SOIL ASSOCIATIONS AND LAND CLASSIFICATION FOR IRRIGATION CHAVES COUNTY

Agricultural Experiment Station
in cooperation with

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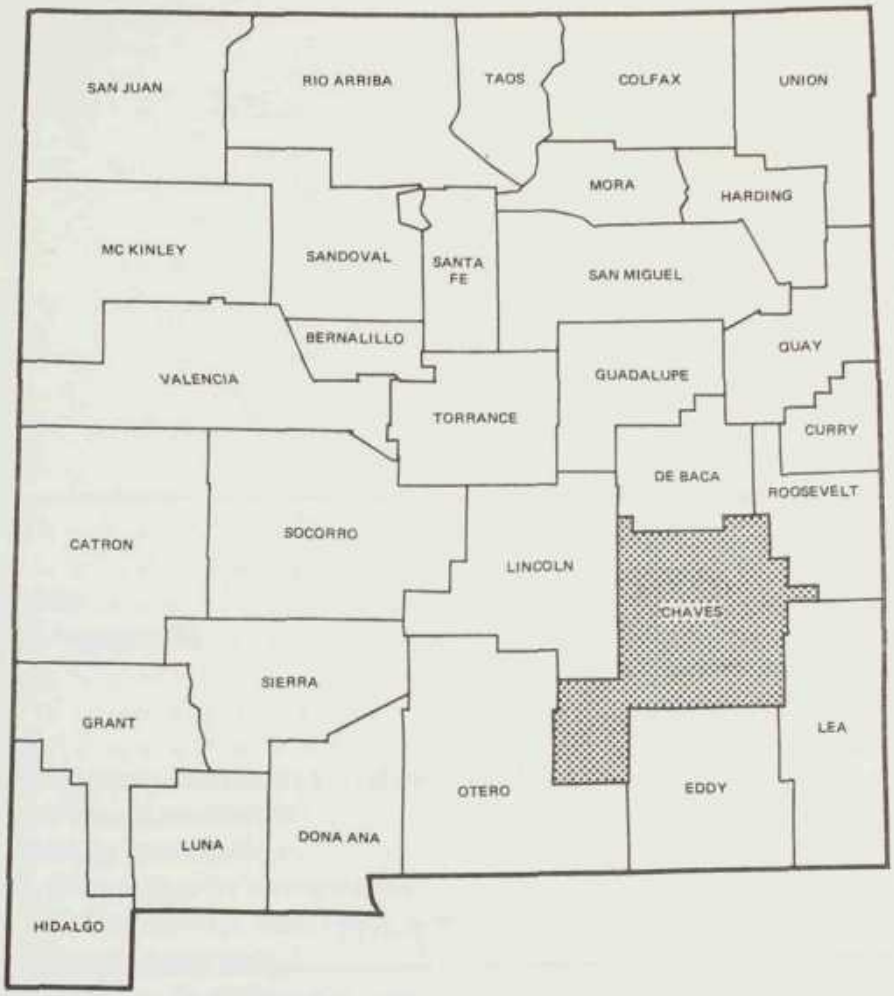

Acknowledgments

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Summary

Chaves County has a total land area of about 3,900,800 acres. Approximately 45 percent of this, or about 1,737,000 acres, is considered suitable for irrigation. Of this total, about 101,000 acres are now irrigated. There remains, therefore, a large acreage of land that is suitable for irrigation. The potential for expanding irrigation is limited by a lack of water and by economic restrictions rather than by a shortage of suitable soils. Of the land classified as suitable for irrigation, approximately 388,030 acres are in irrigation land class 1; 592,363 in class 2; 555,897 in class 3; and 200,724 acres in land class 4. The remaining 2,163,786 acres in the county are in land class 6, which is not suitable for irrigation.

The data are organized and presented on the basis of the 20 soil associations shown on the general soil map (figure 1). The irrigation land classification map (figure 2) is based partly on the soil association map and shows the approximate distribution of the dominant classes.

The soil associations differ significantly in suitability for irrigation as well as for other uses. For example, the limestone hills and mountain foothill areas included in soil associations 12 and 17 are well suited to recreation, range and wildlife. These associations particularly provide a good habitat for many species of wildlife. In contrast, association 1, Reakor-Reeves-Elfrida, is well suited to range use and irrigated agriculture, but offers only limited recreational opportunities and wildlife habitats.

Engineering classification of these soils has also been provided to facilitate use of the soil association information by engineers and others acquainted with these groupings. Information relative to the suitability of the soils for a variety of engineering uses and specific factors limiting their use are also given in the engineering section.

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SOIL ASSOCIATIONS AND LAND CLASSIFICATION FOR IRRIGATION CHAVES COUNTY

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An essential for planning the best possible use of land and water resources in New Mexico is information on the capability of soils for the numerous uses, present and potential. One such land use is irrigated agriculture, and it is important that the many kinds of soils within New Mexico be evaluated for this land use, especially since there is interest in the expansion of irrigation in the state. The water required for the new irrigated land, if expansion should occur, would be developed locally, transferred from other sections of the state, or brought in from distant sources.

The primary purpose of this report is to present information on the suitability of soils in Chaves County for irrigation. The acreage, general location, and relative capability of the soils for such use are given. This information can be used in appraising the value or suitability of large tracts of land for irrigation. Only soils capable of high productivity under sustained irrigation can be expected to provide a satisfactory income for farm operators. Obviously limited or expensive irrigation water should be used on soils that are the most productive and have the fewest limitations. The extent, location, and relative suitability of land for irrigation in Chaves County are presented on the map showing land classification for irrigation (figure 2). The general soils map (figure 1) and a few detailed soil surveys provided the information needed for irrigation land classification.

The general soil map will also be useful in community or broad area planning. For example, from the general soil map of Chaves County, information can be obtained about the location of large tracts of land with soils suitable for the development of irrigated land. It also shows those areas with soils best suited to range, recreation, wildlife, urban or other uses, as well as the general location of soils that will present problems in the construction of roads or building foundations.

The general soil map of Chaves County does not replace the need for detailed soil maps for operational planning on individual farms and ranches or the planning of specific locations for houses, roads, parks, and other items of this nature. General soil maps are suitable *only* for *general or broad area planning*. They can, however, serve a very useful purpose in the planning process.

Procedures

In this county, the irrigation land classes were assigned on the basis of the soil data available from the general soil map (figure 1). Although such maps are often made by generalizing from large-scale detailed soil maps, this was possible only to a limited extent in Chaves County. Detailed soil surveys were almost entirely limited to the irrigated lands and contiguous areas of rangeland

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where special studies were conducted. The general soil map of this county, therefore, was prepared largely on the basis of a field reconnaissance together with interpretation of airphotos, topographic maps, geological maps, and other available information. When the detailed surveys are completed for the entire area, some of the soil names that are used to identify the soil associations may be changed. This will not affect the usefulness of the map, however, because the soil names are only a means of identifying the mapping units. The soil properties and qualities of the soils comprising the mapping units will not change.

The general soil map (figure 1), which is small-scale and shows only soil associations, was prepared by grouping geographically associated soils into 20 units. These units, referred to as "soil associations" are landscapes, or geographic areas, that have a distinctive proportional pattern of soils. Since each kind of soil normally occurs in comparatively small rather than large areas, the map units on the general soil map of Chaves County are generally made up of two or more kinds of soil. In addition, land types and a number of minor soils are commonly components of the map units in this county. The kinds of soil included in each soil association are not necessarily similar. In fact, they often have contrasting characteristics that influence their use and management.

When the soil data were assembled, the major soils and miscellaneous land types within each soil association were placed into one of five classes of land, depending upon their suitability for irrigated agriculture (table 5). The criteria used in the placement of soils in the irrigation land classes are those proposed at the 1967 conference organized by the Federal Water Resources Council[3] and modified by a committee of this conference on January 12, 1968. These criteria were agreed upon by authorities from several organizations concerned with land classification and appear to have a particularly high reliability. For uniform and consistent application of these criteria and standards, the New Mexico Soils Work Group has issued guidelines and clarifications as needed and appropriate.

The classification system establishes four classes of irrigable land and one class of non-irrigable land. Class 1 land has few or no limitations for use as cropland under irrigation. It is productive and well adapted to irrigation. High yields of most climatically adapted crops can be obtained on these lands with good management. Class 2 land, although well suited to irrigation, has slight to moderate limitations for sustained use under irrigation. This is moderately productive land, but it requires more than average management to obtain high yields of climatically adapted crops. Class 3 land, which has moderate to severe limitations for sustained use under irrigation, is generally not as suitable for the production of as wide a range of the climatically adapted crops as land in classes 1 and 2. This land also has more limited productivity for many of the climatically adapted crops, or requires a very high level of management to obtain moderate to high yields. Class 4 land has a very severe limitation for sustained use under irrigation. The land included in this class is suitable for only a relatively few of the climatically adapted crops. Some of this land may be adapted or used for the production of specialized crops under a very high level of management. Class 6 land is not suitable for irrigation.

The land in Chaves County was placed in the various irrigation land classes on the basis of soil properties and qualities that affect their suitability for continued use under irrigation.

Neither the availability of irrigation water nor the cost of pumping and conveying it enters into the classification, nor was the shape, size, and location of lands with respect to other lands to be developed for irrigation considered in this classification. The detailed criteria used in the placement of land in the various irrigation land classes are listed in table 1.

Numerous soil properties and qualities, as well as related land factors, affect the placement of land in this county in the various irrigation land classes. Those features of major importance include soil texture, thickness or depth of effective soil, available water-holding capacity, erosion, surface smoothness, slope, internal soil drainage, salinity, and surface drainage. The Upton soils, for example, were placed in a non-irrigable land class, primarily because the depth of effective soil material is limited and the moisture retention capacity is very low. This is in contrast to the deep soils of the Reakor series which were placed in irrigation land class 1. The Reeves soils were placed in class 3 primarily because of salinity and the limited thickness of effective soil over gypsum or gypsiferous earth. Some Reeves soils were included in class 4 because of a moderate to high salt content or a still more limited thickness of effective soil material. In the western part of the county, steep slopes and rough broken topography, together with shallow, stony, and rocky soils were the principal factors contributing to the placement of a high percentage of the lands in a non-irrigable land class, or class 6.

[3]Proceedings Water Resources Council, Irrigation Land Classification Seminar, Salt Lake City, Utah, July 1967.

Table 1. Land classification specifications for Pacific Southwest Basin irrigation land classes[1]

Land Characteristics	Class 1	Class 2	Class 3	Class 4	Non-irrigable Class 6
Soils					
Texture (Surface 12")[2]	LVFS-CL	LS-C Peat, Muck	MS-C	MS-C	All other lands not meeting
Moisture Retention (AWHC-48")[3]	> 6.0"	4.5" 6.0"	3.0" 4.5"	2.5" 3.0"	criteria for
Effective Depth (inches)	> 40[4]	30- 40	20 - 30	10 - 20	arability
Salinity ($EC_e \times 10^3$ - equil.)	< 4	4 - 8	8 - 12	12 - 16	
Sodic Conditions[5]					
Percent area affected	< 5	5 -15	15 - 25	25 - 35	
Severity of problem[6]	Slight	Moderate	Moderate	Moderate	
Permeability (in place - in/hr)	0.2-5.0	0.05-5.0	0.05-10.0	Any	
Permissible coarse fragments (% by vol.)					
Gravel	15	35	55	70	
Cobbles	5	10	15[7]	35[7]	
Rock Outcrops (distance apart in feet)	200	100	50	30	
Soil Erosion (for all classes)	Severely eroded soils will be downgraded one class. Less severely eroded soils may be downgraded one class, depending on other conditions.				
Topography (or land development items)[8]					
Stone for Removal (cubic yards per acre)	10	25	50	70	
Slope (percent)					
Moderately to severely erodible	< 2	2 - 5	5 - 10	10 - 20	
Slightly erodible	< 4	4 - 10	10 - 20	20 - 25	
Surface Leveling or Tree Removal (amount of cover)	Light	Medium	Medium heavy	Medium heavy	
Irrigation Method	Lands unsuited to gravity irrigation where land grading would permanently reduce soil fertility below arable limits or exceed permissible costs, or field pattern too complex, may be considered for sprinkler. Land must meet other requirements for arability. Designate by "S" - example, 3-S.				
Drainage					
Soil Wetness (depth to water table during growing season with or without drainage)					
Loam or finer	> 60"	40" - 60"	20" - 40"	10" - 20"	
Sandy	> 50"	30" - 50"	20" - 30"	10" - 20"	
Surface Drainage	Good	Good	Restricted	Restricted	
Depth to Drainage Barrier (in feet)	> 7	6 - 7	5 - 6	1.5 - 5	
Air Drainage[9]	No Problem	Minor	Restricted	Restricted	

[1]Specifications are representative of conditions after land is developed for irrigation. Each individual factor represents a minimum requirement, and unless all other factors are near optimum two or more interacting deficiencies may result in land being placed in lower class or designated class 6 -- non-irrigable.

[2]Finer textures may be required than those indicated for each class in areas subject to critical hot spells or wind; coarser textures may sometimes be permissible.

[3]In areas of very warm growing season 3" may be required for class 4 and in cold areas as little as 5" may be permitted for class 1.

[4]Depth of 60" or more is required for class 1 where deep-rooted crops are important.

[5]More extensive and severe sodic problems may be tolerated in areas of wide crop adaptability.

[6]Severity of problem: **Slight** - ESP less than 15% or less than 25% if dominated by nonswelling clays; **moderate** - ESP less than 20% or less than 30% if clay minerals favorable; **severe** - ESP less than 30%; with certain soil minerals may range above 50% as measured by usual techniques.

[7]May range above 50% in subsoil for certain crops if surface soil is favorable.

[8]Special crop and management practices may justify exceeding the limits for stone removal or slope in class 4; irregularity of slope may necessitate downgrading of class unless deficiency is compensated for by possibility of sprinkler irrigation.

[9]Air drainage is a consideration mainly in areas adapted to fruit or to early or late vegetables.

Abbreviations:

LVFS - loamy very fine sand
LS - loamy sand
MS - medium sand
CL - clay loam
C - clay
AWHC - available water holding capacity
ESP - exchangeable sodium percentage

Location and Topography

Chaves County, comprising an area of about 6,095 square miles, or 3,900,800 acres, is located in the southeastern part of New Mexico. It is separated from Texas on the east by Roosevelt and Lea counties and on the south by Eddy County.

Except for small areas in the extreme southwestern part and on the High Plains along the eastern boundary of the county, essentially all surface runoff from this county enters the Pecos River drainage system. The Pecos River, which originates in the Sangre de Cristo Mountain range in the north-central part of the state, flows generally in a north-to-south direction through the central part of the county. Numerous tributary streams enter the Pecos River from the west, and a few relatively small ones from the east. The larger and more extensive drainages and arroyos on the west, which originate in the Capitan, Sierra Blanca, and Sacramento mountains to the west of this county, include Salt Creek, Arroyo Del Macho, Berrendo Creek, Rio Hondo, Rio Felix, and the upper part of the Rio Penasco. Although a few of these large streams are perennial in their upper regions, they are generally intermittent in the county, or flow only following periods of heavy rainfall. Those entering the Pecos River from the east drain relatively small areas and are all intermittent.

A number of different and varied types of topography occur within the county. The extreme southwestern part of the county is dominated by rolling to very steeply sloping limestone hills and mountain footslopes. This area, in particular, is characterized by rough and broken topography that includes numerous very steep canyon walls, breaks, and escarpments. The remainder of the area on the limestone uplands and hills, or that part comprising the western part of the county, is not as steep or as rough and broken. Here, the landscapes are generally strongly sloping to rolling and hilly.

In the part of the county extending from just north of the city of Roswell to the south county boundary, a broad, nearly level to gently sloping, alluvial plain and terrace area extends eastward from the western uplands to the Pecos River. This nearly level to gently sloping plains area, however, is commonly interspersed with undulating to gently rolling ridges and uplands in the western part where it joins the limestone uplands.

A small narrow area along the eastern boundary of this county lies on the Llano Estacado, or High Plains. It is part of an extensive plain in which the gently sloping, smooth-lying surface is broken only by a few drainage depressions and minor areas with undulating or dunelike topography. The undulating and hummocky areas occur in the most easterly extension of this county, where sandy soils are dominant.

The area immediately west of the High Plains, in the eastern part of the county, consists of a large area of sandy plains which slope generally to the west. These are dominated by gently sloping to undulating and duny landscapes.

The northeastern part of the county, and those parts which lie between the sandy plains on the east and the Pecos River, consists generally of a gently sloping and undulating low mesa and plains area. Steeply sloping escarpments and breaks occasionally occur on the sides of the mesas. The difference in local relief is usually less than 100 feet. Interspersed with these steeply sloping breaks and nearly level plains are extensive areas of gently sloping to gently rolling uplands.

Nearly level to very gently sloping flood plains border many of the principal drainages. These occur mainly in the valley bottoms of the Salt Creek, Berrendo Creek, Rio Hondo, Rio Felix, Arroyo Del Macho, and the Pecos River as well as in valleys adjacent to a number of other small intermittent drainages.

Elevations in the county range from about 3,800 feet where the Pecos River enters the county on the north to slightly less than 3,400 where it leaves the county on the south. The terrain rises gradually to both the east and west of the Pecos River, reaching almost 4,800 feet at the Lincoln County border to the west and near 4,300 feet at the Roosevelt and Lea county borders to the east.

Climate[4]

Chaves County has semi-arid, continental climate, characterized by distinct seasons, wide range of diurnal and annual temperatures, moderately low rainfall, and plentiful sunshine.

Average annual precipitation ranges from about 11 inches in the valley to 14 inches on the mesas, and to 18 inches in the mountain foothills. Average precipitation is generally greater at higher elevations, especially in the western part of the

[4]This section was prepared by Frank E. Houghton, ESSA, Weather Bureau State Climatologist.

county, where the flow of moist air upslope brings an increase in condensation. The main source of moist air is the general southeasterly circulation from over the Gulf of Mexico. Nearly three-fourths of the annual precipitation falls during the growing season, May through October, mainly from brief but often intense thunderstorms. Annual precipitation totals may vary greatly, as shown by 32.92 inches at Roswell in 1941, and only 4.35 inches in 1956.

In most of the county, the snowfall season is November through April, with an annual average of 10 inches. Usually, only an inch or two falls in a day and does not stay long on the ground, but 15.3 inches fell at Roswell in 24 hours, December 8 and 9, 1960. In the higher elevations of the southwest, the snow season is longer, with annual averages from 14 to 17 inches. At Elk, 34 inches of snow fell during December 1931.

Temperatures of 90 degrees or higher occur at valley stations on most days from mid-May through mid-September, but nighttime temperatures are generally 30 degrees cooler. Extreme temperatures in the county have been 112 degrees at Bitter Lakes Wildlife Refuge, July 14, 1958, and 29 degrees below zero at Roswell, February 13, 1905. Temperatures in most of the county drop to freezing during most nights from mid-November through mid-March, but rarely does the temperature fail to reach freezing or above during the day, and seldom does the temperature drop to zero. In the cooler southwestern mountains, however, nearer 25 days a year reach 90 degrees or higher, and about 150 days have freezing temperatures. The average freeze-free season, except in the mountains of the southwestern part of the county, is six months, from late April to late October.

The annual pattern of precipitation and temperature at Roswell is shown in table 2. This pattern is representative of other county localities, but for the higher elevations adjustment must be made for increased summer showers, lower temperatures, and greater snowfall. Selected climatological data for several county locations are shown in table 3.

Relative humidity in most of the county is similar to that at Roswell, averaging about 50 percent, and ranging from about 70 percent in the

Table 2. Monthly temperatures and precipitation, Roswell, Chaves County, New Mexico, for period of record 1894-1960, except as noted

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Temperatures (F°)												
Average daily maximum	55	60	67	76	83	92	92	91	85	75	64	55
Average daily minimum	25	28	35	43	52	61	65	64	57	45	32	25
Daily mean	40	44	51	59	68	76	79	78	71	60	48	40
Extreme maximum	88	88	95	97	103	110	110	105	103	94	87	84
Extreme minimum	-19	-29	-5	17	28	45	53	48	33	19	-6	-10
Precipitation												
Average (inches)	.42	.48	.54	.80	1.18	1.36	2.00	1.72	1.84	1.17	.59	.53
Average days 0.10 inch or more (no.)*	2	1	1	2	2	2	4	3	3	2	1	1
Average snowfall (inches)	2.6	2.3	1.0	0.3	T	0	0	0	0	0.1	1.1	2.8

*Period of record 1931-1960
T = Trace, less than 0.05 inch

Table 3. Annual averages of selected climatological data, Chaves County, New Mexico, for the period of record through 1960, except as indicated

Station	Elevation	Temperature			Precipitation		Last 32°F or Lower in Spring	First 32°F or Lower in Fall	Time Between Dates
		Mean maximum	Mean minimum	Yrs. of record	Mean annual	Yrs. of record			
	feet	F°	F°	no.	in.	no.	- - - average date - - -		days
Elk (3 mi. SE)	5,700	71	38	48	16.72	54	April 29	Oct. 17	171
Elkins (Boaz)*	4,030	74	41	34	13.95	38	April 22	Oct. 21	182
Hagerman	3,419	78	43	22	11.90	27	April 11	Oct. 27	199
Mesa Ser. Sta.*	5,000	75	41	13	11.64	14	April 21	Oct. 26	188
Roswell	3,612	75	44	66	12.63	68	April 6	Oct. 31	208
Felix (Flying H)	5,300				13.93	28			
Olive*	4,500				14.13	9			

*Period of record: Elkins, through 1948; Mesa Service Station, through 1952; Olive, through 1929.

early morning to 30 percent in the late afternoon. Lowest humidities occur in the spring. Humidities in the mountains are about 5 percent higher because of their low temperatures.

