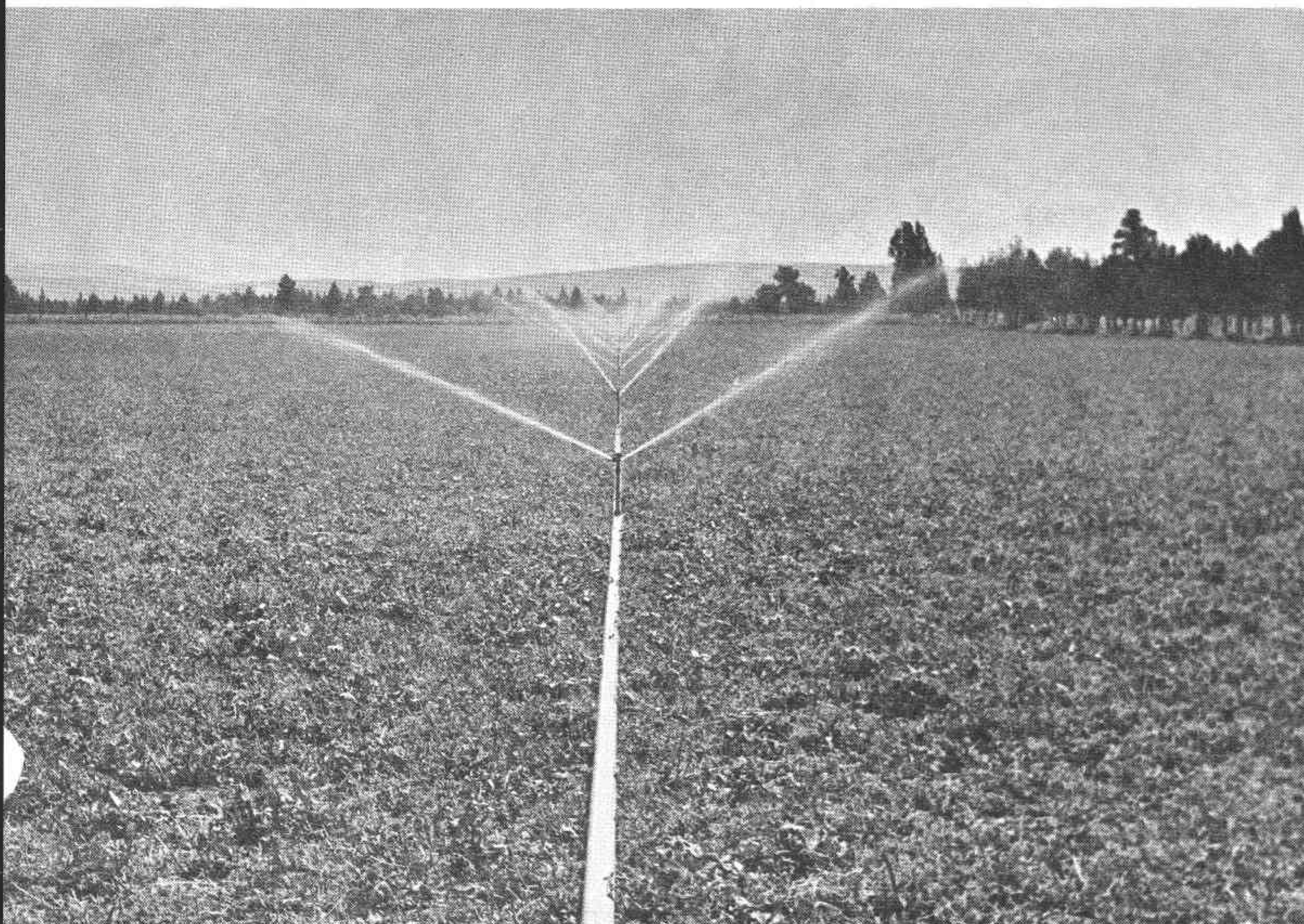
Intake Rates and Storage Capacities of Irrigable Soils in Central and Northeastern Oregon



Special Report 324 May 1971
Agricultural Experiment Station • Oregon State University • Corvallis

CONTENTS

AUTHORS: G. H. Simonson is Associate Professor of Soils and M. N. Shearer is Extension Irrigation Specialist, Oregon State University.

Special Report No. 324, Oregon Agricultural Experiment Station, Corvallis, Oregon. This study was supported by funds from Project 950, Irrigation and Drainage.

ACKNOWLEDGMENTS: This study was planned and conducted cooperatively by the Oregon Agricultural Experiment Station; the Soil Conservation Service, USDA; and the Cooperative Extension Service.

Intake tests were made by Charles R. Dehlinger of the Department of Soils, Oregon State University, with testing equipment provided by the Agricultural Engineering Department. Other persons, in addition to the authors, who participated in planning or field site selection and sampling were John W. Wolfe, James A. Vomocil, and Larry Boersma from Oregon State University and Roy L. Fox, Hyrum J. Woodward, Elwin A. Ross, George L. Green, Dal F. Ames, Terry A. Dallin, Arlo L. Vandenbos, M. Grant Lindsay, Eugene L. Dyksterhuis, and Richard E. Hosler of the Soil Conservation Service.

INTAKE RATES AND STORAGE CAPACITIES OF IRRIGABLE SOILS IN CENTRAL AND NORTHEASTERN OREGON

G. H. Simonson and M. N. Shearer

ABSTRACT

Water intake rates under simulated sprinkler irrigation and available water storage capacities were characterized for 55 important soil types in central and northeastern Oregon. Distribution of the soils is shown by counties and within broad soil associations. Soil profile characteristics, topographic position, and parent material are indicated. Intake rates of irrigated sites averaged 40% slower than dryland sites of the same series. Best estimates are given for anticipated intake rates under irrigated conditions.

INTRODUCTION

Acreage under sprinkler irrigation is increasing rapidly in Oregon, particularly in north central and northeastern Columbia Basin areas where new projects are being developed. Large mechanical-move equipment having relatively high application rates is being used with varying success.

Reliable information on water intake rates and water storage capacity of soils is critically needed for planning, designing, and managing irrigation projects. Such information can have a dominant influence on the choice of new equipment and the economics of irrigation operations. This study reports the results of field and laboratory tests for central and northeastern Oregon as a start in providing this information for soils throughout Oregon.

Objectives of the Study

The primary objective of this study was to characterize water intake rates under sprinkler irrigation for major soil series having potential for irrigation in central and northeastern Oregon.

Other objectives were: (1) to determine the average available water capacity of the major soils, and (2) to evaluate effects of differences in surface condition, texture, and plant cover on infiltration rates.

Description of the Area

The study area encompassed all portions of thirteen Oregon counties including Umatilla, Morrow, Gilliam, Sherman, and Wasco in the Columbia Basin; Jefferson, Deschutes, Crook, and the Fort Rock area of Lake County in central Oregon; the John Day Valley in Wheeler and Grant counties; and valleylands of Union and Wallowa counties in northeastern Oregon.

Wide variations in elevation, climate, soils, and crops occur within the region. Much of the Columbia Basin is presently in dryland wheat production, although sprinkler irrigation development is increasing and large areas below 2,000 feet in elevation have good irrigation potential. Rapid development of sprinkler irrigation is expected on the arid sandy soils near the Columbia River in northern Morrow and Umatilla counties.

Irrigated cropland areas in central Oregon are arid to semiarid and have short frost-free seasons. Surface irrigation predominates at present but there is a trend to sprinkler irrigation, particularly on newer developments. Some conversion to sprinkler irrigation also is taking place in the irrigated semiarid valley lands along the John Day River and in Wallowa County. Large-scale development of sprinkler irrigation is anticipated on presently dry-farmed cropland in the Grande Ronde Valley upon completion of planned water storage projects.

Soil Characteristics and Distribution

The soil series included in this study are either irrigated or have major potential for irrigation. They include most of the major bottomland and terrace soils, and tillable upland soils with gentle topography.

Figure 1 shows general distribution of the soils in broad soil associations named for the most extensive soils. These associations name some extensive series which are not included in this study primarily because they are not suited for irrigation. Conversely, some of the soils studied are not included in the association names but are keyed to areas where they occur (Table 1).

The soils studied are mostly well-drained and medium to coarse in texture with relatively good permeability. Many are deep soils but some have limited depth to hardpan or bedrock. Most of the soils have formed under limited precipitation and are relatively unleached and near neutral or basic in reaction. The organic matter content of soil is largely a reflection of the natural precipitation, and the more arid soils are low in organic matter.

Major characteristics of the soil series, the nature of the parent material from which they are formed, their position in the landscape, and counties in which they occur are given in Table 1. This table groups the soils by the map areas shown in Figure 1.

Soil descriptive terms used in Table 1 are defined as follows: deep soils have profiles more than 40 inches to bedrock, hardpan, or clean gravel; moderately deep soils have 20- to 40-inch profiles; and shallow soils are less than 20 inches deep. The soil type given as part of the soil name indicates texture (particle size distribution) of the plow layer or A1 horizon. Terms in the description such as coarse-silty or sandy indicate the general texture of the major portion of the subsoil, or the B horizon. Soils considered to be low in organic matter have less than 1% in the surface horizon, and this horizon is generally thin. Soils considered high in organic matter have more than 5% in the surface horizon and this horizon is thicker.

