SOIL SURVEY OF THE FALLON AREA, NEVADA

By A. T. STRAHORN and CORNELIUS VAN DUYNE.

DESCRIPTION OF THE AREA.

The Fallon area covers about 150,400 acres of land lying in the west-central part of Nevada and comprising parts of Churchill and Lyon Counties.

The boundaries of the area are very irregular, being controlled by the extent of land now under cultivation or susceptible of irrigation and cultivation under the present irrigation system. The greater part of the area occurs as a continuous body of land extending southeastward from Hazen to Stillwater. The remainder of the area is a long narrow strip, between the Southern Pacific Railroad and the line of the main Lower Truckee Canal, extending westward from Hazen to the boundary line of the Pyramid Lake Indian Reservation, a distance of about 15 miles.

A low, nearly continuous range of mountains extends around three sides of the area. To the north the rolling desert plain reaches for miles until broken by Carson Sink and the still more distant mountains.

This area lies in what is known as the Great Basin. No streams arising within this region discharge their waters into the ocean, but simply into a vast depression, where the water is removed only by seepage or evaporation. This physiographic division has an extent of about 208,000 square miles and covers the greater part of the States of Nevada and Utah and portions of Wyoming, Oregon, and California. Within this region there are three major hydrographic basins which in past geological periods contained extensive bodies of water, having no outlets. With changing climatic and geological conditions these lakes slowly dwindled until at the present time they are represented by relatively small bodies of water, or, in some cases, by extensive barren flats, highly alkaline and devoid of plant and animal life. The bodies of water which now remain are, with few exceptions, very saline, and contain few if any forms of life.

The ancient lakes are known as Lake Bonneville and Lake Lahontan, the former occupying a considerable area in the present State of Utah, and the latter an extensive area in western Nevada.

The Fallon area covers the southern portion of one of the larger arms of the former Lake Lahontan. This is now known as the Carson Desert or as the Carson Sink Valley.

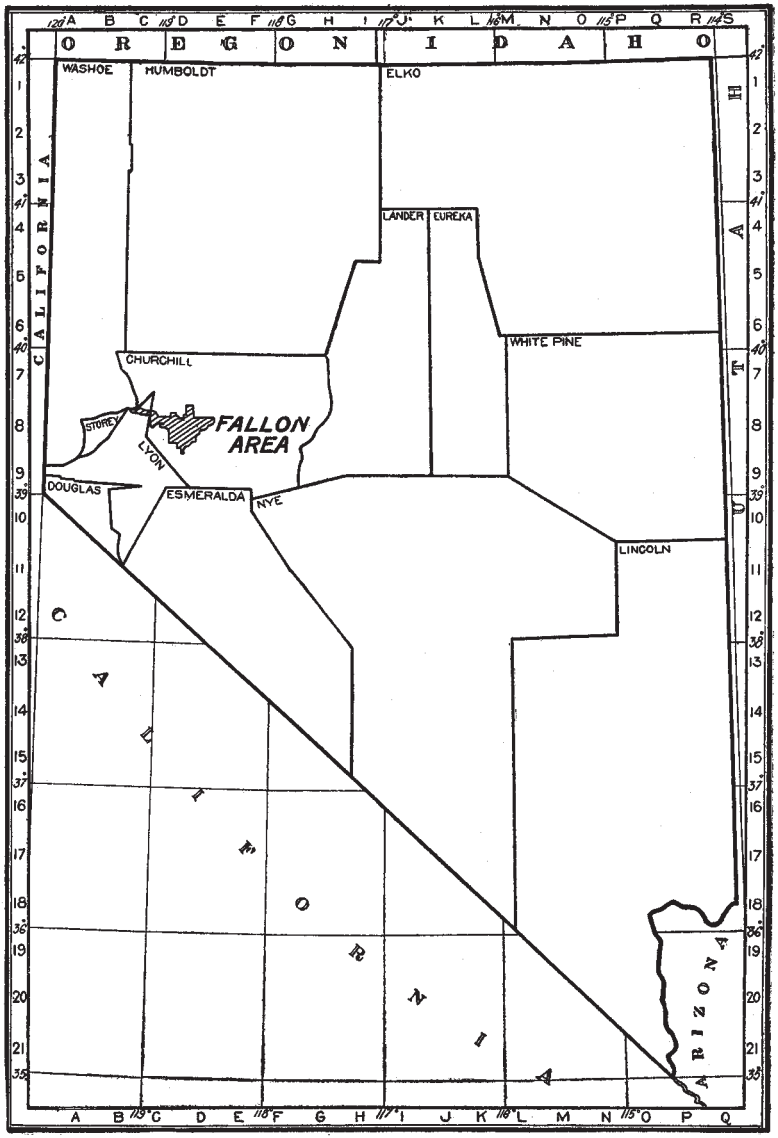

FIG. 47.—Sketch map showing location of the Fallon area, Nevada.

Save for two pronounced irregularities of surface, the area consists of rolling desert land, dotted by a multitude of yellow sand dunes, and by the white glaring surfaces of innumerable barren playas. (Pl. XIX, fig. 2.) Across this desert the courses of the Car-

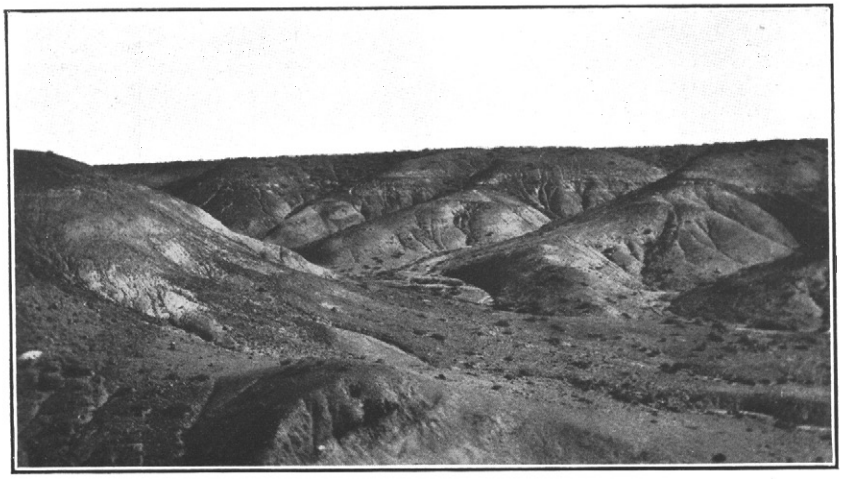

FIG. 1.—EROSION IN LAHONTAN LAKE BEDS NEAR TRUCKEE CHUTE.

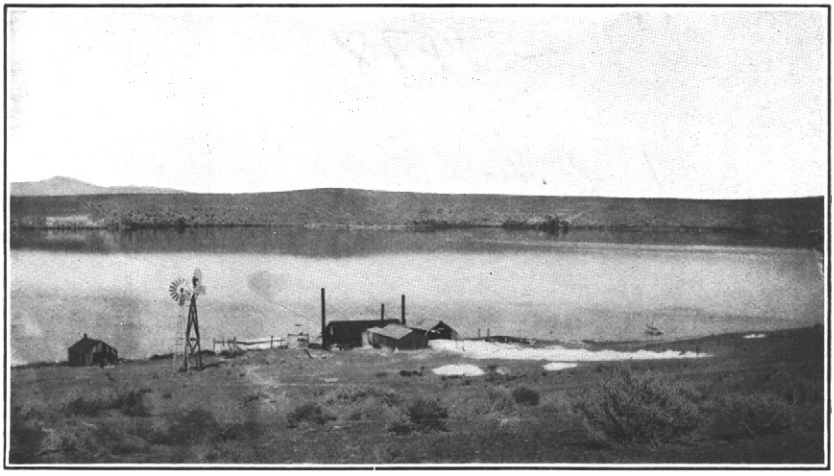

FIG. 2.—BIG SODA LAKE, SHOWING INCLOSING CRATER RIM.

son River and its branches, bordered by cottonwoods and willows, appear as winding ribbons of green in the desert. At each end of the valley lies a lake, now covering extensive areas of lowland, and again, in seasons of unusual aridity, disappearing, leaving level, flat plains, devoid of vegetable life, but covered with salt crystals which give the surface the appearance of newly fallen snow.

Near Fallon a rocky hill—Rattlesnake Hill—rises above the desert and forms a landmark visible from all parts of the valley.

About 2 miles northeast of Leetville two circular depressions containing water and surrounded by prominent rims mark the site of volcanic craters, active during and subsequently to the Lahontan period. The crater rims rise some 80 feet above the surrounding desert and some 150 feet above the inclosed lakes.

The larger body of water, known as Big Soda Lake (Pl. XVI, fig. 2), lies about 50 feet below the level of Carson River and has a depth of about 150 feet in the deepest part. There is no surface inlet or outlet connected with this lake, and the water probably comes by seeping through the subsoil from Carson River. In its passage through the underlying lacustral sediments large amounts of soluble material are picked up and carried into the lake. The smaller of these two depressions, known as Little Soda Lake, is nearly dry, containing water only in depressions. This water is very saline, and upon evaporating, during the summer, leaves a thick deposit of impure sodium carbonate.

The only water courses in this valley are the Carson River and its branches and Stillwater Slough. The former, entering the area through an eroded gorge about 7 miles south of Hazen, flows eastward to a point near Fallon. Here it turns northward and empties into Carson Sink, about 25 miles north of Fallon. The South Branch, or channel, of the Carson River leaves the main stream about 6 miles west of Fallon, and flows southeasterly, discharging its waters into Carson Lake. Prior to 1862 the larger part of the water in Carson River flowed through this branch. In the spring of that year, during an unusual flood, the waters deepened another channel, now the main channel, and since then the larger part of the flow has passed northward into the Sink.

The channels of those streams were frequently unable to carry the spring rush of waters from the mountains and overflowed considerable areas of adjacent bottom land, doing damage both to hay and to stock. To avoid this, the settlers cut the south bank of the Carson River about 3 miles east of the forks and allowed the flood waters to flow onto the desert. A channel was soon cut in the light soil and the stream discharged into Stillwater Slough some distance south of Stillwater.

Since the construction of the present irrigation system both forks of the main stream have been dammed, and now carry no water beyond a trifling amount which reaches them by seepage through the Sink.

Stillwater Slough is a small, winding water course leading from Carson Lake to Carson Sink. Before the change in the flow of the streams, as noted above, this stream carried the overflow from the lake northward into the Sink. Later, the water in the lake being lowered so that it did not overflow, the water in the slough became stagnant. At the present time there is some movement of water, as the drainage waters from the project and the unused irrigation waters are discharged into it.

Although the Great Basin was known to early Spanish missionaries, hunters, and trappers, there are no definite records of exploration and travel until 1832 and 1833. In the former year Captain Bonneville reached the eastern border of the Basin, and a year later Joseph Walker crossed and recrossed the entire Basin. With the passing years numerous scientific and surveying expeditions explored various parts of the Basin, and by 1850 well-defined routes of travel were in existence.

The first permanent settlements were made on Carson River and the South Branch at points where the overland trails crossed the streams. The main stage trail ran south from the present site of Lovelocks to a point on the Carson River at the present site of Leetville. This section was known as the Forty-mile Desert and was one of the most dreaded portions of the entire trail. By the time the emigrants had reached Lovelocks they were frequently in a poor condition to attempt a journey of 40 miles across a waterless sandy desert. As a consequence many animals and not a few persons perished on this stretch of trail. The old trail is still plainly visible and for miles is littered with metal and, rarely, with wooden fragments of broken vehicles.

