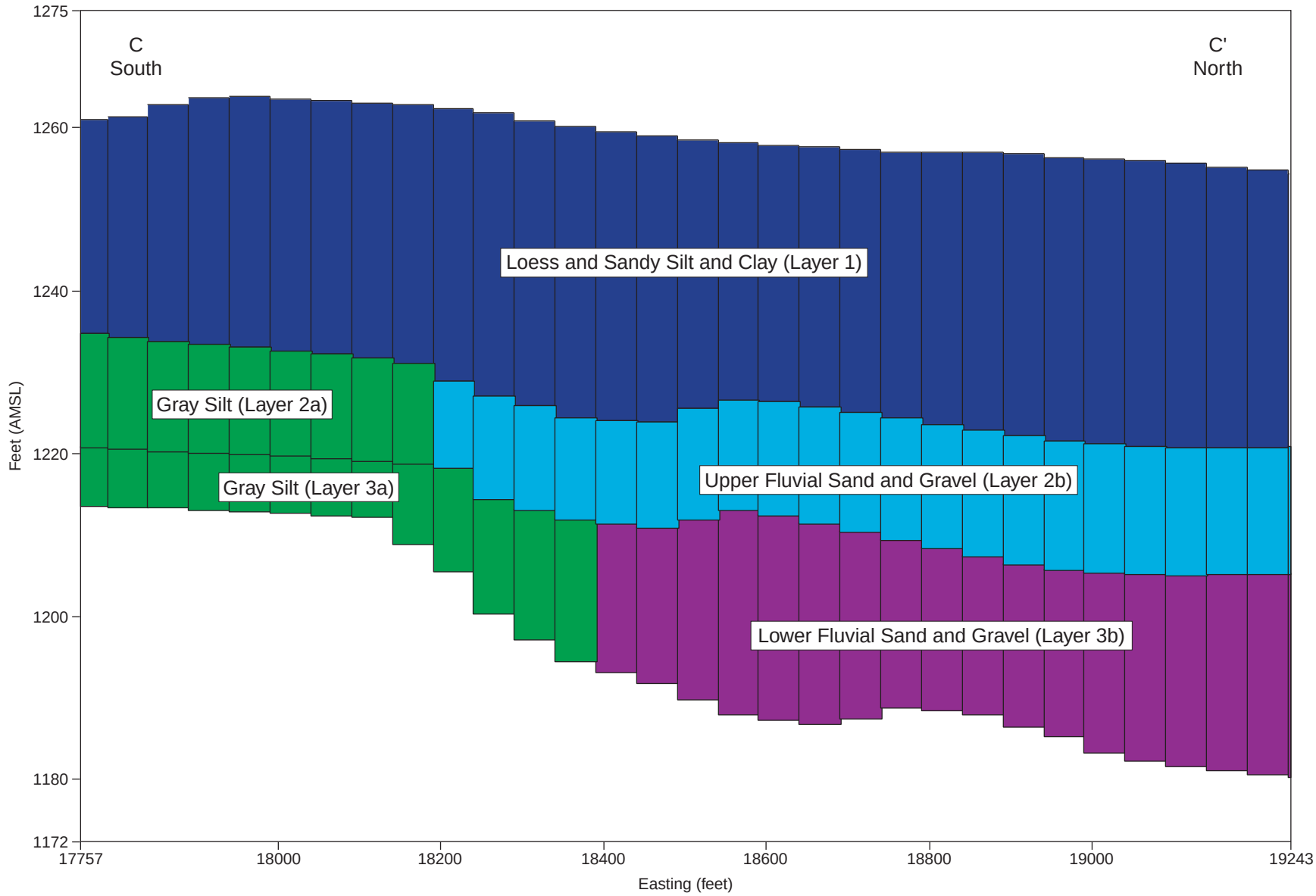


FIGURE H.4 Adams Groundwater Flow Model South-North Cross Section, Equivalent to Geologic Cross Section C-C´ Shown in Figure 4.10