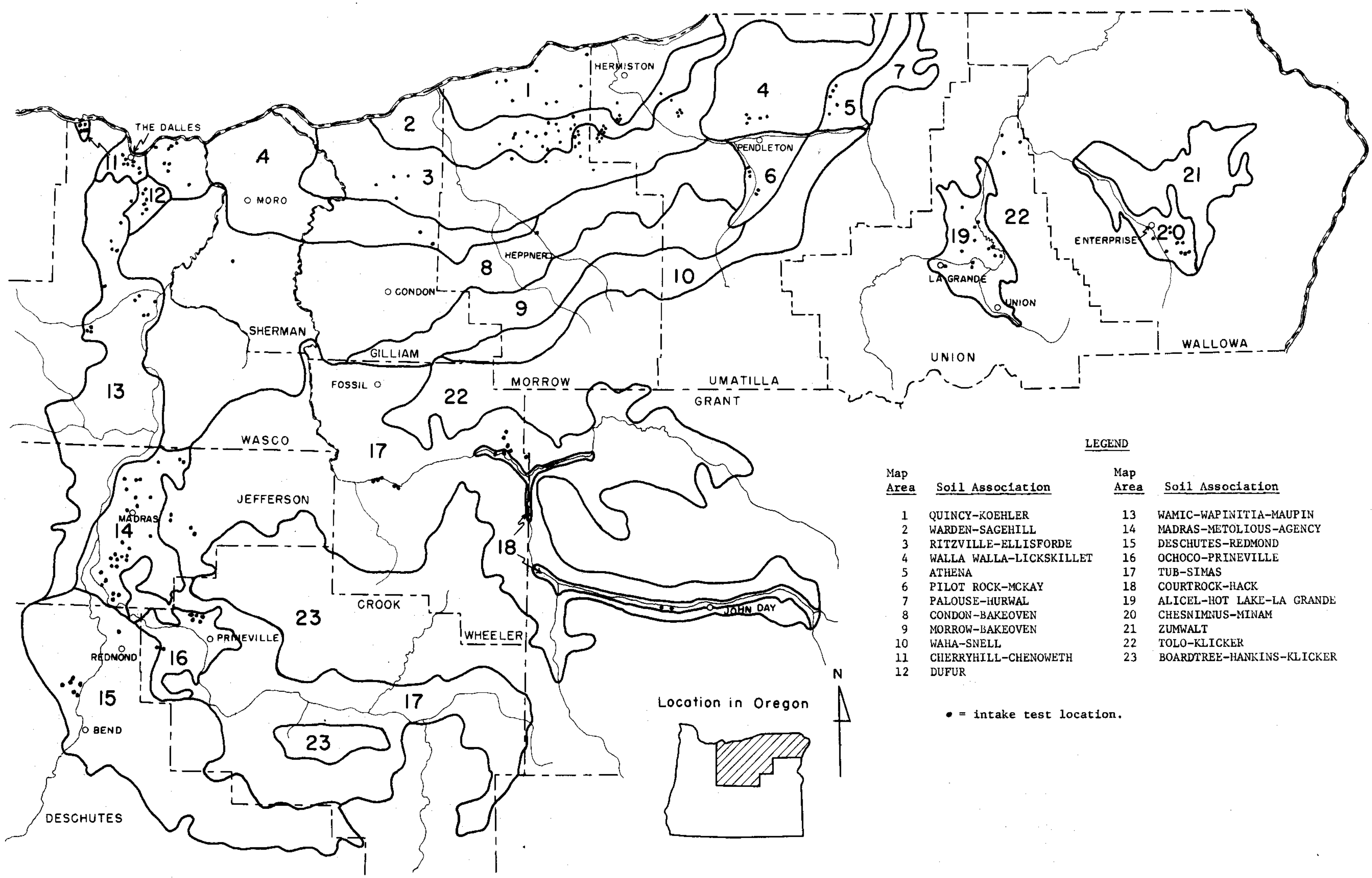


Figure 1. Soil associations in the study area and intake test locations.

Table 1. Characteristics, distribution, intake rates, and available water storage capacities of the soil series

Distribution: Counties	Map areas	Soil type and description	Parent material	Topographic position	Intake rate: Low	Intake rate: High	Intake rate: Best estimate[a/]	Avg. sample depth	Avg. bulk density	Avg. available water storage capacity[b/]	
					inches per hour			inches	gms/cc	in./in.	in./ft.
Morrow, Umatilla, Sherman, Gilliam	1	Quincy loamy fine sand Deep, sandy, low in organic matter	Wind-blown sands	Broad terraces	1.00	2.50	0.80	0-12 12-24 24-36+	1.53 1.52 1.53	0.09 0.09 0.05	1.1[b/] 1.1 0.6
Morrow, Umatilla	1	Quincy fine sand Deep, sandy, low in organic matter	Wind-blown sands	Broad terraces	0.80	1.00	0.80	0-12 12-24 24-36+	1.63 1.64 1.53	0.08 0.06 0.05	0.9[b/] 0.8 0.6
Morrow, Umatilla	1	Koehler loamy fine sand Moderately deep over hardpan, sandy, low in organic matter	Wind-blown sands	Broad terraces	2.00	3.00	0.80	0-12 12-24	1.51 1.41	0.12 0.12	1.4[b/] 1.4
Morrow, Umatilla	2	Sagehill fine sandy loam Moderately deep over sediments, coarse-loamy, low in organic matter	Wind-reworked lake sediments	Dissected lake terraces	0.70	1.80	0.80	0-12 12-23 23-36+	1.33 1.34 1.37	0.11 0.17 0.20	1.3 2.0 2.4
Morrow, Umatilla	2	Warden very fine sandy loam Deep, coarse-silty, low in organic matter	Loess over lake sediments	Dissected lake terraces	1.00	1.30	0.65	0-10 10-20 20-36+	1.28 1.38 1.42	0.12 0.12 0.19	1.4 1.5 2.3
Morrow, Umatilla	2	Warden silt loam Deep, coarse-silty, low in organic matter	Loess over lake sediments	Dissected lake terraces	0.13	0.75	0.25	0-12 12-24 24-36+	1.31 1.27 1.31	0.21 0.23 0.21	2.5 2.7 2.5[c/]
Umatilla	3	Ellisforde silt loam Moderately deep, coarse-silty, mod. low in organic matter	Loess over lake sediments	Dissected lake terraces	0.10	1.20	0.25	0-6 8-23 23-36	1.34 1.24 1.30	0.19 0.19 0.21	2.3 2.2 2.5[c/]
Morrow	3	Ritzville very fine sandy loam Deep, coarse-silty, mod. low in organic matter	Loess	Plateau uplands	0.35	0.40	0.30	0-9 9-25 25-38+	1.34 1.29 1.32	0.18 0.17 0.18	2.1 2.1 2.1[c/]
Morrow, Umatilla, Sherman, Gilliam	3	Ritzville silt loam Deep, coarse-silty, mod. low in organic matter	Loess	Plateau uplands	0.20	0.50	0.25	0-12 12-24 24-36+	1.35 1.45 1.53	0.17 0.22 0.22	2.1 2.6 2.6[c/]
Wasco, Sherman, Gilliam, Morrow, Umatilla	4	Walla Walla silt loam Deep, coarse-silty, medium in organic matter	Loess	Plateau uplands	0.16	0.60	0.30	0-12 12-24 24-36+	1.27 1.29 1.42	0.17 0.19 0.22	2.0 2.2 2.6

Table 1. Continued.

