University of Texas Bulletin

No. 1819: April 1, 1918

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By

D. D. Christner and O. C. Wheeler

ROADS OF TERRELL COUNTY

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BUREAU OF ECONOMIC GEOLOGY AND TECHNOLOGY
DIVISION OF ECONOMIC GEOLOGY
J. A. Udden, Director of the Bureau and Head of the Division

Published by the University six times a month and entered as second-class matter at the postoffice at AUSTIN, TEXAS

Publications of the University of Texas

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B324-1118-3M

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The benefits of education and of useful knowledge, generally diffused through a community, are essential to the preservation of a free government.

Sam Houston

Cultivated mind is the guardian genius of democracy. . . . It is the only dictator that freemen acknowledge and the only security that freemen desire.

Mirabeau B. Lamar

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THE GEOLOGY OF TERRELL COUNTY

By
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INTRODUCTION

Terrell County covers an area of 2,265 square miles. Pecos County forms its northern boundary, Crockett and Val Verde counties the eastern, the Rio Grande River the southern, and Brewster and Pecos counties the western boundary. The length of the southern boundary, formed by the Rio Grande River, is about thirty-nine miles.

The population of Terrell County, according to the 13th U. S. Census report of 1910, was 1,430. The only towns are Sanderson and Dryden. Sanderson, the county-seat, contains about 80 per cent of the population of the county. The Galveston, Harrisburg and San Antonio Railway runs from east to west across the county through Dryden and Sanderson.

The land in Terrell County is used almost exclusively for stock-raising. There are possibly 150 acres of irrigated land along the Pecos River that is under cultivation. Cattle, sheep and goats range over the entire county. Goat-raising seems to be more profitable than cattle- or sheep-raising.

PHYSIOGRAPHY

Relief

The main topographic feature of the county in general consists of the high plains, broken by long, flat-topped ridges and cut by deep canyons. The character of these high plains changes with the formations.

In the country covered by the Edwards limestone, the plains are interrupted by long ridges and wide canyons. These ridges are generally almost flat on top, but there are high places at some few points on the ridges which constitute a divide between one canyon and another. These high places usually form the

head of a small canyon on one side of the divide. Probably the highest one of these divides in the county is what is known as "Big Hill," nine miles north of Sanderson on the Sheffield road. The deepest canyon in the Edwards in this county is the one cut by the Rio Grande River at the Nichols pump. The Pecos River cuts a channel 510 feet deep in the Edwards limestone near the Banner ranch.

The small area covered by the Buda limestone is smooth or very gently rolling, with occasional low ridges and hills.

That part of the county which is covered by the Eagle Ford shales is characterized by conical hills jutting up above the surrounding country, and by long, flat-topped buttes and mesas. One of these conical hills near the Paso Verde Cable on the Rio Grande measured 260 feet above the base. The sides of the canyons that cut through the Eagle Ford are almost perpendicular in the places where the shales are thickest.

The valleys of the Pecos River and of the Rio Grande lie between precipitous cliffs. At the Nichols pump, the Rio Grande has cut a narrow canyon 610 feet deep in the Edwards limestone. Farther down the river, however, the depth decreases until at the Paso Verde Cable and at the Shafter Crossing, it measures only thirty feet. The banks are pendicular even along the lower course of the river near the Terrell-Val Verde county boundary line. The valley gradually widens from west to east as the banks of the river become lower. The Pecos River valley is encased by high, steep ledges of Edwards limestone ranging from 220 feet near Sheffield to 510 feet near the Banner ranch. The cliffs of the Pecos River and of the Rio Grande are unbroken except in those places where a canyon opens into them.

Precipitation

Probably the best available records of the annual precipitation for this part of the country are to be obtained from the records of the United States Weather Bureau, kept at Fort Stockton, Eagle Pass, and El Paso.

From El Paso east along the Rio Grande to the Gulf of Mexico the rainfall steadily increases. Terrell County is about half-way between Fort Stockton and Eagle Pass, and about

one-third of the way between El Paso and Eagle Pass. Since the annual precipitation at Fort Stockton is 15.2 inches and at Eagle Pass is 21 inches, the annual precipitation of Terrell County would be between 17 and 18 inches. On a map of the Rio Grande drainage basin which shows the lines of equal rainfall, the 17-inch line runs straight southwest to northeast across the county just north of Sanderson.