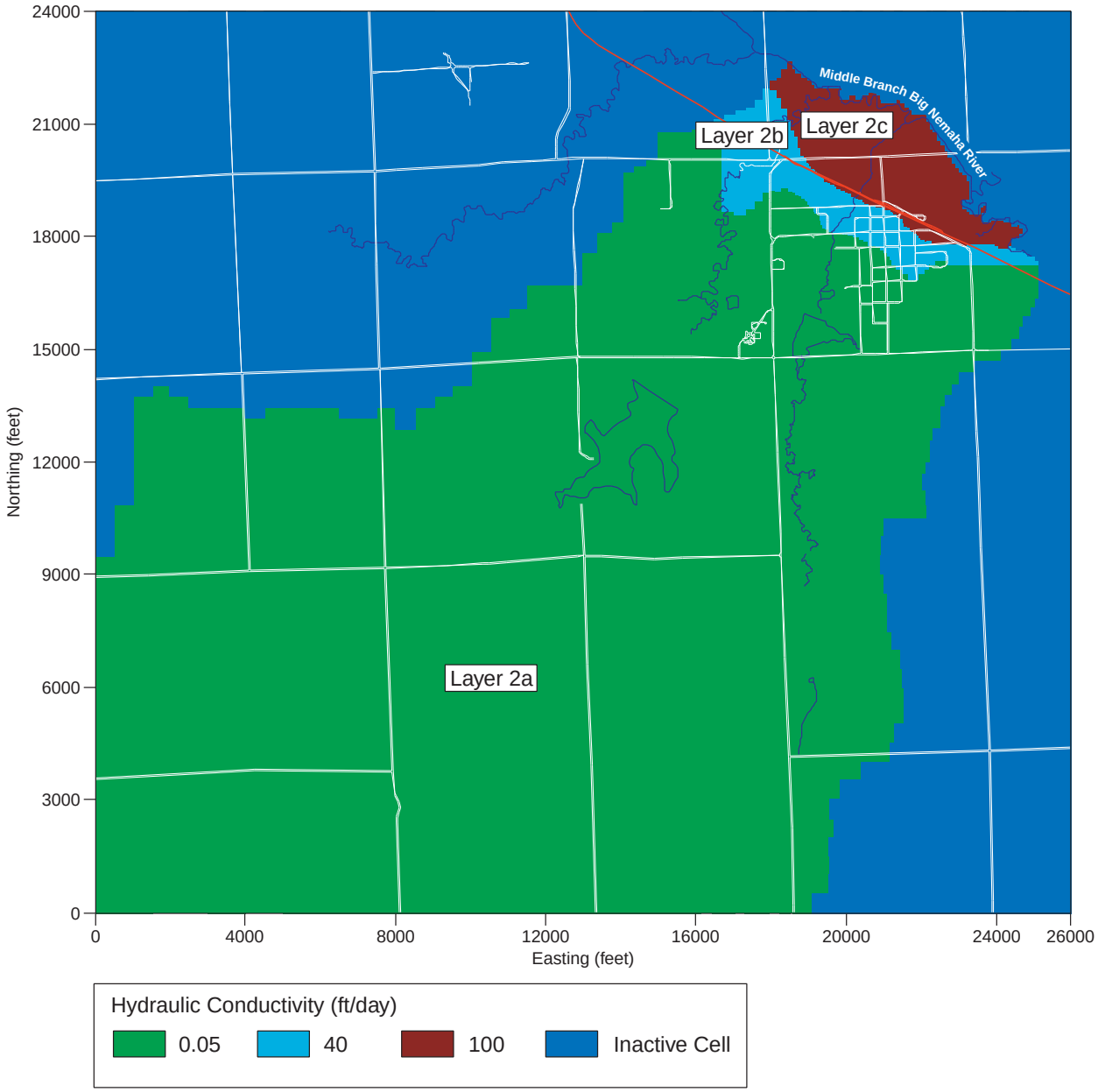


FIGURE H.5 Hydraulic Conductivity Distribution for Adams Groundwater Flow Model Layer 2