Distribution: Counties	Map areas	Soil type and description	Parent material	Topographic position	Intake rate: Low	Intake rate: High	Intake rate: Best estimate[a]	Avg. sample depth	Avg. bulk density	Avg. available water storage capacity[b]	
					inches per hour			inches	gms/cc	in./in.	in./ft.
Sherman, Umatilla	4	Walla Walla silt loam (coarse solum) Deep, coarse-silty, mod. low in organic matter	Loess	Plateau uplands	--	--	0.30	0-8 8-24 24-36+	1.21 1.31 1.31	0.14 0.13 0.13	1.7 1.6 1.6
Umatilla	5	Athena silt loam Deep, fine-silty, mod. high in organic matter	Loess	Plateau uplands	0.20	0.60	0.20	0-8 8-23 23-36+	1.15 1.17 1.09	0.17 0.16 0.15	2.0 1.9 1.8
Umatilla	6	Pilot Rock silt loam Moderately deep, coarse-silty, medium in organic matter	Loess over cemented gravel	Outwash terrace	0.40	0.80	0.40	0-7 7-27	1.16 1.10	0.17 0.17	2.1 2.0
Umatilla, Morrow, Gilliam	3,4,5	Onyx silt loam Deep, coarse-silty, mod. high in organic matter	Recent alluvium	Bottomlands	0.45	1.20	0.25	0-7 7-31 31-36+	1.18 1.13 1.04	0.21 0.21 0.21	2.6[c] 2.6 2.6
Umatilla	2,3,4	Pedigo silt loam Deep, coarse-silty, poorly drained, high in organic matter, calcareous	Recent alluvium	Bottomlands	See Appendix Table 2		0.15	0-12 12-28 28-40+	1.22 1.27 1.22	0.21 0.21 0.18	2.6[c] 2.6 2.2
Gilliam, Morrow, Sherman, Wasco, Umatilla	8	Condon silt loam Moderately deep, fine-silty, medium in organic matter	Loess	Plateau uplands	See Appendix Table 2		0.15	0-7 7-18 18-31	1.21 1.29 1.32	0.21 0.22 0.23	2.5 2.6 2.8
Wasco, Hood River	11	Wind River loamy fine sand Deep, coarse-loamy, medium in organic matter	Water deposits	Dissected lake terraces	0.33	3.00	0.25	0-39 39-85	-- --	0.13 0.08	1.6[c] 1.0
Wasco, Hood River	11	Van Horn fine sandy loam Deep, fine-loamy, medium in organic matter	Water deposits	Dissected lake terraces	0.35	0.40	0.30	0-21 21-42 42-53+	1.39 1.43 1.27	0.15 0.19 0.12	1.8 2.3 1.4
Wasco	11	Chenoweth very fine sandy loam Deep, coarse-loamy, mod. high in organic matter	Water deposits	Dissected lake terraces	See Appendix Table 2		0.20	0-12 12-25 25-41 41-60+	1.55 1.47 1.48 1.41	0.15 0.14 0.13 0.11	1.8 1.7 1.6 1.3
Wasco	11	Cherryhill loam Deep, fine-loamy, mod. high in organic matter	Water deposits	Dissected lake terraces	See Appendix Table 2		0.20	0-10 10-18 18-28 28-40+	1.48 1.60 1.79 1.64	0.19 0.19 0.21 0.17	2.3 2.3 2.5 2.0

Table 1. Continued.

Distribution: Counties	Map areas	Soil type and description	Parent material	Topographic position	Intake rate: Low	High	Best estimate[a/]	Avg. sample depth	Avg. bulk density	Avg. available water storage capacity[b/]	
					inches per hour			inches	gms/cc	in./in.	in./ft.
Wasco	12,13	Tygh fine sandy loam Deep, coarse-loamy, somewhat poorly drained, medium in organic matter	Recent alluvium	Bottomlands	0.90	1.40	0.65	0-19 19-34 34-49+	-- -- --	0.13 0.17 0.07	1.6[c/] 2.0 0.8
Wasco	11,12,13	Endersby sandy loam Deep, coarse-loamy, medium in organic matter	Recent alluvium	Bottomlands	0.80	1.00	0.35	0-18 18-33 33-53+	1.54 1.29 1.34	0.18 0.13 0.17	2.2 1.6 2.0
Wasco, Jefferson	13	Maupin loam Deep, fine-loamy, mod. low in organic matter	Wind and water deposits	Plateau uplands	0.30	1.80	0.30	0-15 15-26+	1.25 1.35	0.20 0.20	2.4 2.4
Wasco	13	Wamic loam Moderately deep, coarse-loamy, mod. low in organic matter	Volcanic ash over buried soil	Plateau uplands	0.40	0.50	0.25	0-8 8-23 23-35 35-39	1.35 1.51 1.48 1.30	0.22 0.23 0.21 0.15	2.6[d/] 2.7 2.5 1.8
Wasco, Jefferson	13	Wapinitia silt loam Deep, fine-loamy, mod. high in organic matter	Mixed ash and loess over water deposits	Plateau uplands	0.40	0.50	0.30	0-16 16-28+	1.28 1.29	0.23 0.24	2.8 2.9
Wasco		Dufur silt loam Deep, coarse-loamy, medium in organic matter	Mixed loess and old sediments	Plateau uplands	0.50	0.65	0.30	0-12 12-32 32-42+	1.25 1.32 1.40	0.17 0.18 0.18	2.1[d/] 2.2 2.2
Jefferson, Deschutes	14	Madras sandy loam Moderately deep to hardpan, fine-loamy, low in organic matter	Old sediments	Upland plains and plateaus	0.20	0.65	0.30	0-13 13-23	1.40 1.35	0.18 0.18	2.2[b/] 2.2
Jefferson, Deschutes	14	Madras loam Moderately deep to hardpan, fine-loamy, low in organic matter	Old sediments	Upland plains and plateaus	0.10	0.73	0.25	0-13 13-23	1.30 1.30	0.18 0.20	2.2[b/] 2.4
Crook, Jefferson, Deschutes	14	Metolious sandy loam Deep, coarse-loamy, low in organic matter	Pumice alluvium	Fans and bottomlands	0.15	0.60	0.35	0-28 28-49 49-60	1.25 1.30 1.40	0.18 0.21 .22	2.2[b/] 2.5 2.6

Table 1. Continued.

Distribution		Soil type and description	Parent material	Topographic position	Intake rate			Avg. sample depth	Avg. bulk density	Avg. available water storage capacity[b/]	
Counties	Map areas				Low	High	Best estimate[a/]				
					inches per hour			inches	gms/cc	in./in.	in./ft.
Crook, Jefferson, Deschutes	14,15,16	Agency sandy loam Moderately deep, coarse-loamy, low in organic matter	Old sediments	Upland plains and plateaus	0.12	0.40	0.25	0-21 21-32	1.40 1.40	0.18 0.18	2.2[b/] 2.2
Crook, Jefferson, Deschutes	14,15,16	Agency loam Moderately deep, coarse-loamy, low in organic matter	Old sediments	Upland plains and plateaus	0.25	1.10	0.25	0-12 12-32	1.35 1.32	0.18 0.18	2.2[b/] 2.2
Crook, Jefferson, Deschutes	14	Lamonta loam Moderately deep to hardpan, fine textured, mod. low in organic matter	Old alluvium	Upland plains and old fans	0.33	0.50	0.35	0-9 9-23	1.25 1.30	0.15 0.13	1.8[c/] 1.6
Jefferson, Wasco	14,17	Willowdale loam Deep, fine-loamy, medium in organic matter	Recent alluvium	Bottomlands	0.30	0.50	0.30	0-12 12-24 24-36+	1.13 1.14 1.11	0.22 0.25 0.26	2.6 3.0 3.1
Deschutes, Crook	15	Deschutes loamy sand Moderately deep, coarse-loamy, low in organic matter	Pumice	Upland plains	1.00	1.60	0.80	0-15 15-28	-- --	0.11 0.14	1.3[c/] 1.6
Deschutes, Crook	15	Deschutes sandy loam Moderately deep, coarse-loamy, low in organic matter	Pumice	Upland plains	0.15	1.40	0.30	0-10 10-19 19-26	1.35 1.34 1.68	0.13 0.16 0.13	1.6[d/] 1.9 1.6
Crook	16	Ochoco sandy loam Moderately deep to hardpan, fine-loamy, low in organic matter	Old alluvium	Valley terraces	0.30	0.50	0.35	0-13 13-23	1.33 1.41	0.18 0.21	2.2 2.5
Crook	16	Prineville sandy loam Moderately deep to hardpan, coarse-loamy, low in organic matter	Old alluvium	Valley terraces	0.45	0.60	0.35	0-6 6-24 24-32	1.24 1.36 1.49	0.14 0.13 0.13	1.7 1.6 1.6
Lake	Fort Rock Area (not shown)	Bonnick loamy sand Deep, sandy, low in organic matter	Wind-reworked lake bed deposits	Basin terraces	0.75	1.00	0.90	0-7 7-21 21-33+	1.14 1.21 1.38	0.09 0.11 0.09	1.1 1.3 1.1

Table 1. Continued.

Distribution: Counties	Distribution: Map areas	Soil type and description	Parent material	Topographic position	Intake rate: Low	Intake rate: High	Intake rate: Best estimate[a/]	Avg. sample depth	Avg. bulk density	Avg. available water storage capacity[b/]	
					inches per hour			inches	gms/cc	in./in.	in./ft.
Lake	Fort Rock Area (not shown)	Fort Rock sandy loam Moderately deep, coarse-loamy, low in organic matter	Lake bed deposits	Basin terraces	0.40	2.00	0.80	0-11 11-21 21-30	1.25[c/] 1.35[c/] 1.30[c/]	0.09 0.15 0.16	1.1[d/] 1.8 1.9
Lake	Fort Rock Area (not shown)	Fort Rock loam Moderately deep, coarse-loamy, low in organic matter	Lake bed deposits	Basin terraces	0.45	0.90	0.50	0-5 5-21 21-30	1.20[c/] 1.35[c/] 1.30[c/]	0.15 0.15 0.16	1.8 1.8 1.9
Grant, Wheeler	18	Kimberly sandy loam Deep, coarse-loamy, moderately low in organic matter	Recent alluvium	Bottomlands	0.90 (one test)	0.90	0.30	0-6 6-42	1.50 1.35	0.10 0.07	1.2 0.8
Grant, Wheeler	18	Kimberly loam Deep, coarse-loamy, medium in organic matter	Recent alluvium	Bottomlands	0.25	0.40	0.30	0-6 6-24 24-36+	1.37 1.17 1.10	0.14 0.13 0.17	1.6 1.5 2.0
Grant, Wheeler	18	Sugarloaf silty clay loam Deep, fine-silty, somewhat poorly drained, medium in organic matter	Alluvium	Low terraces and fans	0.10	0.45	0.20	0-6 6-24 24-46	1.21 1.16 1.16	0.20 0.20 0.19	2.4[c/] 2.4 2.4
Grant, Wheeler, Crook	16,18	Powder silt loam Deep, coarse-silty, mod. low in organic matter	Recent alluvium	Bottomlands	0.25	0.46	0.35	0-7 7-24 24-46+	1.31 1.10 1.14	0.21 0.16 0.17	2.5 2.0 2.1
Grant, Wheeler, Crook	17	Tub silty clay loam Moderately deep, fine textured, high in organic matter	Sedimentary bedrock	Uplands	0.35 (one test)	0.35	0.20	0-15 15-25 25-36	1.35 1.19 1.31	0.23 0.21 0.22	2.8 2.5 2.6
Grant, Wheeler, Crook	18	Courtrock loam Deep, coarse-loamy, medium in organic matter	Alluvium	Alluvial fans	0.34	0.40	0.35	0-7 7-17 17-42	1.38 1.49 1.50	0.13 0.12 0.12	1.6 1.5 1.5
Grant	18	Hack silt loam Deep, fine-loamy, medium in organic matter	Alluvium	Low terraces and fans	0.35	0.45	0.40	0-7 7-18 18-42+	1.34 1.37 1.21	0.19 0.20 0.15	2.3 2.4 1.8

