Volume I

Phase II Investigation report

Citizens Gas and Electric Company Site
Docket No. VII-93F-0033

Prepared for
UtiliCorp United, Inc.

October 1995

Barr
Engineering Company

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List of Acronyms

AOC	Administrative Order on Consent, Docket No. VII-93F-0033
BETX	Benzene, Ethyl Benzene, Toluene and Xylene
bgs	below ground surface
CWG	Carbureted Water Gas
GRI	Gas Research Institute
Iowa DOT	Iowa Department of Transportation
LUST	Leaking Underground Storage Tank
MGP	Manufactured Gas Plant
MSL	Above Mean Sea Level (vertical datum)
MW-	Monitoring Well
NAPL	Nonaqueous-Phase Liquid
ND	Not Detected
PAH	Polynuclear Aromatic Hydrocarbon
PNG	Peoples Natural Gas
TOC	Total Organic Carbon
U.S. EPA	United States Environmental Protection Agency
SB-	Soil Boring

List of Symbols

f_{oc}	Organic Carbon Content [weight/weight]
i	Hydraulic Gradient [Length/Length]
K	Hydraulic Conductivity [Length/Time]
K_d	Distribution Coefficient
K_{oc}	Organic Carbon Partition Coefficient
n	Porosity [Volume/Volume]
q	Darcy Flux [Volume/Time*Area]
R_d	Retardation Factor
ρ_d	Bulk Density [Mass/Volume]

1.0 Introduction

This report presents the findings of the Phase II investigation of the Citizens Gas and Electric Company site. The site is the former location of a manufactured gas plant (MGP) that was located at the northeast and northwest corners of South 7th Street and 11th Avenue (Railroad Crossing), in Council Bluffs, Iowa (Figure 1-1). This report provides a summary and interpretation of the data collected at the site and has been prepared to fulfill the requirements of Paragraph 20 of the Administrative Order on Consent (AOC), Docket No. VII-93-F-0033, between Peoples Natural Gas Company (PNG) and the United States Environmental Protection Agency (U.S. EPA), dated September 30, 1993. A copy of the AOC is contained in Appendix A.

1.1 Report Purpose and Objectives

The Phase II investigation was developed to build upon the site-specific information from the Phase I investigation that was conducted in 1989. The Phase I investigation results are summarized in a report entitled *Report of Findings* (Dames and Moore, April 1990). Polynuclear aromatic hydrocarbons (PAHs) and volatile organic compound concentrations were reported in soil and groundwater samples collected during the Phase I investigation. The PAHs found were restricted to those typical of MGP sites. Groundwater sample analysis for a wide range of volatile organic compounds (EPA Method 8240 and 5030) found only benzene, ethyl benzene, toluene, and xylenes (BETX). The soil and groundwater samples showed relatively low cyanide and phenol concentrations.

The Phase II investigation was designed to accomplish the following objectives:

- Characterize the quantity and distribution of waste in the site soil.
- Characterize likely sources of groundwater contamination.
- Evaluate groundwater quality at the site.
- Acquire upgradient groundwater quality data to compare with groundwater quality data on site and downgradient of the site.

- Provide additional information on the identified contaminated groundwater plume or the presence of contaminated groundwater plumes downgradient of the gasometers.

- Evaluate the mobility and migration potential of the nonaqueous-phase liquid (NAPL) that was discovered in one well at the site.

- Provide the additional investigation requested in a U.S. EPA review of the Phase I investigation, dated January 24, 1992. A copy of U.S. EPA review is contained in Appendix B.

1.2 Report Organization

The following sections provide a general site summary and history including the site location, site definition and ownership, current and historical land use, and the regional site setting (Section 2); investigative activities (Section 3); physical characteristics of the site (Section 4); nature of contamination (Section 5); extent of contamination (Section 6); contaminant fate and transport (Section 7); conclusions (Section 8) and recommendations (Section 9).

2.0 Site Setting

2.1 Site Background Information

2.1.1 Site Definition

The site is located in Potawattamie County in the SW¼ of Section 36, Township 75N, Range 44W, third principal meridian. The site covers two parcels of land that are separated by South 7th Street. The site location, shown on Figure 1-1, is at the northeast and northwest corners of South 7th Street and 11th Avenue (Railroad Crossing), in Council Bluffs, Iowa. East of South 7th Street, the site is an area approximately 275 feet by 298 feet of block 11, and west of South 7th Street, the site is an area approximately 158 feet by 295 feet of block 12. The west portion of the site is surrounded by a 6-foot-high chain-link fence. The PNG property on the east portion of the site is also surrounded by a 6-foot-high chain-link fence.

2.1.2 Site Ownership

A preliminary summary of the history of the gas plant property ownership is presented in Table 2-1. The western portion of the site is currently owned by K.C. Peterson Construction Company. The eastern portion of the site is owned by Utilicorp United Inc., the State of Iowa, Ron and Deb Case, and Linda Whisler. Figure 2-1 shows the approximate property boundaries and lists property ownership.

2.1.3 History of Site and Adjacent Areas

Site history information presented below was obtained from period documents and summaries of historic information cited in section 2.1.3.1. However, limited information was available regarding the manufactured gas production at the site. Accordingly, this Phase II report describes operating information for typical plants of the era of the Citizens Gas and Electric Company facility. Every gas plant was unique, and the generalized information may not fully represent the specific details of the gas production at this site.

2.1.3.1 Gas Plant Site History

According to Mr. M.C. Holder, as reported in the September 22, 1934 *Nonpareil* newspaper of Council Bluffs, Iowa, the gas plant was started in 1870. Initially, the gas manufacturing process was coal carbonization using coal from England. By 1882, oil was used in the production of the manufactured gas (*Nonpareil,* 1934) indicating the plant had converted to a carbureted water gas process. The plant continued to operate through most of 1930. By December 2, 1930, all of west Council Bluffs had been converted to natural gas. In 1952, the gas manufacturing equipment was retired from service, and a propane air plant was installed. Two gasometers, one of 500,000 cubic feet and one of 200,000 cubic feet capacity, were retained to store natural gas for distribution purposes (Duff and Phelps, 1955). A natural gas storage tank was still present at 11th Avenue and 8th Street as late as December 20, 1959 (*Nonpareil,* 1959).

Between 1930 and 1952, the plant was maintained in an operational state for peaking purposes. The gas from the carbureted water gas plant was mixed with vaporized propane to match the heat content of natural gas (*Nonpareil,* 1949).

Sanborn maps of the site dated 1891, 1896, 1928, 1962, and 1968 are available (Figures 2-2, 2-3, 2-4, 2-5 and 2-6). The 1896 map (Figure 2-3) noted that the Council Bluffs Gas and Electric Light Company gas works produced water gas. The 1928 map (Figure 2-4) shows a tar pit (which was listed as a gasometer on previous maps) on the western lot, and purifiers, two buried oil tanks, an additional gasometer and a gas and electric supplies building on the eastern lot. The 1928 map also noted that the gas was generated from coke and oil (which are raw materials for generating carbureted water gas). The facility ownership was shown as Citizens Gas and Electric Company on the 1928 map. A 500,000 cubic foot gasometer was added on the western lot sometime after 1928. The gas works buildings and the gasometer at 8th Street and 11th Avenue are shown on the 1962 (Figure 2-5) and 1968 (Figure 2-6) Sanborn maps.

Information summarized from *Brown's Directory of American Gas Companies* listed the Council Bluffs facility as producing water gas from at least 1890 to 1930 (Radian, 1985). Gas production was listed as 28 million cubic feet in 1900, 88 million cubic feet in 1910, and 160 million cubic feet in 1920.

2.1.3.2 History of Adjacent Areas

The site is located in an industrial neighborhood. The residential presence near the plant in the 1800s has been progressively replaced with industrial land uses. This is reflected in the Sanborn maps of the site. Figures 2-2 through 2-6 show the site and the area approximately one block south, one-half block east, and one-half block west. Currently, one residence located at 1108 South 7th Street is believed to be owner occupied (Barr, 1995a). Other residential structures located along South 7th Street are occupied by commercial interests.

Railroad tracks have bracketed the site on the north and south sides on all Sanborn maps. The 1928, 1961, and 1968 maps show Sinclair Refining Company with gasoline storage at the southeast quadrant of South 8th Street and the railroad tracks at 11th Avenue. The 1928 map also shows the Mona Motor Oil Company to the east and south of the gas works. Petroleum products may have been released at these facilities.

A site-area regulatory database search was conducted in February 1993 by VISTA Environmental Information, Inc. The following U.S. EPA databases were searched: NPL, CERCLIS, RCRA-LgGEN, RCRA-SmGEN, RCRA-TSD, and RCRA-Transp. The following State of Iowa databases were searched: SPL, LUST, SWLF (permitted), SWLF (inactive), and USTs. A copy of the database search report is contained in Appendix C. The search identified 19 sites within a one-mile radius of the Citizens Gas and Electric Company site.

2.1.4 Gas Manufacturing Process Overview

The site history indicates the gas manufacturing process used at this facility was initially coal carbonization, then was converted to carbureted water gas (CWG) after perhaps 12 years of operation. CWG production continued for about 50 years, until 1930. There are differences in waste production between CWG and coal carbonization, differences which influence the expected types and quantities of waste that may be present at the site. The following description of the gas manufacturing process emphasizes CWG. The discussion of byproduct recovery and waste disposal includes comments to identify important differences between CWG and coal carbonization byproducts and residues. The information in this section was obtained from the Gas Research Institute (GRI, 1988) and U.S. EPA guidance documents for management of manufactured gas sites (U.S. EPA, 1988).

The CWG process was invented in 1875 by Lowe and became the predominant form of gas production in the United States. Figure 2-7 shows a general flow chart for the production of CWG. A conventional CWG apparatus consisted of three major components: the blue gas generator, the carburetor, and the superheater.

The CWG process started with the production of blue gas (also known as water gas or blue water gas). The blue gas (primarily carbon monoxide and hydrogen with a heating value of about 300 Btu/ft^3) was produced in the generator in a cyclical manner: first air was blown through a bed of incandescent carbon fuel; then air was cut off; steam was blown through the bed, and the steam reacted with the carbon, producing the blue gas and cooling the bed; the cycle was then repeated. The original carbon fuel used in the CWG process was bituminous coke or anthracite coal. As anthracite coal prices increased at the turn of the century and coke shortages occurred during World War I, processes were modified to use bituminous coal. Blue gas production resulted in the creation of ash and cinders.

The blue gas passed from the generator to the carburetor, as illustrated on Figure 2-7. In the carburetor, carburation oil (pumped from storage and preheated) was sprayed and thermally cracked to form oil gas or carbureted water gas in the presence of the blue gas and steam. The BTU content of the gas was increased to 500 to 600 Btu/ft^3. Any liquid hydrocarbon that could be thermally cracked into gaseous, liquid, and solid products could be used as a carburation oil; however, the selection was often based on cost. Three fractions principally used were naphtha, gas oil, and residual fuel oil. The early CWG processes used naphtha from about 1880 through World War I, at which time other uses of this fraction increased the price, and gas producers started to switch to other fuels. The use of naphtha ended by 1930. A petroleum fraction between kerosene and lubricating oils called gas oil was used increasingly after 1895 until 1930 when the industry began to switch to fuel oil.

The oil gas passed from the carburetor through a superheater and was cracked into simpler gases. The carburetor and superheater were checkerbricked with firebricks. The apparatus was operated in a cyclical manner, with alternate blows to heat the carbon bed and the checkerbrick, followed by runs in which blue gas was produced and hydrocarbons cracked into the gas from oils sprayed onto the hot firebrick of the carburetor. The generator, superheater, and carburetor were supplied with air by a blower. Waste heat produced during the blows was passed through a waste heat boiler, which produced the steam sprayed through the generator. The production of gas was not continuous, consequently a relief holder was used to dampen the fast flow rate changes and provide a relatively constant flow through the exhauster, tar extractor, purifiers, and finally to the

metering and distribution system. The various elements contributing to this gas production process are shown on Figure 2-7.

The raw gas leaving the production apparatus contained impurities, including tar and hydrogen sulfide, that were removed prior to gas distribution. Impurities were removed by passing the raw gas through a purification train that consisted of a series of cleaning and purification processes. A summary of the gas flow and byproduct generation for the gas production and purification process is illustrated on Figure 2-8. There are differences in waste production between CWG and coal carbonization, differences which influence the expected types and quantities of waste that may be present at the site. This discussion identifies important differences between the wastes from these two gas production processes.

Heavy tars were condensed and removed in a water-sealed hydraulic main or washbox where the gas was initially cooled. This washbox is included with the condensers on Figure 2-8. Lighter tars were removed by passing the gas through a series of condensers (typically water-cooled pipes) or scrubbers. Tar fog or aerosols were commonly removed by passing the gas through shavings scrubbers which were towers or boxes that were filled with wood shavings. The gas flowed through the wood chips and the entrained tar would be retained on the wood and be removed from the gas.

Water and light oils also condensed with the tars. The tar/condensate mixture flowed into a tar separator where it was separated into three distinct layers by gravity. The tar would sink to the bottom of the tank and would be removed to a tar pit for storage. Tars were often sold as fuel, sold to refiners, distilled on site, or mixed with carburation stocks.

The oil layer of lighter hydrocarbons floated to the top of the liquid and could be recovered by oil skimmers. Condensate water was the middle layer and was removed. In a coal carbonization process, ammonia and phenol would be recovered from the water. Unlike coal carbonization, the CWG process produced very little ammonia or phenolic compounds and they were not recovered.

After the tars were removed from the raw manufactured gases, naphthalene and light oil were frequently removed from the gas at the naphthalene and light oil scrubbers step on Figure 2-8. Naphthalene and light oils were removed in separate scrubbers that contacted the gas with a relatively small amount of petroleum oil. Naphthalene was removed to prevent it from plugging the oxide boxes or distribution system. Because of its fuel value, the naphthalene-containing oil was never considered a waste product. It was either sold or used at the plant for fuel. If

profitable, the naphthalene could be distilled and sold. The light oils (primarily benzene, xylene, and related substances) were originally considered beneficial in the gas because they enhanced the brightness of the flame. After the invention of the Welsbach gas mantle and the switch from lighting to heating standards for gas, the illuminants were no longer necessary for gas quality and were recovered if economically viable.

Hydrogen sulfide was produced by all manufactured gas processes and was removed by passing the manufactured gas through a series of packed chambers known as purifier boxes. Prior to 1885, the hydrogen sulfide was removed with hydrated lime. The lime could not be regenerated, had a foul odor from the sulfur and tar, and had a blue color from ferric cyanide. The spent lime could be sold or given away for agricultural purposes, but much of it was discarded. After 1885, the purifiers contained iron oxide (typically rusted iron borings) mixed with a fluffing material (typically wood chips, but also blast-furnace slag or corn cobs). The iron oxide reacted with the hydrogen sulfide in the gas to form ferric sulfide, ferrous sulfide, and sulfur. The oxides were periodically revived by blowing air through the purifier or spreading the wood chips on the ground. These actions oxidized the iron sulfides and produced sulfur as a byproduct. The sulfur removed from the gas could either be recovered as a salable byproduct, discharged as hydrogen sulfide to the air, or discarded as waste. Free sulfur, inert iron, and tar eventually built up on the wood chips and the wood chips had to be discarded.

In gas produced by coal carbonization, cyanide was also an impurity, but cyanide was produced only in trace quantities by CWG. Cyanide was generally not recovered from the gas but was instead removed as iron-cyanide complexes in the purifier boxes that removed the hydrogen sulfide from the gas. These iron-cyanide complexes were typically blue in color and were not toxic.

After purification, the gas was pumped into a gasometer until it was sold. This is shown as gas storage on Figure 2-8. Gasometers were large iron tanks that could change volume as gas was added or withdrawn. Gasometers had either a water or a tar seal between the steel riser tank and the sleeve in which the tank moved.

2.1.5 Current Site Conditions

The east portion of the site is the present location of a compressor station and training center owned by PNG. A portion of the circular concrete base of gasometer no. 3 is visible along the south wall of the training center. The original gas plant office building is south of the training

center and once housed some of the purifiers used at the plant. The office building property is owner by Linda Whisler and is used as a warehouse and a office facility for the Council Bluffs Business Association. The Iowa DOT constructed the Highway 192 expressway through the east portion of the site during the mid 1970s.

The west portion of the site is used by KC Peterson Construction Company for offices, maintenance facility, and equipment and material storage. The original gas plant buildings, which originally housed the gas generator and the boilers, are still being used. The former purifier building, shown on the 1962 Sanborn (Figure 2-5) is still standing, but is unused. The warehouse along the north side of the former plant is apparently in use. The above-grade structures of the gasometers have been removed. The small concrete building and vaporizer unit associated with the propane-air installation is present at the corner of South 8th Street and 11th Avenue. Figure 2-9 shows the current site features.

2.2 Regional Characterization

2.2.1 Demographic Information

The population of Council Bluffs is approximately 57,000. Agricultural development encircles the Council Bluffs area to the north, east and south. Directly west of Council Bluffs lies the City of Omaha, Nebraska.

2.2.2 Municipal Water Supply

The City of Council Bluffs obtains most of its drinking water from the Missouri River. The city has two production wells located at North 25th Street for supplemental and emergency purposes. These wells are located near the Missouri River (2.5 miles NW [side gradient] of the site) and are approximately 120 feet deep. Less than 5 percent of the annual drinking water supply is derived from these wells (Barr, 1995b). During very harsh winters, up to 10 percent of the city water may be provided by these wells so as to blend warmer water with cold river water in an effort to prevent pipe freeze-up.

Review of the preliminary assessment information identified one well within one mile northeast (upgradient) of the site and one well approximately one mile west (sidegradient) of the site. No wells were identified within three miles downgradient of the site.

2.2.3 Land Use

The site and the surrounding area is zoned general manufacturing (Barr, 1995c). The City's community development department does not have plans to modify the zoning classification in this area.

2.2.4 Regional Geology

The geology of southwest Iowa is characterized by thick unconsolidated sediments, loess (wind-blown silt), glacial till, and fluvial deposits, overlying Pennsylvanian-age bedrock. These sediments range in thickness from 120 feet on the Missouri River floodplain to more than 400 feet in the bluffs that line the Missouri River.

Pennsylvanian bedrock units in this region consist of alternating shale and limestone formations that lie in an almost horizontal position. Well log data indicate their total thickness to be approximately 700 feet. Older systems underlying the Pennsylvanian consist primarily of limestones, dolostones, and shales with a thickness estimated between 1,350 and 1,400 feet.

2.2.5 Regional Hydrogeology

According to the Iowa Geological Survey, the regional groundwater flow direction is to the south-southwest, toward the Missouri River. In the vicinity of the site, aquifers are present in both the unconsolidated deposits and the bedrock.

Groundwater in the unconsolidated deposits is found primarily in sand and gravel outwash deposits and in the coarse alluvium of buried bedrock valleys, which generally trend to the south-southwest. The bedrock valleys are a system of ancient drainage courses that developed during long periods of preglacial erosion and shorter, but more intense periods of interglacial erosion (USGS, 1980).

Limestones of the Pennsylvanian system are water-bearing. However, the average aquifer yield is low because the confined beds tend to be thin.

2.2.6 Climate

The Council Bluffs region has a typical midcontinental climate, characterized by extreme temperatures and semiarid levels of precipitation. The average yearly temperature is 51.1°F, and the average yearly precipitation is 32.78 inches (NOAA, 1992).

2.2.7 Physiographic and Topographic Setting

The physiography of Council Bluffs is characterized by an urban setting. The prominent physiographic feature of the area is the Missouri River, which forms the border between Iowa and Nebraska.

The topography of southwestern Iowa is characterized by vast plains and gently rolling hills. The Missouri River Valley is the predominant topographical feature in the region. The bluffs exhibit up to 250 feet of relief from the valley floor in the Council Bluffs area. Council Bluffs is situated on the Missouri River. The site lies below the bluff line, on the broad floodplain adjacent to the river.

2.2.8 Environmental Target Areas

The area within several blocks of the site has been urban since before the turn of the century. There are no natural areas, wetlands, or evident environmental target areas in the vicinity of the site.

3.0 Investigative Activities

This section summarizes the investigative activities that have been conducted at or near the site.

3.1 Previous Investigations

3.1.1 Iowa Department of Transportation Investigation

The Iowa Department of Transportation (Iowa DOT) conducted a subsurface investigation in support of the Highway 192 expressway construction. The construction plans noted that there are a few underground pipes remaining in the area near the site, which are known to contain some gasoline and oil. The Iowa DOT construction plans also noted an old gasoline tank at 11 feet below grade at boring F-7235. The sand at three borings (F-7234, F-7235 and F-7236) was reported to have a gas odor and oily scum. The approximate boring locations are shown on Figure 3-1 and the boring logs are contained in Appendix D. It appears that F-7235 was advanced through the floor of gasometer no. 4 which suggests that what the Iowa DOT identified as a gasoline tank was actually the gasometer.

Pier 25 was constructed at the location of F-7235 and consists of four concrete bridge supports. Each concrete support was constructed on top of twelve 35-foot-long creosote-treated timber pilings driven into the coarse alluvial unit. This length of piling would have penetrated the floor of the gasometer.

3.1.2 Leaking Underground Storage Tank (LUST) Sites

Leaking underground storage tank sites have been reported at properties around the site (IDNR, 1992): Farm Services Company, LUST No. 7LTM14 on the west; Tri Valley Seed Company, LUST No. 7LTN34 on the southeast; and Oil Products Company, LUST No. 7LTG97 on the south; McBee's Texaco Station, LUST No. 8LTN74 and Eddy's 503, LUST No. 7LTO39 on the northeast. The location of each LUST is shown on Figure 3-2. The reported extent of groundwater contamination associated with each LUST (if available) is shown on Figure 3-2 along with a brief description of the tank history.

LUST No. 7LTM14 is located across 8th Street from the site. This site has 1.5 feet of free product floating on the perched water table. The IDNR has required the owner to recover free product at this facility. A plume of benzene was identified at LUST No. 7LTG97 south of the site and LUST Nos. 8LTN74 and 7LTO39 northeast of the site. It is not known if the IDNR is requiring groundwater remediation at these sites.

Not all of the petroleum facilities have been investigated to date, and those that have been investigated have not explored potential impacts on the coarse alluvial aquifer. Petroleum facilities are currently located west of the site. Petroleum facilities were also present in the past immediately east (Mona Motor Oil) and south (Sinclair Refining Co.) of the site, as shown on Figures 2-4 and 3-2.

3.1.3 Phase I Investigation

A Phase I investigation was performed at the site in 1989 by Dames and Moore. Fourteen soil borings (ST-1 through ST-14) and four monitoring wells (MW-1 through MW-4) were installed to characterize the extent of contamination associated with the former MGP. The approximate soil boring and monitoring well locations are shown on Figure 3-3. Boring logs are in Appendix E. Eleven soil samples were analyzed for the parameters listed in Table 3-1. Elevated PAH and BETX concentrations were reported in some of the soil samples collected during the Phase I investigation. Concentrations of the sum of PAHs ranged from nondetect to 13,000 mg/kg. BETX concentrations ranged from nondetect to 390 mg/kg. Inorganic compounds were typically reported at low concentrations. The analytical results are summarized in Table 3-2.

Groundwater samples were collected from each monitoring well and analyzed for the parameters listed in Table 3-3. Total PAH and BETX concentrations were reported in the groundwater sample from MW-3 at 5,500 µg/L and 10,800 µg/L, respectively. Inorganic compounds were typically reported at low concentrations. The analytical results are summarized in Table 3-4.

The *Report of Findings* was submitted to the U.S. EPA in September 1991. The U.S. EPA identified several data gaps and submitted comments to PNG on January 24, 1992. A copy of this letter is in Appendix B. As stated below, the Phase II work plan was developed to respond to the identified data gaps.

3.2 Phase II Investigation

Barr Engineering Company developed a work plan (Barr, 1993a) to characterize the extent of MGP waste at the surface and in the subsurface. The additional work was developed to build on the information contained in the *Report of Findings*. The U.S. EPA approved the Phase II work plan on August 11, 1993, and the work was conducted in April 1994. During Phase II, the following media were investigated: soil, groundwater, and nonaqueous-phase liquid (NAPL). The field activities conducted during Phase II are described in the following sections.

3.2.1 Soil Investigation

Fourteen soil borings (SB-15 through SB-28) were installed at the locations shown on Figure 3-3. Soil borings were advanced using hollow-stem-auger drilling methods. Drilling fluid was used inside the augers beginning at depths of 27 to 30 feet due to heaving sands. The depths and elevations for each boring (including the Phase I investigation borings) are summarized in Table 3-5.

Soil samples were collected at each 2½-foot interval using standard split-barrel samplers, large-diameter split-barrel samplers, or thin-wall tube samplers. Potential analytical samples were collected from each split-barrel sample if sufficient recovery was obtained. When sufficient sample volume was recovered, Barr collected split samples for U.S. EPA's representative, Jacobs Engineering Group, Inc. Potential analytical samples were collected in laboratory supplied sample jars and stored in an ice-packed cooler. The final field sampling plan (Barr, 1993b) describes the drilling and sampling methods and procedures. Each soil sample recovered was inspected in the field by a geologist and classified according to ASTM D-2488 standard practice for description and identification of soils (visual-manual procedure). The soil samples were also examined in the field for indications of contamination by noting odors, discoloration, the presence of an oily sheen and organic vapor headspace measurements. The procedures for the field screening tests are discussed in the field sampling plan (Barr, 1993b). The soil descriptions, oil sheen, and headspace readings are listed on the boring logs in Appendix E.

Thirty-eight soil samples were analyzed for the volatile organic compounds, base/neutral compounds and inorganic parameters listed in Table 3-6. Analytical samples were selected to characterize the zones of contamination identified in a soil boring. Field screening results and visual observations were used to identify visually contaminated areas. In general, analytical

samples were selected near the upper or lower fringes of visually contaminated areas and at an interval within the more contaminated area to characterize the zone of contamination in each boring.

Surface soil samples (0-2 ft) were collected at SB-15, SB-16, SB-18, SB-19, SB-22, SB-23, and SB-24. These samples were analyzed for the volatile organic compounds, base/neutral compounds and inorganic parameters in Table 3-6.

Three soil samples were collected and analyzed for the geotechnical parameters in Table 3-6. The samples were collected with 3-inch-diameter, 30-inch-long Shelby tubes. The sample locations were selected to be representative of the hydrostratigraphic units based on the soil classification results, and to provide areal representation of the site.

3.2.2 Groundwater Investigation

The groundwater investigation consisted of an initial round of groundwater sampling, installation of additional monitoring wells, performance of slug tests, and a second round of groundwater sampling. The initial round of groundwater sampling was conducted on July 28, 1992, to verify the concentrations reported in *Report of Findings* (Dames and Moore, 1990). The second round of groundwater sampling was conducted on April 25 and 26, 1994 after the Phase II monitoring well installation. The sample container for PAH analysis at MW-6 broke during shipping. A replacement sample was collected on June 2, 1994. Analytical parameters for the groundwater investigation are listed in Table 3-7. The analytical parameters selected for each sample location for the July 1992 and April 1994 sampling events are summarized in Table 3-8.

Three monitoring wells (MW-5, MW-6, and MW-8) were installed at the locations shown on Figure 3-3. MW-5 was positioned to obtain water quality data upgradient from gasometer no. 2. MW-6 was positioned to assess the presence of a contaminated groundwater plume downgradient of gasometer no. 1 and west purifier building area. MW-8 was positioned to obtain water quality data downgradient of gasometer no. 2 and MW-3.

A fourth monitoring well (MW-7) was planned to be installed near SB-20. This well was not installed due to site conditions (see letter to Ms. Betty Berry, dated April 20, 1994, contained in Appendix F).

The elevation of the top of the casing and ground surface at each monitoring well was surveyed and tied into a common mean-sea-level datum. The well locations were also tied into a site coordinate system. A summary of monitoring-well construction details (including the Phase I investigation monitoring wells) is presented in Table 3-9. Well logs are contained in Appendix G.

In-situ hydraulic conductivity (slug) tests were performed in each monitoring well that did not exhibit gross NAPL contamination. Measurement and analysis procedures are discussed in Appendix H.

3.2.3 Nonaqueous-Phase Liquid (NAPL) Investigation

A one-foot layer of NAPL was discovered at the bottom of MW-3 during the July 28, 1992, sampling event. The presence of NAPL was further investigated on April 4 and 5, 1994, and April 15, 1994.

A peristaltic pump was used to collect the first NAPL samples from MW-3. The pump tubing was lowered into the NAPL layer inside the pipe. The peristaltic pump was not able to pump NAPL to the surface. The suction tube was removed from the well and was found to contain water and NAPL. The peristaltic pump was reversed to push the fluids out of the tube. The fluids were collected in a 1,000-ml graduated cylinder and allowed to separate for about 2 hours. After separation, the water was decanted and approximately 300 ml of NAPL were placed in laboratory-supplied sample containers. These samples contained significant quantities of sediment and water. Due to the limited volume of NAPL in the well and the depth to NAPL, sample collection activities were suspended.

Additional NAPL was collected on April 15, 1994. A stainless steel bailer (3/4" diameter) was used to remove approximately 1,000 ml of fluid from the bottom of the well. The fluids were placed in a 1,000-ml graduated cylinder and allowed to separate for about 3 days. After separation, the graduated cylinder contained approximately 300 ml of NAPL. The overlying water was decanted and the NAPL was placed in laboratory-supplied sample containers. The NAPL samples were analyzed for the parameters listed in Table 3-10. Additional details from the NAPL investigation are in Appendix M.

The entire volume of NAPL recovered from MW-3 was shipped to the laboratory for analysis. Therefore, excess volume for split samples was not available to the U.S. EPA oversight contractor, Jacobs Engineering Group Inc.

4.0 Physical Characteristics of the Site

4.1 Geology

Geologic conditions in the vicinity of the site were evaluated from soil borings placed during the Phase I and the Phase II investigations and published geologic information. Soil testing was conducted to help characterize subsurface conditions and to confirm observations made during the investigation activities. Boring logs for the Phase I and Phase II investigations are presented in Appendix E. Geologic cross sections were developed to interpret the relationship of the geologic units, and are presented on Figures 4-2 through 4-7. Cross section locations are shown on Figure 4-1. Soil testing results are summarized in Table 4-1. A copy of the laboratory soil testing reports are included in Appendix I.

The site geology is characterized by near-surface fill materials that have been placed over backwater alluvial deposits, generally olive to gray clay of fat to lean consistency. The clay overlies alluvial sands, which in turn overlie dolomitic bedrock formations. The following paragraphs describe each unit, based on field observations and soil testing results.

4.1.1 Fill

Fill deposits were encountered across the surface of the site to depths ranging from 5 to 12 feet. The fill material encountered typically consisted of silt, sand and gravel with occasional construction debris, including brick, concrete, glass and slag. Fill material was encountered at greater depths in borings constructed inside gasometers. For example, cardboard and newspaper were encountered from 12.5 to 14.5 feet in a gasometer at boring SB-24.

4.1.2 Fine Alluvium

Fine alluvium underlies the fill unit to about 25 feet below ground surface (bgs). The fine alluvium is an overbank deposit composed primarily of fat and lean clays with occasional silt and fine sand laminations and layers. Generally, the clay is olive to gray in color and in some areas contains abundant organic matter such as roots. Root holes were observed in many of the samples. In some areas the clay contains shell fragments.

Layers and laminations of silty sand and fine sand with silt were observed in most borings within the fine alluvium, and sometimes at similar elevations. Because of the complex nature of overbank deposits, it is not known if the sand units represent isolated lenses or if they are continuous across the site.

Soil testing was performed on two samples from the fine alluvium, borings SB-18 (22.5 to 25 foot depth) and SB-23 (12.5 to 14.5 foot depth). The test results are presented in Table 4-1. Test results indicated that the samples were fat clay (CH) with porosities of 65 percent (volume) and 54.3 percent (volume), respectively and total organic carbon (TOC) of 1.4 percent (weight) and 1.0 percent (weight), respectively. Vertical permeability testing results indicated the soils have low permeabilities (2×10^{-8} cm/s and 1.1×10^{-5} cm/s, respectively). The soil testing results are consistent with observations made during the Phase II investigation.

4.1.3 Coarse Alluvium

Alluvial sand underlies the alluvial clay to an approximate depth of 100 feet bgs. The alluvial sand, or coarse alluvium, generally consists of well sorted fine to medium sand with varying amounts of silt, medium to coarse sand, and gravel. Deposits in the upper portions of the unit typically showed finer grain sizes. Deposits in the lower portion of the unit occasionally showed a high percentage of medium and coarse sand.

The alluvial deposits in this area can contain naturally occurring coal. Coal (lignite) was observed in the coarse alluvium at borings SB-15, SB-18, SB-20, SB-23 and SB-28. Lignite is a common feature in the Missouri River alluvium (Ludvigson, 1994).

Soil testing was performed on one sample from the coarse alluvium, boring SB-23 (37.5 to 39.5 foot depth). Soil test results indicated that the sample was poorly graded (well sorted) fine-grained sand (SP) with a porosity of 37.4 percent (volume) and TOC of 0.4 percent (weight). Vertical permeability testing results indicated a vertical permeability of 2.8×10^{-3} cm/s. The test results are presented in Table 4-1. Based on field observations, the coarse alluvium is of similar character across the site, so these soil test results are considered representative of the coarse alluvium across the site.

4.1.4 Bedrock

Two borings (SB-15 and SB-23) were advanced to bedrock during the Phase II investigation. The Iowa DOT advanced four borings to bedrock near the site during a geotechnical investigation for the nearby Highway 192 expressway bridge (Figure 3-1). Bedrock was encountered in these six borings at elevations from 877 to 886 feet MSL. The bedrock surface elevations are summarized in Table 4-2. Relief along the bedrock surface may indicate a buried channel or scour near boring F-7233.

4.2 Site Hydrogeology

4.2.1 Surface Water

The former gas manufacturing site is located over 3 miles east of the Missouri River on the Missouri River floodplain. Surface-water runoff is directed to the storm sewers that run along South 7th and South 8th Streets or accumulates in a shallow ditch along the railroad tracks. This area of Council Bluffs is served by a combined storm and sanitary sewer system, so the storm water is processed by the sewage treatment plant prior to discharge to the environment (Ecology and Environment, 1990). Areas of the site are covered with gravel that permits infiltration.

4.2.2 Groundwater

4.2.2.1 Fine Alluvium

The clayey and silty soils of the fine alluvium underlie the entire site. The unit is generally about 20 feet thick. During sampling activities, the moisture content of the soils was reported to increase from a moist condition in the shallower clayey and silty soils, with the apparent moisture content increasing with depth. Monitoring well MW-1 is screened over a 10-foot interval in the fine alluvium and is screened through a 2-foot-thick sand lens. In the vicinity of MW-1, the bottom of this lens is approximately 6 feet above the top of the underlying coarse alluvial aquifer. From a consideration of borehole logs, stratigraphy, elevation of screened interval, recharge rate, and water levels measured at the site, MW-1 appears to be completed over an isolated water-bearing zone perched in a sand lens in the fine alluvium.

The static water levels measured at MW-1 (Table 4-3) are 2 to 4 feet higher than the static water levels measured at MW-2. MW-2 is located approximately 12 feet northwest of MW-1 and is screened in the underlying coarse alluvial aquifer. Because the elevation of the static water level in MW-1 was higher than the elevation reported in MW-2, it may be inferred that a downward vertical hydraulic gradient (0.10 foot/foot) exists at this location between the fine- and coarse-grained alluvium.

Field evidence that monitoring well MW-1 is completed in a limited water-bearing zone is suggested by the relatively low yield of groundwater from this lens and by the relatively low recharge rate. During water sampling events, for pump rates of about 1 gallon per minute (gpm), the water level in MW-1 rapidly dropped below the pump intake. (Total volume of water removed was estimated to be about 15 gallons.)

General water chemistry parameters of the perched water were compared to the general chemistry parameters of the coarse alluvial aquifer using a Piper diagram. The analysis indicates the water parameters are similar in both areas. A discussion of the Piper diagram is contained in Appendix J.

4.2.2.2 Coarse Alluvium

The coarse alluvial aquifer is confined by the overlying fine alluvial soils and the underlying limestone bedrock. Coarse alluvial soils underlie the entire site. Most soil borings were terminated at the top of the coarse alluvium. Soil borings SB-15 and SB-23 were continued downward to the underlying limestone bedrock and penetrated the saturated thickness of the coarse alluvial soils (approximately 73 feet).

The groundwater flow direction was evaluated from static water-level elevations measured in wells screened in the coarse alluvial aquifer. The elevations are summarized in Table 4-3. The groundwater gradient was calculated for each monitoring event (Appendix K) and the gradients are shown on Figure 4-8. The gradients in the coarse alluvial aquifer have been very flat and have ranged from 0.0002 to 0.0013 ft/ft. The average gradient measured at the site is 0.0004 ft/ft and the typical groundwater flow direction is from northeast to southwest.

Estimated values for hydraulic conductivity were obtained for the coarse alluvial aquifer from slug-out tests conducted in monitoring wells at the site on April 26, 1994. The details of the slug-out test procedures, method of analysis and results are discussed in Appendix H. The range in the

hydraulic conductivity estimates is from 4.2 feet/day to 39.2 feet/day. The geometric mean of the hydraulic conductivity estimate is 13.5 feet/day. These values are within the expected range for hydraulic conductivity for well sorted sand (Fetter, 1988).

The Darcy flux in the coarse alluvial aquifer can be estimated from the Darcy equation:

$$q = i \bullet K \qquad (1)$$

in which:

q = Darcy flux in units of [volume / unit time-area]

i = Hydraulic gradient in units of [length / length]

K = Hydraulic conductivity in units of [length / unit time].

Given the range values for hydraulic gradient and conductivity discussed above, the minimum and maximum values for the Darcy flux (volume of flow per unit area) in the coarse alluvial aquifer calculated from equation 1 are about 0.0008 feet/day and 0.051 feet/day, respectively. The mean Darcy flux, calculated from the average gradient and geometric mean hydraulic conductivity, is 0.0054 feet/day.

An estimate of the range in average linear groundwater velocity in the coarse alluvial aquifer is calculated by dividing the expected range in Darcy flux by the measured effective porosity (37 percent). The minimum and maximum values for the average linear groundwater velocity in the coarse alluvial aquifer are about 0.002 feet/day (0.7 feet/year) and 0.14 feet/day (51 feet/year), respectively. Using the average gradient and geometric mean hydraulic conductivity, a groundwater migration velocity of 0.015 feet/day (5.5 feet/year) is calculated.

5.0 Nature of Contamination

This section identifies the chemical constituents used in characterizing the extent of contamination at the site (Section 6.0) and summarizes associated chemical constituent properties used to evaluate fate and transport (Section 7.0). Parameters selected for extent of contamination characterization include PAHs, BETX, and inorganic chemicals. Chemical and physical properties of the identified parameters are summarized in this section to indicate potential fate and transport characteristics.

5.1 Identification of Parameters for Extent of Contamination Characterization

The key parameters that will be used in the following sections to characterize the extent of soil and groundwater contamination in the vicinity of the site are listed in Table 5-1. These parameters are associated with on-site operations, by-products, and residuals (Barr, 1993a).

5.2 Chemical and Physical Properties of Identified Parameters

This section presents chemical properties and general transport characteristics of identified parameters in order to aid in the interpretation of data collected during the investigation. Chemical property values from the literature for the identified organic and inorganic parameters have been compiled and tabulated as described below. General transport characteristics for the identified parameters are also summarized below, based on information available from published sources. Environmental fate and transport characteristics specific to the site are addressed in Section 7.0.

5.2.1 Organic Chemicals

The organic chemicals listed in Table 5-1 include PAHs and BETX. Table 5-2 presents values for relevant chemical properties of the identified parameters. Values are presented for:

- Molecular weight and solubility (useful for estimating the amount of a compound dissolved in water).

- Organic carbon partition coefficient (important for estimating the proportion of a compound adsorbed onto the organic carbon in the soil relative to the proportion dissolved in the water).

- Vapor pressure and Henry's Law constant (indicates a compound's tendency to volatilize from water or soil moisture).

- Degradation constant and half life (susceptibility of a compound to be degraded by biological and other processes).

Of the identified organic compounds of interest, PAHs typically have the lowest solubilities in water and tend to be highly adsorbed onto soil organic carbon. PAHs are a major constituent of coal tar. Coal tar is only slightly soluble in water and may be present in soils and groundwater as a separate nonaqueous-phase liquid. Coal tar is more dense than water and may migrate as a separate phase primarily under the influence of gravity. Pockets of concentrated coal tar are likely to be persistent because mixing with groundwater (required for solubilization) and aeration (required for biodegradation) are likely to be limited in the subsurface environment. Where coal tar is present as a separate phase liquid, the dissolution of chemical constituents contained in coal tar would be governed primarily by effective solubilities (i.e., as a component of a complex mixture), rather than by organic carbon partition coefficients shown in Table 5-2.

BETX compounds are much more water-soluble than PAH compounds. Due to these higher solubilities, dissolution in groundwater is a key determinant of the environmental fate of BETX compounds. This high solubility also explains, in part, the susceptibility of BETX compounds to biodegradation. Benzene is the most soluble and mobile of the BETX compounds (Table 5-2).

5.2.2 Inorganic Chemicals

The inorganic chemicals listed in Table 5-1 include metals and cyanide. Table 5-3 presents values for relevant chemical properties of the identified inorganic parameters. Values are presented primarily for Kd, the distribution coefficient (relevant to a parameter's tendency to partition from the dissolved phase and be adsorbed onto fine particles and/or organic carbon present in subsurface materials). Inorganic parameters are typically not volatile or degradable. Speciation and complexation for inorganic parameters can vary depending on the chemical's initial form and ambient environmental conditions such as pH and redox potential.

Arsenic is typically strongly adsorbed to most soils and sediments (EPRI, 1984). Studies of arsenic retention by soil have shown that adsorption is controlled to a large degree by the content of hydrous oxides of iron and aluminum (Jacobs, et al., 1979; Wauchope, 1975; Livesy and Huang, 1981) and solubility is expected to be highly dependent upon redox potential (Eh) and pH conditions. A relative medium mobility in oxidizing environmental conditions was reported by Swartzbaugh et al., 1992.

The transport and fate of cyanide in the soil is dependent on the chemical compound containing the cyanide. Cyanide at MGP sites is predominantly in the form of metal-cyanide complexes (Theis and Young, 1993). Metal-cyanide complexes are generally insoluble. The solubility of metal-cyanide complexes is strongly dependant on the pH. Typically, a higher pH value allows a higher solubility for most of the metal-cyanide complexes (Meeussen et al., 1991).

Lead is present in soils as a cation. Lead is strongly retained by soils, having a relatively low mobility in soil under both oxidizing and reducing conditions (Swartzbaugh, et al., 1992).

Several studies suggest that mercury adsorption in soils is controlled primarily by organic material (Hogg, et al., 1978). However, with time, microbial processes may lead to the formation of elemental mercury, which can be released to water even in the presence of high-organic-material content (Miller, 1975).

5.3 Conclusions

PAHs, BETX, and inorganic chemicals are the parameter groups that will be used for characterizing the extent of contamination. Physical and chemical properties of these parameters provide a context for the evaluation of the extent of contamination in Section 6.0 and for specific fate and transport evaluations subsequently presented in Section 7.0.

The compiled literature information indicates that PAHs are likely to be relatively immobile in the environment. Potential PAH migration is limited by the compounds' low solubilities and tendency to be adsorbed onto aquifer solids.

The literature data indicate that benzene is likely to be the most soluble and mobile of the BETX group. Benzene is typically susceptible to degradation in soil and groundwater environments, potentially resulting in concentration reductions during contaminant migration.

The mobility of inorganic chemicals is variable and strongly dependent on factors such as constituent speciation, acidity/alkalinity, and soil/groundwater geochemistry.

6.0 Extent of Contamination

This section describes the extent of contamination at the site. The site data are presented in various forms—summarized, mapped, or tabulated—in order to define the extent of contamination.

The parameters evaluated in the extent of contamination discussions for soil and groundwater are the PAHs, BETX compounds, and inorganic chemicals listed in Table 5-1. The extent of contamination evaluation is based on samples collected during the Phase I investigation as well as the Phase II investigation.

6.1 Overview

The extent of contamination review led to the observations and conclusions stated below:

- Coal tar is the main contaminant at the site.
- PAHs and BETX were detected in the soil and groundwater samples from the site.
- Soil in the gasometers contains elevated levels of PAHs and BETX. The highest lead concentration (1,190 mg/kg) at the site was reported in sample SB-16-07 from gasometer no. 2 (former tar pit). This concentrations is more than three times the next highest lead concentration.
- The estimated volume of soils associated with the source areas (gasometers) is on the order of 7,000 cubic yards.
- Carcinogenic PAH concentrations above 75 mg/kg were reported in three surface soil samples (SB-18-01, SB-19-01 and SB-24-01). The other surface soil samples reported low levels of PAH compounds.
- Subsurface soils at the site have concentrations of PAHs and BETX. BETX concentrations in the soil are associated with the areas exhibiting PAH concentrations.

- The estimated volume of subsurface soil that exhibits a moderate to heavy oil-sheen is estimated to be on the order of 50,000 cubic yards.

- Groundwater impacts at the MGP site were observed at monitoring wells MW-3, MW-5, and MW-6. Groundwater samples from these wells contained elevated PAH and BETX concentrations. Groundwater impacts were not observed at monitoring wells MW-2 and MW-8. MW-2 is located on the upgradient side of the site and MW-8 is located off-site, approximately 300 feet downgradient of gasometer no. 2.

- The extent of NAPL at the site is not fully known. However, the accumulation of NAPL connected to MW-3 is so restricted that it will not support a NAPL removal rate of 0.01 gpm. The analytical results of NAPL samples identified PAH compounds to be approximately 20 percent of the mass. The specific gravity of the NAPL indicates the material is heavier than water and is expected to sink in the aquifer. NAPL was encountered at the base of the coarse alluvial aquifer.

6.2 Contaminant Distribution

The results of the site investigations were used to characterize the distribution of the key parameters in the soil and groundwater at the site. The analytical results of soil, groundwater and NAPL samples are summarized in Tables 6-1 through 6-7. The sample numbers for soil samples consist of six characters: SB for soil boring, two digits for the soil boring number, and two digits that represent the sample interval (i.e., SB-15-11 is from soil boring 15, the 11th sample interval below the ground surface). Water samples are identified by the designation of the monitoring well from which they were collected. A data validation and quality assurance summary is provided in Appendix L.

The discussion of soil investigation results is divided into three units that may be independently assessed for risk or remedy evaluation. The three units are: (1) source areas; (2) surface soils; and (3) subsurface soils. Subsurface soils are considered to extend to the bottom of the fine alluvium. Since soils making up the porous media of the coarse alluvial aquifer would likely be remedied by groundwater technologies, the extent of contamination associated with the coarse alluvium is discussed in the groundwater section (6.2.3).

The discussion of the groundwater investigation results is focused on the coarse alluvial aquifer, (i.e, groundwater and porous media that make up the aquifer) and includes discussion of the NAPL investigation.

6.2.1 Soil

Elevated PAH and BETX concentrations were reported in soil samples collected at the site. Inorganic compounds were typically reported at low concentrations. Soil quality data for the Phase II investigation is summarized in Table 6-1. The analytical laboratory reports are contained in Appendix N. The field screening results and visual observations were used to interpret the level of contamination between analytical data points (Table 6-2). Field screening results were used to develop Figure 6-1, which shows the area of the site where soils likely exhibit a moderate to heavy oil sheen. The total polynuclear aromatic hydrocarbons (tPAH), carcinogenic polynuclear aromatic hydrocarbons (cPAH) concentrations, and organic-vapor headspace readings are presented on the cross sections in Figures 6-2 through 6-7 in order to provide a more spacial impression of the findings and to help interpret the analytical results. These figures also illustrate the zone where medium to heavy oil sheens were observed on soil samples.

6.2.1.1 Source Areas

The source areas are considered to be the four gasometers that were operated at the site. The higher organic and inorganic compound concentrations associated with the source areas are concentrated just above the bases of the gasometer structures (Figures 3-3 and 6-3).

The soils in each gasometer contain elevated concentrations of BETX and PAH compounds. In addition, elevated lead concentrations were reported in the soil sample from SB-16 (gasometer no. 2). The highest BETX and PAH concentrations were reported in samples collected just above the base of each structure. A concrete obstruction (base) was encountered in each gasometer.

Volume of Source Areas

The extent of the source area is bound by the gasometer side walls and the concrete base of the structure. The volume of soil associated with the source areas operable unit was based on the

gasometer's diameter and the depth at which auger refusal occurred. The volume of soil associated with the source areas is approximately 7,000 cubic yards (Appendix Q).

The presence of contamination outside the source areas is discussed in Sections 6.2.1.2 and 6.2.1.3.

6.2.1.2 Surface Soil

The analytical results of surface soil samples are summarized in Table 6-1. The highest concentrations of PAH compounds were reported in the sample from SB-24 (610 mg/kg tPAH; 180 mg/kg cPAH). This location is within gasometer no. 4, beneath the bridge and is in a local low area. No coal tar presence was observed in the sample. Carcinogenic PAH concentrations were also reported for the surface soil samples from SB-18 and SB-19, at 130 mg/kg and 76 mg/kg, respectively. Cinders and brick debris were evident at the surface near SB-18.

The reported concentrations of inorganic compounds in surface soil samples were compared to the reported concentrations in the surface soil sample from SB-23, located off site. Table 6-3 lists the locations, compounds and concentrations that exceed the concentrations at SB-23. Most of the concentrations shown in this table are less than three times the concentration reported at SB-23.

6.2.1.3 Subsurface Soil

The highest levels of BETX and PAH compounds in the subsurface soils were associated with the thin sand lenses within the fine alluvium unit. As can be seen on Figures 6-2 through 6-7, the highest headspace readings were typically found within or immediately below the sand lenses. The sandy to silty soils typically had a heavy oil sheen. The higher soil PAH and BETX concentrations were reported in soil samples from these intervals. The clay soils beneath the sand lenses typically have rapidly declining PAH and BETX concentrations with increasing depth.

Oily appearance was observed in root holes in the fine alluvial soils. The PAH and BETX concentrations associated with these traces of oil were typically low.

Inorganic compounds were typically reported at low concentrations. The analytical results were compared to the reported concentrations at SB-23. Table 6-4 lists the locations, compounds and concentrations that exceed the highest concentrations reported at SB-23. Most of the concentrations shown in this table are less than three times the concentration detected at SB-23.

Volume of Impacted Soils

Soil samples that exhibited moderate to heavy oil sheens also contained elevated levels of BETX and PAH concentrations (Table 6-2). Therefore, this characteristic was used to identify zones of impacted soils for the order-of-magnitude volume estimate. The data from the Phase I report was interpreted by including areas described on the borings logs as containing "gross contamination", "free product" and "contamination". A plan view of the contaminant distributions is shown on Figure 6-1 and cross-sections are shown on Figures 6-2 through 6-7. These figures were used to calculate an order-of-magnitude estimate of the volume of impacted soils.

The plan view figure was divided into four zones dependent on the observed thickness of the impacted zone in each area. The surface area of each zone was estimated based on the area outlined in the figures contained in Appendix Q. Each zone was multiplied by the average thickness of impacted soils in the respective zone. Based on this methodology, the volume of soil that exhibits a moderate to heavy oil sheen is estimated at 50,000 cubic yards. The calculation is provided in Appendix Q. A more detailed volume estimate should be calculated after a risk assessment has develop appropriate cleanup standards for the site.

6.2.3 Groundwater

This section discusses the magnitude and extent of chemical parameters in the perched water in the fine alluvium, and the groundwater and saturated soils in the coarse alluvial aquifer. One monitoring well (MW-1) is screened though a sand lens within the fine alluvium. Six monitoring wells screened at the top of the coarse alluvial aquifer have been installed at or near the site. Analytical data for groundwater samples collected from these wells are summarized in Tables 6-5 and 6-6. The analytical laboratory reports are contained in Appendix O.

The following subsections discuss the extent and magnitude of BETX compounds, PAH compounds, petroleum hydrocarbons, inorganic compounds, general chemistry parameters, and NAPL in the perched water of the fine alluvium and the groundwater of the coarse alluvial aquifer.

6.2.3.1 Perched Water in the Fine Alluvium

The analytical results for water samples collected from MW-1 are summarized in Table 6-5. BETX and PAH compounds were not detected in the water samples. Total petroleum hydrocarbons as gasoline were reported at a concentration of 200 µg/L which may indicate that an upgradient source of petroleum hydrocarbons is present. The reported concentrations of inorganic compounds in the groundwater are low and consistent with background levels.

Groundwater samples were analyzed for arsenic, chromium, copper, lead, nickel, zinc and cyanide. Chromium, copper and lead were not detected. The other inorganics were detected at low concentrations.

6.2.3.2 Coarse Alluvial Aquifer

Distribution of BETX Compounds

BETX concentrations in the groundwater samples are presented on Figure 6-7. BETX compounds were detected in groundwater samples collected from MW-3, MW-5 and MW-6, but not in samples from MW-2 and MW-4. They were not detected in a sample from MW-8, located off site, downgradient of gasometer no. 2 (tar pit).

Even though the total BETX concentrations were quite different, the relative proportions between the BETX compounds were similar in samples from MW-3 and MW-6. In contrast, benzene was not detected in the MW-5 sample (<20 µg/L), which could indicate that a different benzene source may be present along the south side of the site. It may be possible that benzene has preferentially migrated or biodegraded in the area of MW-5, which also could explain the absence of benzene reported in this water sample.

Distribution of PAH Compounds

Of the identified organic compounds of interest, PAHs typically have the lowest solubilities in water, tend to be concentrated in soils, and are relatively immobile in groundwater.

Total PAH concentrations in groundwater samples are presented on Figure 6-8. The highest reported concentrations of PAHs for groundwater were observed in samples from MW-3 and MW-5. These wells have been contaminated by nonaqueous-phase liquid. NAPL is present in MW-3. Oily

soil cuttings were observed during installation of MW-5 although no contamination was observed in the screened interval at the pilot boring (SB-15) installed approximately 20 feet north of MW-5.

Soil boring SB-20 was placed on the south-central portion of the site along South 7th Street (Figure 3-3). The analytical results of a soil sample (SB-20-11) indicated elevated PAH concentrations are present in the water-saturated soil. Based upon this information, PAH concentrations could also be expected in the groundwater.

MW-6 is located downgradient of the tar pit. Naphthalene (64 µg/L) was the only PAH compound reported in the groundwater sample from MW-6.

PAH compounds were not detected at wells MW-2 and MW-8. MW-2 is located upgradient of the tar pit on the northeast portion of the site. Monitoring well MW-8 is located approximately 300 feet southwest of the gasometer no. 2.

MW-4 is located cross gradient to the tar pit at the northwest corner of the site. A low concentration of naphthalene (22 µg/L) was detected at MW-4 during the first sampling event (12/02/89). PAH compounds were not detected in subsequent samples from this well.

Distribution of Inorganic Compounds

Groundwater samples have been analyzed for various inorganic constituents, including arsenic, calcium, chromium, copper, lead, magnesium, mercury, nickel, potassium, sodium, zinc, and cyanide. Filtered samples were analyzed for arsenic, lead, and mercury. Filtered samples were analyzed to evaluate if the metals were bound to particulate matter in the groundwater samples. The analytical results for groundwater samples analyzed for inorganic parameters are summarized in Table 6-5.

Generally, concentrations of inorganic compounds in the groundwater are low and consistent with background levels. The highest concentrations of total cyanide were detected at concentrations ranging from 0.264 mg/L to 0.493 mg/L in MW-3. Cyanide was detected at a concentration of 0.167 mg/L in MW-6; all other positive detections were reported to be at or below 0.021 mg/L.

Arsenic was detected in filtered and unfiltered samples. The highest concentration of arsenic was reported in the sample from MW-4 at 0.0404 mg/L.

The highest concentrations of total lead measured in the groundwater were 0.06 mg/L in the sample collected from MW-2 and 0.036 mg/L in the sample collected from MW-5 (lead was not detected in the filtered sample); subsequent sampling results from MW-2 have been below detection limits (<0.0088 mg/L). All remaining total lead levels have been measured to be at or below 0.016 mg/L. Lead was not detected in the filtered samples, suggesting the lead may be bound to the sediments.

Distribution of Petroleum Hydrocarbons

Groundwater samples were analyzed for total petroleum hydrocarbons (TPH) as gasoline and as diesel during the 1994 sampling event. The results of the TPH testing program are summarized in Table 6-5.

The results of these analyses indicate that petroleum hydrocarbons may be present in the site groundwater. Gasoline-range hydrocarbon constituents were detected in MW-3, MW-5, MW-6, MW-8. The analytical results indicate that petroleum products may have impacted the groundwater near those wells. Diesel-range organics were detected in MW-5 and MW-6, although the laboratory reported the pattern was atypical of diesel. The highest concentration of total petroleum hydrocarbon (summation of gasoline and diesel range organics) was detected in water samples collected from MW-5 and MW-6 at respective concentrations of 18,400 µg/L and 3,280 µg/L. The analytical results of a duplicate sample from MW-5 had a total petroleum hydrocarbon concentration of 27,400 µg/L.

Distribution of Nonaqueous-Phase Liquid (NAPL)

The deep borings (SB-15 and SB-23) did not identify any evident confining unit within the coarse alluvium unit above the bedrock interface. Odor in the soils was encountered at SB-15 at a depth of approximately 70 feet and extended to 101 feet bgs, the base of the coarse alluvium unit. Oil or an oily sheen was observed in the samples below 90 feet. The samples from 69 feet included the coal fragments and exhibited a naphthalene-like odor although the sample had no oil sheen. The soil cuttings from MW-5 (which was installed approximately 20 feet south of SB-15) were oily. Boring ST-5 encountered oily soils to a depth of 50 feet where the boring terminated beneath gasometer no. 2 (former tar pit). Oily soils were encountered at SB-20 at the top of the coarse alluvium and NAPL has accumulated in MW-3.

The results of the NAPL investigation indicate that the accumulation of NAPL connected to MW-3 is so restricted that it will not support a removal rate of 0.01 gpm. The overlying water column could not be removed from the polyethylene pipe inserted in the NAPL at the base on MW-3. A discussion of the NAPL investigation is contained in Appendix M. A limited volume of NAPL was collected and analyzed; the analytical results are summarized in Table 6-7. The analytical laboratory report is contained in Appendix P.

The analytical results indicate that PAHs comprise approximately 18 percent of the NAPL. BETX compounds account for one percent. Lead and arsenic were detected at low concentrations. Mercury was not detected.

The physical parameters indicate the NAPL is heavier than water (specific gravity = 1.09). The viscosity of the NAPL at 50°F is approximately 22 cSt. The viscosity of water at 50°F is approximately 1 cSt. The NAPL has a high BTU content. The sample contained 5.01 percent ash as it was reported to contain significant amounts of sediments. The material did not flash at a temperature greater than 110°C. Since the material's flash point is greater than 60°C, it is not considered a characteristic waste based on ignitabilty.

7.0 Contaminant Fate and Transport

This section presents an evaluation of the environmental fate and transport of key chemical parameters identified at the site. The evaluation is based on chemical parameter characteristics, the identified distribution of chemicals in soil and groundwater, and data from the site and published sources that describe transport processes affecting chemical parameter migration.

Chemical parameter characteristics are used to assess volatilization, attenuation, and degradation as fate and transport processes affecting chemical constituents identified at the site. Based on this assessment, chemical migration pathways in air, soil, and groundwater are examined using the database assembled during the investigation.

7.1 Chemical Parameter Characteristics

7.1.1 Volatilization

Chemical constituents may be transported from near-surface soils by volatilization. This process involves the transfer of organic chemicals from the soil to the atmosphere. As a result, volatilization can result in reduced concentrations of organic chemicals in near-surface soils as chemicals are transported to the atmosphere. Parameters that quantitatively describe an organic compound's tendency to volatilize are vapor pressure and Henry's Law constant (Table 5-1).

A chemical's vapor pressure describes its propensity to exist in the atmosphere as opposed to existing as a pure chemical in liquid or solid form (Dragun, 1988). Chemicals with vapor pressures of less than 10^{-7} millimeter mercury will volatilize to a negligible degree, while chemicals with vapor pressures greater than 10^{-2} millimeter mercury will volatilize and be present primarily in the atmosphere or in soil air (Dragun, 1988). On this basis, vapor-pressure values for the key organic chemicals listed in Table 5-1 indicate that BETX compounds would be the most likely to volatilize from near-surface soils.

7.1.2 Attenuation

Attenuation describes a chemical constituent's tendency to be adsorbed onto solid particles of the aquifer during transport in groundwater. The property is commonly quantified by a retardation factor (R_d) that reflects the relative velocity of the groundwater compared to the effective transport velocity of the adsorbed constituent (Freeze and Cherry, 1979).

For organic compounds, R_d values are computed based on aquifer bulk density (ρ_b), porosity (n), and organic carbon content (f_{oc}); and on compound-specific values for organic carbon partition coefficient (K_{oc}). Retardation factors are computed using the following equation (Dragun, 1988):

$$R_d = 1 + \frac{\rho_b}{n} \times K_d$$

where: K_d is the distribution coefficient ($K_{oc} \times f_{oc}$).

For the site, the laboratory porosity for coarse alluvial unit sample (SB-23-16) is 0.37 g/g, the bulk density of the aquifer material is 2.0 g/cm^3, and laboratory TOC data show organic carbon content of 0.4 percent (Table 4-1). Organic carbon partition coefficients for the chemicals of concern are listed in Table 5-1. The calculated retardation factor for each BETX and PAH compound is listed in Table 7-1. These data indicate that benzene would be the most mobile of the identified organic chemicals of concern (i.e., R_d equal to 2). The data also indicate that carcinogenic PAHs can be expected to be essentially immobile in groundwater (i.e., R_d greater than 5,300) and that PAHs in general are relatively immobile (i.e., R_d greater than 100).

For inorganic parameters, retardation factors can also be computed using the equation presented above (Dragun, 1988). However, distribution coefficient values for inorganic parameters are less likely to be dependent on organic carbon content and more likely to be influenced by the molecular or ionic form(s) of the constituent, the acidity/alkalinity of the groundwater, and the presence of other solutes (EPRI, 1984). These variabilities are reflected in the wide range of K_d values presented in Table 5-3 for inorganic parameters of concern. In general, available data suggest that the inorganics are likely to be less mobile than the BETX compounds.

7.1.3 Degradation

Biodegradation refers to a biologically induced structural change in an organic chemical that results in removal of the initial chemical over time (Dragun, 1988). Organic chemicals are susceptible to biodegradation to varying degrees, expressed quantitatively by biodegradation rate constants and half-life values (i.e., the time needed for half of an initial concentration to be degraded). Values for these parameters, listed in Table 5-2, indicate that BETX compounds can be considered to be readily biodegradable in the environment. Other degradation processes that can result in reduced concentrations of organic constituents include hydrolysis and photolysis.

7.2 Migration Pathways in Air

Based on analyses of soil samples collected from the upper 2 feet of soils present at the site, the chemical parameters identified in Section 7.1.1 as being susceptible to volatilization are encountered at very low concentrations in near-surface soils. The analytical data (Table 6-1) typically show very low concentrations of BETX compounds, with the highest individual concentration at 6.5 µg/kg.

Organic-vapor monitoring data recorded during the Phase II investigation typically show no detectable concentrations of organic compounds in air, even during intrusive investigative activities in areas of contaminated soil.

7.3 Migration Pathways in Soil

Chemicals present in soils may be transported: (1) to the atmosphere, by volatilization (addressed above in Section 7.2); or (2) to the groundwater, by downward vertical migration in infiltrating precipitation or as a separate phase.

Section 6.2.1 identifies specific areas of the site where elevated PAH concentrations are present in soils. While infiltration through these soil areas may transport PAHs to groundwater, this is a relatively minor transport pathway for the following reasons:

- Most PAH compounds, particularly carcinogenic PAHs, have relatively low solubilities (Table 5-1) that limit potential concentrations that may result from dissolution into infiltration.

- As discussed in Section 7.1.2, PAHs are relatively immobile in soil and groundwater environments.

Migration as a separate phase depends on factors such as the viscosity of the NAPL, surface tension, interfacial tension, pore size, and driving force. Such migration is typically associated with the sources nearly saturated with NAPL.

7.4 Migration Pathways in Groundwater

The preliminary characterization of groundwater transport pathways for the site involves relatively slow horizontal migration of dissolved constituents in the upper portion of the coarse alluvium aquifer. This preliminary characterization is based on the groundwater flow directions, estimated horizontal gradients discussed in Section 4.2.2.2, and the groundwater quality data discussed in Section 6.2.3. The most mobile site parameters (BETX and naphthalene) were not observed in the groundwater sample from monitoring well MW-8, located approximately 300 feet directly downgradient (in the average direction of groundwater flow) from gasometer no. 2. This is consistent with the preliminary characterization.

Factors contributing to the slow horizontal migration of dissolved constituents in the groundwater of the upper portion of the coarse alluvium aquifer are:

- Low horizontal hydraulic gradients and subsequently low horizontal groundwater flow rates.

- Variable horizontal groundwater flow directions that effectively decrease the distance dissolved constituents may migrate from the source.

- Retardation and degradation of organic constituents.

The preliminary characterization of groundwater transport of dissolved constituents from the site is based on the available data. Collection of additional information would allow refinement of the groundwater fate and transport predictions.

NAPL is present in the coarse alluvial aquifer. It is expected to pool at the bedrock surface and may migrate down slope along the bedrock surface.

8.0 Conclusions

The following conclusions were developed based on the site-specific information contained in this report:

- Coal tar is the main contaminant at the site.

- PAHs and BETX compounds were detected in the soil and groundwater samples from the site.

- Sample analytical data and available literature information indicate that none of the inorganic chemicals at the site are at concentrations over an areal extent that would merit further examination. Most of the reported concentrations are within a factor of three times the reported concentrations at SB-23, an off site boring in an area not visibly impacted by contamination.

- Volatile organic compounds in near-surface soils were encountered at very low concentrations. Air monitoring during investigation activities reported no organic vapors at concentrations above work-place standards.

- Carcinogenic PAH concentrations greater than 75 mg/kg were reported in three surface soil samples. The other surface soil samples contained low levels of PAH compounds. Most to the site's surface is paved, gravel-surfaced, or covered by buildings.

- Groundwater impacts at the MGP site were observed at monitoring wells MW-3, MW-5, and MW-6 and at soil boring SB-20 (planned location of MW-7). Groundwater samples from the monitoring wells contained elevated PAH and BETX concentrations. PAHs and BETX were not observed in samples from monitoring wells MW-2, MW-4, and MW-8.

- The estimated linear velocity of groundwater under the site ranges from approximately 0.7 to 50 feet per year. The average linear velocity is estimated to be on the order of

5 feet per year. Organic contaminants move slower than the groundwater due to retardation and degradation.

- The site is surrounded by other potential sources that may have impacted the area around the site (i.e., LUST sites and former petroleum processing and storage facilities). Not all of these facilities have been investigated to date, and those that have been investigated have not explored potential impacts on the coarse alluvial aquifer. Petroleum facilities are located immediately west of the site and were previously located south and east of the site. These former processing facilities could impact the groundwater monitoring network at the site.

- Soil in the gasometers contains elevated levels of PAH and BETX compounds. The highest PAH concentration at the site was reported in sample SB-16-07 from gasometer no. 2 (former tar pit). The estimated volume of soil associated with the source areas (gasometers) is on the order of 7,000 cubic yards.

- Subsurface soils at the site have concentrations of PAHs and BETX. BETX concentrations in the soil are associated with the PAH concentrations. The estimated volume of subsurface soil that exhibits a moderate to heavy oil sheen is on the order of 50,000 cubic yards.

- The extent of NAPL at the site is not fully known. However, the accumulation of NAPL connected to MW-3 is so restricted that it will not support a removal rate of 0.01 gpm. The analytical results of NAPL samples identified PAH compounds to be approximately 18 percent of the mass. The specific gravity of the NAPL indicates the material is heavier than water and is expected to sink in the aquifer. NAPL was encountered at the base of the alluvial aquifer.