Average evaporation, as measured by a Class A pan at Bitter Lake Wildlife Refuge, averages 96 inches, two-thirds of which occurs during the May through October period. Evaporation is likely about 10 percent lower in the mountains, because of the lower temperatures.

Average annual wind speed at Roswell Airport is 10 miles per hour. The wind blows from the southeast quadrant 40 percent of the time, and it is strongest in spring. Strongest winds, those above 24 miles per hour, occur with greatest annual frequency from the west quadrant. The general north-south orientation of the Pecos River Valley probably increases the frequency of winds from those directions at Roswell. Mesa areas, and particularly in the southwestern part, likely have more westerly winds and greater average speed.

Land Use

Roswell, which is the county seat and the population center of Chaves County, is also the site of the earliest settlement in this county. It was an important trading center in the early 1880's. When Chaves was organized from a part of Lincoln County in 1891, the population of the village of Roswell was less than 500. The discovery of an artesian water source in 1890 near the city contributed much to its early growth. By 1900, it had grown to more than 2,000 in population.

Irrigated farming in this artesian basin of Chaves County, which began on an extensive basis about 1900, is an important land use. Most of the water used for irrigation is obtained by pumping from the underground water basin. The favorable climate and soils, together with farm operators' skillful soil management, have made the irrigation successful and productive. The irrigated area consists of approximately 101,000 acres.[5] Although this is a relatively small percentage of the total land area, it contributes significantly to the economy of the county. Alfalfa and cotton are the most extensive crops, but grain sorghums, small grains, corn, and pecans are also produced. Sugar beets and vegetable crops have also been grown to a very limited extent with satisfactory results.

Prior to organization of Chaves County and the expansion of irrigation, the lands comprising this county were used principally for grazing. Ranching is still an important agricultural enterprise. In 1968, most of the county's 157,000 cattle and 149,000 sheep were supported by the county's rangeland.[6]

Another important land use is for wildlife and recreation. The rangeland areas of the county provide suitable habitat for many species of wildlife. The limestone hills in the western part of the country, in particular, provide good habitat for big game animals.

Mineral resources of importance include, oil and gas.

The present land use made of at least one percent of each soil association follows:

Soil Association	*Present Land Use*
1. Reakor-Reeves-Elfrida	Irrigated farming; range
2. Reakor-Upton	Irrigated farming; range
3. Arno-Harkey	Irrigated farming; range
4. Elfrida-Pima-Bigetty	Irrigated farming; range
5. Reeves-Holloman-Gypsumland	Range
6. Upton-Simona	Range
7. Berino-Pintura-Pajarito	Range
8. LaLande-Ima-Gypsumland	Range
9. Redona-Canez-Douro	Range
10. LaLande-Alama-Lacita	Range
11. Jalmar-Tivoli-Faskin	Range
12. Ector-Conger	Range
13. Reagan-Elfrida-Conger	Range
14. Ector-Limestone Rockland	Range
15. Deama-Pastura-Manzano	Range
16. Gypsumland	Range
17. Deama-Limestone Rockland	Range
18. Kimbrough	Range
19. Arvana-Amarillo	Range
20. Brownfield-Tivoli-Amarillo	Range

[5] New Mexico Soil and Water Conservation Needs Inventory, Soil Conservation Service, 1966. Unpublished.

[6] New Mexico Agricultural Statistics, Vol. VI, Supplement 2, 1969.

The 20 soil associations are shown on the small-scale map for Chaves County (figure 1). Each of these general soil areas, or soil associations, includes soils that are geographically associated and comprise recognizable landscapes. They are named for the major soil series and land types that occur within them. In addition to the named soils, they often contain soils of other series. Selected soil characteristics and qualities of major soils in each soil association are summarized in table 4. A description of each of the soil associations follows:

1. Reakor-Reeves-Elfrida association

This association occurs on nearly level to very gently sloping alluvial plains and terraces west of the Pecos River flood plain. It is relatively extensive in the central and south-central parts of the county in the vicinity of Roswell and the communities of Dexter, Hagerman, and Lake Arthur. The soils are forming primarily in old calcareous alluvium from geologic formations dominated by limestone with minor amounts of gypsum, sandstone and other sedimentary rocks. They are strongly calcareous with the calcium carbonate content ranging from 10 to 15 percent in the surface layers to 30 or 35 percent in the subsoil and substratum. The Reeves soils are underlain by gypsiferous earths.

Much of the cropland now irrigated in Chaves County is in this association. Although the major soils are strongly calcareous and contain a relatively high content of lime, they are productive and well-suited to irrigation. The major crops are cotton, alfalfa, grain and forage sorghums, corn, and small grains. Pecans and various vegetable crops are also grown.

The remainder of this association is used for grazing by livestock. Moderate yields of forage are obtained on the native ranges that are in good condition. Black grama, blue grama, burrograss, three-awn, sand dropseed, tobosa, vine mesquite, and bush muhly are the principal grasses. The more common shrubs include broom snakeweed, mesquite, and cacti. This association comprises about 4 percent of the county, or approximately 153,640 acres.

Soil Characteristics. Reakor soils, the dominant and most extensive in the association, occur on nearly level to gently sloping plains and terraces. They normally have a moderately thick surface layer of light brownish-gray to brown strongly calcareous loam. A light brown strongly calcareous loam or a light clay loam subsoil about 24 inches thick underlies the surface layer. The substratum to a depth of 60 inches or more is a light brown very strongly calcareous clay loam. Filaments and small soft masses of lime commonly occur below an average depth of 28 inches.

Reeves soils, which are moderately deep, are underlain by gypsum or gypsiferous earth at depths of 20 to 40 inches. A small acreage of these soils, particularly where they join those of the Holloman series, may be underlain by gypsum at depths of 10 to 20 inches. The subsoil is very pale brown to light gray, massive, strongly calcareous light clay loam. It is moderately to strongly saline in localized areas where drainage is restricted.

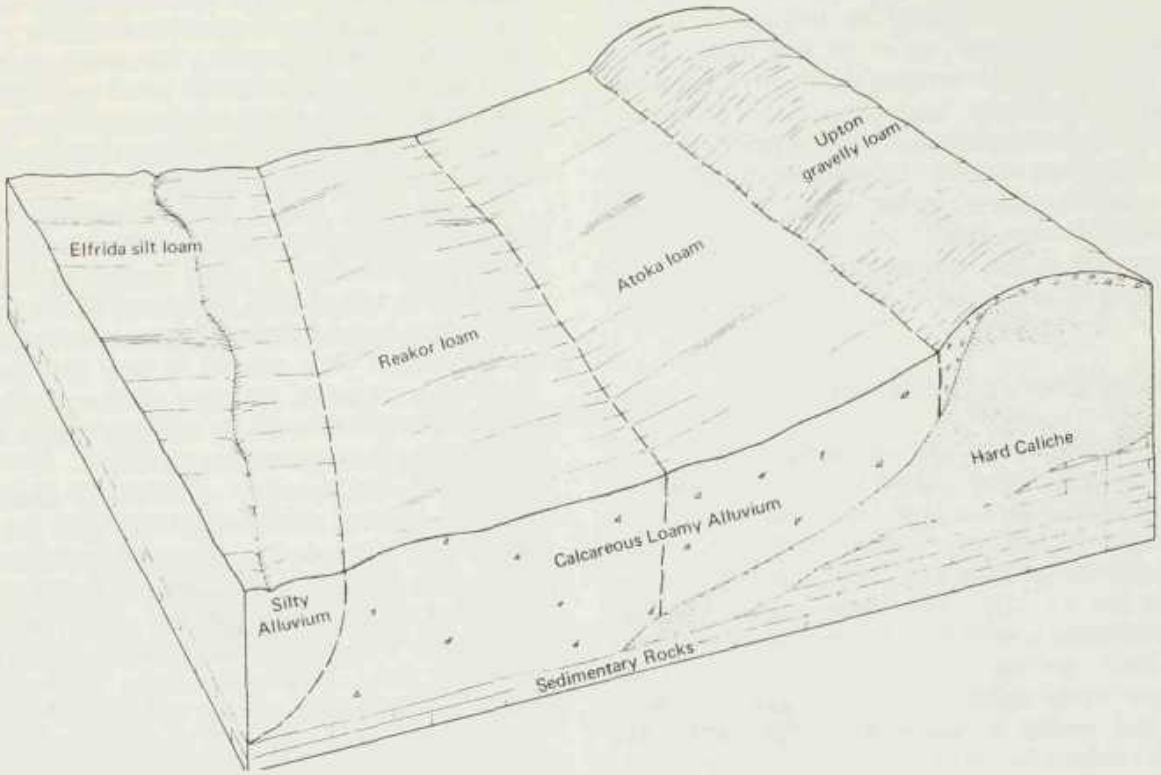
Elfrida soils occupy swales and intermittent drainageways in close association with the Reakor soils. They have a surface layer of grayish-brown to brown silt loam over a thick subsoil of brown silty clay loam. This is underlain by a light brown silty clay loam. Elfrida soils are strongly calcareous and typically have a few filaments and small soft masses of lime in the lower part of the subsoil and substratum. Also in this association are small acreages of Holloman and Upton soils which are shallow, Atoka soils which are moderately deep, and Pima soils which are deep.

Irrigation Potential. There is a high potential for the development of irrigated land in this association. The Reakor and Elfrida soils, which comprise about 70 percent of the association, are well suited for use as cropland under irrigation. The associated Reeves soils, although not as well adapted to irrigation as those of the Reakor and Elfrida series, are nevertheless suitable for irrigation. The salinity hazard and moderate soil depth are the major factors contributing to their placement in irrigation land class 3. The land suitable for irrigation commonly occurs in large tracts with little or no intermingled non-irrigable land. If provided with essential improvements of leveling, installation of irrigation systems, and the application of good farming practices, this land has sufficient productive capacity to support sustained irrigation.

2. Reakor-Upton association

This association, like the Reakor-Reeves-Elfrida association (No. 1), occurs on alluvial plains and terraces west of the Pecos River. It is located

Fig. 3. Typical pattern of soils on the plains and terraces west of the Pecos River. The soils shown are in the Reakor-Upton association.



generally just to the west of association 1, and differs in that it contains a much higher percentage of shallow soils and has a more varied topography. The nearly level to gently sloping landscape occupied by the Reakor and Elfrida soils is commonly interspersed with undulating to gently rolling ridges and uplands occupied by the Upton soils.

The dominant use made of the land in this association is grazing. Under good management, moderate yields of forage are obtained on the moderately deep and deep soils. The more common grasses are black grama, burrograss, tobosa, three-awns, blue grama, and sideoats grama. Under heavy use, the density of such shrubs as creosotebush and broom snakeweed tends to increase, particularly on the shallow soils, such as those of the Upton series. This unit also includes small scattered tracts of irrigated land. The principal soils under irrigation in the unit are Reakor and Elfrida. Most of the irrigated cropland has been leveled, and adequate irrigation systems have been installed for efficient water use. The major crops grown are cotton, alfalfa, grain and forage sorghums, and small grains. This association includes about 187,980 acres, or five percent of the county.

Soil Characteristics. Reakor soils, which are the most extensive, occupy the nearly level to gently sloping plains intermediate in elevation between the Upton and Elfrida soils. They typically have a moderately thick surface layer of light brownish-gray to brown, calcareous loam. A light brown, strongly calcareous loam or light clay loam subsoil about 24 inches thick underlies the surface layer. The substratum to a depth of 60 inches or more is a light brown, very strongly calcareous clay loam. A few fine threads and small soft masses of lime commonly occur below an average depth of 28 inches.

The Upton soils in this association commonly occur on strongly sloping and undulating ridges and uplands just above the position occupied by Reakor soils. They normally consist of less than 10 inches of light brownish-gray, calcareous, gravelly loam over layered and fractured indurated caliche. Angular caliche fragments often occur on the

surface and in the soil layer immediately above the indurated caliche, where they may comprise as much as 35 percent of the soil mass. The depth to the underlying caliche may range from 4 to 20 inches.

The Atoka and Elfrida soils are also relatively extensive in this association. The Atoka soils occur on nearly level to gently sloping plains between the Reakor and Upton soils. Typically they have a moderately thick surface layer of light brownish-gray to brown, strongly calcareous loam. Their subsoil is a light brown, strongly calcareous loam or clay loam containing many distinct filaments and small soft masses of lime. They are underlain by layered and fractured indurated caliche at depths of 20 to 40 inches. The Elfrida soils occupy swales or broad drainageways in close association with the Reakor soils. They are deep and strongly calcareous soils with clay loam or silt loam surface layers and slowly permeable silty clay loam subsoils.

Also in this association are the moderately deep gypsiferous Reeves soils, the gravelly Santo Tomas soils and small acreages of miscellaneous land types such as gullied land and alluvial land. These soils and miscellaneous land types comprise about seven percent of the association.

Irrigation Potential. Although this unit contains about 30 percent non-irrigable land, there is considerable opportunity for expansion of irrigation. The interspersed non-irrigable lands are often in tracts large enough to be excluded from areas planned for irrigation. The Reakor and Elfrida soils are well-suited for use as irrigated cropland. These soils in association with minor acreages of class 3 land should provide tracts of sufficient size to warrant consideration for irrigation.

3. Arno-Harkey association

Included in this association is the nearly level to gently sloping flood plain adjacent to the Pecos River. It comprises an area of about 59,250 acres, or two percent of the county. A relatively high percentage of soils are inadequately drained and saline. The highest concentrations of salts occur where the water tables are close to the surface and where seepage is received from the higher lying terrace lands adjoining this unit on the west. The soils are deep and are forming in strongly calcareous alluvium of mixed origin.

A small part of this association is already irrigated. Although small acreages of Arno and Anthony are irrigated, Harkey is by far the dominant soil used for crop production under irrigation. Where the soils are adequately drained and free of toxic concentrations of salts, moderate to high yields of adapted crops are obtained. The remaining lands in this association are used for grazing, recreation, and wildlife. Bottomless Lake State Park and Bitter Lake National Wildlife Refuge are partly within this association. Recreation areas and fishing are available in the Bottomless Lake State Park.

Scattered and moderately dense stands of salt cedar with an understory of grasses are common on the lands not under irrigation. In addition to salt cedar, native vegetation on the Arno soils consists of salt grass, alkali sacaton, giant sacaton, vine mesquite, tobosa, three-awns, and chamiza. Alkali sacaton, black grama, sideoats grama, blue grama, chamiza, and snakeweed are the more common grasses and shrubs on the Anthony and Harkey soils.

Soil Characteristics. Arno soils, one of the more extensive soils in the association, occur on the nearly level to gently sloping flood plain of the Pecos River. They typically have a surface layer of light reddish-brown to reddish-brown strongly calcareous silty clay loam or clay. This is underlain to a depth of five feet or more by stratified silty clay loams and clays. Although heavy silty clay loam and clay textures are dominant, thin strata of coarse-textured materials often occur below a depth of two or three feet. Some gypsum crystals often occur at depths of 30 to 50 inches from the surface. Approximately 65 percent of the Arno soils in this county are moderately to strongly saline and inadequately drained.

Harkey soils also occur on nearly level to gently sloping flood plains. They typically occupy slightly higher levels or terraces than the associated Arno soils. They are usually free or almost free of salts except in localized areas adjacent to the Pecos River channel where the water table fluctuates and may be less than five feet during part of the year. The Harkey soils generally have a surface layer of light brown to brown very fine sandy loam or loam over a moderately permeable medium-textured subsoil. The substratum is typically stratified and medium to moderately coarse-textured. These soils, which are strongly calcareous, commonly contain a few distinct filaments and small soft masses of lime and gypsum crystals in the subsoil and substratum.

The Anthony soils consist of deep, light colored, calcareous fine sandy loams. They are developing in recent alluvium on nearly level to gently sloping flood plains and adjacent alluvial fans. A moder-

ately thick surface layer of pale brown fine sandy loam is underlain by a rapidly permeable light brown sandy loam. The substratum is a light brown sandy loam stratified with thin lenses of loamy sand, loam, and silt loam. This layer extends to more than 60 inches below the surface.

Also in this association are small areas of deep sandy soils of the Pajarito series, shallow gypsiferous soils, miscellaneous land types such as riverwash, arroyos, rivers, lakes or ponds. These inclusions comprise about 10 percent of the association.

Irrigation Potential. There is only a very limited potential for expansion of irrigated cropland in this association. The Arno soils, because of their low position, slow permeability, and fine-textures, will require very intensive management to prevent further accumulation of salts and the development of unfavorable drainage conditions. The Harkey and Anthony soils, when well drained and free of toxic concentrations of soluble salts, are suitable for use as irrigated cropland. The acreage of these soils available in this association for expansion of irrigated cropland, however, is limited.

4. Elfrida-Pima-Bigetty association

This association includes the soils on the flood plains and in the valleys adjacent to Arroyo Del Macho, Salt Creek, South Berrendo Creek, Rio Hondo, Rio Felix, Rio Penasco, as well as a number of other small drainages. The soils, which are generally deep, occur on nearly level to gently sloping landscapes and are forming in alluvium of mixed origin. Except for a few areas on the plains and terraces near the Pecos River, the units comprising this association are usually long, meandering, and narrow.

A small part of this association is used as irrigated cropland. The major crops grown are cotton, alfalfa, sorghums, and small grains. The remaining and major part of this association is used for grazing by livestock. Moderate yields of forage are obtained on native ranges in good condition. Black grama, blue grama, tobosa grass, vine mesquite, alkali sacaton, burrograss and three-awns are the more common grasses. This association comprises about four percent of the county, or approximately 143,870 acres.

Soil Characteristics. Elfrida soils, the most extensive in the association, occur in swales and on flood plains of intermittent streams. The landscapes occupied by these soils are often concave and have slope gradients of less than one percent. They have a surface layer of grayish-brown to brown silt loam over a thick subsoil of brown silty clay loam. This is underlain by a light brown silty clay loam. Elfrida soils are strongly calcareous and typically have filaments and small soft masses of lime in the lower part of the subsoil and substratum.

Pima soils occupy nearly level to gently sloping flood plains contiguous to intermittent drainages. These soils, which are characterized by their dark colored surface layers, typically have a thick surface layer of dark grayish-brown calcareous clay loam. This is underlain at depths of 20 to 36 inches by a grayish-brown stratified substratum that ranges from medium to moderately coarse in texture. A few thin strata of gravelly materials may occasionally occur in the substratum.

The Bigetty soils also occur in swales and depressional areas in close association with soils of the Elfrida series but differ primarily from these soils in that they are dark colored to a depth of 20 to 30 inches or more. They usually have a thin surface layer of brown to dark brown calcareous silty clay loam over a thick subsoil of dark brown silty clay loam. This is underlain by a light brown to brown clay loam or sandy clay loam. A few distinct small soft masses and filaments of lime are common in the substratum and the lower part of the subsoil.

Also in this association are the deep calcareous Reakor soils, the gravelly Santo Tomas soils, the shallow Upton soils, and small acreages of miscellaneous land types such as gullied land and arroyo bottoms. These soils and miscellaneous land types comprise about 20 percent of the association.

Irrigation Potential. Although the major soils in this association are deep, have high water-holding capacities, and are nearly level to gently sloping, a high percentage of these soils have been placed in class 2 because of an overflow and erosion hazard. They commonly occur in valley bottoms and flood plains where they are susceptible to runoff from higher lying lands. Approximately 55 percent of the land in this unit is in class 2; 25 percent in class 1; 15 percent in class 6; and 5 percent in class 4. The soils in this association offer considerable opportunity for expansion of irrigated land. These soils, however, occur as small, narrow, and meandering areas adjacent to drainages, and their use for irrigation may be precluded by their size, shape, and distribution.