Table 1. Continued.

Distribution					Intake rate			Avg.	Avg.	Avg. available water storage capacity[b]	
Counties	Map areas	Soil type and description	Parent material	Topographic position	Low	High	Best estimate[a]	sample depth	bulk density		
					inches per hour			inches	gms/cc	in./in.	in./ft.
Union, Umatilla	19	Catherine silt loam Deep, fine-silty, somewhat poorly drained, high in organic matter	Recent alluvium	Bottomlands	0.15	0.45	0.30	0-9 9-48+	1.23 --	0.23 0.20	2.7 2.4[c]
Union	19	Alicel loam Deep, fine-loamy, high in organic matter	Older alluvium	Valley terraces	0.30	0.40	0.35	0-17 17-30 30-38+	1.40 1.30 1.50	0.14 0.14 0.17	1.7[d] 1.7 2.1
Union	19	La Grande silt loam Deep, fine-silty, somewhat poorly drained, high in organic matter	Recent alluvium	Bottomlands and fans	0.20	0.35	0.25	0-7 7-17 17-34 34-52+	1.09 1.20 1.18 1.25	0.19 0.22 0.21 0.22	2.2[d] 2.6 2.5 2.6
Union	19	Hot Lake silt loam Moderately deep, coarse-silty, somewhat poorly drained, high in organic matter	Lake bed deposits	Bottomlands and lake beds	0.20	0.30	0.25	0-14 14-20 20-35	1.02 1.07 1.00	0.25 0.23 0.30	2.9[d] 2.8 3.6
Union, Umatilla, Wallowa, Grant	22	Tolo silt loam Deep, coarse-silty, mod. low in organic matter	Volcanic ash	Uplands, mostly forested	0.40	0.45	0.40	0-7 7-18 18-30 30-48+	0.84 0.80 1.05 1.45	0.35 0.30 0.34 0.24	4.2[d] 3.6 4.1 2.9
Wallowa	20	Redmont loam Moderately deep to gravel, fine-loamy, high in organic matter	Recent alluvium	Bottomlands	0.20	0.40	0.25	0-9 9-30	1.06 --	0.16 0.16	2.0 2.0[c]
Wallowa	20	Reavis silt loam Deep, fine-silty, moderate in organic matter	Loess over glacial outwash	Outwash terraces	0.20	0.26	0.25	0-11 11-36	1.16 1.21	0.19 0.16	2.3 1.9
Wallowa	20	Chesnimnus silt loam Deep, fine-loamy, high in organic matter	Loess over glacial outwash	Outwash terraces	0.30	0.30	0.30	0-6 6-21 21-36+	1.34 1.44 1.34	0.22 0.17 0.20	2.6[d] 2.1 2.4

Table 1. Continued.

Distribution					Intake rate			Avg.	Avg.	Avg. available water storage capacity[b]	
Counties	Map areas	Soil type and description	Parent material	Topographic position	Low	High	Best estimate[a]	sample depth	bulk density		
					inches per hour			inches	gms/cc	in./in.	in./ft.
Wallowa	20,21	Zumwalt silt loam Moderately deep, fine textured, mod. well drained, high in organic matter	Mixed ash and loess over tuff	Plateau uplands	0.25	0.30	0.25	0-12 12-24	1.05 1.33	0.22 0.12	2.6 1.4[c]

Note: footnotes b, c, and d apply to the entire profile except where used with individual subhorizons.

a/ Best estimate was arrived at by reducing average dryland test values, averaging individual tests, and making some adjustments where existing experience justified. Individual test results are given in the Appendix.

b/ Values are based on moisture contents between 1/3 and 15 atm. except that field determinations of field capacity are used for Quincy, Koehler, Madras, Agency, and Metolious soils. Data for the latter three soils were reported by S. A. Currie, Central Oregon Experiment Area Annual Reports for 1951, 1952, and 1953. Data for Quincy and Koehler soils were furnished by E. Ross, SCS, Bend.

c/ Values were estimated by comparison with similar soils.

d/ One-third atmosphere moisture contents and bulk densities were from undisturbed core data of previous characterization tests by SCS and OSU laboratories.

In order to relate the data in this report to a particular tract of land, a detailed soil survey is needed to identify the soil types and their precise location in each field. Additional information about most of the soil series and small-scale maps of their general distribution are available in general soil map reports of major river basins in Oregon.[1/] Published detailed soil surveys of Sherman County, the Deschutes Area, and the Prineville Area are available. Unpublished detailed soil surveys of portions of the study area can be consulted in local offices of the Soil Conservation Service.

METHODS AND PROCEDURE

Locating Soil Sites

Soil series were included in the study because they represented extensive irrigable acreage or because they had significant differences in properties such as texture, organic matter content, mineralogy, or water storage capacity. Sites were located and the soils at each location were described by soil scientists from the Soil Conservation Service with assistance from the Experiment Station. Generally, three to five sites of each soil type were selected to test the water intake rates.

Soil sites were selected using the following criteria: (1) the site was representative of a single series and type; (2) the site had a slope gradient of less than 5%; (3) the site was accessible with testing equipment; (4) the soil surface condition was equivalent to a tilled, bare surface after at least one irrigation (if vegetation was present, it was cut and removed so that the soil surface was clearly visible; and (5) moisture content of the surface soil was near field capacity if possible.

Infiltration Testing Procedure

The procedure for determining intake rate was developed by Tovey and Pair[2/]. It utilizes a portable trailer-mounted recirculating unit with a sprinkler head mounted within a circular shield (Figure 2). The test equipment was set up so the sprinkler threw *with* the wind. The sprinkler was run for one or two revolutions to mark the "fan" pattern from the sprinkler.

1/ General Soil Map Reports With Irrigable Areas for Oregon Drainage Basins. Appendix I of Oregon's Long-Range Requirements for Water. State Water Resources Board. Volumes I-4 Hood, I-5 Deschutes, I-6 John Day, I-7 Umatilla, I-8 Grande Ronde, I-13 Goose and Summer Lake. Available from the Department of Soils, Oregon State University, Corvallis, Oregon 97331.

2/ Rhys Tovey. A Portable Irrigation Sprinkler Evaluation Device. Agricultural Engineering 44(12):672-673. December 1963.
Rhys Tovey and C. H. Pair. Measurement of Intake Rate for Sprinkler Irrigation Design. Transactions of the ASAE 9(3):359-363. 1966.

