ANL/EVS/AGEM/TR-06-04

Argonne NATIONAL LABORATORY

Final Work Plan: Targeted Groundwater Sampling and Monitoring Well Installation for Potential Site Reclassification at Barnes, Kansas

Environmental Science Division

USDA United States Department of Agriculture

Work sponsored by Commodity Credit Corporation, United States Department of Agriculture

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Final Work Plan: Targeted Groundwater Sampling and Monitoring Well Installation for Potential Site Reclassification at Barnes, Kansas

by
Applied Geosciences and Environmental Management Section
Environmental Science Division, Argonne National Laboratory

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USDA
United States Department of Agriculture
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Notation

AGEM	Applied Geosciences and Environmental Management
AMSL	above mean sea level
BGL	below ground level
BTEX	benzene, toluene, ethylbenzene, and xylene
°C	degree(s) Celsius
CCC	Commodity Credit Corporation
CPT	cone penetrometer
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ft	foot (feet)
gal	gallon(s)
h	hour
I.D.	inner diameter
in.	inch(es)
KDHE	Kansas Department of Health and Environment
μg/m^3	microgram(s) per cubic meter
μg/L	microgram(s) per liter
mg/L	milligram(s) per liter
mi	mile(s)
MW	monitoring well
ppb	part(s) per billion
ppm	part(s) per million
PVC	polyvinyl chloride
PWS	public water supply
QA	quality assurance
QC	quality control
USDA	U.S. Department of Agriculture
VOC	volatile organic compound

Final Work Plan: Targeted Groundwater Sampling and Monitoring Well Installation for Potential Site Reclassification at Barnes, Kansas

1 Introduction

This *Work Plan* outlines the scope of work for a targeted groundwater sampling investigation and monitoring well installation at Barnes, Kansas. This activity is being conducted at the request of the Kansas Department of Health and Environment (KDHE), in accordance with the intergovernmental agreement between the KDHE and the Commodity Credit Corporation (CCC), an agency of the U.S. Department of Agriculture (USDA). Data resulting from the proposed work will be used to determine the hydraulic gradient near the former CCC/USDA facility, delineate the downgradient carbon tetrachloride plume, and determine additional monitoring requirements at Barnes. The overall goal is to establish criteria for monitoring leading to potential site reclassification.

The proposed work will be performed on behalf of the CCC/USDA by the Environmental Science Division of Argonne National Laboratory. Argonne is a nonprofit, multidisciplinary research center operated by the University of Chicago for the U.S. Department of Energy (DOE). The Farm Service Agency of the USDA has entered into an interagency agreement with DOE, under which Argonne provides technical assistance with environmental site characterization and remediation at former CCC/USDA grain storage facilities.

Argonne issued a *Master Work Plan* (Argonne 2002) to provide general guidance for all investigations at former CCC/USDA facilities in Kansas. The *Master Work Plan*, approved by the KDHE, contains the materials common to investigations at all locations in Kansas. This document must be consulted for the complete details of plans for this work associated with the former CCC/USDA facility at Barnes.

2 Background

2.1 Site History

The city of Barnes, Kansas, is a small, rural community of fewer than 200 residences in Washington County, in north-central Kansas (Figure 2.1). The city lies in a transition zone between the Flint Hills and the glaciated region. The area's topography consists of gently sloping hills of Pleistocene loess (< 20 ft) overlying a shale unit and interbedded shale, limestone, and siltstone of the Permian Chase Group. Groundwater for the public water supply is produced from the bedrock aquifer of the Chase Group.

The city operates two public supply wells (PWS2 and PWS3) in the northwestern portion of the city. The wells are reportedly 155 ft and 160 ft deep, respectively, although no construction details are available (KDHE 1997a). Studies described below indicate that groundwater generally flows toward the northeast, ranging from east-northeast to north-northeast. The site of the former CCC/USDA grain storage facility, located approximately 800 ft east of the public supply wells (Figure 2.2) is, therefore, downgradient of the public wells. (The boundaries for the former CCC/USDA facility shown in Figure 2.2 were drawn on the basis of legal descriptions obtained in 2005.)

Low levels of carbon tetrachloride were initially detected in 1986 in public supply wells PWS2 (2.1 μg/L) and PWS3 (0.5 μg/L). These concentrations are well below the drinking water maximum contaminant level of 5 μg/L for carbon tetrachloride. Since 1986, these wells have been sampled 15 times, most recently in March 2000. The maximum carbon tetrachloride concentrations detected in PWS2 and PWS3 were 2.5 μg/L and 2.1 μg/L, respectively, in July 1987. Since 1987, carbon tetrachloride has been detected in PWS2 in 5 of the 16 sampling events, with the highest concentration of 1.3 μg/L detected in August 1996. During the same period, carbon tetrachloride was detected in PWS3 in only 2 of 16 sampling events, with the highest concentration (1.7 μg/L) detected in July 1999. Carbon tetrachloride was not detected at a detection limit of 0.5 μg/L in both wells in the last known sampling (July 2005). The analytical results for carbon tetrachloride and chloroform in PWS2 and PWS3 are in Table 2.1.

Other documented releases of hazardous chemicals at Barnes include an 18,000-gal spill of nitrate fertilizer from an aboveground storage tank at the Barnes Co-op (KDHE 1990) and

leaking underground fuel storage tanks at Westside Service. Eight monitoring wells were installed because of the Westside Service release (AEI 2000). Two of these monitoring wells have since been abandoned.

TABLE 2.1 Historic analytical results for carbon tetrachloride and chloroform in public supply wells at Barnes, Kansas.

Sample Date	Carbon Tetrachloride (μg/L)		Chloroform (μg/L)	
	PWS2	PWS3	PWS2	PWS3
4/8/86	2.1	0.5	ND	ND
4/22/86	1.3	0.2	ND	ND
7/7/87	2.5	2.1	ND	ND
1/7/88	ND[a]	ND	NR[b]	NR
9/2/88	ND	ND	ND	ND
9/22/88	ND	ND	NR	NR
1/30/89	ND	ND	8.7	0.8
7/13/89	ND	ND	NR	1.5
8/12/91	ND	ND	ND	ND
4/11/95	0.5	ND	ND	ND
7/25/95	1.1	ND	ND	ND
5/1/96	ND	ND	ND	ND
8/13/96[c]	1.3	0.5	NR	NR
8/28/97	0.9	ND	ND	ND
1/29/99	ND	ND	ND	ND
7/12/99	1.2	1.7	NR	0.6
3/22/00	ND (1)[d]	ND (1)	ND (1)	1.9
7/15/02	ND (0.5)	ND (0.5)	NR	NR
7/11/05	ND (0.5)	ND (0.5)	NR	NR

[a] ND, not detected.
[b] NR, result not reported in documents on file.
[c] Data reported by the KDHE (1997b).
[d] Detection limit in parentheses.

2.2 Previous Investigations of Carbon Tetrachloride Contamination

Two investigations have been conducted at Barnes on behalf of the KDHE. The purpose in both cases was to identify potential sources for the carbon tetrachloride in groundwater and to determine the extent of the contamination.

In 1996, PRC Environmental Management conducted a Phase I comprehensive investigation of the site to identify potential sources (PRC 1996) for the contamination in PWS2 and PWS3. Activities focused on the two potential source areas closest to the public supply wells, as follows:

- The site of the former high school, including an agricultural vocational building where chemicals including carbon tetrachloride and chloroform were mixed and stored as part of the high school curriculum and then dumped outside (PRC 1996). Subsequently, the chemicals were inventoried and disposed of as hazardous waste through the KDHE (USD 233 1989). This site is less than 250 ft from the public wells.

- The site of the former CCC/USDA grain storage facility, approximately 800 ft downgradient from the public wells.

As part of the 1996 comprehensive investigation, soil gas and soil samples were collected (April 29, 1996–May 1, 1996) at the sites of the former high school and the former CCC/USDA grain storage facility (PRC 1996). Groundwater samples from the public supply wells and local private wells were also collected. All samples were analyzed for carbon tetrachloride and chloroform. Low levels of carbon tetrachloride and chloroform were detected in soil gas samples at both the former high school and the former CCC/USDA grain storage facility (Figure 2.3). In off-site laboratory analysis of one soil gas sample from each location, the low-level carbon tetrachloride contamination was confirmed. In addition, BTEX (benzene, toluene, ethylbenzene, and xylene) contamination was identified in the soil gas sample from the former CCC/USDA facility. However, neither carbon tetrachloride nor chloroform was detected in soil samples collected at 4–19 ft below ground level (BGL; Figure 2.4), including those collected from the locations with the highest soil gas values. No carbon tetrachloride or chloroform was present above the detection limit in any of the groundwater samples collected in April–May 1996, including those from PWS2 and PWS3 (Table 2.1 and Table A.1).