Another branch of the overland trail, used largely by the pony express, crossed the southern portion of the area, and a station was located at the present site of St. Clair.

The first settlers, aside from those connected with the stage and express companies, located in the river bottoms and the lowlands surrounding Carson Lake. They raised some cattle and sheep and cut quantities of native hay to supply feed for the teams of the stage companies and transient outfits. Others came in and settled along the streams, until practically all of the bottom land was in private ownership. Later arrivals settled on adjacent lands, where it was possible to irrigate from the spring flow of the streams. General farming was not practiced beyond the production of a few staples for home consumption, as there were no available markets. The energy

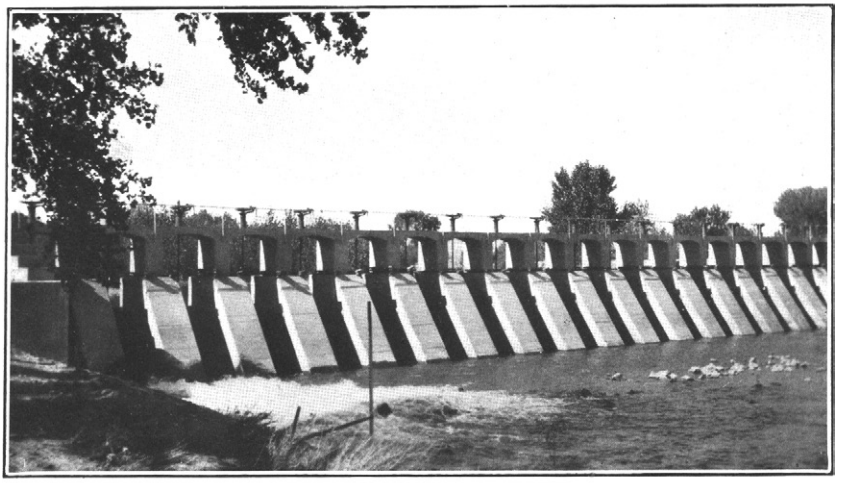

FIG. 1.—CARSON DAM—DOWNSTREAM FACE.

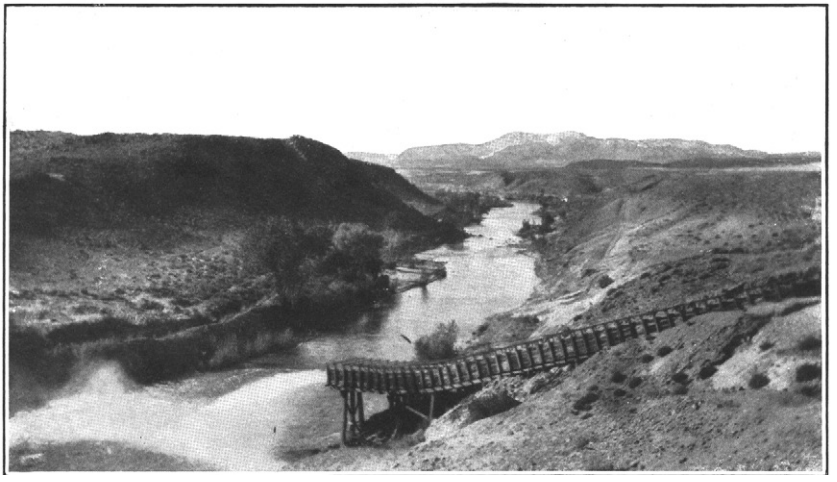

FIG. 2.—TRUCKEE CHUTE, LOOKING UP CARSON RIVER.

of the settlers was directed largely to sheep and cattle raising, as these products could be driven to the desired markets.

No marked agricultural development took place, however, until the construction of the present irrigation system by the United States Reclamation Service. Following this the population of the valley increased by leaps and bounds. Many came unprepared for the conditions which existed, and for a short time more persons were leaving the valley than were coming in. Now, since the conditions are more settled and better understood, there is a slow but steady and sure growth in the permanent population of the valley. This will continue, probably for several years, as the growing commercial enterprises demand, as manufacturing conditions warrant, and until all of the available irrigable land is settled.

Fallon is the largest town in the area, having a population of about 1,000. It is the county seat of Churchill County, the headquarters of the United States Reclamation Service on the project, and will probably always be the principal center of the area.

Hazen, on the main line of the Southern Pacific Railroad, in the eastern part of the project, has a population of about 100. Branch lines of the Southern Pacific lead from this place to Fallon, Tonopah, and Goldfield. Stillwater, an early settlement in the valley and formerly the county seat of Churchill County, is at the eastern end of the project, 14 miles from Fallon. The place is a supply point for the eastern part of the area and for some mining interests in the mountains on the east. Fernley is a small settlement in the western part of the area with a small area of irrigable land tributary to it. It is on the main line of the Southern Pacific Railroad, 12 miles west of Hazen. St. Clair is a small settlement on the South Branch of the Carson River, about 4 miles southwest of Fallon. This was formerly a station on the overland route of the pony express.

The main line of the Southern Pacific Railroad passes just north of the project and with its branches affords direct communication with all of the principal markets of the west. Numerous wagon roads lead from Fallon to various mining camps in the surrounding mountains. Freighting companies and stages afford means of transportation for supplies and passengers.

Markets for the produce from this area exist throughout the State and in the larger cities of adjacent States. Some fear is felt by a few that when the entire area of irrigable land is made productive there will be a surplus and consequent hardship to the farmers. There seems to be little danger of such a condition in the future. At the present time the increase in agricultural products is not keeping pace with the increase of population in this State, nor does it seem probable that the productive agricultural area will increase rapidly

enough to overtake the market demands even for the State, leaving aside the possible markets outside the State. Two conditions are responsible for this. The population of the State, coincident with its mining, agricultural, and commercial development, is increasing rapidly and will continue to do so for a very considerable period. Also the amount of land which may be rendered productive by irrigation is limited, even with the fullest development of the available water.

CLIMATE.

The climate of this region is arid. The records, though covering a comparatively limited period and being more or less incomplete, show that the precipitation is negligible from an agricultural viewpoint, since practically all of it occurs during the winter and early spring months. The storms approach from the southwest and occur as gentle rains, unaccompanied by high winds or electrical disturbances. Snow forms but a small part of the annual precipitation. The ground is seldom covered for more than a day.

Below are given comparative statistics of the monthly mean precipitation for several places in this valley:

Mean monthly and annual precipitation.

Month.	Fallon.	Wadsworth.	Lovelocks.	Month.	Fallon.	Wadsworth.	Lovelocks.
	Inches.	*Inches.*	*Inches.*		*Inches.*	*Inches.*	*Inches.*
January	0.54	0.84	0.43	August	0.06	0.27	0.03
February	.80	.80	.53	September	.20	.26	.25
March	.53	.58	.27	October	.38	.24	.23
April	.34	.32	.18	November	.18	.37	.20
May	.99	.70	.32	December	.64	.58	.19
June	.21	.15	.05	Total	4.97	5.42	2.81
July	.10	.31	.13				

Besides this small annual rainfall the climate is characterized by hot, dry summers and by moderately cool winters. The maximum temperature so far recorded at Fallon is 103° F., and many seasons pass without the thermometer rising above 100° F. Even this extreme heat is not unpleasant, the dryness of the air making it less oppressive than a temperature of 90° F. in the more humid regions of the country. This same dryness of the air is also responsible for a wide daily range in temperature. During the hottest part of the summer the nights are pleasantly cool, and during the winter night temperatures close to zero are usually succeeded by bright, sunshiny days.

Comparative temperatures from different parts of the valley are given in the following table:

Mean monthly and annual temperature.

Month.	Fallon.	Wadsworth.	Lovelocks.	Month.	Fallon.	Wadsworth.	Lovelocks.
	°F.	°F.	°F.		°F.	°F.	°F.
January	30.8	31.2	32.6	August	72.0	75.2	75.6
February	36.1	37.0	35.5	September	60.9	63.0	64.1
March	41.3	41.6	43.5	October	50.7	50.2	52.0
April	50.0	50.4	50.8	November	39.7	39.5	42.0
May	55.7	58.6	60.0	December	32.0	32.2	31.3
June	64.6	66.8	67.8	Total	50.6	52.0	52.6
July	73.5	77.9	76.5				

Data regarding the occurrence of spring and fall frosts and the length of the growing season are so incomplete that no definite conclusion can be reached. Also, the varied topography of the area is responsible for a very wide variation in the dates of frost, and no single set of figures will show the true conditions. For a considerable part of the area the growing season probably extends from the middle of May to the first of October. In low regions, near Carson Lake and along portions of Carson River, the season is probably somewhat shorter. In the higher bench lands, around Soda Lake north of the Carson Dam and along the Main Lower Truckee Canal, the season will probably average from two to four weeks longer than in other sections of the area.

The prevailing direction of the wind is from the southwest. During the spring months winds of considerable force blow for one or more days and often do damage to loose unprotected soils. During the remainder of the year strong winds are unusual and the air movement seldom amounts to more than a pleasant breeze.

Cloudy days are rare during the summer and fall months, and even during the winter the percentage of sunshiny days is large.

Hail and electrical storms are extremely rare and tornadoes are unknown.

AGRICULTURE.

As already stated, the agricultural development of this area began in the early fifties, when overland stage travel was at its height. The first settlers located along the streams and near Carson Lake, and engaged in putting up native hay to supply the stage companies and emigrant trains. Gradually the settlements extended northward along the rivers and onto the plains, and individually owned canals were constructed to utilize the spring flow of the streams in the irrigation of the native grass lands. Cattle raising assumed some im-

portance, the animals ranging over the valley lands and in the foothills and mountains surrounding the valley. Later some alfalfa was grown, but the distance from a market and the lack of an adequate water supply limited the acreage and yield.

When the Reclamation Service undertook the construction of the present canal system practically all of the river bottom land, the lands north of Carson Lake, and a small area of desert land was in private ownership. About 25 per cent of the land was held by titles secured either from the State or Federal Government. Upon the completion of the canal system the cultivated area increased rapidly, new settlers making homestead entries on the desert lands or purchasing lands from older settlers, who, in order to comply with the requirements of the reclamation law, were required to reduce their holdings to 160 acres.

The early settlers depended upon the spring floods in the streams for their irrigation water, and as these streams usually went dry early in the summer, the crop returns were uncertain and usually very light. On all but the lowest lands, which were naturally moist, seldom more than one cutting of alfalfa was secured, and grain often failed to form heads or ripen seed. Not uncommonly grain was cut for hay instead of being allowed to mature.

The early alfalfa fields were, as a rule, poorly prepared for irrigation and the practice of pasturing stock on them in the winter resulted in more or less damage. As a result the yields, rarely over 1½ tons to the acre, were much lower than might have been secured with proper care even with an inadequate water supply. Some fruit trees were planted in the vicinity of the ranch houses to supply the home needs for fruit. Fruit was, however, a secondary consideration and the trees were seldom given any attention and were usually planted in poorly selected locations. In spite of these drawbacks the trees usually grew, though the yields varied largely with the condition of the spring weather.

Under the present order of things alfalfa and grains are generally the first crops to be planted on the newly settled lands, with the former occupying the larger acreage. Vegetables, melons, and small fruits are commonly found on the farms and are frequently a source of revenue, being sold at the stores or retailed in Fallon. Some truck farming has been attempted, mostly by Italians, and the results have been reported as satisfactory. The extent to which this branch of farming may be carried is dependent chiefly upon the increase of local population and secondly upon the demand from the outside markets within easy shipping distances. There will always be a fair demand for such products, but the fact that these generally require quick disposal means that the development of this industry must be

closely watched in order to prevent an overproduction and consequent loss to the farmer.

