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RELATIVE INFILTRATION AND RELATED PHYSICAL CHARACTERISTICS OF CERTAIN
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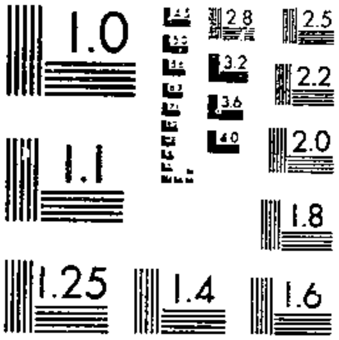

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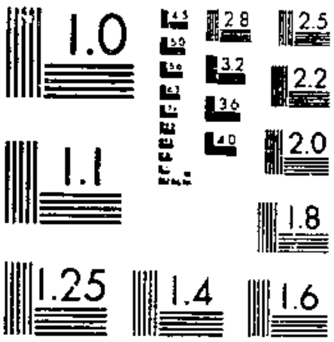

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Relative Infiltration and Related Physical Characteristics of Certain Soils[1]

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CONTENTS

INTRODUCTION

Infiltration, as used in this bulletin, refers to the entrance of water into soils under field conditions. Infiltration rate, as used herein, presupposes an excess of water on the soil surface that tends to produce run-off or, if confined on an area so that run-off cannot occur, a head of water on the soil surface. The rate of infiltration has been observed to differ in different soils. The factors that govern the entrance of water into soil are doubtless complex and have been little studied. However, numerous studies have been made of the flow of liquids through various other porous media, particularly sands of various sizes and assortments. The factors governing the entrance of water into material as complex as soil are clearly more involved. The rate of infiltration is a variable rather than a constant factor, changing with changes in soil structure, the temperature of air, water, and soil, the moisture content of soil, and the degree of biological activity within the soil profile. Some of these factors vary seasonally, and others vary during the course of a single storm. Despite these facts it is recognized that the relative amount of infiltration of water into different soils is associated with their physical characteristics.

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[2] Many members of the staff, both in the Washington office and in the field, assisted materially in the development of the study. Acknowledgment for tangible assistance is due particularly to V. J. Palmer, assistant agricultural engineer; C. C. Butler, junior soil technologist; G. D. Brill, engineering aide; H. N. Holten, assistant scientific aide; and Leo Wheeler, junior laborer, who did much of the field work; also to staff members of several State agricultural experiment stations and soil technologists of the regional offices of the Soil Conservation Service, who rendered material assistance in the selection of profiles for study and provided laboratory facilities in several instances. A. E. Brandt and K. W. Babcock directed much of the statistical work. For the assistance of these and many others the authors wish to express their gratitude.

Infiltration is the only process by which precipitation enters the earth's surface and becomes potentially available to plant and animal life. Whenever the rate of rainfall exceeds the rate of infiltration, surface run-off occurs. Comparatively small differences in infiltration rates may greatly affect the total annual run-off of surface water because rains of high intensity occur less frequently than those of low intensity. A relatively small increase in infiltration rate may eliminate run-off from a large number of storms.

The chief purposes of this study were: (1) To determine the relative rate of infiltration for important soils; (2) to ascertain what relations may exist between infiltration and certain physical properties of these soils; and (3) to explore the problem as a whole, searching for evidences of underlying basic principles and ascertaining directions future studies may take most profitably.

REVIEW OF RELATED INVESTIGATIONS

Investigations dealing with factors that directly affect the infiltration of water into soil have been for the most part restricted to the amount, distribution, and intensity of precipitation. There are, however, considerably more data relating to factors that determine the permeability of porous media and also to physical properties of the soil, which are generally regarded as affecting its permeability.

King (*8*)[3] and Slichter (*21*), as well as Mavis and Wilsey (*11*), have shown the effect of grain size and particle arrangement on the permeability of sands. Muskat (*15*) has dealt in some detail with the factors that govern the permeability of various natural media, showing the complexities of this problem in contrast to the more simple one found in studying the permeability of graded sands of known physical properties.

In a discussion of methods of determining infiltration rate, Horton (*7*) includes among the characteristics that influence it, soil structure, texture, initial moisture content, temperature, and porosity.

Baver,[4] in reviewing data from the Marshall silt loam and Shelby loam soils, states: "The type, rate, and amount of movement will be related to the properties affecting the nature of the pore space." He shows that the most impermeable layer of the Shelby loam contains 5 percent of noncapillary porosity, whereas the minimum noncapillary porosity of the Marshall is 25 percent. Data by Musgrave (*13*) show the infiltration rate of the Marshall to be much above that of the Shelby.

Slater and Byers (*20*) determined the rate of percolation through cores from six soils obtained in the field and transported to the laboratory and compared the rates with certain physical determinations of the cores, including the mechanical analysis, volume weight, moisture equivalent, water-holding capacity, suspension percentage, and dispersion ratio. They found correlations between rate of percolation and silt content, suspension percentage, and percentage of sand, but no definite relationship between rate of percolation and volume weight, percent colloid, or moisture equivalent.

Auten[5] has shown that the organic matter in soil beneath natural

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[3] Italic numbers in parentheses refer to Literature Cited, p. 32.

[4] BAVER, L. D. SOIL CHARACTERISTICS INFLUENCING THE MOVEMENT AND BALANCE OF SOIL MOISTURE Soil Sci. Soc. Amer. Proc. 1:431-437. 1936. [Processed.]

[5] AUTEN, J. T. THE EFFECT OF FOREST BURNING AND PASTURING IN THE OZARKS ON THE WATER ABSORPTION OF FOREST SOILS. U. S. Forest Expt. Sta., Cent. States, Note 16, 5 pp., illus. 1934. [Mimeographed.]

forest vegetation is associated with a markedly higher amount of infiltration than occurs under burned woods or open pasture.

Greene and Ampt (*3*) and others have formulated infiltration equations of more general application, but these have been shown by Hardy (*5*) to be inapplicable to colloidal soils. It appears, therefore, that the physical characteristics of the soil will have to be taken into consideration in the development of any equation to represent the rate of movement of water into a system as complex as that of a soil.

Middleton (*12*) found the dispersion ratio and erosion ratio to be among the best indices of the erosional behavior of soils. These determinations are measures of the ease with which a soil goes into suspension to be carried away in the run-off water or to clog the pores and reduce infiltration, as shown by Lowdermilk (*9*) and other workers.

European investigations of the relation of soil structure to water movement in soils as measured by noncapillary porosity and infiltration rate are reviewed by Sokolovsky (*22*) and Williams (*25*). In general the data show that treatments that increase the number of large stable aggregates increase the noncapillary porosity and the infiltration rates.

Lutz[6] found 45.4 percent and 83.3 percent of the aggregates in the subsoil of the Iredell and Davidson, respectively, to be larger than 0.10 mm. and concluded that the high percentage of large aggregates in the Davidson soil was probably the most important factor in producing greater percolation through this profile.

Bradfield's (*1*) theoretical discussion dealing with structural relationship in soils emphasizes the importance of large stable aggregates in the formation of relatively large pores, which act as a continuous series of connecting chambers through which air and water can readily pass.

Aggregation has been shown to be affected by numerous factors. As shown by Baver[7] and others, the percentage of stable aggregates is correlated with the organic matter and the amount of silt and clay.

From these investigations it is clear that there are many data on the physical properties of soils that portray their structural characteristics. The relation of these properties to infiltration is recognized, but there is little specific information that deals with the movement of water into and through undisturbed soil profiles.

EXPERIMENTAL MATERIAL

The 68 sites included in this study were selected by soils specialists as representative of important contrasting soils. Brief descriptions of the profiles and other information, such as location of site and date of study, are given in the appendix (table 11). Several of the profiles named and described in this table have not as yet been correlated by the Department Committee on Soil and Erosion Surveys. The series designation of these profiles is tentative. These 68 sites represent 39 soil series and 6 of the great soil groups, Gray-brown Podzolic soils, Red and Yellow soils, soils of the northern prairies, northern Chernozem soils, soils of the southern prairies, and Brown

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[6] LUTZ, J. F. THE STRUCTURE OF SOILS AS AFFECTING SOIL EROSION. Amer. Soil Survey Assoc. Bul. 15:98–100. 1934. [Mimeographed.]

[7] BAVER, L. D. AGGREGATION OF SOILS AND CALCIUM ION SATURATION. Amer. Soil Survey Assoc. Bul. 17:28–30. 1936. [Mimeographed.]

soils (*10*). They also represent the 9 following groups of parent material: Glacial accumulations (calcareous), glacial accumulations (slightly calcareous or noncalcareous), Great Plains material, marine deposits (marl and chalk), marine deposits (sands, clays, and limestones), wind-laid deposits (loess), residual accumulations, crystalline rocks, and sandstones and shales. These soils include 16 that are properly classified as sandy clays and sandy loams, or sands, and 52 of finer texture, including loams, silt loams, clay loams, silty clay loams, and clays.

The soils are distributed in all the humidity provinces from wet to arid, all the seasonal distribution of precipitation provinces, and two of the temperature provinces (*23*). Thus, of the climatic provinces occurring within the continental limits of the United States, all are represented except two temperature provinces, the tropical and taiga.

It is to be expected that the field volume weight, organic-matter content, degree of aggregation, moisture equivalent, and other physical properties of soils so distributed would differ widely.

For the purposes of this study, this wide difference in the physical characteristics of the soils selected has, on the one hand many advantages, and, on the other hand, decided disadvantages. The advantages of such diversity lie primarily in the fact that relationships found for this group of soils may reasonably be expected to be found generally for other soils. The disadvantage rests principally in the difficulty of ascertaining minor relationships most probably existing in subgroups of soils of more homogeneous characteristics.

PROCEDURE

FIELD

Various kinds of equipment have been used for determining infiltration rates, including rings, tubes, and rainfall simulators. At the time this study was begun the tube method appeared to be the best adapted to field use, since portability of equipment and water supply must be considered.

A brief discussion of the technique of obtaining infiltration data with tubes should suffice since descriptions and photographs have been published elsewhere (*14*). Galvanized-steel tubes, 9 inches in diameter, 10 or 14 gage, were jacked into the soil from the rear of a weighted truck. The tubes were 18 or 24 inches long, depending on the length of tube required to penetrate the subsoil. After the tubes were sunk until only about 2 to 3 inches of each protruded above the surface, a head of water about one-fourth of an inch deep was maintained on the soil surface enclosed by each tube by means of a self-dispensing calibrated burette. A typical installation of a single burette and steel tube is shown in figure 1. At 15, 30, 60, 120, and 180 minutes from the beginning of a run the amount of water that had been drawn from the burette was read and later converted to surface inches.

The water used for these studies was obtained either from municipal water supplies or from wells or cisterns near the site. Some control of quality was gained by determining the pH value of water that might be available and using water that had a pH value nearest 7.0. Obviously, water having any appreciable degree of turbidity could not be used. Salt concentration was not determined, but, since amounts of water applied were relatively small and duration of tests relatively short, this was not considered an important factor.

Statistical studies[5] made early in the course of the work to ascertain the minimum number of replicates that could be used successfully indicated that on certain soils 6 replicates might be enough; on others as many as 22 were required for the same degree of precision. On the basis of these findings, the use of 24 replicates for the main phase of the field work was adopted as standard for all sites. The 24 tubes were generally placed in 2 rows about 6 feet apart and spaced 18 inches center to center in each row. An initial determination of infiltration rates was made at whatever field-moisture content prevailed at the time, and a succeeding determination was made on the same units 24 hours later. These will be referred to as initial and wet runs, respectively.

FIGURE 1.—Typical installation of a single burette and steel tube.

Obviously it was impossible to select sites on which plant cover and past cropping history were the same. Whenever feasible, the sites were in fields on which row crops were growing. These fields were not recently cultivated, and the ground was in a settled condition. If such areas were not available, the sites selected were on fields of small grain or similar crops. It was necessary that a few of the sites be on areas having a permanent grass cover. Most of these sites were in the Southwest, and there the vegetal cover was for the most part relatively sparse even though the areas were designated as range land. The standard procedure was to remove all vegetal cover and ground litter on the soil surface confined by the tubes, with no disturbance of the soil itself. Musgrave and Free (*14*), however, have shown that the effects on infiltration rates of cultivating to different depths are transitory, and the effect on rates during the wet run are nonsignificant when the tube method is used.

Temperatures of soil at depths of 4 and 15 inches and of water were taken, and the initial moisture content of the soil was determined from samples obtained from locations near the tubes. The moisture content at the beginning of the wet run was determined from samples from two extra tubes sunk for this purpose and given the usual initial applications of water. The infiltration data from these two tubes were not recorded. Obviously because of the inherent variability

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[5] Personal communication from A. E. Brandt.

of soil, particularly in volume weight, the moisture data should be used only as an index of general moisture level.

After the completion of the runs, six tubes from the set were taken at random and necessary data obtained for calculation of volume weights of the horizons or portions of horizons within them. Two composite soil samples for laboratory analyses were obtained, one from the surface soil and one from the subsoil.

LABORATORY

Mechanical analyses were made by the method outlined by Olmstead and others (*16*), except that to conform with the classes recently set up in the Bureau of Chemistry and Soils additional separations were made to include the 0.20-mm. and 0.02-mm. classes. Some of the soils were flocculated by sodium oxalate. In these soils a mixture of sodium hydroxide and sodium oxalate maintained the dispersion effectively. Moisture equivalent was determined by the method of Briggs and McLane (*2*). The dispersion ratios and suspension percentages were determined by the method of Middleton (*12*). The pH determinations were made electrometrically by means of a glass electrode. Specific-gravity determinations were made by the method outlined by Hillebrand (*6*). The field-volume weights were calculated from weights and measurements taken from 6 of the 24 infiltration tubes at each site. Infiltration tubes of known volume were used. A thin rubber bag was inserted in each tube to prevent penetration of water and also to allow water to fill the small irregularities on the surface of the soil. A known volume of water was added, the tube leveled, and the distance from the water level to the top of the tube measured. The soil from the surface horizon was then removed, weighed, and sampled for moisture determinations. This procedure was repeated to obtain field-volume weights of the subsoil. The organic-matter determinations were made by a modification of the Schollenberger rapid-titration method (*18*, *19*), essentially that described by Walkley and Black (*24*). The average ratio of recovery by the dry-combustion and the rapid-titration method was used as the approximate factor for correcting the values obtained for organic matter by the rapid-titration method.[9] Distribution of aggregates was determined by the method described by Yoder (*26*). Air-dried samples were passed through a screen having openings of approximately 7 mm. and allowed to slack in water before fractionation on the sieves.

The porosity of the soil was calculated from the data on the field-volume weight and the specific gravity by the formula

$$\frac{S-A}{S}\times 100=\text{porosity},$$

where S=specific gravity and A=volume weight (apparent specific gravity).

Three different methods of calculating indices of noncapillary porosity were used. The first method consisted of subtracting from total porosity the moisture equivalent converted to a volume basis.

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[9] BROWNING, G. M. A COMPARISON OF DRY COMBUSTION AND RAPID DICHROMATIC TITRATION METHODS FOR DETERMINING ORGANIC MATTER IN SOIL. Soil Sci. Soc. Amer. Proc. 3: 158–161. 1938. [Processed.]

The second method differed from the first only in that the moisture-equivalent value was corrected for texture by using average values of the ratio of field capacity to moisture equivalent observed by Harding (4). The third method of arriving at an index of noncapillary porosity was to calculate the volume of pores not occupied by water 24 hours after the initial run. Soil-moisture data were used for this purpose. All values of noncapillary porosity were expressed in percentage of total volume. A further discussion and a comparison of these three methods is presented on page 20.

RELATED STUDIES

RAINFALL-SIMULATOR METHOD

During the course of the main study one of the field parties was equipped with a rainfall simulator developed in the hydraulic laboratory of the National Bureau of Standards, Washington, D. C., by the Soil Conservation Service. The few data obtained with this were used in comparisons between the sprinkling or rainfall-simulator method of studying infiltration and the tube method used in this study.

The rainfall simulator produced a rainfall intensity of approximately 2.5 inches per hour. To control the effect of air currents on distribution and intensity of rainfall the plot and sprinkling apparatus were enclosed on the top and four sides by tarpaulins supported by a pipe frame. The plots were 6 feet long and 4 feet wide.

All rainfall-simulator sites were on areas having natural land slopes of approximately 6 percent. The antecedent cultural treatment and other pertinent data for each of the areas are given in the appendix (table 11). Before the initial runs the vegetation was pulled from the plots and bordering areas with as little disturbance of the soil as possible. The maximum depth of disturbance in the plot probably did not exceed 3 inches. The soil was then cultivated uniformly to a depth of about 1½ inches and the slope of the plot adjusted to the required 6 percent. At this time many of the roots in the cultivated depth were removed. The plot boundaries were steel sheets 3 inches wide forced into the soil to a depth of about 2 inches. These were joined to a concentrating trough at the lower end of the plot.

The standard manner of applying water to the plots was to make initial and wet runs of 3-hour duration with about 24 hours between the runs. The application of water extended about 18 inches outside the boundaries of the plot. Immediately after the wet run a metal pan was placed on the plot and a run of 30 to 60 minutes duration was made. The rate of run-off from the metal pan was used as the rate of rainfall for both initial and wet runs.

Excellent control of starting and stopping the rainfall was had by an interceptor over the nozzles that permitted the water to waste into troughs under the sprinkling lines until the pressure in the sprinkler was brought to the desired value. The nozzles could then be cleared in unison, which permitted an instantaneous application of water to the plots at the desired intensity. Stop watches synchronized all measurements.

When rate of rainfall is held nearly constant and when rate of run-off is precisely measured at frequent intervals, it is possible to obtain satisfactory infiltration data. The technique employed in this study made possible the elimination of the volume of soil from the volume of run-off and permitted the direct comparison of the amount of water that was applied as rain with that lost as run-off.

Infiltration data for 13 sites secured by the rainfall-simulator method and the tube method are presented in table 1. The rates determined by the former method range from 0 to 0.98 inch per hour, with a mean rate of 0.38, and by the latter method from 0 to 3.08 inches per hour, with a mean of 0.88. However, a highly significant degree of association between these 2 sets of rates is evidenced by a correlation coefficient of 0.76 (the value of *r* at the 1-percent point is 0.68).

TABLE 1.—*Rates of infiltration of various soils from tubes and from rainfall-simulator sites*

Soil type	Rainfall-simulator site No.	Tube site No.	Observed rate of infiltration per hour during third hour of wet run		Rates of infiltration per hour for tube sites [1]
			Rainfall-simulator sites	Tube sites	
			Inch	*Inches*	*Inches*
Cecil clay loam	8	27	0.22	0.06	0.02
Cecil sandy loam	13, 14	31	.40	.40	.26
Davidson clay loam	11, 12	30	.33	.52	.36
Dunkirk silty clay loam	42, 43	36	.02	.02	.02
Honeoye gravelly silt loam	2	22	.80	3.08	1.28
	3	23	.98	1.58	.78
	40	35	.14	1.32	.56
Iredell loam	7	26	.00	.00	.00
Muskingum silt loam	44, 45	37	.06	.40	.32
Orangeburg sandy loam	19, 20	33	.82	1.38	.67
Red Bay loam	22	34	.22	.38	.25
Ruston sandy loam	16, 17, 18	32	98	1.77	1.24
Volusia stony silt loam	5	25	.03	.55	.38

[1] Corrected for reduction because of applications of turbid water.

A study of these two methods might lead one to expect difference in magnitude of the rates obtained because the method of applying the water, the turbidity of the water available for infiltration, and the size of the areas are all different.

It has been shown [10] that an application of turbid water markedly reduced rates determined by the tube method, which normally includes the application of clear water only. Corrections to the data from these 13 sites for an application of turbid water were made in the following manner.

A few tubes from the set of 24 were selected for a further run of 2 hours' duration, following shortly after the completion of the standard wet run, in which turbid water rather than clear was used. The turbid water was obtained by mixing 1 volume of the surface soil with 4 volumes of water, stirring thoroughly, and then allowing the suspension to stand for 15 minutes. The supernatant liquid was then decanted and used as the turbid water. The degree of turbidity obtained should, therefore, be a function of the characteristics of the soil under study. In all tests the application of turbid water reduced

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[10] MUSGRAVE, G. W., and FREE, G. R. PRELIMINARY REPORT ON DETERMINATION OF COMPARATIVE INFILTRATION RATES ON SOME MAJOR SOIL TYPES. Natl. Res. Council, Amer. Geophys. Union Trans. 18 (pt. 2): 345–349, illus. 1937. [Processed.]

the rate, and the percentage reduction thus obtained for the few tubes was applied to the mean of the rates of infiltration of the 24 tubes during the third hour of the standard wet run. This correction because of the application of turbid water was not made to the rates used for the major portion of the work, but only to those used in making comparisons of the two methods.

These corrected rates are given in table 1. They range from 0 to 1.28 inches per hour, with a mean of 0.47. Seven of these corrected rates are higher than the corresponding rates determined by the rainfall-simulator method, four are lower, and two are the same. The difference between the means, which amounts to 0.09 inch per hour, is not significant for these 13 sites.

The greatest differences in rates determined by the two methods (table 1) are for two of the sites on Honeoye and the one on Volusia. These differences and field observational data suggest that forcing tubes into these gravelly and stony soils may have caused disturbance of the field structure.

The soil may be disturbed and its structure modified by the tubes in three ways: (1) When the tubes are jacked into a profile containing considerable gravel or stones, pieces of this material may be forced either into or away from the core of soil by the sharpened end of the tube or they may be forced deeper into the soil ahead of the tube. It is possible that disturbances of this type affect the infiltration data for all profiles in which there is much gravel or stone. (2) Disturbance of soil may result from the compaction caused by introducing the volume of metal into the soil. Such disturbance in soil cores within tubes is probably not great because the walls of the tubes are relatively thin and are sharpened with a bevel on the outside, which leaves the inner walls straight. (3) A disturbance may be caused by the friction and adhesive forces between the soil and the tube. When these forces are greater than the forces holding the soil in an undisturbed state, compression of the soil takes place as the tube sinks. Forces built up by the compression soon reach a point at which they are greater than the frictional forces, and the tube can then slip past that part of the soil, though this leaves a narrow band of compressed soil adjacent to the tube. Early in the development of the tube methodology it was determined that tubes with a diameter of 3 inches could not be generally used because the soil became compacted vertically throughout the whole tube. Similar difficulties were encountered, though to a lesser extent, on one or two occasions during the early work on Marshall soil when 6-inch diameter tubes were used. In these tests, however, the moisture content of the soil seemed to determine the degree of compaction. Tests were then made with tubes of different diameters. The 9-inch diameter appeared to be satisfactory because there was no noticeable vertical compaction of the soil core and no difference in the infiltration rates secured with 9- and 12-inch tubes. It cannot be assumed, however, that there is no disturbance of soil where there is no noticeable compaction of the whole columns.

LATERAL MOVEMENT OF WATER

Soil-moisture data showing lateral movement of subsurface water at seven rainfall-simulator sites are given in table 2. Analysis of variance of these data indicates that there was a highly significant lateral movement of subsurface water as far as 30 inches from the sides of the plots, although the border application of water extended only 18 inches. The extent and depth to which the greatest movement of water occurred were associated with the profile under study. For example, the data for both highly permeable Ruston profiles indicate significant movement in the 25- to 36-inch depth only, whereas the data from both of the less permeable Cecil profiles and also from the Orangeburg profile indicate significant movement above this depth. Significant lateral movement was found at only one depth in one of the Davidson profiles. These differences in lateral movement are probably associated with the relative permeabilities of the surface soils and subsoils.