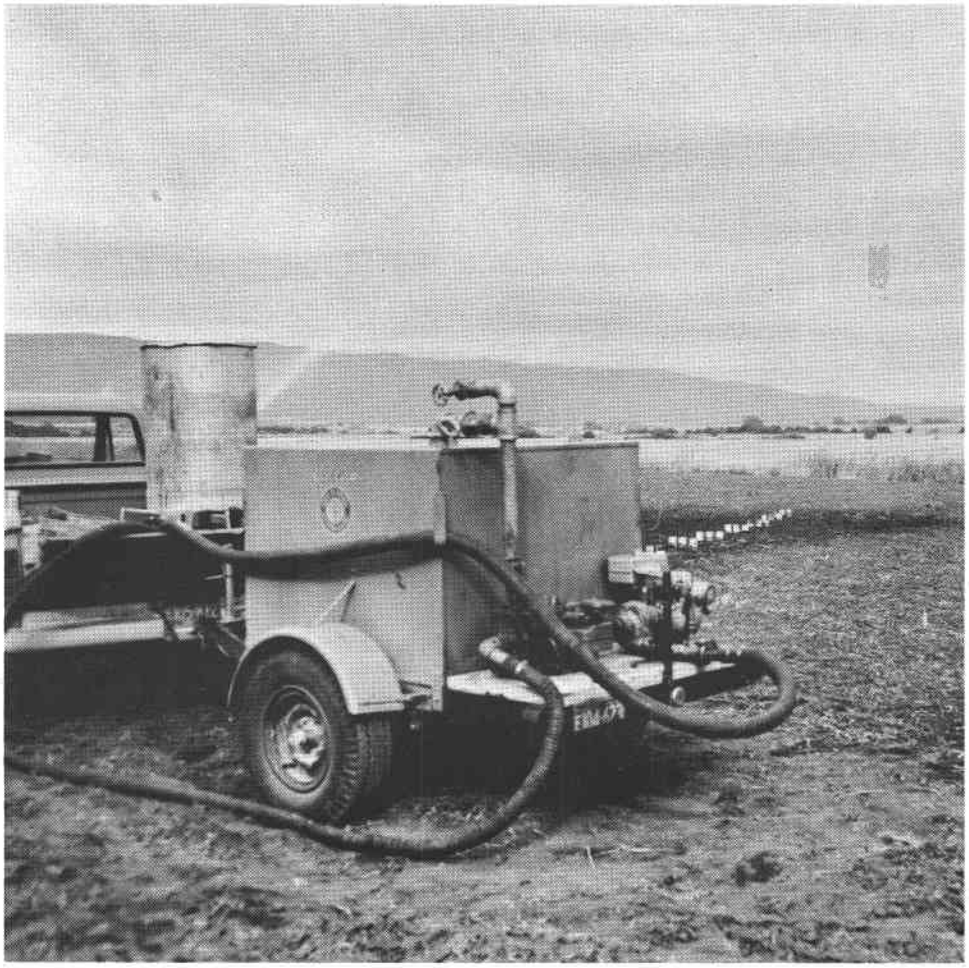


Figure 2. Portable equipment used for sprinkler irrigation water intake tests.

Cans to measure application rates were set at five-foot intervals in groups of three down the center of the fan formed by the spray pattern (Figure 3). Care was taken to avoid foot traffic in the area where the infiltration observations were made.

If the soil moisture content was less than field capacity, the soil was pre-irrigated with about 350 gallons of water to a minimum depth of 3 to 6 inches. The test was run about one hour after the conclusion of the pre-irrigation. If the "intake rate" dropped during the "test" run, the run was considered a wetting operation and another run was made for "test" purposes.

The tests usually were run for one hour with observations taken every 15 minutes. In coarse-textured soils with rapid intake rates, the limited water supply made it necessary to run the tests for shorter lengths of time and convert the can readings to the "inches per hour" rate. Observations under these conditions were made at each quarter of the total test time.

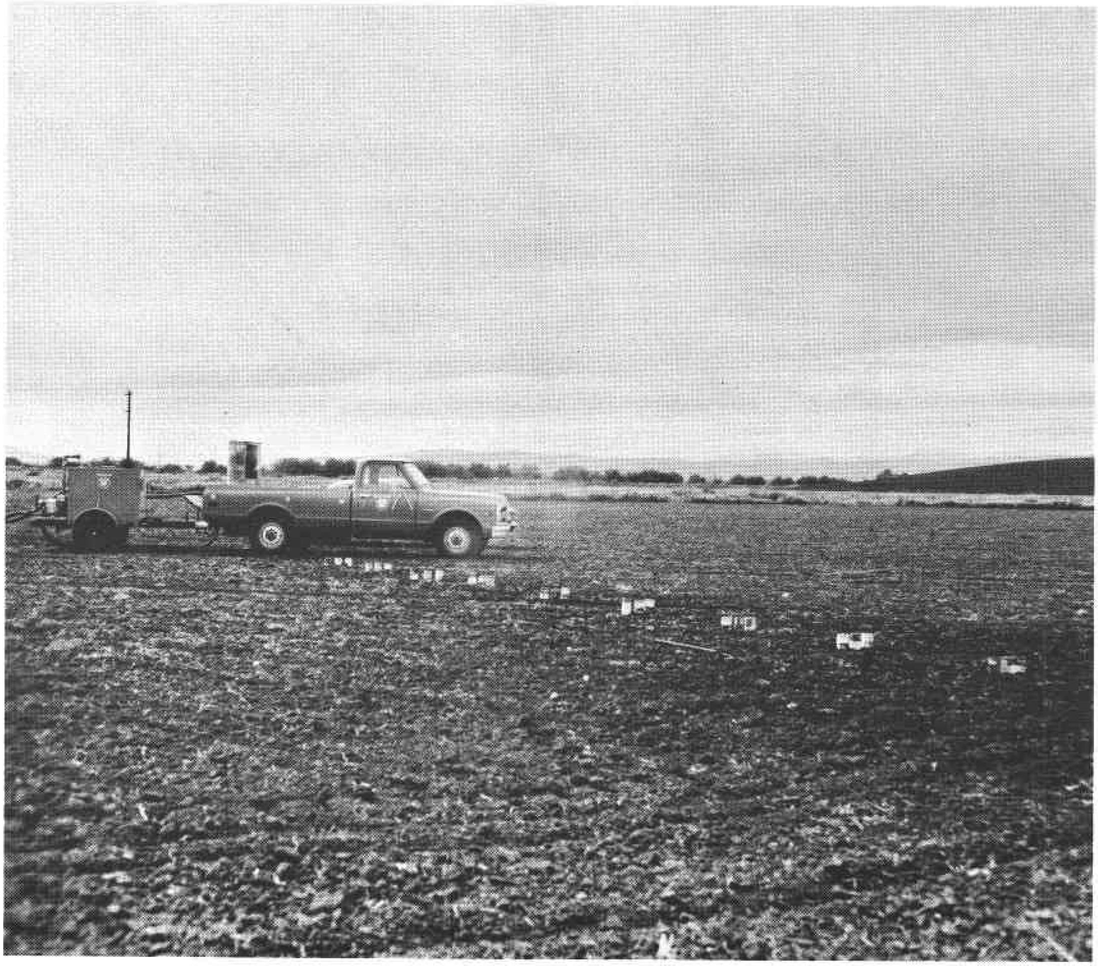


Figure 3. Water intake test equipment in operation with catchment cans arranged along the "fan" of the sprinkler.

Observations were categorized into one of three general classes:

Under		Adequate			Over
1	2	3	4	5	6

1 - Water infiltrated within 1/4 of the time required for the sprinkler spray to return to the point observed.
2 - Water infiltrated within 1/2 of the time required for the sprinkler spray to return to the point observed.
3 - Water infiltrated within 3/4 of the time required for the sprinkler spray to return to the point observed.
4 - Water infiltrated by the time the sprinkler spray returned to the point observed.
5 - Water was ponded at the surface when the sprinkler returned but no runoff had occurred.
6 - Water was ponded and runoff had occurred when the sprinkler returned.

At the conclusion of the test, the can catchments were measured and converted to application rates expressed in inches per hour. Rating number 4, adequate, was the recorded infiltration rate of the soil for each specific test. It is the maximum application rate that should be used with a sprinkler system on the type of soil tested.

Water Storage Capacity and Bulk Density Determinations

Soil samples were collected by SCS soil scientists and engineers from three sites on most of the series for determination of percent of available moisture. Generally, three profile depths were sampled representing the major soil horizons within the rooting zone. Laboratory determinations of percent moisture held at soil water suctions of 1/10 or 1/3 and 15 bar were made by the OSU Department of Soils. These measurements were made on disturbed samples. Bulk density measurements were taken at the time of sampling using an Eley volumeter and an Alpha Lux "Speedy" moisture tester. Separate measurements of the bulk density of the surface soil were taken at the time intake tests were run.

Moisture percentages were calculated on the basis of the oven-dry weight of soil and converted to volume expressed in inches per inch of soil by multiplying by the measured bulk density. Samples previously collected for moisture percent determinations at sites of water intake tests run in central Oregon by the SCS were included in the laboratory tests and data from these sites are incorporated in the study results.

RESULTS AND DISCUSSION

Water Intake Tests

The intake rate of a soil, expressed in inches per hour, is a measure of its capacity to absorb irrigation water applied to the soil surface during the period of the time in which the water is applied. The water intake rate is greatly affected by soil moisture content, texture and structure of the soil, soil cover, sprinkler drop size, farm equipment traffic, human foot traffic, soil management practices, and other factors.

The intake rate values reported in this study principally reflect the soil surface conditions and were not affected by subsurface conditions of the soil profile. The values, therefore, are *maximum* values that should be used for sprinkler system design with the understanding that good irrigation management practices will be followed. If permeability of the soil profile further limits intake rate, the amount of water applied during irrigation must be adjusted to prevent ponding.

In most tests, the application rate increased outwardly from the sprinkler head and then dropped off. This provided two locations where intake rates could be determined. In about two-thirds of the tests, the inner location indicated a higher intake rate than the outer location. This was particularly true on finer textured soils and soils with no cover. In addition, the location where the maximum intake rate was observed was not always the same distance from the sprinkler head.

Since droplet size often affects soil intake values and droplet size and distance from the sprinkler are related, it appeared desirable to adjust determinations for a common distance from the sprinkler. An arbitrary distance of 35 to 40 feet was chosen. The "close in" and "far out" measured determinations were therefore decreased or increased somewhat proportionately to their location for standardization purposes. This adjustment usually amounted to 0.1 to 0.2 inches per hour.

