

# SOIL SURVEY OF THE BROWNSVILLE AREA, TEXAS.

By A. W. MANGUM and ORA LEE, Jr.

## DESCRIPTION OF THE AREA.

The area surveyed is located in the extreme southern part of the State of Texas. It comprises 121,024 acres, or about 189 square miles, of the southeastern part of Cameron County and lies wholly within the broad and comparatively level delta which occurs near the mouth of the Rio Grande. The area owes its irregular shape to the winding course of the Rio Grande, which flows along the southern boundary until it reaches the extreme southern point of Cameron County,

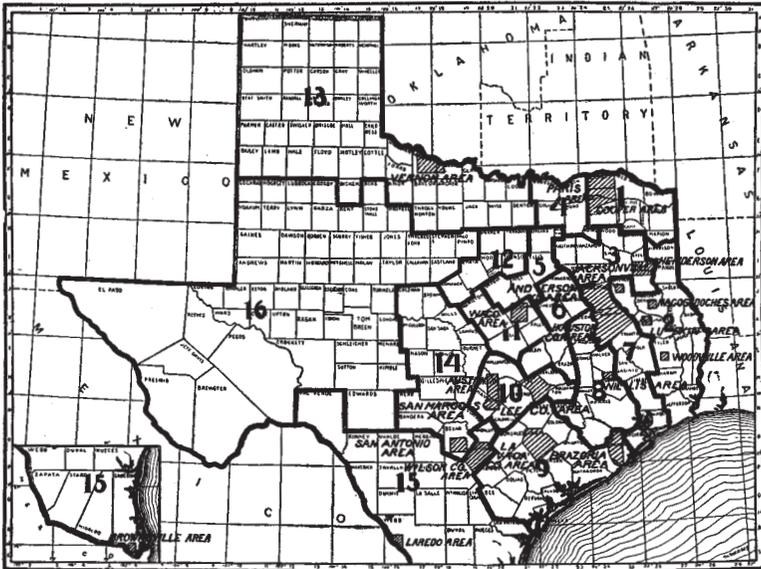


FIG. 22.—Sketch map showing location of the Brownsville area, Texas.

then bending abruptly toward the north and continuing in a general northerly direction for about 6 miles before again bending eastward toward the Gulf of Mexico.

The area is bounded on the north by that portion of Cameron County which lies north of an arbitrary line extending east and west through a point  $3\frac{1}{2}$  miles north of Olmito; on the east by the Rio Grande and by a north and south line extending from the northern boundary

line to a point on the Rio Grande about 9 miles east of Brownsville; on the south by the Rio Grande, which forms the boundary between the United States and Mexico, and on the west by the Rio Grande and a line running north and south through a point  $9\frac{1}{2}$  miles west of Olmito. The area is 21 miles long east and west and varies in width from 3 miles along the western to 16 miles along the eastern boundary.

The area as a whole has the general appearance of a broad, level plain, but it is traversed by numerous narrow, winding sloughs or "resacas," and small lakes or ponds also occur at frequent intervals. These sloughs represent former channels of the Rio Grande and were probably occupied by the river during the period when this section of the valley was being built up as a delta. They are often 15 to 30 feet deep and from 75 to 150 yards wide and are very crooked and winding. When the Rio Grande overflows, or at times of heavy rainfall, they become filled with water and usually contain water during the greater part of the year. The ponds and small lakes, some of which are more than a mile in length, also contain water during the greater part of the year. They are filled by the flood waters during times of heavy rainfall or by the overflow of the "resacas" or river. Many of the larger lakes, such as Lake Lomalta and Lake Tule, show but little decrease in the amount of water they contain, even during very dry seasons. Along the courses of the larger sloughs small crescent-shaped ponds which represent former bends in the courses of these old stream channels are frequently encountered. The water eventually cut through the narrow strips of land which divided the two bends of the stream, thus straightening the present channel and leaving the old channel as a deep crescent-shaped depression.

In the larger bends of the Rio Grande there is usually a distinct escarpment, several feet in height, separating the land which is at present subject to overflow from that occupying a higher terrace. Both along the upper terrace of the Rio Grande and along the courses of the "resacas" natural levees have been built up by the deposition of material brought down by the streams. This causes the land bordering these stream courses to be higher than that situated at a distance from them, and there is a gentle slope from the upper terrace of the river back toward the interior of the area, and the land bordering both sides of the "resacas" slopes gently toward areas lying between these old stream channels or toward areas between them and the river.

A large proportion of the eastern one-third of the area is low, flat, poorly drained land which has been covered very recently by the salt water from the Gulf and is at present in a stage of transition from a swampy condition similar to that found in the salt marshes near the

Gulf to that of poorly drained land which is flooded only at certain seasons of the year. Extending across this section of the area are long, narrow beaches which were formed by the waves when the country was still covered by the waters of the Gulf. These beaches vary in size from low, gently sloping elevations to steep, well-defined ridges which sometimes reach a height of 30 feet or more above the level of the poorly drained "flats." These beaches are seldom more than one-eighth of a mile in width, but often extend for a distance of several miles in a more or less broken ridge.

The natural drainage of a large proportion of the area surveyed is poor. The Rio Grande is the only perennial stream within the area, but, owing to the fact that the general slope of the country is away from the river, it receives a small percentage of the drainage waters of the country bordering it. The course of this stream is exceedingly crooked and is constantly changing. In many of the larger bends the stream traverses a distance of from 2 to 3 miles and then returns to within a few hundred yards of the starting point. The narrow strips of land between the principal beds are constantly becoming narrower as the current of the stream cuts away the banks, and at each annual rise of the river its course is changed, either by the cutting off of some of the larger bends or by returning to some old abandoned channel and forming a new and more crooked course.

The "resacas" which traverse almost every part of the survey receive a large proportion of the drainage waters of the area, but the land bordering them, like that along the river, often slopes away from these old stream channels and causes the intervening depressions to be flooded frequently during times of heavy rainfall. The extensive, flat, poorly drained area in the northeastern part of the survey receives the drainage of a large proportion of the country bordering it. At times of heavy rainfall, when the "resacas" become full from the overflow of the river, the excess water is eventually drained into this low-lying area, causing a considerable proportion of it to remain in a flooded or marshy condition during the greater part of the season.

The better drained sections of the area are covered with a dense growth of mesquite, cactus, and other native vegetation, but as the lower lying areas are approached the growth is lighter, while the broad, poorly drained section mentioned above, as well as other smaller ones subject to overflow, support only a heavy growth of coarse marsh grass, locally known as "sacahuiste" grass.

Prior to the annexation of Texas to the Union the section in which the area surveyed is located was claimed by Mexico and was inhabited exclusively by Mexicans. Americans began to settle the area in about 1856, the majority of them coming from the older settlements of Texas; but the population increased very slowly until about 1861,

when the civil war caused the towns along the Mexican border to become important centers of trade. A very large proportion of the present population is of Mexican origin. Many of these Mexicans have crossed the border and settled in the area during recent years, but the great majority are the descendants of the early inhabitants of this section of the State. During the last five years, however, the increased transportation facilities and rapid agricultural development have attracted settlers from many of the northern States and from the northern part of Texas, so that the American population has increased very rapidly. A very large proportion of those who are at present settling in the area come from the north-central States, but many are coming also from other sections of the Union. A large percentage of the area surveyed is at present undeveloped agriculturally and is thinly settled. The most thickly settled section is found along the old military road which follows closely the course of the Rio Grande.