TABLE 2.—*Lateral movement of water on seven soil sites*

Soil type	Site No.	Rate of infiltration per hour [1]	Depth of determination	Soil moisture determined— Near plot before start of initial run [2]	30 inches from side of plot after wet run [3]	54 inches from side of plot after wet run [3]
		Inches	*Inches*	*Percent*	*Percent*	*Percent*
Ruston loamy sand	23	1.86	7–15	7.8	8.3	7.7
			15–25	9.2	10.2	9.1
			25–36	8.8	[4] 13.6	9.6
Ruston sandy loam	16	1.07	7–15	14.8	11.0	13.8
			15–25	15.8	20.0	19.5
			25–36	19.7	[5] 22.3	21.8
Orangeburg sandy loam	19	.79	7–15	10.9	[5] 13.2	11.6
			15–25	21.4	21.8	21.4
			25–36	19.8	20.8	21.8
Cecil sandy loam	14	.34	7–15	15.7	[4] 18.5	17.6
			15–25	22.2	[4] 26.4	25.4
			25–36	23.6	[5] 26.2	25.6
Davidson clay loam	11	.34	7–15	24.6	26.2	24.8
			15–25	25.7	24.6	24.8
			25–36	25.3	24.7	24.6
Davidson clay loam	12	.32	7–15	24.6	24.6	23.1
			15–25	25.7	27.0	26.0
			25–36	25.3	[4] 29.6	28.0
Cecil sandy loam	15	.26	7–15	16.4	19.2	14.4
			15–25	24.1	[4] 27.3	23.8
			25–36	25.9	27.8	22.9
Mean				10.6	[4] 21.1	19.8

[1] Obtained 90 minutes after start of wet run by rainfall-simulator method.
[2] Each percentage is mean of 4 determinations.
[3] Each percentage is mean of 2 determinations.
[4] Difference from corresponding percentages obtained before initial run is highly significant.
[5] Difference from corresponding percentages obtained before initial run is significant.

This analysis includes only the data on lateral movement from profiles with relatively high infiltration rates. The fact that data from all profiles have not been presented does not mean that water was not found to be moving laterally on some of these profiles omitted. A very marked movement was found on some of the Honeoye profiles, but the data were not complete enough to include in the analysis or were observational only. Obviously, however, in such soils as the Iredell, for which the rate of infiltration as measured by either the tube or rainfall-simulator method was very low, lateral movement of water, if it occurred at all, had little effect on final infiltration rates.

Few data on lateral movement of water were collected for the tube sites. When tubes were being dug for volume-weight determination on site 24, a highly permeable Honeoye sod, water about 8 inches below the tube was found to have spread laterally about 40 inches.

In order to study lateral movement further, tensiometers were introduced at various positions both inside and outside the rainfall-simulator plots and at various depths and distances from the water source. Table 3 shows data on the lateral movement of water for the highly permeable Lordstown stony silt loam. In these data a decrease in recorded tension indicates that water reached the soil around the porous clay cups. It is therefore apparent that subsurface water moved out to a distance of at least 30 inches from the plot. Lateral movement occurred during the wet run as well as during the initial run in this well-drained soil.

TABLE 3.—*Lateral movement of water at site AR-6 of Lordstown stony silt loam* [1]

Location of porous clay cup	Time from start of run until tension decreased most rapidly		Location of porous clay cup	Time from start of run until tension decreased most rapidly	
	Initial run	Wet run		Initial run	Wet run
7-inch depth:	*Minutes*	*Minutes*	15-inch depth:	*Minutes*	*Minutes*
Center of plot	11	13	Center of plot	16	21
6 inches from side of plot	15	15	6 inches from side of plot	55	30
30 inches from side of plot	65	30	30 inches from side of plot	75	65

[1] Data obtained by use of tensiometers.

The lateral movement of subsurface water that was observed may seem at first thought to be at variance with the generally accepted idea that there is relatively little lateral movement under field conditions. It should be kept in mind that it was probably a movement of gravitational water and also that the surrounding area was dryer than the plot area. It is not meant, nor is it the intention even to suggest, that lateral movement would have occurred in these soils under conditions of natural rainfall where a large area would be wetted.

However, some lateral movement of subsurface water possibly occurs on small experimental plots even under natural rains where diverse surface treatments such as fallow and sod are adjacent to each other. This variable of experimentation may be controlled to some extent, of course, by the use of adequate buffer areas around plots and the replication of treatments. Such procedures, however, are attended by some practical difficulties and have not been commonly used.

In the present study, where the natural soil is encased by tubes of 9-inch diameter and 18-inch length and remains in place on the sublayer, lateral movement of water probably occurs only in unusually permeable profiles. The effect of this may be to give in such instances infiltration rates higher than the true rates.

No definite conclusions regarding the relative merits of the tube and rainfall-simulator methods should be drawn from a comparison of these data from 13 sites. The data do, however, indicate rather definitely that turbidity is the principal factor tending to make rates determined by the rainfall-simulator method lower than those determined by the tube method, in which an effort is made to minimize the effect of turbidity. It is probably true that in general a large percentage of the soil moisture used for crop production is derived from rain that enters the soil without becoming very turbid. One of the objectives of recommending changes in land use practices in order to conserve soil and water is to increase the quantity of nonturbid water to a maximum. It would seem then that this phase of the problem should receive some consideration when the worth of various methods is being determined.

RESULTS

RELATIVE INFILTRATION FOR 68 SOIL PROFILES

The cumulative amounts of infiltration with standard errors at 5 time intervals, the soil-moisture data, and the soil and water temperatures for the initial and wet runs on the 68 sites, comprising 39 soil series, are given in the appendix (table 12). Since the initial run necessarily was made at whatever soil-moisture content prevailed in the field at the time, it is to be expected that the data from the initial runs, particularly at the start, would be somewhat more variable than the data from the wet runs. The field-moisture content at the beginning of the initial run might be considered wholly uncontrolled and dependent, to some extent at least, on past climatic conditions. During the wet run, however, the amount of soil moisture should be more dependent on the characteristics of the soil and less affected by past climatic conditions.

Correlations between various periods of the two runs, however, have shown a high degree of relationship. The correlations shown in the following tabulation are all highly significant.

Time intervals for which infiltration rates during the indicated runs are correlated:	*Value of r* [1]
0– 15 minutes initial run 120–180 minutes wet run	0.854
0– 60 minutes initial run 0– 60 minutes wet run	.915
0–120 minutes initial run 0–120 minutes wet run	.881
0–180 minutes initial run 0–180 minutes wet run	.892
60–120 minutes initial run 60–120 minutes wet run	.854
120–180 minutes initial run 120–180 minutes wet run	.859
0– 60 minutes wet run 0–180 minutes wet run	.996
60-120 minutes wet run 0–180 minutes wet run	.996
120–180 minutes wet run 0–180 minutes wet run	.997

[1] Value of r at the 1-percent point (odds 99 to 1) is 0.31.

These high correlation coefficients between amounts of infiltration during various time intervals of both the wet run and the initial and wet runs indicate that all time intervals are samples of the same population. This fact means that the amount of infiltration for the entire 68 sites during any particular time interval may be estimated from the amount of infiltration during any other time interval. It should be kept in mind, however, that this would not necessarily be true for a single soil.

As a matter of convenience only the rates during the third hour of the wet run were used for all correlations and comparisons.

The relative infiltration data for all the 68 sites is presented graphically in figure 2. Here the sites are arranged in order of magnitude of the infiltration rate during the third hour of the wet run. The data pertaining to separate sites will not be discussed in detail. It is

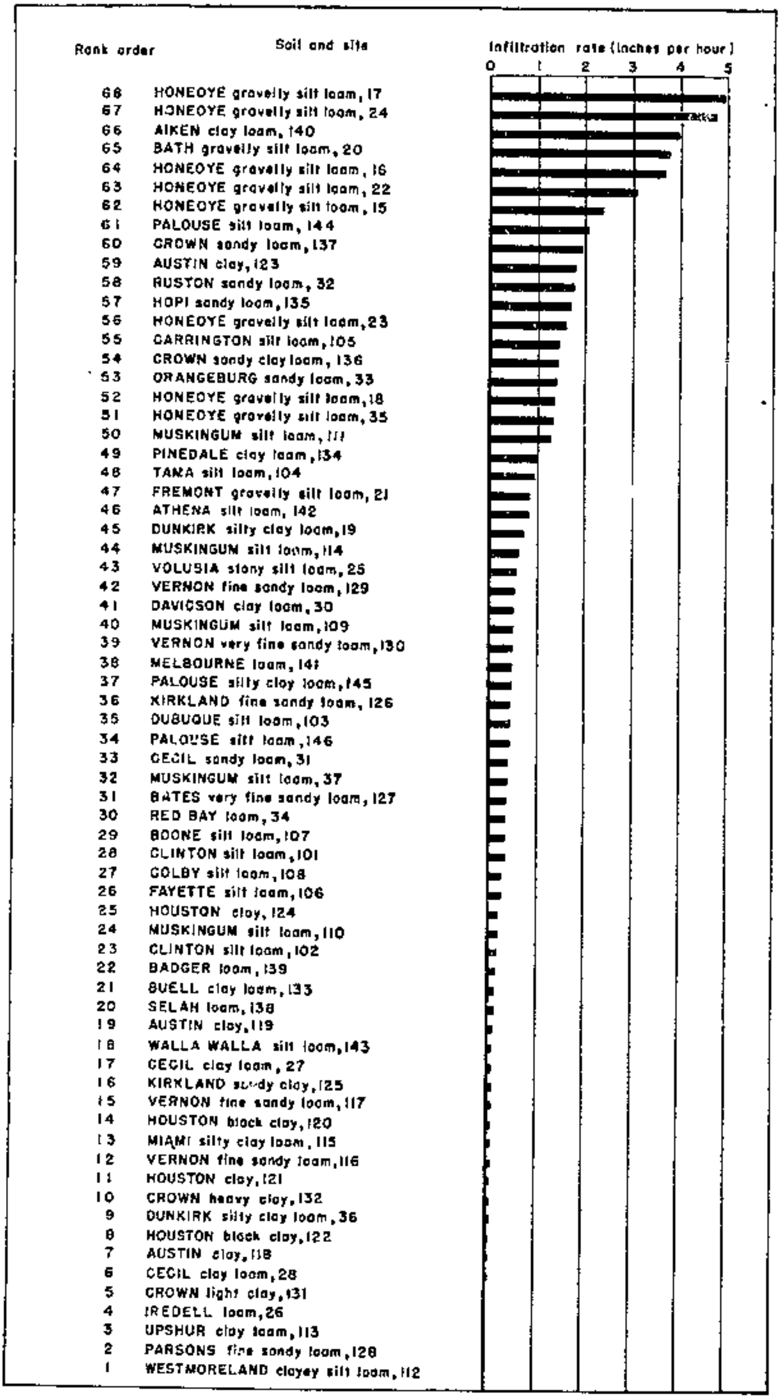

FIGURE 2.—Relative infiltration rates for 68 soils during third hour of the wet run.

apparent from these data, however, that texture of the surface soil is not the principal factor in determining the rank of each of these 68 sites according to their relative infiltration. The rates for those profiles having heavy clay surface soils are generally low. On the other hand the rate for Parsons fine sandy loam was one of the lowest measured. It will be noted also that rates for different sites on the same soil type are not always the same, though there is a tendency for them to be so. As stated later, many of these differences can be explained by differences in the physical characteristics of the profiles.

The mean infiltration data for the 68 profiles are presented in table 4. The relationship of relative infiltration rate and time is presented graphically for 2 soil profiles in figure 3. It is apparent from all the data that the relation between time and infiltration, either on a cumulative or rate basis, is generally curvilinear. The slope of the typical infiltration curve indicates a rapidly changing rate at the start, particularly during the initial run, but soon indicates a nearly constant and slightly declining rate of infiltration.

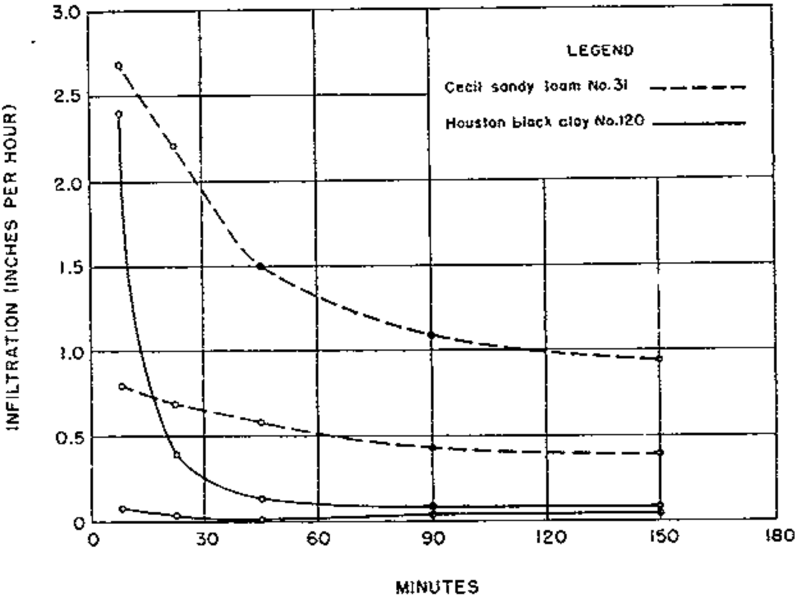

FIGURE 3.—Infiltration rates during initial and wet runs for Cecil sandy loam and Houston black clay. The initial run is higher on the chart than the corresponding wet run.

TABLE 4.—*Summary of mean infiltration data for 68 soil profiles*

Time interval (minutes)	Initial run: Amount of infiltration	Initial run: Average rate of infiltration per hour	Wet run: Amount of infiltration	Wet run: Average rate of infiltration per hour
	Surface inches	*Inches*	*Surface inches*	*Inches*
0–15	1.27	5.08	0.45	1.80
15–30	.57	2.28	.27	1.08
30–60	.90	1.80	.49	.98
60–120	1.49	1.49	.93	.93
120–180	1.35	1.35	0.88	0.88
Total[1]	5.58	......	3.02	

[1] For 3 hours.

GENERAL EQUATION OF INFILTRATION

The infiltration data for any of the 68 profiles may be represented by a general equation of the form

$$I=bt^a,$$

where I=cumulative infiltration inches, t= time of infiltration in minutes, b a coefficient varying for the initial runs on the 68 sites from unity to 0.0087, and a an exponent ranging for the initial runs from 0.04 to 0.82. The form of this equation is the same as that given by Lewis.[11] It does not provide for a constant rate of infiltration even after the lapse of considerable time, except when $a=1.0$. Practically, however, the rate does become almost constant with large values of t. That data obtained from such a varied group of soils under diverse field conditions may be represented by a general equation is undoubtedly of interest.

FACTORS AFFECTING INFILTRATION

The physical and chemical characteristics ascertained for each of these soils and the amount of infiltration occurring during the third hour of the wet run are given in tables 5 and 6. The detailed data from the mechanical and aggregate analyses are in the appendix (tables 13, 14, 15, and 16). The data in these tables have been grouped on the basis of field classification. It will be noted also that in tables 5 and 6 the degree of aggregation in the soil studied has been represented by the percentage of the total weight of the soil in aggregates greater than 0.20 mm. Similarly, the data from the mechanical analyses include only two classifications, namely, the particles less than 0.05 mm. in size and those less than 0.002 mm.

It should probably be stated in connection with tables 5 and 6 that all values pertaining to porosity are on a volume basis. Porosity values are given for surface soil and subsoil separately. These values may be combined—for example, to a depth of 16 inches representing a composite of surface soil and subsoil—by weighting the characteristics of the former in proportion to the depth of surface soil observed in the field. Enough of the subsoil should be included to bring the total height of the column to 16 inches, and the characteristics of the subsoil should be weighted accordingly in arriving at the composite figure.

It will be seen that some of the soils listed in table 5 are erroneously classified as to texture. For example, under clay and clay loams are included four soils that have less than 50 percent of silt and clay. The textural classification is that of soil specialists made without benefit of laboratory analysis. The errors of classification accordingly are in part the result of the recognized difficulty in determining texture precisely by the "feel" of soil, as has been shown by Shaw and Thorp.[12] The errors in classification may also be accounted for in part by the fact that certain of the sites were selected as representative of divergent subgroups within broad, widely recognized groups, such as an eroded phase of a sandy loam, the eroded phase being actually a clay loam. The table accordingly shows both the textural classification made in the field and the quantity of silt and clay determined by mechanical analysis.

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[11] LEWIS, M. R. THE RATE OF INFILTRATION OF WATER IN IRRIGATION PRACTICE. Natl. Res. Council, Amer. Geophys. Union Trans. 18 (pt. 2): 361-368. illus. 1937. [Processed.]

[12] Unpublished paper presented before the Soil Science Society of America.

TABLE 5.—*Rate of infiltration and some physical characteristics of 68 surface soils*

Site No.[2]	Rate of infiltration[3]	Total soil in aggregates >0.20 mm.	Silt and clay <0.05 mm.	Clay <0.002 mm.	Volume weight ratio	Total porosity	Noncapillary porosity index	Organic matter	Moisture equivalent	Suspension	Dispersion ratio	pH value
SILT LOAMS[1]												
	In.	*Pct.*	*Pct.*	*Pct.*		*Pct.*	*Pct.*	*Pct.*		*Pct.*		
19	0.72	9.1	80.5	22.0	1.31	50.8	24.3	1.9	19.4	24.1	30.6	6.79
36	.02	8.4	82.2	21.3	1.35	48.9	21.6	2.2	19.4	11.6	20.0	6.69
37	.40	47.9	70.9	12.3	1.28	51.9	24.2	1.4	22.7	32.9	39.9	4.88
101	.35	9.7	96.5	11.2	1.22	53.8	27.8	1.9	21.9	38.6	40.0	5.66
102	.16	11.8	95.3	13.2	1.31	50.8	23.7	1.4	20.5	37.9	40.4	6.40
103	.44	25.2	86.3	11.3	1.14	56.3	30.8	3.2	24.7	31.3	34.8	5.71
104	.94	21.0	97.4	23.3	1.19	54.8	27.1	3.5	26.4	20.3	30.1	5.27
105	1.42	40.5	85.5	22.8	1.14	56.0	28.2	5.3	28.4	19.4	22.6	5.55
106	.22	11.7	93.1	12.3	1.19	54.6	29.2	2.2	21.9	45.0	37.7	6.26
107	.36	16.2	83.2	12.5	1.31	50.0	22.5	2.1	21.[illegible]	28.4	34.1	6.02
108	.24	28.4	84.2	9.7	1.17	55.0	26.5	3.8	28.3	28.1	30.9	5.24
109	.51	49.8	93.4	10.1	1.19	55.4	29.6	1.4	22.7	23.9	25.4	5.13
110	.78	16.5	84.1	10.3	1.31	50.8	23.2	1.6	21.4	33.6	39.2	5.94
111	1.24	43.7	83.1	6.4	1.17	55.8	30.1	2.2	23.5	17.0	20.1	5.93
114	.61	41.1	80.2	3.9	1.12	57.4	31.0	3.3	26.9	17.8	21.9	5.67
115	.04	11.9	76.2	18.9	1.46	44.3	13.3	2.1	21.7	30.6	39.4	5.26
140	3.98	42.9	76.7	25.4	1.05	61.1	36.3	4.4	27.0	20.1	24.5	5.86
142	.82	14.0	86.6	19.9	1.22	53.4	26.7	2.7	23.3	44.3	50.8	6.53
143	.06	10.5	84.1	16.5	1.30	50.9	21.8	2.5	22.8	41.0	48.8	6.40
144	2.09	15.4	88.4	17.8	1.11	57.6	32.0	3.8	25.0	34.5	39.0	6.47
145	.47	13.8	90.9	23.5	1.16	55.9	30.5	1.6	23.3	34.4	37.9	6.44
146	.43	10.8	86.2	20.0	1.17	55.2	29.4	3.0	23.6	40.6	47.1	5.95
CLAY AND CLAY LOAMS[1]												
27	0.06	6.0	33.6	15.0	1.54	41.4	14.0	0.7	14.7	19.2	50.6	5.57
28	.01	8.7	45.8	34.8	1.31	51.3	23.7	1.4	21.3	20.5	41.1	5.26
30	.52	11.7	50.4	24.7	1.31	51.1	25.1	1.4	18.5	12.6	25.7	6.29
112	.00	34.5	93.4	25.7	1.36	49.4	17.6	1.8	26.5	25.3	27.1	5.44
113	.00	49.7	87.8	34.4	1.35	48.9	17.8	2.0	25.1	17.2	17.6	5.14
118	.01	57.7	87.0	44.9	1.30	50.6	19.9	2.3	27.0	15.0	17.1	8.28
119	.09	59.0	87.3	47.7	1.16	55.4	27.9	2.6	27.1	12.3	14.0	8.27
120	.04	53.7	95.3	61.1	1.05	58.8	34.4	3.2	26.3	11.6	12.2	8.09
121	.02	53.6	91.0	59.0	.94	64.1	36.7	2.8	41.2	13.6	14.9	8.22
122	.01	72.5	92.9	49.2	1.12	57.6	28.4	2.4	32.0	8.7	9.3	8.35
123	1.78	49.9	82.2	41.2	1.16	54.3	28.7	2.6	23.7	11.0	13.2	8.23
124	.18	37.1	91.1	51.0	1.12	57.4	26.6	3.2	35.5	19.7	21.5	8.16
125	.05	19.3	39.9	13.7	1.49	42.9	16.9	1.3	14.1	13.4	33.5	5.57
131	.00	11.8	54.0	26.9	1.33	47.0	19.8	1.1	20.1	16.7	34.2	9.22
132	.02	32.0	94.5	7.9	1.13	57.8	27.0	2.1	34.8	26.6	28.1	8.63
133	.13	16.4	52.9	16.3	1.36	48.7	23.8	1.6	15.5	18.9	35.7	7.72
134	1.00	11.7	41.4	23.7	1.30	50.4	25.3	1.6	17.3	9.8	23.7	8.69
SANDY LOAMS[1]												
31	0.40	14.1	23.7	5.9	1.66	36.4	17.7	0.8	7.5	13.3	55.7	5.47
32	1.77	10.0	11.9	3.5	1.46	44.9	35.5	1.1	3.9	5.8	47.5	5.92
33	1.38	1.4	12.1	3.3	1.53	42.5	32.7	1.0	3.9	7.7	62.9	5.01
116	.03	4.0	30.4	16.9	1.46	43.8	20.6	.9	12.1	14.3	46.5	5.85
117	.04	24.0	42.8	24.4	1.55	40.8	12.0	.9	16.5	8.8	20.4	5.59
126	.46	20.4	36.1	17.7	1.47	43.5	19.5	1.3	12.6	9.5	25.3	5.61
127	.38	20.3	63.2	22.5	1.32	49.0	22.8	2.4	19.7	23.9	37.2	5.75
128	.00	21.1	67.1	10.9	1.41	46.4	21.3	1.2	14.7	41.5	61.4	5.99
129	.55	4.4	26.2	8.9	1.55	41.5	24.2	.7	7.4	14.2	54.2	5.95
130	.51	33.1	[illegible]	18.0	1.35	49.6	23.4	1.3	17.5	27.3	30.8	8.48
135	1.69	9.0	27.2	16.2	1.26	52.3	32.4	.7	11.9	8.9	32.7	8.61
136	1.42	11.0	31.2	12.7	1.33	48.8	27.7	.9	12.0	9.2	29.4	8.72
137	1.93	8.0	41.6	15.4	1.28	49.6	26.3	1.5	15.3	14.2	34.2	8.70
GRAVELLY SILT LOAMS[1]												
15	2.36	48.6	65.1	17.3	1.21	53.7	26.9	5.7	23.8	10.6	15.7	7.49
16	3.67	52.6	61.0	16.3	1.27	51.7	25.6	2.5	20.4	10.9	16.9	7.80
17	4.96	55.1	69.3	23.0	1.19	54.9	28.1	4.7	25.0	9.7	13.3	7.52
18	1.33	59.6	76.0	23.3	1.02	60.9	35.0	6.8	30.4	11.1	14.3	7.70
20	3.75	29.1	62.4	8.5	1.24	52.3	25.0	4.0	23.6	22.2	31.3	5.43
21	.56	26.7	56.7	12.6	1.25	52.1	22.7	4.9	26.8	19.2	33.6	5.27
22	3.08	24.1	63.2	16.5	1.36	48.3	19.1	4.0	22.2	18.3	27.2	7.56
23	1.58	32.3	63.5	15.6	1.23	52.5	25.4	4.0	23.5	14.2	21.4	7.22
24	4.76	61.5	65.1	16.8	1.07	55.8	34.5	5.3	25.4	9.5	13.9	7.14
25	.55	45.3	71.4	16.6	1.04	59.7	32.6	4.8	31.9	9.4	34.2	5.61
35	1.32	49.0	57.1	15.4	1.42	45.8	15.2	3.6	22.3	19.0	30.6	7.71

See footnotes at end of table.