5. Reeves-Holloman-Gypsumland association

This association, which comprises an area of about 163,300 acres, or four percent of the county, lies mainly in the central part of the county. It occurs on landscapes that range from broad, nearly level to gently undulating plains to rolling low hills. The major soils are developing in parent materials derived from gypsiferous rocks with other sedimentary rocks contributing minor amounts. The association is characterized by exposures of gypsiferous earth and the intermingled strongly calcareous soils that are underlain by gypsiferous earths at shallow to moderate depths.

The gypsumland component of this unit supports little usable vegetation and is of very limited value, even as range. The remaining parts of the association support a sparse to fair cover of native grasses, forbs, and brush suitable for grazing by livestock and wildlife. The vegetation consists mainly of gyp grama, black grama, alkali sacaton, burrograss, tobosa, coldenia, tarbush, gyp grass, chamiza, and broom snakeweed. A few small areas in this association receive additional moisture as runoff from surrounding areas. These support dense stands of alkali sacaton and produce high yields of forage.

Soil Characteristics. Reeves soils, one of the more extensive soils in the association, consist of moderately deep, light colored, calcareous loams underlain by gypsiferous earth or rock. They usually have a thin, pale brown, strongly calcareous loam surface layer. This layer grades through a very pale brown, or light gray, clay loam, high in lime, to the underlying gypsiferous earth at depths of 20 to 40 inches. They are moderately to strongly saline in localized areas where drainage is restricted. In this unit, the Reeves soils typically occupy gently sloping plains or the slightly depressed or swale areas.

Holloman soils occur on nearly level to gently sloping and undulating uplands. They are shallow, light colored, strongly calcareous soils underlain by beds of gypsum. The surface layers are pale brown to light brownish-gray loam. These are underlain by gypsum or gypsiferous earth at depths of 4 to 20 inches.

Gypsumland, a miscellaneous land type, is also extensive in this association. It consists of a complex of outcrops of gypsiferous earth or rocks and very shallow soils. The gypsiferous materials vary from white "chalky" earths to hard, light colored, crystalline gypsum rocks. A thin mantle of loamy soil material may occur in small areas between the outcrops of gypsiferous earth or rock. The Gypsumland is widely distributed throughout the association. The topography is varied, ranging from gently undulating to moderately steep and rolling.

Also in this association are small areas of Russler, Reakor (reddish-brown variant), Largo, and Upton soils. The Russler soils are moderately deep, reddish colored, gypsiferous, silty soils on the undulating uplands. The Reakor (reddish-brown variant) soils are similar to Reakor loam (association No. 1) but are redder and coarser-textured in the subsoil and substratum. This soil is scattered throughout the association. Largo soils are deep, reddish colored soils occurring in drainageways and on alluvial fans. Occasionally deep gullies occur in the drainageways.

The Upton soils are very shallow and gravelly on gently sloping to rolling ridges scattered throughout the association. These less extensive soils comprise about 20 percent of the association.

Irrigation Potential. There is very little potential for development of irrigated land in this association because of prevalence of shallow soils and outcrops of gypsiferous earths and rocks. The Reeves soils, although suitable for irrigation, have moderate to severe limitations due to limited soil depth and salinity. Furthermore, they commonly occur in small tracts interspersed with non-irrigable land. Therefore, tracts of land of sufficient size to warrant consideration for future expansion of irrigated land are very limited.

6. Upton-Simona association

This association, which occurs east of the Pecos River in the south-central part of the county, includes an area of approximately 189,830 acres, or about five percent of the county. The topography, which is quite varied, ranges from nearly level to gently sloping plains and mesa tops to strongly sloping and rolling uplands. A small acreage of steeply sloping lands on escarpments and breaks is also included. Although small and scattered areas of deep soils occur in this association, it is dominated by shallow soils underlain by fractured strongly cemented to indurated caliche. Exposures of caliche, shale, and sandstone are common on the breaks and escarpment areas.

The entire association is used for grazing of livestock and wildlife. The soils, which are dominantly shallow and droughty, in general support only a sparse cover of vegetation. Short, mid, and tall grasses with mesquite, creosotebush, broom snakeweed, graythorn, and longleaf ephedra make

up most of the vegetation. The more common grass species on the sandy soils of the Simona series are black grama, sideoats grama, little bluestem, sand muhly, sand dropseed, and three-awns. The grass species on the Upton soils consist mainly of black grama, sideoats grama, hairy grama, blue grama, burrograss, and three-awns.

Soil Characteristics. The Upton soils in this association occur on nearly level to strongly sloping and undulating plains and mesa tops. These very shallow to shallow soils typically have light brownish-gray, calcareous, gravelly loam surface layers. Angular caliche fragments are common and may comprise as much as 35 percent of the soil mass in the soil layers immediately above the underlying indurated caliche. The depth to caliche, which is usually less than 10 inches, may range from 4 to 20 inches.

Simona soils occupy nearly level to undulating plains and mesa tops. They typically have a thin surface layer of grayish-brown to brown, calcareous, fine sandy loam. The subsoil, which is a pale brown, fine sandy loam, usually contains a few to many angular caliche fragments. This is underlain at a depth of less than 20 inches by white or pinkish-white strongly cemented caliche.

Reakor soils (reddish-brown variant) are also moderately extensive in this association. These soils, which occur on nearly level to gently sloping and undulating plains, have a surface layer of light reddish-brown to brown strongly calcareous loam. A light brown or reddish-brown, strongly calcareous, loam or light clay loam subsoil about 24 inches thick underlies the surface layer. The substratum to a depth of 60 inches or more is a light brown, very strongly calcareous, clay loam. Filaments and small soft masses of lime commonly occur below an average depth of 24 inches.

In addition to these three soils, miscellaneous land types and soils of minor extent comprise approximately 15 percent of the association. The land types include rockland, and stony and rough broken land. These land types occupy the steep slopes, breaks, and escarpments and are characterized by outcrops of bedrock. A thin mantle of gravelly or stony soil material is common on the ledges and in the areas between the outcrops of bedrock. Soils of the Berino, Pajarito, Largo, and Bigetty series are also important in this association. The Berino soils have a surface layer of loamy fine sand over a sandy clay loam subsoil. The Pajarito soils, which are deep, have loamy fine sand surface layers and sandy loam or fine sandy loam subsoils. The substratum is typically stratified and may range in texture from loamy sand to fine sandy loam. Largo soils are generally deep, light colored loams and silt loams. They are developing in alluvial materials from the redbed formation. Bigetty soils have a surface layer of silty clay loam over silty clay loam subsoil. They occur in depressional areas where runoff accumulates.

Irrigation Potential. There is very limited potential for the development of irrigated land in this association. Upton and Simona soils are in irrigation land class 6 because of their shallow depth and other soil properties. The remaining soils, or those of Reakor (reddish-brown variant), Berino, Bigetty, Pajarito, and Largo series, are suitable for use as cropland under irrigation, but occur in small tracts intermingled with large areas of class 6 land, and thus merit little consideration for irrigation.

7. Berino-Pintura-Pajarito association

Included in this association is an area of about 95,225 acres east of the Pecos River in the south-central part of the county. It occurs on a nearly level to gently sloping and undulating plain. Coppice dunes dominate the microrelief in much of this association. These dunes, which are forming in and around mesquite and other shrubs, vary in height up to six feet or more.

All the major soils in this association are sandy and highly susceptible to wind erosion; little land in this unit has not been affected by some erosion. The association consists primarily of Berino soils, coppice dune materials (Pintura soils), Pajarito soils, and lesser amounts of Simona and other closely related soils underlain by weakly to strongly cemented caliche.

The soils of this association are used for grazing by livestock. Due to their high susceptibility to wind erosion, a high level of management is essential to prevent depletion of desirable vegetation and soil deterioration. Under good management, moderate forage is obtained. The vegetative cover consists dominantly of tall and mid grasses, mesquite, yucca, creosote bush, snakeweed, and chamiza. The more common grasses include sand bluestem, little bluestem, sand dropseed, sideoats grama, sand muhly, black grama, three-awns, and switchgrass.

Soil Characteristics. Berino soils occupy the nearly level to gently sloping areas between the undulating to duny Pintura and Pajarito soils. The eroded parts of the Berino soils are usually hummocky and often intermingled with the Pintura soils. They have a thin surface layer of

yellowish-red to reddish-brown, noncalcareous, loamy fine sand or fine sand over thick reddish-brown, sandy clay loam subsoil. The lower part of the subsoil, which is normally calcareous, contains a few to many filaments and small soft masses of lime. This is underlain at depths of three to four feet by a pinkish-white sandy clay loam with a very high lime content.

The Pintura component of this association occupies the coppice dunes and those parts of the landscape in this association that are gently rolling. The Pintura soils have surface layers of loose, noncalcareous to weakly calcareous, yellowish-red or reddish-brown, fine sand over thick deposits of fine sand.

Pajarito soils, which are also extensive in this association, occupy nearly level to gently sloping hummocky landscapes. These soils usually have a thin surface layer of yellowish-red, weakly calcareous, loamy fine sand or fine sand. The subsoil and substratum is yellowish-red, calcareous, fine sandy loam extending to over 60 inches. The soils are susceptible to wind erosion where the vegetative cover is seriously depleted.

Also in this association are small areas of active duneland, Cacique, Kermit, Wink, and Simona soils. Active duneland includes the barren or nearly barren sand dunes that are actively eroding. The Cacique and Wink soils are moderately deep sandy soils underlain by indurated caliche and lacustrine material, respectively. The Simona soils are shallow sandy loam soils underlain by indurated caliche. The Kermit soils consist of deep fine sands. These inclusions comprise about 15 percent of the association.

Irrigation Potential. Approximately 61 percent of the land in this association has been classified as suitable for irrigation. The relatively high percentage of non-irrigable land and the restricted capability of that classified as suitable for irrigation, however, limit the opportunity for expansion of irrigation. The Berino and Pajarito soils, which commonly occur as a complex, are usually eroded and hummocky. They account for most of the land classified as suitable for irrigation and are in classes 3 and 4. These lands will require considerable conditioning, including leveling and soil modification, in preparation for irrigation.

8. La Lande-Ima-Gypsumland association

This association, comprising an area of about 138,890 acres, occurs in the north-central part of the county adjacent to the Pecos River. The topography is quite varied, ranging from gently to strongly sloping and undulating on the plains to steep, rough and broken on the escarpments and breaks areas. The soils are developing dominantly in parent materials of sedimentary origin including shale, sandstone, limestone and gypsum. Although there are included soils developing residually in materials from these sedimentary rocks, the major soils in this association are developing in alluvium originating from such materials. In general the soils of this association are moderately to highly susceptible to erosion, and as a result, few areas have not been affected by some erosion. Gullies are common in many of the valley bottoms.

This association, which is used as rangeland, has a highly variable capability for such use. The gypsumland component of this unit, as well as the escarpments and breaks areas, support only sparse cover of usable vegetation and has only a limited value as range. The parts of this general soil area that are dominated by moderately deep and deep soils produce fair to moderate yields of forage under good management. Vegetation consists of blue grama, black grama, gyp grama, mesa dropseed, three-awns, and mesquite.

Soil Characteristics. La Lande soils occur dominantly on the crests and side slopes of slightly elevated ridges in this association. They have a surface layer of reddish-brown noncalcareous loam or fine sandy loam. This is underlain by a reddish-brown calcareous loam. A weak but distinct lime zone in the form of fine soft masses and coatings on sand grains and pebbles commonly occurs at depths of 18 to 40 inches.

Ima soils in this association generally occupy gently to strongly sloping alluvial fans and side slopes. These soils have a surface layer of noncalcareous fine sandy loam or fine sand. This is underlain by a light reddish-brown calcareous fine sandy loam. A few distinct small soft masses and filaments of lime are common in the substratum and lower parts of the subsoil. Most of the Ima soils in this association are moderately to severely eroded. Coppice dunes forming in and around mesquite and other shrubs dominate the microrelief on these eroded phases.

Gypsumland, a miscellaneous land type, has a varied topography ranging from gently sloping and undulating to moderately steep and rolling. It consists of a complex of outcrops of gypsiferous earth or rocks and shallow soils. The gypsiferous materials vary from white "chalky" earths to hard, light colored, crystalline gypsum rocks. A thin mantle of loamy soil material commonly occurs between the outcrops of gypsiferous earth or rock.

Also in this association are soils of the Lacita, Reeves (darker surface variant) and Holloman (darker surface variant) series, as well as a number of other miscellaneous land types including rockland, gullied land, alluvial land and arroyo and drainage bottoms. Lacita soils, which are forming in medium to moderately fine-textured silty alluvium, occur in valley bottoms and on slopes below outcrops of shale, siltstone, and sandstone. These soils, often dissected by gullies, consist of light reddish-brown to reddish-brown calcareous silt loams and light silty clay loams to a depth of six feet or more. The Holloman and Reeves soils are not typical of their series in that they occur in slightly higher rainfall areas and have somewhat darker colored surface layers. Rockland includes the outcrops of shale, sandstone, and other types of sedimentary rocks that usually occur as breaks and escarpments scattered throughout the association. These inclusions comprise about 35 percent of this association.

Irrigation Potential. The major soils of this association have moderate to severe limitations for use as cropland under irrigation. Although the LaLande soils are moderately well suited to irrigation, a majority of soils in this unit were placed in irrigation classes 3 and 4 because of slope, erosion, and unevenness of the land surface. The Ima, which has a moderate water-holding capacity, was also placed in irrigation class 4 because of erosion, unevenness of the land surface, and slope. These class 3 and 4 lands will require considerable soil conditioning and land leveling in preparation for irrigation. In addition, the irrigable land in this association commonly occurs as relatively small tracts interspersed with extensive areas of class 6 lands. Although approximately 40 percent of this association is irrigable, the low capability of the soils for such use together with the high percentage of intermingled non-irrigable land tend to place severe restriction on its use for irrigation.

9. Redona-Canez-Douro association

Included in this association are one large and four small areas in the northeastern part of the county. It consists of an area of about 284,555 acres, which comprises about seven percent of the county. The soils, which are developing in parent materials dominantly of alluvial and eolian origin, occupy gently sloping and undulating landscapes. These soils generally have brown to reddish-brown fine sandy loam or light loam surface layers and moderately permeable sandy clay loam subsoils. They are only slightly to moderately susceptible to erosion and in general support fair to good stands of native vegetation, consisting of black grama, blue grama, hairy grama, sideoats grama, sand dropseed, buffalo grass, tobosa grass, spike muhly, three-awns, yucca, broom snakeweed, and some mesquite and cholla cactus.

Soil Characteristics. Redona soils, the most extensive in this association, have a thin surface layer of brown to reddish-brown noncalcareous fine sandy loam or loam. Their subsoil is a thick reddish-brown sandy clay loam that is noncalcareous in the upper part. This is underlain by a light reddish-brown or pinkish-white very limy loam at depths ranging from about 28 to 40 inches. The maximum lime accumulation usually occurs in the upper part and gradually decreases with depth.

The Canez soils, which are also extensive in this association, differ from the Redona soils in that they do not have a high lime zone or caliche horizon within 40 inches of the surface. These soils usually have a surface layer of brown noncalcareous fine sandy loam over a thick brown or reddish-brown noncalcareous sandy clay loam subsoil. This is underlain to a depth of 60 inches or more by calcareous sandy clay loam soil horizons, in which small soft masses and threads of lime are common.

Douro soils, the other major member of this association, have a surface layer of reddish-brown noncalcareous loamy fine sand or fine sandy loam. Their subsoil is a reddish-brown sandy clay loam typically noncalcareous in the upper part. A few small soft masses and threads of lime are common in the lower part of the subsoil immediately above the underlying indurated caliche. The depth of the caliche layer ranges from about 20 to 36 inches and is usually indurated or strongly cemented in the upper 12 to 18 inches. The degree of cementation usually decreases gradually with depth.

Also in this association are soils of the Jalmar, Ima, and Blakeney series. The Jalmar soils have fine sandy surface layers about 24 inches thick over thick sandy clay loam subsoils. The Ima soils are also deep and consist of fine sandy loams or sandy loams to a depth of 60 inches or more. The Blakeney soils, which are shallow sandy loam soils, are underlain by fractured strongly cemented caliche within a depth of 20 inches. Small acreages of duneland, arroyo bottoms, and other miscellaneous land types comprise the remaining parts of this association.

Irrigation Potential. The major soils in this association have characteristics and properties

favorable for their use as irrigated cropland. Approximately 56 percent of the land in this general soil area has been placed in irrigation land class 2; 21 percent in class 3; 14 percent in class 1; and the remaining 9 percent is non-irrigable (class 6).

The Redona soils, when occurring on smooth nearly level to gently sloping landscapes, were placed in land class 1. The majority of the Redona and Canez soils, however, were placed in land class 2 because of slope and unevenness of the land surface. The Douro soils, because of slope, moderate depth, and water-holding capacity, were included in class 3. These soils together with Jalmar fine sand and Ima fine sandy loam account for most of the land in class 3. The Blakeney soils and small acreages of duneland and arroyo bottoms account for most of the land classified as non-irrigable.

Although the lands in this association will require considerable land leveling and some soil modification and conditioning in preparation for irrigation, they have a relatively high potential for irrigation.

10. La Lande-Alama-Lacita association

This association, which is widely distributed in the north-central part of the county, encompasses an area of about 258,465 acres. Gently sloping and undulating topography is common over much of the area occupied by these soils. A few steep escarpments and breaks, as well as nearly level to gently sloping valley bottoms, are included. The soils are developing dominantly in sediments from formations consisting of interbedded sandstone, shale and siltstone. Although small areas of shallow soils are included, these soils are usually moderately deep to deep and support fair to good stands of both mid and short grass types. The more common grasses are blue grama, black grama, hairy grama, sideoats grama, three-awns, tobosa, alkali sacaton, burro grass, and sand dropseed. Mesquite, yucca, snakeweed, chamiza, and a few cholla cactus are the more prevalent shrubs.

Soil Characteristics. The La Lande soils, which are deep, well drained, and loamy, occur dominantly on crests and side slopes of upland ridges and alluvial fans. The granular noncalcareous surface layer is medium-textured and about six to eight inches thick. This layer is underlain by a reddish-brown, calcareous loam. A weak but distinct lime zone in the form of fine soft masses and coatings on pebbles normally occurs at depths of 18 to 40 inches.

The Alama soils occur on nearly level to gently sloping alluvial fans. They have a thin, granular, reddish-brown silt loam surface layer over a thick subsoil of reddish-brown silty clay loam. This grades into a light reddish-brown or reddish-yellow silt loam at depths of 26 to 30 inches. A few fine soft masses and threads of segregated lime normally are present in this horizon.

Lacita soils, which are also deep, occur dominantly on nearly level to gently sloping channeled valley bottoms and alluvial fans. They have a thin surface layer of reddish-brown calcareous loam or silt loam. This is underlain to a depth of five feet or more by weakly stratified reddish-brown, calcareous silt loams and loams. These soils are susceptible to water erosion where the vegetative cover is depleted and where there is a concentration of runoff. A few deep gullies, particularly in the drainageways, are common.

In addition to the three major soils, gullied land, rough broken and stony land, shallow soils underlain by gypsiferous earths, and soils of the Montoya, Hassell, Newkirk, San Jon, and Ima series comprise about 25 percent of this association. Rough broken and stony land, the most extensive of the miscellaneous land types, consists of a complex of very shallow soils and outcrops of thinly bedded siltstone, shale, sandstone, and other sedimentary rocks. The soils of the Montoya series are deep, fine-textured, and slowly permeable. They occupy the nearly level to gently sloping flood plains and broad valley bottoms. The Hassell soils are reddish-brown, clayey, and slowly permeable. They are underlain by shale at depths ranging from 30 to 50 inches. They have a thin, noncalcareous, silty clay loam surface layer, and a blocky, calcareous heavy clay subsoil. The Newkirk and San Jon soils are shallow to moderately deep soils developing over interbedded shales and sandstone. The Ima soils consist of deep and moderately coarse-textured soils.

Irrigation Potential. This association, which is dominated by class 2 and 3 land, offers a fair potential for expansion of irrigation. Slope, unevenness of the land surface, and erosion were the principal factors contributing to placement of the soils in these land classes. They will, therefore, require considerable land leveling and soil conditioning for irrigation. This association is widely distributed and in small tracts that limit its development for irrigation except where they occur adjacent to other irrigable lands.

11. Jalmar-Tivoli-Faskin association

This association includes an area of about 527,015 acres in the eastern part of the county. It comprises the gently sloping and undulating to gently rolling sandy plains just west of the High Plains escarpment. The soils are generally deep and are developing in sandy eolian and alluvial sediments. In general, they are very susceptible to wind erosion, particularly when the vegetative cover becomes depleted. Hummocky and duned areas are, therefore, common in this association. A few dunes, which are essentially barren of vegetation, actively erode during windy periods.