In 1998–1999, BE&K/Terranext conducted a Phase II comprehensive investigation on behalf of KDHE to determine the extent of the groundwater contamination and the local groundwater gradient (BE&K 1999). Five monitoring wells — MW-1S, MW-1D, MW-2D, MW-3D, and MW-4D — were installed to delineate the contamination previously detected in PWS2 and PWS3 (Figure 2.5). Wells MW-1D, MW-2D, MW-3D, and MW-4D were screened at approximately 100–160 ft BGL to intersect what was believed to be the water-bearing zone in which the public supply wells are screened (Table 2.2). Carbon tetrachloride was detected in MW-4D (on the former CCC/USDA property) at concentrations of 4.0 µg/L and 3.9 µg/L in December 1998 and January 1999, respectively. Carbon tetrachloride was not detected in any of the other monitoring wells in the area in these sampling events.

In the 1999 comprehensive investigation, the groundwater gradient was determined to be to the north-northeast, placing the former CCC/USDA facility downgradient from or cross-gradient to the two public supply wells (BE&K 1999). The two public supply wells and the five monitoring wells were resampled in March 2000 (BE&K 2000). Carbon tetrachloride was again detected in MW-4D, at a concentration of 5.1 µg/L. Carbon tetrachloride was not detected in any of the other monitoring wells (Table 2.2) or the public supply wells (Table 2.1).

During the 2000 sampling event, the groundwater gradient was determined to be to the east-northeast, verifying the position of the former CCC/USDA facility downgradient of the public supply wells (BE&K 2000).

Complete historical analytical results for previous sampling events at Barnes, beginning in 1986, are in Table A.1, Appendix A. All available construction details for the wells sampled as part of the carbon tetrachloride investigations, as well as those sampled as part of the Westside Service investigation, are in Table A.2, Appendix A.

TABLE 2.2 Historic analytical results for carbon tetrachloride and chloroform in monitoring wells at Barnes, Kansas.

		Concentration on Sampling Date Indicated (μg/L)[a]							
		12/28/98		1/29/99		3/22/00		3/8/02	
Well	Screened Interval (ft BGL)	Carbon Tetra-chloride	Chloro-form	Carbon Tetra-chloride	Chloro-form	Carbon Tetra-chloride	Chloro-form	Carbon Tetra-chloride	Chloro-form
MW-1S	13.3–23.3	NS[b]	NS	NS	NS	NS	NS	NS	NS
MW-1D	139.85–159.4	ND[c]	ND	ND	ND	ND	ND	NS	NS
MW-2D	133.26–152.93	ND	ND	ND	ND	ND	ND	NS	NS
MW-3D	133.02–152.73	ND	ND	ND	ND	ND	ND	NS	NS
MW-4D	98.38–118.22	4.0	ND	3.9	ND	5.1	ND	7.3[d]	ND

[a] Practical reporting limit = 1.0 μg/L.

[b] NS, not sampled. For MW-1S, sampling was attempted unsuccessfully on 12/28/98, 1/29/99, and 3/22/00.

[c] ND, not detected.

[d] Sample received by the analytical laboratory at a temperature of 15°C (KDHE 2002).

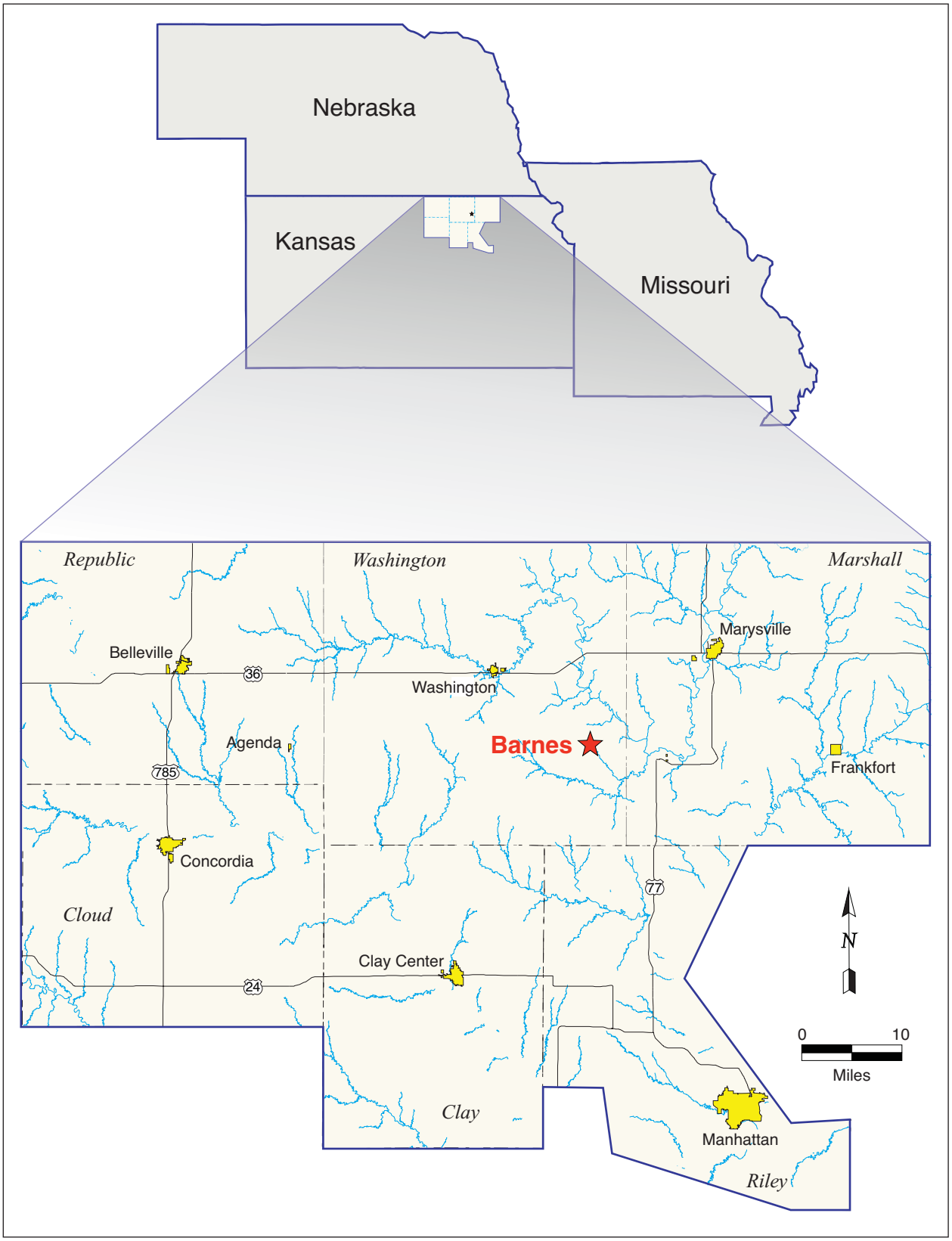

FIGURE 2.1 Location of Washington County and Barnes, Kansas.