TABLE 5.—*Rate of infiltration and some physical characteristics of 68 surface soils*—Continued

LOAMS[1]

Site No.	Rate of infiltration	Total soil in aggregates 0.20 mm.	Silt and clay 0.05 mm.	Clay 0.002 mm.	Volume weight ratio	Total porosity	Noncapillary porosity index	Organic matter	Moisture equivalent	Suspension	Dispersion ratio	pH value
	In.	*Pct.*	*Pct.*	*Pct.*		*Pct*	*Pct.*	*Pct.*		*Pct.*		
26	0.00	8.9	46.2	17.1	1.49	47.2	19.3	1.3	16.2	17.0	35.8	5.48
34	.38	10.1	33.8	18.0	1.44	46.1	23.7	2.3	11.7	14.2	41.0	5.51
138	.11	10.2	57.8	10.3	1.27	50.0	22.0	2.5	23.6	17.0	29.2	7.34
139	.13	12.1	62.5	10.8	1.16	54.9	30.4	2.3	21.4	33.4	53.3	6.62
141	.50	12.7	57.4	16.5	1.44	45.7	17.2	2.9	18.4	29.3	50.8	5.62

[1] Textural classification based on identification in the field by soil specialist.
[2] Site numbers as shown in table 11.
[3] Rate of infiltration as measured for the third hour of the wet run by the tube method.

TABLE 6.—*Rate of infiltration and some physical characteristics of 68 subsoils*

SILT LOAMS[1]

Site No.[2]	Rate of infiltration[3]	Total soil in aggregates >0.20 mm.	Silt and clay <0.05 mm.	Clay <0.002 mm.	Volume weight ratio	Total porosity	Noncapillary porosity index	Organic matter	Moisture equivalent	Suspension	Dispersion ratio	pH value
	In.	*Pct.*	*Pct.*	*Pct.*		*Pct.*	*Pct.*	*Pct.*		*Pct.*		
19	0.72	14.2	82.0	22.0	1.64	39.0	4.6	1.7	21.1	36.9	45.3	7.62
36	.02	20.5	82.5	24.0	1.71	35.4	.5	.4	21.1	20.6	28.3	7.09
37	.40	25.6	69.4	22.6	1.72	36.1	−2.4	.3	24.7	31.7	43.7	4.78
101	.35	29.5	96.8	19.0	1.50	44.9	11.6	.6	24.1	24.6	25.8	5.05
102	.16	12.3	93.5	22.5	1.53	42.9	9.2	.4	23.6	33.3	35.6	5.23
103	.44	28.7	93.9	21.8	1.38	48.9	18.9	.7	22.9	23.5	25.6	5.32
104	.94	44.0	97.5	26.7	1.28	52.1	22.3	1.2	26.3	20.0	20.5	5.06
105	1.42	44.3	83.4	24.8	1.38	48.1	17.3	1.0	24.4	10.4	12.2	4.98
106	.22	29.7	94.8	17.2	1.47	45.6	12.8	1.6	24.3	29.6	31.8	5.76
107	.30	17.6	77.1	16.3	1.49	44.6	14.3	.4	19.8	25.4	32.7	5.97
108	.24	18.4	90.8	12.8	1.51	44.3	11.8	1.7	22.3	40.7	45.6	4.91
109	.51	35.1	96.8	21.5	1.46	46.1	13.3	.5	24.8	21.4	21.9	4.96
110	.18	16.3	78.9	24.8	1.59	42.0	6.3	.6	24.8	29.6	26.0	4.80
111	1.24	52.9	88.4	19.7	1.59	41.3	5.6	.6	24.9	28.5	21.0	5.33
114	.61	13.8	81.7	14.5	1.38	50.4	19.0	1.0	24.3	19.1	22.0	5.00
115	.04	47.3	75.4	33.0	1.59	40.7	5.9	1.0	23.2	22.7	29.0	5.20
140	3.98	61.2	83.1	29.4	1.28	52.9	24.1	2.3	25.0	12.4	14.5	5.94
142	.82	34.0	87.2	15.6	1.19	54.6	20.2	1.7	21.9	14.0	16.0	6.85
143	.06	30.1	84.6	17.9	1.21	53.6	28.1	1.8	21.4	40.6	48.0	6.67
144	2.09	56.3	89.8	22.0	1.14	55.8	30.4	2.5	24.3	23.7	26.4	6.90
145	.47	57.3	91.4	31.9	1.44	45.0	11.6	1.0	26.2	23.1	25.2	6.53
146	.43	39.7	89.2	26.0	1.52	41.5	7.6	1.0	24.3	22.5	25.5	6.78

CLAY AND CLAY LOAMS[1]

Site No.[2]	Rate of infiltration[3]	Total soil in aggregates >0.20 mm.	Silt and clay <0.05 mm.	Clay <0.002 mm.	Volume weight ratio	Total porosity	Noncapillary porosity index	Organic matter	Moisture equivalent	Suspension	Dispersion ratio	pH value
27	0.06	35.3	66.4	49.5	1.43	49.3	13.3	0.7	20.9	17.4	25.7	5.10
28	.01	26.5	70.6	52.0	1.49	44.8	7.3	.5	29.9	13.9	19.1	5.20
30	.52	39.4	74.1	47.5	1.44	46.3	12.6	.9	20.6	12.0	13.6	6.29
112	.00	61.9	94.6	34.2	1.47	44.9	8.7	1.0	28.9	11.6	12.2	5.21
113	.00	44.2	93.8	53.4	1.49	44.4	7.1	.6	29.7	13.4	14.3	4.91
118	.01	83.5	90.0	45.9	1.58	40.4	5.3	1.5	24.2	4.8	5.3	8.07
119	.09	82.5	88.1	43.3	1.54	41.4	7.4	1.8	23.7	4.3	4.8	8.16
120	.04	75.5	96.4	63.2	1.24	52.5	15.9	3.2	43.6	9.7	10.0	7.89
121	.02	75.9	92.5	61.9	1.25	52.8	16.9	2.2	39.7	6.2	6.7	7.69
122	.01	82.2	93.6	54.5	1.43	45.2	9.5	1.7	29.5	7.3	7.7	8.20
123	1.78	80.4	87.1	54.5	1.53	44.8	11.2	2.0	23.4	5.7	6.3	8.17
124	.18	67.2	87.1	42.7	1.32	47.2	12.6	2.7	32.3	6.2	7.1	8.06
125	.05	75.6	65.4	36.0	1.52	42.6	10.2	1.2	21.9	11.3	17.2	7.22
131	.00	19.6	65.7	35.3	1.47	44.7	10.3	.8	26.6	16.0	24.0	0.27
132	.02	46.8	94.5	63.5	1.40	44.9	5.0	1.4	35.7	11.4	12.0	8.41
133	.13	27.4	54.9	28.1	1.50	39.1	6.5	.5	20.2	15.7	29.0	8.08
134	1.00	31.4	48.0	14.5	1.39	46.3	17.1	.6	21.2	10.6	22.1	8.84

See footnotes at end of table.

TABLE 6.—*Rate of infiltration and some physical characteristics of 68 subsoils*—Continued

SANDY LOAMS[1]

Site No.	Rate of infiltration	Total soil in aggregates 0.20 mm.	Silt and clay 0.05 mm.	Clay 0.002 mm.	Volume weight ratio	Total porosity	Noncapillary porosity index	Organic matter	Moisture equivalent	Suspension	Dispersion ratio	pH value
	In.	*Pct.*	*Pct.*	*Pct.*		*Pct.*	*Pct.*	*Pct.*		*Pct.*		
31	0.40	18.7	41.7	20.6	1.58	40.4	13.5	0.6	13.5	9.2	21.7	5.10
32	1.77	22.3	29.3	14.4	1.65	37.7	16.3	.6	9.0	8.5	29.1	5.27
33	1.38	4.9	17.7	6.6	1.62	30.3	24.2	.4	6.1	8.1	45.6	5.15
116	.03	20.9	38.3	27.6	1.62	39.3	8.3	.9	16.9	7.7	20.0	5.44
117	.04	21.7	34.1	21.1	1.65	38.0	8.5	.5	14.9	9.5	27.6	6.00
126	.46	42.8	42.8	28.8	1.61	38.8	6.8	1.3	18.6	11.5	26.4	5.70
127	.38	63.7	71.0	27.2	1.50	42.6	11.0	2.3	21.3	8.2	10.8	5.71
128	.00	42.1	82.2	43.7	1.54	42.3	2.0	1.1	32.1	26.0	31.2	6.60
129	.55	14.9	30.7	16.7	1.56	40.7	17.8	.5	11.1	12.5	40.2	5.05
130	.51	66.0	74.4	13.0	1.54	43.4	12.5	.7	19.0	13.7	17.5	8.96
135	1.09	24.6	35.9	15.4	1.45	43.1	16.3	.6	15.8	8.0	22.3	9.12
136	1.42	30.6	47.7	21.3	1.35	49.1	22.0	1.2	19.0	11.9	24.8	8.82
137	1.93	11.1	53.9	19.8	1.32	49.6	25.6	2.2	15.3	19.7	36.6	8.59

GRAVELLY SILT LOAMS[1]

Site No.	Rate of infiltration	Total soil in aggregates 0.20 mm.	Silt and clay 0.05 mm.	Clay 0.002 mm.	Volume weight ratio	Total porosity	Noncapillary porosity index	Organic matter	Moisture equivalent	Suspension	Dispersion ratio	pH value
15	2.36	55.1	64.4	19.9	1.38	48.7	20.2	2.4	20.5	8.7	13.2	7.61
16	3.67	53.1	56.8	7.9	1.42	46.8	17.9	2.4	19.9	8.4	16.7	7.45
17	4.96	56.4	63.1	20.9	1.33	52.2	25.2	2.2	19.6	10.2	14.2	7.57
18	1.33	11.9	53.8	10.2	1.38	48.9	24.3	1.0	14.6	34.4	57.0	8.14
20	3.75	13.7	59.5	7.5	1.46	45.3	15.9	1.3	19.3	31.3	45.3	5.28
21	.86	27.5	62.5	12.8	1.56	41.6	8.2	2.2	22.1	20.3	30.8	5.08
22	3.08	34.7	63.9	19.3	1.37	49.1	21.8	1.1	18.6	15.8	23.4	7.26
23	1.58	58.2	63.2	14.5	1.41	47.0	18.4	1.9	19.6	12.8	18.8	7.28
24	4.76	53.1	62.4	16.0	1.22	53.8	27.5	2.7	22.3	9.0	13.3	7.68
25	.55	34.2	76.2	19.1	1.26	52.8	21.7	2.0	28.9	19.9	23.5	5.23
35	1.32	39.1	51.6	11.9	1.51	43.9	15.1	1.3	16.8	23.1	45.1	8.00

LOAMS[1]

Site No.	Rate of infiltration	Total soil in aggregates 0.20 mm.	Silt and clay 0.05 mm.	Clay 0.002 mm.	Volume weight ratio	Total porosity	Noncapillary porosity index	Organic matter	Moisture equivalent	Suspension	Dispersion ratio	pH value
26	0.00	28.8	62.4	33.4	1.34	52.0	22.1	0.8	24.3	7.5	11.9	5.92
34	.38	31.4	46.6	31.8	1.62	39.6	10.1	1.0	15.3	6.8	14.4	5.90
138	.11	25.9	61.2	17.9	1.37	47.7	18.3	1.1	22.2	23.2	38.0	7.40
139	.13	21.2	68.8	7.0	1.31	49.4	22.3	1.4	20.6	35.2	46.9	7.15
141	.50	25.1	63.7	25.7	1.58	40.2	8.1	.7	19.7	16.8	20.1	5.85

[1] Textural classification based on identification in the field by soil specialist.
[2] Site number as shown in table 11.
[3] Rate of infiltration as measured for the third hour of the wet run by the tube method.

Simple correlation coefficients between variates, such as organic matter and aggregation and volume weight and suspension percentage, are presented in tables 7 and 8. From these statistical data it can be seen, for example, that there is a highly significant degree of association between organic matter and aggregation in the surface soils of this group of 68 profiles since a correlation coefficient of 0.31 is highly significant and the correlation between these two physical characteristics is 0.55. It should be kept clearly in mind also that simple correlation coefficients can accurately express the degree of association between variates only when the relation is linear.

TABLE 7.—*Correlation coefficients* [1] *of certain characteristics of surface soils*

Characteristics considered	Correlations of designated characteristics with—											
	Infiltration	Aggregation >0.20	Silt and clay	Clay	Volume weight	Total porosity	Noncapillary porosity	Organic matter	Moisture equivalent	Suspension	Dispersion	pH value
Infiltration	----	0.30	−0.11	−0.16	−0.24	0.24	0.36	0.50	0.02	−0.29	−0.29	0.16
Aggregation >0.20	0.30	----	.46	.48	−.56	.57	.30	.55	.61	−.30	−.74	.28
Silt and clay	−.11	.46	----	.35	−.69	.70	.25	.40	.59	.50	−.41	.06
Clay	−.16	.48	.35	----	−.36	.36	.10	.12	.50	−.24	−.55	.43
Volume weight	−.24	−.56	−.69	−.36	----	−.90	−.75	−.63	−.81	−.11	.53	−.31
Total porosity	.24	.57	.70	.36	−.90	----	.76	.62	.82	−.12	−.53	.26
Noncapillary porosity	.36	.30	.25	.10	−.75	.76	----	.38	.30	−.09	−.21	.20
Organic matter	.50	.55	.40	.12	−.63	.62	.38	----	.62	−.06	−.46	.05
Moisture equivalent	.02	.61	.80	.50	−.81	.82	.30	.62	----	.18	−.59	.21
Suspension	−.29	−.30	.50	−.24	−.11	−.12	−.09	−.66	.18	----	.50	−.32
Dispersion	−.20	−.74	−.41	−.55	.53	−.53	−.21	−.46	−.59	.50	----	−.45
pH value	.16	.28	.06	.43	−.31	.26	.20	.05	.21	−.32	−.45	----

[1] Value of r at the 1-percent point (odds 99 to 1) is 0.31; at the 5-percent point (odds 19 to 1), 0.24.

TABLE 8.—*Correlation coefficients* [1] *of certain characteristics of subsoils*

Characteristics considered	Correlations of designated characteristics with—											
	Infiltration	Aggregation >0.20	Silt and clay	Clay	Volume weight	Total porosity	Noncapillary porosity	Organic matter	Moisture equivalent	Suspension	Dispersion	pH value
Infiltration	----	0.07	−0.24	−0.42	−0.33	0.36	0.54	0.40	−0.20	−0.13	−0.03	0.16
Aggregation >0.20	0.07	----	.44	.56	−.25	.22	−.07	.51	.49	−.50	−.73	.34
Silt and clay	−.24	.44	----	.43	−.30	.33	−.17	.24	.75	.28	−.31	−.08
Clay	−.42	.56	−.43	----	−.04	.03	−.39	.15	.74	−.41	−.61	.15
Volume weight	−.33	−.24	−.30	−.04	----	−.97	−.70	−.59	−.37	.04	.20	−.27
Total porosity	.36	.22	.33	.03	−.97	----	.80	.55	.36	.01	−.19	.18
Noncapillary porosity	.54	−.07	−.17	−.39	−.79	.80	----	.39	−.24	−.05	.03	.16
Organic matter	.40	.54	.21	.15	−.59	.55	.30	----	.32	−.16	−.29	.31
Moisture equivalent	−.30	.49	.75	.74	−.37	.36	−.24	.32	----	−.03	−.46	.06
Suspension	−.13	−.50	.28	−.41	.04	.01	−.05	−.16	−.03	----	.78	−.28
Dispersion	−.03	−.73	−.31	−.61	.20	−.19	.03	−.29	−.46	.78	----	−.15
pH value	.16	.34	−.08	.15	−.27	.18	.16	.31	.06	−.28	−.18	----

[1] Value of r at the 1-percent point (odds 99 to 1) is 0.31; at the 5-percent point (odds 19 to 1), 0.24.

TOTAL POROSITY

The pore spaces in soil have commonly been said to consist of (1) pores of capillary dimension, through which water can pass only under tension, and (2) noncapillary pores, which are larger and through which water can move more or less freely under gravitational forces. Accordingly, studies were made of the effect on infiltration rates of the total amount of porosity as well as the amount of large pores. The total porosity of a soil may be expected to determine to some extent the total amount of water that may filter into it.

Correlation of the infiltration rates and total porosities for both the surface soil and subsoil are significant. While this association of infiltration and total porosity is observable in the data, it is somewhat surprising that the amount of pore space without regard to the size of pore shows this effect on the rate of infiltration. An explanation is suggested, however, by the highly significant correlation between total porosity and noncapillary capacity.

NONCAPILLARY POROSITY

Since an exact method of determining the noncapillary porosity has not been devised, a comparison was made of three different methods of arriving at an index of noncapillary porosity. The correlation between infiltration and noncapillary porosity as determined by the three methods is shown in table 9.

TABLE 9.—*Correlation between infiltration and noncapillary porosity obtained by three methods of measurement*

Method of measurement	Correlation coefficient between infiltration and noncapillary porosity in—	
	Surface soil	Subsoil
Volume drained pores beginning wet run	0.47	0.39
Total porosity minus moisture equivalent (volume)	.32	.51
Total porosity minus moisture equivalent (volume) corrected for texture	.36	.54

These correlation coefficients are all highly significant and not greatly different one from another. Considering the relative merits of the three methods, it should be remembered that the volume of drained pores was obtained by subtracting from the total porosity the volume of water in the soil at the beginning of the wet run, 24 hours after the initial run. It is generally recognized by investigators reporting on the determination of field capacity that the moisture content of some soils, particularly the heavy ones, does not come to equilibrium in a 24-hour period. In fact, some soils in this study were found to have water on the surface at the beginning of the wet run. Obviously, under these conditions noncapillary porosity values are erroneous. There were also a few sites on which enough water did not enter the soil during the initial run to bring the soil up to the field capacity. It appears, therefore, that this method of determining noncapillary porosity may entail a great deal of error unless sufficient time is allowed for the excess gravitational water to drain out before the moisture content is determined.

The second procedure is based on the fact that the moisture equivalent is a reasonably good measure of field capacity, particularly in soils that are texturally silt loams. However, it has been shown by Harding (*4*), that the ratio of field capacity to the moisture equivalent is not unity throughout the entire range of soil texture. Instead, the ratio increases as the soils become lighter in texture and decreases slightly as they become heavier in texture. The third method differs from the second only in that an attempt has been made to correct the moisture equivalent and bring it more nearly in line with field-capacity data. It was, therefore, decided to use the data in which this correction has been made as a measure of noncapillary porosity. The correlation between the amount of large pores and infiltration is highly significant in both the surface soils and subsoils ($r=0.36$ and 0.54, respectively). More precise methods for evaluating the amount of effective pores of noncapillary dimensions and size distribution of pores may be expected to reveal a higher correlation between infiltration and noncapillary porosity.

Comparisons were also made between the noncapillary porosity to a 16-inch depth and infiltration during the first, second, and third hours, and the total 3-hour period of the initial run and during the corresponding periods of the wet run. All these relations were found to be highly significant. The correlation coefficients are shown in the following tabulation:

Correlation between noncapillary porosity to a 16-inch depth and infiltration during initial and wet runs:	*Correlation coefficient* [1]
Initial run:	
First hour	0.48
Second hour	.51
Third hour	.52
Total 3-hour period	.55
Wet run:	
First hour	.32
Second hour	.52
Third hour	.52
Total 3-hour	.53

[1] Value of *r* at the 1-percent point is 0.31.

In the same manner correlations were calculated between infiltration and the volume of drained pores, and again a high correlation was found. These correlation coefficients are given in the following tabulation:

Correlation between volume of drained pores to a 16-inch depth and infiltration during periods of the wet run:	*Correlation coefficient*
First hour	[1] 0.51
3-hour period	.51
Third hour	.51

[1] Value of *r* at the 1-percent point is 0.31.

For the entire 68 sites an increase in noncapillary porosity amounting to approximately 6 percent in a depth of 16 inches was accompanied by an increase in rate of infiltration of about 0.6 inch per hour. The relationship of noncapillary porosity and infiltration in surface soil and subsoil are shown by the regression lines in figures 4 and 5, repectively.

AGGREGATION OF SOIL PARTICLES

In an ideal porous medium such as sand of uniform size, the average diameter of individual pores is larger when the mean diameter of the grain is larger. In a soil with a high degree of aggregation the pore size, other things being equal, would be larger than in a soil nonaggregated, in which single-grain structure predominates. This, however, is not universally true in practice since the arrangement of aggregates and the degree of intermingling of single grains may actually develop a more dense medium.

An analysis of the relationship between aggregation and noncapillary porosity of the 68 surface soils (fig. 6) shows that the degree of aggregation is in fact correlated with the amount of large pores ($r=0.30$). The degree of aggregation of these soils is also correlated with infiltration ($r=0.30$). In the subsoils, however, there are no such associations. Since the arrangement of particles and aggregates in an intermingling may be such as to increase or decrease noncapillary porosity it is not to be expected that a high degree of aggregation will invariably be associated with high rates of infiltration.

ORGANIC MATTER

Increase in organic matter in the surface soil and in the subsoil is accompanied by increase in the infiltration rate (figs. 7 and 8).