The soils of this association are used for grazing livestock. A high level of management is essential to prevent depletion of vegetative cover and soil deterioration by wind erosion. Under good management, moderate forage yields are obtained. The vegetative cover consists dominantly of tall and mid grasses, and some short grasses, mesquite, shinnery oak, yucca, and sand sage. The more common grasses include sand bluestem, little bluestem, sand dropseed, giant dropseed, sideoats grama, three-awns, switchgrass, plains bristle grass, blue grama, silver bluestem and black grama.

Soil Characteristics. Jalmar soils occur on gently undulating and hummocky landscapes. They have a thick surface layer of light brown to brown fine sand over a subsoil of red to reddish-brown sandy clay loam. This, in turn, is underlain by a yellowish-red light sandy clay loam. A white fractured caliche layer is often present at depths between four and six feet.

Tivoli soils occupy those parts of the landscape in this association that are gently rolling and have dunelike topography. They have surface layers of loose, noncalcareous yellowish-brown fine sand over thick deposits of fine sand.

Faskin soils occur on the nearly level to gently sloping areas between the rolling and duny landscapes of the Tivoli soils and undulating and hummocky landscapes occupied by the Jalmar soils. These soils have a surface layer of brown noncalcareous fine sandy loam or loamy fine sand over a thick reddish-brown sandy clay loam subsoil that is typically noncalcareous in the upper part. A weak but distinct zone of lime accumulation commonly occurs between 40 and 60 inches in the form of small soft masses and coatings on the surface of the soil peds.

Also in this association are small areas of active duneland, Redona, Gomez, Ima, and Blakeney soils. Active duneland includes the barren or nearly barren sand dunes that are actively eroding. The Redona soils have sandy loam surface layers, sandy clay loam subsoils and a strong lime zone at depths of 28 to 40 inches. The Gomez soils have a loamy fine sand surface, fine sandy loam subsoils, and strong lime zones at depths of 22 to 40 inches. The Ima soils are deep sandy loam soils in depressions and drainageways. The Blakeney soils are shallow sandy loam soils underlain by fractured indurated caliche. These minor soils and land types comprise about 20 percent of the association.

Irrigation Potential. The Jalmar, Faskin, Redona, Gomez, and Ima soils, where they occur in tracts of sufficient size, have properties suitable for use as irrigated cropland. Their sandy textures, high water intake rates, and moderate water-holding capacity, however, limit their suitability. Wind erosion is a moderate to severe hazard, and careful management will be needed to minimize damage by wind. These soils, with essential improvements of land leveling, soil conditioning or modification, and the application of adequate erosion control measures and other accepted good farming practices, should have sufficient productive capacity to support irrigation. In addition to land leveling, the Jalmar and Faskin soils can be improved for irrigation by deep plowing or mixing of the sandy surface layers with the underlying sandy clay loam subsoil.

Tivoli soils, because of their extremely sandy nature, low water-holding capacity, and very high erosion hazard are not recommended for irrigation.

12. Ector-Conger association

This association, like the Ector-Limestone Rockland (No. 14) association, is extensive on the limestone hills and mountain footslopes in the western part of the county. It occupies strongly sloping to rolling and hilly landscapes but is not as steep or as rough and broken as the Ector-Limestone Rockland association. The soils, which are dominantly shallow, are developing in materials of limestone origin. This association is the largest in the county and includes an area of about 635,585 acres, or 16 percent of the county. It is used for livestock grazing and, under good management, fair to moderate yields of forage are obtained. Native vegetation includes blue grama, black grama, sideoats grama, tobosa, three-awns, yucca, and various cacti. Creosotebush and a few mesquite also occur in the southwest part of this association.

Soil Characteristics. Ector soils, the most

extensive in the association, have a thin surface layer of grayish-brown stony or rocky loam. They have a subsoil of dark brown very stony loam. The content of angular limestone fragments ranges from 35 to 75 percent. Below this, at depths ranging from about 4 to 15 inches, is limestone bedrock which has numerous vertical and horizontal cracks. Thin coatings of calcium carbonate commonly occur on the upper part and in the fractures of the underlying limestone bedrock.

Conger soils, the other major soil in this association, generally occur on moderately sloping and rolling landscapes in the lower part and outer fringes of this mapping unit. They have grayish-brown, calcareous, gravelly loam surface layers. This is underlain by fractured, platy, strongly cemented to indurated caliche at depths of 6 to 20 inches. Angular caliche fragments are common in the soil layers above the underlying cemented caliche. Limestone bedrock commonly occurs at varying depths below the caliche.

Included in this association are small acreages of Santo Tomas, Elfrida, and Reagan soils. The Santo Tomas and Elfrida soils occupy the flood plains and valley bottoms of intermittent streams that traverse the area. The deep Reagan soils occur in the small areas with nearly level to gently sloping landscapes. Limestone Rockland, alluvial land, and other miscellaneous land types also occur to a very limited extent. These inclusions comprise 20 percent of this association.

Irrigation Potential. There is essentially no potential for the development of irrigated land in this association. The shallow, stony, and gravelly soils which normally occur on rolling and hilly landscapes are best used as native range. The limited acreage of soils with properties suitable for irrigation commonly occurs in small tracts in valley bottoms and flood plains of intermittent drainages.

13. Reagan-Elfrida-Conger association

Included in this association are a number of comparatively small and widely distributed areas in the northwestern part of the county. They consist of nearly level to gently sloping valley bottoms and the adjacent gently sloping to rolling terraces and plains. The soils, which are calcareous, are forming primarily in calcareous alluvium from geologic formations dominated by limestone with minor amounts from other geologic formations. These soils are similar to those of Reakor-Upton association, but differ in that they are developing in areas of higher rainfall at elevations averaging about 4,500 feet. The average annual precipitation ranges from about 12 to 15 inches. Approximately 88,640 acres, or about 2 percent of the county, is included in this association.

The soils are moderately productive grassland used for the grazing of livestock and wildlife. The more common native vegetation includes blue grama, hairy grama, tobosa, sideoats grama, black grama, sand dropseed, three-awns, and some broom snakeweed, cholla cactus, and mesquite shrubs.

Soil Characteristics. Reagan soils, the most extensive in this association, occupy the nearly level to gently sloping plains and terraces intermediate in elevation between the Conger and Elfrida soils. They typically have a moderately thick surface layer of light brownish-gray to brown calcareous loam. A light brown strongly calcareous loam subsoil about 24 inches thick underlies the surface layer. The substratum to a depth of 60 inches or more is a light brown very strongly calcareous clay loam. A few fine threads and small soft masses of lime commonly occur below an average depth of 30 inches.

Elfrida soils, which are also moderately extensive in this association, occupy nearly level to gently sloping swales and slightly lower lying positions than those of the Reagan series. They have a surface layer of grayish-brown silt loam or loam over a thick subsoil of brown silty clay loam. The underlying material to a depth of 60 inches or more consists of a light brown to brown clay loam or silty clay loam. This is strongly calcareous and usually has filaments and small soft masses of lime in the lower part of the subsoil and in the substratum.

The Conger soils in this association commonly occur on strongly sloping and undulating ridges and uplands just above the position occupied by Reagan soils. They normally consist of less than 10 inches of grayish-brown calcareous gravally loam over layered and fractured indurated caliche. Angular caliche fragments often occur on the surface and in the soft layers above the indurated caliche where they may comprise as much as 35 percent of the soil mass. The depths to the underlying caliche may range from 6 to 20 inches.

Also in this association are the moderately deep Atoka soils, the gravelly Santo Tomas soils, the shallow Ector soils, and small acreages of miscellaneous land types such as riverwash and arroyo bottoms. These soils and miscellaneous land types comprise about 15 percent of the association.

Irrigation Potential. Although this is a relatively small association, about 83 percent of the land in

this unit is suitable for irrigation. Therefore, it offers some opportunity for development of irrigated land, particularly if based on the capability of the soils for such use. Approximately 51 percent of the land in this general soil area is in irrigation land class 1; 30 percent is in class 2; 2 percent in class 4; and the remaining 17 percent is non-irrigable (class 6). The delineations comprising this association, however, generally occur as small and irregularly shaped units with lands included in soil associations 12 and 14 that are dominated by non-irrigable lands. The cost and difficulty of transporting irrigation water to these isolated tracts will undoubtedly restrict their use for irrigation.

14. Ector-Limestone Rockland association

This association, which occurs on limestone hills and breaks, is extensive in the southwestern and western parts of the county. The soils, which are dominantly shallow, stony, and rocky, occur on moderately steep to very steep uplands underlain generally by limestone bedrock. It is, therefore, characterized by its very rough and broken type of topography including numerous very steep canyon walls, breaks, and escarpments. It includes an area of about 375,475 acres, or 10 percent of the county.

The very shallow and steep soils of this association support only a relatively sparse cover of vegetation. Range for livestock and wildlife is the principal use. Short and mid grasses along with sotol, agave, ocotillo, snakeweed, sacahuista, and yucca comprise most of the vegetation. A few juniper trees may occur at the higher elevations where this unit joins the mountain ranges. The more common grasses are blue grama, bush muhly, three-awns, burrograss, tobosa, sideoats grama, wolftail, and tridens species.

Soil Characteristics. Ector soils represent the major component of this association. Although slopes on the landscapes occupied by the Ector soils are not as steep as those of limestone rockland, they do range from strongly sloping to rolling and hilly. These soils have thin grayish-brown stony loam or rocky loam surface layers and dark brown very stony subsoils. Below this and at depths ranging from about 4 to 15 inches is limestone bedrock. Numerous vertical and horizontal cracks are common in the underlying bedrock.

Limestone rockland, a miscellaneous land type, is also an extensive component of this association. It consists of a complex of shallow soils and outcrops of bedrock. Although shallow soils are the most extensive, small areas of moderately deep to deep soils occur interspersed with the shallow soils, rock outcrops and rock ledges. The rock outcrops commonly occur as vertical or nearly vertical exposures and ledges. The interspersed shallow soils are commonly stony and moderately coarse to medium textured. Numerous stones and angular fragments of limestone are also common on the surface.

Also in this association are small areas of Elfrida, Santo Tomas, Atoka, and Reagan soils. The deep medium to moderately fine-textured Elfrida soils and the gravelly Santo Tomas soils occur in the narrow valley bottoms adjacent to drainages. The Reagan and Atoka soils occupy nearly level to gently sloping upland terraces. The Reagan soils are deep, medium to moderately fine-textured, and strongly calcareous. The Atoka soils are similar in texture and reaction, but differ in being underlain at moderate depths by strongly cemented caliche. Alluvial land, riverwash, arroyos, and other miscellaneous land types comprise the remaining parts of this general soil area. These minor soils and land types comprise about 15 percent of the association.

Irrigation Potential. There is essentially no potential for the development of irrigated land in this association because of the rough broken topography, steep slopes, and shallow soils. This association is best used as range for livestock and wildlife. The lands classified as irrigable commonly occur as small tracts interspersed with extensive areas of class 6 land.

15. Deama-Pastura-Manzano association

This association includes an area of about 55,425 acres in the extreme northwestern part of the county. It occupies gently sloping to gently rolling uplands that generally range between 4700 and 5000 feet in elevation. In addition to this prevailing type of topography there are included a few steep breaks or escarpments and nearly level to gently sloping valley bottoms. It is dominated by shallow soils developing residually in materials of limestone origin. It is used for grazing livestock, and, under good management, fair to moderate yields of forage are obtained. Native vegetation includes blue grama, hairy grama, galleta, sideoats grama, sand dropseed, three-awns, and some New Mexico feathergrass, spike muhly, and needle and thread grass. Shrubs and woody species include snakeweed, cholla cactus, and mesquite.

Soil Characteristics. Soils of the Deama series are dominant in this association. They usually occur on nearly level to strongly sloping and gently rolling landscapes. These soils have a surface layer of grayish-brown to brown calcareous stony loam. This grades through a dark grayish-brown very stony loam to the underlying limestone bedrock at a depth of 6 to 20 inches. Coarse angular fragments comprise about 25 to 40 percent of the surface layer to as much as 70 percent in the subsurface layers immediately above the limestone bedrock.

Pastura soils are also shallow, but differ from those of the Deama series in that they are developing on indurated caliche. These soils have a surface layer of grayish-brown calcareous gravelly loam. This grades through a pale brown calcareous loam to the underlying caliche which usually occurs within 12 inches of the surface but may range in depth from 6 to 20 inches. Coarse fragments of very hard caliche are common in the subsurface layers. The degree of cementation of the caliche layer usually decreases gradually with depth and becomes soft to weakly cemented 1 to 3 feet below its upper surface. Limestone bedrock may occur below the indurated caliche layer at variable depths.

Manzano soils, the least extensive of the major soils in this association, occur on nearly level to very gently sloping swales and flood plains of intermittent drainages. The surface layer, about nine inches thick, is a grayish-brown to dark brown noncalcareous loam. The subsoil is a dark grayish-brown clay loam that has a moderate blocky structure, underlain by a substratum of brown light clay loam that usually contains a few pinkish-white specks and threads of segregated lime.

Soils of lesser extent in this association include those of the Harvey, Tapia, and Dean series. The Harvey soils are limy and occur on gently to strongly sloping valley sides. The grayish-brown calcareous loam surface layers of these soils are underlain by a pinkish-white very limy loam at a depth of about 16 to 20 inches. The Tapia soils have thin brown noncalcareous loam surface layers and light brown clay loam subsoils. They are underlain at moderate depths by a layer of indurated caliche gravels and cobbles that are weakly cemented together in the upper part. The Dean soils are light colored and have soft caliche or soil layers with a high content of lime at shallow depths. In addition, there are small acreages of unclassified alluvial soils and miscellaneous land types, including rockland in this association.

Irrigation Potential. The potential for development of irrigated land in this association is limited. The two most extensive soils, Deama and Pastura, are not suitable for irrigation. The Manzano, Harvey, and Tapia soils are suitable but commonly occur as small areas interspersed with large tracts of non-irrigable land. This will undoubtedly tend to restrict their development for irrigation.

16. Gypsumland association

This association, consisting of an area of approximately 169,960 acres, is mainly in the northwestern part of the county. The soils, like those in the Reeves-Holloman-Gypsumland association (No. 5), are forming in gypsiferous material. They differ in that they received slightly more moisture and have somewhat darker surface layers than those soils in association 5. They typically occur in complex patterns on landscapes that range from gently sloping and undulating to rolling. A few steep escarpments and breaks are also included. It is characterized by exposures of gypsiferous earth and intermingled shallow to moderately deep calcareous soils that are underlain by gypsiferous materials.

The soils of this association support a fair cover of native grasses and shrubs, most of which are suitable for grazing and wildlife use. The more common species are alkali sacaton, blue grama, black grama, sand dropseed, gyp grama, bush muhly, burrograss, and gyp grass, chamiza, broom snakeweed, and traces of mesquite.

Soil Characteristics. The major soils in this association are briefly described by groups as they have not been given soil series names. Gypsumland, a miscellaneous land type, however, is the major component in the association. It consists of a complex of outcrops of gypsiferous earth and very shallow soils. The gypsiferous materials vary from white "chalky" earths to hard, light colored, crystalline gypsum rocks. A two- to three-inch mantle of loamy soil material commonly occurs between the exposures of gypsiferous earth.

Soils shallow over gypsiferous earth are also extensive in this association. These soils, which occur on gently sloping and undulating to rolling uplands, have a thin surface layer of light brownish-gray to brown strongly calcareous loam. This grades through soil material of similar color and texture to the underlying gypsiferous earth or gypsum that occurs at a depth of 4 to 20 inches.

The other extensive group of soils in this association consists of moderately deep, well drained, medium-textured, and strongly calcareous

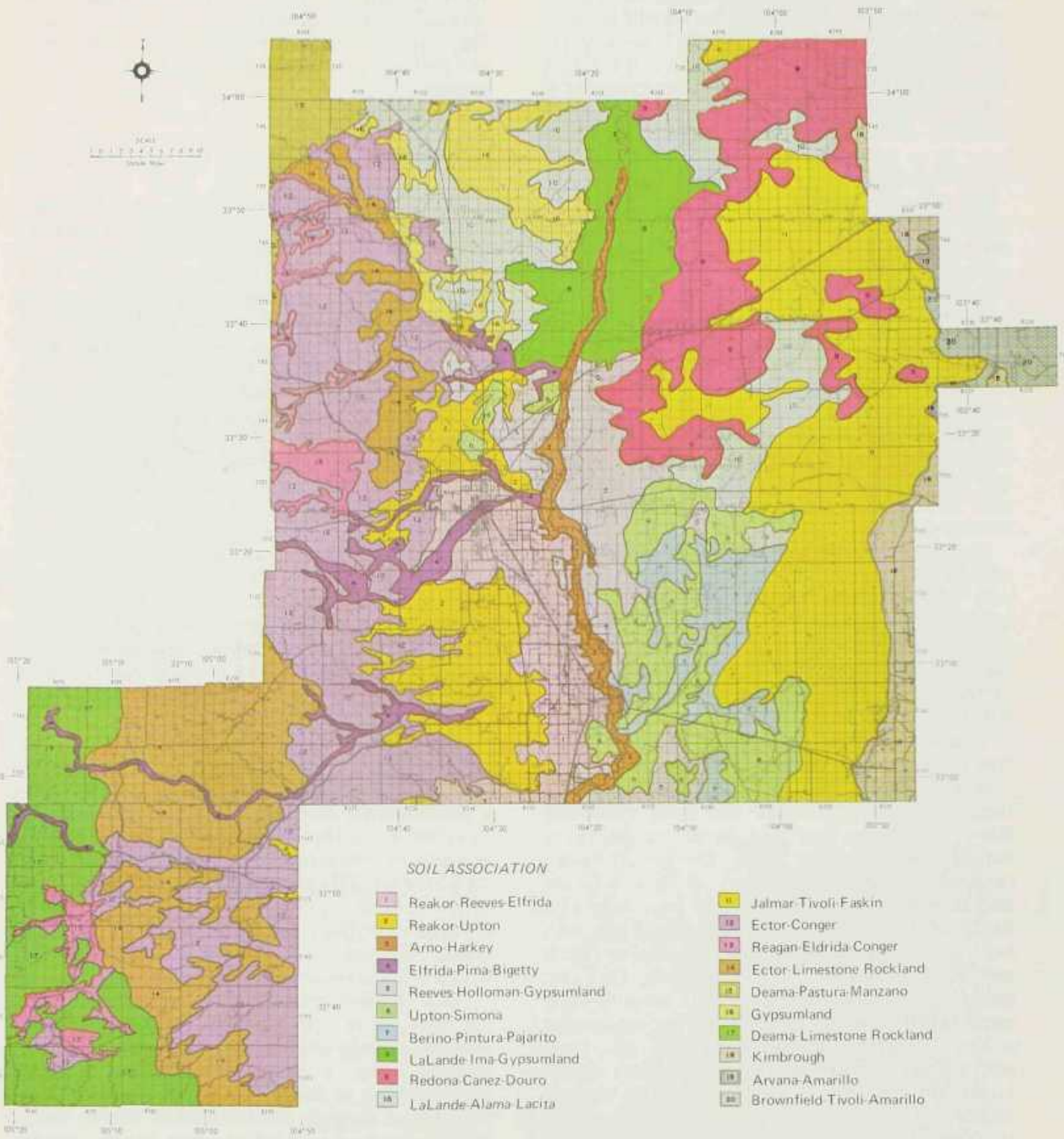


Figure 1. General Soil Map of Chaves County, New Mexico

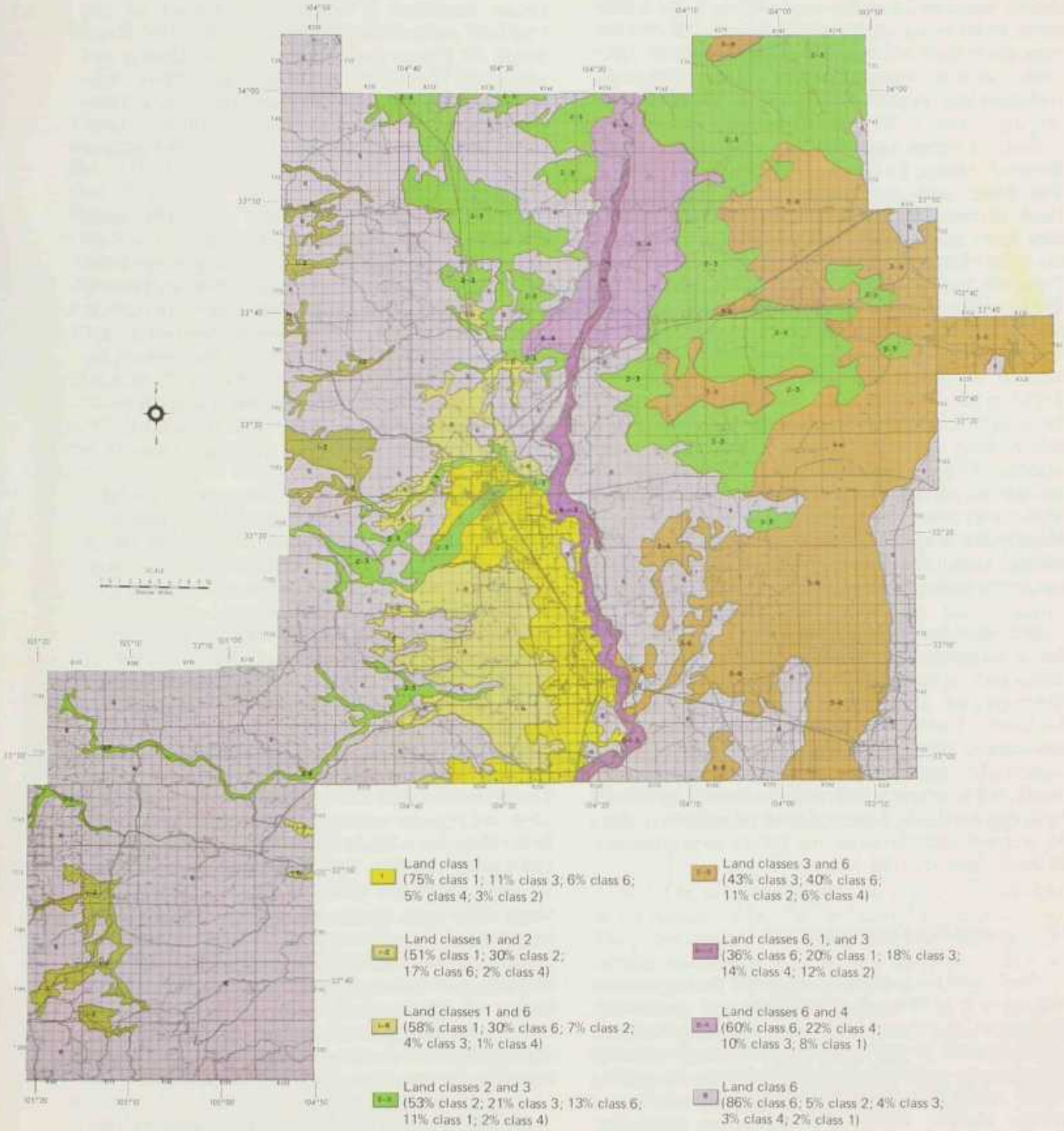


Figure 2. Classification of Land for Irrigation in Chaves County, New Mexico

soils. These soils are developing on gently sloping and undulating uplands in gypsiferous sediments from sedimentary formations containing gypsum, shales, siltstone, and limestone. They have a thin surface layer of light brownish-gray to brown strongly calcareous loam. This is underlain by light brown or pale brown loams and silt loam. White or pinkish-white gypsiferous earth occurs at depths ranging between 20 and 40 inches.

