GEOCHEMICAL DATA FOR THE WELDON SPRING TRAINING AREA AND VICINITY PROPERTY, ST. CHARLES COUNTY, MISSOURI--1990-92

By John G. Schumacher, S.J. Sutley, and J.D. Cathcart

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
foot	0.3048	meter
foot per mile	0.1894	meter per kilometer
cubic foot per second	0.02832	cubic meter per second
mile	1.609	kilometer
inch	25.4	millimeter
acre	0.4047	hectare
foot per second	0.3048	meter per second

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) as follows:

$$°F = (1.8 \times °C) + 32$$

Sea Level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

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By

John G. Schumacher[1], S.J. Sutley[2], and J.D. Cathcart[3]

ABSTRACT

This report presents geochemical and hydrologic data collected during a preliminary investigation of the environmental fate of trinitrotoluene (TNT) and other nitroaromatic compounds at the Weldon Spring training area and vicinity property. Pressure-vacuum lysimeters were installed in the unsaturated zone at four locations along former TNT production lines at depths ranging from 1.9 to 14.2 feet. Large concentrations of TNT from 120 to 31,000 mg/kg (milligrams per kilogram) were detected in surficial soil samples from these areas; however, concentrations in soil-core samples decreased to less than 2 percent of the surface concentrations at depths below 2 feet. Concentrations of TNT (0.46 to 3,070 mg/kg) were detected in 20 of 25 subsurface soil-core samples collected during lysimeter installation. Trinitrobenzene (TNB) was detected in 10 of the soil-core samples at concentrations ranging from 0.21 to 46.2 mg/kg. Six of the soil core samples contained detectable concentrations of 2-amino-4,6-dinitrotoluene (2-Am, 0.34 to 60.2 mg/kg) and one of the samples contained 0.30 mg/kg of 4-amino-2,6-dinitrotoluene (4-Am). Two soil-core samples contained small (2.15 and 4.41 mg/kg) concentrations of 2,4-dinitrotoluene (2,4-DNT) and only one soil-core sample contained a detectable (3.22 mg/kg) concentration of 2,6-dinitrotoluene (2,6-DNT). Total organic carbon contents decreased from an average of 0.17 percent (by weight) in near surface soil core samples to less than 0.05 percent in samples below 1.5 feet in two of the areas instrumented.

Although concentrations of TNT decreased rapidly in soil within a few feet of land surface, water samples collected from lysimeters at depths between 1.0 and 4.0 feet contained large concentrations of TNT (4.1 to 6,250 µg/L; micrograms per liter), 4-Am (less than 3.0 to 1,740 µg/L), and 2-Am (5.9 to 246 µg/L); concentrations of TNB ranging from less than 3.0 to 1,130 µg/L also were detected in the lysimeter samples. No DNT, nitrobenzene (NB), or nitrotoluene (NT) were detected in any of the lysimeter water samples. A sample from one of the lysimeters (LY05) contained 120 mg/L (milligrams per liter) dissolved sodium, 96 mg/L sulfate, and 80 µg/L copper.

Fifty-eight soil samples representing six overburden units were collected in trench excavations at the site. The overburden units sampled included (in descending order) the Peoria Loess, Roxanna Silt, Ferrelview Formation, clay till, preglacial deposit, and residuum. The overburden units at the site consist mainly of silt and clay-size particles. The predominant minerals in the bulk (whole sample) fraction were quartz with lesser quantities of plagioclase, orthoclase, and clay minerals. Clay mineral contents in the units ranged from an average of 12 percent (by weight) in the Roxanna Silt to 26 percent in the residuum. Montmorillonite generally was the predominant mineral in the clay-size fraction, except for several samples of preglacial deposit and residuum where kaolinite was predominant. Samples generally contained between 10 and 25 percent amorphous material that consisted of amorphous iron and manganese oxyhydroxides and poorly crystalline aluminosilicate minerals, such as illite. Samples from the Peoria Loess and Roxanna Silt generally contained detectable quantities of amphibole and pyroxene, whereas samples from the underlying units generally did not. Total organic carbon contents ranged from an average of 0.74 percent by weight in the Peoria Loess to less than 0.05

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percent by weight in the clay till and preglacial deposit. Chemical analysis by X-ray fluorescence and inductively coupled argon plasma emission spectroscopy indicated the chemical composition of the various units generally was similar.

Samples from selected monitoring wells at the site and vicinity property generally had specific conductance values less than 600 µS/cm (microsiemens per centimeter at 25 degrees Celsius), near neutral pH values, and calcium, magnesium, and bicarbonate as the predominate ions. However, specific conductance values as large as 928 µS/cm were detected in a sample from monitoring well MWS-18. This sample also contained among the largest concentrations of sodium (70 mg/L), potassium (6.4 mg/L), bicarbonate (435 mg/L), sulfate (250 mg/L), chloride (9.6 mg/L), total organic carbon (2.2 mg/L), copper (20 µg/L), and among the largest concentrations of calcium (70 mg/L), magnesium (43 mg/L), silica (11 mg/L), dissolved phosphorus (0.21 mg/L), total phosphorus (0.25 mg/L), boron (250 µg/L), lithium (17 µg/L), and strontium (430 µg/L). This sample contained the smallest concentration of barium (33 µg/L).

Detectable concentrations of nitroaromatic compounds were observed in samples from 17 of 21 monitoring well samples and in a sample from Burgermeister spring. Samples from monitoring well MWV-09 generally contained the largest concentrations of TNT (33.9 to 61.5 µg/L), 4-Am (22.8 to 29.2 µg/L), 2-Am (31.8 to 42.9 µg/L), 3,5-dinitroaniline (3,5-DNA; less than 0.25 to 19.6 µg/L), and among the largest concentrations of TNB (3.8 to 20.5 µg/L) and 2,4-DNT (24.1 to 32 µg/L). Concentrations of 4-Am plus 2-Am exceeded TNT concentrations and 4-Am concentrations generally exceeded those of 2-Am. Unlike the lysimeter results, 2,4-DNT and 2,6-DNT were detected nearly as frequently as TNT. Samples from four monitoring wells contained detectable concentrations of 2,3-dinitrotoluene (2,3-DNT), which previously had not been detected at the site.

Results of seepage studies indicate the discharge of Dardenne Creek generally increased throughout the reach measured (County Road DD to County Road N); however, discharge was lost along a short segment near County Road K. Concentrations of most constituents in samples from Dardenne Creek remained the same or decreased from the upstream site (County Road DD) to the downstream site (County Road N), except for concentrations of uranium, which nearly tripled from 1.1 µg/L at the upstream site to 3.1 µg/L at the downstream site. Increased uranium concentrations (5.9 to 8.9 µg/L) were detected in two tributaries, Schote Creek and Burgermeister branch. Concentrations of TNT or other nitroaromatic compounds were not detected in any samples from Dardenne Creek or its tributaries.

INTRODUCTION

The Weldon Spring training area (WSTA) consists of 1,655 acres of land owned by the U.S. Army in south-central St. Charles County, Missouri (fig. 1). The WSTA is part of a larger (about 17,000 acres) site formerly owned by the U.S. Army known as the Weldon Spring ordnance works (WSOW). The WSOW produced more than 700 million pounds of TNT and smaller quantities of DNT during its operation between 1941 and 1945. The plant consisted of 18 nearly identical TNT production lines, 2 DNT production lines, and numerous other production support plants, such as nitric acid, sulfuric acid (H_2SO_4), ammonia oxidation plants (hereafter referred to as TNT or DNT lines), and other facilities. At peak production the plant employed about 3,000 workers (International Technology Corporation, 1989a) and produced nearly 1 million pounds of TNT each day. Fifteen of the TNT lines, both DNT production lines, and nearly all of the major production support facilities were within the boundary of the WSTA site. The remaining three TNT lines were on a 217-acre tract immediately east of the WSTA site now owned by the U.S. Department of Energy. These three lines were demolished in 1955 during the construction of a U.S. Department of Energy uranium feed materials plant. An aerial photograph of part of the WSOW site taken in February 1945 showing the TNT and DNT production lines, production support facilities (southern part of the WSTA), and magazine area (north of the WSTA) is shown in figure 2.

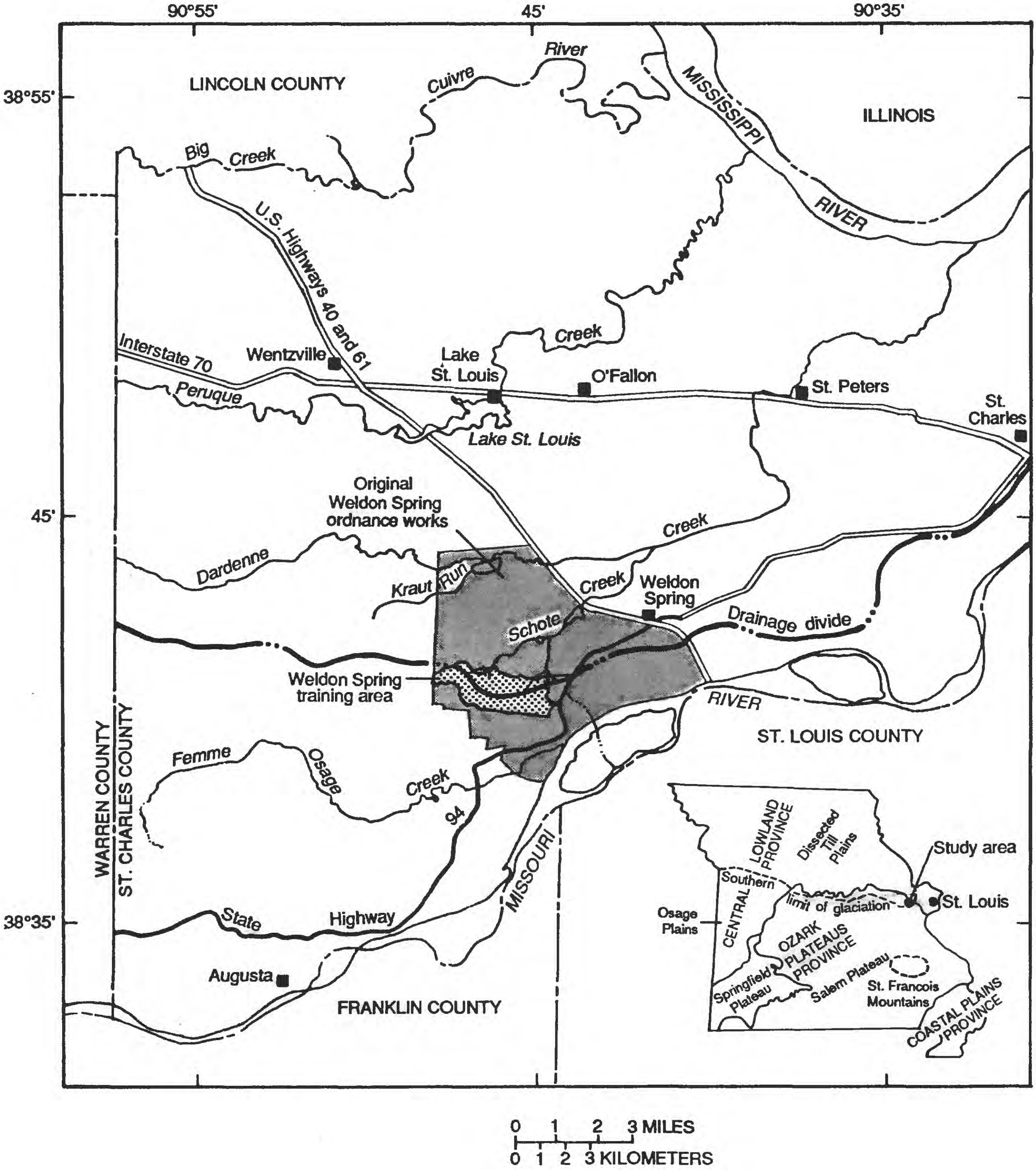


Figure 1.--Location of the Weldon Spring training area and boundary of the the original Weldon Spring ordnance works.

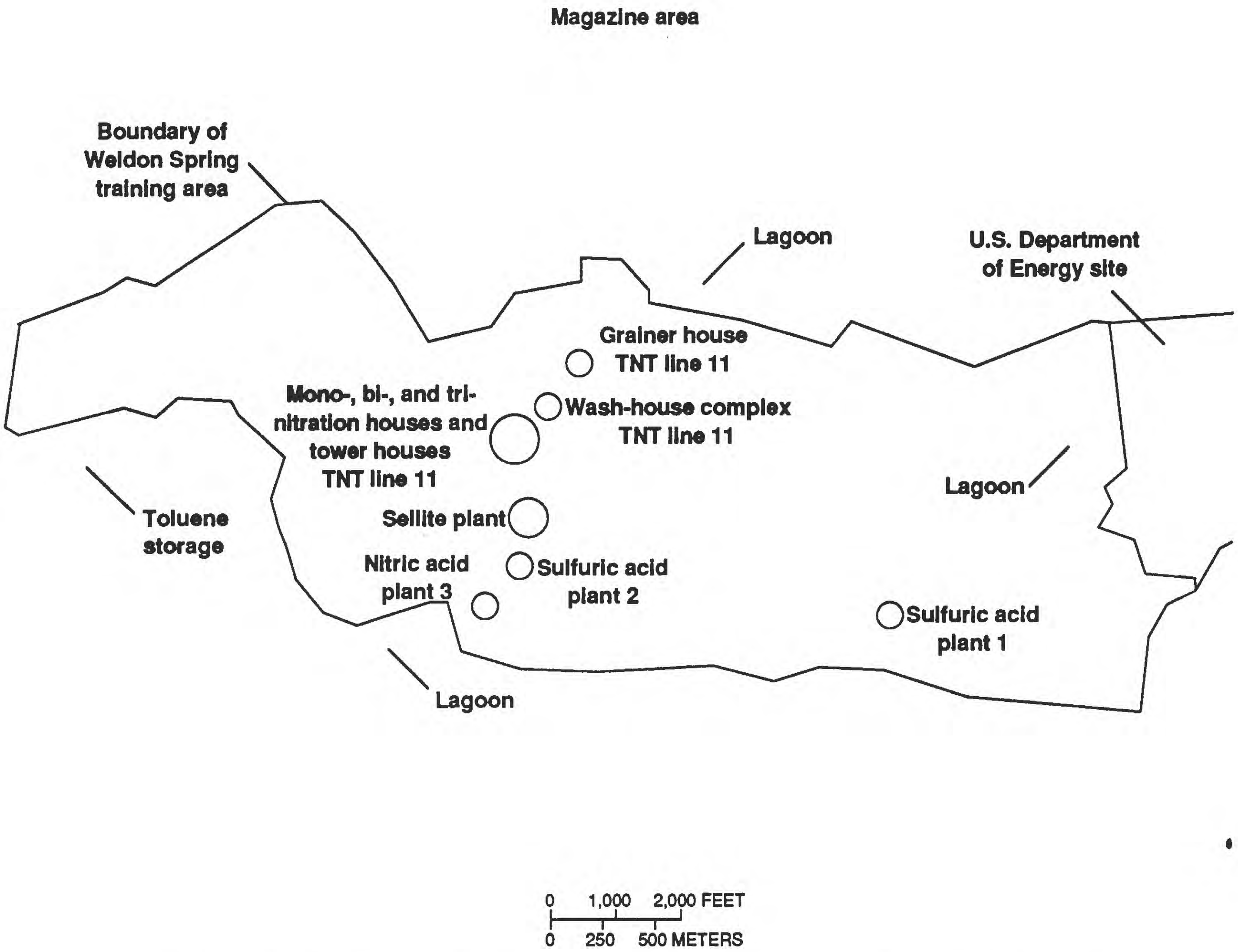
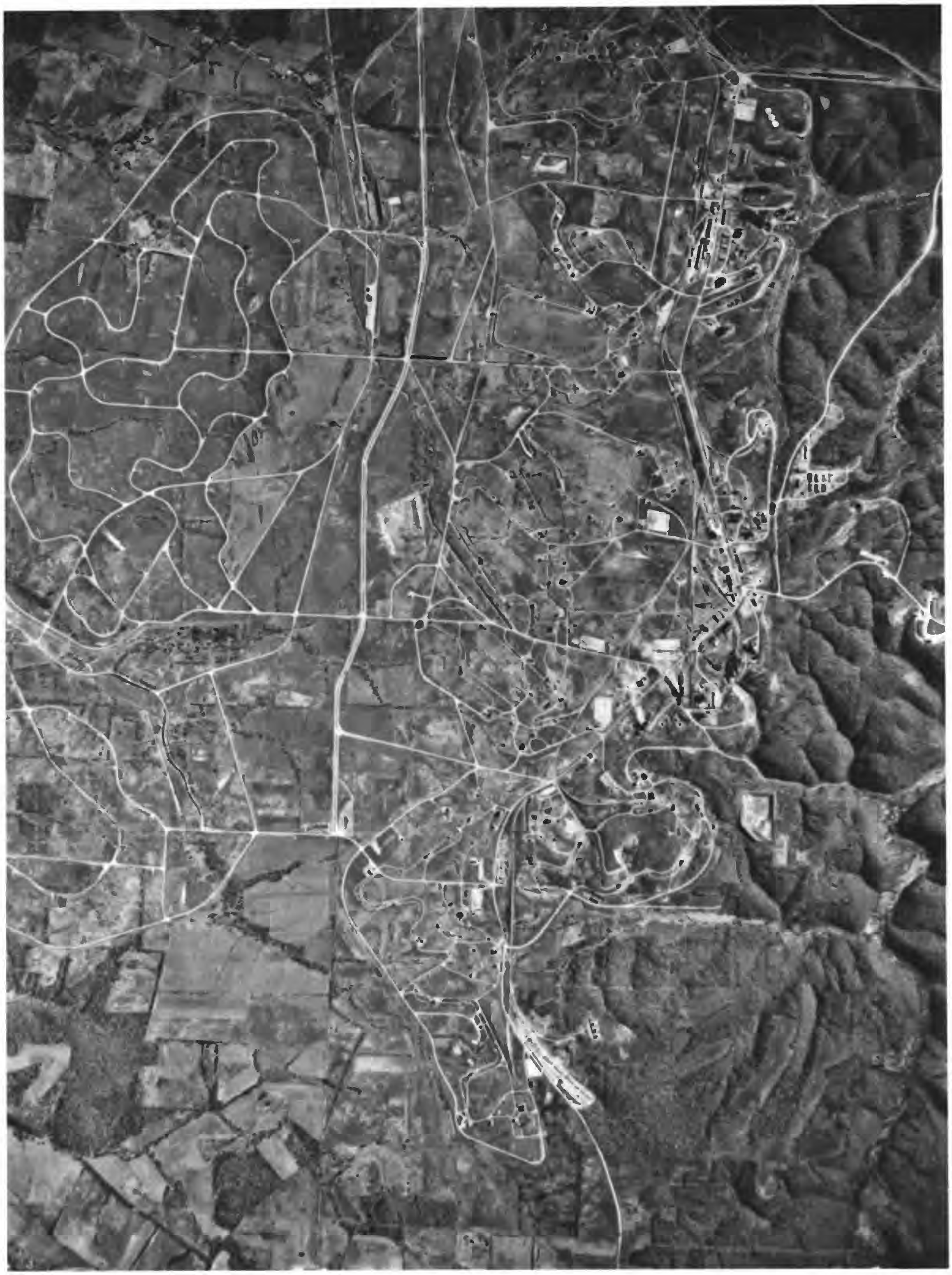


Figure 2.--Aerial photograph of part of the Weldon Spring ordnance works production facilities in February 1945.



TNT was manufactured at the WSTA by a three stage batch process using toluene, nitric acid, and H_2SO_4 as the main raw materials. The purification of TNT was accomplished by rinsing the impure TNT with a solution of sodium bicarbonate and sellite (Na_2SO_3) at the "wash-house" complex. This removed isomers other than 2,4,6-TNT and neutralized any remaining acid present. This process generated large quantities of wastes called "red water" that contained various mixtures of water, inorganic salts, ash, sulfonate derivatives, and nitroaromatic compounds (International Technology Corporation, 1989a).

Before mid-1942, the red water was discharged to settling lagoons at WSOW (some of which are visible in fig. 2), which resulted in contamination of area springs and streams (V.C. Fishel and C.C. Williams, U.S. Geological Survey, written commun., 1944). Because of this observed contamination, a large gravity-flow network of underground wooden wastewater pipelines was constructed in mid-1942 to connect the 18 TNT lines to 3 wastewater-treatment plants (Fraser-Brace Engineering Company, written commun., 1951). Several miles of wastewater pipeline were constructed, of which about 61,000 ft (feet) is still in place (International Technology Corporation, 1989a). Fishel and Williams (written commun., 1944) indicated the gravity-flow lines often became clogged with particulates, causing the red water to back up and flow directly into gullies and streams on and in the vicinity of the WSTA.

At least 4 major cleanup operations have been conducted at the WSTA since 1944 (International Technology Corporation, 1989a), leaving only foundations and a few of the more than 1,000 buildings. Despite these cleanup efforts, concentrations of TNT, ranging from less than 1 mg/kg (milligram per kilogram) to more than 81,000 mg/kg, and lead (Pb), as large as 126,000 mg/kg, have been detected in soils from isolated areas around former production buildings. In addition, concentrations of TNT, Pb, and nickel (Ni) attributable to ordnance production have been detected in soils from isolated areas along former TNT production lines and in areas of fill on the adjacent U.S. Department of Energy site (MK-Ferguson Company and Jacobs Engineering Group, 1990). Although large quantities of TNT have been detected in surficial materials, concentrations generally decreased to less than a few milligrams per kilogram at depths greater than 5 ft below the surface (International Technology Corporation, 1989b).

During 1989, the U.S. Army detected small concentrations of TNT ranging from less than 0.15 to 19 µg/L (micrograms per liter), DNT ranging from less than 0.1 to 8.5 µg/L, and smaller quantities of TNB and nitrotoluene in water samples from 16 of the 34 monitoring wells at the site (International Technology Corporation, 1990). Sufficient data have not been collected to determine if the source of this contamination is related to red water disposal practices during production or to leaching of small quantities of TNT and other nitroaromatic compounds from contaminated surficial soils at the WSTA. Consequently, the primary objective of this investigation was to determine if substantial quantities of TNT and other nitroaromatic compounds are migrating to the ground water from contaminated surficial soils.

Hydrochemical and geochemical data have been collected by the U.S. Geological Survey at the WSTA and adjacent U.S. Department of Energy site since 1984. These data are given in Kleeschulte and others (1986), Kleeschulte and Cross (1990), and Schumacher (1990). During 1990, the U.S. Geological Survey, in cooperation with the U.S. Army Corps of Engineers, Kansas City District, conducted a seepage study of Dardenne Creek in the vicinity of the WSTA site to characterize the water quality and assess ground water-surface water interaction. In addition, water-quality samples were collected from several monitoring wells on and adjacent to the WSTA site. During 1991, the U.S Geological Survey, in cooperation with the U.S. Army Corps of Engineers, Kansas City District began an investigation to characterize the geochemistry of the overburden and determine the environmental fate of TNT at the WSTA site.

This report describes the methods used and presents geochemical, hydrologic, and water-quality data collected by the U.S. Geological Survey at the WSTA site and vicinity property during preliminary investigations of the environmental fate of TNT. The data consist of physical and chemical analysis of soil and water samples from the unsaturated zone, mineralogic and chemical analysis of more than 90 samples of overburden materials at the WSTA, ground-water-quality data, and hydrologic and water-quality data collected during a seepage study of Dardenne Creek.

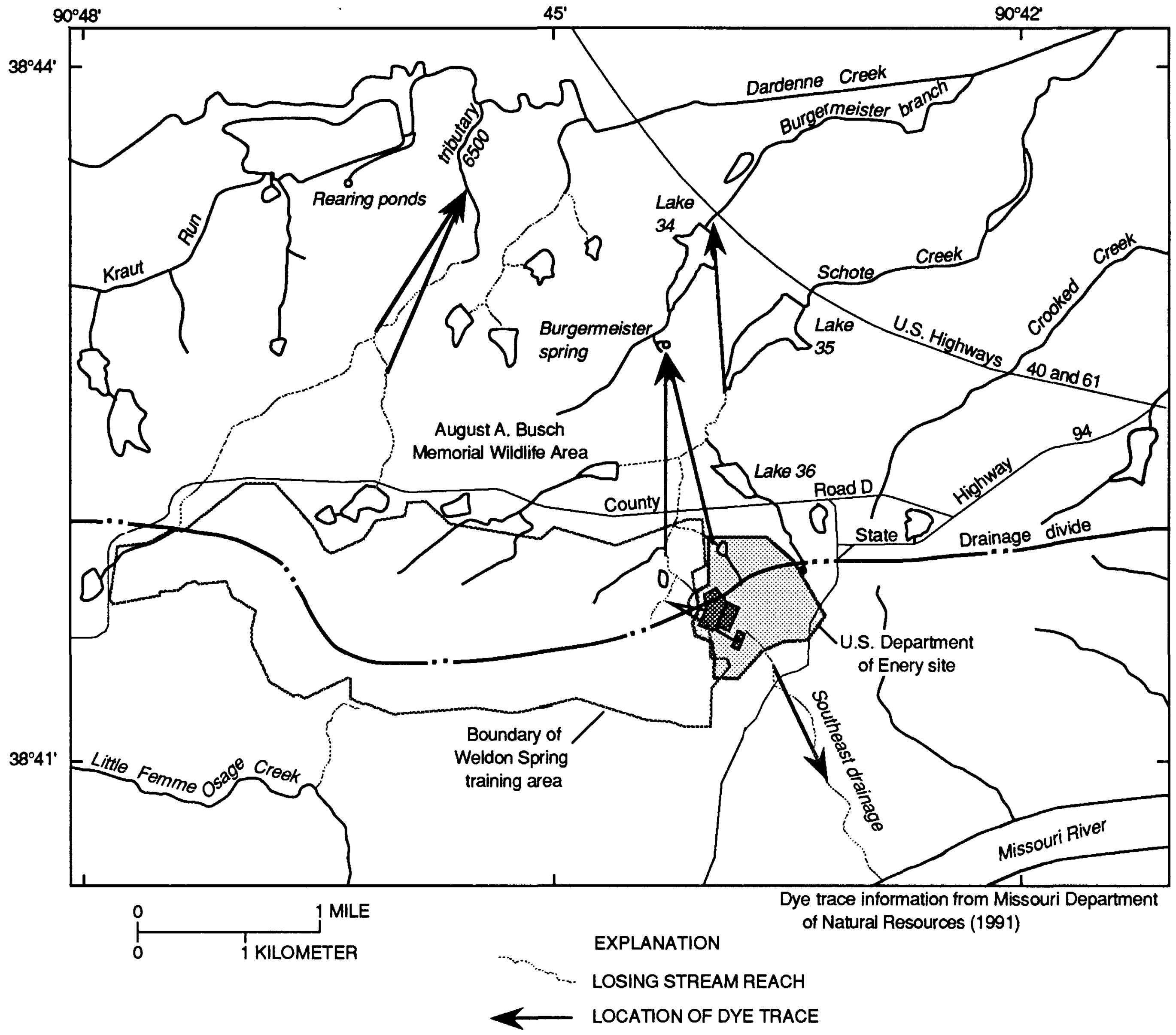
DESCRIPTION OF THE STUDY AREA

Since the WSOW was declared surplus property during 1946, the U.S. Army has transferred ownership of all the original WSOW property, except the 1,655-acre WSTA site. The WSTA is situated along the boundary between the Dissected Till Plains of the Central Lowland Province to the north and the Salem Plateau of the Ozark Plateaus Province (Fenneman, 1938) to the south (fig. 1). The topography of the northern part of the WSTA is characterized by a gently undulating surface of unconsolidated Quaternary loess and glacial drift deposited on residuum and weathered Burlington and Keokuk Limestones of Lower Mississippian age. The topography changes to more rugged, steeply dipping slopes with little glacial drift in the southern part of the WSTA. Average annual precipitation is about 34 in. (inches) per year (National Oceanic and Atmospheric Administration, 1988).

The WSTA is situated along an east-west trending ridge that serves as a surface-water and ground-water divide between the Mississippi River basin to the north and Missouri River basin to the south (Kleeschulte and Emmett, 1986; fig. 1). Surface drainage from the northern part of the WSTA flows into several tributaries of Dardenne Creek. The largest of the tributaries, Schote Creek, drains a large part of the WSTA site and most of the adjacent U.S. Department of Energy site to the east (fig. 3). Seepage data collected by Kleeschulte and others (1986) generally indicated the headwaters of tributaries to Schote Creek were not losing stream segments, except for the middle tributary to Schote Creek that drains the northeastern part of the WSTA (fig. 3). The upper and middle segments of the tributary of Dardenne Creek draining the northwestern part of the WSTA (locally known as tributary 6500) were determined to be losing stream segments (Kleeschulte and Emmett, 1986). Runoff from the southern part of the site flows into Little Femme Osage Creek or its tributaries. This creek enters the Missouri River about 3 mi (miles) southwest of the WSTA.

Ground-water flow beneath the WSTA generally reflects the surface-water drainage. Dye traces conducted by the Missouri Department of Natural Resources (1991) in the vicinity of the WSTA site indicate subsurface connections between losing stream segments and several vicinity springs (fig. 3). Several traces to the north indicated interbasin connections, whereas the traces to the south indicated only intrabasin connections. The dye traces generally indicate that ground water is not transferred between the Mississippi River basin to the north and the Missouri River basin to the south (Missouri Department of Natural Resources, 1991).

Much of the WSTA site is underlain by overburden deposits of variable thickness (0 to more than 61 ft) composed of modified loess, glacial drift, preglacial deposit, and residuum. A recent investigation by the Missouri Department of Natural Resources resulted in the overburden being subdivided into six principal units (Rueff, 1992): (1) Peoria Loess, a reddish-brown silty clay (0 to 5 ft thick) with a moderate moisture content and variable quantities of organic matter; (2) Roxanna Silt, a stiff to very stiff yellow-brown silty clay (0 to 5.8 ft thick) that has a low moisture content; (3) Ferrelview Formation, a stiff brownish-gray to yellow-brown silty-clay (0 to 8 ft thick) that contains abundant iron-manganese oxides and occasional chert pebbles and rock fragments; (4) clay till, a plastic yellow-brown to gray mottled silty clay (1 to 47 ft thick) containing abundant sand and gravel-sized fragments of chert, igneous, and metamorphic rock fragments; (5) preglacial deposit, reddish-brown to light gray discontinuous deposit of clay, silt, silty clay, and silty sand (0 to 4.5 ft thick) containing occasional gravel-size material; and (6) residuum, a highly heterogenous gravelly clay containing abundant chert nodules and highly weathered chert beds. The Roxanna Silt commonly contains vertical fractures that extend into the underlying Ferrelview Formation. The clay till contains fractures that can extend several feet at oblique angles to the vertical. The fracture surfaces often are coated with iron-manganese oxides, small masses of roots, clay skins, and commonly are slickensided (data on file at the U.S. Geological Survey office, Rolla, Missouri).



Dye trace information from Missouri Department of Natural Resources (1991)

Figure 3.--Surface-water features and dye traces in the vicinity of the Weldon Spring training area.

Consolidated rocks immediately beneath the overburden consist of the undifferentiated Mississippian Burlington and Keokuk Limestones. These limestones are coarsely crystalline, medium-to-thickly bedded and contain abundant chert. These units dip slightly to the northeast at about 50 to 70 ft/mi (feet per mile; Kleeschulte and Emmett, 1986). Detailed borehole data from the adjacent U.S. Department of Energy site indicate that the upper part of these limestones is highly weathered, which results in an uneven bedrock surface (MK-Ferguson Company and Jacobs Engineering Group, 1991). The weathered limestone and overlying residuum can be highly permeable, which has caused the complete loss of drilling fluid while drilling boreholes in this area. The water table generally is within a few feet of the residuum-weathered bedrock contact or within the residuum near stream drainages.

NITROAROMATIC COMPOUNDS IN THE UNSATURATED ZONE

Water-quality samples were collected from lysimeters installed in the unsaturated zone beneath surficial soils contaminated by nitroaromatic compounds at several locations on the WSTA site. In addition, soil samples were collected at various intervals during installation of the lysimeters and submitted for various geochemical analyses. These samples were collected as part of preliminary efforts to determine the quantity of TNT and other nitroaromatic compounds in the unsaturated zone.

Methodology

The U.S. Army has analyzed more than 6,000 surficial soil samples from fixed sample grids at the WSTA site (International Technology Corporation, 1989a). These grided areas encompassed all known TNT production and transportation areas at the WSTA site (fig. 4). Within each grided area surficial soil samples were collected on regular intervals of 40 or 80 ft and analyzed for nitroaromatic compounds (International Technology Corporation, 1989a). Based on the frequency and magnitude of the TNT concentration detected in surficial soils by the U.S. Army, four locations were selected for collection of soil and water samples from the unsaturated zone along former TNT lines. These included line 4 (location 1), line 11 (location 2), line 9 (location 3), and line 15 (location 4).

Four pressure-vacuum suction lysimeters were installed at various depths in locations 1 and 2, two lysimeters were installed in location 3, and one lysimeter was installed in location 4. The lysimeters consisted of 2-in. diameter polyvinyl chloride (PVC) tubes fitted with a porous ceramic cup at the bottom. The top of each lysimeter was sealed with a neoprene stopper. Two polyethylene access lines were fitted through the stopper to facilitate application of a vacuum and sample removal.