Brownsville, the county seat of Cameron County, is the principal town in the area. It is located on the Rio Grande, opposite the Mexican city of Matamoros, and has a population of about 8,000. Brownsville is the center of trade for the entire area, and is also of considerable importance on account of the extensive trade which is carried on with Mexico. Olmito, a town of about 150 inhabitants, located on the St. Louis, Brownsville and Mexico Railroad 9 miles north of Brownsville, is also an important local shipping point for the products of the surrounding country.

For many years the lack of transportation facilities was a great hindrance to the development of the area. A few small steamboats traversed the Rio Grande for some distance above Brownsville, and in 1873 the Rio Grande Railroad was constructed, connecting Brownsville with Point Isabel. The construction of the St. Louis, Brownsville and Mexico Railroad, however, which reached the area in 1904, has greatly increased the facilities for transporting the products to the more distant markets. The advent of this railroad, making it possible to transport early vegetables quickly to the northern markets, has been the most important factor in the rapid development of the trucking industry in the area surveyed.

There are a few well-kept public roads which traverse the more thickly settled districts, but the area as a whole is in such an undeveloped state that no extensive road system has been established.

Brownsville is the local market for all of the products of the area. The cattle are usually shipped to Fort Worth and Kansas City. A few goats are also shipped to these markets, but the majority are sold on the local market at Brownsville. The earliest vegetables are usually shipped to the larger cities of northern Texas, but a few are

shipped also to Kansas City, St. Louis, and Chicago. The later vegetables are all shipped to the larger northern markets, such as Denver, Kansas City, St. Louis, Chicago, and New York. All of the sugar cane produced in the area is used at the local sugar mill.

#### CLIMATE.

The climate of the area is semitropical and semiarid. The elevation of the area is only a few feet above sea level, and no part of it is more than 30 miles from the Gulf of Mexico. The prevailing southeast wind, laden with moisture and tempered by its passage across the Gulf, causes a very uniform temperature throughout the year, making the region cooler in summer and warmer in winter than a more inland district of the same latitude and altitude, but not subject to the effect of this wind.

The records of the Weather Bureau station at Fort Brown, near Brownsville, show a mean difference of only 25° F. between the coldest month (January) and the warmest month (July or August). The temperature very rarely reaches 100° F. in summer, the usual day temperature being about 90° F., while in winter it seldom gets as low as 32° F. Sometimes one or two years pass without a killing frost. The average dates of the first and last killing frosts, as recorded at Fort Brown, are December 13 and February 18, but the frosts are usually so light that only the more tender vegetation is damaged. During the winter months cold north winds, locally known as "northers," often cause the temperature to fall several degrees within a few hours. Meeting the moisture-laden breezes from the Gulf, they usually cause rain, and it is only when unaccompanied by rain that they are likely to bring frost. A "norther" generally lasts two or three days, and sometimes several follow in quick succession, though there is usually a period of several weeks between them. These "northers" are not as severe in this section of the State as they are farther north, and unless accompanied by rain they do not interfere with agricultural operations. The normal winter temperature is very favorable for farm work.

The records at Fort Brown show a normal annual rainfall of about 28 inches, distributed quite evenly through the year, with the exception of April, which is very low, and September, which is relatively high. The rainfall is sufficient to support the less exacting cultivated crops, but the area as a whole is classed as semiarid. The atmosphere, however, is very humid, as the winds from the Gulf are heavily laden with moisture.

The following table, compiled from the records of the Weather Bureau station at Fort Brown, situated in the southern part of the

area, shows the normal monthly and annual temperature and precipitation:

*Normal monthly and annual temperature and precipitation.*

Month.	Fort Brown.		Month.	Fort Brown.	
	Tempera- ture.	Precipi- tation.		Tempera- ture.	Precipi- tation.
	<i>°F.</i>	<i>Inches.</i>		<i>°F.</i>	<i>Inches.</i>
January.....	59	1.5	August.....	84	3.0
February.....	63	1.5	September.....	80	6.2
March.....	68	1.4	October.....	74	3.6
April.....	73	0.7	November.....	67	2.0
May.....	78	2.2	December.....	61	1.4
June.....	82	2.7	Year.....	73	28.2
July.....	84	2.0			

AGRICULTURE.

From the early settlement of the area up to within very recent time the whole of Cameron County was utilized as an immense pasture for herds of horses and cattle, which were branded by their owners and allowed their freedom the year round. The lower part of the county, in which the area surveyed is situated, is well watered by the Rio Grande and by numerous large, fresh-water ponds and "resacas," making it well adapted to stock raising, and the owners of the large ranches have always been very prosperous.

Cotton and corn have been cultivated to a limited extent since the area was first settled, and sugar cane has been successfully grown under irrigation for more than thirty years, but no extensive areas were put under irrigation and very little interest was taken in the agricultural development of the locality until about 1902, when a considerable acreage was irrigated and utilized in growing rice. Rice was grown successfully for about three years, but the large amount of water used in flooding the rice fields caused both the soil and subsoil to become thoroughly saturated, and as very little or no provision was made for the proper drainage of this land the evaporation of the water caused the alkali which was taken in solution to be brought up and deposited on the surface. The topographic position of much of this rice land made drainage very difficult, and after the water had evaporated the heavy clay soil baked and sun cracked to such an extent that thorough cultivation was almost impossible. This lack of thorough drainage, resulting in the accumulation of alkali and in the hard, baked condition of the soil, caused the acreage in rice to decrease steadily until 1906, when the crop was abandoned entirely.

Small truck gardens, which were cultivated to supply the local market, demonstrated that both the soil and climatic conditions were well adapted to the production of many varieties of early vegetables, but owing to the lack of transportation facilities no attempt was made

to grow these crops on a large scale until the St. Louis, Brownsville and Mexico Railroad reached the area in 1904. Since the building of this railroad the development of agriculture has progressed very rapidly. Extensive tracts of land have been cleared and put under irrigation, and the area is now becoming one of the principal truck-growing sections of the State.

While stock raising is still an important industry, the large pastures are rapidly being divided into smaller tracts of cultivated land.

The climatic conditions are such as to allow the plowing of the land and the planting, cultivation, and harvesting of crops during almost every month of the year, and two or more crops are often grown on the same land during a single year. The growing of early vegetables is the principal industry in the area, although a small acreage is annually planted to cotton, corn, and sugar cane. The success of the trucking industry depends on the marketing of the crops earlier than they can be grown in areas nearer the larger markets. In the Brownsville area many of these crops are planted in the early fall, and the harvesting and marketing begins in December and continues until late in May. Later in the season, when areas farther north begin to supply the larger markets, the land which was utilized in the growing of early vegetables is cultivated to cotton, corn, or to some forage crop. Sugar cane is not grown extensively at the present time, as there is only one sugar mill in the area, but owing to the high sugar content of the cane and the large yields obtained plans are being formed to establish another large mill in the vicinity of Brownsville, and the acreage devoted to this crop may be expected to increase rapidly. The average yield for many consecutive years is estimated at about 25 to 30 tons per acre, but some of the land in the area, which has recently been put under cultivation, produced an average yield of more than 50 tons per acre. Sugar cane is usually replanted every four or five years.

The principal truck crops grown at present are Irish potatoes, sweet potatoes, cabbage, celery, lettuce, onions, cauliflower, eggplant, beets, cucumbers, melons, carrots, beans, peas, tomatoes, and spinach. Cabbages are more extensively grown than any other crop, and a profitable yield is always secured. The cabbage seed is usually sown in beds early in September and the plants are set out about the first of October. The harvesting of this crop begins about the first of January, and carload shipments have been made as early as January 15. Beets, English peas, and tomatoes are grown to a limited extent for the Christmas markets. Onions are usually set out early in December and harvested during the latter part of March or early in April. The early potatoes are planted about the middle of January and are harvested during the latter part of April or early in May. The yields are not as large as they would be were the harvesting done

later, but the higher prices obtained for the early crop more than compensate for the smaller yields. No corn is grown for other than the local market, but two crops are frequently grown and matured on the same land in a single year. Corn planted as late as the latter part of July matures in the late fall and produces a very fair yield.

