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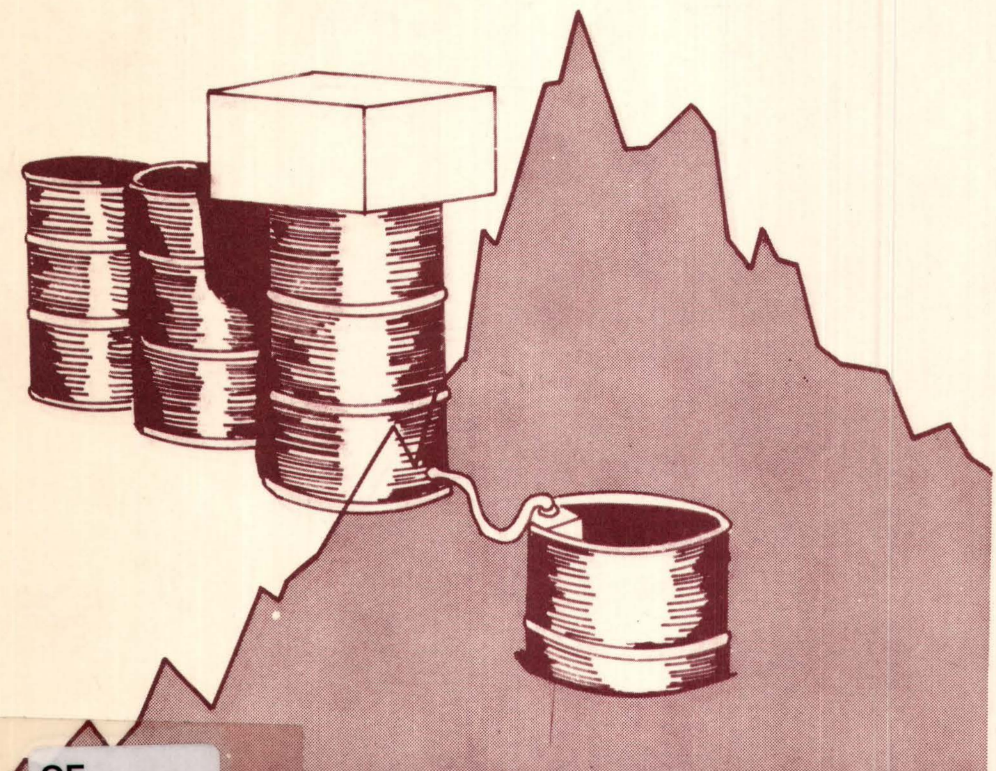
RESULTS OF INFILTRATION TESTS NEAR SCOTT CITY, WESTERN KANSAS

U. S. GEOLOGICAL SURVEY

Water-Resources Investigations 76-12



Prepared in cooperation with the
Kansas Water Resources Board

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16. Abstracts

Infiltration rates in loessial soils were determined by several types of ring infiltrometers. Results were compared with infiltration rates in the underlying loess and with saturated hydraulic conductivities of samples from the unsaturated zone.

Average daily infiltration rates in the soil ranged from 3 to 5 feet using 22-inch ring infiltrometers; 2.3 feet using a 10-inch ring infiltrometer; and from 1.3 to 2.2 feet using double-ring infiltrometers. By comparison, the average daily infiltration rate in the loess using a 10-inch ring infiltrometer was about 13 feet.

Laboratory tests of a soil core indicated that the lowest hydraulic conductivity was in the depth interval from 3.9 to 8.6 inches. Soil in this interval, which coincides with the depth of cultivation, evidently limits the rate of infiltration.

Air-permeability tests of the unsaturated zone indicated low hydraulic conductivities of 1.9 and 0.2 feet per day for the depth intervals from 0 to 5 feet and 57 to 75 feet respectively. The conductivity of the lower interval probably would create a perched water table during prolonged infiltration.

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*Infiltration rates, *Loessial soils, *Infiltrometers, Soil characteristics, Hydraulic conductivity, Air permeability

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April 1976

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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RESULTS OF INFILTRATION TESTS

NEAR SCOTT CITY, WESTERN KANSAS

J. B. Gillespie[1] and G. D. Hargadine[2]

ABSTRACT

Several types of ring infiltrometers were used to determine infiltration rates in loessial soil near Scott City, Kansas. Test results were evaluated for consistency, and were compared with infiltration rates in the underlying loess and with hydraulic conductivities in the unsaturated zone.

Average daily infiltration rates in the Richfield soil ranged from 3 to 5 feet or 0.9 to 1.5 m (metres) after 16 days using 22-inch or 560-mm (millimetre) ring infiltrometers; 2.3 feet (0.7 m) after 68 days using a 10-inch (250-mm) ring infiltrometer; and from 1.3 to 2.2 feet (0.4 to 0.7 m) after 38 days using double-ring infiltrometers. By comparison, the average daily infiltration rate in the underlying Peoria Loess using a 10-inch (250-mm) ring infiltrometer was about 13 feet (4.0 m) after 7 days.

Tests using the double-ring infiltrometer, a paraffin seal in the 22-inch (560-mm) infiltrometer, and the measurement of flow through concentric areas of the soil core indicated that leakage of water between the infiltrometer wall and the soil was not significant. Lateral movement of the wetting front extended radially 4.7 feet (1.4 m) from the infiltrometer wall.

Laboratory tests of a soil core indicated that the lowest hydraulic conductivity was in the depth interval from 3.9 to 8.6 inches (99 to 218 mm). Soil in this interval, which coincides with the depth of cultivation, evidently limits the rate of infiltration.

Air-permeability tests in the unsaturated deposits gave a hydraulic conductivity of 0.2 foot per day (0.1 m/day) for the depth interval from 57 to 75 feet (17.0 to 23.0 m) as compared to a hydraulic conductivity of 1.9 feet per day (0.6 m/day) for the depth interval from 0 to 5 feet (0 to 1.5 m). A perched water table probably would occur above this interval during prolonged infiltration.

Infiltration rates determined from the different types of ring infiltrometers were not consistent, but the tests showed that substantial quantities of water could infiltrate the Richfield soil.

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[2]Geologist, Kansas Water Resources Board

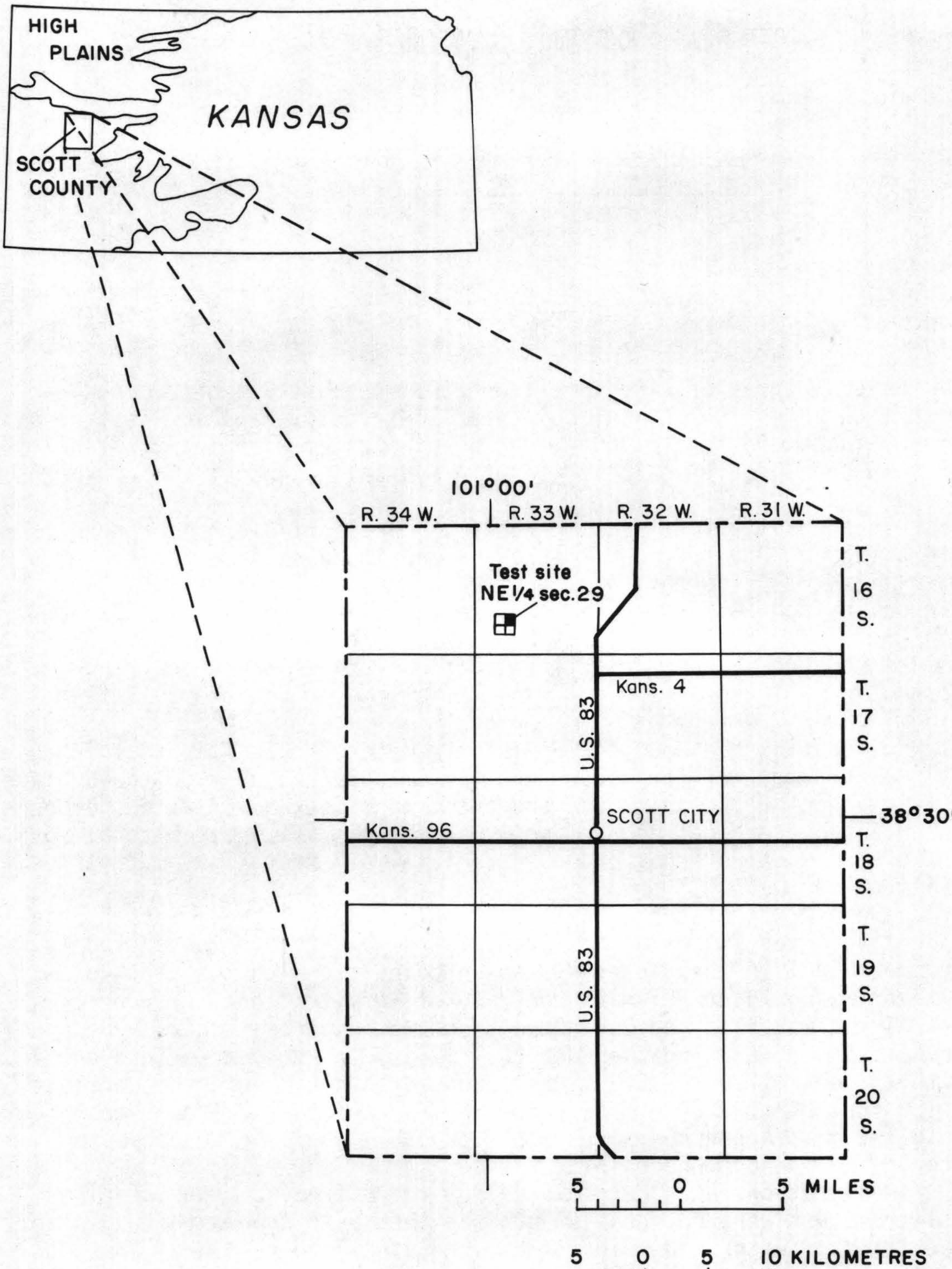


Figure 1.--Index maps showing location of test site in Scott County and High Plains area of western Kansas.

INTRODUCTION

Purpose and Scope

The purpose of this investigation was to evaluate the infiltrometer as a reconnaissance tool for estimating long-term infiltration rates of water into the loessial soils of western Kansas. Such a tool could facilitate the preliminary selection of sites in the High Plains area (fig. 1) where surface runoff or imported water might be infiltrated and temporarily stored in the ground-water reservoir for later use. A basic assumption in this investigation was that soils developed on loess are relatively homogeneous over wide areas and, therefore, infiltration rates into loessial soils should be similar and predictable over wide areas.

Research studies were made in the spring and summer of 1972 to determine whether consistent results could be obtained from duplicate infiltrometer tests at several sites in a small area. These tests included two sizes and two types of infiltrometers that were pressed into the Richfield silt loam soil and one infiltrometer that was pressed into unweathered loess beneath the soil. Consideration was given in all the tests to the effects on infiltration rates of temporal or areal changes in weather, antecedent soil moisture, water temperature, barometric pressure, and lithology. The infiltrometers were covered to exclude sunlight and retard growth of plants and algae. A common source of water was used in all tests.

Because water levels in the High Plains area are declining as a result of irrigation withdrawals, considerable interest has developed in the feasibility of artifically recharging the ground-water reservoir. Areas where water levels in wells have declined significantly are shown in figures 2 and 3.

Additional data on infiltration rates, temperatures, and barometric pressures collected during the tests are available in the office of the U.S. Geological Survey, Lawrence, Kansas.