A soil exploration drill rig was used to install the lysimeters and to collect soil-core samples. The lysimeter boreholes were inclined to place the lysimeter cup directly beneath visibly contaminated surficial soils without drilling through them. This prevented downhole contamination by surficial materials cascading down the borehole. The drill angle varied with the target depth of the lysimeter cup and the extent of surface contamination but ranged from 10 to 20 degrees from the vertical (table 1, at the back of this report). Generally a 2-in. inside diameter (ID) by 4-ft long stainless steel core barrel was pushed into the soil to the desired depth, and then removed to create a small diameter borehole and to extract soil samples. This method was sufficient to depths of about 6 ft. Deeper lysimeters were installed by advancing the core barrel as before, followed by reaming of the hole using a 3-in. diameter auger. A slurry composed of pure 200-mesh silica flour and deionized water was used to ensure the porous ceramic cup was in adequate contact with the surrounding soil. After the hole had been advanced to the desired depth, a measured quantity of silica flour slurry was poured into the borehole and the lysimeter was pushed several inches beneath the top of the slurry. The remaining annular space was filled with hydrated bentonite powder. For lysimeter installations more than 6 ft deep, a 2-in. ID flush-thread PVC pipe was used as a temporary casing. All downhole tools were decontaminated between each borehole and the core barrel was cleaned between each run in deeper holes.

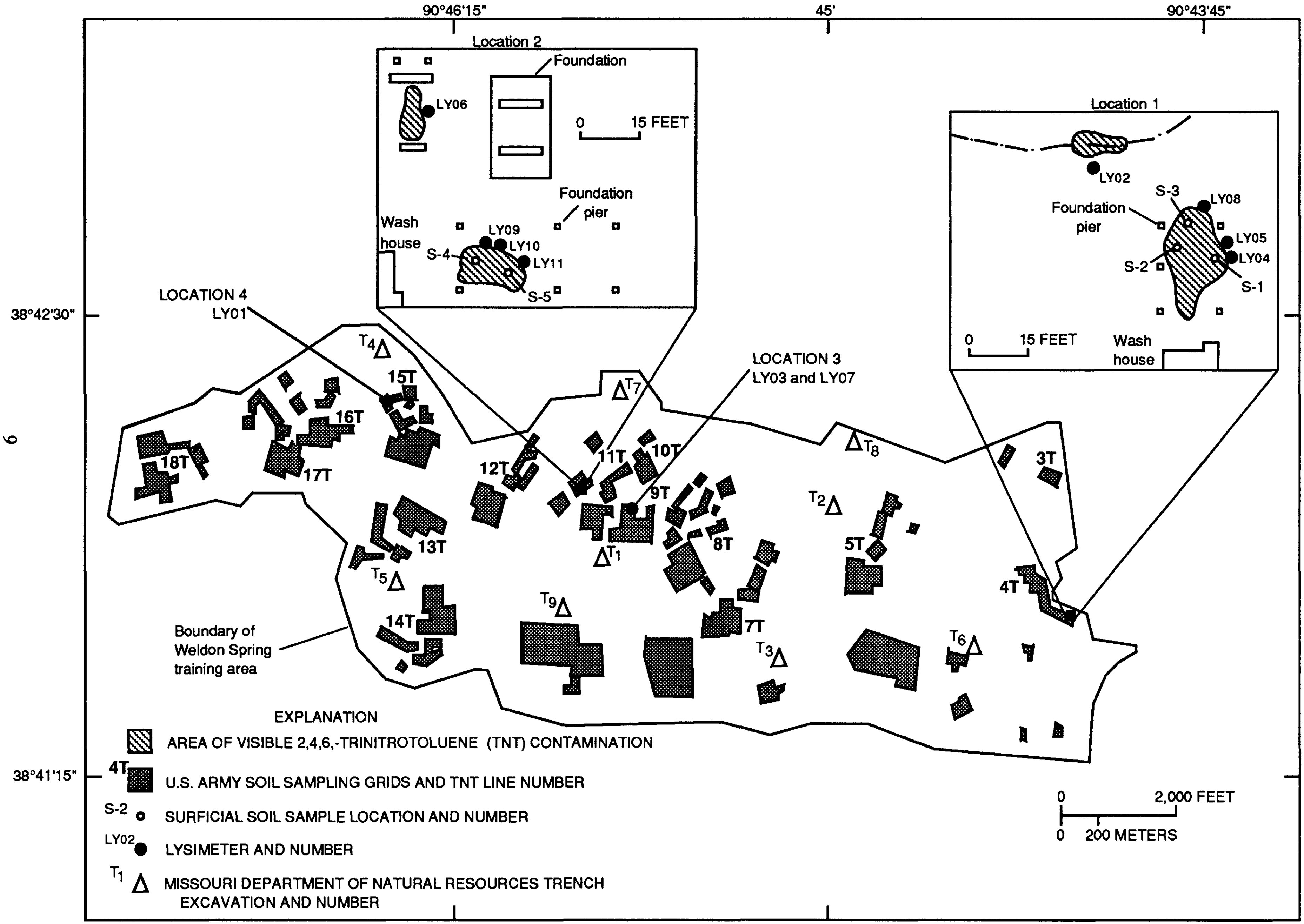


Figure 4.--Location of soil sampling grids, U.S. Geological Survey lysimeters, and Missouri Department of Natural Resources trench excavations.

The lysimeter cups were installed at depths ranging from 1.9 to 14.2 ft (table 1). Six were installed at shallow (less than 3.5 ft) depths (LY05, LY07, LY08, LY09, LY10, and LY11), two at intermediate (3.5 to 8 ft) depths (LY04 and LY06), and three at deep (more than 8 ft) depths (LY01, LY02, and LY03). Three of the lysimeters (LY01, LY03, and LY07) were abandoned because of mechanical problems.

Soil-core samples were collected during lysimeter installation and submitted to the U.S. Army Corps of Engineers laboratory in Omaha, Nebraska, for analysis of nitroaromatic compounds or to the U.S. Geological Survey geochemistry laboratory for physical, mineralogic, and chemical analyses. The core was separated into approximately 2-in. lengths using a stainless steel knife and transferred to glass jars for nitroaromatic analysis or to sealed plastic bags for mineralogic and chemical analysis. Samples for analysis of nitroaromatic compounds were chilled to 4 °C (degrees Celsius) and shipped overnight to the laboratory. These samples were analyzed using the U.S. Environmental Protection Agency (1990) draft method 8330. Analytes included TNT, 4-Am, 2-Am, TNB, dinitrobenzene (DNB), 2,4-dinitrotoluene (2,4-DNT), 2,6-dinitrotoluene (2,6-DNT), cyclo-1,3,5-trimethylene-2,4,6-trinitramine (RDX), cyclotetramethylene tetranitramine (HMX), and nitramine (tetryl). Detection limits ranged from 0.25 mg/kg for TNT and 2,4-DNT to 2.20 mg/kg for HMX. All blank, matrix, and matrix spike recoveries were within the acceptable limits (75 to 125 percent) for these analyses. A description of the methods and analytical procedures used by the U.S. Geological Survey geochemistry laboratory are described in the following section.

Water samples were collected from the lysimeters by applying a vacuum to the lysimeter using a vacuum pump and crimping the access tubes with a pinch clamp. Water moved from the surrounding soil into the ceramic cup if the suction inside the cup was greater than the soil suction. Samples were extracted by using a small hand pump to slightly pressurize the lysimeter and force the sample out of the other access tube. The shallow lysimeters remained dry until October 1991, when rainfall increased and mean daily temperatures decreased (Schumacher and others, 1992). Generally, between 200 and 900 mL (milliliters) of sample could be removed from the shallow lysimeters after a vacuum had been applied for 1 to 2 days. Sample volumes from the shallow lysimeters generally have decreased since early spring 1992 and currently (August 1992) most produce little or no sample. Lysimeter LY04 has remained dry since its installation. Lysimeter LY06 began collecting small quantities (less than about 50 mL) of sample in May 1992, but went dry in late July. All deep lysimeters have remained dry since their installation in August 1991. Water samples for nitroaromatic analysis were collected from the lysimeters, placed into amber glass bottles, chilled to 4 °C, and shipped overnight to the U.S. Geological Survey national water-quality laboratory for analysis.

Water samples from lysimeters were analyzed by high performance liquid chromatography (HPLC). Direct aqueous injection onto the HPLC column using equal volumes of water and acetonitrile was used when sample concentrations permitted. Most samples were prepared by vacuum elutriation of approximately 100 mL of sample through a C-18 solid phase extraction cartridge. The nitroaromatic components were then desorbed from the cartridge with 1.0 mL of methanol and the final volume brought to 2 mL volume with water. These extracts were sealed in a crimped-top container for analysis. Preliminary analyses indicated that the USATHAMA (U.S. Army Toxic and Hazardous Materials Agency, 1983) method for characterization of nitroaromatic compounds was not appropriate for these samples because they contained large concentrations of degradation products (predominately 4-Am and 2-Am) that coeluted with other target compounds. An alternate HPLC method was developed using analytical standards of these degradation products. Extracts were analyzed on a HPLC using a Beckman Ultrasphere ODS[1] 5 μm (micrometers) 4.6 mm (millimeters) by 25 cm (centimeters) analytical column. The mobile phase consisted of gradient elutriation with a mixture of acetonitrile, water, and methanol that began with a mixture ratio of 18:80:02 that was changed to a mixture ratio of 48:50:02 over 25 minutes. Detection and confirmation of analyses were performed

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[1] Use of brand or trade names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

using a photodiode array detector, and quantization was based on the chromatogram generated by the signal at 250 nm (nanometers). Recoveries of the nitroaromatic compounds from 10 µg/L spike solutions ranged from 58 percent for TNB to 105 percent for DNB. A conservative estimate of the detection limit based on positively identifiable analyses was 3 µg/L.

A sample was collected from lysimeter LY05 (January 29, 1992) for determination of temperature, pH, specific conductance, dissolved oxygen, and analysis of inorganic constituents. Because the lysimeter ceramic cup effectively filters out particulates larger than about 1 to 2 µm, this sample was not filtered onsite and was preserved and analyzed as a dissolved sample. All onsite determinations were made according to the methods described in the section titled "Ground-Water Geochemistry." Subsamples were collected for analysis of cations, anions, nutrients, and trace elements. The subsample for analysis of cations and trace elements was placed into an acid-rinsed polyethylene bottle and preserved by acidification to pH less than 2 using ultrapure nitric acid. The subsample for analysis of anions was placed into a polyethylene bottle and the subsample for nutrient analysis was placed into an amber polyethylene bottle and preserved by adding 1 mL of 10^{-4} molar mercuric chloride and chilling to 4 °C. Determinations of inorganic constituents were made at the U.S. Geological Survey national water-quality laboratory according to the methods described by Fishman and Friedman (1989).

Summary of Data

TNT was detected in 20 of the 25 soil-core samples from the lysimeter boreholes and in all of the surficial soil samples from locations 1 and 2 (table 2, at the back of this report). Samples from lysimeter boreholes LY01, LY02, and LY03 were lost in shipment. The surficial soil samples from location 1 contained the largest concentrations of TNT (16,500 to 31,000 mg/kg) detected. These samples were collected from visibly contaminated material overlying lysimeters LY04, LY05, and LY08 (fig. 4). No other nitroaromatic compounds were detected in the surficial soil samples at location 1; however, quantitation of the other nitroaromatic compounds in samples S-1, S-2, and S-3 was difficult because of the large TNT concentrations (table 2). Concentrations of TNT in surface-soil-core samples (0 to less than 0.5 ft depth) from boreholes at this location (LY04, LY05, and LY08) were much smaller (between 583 and 3,070 mg/kg) because the inclined drilling method placed the entry points for these boreholes several feet away from the visibly contaminated area where the surficial-soil samples were collected. The TNT concentrations in surface-soil samples were smaller at location 2 (samples S-4 and S-5) where screening indicated concentrations ranging from about 120 to 7,500 mg/kg. Concentrations of TNT in surface core samples from boreholes LY06, LY09, and LY10 were 12.8, 148, and 559 mg/kg (table 2).

Concentrations of TNT decreased substantially within the first 1 ft of depth in all boreholes and concentrations at depths below 2 ft were less than 2 percent of the surface concentrations (table 2). For example, concentrations of TNT in core samples from borehole LY05 decreased from 922 mg/kg at 0 to 0.4 ft to 0.70 mg/kg at 2.0 to 2.2 ft. The actual decrease is much more dramatic because the surficial soil sample collected above the cup of lysimeter LY05 (sample S-1) had a TNT concentration of 16,500 mg/kg (table 2). Similar decreases were observed in previous investigations at the WSTA (International Technology Corporation, 1989b). An exception is the slight increase in TNT concentrations with increasing depth in boreholes LY04 and LY09. This slight increase indicates the boreholes had extended beneath the nearby visibly contaminated surficial soils (fig. 4).

Of the 25 soil-core samples, only one sample from lysimeter borehole LY06 (0.0 to 0.3 ft) contained a detectable concentration (0.30 mg/kg) of 4-Am. Six soil-core samples contained detectable quantities (0.34 to 60.2 mg/kg) of 2-Am (table 2) and 10 of the soil-core samples contained detectable concentrations of TNB. The largest TNB concentration (46.2 mg/kg) was detected in a surface-core sample (0 to 0.2 ft) from lysimeter LY08. Except for small concentrations (2.15 and 4.41 mg/kg) of 2,4-DNT in surface-core samples from lysimeter boreholes LY08 and LY07 and a small quantity

(3.22 mg/kg) of 2,6-DNT in the surface-core sample from lysimeter borehole LY07, none of the soil-core samples contained detectable concentrations of 2,4-DNT or 2,6-DNT. None of the soil-core samples contained detectable quantities of DNB or HMX.

Semiquantitative analysis of small particulate TNT crystals found at the surface at location 2 indicated the crystals were nearly pure TNT containing less than 1 percent impurities. No large differences were detected in subsamples collected from the exterior and interior of the crystals to determine the effects of weathering. The crystals were mostly pure TNT but included small quantities of TNB (0.11 to 0.27 percent by weight). None of the particulate TNT samples contained detectable quantities of 4-Am, 2-Am, DNB, 2,4-DNT, or 2,6-DNT; however, the large quantity of TNT made quantitation of other nitroaromatic compounds difficult.

Analyses for nitroaromatic compounds were made on 26 water samples collected from 5 lysimeters (LY05, LY08, LY09, LY10, and LY11). Concentrations of nitroaromatic compounds were detected in water samples from all five of these lysimeters (table 3, at the back of this report). The largest concentrations generally were detected in water samples from lysimeter LY08. Soil-core samples from this lysimeter borehole also contained the largest concentrations of nitroaromatic compounds. Concentrations of TNT ranged from 4.1 μg/L in a water sample from lysimeter LY10 to 6,250 μg/L in a sample from lysimeter LY08. Concentrations of 4-Am ranged from less than 3.0 μg/L in the water sample from lysimeter LY10 to more than 1,700 μg/L in a sample from lysimeter LY08. Concentrations of 2-Am generally were less than 50 percent of the 4-Am concentrations and ranged from 5.9 μg/L in the water sample from lysimeter LY10 to 246 μg/L in a sample from lysimeter LY05. Generally the concentrations of 4-Am and 2-Am averaged about 50 and 15 percent of the TNT concentration, except in two samples from lysimeter LY09 and the sample from lysimeter LY 10 where the concentrations of 2-Am exceeded those of TNT. Concentrations of TNB were variable and ranged from less than detection in several samples to 1,130 μg/L in a sample from lysimeter LY09. Samples from this lysimeter generally contained the largest concentration of TNB, which averaged 368 μg/L in four samples. No detectable quantities of 2,4-DNT, 2,6-DNT, NB, or nitrotoluene were detected in any of the lysimeter water samples.

Concentrations of TNT in the lysimeter water samples tended to peak in December or early January. For example, the mean TNT concentration in samples from lysimeter LY05 increased more than 40 percent from 972 μg/L in six samples collected before December 1991 to 1,387 μg/L in three samples collected in December 1991 and early January 1992 (table 3). Concentrations then decreased to a mean of only 674 μg/L in three samples collected in mid-January and February. Concentrations of 4-Am in water samples from LY05 followed a trend similar to that for TNT; however, the variation in concentrations was more subdued. The concentrations of 2-Am or TNB did not follow the trends observed in the TNT and 4-Am concentrations. A split sample was collected from lysimeter LY05 on January 15, 1992, to test for biologic degradation in sample bottles before extraction and analysis. Mercuric chloride was added to one split sample and the other was untreated. No significant difference was detected in the concentrations of TNT, 4-Am, or 2-Am; however, the concentration of TNB in the untreated sample was nearly twice as large (10 μg/L) as the concentration in the treated sample (5.5 μg/L).

Physical properties and concentrations of inorganic constituents in a water sample from lysimeter LY05 collected on January 29, 1992, are listed in table 4 (at the back of this report). The specific conductance [720 μS/cm (microsiemens per centimeter at 25 degrees Celsius)] was slightly larger than values recently measured in ground-water samples (355 to 711 μS/cm) at the WSTA (International Technology Corporation, 1991). The sample had a near neutral pH and more than 1.0 mg/L (milligram per liter) of dissolved oxygen. The sample contained large concentrations of sodium (Na, 120 mg/L) and sulfate (SO_4, 96 mg/L) and smaller concentrations of calcium (Ca, 48 mg/L), magnesium (Mg, 18 mg/L), potassium (K, 0.20 mg/L), and chloride (Cl, 13 mg/L). Concentrations of nutrients (nitrogen and phosphorus species) were at or less than detection. Concentrations of trace elements were generally small, except for concentrations of barium (Ba, 56 µg/L), copper (Cu, 80 µg/L), iron (Fe, 25 µg/L), manganese (Mn, 120 µg/L), Ni (10 µg/L), strontium (Sr, 200 µg/L), and zinc (Zn, 86 µg/L).

OVERBURDEN CHARACTERIZATION

Ninety-three soil samples were collected from various overburden units at the WSTA site for physical, chemical, and mineralogic characterization. These samples were collected from trench excavations and U.S. Geological Survey lysimeter boreholes at the WSTA.

Methodology

Fifty-eight soil samples were collected from Missouri Department of Natural Resources, Division of Geology and Land Survey trench excavations and 35 core samples were collected from U.S. Geological Survey lysimeter installations at the WSTA site. The location of the trench excavations and the lysimeter boreholes are shown in figure 4. Samples collected from trench excavations were selected to represent each overburden unit encountered based on observations by Missouri Department of Natural Resources, Division of Geology and Land Survey geologists. Samples were collected from trench walls using a pick and placed into sealed plastic bags for transport to the laboratory. Occasional split samples were collected and placed into sealed glass jars for determination of moisture content. Core samples from the lysimeters boreholes generally were collected where observable changes in texture or color occurred; however, detailed geologic logs are not available for these boreholes.

Except for samples submitted for the determination of moisture content, all samples were air dried, disaggregated with a jaw crusher, and split into two 3-oz (ounce) containers. One split (split 1) was used for the determination of grain-size, clay mineralogy, ash content, and chemical analysis by inductively coupled argon plasma emission spectroscopy (ICP, fig. 5). The other split (split 2) was pulverized to less than 0.125 mm for determination of bulk mineralogic properties, carbon content, essential and non-essential water content, and major element contents.

Grain-size analysis and clay separation (clay-size fraction) were made using modification of standard U.S. Geological Survey techniques (Starkey and others, 1984). About 25 to 30 g (grams) of material from split 1 was weighed and placed in a polypropylene Griffin beaker with 200 mL of distilled water. The sample was soaked overnight and disaggregated for 15 to 30 minutes in an ultrasonic generator. The coarse-size fraction (greater than 0.062 mm) was collected by wet sieving with a stainless steel sieve and transferred to an evaporating dish. The initial 250 mL of the clay-silt suspension passing through the sieve was collected in a bottle and centrifuged at 600 rpm (revolutions per minute) for 7.5 minutes to obtain a clay-size suspension. The remaining clay-silt suspension was placed into a 1,000 mL beaker. Oriented clay mineral specimens for X-ray diffraction analysis were prepared from the clay-size suspension using the filter-membrane, peel technique (Pollastro, 1982). The clay-size material was deposited onto a smooth, microporous membrane (0.45 µm pore size) by vacuum, then rolled onto a wet petrographic slide. The clay-silt suspension was centrifuged to separate the silt and clay size fractions; then each fraction was dried and weighed to determine the percentage of each in the bulk sample. The dried clay- and silt-size fractions were submitted for chemical analysis using multichannel ICP.

The bulk (whole sample) mineralogic content of the samples was determined on a subsample from split 2 (fig. 5). The subsamples were analyzed by an automated X-ray diffraction system, and the reference intensity ratio (RIR) method (Davis, 1988) was used to determine semi-quantitative mineral contents. Mineral contents are given in percent by weight and the relative standard deviation (RSD) was about 12 to 15 percent for mineral contents greater than 20 percent by weight and between 15 and 20 percent for mineral contents less than 20 percent by weight. Clay mineral contents were determined using a manual X-ray diffraction goniometer and the oriented slides prepared as described

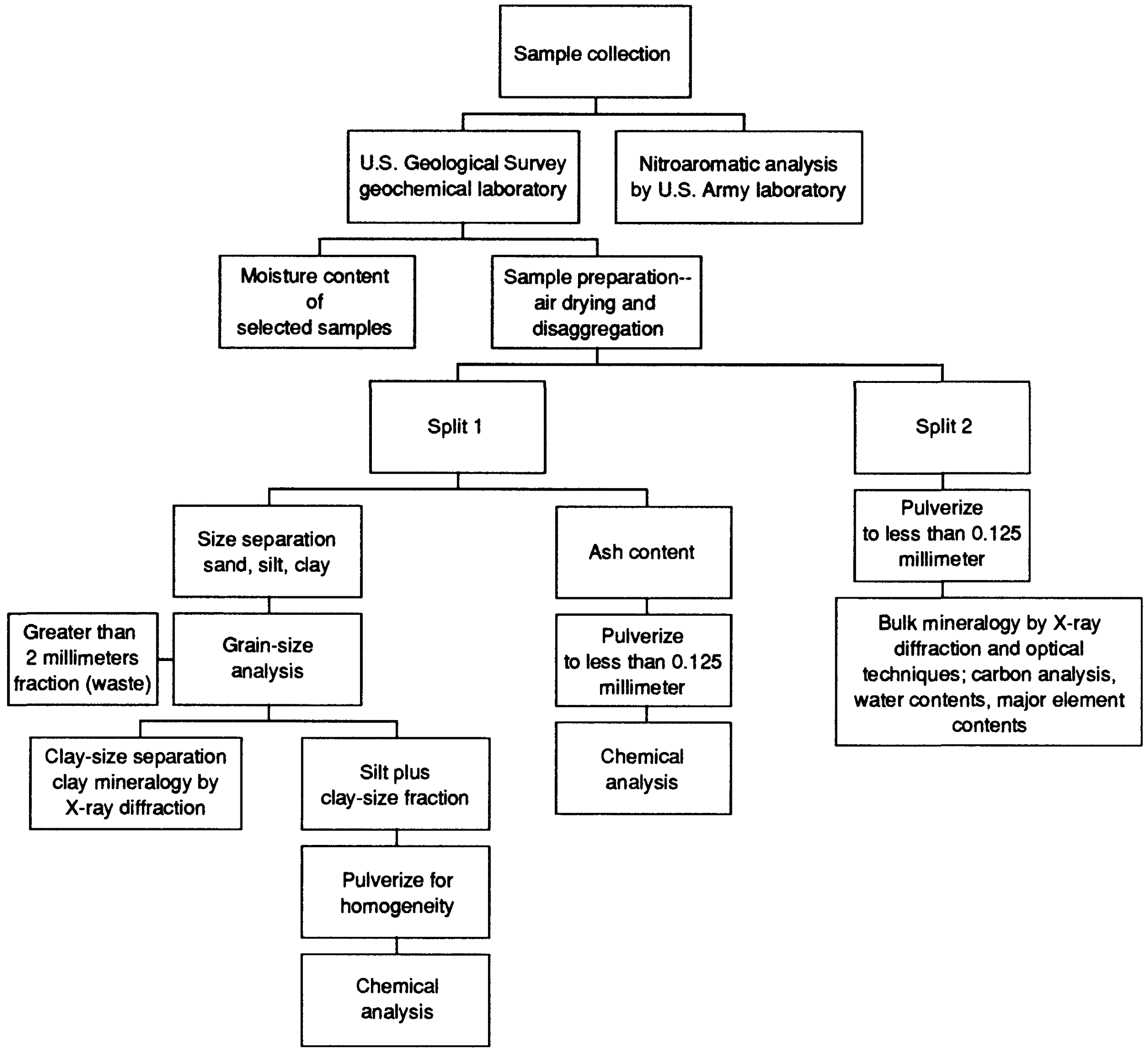


Figure 5.--Flowchart of overburden characterization procedures.

previously. The RIR method was used to determine the clay mineral contents; however, because of the small sample sizes, the RSD for the clay mineral analysis was 15 to 20 percent for contents larger than 20 percent by weight and 20 to 25 percent for contents less than 20 percent by weight.

Moisture content was determined on selected samples that were placed into sealed glass jars onsite and shipped to the laboratory. Moisture content was determined by weighing about 10 g of each sample in an evaporating dish and subsequent drying in an oven at 105 °C for 24 hours. The sample was removed, cooled in a desiccator, weighed, lightly disaggregated, and dried again for 6 hours. The process was repeated until the final weight had stabilized. The moisture content (in percent by weight) was calculated as the difference between the initial and final sample weight divided by the initial weight.

The total water content (Norton and Papp, 1990) of the samples was determined by placing a 50 g subsample from split 2 (fig. 5) into a Pyrex cup and adding 300 mg (milligrams) of flux (lead oxide, lead chromate, and calcium carbonate). The sample-flux mix was heated in a furnace at 900 °C. The evolved water was determined by coulometric titration. The non-essential water content was calculated by heating 1 g of sample in an oven at 110 °C for 4 hours and measuring the water loss by the difference between the initial and final weights. The essential water (mineral bound water) was calculated by subtracting the non-essential water content from the total water content.

Total carbon (TC) contents were determined by combustion of a small (less than 1 g) subsample from split 2 (fig. 5) in a stream of oxygen and measurement of the carbon dioxide (CO_2) generated by infrared absorption (Curry, 1990a). Carbonate carbon was determined by treating 0.5 g of sample with hot 2N (normal) perchloric acid ($HClO_4$). The evolved CO_2 was passed through a cell containing a solution of monoethanolamine. The CO_2 was absorbed by the monoethanolamine and coulometrically titrated. Total organic carbon (TOC) contents were determined by subtracting the carbonate carbon from the TC values according to methods described in Jackson and others (1987).

Major element contents (expressed as percent by weight oxides) in the bulk sample were determined using wavelength dispersive X-ray fluorescence according to procedures described by Taggart and others (1987). Determinations were made on a small (about 1 g) subsample from split 2. This method also allowed for the gravimetric determination of loss-on-ignition at 925 °C. The RSD for major element oxide determinations was less than 1 percent. Elemental contents of sulfur (S) were determined by combustion of the sample at 1,370 °C and measurement of the sulfur dioxide (SO_2) generated by infrared absorption spectrophotometry (Curry, 1990b). The RSD for S determinations was 3 percent over a concentration range of 0.05 to 32 percent by weight. Total Cl and fluoride (F) contents were determined by ion-selective electrode potentiometry (ISE) on subsamples from split 2 (fig. 5). The determination for total Cl was made after digesting the sample with potassium permanganate, H_2SO_4, and hydrofluoric acid (HF) and reduction of the chlorine gas evolved to chloride ion by a solution of sodium sulfite in potassium hydroxide (Aruscavage, 1990). The RSD of Cl contents determined by this method was 5 percent over a concentration range of 0.01 to 2 percent by weight. The total F determination was made after fusing the sample with a mixture of sodium carbonate, potassium carbonate, and potassium nitrate, and subsequent dissolution with citric acid (O'Leary and Hopkins, 1990). The RSD for total F contents was 0.01 percent over a concentration range of 0.01 to 14 percent by weight.

Contents of major and trace elements in the less than 0.062 mm size fraction (fine fraction) were determined by multichannel ICP (fig. 5). Each sample was dissolved using low temperature digestion with concentrated hydrochloric acid (HCl), HF, and $HClO_4$ (Crock and others, 1983). Lutetium was added at the beginning of the digestion process as an internal standard (5 mg/L). After digestion the acidic sample was dried and the residue dissolved in 1 mL of aqua regia and diluted to 10 g. The RSD of element contents by this method was about 5 percent.

Ashing of samples was done using a modification of the standard U.S. Geological Survey procedure for ashing coal (Golightly and Simon, 1989). About 3 to 5 g of pulverized sample from split 1 (fig. 5) was weighed and placed into a porcelain crucible. Each sample was slowly heated to 200 °C for 1.5 hours then heated to 350 °C for 2 hours, followed by a final heating at 525 °C for as much as 36 hours to complete the ashing. The percent ash was calculated by dividing the final weight of the ash by the initial sample weight. Following ashing, ash samples were submitted for elemental analysis by ICP.

Summary of Physical and Mineralogic Data

Because the soil samples from lysimeter boreholes were from potentially disturbed or contaminated areas, physical, mineralogic, and chemical data about samples from these boreholes are included in separate tables. Data from these boreholes generally were not used in describing the general characteristics of the overburden at the site.

The unconsolidated overburden units at the WSTA site (Peoria Loess, Roxanna Silt, Ferrelview Formation, clay till, preglacial deposit, and residuum) are primarily composed of silt and clay with lesser quantities of coarse material (table 5, at the back of this report). The Roxanna Silt contained the largest quantities of silt (averaging about 73 percent by weight in nine samples) and the smallest quantities of coarse material (about 5 percent by weight). The Ferrelview Formation and residuum contained the largest quantity of clay-size material (averaging 39 percent by weight in samples from each unit) and the residuum contained the largest quantity of coarse-size material (average of 41 percent). The largest individual clast found in the trench excavations was a small boulder about 40 cm in diameter of amphibolite from the clay till in an excavation near trench 4 (fig. 4).

The predominate mineral in the bulk (whole sample) fraction of the various units was quartz, ranging from an average of 39 percent by weight in the residuum to 46 percent by weight in the Roxanna Silt (table 5). The overburden units contained lesser quantities of plagioclase, orthoclase, and clay minerals. Plagioclase generally was more abundant than orthoclase except for samples from the residuum where, when feldspars were detected, orthoclase was more abundant. Overall the clay mineral contents (smectite plus kaolinite) ranged from an average of 12 percent by weight in the Roxanna Silt to 26 percent by weight in the residuum. Usage of the term smectite refers to total expandable clays such as montmorillonite in the bulk fraction. Generally, kaolinite contents increased in samples from the lower units and ranged from about 2 percent by weight in the Peoria Loess to about 13 percent in the preglacial deposit. Calcite was detected in only 6 of the 58 samples from the trenches and ranged from only a trace in a sample of preglacial deposit from trench 3 to 17 percent by weight in the residuum sample from trench 9 (table 5). Samples from the Peoria Loess and Roxanna Silt generally contained detectable quantities of pyroxene and amphibole, whereas samples from the underlying units generally did not. Samples from these two units also contained the largest quantities of feldspars (plagioclase plus orthoclase) and the smallest quantities of clay minerals (smectite plus kaolinite). In general, all samples contained about 10 to 25 percent amorphous material in the bulk and clay-size fractions. This amorphous material consisted of amorphous iron and manganese oxyhydroxides and amorphous or extremely poorly crystalline aluminosilicates, such as illite. Physical and mineralogic data on soil-core samples from the lysimeter boreholes were similar to data from the trench samples and are listed in table 6 (at the back of this report).

Detailed clay mineralogy of overburden soil samples from the trench excavations indicated montmorillonite was the predominate clay mineral in the clay-size fraction (less than 0.002 mm) except in 7 of the 13 samples from the preglacial deposit and the residuum where kaolinite contents equaled or exceeded the montmorillonite contents (table 5). Kaolinite comprised between 60 and 80 percent of the clay-size fraction in three samples of preglacial deposit from trench 1 and one residuum sample from trench 6. Most kaolinite was well crystallized, whereas the montmorillonite was moderately to poorly crystalline, and the illite generally was poorly crystalline.

Summary of Moisture, Carbon, and Major Element Contents

A summary of moisture, carbon, and major element contents in samples from the trench excavations are given in table 7 (at the back of this report). Moisture contents in trench samples ranged from an average of 22 percent by weight in the Peoria Loess to 13 percent by weight in the Roxanna Silt. No residuum samples and only one preglacial deposit sample were submitted for field moisture analysis. Total water contents reflect structural water in mineral phases and sorbed or free water in the samples. Consequently, total water contents generally were larger in samples from units containing more clay-size material and clay minerals, such as the Ferrelview Formation and the residuum. Most of the total carbon (TC) detected in samples from the overburden was present as total organic carbon (TOC) except for the two samples that contained large calcite contents (clay till sample at 20.0 ft from trench 4 and residuum sample at 20.5 ft from trench 9). The TOC contents generally decreased with depth, averaging 0.74 percent by weight in the Peoria Loess, less than 0.13 percent by weight in the Roxanna Silt, less than 0.09 percent by weight in the Ferrelview Formation, less than 0.05 percent by weight in the clay till and preglacial deposit, and less than 0.06 percent by weight in the residuum (values less than the detection limit were assumed to be at the detection limit). The Fe contents (expressed as FeO) ranged from an average of 2.88 percent by weight in the preglacial deposit to an average of 4.57 and 4.82 percent by weight in the clay till and Peoria Loess. Contents of Na and K (expressed as Na_2O and K_2O) generally decreased in the lower units with the Peoria Loess and Roxanna Silt containing the largest contents and the residuum containing the smallest contents. Contents of S and Cl were less than the detection limit of 0.05 and 0.01 percent by weight in all samples. The two kaolinite-rich samples of preglacial deposit from trench 1 (15.0 to 18.0 ft and 18.0 to 19.0 ft) contained the largest aluminum (Al) contents (about 30 percent by weight as Al_2O_3, table 7) and titanium (Ti) contents (1.89 and 1.84 percent by weight TiO_2).

Moisture, carbon, and major element contents in samples from the lysimeter boreholes (table 8, at the back of this report) were similar to samples from the trench excavations. Major element contents in samples from the lysimeter boreholes were similar to those from trench samples. A clay till sample from lysimeter borehole LY01 at 11.8 to 12.1 ft deep had the largest Fe content (8.03 percent by weight as FeO) of any overburden sample from the site.