Sorghum cane is also grown during the summer months as a forage crop. Lettuce, celery, cauliflower, eggplant, beets, carrots, watermelons, muskmelons, and both the California pink beans and string beans are grown very successfully for local and distant markets. Cotton is grown on both the irrigated and unirrigated land, and good yields are secured, especially where irrigation is practiced. The Cameron clay and the Laredo silty clay loam seem well adapted to the production of sugar cane, while the lighter textured soils seem better adapted to the melon and vegetable crops.

No well-established system of rotation is practiced in the area. The land is under cultivation during the entire year, and as soon as one crop is harvested the fields are prepared for another. On many of the truck farms the potato, cabbage, and onion crops are usually followed by corn or sorghum cane, as these crops can be grown and matured before the planting of the early vegetables in the fall. Cowpeas do exceedingly well on all types of soil under cultivation, and where included in a system of rotation they have proved very beneficial in keeping the soil in a productive state. Though little rotation has been practiced in the growing of sugar cane, very profitable yields are still secured from fields which have been cultivated to this crop for many years. As a rule irrigation is practiced in the cultivation of all the crops, though some cotton, as before stated, as well as corn, is grown on both irrigated and unirrigated land.

The labor employed on both the farms and cattle ranches consists almost entirely of Mexicans. This class of labor is very cheap and plentiful during all seasons of the year. On some of the cattle ranches laborers are often hired by the month, but on the truck farms they are usually hired by the day, at wages ranging from 50 to 75 cents without board.

The size of the farms in the area varies from about 100 to more than 1,000 acres. When the agricultural development of the area began the owners of the large ranches preferred to sell the land in large tracts, and the low price of the unimproved land made it possible for the purchasers to buy tracts of from 800 to more than 1,000 acres. The success of the trucking industry, however, is causing a demand for smaller tracts of land, and some of the larger areas are now being divided into tracts of 20 and 40 acres. Only a small proportion of the larger holdings was put under cultivation at first, but the remainder is being cleared and improved rapidly. The average cost of clearing the land is estimated at about \$8 an acre.

Very little land is rented for agricultural purposes, as the acreage of improved land is seldom more than the owner can cultivate; but a small acreage is annually rented either for a share of the crops or for cash. Improved farming land not under irrigation has been rented for \$1 an acre, but a rental of from \$4 to \$6 an acre has been paid for highly improved land well drained and under irrigation. When the land is rented for cash, however, the owner does not furnish the water for irrigation in cases where it is obtained from the canals of the irrigation companies. The land rented for truck growing is usually farmed on shares, the landowner furnishing the seed, water, work animals, and farming machinery and receiving one-half of the crops produced. When cotton and corn land is rented on shares the owner furnishes the land only and receives one-third or one-fourth of the crop produced. The value of the unimproved farming lands varies from about \$4 to \$25 an acre, according to location, the natural drainage, and facilities for putting it under irrigation. Land highly improved and put under irrigation is often valued at \$50 or \$60 an acre.

The thorough drainage of the heavier types of soil, a more economical use of irrigation water, and thorough cultivation of the soil would greatly increase the agricultural value of a large proportion of the land at present under cultivation. The lack of proper drainage causes the accumulation of alkali in the low depressions occupied by the heavy clay soils, especially where irrigation is practiced, as these low-lying areas usually receive the seepage waters from the adjacent fields. Because of a lack of experience in the growing of crops under irrigation, there is often a tendency to use an excessive amount of water and to substitute irrigation for cultivation.

#### SOILS.

The several types of soil encountered in the Brownsville area are very closely related, as all are derived from the silt, clay, and fine sand which has been deposited as a delta at the mouth of the Rio Grande. They may be separated broadly into three groups—first, those which occupy the comparatively well-drained sections of the area and owe their origin to the weathering of the material laid down at an early period in the formation of the Rio Grande delta; second, those occupying that section of the area which was covered recently by the salt water of the Gulf, and, third, that which occupies the lower terrace in the larger bends of the Rio Grande and is being modified by the deposition of fine sand and silt and clay during each annual overflow of the stream. The soils of these three divisions have been classified into eight distinct types, the separation being based principally on the texture of soil and subsoil to a depth of 3 feet; but where the agricultural value of a soil is influenced to any great ex-

tent by the lack of drainage or by its topographic position or other local influences such areas have been indicated on the soil map either by means of a symbol or, if of sufficient importance, have been classed as separate types.

During the period when the area was being built up as a delta by the Rio Grande the river had several outlets or channels, and at times of overflow the coarser materials held in suspension by the waters of the river were laid down in the swifter currents near the banks of the stream, forming a low ridge or natural levee composed of silt and fine sand. A similar deposit extends along the banks of the old stream channels, and it is also frequently encountered along the upper terrace of the present channel of the river. The weathering of this material forms the lighter textured soils, which are locally known as "resaca land." The land lying between these various channels of the river is lower than that which borders it on either side and remains in a wet, flooded condition for a much longer period. These broad, level areas were flooded at times of overflow, and the slow deposition of the finer particles of silt and clay, held in suspension by the water which covered them, has given rise to the heavy black clay which occupies the lower depressions in almost every part of the survey.

The soil occupying the areas between the low ridges bordering the old stream channels and the broad shallow depressions occupied by the heavy clay soils represents an intermediate type between the heavy clay soils of the depressions and the light silty loam on the ridges. The material deposited over these intermediate areas contains a smaller quantity of clay than that which was laid down in the lower depressions, and the amount of fine sand present is much less than that found in the material deposited nearer the old stream channels. The resulting soil is in most cases a heavy clay loam, but it varies slightly in texture, containing a larger proportion of silt where it grades into the lighter silt loam on the ridges and gradually becoming heavier as it approaches the areas of stiff black clay. These three types of soil embrace a very large proportion of all the cultivated land and occupy the greater part of the western three-fourths of the area surveyed.

In the extreme northern part of the survey there are several more or less extensive areas of a heavy brown silty clay, which is closely related to the heavier type of soil mentioned above. This type, however, does not occupy low or poorly drained depressions, and as a whole it is fairly well drained. Two small areas occur where this heavy brown clay has been laid down over deposits of silt and fine sand, forming a brown clay loam, underlain by a light silty subsoil.

The soil occupying the extensive, poorly drained "flats" in the northeastern section of the survey represents the earlier stages in

the formation of the soils over a very large proportion of the survey. The large quantity of silt and clay brought down by the Rio Grande is deposited in the shallow water near its outlet, forming extensive "clay flats" which soon become covered with a heavy growth of coarse marsh grass. As the area of these salt marshes is extended out into the water the surface is gradually built up by the continual deposition of the silt and clay held in suspension by the shallow water which covers it. At times of high water these marshy areas are flooded by the river, and the large quantity of silt and clay deposited during these overflows soon builds up the surface until it is no longer covered by the salt water.

During the earlier period in the formation of this extensive marshy area, while it was still covered by the salt waters of the Gulf, the action of the waves formed the long, narrow beaches of silt and clay which extend across the poorly drained section of the area in a series of low narrow ridges. The soil occupying these old beaches is not subject to overflow and is well drained, but its location in the poorly drained area and its limited extent cause it to be of small agricultural value.