Below is shown a table giving the average annual rainfall at El Paso, Fort Stockton, and Eagle Pass, and the length of time covered by the observations on which these averages are based in each case. This table is taken from Water Supply Paper No. 58 of the United States Geological Survey, page 22.

TABLE SHOWING THE AVERAGE ANNUAL PRECIPITATION AT EL PASO, FORT STOCKTON, AND EAGLE PASS

Station	Length of record Years	Average annual rainfall inches
El Paso	50	9.1
Fort Stockton	30	15.2
Eagle Pass	34	21.0

DRAINAGE

The general direction of all streams and canyons in Terrell County is southeast; those in the northern part running east-southeast and emptying into the Pecos River, those in the southern part running south-southeast and emptying into the Rio Grande. The county is drained altogether by streams flowing in long, deep canyons. All the largest canyons in the county empty into the Pecos. Lozier Canyon drains more territory than any other single canyon in the county. The only running streams in the county are Independence and Richland creeks, which are fed by strong springs a few miles above their mouths. Because of the great amount of territory drained by the large canyons and because of the occasional sudden cloudbursts, the canyons sometimes become very dangerous for a few hours after a heavy downpour of rain.

The Water Discharge of the Pecos River

The following table, showing the amount of water in the Pecos River for a period of fourteen years, was compiled from data secured from Water Supply Paper No. 358, of the United States Geological Survey, pages 359 and 360. The United States section of the International Water Commission maintains a station at Moorehead, Texas, for the purpose of measuring the discharge of the Pecos River, and the material in the above mentioned paper was taken from reports submitted by the Director of this station.

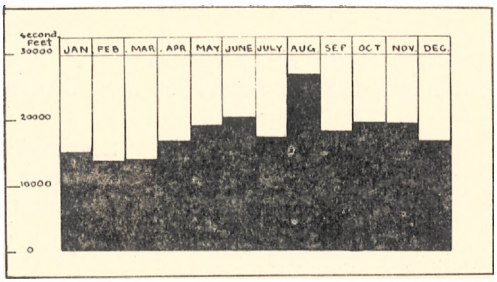

Fig. 1. Diagram showing average monthly discharge of the Pecos River at Moorehead. Based on measurements taken by the U. S. Geological Survey during the years 1900-1913. Averages are given in second-feet.

The small diagram shows, graphically, the average monthly discharge of the Pecos River for the period of 1900-1913.

The period of time covered by the larger table is from 1900-1913. The measurements for January, February, March, and April cover a period of fourteen years, from 1900-1913, inclusive. Those for May, June, July, August and September cover a period of thirteen years, from 1901-1913, inclusive, while the measurements for October, November and December cover a period of thirteen years, from 1900-1912, inclusive.