9.0 Recommendations

Recommendations were developed based on review of the site-specific information. The conclusions of the Phase II investigation lead to the following recommendations:

1. Conduct a supplemental groundwater investigation to further evaluate groundwater flow at the site and groundwater quality near the site.

    a. The investigation should consist of evaluating the contaminant plume downgradient of the site, and gathering information to support fate and transport modeling. The investigation should include installing a monitoring well downgradient of gasometers no. 3 and no. 4 which are located on the eastern portion of the site. The well should be installed south of SB-20 and should be screened at the top of the coarse alluvial aquifer.

    b. The investigation should involve installing an additional upgradient monitoring well. The well should be installed upgradient of the west portion of the site and screened at the top of the coarse alluvial aquifer.

    c. The investigation should include precautions to distinguish potential influence of LUST and former petroleum facilities adjacent to and in the vicinity of the site. Screening measures, such as soil gas and temporary well points may be used during the recommended supplemental groundwater investigation to assist in distinguishing potential impacts from different sources.

    d. The lower portion of the coarse alluvial aquifer should be evaluated to assess whether or not a contaminant plume is present downgradient of the site.

    e. A work plan defining the investigation program should be prepared following approval of this report.

2. Conduct a limited surface-soil investigation in the areas that exhibited elevated PAH concentrations. Soil samples would be collected from the top 6 inches and analyzed for

PAH compounds. The analytical results will be used to assess the risk posed to on-site workers.

3. Develop an assessment to evaluate the risk to human health and the environment represented by the identified contaminants at the site. The assessment should evaluate the risks associated with exposure to contaminated soil and groundwater. The results of the risk assessment would be used to develop appropriate cleanup standards for the site and to guide selection of appropriate remedial measures for the soil and groundwater.

4. Following risk assessment development of relevant thresholds for soils at various depth intervals, additional subsurface investigation may be needed to evaluate the extent of contamination in the subsurface soils.

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Tables

Table 2-1

Summary of Property Ownership
Citizens Gas and Electric Company Site

1870: Manufactured gas produced at the site by George F. Wright and several associates.

1889: Property transferred to Council Bluffs Gas & Electric Light Company, an Iowa corporation. Council Bluffs Gas & Electric Light Company liquidated in bankruptcy court in 1898.

1899: Council Bluffs Gas & Electric Company, an Iowa corporation, becomes owner of the property.

1901: Citizens Gas & Electric Company ("CGE") purchases the site.

1903: CGE comes under the control and operation of Omaha Electric Light & Power Company.

1917: American Power and Light Company ("APL") purchases CGE and incorporates Nebraska Power Company ("NPC"). CGE becomes a wholly owned subsidiary of NPC.

1925: Electric Bond & Share acquires the outstanding stock of APL.

1928: Council Bluffs Gas Company, a wholly owned subsidiary of Union Utilities, Inc., a Delaware corporation, purchases the property.

1929: Council Bluffs Gas Company is acquired by Lone Star Gas Corporation, a Delaware corporation.

1942: Lone Star Gas Corporation is ordered to sell Council Bluffs Gas Company by the Securities & Exchange Commission. Council Bluffs Gas is acquired by a number of small investors, most living on the east coast. Lone Star Gas Company, a Texas corporation, is incorporated and authorizes the issuance of stock to Lone Star Gas Corporation in exchange for the assets, property, and business of Lone Star Gas Corporation. Lone Star Gas Corporation is dissolved in 1943.

1960: Council Bluffs Gas Company is purchased by Northern Natural Gas Company.

1972: Iowa Department of Transportation obtains right of way to construct Highway 192 Expressway.

1985: The assets of Council Bluffs Gas Company, now called Peoples Natural Gas Company, are purchased by UtiliCorp.

1986: K. C. Peterson Construction purchases most of the former MGP from UtiliCorp.

See Figure 2-1 for current property boundaries and ownership

Table 3-1

Soil Analytical Parameters
Phase I Investigation
Citizens gas And Electric Company Site

Volatile Organic Compounds

- Acetone
- Acrolein
- Acrylonitrile
- Benzene
- Bromodichloromethane
- Bromoform
- Bromomethane
- 2-Butanone
- Carbon Disulfide
- Carbon Tetrachloride
- Chlorobenzene
- Chloroethane
- 2-Chloroethylvinyl Ether
- Chloroform
- Chloromethane
- Dibromochloromethane
- 1,2-Dichlorobenzene
- 1,3-Dichlorobenzene
- 1,4-Dichlorobenzene
- 1,1-Dichloroethane
- 1,2-Dichloroethane
- 1,1-Dichloroethene
- Cis-1,2-Dichloroethene
- Trans-1,2-Dichloroethene
- 1,2-Dichloropropane
- Cis-1,3-Dichloropropene
- Trans-1,3-Dichloropropene
- Ethyl Benzene
- 2-Hexanone
- Methylene Chloride
- 4-Methyl-2-Pentanone
- Styrene
- 1,1,2,2-Tetrachloroethane
- Tetrachloroethene
- Toluene
- 1,1,1-Trichloroethane
- 1,1,2-Trichloroethane
- Trichloroethene
- Trichlorofluoromethane
- Vinyl Acetate
- Vinyl Chloride
- Xylenes, Total

Inorganics/Metals

- Arsenic
- Chromium, Total
- Copper
- Cyanide, Total
- Lead
- Phenol
- Solids, Total
- pH

Base/Neutral Compounds

- Acenaphthene
- Acenaphthylene
- Aniline
- Anthracene
- Benzidine
- Benzo(a)anthracene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Benzo(a)pyrene
- Benzo(g,h,i)perylene
- Benzyl Alcohol
- Benzyl Butyl Phthalate
- Bis(2-chloroethyl)ether
- Bis(2-chloroethoxy)methane
- Bis(2-ethylhexyl)phthalate
- Bis(2-chloroisopropyl)ether
- 4-Bromophenyl Phenyl Ether
- 4-Chloroaniline
- 2-Chloronaphthalene
- 4-Chlorophenyl Phenyl Ether
- Chrysene
- Dibenzo(a,h)anthracene
- Dibenzofuran
- Di-n-Butylphthalate
- 1,2-Dichlorobenzene
- 1,3-Dichlorobenzene
- 1,4-Dichlorobenzene
- 3,3'-Dichlorobenzidine
- Diethyl Phthalate
- Dimethyl Phthalate
- 2,4-Dinitrotoluene
- 2,6-Dinitrotoluene
- Di-n-Octylphthalate
- Fluoranthene
- Fluorene
- Hexachlorobenzene
- Hexachlorobutadiene
- Hexachlorocyclopentadiene

Table 3-1 (cont.)

Soil Analytical Parameters
Phase I Investigation
Citizens gas And Electric Company Site

Base/Neutral Compounds (cont.)

Hexachloroethane
Indeno(1,2,3-cd)pyrene
Isophorone
2-Methylnaphthalene
Naphthalene
2-Nitroaniline
3-Nitroaniline
4-Nitroaniline
Nitrobenzene
n-Nitrodimethylamine
n-Nitrosodiphenylamine
n-Nitrosodi-n-Propylamine
Phenanthrene
Pyrene
1,2,4-Trichlorobenzene

Table 3-2

Soil Quality Data
Phase I Investigation
Citizens Gas and Electric Company Site

Parameters	Units	ST-1 25'	ST-2 15'	ST-2 35'	ST-3 20'	ST-4 20'	ST-5 12.5'	ST-6 12.5'	ST-8 20'	ST-9 15'	ST-13 10'	ST-14 15'
Volatile Organic Compounds												
Acetone	µg/g	--	--	--	--	--	--	--	<10	<10	--	--
Acrolein	µg/g	<10	<10	<10	<10	<10	<50	<50	--	--	<10	<10
Acrylonitrile	µg/g	<10	<10	<10	<10	<10	<50	<50	--	--	<10	<10
Benzene	µg/g	<1	<1	<1	<1	<1	32.4	116	5.3	<1	<1	<1
Bromodichloromethane	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
Bromoform	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
Bromomethane	µg/g	<10	<10	<10	<10	<10	<50	<50	<10	<10	<10	<10
2-Butanone	µg/g	--	--	--	--	--	--	--	<10	<10	--	--
Carbon Disulfide	µg/g	--	--	--	--	--	--	--	<1	<1	--	--
Carbon Tetrachloride	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
Chlorobenzene	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
Chloroethane	µg/g	<10	<10	<10	<10	<10	<50	<50	<10	<10	<10	<10
2-Chloroethylvinyl Ether	µg/g	<1	<1	<1	<1	<1	<5	<5	<10	<10	<1	<1
Chloroform	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
Chloromethane	µg/g	<10	<10	<10	<10	<10	<50	<50	<10	<10	<10	<10
Dibromochloromethane	µg/g	--	--	--	--	--	--	--	<1	<1	--	--
1,2-Dichlorobenzene	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
1,3-Dichlorobenzene	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
1,4-Dichlorobenzene	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1

See Figure 3-3 for boring locations

Table 3-2 (Cont.)

Soil Quality Data
Phase I Investigation
Citizens Gas and Electric Company Site

Parameters	Units	ST-1 25'	ST-2 15'	ST-2 35'	ST-3 20'	ST-4 20'	ST-5 12.5'	ST-6 12.5'	ST-8 20'	ST-9 15'	ST-13 10'	ST-14 15'
1,1-Dichloroethane	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
1,2-Dichloroethane	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
1,1-Dichloroethene	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
Cis-1,2-Dichloroethene	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
Trans-1,2-Dichloroethene	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
1,2-Dichloropropane	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
Cis-1,3-Dichloropropene	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
Trans-1,3-Dichloropropene	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
Ethyl Benzene	µg/g	<1	<1	<1	<1	<1	48	31.5	14.2	<1	<1	<1
2-Hexanone	µg/g	--	--	--	--	--	--	--	<10	<10	--	--
Methylene Chloride	µg/g	<5	<5	<5	<5	<5	<25	<25	<5	<5	<5	<5
4-Methyl-2-Pentanone	µg/g	--	--	--	--	--	--	--	<10	<10	--	--
Styrene	µg/g	--	--	--	--	--	--	--	<1	<1	--	--
1,1,2,2-Tetrachloroethane	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
Tetrachloroethene	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
Toluene	µg/g	<1	<1	<1	<1	<1	35.6	147	8.4	<1	<1	<1
1,1,1-Trichloroethane	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
1,1,2-Trichloroethane	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
Trichloroethene	µg/g	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1	<1
Trichlorofluoromethane	µg/g	<1	<1	<1	<1	<1	<5	<5	--	--	<1	<1

See Figure 3-3 for boring locations

Table 3-2 (Cont.)

Soil Quality Data
Phase I Investigation
Citizens Gas and Electric Company Site

Parameters	Units	ST-1 25'	ST-2 15'	ST-2 35'	ST-3 20'	ST-4 20'	ST-5 12.5'	ST-6 12.5'	ST-8 20'	ST-9 15'	ST-13 10'	ST-14 15'
Vinyl Acetate	µg/g	--	--	--	--	--	--	--	<10	<10	--	--
Vinyl Chloride	µg/g	<5	<5	<5	<5	<5	<50	<50	<10	<10	<5	<10
Xylenes, Total	µg/g	<1	<1	<1	<1	<1	26.6	96.8	16.9	<1	<1	<1
Base/Neutral Compounds												
Acenaphthene	µg/g	<1	<1	<1	<1	<1	550	<200	39	<1	<1	21
Acenaphthylene	µg/g	<1	<1	<1	<1	<1	1100	630	270	<1	<1	11
Aniline	µg/g	--	--	--	--	--	--	--	<10	<1	--	--
Anthracene	µg/g	<1	<1	<1	<1	<1	660	590	130	<1	<1	19
Benzidine	µg/g	<5	<5	<5	<5	<5	<500	<1000	<50	<5	<5	<25
Benzo(a)anthracene	µg/g	<1	<1	<1	<1	<1	270	460	86	<1	<1	13
Benzo(b)fluoranthene	µg/g	<1	<1	<1	<1	<1	<100	310	32	<1	<1	5
Benzo(k)fluoranthene	µg/g	<1	<1	<1	<1	<1	<100	420	26	<1	<1	7
Benzo(a)pyrene	µg/g	<1	<1	<1	<1	<1	150	490	44	<1	<1	8
Benzo(ghi)perylene	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
Benzyl Alcohol	µg/g	--	--	--	--	--	--	--	<10	<1	--	--
Benzyl Butyl Phthalate	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
Bis(2-chloroethyl)ether	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
Bis(2-chloroethoxy)methane	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
Bis(2-ethylhexyl)phthalate	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
Bis(2-chloroisopropyl)ether	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5

See Figure 3-3 for boring locations

Table 3-2 (Cont.)

Soil Quality Data
Phase I Investigation
Citizens Gas and Electric Company Site

Parameters	Units	ST-1 25'	ST-2 15'	ST-2 35'	ST-3 20'	ST-4 20'	ST-5 12.5'	ST-6 12.5'	ST-8 20'	ST-9 15'	ST-13 10'	ST-14 15'
4-bromophenyl Phenyl Ether	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
4-Chloroaniline	µg/g	--	--	--	--	--	--	--	<10	<1	--	--
2-Chloronaphthalene	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
4-Chlorophenyl Phenyl Ether	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
Chrysene	µg/g	<1	<1	<1	<1	<1	260	420	82	<1	<1	13
Dibenzo(a,h)anthracene	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
Dibenzofuran	µg/g	--	--	--	--	--	--	--	18	<1	--	--
Di-n-butylphthalate	µg/g	<1	<1	<1	<1	6	<100	<200	<10	<1	<1	<5
1,2-Dichlorobenzene	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
1,3-Dichlorobenzene	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
1,4-Dichlorobenzene	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
3,3'-Dichlorobenzidine	µg/g	<2	<2	<2	<2	<2	<200	<400	<20	<2	<2	<10
Diethyl Phthalate	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
Dimethyl Phthalate	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
2,4-Dinitrotoluene	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
2,6-Dinitrotoluene	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
Di-n-octylphthalate	µg/g	<1	<1	<1	<1	<1	<100	<200		<1	<1	<5
Fluoranthene	µg/g	<1	<1	<1	<1	<1	550	910	140	<1	<1	26
Fluorene	µg/g	<1	<1	<1	<1	<1	810	660	160	<1	<1	20
Hexachlorobenzene	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5

See Figure 3-3 for boring locations

Table 3-2 (Cont.)

Soil Quality Data
Phase I Investigation
Citizens Gas and Electric Company Site

Parameters	Units	ST-1 25'	ST-2 15'	ST-2 35'	ST-3 20'	ST-4 20'	ST-5 12.5'	ST-6 12.5'	ST-8 20'	ST-9 15'	ST-13 10'	ST-14 15'
Hexachlorobutadiene	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
Hexachlorocyclopentadiene	µg/g								<10	<1		
Hexachloroethane	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
Indeno(1,2,3-cd)pyrene	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
Isophorone	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
2-Methylnaphthalene	µg/g	--	--	--	--	--	--	--	<10	<1	--	--
Naphthalene	µg/g	<1	<1	<1	<1	<1	4900	2200	760	<1	<1	8
2-Nitroaniline	µg/g	--	--	--	--	--	--	--	<50	<5	--	--
3-Nitroaniline	µg/g	--	--	--	--	--	--	--	<50	<5	--	--
4-Nitroaniline	µg/g	--	--	--	--	--	--	--	<50	<5	--	--
Nitrobenzene	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
N-Nitrodimethylamine	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
N-Nitrosodiphenylamine	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
N-Nitrosodi-n-propylamine	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
Phenanthrene	µg/g	<1	<1	<1	<1	<1	2900	1380	420	<1	<1	19
Pyrene	µg/g	<1	<1	<1	<1	<1	810	760	180	<1	<1	31
1,2,4-Trichlorobenzene	µg/g	<1	<1	<1	<1	<1	<100	<200	<10	<1	<1	<5
Inorganic Analysis												
Cyanide, total	µg/g	0.31	<0.05	<0.05	<0.05	<0.05	3.2	8	<0.2	<0.2	0.24	55.2
Phenol	µg/g	0.9	1.62	<0.06	0.46	1.63	22.2	136	0.76	<0.2	<0.05	0.92

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See Figure 3-3 for boring locations

Table 3-2 (Cont.)

Soil Quality Data
Phase I Investigation
Citizens Gas and Electric Company Site

Parameters	Units	ST-1 25'	ST-2 15'	ST-2 35'	ST-3 20'	ST-4 20'	ST-5 12.5'	ST-6 12.5'	ST-8 20'	ST-9 15'	ST-13 10'	ST-14 15'
Arsenic	µg/g	5.9	6.2	1.7	4.3	2	0.62	2.61	2.9	2.9	1.77	1.99
Solids, Total	%	73.34	74.3	82.86	78.91	81.99	82.26	73.51	65.97	73.95	78.97	70.6
pH		9.02	7.49	8.72	8.44	8.51	8.96	8.88	8.91	8.33	8.48	9
Metal Analysis												
Cadmium	µg/g	--	--	--	--	--	--	--	--	--	0.74	0.97
Chromium, Total	µg/g	12.8	10.6	5.5	10.8	12.4	17.9	10.7	16.1	14.9	13.4	10.7
Copper	µg/g	17.9	21.2	1.9	11.7	20.1	72.1	21.1	31.7	22.3	20.8	15.9
Lead	µg/g	21.1	20.5	5.7	17.6	21.2	464	26.7	28.3	24.1	17.4	49.2
Nickel	µg/g	22.4	23	9.5	18.4	22.8	15.4	20.5	26.2	29.7	21.8	14.9
Zinc	µg/g	64.8	63.5	22.2	47	67.3	456	88.3	95.6	76.1	62.6	114

See Figure 3-3 for boring locations

Table 3-3

Groundwater Analytical Parameters
Phase I Investigation
Citizens Gas and Electric Company Site

Volatile Organic Compounds

- Acrolein
- Acrylonitrile
- Benzene
- Bromodichloromethane
- Bromoform
- Bromomethane
- Carbon Tetrachloride
- Chlorobenzene
- Chloroethane
- 2-Chloroethylvinyl Ether
- Chloroform
- Chloromethane
- Chlorodibromomethane
- 1,2-Dichlorobenzene
- 1,3-Dichlorobenzene
- 1,4-Dichlorobenzene
- 1,1-Dichloroethane
- 1,2-Dichloroethane
- 1,1-Dichloroethylene
- 1,2-Dichloroethylene, cis
- 1,2-Dichloroethylene, trans
- 1,2-Dichloropropane
- Cis-1,3-Dichloro-1-propene
- Trans-1,3-Dichloro-1-propene
- Ethyl Benzene
- Methylene Chloride
- 1,1,2,2-Tetrachloroethane
- Tetrachloroethylene
- Toluene
- 1,1,1-Trichloroethane
- 1,1,2-Trichloroethane
- Trichloroethylene
- Trichlorofluoromethane
- Vinyl Chloride
- Xylenes, Total

Inorganics/Metals

- Arsenic
- Cadmium
- Chromium, Total
- Copper
- Cyanide, Total
- Lead
- Nickel
- Zinc
- Phenol
- pH

Base/Neutral Compounds

- Acenaphthene
- Acenaphthylene
- Anthracene
- Benzidine
- Benzo(a)anthracene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Benzo(a)pyrene
- Benzo(g,h,i)perylene
- Benzyl Butyl Phthalate
- Bis(2-chloroethyl)ether
- Bis(2-chloroethoxy)methane
- Bis(2-ethylhexyl)phthalate
- Bis(2-chloroisopropyl)ether
- 4-Bromophenyl Phenyl Ether
- 2-Chloronaphthalene
- 4-Chlorophenyl Phenyl Ether
- Chrysene
- Dibenzo(a,h)anthracene
- Di-n-Butylphthalate
- 1,2-Dichlorobenzene
- 1,3-Dichlorobenzene
- 1,4-Dichlorobenzene
- 3,3'-Dichlorobenzidine
- Diethyl Phthalate
- Dimethyl Phthalate
- 2,4-Dinitrotoluene
- 2,6-Dinitrotoluene
- Di-n-Octylphthalate
- Fluoranthene
- Fluorene
- Hexachlorobenzene
- Hexachlorobutadiene
- Hexachlorocyclopentadiene
- Hexachloroethane
- Indeno(1,2,3-cd)pyrene
- Isophorone
- Naphthalene
- Nitrobenzene
- n-Nitrodimethylamine
- n-Nitrosodiphenylamine
- n-Nitrosodi-n-Propylamine
- Phenanthrene
- Pyrene
- 1,2,4-Trichlorobenzene

TABLE 3-4

GROUNDWATER QUALITY DATA
PHASE I INVESTIGATION
CITIZENS GAS AND ELECTRIC COMPANY SITE

(concentrations in ug/L, unless otherwise noted)

	MW1	MW2	MW3	MW4
Volatile Organic Compounds	12/02/89	12/02/89	12/02/89	12/02/89
Acrolein	<10	<10	<10	<10
Acrylonitrile	<10	<10	<10	<10
Benzene	<1.0	<1.0	6310	<1.0
Bromodichloromethane	<1.0	<1.0	<1.0	<1.0
Bromoform	<1.0	<1.0	<1.0	<1.0
Bromomethane	<10	<10	<10	<10
Carbon Tetrachloride	<1.0	<1.0	<1.0	<1.0
Chlorobenzene	<1.0	<1.0	<1.0	<1.0
Chloroethane	<10	<10	<10	<10
2-Chloroethylvinyl Ether	<1.0	<1.0	<1.0	<1.0
Chloroform	<1.0	<1.0	<1.0	<1.0
Chloromethane	<10	<10	<10	<10
Chlorodibromomethane	<1.0	<1.0	<1.0	<1.0
1,2-Dichlorobenzene	<1.0	<1.0	<1.0	<1.0
1,3-Dichlorobenzene	<1.0	<1.0	<1.0	<1.0
1,4-Dichlorobenzene	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	<1.0	<1.0	<1.0	<1.0
1,2-Dichloroethane	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethylene	<1.0	<1.0	<1.0	<1.0
1,2-Dichloroethylene, cis	<1.0	<1.0	<1.0	<1.0
1,2-Dichloroethylene, trans	<1.0	<1.0	<1.0	<1.0
1,2-Dichloropropane	<1.0	<1.0	<1.0	<1.0
Cis-1,3-Dichloro-1-propene	<1.0	<1.0	<1.0	<1.0
Trans-1,3-Dichloro-1-propene	<1.0	<1.0	<1.0	<1.0
Ethyl Benzene	<1.0	<1.0	2410	<1.0
Methylene Chloride	<5.0	<5.0	<5.0	<5.0
1,1,1,2-Tetrachloroethane	<1.0	<1.0	<1.0	<1.0
Tetrachloroethylene	<1.0	<1.0	<1.0	<1.0
Toluene	<1.0	<1.0	234	<1.0
1,1,1-Trichloroethane	<1.0	<1.0	<1.0	<1.0
1,1,2-Trichloroethane	<1.0	<1.0	<1.0	<1.0
Trichloroethylene	<1.0	<1.0	<1.0	<1.0
Trichlorofluoromethane	<1.0	<1.0	<1.0	<1.0
Vinyl Chloride	<10	<10	<10	<10
Xylenes	<1.0	<1.0	1840	<1.0
Inorganic Compounds				
Cyanide, mg/L	0.002	<0.001	0.493	0.005
pH, units	6.96	7.25	8.57	7.66
Phenol, mg/L	<0.002	<0.002	0.109	<0.002
Arsenic, mg/L	0.001	0.003	0.002	<0.001
Cadmium, mg/L	<0.005	<0.005	<0.005	<0.005
Chromium, total, mg/L	<0.005	0.022	0.033	<0.005
Copper, mg/L	<0.01	0.06	0.05	<0.01
Lead, mg/L	<0.04	0.06	0.10	<0.04
Nickel, mg/L	0.05	0.05	0.11	<0.01
Zinc, mg/L	0.016	0.275	0.711	<0.005

See Figure 3-3 for monitoring well locations.

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TABLE 3-4 (cont.)

GROUNDWATER QUALITY DATA
PHASE I INVESTIGATION
CITIZENS GAS AND ELECTRIC COMPANY SITE

(concentrations in ug/L, unless otherwise noted)

	MW1	MW2	MW3	MW4
Base/Neutral Compounds	12/02/89	12/02/89	12/02/89	12/02/89
Acenaphthene	<10	<10	83	<10
Acenaphthylene	<10	<10	52	<10
Anthracene	<10	<10	97	<10
Benzidine	<50	<50	<50	<50
Benzo(a)anthracene	<10	<10	<10	<10
Benzo(b)fluoranthene	<10	<10	<10	<10
Benzo(k)fluoranthene	<10	<10	<10	<10
Benzo(a)pyrene	<10	<10	<10	<10
Benzo(ghi)perylene	<10	<10	<10	<10
Butyl benzyl phthalate	<10	<10	<10	<10
Bis(2-chloroethyl)ether	<10	<10	<10	<10
Bis(2-chloroethoxy)methane	<10	<10	<10	<10
Bis(2-ethylhexyl)phthalate	<10	<10	<10	<10
Bis(2-chloroisopropyl)ether	<10	<10	<10	<10
4-Bromophenyl phenyl ether	<10	<10	<10	<10
2-Chloronaphthalene	<10	<10	<10	<10
4-Chlorophenyl phenyl ether	<10	<10	<10	<10
Chrysene	<10	<10	<10	<10
Dibenzo(ah)anthracene	<10	<10	<10	<10
Di-n-butyl phthalate	<10	<10	<10	<10
1,2-Dichlorobenzene	<1.0	<1.0	<1.0	<1.0
1,3-Dichlorobenzene	<1.0	<1.0	<1.0	<1.0
1,4-Dichlorobenzene	<1.0	<1.0	<1.0	<1.0
3,3-Dichlorobenzidine	<20	<20	<20	<20
Diethyl phthalate	<10	<10	<10	<10
Dimethyl phthalate	<10	<10	<10	<10
2,4-Dinitrotoluene	<10	<10	<10	<10
2,6-Dinitrotoluene	<10	<10	<10	<10
Di-n-octyl phthalate	<10	<10	<10	<10
Fluoranthene	<10	<10	<10	<10
Fluorene	<10	<10	37	<10
Hexachlorobenzene	<10	<10	<10	<10
Hexachlorobutadiene	<10	<10	<10	<10
Hexachlorocyclopentadiene	<10	<10	<10	<10
Hexachloroethane	<10	<10	<10	<10
Indeno(1,2,3,cd)pyrene	<10	<10	<10	<10
Isophorone	<10	<10	<10	<10
Naphthalene	--	--	--	--
Nitrobenzene	<10	<10	<10	<10
N-Nitrosodimethylamine	<10	<10	<10	<10
N-Nitrosodiphenylamine	<10	<10	<10	<10
N-Nitrosodi-n-propylamine	<10	<10	<10	<10
Phenanthrene	<10	<10	45	<10
Pyrene	<10	<10	<10	<10
1,2,4-Trichlorobenzene	<10	<10	<10	<10

See Figure 3-3 for monitoring well locations.

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Table 3-5

Soil Boring Summary
Citizens Gas and Electric Company Site

Boring Number	Depth (ft.)	Elevation (ft. MSL)		Date Completed
		Ground	Bottom	
ST-1	30	984.94	954.94	11/13/89
ST-2	41.5	984.73	943.23	11/13/89
ST-3	32.5	984.60	952.10	11/14/89
ST-4	25	984.90	959.90	11/14/89
ST-5	50	983.35[1]	933.35	11/14/89
ST-6	31.5	983.75[1]	952.25	11/15/89
ST-7	25	--	--	11/16/89
ST-8	31.5	983.40[1]	951.90	11/16/89
ST-9	31.5	984.90	953.40	11/17/89
ST-10	26.5	985.33	958.83	11/27/89
ST-11	26.5	983.66	957.10	11/28/89
ST-12	25	983.57	958.57	11/28/89
ST-13	31.5	984.56[1]	953.06	12/01/89
ST-14	31.5	983.28	951.78	12/01/89
SB-15	101	983.69	882.69	04/19/94
SB-16	16.5	983.28	966.78	04/08/94
SB-17	24.5	982.94	958.44	04/07/94
SB-18	30.0	983.06	953.06	04/12/94
SB-19	24.5	983.02	958.52	04/07/94
SB-20	32	983.32	951.32	04/13/94
SB-21	4.5	984.36	979.86	04/06/94
SB-22	24.5	984.33	959.83	04/05/94
SB-23	101.5	983.67	882.17	04/15/94
SB-24	16.5	984.29	967.79	04/06/94
SB-25	4	984.42	980.42	04/06/94
SB-26	4	984.39	980.39	04/06/94
SB-27	24.5	984.68	960.18	04/06/94
SB-28	37	982.95	945.95	04/13/94

[1] Approximate Elevation
See Figure 3-3 for boring locations

Table 3-6

Soil Analytical Parameters
Phase II Investigation
Citizens Gas and Electric Company Site

Volatile Organic Compounds
- Benzene[1]
- Ethyl Benzene
- Toluene
- Xylenes, Total

Base/Neutral Compounds
- Acenaphthene
- Acenaphthylene
- Anthracene
- Benzo(a)anthracene[1]
- Benzo(a)pyrene[1]
- Benzo(b)fluoranthene[1]
- Benzo(k)fluoranthene[1]
- Benzo(g,h,i)perylene
- Chrysene[1]
- Dibenzo(a,h)anthracene[1]
- Fluoranthene
- Fluorene
- Indeno(1,2,3-cd)pyrene[1]
- Naphthalene
- Phenanthrene
- Pyrene

Geotechnical Parameters
- Grain Size Distribution
- Atterburg Limits
- Porosity
- TOC
- Permeability

Inorganic Parameters
- Arsenic
- Chromium, Total
- Copper
- Lead
- Mercury
- Nickel
- Zinc
- Cyanide, Total

Other Parameters
- BTU Content
- Ash
- Sulfur
- Flashpoint

Field Parameters
- Headspace
- Oil Sheen
- Odor
- Visual Examination

[1] Suspected Carcinogen (U.S. EPA designation A, B1 or B2)

Table 3-7

Groundwater Analytical Parameters
Phase II Investigation
Citizens Gas and Electric Company Site

Volatile Organic Compounds
- Benzene[1]
- Ethyl Benzene
- Toluene
- Xylenes, Total

Base/Neutral Compounds
- Acenaphthene
- Acenaphthylene
- Anthracene
- Benzo(a)anthracene[1]
- Benzo(a)pyrene[1]
- Benzo(b)fluoranthene[1]
- Benzo(k)fluoranthene[1]
- Benzo(g,h,i)perylene
- Chrysene[1]
- Dibenzo(a,h)anthracene[1]
- Fluoranthene
- Fluorene
- Indeno(1,2,3-cd)pyrene[1]
- Naphthalene
- Phenanthrene
- Pyrene

Inorganic Parameters
- Arsenic
- Lead
- Mercury
- Cyanide, Total
- Phenol
- Calcium
- Magnesium
- Sodium
- Sulfate
- Potassium
- Chloride
- Carbonate
- Bicarbonate

Other Parameters
- MTBE
- TPH - Diesel
- TPH - Gas
- TPH - Extended

Field Parameters
- Temperature
- Specific Conductance
- pH
- Water Elevation

[1] Suspected Carcinogen (U.S. EPA designation A, B1 or B2)

Table 3-8

Groundwater Sample Location and Analytical Parameters
Phase II Investigation
Citizens Gas and Electric Company Site

	July 1992						April 1994						
	Water Elevation	Volatile Organic Compounds	Base/Neutral Compounds	Cyanide	MTBE TPH as -Gasoline -Diesel	Field Data	Water Elevation	Volatiles	Base/Neutral Compounds	Phenol Lead Mercury Cyanide Arsenic	TPH as -Gasoline -Diesel -Extended	Calcium Magnesium Sodium Potassium Sulfate Chloride Carbonate Bicarbonate	Field Data
MW1	X						X	X	X	X		X	X
MW2	X	X	X	X		X	X	X	X	X	X	X	X
MW3	X	X	X	X	X	X	X	X	X	X	__[1]	X	X
MW4	X	X	X	X		X	X	X	X	X	X	X	X
MW5							X	X	X	X	X	X	X
MW6							X	X	X	X	X	X	X
MW7	Not installed due to site conditions												
MW8							X	X	X	X	X	X	X

See Figure 3-3 for monitoring well locations

TPH - Total Petroleum Hydrocarbon

Field data includes:
- Temperature
- Conductivity

[1] Analysis for TPH was not conducted due to an error.

Table 3-9

Monitoring Well Construction Summary
Citizens Gas and Electric Company Site

Well Number	Depth (ft.)	Elevations (Ft. MSL)				Screen Length (ft.)
		Ground	Top of Riser	Top of Screen	Bottom of Screen	
MW1	25	984.90	986.25	971.25	961.25	10
MW2	44	985.33	987.75	951.75	941.75	10
MW3	43	983.66	985.44	950.44	940.44	10
MW4	43	983.57	984.36	949.36	939.36	10
MW5	38	983.44	983.49	955.19	945.19	10
MW6	38	982.11	984.27	954.07	944.07	10
MW7	Not installed due to site conditions					
MW8	38	983.55	985.58	955.61	945.61	10

See Figure 3-3 for monitoring well locations

Table 3-10

NAPL Analytical Parameters
Phase II Investigation
Citizens Gas and Electric Company Site

Volatile Organic Compounds
- Benzene[1]
- Ethyl Benzene
- Toluene
- Xylenes, Total

Base/Neutral Compounds
- Acenaphthene
- Acenaphthylene
- Anthracene
- Benzo(a)anthracene[1]
- Benzo(a)pyrene[1]
- Benzo(b)fluoranthene[1]
- Benzo(k)fluoranthene[1]
- Benzo(g,h,i)perylene
- Chrysene[1]
- Dibenzo(a,h)anthracene[1]
- Fluoranthene
- Fluorene
- Indeno(1,2,3-cd)pyrene[1]
- Naphthalene
- Phenanthrene
- Pyrene

Other Parameters
- Arsenic
- Lead
- Mercury
- Cyanide, Total
- Phenol
- TPH
- Specific Gravity
- Viscosity
- Interfacial Tension

Incineration Parameters
- BTU Content
- Ash
- Sulfur
- Flashpoint

[1] Suspected Carcinogen (U.S. EPA designation A, B1 or B2)

Table 4-1

Soil Test Results
Citizens Gas and Electric Company Site

Boring Identification	Depth Below Ground Surface (ft)	Atterberg Limits			Grain Size Distribution and Hydrometer	Vertical Permeability (cm/sec) K @ 20°C	Moisture Density		Porosity (%)	Total Organic Carbon (TOC)
		Liquid Limit (%)	Plastic Limit (%)	Plasticity Index			Water Content (%)	Dry Density (pcf)		
SB-18	22.5 - 25	92.9	28.2	64.7	(1)	3.2×10^{-8}	67.8	59.4	65.0	1.4
SB-23	12.5 - 14.5	67.7	22.6	45.1	(1)	1.1×10^{-5}	40.7	77.5	54.3	1.0
SB-23	37.5 - 39.5	--	--	--	(1)	2.8×10^{-3}	22.7	103.6	37.4	0.4

(1) See Appendix I for grain size distribution and hydrometer data.

See Figure 3-3 for boring locations

Table 4-2

Bedrock Surface Elevations
Citizens Gas and Electric Company Site

Boring Location	Elevation (Ft. MSL)
SB-15	882.69
SB-23	882.17
F-7225	886.0
F-7233	877.5
F-7237	880.5
F-7240	882.5

See Figure 3-1 for boring locations

Table 4-3

Groundwater Elevation Summary
Citizens Gas and Electric Company Site

Monitoring Location	Static Water Elevation (feet MSL)					
	12/02/89	08/30/91	07/28/92	04/04/94	04/25/94	06/02/94
MW1	969.08	970.74	973.05	--	970.87	972.50
MW2	967.10	968.5	969.07	968.57	968.87	969.83
MW3	966.88	968.39	968.96	968.47	--	
MW4	966.93	968.37	968.88	968.40	967.78	968.66
MW5	--	--	--	--	968.68	--
MW6	--	--	--	--	968.74	969.64
MW8	--	--	--	--	968.61	969.64

See Figure 4-8 for monitoring well locations and groundwater gradients. Groundwater gradient calculations are in Appendix K.

Table 5-1

Parameters Identified for Characterization of Extent Citizens Gas and Electric Company Site

Inorganics	
Arsenic	Lead
Cyanide	Mercury
Volatile Organic Compounds	
Benzene	Toluene
Ethyl Benzene	Xylenes
Semivolatile Organic Compounds	
Acenaphthene	Chrysene
Acenaphthylene	Dibenzo(ah)anthracene
Anthracene	Fluoranthene
Benzo(a)anthracene	Fluorene
Benzo(a)pyrene	Indeno(1,2,3-cd)pyrene
Benzo(b)fluoranthene	Naphthalene
Benzo(ghi)perylene	Phenanthrene
Benzo(k)fluoranthene	Pyrene

TABLE 5-2
ORGANIC CHEMICAL PARAMETERS
CITIZENS GAS AND ELECTRIC COMPANY SITE

CHEMICAL DETECTED	MOLECULAR WEIGHT	SOLUBILITY (ug/L) (@ 20 C)	REFERENCE	LOG Koc	Koc	REFERENCE	VAPOR PRESSURE (mm @ 20 C)	REFERENCE	HENRY'S LAW CONSTANT (atm-m3/mol) (@ 25 C)	REFERENCE	DEGRADATION CONSTANT k (1/day)	REFERENCE	HALF LIFE 1/2 (days)	REFERENCE
VOLATILE ORGANIC COMPOUNDS														
Benzene	78	1,780.000	1	1.69	48.98	1	76.00	1	0.0055	1	0.034	6	5 - 16	10
													10 - 730	13
													55 - 2884	13
													68 - 110	14
Ethyl benzene	106	152.000	1	1.98	95.50	1	7.08	1	0.0086	1	0.083	6	3 - 10	10
Toluene	92	515.000	1	2.06	114.82	1	22.00	1	0.0057	1	0.1-1	7	0.7 - 7	7
													4 - 22	10
													37 - 39	14
Xylenes (m-)	106	182.000	1	2.99	977	1	8.29 @ 25 C	1	0.0070	1	0.073 - 0.087	6	7 - 28	10
Xylenes (m-,o-,p-)													11 - 37	14
CARCINOGENIC PAHS														
Benzo(a)anthracene	228	5.70	1	6.14	1.4E+06	1	5.0E-09	1	6.6E-07	1	0.005	5	168.0	5
											0.0008	2	41 - 240	2
													102 - 679	10
Benzo(a)pyrene	252	4.00	2	6.00	1.0E+06	1	5.0E-07	2	<2.4E-06	1	0.003	5	280.0	5
											0.0009	2	347	2
													68 - 263	10
Benzo(b)fluoranthene	252	1.2 @ 25 C	1	5.74	5.5E+05	1	5.0E-07	1	1.2E-05	1	0.006 - 0.007	7	98 - 130	7
													360 - 810	10
Benzo(k)fluoranthene	252	0.55 @ 25 C	1	6.84	4.4E+06	1	9.6E-11 @ 25 C	1	1.0E-03	1	0.001-0.007	8	105 - 146	9
													909 - 2139	10
Chrysene	228	6 @ 25 C	1	5.39	2.5E+05	1	6.3E-07	1	7.3E-20	1	0.067 - 0.126	5		
											0.0061	2	328	2
													372 - 993	10
Dibenz(ah)anthracene	278	0.50	1	6.22	1.7E+06	1	1.0E-10	1	7.3E-09	1	0.004-0.005	7	141 - 190	7
													361 - 942	10
Indeno(1,2,3,cd)pyrene	276	62.00	1	7.29	1.9E+07	1	1.0E-10	1	3.0E-20	1			599 - 730	10

TABLE 5-2 (cont.)
ORGANIC CHEMICAL PARAMETERS
CITIZENS GAS AND ELECTRIC COMPANY SITE

CHEMICAL DETECTED	MOLECULAR WEIGHT	SOLUBILITY (ug/L) (@ 20 C)	REFERENCE	LOG Koc	Koc	REFERENCE	VAPOR PRESSURE (mm @ 20 C)	REFERENCE	HENRY'S LAW CONSTANT (atm-m3/mol) (@ 25 C)	REFERENCE	DEGRADATION CONSTANT k (1/day)	REFERENCE	HALF LIFE t1/2 (days)	REFERENCE
NON-CARCINOGENIC PAHS														
Acenaphthene	154	3470 @ 25 C	1	3.66	4.6E+03	11	0.001 - 0.01	1	1.5E-04	1	0.014-0.017	8	45.0	9
													12.3-102	10
Acenaphthylene	152	3930 @ 25 C	1	3.66	4.6E+03	1	2.9E-02	1	2.8E-04	1	0.037	5	19.0	5
													42.5 - 60	10
Anthracene	178	41	1	4.27	1.9E+04	1	2.0E-04	1	6.5E-05	1	0.018	5	39.0	5
											0.0268	2	17	2
													50 - 480	10
Benzo(ghi)perylene	276	0.26	1	6.89	7.8E+06	1	1.0E-10	1	1.4E-07	1			580 - 650	10
Fluoranthene	202	166	1	4.62	4.2E+04	1	1.0E-02	1	1.7E-02	1	0.007	5	127.0	5
											0.0223	2	39	2
													140 - 440	10
Fluorene	166	1,690 @ 25 C	1	3.70	5.0E+03	1	0.001 - 0.01	1	2.1E-04	1	0.014-0.017	8	45.0	9
													32-60	10
Naphthalene	128	31,700 @ 25 C	4	2.74	5.5E+02	1	4.9E-02	1	4.6E-04	1	0.037	5,6,7	30.00	5,6,7
Phenanthrene	178	1,000 @ 25 C	1	3.72	5.2E+03	1	2.1E-04	1	3.9E-05	1	0.027	5	28.0	5
											0.0007	2	9.7	2
													16 - 200	10
Pyrene	202	13 @ 25 C	1	4.66	4.6E+04	1	6.9E-07	1	1.1E-05	1	0.02 - 0.231	5	3 - 35	5
											0.019	2	58	2
													210 - 1898	10

1. Montgomery and Welkom, 1990.
2. Bulman et al., 1985.
3. Hawley, 1981.
4. Callahan et al., 1979.
5. Sims et al., 1986.
6. Loehr and Sims, 1987.
7. American Petroleum Institute (API), 1984.
8. Environmental Research and Technology, Inc. (ERT), 1985.
9. ERT, 1986.
10. Syracuse Research Corporation, 1989.
11. Lyman, et al., 1990.
12. Mackay, et al., 1992.
13. Howard, et al., 1991.
14. Dragun, 1988.

NA: Not Available

TABLE 5-3
INORGANIC CHEMICAL PARAMETERS
CITIZENS GAS AND ELECTRIC COMPANY SITE

CHEMICAL DETECTED	MOLECULAR WEIGHT	EXPERIMENTAL OR MEASURED AQUEOUS CONCENTRATION*	REFERENCE	SOIL TYPE	Kd (ml/g)	Kd (ml/g) (mean)	REFERENCE	COMMENTS
Arsenic	74.9	70 ppm	1		6 - 60		1	Lab results for [As]=1 ppm. Kd is strongly pH dependent.
		88 ppm	2		2.95		2	Lab experiments were conducted on sandy till.
					1.9 - 18	6.7	3	Measured range for Kd in soils.
		<0.2 - 420 ppb	4	Alluvial Material	5,500 - 512		4	Lab experiments were conducted on soils.
		0.4 - 483 ppb	4	Silty Fine Sand	2,500 - 521		4	Lab experiments were conducted on soils.
		2.2 - 495 ppb	4	Brown Clayey Sand	455 - 162		4	Lab experiments were conducted on soils.
		10 - 514 ppb	4	Fine Sand	110 - 15		4	Lab experiments were conducted on soils.
Lead	207.2			Fe-oxides	24,000		4	Calculated using values for Langmuir constants Kl and Am.
				Soils	980		4	Calculated using values for Langmuir constants Kl and Am.
				Sediments	1,500		4	Calculated using values for Langmuir constants Kl and Am.
					4.5 - 7,640	99.5	3	Measured range for Kd in soils.
Mercury	200.6			Sediments	50,000		4	Calculated using average values for Langmuir constants Kl and Am.
				Sandy Sediment	5,530		4	Calculated using values Langmuir constants Kl and Am for sandy sediment.
Cyanide	32.0				NA	NA	6	At a pH < 9.2 most of the free cyanide in solution should exist as hydrogen cyanide. Existing data indicate that the adsorption of hydrogen cyanide to suspended solids and sediment will not be significant. The extent of adsorption increases with decreasing pH and increases with increasing iron oxide, clay and organic material. Adsorption is probably insignificant even for metal cyanides when compared to volatilization and biodegradation.

1. Xu et al., 1988.
2. Griffin et al., undated.
3. Dragun, 1988.
4. Bodek et al., 1988.
5. Ral and Zachara, 1984.
6. Syracuse Research Corporation, 1991.

NA: Not Available

* Literature value

TABLE 6-1

SOIL QUALITY DATA
PHASE II INVESTIGATION
CITIZENS GAS AND ELECTRIC COMPANY SITE

(concentrations in ug/kg, unless noted otherwise)

	SB1501	SB1511	SB1512	SB1529	SB1537	SB1541	SB1601
	04/18/94	04/18/94	04/18/94	04/18/94	04/19/94	04/19/94	04/08/94
Volatile Organic Compounds							
Benzene	<1.2	<1.2	1.3	18000	6400	<1.1	95
Ethyl Benzene	<1.2	<1.2	<1.2	11000	14000	22	12
Toluene	<1.2	<1.2	<1.2	<380	6500	<1.1	<6.3
m & p Xylene	<2.5	<2.4	<2.5	5400	8900	3.6	<13
o-Xylene	<1.2	<1.2	<1.2	3200	5000	7.5	9.9
Sum of BETX	ND	ND	1.3	38000	41000	33	120
Base/Neutral Compounds							
Suspected Carcinogenic PAHs							
Benzo(a)anthracene	380 j	<410	<420	<430	210000 j	7500 j	250 j
Benzo(a)pyrene	410 j	<410	<420	<430	140000 j	5400 j	210 j
Benzo(b)fluoranthene	400 j	<410	<420	<430	65000 j	2600 j	200 j
Benzo(k)fluoranthene	550	<410	<420	<430	110000 j	4000 j	220 j
Chrysene	450	<410	<420	<430	200000 j	7200 j	270 j
Dibenzo(ah)anthracene	100 j	<410	<420 *	<430	<430000 *	<7800 *	<420
Indeno(1,2,3,cd)pyrene	170 j	<410	<420 *	<430	<430000 *	1600 j*	97 j
Sum of Carcinogens	2500 a	ND	ND	ND	730000 a	28000 a	1200 a
Non-Carcinogenic PAHs							
Acenaphthene	73 j	<410	<420	740	130000 j	6100 j	<420
Acenaphthylene	110 j	<410	<420	<430	810000	19000	60 j
Anthracene	85 j	<410	<420	<430	380000 j	12000	95 j
Benzo(ghi)perylene	160 j	<410	<420 *	<430	<430000 *	2400 j*	130 j*
Fluoranthene	560	<410	<420	<430	440000	15000	520
Fluorene	75 j	<410	<420	<430	570000	17000	73 j
Napthalene	190 j	<410	<420	14000	2900000	44000	580
Phenanthrene	340 j	<410	59 j	<430	1300000	41000	430
Pyrene	670	<410	<420	<430	660000	21000	500
Sum of Total PAH Compounds	4700 a	ND	59 a	15000 a	7900000 a	210000 a	3600 a
Metals							
Arsenic, mg/kg	27.2 *	2.1 b*	4.6 b*	145 *	3.0 b*	2.9 b*	10.8 *
Chromium, total, mg/kg	17.9	6.3	5.4	13.9	7.1	4.8	19.4
Copper, mg/kg	20.9	1.3	1.9	22.9	3.4	2.8	15.5
Lead, mg/kg	44.0	4.2	4.7	49.7	5.7	3.1	63.1 *
Mercury, mg/kg	0.17	<0.03	<0.03	0.12	<0.03	<0.03	0.09 b
Nickel, mg/kg	26.4 *	10.1 *	13.1 *	165 *	13.2 *	11.9 *	27.3
Zinc, mg/kg	110 *	19.8 *	20.2 *	178 *	23.6 *	17.2 *	106 *
Cyanide, mg/kg	0.42 b	<0.21	0.33 b	<0.26	<0.20	<0.19	0.91

ND Not detected.
a Estimated value, calculated using some or all values that are estimates.
b Potential false positive value based on blank data validation procedure.
j Reported value is less than the stated laboratory quantitation limit and is considered an estimated value.
* Estimated value, QA/QC criteria not met.

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TABLE 6-1 (cont.)

SOIL QUALITY DATA
PHASE II INVESTIGATION
CITIZENS GAS AND ELECTRIC COMPANY SITE

(concentrations in ug/kg, unless noted otherwise)

	SB1602	SB1605	SB1607	SB1703	SB1708	SB1710	SB1801
	04/08/94	04/08/94	04/08/94	04/07/94	04/07/94	04/07/94	04/11/94
Volatile Organic Compounds							
Benzene	27000	170000	230000	<140	21000	470	1.5 *
Ethyl Benzene	45000	74000	170000	3300	140000	580	<1.0
Toluene	33000	140000	280000	290	66000	420	1.1 *
m & p Xylene	40000	160000	100000	900	95000	360	<2.0
o-Xylene	30000	100000	53000	1900	58000	220	<1.0
Sum of BETX	180000	640000	830000	6400	380000	2100	2.6 a
Base/Neutral Compounds							
Suspected Carcinogenic PAHs							
Benzo(a)anthracene	30000 j	<13000	990000 j	17000 j	9000 j	<490	30000
Benzo(a)pyrene	49000	<13000	530000 j	10000 j	5000 j	<490	22000
Benzo(b)fluoranthene	22000 j	<13000	<2600000	5100 j	2400 j	<490	14000 j
Benzo(k)fluoranthene	37000	<13000	600000 j	7200 j	5200 j	<490	20000
Chrysene	32000	<13000	870000 j	15000 j	8500 j	<490	31000
Dibenzo(ah)anthracene	6900 j	<13000	<2600000	<24000	<23000	<490	5300 j
Indeno(1,2,3,cd)pyrene	14000 j	<13000	<2600000	<24000	<23000	<490	9700 j
Sum of Carcinogens	190000 a	ND	3000000 a	54000 a	30000 a	ND	130000 a
Non-Carcinogenic PAHs							
Acenaphthene	9200 j	<13000	550000 j	85000	44000	1100	4300 j
Acenaphthylene	30000 j	3000 j	4100000	21000 j	4500 j	<490	14000 j
Anthracene	7800 j	3100 j	1800000 j	36000	18000 j	68 j	16000 j
Benzo(ghi)perylene	16000 j*	<13000*	<2600000 *	<24000 *	<23000 *	<490	14000 j
Fluoranthene	17000 j	2700 j	2300000 j	30000	17000 j	<490	50000
Fluorene	10000 j	4000 j	2900000	58000	25000	430 j	<19000
Napthalene	150000	23000	15000000	83000	150000	5300	<19000
Phenanthrene	14000 j	13000 j	7600000	120000	64000	310 j	65000
Pyrene	51000	5000 j	3400000	52000	28000	<490	80000
Sum of Total PAH Compounds	500000 a	54000 a	41000000 a	540000 a	380000 a	7200 a	380000 a
Metals							
Arsenic, mg/kg	14.9 *	11.1 *	14.4 *	14.4 *	9.8 *	7.3 b*	12.9
Chromium, total, mg/kg	14.3	14.8	3.3	24.3	18.6	28.0	9.8
Copper, mg/kg	15.3	12.8	48.9	26.6	17.2	27.4	14.7
Lead, mg/kg	79.0 *	10.6 *	1190 *	19.3 *	20.0 *	14.9 *	67.7
Mercury, mg/kg	0.08 b	0.05 b	0.68	0.05 b	<0.04	0.06 b	0.05
Nickel, mg/kg	25.0	23.4	7.9	35.9	31.6	33.4	14.7
Zinc, mg/kg	155 *	54.9 *	240 *	94.7 *	65.3 *	95.4 *	69.0
Cyanide, mg/kg	<0.21	1.00	21.7	0.26	<0.23	<0.26	<0.21

ND Not detected.
a Estimated value, calculated using some or all values that are estimates.
b Potential false positive value based on blank data validation procedure.
j Reported value is less than the stated laboratory quantitation limit and is considered an estimated value.
* Estimated value, QA/QC criteria not met.

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TABLE 6-1 (cont.)

SOIL QUALITY DATA
PHASE II INVESTIGATION
CITIZENS GAS AND ELECTRIC COMPANY SITE

(concentrations in ug/kg, unless noted otherwise)

	SB1811	SB1812	SB1901	SB1905		SB1908	SB1910
	04/12/94	04/12/94	04/07/94	04/07/94 Sample	04/07/94 Duplicate	04/07/94	04/07/94
Volatile Organic Compounds							
Benzene	<1.7	1.5	<1.2	700	390	16000	110
Ethyl Benzene	<1.7	<1.2	<1.2	12000	5800	3000	17
Toluene	<1.7	<1.2	<1.2	420	<280	30000	46
m & p Xylene	<3.4	<2.5	<2.4	6800	2400	19000	26
o-Xylene	<1.7	<1.2	<1.2	4300	2000	11000	30
Sum of BETX	ND	1.5	ND	24000	11000	79000	230
Base/Neutral Compounds							
Suspected Carcinogenic PAHs							
Benzo(a)anthracene	<570	<420	15000	740	8800	38000 j	100 j
Benzo(a)pyrene	<570	<420	14000	580	6100	24000 j	<560
Benzo(b)fluoranthene	<570	<420	11000	660	3500	10000 j	<560
Benzo(k)fluoranthene	<570	<420	14000	940	3600	24000 j	<560
Chrysene	<570	<420	14000	700	8300	35000 j	96 j
Dibenzo(ah)anthracene	<570	<420	2600 j	110 j	660	<47000	<560
Indeno(1,2,3,cd)pyrene	<570	<420	5700 j	210 j	1100	<47000	<560
Sum of Carcinogens	ND	ND	76000 a	3900 a	32000	130000 a	200 a
Non-Carcinogenic PAHs							
Acenaphthene	<570	<420	960 j	1400	15000	14000 j	<560
Acenaphthylene	<570	<420	5000 j	510	3400	110000	220 j
Anthracene	<570	<420	8800	780	7400	53000	110 j
Benzo(ghi)perylene	<570	<420	7600 j*	180 j*	990 *	6200 j*	200 j*
Fluoranthene	<570	<420	23000	1600	15000	79000	200 j
Fluorene	<570	<420	9500	1400	6100	84000	200 j
Napthalene	890	87 j	3600 j	470 j	2100	380000	1100
Phenanthrene	<570	110 j	42000	2900	30000	210000	540 j
Pyrene	<570	<420	31000	1500	18000	100000	280 j
Sum of Total PAH Compounds	890	200 a	210000 a	15000 a	130000	1200000 a	3000 a
Metals							
Arsenic, mg/kg	16.1	2.6 b	8.7 *	14.5 *	7.9 b*	14.5 *	12.4 *
Chromium, total, mg/kg	36.2	6.8 *	17.4	25.9	30.6	24.7	37.1
Copper, mg/kg	31.4	1.0	22.4	25.6	26.6	24.5	28.5
Lead, mg/kg	19.6	4.0	48.2 *	18.1 *	19.3 *	89.9 *	14.2 *
Mercury, mg/kg	<0.04	<0.03	3.2	0.06 b	0.05 b	0.06 b	0.07 b
Nickel, mg/kg	40.6	10.3	25.2	35.5	32.2	32.8	41.4
Zinc, mg/kg	116	17.6	104 *	86.2 *	93.5 *	80.7 *	105 *
Cyanide, mg/kg	<0.29	<0.20	9.6	0.32	<0.24	0.42	<0.28

ND Not detected.
a Estimated value, calculated using some or all values that are estimates.
b Potential false positive value based on blank data validation procedure.
j Reported value is less than the stated laboratory quantitation limit and is considered an estimated value.
* Estimated value, QA/QC criteria not met.

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TABLE 6-1 (cont.)

SOIL QUALITY DATA
PHASE II INVESTIGATION
CITIZENS GAS AND ELECTRIC COMPANY SITE

(concentrations in ug/kg, unless noted otherwise)

	SB2006		SB2011	SB2013	SB2102	SB2201	SB2205
	04/13/94 Sample	04/13/94 Duplicate	04/13/94	04/13/94	04/05/94	04/05/94	04/05/94
Volatile Organic Compounds							
Benzene	<67	<55	<540	15	160000	1.5	<1.2
Ethyl Benzene	<67	<55	14000 *	88	370000	<1.2	1.5
Toluene	<67	<55	<540	<2.3	430000	<1.2	<1.2
m & p Xylene	190	640	5600	31	240000	<2.3	2.8
o-Xylene	<67	130	4200	34	120000	<1.2	4.4
Sum of BETX	190	770	24000 a	170	1300000	1.5	8.7
Base/Neutral Compounds							
Suspected Carcinogenic PAHs							
Benzo(a)anthracene	770 j	560 j	30000	11000 j	350000 j	9400	790
Benzo(a)pyrene	540 j	380 j	19000 j	6900 j	250000 j	6400	360 j
Benzo(b)fluoranthene	320 j	200 j	9000 j	3100 j	<630000	10000 *	<430
Benzo(k)fluoranthene	410 j	330 j	14000 j	5300 j	<630000	5400	800
Chrysene	860	640 j	28000	10000 j	370000 j	9600	820
Dibenzo(ah)anthracene	<850	<880	3300 j	<21000	<630000	670 j	110 j
Indeno(1,2,3,cd)pyrene	140 j	<880	5600 j	<21000	<630000	5600	290 j
Sum of Carcinogens	3000 a	2100 a	110000 a	36000 a	970000 a	47000 a	3200 a
Non-Carcinogenic PAHs							
Acenaphthene	2100	1600	110000	47000	680000	<1900	<430
Acenaphthylene	210 j	<880	14000 j	4900 j	250000 j	940 j	<430
Anthracene	1000	770 j	51000	20000 j	480000 j	900 j	140 j
Benzo(ghi)perylene	130 j	120 j	6600 j	<21000	<630000	9500 *	390 j
Fluoranthene	1200	750 j	46000	18000 j	650000	8800	1300
Fluorene	1300	950	66000	28000	520000 j	1000 j	220 j
Napthalene	<850	<880	460000	160000	9300000	860 j	1500
Phenanthrene	830 j	1300	160000	68000	2100000	6800	1600
Pyrene	2000	1400	71000	31000	950000	20000	2000
Sum of Total PAH Compounds	12000 a	9000 a	1100000 a	410000 a	16000000 a	96000 a	10000 a
Metals							
Arsenic, mg/kg	11.8	14.2	4.8 b	4.4 b	8.4	15.4	9.3
Chromium, total, mg/kg	13.4	12.8	7.6	6.3	17.6	16.7	15.4
Copper, mg/kg	9.2	9.7	3.0	1.8	12.8 *	153 *	14.6 *
Lead, mg/kg	9.0	8.6	4.7	5.5	388 *	95.2 *	13.0 *
Mercury, mg/kg	<0.03	<0.03	<0.03	<0.03	0.06	0.10	<0.03
Nickel, mg/kg	23.4	20.5	10.2	14.9	18.9	24.2	22.3
Zinc, mg/kg	40.7	39.5	19.2	24.1	51.3	87.7	49.8
Cyanide, mg/kg	<0.22	<0.23	<0.21	<0.21	27.4	20.5	0.59 b

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j Reported value is less than the stated laboratory quantitation limit and is considered an estimated value.
* Estimated value, QA/QC criteria not met.

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TABLE 6-1 (cont.)

SOIL QUALITY DATA
PHASE II INVESTIGATION
CITIZENS GAS AND ELECTRIC COMPANY SITE

(concentrations in ug/kg, unless noted otherwise)

	SB2210	SB2301	SB2312	SB2314	SB2326	SB2401	SB2403
	04/05/94	04/14/94	04/14/94	04/14/94	04/14/94	04/05/94	04/05/94
Volatile Organic Compounds							
Benzene	<1.3	<1.1	<1.2	<1.1	--	6.5 *	--
Ethyl Benzene	16	<1.1	<1.2	<1.1	--	<1.1	--
Toluene	<1.3	<1.1	<1.2	<1.1	--	2.6 *	--
m & p Xylene	<2.5	<2.3	<2.4	<2.1	--	<2.2	--
o-Xylene	6.5	<1.1	<1.2	<1.1	--	1.2 *	--
Sum of BETX	22.5	ND	ND	ND	--	10.3 a	--
Base/Neutral Compounds							
Suspected Carcinogenic PAHs							
Benzo(a)anthracene	740 j	510	<400	<410	<380	45000 j	70000 j
Benzo(a)pyrene	500 j	430	<400	<410	<380	14000 j	46000 j
Benzo(b)fluoranthene	<920	530	<400	<410	<380	24000 j	<130000
Benzo(k)fluoranthene	380 j	540	<400	<410	<380	24000 j	<130000
Chrysene	770 j	590	<400	<410	<380	58000	80000 j
Dibenzo(ah)anthracene	<920	66 j	<400	<410	<380	<45000	<130000
Indeno(1,2,3,cd)pyrene	<920	140 j	<400	<410	<380	14000 j	<130000
Sum of Carcinogens	2400 a	2800 a	ND	ND	ND	180000 a	200000 a
Non-Carcinogenic PAHs							
Acenaphthene	560 j	81 j	<400	<410	<380	<45000	290000
Acenaphthylene	<920	<380	<400	<410	<380	<45000	40000 j
Anthracene	520 j	160 j	<400	<410	<380	<45000	120000 j
Benzo(ghi)perylene	250 j	130 j	<400	<410	<380	22000 j	<130000
Fluoranthene	1800	1000	<400	<410	<380	80000	110000 j
Fluorene	1200	92 j	<400	<410	<380	17000 j	130000
Napthalene	55000	110 j	<400	<410	<380	<45000	1500000
Phenanthrene	5800	840	<400	<410	<380	190000	480000
Pyrene	2200	1000	<400	<410	<380	120000	180000
Sum of Total PAH Compounds	70000 a	6200 a	ND	ND	ND	610000 a	3000000 a
Metals							
Arsenic, mg/kg	11.6	10.0	3.4 b	2.7 b	--	12.3	--
Chromium, total, mg/kg	14.1	19.2	5.1	5.6	--	18.4	--
Copper, mg/kg	12.2 *	18.1	2.3	2.3	--	256 *	--
Lead, mg/kg	8.3 *	69.0	4.1	4.3	--	186 *	--
Mercury, mg/kg	<0.03	0.09	<0.03	<0.03	--	2.4	--
Nickel, mg/kg	22.4	27.5	9.7	11.7	--	38.3	--
Zinc, mg/kg	50.9	193	17.1	20.7	--	304	--
Cyanide, mg/kg	0.39 b	<0.20	<0.20	<0.21	--	29.5	--

-- Not analyzed.
ND Not detected.
a Estimated value, calculated using some or all values that are estimates.
b Potential false positive value based on blank data validation procedure.
j Reported value is less than the stated laboratory quantitation limit and is considered an estimated value.
* Estimated value, QA/QC criteria not met.

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TABLE 6-1 (cont.)

SOIL QUALITY DATA
PHASE II INVESTIGATION
CITIZENS GAS AND ELECTRIC COMPANY SITE

(concentrations in ug/kg, unless noted otherwise)

	SB2406	SB2407	SB2704	SB2707	SB2710	SB2817
	04/05/94	04/05/94	04/05/94	04/05/94	04/05/94	04/13/94
Volatile Organic Compounds						
Benzene	790000	820000	3.9	9400	950	3.1
Ethyl Benzene	520000	270000	23	59000	11000	<1.1
Toluene	1200000	930000	<1.3	<3100	<640	<1.1
m & p Xylene	450000	500000	<2.5	12000	6000	2.9
o-Xylene	230000	250000	5.3	37000	3400	<1.1
Sum of BETX	3200000	2800000	32.2	120000	21000	6.0
Base/Neutral Compounds						
Suspected Carcinogenic PAHs						
Benzo(a)anthracene	370000 j	440000 j	1700 j	50000 j	8100 j	<420
Benzo(a)pyrene	240000 j	290000 j	1000 j	33000 j	6200 j	<420
Benzo(b)fluoranthene	<910000	<910000	<1700	<130000	<13000	<420
Benzo(k)fluoranthene	<910000	<910000	700 j	<130000	5500 j	<420
Chrysene	410000 j	520000 j	1700 j	51000 j	8400 j	<420
Dibenzo(ah)anthracene	<910000	<910000	<1700	<130000	<13000	<420
Indeno(1,2,3,cd)pyrene	<910000	<910000	<1700	<130000	<13000	<420
Sum of Carcinogens	1000000 a	1300000 a	5100 a	130000 a	28000 a	ND
Non-Carcinogenic PAHs						
Acenaphthene	600000 j	780000 j	9300	190000	24000	<420
Acenaphthylene	990000	1200000	<1700	<130000	<13000	<420
Anthracene	650000 j	810000 j	2800	87000 j	13000 j	<420
Benzo(ghi)perylene	<910000	<910000	<1700	<130000	<13000	<420
Fluoranthene	560000 j	690000 j	3100	87000 j	16000	<420
Fluorene	690000 j	860000 j	5200	89000 j	13000 j	<420
Napthalene	11000000	14000000	<1700	1000000	300000	<420
Phenanthrene	2400000	3000000	14000	350000	55000	<420
Pyrene	890000 j	1100000	4500	120000 j	23000	<420
Sum of Total PAH Compounds	19000000 a	24000000 a	44000	2100000 a	470000 a	ND
Metals						
Arsenic, mg/kg	24.0	25.7	5.5	8.6	13.1	4.3 b
Chromium, total, mg/kg	17.7	19.4	18.2	10.6	13.6	6.4
Copper, mg/kg	126 *	160 *	18.4 *	8.5 *	13.0 *	1.6
Lead, mg/kg	315 *	399 *	12.5 *	6.7 *	8.9 *	4.4
Mercury, mg/kg	0.64	0.47	0.04	<0.03	<0.03	<0.03
Nickel, mg/kg	33.1	27.6	25.8	18.9	19.8	10.8
Zinc, mg/kg	418	751	79.1	39.8	50.4	40.6
Cyanide, mg/kg	41.1	20.1	0.42 b	<0.43	<0.21	<0.21

ND Not detected.
a Estimated value, calculated using some or all values that are estimates.
b Potential false positive value based on blank data validation procedure.
j Reported value is less than the stated laboratory quantitation limit and is considered an estimated value.
* Estimated value, QA/QC criteria not met.