Ranges of test values for each soil type are shown in Table 1 with a "best estimate" indicated for design purposes. Results of individual tests are shown in Appendix Table 1. *Common sense and judgment must be exercised by the sprinkler system designer in using these figures.* The type of crop grown, the soil surface treatment, the amount of water applied during each irrigation, and the type of system to be used should be considered in selecting design values for specific locations. For example, considerable bare soil is exposed during much of the growing season for mint and potatoes. As a result, values selected for specific soils where these crops are grown should be lower than for full cover crops such as alfalfa.

Where only tests from nonirrigated sites were available, or if unusual circumstances in the irrigated site rendered the results questionable, the "best values" were estimated by averaging, then reducing dryland test values 40%. The relationships between irrigated and dryland intake rates for major soil textures in the tests conducted are shown in Table 2. These relationships were the basis for the 40% reduction.

Table 2. Comparison of intake rates of dryland and irrigated test sites by soil type

Soil texture class	Number of tests	Intake rate of irrigated soil as a percent of "dryland" intake rate
Sandy loam	39	71 percent
Fine sandy loam	9	52 percent
Loam	35	61 percent
Silt loam	44	58 percent
		Average = 60.5 percent

The results of intake tests made by the SCS on operating irrigation systems are given in Appendix Table 2. These intake rates reflect somewhat different testing conditions than the rates determined in this study and generally show lower rates for comparable soils (see footnote to the table). These additional results were considered in arriving at the "best estimate" for some of the soils given in Table 1.

Available Water Capacity

Amount and frequency of irrigation water applications needed for a particular crop are affected by the water storage capacity of the soils. Knowledge of the soil's capacity to hold water is essential for planning an irrigation program and selecting an irrigation system design.

The available water capacity of a soil is the amount of water that can be stored in the soil profile and extracted by roots of growing plants. It is the amount of water held in the soil between the field capacity and the permanent wilting point. Not all this water is equally available to plants. Experience has indicated that only 30 to 50% of the available water is extracted easily enough by plants to be considered readily available.

Field capacity of a soil is the amount, expressed as a percentage by weight of water left in the profile one to three days after saturation when free drainage has ceased. The amount of water held at field capacity is determined by field measurements. However, field measurements are not generally available. The moisture content of samples corresponding to a suction of 1/3 atm. after being saturated was used to approximate field capacity. The permanent wilting percentage was approximated by the amount of water corresponding to a suction of 15 atm.

The available water capacities reported in Table 1 are calculated from averages of percent of moisture held by disturbed samples between 1/3 and 15 atm. except as noted. Actual field measurements of water held 24 to 48 hours after saturation were used in calculating the available water storage capacity of Agency, Madras, Metolious, Koehler, and Quincy soils. Values thus determined for Quincy fine sand are 100% higher than those measured between 1/3 and 15 atm. and are almost equal to moisture held between 1/10 and 15 atm. Available water capacities shown for Quincy loamy fine sand are 50% above the 1/3 to 15 atm. moisture contents but are little more than half of the values measured between 1/10 and 15 atm.

Available water capacities of some series in Table 1 are based on data from previous characterization studies of the series as indicated by the footnote. These studies utilized undisturbed clod or core samples for determinations of 1/3 atm. moisture retention and bulk density. Undisturbed samples are often used because they better represent the *in situ* field conditions. However, comparison of available data determined by the two methods for the same series indicates that for most soils, the 1/3 atm. moisture contents of disturbed and undisturbed samples are quite similar.

The water storage capacity of soils is strongly related to the texture (particle-size distribution) of the different soil horizons and to the total soil depth. Other characteristics such as organic matter content, structure, and mineralogy also are important. The presence of volcanic ash in soils such as Tolo, Wamic, Hot Lake, Metolious, and probably Wapinitia and Willowdale, apparently accounts for their exceptionally high moisture storage capacities.

Sample depths and water storage values given in Table 1 are averages to be used only as general guides. Individual soils within a given series, though similar, will vary in total depth and thickness of horizons and other characteristics. Each series will therefore have a range of water storage capacities, both within horizons and between profiles.

Appendix Table 1. Results of soil intake rate tests conducted cooperatively by Oregon State University and the Soil Conservation Service, USDA, in 1970

County	Test No.	Intake Rate	Soil type	Surface bulk density	Site conditions		
					Dryland	Irrigated	Site cover
		in./hr.					
Morrow	2	2.90	Koehler loamy fine sand	1.44	X		Native
Morrow	6	2.00	Koehler loamy fine sand	1.34	X		Native
Morrow	7	3.00	Koehler loamy fine sand	1.40	X		Native
Morrow	3	.25	Warden silt loam	1.20			Cropped
Morrow	13	.75	Warden silt loam	1.25	X		Native
Morrow	16	.50	Warden silt loam	1.34	X		Native
Morrow	17	.60	Warden silt loam	1.32	X		Native
Morrow	18	.13	Warden silt loam	1.43	X		Native
Morrow	4	1.60	Sagehill fine sandy loam	1.42	X		Native
Morrow	21	1.40	Sagehill fine sandy loam	1.48	X		Native
Morrow	22	1.00	Sagehill fine sandy loam	1.42	X		Native
Morrow	23	.70	Sagehill fine sandy loam	1.37	X		Native
Morrow	29	1.80	Sagehill fine sandy loam	1.39	X		Native
Morrow	9	.80	Quincy fine sand	1.50	X		Native
Morrow	10	.90	Quincy fine sand	1.48	X		Native
Morrow	11	1.00	Quincy fine sand	1.55	X		Native
Morrow	12	1.10	Warden very fine sandy loam	1.42	X		Native
Morrow	14	1.30	Warden very fine sandy loam	1.38	X		Native
Morrow	15	1.20	Warden very fine sandy loam	1.25	X		Native
Morrow	19	1.10	Warden very fine sandy loam	1.13	X		Crested wheatgrass
Morrow	20	1.00	Warden very fine sandy loam	1.27	X		Native
Morrow	26	.40	Ritzville very fine sandy loam	1.07			Grain
Morrow	27	.35	Ritzville very fine sandy loam	1.15			Grain
Morrow	28	.40	Ritzville very fine sandy loam	1.13			Grain
Umatilla	50	.70	Ellisforde silt loam	1.23	X		Sagebrush & cheatgrass
Umatilla	51	.90	Ellisforde silt loam	1.22	X		Sagebrush & cheatgrass

Appendix Table 1. Continued.

County	Test No.	Intake Rate	Soil type	Surface bulk density	Site conditions		
					Dryland	Irrigated	Site cover
		in./hr.					
Umatilla	52	1.20	Ellisforde silt loam	1.28	X		Sagebrush & cheatgrass
Umatilla	53	1.10	Ellisforde silt loam	1.19	X		Grass
Umatilla	53(d)	1.00	Ellisforde silt loam	1.23	X		Summer fallow
Umatilla	54	0.10	Ellisforde silt loam	1.47		X	Onions
Umatilla	55	.50	Ritzville silt loam	1.37		X	Wheat, barley & cheatgrass
Umatilla	56	.20	Ritzville silt loam	1.36		X	Onions
Morrow	24	.20	Ritzville silt loam	1.19	X		Grain
Morrow	25	.25	Ritzville silt loam	1.13	X		Grain
Morrow	30	.20	Ritzville silt loam	1.25	X		Grain
Morrow	31	.30	Ritzville silt loam	1.31	X		Grain
Umatilla	57	.16	Walla Walla silt loam	1.39		X	Onions
Umatilla	75	.50	Walla Walla silt loam	1.22	X		Summer fallow
Umatilla	76	.55	Walla Walla silt loam	1.10	X		Summer fallow
Umatilla	77	.60	Walla Walla silt loam	1.10	X		Summer fallow
Umatilla	78	.60	Walla Walla silt loam	1.22	X		Summer fallow
Umatilla	79	.60	Walla Walla silt loam	1.22	X		Summer fallow
Umatilla	86	.50	Walla Walla silt loam	1.11	X		Summer fallow
Umatilla	59	2.50	Quincy loamy fine sand	1.43	X		Volunteer grain
Umatilla	60	1.80	Quincy loamy fine sand	1.48	X		Summer fallow
Umatilla	61	1.00	Quincy loamy fine sand	1.51	X		Weeds & moss, cheatgrass
Umatilla	62	1.40	Quincy loamy fine sand	1.45		X	Potatoes
Morrow	1	1.30	Quincy loamy fine sand	1.57	X		Native brush
Morrow	5	.70	Quincy loamy fine sand	1.52	X		Native brush
Morrow	8	1.00	Quincy loamy fine sand	1.66	X		Native brush chiseled
Umatilla	63	.50	Onyx silt loam	1.18		X	Sugar beets
Umatilla	64	.50	Onyx silt loam	1.18		X	Young alfalfa
Umatilla	65	1.20	Onyx silt loam	--		X	Young alfalfa

Appendix Table 1. Continued.