For the benefit of those readers who are accustomed to using the metric system, the English units of measurement given in this report also are given in equivalent metric units (in parentheses) using the following abbreviations and conversion factors:

English unit	Multiply by	Metric unit
inch (in)	25.4	millimetre (mm)
foot (ft)	.3048	metre (m)
mile (mi)	1.609	kilometre (km)
acre	.4047	square hectometre (hm^2)
feet per day (ft/day)	.3048	metres per day (m/day)

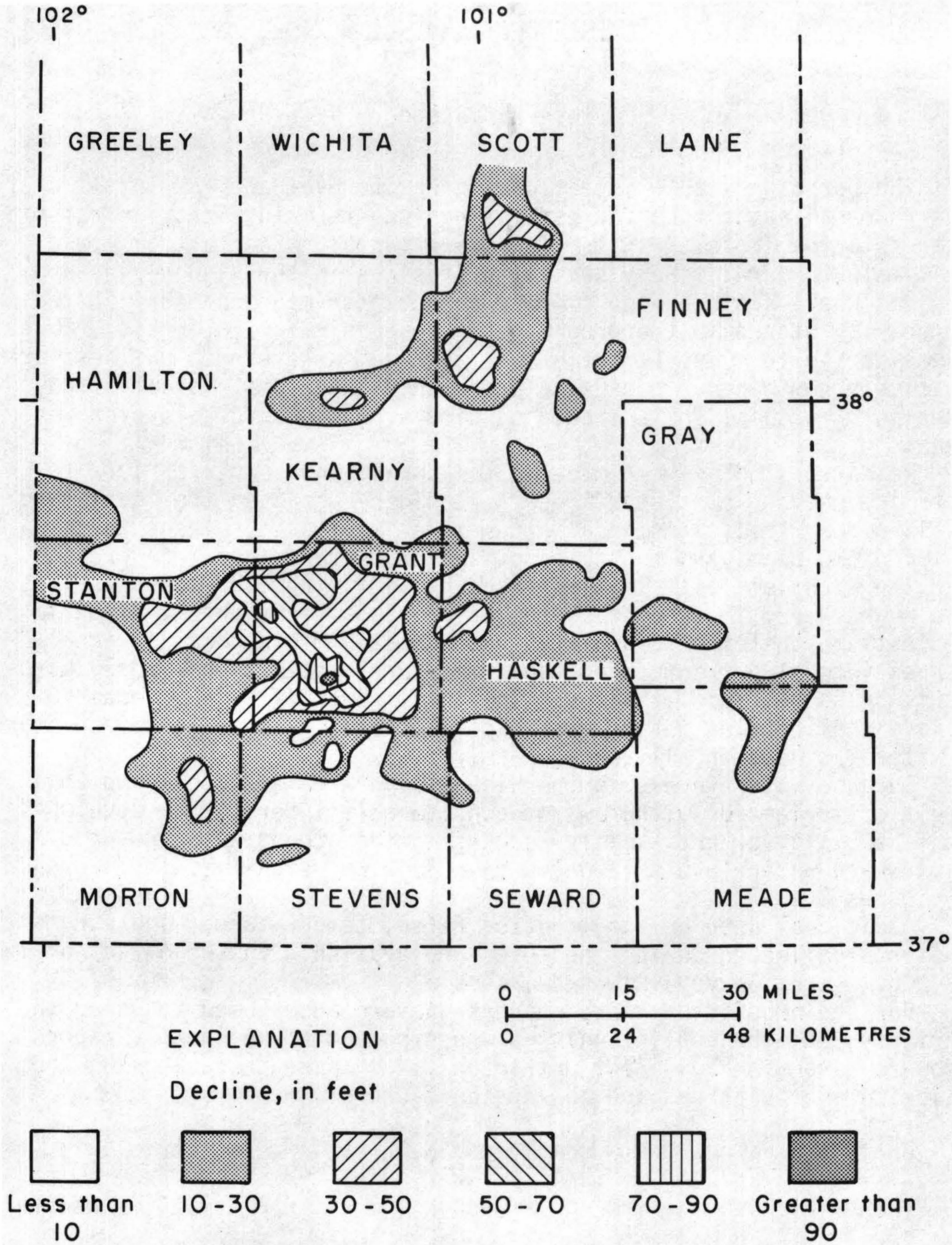


Figure 2.--Water-level decline in southern High Plains, 1940-70. (From Kansas State Board of Agriculture, 1971, Kansas Agriculture: 53rd Ann. Rept., p. 153.)

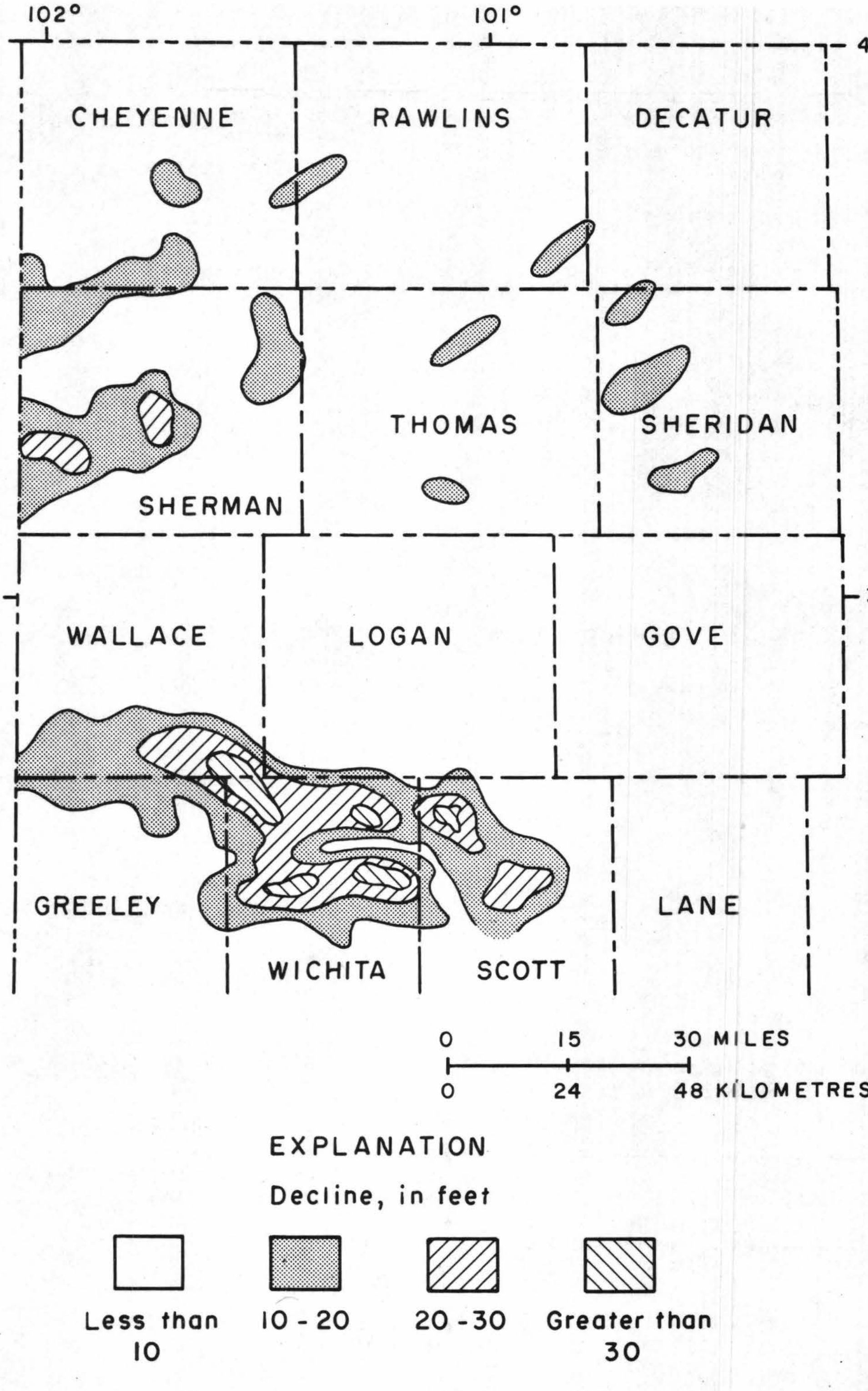


Figure 3.--Water-level decline in northern High Plains, 1950-70. (From Kansas State Board of Agriculture, 1971, Kansas Agriculture: 53rd Ann. Rept., p. 154.)

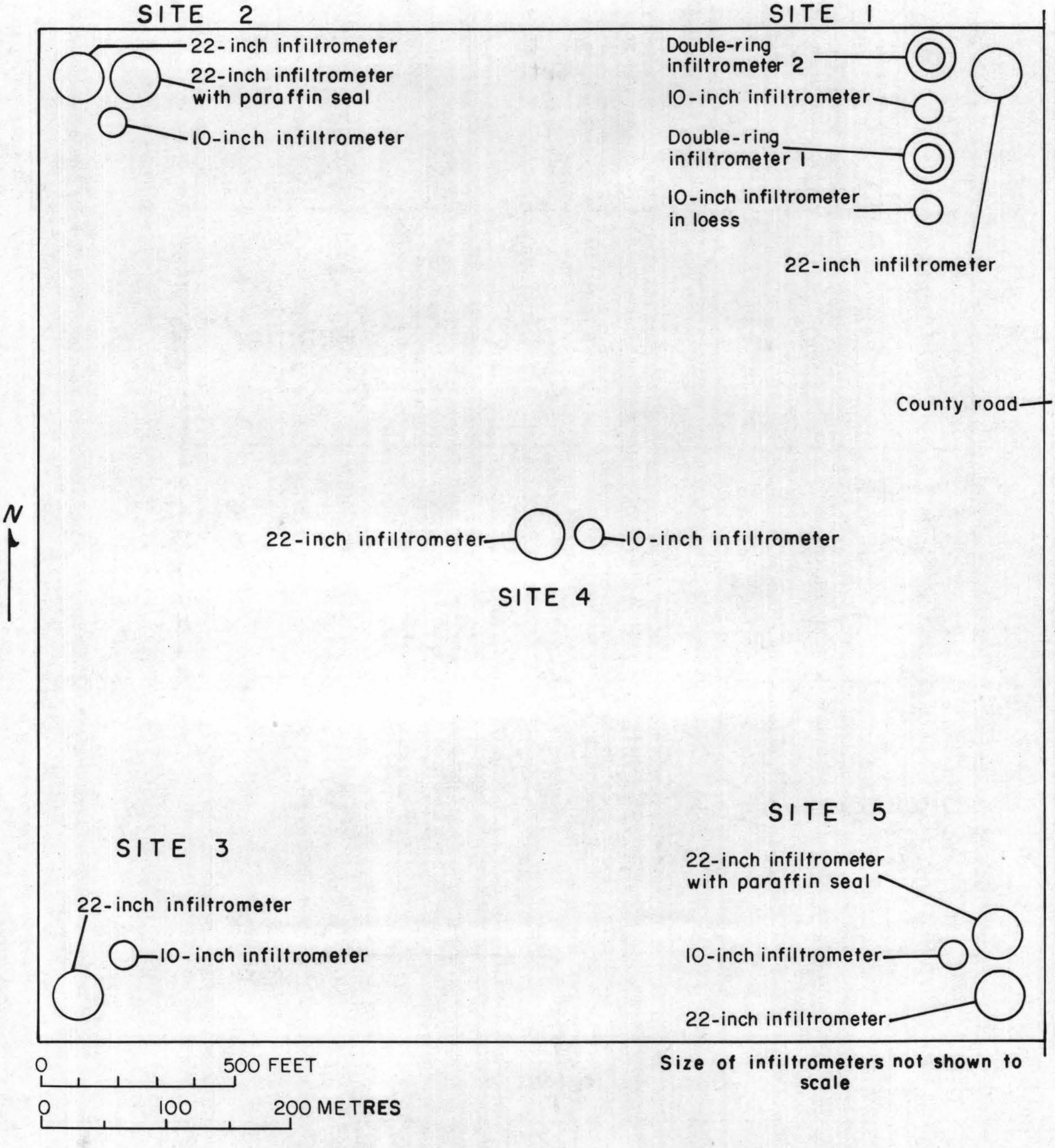


Figure 4.--Location of infiltration tests in NE¼ sec.29, T.16 S., R.33 W., Scott County.