Potatoes are grown on practically every farm in the area to supply the home and in a few cases a considerable part of the farm has been devoted to this crop. The yields, which vary from 3 to 10 tons to the acre, depend upon the nature of the soil, the quantity of alkali present, and the care and attention given to cultivating and irrigating the crop.

Not a great deal of attention is being given to fruit culture. The older orchards give some returns, but newly planted trees are rare. Present conditions require the settler to produce an immediate paying crop, and few can afford to wait for several years to secure returns, as is necessary in fruit culture.

Some native hay is being cut on the lower lands in the southern part of the project, but the production is gradually decreasing, as these lands are passing in small tracts into the hands of new settlers.

Alfalfa yields from 3 to 4 tons per acre in three cuttings, the yields being largely governed by the age of the field, the condition of the stand, care given to preparing the ground, and the manner of handling the fields from year to year. Alfalfa is commonly sowed with a nurse crop of oats, barley, or millet. This is generally not considered as the best practice, but, with few exceptions, it is a good method for this area. The soils are generally light and easily moved by the winds, and the quicker growing grain holds the soil in place until the alfalfa gets a foothold.

Barley is grown to a greater extent than other grains, the yields varying from one-half ton to more than 1 ton per acre. The largest yields this past season were secured on the heavier soils in the eastern and southern parts of the area.

The new settler who secures land in one of the older settled portions of the area usually finds conditions favorable for immediate crop production. A larger part of the land requires little or no leveling, the amount of brush to be removed is generally small, and alkali is seldom present in dangerous proportions. The water table is sometimes rather close to the surface, but this will be remedied in the near future.

The new settler who secures a homestead on the unpatented desert lands is confronted with several conditions which must be changed before returns may be had from the farm. A considerable quantity of desert brush must be removed and disposed of; a large amount of leveling must be done, and except in very few instances checks and levees must be constructed; and, should alkali be present, some means must be found to remove it from the soil or to prevent its further concentration.

The usual and perhaps the most economical method of removing brush is to drag the surface with a railroad rail with one or two teams on each end, as conditions demand. Another implement is a flat bar of sharpened steel mounted on skids so that it slides on or just below the surface of the soil. This is not so economical as the former method, since the bar must be short and rigid to withstand the strain, and consequently not as much ground can be covered as when the rail is used. After dragging the broken brush is forked or raked with a hay rake into piles and burned. In some instances temporary shelters for animals have been constructed with this brush and where very heavy the stems afford considerable fuel.

The land is plowed preparatory to leveling, using a heavy breaking plow to cut through the roots of the brush. In a few places the desert land is so level that this deep plowing is not really necessary and is seldom practiced. In places where the soil is very light the surface is leveled without previous plowing. Following the general leveling of the field, it is divided into checks or basins, and laterals are constructed to carry water to these.

The annual wind movement of this area is low, but during certain seasons of the year violent winds sweep across the valley and may be the cause of considerable damage to unprotected soils. On light, sandy soils, if unprotected, the movement of earth may be so great as to require releveling and reconstruction of the water-distributing system. The damage may not be confined to a particular field, but adjacent fields and crops may be badly damaged by the drifted soil. The use of wind-breaks is recommended generally for this area, and fortunately these are not difficult to secure. Cottonwood cuttings placed in moist soil or along ditch banks grow rapidly. Cottonwood logs, used for footbridges across canals, have been known to sprout and produce large trees. The Lombardy poplar, although of slow growth, makes an excellent wind-break when closely planted. The tamarisk and Russian olive grow rapidly when planted in moist localities. Not only will these trees form an efficient protection against the wind, but they will furnish wood for fuel and fence posts.

In sections of the area where the soil is unusually light, it is recommended that in addition to providing wind-breaks the land be cleared in rather narrow strips running at right angles to the prevailing direction of the wind, with intervening strips of uncleared land. After the first strips have been thoroughly started the remaining brush may be removed. The efficiency of this plan lies in that only a part of the land is exposed to the action of the wind at any one time.

If alkali is present in the soil in any considerable quantities, drainage will be necessary in order to insure profitable cultivation. If the amount of alkali is not too large, or is not concentrated, there

are certain crops which may succeed and yield a fair profit. Alfalfa ranks as a fairly successful crop, especially if a good stand is secured the first year. Sugar beets are one of the most resistant crops and in alkali soils may be grown for cattle feed until cultivation and irrigation has reduced the alkali in the soil to an amount tolerated by less resistant crops. Some of the maizes and sorghums are fairly resistant to alkali, and will furnish a considerable quantity of forage for the farm animals.

The new settler in this area frequently encounters areas of soil which bake after cultivation and irrigation and cause more or less damage, especially to young crops. Such soil areas probably are best handled by securing as mellow a seed bed as possible, and by keeping the surface from crusting by using a corrugated roller, or if in furrow crops, such as potatoes and corn, by using a light cultivator or weeder.

The adaptability of the soils to various crops has not yet received much attention. The larger number of settlers have found it necessary to bend their efforts toward the production of immediate cash crops, whether the soil was best adapted to the crops grown or not. As conditions become more settled this phase of agriculture will receive more attention and the growing of various products will become more and more specialized. The lighter soils will ultimately be devoted to the growing of truck crops, potatoes, small fruits, and alfalfa. The larger fruits will attain the best development and regularity of yield on the higher portions of the area, where the danger from spring frosts is at a minimum. Smaller fruits will have a wider range in distribution, the extent being governed by the commercial demand.

Sugar beets will be most successfully produced on the heavier soils of the area, particularly in the eastern and southern portions. Grains may be grown on any of the soils of the area, except where alkali conditions are unfavorable, but the lightest soils will be found the least desirable, owing to the possible damage from wind and to the difficulty of keeping sufficient moisture in the soil. Alfalfa will probably be the most widely distributed crop in the area, since it is the easiest forage crop for the settler to produce. It offers financial returns from the sale of hay and a fair profit may be secured by the production of seed.

Alfalfa, as has been said, will be one of the leading staples. There is no danger of an overproduction, as there is always a strong demand, particularly from mining districts of the State. The future local development of the dairying and stock-raising industries guarantees the consumption of all available hay and forage products.

Sugar beets have been tried in various portions of the area in order to determine their adaptability to local conditions with a view

toward securing a sugar factory. In certain portions of the area, particularly where the soils are heavy, beets with an unusually high sugar content and purity have been secured. Beet culture requires a large amount of hand labor, which is not available at the present. This is not an insurmountable obstacle, and when remedied the growing of sugar beets will prove fairly profitable to the farmers.

The development of the fruit industry, aside from market conditions, depends more upon the selection of localities free from late spring frosts than almost any one other condition. There need be little fear of an overproduction, as the whole State presents a good market.

There is a good demand for all classes of truck crops, and although it is easily possible to create an oversupply of these products, there is not much danger of this for some time. At present large quantities of produce are shipped in from outside points, and to supply this demand with home products, to keep pace with the growing population, and to supply the neighboring mining camps will allow a considerable increase in the trucking industry.

The supply of poultry and eggs is far short of the demand, and high prices are the rule. As a side line for the farmer, poultry will yield a good revenue, and it is probable that poultry raising could be made a success as a specialty by a number of farmers in different parts of the area.

So far the demand for farm hands has not exceeded the supply, and it is not likely that this question will ever become serious, as the limited size of the farms makes it possible for the settler to do much of the work himself, and it is only during the haying season that much additional help is necessary. At the present time wages for farm hands run from $35 a month with board to $2 a day with board during the harvest time.

All of the lands which were a part of the public domain at the time this project was formed are procurable by simply complying with the homestead and reclamation laws. These require five years of residence on the land, actual improvement, and the paying of certain water fees. As a result the greater part of the land in the project is, or soon will be, held in small individual tracts, and settled by the owners. On those lands which were owned privately before the project was formed, individual ownership and operation is the rule. Some of this land is leased, but the area so held and farmed is small and of little importance.

Under the terms of the reclamation law the size of patented farms is limited to 160 acres. Owners of lands in excess of this amount must agree to dispose of the excess. The public land has been divided into farm units ranging in size fron 40 to 160 acres, the average

size being 80 acres. The size of these units is governed by the location, levelness of the land, and nature of the soil. In addition to the public and private lands, a part of the land is held by the Southern Pacific Railroad and may be purchased from that company, the buyer agreeing to pay the water tax required by the Reclamation Service.

No specific value can be attached to the Government lands in the valley, as the title still remaining with the Government lands can not be sold or transferred. The first cost to the settler of these lands is about $3.70 an acre of irrigable land. This includes the filing fee, required by the U. S. Land Office, and the first installment of the water charge, which is required by the Reclamation Service. Thereafter the annual water tax must be paid into the local offices of the latter at Fallon.

Private lands without a water right may be secured for $5 to $25 an acre, depending upon the soil, location, and improvements. Here also the settler must meet the annual payment of the water tax. Private lands carrying a water right may be purchased for from $30 to $100 an acre, depending upon location and improvements. On these lands the settler is required to pay only the annual maintenance fee on the irrigation system—about 60 cents an acre.

The cost of railroad lands varies between $1.25 and $15 an acre, to which must be added the yearly water tax. The payments on these lands are graduated, extending over a period of five years, with 6 per cent interest on deferred payments.

Many persons, with but little capital and ignorant of the existing conditions, have come to this valley and made filings on Government land. A few of these individuals have succeeded; others, in Western parlance, "have gone broke," and moved away. Generally speaking, no one can succeed here without at least $1,000 in cash, and the advice along this line by the Reclamation Service is given below.

Do not make the mistake of thinking that you can come to the Truckee-Carson project without any capital or equipment, settle on a homestead, and make a success. Every new settler will need capital, just as he would if he went into any other country. The amount, of course, will vary with the individual, but few men will succeed without some capital. You will need a house to live in, fences, a well, barn, provisions for family and feed for stock for at least one year, farm machinery, tools, and seed. You will be unable to secure credit at the local stores, as you are unknown, and you have nothing to mortgage on a homestead. Consequently, your capital should be sufficient to enable you to bring your farm to a paying basis, and this will require at least one year. The future agricultural development of this area will depend not only upon the adaptability of the soils and climate to various agricultural products, but also upon the demands of outside markets and upon outside competition,[a]

[a] Truckee-Carson Irrigation Project, Nevada, Sept. 15, 1909.

SOILS.

This area lies in what was in comparatively recent geologic time an inland lake covering the greater part of western and northern Nevada. This is known as Lake Lahontan, and was similar to Lake Bonneville, the latter covering the greater part of Utah.

During the life of Lake Lahontan a vast quantity of material was eroded from the surrounding watershed, carried into the lake by the streams, and deposited on its bottom. (Pl. XVI, fig. 1.) This material to-day forms the greater part of the soils of the Carson Sink Valley. Since its deposition beneath the waters of the lake, this material has been more or less reworked, apparently during a shallow stage of the lake, and has also been subjected to some rearrangement through the action of streams and winds since the disappearance of the lake. This division of the soils has been designated as the Lahontan series, the type members being a stony sandy loam, gravelly loam, fine sand, sandy loam, fine sandy loam, clay loam, and clay. In addition to these types, there are two additional types, which, although formed during the Lahontan period, have since undergone changes which warrant their separation from that series. These types are the Fernley fine sand and the Churchill clay.