County	Test No.	Intake Rate	Soil type	Surface bulk density	Site conditions: Dryland	Irrigated	Site cover
		in./hr.					
Umatilla	66	.45	Onyx silt loam	0.98		X	Young alfalfa
Umatilla	67	.70	Onyx silt loam	1.02		X	Young alfalfa
Umatilla	70	.75	Pilot Rock silt loam	1.32	X		Cheatgrass & moss
Umatilla	71	.40	Pilot Rock silt loam	1.07	X		Summer fallow
Umatilla	72	.40	Pilot Rock silt loam	0.94	X		Summer fallow
Umatilla	73	.80	Pilot Rock silt loam	--	X		Summer fallow
Umatilla	74	.80	Pilot Rock silt loam	--	X		Summer fallow
Umatilla	81	.15	Athena silt loam	--		X	Peas
Umatilla	82	.60	Athena silt loam	--	X		Summer fallow
Umatilla	83	.25	Athena silt loam	--		X	Peas
Umatilla	84	.35	Athena silt loam	1.17	X		Summer fallow
Umatilla	85	.20	Athena silt loam	--		X	Fresh plowed
Jefferson	100	.30	Metolious sandy loam	1.20		X	Mint
Jefferson	101	.15	Metolious sandy loam	1.39		X	Mint
Jefferson	103	.30	Metolious sandy loam	1.37		X	Mint
Jefferson	104	.27	Metolious sandy loam	1.36		X	Mint
Jefferson	113	.50	Metolious sandy loam	1.24		X	Potatoes
Jefferson	141	.60	Metolious sandy loam	1.01	X		Cheatgrass & wheatgrass
Jefferson	102	.17	Agency loam	1.43		X	Mint
Jefferson	111	.35	Agency loam	1.17		X	Mint
Jefferson	127	1.10	Agency loam	1.22	X		Dried up alfalfa
Jefferson	128	.25	Agency loam	0.96		X	Young potatoes
Jefferson	140	1.00	Agency loam	1.07	X		Dryland wheat
Jefferson	145	.33	Agency loam	1.13		X	Rolled and cut mint
Jefferson	112	.12	Agency sandy loam	1.43		X	Mint
Jefferson	115	.30	Agency sandy loam	1.44		X	Mint
Jefferson	118	.40	Agency sandy loam	1.10		X	Summer fallow
Jefferson	119	.16	Agency sandy loam	1.47		X	Mint

Appendix Table 1. Continued.

County	Test No.	Intake Rate	Soil type	Surface bulk density	Site conditions		
					Dryland	Irrigated	Site cover
		in./hr.					
Jefferson	146	.15	Agency sandy loam	1.24		X	Mint
Jefferson	105	.40	Madras sandy loam	1.22	X		Weeds
Jefferson	106	.20	Madras sandy loam	1.30		X	Mint
Jefferson	107	.33	Madras sandy loam	1.26		X	Mint
Jefferson	120	.65	Madras sandy loam	1.39		X	Mint
Jefferson	144	.40	Madras sandy loam	1.04	X		Summer fallow
Jefferson	147	.35	Madras sandy loam	1.23	X		Wheat
Jefferson	114	.10	Madras loam	1.20		X	Mint
Jefferson	116	.20	Madras loam	1.40		X	Mint
Jefferson	117	.40	Madras loam	1.29		X	Mint
Jefferson	142	.40	Madras loam	1.08	X		Wheatgrass
Jefferson	143	.73	Madras loam	1.14	X		Barley-cheatgrass
Jefferson	108	.50	Lamonta loam	1.13		X	Mint
Jefferson	109	.33	Lamonta loam	1.52		X	Mint
Jefferson	110	.35	Lamonta loam	1.25		X	Mint
Jefferson	121	.30	Willowdale loam	1.25		X	Alfalfa
Jefferson	122	.50	Willowdale loam	1.26		X	Alfalfa
Jefferson	123	.50	Willowdale loam	1.07	X		Summer fallow
Jefferson	124	.35	Willowdale loam	1.29		X	Hay
Deschutes	127	1.00	Deschutes loamy sand	1.00	X		Summer fallow
Deschutes	128	1.20	Deschutes loamy sand	1.19	X		Sage & rabbitbrush
Deschutes	130	1.60	Deschutes loamy sand	1.15	X		Sagebrush, etc.
Deschutes	125	.40	Deschutes sandy loam	1.20		X	Weeds & timothy seeding
Deschutes	126	1.00	Deschutes sandy loam	1.18	X		Brush
Deschutes	129	1.40	Deschutes sandy loam	1.15	X		Rabbitbrush, etc.

Appendix Table 1. Continued.

County	Test No.	Intake Rate	Soil type	Surface bulk density	Site conditions: Dryland	Irrigated	Site cover
		in./hr.					
Crook	208	.25	Deschutes sandy loam	1.31		X	Mint
Crook	209	.15	Deschutes sandy loam	1.30		X	Mint
Wasco	150	1.40	Tygh fine sandy loam	1.12	X		Summer fallow
Wasco	154	.90	Tygh fine sandy loam	1.21		X	Cut alfalfa
Wasco	155	.90	Tygh fine sandy loam	1.14	X		Dryland alfalfa
Wasco	151	.80	Endersby sandy loam	1.39		X	Cropped hay field
Wasco	152	.80	Endersby sandy loam	1.35	X		Summer fallow
Wasco	153	1.00	Endersby sandy loam	1.36		X	Tall grass
Wasco	156	.33	Wind River loamy fine sand	1.44		X	Cherry orchard
Wasco	157	2.00	Wind River loamy fine sand	1.44	X		Orchard-peaches
Wasco	158	3.00	Wind River loamy fine sand	1.51			Orchard-mulch
Wasco	159	.40	Van Horn fine sandy loam	1.42			Cherry orchard
Wasco	160	.35	Van Horn fine sandy loam	1.42			Cherry orchard
Wasco	161	.35	Van Horn fine sandy loam	1.55		X	Cherry orchard
Wasco	162	.30	Maupin loam	1.44	X		Summer fallow
Wasco	163	.70	Maupin loam	1.51	X		Summer fallow
Wasco	164	.45	Maupin loam	1.48		X	Young alfalfa
Wasco	165	.40	Wapinitia silt loam	1.47	X		Summer fallow
Wasco	166	.50	Wapinitia silt loam	1.26	X		Summer fallow
Wasco	167	.50	Wapinitia silt loam	1.37	X		Dry alfalfa
Wasco	168	.50	Wamic loam	1.14	X		Dryland alfalfa
Wasco	169	.40	Wamic loam	1.45	X		Summer fallow
Wasco	170	.43	Wamic loam	1.43	X		Summer fallow
Wasco	171	.50	Dufur silt loam	1.21	X		Summer fallow

Appendix Table 1. Continued.

County	Test No.	Intake Rate	Soil type	Surface bulk density	Site conditions		
					Dryland	Irrigated	Site cover
		in./hr.					
Wasco	172	.65	Dufur silt loam	1.24	X		Stubble mulch
Wasco	173	.57	Dufur silt loam	1.29	X		Summer fallow
Crook	200	.50	Ochoco sandy loam	1.31		X	Mint
Crook	201	.30	Ochoco sandy loam	1.27		X	Mint
Crook	206	.30	Ochoco sandy loam	1.30		X	Mint
Crook	207	.45	Ochoco sandy loam	1.26		X	Mint
Crook	202	.45	Prineville sandy loam	1.19		X	Mint
Crook	203	.60	Prineville sandy loam	1.19		X	Harvested mint
Crook	204	.50	Prineville sandy loam	1.37		X	Harvested mint
Crook	205	.45	Prineville sandy loam	1.34		X	Harvested mint
Lake	250	.60	Fort Rock sandy loam	1.12	X		Wild rye
Lake	252	.45	Fort Rock sandy loam	1.16		X	Pasture
Lake	254	1.00	Fort Rock sandy loam	1.02		X	Alfalfa
Lake	256	1.00	Fort Rock sandy loam	--		X	Alfalfa
Lake	260	2.00	Fort Rock sandy loam	1.16		X	Alfalfa
Lake	251	.65	Fort Rock loam	1.27		X	Uncut alfalfa
Lake	253	.45	Fort Rock loam	1.30		X	Alfalfa
Lake	255	.90	Fort Rock loam	0.99		X	Alfalfa
Lake	257	.75	Bonnick loamy sand	1.28		X	Alfalfa
Lake	258	1.00	Bonnick loamy sand	1.02		X	Alfalfa
Lake	258	1.00	Bonnick loamy sand	1.13		X	Alfalfa
Lake	261	.90	Bonnick loamy sand	1.34		X	Alfalfa
Wheeler	301	.46	Powder silt loam	1.49		X	Alfalfa
Wheeler	303	.40	Powder silt loam	1.20		X	Alfalfa
Wheeler	307	.25	Powder silt loam	1.29		X	Alfalfa

Appendix Table 1. Continued.