DISCHARGE MEASUREMENTS OF PECOS RIVER AT MOOREHEAD, TEXAS, FROM 1900 TO 1913

Measurements given in second-feet

Month	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	Total	Average monthly discharge
January	------	15,748	20,925	16,244	6,324	18,755	25,730	17,794	23,777	13,144	9,641	7,440	9,393	9,455	194,370	14,951*
February	------	17,264	16,652	15,260	5,829	21,616	21,812	16,660	16,037	6,468	8,512	13,020	8,178	7,252	174,560	13,428*
March	------	13,733	13,051	14,973	5,270	41,974	17,205	15,376	12,524	9,145	8,029	8,680	8,370	7,440	175,770	13,520*
April	------	22,890	9,180	12,330	7,320	3,960	50,040	14,940	13,120	7,350	8,100	25,620	8,640	31,830	215,320	16,563*
May	25,296	11,788	19,840	11,408	10,292	52,111	20,832	13,051	11,129	9,114	8,370	18,290	5,797	46,779	264,097	18,864†
June	25,290	9,630	9,570	30,330	52,290	52,350	24,870	12,450	10,110	8,910	5,700	8,220	6,120	25,440	228,930	20,091†
July	17,205	10,571	27,435	17,112	15,066	33,088	26,319	10,044	32,643	12,431	5,332	7,006	5,053	20,925	240,230	17,159†
August	15,407	21,328	33,294	6,758	7,533	81,127	112,910	7,525	22,289	15,717	12,152	26,877	4,526	8,184	375,627	26,830†
September	29,160	7,950	20,340	9,120	53,070	28,140	19,230	7,170	26,670	11,700	6,960	7,290	4,200	23,130	254,220	18,158†
October	46,841	17,391	13,330	5,983	74,289	19,096	16,709	18,414	12,679	8,742	12,989	7,750	3,286	------	257,499	19,807‡
November	24,870	43,050	12,750	6,570	45,990	20,100	15,750	43,830	11,520	9,390	8,820	7,260	6,210	------	256,110	19,700‡
December	15,159	24,490	12,834	7,285	24,655	37,820	22,010	26,937	10,757	11,780	7,161	8,959	8,773	------	218,610	16,816‡

*From 1901-1913, inclusive.
†From 1900-1913, inclusive.
‡From 1900-1912, inclusive.

Soils and Vegetation

The soils of Terrell County are mostly poor and very thin, in comparison with soils in other parts of the state. They are composed mainly of Pleistocene materials and are underlain by solid masses of limestone. The soils are thinnest on the uplands, where they are prevented from accumulating by the sheet-water floods; and deepest in the canyons where they are carried down and deposited by the drainage from the surrounding country. There are many large areas where no soil can accumulate on account of the floods, and where the surface consists of bare ledges of limestone. The best soils in this region are in Pecos River valley and in the canyons in the northern part of the county.

Vegetation is scarce in Terrell County, both on account of the poor soil and on account of the scanty rainfall. With the exception of the vegetation along the Pecos River, the best in the county is found in Independence Canyon, Downie Canyon, and on the uplands near the Terrell-Brewster County boundary line along the Shepbaugh ranch road, southeast of Sanderson. Vegetation, especially grass, is in general markedly better in the northern and central sections of the county than in the southern. The only trees of any size are found in the north part of the county near Independence, Richland, and Geddes springs, where a few moderately large oak, hackberry, and cedar trees grow. There is practically no grass growing on the Eagle Ford formation. One peculiar fact is that cedars were observed growing on the Buda and Edwards limestones, but nowhere were they seen on the Eagle Ford.

The vegetation in the canyons consists of oaks, willows, cedars, walnuts, Mexican persimmons, hackberries, mesquites, sagebrush, and grass. The higher ridges and plateaus are covered with sotol, sage brush, mesquite, lechuguilla, yucca, various species of cacti, rare guayule, cedar bushes, Spanish daggers, and sparsely scattered patches of grass.

GEOLOGY

Stratigraphy

It is known from investigations made to the west of this region and from two deep explorations made in this county,

that the Pennsylvanian underlies the Cretaceous formations. The rocks which are naturally exposed in this area belong to the Cretaceous age. They are concealed only in a few places by later deposits. The Comanchean Cretaceous formations exposed in the county consist of the Devil's River limestone, the Del Rio clay, and the Buda limestone. The Eagle Ford is the only Upper Cretaceous formation found in the county. The stratigraphic succession is as indicated in the following table:

Age of deposits	Nature of Material
Pleistocene	Silt, sand, gravel
Cretaceous	
Upper, Eagle Ford	Flaggy limestone
Comanchean	
Buda	Fine-grained limestone
Del Rio	Clay and sandstone
Devil's River	
Georgetown	Fine-grained limestone
Edwards	Coarse limestone
Walnut	Soft limestone
Pennsylvanian	Shale, sandstone and limestone

The Pennsylvanian

The Pennsylvanian is known only from some cuttings submitted by Mr. Charles Downie of Sanderson, Texas. Some of these were taken from a boring made at the foot of a hill in Downie Canyon, ten miles due north of Sanderson on Survey 21, in Block M. M. These cuttings came from a depth of 720 feet below the surface. They consisted of gray sand and black shale. The sand was nearly all angular and consisted of grains mostly measuring from one-eighth to one-half millimeter in diameter. Scales of mica were present. There were also some fragments of green shale. The degree of induration of the shale, the mica present, the absence of calcareous material in the shale, its color and aspect generally, were such as to make the recognition of the cuttings as coming from the Tesnus formation practically certain, in the opinion of Dr. Udden, who made the examination.

