SOIL SURVEY

The Idaho Falls Area Idaho

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UNITED STATES DEPARTMENT OF AGRICULTURE
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In cooperation with the
UNIVERSITY OF IDAHO COLLEGE OF AGRICULTURE AND
AGRICULTURAL EXPERIMENT STATION

How to Use THE SOIL SURVEY REPORT

FARMERS who have lived in one locality for a long time come to know about the soil differences on their own farms and on those of their immediate neighbors. What they do not know, unless a soil survey has been made, is how nearly their soils are like those at experiment stations or in other localities from which higher yields are reported. They do not know whether these higher yields are from soils like their own or so different that they could not hope to get equally high ones, even if they adopted the practices followed in these other places. These similarities and differences among soils are known only after a map of the soils has been made. Knowing what kind of soil one has and comparing it with soils on which new developments have proved successful will remove some of the risk in trying new methods and varieties.

SOILS OF A PARTICULAR FARM

To find what soils are on any farm or other tract of land, locate it on the soil map, which is in the envelope inside the back cover. This is easily done by finding the township and section the farm is known to be in and locating its boundaries by such landmarks as roads, streams, villages, and other features.

Each kind of soil is marked with a symbol on the map; for example, all soils marked Bm are of the same kind. To find the name of the soils so marked, look at the legend printed near the margin of the map and find Bm. The color where Bm appears in the legend will be the same as where it appears on the map. The Bm means Bannock silty clay loam. A section of this report (see table of contents) tells what Bannock silty clay loam is like, for what it is mainly used, and some of the uses to which it is suited.

How productive is Bannock silty clay loam? Find this soil name in the left-hand column of table 6, and note the yields of the different crops opposite it. This table also gives expectable yields for all the other soils mapped, so that the different soils may be compared.

Read in the section on Soil Series, Types, and Phases to learn what are good uses and management practices for this soil. Look also at the sections on Land Use and Management, Irrigation and Drainage, Productivity Ratings, and Land Classes. Find out what is said there about rotations, fertilizing, drainage, erosion control, and other management practices applying to this soil.

SOILS OF THE AREA AS A WHOLE

If a general idea of the soils of the area is wanted, read the introductory part of the section on Soils. This tells where the principal kinds are found, what they are like, and how they are related to one another. Then study the soil map and notice how the different kinds of soils tend to be arranged in different localities. These patterns are likely to be associated with well-recognized differences in type of farming and land use.

A newcomer who considers purchasing a farm in the area will want to know about the climate as well as the soils; the types and sizes of farms; the principal farm products and how they are marketed; the kinds and conditions of farm tenure; kinds of farm buildings, equipment, and machinery; availability of schools, highways, railroads, telephone and electric services, and water supplies; industries; and cities, villages, and population characteristics. This information will be found in the sections on General Nature of the Area and on Agriculture.

Students and others interested in how the soils of the area were formed and how they are related to the great soil groups of the world should read the section on Morphology and Genesis of Soils.

This publication on the soil survey of the Idaho Falls area, Idaho, is a cooperative contribution from the—

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Series 1939, No. 8 Issued December 1950

SOIL SURVEY OF THE IDAHO FALLS AREA, IDAHO

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CONTENTS

THE Idaho Falls area, a broad valley or plain wholly within Bonneville County, includes practically all the irrigated land on either side of the Snake River in the county. Under irrigation the river valley has become a successful agricultural region. Potatoes, sugar beets, alfalfa, and small grains are the chief crops; some cattle, sheep, and hogs are raised; and the dairy industry is increasing in importance. Sugar beets and dairy products are processed, and potato flour is manufactured. Many of the needs of the area, particularly for construction materials, are met by local industries. To provide a basis for the best agricultural uses of the land a cooperative soil survey was begun in 1939 by the United States Department of Agriculture and the University of Idaho College of Agriculture and Agricultural Experiment Station.

GENERAL NATURE OF THE AREA

LOCATION AND EXTENT

The Idaho Falls area comprises 140,800 acres in the southeastern part of Idaho. Idaho Falls, the county seat, is 340 miles southeast of Moscow, 220 miles east of Boise, and 145 miles northeast of Twin Falls (fig. 1). Lying wholly within Bonneville County, the area includes practically all the irrigated land on either side of the Snake River. It extends from north to south across the narrow western part of the county from the Jefferson County line on the north to the Bingham County line on the south. The irregular western and the eastern boundaries are drawn arbitrarily to include the main section of irrigated land.

PHYSIOGRAPHY, RELIEF, AND DRAINAGE

The Idaho Falls area is part of the broad valley or plain usually known as the upper Snake River Valley, which lies within and along the eastern edge of the Snake River plain. The plain forms a broad crescent extending westward from the Yellowstone Park region across the southern part of Idaho to the Oregon line and is considered an eastern extension of the lava-covered Columbia Plateaus.

The Snake River, which flows partly over gravelly beds and partly in basaltic box canyons slightly below the main floor of the valley, traverses the western part of the area. Different levels of the alluvial plain are separated by several short abrupt terrace escarpments or breaks. Although the larger part of this plain is a terrace, or bench, it includes areas of gently sloping alluvial fans adjacent to the uplands to the east and minor areas of bottom lands along the smaller streams. The alluvial deposits of sand, silt, and clay on the plain reach variable depths over the underlying coarse sand, gravel, and cobbles of the older Snake River alluvium. This coarse material is in places more than 80 feet deep.

In relatively small areas near the outer edge of the plain near Idaho Falls and the towns of Ammon and Iona, basalt bedrock, covered by only a thin layer of wind-laid material, rises as low hills

FIGURE 1.—Location of the Idaho Falls area in Idaho.

10 to 15 feet above the surrounding plain. South of Idaho Falls in the vicinity of Taylor is a narrow band of sandy soils, hummocks sparsely covered with grass, and barren sand dunes that reach a height of 50 feet or more above the surrounding country. This area, referred to as the Sand Hills, extends in a northeasterly direction for about 6 miles along and between the present channels of Sand Creek and Little Sand Creek. Bordering the southeastern part of the valley east and south of Ammon remnants of terracelike plains rise to heights of 25 to 100 feet or more above the valley floor, and in the extreme southeastern corner of the area, to elevations of 5,000 [1] feet.

[1] Elevations along the Snake River are from U. S. Geological Survey sheets of the Snake River Valley; elevations of other points from U. S. Geological Survey topographic quadrangles of 1925.

The valley is bounded on the east by the gently to steeply rolling foothills of the Blackfoot Mountains and the Caribou Range. To the west, the area extends into the undulating to gently rolling uplands of the loess-covered Snake River plain. Rising rather abruptly above the alluvial floor of the valley to a height of 10 to 20 feet in the southwestern part and 50 to 75 feet in the northern and more rolling part, the plain largely conforms to the relief of the underlying Snake River basalt. It is considerably modified, however, by the depth of loess deposits and to a lesser extent by desert streamway erosion. In the northwestern corner an extinct basalt volcano, or cinder cone, breaks the level of the plain. In the extreme southwestern corner the area includes a small part of the so-called Hell's Half Acre, an extensive area of barren black basalt of relatively recent flow (*5, p. 94*).[2] For a distance of 5 miles to the north and northeast of this flow the land is rolling and the loess deposits are of variable thickness over the jagged surface of the underlying basalt. In places the loess is absent and the older deposit of brown and gray basalt entirely exposed.

A desert drainageway enters the area from the west, just a mile south of the cinder cone, winds south into a basinlike flat in section 8, of township 2 north, range 37 east, and opens onto the alluvial plain in the southwestern corner. A number of smaller intermittent natural drainageways also traverse the area for long or short distances, modifying slightly the general level of the plain and causing a gently rolling or, in some places, steeply sloping to rough broken relief.

The streams and larger intermittent watercourses that drain the foothills to the east and southeast of the area have cut their way through the otherwise rolling country until many steep and some precipitous canyons have been formed. In their intricate meanderings over the alluvial floor of the valley the streams have made and abandoned numerous shallow channels. Watercourses not filled in when the land is leveled for agricultural use are utilized to divert water for irrigation or used as natural drains for waste irrigation water.

Willow Creek, with headwaters in the mountains southeast of the area, is one of the largest creeks in the State. Flowing north it enters the area in the northeast, near Ririe, and then turns to the southwest, where just north of Idaho Falls its North and South Branches empty part of their waters into the Snake River. Sand Creek and Little Sand Creek form distributary channels of Willow Creek in its lower course.

The waters of Henrys Creek and Taylor Creek have been diverted near their mountain headwaters to irrigate a high plateau in the southern edge of the area. Their channels and those of Rock Hollow and numerous smaller drains are not traceable for any great distance after they emerge into the valley.

The alluvial floor of the valley slopes very gradually to the south and west. The elevation at Ririe is 4,965 feet; 15 miles west, at a point on the west bank of the river just one-fourth mile south of the county line, it is 4,755 feet; at Idaho Falls, on the east bank of the river, 4,710 feet; at Ammon, a few miles to the southeast, 4,714 feet; and where the river crosses the Bingham County line, 4,646 feet.

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[2] Italic numbers in parentheses refer to Literature Cited, p. 69.

CLIMATE

The Idaho Falls area has a semiarid continental climate in which the seasonal and daily temperature changes are extreme. The summer day temperatures are moderated by the high altitude and rare atmosphere, and the evenings are cool. The winters are usually cold, with an average snowfall of 49.2 inches. Throughout the year there is a high percentage of clear days. The more important climatic data of the area, as recorded at the United States Weather Bureau station at Idaho Falls, are given in table 1.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Idaho Falls, Bonneville County, Idaho*

[Elevation, 4,744 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year	Total for the wettest year	Average snowfall
	° F.	° F.	° F.	*Inches*	*Inches*	*Inches*	*Inches*
December	23.1	61	−24	0.97	1.65	0.80	10.6
January	19.4	51	−34	1.10	.08	3.66	18.4
February	23.5	59	−32	1.03	.56	5.14	6.5
Winter	22.0	61	−34	3.10	2.29	9.60	35.5
March	33.8	74	−26	.86	.31	.97	6.4
April	44.9	86	11	.89	.68	3.13	1.6
May	53.4	95	20	1.37	.34	.74	.5
Spring	44.0	95	−26	3.12	1.33	4.84	8.5
June	60.8	98	24	1.10	.60	1.09	(1)
July	68.9	99	32	.61	.55	1.21	0
August	66.7	97	22	.61	(1)	.95	0
Summer	65.5	99	22	2.32	1.15	3.25	(1)
September	57.2	91	15	.81	.44	0	(1)
October	47.0	85	1	1.06	.47	1.71	1.6
November	33.6	70	−26	.61	.36	1.91	3.6
Fall	45.9	91	−26	2.48	1.27	3.62	5.2
Year	44.3	99	−34	11.02	[2] 6.04	[3] 21.31	49.2

[1] Trace. [2] In 1924. [3] In 1881.

The mean annual summer temperature is 65.5° F. and that of winter 22.0°, with unusual absolute extremes of 99° and −34°. The spring, summer, and fall temperatures are ideal for livestock raising and dairying and, where irrigation is possible, for crop growing. The ground remains open until some time in mid or late November, enabling the farmers to complete their fall plowing. Severe winter temperatures, however, make it necessary to feed and shelter livestock during the cold months.

The date of the average last killing frost in spring is May 17; the average earliest in fall is September 21. This gives the area an average frost-free period of 126 days, although killing frosts have been recorded as late as July 7 and as early as August 25. Late spring frosts often damage young potato plants. The relatively short growing season and high altitude are not favorable for corn and beans and also tend to reduce the yield of sugar beets.

The mean annual precipitation in the area is 11.02 inches, of which less than half falls from April to September. In general, the precipitation may be described as sub-Pacific (*2, p. 16*), since it is fairly well distributed throughout all the seasons except summer, when it is chiefly in the form of scattered local thundershowers. The inadequacy of the warm-season rainfall to meet the moisture requirements of crops is best understood in the light of the high rate of evaporation. Measurements made at Aberdeen, Idaho, over a period of 6 years show an average evaporation of 42 inches from a free water surface during the 6 months from April to September (*2, p. 48*).

Local and seasonal variations in the climate also are of agricultural significance. Killing frosts generally occur earlier in fall on the uplands west of the river than in other places but are found of material assistance in maturing potato tubers. Unseasonal killing frosts occurring in a basinlike depression of the upland region in the western part of the area more often prove a hazard to crops.

Other climatic factors also affect the crops. Unpredictable late spring rains may seriously interfere with alfalfa haying but often aid in the control of aphids on seed peas. Hailstorms, local in nature and confined for the most part to hail belts, sometimes cause damage to certain crops. In years of late cold springs crop yields are often seriously reduced by poor germination of seed and slow growth, while in years of heavy infestation by the alfalfa weevil serious damage is suffered by the first hay crop.

This area is in the region of the "westerlies," so called because the prevailing winds throughout spring, summer, and fall are from the southwest. Strong winds in spring and early in summer sometimes give rise to dust storms that are more disagreeable than destructive. Agriculture in the area is largely dependent upon precipitation in the upper watershed of the Snake River and its tributaries and upon storage of this water for uniform flow and supply throughout the growing season. Deep mountain snows melting during May, June, and July form the major source of irrigation water for the valley. Some of the rainfall, however, comes from moisture evaporated from the irrigated land surface and reprecipitated in the mountain headwater regions of the Snake River (*5, p. 19*).

Throughout the growing season there is a high average daily amount of sunshine. During spring, summer, and fall, March to November, inclusive, the seasonal averages are respectively, 8.5, 11.5, and 7.5 hours daily, and during the three winter months, 4.5 hours (*3*).

WATER SUPPLY

The natural water supply for irrigation for this area is furnished by the Snake River and Willow Creek. On most of the farms water diverted from these streams for irrigation also provides drinking water for livestock. On many farms it is used for household needs, although an increasing number of deep wells are being drilled. One well often supplies several neighboring farms.

The depth of the ground-water table in the greater part of the area necessitates deep wells. In the vicinity of Ririe and along the Snake River to within a few miles of the Jefferson County line the water table is rather shallow. At the county line, however, it passes below the level of the river at a very steep gradient. The depth is something more than 100 feet in a well on the west bank of the river at Idaho Falls. West of the river the deep water table drops sharply toward the desert. In several localities on the plain to the west the depth is as great as 1,000 feet.

Considerable water is lost underground from irrigation ditches, by seepage from irrigated fields, and through waste drained into deep lava tubes. The underground water lost east of the river probably reaches the deep water table and again comes to the surface near the American Falls Reservoir (*5, pp. 12–17*).

VEGETATION

The native vegetation of this area is of the sagebrush (northern desert-shrub) type and its grass associates. Big sagebrush with some rabbitbrush predominates on undeveloped land in the valley and on the foothills. Giant ryegrass occurs in ravines and depressed areas, and bunchgrass in protected spots. Because of intensive overgrazing, downy brome, locally called cheatgrass, has largely replaced the native grasses. Along irrigation canals and drains, willows grow profusely. Farmstead plantings and hedgerows are predominantly of cottonwood and Lombardy, silver, and Carolina poplars. In the sand-hill area the lower hummocks are covered with bunchgrass, annual weeds, and flowering shrubs almost to the exclusion of sagebrush.

ORGANIZATION AND POPULATION

In 1911 an area of 1,904 square miles was divided off from the northeastern part of Bingham County and made into a county, named in honor of an early explorer, Capt. B. L. E. Bonneville, United States Army.

The site of present-day Idaho Falls was known as Eagle Rock until 1900. Located at the point where early travelers between the Montana gold mines and Salt Lake City forded the Snake River, it played an important role in the history of this part of the West. Ferry service was inaugurated in 1863, and in 1865 a bridge was constructed.

Settlement of Eagle Rock began in 1865 but the establishment of a permanent agricultural community in this section was not begun until 1880, when a number of Mormons from Utah filed claims and developed an irrigation system that made farming possible. Later settlers came from various places, particularly the Midwestern States, and represented various backgrounds.

With its population of 15,024, Idaho Falls, the county seat, is the center of trade and commerce for an extensive area of range and farm land. It is approximately the geographic center of the area and easily reached from the neighboring small towns by a system of rail and all-weather motor roads. These towns and a number of railroad sidings have cooperative and privately owned storage facilities and serve as loading points for various farm products.

TRANSPORTATION AND MARKETS

Transportation facilities are provided by the Union Pacific Railroad, which has a branch line from Idaho Falls to West Yellowstone and additional lines into the principal outlying agricultural sections of this and adjoining areas.

Motor vehicle travel is facilitated by two hard-surfaced Federal highways and one State highway. United States Highway No. 91, running north and south, is joined at Idaho Falls by United States Highway No. 191, which comes in from the north through Ucon and is joined 3 miles northeast of Idaho Falls by State Highway No. 29 from Swan Valley and Ririe. Bus and truck service is available on all highways.

In addition to the main highways, a number of county roads are maintained. The towns of Ammon and Lincoln are connected with Idaho Falls by hard-surfaced roads, and in the irrigated part of the area, there are unpaved roads on nearly every section line. East of the river and in the New Sweden district most of these roads are graded and graveled, and except when covered by deep winter snows they can be used the year round.

Daily mail and passenger service is available from the municipal airport located just northwest of Idaho Falls.

Most of the grain and all the hay grown on irrigated farms is used for feed where raised, but a considerable part of the agricultural products is consumed outside the intermountain region, necessitating long and expensive hauls to the markets of the Midwest and the Pacific coast.

Livestock is shipped to midwestern, southwestern, and Pacific markets, and peas are bought on contract by various seed houses for sale as a canning variety to midwestern farmers. It is estimated that more than 90 percent of the honey produced in the upper Snake River Valley is consumed outside the boundaries of the State, and marketable potatoes go to midwestern and Pacific markets. About 10,000,000 pounds of cull potatoes, however, are processed annually in Idaho Falls by a potato flour mill, which ships its products to markets throughout the United States and to various foreign countries. The sugar-beet crop is processed at a factory in Lincoln, 3 miles east of Idaho Falls, and two cooperatively owned plants, one at Idaho Falls and one at Rexburg, in Madison County, process and market dairy products from the ever-increasing dairy industry of the upper Snake River Valley.

CULTURAL DEVELOPMENT AND IMPROVEMENT

There are 28 elementary schools, 4 high schools, and 2 junior high schools in the area. The average farmstead consists of a well-built comfortable house, a comparatively small barn, a granary, and a machine shed. Most farms also have a potato cellar. Electricity and telephone service are available in the majority of communities. All farms are fenced, generally with net or barbed wire. Where legume pastures are rotated and ditch and canal banks pastured, electric fencing is often used.

INDUSTRIES

Many of the needs of the community, particularly for construction materials, are met by local industries. Gravel for roads and building purposes occurs in abundance throughout the valley. A small plant just south of Ammon makes building tile and brick from the heavy Paul silty clay. Building blocks are made both from a light-weight asbestoslike stone quarried out of the hills bordering the southeastern part of the area and from the many-colored volcanic material cut from the cinder cone. A small iron foundry operates in Idaho Falls.

AGRICULTURE

EARLY AGRICULTURE

Prior to about 1884, when the first irrigation canal was built, the agriculture of the area consisted primarily of raising beef cattle, an enterprise begun about 1871. The wild hay used for winter feed was cut from patches among the sagebrush in the valley. At that time there was some dry farming and, close to the river, a few small areas of land under irrigation.

The completion in 1881 of the narrow-gage Utah & Northern Railroad, replaced by standard-gage track by the Oregon Short Line Railroad shortly after 1884, provided a means of transportation to Salt Lake City. Within a short time the availability of marketing facilities had led to the organization of companies for the construction of a system of canals, ditches, and dams for diverting irrigation water from the river and made greatly widened agricultural development possible.

During a period of relatively high rainfall from about 1910 to 1917, claims were filed for most of the tillable land on the plain west of Idaho Falls, and the region was dry-farmed to wheat (*5, p. 11*). In 1920 the Utah-Idaho Sugar Company bought a tract of this land in township 3 north, range 37 east and installed a pumping plant to raise irrigation water out of the Great Western Canal.

CROPS

The acreage of the principal crops grown in Bonneville County during stated years, as compiled from data in United States census reports, is shown in table 2. Although the area surveyed represents only about one-ninth of the land of Bonneville County it constitutes practically 94 percent of the irrigated acreage. Crops in the extensive dry-farming sections are confined mainly to the production of grain and alfalfa seed; hence the acreage in sugar beets, potatoes, and peas, and, to a somewhat lesser extent, in clover and alfalfa, can be considered as approximately that of these crops in the Idaho Falls area.

TABLE 2.—*Acreage of the principal crops in Bonneville County, Idaho, in stated years*

Crops	1919	1929	1939	Crops	1919	1929	1939
	Acres	*Acres*	*Acres*		*Acres*	*Acres*	*Acres*
Wheat	42,424	61,934	61,229	Oats	7,574	5,835	6,707
Alfalfa	26,966	38,933	42,492	Peas, dried	1,206	11,594	2,363
Barley	791	4,007	9,478	Potatoes	7,988	12,685	20,316
Clover	262	203	110	Sugar beets	2,093	7,963	7,270

The value of all agricultural products in the county by classes in the years 1919, 1929, and 1939 is shown in table 3.

TABLE 3.—*Value of all agricultural products in Bonneville County, Idaho, by classes*

Product	1919	1929	1939
Cereals	$1,556,631	$1,403,673	$1,109,572
Other grains and seeds	213,130	688,224	139,859
Fruits and nuts	13,698	31,561	6,631
Hay and forage	1,802,063	1,063,586	799,915
Vegetables:			
For sale (inclusive of potatoes)	2,787,425	2,834,793	2,067,965
For home use only (exclusive of potatoes)		38,214	42,614
All other crops	176,421	547,628	315,953
Livestock:			
Domestic animals	3,213,916	2,264,441	2,109,466
Dairy products sold	136,851	450,860	391,156
Honey and wax	16,906	2,185	1,894
Poultry and eggs	177,248	237,221	145,633
Wool	155,691	171,271	210,198
Total value	10,249,980	9,733,657	7,340,856

Alfalfa, one of the first crops to be grown in the area, has always held an important place in crop rotation. The acreage has increased in proportion to the extension of irrigation, but in recent years much of the increase has been due also to the growing practice of shortening the cycle in the rotation. Alfalfa is grown on all soil types, primarily as hay for local use.

The acreage of medium red clover, grown principally under contract with seed companies, fluctuates with the general price trend. Poor yields and infestation of much of the land with wireworms, however, have seriously decreased the acreage. Most of the crop is grown on the medium- to light-textured soils, chiefly those of the Portneuf and Bannock series.