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TABLE 6-2

SUMMARY OF SOIL FIELD SCREENING AND LABORATORY ANALYTICAL RESULTS
CITIZENS GAS AND ELECTRIC COMPANY SITE

Hydro-Geologic Unit	Sample Number	Depth (Ft.)	Headspace Reading (ppm)	Oil Sheen	PAHs Total (mg/Kg)	PAHs Carcinogenic (mg/Kg)	BETX (mg/Kg)	Phenol (mg/Kg)	Arsenic (mg/Kg)	Chromium (mg/Kg)	Copper (mg/Kg)	Lead (mg/Kg)	Mercury (mg/Kg)	Nickel (mg/Kg)	Zinc (mg/Kg)	Total Cyanide (mg/Kg)
Fill	ST-1	0-5	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-1	7.5	12	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-1	9	2	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-1	12.5	1.9	--	--	--	--	--	--	--	--	--	--	--	--	--
Fine	ST-1	15	2.5	--	--	--	--	--	--	--	--	--	--	--	--	--
Alluvium	ST-1	17.5	4.8	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-1	20	3.5	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-1	22.5	8	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-1	25	3	--	ND	ND	ND	0.9	5.9	12.8	17.9	21.1	--	22.4	64.8	0.31
	ST-1	27.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Coarse Alluvium	ST-1	30	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-2	2.5	0.8	--	--	--	--	--	--	--	--	--	--	--	--	--
Fill	ST-2	5	4.6	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-2	7.5	7.5	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-2	10	9.2	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-2	12.5	27.1	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-2	15	20.5	--	ND	ND	ND	1.62	6.2	10.6	21.2	20.5	--	23	63.5	<0.05
	ST-2	17.5	84	--	--	--	--	--	--	--	--	--	--	--	--	--
Fine	ST-2	20	97	--	--	--	--	--	--	--	--	--	--	--	--	--
Alluvium	ST-2	22.5	92	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-2	25	82	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-2	27.5	47.2	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-2	30	40	--	--	--	--	--	--	--	--	--	--	--	--	--
Coarse	ST-2	35	25	--	ND	ND	ND	<0.06	1.7	5.5	1.9	5.7	--	9.5	22.2	<0.05
Alluvium	ST-2	40	37	--	--	--	--	--	--	--	--	--	--	--	--	--
Fill	ST-3	2.5	27.5	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-3	5	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-3	7.5	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-3	10	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-3	12.5	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-3	15	0	--	--	--	--	--	--	--	--	--	--	--	--	--
Fine	ST-3	17.5	23	--	--	--	--	--	--	--	--	--	--	--	--	--
Alluvium	ST-3	20	0	--	ND	ND	ND	0.46	4.3	10.8	11.7	17.6	--	18.4	47	<0.05
	ST-3	22.5	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-3	25	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-3	27.5	0	--	--	--	--	--	--	--	--	--	--	--	--	--
Coarse	ST-3	30	0	--	--	--	--	--	--	--	--	--	--	--	--	--
Alluvium	ST-3	32.5	0	--	--	--	--	--	--	--	--	--	--	--	--	--

-- : Not analyzed; ND : Not detected; Oil Sheen: N = None, L = Low, M = Moderate, H = Heavy; See Figure 3-3 for Boring Locations

TABLE 6-2 (cont.)

SUMMARY OF SOIL FIELD SCREENING AND LABORATORY ANALYTICAL RESULTS
CITIZENS GAS AND ELECTRIC COMPANY SITE

Hydro-Geologic Unit	Sample Number	Depth (Ft.)	Headspace Reading (ppm)	Oil Sheen	PAHs Total (mg/Kg)	PAHs Carcinogenic (mg/Kg)	BETX (mg/Kg)	Phenol (mg/Kg)	Arsenic (mg/Kg)	Chromium (mg/Kg)	Copper (mg/Kg)	Lead (mg/Kg)	Mercury (mg/Kg)	Nickel (mg/Kg)	Zinc (mg/Kg)	Total Cyanide (mg/Kg)
Fill	ST-4	2.5	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-4	5	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-4	7.5	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-4	10	0	--	--	--	--	--	--	--	--	--	--	--	--	--
Fine	ST-4	12.5	0	--	--	--	--	--	--	--	--	--	--	--	--	--
Alluvium	ST-4	15	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-4	17.5	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-4	20	0	--	6	ND	ND	1.63	2	12.4	20.1	21.2	--	22.8	67.3	<0.05
Coarse	ST-4	22.5	0	--	--	--	--	--	--	--	--	--	--	--	--	--
Alluvium	ST-4	25	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-4	27.5	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-5	2.5	84.9	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-5	5	31.5	--	--	--	--	--	--	--	--	--	--	--	--	--
Fill	ST-5	7.5	346	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-5	10	130	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-5	12.5	57	--	13,000	680	140	22.2	0.62	17.9	72.1	464	--	15.4	456	3.2
	ST-5	415	134	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-5	20	110	--	--	--	--	--	--	--	--	--	--	--	--	--
Fine	ST-5	25	265	--	--	--	--	--	--	--	--	--	--	--	--	--
Alluvium	ST-5	30	1900	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-5	35	503	--	--	--	--	--	--	--	--	--	--	--	--	--
Coarse	ST-5	540	1283	--	--	--	--	--	--	--	--	--	--	--	--	--
Alluvium	ST-5	45	1043	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-5	50	648	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-6	2.5	12	--	--	--	--	--	--	--	--	--	--	--	--	--
Fill	ST-6	5	4	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-6	7.5	4.7	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-6	10	90	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-6	125	380	--	9,200	2,100	390	136	2.61	10.7	21.1	26.7	--	20.5	88.3	8
	ST-6	15	575	--	--	--	--	--	--	--	--	--	--	--	--	--
Fine	ST-6	17.5	114	--	--	--	--	--	--	--	--	--	--	--	--	--
Alluvium	ST-6	20	210	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-6	22.5	69.5	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-6	25	57.5	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-6	27.5	87.1	--	--	--	--	--	--	--	--	--	--	--	--	--
Coarse Alluvium	ST-6	30	49.2	--	--	--	--	--	--	--	--	--	--	--	--	--

-- : Not analyzed; ND : Not detected; Oil Sheen: N = None, L = Low, M = Moderate, H = Heavy; See Figure 3-3 for Boring Locations

TABLE 6-2 (cont.)

SUMMARY OF SOIL FIELD SCREENING AND LABORATORY ANALYTICAL RESULTS
CITIZENS GAS AND ELECTRIC COMPANY SITE

Hydro-Geologic Unit	Sample Number	Depth (Ft.)	Headspace Reading (ppm)	Oil Sheen	PAHs		BETX (mg/Kg)	Phenol (mg/Kg)	Arsenic (mg/Kg)	Chromium (mg/Kg)	Copper (mg/Kg)	Lead (mg/Kg)	Mercury (mg/Kg)	Nickel (mg/Kg)	Zinc (mg/Kg)	Total Cyanide (mg/Kg)
					Total (mg/Kg)	Carcinogenic (mg/Kg)										
Fill	ST-7	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-7	10	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fine	ST-7	15	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alluvium	ST-7	20	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-7	25	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-8	2.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fill	ST-8	5	50	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-8	7.5	280	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-8	10	97	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-8	12.5	141.7	--	--	--	--	--	--	--	--	--	--	--	--	--
Fine	ST-8	15	604	--	--	--	--	--	--	--	--	--	--	--	--	--
Alluvium	ST-8	17.5	142	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-8	20	91.7	--	2,400	270	44	0.76	2.9	16.1	31.7	28.3	--	26.2	95.6	<0.2
	ST-8	25	79	--	--	--	--	--	--	--	--	--	--	--	--	--
Coarse Alluvium	ST-8	30	68.8	--	--	--	--	--	--	--	--	--	--	--	--	--
Fill	ST-9	2.5	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-9	5	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-9	7.5	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-9	10	0	--	--	--	--	--	--	--	--	--	--	--	--	--
Fine	ST-9	12.5	3.1	--	--	--	--	--	--	--	--	--	--	--	--	--
Alluvium	ST-9	15	2.5	--	ND	ND	ND	<0.1	2.9	14.9	22.3	24.1	--	29.7	76.1	<0.2
	ST-9	17.5	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-9	20	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-9	22.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fill	ST-10	5	0	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-10	10	0	--	--	--	--	--	--	--	--	--	--	--	--	--
Fine	ST-10	15	15	--	--	--	--	--	--	--	--	--	--	--	--	--
Alluvium	ST-10	20	2.9	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-10	25	--	--	--	--	--	--	--	--	--	--	--	--	--	--

-- : Not analyzed; ND : Not detected; Oil Sheen: N = None, L = Low, M = Moderate, H = Heavy; See Figure 3-3 for Boring Locations

TABLE 6-2 (cont.)

SUMMARY OF SOIL FIELD SCREENING AND LABORATORY ANALYTICAL RESULTS
CITIZENS GAS AND ELECTRIC COMPANY SITE

Hydro-Geologic Unit	Sample Number	Depth (Ft.)	Headspace Reading (ppm)	Oil Sheen	PAHs		BETX (mg/Kg)	Phenol (mg/Kg)	Arsenic (mg/Kg)	Chromium (mg/Kg)	Copper (mg/Kg)	Lead (mg/Kg)	Mercury (mg/Kg)	Nickel (mg/Kg)	Zinc (mg/Kg)	Total Cyanide (mg/Kg)
					Total (mg/Kg)	Carcinogenic (mg/Kg)										
Fill	ST-11	5	5	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-11	10	70	--	--	--	--	--	--	--	--	--	--	--	--	--
Fine	ST-11	15	99	--	--	--	--	--	--	--	--	--	--	--	--	--
Alluvium	ST-11	20	137	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-11	25	557	--	--	--	--	--	--	--	--	--	--	--	--	--
Fill	ST-12	5	7.5	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-12	10	14.2	--	--	--	--	--	--	--	--	--	--	--	--	--
Fine	ST-12	15	31	--	--	--	--	--	--	--	--	--	--	--	--	--
Alluvium	ST-12	20	38	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-12	25	5	--	--	--	--	--	--	--	--	--	--	--	--	--
Fill	ST-13	2.5	33	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-13	5	87	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-13	7.5	68	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-13	10	90	--	ND	ND	ND	<0.5	1.77	13.4	20.8	17.4	--	21.8	62.6	0.24
Fine	ST-13	12.5	460	--	--	--	--	--	--	--	--	--	--	--	--	--
Alluvium	ST-13	15	907	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-13	20	632	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-13	25	137	--	--	--	--	--	--	--	--	--	--	--	--	--
Coarse Alluvium	ST-13	30	94	--	--	--	--	--	--	--	--	--	--	--	--	--
Fill	ST-14	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-14	10	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fine	ST-14	15	--	--	200	46	--	0.92	1.99	10.7	15.9	49.2	--	14.9	114	55.2
Alluvium	ST-14	20	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	ST-14	25	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Coarse Alluvium	ST-14	30	--	--	--	--	--	--	--	--	--	--	--	--	--	--

-- : Not analyzed; ND : Not detected; Oil Sheen: N = None, L = Low, M = Moderate, H = Heavy; See Figure 3-3 for Boring Locations

TABLE 6-2 (cont.)

SUMMARY OF SOIL FIELD SCREENING AND LABORATORY ANALYTICAL RESULTS
CITIZENS GAS AND ELECTRIC COMPANY SITE

Hydro-Geologic Unit	Sample Number	Depth (Ft.)	Headspace Reading (ppm)	Oil Sheen	PAHs		BETX (mg/Kg)	Arsenic (mg/Kg)	Chromium (mg/Kg)	Copper (mg/Kg)	Lead (mg/Kg)	Mercury (mg/Kg)	Nickel (mg/Kg)	Zinc (mg/Kg)	Total Cyanide (mg/Kg)
					Total (mg/Kg)	Carcinogenic (mg/Kg)									
	SB-15-01	0-2.5	18	N	4.7	2.5	ND	27.2	17.9	20.9	44	0.17	26.4	110	0.42
Fill	SB-15-02	2.5-4.5	12	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-03	5-7	16	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-04	7.5-9.5	24	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-05	10-12	28	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-06	12.5-14.5	14	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-07	15-17	22	N	--	--	--	--	--	--	--	--	--	--	--
Fine	SB-15-08	17.5-19.5	15	N	--	--	--	--	--	--	--	--	--	--	--
Alluvium	SB-15-09	20-22	16	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-10	22.5-24.5	8	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-11	25-27	0.8	N	ND	ND	ND	2.1	6.3	1.3	4.2	<0.03	10.1	19.8	<0.21
	SB-15-12	27.5-29.5	0.8	N	0.059	ND	0.0013	4.6	5.4	1.9	4.7	<0.03	13.1	20.2	0.33
	SB-15-13	30-32	1	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-14	32.5-34.5	1	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-15	35-37	--	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-16	37.5-39.5	1	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-17	40-42	3	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-18	42.5-44.5	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-19	45-47	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-20	47.5-49.5	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-21	50-52	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-22	52.5-54.5	1	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-23	55-57	1	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-24	57.5-59.5	3	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-25	60-62	1	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-26	62.5-64.5	--	N	--	--	--	--	--	--	--	--	--	--	--
Coarse	SB-15-27	65-67	--	N	--	--	--	--	--	--	--	--	--	--	--
Alluvium	SB-15-28	67.5-69.5	526	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-29	70-72	433	N	15	ND	38	145	13.9	22.9	49.7	0.12	165	178	0.26
	SB-15-30	72.5-74.5	758	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-31	75-77	339	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-32	77.5-79.5	23	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-33	80-82	64	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-34	82.5-84.5	65	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-35	85-87	149	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-36	87.5-89.5	193	N	--	--	--	--	--	--	--	--	--	--	--
	SB-15-37	90-92	405	H	7900	730	41	3	7.1	3.4	5.7	<0.03	13.2	23.6	<0.20
	SB-15-38	92.5-94.5	2815	H	--	--	--	--	--	--	--	--	--	--	--
	SB-15-39	95-97	139	H	--	--	--	--	--	--	--	--	--	--	--
	SB-15-40	97.5-99.5	212	M	--	--	--	--	--	--	--	--	--	--	--
	SB-15-41	100-102	214	M	210	28	0.033	2.9	4.8	2.8	3.1	<0.03	11.9	17.0	<0.19

-- : Not Analyzed; ND - Not detected; Oil Sheen : N = None, L = Low, M = Moderate, H = Heavy; See Figure 3-3 for Boring Locations

TABLE 6-2 (cont.)

SUMMARY OF SOIL FIELD SCREENING AND LABORATORY ANALYTICAL RESULTS
CITIZENS GAS AND ELECTRIC COMPANY SITE

Hydro-Geologic Unit	Sample Number	Depth (Ft.)	Headspace Reading (ppm)	Oil Sheen	PAHs		BETX (mg/Kg)	Arsenic (mg/Kg)	Chromium (mg/Kg)	Copper (mg/Kg)	Lead (mg/Kg)	Mercury (mg/Kg)	Nickel (mg/Kg)	Zinc (mg/Kg)	Total Cyanide (mg/Kg)
					Total (mg/Kg)	Carcinogenic (mg/Kg)									
	SB-16-01	0-2.5	33	N	3.6	1.2	0.12	10.8	19.4	15.5	63.1	0.09	27.3	106	0.91
	SB-16-02	2.5-4.5	119	H	500	190	180	14.9	14.3	15.3	79	0.08	25	155	<0.21
	SB-16-03	5-7	202	H	--	--	--	--	--	--	--	--	--	--	--
Fill	SB-16-04	7.5-9.5	197	H	--	--	--	--	--	--	--	--	--	--	--
	SB-16-05	10-12	1853	H	54	ND	640	11.1	14.8	12.8	10.6	0.05	234	54.9	1
	SB-16-06	12.5-14.5	1982	H	--	--	--	--	--	--	--	--	--	--	--
	SB-16-07	15-17	891	H	41000	3000	830	14.4	3.3	48.9	1190	0.68	7.9	240	21.7
Fill	SB-17-01	0-2.5	2	L	--	--	--	--	--	--	--	--	--	--	--
	SB-17-02	2.5-4.5	14	L	--	--	--	--	--	--	--	--	--	--	--
	SB-17-03	5-7	34	M	540	54	6.4	140.4	24.3	26.6	19.3	0.05	35.9	94.7	0.26
	SB-17-04	7.5-9.5	240	M-H	--	--	--	--	--	--	--	--	--	--	--
	SB-17-05	10-12	60	M	--	--	--	--	--	--	--	--	--	--	--
Fine	SB-17-06	12.5-14.5	185	M-H	--	--	--	--	--	--	--	--	--	--	--
Alluvium	SB-17-07	15-17	240	M-H	--	--	--	--	--	--	--	--	--	--	--
	SB-17-08	17.5-19.5	375	M-H	380	30	380	9.8	18.6	17.2	20	<0.04	31.6	65.3	<0.23
	SB-17-09	20-22	1568/1457	H	--	--	--	--	--	--	--	--	--	--	--
	SB-17-10	22.5-24.5	201	L	7.2	ND	2.1	7.3	28	27.4	14.9	0.06	33.4	95.4	<0.26
	SB-18-01	0-2.5	3	L	380	130	0.0026	12.9	9.8	14.7	67.7	0.05	14.7	69	<0.21
Fill	SB-18-02	2.5-4.5	36	M	--	--	--	--	--	--	--	--	--	--	--
	SB-18-03	5-7	2	L	--	--	--	--	--	--	--	--	--	--	--
	SB-18-04	7.5-9.5	39	L	--	--	--	--	--	--	--	--	--	--	--
	SB-18-05	10-12	20	N	--	--	--	--	--	--	--	--	--	--	--
	SB-18-06	12.5-14.5	25	N	--	--	--	--	--	--	--	--	--	--	--
	SB-18-07	15-17	34	N	--	--	--	--	--	--	--	--	--	--	--
Fine	SB-18-08	17.5-19.5	111	M-H	--	--	--	--	--	--	--	--	--	--	--
Alluvium	SB-18-09	20-22	107	H	--	--	--	--	--	--	--	--	--	--	--
	SB-18-10	22.5-24.5	--	H	--	--	--	--	--	--	--	--	--	--	--
	SB-18-11	25-27	2	N	0.89	ND	ND	2.6	6.8	1	4	<0.03	10.3	17.6	<0.20
	SB-18-12	27.5-29.5	4	N	0.2	ND	0.0015	--	--	--	--	--	--	--	--

-- : Not Analyzed; ND - Not detected; Oil Sheen : N = None, L = Low, M = Moderate, H = Heavy; See Figure 3-3 for Boring Locations

TABLE 6-2 (cont.)

SUMMARY OF SOIL FIELD SCREENING AND LABORATORY ANALYTICAL RESULTS
CITIZENS GAS AND ELECTRIC COMPANY SITE

Hydro-Geologic Unit	Sample Number	Depth (Ft.)	Headspace Reading (ppm)	Oil Sheen	PAHs		BETX (mg/Kg)	Arsenic (mg/Kg)	Chromium (mg/Kg)	Copper (mg/Kg)	Lead (mg/Kg)	Mercury (mg/Kg)	Nickel (mg/Kg)	Zinc (mg/Kg)	Total Cyanide (mg/Kg)
					Total (mg/Kg)	Carcinogenic (mg/Kg)									
	SB-19-01	0-2.5	4	N	210	76	ND	8.7	17.4	22.4	48.2	3.2	25.2	104	9.6
Fill	SB-19-02	2.5-4.5	1	L	--	--	--	--	--	--	--	--	--	--	--
	SB-19-03	5-7	4	N	--	--	--	--	--	--	--	--	--	--	--
	SB-19-04	7.5-9.5	46/39	L	--	--	--	--	--	--	--	--	--	--	--
	SB-19-05	10-12	299/230	H	130	32	24	14.5	25.9	25.6	18.1	0.06	35.5	86.2	0.32
Fine	SB-19-06	12.5-14.5	436	H	--	--	--	--	--	--	--	--	--	--	--
Alluvium	SB-19-07	15-17	1055	H	--	--	--	--	--	--	--	--	--	--	--
	SB-19-08	17.5-19.5	1127	H	1200	130	79	14.5	24.7	24.5	89.9	0.06	32.8	80.7	0.42
	SB-19-09	20-22	1027	H	--	--	--	--	--	--	--	--	--	--	--
	SB-19-10	22.5-24.5	108	N	3	0.2	0.23	12.4	37.1	28.5	14.2	0.07	41.4	105	<0.28
Fill	SB-20-01	0-2.5	3	L	--	--	--	--	--	--	--	--	--	--	--
	SB-20-02	2.5-4.5	53	L	--	--	--	--	--	--	--	--	--	--	--
	SB-20-03	5-7	34	L	--	--	--	--	--	--	--	--	--	--	--
	SB-20-04	7.5-9.5	262	L	--	--	--	--	--	--	--	--	--	--	--
	SB-20-05	10-12	312/327	L	--	--	--	--	--	--	--	--	--	--	--
Fine	SB-20-06	12.5-14.5	300	M	12	3	0.77	11.8	13.4	9.2	9	<0.03	23.4	40.7	<0.22
Alluvium	SB-20-07	15-17	337	M-H	--	--	--	--	--	--	--	--	--	--	--
	SB-20-08	17.5-19.5	339	H	--	--	--	--	--	--	--	--	--	--	--
	SB-20-09	20-22	354	H	--	--	--	--	--	--	--	--	--	--	--
	SB-20-10	22.5-24.5	233	N	--	--	--	--	--	--	--	--	--	--	--
Coarse	SB-20-11	25-27	267	M	1100	110	24	4.8	7.6	3	4.7	<0.03	10.2	19.2	<0.21
Alluvium	SB-20-12	27.5-29.5	--	--	--	--	--	--	--	--	--	--	--	--	--
	SB-20-13	30-32	235	H	410	36	0.17	4.4	6.3	1.8	5.5	<0.03	14.9	24.1	<0.21
Fill	SB-21-01	0-2.5	593	L	--	--	--	--	--	--	--	--	--	--	--
	SB-21-02	2.5-4.5	1025	H	16000	970	1300	--	--	--	--	--	--	--	--
	SB-22-01	0-2.5	0	N	96	47	0.0015	15.4	16.7	153	95.2	0.1	24.2	87.7	20.5
Fill	SB-22-02	2.5-4.5	8	N	--	--	--	--	--	--	--	--	--	--	--
	SB-22-03	5-7	4	L	--	--	--	--	--	--	--	--	--	--	--
	SB-22-04	7.5-9.5	104	L	--	--	--	--	--	--	--	--	--	--	--
	SB-22-05	10-12	71	L	10	3.2	0.0087	9.3	15.4	14.6	13	<0.03	22.3	49.8	0.59
Fine	SB-22-06	12.5-14.5	274	L	--	--	--	--	--	--	--	--	--	--	--
Alluvium	SB-22-07	15-17	382	M	--	--	--	--	--	--	--	--	--	--	--
	SB-22-08	17.5-19.5	362	M	--	--	--	--	--	--	--	--	--	--	--
	SB-22-09	20-22	429	H	--	--	--	--	--	--	--	--	--	--	--
	SB-22-10	22.5-24.5	145	H	70	2.4	0.023	11.6	14.1	12.2	8.3	<0.03	22.4	50.9	0.39

-- : Not Analyzed; ND - Not detected; Oil Sheen : N = None, L = Low, M = Moderate, H = Heavy; See Figure 3-3 for Boring Locations

TABLE 6-2 (cont.)

SUMMARY OF SOIL FIELD SCREENING AND LABORATORY ANALYTICAL RESULTS
CITIZENS GAS AND ELECTRIC COMPANY SITE

Hydro-Geologic Unit	Sample Number	Depth (Ft.)	Headspace Reading (ppm)	Oil Sheen	PAHs		BETX (mg/Kg)	Arsenic (mg/Kg)	Chromium (mg/Kg)	Copper (mg/Kg)	Lead (mg/Kg)	Mercury (mg/Kg)	Nickel (mg/Kg)	Zinc (mg/Kg)	Total Cyanide (mg/Kg)
					Total (mg/Kg)	Carcinogenic (mg/Kg)									
	SB-23-01	0-2.5	0	N	6.2	2.8	ND	10	19.2	18.1	69	0.09	27.5	193	<0.20
Fill	SB-23-02	2.5-4.5	--	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-03	5-7	--	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-04	7.5-9.5	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-05	10-12	2	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-06	12.5-14.5	--	N	--	--	--	--	--	--	--	--	--	--	--
Fine	SB-23-07	15-17	0	N	--	--	--	--	--	--	--	--	--	--	--
Alluvium	SB-23-08	17.5-19.5	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-09	20-22	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-10	22.5-24.5	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-11	25-27	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-12	27.5-29.5	0	N	ND	ND	ND	3.4	5.1	2.3	4.1	<0.03	9.7	17.1	<0.20
	SB-23-13	30-32	--	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-14	32.5-34.5	0	N	ND	ND	ND	2.7	5.6	2.3	4.3	<0.03	11.7	20.7	<0.21
	SB-23-23	35-37	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-16	37.5-39.5	--	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-17	40-42	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-18	42.5-44.5	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-19	45-47	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-20	47.5-49.5	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-21	50-52	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-22	52.5-54.5	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-23	55-57	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-24	57.5-59.5	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-25	60-62	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-26	62.5-64.5	9	N	--	--	--	--	--	--	--	--	--	--	--
Coarse	SB-23-27	65-67	0	N	--	--	--	--	--	--	--	--	--	--	--
Alluvium	SB-23-28	67.5-69.5	0	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-29	70-72	--	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-30	72.5-74.5	--	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-31	75-77	--	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-32	77.5-79.5	--	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-33	80-82	--	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-34	82.5-84.5	--	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-35	85-87	--	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-36	87.5-89.5	--	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-37	90-92	--	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-38	92.5-94.5	--	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-39	95-97	--	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-40	97.5-99.5	--	N	--	--	--	--	--	--	--	--	--	--	--
	SB-23-41	100-102	--	N	--	--	--	--	--	--	--	--	--	--	--

-- : Not Analyzed; ND - Not detected; Oil Sheen : N = None, L = Low, M = Moderate, H = Heavy; See Figure 3-3 for Boring Locations

TABLE 6-2 (cont.)

SUMMARY OF SOIL FIELD SCREENING AND LABORATORY ANALYTICAL RESULTS
CITIZENS GAS AND ELECTRIC COMPANY SITE

Hydro-Geologic Unit	Sample Number	Depth (Ft.)	Headspace Reading (ppm)	Oil Sheen	PAHs		BETX (mg/Kg)	Arsenic (mg/Kg)	Chromium (mg/Kg)	Copper (mg/Kg)	Lead (mg/Kg)	Mercury (mg/Kg)	Nickel (mg/Kg)	Zinc (mg/Kg)	Total Cyanide (mg/Kg)
					Total (mg/Kg)	Carcinogenic (mg/Kg)									
	SB-24-01	0-2.5	3	L	610	180	0.01	12.3	18.4	256	186	2.4	38.3	304	29.5
	SB-24-02	2.5-4.5	2	N	--	--	--	--	--	--	--	--	--	--	--
Fill	SB-24-03	5-7	301	H	3000	200	--	--	--	--	--	--	--	--	--
	SB-24-04	7.5-9.5	790	H	--	--	--	--	--	--	--	--	--	--	--
	SB-24-05	10-12	781	H	--	--	--	--	--	--	--	--	--	--	--
	SB-24-06	12.5-14.5	821	H	19000	1000	3200	24	17.7	126	315	0.64	33.1	418	41.1
	SB-24-07	15-16.5	--	H	24000	1300	2800	25.7	19.4	160	399	0.47	27.6	751	20.1
Fill	SB-25-01	0-2.5	1131	L	--	--	--	--	--	--	--	--	--	--	--
	SB-25-02	2.5-4.5	--	H	--	--	--	--	--	--	--	--	--	--	--
Fill	SB-26-01	0-2.5	20	N	--	--	--	--	--	--	--	--	--	--	--
	SB-26-02	2.5-4.5	290	H	--	--	--	--	--	--	--	--	--	--	--
Fill	SB-27-01	0-2.5	4	N	--	--	--	--	--	--	--	--	--	--	--
	SB-27-02	2.5-4.5	--	N	--	--	--	--	--	--	--	--	--	--	--
	SB-27-03	5-7	10	N	--	--	--	--	--	--	--	--	--	--	--
	SB-27-04	7.5-9.5	260	M	44	5.1	0.032	5.5	18.2	18.4	12.5	0.04	25.8	79.1	0.42
	SB-27-05	10-12	561	M	--	--	--	--	--	--	--	--	--	--	--
Fine	SB-27-06	12.5-14.5	340	M	--	--	--	--	--	--	--	--	--	--	--
Alluvium	SB-27-07	15-17	295	H	2100	130	120	8.56	10.6	8.5	6.7	<0.03	18.9	39.8	<0.43
	SB-27-08	17.5-19.5	420	M-H	--	--	--	--	--	--	--	--	--	--	--
	SB-27-09	20-22	500	M-H	--	--	--	--	--	--	--	--	--	--	--
	SB-27-10	22.5-24.5	420	M-H	470	28	21	13.1	13.6	13	8.9	<0.03	19.8	50.4	<0.21
	SB-28-12	27.5-29.5	--	--	--	--	--	--	--	--	--	--	--	--	--
	SB-28-13	30-32	167	N	--	--	--	--	--	--	--	--	--	--	--
Coarse	SB-28-14	32.5-34.5	27	N	--	--	--	--	--	--	--	--	--	--	--
Alluvium	SB-28-15	35-37	95	N	--	--	--	--	--	--	--	--	--	--	--
	SB-28-16	37.5-39.5	33	N	--	--	--	--	--	--	--	--	--	--	--
	SB-28-17	40-42	36	N	ND	ND	6	4.3	6.4	1.6	4.4	<0.03	10.8	40.6	<0.21

-- : Not Analyzed; ND - Not detected; Oil Sheen : N = None, L = Low, M = Moderate, H = Heavy; See Figure 3-3 for Boring Locations

TABLE 6-3

SURFACE SOIL DATA
COMPARISION OF INORGANIC CONCENTRATIONS
CITIZENS GAS AND ELECTRIC COMPANY SITE

Sample Number	Depth (Ft.)	Arsenic (mg/Kg)	Chromium (mg/Kg)	Copper (mg/Kg)	Lead (mg/Kg)	Mercury (mg/Kg)	Nickel (mg/Kg)	Zinc (mg/Kg)
SB-15-01	0-2.5	27.2	--	20.9	--	0.17	--	--
SB-16-01	0-2.5	10.8	19.4	--	--	--	--	--
SB-18-01	0-2.5	12.9	--	--	--	--	--	--
SB-19-01	0-2.5	--	--	22.4	--	3.2	--	--
SB-22-01	0-2.5	15.4	--	153	95.2	0.1	--	--
SB-24-01	0-2.5	12.3	--	256	186	2.4	38.3	304
Criteria								
SB-23-01	0-2.5	10	19.2	18.1	69	0.09	27.5	193

See Figure 3-3 for Boring Locations

--: Less than reported concentration at SB-23-01.

TABLE 6-4

SUBSURFACE SOIL DATA
COMPARISON OF INORGANIC CONCENTRATIONS
CITIZENS GAS AND ELECTRIC COMPANY SITE

Sample Number	Depth (Ft.)	Arsenic (mg/Kg)	Chromium (mg/Kg)	Copper (mg/Kg)	Lead (mg/Kg)	Mercury (mg/Kg)	Nickel (mg/Kg)	Zinc (mg/Kg)
ST-1	25	--	--	--	--	--	--	--
ST-2	15	--	--	21.2	--	--	--	--
ST-2	35	--	--	--	--	--	--	--
ST-3	20	--	--	--	--	--	--	--
ST-4	20	--	--	20.1	--	--	--	--
ST-5	12.5	--	--	72.1	464	--	--	456
ST-6	125	--	--	21.1	--	--	--	--
ST-8	20	--	--	31.7	--	--	--	--
ST-9	15	--	--	22.3	--	--	29.7	--
ST-13	10	--	--	20.8	--	--	--	--
ST-14	15	--	--	--	--	--	--	--
SB-15-11	25-27	--	--	--	--	--	--	--
SB-15-12	27.5-29.5	--	--	--	--	--	--	--
SB-15-29	70-72	145	--	22.9	--	0.12	165	--
SB-15-37	90-92	--	--	--	--	--	--	--
SB-15-41	100-102	--	--	--	--	--	--	--
SB-16-02	2.5-4.5	14.9	--	--	79	--	--	--
SB-16-05	10-12	11.1	--	--	--	--	234	--
SB-16-07	15-17	14.4	--	48.9	1190	0.68	--	240
SB-17-03	5-7	140.4	24.3	26.6	--	--	35.9	--
SB-17-08	17.5-19.5	--	--	--	--	--	31.6	--
SB-17-10	22.5-24.5	--	28	27.4	--	--	33.4	--
SB-18-11	25-27	--	--	--	--	--	--	--
SB-19-05	10-12	14.5	25.9	25.6	--	--	35.5	--
SB-19-08	17.5-19.5	14.5	24.7	24.5	89.9	--	32.8	--
SB-19-10	22.5-24.5	12.4	37.1	28.5	--	--	41.4	--
SB-20-06	12.5-14.5	11.8	--	--	--	--	--	--
SB-20-11	25-27	--	--	--	--	--	--	--
SB-20-13	30-32	--	--	--	--	--	--	--
SB-22-05	10-12	--	--	--	--	--	--	--
SB-22-10	22.5-24.5	11.6	--	--	--	--	--	--
SB-23-12	27.5-29.5	--	--	--	--	--	--	--
SB-23-14	32.5-34.5	--	--	--	--	--	--	--
SB-24-06	12.5-14.5	24	--	126	315	0.64	33.1	418
SB-24-07	15-16.5	25.7	19.4	160	399	0.47	27.6	751
SB-27-04	7.5-9.5	--	--	18.4	--	--	--	--
SB-27-07	15-17	--	--	--	--	--	--	--
SB-27-10	22.5-24.5	13.1	--	--	--	--	--	--
SB-28-17	40-42	--	--	--	--	--	--	--
Criteria								
SB-23-01	0-2.5	10	19.2	18.1	69	0.09	27.5	193

See Figure 3-3 for Boring Locations

--: Less than reported concentration at SB-23-01

TABLE 6-5

GROUNDWATER QUALITY DATA
CITIZENS GAS AND ELECTRIC COMPANY SITE
(concentrations in ug/L, unless noted otherwise)

	MW1		MW2		
	12/02/89	04/25/94	12/02/89	07/28/92	04/25/94
Volatile Organic Compounds					
Benzene	<1.0	<1.0	<1.0	<0.5	<1.0
Ethyl Benzene	<1.0	<1.0	<1.0	<0.5	<1.0
Toluene	<1.0	<1.0	<1.0	<0.5	<1.0
m & p Xylene	--	<2.0	--	--	<2.0
o-Xylene	--	<1.0	--	--	<1.0
Xylenes, total	<1.0	--	<1.0	<0.5	--
Sum of BETX	ND	ND	ND	ND	ND
Base/Neutral Compounds					
Suspected Carcinogenic PAHs					
Benzo(a)anthracene	<10	<10	<10	<10	<10
Benzo(a)pyrene	<10	<10	<10	<10	<10
Benzo(b)fluoranthene	<10	<10	<10	<10	<10
Benzo(k)fluoranthene	<10	<10	<10	<10	<10
Chrysene	<10	<10	<10	<10	<10
Dibenzo(ah)anthracene	<10	<10	<10	<10	<10
Indeno(1,2,3,cd)pyrene	<10	<10	<10	<10	<10
Sum of Carcinogens	ND	ND	ND	ND	ND
Non-Carcinogenic PAHs					
Acenaphthene	<10	<10	<10	<10	<10
Acenaphthylene	<10	<10	<10	<10	<10
Anthracene	<10	<10	<10	<10	<10
Benzo(ghi)perylene	<10	<10	<10	<10	<10
Fluoranthene	<10	<10	<10	<10	<10
Fluorene	<10	<10	<10	<10	<10
Napthalene	<10	<10	<10	<10	<10
Phenanthrene	<10	<10	<10	<10	<10
Pyrene	<10	<10	<10	<10	<10
Sum of Total PAH Compounds	ND	ND	ND	ND	ND
Phenolics	<2.0	14	<2.0	--	<5.0
Metals					
Arsenic, mg/L	0.001	0.0152 *	0.003	--	0.0052 *
Arsenic, filtered, mg/L	--	0.0195	--	--	0.0192
Chromium, total, mg/L	<0.005	--	0.022	--	--
Copper, mg/L	<0.01	--	0.06	--	--
Lead, mg/L	<0.04	0.0126 *	0.06	--	<0.0088 **
Lead, filtered, mg/L	--	<0.0088	--	--	<0.0088
Mercury, mg/L	--	<0.00013	--	--	<0.00013
Mercury, filtered, mg/L	--	<0.00013	--	--	<0.00013
Nickel, mg/L	0.05	--	0.05	--	--
Zinc, mg/L	0.016	--	0.275	--	--
Cyanide, mg/L	0.002	<0.0017	<0.001	<0.0022	<0.0017
General Parameters					
TPH as Gasoline	--	200	--	--	<50
TPH as Diesel	--	<150	--	--	<150

-- Not analyzed.
ND Not detected.
* Estimated value, QA/QC criteria not met.
** Unusable value, QA/QC criteria not met.
See Figure 3-3 for monitoring well locations.

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TABLE 6-5 (cont.)

GROUNDWATER QUALITY DATA
CITIZENS GAS AND ELECTRIC COMPANY SITE
(concentrations in ug/L, unless noted otherwise)

	MW3				MW4	
	12/02/89	07/28/92 Sample	07/28/92 Duplicate	04/04/94	12/02/89	07/28/92
Volatile Organic Compounds						
Benzene	6310	2300	5500	4300	<1.0	<0.5
Ethyl Benzene	2410	830	1300	<50	<1.0	<0.5
Toluene	234	160	190	550	<1.0	<0.5
m & p Xylene	--	--	--	310	--	--
o-Xylene	--	--	--	310	--	--
Xylenes, total	1840	740	1100	--	<1.0	<0.5
Sum of BETX	10800	4000	8100	5500	ND	ND
Base/Neutral Compounds						
Suspected Carcinogenic PAHs						
Benzo(a)anthracene	<10	<250	<250	5 j	<10	<10
Benzo(a)pyrene	<10	<250	<250	<10	<10	<10
Benzo(b)fluoranthene	<10	<250	<250	<10	<10	<10
Benzo(k)fluoranthene	<10	<250	<250	<10	<10	<10
Chrysene	<10	<250	<250	5 j	<10	<10
Dibenzo(ah)anthracene	<10	<250	<250	<10	<10	<10
Indeno(1,2,3,cd)pyrene	<10	<250	<250	<10	<10	<10
Sum of Carcinogens	ND	ND	ND	10 a	ND	ND
Non-Carcinogenic PAHs						
Acenaphthene	83	180 j	200 j	72	<10	<10
Acenaphthylene	52	110 j	100 j	45	<10	<10
Anthracene	97	<250	<250	11	<10	<10
Benzo(ghi)perylene	<10	<250	<250	<10	<10	<10
Fluoranthene	<10	<250	<250	10	<10	<10
Fluorene	37	60 j	<250	33	<10	<10
Napthalene	5200	5600	5800	1500	22.1	<10
Phenanthrene	45	72 j	64 j	55	<10	<10
Pyrene	<10	<250	<250	16	<10	<10
Sum of Total PAH Compounds	5500	6000 a	6200 a	1800	22.1	ND
Phenolics	109	--	--	--	<2.0	--
Metals						
Arsenic, mg/L	0.002	--	--	0.0042 b	<0.001	--
Arsenic, filtered, mg/L	--	--	--	0.0066 b	--	--
Chromium, total, mg/L	0.033	--	--	--	<0.005	--
Copper, mg/L	0.05	--	--	--	<0.01	--
Lead, mg/L	0.10	--	--	0.0166 *	<0.04	--
Lead, filtered, mg/L	--	--	--	<0.0088	--	--
Mercury, mg/L	--	--	--	<0.00013	--	--
Mercury, filtered, mg/L	--	--	--	<0.00013	--	--
Nickel, mg/L	0.11	--	--	--	<0.01	--
Zinc, mg/L	0.711	--	--	--	<0.005	--
Cyanide, mg/L	0.493	0.33	0.31	0.264	0.005	0.011
General Parameters						
TPH as Gasoline	--	28000	38000	--	--	--
TPH as Diesel	--	<25000	<25000	--	--	--

-- Not analyzed.
ND Not detected.
a Estimated value, calculated using some or all values that are estimates.
b Potential false positive value based on blank data validation procedure.
j Reported value is less than the stated laboratory quantitation limit and is considered an estimated value.
* Estimated value, QA/QC criteria not met.
See Figure 3-3 for monitoring well locations.

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TABLE 6-5 (cont.)
GROUNDWATER QUALITY DATA
CITIZENS GAS AND ELECTRIC COMPANY SITE
(concentrations in ug/L, unless noted otherwise)

	MW4	MW5		MW6		MW8
	04/25/94	04/26/94 Sample	04/26/94 Duplicate	04/26/94	06/02/94	04/26/94
Volatile Organic Compounds						
Benzene	<1.0	<20	<20	2600	--	<1.0
Ethyl Benzene	<1.0	760	830	370	--	<1.0
Toluene	<1.0	39	41	<100	--	<1.0
m & p Xylene	<2.0	290	320	280	--	<2.0
o-Xylene	<1.0	320	360	<100	--	<1.0
Xylenes, total	--	--	--	--	--	--
Sum of BETX	ND	1400	1600	3200	--	ND
Base/Neutral Compounds						
Suspected Carcinogenic PAHs						
Benzo(a)anthracene	<10	100 j	<500	--	<10	<10
Benzo(a)pyrene	<10	<500	<500	--	<10	<10
Benzo(b)fluoranthene	<10	<500	<500	--	<10	<10
Benzo(k)fluoranthene	<10	<500	<500	--	<10	<10
Chrysene	<10	100 j	<500	--	<10	<10
Dibenzo(ah)anthracene	<10	<500	<500	--	<10	<10
Indeno(1,2,3,cd)pyrene	<10	<500	<500	--	<10	<10
Sum of Carcinogens	ND	200 a	ND	--	ND	ND
Non-Carcinogenic PAHs						
Acenaphthene	<10	880	600	--	<10	<10
Acenaphthylene	<10	120 j	<500	--	<10	<10
Anthracene	<10	170 j	<500	--	<10	<10
Benzo(ghi)perylene	<10	<500	<500	--	<10	<10
Fluoranthene	<10	230 j	<500	--	<10	<10
Fluorene	<10	300 j	190 j	--	<10	<10
Napthalene	<10	9600	6500	--	64	<10
Phenanthrene	<10	870	270 j	--	<10	<10
Pyrene	<10	320 j	<500	--	<10	<10
Sum of Total PAH Compounds	ND	13000 a	7600 a	--	64	ND
Phenolics	<5.0	9.0	6.0	<5.0	--	<5.0
Metals						
Arsenic, mg/L	0.0334 *	0.0060 *	0.0108 *	0.0113 *	--	0.0218 *
Arsenic, filtered, mg/L	0.0404	0.0060 B	0.0065 B	0.0176	--	0.0163
Chromium, total, mg/L	--	--	--	--	--	--
Copper, mg/L	--	--	--	--	--	--
Lead, mg/L	<0.0088 **	0.0339 *	0.0363 *	<0.0088 **	--	<0.0088 **
Lead, filtered, mg/L	<0.0088	<0.0088	<0.0088	<0.0088	--	<0.0088
Mercury, mg/L	<0.00013	<0.00013	0.00016	<0.00013	--	<0.00013
Mercury, filtered, mg/L	<0.00013	<0.00013	<0.00013	<0.00013	--	<0.00013
Nickel, mg/L	--	--	--	--	--	--
Zinc, mg/L	--	--	--	--	--	--
Cyanide, mg/L	0.0065 B	0.0209	0.0210	0.167	--	0.0058 B
General Parameters						
TPH as Gasoline	<50	6400	7400	2300	--	630
TPH as Diesel	<150	12000 (1)	20000 (1)	980 (2)	--	<150

-- Not analyzed.
ND Not detected.
a Estimated value, calculated using some or all values that are estimates.
B The reported value is less than the Contract Required Detection Limit (CRDL) but greater than or equal to the Instrument Detection Limit (IDL).
j Reported value is less than the stated laboratory quantitation limit and is considered an estimated value.
* Estimated value, QA/QC criteria not met.
** Unusable value, QA/QC criteria not met.
(1) The material present does not have a typical diesel pattern. It may be a different petroleum product or a mixture of petroleum products.
(2) The material present does not have a typical diesel pattern. It may be a different petroleum product, a weathered petroleum product, and/or biological in origin.

See Figure 3-3 for monitoring well locations.

TABLE 6-6

GROUNDWATER QUALITY DATA
GENERAL CHEMISTRY
CITIZENS GAS AND ELECTRIC COMPANY SITE

(concentrations in mg/L)

	MW1	MW2	MW4	MW5		MW6	MW8
	04/25/94	04/25/94	04/25/94	04/26/94 Sample	04/26/94 Duplicate	04/26/94	04/26/94
Calcium	212	153	169	198	205	126	141
Magnesium	76.1	64.4	71.0	59.4	61.4	45.8	50.3
Potassium	7.9	5.85	8.08	12.20	12.50	9.55	7.89
Sodium	44.6	35.6	33.4	34.9	36.0	68.4	57.1
Sulfate	139	94	61	179	176	7.9	67
Chloride	78	134	120	73	74	54	32
Carbonate Alkalinity	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Bicarbonate Alkalinity	530	410	620	570	560	600	620
Total Alkalinity	530	410	620	570	560	600	620

See Figure 3-3 for monitoring well locations.

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TABLE 6-7

NAPL ANALYTICAL RESULTS
ESTIMATED CONCENTRATIONS
CITIZENS GAS AND ELECTRIC COMPANY SITE

(concentrations in ug/kg, unless otherwise noted)

	MW3P
	04/18/94
Benzene	850000
Ethyl Benzene	4100000
Toluene	1200000
Xylenes	4200000
Sum of BETX	10000000
Napthalene	77000000
Acenaphthylene	17000000
Acenaphthene	<9900000
Fluorene	15000000
Phenanthrene	39000000
Anthracene	9900000
Fluoranthene	12000000
Pyrene	15000000
Benzo(a)anthracene	<9900000
Chrysene	<9900000
Benzo(b)fluoranthene	<9900000
Benzo(k)fluoranthene	<9900000
Indeno(1,2,3,cd)pyrene	<9900000
Dibenzo(ah)anthracene	<9900000
Benzo(ghi)perylene	<9900000
Sum of Total PAH Compounds	180000000
Arsenic, mg/kg	6.4
Lead, mg/kg	1.4
Mercury, mg/kg	<0.10
Cyanide, mg/kg	<0.50
Phenol, 4AAP, mg/kg	1.1
Percent Sulfur	0.56
Percent Ash	5.01
BTU per pound	14433
Flash Point, oC	>110 (1)
Specific Gravity	1.0966
Viscosity @50oC	22

---

(1) Vapor ignites at >72oC.

See Figure 3-3 for location of monitoring well MW3.

.003

06/26/95

Table 7-1

Calculated Retardation Factors
Citizens Gas and Electric Company Site

Parameter	Koc	Kd	Rd
Benzene[1]	49	0.20	2.0
Ethyl Benzene	96	0.38	3.0
Toluene	110	0.46	3.5
Xylene	980	3.9	22
Naphthalene	550	2	13
Acenaphthylene	4,800	19	100
Acenaphthene	4,600	18	99
Fluorene	5,000	20	110
Phenanthrene	5,200	21	110
Anthracene	19,000	76	410
Fluroanthene	42,000	168	900
Pyrene	46,000	184	980
Benzo(a)anthracene[1]	1,400,000	5,600	30,000
Chrysene[1]	250,000	1,000	5,300
Benzo(b)fluoranthene[1]	550,000	2,200	12,000
Benzo(k)fluoranthene[1]	4,400,000	17,600	94,000
Benzo(a)pyrene[1]	1,000,000	4,000	21,000
Indeno(1,2,3-cd)pyrene[1]	19,000,000	76,000	410,000
Dibenzo(ah)anthracene[1]	1,700,000	6,800	36,000
Benzo(ghi)perylene	7,800,000	31,200	170,000

[1] Suspected Carcinogenic (U.S. EPA designation A, B1 or B2)

Figures

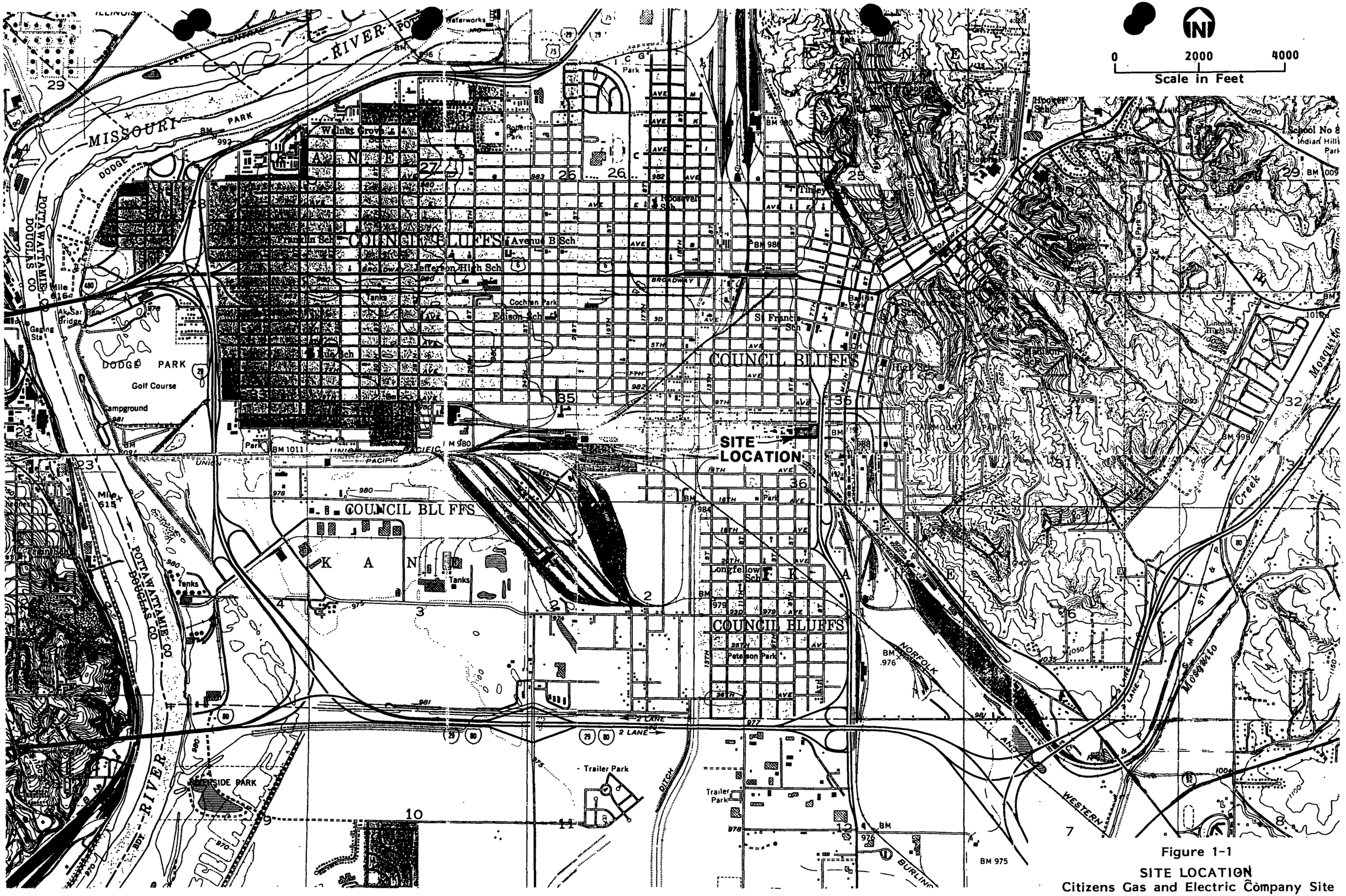


Figure 1-1

SITE LOCATION
Citizens Gas and Electric Company Site

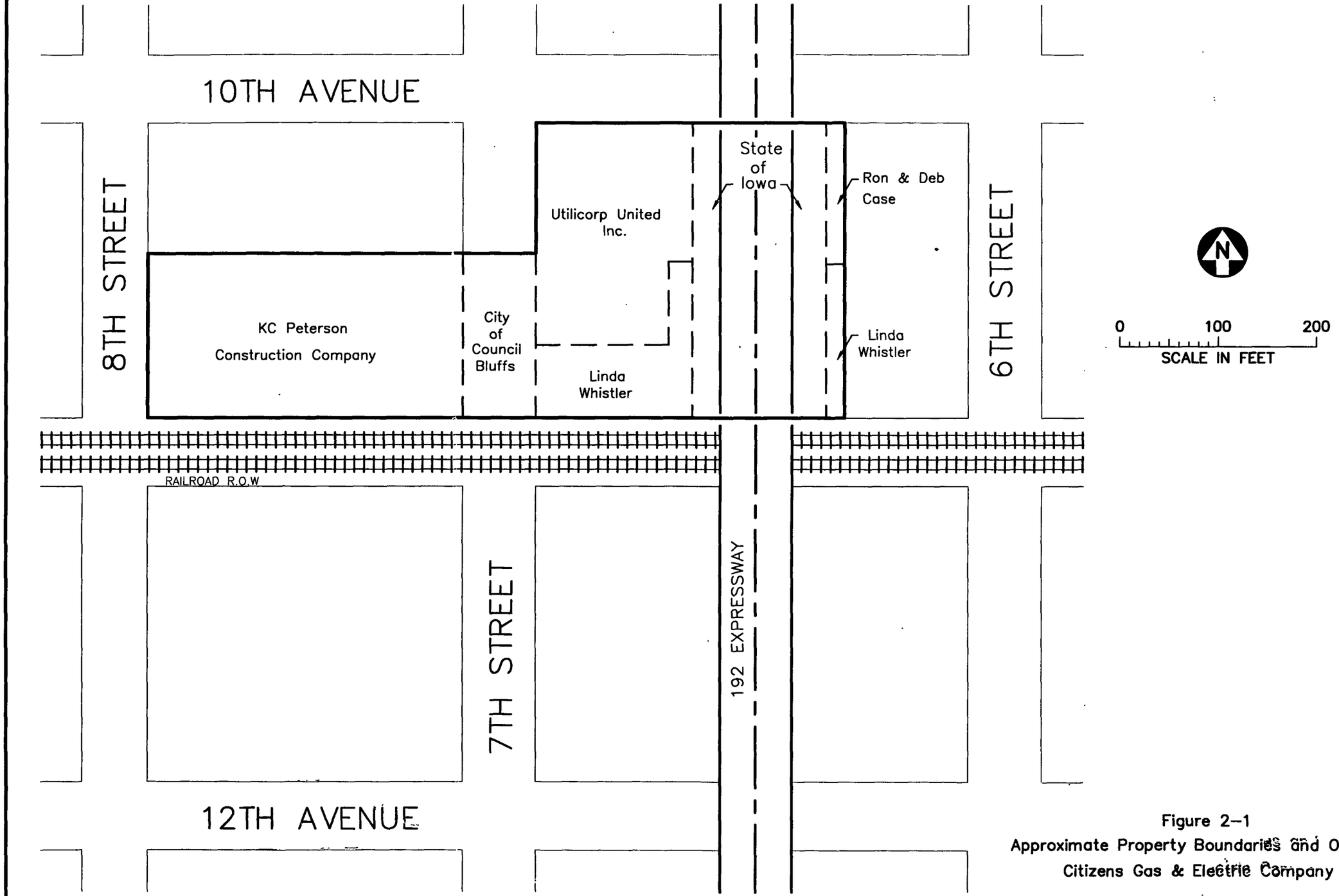


Figure 2–1
Approximate Property Boundaries and Ownership
Citizens Gas & Electric Company Site

SCM C:\SCM\157B001\OWNER-4 100.00 02/03/1995 12:29:35

UNION PACIFIC
LOCAL FREIGHT DEPOT.

PLATFORM 4" HIGH.

(OPENED.)

ALLEY

12

GASOMETER.

COUNCIL BLUFFS GAS & ELECTRIC LIGHT CO.

GAS WORKS.

METER HO.

Coal Rm.

RETORTS

ENG. RM.

PURIFYING

11

GASOMETER.

EXHAUSTER HO.

LIME

HAWKEYE ROLLER MILLS. Closed.

Dw'g

11TH C. B. & Q. R. R. MAIN TRACK. AV.

0 50 100
Scale in Feet

PLATFORM

W. A. MAURER Grn. W. Ho.

13

14

S. 7TH ST.

S. 6TH ST.

Agricult'l Implts Storage

Figure 2-2

SITE AND VICINITY, 1891
Source: 1891 Sanborn Map
Citizens Gas and Electric Company Site

LOCAL FREIGHT DEPOT.

PLATFORM 4" HIGH

(NOT OPENED)

ALLEY

12

11

20'

Gasometer

COUNCIL BLUFFS GAS & ELECTRIC LIGHT CO.

Gasometer

Meter H.

A1

Blk. Rm.

Eng. Rm.

Purifying Hs.

Coal R'm.

Vac.

Lime

Governor & Mr.

MONARCH AXLE GREASE FAC.

1B W. Ho. R. CL.

2B

C

Storage

GAS WORKS.

WATER GAS.

11TH AV.

C. B. & Q. R. R. MAIN TRACK.

C. & N. W. R.

0 50 100

Scale in Feet

619

13

14

15

S. 7TH ST.

ST.

Pump W. Ho.

Wind Mill & Pipt

Storage

PLATFORM.

Figure 2-3

SITE AND VICINITY, 1896
Source: 1896 Sanborn Map
Citizens Gas and Electric Company Site

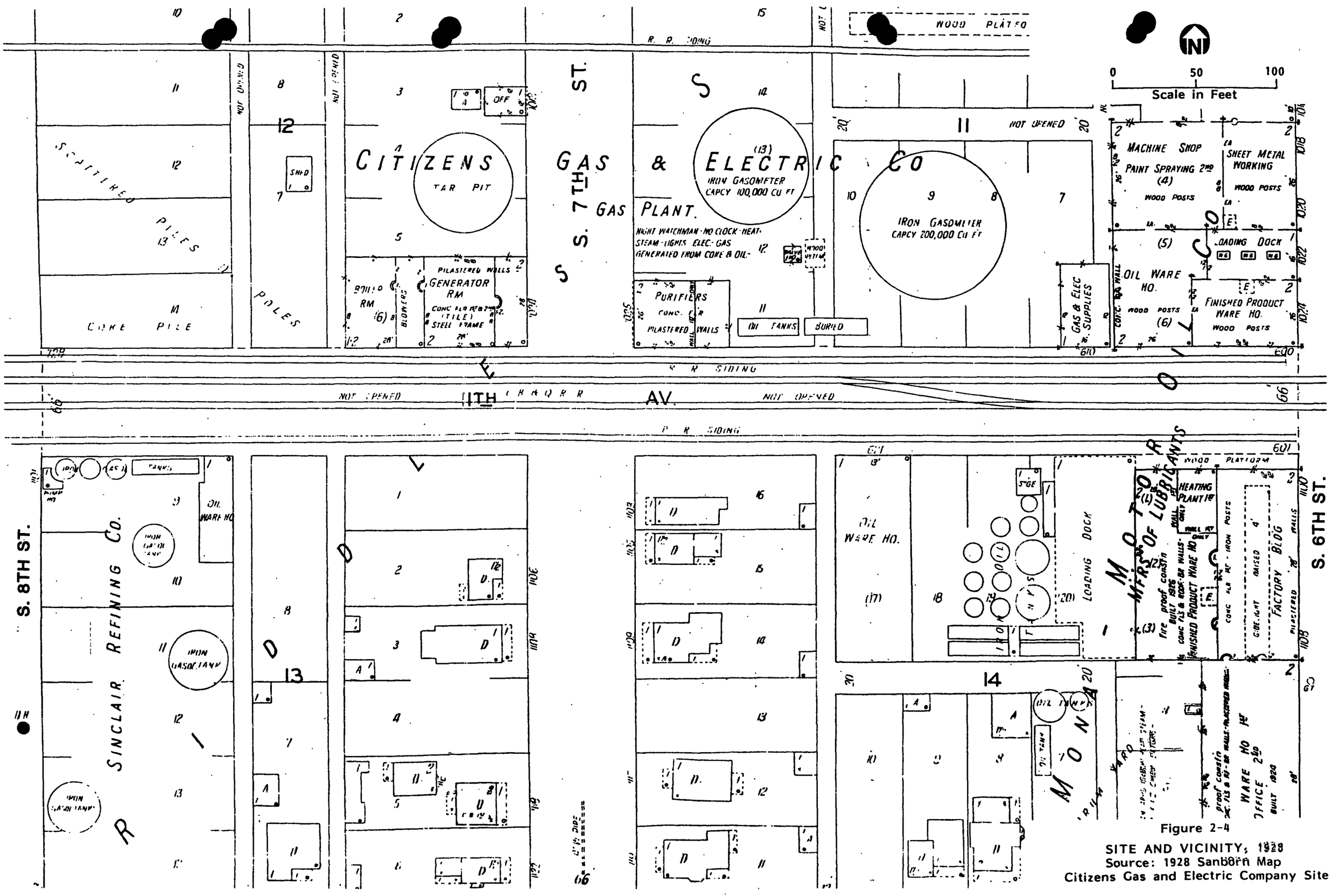


Figure 2-4

SITE AND VICINITY, 1928
Source: 1928 Sanborn Map
Citizens Gas and Electric Company Site

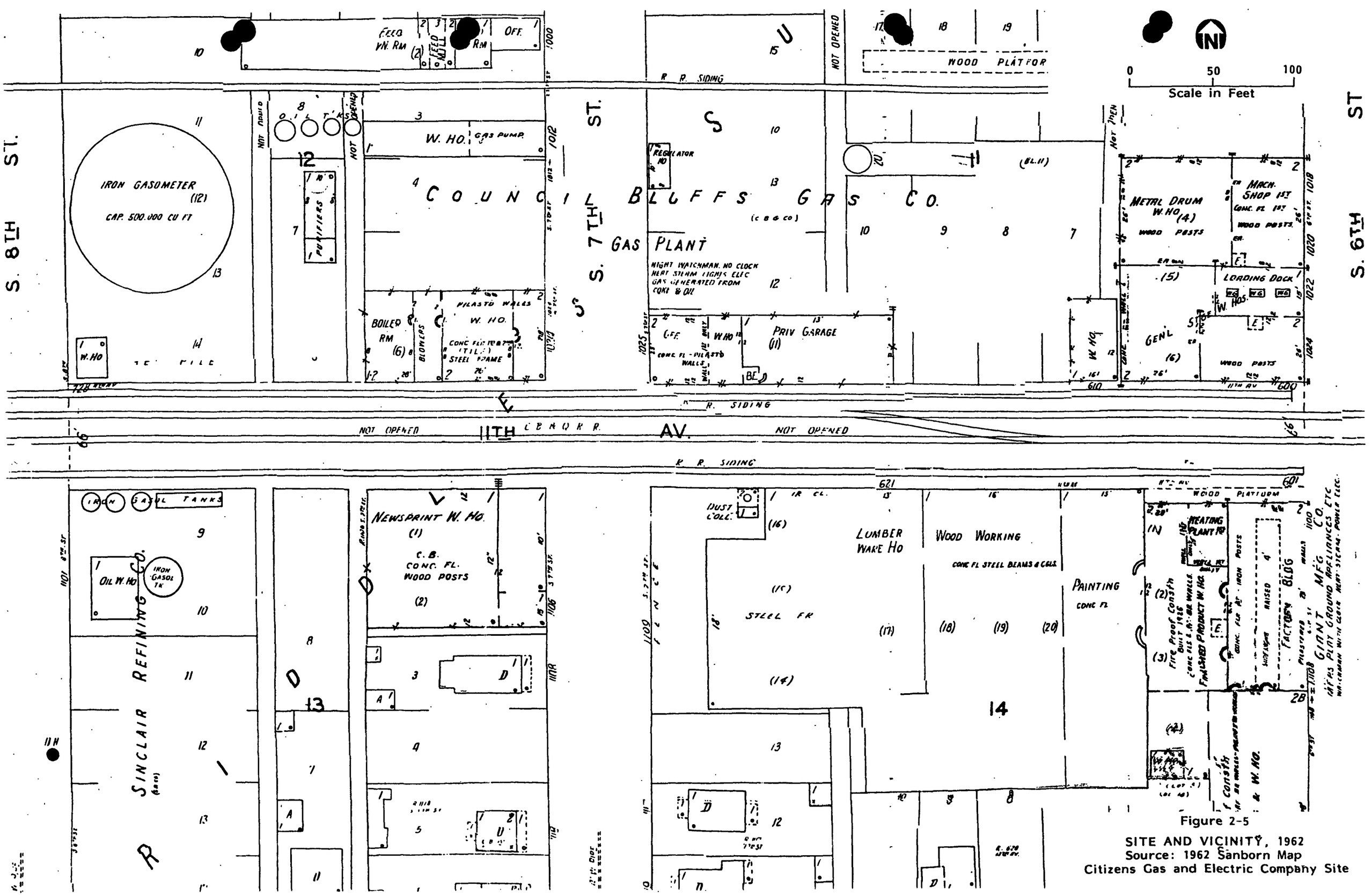


Figure 2-5

SITE AND VICINITY, 1962
Source: 1962 Sanborn Map
Citizens Gas and Electric Company Site

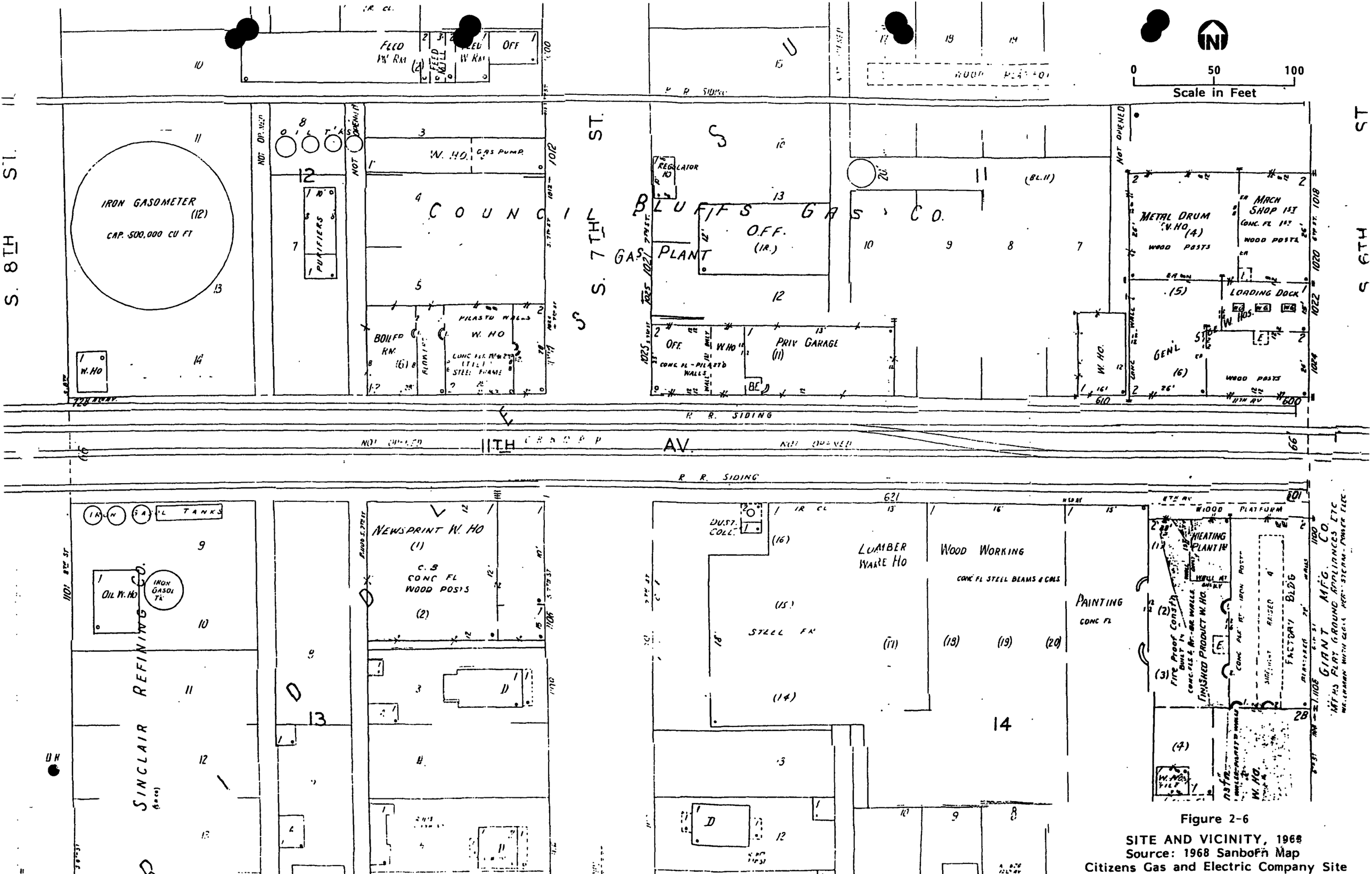


Figure 2-6

SITE AND VICINITY, 1968
Source: 1968 Sanborn Map
Citizens Gas and Electric Company Site