Soils of minor extent in this association include those of Alama, La Lande, Lacita, and Quay series. The Alama soils are deep and have a moderately thick surface layer of reddish-brown loam over a clay loam or silty clay loam subsoil. La Lande soils occur in close association with the Alama soils on the crests and side slopes of slightly elevated ridges. These soils are deep, reddish-brown, and medium-textured. The Lacita soils which usually occur in valley bottoms, consist of reddish-brown calcareous silt loams and light silty clay loams to a depth of six feet or more. They are often dissected by gullies. The Quay soils occur mainly on fans and valley-filling slopes at the base of escarpments and breaks. These soils have reddish-brown loam surface layers, a clay loam subsoil, and a pinkish-white very limy loam or clay loam substratum. Miscellaneous land types, including rockland, gullied land, and arroyo bottoms, comprise the remaining parts of this association.

Irrigation Potential. There is very little potential for development of irrigated land in this association due to the prevalence of shallow soils and outcrops of gypsiferous earth. The Alama, La Lande, Lacita, and Quay soils included in this association have characteristics that make them suitable for irrigation, but they commonly occur as small tracts interspersed with extensive areas of non-irrigable land. Tracts of land of sufficient size to warrant consideration for future expansion of irrigated land are very limited.

17. Deama-Rockland association

This association includes soils and land types on rolling to very steep limestone hills and mountain footslopes. It consists of an area of approximately 240,930 acres in the extreme southwestern part of the country at elevations that range between about 5,000 and 6,500 feet. The soils, which are dominantly shallow, stony, and rocky, are generally underlain by limestone bedrock within a depth of 20 inches. Small areas of moderately deep and deep soils, however, occur to a very limited extent principally in the valley areas and flood plains contiguous to the intermittent drainages.

These soils are used as range for livestock and wildlife. Although the density and amount of forage produced is somewhat restricted on the rockland component of this association, moderate yields of forage are obtained on the Deama and associated soils. The more common native vegetation includes blue grama, sideoats grama, bluestem species, western wheatgrass, tridens, three-awns, and scattered stands of pinyon and juniper trees.

Soil Characteristics. Deama soils, the most extensive in the association, commonly occur on rolling uplands. Slopes, however, may range from gently sloping to steep and hilly. These soils have a surface layer of dark grayish-brown to brown calcareous stony loam. This grades through a dark grayish-brown very stony loam to the underlying limestone bedrock at a depth of 6 to 20 inches. Angular coarse fragments comprise about 25 to 40 percent of the surface layer and as much as 70 percent in the underlying material above the limestone bedrock.

Rockland is also an extensive component of this association. It consists dominantly of a complex of very shallow soils and outcrops of limestone. Other types of sedimentary rocks may occur to a very limited extent. It is characterized by numerous rock outcrops, bare rock ledges, and a large amount of loose rock and stones on the surface. A thin mantle of stony or gravelly materials is common between the outcrops and exposures of bedrock. It commonly occurs on steep slopes, escarpments, and breaks.

Soils of lesser extent in this association include those of the Remunda, Ruidoso, and Jarita series. The Remunda and Ruidoso soils occur on nearly level to strongly sloping valley slopes and alluvial fans. They have thick, dark colored surface layers and clayey subsoils. The Jarita soils usually occur as small areas on gently sloping to moderately steep ridge tops, crests, and saddles of low rolling limestone hills. These soils, which have dark colored silt loam surface layers and silty clay loam subsoils are underlain by limestone bedrock at depths of 20 to 40 inches. In addition to these soils, small acreages of unclassified alluvial soils, drainageways, and other miscellaneous land types comprise the remaining parts of this association.

Irrigation Potential. There is essentially no potential for development of irrigated land in this association because of the prevalence of shallow soils, rock outcrops, steep slopes, and rough broken topography. The lands classified as suitable

for irrigation are widely distributed and usually occur as small tracts.

18. Kimbrough association

This association, like associations 19 and 20, occurs on that part of the Llano Estacado, or High Plains, that lies within Chaves County. Included is an area of about 88,175 acres in the eastern part of the county immediately above the escarpment that marks the western boundary of the High Plains. The soils, which are dominantly shallow, occur on nearly level to very gently sloping uplands. Although this general soil area is remarkably smooth, a number of swales or very slightly depressed drainageways occur locally and terminate in shallow depressions or playas.

It supports a relatively dense cover of grass, and, under good management, moderate yields of forage are obtained. The principal grasses are blue grama, sand dropseed, buffalo grass, sideoats grama, black grama, bush muhly, three-awns, New Mexico feathergrass, and tobosa. In the swales and slightly depressed areas, tobosa grass often comprises a relatively high percentage of the plant community. In addition to the grasses, a few mesquite shrubs, broom snakeweed, small soapweed, and various species of cacti are also commonly found.

Soil Characteristics. Kimbrough soils, the most extensive in the association, occur on nearly level to gently sloping uplands. The surface layer to an average depth of six to eight inches consists of a dark grayish-brown noncalcareous to weakly calcareous gravelly loam. The gravels, which are dominantly angular, hard caliche fragments, may comprise as much as 30 percent of the soil volume. Where the soils are deeper than the average, the soil layer immediately above the caliche is commonly strongly calcareous and lighter colored. Indurated caliche occurs at depths of 4 to 20 inches.

The Stegall, Arvana, Slaughter, Sharvana, and Lea series are also common and occur generally in small depressional areas and swales, or on nearly level plains throughout the association. Stegall soils have a dark grayish-brown noncalcareous loam surface layer and a blocky mildly alkaline clay loam subsoil. The Arvana soils have reddish-brown fine sandy loam surface layers and sandy clay loam subsoils. The Lea soils differ principally from the Stegall soils in having coarser-textured or loam subsoils that contain fine threads and filaments of carbonate. The soils of these series are usually underlain by indurated caliche at depths ranging from about 20 to 40 inches. The Slaughter and Sharvana soils, which are shallow, are underlain by indurated caliche at depths of 10 to 20 inches.

A small acreage of stony and rough broken land occurs along the western margin of this association and consists of the steep breaks and escarpments with exposures of caliche, sandstone, shale and other types of sedimentary rocks. A thin mantle of soil commonly occurs between the outcrops of bedrock and other materials.

Irrigation Potential. There is little or no potential for development of irrigated land in this association because it is dominated by the shallow soils of the Kimbrough series which are not suitable for such use. Although small bodies of arable soils suitable for use as cropland under irrigation are included, their use for this purpose generally will not be feasible because they are interspersed with large tracts of non-irrigable soils.

19. Arvana-Amarillo association

This general soil area occurs in close association with the Brownfield-Tivoli-Amarillo association in the eastern part of the county. It occurs on nearly level to very gently sloping and undulating landscapes, whereas the Brownfield-Tivoli-Amarillo association (20) is characterized by undulating to rolling and hummocky topography. The included soils are dominantly moderately deep to deep and well drained. They have moderately coarse-textured surface layers. Approximately 7570 acres, or less than one percent of the county, are included in this association.

It supports a good cover of native grass with blue grama, hairy grama, black grama, little bluestem, New Mexico feathergrass, sand muhly, three-awns, and sideoats grama being the more important species.

Soil Characteristics. Arvana soils are dominant and comprise about 50 percent of this association. They are mainly on nearly level to very gently sloping landscapes. The surface layer is a brown to reddish-brown noncalcareous loamy fine sand or fine sandy loam. Their subsoil is a moderately thick reddish-brown sandy clay loam that is typically neutral in reaction. This is underlain by indurated to strongly cemented caliche, which is commonly fractured, at depths ranging from 20 to 36 inches.

Amarillo soils occur on nearly level to very gently undulating landscapes. They have a surface layer of brown to reddish-brown loamy fine sand or fine sandy loam that is leached free of lime.

Table 4. Soil characteristics and qualities of major soils in each soil association, Chaves County, New Mexico

Soil Map Symbol and Soil Association	Dominant Slope Range (percent)	Approximate Percent of Association	Pedologic Classification		Texture[1]
			Subgroup	Family	
1 Reakor-Reeves-Elfrida					
Reakor loam	0-3	65	Typic Calciorthid	Fine-loamy, mixed, thermic	Loam
Reeves loam	0-3	15	*Typic Calciorthid*	*Fine-loamy, gypsic, thermic*	Loam
Elfrida silt loam	0-1	10	Pachic Calciustoll	Fine-loamy, mixed, thermic	sil;cl
Other soils		10			
2 Reakor-Upton					
Reakor loam	0-3	55	(See soil association 1)		
Upton gravelly loam	0-10	30	Typic Paleorthid	Loamy, carbonatic, thermic, shallow	gl;fsl
Elfrida silt loam	0-1	5	(See association 1)		
Atoka loam	0-3	3	Typic Paleorthid	Fine-loamy, mixed, thermic	Loam
Other soils		7	(See association 1)		
3 Arno-Harkey					
Arno silty clay loam	0-1	40	Vertic Torrifluvent	Fine, mixed, calcareous thermic	*sicl;clay*
Harkey very fine sandy loam	0-1	30	Typic Torrifluvent	Coarse-silty, mixed, calcareous, thermic	vfsl;sl;loam
Anthony fine sandy loam	0-1	20	Typic Torrifluvent	Coarse-loamy, mixed, calcareous, thermic	fsl;sl
Other soils and land types		10			
4 Elfrida-Pima-Bigetty					
Elfrida silt loam	0-1	30	Pachic Calciustoll	Fine-loamy, mixed, thermic	sil;cl
Pima clay loam	0-2	25	Cumulic Haplustoll	Fine-silty, mixed, thermic	cl;sil;loam
Bigetty silty clay loam	0-1	25	Cumulic Haplustoll	Fine-silty, mixed, thermic	sicl;loam
Other soils and land types		20			
5 Reeves-Holloman-Gypsum Land					
Reeves loam	0-3	25	(See association 1)		
Holloman loam	0-3	25	Typic Torriorthent	Fine-loamy, gypsic, thermic, shallow	Loam
Gypsum land		30	A miscellaneous land type		
Other soils and land types		20			
6 Upton-Simona					
Upton gravelly loam	0-10	40	(See association 2)		
Simona fine sandy loam	0-3	30	Typic Paleorthid	Loamy, mixed, thermic, shallow	fsl;lfs
Reakor loam (reddish-brown variant)	0-3	15	Typic Calciorthid	Fine-loamy, mixed, thermic	Loam
Other soils and land types		15			
7 Berino-Pintura-Pajarito					
Berino loamy fine sand	0-3	35	Typic Haplargid	Fine-loamy, mixed, thermic	*lfs;fs*
Pintura fine sand	0-5	30	Typic Torripsamment	Mixed, thermic	fs
Pajarito loamy fine sand	0-3	20	Typic Camborthid	Coarse-loamy, mixed, thermic	fs;lfs
Other soils and land types		15			
8 La Lande-Ima-Gypsumland					
La Lande loam	0-9	25	Ustollic Camborthid	Fine-loamy, mixed, thermic	Loam;fsl
Ima fine sandy loam	1-9	15	Ustochreptic Camborthic	Coarse-loamy, mixed, thermic	fsl;fs
Gypsumland	0-25	25	A miscellaneous land type		
Other soils and land types		35			
9 Redona-Canez-Douro					
Redona fine sandy loam	0-5	40	Ustollic Haplargid	Fine-loamy, mixed, thermic	fsl;loam
Canez fine sandy loam	0-3	30	Ustollic Haplargid	Fine-loamy, mixed, thermic	fsl;loam
Douro loamy fine sand	0-5	15	Petrocalcic Ustalfic Paleargid	Fine-loamy, mixed, thermic	lfs;fsl
Other soils and land types		15			
10 La Lande-Alama-Lacita					
La Lande loam	0-5	45	Ustollic Camborthid	Fine-loamy, mixed, thermic	Loam
Alama silt loam	0-3	20	Ustollic Camborthid	Fine-silty, mixed, thermic	sil;loam
Lacita loam, eroded	0-3	10	Ustic Torriorthent	Fine-silty, mixed (calcareous), thermic	Loam;sil
Other soils and land types		25			
11 Jalmar-Tivoli-Faskin					
Jalmar fine sand	0-3	35	Arenic Ustalfic Haplargid	Loamy, mixed, thermic	*fs*
Tivoli fine sand	0-5	30	Typic Ustipsamment	Mixed, thermic	fs
Faskin fine sandy loam	0-3	15	Ustalfic Haplargid	Fine-loamy, mixed, thermic	fsl;lfs
Other soils and land types		20			
12 Ector-Conger					
Ector stony and rocky loams	0-30	60	Aridic Lithic Calciustoll	Loamy-skeletal, carbonatic, thermic	stl;rl
Conger gravelly loam	0-15	20	Ustollic Paleorthid	Loamy, mixed, thermic, shallow	gl;loam
Other soils and land types		20			

Surface Soil Features		Subsoil Features				Soil Depth[5]	AWHC[6]
Color[2]	Carbonates[3]	Texture[1]	Color	Permeability[4]	Substratum	(inches)	(inches)
Light brownish-gray to brown	Strongly calc.	Loam;cl	Light brown	Moderate	Calcareous alluvium	60 or more	7 to 8
Pale brown	Strongly calc.	Loam;cl	Very pale brown	Moderate	Gypsiferous earth	10 to 40	4 to 6
Grayish-brown to brown	Strongly calc.	sicl;cl	Brown	Slow	Calcareous alluvium	60 or more	7 to 8
Light brownish-gray	Strongly calc.	grl	Pale brown to brown	Moderate to rapid	Strongly cemented to indurated caliche	4 to 20	1 to 3
Light grayish-brown to brown	Strongly calc.	Loam;cl	Light brown to brown	Moderate	Caliche; fractured and indurated in upper part	20 to 40	4 to 6
Reddish-brown	Strongly calc.	Clay;sicl	Light reddish-brown	Very slow	Clayey alluvium	60 or more	7 to 8
Light brown to brown	Strongly calc.	vfsl;loam	Light brown to brown	Moderate	Loamy alluvium	60 or more	6 to 7
Pale brown	Strongly calc.	sl;fsl;lfs	Light brown	Rapid	Sandy alluvium	60 or more	5 to 6
Grayish-brown to brown	Strongly calc.	sicl;cl	Light brown	Slow	Calcareous alluvium	60 or more	7 to 8
Dark grayish-brown	Calc.	cl;sicl;vfsl	Dark grayish-brown	Slow	Loamy alluvium	60 or more	7 to 8
Brown to dark brown	Calc.	sicl;cl	Dark brown	Slow	Loamy alluvium	60 or more	7 to 8
Pale brown	Strongly calc.	Loam;cl	Light brownish-gray	Moderate	Gypsiferous earth and rock	4 to 20	1 to 3
Grayish-brown to brown	Calc.	gfsl;fsl;lfs	Pale brown	Rapid	Caliche; platy and indurated in upper foot	7 to 24	1 to 3
Light reddish-brown to brown	Strongly calc.	Loam;cl	Reddish-brown	Moderate	Calcareous alluvium	60 or more	7 to 8
Yellowish-red to reddish-brown	Non-calc.	scl	Reddish-brown	Moderate	Soft to weakly cemented caliche	36 to 48	4 to 6
Yellowish-red	Non-calc.	fs	Light reddish-brown	Very rapid	Sandy eolian sediments	60 or more	3
Yellowish-red	Weakly calc.	fsl	Yellowish-red	Rapid	Sandy alluvium	60 or more	4 to 5
Reddish-brown	Non-calc.	Loam;scl	Reddish-brown	Moderate	Loamy alluvium	60 or more	5 to 7
Reddish-brown	Non-calc.	sl;loam	Light reddish-brown	Rapid	Moderately coarse textured alluvium	60 or more	4 to 5
Brown to reddish-brown	Non-calc.	scl	Reddish-brown	Moderate	Very calcareous loamy sediments	60 or more	6 to 7
Brown	Non-calc.	scl	Reddish-brown	Moderate	Loamy alluvium	60 or more	6 to 7
Reddish-brown	Non-calc.	scl	Reddish-brown	Moderate	Caliche; 12 to 18 inches strongly cemented	20 to 36	3 to 4.5
Reddish-brown	Calc.	Loam	Reddish-brown	Moderate	Calcareous alluvium	60 or more	7
Reddish-brown	Weakly calc.	sicl;cl	Reddish-brown	Slow	Loamy alluvium	60 or more	7 to 8
Reddish-brown	Calc.	sil;loam	Reddish-brown	Moderate to slow	Loamy alluvium	60 or more	7
Light brown to brown	Non-calc.	scl	Red to reddish-brown	Moderate	Sandy clay loam	48 to 60	4 to 6
Yellowish-brown	Non-calc.	fs	Pale brown to yellowish-brown	Very rapid	Fine sand	60 or more	3
Brown	Non-calc.	scl	Reddish-brown	Moderate	Sandy clay loam	60 or more	6 to 7
Grayish-brown	Calc.	stl	Dark brown	Moderate	Limestone bedrock	4 to 15	1 to 2
Grayish-brown	Calc.	gl;gcl	Pale brown	Moderate	Caliche; indurated in upper part	6 to 20	1 to 3