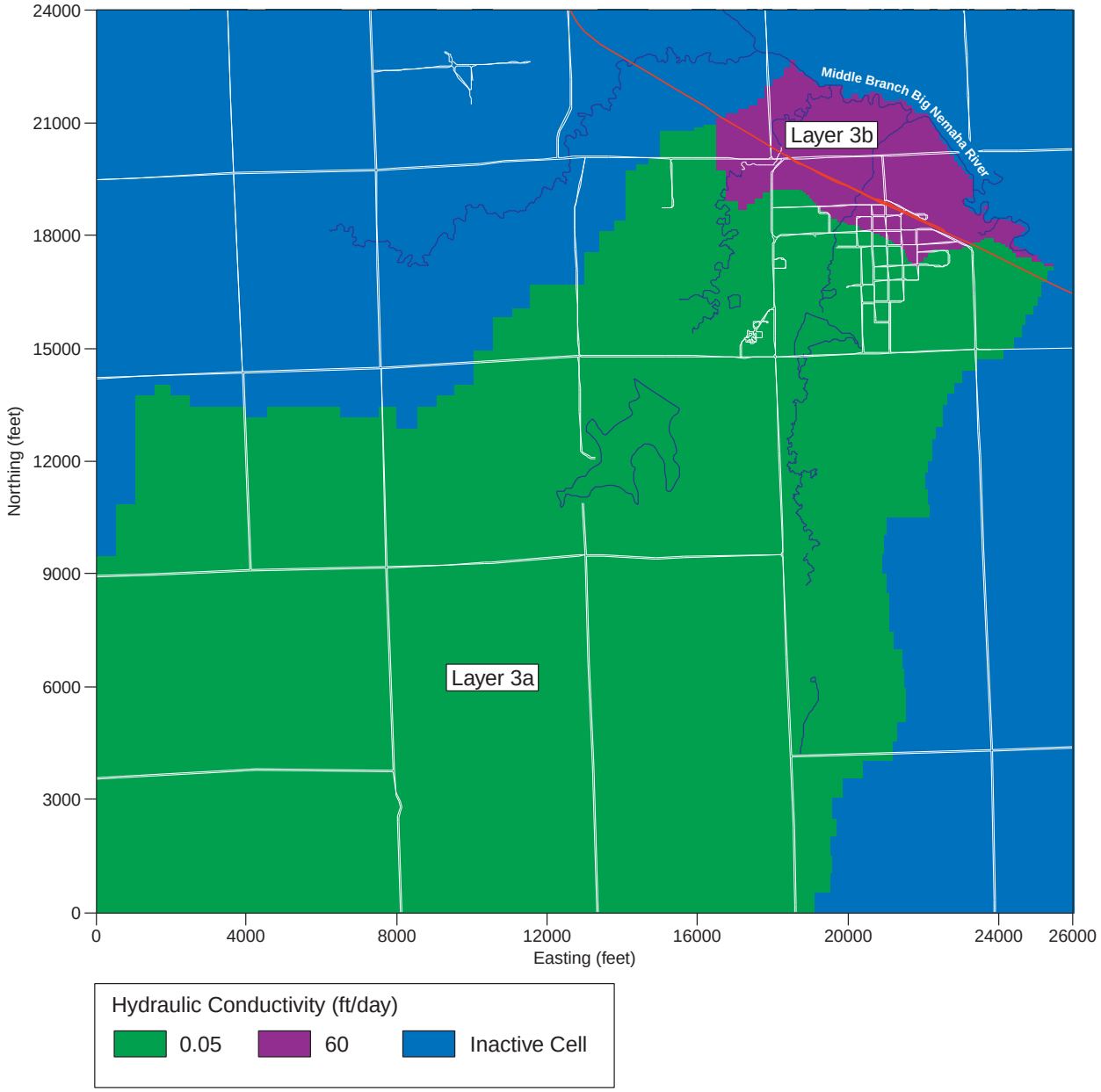


FIGURE H.6 Hydraulic Conductivity Distribution for Adams Groundwater Flow Model Layer 3