Summary of Chemical Contents in the Silt-Clay Size Fraction and Ashed Samples

Chemical analysis of the silt-clay or fine (less than 0.062 mm) fraction of overburden samples from trench and lysimeter boreholes are listed in tables 9 and 10 (at the back of this report). The Al contents in trench samples ranged from an average of 10 percent by weight in the residuum to 5.2 percent by weight in the Roxanna Silt. Contents of arsenic (As), Pb, and Ni generally were small in the trench and lysimeter samples; however, contents of these elements tended to increase in samples from the lower units. For example, in samples from the trench excavations the average Pb content increased from 15 and 13 mg/kg in the Peoria Loess and Roxanna Silt to 27 and 24 mg/kg in the preglacial deposit and residuum (table 9). The three samples of preglacial deposit from trench number 1 contained the largest Pb contents detected (35, 37, and 51 mg/kg, table 9). The largest Pb content detected in the lysimeter borehole samples (32 mg/kg, table 10) was in a clay till sample (LY03, 13.0 to 13.6 ft). Contents of Ni more than doubled in the residuum as compared to the overlying units.

Results of chemical analysis on ashed overburden samples from trench excavations and lysimeter boreholes are listed in tables 11 and 12 (at the back of this report). The percent ash (percentage of sample remaining after ashing) in the trench samples ranged from an average of 93 percent by weight in the residuum to 96 percent by weight in the Roxanna Silt (table 11). Generally, constituent contents in ashed samples were similar to contents detected in the silt-clay size fraction (tables 9 and 10) and contents were similar between ashed samples from the trenches (table 11) and the lysimeter boreholes (table 12).

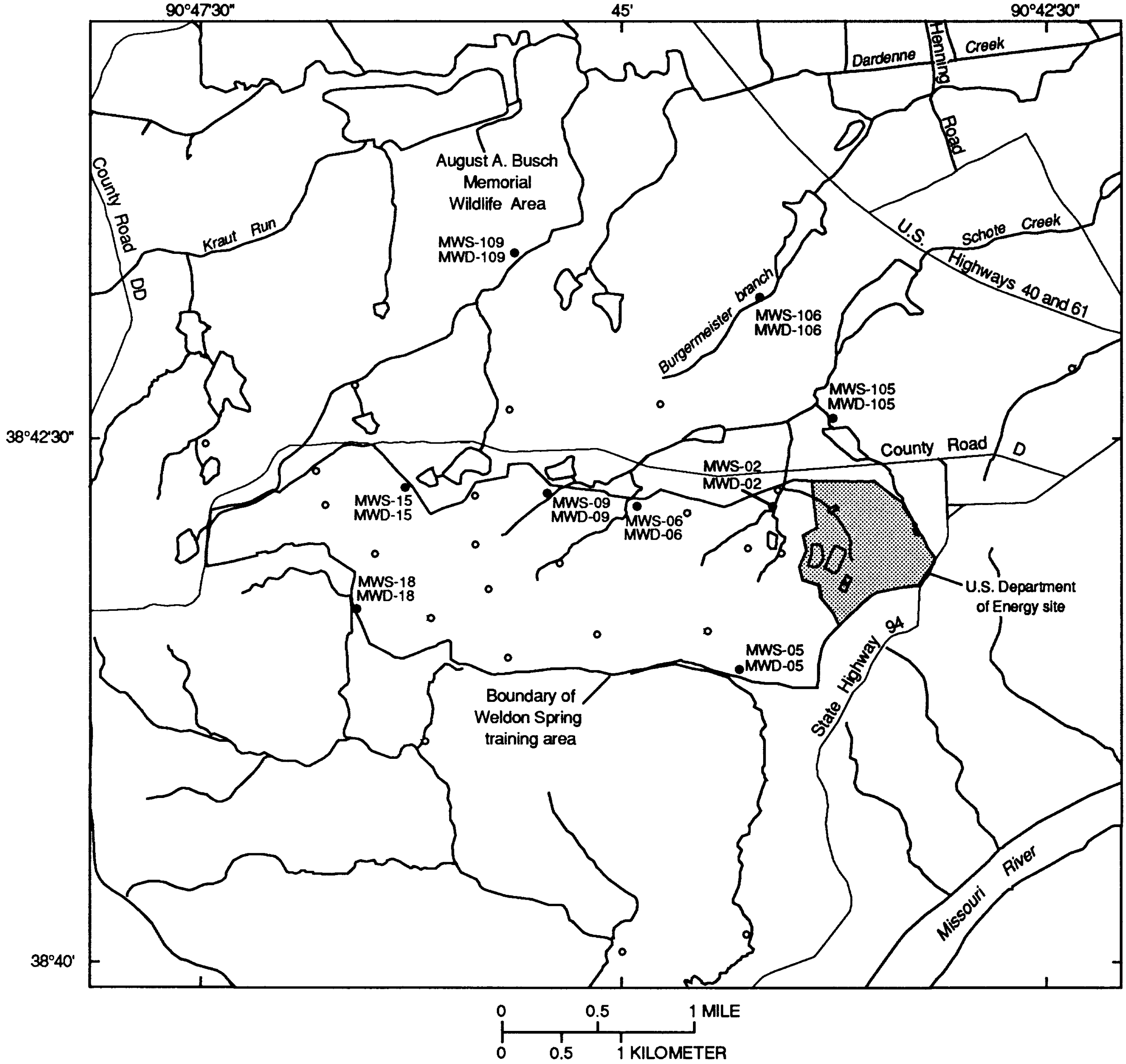
GROUND-WATER GEOCHEMISTRY

Water-quality samples were collected during 1990 from selected monitoring wells at the WSTA site and on the adjacent August A. Busch Memorial Wildlife Area to the north to characterize the geochemistry of the shallow ground water beneath the training area (fig. 6). The samples were analyzed for dissolved major cations and anions, TOC, dissolved nutrients (nitrogen and phosphorus species), and dissolved trace elements. Values of physical properties, such as specific conductance, pH, oxidation-reduction potential (Eh), temperature, and concentrations of selected chemical constituents, such as dissolved oxygen, total alkalinity, and ferrous iron (Fe^{2+}), were determined at the time of sample collection. The relative age of the water in selected samples was dated by determining concentrations of tritium. The data were collected to determine if variability in ground-water geochemistry correlated with variability in the distribution of contaminants in the ground water, particularly concentrations of nitroaromatic compounds. Additional water-quality samples were collected from selected monitoring wells and Burgermeister spring (fig. 7) during 1992 for the determination of nitroaromatic compounds. The 1992 sampling was initiated to determine if TNT degradation products observed in the lysimeter samples also were detected in the shallow ground water.

Methodology

Specific conductance of water samples was measured using a portable conductivity meter with temperature compensation designed to express values in microsiemens per centimeter at 25 °Celsius. The meter was calibrated before each measurement using standards prepared by the U.S. Geological Survey water-quality laboratory in Ocala, Florida. The pH was measured using a portable pH meter calibrated with standard buffers bracketing the expected sample pH before each measurement. The Eh was determined by measuring the voltage potential developed at the surface of a platinum electrode immersed in the sample, and values were corrected to the standard hydrogen electrode. Water temperature was measured to the nearest 0.5 °C by a thermistor attached to a pH meter. Dissolved oxygen concentrations were determined by colorimetry to the nearest 0.05 mg/L using a diethylene glycol and rhodazine-D method developed by Chemetrics. This method was applicable for concentrations of dissolved oxygen ranging from 0.05 to 1.0 mg/L. Alkalinity was determined on 25 mL of sample by using incremental titration of 0.16 N standardized H_2SO_4 past the carbonate-bicarbonate inflection point (approximately pH 8.3) and the bicarbonate-carbonic acid inflection point (approximately pH 4.5). Concentrations of carbonate, bicarbonate, and carbonate alkalinity were later computed using a computer program to integrate the rate of pH change to the equivalence of acid added. The Fe^{2+} concentrations were determined by using a modification of the phenanthroline method developed by the Hach Company. Values were determined onsite using a portable spectrophotometer calibrated and set at a 510-nm wavelength.

Water-quality samples collected during 1990 from most monitoring wells were obtained using a 3-in. diameter submersible pump. Each monitoring well was purged before sampling. During purging, specific conductance, pH, Eh, temperature, and dissolved-oxygen concentrations were monitored in a flow-through cell attached to the discharge line of the pump, and water-quality samples were not collected until these measurements stabilized. A minimum of two pipe-volumes of water was removed from most monitoring wells before sampling; however, several monitoring wells recovered slowly (MWS-02, MWD-05, MWS-06, MWD-15, MWS-18, and MWD-109), requiring more than 4 hours to recover, and these wells were sampled after purging only one pipe-volume. In the case of monitoring well MWD-05, the well required 5 days to recover before it could be sampled. Monitoring well MWS-105 was purged and sampled using a 2-in. diameter disposable polyethylene bailer. Concentrations of alkalinity and Fe^{2+} were determined immediately after sample collection. During alkalinity titrations, a second pH and temperature measurement was made for comparison with flow-through cell readings.

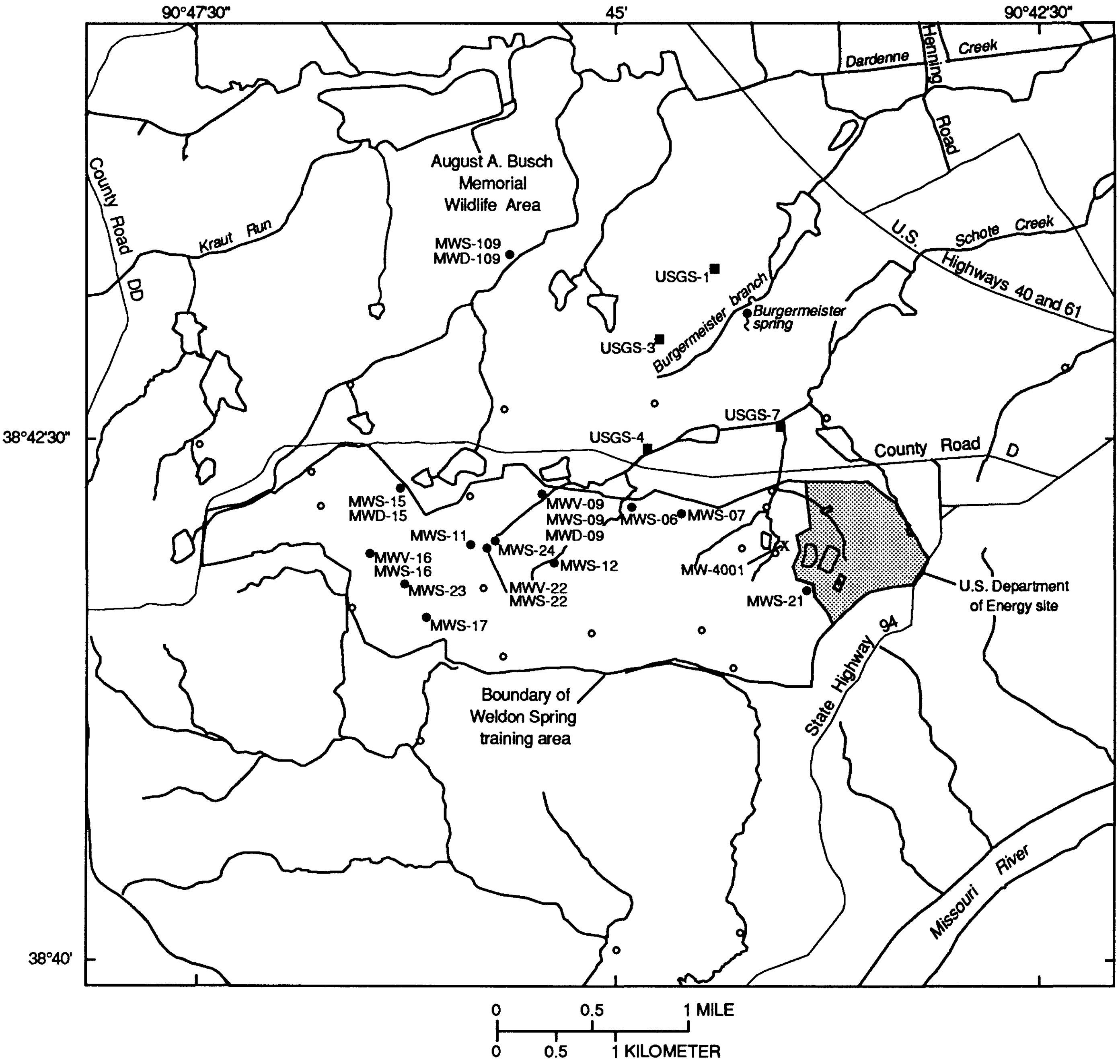


EXPLANATION

MWS-109 MWD-109 ● U.S. ARMY MONITORING WELL CLUSTER--Number designates well sampled for inorganic constituents during 1990; MWS indicates shallow well; MWD indicates deep well

○ U.S. ARMY MONITORING WELL--Not sampled during this study

Figure 6.--Location of U.S. Army monitoring wells sampled during 1990 at the Weldon Spring training area and vicinity.



EXPLANATION

MWV-09
MWS-09 ● U.S. ARMY MONITORING WELL OR WELL CLUSTER--Number designates well sampled for nitroaromatic compounds during 1992; MWV indicates well completed in the overburden; MWS indicates shallow well; MWD indicates deep well
MWD-09

○ U.S. ARMY MONITORING WELL--Not sampled during 1992

USGS-1 ■ U.S. GEOLOGICAL SURVEY MONITORING WELL--Number designates well sampled for nitroaromatic compounds during 1992

MW-4001 x U.S. DEPARTMENT OF ENERGY MONITORING WELL--Number designates well sampled for nitroaromatic compounds during 1992

Figure 7.--Location of ground-water sites sampled for nitroaromatic compounds during 1992 at the Weldon Spring training area and vicinity.

Chemical constituents determined in ground-water samples are dissolved unless specified otherwise. Inorganic chemical constituents referred to as "dissolved" were filtered through a 142-mm diameter, 0.1-µm pore size cellulose-nitrate membrane filter placed in a lucite holder. A peristaltic pump was used as the pressure source for filtration. After filtration, samples for dissolved cations were placed in acid-washed polyethylene bottles and preserved with ultrapure nitric acid to a pH less than 2. Samples for dissolved anions were placed into clean polyethylene bottles. Dissolved nutrient samples were placed in 250-mL amber polyethylene bottles and preserved by adding 1 mL of 10^{-4} molar mercuric chloride and chilling to 4 °C. The TOC samples were collected in 250-mL amber glass bottles and preserved by chilling to 4 °C. Samples for tritium determinations were collected in 1-L (liter) glass bottles by filling from the bottom using a silicon hose to exclude any contact with the atmosphere. Inorganic constituents and tritium determinations were made according to the methods described by Fishman and Friedman (1989). The TOC determinations were made according to the procedures outlined in Wershaw and others (1983). Water-quality data collected during 1990 are given in table 13 (at the back of this report).

Water-quality samples for nitroaromatic analysis were collected during 1992 using a 2-in. diameter stainless steel submersible pump fitted with teflon impellers and polyethylene tubing. Each monitoring well was purged before sampling using either a dedicated PVC bailer or the submersible pump. During purging, specific conductance, water temperature, dissolved oxygen, and pH values were monitored and samples were not collected until these values had stabilized. If a monitoring well went dry during purging, it was allowed to recover, purged again, and sampled after removing only two pipe-volumes. The water sample from Burgermeister spring was collected by immersing the sample bottle below the water surface at the spring orifice until filled.

Samples for nitroaromatic analysis were placed in 1-L opaque bottles, chilled to 4 °C, and shipped overnight to the U.S. Geological Survey laboratory in Denver, Colorado. The samples were extracted within 5 days and the extracts were analyzed within 14 days of sample collection. The water samples were prepared for analysis by vacuum elutriation of approximately 400 mL of sample through a 3-cc (cubic centimeter) C-18 solid phase extraction cartridge (6-cc C-18 cartridge was used after December 1, 1992, to improve recoveries). The cartridge was conditioned with successive rinses of 10 mL methanol and reagent grade water before sample extraction. The nitroaromatic components were desorbed from the cartridge using 2.0 mL of methanol, which then was nitrogen evaporated to 1.0 mL, and brought to a 2.0 mL final volume with reagent grade water. The extractions were chilled and sealed in crimp-top containers for HPLC analysis.

Concentrations of TNT, 4-Am, 2-Am, TNB, 3,5-DNA, DNB, 2-nitrotoluene (2-NT), 3-nitrotoluene (3-NT), 4-nitrotoluene (4-NT), and NB in sample extracts were determined by reversed-phase HPLC. Small concentrations of 2,3-DNT were detected in some samples but were not quantified. The mobile phase consisted of a gradient elution that began with an acetonitrile:water:methanol mixture ratio of 15:80:05 that was changed to a 47:48:05 ratio over 25 minutes using a flow rate of 1.0 mL/min (milliliter per minute). The analytical column used was a Beckman Ultrasphere ODS 5 mm 4.6 by 25 cm column. Detection and confirmation were made using a photodiode array detector. Quantification was based on the chromatogram generated by the signal at 250 nm. A modification of the USATHAMA method for determining explosives in water was used for determination of 2,4-DNT and 2,6-DNT concentrations. The mobile phase in this procedure consisted of isocratic elution using an acetonitrile:water:methanol mixture with a ratio of 15:45:40. The column, flow rate, detection, and quantification were the same as described in the preceding paragraph.

A more rigorous quality assurance-quality control (QA-QC) protocol was developed for the 1992 nitroaromatic compound sampling. This protocol consisted of various field blanks, field duplicates, and split samples analyzed by the U.S. Army contract laboratory. Laboratory QA-QC protocol included a minimum of 10 percent blanks, 10 percent spikes, and 10 percent replicates during a given analytical run. Each analytical run was assigned a numerical value (designated QC group). The QA-QC data for each analytical run are summarized in table 14 (at the back of this report). The concentrations of nitroaromatic compounds in samples from selected ground-water sites sampled during 1992 are listed in table 15 (at the back of this report). Each sample listed in table 15 has an associated QC group number that indicates what analytical run the sample was actually analyzed. In this way, each sample listed in table 15 can be cross-referenced to the appropriate QA-QC data summarized in table 14.

Summary of Data

Values of specific conductance ranged from 378 μS/cm in a sample from monitoring well MWD-15 to 928 μS/cm in a sample from monitoring well MWS-18 (table 13). Specific conductance values in samples from most monitoring wells generally were less than 600 μS/cm. The pH values of monitoring well samples were near neutral and ranged from 6.3 to 7.8. The sample from monitoring well MWS-18 also contained the largest concentrations of Na (70 mg/L), K (6.4 mg/L), bicarbonate (HCO_3, 435 mg/L), SO_4 (250 mg/L), Cl (9.6 mg/L), TOC (2.2 mg/L), Cu (20 μg/L), and among the largest concentrations of Ca (70 mg/L), Mg (43 mg/L), SiO_2 (11 mg/L), dissolved phosphorus (P, 0.21 mg/L), total phosphorus (P_t, 0.25 mg/L), boron (B, 250 μg/L), lithium (Li, 17 μg/L), and Sr (430 μg/L). This sample also contained the smallest concentration of barium (Ba, 33 μg/L). Concentrations of dissolved oxygen in samples from the monitoring wells sampled generally were less than 1.0 mg/L; however, three of the samples (MWS-15, MWS-18, and MWD-106) contained concentrations of dissolved oxygen greater than 1.0 mg/L.

Samples from two monitoring wells (MWS-15 and MWD-15) were the only samples to contain concentrations of nitrite plus nitrate (NO_2+NO_3) as nitrogen larger than 1.0 mg/L (table 13). Concentrations of total ammonia plus organic nitrogen [$(NH_3+ON)_t$] as nitrogen were less than 0.5 mg/L except for the samples from monitoring wells MWS-06 (1.7 mg/L) and MWD-15 (0.5 mg/L). The sample from monitoring well MWD-15 also contained the largest concentrations of nitrite (NO_2, 0.04 mg/L), ammonia (NH_3, 0.15 mg/L), P and P_t (1.5 mg/L), and orthophosphate (PO_4, 1.2 mg/L). The concentrations of P and P_t in the sample from this well (1.5 mg/L) were larger than any values previously detected from the WSTA and adjacent U.S. Department of Energy site or vicinity property (Kleeschulte and others, 1986; Kleeschulte and Cross, 1990; Schumacher, 1990). In addition, the concentrations of P and P_t in samples from monitoring wells MWS-06, MWD-06, MWD-09, and MWS-18 also were among the largest detected.

Concentrations of trace elements generally were near or less than detection except for concentrations of B, cadmium (Cd), Fe, Li, Mn, Ni, Sr, and Zn. Concentrations of B generally were less than about 20 μg/L except for samples from monitoring wells MWD-05 (300 μg/L), MWS-18 (250 μg/L), and MWD-18 (50 μg/L). Samples from monitoring wells MWS-105 and MWS-109 contained the largest concentrations of Cd (10 and 3 μg/L) and among the largest concentrations of Ni (10 and 4 μg/L). Concentrations of Fe ranged from less than 3 μg/L in the sample from monitoring well MWS-109 to 100 μg/L in the sample from monitoring well MWS-06. Concentrations of Mn ranged from 1 μg/L in the sample from monitoring well MWS-15 to 160 μg/L in the sample from monitoring well MWD-02. Concentrations of Sr generally were less than about 200 μg/L except for samples from monitoring wells MWD-05 (1,200 μg/L), MWS-06 (230 μg/L), MWS-18 (430 μg/L), and MWD-18 (410 μg/L). The largest Zn concentrations were detected in samples from monitoring wells MWD-05 (36 μg/L) and MWS-06 (79 μg/L).

Concentrations of As, Pb, and tritium generally were small in all samples. The largest As values were in the samples from monitoring wells MWD-15 and MWS-105 (4 μg/L) and the largest Pb concentration was in the sample from monitoring well MWS-106 (3 μg/L). Water samples from nine of the monitoring wells were analyzed for concentration of tritium. Only the sample from monitoring well MWS-15 contained concentrations of tritium, 42 pCi/L (picocuries per liter), larger than the detection limit of 5.7 pCi/L.

Seventeen of the 21 monitoring wells sampled during 1992 and Burgermeister spring contained detectable concentrations of nitroaromatic compounds (table 15). The sample from monitoring well MWV-09 generally contained the largest concentrations of TNT (33.9 to 61.5 μg/L), 4-Am (22.8 to 29.2 μg/L), 2-Am (31.8 to 42.9 μg/L), 3,5-DNA (less than 0.25 to 19.6 μg/L), and among the largest concentrations of TNB (3.8 to 20.5 μg/L) and 2,4-DNT (24.1 to 32.0 μg/L). Concentrations of 4-Am or 2-Am were detected in samples from 17 of the monitoring wells and Burgermeister spring making amino dinitrotoluenes the most frequently detected nitroaromatic compounds. The largest concentrations of 4-Am and 2-Am generally were in samples from monitoring well MWV-09. Concentrations of 4-Am plus 2-Am samples exceeded TNT concentrations, and 4-Am concentrations generally were larger than those of 2-Am. Concentrations of TNB ranged from less than the detection limit in 9 monitoring wells and Burgermeister spring to 44.4 μg/L in the sample from monitoring well MW-4001. The sample from monitoring well MW-4001 was slightly yellow. This condition previously had been observed in several lysimeter water samples containing moderate concentrations of TNB. Detectable concentrations of 3,5-DNA were in samples from 14 monitoring wells. The sample from monitoring well MWS-17 contained the largest concentrations of 2,4-DNT (44.0 μg/L), 2,6-DNT (61.4 μg/L), 2-NT (21 μg/L), 3-NT (0.9 μg/L), and 4-NT (3.8 μg/L); however, TNT was not detected in this sample. Unlike the lysimeter samples, 2,4-DNT and 2,6-DNT were detected as frequently as TNT. None of the samples contained detectable quantities of DNB; however, samples from five monitoring wells (MWS-11, MWS-15, MWD-15, MWS-16, and USGS-4) contained detectable quantities of a previously unidentified compound that was determined to be 2,3-DNT.

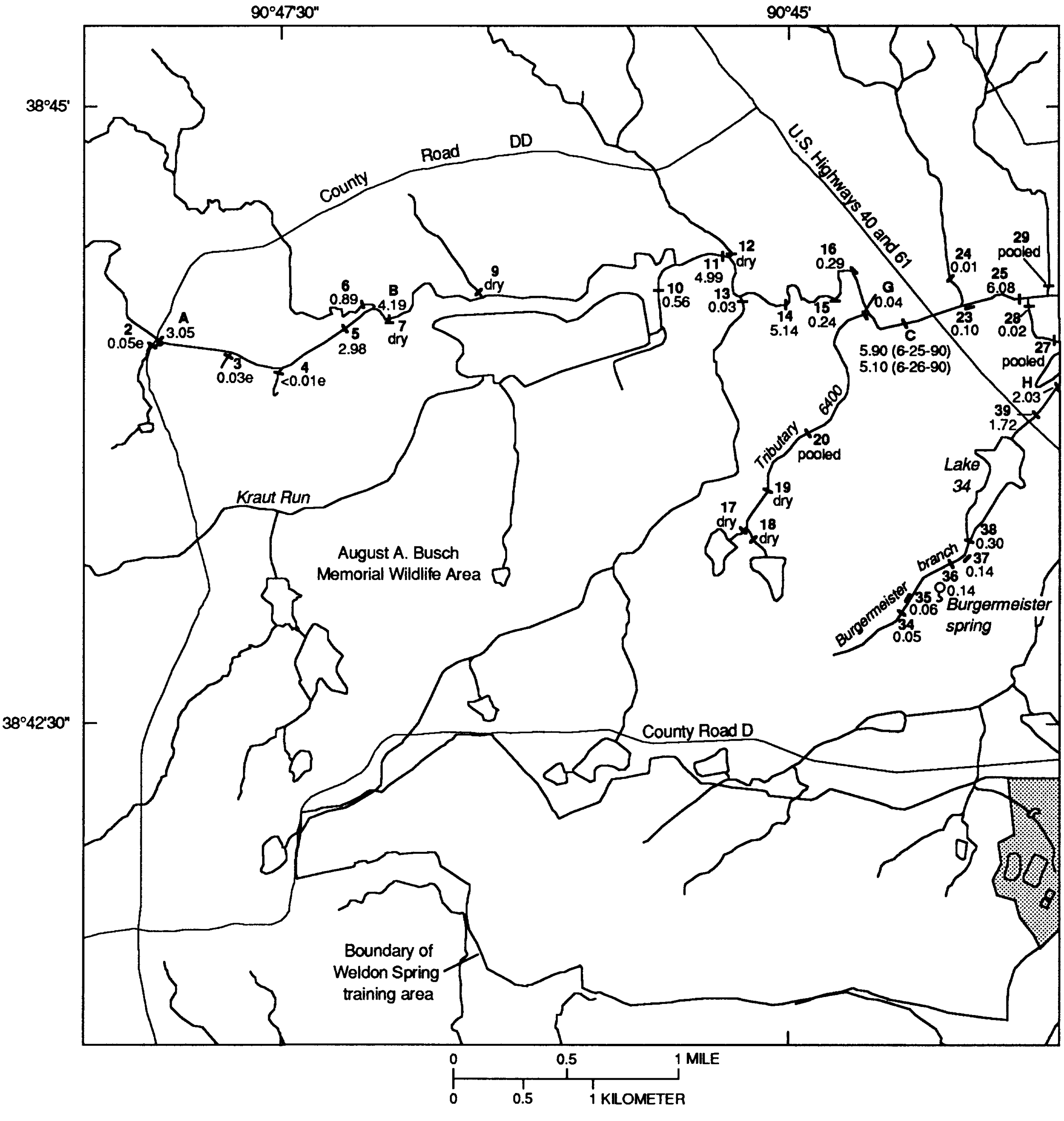
SEEPAGE STUDY OF DARDENNE CREEK

A seepage run was made on about a 10 mi reach of Dardenne Creek in the vicinity of the WSTA site on June 25 and 26, 1990, to quantitatively determine the degree of ground- and surface-water interaction along this segment of Dardenne Creek. Discharge, specific conductance, and water temperature were measured at 59 sites along Dardenne Creek, its tributaries, and vicinity springs (fig. 8). Water-quality samples were collected at selected locations to determine how the water quality in Dardenne Creek changed downstream from the WSTA site. These samples were analyzed for dissolved major cations and anions, TOC, dissolved nutrients, dissolved trace elements, and nitroaromatic compounds. A second seepage run was made along a selected reach of Dardenne Creek on July 16, 1990, to verify results of the June 25 and 26 seepage run.

Methodology

The seepage run was made on June 25 and 26, 1990, during a transition time between spring high base-flow conditions and summer low base-flow conditions. Flow in Dardenne Creek and tributaries was being sustained by ground- and surface-water interaction and spring discharge, and not runoff from precipitation. Discharge measurements were made at selected locations along Dardenne Creek and generally at the mouth of tributaries. Locations were selected where stream channel morphology and velocity were sufficient for discharge measurements. Discharge was measured using either a standard AA current meter or a pygmy current meter where stream velocities were less than 1 ft/sec (foot per second) and depths were less than 1 ft. Where streamflow was not sufficient for either of the above methods, the discharge was estimated. Discharge measurements were rated according to the stream channel conditions and uniformity of flow and generally the measured discharge values should be reliable to within 5 to 8 percent. Estimated discharge values may vary more than 8 percent. Water temperature and specific conductance were measured at each discharge measurement site.

Special emphasis was placed on the two unnamed tributaries of Dardenne Creek; the unnamed tributary that contains Burgermeister spring (commonly referred to as Burgermeister branch) and the unnamed tributary just west of Burgermeister branch (referred to as tributary 6400). These two tributaries drain part of the WSTA. Sixteen discharge measurements were made on Burgermeister branch and its tributaries both upstream and downstream from Burgermeister spring. This included a slough near Twin Island Lake. Five sites were measured along tributary 6400.



EXPLANATION

A 3.05 WATER-QUALITY SAMPLING SITE AND LETTER--Number is discharge, in cubic feet per second

33 6.61 DISCHARGE MEASUREMENT SITE AND NUMBER--Lower number is discharge in cubic feet per second; e, indicates estimated discharge; <, less than

Figure 8.--Results of seepage run along Dardenne Creek and tributaries in the vicinity of the Weldon Spring training area, June 25-26, 1990.

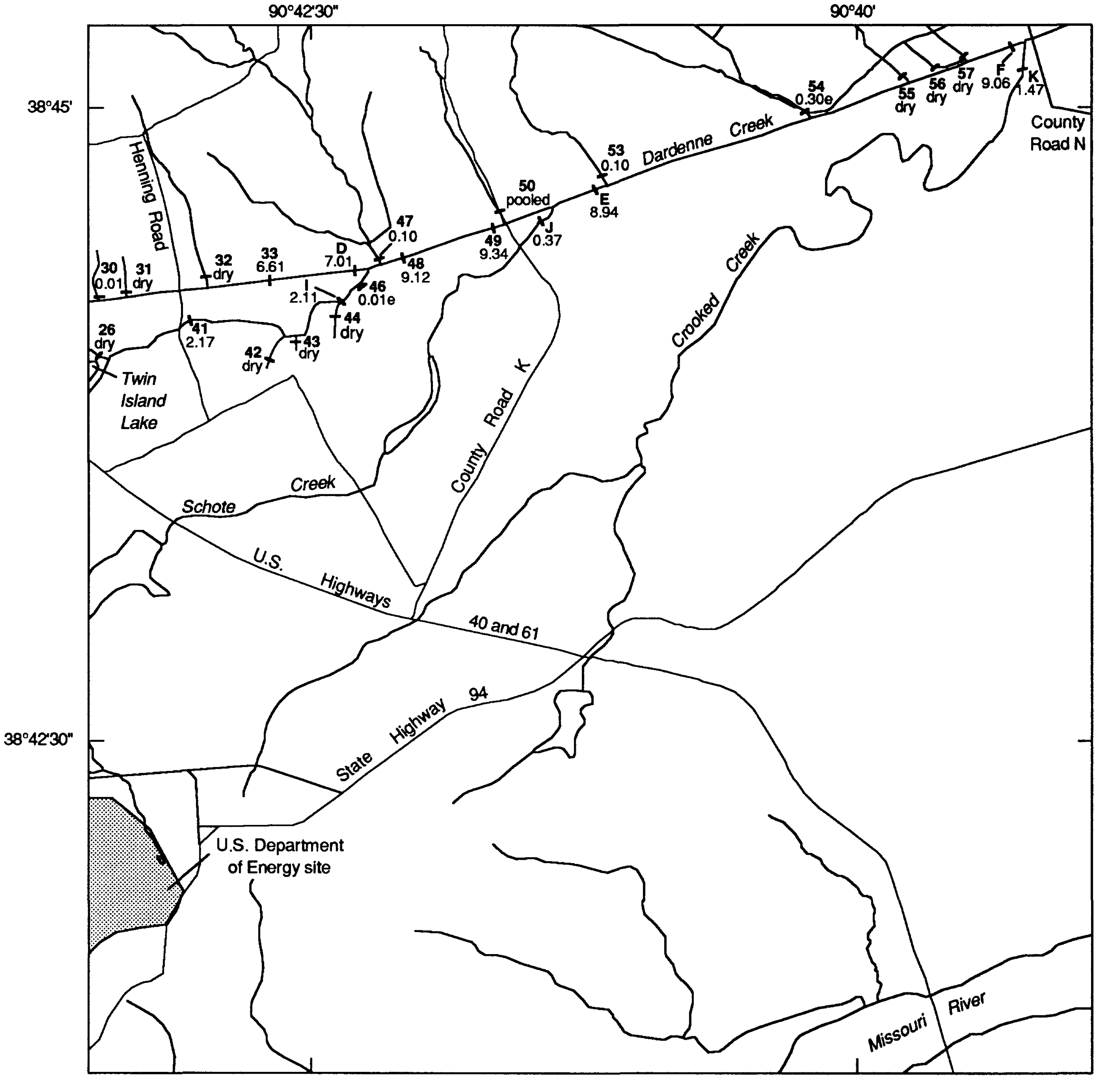


Figure 8.--Results of seepage run along Dardenne Creek and tributaries in the vicinity of the Weldon Spring training area, June 25-26, 1990--Continued.