Table 4. Continued

Soil Map Symbol and Soil Association	Dominant Slope Range (percent)	Approximate Percent of Association	Pedologic Classification: Subgroup	Pedologic Classification: Family	Texture[1]
13 Reagan-Elfrida-Conger					
Reagan loam	0-5	55	Ustollic Calciorthid	Fine-silty, mixed, thermic	Loam
Elfrida silt loam	0-2	15	Pachic Calciustoll	Fine-loamy, mixed, thermic	Loam;sil
Conger gravelly loam	0-10	15	Ustollic Paleorthid	Loamy, mixed, thermic, shallow	gl;loam
Other soils and land types		15			
14 Ector-Limestone Rockland					
Ector stony and rocky loams	10-35	45	Aridic Lithic Calciustoll	Loamy-skeletal, carbonatic, thermic	stl;rl
Limestone rockland	25-65+	40	A miscellaneous land type		
Other soils and land types		15			
15 Deama-Pastura-Manzano					
Deama cobbly loam	0-25	65	Aridic Lithic Calciustoll	Loamy-skeletal, carbonatic, mesic	col;stl
Pastura gravelly loam	0-10	15	Ustollic Paleorthid	Loamy, mixed, mesic, shallow	gl;loam
Manzano loam	0-3	8	Cumulic Haplustoll	Fine-loamy, mixed, mesic	Loam;cl
Harvey loam	0-5	5	Ustollic Calciorthid	Fine-loamy, mixed, mesic	Loam;fsl
Other soils and land types		7			
16 Gypsumland					
Gypsumland		40	A miscellaneous land type		
Shallow gypsiferous soils		20	Ustic Torriorthent	Fine-loamy, gypsic, thermic, shallow	Loam
Moderately deep gypsiferous soils		20	Ustollic Calciorthid	Fine-loamy, gypsic, thermic	Loam
Other soils and land types		20			
17 Deama-Limestone Rockland					
Deama cobbly loam	0-45	50	Aridic Lithic Calciustoll	Loamy-skeletal, carbonatic, mesic	col;stl
Limestone rockland	35-70+	30	A miscellaneous land type		
Other soils and land types		20			
18 Kimbrough					
Kimbrough gravelly loam	0-2	70	Paleorthidic Calciustoll	Loamy, mixed, thermic, shallow	grl;loam
Stegall loam	0-1	4	Aridic Petrocalcic Paleustoll	Fine, mixed, thermic	Loam;sicl
Lea loam	0-1	3	Aridic Petrocalcic Paleustoll	Fine-loamy, mixed, thermic	Loam
Arvana fine sandy loam	0-2	5	Aridic Petrocalcic Paleustalf	Fine-loamy, mixed, thermic	fsl;lfs
Other soils and land types		18			
19 Arvana-Amarillo					
Arvana loamy fine sand	0-3	50	Aridic Petrocalcic Paleustalf	Fine-loamy, mixed, thermic	lfs;fsl
Amarillo loamy fine sand	0-3	10	Aridic Paleustalf	Fine-loamy, mixed, thermic	lfs;fsl
Other soils		40			
20 Brownfield-Tivoli-Amarillo					
Brownfield fine sand		45	Arenic Aridic Paleustalf	Loamy, mixed, thermic	fs
Tivoli fine sand		20	Typic Ustipsamment	Mixed, thermic	fs
Amarillo loamy fine sand		15	Aridic Paleustalf	Fine-loamy, mixed, thermic	lfs;fsl
Other soils		20			

[1]Abbreviations used for textural classes:

fs-fine sand; fsl-fine sandy loam; gl-gravelly loam; rl-rocky loam
ls-loamy sand; vfsl-very fine sandy loam; scl-sandy clay loam; col-cobbly loam
lfs-loamy fine sand; gsl-gravelly sandy loam; sil-silty loam; cl-clay loam
sl-sandy loam; gfsl-gravelly fine sandy loam; stl-stony loam; sicl-silty clay loam

[2]Colors are for dry soil

[3]Calc. -- calcareous

Surface Soil Features		Subsoil Features				Soil Depth[5]	AWHC[6]
Color[2]	Carbonates[3]	Texture[1]	Color	Permeability[4]	Substratum	(inches)	(inches)
Light brownish-gray	Strongly calc.	Loam;cl	Light brown	Moderate	Calcareous alluvium	60 or more	7
Grayish-brown to brown	Strongly calc.	sicl;cl	Brown	Slow	Calcareous alluvium	60 or more	7
Grayish-brown	Calc.	gl;gcl	Pale brown	Moderate	Caliche; indurated in upper part	6 to 20	1 to 3
Grayish-brown	Calc.	stl	Dark brown	Moderate	Limestone bedrock	4 to 15	1 to 2
Grayish-brown to brown	Calc.	stl	Dark grayish-brown	Moderate	Limestone bedrock	6 to 20	1 to 3
Grayish-brown	Calc.	gl;loam	Pale brown	Moderate	Caliche; indurated in the upper part	6 to 20	1 to 3
Grayish-brown to dark brown	Non-calc.	Loam;cl	Dark grayish-brown	Slow	Loamy alluvium	60 to more	8
Light brown to brown	Calc.	Loam;scl;cl	Light brown	Moderate	Soft caliche or very limy loam	15 to 20	3 to 4
Pale brown	Strongly calc.	Loam	Light brownish-gray	Moderate	Gypsiferous earth and rock	4 to 20	1 to 3
Brown to light brownish-gray	Strongly calc.	Loam	Light brown or pale brown	Moderate	Gypsiferous earth and rock	20 to 40	4 to 6
Grayish-brown to brown	Calc.	stl	Dark grayish-brown	Moderate	Limestone bedrock	6 to 20	1 to 3
Dark grayish-brown	Weakly calc.	Loam;grl	Brown	Moderate ro rapid	Indurated caliche	4 to 20	1 to 3
Dark brown to grayish-brown	Non-calc.	cl;sicl	Brown to dark brown	Slow	Indurated caliche	20 to 40	4 to 6
Dark grayish-brown	Weakly calc.	Loam	Grayish-brown	Moderate	Indurated caliche	20 to 40	4 to 6
Brown to reddish-brown	Non-calc.	scl	Reddish-brown	Moderate	Caliche; strongly cemented in upper part	20 to 36	3 to 5
Brown to reddish-brown	Non-calc.	scl	Reddish-brown	Moderate	Caliche; strongly cemented in upper part	20 to 36	3 to 5
Brown to reddish-brown	Non-calc.	scl	Yellowish-red to reddish-brown	Moderate	Calcareous loamy sediments	40 to 60	5 to 7
Light brown	Non-calc.	scl	Yellowish-red and red	Moderate	Sandy and loamy eolian sediments	60 or more	5
Pale brown	Non-calc.	fs	Light yellowish-brown	Very rapid	Sandy eolian sediments	60 or more	3
Brown to reddish-brown	Non-calc.	scl	Yellowish-red to reddish-brown	Moderate	Calcareous loamy sediments		

[4]Permeability classes and approximate rates per hour:
Very slow - less than 0.20 inches per hour Rapid - 2.00 to 6.30 inches per hour
Slow - 0.20 to 0.63 inches per hour Very rapid - more than 6.30 inches per hour
Moderate - 0.63 to 2.00 inches per hour

[5]Depth in inches from surface of effective soil

[6]AWHC - Available water-holding capacity (esttmated to a depth of 4 feet or for effective soil material if less than 4 feet)

Their subsoil is a thick yellowish-red to reddish-brown sandy clay loam that is typically noncalcareous in the upper part. This is underlain by a light reddish-brown sandy clay loam with a high lime content. The lime or calcium carbonate below an average depth of 40 inches is typically visible in the form of threads and small soft masses.

Soils of the Portales, Clovis, Gomez, Sharvana, and Kimbrough series also comprise significant acreages in this association. The Portales and Clovis soils are moderately deep over soft caliche, the Sharvana and Kimbrough soils are shallow over indurated caliche and the Gomez soils, which are sandy, are underlain by soil layers high in lime at moderate depths.

Irrigation Potentials. The major soils in this association have characteristics and properties favorable for their use as irrigated cropland. The Amarillo soils, which are in class 2, are moderately well suited to cropland use under irrigation. Their major limitations are the undulating land surface and a slight to moderate susceptibility to wind erosion. The Arvana soils, in addition to the wind erosion hazard, are of moderate depth and water-holding capacity. Because of these characteristics and properties, the Arvana soils were placed in irrigation land class 3. The Portales and Clovis soils, because of their moderate depth and water-holding capacity, were included in irrigation land class 2. These soils together with Amarillo loamy fine sand account for most of the land in class 2. The Sharvana, Kimbrough, and Gomez soils are not suitable for use as irrigated cropland due to their limited water-holding capacity, shallow depth, or sandy textures. Approximately 32 percent of the land in this association is in land class 6. It is often interspersed with the lands suitable for irrigation, and this will tend to limit the size of the tracts that can be developed for irrigation.

20. Brownfield-Tivoli-Amarillo association

This association, which includes an area of approximately 37,020 acres, occurs on the High Plains in the extreme east-central part of the county.

A characteristic feature of this sandy soil area is the gently undulating to rolling or duny topography. The soils, which are generally deep and highly susceptible to wind erosion, are developing in sandy eolian and alluvial sediments.

The native pasture areas in this association that are in good condition support a fair to good cover of tall and mid grasses. However, a few dunes that are bare or nearly bare of vegetation are included. These areas actively erode during windy periods. The more common grasses are sand bluestem, little bluestem, switchgrass, sandreed, Indiangrass, sideoats grama, black grama, and sand dropseed. In addition to the grasses, these soils often support scattered to relatively dense stands of shrubs, including shinnery oak, yucca, mesquite, sandsage, and various species of cacti.

Soil Characteristics. Brownfield soils, the most extensive in the association, usually occur on gently undulating and hummocky landscapes. They have a thick surface layer of light brown, loose, noncalcareous fine sand. The surface layer rests abruptly on the yellowish-red to red sandy clay loam subsoil that ranges from two to three feet in thickness. It is generally noncalcareous, but locally it may be calcareous in the lower part. This is underlain by a calcareous light sandy clay loam.

Tivoli soils, which occupy the gently rolling and duny landscapes in this association, are characterized by their very rapidly permeable loose and extremely sandy profiles. They typically consist of a pale brown or light yellowish-brown noncalcareous fine sand to a depth of six feet or more.

Although occasionally hummocky and slightly undulating, the Amarillo soils in this association generally occupy the more level parts of the landscape. They have a surface layer of brown loamy fine sand that is leached free of lime. Their subsoil is a thick reddish-brown to yellowish-red sandy clay loam that is typically free of lime in the upper part. This is underlain by a light reddish-brown sandy clay loam with a high lime content. The lime or calcium carbonate below an average depth of 40 inches is typically visible in the form of threads and small soft masses.

Also of importance in this association are soils of the Springer, Gomez, Arvana, and Sharvana series. The Springer soils are similar to those of the Amarillo series but differ in having sandy loam or coarser-textured subsoils. The Gomez soils, which are sandy, are underlain by layers high in lime at moderate depths. The Arvana soils are underlain by indurated caliche at moderate depths, as are those of the Sharvana series at depths of 12 to 20 inches. In addition to these soils, the shallow Kimbrough and Potter soils occur to a very limited extent.

Irrigation Potential. The soils in this association suitable for irrigation are dominantly in irrigation land class 3, with lesser amounts in classes 2 and 4. These soils have moderate to severe limitations for use as cropland under irrigation. The Brownfield and Arvana soils account for the ma-

jority of the land in class 3. These soils, which are characterized by sandy surface layers, are susceptible to wind erosion under cultivation, hence management practices to minimize damage by wind erosion will be needed. The hummocky and eroded phases of the Amarillo soils were also included in class 3. Shallow soils and eroded phases of the Brownfield soils comprise most of the land included in class 4. Due to their low water-holding capacity, sandy textures, and very high susceptibility to damage by wind erosion, soils of the Gomez, Tivoli, and Sharvana series are not suitable for use as cropland under irrigation. These soils, which are in class 6, comprise about 27 percent of this general soil area.

Although there are limitations, there is some potential for development of irrigated land in this association. In addition to the wind erosion hazard and the unevenness of the land surface, irrigable and non-irrigable lands are interspersed in many parts of this association. This limits the size of the areas that can be developed for irrigation.

Suitability Of Soils For Irrigation

In this section, the extent, location, and suitability of soils for irrigation, as well as their placement in the various irrigation land classes are discussed. The acreage of irrigable and non-irrigable land in each of the 20 soil associations is shown in table 5. These estimates were determined on the basis of the kinds of soils occurring in the soil associations.

The approximate distribution of the various land classes in Chaves County is shown on the irrigation land class map (figure 2). This map is based on the soil association map (figure 1) and the acreages of land classes in each of the soil associations (table 5). The land class or classes shown comprise more than 75 percent of the delineated area. No land class was shown that did not comprise at least 15 percent of the area as identified on the map. Where more than one land class is shown, the most extensive class is indicated first, followed in order by those of lesser extent. The small scale of the irrigation land class map precludes the possibility of showing small areas of land with different capabilities for irrigation. For example, the large and extensive areas of class 6 land may contain small tracts of land suitable for irrigation. Because of the limitation of map scale, these small tracts that differ in capability for irrigation are not shown.

The irrigation land classes provided a relative rating of the suitability of land for irrigation. Class 1 land has few or no limitations for irrigation. The limitations for use of land under irrigation increases from 1 through 4, with class 4 having severe limitations for use. Class 6 land is non-irrigable. An analysis of the irrigation land classification data (table 5 and figure 2) indicates that the following six soil associations offer the best potential for expansion of irrigated land in Chaves County:

1. Reakor-Reeves-Elfrida
2. Reakor-Upton
13. Reagan-Elfrida-Conger
4. Elfrida-Pima-Bigetty
9. Redona-Canez-Douro
10. La Lande-Alama-Lacita

These six soil associations (figure 1) contain slightly more than 950,000 acres, or about 55 percent of the 1,737,000 acres of land classified as irrigable in this county. They also contain approximately 77 percent of the class 1 and 2 land.

In comparison with the other soil associations, the Reakor-Reeves-Elfrida association (number 1) offers the best possibilities for expansion of irrigated land in Chaves County. The irrigable land in this association, which is dominantly in land class 1, occurs in relatively large tracts with little or no interspersed non-irrigable land. It occupies nearly level to gently sloping landscapes and will require a minimum amount of land leveling and conditioning in preparation for irrigation. A part of this soil association, however, is in urban areas, industrial sites, highways, roads, and other built-up areas. It also contains most of the 101,000 acres of land now irrigated in Chaves County. The lands already in these uses were not deducted from the acreage that is indicated as suitable for irrigation.

There is also considerable opportunity for expansion of irrigated land in the Reakor-Upton association. Similar to association 1, it is also dominated by extensive areas of class 1 land but differs in that it contains about 30 percent of non-irrigable or class 6 lands. The strongly sloping and undulating ridges occupied by the Upton soils comprise the majority of the land in class 6. Although the lands suitable for irrigation are intermingled with this class 6 land, they are

Table 5. Estimated acreage and approximate percentage of land in each irrigation land class by soil association, Chaves County, New Mexico*

Soil Map Symbol and Soil Association	Class 1		Class 2		Class 3		Class 4		Classes 1 to 4 Total		Class 6		Grand Total		Principal Limiting Factor(s)
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	
1 Reakor-Reeves-Elfrida															
Reakor loam	98,331				1,536				99,867				99,867		
Reeves loam					15,364		7,682		23,046				23,046		Salinity;soil depth
Elfrida silt loam	15,364								15,364				15,364		
Other soils	1,536		4,609						6,145		9,218		15,363		
Total	115,231	75	4,609	3	16,900	11	7,682	5	144,422	94	9,218	6	153,640	4	
2 Reakor-Upton															
Reakor loam	93,990		9,399						103,389				103,389		
Upton loam											56,394		56,394		Soil depth
Elfrida silt loam	9,399								9,399				9,399		
Atoka loam			5,639						5,639				5,639		AWHC**:soil depth
Other soils and land types	3,760				7,519		1,880		13,159				13,159		
Total	107,149	58	15,038	7	7,519	4	1,880	1	131,586	70	56,394	30	187,980	5	
3 Arno-Harkey															
Arno silty clay loam							8,295		8,295		15,405		23,700		Salinity;wetness
Harkey very fine sandy loam	11,554		2,666		3,555				17,775				17,775		Salinity;wetness
Anthony fine sandy loam			4,740		7,110				11,850				11,850		AWHC;erosion
Other soils											5,925		5,925		
Total	11,554	20	7,406	12	10,665	18	8,295	14	37,920	64	21,330	36	59,250	2	
4 Elfrida-Pima-Bigetty															
Elfrida silt loam	21,580		21,580						43,160				43,160		Overflow
Pima clay loam			35,968						35,968				35,968		Overflow
Bigetty loam	14,387		21,580						35,967				35,967		Overflow
Other soils and land types							7,194		7,194		21,581		28,775		
Total	35,967	25	79,128	55			7,194	5	122,289	85	21,581	15	143,870	4	
5 Reeves-Holloman-Gypsum Land															
Reeves loam					16,330		8,165		24,495		16,330		40,825		Salinity;soil depth
Holloman loam											40,825		40,825		Soil depth;salinity
Gypsum land											48,990		48,990		Soil;topography
Other soils and land types			3,266		1,633				4,899		27,761		32,660		
Total			3,266	2	17,963	11	8,165	5	29,394	18	133,906	82	163,300	4	
6 Upton-Simona															
Upton gravelly loam											75,932		75,932		Soil depth
Simona fine sandy loam											56,949		56,949		Soil depth
Reakor loam (reddish-brown variant)	14,238		14,237						28,475				28,475		Slope
Other soils and land types			2,848		8,541		5,695		17,084		11,390		28,474		
Total	14,238	8	17,085	8	8,541	5	5,695	3	45,559	24	144,271	76	189,830	5	
7 Berino-Pintura-Pajarito															
Berino loamy fine sand					4,761				4,761				4,761		AWHC
Berino and Pajarito soils, eroded					38,089		9,523		47,612				47,612		AWHC;erosion
Pintura fine sand											28,568		28,568		AWHC;soil texture
Other soils and land types							5,714		5,714		8,570		14,284		
Total					42,850	45	15,237	16	58,087	61	37,138	39	95,225	2	
8 La Lande-Ima-Gypsum Land															
La Lande loam			11,111		13,889		9,722		34,722				34,722		Slope;erosion
Ima fine sandy loam							20,833		20,833				20,833		Erosion;AWHC;slope
Gypsum land											34,723		34,723		Soil;topography
Other soils and land types											48,612		48,612		
Total			11,111	8	13,889	10	30,555	22	55,555	40	83,335	60	138,890	4	

Table 5. Continued

Soil Map Symbol and Soil Association	Class 1		Class 2		Class 3		Class 4		Classes 1 to 4 Total		Class 6		Grand Total		Principal Limiting Factor(s)
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	
9 Redona-Canez-Douro															
Redona fine sandy loam	39,838		73,984						113,822				113,822		Slope
Canez fine sandy loam			85,367						85,367				85,367		Slope
Douro loamy fine sand					42,683				42,683				42,683		AWHC;soil depth
Other soils and land types					17,073				17,073		25,610		42,683		
Total	39,838	14	159,351	56	59,756	21			258,945	91	25,610	9	284,555	7	
10 La Lande-Alama-Lacita															
La Lande loam			75,601		40,708				116,309				116,309		Slope
Alama silt loam			51,693						51,693				51,693		Overflow
Lacita loam, eroded					25,846				25,846				25,846		Erosion;overflow
Other soils and land types					18,093		7,754		25,847		38,770		64,617		
Total			127,294	49	84,647	33	7,754	3	219,695	85	8,770	15	258,465	7	
11 Jalmar-Tivoli-Faskin															
Jalmar fine sand					158,105				158,105				158,105		AWHC;slope;erosion
Tivoli fine sand											158,105		158,105		AWHC;soil texture
Faskin-Jalmar soils					52,701				52,701				52,701		Slope;erosion
Faskin fine sandy loam			52,701						52,701				52,701		Slope
Other soils and land types			15,810		10,540		21,081		47,431		57,972		105,403		
Total			68,511	13	221,346	42	21,081	4	310,938	59	216,077	41	527,015	14	
12 Ector-Conger															
Ector stony and rocky loams											381,351		381,351		Soil depth;slope
Conger gravelly loam											127,117		127,117		Soil depth
Other soils and land types	19,068		31,779				25,423		76,270		50,847		127,117		
Total	19,068	3	31,779	5			25,423	4	76,270	12	559,315	88	635,585	16	
13 Reagan-Elfrida-Conger															
Reagan loam	31,689		17,063						48,752				48,752		Slope
Elfrida loam	13,296								13,296				13,296		
Conger gravelly loam											13,296		13,296		Soil depth
Other soils and land types			8,864				2,659		11,523		1,773		13,296		
Total	44,985	51	25,927	30			2,659	2	73,571	83	15,069	17	88,640	2	
14 Ector-Limestone Rockland															
Ector stony and rocky loams											168,964		168,964		Soil depth;slope
Limestone rockland											150,190		150,190		Soil;topography
Other soils and land types			7,510		7,509		11,264		26,283		30,038		56,321		
Total			7,510	2	7,509	2	11,264	3	26,283	7	349,192	93	375,475	10	
15 Deama-Pastura-Manzano															
Deama gravelly loam											36,026		36,026		Soil depth
Pastura gravelly loam											8,314		8,314		Soil depth
Manzano loam			4,434						4,434				4,434		Overflow
Harvey loam					2,771				2,771				2,771		AWHC;slope
Other soils and land types			554		1,109				1,663		2,217		3,880		
Total			4,988	9	3,880	7			8,868	16	46,557	84	55,425	1	
16 Gypsum Land Association															
Gypsum land											67,984		67,984		Soil;topography
Shallow gypsiferous soils											33,992		33,992		Soil depth;salinity
Moderately deep gypsiferous soils											33,992		33,992		Salinity;AWHC
Other soils and land types			10,198		8,498		8,498		27,194		6,798		33,992		
Total			10,198	6	8,498	5	8,498	5	27,194	16	142,766	84	169,960	4	

Table 5. Continued

Soil Map Symbol and Soil Association	Class 1		Class 2		Class 3		Class 4		Classes 1 to 4 Total		Class 6		Grand Total		Principal Limiting Factor(s)
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	
17 Deama-Limestone Rockland															
Deama cobbly loam											120,465		120,465		Soil depth
Limestone rockland											72,279		72,279		Soil;topography
Remunda silty clay loam					19,274				19,274				19,274		Slope
Other soils and land types			4,819		7,228		7,228		19,275		9,637		28,912		
Total			4,819	2	26,502	11	7,228	3	38,549	16	202,381	84	240,930	6	
18 Kimbrough Association															
Kimbrough gravelly loam											61,723		61,723		Soil depth
Other soils and land types			10,581				3,526		14,107		12,345		26,452		
Total			10,581	12			3,526	4	14,107	16	74,068	84	88,175	2	
19 Arvana-Amarillo															
Arvana loamy fine sand					3,028		757		3,785				3,785		AWHC;soil depth
Amarillo loamy sand			757						757				757		AWHC;texture
Other soils and land types			227		379				606		2,422		3,028		
Total			984	13	3,407	45	757	10	5,148	68	2,422	32	7,570	***	
20 Brownfield-Tivoli-Amarillo															
Brownfield fine sand					16,659				16,659				16,659		AWHC;texture;erosion
Tivoli fine sand											7,404		7,404		AWHC;texture
Amarillo loamy fine sand			2,778		2,775				5,553				5,553		AWHC;texture
Other soils and land types					2,591		2,221		4,812		2,592		7,404		
Total			2,778	8	22,025	59	2,221	6	27,024	73	9,996	27	37,020	1	
Grand Total	388,030	10	592,363	16	555,897	14	200,724	5	1,737,014	45	2,163,786	55	3,900,800	100	

*Percentages are of associations except Grand Total which is percent of county

**Abbreviation for available water-holding capacity

***Less than 0.5 percent

generally of sufficient size to merit consideration for irrigation. The suitability of lands in Reakor-Upton association for irrigation is reflected in the land classification as about 58 percent in class 1; 7 percent in class 2; 4 percent in class 3; 1 percent in class 4; and 30 percent in class 6.