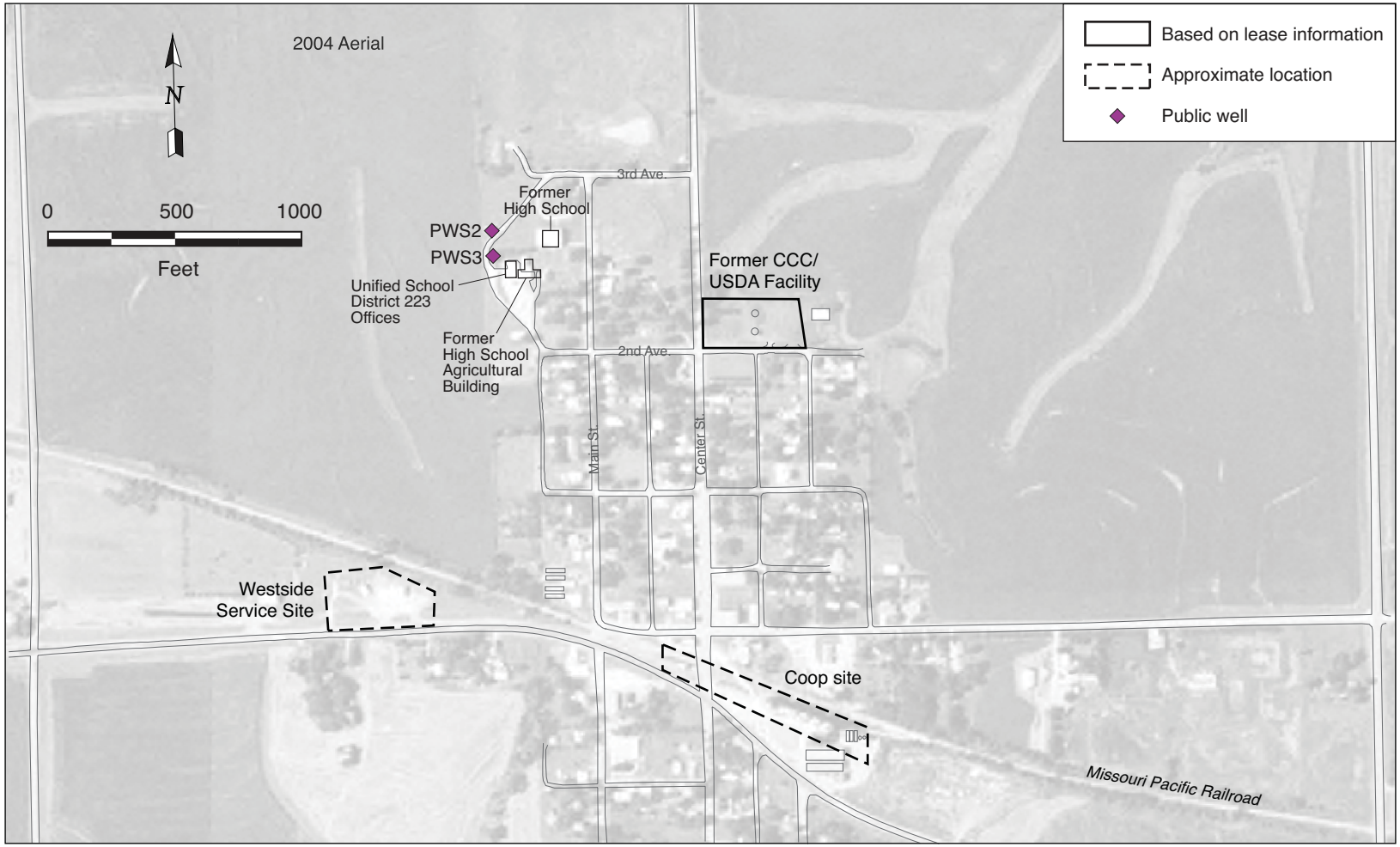

FIGURE 2.2 Locations of the former CCC/USDA facility, other relevant structures and facilities, and the public supply wells at Barnes. Source of photograph: NAIP (2004)

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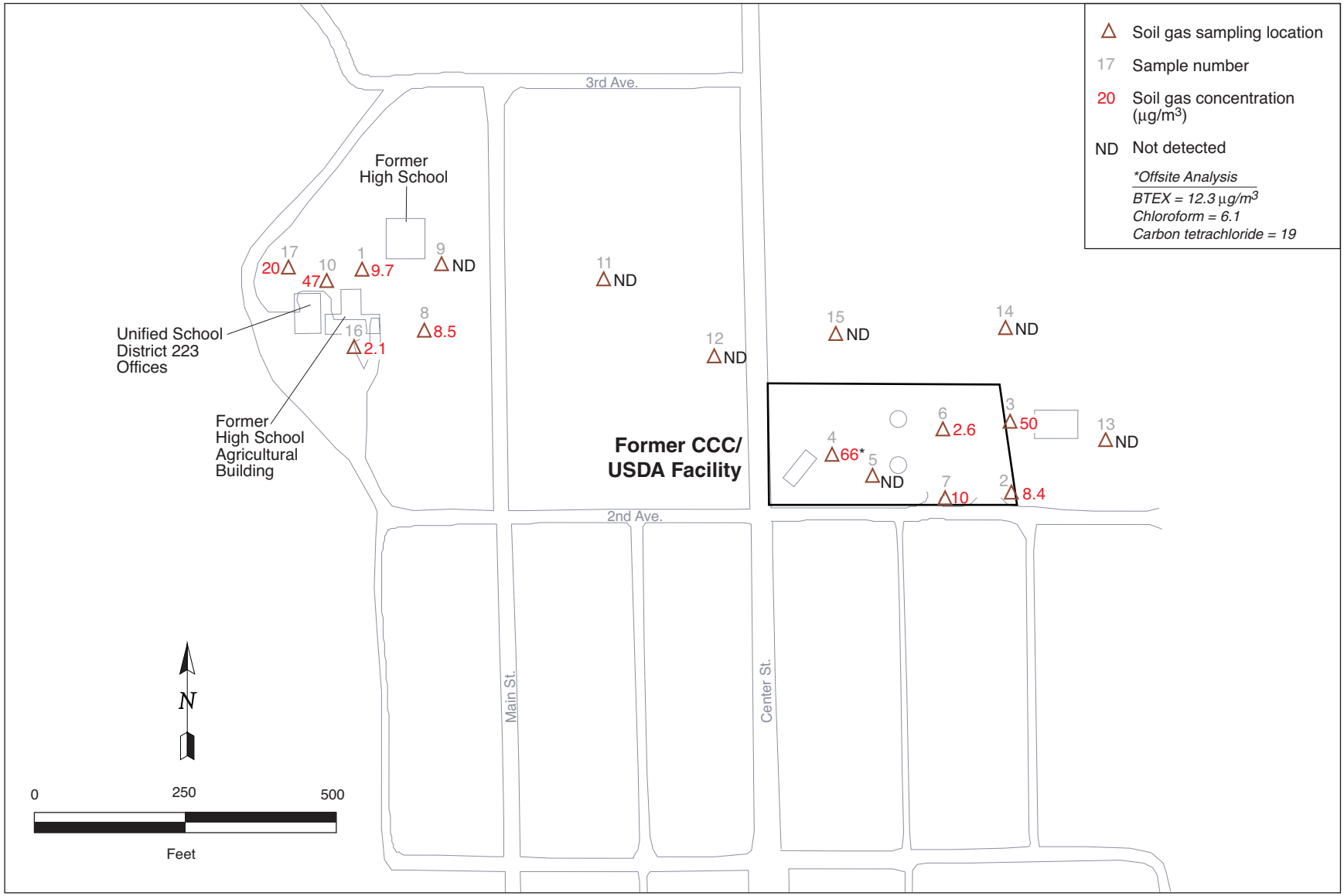

FIGURE 2.3 Carbon tetrachloride concentrations (maximum values) detected in soil gas in the KDHE's 1996 comprehensive investigation. Source of data: PRC (1996).