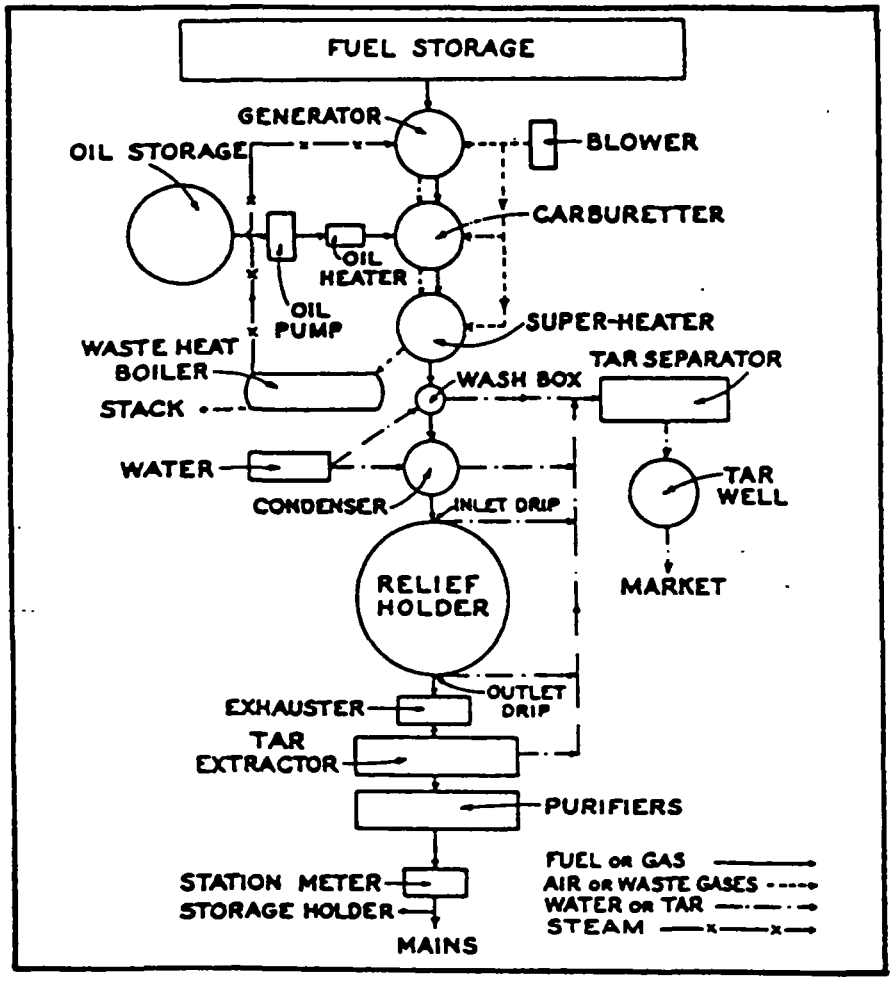


Figure 2-7

FLOW CHART FOR TYPICAL CARBURETED WATER-GAS PLANT
Citizens Gas and Electric Company Site

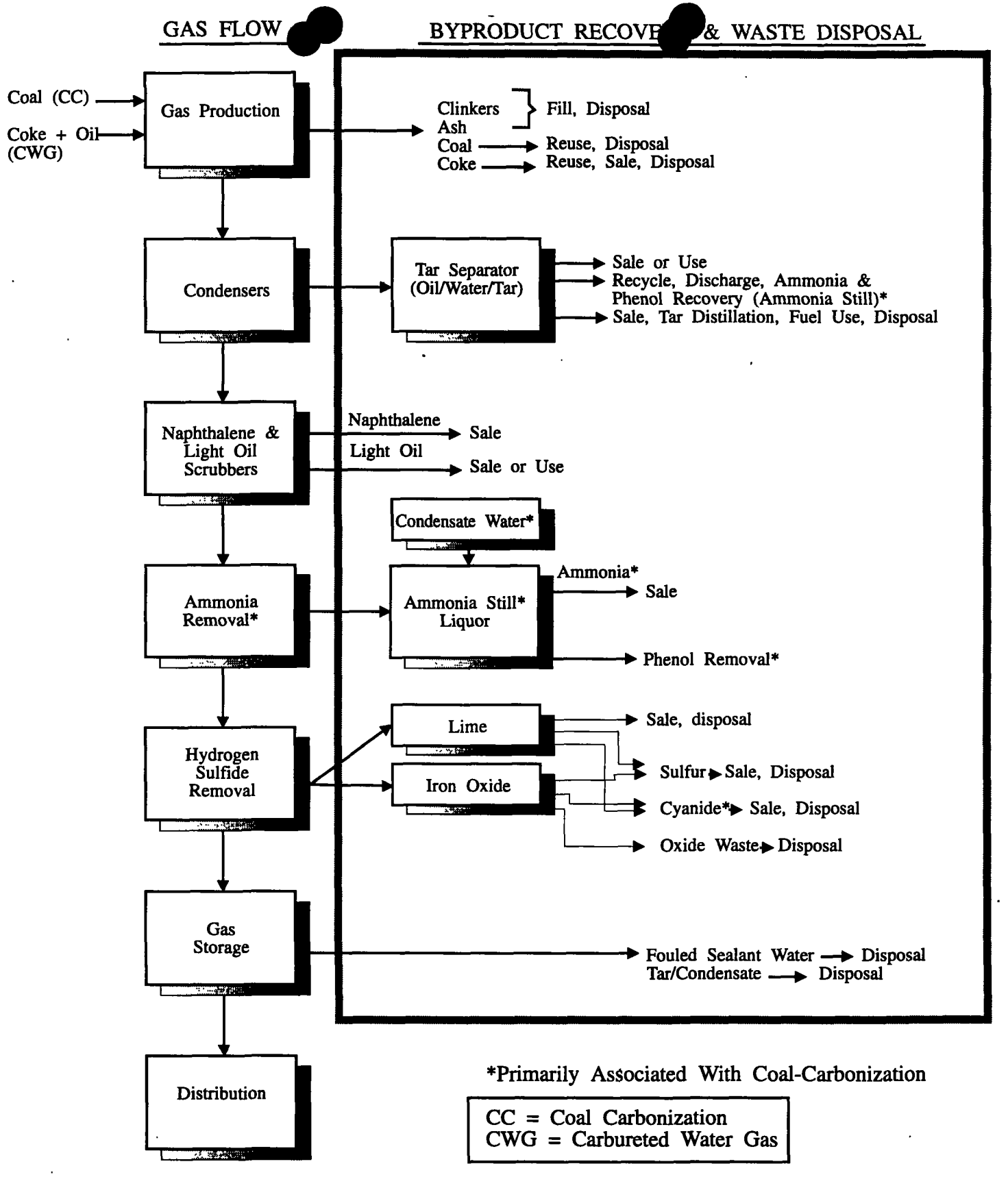


Figure 2-8

MANUFACTURED GAS PROCESS, BYPRODUCT RECOVERY AND WASTE DISPOSAL

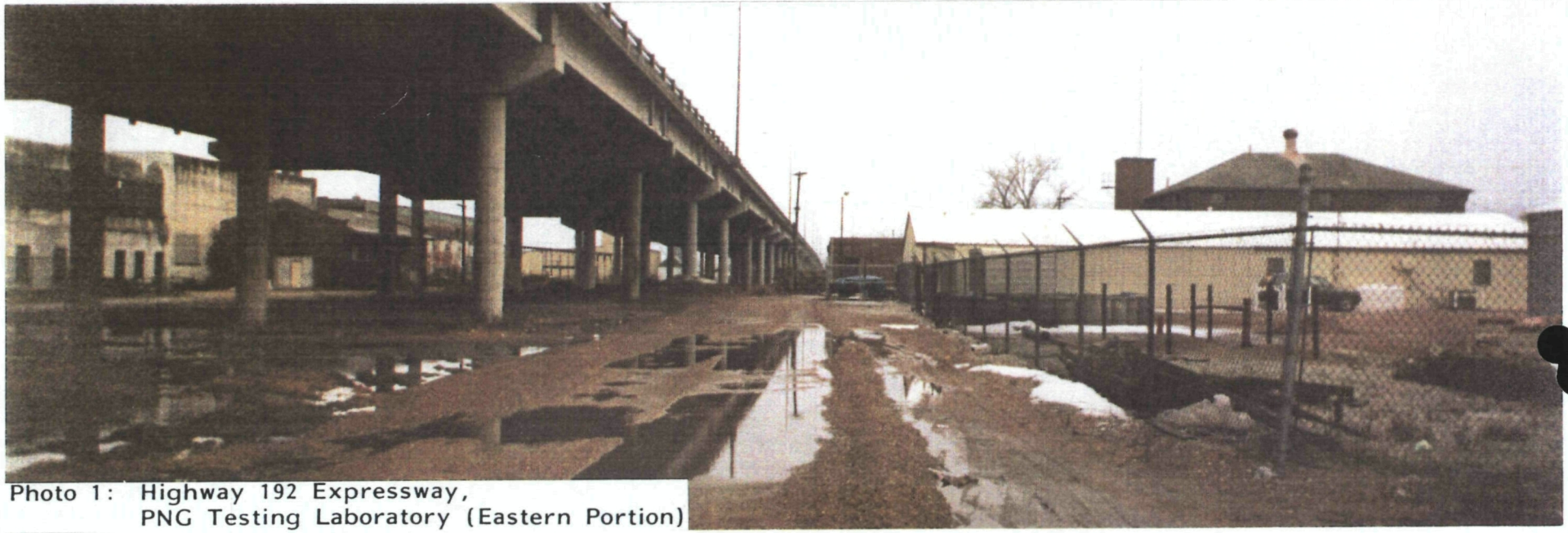


Photo 1: Highway 192 Expressway,
PNG Testing Laboratory (Eastern Portion)

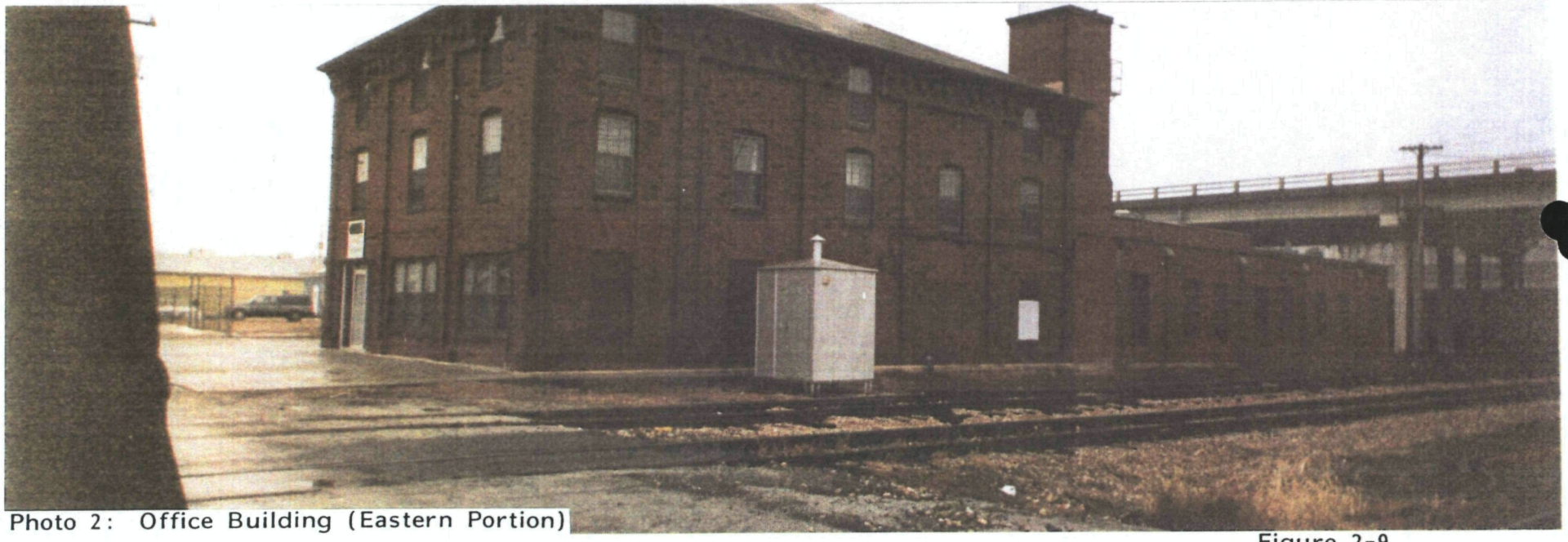


Photo 2: Office Building (Eastern Portion)

Figure 2-9

SITE FEATURES
Citizens Gas and Electric Company Site

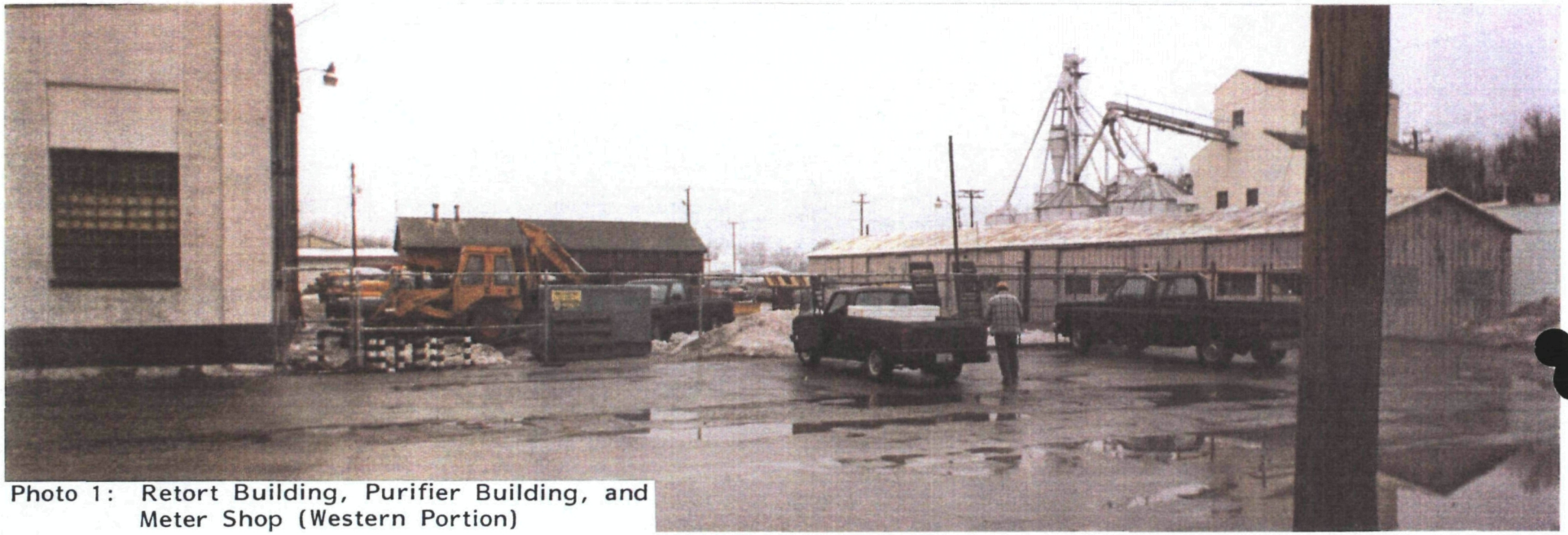


Photo 1: Retort Building, Purifier Building, and Meter Shop (Western Portion)

Photo 2: Meter Shop and Purifier Building (Western Portion)

Figure 2-9 (cont.)

SITE FEATURES
Citizens Gas and Electric Company Site

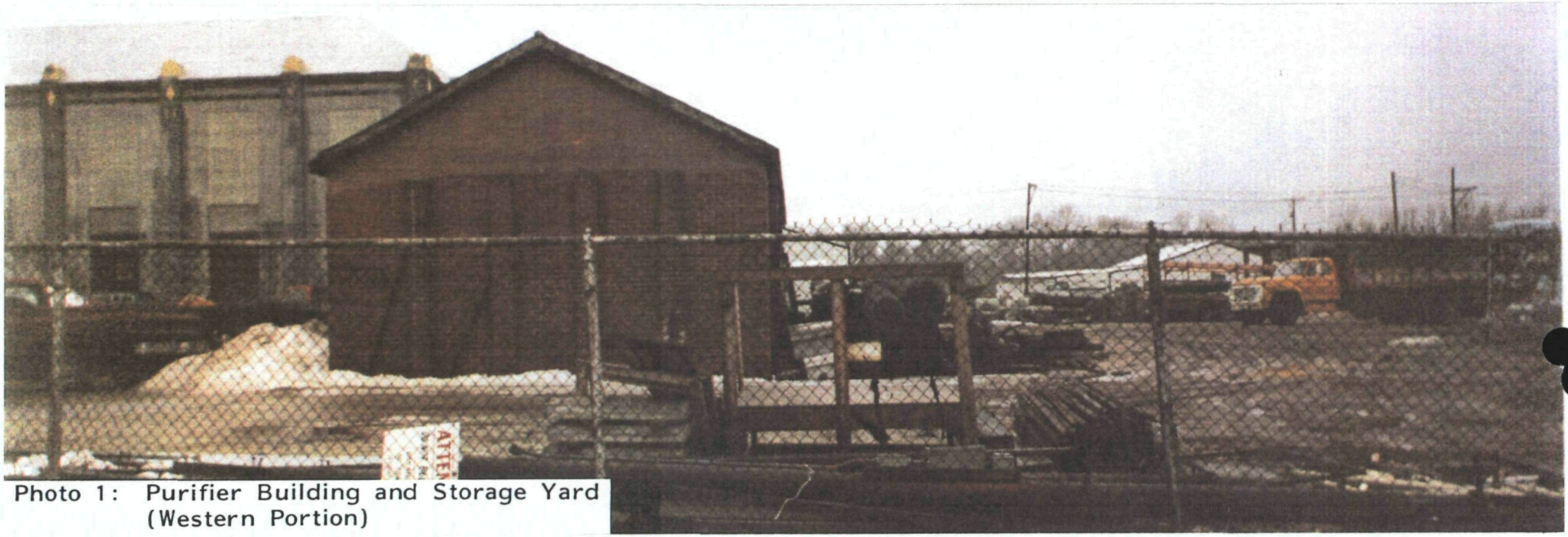


Photo 1: Purifier Building and Storage Yard (Western Portion)

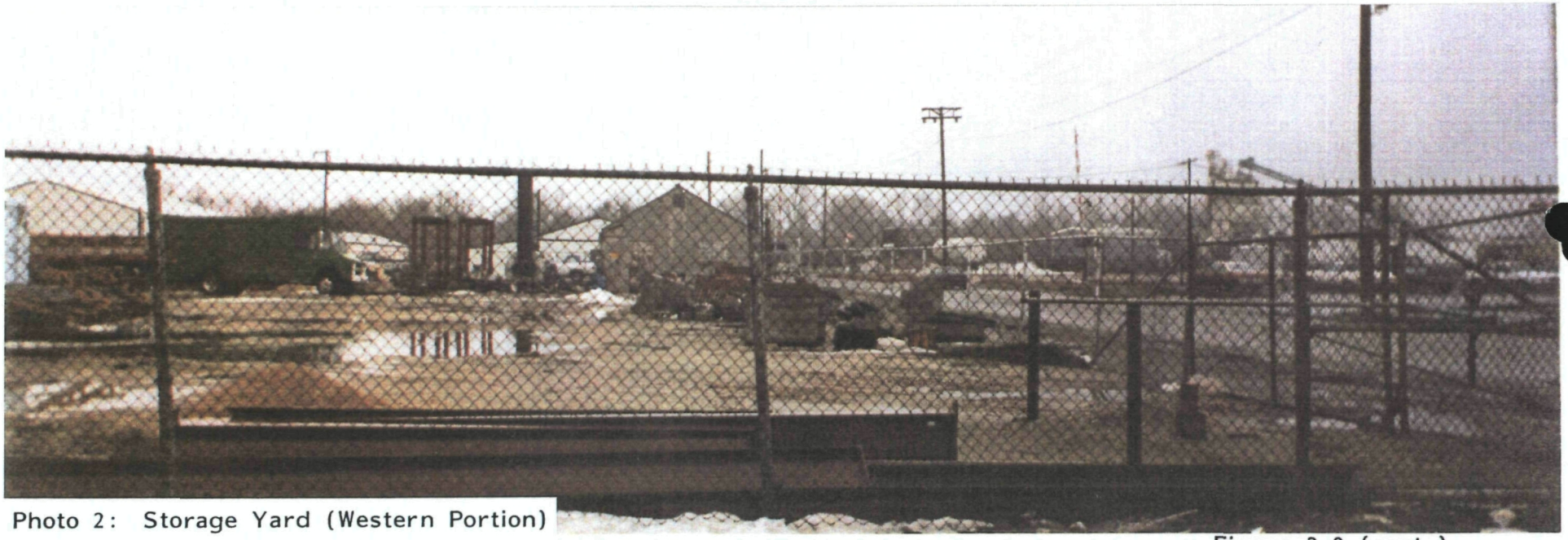


Photo 2: Storage Yard (Western Portion)

Figure 2-9 (cont.)

SITE FEATURES
Citizens Gas and Electric Company Site

Photo 1: Storage Yard (Western Portion)

Photo 2: Propane-Air Installation and Storage Yard (Western Portion)

Figure 2-9 (cont.)

SITE FEATURES
Citizens Gas and Electric Company Site

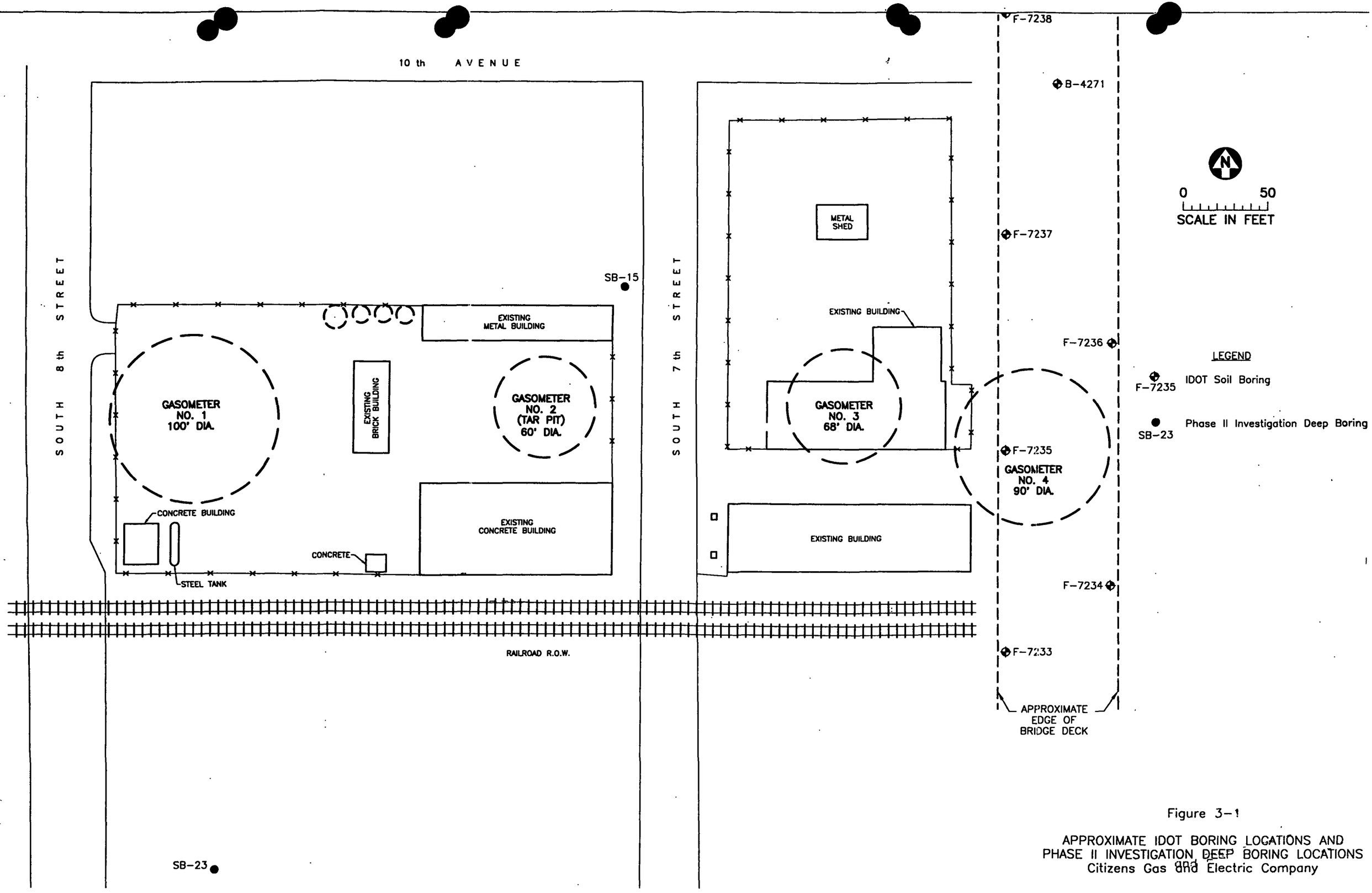


Figure 3-1

APPROXIMATE IDOT BORING LOCATIONS AND
PHASE II INVESTIGATION DEEP BORING LOCATIONS
Citizens Gas and Electric Company

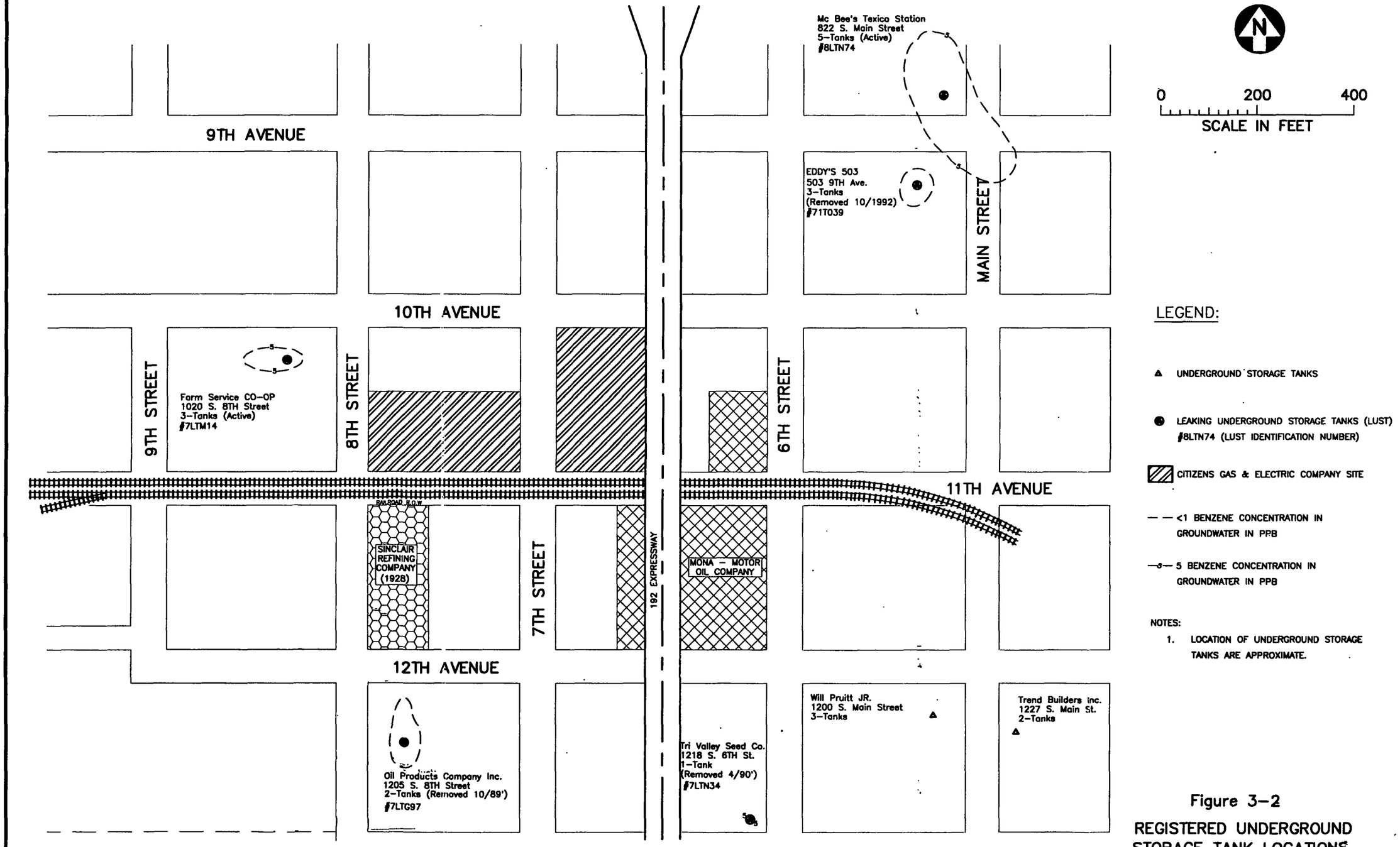


Figure 3-2

REGISTERED UNDERGROUND STORAGE TANK LOCATIONS
Citizens Gas & Electric Company Site

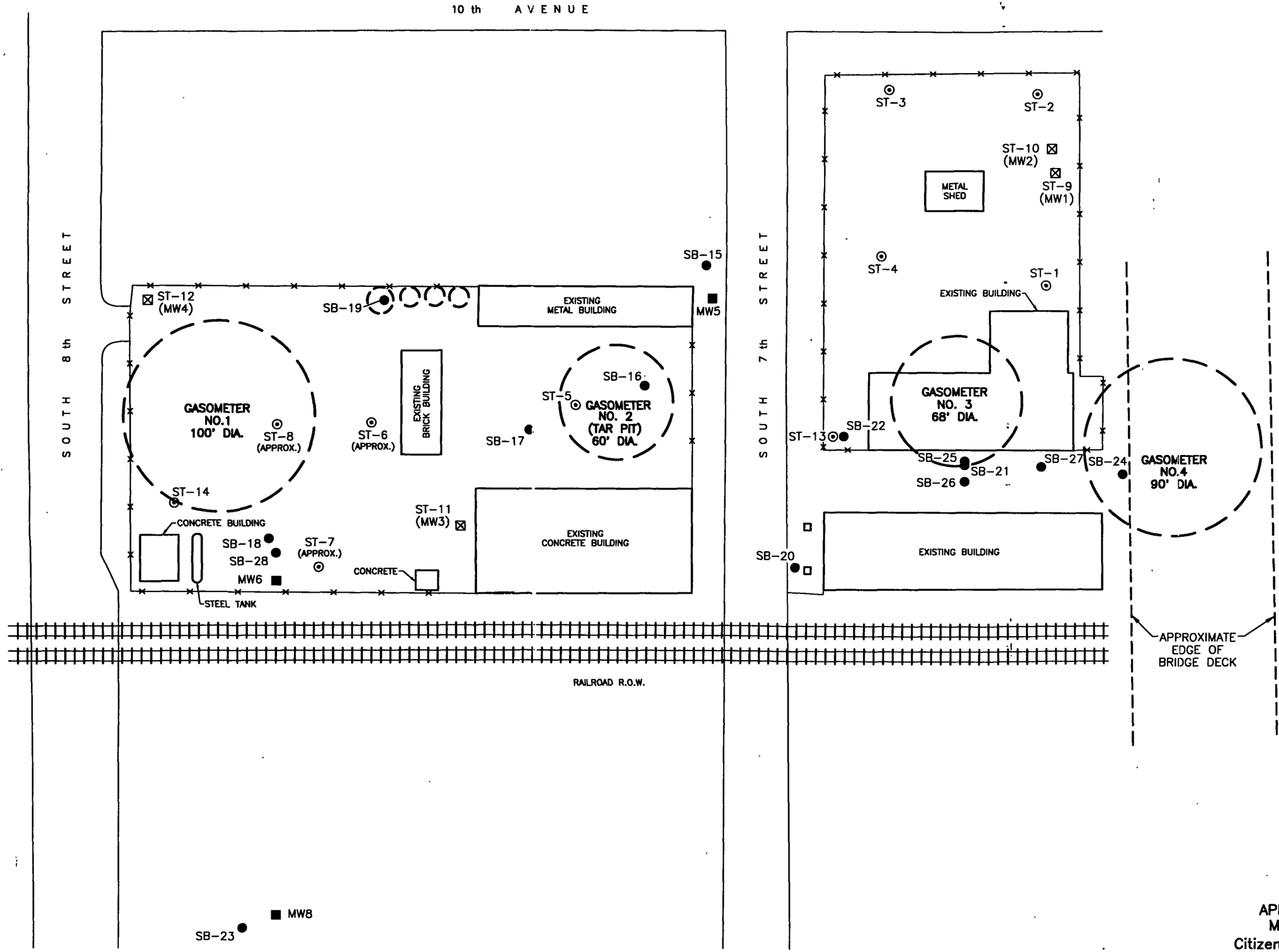
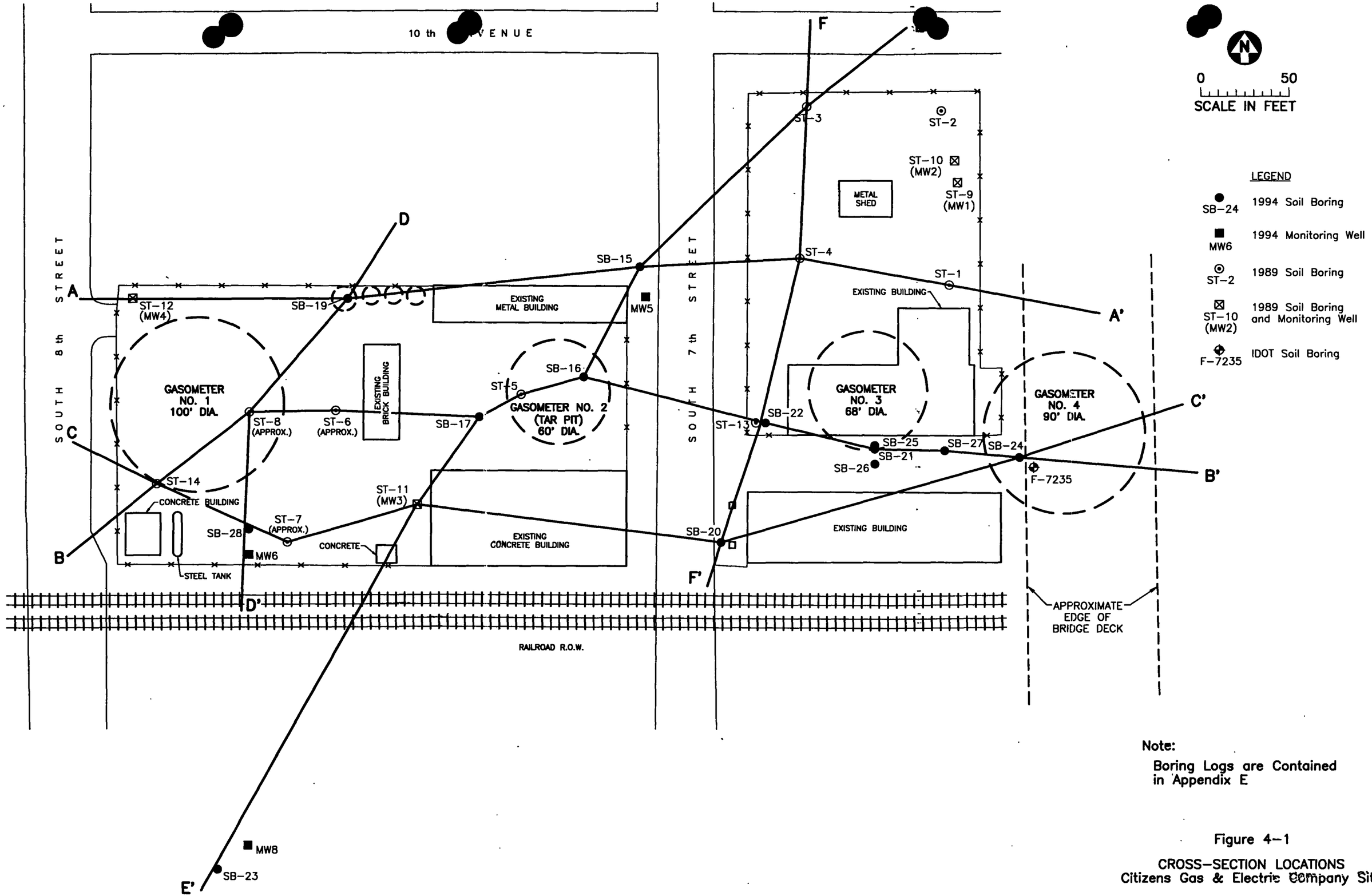


Figure 3-3

APPROXIMATE SOIL BORING AND MONITORING WELL LOCATIONS

Citizens Gas & Electric Company Site



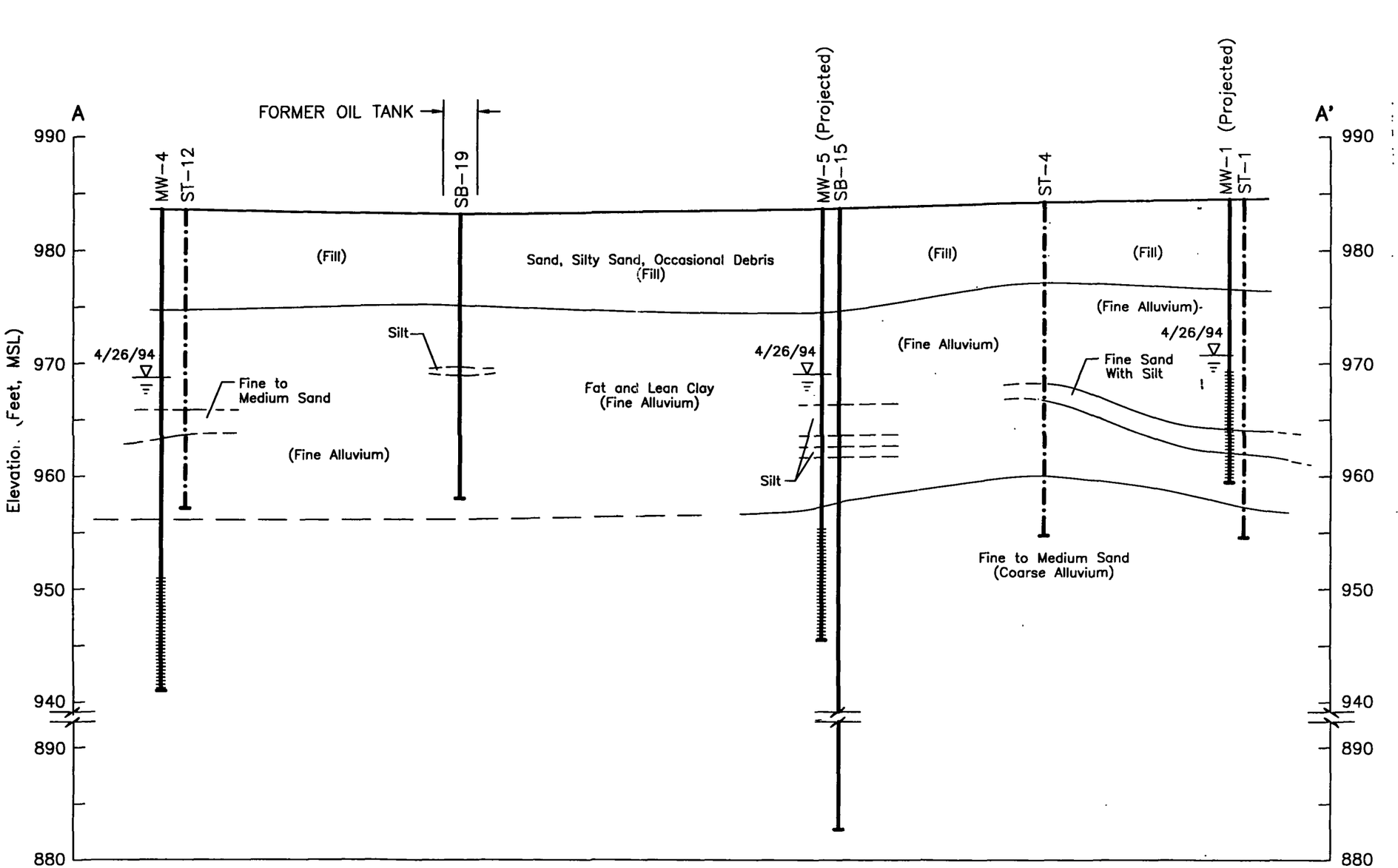
C:\PROJECTS\1578001\CBLUXS 50.00 01/09/1995 14:00:14

Note:

Boring Logs are Contained in Appendix E

Figure 4-1

CROSS-SECTION LOCATIONS
Citizens Gas & Electric Company Site



0 50 100
SCALE IN FEET
5X VERTICAL EXAGGERATION

Screened Interval

1989 Dames and Moore Soil Boring

1994 Soil Boring

Geologic Contact
(Dashed Where Uncertain)

Water Elevation

Figure 4-2

GEOLOGIC CROSS-SECTION A-A'
Citizens Gas and Electric Company
June 1994

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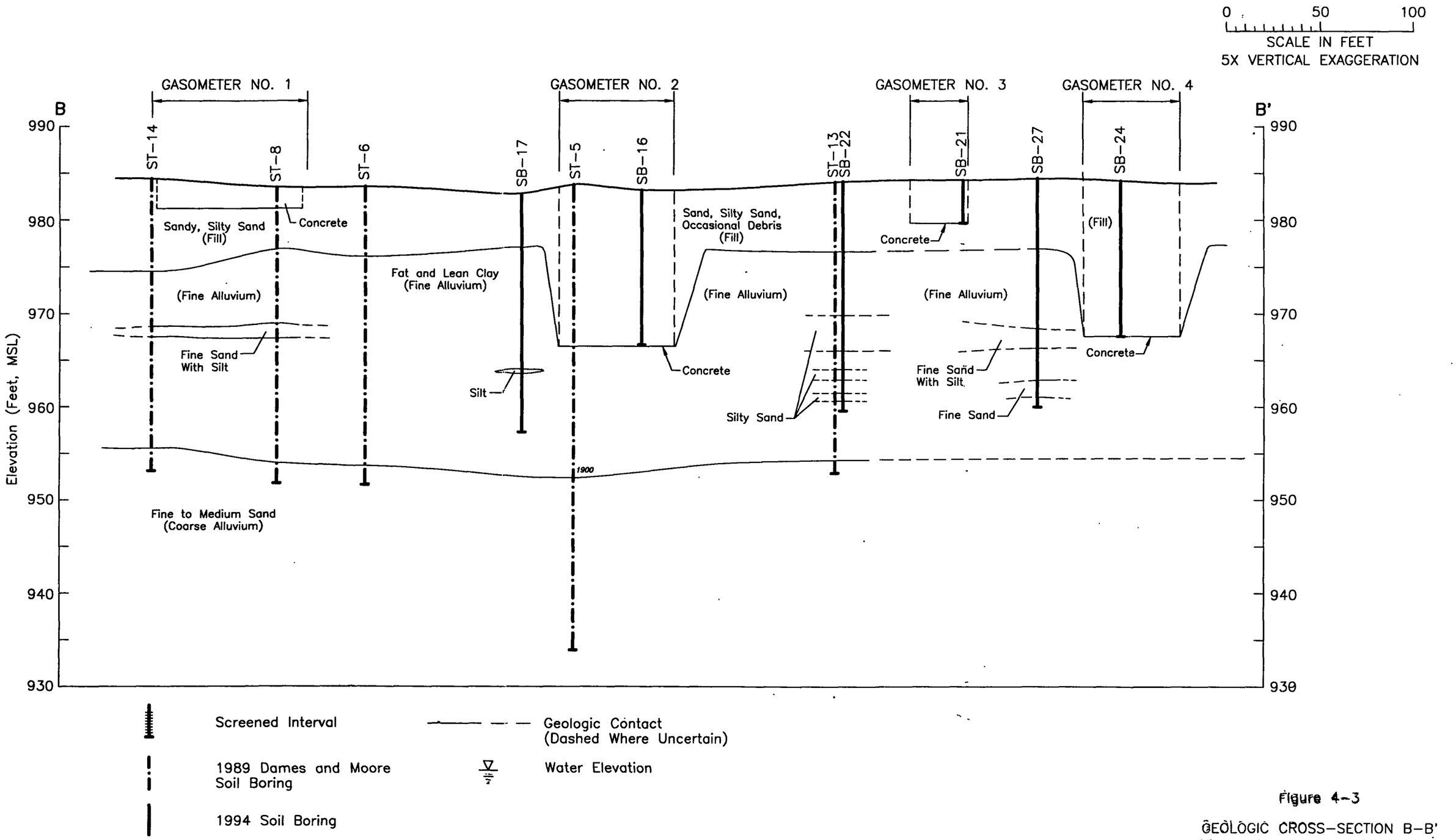

Figure 4-3

GEOLOGIC CROSS-SECTION B-B'
Citizens Gas and Electric Company
June 1994

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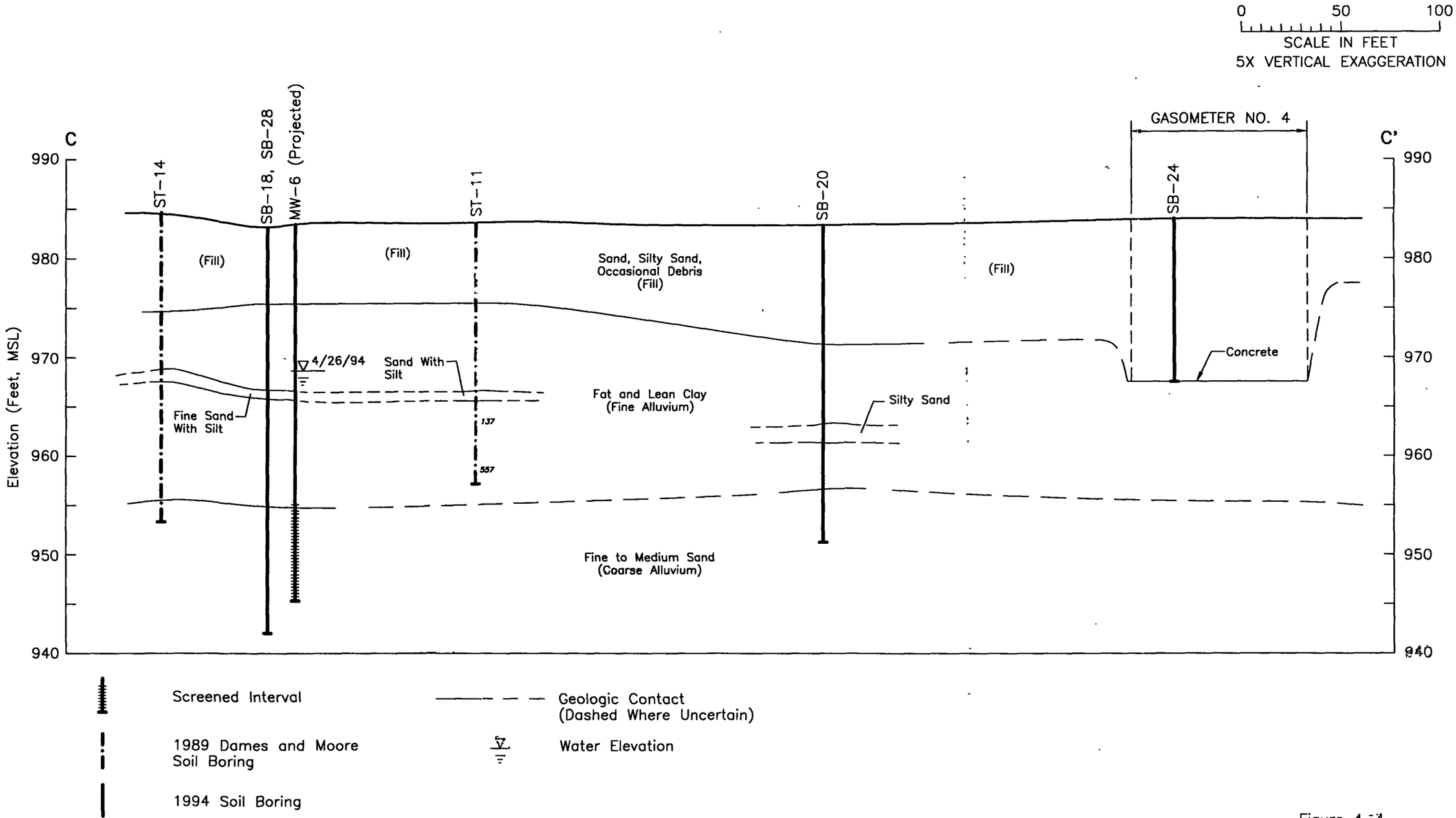

Figure 4-4

GEOLOGIC CROSS-SECTION C-C'
Citizens Gas and Electric Company
June 1994

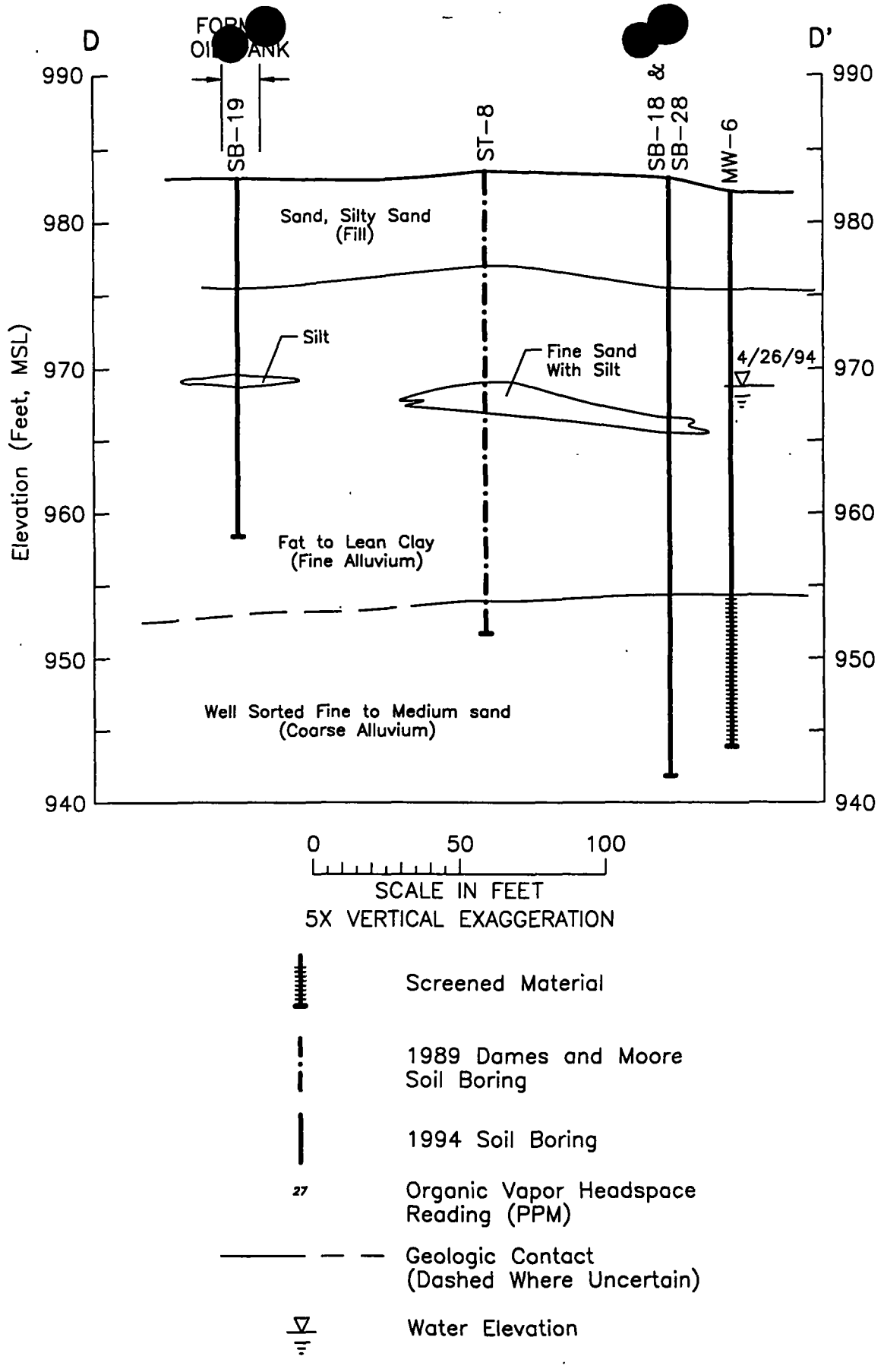

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Figure 4-5

GEOLOGIC CROSS-SECTION D-D'
Citizens Gas and Electric Company
June 1994

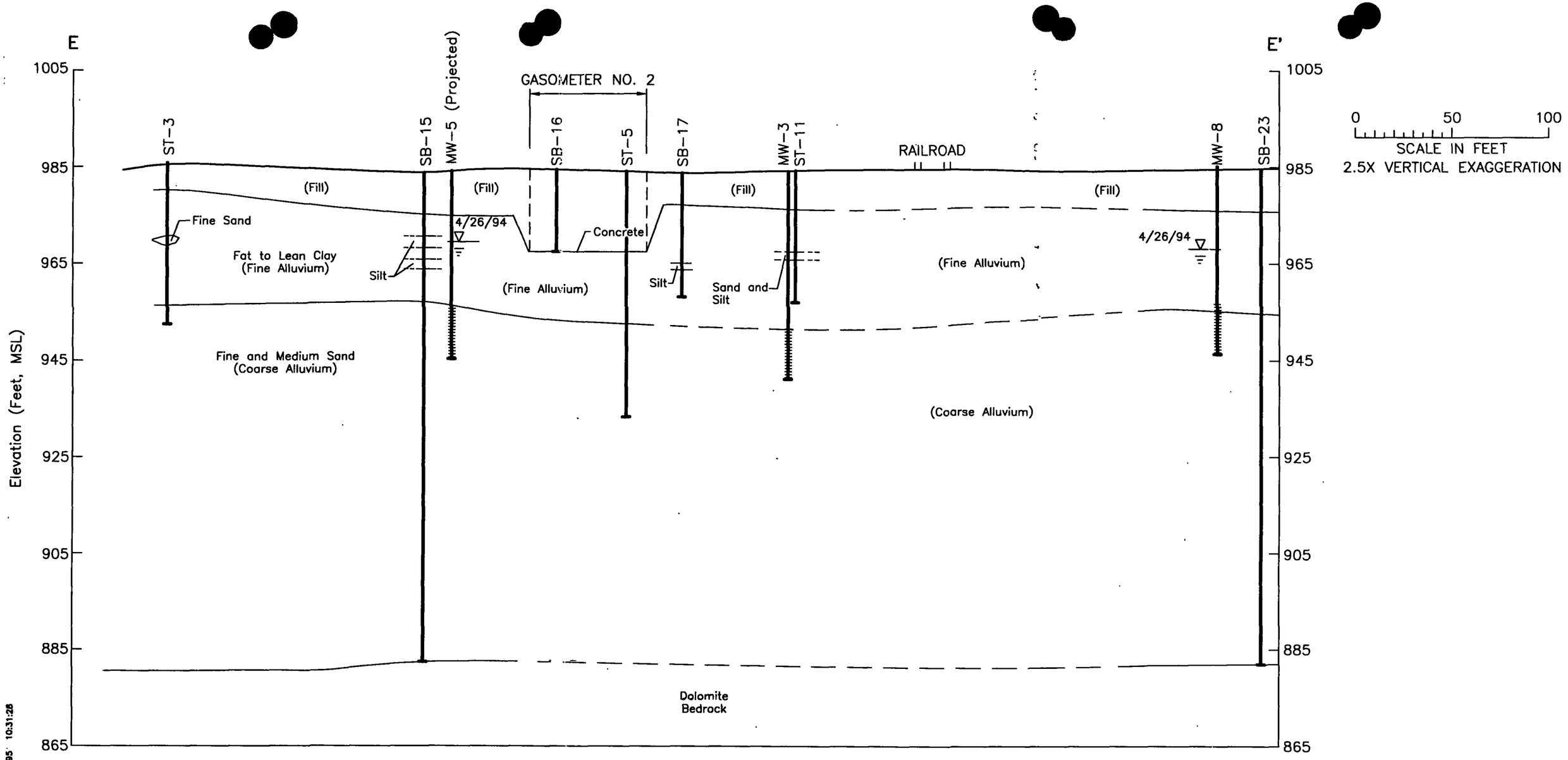
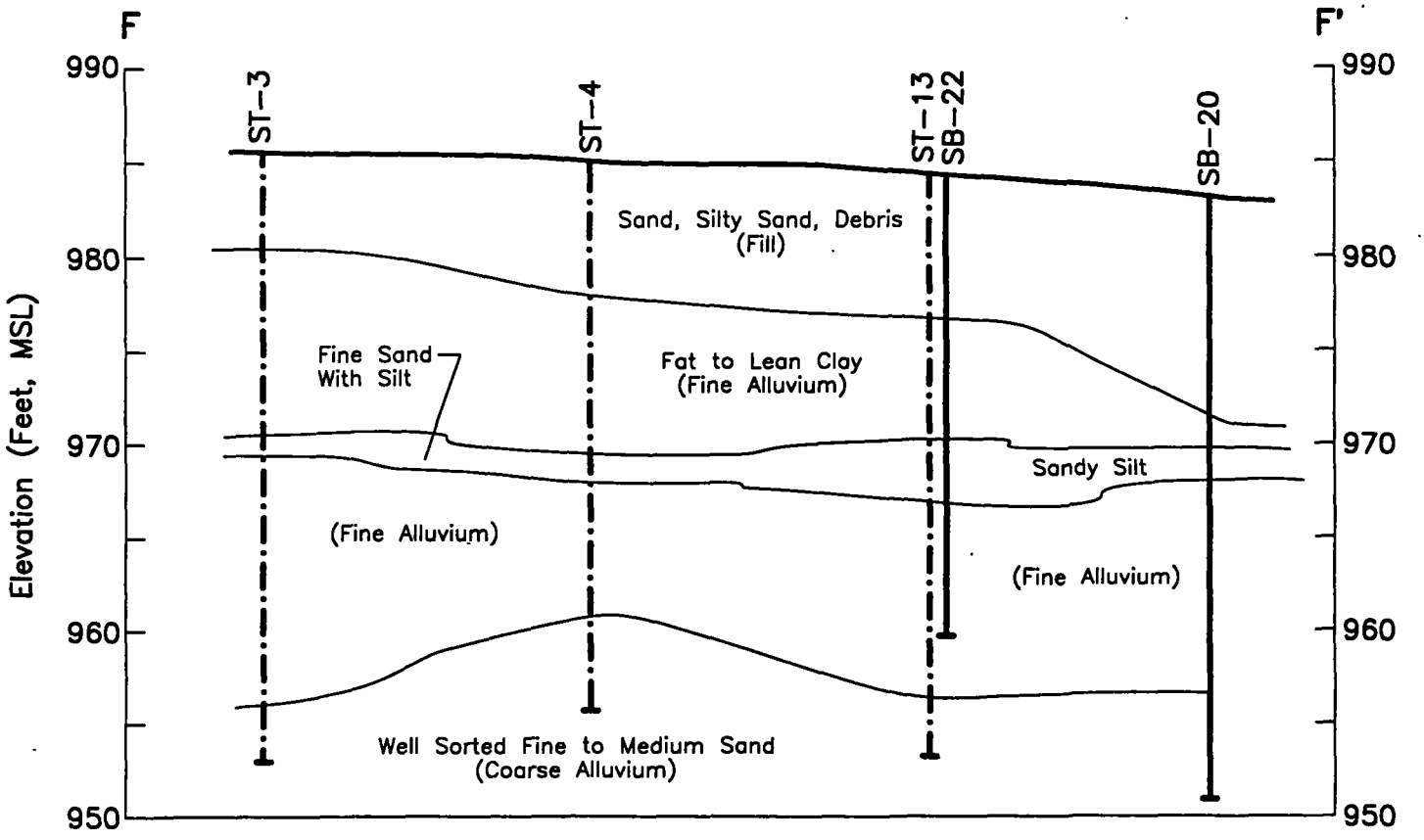


Figure 4-6

GEOLOGIC CROSS-SECTION E-E'
Citizens Gas and Electric Company
June 1994



0 50 100

SCALE IN FEET

5X VERTICAL EXAGGERATION

Screened Interval

1989 Dames and Moore Soil Boring

1994 Soil Boring

Geologic Contact (Dashed Where Uncertain)

Jan Moss \PROJECTS\2369135\CITXSF2 1.00 07/15/1994 15:55:57

Table 4-7

GEOLOGIC CROSS-SECTION F-F'
Citizens Gas and Electric Company
June 1994

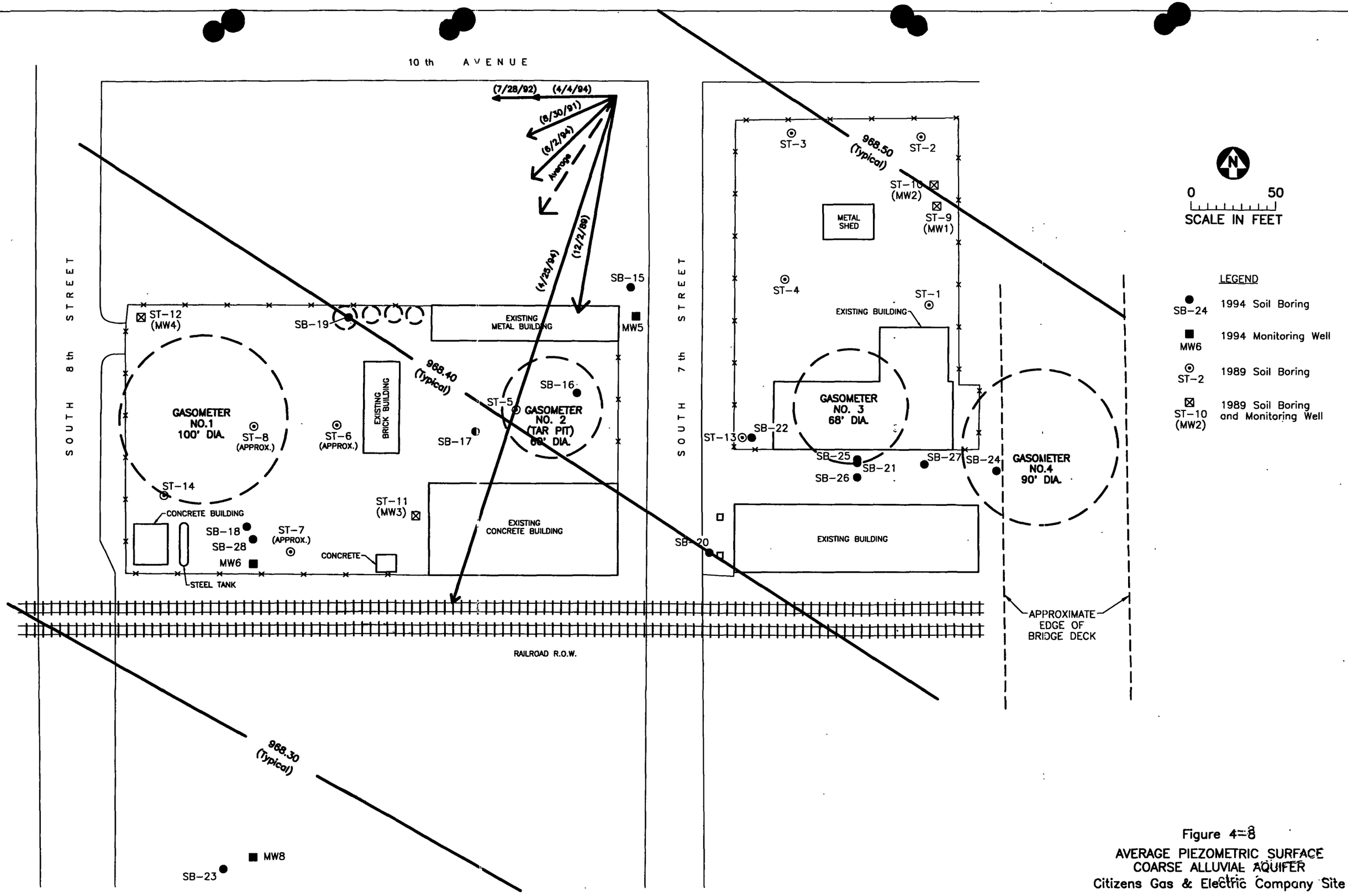


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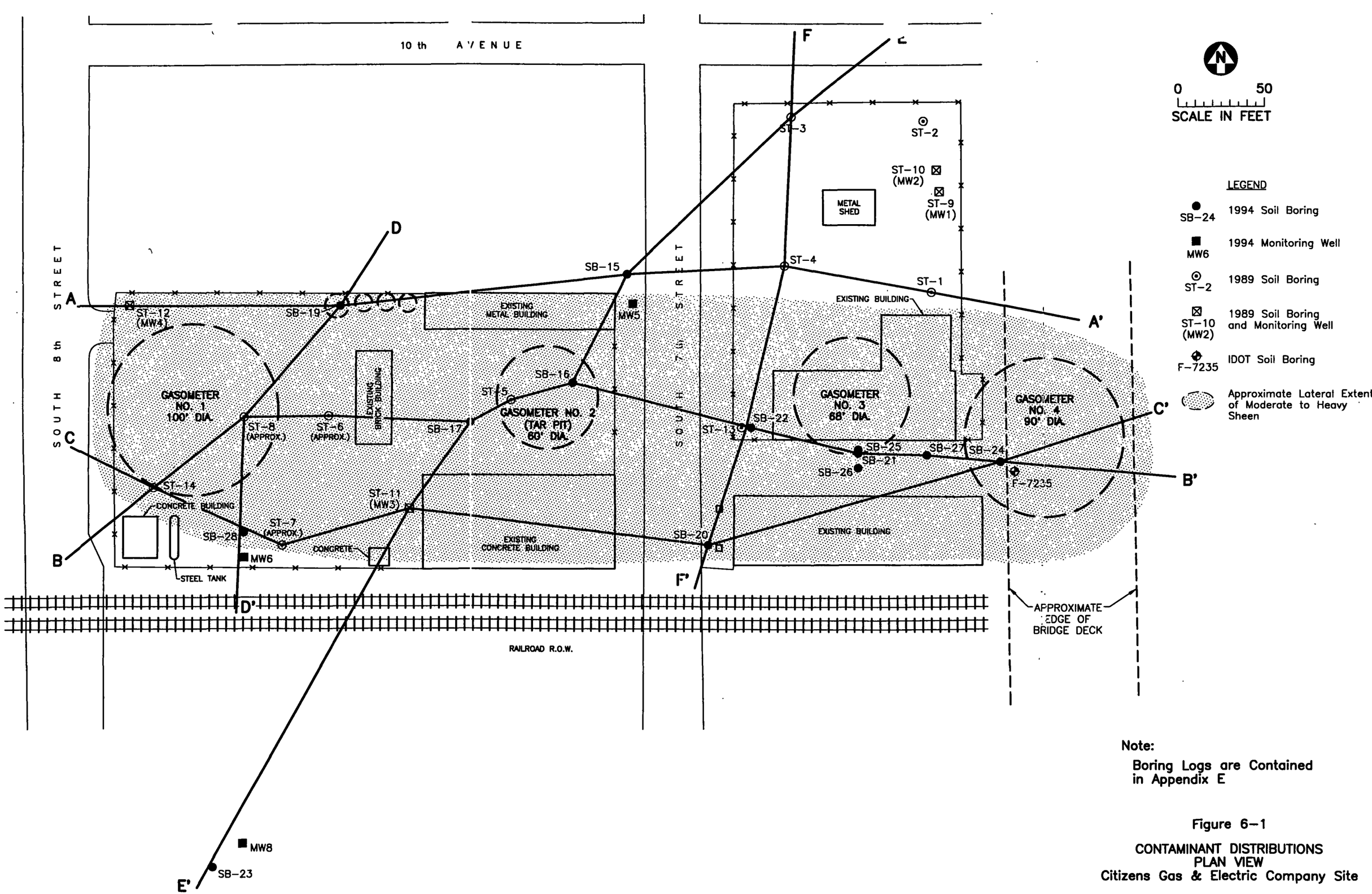
Figure 4-8
AVERAGE PIEZOMETRIC SURFACE
COARSE ALLUVIAL AQUIFER
Citizens Gas & Electric Company Site