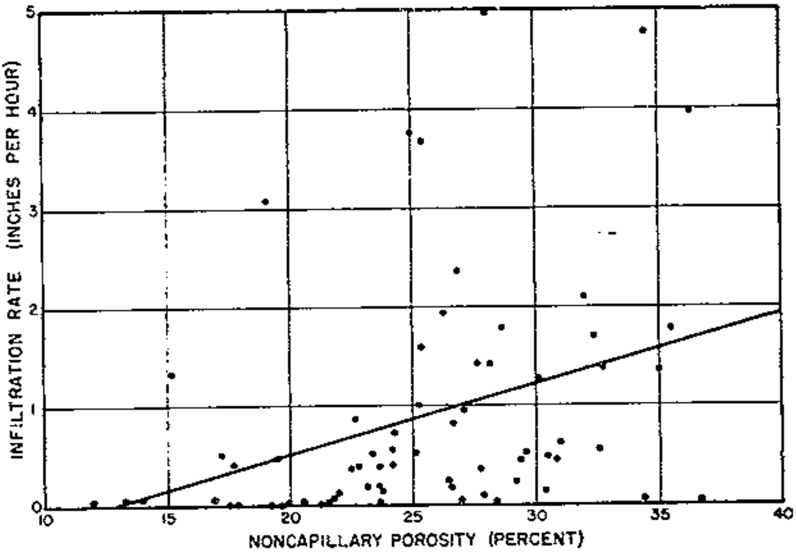

FIGURE 4.—Relation between noncapillary porosity of the surface soil and infiltration rate during the third hour of the wet run.

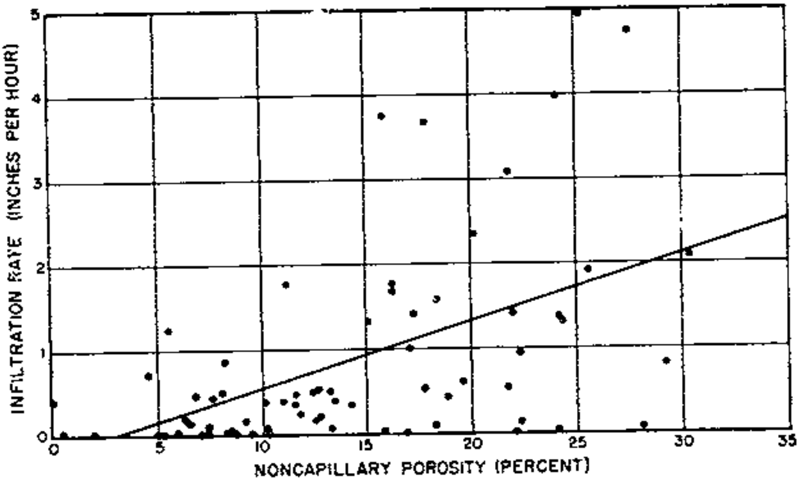

FIGURE 5.—Relation between noncapillary porosity of the subsoil and infiltration rate during the third hour of the wet run.

In both surface soil and subsoil the correlation is highly significant (r=0.50 and 0.40, respectively). The organic-matter content is also highly correlated with degree of aggregation of both the surface soil and subsoil (figs. 9 and 10). This substantiates the generally accepted idea that organic matter is one of the factors contributing to the formation of aggregates. Organic matter is also correlated with noncapillary porosity in both the surface soil and subsoil to a highly significant degree ($r=0.38$ and 0.39, respectively).

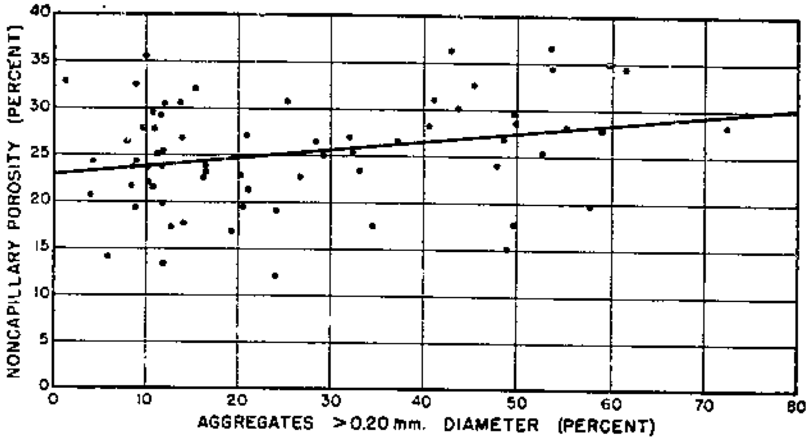

FIGURE 6.—Relation between aggregation of the surface soil and noncapillary porosity.

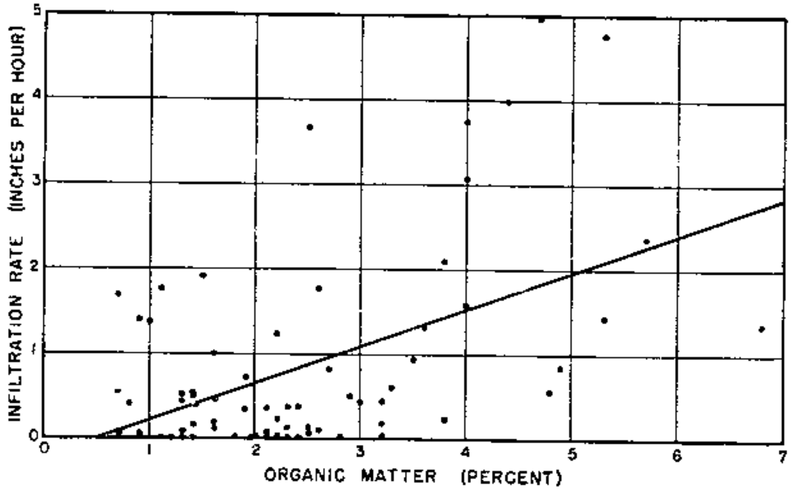

FIGURE 7.—Relation between organic matter in the surface soil and infiltration during the third hour of the wet run.

SILT AND CLAY

Silt and clay, or particles of less than 0.05 mm., includes that part of the soil in which such phenomena as swelling and shrinking, cohesion, plasticity, and cementing of particles principally occur. It includes the colloidal fraction as one of the most active constituents. In these soils silt and clay is found to be correlated to a highly significant degree with aggregation in both the surface soils and subsoils ($r=0.46$ and 0.44, respectively). It is also correlated negatively to a significant degree with volume weight ($r=-0.69$ and -0.30 in the surface soil and subsoil, respectively). The soils that are higher in silt and clay also are higher in organic matter (correlations for the surface soil and subsoil are 0.40 and 0.24, respectively). In the surface samples the correlation of silt and clay with infiltration is not significant. In the subsoils, however, an increase of these fine particles, with their associated properties such as swelling with moisture, is accompanied by a decrease in infiltration ($r=-0.24$).

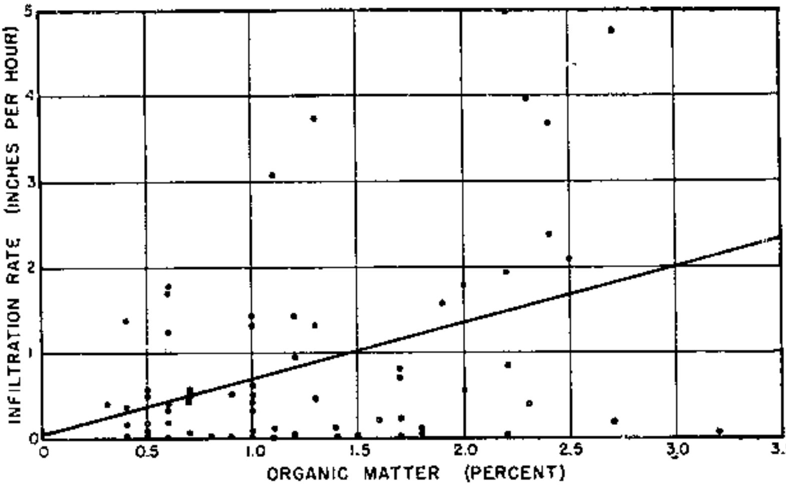

FIGURE 8.—Relation between organic matter in the subsoil and infiltration during the third hour of the wet run.

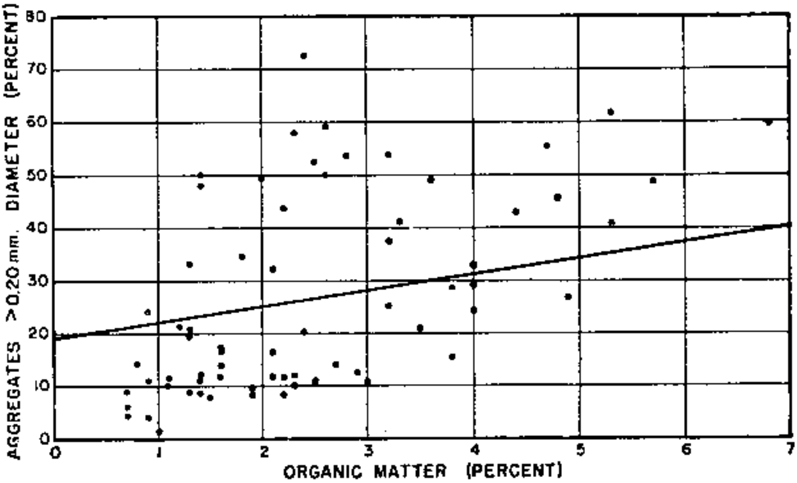

FIGURE 9.—Relation between organic matter of the surface soil and aggregation.

CLAY

The clay fraction, comprising particles less than 0.002 mm., behaves in much the same way as the combined silt and clay. There is, however, no particular association with the organic-matter content of the soil, and in the subsoil there is no association with volume weight. In both the surface soil and subsoil clay is correlated to a highly

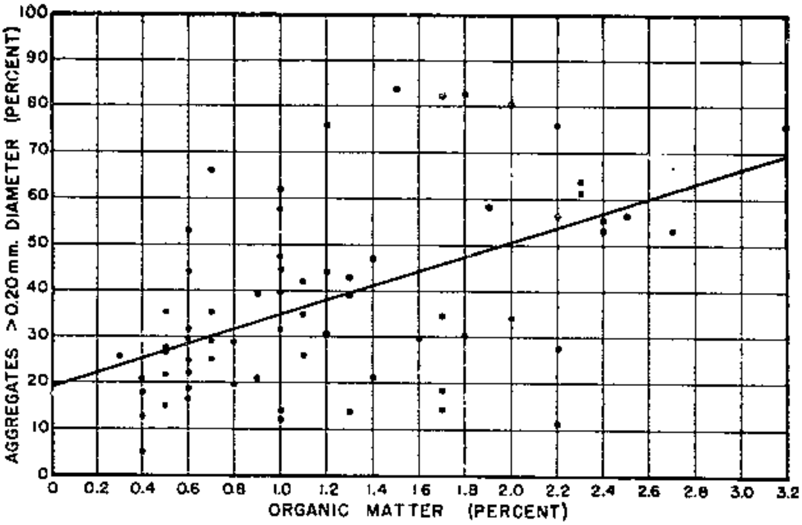

FIGURE 10.—Relation between organic matter of the subsoil and aggregation.

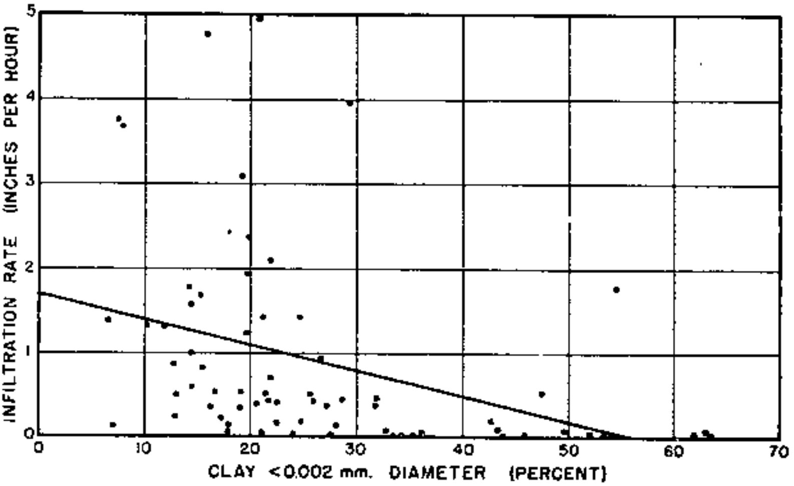

FIGURE 11.—Relation between clay content of the subsoil and infiltration during the third hour of the wet run.

significant degree with aggregation ($r=0.48$ and 0.56, respectively) and also with silt and clay ($r=0.35$ and 0.43, respectively). A striking feature of this part of the study is the highly significant negative correlation ($r=-0.42$) between clay content of the subsoil and infiltration rate. This relationship is shown in figure 11.

DISPERSION RATIO

The dispersion ratio is obtained by dividing the suspension percentage by the percentage of silt and clay. Therefore the dispersion ratio, as well as the suspension percentage, is a measure of the ease with which a large proportion of the particles is brought into suspension. The correlations with infiltration are essentially the same as with suspension percentage. Suspension percentage and dispersion ratio were both found to be highly correlated with aggregation, both decreasing with an increase in aggregation. Such a correlation is expected since a high degree of aggregation indicates that a large number of the smaller particles have been grouped together. This grouping decreases the tendency for particles to go into suspension. Organic matter has contributed to aggregation, and the relation of dispersion ratio to organic matter is shown in figure 12. The infiltration data in the study were obtained with a minimum of agitation from application of water to the surface of the soil inside the tubes. Therefore there would not be so great a tendency under these conditions for a reduction in infiltration caused by clogging of the soil pores as under natural field conditions, under which the impact of the raindrop and the velocity of run-off may cause considerable disturbance of the surface, particularly in the absence of vegetal cover.

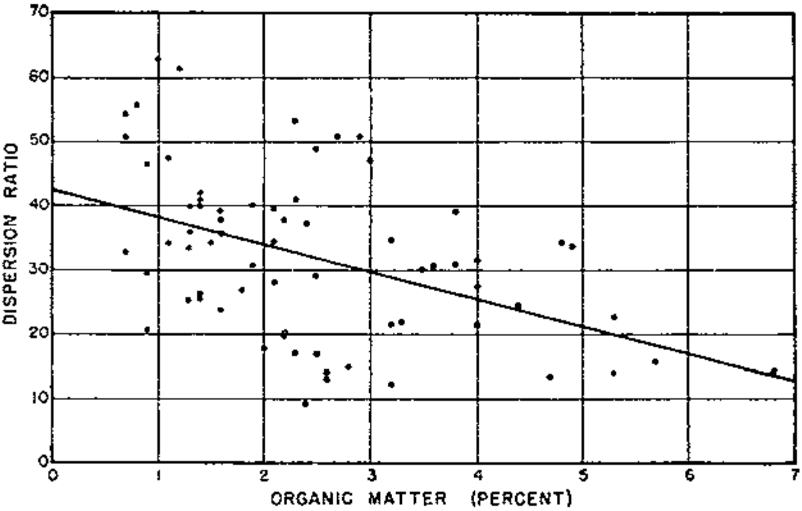

FIGURE 12.—Relation between organic matter of the surface soil and dispersion ratio.

The highly significant correlation between suspension and pH value seems logical because of the flocculation commonly found at the higher pH values.

MOISTURE EQUIVALENT

Infiltration is not significantly correlated with the moisture equivalent in the surface soil ($r=0.02$); in the subsoil r is -0.30, which is significant but less than the value necessary for a highly significant correlation. Moisture equivalent is dependent to a very large extent on the colloidal properties, organic and inorganic, of the soil. This is shown by the highly significant correlations of 0.62 and 0.32 between moisture equivalent and organic matter in the surface soil and subsoil, respectively, and 0.50 and 0.74 between moisture equivalent and clay in the surface soil and subsoil, respectively. Its association appears to be primarily with the clay and organic-matter content rather than with infiltration.

Since the moisture equivalent increases as the amount of colloid increases the infiltration rate might be expected to decrease. That it does not is apparently due to the fact that the moisture equivalent is affected only slightly by aggregation, whereas it is conceivable that a clay soil well aggregated would be similar to a sand in its permeability to water. As noted elsewhere, the moisture equivalent has been shown to be a reasonably good measure of the field capacity, which in turn is a measure of the water that moves only against capillary forces. Its value, then, lies in the fact that when it is subtracted from the total porosity, a figure that is an index of noncapillary porosity is obtained, and this has been shown to be significantly correlated with the infiltration rate.

SOIL REACTION (pH)

The absolute pH value, or hydrogen-ion concentration, is not directly associated with the infiltration rates. Correlations between departure from neutrality (pH value =7.0) and infiltration rates were calculated and found significant but not highly so for the surface soils, and not significant for the subsoils ($r= -0.27$ and -0.17, respectively). There is, however, no particular reason for using departures from neutrality (pH value=7.0) rather than departures from a pH value of 7.5, for example. It might be expected that the optimum pH value from the standpoint of infiltration would correspond with the pH value at which maximum flocculation occurs. The correlation of pH values with dispersion and aggregation suggests that the pH value under certain conditions is associated with factors that apparently affect infiltration. Certainly there may also be an indirect effect of pH value on infiltration rates since the pH value affects the amount and kind of plant growth.

TEMPERATURE

The design of this experiment did not permit a study of the effects of temperature on infiltration at the time of the run. However, as mentioned previously, temperatures of both soil and water were observed and an effort was made to determine whether temperature might be one of the dominant variables affecting the data and the conclusions that might be drawn from them. Temperature at the time of any study of infiltration might be expected to have some effect on infiltration through its effect on the general level of biotic activities, viscosity of water, viscosity and permeability of soil colloids, and perhaps to some degree through its effect on the viscosity and volume of soil air. The effect of temperature on infiltration is therefore undoubtedly complex.

The temperatures of water for the 68 sites or 136 runs varied from 37° to 96° F., with a mean of 62.2°. The median temperature was approximately the same as the mean. The temperatures of the soil at depths of 4 inches and 15 inches ranged from 36° to 83° and from 42° to 78°, respectively. The corresponding means were both 57.5°.

There is a tendency toward an increase in rate of infiltration with an increase in soil temperature, and the correlation becomes significant but not highly so for the wet run (r=0.28). Temperatures of the water on the soil surface are found to be similarly associated with infiltration rates.

However, when temperature is included in a multiple correlation with other factors that have been demonstrated to be highly correlated with infiltration, such as noncapillary porosity, organic matter, and clay in the subsoil, the contribution of temperature is seen to be negligible. It can, therefore, be stated with a considerable degree of assurance that while temperature at the time of the run may have affected infiltration to some degree it was not a dominant factor.

OTHER VARIABLES

Another factor that affects the permeability of water through soils is the state of hydration of its colloids. If part of the water entering the soil pores is held on the surface of the particles forming the pores and causes swelling, the effective pore size will decrease. Thus pores of noncapillary dimension may be reduced to capillary pores, and capillary pores may become essentially sealed to water movement. On the other hand, soils that are capable of holding water by capillarity without swelling may permit rapid downward movement of water. A large difference is to be expected in the swelling of the soils in this study since the amount and type of colloidal material differs widely. Volume changes that occurred when undisturbed samples at field capacity were air dried were studied for certain of the soils. Detailed data are not shown here. Extreme values in volume changes of 0.0 and 53.8 percent were found for the subsoil of the Vernon sandy loam and Houston clay, respectively. In general, the soils high in clay gave greater volume changes than the lighter-textured soils. The numerous exceptions noted, however, indicate that type as well as amount of colloidal material affects swelling. While swelling and hydration undoubtedly influenced the infiltration rates found in this study, it is impossible to evaluate their effect on individual soils.

The moisture content at the time an infiltration determination starts may materially affect not only the rate of infiltration but also the total amount of water a soil will absorb. In other words, of the total porosity in a soil the part that is not filled with water is potential storage space for water. In this study the initial runs were conducted at whatever moisture content prevailed at the time of the test. It appears from the data that the rapidity and the extent of the rise in the initial part of the infiltration curve is influenced to some extent by the moisture content of the soil. This is a very important consideration under field conditions since the moisture content of the soil varies widely from time to time. In this study the infiltration rate for the third hour of the wet run was correlated with the physical properties of the soil, and at the beginning of this period, presumably, the effect of the initial moisture content had largely disappeared since changes resulting from hydration and swelling would become more or less constant within 24 hours after the initial run.

It has been suggested by other workers, including Horton (*7*) and Powers (*17*), that the movement and escape of soil air displaced by the water entering the soil as infiltration may affect the rate of infiltration. The hypothesis is that water can, in general, enter the soil only so fast as air escapes. As the depth of penetration increases, the resistance to outflow of air increases, owing to the greater length of upward flow. It is conceivable that under these circumstances there could be some slight compression of soil air that would tend to produce a back pressure. This pressure would tend to lower the rate of infiltration, along with other factors such as swelling of colloid, plugging of pores, and increase in amount of space occupied by the water. This is undoubtedly a phase of the problem that should receive attention since specific data demonstrating its practical importance are lacking. It would seem, however, that in spite of the effect of this factor, or possibly because of it, the amount of large pores would still have a dominating influence on the rate of infiltration. In this study no direct measurements of air movement were made, although at some sites bubbles of air were seen escaping through the water on the soil surface.

Prediction of Infiltration Rates

A summary of those characteristics of soils that are significantly correlated with infiltration during the third hour of the wet run is given in table 10.

TABLE 10.—*Characteristics of soil that are significantly correlated with infiltration during the third hour of the wet run*

Correlation with infiltration	Characteristics of—	
	Surface soil	Subsoil
Positive	Total porosity [1] Aggregation [1] Organic matter [2] Noncapillary porosity [2]	Total porosity.[2] Organic matter.[2] Noncapillary porosity.[2]
Negative	Volume weight [1] Suspension [1] Dispersion [1]	Volume weight.[2] Moisture equivalent.[1] Silt and clay.[1] Clay.[2]

[1] Significant (5-percent point).
[2] Highly significant (1-percent point).

The correlations obtained in this study are in accord with basic principles of soil physics. The effect of organic matter on aggregation and of aggregation on noncapillary porosity; the value of suspension percentage and dispersion ratio as indicators of the ease with which aggregates may be broken down and pores clogged by soil particles; the reduction of the size of pores or the total porosity by the amount of clay in the subsoil or the swelling of colloids in the presence of water—all these are in accord with our general knowledge of the behavior of the soil complex.

Approximately 40 combinations of the most promising soil characteristics, as indicated by the simple correlation coefficients, were studied in the form of multiple regressions in an effort to ascertain what combination of characteristics would yield the most significant regression on infiltration. Since the 68 soils in this group have highly divergent characteristics and since several of the characteristics themselves are only indices of actual physical properties (noncapillary porosity, for example, is an index of the size of pores), it was expected merely that major trends of association of infiltration and certain physical properties would be disclosed.

Sixteen of the forty combinations proved to have highly significant multiple regressions. Thus there was a high degree of success in demonstrating statistically the interplay of certain characteristics with infiltration. It is to be remembered that these associations are for the entire group of 68 sites rather than for individual sites.

The highest multiple correlation coefficient obtained was 0.71, and the corresponding standard error of estimate for a mean infiltration rate of 0.88 inch per hour for the 68 sites was 0.10. These were obtained from a combination of soil characteristics that included noncapillary porosity and organic matter in both surface soil and subsoil and clay in the subsoil. It is apparent that such a multiple regression would not be very satisfactory in predicting the infiltration rate for a single site since the standard error of a predicted value for a single site is 0.85 inch.