The great increase in the sugar-beet acreage from 1919 to 1929 was largely due to the extension of irrigation, particularly to the Osgood tract, where the relative annual sugar-beet acreage is high. A slump from 1929 to 1939 was brought on in part by a virus disease carried by the white fly. Development of resistant varieties, however, has reversed the trend, and sugar beets now compete with potatoes for first place among the cash crops of the area. Beets are grown on the relatively gravel-free medium- to heavy-textured soils. The Paul and the Portneuf soils are the principal ones used for their cultivation. The beets are processed at the sugar factory at Lincoln.

In 1919, potatoes occupied nearly four times the acreage of sugar beets and continually increased through 1939, when one-sixth of Idaho's potato crop was raised in Bonneville County. The increase during recent years, stimulated by the strong demand for potatoes in the East and Midwest during the dry years in the thirties,[3] has been, however, at the expense of the acreage used for sugar beets, peas, and grain. Potatoes are particularly adapted to the medium- to light-textured soils and are grown chiefly on the Portneuf soils.

The production of seed peas increased enormously during the first 10 years after their introduction in 1921. Garden varieties suitable for canning are the principal type under cultivation. The peas are grown under contract for various seed houses supplying farmers in

[3] SHULL, W. E. ALFALFA WEEVIL CONTROL. Univ. of Idaho, Col. of Agr. Ext. Div., Agr. Ext. Leaflet 15, 2 pp., 1939. [Mimeographed.]

the Middle West. Medium- to light-textured soils are generally used for this crop.

On farms in the irrigated valley, wheat, oats, and barley are grown in rotation as companion crops for alfalfa and clover seedings, wheat ranking first in importance. Some wheat is marketed for milling purposes, but all the barley and oats are fed to livestock.

A limited acreage in corn and beans and other garden vegetables was reported in 1939, and apples, plums, pears, cherries, grapes, raspberries, strawberries, currants, and gooseberries, raised in small farm orchards, supply part of the local market demand.

AGRICULTURAL PRACTICES

Crop rotation is a general practice in this area. The principal cash crop receives the available barnyard manure and the little commercial fertilizer used. Commercial fertilizer, chiefly phosphates, which are recommended for beet crops grown on high lime-content soils, is now used in increasing quantities. The number of farms in the county using commerial fertilizer increased from 1919 to 1929 from 24 to 45, or from 1.6 to 2.9 percent of the total. Since most or all of the commercial fertilizer is used in the irrigated valley, the percentage of the farms in the area using commercial fertilizer would be much higher.

Studies made at the Aberdeen Branch Agricultural Experiment Station have tended to increase the general use of phosphate fertilizer on alfalfa, clover, and sugar beets grown on soils of high lime content.

Much of the plowing on the medium- to heavy-textured soils, particularly those on the heavy-textured Paul series, is done in fall. Sandy soils, which are subject to blowing, are plowed in spring.

Most of the alfalfa grown in the valley is of the Hardy Grimm and common varieties, with some Ladak. Seed is generally purchased through seed houses from local seed-producing areas to the north and south. New seedings are usually at the rate of 10 pounds an acre, sown with some small grain or with peas as a companion crop. Applications of 30 to 55 pounds an acre of available P_2O_5 at the time of seeding are found to be most economical (*6*); although after establishment, heavier applications, up to 120 pounds, have resulted in a greater residual effect on the following crops.

Alfalfa makes two mature cuttings of hay and a smaller third growth that is either cut for hay or fall-pastured. Alfalfa is especially well adapted to the medium- to light-textured soils. On these soils the old stands are broken out of sod either in fall or in spring. The practice of "crowning" in fall and then plowing deeper in spring is sometimes used on the Portneuf soils. Where alfalfa is grown on the heavier textured Paul soils, the sod is plowed in fall.

Medium-red clover is seeded at the rate of 10 pounds an acre with a small-grain companion crop. It is used for pasture until about the first to tenth of June or is clipped at about that time. This practice controls aphids and results in heavier seed yields. Greatly increased clover yields have resulted at the Aberdeen Branch Experiment Station from the use of phosphate fertilizers; their use in red clover seed-producing areas is a recommended practice. The clover is left on the land for 2 years, usually in a 4- or 5-year rotation.

Biennial white or yellow sweetclover is grown for pasture and to an ever-increasing extent as a green-manure crop on farms that have insufficient barnyard manure. In this practice it is seeded at the rate of 10 pounds an acre in fall and is plowed under the following May.

Potatoes usually follow legumes in the rotation. Wherever they are grown for 2 years or more in succession, the land is usually manured after the first year's crop following alfalfa. In the medium- to heavy-textured soils the land is usually plowed in fall, but where alfalfa is grown, there is more green manure to be turned under if plowing is done in spring.

Russet Burbank (Idaho Russet; Netted Gem) is the principal potato grown in the Idaho Falls area, although some Rural New Yorker are grown for the early fall market. Potatoes are planted at the rate of 1,000 to 1,200 pounds an acre in the latter part of May or the first of June. Irrigation is by all or alternate furrows. To insure uniform growth the water is turned on the fields at regular intervals of 7 to 10 days, depending upon the soil type. Frequent irrigation is necessary, particularly on heavy soils that become very hard when dry. The potatoes are usually dug in October and November.

The importance of disease-free potato seed is well recognized throughout the area, and since only a few farmers own plots in isolated areas where the fields can be thoroughly rogued for diseased plants, most farmers buy seed potatoes from certified growers. They increase this certified seed for 1 year and use 1 year out of certification for seed for commercial plantings.

Potato crops may be damaged by fusarium wilt, brown rot (bacterial wilt), ring rot, mosaic, rhizoctonia canker, spindle tuber, and the common scab. Eelworms and wireworms also cause damage to the tubers (*8*).

Sugar beets must have highly fertile ground to insure the best yield. They cannot, however, be grown after legumes in the rotation, because the undecomposed legume roots interfere with seeding and with tilling the young plants. Farmers therefore plant the beets following potatoes or, where the soil is very heavy and potatoes are not grown, following small grains. Sugar beets grown on the more calcareous soils, principally those of the valley floor, are generally fertilized with phosphate fertilizer. Recommended applications (*6*) are 25 to 50 pounds an acre of available P_2O_5 at the time of seeding. The fertilizer may be either broadcast or applied with the seed. If applied with the seed, the application should be lighter.

Medium- to heavy-textured soils are best adapted to sugar beets. Sandy or gravelly soils make it difficult to prepare a sufficiently firm seedbed. Furthermore the large quantity of gravel in some soils seriously interferes with seeding and with the cultivation of young plants. Beets are seeded in April, or as early as the season will permit, at the rate of 15 to 20 pounds an acre in rows every 24 inches or alternately 18 and 24 inches apart. They are usually irrigated by alternate rows. Beets are not irrigated so regularly nor so frequently as potatoes, except on sandy soils, where they are irrigated once a week. The crop is harvested in October and November, being hauled directly from the fields to beet dumps for weighing and loading and thence to the processing plant at Lincoln.

In the upper Snake River Valley small grains are grown principally for feed and planted either at the time of the legume seeding to serve as a companion crop, or following alfalfa, as in some areas of Paul silty clay, where alfalfa is preferred to potatoes. The rotation is then alfalfa, wheat, sugar beets, wheat, and alfalfa. Wheat, barley, and oats are seeded in April and harvested in the latter part of July or in August. Wheat and barley are seeded at the rate of about 1½ bushels an acre. Where these grains are damaged by smut, they usually are treated before sowing.

Dicklow and Federation are the most popular varieties of soft white spring wheat grown under irrigation. Lemhi is a Federation-Dicklow cross and combines the milling qualities of the Dicklow with the high yielding and stiffer straw of the Federation. Turkey Red, a hard red winter wheat, grown principally under the dry-land agriculture adjoining the area, is used in some local communities in the irrigated valley. It matures early and thus saves irrigation water in the latter part of the season.

Trebi is the most common barley variety grown. Velvon, a new smooth-awned variety, has been developed in Utah and is being grown successfully in small acreages by many farmers in the valley. It yields about as well as the high-yielding Trebi and does not lodge so badly. The straw is better stock feed because of its smooth-awned heads.

Bannock and Overland are the most popular varieties of oats grown. Overland, most recently introduced, is being grown to an increasing extent as a companion crop.

Peas, chiefly Perfection and Everbearing varieties, are grown extensively in limited areas. They sometimes are seeded in April as a companion crop for alfalfa. When planted together, however, their irrigation presents difficulties, as the young alfalfa plants require more frequent watering than is good for the peas. The germination of seed peas has been found by the Aberdeen Experiment Station to be increased by the use of special seed treatments. To prevent scalding of the seed pods by flood irrigation, peas are best seeded in raised rows and irrigated by the corrugation or small-furrow method.

LIVESTOCK AND LIVESTOCK PRODUCTS

The number of domesticated animals in Bonneville County in stated years is shown in table 4.

TABLE 4.—*Number of domestic animals in Bonneville County, Idaho, in stated years*

Livestock	1919	1929	1939	Livestock	1919	1929	1939
Horses	11,686	8,948	[1] 6,913	Swine	17,126	17,246	[3] 11,339
Mules	246	117	[1] 22	Chickens	66,893	[1] 66,117	[3] 68,389
Cattle	19,790	[1] 14,604	[1] 20,700	Turkeys			[3] 492
Sheep	43,143	104,743	[2] 91,201	Bees (hives)	865	732	1,428

[1] Over 3 months old. [2] Over 6 months old. [3] Over 4 months old.

It is apparent that from 1919 to 1929, the period of major development of large acreages of cash crops in the irrigated valley, the number of cattle decreased, though 1939 showed an increase over 1929. The expansion of the dairy industry and the growing practice of feeding young cattle in winter feed lots probably account for a larger percentage in the number of cattle in the valley than does an increase in the size of the small-farm beef herd.

Beef cattle are principally of the Hereford breed. Registered Hereford sires are raised on a farm northeast of Idaho Falls. Small dairy herds number about 4 or 5 cows per farm, although there are some larger herds of 20 and 30. The principal breed is the Holstein-Friesian, the Jersey and Guernsey being raised in smaller numbers. The value of all dairy products sold in Bonneville County increased from $136,851 in 1919 to $450,860 in 1929. Most of these products go direct to local cooperative markets.

The enormous increase in the number of sheep in the county from 1920 to 1940 can be only partly accounted for by an increase in the size and number of farm flocks in the Idaho Falls area. There is a growing practice among farmers of buying and fattening lambs late in fall and in winter and also of wintering large flocks of sheep until after lambing in spring, when they are summer grazed on the national range.

Although the number of hogs had decreased in 1940, as compared with 1929, the present trend on valley farms is to increase their production. An average of four to seven brood sows are maintained on each farm, the principal breeds being Duroc Jersey, Spotted Poland China, and Chester White.

Most farms have a flock of chickens to furnish eggs and meat for home consumption. A few larger flocks and several large flocks of turkeys are raised on a commercial basis in the vicinity of Idaho Falls. The chickens are chiefly White Leghorn.

The number of horses and mules has steadily decreased since 1919. Epidemics of brain fever (equine encephalomyelitis) have greatly accelerated the decrease since 1939 and have been an important factor in the trend toward the use of tractors for power. The average number of horses on each farm is about four middle-aged to fairly old stock, mostly Belgian, Shire, and Percheron. Farmers continuing to use horses for farm work are accustomed to raise their own stock.

In 1919, 62.4 percent of the farms of Bonneville County reported purchasing feed, at a total cost of $505,495. In 1929, this percentage had dropped to 48.3, and expenditures for feed to $219,273. Only the farms that feed and fatten large flocks of lambs and young cattle have to make extensive purchases of feed. Grain and sugar beet byproducts and lesser quantities of hay are bought in considerable quantities, usually from local concerns.

LAND USE CHANGES

Some individual holdings of 320 to 4,000 acres are dry-farmed, but the average farm in the irrigated valley is approximately 80 acres. The majority of the irrigated farms have been brought under irrigation directly from their natural sagebrush state, but some were first put under cultivation by the use of dry-farming methods during

World War I. Although their cultivation was later abandoned, they were eventually restored to use when irrigation water became available. There has been no great change in the type of farming under irrigation, although the relative acreages of alfalfa have increased under the practice of shorter legume rotations. Market demand determines the importance of most of the other crops grown.

FARM TENURE

The trend of farm tenure in Bonneville County is shown by United States census data: In the year 1920, 80 percent of the farms were owner operated. By 1930, the percentage had dropped to a low of 63.3, but by 1940, it had increased to 67.8 percent. Since many of the dry-land farms are owned by credit corporations or loan agencies, there will probably be no immediate large increase in the percentage of owner-operated farms in the county as a whole. According to the land classification and area reports of the Bonneville County agricultural planning program for the years 1938 and 1939, approximately one-third of the farms of the Idaho Falls area were being rented, chiefly on the share-crop basis.

Additional help is needed on most farms during the busy season in spring and during haying and harvest in summer and fall. Much of it is exchange labor from neighboring farms, although transient labor is hired for thinning sugar beets and for harvesting potatoes and topping beets. On farms where a considerable number of livestock are wintered or fattened in the feed lot, local year-round help is hired. In 1929, 78 percent of the farms in the county reported some expenditure for labor. This was an increase of about 9 percent over 1919. The average farm expenditure, however, decreased from $750 in 1919 to $582 in 1929.

FARM INVESTMENT

In 1929 the average farm investment for Bonneville County was $15,661, of which 67.4 percent was in land. The value of farm buildings represented 15 percent of the capital investment; domestic animals (including poultry and bees), 9.4 percent; and farming implements, 8.2 percent. Compared with the dry-land farms, the small farms in the irrigated valley show a much higher land value and greater investment in farm building and livestock.

On farms in the Idaho Falls area there has been an increase in the use of tractor power, particularly for plowing, and a few all-crop harvesters are used in harvesting small grains. The usual farm equipment, however, consists of plows, drills, planters, cultivators, harrows, diggers, binders, mowers, rakes, and stackers.

TYPES OF FARMS

Aside from the 6,000 or 7,000 acres of dry-farm land included in the northwestern part of the area and parts of the dry-land farms skirting the eastern edge of the valley, all the farms surveyed are irrigated. Most of the farming is of a general nature, except that a larger percentage of livestock is raised on some of the very sandy and very gravelly soils, where the more intensive cropping is impractical, and in some restricted areas the farms represent large acreages of cash crops in an intensive rotation.

Farms of this area fall largely into groups of 40, 80, and 120 acres (*1*). There is apparently no relation between size and area, as all three sizes are found throughout the entire irrigated area.

SOIL SURVEY METHODS AND DEFINITIONS

In making a soil survey the soils are examined, classified, and mapped in the field and their characteristics recorded, particularly in regard to the growth of various crops, grasses, and trees.

The soils and the underlying formations are examined systematically in many locations. Test pits are dug, borings made, and highway or railroads cuts and other exposures studied. Each reveals a series of distinct soil layers, or horizons, termed collectively the soil profile. Each horizon, as well as the underlying parent material, is studied in detail, and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The chemical reaction of the soil and its content of lime and salts are determined by simple tests.[4] Other features taken into consideration are drainage, both internal and external, the relief, or lay of the land, and the interrelations of soil and vegetation.

The soils are classified according to their characteristics, both internal and external, with special emphasis on features that influence the adaptation of the land to the production of crop plants, grasses, and trees. On the basis of these characteristics the soils are grouped in the following classification units: (1) Series, (2) type, (3) phase, and (4) miscellaneous land types.

The series is a group of soils having the same genetic horizons, similar in their important characteristics and arrangement in the profile, and having similar parent material. Thus, the series comprises soils having essentially the same color, structure, natural drainage, and other important internal characteristics and the same range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The series are given geographic names taken from localities near which they were first identified. Thus, Portneuf and Bannock are names of important soil series in the Idaho Falls area.

Within a soil series are one or more types, defined according to the texture of the upper part of the soil, such as sand, loamy sand, sandy loam, loam, silt loam, silty clay loam, or silty clay, terms which are added to the series name to give the complete name of the soil type. For example, Portneuf silt loam and Portneuf fine sandy loam are soil types within the Portneuf series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics.

A soil phase is a subdivision of the type, each phase differing from the others in some feature other than major profile characteristics that may be of special practical significance. Differences in relief, stoniness, and degree of erosion cause soil types to be divided into

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[4] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality; higher values, alkalinity; and lower values, acidity. The presence of lime is detected by the use of a dilute solution of hydrochloric acid.

phases. For example, within the normal range of relief of a soil type some areas may have slopes adapted to the use of machinery and the growth of cultivated crops and others may not. Even though no important differences may be apparent in the soil profile, or in its ability to support native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. Bannock fine sandy loam, sloping phase, and Bannock fine sandy loam, shallow phase, are phases of Bannock fine sandy loam.

The soil type or, where subdivided, the soil phase is the principal unit of mapping, and because of its specific character it is usually the unit to which agronomic data are definitely related. In comparisons between phases of a type, the principal phase, which in this report bears only the type name, is referred to as the normal phase.

Some areas that have no true soil—as Lava flows and Dune sand—are termed miscellaneous land types.

The soil surveyor makes a map of the area, showing the location of each of the soil types, phases, and miscellaneous land types in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

Some of the terms in the succeeding paragraphs are in common use and need no explanation. Others have special meanings in soil science. For example:

Permeability refers to the relative freedom with which the soil is penetrated by plant roots, water, and air. Very high permeability is an undesirable condition because it allows water to move too rapidly through the soil and results in loss by deep percolation. It generally connotes a loose unstable condition of the soil. High permeability is favorable for root penetration and tilth but allows somewhat more rapid penetration of moisture than is ideal for most crops; moderate permeability is the ideal condition, allowing free penetration of roots, water, and air but facilitating the maintenance of favorable moisture conditions for plants; low permeability is undesirable as it retards penetration of roots and water, resulting in unfavorably high moisture conditions for long periods, thus interfering with the growth of many crop plants and rendering tillage difficult.

Water-holding capacity is an expression of the total quantity of water available to plants within a depth readily penetrated by roots when the soil is at field moisture capacity; that is, after free water has had time to drain off. A soil of a low water-holding capacity requires frequent irrigation with small quantities of water, whereas soils with high water-holding capacity may be irrigated with rather large quantities at long intervals.

Natural fertility refers to the natural ability of the soil to provide the proper nutrient compounds in proper quantity and in the proper balance for the growth of the common crops when other factors, such as light, temperature, moisture, and physical condition, are favorable.

Workability refers to the relative amount of work required in tilling and irrigating the land and the relative feasibility of operating farm machinery and distributing irrigation water.

Erosion hazard refers to probable susceptibility to erosion when the land is cultivated or heavily grazed.

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SOILS

SOILS AND THEIR RELATIONS

The soils of the Idaho Falls area have developed from wind- and water-borne material deposited over flows of the Snake River basalt and beds of sand, gravel, and boulders of the old Snake River alluvium. Having developed under the climate and vegetation of the northern semiarid region, they are relatively low in nitrogen and organic matter and usually light in color. As a result of the lack of rainfall these soils have undergone little leaching and consequently they are rich in mineral fertility. Near the surface they are calcareous[5] and have a slightly to strongly alkaline reaction (pH 7.5–8.5).

The low humus content of these virgin soils has been a determining factor in the establishment of a highly diversified system of agriculture under irrigation. In the attempt to increase and maintain the organic fertility of these soils, extensive acreages of legumes (alfalfa and clover) have been grown in rotation with small grains, potatoes, and sugar beets. The hay and most of the grain grown as a companion crop for alfalfa and clover are used as feed for livestock on farms in the valley. Barnyard manure forms an important supplement to the legumes in the maintenance of fertility.

The natural fertility of large areas of these soils, particularly in the uplands, is fairly uniform. Extreme differences do arise, nevertheless, in small areas that are steeply rolling to hilly or have shallow soils over basalt and in larger areas of extremely sandy or gravelly soil. All the soils are moderately well to excessively drained, the heavy-textured ones having open porous gravelly substrata; and there is no serious problem of high water table. Approximately 90 percent of the soils have a nearly level to gently sloping or undulating surface and in texture and depth are adapted to farming under irrigation.

SOIL GROUPS

For the sake of convenience and as a means of helping the reader to understand and keep in mind their chief characteristics, interrelations, and agricultural uses, the various soils in the Idaho Falls area have been arranged in a number of groups and subgroups. Some of the groups are closely related and in places merge with one another without a distinct line of demarcation. Others are more distinct and are separated by more obvious boundaries.

The principal groupings, which are based largely on physiographic position, divide these soils into (1) soils of the uplands, (2) soils of the alluvial valley floor (terraces and alluvial fans), and (3) soils of alluvial bottom lands.

Within these main groups are a number of subgroups based on differences in relief or lay of the land, soil depth, texture, permeability, and water-holding capacity.

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[5] Calcareous soils are soils that contain sufficient calcium carbonate or lime to effervesce visibly when treated with dilute hydrochloric acid. Soils that do not so effervesce, however, are not necessarily of acid reaction and may contain enough lime released during the processes of plant growth to maintain fertility.

SOILS OF THE UPLANDS

Nearly level to hilly uplands comprise about one-third of the area surveyed. The soils of the uplands have developed from a fine floury even-textured wind-borne material known as loess, which has been deposited from atmospheric suspension over the plainlike lava flows west of the Snake River and the rolling to hilly lava plateaus and remnants of high terraces to the east and southeast of the area. These are light-colored soils, chiefly silt loam. The depth of the parent soil material over the underlying strata; the depth, color, and lime content of the surface soil; and the compaction of the subsoil vary somewhat with the relief. Nearly level, undulating, and gently rolling areas of these soils are very fertile and when irrigated are admirably adapted to all crops grown in the area. The uniformly favorable texture of the soils and their parent material gives them a good moisture-holding capacity, and consequently they do not need so much irrigation as other soils of the area.

Soils of nearly level to undulating uplands:

- Portneuf fine sandy loam
- Portneuf silt loam and its deep phase
- Wheeler silt loam, level phase

Deep soils of rolling uplands:

- Portneuf silt loam, rolling phase
- Wheeler silt loam

Shallow soils of rolling uplands:

- Portneuf fine sandy loam, rolling shallow phase
- Portneuf silt loam, rolling shallow phase
- Wheeler sandy loam

Soils of steep uplands:

- Portneuf silt loam, steep phase
- Wheeler silt loam, steep phase

SOILS OF THE ALLUVIAL VALLEY FLOOR

The soils of the alluvial valley floor—terraces and alluvial fans—have, for the most part, developed from relatively fine-textured alluvium that has been deposited over the coarser stratified sand and gravel of the Snake River alluvium. In places this alluvium has been redistributed by wind and modified by wind-borne materials.