In the larger bends of the Rio Grande the bank against which the swifter current strikes is being cut away very rapidly, while on the side within the bend a low terrace is being built up by the material deposited in the slower currents. As the course of the river is gradually changed the inner bank of the bends is built out by the deposition of the coarser material which was held in suspension, and a deep deposit of sand and silt is eventually formed, which extends from the former banks or upper terrace to the present channel of the stream. A deposit of silt and clay has been laid down upon the coarser material of these sandy terraces by the water which covered them during times of overflow, with the result that in such places is found a heavy clay loam underlain by a light sandy subsoil. The soil occupying these lower terraces is still in the process of formation, as a large amount of silt and clay is deposited over these areas at each annual overflow of the river.

The following table gives the name and extent of each soil type mapped in the area surveyed:

*Areas of different soils.*

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Lomalta clay-----	36,544	30.2	Point Isabel clay-----	4,096	3.4
Laredo silty clay loam-----	33,216	27.4	Laredo clay-----	3,136	2.6
Cameron clay-----	27,072	22.4	Laredo silty clay-----	448	.4
Laredo silt loam-----	8,448	6.9	Tótal-----	121,024	-----
Rio Grande silty clay-----	8,064	6.7			

## LAREDO SILT LOAM.

The Laredo silt loam to an average depth of 12 inches consists of a light-brown to gray silt loam containing a very large percentage of fine and very fine sand. The color varies slightly with the amount of organic matter present, the soil in the shallow depressions being usually darker and slightly heavier in texture than that occupying the level areas or low elevations. This soil grades into a subsoil of about the same texture, but usually lighter in color, and often containing slightly more silt and clay than the surface soil. The large amount of fine sand and silt in the soil makes it very easy to cultivate, and when plowed the surface breaks up into a loose, friable condition. The surface of the unimproved areas, however, becomes very dry, hard, and compact and often has the general appearance of a fine sandy loam.

Small areas of this type of soil occur upon the upper terraces of the Rio Grande and also along the banks and in the bends of many of the larger "resacas," or abandoned river channels. A very narrow strip of this light, silty soil usually borders the banks of the old stream channels, but in many localities it is too narrow to be indicated on a map of the scale used. No large unbroken areas occur, but small areas, varying from a few acres to about 2 square miles in extent, are encountered in almost every well-drained section of the area surveyed.

The Laredo silt loam occupies slight elevations or low ridges, but the surface is almost level and the slope toward the old stream course or toward the areas occupying a lower topographic position is very gentle. The larger areas of the type are usually traversed by abandoned stream courses or by long, narrow, crescent-shaped ponds, which contain water during a greater part of the season. The soil is naturally well drained and is free from any harmful accumulation of alkali.

The Laredo silt loam is derived through weathering from the fine sand and silt which has been deposited by the waters of the Rio Grande during times of overflow. The areas near the river were formed during the period when the Rio Grande was building up the low natural levee which borders the upper channel. The deposits of this material, however, which occur farther back from the stream, were made during the period when the abandoned stream channels, near which they occur, were occupied by the waters of the river. This soil is covered by a very heavy growth of almost every variety of native vegetation, and especially with mesquite and cactus, which usually reach a larger growth than on any other soil in the area.

A limited acreage of the Laredo silt loam is under cultivation, but the light, silty texture of both soil and subsoil, its level topography,

and good natural drainage make it one of the most valuable soils in the area for the growing of early vegetables. It seems well adapted to cabbage, sweet potatoes, and melons, and when well cultivated it also produces very profitable yields of all crops grown in the area. Cotton and corn have been grown to a limited extent on unirrigated areas, but as the soil is easily affected by drought profitable yields are very uncertain on unirrigated land. The average yield of cabbage during the last few years is estimated by those cultivating this soil to be about 15,000 pounds per acre, but some of the well-cultivated areas produced larger yields. Onions produce an average yield of 18,000 pounds per acre, and a yield of more than 20,000 pounds is not uncommon where the best cultural practices are followed. The early crop of Irish potatoes usually yields about 60 bushels per acre, but larger yields are obtained from the crop harvested later in the season. Sweet potatoes are also grown to a limited extent and good yields are secured. There is a small acreage cultivated to peas, beets, tomatoes, lettuce, and other vegetables grown for the early market, and when well cultivated profitable returns are assured.

The unimproved land of this type of soil is valued at from \$12 to \$30 an acre, according to location in the area; but when it is cleared and under cultivation and irrigation it brings from \$40 to \$60 an acre.

The average results of mechanical analyses of this type of soil are shown in the following table:

*Mechanical analyses of Laredo silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
16145,16952,16954.	Soil.....	0.1	0.4	0.1	2.3	14.4	67.8	11.4
16146,16953,16955.	Subsoil....	.0	.3	.1	7.5	11.7	66.4	13.8

The following samples contained more than one-half of 1 per cent of calcium carbonate ( $\text{CaCO}_3$ ): No. 16952, 18.8 per cent; No. 16953, 19.5 per cent; No. 16954, 15.3 per cent; No. 16955, 21.6 per cent.

LAREDO SILTY CLAY LOAM.

The soil of the Laredo silty clay loam consists of a dark-brown to black heavy silty loam to silty clay loam with an average depth of about 12 inches. It contains a large quantity of silt and clay, which causes the surface to bake and sun-crack to a considerable extent. The soil is sticky and plastic when wet, and the type as a whole has many of the characteristics of a soil of heavier texture. The subsoil, from 12 to 36 inches, is a light-brown to drab silty clay loam, which becomes much lighter in color as the depth increases and usually contains a slightly higher percentage of silt and clay than the

soil. The subsoil is sticky and plastic when wet, but when dry it becomes hard and compact and is easily crushed into a fine gray powder.

The Laredo silty clay loam is easily reduced to a state of thorough cultivation. The surface breaks up into a loamy friable condition free from hard clods, and the well-cultivated areas always have a desirable tilth. This soil occurs in long narrow bodies, which extend across the area, following closely the general course of the former channels of the Rio Grande. The topography of the type is almost level, but there is usually a gentle slope toward the depressions occupied by the Cameron clay. Although the Laredo silty clay loam usually lies along each side of the old stream channels which traverse the area, they receive the drainage water from a very small proportion of the type, for the land bordering the channels has been built above that situated at a greater distance from these channels, and thus the drainage is away from the streams into the depressions. This aids in keeping the latter in a wet or flooded condition most of the time. In the areas embraced by this type of soil occur a few small, shallow depressions, where water collects at times of heavy rains, but as a whole the type is well drained.

The material from which this soil has been derived was deposited in the slower currents at times of overflow of the Rio Grande, during the time when the river occupied the abandoned channels near which the soil occurs. The areas occupied by this type of soil did not remain in a flooded condition during long periods and there was not that slow deposition of the finer materials in still or stagnant water, such as took place in the depressions. During times of overflow, however, a larger amount of material was laid down nearer the stream and the silt, clay, and fine sand composing this soil were deposited in the quieter currents at a distance from the main channel. The texture of the soil varies slightly, the areas nearer the old stream channels containing the larger amount of silt and fine sand, while the heavier phase occurs along the boundary with the Cameron clay. Small accumulations of alkali sometimes occur in the shallow depressions or in small level areas, where the natural drainage is not sufficient to prevent the accumulation of salts on the surface. These small areas, however, have frequently been freed from any harmful accumulations of alkali by the construction of open drainage ditches.