Location of Test Area

This investigation was made in the NE¼ sec.29, T.16 S., R.33 W. (fig. 1), about 11 miles (18 km) north-northwest of Scott City, in Scott County, Kansas. Infiltration-test Sites 1 through 5 were located within the same quarter section, as shown in figure 4.

Appreciation is extended to Mr. Roy Fairleigh, who allowed the use of 160 acres (65 hm^3) of fallow land and assisted in the study.

Physiographic Setting

The flat topography in the vicinity of the test sites (fig. 5) is typical of much of the upland topography in the High Plains. The soil that underlies the test area is about 3 feet (0.9 m) thick and is classified as Richfield silt loam. A general description of the soil profile of the Richfield, the predominant soil on the High Plains, is given in figure 6 and a detailed description of material in the profile is given in table 1. Table 2 gives a particle-size analysis of the soil.

About 22 feet (7 m) of the Pleistocene Peoria Loess underlie the Richfield soil (fig. 7). The loess is underlain by approximately 170 feet (52 m) of the Pliocene Ogallala Formation, which is composed of partially cemented sand, silt, gravel, and a small amount of clay (E. D. Gutentag, oral commun., 1973). Below the Ogallala lie the chalky shales (bedrock) of the Upper Cretaceous Niobrara Formation that retard the downward movement of ground water.

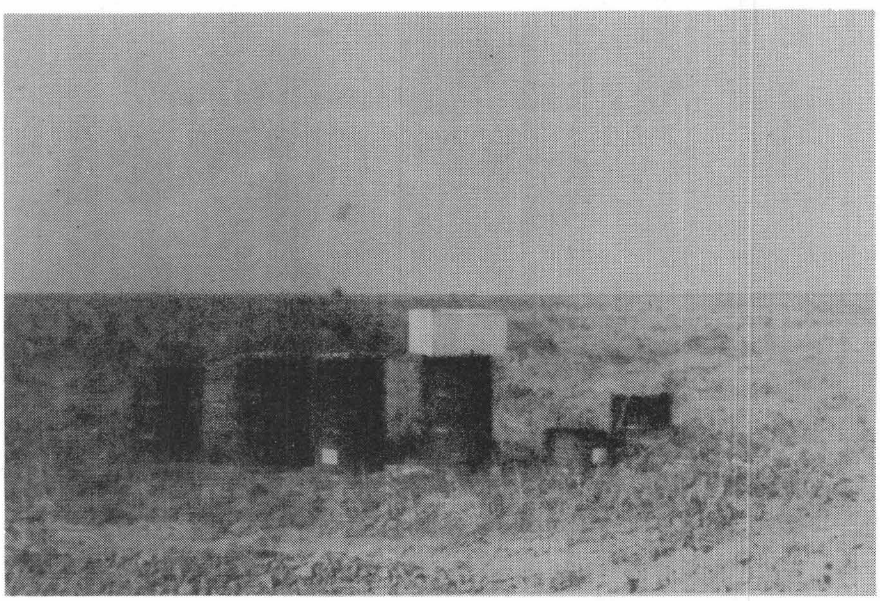


Figure 5.--Flat topography at the test site, typical of the High Plains.

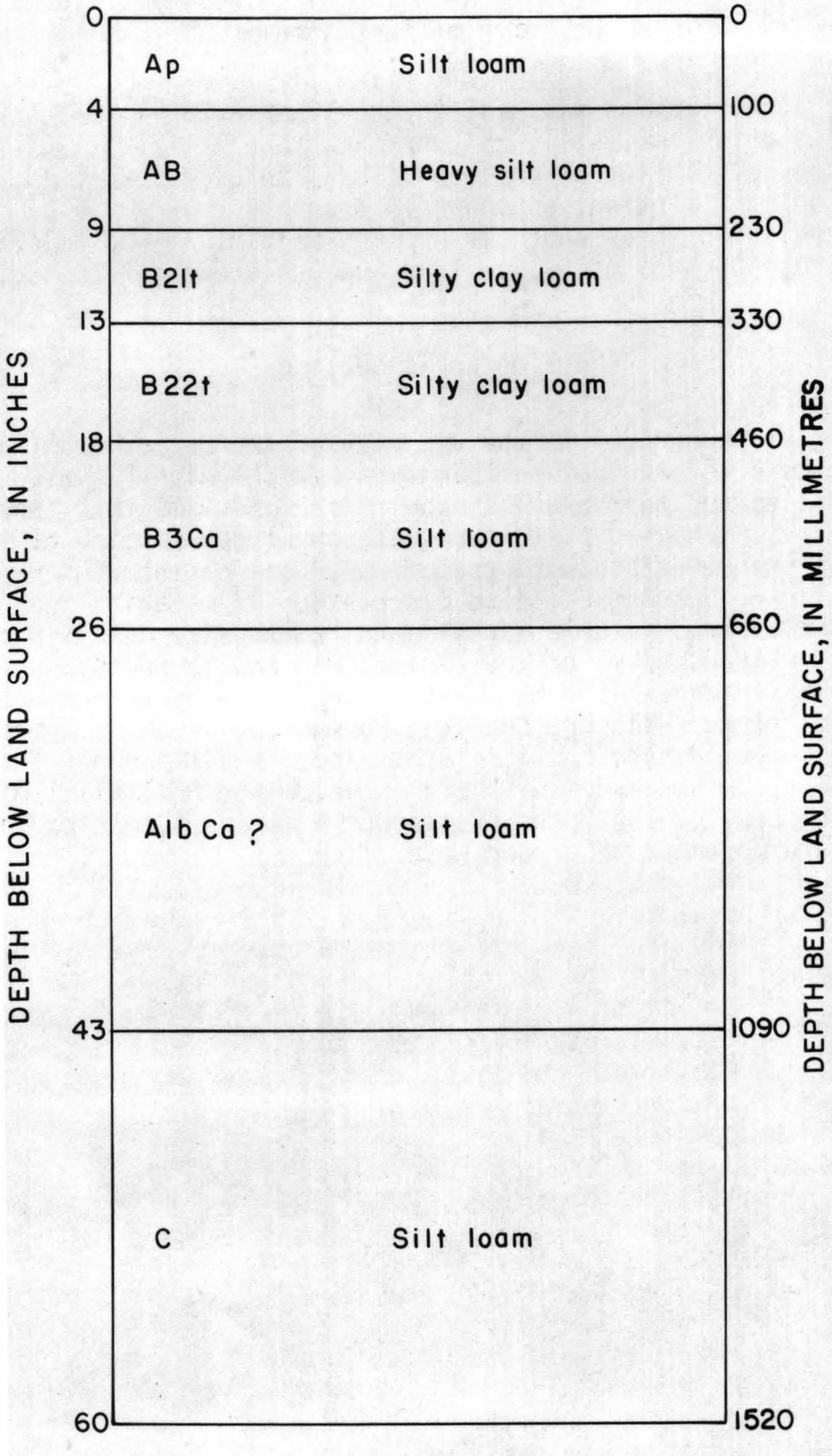


Figure 6.--Generalized soil profile of Richfield silt loam in test area.

Table 1.--Soil profile of Richfield silt loam at test area.

A representative profile of Richfield silt loam as described by R. C. Angell (U.S. Soil Conservation Service, 1972), in the NE¼ of section 29, T.16 S., R.33 W. where infiltration tests were run. Profile located about 150 feet (46 m) west and 100 feet (30 m) south of the NE corner of the quarter. Colors are described according to the Rock-Color-Chart, distributed by the Geological Society of America.

Ap	0 to 4 inches (0 to 100 mm), grayish brown (10YR 5/2) silt loam, very dark grayish-brown (10YR 3/2) when moist; weak, very fine granular structure; slightly hard when dry, friable when moist; many fine roots; weak, medium platy at base of layer; noneffervescent, slightly acid; abrupt, smooth boundary.
AB	4 to 9 inches (100 to 230 mm) brown (10YR 5/3), heavy silt loam, dark brown (10YR 3/3) when moist. Moderate, fine and medium subangular blocky structure; slightly hard when dry, friable when moist; few fine roots; noneffervescent; slightly acid; clear, smooth boundary.
B21t	9 to 13 inches (230 to 330 mm) brown (10YR 5/3), silty clay loam, dark brown (10YR 3/3) when moist; weak, fine prismatic breaking to moderate, very fine subangular blocky structure; hard when dry, firm when moist; few fine roots; noneffervescent; neutral; clear smooth boundary.
B22t	13 to 18 inches (330 to 460 mm) dark grayish-brown (10YR 4/2), silty clay loam; very dark brown (10YR 2/2) when moist; moderate medium prismatic breaking to moderate fine subangular blocky; hard when dry, firm when moist; few fine roots; thin discontinuous clay films; noneffervescent; mildy alkaline; clear, smooth boundary.
B3Ca	18 to 26 inches (460 to 660 mm) light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; moderate fine subangular blocky structure; slightly hard when dry, friable when moist; few fine roots; many fine pores; few fine spots of segregated lime; strongly effervescent; moderately alkaline; gradual smooth boundary.
AlbCa ?	26 to 43 inches (660 to 1,090 mm) light brownish-gray (10YR 6/2) silt loam, dark grayish-brown (10YR 4/2) when moist; moderate fine subangular blocky structure; slightly hard when dry, friable when moist; many fine pores; about 40 to 60 percent of bed surfaces have thin coatings of white segregated lime, lime filling in many pores; violently effervescent; moderately alkaline; gradual smooth boundary.
C	43 to 60 inches (1,090 to 1,520 mm) light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; massive; soft when dry, very friable when moist; many fine pores; few fine spots of segregated lime; strongly effervescent; moderately alkaline.

Remarks: Soil profiles were examined at several locations in this quarter section and only minor variations were observed outside of the depressed areas.