These soils, because of the wide range in the source of their parent material and mode of deposit, are much less uniform in character than the loessal soils of the uplands. Their texture ranges from sand to silty clay and their colors usually from light brownish gray to pale brown, although very light brownish gray, dark brown, and dark brownish gray are found.

The soils of the valley floor occupy relatively low positions where water from the river and streams is easily available. For this reason they were among the first to be brought under irrigation, the majority having been under cultivation for 40 years or more before this survey. They are generally level, have moderate to excessive internal drainage, and for the most part are productive.

All the crops common to this area can be successfully grown on these soils. During recent years, however, fertilizer has been used increasingly on the highly calcareous soils in growing sugar beets, and somewhat less on alfalfa and clover.

On excessively gravelly soils in the northern part of the county alfalfa for hay is grown in long rotations, with shorter periods for potatoes. The land is then reseeded to alfalfa, with grain or peas as a companion crop.

The soils of the terraces include the light- to moderately heavy-textured soils of the Bannock series, which have a moderately compact, very limy subsoil and open porous substrata; and the soils of the Paul series with heavier textured and more slowly permeable subsoil and substratum. The soils of the alluvial fans are represented by the deep permeable fine sandy and silty soils of the Ammon series.

Medium- to heavy-textured soils of nearly level to gently undulating terraces over beds of gravel:

- Bannock gravelly silty clay loam
- Bannock loam
- Bannock silty clay loam
- Bannock very fine sandy loam

Sandy loams of nearly level to gently undulating terraces over beds of gravel:

- Bannock fine sandy loam
- Bannock sandy loam

Medium-textured gravelly soils of nearly level to gently undulating terraces over beds of gravel:

- Bannock gravelly fine sandy loam
- Bannock gravelly loam

Fine sands on nearly level to gently undulating terraces over beds of gravel:

- Bannock fine sand
- Bannock gravelly loamy fine sand
- Bannock loamy fine sand

Shallow soil on nearly level to gently undulating terraces over gravel and basalt bedrock:

- Bannock fine sandy loam, shallow phase

Medium- to light-textured soils of sloping and smooth to uneven terraces over beds of gravel:

- Bannock fine sandy loam, sloping phase
- Bannock gravelly fine sandy loam, sloping phase
- Bannock gravelly loam, sloping phase
- Bannock loamy fine sand, sloping phase

Heavy-textured soil of sloping and smooth to uneven terraces over beds of gravel:

- Bannock silty clay loam, sloping phase

Very sandy soils on sloping and uneven terraces over beds of gravel:

- Bannock fine sand, hummocky phase
- Bannock fine sand, sloping phase

Soil on steep terrace escarpments:

- Bannock gravelly silty clay loam, steep phase

Fine-textured soils with a heavy subsoil on nearly level terraces:

- Paul gravelly silty clay
- Paul gravelly silty clay loam
- Paul silty clay
- Paul silty clay loam

Soil with heavy subsoil on sloping terraces:

Paul silty clay loam, sloping phase

Medium-textured soils with heavy subsoil on nearly level to slightly uneven terraces:

Paul loam
Paul sandy loam

Sand over heavy subsoil on nearly level to slightly uneven terraces:

Paul sand

Medium-textured soil on nearly level to very gently sloping alluvial fans:

Ammon silt loam

Light-textured soil on nearly level to very gently sloping alluvial fans:

Ammon fine sandy loam

Soil on sloping and smooth to uneven alluvial fans:

Ammon fine sandy loam, sloping phase

SOILS OF THE ALLUVIAL BOTTOM LANDS

The soils that occupy comparatively narrow alluvial bottom lands along small streams are of relatively small extent. For this reason they are of minor agricultural importance, although fertile and highly productive under irrigation. They have soil materials of recent geologic accumulation, characterized by stratified layers, differing principally in texture.

Soils of medium to moderately heavy surface soil textures and friable permeable subsoil:

Ammon silt loam, bottom-land phase
Blackfoot silt loam
Red Rock silty clay loam
Red Rock loam

SOIL SERIES, TYPES, AND PHASES

The soils of the county[6] are here described in detail and their agricultural relations discussed. Four miscellaneous land types—Dune sand, Lava flows, Rough broken land (Wheeler soil material), and Scabland—are included. The location and distribution of all are shown on the accompanying soil map, and their acreage and proportionate extent are given in table 5.

AMMON SERIES

The Ammon soils occupy gently sloping alluvial fans between benchlands and the alluvial floor of the valley. They are of smooth texture and mellow consistence throughout. The surface soil for the most part contains lime, seldom being leached beyond a depth of 2 or 3 inches, but there is no appreciable lime concentration in the subsoil. Under cultivation and when moist these soils are a very pale brown or light yellowish brown, changing very gradually at a depth of 3 or 4 feet. In places they contain a few fine angular and subangular pebbles, especially where adjacent to the Wheeler soils and along the several stream channels coming from these hills.

[6] When a soil type is subdivided into phases, that part of the type that bears no phase name is referred to as the normal phase of the type.

TABLE 5.—*Acreage and proportionate extent of the soils mapped in the Idaho Falls area, Idaho*

Soil	Acres	Percent	Soil	Acres	Percent
Ammon fine sandy loam	575	0.4	Paul gravelly silty clay	709	0.5
Sloping phase	511	.4	Paul gravelly silty clay loam	2,503	1.8
Ammon silt loam	3,339	2.4	Paul loam	3,782	2.7
Bottom-land phase	508	.4	Paul sand	377	.3
Bannock fine sand	376	.3	Paul sandy loam	1,132	.8
Hummocky phase	1,307	.9	Paul silty clay	13,945	9.9
Sloping phase	1,960	1.4	Paul silty clay loam	10,845	7.7
Bannock fine sandy loam	5,214	3.7	Sloping phase	336	.2
Shallow phase	540	.4	Portneuf fine sandy loam	418	.3
Sloping phase	977	.7	Rolling shallow phase	306	.2
Bannock gravelly fine sandy loam	3,955	2.8	Portneuf silt loam	15,310	10.9
Sloping phase	900	.6	Deep phase	1,543	1.1
Bannock gravelly loam	8,449	6.0	Rolling phase	14,805	10.5
Sloping phase	1,611	1.1	Rolling shallow phase	794	.6
Bannock gravelly loamy fine sand	305	.2	Steep phase	2,153	1.5
Bannock gravelly silty clay loam	3,114	2.2	Red Rock loam	1,397	1.0
Steep phase	595	.4	Red Rock silty clay loam	350	.2
Bannock loam	10,381	7.4	Rough broken land (Wheeler soil material)	2,850	2.0
Bannock loamy fine sand	2,402	1.7	Scabland	4,006	2.8
Sloping phase	781	.6	Wheeler sandy loam	591	.4
Bannock sandy loam	835	.6	Wheeler silt loam	3,920	2.8
Bannock silty clay loam	4,051	2.9	Level phase	735	.5
Sloping phase	151	.1	Steep phase	1,927	1.4
Bannock very fine sandy loam	1,198	.9			
Blackfoot silt loam	1,179	.8	Total	140,800	100.0
Dune sand	179	.1			
Lava flows	723	.5			

Where the Ammon soils merge with those of the Paul series a firm to compact pinkish-gray to light brownish-gray silty clay loam heavily veined with lime is encountered at a depth of 2 to 4 feet. The silty clay loam usually extends for 3 feet or more to strata of loose sand and gravel. In the center of large areas of Ammon soils, this heavy-textured layer is not encountered above a depth of 6 feet. It is a foot or less thick and when dry is very hard brittle heavily lime-veined bluish-gray heavy silt loam. Ammon silt loam and its bottom-land phase and Ammon fine sandy loam and its sloping phase are mapped.

Ammon silt loam.—The most extensive of the Ammon series, this soil is developed from the finer textured light-colored material washed from the adjacent rolling hills of the Wheeler soils and deposited over the valley floor on the very gently sloping alluvial fan that skirts the upland.

The larger part of this soil occurs in three areas extending along the base of the upland from the Bingham County line south of Taylor to just southeast of Dewey School. Smaller areas occur 1 mile east of Ammon and 2 miles north of Iona. Several small areas are south of Ririe. Because of its mode of accumulation this soil has a considerable range in depth over the older alluvium of the valley floor, but in general it has a 24-inch surface soil consisting of a pale-brown calcareous soft silt loam that readily crumbles to a fine granular or powdery material when disturbed. Below about 24 inches and continuing to about 48 inches it becomes gradually lighter in color and in places contains thin layers relatively high in fine or very fine sand. A few angular and subangular fragments of basalt and limestone are widely scattered over the surface and throughout the soil profile and usually increase somewhat in number in the lower part of the profile.

Below about 48 inches the material is slightly harder. It is very light yellowish brown and contains some very fine veins of lime accumulation and lime coatings on the slightly hard nodular aggregates. At about 72 inches and continuing down to the sand and gravel substrata there is a very pale-brown silt loam, somewhat more compact and having considerable lime veining.

Nearly all of this soil is farmed. There are only a few small areas in the narrow valleys of some of the drainageways to which water has not been diverted. Like the soils of the Portneuf and Wheeler series it is low in organic matter, but also like these soils it is responsive to management practices. This soil affords easy penetration for roots and can be easily tilled and irrigated, being admirably adapted to all crops grown in the upper Snake River Valley.

The very gently sloping relief makes it easy to irrigate row crops and to flood sod or grain crops. The soil readily absorbs water, but unlike Portneuf silt loam, which has a less pervious zone of lime accumulation, it does not have so high water-holding capacity and consequently allows the excess moisture to percolate more readily to the substrata and be lost. Because of the more rapid percolation rate, somewhat larger heads of water are used in irrigation than for Portneuf silt loam. Long runs with the slope should be avoided in laying out the irrigation rows.

The usual rotation on this soil includes alfalfa, which is grown for a number of years, but recently this period has been shortened, because of bacterial wilt and the thinning out of the older stands by dandelions. The general decline in yields of cash crops has also proved a factor in shortening the rotations. Alfalfa occupies about one-third of this soil for 2 or 3 years, yielding from 3 to 6 tons an acre. Potatoes, which are the principal cash crop, follow alfalfa and precede sugar beets. The potato yield is 250 to 450 bushels an acre, and that of sugar beets, 10 to 18 tons. Small grains enter the rotation as a companion crop for new seedings of alfalfa and clover. Wheat averages about 60 bushels an acre, whereas barley and oats yield 80 or 90 bushels. Small acreages of peas and red clover for seed yield about the same as on Portneuf silt loam.

Potatoes and sugar beets respond in a marked degree to organic fertilization, which is usually in the form of barnyard manure applied the second and third years following alfalfa in the rotation. In some instances where an abundance of barnyard manure is available, heavy and frequent applications to the cash crops tend to supplant the usual rotation with alfalfa. Since the soil is normally calcareous to the surface, a marked increase in the yields of alfalfa and sugar beets has resulted from the application of phosphate fertilizer and a definite residual effect has been noted on potato yields following the more vigorous alfalfa crop.

As mapped in this survey, this silt loam includes a number of small scattered areas containing a somewhat higher proportion of fine and very fine sand than is normal. They occur most extensively in an area between Iona and just northeast of Washington School. A number of other small and widely scattered areas are gritty and of coarser loam texture, and contain a larger quantity of coarser basalt sand. These variations occur mainly in sections 10, 11, and 29 of township 1 north, range 38 east, and sections 20 and 30 of township 3 north, range 39 east. These sandier and coarser textured soils are of slightly lower moisture-retaining capacity and the crop yields are a little lower.

Ammon silt loam, bottom-land phase.—This phase is found in the alluvial bottom land along a drainageway that passes through townships 2 and 3 north, range 37 east, and deposits its runoff waters and sediments on the valley floor below.

Under its virgin sagebrush cover, this soil is characterized by a layer of ½ to 1 inch of undecomposed plant remains and pale-brown single-grained very fine sand that overlies a pale or very pale-brown soft silt loam with a high content of very fine sand. At about 4 inches the soil is somewhat lighter in color and has a distinct though fragile and irregular prismatic structure that continues downward to a depth of about 29 inches. The maximum root distribution is to about 17 inches. At about 29 inches the silt loam is slightly firmer and contains a few very fine lime veins. It is underlain at about 58 inches by a slightly hard very light yellowish-brown silt loam containing a noticeable proportion of very fine sand. In this layer the thin lime veins are more pronounced, and numerous small white rootlets also occur. At 72 inches and continuing to an undetermined depth below 90 inches there is a softer very light yellowish-brown very fine sandy loam with only an occasional faint lime vein in evidence. The entire profile is calcareous.

Approximately half this soil is under cultivation, its cropping and tillage treatment being the same as that of the associated Portneuf silt loam. Much of it, however, occurs in small areas bounded by the meanderings of the drainage channel and the irregular steep banks separating it from the upland, and consequently tillage operations are difficult. Some of these areas are left undisturbed as native pasture; others are seeded to a pasture mixture and, with the adjacent sloping uplands, provide excellent summer pasture where they can be irrigated.

Ammon fine sandy loam.—Nearly all of this soil is in an area east of Iona and Ammon, the fine sandy parent material having been washed down from associated areas of Wheeler sandy loam. Smaller areas occur in sections 20 and 21, of township 3 north, range 39 east. This soil differs from Ammon silt loam not only in its coarser texture, lighter color, and lower organic-matter content, but in its larger quantity of small angular and subangular basalt fragments and volcanic cinders, usually encountered below a depth of 1 to 2 feet and in places scattered over the surface. Approximately half this soil as mapped has a loamy fine sand texture.

More than 95 percent of this soil is farmed. Because of its open porous character and low organic-matter content, however, it is very droughty, and where clean tilled it is subject to wind erosion. Alfalfa occupies one-third to one-half of the soil area. Potatoes, the second most important crop, generally follow alfalfa in the rotation. Under irrigation the soil leaches readily and as a result requires careful management. Alfalfa hay yields are from one-third less to nearly as much as on Ammon silt loam.

Because of the light texture, the surface soil is at most only slightly calcareous, and applications of phosphate fertilizer to alfalfa or clover give little or no response. Stands of alfalfa have been greatly improved by top dressing with barnyard manure. Farmers frequently plow under a fairly heavy top dressing of manure with some of the alfalfa when preparing the land for other crops. Potatoes yield 150 to 250 bushels. Where they are planted several years in succession following alfalfa, manure is applied the second and third years out of sod.

Ammon fine sandy loam, sloping phase.—This phase occurs in very small widely scattered areas along the eastern edge of the valley, where it is associated with Ammon silt loam on slopes adjacent to the soils of the Wheeler series, and in the short narrow valleys of intermittent drainageways. A few small areas of loam and silt loam also are included in the map. The phase contains more basalt fragments over the surface and throughout the profile and is lighter in color and probably lower in organic matter than the Wheeler soils. With increased depth the soil is coarser and has a larger number of basalt and cinder fragments, which are angular to subangular and 1 to 2 inches in diameter. This material extends to undetermined depths and probably overlies basalt bedrock similar to that underlying the adjoining Wheeler soils.

Although at least half the total area is being farmed, the unfavorable topography makes irrigation difficult. The use of short crop rotations, including alfalfa, and the application of barnyard manure to the cash crops are necessary to maintain yields at even three-fourths of those on associated areas of Ammon silt loam. Because of the difficulty of managing small areas of this soil, more than half the cultivated fields are kept in alfalfa for extended periods or are left as permanent pasture. When sodded the slopes can be more efficiently irrigated, and their erosion reduced to a minimum.

BANNOCK SERIES

The soils of the Bannock series occur over wide areas north of Ucon, extending northward beyond the county boundary and as far east as Ririe; in the southern part from the upland west of the river eastward to Idaho Falls, Ammon, and Taylor; and to the southwest on both sides of the river into Bingham County.

The surface soil has a scattering of gravel, which continues throughout the profile. When dry, the soil to a depth of 8 to 15 inches, ranges from light brownish gray in the coarser textured types to grayish brown in those that are of heavy texture. Under moist field conditions the surface soil is light grayish brown to brown. In the virgin condition the top 8 to 15 inches are leached of carbonates, whereas under irrigation the surface soil becomes mildly calcareous as a result of the deposit of carbonates by irrigation water and their natural upward movement from the underlying lime layer.

The principal layer of lime accumulation in typical Bannock soils is in the finer textured materials above the gravel, but lime may be found in the gravelly strata also. This gravelly lime layer is hard but usually not cemented. It becomes looser and more pervious under irrigation. In the gravelly types and in shallow areas, gravel is much in evidence in the surface soil and is predominant throughout the subsoil. In these, the lime layer lies at a shallower depth and lime accumulates in the shallow-lying gravel substrata.

With the exception of a few excessively gravelly areas in the vicinity of Ucon and the hummocky and shallow areas, all soils of this series are under cultivation. The Bannock series is represented by 11 types and 9 phases.

Bannock silty clay loam.—The larger areas of this soil are east of the river between the region south of Idaho Falls and Cotton Siding. Some small areas also occur on the western side of the valley floor. This soil contains more organic matter than the other types of Bannock soils; is more deeply leached in the virgin condition; and usually is of greater depth over the underlying gravel stratum. The surface is nearly level to gently sloping. Excellent internal drainage is afforded by the open porous sand and gravel substratum, and in very flat areas the surface drainage has been improved by grading to form a very gradual slope.

The soil to a depth of about 17 inches is a soft to slightly hard silty clay loam, light brownish gray to pale brown in the surface 8 inches and gradually changing to a very pale brown with increase in depth. Some dark-colored organic matter coats the individual soil aggregates. Although leached of lime in its virgin condition, the surface soil is usually mildly calcareous in cultivated fields.

Veined with lime and of an irregular blocky structure, the subsoil to a depth of about 25 inches is a light yellowish-gray calcareous silty clay loam that becomes hard when dry. Below 25 inches and extending to a depth of about 40 inches the subsoil is a light yellowish-gray loam of angular blocky structure with white lime accumulations in seams. It is firm in place when moist and becomes hard when dry; nevertheless, it permits thorough root penetration. In places this layer overlies the stratum of sand and gravel into which the lime accumulation extends, softly cementing it when dry. At greater depths the under side of the pebbles and cobbles is coated with lime. In places a layer of loamy fine sand and sand, which in places has a high content of basalt grains, overlies a gravel stratum at much greater depths. Where this occurs the lime accumulation terminates in the sandy layers.

This is the most productive soil of the Bannock series, particularly for sugar beets and small grains. It provides a firm seedbed and, having a high moisture-holding capacity, can maintain a more even distribution of water between irrigations. When used in a rotation, alfalfa occupies about half the area; the other half is planted in equal proportion to potatoes and sugar beets. Wheat, barley, oats, and to a certain extent peas, are grown as companion crops for the alfalfa and clover seedings.

Because this soil does not have a high lime concentration close to the surface, its need for phosphate fertilizer is not so great as that of many other soils of the Bannock series. Applications of 25 to 35 pounds of available phosphoric acid (P_2O_5) an acre are made to sugar beets. Very little is applied to alfalfa except on small areas where scraping and leveling have exposed, or nearly exposed, the lime layer. Applications of barnyard manure and, to a limited extent, the practice of plowing under green manure are used to help maintain the organic fertility of this soil. Annual yields of alfalfa hay range from 2 to 4 tons an acre; sugar beets, 10 to 18 tons; potatoes, 200 to 350 bushels; wheat, 40 to 70; barley and oats, 60 to 100; peas, 20 to 35; and red clover seed, 6 to 12.

Bannock silty clay loam, sloping phase.—This phase is found principally southwest of Idaho Falls, in association with the normal phase of the type. It occurs as long narrow areas of sloping terrace escarpments or unevenly undulating areas.

Usually the surface soil is shallower and contains more gravel than the normal phase. In both, the process of scraping and leveling has exposed lime spots. It is possible to grow the same crops on the two soils, but the yields are materially lower on this phase because the soil is more shallow and the relief unfavorable for irrigation. Heavier and more frequent applications of manure as well as applications of phosphate fertilizer to legumes and sugar beets keep the crop yields to within about three-fourths of those on the normal phase.

Bannock gravelly silty clay loam.—This soil occurs in small widely scattered bodies throughout the Bannock soil areas. The depth of the soil over the gravel stratum is less in this soil than in the silty clay loam and its surface soil lighter in color. With a relatively high gravel content continuing through the profile, its water-holding capacity also is considerably less. Where the uneven undulating relief has been modified by scraping and leveling for irrigation, the highly calcareous gravelly subsoil is exposed in places. All areas of this soil are under cultivation. Planted to alfalfa, potatoes, wheat, peas, clover, and sugar beets, it receives essentially the same management as the associated silty clay loam. Alfalfa hay yields 2 to 3 tons an acre; potatoes, 125 to 250 bushels; wheat, 30 to 60; and barley and oats, 40 to 90.

Bannock gravelly silty clay loam, steep phase.—This phase occurs in long narrow irregular areas in association with other soils of the Bannock series. Representing steep and often gravelly terrace escarpments and steep areas bordering either side of the streams and drainageways, it is not favorable for agriculture; but small patches have been utilized after bench terracing and heavy applications of barnyard manure and phosphate fertilizer.

Bannock loam.—Occupying the most extensive area of the series, this type occurs chiefly west of the Snake River in township 1 north, range 37 east; 2 miles south of Idaho Falls; in the vicinity north and northeast of Coltman School; and in an irregular continuous area between Ucon and Ririe. The surface is smooth and nearly level, the slight undulations having been obliterated in the process of scraping and grading to develop a sufficient gradient for irrigation.

Under cultivation the upper 12 inches are a calcareous somewhat gritty loam, which is light brownish gray when dry but pale brown, very friable, and characterized by a medium-crumb structure when moist. Under the surface soil the loam is heavier, firmer, more highly calcareous, and lighter in color. At about 20 inches the soil is a very light brownish-gray loam with some lime concentrations in veins and hard nodular aggregates but chiefly as lime flour. When dry this layer becomes hard; when moist it is friable to slightly firm and allows thorough root penetration. This layer gradually changes to a very light yellowish-brown calcareous loamy fine sand containing numerous angular basalt grains and fragments. Below about 48 inches is mixed sand and gravel in stratified beds. There is a scattering of gravel over the surface and throughout the profile. Internal drainage is excellent. With the exception of its deeper relatively gravel-free areas the soil has only a fair water-holding capacity.