The Laredo silty clay loam supports a heavy growth of mesquite, cactus, and other native vegetation, and the average cost of clearing the land for agricultural purposes is estimated at about \$8 to \$10 an acre. The Laredo silty clay loam is one of the most productive soils in the area and is well adapted to the growing of early vegetables. It also produces profitable yields of the staple crops, such as corn,

cotton, and sugar cane. Every variety of early vegetable grown in the area is successfully cultivated on this type of soil. Fair yields of both cotton and corn are often secured during a favorable season without irrigation. During the present season a limited acreage was planted to celery and a profitable yield was secured. Lettuce, melons, cauliflower, beets, peas, cabbage, onions, eggplant, cucumbers, tomatoes, carrots, and both sweet and Irish potatoes are all profitably grown on the irrigated area. Only a small proportion of the total acreage of this soil has as yet been cleared and put under irrigation. Many of the crops grown have been cultivated only on a very small scale, more or less as an experiment, but when well cultivated and irrigated very profitable yields have always been secured. Cabbage is the principal crop grown on this soil at the present time and gives an average yield of about 15,000 pounds per acre, though yields of 18,000 to 20,000 pounds per acre have been secured on well-cultivated land. The average yield of onions on this soil for the past three years is estimated at about 18,000 pounds per acre. The Irish potato crop harvested early in May usually produces an average yield of 60 to 70 bushels per acre, but larger yields are secured from the crop harvested later in the season. Sugar cane does well on this soil, giving an average yield of about 25 to 30 tons per acre during the four years between the time the field is planted to this crop and the time it is replanted. A yield of more than 40 tons per acre, however, has been secured on land recently put under cultivation.

The agricultural development of the Laredo silty clay loam is progressing very rapidly, as its topographic position causes it to be well drained and easily irrigated, and its texture makes it well adapted to the growing of early truck. The unimproved land is valued at from \$20 to \$35 an acre, according to its location in the area; but land which has been cleared and supplied with water is in many cases valued at more than \$50 an acre.

The following table gives the average results of mechanical analyses of samples of the Laredo silty clay loam:

*Mechanical analyses of Laredo silty clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
16143, 16948, 16950.	Soil.....	0.0	0.5	0.5	4.2	9.2	62.5	22.9
16144, 16949, 16951.	Subsoil....	Trace.	.2	.1	2.2	6.9	65.5	25.4

The following samples contained more than one-half of 1 per cent of calcium carbonate ( $\text{CaCO}_3$ ): No. 16948, 7.7 per cent; No. 16949, 20.8 per cent; No. 16950, 17.4 per cent; No. 16951, 23.7 per cent.

## CAMERON CLAY.

The surface soil of the Cameron clay consists of a heavy dark-brown to black clay which has an average depth of 12 to 15 inches. When wet, the soil is very sticky and tenacious, and on drying the surface bakes and sun cracks to such an extent that thorough cultivation is almost impossible. The subsoil—12 to 36 inches—is a heavy clay which is slightly lighter in color than the surface soil, but contains a higher percentage of silt and clay. Small lime concretions are frequently encountered in the deeper subsoil.

The surface of the better drained areas breaks up into a friable, loamy condition. The poorly drained areas are very difficult to cultivate, as they remain in a wet condition for long periods and when dry the surface is so hard and baked that the cultivation of the soil is almost impossible. This soil occurs in areas of greater or less extent in almost every locality embraced by the survey. It occupies the broad, shallow basins which occur between the abandoned river channels, and as a whole it is very poorly drained. The lower portions of these broad, shallow depressions remain in a wet and flooded condition during the greater part of the year, as they receive the drainage water from the lands bordering them. The areas are in general lower than the lands bordering the old stream channels, and thorough drainage of the lower depressions would be difficult and expensive.

The origin of this heavy clay soil can be traced to the sorting power of flowing water, the type having been built up of the finest particles carried by the Rio Grande—particles of so slight specific gravity as to remain in suspension until carried into depressions where there was practically no current after the subsidence of the floods.

The topographic position of the areas occupied by the Cameron clay, which causes them to receive the seepage water from the bordering lands, together with the lack of proper drainage, has resulted in the accumulation of alkali in almost all of the lower depressions. When the heavy clay is flooded and no provision is made for the proper drainage of the soil, as was the case in the growing of rice, a large amount of alkali is accumulated near the surface, but when the soil is well drained alkali does not occur in sufficient amounts to be harmful to crops. Several small areas where alkali had accumulated to an extent to be harmful to crops have been reclaimed recently by the thorough drainage of the land. The better drained areas along the upper slopes of the basins support a heavy growth of mesquite, cactus, and other native vegetation, but as the lower depressions are approached the growth generally becomes lighter, and the lowest portions support only a heavy growth of coarse marsh grass. Since the growing of rice was abandoned in the area, the acreage of Cameron clay under cultivation has decreased,

but where the soil is comparatively well drained it produces profitable yields of corn, sugar cane, cotton, and of many varieties of vegetables. The better drained areas seem well adapted to sugar cane and annually produce profitable yields.

Only a small percentage of the total area of this soil is at present under cultivation, and its poorly drained condition as a whole has greatly hindered its agricultural development. None of the lower depressions have been drained and cultivated, but they are at present utilized as pasture land for stock. The average yield of sugar cane is 25 to 30 tons per acre, but much larger yields have been secured on well-drained areas recently put under cultivation. Cotton is grown on both the irrigated and unirrigated areas and gives an average yield of three-fourths to 1 bale per acre. A yield of more than 1 bale per acre has been produced on well-drained irrigated land. Corn when irrigated will produce an average yield of 50 to 60 bushels per acre, and during a favorable season 40 bushels per acre has frequently been secured on unirrigated land. When irrigation is practiced two crops of corn can be grown each year. The Cameron clay is not as well adapted to the growing of vegetables as the lighter textured soils, but when well drained and thoroughly cultivated fair yields of cabbage, potatoes, and celery have been secured. Cowpeas also do well on this soil.

The average results of mechanical analyses of this type of soil are given in the following table:

*Mechanical analyses of Cameron clay.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
16141,16970,16974.	Soil.....	0.0	0.4	0.2	1.5	2.2	45.8	49.6
16142,16971,16975.	Subsoil....	.1	.3	.1	.5	1.1	43.3	54.7

The following samples contained more than one-half of 1 per cent of calcium carbonate ( $\text{CaCO}_3$ ): No. 16970, 17.9 per cent; No. 16971, 21.8 per cent; No. 16974, 17 per cent; No. 16975, 22.1 per cent.

#### LAREDO CLAY.

The surface soil of the Laredo clay, to an average depth of 12 to 15 inches, consists of a heavy brown to reddish-brown clay. This soil grades into a stiff, reddish-brown clay subsoil which becomes slightly heavier in texture and lighter in color as the depth increases. The Laredo clay is stiff and tenacious when wet, but is friable and granular when in a dry and well-cultivated condition. The surface of the uncultivated areas becomes hard and baked, and large sun cracks frequently occur, some of which extend down into the deeper subsoil.

The largest area of this soil occurs a few miles north of Olmito and is crossed by the northern boundary of the survey. A few

smaller areas, varying in size from a few acres to about 2 square miles, are also found in the north-central and northwestern sections of the survey.

The surface of the areas occupied by the Laredo clay is comparatively level, but there is usually a sufficient slope toward the adjacent depressions to insure very fair natural drainage. The type as a whole occupies a fairly high topographic position and does not receive the seepage or drainage water from any of the surrounding country. Slight accumulations of alkali sometimes occur in small shallow depressions, where at times of heavy rains water collects and remains until evaporated, but the natural drainage prevents the accumulation of salts over any extensive area.

The material from which this soil is derived consists of the finer particles of silt and clay deposited by the waters of the Rio Grande at a comparatively early period in the formation of that portion of the delta embraced by this survey. These level areas were gradually built up above the level of the neighboring salt marshes by the continual deposition of silt and clay held in suspension by the water which covered them during times of overflow.