The Reagan-Elfrida-Conger association (number 13) is also dominated by land in irrigation land classes 1 and 2. Approximately 83 percent of the land in this association has been classified as irrigable, and on the basis of soils there is a potential for expansion of irrigation. However, unlike 1 and 2, a considerable part of the land in this unit occurs as relatively small and irregular shaped tracts interspersed with non-irrigable lands of associations 12 and 14. The cost and difficulty of transporting irrigation water to these small and isolated tracts will undoubtedly place some restrictions on their use for this purpose.

The Elfrida-Pima-Bigetty association, which occurs in valley bottoms adjacent to the larger intermittent drainages, also contains a high percentage (85 percent) of land classified as suitable for irrigation. Much of the land in this association was placed in irrigation land class 2 because of a flooding and drainage hazard. In addition, a part of the lands in this unit occur as small tracts in narrow and meandering valley bottoms which will undoubtedly tend to place some restrictions on their use for irrigation. Regardless of these limitations, there is a good potential for expansion of irrigation, particularly on those lands of this unit that occur in close association with the irrigable lands of association 1 and 2.

The Redona-Canez-Douro (No. 9) and La Lande-Alama-Lacita (No. 10) associations, which occur closely associated in the northeastern part of the county, are dominated by soils suitable for irrigation. Approximately 88 percent of the land in these two associations has been classified as suitable for irrigation. In the Redona-Canez-Douro association, about 56 percent of the land is in class 2; 21 percent in class 3; 14 percent in class 1; and the remaining 9 percent is non-irrigable, or in class 6. The percentage distribution of land classes in the La Lande-Alama-Lacita association is similar, as 49 percent is in class 2; 33 percent class 3; 3 percent class 4; and the remaining 15 percent in class 6, or non-irrigable. The irrigable land in these two associations, which is dominantly in land classes 2 and 3, has slight to moderate limitations for use under irrigation. The land surface is usually undulating and sloping, so they will require considerable leveling and land preparation before they can be profitably used for irrigation.

The Berino-Pintura-Pajarito (No. 7), Jalmar-Tivoli-Faskin (No. 11), Arvana-Amarillo (19), and Brownfield-Tivoli-Amarillo were also combined on the irrigation land classification map (figure 2) because of similarity in the percentages of land in each of the land classes. Although 60 percent of the land in these four soil associations has been classified as suitable for irrigation, it is not as well adapted to this use as the irrigable land in the six previously discussed soil associations. The soils which have moderate to severe limitations for use under irrigation are dominantly in class 3, with small amounts in classes 4 and 2. The surface of these lands is generally uneven, hummocky, or so sloping that they will require considerable land leveling and land preparation before they can be profitably used for irrigation. In addition to the hummocky and uneven topography, the soils of this association have a low to moderate moisture-retention capacity, and a moderate to severe wind-erosion hazard. The extremely sandy soils of the Pintura and Tivoli series are in land class 6 because of their low moisture-retention capacity and high wind-erosion hazard. Rough broken and stony land, soils shallow over caliche, and active duneland account for most of the other land included in class 6. These are commonly interspersed with the lands suitable for irrigation, and will tend to limit the size of tracts that can be developed for irrigation.

The Arno-Harkey association occupies flood plains and low-lying positions along the Pecos River and its tributaries. The soils in this association are, therefore, susceptible to accumulation of salts and development of unfavorable drainage conditions. Because of these problems or those inherent in the irrigation of these soils, the opportunity for any significant increase of irrigated land in this association is very limited. Most of the small acreage of class 1 is already under irrigation.

Approximately 40 percent of the land in the La Lande-Ima-Gypsumland association has been classified as irrigable. The La Lande and Ima soils, which account for most of the land classified as suitable for irrigation, were placed dominantly in land classes 4 and 3 because of slope, erosion, and unevenness of the land surface. These irrigable lands will require considerable soil conditioning and land leveling for irrigation. In addition to the relatively low capability of the lands classified as suitable for irrigation, they commonly occur intermingled with extensive areas of class 6 land. These factors will undoubtedly tend to place severe restrictions on the use of the lands in this association for irrigation.

In the remaining eight soil associations, the percentage of irrigable land ranges from little or

none in soil associations 12 and 14 to about 24 percent in soil association 6. The opportunity for any significant expansion of irrigated land is very limited or nonexistent, primarily because the soils classified as suitable for irrigation are often in small tracts and widely scattered in large areas of non-irrigable lands.

The suitability of the potential irrigable land in Chaves County compares favorably with that in the adjoining counties of southeastern New Mexico. Of the 1,737,000 acres of land considered suitable for irrigation, about 22 percent is class 1, 34 percent class 2, 32 percent class 3, and 12 percent class 4.

Suitability Of Soils For Engineering And Related Uses

In this section information is provided on engineering properties and uses of soils as construction material and as a support for various kinds of structures. The information provided is in tabular form and in accordance with soil associations shown on the small-scale soil map (figure 1). Selected engineering properties, engineering classifications, and estimates on the suitability of soils for specified engineering uses are indicated for the major soils in each soil association. This correlation of engineering data and soil properties according to soil associations or general soil areas can be useful in estimating the suitability of certain areas for engineering purposes. The information on general soil problems, limitations, and hazards can also be helpful in the selection of areas for various engineering structures or practices.

The data presented here will not eliminate the need for on-site sampling and testing of sites for design and construction of specific engineering works and uses. This is particularly true at those sites of specific engineering works involving heavy loads or where excavations are deeper than the soil depths reported here. In addition, the general soil map does not delineate or specifically show the location of the individual kinds of soil.

The general soil map is useful, however, for planning more detailed investigations and for suggesting the kinds of problems that may be expected in each of the soil associations.

Engineering Soil Groups and Estimated Soil Properties

Estimates of selected soil properties and engineering groups of importance in engineering are given in table 6. Information taken from the detailed soil surveys, knowledge of the soil types of the county, and a limited amount of laboratory test data were used as a basis for making these estimates.

A brief explanation of some of the terms used in table 6 follows:

The "USDA texture" is determined by the relative proportions of sand, silt, and clay in the soil mass. It is the standard procedure used by the U.S. Department of Agriculture to classify soils according to texture.

Highway engineers generally classify soil materials in accordance with the system approved by the American Association of State Highway Officials.[7] In this system (AASHO), classification is based on the gradation, liquid limit, and plasticity index of the soil. Highway performance has been related to this system of classification. All soil materials are classified in seven principal groups. The groups range from A-1 (gravelly soils of high bearing capacity, the best soils for subgrades) to A-7 (clay soils having low strength when wet, the poorest soils for subgrades).

Many engineers prefer to use the Unified soil classification system established by the Waterways Experiment Station, Corps of Engineers.[8] This system is based on identification of soils according to their texture and plasticity and their performance as engineering construction materials. Soil materials are identified as coarse grained (8 classes), fine grained (6 classes), or highly organic.

The estimated percentage of soil material passing sieves No. 4, No. 10 and No. 200 is in the columns headed by these sieve numbers. The percentage of material as given reflects the normal range for the soil series, and most soils within a series will fall within the range indicated.

Permeability as indicated in table 6 relates to the rate water moves through undisturbed and uncompacted soil. The estimates are based on the texture, structure, and porosity of the soil.

[7] American Association of State Highway Officials, 1955 Standard Specifications for Highway Materials and Methods of Sampling and Testing. Ed. 7, part 1, 257 pp., illus.

[8] Waterways Experiment Station, Corps of Engineers. 1953 the Unified Soil Classification System. Tech. Memo. 3-357. 2 V. and appendix .

Table 6. Engineering soil groups and estimated soil properties, Chaves County, New Mexico

Soil Map Symbol and Soil Association	Depth from Surface	Classification			Percentage Passing Sieve-- No. 4 (4.7mm)	No. 10 (2.0mm)	No. 200 (0.074mm)	Range in Permeability	Shrink-swell Potential
		USDA texture	Unified	AASHO					
	in.							in/hr	
1 Reakor-Reeves-Elfrida									
Reakor	0-28	Loam	ML-CL	A-4	100	95-100	60-75	0.63-2.00	Low
	28-60	Clay loam	CL	A-6	100	100	65-80	0.20-0.63	Low to moderate
Reeves	0-8	Loam	ML-CL	A-4	100	100	55-70	0.63-2.00	Low
	8-32	Light clay loam	CL or ML-CL	A-6 or A-4	100	100	60-75	0.63-2.00	Low to moderate
Elfrida	0-12	Silt loam	ML-CL	A-4	100	100	65-85	0.63-2.00	Low
	12-60	Silty clay loam	CL	A-6	100	100	70-95	0.20-0.63	Moderate
2 Reakor-Upton									
Reakor	0-28	Loam	ML-CL	A-4	100	95-100	60-75	0.63-2.00	Low
	28-60	Clay loam	CL	A-6	100	100	65-80	0.20-0.63	Low to moderate
Upton	0-9	Gravelly loam	SM	A-4	75-85	60-85	25-45	2.00-6.30	Low
3 Arno-Harkey									
Arno	0-14	Silty clay loam	CL	A-6	100	100	85-95	<0.20	Moderate
	14-60+	Silty clay	CH	A-7	100	100	85-95	<0.20	High
Harkey	0-60	Very fine sandy loam and loam	ML or ML-CL	A-4	100	95-100	50-75	0.63-2.00	Low to moderate
Anthony	0-15	Sandy loam	SM	A-2	100	100	20-35	2.00-6.30	Low
	15-60	Stratified sandy loam and loamy sand	SM	A-2	95-100	95-100	10-30	2.00-6.30	Low
4 Elfrida-Pima-Bigetty									
Elfrida	(See association 1)								
Pima	0-30	Clay loam	CL	A-6	100	100	70-80	0.20-0.63	Moderate
	30-60	Stratified loams and fine sandy loams	ML	A-4	100	95-100	40-75	0.63-2.00	Low
Bigetty	0-45	Silty clay loam	CL	A-6 or A-7	100	100	85-95	0.20-0.63	Moderate to high
	45-60	Clay loam	CL	A-6	100	100	70-80	0.20-0.63	Moderate
5 Reeves-Holloman-Gypsumland									
Reeves	0-8	Loam	ML-CL	A-4	100	100	55-70	0.63-2.00	Low
	8-32	Light clay loam	CL or ML-CL	A-6 or A-4	100	100	60-75	0.63-2.00	Low to moderate
Holloman	0-9	Loam	ML-CL	A-4	100	100	60-75	0.63-2.00	Low
	9+	Gypsiferous earth							
5 Upton-Simona									
Upton	0-9	Gravelly loam	SM	A-4	75-85	60-85	25-45	2.00-5.00	Low
	9+	Indurated caliche							
Simona	0-15	Fine sandy loam	SM	A-4 or A-2	90-100	80-90	30-55	2.00-6.30	Low
	15+	Caliche; upper part strongly cemented							
7 Berino-Pintura-Pajarito									
Berino	0-12	Loamy fine sand	SM	A-2	100	100	15-30	2.00-6.30	Low
	12-36	Sandy clay loam	SC	A-6	100	100	35-55	0.63-2.00	Low to moderate
	36+	More than 15% CaCo3							
Pintura	0-60	Fine sand	SM	A-2-4	100	100	10-30	>6.30	Low
Pajarito	0-10	Loamy fine sand	SM	A-2	95-100	95-100	15-30	2.00-6.30	Low
	10-60	Fine sandy loam	SM	A-4	95-100	95-100	35-50	2.00-6.30	Low
8 La Lande-Ima-Gypsumland									
La Lande	0-9	Loam	ML	A-4	100	100	60-85	0.63-2.00	Low
	9-22	Heavy loam	CL	A-6	100	100	85-95	0.63-2.00	Low to moderate
	22-60	Loam	ML	A-4	95-100	95-100	60-95	0.63-2.00	Low
Ima	0-45	Fine sandy loam	SM	A-2-4	100	100	30-45	2.00-6.30	Low
	45-60	Sandy loam	SM	A-2-4	100	100	20-40	2.00-6.30	Low

Table 6. Continued

Soil Map Symbol and Soil Association	Depth from Surface	Classification			Percentage Passing Sieve--			Range in Permeability	Shrink-swell Potential
		USDA texture	Unified	AASHO	No. 4 (4.7mm)	No. 10 (2.0mm)	No. 200 (0.074mm)		
	in.							in/hr	
9 Redona-Canez-Douro									
Redona	0-10	Fine sandy loam	SM	A-4	100	100	40-60	2.00-6.30	Low
	10-30	Sandy clay loam	SC	A-6 or A-4	100	100	45-65	0.63-2.00	Low to moderate
	30-60	Light clay loam	CL	A-6 or A-4	100	100	50-65	0.63-2.00	Low
Canez	0-8	Fine sandy loam	SM	A-4	100	100	35-55	2.00-6.30	Low
	8-24	Sandy clay loam	SC	A-6 or A-4	100	100	45-65	0.63-2.00	Low to moderate
	24-60	Light sandy clay loam	SC	A-4 or A-6	100	100	35-65	0.63-2.00	Low
Douro	0-10	*Loamy fine sand*	SM	A-2	100	100	15-30	2.00-6.30	Low
	10-30	Sandy clay loam	SC	A-6	100	100	35-55	0.63-2.00	Low to moderate
	30+	Indurated caliche							
10 La Lande-Alama-Lacita									
La Lande	(See association 8)								
Alama	0-6	Silt loam	ML	A-4	100	100	70-90	0.63-2.00	Low
	6-28	Light silty clay loam	CL	A-6	100	100	80-95	0.20-0.63	Moderate
	28-60	Silt loam	ML	A-4	100	100	60-80	0.20-0.63	Low
Lacita	0-24	Loam	ML	A-4	100	100	65-90	0.20-2.00	Low
	24-60	Heavy silt loam	ML or CL	A-4 or A-6	100	100	75-95	0.20-0.63	Low to moderate
11 Jalmar-Tivoli-Faskin									
Jalmar	0-24	Fine sand	SM	A-2	100	100	10-20	>6.30	Low
	24-50	Sandy clay loam	SC	A-6	100	100	35-55	0.63-2.00	Low to moderate
Tivoli	0-60	Fine sand	SP or SM-SP	A-3	100	100	5-15	>6.30	Low
Faskin	0-10	Fine sandy loam	SM	A-4	100	100	40-60	2.00-6.30	Low
	10-40	Sandy clay loam	SC	A-6	100	100	40-55	0.63-2.00	Low to moderate
	40-60	Light sandy clay loam	SC or CL	A-6	100	100	40-70	0.63-2.00	Low
12 Ector-Conger									
Ector	0-6	Stony loam	GM	A-4	55-80*	50-75*	35-50*	0.63-2.00	Low
	6+	Limestone bedrock							
Conger	0-9	Gravelly loam	SM	A-4	75-85*	60-85*	25-45*	0.63-2.00	Low
	9+	Indurated caliche							
13 Reagan-Elfrida-Conger									
Reagan	0-26	Loam	ML-CL	A-4	100	100	60-75	0.63-2.00	Low
	26-60	Clay loam	CL	A-6	100	100	65-85	0.20-0.63	Low to moderate
Elfrida	0-12	Silt loam	ML-CL	A-4	100	100	65-85	0.63-2.00	Low
	12-60	Silty clay loam	CL	A-6	100	100	70-95	0.20-0.63	Moderate
Conger	0-9	Gravelly loam	SM	A-4	75-85*	60-85*	35-50*	0.63-2.00	Low
	9+	Indurated caliche							
14 Ector-Limestone Rockland									
Ector	0-6	Stony loam	GM	A-4	55-80*	50-75*	35-50*	0.63-2.00	Low
	6+	Limestone bedrock							
Limestone rockland	(A miscellaneous land type - no estimates made)								
15 Deama-Pastura-Manzano									
Deama	0-9	Cobbly loam	GM or GC	A-4	50-70*	45-65*	35-50*	0.63-2.00	Low
	9+	Limestone bedrock							
Pastura	0-9	Loam	ML	A-4	65-80*	60-75*	50-65*	0.63-2.00	Low
	9+	Indurated caliche							
Manzano	0-12	Loam	ML	A-4	100	100	60-80	0.63-2.00	Low
	12-50	Light clay loam	CL	A-6	100	100	70-95	0.20-0.63	Moderate

Table 6. Continued

Soil Map Symbol and Soil Association	Depth from Surface	Classification			Percentage Passing Sieve-- No. 4 (4.7mm)	No. 10 (2.0mm)	No. 200 (0.074mm)	Range in Permeability	Shrink-swell Potential
		USDA texture	Unified	AASHO					
	in.							in/hr	
16 Gypsumland									
Shallow gypsiferous soils	0-9	Loam	ML-CL	A-4	100	100	60-75	0.63-2.00	Low
	9+	Gypsiferous earth							
Moderately deep gypsiferous soils	0-8	Loam	ML-CL	A-4	100	100	55-70	0.63-2.00	Low
	8-32	Light clay loam	CL or ML-CL	A-6 or A-4	100	100	60-75	0.63-2.00	Low to moderate
17 Deama-Limestone Rockland									
Deama	0-9	Cobbly loam	GM or GC	A-4	50-70*	45-65*	35-50*	0.63-2.00	Low
	9+	Limestone bedrock							
Limestone rockland	(A miscellaneous land type - no estimates made)								
18 Kimbrough									
Kimbrough	0-6	Gravelly loam	ML	A-2 or A-4	75-85*	70-85*	20-45*	0.63-2.00	Low
	6+	Indurated caliche							
Arvana	0-6	Fine sandy loam	SM	A-4	100	100	40-55	2.00-6.30	Low
	6-28	Sandy clay loam	SC	A-6	100	100	40-55	0.63-2.00	Low to moderate
	28+	Indurated caliche							
Lea	0-10	Loam	ML-CL	A-4	100	100	55-70	0.63-2.00	Low
	10-26	Heavy loam	CL	A-4	100	100	60-75	0.63-2.00	Low to moderate
	26+	Indurated caliche							
Stegall	0-9	Loam	ML or CL	A-4	100	100	60-80	0.63-2.00	Low
	9-30	Heavy clay loam	CL	A-6	100	100	65-80	0.20-0.63	Moderate
	30+	Indurated caliche							
19 Arvana-Amarillo									
Arvana	0-8	Loamy fine sand	SM	A-2	100	100	15-30	2.00-6.30	Low
	8-28	Sandy clay loam	SC	A-6	100	100	40-55	0.63-2.00	Low to moderate
	28+	Indurated caliche							
Amarillo	0-10	Loamy fine sand	SM	A-2-4	100	100	15-30	2.00-6.30	Low
	10-36	Sandy clay loam	SC	A-6	100	100	40-55	0.63-2.00	Low to moderate
	36-50	Light sandy clay loam		A-6 or A-4	100	100	35-55	0.63-2.00	Low
20 Brownfield-Tivoli-Amarillo									
Brownfield	0-22	Fine sand	SM	A-2-4	100	100	10-20	>6.30	Low
	22-60	Sandy clay loam	SC	A-6	100	100	35-55	0.63-2.00	Low to moderate
Tivoli	0-60	Fine sand	SP-SM	A-3	100	100	5-15	>6.30	Low
Amarillo	(See association 19)								