The type is easily tilled and irrigated and is productive. Very good yields are obtained where heavy applications of barnyard manure supplement 5- or 6-year rotations including alfalfa or clover. Where phosphate fertilizer is applied to new seedings of legumes, the alfalfa hay and red clover hay and seed yields are often doubled. Alfalfa hay produces 2 to 5 tons an acre; potatoes, 200 to 400 bushels; wheat, 30 to 70; barley, 40 to 90; oats, 50 to 100; and red clover, 5 to 10. Peas are as dependent upon the season as upon soil conditions. Late spring frosts frequently cut the harvest in half. Aphids likewise are likely to work havoc with this crop.

Bannock gravelly loam.—This soil is found principally in large areas scattered over the valley in the northern part of the area, west north, and east of Ucon. There are also important bodies south and southwest of Idaho Falls. The topography is uneven, the low undulations having necessitated considerable scraping and leveling to facilitate irrigation.

The surface soil is a gravelly light brownish-gray gritty loam. It is more compact below 6 inches and at about 12 inches is underlain by a very gravelly hard to softly cemented layer containing much accumulated lime. Below 14 to 24 inches the lime layer gives way to a layer of pebbles and cobbles coated on their under side with lime and silica.

The moisture-holding capacity of this soil is low, irrigation water being readily absorbed and draining rapidly through the porous gravelly soil into the underlying gravel. This condition can be improved by increasing the normally low organic-matter content with heavy applications of barnyard manure, a practice more effective in stepping up crop yields in a legume rotation than is the use of commercial fertilizer.

Nearly all this soil is under cultivation, from about a half to a third being used for alfalfa. Other crops in the rotation are potatoes, clover, small grains, and peas. Only a comparatively small acreage of sugar beets is grown. Potatoes and peas are irrigated by the furrow method; small grains and hay by flooding. In either method large heads of water on short runs are necessary to saturate the soil evenly. More frequent irrigation is necessary for all crops than on the deeper and less gravelly soils.

Some excessively gravelly areas, occurring especially in the vicinity of Ucon and northward, northwest of Coltman School, and in the northwest corner of township 3 north, range 39 east, are included on the map. In these areas the lime layer is at very irregular depths. The excessive quantity of gravel over the surface and through the soil seriously interferes with cultivation, making the soil very droughty and relatively unproductive. Much of this land is kept in alfalfa hay for long periods, the alfalfa being rotated with a crop of potatoes and then followed by hay with a small-grain companion crop. A common practice in the management of very gravelly soils is to roll the seedbed after seeding to facilitate irrigating, haying, and harvesting.

The crop yields on this gravelly loam are almost as variable as the soil. Alfalfa hay yields 2 to 4 tons an acre, although yields of 6 tons have been reported. Potatoes grown on excessively gravelly soils are not of good quality. On the average they yield 150 to 250 bushels. Yields of grain are only fair; wheat yields 20 to 40 bushels; oats and barley, 30 to 70; peas, 15 to 35; and clover seed, 4 to 10.

Bannock gravelly loam, sloping phase.—This soil occurs in small widely scattered bodies in close association with other gravelly soils of this series. It is found on low narrow terrace escarpments and along shallow abandoned stream courses. Its surface relief differs from that of the normal phase, however, in being unevenly sloping and unfavorable for irrigation. Leveling is not very satisfactory, in view of the increase in gravel content with depth and presence of a thick porous bed of gravel at depths from 18 inches to 2 feet.

Considerable areas of this soil are under cultivation, mainly in the production of alfalfa hay and occasional crops of potatoes, peas, and small grains. Yields of all these crops are somewhat lower than on the normal phase of the type. Where it is associated with Bannock loam, the soil has considerably less gravel on the surface and throughout the profile and is not so difficult to irrigate or to cultivate as in other places. Heavy applications of manure and phosphate fertilizer to new alfalfa seedings give a satisfactory return. Yields of all crops are about a fourth to a third less than on the more level areas of the normal phase.

Bannock very fine sandy loam.—This soil, the largest single area of which is southeast of Idaho Falls, occurs in widely scattered places over the valley floor. Although it has a scattering of gravel throughout the profile, it is usually freer of surface gravel than other Bannock soils and its generally more uniform texture indicates deposition or modification of materials by the wind.

In the virgin condition, this soil has a fragile very pale-brown crust one-fourth to one-half inch thick. Under the crust to a depth of about 3 inches the soil is a pale-brown very fine sandy loam that breaks into soft blocks about 1 to 1½ inches thick and is underlain first by a pale-brown very fine sandy loam and then at about 8 inches by a heavy silt loam. This layer is somewhat more compact than the upper part of the soil and has a poorly defined prismatic structure. Where undisturbed the soil to this depth is leached of lime, although under cultivation it becomes mildly calcareous. Below 15 inches there is very light brownish-gray loam that is hard when dry and contains much lime. When moist this lime layer is friable and is readily penetrated by crop roots. It is underlain at a depth of about 40 inches by gravel strata. The under side of the gravel and cobbles in the upper part of the gravel strata is coated to some extent with lime.

This soil is as productive as Bannock silty clay loam and is adapted to a greater variety of crops. Its uniform slope is favorable for the distribution of irrigation water, and its internal drainage is excellent.

Alfalfa yields 2 to 4 tons an acre; sugar beets, 8 to 16; potatoes, 200 to 400 bushels; peas, 15 to 35; clover seed, 4 to 10; wheat, 30 to 70; and barley and oats, 50 to 100 bushels.

Small areas of this soil are adjacent to Bannock silt loam of the Blackfoot-Aberdeen area with which it merges.

Bannock fine sandy loam.—This soil occurs in relatively small areas widely scattered over the valley floor, although it lies principally in the northern part and southwest of Idaho Falls. The largest continuous area is in the vicinity of Coltman School.

The top 8 inches is a light brownish-gray to pale-brown soft fine sandy loam that is underlain by brownish-gray to light brownish-gray loam. At about 19 inches the soil is a hard very light brownish-gray smooth-textured loam of high lime content and separates when disturbed into thin horizontal plates. A light yellowish-gray single-grained calcareous fine sand, in which are occasional thin lenses of compact to softly cemented fine sand, lies immediately under this layer. Above the gravel strata, which begin at about 6 feet, there is a 10-inch layer of mixed and stratified quartz and basalt sand of a salt-and-pepper color. A scattering of small rounded gravel occurs throughout the entire profile.

The typical relief in virgin areas is slightly undulating, but the practice of scraping and leveling for a more even distribution of irrigation water has obliterated these irregularities. This soil very readily absorbs water, the excess draining into the gravelly substratum.

Intertilled crops are irrigated by the furrow method; small grains, alfalfa and clover, by the border method. In either system large heads of water on short rows and lands are most satisfactory for uniform moisture distribution.

Practically all of this soil is under cultivation in the production of alfalfa hay, potatoes, small grains, sugar beets, red clover, and peas. The shorter rotations, where legumes and nonlegumes occupy the land for an equal number of years, have proved beneficial in maintaining fertility. Heavy applications of barnyard manure and green-manure crops increase the relatively low moisture-holding capacity. Applications of phosphate fertilizer have not proved altogether satisfactory, although they improve young stands of alfalfa and red clover growing on exposed limy spots. The surface of this and sandier soils of the Bannock series is for the most part rather deeply leached of lime. The soil responds well to the use of organic fertilizer. It is entirely probable that moderate applications of phosphate fertilizer, as a supplement to the manure, would prove helpful to alfalfa, red clover, sugar beets, and the like. Hay and potatoes yield well on this soil if farmed in a rotation half of which is alfalfa. Alfalfa yields 2 to 5 tons an acre; sugar beets, 6 to 14; potatoes, 200 to 400 bushels; clover seed, 5 to 9; wheat, 20 to 60; barley and oats, 30 to 70; and seed peas, 10 to 40 bushels.

A small area of soil on the river bottom, which has been included with Bannock fine sandy loam, consists of more recent alluvial material underlain by loose sand and gravel, and has a lower moisture-holding capacity. This land is used for purposes similar to those for the fine sandy loam but does not give such high yields.

Bannock fine sandy loam, sloping phase.—The sloping phase, the larger areas of which occur in and near Idaho Falls, differs from the normal phase of the type in having a shallower, more porous surface soil, lower organic-matter content, more sloping relief, and usually more surface gravel. Much of the naturally uneven surface has been leveled and scraped to form uniform slopes or bench terraces. Approximately half the soil, scattered in small areas over the valley floor, is farmed.

Bannock fine sandy loam, shallow phase.—This phase, which is like the normal phase of the type except in being underlain at depths of 3 feet or less by basalt bedrock, occurs in small widely scattered areas, principally along the western edge of the valley floor. A few gravelly soils as well as some soils showing minor variations, such as a range in texture from loam to sand and sloping to level relief, also are mapped. Because of its close association with irregular areas of nonirrigable land, the occasional very shallow spots or outcropping of basalt, and the uneven topography typical of this condition, less than half this soil is cultivated. Yields are erratic. Cultivated areas forming part of a field unit in association with other soil types receive the same management and are planted in the same crop rotation as the other soils.

Bannock gravelly fine sandy loam.—Most of this soil occurs south of Idaho Falls and in the vicinity of Ucon and the Shelton School. Small areas of gravelly sandy loam and some excessively gravelly stretches north and northeast of Ucon and north of Coltman School, however, also are included.

In the main this soil does not differ greatly from Bannock gravelly loam, except in being more open, sandy, and droughty and lower in organic fertility. In a few of the more gravelly areas more than 90 percent of the ground surface is covered with large pebbles and small cobbles, which continue down through the soil profile. Like Bannock gravelly loam the relief is characterized by uneven undulations or very low rolls and dips.

Water requirements for crops grown on this soil are high. The surface soil is deeply leached of lime, and the lime layer, lying at widely variable depths, is less pronounced than in the gravelly loam. In a few small scattered areas the gravelly fine sandy loam profile is very shallow over the lime layer, which lies at a depth of 8 to 12 inches. With the exception of scraped spots exposing this lime layer, there is no marked crop response to applications of phosphate fertilizer; with the use of short rotations and heavy applications of barnyard manure or the plowing under of green-manure crops, however, the soil gives marked response, and yields of 2 to 4 tons of alfalfa to the acre and 150 to 350 bushels of potatoes are produced. Management on the excessively gravelly areas is difficult. Frequent tillage is impractical, and the soil is very droughty. Furthermore, unless it is kept in a high state of organic fertility by heavy and frequent applications of manure, the yields are poor.

Rotations on this gravelly soil are similar to practices on the closely associated Bannock gravelly loam—a comparatively large acreage is planted in alfalfa for hay, followed by a relatively short period, 2 or

3 years, in potatoes and small grains. A large quantity of red clover seed is raised on this soil type.

Alfalfa hay is the principal crop and is allowed to remain on the land for extended periods. In many places it is top-dressed annually with manure. Because of the extreme difficulty of plowing and tilling, the periods during which the soil is planted in other crops are short. Potatoes may be grown 1 year, and small grain the next; or small grain may be planted 1 year to be followed by alfalfa.

Bannock gravelly fine sandy loam, sloping phase.—The larger areas of this phase are in the vicinity of Ucon, although smaller tracts are scattered over the valley floor in association with other Bannock types. The phase also includes small areas having a sandy loam texture, and a very few small widely scattered areas in which the lime layer is nearer the surface than in the normal phase.

Where this soil occurs in association with the normal phase, the surface soil is not so gravelly and its potential productivity is not greatly different from smoother areas of Bannock gravelly fine sandy loam. Where associated with the excessively gravelly areas of the normal phase, the sloping phase becomes more gravelly and necessitates heavier applications of barnyard manure and organic residues, such as green manure, which are plowed under to increase the moisture-holding capacity of the soil. The rotations used on this soil are similar to those on other gravelly soils of this series.

Bannock loamy fine sand.—This soil occurs principally in the vicinity of the Fairview School west of Ucon, and in the sand-hill region, north and northeast of Taylor.

The upper 14-inch layer, which is slightly hard and brittle under dry field conditions, is made up of a very light brownish-gray noncalcareous loamy fine sand underlain by calcareous light-gray fine sandy loam that extends to 24 inches, where the main layer of lime accumulation occurs as a chalky white hard loam. Under moist conditions the soil in this layer is fairly friable and easily penetrated by plant roots. Loose incoherent gravel and yellow sand are encountered at about 36 inches.

The surface shows some very minor irregularities, although for the most part it is favorable for irrigation. By plowing quantities of manure and crop residue into this soil, its water-holding capacity and productivity can be greatly increased. Large heads of water in short runs are used in irrigating crops. In fall and spring there is considerable danger of soil blowing. The winds have reworked the surface material of this soil over large areas into small patches and hummocks of sand and fine sand. To control this problem farmers commonly cover the surface with strawy manure.

Normally this soil is not highly productive, but under careful management it produces good yields of hay and potatoes, as also of clover seed. Hay yields of 1 to 4 tons an acre and potato yields of 150 to 300 bushels prevail. Crops are usually rotated, but in order to reduce wind and water erosion many farmers keep the land in alfalfa or in pasture over extended periods and give it annual top dressings of manure. Potatoes and small grains are used in the rotation for 2 or 3 years, the grain being used as a companion for the legumes.

Bannock loamy fine sand, sloping phase.—This phase, including a few small areas having a loamy sand texture, has been mapped principally in the northern part of this area, where it is associated with extensive areas of the normal phase.

Except for slope there is very little difference between the sloping and the normal phases. In the sloping phase, however, the depth to the layer of accumulated lime is not so great as in the normal. Soils of this texture on sloping areas are difficult to irrigate and when cultivated and irrigated are subject to wind and water erosion. Only about half the phase is under cultivation. Where farmed it is rotated to about the same crops and under the same management practices as the normal phase.

Bannock gravelly loamy fine sand.—A small acreage of this soil occurs over the valley floor in small widely scattered areas in association with the sandier types of the Bannock series. The large quantity of gravel over the surface and throughout the profile makes tillage and irrigation somewhat difficult. The relief, however, is favorable for irrigation, and nearly all the soil is cultivated. Water quickly drains into the gravel strata, making irrigation necessary more frequently than on gravel-free soils. This rapid water loss also results in soil leaching and the loss of the more soluble plant nutrients. Careful management must therefore include the application and conservation of mineral and organic fertilizers.

Bannock sandy loam.—Although found mainly in the vicinity of Cotton Siding, smaller areas of this soil are widely scattered over the valley floor. It has a coarser sandy texture than Bannock fine sandy loam, is more deeply leached of lime, and in general is more droughty. Its relief is favorable for irrigation, and all of it is under cultivation, with about the same management and crop rotation practices as are used for the fine sandy loam. It is probable that, because of its coarser texture, it requires a relatively greater quantity of plant remains and barnyard manure to give the same yields as Bannock fine sandy loam.

Bannock fine sand.—Occurring only in small tracts, this soil occupies isolated areas northeast of Taylor and on either side of the Snake River north of Idaho Falls. The surface is light brownish-gray to pale-brown noncalcareous fine sand. Although normally of single-grain structure, under virgin conditions the surface 3 inches in places tends to be coarse, very fragile, and platy. Below about 14 inches the fine sand is very light brownish gray, mildly calcareous, and firmer in place than the surface layer. Accumulated lime in this layer seems to be entirely confined to the walls of root channels and very small perforations. At about 28 inches the material is grayer, somewhat firmer in place, and slightly more uniformly calcareous. The main zone of lime accumulation occurs at about 32 inches; here the sand is loamy and hard but breaks easily into angular fragments when disturbed. A somewhat stratified sand consisting of pale-yellow quartz grains, white mica flakes, and black and brown basalt grains giving a salt-and-pepper effect underlies the lime zone at 41 inches. This sand is loose and calcareous and at about 46 inches gives way to loosely bedded sand and gravel. The under side of the pebbles in this material is lime-coated. A scattering of rounded gravel occurs throughout the soil and subsoil, and occasional subangular basalt fragments occur below about 32 inches.

Probably less than half this soil is farmed. It is associated with sloping and hummocky phases of the type and with dunes of sand northeast of Taylor. In its natural condition it is not favorable for irrigation, because of the uneven undulating to hummocky relief. All cultivated areas have been scraped and leveled for irrigation.

This soil is exceedingly droughty and very low in organic matter. In the production of crops, which are mainly alfalfa hay and potatoes, all available plant residues and barnyard manure are applied. Incorporated with the tilled soil or as top dressings to new seedings, they prevent wind erosion and consequent loss of seed.

Perhaps better than three-fourths of the total tilled acreage is in alfalfa, which remains on the land for extended periods, usually until the stand becomes poor. Alfalfa hay yields are 1 to 2 tons an acre, and when the alfalfa sod is broken up, a crop of potatoes, seldom two crops, occupies the land. The following year the land is reseeded to alfalfa with some small grain as a companion crop. Potato yields vary from 75 to 200 bushels an acre. Yields for grain crops are very low; most grains produce only 10 to 30 bushels.

Bannock fine sand, sloping phase.—This phase occurs in small widely scattered areas in association with other sandy soils of the Bannock series. Because of the unfavorable relief little of it is farmed.

Bannock fine sand, hummocky phase.—This phase occurs on uneven relief, ranging from low minor undulations to long hummocky swells that extend in the direction of the prevailing winds, northeast and southwest across the area. Scattered in relatively small areas, most of the phase is in the sand-hill region south of Idaho Falls and along either side of the river to the north. None of it is under cultivation, but the hummocks are sparsely to moderately covered with bunchgrass, annual weeds and grasses, and shrubs. Such vegetation does not afford much pasture but serves to prevent wind erosion and deposition onto adjoining cultivated areas. Irrigation is impossible except where the surface of the ground is scraped and leveled.

BLACKFOOT SERIES

The Blackfoot soil is deep, dark-colored, and permeable and occurs on alluvial fans and bottom lands. It is inherently fertile and, although of relatively small extent, is the most productive soil of the Idaho Falls area. Blackfoot silt loam is the only type of the series that occurs in the area.

Blackfoot silt loam.—Blackfoot silt loam is an organically stained mildly calcareous soil in bottom lands. It is formed from alluvium washed from the higher elevations of the mountains and deposited over the valley floor and in small areas along stream channels. This deposit ranges in depth from several inches to more than 4 feet and at the marginal edges blends into the soils of the Ammon and the Paul series over which it is deposited.

Most of this soil type occurs in township 1 north, range 38 east, just east of the Washington School. Numerous smaller areas are north of Idaho Falls and Iona along the many channels of Willow

Creek, in sections 24 to 27 and 32, township 3 north, range 38 east; and in section 19, township 3 north, range 39 east.

Under ordinary conditions the 18-inch surface layer is a brownish-gray soft calcareous silt loam, but a few small areas have a silty clay loam texture. The moist soil is very dark or dusky brown and under cultivation quickly breaks up from large very friable clods to a crumblike structure. Under the surface layer there is medium to dark brownish-gray calcareous silt loam that when dry is slightly harder. The color gradually lightens with increased depth, and at about 27 inches the soil is a very light brownish-gray calcareous smooth-textured loam that tends to be slightly harder in place than the layer above. In this layer there may be broad irregular tongues of surface soil extending to a depth of 4 feet. Faint lime veinings are in this part, and at about 48 inches the soil is a very pale-brown silty clay loam, heavily veined with lime. This layer when moist is somewhat darker and has the distinctly pinkish cast characteristic of the Paul subsoil. The silty clay loam continues to a depth of about 80 inches, where it is underlain by light-brown sand.

This soil is inherently fertile, readily irrigated, and easily tilled. The large area east of the Washington School slopes to the west, affording good surface drainage and distribution of irrigation water. Excess water readily percolates through the friable silt loam, being retarded only slightly by the heavier textured deep subsoil above open porous substrata of sand and gravel.

All the type is farmed, but constant intensive cropping will in time decrease its organic-matter content to the point where to maintain present high yields application of barnyard manure to the cash crops and use of relatively short rotations with legumes will be necessary. The entire profile is calcareous, and after having been cultivated 40 years or more the soil now needs applications of phosphate fertilizer to give increased yields of alfalfa and sugar beets. Phosphate fertilizer used on fields planted to alfalfa has been found to have a residual effect on the potato crop grown after the alfalfa.

Where land of this type is farmed by the owner, it is usually cropped in a fairly strict rotation, which consists of 2 or 3 years in alfalfa followed by 2 years of potatoes (pl. 1, *A*) and 1 year of grain, after which the land is seeded again to alfalfa. If sugar beets are used in the rotation they follow a year of potatoes. Sugar beets are normally grown only in 1-year periods, but sometimes they are planted 2 years in succession. Alfalfa hay yields 3 to 6 tons an acre; sugar beets, 12 to 18 tons; potatoes, 350 to 400 bushels; wheat, 60 bushels or more; and barley and oats, 80 to 90.

DUNE SAND

With the exception of a dune on an island in the Snake River 7 miles north of Idaho Falls, Dune sand is found in the sand-hill region between Taylor and Ammon. There it is associated with sandy types of the Bannock series, which extend about 6 miles into Bonneville County in a general northeast-southwest direction. Made up of a mixture of basalt and quartz sand, it occurs as rolling to steeply rolling shifting wind-blown dunes. Unlike associated areas of Bannock fine sand and its hummocky phase, it has no profile development and because of its instability and porosity cannot support a stabilizing vegetative cover of annual weeds, shrubs, and coarse grasses.

Dune sand is of agricultural significance as a result of its continuous drifting and steady encroachment upon the heavier, more productive soils. The most serious drifting occurs during the high winds early in spring and in the fall of successive dry years. Because of the low rainfall and impracticability of irrigation it would be difficult to establish a growth of grasses or other stabilizing vegetation over the dunes.

LAVA FLOWS

Lava flows occur in the extreme southwestern corner of the area where the survey included the easternmost extension of Hell's Half Acre. Practically the entire land surface is occupied by barren lava flows characterized by sharp jagged surfaces, crevices, and angular blocks. The rock surface is unweathered and has practically no soil except wind-borne material that has lodged in crevices, cracks, and sheltered pockets. Native vegetation is limited to an occasional juniper or to scattered stunted desert shrubs. The type has no agricultural or grazing value, and owing to its exceedingly rough surface and lack of vegetation it is avoided by stock (pl. 1, *B*).