Gaining and losing reaches of Dardenne Creek were identified by using measured discharge values to calculate the net increase or decrease in discharge along a specific stream reach. The net increase or decrease in discharge was determined as

$$Q_{net} = Q_{DS} - \left(Q_{US} + \sum_{i=1}^{i=n} Q_{t_i}\right),$$

where Q_{net} is the net increase or decrease in discharge along a stream reach, in cubic feet per second;

Q_{DS} is discharge at the downstream site, in cubic feet per second;

Q_{US} is discharge at the upstream site, in cubic feet per second; and

Q_{t_i} is discharge of tributary i, between the upstream and downstream sites, in cubic feet per second.

A positive value of Q_{net} indicates a net increase in discharge along the stream reach not accounted for by the measured tributaries. This unaccounted for increase in discharge was assumed to be from diffuse ground-water inflow. A negative value of Q_{net} indicated the stream reach lost a component of discharge to the subsurface.

Six water-quality samples were collected along Dardenne Creek and five water-quality samples were collected from various tributaries from the south. Each water-quality sample was a composite of five to seven vertical subsamples collected at equal distances across the stream. A 500-mL polyethylene bottle was immersed beneath the surface at each vertical section and this was emptied into a standard U.S. Geological Survey churn splitter. Specific conductance, pH, and temperature were measured in the stream near the centroid of flow. Additional measurements were taken near opposite banks of the stream to ensure the stream was mixed. Alkalinity was measured on a non-filtered aliquot from the churn splitter shortly after sample collection. Samples for the determination of inorganic constituents and nutrients were processed and preserved as described previously. Samples for nitroaromatic compound determinations were collected by immersing a 1-L amber glass bottle (certified organic free from the laboratory) below the surface in three to five vertical sections across the stream. This ensured the entire cross section of the stream was sampled. Care was taken such that disturbed sediments from the stream bottom did not enter any of the sample bottles. Water-quality samples were collected from Burgermeister spring and tributaries with small widths by immersing the collection bottles below the surface near the centroid of flow.

Samples were submitted to the U.S. Geological Survey national water-quality laboratory for determinations of major and trace inorganic constituents and nitroaromatic compounds. Samples for inorganic constituents and TOC analysis were preserved as previously mentioned. The inorganic constituents were analyzed using methods described in Fishman and Friedman (1989). Nitroaromatic compounds were extracted and analyzed by HPLC using an Ultrasphere ODS 5 µm column. Temperature was held constant at 40 °C and the mobile phase consisted of a linear gradient mixture of water-acetonitrile (100:0) changing to a 25:75 mixture over 20 minutes. Ultraviolet (UV) absorbance detection at 205 and 220 nm, and UV spectral matching was used to confirm the analytes present. Analyses included TNT, NB, 2,4-DNT, and 2,6-DNT. Detection limits for the TNT and the DNT isomers were 0.05 µg/L and 0.5 µg/L for NB. Recoveries ranged from 65 percent for the DNT isomers to 83 percent for TNT.

Results of Dardenne Creek Seepage Studies

Sites where discharge, specific conductance, and temperature were measured are designated by a number, and sites where water-quality samples were collected are designated by a letter in figure 8. Water-quality samples were collected at the same location discharge measurements were made except at site D on Dardenne Creek. At this location the water-quality samples were collected immediately upstream from the junction with Burgermeister branch, and the discharge measurement was made immediately downstream from the junction with Burgermeister branch (site 48). The discharge of 7.01 ft^3/s (cubic feet per second) associated with this water-quality sample was calculated by subtracting the discharge from Burgermeister branch (2.11 ft^3/s, site I) from the discharge at site 48 (9.12 ft^3/s). Discharge, specific conductance, and temperature data for the June 25 and 26, 1990, seepage run are listed in table 16 (at the back of this report). Discharge data collected during the seepage run on June 25 and 26, 1990, indicated a net increase in discharge of 6.01 ft^3/s of Dardenne Creek from the upstream site at County Road DD (site A) to the downstream site (site F) upstream from County Road N (fig. 8). More than 80 percent of this net increase can be accounted for by inflow from measured tributaries; however, increases in discharge along specific reaches cannot be completely attributed to inflow from tributaries. For example on June 25 discharge along the first reach measured, site A to U.S. Highways 40 and 61 (fig. 8), increased 2.85 ft^3/s from 3.05 ft^3/s at the upstream site (site A, fig. 8) to 5.90 at the downstream site (site C). However, the measured inflow from tributaries along this reach was only about 2.14 ft^3/s, indicating about 0.71 ft^3/s (or about 25 percent) of the increase in discharge was not accounted for by measured tributary inflow. This unaccounted discharge was assumed to be from diffuse ground-water inflow.

The discharge at site C decreased from 5.90 ft^3/s on June 25, 1990, to 5.10 ft^3/s on June 26, 1990, (table 16). The second reach of Dardenne Creek measured was from U.S. Highways 40 and 61 (site C, fig. 8) to 0.3 mi downstream from Henning Road (site 33). Discharge along this reach on June 26, 1990, increased 1.51 ft^3/s from 5.10 ft^3/s at site C to 6.61 ft^3/s at site 33. Measured tributary inflow along this reach was only 0.14 ft^3/s indicating 1.37 ft^3/s (or about 90 percent) of the increase in discharge was not attributable to surface-water inflow. Discharge along the third reach of Dardenne Creek on June 26 increased 2.33 ft^3/s from 6.61 ft^3/s at site 33 to 8.94 ft^3/s at site E. The measured tributary inflow along this reach (2.59 ft^3/s) was 0.26 ft^3/s larger than the measured increase in discharge between sites 33 and E, indicating a small net loss of water from the stream along this reach. Overall, the 0.26 ft^3/s loss in flow represented only about a 3 percent loss of the total flow, which was less than the accepted error of 5 to 8 percent in the discharge measurements. However, much of the loss occurred near County Road K where the discharge of Dardenne Creek decreased 0.40 ft^3/s from 9.34 ft^3/s upstream from County Road K (site 49) to 8.94 ft^3/s 0.4 mi downstream from County Road K at site E. This decrease occurred despite inflow of 0.37 ft^3/s from Schote Creek (site J), indicating Dardenne Creek lost a total of 0.77 ft^3/s (about 8 percent) of its discharge along this short segment near County Road K.

Discharge along the fourth reach of Dardenne Creek on June 26, 1990, increased 0.12 ft^3/s from 8.94 ft^3/s at site E to 9.06 ft^3/s at site F. The measured tributary inflows along this reach totaled about 0.40 ft^3/s, indicating that Dardenne Creek may have lost about 0.28 ft^3/s (about 3 percent) of flow along this reach; however, this small loss is within the 5 to 8 percent error in the measured discharge values.

A second seepage run was made on July 16, 1990, along the third reach of Dardenne Creek (site 33 to site E). Data from this seepage run are shown in table 17 (at the back of this report). This seepage run was made at lower base flow conditions as the measured discharge at site 33 was only 2.26 ft^3/s (table 17) compared to 6.61 ft^3/s (table 16) measured during the first seepage run. Although this reach had a slight net loss of discharge in the first seepage run, a slight net increase (0.04 ft^3/s) in discharge was detected during the second seepage run (table 17). This slight increase (about 1 percent) was insignificant in that it was within the measurement error of 5 percent. The losing segment identified in the first seepage run near County Road K (between sites 49 and E) also had a net loss of water during this seepage run. The discharge decreased from 3.73 ft^3/s at site 49 to 3.66 ft^3/s at site E despite inflow of 0.14 ft^3/s from Schote Creek (table 17). The net loss in discharge (0.21 ft^3/s) represented only about

5 percent of the discharge from site 49 plus Schote Creek and may be within measurement error. Data from the two seepage runs indicate that Dardenne Creek is a gaining stream throughout the reach from County Road DD to just above County Road N except for a small reach in the vicinity of County Road K, which had a net loss of discharge.

Results of 11 water-quality samples collected during the June 25 and 26, 1990, seepage run are listed in table 18 (at the back of this report). Six samples were collected along Dardenne Creek (sites A, B, C, D, E, and F) and five additional samples were collected along various tributaries (sites G, H, I, J, and K). Specific conductance values ranged from 180 µS/cm near the mouth of tributary 6400 (site G) to 491 µS/cm at the downstream site on Schote Creek (site J). Several sites measured during the June 25 and 26 seepage run had larger values of specific conductance than the water-quality sites A to K (table 16); however, because no water-quality samples were collected at these sites, they are not discussed further in this report. Values of pH were slightly alkaline except for site G where the pH was 5.2. Besides having the smallest specific conductance and pH values, the sample from site G generally contained the smallest concentrations of most constituents except for concentrations of SiO_2 (21 mg/L), NO_2+NO_3 (5.3 mg/L), $[(NH_3+ON)_t]$ (0.50 mg/L), Ba (130 µg/L), and Zn (13 µg/L) where the concentrations were among the largest (all concentrations are dissolved unless specified otherwise). The largest concentrations of most constituents were detected in the sample from the downstream site on Schote Creek (site J, fig. 8). This sample contained the largest concentrations of Mg (14 mg/L), Na (22 mg/L), K (3.2 mg/L), HCO_3 (240 mg/L), SO_4 (33 mg/L), Cl (30 mg/L), bromide (Br, 0.06 mg/L), dissolved solids (297 mg/L), $[(NH_3+ON)_t]$ (0.80 mg/L as N), P and PO_4 (0.05 mg/L), P_t (0.10 mg/L), B (50 µg/L), and Sr (190 µg/L) and among the largest concentrations of uranium (U, 5.9 µg/L). Samples from Burgermeister branch (sites H and I) contained the largest concentrations of U (8.9 and 8.5 µg/L).

Specific conductance values generally decreased along Dardenne Creek from 401 µS/cm at the upstream site (site A) to 352 µS/cm at the downstream site (site F, fig. 8). Concentrations of most constituents in samples from Dardenne Creek remained nearly the same or decreased from site A to site F; however, concentrations of U nearly tripled from 1.1 µg/L at site A to 3.1 µg/L at site F (table 18). The increase in U concentrations occurred downstream from the mouth of Burgermeister branch and Schote Creek. The sample from Dardenne Creek immediately upstream from the mouth of Burgermeister branch (site D) had a U concentration of 1.0 µg/L and the Dardenne Creek sample downstream from the mouth of Schote Creek (site E) had a U concentration of 3.1 µg/L. No nitroaromatic compounds were detected in any of the samples, although HPLC analysis indicated the presence of atrazine in several of the samples from Dardenne Creek.

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(pg 33 follows)

Table 1.--*Physical description of lysimeter installations*

Lysimeter (fig. 4)	U.S. Army grid number	Date installed	Drill angle (degrees)	Borehole depth, vertical (feet)	Base of lysimeter (feet)	Top of silica flour (feet)
			Location 1			
LY02	4TB	08-28-91	12	14.7	14.2	12.5
LY04	4TB	09-11-91	10	6.3	6.0	4.5
LY05	4TB	09-11-91	18	2.2	1.9	1.0
LY08	4TB	12-05-91	20	3.3	2.4	2.1
			Location 2			
LY06	11TB	09-12-91	18	3.8	3.6	3.6
LY09	11TB	02-17-91	17	2.4	2.3	1.6
LY10	11TB	12-17-91	11	3.3	3.1	2.6
LY11	11TB	01-29-92	10	3.2	3.0	2.1
			Location 3			
LY03	9TA	08-29-91	12	12.4	12.7	10.0
LY07	9TA	12-04-91	15	2.5	2.1	1.9
			Location 4			
LY01	15TD	08-27-91	15	12.1	11.1	8.7

Table 2.--*Concentrations of nitroaromatic compounds in surficial soil and soil-core samples from lysimeter boreholes*

[TNT, 2,4,6-trinitrotoluene; 4-Am, 4-amino-2,6-dinitrotoluene; 2-Am, 2-amino-4,6-dinitrotoluene; TNB, trinitrobenzene; DNB, 1,3-dinitrobenzene; 2,4-DNT, 2,4-dinitrotoluene; 2,6-DNT, 2,6-dinitrotoluene; RDX, cyclo-1,3,5-trimethylene 2,4,6-trinitramine; HMX, cyclotetra-methylene tetranitramine; Tetryl, nitramine; all concentrations are in milligrams per kilograms; <, less than; --, no data]

Sample number (fig. 4)	Sample interval (feet)	TNT	4-Am	2-Am	TNB	DNB	2,4-DNT	2,6-DNT	RDX	HMX	Tetryl
						Location 1					
[a]S-1	Surface	16,500	<2.6	<2.6	<2.5	<2.5	<2.5	<2.6	<10.0	<22.0	<6.5
[a]S-2	Surface	24,900	<2.6	<2.6	<2.5	<2.5	<2.5	<2.6	<10.0	<22.0	<6.5
[a]S-3	Surface	31,000	<2.6	<2.6	<2.5	<2.5	<2.5	<2.6	<10.0	<22.0	<6.5
LY04	0.0-0.5	583	<.26	<.26	1.37	<.25	<.25	<.26	1.10	<2.20	<.65
	2.7-3.0	2.22	<.26	<.26	<.25	<.25	<.25	<.26	<1.00	<2.20	<.65
	4.4-4.9	1.73	<.26	<.26	<.25	<.25	<.25	<.26	<1.00	<2.20	<.65
	5.1-5.3	3.45	<.26	<.26	<.25	<.25	<.25	<.26	<1.00	<2.20	<.65
	6.3-6.5	4.95	<.26	<.26	<.25	<.25	<.25	<.26	<1.00	<2.20	<.65
LY05	0.0-0.4	922	<.26	<.26	2.24	<.25	<.25	<.26	1.46	<2.20	<.65
	1.2-1.5	2.49	<.26	<.26	<.25	<.25	<.25	<.26	<1.00	<2.20	<.65
	2.0-2.2	.70	<.26	<.26	<.25	<.25	<.25	<.26	<1.00	<2.20	<.65
LY08	0.0-0.2	3,070	<.26	<.26	46.2	<.25	2.15	<.26	[b]9.01	<2.20	[b]1.32
	2.9-3.1	56.8	<.26	<.26	<.25	<.25	<.25	<.26	<1.00	<2.20	<.65

Table 2.--*Concentrations of nitroaromatic compounds in surficial soil and soil-core samples from lysimeter boreholes*--Continued

Sample number (fig. 4)	Sample interval (feet)	TNT	4-Am	2-Am	TNB	DNB	2,4-DNT	2,6-DNT	RDX	HMX	Tetryl
					Location 2						
S-4	Surface	[c]120	--	--	--	--	--	--	--	--	--
S-5	Surface	[c]7,500	--	--	--	--	--	--	--	--	--
LY06	0.0-0.3	12.8	0.30	0.34	<0.25	<0.25	<0.25	<0.26	<1.00	<2.20	<0.65
	0.5-0.7	.77	<.26	<.26	<.25	<.25	<.25	<.26	<1.00	<2.20	<.65
	0.9-1.1	.55	<.26	.40	<.25	<.25	<.25	<.26	<1.00	<2.20	<.65
	1.9-2.1	<.25	<.26	<.26	<.25	<.25	<.25	<.26	<1.00	<2.20	<.65
	2.8-3.0	<.25	<.26	<.26	<.25	<.25	<.25	<.26	<1.00	<2.20	<.65
LY09	0.0-0.2	148	<.26	9.11	.61	<.25	<.25	<.26	<1.00	<2.20	<.65
	0.2-0.4	11.7	<.26	2.85	.67	<.25	<.25	<.26	<1.00	<2.20	<.65
	0.9-1.1	.46	<.26	<.26	8.03	<.25	<.25	<.26	<1.00	<2.20	<.65
	2.2-2.4	.76	<.26	<.26	[d].21	<.25	<.25	<.26	<1.00	<2.20	<.65
LY10	0.0-0.5	559	<.26	6.6	2.1	<.25	<.25	<.26	<1.00	<2.20	<.65
	0.8-1.0	<.25	<.26	<.26	<.25	<.25	<.25	<.26	<1.00	<2.20	<.65
	1.8-2.1	<.25	<.26	<.26	<.25	<.25	<.25	<.26	<1.00	<2.20	<.65
	3.0-3.3	<.25	<.26	<.26	<.25	<.25	<.25	<.26	<1.00	<2.20	<.65
					Location 3						
LY07	0.0-0.3	1,020	<0.26	60.2	1.91	<0.25	4.41	3.22	<1.00	<2.20	<0.65
	2.3-2.5	1.44	<.26	<.26	.91	<.25	<.25	<.26	<1.00	<2.20	<.65

[a] Detection limit raised due to interference from large TNT peak.

[b] Unconfirmed because of matrix interference.

[c] Concentration estimated using field screening method (Medary, 1992).

[d] Estimated concentration less than the detection limit.

Table 3.--*Concentrations of nitroaromatic compounds in water samples from lysimeters*

[TNT, 2,4,6-trinitrotoluene; 4-Am, 4-amino-2,6-dinitrotoluene; 2-Am, 2-amino-4,6-dinitrotoluene; TNB, trinitrobenzene; 2,4-DNT, 2,4-dinitrotoluene; 2,6-DNT, 2,6-dinitrotoluene; NB, nitrobenzene; NT, nitrotoluene; all concentrations are total and in micrograms per liter; <, less than]

Lysimeter number (fig. 4)	Date	Time	TNT	4-Am	2-Am	TNB	2,4-DNT	2,6-DNT	NB	NT
					Location 1					
LY05	10-04-91	1210	1,230	397	215	[a]106	<3.0	<3.0	<3.0	<3.0
	10-10-91	1140	813	422	246	61.9	<3.0	<3.0	<3.0	<3.0
	10-18-91	1110	1,010	660	242	17.3	<3.0	<3.0	<3.0	<3.0
	10-22-91	1200	816	566	240	12.9	<3.0	<3.0	<3.0	<3.0
	10-31-91	1145	923	603	212	3.2	<3.0	<3.0	<3.0	<3.0
	11-13-91	0940	1,040	574	142	2.7	<3.0	<3.0	<3.0	<3.0
	12-06-91	0910	1,340	826	134	<3.0	<3.0	<3.0	<3.0	<3.0
	12-16-91	1230	1,580	816	148	6.9	<3.0	<3.0	<3.0	<3.0
	01-08-92	1148	1,240	661	140	20.5	<3.0	<3.0	<3.0	<3.0
	01-15-92	1005	610	445	129	10.0	<3.0	<3.0	<3.0	<3.0
	[b]01-15-92	1010	598	474	138	[c]5.5	<3.0	<3.0	<3.0	<3.0
	02-06-92	1150	715	540	231	[c]9.9	<3.0	<3.0	<3.0	<3.0
	02-20-92	1240	697	487	197	[c]8.5	<3.0	<3.0	<3.0	<3.0
LY08	12-16-91	1235	[a]3,270	[a]1,740	[a]237	[a,c]<3.0	<3.0	<3.0	<3.0	<3.0
	12-26-91	1115	6,250	616	161	18.0	<3.0	<3.0	<3.0	<3.0
	01-08-92	1200	3,870	821	194	9.8	<3.0	<3.0	<3.0	<3.0
	01-15-92	1030	3,120	728	157	[c]<3.0	<3.0	<3.0	<3.0	<3.0
	02-06-92	1145	1,760	631	143	17.1	<3.0	<3.0	<3.0	<3.0
	02-20-92	1251	1,690	593	136	<3.0	<3.0	<3.0	<3.0	<3.0
					Location 2					
LY09	12-26-91	1100	96.3	23.7	[c]21.0	[a]85.9	<3.0	<3.0	<3.0	<3.0
	01-08-92	1125	50.1	36.1	[c]39.7	[a]150	<3.0	<3.0	<3.0	<3.0
	01-15-92	1100	25.9	36.3	32.2	[a]106	<3.0	<3.0	<3.0	<3.0
	02-20-92	1325	9.1	41.9	29.8	[a]1,130	<3.0	<3.0	<3.0	<3.0
LY10	02-20-92	1330	4.1	<3.0	5.9	<3.0	<3.0	<3.0	<3.0	<3.0
LY11	02-06-92	1115	462	165	40.7	13.5	<3.0	<3.0	<3.0	<3.0
	02-20-92	1320	364	165	35.5	<3.0	<3.0	<3.0	<3.0	<3.0

[a] Direct injection.

[b] Duplicate sample preserved with mercuric chloride.

[c] Not spectrally confirmed.

Table 4.--*Physical properties and dissolved inorganic chemical constituents in a water sample from lysimeter LY05 (January 29, 1992)*

[All concentrations are dissolved unless stated otherwise; >, greater than; <, less than]

Physical property or chemical constituent	Unit	Value or concentration
Specific conductance	Microsiemens per centimeter at 25 degrees Celsius	720
pH	Standard units	7.2
Temperature	Degrees Celsius	9.5
Dissolved oxygen	Milligrams per liter	>1.0
Calcium	Milligrams per liter	48
Magnesium	Milligrams per liter	18
Sodium	Milligrams per liter	120
Potassium	Milligrams per liter	.20
Sulfate	Milligrams per liter	96
Chloride	Milligrams per liter	13
Fluoride	Milligrams per liter	.70
Silica	Milligrams per liter	46
Nitrite plus nitrate	Milligrams per liter	<.05
Nitrite	Milligrams per liter	<.01
Ammonia	Milligrams per liter	.01
Phosphorus	Milligrams per liter	<.01
Orthophosphate	Milligrams per liter	<.01
Arsenic	Micrograms per liter	<1
Barium	Micrograms per liter	56
Beryllium	Micrograms per liter	<.5
Boron	Micrograms per liter	<10
Cadmium	Micrograms per liter	<1.0
Chromium	Micrograms per liter	<5
Cobalt	Micrograms per liter	<3
Copper	Micrograms per liter	80
Iron	Micrograms per liter	25
Lead	Micrograms per liter	<10
Lithium	Micrograms per liter	7
Manganese	Micrograms per liter	120
Molybdenum	Micrograms per liter	<10
Nickel	Micrograms per liter	10
Selenium	Micrograms per liter	<1
Silver	Micrograms per liter	<1.0
Strontium	Micrograms per liter	200
Vanadium	Micrograms per liter	<6
Zinc	Micrograms per liter	86

TABLES 5 AND 6

ABBREVIATIONS AND REPORTING UNITS FOR CHEMICAL CONSTITUENTS AND NOTATIONS USED IN TABLES

Coarse	Particles with a diameter greater than 0.062 millimeter, in percent by weight
Silt	Particles with a diameter less than 0.062 millimeter but greater than 0.002 millimeter, in percent by weight
Clay	Particles with a diameter less than 0.002 millimeter, in percent by weight
Qtz	Quartz, in percent by weight
Plag	Plagioclase, in percent by weight
Ortho	Orthoclase, in percent by weight
Smec	Smectite, in percent by weight
Kaol	Kaolinite, in percent by weight
Mica	Mica, in percent by weight
Amor	Amorphous minerals, in percent by weight
Calc	Calcite, in percent by weight
Anhy	Anhydrite, in percent by weight
Pyrox	Pyroxene, in percent by weight
Dolo	Dolomite, in percent by weight
Amph	Amphibole, in percent by weight
Mont	Montmorillinite, in percent by weight
Ill	Illite, in percent by weight

Table 5.--*Grain size and semiquantative bulk and clay mineralogy of overburden samples from trench excavations*

[Percentages may not sum to 100 percent due to rounding error; nd, not detected; t, trace; <, less than]

Trench number	Sample interval	Grain size (percent by weight)			Bulk mineralogy (approximate percent by weight of total sample)												Clay mineralogy (percentage of clay-size fraction)				
(fig. 4)	(feet)	Coarse	Silt	Clay	Qtz	Plag	Ortho	Smec	Kaol	Mica	Amor	Calc	Anhy	Pyrox	Dolo	Amph	Mont	Kaol	Ill	Qtz	Amor
											Peoria Loess										
2	0.0-0.8	8	78	14	50	13	6	4	2	2	20	nd	nd	3	nd	t	30	10	10	25	15
	0.8-1.8	3	65	32	35	9	5	15	3	2	30	nd	nd	2	nd	nd	55	10	5	10	20
	1.9-2.4	2	67	31	38	10	6	16	3	2	25	nd	nd	2	nd	nd	60	10	5	10	15
3	0.5-1.2	6	72	22	40	15	10	10	2	2	20	nd	nd	3	nd	t	50	10	10	15	15
5	0.0-4.7	2	76	22	45	12	6	10	2	3	20	nd	nd	3	nd	t	50	10	5	20	15
6	1.0	7	64	29	40	12	6	14	2	2	25	nd	nd	2	nd	t	50	5	10	10	25
	2.0	4	68	27	40	10	6	14	2	3	25	nd	nd	2	nd	t	50	5	10	10	25
7	0.0-1.6	7	81	12	50	14	8	3	1	3	20	nd	nd	2	nd	t	25	10	10	30	25
	2.0-2.9	3	68	29	40	11	5	14	3	2	25	nd	nd	2	nd	nd	50	10	10	10	20
8	0.0-0.3	17	68	15	45	14	6	4	1	2	25	nd	nd	2	nd	t	35	15	10	15	25
	0.3-1.6	5	65	30	42	8	4	13	3	3	25	nd	nd	t	nd	t	45	10	10	15	20
9	3.0	6	70	24	40	11	7	10	3	3	25	nd	nd	2	nd	t	45	10	15	10	20
											Roxanna Silt										
2	2.8-6.3	2	72	26	40	11	6	12	3	2	25	nd	nd	3	nd	t	50	10	10	10	20
3	2.1-3.8	10	72	18	47	12	9	10	2	t	20	nd	nd	2	nd	t	55	15	t	15	15
4	2.5-3.7	8	62	30	46	10	7	15	3	1	20	nd	nd	nd	t	nd	50	15	t	15	20
5	4.7-7.0	8	73	19	50	8	6	7	2	t	20	4	nd	nd	2	t	40	15	t	20	25
6	4.0	6	71	23	50	13	8	8	2	1	15	nd	nd	2	nd	1	40	10	<5	15	20
7	3.0-6.9	1	79	20	48	12	6	8	2	2	20	nd	nd	2	nd	t	45	10	10	15	20
8	2.0-3.0	3	73	24	40	11	6	15	2	1	25	nd	nd	2	nd	nd	65	10	5	5	15
	5.0-6.0	4	77	19	48	14	7	8	2	1	20	nd	nd	2	nd	t	45	10	<5	10	30
9	6.0	4	79	17	50	11	8	8	2	1	20	nd	nd	2	nd	t	50	10	5	15	20
											Ferrelview Formation										
2	7.3-8.3	6	60	34	44	10	5	17	3	2	20	nd	nd	nd	nd	nd	55	10	<5	10	20
	9.3-11.8	15	44	41	42	5	4	21	4	2	25	nd	nd	nd	nd	nd	60	10	<5	5	20
4	3.7-5.4	6	54	40	48	7	5	14	5	2	20	nd	nd	nd	nd	nd	50	15	<5	15	20
	5.4-9.5	6	55	39	40	7	4	20	6	1	20	nd	nd	nd	nd	nd	55	20	t	10	15
6	6.0	4	61	35	42	6	4	21	3	1	25	nd	nd	t	nd	t	65	10	<5	10	15
7	6.9-13.0	4	53	43	40	4	3	24	4	2	25	nd	nd	nd	nd	nd	60	10	<5	5	20
8	7.0-8.0	3	62	35	40	7	5	20	3	1	25	nd	nd	nd	nd	nd	60	10	5	10	15
	13.0-14.0	9	52	39	42	5	5	25	4	1	20	nd	nd	nd	nd	nd	65	10	<5	5	20
9	9.0	4	58	38	42	6	5	13	5	1	25	1	nd	nd	nd	nd	50	15	<5	10	25
	12.0	9	44	47	39	5	4	28	5	2	20	nd	nd	nd	nd	nd	65	15	<5	5	15
	13.0	12	48	40	42	4	3	22	5	2	20	1	nd	nd	nd	nd	60	15	<5	5	15

Table 5.--*Grain size and semiquantative bulk and clay mineralogy of overburden samples from trench excavations*--Continued

Trench number	Sample interval	Grain size (percent by weight)			Bulk mineralogy (approximate percent by weight of total sample)												Clay mineralogy (percentage of clay-size fraction)				
(fig. 4)	(feet)	Coarse	Silt	Clay	Qtz	Plag	Ortho	Smec	Kaol	Mica	Amor	Calc	Anhy	Pyrox	Dolo	Amph	Mont	Kaol	Ill	Qtz	Amor
Clay till																					
1	7.0-7.5	5	45	50	40	5	4	26	6	2	20	nd	nd	nd	nd	nd	60	15	<5	10	15
2	13.0-17.8	30	38	32	45	12	7	15	6	3	15	nd	nd	1	nd	nd	50	20	10	5	15
3	4.8-5.8	19	54	27	50	8	5	8	3	1	25	nd	nd	nd	t	nd	30	15	t	30	25
	6.5-9.9	17	39	44	40	8	5	23	6	2	20	nd	nd	nd	nd	nd	60	15	5	10	10
4	11.0	26	40	34	40	5	8	20	5	t	20	nd	nd	nd	nd	nd	60	20	t	5	15
	20.0	25	43	32	40	8	7	18	6	1	20	4	nd	nd	nd	nd	60	20	t	10	20
5	7.0-7.7	7	60	33	45	6	5	10	6	2	25	nd	nd	nd	nd	nd	35	20	5	20	20
	7.7-8.2	7	46	47	41	4	4	20	4	1	25	nd	nd	nd	nd	nd	45	25	t	15	15
6	12.0	27	37	36	40	14	6	23	3	1	15	nd	nd	nd	nd	nd	70	10	<5	5	15
7	14.0-17.0	22	35	43	40	8	5	24	4	1	20	nd	nd	nd	nd	nd	60	10	5	5	20
8	15.0-16.0	14	49	37	40	6	4	17	6	1	25	nd	nd	nd	nd	nd	50	20	<5	5	25
	21.0	31	45	24	45	8	9	13	4	2	20	nd	nd	t	nd	t	60	15	10	5	10
9	16.0	30	45	25	48	12	9	13	4	1	15	nd	nd	nd	nd	nd	55	20	5	5	15
Preglacial deposit																					
1	15.0-18.0	1	51	48	30	3	3	3	35	3	20	nd	nd	nd	nd	nd	5	80	<5	5	10
	18.0-19.0	2	58	40	30	2	4	2	28	6	25	nd	nd	nd	nd	nd	5	70	5	5	15
	19.5-20.5	60	22	18	52	2	4	2	11	2	25	nd	nd	nd	nd	nd	10	60	5	10	15
3	10.0-12.5	4	73	23	50	7	7	8	4	3	20	t	nd	nd	t	nd	40	20	5	25	10
	12.8-13.1	10	61	29	56	6	6	7	5	1	20	nd	nd	t	nd	nd	30	25	5	30	10
6	14.0	57	22	21	50	22	8	10	2	1	10	nd	nd	1	nd	t	50	15	5	15	15
	15.0	56	20	24	45	5	5	7	4	1	35	nd	nd	nd	nd	nd	35	20	5	10	30
Residuum																					
2	18.0-18.8	27	21	52	32	2	4	16	15	2	30	nd	nd	nd	nd	nd	35	35	<5	10	20
3	14.0-15.5	70	16	14	57	1	5	4	4	2	25	nd	nd	nd	nd	t	30	30	10	15	15
5	20.0	17	22	61	27	nd	nd	20	20	3	30	nd	nd	nd	nd	nd	35	35	5	10	15
	20.5	32	18	50	35	nd	nd	20	12	2	30	nd	nd	nd	nd	nd	40	25	<5	15	20
6	19.0-20.0	67	14	19	50	nd	nd	4	12	1	30	nd	nd	nd	nd	nd	20	60	<5	5	15
9	20.5	32	29	39	35	nd	3	22	10	2	25	17	nd	nd	nd	nd	60	20	<5	<5	15

Table 6.--*Grain size and mineralogic content of overburden core samples from lysimeter boreholes*

[Percentages may not sum to 100 percent due to rounding error; nd, not detected; t, trace; <, less than]

Lysimeter borehole (fig. 4)	Sample interval (feet)	Grain size (percent by weight)			Bulk mineralogy (approximate percent by weight of total sample)						
		Coarse	Silt	Clay	Qtz	Plag	Ortho	Smec	Kaol	Mica	Amor
					Peoria Loess						
LY03	1.2-1.7	4	67	29	42	6	4	14	4	5	25
	1.7-2.3	3	70	27	40	9	7	14	3	1	25
					Roxanna Silt						
LY01	2.3-2.8	12	70	18	45	10	5	8	3	1	25
LY03	2.9-3.7	3	76	21	47	12	7	11	3	1	20
	3.9-4.4	4	75	21	45	12	8	9	2	1	20
					Ferrelview Formation						
LY01	4.8-5.4	7	45	48	35	7	3	19	6	2	25
LY02	1.0-1.5	11	60	29	43	8	5	11	4	1	20
	1.8-2.2	6	55	39	40	8	4	20	5	2	20
LY03	5.2-6.1	6	62	32	48	8	6	15	3	1	20
	8.7-9.1	9	45	46	35	7	4	20	8	2	25
LY04	1.0-1.5	8	62	30	45	10	5	14	4	1	20
LY06	0.9-1.1	14	49	37	45	5	3	16	4	1	25
LY09	0.4-0.7	13	61	26	52	6	5	13	2	1	20
	2.7-3.0	10	62	28	45	6	5	15	3	nd	25
					Clay till						
LY01	8.5-9.0	29	34	37	45	7	4	13	6	1	25
	10.3-10.6	34	37	29	55	7	4	14	5	1	15
	11.8-12.1	55	23	22	44	8	5	11	6	1	25
LY02	3.4-3.7	25	44	31	45	8	6	14	4	1	20
	4.6-4.9	27	41	32	45	10	5	17	5	1	15
	5.4-5.7	13	44	43	35	10	5	20	7	2	20
	7.8-8.4	3	63	34	45	8	4	18	5	2	20
	8.4-8.8	1	61	38	45	7	5	17	6	2	20
LY03	10.5-11.0	15	50	35	42	5	3	18	5	1	25
	11.3-12.0	16	37	47	40	4	6	22	7	2	20
	13.0-13.6	28	38	34	45	8	6	16	8	2	15
	14.7-15.0	5	72	23	40	9	6	12	4	1	20
	15.0-15.3	27	44	29	40	10	6	14	5	1	25
LY04	4.4-4.9	27	38	35	40	8	7	14	8	1	20
	5.9-6.3	25	42	33	40	8	8	14	7	4	20
LY06	2.8-3.0	27	39	34	48	4	5	15	6	1	20
	3.1-3.4	45	25	30	50	2	2	14	5	1	25
					Preglacial deposit						
LY02	10.0-10.3	3	70	27	52	6	4	15	3	1	20
	11.6-12.1	2	70	28	50	6	4	13	5	1	20
	13.6-13.8	6	57	37	45	5	3	14	6	1	25
					Residuum						
LY02	13.8-14.1	5	56	39	45	7	4	16	7	2	20