The general structure of the Lahontan and associated soils is from 20 inches to 6 feet of material which determines the individual type. This is underlain either by a stratum of gravelly sandy loam or gravelly sand. This stratum is of variable depth and is underlain either by a lacustral clay (usually below 6 feet) or by a very compact fine sandy loam. The topography of the heavier members of this series varies from level to sharply eroded. The former condition is found throughout the area where these soils occur, while the latter phase is most pronounced in the western portion of the area, where the old Lahontan sediments occur as high eroded bluffs and knolls. The lighter members are seldom level, but vary from slightly rolling to very hummocky. The coarser members, as the stony and gravelly loams, usually have a uniform surface, but with a sharp inclination from the line of the canal toward the lower lands.

All of the heaviest soil carries excessive amounts of alkali, while the lighter members may or may not be affected in this manner.

The next most extensive series is the Carson series. This, like the Lahontan series, is of lacustrine origin, but differs in that it is of more recent formation. The included types are a clay loam, a clay, and a clay adobe. The soils are always of a heavy texture, drab or dark-brown to nearly black in color, and seldom contain gravel or sand in the subsoil. The members of this series are found in the vicinity of Carson Lake and along Stillwater Slough. Alkali is commonly present in all of these soils, although not always in harmful quantities.

A small proportion of the soils in this area have their origin in the reworking of the Lahontan sediments by the Carson River and its branches, and by the addition of material carried in suspension by these streams. This class of soil, designated as the Fallon series, includes a fine sandy loam and a loam. This series is characterized by a soil from 18 inches to 4 feet or more in depth, which determines the textural name. This surface material is underlain by a bed of coarser and lighter river sediments. These soils occur in the lowlands bordering the several stream channels in the area. The surface may be level or somewhat uneven as the result of the action of flood waters. The areas are subject to occasional overflow, and are frequently covered with timber and underbrush. Alkali is not often present in the soils of this series.

In addition to the several series of soils just mentioned, there are two individual types of soil which do not come within the foregoing classification. One of these, Dunesand, is widely scattered throughout the area, occurring as knolls and ridges of more or less prominence, usually treeless, but covered with a scanty growth of desert brush. (Pl. XIX, fig. 1.) The other type, Soda Lake sand, is confined to a circular area surrounding the soda lakes northeast of Leetville. This soil is both lacustral and volcanic in origin and generally occupies a higher elevation than the surrounding desert soils.

The following table gives the name and extent of each of the soils mapped:

Areas of different soils.

Soils.	Acres.	Per cent.	Soils.	Acres.	Per cent.
Lahontan sandy loam	48,704	32.4	Carson clay	4,288	2.9
Lahontan fine sand	22,208	14.8	Lahontan gravelly loam	4,096	2.7
Dunesand	14,784	9.9	Soda Lake sand	4,032	2.6
Carson clay loam	9,344	6.2	Lahontan stony sandy loam	3,328	2.2
Lahontan fine sandy loam	8,064	5.4	Fallon fine sandy loam	2,816	1.9
Lahontan clay	8,000	5.3	Churchill clay	1,024	.7
Fallon loam	6,592	4.4	Fernley fine sand	960	.6
Lahontan clay loam	6,400	4.2			
Carson clay adobe	5,760	3.8	Total	150,400	

LAHONTAN STONY SANDY LOAM.

The Lahontan stony sandy loam consists of from 18 inches to 6 feet of compact gray sandy loam, carrying from 10 to 80 per cent, with an average of probably 40 per cent of rough, angular rock fragments ranging in size from small fragments to bowlders. The stony component of this type may not extend below 18 inches, and in such cases the soil is a gray, sticky, compact sandy loam. In a very few cases the bed rock approaches within 2 feet of the surface, but it usually lies more than 6 feet below. The larger part of the stone in

this type is a vesicular lava, some massive basalt is present, and quantities of breccia are not uncommon. The bed rock consists of either a fractured or compact dark-colored lava, with an occasional thin coating of calcareous material.

This type is confined entirely to the western part of the area and occurs as rather narrow, irregular bodies bordering the main Lower Truckee Canal. The largest body is found south of Hazen, and a few smaller areas occur east and south of Fernley.

The elevation of the Lahontan stony sandy loam is usually considerably greater than that of adjacent types. South of Hazen the boundary between much of this soil and the other types is marked by a narrow strip of badly eroded land, unfit for cultivation. Aside from this the surface is fairly uniform, with a pronounced slope away from the canal.

The Lahontan stony sandy loam owes its origin both to lacustral and colluvial agencies. The greater part of the finer material represents sediments of former Lake Lahontan. The coarser material has been derived from near-by mountain slopes, which rise above the line of the canal. Subsequent erosive agencies have affected the surface and are responsible for the broken topography south of Hazen. The greater part of this type does not contain much alkali. The subsoil frequently carries appreciable quantities, and sometimes enough to place this type in the class of alkali soils. As a general rule there is but little danger from this alkali, since the high elevation of the soil and its porosity insures ready drainage.

At the present time the Lahontan stony sandy loam is uncultivated. Some areas are doubtless too stony to be of much value, and in others the bed rock is too close to the surface to allow of successful cultivation. Where these objectionable features are not present alfalfa, grains, and general farm crops will do well. It is not improbable that the larger fruits will prove very well adapted to this type, as there is less danger from late spring frosts than in some other sections and the neighboring mountains offer some protection from wind. On account of the surface slopes, irrigation by the contour or some similar method will be a necessity in order to avoid washing of the soil.

The following table gives the results of a mechanical analysis of the soil of this type:

Mechanical analyses of Lahontan stony sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
22101	Soil	3.6	10.3	13.6	30.6	18.6	14.2	9.4

The above sample contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$), viz, 2.14 per cent.

LAHONTAN GRAVELLY LOAM.

The Lahontan gravelly loam consists of from 12 inches to 6 feet of light-gray fine loam, carrying a considerable quantity of rounded waterworn gravel and rock fragments. The gravel may disappear at any depth below the surface foot, the soil remaining a fine loam. In a few cases a stratum of yellowish sandy loam was found below 3½ feet, but this is not sufficiently general to be considered typical of this soil. Beds of volcanic ash and diatomaceous earth are sometimes found in the higher lying areas of this type, and are frequently exposed along the line of the main canal.

This type is confined to the western part of the area, between Hazen and Fernley, and occurs on high bench lands, just below the main Lower Truckee Canal, or below areas of Lahontan stony sandy loam. The larger part of this type has a fairly uniform surface, with a pronounced slope toward the lower lands. West of Hazen a portion of this type is too rough and eroded to be of any agricultural value. In most places the boundary between this type and adjacent soils is marked by an abrupt descent of 10 to 20 feet.

The greater part of this type is made up of sediments deposited in the waters of Lake Lahontan, while the coarser gravels represent colluvial material carried from the mountains lying south of this part of the area.

With the exception of the body of this type southeast of Fernley, and a small area southeast of Argo, alkali is generally present in the soil and in quantities greater than 0.20 per cent. In the non-alkaline sections just mentioned there is frequently an appreciable quantity of alkali in the fifth and sixth foot below the surface. The highest concentrations of alkali occur in the rougher portions of the type west of Hazen, but are of no concern as the land is of no value. There is no danger to be feared from the alkali in this soil, since the elevation and texture assure ready subsurface and surface drainage, and one or two seasons of irrigation will effectually remove the salts in the subsoil.

At the present time the total cultivated area does not exceed 40 acres, the larger part of which is planted to alfalfa. Some cottonwoods have been started along the ditch banks, and a small tract was planted to potatoes and vegetables. Alfalfa produces from 3 to 6 tons per acre, and potatoes are reported to have yielded 6 tons per acre. The larger fruits, although not yet tested, will probably succeed, as the danger from late spring frosts is slight.

Basin irrigation is not practicable owing to the slope of the surface, and a modified method of furrow irrigation is in common use.

The following table gives the results of a mechanical analysis of the soil:

Mechanical analyses of Lahontan gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
22103	Soil	1.0	4.4	3.6	10.6	20.6	45.0	15.2

LAHONTAN FINE SAND.

The Lahontan fine sand consists of a fine to medium textured yellowish sand, usually about 24 inches deep, but sometimes extending to 6 feet in depth. The texture usually becomes coarser with increasing depth. Where the sand is less than 6 feet in depth it is underlain by a coarse gravelly sandy loam. The boundaries between this and adjoining soils are usually very indefinite, the type merging gradually into the slightly heavier types of the series on one hand and into Dunesand on the other. The separation from the last-named soil is based almost entirely on the topography; and small knolls of Dunesand, not large enough to be indicated on the map, commonly dot the surface of this type.

The Lahontan fine sand is scattered throughout the area in bodies of varying size. The two most extensive areas are found west of Fallon on both sides of the Carson River. One of these begins near the line between ranges 26 and 27 E. and extends in a northeasterly direction for about 12 miles. The other occupies practically all of the western half of T. 18 N., R. 28 E.

The surface of this soil is rolling, and in places this unevenness is so pronounced that the soil is practically valueless for farming. Such areas are closely comparable to Dunesand.

The Lahontan fine sand owes its origin to material deposited in the valley during the lake period. Since deposition it has undergone considerable alteration, having probably been washed and assorted by the waves during the shallow stages in the final recession of the lake and by subsequent action of the streams and winds.

The type, as a whole, is free from alkali. In small depressions where heavier soils approach the surface and the drainage is poor some alkali is frequently present. Such areas are small and of no agricultural value, aside from the presence of alkali. The type is treeless, but supports a moderate growth of desert shrubs.

The cultivated area of this soil is limited to a few farm units west of St. Clair and east of Fallon. The settlement of this type has been slow, as the uneven surface and consequent expense of leveling for irrigation have turned intending settlers to other types

of soil. In the cultivated sections alfalfa has yielded from 2 to 6 tons per acre, depending upon the age of the field, stand of plants, and care in preparing the land and in irrigating the crop. Potatoes have yielded from 2 to 6 tons per acre, and it is possible that the latter yield may be exceeded. Besides being well adapted to alfalfa and potatoes, this type will prove suitable for small fruits and various trucking crops. The light texture of this soil renders it liable to damage by heavy winds, and it should not be left without some protective covering.

The following table gives the average results of mechanical analyses of typical samples of the soil of this type:

Mechanical analyses of Lahontan fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
22099, 22100.....	Soil.....	2.1	4.4	5.4	53.2	26.2	5.1	3.6

LAHONTAN SANDY LOAM.

The Lahontan sandy loam consists of a yellowish or gray sandy loam of fine to somewhat coarse texture, extending to a depth of from 30 inches to 6 feet or more. Small quantities of fine waterworn gravel occur in the upper portion of the soil section, and in places the surface is covered with a thin veneer of wind-blown sand, occasionally forming small dunes. When less than 6 feet in depth it is underlain by a gravelly sand, the gravel being generally fine and well rounded. Where this type merges into the heavier members of either the Lahontan or Carson series the gravelly subsoil may be either partially or wholly replaced by a clay loam subsoil. Such areas are small, irregular, and of but little importance.

The Lahontan sandy loam occurs throughout the area east and north of Truckee Chute and Carson Dam as small to moderately extensive areas or scattered about throughout the central, southern, and eastern parts of the area, and as a single extensive body extending from a short distance north of Truckee Chute northeastward for about 4 miles.

The type occupies low flat plains of deficient natural drainage to areas of pronounced slope lying well above the level of the adjacent Carson River Valley and the general level of the area surveyed. The character of surface varies from nearly level to very uneven. The more level phases are found south of Fallon and east of St. Clair. In the northern half of the project the surface is more rolling, the more irregular topography occurring north and north-

east of Rattlesnake Hill, where rounded knobs and ridges rise from 15 to 20 feet above the general elevation of the country.