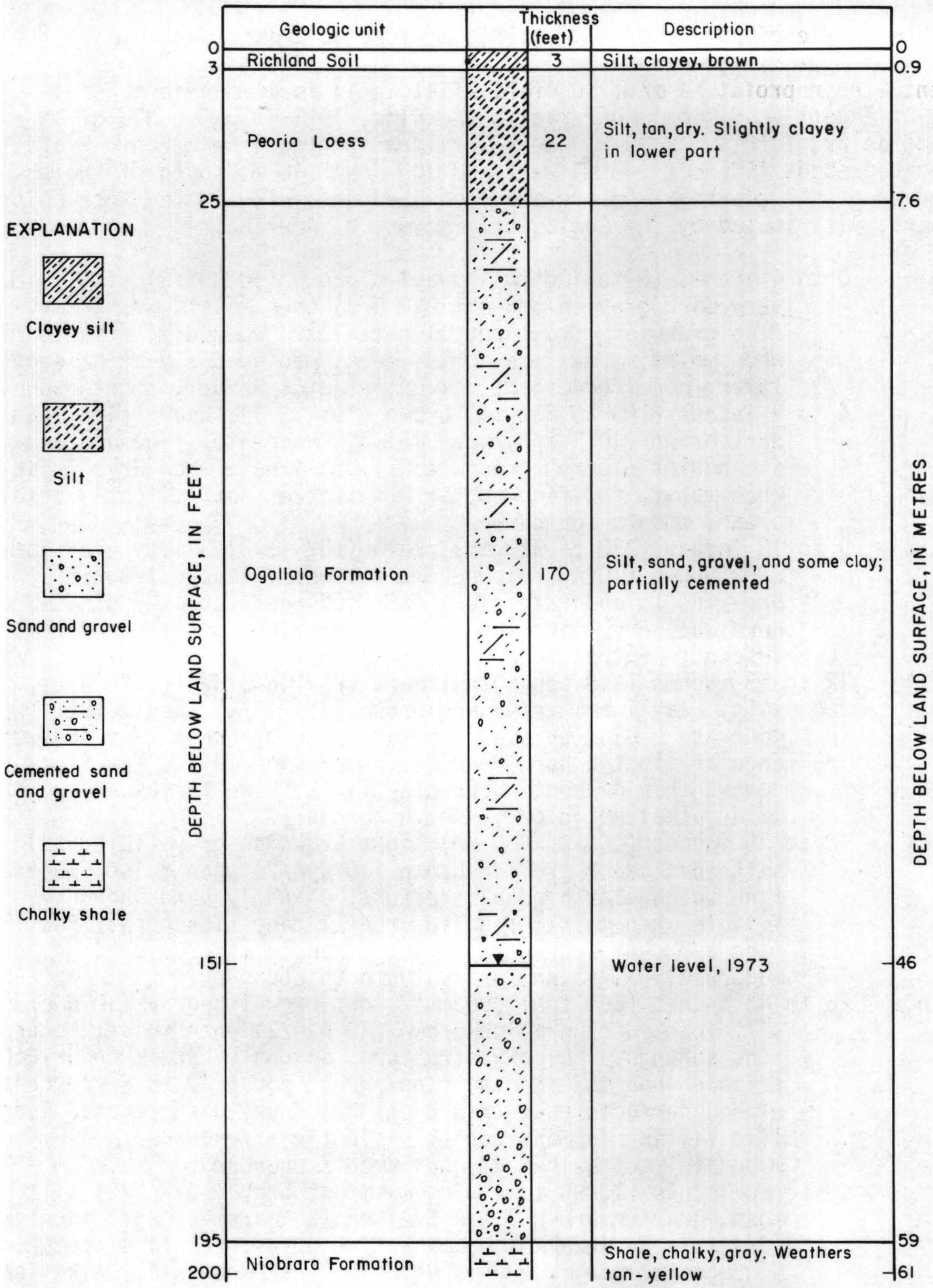


Figure 7.--Generalized section of geologic units underlying test area.

Table 2.--Particle-size analysis of the Richfield silt loam at Sites 1 through 5.

Site	Depth interval, in inches	Particle size, in percent, Clay <.004 mm	Silt .004 to .006 mm	Sand >.062 mm
1	0-7	24	57	19
	7-13	30	60	10
	13-19	33	54	13
	19-26	31	59	10
2	0-9	36	55	9
	9-14	35	56	9
	14-20	33	61	6
	20-29	31	61	8
3	0-6	29	55	16
	6-14	30	54	16
	14-20	28	71	1
	20-28	26	62	12
4	0-7	23	58	18
	7-12	30	49	21
	12-20	31	50	19
	20-26	29	51	20
5	0-7	25	48	27
	7-13	31	49	20
	13-19	33	54	13
	19-25	28	52	20

The water table under the test area lies within the Ogallala Formation at approximately 150 feet (46 m) below land surface. The water level has declined about 25 to 30 feet (8 to 9 m) since irrigation by ground water from wells has become established.

Source and Quality of Water

All the water used in the infiltration tests was obtained from an irrigation well located in the NW¼SW¼, sec.19, T.16 S., R.33 W., approximately 2 miles (3.2 km) west of the test area. The well yields water, classed on the basis of predominant ions as a calcium bicarbonate type, from sand and gravel deposits in the lower part of the Ogallala Formation (fig. 7). A chemical analysis of the water is given in table 3.

Table 3.--Chemical analysis of ground water used in the infiltration tests.

[Chemical constituents expressed in mg/l (milligrams per litre).]

Item	Concentration (mg/l)	Item	Concentration (mg/l)
Dissolved solids (residue @ 180°C)	287	Dissolved chloride (Cl)	12
Dissolved silica (SiO_2)	27	Dissolved fluoride (F)	2.0
Dissolved calcium (Ca)	45	Dissolved nitrate (NO_3)	12
Dissolved magnesium (Mg)	13	Hardness as $CaCO_3$	
		Total hardness	166
Sodium + Potassium (Na+K)	34	Carbonate hardness	166
		Non-carbonate hardness	0
Bicarbonate (HCO_3)	210		
		Specific conductance (microsiemens @ 25°C)	450
Dissolved sulfate (SO_4)	38		
		pH (units)	7.9

DIRECT MEASUREMENT OF INFILTRATION RATES

Infiltration rates were measured by using ring infiltrometers pressed into the soil at Sites 1 through 5. A float valve commonly used in stock tanks was mounted inside each infiltrometer (fig. 8) to maintain a constant water level of 0.5 foot (0.15 m), and the infiltrometers were covered to keep out dust and sunlight. A garden hose connected the float valve to reservoir barrels, and the reservoir barrels were connected to each other by 2-inch (51-mm) hose so that water levels in the barrels would equalize quickly (fig. 9). Water-level changes were measured by a float-driven recorder installed in a shelter on top of one reservoir barrel (fig. 10). The infiltration rate was computed from these measurements. During most of the tests, the temperature at the water-soil interface and the barometric pressure also were recorded (fig. 10).

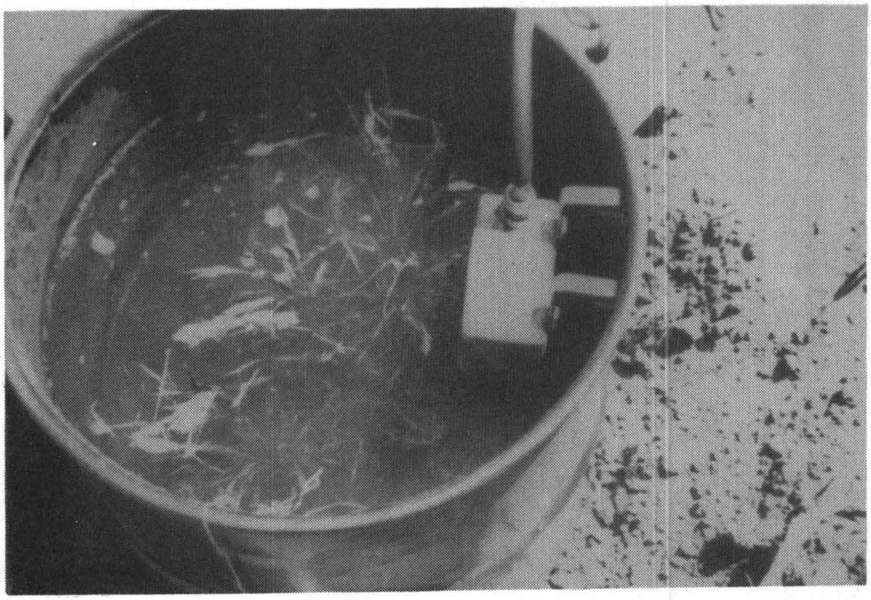


Figure 8.--View of 22-inch (560-mm) ring infiltrometer with supply hose and float valve.

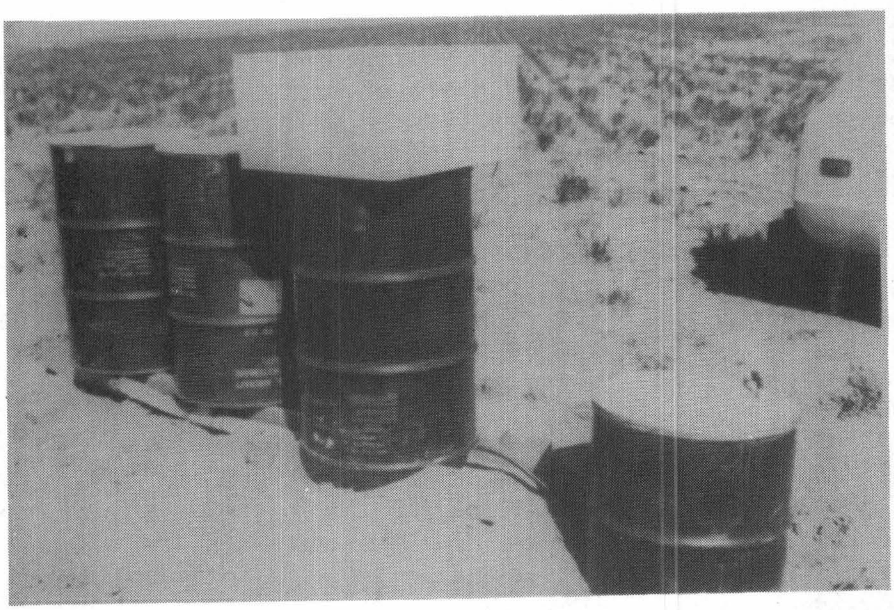


Figure 9.--View of 22-inch (560-mm) ring infiltrometer with reservoir barrels and recorder shelter.

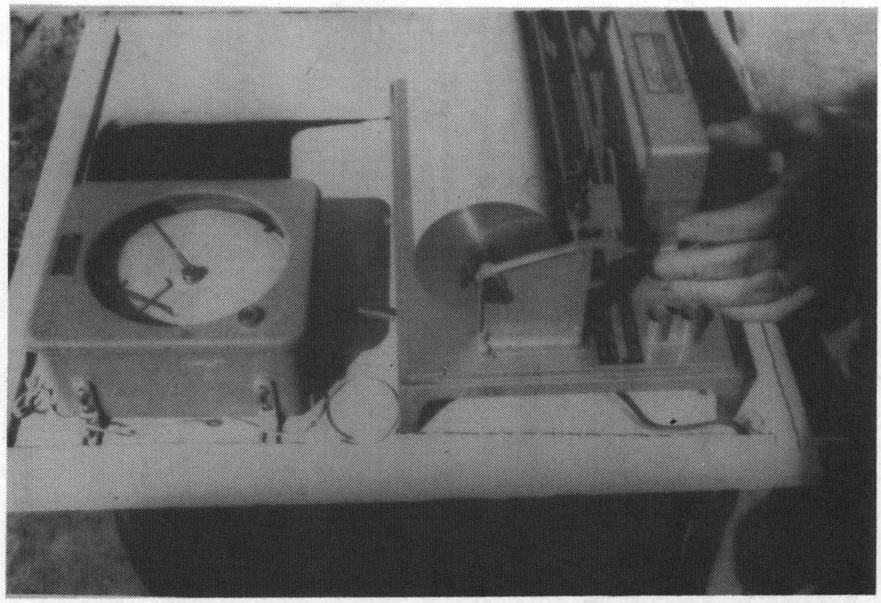


Figure 10.--Water-level recorder and thermograph.

Ring Infiltrometers, 22 Inches (560 mm) in Diameter

A ring infiltrometer, 22 inches (560 mm) in diameter, was installed at each of the five sites to a depth of 22 to 24 inches (560 to 610 mm). The bottom of each infiltrometer was below the B22t soil zone (fig. 6), which was assumed to be the least permeable zone and the zone that limits the infiltration rate of water. Aronovici (1955) demonstrated that the installation of an infiltrometer to a depth greater than the zone limiting infiltration caused minimal effect from lateral flow.

Infiltration tests at Sites 1 through 5 were run from April 24 to May 9, 1972. The surface of the soil was very loose and fluffy because of the freezing and thawing action during the previous winter and spring. The average daily infiltration rates are shown in figure 11. The infiltration rates ranged from 0.85 to 2.75 ft/day (0.26 to 0.84 m/day) after 12 hours of submergence, from 1.40 to 5.05 ft/day (0.43 to 1.54 m/day) after 11 days, and from 3.80 to 5.40 ft/day (0.85 to 1.65 m/day) at the end of each test. On the fifth day of the tests at Sites 1 and 2, the infiltrometers went dry because the reservoir barrels inadvertently had not been filled. When the tests resumed, the initial infiltration rates were reduced by several feet per day, but the rates rapidly increased (fig. 11). The correlation between the infiltration rates at Sites 1 through 5 was not good. However, these tests indicate that water can infiltrate the Richfield soil at rates ranging from about 3 to 5 ft/day (0.9 to 1.5 m/day).