Table 6.--*Grain size and mineralogic content of overburden core samples from lysimeter boreholes*--Continued

Lysimeter borehole (fig. 4)	Sample interval (feet)	Bulk mineralogy--Continued (approximate percent by weight of total sample)					Clay mineralogy (percentage of clay-size fraction)				
		Calc	Anhy	Pyrox	Dolo	Amph	Smec	Kaol	Ill	Qtz	Amor
Peoria Loess											
LY03	1.2-1.7	nd	nd	3	nd	nd	55	5	5	10	25
	1.7-2.3	nd	nd	2	1	nd	60	10	5	15	10
Roxanna Silt											
LY01	2.3-2.8	nd	nd	nd	nd	nd	45	15	5	10	25
LY03	2.9-3.7	nd	nd	nd	nd	nd	55	10	<5	10	20
	3.9-4.4	nd	nd	2	1	t	45	15	t	20	20
Ferrelview Formation											
LY01	4.8-5.4	nd	nd	nd	nd	nd	55	15	5	10	20
LY02	1.0-1.5	8	nd	nd	nd	nd	40	15	<5	10	30
	1.8-2.2	nd	nd	nd	nd	nd	60	15	t	10	15
LY03	5.2-6.1	nd	nd	nd	nd	nd	50	10	<5	10	25
	8.7-9.1	nd	nd	nd	nd	nd	50	20	t	15	15
LY04	1.0-1.5	nd	nd	nd	nd	nd	50	15	5	10	20
LY06	0.9-1.1	nd	nd	nd	nd	nd	50	10	<5	10	25
LY09	0.4-0.7	nd	nd	nd	nd	nd	55	10	5	10	20
	2.7-3.0	nd	nd	nd	nd	t	55	10	nd	10	25
Clay till											
LY01	8.5-9.0	nd	nd	t	nd	nd	45	25	5	15	10
	10.3-10.6	nd	nd	nd	nd	nd	50	20	5	10	15
	11.8-12.1	t	nd	nd	nd	nd	45	20	5	10	20
LY02	3.4-3.7	nd	3	nd	nd	nd	50	15	5	10	20
	4.6-4.9	t	nd	t	nd	nd	60	15	t	10	15
	5.4-5.7	nd	nd	nd	nd	nd	45	20	5	15	15
	7.8-8.4	2	nd	nd	nd	nd	55	15	<5	10	20
	8.4-8.8	nd	nd	nd	nd	nd	50	20	t	10	20
LY03	10.5-11.0	nd	nd	nd	nd	nd	55	15	5	10	15
	11.3-12.0	nd	nd	nd	nd	nd	55	15	t	10	20
	13.0-13.6	nd	nd	nd	nd	nd	50	25	<5	5	15
	14.7-15.0	nd	nd	3	3	nd	55	15	5	10	15
	15.0-15.3	nd	nd	nd	nd	nd	55	20	5	5	15
LY04	4.4-4.9	nd	nd	nd	nd	nd	45	25	5	10	15
	5.9-6.3	3	nd	nd	nd	nd	45	25	5	10	15
LY06	2.8-3.0	nd	nd	nd	nd	nd	45	20	<5	10	20
	3.1-3.4	nd	nd	nd	nd	nd	50	15	<5	5	25
Preglacial deposit											
LY02	10.0-10.3	t	nd	nd	nd	nd	60	15	5	5	15
	11.6-12.1	nd	nd	nd	nd	nd	50	20	<5	10	20
	13.6-13.8	nd	nd	nd	nd	nd	40	20	5	15	20
Residuum											
LY02	13.8-14.1	3	nd	nd	nd	nd	45	20	5	15	15

TABLES 7 AND 8

ABBREVIATIONS AND REPORTING UNITS FOR CHEMICAL CONSTITUENTS AND NOTATIONS USED IN TABLES

TC	Total carbon
TOC	Total organic carbon
Crbnt C	Carbonate carbon
CO_2	Carbon dioxide
SiO_2	Silicon content expressed as silicon dioxide
Al_2O_3	Aluminum content expressed as aluminum oxide
FeO	Iron content expressed as iron oxide
CaO	Calcium content expressed as calcium oxide
MgO	Magnesium content expressed as magnesium oxide
Na_2O	Sodium content expressed as sodium oxide
K_2O	Potassium content expressed as potassium oxide
TiO_2	Titanium content expressed as titanium oxide
P_2O_5	Phosphorus content expressed as phosphorus oxide
MnO	Manganese content expressed as manganese oxide
S	Sulfur
Cl	Chloride
F	Fluoride
<	less than
--	No data

Table 7.--*Moisture, carbon, and major element contents of overburden samples from trench excavations*

[All constituents contents are in percent by weight]

Trench number (fig. 4)	Sample interval (feet)	Moisture	Water content			Carbon content			Major element content												
			Total water	Essential water	Nonessential water	TC	TOC	Crnbt C	SiO_2	Al_2O_3	FeO	CaO	MgO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	S	Cl	F
									Peoria Loess												
2	0.0-0.8	24.2	4.62	3.12	1.50	1.32	1.31	0.01	75.5	9.14	4.00	0.47	0.63	1.05	1.58	0.77	0.11	0.24	<0.05	<0.01	0.04
	0.8-1.8	27.0	8.45	4.95	3.50	.80	.80	<.01	64.1	15.0	6.18	.59	1.33	.84	1.67	.72	.10	.06	<.05	<.01	.03
	1.9-2.4	--	6.46	3.76	2.70	.56	.56	<.01	68.7	13.0	5.10	.74	1.21	1.10	2.03	.75	.11	.07	<.05	<.01	.03
3	0.5-1.2	--	5.89	3.64	2.25	<.05	<.05	<.01	71.1	12.4	4.84	.44	.93	.93	1.62	.77	.07	.03	<.05	<.01	.02
5	0.0-4.7	18.0	4.01	2.40	1.61	.05	.05	<.01	74.6	10.8	3.88	.56	.87	1.15	2.04	.80	.09	.04	<.05	<.01	.01
6	1.0	--	7.20	4.56	2.64	1.17	1.17	<.01	67.3	13.2	5.45	.66	1.10	.96	1.79	.75	.10	.10	<.05	<.01	.05
	2.0	--	5.96	3.52	2.44	.53	.53	<.01	68.9	12.9	4.94	.79	1.19	1.16	2.06	.75	.12	.10	<.05	<.01	.05
7	0.0-1.6	--	4.22	3.16	1.06	1.11	1.11	<.01	77.1	8.65	3.49	.41	.54	1.05	1.52	.77	.10	.25	<.05	<.01	.03
	2.0-2.9	--	6.00	3.55	2.45	.34	.34	<.01	69.2	12.9	5.04	.69	1.20	1.13	2.07	.74	.11	.05	<.05	<.01	.04
8	0.0-0.3	20.0	5.17	3.75	1.42	1.52	1.52	<.01	74.0	9.44	4.06	.48	.65	1.01	1.58	.76	.12	.22	<.05	<.01	.01
	0.3-1.6	20.0	7.15	4.61	2.54	1.01	1.01	<.01	67.6	13.3	5.49	.51	1.11	.88	1.65	.74	.10	.07	<.05	<.01	.03
9	3.0	--	6.84	4.23	2.61	.47	.47	<.01	67.2	13.8	5.33	.68	1.28	.93	2.06	.73	.09	.05	<.05	<.01	.03
									Roxanna Silt												
2	2.5-3.0	12.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2.8-6.3	--	4.16	2.42	1.74	0.33	0.33	<0.01	74.2	11.0	3.99	0.88	0.93	1.28	2.03	0.79	0.13	0.07	<0.05	<0.01	0.03
	5.0-5.5	14.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3	2.1-3.8	11.0	3.40	2.14	1.26	<.05	<.05	<.01	78.7	8.80	3.06	.43	.56	.98	1.44	.79	<.05	.09	<.05	<.01	.03
4	2.5-3.7	16.0	4.68	3.09	1.59	.16	.16	<.01	76.3	10.1	4.00	.50	.60	.78	1.18	.80	<.05	.10	<.05	<.01	.04
5	4.7-7.0	15.0	3.43	2.19	1.24	.06	.06	<.01	80.1	8.54	2.94	.38	.54	.70	1.34	.82	<.05	.13	<.05	<.01	.02
6	4.0	--	3.63	2.31	1.32	.12	.12	<.01	78.5	9.26	3.13	.60	.61	1.08	1.45	.76	.06	.06	<.05	<.01	.01
7	3.0-6.9	--	3.69	2.12	1.57	.10	.10	<.01	76.6	10.0	3.37	.80	.82	1.26	1.84	.81	.11	.06	<.05	<.01	.02
8	2.0-3.0	14.0	4.96	2.90	2.06	.18	.18	<.01	71.7	11.9	4.56	.78	1.11	1.25	2.21	.78	.12	.08	<.05	<.01	.03
	4.0	10.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5.0-6.0	15.5	3.64	2.24	1.40	<.05	<.05	<.01	78.5	9.23	3.19	.59	.62	1.08	1.41	.83	.05	.10	<.05	<.01	.03
9	6.0	--	3.40	2.16	1.24	.08	.08	<.01	78.3	9.27	3.10	.72	.69	1.27	1.63	.80	.08	.07	<.05	<.01	.03
									Ferrelview Formation												
2	7.3-8.3	--	5.43	3.09	2.34	0.23	0.23	<0.01	73.9	11.4	4.49	0.56	0.73	0.82	1.16	0.74	<0.05	0.02	<0.05	<0.01	0.03
	9.3-11.8	18.0	6.99	3.90	3.09	<.05	<.05	<.01	71.4	12.6	5.34	.58	.84	.58	.95	.66	<.05	.04	<.05	<.01	.03
4	3.7-5.4	16.0	6.04	3.82	2.22	<.05	<.05	<.01	73.0	11.9	4.76	.53	.70	.64	.95	.75	<.05	<.02	<.05	<.01	.01
	5.4-9.5	18.0	7.10	4.44	2.66	<.05	<.05	<.01	70.3	13.5	4.82	.55	.80	.56	.90	.72	<.05	<.02	<.05	<.01	.04
6	6.0	--	5.19	2.98	2.21	.10	.10	<.01	75.1	11.3	3.78	.57	.70	.88	1.16	.75	<.05	<.02	<.05	<.01	.02
7	6.9-13.0	--	7.15	3.94	3.21	<.05	<.05	<.01	71.3	12.9	4.46	.58	.81	.57	.90	.72	<.05	<.02	<.05	<.01	.04
8	7.0-8.0	18.0	7.06	4.27	2.79	<.05	<.05	<.01	70.1	13.6	4.75	.62	.89	.77	1.06	.75	<.05	<.02	<.05	<.01	.02
	10.0	17.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	13.0-14.0	--	7.08	3.98	3.10	<.05	<.05	<.01	72.2	12.6	4.53	.57	.75	.46	.72	.71	<.05	<.02	<.05	<.01	.02
9	9.0	--	7.31	4.39	2.92	.16	.14	.02	70.3	13.4	4.77	.71	.88	.68	.94	.73	<.05	<.02	<.05	<.01	.05
	12.0	--	7.54	4.29	3.25	.09	.09	<.01	70.6	13.3	4.89	.66	.84	.49	.75	.68	<.05	<.02	<.05	<.01	.04
	13.0	--	7.13	4.22	2.91	.07	.05	.02	72.1	12.5	4.72	.68	.78	.46	.69	.68	<.05	<.02	<.05	<.01	.08

Table 7.--*Moisture, carbon, and major element contents of overburden samples from trench excavations*--Continued

Trench number (fig. 4)	Sample interval (feet)	Moisture	Water content			Carbon content			Major element content												
			Total water	Essential water	Nonessential water	TC	TOC	Crnbt C	SiO_2	Al_2O_3	FeO	CaO	MgO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	S	Cl	F
Clay till																					
1	7.0-7.5	--	7.58	4.55	3.03	0.05	0.05	<0.01	69.0	14.0	5.01	0.65	0.91	0.55	0.79	0.72	<0.05	<0.02	<0.05	<0.01	0.03
2	13.0-17.8	--	5.17	2.95	2.22	<.05	<.05	<.01	74.4	11.3	4.31	.67	.78	.98	1.44	.66	.11	.08	<.05	<.01	.05
	13.5-14.0	14.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3	4.8-5.8	14.0	4.60	2.71	1.89	<.05	<.05	<.01	77.3	9.79	3.94	.43	.60	.67	1.01	.76	<.05	.20	<.05	<.01	.03
	6.5-9.0	20.0	6.85	4.04	2.81	<.05	<.05	<.01	69.8	13.3	5.29	.61	.88	.59	1.09	.69	<.05	<.02	<.05	<.01	.02
4	11.0	--	5.71	3.62	2.09	<.05	<.05	<.01	72.9	11.8	4.75	.63	.76	.64	1.20	.67	.06	.22	<.05	<.01	.04
	20.0	15.0	5.71	3.56	2.15	.13	.01	.12	72.7	11.7	4.37	1.09	.81	.56	1.16	.65	.05	<.02	<.05	<.01	.04
5	7.0-7.7	15.0	4.98	3.09	1.89	<.05	<.05	<.01	76.5	10.6	3.52	.37	.67	.45	1.10	.80	<.05	.02	<.05	<.01	.02
	7.7-8.2	19.0	7.20	4.49	2.71	.06	.06	<.01	69.5	13.7	5.11	.45	.85	.30	1.00	.75	<.05	<.02	<.05	<.01	.04
6	12.0	--	5.83	3.43	2.40	<.05	<.05	<.01	73.7	11.7	4.57	.61	.81	.67	1.17	.65	.06	.05	<.05	<.01	.04
7	14.0-17.0	--	6.55	3.72	2.83	<.05	<.05	<.01	71.6	12.9	4.49	.69	.78	.72	1.16	.60	<.05	.18	<.05	<.01	.03
8	14.0-15.0	18.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	15.0-16.0	--	7.70	4.36	3.34	<.05	<.05	<.01	70.5	13.5	4.83	.61	.82	.34	.72	.68	<.05	<.02	<.05	<.01	.02
	21.0	--	5.09	3.12	1.97	<.05	<.05	<.01	74.5	10.9	5.03	.68	.78	.65	1.49	.65	.12	.09	<.05	<.01	.02
9	16.0	--	5.36	3.25	2.11	<.05	<.05	<.01	74.0	11.3	4.18	.68	.76	.65	1.36	.65	.08	.16	<.05	<.01	.04
Preglacial deposit																					
1	15.0-18.0	--	10.9	9.53	1.37	<0.05	<0.05	<0.01	52.9	30.1	1.46	0.34	0.64	0.16	1.35	1.89	0.09	0.02	<0.05	<0.01	0.02
	18.0-19.0	--	11.0	9.82	1.18	<.05	<.05	<.01	52.1	30.1	1.73	.32	.57	<.15	1.25	1.84	.10	<.02	<.05	<.01	.02
	19.5-20.5	--	4.14	3.55	.59	<.05	<.05	<.01	79.6	11.1	2.11	.20	.42	<.15	.91	.68	.06	<.02	<.05	<.01	.02
3	10.0-12.5	8.0	3.27	2.12	1.15	<.05	<.05	<.01	81.9	8.12	2.29	.33	.46	.61	1.23	.92	<.05	.05	<.05	<.01	.01
	12.8-13.1	--	4.14	2.71	1.43	<.05	<.05	<.01	79.7	9.19	2.78	.30	.49	.40	1.08	.91	<.05	<.02	<.05	<.01	.02
6	14.0	--	3.23	2.01	1.22	<.05	<.05	<.01	80.9	8.64	2.92	.62	.53	.92	1.27	.41	.06	.06	<.05	<.01	.04
	15.0	--	5.51	3.83	1.68	<.05	<.05	<.01	76.0	9.15	6.89	.30	.55	.16	.39	.37	<.05	.09	<.05	<.01	.03
Residuum																					
2	18.0-18.8	--	9.96	6.28	3.68	<0.05	<0.05	<0.01	63.4	18.6	4.66	0.63	1.10	0.15	0.53	0.74	0.07	0.05	<0.05	<0.01	0.05
3	14.0-15.5	--	2.95	2.20	.75	<.05	<.05	<.01	84.8	4.96	4.70	.14	.24	<.15	.34	.29	.06	<.02	<.05	<.01	.01
5	20.0	--	11.6	7.35	4.25	<.05	<.05	<.01	55.2	21.9	6.28	.96	1.15	<.15	.75	.62	.13	.22	<.05	<.01	.07
	20.5	--	9.41	5.89	3.52	<.05	<.05	.02	64.7	17.3	4.76	.89	.95	<.15	.53	.45	.09	.22	<.05	<.01	.06
6	19.0-20.0	--	5.20	3.54	1.66	<.05	<.05	<.01	80.5	10.1	1.69	.33	.59	<.15	.35	.51	<.05	.03	<.05	<.01	.06
9	20.5	--	8.42	5.20	3.22	1.18	.09	1.09	58.7	16.1	3.21	6.16	1.17	.18	1.03	.64	.09	.12	<.05	<.01	.04

Table 8.--*Moisture, carbon, and major element contents of overburden core samples from lysimeter boreholes*

[All constituents contents are in percent by weight]

			Water content			Carbon content			Major element content												
Lysimeter borehole (fig. 4)	Sample interval (feet)	Mois-ture	Total water	Essen-tial water	Non-essential water	TC	TOC	Crbnt C	SiO_2	Al_2O_3	FeO	CaO	MgO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	S	Cl	F
									Peoria Loess												
LY03	1.2-1.7	--	7.96	4.71	3.25	0.73	0.73	<0.01	66.5	14.1	5.48	0.63	1.22	0.96	1.82	0.74	0.08	0.03	<0.05	<0.01	0.02
	1.7-2.3	--	5.50	3.23	2.27	.32	.32	<.01	70.2	12.4	4.75	.75	1.10	1.14	2.07	.77	.10	.05	<.05	<.01	.04
									Roxanna Silt												
LY01	2.3-2.8	--	5.04	3.25	1.79	0.32	0.32	<0.01	75.4	10.1	4.09	0.44	0.66	0.84	1.29	0.78	<0.05	0.11	<0.05	<0.01	0.02
LY03	2.9-3.7	--	4.07	2.53	1.54	.14	.14	<.01	75.4	10.4	3.62	.81	.85	1.28	1.97	.81	.10	.07	<.05	<.01	.03
	3.8-4.5	--	3.27	1.94	1.33	.16	.16	<.01	78.5	9.10	3.16	.66	.63	1.11	1.53	.80	.06	.13	<.05	<.01	.01
									Ferrelview Formation												
LY01	4.8-5.4	--	7.28	4.15	3.13	0.06	0.06	<0.01	70.7	13.5	4.70	0.49	0.84	0.65	1.02	0.74	<0.05	<0.02	<0.05	<0.01	0.04
LY02	1.0-1.5	--	5.30	3.22	2.08	.64	.20	.44	72.5	10.4	3.73	2.70	.61	.72	1.19	.73	<.05	.12	<.05	<.01	.02
	1.8-2.2	--	6.19	3.98	2.21	<.05	<.05	<.01	73.0	12.3	4.20	.56	.73	.61	1.09	.73	<.05	.05	<.05	<.01	.04
LY03	5.2-6.1	--	6.71	3.73	2.98	.06	.06	<.01	72.4	12.2	4.79	.61	.76	.68	.88	.76	<.05	.06	<.05	<.01	.03
	8.7-9.1	--	7.03	3.97	3.06	<.05	<.05	<.01	72.0	12.6	4.66	.58	.74	.42	.66	.72	<.05	<.02	<.05	<.01	.01
LY04	1.0-1.5	--	4.86	2.70	2.16	<.05	<.05	<.01	77.4	10.3	3.10	.52	.61	.81	1.23	.75	<.05	.02	<.05	<.01	.04
LY06	0.9-1.1	--	7.88	4.71	3.17	.39	.39	<.01	70.4	12.8	5.24	.54	.75	.41	.81	.65	<.05	.03	<.05	<.01	.05
LY09	0.4-0.7	--	4.52	2.35	2.17	.08	.08	<.01	78.5	9.54	3.16	.51	.52	.59	1.00	.72	<.05	<.02	<.05	<.01	.05
	1.1-1.3	32.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2.7-3.0	--	4.98	2.70	2.28	<.05	<.05	<.01	76.9	10.4	3.61	.47	.59	.62	1.03	.76	<.05	.02	<.05	<.01	.04
LY10	1.2-1.4	19.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2.4-2.7	20.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 8.--*Moisture, carbon, and major element contents of overburden core samples from lysimeter boreholes*--Continued

Lysimeter borehole (fig. 4)	Sample interval (feet)	Moisture	Water content			Carbon content			Major element content												
			Total water	Essential water	Nonessential water	TC	TOC	Crbnt C	SiO_2	Al_2O_3	FeO	CaO	MgO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	S	Cl	F
Clay till																					
LY01	8.5-9.0	--	6.14	3.26	2.88	<0.05	<0.05	<0.01	74.1	11.3	4.61	0.46	0.71	0.49	1.00	0.64	<0.05	0.07	<0.05	<0.01	0.02
	10.3-10.6	--	4.53	2.58	1.95	<.05	<.05	<.01	79.4	9.47	2.99	.38	.55	.50	.99	.63	<.05	.08	<.05	<.01	.03
	11.8-12.1	--	4.71	2.92	1.79	.05	.03	.02	76.2	8.02	8.03	.41	.44	.41	.74	.47	.09	.16	<.05	<.01	.03
LY02	3.4-3.7	--	5.48	3.13	2.35	<.05	<.05	<.01	74.7	10.9	4.68	.46	.64	.61	1.08	.66	<.05	.07	<.05	.01	.02
	4.6-4.9	--	5.30	3.12	2.18	<.05	<.05	<.01	73.5	11.3	5.08	.55	.70	.64	1.31	.66	.08	.08	<.05	<.01	.04
	5.4-5.7	--	7.24	4.06	3.18	.05	.04	.01	68.3	12.6	7.86	.62	.81	.53	1.04	.70	.12	.07	<.05	<.01	.02
	7.8-8.4	--	5.54	2.67	2.87	<.05	<.05	<.01	76.5	11.0	2.56	.52	.64	.64	1.08	.90	<.05	<.02	<.05	<.01	.04
	8.4-8.8	--	5.39	3.09	2.30	<.05	<.05	<.01	76.3	11.2	2.63	.51	.65	.61	1.06	.89	<.05	.04	<.05	<.01	.04
LY03	10.5-11.0	--	6.95	3.65	3.30	<.05	<.05	<.01	75.5	10.5	4.87	.41	.66	.23	.49	.45	<.05	<.02	<.05	.09	.02
	11.3-12.0	--	7.24	4.10	3.14	<.05	<.05	<.01	70.8	13.4	4.74	.63	.77	.41	.74	.67	<.05	<.02	<.05	<.01	.02
	13.0-13.6	--	5.73	2.69	3.04	<.05	<.05	<.01	73.0	12.0	3.95	.69	.79	.69	1.35	.64	.09	.08	<.05	<.01	.04
	14.7-15.0	--	6.32	3.81	2.51	.49	.49	<.01	68.3	12.8	5.00	.66	1.05	.96	1.80	.72	.09	.05	<.05	<.01	.02
	15.0-15.3	--	5.56	3.40	2.16	.20	.20	<.01	73.8	11.3	4.23	.71	.77	.77	1.50	.68	.09	.12	<.05	<.01	.02
LY04	4.4-4.9	--	6.17	3.32	2.85	<.05	<.05	<.01	71.3	11.7	6.50	.59	.74	.63	1.33	.64	.10	.26	<.05	<.01	.05
	5.9-6.3	--	5.40	2.88	2.52	<.05	<.05	.04	73.1	11.0	5.52	.76	.70	.63	1.36	.67	.13	.14	<.05	.08	.04
LY06	2.8-3.0	--	6.26	3.58	2.68	<.05	<.05	<.01	74.9	11.0	4.79	.44	.69	.34	.65	.60	<.05	.03	<.05	<.01	.03
	3.1-3.4	--	6.37	3.67	2.70	<.05	<.05	<.01	72.8	12.1	4.72	.56	.66	.45	.74	.70	<.05	<.02	<.05	.01	.02
Preglacial deposit																					
LY02	10.0-10.3	--	4.15	2.49	1.66	<0.05	<0.05	<0.01	81.7	8.58	1.88	0.44	0.48	0.62	1.00	0.84	<0.05	<0.02	<0.05	<0.01	0.02
	11.6-12.1	--	4.36	2.73	1.63	<.05	<.05	<.01	80.0	8.91	1.98	.42	.48	.63	1.01	.88	<.05	<.02	<.05	<.01	.02
	13.6-13.8	--	5.83	3.36	2.47	<.05	<.05	<.01	75.3	10.5	4.87	.45	.60	.38	.84	.88	.08	.05	<.05	<.01	.02
Residuum																					
LY02	13.8-14.1	--	5.69	3.44	2.25	0.40	0.16	0.24	73.3	11.0	3.97	1.55	0.71	0.38	0.87	0.89	0.06	0.05	<0.05	<0.01	0.04

TABLES 9, 10, 11, and 12

ABBREVIATIONS AND REPORTING UNITS FOR CHEMICAL CONSTITUENTS AND NOTATIONS USED IN TABLES

Al	Aluminum, percent by weight
Ca	Calcium, percent by weight
Fe	Iron, percent by weight
K	Potassium, percent by weight
Mg	Magnesium, percent by weight
Na	Sodium, percent by weight
P	Phosphorus, percent by weight
Ti	Titanium, percent by weight
As	Arsenic, in milligrams per kilogram
Ba	Barium, in milligrams per kilogram
Be	Beryllium, in milligrams per kilogram
Bi	Bismuth, in milligrams per kilogram
Cd	Cadmium, in milligrams per kilogram
Ce	Cesium, in milligrams per kilogram
Cr	Chromium, in milligrams per kilogram
Co	Cobalt, in milligrams per kilogram
Cu	Copper, in milligrams per kilogram
Eu	Europium, in milligrams per kilogram
Ga	Gallium, in milligrams per kilogram
Au	Gold, in milligrams per kilogram
Ho	Holmium, in milligrams per kilogram
La	Lanthanum, in milligrams per kilogram
Pb	Lead, in milligrams per kilogram
Li	Lithium, in milligrams per kilogram
Mn	Manganese, in milligrams per kilogram
Mo	Molybdenum, in milligrams per kilogram
Nd	Neodymium, in milligrams per kilogram
Ni	Nickel, in milligrams per kilogram
Nb	Niobium, in milligrams per kilogram
Sc	Scandium, in milligrams per kilogram
Ag	Silver, in milligrams per kilogram
Sr	Strontium, in milligrams per kilogram
Ta	Tantalum, in milligrams per kilogram
Th	Thorium, in milligrams per kilogram
Sn	Tin, in milligrams per kilogram
U	Uranium, in milligrams per kilogram
V	Vanadium, in milligrams per kilogram
Yb	Ytterbium, in milligrams per kilogram
Y	Yttrium, in milligrams per kilogram
Zn	Zinc, in milligrams per kilogram
<	Less than

Table 9.--*Chemical analysis of the fine (less than 0.062 millimeter) fraction of overburden samples from trench excavations*

Trench number (fig. 4)	Sample interval (feet)	Al	Ca	Fe	K	Mg	Na	P	Ti	As	Ba	Be	Bi	Cd	Ce	Cr	Co	Cu	Eu	Ga	Au
Peoria Loess																					
2	0.0-0.8	4.7	0.36	1.9	1.3	0.35	0.82	0.03	0.32	<10	520	1	<10	<2	61	52	6	13	<2	9	<8
	0.8-1.8	7.3	.42	3.8	1.4	.72	.67	.03	.34	20	540	2	<10	<2	60	79	14	29	<2	16	<8
	1.9-2.4	6.7	.53	3.3	1.8	.70	.87	.04	.35	10	690	2	<10	<2	88	76	17	25	<2	14	<8
3	0.5-1.2	6.2	.33	3.0	1.4	.52	.78	.02	.33	10	500	1	<10	<2	63	64	7	20	<2	14	<8
5	0.0-4.7	5.8	.43	2.7	1.7	.53	.96	.03	.35	<10	620	1	<10	<2	78	60	9	20	<2	13	<8
6	1.0	6.6	.46	3.1	1.5	.62	.72	.03	.36	10	520	1	<10	<2	62	73	9	27	<2	15	<8
	2.0	6.4	.57	3.0	1.7	.65	.89	.05	.35	10	700	1	<10	<2	77	60	9	22	<2	15	<8
7	0.0-1.6	4.4	.30	1.6	1.3	.29	.80	.03	.32	<10	520	1	<10	<2	62	48	8	12	<2	10	<8
	2.0-2.9	6.5	.50	3.2	1.7	.68	.86	.03	.36	10	640	1	<10	<2	75	73	8	23	<2	15	<8
8	0.0-0.3	5.1	.37	2.2	1.3	.40	.80	.04	.34	10	530	1	<10	<2	63	58	7	15	<2	11	<8
	0.3-1.6	6.6	.37	3.4	1.3	.62	.68	.03	.35	10	500	1	<10	<2	60	76	8	24	<2	14	<8
9	3.0	6.8	.49	3.3	1.7	.71	.79	.03	.36	10	600	1	<10	<2	74	77	13	24	<2	16	<8
Roxanna Silt																					
2	2.8-6.3	5.8	0.63	2.6	1.8	0.55	1.0	0.05	0.37	<10	650	1	<10	<2	67	62	10	16	<2	13	<8
3	2.1-3.8	4.9	.36	1.9	1.3	.34	.86	.01	.32	<10	580	1	<10	<2	63	45	7	11	<2	11	<8
4	2.5-3.7	5.6	.40	2.7	1.0	.38	.64	.02	.33	10	530	1	<10	<2	74	59	20	15	<2	12	<8
5	4.7-7.0	4.9	.31	2.0	1.2	.35	.59	.01	.36	<10	530	1	<10	<2	66	48	17	14	<2	11	<8
6	4.0	4.8	.44	1.9	1.3	.34	.87	.02	.33	<10	540	1	<10	<2	56	40	7	9	<2	12	<8
7	3.0-6.9	5.3	.60	2.2	1.6	.47	.99	.04	.38	<10	650	1	<10	<2	66	57	8	18	<2	11	<8
8	2.0-3.0	6.1	.58	3.0	1.8	.63	.98	.04	.35	10	690	1	<10	<2	77	68	10	21	<2	14	<8
	5.0-6.0	4.8	.44	1.9	1.2	.34	.86	.01	.37	<10	470	<1	<10	<2	52	50	8	9	<2	11	<8
9	6.0	5.0	.54	2.0	1.4	.39	.97	.02	.36	<10	530	1	<10	<2	59	52	8	12	<2	11	<8
Ferrelview Formation																					
2	7.3-8.3	5.4	0.38	2.7	1.1	0.36	0.70	0.01	0.34	<10	430	1	<10	<2	64	61	7	12	<2	12	<8
	9.3-11.8	6.7	.42	3.5	.83	.51	.43	.01	.34	<10	350	2	<10	<2	92	71	16	21	<2	16	<8
4	3.7-5.4	6.2	.39	3.2	.77	.41	.50	.01	.32	10	390	1	<10	<2	64	66	11	11	<2	13	<8
	5.4-9.5	7.5	.42	3.5	.73	.50	.41	.01	.34	<10	340	1	<10	<2	49	69	7	16	<2	16	<8
6	6.0	5.6	.40	2.4	1.0	.37	.70	.01	.33	<10	430	1	<10	<2	63	49	6	11	<2	13	<8
7	6.9-13.0	6.1	.39	2.7	.76	.40	.48	.01	.35	<10	310	1	<10	<2	64	66	7	13	<2	13	<8
8	7.0-8.0	6.0	.40	2.6	.88	.42	.64	.01	.34	<10	450	1	<10	<2	67	63	7	12	<2	14	<8
	13.0-14.0	6.0	.38	2.8	.61	.40	.37	.01	.34	10	220	1	<10	<2	53	65	5	12	<2	13	<8
9	9.0	6.1	.41	2.7	.65	.44	.43	.01	.33	10	260	1	<10	<2	50	64	6	12	<2	13	<8
	12.0	6.6	.45	3.0	.77	.47	.53	.01	.34	<10	390	1	<10	<2	59	69	7	12	<2	14	<8
	13.0	6.0	.41	2.8	.59	.40	.38	.01	.33	<10	300	1	<10	<2	56	60	6	12	<2	14	<8

Table 9.--*Chemical analysis of the fine (less than 0.062 millimeter) fraction of overburden samples from trench excavations*--Continued