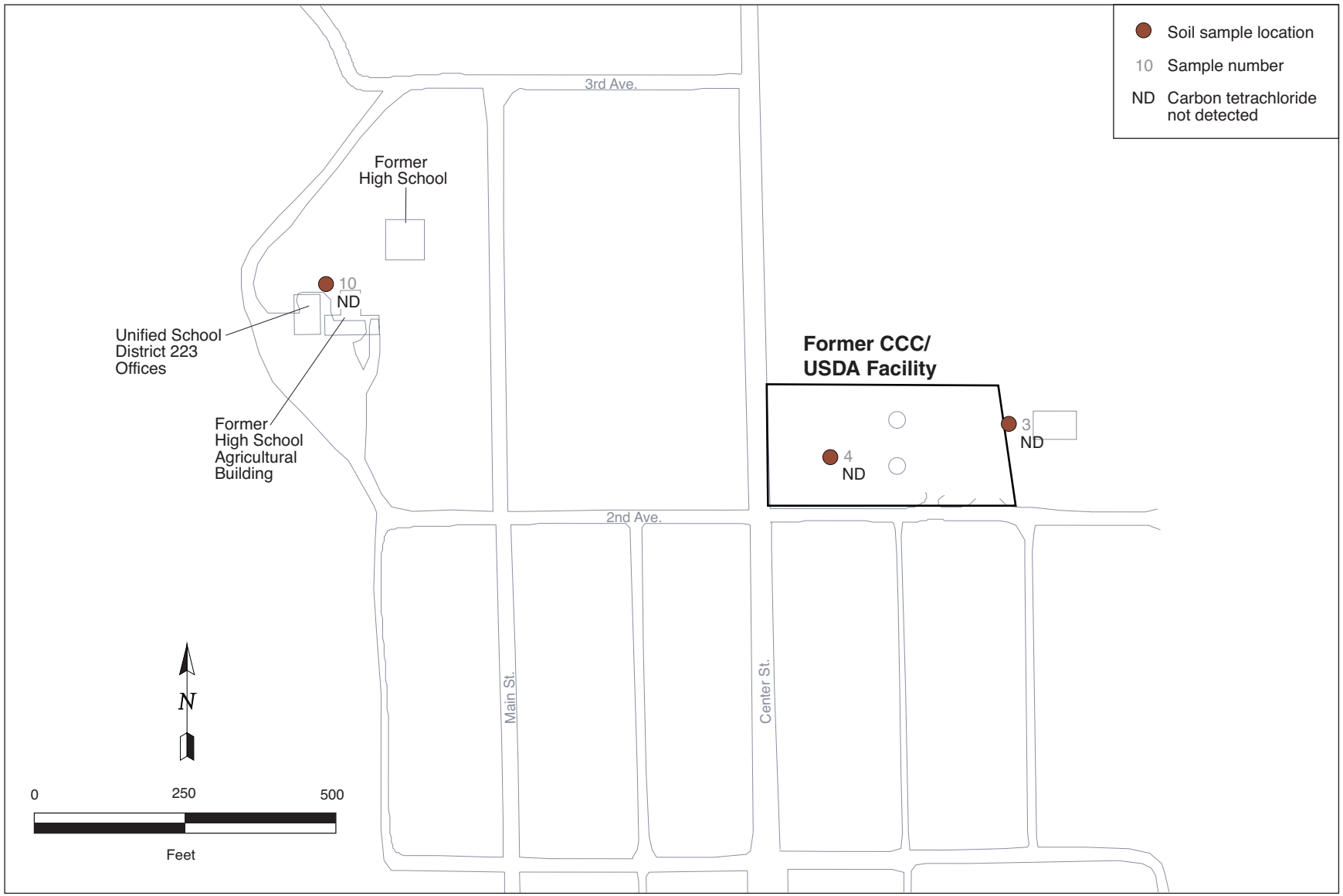

FIGURE 2.4 Carbon tetrachloride concentrations detected in soil in the KDHE's 1996 comprehensive investigation. Source of data: PRC (1996).

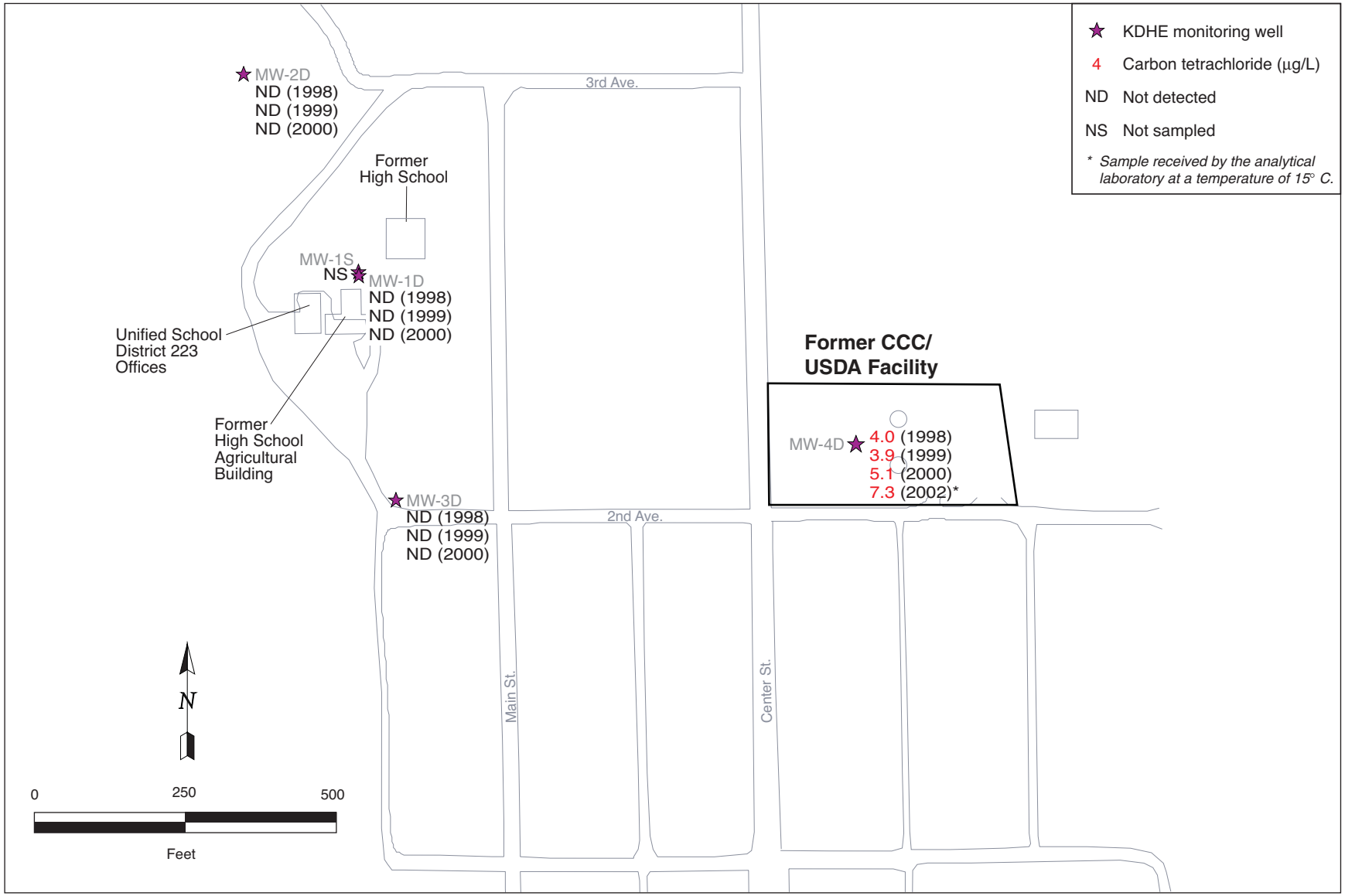

FIGURE 2.5 Carbon tetrachloride concentrations detected in groundwater in the KDHE's 1999 comprehensive investigation. Source of data: BE&K (1999).

3 Planned Work at Barnes

3.1 Project Objectives

The objectives of this project are to (1) determine the hydraulic gradient near the former CCC/USDA facility, (2) delineate the downgradient carbon tetrachloride plume, and (3) design and implement an expanded monitoring network at Barnes.

3.2 Scope of Work

To satisfy the project objectives, the following activities are planned:

- Measure depth to groundwater and collect groundwater samples at the following locations (Figure 3.1):
  - Four existing monitoring wells (MW-1D through MW-4D)
  - One existing private well (Oentrich well)
- Use the cone penetrometer (CPT) for initial groundwater sampling and water level measurement at the six new locations shown in Figure 3.1. These locations are subject to change pending the results of early investigational activities.
- Install long-term monitoring wells at locations to be selected, with the concurrence of the CCC/USDA and KDHE project managers, on the basis of the initial results.
- Begin a two-year period of twice yearly groundwater sampling and continuous water level monitoring to verify the direction of groundwater flow and observe variations due to seasonal events such as pumping of wells in the area.

3.3 Investigation Methods

3.3.1 Methods for Sampling Existing Wells

Measurements of static water levels and well depths will be recorded, along with sampling details for both the private wells and the monitoring wells at Barnes. This work will be in accordance with the procedures described in the *Master Work Plan* (Argonne 2002, Sections 6.1.2 and 6.2), as follows:

1. The well number, the well owner's name, or both will be documented in the site field notebook.

2. If possible, the static groundwater level and then the total depth will be measured and documented for each well.

3. The groundwater from each well will be purged until field parameters of pH, temperature, and conductivity are stable. If possible, a minimum of three well volumes of water will be purged. The field parameters and volume purged will be documented. Each well will be purged before it is sampled.

4. The wells will be sampled after adequate recharge has occurred but no more than 24 h after purging.

5. Groundwater samples for analysis of volatile organic compounds (VOCs) including carbon tetrachloride, chloroform, and methylene chloride; petroleum products; and nitrate will be collected in laboratory-approved containers and immediately placed in a cooler at 4°C. These samples will be shipped for overnight delivery to the Applied Geosciences and Environmental Management (AGEM) Laboratory at Argonne for off-site analysis.

6. Any unavoidable deviations from these procedures will be documented in the field notebook.

3.3.2 Methods for Sampling Groundwater with the Cone Penetrometer

Groundwater sampling with the CPT will be performed in accordance with the procedures described in the *Master Work Plan* (Argonne 2002, Sections 6.1.2, 6.2 and 6.5), by first using the CPT rods to push a sacrificial tip and 0.5-in.-I.D. polyvinyl chloride (PVC) filter screen and riser to the desired maximum sampling depth. The rods will then be partially withdrawn to the desired minimum sampling depth, to expose the screen to the formation waters. Samples will be collected from the PVC casing by using a bailer, without purging, for preservation and analysis as described in Section 3.3.1 and Section 3.5.