Only a very limited acreage of this soil is cultivated at the present time, the remainder being covered by a heavy growth of native vegetation. Both the cactus and mesquite attain a very large growth. The average cost of clearing the land is estimated at about \$8 to \$10 an acre.

The small area under cultivation is very productive, and when well cultivated the irrigated land produces very profitable yields of corn, cotton, rice, and of many varieties of early vegetables. The average yield of rice was about 12 sacks per acre, but the continual flooding of the land, necessary in the cultivation of this crop, caused the heavy clay soil on drying to become so baked and sun cracked that thorough cultivation was almost impossible, and hence the crop was soon abandoned. The flooding of the soil during the period it was cultivated to rice also caused the accumulation of alkali in some of the lower depressions. Thorough drainage, however, has reclaimed these limited areas from any harmful amounts of salts. The average yield of cotton when grown under irrigation is estimated at 1 bale per acre. Corn has been grown to a limited extent without irrigation, and during a favorable season it produces about 30 bushels per acre. Where no irrigation is practiced, however, a profitable yield is very uncertain. No corn has been grown on the irrigated areas of this soil up to the present time. Beans, peas, cauliflower, cabbage, tomatoes, lettuce, cowpeas, and Irish potatoes have all been successfully grown. A small amount of celery was also grown during the past season with very fair results.

The improved land of this type located near a shipping point is valued at \$40 to \$50 an acre, while the unimproved land varies from \$10 to \$25 an acre, according to the location in the area.

The results of mechanical analyses of the Laredo clay are given in the following table:

*Mechanical analyses of Laredo clay.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
16960-----	Soil-----	0.0	0.2	0.4	9.4	4.1	47.6	38.2
16961-----	Subsoil----	.0	.3	1.1	2.2	.2	34.6	62.1

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO<sub>3</sub>): No. 16960, 21 per cent; No. 16961, 21.4 per cent.

#### LAREDO SILTY CLAY.

The surface soil of the Laredo silty clay is a heavy brown silty clay having an average depth of about 15 inches. This grades into a stiff compact silty clay subsoil, slightly lighter in color, which gradually becomes more silty in texture as the depth increases. At an average depth of 25 to 30 inches the subsoil grades into a light-brown silty loam, which is sticky and plastic when wet, but often contains a considerable amount of very fine sand. The surface of this soil does not bake and sun crack to such an extent as to interfere with its cultivation, and when plowed it breaks up easily into a loose, loamy condition.

The Laredo silty clay occurs only in two small areas in the north-central part of the survey. The larger one occurs along the upper edge of the broad, poorly drained "flats" occupied by the Lomalta clay, while the smaller is located between this poorly drained area and one of the larger "resacas." Though the topography is almost level, there is a gentle slope toward the adjacent lowlands, which causes the type as a whole to have fair natural drainage. The soil is derived from the silt and clay which were deposited at a time when these broad, level areas were frequently flooded by the overflow of the river. The finer particles of silt and clay forming the soil were laid down over the coarser silty material of the lower subsoil, which probably had been deposited along the low beach of the old salt marshes or had been laid down near the old stream channels at times of overflow.

In the larger area of the type there are small, narrow depressions where alkali has accumulated to such an extent as to be harmful to most cultivated crops. These small areas, however, are easily reclaimed by thorough drainage. A large proportion of both areas of the Laredo silty clay is cleared and under cultivation. The unim-

proved land, which borders the Lomalta clay, is not as well drained as that which is under cultivation, and small areas where alkali has accumulated on the surface occur more frequently. When well drained the irrigated land produces very profitable yields of corn, cotton, sugar cane, and several kinds of vegetables. Lettuce, cauliflower, tomatoes, beans, peas, and cabbage have all been grown for the early northern markets. The smaller area is not at present under irrigation, but during a favorable season a fair yield of cotton or corn is secured.

The average results of mechanical analyses of this type of soil are given in the following table:

*Mechanical analyses of Laredo silty clay.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
16966, 16968 -----	Soil.....	Trace.	0.4	0.1	1.5	7.8	57.8	32.0
16967, 16969 -----	Subsoil....	Trace.	.1	.1	.5	3.4	66.0	29.9

The following samples contained more than one-half of 1 per cent of calcium carbonate ( $\text{CaCO}_3$ ): No. 16966, 7.1 per cent; No. 16967, 19.2 per cent; No. 16968, 5.7 per cent; No. 16969, 25.5 per cent.

#### LOMALTA CLAY.

The surface soil of the Lomalta clay, to an average depth of 12 to 15 inches, consists of a dark-drab to black clay or silty clay. It is very stiff and tenacious when wet, and bakes and sun cracks when in a dry condition. When the surface becomes dry and baked it often has a light grayish appearance, but in the depressions where organic matter has accumulated and decayed under conditions of poor drainage the color usually varies from light brown to black. This soil grades rapidly into a light-brown to reddish-brown silty clay subsoil, which becomes lighter in color as the depth increases and often contains local beds of crystalline gypsum and small lime concretions.

The Lomalta clay occurs in one extensive unbroken body, which embraces a very large proportion of the entire northeastern one-fourth of the area surveyed. The topography is almost level, but low, shallow depressions, which remain in a wet and flooded condition during the greater part of the year, and small lakes and marshes occur at frequent intervals over the entire area occupied by this type, and the soil as a whole is very poorly drained. The type was covered by the salt water of the Gulf within comparatively recent times, and the areas bordering the shallow lagoons of salt water that extend inland from the coast are still in a marshy condition and represent the earlier stages in the formation of this soil.

A considerable quantity of alkali is present in both soil and subsoil, and the facilities for drainage are so poor that the reclamation of the land for agricultural purposes would be very difficult.

None of this type of soil is under cultivation, but it supports a heavy growth of a coarse marsh grass and is utilized as pasture land for stock. No cactus, mesquite, or other varieties of native vegetation, such as grow on the better drained soils, are found in the area occupied by this type.

The results of mechanical analyses of the Lomalta clay are given in the following table:

*Mechanical analyses of Lomalta clay.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
16956-----	Soil-----	0.0	0.2	0.2	2.3	2.5	57.5	38.1
16957-----	Subsoil----	.3	.4	.3	1.5	1.9	67.1	28.3

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO<sub>3</sub>): No. 16956, 15.6 per cent; No. 16957, 20.7 per cent.

POINT ISABEL CLAY.

The surface soil of the Point Isabel clay is a heavy drab to brown clay, with an average depth of 10 to 15 inches. The subsoil to a depth of 36 inches differs very little in texture from the surface soil, but is slightly lighter in color. This soil does not become baked and sun cracked like the other heavier types, which are not so thoroughly drained, but a very thin baked crust is often formed on the surface, causing it to have a light grayish appearance.

The Point Isabel clay occurs as long, narrow ridges or beaches, which extend across the large, poorly drained basin occupying the northeast one-fourth of the area. These ridges are seldom more than a few rods wide, but often have an elevation of 30 feet or more above the level of the adjacent poorly drained "flats." The summits of the larger beaches are almost level, but the slopes are steep and abrupt and the water which falls on them is rapidly carried down to the lower levels, causing the soil to be excessively drained.

The areas occupied by this soil were formed by wave action during the period when the broad, level basin now occupied by the Lomalta clay was still covered by the salt waters of the Gulf and the silt and clay brought down by the river were being deposited in the shallow water near its mouth.

This type of soil is of little or no agricultural value at the present time, as its location in the midst of the poorly drained section of the area, its topography, and the excessive drainage render it unfit for the cultivation of the crops now grown in the area. The character-

istic growth consists of the Spanish dagger and several varieties of cactus. It also supports a light growth of mesquite.