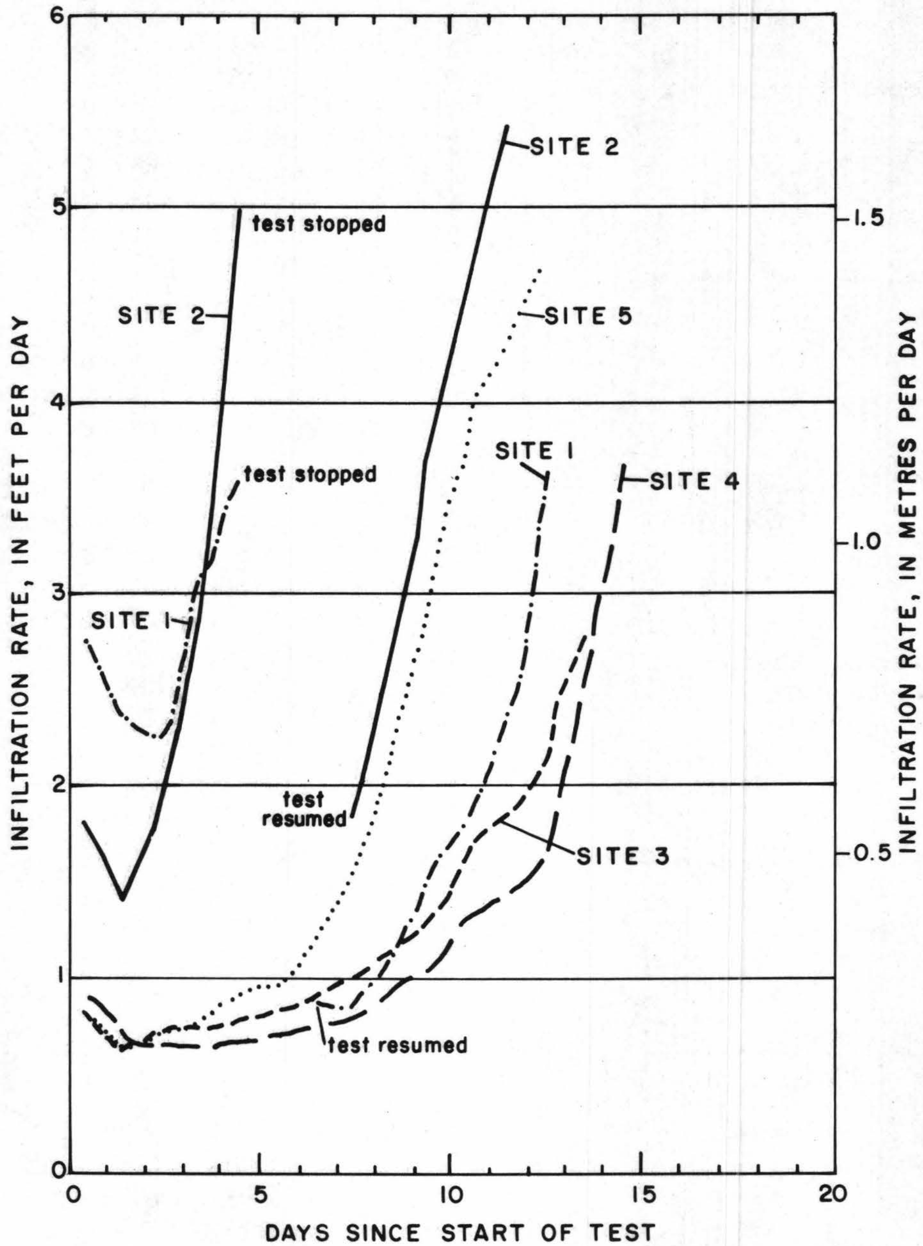
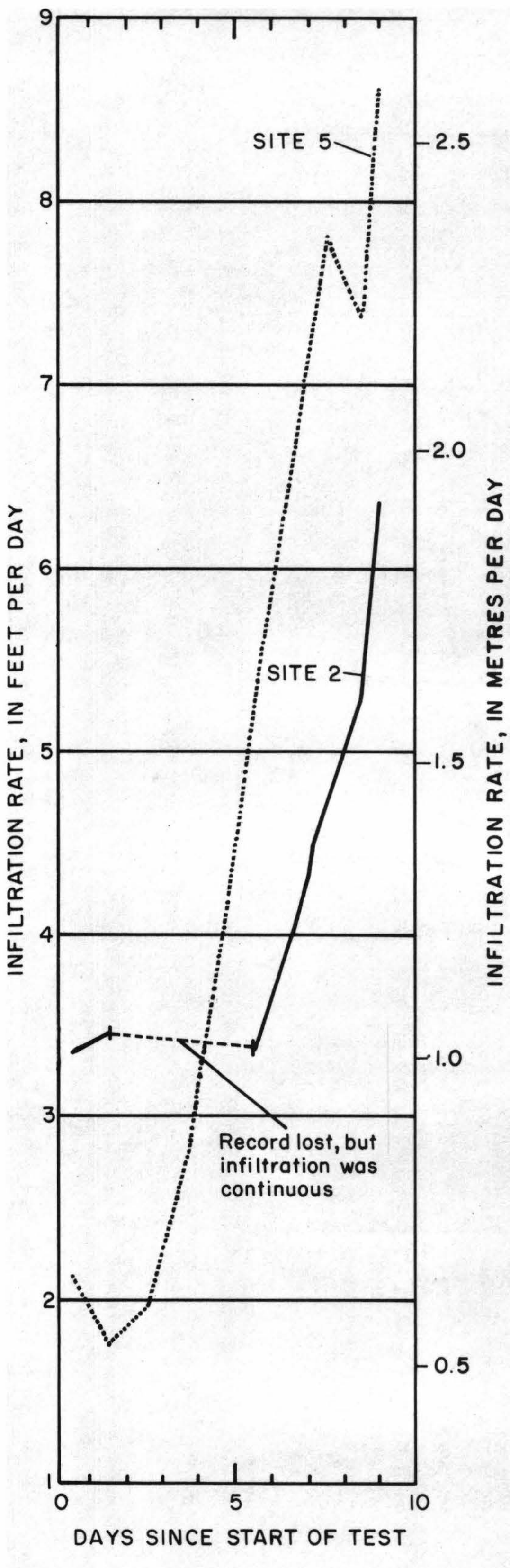


Figure 11.--Average daily infiltration rate for 22-inch (560-mm) ring infiltrometers at Sites 1 through 5.



As the initial test results indicated infiltration rates greater than anticipated, leakage of water between the infiltrometer wall and the soil was suspected to be a significant factor. Another 22-inch (560-mm) infiltrometer was installed at both Sites 2 and 5, in the same manner as previously described, and melted paraffin was poured into the annular space between the soil and the infiltrometer wall. Infiltration tests were run in the paraffin-sealed infiltrometers from May 17-27, 1972. The infiltration rates from these tests (fig. 12) were higher than the rates in the previous tests at Sites 2 and 5 (fig. 11) indicating that leakage at the interface between the soil and the infiltrometer wall was not significant. When all the infiltrometers were removed at the end of the tests, there was no visible evidence of rodent holes or piping; however, numerous roots, root tubes, and earthworm borings were observed.

Figure 12.--Average daily infiltration rate for 22-inch (560-mm) ring infiltrometers with paraffin seal at Sites 2 and 5.

Ring Infiltrometers, 10 Inches (250 mm) in Diameter

A ring infiltrometer, 10 inches (250 mm) in diameter (fig. 13), was installed at each of the five sites to a depth of 16 inches (410 mm). These infiltrometers did not completely penetrate the B22t soil zone (fig. 6). When the 10-inch (250-mm) infiltrometers were installed, it was evident that the soil surface had been partially compacted by heavy summer rains. Infiltration tests at Sites 1 through 5 were run from June 6 to July 17, 1972. The average daily infiltration rates for these tests are shown in figure 14. The data indicate that only the infiltrometer at Site 2 behaved similarly to the previous tests in the 22-inch (560-mm) infiltrometer. In the authors' judgment, infiltration rates in the 10-inch (250-mm) infiltrometers were lower than rates in the 22-inch (560-mm) infiltrometers owing mainly to compaction of the soil surface rather than to differences in the soil. During the test at Site 1, the infiltration rate gradually increased, to 5.9 ft/day (1.8 m/day) by the 36th day, and then gradually decreased, to 2.3 ft/day (0.7 m/day) by the 68th day when the test ended (fig. 15).

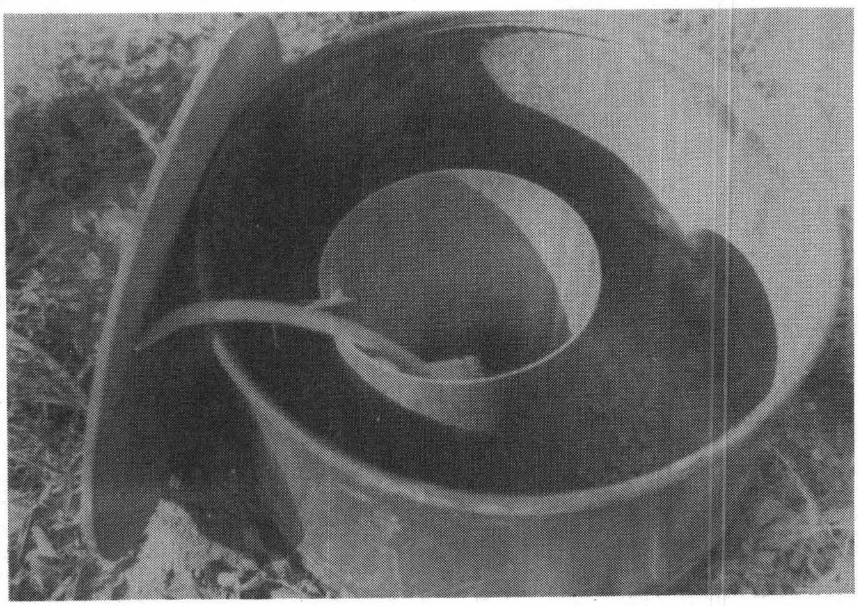


Figure 13.--View of 10-inch (250-mm) ring infiltrometer with supply hose and float valve.