The groundwater samples collected with the CPT will be submitted to the AGEM Laboratory for rapid-turnaround (24-h) analyses (Section 3.5), to facilitate review of the investigation results during the field program.

The temporary observation points will be abandoned in accordance with KDHE requirements upon completion of the field investigation. At the discretion of the CCC/USDA and KDHE project managers, permanent monitoring wells can be installed at these locations in accordance with procedures described in Section 3.3.3.

3.3.3 Methods for Installing Monitoring Wells

Permanent 1-in.-diameter monitoring wells will be installed by using the CPT, wherever possible, in accodance with procedures described in the *Master Work Plan* (Argonne 2002) and the requirements specified by the KDHE (http://www.kdheks.gov/pdf/regs/28-30.pdf). If penetration to the appropriate zone with the CPT is not possible because of subsurface conditions, the permanent monitoring wells will be installed by using a hollow-stem auger rig in accordance with the general procedures in Section 6.4.3 of the *Master Work Plan* (Argonne 2002). The wells will consist of 2-in. PVC casing installed in 8.25-in.-diameter boreholes. Screens will be 0.010-in. mill slot, PVC, 10 ft long. A 10/20 (or #20) filter pack is anticipated, on the basis of previous experience in the area. The filter pack will extend 5 ft below and 2 ft above the screened interval. At the bottom of each well, a 5-ft section of blank casing capped on the bottom will serve as a silt trap.

All wells will be constructed in accordance with KDHE guidelines. Any variances required will be obtained from the appropriate agency prior to installation. All soil waste will be

scarified on location. Development water will be discharged appropriately, as indicated by the results of confirmatory sampling and analysis for contaminants. Surface completions will consist of KDHE-approved flush mounts, as shown in the specifications for 2-in. casing in Figure F.4, Appendix F, of the *Master Work Plan*. After installation, each well will be pumped and developed for a minimum of two hours.

3.4 Reporting

A report will be prepared and submitted to the KDHE within 90 days of the completion of field work described here.

3.5 Quality Assurance and Quality Control

Included in this section is a summary of methods that will be followed to meet quality assurance/quality control (QA/QC) standards. Descriptions of all QA/QC methods are in Section 4.2 of the *Master Work Plan* (Argonne 2002). That document should be consulted for more a more detailed narrative of the QA/QC procedures.

The QA/QC requirements during field sampling are as follows:

- Ensure that samples collected are representative of current site conditions.

- Ensure that sufficient samples are collected to meet the monitoring goals.

- Ensure that field instrument calibration procedures are followed and that the appropriate number of field blanks, rinsate samples, trip blanks, and field replicates are collected. For this project, a minimum of one field blank, one rinsate sample, one trip blank, and one or two field replicates will be collected.

- Record in a bound notebook with printed page numbers all details of the work conducted. Use permanent ink for this documentation.

- To the extent possible, use disposable sampling equipment at each sampling location.

- Between wells, thoroughly rinse RediFlow pumps and hoses. Triple-wash all other nondisposable sampling equipment with a nonionic detergent in water, then rinse with water.

- Collect groundwater samples according to the procedures specified in Section 3.3.1.

- Label sample containers as instructed in Appendix D, Section D.1.4, of the *Master Work Plan* (Argonne 2002). At a minimum, include the following information: sample identifier, date, time, preservative, and intended analysis. Use preprinted sample labels for this task.

- Complete a preprinted chain-of-custody record as instructed in Appendix D, Section D.1.5, of the *Master Work Plan* (Argonne 2002).

- Appropriately pack and seal shipping containers to ensure that chain of custody is maintained.

- Use preprinted shipping labels for sample containers being sent to laboratories for off-site analyses.

Laboratory QA/QC procedures are designed to ensure that sample integrity is maintained and that sample analysis is reproducible. This will be accomplished, in part, by verifying that laboratory-related field documentation is complete and that procedures have been followed with regard to chain-of-custody records, sample storage, and sample holding times. In addition, laboratory procedures, equipment calibration, and performance standards (reproducibility, standards, spikes recoveries, etc.) will be reviewed and documented in the monitoring report discussed in Section 3.4.

Groundwater samples received at the AGEM Laboratory will be analyzed within the specified holding times for VOCs with a gas chromatograph-mass spectrometer system. Laboratory methods to be used will include modifications of U.S. Environmental Protection

Agency (EPA) Methods 5030B and 8260B. To ensure reproducibility, 10% of the samples (including one sample from the proposed sampling location on the southern edge of the former CCC/USDA facility) will be selected for analysis by a second laboratory with the EPA's Contract Laboratory Program methods. An index of the EPA methods is online (http://www.epa.gov/epahome/index/).

Samples collected for nitrate analysis will be shipped to Severn-Trent Laboratories for analysis with EPA Method 300.

Quality assurance records completed during the project will be maintained by the QA/QC coordinator and stored with the project files.

3.6 Health and Safety

The general health and safety plan for use at Barnes is in Section 3 of the *Master Work Plan* (Argonne 2002). The general plan addresses all anticipated safety issues for the activities to be conducted. Specific emergency information for use at Barnes is in Figure 3.2 and Table 4.1.

Washington County has 911 service for all emergencies. Note that 911 calls from cell phones can be routed to various 911 centers, depending on which tower picks up the call. Ask whether you have the **Washington County 911 Center** before you describe your emergency. The call will be transferred if you have reached a different 911 center.

TABLE 3.1 Emergency information for the sampling event at Barnes, Kansas.[a]

Resource	Telephone No.	Name
All Emergencies	911[b]	Washington County 911 Center
Hospital	785-337-2214	Washington County Hospital Dist. 1[c] (Hanover Hospital and Clinic) 205 South Hanover Hanover, Kansas
Police	785-325-2293	Washington County Sheriff (nonemergency) 301 B Street Washington, Kansas
Industrial Hygiene	630-252-3310	Argonne — Industrial Hygiene
Safety	630-252-2885	EVS Division[d] Field Safety Coordinator (Monte Brandner)
	630-252-3924	EVS Division[d] Environment, Safety, and Health Coordinator (Dave Peterson)
Security	630-252-5737	Argonne — Operations Security (workdays)
	630-252-5731	Argonne — Operations Security (weekends and after hours)
Poison Control	800-222-1222 or 913-588-6633	Mid-America Poison Control Center, University of Kansas Medical Center
Utilities Survey	800-344-7233 (800-DIG-SAFE)	Kansas One Call, Wichita, Kansas

[a] Post this table in the field operations base.

[b] 911 calls from cell phones can be picked up by various 911 centers, depending on call volumes. Ask whether you have the **Washington County 911 Center** before you describe your emergency. The call will be transferred if you have reached a different 911 center.

[c] The route from Webber to the hospital is shown in Figure 3.2.

[d] Environmental Science Division at Argonne National Laboratory.