DISCUSSION

SIZE AND PERMANENCY OF PORES

The relation of soil-porosity factors to the infiltration of surface waters is deserving of further study. Long-established principles in the field of hydraulics are not entirely unrelated to the infiltration problem. The evidence of the probable effect of size of pore or channel on the rate of movement of water is in harmony with hydraulic principles.

Preponderance of large pores in soil is in part the result of natural forces active in the development of a soil profile, such as degree of weathering and kind of parent material and the combined effects of the biologic forces at play on it, and in part the result of man's modification of these processes of nature.

Large pores in soil—the proportionate amount of which in this study is indicated by noncapillary porosity calculations of two different kinds, each of which gives essentially similar values—are due primarily to the amount of large soil particles or aggregates and their arrangement. The intermingling of large and small particles may provide either a less dense or more dense soil horizon (as shown by Schlicter and others), but it appears from data relating to these soils that usually an increase in aggregation is accompanied by an increase in noncapillary porosity. In this group of soils organic-matter content, silt and clay, clay, and dispersion ratio are significantly associated with aggregation.

The rate of water intake varies with the amount of effective noncapillary porosity of a soil, which differs under different conditions. When the pores of a soil are already partly or wholly filled by water of a preceding rain or when clogged at points of constriction by dispersed soil particles that have been washed into them, water intake is impeded. If aggregates are relatively unstable, continued application of water may reduce noncapillary porosity.

The fact that the rate of infiltration during the wet run, which succeeded the initial run by 24 hours, was usually lower than the rate at the close of the initial run indicates that something of this kind has occurred. It is reasonable to suppose that during this 24-hour period some changes in soil structure have taken place. Colloids may continue to swell through the slow imbibition of water, some aggregates may continue to slake and disintegrate, and dispersed particles that have recently moved downward to points of constriction may become cemented in place. The degree to which these various actions take place varies, of course, with the physical properties of different soils

This study is an exploratory one, the ramifications of which will not be fully understood without much additional work. It is believed that it serves to point the way toward future investigations that may be productive. We need a development of several techniques, particularly one for the precise measurement of the size distribution of soil pores. The causes of their formation and permanence is a matter of the utmost importance. In future work the study of soil texture alone and of the genetic origin of soils as criteria of infiltration may well be subordinated to other directions of effort.

PRACTICAL APPLICATION OF FINDINGS

The possibilities of modifying infiltration rates in farming practice deserve attention. Either destructive or constructive practices may be in operation on a given land surface. Among the destructive practices are: (1) Intensive cultivation, which results in destruction of aggregates as well as the organic matter that is effective in their formation; (2) undue compaction of the soil such as may be caused by excessive grazing, particularly when the soil is wet, or by inopportune plowing or tillage, which puddles the soil; and (3) practices that permit the loss of the surface soil, which is usually more highly aggregated than the subsoil and of higher organic-matter content and is often of coarser texture.

Among the constructive practices are most of the items commonly recommended for wise soil management, particularly: (1) The incorporation and maintenance of organic matter through such practices as the use of good rotations, the return of crop residues, and the application of manure; (2) the use of cover on the land—particularly close-growing vegetation, such as grass, which is notable for its effect on aggregation, and forest, and winter cover crops, also straw, stubble, or even stones—which serve as a protection from the impact of rain and reduce the turbidity of surface water; (3) wise culture and tillage, such as the breaking of the surface crust after rains, fall plowing of heavy dense soils where conditions warrant, and manipulation of the soil under favorable moisture conditions and in a manner to improve tilth; and (4) practices that retard the rate of run-off and thereby reduce its velocity and turbidity and provide more time for the infiltration of surface waters.

SUMMARY

This study was designed to determine the relative infiltration of 68 soils and related soil characteristics.

The relative infiltration of soil in situ was determined by the tube method. The data are from 68 sites scattered from Georgia to Oregon and from New York to New Mexico. These sites include soils having a wide range of texture and representative of most of the great soil and parent-material groups. They are representative also of most of the climatic provinces of the United States.

Samples from each site were forwarded to a central laboratory, where certain important soil characteristics were determined.

Definite association of infiltration with all indices of large pores or with those factors affecting pore size was found for the 68 soil sites. Particularly, noncapillary porosity, degree of aggregation, organic matter, and amount of clay in the subsoil may be regarded as determinants of infiltration. Similarly, those factors that determine the permanency of large pores, such as suspension percentage and dispersion ratio, are associated with infiltration rates.

Correlations between soil properties that do not so directly affect infiltration were found at many points in the data. Among these are the positive correlation between organic matter and moisture equivalent and between clay and moisture equivalent, the significant negative correlation between suspension percentage and pH value, and the negative correlation between content of silt and clay and volume weight. These correlations are in accord with the findings of numerous other workers and with well-recognized principles of soil physics.

For maintaining or increasing the infiltration rate of field soils the study indicates the value of the commonly recommended soil-management practices, which include the incorporation of organic matter and its maintenance at a reasonably high level, proper tillage practices, and a good cropping program. Conversely it is indicated that those practices tending to reduce the degree of aggregation, decrease the stability of aggregates, and increase the turbidity of water available for infiltration are usually conducive to a reduction in the rate of intake of natural rains.

Related studies conducted on 13 sites during the course of the main investigation covered by this report indicated rather definitely that differences in turbidity of water available for infiltration was one of the most important factors tending to make infiltration rates determined by the rainfall-simulator method lower than those determined by the tube method. This and the fact that some lateral movement of subsurface water was observed for both these methods of determining infiltration rates, which involve the artificial application of water, lend support to the idea that probably these rates and others that are found when water is artificially applied should be considered as relative rather than absolute; and these values should always be considered as relative if used in the design of control measures.

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APPENDIX

TABLE 11.—*Description of the soils of sites on which rates of infiltration were measured*

Soil type [1]	Location of site	Site No.	Method	Date of initial run	Description of profile	Cultural treatment	Depth of sampling for laboratory study
Aiken clay loam	Farm of Hudson Duncan Fruit Co., Newberg, Oreg.	140	Tube	May 23, 1938	0-5 inches. Dark reddish-brown clay loam with crumb structure. 5-10 inches. Dark reddish-brown clay loam with compact granular structure. 10-24 inches. Red clay loam, fairly plastic. Plasticity increases with increase in depth, becoming plastic red clay at 24 inches. Fragments of decomposed basalt occur throughout profile and become more frequent with increase in depth.	Fruit orchard with small grain and vetch as winter cover crop on site at time of run. Past winter cover crop, cowpeas.	*Inches* 0-6 6-16
Austin clay (slightly eroded).	Field R. S. T of soil and water conservation experiment station, Temple, Tex.	118	do	Feb. 24, 1938	0-7 inches. Black or dark-gray heavy calcareous clay. 7-36 inches. Brownish-gray heavy clay becoming lighter in color with increase in depth. White shell fragments throughout profile.	Oats 3 inches high on site at time of run. Recent crops: Cotton and corn.	0-7 7-16
Austin clay (severely eroded).	Field R of soil and water conservation experiment station, Temple, Tex.	119	do	Feb. 28, 1938	0-6 inches. Grayish-black heavy calcareous clay. 6-36 inches. Brownish-gray heavy clay becoming lighter gray with increase in depth. White shell fragments throughout profile.	Oats 4 inches high on site at time of run. Corn for last 2 years.	0-6 6-16
	South of office of soil and water conservation experiment station, Temple, Tex.	123	do	Mar. 14, 1938	0-7 inches. Grayish-black crumbly calcareous clay. 7-20 inches. Light grayish-brown heavy clay. 20-36 inches. Grades from light grayish-brown to light-brown, almost yellow, calcareous clay. White shell fragments throughout profile.	Seeded to oats for last 3 years.	0-7 7-16
Badger loam [2]	Farm of John A. McCune, Ellensburg, Wash.	139	do	May 18, 1938	0-8 inches. Light-brown loam with appreciable quantity of fine sand. 8-13 inches. Light-brown loam with granular structure. 13-24 inches. Yellowish-brown silty clay loam. 24-36 inches. A little lighter in color than 13-24-inch layer and more mellow; contains more fine sand.	Peas 3 inches high on site. Recent crops: Potatoes and peas.	0-8 8-18

Bates very fine sandy loam (shallow phase).	Farm of J. F. Darby, Broken Arrow, Okla.	127	do	Mar. 30, 1936	0-6 inches. Dark grayish-brown very fine sandy loam. 6-14 inches. Light grayish-brown very fine sandy loam containing small particles of sandstone. Below 14 inches reddish-yellow sandy clay	Winter wheat on site. Recent crops: Cowpeas and oats.	0-6 6-15
Bath gravelly silt loam.	Farm of Frank French, Wallace, N. Y.	20	do	Aug. 9, 1937	0-9 inches. Reddish-brown very friable silt loam. 9-20 inches. Yellowish-brown silt loam somewhat more compact than surface. Below 20 inches. Yellowish-olive gritty compact silt loam. The whole profile contains pieces of sandstone, which increase in size and number with increase in depth.	Soybeans and millet about 6 inches high on site. Recent crops: Oats and clover.	0-9 9-15
Boone silt loam (typical).	Farm of Paul Rontoski, Independence, Wis.	107	do	Oct. 28, 1937	0-8 inches. Grayish-brown silt loam 8-30 inches. Yellowish-brown silty clay loam, somewhat plastic when wet. Some sand mixed with lower portion.	Corn on site for last 2 years.	0-8 8-16
Buell clay loam [2]	Just north of boundary of Navajo Soil and Water Conservation Experiment Station, Gallup, N. Mex.	133	do	Apr. 21, 1938	0-8 inches. Brown clay loam 8-28 inches. Light reddish-brown sandy clay Below 28 inches. Partly decomposed sandstone.	Range land. Moderate grass cover. Sparsely timbered.	0-9 9-22
Carrington silt loam (typical).	Doten farm, Spring Valley, Minn.	105	do	Sept. 17, 1937	0-9 inches. Dark-brown to nearly black silt loam. 9-24 inches. Yellowish-brown silty clay loam; contains considerable rock and gravel.	Corn on site for last 2 years.	0-9 9-22
Cecil clay loam	Spalding farm near northeast corner of soil and water conservation experiment station, Watkinsville, Ga.	27 8	do Rainfall simulator	Nov. 22, 1937	0-4 inches. Reddish-brown clay loam 4-22 inches. Red clay containing small amounts of mica flakes and disintegrated rocks in lower portion. Below 22 inches. Deep red, a more compact clay than the 4-22-inch layer and contains greater amounts of disintegrated rock and mica.	Plowed 4 inches deep and seeded to rye 1 month before site was made. Recent crops: Corn and cotton.	0-4 4-15
	Percy farm of soil and water conservation experiment station, Watkinsville, Ga.	28	Tube	Nov. 26, 1937	0-5 inches. Reddish-brown clay loam. More clay and less sand than on site 27. 5-21 inches. Red clay mixed with small amounts of mica and disintegrated rock. Less mica and rock than on site 27. Below 21 inches. A darker red, heavier clay than the 5-21-inch layer with greater amounts of mica and disintegrated rock.	Plowed to a depth of 5 inches a month before run and seeded to rye. Recent crops: Corn and cotton.	0-5 5-15
	North of pine grove on Vaughn farm at soil and water conservation experiment station, Watkinsville, Ga.	33	Rainfall simulator	May 3, 1938	0-2½ inches. Reddish-brown clay loam Below 2½ inches. Heavy dark-red brittle clay. Below 6 inches a great deal of mica and disintegrated rock.	Weeds in 1937. Recent crops: Peas, oats, and cotton.	0-2½ 2½-6½

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[1] Representative sites were selected by soils specialists.

[2] Local name, soil not correlated.

TABLE 11.—*Description of the soils of sites on which rates of infiltration were measured*—Continued

Soil type	Location of site	Site No.	Method	Date of initial run	Description of profile	Cultural treatment	Depth of sampling for laboratory study
							Inches
Cecil sandy loam	Vaughn farm of soil and water conservation experiment station, Watkinsville, Ga.	31 10 13 14 15	Tube Rainfall simulator do do do	Feb. 1, 1938 Dec. 2, 1937 Jan. 12, 1938 Jan. 18, 1938 Jan. 20, 1938	0-8 inches. Grayish-brown sandy loam 8-16 inches. Grades from yellow sandy loam through orange sandy clay to heavy red clay. 16-32 inches. Heavy red clay containing no mica or parent material.	1937 crop sorghum. Recent crops: Peas, oats, cotton, and corn.	0-8 8-16 16-32
	In pine grove on Vaughn farm of soil and water conservation experiment station, Watkinsville, Ga.	26 27	do do	Apr. 5, 1938 Apr. 7, 1938	0-½ inch. A layer covered with ¾ inch of pine needles. ½-5 inches. Grayish-brown sandy loam 5-12 inches. Yellowish-brown to orange sandy clay. Below 12 inches. Heavy red friable clay. Both profiles contain a considerable number of roots in first 15 inches varying from ¾ inch to smaller sizes. A hole of loose soil about 2 inches in diameter extends in a diagonal direction across 1 corner of plot on site 26. A similar hole runs from the middle of the plot through the base of the plot on site 27.	Pine grove for last 40 years. Under cultivation at one time.	½-5 5-12 12-17
	South of pine grove on Vaughn farm at soil and water conservation experiment station, Watkinsville, Ga	28 34	do do	Apr. 13, 1938 May 6, 1938	0-6 inches. Grayish-brown sandy loam 6-13 inches. Yellowish-brown to orange sandy clay. Below 13 inches. Heavy red clay containing no mica or parent material.	Weeds in 1937. Recent crops: Peas, oats, and cotton.	0-6 6-13 13-20
	Vaughn farm of soil and water conservation experiment station, Watkinsville, Ga.	29 30 32	do do do	Apr. 9, 1938 Apr. 21, 1938 Apr. 27, 1938	0-5 inches. Grayish-brown sandy loam 5-15 inches. Grades from yellow sandy loam through orange sandy clay to heavy red clay. Below 15 inches. Heavy red clay containing no mica or parent material. On site 32 there is evidence of considerable difference in the compactness of the soil in very localized areas; this appears to be due to old root locations.	Sorghum in 1937. Recent crops: Peas, oats, cotton, and corn.	0-5 5-15 15-22
	Vaughn farm of soil and water conservation experiment station, Watkinsville, Ga.	31	do	Apr. 25, 1938	0-6 inches. Grayish-brown sandy loam 6-12 inches. Grades from yellow sandy loam through orange sandy clay to heavy red clay. Below 12 inches. Heavy red clay containing no mica or parent material. Old root locations, as on site 32.	Sorghum in 1937. Recent crops: Peas, oats, cotton, and corn.	0-6 6-12 12-22

	Farm of J. H. Gray, High Point, N. C.	36	do	May 16, 1938	0-7 inches. Reddish-brown sandy loam Below 7 inches. Brownish-red heavy sandy clay grading into brownish-red clay. Considerable amounts of mica below 7 inches. This profile also seems to be a mixed phase of Cecil.	Wheat in 1937. Recent crops: Lespedeza, wheat, and corn.	0-7 7-20
Cecil sandy clay loam.	Field M of soil and water conservation experiment station, Statesville, N. C.	39	do	June 1, 1938	0-7 inches. Reddish-brown sandy clay loam Below 7 inches. Heavy red friable clay that becomes heavier with increase in depth.	Cotton in 1938. Recent crops: Oats, cotton, and lespedeza.	0-7 7-20
Clinton silt loam	Near control plots at soil and water conservation experiment station, La Crosse, Wis.	101	Tube	Aug. 31, 1937	0-7 inches. Dark-brown heavy silt loam 7-20 inches. Yellowish-brown granular heavy silt loam. 20-32 inches. Dark grayish-yellow friable silt loam.	Second-year corn in 1937	0-7 7-16
Clinton silt loam (eroded).	Soil and water conservation experiment station, La Crosse, Wis.	102	do	Sept. 3, 1937	0-8 inches. Brown heavy silt loam, mixture of surface soil and subsoil. 8-16 inches. Yellowish-brown heavy silt loam. Below 16 inches. Dark grayish-yellow friable silt loam.	Corn in 1937	0-8 8-16
Colby silt loam	Farm of A. Rufling, Marshfield, Wis.	108	do	Oct. 1, 1937	0-8 inches. Medium dark-brown silt loam 8-14 inches. Light grayish-brown silt loam 14-36 inches. Mottled grayish-brown changing to sticky heavy clay.	Second-year corn in 1937	0-8 8-16
Crown light clay (colluvial phase).	Navajo Soil and Water Conservation Experiment Station, Gallup, N. Mex.	131	do	Apr. 15, 1938	0-3 inches. Fine, yellowish, loose mulch Below 3 inches. Compact brownish-yellow clay.	Range land	0-3 3-9 9-15
Crown heavy clay [2]	do	132	do	Apr. 18, 1938	0-3 inches. Fine, yellowish, loose mulch 3-7 inches. Rather loose grayish-brown clay Below 7 inches. Heavy grayish-brown clay underlaid by stratified sands and sandy loams at about 20 inches.	do	0-7 7-15
Crown sandy clay loam [2] (colluvial phase).	do	136	do	May 2, 1938	0-3 inches. Light-brown mulch 3-8 inches. Light-brown sandy clay loam 8-22 inches. Light-brown friable clay	do	0-8 8-16
Crown sandy loam [2]	do	137	do	May 4, 1938	0-18 inches. Light-brown sandy loam 18-36 inches. Same as 0-18-inch layer but contains more sand.	do	0-7 7-16
Davidson clay loam	Wood farm near Monticello, Ga.	30 11 12	do Rainfall simulator do	Dec. 15, 1937 Dec. 14, 1937 Dec. 16, 1937	0-7 inches. Very dark reddish-brown clay loam. 7-22 inches. Dark-red clay, heavy, smooth, firm, and sticky but not tenacious. 22-36 inches. Same material as 7-22-inch layer, but it becomes heavier with increase in depth.	Corn in 1937. Recent treatment: Idle and in corn.	0-7 7-15
Dubuque silt loam	Farm of Ed Quinn, Cashton, Wis.	103	Tube	Sept. 9, 1937	0-6 inches. Light yellowish-brown friable silt loam. Below 6 inches. Brownish-red gritty clay containing considerable cherty material at 12 inches and deeper.	Second-year corn in 1937	0-6 6-15

[2] Local name soil not correlated.

TABLE 11.—*Description of the soils of sites on which rates of infiltration were measured*—Continued

Soil type	Location of site	Site No.	Method	Date of initial run	Description of profile	Cultural treatment	Depth of sampling for laboratory study
							Inches
Dunkirk silty clay loam.	Border of soil and water conservation experiment station plots on canning crops farm of New York Agricultural Experiment Station, Geneva, N. Y.	19	Tube	Aug. 4, 1937	0-7 inches. Light-brown silty clay loam 7-15 inches. Brownish-yellow silty clay, more compact than 0-7-inch layer. Below 15 inches. Grayish-yellow compact material. A line of tile was later found under this site.	Fallow. Last cultivated 2 weeks before run.	0-7 7-15
	Canning crops farm of New York experiment station, Geneva, N. Y.	36	do	June 16, 1938	0-8 inches. Medium-brown silty clay loam containing more clay than previous Dunkirk site; also more compact. 8-20 inches. Light brownish-yellow more compact silty clay. Below 20 inches. Grayish-yellow compact material.	Oats in 1938. Recent crops: Corn, soybeans, and sweetclover.	0-8 8-20
		42	Rainfall simulator	June 15, 1938			
		43	do	June 17, 1938			
Fayette silt loam	Farm of Albert Gaustad, Houston, Minn.	106	Tube	Sept. 22, 1937	0-6 inches. Light grayish-brown silt loam 6-16 inches. Yellowish-brown silt loam, slightly heavier and more compact than 0-6-inch layer. Below 16 inches. Yellow moderately compact silt loam.	Third-year corn in 1937	0-6 6-16
Fremont gravelly silt loam.	Edwards farm, Cohocton, N. Y.	21	do	Aug. 12, 1937	0-7 inches. Gray friable silt loam 7-12 inches. Gray silt loam moderately mottled with rust brown. 12-24 inches. Yellowish-gray very compact gritty silt loam, highly mottled. Numerous sandstone rocks throughout profile.	Buckwheat in 1937	0-7 7-12
Athena silt loam	Farm of C. J. Broughton, Dayton, Wash.	142	do	June 2, 1938	0-10 inches. Light-brown granular silt loam 10-25 inches. Light-brown silty clay loam, granular, and with a slight yellowish color. Below 25 inches. Yellowish-brown heavy silt loam containing appreciable amounts of very fine sand.	Spring wheat in 1938. Recent crops: Peas and wheat. Subsoiled 16 to 18 inches in fall of 1935.	0-7 7-16
Honeoye gravelly silt loam.	Field 17 of soil and water conservation experiment station, Marcellus, N. Y.	15	do	July 2, 1937	0-7 inches. Grayish-brown silt loam 7-14 inches. Yellowish-brown silt loam heavier than surface soil. 14-22 inches. Transition material, calcareous below 18 inches. Gravel and stones found throughout profile but increase in number and size with increase in depth.	Oats and barley in 1937. Plowed May 15, 1937.	0-7 7-14

Honeoye gravelly silt loam (eroded).	Field 10 of soil and water conservation experiment station, Marcellus, N. Y.	16	do	July 9, 1937	Profile differs from that of site 15 in that the upper subsoil contains more sand and fine gravel.	Oats and barley in 1937. Plowed May 10, 1937.	0-7 7-14
Honeoye gravelly silt loam.	do	17	do	July 15, 1937	Profile different from that of site 15 in that it has more surface soil because of deposition.	Oats and barley in 1937. Plowed about May 10, 1937	0-8 8-15
	do	18	do	July 22, 1937	Profile considerably different from that of site 15 in that the surface soil is much darker than that of typical Honeoye and the subsoil has considerable gray mottling. Might be called Lyons rather than Honeoye. A localized area that is wet and seepy part of the time.	Oats and barley in 1937. Plowed about May 6, 1937.	0-8 8-15
	Field 17 near site 15 tube of soil and water conservation experiment station, Marcellus, N. Y.	22 23 1 2 3 41	do do Rainfall simulator do do do	Sept. 23, 1937 Oct. 1, 1937 Sept. 20, 1937 Sept. 23, 1937 Oct. 1, 1937 June 10, 1938	Profiles are the same as those of site 15 except that on sites 23, 3, and 41 the subsoil is slightly mottled.	Oats and barley in 1937. Plowed about May 15, 1937.	0-7 7-14
Honeoye gravelly silt loam (sod).	Field 2 of soil and water conservation experiment station, Marcellus, N. Y.	24 4	Tube Rainfall simulator	Oct. 8, 1937	0-8 inches. Dark-brown gravelly silt loam 8-24 inches. Grades from brown to lighter brown mottled with yellow gravelly silt loam; more compact than surface layer. Below 24 inches. About the same material as that of the 8-24-inch layer but contains much more sand, gravel, and rock.	Dense bluegrass sod, which probably had not been disturbed for many years.	0-8 8-15
Honeoye gravelly silt loam.	Field 5 of soil and water conservation experiment station, Marcellus, N. Y.	35 40	Tube Rainfall simulator	June 8, 1938 June 7, 1938	0-7 inches. Dark grayish-brown silt loam Below 7 inches. Mottled grayish-yellow heavy silt loam with the gray becoming more prominent with increase in depth. Many rocks of various sizes appear throughout profile. The B horizon is not very definite.	Timothy and weeds in 1938. Recent crops: Oats and buckwheat.	0-7 7-18
Hopi sandy loam [1]	Navajo Soil and Water Conservation Experiment Station, Gallup, N. Mex.	135	Tube	Apr. 28, 1938	0-3 inches. Very light-brown loose sandy loam. 3-18 inches. Light-brown sandy loam Below 18 inches. Grayish-brown clay loam containing nodules of lime. Disintegrated yellow sandstone encountered at 24 inches.	Range land. Covered with sparse stand of grass.	0-3 3-15
Houston black clay (slightly eroded).	Field O of soil and water conservation experiment station, Temple, Tex.	120	do	Mar. 3, 1938	0-12 inches. Dark-gray to black calcareous heavy clay. 12-36 inches. Grades into a brownish-gray heavy, waxy calcareous clay, which becomes lighter in color with depth.	Oats in 1938. Recent crops. Corn and cotton.	0-12 12-21
Houston black clay (moderately eroded).	do	122	do	Mar. 10, 1938	0-7 inches. Dark-gray to black calcareous heavy clay. 7-36 inches. Grades into a light brownish-gray waxy clay, which becomes lighter in color with depth.	do	0-7 7-16

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[1] Local name, soil not correlated.