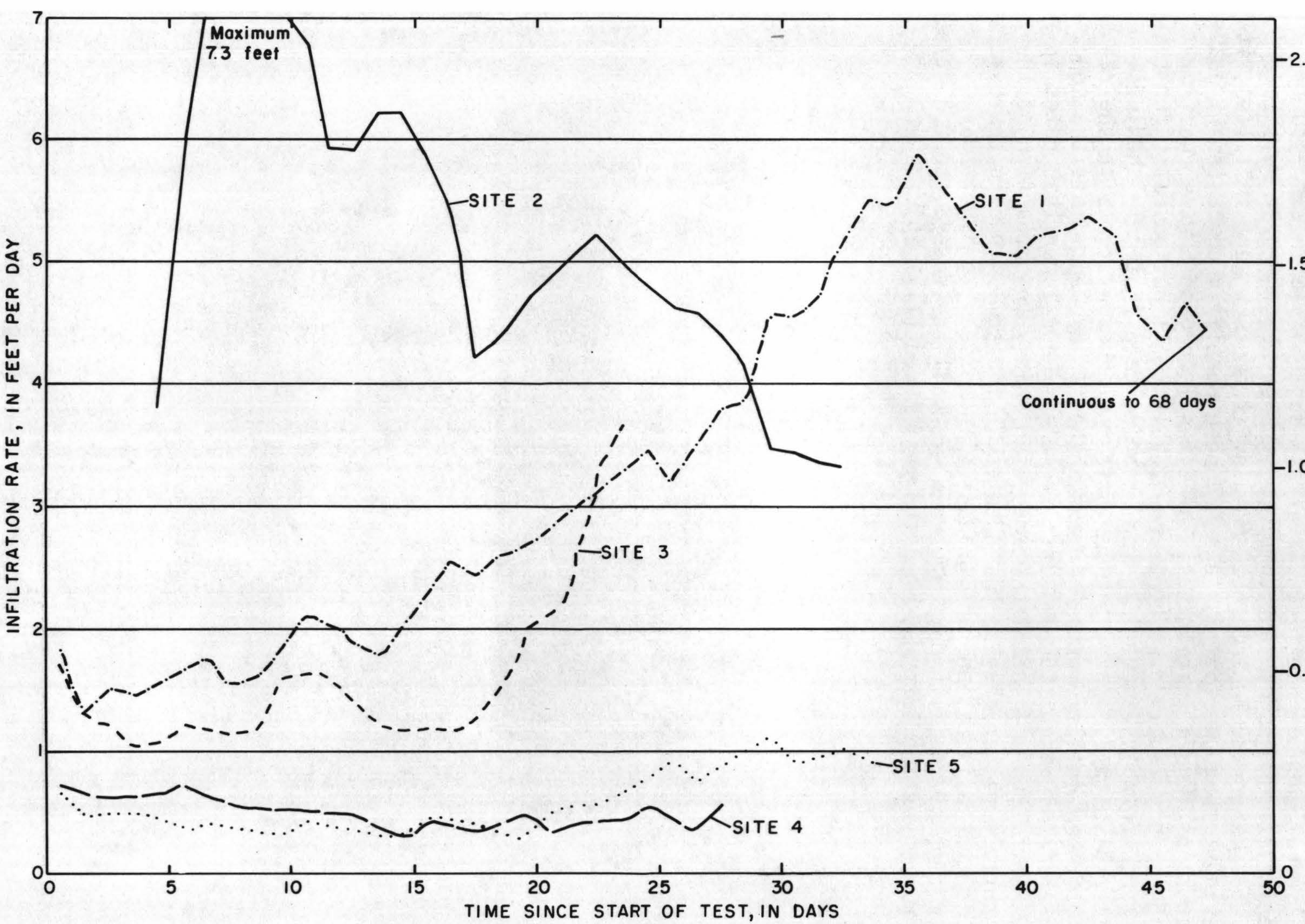


Figure 14.--Average daily infiltration rate for 10-inch (250-mm) ring infiltrometers at Sites 1 through 5.

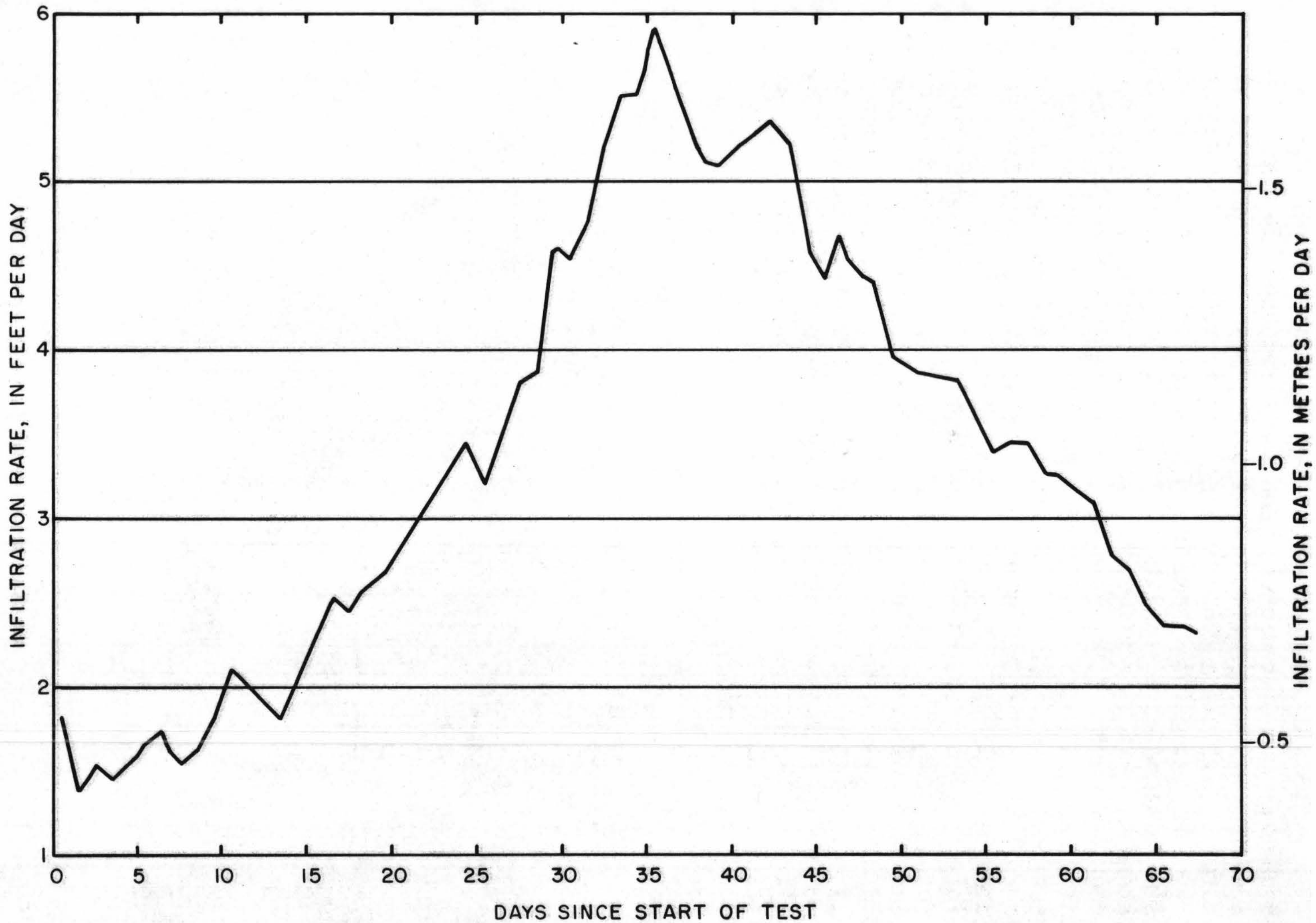


Figure 15.--Average daily infiltration rate for 10-inch (250-mm) infiltrometer, Site 1.

Double-Ring Infiltrometers

Two double-ring infiltrometers were installed about 10 feet (3 m) apart to a depth of 5 inches (130 mm) at Site 1 (fig. 16). The construction consisted of a 10-inch (250-mm) ring infiltrometer in the center of a 22-inch (560-mm) ring infiltrometer. The water level in both infiltrometers was maintained at a constant 0.5 foot (0.2 m). The double-ring infiltrometers did not penetrate the B soil zone (fig. 6). The purpose of using double-ring infiltrometers was to create an outer ring that, theoretically, would reduce lateral movement of water from the inner ring (edge effect). Thus, the infiltration rate measured in the inner ring would reflect all of the water moving vertically below the ring (Burgy and Luthin, 1956).

The infiltration tests using the double-ring infiltrometers at Site 1 were run from July 19 to August 28, 1972. The infiltration rates in inner and outer rings No. 1 decreased in the first 12 days to about 1 ft/day (0.3 m/day) and were very similar (fig. 17). Rates in inner and outer rings No. 2 increased during the first 6 days of the test so that the rate in the inner ring was about twice the rate in the outer ring. From the sixth to the fifteenth day, the last 20 days of the test, all the infiltration rates were relatively similar, ranging from 1.3 to 2.2 ft/day (0.4 to 0.7 m/day).

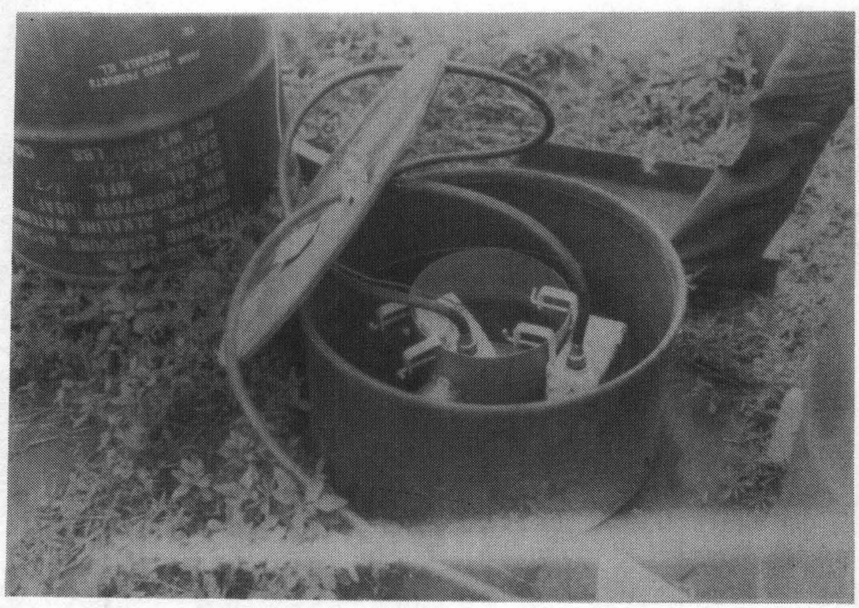


Figure 16.--View of double-ring infiltrometer with supply hoses and float valves.