Some other cuttings were taken from a well a few miles east from Downie's Ranch, and located in the same canyon. These are, as near as it could be ascertained, from about 800 feet below

the surface. These have been examined by Mr. V. V. Waite, who describes them as follows:

"One sample consists of black shale, gray to black limestone, and some fragments of light yellow, pink and very light gray limestone, the latter probably having come down from above the main rocks represented in the sample. Much chert and pyrite and some mica present. When heated in closed tube, the shale and the limestone give strong fumes of bitumen and ammonia. In one thin section, the dark limestone is seen to be somewhat crystalline; and in another, many sponge spicules lay in a matrix of partly crystalline and partly granular material which was impregnated with bituminous material. The matrix has many very minute dark specks. Another sample of cuttings from about the same depth in this boring consisted mostly of black shale and of dark gray to black limestone. There was also some light gray and some black chert, with some pyrite. Some minute spherical concretions of black pyrite were noted. The shale as well as the limestone resemble those in the other sample in thin section, and under heat. The general aspect of these cuttings makes it probable that they are from the Dimple formation."

The Devil's River Limestone

The Devil's River limestone is here used to include all exposed Cretaceous formations underlying the Del Rio clay. This classification is used for convenience. All of the Comanchean Cretaceous exposed in this part of the state underlying the Del Rio clay is limestone, and the time at our disposal in the field was too limited to permit any subdivision of this formation. It is known to include equivalents of the Georgetown, the Edwards and the Walnut Clay in north-central Texas.

This formation covers more than one-half the total area of Terrell County. The limestone varies in degree of induration from hard, massive limestone to soft, chalky, easily crumbling material. The soft layers are few and perhaps limited in extent. The part corresponding to the Edwards apparently makes up the bulk of the Devil's River formation exposed in this county. It is easily recognized by its characteristic weathering into steep bluffs. Many layers and nodules of flint are found in this part of the section. A freshly broken surface of the limestone has a light-grayish, crystalline appearance. In the southern part of the county, especially near the Stencil and the

Elders ranches, there are many small nodules of hematite found in the limestone. The thickest exposures of the Devil's River in the county are along the Rio Grande. At the Nichols pump the cliffs composed of this limestone are slightly more than 600 feet high, and at the Banner ranch on the Pecos River, the cliffs carved out of the same formation measure 510 feet. Of the fossils observed, *Pectens* and *Gryphaeas* were the most common. Near the top of the Edwards, such echinoids as *Epiaster* and *Enallaster,* various ammonoids, and *Trigonias* were observed.

Immediately overlying the part corresponding to the Edwards, is a white limestone of very fine texture. This without doubt represents the Georgetown formation. It shows in many places an obscurely nodular structure. The Georgetown is present all over the county immediately under the Buda or the Del Rio, where the latter is present. The best exposure seen of the contact between the Georgetown and the Edwards was about a quarter of a mile south of the Elders ranch house. Here the Georgetown is approximately fifty feet thick. A horizon probably corresponding to the Walnut Clay was noted in some of the ravines in the northwest part of the county.

The Del Rio Clay

The Del Rio clay outcrops in a limited area around Dryden and more extensively on some hills west of the Nichols ranch near the Rio Grande, where it measures at least forty feet in thickness. It is not now, and probably never was, one continuous stratum extending over the entire area. It gradually thins out and disappears between the Buda and the Georgetown when followed for some distance in any direction. On the north bank of Dryden canyon, just north of the town of Dryden, the Del Rio can be seen between the Georgetown and the Buda, gradually thinning out toward the east until it finally disappears about 100 yards from the road. The thickest part of the clay here is about nine feet. In this locality the Del Rio is a soft, loose, brownish-yellow clay, full of *Exogyra arietina.* Other outcrops of the clay with the same lithologic and paleontologic characteristics are found a short distance west of Dry-

den on the Sanderson road, at the foot of a low ridge of Buda limestone. Different in characteristics from the soft clay around Dryden is an outcrop of hard and somewhat calcareous and sandy thin-bedded rock occurring west of the Nichols ranch on the road to the Nichols pump. Here the deposit forms several long ridges between 25 and 30 feet high. Some layers of this rock show ripple marks, indicating that the water was shallow at the time that the formation was deposited. An abundance of the fossil *Nodosaria texana* was found in this locality.