Trench number (fig. 4)	Sample interval (feet)	Al	Ca	Fe	K	Mg	Na	P	Ti	As	Ba	Be	Bi	Cd	Ce	Cr	Co	Cu	Eu	Ga	Au
									Clay till												
1	7.0-7.5	7.3	0.47	3.3	0.65	0.53	0.43	0.01	0.34	<10	290	1	<10	<2	48	65	6	17	<2	17	<8
2	13.0-17.8	12	.57	3.9	.57	.82	.10	.03	.54	23	190	2	<10	<2	80	150	7	14	<2	35	<8
3	4.8-5.8	5.7	.34	2.5	.87	.39	.54	.01	.33	<10	460	1	<10	<2	82	62	37	10	<2	13	<8
	6.5-9.9	7.9	.49	4.3	.89	.60	.39	.02	.35	20	680	2	<10	<2	110	82	14	27	<2	18	<8
4	11.0	7.6	.52	4.2	1.0	.58	.34	.03	.36	10	540	3	<10	<2	510	82	94	29	2	18	<8
	20.0	7.2	.97	3.6	1.0	.60	.39	.03	.36	<10	380	2	<10	<2	96	83	12	28	<2	16	<8
5	7.0-7.7	5.8	.29	2.5	.94	.39	.36	.01	.36	<10	410	1	<10	<2	81	63	8	13	<2	13	<8
	7.7-8.2	7.3	.34	3.5	.82	.50	.23	.01	.36	<10	340	1	<10	<2	74	77	8	16	<2	17	<8
6	12.0	7.0	.46	3.7	1.0	.57	.44	.03	.38	20	410	3	<10	<2	85	76	19	24	2	17	<8
7	14.0-17.0	7.8	.54	3.8	.91	.56	.41	.01	.37	10	310	3	<10	<2	260	75	65	19	<2	17	<8
8	15.0-16.0	6.8	.43	3.2	.59	.46	.26	.01	.37	10	220	2	<10	<2	48	73	15	13	<2	15	<8
	21.0	6.8	.53	4.3	1.3	.54	.42	.06	.38	20	460	2	<10	<2	86	78	17	27	<2	16	<8
9	16.0	6.8	.51	3.4	1.2	.52	.44	.04	.40	10	510	4	<10	<2	230	77	14	24	5	17	<8
									Preglacial deposit												
1	15.0-18.0	15	0.26	1.0	1.1	0.36	0.09	0.04	0.80	<10	270	4	<10	<2	140	190	9	40	2	39	<8
	19.5-20.5	12	.29	2.7	1.5	.47	.10	.05	.90	20	320	3	<10	<2	190	190	9	30	3	37	<8
	18.0-19.0	15	.24	1.2	1.0	.32	.08	.05	.87	10	260	3	<10	<2	190	170	12	45	2	39	<8
3	10.0-12.5	4.1	.23	1.5	1.0	.24	.50	.01	.35	<10	440	1	<10	<2	83	42	11	10	<2	9	<8
	12.8-13.1	4.8	.22	1.7	.94	.28	.33	.01	.38	<10	370	1	<10	<2	85	52	9	12	<2	10	<8
6	14.0	7.1	.51	3.9	1.2	.57	.53	.04	.39	10	510	3	<10	<2	190	81	16	22	6	16	<8
	15.0	8.0	.38	5.1	.60	.55	.15	.02	.38	21	810	2	<10	<2	57	81	13	19	<2	20	<8
									Residuum												
2	18.0-18.8	6.9	0.49	3.5	1.3	0.57	0.45	0.04	0.38	10	510	3	<10	<2	120	85	14	27	3	17	<8
3	14.0-15.5	6.6	.24	3.4	.83	.36	.14	.02	.38	20	340	2	<10	<2	75	78	10	14	<2	14	<8
5	20.0	13	.78	4.3	.67	.77	.09	.06	.41	20	480	5	<10	<2	200	120	49	32	9	31	<8
	20.5	13	.87	4.6	.63	.81	.07	.06	.41	10	600	4	<10	<2	160	120	34	32	6	33	<8
6	19.0-20.0	11	.51	2.5	.60	.73	.09	.02	.59	20	260	3	<10	<2	340	190	22	8	3	26	<8
9	20.5	10	2.6	2.8	1.1	.88	.12	.05	.44	10	580	10	<10	<2	180	95	81	26	5	27	<8

Table 9.--*Chemical analysis of the fine (less than 0.062 millimeter) fraction of overburden samples from trench excavations*--Continued

Trench number (fig. 4)	Sample interval (feet)	Ho	La	Pb	Li	Mn	Mo	Nd	Ni	Nb	Sc	Ag	Sr	Ta	Th	Sn	U	V	Yb	Y	Zn
									Peoria Loess												
2	0.0-0.8	<4	32	16	21	410	<2	27	14	9	7	<2	110	<40	10	<5	<100	65	2	14	43
	0.8-1.8	<4	32	15	31	350	<2	27	25	12	11	<2	110	<40	11	<5	<100	120	2	17	76
	1.9-2.4	<4	44	15	28	470	<2	40	27	12	10	<2	140	<40	10	<5	<100	100	3	24	72
3	0.5-1.2	<4	36	14	30	180	<2	29	25	9	9	<2	110	<40	10	<5	<100	89	2	18	58
5	0.0-4.7	<4	41	15	25	300	<2	36	20	9	9	<2	140	<40	10	<5	<100	81	2	20	55
6	1.0	<4	35	14	29	370	<2	31	27	11	10	<2	110	<40	10	<5	<100	100	2	19	71
	2.0	<4	48	13	28	470	<2	45	33	11	10	<2	140	<40	10	<5	<100	92	3	34	63
7	0.0-1.6	<4	32	15	21	510	<2	25	12	9	6	<2	100	<40	8	<5	<100	59	2	13	36
	2.0-2.9	<4	42	13	26	300	<2	35	23	12	10	<2	130	<40	9	<5	<100	100	2	21	69
8	0.0-0.3	<4	32	18	23	460	<2	26	17	7	7	<2	110	<40	9	<5	<100	76	2	14	47
	0.3-1.6	<4	32	14	30	240	<2	27	23	11	10	<2	100	<40	9	<5	<100	110	2	16	63
9	3.0	<4	39	16	29	370	<2	34	25	11	11	<2	120	<40	11	<5	<100	110	2	19	64
									Roxanna Silt												
2	2.8-6.3	<4	38	11	28	440	<2	31	26	11	9	<2	150	<40	8	<5	<100	79	2	22	54
3	2.1-3.8	<4	38	11	26	290	<2	31	19	8	7	<2	110	<40	8	<5	<100	63	2	20	36
4	2.5-3.7	<4	41	19	31	560	<2	32	23	8	8	<2	91	<40	10	<5	<100	80	2	21	42
5	4.7-7.0	<4	35	14	30	520	<2	27	22	10	7	<2	92	<40	9	<5	<100	66	2	16	39
6	4.0	<4	33	12	25	240	<2	26	15	9	6	<2	120	<40	8	<5	<100	62	2	17	26
7	3.0-6.9	<4	40	12	29	380	<2	32	24	11	8	<2	140	<40	8	<5	<100	72	2	22	44
8	2.0-3.0	<4	43	16	25	390	<2	38	22	11	9	<2	150	<40	10	<5	<100	90	3	25	61
	5.0-6.0	<4	31	11	27	320	<2	25	17	9	7	<2	110	<40	9	<5	<100	61	2	16	30
9	6.0	<4	34	11	28	380	<2	28	22	10	7	<2	130	<40	9	<5	<100	65	2	18	36
									Ferrelview Formation												
2	7.3-8.3	<4	31	14	26	180	<2	26	17	10	8	<2	94	<40	9	<5	<100	75	2	17	27
	9.3-11.8	<4	30	15	35	330	<2	25	33	11	10	<2	75	<40	11	<5	<100	98	2	17	48
4	3.7-5.4	<4	34	19	29	180	<2	29	19	9	9	<2	74	<40	11	<5	<100	88	2	15	39
	5.4-9.5	<4	26	16	31	120	<2	20	20	11	11	<2	65	<40	10	<5	<100	99	2	10	49
6	6.0	<4	34	13	25	120	<2	29	16	8	8	<2	94	<40	9	<5	<100	74	2	18	27
7	6.9-13.0	<4	25	15	27	130	<2	21	16	10	8	<2	65	<40	9	<5	<100	78	2	12	41
8	7.0-8.0	<4	28	13	26	130	<2	25	15	9	9	<2	83	<40	11	<5	<100	77	2	14	36
	13.0-14.0	<4	27	14	27	82	<2	23	19	10	9	<2	56	<40	11	<5	<100	82	2	13	37
9	9.0	<4	26	13	27	91	<2	21	18	7	9	<2	62	<40	10	<5	<100	78	2	13	39
	12.0	<4	28	15	29	120	<2	24	18	9	9	<2	76	<40	10	<5	<100	88	2	15	40
	13.0	<4	27	15	28	82	<2	23	20	9	9	<2	58	<40	11	<5	<100	81	2	13	39

Table 9.--*Chemical analysis of the fine (less than 0.062 millimeter) fraction of overburden samples from trench excavations*--Continued

Trench number (fig. 4)	Sample interval (feet)	Ho	La	Pb	Li	Mn	Mo	Nd	Ni	Nb	Sc	Ag	Sr	Ta	Th	Sn	U	V	Yb	Y	Zn
Clay till																					
1	7.0-7.5	<4	33	17	33	110	<2	28	23	11	11	<2	67	<40	10	<5	<100	97	2	15	48
2	13.0-17.8	<4	58	15	120	300	<2	32	58	24	22	<2	100	<40	16	<5	<100	150	3	34	70
3	4.8-5.8	<4	47	20	31	900	<2	37	20	10	8	<2	77	<40	11	<5	<100	78	2	21	34
	6.5-9.9	<4	48	20	41	190	<2	41	50	13	13	<2	83	<40	12	<5	<100	130	3	35	72
4	11.0	<4	88	26	44	1,200	2	79	68	13	13	<2	86	<40	13	<5	<100	130	4	41	80
	20.0	<4	38	21	40	190	<2	31	39	12	12	<2	90	<40	11	<5	<100	120	2	18	70
5	7.0-7.7	<4	40	18	32	170	<2	31	22	10	8	<2	73	<40	11	<5	<100	81	2	15	39
	7.7-8.2	<4	39	17	36	130	<2	29	28	13	11	<2	65	<40	11	<5	<100	100	2	18	52
6	12.0	<4	100	13	38	330	<2	83	51	13	12	<2	93	<40	12	<5	<100	110	4	40	68
7	14.0-17.0	<4	30	29	44	510	<2	26	49	12	12	<2	81	<40	12	<5	<100	100	3	16	59
8	15.0-16.0	<4	27	14	35	130	<2	21	25	13	10	<2	55	<40	11	<5	<100	89	2	13	47
	21.0	<4	73	16	43	670	3	53	70	13	12	<2	99	<40	13	<5	<100	120	6	87	83
9	16.0	<4	160	16	40	1,300	<2	140	79	14	12	<2	97	<40	12	<5	<100	110	8	110	73
Preglacial deposit																					
1	15.0-18.0	<4	97	37	180	140	<2	73	71	26	30	<2	180	<40	25	<5	<100	160	6	83	64
	19.5-20.5	<4	100	35	120	150	<2	100	72	26	31	<2	150	<40	25	<5	<100	180	10	150	89
	18.0-19.0	<4	120	51	180	150	<2	90	82	27	29	<2	210	<40	24	<5	<100	200	5	56	81
3	10.0-12.5	<4	45	17	26	280	<2	35	16	9	6	<2	71	<40	9	<5	<100	52	2	16	26
	12.8-13.1	<4	45	14	30	140	<2	35	19	10	7	<2	57	<40	12	<5	<100	60	2	16	33
6	14.0	<4	290	17	37	800	<2	210	65	14	12	<2	100	<40	10	<5	<100	110	7	100	75
	15.0	<4	44	17	45	1,100	2	36	66	15	12	<2	48	<40	12	<5	<100	140	4	41	70
Residuum																					
2	18.0-18.8	<4	110	17	42	630	<2	92	55	13	12	<2	99	<40	12	<5	<100	120	5	70	76
3	14.0-15.5	<4	49	19	41	270	<2	36	32	11	9	<2	49	<40	11	<5	<100	110	2	23	48
5	20.0	5	220	32	100	1,300	<2	240	150	20	28	<2	73	<40	16	<5	<100	120	15	280	380
	20.5	5	150	29	97	1,700	<2	160	120	19	27	<2	69	<40	16	<5	<100	120	13	260	410
6	19.0-20.0	<4	130	24	74	460	<2	110	74	22	19	<2	77	<40	14	<5	<100	160	6	76	81
9	20.5	5	180	21	130	790	<2	150	260	24	20	<2	82	<40	13	<5	<100	130	13	250	500

Table 10.--*Chemical analysis of the fine (less than 0.062 millimeter) fraction of overburden core samples from lysimeter boreholes*

Lysimeter borehole (fig. 4)	Sample interval (feet)	Al	Ca	Fe	K	Mg	Na	P	Ti	As	Ba	Be	Bi	Cd	Ce	Cr	Co	Cu	Eu	Ga	Au
Peoria Loess																					
LY03	1.2-1.7	6.9	0.44	3.4	1.5	0.65	0.76	0.03	0.32	<20	580	<2	<20	<4	63	64	9	26	<4	10	<20
	1.7-2.3	6.7	.55	3.2	1.7	.66	.89	.04	.34	<10	640	2	<10	<2	88	70	12	24	<2	15	<8
Roxanna Silt																					
LY01	2.3-2.8	5.2	0.32	2.4	1.1	0.36	0.69	0.01	0.41	<20	540	<2	<20	<4	70	54	10	10	<4	10	<20
LY03	2.9-3.7	5.6	.58	2.4	1.6	.49	1.0	.04	.34	<20	590	<2	<20	<4	61	53	7	10	<4	10	<20
	3.9-4.4	4.9	.50	2.0	1.3	.37	.92	.02	.31	<10	580	1	<10	<2	50	47	7	10	<2	11	<8
Ferrelview Formation																					
LY01	4.8-5.4	6.7	0.34	3.0	0.82	0.45	0.50	<0.01	0.35	<20	380	<2	<20	<4	66	63	6	10	<4	10	<20
LY02	1.0-1.5	5.9	1.3	2.6	1.1	.37	.61	.01	.40	<20	500	<2	<20	<4	77	60	10	10	<4	10	<20
	1.8-2.2	6.6	.41	2.9	.89	.44	.48	.01	.34	<10	440	1	<10	<2	59	66	8	12	<2	14	<8
LY03	5.2-6.1	6.3	.45	3.0	.73	.43	.52	<.01	.36	<20	390	<2	<20	<4	57	61	10	10	<4	10	<20
	8.7-9.1	6.9	.44	3.2	.56	.45	.34	.01	.34	<10	250	1	<10	<2	45	69	6	13	<2	15	<8
LY04	1.0-1.5	5.5	.38	2.2	1.0	.35	.62	.01	.34	<20	450	<2	<20	<4	55	55	6	25	<4	10	<20
LY06	0.9-1.1	7.0	.40	3.7	.69	.45	.32	.02	.33	<20	340	2	<20	<4	120	68	25	20	<4	10	<20
LY09	0.4-0.7	4.9	.37	2.0	.88	.27	.51	.01	.33	<10	360	1	<10	<2	73	54	9	11	<2	10	<8
	2.7-3.0	5.4	.35	2.4	.87	.32	.50	.01	.36	<10	350	1	<10	<2	58	60	8	11	<2	12	<8
Clay till																					
LY01	8.5-9.0	7.0	0.37	3.6	0.87	0.50	0.36	0.02	0.35	<20	390	2	<20	<4	140	80	36	21	<4	20	<20
	10.3-10.6	6.4	.31	2.6	.92	.41	.37	.01	.39	<20	410	<2	<20	<4	88	68	30	10	<4	10	<20
	11.8-12.1	6.0	.28	5.5	.78	.36	.29	.04	.35	<20	450	3	<20	<4	110	94	23	20	<4	10	<20
LY02	3.4-3.7	6.6	.35	3.5	.93	.43	.46	.01	.35	<20	430	<2	<20	<4	70	68	20	20	<4	10	<20
	4.6-4.9	7.8	.46	5.0	1.2	.59	.36	.05	.36	20	700	2	<10	<2	130	89	16	30	2	18	<8
	5.4-5.7	7.0	.42	5.4	.86	.51	.39	.05	.38	30	370	2	<20	<4	83	80	10	29	<4	10	<20
	7.8-8.4	5.6	.35	1.6	.85	.35	.46	<.01	.37	<20	370	<2	<20	<4	66	55	5	10	<4	10	<20
	8.4-8.8	5.9	.38	1.9	.89	.37	.48	.01	.37	<10	410	1	<10	<2	81	66	7	23	<2	13	<8
LY03	10.5-11.0	6.8	.42	3.4	.65	.42	.35	.01	.39	<20	240	<2	<20	<4	62	68	7	10	<4	10	<20
	11.3-12.0	8.1	.53	3.8	.61	.52	.27	.01	.35	10	220	2	<10	<2	76	82	9	17	<2	18	<8
	13.0-13.6	7.5	.54	3.2	1.1	.56	.44	.05	.38	<20	410	3	<20	<4	390	85	73	29	8	20	<20
	14.7-15.0	7.0	.50	3.5	1.5	.66	.78	.03	.36	10	610	2	<10	<2	93	77	16	26	<2	15	<8
	15.0-15.3	7.0	.53	3.3	1.3	.55	.52	.04	.37	<20	530	3	<20	<4	160	79	38	21	4	20	<20
LY04	4.4-4.9	7.1	.46	5.2	1.1	.55	.48	.05	.35	20	520	2	<20	<4	150	85	51	29	<4	10	<20
	5.9-6.3	6.9	.49	4.7	1.2	.51	.43	.06	.41	<20	610	3	<20	<4	170	84	10	26	<4	10	<20
LY06	2.8-3.0	7.0	.38	3.8	.65	.47	.28	.01	.35	<20	300	<2	<20	<4	120	70	20	20	<4	10	<20
	3.1-3.4	7.5	.40	4.5	.55	.49	.21	.01	.31	20	280	<2	<20	<4	81	75	20	10	<4	20	<20

Table 10.--*Chemical analysis of the fine (less than 0.062 millimeter) fraction of overburden core samples from lysimeter boreholes*--Continued

Lysimeter borehole (fig. 4)	Sample interval (feet)	Al	Ca	Fe	K	Mg	Na	P	Ti	As	Ba	Be	Bi	Cd	Ce	Cr	Co	Cu	Eu	Ga	Au
									Preglacial deposit												
LY02	10.0-10.3	4.7	0.30	1.4	0.81	0.28	0.47	<0.01	0.35	<20	360	<2	<20	<4	62	49	4	10	<4	10	<20
	11.6-12.1	4.6	.31	1.4	.82	.27	.47	.01	.37	<20	350	<2	<20	<4	67	47	6	10	<4	10	<20
	13.6-13.8	5.3	.30	2.8	.68	.33	.30	.03	.38	<20	310	<2	<20	<4	61	59	9	10	<4	10	<20
									Residuum												
LY02	13.8-14.1	6	0.40	2.3	0.73	0.39	0.29	0.02	0.39	<10	340	1	<10	<2	63	77	9	12	<2	14	<8

Table 10.--*Chemical analysis of the fine (less than 0.062 millimeter) fraction of overburden core samples from lysimeter boreholes*--Continued

Lysimeter borehole (fig. 4)	Sample interval (feet)	Ho	La	Pb	Li	Mn	Mo	Nd	Ni	Nb	Sc	Ag	Sr	Ta	Th	Sn	U	V	Yb	Y	Zn
Peoria Loess																					
LY03	1.2-1.7	<8	39	10	27	260	<4	35	23	9	10	<4	110	<80	10	<10	<200	100	2	20	69
	1.7-2.3	<4	48	13	27	300	<2	43	27	9	11	<2	140	<40	11	<5	<100	95	3	26	70
Roxanna Silt																					
LY01	2.3-2.8	<8	45	10	27	610	<4	39	23	10	8	<4	93	<80	10	<10	<200	75	2	25	40
LY03	2.9-3.7	<8	39	10	28	370	<4	32	26	8	8	<4	150	<80	10	<10	<200	75	3	25	54
	3.9-4.4	<4	31	12	29	450	<2	25	23	7	7	<2	120	<40	9	<5	<100	63	2	18	39
Ferrelview Formation																					
LY01	4.8-5.4	<8	36	10	29	160	<4	29	20	10	10	<4	70	<80	10	<10	<200	90	<2	20	43
LY02	1.0-1.5	<8	40	20	26	760	<4	34	20	10	9	<4	89	<80	10	<10	<200	82	2	21	37
	1.8-2.2	<4	32	12	28	260	<2	23	18	10	10	<2	71	<40	9	<5	<100	81	2	13	40
LY03	5.2-6.1	<8	30	20	31	340	<4	26	20	9	9	<4	73	<80	10	<10	<200	87	2	10	42
	8.7-9.1	<4	26	15	27	91	<2	22	19	10	10	<2	57	<40	11	<5	<100	89	1	12	46
LY04	1.0-1.5	<8	32	10	24	180	<4	29	10	8	8	<4	85	<80	10	<10	<200	72	<2	10	38
LY06	0.9-1.1	<8	35	20	30	250	<4	32	25	9	10	<4	64	<80	10	<10	<200	97	2	20	49
LY09	0.4-0.7	<4	34	14	23	190	<2	28	15	8	7	<2	74	<40	9	<5	<100	65	2	17	33
	2.7-3.0	<4	32	16	26	220	<2	25	15	10	8	<2	72	<40	9	<5	<100	72	2	15	28
Clay till																					
LY01	8.5-9.0	<8	43	20	33	750	<4	34	35	10	10	<4	74	<80	10	<10	<200	110	2	20	58
	10.3-10.6	<8	47	10	33	570	<4	36	28	10	10	<4	71	<80	10	<10	<200	88	2	21	48
	11.8-12.1	<8	140	28	31	1,400	<4	98	43	9	10	<4	66	<80	10	<10	<200	110	3	41	52
LY02	3.4-3.7	<8	33	20	31	510	<4	27	27	9	10	<4	73	<80	10	<10	<200	100	<2	20	49
	4.6-4.9	<4	92	16	40	620	<2	83	51	13	14	<2	90	<40	13	<5	<100	140	4	35	83
	5.4-5.7	<8	52	10	31	460	<4	39	44	10	10	<4	71	<80	10	<10	<200	130	3	34	71
	7.8-8.4	<8	41	10	26	150	<4	34	10	10	8	<4	69	<80	10	<10	<200	64	<2	20	48
	8.4-8.8	<4	42	16	27	270	<2	35	18	11	9	<2	73	<40	11	<5	<100	70	2	16	51
LY03	10.5-11.0	<8	28	20	27	110	<4	24	23	10	10	<4	61	<80	10	<10	<200	94	2	10	46
	11.3-12.0	<4	28	20	43	110	<2	21	33	13	12	<2	62	<40	12	<5	<100	120	2	13	56
	13.0-13.6	<8	310	32	43	620	<4	270	64	10	10	<4	97	<80	10	<10	<200	120	9	130	74
	14.7-15.0	<4	59	17	30	330	<2	48	29	10	11	<2	120	<40	10	<5	<100	110	3	25	70
	15.0-15.3	<8	150	10	38	590	<4	130	54	10	10	<4	100	<80	10	<10	<200	110	5	60	72
LY04	4.4-4.9	<8	44	29	35	1,200	<4	34	56	10	10	<4	89	<80	10	<10	<200	130	3	28	83
	5.9-6.3	<8	120	20	35	1,000	<4	110	53	10	10	<4	93	<80	10	<10	<200	120	5	58	75
LY06	2.8-3.0	<8	38	20	35	340	<4	29	30	10	10	<4	61	<80	10	<10	<200	99	2	20	49
	3.1-3.4	<8	38	20	36	250	<4	30	32	9	10	<4	63	<80	10	<10	<200	110	2	21	55

Table 10.--*Chemical analysis of the fine (less than 0.062 millimeter) fraction of overburden core samples from lysimeter boreholes*--Continued

Lysimeter borehole (fig. 4)	Sample interval (feet)	Ho	La	Pb	Li	Mn	Mo	Nd	Ni	Nb	Sc	Ag	Sr	Ta	Th	Sn	U	V	Yb	Y	Zn
									Preglacial deposit												
LY02	10.0-10.3	<8	37	8	22	130	<4	30	10	9	7	<4	66	<80	10	<10	<200	59	<2	10	38
	11.6-12.1	<8	40	9	24	110	<4	32	10	9	7	<4	68	<80	10	<10	<200	55	<2	20	39
	13.6-13.8	<8	43	20	31	360	<4	32	23	9	8	<4	50	<80	10	<10	<200	100	<2	20	43
										Residuum											
LY02	13.8-14.1	<4	37	21	36	290	<2	27	21	11	8	<2	53	<40	11	<5	<100	85	2	13	47

Table 11.--*Ash content and chemical analysis of ashed overburden samples from trench excavations*

Trench number (fig. 4)	Sample interval (feet)	Percent ash	Al	Ca	Fe	K	Mg	Na	P	Ti	As	Ba	Bc	Bi	Cd	Ce	Cr	Co	Cu	Eu	Ga	Au
									Peoria Loess													
2	0.0-0.8	94.6	4.8	0.37	2.4	1.2	0.34	0.85	0.04	0.33	10	550	1	<10	<2	63	54	12	13	<2	10	<8
	0.8-1.8	92.3	7.8	.43	4.2	1.3	.76	.64	.04	.36	10	560	2	<10	<2	62	89	15	29	<2	17	<8
	1.9-2.4	97.6	6.9	.55	3.5	1.6	.71	.87	.04	.37	10	710	2	<10	<2	89	81	19	29	<2	17	<8
3	0.5-1.2	94.4	6.5	.34	3.4	1.3	.57	.75	.03	.38	10	500	1	<10	<2	68	64	8	21	<2	15	<8
5	0.0-4.7	96.0	5.7	.42	2.7	1.7	.52	.95	.04	.38	10	610	1	<10	<2	77	51	10	20	<2	12	<8
6	1.0	94.2	6.9	.48	3.6	1.4	.63	.72	.04	.37	10	540	2	<10	<2	67	73	14	32	<2	15	<8
	2.0	98.6	6.7	.58	3.3	1.6	.67	.89	.05	.36	10	730	2	<10	<2	78	64	10	23	<2	16	<8
7	0.0-1.6	95.7	4.4	.29	2.1	1.2	.28	.82	.03	.32	10	600	1	<10	<2	63	44	14	10	<2	11	<8
	2.0-2.9	93.4	6.8	.52	3.5	1.6	.72	.92	.04	.37	20	650	2	<10	<2	75	68	9	27	<2	15	<8
8	0.0-0.3	95.0	5.1	.37	2.7	1.2	.38	.84	.05	.36	20	630	1	<10	<2	71	52	18	17	<2	12	<8
	0.3-1.6	94.3	6.9	.38	3.8	1.2	.64	.70	.04	.37	20	540	1	<10	<2	59	86	10	27	<2	15	<8
9	3.0	93.5	7.2	.51	3.7	1.5	.76	.75	.03	.37	10	640	2	<10	<2	72	72	13	28	<2	16	<8
									Roxanna Silt													
2	2.8-6.3	95.3	5.7	0.64	2.6	1.6	0.52	1.0	0.05	0.37	<10	640	1	<10	<2	62	63	9	15	<2	13	<8
3	2.1-3.8	96.7	4.5	.33	2.1	1.2	.31	.79	.02	.34	<10	580	1	<10	<2	73	43	10	13	<2	10	<8
4	2.5-3.7	95.4	4.9	.36	2.8	.93	.33	.62	.02	.35	10	490	1	<10	<2	79	50	24	12	<2	11	<8
5	4.7-7.0	96.4	4.5	.29	2.0	1.1	.30	.58	.01	.36	<10	500	1	<10	<2	74	50	21	11	<2	8	<8
6	4.0	95.6	4.6	.42	1.9	1.1	.32	.83	.02	.32	<10	520	1	<10	<2	59	38	9	11	<2	10	<8
7	3.0-6.9	92.4	5.3	.58	2.2	1.4	.46	1.0	.04	.37	<10	620	1	<10	<2	63	59	8	13	<2	12	<8
8	2.0-3.0	96.6	6.2	.58	3.0	1.7	.62	1.0	.04	.34	10	700	1	<10	<2	80	71	22	23	<2	13	<8
	5.0-6.0	96.3	4.7	.43	2.1	1.1	.32	.86	.02	.35	<10	510	1	<10	<2	68	51	14	10	<2	10	<8
9	6.0	99.0	4.7	.52	2.0	1.2	.36	.93	.02	.35	<10	510	1	<10	<2	56	46	9	13	<2	10	<8
									Ferrelview Formation													
2	7.3-8.3	96.3	5.7	0.40	2.8	0.91	0.39	0.64	0.01	0.34	<10	420	1	<10	<2	77	58	8	13	<2	12	<8
	9.3-11.8	94.5	6.3	.40	3.4	.74	.46	.44	.01	.31	10	350	2	<10	<2	75	63	14	18	<2	13	<8
4	3.7-5.4	94.5	6.1	.39	3.2	.78	.41	.50	.01	.35	<10	400	1	<10	<2	59	54	12	12	<2	13	<8
	5.4-9.5	93.4	7.0	.40	3.3	.71	.47	.42	.01	.36	10	340	1	<10	<2	52	65	7	14	<2	15	<8
6	6.0	94.2	5.6	.40	2.4	.86	.37	.67	.01	.32	<10	420	1	<10	<2	53	51	6	10	<2	12	<8
7	6.9-13.0	91.4	6.7	.41	3.0	.69	.44	.45	.01	.36	10	380	1	<10	<2	60	56	7	13	<2	15	<8
8	7.0-8.0	96.0	6.7	.43	3.1	.79	.48	.59	.01	.35	<10	410	1	<10	<2	60	72	8	15	<2	15	<8
	13.0-14.0	93.5	6.3	.40	3.1	.54	.42	.33	.01	.33	10	210	1	<10	<2	49	67	6	11	<2	13	<8
9	9.0	94.3	6.6	.54	3.1	.66	.47	.51	.01	.34	10	370	1	<10	<2	53	69	7	13	<2	15	<8
	12.0	89.4	6.5	.45	3.2	.54	.46	.36	.01	.33	10	230	1	<10	<2	44	68	6	15	<2	14	<8
	13.0	90.9	6.4	.48	3.5	.50	.43	.35	.01	.32	10	330	2	<10	<2	45	70	6	14	<2	15	<8

Table 11.--*Ash content and chemical analysis of ashed overburden samples from trench excavations*--Continued

Trench number (fig. 4)	Sample interval (feet)	Percent ash	Al	Ca	Fe	K	Mg	Na	P	Ti	As	Ba	Be	Bi	Cd	Ce	Cr	Co	Cu	Eu	Ga	Au
										Clay till												
1	7.0-7.5	93.1	7.2	0.47	3.4	0.65	0.52	0.44	0.01	0.36	10	300	1	<10	<2	57	62	6	16	<2	16	<8
2	13.0-17.8	97.6	5.6	.46	2.8	1.1	.43	.50	.04	.30	10	450	2	<10	<2	89	61	12	20	2	13	<8
3	4.8-5.8	99.3	4.5	.29	2.2	.87	.29	.58	.01	.35	<10	480	1	<10	<2	90	49	50	12	<2	10	<8
	6.5-9.9	93.7	6.8	.45	3.5	.84	.50	.44	.02	.35	10	560	2	<10	2	75	73	10	20	<2	15	<8
4	11.0	94.8	6.1	.46	3.2	.97	.43	.44	.02	.32	10	590	3	<10	<2	550	55	210	22	2	15	<8
	20.0	94.7	6.1	.73	3.0	.93	.47	.43	.02	.33	10	380	2	<10	<2	100	53	13	21	<2	13	<8
5	7.0-7.7	95.1	5.5	.27	2.4	.87	.37	.34	.01	.39	<10	390	1	<10	<2	77	55	8	13	<2	12	<8
	7.7-8.2	93.1	7.3	.34	3.6	.82	.50	.23	.01	.38	10	340	1	<10	<2	83	63	7	17	<2	16	<8
6	12.0	99.3	5.8	.42	3.0	.84	.44	.47	.02	.30	<10	390	2	<10	<2	100	61	25	18	2	13	<8
7	14.0-17.0	96.4	6.6	.49	3.2	.84	.45	.51	.01	.31	10	360	2	<10	<2	170	58	260	17	<2	14	<8
8	15.0-16.0	94.9	6.7	.43	3.1	.53	.44	.25	.01	.34	10	250	2	<10	<2	42	70	21	13	<2	16	<8
	21.0	96.3	5.4	.47	3.3	1.0	.41	.47	.04	.30	20	460	2	<10	<2	66	65	17	19	<2	12	<8
9	16.0	96.3	5.7	.48	2.8	.94	.41	.50	.03	.31	<10	470	4	<10	<2	220	64	12	19	4	14	<8
										Preglacial deposit												
1	15.0-18.0	90.0	16	0.28	1.1	1.2	0.39	0.10	0.04	1.1	20	310	4	<10	<2	140	150	12	53	2	43	<8
	19.5-20.5	96.0	6.6	.19	1.7	.87	.28	.06	.03	.41	10	200	2	<10	<2	90	77	5	28	2	19	<8
	18.0-19.0	90.1	17	.26	1.3	1.1	.35	.09	.05	1.1	20	290	3	<10	<2	190	130	15	52	2	41	<8
3	10.0-12.5	97.0	4.2	.24	1.6	.98	.26	.47	.01	.39	<10	450	1	<10	<2	92	39	13	12	<2	8	<8
	12.8-13.1	96.0	4.8	.23	1.9	.88	.28	.31	.01	.39	<10	370	1	<10	<2	97	45	10	13	<2	11	<8
6	14.0	99.3	4	.45	1.7	.85	.24	.74	.02	.18	<10	390	2	<10	<2	80	36	7	9	2	9	<8
	15.0	95.9	5.5	.25	4.8	.37	.35	.12	.02	.25	10	590	2	<10	<2	39	73	12	18	<2	12	<8
										Residuum												
2	18.0-18.8	90.8	10	0.49	3.4	0.46	0.68	0.10	0.03	0.47	23	240	1	<10	<2	67	140	7	14	<2	28	<8
3	14.0-15.5	96.3	3.9	.15	3.7	.46	.21	.08	.02	.22	20	240	1	<10	<2	47	70	8	12	<2	9	<8
5	20.0	89.1	12	.75	4.4	.65	.74	.10	.05	.42	20	550	4	<10	<2	210	92	62	28	8	29	<8
	20.5	90.3	11	.76	3.8	.50	.66	.06	.05	.32	10	580	3	<10	<2	140	72	37	26	5	26	<8
6	19.0	96.9	6.5	.30	1.5	.33	.42	.07	.01	.36	<10	190	2	<10	<2	180	130	13	8	<2	15	<8
9	20.5	94.4	8.8	4.7	2.4	.78	.70	.12	.04	.37	20	520	8	<10	<2	150	77	82	21	4	20	<8