PAUL SERIES

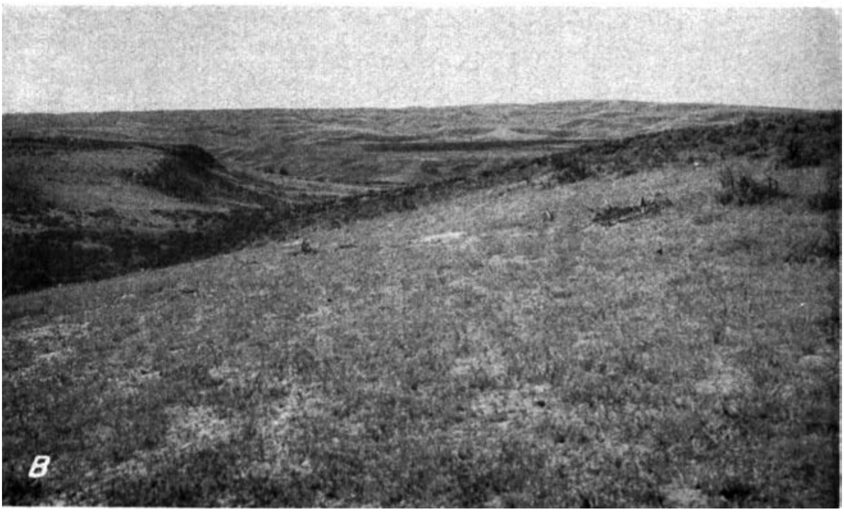
The Paul series, approximately all of which is under cultivation, forms a continuous body of soils to the east and northeast of Idaho Falls. Extending westward from near the northeastern corner of the area where Willow Creek enters the valley, the belt broadens to occupy most of the width of the valley floor south of Ucon and east of Idaho Falls. The belt narrows somewhat as it stretches southward to Ammon and south and southwest through Taylor into Bingham County.

These soils occupy back-terrace positions and apparently have been formed from alluvial material transported from higher elevations and laid down over older gravelly deposits.

Normally Paul soils have a relatively flat relief. Their sand and gravel strata are found at a greater depth than in the soils of the Bannock series, and internal drainage is slower. They are also consistently less gravelly, although in a few places there are scatterings of surface gravel and occasional pebbles throughout the soil. Their color is somewhat darker and browner than most other soils of the area and their texture characteristically heavier.

The surface layer of the Paul soils to an average depth of about 14 inches is pale brown to dark brown and in virgin condition is leached of lime. In all types this layer is permeable and friable. Under the surface there is a pale-brown medium- to heavy-textured subsoil, usually somewhat harder than the surface layer, and at about 24 inches there is a hard heavy-textured layer, heavily veined with lime accumulations. This very pale-brown layer with a pinkish cast is plastic when wet. Continuing to depths of 3 to 5 feet it is underlain by an increasingly lighter textured very light brownish-gray or very pale-brown deep subsoil that is veined with accumulated lime. Underlying strata of sand and gravel are encountered at depths of 5 to 7 feet.

A. Potatoes, a highly important cash crop, on Blackfoot silt loam.
B. Rough surface and sparse vegetation on recent Lava flows on western margin of the area.



A. Wheat on Paul silty clay, an important and productive soil of the Snake River Valley.
B. Typical rolling relief of the Wheeler soils.

Much of the originally uneven microrelief of the soils of the valley floor has been smoothed by scraping and leveling for the purpose of facilitating irrigation. These areas, which are usually small and sometimes appear as gray spots in plowed fields, indicate places where the lime layer has been exposed. Delineation of such soils on the map, however, has been considered of little importance and therefore not attempted, since their area and number are relatively small and they have often been brought up to a productive par with surrounding fields by the applications of phosphate fertilizer.

Seven types and one phase of the Paul series, the third most extensive series of this survey, are mapped in this area.

Paul silty clay.—The most extensive soil of the valley floor, this soil occurs in large fairly continuous areas in close association with other soils of the series east of Idaho Falls, and north from the Dewey School through Ammon, Lincoln, and Iona to south and east of Ucon. It occupies the lower, more level positions of the Paul soil areas, and consequently has slower surface drainage; although the general southwesterly slope of the valley floor affords sufficient surface drainage for the removal of spring runoff and excess irrigation waters except in lower flats or depressed positions. Water drains slowly through the fine soil material, but the open porous gravel substrata provide free underdrainage to a deeper water table.

An occasional light sprinkling of gravel occurs over the surface and throughout the profile. When allowed to become very dry, this soil shrinks and cracks very deeply. Surface soil washed into these cracks forms thick angular veins or threads penetrating the lighter brown material throughout the lower subsoil.

The upper 17 inches of this soil is moderate brown under moist field conditions but dries out to a light brown or pale brown. As compared with other soils of the area, however, it generally has a somewhat reddish cast. When disturbed this layer breaks into large well-defined prisms. Tilling crumbles the soil into small nutlike or large granular aggregates that are sticky and plastic when wet, friable when moist, and hard when dry. Below 17 inches the soil is harder, less granular, and slightly lighter in color.

To about 28 inches the subsoil is a mildly calcareous pale-brown silty clay with a slightly pinkish cast. When disturbed it breaks into large blocklike prisms that split further into various-sized sharply angular aggregates containing many small pores. Underlying this layer the soil is pale-brown silty clay, which like the layer above, is hard and compact in place and when disturbed breaks into angular aggregates, some of which have a thin coating of lime. A few nodular soil aggregates and the walls of former roots channels in this layer show a coating of accumulated lime. Roots are able to penetrate this layer, although the mass of roots is confined to the surface 2 feet.

At a depth of about 37 inches the subsoil is very pale-brown silt loam containing layers of very fine sand. These layers have a slightly hard to hard consistence and are veined with lime accumulations. The accumulations decrease, however, in the underlying softer very pale-brown silt loam found at about 51 inches. At 63 inches the material is calcareous light brownish-gray very fine sandy loam, underlain by bedded gravel and sand at an average depth of about 84 inches.

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All this soil is farmed. Its heavy texture adapts it to sugar beets and small grains, although it is also planted to potatoes. Alfalfa is used in the crop rotations, being considered of primary importance for maintaining organic fertility and keeping the soil from puddling. Common alfalfa is preferred over other varieties for this purpose because of its deeper root system. Alfalfa does not grow vigorously on this soil type and yields are not usually high. Where barnyard manure is available in quantity, it is applied to cash crops, sometimes being used instead of alfalfa in the rotation. Both, however, are usually used in the regular rotation, which includes 2 or 3 years of alfalfa, followed by potatoes or grain, and 2 years of sugar beets. When the land is seeded back into alfalfa a small-grain companion crop, generally wheat, is planted with it. If the land is broken out of alfalfa in fall a fair stand of hay is often plowed under.

Where not depleted by continuous and extensive cropping, the surface soil has a moderately high content of organic matter and is moderately tillable within its narrow optimum moisture range. It is usually plowed in fall, if the season permits, and left unharrowed, inasmuch as the action of the frost greatly improves its tilth for the preparation of a spring seedbed.

After being under irrigation many years the surface layer has become mildly calcareous. Yields following applications of 30 to 60 pounds to the acre of available phosphoric acid on new seedings of alfalfa and 25 to 35 pounds annually on sugar beets, have not shown consistent increases, although they have been sufficient to indicate the decreasing availability of phosphate.

The establishment of a sugar factory in the heart of the Paul soil area at Lincoln probably was a factor in encouraging large-scale cultivation of sugar beets in this locality. Most important, however, was the adaptability of this soil and Paul silty clay loam to the crop; actually these two soils are planted to greater acreages of sugar beets than any other soils of the area. Yields are 10 to 18 tons an acre. Wheat, which is used on local farms as animal feed, is grown in larger acreages than any other small grain (pl. 2, *A*). Yields vary from 40 to 80 bushels an acre, whereas yields of barley and oats are 70 to 120 bushels. Alfalfa hay yields 2 to 4 tons, and potatoes, 150 to 250 bushels.

Paul gravelly silty clay.—This soil occurs in small isolated areas in association with other types of the Paul series near Ammon and Lincoln, northeast of Idaho Falls, and south of Ucon.

Unlike Paul silty clay, in which the underlying gravel strata are at 84 inches, this gravelly type has an underlying porous gravel strata at a depth of about 3 or 4 feet. The quantity of gravel in the surface soil is usually not sufficient to interfere seriously with tillage practices, although it is a hindrance in the seeding and early cultivation of sugar beets. The zone of lime accumulation is much closer to the surface, and under irrigation the entire profile is more highly calcareous than in Paul silty clay.

All of this soil is under cultivation to crops commonly grown in the valley. The acreage in sugar beets is proportionally much less than on associated gravel-free soils, and that in alfalfa, small grains, and possibly potatoes, relatively greater. Yields of alfalfa hay are as high as on the gravel-free Paul silty clay or higher. Yields of sugar beets are about a third lower. Despite the gravel, which increases aeration and decreases the tendency to puddle, this soil demands the same tillage practices as Paul silty clay and usually is given heavier and more frequent applications of barnyard manure. Decided crop response from the application of phosphate fertilizer is to be expected.

Paul silty clay loam.—Most of this soil occurs as a part of the large area of Paul soils in the eastern part of the valley, where it lies in elongated areas adjacent to Paul silty clay. On the whole it occupies slightly higher positions and has a greater slope than the more level basinlike areas of Paul silty clay. The surface soil is lighter in texture than in Paul silty clay, more friable, and easily tilled and irrigated; the subsoil is less clayey and lighter in color; and stratified sand and gravel are likely to be found much closer to the surface.

The surface 10 or 14 inches is pale to moderate-brown slightly hard weakly granular silty clay loam and is underlain by a more compact layer of pale to very pale-brown silty clay with a pinkish cast. Under irrigation the layers above the zone of lime accumulation are usually mildly calcareous. Accumulated lime occurs mainly in veins or layers coating the large angular soil aggregates in the silty clay at about 24 inches and continues into the light brownish-gray silt loam at about 32 inches. The silt loam grades at about 41 inches into a similarly colored but softer loam, which extends to a layer of very pale-brown calcareous loamy fine sand. This sand in places is made up of a mixture of quartz and basalt sand. Underlying the sand layer at 70 inches there is a porous stratum of gravel and cobbles embedded in sand.

The slope provides adequate surface drainage and the porous gravelly substratum insures free drainage for water percolating down through the subsoil.

Crops on this soil probably require less water than those on Paul silty clay. The water-holding capacity is nearly as great as that of Paul silty clay, and its lighter-textured surface soil more readily absorbs water and releases a greater proportion of it to plants. The organic-matter content of the two soils is similar. Small grains and hay are irrigated by the border method; intertilled crops, by the furrow method.

Farmers maintain the fertility of this soil by crop rotations that include alfalfa and by the application of the available barnyard manure to the cash crops. After 40 years or more of irrigated agriculture the surface 12 inches and usually the entire profile above the zone of lime accumulation have become at least mildly calcareous. Increased yields of alfalfa hay and of sugar beets made possible with applications of phosphate fertilizer, indicate the decreasing availability of phosphate in this soil.

Because of its soil-building properties, alfalfa occupies nearly a third of the acreage of this soil type. Yields of alfalfa are 10 to 20 percent higher than on Paul silty clay, and potatoes are better adapted to it and are grown in preference to wheat following alfalfa in the rotation. They yield 150 to 300 bushels an acre. Sugar beets for the most part retain their importance as a cash crop, the yields being about the same as those on Paul silty clay. Wheat yields also are similar, but barley and oats yield somewhat more on this lighter textured soil.

Paul silty clay loam, sloping phase.—This phase occurs in widely scattered, small irregular areas on slopes between different terraces or along abandoned stream channels near Ammon and Iona and north and west of Crowley School. It also includes small areas of silty clay texture. Its slope makes it more difficult to irrigate than the normal phase, compared with which it has a shallower lighter brown surface soil. It is lower in organic-matter content and is underlain at shallower depth by the limy subsoil and the substrata of gravel and sand.

All this soil is under cultivation. Crops are the same as those grown on the normal phase, but the yields are approximately a fourth to a third lower. The small areas comprising the phase demand special attention in irrigation and drainage because of the irregularity of the surface. Where irrigated they are invariably calcareous throughout, but respond satisfactorily when fertilized with phosphate fertilizer. Heavier applications of barnyard manure to cash crops in the rotation are necessary to maintain yields and the organic-matter content of this soil and to reduce erosion caused by irrigation on the uneven relief.

Paul gravelly silty clay loam.—The most extensive gravelly type of the Paul series, this soil occurs chiefly in the vicinity of Ammon and Iona but also in small areas widely scattered over the Paul series area.

The quantity of gravel on the surface and throughout the soil, as well as the slightly uneven relief, makes this type less desirable for irrigation than the gravel-free Paul silty clay loam. The depth to the sand and gravel substrata varies but for the most part is shallower than in Paul silty clay loam. Its normally lower organic-matter content reduces crop yields below those on the silty clay loam and necessitates more frequent and heavier applications of barnyard manure or plant residues to maintain its fertility.

Because of the quantity of gravel in this soil, most of it is planted to a rotation of alfalfa, potatoes, and small grains, only relatively small acreages being in sugar beets. The rotation is usually 2 to 4 years in alfalfa followed by 3 or 4 years in other crops. Hay yields are not materially less than on the gravel-free soil, but sugar beet yields are about a third less. Potatoes and small grains yield about a fourth less than on Paul silty clay loam.

Paul loam.—This soil is among the better agricultural soils of the Idaho Falls area. The largest bodies occur adjacent to the soils of the Ammon series and in association with the sandier Paul types near the sandy wind-reworked deposits of the valley north of Taylor and in the vicinity of Washington and Dewey Schools. Smaller widely scattered bodies occur in association with Paul silty clay loam. Included also with this soil are areas in which the surface texture approaches a sandy clay loam and small areas of gravelly soil, found principally along the north side of the sand-hill region north of Taylor and to a lesser extent west of Ammon.

Under cultivation the upper 12-inch layer of this soil is a pale-brown soft to slightly hard gritty loam that becomes dark brown when moist. It is underlain by a light- or pale-brown clay loam that is considerably firmer in place. Virgin soil is leached of lime to this depth; soil that has been under irrigation is usually mildly calcareous. At about 24 inches moderate lime veining occurs in the upper part of the underlying light brownish-gray clay loam that continues to an average depth of 40 inches; however, the maximum accumulation of lime and compaction is at about 36 inches. When moist the upper part of the lime layer has a distinct pinkish cast. Beneath this layer there is in places a layer of mixed and stratified quartz and basalt sand covering the gravel, cobbles, and sand substrata; and in other places the zone of lime accumulation gradually merges with the underlying light-gray calcareous sand and sandy clay that occasionally contain some lime-coated gravel and extend down to the loose gravel and sand substrata to be found at about 48 inches. Some pebbles are also scattered throughout the soil and over the surface.

Nearly all this soil is under cultivation. Because of its nearly level to gently sloping relief it is easily irrigated. Surface and internal drainage are good and the tendency for water to remain in small depressed areas is much less than in the heavier textured types. The water-holding capacity is good.

With a naturally better tilth and wider optimum moisture range than Paul silty clay loam this soil is adapted to a wider diversification in cropping; moreover, yields of most crops compare very favorably with yields on Paul silty clay loam. Under consistent and careful management to maintain organic fertility, yields of potatoes, the principal cash crop, average 50 bushels an acre more, and alfalfa hay half a ton more than on Paul silty clay loam. The gravelly soils of the series are somewhat less productive than gravel-free soils, because of their lower organic-matter content and the presence of the gravel, which make them more droughty and more difficult to irrigate and till.

The lower organic-matter content of this soil, however, is more readily depleted than in the less porous Paul silty clay loam and Paul silty clay; to maintain its fertility farmers plant about a third of the area to alfalfa hay. Heavy applications of available barnyard manure, usually to potatoes, are commonly made as a method of increasing yields.

Crop rotations practiced on this soil consist of 2 to 4 years in alfalfa followed by 3 or 4 years in other crops. Small grains seldom occupy the land for more than 1 year and then serve as a companion crop for legumes. The rotation is practiced on the gravelly areas with a proportionately larger acreage in alfalfa and a much smaller acreage in sugar beets.

Paul sandy loam.—This soil occupies nearly level to gently sloping easily irrigated areas on the valley floor in close association with wind-worked sandy soils and along present and abandoned stream channels traversing the Paul soils. The largest areas occur north of Taylor and west of Washington School and on either side of Snake River north of Idaho Falls. Smaller areas are in the vicinity of

Lincoln and St. Leon Siding. Several small areas that have considerably more gravel than is representative are 1 and 2 miles north of Washington School and 2 miles northwest of Ammon.

Under moist field conditions, the surface soil is dark brown to very dark brown. When dry, the 9-inch surface layer is pale-brown crumbly sandy loam that grades with depth into a light- or moderate-brown sandy loam. At an average depth of 18 inches the soil rather abruptly becomes a very pale-brown slightly hard calcareous loam, slightly veined with lime. At about 27 inches and extending to an average depth of 40 inches is the layer of maximum lime accumulation—a very pale-brown calcareous hard silty clay loam with small veinings of lime. Beneath the lime layer the soil is slightly hard very light brownish-gray calcareous loam that grades into open porous gravel and cobbles embedded in sand at about 56 inches. Over the surface and throughout the sandy layers a scattering of very small basalt fragments as well as quartzitic gravel may be found. The basalt grains make up much of the sand content and give the soil its characteristic dark color.

The surface soil readily absorbs water, so that larger heads on shorter runs are necessary for an even distribution of the irrigation water. It is not so droughty as sandy types of the other series of soils, because the medium- to heavy-textured subsoil retains more moisture.

This soil has nearly as high an organic-matter content as Paul loam, but because of its sandier surface it is more rapidly depleted by cropping and requires not only more legumes in the rotation but more frequent and heavier applications of barnyard manure to the cash crops. In some areas irrigation has made the 12- to 18-inch surface layer mildly calcareous. Applications of phosphate fertilizer, however, have not shown any marked increase in crop yields.

All crops common to the area are grown on this soil. Alfalfa hay and potatoes give the best yields and are the principal crops. Alfalfa yields 3 to 5 tons an acre; potatoes, 200 to 400 bushels; wheat, 20 to 50; and barley and oats, 30 to 80.

Paul sand.—Areas of this soil type occur in widely scattered small tracts over the valley floor, especially just northwest of the Dewey School in sections 3 and 4, township 1 north, range 38 east; in section 32, township 3 north, range 38 east; and in section 7, township 2 north, range 39 east. It is usually associated with Paul sandy loam but has a sandier and usually deeper surface. Much of its dark color is due to the basalt sand with which it is mixed. Its organic-matter content is low but not so low as in Bannock fine sand or Bannock loamy fine sand.

This soil has a favorable relief for irrigation, but its deep surface soil of sand makes uniform distribution of irrigation water difficult. Since it is droughty and subject to wind erosion it is usually kept in alfalfa for extended periods. To improve the stands of alfalfa it often is top-dressed with light to medium applications of barnyard manure. Alfalfa occupies one-half to three-fourths of the acreage of this soil, which is planted to potatoes when broken out of sod.

PORTNEUF SERIES

The Portneuf soils occur largely on an upland plain west of the Snake River. The surface of this plain in most places is nearly level to undulating, becoming rolling to steep along the natural drainageways and rough and broken in places along the edge of the valley or where the deposit of loess is irregularly thin over the underlying lava, especially near the cinder cone and lava fields.

Included with these soils are isolated areas in which loess overlies the gravelly and sandy strata of the valley floor to depths ranging from about 6 to 15 feet. The normal relief here is undulating to somewhat hummocky, and the profile is very similar to that of the Portneuf soils of the uplands, although in most instances the natural profile and relief have been destroyed by severe scraping and leveling in preparation for irrigation.

The soils of this series are light in color and low in organic matter, having developed from an even-colored uniform floury calcareous loess under northern desert shrub and grass vegetation in a region of low rainfall. Under cultivation the dry soil of the more level areas is a pale or very pale brown or a light brownish gray that becomes darker but is still a pale or weak brown with an increase in moisture content. On rolling to steep land, exposure of the lime layer in dry fields gives rise to light-gray spots. The surface soil to an average depth of 10 inches is predominantly silt loam, although in some small areas it is fine sandy loam. It is pale brown, soft, and noncalcareous, with indistinct prismatic structure. The very light brownish-gray highly calcareous subsoil becomes hard at an average depth of about 14 inches and continues to about 3 feet, where it is light yellowish gray. This layer is underlain at 3 or 4 feet by a soft floury light yellowish-gray calcareous silt loam or very fine sandy loam. Under cultivation and irrigation the surface soil becomes calcareous within a few years.

Approximately three-fourths of the area of these soils is under cultivation. The greater part is irrigated by gravity flow, but surface water is pumped to irrigate one area. Crop yields from dry-farmed areas are low, however, and crops frequently fail during seasons of low rainfall.

Two types and five phases of the Portneuf series are mapped in the Idaho Falls area.

Portneuf silt loam.—The most extensive soil in the Idaho Falls area, this soil occurs in association with the rolling phase, principally in large continuous areas on the nearly level uplands west of the river.

In places where the soil has not been disturbed, the upper 8 inches are usually a pale-brown soft noncalcareous silt loam, and are underlain by a somewhat harder light brownish-gray mildly calcareous silt loam. This layer ends abruptly at 14 inches and is underlain by the main layer of lime accumulation, made up of light-gray to light yellowish-gray highly calcareous silt loam, which is hard and compact when dry but softens up considerably under irrigation. The lime occurs in nodular aggregates, in flakes, and in lime seams. Roots penetrate this layer but are found chiefly between the faces of structural units and in cracks. The soil below 36 inches is a soft floury highly calcareous light yellowish-gray silty and very fine sandy material, with some lime accumulation in firm nodules and in very thin veins. This layer extends to about 54 inches and is underlain by uniformly colored light yellowish-gray or very light yellowish-brown highly calcareous soft very fine sandy and silty parent loess that extends to undetermined depths below 6 feet.