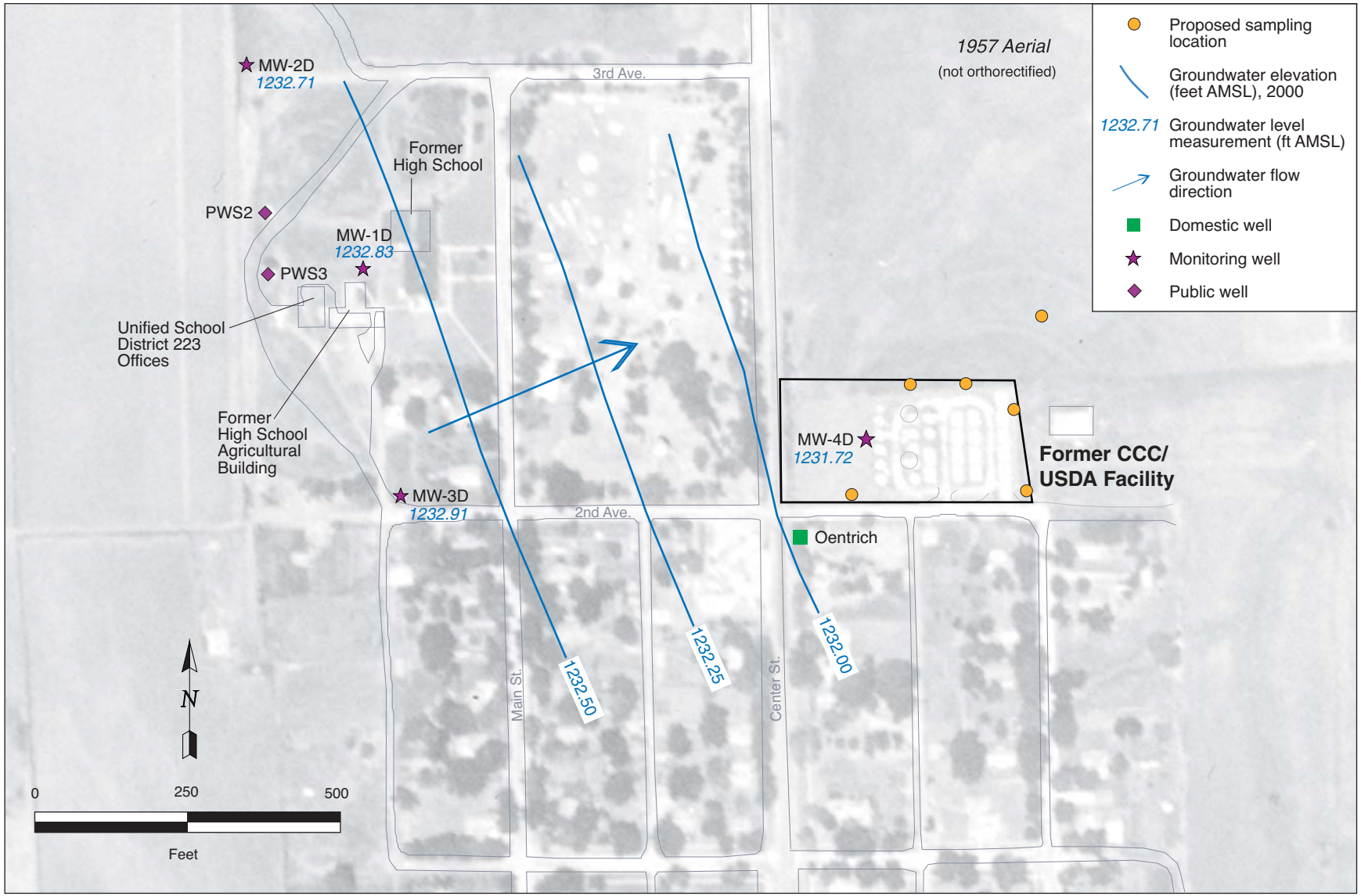

FIGURE 3.1 Proposed locations for groundwater sampling at Barnes. Source of photograph: USDA (1957).

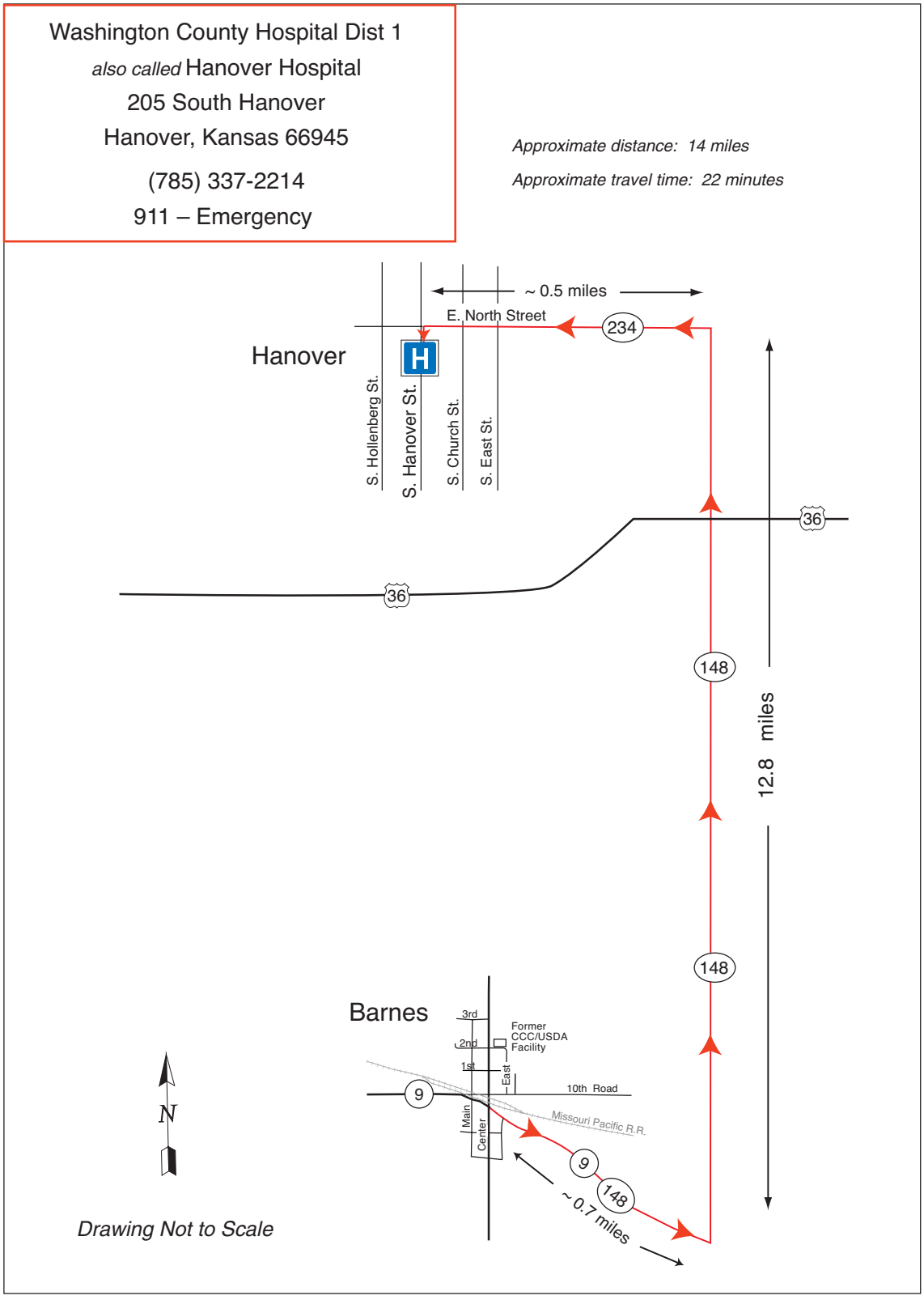

FIGURE 3.2 Emergency route from Barnes to Washington County Hospital Dist. 1 (also called Hanover Hospital and Clinic), Hanover.

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USD 233, 1989, *Inventory of Chemical Waste Accumulated*, transmitted from D.L. Johnson (district superintendent) to J. Goetz (Hazardous Waste Section, Kansas Department of Health and Environment, Topeka, Kansas).

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Appendix A:

Complete Historical Analytical Results and Well Construction Summary for Barnes, Kansas

TABLE A.1 Complete historical analytical data for Barnes, Kansas.

					Concentration (ppb)						
					Field Laboratory Analysis		Off–Site Laboratory Analysis				
Date	Location	Medium[b]	Sample Depth (ft BGL)	Depth to Water (ft BGL)	Carbon Tetrachloride	Chloroform	Carbon Tetrachloride	Chloroform	Methylene Chloride	Total BTEX[a]	Nitrates (ppm)
Historical public well sampling reported by PRC (1996) and KDHE (1997a) and CCC/KDHE private well sampling program											
4/8/86	PWS2	GW	155 (TD)[c]	NM[d]	NA[e]	NA	2.1	ND[f]	NR[g]	NR	—
4/22/86	PWS2	GW	155 (TD)	NM	NA	NA	1.3	ND	NR	NR	—
7/7/87	PWS2	GW	155 (TD)	NM	NA	NA	2.5	ND	NR	NR	10.6
1/7/88	PWS2	GW	155 (TD)	NM	NA	NA	ND	NR	NR	NR	10
9/2/88	PWS2	GW	155 (TD)	NM	NA	NA	ND	ND	NR	NR	—
9/22/88	PWS2	GW	155 (TD)	NM	NA	NA	ND	NR	NR	NR	9.4
1/30/89	PWS2	GW	155 (TD)	NM	NA	NA	ND	8.7	NR	NR[h]	9.06
7/13/89	PWS2	GW	155 (TD)	NM	NA	NA	ND	NR	NR	NR	8.15
8/12/91	PWS2	GW	155 (TD)	NM	NA	NA	ND	ND	NR	NR[h]	—
4/11/95	PWS2	GW	155 (TD)	NM	NA	NA	0.5	ND	NR	NR	—
7/25/95	PWS2	GW	155 (TD)	NM	NA	NA	1.1	ND	NR	NR	—
4/8/86	PWS3	GW	160 (TD)	NM	NA	NA	0.5	ND	NR	NR	—
4/22/86	PWS3	GW	160 (TD)	NM	NA	NA	0.2	ND	NR	NR	—
7/7/87	PWS3	GW	160 (TD)	NM	NA	NA	2.1	ND	NR	NR	10.6
1/7/88	PWS3	GW	160 (TD)	NM	NA	NA	ND	NR	NR	NR	8.15
9/2/88	PWS3	GW	160 (TD)	NM	NA	NA	ND	ND	NR	NR	—
9/22/88	PWS3	GW	160 (TD)	NM	NA	NA	ND	NR	NR	NR	9.4
1/30/89	PWS3	GW	160 (TD)	NM	NA	NA	ND	0.8	NR	NR	8.11
7/13/89	PWS3	GW	160 (TD)	NM	NA	NA	ND	1.5	NR	NR	—
8/12/91	PWS3	GW	160 (TD)	NM	NA	NA	ND	ND	NR	NR	—
4/11/95	PWS3	GW	160 (TD)	NM	NA	NA	ND	ND	NR	NR	—
7/25/95	PWS3	GW	160 (TD)	NM	NA	NA	ND	ND	NR	NR	—
Sampling for the Phase I comprehensive investigation (PRC 1996)											
4/30/96	Probe 1	SG	4–6	—	< 1	< 2	NA	NA	NA	NA	NA
4/30/96	Probe 1	SG	10–12	—	< 1	< 2	NA	NA	NA	NA	NA
4/30/96	Probe 1	SG	16–18	—	9.7	< 2	NA	NA	NA	NA	NA