The more extensive elevated body lying northeast of Truckee Chute occurs as a bench from 30 to 50 feet above the surrounding soils to the north and east, and merges gradually into the soils to the south and west. The southwestern extension of this body is very rolling to rough along the bluffs bordering the bottom lands of Carson River. The remainder of this body has a rather uniform surface, and is easily leveled, excepting where it drops suddenly to lower-lying soils.

The subsoil drainage is good, except in the heavier phases of the lower lying bodies where percolation is slow and the soil often puddles. In these lower areas there is a frequent lack of drainage channels, the surface waters finding their way to near-by depressions, where they either pass into the soil or are removed by evaporation. In some such cases the construction of artificial drainage courses is necessary on account of the presence of alkali salts.

In the lower bodies of this type alkali seldom occurs in large areas of uniform concentration but as numerous small irregular bodies of varying alkali content. The alkali in these areas comes mainly from the surrounding heavier soils from which it is leached by drainage waters and concentrated by evaporation. It is probable that 50 per cent of these lower-lying bodies of the Lahontan sandy loam carry too much alkali to permit the profitable growing of crops. Black alkali is extremely rare in the virgin soil, but usually develops wherever there is much seepage into poorly drained depressions. With the exception of one 10-acre field of irrigated land all of the higher-lying body occurring northeast of Truckee Chute carries alkali in quantities between 0.20 to 0.40 of 1 per cent. The removal of the alkali on the cultivated land referred to with two seasons' irrigation indicates that there is no danger to be feared from its presence, owing to the favorable natural slope, and that its reclamation is an easy matter.

This type of soil is of lacustrine formation and since its deposition has been subjected to the force of various agencies which have resulted in a reworking of much of the soil.

Except for plantings on various farm units and in and around Fallon this type is treeless. It supports a rather dense native growth of desert shrubs, the most common being several varieties of rabbit bush, greasewood, and saltbush.

Prior to the construction of the present irrigation system practically none of this type was under cultivation. Here and there a few acres were farmed where it was possible to secure water for irrigation from the Carson River during the time of the winter and spring floods. Alfalfa was grown almost to the exclusion of other crops, the yields ranging from 1 to 3 tons per acre, depending upon the length of the irrigating season. A little grain was sometimes grown,

but the scarcity of water usually compelled the cutting of the crop for hay.

On farm units settled since the construction of the present canal system alfalfa still maintains the lead in acreage. The yields range from 4 to 7 tons per acre. Potatoes yield well—4 to 10 tons per acre—and are of very good quality. As farming conditions become more settled, potatoes will doubtless become one of the important products on this type of soil. It is also a good trucking soil, and small fruits give promise of being profitable, at least as secondary crops. Grains do well, but their cultivation should be restricted as far as possible to the heavier phases. It is not wise to have this soil exposed to the force of the winds, and for this reason fall plowing is not recommended, unless it is to be followed by sowing winter grain or some other cover crop. In the case of the extensive higher-lying body lying northeast of Truckee Chute the single small field mentioned above is all of this type under cultivation at the present time. This is in alfalfa, which returns from 4 to 6 tons per acre. The relatively high elevation of the bench upon which this soil is found insures longer seasons free from late frosts than is enjoyed by the lower-lying soils, and the type offers an opportunity for growing the tree fruits. Without doubt the situation is one of the best in the area for this purpose, and experimental orchards may well be planted. Efficient windbreaks will be found advisable, as the bench is exposed to the full force of the western winds.

The following table gives the average results of mechanical analyses of samples of the soil and one of the subsoil of this type:

Mechanical analyses of Lahontan sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
22104, 22118.....	Soil.....	2.1	11.2	9.4	36.1	18.1	13.3	9.6
22105.....	Subsoil.....	6.1	21.2	13.5	27.1	16.6	9.2	6.4

The following samples contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$): No. 22104, 1.07 per cent; No. 22118, 2.70 per cent.

LAHONTAN FINE SANDY LOAM.

The Lahontan fine sandy loam to a depth of 24 inches to 6 feet consists of a light yellowish-gray compact fine sandy loam. Where the fine sandy loam does not extend to 6 feet it is underlain either by a rather coarse light-gray sandy loam or by a somewhat darker-colored coarse sand. At about 30 inches below the surface there is usually found a very compact layer of soil, which, though generally only a few inches thick, may extend to a depth of 4 feet or more. In

cultivation this compact subsoil may become a hindrance where there is any alkali present, as it retards the movement of water in the soil, and in this way makes the removal of the alkali difficult.

The surface of this type is not infrequently broken by very small sand dunes or by low mounds of wind-blown material lodged about the bases of desert shrubs.

The principal body of this soil, covering about 9 square miles, occurs in T. 19 N., R. 30 E., 8 miles east of Fallon. Several small isolated bodies are found in different parts of the eastern half of the area.

The surface of the Lahontan fine sandy loam, aside from the small knolls of drifted material mentioned, is without any marked irregularity, and parts of the type are level. Surface drainage is absolutely lacking, and the subsoil drainage is more or less effective, depending upon the varying compactness of the subsoil.

This type, like other soils of the Lahontan series, is of lacustrine origin and has been but little modified since its original deposition. The greater part of it contains approximately 1 per cent of alkali, and is not suitable for cultivation until this has been removed by underdrainage and flooding.

This soil is treeless, the native vegetation consisting of a species of suæda, greasewood, and saltbrush. The main body is not as yet under cultivation. Two or three of the smaller areas are farmed largely in the production of alfalfa. When alkali has been removed the soil will prove adapted to alfalfa, grains, and small fruits.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Lahontan fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
22106, 22108.....	Soil.....	0.1	1.1	1.7	41.2	29.9	13.6	12.7
22107, 22109.....	Subsoil.....	2.2	19.6	10.9	31.9	18.3	11.3	5.7

LAHONTAN CLAY LOAM.

The Lahontan clay loam consists of from 18 inches to 6 feet of a light-gray or grayish-brown clay loam, usually underlain below 18 inches by a coarse grayish sandy loam, often carrying appreciable quantities of fine waterworn gravel. Small knolls of wind-blown material, similar to those occurring on the Lahontan fine sandy loam, are common. A compact stratum of soil is sometimes found at about 30 inches, although this condition is not as general as in the type just described.

With one or two exceptions the Lahontan clay loam is confined to the eastern half of the area. The larger bodies occur east of Fallon and east of St. Clair, while several small widely scattered bodies lie north of Fallon.

The general topography presents a rolling surface, but small areas of level land are not uncommon. Like the other soils of this series, this type is made up of lacustrine sediments, but aside from the small areas of drifted material the soil has undergone but little, if any, subsequent alteration.

Probably about 50 per cent of the area of the Lahontan clay loam carries more than 0.20 per cent of alkali, and of this over one-half contains quantities large enough to be injurious to cultivated plants. The surface foot of soil is usually free from alkali; below that depth the content is fairly uniform. Black alkali is seldom found in the undisturbed soil, but is commonly present in depressions wherever seepage water accumulates. Besides its toxic effect the alkali injures crops in irrigated sections by increasing the tendency of the surface to crust. The germination of seed is thus prevented or young plants are killed, making it difficult to get a stand of alfalfa.

Except for plantings around farmhouses and along the roads in the older settled portions the type is treeless. The usual vegetation consists of suaeda and greasewood, with sagebrush and rabbit bush in alkali-free areas.

The larger part of the Lahontan clay loam was owned privately when the Truckee-Carson project was begun. It was found possible to irrigate this land at no great expense by diverting water from the Carson River, and early settlers took up the land. Alfalfa was the principal crop, followed by grain. The yields were usually low, owing to the scarcity of water during the summer. Some of this land is not yet filed upon, but it is generally undesirable owing to the presence of alkali.

Where facilities for proper irrigation exist alfalfa and grain give profitable yields on this soil, the former yielding from 4 to 6 or even 7 tons per acre, and the latter, principally barley, 1 ton or more per acre. Potatoes do fairly well, although probably not as profitable as on some of the lighter soils of the area. Sugar beets promise well where they have been tested, and will be a valuable crop when a factory shall be established to utilize it. A few fruit trees, mostly apples and pears, are found on some of the older farms. The yields are irregular, owing to late spring frosts, and this will in all likelihood prevent the development of fruit growing on a commercial scale.

The following table gives the average results of mechanical analyses of the soil of this type:

Mechanical analyses of Lahontan clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
22110, 22111.....	Soil.....	0.4	2.6	4.5	17.0	20.1	31.5	23.9

LAHONTAN CLAY.

The Lahontan clay consists of 18 inches to 6 feet of gray to grayish-brown sticky clay. This is commonly underlain, below 18 inches, by either a very compact brown or grayish-brown fine sandy loam, a gravelly sand, or both. In the last case the fine sandy loam is seldom more than a foot in thickness. In the western part of the area the clay not infrequently extends to a depth of 6 feet or more. Passing eastward it gradually becomes shallower.

About 3 miles south of Hazen there is an area of badly eroded knolls and ridges of a whitish, compact clay loam which appears to be old lake sediments in place. As the area of this is small and of absolutely no agricultural value on account of the alkali and uneven surface, it has been included with the Lahontan clay.

This type is confined to the northern half of the project, where it is distributed from the eastern nearly to the western boundary. Two extensive bodies are developed, one near Fallon and the other near Hazen, but the usual occurrence is in somewhat circular or oval bodies of small extent.

With the exception of the uneven areas south of Hazen the surface of this soil is level and unbroken, except by occasional knolls of wind-blown material lodged about desert brush. The type is lower lying than that of surrounding soils and receives the drainage water. There are no surface outlets for this water and the compact nature of the surface soil prevents its removal downward, so that in the winter and spring, the seasons of heaviest rainfall, the areas become transient lakes. Every stream covers the surface with a sheet of water, and in a few hours, if the day is bright and warm, the lake vanishes, leaving a flat white surface, barren of vegetation. It is this type which forms the playas or mud plains, a feature characteristic of the arid desert. The formation of these is due to the transportation of fine silts and clay particles by storm waters from higher soils into depressions without a drainage outlet. Repetitions of this process through ages have resulted in the formation of absolutely level, white clay flats.

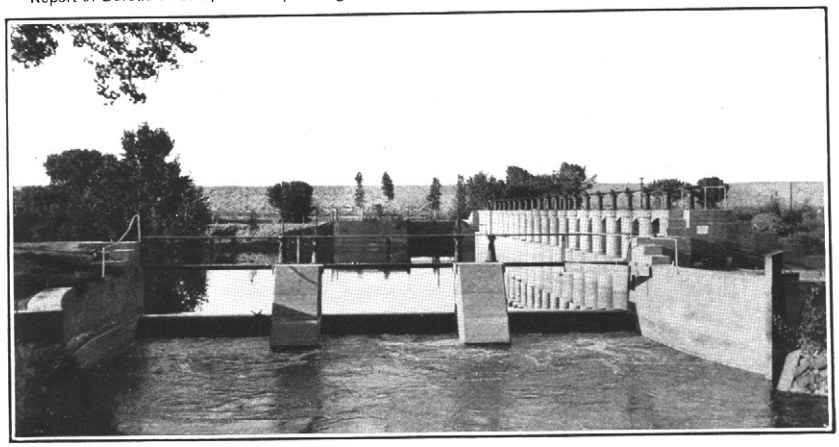

FIG. 1.—CARSON DAM AND MOUTH OF SOUTH SIDE CANAL.