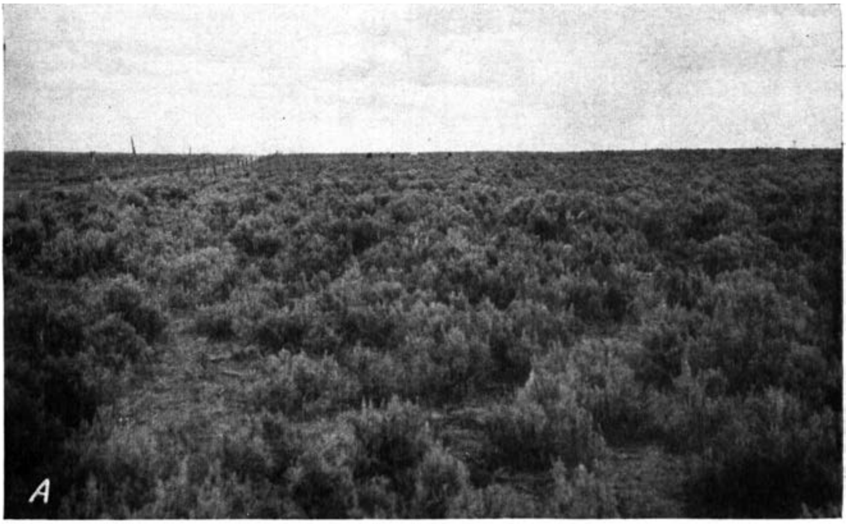
Southwest of Idaho Falls in the vicinity of the New Sweden School there is a variation that extends into the southwestern corner of the area. This is on a nearly level to gently undulating loessal plain lying 10 to 20 feet above the western edge of the valley floor but not so high as the main body of Portneuf soils. In general the variation differs little from the normal soil, although it is freer from lime to a somewhat greater depth. A 6- to 8-foot layer of stratified sand and gravel underlies the variation at an average depth of 15 feet.

Isolated areas in which the soil has developed from loess overlying the gravelly strata of the valley floor are also included with this soil. These are similar to soils of the Bannock series but have no gravel within a depth of 6 feet of the surface. Part of this variation occurs in township 3 north, range 37 east, 1 mile south of Payne. Another area is in section 21, township 1 north, range 38 east, half a mile south of Washington School, and two small areas are in township 1 north, range 37 east, 1 mile south of Cotton Siding. Small areas of very fine sandy loam are also included. These are confined largely to the northeastern part of the upland plain, west of the river.

The relief of this soil is ideal for the distribution of irrigation water, as it ranges from nearly level to gently sloping and somewhat undulating, facilitating good surface drainage. The layer of accumulated lime slows the downward percolation of irrigation water but does not interfere with good internal drainage.

By far the greater part of the acreage is under irrigation, water being diverted largely by gravity flow, although large areas are irrigated by pumping from surface flow. A considerable acreage is above present irrigation canals and ditches, however, and the northwestern corner of the area has been abandoned to sagebrush (pl. 3, *A*), rabbitbrush, and scattered bunchgrasses. South of the cinder cone a fairly large area is dry-farmed to wheat, barley, and rye. Alfalfa and small grains are irrigated by the border method; potatoes and sugar beets by the furrow method. Where peas are not flood-irrigated the corrugation method is used.

Most of this soil is in alfalfa and potatoes (pl. 3, *B*). Alfalfa is an important crop on farms where a highly diversified system of agriculture is practiced or on farms where alfalfa is rotated with the cash crops, potatoes and sugar beets. Alfalfa yields range from 3 to 6 tons an acre from two large cuttings and an occasional smaller third cutting. Potatoes follow hay in the rotation and occupy nearly as large an annual acreage as alfalfa, particularly in the southern part of the soil area, where fewer sugar beets are grown. Potatoes yield 250 to 500 bushels an acre, and sugar beets, 12 to 18 tons. Small grains and sometimes peas are used for companion crops for seedings of alfalfa. Wheat yields 40 to 70 bushels; barley, 60 to 90; and oats, 60 to 100. In some localities there is a considerable acreage in seed peas, which yield 20 to 50 bushels an acre.



A, Native heavy growth of sagebrush on virgin desert area of Portneuf silt loam.
B, Alfalfa hay on Portneuf silt loam.

A, Feeder lambs pasturing on sugar beet tops grown on Portneuf silt loam, rolling phase.
B, Exposed cut in Portneuf silt loam, rolling phase, showing layer of accumulated lime near surface and coarse prismatic structure.

Although this is one of the most productive soils of the area, it has a relatively low organic-matter content and requires good management to maintain high yields. Short rotations of 2 to 4 years in alfalfa or clover and 3 or 4 years in other crops are essential. Available barnyard manure also is used. The practice of applying phosphate fertilizer to sugar beets at the rate of 35 to 40 pounds an acre of available P_2O_5, and to new seedings of alfalfa and to clover at the rate of 40 to 80 pounds of available P_2O_5 is increasing. The response to applications of phosphate fertilizer has, in general, been much less on land that has been kept in a high state of organic fertility by manuring and growing legumes.

Portneuf silt loam, deep phase.—This phase occupies local shallow basinlike depressions or occurs along small natural drainageways that receive deposition of surface material eroded from surrounding soils. In places such deposits may be several feet deep. The phase usually has a deeper lime-free surface, a somewhat heavier texture, and slightly darker brown color than the normal phase. The areas mapped occcur usually in small isolated bodies in the uplands of the western part, principally in township 3 north, range 37 east and in the vicinity of Osgood and the cinder cone.

The upper 14 inches of this soil is a pale-brown mellow heavy silt loam underlain to depths ranging from 16 inches to 2 feet or more by a paler brown or light yellowish-gray heavy silt loam. This layer is leached of lime and although as soft as the surface layer, it breaks into small angular aggregates. Beneath this depth there is a moderately compact light brownish-gray calcareous heavy silt loam or silty clay loam that extends to about 36 inches, where the lime is more concentrated. The lime layer is hard when dry but friable when moist. The soft floury very light yellowish-brown loessal parent material is at depths of 4 to 6 feet.

All of this soil that is associated with irrigated areas of other soils of the Portneuf series is under cultivation. Because of its close association with adjacent rolling and steep areas of the Portneuf soils, it receives depositions of materials eroded from these soils when they are being irrigated. As a consequence it is considerably higher in organic matter and is recognized by the farmers as a stronger soil than some others. All crops used in rotation on the normal phase can be grown on this soil. Yields are similar, and for some crops, especially alfalfa, potatoes, and sugar beets, may be larger than on the normal phase. Small grains, however, tend to lodge on this soil.

Because of its position this phase receives waste irrigation water from higher ground and crops may be flooded out in places where water from adjoining slopes and short drains is allowed to collect. To remedy this situation farmers sink drainage wells 100 to 200 feet deep into natural crevices or openings in the underlying lava.

Portneuf silt loam, rolling phase.—This phase, which occurs extensively in association with the normal phase in large irregular continuous areas, is characterized by uneven undulations, low rolling knobs, and long slopes, probably owing largely to the unevenness of the underlying basalt beds and to modification by intermittent stream erosion. Slopes range from about 4 to 10 or 12 percent (pl. 4, *A*).

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In virgin condition this soil contains no lime to an average depth of 4 to 6 inches, although where disturbed by cultivation it is generally calcareous to the surface. The surface soil is thinner and is usually a paler brown than that of the normal phase and the lime layer is usually not so hard nor so thick (pl. 4, *B*). Stock trails worn over this and steeper phases of the Portneuf soil expose lime nodules that resemble small rounded pebbles.

Included with this phase are areas having a very fine sandy loam surface soil and a higher content of fine and very fine sand in the subsoil and parent material. These areas lie largely between the Snake River and United States Highway 91 northwest of Idaho Falls.

Where gravity water is available all this soil is irrigated. Because of its rolling relief, however, irrigation is much more difficult than on the normal phase. In order to retard erosion and loss of irrigation water small heads of water are used in the furrow method of irrigating row crops. These crops are often planted on contours conforming to the uneven relief. Small grains and alfalfa are irrigated by lands in which corrugations direct the water more evenly over the slopes. This phase produces the same crops as the associated more nearly level phase. The yields are high, although even under similar management practices they are normally 20 to 30 percent lower than on the more nearly level areas. In maintaining this soil in a high state of productivity, short crop rotations must be practiced and heavier and more frequent applications of barnyard manure made to the cash crops than on the normal phase. Because of the calcareous surface soil and the nearness to the surface of the layer of high lime accumulation, applications of phosphate fertilizer to sugar beets, clover, and new alfalfa seedings give striking increases in yield.

Portneuf silt loam, steep phase.—This phase is found in long narrow irregular strips bordering intermittent drainageways, and a narrow irregular band separates the uplands and the alluvial floor of the valley north of Idaho Falls. The largest single area is 4 miles west of Idaho Falls.

Under a sagebrush cover the soil is calcareous to the surface. When distributed the very thin layers above the lime layer break out in fragile thin flat blocks. The 4- to 6-inch layer of accumulated lime, which lies at depths of 3 to 6 inches, is neither so thick nor so hard as in the level to rolling areas.

Small isolated bodies of very fine sandy loam and fine sandy loam in the vicinity and north of Payne, as well as numerous small narrow rough broken areas where the basalt bedrock is exposed, are included.

The steep slopes of this soil make irrigation exceedingly difficult and in places impracticable. The loessal soil material washes and gullies very badly and must be handled with constant and extreme care when irrigated. Despite the steepness of the slopes, however, a considerable acreage of this phase is under irrigation and cultivation.

Crop yields are erratic but are usually low because of the difficulty of maintaining fertility and a uniformly favorable degree of moisture for the growing plants. Much of this steep land is kept in hay for extended periods. If seeded and irrigated this soil would furnish good summer pasture and erode less than if cultivated.

Portneuf silt loam, rolling shallow phase.—This soil occurs principally as numerous small areas in the midst of the Scabland 5 miles west of Idaho Falls and around the base of the cinder cone. The soil profile is similar to that of the rolling phase of the type but much shallower, being underlain by basalt bedrock, which sometimes appears as an outcrop and on the average is not more than 3 feet below the surface. Much of this phase is under irrigation and cultivated. The same crops are raised as on other soils of the Portneuf series. The soil produces fair yields, but unevenness of surface, shallowness, and the existence of areas where the underlying basalt is exposed make cultivation, irrigation, and harvesting difficult.

Portneuf fine sandy loam.—This soil is represented by only a few very small isolated areas, mainly west of Idaho Falls, north of Payne, 1 mile south of Cotton Siding and scattered over the valley floor in association with soils of the Bannock series.

To an average depth of 18 to 20 inches the soil is a very pale-brown noncalcareous soft light-textured fine sandy loam. The very light brownish- to yellowish-gray calcareous subsoil continues to a depth of as much as 5 feet, with the layer of maximum lime accumulation occurring at 2½ to 3 feet. The lime layer is neither so concentrated nor so hard as in Portneuf silt loam and can be easily penetrated by roots. The calcareous loessal parent material is light yellowish-gray and high in fine and very fine sand. In its normal condition the surface of the soil is undulating to hummocky, but it has been considerably modified by scraping and leveling for irrigation.

Most of the soil is being farmed, although cultivation is impracticable on a few very small higher lying areas where the relief is uneven and rolling and consequently unfit for irrigation.

Under irrigation the soil produces the crops commonly grown in the area. The best methods for increasing yields have been found to be continuous heavy applications of barnyard manure and the use of short rotations with alfalfa or clover. In this way the organic-matter content of the soil is increased or maintained and wind erosion materially decreased.

Alfalfa and potatoes grown in rotation average nearly as high in yield as on Portneuf silt loam, whereas yields of sugar beets and small grains are about a fourth to a third lower.

Portneuf fine sandy loam, rolling shallow phase.—The larger areas of this phase occur in the vicinity of Idaho Falls, and smaller areas are close to and west of the river in the vicinity of Payne and north to the county line. Only a small part is under irrigation, principally because of the naturally rolling relief, shallowness, and frequent outcroppings of basalt bedrock.

RED ROCK SERIES

The Red Rock series comprises two types occurring on the bottom lands or flood plains of small streams. They are pale brown or light brownish gray, moderately deep to deep, permeable, and fertile; but their location along stream channels, where uneven relief makes cultivation and irrigation difficult, lowers their value for crop production.

Red Rock loam.—This soil occurs along streams on the valley floor, the larger areas forming rather continuous narrow stretches along Willow Creek. It is found also along the channels of Sand Creek. A few areas are dissected by numerous abandoned stream channels.

The 15-inch surface layer is a soft light brownish-gray calcareous smooth-textured loam that becomes dark brown when moist. Under the upper layer the loam is also calcareous and soft, but of a lighter brown and a higher content of fine sand. At about 39 inches a similarly colored soft smooth-textured loam is encountered. This layer continues to about 45 inches, where it gives away to gravel loosely embedded in sand. The entire soil is calcareous, the lime being well distributed throughout the different layers.

Because of its irregular surface and the fact that numerous meandering stream channels isolate whole areas, this soil does not lend itself to easy irrigation or cultivation. It was not until relatively recent years that much of it was leveled and graded for irrigation.

The soil is fairly productive, although it is more droughty than the associated soils of the Paul series. Its natural fertility is somewhat susceptible to loss by leaching. A very high percentage of the land is farmed to alfalfa, potatoes, sugar beets, and small grains, planted in rotation. Yields are comparable to those on Bannock loam.

A considerable acreage of small level areas is being pastured where this soil is associated with the areas adjoining stream channels. These areas are sown to a permanent pasture mixture and afford excellent summer grazing in shady places where water from Willow Creek is available.

Red Rock silty clay loam.—This soil occurs in sections 7 and 16 of township 2 north, range 38 east and along Willow Creek in township 3 north, range 39 east. It differs from Red Rock loam in having a somewhat browner surface soil and a deeper deposit of fine-textured material over the sand, which is encountered at about 4 feet. Most of this soil is under cultivation and is somewhat more retentive of moisture and organic fertility than Red Rock loam.

ROUGH BROKEN LAND (WHEELER SOIL MATERIAL)

The areas classified as Rough broken land (Wheeler soil material) range all the way from a silt loam through very fine sandy loam, sandy loam, and loamy sand. In some places there are irregularly steep to almost precipitous slopes, exposing basalt rock outcrop and forming the steep and rugged walls of incised streamways and the uneven slopes of the Wheeler benches above the valley. These soils offer some pasture early in spring and later after fall rains, but none of them are tilled, either under dry land agriculture or irrigation. For the most part they support only a scattered growth of sagebrush, rabbitbrush, and annual weeds and grasses.

SCABLAND

Scabland consists of a complex of barren basalt outcrops and thin deposits of soil over basalt bedrock so intermixed that they cannot be delineated on the soil map. Approximately two-thirds of it occurs in the southwestern corner of the area, where the deposit of loess on the whole is relatively thin over the uneven surface of the underlying basalt. Most of the Scabland on the valley floor is found in the vicinity of Idaho Falls and along the river. Several small areas also occur northeast of Ammon. The intrusions of basalt through the Snake River alluvium are small, and where they lie well above the surrounding soils of the valley floor they have a thin soil covering of loessal origin. Other small areas occur where the basalt bedrock is overlain by a shallow layer made up of the associated soils of the valley floor. Unable to support more than sagebrush, annual weeds, and grasses, this land type has a very limited value as pasture.

WHEELER SERIES

The soils of the Wheeler series have developed from the loess of the rolling foothills and benchlands just east of the Snake River alluvial plain (pl. 2, *B*). The deposit of loess from which these soils were formed is not of uniform depth over the underlying basalt—it is deeper on foothills than over the plain west of the Snake River, while it is somewhat shallower over the remnants of the benchlike terraces adjacent to the valley.

In general the Wheeler soils are similar to the Portneuf but differ in having a calcareous surface soil and a subsoil somewhat softer, more permeable, and containing less lime.

The surface soil is soft calcareous silt loam. To about 15 inches the soil is pale to very pale brown or pale yellowish brown; below that depth it is lighter and grayer. A light yellowish-gray layer of lime accumulation usually occurs at about 24 inches and extends to 3 or 4 feet. Under dry field conditions the lime layer is slightly hard. The parent material is highly calcareous, soft, and uniform in texture and color.

All soils of this series on the lower benchlands bordering the eastern edge of the valley floor are under irrigation from water diverted by gravity flow. Water from surface flow is pumped to some of the higher benchlike plateaus, although one such area is irrigated by the diversion of two small mountain streams. Dry-land agriculture, extensively developed in the rolling foothill region nearer the mountains where there is more rainfall, is used also on the large areas of gently sloping to rolling Wheeler soils south of Ririe.

There is little native pasture on the Wheeler soils. Constant overgrazing has killed the bunchgrass, and the weeds and annual grasses that have replaced them are palatable to livestock for only a short time in spring and early summer.

The sandy loam and three phases of the silt loam were identified in this area.

Wheeler silt loam.—Occupying gently rolling uplands along the eastern edge of the valley, this soil covers large areas south of Willow Creek in township 3 north, range 39 east, and township 3 north, range 40 east. Included with this soil are also small areas bordering shallow intermittent drainageways, chiefly in township 3 north, range 39 east, which have numerous outcroppings and only a shallow layer of soil over the basalt.

The 5-inch surface layer is mildly calcareous soft very pale-brown silt loam of fragile blocklike structure under virgin sagebrush condi-

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tions. The silt loam upper subsoil is somewhat harder, more highly calcareous, and lighter in color than the surface soil. This part of the subsoil has a yellowish cast and breaks out in vertically elongated blocklike aggregates that extend to just above the slightly hard lime layer encountered at about 24 inches. Lime has concentrated in seams along the irregular fractures of the loam in this layer or takes the form of hard rounded and cylindrical nodular aggregates. The main concentration is in the form of lime flour and lime flakes. Roots of grass and shrubs penetrate this layer, and under irrigation crop roots seemingly encounter very little resistance. The soft light yellowish-gray calcareous parent loess is found at about 46 inches. This single-grain, very fine sandy loam continues to an undetermined depth below 6 feet.

Some of this soil, mainly that on the lower benchlike terraces adjacent to the valley, is under irrigation. One area is irrigated by water diverted from Henrys Creek and Taylor Creek. Dry land agriculture is practiced on soil of this kind south of Ririe, and areas dry-farmed for a number of years shortly after 1910 but later abandoned to annual weeds, grasses, and desert vegetation are once more in cultivation.

The normally gently rolling relief of this soil makes for somewhat rapid external drainage; hence care must be practiced in irrigating the more sloping areas. The lime layer softens under irrigation and with the deep loessal subsoil readily absorbs moisture.

The principal acreage of this soil is in alfalfa, followed by potatoes, sugar beets, and small grains. The rotations include 3 or 4 years in alfalfa usually followed by 4 years in other crops, although to a certain extent shorter rotations are practiced. Dry-farmed areas are cropped to wheat or barley every other year, in the alternate year being left fallow.

Yields of alfalfa hay average 2 to 6 tons an acre from two cuttings, and yields of alfalfa seed, about 300 pounds. Potatoes in rotation with alfalfa yield 200 to 500 bushels, the highest yields being on the more level areas. Yields of grain under irrigation are high—wheat yields 40 to 70 bushels; barley and oats, 50 to 100.

In virgin condition this soil, like the Portneuf soils, is low in organic-matter content. The application of available barnyard manure to the cash crops also materially aids the legumes, principally alfalfa, to increase or maintain the organic fertility of the soil. This soil is calcareous to the surface and for this reason needs phosphate fertilization when planted in alfalfa, clover, sugar beets, or other crops that need large quantities of phosphate. Applications of 40 to 80 pounds of available P_2O_5 to the acre on new seedings of legumes and 25 to 40 pounds of available P_2O_5 annually on sugar beets would probably show definite response in crop yields.

Wheeler silt loam, level phase.—A comparatively small acreage of this phase has been mapped. Small areas occur in section 11 of township 1 north, range 38 east and in section 18 of township 3 north, range 40 east. Others are 2 miles southeast of Washington School, south of Ririe, and in the vicinity of Shelton Cemetery.

The more level areas, unlike those of the normal phase, have been leached of lime to a depth of 2 to 6 inches. The layer of lime accumulation, which lies at relatively shallow depth, is somewhat more compact in the level than in the normal phase of this type and only somewhat less compact than in soils of the Portneuf series.

Only approximately half the total acreage of this soil lies below the present gravity irrigation ditches and can be irrigated; the rest is dry-farmed. Where it can be irrigated its nearly level to very gently sloping surface is ideal for the distribution of irrigation water. Like other soils of the Wheeler series, it readily absorbs moisture and is sufficiently porous to allow water to percolate into the underlying soft loess parent material.

Yields of crops grown on this soil, principally alfalfa, potatoes, sugar beets, and small grains, are on a par with the good yields obtained on the normal phase of Portneuf silt loam.

Wheeler silt loam, steep phase.—This soil occupies uplands along the east side of the valley, the largest area 2 miles southeast of Ammon, and smaller areas south of Washington School in township 1 north, range 38 east.

This soil is similar to the normal phase except for its steeper relief, shallower surface soil, and even softer, more permeable subsoil. Lime accumulation in the upper 2 feet occurs as incipient faint veinings or flakes or as a coating to the soft nodular soil aggregates. This layer is only a little harder than the soft even-textured calcareous underlying loess. The soil is very pale brown to very light brownish gray in the surface few inches and gradually changes to light yellowish gray in the underlying parent material.

Areas east of Iona have a sandy loam or loamy sand texture. These coarser textured soils contain a considerable quantity of angular and subangular lime-coated basalt fragments.

Little of this phase is cultivated, but where it occurs in association with Wheeler soils that are not so steep, it is irrigated and cultivated and is planted chiefly in alfalfa, which yields proportionally better than intertilled crops or small grains. Erosion caused by irrigation is reduced to a minimum by keeping the land in alfalfa for long periods or by sowing it to a permanent pasture mixture. The alfalfa or pasture sod more readily absorbs water and reduces surface runoff.

Wheeler sandy loam.—This soil occurs on the west-facing upland slopes east of Iona. Several areas having a loamy sand texture also are included. Many lime-coated angular and subangular basalt fragments are scattered over the surface as well as through the profile. Basalt rock is found a short distance under the surface soil. All this soil has remained in scattered desert shrub vegetation and, with associated steeper slopes, supports only very meager native pasture.

PRODUCTIVITY RATINGS

The approximate average crop yields to be expected over a period of years from the different soils in the Idaho Falls area are given in table 6. The expected average yields in columns A are under the most common management practices; in columns B, under improved management practices as recommended by the State agricultural experiment station and the agricultural extension service.