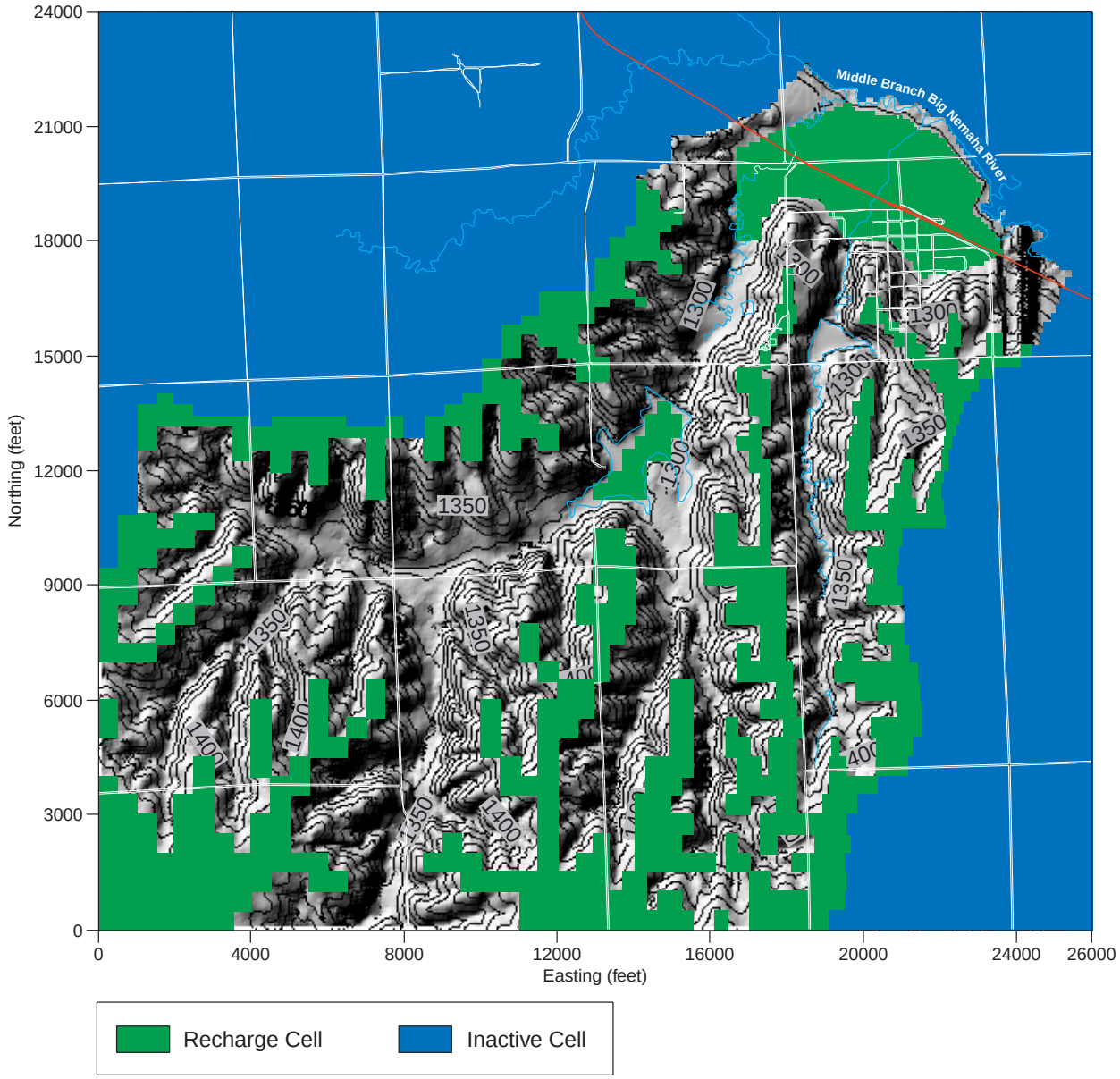


FIGURE H.7 Area of Adams Groundwater Flow Model Where Uniform Recharge Was Applied at the Rate of 6.5 in./yr