Table 11.--*Ash content and chemical analysis of ashed overburden samples from trench excavations*--Continued

Trench number (fig. 4)	Sample interval (feet)	Ho	La	Pb	Li	Mn	Mo	Nd	Ni	Nb	Sc	Ag	Sr	Ta	Th	Sn	U	V	Yb	Y	Zn
										Peoria Loess											
2	0.0-0.8	<4	32	27	20	940	<2	27	13	9	7	<2	110	<40	11	<5	<100	77	1	12	46
	0.8-1.8	<4	33	21	33	430	<2	28	26	12	12	<2	110	<40	11	<5	<100	130	2	17	83
	1.9-2.4	<4	43	17	28	540	<2	41	25	12	11	<2	140	<40	11	<5	<100	110	2	25	75
3	0.5-1.2	<4	38	15	32	300	<2	32	26	11	10	<2	110	<40	10	<5	<100	100	2	18	64
5	0.0-4.7	<4	42	16	25	360	<2	35	18	10	9	<2	140	<40	10	<5	<100	82	2	18	54
6	1.0	<4	34	21	29	750	<2	30	28	11	11	<2	110	<40	11	<5	<100	110	2	19	73
	2.0	<4	46	19	29	620	<2	44	36	10	11	<2	140	<40	12	<5	<100	98	3	35	66
7	0.0-1.6	<4	29	25	19	1,700	<2	24	13	8	6	<2	100	<40	11	<5	<100	69	1	11	40
	2.0-2.9	<4	42	15	27	390	<2	35	24	11	11	<2	140	<40	11	<5	<100	110	2	21	74
8	0.0-0.3	<4	32	28	23	1,600	<2	25	16	10	7	<2	110	<40	11	<5	<100	85	2	13	50
	0.3-1.6	<4	32	21	31	470	<2	26	24	12	11	<2	110	<40	13	<5	<100	120	2	15	67
9	3.0	<4	38	20	30	420	<2	33	26	12	12	<2	120	<40	12	<5	<100	120	2	19	72
										Roxanna Silt											
2	2.8-6.3	<4	34	14	26	470	<2	30	24	9	9	<2	150	<40	9	<5	<100	76	2	21	54
3	2.1-3.8	<4	40	13	24	630	<2	35	19	9	6	<2	110	<40	12	<5	<100	64	2	20	34
4	2.5-3.7	<4	43	26	27	810	<2	36	22	8	7	<2	87	<40	11	<5	<100	78	2	21	34
5	4.7-7.0	<4	36	17	26	750	<2	30	20	10	6	<2	89	<40	10	<5	<100	64	2	15	35
6	4.0	<4	31	14	23	400	<2	26	14	9	6	<2	110	<40	9	<5	<100	62	2	16	29
7	3.0-6.9	<4	39	12	28	430	<2	31	25	10	8	<2	140	<40	8	<5	<100	71	2	21	45
8	2.0-3.0	<4	41	17	25	620	<2	35	25	10	10	<2	150	<40	10	<5	<100	90	2	24	63
	5.0-6.0	<4	32	17	27	930	<2	29	22	9	7	<2	110	<40	10	<5	<100	65	2	16	33
9	6.0	<4	31	15	27	450	<2	25	21	9	7	<2	130	<40	9	<5	<100	63	2	16	36
										Ferrelview Formation											
2	7.3-8.3	<4	30	17	27	220	<2	25	18	9	8	<2	89	<40	11	<5	<100	77	2	15	33
	9.3-11.8	<4	27	18	30	330	<2	24	30	8	9	<2	75	<40	10	<5	<100	91	2	16	45
4	3.7-5.4	<4	33	18	29	200	<2	30	19	10	9	<2	75	<40	13	<5	<100	88	2	16	39
	5.4-9.5	<4	26	21	29	180	<2	20	17	10	10	<2	66	<40	11	<5	<100	93	1	10	45
6	6.0	<4	31	15	24	110	<2	27	15	8	8	<2	90	<40	10	<5	<100	74	2	17	30
7	6.9-13.0	<4	25	15	29	130	<2	20	16	11	9	<2	65	<40	10	<5	<100	86	2	13	48
8	7.0-8.0	<4	28	17	29	170	<2	23	16	10	10	<2	81	<40	10	<5	<100	88	2	15	44
	13.0-14.0	<4	25	18	27	93	<2	21	18	10	9	<2	55	<40	11	<5	<100	84	2	12	42
9	9.0	<4	27	19	29	120	<2	23	17	10	10	<2	74	<40	11	<5	<100	90	2	14	42
	12.0	<4	25	19	29	93	<2	19	19	10	10	<2	59	<40	10	<5	<100	89	2	12	45
	13.0	<4	24	24	30	100	<2	21	22	9	9	<2	59	<40	11	<5	<100	98	2	13	48

Table 11.--*Ash content and chemical analysis of ashed overburden samples from trench excavations*--Continued

Trench number (fig. 4)	Sample interval (feet)	Ho	La	Pb	Li	Mn	Mo	Nd	Ni	Nb	Sc	Ag	Sr	Ta	Th	Sn	U	V	Yb	Y	Zn
										Clay till											
1	7.0-7.5	<4	33	20	32	170	<2	26	23	11	11	<2	68	<40	11	<5	<100	100	2	16	48
2	13.017.8	<4	85	16	30	610	<2	67	49	10	9	<2	100	<40	9	<5	<100	91	4	55	58
3	4.8-5.8	<4	47	27	24	1,300	<2	38	17	10	6	<2	79	<40	11	<5	<100	66	2	21	28
	6.5-9.9	<4	39	16	34	160	<2	34	39	12	11	<2	86	<40	11	<5	<100	100	3	27	58
4	11.0	<4	68	29	38	1,900	<2	63	68	10	10	<2	94	<40	13	<5	<100	100	3	33	60
	20.0	<4	29	20	31	200	<2	23	33	10	10	<2	91	<40	11	<5	<100	97	2	15	57
5	7.0-7.7	<4	37	17	30	170	<2	28	20	11	8	<2	71	<40	11	<5	<100	78	2	14	39
	7.7-8.2	<4	37	19	35	130	<2	29	27	11	10	<2	66	<40	14	<5	<100	100	2	18	53
6	12.0	<4	82	17	28	460	<2	66	41	10	9	<2	92	<40	10	<5	<100	91	3	31	53
8	15.0-16.0	<4	22	20	32	200	<2	17	23	11	10	<2	55	<40	11	<5	<100	81	1	11	48
	21.0	<4	53	18	31	790	2	36	55	10	9	<2	97	<40	10	<5	<100	94	4	65	63
9	16.0	<4	130	20	31	1,100	2	120	66	10	9	<2	99	<40	11	<5	<100	91	6	86	59
										Preglacial deposit											
1	15.0-18.0	<4	99	41	200	330	<2	74	94	46	33	<2	200	<40	31	<5	<100	170	6	88	72
	19.5-20.5	<4	50	18	61	180	<2	51	49	12	17	<2	79	<40	14	<5	<100	100	5	80	57
	18.0-19.0	<4	120	50	200	230	<2	90	97	34	32	<2	240	<40	30	<5	<100	220	4	54	92
3	10.0-12.5	<4	51	17	27	380	<2	40	18	10	6	<2	71	<40	11	<5	<100	54	2	17	32
	12.8-13.1	<4	47	19	31	170	<2	37	19	9	7	<2	56	<40	13	<5	<100	59	2	18	36
6	14.0	<4	110	12	16	380	<2	79	28	6	5	<2	130	<40	6	<5	<100	46	3	40	31
	15.0	<4	31	15	34	870	2	23	60	8	8	<2	39	<40	8	<5	<100	100	3	29	65
7	14.0-17.0	<4	24	47	39	1,600	<2	21	53	10	9	<2	89	<40	11	<5	<100	84	2	13	49
										Residuum											
2	18.0-18.8	<4	48	21	100	530	<2	29	52	20	19	<2	88	<40	15	<5	<100	130	2	27	62
3	14.0-15.5	<4	33	16	26	240	<2	25	29	6	5	<2	31	<40	8	<5	<100	110	2	18	38
5	20.0	5	190	35	110	1,700	<2	210	160	20	26	<2	76	<40	17	<5	<100	110	13	220	390
	20.5	<4	100	29	78	1,800	<2	110	110	16	22	<2	58	<40	15	<5	<100	99	9	170	340
6	19.0	<4	72	18	46	300	<2	58	44	11	11	<2	49	<40	10	<5	<100	91	4	45	48
9	20.5	4	140	22	100	900	<2	120	220	17	17	<2	74	<40	10	<5	<100	110	10	210	380

Table 12.--*Ash content and chemical analysis of ashed overburden core samples from lysimeter boreholes*

Lysimeter borehole (fig. 4)	Sample interval (feet)	Percent ash	Al	Ca	Fe	K	Mg	Na	P	Ti	As	Ba	Be	Bi	Cd	Ce	Cr	Co	Cu	Eu	Ga	Au
Peoria Loess																						
LY03	1.2-1.7	93.5	7.4	0.49	3.8	1.5	0.73	0.77	0.04	0.35	10	610	2	<10	<2	68	68	11	31	<2	16	<8
	1.7-2.3	94.7	6.7	.57	3.4	1.8	.67	.98	.04	.40	<10	680	2	<10	<2	93	58	15	24	<2	15	<8
Roxanna Silt																						
LY01	2.3-2.8	95.8	5.6	0.34	3.1	1.1	0.40	0.67	0.01	0.38	<10	590	1	<10	<2	72	66	15	15	<2	12	<8
LY03	2.9-3.7	96.6	5.8	.62	2.6	1.7	.52	1.0	.04	.33	<10	660	1	<10	<2	62	58	10	20	<2	12	<8
	3.9-4.4	96.7	4.9	.50	2.3	1.3	.38	.91	.03	.39	<10	630	1	<10	<2	80	41	13	14	<2	11	<8
Ferrelview Formation																						
LY01	4.8-5.4	94.0	7.3	0.38	3.3	0.84	0.51	0.50	0.01	0.35	<10	410	1	<10	<2	64	65	6	18	<2	16	<8
LY02	1.0-1.5	95.4	5.6	3.4	2.7	1.0	.37	.59	.02	.32	<10	530	1	<10	<2	77	57	19	15	<2	12	<8
	1.8-2.2	94.7	6.1	.40	2.7	.86	.40	.48	.01	.34	<10	460	1	<10	<2	65	51	12	10	<2	13	<8
LY03	5.2-6.1	94.6	6.6	.48	3.5	.76	.47	.55	.01	.37	<10	430	1	<10	<2	60	70	12	13	<2	15	<8
	8.7-9.1	93.8	6.5	.42	3.2	.53	.43	.33	.01	.35	10	240	1	<10	<2	45	56	5	14	<2	14	<8
LY04	1.0-1.5	95.8	5.6	.41	2.3	1.0	.37	.63	.01	.33	<10	500	1	<10	<2	57	49	7	29	<2	12	<8
LY06	0.9-1.1	93.6	6.6	.40	3.7	.66	.44	.31	.02	.30	10	360	2	<10	<2	110	62	28	22	<2	15	<
LY09	0.4-0.7	96.3	4.7	.38	2.1	.70	.26	.47	.01	.30	<10	340	1	<10	<2	66	47	8	11	<2	10	<8
	2.7-3.0	96.3	5.0	.32	2.2	.72	.30	.46	.01	.32	<10	320	1	<10	<2	55	52	7	10	<2	11	<8
Clay till																						
LY01	8.5-9.0	95.2	5.9	0.34	3.2	0.80	0.41	0.37	0.01	0.28	<10	400	2	<10	<2	140	65	44	17	<2	13	<8
	10.3-10.6	96.2	5.1	.29	2.1	.82	.32	.39	.01	.28	<10	430	1	<10	<2	72	49	32	13	<2	12	<8
	11.8-12.1	95.8	4.3	.26	7.3	.68	.26	.31	.05	.22	<10	430	3	<10	<2	79	66	26	14	<2	9	<8
LY02	3.4-3.7	95.2	5.7	.35	3.2	.88	.37	.49	.01	.31	10	430	1	<10	<2	70	61	20	16	<2	13	<8
	4.6-4.9	95.4	6.1	.41	3.7	1.1	.43	.53	.04	.33	10	760	2	<10	<2	100	59	17	24	<2	13	<8
	5.4-5.7	94.0	6.9	.45	5.7	.85	.50	.42	.05	.34	21	400	2	<10	<2	70	82	17	24	<2	15	<8
	7.8-8.4	95.5	6.0	.38	1.8	.89	.38	.48	.01	.39	<10	410	1	<10	<2	67	67	6	15	<2	15	<8
	8.4-8.8	95.1	5.9	.38	1.8	.86	.38	.47	.01	.43	<10	420	1	<10	<2	81	55	6	13	<2	13	<8
LY03	10.5-11.0	94.4	6.3	.42	3.2	.60	.39	.34	.01	.30	<10	230	1	<10	<2	53	49	6	14	<2	13	<8
	11.3-12.0	93.7	7.0	.47	3.2	.62	.44	.32	.01	.33	10	240	2	<10	<2	62	61	7	14	<2	14	<8
	13.0-13.6	95.0	6.3	.53	2.7	1.1	.46	.54	.04	.29	<10	410	3	<10	<2	310	62	80	27	6	15	<8
	14.7-15.0	93.8	6.8	.50	3.5	1.5	.64	.81	.04	.37	10	640	2	<10	<2	98	60	19	24	<2	15	<8
	15.0-15.3	95.2	6.1	.56	3.0	1.2	.48	.61	.04	.31	<10	540	3	<10	<2	150	59	60	23	3	15	<8
LY04	4.4-4.9	95.0	6.2	.45	4.6	1.1	.44	.52	.04	.29	10	610	2	<10	<2	150	66	78	28	<2	14	<8
	5.9-6.3	95.4	6.0	.56	4.0	1.1	.43	.52	.06	.29	<10	620	2	<10	<2	140	60	12	23	3	14	<8
LY06	2.8-3.0	95.0	5.8	.33	3.4	.53	.40	.23	.01	.28	<10	290	1	<10	<2	110	53	15	15	<2	13	<8
	3.1-3.4	95.0	5.4	.30	3.6	.40	.37	.15	.01	.23	10	260	1	<10	<2	59	51	13	17	<2	11	<8

Table 12.--*Ash content and chemical analysis of ashed overburden core samples from lysimeter boreholes*--Continued

Lysimeter borehole (fig. 4)	Sample interval (feet)	Percent ash	Al	Ca	Fe	K	Mg	Na	P	Ti	As	Ba	Be	Bi	Cd	Ce	Cr	Co	Cu	Eu	Ga	Au
										Preglacial deposit												
LY02	10.0-10.3	96.6	4.7	0.33	1.4	0.83	0.27	0.49	0.01	0.33	<10	390	1	<10	<2	64	48	4	11	<2	10	<8
	11.6-12.1	96.6	4.7	.32	1.4	.84	.28	.49	.01	.36	<10	380	<1	<10	<2	64	47	6	17	<2	11	<8
	13.6-13.8	95.4	5.7	.34	3.4	.70	.36	.29	.03	.36	10	340	1	<10	<2	61	58	12	15	<2	13	<8
										Residuum												
LY02	13.8-14.1	94.7	6	0.50	2.9	0.75	0.40	0.30	0.02	0.44	<10	360	1	<10	<2	68	58	12	15	<2	15	<8

Table 12.--*Ash content and chemical analysis of ashed overburden core samples from lysimeter boreholes*--Continued

Lysimeter borehole (fig. 4)	Sample interval (feet)	Ho	La	Pb	Li	Mn	Mo	Nd	Ni	Nb	Sc	Ag	Sr	Ta	Th	Sn	U	V	Yb	Y	Zn
									Peoria Loess												
LY03	1.2-1.7	<4	38	20	31	320	<2	32	26	11	12	<2	120	<40	10	<5	<100	120	2	18	76
	1.7-2.3	<4	49	19	27	460	<2	43	25	9	11	<2	150	<40	13	<5	<100	100	3	24	68
									Roxanna Silt												
LY01	2.3-2.8	<4	42	19	29	960	<2	35	25	10	8	<2	94	<40	11	<5	<100	89	2	25	42
LY03	2.9-3.7	<4	37	17	29	550	<2	30	29	8	8	<2	150	<40	8	<5	<100	80	2	24	55
	3.9-4.4	<4	40	23	29	1,200	<2	33	30	11	7	<2	120	<40	10	<5	<100	71	2	21	40
									Ferrelview Formation												
LY01	4.8-5.4	<4	33	10	31	180	<2	28	23	11	11	<2	73	<40	12	<5	<100	99	2	16	48
LY02	1.0-1.5	<4	36	21	25	1,100	<2	32	19	9	8	<2	96	<40	10	<5	<100	81	2	17	36
	1.8-2.2	<4	33	16	26	440	<2	27	18	9	9	<2	72	<40	11	<5	<100	76	2	14	37
LY03	5.2-6.1	<4	30	25	35	470	<2	25	21	10	10	<2	77	<40	11	<5	<100	99	2	14	44
	8.7-9.1	<4	26	16	25	96	<2	21	18	10	9	<2	56	<40	11	<5	<100	87	1	10	43
LY04	1.0-1.5	<4	30	14	24	220	<2	26	13	9	8	<2	89	<40	13	<5	<100	74	1	12	36
LY06	0.9-1.1	<4	30	21	29	270	<2	29	25	9	9	<2	65	<40	11	<5	<100	94	2	16	45
LY09	0.4-0.7	<4	31	17	22	180	<2	27	14	8	7	<2	69	<40	8	<5	<100	64	1	15	30
	2.7-3.0	<4	29	16	23	190	<2	24	13	9	7	<2	66	<40	10	<5	<100	66	1	13	29
									Clay till												
LY01	8.5-9.0	<4	34	23	28	850	<2	27	33	9	9	<2	74	<40	10	<5	<100	94	2	15	47
	10.3-10.6	<4	33	15	25	640	<2	26	25	8	7	<2	73	<40	8	<5	<100	69	1	14	37
	11.8-12.1	<4	92	24	23	1,400	2	65	39	6	7	<2	68	<40	9	<5	<100	99	3	32	43
LY02	3.4-3.7	<4	28	22	27	530	<2	25	25	9	8	<2	77	<40	11	<5	<100	89	2	14	41
	4.6-4.9	<4	65	19	28	710	<2	57	41	10	9	<2	99	<40	10	<5	<100	100	2	25	61
	5.4-5.7	<4	38	16	30	550	<2	28	46	10	11	<2	77	<40	11	<5	<100	130	3	28	67
	7.8-8.4	<4	40	12	28	190	<2	33	18	12	9	<2	74	<40	11	<5	<100	68	1	16	49
	8.4-8.8	<4	40	18	28	350	<2	34	19	12	9	<2	73	<40	13	<5	100	71	2	16	53
LY03	10.5-11.0	<4	23	19	25	92	<2	19	22	10	9	<2	60	<40	10	<5	<100	88	1	9	41
	11.3-12.0	<4	24	17	36	96	<2	18	28	12	10	<2	66	<40	11	<5	<100	94	1	10	48
	13.0-13.6	<4	230	29	36	590	<2	200	56	10	10	<2	110	<40	9	<5	<100	96	6	95	61
	14.7-15.0	<4	61	19	29	460	<2	52	29	11	11	<2	130	<40	11	<5	<100	110	2	26	68
	15.0-15.3	<4	120	15	32	940	<2	100	56	10	10	<2	110	<40	11	<5	<100	96	48	4	60
LY04	4.4-4.9	<4	39	21	30	1,600	2	31	57	10	10	<2	100	<40	12	<5	<100	110	2	23	69
	5.9-6.3	<4	92	20	29	1,200	<2	84	52	9	10	<2	100	<40	11	<5	<100	100	4	45	62
LY06	2.8-3.0	<4	30	18	30	320	<2	23	28	8	9	<2	54	<40	10	<5	<100	84	1	14	41
	3.1-3.4	<4	27	16	28	200	<2	22	26	6	8	<2	50	<40	8	<5	<100	83	1	13	46

Table 12.--*Ash content and chemical analysis of ashed overburden core samples from lysimeter boreholes*--Continued

Lysimeter borehole (fig. 4)	Sample interval (feet)	Ho	La	Pb	Li	Mn	Mo	Nd	Ni	Nb	Sc	Ag	Sr	Ta	Th	Sn	U	V	Yb	Y	Zn
									Preglacial deposit												
LY02	10.0-10.3	<4	35	10	22	160	<2	28	13	9	7	<2	69	<40	10	<5	<100	57	1	13	38
	11.6-12.1	<4	38	15	24	130	<2	30	12	9	7	<2	70	<40	11	<5	<100	55	1	15	41
	13.6-13.8	<4	37	21	33	440	<2	27	27	10	8	<2	53	<40	12	<5	<100	120	1	16	48
									Residuum												
LY02	13.8-14.1	<4	40	24	36	400	<2	31	23	12	9	<2	57	<40	12	<5	<100	110	2	16	52

TABLE 13

ABBREVIATIONS AND REPORTING UNITS FOR CHEMICAL CONSTITUENTS AND NOTATIONS USED IN TABLE

Depth	Total depth of well, in feet
Cond	Specific conductance, in microsiemens per centimeter at 25 degrees Celsius
pH	In standard units
Eh	Oxidation reduction potential, in millivolts
Temp	Temperature, in degrees Celsius
DO	Dissolved oxygen, in milligrams per liter
Ca	Calcium, dissolved, in milligrams per liter
Mg	Magnesium, dissolved, in milligrams per liter
Na	Sodium, dissolved, in milligrams per liter
K	Potassium, dissolved, in milligrams per liter
HCO_3	Bicarbonate, incremental titration, in milligrams per liter
CO_3	Carbonate, incremental titration, in milligrams per liter
Alk	Alkalinity, incremental titration, total as $CaCO_3$, in milligrams per liter
Alk (EP)	Alkalinity, end point titration to pH 4.5, total as $CaCO_3$, in milligrams per liter
SO_4	Sulfate, dissolved, in milligrams per liter
Cl	Chloride, dissolved, in milligrams per liter
F	Fluoride, dissolved, in milligrams per liter
Br	Bromide, dissolved, in milligrams per liter
SiO_2	Silica, dissolved, in milligrams per liter
DS	Dissolved solids, residue at 180 degrees Celsius, in milligrams per liter
TOC	Total organic carbon, in milligrams per liter
NO_2	Nitrite, dissolved as nitrogen, in milligrams per liter
NO_2+NO_3	Nitrite plus nitrate, dissolved as nitrogen, in milligrams per liter

NH_3	Ammonia, dissolved as nitrogen, in milligrams per liter
$(NH_3+ON)_t$	Ammonia plus organic nitrogen, total as nitrogen, in milligrams per liter
P	Phosphorus, dissolved, in milligrams per liter
P_t	Phosphorus, total as nitrogen, in milligrams per liter
PO_4	Orthophosphate, dissolved as phosphorous, in milligrams per liter
As	Arsenic, dissolved, in micrograms per liter
Ba	Barium, dissolved, in micrograms per liter
Be	Beryllium, dissolved, in micrograms per liter
B	Boron, dissolved, in micrograms per liter
Cd	Cadmium, dissolved, in micrograms per liter
Cr	Chromium, dissolved, in micrograms per liter
Co	Cobalt, dissolved, in micrograms per liter
Cu	Copper, dissolved, in micrograms per liter
Fe	Iron, dissolved, in micrograms per liter
Pb	Lead, dissolved, in micrograms per liter
Li	Lithium, dissolved, in micrograms per liter
Mn	Manganese, dissolved, in micrograms per liter
Mo	Molybdenum, dissolved, in micrograms per liter
Ni	Nickel, dissolved, in micrograms per liter
Se	Selenium, dissolved, in micrograms per liter
Ag	Silver, dissolved, in micrograms per liter
Sr	Strontium, dissolved, in micrograms per liter
V	Vanadium, dissolved, in micrograms per liter
Zn	Zinc, dissolved, in micrograms per liter
U	Uranium, dissolved, in micrograms per liter
Trit	Tritium, total, in picocuries per liter

Table 13.--*Water-quality data for samples from selected monitoring wells*

[--, no data; >, greater than; <, less than]

Local identifier (fig. 6)	Date	Time	Depth	Cond	pH	Eh	Temp	DO	Ca	Mg
MWS-02	08-23-90	1445	55.80	402	7.5	--	14.0	0.9	41	25
MWD-02	08-23-90	1100	125.10	438	7.4	--	13.0	<.05	42	31
MWS-05	08-22-90	1700	67.00	468	7.5	--	13.5	.8	38	37
MWD-05	08-29-90	0850	116.10	481	7.2	--	13.0	.6	48	33
MWS-06	08-22-90	1330	60.00	594	7.1	--	13.5	.3	64	39
MWD-06	08-22-90	1445	129.50	603	7.5	--	14.0	.4	62	36
MWS-09	08-21-90	1428	46.60	456	6.3	313	15.0	.5	62	21
MWD-09	08-21-90	1523	146.00	470	6.8	--	15.0	.9	58	25
MWS-15	08-21-90	1246	48.00	478	6.6	353	14.5	>1.0	75	12
MWD-15	08-21-90	1124	133.50	378	7.8	289	15.0	1.0	35	19
MWS-18	08-22-90	1020	72.00	928	7.3	358	14.5	>1.0	70	43
MWD-18	08-20-90	0900	133.00	512	7.3	--	13.5	.3	43	41
MWS-105	08-24-90	0935	69.20	439	7.5	--	13.5	--	44	32
MWD-105	08-24-90	0835	150.00	593	7.2	--	13.5	.9	59	43
MWS-106	06-12-90	1650	48.00	500	7.3	--	--	<.05	57	32
MWD-106	06-12-90	1800	148.20	544	7.2	--	13.0	2.0	58	37
MWS-109	08-28-90	1310	75.50	543	6.9	--	13.5	.7	61	36
MWD-109	08-28-90	1410	138.50	543	7.2	--	13.0	.8	61	36

Table 13.--*Water-quality data for samples from selected monitoring wells*--Continued

Local identifier (fig. 6)	Date	Na	K	HCO_3	CO_3	Alk	Alk (EP)	SO_4	Cl	F
MWS-02	08-23-90	6.0	0.50	258	0	212	211	--	3.1	1.1
MWD-02	08-23-90	7.1	.40	308	0	252	248	18	3.0	1.1
MWS-05	08-22-90	5.4	.80	312	0	256	250	20	3.1	1.0
MWD-05	08-29-90	7.9	5.3	308	0	252	251	24	3.7	1.2
MWS-06	08-22-90	9.9	.80	403	0	330	328	24	3.6	.20
MWD-06	08-22-90	7.8	.40	403	0	330	329	21	3.6	1.1
MWS-09	08-21-90	6.4	.50	303	0	248	240	13	3.3	1.0
MWD-09	08-21-90	8.1	.60	312	0	256	247	10	3.2	1.1
MWS-15	08-21-90	9.1	1.8	266	0	218	211	39	4.6	1.1
MWD-15	08-21-90	16	2.3	229	0	188	183	8.5	4.0	1.1
MWS-18	08-22-90	70	6.4	435	0	357	342	250	9.6	1.0
MWD-18	08-20-90	6.6	2.1	339	0	278	276	15	4.6	<.10
MWS-105	08-24-90	5.4	.80	303	0	248	244	13	3.8	.20
MWD-105	08-24-90	6.6	1.0	393	0	322	321	29	3.9	1.2
MWS-106	06-12-90	8.5	.70	348	0	285	281	10	4.4	.30
MWD-106	06-12-90	6.2	1.2	393	0	322	318	16	4.7	.90
MWS-109	08-28-90	5.7	.70	371	0	304	306	14	3.6	.40
MWD-109	08-28-90	8.2	1.2	366	0	300	298	18	4.9	.20

Table 13.--*Water-quality data for samples from selected monitoring wells*--Continued

Local identifier (fig. 6)	Date	Br	SiO_2	DS	TOC	NO_2	NO_2+NO_3	NH_3	$(NH_3+ON)_t$
MWS-02	08-23-90	--	8.1	210	0.3	<0.01	<0.10	0.02	<0.20
MWD-02	08-23-90	--	7.8	217	.2	<.01	<.10	<.01	<.20
MWS-05	08-22-90	--	7.7	248	.6	.01	<.10	.01	.30
MWD-05	08-29-90	--	7.9	272	.7	.03	<.10	.07	<.20
MWS-06	08-22-90	--	12	328	--	<.01	<.10	.03	1.7
MWD-06	08-22-90	--	10	314	.3	<.01	<.10	<.01	<.20
MWS-09	08-21-90	--	8.7	242	.3	.01	<.10	<.01	<.20
MWD-09	08-21-90	--	9.6	256	.3	.02	.60	<.01	<.20
MWS-15	08-21-90	--	12	291	.9	.01	2.1	<.01	.20
MWD-15	08-21-90	--	11	221	1.5	.04	3.6	.15	.50
MWS-18	08-22-90	--	11	611	2.2	.02	.50	<.01	.30
MWD-18	08-20-90	--	8.0	267	.8	.01	<.10	<.01	.20
MWS-105	08-24-90	--	8.3	244	--	<.01	<.10	<.01	.30
MWD-105	08-24-90	--	8.4	326	1.0	<.01	<.10	.01	<.20
MWS-106	06-12-90	0.02	9.2	267	.4	<.01	<.10	.03	<.20
MWD-106	06-12-90	.04	8.1	289	1.5	<.01	<.10	.03	.40
MWS-109	08-28-90	--	8.4	286	.8	<.01	<.10	.01	<.20
MWD-109	08-28-90	--	8.3	296	.4	<.01	<.10	.02	<.20

Table 13.--*Water-quality data for samples from selected monitoring wells*--Continued

Local identifier (fig. 6)	Date	P	P_t	PO_4	As	Ba	Be	B	Cd
MWS-02	08-23-90	0.06	0.07	0.02	<1	100	<0.5	<10	<1.0
MWD-02	08-23-90	.06	.06	.02	2	160	<.5	10	<1.0
MWS-05	08-22-90	.02	.03	.02	1	110	<.5	20	<1.0
MWD-05	08-29-90	.06	.06	.04	<1	110	<.5	300	1.0
MWS-06	08-22-90	.78	.89	<.01	2	110	<.5	10	2.0
MWD-06	08-22-90	.27	.25	.22	2	160	<.5	10	<1.0
MWS-09	08-21-90	.03	.03	.02	<1	130	<.5	<10	<1.0
MWD-09	08-21-90	.39	.39	.34	1	140	<.5	<10	<1.0
MWS-15	08-21-90	.05	.06	.05	<1	74	<.5	20	1.0
MWD-15	08-21-90	1.5	1.5	1.2	4	73	<.5	20	<1.0
MWS-18	08-22-90	.21	.25	.18	2	33	<.5	250	<1.0
MWD-18	08-20-90	.03	.04	.03	<1	130	<.5	50	<1.0
MWS-105	08-24-90	.07	.09	.05	4	140	<.5	<10	10
MWD-105	08-24-90	.04	.03	.02	<1	110	<.5	10	<1.0
MWS-106	06-12-90	.07	.09	.07	<1	220	<.5	<10	<1.0
MWD-106	06-12-90	.04	.09	.02	<1	150	<.5	<10	<1.0
MWS-109	08-28-90	.04	.02	.03	<1	170	<.5	<10	3.0
MWD-109	08-28-90	.02	.02	.02	<1	130	<.5	<10	<1.0

Table 13.--*Water-quality data for samples from selected monitoring wells*--Continued

Local identifier (fig. 6)	Date	Cr	Co	Cu	Fe	Pb	Li	Mn	Mo
MWS-02	08-23-90	<5	<3	<10	7	1	7	2	<10
MWD-02	08-23-90	<5	<3	<10	27	1	9	160	<10
MWS-05	08-22-90	<5	<3	<10	3	<1	6	21	<10
MWD-05	08-29-90	<5	<3	<10	6	2	20	22	<10
MWS-06	08-22-90	<5	<3	<10	100	<1	9	81	<10
MWD-06	08-22-90	<5	<3	<10	12	1	11	79	<10
MWS-09	08-21-90	<5	<3	<10	7	2	13	20	<10
MWD-09	08-21-90	<5	<3	<10	14	2	9	3	<10
MWS-15	08-21-90	<5	<3	<10	3	<1	9	1	<10
MWD-15	08-21-90	<5	<3	<10	8	<1	5	5	<10
MWS-18	08-22-90	<5	<3	20	4	<1	17	18	<10
MWD-18	08-20-90	<5	<3	<10	16	1	10	10	<10
MWS-105	08-24-90	<5	<3	<10	3	<1	6	80	<10
MWD-105	08-24-90	<5	<3	<10	17	1	8	38	<10
MWS-106	06-12-90	<1	<3	1	16	3	7	110	<10
MWD-106	06-12-90	<1	<3	1	18	<1	9	19	<10
MWS-109	08-28-90	<5	<3	<10	<3	1	7	16	<10
MWD-109	08-28-90	<5	<3	<10	18	2	8	15	<10

Table 13.--*Water-quality data for samples from selected monitoring wells*--Continued