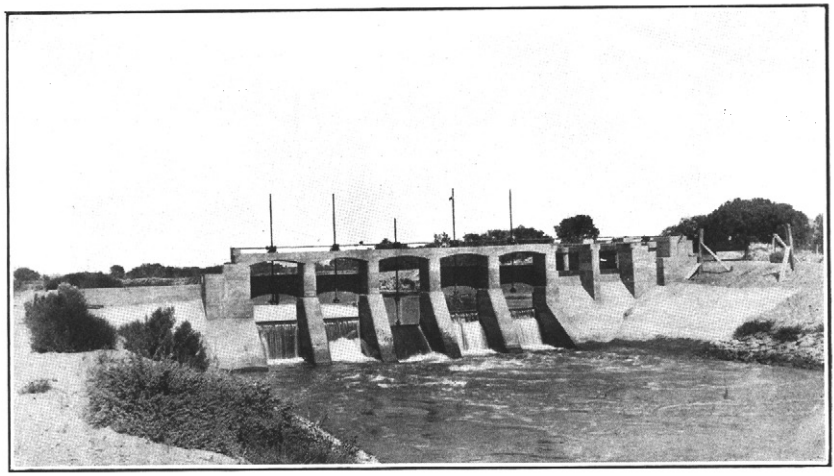

FIG. 2.—SHOWING SUBSTANTIAL MASONRY OF CANAL STRUCTURE.

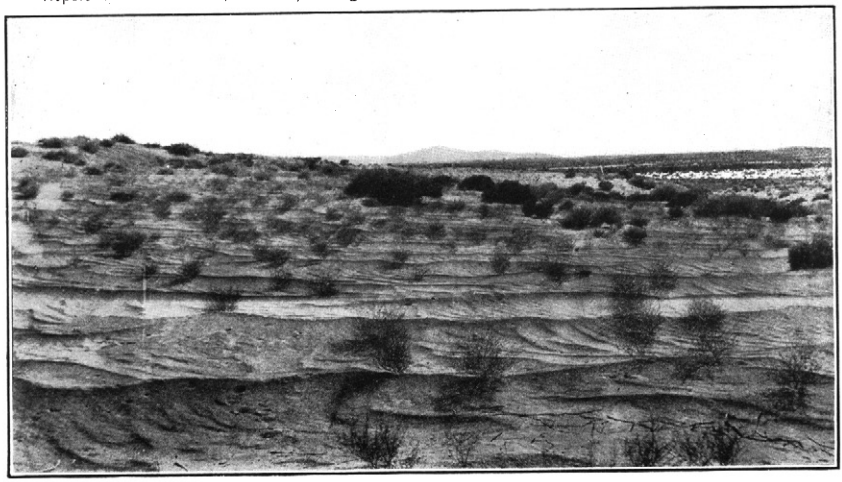

FIG. 1.—CHARACTER OF SURFACE OF DUNESAND AREAS.

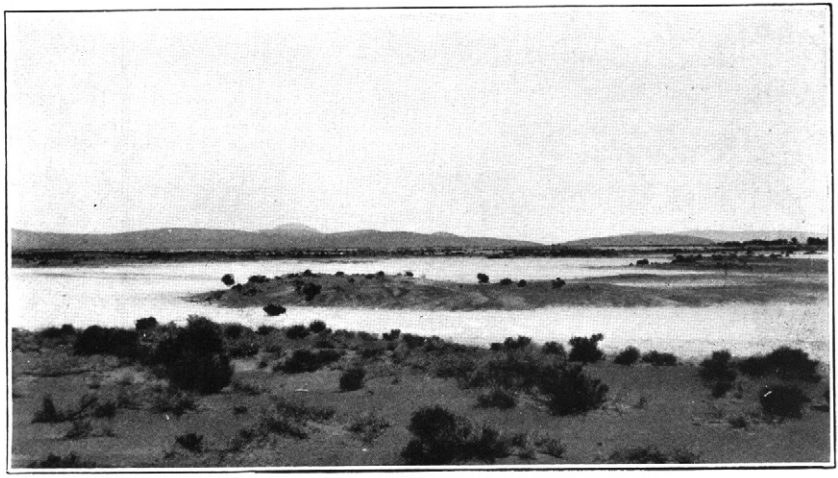

FIG. 2.—SHOWING GENERAL CHARACTER OF THE COUNTRY AND THE PLAYAS.

With scarcely an exception the bodies of this type contain too much alkali to be of any agricultural value until reclaimed, and as the construction of drainage works for such depressions would require a greater outlay than would be justified by the returns of any crop which could be produced under the existing climatic conditions, much of the type will remain in its present condition. It is without doubt the least valuable soil in the area.

The results of mechanical analyses of samples of the soil and subsoil are given in the following table:

Mechanical analyses of Lahontan clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
22112	Soil	0.0	0.6	0.8	4.8	16.4	36.2	41.1
22113	Subsoil	1.7	5.9	5.3	22.9	32.9	13.8	17.6

The following samples contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$): No. 22112, 10.48 per cent; No. 22113, 0.82 per cent.

CARSON CLAY LOAM.

The Carson clay loam to a depth of 2 to 4 feet consists of a dark-drab to black sticky clay loam. Below 2 feet the surface material is often underlain by a rather coarse, dark-yellowish sandy loam. This profile is representative of the main body of the soil, variations occurring only where it merges into adjacent soil types. The soil becomes heavier and the sand content of the subsoil decreases as the Carson clay is approached, and the soil becomes lighter in color and texture as it grades into soils of the Lahontan series. Where this type is heavier than normal it has a tendency toward an adobe structure.

The Carson clay loam occurs as a long, irregular body in the southern part of the area where it borders the heavier soils surrounding Carson Lake. The surface varies from level to slightly rolling and hummocky. The latter character of surface is found in the western extension of the type, and considerable leveling will be necessary to prepare some of the land for irrigation.

Owing to the rather compact surface soil and the usually high water table, the underdrainage is poor. The surface slope, although very slight, is sufficient to carry away surface waters through natural or artificial drainage courses.

This soil is a recent lacustrine formation, and represents material deposited in the waters of Carson Lake. A considerable portion of the area now occupied by this soil was a part of Carson Lake when the country was first settled. After New River was formed in the

early sixties by the cutting of the bank of Carson River the lake gradually receded and this land was added to the grazing lands already in use.

Except in a small part of the western extension of the type, alkali is always found in the soil. The usual concentration ranges between 0.20 to 0.40 of 1 per cent, with occasional small areas running nearly to 1 per cent. Black alkali does not occur in this soil except in a few instances where seepage has concentrated the soluble salts. The larger part of the type is covered with a dense growth of native grasses which are cut for hay. Heavy growths of tules cover poorly drained areas, but these are slowly disappearing as the land is being drained and placed under cultivation. The more elevated and drier areas indicated by growths of greasewood, rabbit bush, and saltgrass are abundant.

Practically all of this type is in private ownership, the land having been filed on in the early days. Hay, from the native grasses, was the principal product at that time, the supply being used by the stage companies and by emigrant trains.

Prior to the construction of the present irrigation system this land was irrigated by diverting the spring waters of the South Branch of Carson River and flooding the land. This resulted in the over-irrigating of the land, the water table approached the surface, and large areas of tules sprang up. Alfalfa was later introduced, displacing much of the native hay, and it is now the principal crop on this soil. Yields of 4 to 6 tons per acre are secured.

Sugar beets have been tested on this soil, and have given good yields of high quality. A few fruit trees have been planted and have yielded a good quality of fruit, but the conditions as to frost are unfavorable to embarking in the industry. Grains do well, barley being the principal crop and yielding from one-half ton to more than 1 ton per acre.

Under the requirements of the reclamation law the landowners in this section have placed their lands exceeding 160 acres on the market, and the larger part of this has been disposed of to new settlers.

CARSON CLAY.

The Carson clay consists of 6 feet or more of drab to black clay, which in heavier areas sometimes has a tendency to an adobe structure. Along the outer margin of this type, an old shore line of Carson Lake, the surface of the soil is frequently covered with an inch or two of fine sand.

This soil is confined to the lowlands surrounding Carson Lake. The surface has a slight fall toward the lake. It has the smoothest surface of any type in the area, and requires no leveling for irriga-

tion. This uniform level surface gives slow drainage and the movement through the subsoil is also sluggish.

The Carson clay is of recent lacustrine formation, the waters of the lake having receded from the most of it within the last few years.

Aside from one narrow strip of soil containing nearly 0.60 per cent of alkali, the entire type carries from 0.20 to 0.40 per cent of soluble material. The alkali is rather uniformly distributed throughout the soil profile.

This soil is treeless and rarely carries even the common desert shrubs. A fair growth of grass occurs over the most of the type and heretofore the land has been used for grazing purposes. None of the land has yet been filed on under the homestead and reclamation laws, but several square miles have been leased by a company for the purpose of grain farming. Several hundred acres of barley were grown this past season, giving an average yield of about 10 sacks per acre. A larger yield than this should be obtained, but late seeding and lack of proper arrangements to care for such a large acreage reduced the yield considerably. This soil is probably best adapted to the production of alfalfa, grain, and sugar beets.

Plans by the Reclamation Service contemplate the draining of Carson Lake, which will add to the areas of this type of soil.

A problem connected with the proper utilization of the soil is the matter of providing drainage. Owing to the slight fall of the country, the comparatively low elevation, and the heavy nature of the soil, a high-water table seems unavoidable, with a probable coincident concentration of alkali.

The following table gives the results of a mechanical analysis of the soil of this type.

Mechanical analyses of Carson clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
22087.....	Soil.....	0.0	0.4	0.3	1.8	2.6	26.5	68.2

The above sample contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$), viz, 1.93 per cent.

CARSON CLAY ADOBE.

The Carson clay adobe consists of 6 feet of heavy black clay, with typical adobe structure. Over small areas the heavy material is sometimes covered with a thin coating of lighter soil either washed from adjacent soil or deposited from overflow waters of the Carson Slough.

As this soil merges into the Lahontan fine sandy loam its texture and color become very much lighter, and a stratum of sand or sandy

loam is frequently found in the subsoil. In the transition to the Lahontan clay the color is very much lighter, the texture changes somewhat, and the adobe characteristics nearly disappear.

With the exception of one small body of this soil about 10 miles south of Fallon, the type is limited to an extensive area near Stillwater, the larger proportion lying west of the channel of Stillwater Slough.

The surface of the greater part of this type is very level, the only irregularities being near Stillwater Slough, where some erosion has occurred. There are no drainage ways through this type, except the stream mentioned. The bed of this is several feet below the surface and it provides fair underdrainage and an outlet for any artificial drains that may be required in the future.

This Carson clay adobe occupies an area covered by Lake Lahontan during its later stages, and owes its origin to the weathering of sediments laid down in the lake waters. All of it carries over 0.20 per cent of alkali, the usual content being between 0.20 and 0.40 per cent. Along the boundaries between this type and other soils carrying excessive amounts of alkali, the content in this type is often high. As alkali moves slowly through heavy soils it will be some time before conditions become serious, but it is practically a certainty that the alkali will accumulate in dangerous amounts sooner or later. It would be well to forestall this trouble by putting in drainage ditches and washing out the alkali in the cultivated areas by occasional surface flooding, provided the irrigation of the crops does not suffice to keep the soil free.

Some of this type has been in private ownership for many years, irrigation water being secured from Stillwater Slough and from New River. Alfalfa has been the principal crop, the yield ranging from 1 ton to 2 tons per acre. Water has seldom been available for irrigation later than the 1st of July, and the yields have been low on that account. With sufficient water the soil should yield from 4 to 6 tons per acre. Barley is the principal grain produced, the yields running from one-half ton to over 1 ton per acre, depending upon the attention given to preparing the land and irrigating.

On those parts of this type recently settled grain is the first crop to be sown. This is because the larger part of the land requires no leveling, and a cash crop is available the first year after settlement. Sugar beets have given good indications, and with a factory to use the product this portion of the area will probably become one of the beet-growing centers of the project.