TABLE 6.—*Estimated average acre yields of the principal crops on soils of the Idaho Falls area, Idaho* [1]

[Yields in columns A are obtained under prevailing practices; those in columns B, under improved practices]

Soil	Alfalfa hay (tons)		Potatoes (bushels)		Sugar beets (tons)		Wheat (bushels)		Barley (bushels)		Oats (bushels)		Peas, seed (bushels)		Red clover seed (bushels)		Irrigated pasture (cow-acre-days) [3]		Unirrigated pasture range (cow-acre-days) [2]
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Ammon fine sandy loam	2.5	4.0	200	250	7	12	25	35	40	55	45	70	20	40	5	10	100	275	(3)
Sloping phase	2.0	4.0	150	200	6	10	20	30	35	50	40	65	20	35	5	8	100	250	(3)
Ammon silt loam	3.5	5.0	300	400	14	17	45	60	70	90	80	100	25	45	7	12	150	320	(3)
Bottom-land phase	3.5	5.0	300	400	14	17	45	55	70	90	75	100	25	45	7	12	150	320	(3)
Bannock fine sand	1.0	1.5	75	125	4	6	10	15	10	15	15	25	5	15	3	5	50	200	(3)
Hummocky phase	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	2
Sloping phase	1.0	1.5	75	125	4	6	10	15	10	15	15	25	5	15	3	5	50	200	(3)
Bannock fine sandy loam	2.0	4.0	225	300	8	12	35	40	45	60	50	70	20	40	5	9	100	300	(3)
Shallow phase	1.0	2.0	125	150	6	7	15	25	20	30	20	30	10	20	3	5	75	200	(3)
Sloping phase	2.0	3.5	150	200	6	9	20	30	30	50	35	50	15	25	4	7	100	250	(3)
Bannock gravelly fine sandy loam	2.0	3.0	175	200	6	8	20	35	30	50	40	65	15	30	4	7	110	275	(3)
Sloping phase	1.0	2.0	100	150	4	6	15	25	20	30	20	40	7	15	3	5	85	225	(3)
Bannock gravelly loam	2.0	3.0	175	200	6	8	20	35	30	50	40	65	15	35	4	7	120	300	(3)
Sloping phase	1.0	3.0	100	150	5	7	15	25	25	35	30	45	8	15	3	5	100	250	(3)
Bannock gravelly loamy fine sand	1.0	3.0	125	150	4	6	10	20	15	25	25	40	8	15	3	5	75	250	(3)
Bannock gravelly silty clay loam	2.0	3.0	125	175	5	7	35	50	50	60	65	90	15	40	4	7	100	300	(3)
Steep phase	(2)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	4
Bannock loam	2.0	4.0	220	320	9	14	35	50	50	70	60	85	20	40	5	10	120	320	(3)
Bannock loamy fine sand	1.5	3.0	150	200	5	7	15	25	20	30	30	45	10	25	3	6	75	250	(3)
Sloping phase	1.0	3.0	125	175	5	7	15	25	20	30	25	40	10	20	3	6	75	250	(3)
Bannock sandy loam	2.0	3.0	200	250	7	10	25	30	40	50	40	65	20	35	5	8	100	250	(3)
Bannock silty clay loam	2.0	4.0	200	300	12	16	45	60	70	85	75	100	20	40	6	12	100	300	(3)
Sloping phase	1.5	3.0	160	180	9	11	35	50	45	65	55	70	15	30	3	7	100	275	(3)
Bannock very fine sandy loam	2.0	4.0	220	320	9	14	35	50	50	70	60	85	20	40	5	10	120	320	(3)
Blackfoot silt loam	4.0	6.0	350	400	15	18	55	65	75	90	90	120	30	45	7	12	150	350	(3)
Dune sand	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Lava flows	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Paul gravelly silty clay	2.0	3.0	100	150	8	10	45	60	60	80	75	95	10	20	3	5	100	300	(3)
Paul gravelly silty clay loam	2.0	3.0	125	175	8	10	45	60	60	80	75	90	12	20	3	5	100	300	(3)
Paul loam	2.5	4.0	250	300	10	14	40	60	55	80	65	90	25	40	5	8	100	300	(3)
Paul sand	2.0	3.0	150	200	6	7	15	30	30	45	35	50	10	25	3	6	75	200	(3)
Paul sandy loam	3.0	4.0	250	300	8	10	25	40	40	60	50	75	25	45	5	8	125	325	(3)
Paul silty clay	2.0	3.0	150	200	15	18	55	70	80	90	85	110	15	20	3	5	100	300	(3)
Paul silty clay loam	2.0	3.0	175	250	15	17	55	70	75	90	85	110	15	25	3	6	120	300	(3)
Sloping phase	1.5	3.0	130	180	10	12	35	50	50	65	60	80	15	30	3	7	100	275	(3)

Portneuf fine sandy loam	3.0	5.0	250	350	8	12	30	40	40	60	50	80	20	40	5	8	100	300	(3)
Rolling shallow phase	1.5	3.0	150	175	8	10	20	30	25	40	40	50	10	15	4	7	75	250	(3)
Portneuf silt loam	3.5	5.0	300	400	14	17	45	60	70	90	75	100	25	45	7	12	125	300	5
Deep phase	3.5	5.0	350	400	15	17	40	50	65	80	80	90	25	45	7	12	150	320	(3)
Rolling phase	2.5	5.0	225	300	10	14	40	50	55	70	60	85	25	40	7	12	100	250	(3)
Rolling shallow phase	1.5	2.0	150	175	7	10	20	30	25	40	35	50	10	15	3	7	75	250	(3)
Steep phase	1.0	3.0	100	150	6	8	15	30	25	40	30	45	10	30	4	7	50	200	(3)
Red Rock loam	2.0	4.0	250	300	12	15	40	60	55	80	60	90	25	40	5	8	150	350	(3)
Red Rock silty clay loam	2.0	3.0	175	250	15	17	50	70	75	90	85	110	15	25	3	6	120	320	(3)
Rough broken land (Wheeler soil material)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	2
Scabland	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	2
Wheeler sandy loam	2.0	3.0	175	200	6	7	15	30	30	50	35	50	15	30	4	7	100	200	(3)
Wheeler silt loam	2.5	5.0	225	300	10	14	40	50	55	70	60	85	25	40	7	12	110	250	5
Level phase	3.0	5.0	250	350	12	15	40	55	60	80	70	90	25	40	7	12	125	300	(3)
Steep phase	1.0	3.0	100	150	6	8	15	30	25	40	30	45	10	30	4	7	50	200	4

[1] Average annual yields obtained under irrigation farming, except for the rating given a few unirrigated soils used extensively as range for livestock.

[2] Cow-acre-days, used to express the carrying capacity of pasture land or range, is the product of the number of animal units carried per acre multiplied by the number of days that animals can be grazed without injury to pasture; for example, a soil that supports 1 animal unit per acre for 360 days rates 360; a soil supporting 1 animal unit on 2 acres for 180 days rates 90; and a soil supporting 1 animal unit on 4 acres for 100 days rates 25.

[3] Soil is unsuited to and not used for this crop.

The most common practices, which are variable because they depend to some extent on the soil, have already been mentioned in this report under many of the soil descriptions. In general they include various-length crop rotations that consist of growing in succession alfalfa (or clover), potatoes, and sugar beets or small grains; and the occasional application of manure if available. They do not, however, include the use of commercial fertilizer. The principal differences between common and improved management practices lies in the length of time the various soils are planted to the various crops. In general the sandier, shallower, and steeper soils are kept in alfalfa for the greater part of the time and are planted to row crops for shorter periods. Irrigation practices on the different soils also vary, since the sandier and shallower soils require more frequent irrigation to maintain favorable moisture conditions.

Improved practices include short crop rotations that keep the land in alfalfa (or clover) at least half the time but not more than 4 years at a stretch; the application of barnyard manure at least once during each rotation period; and use of liberal quantities of phosphate fertilizer on alfalfa that is to be followed by potatoes or sugar beets. Nitrogenous fertilizer is used on potatoes when they do not follow alfalfa in the rotation, and phosphate fertilizer on potatoes and sugar beets if the preceding alfalfa crop has not been given liberal applications of that fertilizer. Small grains are grown but 1 year in the rotation, as a companion crop for alfalfa or clover. In some instances sweetclover may replace alfalfa as a green-manure crop in the rotation. The steeper and more erodible soils are used largely for irrigated pasture and alfalfa.

In studying table 6 it should be borne in mind that the yields indicated are averages over a period of years, good and bad, and that in any one year the yields may either fall below or exceed the averages.

Although in their natural state the soils of the Idaho Falls area have low productivity, because of the climate, they become highly productive under irrigation and compare for the most part favorably with soils in other parts of the United States. Their rating, based on a weighted average of the productivity indexes for various groups according to the relative acreages of the crops, is given in table 7.

The index of 100 in this table represents the average yield of the crop that might be expected from the higher yielding soils in the United States. As in table 6 columns A are computed from the average yields and columns B indicate anticipated yields under improved practices.

TABLE 7.—*Productivity ratings and land classes of soils in the Idaho Falls area, Idaho*

FIRST-CLASS SOILS—EXCELLENT CROPLAND

[Yields in columns A are obtained under prevailing practices; those in columns B, under improved practices]

Soil[1]	Crop productivity ratings under irrigation farming for—																	
	Alfalfa hay (100=4 tons)		Potatoes (100=200 bushels)		Sugar beets (100=12 tons)		Wheat (100=25 bushels)		Barley (100=40 bushels)		Oats (100=50 bushels)		Peas, seed (100=25 bushels)		Red clover, seed (100=6 bushels)		Pasture, seeded and irrigated (100=100 cow-acre-days)[2]	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Blackfoot silt loam	100	150	175	200	125	150	240	250	190	225	180	240	120	180	120	200	150	350
Portneuf silt loam	90	125	150	200	120	140	180	240	175	225	150	200	100	180	120	200	125	300
Deep phase	90	125	175	175	125	140	160	200	140	200	160	180	100	180	120	200	150	300
Ammon silt loam	90	125	150	200	120	140	180	240	175	225	160	200	100	180	120	200	150	320
Bottom-land phase	90	125	150	150	120	140	180	220	175	225	150	200	100	180	120	200	150	320
Portneuf fine sandy loam	90	125	140	175	80	120	160	180	150	175	140	180	100	180	120	200	100	300
Wheeler silt loam, level phase	75	125	125	175	100	125	160	220	150	200	140	180	100	160	120	200	125	300
SECOND-CLASS SOILS—GOOD CROPLAND																		
Portneuf silt loam, rolling phase	60	125	110	150	80	120	160	200	140	175	120	170	100	160	120	200	100	250
Wheeler silt loam	60	125	110	150	80	120	160	200	140	175	120	170	100	160	120	200	100	250
Red Rock silty clay loam	50	75	100	125	125	140	220	280	190	225	170	220	80	160	50	100	100	300
Paul loam	60	100	125	150	100	125	160	240	140	200	130	180	100	160	80	130	150	350
Bannock silty clay loam	50	100	100	150	100	130	180	240	175	210	150	200	80	160	100	200	100	300
Paul silty clay loam	50	75	90	125	125	140	220	280	190	225	170	220	60	100	50	100	120	300
Red Rock loam	50	100	125	150	80	120	160	240	140	200	120	180	100	160	80	120	150	350
Paul silty clay	50	75	75	100	125	150	220	280	200	225	170	220	60	80	50	80	100	300
Paul sandy loam	75	100	125	150	65	80	100	160	100	150	100	150	100	180	80	130	125	325
Bannock loam	50	100	110	160	75	120	140	200	125	175	120	170	80	160	80	170	120	320
Bannock very fine sandy loam	50	100	110	160	75	120	140	200	125	175	120	170	80	160	80	170	120	320
Bannock fine sandy loam	50	100	110	150	65	100	140	160	110	150	100	140	80	160	80	150	100	300
Ammon fine sandy loam	60	100	100	125	60	100	100	140	100	110	90	140	80	160	85	165	100	275
Bannock sandy loam	50	75	100	125	60	80	100	120	100	125	80	130	80	140	80	130	100	250
Paul gravelly silty clay loam	50	75	60	90	65	80	180	240	150	200	150	190	50	80	50	80	100	300
Paul gravelly silty clay	50	75	50	75	65	80	180	240	150	200	150	190	40	80	50	80	100	300
Bannock gravelly silty clay loam	50	75	60	80	40	60	140	200	125	150	130	180	60	150	65	120	100	300

See footnotes at end of table.

TABLE 7.—*Productivity ratings and land classes of soils in the Idaho Falls area, Idaho*—Continued

THIRD-CLASS SOILS—FAIR CROPLAND

Soil[1]	Crop productivity ratings under irrigation farming for—																	
	Alfalfa hay (100=4 tons)		Potatoes (100=200 bushels)		Sugar beets (100=12 tons)		Wheat (100=25 bushels)		Barley (100=40 bushels)		Oats (100=50 bushels)		Peas, seed (100=25 bushels)		Red clover, seed (100=6 bushels)		Pasture, seeded and irrigated (100=100) cow-acre-days)[2]	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Ammon fine sandy loam, sloping phase	50	100	75	100	50	85	80	120	80	120	80	130	80	140	85	130	100	250
Bannock fine sandy loam, sloping phase	50	90	75	100	50	75	80	120	75	125	70	100	60	100	65	120	100	250
Bannock silty clay loam, sloping phase	35	75	80	90	75	90	140	200	110	160	110	140	60	120	50	120	100	275
Paul silty clay loam, sloping phase	40	60	65	90	80	100	140	200	125	160	120	160	60	120	50	120	100	275
Bannock gravelly loam	50	75	90	100	50	65	80	140	75	125	80	130	60	140	65	120	120	300
Bannock gravelly fine sandy loam	50	75	90	100	50	65	80	140	75	125	80	130	60	120	65	120	110	275
Wheeler sandy loam	50	75	90	100	50	60	60	120	75	125	70	100	60	120	65	120	100	200
Paul sand	50	75	75	100	50	60	60	120	75	110	70	100	40	100	50	100	75	200
Portneuf fine sandy loam, rolling shallow phase	40	75	75	90	65	80	80	120	60	100	80	100	40	60	65	120	75	250
Portneuf silt loam, rolling shallow phase	40	50	75	90	60	80	80	120	60	100	70	100	40	60	50	120	75	250
Bannock loamy fine sand	40	75	75	100	40	60	60	10C	50	75	60	90	40	100	50	100	75	250
FOURTH-CLASS SOILS—POOR CROPLAND																		
Portneuf silt loam, steep phase	25	75	50	75	50	65	60	120	60	100	60	90	40	120	65	120	50	290
Wheeler silt loam, steep phase	25	75	50	50	50	65	60	120	60	100	60	90	40	120	65	120	50	200
Bannock loamy fine sand, sloping phase	25	75	60	90	40	60	60	100	50	75	50	80	40	80	50	100	75	250
Bannock fine sandy loam, shallow phase	25	50	60	75	50	60	60	100	50	75	40	60	40	80	50	80	75	200
Bannock gravelly loamy fine sand	25	75	60	75	35	50	40	180	35	60	50	80	30	60	50	80	75	250
Bannock gravelly loam, sloping phase	25	75	50	75	40	60	60	100	60	90	60	90	30	60	50	80	100	250
Bannock gravelly fine sandy loam, sloping phase	25	50	50	75	35	50	60	100	60	90	50	90	30	60	50	80	85	225
Bannock fine sand	25	40	40	60	35	50	40	60	25	35	30	50	20	60	50	80	50	200
Sloping phase	25	40	40	60	35	50	40	60	25	35	30	50	20	60	50	80	50	200

FIFTH-CLASS SOILS—NONARABLE RANGE LAND

Rough broken land (Wheeler soil material)	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	[4] 2
Bannock gravelly silty clay loam, steep phase	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	[4] 4
Bannock fine sand, hummocky phase	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	[4] 2
Scabland	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	[4] 2

SIXTH-CLASS SOILS—WASTELAND

Dune sand	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])
Lava flows	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])	([3])

[1] Soils listed in approximate order of physical suitability for general farming purposes, under prevailing and recommended practices.
[2] See table 6, footnote 2.
[3] Soil is unsuited to and not used for this crop.
[4] Estimates for unirrigated range pasture.

LAND CLASSES

The soils of the area are classed in six groups, according to general suitability for the production of crops under irrigation. The classes are based primarily on productivity but also take into consideration workability and the possibility of maintaining productivity over a longer period.

The principal soil factors affecting productivity are depth, permeability, water-holding capacity, and fertility. The relief, as it affects efficient tillage and the distribution of irrigation water, also is important. The workability of a soil is dependent largely on slope or relief, soil texture, and consistence. Characteristics affecting the conservability of a soil and the maintenance of its productivity are chiefly slope, permeability, and consistence.

First-class soils, designated excellent cropland, occur on smooth or nearly level to gently undulating relief. They are medium-textured, deep, permeable, fairly fertile, and have a high moisture-holding capacity. They are well drained, easily tilled and irrigated, and highly productive under irrigation and proper management. They have a general productivity rating under common farming practices of more than 100 and under improved farming practices of more than 150, and for some crops, much higher.

Second-class soils, classed as good cropland, make up more than half the area surveyed. The soils are varied but in general have some physical feature, or combination of features, that makes them less favorable for irrigation or production of crops than are the First-class soils. In some instances the relief is less favorable for irrigation or control of runoff and erosion; in others the texture is somewhat heavier or somewhat lighter than ideal. In some instances the soil is of comparatively low moisture-holding capacity; in others soil fertility is not so high as in the First-class soils. In general, soils of this class have a general productivity rating under common practices ranging from 70 to 100; under improved practices from about 100 to 150.

Third-class soils, considered fair cropland, are distinctly less productive and harder to work and to irrigate because of sloping or uneven relief or gravelly texture. In general their productivity is considerably lower than that of First- and Second-class soils, rating under common practices 50 to 70, and under improved practices about 75 to 100.

Fourth-class soils, designated poor cropland, include soils with steep slopes and very shallow or sandy droughty soils. Productivity under common management ranges from about 30 to 50, and under improved practices from about 50 to 80.

Fifth-class soils, which comprise nonarable range land, consist of steep or rough land or excessively sandy soils and Scabland. They furnish only limited native pasture.

Sixth-class soils are considered wasteland. They are made up exclusively of Dune sand and Lava flows and are practically barren.

LAND USE AND MANAGEMENT

The agricultural history of the irrigated parts of the Idaho Falls area has shown that the low humus content and limited organic fertility of the soils are the principal factors limiting crop production. In an attempt to maintain fertility, farmers for many years have used crop rotations that included legumes. The principal legume utilized in the rotation is alfalfa, which was first grown on irrigated fields as a winter feed for livestock. As irrigation became more widespread farmers found first that potatoes and grain and later sugar beets yielded better when planted in rotation with alfalfa. Originally these rotations were not fixed and were usually rather long. As a cash crop, however, alfalfa hay brought small returns. At that time the only manure applied to the soil came from the small farm herd fed on alfalfa hay.

Gradually decreasing crop yields have resulted in shorter and more fixed rotations, but the practice of turning under only the roots and stubble of the legume has proved insufficient to maintain soil productivity. Farmers, furthermore, have found it difficult to keep a large enough farm herd to use all the hay produced and consequently they now sell their surplus hay to sheep growers and lease their fields as fall pasture.

On farms where there has been a better balance between farm crops and livestock and where, during a short rotation, all of the land has gotten at least one application of manure between the legume crops, higher yields have been maintained, and alfalfa and sugar beets have shown less need for phosphate fertilizer. On many farms where the practice is not possible the interval between crops of alfalfa is lengthened by adding to the rotation a green-manure crop, usually sweetclover, which is plowed under in the spring following a grain-crop harvest. It is also a common practice when breaking out stands of alfalfa to plow under the green growth.

Continued irrigation over a period of years causes most soils to become less productive for crops that feed heavily on available phosphate, as alfalfa, red clover, and sugar beets. Work done at the Branch Experiment Station, at Aberdeen, as well as the experience of individual farmers throughout the upper Snake River Valley, has demonstrated the increasing need of crops for fertilizers containing available phosphate. The decrease in the availability of the soil phosphate has been definitely correlated with a high lime content of the surface soil (*6, p. 23*).

Most of the medium- to heavy-textured soils of this area become calcareous when irrigated. The surface of virgin soils of the Portneuf, Bannock, and Paul series is leached of carbonates to depths of 8 to 20 inches. Studies made of adjacent virgin and irrigated areas of Bannock gravelly loam and Bannock fine sandy loam in Bingham County (*4*), show a large increase in lime above the zone of lime accumulation and a corresponding decrease in the soluble phosphate in these upper horizons in irrigated areas. In the Idaho Falls area a small virgin area of Paul silty clay loam that received occasional flooding from the small ditch that irrigates the adjoining field was found to be mildly calcareous in the surface 2 to 6 inches, although below this depth as far as 16 inches it was noncalcareous.

The practice of scraping and filling to level fields for irrigation, as well as normal tillage operations, does much to distribute lime mechanically throughout the tilled depth of the soil in some areas. Moreover, under irrigation the zone of lime accumulation becomes thoroughly saturated and when the surface soil dries there may be some upward movement of lime in solution in the capillary rise of the water. It is possible also that much of the lime that has accumulated in the surface layer of irrigated soils has been deposited by irrigation water diverted from the Snake River (*4*). Water samples taken from the Snake River, at Blackfoot, in Bingham County, were found to carry 50 parts per million of calcium (*5, p. 174*).

Fertilizer studies at the Idaho Branch Agricultural Experiment Station since 1921 (*6*) have established a number of facts. Results of the earlier trials in the use of phosphate fertilizers on alfalfa indicate that the supply of available phosphate in the soils decreases and the lime in the surface soil increases after extended use of irrigation. Subsequent experiments indicate that in general the higher the lime content the greater is the possibility that phosphate fertilization is advisable. For both immediate and continued crop response, however, a large part of the phosphorus in phosphate fertilizer must be readily available. The soils on which these fertility trials were made are similar in lime content and concentration to the Portneuf and Bannock soils of the Idaho Falls area. Classified with the soils of the Delco series in the Soil Survey of the Blackfoot-Aberdeen Area, they are pale brown and characterized by a shallow surface soil containing little lime and a moderately compact subsoil layer of lime accumulation.

Crop rotation is the farmer's best and most practical method of proportionally distributing his crops, maintaining the fertility of the soil, and aiding in the control of insect pests, various plant diseases, and noxious weeds. Supplementary measures must often be taken to control all these conditions, but infestations of weeds, insect pests, and bacterial diseases are aggravated by the continuous growing of single crops.

The present trend is to recommend shorter rotations, covering 4 to 7 years, during which legumes occupy the land for 2 or 3 years and other crops about an equal length of time.