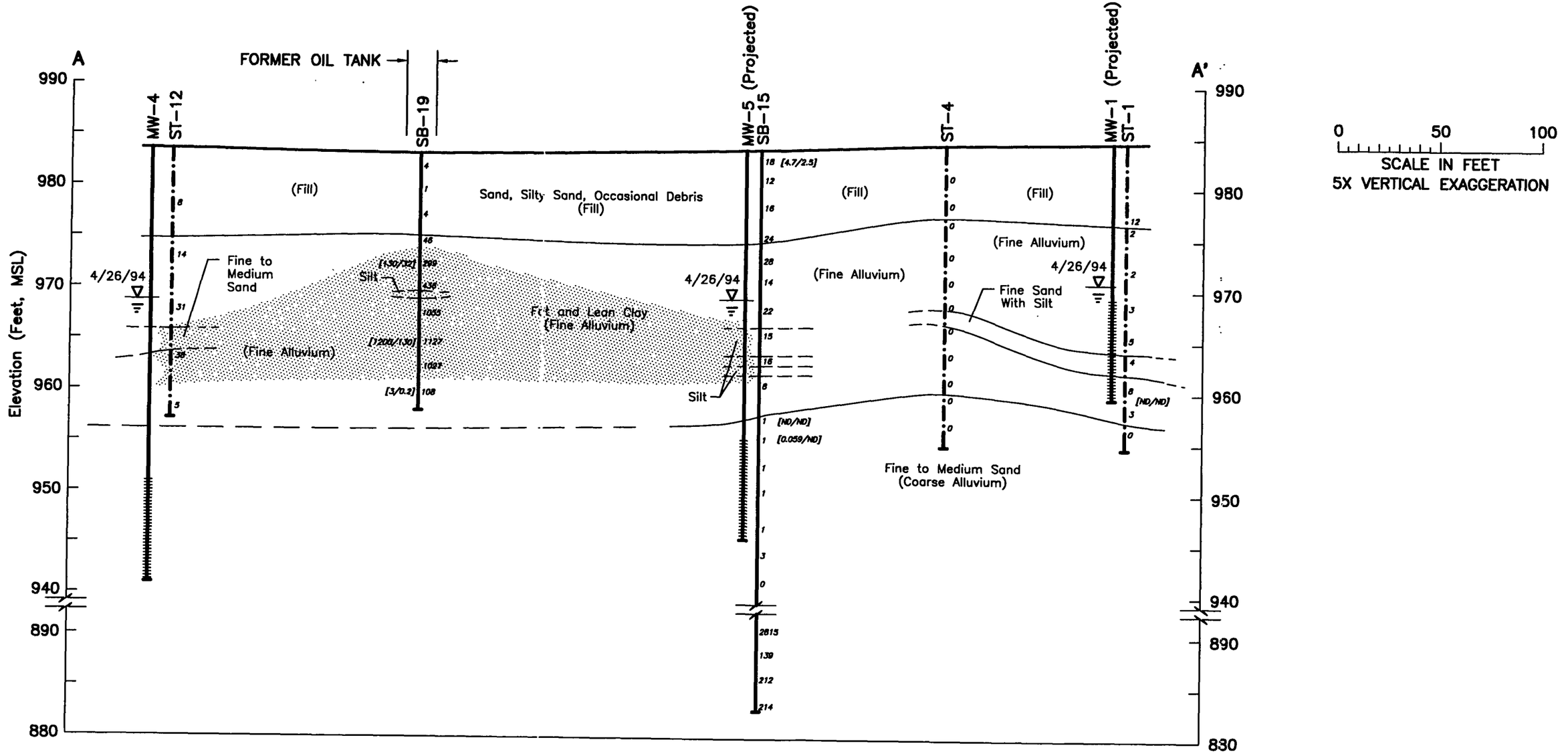
M:\CAD\1578001\1174_1 50.00 07/08/1995 07:45:05

Note:

Boring Logs are Contained in Appendix E

Figure 6–1

CONTAMINANT DISTRIBUTIONS PLAN VIEW Citizens Gas & Electric Company Site



Screened Interval

1989 Dames and Moore Soil Boring

1994 Soil Boring

27 Organic Vapor Headspace Reading (PPM)

[130/32] Total PAH's / Analytical Data (Concentrations in mg/Kg) / Carcinogenic PAH's

ND Not Detected

Geologic Contact (Dashed Where Uncertain)

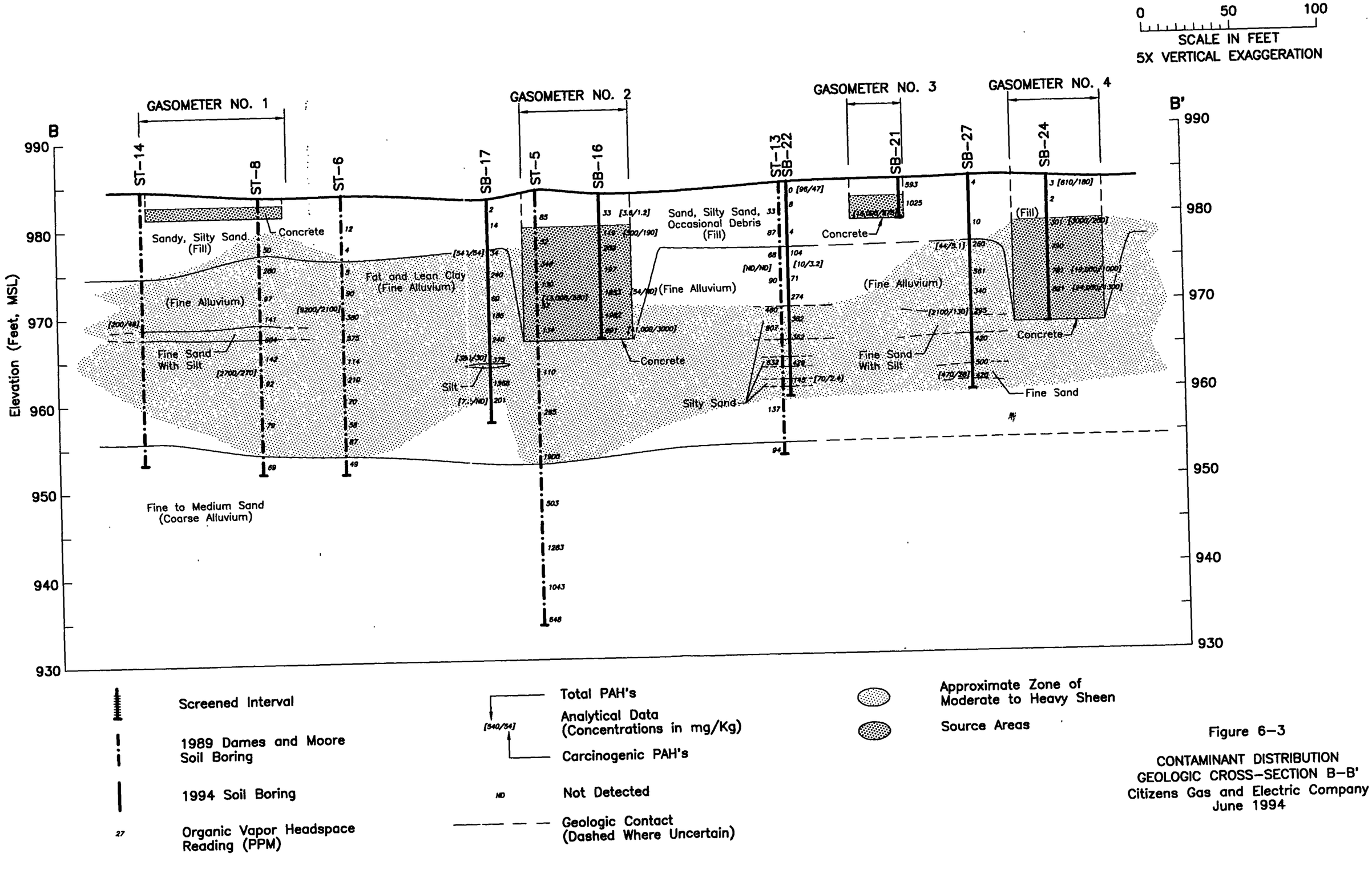
Water Elevation

Approximate Zone of Moderate to Heavy Sheen

Figure 6–2

CONTAMINANT DISTRIBUTION
GEOLOGIC CROSS–SECTION A–A'
Citizens Gas and Electric Company
June 1994

F V:\CAD\157600\1141_1 1.00 07/03/1995 12:46:00



Screened Interval

1989 Dames and Moore Soil Boring

1994 Soil Boring

27 Organic Vapor Headspace Reading (PPM)

[540/54] Total PAH's / Carcinogenic PAH's — Analytical Data (Concentrations in mg/Kg)

ND Not Detected

Geologic Contact (Dashed Where Uncertain)

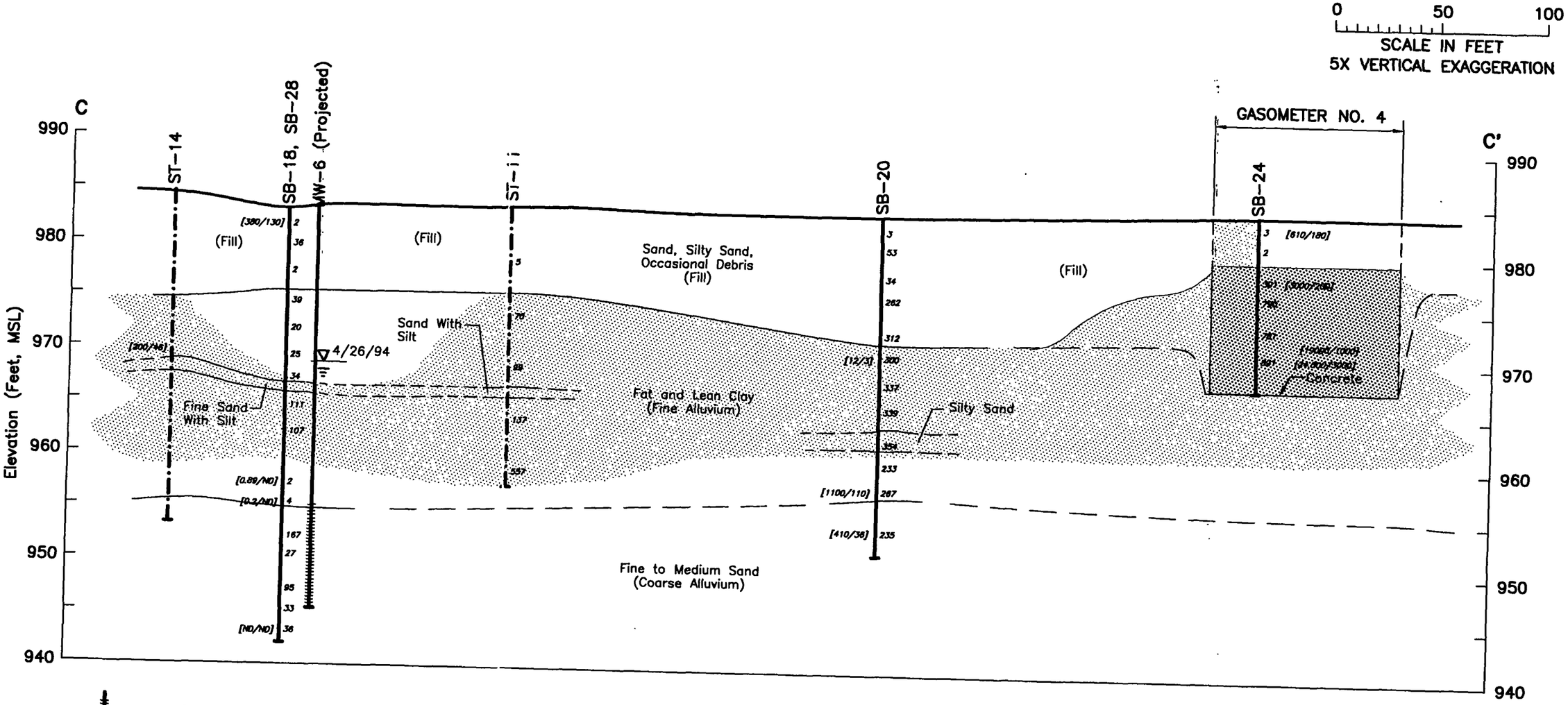
Approximate Zone of Moderate to Heavy Sheen

Source Areas

Figure 6-3

CONTAMINANT DISTRIBUTION
GEOLOGIC CROSS-SECTION B-B'
Citizens Gas and Electric Company
June 1994

PW M:\CAD\1578001\1142_1 1.00 07/06/1995 08:03:42



Screened Interval

1989 Dames and Moore Soil Boring

1994 Soil Boring

Organic Vapor Headspace Reading (PPM)

Total PAH's

Analytical Data (Concentrations in mg/Kg)

Carcinogenic PAH's

Not Detected

Geologic Contact (Dashed Where Uncertain)

Water Elevation

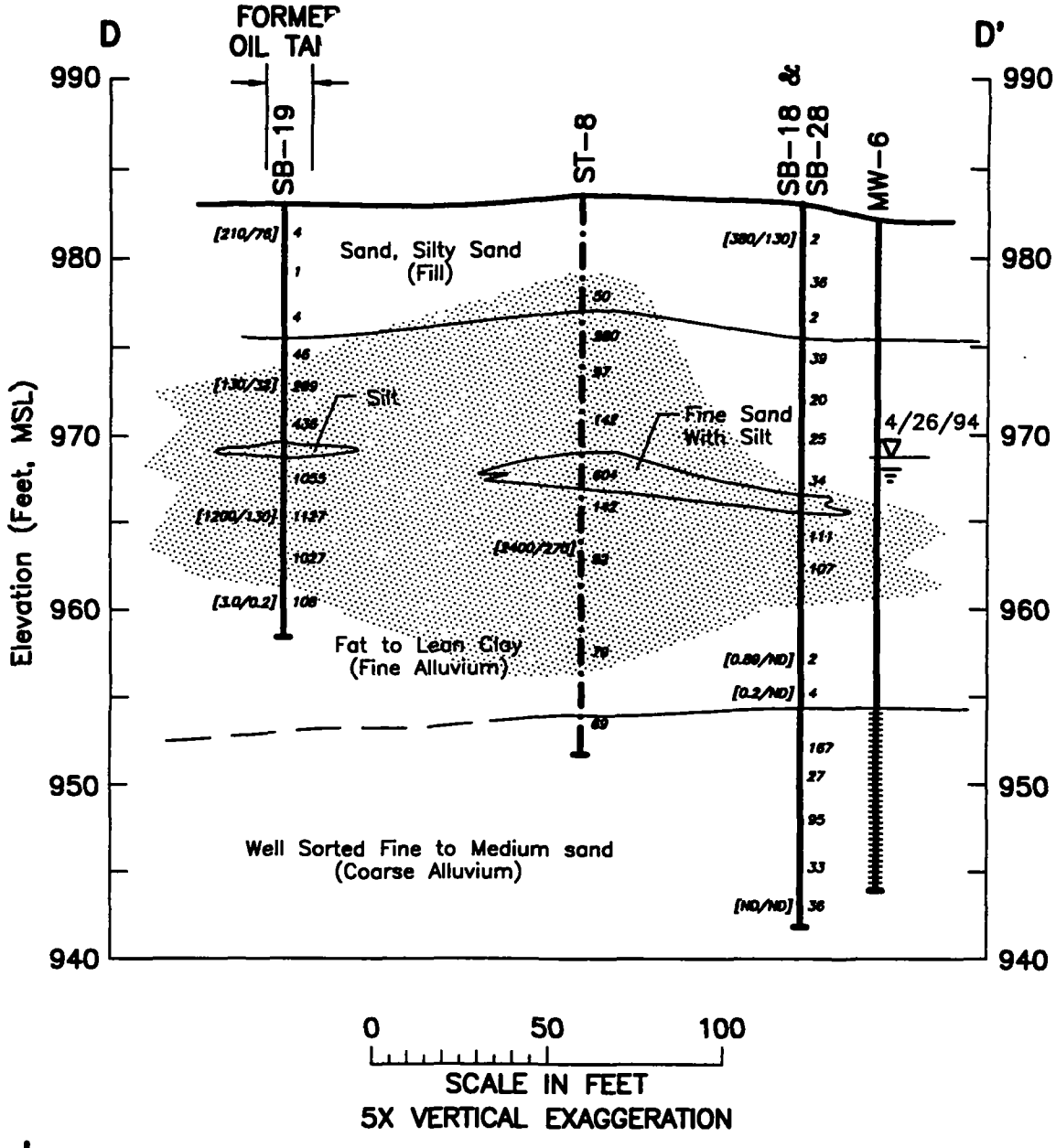
Approximate Zone of Moderate to Heavy Sheen

Source Areas

Figure 6-4

CONTAMINANT DISTRIBUTION
GEOLOGIC CROSS-SECTION C-C'
Citizens Gas and Electric Company
June 1994

PWJ M:\CAD\1578001\1143_1 1.00 07/08/1995 08:16:02



Screened Material

1989 Dames and Moore Soil Boring

1994 Soil Boring

27 Organic Vapor Headspace Reading (PPM)

Water Elevation

[240/130] Total PAH's / Analytical Data (Concentrations in mg/Kg) / Carcinogenic PAH's

ND Not Detected

Geologic Contact (Dashed Where Uncertain)

Approximate Zone of Moderate to Heavy Sheen

PVJ M:\CAD\1578001\1146_1 1.00 07/03/1995 12:15:08

Figure 6-5

CONTAMINANT DISTRIBUTION
GEOLOGIC CROSS-SECTION D-D'
Citizens Gas and Electric Company
June 1994

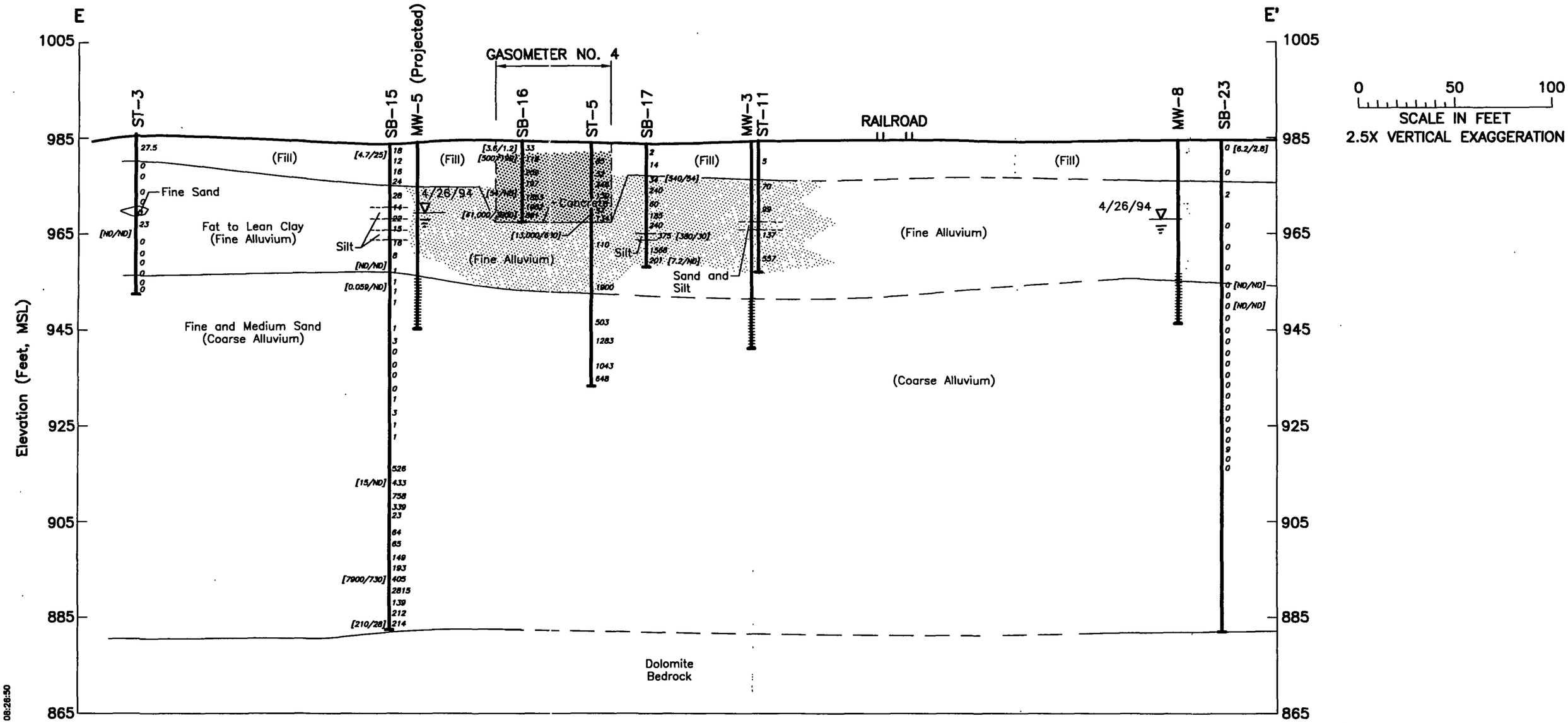


Figure 6-6

CONTAMINANT DISTRIBUTION
GEOLOGIC CROSS-SECTION E-E'
Citizens Gas and Electric Company
June 1994

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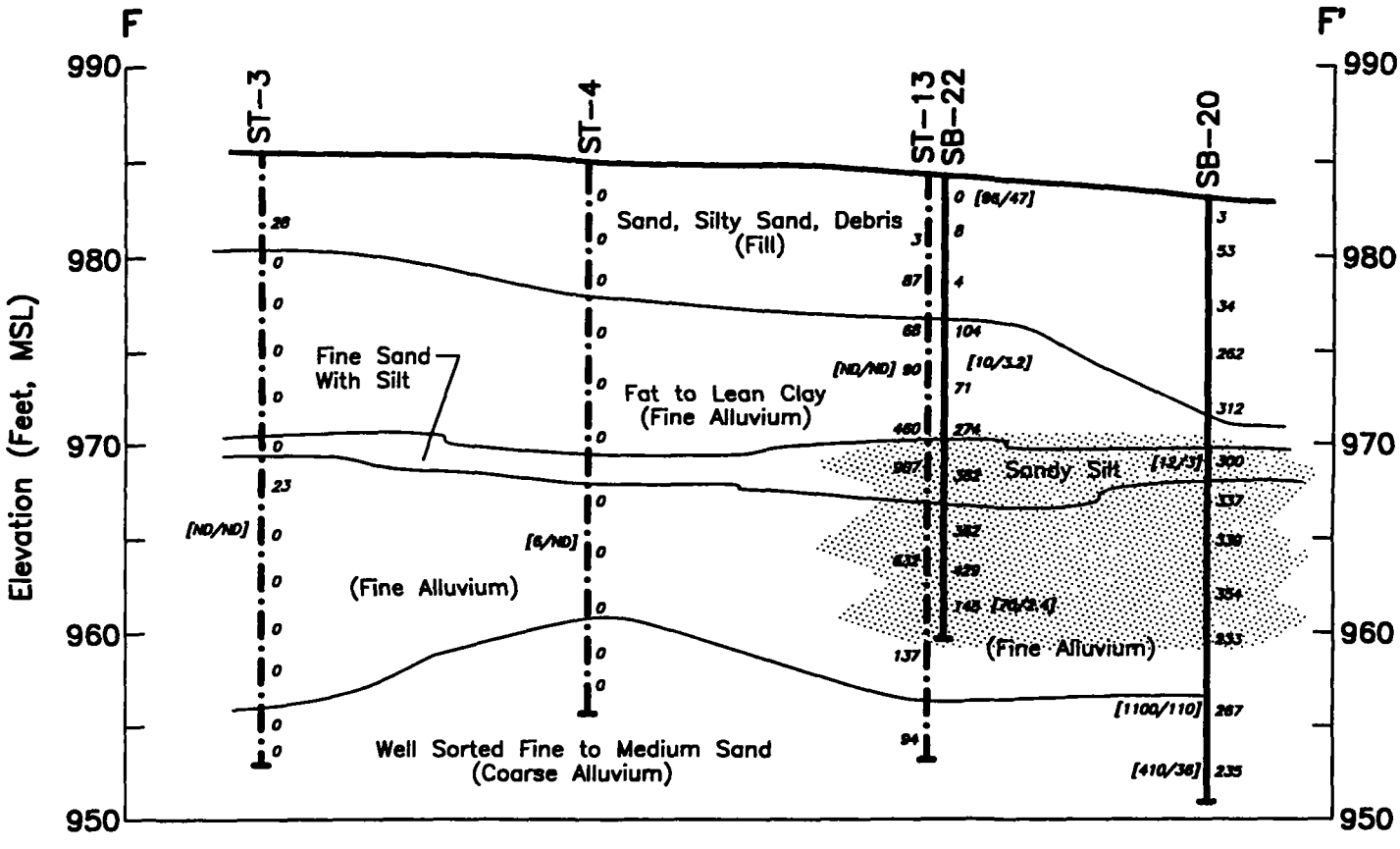

Screened Interval

1989 Dames and Moore Soil Boring

1994 Soil Boring

27 Organic Vapor Headspace Reading (PPM)

Approximate Zone of Moderate to Heavy Sheen

Total PAH's

[96/42] Analytical Data (Concentrations in mg/Kg)

Carcinogenic PAH's

ND Not Detected

Geologic Contact (Dashed Where Uncertain)

P :\CAD\1578001\1145_1 1.00 07/03/1995 11:55:14

Figure 6-7

CONTAMINANT DISTRIBUTION
GEOLOGIC CROSS-SECTION F-F'
Citizens Gas and Electric Company
June 1994

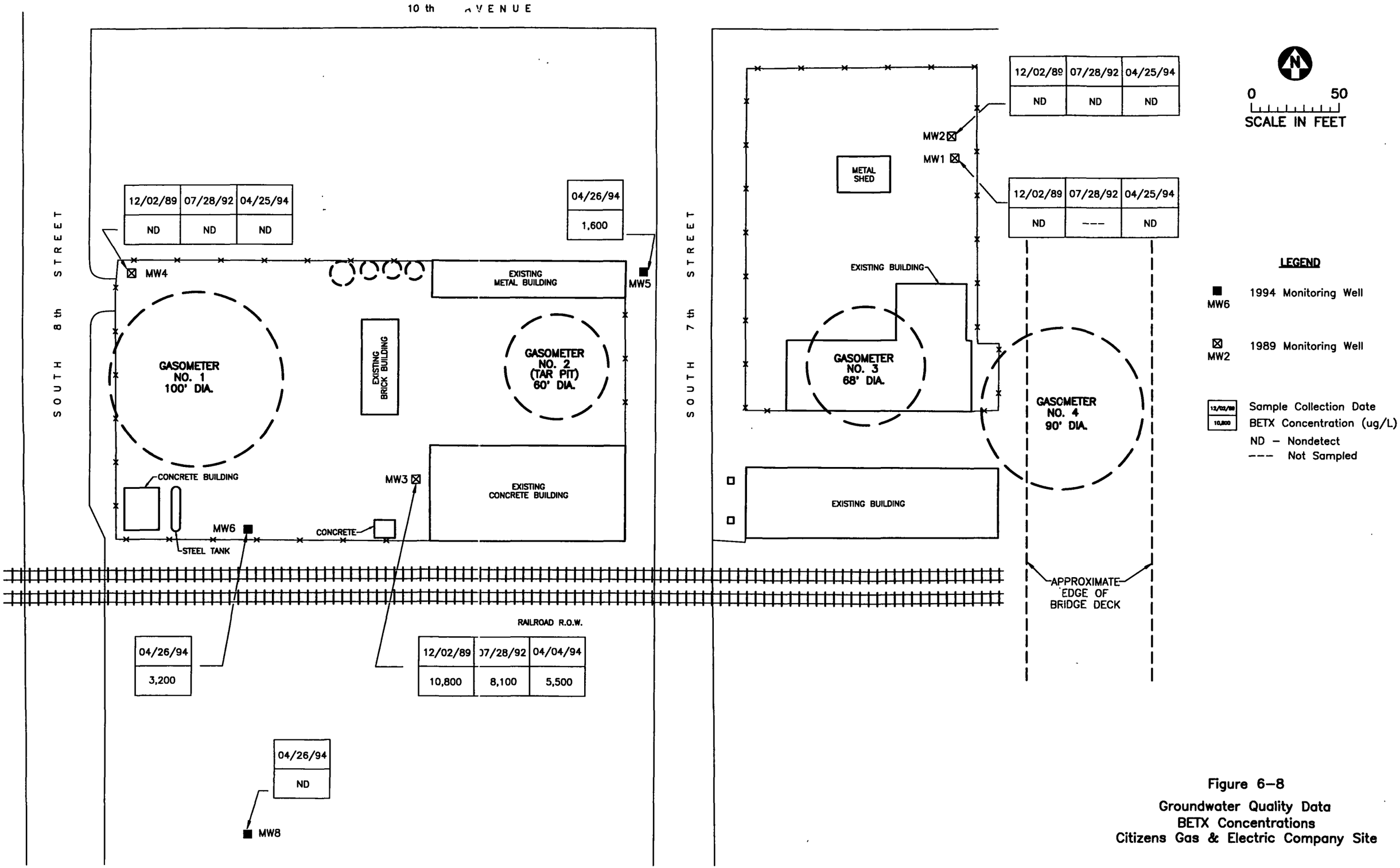

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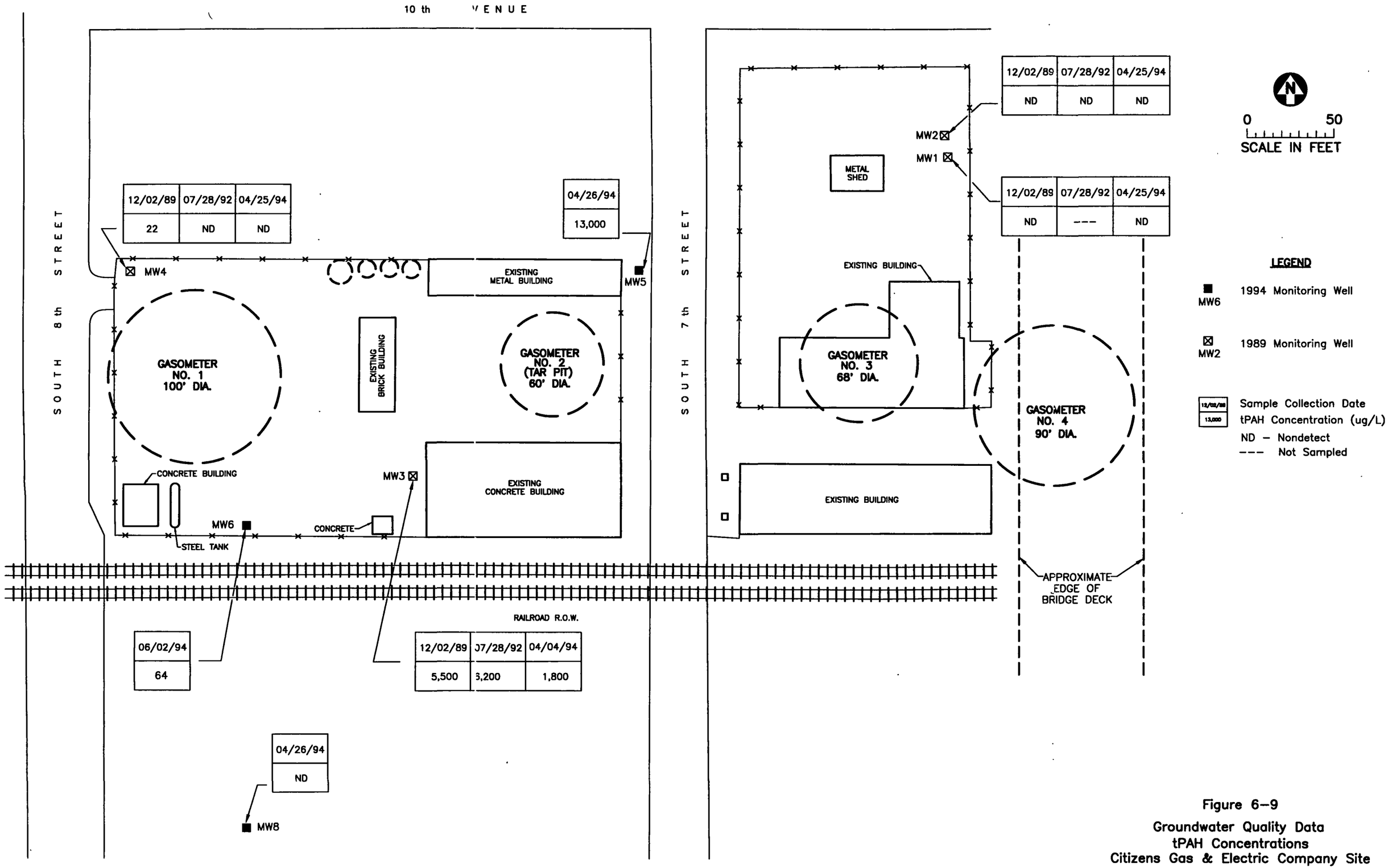
Figure 6–8
Groundwater Quality Data
BETX Concentrations
Citizens Gas & Electric Company Site



I M:\CAD\157600\1178_1 50.00 07/03/1995 11:39:20

Figure 6–9
Groundwater Quality Data
tPAH Concentrations
Citizens Gas & Electric Company Site

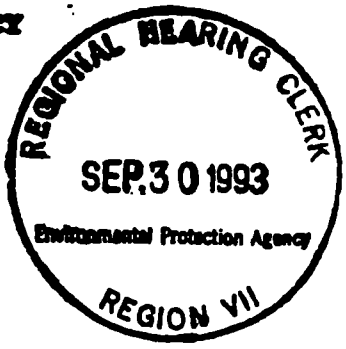
Appendices

Appendix A

Administrative Order on Consent
(Docket No. VII-93-F-0033)

FILE COPY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VII
726 MINNESOTA AVENUE
KANSAS CITY, KANSAS 66101



In the Matter of:	
Citizen Gas and Electric Company Site, Council Bluffs, Iowa	
Peoples Natural Gas Company,	
Respondent	Docket No. VII-93-F-0033
Proceedings under Sections 104 and 122 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 U.S.C. §§ 9604 and 9622).	ADMINISTRATIVE ORDER ON CONSENT

ADMINISTRATIVE ORDER ON CONSENT

TABLE OF CONTENTS

I. PRELIMINARY STATEMENT

1. This Administrative Order on Consent is issued to Peoples Natural Gas Company (hereinafter "Peoples" or "Respondent") pursuant to the authority vested in the President of the United States by Sections 104 and 122 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act, 42 U.S.C. §§ 9604 and 9622. The authority to issue such orders pursuant to Sections 104 and 122 of CERCLA was delegated to the Administrator of the United States Environmental Protection Agency (EPA) by Executive Order 12580, 57 Federal Register 2,923, dated January 23, 1987, and was further delegated to the Regional Administrators by EPA Delegation Nos. 14-14-A, dated April 16, 1984, and 14-14-C, dated September 13, 1987. This authority was subsequently redelegated to the Director, Waste Management Division, by EPA Delegation No. R7-14-14C, dated May 16, 1988.

2. By signing this Order, Respondent neither admits nor denies the findings of fact or the conclusions of law or determinations made herein; however, Respondent admits the jurisdiction of the EPA to issue and enforce the terms of this Order, agrees to undertake all actions required by the terms and conditions of this Order and consents to be bound by the requirements set forth herein.

and sulfur compounds before use. After approximately 1882, gas was manufactured from oil, rather than coal. By-product tars and carbon were produced along with the gas. A variety of oil-based feedstocks were used to produce gas, including kerosene, diesel oil and bunker C fuel oil. By-product tars were either refined into marketable products, such as creosote, road tars, fuels, and various pitches, or disposed of on site. Typical wastes associated with these gas production methods include spent oxide waste, tar residues, sludges, wastewater, ash, and phenolic and ammonia compounds.

7. The Site is located approximately 2 miles east of the Missouri River on the floodplain.

8. In 1989 Peoples conducted a Phase I preliminary investigation at the Site, which included soil borings and ground water sampling. This investigation included the installation of four ground water monitoring wells and on-site soil borings. Elevated levels of benzene, toluene, xylene, ethylbenzene, and cyanide were found in one of the monitoring wells. Benzene, toluene, ethylbenzene, and xylene were found in three of the eleven soil samples collected on site. The investigation also found indications that volatile organic compounds have migrated off site.

9. Peoples Natural Gas Company is a regulated public utility and a division of Utilicorp United, Inc., a Delaware corporation.

10. Peoples Natural Gas Company previously owned the entire Site and currently owns the eastern portion of the Site located as follows: Block 11, which is at the northeast corner of South 7th

15. The Site is a facility as defined in Section 101(9) of CERCLA, 42 U.S.C. § 9601(9).

16. Respondent is the current and past owner of the Site and is a responsible party pursuant to Section 107(a) of CERCLA, 42 U.S.C. § 9607(a).

VI. DETERMINATIONS

17. Based upon the foregoing findings of fact and conclusions of law, the Director, Waste Management Division, EPA Region VII, has determined that:

a. EPA is authorized to act pursuant to Section 104 of CERCLA, 42 U.S.C. § 9604, to investigate the existence and extent of the release or threat of release, the source and nature of the hazardous substances, pollutants or contaminants involved, and the extent of danger to the public health and welfare and the environment;

b. So long as Respondent complies with the requirements of this Order, including schedules set forth herein, such actions will be undertaken properly and promptly; and

c. The actions required by this Order are necessary response actions and are consistent with CERCLA and the National Contingency Plan.

VII. ORDER ON CONSENT

18. It is hereby agreed by the Parties that Respondent shall perform the tasks and submit deliverables with respect to the Site set forth in the Phase II Investigation Work Plan, attached to this Order as Attachment I.

recommendation on the need for further investigation or other response action.

VIII. ADDITIONAL WORK

21. During the course of this investigation, EPA may determine that sampling, analysis, reporting or other tasks in addition to those specifically set forth in the Work Plan or this Order are necessary to satisfy the purposes of this Order. If EPA so determines, it will advise Respondent, in writing, of the nature of the additional tasks and the basis for EPA's determination that such additional work is necessary. Within ten (10) calendar days of receiving such notice from EPA, Respondent shall either advise EPA, in writing, that it will conduct the additional work or initiate dispute resolution in accordance with paragraph 33. If Respondent agrees to conduct such additional work, within thirty (30) calendar days of receipt of EPA's notice, Respondent shall submit to EPA a revised Phase II Investigation Work Plan or an addendum to the Phase II Investigation Work Plan covering the additional work. If Respondent disputes the additional work, it shall submit to EPA either a revised Phase II Investigation Work Plan or an addendum to the Phase II Investigation Work Plan covering whatever additional work is found to be appropriate upon conclusion of the dispute resolution process. Respondent shall undertake, perform and complete all additional tasks, including providing such documents and reports, in accordance with the standards, specifications and schedules determined or approved by EPA.

24. All sample collection and analysis shall be performed in compliance with EPA-approved methods, including timing of analysis, documentation of sample collection, handling and analysis, as provided in the Phase II Investigation Work Plan.

25. Laboratory deliverables for all analytical work performed pursuant to this Order, as specified in the Contract Lab Statement of Work, shall be submitted to EPA in accordance with the requirements of paragraph 22.c. Any deviations from the procedures and methods set forth in these documents must be approved in writing by EPA prior to use.

26. Respondent shall use the quality assurance, quality control, and chain of custody procedures specified in the Quality Assurance Project Plan as approved by EPA for all sample collection and analysis performed pursuant to this Order.

27. All laboratories analyzing samples pursuant to this Order shall perform, at Respondent's expense, analyses of samples provided by EPA to demonstrate the quality of each such laboratory's analytical data as provided in the Phase II Investigation Work Plan.

28. Respondent shall ensure that EPA representatives are allowed access, for auditing purposes, to all laboratories and personnel utilized by Respondent for sample collection and analysis and other field work.

approval, for a period equal to the delay resulting from such circumstances. All such modifications of the schedule caused by a force majeure shall be made in accordance with paragraph 76 of this Order. The schedule for those tasks which are not specifically altered by these modifications remains unchanged unless altered in accordance with paragraph 76. In the event EPA and Respondent cannot agree that any delay or failure has been or will be caused by a force majeure, or if there is no agreement on the length of the extension, this dispute shall be resolved in accordance with the Dispute Resolution provisions of paragraph 33 of this Order.

XII. DOCUMENT REVIEW AND APPROVAL

32. The following procedure will apply to the review and approval of the Phase II Investigation Report and any other plans, reports, or other documents submitted to EPA for review and approval, including plans and reports submitted pursuant to paragraph 21, above, pertaining to Additional Work. EPA will review each such document and notify Respondent, in writing, as to its approval or disapproval thereof. In the event EPA does not approve any such document, it will provide a written statement as to the basis of the disapproval. Within thirty (30) business days of receipt of the EPA comments, or such longer time period as agreed to by the Parties, Respondent shall amend the document in accordance with those comments or as otherwise agreed upon by EPA, and shall submit the amended report to EPA. EPA will make the final determination as to whether the document submitted by Respondent is in compliance with the requirements of this Order.

dispute regardless of whether Respondent agrees with the decision. If the Respondent does not agree to perform, or does not actually perform the work in accordance with EPA's final decision, EPA reserves the right, in its sole discretion, to conduct the work itself, to seek reimbursement from the Respondent, to seek enforcement of the decision, to seek stipulated penalties, or to seek any other appropriate relief, or any combination of the above.

34. Respondent is not relieved of its obligation to perform and conduct activities and submit deliverables on the schedule set forth in the Phase II Investigation Work Plan while a matter is pending in dispute resolution. The invocation of dispute resolution does not stay stipulated penalties under this Order.

35. Notwithstanding any other provisions of this Order, no action or decision by EPA, including without limitation decisions of the Regional Administrator of EPA Region VII, or his designee, pursuant to this Order shall constitute final agency action giving rise to any rights to judicial review prior to EPA's initiation of judicial action to compel Respondent's compliance with the requirements of this Order.

XIV. CONFIDENTIAL BUSINESS INFORMATION

36. Respondent may assert a business confidentiality claim covering all or part of the information submitted pursuant to this Order. The information covered by such a claim will be disclosed by EPA only to the extent and by the procedures specified in 40 C.F.R. Part 2, Subpart B. Such a claim may be made by placing on or attaching to the information, at the time it is submitted to

XVI. ACCESS

39. Except as provided in paragraph 41, with respect to property not owned or controlled by Respondent, Respondent shall provide access to EPA to all property upon which any activities are being conducted or have been conducted pursuant to this Order such that EPA and its authorized representatives are able to enter and move freely about such property at all reasonable times for the following purposes:

a. Inspecting and copying records, files, photographs, operating logs, contracts and other documents relating to this response action;

b. Reviewing the status of activities being conducted pursuant to this Order;

c. Collecting such samples or conducting such tests as EPA determines are necessary or desirable to monitor compliance with the terms of this Order or to protect the public health, welfare, or the environment;

d. Using sound, optical or other types of recording equipment to record activities which have been or are being conducted pursuant to this Order; and

e. Verifying data and other information submitted by Respondent pursuant to this Order.

40. Under this Order, providing access to EPA means providing access to employees of EPA and other duly authorized representatives of the EPA.

reference into this Order. In the event any such access agreement is not obtained within this time period, Respondent shall notify EPA in writing of their lack of access, the efforts they made to obtain access, and an explanation of the basis therefore, e.g., inability to locate the current owner of the property, lack of response to request for access, or denial of access. In the event EPA obtains access, Respondent shall undertake work on such property in accordance with the approved Work Plan. In the event that EPA performs those tasks or activities, Respondent shall perform all other activities not requiring access to that property, and shall reimburse EPA for all costs incurred in performing such activities. Respondent additionally shall integrate the results of any such tasks undertaken by EPA into its reports and deliverables. If, after using its best efforts, as defined herein, to do so, Respondent is unable to obtain access to such property, a force majeure shall be deemed to have occurred.

42. Nothing herein is intended to limit in any way EPA's right of access under CERCLA or any other legal authority.

XVII. RECORD PRESERVATION

43. Unless otherwise permitted by EPA, Respondent shall, without regard to any document retention policy to the contrary, preserve during the pendency of this Order and for a minimum of six (6) years after its termination, all records and documents in its possession, custody or control containing information related to wastes containing hazardous substances generated, stored, treated or disposed of on the site, the release or threatened release of

beyond the terms of this Order. EPA reserves the right to take any enforcement action pursuant to RCRA, CERCLA or any other available legal authority for relief including, but not limited to, injunctive relief, monetary penalties, and punitive damages for any violation of law or this Order.

47. EPA reserves the right to revise or prepare, in whole or in part, documents required by this Order, to undertake response action(s) to address the release or threat of release of hazardous substances at the Site at any time and to seek reimbursement from Respondent thereafter for such costs incurred by the United States.

48. EPA reserves the right to perform any portion of the work herein or any additional site characterization, feasibility study, and response/correction actions as it deems necessary to protect human health and the environment. EPA may exercise its authority under CERCLA to undertake removal actions or remedial actions at any time. In any event, EPA reserves its right to seek reimbursement from Respondent for such additional costs incurred by the United States. Notwithstanding compliance with the terms of this Order, Respondent is not released from liability, if any, for the costs of any response actions taken or authorized by EPA.

49. Compliance by Respondent with the terms of this Order shall not relieve Respondent of its obligation to comply with RCRA or any other applicable local, state or federal laws and regulations.

50. This Order is not intended to be nor shall it be construed as a permit. This Order does not relieve Respondent of

costs will consist of a certified Agency Financial Management System summary data (SPUR Reports), or such other summary as certified by EPA, including the following information:

a. EPA's payroll costs, including the names of the individuals charging time to the Site, the pay periods in which each individual charged time to the Site, the number of hours charged by each individual per pay period, and the payroll cost per individual per pay period;

b. EPA's travel costs, including the names of the individuals charging travel costs to this Site and the date and amount of payment of each travel claim charged to the Site;

c. EPA's indirect costs charged for regional staff time, including the individual's name, pay period, the number of hours per pay period, the indirect cost rate, and total indirect cost;

d. Contract costs, including for each such payment the amount paid, the date paid, and invoice number; and

e. the amount and date paid for any other costs.

The summary provided by EPA shall serve as basis for payment demands.

54. Respondent shall, within thirty (30) days of receipt of each accounting, remit a certified or cashier's check for the amount of those costs. Checks should be made payable to the Hazardous Substance Response Fund and should include a reference to

to this Order, as well as any other past and future costs incurred by the United States in connection with the Site.

XX. OTHER CLAIMS

59. Nothing in this Order shall constitute or be construed as a release from any claim, cause of action or demand in law or equity against any person, firm, partnership, or corporation for any liability it may have arising out of or relating in any way to the generation, storage, treatment, handling, transportation, release, or disposal of any hazardous constituents, hazardous substances, hazardous wastes, pollutants, or contaminants found at, taken to, or taken from the Site.

XXI. OTHER APPLICABLE LAWS

60. All actions required to be taken pursuant to this Order shall be undertaken in accordance with the requirements of all applicable local, state and federal laws and regulations, including, but not limited to, any permitting or licensing requirements. All reports, plans, specifications, and schedules submitted pursuant to this Order are, upon approval by EPA, incorporated into this Order. Unless otherwise excused by law, any noncompliance with the requirements of such EPA-approved reports, plans, specifications, or schedules shall be considered a failure to achieve compliance with the requirements of this Order.

XXII. PENALTIES FOR NONCOMPLIANCE

61. Respondent is hereby advised that, pursuant to Section 109 of CERCLA, 42 U.S.C. § 9609, civil penalties of not more than $25,000 per day for each day during which a violation continues may

on timeliness; nevertheless, penalties shall accrue from the day a violation commences. Payment shall be due within thirty (30) days of receipt of a demand letter from EPA. EPA may, in its sole discretion, waive or suspend any stipulated penalties, or the accrual of such penalties, due to it under this Section based upon equitable considerations.

64. Respondent shall pay interest on the unpaid balance, which shall begin to accrue at the end of the 30-day period, at the rate established by the Department of Treasury pursuant to 30 U.S.C. § 3717. Respondent shall further pay a handling charge of 1 percent to be assessed at the end of each thirty-one (31) day period and a 6 percent per annum penalty charge to be assessed if the penalty is not paid in full within ninety (90) days after it is due.

65. Respondent shall make all payments by forwarding a check to:

Mellon Bank, EPA Region VII
Superfund
FNMG Section
Post Office Box 360748M
Pittsburgh, PA 15251

Checks should identify the name of the site, the site identification number, the account number, and the title of this Order. A copy of the check and/or transmittal letter shall be forwarded to the EPA Project Coordinator.

66. For submittal of the Phase II Investigation Report, stipulated penalties shall accrue in the amount of $250.00 per day, per violation, for the first seven (7) days of noncompliance;

does not alter Respondent's obligation to complete performance under this Order.

71. The stipulated penalties set forth in this Section do not preclude EPA from pursuing any other remedies or sanctions which may be available to EPA by reason of Respondent's failure to comply with any of the requirements of this Order, nor shall payment of said penalties relieve Respondent of the responsibility to comply with this Order.

XXIV. INDEMNIFICATION OF THE UNITED STATES GOVERNMENT

72. Respondent agrees to indemnify and save and hold the United States Government, its agencies, departments, agents and employees, harmless from any and all claims or causes of action arising from or on account of acts or omissions of Respondent or its officers, employees, receivers, trustees, agents, contractors, subcontractors or assigns, in carrying out any activities pursuant to this Order. EPA is not and shall not be represented to be a party to any contract entered into by Respondent to carry out activities pursuant to this Order; provided, however, that Respondent shall be under no duty to indemnify the United States for claims or causes of action arising from or on account of negligent, willful or intentional acts or omissions of the United States, its officers, agents, employees or any other person acting on its behalf. Nothing herein is intended to or shall be construed as extending the liability of the United States beyond that provided for under Federal law.

any such liability, indemnification, contribution, reimbursement and cost recovery.

74. Respondent's consent to EPA jurisdiction and authority to issue this Order is solely for the purposes of entry and enforcement of this Order. Said consent shall not constitute any admission by Respondent of any liability with respect to these matters, conditions on or surrounding the Site or any acts or omissions by any person concerning the Site. By signing this Order, Respondent does not waive, except for their consent to jurisdiction for purposes of entry and enforcement of this Order, including actions for penalties for non-compliance with the terms of this Order, any claim or defense that they might have raised to this Order, or that they might raise in any other judicial or administrative proceeding brought by EPA, including enforcement actions involving the dispute resolution provisions of paragraph 33 of this Order, any other governmental agency or any other person.

XXVI. NOTICE TO THE STATE

75. EPA has notified the State of Iowa as to the issuance of this Order.

XXVII. MODIFICATION

76. This Order may be modified by the mutual agreement of all parties. Any such amendments shall be in writing and shall be signed by representatives of all parties. Unless otherwise provided for in the amendment, the effective date of any such modification shall be the date on which the written agreement of modification has been signed by all parties.

IN WITNESS WHEREOF, the parties have affixed their signatures below:

For the United States Environmental Protection Agency, Region VII

Daniel J. Shiel
Assistant Regional Counsel
U.S. Environmental Protection Agency
Region VII

9/30/93
Date

For Peoples Natural Gas Company

P. B. Tvrdik
Sr. Vice President

9/29/93
Date

IT IS SO ORDERED.

David A. Wagoner
Director, Waste Management Division
U/S. Environmental Protection Agency
Region VII

9/30/93
Date

Appendix B

U.S. EPA Review of Phase I Investigation Report

(11)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VII
726 MINNESOTA AVENUE
KANSAS CITY, KANSAS 66101

JAN 24 1992

Mr. Gregory J. Benak, Attorney
Peoples Natural Gas
1815 Capitol Avenue
Omaha, Nebraska 68102

Dear Mr. Benak:

Re: Peoples Natural Gas Company
Council Bluffs, Iowa Site

Enclosed is a copy of the U. S. Environmental Protection Agency's comments on the Phase I Investigation Report for the above-referenced site.

We expect to forward our proposed administrative consent order concerning additional site investigation to you for review in the very near future.

If you have any questions about this matter please call me at (913) 551-7278.

Sincerely yours,

Daniel J. Shiel
Assistant Regional Counsel

Enclosure

cc: Russell Selman w/enclosure

RECYCLE

COMMENTS ON
REPORT OF FINDINGS
PHASE I INVESTIGATION
FOR
PEOPLES NATURAL GAS
COUNCIL BLUFFS, IOWA
APRIL 12, 1990

INTRODUCTION

In support of the U.S. Environmental Protection Agency (EPA) Region VII, Jacobs Engineering Group Inc. (Jacobs) has completed a review of the document entitled Report of Findings Phase I Investigation for Peoples Natural Gas, Council Bluffs, Iowa. This document was completed by Dames and Moore and is dated April 12, 1990. EPA Region VII had previously requested this document from the responsible party for review, however it was not received by EPA until September 1991. Jacobs was tasked at that time to conduct a review of this document to identify any potential data gaps and inconsistencies prior to the responsible party conducting additional activities at the site.

GENERAL COMMENT

In contrast to a Preliminary Assessment (PA) or Screening Site Investigation (SSI) Report, limited background information on historical operations at this facility is presented and no target information is included. Specifically, little or no information is presented on volumes of wastes that were generated during coal gas manufacturing. The report does not include any information concerning other past/potential sources of contamination.

SPECIFIC COMMENTS

Presented below is a listing of specific comments and data gaps which were identified. These comments are referenced to the specific section of the text in question.

1. Section 2.0 Potential Wastes Associated with Coal Gasification. Historical site information does not indicate volumes of wastes generated, such as spent oxide fill material, tar sludges, tar residues, and waste water. This information could be correlated with approximate volumes of wastes detected on-site.

2. Section 3.0 Scope of Work and Purpose. The Scope of Work dated June 23, 1989 is not included in this report. Therefore the rationale for work performed is not presented in this document. Specifically, the rationale for soil boring locations is not presented. Justification that these locations are likely to define extent of subsurface contamination is not presented. For example, boring ST-5 identifies this area as the former tar pit area, but no borings were advanced to delineate the extent of this burial pit.

   The location for boring ST-12 is not given.

   The rationale for selection of the location of soil samples submitted for laboratory analysis is not provided. It does not appear that soil sample locations have provided information on the extent and the levels of contamination, nor have they delineated highly contaminated areas ("hot spots"). Several references to contamination at depth were noted in the boring logs but no samples were collected. These are referenced in detail in #8. Analysis of soil samples collected throughout the vertical extent of each boring would have provided information on the vertical extent and level of contamination.

- In Boring ST-5, free product is noted as present in sample D-2. The depth of sample D-2 is not included on the boring log. Sample D-2 is noted as occurring in the interval from ground surface to a depth of 8 ft bls. Sample D-2 was not submitted for laboratory analysis. Free product is also noted as occurring in this boring in the interval between 8 ft bls and 13 ft bls. A sample was collected in this interval (12.5 ft bls); however, it is not known if this sample represents free product or native soil. Photoionization detector (PID) data for this boring indicate volatile organics were detected in a head space analysis sample at levels of 57 ppm at this sampling interval (12.5 ft bls). Head space PID data indicate volatile organics at levels up to 1900 ppm in this boring, however, a sample was not collected for laboratory analysis from this interval for comparison.

- In Boring ST-6, tar is noted on the boring log in the interval from 8 ft bls to a depth of 15 ft bls. A sample was collected from this interval at a depth of 12.5 ft bls; however, no sample description is included to determine if this sample contained tar. PID data from this boring indicate headspace organic vapors at a level of 380 ppm at the interval (8 - 15 ft bls). PID levels increase to 575 ppm at a depth of 15 ft bls, but no sample was collected for analysis. Contamination is also noted in a fine sand interval in Boring ST-6 at a depth of 30 ft bls to 31.5 ft bls. No sample was collected in this interval for laboratory analysis.

- In Boring B-7, free product is recorded as being present in the interval from 7 ft bls to 13 ft bls. No sample was collected from this interval for laboratory analysis and no PID data are included for this boring.

- In Boring ST-8, "product", "occasional organics", and "gross contamination" are recorded as occurring in this boring at depth intervals of 4 ft bls to 7 ft bls, 7 ft bls to 15 ft bls, 17 ft bls to 30 ft bls, and 30 ft bls to 30.5 ft bls. The PID Field Data Sheet for this boring notes free product at the following depth intervals: 5 ft, 7.5 ft, 17.5 ft, and 20 ft. Head space analysis data (PID data) range up to 604 ppm in this boring. Only one sample was collected for laboratory analysis from this boring at a depth of 20 ft bls.

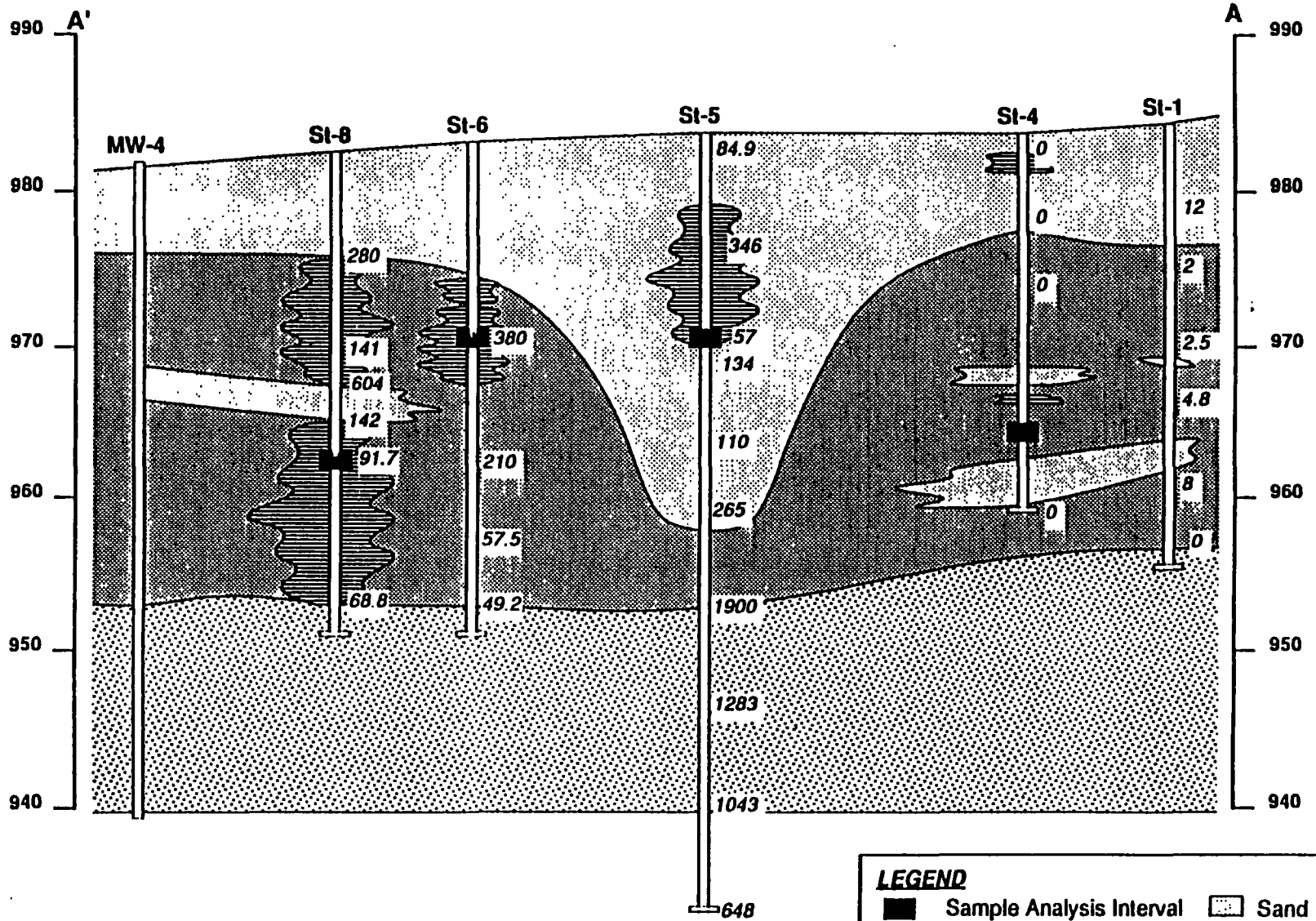
- In Boring ST-9 (MW-1), occasional organics are noted in the boring log in the interval from 2 ft bls to 15 ft bls. One sample was collected from this boring for laboratory analysis at a depth of 15 ft bls. It cannot be determined if the sample collected from ST-9 represents waste organics or native soil.

- In Boring ST-10, occasional organics are noted in the boring log in the interval from the ground surface to a depth of 12 ft bls. No sample was collected from this boring for laboratory analysis. PID data for this boring indicate low levels (2.9 - 15 ppm) of volatile organics detected.

- In Boring ST-11 (MW-3), "free product" is noted in the boring log as occurring in the interval from 8 ft bls to a depth of 17 ft bls. Gross contamination is also noted in this boring from the interval 18 ft bls to 26.5 ft bls. No sample was collected from this boring for laboratory analysis. The PID Field Data Sheet indicates free product (FP) at a depth of approximately 7 ft bls. PID head space analysis indicates volatile organics at levels up to 557 ppm.

- In Boring ST-12, "occasional organics" are noted in the boring log in the interval from 8 ft bls to a depth of 18 ft bls; "free product" is noted as occurring in the interval from 19 ft bls to a depth of 25 ft bls. No samples were collected from this boring for laboratory analysis even though free product wastes are present in this boring.

COUNCIL BLUFFS FMGP



NOTE: AREAS OF CONTAMINATION DEPICTED ON THIS DIAGRAM ARE ONLY MEANT TO DELINEATE ZONES WHERE TAR, FREE PRODUCT OR ORGANICS WERE NOTED ON BORING LOGS AND NOT TO DELINEATE EXTENT OF CONTAMINATION. SPECIFIC DEPTHS AND THICKNESSES OF CONTAMINATION WERE NOT INCLUDED ON BORING LOGS TO ALLOW FOR A MORE DETAILED DEPICTION OF WASTE EXTENT.

Appendix C

Regulatory Data Base Search

VISTA
NATIONAL RADIUS PROFILE

Vista Report #: 5-BECBOC-1121001 Date of Report: 2/18/93

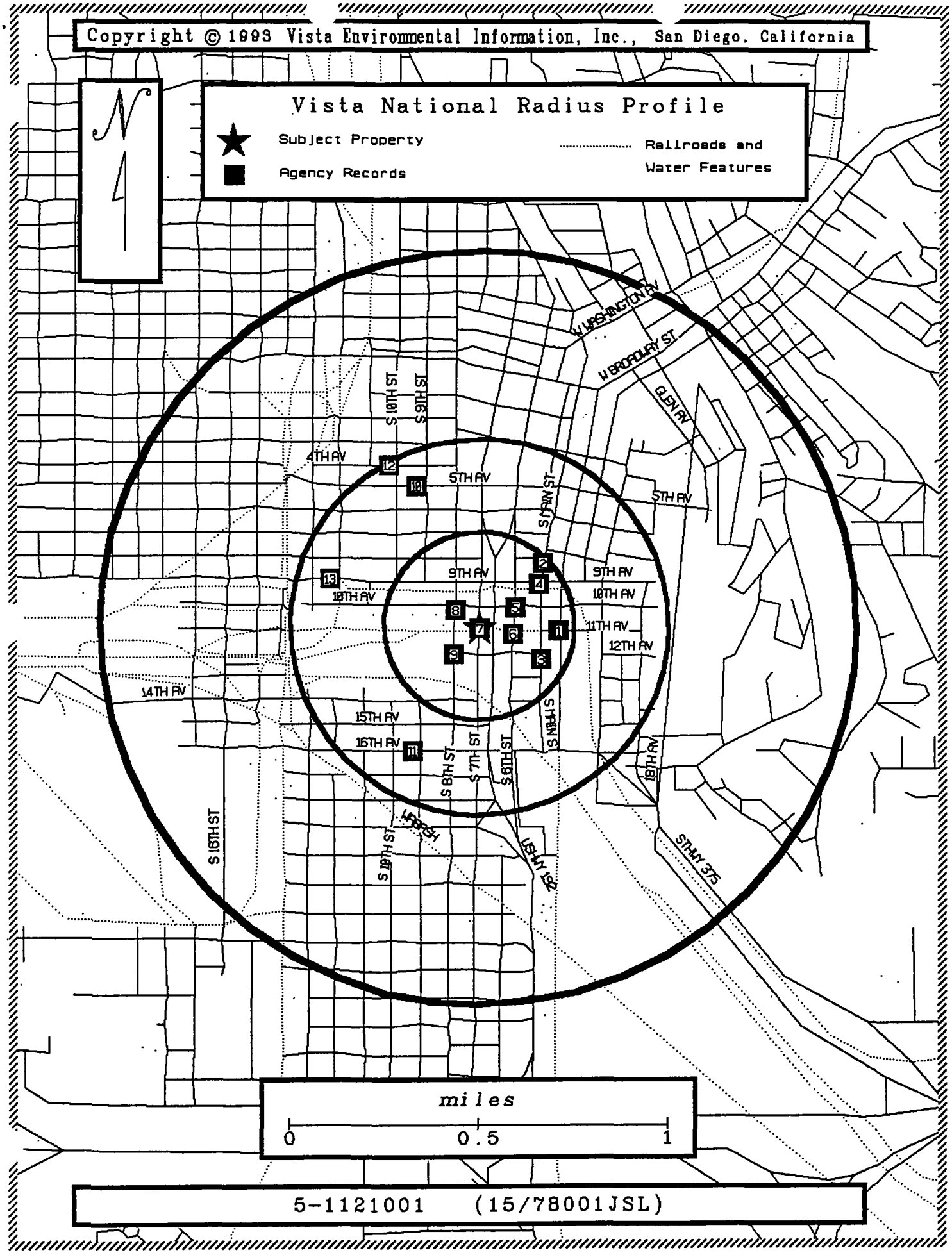
Ref/Loan #: 15/78001JSL
Client: CAROLYN KOHRO, BARR ENGINEERING - BLOOMINGTON
8300 NORMAN CENTER DR, BLOOMINGTON, MN 55437-1026
Subject
Property: 7TH ST & 11TH AVE (NE & NW CRN 7TH & 11TH)
COUNCIL BLUFF, IA 51501

SUMMARY OF FEDERAL RECORDS FOUND

Database & Date	Agency and Type of Records	0 to 1/4 mi	1/4 to 1/2 mi	1/2 to 1 mi	TOTAL
NPL 10/92	US EPA Superfund Sites	0	0	0	0
CERCLIS 11/92	US EPA Potential Superfund Sites	1	0	--	1
RCRA-LgGen 07/92	US EPA RCRA Large Quantity Generators	1	--	--	1
RCRA-SmGen 07/92	US EPA RCRA Small and Very Small Quantity Generators	3	--	--	3
RCRA-TSD 07/92	US EPA RCRA Treatment,Storage,and/or Disposal Sites	0	0	0	0
RCRA-Transp 07/92	US EPA RCRA Transporters	1	--	--	1
	FEDERAL RECORDS Sub-total:	6	0	0	6

Note: 1) A dash (--) indicates the list is not searched at that distance.
2) Sites often have a record in more than one database.

 For more information call: (619) 450-6100



5-1121001 (15/78001JSL)

RCRA-LgGen

MAP REF #	EPA ID / AGENCY ID	SITE NAME AND ADDRESS

WITHIN 1/4 MILE

6 ENVIRONMENTAL SALVAGE LTD — COUNCIL BLUFFS — Distance: .09 mi.
1201 S 6TH ST — 51501 — Direction: SE
Vista ID: 141142

IAD980633028 Generator Class :Generators who generate at least 1000 kg./month of non-acutely hazardous waste (or 1 kg./month of acutely hazardous waste).