TABLE A.1 (Cont.)

Date	Location	Medium[b]	Sample Depth (ft BGL)	Depth to Water (ft BGL)	Concentration (ppb)						Nitrates (ppm)
					Field Laboratory Analysis		Off–Site Laboratory Analysis				
					Carbon Tetrachloride	Chloroform	Carbon Tetrachloride	Chloroform	Methylene Chloride	Total BTEX[a]	
Sampling for the Phase I comprehensive investigation (PRC 1996) (cont.)											
4/30/96	Probe 2	SG	4–6	—	< 1	< 2	NA	NA	NA	NA	NA
4/30/96	Probe 2	SG	7–9	—	8.4	< 2	NA	NA	NA	NA	NA
4/30/96	Probe 2	SG	12–14	—	< 1	< 2	NA	NA	NA	NA	NA
4/30/96	Probe 3	SG	6–9	—	50	< 2	NA	NA	NA	NA	NA
4/30/96	Probe 4	SG	4–6	—	66	15	19	6.1	< 3.5	12.3	NA
4/30/96	Probe 5	SG	4–6	—	< 1	< 2	NA	NA	NA	NA	NA
4/30/96	Probe 6	SG	4–6	—	2.6	< 2	NA	NA	NA	NA	NA
4/30/96	Probe 7	SG	6–8	—	10	< 2	NA	NA	NA	NA	NA
4/30/96	Probe 8	SG	22–24	—	8.5	3.5	NA	NA	NA	NA	NA
4/30/96	Probe 9	SG	16–18	—	< 1	< 2	NA	NA	NA	NA	NA
4/30/96	Probe 10	SG	16–18	—	47	2.6	28	< 2.5	< 3.5	2.9	NA
5/1/96	Probe 11	SG	11–13	—	< 1	< 2	NA	NA	NA	NA	NA
4/30/96	Probe 12	SG	7–9	—	< 1	< 2	NA	NA	NA	NA	NA
4/30/96	Probe 13	SG	4–6	—	< 1	< 2	NA	NA	NA	NA	NA
5/1/96	Probe 14	SG	7–9	—	< 1	< 2	NA	NA	NA	NA	NA
5/1/96	Probe 15	SG	4–6	—	< 1	< 2	NA	NA	NA	NA	NA
5/1/96	Probe 16	SG	16–18	—	2.1	< 2	NA	NA	NA	NA	NA
5/1/96	Probe 17	SG	16–18	—	20	< 2	NA	NA	NA	NA	NA
							NA	NA	NA	NA	NA
5/1/96	Probe 4	S	4–6	—	< 1	< 0.2	< 30	< 13	< 64	NA	NA
5/1/96	Probe 3	S	4–6	—	< 1	< 0.2	< 30	< 13	< 64	NA	NA
5/1/96	Probe 3 Dup	S	4–6	—	< 1	< 0.2	< 30	< 13	< 64	NA	NA
5/1/96	Probe 10	S	17–19	—	< 1	< 0.2	< 30	< 13	< 64	NA	NA
4/29/96	Cooney	GW	Unknown	NM	NA	NA	< 1.2	< 0.5	< 2.5	NA	NA
4/29/96	Oentrich	GW	150	NM	NA	NA	< 1.2	< 0.5	< 2.5	NA	NA
4/29/96	Perkins	GW	60	NM	NA	NA	< 1.2	< 0.5	< 2.5	NA	NA
5/1/96	Rothlisberger	GW	100	NM	NA	NA	< 1.2	< 0.5	< 2.5	NA	NA
5/1/96	PWS3	GW	160 (TD)	NM	NA	NA	< 1.2	< 0.5	< 2.5	NA	NA
5/1/96	PWS2	GW	155 (TD)	NM	NA	NA	< 1.2	< 0.5	< 2.5	NA	NA

TABLE A.1 (Cont.)

Date	Location	Medium[b]	Sample Depth (ft BGL)	Depth to Water (ft BGL)	Concentration (ppb)						
					Field Laboratory Analysis		Off–Site Laboratory Analysis				
					Carbon Tetrachloride	Chloroform	Carbon Tetrachloride	Chloroform	Methylene Chloride	Total BTEX[a]	Nitrates (ppm)
Public water supply sampling reported by the KDHE (1997b)											
8/13/96	PWS2	GW	155 (TD)	NM	NA	NA	1.3	NR	NR	NR	NA
8/13/96	PWS3	GW	160 (TD)	NM	NA	NA	0.5	NR	NR	NR	NA
Private well sampling reported by the KDHE (1998)											
8/28/97	PWS2	GW	155 (TD)	NM	NA	NA	0.9	< 0.5	< 0.5	< 0.5	NA
8/28/97	PWS3	GW	160 (TD)	NM	NA	NA	< 0.5	< 0.5	< 0.5	< 0.5[h]	NA
6/23/98	Finch[k]	DW	Unknown	NM	NA	NA	< 0.5	< 0.5	< 0.5	< 0.5	< 20
Sampling reported in the 1999 Comprehensive Investigation Report by BE&K Terranext											
11/30/98	MW–1D	S	21–23	—	NA	NA	< 6.25	< 6.25	< 6.25	< 6.25[i]	NA
12/1/98	MW–2D	S	21–23	—	NA	NA	< 6.4	< 6.4	< 6.4	< 6.4	NA
12/1/98	MW–2D Dup	S	21–23	—	NA	NA	< 5.55	< 5.55	< 5.55	< 5.55	NA
12/1/98	MW–3D	S	15–17	—	NA	NA	< 6.6	< 6.6	< 6.6	< 6.6	NA
12/1/98	MW–4D	S	6–8	—	NA	NA	< 6.25	< 6.25	< 6.25	< 6.25	NA
12/28/98	MW–1S	GW	13.3–23.3	Dry	NS[j]	NS	NS	NS	NS	NS	NS
12/28/98	MW–1D	GW	139.85–159.4	107.74	NA	NA	< 1	< 1	< 1	< 1	NA
12/28/98	MW–2D	GW	133.26–152.93	100.61	NA	NA	< 1	< 1	< 1	< 1	NA
12/28/98	MW–3D	GW	133.02–152.73	97.69	NA	NA	< 1	< 1	< 1	< 1	NA
12/28/98	MW–4D	GW	98.38–118.22	79.93	NA	NA	4	< 1	< 1	< 1	NA
1/29/99	MW–1S	GW	13.3–23.3	Dry	NS	NS	NS	NS	NS	NS	NS
1/29/99	MW–1D	GW	139.85–159.4	109.5	NA	NA	< 1	< 1	< 1	< 1	NA
1/29/99	MW–2D	GW	133.26–152.93	107.27	NA	NA	< 1	< 1	< 1	< 1	NA
1/29/99	MW–3D	GW	133.02–152.73	103.71	NA	NA	< 1	< 1	< 1	< 1	NA
1/29/99	MW–4D	GW	98.38–118.22	84.52	NA	NA	3.9	< 1	< 1	< 1	NA
1/29/99	MW–4D Dup	GW	98.38–118.22	84.52	NA	NA	3.7	< 1	< 1	< 1	NA

TABLE A.1 (Cont.)