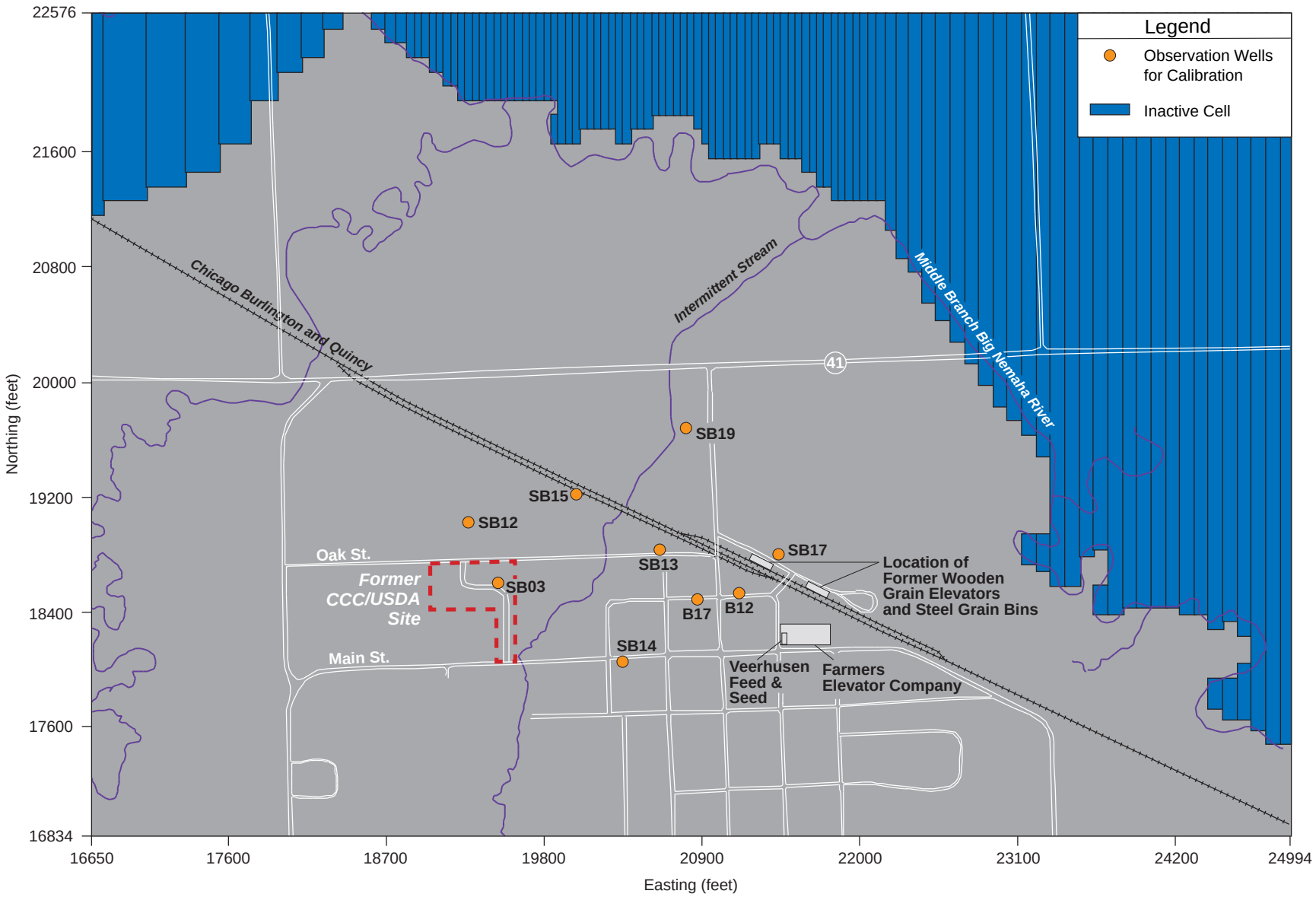


FIGURE H.8 Map Showing Locations of the May 11, 2000, Water Level Measurements Used for Calibration of the Adams Groundwater Flow Model