TABLE 11.—*Description of the soils of sites on which rates of infiltration were measured*—Continued

Soil type	Location of site	Site No.	Method	Date of initial run	Description of profile	Cultural treatment	Depth of sampling for laboratory study
Houston clay (moderately eroded).	Field R of soil and water conservation experiment station, Temple, Tex.	121	Tube	Mar. 7, 1938	0–7 inches. Dark-brown calcareous clay 7–20 inches. Brownish-black crumbly calcareous clay. 20–36 inches. Becomes lighter brown with increase in depth and grades into a yellowish-brown calcareous clay.	Oats in 1938. Recent crops: Cane and cotton.	*Inches* 0–7 7–16
Houston clay (shallow phase).	Curtis farm near Troy, Tex	124	do	Mar. 16, 1938	0–7 inches. Dark-brown crumbly calcareous clay. 7–18 inches. Yellowish-brown crumbly calcareous clay. Below 18 inches. Grades into a yellowish-white crumbly chalky marl, which becomes almost solid at 33 inches.	Oats and vetch in 1938. Recent crops: Oats following oats.	0–7 7–16
Iredell loam	Mathewson farm, Lexington, Ga.	26 7	do Rainfall simulator	Nov. 15, 1937 do	0–6 inches. Yellowish-brown heavy loam Below 6 inches. Plastic brownish-yellow clay. Parent material began to show below 30 inches.	Millet and vetch in 1937. Recent crops: Millet, corn, and vetch.	0–6 6–15
Kirkland sandy clay	Soil and water conservation experiment station, Guthrie, Okla.	125	Tube	Mar. 22, 1938	0–5 inches. Dark reddish-brown sandy clay 5–28 inches. Grades from light-red sandy clay to rather plastic red clay.	Wheat in 1937. Recent crops: Cotton and oats.	0–5 5–16
Kirkland fine sandy loam.	Gaffney farm, Guthrie, Okla.	126	do	Mar. 24, 1938	0–10 inches. Dark reddish-brown sandy loam containing a few small sandstone fragments in lower depths. Below 10 inches. Grades from reddish sandy clay to rather plastic clay.	Winter wheat in 1938. Recent crops: Cotton and oats.	0–10 10–16
Lordstown stony silt loam.	Arnot soil and water conservation experiment station, Ithaca, N. Y.	6	Rainfall simulator	Oct. 26, 1938	0–7 inches. Dark-brown silt loam 7–20 inches. Yellowish-brown silty clay Below 20 inches. Almost solid rock. A large amount of shale rock, varying in size to about 10 inches in diameter, scattered over surface and throughout profile.	Small grain in 1937	0–7 7–20
Melbourne loam	Farm of B. F. Yergen, Newberg, Oreg.	141	Tube	May 25, 1938	0–10 inches. Brown loam, high in sand. Practically structureless. 10–20 inches. Yellow sandy clay; structure poorly developed, somewhat prismatic. 20–28 inches. Heavy yellow clay, some mottling.	Pear orchard, with crop of vetch and barley plowed under.	0–7 7–21

Miami silty clay loam.	Sells farm, property of Ohio State University, Columbus, Ohio.	115	do	Oct. 11, 1937	0-7 inches. Dark grayish-brown silty clay loam containing some small stones. 7-20 inches. Light-brown heavy silty clay containing some small stones. Below 20 inches. Heavy material containing considerable gravel and stone.	Corn in 1937. Recent crops: Soybeans and corn.	0-7 7-15
Muskingum silt loam.	Near rotation plot 2 of soil and water conservation experiment station, Zanesville, Ohio.	109	do	Aug. 8, 1937	0-7 inches. Light-brown silty loam 7-22 inches. Considerably more clay and more reddish than above layer. Below 22 inches. Same material as above but contains a great deal of light-colored shale.	Corn in 1937. Meadow year before.	0-7 7-16
	Field J of soil and water conservation experiment station, Zanesville, Ohio.	37 44 45	do Rainfall simulator do	June 28, 1938 June 24, 1938 June 27, 1938	0-7 inches. Grayish-brown heavy silt loam 7-20 inches. Yellowish-brown heavy clay with numerous small pieces of shale and sandstone. 20-24 inches. Same material as 7- to 20-inch layer but contains much more sandstone and shale. Below 24 inches. Almost solid rock	Timothy and weeds in 1938.	0-7 7-20
	Above terrace C-2 of soil and water conservation experiment station, Zanesville, Ohio.	110	Tube	Aug. 14, 1937	0-5 inches. Brown heavy silt loam 5-24 inches. Reddish-brown silt with layers of shale. Below 24 inches. Almost solid shale and sandstone.	Clover seeded after wheat in 1937. Recent crops: Corn, wheat, and hay.	0-5 5-15
	Farm of Floyd Lapp near Adamsville, Ohio.	111	do	Oct. 25, 1937	0-8 inches. Dark-brown silt loam 8-20 inches. Lighter brown and more compact silt loam mixed with particles of light-colored shale. More sand throughout profile than is found in Muskingum profiles on soil and water conservation experiment station, Zanesville, Ohio.	Winter wheat in 1937. Recent crops: Corn, hay, and wheat.	0-8 8-16
	Near southwest corner of soil and water conservation experiment station, Zanesville, Ohio.	114	do	Sept. 8, 1937	0-7 inches. Dark-brown silt loam. 7-18 inches. Light-brown silt mixed with some shale. 18-36 inches. Very little change in color from that of 7- to 18-inch layer but material becomes heavier and mixed with considerable more shale.	Corn in 1937. Recent crops: Wheat, hay, and corn.	0-7 7-15
Orangeburg sandy loam.	Farm of Mrs. S. M. Jones near Ellaville, Ga.	33 19 20	do Rainfall simulator do	Feb. 25, 1938 Feb. 24, 1938 Feb. 28, 1938	0-7 inches. Grayish-brown sandy loam 7-12 inches. Brownish-yellow sandy loam a little heavier than 0- to 7-inch layer. 12-20 inches. Light-red sandy loam grading into a bright-red friable sandy clay, which becomes heavier with depth. Below 20 inches. Red crumbly heavy sandy clay.	Corn, peas, and beans in 1937. Recent crops: Chufa, corn, beans, and and peas.	0-7 7-12 12-20
Palouse silt loam (deep phase).	Field 7 between terraces 5 and 6 on soil and water conservation experiment station Pullman, Wash.	144	Tube	June 7, 1938	0-14 inches. Dark-brown friable silt loam with the surface showing a platy structure. 14-36 inches. Dark-brown heavy silt loam, a shade lighter in color than the surface soil.	Winter wheat in 1938. Summer fallow in 1937.	0-6 6-21

TABLE 11.—*Description of the soils of sites on which rates of infiltration were measured*—Continued

Soil type	Location of site	Site No.	Method	Date of initial run	Description of profile	Cultural treatment	Depth of sampling for laboratory study
Palouse silt loam (shallow phase).	Field 4 of soil and water conservation experiment station, Pullman, Wash.	146	Tube	June 13, 1938	0–12 inches. Dark-brown heavy silt loam, granular and friable. 12–18 inches. Tawny-brown silty clay loam, which becomes slightly heavier with depth. Below 18 inches. Yellowish-brown clay loam to silty clay loam.	Spring wheat in 1938. Recent crops: Peas, wheat, and sweetclover.	*Inches* 0–8 8–21
Palouse silty clay loam (shallow phase).	Field 7 of soil and water conservation experiment station, Pullman, Wash.	145	do	June 9, 1938	0–8 inches. Grayish-brown silty clay loam, fairly friable. 8–20 inches. Tawny-brown silty clay loam to clay loam. Below 20 inches.[4] Yellowish-brown silty clay loam.	Winter wheat in 1938. Summer fallow in 1937.	0–8 8–16
Parsons fine sandy loam.	Farm of Paul C. Myers near Broken Arrow, Okla.	128	do	Apr. 1, 1938	0–12 inches. Grayish-brown fine sandy loam. Below 12 inches. Dense, tough, reddish-yellow clay mottled with gray.	Cane in 1937. Recent crops: Oats and lespedeza.	0–12 12–20
Pinedale clay loam [3]	Navajo Soil and Water Conservation Experiment Station, Gallup, N. Mex.	134	do	Apr. 25, 1938	0–2 inches. Fine granular mulch 2–7 inches. Brown clay loam Below 7 inches. Brown sandy clay changing to an olive-brown clay, which covers parent sandstone material at 36 inches.	Range land. Sparse cover of grass.	0–7 7–15
Ruston loamy sand	Farm of Mrs. H. G. Adams near Americus, Ga.	23	Rainfall simulator.	Mar. 19, 1938	0–6 inches. Gray loamy sand 6–12 inches. Light brownish-gray loamy sand. 12–23 inches. Reddish-brown loamy sand 23–36 inches. Reddish-orange loamy sand Below 36 inches. Brownish-red sandy clay	Oats in 1935. Idle since that date.	0–6 6–12 12–23 23–36 36–42
Red Bay loam	Farm of T. M. Merritt, Americus, Ga.	34 22 25	Tube Rainfall simulator do	Mar. 15, 1938 Mar. 11, 1938 Mar. 24, 1938	0–5 inches. Brownish-red loam 5–15 inches. Dark-red heavy sandy clay Below 15 inches. Dark-red heavy clay, which becomes heavier with increase in depth.	Cotton in 1937. Recent crops: Corn, oats, and cotton.	0–5 5–15
Ruston sandy loam	Farm of J. D. Moore, near Americus, Ga.	32 16 17 18	Tube Rainfall simulator do do	Feb. 10, 1938 Feb. 8, 1938 Feb. 14, 1938 Feb. 16, 1938	0–7 inches. Grayish-brown sandy loam 7–11 inches. Brownish-yellow sandy loam, which becomes a little heavier with increase in depth. Below 11 inches. Yellowish-red sandy clay, which becomes heavier with increase in depth.	Cotton in 1937. Cotton and corn rotation for years.	0–7 7–11 11–20
Selah loam [3]	Farm of Dan McKenze, Ellensburg, Wash.	138	Tube	May 16, 1938	0–12 inches. Grayish-brown loam becoming slightly heavier in lower 6 inches. 12–18 inches. Grayish-brown silty clay loam with granular structure. 18–27 inches. Slightly reddish-brown clay loam. Slightly prismatic in structure. Below 27 inches. Gliche layer, apparently impervious to plant roots.	Fallow in 1938. Recent crops: Peas and potatoes.	0–12 12–20

Tama silt loam	Farm of H. T. Hanson, Westby, Wis.	104	do	Sept. 14, 1937	0-9 inches. Dark-brown to almost black, smooth, friable silt loam. 9-22 inches. Deep-brown silt loam that grades with depth into brownish-yellow silt loam. Below 22 inches. Brownish-yellow heavy silt loam or silty clay loam.	Second-year corn in 1937	0-9 9-22
Upshur clay loam	Copland farm, Rex Mills, Ohio	113	do	Nov. 2, 1937	0-5½ inches. Dark-red clay loam showing traces of organic matter. 5½-20 inches. Dark-red clay with no organic matter apparent. Below 20 inches. Same material as 5½-20-inch layer but becomes more crumbly with increase in depth.	Corn in 1937. Recent crops: Oats and clover.	0-5½ 7-15
Vernon fine sandy loam.	West of control plots on soil and water conservation experiment station, Guthrie, Okla.	116	do	Nov. 29, 1937	0-8 inches. Dark brownish-red fine sandy loam. 8-16 inches. Bright-red sandy clay Below 16 inches. Weathered sandstone	Oats with cowpeas turned under in 1937. Fallow at time of run.	0-8 8-15
	Field B of soil and water conservation experiment station, Guthrie, Okla.	117	do	Dec. 4, 1937	0-13 inches. Dark reddish-brown fine sandy loam. 13-20 inches. Light-yellow and deep-red sandy clay. Below 20 inches. Weathered sandstone	Winter wheat at time of run. Recent crops: Cotton, oats, and sorghum.	0-13 13-20
	Plot K3 of soil and water conservation experiment station, Guthrie, Okla.	129	do	Apr. 4, 1938	0-8 inches. Dark reddish-brown fine sandy loam. 8-20 inches. Bright-red fine sand to sandy clay. Below 20 inches. Friable red clay to sandy clay.	Wheat cover crop at time of run. Continuous cotton since 1932.	0-8 8-21
Vernon very fine sandy loam.	Farm of K. E. Driskell, Elk City, Okla.	130	do	Apr. 10, 1938	0-10 inches. Reddish-brown to red very fine sandy loam. Reddish color increases with depth; no structural development. 10-14 inches. Weathered shale, highly calcareous. Below 14 inches. Parent material	Grain sorghum since 1936	0-9 9-16
Volusia stony silt loam.	Farm of Jerry A. Rosak, near Arnot soil and water conservation experiment station, near Ithaca, N. Y.	25 5	do Rainfall simulator	Oct. 19, 1937 Oct. 18, 1937	0-6 inches. Brownish-gray quite friable silt loam. 6-11 inches. Lighter brown than 0 to 6-inch layer and increases in compactness. Below 11 inches. Dark-gray very compact and highly mottled mixture of clay and shale. The profile is quite variable.	Timothy, orchard grass, and clover pasture for last 2 years.	0-6 6-11 11-15
Walla Walla silt loam.	Farm of C. J. Broghton, Dayton, Wash.	143	Tube	June 3, 1938	0-16 inches. Brown friable and granular silt loam, which becomes lighter in color with increase in depth. 16-30 inches. Light-brown heavy silt loam, somewhat compact. Below 30 inches. Yellowish-brown heavy silt loam.	Spring wheat in 1938. Summer fallow and wheat 2 years before.	0-7 7-16
Westmoreland clayey silt loam.	Farm of Hugh Patton, New Concord, Ohio.	112	do	Oct. 28, 1937	0-5 inches. Dark-brown clayey silt loam 5-36 inches. Gradual change in color from dark brown to almost light gray. The whole profile is very sticky and quite variable.	Corn in 1937	0-5 5-15

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[1] Local name, soil not correlated.

TABLE 12.—*Rates of infiltration of soils as obtained on sites with recorded soil moisture and soil and water temperatures*

[Tube method]

Soil type	Location of site	Site No.	Kind of run[1]	Soil moisture[2] before run at depth of—			Soil temperature before run at depth of—		Temperature of water of run	Cumulative amounts of infiltration, with standard errors, during period of—				
				0-7 inches	7-15 inches	15-25 inches	4 inches	15 inches		0-15 minutes	0-30 minutes	0-60 minutes	0-120 minutes	0-180 minutes
				Percent	*Percent*	*Percent*	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Aiken clay loam	Newberg, Oreg	140	Initial	21.0	25.8	25.7	62	58	68	3.05±0.41	4.47±0.53	6.87±0.74	11.40±1.12	15.32±1.47
			Wet	36.7	30.6	30.4	64	59	68	2.21± .22	3.35± .35	5.75± .62	10.18±1.08	14.16±1.50
Austin clay (slightly eroded)	Temple, Tex	118	Initial	26.4	21.4	19.8	48	53	49	.16± .02	.18± .03	.19± .03	.21± .03	.24± .03
			Wet	30.6	22.2	20.7	48	53	52	.01± .02	.01± .02	.01± .03	.02± .03	.03± .04
Austin clay (severely eroded)	do	119	Initial	24.2	22.6	20.8	58	46	66	.80± .05	.90± .06	1.03± .09	1.28± .15	1.55± .22
			Wet	35.2	26.8	23.3	56	58	58	.22± .04	.24± .04	.30± .05	.38± .06	.47± .08
		123	Initial	16.5	17.8	18.4	66	63	74	2.05± .20	2.89± .35	4.25± .59	6.74±1.10	9.15±1.61
			Wet	28.0	21.7	21.2	64	64	68	1.32± .19	1.79± .31	2.67± .55	4.43±1.03	6.21±1.51
Badger loam[3]	Ellensburg, Wash	139	Initial	16.8	22.7	21.7	40	52	54	1.10± .05	1.36± .07	1.66± .10	2.12± .17	2.54± .24
			Wet	29.4	25.6	23.6	53	51	68	.12± .02	.16± .02	.23± .03	.37± .05	.50± .06
Bates very fine sandy loam	Broken Arrow, Okla	127	Initial	24.7	23.9	22.2	64	58	74	.78± .06	1.29± .10	2.19± .18	3.92± .33	5.62± .51
			Wet	25.5	24.4	23.1	50	59	62	.31± .02	.44± .03	.65± .04	1.06± .06	1.44± .08
Bath gravelly silt loam	Wallace, N. Y	20	Initial	21.8	20.4	15.8	76	75	80	3.65± .35	6.13± .68	10.82±1.27	17.15±2.28	23.43±3.21
			Wet	27.4	25.7	23.2	71	74	71	1.97± .22	3.25± .42	5.55± .78	9.57±1.42	13.32±2.00
Boone silt loam (typical)	Independence, Wis	107	Initial	14.3	11.3	12.3	51	55	49	.82± .08	1.14± .10	1.51± .10	2.01± .10	2.38± .10
			Wet	24.6	17.6	11.5	52	55	57	.20± .05	.43± .07	.65± .11	1.05± .17	1.41± .24
Buell clay loam[3]	Mexican Springs, N. Mex.	133	Initial	14.6	16.0	18.9	46	45	66	1.48± .11	1.92± .11	2.35± .10	2.82± .13	3.21± .18
			Wet	24.4	21.8	21.0	48	46	62	.20± .03	.35± .04	.42± .04	.56± .06	.69± .07
Carrington silt loam (typical)	Spring Valley, Minn.	105	Initial	21.1	15.2	13.9	61	61	63	1.87± .15	2.95± .22	4.42± .38	6.62± .71	8.49±1.02
			Wet	32.7	27.4	23.9	62	61	66	.70± .07	1.18± .12	1.97± .24	3.46± .45	4.88± .63
Cecil clay loam	Watkinsville, Ga	27	Initial	17.0	26.7	28.0	42	43	51	.99± .07	1.12± .07	1.31± .09	1.51± .10	1.67± .12
			Wet	27.4	28.6	25.9	36	42	43	.01±	.02± .01	.04± .01	.09± .02	.15± .03
		28	Initial	18.8	23.2	24.1	50	49	51	1.32± .05	1.38± .05	1.46± .05	1.51± .05	1.56± .05
			Wet	41.9	36.4	31.4	52	51	54	.00	.00	.01± .01	.02± .01	.03± .02
Cecil sandy loam	do	31	Initial	10.5	15.5	26.4	45	44	44	.67± .06	1.22± .10	1.97± .11	3.07± .19	4.01± .27
			Wet	14.0	18.6	26.8	42	42	48	.20± .03	.37± .05	.66± .06	1.09± .09	1.49± .11
Clinton silt loam (typical)	La Crosse, Wis	101	Initial	11.8	15.5	15.3	83	72	96	.59± .06	.79± .08	1.05± .11	1.33± .11	1.55± .11
			Wet	27.7	23.0	19.5	81	78	94	.17± .05	.27± .08	.46± .13	.83± .25	1.18± .34
Clinton silt loam (eroded)	do	102	Initial	11.3	13.9	16.4	79	75	92	1.24± .05	1.60± .08	1.91± .10	2.20± .11	2.41± .12
			Wet	28.8	23.4	19.5	74	74	79	.13± .02	.19± .02	.27± .03	.43± .04	.59± .06
Colby silt loam (typical)	Marshfield, Wis	108	Initial	17.4	10.3	11.8	57	58	57	.82± .05	1.07± .07	1.41± .11	1.85± .17	2.19± .20
			Wet	28.4	21.0	15.8	53	56	49	.37± .03	.47± .04	.63± .07	.88± .10	1.12± .14
Crown light clay (colluvial phase).[3]	Mexican Springs, N. Mex.	131	Initial	16.5	12.4	8.5	40	44	49	1.04± .04	1.34± .05	1.61± .06	1.77± .07	1.87± .08
			Wet	34.0	24.3	16.0	44	46	46	.00	.00	.00	.00	.00
Crown heavy clay[3]	do	132	Initial	18.2	21.2	20.4	48	49	63	1.13± .07	1.63± .06	1.92± .08	1.99± .08	2.04± .08
			Wet	47.2	20.2	20.9	49	50	64	.00	.01±	.01±	.02± .01	.04± .01