The following table gives the average results of mechanical analyses of the soil of this type:

Mechanical analyses of Carson clay adobe.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
22088, 22089.....	Soil.....	0.1	0.5	0.8	8.7	12.2	35.9	41.9

FALLON FINE SANDY LOAM.

The Fallon fine sandy loam consists of 2 to 4 feet of a brown to light yellowish brown, slightly micaceous, fine sandy loam. This is underlain either by coarse yellowish sandy loam or by fine gravelly sand. The texture of the soil is subject to considerable variation owing to the manner of its formation, but the description fits the greater part of the type as developed in the Truckee-Carson project. In places a thin veneer of alluvial sand occurs; a surface wash of heavier soil is not uncommonly found near the base of terraces; and the structure of the subsoil is subject to considerable variation in the arrangement of the various grades of material.

The Fallon fine sandy loam occurs along the course of the Carson River eastward from the point where New River leaves the main stream. It lies at a lower level than the adjoining desert lands. The surface may be fairly level, but is usually somewhat irregular as a result of overflows from Carson River. It is subject to flooding only during unusually high stages of the river.

This is an alluvial soil derived from deposits laid down by the river. The materials have been in part carried from the upper reaches of the stream and in part represent reworked Lahontan sediments through which the river has carved its course.

On account of the low position of the type the water table lies rather near the surface, but the porous texture allows free movement of the soil water, and the drainage is fairly good. The surface soil usually carries traces of alkali, and the subsoil may or may not contain an appreciable quantity. A few small areas are found where the content ranges from 200 parts to 400 parts per 100,000, or 0.20 to 0.40 per cent, but the larger part of the type is practically unaffected. The native vegetation consists of cottonwood, willow, and various vines and underbrush, the latter sometimes forming small impenetrable jungles. Some pasture is afforded by the native grasses, which flourish where the timber is not too thick.

Practically all of this soil has been in private ownership for many years, although but a small percentage of it has been cultivated. Irrigation water was taken from the river, but the supply was usually

exhausted in the early summer, and the yields of crops were light. Alfalfa produced from 1 ton to 3 tons per acre. Grain was often cut for hay, as the supply of water was not sufficient to mature the crop. Wheat and oats yield well, but are seldom grown. Some fruit may probably be grown for home use, but the danger of late spring frosts will prevent the planting of commercial orchards.

The following table gives the results of mechanical analyses of soil and subsoil of this type:

Mechanical analyses of Fallon fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
22092	Soil	0.0	0.4	0.7	19.8	51.2	19.7	8.3
22093	Subsoil	.0	.1	1.4	64.7	23.6	4.8	5.1

FALLON LOAM.

The Fallon loam consists of from 18 inches to 6 feet of dark gray to nearly black loam. Where the surface material does not extend throughout the profile, below 18 inches there may occur either a coarse yellowish sandy loam or a fine gravelly sand. Excepting occasional small areas, covered with a veneer of alluvial sand, the upper section of this soil maintains a uniform loam texture. Below the loam the type closely resembles the Fallon fine sandy loam in textural irregularity of materials.

The Fallon loam is generally found in long irregular bodies in the lowlands along Carson River and its branches. In the vicinity of St. Clair it extends some distance from the present course of South Branch, covering what was probably a delta of the stream during former high stages of Carson Lake.

The areas of this soil are more or less eroded by former overflows from the streams, and occasional knolls of aeolian and alluvial sand are not uncommon, all of which make the surface uneven and necessitate leveling for irrigation.

The texture of the soil allows the ready passage of water, although a high water table not infrequently retards the removal of surplus irrigation water. In some cases overirrigation has maintained the water table dangerously near the surface, while in other cases the level of the ground water rises and falls with the fluctuating level of the streams.

This type has its origin in the alluvial material deposited by flood waters of the larger streams. Portions of the type are sometimes overflowed, and are subjected to some alteration either by erosion or by the addition of suspended material.

This soil is practically free from alkali. In a few cases the immediate surface soil contains sufficient alkali to be apparent either in the character of vegetation or in a slight crust. Even in such areas only a trace of alkali could be found below the immediate surface.

Areas of this type support a native vegetation consisting practically of cottonwood and willow, with some underbrush. Where the timber has been removed and the land left uncultivated, a thick growth of rabbit brush and black sage is encountered.

Like the Fallon fine sandy loam, the larger part of the area of this type is in private ownership. Alfalfa has been the leading crop, supplemented by grain, but the cultivated area has been limited both by an inadequate water supply and the lack of a market.

Alfalfa is still the important product, yielding from 3 to 7 tons per acre. Some grain is also grown, but only in limited amounts. Potatoes, with proper care, yield from 4 to 10 tons per acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Fallon loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
22094, 22096.....	Soil.....	1.5	5.3	3.8	16.2	23.7	29.8	19.9
22095, 22097.....	Subsoil.....	6.7	24.4	18.4	25.0	12.7	7.7	5.2

SODA LAKE SAND.

The Soda Lake sand consists of from 18 inches to 6 feet of gray rather compact sand carrying varying quantities of fine angular fragments of a scoriaceous basalt. Where a change in texture takes place the surface material is underlain by a fine gravelly sand. This may extend to a depth of 6 feet or more, but frequently at about 4 feet rests upon a compact whitish loam.

This type occurs as a roughly circular body, surrounding the soda lakes lying about 2 miles northeast of Leetville. It occupies the high sloping sides of old volcanic crater rims surrounding the two lakes and merges with a gentle slope into the rolling desert lands. The surface varies from rather uniform to very irregular, the latter phase being too rough for cultivation or irrigation. The slope around the craters is quite steep, although the irregularities of the surface are very slight. The drainage is excellent.

This soil owes its origin to the intermingling of lacustrine sediments and weathered products of volcanic rocks. The surface soil is composed largely of lapilli and fine fragments of basalt.

Traces of alkali are occasionally evident in this type at lower levels where seepage from the canal lines has concentrated the soluble material in the soil. Tests of the undisturbed soil failed to show more than negligible quantities of alkali. The open porous texture of the soil is an assurance that alkali will never become troublesome.

This land is subject to entry under the homestead and reclamation laws, but none of it is under cultivation. This is largely due to the distance from town and a feeling that it may not be adapted to crops suitable for the region. It appears that aside from its distance from town this type is a desirable soil for all of the products grown in the area, and on account of its elevation and longer growing season may become important as a fruit soil. A part of the soil lies above the lines of the gravity canals, but plans for the extension of the irrigable area contemplate the irrigation of the higher slopes by pumping from the canals.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Soda Lake sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
22116	Soil	6.3	21.9	21.4	31.3	5.6	7.3	6.1
22117	Subsoil	8.6	38.7	25.0	20.9	1.6	1.0	4.4

FERNLEY FINE SAND.

The Fernley fine sand consists of 3 to 6 feet of light-brown fine sand. Where there is a change of texture below 36 inches a gravelly sand appears. This type is subject to some irregularity, especially along its boundary with other types.

The Fernley fine sand occurs as a single body of soil, extending from near Fernley westward to the limits of the area. It lies at a somewhat lower elevation than surrounding soils and, except in the western parts, possesses a uniform surface slope to the north. Some leveling is required before irrigation but much less than is usually required on other soils in the area.

The origin of this type is not clear, but it appears to be an old lake deposit, reworked by a later stream, possibly a former branch of the Truckee River.

This type does not carry enough alkali to be indicated on the map, but one or two very small areas of alkali occur where adjacent soils are affected. It is probable that with the extension of irrigated areas

drainage ditches will be required in portions of this type lying below the gravelly bench occupied by the Lahontan gravelly loam. The subsoil of the latter type frequently carries some alkali, and seepage of irrigation water may transfer the alkali to the lower lands.

A considerable proportion of this type is under cultivation and planted entirely to alfalfa. When a good stand has been secured, and the fields are given proper care, the yields range from 4 to 7 tons per acre. Vegetables and small fruits should also do well on this type of soil.

The following table gives the results of a mechanical analysis of the soil of this type:

Mechanical analyses of Fernley fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
22098.....	Soil.....	1.1	7.8	9.3	49.0	17.6	9.6	5.5

CHURCHILL CLAY.

The Churchill clay consists of 6 feet of compact dark to yellowish clay, carrying considerable quantities of tufa on the surface. The same material is occasionally found at a depth of 6 to 8 inches below the surface, where it is often cemented into an almost impenetrable hardpan. This layer is usually from 1 to 3 inches in thickness. A peculiarity of this type lies in the porous or honeycombed nature of the subsoil in certain sections. This apparently consists of numerous small subterranean cavities or tubes, more or less connected. During the inspection of this soil it was a common occurrence for the soil auger to encounter hollow places and drop for several inches.

Upon turning the water into the canal crossing this type, as much as 2 second-feet of water disappeared through the soil and continued to do so for several weeks, and as a result the level of the ground water was raised perceptibly in the vicinity.

The Churchill clay occurs in two bodies in the northern part of T. 19 N., R. 29 E. These bodies are evidently but portions of a single large body which extends beyond the limits of the present survey.

This type is apparently of lacustrine origin modified by the action of active saline springs, which deposited the tufa on and just below the surface. The soil contains over 1 per cent of alkali, and this with the cemented layer below the surface renders the type wholly unfit for agriculture.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Churchill clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
22090	Soil	1.6	6.8	10.5	20.5	9.0	16.9	34.6
22091	Subsoil	.0	5.2	6.5	13.2	12.7	24.0	37.5

DUNESAND.

Dunesand consists of 6 feet or more of fine, incoherent, wind-blown sand. This soil is found in irregular, widely scattered bodies throughout the larger part of the area, either as high, rounded dunes of varying sizes or as more or less connected lines of dunes joined by low ridges of the same material. Very small areas of this type occur within other types of soil. Although too small to be shown on the map, these dunes exercise an effect on the agricultural value of the other types by making it more expensive to bring them under cultivation.

In the southern part of the area the Dunesand extends in long, irregular bodies, which, apparently, were formed along an old shore line of Carson Lake. Most of the dunes are stationary, owing to the presence of various desert shrubs, which prevent drifting by the wind. There are one or two instances where the dunes which lack such protection are moving slowly northeastward.

The formation of this type is due entirely to wind action on fine unconsolidated sands. The drainage is excellent, and the soil is free from alkali.

Dunesand is the most extensive nonagricultural type in the area. It lies above the level of the gravity canals, and even were it supplied with water by pumping, its agricultural value would be doubtful. Protection from the wind would be difficult, and probably no crop would justify the expense of pumping the large quantity of water which would be required.

In no case should the native desert vegetation be cleared from the Dunesand areas.

IRRIGATION.

Prior to the construction of the present irrigation system by the United States Reclamation Service the water supply for irrigation purposes was derived from the spring and early summer flows of Carson River and its branches and from Stillwater Slough. The early settlers along these streams constructed small ditches and di-

verted the water by means of brush or log dams. The water was led directly to the field, or depressions some distance from the river were converted into shallow reservoirs and the water used as desired. In the former case the construction of the dams and canals was usually the work of individual farmers, although in some cases those with adjoining properties cooperated in securing their water supply. In cases where reservoirs were constructed the work was usually the result of the efforts of a number of settlers owning land which could be irrigated from a central point. Scarcity of water caused more or less friction between the farmers. Water was seldom available for irrigation after July 1, and in many years the supply failed before that time. As a result seldom more than one cutting of alfalfa was secured, except in naturally moist locations, where two cuttings were usually possible. Grain often failed to mature for lack of water and was cut for the hay or pastured.