The results of mechanical analyses of the Point Isabel clay are given in the following table:

*Mechanical analyses of Point Isabel clay.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
16958-----	Soil-----	0.0	0.3	0.2	7.0	3.6	39.5	50.0
16959-----	Subsoil----	.1	.1	.2	6.7	1.7	45.2	46.3

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO<sub>3</sub>): No. 16958, 12.9 per cent; No. 16959, 11.6 per cent.

#### RIO GRANDE SILTY CLAY.

The soil of the Rio Grande silty clay, to an average depth of about 12 inches, is a dark-brown to black silty clay to clay. This grades into a lighter textured subsoil consisting of silt and fine sand, which rapidly becomes lighter in texture as the depth increases, until at 30 to 36 inches it is a light-gray fine to very fine sandy loam. When dry the soil becomes hard, baked, and sun-cracked. Low ridges of fine sand and silt are encountered in the larger areas of the type, but they are not of sufficient extent to be indicated on a map of the scale used.

This type of soil occupies the lower terrace in the larger bends of the Rio Grande and is subject to overflow at times of high water. The land bordering the present channel of the stream is usually higher than that farther back from the river, forming a shallow, poorly drained basin near the foot of the upper terrace. The surface of these basins is comparatively level, but small, poorly drained depressions and low, narrow ridges, which have been formed by the currents at times of overflow, occur frequently over all of the larger areas. A lighter phase of this soil occupies the low ridges and usually contains a much higher percentage of fine sand than that found on the more level areas or slight depressions, while the stiffer clay occurs in the lower depressions, which remain in a wet and flooded condition for long periods after each annual overflow.

The Rio Grande silty clay is derived from the more recent deposits of sand, silt, and clay laid down near the present channel of the river. As the river gradually cuts away its bank on one side of the bends the opposite bank is built out by the deposition of fine sand and silt, eventually forming a low, sandy terrace. The banks of this lower terrace are gradually built up by the greater deposition of material near the present channel of the stream, and the water which collects at times of overflow in the shallow sandy basins thus formed

slowly deposits the finer particles of silt and clay held in suspension, forming a heavy silty clay soil which overlies the lighter textured subsoil. This soil is still in the process of formation in all of the larger bends of the Rio Grande.

The areas embraced by this type are covered by a heavy growth of semitropical vegetation. Extensive groves of palms sometimes occur in the better drained sections of the larger areas, while the lower depressions support a heavy growth of cane, tules, and many varieties of coarse marsh grass.

None of this soil is under irrigation at the present time, as it is subject to annual overflow and often remains in a poorly drained or flooded condition for long periods of time. The better drained areas, however, are often cultivated to cotton and corn, and when these crops are not damaged by overflow they produce very fair yields. The average yield of corn is estimated at about 30 bushels per acre, but much larger yields have been obtained on well-cultivated areas during a favorable season. Cotton does fairly well, and when not damaged by overflow or by the boll weevil a yield of from three-fourths to 1 bale per acre has often been secured. During the last few years the crop has not been damaged by the boll weevil to any great extent. The value of this land varies from \$10 to \$25 an acre, according to its location in the area and drainage conditions.

The following table shows the results of mechanical analyses of the Rio Grande silty clay:

*Mechanical analyses of Rio Grande silty clay.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
16964-----	Soil-----	0.1	0.8	3.4	10.6	2.4	41.4	42.2
16965-----	Subsoil---	.0	.2	.0	25.0	14.4	42.1	18.4

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO<sub>3</sub>): No. 16964, 16.2 per cent; No. 16965, 17.7 per cent.

#### IRRIGATION.

The water supply for irrigation purposes is obtained from the Rio Grande and from the abandoned channels of this stream, which become filled at times of overflow and act as natural reservoirs. These old stream channels often become partially dry, but deep basins occur frequently along their courses, which contain a large amount of water during every season of the year. The water of the Rio Grande holds in suspension a large quantity of silt, which is deposited in the larger irrigation canals, causing them to fill up rapidly. The water obtained from the old stream channels or "resacas," however, has a very low silt content, as this material is deposited before the water

is used for irrigation. The following analysis of water from the Rio Grande shows the quantity of mineral matter held in solution and of silt held in suspension. This sample was taken when the river was very low, and the quantity of silt is probably less than the water contains when the river is at its normal height.

*Analysis of water taken from the Rio Grande about 5 miles southeast of Brownsville.*

	Parts per 100,000.
Silt in suspension -----	28.0
Total dissolved salts-----	96.0
Sodium bicarbonate (calculated from $\text{HCO}_3$ )-----	18.5
NaCl (calculated from Cl)-----	24.2

Owing to the fact that the upper terrace bordering the river is higher than the land farther back from the stream, there is a sufficient slope to permit the use of open canals in distributing the water over the area under irrigation. At the present time the larger canals are distributing water over areas situated several miles back from the river without a second lift being necessary. Water has to be pumped from the river to the level of the upper terrace, where it enters the main canal and is carried by gravity to the areas under irrigation.

The largest system of irrigation in the area surveyed is owned and operated by a Brownsville company. This system furnishes water at present for the irrigation of about 4,800 acres and has the capacity for irrigating a considerably larger acreage. Where water is obtained from the canals of this company the landowner pays for the construction of the laterals leading from the main canal to the lands to be irrigated and pays an annual rental of \$6 an acre for the use of the water on land cultivated to cotton, corn, or sugar cane and \$10 an acre for the irrigation of land utilized in the growing of truck. The cost of constructing the lateral ditches depends largely on the nature of the country traversed by them, but the average cost per mile is estimated at from \$40 to \$50.

On some of the larger farms, located along the river, where truck and sugar cane are grown extensively, the water for irrigating purposes is pumped directly from the river to the shallow ditches, which distribute it over the cultivated fields. The small pumping stations on these farms are usually equipped with a steam pump which has a capacity for irrigating from 300 to 500 acres. The average cost of putting the land under irrigation, not including cost of pumping plant, is estimated at approximately \$4 an acre, and the daily running expenses of a plant which will irrigate 20 acres of sugar cane or 10 acres of vegetables a day is estimated at about \$3.50. Small gasoline engines are used to pump water from the "resacas" for the irrigation of the small truck farms located along the old stream channels.

The total area under irrigation within the boundaries of the survey is approximately 5,750 acres. Almost the entire area of every type of soil encountered in the survey can be easily and profitably irrigated, with the exception of the narrow ridges found in the north-eastern part and the lowlands, which are subject to overflow and so poorly drained that they are at present unfit for cultivation. The extent of the area under irrigation is increasing rapidly from year to year.

The furrow system of irrigation is used in the cultivation of all the crops grown in the area. The lateral ditches are usually about 25 or 30 rods apart, and the slopes of the fields are so gentle that the shallow furrows between the rows of plants are run straight down the grade.

#### ALKALI.

Alkali occurs in sufficient amounts to be harmful to crops in almost every section of the area where water collects and stands for long periods of time and where the natural drainage is so poor that this water is removed only by evaporation.

The alkali owes its origin to the deposition of the salts held in solution by the salt water which was slowly evaporated during the period when this delta land was passing from the salt-marsh stage to the stage represented by the poorly drained "flats" which have only a slight elevation above sea level. In the better drained sections of the area alkali occurs only in small depressions, seldom more than a few square rods in extent, which receive the seepage water from the surrounding land and remain in a wet and flooded condition. Thorough drainage, however, soon frees the soil from these small accumulations of salt.