Crown sandy clay loam [3]	do	136	Initial	6.7	13.5	11.3	55	53	52	1.54± .03	2.16± .04	3.42± .07	6.65± .16	8.87± .26
			Wet	16.6	19.0	18.6	52	53	56	.73± .02	1.10± .03	1.73± .04	3.03± .07	4.45± .11
Crown sandy loam [3]	do	137	Initial	8.8	12.3	8.6	49	51	55	1.73± .16	2.69± .25	4.15± .38	6.93± .59	9.81± .80
			Wet	19.9	20.3	18.6	48	50	52	1.15± .14	1.77± .23	2.81± .41	4.78± .75	6.71±1.09
Davidson clay loam	Monticello, Ga	30	Initial	19.6	24.7	27.0	45	49	46	1.43± .13	2.05± .21	3.23± .40	5.16± .73	7.01±1.04
			Wet	27.8	30.1	34.0	58	54	53	.33± .06	.50± .09	.78± .13	1.30± .21	1.82± .29
Dubuque silt loam (typical)	Cashton, Wis	103	Initial	5.9	8.0	10.3	74	72	78	.92± .03	1.22± .04	1.77± .08	2.68± .14	3.43± .16
			Wet	37.2	25.3	18.8	67	70	64	.14± .03	.24± .06	.46± .10	.87± .19	1.31± .27
Dunkirk silty clay loam	Geneva, N. Y	19	Initial	15.4	18.8	18.9	69	68	70	.68± .06	.91± .09	1.19± .14	1.57± .21	1.87± .28
			Wet	28.3	23.1	22.3	76	76	78	.11± .07	.24± .12	.57± .24	1.22± .46	1.94± .66
		36	Initial	13.4	15.1	16.8	73	65	74	.34± .03	.48± .04	.66± .10	.74± .15	.92± .17
			Wet	24.5	18.0	18.9	76	68	76	.00	.00	.00	.01	.03± .02
Fayette silt loam (typical)	Houston, Minn	106	Initial	10.0	10.0	11.0	69	63	83	1.37± .07	1.65± .06	1.91± .06	2.19± .07	2.42± .08
			Wet	20.7	23.2	10.5	69	66	83	.18± .01	.25± .02	.36± .03	.59± .04	.81± .06
Fremont gravelly silt loam	Cohocton, N. Y	21	Initial	22.7	15.6	11.5	69	65	66	1.49± .09	2.04± .11	2.81± .15	3.87± .21	4.76± .27
			Wet	27.1	24.0	17.2	66	67	60	.50± .07	.70± .09	1.25± .13	2.16± .23	3.02± .33
Athena silt loam [3]	Dayton, Wash	142	Initial	12.0	12.8	12.8	60	60	70	1.71± .30	2.33± .25	3.28± .36	4.88± .57	6.34± .76
			Wet	27.3	24.5	22.2	60	60	67	.75± .17	1.18± .30	1.73± .51	2.63± .84	3.45±1.13
Honeoye gravelly silt loam (normal).	Marcellus, N. Y	15	Initial	20.3	22.6	19.5	70	62	78	1.98± .23	3.12± .42	5.36± .83	9.75±1.49	13.76±2.12
			Wet	32.7	30.6	24.5	68	63	80	.92± .18	1.57± .34	2.78± .63	5.03±1.13	7.39±1.61
Honeoye gravelly silt loam (eroded).	do	16	Initial	16.4	16.1	15.1	80	75	89	2.25± .14	3.52± .32	5.71± .53	9.08± .82	12.24±1.10
			Wet	26.6	23.0	19.3	74	75	84	1.52± .19	2.66± .33	4.90± .58	9.18±1.00	12.85±1.34
Honeoye gravelly silt loam (deposition).	do	17	Initial	20.7	15.8	16.4	74	72	82	2.93± .35	4.51± .58	6.92± .97	11.11±1.60	14.70±2.15
			Wet	29.8	23.8	22.1	79	77	86	1.76± .25	3.19± .42	5.73± .76	11.02±1.37	15.98±1.89
Honeoye gravelly silt loam (seepy)	do	18	Initial	39.0	23.8	20.6	72	69	88	.97± .23	1.60± .40	2.62± .63	4.42±1.08	6.08±1.51
			Wet	41.2	26.1	18.5	71	69	75	.53± .15	.90± .26	1.71± .46	3.08± .83	4.41±1.17
Honeoye gravelly silt loam (normal).	do	22	Initial	19.8	17.1	14.3	63	63	72	2.23± .25	3.80± .46	6.71± .88	11.99±1.63	16.93±2.24
			Wet	25.4	22.7	19.2	67	64	73	1.01± .18	1.77± .32	3.44± .60	6.72±1.14	9.80±1.63
		23	Initial	17.3	15.4	12.6	63	61	70	1.73± .19	2.74± .33	4.40± .59	7.16± .98	9.72±1.33
			Wet	20.7	21.4	16.1	62	61	61	.63± .13	1.16± .24	2.19± .46	4.00± .84	5.58±1.13
Honeoye gravelly silt loam (sod)	do	24	Initial	14.6	15.4	14.3	57	57	51	4.70± .41	7.71± .70	12.11±1.16	18.82±1.90	24.58±2.53
			Wet	32.3	24.3	22.5	49	53	43	2.26± .25	4.00± .45	7.22± .86	12.92±1.56	17.68±2.30
Honeoye gravelly silt loam	do	35	Initial	22.6	19.8	16.7	66	50	59	1.12± .10	1.70± .18	2.57± .32	4.16± .58	5.77± .83
			Wet	24.9	20.8	14.3	65	62	59	.80± .28	1.24± .44	2.00± .67	3.53±1.16	4.85±1.47
Hopi sandy loam [3]	Mexican Springs, N. Mex.	135	Initial	10.2	12.4	7.9	52	53	64	1.54± .04	2.35± .06	4.02± .10	7.46± .23	11.11± .39
			Wet	17.8	16.2	15.0	53	54	68	.65± .02	1.04± .04	1.75± .06	3.31± .12	5.00± .20
Houston clay (shallow phase)	Temple, Tex	124	Initial	30.2	26.6	23.3	69	65	80	.75± .07	.89± .09	1.07± .14	1.35± .24	1.55± .35
			Wet	40.5	33.4	28.7	62	66	70	.12± .02	.16± .04	.24± .07	.38± .13	.56± .21
Houston black clay (slightly eroded).	do	120	Initial	38.5	39.8	38.4	60	60	67	.60± .03	.70± .03	.77± .04	.86± .07	.94± .10
			Wet	54.6	43.9	40.5	64	62	72	.02± .01	.03± .01	.04± .02	.08± .05	.12± .08
Houston black clay (moderately eroded).	do	122	Initial	28.0	27.3	26.1	56	60	62	.86± .02	.94± .03	1.02± .04	1.11± .04	1.17± .05
			Wet	40.7	29.0	26.4	58	62	68	.02± .01	.03± .01	.04± .02	.06± .02	.07± .02
Houston clay (moderately eroded)	do	121	Initial	32.4	34.5	32.2	58	62	60	1.04± .03	1.07± .05	1.11± .05	1.16± .05	1.19± .05
			Wet	54.9	43.0	35.5	58	62	59	.04± .02	.04± .02	.05± .02	.07± .02	.09± .03
Iredell loam	Lexington, Ga	26	Initial	20.4	39.5	41.2	52	55	58	0.10± .02	0.12± .02	.13± .02	.16± .02	.19± .02
			Wet	23.2	37.3	40.8	48	52	55	.00	.00	.00	.00	.00
Kirkland sandy clay	Guthrie, Okla	125	Initial	15.0	21.6	20.8	64	62	66	.82± .04	1.07± .05	1.36± .05	1.69± .06	1.92± .08
			Wet	21.9	17.6	27.5	55	60	60	.07± .01	.09± .01	.13± .02	.19± .03	.24± .03
Kirkland fine sandy loam	do	126	Initial	12.7	16.8	16.1	58	58	66	.74± .08	1.06± .12	1.53± .18	2.33± .20	3.08± .38
			Wet	19.2	20.1	18.4	67	61	68	.26± .03	.41± .05	.64± .08	1.08± .14	1.54± .19

See footnotes at end of table.

TABLE 12.—*Rates of infiltration of soils, recorded soil moisture, and soil and water temperatures*—Continued

Soil type	Location of site	Site No.	Kind of run	Soil moisture before run at depth of—			Soil temperature before run at depth of—		Temperature of water of run	Cumulative amounts of infiltration, with standard errors, during period of—				
				0-7 inches	7-15 inches	15-25 inches	4 inches	15 inches		0-15 minutes	0-30 minutes	0-60 minutes	0-120 minutes	0-180 minutes
				Percent	*Percent*	*Percent*	*°F.*	*°F.*	*°F.*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Melbourne loam	Newberg, Oreg	141	Initial	11.7	16.2	18.9	70	65	80	.95± .08	1.17± .11	1.52± .18	2.02± .26	2.50± .36
			Wet	25.9	20.4	21.8	68	66	74	.16± .04	.30± .08	.52± .15	.95± .28	1.45± .43
Miami silty clay loam	Columbus, Ohio	115	Initial	17.5	22.9	19.0	45	47	41	.25± .02	.36± .02	.51± .03	.74± .05	.90± .07
			Wet	27.0	27.4	26.5	42	47	43	.00	.01	.03± .01	.07± .02	.11± .02
Muskingum silt loam	Zanesville, Ohio	37	Initial	22.6	20.7	22.04	62	64	66	.17± .04	.29± .06	.47± .09	.79± .14	1.15± .21
			Wet	27.0	21.0	19.3	75	66	71	.16± .04	.26± .07	.45± .12	.82± .22	1.22± .33
		109	Initial	17.4	18.0	18.2	52	59	53	2.02± .10	2.61± .08	3.06± .08	3.56± .14	3.95± .20
			Wet	28.7	26.4	23.3	52	50	47	.71± .05	.90± .06	1.23± .09	1.81± .15	2.32± .20
		110	Initial	15.0	14.3	17.6	46	54	51	.40± .05	.60± .05	.86± .06	1.21± .07	1.48± .08
			Wet	23.6	21.0	15.6	43	49	43	.05± .01	.10± .02	.19± .04	.37± .06	.55± .08
	Adamsville, Ohio	111	Initial	24.5	22.3	19.3	40	46	42	1.86± .07	2.52± .12	3.49± .22	5.16± .46	6.64± .71
			Wet	26.8	23.9	24.4	49	48	56	.72± .09	1.04± .18	1.66± .37	2.88± .73	4.12±1.07
	Zanesville, Ohio	114	Initial	26.5	20.9	17.7	45	47	55	1.79± .28	2.62± .46	3.80± .66	5.31± .75	6.50± .83
			Wet	35.0	27.1	24.1	44	48	51	.36± .04	.54± .05	.86± .09	1.48± .16	2.09± .25
Orangeburg sandy loam	Ellaville, Ga	33	Initial	7.2	9.0	17.7	45	50	56	1.80± .24	3.23± .42	5.66± .55	9.93± .79	13.77± .99
			Wet	9.3	12.9	19.4	52	48	59	.76± .06	1.23± .08	1.98± .12	3.47± .19	4.85± .23
Palouse silt loam (deep phase)	Pullman, Wash	144	Initial	11.0	13.5	14.7	62	55	80	2.23± .28	3.19± .42	4.61± .64	6.92±1.04	8.90±1.39
			Wet	33.3	31.2	28.8	54	55	56	1.08± .21	1.77± .36	3.02± .64	5.18±1.14	7.27±1.63
Palouse silt loam	do	146	Initial	7.0	13.3	18.2	62	61	64	1.18± .05	1.66± .07	2.41± .13	3.62± .21	4.74± .27
			Wet	35.2	23.5	22.2	60	60	62	.19± .04	.32± .04	.56± .06	1.00± .09	1.43± .12
Palouse clay silty loam (shallow phase).	do	145	Initial	8.8	14.4	16.8	52	58	52	.96± .09	1.44± .11	2.30± .15	3.68± .20	4.73± .23
			Wet	32.2	25.7	22.0	58	56	52	.27± .03	.42± .04	.68± .07	1.15± .11	1.62± .15
Parsons fine sandy loam	Broken Arrow, Okla	128	Initial	25.8	26.0	27.0	50	56	50	.10± .01	.13± .01	.15± .01	.16± .01	.18± .01
			Wet	30.0	28.9	26.4	42	49	44	.00	.00	.00	.00	.00
Pinedale clay loam	Mexican Springs, N. Mex.	134	Initial	13.5	17.0	11.9	58	54	62	1.54± .06	2.49± .09	4.17± .13	7.19± .22	10.02± .29
			Wet	23.2	23.2	19.4	49	54	54	.48± .02	.81± .04	1.36± .05	2.36± .08	3.36± .11
Red Bay loam	Americus, Ga	34	Initial	11.8	13.6	14.7	71	64	76	1.12± .06	1.57± .10	2.23± .18	3.53± .34	4.55± .49
			Wet	16.5	18.0	18.0	62	61	66	.13± .02	.24± .02	.44± .03	.80± .04	1.18± .06
Ruston sandy loam	do	32	Initial	6.4	13.7	18.6	64	56	66	2.92± .13	4.77± .25	8.51± .52	15.27± .81	21.75±1.67
			Wet	10.2	15.5	20.0	58	57	64	1.01± .05	1.52± .08	2.41± .13	4.17± .24	5.94± .36
Selah loam [3]	Ellensburg, Wash	138	Initial	17.5	24.3	23.9	55	54	62	.83± .04	1.01± .06	1.24± .07	1.58± .10	1.83± .12
			Wet	32.8	28.8	28.9	52	53	53	.04± .01	.07± .01	.13± .02	.21± .03	.32± .04
Tama silt loam (typical)	Westby, Wis	104	Initial	19.5	15.2	17.7	63	63	70	1.72± .20	2.45± .32	3.58± .49	5.45± .78	7.12±1.02
			Wet	30.6	29.3	29.4	56	61	59	.48± .07	.73± .11	1.22± .20	2.17± .38	3.11± .55
Upshur clay loam	Rix Mills, Ohio	113	Initial	22.7	27.4	24.4	50	51	55	.20± .01	.23± .01	.24± .01	.27± .01	.27± .01
			Wet	30.1	30.0	26.0	43	49	41	.00	.00	.00	.00	.00

Vernon fine sandy loam	Guthrie, Okla	116	Initial	12.7	15.4	12.5	42	44	47	.83± .06	.89± .06	.98± .07	1.11± .08	1.23± .10
			Wet	27.7	20.3	18.5	41	44	45	.00	.00	.01	.03± .01	.06± .01
		117	Initial	16.1	14.4	11.1	46	47	43	.55± .02	.64± .03	.74± .04	.86± .05	.95± .06
			Wet	23.1	19.8	11.9	41	45	37	.02± .01	.03± .01	.05± .01	.09± .02	.13± .03
		129	Initial	10.6	13.5	15.3	58	56	74	1.02± .10	1.46± .15	2.21± .22	3.56± .33	4.83± .45
			Wet	16.9	17.1	17.7	60	58	66	.32± .03	.52± .04	.83± .05	1.41± .09	1.96± .12
Vernon very fine sandy loam	Elk City, Okla	130	Initial	15.4	15.1	12.7	42	46	49	1.43± .15	1.90± .20	2.71± .27	4.17± .39	5.50± .48
			Wet	23.9	19.0	14.3	48	49	52	.29± .03	.45± .04	.74± .06	1.33± .09	1.84± .11
Volusia stony silt loam	Cayuta, N. Y	25	Initial	40.3	35.5	28.2	54	53	60	1.04± .12	1.57± .18	2.51± .30	3.91± .49	5.07± .65
			Wet	42.8	36.4	24.6	52	51	53	.38± .06	.59± .10	.96± .16	1.56± .27	2.11± .36
Walla Walla silt loam	Dayton, Wash	143	Initial	9.0	10.0	8.8	60	62	70	.51± .02	.59± .02	.71± .02	.89± .03	1.04± .03
			Wet	23.7	11.8	10.7	62	62	62	.01	.02± .01	.05± .01	.10± .01	.16± .01
Westmoreland clayey silt loam	New Concord, Ohio	112	Initial	30.0	32.2	31.8	46	49	45	.02± .01	.03± .01	.04± .01	.04± .01	.05± .01
			Wet	28.5	29.5	30.6	43	50	46	.00	.00	.00	.00	.00

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[1] All initial runs were made at field moisture content. All wet runs were made 24 hours after initial runs.

[2] Soil-moisture content determined from 2 samples only used as index of moisture level.

[3] Local name, soil not correlated.

TABLE 13.—*Mechanical analysis of surface soil from the 68 infiltration sites*

Soil No.	Soil type	Depth	>2.0 mm.	2.0–1.0 mm.	1.0–0.50 mm.	0.50–0.20 mm.	0.20–0.10 mm.	0.10–0.05 mm.	0.05–0.005 mm.	<.005 mm.	<.002 mm.
		In.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
19	Dunkirk silty clay loam	0–6	1.5	0.5	0.8	1.3	10.0	5.4	52.0	28.5	22.0
36	do	0–6	.3	.3	.7	1.0	6.2	9.3	56.3	25.9	21.3
37	Muskingum silt loam	0–6	2.4	.9	1.6	2.1	9.0	13.1	50.8	20.1	12.3
101	Clinton silt loam	0–7		.1	.2	.1	1.7	1.4	79.5	17.0	11.2
102	do	0–9	....	....	....	.2	.6	3.9	75.0	20.3	13.2
103	Dubuque silt loam	0–6	....	.4	1.4	3.5	4.0	3.8	66.5	20.4	11.3
104	Tama silt loam	0–9	....	.2	.2	.2	.3	1.7	70.3	27.1	23.3
105	Carrington silt loam	0–10	....	1.1	1.6	4.1	5.1	2.6	57.0	28.5	22.8
106	Fayette silt loam	0–6		.3	.4	.5	3.2	2.5	74.0	19.1	12.3
107	Boone silt loam	0–8	....	.3	1.9	6.0	5.4	3.2	66.1	17.1	12.5
108	Colby silt loam	0–7		1.0	2.3	3.8	5.8	2.9	66.9	17.3	9.7
109	Muskingum silt loam	0–8	.8	.3	.3	.7	2.5	2.0	72.5	20.0	10.1
110	do	0–5	3.2	1.4	1.2	1.4	5.4	3.3	60.3	23.8	10.3
111	do	0–7	.8	1.0	1.9	4.4	7.0	1.7	63.4	19.8	6.4
114	do	0–4	3.1	1.4	1.5	2.4	7.6	3.8	65.2	15.0	3.9
115	Miami silty clay loam	0–5	1.8	1.6	2.8	3.5	8.2	5.9	47.9	28.3	18.9
140	Aiken clay loam	0–7	6.8	1.4	2.3	2.6	5.0	5.2	47.3	29.4	25.4
142	Athena silt loam	0–5		....	....	.9	1.4	11.1	66.0	20.6	19.9
143	Walla Walla silt loam	0–7			.2	.2	1.6	13.9	62.5	21.6	16.5
144	Palouse silt loam	0–7		.2	.2	.1	1.1	10.0	61.8	26.6	17.8
145	Palouse silty clay loam	0–9			.1	.2	1.5	7.3	60.2	30.7	23.5
146	Palouse silt loam	0–8		.1	.2	.2	1.1	12.2	62.7	23.5	20.0
27	Cecil clay loam	0–4	3.4	12.5	15.3	12.8	17.0	5.3	11.1	22.5	18.0
28	do	0–5	8.1	9.0	8.7	9.8	14.5	4.1	8.8	37.0	31.8
30	Davidson clay loam	0–7	.9	1.1	6.2	11.3	21.7	8.4	19.7	30.6	24.7
112	Westmoreland clayey silt loam	0–4		.6	.7	.7	3.0	1.6	58.7	31.7	25.7
113	Upshur clay loam	0–5		.7	1.0	1.7	4.5	4.2	40.4	47.5	34.4
118	Austin clay	0–7	1.2	1.1	.8	.9	4.5	4.5	22.3	64.7	44.9
119	do	0–6	1.0	1.5	.9	.8	4.3	4.2	23.4	63.9	47.7
120	Houston black clay	0–12		.3	.6	.5	1.5	1.8	24.9	70.4	61.1
121	Houston clay	0–7	.3	.3	.6	.8	3.5	3.5	22.4	68.6	59.0
122	Houston black clay	0–7	.5	.6	.5	.5	2.3	2.7	26.6	66.3	49.2
123	Austin clay	0–7	.9	1.4	1.7	1.6	6.3	5.9	33.4	48.8	41.2
124	Houston clay	0–7	.4	1.0	.9	.7	2.8	3.0	28.8	62.3	51.2
125	Kirkland sandy clay	0–5	.5	.1	.2	.8	42.1	16.4	18.6	21.3	18.7
131	Crown light clay	0–7	1.0	.1	.3	2.2	27.4	15.0	21.1	32.9	26.9
132	Crown heavy clay	0–7	....	.2	.3	.3	2.1	2.6	69.8	24.7	7.9
133	Buell clay loam	0–9	....	.3	.5	1.3	16.9	28.1	33.3	19.6	16.3
134	Pinedale clay loam	0–7	....	.3	.6	3.4	33.3	21.0	10.9	30.5	23.7
31	Cecil sandy loam	0–5	1.7	8.5	22.3	17.8	20.0	6.0	14.2	9.5	5.9
32	Ruston sandy loam	0–7	1.2	1.0	18.0	32.8	27.6	6.5	7.8	4.2	3.5
33	Orangeburg sandy loam	0–7	.8	3.7	24.5	15.3	32.6	10.9	8.0	4.2	3.3
116	Vernon fine sandy loam	0–8	.9	.2	.2	1.6	51.3	15.4	11.3	19.1	16.9
117	do	0–13	.4	.2	.3	1.6	36.0	17.8	17.1	25.7	24.4
126	Kirkland fine sandy loam	0–10	3.5	.4	.3	.3	42.0	17.6	17.6	18.3	17.7
127	Bates very fine sandy loam	0–6	1.7	.4	.8	.9	9.5	23.5	32.9	30.3	22.5
128	Parsons fine sandy loam	0–12	.9	.8	1.2	.7	4.0	24.7	53.3	13.8	10.8
129	Vernon fine sandy loam	0–8	1.0	.2	.3	2.1	54.8	15.4	16.1	10.1	8.9
130	Vernon very fine sandy loam	0–9	.8	.3	.5	.6	3.4	26.4	40.4	27.6	18.6
135	Hopi sandy loam	0–3	....	....	.2	3.1	50.5	19.0	9.0	18.2	16.2
136	Crown sandy clay loam	0–8	....	....	.1	4.6	38.3	25.8	14.2	17.0	12.7
137	Crown sandy loam	0–7	....	....	.3	4.1	39.5	14.5	24.1	17.5	15.4
15	Honeoye gravelly silt loam	0–6	4.4	1.5	2.2	4.0	14.0	8.8	41.5	23.6	17.3
16	do	0–6	5.8	2.0	2.5	4.9	14.5	9.3	38.3	22.7	16.3
17	do	0–7	5.0	1.6	1.0	3.8	11.1	7.3	39.0	30.2	23.0
18	do	0–7	1.8	1.3	1.4	2.8	8.7	8.0	42.9	33.1	23.3
20	Bath gravelly silt loam	0–8	11.3	3.4	2.7	2.7	6.1	11.4	51.5	10.9	8.5
21	Fremont gravelly silt loam	0–7	15.9	1.5	1.7	4.1	12.3	7.8	38.4	18.3	12.6
22	Honeoye gravelly silt loam	0–7	6.1	1.5	2.3	4.8	13.4	8.7	38.3	24.9	16.5
23	do	0–7	4.3	1.0	2.2	4.4	15.1	9.5	41.3	22.2	15.6
24	do	0–7	4.1	2.0	2.0	5.1	14.8	6.3	42.6	22.5	16.8
25	Volusia stony silt loam	0–4	14.9	4.1	3.1	1.3	2.2	3.0	48.2	23.2	16.6
35	Honeoye gravelly silt loam	0–6	7.8	2.0	2.9	5.2	14.6	10.4	31.2	25.9	15.4
26	Iredell loam	0–6	2.7	3.0	7.1	9.0	19.5	12.5	25.0	21.2	17.1
34	Red Bay loam	0–5	1.9	2.5	12.1	24.3	21.0	3.4	13.1	20.8	18.0
134	Selah loam	0–10	.5	.5	1.9	5.7	19.9	13.7	40.2	17.6	10.3
139	Badger loam	0–6	.2	.2	.9	4.6	16.9	14.7	46.3	16.2	10.6
141	Melbourne loam	0–6	.5	.5	.8	1.6	30.8	8.4	35.4	22.0	16.5