*Fragments larger than 3 inches included in the estimates

Table 7. Interpretation of soil properties for engineering uses, Chaves County, New Mexico

Soil Map Symbol and Soil Association	Suitability as a Source of -- Topsoil	Suitability as a Source of -- Road fill	Degree of Limitation for Septic Tank Filter Fields	Corrosion Potential (untreated steel pipe)
1 Reakor-Reeves-Elfrida				
Reakor loam	Fair; moderately alkaline	Fair	Moderate; moderately slow to moderate permeability	Moderate
Reeves loam	Fair; moderately alkaline	Poor to fair	Moderate; gypsiferous materials at 20 to 36 inches	High
Elfrida silt loam	Fair to good; moderately alkaline and silty	Poor; plastic materials	Moderate; subject to occasional flooding; slow permeability	Moderate
2 Reakor-Upton				
Reakor loam	(See association 1)			
Upton gravelly loam	Poor; calcareous and gravelly	Fair to good; caliche at 4 to 20 inches; may require crushing	Severe; shallow to indurated caliche	Moderate
3 Arno-Harkey				
Arno silty clay loam	Poor; clayey and saline	Poor to very poor; plastic	Severe; slowly permeable; occasional flooding; possible watertable	High
Harkey very fine sandy loam	Fair; moderately alkaline	Fair	Moderate; subject to occasional flooding	Moderate
Anthony sandy loam	Poor; sandy and erodible	Good	Slight	Low
4 Elfrida-Pima-Bigetty				
Elfrida silt loam	(See association 1)			
Pima clay loam	Fair; clayey	Poor; plastic material	Severe; moderately slow permeability; subject to flooding	Moderate
Bigetty silty clay loam	Fair; clayey	Poor; plastic material moderate shrink-swell	Severe; subject to flooding; slow permeability	Moderate
5 Reeves-Holloman-Gypsumland				
Reeves loam	(See association 1)			
Holloman loam	Poor; saline and alkaline	Poor; unstable material	Severe; less than 20 inches to gypsum or gypsiferous earth	High
6 Upton-Simona				
Upton gravelly loam	Poor; calcareous and gravelly	Fair to good; caliche at 4 to 20 inches; may require crushing	Severe; shallow to indurated caliche	Moderate
Simona fine sandy loam	Poor; sandy and erodible	Fair to good; caliche may require crushing	Severe; hard caliche below 7 to 24 inches	Moderate
7 Berino-Pintura-Pajarito				
Berino loamy fine sand	Poor; sandy and erodible surface layers	Surface layers good; fair to a depth of 40 inches when mixed	Moderate; moderately permeable subsoil and substratum	Moderate
Pintura fine sand	Poor; very erodible fine sand	Good	Slight; may occur as coppice dunes over less permeable material	Low
Pajarito loamy fine sand	Poor; sandy and erodible	Good to fair	Slight; rapidly permeable	Low

Soil Features Affecting--				
		Farm ponds		
Foundation support	Highway location	Reservoir area	Embankment	Terraces, diversions contour furrows and pitting
Moderate to low shrink-swell; fair bearing capacity and shear strength	Unstable at high moisture content	Moderately slow permeability below 30 inches; may need compaction	Calcareous material; difficult to vetetate	Difficult to vegetate; fairly stable if compacted
Poor to fair bearing capacity and shear strength; moderate shrink-swell	Gypsiferous materials at 20 to 36 inches	Poor; subject to seepage; solution holes and crevices	Limited material; gypsiferous material at 20 to 40 inches	Gypsiferous materials
Fair to poor bearing capacity and shear strength; moderate shrink-swell	Subject to occasional flooding; moderately plastic materials	**	Fair stability; subject to some cracking	Clayey material; difficult to vegetate
Good bearing capacity	Hard caliche at 4 to 20 inches	*	*	*
Poor bearing capacity; high shrink-swell; poor to fair shear strength	Subject to flooding; unstable when wet; high shrink-swell	Generally no adverse soil features; occasional gypsum strata or sandy strata may permit some seepage	Clayey material; subject to cracking; low stability	High shrink-swell; low stability; subject to cracking
Fair bearing capacity and shear strength	Occasional seep and saline areas; low to moderate shrink-swell	Moderately permeable; may require compaction	Calcareous material; difficult to vegetate	Stable if compacted; calcareous material
Good if confined	Erodible when exposed on embankments	Rapidly permeable; subject to seepage	Sandy material; erodible and difficult to vegetate	Erodible and permeable
Fair bearing capacity and shear strength; moderate shrink-swell	Subject to occasional flooding	**	Fair stability; subject to some cracking	**
Moderate to high shrink-swell; fair bearing capacity	Subject to occasional flooding; plastic material	**	Fair stability; subject to cracking	Clayey material
Poor bearing capacity and shear strength; gypsiferous material within 20 inches of surface	Gypsum or gypsiferous earth at 4 to 20 inches; unstable material	*	*	*
Good bearing capacity	Hard caliche at 4 to 20 inches	*	*	*
Good bearing capacity; indurated caliche at 7 to 24 inches	Hard caliche at 7 to 24 inches; sandy surface material very erodible	*	*	*
Good bearing capacity and shear strength	Erodible on exposed embankments; other soil features favorable	Moderately permeable	Erodible; fair stability when mixed and compacted	Surface layers erodible; fair stability when mixed with subsoil material and compacted
Good if confined	Erodible sand; hummocky; some blowing and drifting sand	Very permeable*	Porous; erodible and unstable	*
Good if confined	Erodible when exposed on embankments; some drifting sand	Porous and permeable material	Sandy and porous material; highly erodible	*

Table 7. Continued

Soil Map Symbol and Soil Association	Suitability as a Source of -- Topsoil	Road fill	Degree of Limitation for Septic Tank Filter Fields	Corrosion Potential (untreated steel pipe)
8 La Lande-Ima-Gypsumland				
La Lande loam	Fair;erodible	Fair	Slight to moderate; moderately permeable	Moderate
Ima fine sandy loam	Poor; sandy and erodible	Good to fair	Slight	Low
Gypsumland	(A miscellaneous land type - no interpretations made)			
9 Redona-Canez-Douro				
Redona fine sandy loam	Fair; moderately sandy and erodible	Fair; low to moderate shrink-swell	Slight to moderate; moderately permeable	Moderate
Canez fine sandy loam	Fair; moderately sandy and erodible	Fair; low to moderate shrink-swell	Moderate; moderately permeable	Moderate
Douro loamy fine sand	Poor; sandy and erodible	Fair	Severe; indurated caliche at a depth of 20 to 36 inches	Moderate
10 La Lande-Alama-Lacita				
La Lande loam	(See association 8)			
Alama silt loam	Fair to a depth of 6 to 10 inches; silty and erodible	Poor	Severe; slow permeability	Moderate
Lacita loam	Poor to fair; silty and erodible	Fair	Moderate to severe; occasional overflow; moderately slow permeability	Moderate
11 Jalmar-Tivoli-Faskin				
Jalmar fine sand	Poor; very erodible fine sand	Good to 24 inches; fair 24 to 60 inches	Moderate; moderately permeable below 24 inches	Low
Tivoli fine sand	Poor; very sandy and erodible	Good if soil binder added	Slight	Low
Faskin fine sandy loam	Fair; moderately sandy and erodible	Fair	Moderate to slight; moderately permeable	Low to moderate
12 Ector-Conger				
Ector stony loam	Poor; high content of gravel and cobble	Fair; amount of material very limited	Severe; shallow to limestone bedrock	Moderate
Conger gravelly loam	Poor; calcareous and gravelly	Fair; caliche within 20 inches; may require crushing	Severe; shallow to indurated caliche	Moderate
13 Reagan-Elfrida-Conger				
Reagan loam	Fair; moderately alkaline	Fair	Moderate; permeability moderate	Moderate
Elfrida silt loam	Fair to good; moderately alkaline and silty	Poor; plastic materials	Moderate; subject to occasional flooding; slow permeability	Moderate
Conger gravelly loam	(See association 12)			
14 Ector-Limestone Rockland				
Ector stony loam	Poor; high content of gravel and cobble	Fair; amount of material very limited	Severe; shallow to limestone bedrock	Moderate
Limestone rockland	(A miscellaneous land type)			

Soil Features Affecting --				
		Farm ponds		
Foundation support	Highway location	Reservoir area	Embankment	Terraces, diversions contour furrows and pitting
Fair bearing capacity and shear strength	Gently to strongly sloping	Subject to seepage; moderately permeable	Fairly stable; medium to high compressibility	Undulating topography; channels subject to siltation
Good bearing capacity and fair shear strength	Erodible when exposed on embankments; some drifting sand	Permeable material; subject to seepage	Sandy and erodible material; fair stability when compacted	*
Good bearing capacity and shear strength	Surface layers sandy and erodible; slight to moderately plastic subsoil	Subject to seepage; may require compaction	Fair stability when compacted	Surface layers subject to wind erosion
Good bearing capacity; low to moderate shrink-swell	Surface layers subject to wind erosion; subsoil slight to moderately plastic	Moderately permeable; will require compaction	Fairly stable if compacted	Surface layers subject to wind erosion
Indurated caliche at 20 to 36 inches; good bearing capacity	Indurated caliche at a depth of less than 3 feet	Moderately permeable; subject to seepage if caliche is exposed	Depth to caliche limits amount of borrow material	Indurated caliche at 20 to 36 inches
Poor to fair bearing capacity and shear strength	Silty and erodible materials when exposed on embankments	**	Poor to fair compaction characteristics; erodible	Silty material; slow permeability
Fair to poor bearing capacity and shear strength	Highly erosive when exposed on embankments; subject to occasional flooding; gullies	Moderately slow permeability; requires compaction	Erodible; unstable material; difficult to vegetate	Unstable embankments; channels subject to siltation
Good bearing capacity and shear strength; may be necessary to confine surface layers	Surface layers to a depth of 24 inches	Very permeable to 24 inches; moderately permeable 24 to 60 inches	Erodible and unstable materials; porous to a depth of 24 inches	*
Good if confined	Erodible; hummocky; blowing and drifting sand	Very permeable*	Porous; erodible and unstable*	*
Good to fair bearing capacity and shear strength	Surface layers erodible; slight to medium plasticity	Moderately permeable; may require compaction	Fair stability if compacted	Surface layers sandy and subject to wind erosion; moderately permeable
Good; limestone bedrock at 4 to 20 inches	Shallow to limestone bedrock; steep slopes and hilly topography	*	*	*
Good bearing capacity; low shrink-swell	Indurated caliche within a depth of 20 inches	*	*	*
Fair bearing capacity and shear strength	**	Moderately slow permeability below 30 inches; may need compaction	Calcareous material; difficult to vegetate	Difficult to vegetate; fairly stable if compacted
Fair to poor bearing capacity and shear strength; moderate shrink-swell	Subject to occasional flooding; moderately plastic materials	**	Fair stability; subject to some cracking	Clayey material; difficult to vegetate
Good; limestone bedrock at 4 to 20 inches	Shallow to limestone bedrock; steep slopes and hilly topography	*	*	*

Table 7. Continued

Soil Map Symbol and Soil Association	Suitability as a Source of -- Topsoil	Road fill	Degree of Limitation for Septic Tank Filter Fields	Corrosion Potential (untreated steel pipe)
15 Deama-Pastura-Manzano				
Deama cobbly loam	Poor; high content of cobble	Fair; amount of material very limited	Severe; shallow to limestone bedrock	Moderate
Pastura gravelly loam	Poor; thin surface layer with caliche fragments	Fair; limited material unless caliche is crushed	Severe; very shallow to cemented caliche	Moderate
Manzano loam	Good to a depth of 8 to 12 inches	Fair to poor; moderately plastic	Moderate; slow permeability; occasional flooding	Moderate
16 Gypsum Land				
Shallow gypsiferous soils	Poor; saline and alkaline	Poor; unstable material	Severe; less than 20 inches to gypsum or gypsiferous earth	High
Moderately deep gypsiferous soils	Fair; moderately alkaline	Poor to fair	Moderate; gypsiferous materials at 20 to 36 inches	High
17 Deama-Limestone Rockland				
Deama cobbly loam	Poor; high content of cobble	Fair; amount of material very limited	Severe; shallow to limestone bedrock	Moderate
Limestone rockland	(A miscellaneous land type - no interpretations made)			
18 Kimbrough				
Kimbrough gravelly loam	Poor; excessive caliche fragments	Fair; material very limited	Severe; indurated caliche at 4 to 20 inches	Moderate
Arvana fine sandy loam	Fair; moderately sandy and erodible	Fair	Severe; indurated caliche at depth less than 3 feet	Moderate
Lea loam	Upper 8 to 10 inches good	Fair	Severe; indurated caliche at 20 to 40 inches	Moderate
Stegall loam	Upper 6 to 10 inches good	Poor; moderate shrink-swell	Severe; indurated caliche at 20 to 40 inches	Moderate
19 Arvana-Amarillo				
Arvana loamy fine sand	Poor; sandy and erodible	Fair	Severe; indurated caliche at depth less than 3 feet	Moderate
Amarillo loamy fine sand	Poor; sandy and erodible	Good to depth of 10 inches; fair below	Slight to moderate; moderately permeable	Moderate
20 Brownfield-Tivoli-Amarillo				
Brownfield fine sand	Poor; very sandy and erodible	Good to a depth of 2 feet; fair below	Moderate; moderately permeable substratum	Moderate
Tivoli fine sand	Poor; very sandy and erodible	Good if soil binder added	Slight	Low
Amarillo loamy fine sand	(See association 19)			

*Unsuitable or practice not applicable
**Soil features favorable

Soil Features Affecting--				
		Farm ponds		
Foundation support	Highway location	Reservoir area	Embankment	Terraces, diversions contour furrows and pitting
Good; limestone bedrock at 4 to 20 inches	Shallow to limestone bedrock; gently to strongly sloping	*	*	*
Shallow to indurated caliche with good bearing capacity	Shallow to cemented caliche	Subject to seepage; shallow to caliche	Very limited material	*
Fair bearing capacity and shear strength; moderate shrink-swell	Occasional flooding moderately plastic material	**	Fair to good stability	Features generally favorable; occasional deep gully
Poor bearing capacity and shear strength; gypsiferous material within 20 inches of surface	Gypsum or gypsiferous earth 4 to 20 inches; unstable material	*	*	*
Poor to fair bearing capacity and shear strength; moderate shrink-swell	Gypsiferous materials at 20 to 36 inches	Poor; subject to seepage; solution holes and crevices	Limited material; gypsiferous material at 20 to 36 inches	Gypsiferous materials
Good; limestone bedrock at 4 to 20 inches	Shallow to limestone bedrock; gently to strongly sloping	*	*	*
Good; indurated caliche at 4 to 20 inches	Indurated caliche at 4 to 20 inches; limited borrow material	*	*	*
Indurated caliche at 20 to 36 inches	Indurated caliche at depth of less than 3 feet	Moderately permeable; subject to seepage if caliche is exposed	Fair stability if compacted; material limited	Surface layers subject to wind erosion; moderately deep to caliche
Indurated caliche at 20 to 36 inches; material above caliche has fair bearing capacity and shear strength	Indurated caliche at 2 to 3 feet	Moderately permeable; subject to seepage if indurated caliche is exposed	Fair to good stability; limited amount of borrow material	Borrow materials limited by depth to caliche
Indurated caliche at 20 to 40 inches; material above caliche has fair bearing capacity and shear strength	Indurated caliche at 20 to 40 inches; moderate shrink-swell	Slow permeability; subject to seepage if caliche is exposed	Fair to good stability; limited amount of borrow materials	Borrow materials limited by depth to caliche
Indurated caliche at 20 to 36 inches	Indurated caliche at depth of less than 3 feet	Moderately permeable; subject to seepage if caliche is exposed	Fair stability if compacted; material limited	Surface layers subject to wind erosion; moderately deep to caliche
Good bearing capacity and shear strength	Surface layers erodible; slightly to moderately plastic subsoil	Subject to seepage; requires compaction	Surface layer sandy and permeable; subsoil material has fair stability if compacted	*
Good bearing capacity and shear strength; surface layers erodible	Erodible when exposed on embankments; some drifting sand	Surface layers very sandy; subject to seepage	Sandy material; erodible	Sandy materials subject to wind erosion
Good if confined	Erodible; hummocky; blowing and drifting sand	Very permeable*	Porous; erodible and unstable*	*

Shrink-swell potential is an indication of the volume change to be expected of the soil material with changes in moisture content. Shrinking and swelling of soils cause much damage to building foundations, roads, and other structures. A high shrink-swell potential indicates hazards to the maintenance of structures constructed in, on, or with such materials.

Engineering Interpretations

Table 7 indicates the relative suitability of soils to support various structures, to serve as construction materials for highways, farm facilities, and other engineering structures, to absorb sewage effluent, and to serve for other engineering purposes. Also listed are soil features or properties that might present difficulties or affect such uses. Although soil features restricting the use of soils for various engineering structures are emphasized, favorable soil features may also be listed. The ratings and other interpretations in this table are based on the estimated soil properties for engineering uses as listed in table 6, on available test data, and field experience.

Topsoil is a term used to designate a fertile soil or soil material of favorable texture, structure, and organic matter content used as a topdressing for lawns, roadbanks, and various other engineering structures. The ratings of poor, fair, or good indicate the general suitability of the surface soil layers for such use.

Suitability ratings of poor, fair, or good for road fill are given for the major soils in each soil association. The ratings are based on the performance of the soil material when excavated and used as borrow for highway subgrade.

Sewage filter fields are affected mainly by permeability, depth to water table, depth to bedrock or indurated caliche, and susceptibility to flooding. The degree of limitations and principal reasons for assigning moderate or severe limitations are given.

A corrosion potential of low, moderate, or high is indicated for the major soils in each soil association. Corrosivity, as used here, indicates the potential danger of uncoated steel pipe to corrode or become weakened through chemical action. Among the features considered in rating corrosion potential are soil drainage, presence of soluble salts, and frequency of wetting and drying. The texture, structure, and porosity of the soil are also important because of their effect on aeration, moisture-holding capacity, and movement of water.

In the remainder of the columns in table 7 are given the major soil features or properties that affect the use of a soil for specified purposes. For example, under the column headed "Foundation Support" are listed those features of the undisturbed soil that influence its capacity to support low buildings with normal foundation loads. Although specific values of bearing capacity and shear strength are not assigned, general values are indicated.

Highway location is influenced by features of the undisturbed soil that affect construction and maintenance of highways. The soil features considered include the depth to bedrock and caliche, the content of stones and rocks, the suitability for embankments, susceptibility to overflow, erodibility, stability, ease of excavation and hauling, salinity, plasticity, and topography. The more common soil features affecting highway construction and maintenance are listed in the column headed "Highway Location".

The soil features that affect seepage or loss of water from excavated reservoir sites are those considered under farm pond reservoir areas. The permeability, depth to bedrock or caliche, and possibility of exposing porous strata are some of the items listed.

Farm pond embankments serve as dams. The major soil features, of both subsoil and substratum, that are of importance in the use of soils for constructing embankments are considered.

Terraces and diversions are low structures designed to retain or direct water. Pitting, chiseling, and contour furrowing serve to loosen the soil and retain water from rainfall and snow melt. The intake rate, permeability, stability of clods, and the use of the soil material for embankments are the soil features considered.

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