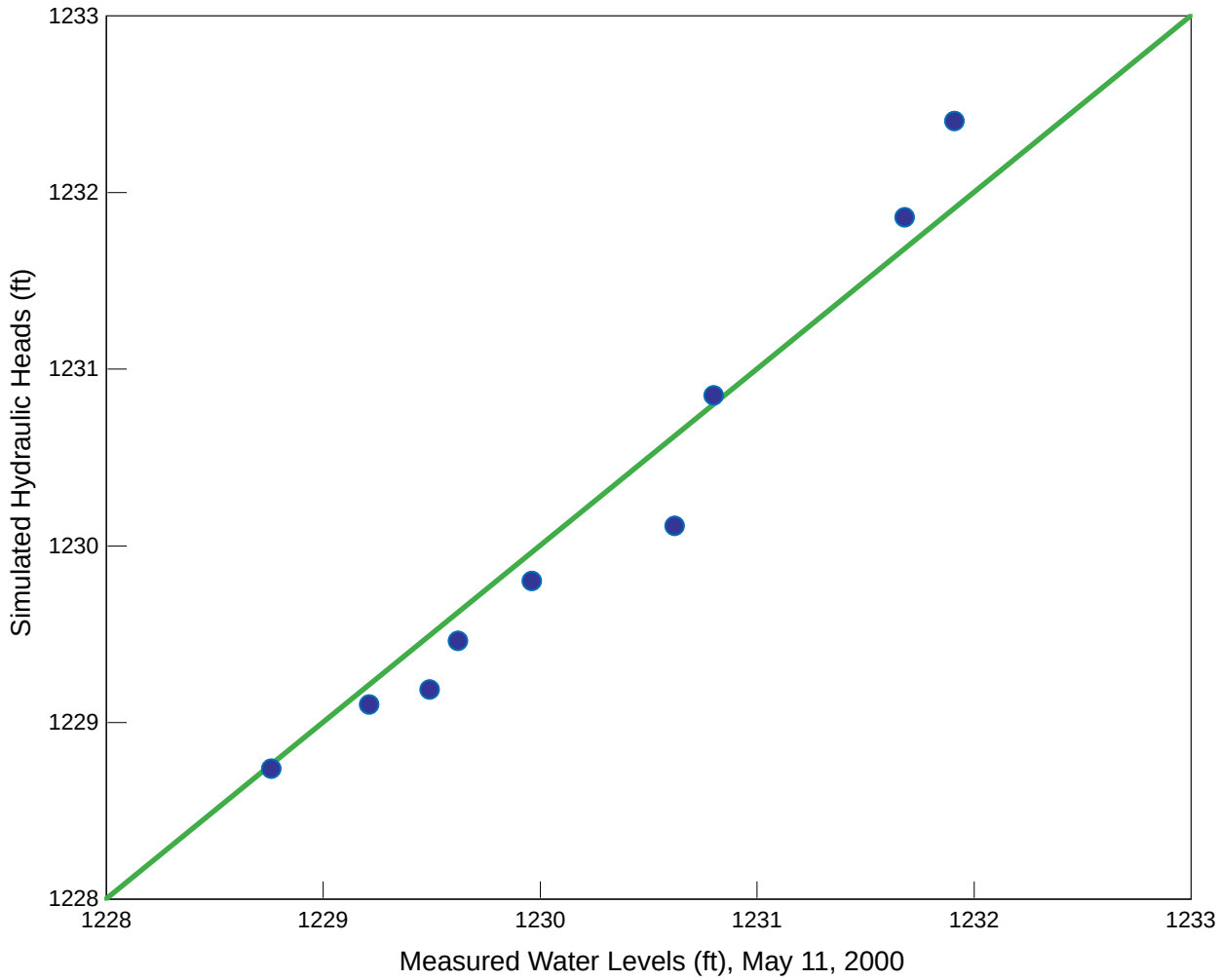


FIGURE H.9 Comparison of Measured Water Levels and Simulated Hydraulic Heads for Final Calibration of the Adams Groundwater Flow Model