Local identifier (fig. 6)	Date	Ni	Se	Ag	Sr	V	Zn	U	Trit
MWS-02	08-23-90	1	--	<1.0	94	<6	7	--	<5.7
MWD-02	08-23-90	2	--	1.0	110	<6	9	--	<5.7
MWS-05	08-22-90	<5	--	<1.0	130	<6	5	--	<5.7
MWD-05	08-29-90	<2	--	<1.0	1,200	<6	36	--	--
MWS-06	08-22-90	<1	--	<1.0	230	<6	79	--	<5.7
MWD-06	08-22-90	5	--	<1.0	150	<6	15	--	<5.7
MWS-09	08-21-90	2	--	<1.0	120	<6	13	--	--
MWD-09	08-21-90	1	--	<1.0	140	<6	19	--	<5.7
MWS-15	08-21-90	<2	--	<1.0	120	<6	6	--	42
MWD-15	08-21-90	<1	--	<1.0	150	<6	15	--	--
MWS-18	08-22-90	<4	--	<1.0	430	<6	14	--	--
MWD-18	08-20-90	1	--	<1.0	410	<6	18	--	<5.7
MWS-105	08-24-90	10	--	<1.0	100	<6	15	--	--
MWD-105	08-24-90	<1	--	<1.0	180	<6	15	--	<5.7
MWS-106	06-12-90	2	<1	<1.0	140	<6	7	0.60	--
MWD-106	06-12-90	1	<1	<1.0	160	<6	8	.30	--
MWS-109	08-28-90	4	--	<1.0	160	<6	12	--	--
MWD-109	08-28-90	2	--	<1.0	180	<6	19	--	--

Table 14.--*Quality assurance and quality control data for nitroaromatic sampling during 1992*

[QC, quality control; TNT, 2,4,6-trinitrotoluene; 4-Am, 4-amino-2,6-dinitrotoluene; 2-Am, 2-amino-4,6-dinitrotoluene; TNB, trinitrobenzene; 3,5-DNA, 3,5-dinitroaniline; DNB, 1,3-dinitrobenzene; 2,4-DNT, 2,4-dinitrotoluene; 2,6-DNT, 2,6-dinitrotoluene; 2-NT, 2-nitrotoluene; 3-NT, 3-nitrotoluene; 4-NT, 4-nitrotoluene; NB, nitrobenzene; 2-3-DNT, 2,3-dinitrotoluene; --, not applicable; <, constituent not detected at the reported level; nt, not tested; µg/L, micrograms per liter]

QC group no.	Description	Date	TNT	4-Am	2-Am	TNB	3,5-DNA	DNB	2,4-DNT	2,6-DNT	2-NT	3-NT	4-NT	NB	2,3-DNT
1	Lab blank, concentration	--	<0.5	<0.3	<0.5	<0.3	nt	nt	<0.5	<0.5	nt	nt	nt	<0.5	nt
1	Percent recovery, 5 µg/L spike	--	72	80	70	19	nt	nt	122	112	nt	nt	nt	nt	nt
1	[a]MWV-09, concentration	06-01-92	38	nt	nt	14	nt	<.25	28	<.5	<.25	<.25	<.25	8.4	nt
1	[a]MWS-15, concentration	06-01-92	8.2	nt	nt	1.7	nt	<0.25	<.25	<.25	<0.25	<0.25	<0.25	<.25	nt
1	[a]MWV-16, concentration	06-01-92	4.5	nt	nt	6.2	nt	<.25	<.5	<.5	<.25	<.25	<.25	<.25	nt
1	[a]MWS-16, concentration	06-01-92	1.5	nt	nt	8.4	nt	<.25	<.25	<.25	<.25	<.25	<.25	<.25	nt
1	[a]MWS-21, concentration	06-03-92	3.4	nt	nt	<.5	nt	<.25	.6	<.25	<.25	<.25	<.25	<.25	nt
1	[a]MWV-22, concentration	06-02-92	<.5	nt	nt	<.5	nt	<.25	<.5	<.5	<.25	<.25	<.25	<.25	nt
1	MWV-22 field duplicate, concentration	06-02-92	[b]<.5	.5	<.5	<.3	nt	nt	[b]<.5	<.5	nt	nt	nt	nt	nt
4	Lab blank, concentration	--	<.5	<.5	<.4	<.5	<0.4	nt	<.3	<.5	nt	nt	nt	<.5	nt
4	Percent recovery, 1.25 µg/L spike	--	101	95	100	63	nt	nt	101	101	nt	nt	nt	58	nt
4	MWS-21, lab duplicate, concentration	--	.8	1.3	.4	<.5	nt	nt	.4	<.5	nt	nt	nt	nt	nt
4	MWS-21, field duplicate, concentration	08-19-92	.9	1.4	.4	<.5	nt	nt	.4	<.5	nt	nt	nt	nt	nt
5	Lab blank, concentration	--	<.5	<.5	<.5	<.5	<.25	<.5	<.5	<.5	<.5	<.5	<.5	<.5	nt
5	Percent recovery, 1.0 µg/L spike	--	90	nt	nt	30	nt	54	79	90	44	44	60	34	nt
5	MWV-09, lab duplicate, concentration	--	7.8	21	14.5	1.6	.4	nt	.8	3.3	nt	nt	nt	nt	nt
5	[a]MWS-15, concentration	11-16-92	5.9	15	14	.8	nt	<.25	<1	2.2	<.25	<.25	<.25	<.25	nt

Table 14.--*Quality assurance and quality control data for nitroaromatic sampling during 1992*--Continued

QC group no.	Description	Date	TNT	4-Am	2-Am	TNB	3,5-DNA	DNB	2,4-DNT	2,6-DNT	2-NT	3-NT	4-NT	NB	2,3-DNT
6	Field blank, concentration	12-10-92	<0.1	<0.1	<0.1	<0.1	<0.25	<0.25	<0.1	<0.1	<0.25	<0.25	<0.25	<0.25	nt
6	MWS-09, field duplicate, concentration	12-08-92	<.1	<.1	<.1	<.1	<.25	<.25	<.1	<.1	<.25	nt	nt	nt	nt
6	Lab blanks, 6 total, concentration	--	<.1	<.1	<.1	<.1	<.25	<.25	<.1	<.1	<.25	<.25	<.25	<.25	nt
6	Average percent recovery from three 1.5 µg/L spikes	--	81	94	92	34	67	32	64	86	nt	59	45	32.4	nt
6	MWS-22, lab duplicate, concentration	--	<.1	.2	[b]<.1	<.1	<.25	<.25	<.1	[c]<.1	<.25	<.25	<.25	<.25	nt
7	Lab blanks, 3 total, concentration	--	<.1	<.1	<.1	<.1	<.25	<.25	<.1	<.1	<.25	<.25	<.25	<.25	nt
7	Average percent recovery from three 1.5 µg/L spikes	--	81	94	92	34	67	nt	64	86	nt	59	45	32	nt
7	MW-4001, lab duplicate, concentration	--	1.8	23.4	16.3	32.1	3.82	<.25	2.9	4.6	<.25	<.25	<.25	<.25	nt
7	MWS-24, lab duplicate, concentration	--	.4	3.6	1.7	.8	.2	<.25	<.1	.6	<.25	<.25	<.25	<.25	nt
8	Lab blank, concentration	--	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5	nt
8	Percent recovery, 2.0 µg/L spike	--	87	106	78	80	103	nt	92	95	nt	80	70	87	nt

[a] Split sample results from U.S. Army contract laboratory (Mary Jank, International Technology Corporation, written commun., August 25, 1992).

[b] Constituent may be present at or below the reported value but could not be spectrally confirmed.

[c] Constituent detected and spectrally confirmed below the reported value but could not be quantified because of small concentration or interference.

Table 15.--*Concentration of nitroaromatic compounds in selected ground-water sites sampled during 1992*

[QC, quality control; TNT, 2,4,6-trinitrotoluene; 4-Am, 4-amino-2,6-dinitrotoluene; 2-Am, 2-amino-4,6-dinitrotoluene; TNB, trinitrobenzene; 3,5-DNA, 3,5-dinitroaniline; DNB, 1,3-dinitrobenzene; 2,4-DNT, 2,4-dinitrotoluene; 2,6-DNT, 2,6-dinitrotoluene; 2-NT, 2-nitrotoluene; 3-NT, 3-nitrotoluene; 4-NT, 4-nitrotoluene; NB, nitrobenzene; 2-3-DNT, 2,3-dinitrotoluene; --, not applicable; <, constituent not detected at the reported level; nt, not tested; µg/L, micrograms per liter; t, detected in trace quantity but not quantified]

Site name (fig. 7)	QC group number (table 14)	Sample date	TNT	4-Am	2-Am	TNB	3,5-DNA	DNB	2,4-DNT	2,6-DNT	2-NT	3-NT	4-NT	NB	2,3-DNT
Burgermeister spring	7	12-16-92	0.4	0.7	0.3	<0.10	[a]<0.10	<0.25	0.23	[a]<0.1	<0.25	<0.25	<0.25	<0.25	nt
MW-4001	7	12-17-92	2.2	24.7	17.0	44.4	5.1	<.10	3.0	4.7	<.10	<.10	<.10	<.10	nt
MWS-06	6	12-08-92	<.1	<.1	<.1	<.1	<.25	<.25	<.1	<.1	<.25	<.25	<.25	<.25	nt
MWS-07	7	12-15-92	1.5	11.5	5.5	10.1	.60	<.10	<.1	[a]<1.0	<.10	<.10	<.10	<.10	nt
MWV-09	1	06-01-92	33.9	22.8	31.8	3.8	<.25	nt	32.0	<.5	nt	nt	nt	<.50	nt
	5	11-16-92	45.3	25.1	40.0	14.2	8.9	<.50	24.1	[b]<.2	<.50	<.50	<.50	<.50	nt
	6	12-08-92	61.5	29.2	42.9	20.5	19.6	<.25	24.6	<.1	<.25	<.25	<.25	<.25	nt
MWS-09	6	12-08-92	<.1	<.1	<.1	<.1	<.25	<.25	<.1	<.1	<.25	<.25	<.25	<.25	nt
MWS-11	6	12-08-92	[a].9	2.8	.6	<.1	.33	<.25	[a]<.1	.6	<.25	<.25	<.25	<.25	t
MWS-12	6	12-10-92	<.1	1.3	.5	.2	1.5	<.25	1.5	8.5	9.2	.60	.60	<.25	nt
MWS-15	1	06-01-92	5.9	24.0	15.2	.8	nt	nt	[b]<.5	[b]<.5	nt	nt	nt	<.50	nt
	5	11-16-92	7.8	17.8	11.2	1.1	.30	<.5	.8	3.4	<.50	<.50	<.50	<.50	nt
	6	12-09-92	9.2	22.3	14	2.4	.90	<.25	.3	2.2	<.25	<.25	<.25	<.25	t
MWD-15	6	12-09-92	<.1	2.1	.8	<.1	.40	<.25	[a]<.1	1	<.25	<.25	<.25	<.25	t
MWV-16	1	06-01-92	2.7	5.9	4.1	1.1	nt	nt	[b]<.5	[b]<.5	nt	nt	nt	<.50	nt
MWS-16	1	06-01-92	3.6	8.9	5	2.7	nt	nt	[b]<.5	[b]<.5	nt	nt	nt	<.50	nt
	6	12-09-92	2.6	9.2	5	3.4	1.2	<.25	.15	1.8	<.25	<.25	<.25	<.25	t
MWS-17	6	12-09-92	<.1	6.9	3.1	<.1	3.7	<.25	44.0	61.4	21	.90	3.8	<.25	nt
MWS-21	1	06-03-92	2.3	2.6	[b]<.5	.3	nt	nt	[b]<.5	<.5	nt	nt	nt	<.50	nt
	4	08-19-92	.8	1.2	.4	<.5	t	nt	.3	<.5	nt	nt	nt	<.50	nt
	7	12-15-92	.5	.8	.3	<.1	.30	<.10	.6	.1	<.10	<.10	<.10	<.10	nt

Table 15.--*Concentration of nitroaromatic compounds in selected ground-water sites sampled during 1992*--Continued

Site name (fig. 7)	QC group number (table 14)	Sample date	TNT	4-Am	2-Am	TNB	3,5-DNA	DNB	2,4-DNT	2,6-DNT	2-NT	3-NT	4-NT	NB	2,3-DNT
MWV-22	1	06-02-92	[a]<0.5	0.5	<0.5	<0.3	nt	nt	[a]<0.5	<0.5	nt	nt	nt	<0.50	nt
	4	08-19-92	<.5	.2	[a]<.5	<.5	t	nt	<.3	<.5	nt	nt	nt	<.50	nt
	6	12-10-92	<.1	.2	[a]<.1	<.1	<0.25	<0.25	<.1	[a]<.1	<0.25	<0.25	<0.25	<.25	nt
MWS-22	6	12-10-92	<.1	.2	[a]<.1	<.1	<.25	<.25	<.1	[a]<.1	<.25	<.25	<.25	<.25	nt
MWS-23	1	06-02-92	<.5	<.3	<.5	<.3	nt	nt	<.5	<.5	nt	nt	nt	<.50	nt
	4	08-19-92	<.5	<.5	<.4	<.5	<.50	nt	<.3	<.5	nt	nt	nt	<.50	nt
MWS-24	7	12-15-92	.3	3.8	1.9	1.7	.60	<.25	<.1	.2	<.25	<.25	<.25	<.25	nt
USGS-1	7	12-16-92	<.1	.3	[a]<.1	.1	.60	<.25	[a]<.1	[a].2	<.25	<.25	<.25	<.25	nt
USGS-3	7	12-16-92	<.1	.1	<.1	.2	[a]<.10	<.25	[a]<.1	[a]<.1	<.25	<.25	<.25	<.25	nt
USGS-4	7	12-16-92	<.1	1.4	1.1	.9	1	<.25	.6	1.8	<.25	<.25	<.25	<.25	t
USGS-7	7	12-16-92	<.1	<.1	<.1	<.1	<.10	<.25	<.1	<.1	<.25	<.25	<.25	<.25	nt

[a] Constituent may be present at or below the reported value but could not be spectrally confirmed.

[b] Constituent detected and spectrally confirmed below the reported value but could not be quantified because of small concentration or interference.

Table 16.--*Discharge, specific conductance, and temperature at seepage sites for the Dardenne Creek seepage run, June 25-26, 1990*

[Latitude and longitude are in degrees, minutes, and seconds (DDMMSS); Q, instantaneous discharge in cubic feet per second; cond, specific conductance in microsiemens per centimeter at 25 degrees Celsius; temp, water temperature in degrees Celsius; e, estimated; --, no data]

Map letter or number (fig. 8)	Site designation	Latitude (DDMMSS)	Longitude (DDDMMSS)	Date	Q	Cond	Temp
A	Dardenne Creek at County Road DD bridge	384404	0904810	6-25-90	3.05	397	26.0
2	South tributary of Dardenne Creek 100 feet downstream from County Road DD bridge	384403	0904811	6-25-90	.05e	--	--
3	South tributary of Dardenne Creek 0.4 mile downstream from County Road DD bridge	384358	0904752	6-25-90	.03e	--	--
4	South tributary of Dardenne Creek 0.6 mile downstream from County Road DD bridge	384354	0904737	6-25-90	<.01e	--	--
5	Dardenne Creek 0.8 mile downstream from County Road DD bridge	384401	0904724	6-25-90	2.98	393	26.0
6	North tributary of Dardenne Creek 1.1 miles downstream from County Road DD bridge	384411	0904708	6-25-90	.89	299	21.0
7	South tributary of Dardenne Creek 1.3 miles downstream from County Road DD bridge	384406	0904703	6-25-90	Dry	--	--
B	Dardenne Creek 1.3 miles downstream from County Road DD bridge	384407	0904702	6-25-90	4.19	362	25.0
9	North tributary of Dardenne Creek 1.9 miles downstream from County Road DD bridge	384413	0904636	6-25-90	Dry	--	--
10	Outflow from Busch Lake 33 1.9 miles upstream from U.S. Highways 40 and 61 bridge	384415	0904543	6-25-90	.56	318	28.5
11	Dardenne Creek 1.7 miles upstream from U.S. Highways 40 and 61 bridge	384422	0904525	6-25-90	4.99	383	24.5
12	North tributary of Dardenne Creek 1.7 miles upstream from U.S. Highways 40 and 61 bridge	384422	0904520	6-25-90	Dry	--	--
13	South tributary of Dardenne Creek 1.5 miles upstream from U.S. Highways 40 and 61 bridge	384409	0904518	6-25-90	.03	260	19.5
14	Dardenne Creek 1.3 miles upstream from U.S. Highways 40 and 61 bridge	384408	0904504	6-25-90	5.14	378	25.5
15	South tributary of Dardenne Creek 0.8 mile upstream from U.S. Highways 40 and 61 bridge	384408	0904450	6-25-90	.24	315	17.5
16	North tributary of Dardenne Creek 0.5 mile upstream from U.S. Highways 40 and 61 bridge	384414	0904442	6-25-90	.29	492	18.5
17	West fork of tributary 6400 at Busch Road C	384343	0904452	6-25-90	Dry	--	--
18	East fork of tributary 6400 at Busch Road C	384343	0904446	6-25-90	Dry	--	--
19	Tributary 6400 100 feet downstream from Busch Road C	384347	0904447	6-25-90	Dry	--	--
20	Tributary 6400 0.2 mile downstream from Busch Road C	384353	0904449	6-25-90	Pooled	120	17.0
G	Tributary 6400 100 feet upstream from mouth	384406	0904443	6-25-90	.04	165	17.0
C	Dardenne Creek 0.1 mile upstream from U.S. Highways 40 and 61 bridge	384402	0904424	6-25-90 6-26-90	5.90 5.10	369 458	27.0 24.0
23	South tributary of Dardenne Creek 0.2 mile downstream from U.S. Highways 40 and 61 bridge	384401	0904408	6-26-90	.10	280	21.5

Table 16.--*Discharge, specific conductance, and temperature at seepage sites for the Dardenne Creek seepage run, June 25-26, 1990*--Continued

Map letter or number (fig. 8)	Site designation	Latitude (DDMMSS)	Longitude (DDDMMSS)	Date	Q	Cond	Temp
24	North tributary of Dardenne Creek 0.3 mile downstream from U.S. Highways 40 and 61 bridge	384409	0904413	6-26-90	0.01	528	21.5
25	Dardenne Creek upstream from slough 0.5 mile downstream from U.S. Highways 40 and 61 bridge	384408	0904355	6-26-90	6.08	376	24.0
26	Slough at Twin Island Lake 0.4 mile upstream from mouth	384356	0904341	6-26-90	Dry	--	--
27	Slough at Twin Island Lake 0.2 mile upstream from mouth	384359	0904350	6-26-90	Pooled	--	--
28	Slough at Twin Island Lake near mouth	384406	0904353	6-26-90	.02	528	25.5
29	North tributary of Dardenne Creek 0.6 mile downstream from U.S. Highways 40 and 61 bridge	384412	0904348	6-26-90	Pooled	--	--
30	North tributary of Dardenne Creek 0.6 mile downstream from U.S. Highways 40 and 61 bridge	384410	0904343	6-26-90	.01	--	--
31	North tributary of Dardenne Creek 0.8 mile downstream from U.S. Highways 40 and 61 bridge	384411	0904347	6-26-90	Dry	--	--
32	North tributary of Dardenne Creek 0.1 mile downstream from Henning Road	384413	0904310	6-26-90	Dry	--	--
33	Dardenne Creek 0.3 mile downstream from Henning Road	384413	0904300	6-26-90	6.61	370	24.0
D	Dardenne Creek 150 feet upstream from Burgermeister branch	384416	0905432	6-26-90	7.01	360	24.0
34	Burgermeister branch tributary 0.3 mile upstream from Busch Lake 34	384258	0904428	6-26-90	.05	430	15.5
35	Spring branch into Burgermeister branch tributary 0.3 mile upstream from Busch Lake 34	384259	0904427	6-26-90	.06	--	12.5
36	Burgermeister branch 50 feet upstream from Burgermeister spring	384304	0904419	6-26-90	.14	435	16.0
37	Burgermeister spring	384304	0904418	6-26-90	.14	665	13.0
38	Burgermeister branch tributary 100 feet upstream from Busch Lake 34	384306	0904414	6-26-90	.30	540	16.0
39	Burgermeister branch tributary 100 feet downstream from U.S. Highways 40 and 61	384339	0904353	6-26-90	1.72	240	27.0
H	Burgermeister branch tributary 0.2 mile downstream from U.S. Highways 40 and 61	384347	0904345	6-26-90	2.03	264	26.0
41	Burgermeister branch tributary 80 feet downstream from Henning Road	384403	0904317	6-26-90	2.17	259	25.0
42	South tributary of Burgermeister branch tributary 0.6 mile downstream from Henning Road	384347	0904255	6-26-90	Dry	--	--
43	South tributary of Burgermeister branch tributary 0.6 mile downstream from Henning Road	384356	0904242	6-26-90	Dry	--	--
44	South tributary of Burgermeister branch tributary 0.9 mile downstream from Henning Road	384407	0904231	6-26-90	Dry	--	--

Table 16.--*Discharge, specific conductance, and temperature at seepage sites for the Dardenne Creek seepage run, June 25-26, 1990*--Continued

Map letter or number (fig. 8)	Site designation	Latitude (DDMMSS)	Longitude (DDDMMSS)	Date	Q	Cond	Temp
I	Burgermeister branch 0.2 mile upstream from mouth	384409	0904230	6-26-90	2.11	255	24.0
46	Bank seepage 0.1 mile upstream from mouth	384410	0904228	6-26-90	.01e	318	22.5
47	North tributary of Dardenne Creek 0.6 mile upstream from County Road K	384418	0904221	6-26-90	.10e	--	22.5
48	Dardenne Creek 0.5 mile upstream from County Road K	384417	0904216	6-26-90	9.12	364	24.0
49	Dardenne Creek 300 feet upstream from County Road K	384425	0904145	6-26-90	9.34	338	25.0
50	North tributary of Dardenne Creek at County Road K	384427	0904144	6-26-90	Pooled	--	--
J	Schote Creek 0.1 mile upstream from mouth	384427	0904133	6-26-90	.37	503	22.0
E	Dardenne Creek 0.4 mile downstream from County Road K	384433	0904117	6-26-90	8.94	348	25.0
53	North tributary of Dardenne Creek 0.4 mile downstream from County Road K	384435	0904115	6-26-90	.10	586	25.0
54	North tributary of Dardenne Creek near County Road N	384450	0904015	6-26-90	.30e	473	18.0
55	North tributary of Dardenne Creek 1.9 miles downstream from County Road N	384458	0903948	6-26-90	Dry	--	--
56	West fork of north tributary of Dardenne Creek 0.4 mile upstream from County Road N	384501	0903940	6-26-90	Dry	--	--
57	East fork of north tributary of Dardenne Creek 0.4 mile upstream from County Road N	384503	0903931	6-26-90	Dry	--	--
F	Dardenne Creek 0.2 mile upstream from County Road N	384503	0903918	6-26-90	9.06	351	26.0
K	Crooked Creek tributary of Dardenne Creek 250 feet upstream from mouth	384504	0903912	6-26-90	1.47	395	22.5

Table 17.--*Discharge and specific conductance at seepage sites for the second Dardenne Creek seepage run, July 16, 1990*

[Latitude and longitude are in degrees, minutes, and seconds (DDDMMSS); Q, instantaneous discharge in cubic feet per second; cond, specific conductance in microsiemens per centimeter at 25 degrees Celsius; --, no data]

Map letter or number (fig. 8)	Site designation	Latitude (DDMMSS)	Longitude (DDMMSS)	Q	Cond
33	Dardenne Creek 0.3 mile downstream from Henning Road	384413	904300	2.26	397
I	Burgermeister branch 40 feet upstream from mouth	384409	904230	1.19	316
47	North tributary of Dardenne Creek 0.6 mile upstream from County Road K	384418	904221	.03	380
48	Dardenne Creek 0.5 mile upstream from County Road K	384417	904216	3.57	363
49	Dardenne Creek 300 feet upstream from County Road K	384425	904145	3.73	356
50	North tributary of Dardenne Creek at County Road K	384427	904144	Pooled	--
J	Schote Creek 0.1 mile upstream from mouth	384427	904133	.14	503
E	Dardenne Creek 0.4 mile downstream from County Road K	384433	904117	3.66	368

TABLE 18

ABBREVIATIONS AND REPORTING UNITS FOR CHEMICAL CONSTITUENTS AND NOTATIONS USED IN TABLE

Q	Discharge, instantaneous, in cubic feet per second
Cond	Specific conductance, in microsiemens per centimeter at 25 degrees Celsius
pH	In standard units
Temp	Temperature, in degrees Celsius
Ca	Calcium, dissolved, in milligrams per liter
Mg	Magnesium, dissolved, in milligrams per liter
Na	Sodium, dissolved, in milligrams per liter
K	Potassium, dissolved, in milligrams per liter
HCO_3	Bicarbonate, incremental titration, in milligrams per liter
CO_3	Carbonate, incremental titration, in milligrams per liter
Alk	Alkalinity, incremental titration, total as $CaCO_3$, in milligrams per liter
Alk (FET)	Alkalinity, fixed endpoint titration, total as $CaCO_3$, in milligrams per liter
SO_4	Sulfate, dissolved, in milligrams per liter
Cl	Chloride, dissolved, in milligrams per liter
F	Fluoride, dissolved, in milligrams per liter
Br	Bromide, dissolved, in milligrams per liter
SiO_2	Silica, dissolved, in milligrams per liter
DS	Dissolved solids, residue at 180 degrees Celsius, in milligrams per liter
TOC	Total organic carbon, in milligrams per liter
NO_2	Nitrite, dissolved as nitrogen, in milligrams per liter
NO_2+NO_3	Nitrite plus nitrate, dissolved as nitrogen, in milligrams per liter
NH_3	Ammonia, dissolved as nitrogen, in milligrams per liter
$(NH_3 + ON)_t$	Ammonia plus organic nitrogen, total as nitrogen, in milligrams per liter

P	Phosphorus, dissolved, in milligrams per liter
P_t	Phosphorus, total as nitrogen, in milligrams per liter
PO_4	Orthophosphate, dissolved as phosphorous, on milligrams per liter
As	Arsenic, dissolved, in micrograms per liter
Ba	Barium, dissolved, in micrograms per liter
Be	Beryllium, dissolved, in micrograms per liter
B	Boron, dissolved, in micrograms per liter
Cd	Cadmium, dissolved, in micrograms per liter
Cr	Chromium, dissolved, in micrograms per liter
Co	Cobalt, dissolved, in micrograms per liter
Cu	Copper, dissolved, in micrograms per liter
Fe	Iron, dissolved, in micrograms per liter
Pb	Lead, dissolved, in micrograms per liter
Li	Lithium, dissolved, in micrograms per liter
Mn	Manganese, dissolved, in micrograms per liter
Mo	Molybdenum, dissolved, in micrograms per liter
Ni	Nickel, dissolved, in micrograms per liter
Se	Selenium, dissolved, in micrograms per liter
Ag	Silver, dissolved, in micrograms per liter
Sr	Strontium, dissolved, in micrograms per liter
Th	Thorium, in micrograms per liter
V	Vanadium, dissolved, in micrograms per liter
Zn	Zinc, dissolved, in micrograms per liter
U	Uranium, dissolved, in micrograms per liter
TNT	2,4,6-Trinitrotoluene, total, in micrograms per liter
2,4-DNT	2,4-Dinitrotoluene, total, in micrograms per liter
2,6-DNT	2,6-Dinitrotoluene, total, in micrograms per liter
NB	Nitrobenzene
<	Less than

Table 18.--*Water-quality data for the Dardenne Creek seepage run, June 25-26, 1990*

Map letter (fig. 8)	Local identifier	Date	Time	Q	Cond	pH	Temp	Ca	Mg	Na	K	HCO_3	CO_3	Alk	Alk (FET)	SO_4
A	Dardenne Creek at County Road DD bridge	6-25-90	1415	3.05	401	7.9	27.5	63	9.4	8.8	2.6	215	0	176	175	30
B	Dardenne Creek 1.3 miles downstream from County Road DD bridge	6-25-90	1545	4.19	384	7.7	25.0	59	9.0	7.7	2.4	212	0	174	172	26
C	Dardenne Creek 0.1 mile upstream from U.S. Highways 40 and 61 bridge	6-25-90	1700	5.90	368	8.1	26.5	55	9.0	8.6	2.8	202	0	165	164	25
D	Dardenne Creek 0.65 mile upstream from County Road K	6-26-90	930	7.01	360	7.5	24.0	53	9.1	9.1	2.7	204	0	167	164	25
E	Dardenne Creek 0.4 mile downstream from County Road K	6-26-90	1230	8.94	344	7.9	24.5	50	9.0	9.6	2.7	187	0	153	152	24
F	Dardenne Creek 0.2 mile upstream from County Road N	6-26-90	1500	9.06	352	8.2	26.0	51	9.3	10	2.7	189	0	155	156	23
G	Tributary 6400 100 feet upstream from mouth	6-25-90	1800	.04	180	5.2	13.5	15	4.7	3.5	.8	29	0	24	22	20
H	Burgermeister branch tributary 0.2 mile downstream from U.S. Highways 40 and 61	6-26-90	1330	2.00	264	7.5	25.5	35	6.6	8.6	2.6	133	0	109	109	19
I	Burgermeister branch 0.2 mile upstream from mouth	6-26-90	900	2.10	276	7.2	22.5	37	7.0	8.9	2.6	145	0	119	117	19
J	Schote Creek 0.1 mile upstream from mouth	6-26-90	1100	.37	491	7.6	22.5	63	14	22	3.2	240	0	197	196	33
K	Crooked Creek tributary of Dardenne Creek 250 feet upstream from mouth	6-26-90	1700	1.50	379	7.8	23.5	49	11	16	3.1	192	0	157	157	24

Table 18.--*Water-quality data for the Dardenne Creek seepage run, June 25-26, 1990*--Continued

Map letter (fig. 8)	Cl	F	Br	SiO_2	DS	TOC	NO_2	NO_2 + NO_3	NH_3	$(NH_3 + ON)_t$	P	P_t	PO_4	As	Ba	Be	B
A	16	0.2	0.02	8.0	238	2.9	0.01	0.39	0.02	0.30	<0.01	0.02	<0.01	<1	130	<0.5	30
B	15	.2	.03	8.4	220	3.9	.01	.28	.03	.30	.01	.03	.01	<1	130	<.5	30
C	15	.2	.03	8.4	208	3.8	.01	.26	.01	.40	.02	.04	.01	<1	120	<.5	30
D	15	.2	.02	7.8	207	3.9	<.01	.21	<.01	.40	.03	.05	.03	<1	120	<.5	30
E	16	.3	.03	8.0	198	4.4	.01	.29	.01	.30	.02	.05	.01	<1	120	<.5	40
F	16	.2	.02	8.0	196	4.8	<.01	.26	<.01	.30	.01	.05	<.01	<1	120	<.5	30
G	8.5	.1	.02	21	147	.6	<.01	5.3	.01	.50	.02	.02	.02	<1	130	<.5	30
H	14	.3	.01	8.3	153	6.9	.03	.41	.12	.50	<.01	.06	<.01	1	120	<.5	40
I	15	.3	.02	8.5	150	5.6	.02	.61	.03	.50	.01	.06	<.01	1	110	<.5	40
J	30	.3	.06	11	297	4.4	.02	1.3	.05	.80	.05	.10	.05	1	130	<.5	50
K	22	.2	.03	9.4	214	4.4	.01	.54	.02	.40	<.04	.06	.04	1	110	<.5	30

Table 18.--*Water-quality data for the Dardenne Creek seepage run, June 25-26, 1990*--Continued

Map letter (fig. 8)	Cd	Cr	Co	Cu	Fe	Pb	Li	Mn	Mo	Ni	Se	Ag	Sr	Th	V	Zn	U
A	1.0	<5	<3	<10	<3	<10	6	210	<10	<10	<1	<1.0	120	<0.1	<6	<3	1.1
B	<1.0	<5	<3	<10	20	<10	8	290	<10	<10	<1	<1.0	110	.3	<6	<3	1.2
C	<1.0	<5	<3	<10	6	<10	8	190	<10	<10	<1	<1.0	110	.2	<6	6	1.0
D	<1.0	<5	<3	<10	<3	<10	7	96	<10	<10	<1	<1.0	110	<.1	<6	<3	1.0
E	1.0	<5	<3	<10	<3	<10	5	120	<10	<10	<1	<1.0	120	<.1	<6	<3	3.1
F	<1.0	<5	<3	<10	<3	<10	6	67	<10	<10	<1	<1.0	120	<.1	<6	<3	3.1
G	<1.0	<5	<3	<10	6	<10	6	15	<10	<10	<1	<1.0	110	<.1	<6	13	<.01
H	<1.0	<5	<3	<10	3	<10	5	1,000	<10	<10	<1	<1.0	98	<.1	<6	<3	8.9
I	<1.0	<5	<3	<10	4	<10	7	350	<10	<10	<1	<1.0	97	<.1	<6	<3	8.5
J	<1.0	<5	<3	<10	5	<10	7	230	<10	<10	<1	<1.0	190	<.1	<6	6	5.9
K	<1.0	<5	<3	<10	5	<10	5	62	<10	<10	<1	<1.0	120	<.1	<6	21	.8

Table 18.--*Water-quality data for the Dardenne Creek seepage run, June 25-26, 1990*--Continued

Map letter (fig. 8)	TNT	2,4-DNT	2,6-DNT	NB
A	<0.05	<0.05	<0.05	<0.5
B	<.05	<.05	<.05	<.5
C	<.05	<.05	<.05	<.5
D	<.05	<.05	<.05	<.5
E	<.05	<.05	<.05	<.5
F	<.05	<.05	<.05	<.5
G	<.05	<.05	<.05	<.5
H	<.05	<.05	<.05	<.5
I	<.05	<.05	<.05	<.5
J	<.05	<.05	<.05	<.5
K	<.05	<.05	<.05	<.5