TABLE 14.—*Mechanical analysis of subsoil from the 68 infiltration sites*

Soil No.	Soil type	Depth	>2.0 mm.	2.0–1.0 mm.	1.0–0.50 mm.	0.50–0.20 mm.	0.20–0.10 mm.	0.10–0.05 mm.	0.05–0.005 mm.	<.005 mm.	<.002 mm.
		In.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
19	Dunkirk silty clay loam	6–15	0.8	0.4	0.6	1.4	8.7	6.1	50.4	31.6	22.0
36	do	6–15	.3	.3	.7	1.0	6.1	9.1	54.2	28.3	24.0
37	Muskingum silt loam	8–15	4.4	.9	1.5	2.1	8.8	12.9	39.0	30.4	22.6
101	Clinton silt loam	7–14	------	------	------	.2	.2	2.8	69.6	27.2	19.0
102	do	9–15	------	------	.1	.1	.8	5.5	64.7	28.8	22.5
103	Dubuque silt loam	6–13	------	.1	.5	1.6	2.2	1.7	66.7	27.2	21.8
104	Tama silt loam	9–21	------	------	------	.1	.2	2.2	66.1	31.4	28.7
105	Carrington silt loam	10–21	------	.3	2.4	4.9	6.1	2.9	55.3	28.1	24.8
106	Fayette silt loam	6–15	------	.1	.1	.2	1.0	3.8	67.5	27.3	17.2
107	Boone silt loam	8–15	------	.6	3.6	8.2	7.4	3.1	57.9	19.2	16.3
108	Colby silt loam	7–14	------	.9	.8	.9	3.1	3.5	70.4	20.4	12.8
109	Muskingum silt loam	8–15	1.0	.1	.2	.2	.5	1.2	66.4	30.7	21.5
110	do	5–14	6.3	1.3	1.4	1.4	6.2	4.5	46.8	32.1	24.8
111	do	7–14	.4	.6	1.3	2.5	4.8	2.0	56.3	32.3	19.7
114	do	7–15	5.9	1.7	1.3	1.3	3.6	4.5	52.0	29.1	14.5
115	Miami silty clay loam	7–14	3.6	2.2	2.6	3.1	7.9	5.2	31.7	43.7	33.0
140	Aiken clay loam	7–15	3.2	.8	1.6	2.0	4.5	4.8	41.7	41.4	29.4
142	Athena silt loam	5–14	------	------	.1	.1	1.8	10.8	64.9	22.3	15.6
143	Walla Walla silt loam	7–15	------	------	.1	.1	1.8	13.4	62.5	22.1	17.9
144	Palouse silt loam	7–20	------	------	.1	.1	1.2	8.8	62.7	27.1	22.0
145	Palouse silty clay loam	9–15	------	------	.1	.1	1.2	7.2	53.5	37.9	31.9
146	Palouse silt loam	8–21	------	------	.1	.1	.9	9.7	59.5	29.7	26.0
27	Cecil clay loam	4–15	5.9	7.9	8.5	4.8	5.0	1.5	10.3	56.3	49.5
28	do	5–15	2.8	5.3	6.0	5.2	7.2	3.1	11.8	58.8	52.0
30	Davidson clay loam	7–16	------	.6	4.0	5.9	10.3	5.1	16.4	58.0	47.5
112	Westmoreland clayey silt loam	4–14	------	.3	.5	.7	2.0	1.9	48.3	46.3	34.2
113	Upshur clay loam	5–15	------	------	------	.5	2.3	3.4	25.6	68.2	53.4
118	Austin clay	7–16	1.2	.7	.6	.6	3.3	3.6	22.8	67.4	45.9
119	do	6–16	1.7	1.2	.6	.6	3.7	4.1	22.3	65.8	43.3
120	Houston black clay	12–21	------	.2	.2	.3	1.2	1.7	23.3	73.1	63.2
121	Houston clay	7–16	------	.3	.4	.7	2.8	3.3	23.5	69.0	61.9
122	Houston black clay	7–16	.4	.4	.5	.5	2.0	2.6	22.6	71.0	54.5
123	Austin clay	7–16	3.7	1.2	.8	.8	2.5	3.9	22.2	65.1	54.5
124	Houston clay	7–16	.7	1.3	1.2	.9	4.1	4.7	23.0	64.1	42.7
125	Kirkland sandy clay	5–16	------	------	.5	.7	23.2	10.2	19.5	45.9	36.0
131	Crown light clay	7–16	1.3	.1	.3	1.6	20.8	10.2	25.9	39.9	35.3
132	Crown heavy clay	7–15	------	------	.3	.3	2.3	2.6	16.1	78.4	63.5
133	Buell clay loam	9–22	------	------	.3	1.1	16.4	27.3	23.4	31.5	28.1
134	Pinedale clay loam	7–15	------	------	.3	2.4	30.0	19.3	27.9	20.1	14.5
31	Cecil sandy loam	5–13	1.2	9.9	17.4	13.1	14.2	2.6	17.0	24.2	20.6
32	Ruston sandy loam	7–10	.7	1.0	8.0	22.9	27.1	10.9	12.0	17.5	14.4
33	Orangeburg sandy loam	7–12	.5	5.2	22.5	15.6	25.7	12.8	8.8	9.0	6.6
116	Vernon fine sandy loam	8–16	.5	.2	.3	1.6	48.6	10.3	9.2	20.3	27.6
117	do	13–20	.6	------	.1	1.4	42.2	21.6	11.2	22.9	21.1
126	Kirkland fine sandy loam	10–16	1.6	.3	.1	.1	38.0	17.1	11.4	31.4	28.8
127	Bates very fine sandy loam	6–15	6.3	.8	1.0	1.0	.9	19.0	38.8	32.3	27.2
128	Parsons fine sandy loam	12–22	1.6	.6	.5	.3	2.3	12.5	34.6	47.5	43.7
129	Vernon fine sandy loam	8–21	.8	.1	.2	1.0	51.4	15.8	12.4	18.4	16.7
130	Vernon very fine sandy loam	9–16	3.9	.1	.6	1.2	5.0	14.8	45.9	28.3	13.0
135	Hopi sandy loam	3–15	------	------	.2	4.9	46.5	12.5	17.9	18.0	15.4
136	Crown sandy clay loam	8–16	------	------	.1	4.9	31.4	15.9	21.4	26.3	21.3
137	Crown sandy loam	7–16	------	------	.3	1.9	25.0	18.9	10.6	34.3	19.8
15	Honeoye gravelly silt loam	6–15	5.5	1.5	2.2	4.7	15.4	6.3	40.3	24.0	19.9
16	do	6–14	6.5	2.7	3.0	6.0	18.4	6.6	39.1	17.9	7.9
17	do	7–16	6.7	1.9	2.4	4.3	14.3	7.3	37.5	25.6	20.9
18	do	7–15	10.3	3.5	3.5	5.4	14.9	8.6	40.8	13.0	10.2
20	Bath gravelly silt loam	8–16	13.6	4.2	2.9	2.6	5.8	11.4	49.8	9.6	7.5
21	Fremont gravelly silt loam	7–11	14.9	4.0	2.1	.8	6.2	9.5	46.0	16.4	12.8
22	Honeoye gravelly silt loam	7–14	6.5	2.2	3.5	5.1	12.0	6.8	37.9	26.0	19.3
23	do	7–14	------	3.9	2.9	4.7	15.3	10.0	40.9	22.3	14.5
24	do	7–14	6.7	2.4	2.4	5.0	15.3	5.8	40.0	22.4	16.0
25	Volusia stony silt loam	4–13	10.2	1.8	1.1	.8	1.5	8.4	40.5	26.7	19.1
35	Honeoye gravelly silt loam	6–14	11.4	2.3	3.4	4.8	15.1	11.4	36.0	14.5	11.0
26	Iredell loam	6–16	3.0	8.1	8.6	4.8	9.4	3.7	23.2	39.1	33.4
34	Red Bay loam	5–15	.3	2.2	9.5	18.8	19.1	3.4	9.4	37.3	31.8
138	Selah loam	12–21	------	.7	1.3	6.5	21.2	9.1	37.6	23.6	17.9
139	Badger loam	6–16	------	.2	.6	3.7	13.4	13.3	51.5	17.3	7.0
141	Melbourne loam	6–21	.8	.2	.6	1.7	25.7	7.3	32.1	31.5	25.7

TABLE 15.—*Aggregate distribution of surface soil from the 68 infiltration sites*

Soil No.	Soil type	Depth	>2.0 mm.	2.0–1.0 mm.	1.0–0.50 mm.	0.50–0.25 mm.	0.25–0.10 mm.	0.10–0.05 mm.	<0.05 mm.	>0.25 mm.
		Inches	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
19	Dunkirk silty clay loam	0–6	1.6	2.3	3.7	5.6	13.5	32.0	41.3	13.2
36	do	0–6	1.1	2.1	3.2	4.3	9.5	41.2	38.6	10.7
37	Muskingum silt loam	0–6	22.0	14.5	11.3	7.1	9.3	16.7	19.1	54.9
101	Clinton silt loam	0–7	.5	2.2	3.1	4.3	9.4	25.5	55.1	10.1
102	do	0–9	1.7	2.7	3.2	4.4	10.4	24.9	52.7	12.0
103	Dubuque silt loam	0–6	2.5	4.8	11.4	11.8	17.0	6.8	45.7	30.5
104	Tama silt loam	0–9	1.9	3.2	7.8	8.7	15.9	19.7	42.8	21.6
105	Carrington silt loam	0–10	9.9	10.4	14.1	12.9	17.7	13.0	22.0	47.3
106	Fayette silt loam	0–6	2.0	2.5	3.2	5.2	14.6	24.8	47.7	12.9
107	Boone silt loam	0–8	2.4	3.3	7.9	10.8	13.2	22.4	40.0	24.4
108	Colby silt loam	0–7	6.5	8.2	11.6	9.2	13.6	13.0	37.9	35.5
109	Muskingum silt loam	0–8	12.8	13.1	16.2	9.8	10.1	13.7	24.3	51.9
110	do	0–5	4.7	4.9	7.0	7.1	12.3	28.5	35.8	23.7
111	do	0–7	12.7	13.4	14.6	11.1	11.5	19.1	17.6	51.8
114	do	0–4	16.9	15.1	17.5	10.0	13.5	9.2	17.8	59.5
115	Miami silty clay loam	0–5	3.5	5.6	6.3	6.2	14.1	27.4	36.9	21.6
140	Aiken clay loam	0–7	21.6	14.4	12.5	7.5	7.8	11.9	24.3	56.0
142	Athena silt loam	0–5	2.6	3.8	4.2	4.3	10.2	25.1	49.8	14.9
143	Walla Walla silt loam	0–7	.9	1.7	2.2	6.1	4.1	36.2	48.8	10.9
144	Palouse silt loam	0–7	.8	2.7	5.3	7.1	8.4	37.5	38.2	15.9
145	Palouse silty clay loam	0–9	.7	2.7	5.1	5.6	10.0	29.4	46.5	14.1
146	Palouse silt loam	0–8	.5	2.0	3.6	5.2	9.4	28.1	51.2	11.3
27	Cecil clay loam	0–4	12.3	15.6	17.1	9.2	13.0	9.5	23.3	54.2
28	do	0–5	6.6	11.2	15.3	11.2	17.9	10.8	18.8	44.3
30	Davidson clay loam	0–7	2.0	6.3	17.9	14.2	24.4	16.1	19.1	40.4
112	Westmoreland clayey silt loam	0–4	5.0	9.3	12.5	9.7	11.6	24.1	27.8	36.5
113	Upshur clay loam	0–5	7.3	12.4	20.5	12.0	13.3	15.5	18.7	52.5
118	Austin clay	0–7	14.3	20.9	17.0	9.5	13.7	11.2	13.4	61.7
119	do	0–6	15.1	21.9	17.0	9.2	13.7	9.8	13.3	63.2
120	Houston black clay	0–12	1.6	18.1	22.4	13.0	16.1	12.2	16.6	55.1
121	Houston clay	0–7	1.9	15.6	22.8	14.3	17.6	16.7	16.1	55.6
122	Houston black clay	0–7	6.5	22.2	24.8	21.1	14.3	1.7	9.4	74.6
123	Austin clay	0–7	16.4	20.6	11.6	6.7	11.2	18.0	15.5	55.3
124	Houston clay	0–7	3.4	15.5	10.3	10.9	15.6	12.4	22.0	40.1
125	Kirkland sandy clay	0–5	4.8	5.5	4.9	5.7	20.8	37.6	11.7	20.9
131	Crown light clay	0–7	1.3	1.4	4.3	8.4	20.2	41.7	22.7	15.4
132	Crown heavy clay	0–7	.8	4.3	12.6	15.1	24.2	14.2	28.8	32.8
133	Buell clay loam	0–9	2.5	4.6	4.7	6.7	13.5	42.0	26.0	18.5
134	Pinedale clay loam	0–7	4.7	2.6	1.9	6.8	23.2	48.0	12.8	16.0
31	Cecil sandy loam	0–5	2.7	14.4	27.1	11.2	17.9	10.1	16.6	55.4
32	Ruston sandy loam	0–7	.4	2.5	23.2	21.8	22.7	21.1	8.3	47.9
33	Orangeburg sandy loam	0–7	.4	6.1	28.1	11.1	23.6	23.9	6.8	45.7
116	Vernon fine sandy loam	0–8	1.0	.8	1.0	4.1	36.8	38.0	18.3	6.9
117	do	0–13	2.7	6.6	8.2	9.0	31.1	27.2	15.2	26.5
126	Kirkland fine sandy loam	0–10	6.4	6.6	7.0	4.9	27.9	33.2	14.0	24.9
127	Bates very fine sandy loam	0–6	4.0	7.1	7.0	6.0	12.7	36.0	27.2	24.1
128	Parsons fine sandy loam	0–12	4.6	8.4	6.9	4.8	7.3	30.6	37.4	24.7
129	Vernon fine sandy loam	0–8	1.7	1.1	1.1	4.1	35.5	40.2	16.3	8.0
130	Vernon very fine sandy loam	0–9	4.8	10.3	11.4	8.8	11.8	23.8	29.1	35.3
135	Hopi sandy loam	0–3	2.3	2.0	2.0	6.0	28.2	39.4	20.1	12.3
136	Crown sandy clay loam	0–8	4.6	2.6	1.8	6.7	22.8	48.9	12.6	15.7
137	Crown sandy loam	0–7	2.3	2.1	1.9	6.1	28.4	38.0	20.3	12.4
15	Honeoye gravelly silt loam	0–6	13.1	15.6	20.7	11.3	16.6	10.7	12.0	60.7
16	do	0–6	22.1	19.8	17.0	8.9	12.3	12.3	7.6	67.8
17	do	0–7	23.9	15.9	17.0	10.6	13.1	4.9	14.6	67.4
18	do	0–7	19.8	19.3	18.8	9.0	13.6	2.8	16.7	66.9
20	Bath gravelly silt loam	0–8	14.2	9.4	14.0	11.6	15.7	13.8	21.3	49.2
21	Fremont gravelly silt loam	0–7	19.6	10.4	10.5	9.4	12.8	14.9	22.4	49.9
22	Honeoye gravelly silt loam	0–7	7.7	8.9	12.6	9.6	20.3	15.3	25.6	38.8
23	do	0–7	6.9	11.4	14.5	11.4	20.4	12.7	22.7	44.2
24	do	0–7	20.0	25.9	20.5	8.9	11.8	5.1	7.8	75.3
25	Volusia stony silt loam	0–4	23.6	16.4	17.2	11.3	13.6	8.5	9.4	68.5
35	Honeoye gravelly silt loam	0–6	28.3	13.3	14.7	10.6	11.3	10.2	11.6	66.9
26	Iredell loam	0–6	3.0	9.3	13.2	10.8	20.9	23.7	19.1	36.3
34	Red Bay loam	0–5	7.2	7.8	17.2	18.7	24.1	18.4	6.6	50.9
138	Selah loam	0–12	1.1	2.1	5.5	10.1	12.1	35.7	33.4	18.8
139	Badger loam	0–6	2.3	2.5	3.9	9.3	13.1	30.5	38.4	18.0
141	Melbourne loam	0–6	1.5	3.6	5.3	5.7	19.8	28.9	35.2	16.1

TABLE 16.—*Aggregate distribution of subsoil from the 68 infiltration sites*

Soil No.	Soil type	Depth	>2.0 mm.	2.0–1.0 mm.	1.0–0.50 mm.	0.5–0.25 mm.	0.25–0.10 mm.	0.10–0.05 mm.	<0.05 mm.	>0.25 mm.
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
19	Dunkirk silty clay loam	6–15	1.8	2.6	5.5	7.7	14.6	21.2	46.0	17.6
36	do	6–15	2.2	4.5	7.8	8.3	8.1	33.1	36.0	22.8
37	Muskingum silt loam	6–15	18.7	5.4	5.6	4.8	10.8	22.2	32.5	34.5
101	Clinton silt loam	7–14	------	2.7	12.9	14.1	23.3	9.3	37.7	29.7
102	do	9–15	------	.9	3.9	7.7	22.6	26.8	38.1	12.5
103	Dubuque silt loam	6–13	2.2	4.1	11.0	13.6	17.8	26.0	25.3	30.9
104	Tama silt loam	9–21	.5	6.4	21.2	16.0	23.9	11.0	21.0	44.1
105	Carrington silt loam	10–21	.6	8.0	23.5	19.8	23.2	11.8	13.1	51.9
106	Fayette silt loam	6–15	.5	4.6	12.6	12.4	20.5	7.5	41.9	30.1
107	Boone silt loam	8–15	------	1.9	13.5	14.0	4.0	22.3	43.7	30.0
108	Colby silt loam	7–14	.9	1.9	7.7	10.8	19.1	15.5	44.1	21.3
109	Muskingum silt loam	8–15	.9	4.8	14.9	16.0	25.1	25.3	13.0	36.6
110	do	5–14	12.9	4.8	7.2	7.8	15.8	26.8	21.7	32.7
111	do	7–14	.6	3.5	10.2	12.4	23.6	24.8	24.9	26.7
114	do	7–15	7.2	7.7	16.5	13.3	22.4	15.5	17.4	44.7
115	Miami silty clay loam	7–14	16.3	19.3	15.4	7.8	12.8	14.0	14.4	58.8
140	Aiken clay loam	7–15	3.3	25.5	25.4	14.6	8.7	12.0	10.5	68.8
142	Athena silt loam	5–14	7.8	9.0	9.5	7.6	11.6	19.9	33.7	34.8
143	Walla Walla silt loam	7–15	12.3	7.1	5.7	5.2	7.7	27.0	35.0	30.3
144	Palouse silt loam	7–20	11.1	18.3	18.7	8.4	10.3	15.1	18.1	56.5
145	Palouse silty clay loam	9–15	9.7	20.3	19.3	8.2	9.6	14.6	18.3	57.5
146	Palouse silt loam	8–21	1.5	13.3	15.3	9.8	11.2	28.8	20.1	39.9
27	Cecil clay loam	4–15	8.0	12.4	17.5	11.0	4.6	29.0	17.5	48.9
28	do	5–15	2.1	10.1	20.9	13.8	11.7	28.7	12.7	46.9
30	Davidson clay loam	7–16	10.1	17.0	23.5	12.1	16.6	13.1	7.6	62.7
112	Westmoreland clayey silt loam	4–14	7.9	17.7	22.0	10.1	13.9	18.1	10.3	57.7
113	Upshur clay loam	5–15	1.8	18.4	30.1	13.1	12.0	12.6	12.0	63.4
118	Austin clay	7–16	27.3	38.4	18.6	4.1	5.3	3.7	2.6	88.4
119	do	6–16	21.5	40.8	18.5	5.8	5.8	2.8	4.8	86.6
120	Houston black clay	12–21	2.3	31.1	33.2	9.8	9.7	3.0	10.0	76.4
121	Houston clay	7–16	4.4	31.6	31.2	10.1	10.1	6.3	6.3	77.3
122	Houston black clay	7–16	11.2	38.7	27.6	6.5	6.9	3.5	5.6	84.0
123	Austin clay	7–16	33.0	33.0	15.9	5.0	6.0	.6	6.5	86.9
124	Houston clay	7–16	3.3	28.4	30.0	9.6	10.3	11.5	6.9	71.3
125	Kirkland sandy clay	5–16	34.3	24.3	13.6	4.6	11.8	5.2	6.2	76.8
131	Crown light clay	7–16	2.2	3.3	7.2	10.2	22.8	29.7	24.6	22.9
132	Crown heavy clay	7–15	.6	6.9	20.9	19.0	21.9	15.1	15.6	47.4
133	Buell clay loam	9–22	2.7	7.3	8.9	9.9	14.6	35.0	21.6	28.8
134	Pinedale clay loam	7–15	5.9	8.3	10.0	9.9	25.1	25.6	15.2	34.1
31	Cecil sandy loam	5–13	1.7	11.6	24.1	13.3	20.9	20.7	7.7	50.7
32	Ruston sandy loam	7–10	1.1	7.2	26.9	19.7	22.6	14.5	8.0	54.9
33	Orangeburg sandy loam	7–12	6.4	6.5	25.6	10.2	21.6	19.9	9.8	48.7
116	Vernon fine sandy loam	8–16	2.1	4.0	6.9	9.6	41.4	24.6	10.5	23.5
117	do	13–20	2.4	6.1	7.5	7.8	33.7	32.9	9.6	23.8
126	Kirkland fine sandy loam	10–16	9.3	13.3	14.4	7.9	25.8	18.5	10.8	44.9
127	Bates very fine sandy loam	6–15	24.5	27.4	15.6	5.3	8.6	11.0	7.6	72.8
128	Parsons fine sandy loam	12–22	12.1	16.3	10.9	5.8	7.2	13.2	34.5	45.1
129	Vernon fine sandy loam	8–21	2.0	1.8	7.1	6.1	32.9	34.8	15.3	17.0
130	Vernon very fine sandy loam	9–16	31.9	20.7	13.4	5.8	7.9	8.4	11.9	71.8
135	Hopi sandy loam	3–15	5.5	5.7	5.8	12.7	36.2	21.2	9.9	29.7
136	Crown sandy clay loam	8–16	6.6	8.1	8.5	12.4	27.4	25.4	11.6	35.6
137	Crown sandy loam	7–16	2.0	2.5	3.0	5.8	25.8	37.4	23.5	13.3
15	Honeoye gravelly silt loam	6–15	15.7	21.3	21.2	10.8	12.4	9.1	9.5	69.0
16	do	6–14	20.4	22.1	19.2	9.6	11.6	6.8	10.3	71.3
17	do	7–18	26.6	19.8	17.2	8.1	12.8	6.6	8.9	71.7
18	do	7–15	9.2	9.0	9.8	6.6	13.9	16.5	35.0	34.6
20	Bath gravelly silt loam	8–16	15.7	10.6	12.3	8.4	11.4	16.5	25.1	47.0
21	Fremont gravelly silt loam	7–11	19.6	10.8	10.5	6.2	9.7	14.4	26.8	47.1
22	Honeoye gravelly silt loam	7–14	7.6	11.7	18.0	12.0	21.8	3.9	25.0	49.3
23	do	7–14	6.9	10.8	20.2	14.1	23.6	10.9	13.5	52.0
24	do	7–14	15.4	19.0	22.9	12.3	16.9	5.4	8.1	69.6
25	Volusia stony silt loam	4–13	12.6	9.1	15.1	11.3	17.5	15.4	10.0	48.1
35	Honeoye gravelly silt loam	6–14	21.3	18.3	15.7	7.7	8.7	4.3	26.0	61.0
26	Iredell loam	6–16	7.4	21.9	13.1	10.9	14.4	23.9	8.4	53.3
34	Red Bay loam	5–15	1.6	10.5	33.9	21.2	21.8	7.2	3.8	67.2
138	Selah loam	12–21	3.3	6.2	11.4	13.5	14.0	23.2	28.4	34.4
139	Badger loam	6–16	6.2	6.0	5.9	7.6	9.8	25.8	38.7	25.7
141	Melbourne loam	6–21	1.7	6.4	13.3	12.0	23.9	21.4	21.3	33.4

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