Alkali frequently occurs in the lower depressions of the broad, shallow basins occupied by the Cameron clay. These shallow depressions receive the drainage water from all of the surrounding land and remain in a flooded condition during the greater part of the year. As the water evaporates the alkali held in solution by the waters which thoroughly saturated the soil and deeper subsoil, and also that contained in the seepage water from the surrounding land, becomes concentrated in the surface soil, often causing it to contain such a high percentage of soluble salts that it supports only a growth of coarse salt grass.

The greater quantity of alkali seems to occur in the deeper subsoil, and when these low-lying areas are flooded, either naturally or by irrigation, and no provision is made to drain them thoroughly, accumulations of alkali soon appear on the surface and the agricultural value of the land is greatly decreased. When these areas are properly drained, however, no harmful accumulations of alkali occur.

The soil most affected by alkali is that occupying the broad, poorly drained "flats" in the northeastern section of the area. This land was recently a vast salt marsh, and its natural drainage is insufficient to remove any of the salt which was accumulated during this stage in its formation.

The following analysis shows the chemical composition of the alkali which occurs in the area:

*Chemical analysis of alkali in soil.*

Constituent.	Sample taken 1 mile northeast of Olmito.	Constituent.	Sample taken 1 mile northeast of Olmito.
Ions:	<i>Per cent.</i>	Conventional combination:	<i>Per cent.</i>
Calcium (Ca).....	12.66	Calcium sulphate (CaSO <sub>4</sub> ).....	14.09
Magnesium (Mg).....	3.04	Calcium chloride (CaCl).....	23.53
Sodium (Na).....	19.03	Magnesium chloride (MgCl <sub>2</sub> ).....	11.92
Potassium (K).....	.94	Potassium chloride (KCl).....	1.80
Sulphuric acid (SO <sub>4</sub> ).....	9.94	Sodium bicarbonate (NaHCO <sub>3</sub> ).....	.97
Chlorine (Cl).....	53.68	Sodium chloride (NaCl).....	47.65
Bicarbonic acid (HCO <sub>3</sub> ).....	.71	Per cent soluble.....	3.39
Carbonic acid (CO <sub>2</sub> ).....			

SUMMARY.

The Brownsville survey comprises an area of 189 square miles along the Rio Grande, in southern Cameron County, the southernmost point of Texas. The topography of the area is almost level, and drainage as a whole is naturally poor.

A large proportion of the present population is of Mexican origin. Though the area is yet but thinly settled, its recent agricultural development has caused a rapid increase in the population, and settlers are coming in from many of the Northern and Central States.

The St. Louis, Brownsville and Mexico Railroad furnishes adequate means for transporting the products of the area to the more distant markets.

The climate is semitropical and semiarid. The winters are so mild that vegetation is seldom seriously damaged by frosts.

Stock raising was the principal industry until the railroad reached the area in 1904. Since then the agricultural development of the irrigable lands has progressed rapidly. The growing of truck for the northern markets is now the principal industry in the area. Good yields of the staples—sugar cane, cotton, and corn—are secured.

The available farm labor consists almost exclusively of Mexicans. Laborers are plentiful during all seasons of the year, and wages are low—from 50 to 75 cents a day without board.

Farming lands are usually owned in large tracts, though a very limited acreage is at present under cultivation. The rapid development of the trucking industry is causing a demand for small farms, and as a result the larger ranches are being subdivided.

Eight types of soil were encountered, all closely related and all derived from delta materials of the Rio Grande. The area was once a poorly drained salt marsh, but has been gradually built up above the level of the salt water by the silt and clay deposited during overflows of the Rio Grande. The lighter textured soils were deposited in the swifter currents near the stream channels, while the heavier clays occur in the depressions which remained in a flooded condition for long periods of time.

The Laredo silt loam, which consists of a light-brown to gray silty loam, underlain by a light silty subsoil, is one of the most valuable trucking soils in the area. It occurs near the upper terrace of the Rio Grande and borders the larger "resacas."

The Laredo silty clay loam is the intermediate type between the light silty clay bordering the "stream" channels and the heavy clay occupying the depressions. The soil is a light-brown loam, underlain by a light-brown to gray subsoil, slightly heavier in texture. It is friable and loamy when well cultivated and is one of the most productive soils of the area.

The Cameron clay is a heavy black to dark-brown clay, occupying low, poorly drained basins. It is a productive soil when well drained, but usually contains alkali, and the surface becomes so hard and baked on drying that thorough cultivation is very difficult. The depressions occupied by this type receive the drainage waters of the lands surrounding them and are frequently flooded.

The Laredo clay is a heavy brown clay which bakes and sun cracks when dry, but breaks up into a loamy, friable condition. It is fairly well drained. The very small area of this soil at present cultivated produces very profitable yields of all crops grown in the area.

The Laredo silty clay is a heavy brown clay loam, underlain by a heavy clay loam subsoil, which gradually becomes lighter as the depth increases and grades at 25 to 30 inches into a light-brown silty loam. It is comparatively well drained, but contains a small amount of alkali in the shallow depressions. Where well drained and well cultivated it produces very profitable yields of all crops grown in the area.

The Lomalta clay is a heavy dark-brown to black silty clay, underlain by a heavy silty clay subsoil which is slightly lighter in color. It occupies a broad, flat basin which was, within comparatively recent times, an extensive salt marsh. This soil is so poorly drained and contains such a large amount of alkali that it is at present unfit for cultivation.

The Point Isabel clay, which consists of a light-brown loam to clay loam, occupies long, narrow beaches in the northeastern part of the area. These ridges represent old beach lines which were formed by the action of the water during the period when this section of the area was covered by the salt waters of the Gulf.

The Rio Grande silty clay is a heavy silty clay overlying a fine sandy to silty subsoil. It occupies the lower terraces which occur in the larger bends of the river, and represents the more recent deposits of the Rio Grande. It is subject to annual overflow.

There are at present about 5,750 acres under irrigation in the area, and the acreage is increasing very rapidly. The water for irrigation purposes is obtained from the Rio Grande and from the abandoned channels of this stream. It is raised to the upper terrace of the river by pumps and carried by gravity, in open ditches, to the land at a distance from the stream. Irrigation is necessary on all types of soil in order to cultivate them with any certainty of securing profitable yields.

Alkali occurs in small poorly drained depressions in almost every section of the area, but where thorough drainage is possible the soil can be easily freed from any harmful accumulations of salts.

# Accessibility Statement

---

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at (800) 457-3642 or by e-mail at [ServiceDesk-FTC@ftc.usda.gov](mailto:ServiceDesk-FTC@ftc.usda.gov). For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at <http://offices.sc.egov.usda.gov/locator/app>.

The U.S. Department of Agriculture (USDA) prohibits discrimination against its customers. If you believe you experienced discrimination when obtaining services from USDA, participating in a USDA program, or participating in a program that receives financial assistance from USDA, you may file a complaint with USDA. Information about how to file a discrimination complaint is available from the Office of the Assistant Secretary for Civil Rights. USDA prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex (including gender identity and expression), marital status, familial status, parental status, religion, sexual orientation, political beliefs, genetic information, reprisal, or because all or part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.)

To file a complaint of discrimination, complete, sign, and mail a program discrimination complaint form, available at any USDA office location or online at [www.ascr.usda.gov](http://www.ascr.usda.gov), or write to:

USDA  
Office of the Assistant Secretary for Civil Rights  
1400 Independence Avenue, S.W.  
Washington, DC 20250-9410

Or call toll free at (866) 632-9992 (voice) to obtain additional information, the appropriate office or to request documents. Individuals who are deaf, hard of hearing, or have speech disabilities may contact USDA through the Federal Relay service at (800) 877-8339 or (800) 845-6136 (in Spanish). USDA is an equal opportunity provider, employer, and lender.

Persons with disabilities who require alternative means for communication of program information (e.g., Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).