County	Test No.	Intake Rate	Soil type	Surface bulk density	Site conditions		
					Dryland	Irrigated	Site cover
		in./hr.					
Wheeler	302	.40	Kimberly loam	1.11		X	Alfalfa
Wheeler	308	.25	Kimberly loam	1.57		X	Alfalfa
Wheeler	300	.25	Kimberly loam	1.36		X	Alfalfa
Grant	315	.30	Kimberly loam	1.50			Alfalfa
Wheeler	305	.45	Sugarloaf silty clay loam	1.09		X	Alfalfa
Wheeler	306	.25	Sugarloaf silty clay loam	1.21		X	Alfalfa
Wheeler	310	.35	Sugarloaf silty clay loam	1.21		X	Alfalfa
Wheeler	309	.10	Sugarloaf silty clay loam	1.27		X	Alfalfa
Grant	312	.40	Courtrock loam	1.56		X	Stubble
Grant	313	.40	Courtrock loam	1.23	X		Stubble
Grant	316	.34	Courtrock loam	1.59		X	Alfalfa
Grant	314	.35	Hack silt loam	1.34		X	Stubble
Grant	317	.35	Hack silt loam	1.29	X		Weeds & stubble
Grant	318	.45	Hack silt loam	1.15		X	Alfalfa
Wheeler	311	.35	Tub silty clay loam	1.26		X	Alfalfa
Wheeler	304	.90	Kimberly sandy loam	1.33		X	Alfalfa
Union	319	.45	Catherine silt loam	1.01	X		Stubble, disked
Union	323	.15	Catherine silt loam	1.09	X		Ready to plant
Union	330	.33	Catherine silt loam	0.89	X		New seeding grain
Union	320	.35	Alicel loam	1.68	X		Ready for seeding
Union	324	.30	Alicel loam	1.11	X		Ready for seeding
Union	328	.40	Alicel loam	1.26	X		Recently rod weeded
Union	321	.20	La Grande silt loam	1.05	X		Burnt stubble
Union	322	.20	La Grande silt loam	1.00	X		Ready for planting

Appendix Table 1. Continued.

County	Test No.	Intake Rate	Soil type	Surface bulk density	Site conditions		
					Dryland	Irrigated	Site cover
		in./hr.					
Union	327	.35	La Grande silt loam	0.94	X		Ready for planting
Union	325	.25	Hot Lake silt loam	1.05	X		New seeding grain
Union	326	.30	Hot Lake silt loam	0.86	X		Ready for planting
Union	329	.20	Hot Lake silt loam	0.93	X		Summer fallow
Union	331	.45	Tolo silt loam	0.92	X		Stubble
Union	332	.45	Tolo silt loam	0.82	X		Bluegrass pasture
Union	333	.40	Tolo silt loam	0.98	X		Stubble
Wallowa	334	.40	Redmont loam	1.20	X		Summer fallow
Wallowa	335	.20	Redmont loam	0.99	X		Summer fallow
Wallowa	336	.20	Redmont loam	0.84	X		Summer fallow
Wallowa	337	.26	Reavis silt loam	1.23	X		Young grain
Wallowa	340	.20	Reavis silt loam	1.15	X		Young grain
Wallowa	341	.25	Reavis silt loam	1.20	X		Young grain
Wallowa	338	.30	Chesnimnus silt loam	1.18	X		Young grain
Wallowa	339	.30	Chesnimnus silt loam	1.34	X		Young grain
Wallowa	342	.25	Zumwalt silt loam	1.07	X		Young grain
Wallowa	343	.30	Zumwalt silt loam	1.22		X	Cut-over grain

Appendix Table 2. Results of soil intake rate tests conducted by the soil Conservation Service, USDA*

County	SCS No.	Intake rate	Soil type	Site cover
		in./hr.		
Morrow, Gilliam, Sherman	044	.12	Ritzville silt loam	Pasture
Morrow, Gilliam, Sherman	045	.31	Ritzville silt loam	Alfalfa
Morrow, Gilliam, Sherman	062	.38	Ritzville silt loam	Fallow
Morrow, Gilliam, Sherman	062	.37	Ritzville silt loam	Fallow
Morrow, Gilliam, Sherman	040	.19	Onyx silt loam	Wheat
Morrow, Gilliam, Sherman	043	.21	Onyx silt loam	Alfalfa
Morrow, Gilliam, Sherman	047	.21	Onyx silt loam	Stubble
Morrow, Gilliam, Sherman	047	.18	Onyx silt loam	Stubble
Morrow, Gilliam, Sherman	047	.21	Onyx silt loam	Stubble
Morrow, Gilliam, Sherman	042	--	Onyx silt loam	--
Morrow, Gilliam, Sherman	061	.10	Condon silt loam	Alfalfa
Morrow, Gilliam, Sherman	039	.18	Condon silt loam	Alfalfa
Morrow, Gilliam, Sherman	063	.28	Warden silt loam	Fallow
Morrow, Gilliam, Sherman	063	.21	Warden silt loam	Fallow
Morrow, Gilliam, Sherman	064	.42	Warden silt loam	Fallow
Morrow, Gilliam, Sherman	037	.18	Walla Walla silt loam	Alfalfa
Morrow, Gilliam, Sherman	046	--	Walla Walla silt loam	Alfalfa
Jefferson	180	.11	Lamonta loam	Mint
Jefferson	181	.16	Agency loam	Mint
Jefferson	181	.14	Agency loam	Mint
Jefferson	182	.20	Agency sandy loam	Mint
Jefferson	183	.17	Madras loam	Grain
Jefferson	184	.16	Madras sandy loam	Mint
Jefferson	185	.22	Madras sandy loam	Potatoes

Appendix Table 2. Continued.

County	SCS No.	Intake rate	Soil type	Site cover
		in./hr.		
Jefferson	186	.18	Madras sandy loam	Mint
Jefferson	186	.20	Madras sandy loam	Mint
Jefferson	187	.13	Metolious sandy loam	Mint
Jefferson	187	.14	Metolious sandy loam	Mint
Jefferson	187	.21	Metolious sandy loam	New grass seeding
Jefferson	189	.21	Willowdale loam	Grain
Jefferson	189	.20	Willowdale loam	Grain
Wheeler	296	.16	Sugarloaf silty clay loam	Alfalfa
Wheeler	296	.19	Sugarloaf silty clay loam	Alfalfa
Wheeler	297	.21	Sugarloaf silty clay loam	Alfalfa
Wheeler	298	.16	Powder silt loam	Alfalfa
Wheeler	299	.14	Kimberly sandy loam	Alfalfa
Wasco	01	.20	Wind River sandy loam	Orchard w/o cover
Wasco	02	.30	Wind River sandy loam	Orchard w/o cover
Wasco	01	.20	Wind River sandy loam	Orchard w/o cover
Wasco	03	.24	Cherryhill loam	Orchard w/o cover
Wasco	04	.17	Cherryhill loam	Orchard w/o cover
Wasco	04	.14	Cherryhill loam	Orchard w/o cover
Wasco	05	.21	Chenoweth loam	Orchard w/cover
Wasco	05	.19	Chenoweth loam	Orchard w/cover
Wasco	06	.14	Chenoweth loam	Alfalfa
Wasco	07	.31	Chenoweth loam	Orchard w/cover
Wasco	07	.40	Chenoweth loam	Orchard w/cover
Wasco	08	.36	Dufur silt loam	Alfalfa
Wasco	08	.27	Dufur silt loam	Alfalfa

Appendix Table 2. Continued.

County	SCS No.	Intake rate	Soil type	Site cover
		in./hr.		
Wasco	09	.21	Walla Walla silt loam	Alfalfa
Wasco	09	.23	Walla Walla silt loam	Alfalfa
Wasco	013	.12	Wamic sandy loam	Pasture
Wasco	014	.15	Wamic sandy loam	Alfalfa
Wasco	022	.14	Endersby loam	Alfalfa
Wasco	023	.30	Endersby loam	Wheat
Wasco	024	.22	Endersby loam	Alfalfa
Wasco	027	.27	Maupin loam	Alfalfa
Wasco	027	.25	Maupin loam	Alfalfa
Wasco	025	.24	Maupin loam	Alfalfa
Wasco	025	.38	Maupin loam	Alfalfa
Wasco	030	.24	Van Horn very fine sandy loam	Orchard w/o cover
Wasco	030	.30	Van Horn very fine sandy loam	Orchard w/o cover
Wasco	031	.16	Van Horn very fine sandy loam	Orchard w/o cover
Wasco	032	.14	Van Horn very fine sandy loam	Orchard w/o cover
Wasco	034	.18	Pedigo silt loam	Pasture
Wasco	033	.11	Pedigo silt loam	Alfalfa
Wasco	033	.13	Pedigo silt loam	Alfalfa
Wasco	035	.20	Pedigo silt loam	Alfalfa

* These test results were included in the report for comparison purposes. The procedure used in conducting these tests differs from the one used in the cooperative tests and is described in SCS Engineering Handbook, Section 15, Chapter 1, page 28; and Oregon SCS Engineering Technical Note No. 1.

These tests were made on operating systems near the end of an irrigation when the intake rate of the soil approached a minimum value. This can result in lower values than developed in the cooperative study, particularly if the area where the measurement is made is overirrigated, has a restrictive layer, or if the water has been applied at a high rate or with large drops for a long period of time. It is indicative, however, of what happened under the existing irrigation program and reflects characteristics of the soil profile as well as the soil surface.