The greatest benefit from the growing of alfalfa is seemingly imparted to the soil during the first 2 years. Three- and 4-year old stands of alfalfa often suffer severe damage and thinning from bacterial wilt. Alfalfa crops in the valley are often seriously damaged by the alfalfa weevil. The greatest damage has been suffered by the first hay crop and has been more pronounced on soils of the valley floor than on the adjoining upland. Since little alfalfa seed is grown in this area, almost no attempt has been made to control the weevil by chemical sprays. Considerable study, however, has been made on the control of the alfalfa weevil by the University of Idaho.[7]

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[7] EKE, P. A., and JOHNSON, N. W. BASIC DATA FOR LAND CLASSIFICATION OF BONNEVILLE COUNTY, IDAHO. Univ. Idaho Agr. Expt. Sta. Dept. of Agr. Econ. in cooperation with Works Progress Adm., Idaho State Planning Bd., and U. S. Forest Serv. Ser. 2, 26 pp., illus. 1937. [Processed.]

Wireworms seriously damage crops of sugar beets and small grains in the early growth and potatoes at all stages. Areas suffering damage have been continually widening. Considerable study has been made concerning the life cycle and feeding habits of this organism (*7, p. 30*), and short rotations have been found probably the best method of control. Studies have shown that infestation by wireworms is heaviest on potatoes and lightest on alfalfa, and that on red clover, it is twice as great as on alfalfa.

Chlorosis is frequently evident in many of the small farm orchards, particularly where the soil has a shallow lime layer. Studies made by various departments of the Idaho Agricultural Experiment Station (*7*) indicate that there is close correlation between the lime content of the soils and the type of chlorosis found in southeastern Idaho. Cottonwood and poplar trees sometimes become chlorotic and eventually die.

In this region of rather deep loessal and alluvial soils and an abundant supply of moisture through irrigation, noxious weeds flourish unless kept continuously in check. Canal and ditch banks, fence lines and roadways furnish well-watered and fertile out-of-the-way places for weeds to start. The most widely distributed are morning glory, whitetop, burdock, Russian knap weed, Canadian thistle, povertyweed, and quackgrass. Seed distribution is greatly widened by irrigation waters contaminated by weed-infested canal banks or runoff water from infested fields. Clean cultivation is the best method of eradicating weeds from large fields.

Calcium chlorate or carbon bisulfide are applied to small patches along roadways, fence lines, and canal banks, and other methods are used. Some countywide programs for the eradication of noxious weeds have been launched. Weeds are usually not so much of a problem on farms in the uplands as on older ones on the adjoining valley floor.

Fertility trials at the Aberdeen Branch Experiment Station indicate the need of organic or nitrogenous fertilizers for potatoes, which when grown on land of better than average fertility and in the proper rotation showed profitable results from applications of nitrogenous fertilizers.

There has been considerable question among farmers who have used phosphate fertilizers for alfalfa and sugar beets as to their value for potatoes. The Progress Report of Fertilizer Investigations (*6*) reports that experiments with phosphate fertilization of potatoes show that when potatoes are grown in a balanced rotation in which the legumes, particularly red clover and alfalfa, have had sufficient available phosphorus for proper development, the use of available phosphate fertilizer on potatoes is not profitable. Where nitrogen is found to be out of balance with phosphorus or in excess of plant requirements, however, an application of 40 to 80 pounds an acre of available P_2O_5 is desirable.

Under irrigation, soils of this area seeded to a pasture mixture produce excellent permanent summer pasture. These pastures are usually seeded early in spring, then harrowed and rolled to insure a maximum stand. Most of the pastures, however, have been confined to isolated fields, where for some physical reason the land is not adapted to the crop used in the rotation on the adjacent fields. Much of the pasture is rotated with legumes, as alfalfa or sweetclover. Extensive areas of noncropped lands adjacent to this area afford limited early spring pasture for sheep. As a result of overgrazing and abandonment of dry farming, a dense young growth of sagebrush and rabbitbrush has now taken over much of the range, and its estimated carrying capacity is only 1 animal unit for 50 to 80 acres. There is some growth of giant ryegrass, bunch wheatgrass, and sweet sage, but most of the grass cover is downy chessgrass. Seeding trials in range studies by the National Forest Service at Grays Lake recommend reseedings of crested wheatgrass.

Some farms in the valley have large flocks of sheep and a few large herds of range cattle that are summer grazed on the national forests. These herds and flocks, as well as those moved in from the ranges of this and neighboring States for winter feeding, are brought down into the valley after harvest to pasture on fields of stubble and alfalfa and sugar-beet tops.

IRRIGATION AND DRAINAGE

The rise of the upper Snake River Valley as a successful agricultural region was made possible by the development of the irrigation system. Crop failures and the final abandoning of extensive areas devoted to dry-land farming proved that in this area a permanent system of agriculture depended upon irrigation. The early source of irrigation water was the normal seasonal flow of the Snake River. Later the construction of large reservoirs in the mountain headwaters of the river insured a more even supply and permitted a wider development of this region. There are two large storage reservoirs on the Snake River above Idaho Falls: Jackson Lake Reservoir, with a storage capacity of 847,000 acre-feet; and Henry Lake, with a capacity of 75,000 acre-feet.

The entire Upper Snake River Valley is in Irrigation District No. 36. Most of the irrigation in the Idaho Falls area is by gravity flow, although there are several small and one larger pumping project where water is pumped from the Snake River and from diversion canals to higher-lying lands. In most years there is an abundant supply of gravity water available to the farmers at a very reasonable rate. Dams on the river divert water into the several cooperatively owned canals that serve this area. Water is allocated to the farmer at his head gate by the acre-foot and miners' inch. During successive dry years there is some curtailment in the supply, particularly to water users from canals that have later water rights from the Snake River. Crops and soils differ greatly in the quantity of water necessary to mature a crop. The average requirement is somewhat less than 4 acre-feet, but on the very sandy soils it runs in excess of 8 acre-feet, largely because of loss of water by deep percolation.

Intertilled crops are irrigated by furrows; small grains and hay crops, by flooding between lands or borders. Frequently the border method is supplemented by the use of corrugations. Where the land is somewhat uneven to rolling the corrugation method aids in a more uniform distribution of water.

Runoff from irrigation is diverted into large drainage ditches although many of the deeper stream channels also are used. Where the gradient and difference in elevation will allow, much of the runoff is rediverted into irrigation canals and often is used again on the same farm.

West of the river on the soils of the Portneuf series the runoff irrigation water is not so completely drained back into the irrigation ditches and forms ponds in small and large depressed areas during the irrigation season. Much of this water seeps away or evaporates, but some of the larger depressions have become more or less permanent ponds. Wells to depths of 50 to 200 feet are often sunk in these depressions so that the water may drain into crevices and openings in the underlying lava. Such water is lost for further irrigation in the immediate locality. That which escapes into the gravel strata underlying the soils of the valley floor, however, is recovered at various points farther down the valley (*5, p. 115*).

The underlying open and porous gravel and sand strata as well as the deep water table assure good drainage of most of the soils of the valley floor, as none have impermeable horizons of lime accumulation. There is no harmful seepage or accumulation of alkali salts. The deep loessal deposits of the Portneuf and Wheeler soils are underlain by a somewhat porous basalt that insures subdrainage of these soils. Surface drainage of the Paul silty clay loam and Paul silty clay, however, must often be insured by proper slope gradient and care in irrigation. Paul silty clay has especially slow internal drainage, and if improperly managed when irrigated and tilled it is likely to puddle.

EROSION

There is some active erosion of soils under irrigation in this area. Unwise use of irrigation water on soils that are particularly susceptible to erosion may in time raise a major problem. The soils of the Portneuf, Wheeler, and Ammon series, because of their relief and uniform loessal textures, are particularly susceptible to erosion. Irrigation on the sloping, rolling, and steep phases of these soils has in numerous places exposed the limy subsoil layer. Drainage ditches are in places enlarged into wide gullies, consequently where there is any slope to these ditches, the construction of checks is advisable. Farmers control irrigation erosion on uneven or sloping land by contour furrowing and by using small heads of water in corrugations. The border method is utilized when irrigating small grains and hay.

In the uplands adjoining the irrigated valley, wind and water erosion has been materially increased by continued overgrazing of the sparse desert vegetation. The soils of the Wheeler series are subject to more severe erosion by spring runoff and occasional summer thundershowers than the Portneuf soils, which are usually on less rolling relief. Sheet erosion is common, and gullying occurs in many of the short tributary drainageways on the steep slopes.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of weathering and soil development acting on the parent material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend on (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life in and on the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of development have acted upon the material. The climate, and its influence on soil and plants, depends not only on temperature, rainfall, and humidity but also on the physical characteristics of the soil or soil material and on the relief, which, in turn, strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

The upper Snake River Valley, of which the Idaho Falls area constitutes an important part, is the northeasternmost extension of the intermountain physiographic region known as the Snake River Plain. The soils of the area have been formed from transported calcareous parent materials under the influence of a semiarid climate and a northern desert shrub type of vegetation. They have developed through the soil-forming process of calcification and are characterized by a zone of calcium carbonate accumulation of variable degrees of development, dependent upon the relief they occupy and the age of deposit. Known as Pedocals, the soils of this area are related to the great soil groups of Brown soils and Sierozems.

The soil-forming forces of a desert climate alter the characteristics of the parent material little, but in the normal soils of the area there is some soil development and the formation of definite surface soil and subsoil layers. Approximately a third of the average annual precipitation of about 11 inches falls during winter months when the ground is frozen, and of this a part is lost in spring runoff.

The moisture that falls as summer showers is subject to a high rate of evaporation owing to the prevailing dry southwesterly winds and the meager shade afforded by the usual vegetative cover. In the normal soil, however, even that much moisture has leached the carbonates from the surface soil to an average depth of 10 to 14 inches and concentrated them below that depth.

The native northern desert shrub type of vegetation returns very little vegetative debris to the soil. From the sparse growth of grasses and of leaves of shrubs there is a limited accumulation of organic matter and a weak calcium cycle, but the rate of decomposition of the surface debris and of the larger roots of the dead brush is slow in the dry soil. Under natural conditions rodents account for most of the redistribution of the lime and organic matter throughout the soil; and under irrigation the activity of large numbers of earthworms also is very much in evidence.

The soils of the uplands, represented by the Portneuf and Wheeler series, have developed from loessal deposits. The loess in this region is of undetermined origin but is generally believed to have been material borne in by the prevailing westerly winds from large lake beds, alluvium deposited by streams, and substances erupted by volcanic action (*5, p. 23*). This wind-borne material was deposited to variable depths over nearly level to rolling beds of the Snake River basalt west of the valley floor, and over undifferentiated lava flows of various ages and of cinder deposits of a more uneven hilly relief east of the alluvial floor of the valley. This loess is highly calcareous and has probably accumulated over a long period of years. Some authorities point out (*5, p. 23*) that its slow rate of accumulation is indicated by the fact that the most recent lava flows in the region, probably not less than 1,000 years old, are still free of soil and that only the cracks in their surface show evidence of some deposits of wind-borne material. This loess was also deposited over the alluvial floor of the valley. In isolated areas deposits of uniform-textured loess have been made to maximum depths of about 12 feet over the mixed sand, gravel, and boulders of the Snake River alluvium. Islandlike areas of basalt bedrock in this gravelly alluvium have a variable but generally a thin covering of loess.

The most mature or normally developed soils of the area are light-colored, and although relatively low in organic matter they are high in mineral fertility. Lime has been leached from the surface soil to a depth of about 10 or 14 inches and deposited in the lower horizons to depths as great as 5 feet. The lime accumulation occurs principally in veins, and to some extent as lime nodules, in a horizon that attains a variable degree of compaction and soft cementation.

The normal soil profile in this region is exemplified by Portneuf silt loam, which occurs on a nearly level to gently sloping relief. This soil is characterized by a pale-brown soft and somewhat prismatic surface of light to medium texture, over a very pale-brown or very light brownish-gray hard layer of nodular and veined lime accumulation. The color and structural and textural differences in the several horizons indicate the accumulation or translocation of organic and inorganic soil materials and the development of a solum. Owing to the sparseness of the natural vegetation, the erosive action of both wind and water have resulted in a normal removal of surface soil in this region throughout the period of its development.

The profile of Portneuf silt loam described below is representative of soils occupying an approximately 2-percent slope and supporting a fair stand of sagebrush and rabbitbrush.

0 to 1/16 or 1/4 inch, fragile surface crust of very light brownish-gray very fine sand or silt, cracked in a geometric pattern that conforms to the blocky structure of the horizon below; a thin layer of mixed very fine sand and undecomposed plant remains in small protected areas around the base of desert shrubs.

1/16 or 1/4 to 3 inches, very light brownish-gray noncalcareous silt loam, breaking out in fragile flat 2- to 6-inch geometric blocks that separate horizontally into thin layers, the first inch having a clearly defined fragile platy structure.

3 to 11 inches, pale-brown noncalcareous silt loam, the maximum intensity of color occurring at about 9 inches; soft prismatic structure; somewhat vesicular.

11 to 14 inches, light brownish-gray calcareous silt loam, slightly hard and transitional to the main zone of lime accumulation.

14 to 40 inches, light-gray hard zone of lime accumulation; lime occurs in heavy veins and as nodules 1/16 to 1/2 inch in diameter, lime flour, and flakes. Roots have penetrated through this horizon. The material breaks out in irregular brittle aggregates along heavily lime-seamed fractures.

40 inches +, soft friable light yellowish-gray highly calcareous silt, readily crumbling when disturbed to a floury almost single-grained silt. The maximum degree of structural and color development occurs at 3 to 11 inches. In some profiles this horizon is slightly heavier in texture than the thin surface layer, indicating a possible slight downward translocation of clay or hydrolysis of the material in place and development of organic colloids.

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The soils of the Wheeler series are similar to those of the Portneuf in having developed from light yellowish-gray calcareous loess. In the case of the Wheeler soils, however, the loess has been deposited over a more rolling topography. The loess probably belongs to the same geologic age as that underlying the more mature soils of the area, but the rolling relief and consequently more rapid runoff of the Wheeler soils have made for more rapid removal of the surface soil by wind and water erosion. The erosion has resulted in a younger, less maturely developed profile in which the surface soil is practically unleached of lime and the layer of lime accumulation is less hard and concentrated.

On some of the more level or gently sloping areas the surface soil to several inches has been leached of lime and the zone of lime accumulation is fairly hard. In these areas the degree of development approaches that of the Portneuf soils.

The profile of Wheeler silt loam examined under native sagebrush cover is as follows:

0 to 3 inches, a thin fragile surface crust of very light brownish-gray very fine sand or silt, cracked in places in irregular geometric patterns; below the crust a very light brownish-gray mildly calcareous silt loam that may be removed in soft flat horizontal blocks, easily crumbled to a fine soft granular condition.

3 to 14 inches, very pale-brown calcareous silt loam, tending when disturbed, to break out into large irregular ill-defined prisms, which are vesicular and have no definite horizontal or vertical cleavages but very readily crumble to a fine granular condition.

14 to 18 inches, light brownish-gray calcareous silt loam without consistent compaction or structure.

18 to 30 inches, a slightly hard layer of lime accumulation in a light-gray silt loam, occurring mostly as lime flour and in flakes, with some veining and nodular lime development. The calcareous nodular aggregates are not so hard nor so indurated with lime as those in the Portneuf soils.

30 inches +, parent material of soft floury calcareous creamy-gray silt.

The soils of the valley floor have developed from calcareous alluvial deposits that in places have been modified by wind action and by the deposition of wind-borne materials. With the exception of the soils of the Paul series and of Blackfoot silt loam, the soils of this area are light brownish gray to pale brown and naturally low in organic matter.

The soils of the Bannock and the Paul series have developed from an alluvium of more varied geological origin than those of the Ammon, Blackfoot, and the Red Rock series. They have developed under the same general climatic and vegetative conditions as the Portneuf soils.

The Bannock soils are similar in morphology to the Portneuf but have been developed on nearly level to gently sloping terraces from a more or less gravelly alluvium that has been modified to some extent by the deposition or shifting of wind-laid materials.

The soils of the Paul series have developed from a finer textured alluvium than those of the Bannock. The brown and reddish-brown clays that were probably eroded from the high elevations of rolling to mountainous slopes of formations high in rhyolite and andesite were deposited in the quieter backwaters of the valley between the coarser deposits of the Bannock series and the upland to the southeast of the valley. This parent deposit has given rise to a browner or somewhat reddish-brown soil. The Paul series is characterized by brownish-gray to dark-brown soft to slightly hard surface soils that pass into a browner heavy-textured harder horizon at about 6 to 10 inches and from that depth continue to a light brownish-gray or very pale-brown layer of lime accumulation, lying at greater average depth than that of the lime layer in the soils of the Bannock series.

The following profile description is of Paul silty clay loam under sagebrush. The size and distribution of the large sagebrush indicated that this soil had never been tilled.

0 to 3 inches, brownish-gray silt loam, breaking into flat blocklike platy-structured aggregates 2 to 6 inches in diameter.

3 to 6 inches, brownish-gray light silty clay loam, separating horizontally, like the horizon above, into soft friable vesicular platelike blocks up to 6 inches in diameter.

6 to 16 inches, pale-brown silty clay, becoming dark brown when moist, the dry soil breaking out in slightly hard prisms 2 to 4 inches in diameter. These can be readily crumbled into subangular nutlike aggregates that vary in size from irregular fine blocky somewhat vesicular aggregates 1/16 to 1/4 of an inch in diameter to others up to 2 inches. The combination of these into larger units determines the jagged outline into which the prism breaks. Numerous very small rootlets are massed between the faces of these larger structural aggregates.

16 to 24 inches, light brownish-gray calcareous heavy silty clay loam with a slightly pinkish cast and throughout which the lime is well disseminated, is slightly hard to hard in place, and breaks out into sharply angular pieces that offer moderate resistance to crushing. The irregular blocky bright aggregates are somewhat larger than those of the layer above, measuring up to 1/2 inch in diameter.

24 to 40 inches, lighter brownish-gray silty clay loam, forming the main horizon of lime accumulation, which occurs principally in veins or as a thin coating over somewhat vesicular cubically angular structural aggregates. There is also some nodular lime development. The horizon is hard in place and the 1- to 2-inch angular nutlike fragments into which the soil breaks firmly resist crushing. Small roots penetrate this horizon chiefly between the faces of the angular soil units.

40 to 77 inches, a light brownish-gray lime-veined silty clay loam, becoming with depth increasingly more friable and lighter and grayer in color. The small soil aggregates are less angular and more granular in the lower part.

77 inches +, light grayish-brown calcareous sand.

The soils of the Ammon, Blackfoot, and Red Rock series are azonal soils without well-developed profiles. The Ammon soils, formed from alluvium only recently eroded from the rolling hills of the Wheeler soils and laid on very gently sloping alluvial fans, are characterized by pale-brown light- to medium-textured soils in which there is very little change in color, texture, or consistence to depths of 3 feet or more. In virgin areas of these soils, carbonates are leached from the surface soil to a maximum depth of 3 inches, and there are slight accumulations of lime in a slightly hard horizon.

The following profile of Ammon silt loam is representative of this soil under sagebrush cover:

0 to 1/4 inch, thin fragile surface crust of very light brownish-gray silt loam.

1/4 to 3/4 inch, loose fine granular pale or very pale-brown silt loam.

3/4 to 2 1/2 inches, pale-yellow or very pale-brown silt loam, breaking out in large soft flat geometric blocks, which are outlined by vertical cracks and separate horizontally into fragile plates.

2 1/2 to 8 inches, pale-brown soft silt loam, breaking into large irregular prismlike aggregates.

8 to 15 inches, pale-brown soft silt loam with considerable very fine sand; somewhat vesicular.

15 to 33 inches, pale-brown soft silt loam of a definite yellowish cast; more vesicular and of more definite but smaller prismatic structure than the layers above, with some elongated slightly hard lime-coated nodular soil aggregates ½ to 1 inch in diameter, their centers darker gray.

33 to 42 inches, a weakly developed horizon of lime accumulation, the lime occurring principally as lime flour, flakes, and in thin veins along fractures of this slightly hard very light yellowish-brown silt loam, in which are moderately hard gray lime-coated nodules similar to those of the layers above.

42 inches +, a light yellowish-gray highly calcareous floury silt loam.

The soil of the Blackfoot series has little morphological relationship to any of the other soils of the area. More highly organic than the other soils, it consists of dark-gray alluvial deposits eroded from soils developed under the cooler and more humid climate of the mountains and deposited by floodwaters on the alluvial floor of the Snake River Valley.

The following profile description is representative of an area of Blackfoot silt loam under cultivation and in rotation pasture:

0 to 18 inches, brownish-gray calcareous silt loam, becoming dusky brown or brownish black when moist; the surface soil when disturbed breaking out in large irregular clods that are readily reduced to a soft granular mass. Below the plowed depth the soil is very porous and contains many worm holes and worm casts.

18 to 27 inches, brownish-gray calcareous silt loam, when moist becoming dusky brown and breaking out into large very friable clods that break up into porous subangular and rounded nutlike aggregates ½ to 1½ inches in diameter; and when dry becoming slightly harder than the surface horizon.

27 to 46 inches, very light brownish-gray calcareous smooth-textured loam, becoming when moist a pale brown and forming into very porous subangular to rounded aggregates up to 3 inches in diameter and having some mycelialike lime veining. The dry structural aggregates are slightly harder than in the horizon above.

46 to 78 inches, very light brownish-gray silty clay loam heavily veined with lime and when moist of a slightly pinkish cast. This continues to about 78 inches where it is underlain by light-brown sand.

The relatively recent stream alluvium from which the soil of the Red Rock series has developed is derived from a wider geological source than the alluvial deposits of the Ammon and Blackfoot series. These pale-brown medium-textured deposits, closely associated with the soils of the Paul series, have little or no profile development. There is no textural difference between the horizons other than that due to diversity in the mode of deposition of parent material. There has been some slight movement of lime through the profile but its accumulation in the lower horizons is apparent in faint veins in only a few of the profiles examined.

The following profile description of Red Rock loam is of the soil in an irrigated permanent pasture.

0 to 15 inches, pale-brown or light brownish-gray soft smooth-textured loam, dark brown when moist and when disturbed forming large irregular vertical blocks that break up into vesicular nutlike aggregates 1 inch in diameter. The soil evidences considerable earthworm activity. Its color becomes slightly lighter with depth.

15 to 39 inches, pale- to very pale-brown loam with a higher content of fine sand; soft and porous, and containing many worm holes and worm casts.

39 to 45 inches, pale-brown smooth-textured loam. The moist soil digs out in large very friable clods. The entire profile is calcareous and overlies mixed sand and gravel.

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