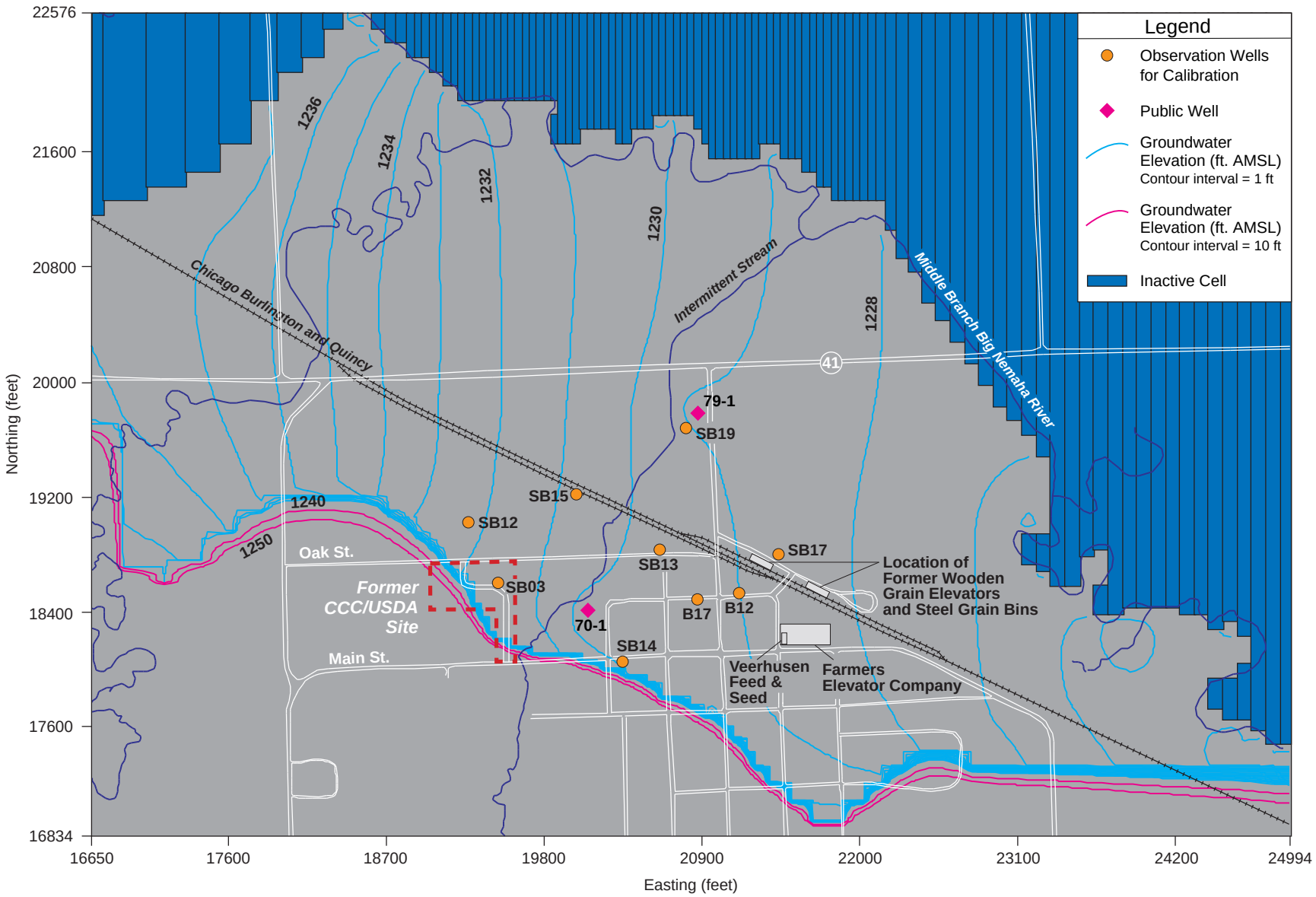


FIGURE H.10 Simulated Potentiometric Surface within the Adams Groundwater Flow Model Domain

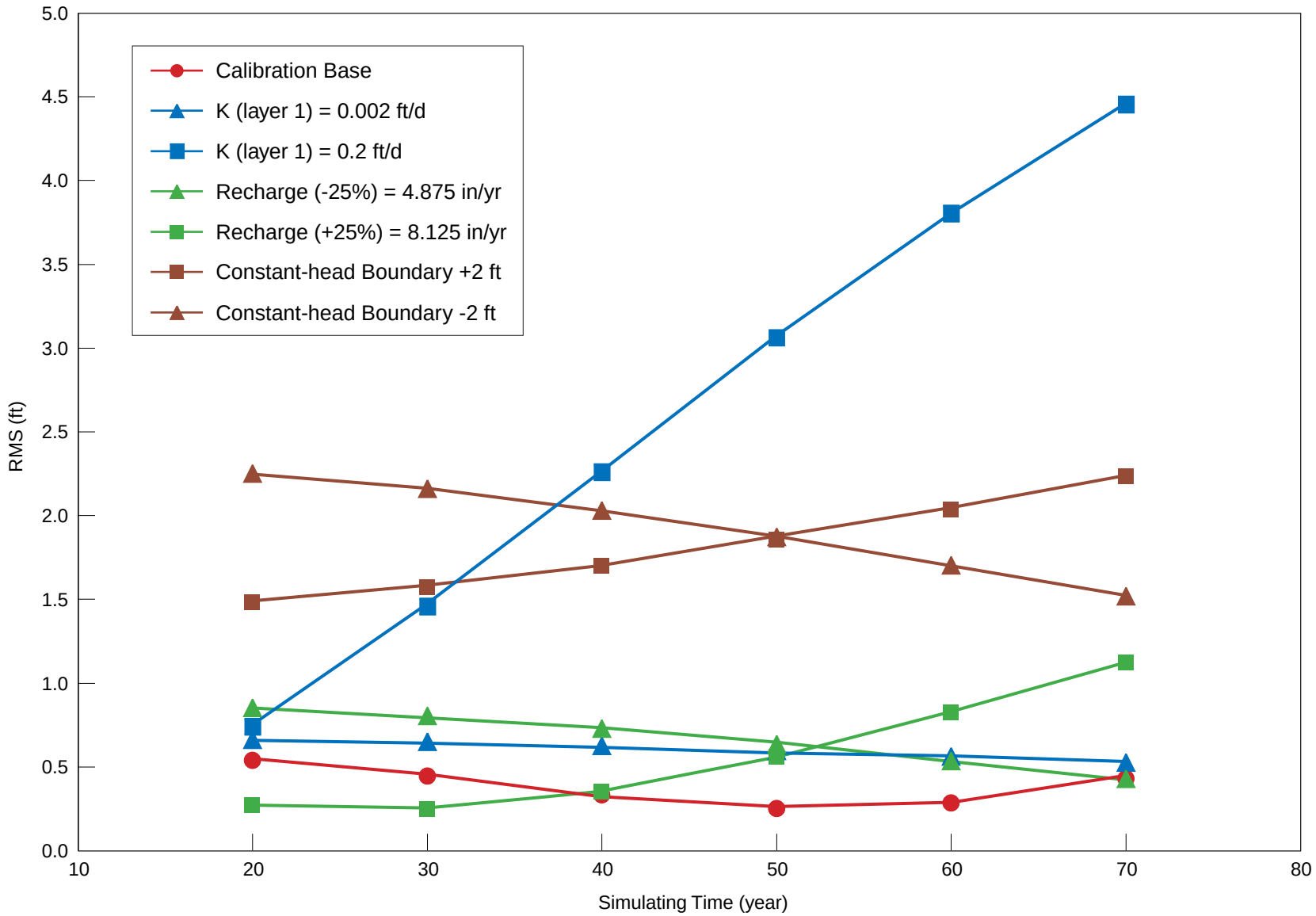


FIGURE H.11 Summary of Parameter Sensitivity Analyses for the Adams Groundwater Flow Model at Various Simulation Times from 20 to 70 Years