RCRA-Transp

MAP REF #	EPA ID / AGENCY ID	SITE NAME AND ADDRESS		
WITHIN 1/4 MILE				
6		ENVIRONMENTAL SALVAGE LTD 1201 S 6TH ST	COUNCIL BLUFFS 51501	Distance: .09 mi. Direction: SE Vista ID: 141142
	IAD980633028	Transporter Status :Engaged in the off-site transportation of hazardous waste		

LUST

MAP REF #	EPA ID / AGENCY ID	SITE NAME AND ADDRESS		
WITHIN 1/4 TO 1/2 MILE				
12		BLUE STAR FOODS 1023 4TH ST	COUNCIL BLUFFS 51503	Distance: .49 mi. Direction: NW Vista ID: 51484
13		AMERICAN FUELS LTD 1231 9TH AVENUE	COUNCIL BLUFFS 51501	Distance: .41 mi. Direction: NW Vista ID: 2066862
	8601538			

UST's

MAP REF #	EPA ID / AGENCY ID	SITE NAME AND ADDRESS

WITHIN 1/4 MILE

9 OIL PRODUCTS CO INC — COUNCIL BLUFFS — Distance: .10 mi.
1205 S 8TH ST — 51501 — Direction: SW
Vista ID: 2066684

8607908 Number of Underground Tanks: 2
Contents : DIESEL,KEROSENE

CERCLIS

SITE NAME AND ADDRESS	VISTA ID	EPA ID / AGENCY ID
DRUMCO INC: 116TH & 29TH AVE, COUNCIL BLUFFS 51501	2827954	IAT200010718

Status	: NOT PROP/CURR/DELE NPL
Site Ownership	: OTHER
Lead Agency	: NO DETERMINATION
Site Events	:
Event Type	: SCREENING SITE INSPECTION
Lead Agency	: FUND LEAD
Event Type	: PRELIMINARY ASSESSMENT
Lead Agency	: FUND LEAD
Event Type	: DISCOVERY
Lead Agency	: FUND LEAD

LUST

SITE NAME AND ADDRESS	VISTA ID	EPA ID / AGENCY ID
QUICK STORE: RR 3, COUNCIL BLUFFS 51503	2084185	
		8606256
SKYWAY OIL: RR 3 BX 15, COUNCIL BLUFFS 51503	2084186	
		8600617
COUNCIL BLUFFS MUNIC AIRPORT: RTE 3 BOX 77L, COUNCIL BLUFFS 51503	2088048	
		9016682
LONG'S LANDING: , COUNCIL BLUFFS	3281037	
Owner Name : POTTAWATTAMIE COU		7LTP73
Owner Address : COURTHOUSE ANNEX		
COUNCIL BLUFF , IA 51501		

UST's

SITE NAME AND ADDRESS	VISTA ID	EPA ID / AGENCY ID
MARVEL & ROGER GREEN: RTE 1 BOX 116, COUNCIL BLUFFS 51501	2086327	
Number of Underground Tanks: 2		8915082
Contents : DIESEL,GASOLINE (UNSPECIFIED)		
DALE SCHMIESING: RTE 1 BOX 55A, COUNCIL BLUFFS 51503	2086328	
Number of Underground Tanks: 2		8914645
Contents : GASOLINE (UNSPECIFIED)		
JOHN POORE: ROUTE 1, COUNCIL BLUFFS 51503	2086329	
Number of Underground Tanks: 2		8606725
Contents : DIESEL		
KEITH H HUSZ: RTE 1 BOX 18, COUNCIL BLUFFS 51503	2086330	
Number of Underground Tanks: 2		8914552
Contents : GASOLINE (UNSPECIFIED),DIESEL		
POLLUTION CONTROL PLANT: RTE 1, COUNCIL BLUFFS 51503	2086331	
Number of Underground Tanks: 2		8911990
Contents : GASOLINE (UNSPECIFIED),DIESEL		
ROBERT THIESCHAFER: RTE 1 BOX 82, COUNCIL BLUFFS 51503	2086332	
Number of Underground Tanks: 1		8914815
Contents : GASOLINE (UNSPECIFIED)		
WILLIAM ROBERTS: RTE 1 BOX 126, COUNCIL BLUFFS 51503	2086333	
Number of Underground Tanks: 1		8914607
Contents : GASOLINE (UNSPECIFIED)		
MCMULLEN FORD: 3301 HIGHWAY 192, COUNCIL BLUFFS 51501	2087061	
Number of Underground Tanks: 1		8608164
Contents : UNKNOWN		

UST's

SITE NAME AND ADDRESS	VISTA ID	EPA ID / AGENCY ID
ST JOSEPH CEMETERY: RTE 3 BOX 32, COUNCIL BLUFFS 51503	2088055	
Number of Underground Tanks: 1		8915057
Contents : GASOLINE (UNSPECIFIED)		
MERYLE OSBORN: RTE 4 BOX 246, COUNCIL BLUFFS 51503	2088290	
Number of Underground Tanks: 2		8914568
Contents : GASOLINE (UNSPECIFIED),DIESEL		
RICK WENNINGHOFF: RTE 4 BOX 200, COUNCIL BLUFFS 51503	2088291	
Number of Underground Tanks: 1		8914622
Contents : GASOLINE (UNSPECIFIED)		
AT&T COMMUNICATIONS: , COUNCIL BLUFFS	2838112	
Number of Underground Tanks: 1		8608000
Contents : DIESEL		
LONG'S LANDING: , COUNCIL BLUFFS	2838134	
Number of Underground Tanks: 1		8810950
Contents : GASOLINE (UNSPECIFIED)		
POTTAWATTAMIE COUNTY ENGINEERS OFFIC: , COUNCIL BLUFFS 51501	2839136	
Number of Underground Tanks: 4		8602740
Contents : WASTE OIL,GASOLINE (UNSPECIFIED),DIESEL		
WALLACE HANSEN: , COUNCIL BLUFFS 51501	2839137	
Number of Underground Tanks: 1		8915019
Contents : GASOLINE (UNSPECIFIED)		
: RTE 2 BOX 44, COUNCIL BLUFFS 51503	2840789	
Number of Underground Tanks: 1		8914748
Contents : GASOLINE (UNSPECIFIED)		

DESCRIPTION OF DATABASES SEARCHED

Below are general descriptions of the federal and state databases that VISTA searches for the National Radius Profile.

FEDERAL DATABASES

Please check the "Summary of Federal Records Found" to determine the specific dates of the federal databases searched for this profile.

U.S. EPA: NPL

The National Priorities List (NPL) is the EPA's database of uncontrolled or abandoned hazardous waste sites identified for priority remedial action under the Superfund Program. A site, to be included on the NPL, must either meet or surpass a predetermined hazard ranking systems score, or be chosen as a state's top-priority site, or meet all three of the following criteria:

1) The US Department of Health and Human Services issues a health advisory recommending that people be removed from the site to avoid exposure.
2) The EPA determines that the site represents a significant threat.
3) The EPA determines that remedial action is more cost-effective than removal action.

U.S. EPA: CERCLIS

The CERCLIS List is a compilation by the EPA of the sites which the EPA has investigated or is currently investigating for a release or threatened release of hazardous substances pursuant to the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA or Superfund Act).

U.S. EPA: RCRA (RCRIS/HWDMS)

The EPA's Resource Conservation and Recovery Act (RCRA) Program identifies and tracks hazardous waste from the point of generation to the point of disposal. The RCRA Facilities database is a compilation by the EPA of reporting facilities that generate, transport, treat, store or dispose of hazardous waste.

STATE DATABASES

Please check the "Summary of State Records Found" to determine if the following type of databases are available from VISTA for the state in which the subject property of this report is located. Please note that if the Summary does not list one of the following databases, it is not currently available. You may also determine the specific names and dates of the databases searched for this profile in the summary.

STATE: SPL

The State Priority List is a generic name for databases maintained by many states that contain sites considered to be actually or potentially contaminated and presenting a possible threat to human health and the environment. These sites are generally listed by the state to warn the public or as a part of an an investigation and cleanup program managed by the state.

STATE: LUST

This is a database maintained by state or local agencies of known or suspected leaking underground storage tanks.

STATE: UST

This is a database maintained by state or local agencies of registered underground storage tanks.

STATE: SWLF

This is a database maintained by state or local agencies of Solid Waste Landfills, Incinerators, and transfer stations.

FEDERAL RECORDS REPORT

TABLE OF CONTENTS

FACILITY ADDRESS SPILL DATE

PEOPLES NATURAL GAS CO. (CONT'D)

Spill Time	: 4:10 PM
Source/Agency	: NATIONAL RESPONSE CENTER
Caller Name	: TALCOTT, JAMES
Caller Organization	: PEOPLES NATURAL GAS CO.
Caller Address	: 25 MAIN PLACE
	: COUNCIL BLUFFS, IA 51501
Material Spilled	: NATURAL GAS
Source of Spill	: PIPELINE
Medium Affected	: AIR
Waterway Affected	: RESIDENTIAL AREA
Reported Cause	: OTHER
Notification	: STATE AND LOCAL AUTHORITY

MISIDENTIFIED RECORDS SEARCH

The following sites, located in the search city, have inadequate or incomplete zip code information in the database records and may be located near the subject property:

Case Number: 02797 03/12/1987
COUNCIL BLUFFS, IA 5155

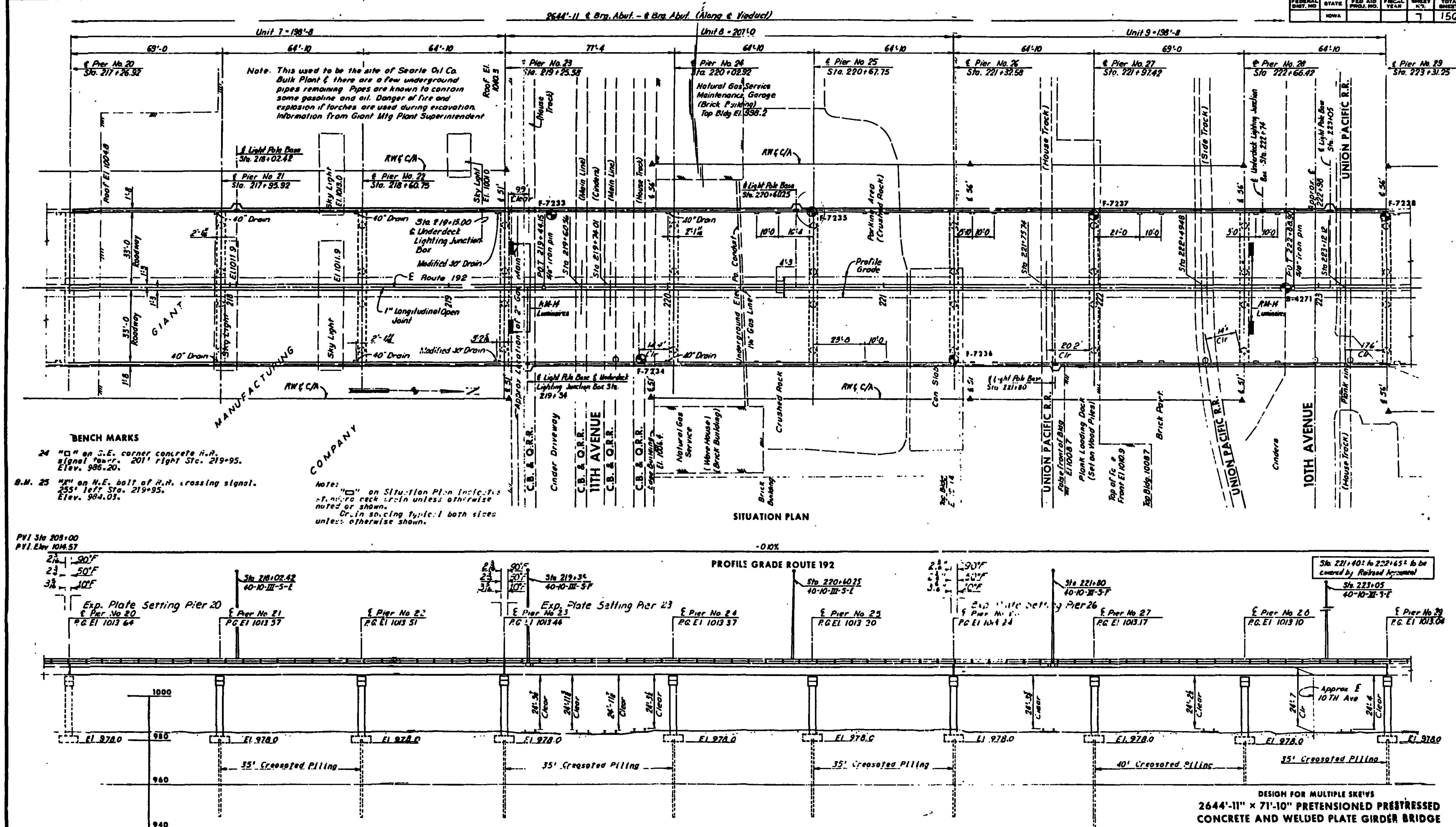
Spill Time	: 5:30 AM
Source/Agency	: NATIONAL RESPONSE CENTER
Discharger Address	: COUNCIL BLUFFS, UNION PACIFIC RR YARD, TRACK E-2
	: COUNCIL BLUFFS, IA 5155
Discharger Phone	: 0
Caller Name	: ,BERGHOLM, REX
Caller Organization	: UNION PACIFIC RR
Caller Address	: 1416 DODGE ST
	: OMAHA, NE 68179
Material Spilled	: 8.00 GAL POTASSIUM HYDROXIDE
Reported Cause	: OTHER

Case Number: 09069JJ 0900 08/12/1989
ALFORD'S TRUCK STOP
COUNCIL BLUFFS, IA

Source/Agency	: ENVIRONMENTAL PROTECTION AGENCY
Discharger Organization	: ALFORD'S TRUCK STOP
Discharger Address	: 2601 SOUTH 24TH STREET
	: COUNCIL BLUFFS, IA
Material Spilled	: DIESEL
Source of Spill	: FIXED FACILITY
Vehicle Id	: NONE

Appendix D

Iowa Department of Transportation Boring Logs



BENCH MARKS

24 "□" on S.E. corner concrete R.R. signal tower. 201' right Sta. 219+95. Elev. 986.20.

B.M. 25 "X" on N.E. bolt of R.R. crossing signal. 255' left Sta. 219+95. Elev. 984.03.

Note: "□" on Situation Plan indicates standard deck drain unless otherwise noted or shown. Drain spacing typical both sides unless otherwise shown.

NOTE: The information shown on this drawing concerning type and location of underground utilities is not guaranteed to be accurate or all inclusive. The Contractor is responsible for making his own determinations as to the type and location of underground utilities as may be necessary to avoid damage thereto.

FEDERAL DIST. NO.	STATE	FED AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
	IOWA			7	156

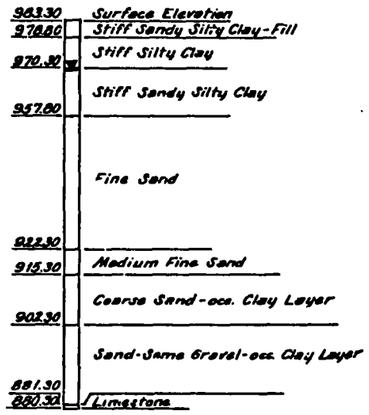
HOWARD, NEEDLES, TAMMEN & BERGENDOFF
CONSULTING ENGINEERS
KANSAS CITY — NEW YORK
MADE LER DATE 1-29-70 CHECKED JFP DATE 8-6-70

DESIGN FOR MULTIPLE SKEWS
2644'-11" × 71'-10" PRETENSIONED PRESTRESSED CONCRETE AND WELDED PLATE GIRDER BRIDGE
COUNCIL BLUFFS, IOWA — ROUTE 192 VIADUCT

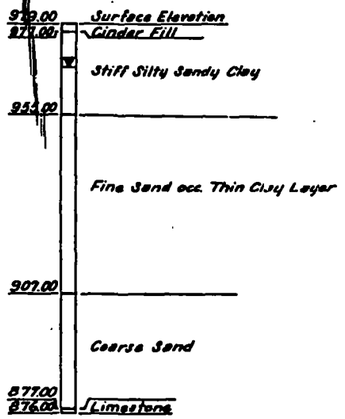
SITUATION PLAN

STATION 214 + 13.71 ROUTE 192 — PROJECT NO. U-192-1(2)-40-78
POTTAWATTAMIE COUNTY
IOWA STATE HIGHWAY COMMISSION
DEC. 1972 — SHEET 4 OF 75
DESIGN NO. 169 — POTTAWATTAMIE COUNTY — FILE NO. 23239

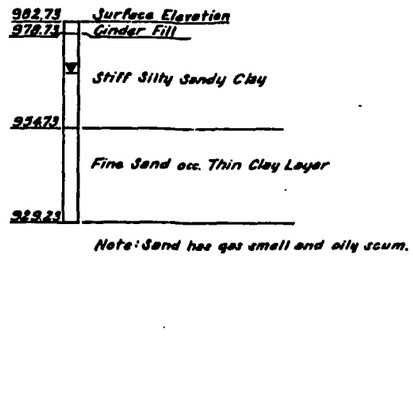
FEDERAL DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO	TOTAL SHEETS
	IOWA			11	156



B-4269

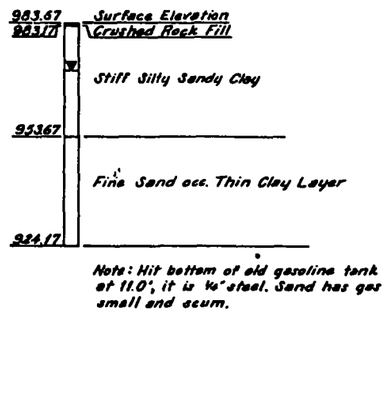


F-7233



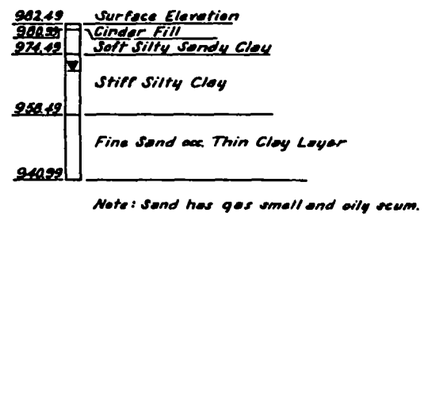
Note: Sand has gas smell and oily scum.

F-7234



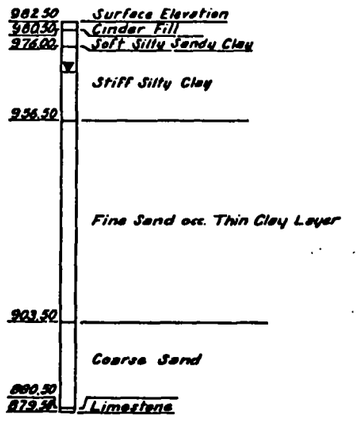
Note: Hit bottom of old gasoline tank at 11.0', it is ¼" steel. Sand has gas smell and scum.

F-7235



Note: Sand has gas smell and oily scum.

F-7236



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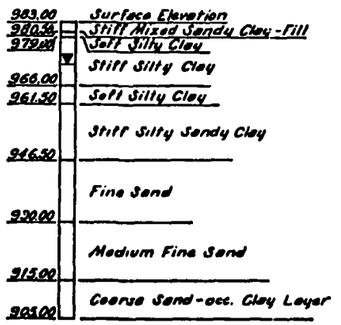
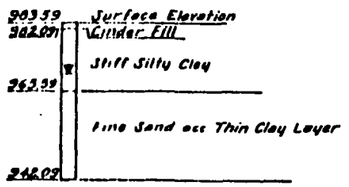


B-4271



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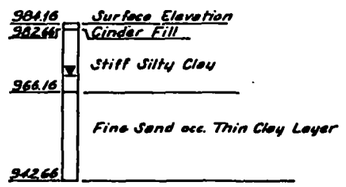
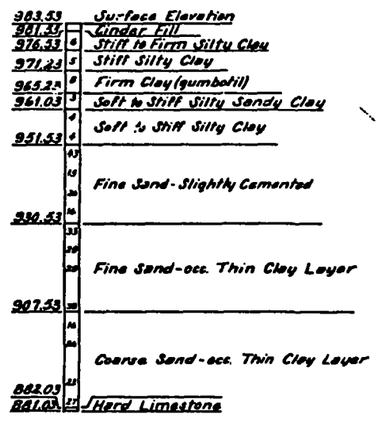


F-7239



G-702

▼ Indicates ground water level on 9-13-68 for B- borings and 8-11 & 8-4-69 for F- borings.

Figures inside boring log diagram indicate, N-values, number of blows of a 140 lb hammer falling 30" required to drive a 2" O.D., 1⅜" I.D. split barrel sampler one foot.

NOTE:
Subsurface information shown on this drawing was obtained solely for use in establishing design controls for the project. The accuracy of this information is not guaranteed and it is not to be construed as part of the plans governing construction of the project.

DESIGN FOR MULTIPLE SKEWS
2644'-11" × 71'-10" PRETENSIONED PRESTRESSED CONCRETE AND WELDED PLATE GIRDER BRIDGE
COUNCIL BLUFFS, IOWA ROUTE 192 VIADUCT

SOUNDING DATA

STATION 214 + 13.71 ROUTE 192 PROJECT NO. U-192-1(2)-40-78
POTTAWATTAMIE COUNTY
IOWA STATE HIGHWAY COMMISSION
DEC. 1972 SHEET 9 OF 75

HOWARD, NEEDLES, TAMMEN & BERGENDOFF
CONSULTING ENGINEERS
KANSAS CITY NEW YORK
MADE RDB DATE 1-29-70 CHECKED GL DATE 2-27-70

DESIGN NO. 169 POTTAWATTAMIE COUNTY FILE NO. 23239

Appendix E

Soil Boring Logs

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	DRILLER	LOGGER
ST-1	See Plan	96.91	100	RE	MAL

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	___ HOURS	Gravel	GEO - 88
18.0'				DRILLING METHOD: 4¼" hollow stem augers	TOTAL DEPTH: 30.0'

DEPTH	SAMPLE NO. & TYPE	HNu READING	COLOR	MOIST	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	DEPTH
			Dark Brown	Damp	CL	6" gravel, silty clay, occasional gravel, fill, stiff.	
	D-1						
5			Brown			Silty clay, stiff, iron and carbon stains, occasional gravel.	5
	D-2						
			Grayish Brown		CL with fine sand	Very stiff, silty clay with sand, iron and carbon stains, occasional gravel.	
10							10
	D-3						
	D-4						
15							15
	D-5					Blocky streaks, occasional calcite, iron & carbon concretions, very stiff, silty clay with some fine sand, no odor.	
	D-6			Saturated		Little more silt, slight odor.	
20							20
	D-7						
			Tan-Brown		SP with silt	Silty clay, fine sand, iron and carbon stains, occasional gravel.	
					CL	Stiff, silty clay, iron and carbon stains, occasional fine sand, no odor.	
25	D-8						25
	D-9						
30					SP	Fine sand, poorly sorted, occasional carbon stains, no odor.	30
						Bottom of Hole @ 30.0'	
35						Note: Alluvial setting.	35

Geotechnical Services Inc.

Project	
PEOPLES NATURAL GAS	
Location	
Council Bluffs, Iowa	
Job No. 3ZG017	Date 11-13-89

Form 301 1/89

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	DRILLER	LOGGER
ST-2	See Plan	96.41	100	RE	MAL

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	HOURS	Gravel	GEO - 88
17.5'				DRILLING METHOD: 4¼" hollow stem augers	TOTAL D: 41.5

DEP. Ft.	SAMPLE NO. & TYPE	HNu READING	COLOR	MOIST	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	DEP. Ft.
			Dark Brown	Damp	CL	Coarse gravel 1', dark brown fill 1', stiff, silty clay, iron and carbon stains, occasional gravel, no odor.	
5	U-1						5
	U-2						
	U-3						
10			Gray Green			Slight odor, silty clay with some fine sand iron and carbon stains, roots @ 12.0'.	10
	U-4						
	U-5					Strong odor @ 13.0'.	
15							15
	U-6		Lab Sample				
	U-7			Saturated		More sand at 17.5' some silt.	
20							20
	U-8						
	U-9						
25							25
	U-10						
	U-11						
30							30
	D-1				SP	Fine sand, iron and carbon stains, poorly sorted, slight odor.	
35	D-2		Lab Sample				35

Geotechnical Services Inc.

Project	
PEOPLES NATURAL GAS	
Location	
Council Bluffs, Iowa	
Job No. 3ZG017	Date 11-13-89

Form 301 1/88

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	DRILLER	LOGGER
ST-2	See Plan	96.41	100	RE	MAL

DEP. Ft.	SAMPLE NO. & TYPE	HNu READING	COLOR	MOIST.	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	DEP. Ft.
40	D-3		Gray Green	Saturated	SP	Fine sand, iron and carbon stains, poorly sorted, slight odor.	40
45						Bottom of Hole @ 41.5'.	45
50							50
55							55
60							60
65							65
70							70
75							75

Geotechnical Services Inc.

Project	
PEOPLES NATURAL GAS	
Location	
Council Bluffs, Iowa	
Job No. 3ZG017	Date 11-13-89

Form 301-2 1/89

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	DRILLER	LOGGER
ST-3	See Plan	96.41'	100	RE	MAL

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	___ HOURS	Gravel	GEO - 88
15.0'				DRILLING METHOD: 4¼" hollow stem augers	TOTAL: 32.5

DEP. Ft.	SAMPLE NO. & TYPE	HNu READING	COLOR	MOIST	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	DEP. Ft.
			Dark Brown	Damp	CL	Coarse gravel 8", dark brown organic fill 1½', silty clay, stiff, iron and carbon stains, no odor, occasional gravel, pin holes.	
	U-1						
5							5
	U-2		Grayish Brown			Stiff, silty clay, blocky streaks, pinholes iron and carbon stains, no odor.	
	U-3						
10							10
	U-4					Little more fine sand @ 10.5', organics at 12.0'.	
	U-5						
15							15
	U-6			Saturated	SP w/clay	Fine sand with silt and clay.	
			Brown		CL	Fat clay with little silt, iron and carbon stains, very stiff.	
	U-7						
20							20
	U-8						
	U-9					More fine sand.	
25							25
	U-10						
	U-11						
30							30
					SP	Fine sand, poorly sorted, some silt, iron and carbon stains.	
35						Bottom of Hole @ 32.5'	35

Geotechnical Services Inc.

Project	
PEOPLES NATURAL GAS	
Location	
Council Bluffs, Iowa	
Job No.	Date
3ZG017	11-14-89

Form 301 1/89

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	DRILLER	LOGGER
ST-4	See Plan	96.76	100	RE	MAL

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	____ HOURS	Gravel	GEO - 88
15.5'				DRILLING METHOD: 4¼" hollow stem augers	TOTAL DEPTH: 25.0'

DEP. FT.	SAMPLE NO. & TYPE	HNu READING	COLOR	MOIST	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	DEP. FT.
			Dark Brown	Damp	CL	8" road gravel, 1' dark brown fill, organics, silty clay, stiff, iron and carbon stains.	
5	U-1						5
	U-2						
			Grayish Brown			Very stiff, silty clay, iron and carbon stains, occasional gravel, occasional calcite concretions, occasional organics, no odor.	
10	U-3						10
	U-4						
	U-5						
15							15
	U-6			Saturated	SP	Fine sand with some silt.	
	U-7				CL	Fat clay, blocky streaks, little silt, occasional organics, occasional calcite concretions.	
20	U-8		Lab Sample				20
					SP with some silt	Fine sand, poorly sorted, little silt.	
25							25
30						Bottom of Hole @ 25.0'.	30
35							35

Geotechnical Services Inc.

Project	
PEOPLES NATURAL GAS	
Location	
Council Bluffs, Iowa	
Job No. 3ZG017	Date 11-14-89

Form 301 1/89

BORING LOG

DRILL HOLE NO.	LOCATION OF DF HOLE	ELEVATION	DATUM	DRILLER	LOGGER
ST-5	See Plan	95.05	100	RE	MAL

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	____ HOURS	Asphalt	GEO - 88
5.0'				DRILLING METHOD: 4¼" hollow stem augers	TOTAL DE: 50.0'

DEP. FT.	SAMPLE NO. & TYPE	HNu READING	COLOR	MOIST	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	DEP. FT.
5	D-1		Black	Damp	CL	4" asphalt, junk fill, silty, sandy, gravel, clay with wood and brick etc.	5
	D-2			Saturated		Free product in sample D-2	
10	D-3				SP	Fine - medium sand and tar (free product).	10
	D-4						
15	D-5				SP with Clay	Silty clay, sand, fill, bricks, cobbles, etc. strong odor.	15
	D-6		Grayish Brown				
20	D-7						20
	D-8						
25	D-9						25
	D-10						
30					CL	Clay with some silt, occasional gravel, strong odor.	30
	D-11				SP	Fine sand, little silt, poorly sorted.	
35							35

Geotechnical Services Inc.

Project	
PEOPLES NATURAL GAS	
Location	
Council Bluffs, Iowa	
Job No. 3ZG017	Date 11-14-89

Form 301 1/89

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	DRILLER	LOGGER
ST-5	See Plan	95.05	100.0	RE	MAL

DEP. Ft.	SAMPLE NO. & TYPE	HNu READING	COLOR	MOIST	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	DEP Ft.
40	D-14		Grayish Brown	Saturated	SP	Fine sand, poorly sorted, little silt, strong odor	40
45	D-15						45
50	D-16						50
	D-17						
55						Bottom of Hole @ 50.0'	55
60							60
65							65
70							70
75							75

Geotechnical Services Inc.

Project: PEOPLES NATURAL GAS

Location: Council Bluffs, Iowa

Job No.: 3ZG017

Date: 11/14/89

Form 301-2 1/89

BORING LOG

DRILL HOLE NO.	LOCATION OF HOLE	ELEVATION	DATUM	DRILLER	LOGGER
ST-6	See Plan	95.45	100	RE	MAL

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	___ HOURS	Gravel	GEO - 88
30.0'				DRILLING METHOD: 4¼" hollow stem augers	TOTAL: 31.5

DEP. FT.	SAMPLE NO. & TYPE	HNu READING	COLOR	MOIST	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	DEP. FT.
			Tan-Brown	Damp	CL	8" fill gravel, 1' dark brown silty clay fill, bricks, gravel, clinkers etc.	
	U-1		Gray Brown				
5							5
	U-2					Fill, strong odor, discolored.	
	U-3		Bluish Gray			Stiff, silty clay, occasional organics, occasional fine sand, blocky streaks, tar in sample.	
10							10
	D-1						
	U-4		Lab Sample				
15							15
	U-5		Grayish Brown w/Red Mottles			Very stiff, fat clay, product, occasional calcite concretions, iron and carbon stains, strong odor.	
	U-6						
20			No Mottles				20
	U-7						
	U-8						
25							25
	U-9					Little more fine sand @ 26.0'.	
	U-10						
30							30
	U-11			Saturated	SP	Fine sand, poorly sorted, little silt, contamination.	
35						Bottom of Hole @ 31.5'	35

Geotechnical Services Inc.

Project	
PEOPLES NATURAL GAS	
Location	
Council Bluffs, Iowa	
Job No. 3ZG017	Date 11-15-89

Form 301 1/89

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	DRILLER	LOGGER
B-7	See Plan	95.05	100	RE	MAL

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	HOURS	Gravel	GEO - 88
7.0'				DRILLING METHOD: 6" continuous flight augers	TOTAL DEPTH: 25.0'

DEP. FT.	SAMPLE NO. & TYPE	HNu READING	COLOR	MOIST	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	DEP. FT.
5			Dark Brown	Saturated	CL	8" gravel, silty clay fill, gravel, bricks etc.	5
10			Black	Saturated		Slag, clay, gravel, strong odor, free product.	10
15					CL	Very stiff, fat silty clay, strong odor, occasional gravel, calcite concretions.	15
20							20
25			Gray with Brown Mottles				25
30						Bottom of Hole @ 25.0'	30
35							35

Geotechnical Services Inc.

Project: PEOPLES NATURAL GAS

Location: Council Bluffs, Iowa

Job No.: 3ZG017

Date: 11-16-89

Form 301 1/89

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	DRILLER	LOGGER
ST-8	See Plan	95.10	100	RE	MAL

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	HOURS	Gravel	GEO - 88
12.0'				DRILLING METHOD: 4¼" hollow stem augers	TOTAL: 31.5'

DEP. Ft.	SAMPLE NO. & TYPE	HNu READING	COLOR	MOIST	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	DEP. Ft.
			Dark Brown	Damp	CL	8" coarse gravel, 1' black fill, bricks wood etc. 2-4' concrete.	
	D-1						
5			Black			Slag, silty clay, product, sand and gravel, fill, stiff.	5
	D-2						
					CL	Stiff, silty clay, occasional gravel, fine sand, occasional organics, gross contamination.	
	D-3						
10							10
	D-4						
				Saturated			
	D-5						
15							15
	D-6				SP	Fine sand, poorly sorted, dense, some silt, occasional gravel.	
					CL	Very stiff, silty clay, iron and carbon stains, strong odor, gross contamination.	
	D-7						
20							20
	D-8		Lab Sample				
25							25
	D-9						
30							30
	D-10				SP	Fine sand, little silt, dense, slight contamination.	
35						Bottom of Hole @ 31.5'	35

Geotechnical Services Inc.

Project	
PEOPLES NATURAL GAS	
Location	
Council Bluffs, Iowa	
Job No. 3ZG017	Date 11-16-89

Form 301 1/89

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	DRILLER	LOGGER
ST-9	See Plan	96.61	100	RE	MAL

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	HOURS	Gravel	GEO - 88
16.5'				DRILLING METHOD: 4¼" hollow stem augers	TOTAL DEPTH: 31.5'

DEP. FT.	SAMPLE NO. & TYPE	HNu READING	COLOR	MOIST.	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	DEP. FT.
			Dark Brown	Damp	CL SP	8" gravel, 1'dark silty clay fill, fill-gravel, bricks, wood etc.	
	D-1		Brown		CL	Stiff, silty clay, iron and carbon stains, slight odor, occasional gravel, occasional organics.	
5							5
	D-2						
			Gray			Very stiff.	
	D-3						
10							10
	D-4						
	D-5						
15							15
	D-6		LAB SAMPLE				
				Saturated	SP with clay	Fine sand, poorly sorted, some silty clay, iron and carbon stains.	
	D-7					Silty clay with some fine sand, very stiff.	
20							20
	D-8						
25							25
	D-9						
30							30
	D-10						
						Mw-1 Bottom of Hole @ 31.5' Bottom of Well @ 23.0'	
35							35

Geotechnical Services Inc.

Project	
PEOPLES NATURAL GAS	
Location	
Council Bluffs, Iowa	
Job No. 3ZG017	Date 11-17-89

Form 301 1/89

BORING LOG

DRILL HOLE NO.	LOCATION OF D' HOLE	ELEVATION	DATUM	DRILLER	LOGGER
ST-10	See Plan	96.61	100	JA	MAL

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	HOURS	Gravel	Mobile B-57
18.0'				DRILLING METHOD: 6¼" hollow stem augers	TOTAL DE: 26.5'

DEP. FT.	SAMPLE NO. & TYPE	HNu READING	COLOR	MOIST	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	DEP. FT.
5			Brown-Greenish Brown	Damp	CL	8" gravel, 1' fine fill sand, silty clay fill, iron and carbon stains, occasional gravel, no odor, occasional fine sand, occasional organics.	5
	U-1		Dark Brown-Gray			Very stiff, less sand @ 6.0'.	
10							10
	U-2						
15			Bluish-Brown with Black Mottles			Very stiff, silty clay, blocky streaks, iron and carbon stains, slight odor, occasional fine sand.	15
	U-3						
20				Saturated	SP	Fine-medium sand with some silt and clay, iron and carbon stains, slight odor.	20
	U-4				CL	Very stiff, silty clay, iron and carbon stains, occasional fine sand.	
25							25
	U-5						
30						Bottom of Hole @ 26.5' Bottom of Well @ 44'± !! (Figured from inside of casing - no samples.)	30
35							35

Geotechnical Services Inc.

Project	
PEOPLES NATURAL GAS	
Location	
Council Bluffs, Iowa	
Job No.	Date
3ZG017	11-27-89

Form 301 1/89

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	DRILLER	LOGGER
ST-11	See Plan	95.05	100	JA	MAL

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	____ HOURS	Gravel	Mobile B-57
8.0'				DRILLING METHOD: 6¼" hollow stem augers	TOTAL DEPTH: 26.5'

DEP. FT.	SAMPLE NO. & TYPE	HNu READING	COLOR	MOIST	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	DEP. FT.
5	U-1		Dark Brown	Damp	CL	8" gravel, sandy, gravely, silty clay, bricks, glass, wood etc., fill. 8'	5
10	U-2		Dark Gray	Saturated	CL	Very stiff, silty clay, iron and carbon stains, free product, occasional gravel and sand.	10
15	U-3					17	15
				Saturated	SP	12 Fine-medium sand with silt and clay, iron and carbon stains.	
20	U-4				CL	Very stiff, silty clay, gross contamination occasional gravel and fine sand.	20
25	U-5					26.5	25
30						MW- Bottom of Hole @ 26.5'	30
35							35

Geotechnical Services Inc.

Project	
PEOPLES NATURAL GAS	
Location	
Council Bluffs, Iowa	
Job No.	Date
3ZG017	11-28-89

Form 301 1/89

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	DRILLER	LOGGER
ST-12	See Plan	95.35	100	JA	MAL

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	___ HOURS	Gravel	Mobile B-57
18.0'				DRILLING METHOD: 6¼" hollow stem augers	TOTAL: 25.0

DEP. FT.	SAMPLE NO. & TYPE	HNu READING	COLOR	MOIST	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	DEP. FT.
5			Dark Brown	Damp	CL	8" road gravel, sand, silty, gravel, clay, brick, glass, wood, etc (fill).	5
	U-1					8	
10			Bluish Gray		CL	Very stiff, silty clay, iron and carbon stains, occasional sand and gravel, occasional organics.	10
	U-2						
15							15
	U-3					18	
					SP	Fine-medium sand.	
20					CL	Very stiff, silty clay, iron and carbon stains, occasional organics, shell fragments, free product.	20
	U-4						
25						25	25
	U-5						
30						Bottom of Hole @ 25.0'	30
35							35

Geotechnical Services Inc.

Project	
PEOPLES NATURAL GAS	
Location	
Council Bluffs, Iowa	
Job No. 3ZG017	Date 11-28-89

Form 301 1/89

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	DRILLER	LOGGER
ST-13	See Plan	95.05	100	MO	MAL

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	HOURS	Gravel	Mobile B-57
28.0'				DRILLING METHOD: 4¼" hollow stem augers	TOTAL DEPTH: 31.5'

DEP. FT.	SAMPLE NO. & TYPE	HNu READING	COLOR	MOIST	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	DEP. FT.
			Gray with Red Mottles	Damp	CL	8" gravel, silty, sandy, gravely, clay fill iron and carbon stains, cinders, etc.	
	U-1						
5			Dark Gray			Contamination, odor, slight sheen on sample.	5
	U-2						
	U-3				CL	Stiff, silty clay, occasional sand and gravel, strong odor, occasional organics.	
10							10
	U-4		LAB ANALYSIS				
					SP with clay	Fine sand with silty clay, strong odor, carbon stains, sheen on sample.	
	U-5						
15							15
	U-6						
			Brown with gray mottles		CL	Very stiff, silty clay, iron and carbon stains, occasional fine sand, occasional organics, blocky streaks, pin holes.	
20							20
	U-7						
25							25
	U-8						
				Saturated	SP	Fine-medium sand, slight odor, iron and carbon stains.	
30							30
	U-9						
35						Bottom of Hole @ 31.5'	35

GS Geotechnical Services Inc.

Project: PEOPLES NATURAL GAS

Location: Council Bluffs, Iowa

Job No.: 3ZG017

Date: 12-1-89

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BORING LOG

DRILL HOLE NO.	LOCATION OF D. HOLE	ELEVATION	DATUM	DRILLER	LOGGER
ST-14	See Plan	96.26	100	MO	MAL

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	___ HOURS	Gravel	Mobile B-5
7.0'				DRILLING METHOD: 4¼" hollow stem augers	TOTAL: 31.5'

DEP. Ft.	SAMPLE NO. & TYPE	HNu READING	COLOR	MOIST	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	DEP. Ft.
5			Dark Brown	Damp	CL	8" gravel, silty, sandy gravely clay (fill) cinders, bricks, etc.	5
	U-1						
10				Saturated			10
	U-2				CL	Stiff, silty clay, iron and carbon stains, gross contamination.	
15							15
	U-3		LAB SAMPLE		SP w/CL	Fine sand with silt and clay.	
					CL		
20							20
	U-4						
25							25
	U-5						
30					SP	Fine-medium sand, with occasional silt and clay with gravel.	30
	U-6						
35						Bottom of Hole @ 31.5'	35

Geotechnical Services Inc.

Project	
PEOPLES NATURAL GAS	
Location	
Council Bluffs, Iowa	
Job No. 3ZG017	Date 12-1-89

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BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	DRILLER	LOGGER
MW-1	See Plan			R. Epply	M. Lohnes

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	___ HOURS	Gravel	GEO 88
16.5'				DRILLING METHOD: 6¼" hollow stem augers	TOTAL DEPTH: 24.0'

DEP. Ft.	SAMPLE NO. & TYPE	HNu READING	COLOR	MOIST	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	DEP. Ft.
			Dark Brown	Dmap	CL	8" gravel, 1' sandy silty clay fill, gravel, bricks, wood, etc.	
					SP		
	D-1	4	Brown		CL	Stiff, silty clay, iron and carbon stains, slight odor, occasional gravel, occasional organics	
5							5
	D-2	2					
	U-1		Gray			Very stiff @ 7.0'	
10							10
	U-2						
	U-3						
15							15
	U-4						
				Saturated	SP	Fine sand, poorly sorted, some silt and clay, iron and carbon stains	
	U-5				CL w/SP	Silty clay with some fine sand, very stiff	
20							20
	U-6						
25							25
						Bottom of Hole @ 24.0'	
30							30
35							35

Geotechnical Services Inc.

Project	Peoples Natural Gas	
Location	Council Bluffs, Iowa	
Job No.	3ZG017	Date 11/17/89

Form 301 1/88

BORING LOG

PROJECT: Citizens Gas and Elr 'c Co. Site
DATE STARTED: 4/18/94
DATE COMPLETED: 4/19/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: Ray Coons (J&R)

BORING N SB-15
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 983.69 ft. MSL

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0					CL	
	18	-	G	D-M		SANDY LEAN CLAY (CL) - About 10% silt, 20% sand, trace gravel, very dark gray (10YR 3/1), very slight chemical odor, no sheen (fill).
						Slight dark discoloration, dark greenish-gray (5GY 4/1), slight odor.
	12	2 2 3 3	SB	M		Trace clinkers, slag, no odor, very dark gray (N 3/).
5						
	16	2 1 2 3	SB	M		
	24	1 2 2 3	SB	M		
						9.0'
10						LEAN CLAY WITH A LITTLE SILT (CL) - About 10% silt, silt is mottled and is a little darker and has a slightly stronger odor, gray (N 5/), slight odor, no sheen (alluvium).
	28	1 2 3 5	SB	M		
						13.0'
				M	ML	
	14	1 2 3 4	SB	W		SILT (ML) mostly silt with a little clay, gray (N 5/), slight odor, no sheen (alluvium).
15						
		1		W		15.5'
	22	2 3 4	SB	M	CL	LEAN CLAY (CL) - Abundant root holes and oxidation, moderate hardness, low plasticity, very slow dilatency, gray (N 5/), no odor, no sheen (alluvium).
						17.5'
	15	2 3 3 2	SB	W	ML	SILT (ML) - Mottled oxidation abundant, trace root holes, olive gray (5Y 5/2), slight odor, no sheen (alluvium).
20						~20.0'
		1		M	CH	FAT CLAY (CH).
	16	2 4 6	SB	W		20.5'
					ML	SILT (ML).
						22.0'
		1		M	CH	FAT CLAY (CH), moderate hardness, moderate-high plasticity, no dilatency.
	8	2 3 4	SB	W		23.5'
					ML	SILT (ML).
25						24.5'
	0.8 0.0	2 2 5 12	SB	M W	CH	FAT CLAY (CH), duplicate headspace sample collected.
						26.7'
					SP	POORLY GRADED SAND (SP) - Mostly fine sand, trace medium sand, dark greenish gray (5GY 4/1), no odor, no sheen (alluvium).
	0.8	1 3 5 12	SB	W		
30						

COMMENT: Soil boring constructed with 7 7/8-inch (OD), 4 1/4-inch (ID) hollow-stem auger. Soil samples were collected with either a 2-inch or 3-inch split-barrel sampler (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure).
G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet.

BORING LOG

PROJECT: Citizens Gas and Elr 'c Co. Site
DATE STARTED: 4/18/94
DATE COMPLETED: 4/19/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: Ray Coons (J&R)

BORING I SB-15 (Cont.)
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 983.69

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
30						
	1	22 27 33 30	SB	W	SP	Fine sand as above.
	1	5 2 11 14	SB	W		
35						
	-	-	-	-		No sampling.
	1	6 6 27 40	SB	W		
40						
	3	4 15 28 64	SB	W		
	0	11 61 41 38	SB	W		
45						
	0	6 13 12 12	SB	W		Mostly fine to medium sand, about 5% silt.
	0	4 8 12 14	SB	W		Mostly fine sand, 1/4-inch lignite lamina.
50						
	0	3 2 5 5	SB	W		Trace lignite.
	1	4 7 9 10	SB	W		
55						
	3	1 2 5 10	SB	W		50% fine to medium sand, 40% fine sand, 5 to 10% silt.
	1	8 11 15 16	SB	W		
60						

COMMENT: Soil boring constructed with $7^7/_8$-inch (OD), $4^1/_4$-inch (ID) hollow-stem auger. Soil samples were collected with either a 2-inch or 3-inch split-barrel sampler (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure).
G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet.

BORING LOG

PROJECT: Citizens Gas and Ele : Co. Site
DATE STARTED: 4/18/94
DATE COMPLETED: 4/19/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: Ray Coons (J&R)

BORING N SB-15 (Cont.)
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 983.69

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
60					SP	
	1	3 5 8 12	SB	W		POORLY GRADED SAND as above.
	-	5 8 20 25	SB	W		
65						
	-	- -	-	-		No sampling.
	526	10 5 8 11	SB	W		
						69.0'
70						POORLY GRADED SAND (SP), mostly fine sand. At 69 feet, 6-inch layer of lignite with fine platy structure. The lignite is very dark gray (N 3/) and exhibits a moderate naphthalene-like odor, no sheen.
	433	1 2 11 13	SB	W		Sand is dark greenish gray (SGY 4/1) with moderate odor.
	758	3 4 14 23	SB	W		
75						
	339	5 10 26 26	SB	W		Trace hydrophobic silt-size particles floating in water.
	23	5 10 13 22	SB	W		10% lignite as medium sand, slight odor.
80						
	64	6 4 8 10	SB	W		5% lignite as medium sand.
	65	10 12 9 12	SB	W		5% lignite.
85						
	149	9 8 8 13	SB	W		10% lignite as medium-coarse sand, trace gravel size wood fragments.
	193	4 8 13 30	SB	W		5% lignite.
90						

COMMENT: Soil boring constructed with $7^7/_8$-inch (OD), $4^1/_4$-inch (ID) hollow-stem auger. Soil samples were collected with either a 2-inch or 3-inch split-barrel sampler (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure).
G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet.

BORING LOG

PROJECT: Citizens Gas and Ele : Co. Site
DATE STARTED: 4/18/94
DATE COMPLETED: 4/19/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: Ray Coons (J&R)

BORING N SB-15 (Cont.)
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 983.69

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
90						
	405	5 9 12 15	SB	W M	SP SW	Poorly graded sand as above. 90.5' Well graded sand (SW), strong naphthalene-like odor, abundant oil blebs. 91.5'
					CH	Fat clay. 92.5'
	2815	4 6 7 13	SB	W	SW, SP, CH	Mixed sand and clay stringers, trace gravel, oil blebs in pore spaces, color from dark gray-brown to reddish-brown.
95						
	139	3 2 2 4	SB	W		96.5'
					SW	Well graded sand (SW). 97.5'
	212	12 14 36 33	SB	W	SP	Poorly graded sand (SP), mostly medium to coarse grained, about 10 to 15% fine sand, trace coarse sand-sized lignite.
100						
	214	10 5 10 16	SB	W		Sample is from heaved sand. 101.0' Boring Terminated at Bedrock
	-					
105						
110						
115						
120						

COMMENT: Soil boring constructed with $7^{7}/_{8}$-inch (OD), $4^{1}/_{4}$-inch (ID) hollow-stem auger. Soil samples were collected with either a 2-inch or 3-inch split-barrel sampler (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure).
G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet.

BORING LOG

PROJECT: Citizens Gas and El[illegible] c Co. Site
DATE STARTED: 4/8/94
DATE COMPLETED: 4/8/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: Ray Coons (J&R)

BORING I SB-16
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 983.28 Ft. MSL

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0						ASPHALT - about 6 inches. 0.5'
	33	-	G	M	ML/CL	CLAYEY SILT (ML/CL) with a little coarse sand, soft, nonelastic, dark gray (5Y 4/1) no odor, no sheen (fill).
	119	2 3 4 4	SB	M		Mottled oiliness, very dark gray (5Y 3/1), moderate odor, heavy sheen, oil blebs.
5						~5.0'
	202	1 1 2 2	SB	M	CL	SANDY LEAN CLAY WITH A LITTLE GRAVEL(CL), gravel is clinkers and rocks, very soft, black discolored, semi-viscous tar or tar-like substance in pore spaces, strong odor, heavy sheen, blebs, and brownish film (fill).
	197	1 2 3 3	SB	M		
10						~10.0'
	1853	1 1 2 3	SB	M-W	ML	SILT (ML), trace of roots, rapid dilatency, olive-gray (5Y 4/2), very strong odor, oil blebs are abundant and reddish-brown in color (fill).
	1982	1 1 2 5	SB	M-W		
15						
	891	1 2 50+	SB	M	Tar	VISCOUS TAR ON CONCRETE. 16.5' Boring Obstructed on Concrete
20						
25						
30						

COMMENT: Soil boring constructed with 7 7/8-inch (OD), 4 1/4-inch (ID) hollow-stem auger. Soil samples were collected with either a 2-inch or 3-inch split-barrel sampler (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure). G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet. * Headspace test performed from 8 oz. analytical jar.

BORING LOG

PROJECT: Citizens Gas and El c Co. Site
DATE STARTED: 4/7/94
DATE COMPLETED: 4/7/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: John Coons (J&R)

BORING I . SB-17
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 982.94

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0						ASPHALT - about 6 inches. 0.5'
	2	-	G	M	SM-SC	SILTY SAND WITH CLAY (SM-SC) about 20% silt, 10% clay, sand is fine to medium grained, trace gravel, very dark brown (7.5YR 2.5/1) no odor, very light sheen (fill). 2.5'
	14	5 10 12 6	SB	M	SM	SILTY SAND WITH GRAVEL (SM) - gravel fraction is brick and cinders; sand is also part cinders, black (5Y 2.5/1), very slight chemical odor, light sheen (fill).
5						5.5'
	34*	2 3 4 5	SB	M	CL	LEAN CLAY (CL) - moderate toughness and hardness, low plasticity, olive-gray (5Y 4/2) with oil that is golden and mottled, moderate odor, moderate sheen (alluvium).
	240	3 4 7 9	SB	M	CH/CL	7.5' FAT TO LEAN CLAY (CH/CL) - moderate toughness and hardness, moderate plasticity, olive-gray with black, mottled, discoloration, silt laminae at 8.5 and 9' which exhibit moderate odor and moderate-heavy sheen (alluvium).
10						
	60	1 4 4 6	SB	M		Trace of roots, moderate odor, moderate sheen.
	185	2 3 4 6	SB	M		Abundant iron mottling, oil in root holes, moderate odor, moderate-heavy sheen.
15						
	240	2 2 4 7	SB	M		
	375	1 1 2 3	SB	M W M		
					SM	18.5'
20						SILTY SAND (SM), abundant oil in pore spaces, black (5Y 2.5/2), strong odor, strong sheen. 19.0'
	1568 1457	1 1 1 3	SB	W and M		INTERBEDDED CLAY, SILT, AND FINE SAND. Shell fragments are abundant, visible oil in silt and sand, very strong odor, olive-brown (2.5Y 4/3). Duplicate headspace sample collected. ~22.0'
	201	1 3 4 6	SB	M	CH	FAT CLAY (CH), moderate hardness, moderate-high plasticity, slow dilatency, some iron mottling, some shells, some roots, slight odor, light sheen (alluvium).
25						24.5' E.O.B.
30						

COMMENT: Soil boring constructed with $7^7/_8$-inch (OD), $4^1/_4$-inch (ID) hollow-stem auger. Soil samples were collected with either a 2-inch or 3-inch split-barrel sampler (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure). G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet. * Headspace test performed from 8 oz. analytical jar.

BORING LOG

PROJECT: Citizens Gas and El[illegible] Co. Site
DATE STARTED: 4/11/94
DATE COMPLETED: 4/12/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: John and Ray Coons (J&R)

BORING N SB-18
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 983.06

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0						
	2	-	G	M-D	SM	SILTY SAND WITH GRAVEL (SM) - About 30% silt, 25% gravel, sand is fine to medium, gravel is angular to subangular - mostly brick fragments, dark reddish brown (5YR 3/3) slight odor, very light sheen (fill).
	36	7 10 12 9	SB	M-D M	SP-SM	3.5' POORLY GRADED SAND WITH SILT (SP-SM) coarser fraction is mainly slag, fine fraction is mainly coal fines, black (5YR 2.5/1), moderate odor, moderate sheen (fill).
5						
	2"	5 2 1 5	SB	M W		5.5' POORLY GRADED SAND WITH SILT(SP-SM) mostly medium sand with about 10% silt, sample is white (5YR 8/1) and reacts violently with dilute HCL, no odor, no sheen (fill).
						7.5'
	39	9 11 8 7	SB	M	CL/ ML	SILTY LEAN CLAY (CL/ML) - About 10-15% silt, some as shell fragments, trace roots some mottled, black discoloration, very dark gray (5Y 3/1), slight petroleum odor, light sheen (alluvium).
10						10.0'
	20	1 4 4 6	SB	M	CL	LEAN CLAY WITH A LITTLE SILT (CL) moderate hardness, low plasticity, slow dilatency, dark gray (5Y 4/1) with some black mottles, about 5% shell fragments as silt, slight odor, no sheen (alluvium) (soft mucky layer 10.5-11.0')
	25	2 2 3 3	SB	M		Low recovery, sheen on split-barrel.
15						~15'
	34	1 2 3 6	SB	M W	CL/ CH SM	LEAN TO FAT CLAY (CL/CH) moderate hardness, moderate plasticity, slow dilatency, some black mottling, slight odor, no sheen (alluvium). 16.5' SILTY SAND (SM) - About 20% silt, sand is fine, olive gray (5Y 4/2) slight odor, no sheen.
						17.5'
	111	2 2 4 5	SB	M	CH/ CL	FAT TO LEAN CLAY (CH/CL) - moderate hardness, moderate-high plasticity, slow dilatency, trace shell fragments as silt, oil is abundant in fractures and root holes, moderate odor, moderate-heavy sheen (alluvium).
20						20.0'
	107	2 2 2 2	SB	M	CL	LEAN CLAY(CL) low hardness, low-moderate plasticity, slow dilatency, olive gray (5Y 4/2), slight odor, oil in root holes, less oil in bottom of sample (alluvium).
	-	-	TW	-		
25						25.0'
	2	1 1 2 2	SB	M	CH/ CL	FAT TO LEAN CLAY(CH/CL) moderate hardness, moderate plasticity, slow dilatency, olive gray (5Y 5/2), trace black discoloration in zones, trace wood fibers, slight odor, no sheen.
						28.5'
	4	7 7 17 26	SB	M W	SP	POORLY GRADED SAND(SP) trace fines, trace sand size shell and lignite fragments, very slight odor, no sheen (alluvium). 30.0'
30						E.O.B.

COMMENT: Soil boring constructed with 7 7/8-inch (OD), 4 1/4-inch (ID) hollow-stem auger. Soil samples were collected with either a 2-inch or 3-inch split-barrel sampler (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure). G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet. * Headspace test performed from 8 oz. analytical jar.

BORING LOG

PROJECT: Citizens Gas and Elc ; Co. Site
DATE STARTED: 4/7/94
DATE COMPLETED: 4/7/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: John Coons (J&R)

BORING N SB-19
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 983.02 Ft. MSL

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0						
	4	-	G	D	SM	SILTY SAND WITH GRAVEL (SM) - About 20% silt, 15% angular-subrounded gravel, brown (7.5YR 4/2), no odor, no sheen (fill).
				D		3.0'
	1*	3 6 5 4	SB	M	SC	CLAYEY SAND (SC) - About 10% gravel, some of sand fraction is coal fines, upper part of sample is olive gray in lower part gray (N 3/), very slight odor, light sheen (fill).
5						
		1 10		M		
	4*	8 5	SB	W	SP	POORLY GRADED SAND WITH GRAVEL (SP) - About 20% angular to subangular gravel, resembles brick fragments and crushed rock, very dark gray (N 3/), very slight odor, no sheen (fill).
						7.5'
	46 39	6 9 9 9	SB	M	CH/CL	FAT TO LEAN CLAY (CH/CL) - moderate hardness, high plasticity, slow dilatency, very dark gray (N 3/), slight odor, light sheen (alluvium). Sheen becomes heavy, oil in root holes is abundant, strong odor, trace shell. fragments.
10						
	299 230	1 5 7 8	SB	M		
						~12.5'
		5 4			CL	LEAN CLAY (CL) low to moderate hardness, low plasticity, trace shells.
	436	4 4	SB	M	ML	SILT (ML) - Abundant oil and heavy sheen, strong odor.
15					CL	LEAN CLAY (CL) - low to moderate hardness, low plasticity, trace shells Some iron mottling.
	1055	1 3 3 5	SB	M		
						17.5'
	1127	2 3 3 5	SB	M	CL/CH	LEAN TO FAT CLAY (CL/CH) - heavy iron mottling, heavy oil content in root holes, olive gray (5Y 3/2), strong odor, heavy sheen (alluvium).
20						
	1027	3 3 5 6	SB	M		Some silt laminations with high oil content.
						22.5'
	108	1 2 3 4	SB	M	CH	FAT CLAY (CH) - low moderate hardness, moderate plasticity, slow dilatency, trace oil in top of sample, cleans up with depth, greenish gray (5YG 5/1), slight odor, no sheen (alluvium).
25						24.5'
						E.O.B.
30						

COMMENT: Soil boring constructed with 7 7/8-inch (OD), 4 1/4-inch (ID) hollow-stem auger. Soil samples were collected with either a 2-inch or 3-inch split-barrel sampler (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure). G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet. * Headspace test performed from 8 oz analytical jar.

BORING LOG

PROJECT: Citizens Gas and El[illegible] Co. Site
DATE STARTED: 4/13/94
DATE COMPLETED: 4/13/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: Ray Coons (J&R)

BORING N SB-20
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 983.32 Ft. MSL

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0						4-inches concrete.
	3	-	G	D	SM	SILTY SAND WITH GRAVEL (SM) - About 15% silt, 15% gravel, sand is fine to medium, black (2.5Y 2.5/1), no odor, light sheen (fill).
	53	2 1 2 2	SB	D M		3.5'
5					CL	LEAN (CLAY) - Low-moderate hardness, low plasticity, slow dilatency, dark gray (2.5Y 4/1), slight odor, no sheen (fill).
	34	2 3 3 4	SB	M		Dark greenish gray (5GY 4/1), very light sheen, possible diesel odor.
	262	2 6 8 11	SB	M		
10						
	312	3 6				Headspace duplicate collected.
	327	8 12	SB	M		12.0'
	300	1 2 2 4	SB	M W	SC	CLAYEY FINE SAND (SC) - About 25% clay, moderate odor, thin rainbow sheen (moderate), dark gray (N 4/) (Alluvium) 13.5'
15					ML	SANDY SILT (ML) - About 40% fine sand, very dark gray (N 3/), moderate odor (possibly old diesel odor), moderate heavy sheen (alluvium).
	337	2 2 2 4	SB	M- W	CL/ ML ML/ CL	15.0' SILTY CLAY/CLAYEY SILT (CL/ML/ML/CL), very dark gray (N 3/) moderate to strong odor (old diesel), heavy sheen (alluvium).
	339	3 4 6 10	SB	M- W		Oil in root holes, moderate sheen, discoloration is black and mottled, odor is no longer diesel-like.
20						20.0'
	354	3 4 7 7	SB	M	SM	SILTY SAND (SM) - About 15% silt, rapid dilatency, oil is abundant, dark gray (N 3/), moderate to strong odor (alluvium) clay in end of spoon.
	233	2 4 5 5	SB	W	CH	22.0' FAT CLAY (CH) - Moderate hardness, moderate-high plasticity, very slow dilatency, some iron mottling, sight odor, no sheen (alluvium).
25						
	267	0 2 12 52	SB	M W		26.5'
	-	-	-	-	SP	POORLY GRADED SAND WITH A LITTLE SILT (SD), top 2-inches of sample is black with abundant oil blebs, strong naphthalene-like odor, middle of sample has light sheen, appears to clean up with depth dark gray (N 4/).
30						

COMMENT: Soil boring constructed with $7^7/_8$-inch (OD), $4^1/_4$-inch (ID) hollow-stem auger. Soil samples were collected with either a 2-inch or 3-inch split-barrel sampler (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure). G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet. * Headspace test performed from 8 oz analytical jar.

BORING LOG

PROJECT: Citizens Gas and Ele ; Co. Site
DATE STARTED: 4/13/94
DATE COMPLETED: 4/13/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: Ray Coons (J&R)

BORING N SB-20 (Cont.)
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 983.32

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
30	*235	6 11 15 25	SB	W	SP	Poorly graded sand (SP), mostly fine sand with a little silt, oil is abundant, moderate odor, heavy sheen (Alluvium). 32.0' E.O.B.
35						
40						
45						
50						
55						
60						

COMMENT: Soil boring constructed with 7 7/8-inch (OD), 4 1/4-inch (ID) hollow-stem auger. Soil samples were collected with either a 2-inch or 3-inch split-barrel sampler (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure). G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet. * Headspace test performed from 8 oz analytical jar.

BORING LOG

PROJECT: Citizens Gas and El[illegible] Co. Site
DATE STARTED: 4/6/94
DATE COMPLETED: 4/6/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: John Coons (J&R)

BORING N SB-21
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 984.36 Ft. MSL

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0						Concrete - 6 inches.
	593	-	G	M	ML/CL	Clayey silt (ML/CL) - About 30% clay, trace fine sand, dark greenish gray (5Y 4/1), moderate odor, very light sheen (fill).
	1025	1 1 1 50+	SB	M		4.0'
5					SM	Silty sand with gravel (SM) - discolored very dark gray (N 3/). Strong odor, brown oil blebs, heavy sheen (fill).
						4.5'
						Boring Obstructed at 4.5'
10						
15						
20						
25						
30						

COMMENT: Soil boring constructed with 7 7/8-inch (OD), 4 1/4-inch (ID) hollow-stem auger. Soil samples were collected with either 2-inch or 3-inch split-barrel samplers (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure). G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet. * Headspace test performed from 8 oz analytical jar.

BORING LOG

PROJECT: Citizens Gas and E' ic Co. Site
DATE STARTED: 4/5/94
DATE COMPLETED: 4/5/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: John Coons (J&R)

BORING : SB-22
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 984.33 Ft. MSL

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0						
	0	-	G	D-M	SC	CLAYEY SAND (SC) - About 20% clay and some silt, mostly fine to medium sand, about 20% subrounded gravel, dark reddish gray (5YR 4/1) and gray (5Y 4/1) (Fill)
	8	1 1 1 WOH	SB	M-W		CLAYEY SAND is mixed with a white pasty material which reacts violently with HCl; its color is white (N 8/) (Fill) Also some medium sand sized coal fines present black (N 2.51).
5						5.5'
	4	2 1 2 4	SB	M	CL/ ML	SILTY LEAN CLAY (CL/ML) about 20-30% silt, some fine to coarse sand, trace gravel; piece of brick, very dark gray (N 3/) slight naphthalene odor, very light sheen, (fill).
						7.5'
	104	2 5 7 10	SB	M	CL	LEAN CLAY WITH A LITTLE SILT (CL), dark gray (5Y 4/1) slight to moderate odor, very light sheen (alluvium).
10						
	71	3 4 5 6	SB	M		Occasional medium to coarse sand and some iron staining.
	274	1 1 1 1	SB	M		
						14.0'
15					SM	
	392	3 Blows WOH	SB	M		SILTY SAND WITH A LITTLE CLAY (SM) - About 5-10% clay, 30% silt, sand is very fine, dark gray, moderate odor, moderate sheen (Alluvium), occasional rounded -subrounded gravel.
						17.5'
	362	1 1 1 1	SB	M	CL	LEAN CLAY WITH A LITTLE SILT (CL) trace subrounded limestone pebbles, dark gray (5Y 4/1) moderate odor, moderate sheen (Alluvium).
20						
		2 2		W	SM	20.0'
	429	3 2	SB	M	CL	SILTY SAND WITH A LITTLE CLAY (SM) - mostly very fine sand and a trace of medium sand, some iron staining, olive gray (5Y 5/2), strong odor, heavy sheen (Alluvium).
						21.0'
	145	4 5 4 4	SB	W M	SM CL	LEAN CLAY WITH A LITTLE FINE TO MEDIUM SAND (CL) heavy iron staining, black oil blebs in root holes, olive gray (5Y 5/2) strong odor, moderate to heavy sheen (Alluvium).
						22.5'
25						SILTY SAND (SM) - About 40% silt sand is very fine olive gray (5Y 5/2), strong odor, moderate sheen (alluvium).
						23.5'
						LEAN CLAY WITH A LITTLE FINE SAND (CL) - trace roots, oxidation along root holes, oil present in root holes (alluvium).
						24.5'
30						E.O.B.

COMMENT: Soil boring constructed with 7 7/8-inch (OD), 4 1/4-inch (ID) hollow-stem auger. Soil samples were collected with either a 2-inch or 3-inch split-barrel sampler (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure). G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet. * Headspace test performed from 8 oz analytical jar.

BORING LOG

PROJECT: Citizens Gas and Ele[illegible] Co. Site
DATE STARTED: 4/14/94
DATE COMPLETED: 4/15/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: Ray Coons (J&R)

BORING N SB-23
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 983.67 Ft. MSL

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0					OL/OH	Topsoil.
	0	-	G	M	SM	Silty sand with a little gravel (SM) - About 20% silt, 70% fine to medium sand, 10% gravel, dark gray brown (2.5Y 4/2), no odor, no sheen (fill).
	-	-	-	-		No sampling due to course debris.
5						
	-	-	-	-		No sampling due to coarse debris.
				W	ML	7.5'
	0	1 5 5 7	SB	M	CL/ML	Silt (ML) black (2.5Y 2.5/1), sample is wet, maybe perched water. 8.0'
10						Silty lean clay (CL/ML) - Moderate to high hardness, low-moderate plasticity, no dilatency, greenish gray (5GY 5/1), trace wood and shell fragments and a little iron staining, no odor, no sheen (alluvium).
	2	2 3 3 7	SB	M		
	-	-	TW	-		
15						15.5'
	0	1 4 3 6	SB	M	CH	Fat clay with a little silt (CH) - moderate hardness, moderate to high plasticity, slow dilatency, some iron mottling, trace roots, no odor, no sheen (alluvium).
	0	3 3 5 5	SB	M		Occasional silt laminae, semiabundant roots and some oxidation.
20						
	0	1 2 2 3	SB	M		Clay becomes softer, less oxidation.
	0	2 2 2 3	SB	M	ML/CL	Clayey silt (ML/CL) - very dark gray (N 3/1).
					CH/CL	24.0'
25						Soft fat to lean clay (CH/CL) very slight odor (H_2S?) no sheen (alluvium).
	0	3 3 3 4	SB	M		Poorly graded fine sand (SP), no odor, no sheen.
						28.5'
				W	SP	Lean clay (CL).
					CL	29.0'
	0	2 4 4 6	SB	M W	SP	Poorly graded sand (SP) - mostly fine to medium sand, some coarse sand, trace silt, dark gray (N 3/), no odor, no sheen (alluvium).
30						

COMMENT: Soil boring constructed with 7 7/8-inch (OD), 4 1/4-inch (ID) hollow-stem auger. Soil samples were collected with either a 2-inch or 3-inch split-barrel sampler (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure). G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet. * Headspace test performed from 8 oz analytical jar.