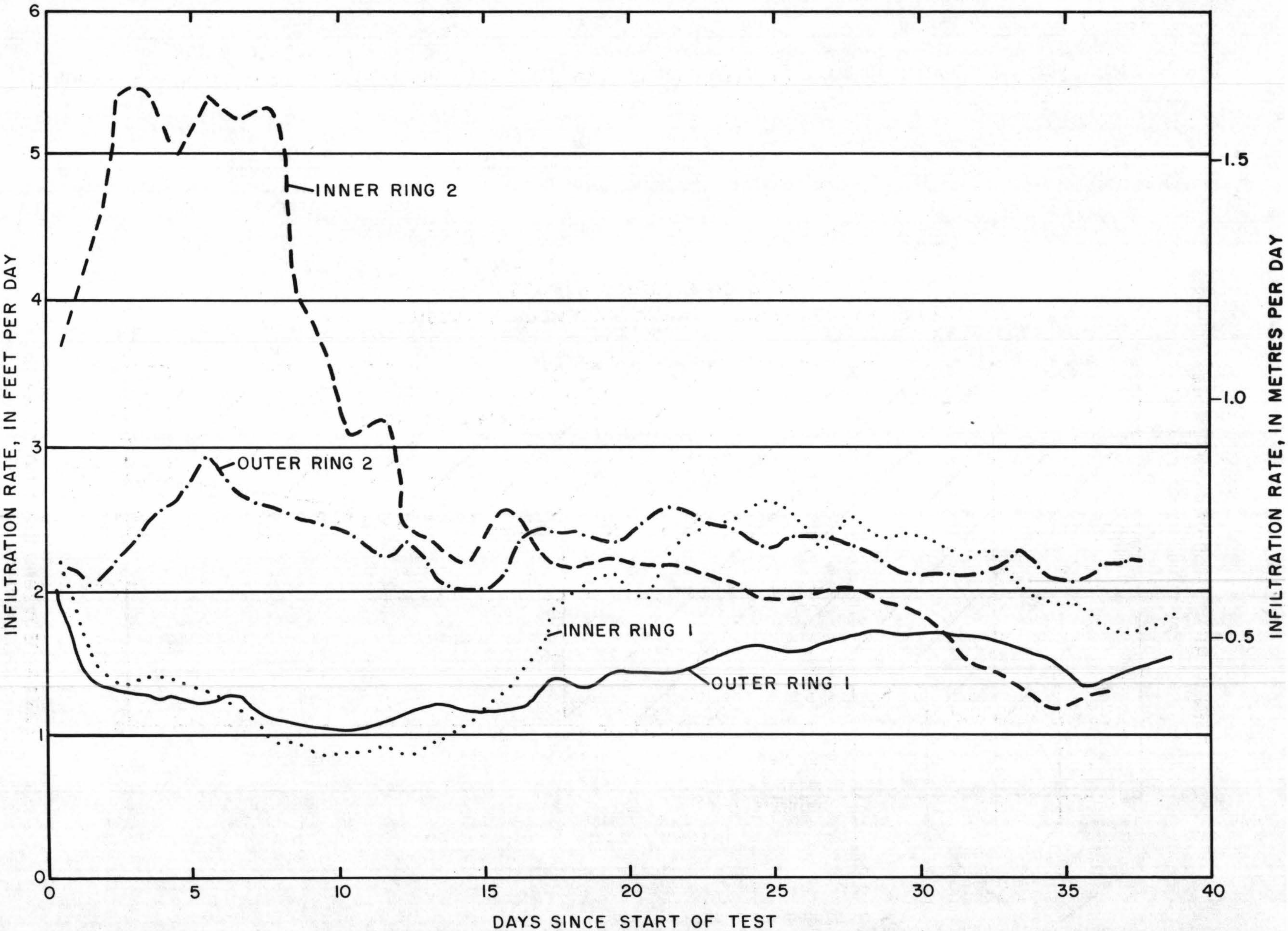


Figure 17.--Average daily infiltration rate for double-ring infiltrometers, Site 1.

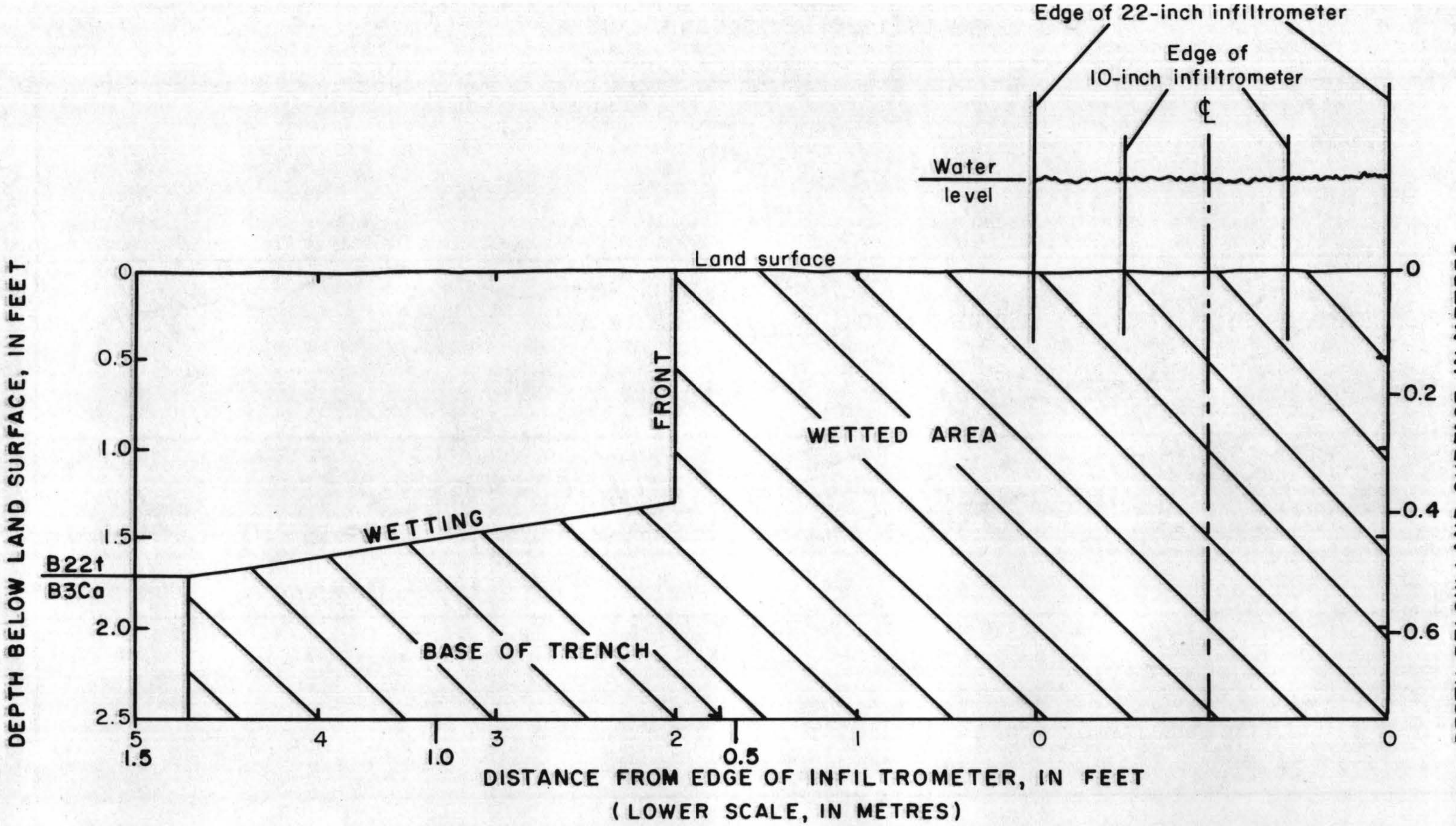


Figure 18.--Profile of wetted area in trench extending radially from double-ring infiltrometer No. 1 at Site 1.

About 2 weeks after the double-ring infiltrometer tests started, the lateral movement of the wetted area was determined from an open trench 1 foot (0.3 m) wide by 2.5 feet (0.8 m) deep by 8 feet (2.4 m) long that extended radially from the edge of ring No. 1. Figure 18 gives a profile of the wetted area adjacent to the infiltrometer. The soil surface was wet to a distance of 2 feet (0.6 m) from the outer edge of the infiltrometer and to a depth of 1.3 feet (0.4 m). The edge of the wetting front sloped downward from there to a point 1.7 feet (0.5 m) in depth and a distance of 4.7 feet (1.4 m) from the outer edge of the infiltrometer, which coincides with the contact between the noncalcareous B zone (B22t) and the calcareous B zone (B3Ca). From that point, the outer edge of the wetting front extended vertically downward to the base of the trench.

Ring Infiltrometer in Loess

A ring infiltrometer, 10 inches (250 mm) in diameter, was installed in the underlying Peoria Loess at Site 1 to compare infiltration rates of the loess with those of the Richfield soil. A hole was "cored" into the upper part of the loess by pressing a 22-inch (560-mm) infiltrometer to a depth of 4 feet (1.2 m) and removing both the soil and the infiltrometer. Then a 10-inch (250-mm) infiltrometer was pressed into the loess at the bottom of the hole to a depth of 12 inches (300 mm).

An infiltration test was run from August 23-31, 1972. The average infiltration rate in ft/day increased from 5.25 feet (1.6 m) after 12 hours of submergence to 13.0 feet (4.0 m) after 7 days of submergence (fig. 19). The high infiltration rate in the loess, which was more than double the rate in the soil zone, indicated that the downward movement of water was limited by the infiltration rate through the soil as previously had been assumed.

INDIRECT MEASUREMENT OF FLOW CHARACTERISTICS

Concentric-Ring Method

The concentric-ring method of measuring flow through the infiltrometers was used to determine the infiltration rate in different areas of the ring and to determine the magnitude of leakage between the soil and the infiltrometer wall. Two 22-inch (560-mm) ring infiltrometers from Sites 1 and 2 and one 10-inch (250-mm) ring infiltrometer from Site 2 were carefully lifted with the soil cores intact within each infiltrometer. The infiltrometers were placed on containers divided into three concencentric areas. Water was passed through the soil cores inside the infiltrometers and the infiltration rates were calculated and adjusted for each concentric area (inner, middle, and outer). The tests on the two infiltrometers from Site 2 were run for 24 hours (fig. 20). The test on the 22-inch (560-mm) infiltrometer from Site 1 was run for 298 hours (fig. 21). The data acquired from these tests showed a slightly higher infiltration rate for the inner area than for the outer area, indicating that leakage along the edges of the infiltrometers is not a significant factor.

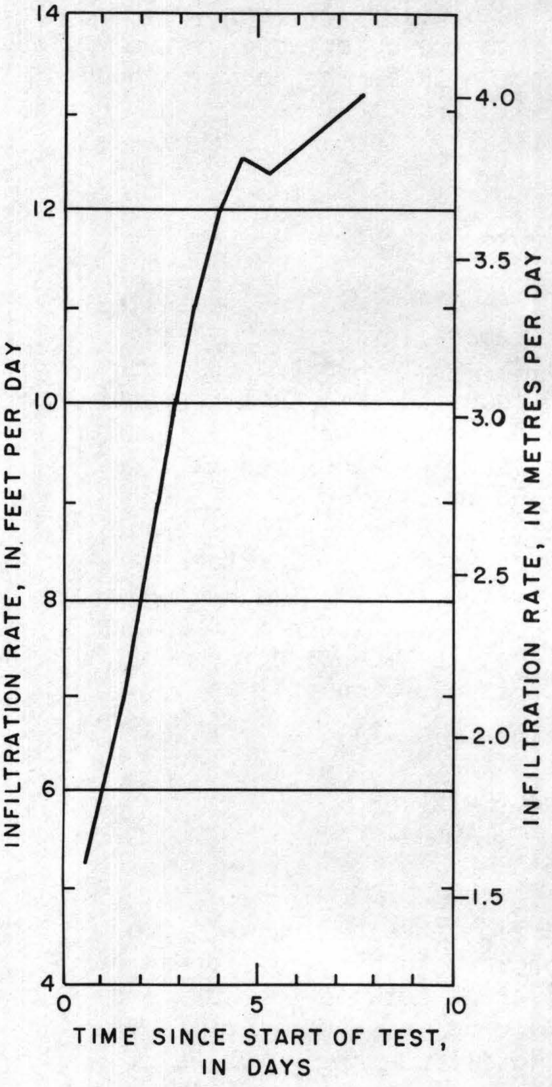


Figure 19.--Average daily infiltration rate in loess for 10-inch (250-mm) ring infiltrometer.