The present irrigation system includes a diversion dam in the Truckee River near Clarks Station, on the Southern Pacific Railroad, a main canal emptying into the Carson River about 8 miles south of Hazen, a diversion dam in the Carson River 12 miles west of Fallon, and a system of distributing canals leading from that point.

The diversion dam known as the Truckee Dam in the Truckee River is a massive structure of reenforced concrete which raises the level of the river 10 or 12 feet. From this point a canal follows along the lower slopes of the mountains until the Carson River is reached, where the water plunges down a chute 100 feet into the bed of that stream. (Pl. XVII, fig. 2.)

Near the Gilpin water tank on the Southern Pacific Railroad a spillway in the main canal provides for possible emergencies and is so planned that at some future time water may be diverted at this point and used in irrigating lands on the Pyramid Lake Indian Reservation, which lies to the north. From the Truckee chute the bed of the Carson River serves as a canal until the Carson Dam is reached. (Pl. XVII, fig. 1.) At this point a concrete dam raises the water several feet, and from it two large canals, one on each side, lead the water to the main part of the project. (Pl. XVIII, fig. 1.)

All of the structures in this system, excepting a few temporary timber waste ways, are solidly built of steel and concrete, which, although making the first cost somewhat higher than all timberwork, insure future low maintenance charges. (Pl. XVIII, fig. 2.)

Under the terms of the reclamation act the cost of this system must be returned to the Government by the settlers in ten annual installments without interest. In addition to this, an annual maintenance fee to cover the operating expenses is required. On this project the cost of the system amounts to $30 an acre, and the present maintenance fee is 60 cents an acre, making the annual water tax

$3.60 an acre. Failure to make these payments before certain dates results in the cancellation of the homestead entry and throws the land open for reentry. After the cost of the irrigation system has been paid to the Government it is to be turned over to the settlers and managed by them.

The distribution of the water and care of the system are in the hands of the Reclamation Service, and water is delivered to the farm units by ditch riders upon request of the settlers. The duty of water is estimated at 3 feet per acre.

At the present time practically 100,000 acres of land are under the ditch, and means are now being considered by which this area will be increased to over 200,000 acres. These plans call for the construction of two reservoirs on the Carson River west of the Truckee chute, the construction of a retaining dam at Lake Tahoe, at the mouth of the Truckee River, the irrigation of the Pyramid Indian Reservation, and the extension of the present canal system to include land in the valley not under irrigation at this time. Other plans contemplate the developing of the water power at the Truckee chute and at a point in the main canal south of the Carson River about 7 miles west of Fallon.

The basin or check system of irrigation is commonly used, although on the sloping lands below the Main Lower Truckee Canal a modified method of furrow irrigation is practiced. In the check system the aim of the irrigator is to secure rectangular checks, since this arrangement permits a rapid distribution of water and the farming operations are facilitated. On some of the more uneven lands this is not always possible, and the checks are often irregular in shape and occasionally lie at different levels.

On the sloping lands the basin system of irrigation is not possible, as the land can not be divided to advantage. In the system used here the surface is leveled in one direction across the slope. The supply ditch runs down the slope, or, if the slope is too steep, then across the slope to prevent washing of the soil. Then, with an implement constructed for the purpose, small parallel water courses, 20 to 36 inches apart and from 1 to 3 inches in depth, are run across the slope, with just enough fall to carry water across the field. Water is run slowly into these courses until the soil has absorbed enough water by seepage for the needs of the crop. Since successful irrigation by this method depends upon a rapid lateral movement of water through the soil, it is obvious that the method is practicable only on soil with medium to light texture. Vegetables and fruits are irrigated by the furrow method.

DRAINAGE.

An investigation of the underground waters of Carson Sink Valley made by the United States Geological Survey in 1905, before this area was irrigated by the present system, showed that the highest water table occurred near the stream courses and lakes in the valley, and that as the distance from the streams increased the level of the water became lower and lower.

The natural flow of these streams was responsible to a certain extent for the high water table near these courses, but the fact that these lands were usually heavily irrigated during the spring and early summer months had much to do with maintaining the level of the ground water.

The high water table at the present time is generally most noticeable in those lands which have been under irrigation for many years. This is especially noticeable in the lands northeast of Carson Lake, where the water table is often very close to the surface and where growths of tule indicate a very wet soil. On the newer settled sections of the area the level of the ground water is undergoing rapid changes, due to two causes. Overirrigation is mainly responsible, while seepage from canals running through light-textured soils is a contributing cause. In the former case the rise of the ground water is not always evident from surface indications, as the water has as yet done but little damage to crops either by its presence or by the accumulation of alkali. In the latter case the seepage from the canals has resulted in wet, swampy places, which usually contain large quantities of alkali. These areas cover no great extent, but are confined to narrow strips of land bordering the canals.

As has been noted already, there are aside from the river courses no natural drainage courses in the area. With a somewhat high natural water table it would not be long, with irrigation, before the level of the ground water would stand at or near the surface of all of the lower levels. As a result large areas would become worthless from saturation and from the accumulation of alkali salts. These conditions have been recognized, and a series of open-drainage ditches have been constructed in settled portions of the area, and are planned and will be constructed in other sections when the settlement demands.

Besides serving as a means of controlling the height of the ground-water, the drainage ditches will afford outlets for drainage water when the reclamation of the alkali lands is undertaken. There is a considerable area of alkaline soil, as indicated by the alkali map, which must be reclaimed by draining and flooding before it will be of any agricultural value. Owing to this fact the larger part of these

lands have been withdrawn from entry until drains have been constructed through them. The cost of reclaiming these lands will fall upon the entryman.

ALKALI.

Alkali is generally present in all the soils of the area, excepting Dunesand, the Lahontan fine sand, and the Fallon loam. The content ranges from a mere trace to quantities absolutely prohibitive of cultivation.

The most extensive alkali areas occur in the eastern half of the survey and in the country south and west of Hazen. In these sections probably 70 per cent of the area contains over 200 parts per 100,000, or 0.20 per cent, of alkali. Outside of these bodies the alkali rarely occurs in areas of any great extent, but is confined to scattered isolated areas where the natural drainage is deficient.

In the eastern part of the area there are three fairly well defined centers of high alkali concentration and between these are found varying acreages of good tillable land. One of the worst alkali areas extends from Rattlesnake Hill northeastward to the limits of the survey. Here the amount of alkali in the soil is generally above 1,000 parts per 100,000, or 1 per cent, the only soil which is free from alkali being Dunesand. Another center of concentration occurs in the central part of T. 18 N., R. 29 E., about 5 miles southeast of Fallon, and extends southward toward Carson Lake. The larger part of the land in this section contains over 400 parts per 100,000, or 0.40 per cent, of alkali and there is a considerable average with more than 1 per cent. The third region of affection occurs in the central and southern parts of T. 19 N., R. 30 E. Here the alkali is found in rather extensive bodies and ranges in concentration from 0.60 to over 1 per cent, equivalent to 600 to 1,000 parts per 100,000.

In the western portion of the area, the larger amounts of alkali are generally confined to the lower, heavier soils, and the content decreases with the elevation of the surface.

In studying the relations between the types of soil and the occurrence of alkali it is found that all of the soils of the Lahontan series, excepting the fine sand and stony sandy loam, may carry excessive quantities of alkali. The Lahontan sandy loam contains less alkali than the other soils, although it does sometimes carry large amounts. The soils of the Carson series, with hardly an exception, contain alkali, but the concentration is seldom higher than 0.40 per cent.

In the remaining soils of the area alkali is not often found in dangerous quantities, and the larger proportion of these types do not contain more soluble material than would be expected in a fertile soil. The only exception to this is the Churchill clay, with more than 1 per cent of alkali.

The following table shows the extent of the several grades of alkali lands:

Content of alkali.	Acres.	Per cent.
Less than 200 parts per 100,000	82,624	54.9
From 200 to 400 parts per 100,000	38,784	25.8
From 400 to 600 parts per 100,000	8,768	5.8
From 600 to 1,000 parts per 100,000	8,128	5.4
Over 1,000	12,096	8.1
Total	150,400	.....

The origin of the alkali in this area lies in the soluble material carried by the waters of former Lake Lahontan, which upon the disappearance of the water remained in the soil. The present location of the alkali areas is, however, mainly due to secondary causes. In a few places where the old Lahontan sediments remain undisturbed, the alkali probably occurs as it was first deposited. In other portions of the area the present distribution of the alkali is mainly due to the leaching of the salts from well-drained soils into areas of deficient drainage. Besides the natural forces governing the distribution of the alkali, more or less movement of the salts is taking place as a result of irrigation. In some areas where seepage or deficient drainage occurs the alkali is increasing, and will demand attention to prevent injury to cultivated lands. In other sections where the subsoil drainage is good the alkali is being removed beyond the reach of cultivated crops.

The alkali in this area is mainly white alkali, i. e., a combination of soluble materials which do not contain sodium carbonate. When the latter salt is present in appreciable quantities the alkali is known as black alkali, for the reason that the carbonate exerts a corrosive effect on organic matter and colors seepage water or the surface of the soil a dark brown or black. In this area black alkali is very rarely found in the native desert soils, but is commonly present in depressions where seepage has resulted in the concentration of the alkali. It is sometimes seen where canals have been built above the level of the ground, and where seepage water from the canal has accumulated in the narrow pits.

SUMMARY.

The Fallon area occupies about 150,400 acres in western Nevada in the Carson Sink Valley. It occupies land formerly covered by an inland lake, which extended over a large part of the western part of the State.

Carson River and its branches and Stillwater Slough afford the only drainage in the valley. Carson Lake, southeast of the area, and Carson Sink, some distance north of the area, are remnants of the former lake once covering the valley.

The first settlements in the valley were made along the streams in the early fifties when overland-stage travel to California was at its height.

The principal towns are Fallon, Hazen, Fernley, and Stillwater. The main line of the Southern Pacific Company, with its various branches, offers an outlet to distant markets. Stage lines lead to distant mountain settlements.

The climate is arid and characterized by moderate temperatures, low rainfall, low average wind movement, and few cloudy days. The growing season extends from about the middle of May to the 1st of October.

The river lands have been cultivated for many years, but the scarcity of water and the lack of a market restricted the development of the valley.

Under the present irrigation system alfalfa is the principal crop, followed by grains and potatoes. Commercial fruit growing will be limited to the higher lands less affected by late frosts.

The size of the farms ranges from 40 to 160 acres, and practically all are operated by the owners. Patented land may be purchased for $10 to $100 an acre, depending upon location, soil, improvements, and water right.

The majority of the soils are of lacustrine origin. Their texture varies from sand to clay, the prevailing soils being sandy loams and loams. Along the streams narrow areas of alluvial soil are found. The lighter soils drift easily, and windbreaks are desirable. With the exception of the lowlands near Carson Lake and the alluvial soils along the streams, the soils of the area are generally deficient in organic matter.

Alkali is generally present in all but the lightest of the soils of the area. No loss has yet resulted from the cultivation of alkali soils, as the poorest land is not yet settled. Reclamation of parts of the project by drainage will be necessary in the future. Black alkali is extremely rare in the native soil and in well-drained cultivated areas.

The water supply for the irrigation of the area comes from the Truckee and Carson rivers. The cost of the water is $30 per acre, payable to the Government in ten annual installments, without interest. An annual maintenance fee of 60 cents per acre is required. The basin method and a modified furrow method of irrigation are in general use.

Plans call for the extension of the irrigable area, which is now about 100,000 acres, to 200,000 acres.

The level of the water table is gradually rising, but a system of drainage ditches insures control and prevention of any damage from this source.

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