BORING LOG

PROJECT: Citizens Gas and El[illegible] Co. Site
DATE STARTED: 4/14/94
DATE COMPLETED: 4/15/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: Ray Coons (J&R)

BORING N SB-23 (Cont.)
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 983.67

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
30						
	-	-	-	-		No sampling.
					SP	
	0	4 12 24 57	SB	W		POORLY GRADED SAND (SD), mostly fine sand, trace of silt, trace medium sand, dark gray (N 4/), no odor, no sheen (alluvium).
35						
						35.5'
	0	7 13 17 14	SB	W	CL	
					SP	LEAN CLAY (CL) - about 8-inches. 36.0'
	-	-	TW	-		POORLY GRADED FINE SAND (SP).
40						
	0	7 8 9 10	SB	W		
						43.0'
		6		W		
	0	21 14 17	SB	M W	CL	LEAN CLAY (CL) - about 4 inches.
						43.5'
					SP	POORLY GRADED SAND(SP) - About 15% fine and, mostly fine to medium grained, trace course sand, trace lignite, dark gray (N 4/), no odor, no sheen (alluvium).
45						
	0	14 11 10 12	SB	W		Dark grayish brown (10Y 4/2).
	0	8 9 12 14	SB	W		
50						
	0	9 10 11 12	SB	W		Abundant lignite, 10-15%, some of which is gravel-sized.
	0	8 12 11 12	SB	W		Abundant lignite, occasional stringers of olive fat clay.
55						
	0	8 7 8 6	SB	W		Mostly medium sand, some fine and course sand, some lignite, dark gray brown (10Y 4/2).
						Stringers of fat clay.
						59.0'
	0	5 6 8 7	SB	W	SW	WELL GRADED SAND (SW), about 30% fine sand, 20% medium sand, 30% course sand, some gravel and silt, no odor, no sheen (alluvium).
60						

COMMENT: Soil boring constructed with 7 7/8-inch (OD), 4 1/4-inch (ID) hollow-stem auger. Soil samples were collected with either a 2-inch or 3-inch split-barrel sampler (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure). G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet. * Headspace test performed from 8 oz analytical jar.

BORING LOG

PROJECT: Citizens Gas and Ele ; Co. Site
DATE STARTED: 4/14/94
DATE COMPLETED: 4/15/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: Ray Coons (J&R)

BORING N SB-23 (Cont.)
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 983.67

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
60						
	0	3 19 35 19	SB	W	SP	POORLY GRADED SAND (SP), mostly medium sand, some fine and course sand, trace gravel, no odor, no sheen (alluvium).
	9	32 48 42 15	SB	W		
65						
	0	11 10 15 16	SB	W		Sand grades to fine with a trace of medium sand, gray (N 5/).
	0	7 8 8 13	SB	W		
70						
	-	16 11 15 25	SB	W		
	-	30 58 33 28	SB	W		
75						
	-	6 2 3 5	SB	W		
	-	7 5 8 10	SB	W		
80						
	-	1 2 1 1	SB	W		
	-	10 8 9 12	SB	W		Sand is very saturated
					CL	84.0'
85						SANDY LEAN CLAY WITH GRAVEL (CL) (alluvium).
	-	15 18 18 16	SB	W	SP	85.0'
	-	7 40 50+	SB	W		POORLY GRADED SAND (SP) mostly medium and coarse sand, no odor, no sheen (alluvium).
90						

COMMENT: Soil boring constructed with 7 7/8-inch (OD), 4 1/4-inch (ID) hollow-stem auger. Soil samples were collected with either a 2-inch or 3-inch split-barrel sampler (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure). G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet. * Headspace test performed from 8 oz analytical jar.

BORING LOG

PROJECT: Citizens Gas and Ele : Co. Site
DATE STARTED: 4/14/94
DATE COMPLETED: 4/15/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: Ray Coons (J&R)

BORING N SB-23 (Cont.)
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 983.67

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
90					SP	
	-	-	-	-		No sampling.
	-	1 1 8 13	SB	W		POORLY GRADED SAND (SP).
95						
	-	-	-	-		No sampling.
	-	-	-	-		No sampling.
100						
	-	-	SB	W		POORLY GRADED SAND(SP) - Mostly medium and coarse sand, no odor, no sheen. (alluvium).
						101.6' Boring Terminated at Bedrock
105						
110						
115						
120						

COMMENT: Soil boring constructed with 7 7/8-inch (OD), 4 1/4-inch (ID) hollow-stem auger. Soil samples were collected with either a 2-inch or 3-inch split-barrel sampler (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure). G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet. * Headspace test performed from 8 oz analytical jar.

BORING LOG

PROJECT: Citizens Gas and El c Co. Site
DATE STARTED: 4/6/94
DATE COMPLETED: 4/6/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: John Coons.(J&R)

BORING I SB-24
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 984.29 Ft. MSL

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0						
	3	-	G	D-M	SM	SILTY SAND WITH GRAVEL (SM) - About 20% silt, 10% gravel, sand is fine to medium, black (5YR 2.5/1), earthy odor, very light sheen (fill).
						3.0'
	2	3blows WOH	SB	M	ML	SILT WITH A LITTLE FINE SAND (ML) - very soft, no plasticity, dark greenish gray (5GY 4/1) slight odor, no sheen (fill).
5						
	301	1 0 1 4	SB	W		Very dark gray (N 3/), moderate to strong naphthalene-like odor, heavy sheen.
	790(1)	2 WOH	SB	W		No soil recovery; silty, soupy water in spoon, very strong odor, high percentage of oil in sample.
10						
	1014(1)	1 WOH	SB	W		Poor recovery, silty muck with about 20% wood fibers, resembles swamp deposits, very strong odor, heavy sheen.
	781*	WOH	SB	W		Silty muck with 30-40% roots and branches and some cardboard and newspaper, black (N2.5/) very strong odor and sheen (fill).
15						
	821*	WOH 50+	SB	W		16.5' Boring Obstructed
20						
25						
30						

COMMENT: Soil boring constructed with 7 7/8-inch (OD), 4 1/4-inch (ID) hollow-stem auger. Soil samples were collected with either a 2-inch or 3-inch split-barrel sampler (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure). G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet. * Headspace test performed from 8 oz analytical jar. (1) Headspace sample was predominantly water.

BORING LOG

PROJECT: Citizens Gas and Ele Co. Site
DATE STARTED: 4/6/94
DATE COMPLETED: 4/6/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: John Coons (J&R)

BORING N SB-25
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 984.42 Ft. MSL

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0				D		Concrete about 6 inches
	1131	-	G	M	ML/CL	Clayey silt (ML/CL) - About 30% clay, very soft, some fine sand, very dark, gray (N 3/), slight odor, light sheen (fill).
	-	4 4 2 3	SB	M		3.8'
5					SM	Silty sand (SM) - about 20% silt, sand is fine and some medium grained, very black (N 2.5/), very strong odor, reddish brown oil blebs, heavy sheen, (fill).
						4.0' Boring Obstructed
10						
15						
20						
25						
30						

COMMENT: Soil boring constructed with 7 7/8-inch (OD), 4 1/4-inch (ID) hollow-stem auger. Soil samples were collected with either a 2-inch or 3-inch split-barrel sampler (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure). G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet. * Headspace test performed from 8 oz analytical jar.

BORING LOG

PROJECT: Citizens Gas and El ic Co. Site
DATE STARTED: 4/6/94
DATE COMPLETED: 4/6/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: John Coons (J&R)

BORING : SB-26
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 984.39 Ft. MSL

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0						Concrete - About 6 inches.
	20	-	G	M	SM	Silty sand with a little gravel (SM) - About 2.5% silt, sand is mostly fine to medium grained, gravel is subrounded, very dark brown (10YR 2/3), earthy odor, no sheen (fill).
	290	1 1 1 50+	SB	M	ML/CL	3.8' Clayey silt with a little sand (ML/CL) - About 20% clay, sand is fine to medium, dark greenish gray, strong odor, brownish-reddish oil blebs, (fill).
5						4.0' Boring Obstructed
10						
15						
20						
25						
30						

COMMENT: Soil boring constructed with 7 7/8-inch (OD), 4 1/4-inch (ID) hollow-stem auger. Soil samples were collected with either a 2-inch or 3-inch split-barrel sampler (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure). G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet. * Headspace test performed from 8 oz analytical jar.

BORING LOG

PROJECT: Citizens Gas and Ele : Co. Site
DATE STARTED: 4/6/94
DATE COMPLETED: 4/6/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: John Coons (J&R)

BORING N SB-27
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 984.68 Ft. MSL

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0						CONCRETE - About 6 inches.
	4	-	G	M	ML/CL	CLAYEY SILT WITH A LITTLE SAND (ML/CL) - About 30% clay, sand is mostly fine to medium grained (fill).
						2.5'
	-	2 2 2 2	SB	M	CL/ML	SILTY LEAN CLAY (CL/ML) - Trace of coal, trace of iron (nails?), a little wood debris, abundant iron staining, brownish yellow (10YR 6/6) and dark brown (10YR 3/3), slight odor, no sheen (fill).
5						5.5'
	10	1 1 1 2	SB	M	ML/CL	CLAYEY SILT WITH A LITTLE FINE SAND (ML/CL) - fine sand appears to be coal fines, very dark brown (10YR 2/2), slight odor, no sheen (fill).
						7.5'
	260	3 4 7 11	SB	M	CL/ML	SILTY LEAN CLAY (CL/ML) - About 15-20% silt, moderate toughness, low plasticity, olive gray (5Y 4/2) moderate odor, moderate sheen (alluvium).
10						10.5'
	561	20 6 8 11	SB	M	CL	LEAN CLAY WITH A LITTLE SILT (CL) - Moderate hardness, low to moderate plasticity, slow dilatency, discolored very dark gray (N 3/) oil is present in root holes, moderate odor, moderate sheen (alluvium).
	340	4 6 7 8	SB	M		
15						16.0'
	295	4 5 4 4	SB	M W	SP-SM	POORLY GRADED SAND WITH SILT (SP-SM) - About 10% silt, sand is fine grained, dark brownish gray, very oily (oil is yellow) strong odor, heavy sheen (alluvium).
						18.0'
	420	4 6 6 5	SB	W M	CL	LEAN CLAY WITH A LITTLE SILT (CL) - About 5-10% silt, low to moderate plasticity, dark greenish gray (5GY 4/1) with orangish-brown oil in fractures and pinholes, slight to moderate odor, moderate to heavy sheen (alluvium).
20						21.5'
	500	1 3 5 9	SB	M W	SP	POORLY GRADED SAND (SD) very fine grained, dark greenish gray (5GY 4/1) with orangish-brown oil blebs, moderate to strong odor, moderate to heavy sheen (alluvium).
	420	1 2 6 6	SB	W M		23.5'
25					CL	LEAN CLAY WITH A LITTLE SILT (CL) moderate to high toughness, low to moderate plasticity, slow dilatency, dark greenish gray (5GY 4/1), yellowish brown oil in root holes, moderate to strong odor, moderate to heavy sheen (alluvium).
						24.5' E.O.B.
30						

COMMENT: Soil boring constructed with 7 7/8-inch (OD), 4 1/4-inch (ID) hollow-stem auger. Soil samples were collected with either a 2-inch or 3-inch split-barrel sampler (SB) in general accordance with ASTM Method D-1586, Standard Methods for Penetration Test and Split-Barrel Sampling of Soils. The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure). G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet. * Headspace test performed from 8 oz analytical jar.

BORING LOG

PROJECT: Citizens Gas and Ele : Co. Site
DATE STARTED: 4/13/94
DATE COMPLETED: 4/13/94
FIELD INSPECTOR: D. Moore(BEC)
CREW CHIEF: Ray Coons (J&R)

BORING N SB-28 (Cont.)
RISER PIPE ELEVATION: NA
GROUND SURFACE ELEVATION: 982.95 ft. MSL

Depth (Feet)	Net OVA (ppm)	Blows Per 6"	Sample Type	Water Content	Profile	DESCRIPTION OF MATERIALS AND REMARKS
30	167	7 8 9 11	4' SB	W	SP-SM	(28-32' Sample Continued)POORLY GRADED SAND WITH SILT(SP-SM) about 10% of silt, mostly fine sand, some fine to medium sand, dark gray (N 4/), trace shell fragments, slight odor, no sheen, (alluvium).
	27*	8 15 21 31	4' SB	W		
35	95	24 31 24 25			SP	POORLY GRADED SAND (SP) - mostly fine to medium sand and fine sand, a little soft lignite, dark gray (N 4/), slight odor, no sheen (alluvium).
	33	8 10 16 22	4' SB	W		
40	36	21 14 12 16				Some coarse sand and gravel.
						37.0' E.O.B.
45						
50						
55						
60						

COMMENT: Soil boring constructed with 7 7/8-inch (OD), 4 1/4-inch (ID) hollow-stem auger. Soil samples were collected with a 3-inch diameter, 4-foot long split-barrel sampler (SB). The samples were described according to ASTM Method D-2488, Standard Practice for Description and Identification of Soils (visual-manual procedure). G = grab; SB = split-barrel; TW = thin-wall; D = dry; M = moist; W = wet. *Headspace test performed from 8 oz. analytical jar.

Appendix F

April 20, 1994 Letter
to Ms. Betty Berry

Barr
Engineering Company
Including A.W. Mathews

8300 Norman Center Drive
Minneapolis, MN 55437-1026
Phone: (612) 832-2600
Fax: (612) 832-2601

April 20, 1994

Ms. Betty Berry
U.S. Environmental Protection Agency
Region VII
726 Minnesota Avenue
Kansas City, KS 66101

Re: Citizens Gas and Electric Site
Council Bluffs, Iowa

Dear Ms. Berry:

This letter is to confirm our conversation of April 15, 1994. We discussed the observations made of soil conditions at Soil Boring SB-20 (Monitoring Well MW7). We agreed that MW7 would neither be installed nor moved to a different location in this phase of work.

The sandy soil in which MW7 was to be screened was oily. The analytical results of groundwater samples from this well would not be representative of groundwater quality, since the samples would contain oil. The boring, SB-20, placed at this location has achieved the objectives described in the Work Plan (Table 5) for the boring and well at this location. Specifically, the boring has determined that there is oiliness in the soil in this area, generally downgradient of the gasometer. Groundwater sampling at this location would not alter the conclusion that oil is present and would not assist in delineating the extent of a groundwater plume. On this basis, you agreed we need not place MW7 at this location.

Barr believes it would be prudent to evaluate the site data before selecting a new location for a well downgradient of the east gasometer area. As we discussed, a well to monitor groundwater downgradient of the easterly portion of the site will be proposed for a future phase of work for the site which will address groundwater migration. Postponing placement of the well until a future phase will also allow time to obtain of access onto the private property where such a well would most likely be placed. In view of these considerations, you agreed that we did not need to relocate MW7 in this phase of the work.

We also discussed and you agreed to a change in the laboratory providing analysis for flashpoint samples. Aspen Research Laboratories, Inc., rather than Huntington Laboratories, will do flashpoint analysis, as the latter has

concluded their equipment will not handle the soil-tar mix. This change does not affect the QAPP.

As we discussed in our conversation of April 5, 1994, the samples for analysis of chemical parameters are being sent to the CH_2M Hill, but the analysis itself is being done at the CH_2M Hill Gainesville, Florida laboratory, rather than the Montgomery, Alabama laboratory mentioned in the QAPP. These laboratories have recently become independent of CH_2M Hill and are now called Quality Analytical Laboratories.

If this letter does not conform to your understanding of these matters or if you have any questions, do not hesitate to call.

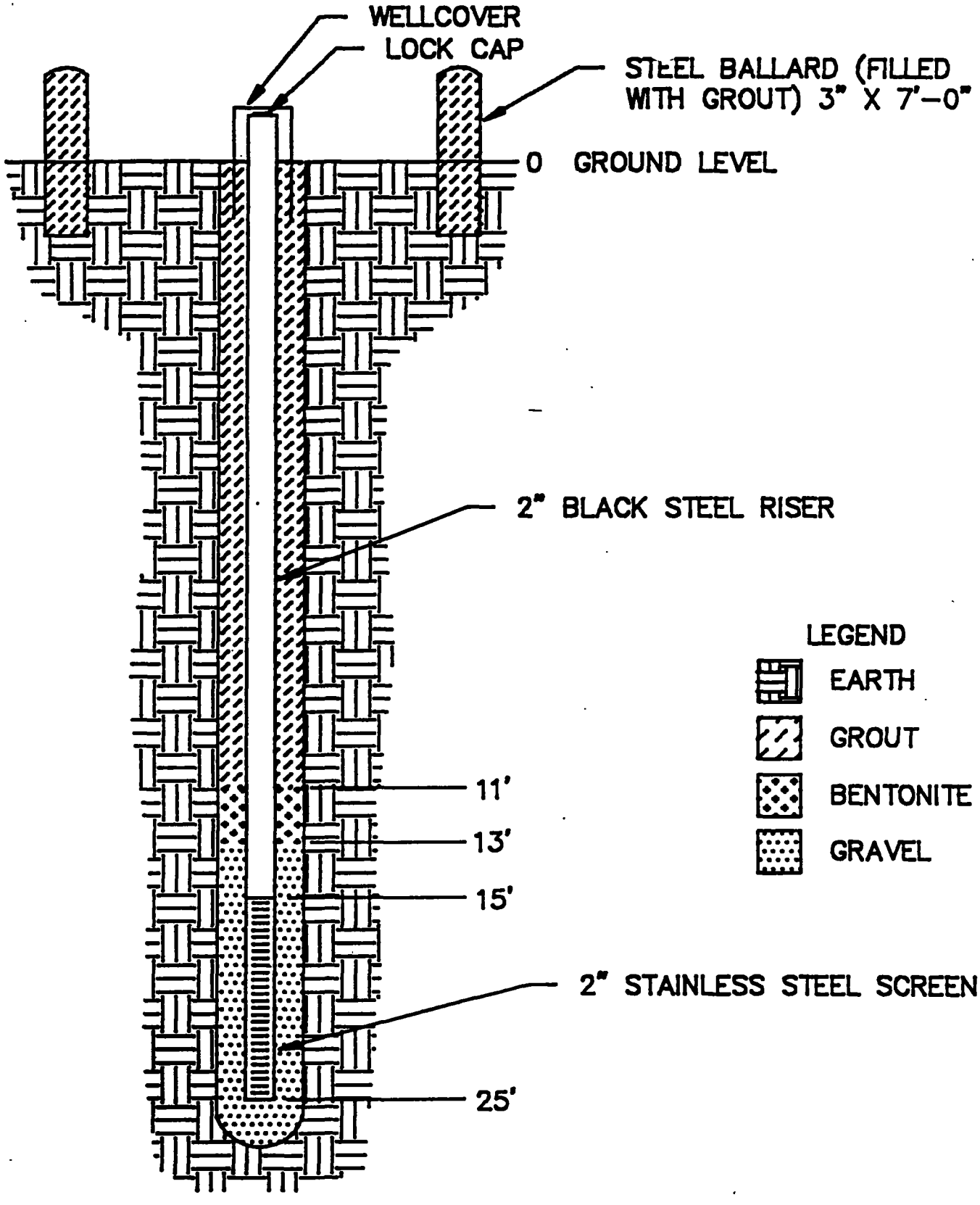
Yours truly,

James R. Langseth

JRL:crs
c: Russell Selman
Gregory Benak
Michael Kisicki
15\78\001\B10.LTR

Appendix G

Well Logs

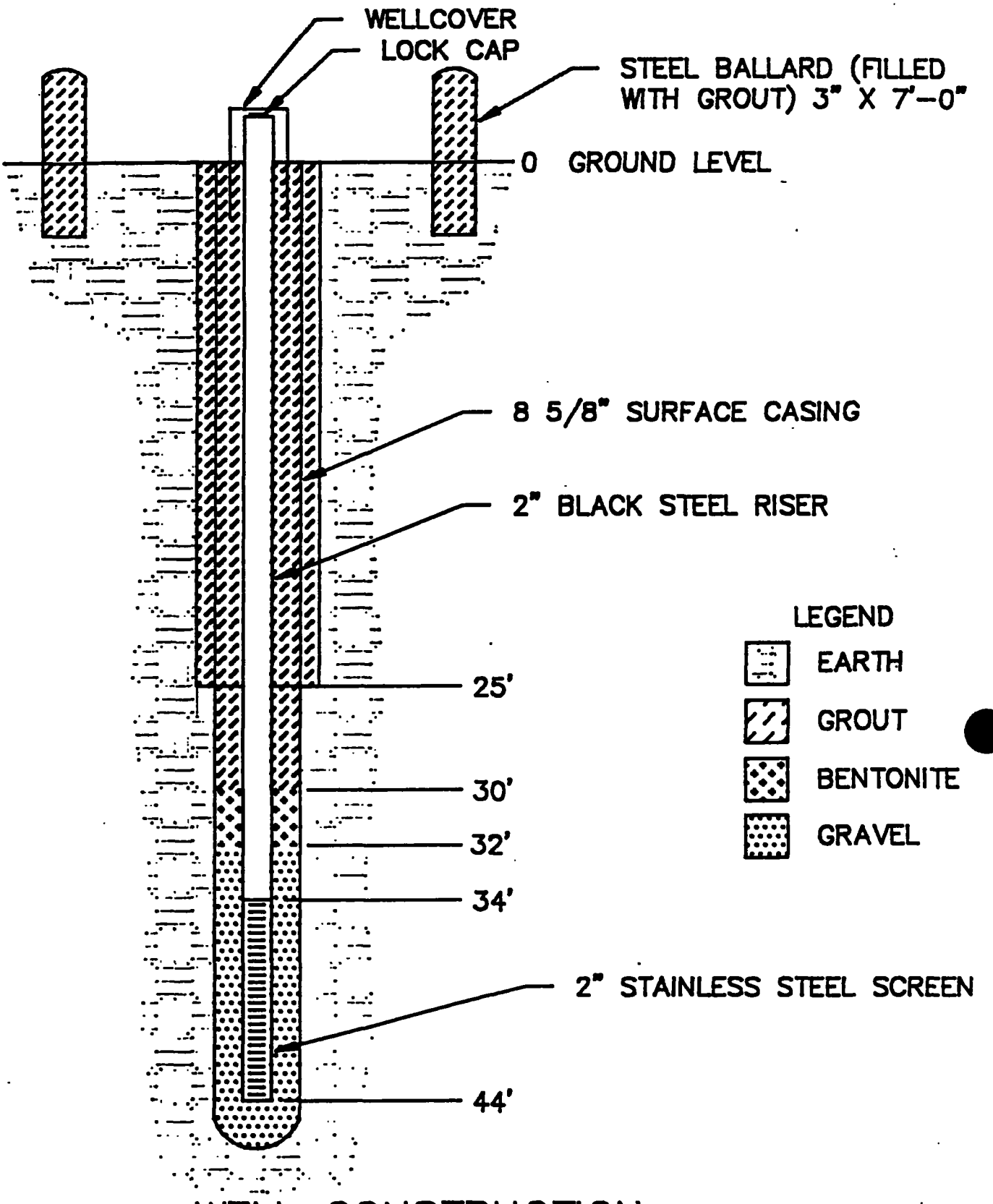


WELL CONSTRUCTION
FOR MONITOR WELL #1

GEOTECHNICAL SERVICES INC.

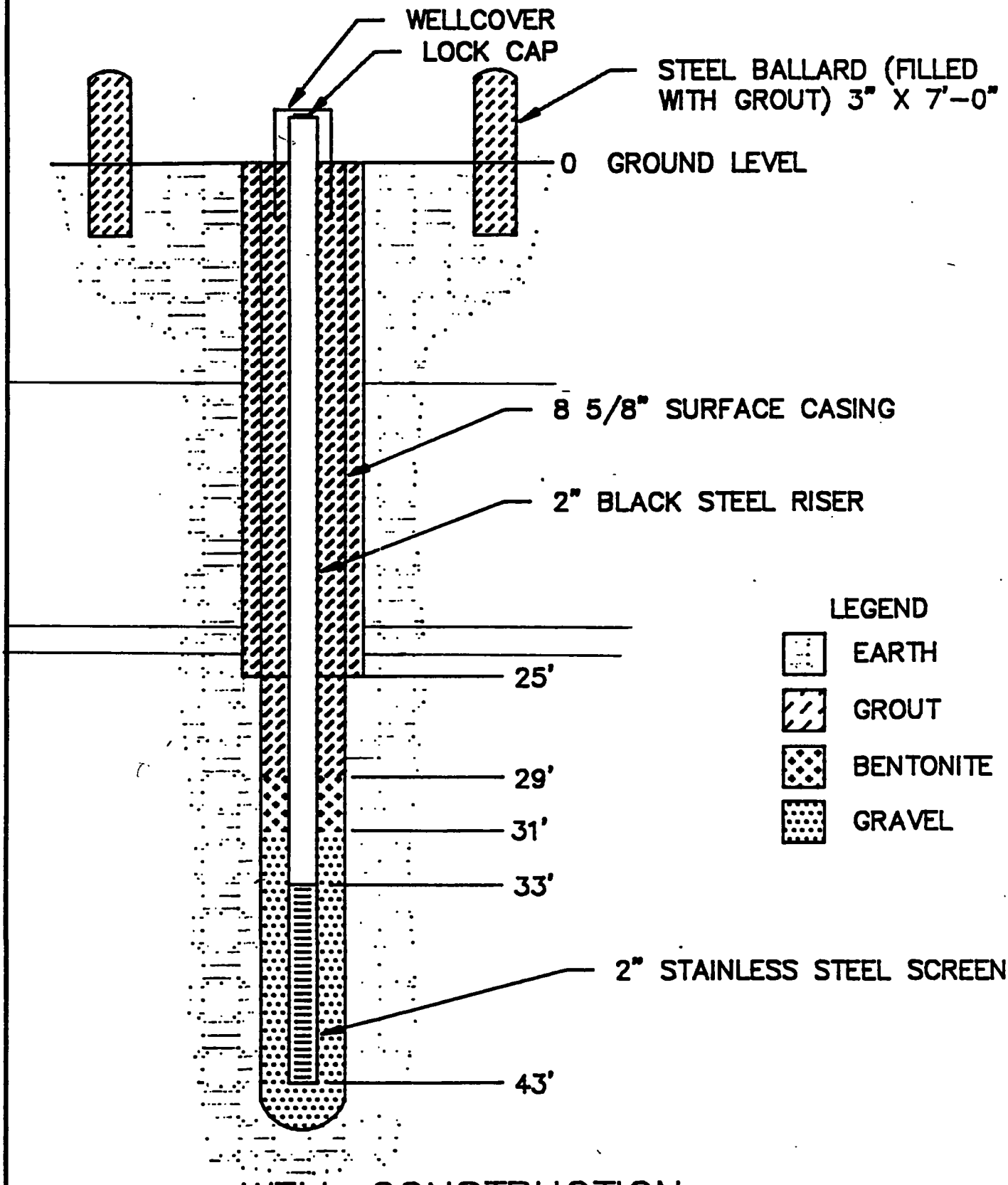
PROJECT
PEOPLES NATURAL GAS
COUNCIL BLUFFS, IA.

JOB NO. 3ZG017	DRAWN HRS
DATE 1-11-90	APPROVED
REVISION	DWG. NO. 3ZG017A
SCALE NONE	SHEET 1 OF 2



WELL CONSTRUCTION
FOR MONITOR WELL #2

GEOTECHNICAL SERVICES INC.	PROJECT: PEOPLES NATURAL GAS COUNCIL BLUFFS, IA.	JOB NO. 3ZG017	DRAWN HPS
		DATE 12-14-89	APPROVED
		REVISION	DWG. NO. 3ZG017
		SCALE: NOTED	SHEET 1 OF 2



WELL CONSTRUCTION
FOR MONITOR WELL #3 & 4

GEOTECHNICAL SERVICES INC.	PROJECT: PEOPLES NATURAL GAS COUNCIL BLUFFS, IA.	JOB NO. 3ZG017	DRAWN HRS
		DATE 12-14-89	APPROVED
		REVISION	DWG. NO. 3ZG017
		SCALE NOTED	SHEET 2 OF 2

WELL LOG

BARR ENGINEERING CO.
Minneapolis, Minnesota

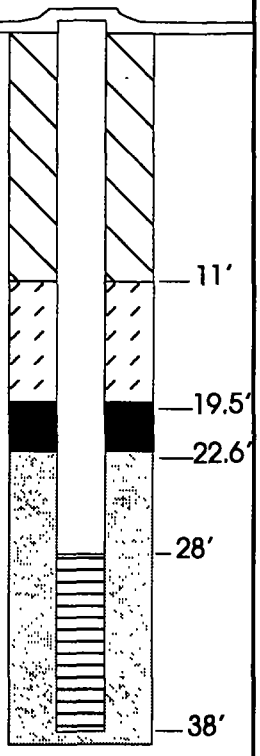
Project Citizens Gas and Electric Co. Site — Well No. MW5

Date Started 4/20/94

Date Completed 4/20/94 — Riser Pipe Elevation 983.49

Field Inspector D. Moore (Barr)

Crew Chief Ray Coons (J&R) — Ground Surface Elevation 983.44

BOREHOLE CONSTRUCTION NOTES	LITHOLOGY	WELL CONSTRUCTION	WELL CONSTRUCTION NOTES
Borehole advanced to 40 foot depth using 6 1/4" (ID) hollow stem augers. Screen and riser pipe assembled through augers. Augers retracted during installation of sand pack, bentonite seal and neat cement grout.	0' Sand and Gravel (Fill) 9.0' Fat and Lean Clay (Fine Alluvium) 26.7' Fine Sand (Coarse Alluvium)		2-inch diameter stainless-steel well screen 38' - 28' below ground surface (BGS) 2-inch diameter stainless steel riser 28' - 0' (BGS) Annulus between well and borehole backfilled with 1.) #35-45 Muskateen filter sand 39' -22.6' (BGS) 2.) Bentonite pellet seal 22.6-19.5' (BGS) 3.) Bentonite slurry 19.5'-approximately 11' (BGS) 4.) Neat Cement Grout 11'-1' (BGS) 4' x 4' x 1' concrete pad constructed around well. At-grade well protection placed over riser. Well developed on 4/25/94.

Comments: Lithology from SB-15
Vertical Scale: 1" = 10'

WELL LOG

BARR ENGINEERING CO.
Minneapolis, Minnesota

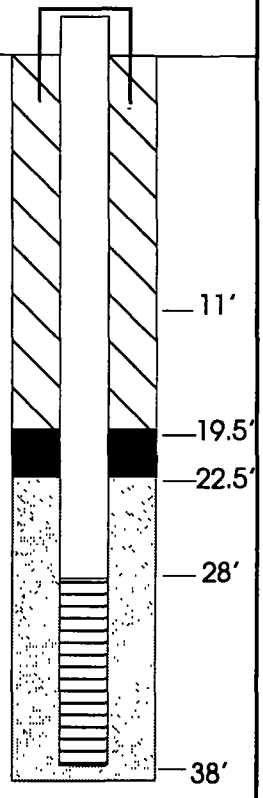
Project Citizens Gas and Electric Co. Site — Well No. MW8

Date Started 4/21/94

Date Completed 4/21/94 — Riser Pipe Elevation 985.58

Field Inspector D. Moore (Barr)

Crew Chief Ray Coons (J&R) — Ground Surface Elevation 983.55

BOREHOLE CONSTRUCTION NOTES	LITHOLOGY	WELL CONSTRUCTION	WELL CONSTRUCTION NOTES
Borehole advanced to 40 foot depth using 6 1/4" (ID) hollow stem augers. Screen and riser pipe assembled through augers. Augers retracted during installation of sand pack, bentonite seal and neat cement grout.	0' Sand and Gravel and Debris (Fill) 7.5' Fat and Lean Clay (Fine Alluvium) 29.0' Fine Sand (Coarse Alluvium)		2-inch diameter stainless-steel well screen 38' - 28' below ground surface (BGS) 2-inch diameter stainless steel riser 28' (BGS) to 2' above ground surface. Annulus between well and borehole backfilled with 1.) #35-45 Muskateen filter sand 39' -22.5' (BGS) 2.) Bentonite pellet seal 22.5-19.5' (BGS) 3.) Neat cement grout 19.5'-0 (BGS) Protective Casing Placed Around Riser. Barr Lock Installed on Protective Casing. Bumper Posts Installed Around Well. Well developed on 4/26/94.

Comments: Lithology from SB-23
Vertical Scale: 1" = 10'

WELL LOG

BARR ENGINEERING CO.
Minneapolis, Minnesota

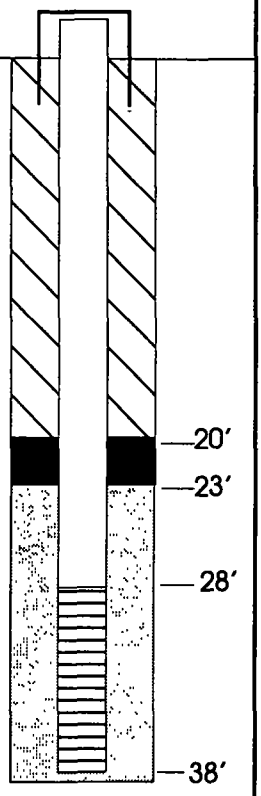
Project Citizens Gas and Electric Co. Site — Well No. MW6

Date Started 4/22/94

Date Completed 4/22/94 — Riser Pipe Elevation 984.27

Field Inspector D. Moore (Barr)

Crew Chief Ray Coons (J&R) — Ground Surface Elevation 982.11

BOREHOLE CONSTRUCTION NOTES	LITHOLOGY	WELL CONSTRUCTION	WELL CONSTRUCTION NOTES
Borehole advanced to 25 foot depth using 12" (OD) solid stem augers. 9-inch, schedule 80 black steel pipe pushed to 27-foot depth, and grouted in place. 4 1/4-inch hollow stem auger advanced through 9-inch casing to 43 foot depth. Screen and riser pipe assembled through augers. Augers retracted during installation of sand pack, bentonite seal and neat cement grout.	0' Sand and Gravel and Debris (Fill) 7.5' Fat and Lean Clay (Fine Alluvium) 28.5' Fine Sand (Coarse Alluvium)		2-inch diameter stainless-steel well screen 38' - 28' below ground surface (BGS) 2-inch diameter stainless steel riser 28'(BGS)- 2' above ground surface. Annulus between well and borehole backfilled with 1.) #35-45 Muskateen filter sand 38' -23' (BGS) 2.) Bentonite pellet seal 23 - 20' (BGS) 3.) Neat cement grout 20.0' - 0' (BGS) Protective Casing Placed Around Riser. Barr Lock Installed on Protective Casing. Bumper Posts Installed Around Well. Well Developed on 4/25/94.

Comments: Lithology from SB-18 and SB-28
Vertical Scale: 1" = 10'

Appendix H

Insitu Hydraulic Testing Procedures

Appendix H
In Situ Hydraulic Testing Procedures

Hydraulic conductivity estimates were obtained at monitoring wells MW-1, MW-2, MW-5, MW-6, and MW-8 by slug test methods. Slug tests were conducted at monitoring well MW-4. However, the data obtained is considered unusable because the PVC slug was not placed deep enough in the water column and only a small amount of water was displaced. Another slug test will be performed during a future phase of investigation. Table H-1 presents test input parameters used for hydraulic conductivity estimates, and Table H-2 presents a summary of hydraulic conductivity estimates. Test procedures and results are discussed below.

General Test Procedures

Static water levels were measured prior to the start of each test using an electronic water level measuring device. Water levels measured during the test were obtained using an In Situ, Inc. Model PTX160D pressure transducer connected to a Hermit SE1000C data logger.

The data were downloaded from the Hermit data logger to an IBM-compatible personal computer in ASCII format. Each data file was then imported into a QUATTRO PRO spreadsheet for formatting as AQTESOLV input files. AQTESOLV is a software package for aquifer test analysis (Duffield and Rumbaugh, 1989).

Slug Test Methods

The slug tests consisted of dropping a solid PVC cylinder into the well below the static water level and allowing the water level to equilibrate. When the water level in the well returned to the level measured before the slug was introduced, the slug was removed and the data logger was simultaneously started.

The slug test data files were evaluated using the Bouwer and Rice method for unconfined aquifers (Bouwer and Rice, 1976; Bouwer, 1989). Hydraulic conductivity was estimated for the strata penetrated by each well based on the following equation:

$$K = \frac{r_c^2 \ln (R_e/r_w)}{2L} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

K = hydraulic conductivity in feet per minute

r_c = radius of the well section in which the water level is changing, in feet

ln = natural logarithm

R_e = effective radial distance over which the head difference is dissipated, in feet

r_w = radial distance between the well centerline and undisturbed aquifer, in feet

L = length of the well intake (screen or filter pack) through which groundwater enters the well, in feet

t = time since the beginning of the test, in minutes

y_0 = difference between the observed water level at time zero and static water level, in feet

y_t = difference between the observed water level at time t and static water level, in feet

The effective radial distance over which the head difference is dissipated, R_e, is a function of the well geometry and position within the aquifer and is determined based on analog analyses (Bouwer and Rice, 1976). For the wells installed in this study, the radial distance between the well centerline and undisturbed aquifer, r_w, is assumed to be equal to the radius of the borehole created by the hollow-stem auger. Input data used for data reduction are indicated in Table H-1.

The Theis equation, which forms the basis of the Bouwer and Rice method, is based on the following assumptions (Todd, 1959):

- Flow velocities are proportional to the tangent of the hydraulic gradient rather than the sine.
- Horizontal, radial flow occurs throughout the aquifer.
- The aquifer is confined.
- Wells are fully penetrating.
- Darcy's Law is valid for the aquifer tested.
- The aquifer can be treated as representative continuum.
- The aquifer is homogeneous and isotropic.

The Bouwer and Rice method further assumes the analogue evaluation of effective radius is valid and applicable to unconfined aquifers and partially penetrating wells.

Slug Test Results

Hydraulic conductivity estimates were obtained using the results of slug testing conducted at monitoring wells MW-1, MW-2, MW-5, MW-6, and MW-8 and the geometric mean of hydraulic conductivity estimates for monitoring wells MW-2, MW-5, MW-6, and MW-8 are presented in Table H-2. Test data is attached. Well number MW-1 had a static water level below the top of the filter pack. This led to a "double straight-line effect" in the time-drawdown plots. The first straight line segment represents the hydraulic conductivity of the filter pack (Bouwer, 1989). The second straight line segment represents the hydraulic conductivity of the aquifer and was used for the analysis.

Hydraulic conductivity estimates obtained from slug tests were consistent with published values for fine sand of 3.2 to 16 feet/day (Kruseman and deRidder, 1991) with the exception of monitoring well MW-1 which yielded lower conductivity estimate results. Figure H-1 graphically compares results of hydraulic conductivity estimates from the five monitoring wells.

Laboratory permeability results reported 7.9 feet/day on a sample collected from 37.5 to 39.5 feet below ground surface from Boring SB-23. Hazen method (Hazen, 1892) for correlation of permeability and grain size resulted in a estimated permeability of 68 feet/day for this sample.

These apparent discrepancies in hydraulic conductivities estimated by different analytical methods and literature values are in the range of hydraulic conductivity expected error (generally about an order of magnitude between laboratory and slug test hydraulic conductivity estimates). These variations are a factor of test method and test scale with larger scale test generally more representative of actual aquifer characteristics. The relatively low hydraulic conductivity estimates obtained from slug tests performed on monitoring well MW-1 reflect aquifer characteristics of different stratigraphy in the screened interval of this monitoring well.

References

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Bouwer H. and R.C. Rice, 1976. A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells. Water Resources Research, Vol. 12, No. 3, p. 423-428.

Duffield, G.M. and J.O. Rumbaugh III, 1989. AQTESOLV, Aquifer Test Design and Analysis Computer Software. Geraghty & Miller Modeling Group, Reston, Virginia.

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Kruseman, G.P. and J.A. deRidder, 1991. Analysis and Evaluation of Pumping Test Data, 2nd edition. International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands.

Todd, D.K., 1959. Ground Water Hydrology. John Wiley & Sons, Inc., New York, New York.

Table H-1

Input Parameters for Bouwer and Rice Slug Test Evaluations

Monitoring Well Designation	Initial Drawdown (ft)	Radius of Casing (ft)	Radius of Well* (ft)	Saturated Thickness (ft)	Well Screen Length (ft)	Static Height of Water in the Well (ft)
MW-1	1.3	0.083	0.501	112	10.0	9.71
MW-2	1.2	0.083	0.501	112	10.0	17.51
MW-5	1.8	0.083	0.501	112	10.0	30.56
MW-6	1.0	0.083	0.501	112	10.0	24.64
MW-8	1.7	0.083	0.501	112	10.0	23.00

* Effective well radius (i.e., radius of filter pack).

Table H-2

Hydraulic Conductivity Estimates From Slug Test Results

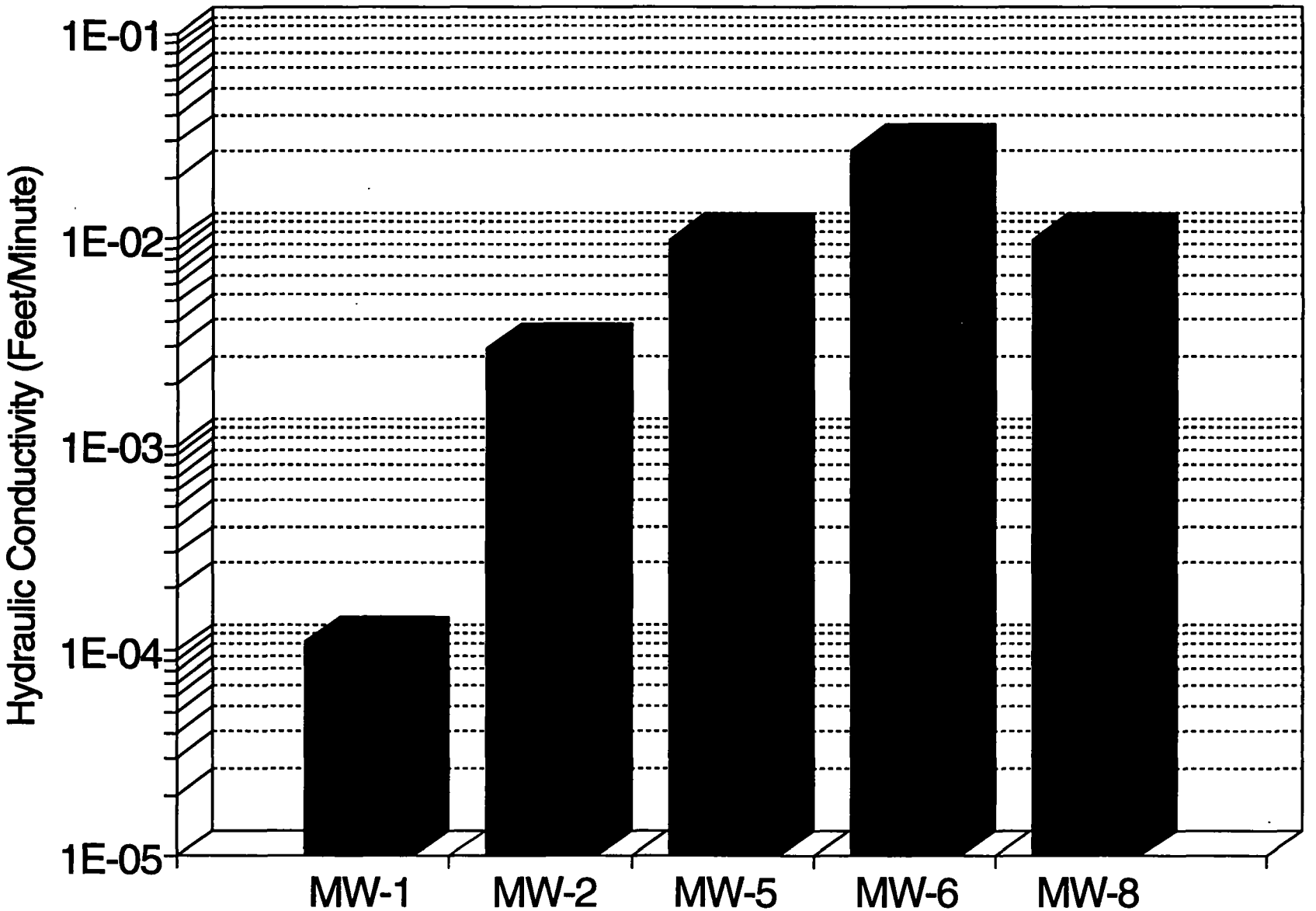
Monitoring Well Number	Hydraulic Conductivity Estimates		
	Feet/Day	Feet/Minute	Centimeter/Second
MW-1	0.2	1.1E-04	3.9E-05
MW-2	4.2	2.9E-03	1.5E-03
MW-5	14.1	9.8E-03	5.0E-03
MW-6	39.2	2.7E-02	1.4E-02
MW-8	14.1	9.8E-03	5.0E-03

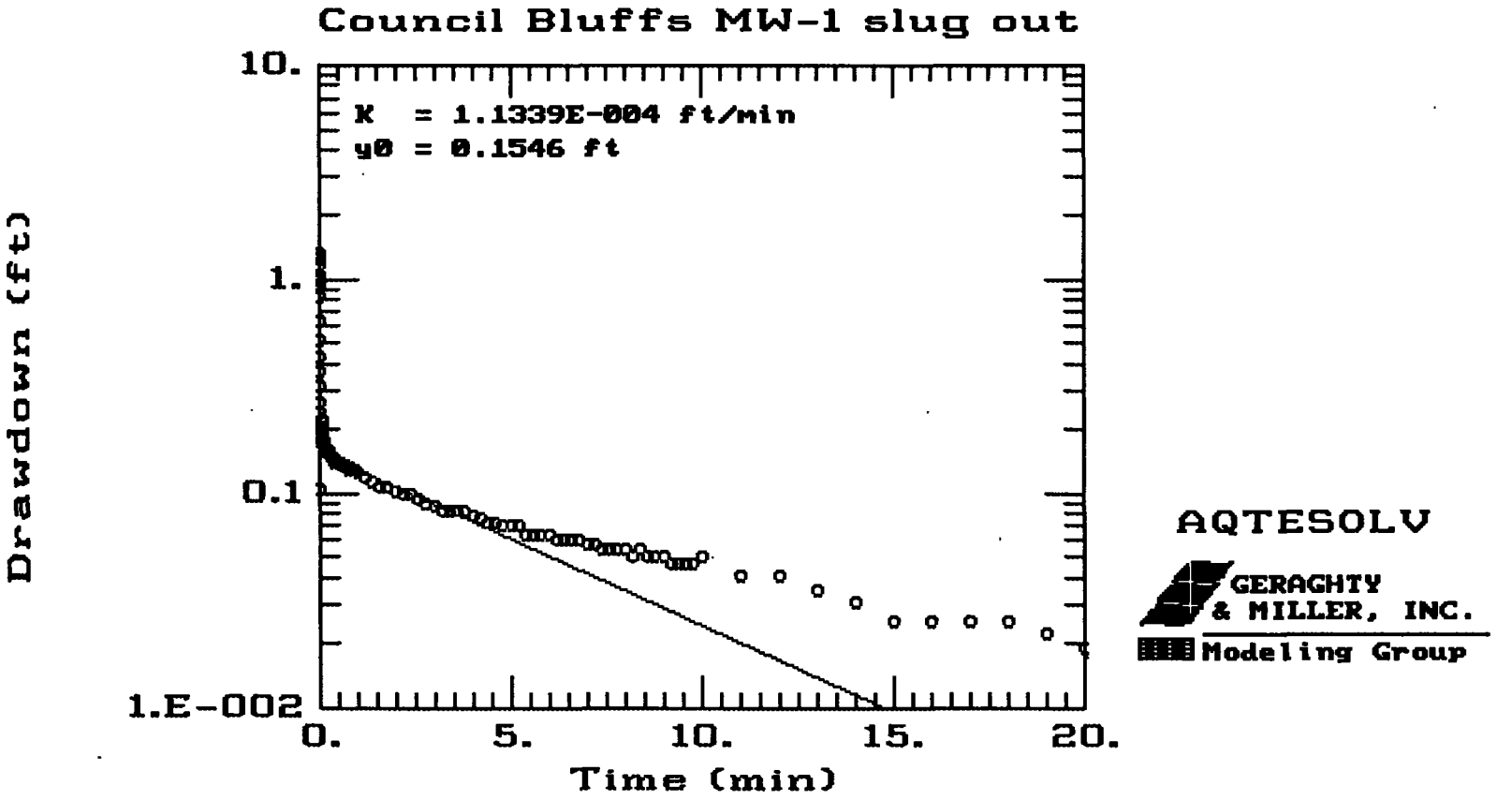
Note: Numbers are rounded.

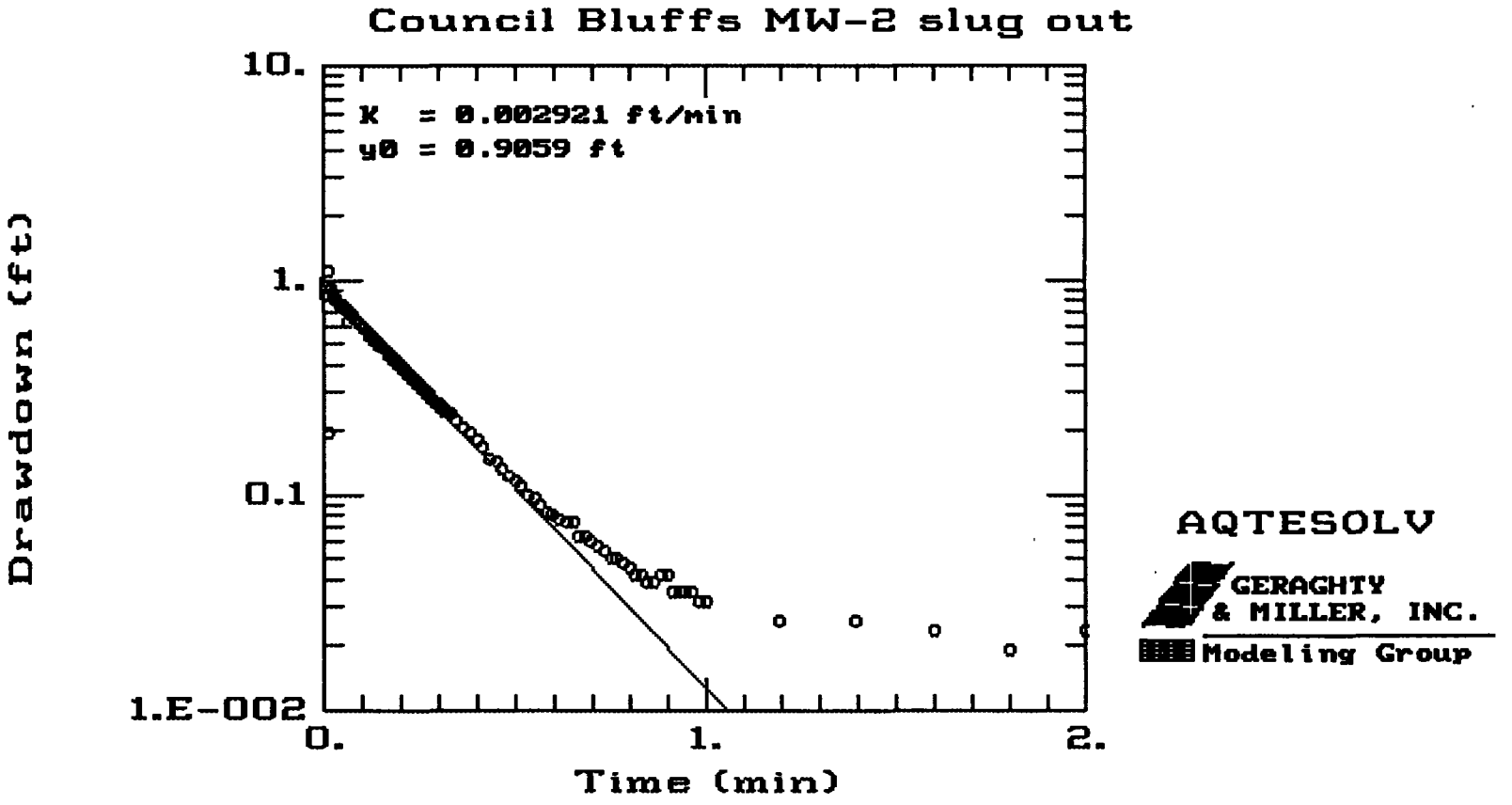
Geometric Mean = 13.5 Feet/Day

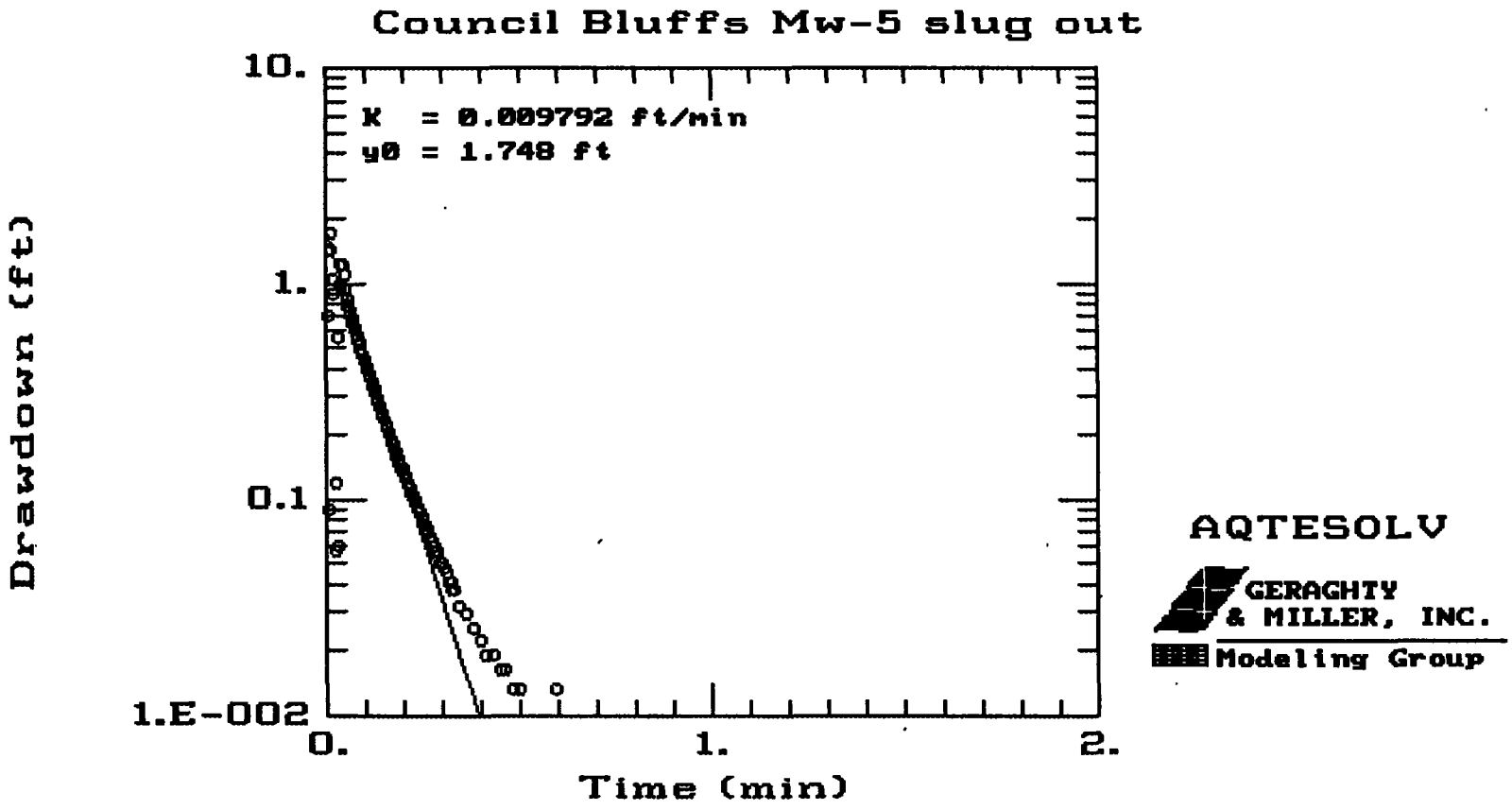
Based on monitoring wells MW-2, MW-5, MW-6, and MW-8.

Figure H-1 Hydraulic Conductivity
Citizens Gas and Electric Company Site




Council Bluffs MW-1 slug out
K = 1.1339E-004 ft/min
y0 = 0.1546 ft
Drawdown (ft)
10.
1.
0.1
1.E-002
0.
5.
10.
15.
20.
Time (min)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group


Council Bluffs MW-2 slug out
K = 0.002921 ft/min
y0 = 0.9059 ft
10.
1.
0.1
1.E-002
0.
1.
2.
Drawdown (ft)
Time (min)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group


Council Bluffs Mw-5 slug out
K = 0.009792 ft/min
y0 = 1.748 ft
10.
1.
0.1
1.E-002
Drawdown (ft)
0.
1.
2.
Time (min)
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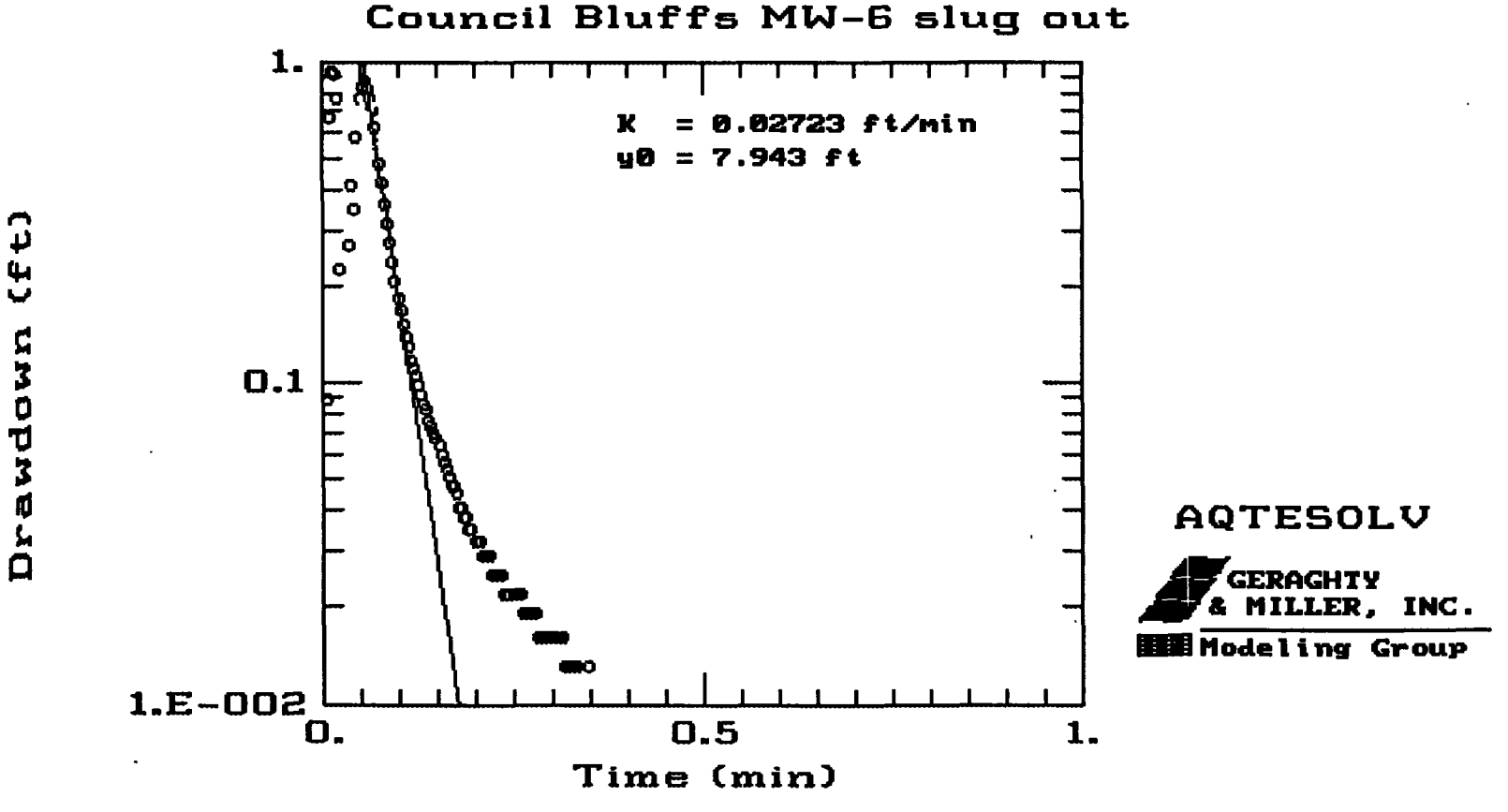
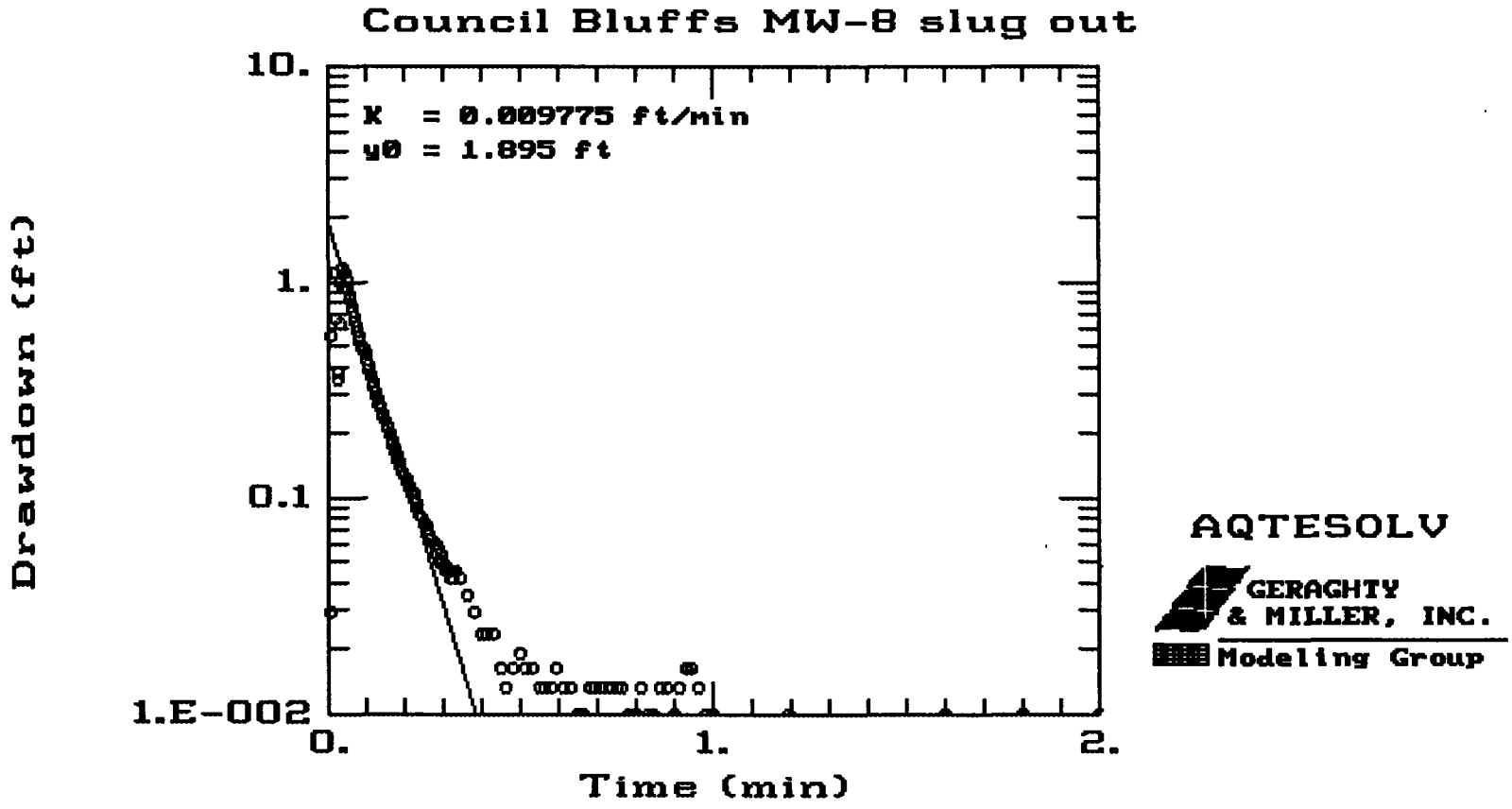
GERAGHTY & MILLER, INC.
Modeling Group


Council Bluffs MW-6 slug out
K = 0.02723 ft/min
y0 = 7.943 ft
Drawdown (ft)
1.
0.1
1.E-002
0.
0.5
1.
Time (min)
AQTESOLV
GERAGHTY
& MILLER, INC.
Modeling Group


Council Bluffs MW-8 slug out
X = 0.009775 ft/min
y0 = 1.895 ft
10.
1.
0.1
1.E-002
0.
1.
2.
Drawdown (ft)
Time (min)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group

Appendix I

Laboratory Soil Testing Reports

BRAUN[SM]
INTERTEC

Braun Intertec Corporation
6875 Washington Avenue South
P.O. Box 39108
Minneapolis, Minnesota 55439-0108
612-941-5600 Fax: 942-4844

Engineers and Scientists Serving the Built and Natural Environments[SM]

June 28, 1994

Project CVXX-94-1AAX
Report 94-1824

Mr. Marti Harding
Barr Engineering Company
8300 Norman Center Drive
Suite 300
Minneapolis, MN 55437-1026

Dear Mr. Harding:

Re: 15/78-001JSL22

Braun Intertec Corporation received your analytical request on May 23, 1994. Analytical results are summarized on the following laboratory report.

Routine Braun Intertec Corporation QA/QC was followed. Quality control data have been reviewed. No anomalies were encountered in the analysis of these samples.

We appreciate the opportunity to meet your analytical needs. If you have any questions or need additional information, please call Dean Almquist at 612-942-4936.