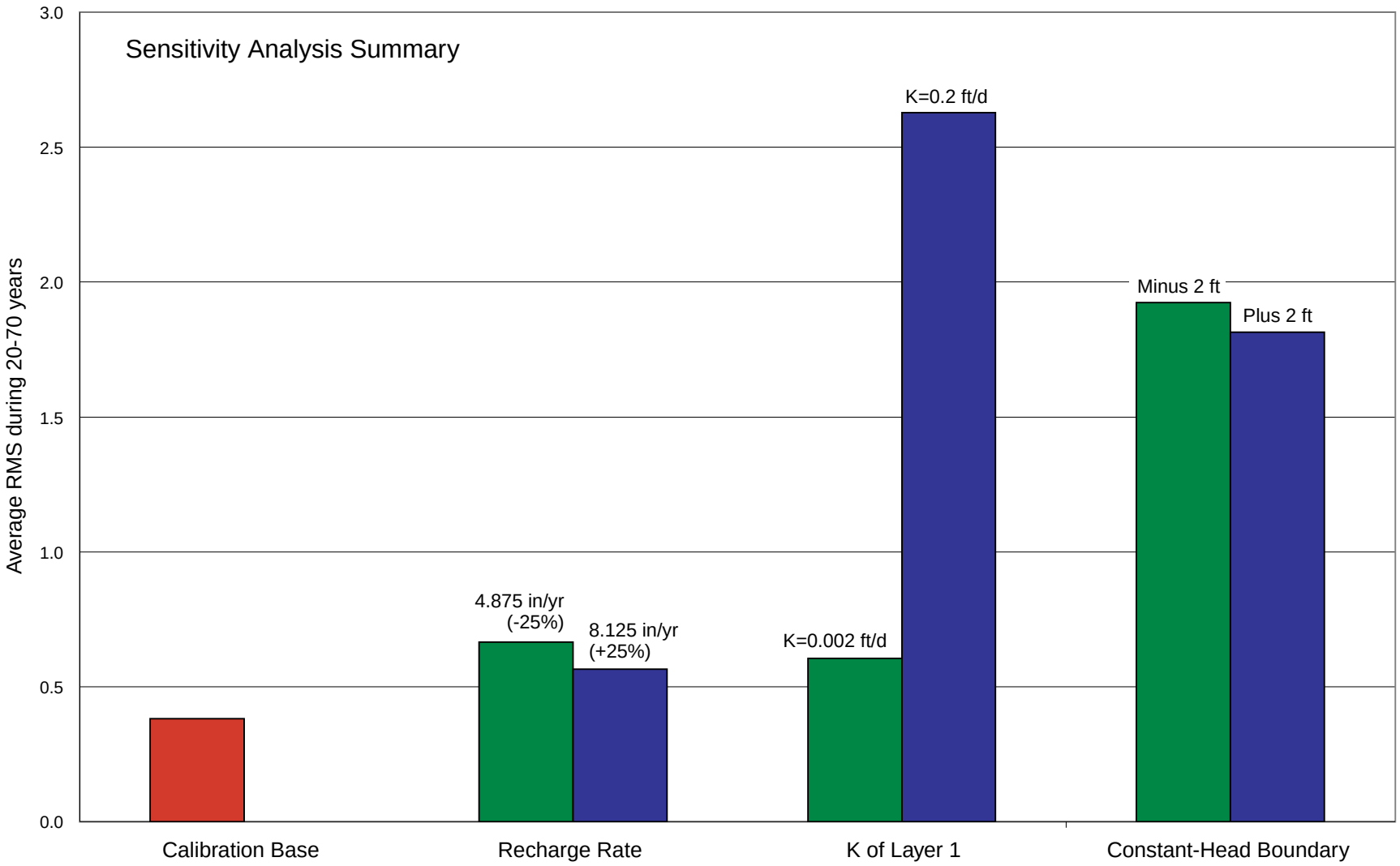


FIGURE H.12 Overall Summary of Parameter Sensitivity Analyses for the Adams Groundwater Flow Model