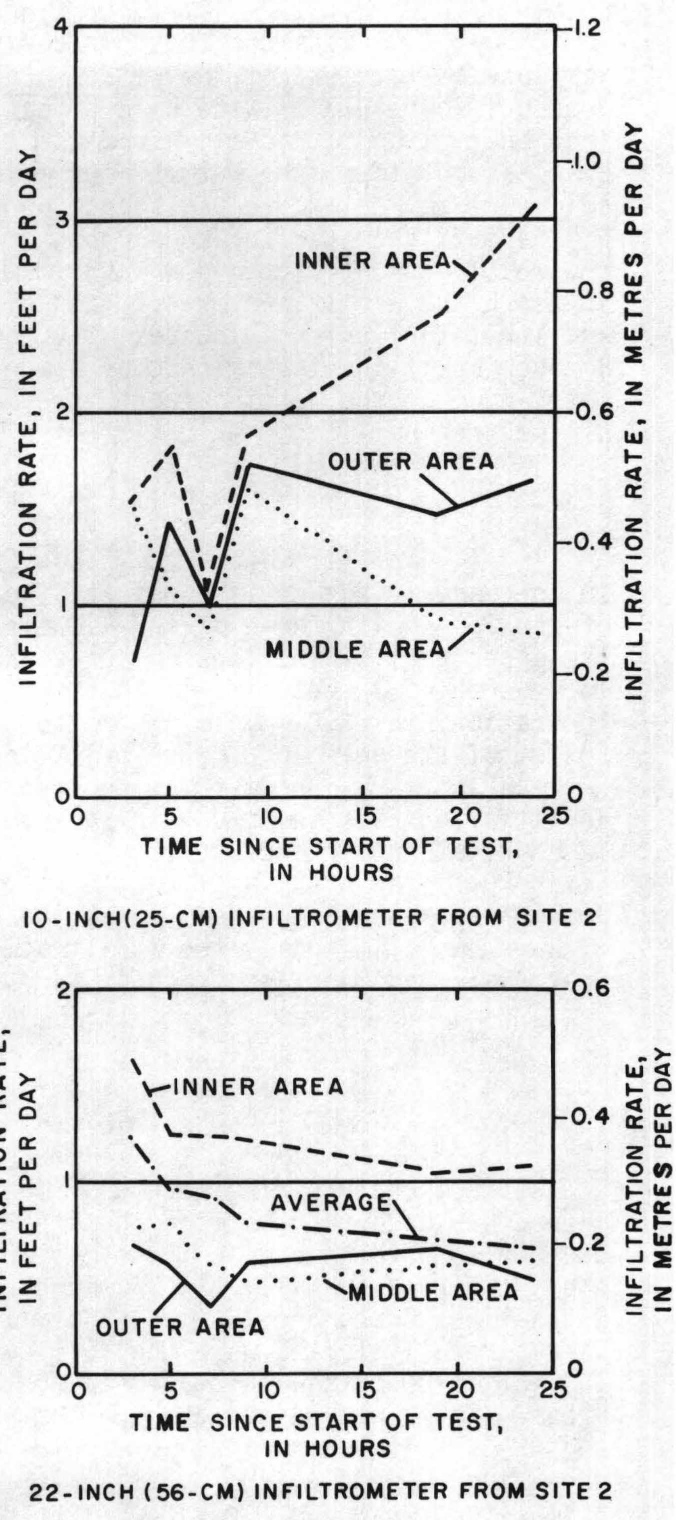


Figure 20.--Infiltration rate for 24-hour concentric-area tests, Site 2.

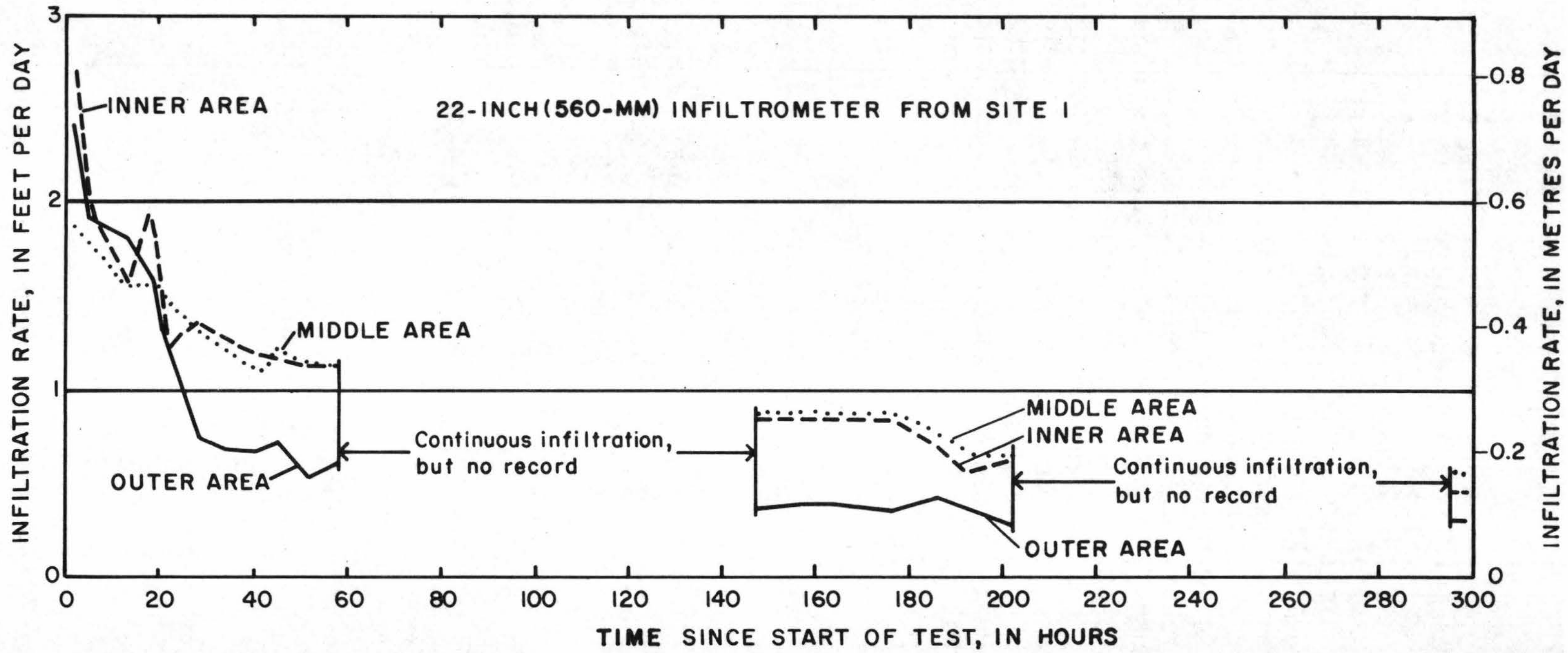


Figure 21.--Infiltration rate for 298-hour concentric area test, Site 1.

Laboratory Test of Hydraulic Conductivity

The hydraulic conductivity of a soil sample collected near Site 1 was tested in the U.S. Geological Survey Hydrologic Laboratory in Denver, Colo. This sample was collected by pressing a 5-inch (130-mm) aluminum irrigation pipe to a depth of 2 feet (0.6 m) and removing the soil with as little disturbance as possible. The test used water from the same source as that used during the ring-infiltration tests. Results of the laboratory test are shown in table 4. The depth interval from 3.9 to 8.6 inches (99 to 218 mm), which gave the lowest hydraulic conductivity value, was the zone that limited the rate of infiltration. The moisture content of 539 grams of water to 5.4 cubic metres of pore volume indicated that the zone was almost completely saturated during the test. The total porosity in this zone was 41.6 percent. The authors believe that this infiltration-limiting zone occurred at the base of normal cultivation, which commonly is known as the "plow pan".

Table 4.--Hydraulic conductivity of soil sample from Site 1.

Sample depth, interval, in inches	Hydraulic conductivity at 4.7-inch (119-mm) intervals, in feet per day
0.0- 3.9	loose soil - no data
3.9- 8.6	0.21
8.6-13.4	7.2
13.4-18.1	7.9
18.1-22.4	10.2

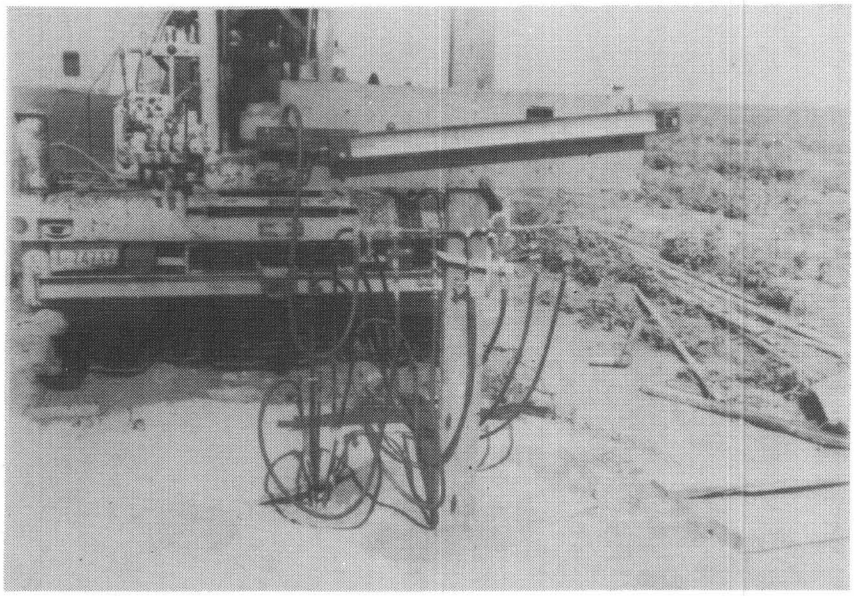


Figure 22.--View of tubing, manifold, and inclined manometer used in air-permeability test.

Air-Permeability Test of Hydraulic Conductivity

The effective pneumatic diffusivity of selected layers in the unsaturated zone was determined by the analysis of changes in air pressure at depth in response to changes in atmospheric pressure at the land surface (E. P. Weeks, written commun., 1975). Short screens were installed at each layer boundary and connected by tubing (tightly cemented in place) through a manifold to an inclined manometer (fig. 22). Manometer readings were made periodically for each screen during a time of changing atmospheric pressure. Pneumatic diffusivity values were computed by an electric-analog model using the method described by E. P. Weeks, written commun., 1975. These diffusivity values were used with assumed values of drained porosity to determine the air permeability and the equivalent hydraulic conductivity of the various intervals.

Air-permeability tests were run at Site 4 on July 13 and August 3, 1972. A summary of the analyses of data is given in table 5. The layer of lowest hydraulic conductivity was in the Ogallala Formation at a depth of 57 to 75 feet (17 to 23 m) below land surface. If a sufficient amount of water from natural or artificial recharge percolated downward to saturate this layer, temporary perching of water probably would occur above the zone. The hydraulic conductivity for the depth interval from 0 to 5 feet (0 to 1.5 m) was lower than the hydraulic conductivity calculated from observed infiltration rates because the permeability to air was reduced by the high moisture content in the soil from summer rains.

Table 5.--Summary of the analyses of data for air-permeability tests, 1972.

Depth interval (feet)	PDe 1/		Kw 2/			$\emptyset_d$ 3/
	July 13	Aug. 2	July 13	Aug. 2	Average	(assumed)
0- 5	0.3	0.24	2	1.8	1.9	0.2
5- 43	3.0	3.9	20	29	24	.2
43- 57	.45	.48	3	3.6	3.3	.2
57- 75	.05	.027	.2	0.1	.2	.1
75-150	.9	.8	6.5	6	6.2	.2

1/ PD_e = effective pneumatic diffusivity, in ft^2/s (0.0929 x m^2/s).

2/ K_w = hydraulic conductivity, in ft/day (0.3048 x m/day).

3/ $\emptyset_d$ = drained porosity.

CONCLUSIONS

In general, the infiltration tests showed that substantial quantities of water could infiltrate the Richfield silt loam. Owing to the variability of the infiltration rates in space and time, it is debatable whether ring infiltrometers could be used as a reconnaissance technique to determine the recharge potential of a given area. Tests should be made to compare infiltration rates determined from ring infiltrometers to rates determined from an infiltration pond. Compaction of the surface by hard summer rains and development of a "plow pan" at the base of the depth of cultivation appear to be the main factors that reduce infiltration through the Richfield silt loam soil in western Kansas.

The infiltration tests indicate that edge effects using the 10-inch (250-mm) and 22-inch (560-mm) single-ring infiltrometers pressed into the the B-zone of the soil were negligible; therefore, double-ring infiltrometers are not needed.

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