Sincerely,

Dean O. Almquist
Project Manager

Mark D. Lanz, CIH
Administrative Manager

Attachments
Chain of Custody
Laboratory Results

Client:	Barr Engineering Company	**Laboratory:**	Braun Intertec Corporation	**Date Sampled:**	04/11/94
Log-in:	94-1824	**Lab Contact/Phone:**	D. Almquist/612-942-4936	**Date Received:**	05/23/94
Project Number:	CVXX-94-1AAX	**Sampler:**	Client	**Date Reported:**	06/28/94
Matrix:	Solid	**% Moisture:**	Not Applicable		
Lab Sample ID:	94-1824-01	**MDL:**	Method Detection Limit		
		RL:	Reporting Limit		

Client Sample ID/Description: SB-18-10

Compound	Extract Method	Extract Date	Analysis Method	Analysis Date	Dilution Factor	MDL	RL	Sample Result	
Analysis performed by a contract laboratory									
Total Organic Carbon	-	-	EPA 415.1	06/01/94	1	0.01	0.01	1.4	%

(Report continued on next page)

Client:	Barr Engineering Company	**Laboratory:**	Braun Intertec Corporation	**Date Sampled:**	04/14/94
Log-in:	94-1824	**Lab Contact/Phone:**	D. Almquist/612-942-4936	**Date Received:**	05/23/94
Project Number:	CVXX-94-1AAX	**Sampler:**	Client	**Date Reported:**	06/28/94
Matrix:	Solid	**% Moisture:**	Not Applicable		
Lab Sample ID:	94-1824-02	**MDL:**	Method Detection Limit		
		RL:	Reporting Limit		

Client Sample ID/Description: SB-23-6

Compound	Extract Method	Extract Date	Analysis Method	Analysis Date	Dilution Factor	MDL	RL	Sample Result	
Analysis performed by a contract laboratory									
Total Organic Carbon	-	-	EPA 415.1	06/01/94	1	0.01	0.01	1.0	%

(Report continued on next page)

Client:	Barr Engineering Company	**Laboratory:**	Braun Intertec Corporation	**Date Sampled:**	04/14/94
Log-in:	94-1824	**Lab Contact/Phone:**	D. Almquist/612-942-4936	**Date Received:**	05/23/94
Project Number:	CVXX-94-1AAX	**Sampler:**	Client	**Date Reported:**	06/28/94
Matrix:	Solid	**% Moisture:**	Not Applicable		
Lab Sample ID:	94-1824-03	**MDL:**	Method Detection Limit		
		RL:	Reporting Limit		

Client Sample ID/Description: SB-23-14

Compound	Extract Method	Extract Date	Analysis Method	Analysis Date	Dilution Factor	MDL	RL	Sample Result	
Analysis performed by a contract laboratory									
Total Organic Carbon	-	-	EPA 415.1	06/01/94	1	0.01	0.01	0.40	%

(Report continued on next page)

Client:	Barr Engineering Company	**Laboratory:**	Braun Intertec Corporation	**Date Sampled:**	
Log-in:	94-1824	**Lab Contact/Phone:**	D. Almquist/612-942-4936	**Date Received:**	05/23/94
Project Number:	CVXX-94-1AAX	**Sampler:**	Client	**Date Reported:**	06/28/94
Matrix:	Solid	**% Moisture:**	Not Applicable		
Lab Sample ID:	94-1824-04	**MDL:**	Method Detection Limit		
		RL:	Reporting Limit		

Client Sample ID/Description: Method Blank

Compound	Extract Method	Extract Date	Analysis Method	Analysis Date	Dilution Factor	MDL	RL	Sample Result
Analysis performed by a contract laboratory								
Total Organic Carbon	-	-	EPA 415.1	06/01/94	1	0.01	0.01	<0.01 %

(Report continued on next page)

Client:	Barr Engineering Company	**Laboratory:**	Braun Intertec Corporation	**Date Sampled:**	
Log-in:	94-1824	**Lab Contact/Phone:**	D. Almquist/612-942-4936	**Date Received:**	05/23/94
Project Number:	CVXX-94-1AAX	**Sampler:**	Client	**Date Reported:**	06/28/94
Matrix:	Solid	**% Moisture:**	Not Applicable		
Lab Sample ID:	94-1824-05	**MDL:**	Method Detection Limit		
		RL:	Reporting Limit		

Client Sample ID/Description: Matrix Spike

Compound	Extract Method	Extract Date	Analysis Method	Analysis Date	Dilution Factor	MDL	RL	Sample Result

NO ANALYSIS PERFORMED ON THIS SAMPLE

(Report continued on next page)

Client:	Barr Engineering Company	**Laboratory:**	Braun Intertec Corporation	**Date Sampled:**	
Log-in:	94-1824	**Lab Contact/Phone:**	D. Almquist/612-942-4936	**Date Received:**	05/23/94
Project Number:	CVXX-94-1AAX	**Sampler:**	Client	**Date Reported:**	06/28/94
Matrix:	Solid	**% Moisture:**	Not Applicable		
Lab Sample ID:	94-1824-06	**MDL:**	Method Detection Limit		
		RL:	Reporting Limit		

Client Sample ID/Description: Sample Duplicate

Compound	Extract Method	Extract Date	Analysis Method	Analysis Date	Dilution Factor	MDL	RL	Sample Result	
Analysis performed by a contract laboratory									
Total Organic Carbon	-	-	EPA 415.1	06/01/94	1	0.01	0.01	1.1	%

(Report continued on next page)

Client:	Barr Engineering Company	**Laboratory:**	Braun Intertec Corporation	**Date Sampled:**	
Log-in:	94-1824	**Lab Contact/Phone:**	D. Almquist/612-942-4936	**Date Received:**	05/23/94
Project Number:	CVXX-94-1AAX	**Sampler:**	Client	**Date Reported:**	06/28/94
Matrix:	Solid	**% Moisture:**	Not Applicable		
Lab Sample ID:	94-1824-07	**MDL:**	Method Detection Limit		
		RL:	Reporting Limit		

Client Sample ID/Description: Laboratory Method Standard

Compound	Extract Method	Extract Date	Analysis Method	Analysis Date	Dilution Factor	MDL	RL	Sample Result	
SPIKE-TOC									
Total Organic Carbon	-	-	EPA 9060	06/01/94	1	-	-	3.30	%

(End of Report)

Bar. Chain of Custody

94-1824

Bar. Engineering Company
8300 Norman Center Drive
Minneapolis, MN 55437-1026
(612) 832-2600

Project Number: 15178-001 FSC22

No: № 0746
CVXX-94-7AAX

Project Manager: Thomas Mathson

Project Contact: Dave Moore/Tom Mathson

Laboratory: Braun

Remarks/ Analysis Required:

	Sample Identification	Collection Date	Collection Time	Water	Soil	Grab	Comp.	Blank	Volatile Organic	Semivolatile Organic	Total Metals	Dissolved Metals	General	Cyanide	Nutrients	Oil and Grease	TOC	Sulfide	Dioxin	Whirlpak/Bacteria	Total Phenol	Total Hardness	Total No. Of Containers	Remarks/ Analysis Required
-01	SB-18-10	4/11			X	X											X							TOC
-02	SB-23-6	4/14			X	X											X							"
-03	SB-23-14	4/14			X	X											X							"
	-04 Method Blank																							
	-05 Matrix Spike																							
	-06 Sample Duplicate																							
	-07 Labacatory Method Standard																							

Sampled By: DDM	Relinquished By: DDM	Date: 5/23	Time: 13:40	Received by Lab:	Date: 5/23/94	Time: 1340
Received By:	Relinquished By:	Date	Time	Received by Lab:	Date	Time
Remarks:	Samples Shipped VIA ☐ Air Freight ☐ Fed. Exp. ☐ Sampler ☒ Other Hand			Air Bill Number:		

Distribution: White-Original Accompanies Shipment to Lab; Yellow - Lab Coordinator; Pink-Field Copy

Appendix J

Piper Diagram Discussion

Appendix J
Discussion of Piper Diagram

The current groundwater monitoring network at the Citizens Gas and Electric Company Site consists of seven wells: MW-1, MW-2, MW-3, MW-4, MW-5, MW-6, and MW-8. From a consideration of borehole logs, stratigraphy, elevation of screened interval, recharge rate, and water levels measured in each respective well, MW-1 appears to be completed over an isolated zone perched in the fine alluvium. The bottom of this zone is approximately 6 feet above the top of the underlying coarse alluvial aquifer. The other six wells (i.e.; MW-2, MW-3, MW-4, MW-5, MW-6, and MW-8) are completed in the coarse alluvial aquifer.

To assist in evaluating groundwater quality in the perched zone and within the coarse alluvial aquifer, water samples were collected and the groundwater chemistry was analyzed according to those procedures described by Piper (1953). The Piper trilinear plotting of water analysis constitutes a useful tool in water analysis interpretation that can be an aid in identifying water samples of common origin.

The Piper trilinear plot for water samples collected on April 25 and 26, 1994 is presented on Figure J-1. As seen on the figure, major ions are plotted in the two base triangles of the diagram as cation and anion percentages of milliequivalents per liter. The respective cation and anion locations for each analysis is projected into the diamond-shaped field which indicates the character of each groundwater sample as represented by the relationships among the Na + K, Ca + Mg, CO_3 + HCO_3, and Cl + SO_4 ions. As seen on the diagram, the locus of points for the water samples from the coarse alluvial aquifer (i.e., from Wells MW-2, MW-4, MW-5, MW-6, and MW-8) do not appear to be concentrated in a particular zone, but are spread out over a relatively large area. This suggests there is some variability in the composition of waters from the coarse alluvial aquifer.

From the Piper Diagram, the water sample from Monitoring Well MW-1 is seen to plot in the vicinity of the locations of sample points from MW-4 and MW-5. However, due to the variability of the composition of the waters from the coarse alluvial aquifer, the results of the Piper Diagram are difficult to interpret. Thus, it cannot be inferred if the water sample from the perched zone has the same or a different source than the groundwaters from the coarse alluvial aquifer.

References

Piper, A.M., 1953, A Graphic Procedure In The Geochemical Interpretation Of Groundwater Analysis, American Geophysical Union Transactions, v. 25, pp. 914-923.

MW1 Cations MW1: Ca^{2+}: Measured: 212 mg/L

$$\text{Eq. wt.} = \frac{40.08}{2} = 20.04 \frac{g}{equiv} \text{ or } 20.04 \frac{mg}{meq}$$

$$\rightarrow \frac{212 \frac{mg}{L}}{20.04 \frac{mg}{meq}} = 10.58 \frac{meq}{L}$$

$\rightarrow$ Mg^{2+}: Meas.: 76.1

$$\text{Eq. wt.} = \frac{24.3}{2} = 12.15 \text{ mg/meq} ;$$

$$\frac{76.1 \frac{mg}{L}}{12.15 \frac{mg}{meq}} = 6.26 \frac{meq}{L}$$

$\rightarrow$ Na: Meas 44.6 mg/L

$$\text{Eq. wt.} = 22.99 \text{ mg/meq} ; \quad \frac{44.6}{22.99} = 1.94 \frac{meq}{L}$$

$\rightarrow$ K: Meas: 7.9 mg/L

$$\text{Eq wt} = 39.10 \text{ mg/meq} ; \quad \frac{7.9}{39.1} = 0.2 \frac{meq}{L}$$

MW1 Anions HCO_3^- as $CaCO_3$: measured = 530 mg/L.

÷ by 0.8202 to convert to ppm in terms of bicarbonate ∴

$$HCO_3: \text{measured} = \frac{530 \text{ mg/L}}{0.8202} = 646.18 \frac{\text{mg}}{\text{L}}$$

$$\text{Eq. wt.} = \frac{61 \text{ GFW}}{1 \text{ Z}} = 61 \frac{\text{mg}}{\text{meq}}$$

$$\rightarrow \frac{646.18 \text{ mg/L}}{61 \text{ mg/meq}} = 10.59 \text{ meq/L}.$$

Cl^- : Meas: 78 mg/L.

$$\rightarrow \text{eq wt} = 35.45 \frac{\text{mg}}{\text{meq}}; \quad \frac{78 \text{ mg/L}}{35.45 \text{ mg/meq}} = 2.20 \frac{\text{meq}}{\text{L}}$$

$SO_4^=$: meas: 139 mg/L

$$\rightarrow \text{eq wt} = 48.03 \frac{\text{mg}}{\text{meq}}; \quad \frac{139 \text{ mg/L}}{48.03 \text{ mg/meq}} = 2.89 \frac{\text{meq}}{\text{L}}$$

BARR ENGINEERING CO.

NAME BJV
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Balance Error

Σanions = 15.68
ΣCations = 18.98

$$e = \frac{\Sigma c - \Sigma a}{\Sigma c + \Sigma a} = \frac{18.98 - 15.68}{18.98 + 15.68} = 0.10 \text{ meq/L}$$

$\Sigma c - \Sigma a = 3.30$ meq/L

distribute 3.30 meq/L to anions:

HCO_3^- : $\frac{10.59}{15.68} \times 3.3 = 2.23$ meq/L : $\Sigma = 10.59 + 2.23 = 12.82$

Cl^- : $\frac{2.20}{15.68} \times 3.3 = 0.46$ meq/L : $\Sigma = 2.20 + 0.46 = 2.66$

SO_4^{2-} : $\frac{2.89}{15.68} \times 3.3 = 0.61$ meq/L $\Sigma = 2.89 + 0.61 = 3.47$

$\Sigma = 18.9$

MW2 CATIONS

Ca [153 mg/L) ; $\frac{153 \text{ mg/L}}{20.04 \text{ mg/meq}} = 7.63 \text{ meq/L}$

Mg [64.4 mg/L] $\frac{64.4 \text{ mg/L}}{12.15 \text{ mg/meq}} = 5.3 \text{ meq/L}$

Na [35.6 mg/L] $\frac{35.6 \text{ mg/L}}{22.99 \text{ mg/meq}} = 1.55 \text{ meq/L}$

K [5.85 mg/L] $\frac{5.85 \text{ mg/L}}{39.10 \text{ mg/meq}} = 0.15 \text{ meq/L}$

$\Sigma = 14.63$

ANIONS

HCO_3^- [410 as $CaCO_3$] = [410/0.820 as HCO_3] = 500 mg/L

; $\frac{500 \text{ mg/L}}{61 \text{ mg/meq}} = 8.20 \text{ meq/L}$

Cl^- [134 mg/L] ; $\frac{159 \text{ mg/L}}{35.45 \text{ mg/meq}} = 4.49 \text{ meq/L}$

SO_4^{2-} [94 mg/L] ; $\frac{94 \text{ mg/L}}{48.03 \text{ mg/meq}} = 1.96 \text{ meq/L}$

$\Sigma = 14.64$

Cation Balance

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MW4 CATIONS

Ca [169 mg/L] ; $\frac{169 \text{ mg/L}}{20.04 \text{ mg/meq}} = 8.43$ meq/L

Mg [71 mg/L] ; $\frac{71 \text{ mg/L}}{12.15 \text{ mg/meq}} = 5.84$ meq/L

Na [33.4 mg/L] ; $\frac{33.4 \text{ mg/L}}{22.99 \text{ mg/meq}} = 1.45$ meq/L

K [8.08 mg/L] $\frac{8.08 \text{ mg/L}}{39.10 \text{ mg/meq}} = 0.21$ meq/L

$\Sigma = 15.93$ meq/L

ANIONS

HCO_3^- [620 mg/L as $CaCO_3$] = [620/1.82 mg/L as HCO_3^-] = 756 mg/L

; $\frac{756 \text{ mg/L}}{61 \text{ mg/meq}} = 12.40$ meq/L

Cl^- [120 mg/L] ; $\frac{120 \text{ mg/L}}{35.45 \text{ mg/meq}} = 3.39$ meq/L

SO_4^{2-} [61 mg/L] ; $\frac{61 \text{ mg/L}}{48.03 \text{ mg/meq}} = 1.27$ meq/L

$\Sigma = 17.06$ meq/L

Error Balance

$\Sigma A - \Sigma C = 17.06 - 15.93 = 1.13$ meq/L

Distributing Error to Cations:

Ca: $\frac{8.43}{15.93} \times 1.13 + 8.43 = 0.60 + 8.43 = 9.03$ meq/L

Mg: $\frac{5.84}{15.93} \times 1.13 + 5.84 = 0.41 + 5.84 = 6.25$ meq/L

Na: $\frac{1.45}{15.93} \times 1.13 + 1.45 = 0.10 + 1.45 = 1.55$ meq/L

K: $\frac{0.21}{15.93} \times 1.13 + 0.21 = 0.01 + 0.21 = 0.22$ meq/L

$\Sigma = 17.06$ meq/L

MW 5 CATIONS.

Ca [198 mg/L] ; $\frac{198 \text{ mg/L}}{20.04 \text{ mg/meq}}$ = 9.88 meq/L

Mg [59.4 mg/L] ; $\frac{59.4 \text{ mg/L}}{12.15 \text{ mg/meq}}$ = 4.89 meq/L

Na [34.9 mg/L] $\frac{34.9 \text{ mg/L}}{22.99 \text{ mg/meq}}$ = 1.52 meq/L

K [12.2 mg/L] $\frac{12.2 \text{ mg/L}}{39.10 \text{ mg/meq}}$ = 0.31 meq/L

ΣCations = 16.60 meq/L

ANIONS.

HCO_3^- [570 mg/L as $CaCO_3$] = [695.12 mg/L as HCO_3^-] = 695.12 mg/L

; $\frac{695.12 \text{ mg/L}}{61 \text{ mg/meq}}$ = 11.40 meq/L.

Cl^- [73 mg/L] ; $\frac{73 \text{ mg/L}}{35.45 \text{ mg/meq}}$ = 2.06 meq/L

SO_4^{2-} [179 mg/L] ; $\frac{179 \text{ mg/L}}{48.03 \text{ mg/meq}}$ = 3.73 meq/L

ΣAnions = 17.19 meq/L.

Error Balance:

$\Sigma A - \Sigma C = 0.59$

Distributing Error to Cations:

Ca: $\frac{9.88}{16.60} \times 0.59 + 9.88 = 0.35 + 9.88 = 10.23$ meq/L.

Mg: $\frac{4.89}{16.60} \times 0.59 + 4.89 = 0.17 + 4.89 = 5.06$ meq/L

Na: $\frac{1.52}{16.60} \times 0.59 + 1.52 = 0.05 + 1.52 = 1.57$ meq/L

K: $\frac{0.31}{16.60} \times 0.59 + 0.31 = 0.01 + 0.31 = 0.32$ meq/L

Σ = 17.18 meq/L

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NW6 CATIONS

Ca [126 mg/L] ; $\frac{126 \text{ mg/L}}{20.04 \text{ mg/meq}} = 6.29 \frac{\text{meq}}{\text{L}}$

Mg [45.8 mg/L] ; $\frac{45.8 \text{ mg/L}}{12.15 \text{ mg/meq}} = 3.77 \frac{\text{meq}}{\text{L}}$

Na [68.4 mg/L] $\frac{68.4 \text{ mg/L}}{22.99 \text{ mg/meq}} = 2.98 \frac{\text{meq}}{\text{L}}$

K [9.55 mg/L] $\frac{9.55 \text{ mg/L}}{39.10 \text{ mg/meq}} = 0.24 \frac{\text{meq}}{\text{L}}$

Σ 13.28 meq/L

HCO_3^- [600 mg/L as $CaCO_3$] = [600/.82 mg/L as HCO_3^-] = 731.71 mg/L

; $\frac{731.71}{61} = 12.00$ meq/L

Cl^- [54 mg/L] ; $\frac{54}{35.45} = 1.52$ meq/L

SO_4^{2-} [7.9 mg/L] $\frac{7.9}{48.03} = 0.16$ meq/L

$\Sigma = 13.68$

Error Balance

$\Sigma A - \Sigma C = 0.40$ meq/L

Distributing Error to Cations

Ca: $\frac{6.29}{13.28} \times 0.4 + 6.29 = 0.19 + 6.29 = 6.48$

Mg: $\frac{3.77}{13.28} \times .4 + 3.77 = 0.11 + 3.77 = 3.88$

Na: $\frac{2.98}{13.28} \times .4 + 2.98 = 0.09 + 2.98 = 3.07$

K: $\frac{0.24}{13.28} \times .4 + 6.24 = 0.01 + 0.24 = 0.25$

$\Sigma = 13.68$

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MW3

CATIONS

Ca [141 mg/L]; $\frac{141 \text{ mg/L}}{20.04 \text{ mg/meq}} = 7.04$ meq/L

Mg [50.3 mg/L]; $\frac{50.3}{12.15} = 4.14$ meq/L

Na [57.1 mg/L]; $\frac{57.1}{22.99} = 2.48$ meq/L

K [7.89 mg/L]; $\frac{7.89}{39.10} = 0.20$ meq/L

$\Sigma = 13.87$ meq/L

ANIONS

HCO_3^- [620 mg/L as $CaCO_3$] = 620/0.82 meq/L as HCO_3^- = 756 mg/L

; $\frac{756 \text{ mg/L}}{61 \text{ mg/meq}} = 12.40$ meq/L

Cl^- [32 mg/L] = $\frac{32}{35.45} = 0.90$ meq/L

SO_4^{2-} [67 mg/L] = $\frac{67}{48.03} = 1.39$ meq/L

$\Sigma = 14.69$

Error Balance

$\Sigma A - \Sigma C = 14.69 - 13.87 = 0.82$ meq/L

Distributing Error To Cations

Ca: $\frac{7.04}{13.87} \times 0.82 + 7.04 = 0.42 + 7.04 = 7.46$

Mg: $\frac{4.14}{13.87} \times 0.82 + 4.14 = 0.24 + 4.14 = 4.38$

Na: $\frac{2.48}{13.87} \times 0.82 + 2.48 = 0.15 + 2.48 = 2.63$

K: $\frac{0.20}{13.87} \times 0.82 + 0.20 = 0.01 + 0.20 = 0.21$

$\Sigma = 14.68$

BARR ENGINEERING CO.

NAME BA
DATE 6/27/04
SHEET (2) 1 IN SET
PAGE _____ IN FILE

Coon Rapids

CHECKED BY _____
DATE _____

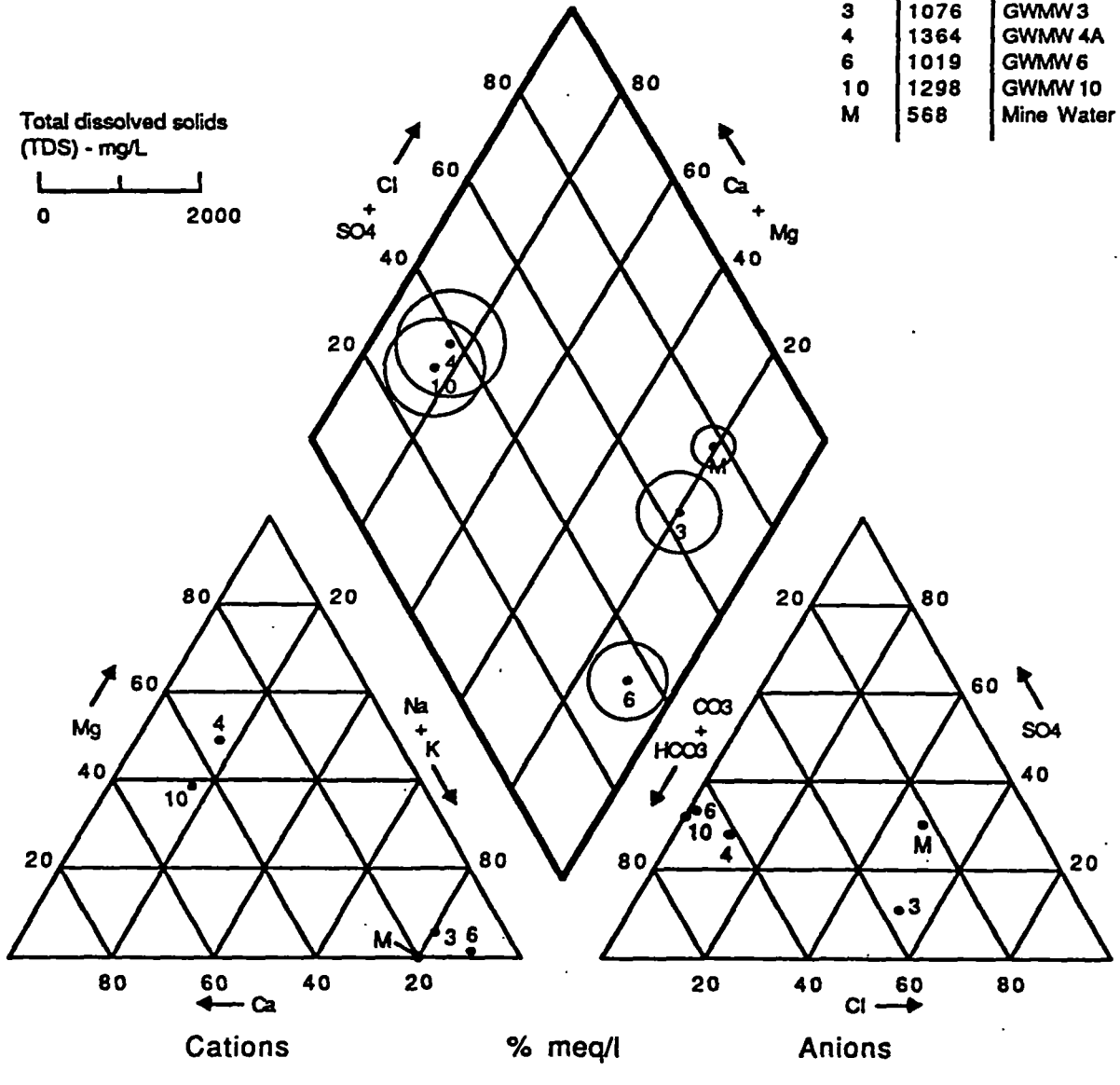
SUMMARY SHEET

CATIONS

WELL	Ca mg	Ca meq	Mg mg	Mg meq	Na mg	Na meq	K mg	K meq	Σ C meq	Ca %	Mg %	Na + K %
MW 1	212	10.58	76.1	6.26	44.6	1.94	7.9	0.2	18.78	56	33	11
MW 2		7.63		5.3		1.55		0.15	14.63	52	36	12
MW 4		9.03		6.25		1.55		0.22	17.06	53	37	10
MW 5		10.23		5.96		1.57		0.32	17.18	60	29	11
MW 6		6.48		3.88		3.07		0.25	13.68	47	28	24
MW 8		7.46		4.38		2.63		0.21	14.68	52	30	18

ANIONS

	HCO_3^-	Cl^-	SO_4^{2-}	Σ A	HCO_3^- %	Cl %	SO_4^{2-} %
MW1	12.82	2.66	3.47	18.95	68	14	18
MW2	8.20	4.47	1.96	14.64	56	31	13
MW4	12.40	3.39	.27	17.06	73	20	7
MW5	11.40	2.06	3.73	17.19	66	12	22
MW6	12.00	1.52	0.16	13.68	88	11	1
MW8	12.40	0.90	1.39	14.69	84	6	9



Project Name	Cannon Mine	Piper Diagram for Ground and Mine Water	Figure 6-1
Woodward-Clyde Consultants			90C0390A

4. Water Sample Collected from Monitoring Well MW-4

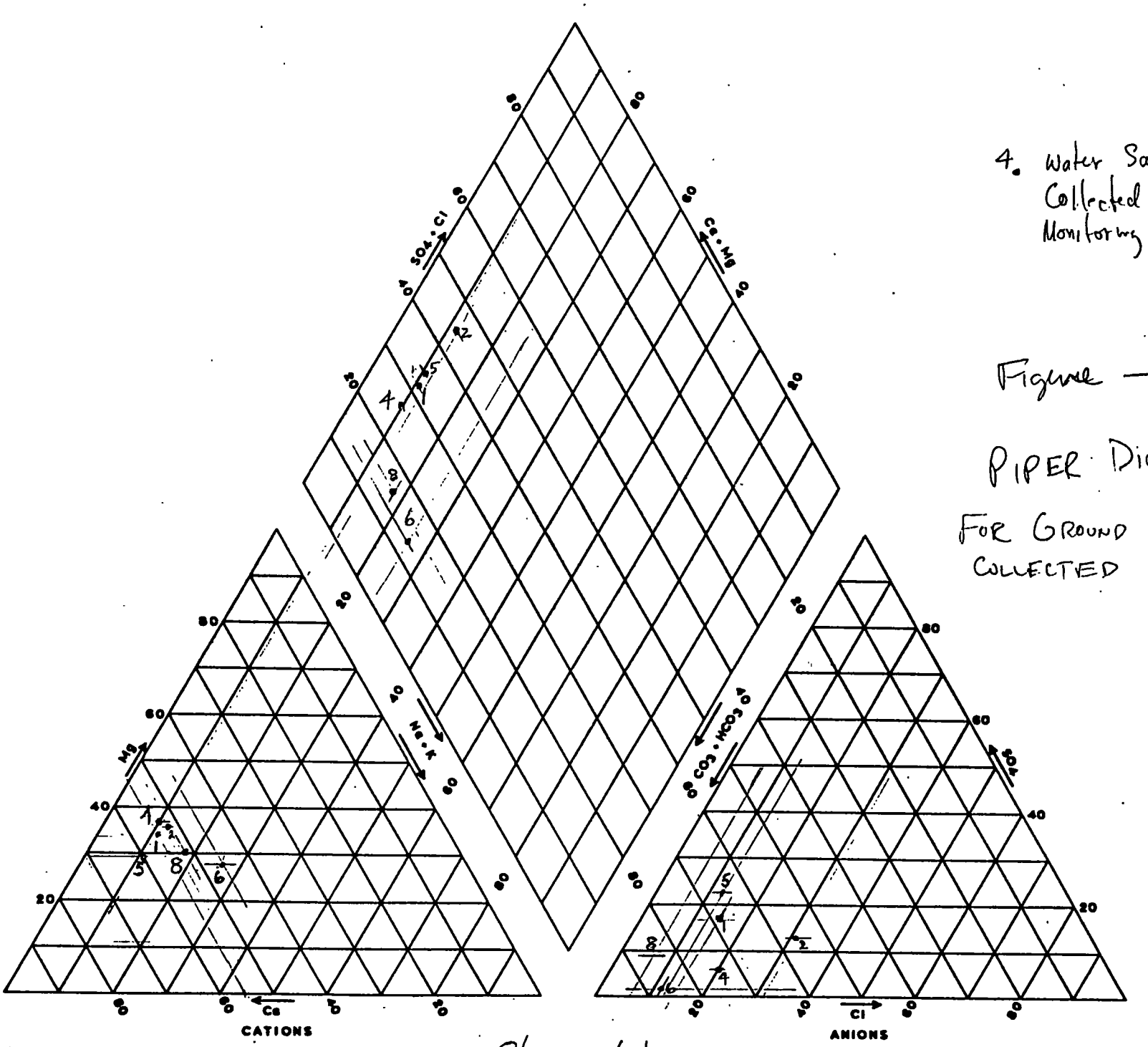


Figure —

PIPER Diagram

FOR GROUND WATER COLLECTED 4/25/94

% meq/Liter

BH. 6/28/94

Appendix K

Groundwater Gradient Calculation

07/28/92	Elev	Distance	Coordinates	Vectors		Sum	Gradient (Ft/Ft)		Average Gradient (ft/ft)
W2	969.07	369	312.5	-0.000183	N				
			196.25	-0.000115	E				
W3	968.96	0	0			0.0000	0.00028	-0.00033 N	0.00041
			0			-0.0003 E		-0.00024 E	
W4	968.88	203	165	0.000229	N				
			118.75	0.000165	W				

08/30/91	Elev	Distance	Coordinates	Vectors		Sum	Gradient (Ft/Ft)
W2	968.5	369	312.5	-0.000183	N		
			196.25	-0.000115	E		
W3	968.39	0	0			-0.0001	0.00020
			0			-0.0002 E	
W4	968.37	203	165	0.000057	N		
			118.75	0.000041	W		

12/02/89	Elev	Distance	Coordinates	Vectors		Sum	Gradient (Ft/Ft)
W2	967.1	369	312.5	-0.000366	N		
			196.25	-0.000230	E		
W3	966.88	0	0			-0.0005	0.00053
			0			-0.0001 E	
W4	966.93	203	165	-0.000143	N		
			118.75	-0.000103	W		

04/04/94	Elev	Distance	Coordinates	Vectors		Sum	Gradient (Ft/Ft)
W2	968.57	369	312.5	-0.000166	N		
			196.25	-0.000105	E		
W3	968.47	0	0			0.0000	0.00025
			0			-0.0002 E	
W4	968.4	203	165	0.000201	N		
			118.75	0.000144	W		

04/25/94	Elev	Distance	Coordinates	Vectors		Sum	Gradient (Ft/Ft)
W2	968.87	468	225	-0.000098	N		
			410	-0.000179	E		
W3		100					
W4	968.78	163	148	-0.000168	N		
			68	-0.000077	W		
W5	968.86	275	148	-0.000171	N		
			230	-0.000266	E		
W6	968.74	0	0			-0.0012	0.00127
			0			-0.0004 E	
W8	968.61	160	160	0.000765	S		
			10	0.000048	W		

06/02/94	Elev	Distance	Coordinates	Vectors		Sum	Gradient (Ft/Ft)
W2	969.83	468	225	-0.000144	N		
			410	-0.000262	E		
W3		100					
W4	969.66	163	148	-0.000084	N		
			68	-0.000039	W		
W5		275	148	N	N		
			230	E	E		
W6	969.64	0	0			-0.0002	0.00032
			0			-0.0002 E	
W8	969.64	160	160	0.000000	S		
			10	0.000000	W		

Appendix L

Data Validation and Quality Assurance Summary

Appendix L
Data Validation and Quality Assurance Summary

The quality control data from the Phase II investigation at Citizens Gas and Electric Company site in Council Bluffs, Iowa was evaluated to assess the integrity of the sampling procedures and the validity of the analytical results. The quality control practices and procedures (field and laboratory) followed during the 1994 sampling and analysis of the samples are detailed in the Quality Assurance Project Plan (QAPjP) for the site (Barr, 1993).

Laboratory Quality Control

Laboratory based quality control procedures were utilized to assess and monitor the validity of the analytical data generated from the analytical systems used for sample analysis. Established acceptance criteria were used to measure the degree of precision and accuracy obtained from the analytical process. CH2M Hill Laboratories was contracted for the analytical work.

Field Quality Control

A review of the field blanks and field duplicates was conducted to assess the integrity of the sampling procedures and analytical results from samples collected during April 1994 at the site. The quality control data was evaluated according to the procedures outlined in the standard operating procedure (SOP) for the evaluation of blank data and the standard operating procedure (SOP) for the evaluation of field duplicate data which are included in this appendix. All data requiring the assignment of data qualifiers, based on these data validation procedures, are footnoted in the data tables.

Field blanks (and trip blanks for volatiles) were collected to monitor contamination from any or all the following sources: improper decontamination, sampling, sample transport, and laboratory procedures.

Field duplicate samples were collected and analyzed to evaluate the precision of the resulting data. The precision was evaluated by calculating the relative percent difference (RPD) for the data pairs. The RPD formula is as follows:

$$RPD = \frac{D1 - D2}{(D1 + D2)/2} \times 100$$

Where: D1 = concentration of sample
D2 = concentration of duplicate sample

The RPD was calculated only for data pairs reported above the reporting limits and without data qualifiers assigned.

Data Validation — Soil

The soil sample data sets were validated in a manner generally following the EPA laboratory data validation functional guidelines for evaluating organic and inorganic analyses. The data qualifiers assigned to some of the data values were taken from a data qualifiers document that lists and defines the Barr data qualifiers. A copy of the data qualifiers document is provided in this appendix.

Blanks — Soil Samples

The organic parameters (Benzene, Ethyl Benzene, Toluene, and Xylene (BETX), and the semivolatile (PAHs)), the blanks (including field, trip, and laboratory or method blanks) were reported by the laboratory to have no parameters above the reporting limits. Therefore, no organic parameter data from the soil samples required data qualifiers due to blank contamination.

For the inorganic parameters (total cyanide and metals), sufficient concentrations of three parameters (mercury, cyanide, and arsenic) were present in some of the blanks to require the assignment of the Barr data qualifier "b" (potential false positive) to several soil samples.

The blank data associated with the soil samples are presented in Table L-1.

Field Duplicates Sample — Soils

Two masked field sample duplicates were taken at the site: M-1 (duplicate of SB-19-05) and M-2 (duplicate of SB-20-06). Relative percent differences were calculated for volatile duplicate sample data pairs and are presented in Table L-2. Both masked duplicate samples were collected from boring locations where the extent of contamination was expected to be of a heterogenous nature. The sample site conditions included visual observation of rootholes through which organic contaminants had infiltrated. Any soil sample taken from such field conditions may result in a analytical data with an elevated degree of reproducibility. For the masked field duplicate sample M-1 (SB-19-05), the average RPD for the following parameters were: BETX (76 percent), semivolatiles (150 percent), and for metals (10.1 percent). For the masked field duplicate sample

M-2 (SB-20-06), the average RPD for the following parameters were: BETX (108 percent), semivolatiles (32 percent), and metals (8.2 percent).

No soil sample data required data qualifiers on the basis of the sampling and analysis precision.

Laboratory Duplicate Analysis — Soils

Several soil samples were assigned the Barr data qualifier * (estimated value) for either chromium, copper, or arsenic due to the laboratory duplicate analysis data as required by the data validation guidelines. However, as stated earlier, it was expected that many of the samples were of a heterogenous nature in respect to the constituent contaminants.

Data Quality Conclusions — Soils

The quality control aspects of the investigation at the site demonstrated an acceptable degree of compliance to the project's data quality objectives as measured by the quality control samples in light of the heterogenous nature of the field samples.

During the data validation process, several data qualifiers were assigned to the soil sample data when quality assurance/quality control criteria were not met by the laboratory analysis. The qualifiers assigned included "*" (Estimated value, QA/QC criteria not met) and "b" (potential false positive). The reasons for the * data qualifiers included continuing calibration criteria for the PNAs, surrogate spike recoveries from the BETX analysis, spike recovery from the BETX analysis, lead sample spike recovery, and ICP serial dilution for zinc.

The project goal of 95 percent completeness for analytical data was met. All soil data reported by the laboratory was deemed useable based on the data validation criteria.

Data Validation — Groundwater

The groundwater sample data set was validated in a manner generally following the EPA laboratory data validation functional guidelines for evaluating organic and inorganic analyses. Some additional data qualifiers were assigned to the groundwater data as a result of the data validation process. The laboratory reported some non-carcinogenic PAHs as estimated values since they were below the EPA contract required reporting limits (CRDL) but above the method detection limits.

Blanks — Groundwater

The field, trip, and laboratory blanks were evaluated during the data validation process for the potential impact on sample data quality. No groundwater sample data required data qualifiers due to blank contamination.

The blank data associated with the groundwater samples are presented in Table L-3.

Field Duplicate Samples — Groundwater

Relative percent differences were calculated for volatile duplicate sample data pairs and are presented in Table L-4. One masked field duplicate sample was collected and analyzed (M-1 = MW-5). The duplicate data demonstrated good precision for the BETX (5.8 - 11.8 percent RPD), and filtered metals (8 percent RPD).

The general chemistry RPDs were low (1.4-1.8) for all parameters except for phenolics which were at 40 percent RPD. However, the phenolics data were close to the reporting limits which may result in elevated RPDs being calculated. The actual phenolics concentrations were 0.006 and 0.009 mg/l with the reporting limits was at 0.005 mg/l.

For PNAs, the RPDs were between 37.8 and 38.5 percent.

For filtered arsenic, the RPD was 8.0 percent. For cyanide, the RPD was 0.5 percent.

Laboratory Duplicate Analysis — Groundwater

In the laboratory duplicate of MW-2, the RPDs for the metals low reflecting good precision. In the laboratory duplicate of MW-3, lead (200 percent) was beyond the criteria and the other metals were between 1.5 and 41.4 percent RPD.

Data Quality Conclusions — Groundwater

The quality control aspects of the monitoring program overall at the site demonstrated a acceptable degree of compliance to the data quality objectives as measured by the quality control samples.

The project goal of 95 percent completeness for analytical data was met. All groundwater data reported by the laboratory was deemed useable based on the data validation criteria.

Data Entry Verification

All laboratory data which was entered into the Barr point sample database was checked for entry accuracy and completeness.

For the data summary tables, sums of the carcinogenic PAHs and the sums (rounded to two significant figures) of the PAH compounds were calculated and reported on the data summary tables. Non-detected values were not included in the calculations.

TABLE L-1

SOIL BLANK QUALITY DATA
PHASE II INVESTIGATION
CITIZENS GAS AND ELECTRIC COMPANY SITE

(concentrations in ug/kg, unless noted otherwise)

	FIELD BLANKS		TRIP BLANKS		
	04/07/94	04/13/94	04/07/94	04/11/94	04/19/94
Volatile Organic Compounds					
Benzene	<1.0	<1.0	<1.0	<1.0	<1.0
Ethyl Benzene	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene	<1.0	<1.0	<1.0	<1.0	<1.0
m & p Xylene	<2.0	<2.0	<2.0	<2.0	<2.0
o-Xylene	<1.0	<1.0	<1.0	<1.0	<1.0
Base/Neutral Compounds					
Suspected Carcinogenic PAHs					
Benzo(a)anthracene	<10	<10	--	--	--
Benzo(a)pyrene	<10	<10	--	--	--
Benzo(b)fluoranthene	<10	<10	--	--	--
Benzo(k)fluoranthene	<10	<10	--	--	--
Chrysene	<10	<10	--	--	--
Dibenzo(ah)anthracene	<10	<10	--	--	--
Indeno(1,2,3,cd)pyrene	<10	<10	--	--	--
Non-Carcinogenic PAHs					
Acenaphthene	<10	<10	--	--	--
Acenaphthylene	<10	<10	--	--	--
Anthracene	<10	<10	--	--	--
Benzo(ghi)perylene	<10	<10	--	--	--
Fluoranthene	<10	<10	--	--	--
Fluorene	<10	<10	--	--	--
Napthalene	<10	<10	--	--	--
Phenanthrene	<10	<10	--	--	--
Pyrene	<10	<10	--	--	--
Metals					
Arsenic, mg/kg	<0.0031	<0.0031	--	--	--
Chromium, total, mg/kg	<0.0020	<0.0020	--	--	--
Copper, mg/kg	0.0036	<0.0019	--	--	--
Lead, mg/kg	<0.00088	<0.00088	--	--	--
Mercury, mg/kg	0.00015	<0.00013	--	--	--
Nickel, mg/kg	<0.0116	<0.0116	--	--	--
Zinc, mg/kg	0.0025	<0.00090	--	--	--
Cyanide, mg/kg	<0.0017	<0.0017	--	--	--

-- Not analyzed.

3,.006
07/20/94

TABLE L-1 (cont.)

SOIL BLANK QUALITY DATA
PHASE II INVESTIGATION
CITIZENS GAS AND ELECTRIC COMPANY SITE

(concentrations in ug/kg, unless noted otherwise)

	LAB BLANKS					
	04/05/94	04/07/94	04/08/94	04/11/94	04/12/94	04/13/94
Volatile Organic Compounds						
Benzene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ethyl Benzene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
m & p Xylene	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
o-Xylene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Base/Neutral Compounds						
Suspected Carcinogenic PAHs						
Benzo(a)anthracene	<330	<330	<10000	--	--	<330
Benzo(a)pyrene	<330	<330	<10000	--	--	<330
Benzo(b)fluoranthene	<330	<330	<10000	--	--	<330
Benzo(k)fluoranthene	<330	<330	<10000	--	--	<330
Chrysene	<330	<330	<10000	--	--	<330
Dibenzo(ah)anthracene	<330	<330	<10000	--	--	<330
Indeno(1,2,3,cd)pyrene	<330	<330	<10000	--	--	<330
Non-Carcinogenic PAHs						
Acenaphthene	<330	<330	<10000	--	--	<330
Acenaphthylene	<330	<330	<10000	--	--	<330
Anthracene	<330	<330	<10000	--	--	<330
Benzo(ghi)perylene	<330	<330	<10000	--	--	<330
Fluoranthene	<330	<330	<10000	--	--	<330
Fluorene	<330	<330	<10000	--	--	<330
Napthalene	<330	<330	<10000	--	--	<330
Phenanthrene	<330	<330	<10000	--	--	<330
Pyrene	<330	<330	<10000	--	--	<330
Metals						
Arsenic, mg/kg	--	--	--	--	--	--
Chromium, total, mg/kg	--	--	--	--	--	--
Copper, mg/kg	--	--	--	--	--	--
Lead, mg/kg	--	--	--	--	--	--
Mercury, mg/kg	--	--	--	--	--	--
Nickel, mg/kg	--	--	--	--	--	--
Zinc, mg/kg	--	--	--	--	--	--
Cyanide, mg/kg	--	--	--	--	--	--

-- Not analyzed.

3,.007
07/20/94

TABLE L-1 (cont.)

SOIL BLANK QUALITY DATA
PHASE II INVESTIGATION
CITIZENS GAS AND ELECTRIC COMPANY SITE

(concentrations in ug/kg, unless noted otherwise)

	LAB BLANKS	
	04/18/94	04/19/94
Volatile Organic Compounds		
Benzene	<1.0	<1.0
Ethyl Benzene	<1.0	<1.0
Toluene	<1.0	<1.0
m & p Xylene	<2.0	<2.0
o-Xylene	<1.0	<1.0
Base/Neutral Compounds		
Suspected Carcinogenic PAHs		
Benzo(a)anthracene	<330	--
Chrysene	<330	--
Benzo(b)fluoranthene	<330	--
Benzo(k)fluoranthene	<330	--
Benzo(a)pyrene	<330	--
Indeno(1,2,3,cd)pyrene	<330	--
Dibenzo(ah)anthracene	<330	--
Non-Carcinogenic PAHs		
Acenaphthene	<330	--
Acenaphthylene	<330	--
Anthracene	<330	--
Benzo(ghi)perylene	<330	--
Fluoranthene	<330	--
Fluorene	<330	--
Napthalene	<330	--
Phenanthrene	<330	--
Pyrene	<330	--
Metals		
Arsenic, mg/kg	--	--
Chromium, total, mg/kg	--	--
Copper, mg/kg	--	--
Lead, mg/kg	--	--
Mercury, mg/kg	--	--
Nickel, mg/kg	--	--
Zinc, mg/kg	--	--
Cyanide, mg/kg	--	--

-- Not analyzed.

3,.007
07/20/94

TABLE L-2

SOIL DUPLICATE DATA
PHASE II INVESTIGATION
CITIZENS GAS AND ELECTRIC COMPANY SITE

(concentrations in ug/kg, unless noted otherwise)

	SB1905		RPD	SB2006		RPD
	04/07/94 Sample	04/07/94 Duplicate		04/13/94 Sample	04/13/94 Duplicate	
Volatile Organic Compounds						
Benzene	700	390	57	<67	<55	
Ethyl Benzene	12000	5800	70	<67	<55	
Toluene	420	<280		<67	<55	
m & p Xylene	6800	2400	96	190	640	108
o-Xylene	4300	2000	73	<67	130	
Sum of BETX	24000	11000		190	770	
Base/Neutral Compounds						
Suspected Carcinogenic PAHs						
Benzo(a)anthracene	740	8800	169	770 j	560 j	
Benzo(a)pyrene	580	6100	165	540 j	380 j	
Benzo(b)fluoranthene	660	3500	137	320 j	200 j	
Benzo(k)fluoranthene	940	3600	117	410 j	330 j	
Chrysene	700	8300	169	860	640 j	
Dibenzo(ah)anthracene	110 j	660		<850	<880	
Indeno(1,2,3,cd)pyrene	210 j	1100		140 j	<880	
Sum of Carcinogens	3900 a	32000		3000 a	2100 a	
Non-Carcinogenic PAHs						
Acenaphthene	1400	15000	166	2100	1600	27
Acenaphthylene	510	3400	148	210 j	<880	
Anthracene	780	7400	162	1000	770 j	
Benzo(ghi)perylene	180 j*	990 *		130 j	120 j	
Fluoranthene	1600	15000	161	1200	750 j	
Fluorene	1400	6100	125	1300	950	31
Napthalene	470 j	2100		<850	<880	
Phenanthrene	2900	30000	165	830 j	1300	
Pyrene	1500	18000	169	2000	1400	35
Sum of Total PAH Compounds	15000 a	130000		12000 a	9000 a	
Metals						
Arsenic, mg/kg	14.5 *	7.9 b*		11.8	14.2	18.5
Chromium, total, mg/kg	25.9	30.6	16.6	13.4	12.8	4.6
Copper, mg/kg	25.6	26.6	3.8	9.2	9.7	5.3
Lead, mg/kg	18.1 *	19.3 *		9.0	8.6	4.6
Mercury, mg/kg	0.06 b	0.05 b		<0.03	<0.03	
Nickel, mg/kg	35.5	32.2	9.8	23.4	20.5	13.2
Zinc, mg/kg	86.2 *	93.5 *		40.7	39.5	3.0
Cyanide, mg/kg	0.32	<0.24		<0.22	<0.23	

---

a Estimated value, calculated using some or all values that are estimates.
b Potential false positive value based on blank data validation procedure.
j Reported value is less than the stated laboratory quantitiation limit and is considered an estimated value.
* Estimated value, QA/QC criteria not met.
RPD Relative Percent Difference

3,.010
07/20/94

TABLE L-3

WATER BLANK QUALITY DATA
CITIZENS GAS AND ELECTRIC COMPANY SITE

(concentrations in ug/L, unless noted otherwise)

	FIELD BLANKS			TRIP BLANKS		
	12/02/89	07/28/92	04/25/94	07/28/92	04/04/94	04/25/94
Volatile Organic Compounds						
Benzene	1.0	<0.5	<1.0	<0.5	<1.0	<1.0
Ethyl Benzene	<1.0	<0.5	<1.0	<0.5	<1.0	<1.0
Toluene	1.5	<0.5	<1.0	<0.5	<1.0	<1.0
m & p Xylene	--	--	<2.0	--	<2.0	<2.0
o-Xylene	--	--	<1.0	--	<1.0	<1.0
Xylenes, total	--	--	--	--	--	--
Base/Neutral Compounds						
Suspected Carcinogenic PAHs						
Benzo(a)anthracene	--	<10	<10	--	--	--
Benzo(a)pyrene	--	<10	<10	--	--	--
Benzo(b)fluoranthene	--	<10	<10	--	--	--
Benzo(k)fluoranthene	--	<10	<10	--	--	--
Chrysene	--	<10	<10	--	--	--
Dibenzo(ah)anthracene	--	<10	<10	--	--	--
Indeno(1,2,3,cd)pyrene	--	<10	<10	--	--	--
Non-Carcinogenic PAHs						
Acenaphthene	--	<10	<10	--	--	--
Acenaphthylene	--	<10	<10	--	--	--
Anthracene	--	<10	<10	--	--	--
Benzo(ghi)perylene	--	<10	<10	--	--	--
Fluoranthene	--	<10	<10	--	--	--
Fluorene	--	<10	<10	--	--	--
Napthalene	--	--	<10	--	--	--
Phenanthrene	--	<10	<10	--	--	--
Pyrene	--	<10	<10	--	--	--
Phenolics	--	--	<5.0	--	--	--
Metals						
Arsenic, mg/L	--	--	<0.0031	--	--	--
Arsenic, filtered, mg/L	--	--	<0.0031	--	--	--
Chromium, total, mg/L	--	--	--	--	--	--
Copper, mg/L	--	--	--	--	--	--
Lead, mg/L	--	--	<0.00088	--	--	--
Lead, filtered, mg/L	--	--	<0.00088	--	--	--
Mercury, mg/L	--	--	<0.00013	--	--	--
Mercury, filtered, mg/L	--	--	<0.00013	--	--	--
Nickel, mg/L	--	--	--	--	--	--
Zinc, mg/L	--	--	--	--	--	--
Cyanide, mg/L	--	<0.0022	<0.0017	--	--	--
General Parameters						
TPH as Gasoline	--	<50	--	--	--	--
TPH as Diesel	--	<500	--	--	--	--

-- Not analyzed.

3,.008
07/20/94

TABLE L-3 (cont.)

WATER BLANK QUALITY DATA
CITIZENS GAS AND ELECTRIC COMPANY SITE

(concentrations in ug/L, unless otherwise noted)

	LAB BLANKS		
	07/28/92	04/04/94	04/25/94
Volatile Organic Compounds			
Benzene	<0.5	<1.0	<1.0
Ethyl Benzene	<0.5	<1.0	<1.0
Toluene	<0.5	<1.0	<1.0
m & p Xylene	--	<2.0	<2.0
o-Xylene	--	<1.0	<1.0
Xylenes, total	<0.5	--	--
Base/Neutral Compounds			
Suspected Carcinogenic PAHs			
Benzo(a)anthracene	<10	<10	<10
Benzo(a)pyrene	<10	<10	<10
Benzo(b)fluoranthene	<10	<10	<10
Benzo(k)fluoranthene	<10	<10	<10
Chrysene	<10	<10	<10
Dibenzo(ah)anthracene	<10	<10	<10
Indeno(1,2,3,cd)pyrene	<10	<10	<10
Non-Carcinogenic PAHs			
Acenaphthene	<10	<10	<10
Acenaphthylene	<10	<10	<10
Anthracene	<10	<10	<10
Benzo(ghi)perylene	<10	<10	<10
Fluoranthene	<10	<10	<10
Fluorene	<10	<10	<10
Napthalene	--	<10	<10
Phenanthrene	<10	<10	<10
Pyrene	<10	<10	<10
Phenolics	--	--	<5.0
Metals			
Arsenic, mg/L	--	0.003526	<0.0031
Arsenic, filtered, mg/L	--	0.003526	<0.00310
Chromium, total, mg/L	--	--	--
Copper, mg/L	--	--	--
Lead, mg/L	--	<0.00088	<0.00088
Lead, filtered, mg/L	--	<0.00088	<0.00088
Mercury, mg/L	--	<0.00013	<0.00013
Mercury, filtered, mg/L	--	<0.00013	<0.00013
Nickel, mg/L	--	--	--
Zinc, mg/L	--	--	--
Cyanid, mg/L	<0.0022	<0.00171	<0.00171
General Parameters			
TPH as Gasoline	<50	--	<50
TPH as Diesel	<500	--	<150

-- Not analyzed.

3,.009
07/20/94

TABLE L-4

WATER DUPLICATE DATA
CITIZENS GAS AND ELECTRIC COMPANY SITE

(concentrations in ug/L, unless otherwise noted)

	MW3		RPD	MW5	MW5	RPD
	07/28/92 Sample	07/28/92 Duplicate		04/26/94 Sample	04/26/94 Duplicate	
Volatile Organic Compounds						
Benzene	2300	5500	82	<20	<20	
Ethyl Benzene	830	1300	44	760	830	9
Toluene	160	190	17	39	41	5
m & p Xylene	--	--		290	320	10
o-Xylene	--	--		320	360	12
Xylenes	740	1100	39	610	680	11
Sum of BETX	4000	8100	68	1400	1600	13
Base/Neutral Compounds						
Suspected Carcinogenic PAHs						
Benzo(a)anthracene	<250	<250		100 j	<500	
Benzo(a)pyrene	<250	<250		<500	<500	
Benzo(b)fluoranthene	<250	<250		<500	<500	
Benzo(k)fluoranthene	<250	<250		<500	<500	
Chrysene	<250	<250		100 j	<500	
Dibenzo(ah)anthracene	<250	<250		<500	<500	
Indeno(1,2,3,cd)pyrene	<250	<250		<500	<500	
Sum of Carcinogens	ND	ND		200 a	ND	
Non-Carcinogenic PAHs						
Acenaphthene	180 j	200 j		880	600	38
Acenaphthylene	110 j	100 j		120 j	<500	
Anthracene	<250	<250		170 j	<500	
Benzo(ghi)perylene	<250	<250		<500	<500	
Fluoranthene	<250	<250		230 j	<500	
Fluorene	60 j	<250		300 j	190 j	
Napthalene	5600	5800	4	9600	6500	38
Phenanthrene	72 j	64 j		870	270 j	
Pyrene	<250	<250		320 j	<500	
Sum of Total PAH Compounds	6000 a	6200 a		13000 a	7600 a	
Phenolics	--	--		9.0	6.0	40

-- Not analyzed.
ND Not detected.
a Estimated value, calculated using some or all values that are estimates.
j Reported value is less than the stated laboratory quantitation limit and is considered an estimated value.
RPD Relative Percent Difference
3,.011
07/20/94

TABLE L-4 (cont.)

WATER DUPLICATE DATA
CITIZENS GAS AND ELECTRIC COMPANY SITE

(concentrations in ug/L, unless otherwise noted)

	MW3		RPD	MW5	MW5	RPD
	07/28/92 Sample	07/28/92 Duplicate		04/26/94 Sample	04/26/94 Duplicate	
Metals						
Arsenic, mg/L	--	--		0.0060 *	0.0108 *	
Arsenic, filtered, mg/L	--	--		0.0060 B	0.0065 B	8.0
Chromium, total, mg/L	--	--		--	--	
Copper, mg/L	--	--		--	--	
Lead, mg/L	--	--		0.0339 *	0.0363 *	
Lead, filtered, mg/L	--	--		<0.0088	<0.0088	
Mercury, mg/L	--	--		<0.00013	0.00016	
Mercury, filtered, mg/L	--	--		<0.00013	<0.00013	
Nickel, mg/L	--	--		--	--	
Zinc, mg/L	--	--		--	--	
Cyanide, mg/L	0.33	0.31	6.2	0.0209	0.0210	0.5
General Parameters						
TPH as Gasoline	28000	38000	30	6400	7400	14
TPH as Diesel	<25000	<25000		12000 (1)	20000 (1)	

-- Not analyzed.

B The reported value is less than the Contract Required Detection Limit (CRDL) but greater than or equal to the Instrument Detection Limit.

(1) The material present does not have a typical diesel pattern. It may be a different petroleum product or a mixture of petroleum products.

* Estimated value, QA/QC criteria not met.

RPD Relative Percent Difference

3,.011

07/20/94

BARR ENGINEERING STANDARD OPERATING PROCEDURE FOR THE EVALUATION OF FIELD DUPLICATE DATA

(Based in part on the USEPA Laboratory Data Validation Functional Guidelines for Evaluating Organic and Inorganic Analyses, 1988)

A. Objective

Field duplicate samples may be collected and analyzed as an indication of overall precision. These analyses measure field sampling precision, laboratory analysis precision, and sample heterogeneity. Therefore, the results may have more variability than lab duplicates which measure only the precision of lab related analytical steps. It is expected that soil duplicate results will have a greater variance than water matrices due to difficulties associated with collecting identical field samples. A heterogenous sample may result in a very high relative percent difference (RPD) which may approach 200%. Analytical sample duplicate data which are close in concentration to the reporting limit may also result in high RPDs.

B. Criteria

There are no specific review criteria for field duplicate analyses comparability found in the EPA guidelines. However, advisory criteria limits for laboratory precision may be reported by the laboratory.

C. Evaluation Procedures

The sampling location for samples which are submitted as field duplicates should be identified using the field sampling logs. The reviewer should compare the results reported for each sample and calculate the Relative Percent Difference (RPD).

$$\%RPD = \frac{|D_1 - D_2|}{D_1 + D_2} \times 200$$

where: D_1 = Sample Result, D_2 = Duplicate Sample Result

Note: Do **not** calculate RPDs for data pairs from which one or both data points are reported as non-detected (< or U) or have the following qualifiers assigned: **b**, ******, or **R**.

D. Action

Any evaluation of the field duplicates should be provided with the reviewer's comments to the project manager.

2/24/94

DATA QUALIFIERS

Barr Data Qualifiers: Used by Barr during Routine and Audit level data validation

b	Potential false positive value based on blank sample data validation procedure.
c	Coeluting compound.
DLND	Not detected, detection limit not determined.
e	Estimated value, exceeded the instrument calibration range.
h	EPA sample extraction or analysis holding time was exceeded.
j	Reported value is less than the stated laboratory quantitation limit and is considered an estimated value.
ND	Not detected.
p	Small peak in chromatogram below method detection limit. (Use only if the laboratory has reported the p)
r	The presence of the compound is suspect based on the ID criteria of the retention time and relative retention time obtained from the examination of the chromatograms.
--	Not analyzed.
*****	Estimated value, QA/QC criteria not met.
******	Unusable value, QA/QC criteria not met.

A project specific or unique data qualifier can be used and is designated with a number in parenthesis followed by the detailed footnote. An example is as follows:

(1) "The laboratory reported the compound identification as being suspect."

The following qualifier is used only when reporting sums of parameter groups:

a	Estimated value, calculated using some or all values that are estimates.

Historical use only:

i	Indeterminate value based on failure of blind duplicate data to meet quality assurance criteria.
s	*Potential false positive value based on statistical analysis of blank sample data. (Historical only--not presently used.)*

BARR ENGINEERING STANDARD OPERATING PROCEDURE FOR THE EVALUATION OF BLANK DATA

(Based on the USEPA Laboratory Data Validation Functional Guidelines for Evaluating Organic and Inorganic Analyses, 1988.)

A. OBJECTIVE

The assessment of blank analysis results is required in order to determine the existence and magnitude of contamination and to identify potential false positive sample results. The criteria for evaluation of blanks apply to any blank (field, trip, method, preparative) associated with the samples. If target analyte contamination problems exist with the blanks, all associated sample data must be carefully evaluated to determine the extent, if any, that the contaminants have affected the sample data.

B. CRITERIA

No target analyte contaminants should be present in the blank(s).

C. EVALUATION PROCEDURE

1. Review the results of all associated blank(s) from laboratory data summary reports and raw data (chromatograms, reconstructed ion chromatograms, quantitation reports or data system printouts).

2. Verify that method blank analysis have been reported per matrix, per concentration level, for each system used to analyze volatile samples, for each extraction batch for semivolatiles and for each batch of metals.

D. ACTION

Action in the case of contaminated blank results depends on the circumstances and origin of the blank. Positive sample results that do not exceed five times the corresponding positive blank results, or ten times for common contaminants, should be qualified with the letter "b" as a potential false positive value. In instances where more than one blank is associated with a given sample, qualification should be based upon a comparison with the associated blank having the highest concentration of a contaminant. The results must not be corrected by subtracting any blank value. Specific actions are as follows:

1. *If a compound is found in a blank but not found in the sample, no qualifying action is taken.* Follow-up corrective actions may be addressed with the laboratory (s) to attempt to identify and eliminate the sources of the blank contamination whenever possible.

2. *Any compound (other than those listed below) detected in the sample which was also detected in associated blanks, must be qualified with the letter "b" when the sample concentration is less than five times the blank concentration.* For the following compounds, the results are qualified when the sample concentration is less than 10 times the blank concentration.

Common lab contaminants:

Methylene chloride
Acetone
Toluene
2-Butanone (MEK)
Common phthalate esters (bis-2-ethyl hexyl phthalate, di-n-octyl phthalate)
Octachlorodibenzo-p-dioxin (OCDD)

The reviewer should note that the blank analyses may not involve the same weights, volumes, or dilution factors as the associated samples. These factors must be taken into consideration when applying the 5x and 10x criteria, such that a comparison of the total amount of contamination is actually made.

When the blank analysis does not involve the same dilution factors as the associated sample analyses, apply the 5x or 10x criteria as follows:

a. Determine which rule (5x or 10x) applies to the compound.
b. Multiply the reported blank value of the compound times the rule that applies.
c. Multiply the result of step b times the dilution factor of the related sample.
d. Compare the sample value to the adjusted blank value (result of step c.).

Sample values less than the associated blank values must be qualified with the letter "b" in the Barr Point Sample Database and on tables which are generated from the database.

Also, there may be instances where contamination was not present in the associated blanks, but qualification of the sample was determined to be necessary. Contamination introduced through the use of dilution water is one example. Instances of this occurring may be detected when contaminants are found in the diluted sample result, but are absent in the undiluted sample result. Since both results are not routinely reported, it may be difficult to verify this source of

contamination. However, if the reviewer determines that the concentration is from a source other than the sample, the data should be qualified. In this case, the 5x or 10x rule does not apply; the sample value should be reported as a non-detect.

3. If gross contamination exists, all compounds affected should be flagged as unusable due to interference in all samples affected.

4. If inordinate amounts of other target compounds are found at low levels in the blank(s), it may be indicative of a problem at the laboratory and should be noted in the data review comments which are forwarded to the project manager.

5. Similar consideration should be given to tentatively identified compounds (TICs) which are found in both the sample and associated blank(s).

Appendix M

NAPL Investigation Results

Appendix M

Nonaqueous-Phase Liquid Investigation Results

A one foot layer of nonaqueous-phase liquid (NAPL) was discovered in Monitoring Well MW-3 during the July 28, 1992 sampling event. Monitoring Well MW-3 was installed in the coarse alluvial aquifer during the Phase I investigation in December 1989. Although a soil boring log or construction log was not prepared for this well, the well is believed to be screened through the top 10 feet of the coarse alluvial aquifer.

Based on the flow of free-phase NAPL into the well, it is inferred that an accumulation of mobile NAPL is pooled in the vicinity of Monitoring Well MW-3. However, the extent of this accumulation of mobile NAPL is not known. During the Phase II investigation, activities were designed to evaluate the extent and mobility of the NAPL without drilling additional borings in this area.

If a well is screened entirely within a pool of NAPL and the hydrostatic head (water) in the casing is reduced by pumping or bailing, the NAPL would be expected to rise inside the casing to equalize the hydraulic pressure exerted by the fluid column outside the well in the formation. If the well is hydraulically connected to a NAPL pool with sufficient mobile free-phase NAPL, the entire water column in the casing could be removed and a column of NAPL would remain inside the casing. If the connected-phase pool has not developed sufficient saturations to permit NAPL migration into the well at a rate equal to the rate of fluid withdrawal, then the water:NAPL interface outside the well would drop to the inlet and water would enter the casing. Under this scenario, the entire water column could not be removed since any water removed is replaced by water entering through the bottom.

Since MW-3 was believed to be screened over the water:NAPL interface, a 1½-inch diameter polyethylene pipe was inserted into the monitoring well. A notch was cut into the pipe approximately 3 inches from the bottom end of the pipe to allow NAPL to enter through the side of the pipe. Initially, the pipe was open to the NAPL layer, only.

A peristaltic pump was used to withdraw the overlying water column from the inside of the pipe. The air:water and water:NAPL interface elevations were measured prior to pumping and after each 1 liter volume of water was removed from the pipe. An ORS interface probe was used to measure the interface elevations.

Approximately three liters of water were withdrawn from the polyethylene pipe. The volume of water removed and the resulting interface elevations are summarized in Table M-1. The water removal rate was approximately 0.01 gpm.

After the first volume of water was removed (approximately 1,450 ml = 970 ml in graduated cylinder + 480 ml to fill tubing), the water:NAPL interface elevation in the pipe rose approximately 2.7 feet (approximate elevation 945.9 ft MSL), while the water elevation was unchanged. This pattern of the increasing water:NAPL interface elevation was expected to continue if an accumulation of mobile NAPL was present.

After the second volume of water was removed (approximately 980 ml), the air:water interface elevation fell by 0.63 feet and the water:NAPL interface elevation was essentially unchanged. The third volume of water was removed (approximately 1,080 ml) and the interface elevations were essentially unchanged. Apparently, there is not a sufficient accumulation of NAPL connected to MW-3 to support a removal rate of 0.01 gpm. This is evidenced by the flow of water into the polyethylene pipe to replace the water being removed.

After withdrawing the second volume of water from MW-3 (980 ml), the air:water interface dropped by 0.63 feet. The "drawdown" was still observed after the third volume of water was removed. A possible explanation for the decrease of the air:water interface is the viscosity of the NAPL. The viscosity of the NAPL is approximately 20 times that of water. There is minimum force (pressure) required to overcome the viscous forces of the NAPL and allow water to travel through the NAPL column. As the driving force increases, more water is allowed to flow through the NAPL column. As the pressures approach equilibrium, the driving force decreases and the flow of water decreases. Over a longer period of time, the interface elevations would reach an equilibrium.

The initial volume of NAPL in MW-3 was approximately 830 mls. The initial volume of NAPL above the pipe's inlet was calculated to be approximately 350 ml. The volume of NAPL in the pipe after withdrawing the first volume of water was 1,530 ml. It appears that an additional 700 ml of NAPL entered the well due to pumping. Of the total volume, 300 mls were collected for analyses. The water:NAPL interface elevation should have been approximately 945 feet MSL after sample collection although the interface elevations were not measured at this time.

The air:water and water:NAPL interface elevations in the pipe were measured on April 8, 1994. The water:NAPL interface elevation was at 941.64 feet MSL (approximately 3.4 feet lower than expected). It appears the NAPL drained out of the well and into the surrounding formation. The NAPL in the formation was not able to support the pressure exerted by the column of NAPL inside the pipe.

The NAPL accumulation rate between April 8, 1994 and April 15, 1994 was approximately 2.1×10^{-5} gpm (800 mls over 7 days). Although NAPL accumulates in MW-3, it may migrate from the well when the hydraulic head increases to a sufficient pressure to overcome resistive capillary forces.

Table M-1

Interface Elevations in Monitoring Well Mw-3
NAPL Investigation
Citizens Gas and Electric Company Site

	04/04/94				04/08/94	04/15/94	
Volume Removed (ml)	0	1450	980	1080	--	--	--
Air:Water	968.47	968.38	967.75	967.83	968.39	968.54	--
Water:NAPL	943.14	945.86	946.00	945.90	941.64	942.25	942.94