Date	Location	Medium[b]	Sample Depth (ft BGL)	Depth to Water (ft BGL)	Concentration (ppb)						Nitrates (ppm)
					Field Laboratory Analysis		Off–Site Laboratory Analysis				
					Carbon Tetrachloride	Chloroform	Carbon Tetrachloride	Chloroform	Methylene Chloride	Total BTEX[a]	
Sampling reported in the 1999 Comprehensive Investigation Report by BE&K Terranext (cont.)											
1/29/99	Oentrich	GW	150	NM	NA	NA	< 1	< 1	< 1	< 1	NA
1/29/99	PWS2	GW	155 (TD)	NM	NA	NA	< 1	< 1	< 1	< 1	NA
1/29/99	PWS3	GW	160 (TD)	NM	NA	NA	< 1	< 1	< 1	< 1	NA
Sampling of wells reported by the KDHE (2001)											
5/4/99	MW–1S	GW	13.3–23.3	Dry	NS	NS	NS	NS	NS	NS	NS
7/12/99	PWS2	GW	155 (TD)	NM	NA	NA	1.2	NR	NR	NR	NA
7/12/99	PWS3	GW	160 (TD)	NM	NA	NA	1.7	0.6	NR	NR	NA
Sampling reported by BE&K (2000)											
3/22/00	MW–1S	GW	13.3–23.3	Dry	NS	NS	NS	NS	NS	NS	NS
3/22/00	MW–1D	GW	139.85–159.4	119.09	NA	NA	< 1	< 1	< 1	NA[h]	NA
3/22/00	MW–2D	GW	133.26–152.93	116.8	NA	NA	< 1	< 1	< 1	NA	NA
3/22/00	MW–3D	GW	133.02–152.73	113.69	NA	NA	< 1	< 1	< 1	NA	NA
3/22/00	MW–4D	GW	98.38–118.22	95.21	NA	NA	5.1	< 1	< 1	NA	NA
3/22/00	MW–4D Dup	GW	98.38–118.22	95.21	NA	NA	4.9	< 1	< 1	NA	NA
3/22/00	PWS2	GW	155 (TD)	NM	NA	NA	< 1	< 1	< 1	NA	NA
3/22/00	PWS3	GW	160 (TD)	NM	NA	NA	< 1	1.9	< 1	NA[h]	NA
Sampling reported for Westside Service underground storage tank site by AEI (2000)											
10/17/00	MW–1	GW	10–45	15.8	NA	NA	NA	NA	NA	12800	NS
10/17/00	MW–2	GW	10–45	16.19	NA	NA	NA	NA	NA	396	NS
10/17/00	MW–3	GW	10–40	19.94	NS	NS	NS	NS	NS	NS	NS
10/17/00	MW–4	GW	10–45	14.02[l]	NS	NS	NS	NS	NS	NS	NS
10/17/00	MW–5	GW	10–50	44.22	NA	NA	NA	NA	NA	ND	NS
10/17/00	MW–7	GW	24.5–64.5	62.67	NA	NA	NA	NA	NA	ND	NS

TABLE A.1 (Cont.)

Date	Location	Medium[b]	Sample Depth (ft BGL)	Depth to Water (ft BGL)	Concentration (ppb)						Nitrates (ppm)
					Field Laboratory Analysis		Off–Site Laboratory Analysis				
					Carbon Tetrachloride	Chloroform	Carbon Tetrachloride	Chloroform	Methylene Chloride	Total BTEX[a]	
Sampling reported for Westside Service underground storage tank site by AEI (2000) (cont.)											
10/17/00	MW–8	GW	23.5–63.5	53.4	NA	NA	NA	NA	NA	ND	NS
10/17/00	MW–9	GW	40.80	63.12	NA	NA	NA	NA	NA	ND	NS
Sampling reported by the KDHE (2002)											
3/8/02	MW–4D	GW	98.38–118.22	NR	NA	NA	7.3 [m]	< 1	< 0.9	< 0.4	NA
Sampling of public water supply wells, reported by the KDHE (2006)											
7/15/02	PWS2	GW	155 (TD)	NR	NA	NA	< 0.5	NR	< 0.5	< 0.5	NR
7/15/02	PWS3	GW	160 (TD)	NR	NA	NA	< 0.5	NR	< 0.5	<0.5	NR
7/11/05	PWS2	GW	155 (TD)	NR	NA	NA	< 0.5	NR	< 0.5	< 0.5	NR
7/11/05	PWS3	GW	160 (TD)	NR	NA	NA	< 0.5	NR	< 0.5	<0.5	NR

[a] BTEX: benzene toluene, ethylbenzene, and xylene.
[b] Medium types: DW, drinking water; GW, groundwater; S, soil; SG, soil gas.
[c] TD: total depth.
[d] NM: not measured.
[e] NA: sample not analyzed for this constituent.
[f] ND: contaminant not detected.
[g] NR: result not reported in investigation reports on file.
[h] Trihalomethane compounds other than chloroform reported at trace concentrations.
[i] Acetone present at low concentration is likely a laboratory contaminant.
[j] NS: no sample (dry well).
[k] Site of Barnes south former CCC/USDA facility.
[l] Not sampled because of the presence of free product.
[m] Sample received by the analytical laboratory at a temperature of 15°C (KDHE 2002).

TABLE A.2 Construction summary for wells at Barnes, Kansas.

Well Name	Well Location	WWC-5 Filed	Well Diameter (in.)	Casing Type	Elevation (ft AMSL)		Screen Length (ft)	Depth (ft BGL)			Completion Date
					Ground	Casing		Screen	Filter	Total	
Public wells (reported by KDHE 1997a)[a]											
PWS2	1000 ft west of CCC/USDA facility	No	10	Steel	Unk[a]	Unk	Unk	Unk	Unk	155	1928
PWS3	1000 ft west of CCC/USDA facility	No	8	Steel	Unk	Unk	Unk	Unk	Unk	160	1955
Private wells (well depths reported by PRC [1996])											
Cooney	5/8 mi west-southwest of CCC/USDA facility	No	Unk	Unk	Unk	Unk	Unk	Unk	Unk	Unk	Unk
Oentrich	200 ft south of CCC/USDA facility	No	Unk	Unk	Unk	Unk	Unk	Unk	Unk	~150	Unk
Perkins	3/4 mi south of CCC/USDA facility	No	Unk	Unk	Unk	Unk	Unk	Unk	Unk	~60	Unk
Rothlisberger	3/8 mi southeast of CCC/USDA facility	No	Unk	Unk	Unk	Unk	Unk	Unk	Unk	~100	Unk
Finch	Approximately 1 mi south of Barnes	No	Unk	Unk	Unk	Unk	Unk	Unk	Unk	Unk	Unk
Monitoring wells installed for carbon tetrachloride investigation (construction details reported by BE&K [1999])											
MW-1S	North of former agricultural bldg	No	2	PVC	1352.60	1352.16	10	13.3–23.3	Unk	23.66	12/98
MW-1D	North of former agricultural bldg	No	2	PVC	1352.60	1351.92	15	139.85–159.40	Unk	160.53	12/98
MW-2D	Approximately 140 ft north of PWS2	No	2	PVC	1349.78	1349.51	15	133.26–152.93	128.9–153.37	153.37	12/98
MW-3D	Northeast of intersection of alley and 2nd Ave.	No	2	PVC	1347.03	1346.60	15	133.02–152.73	129–153.33	153.33	12/98
MW-4D	Former CCC/USDA facility	No	2	PVC	1327.67	1326.93	15	98.38–118.22	94–118.82	118.82	12/98
Monitoring wells installed for Westside Service underground storage tank investigation (construction information from WWC registrations in state database and AEI [2000])											
MW-1	West of Co-op, south of railroad	Yes	2	PVC	1338.20	1337.80	35	10–45	9–45	45	9/99
MW-2	West of Co-op, south of railroad	Yes	2	PVC	1337.67	1337.19	35	10–45	9–45	45	9/99
MW-3	West of Co-op, south of railroad	Yes	2	PVC	1337.10	1336.81	30	10–40	9–40	40	9/99
MW-4	West of Co-op, south of railroad	Yes	2	PVC	1337.62	1337.29	35	10–45	9–45	45	9/99
MW-5	West of Co-op, south of railroad	Yes	2	PVC	1336.52	1336.17	40	10–50	9–50	50	9/99
MW-7[b]	West of Co-op, south of railroad	Yes	2	PVC	1338.13	1337.82	40	24.5–64.5	23.5–64.5	64.5	9/99
MW-8[b]	West of Co-op, south of railroad	Yes	2	PVC	1337.66	1337.29	40	23.5–63.5	22.5–63.5	63.5	9/99
MW-9	West of Co-op, south of railroad	Yes	2	PVC	1336.09	1335.75	40	40–80	39–80	85	9/99

[a] Unk, unknown.

[b] Westside Service monitoring wells MW-7 and MW-8 were plugged on 4/22/04.