The Buda Limestone

The Buda limestone outcrops in a broad belt about twenty miles wide, running in a northeast-southwest direction across the country. The northern limit of this belt runs through Dryden and crosses the Rio Grande near the Bone Watering crossing. In the southeastern parts of the county this formation occurs in the beds and walls of the canyons. Here the contact line between the Buda and the Eagle Ford formations is very sharp and pronounced. Near the northern limit of its exposure the Buda is found forming low hills and gently rolling tablelands.

The upper part of the Buda consists of three or four layers of very hard and massive limestone, each two or three feet thick. The lower part of the formation is thicker-bedded and contains occasional thin layers of shale and clay. The best exposure observed was on the Rio Grande at the Paso Verde cable, where the Buda forms perpendicular walls thirty feet high.

The fossils found and identified in the Buda were: *Pecten roemeri,* several species of *Grypheas,* a *Vola,* and a gastropod.

The Upper Cretaceous

The Eagle Ford Formation

Immediately overlying the Buda limestone which is the uppermost formation of the Comanchean or Lower Cretaceous, is the Eagle Ford, the lowest formation of the Upper Cretaceous. The best exposure of the Eagle Ford occurs about four miles up Lozier Canyon from the Rio Grande, where it forms a perpen-

dicular cliff 310 feet high. This formation consists in the main of thinly bedded layers of impure limestone and some marly and sandy, shaly clay.

At the base, the Eagle Ford contains beds of marly and bituminous shale. These basal layers are usually black and when broken open, yield a very strong odor of oil and gas. These black shaly beds continue upward for about twenty feet, and then merge into more calcareous layers of a lighter color with less of the oil and gas odor. The characteristic color of the upper portion of this formation is a cream yellow. The division line between the yellow flags above and the darker more shaly layers below, may, in some places, be followed for miles on the surface. The lighter color of the upper layers is due to the weathering. A freshly exposed surface has the darker color of the lower layers.

Some layers of this formation are sandy while others are impure limestone. Usually there are thin seams of very soft and easily eroded shales separating the harder flaggy layers. In the upper portion some of the beds consist of a dull white limestone. The thickest layers of this formation measure in most cases less than one foot.

In the upper part of the Eagle Ford a thin seam or layer of bentonite was observed. In several thin layers of this formation, 126 feet above the base, small networks of lines resembling frost-cracks were found. One of the most uniform characteristics of the Eagle Ford noted in this county was its jointing. The rocks always break up into rectangular blocks of three unequal dimensions. They are considerably longer than they are wide, and wider than they are thick. Some blocks were noted which were several feet long, three or four inches wide, and one or two inches thick.

In nearly all horizons of the Eagle Ford, an abundance of Inoceramı and fish scales were found. These occur evidently at all horizons in the formation.

The Pleistocene

The Pleistocene consists mainly of clay, sand, gravel, boulders, and flint from the Edwards limestone. It is confined

mostly to the canyons, where it is deposited by the drainage. Wherever accumulations of such material are found outside the canyons, they are only a few feet in thickness. In most places outside the canyons no Pleistocene material accumulates. Bare ledges of limestone form the surface of the land. The deepest known Pleistocene deposit is in the Downie Canyon. Near the north side of the canyon at the Downie well, drilled in 1918, 225 feet of Pleistocene deposits were encountered above the Edwards limestone. At the Courthouse well in Sanderson Canyon, 212 feet of Pleistocene was found overlying the Edwards. Evidently these canyons were here much deeper in early Pleistocene times than they are at present. Near the mouths of these canyons where they empty into the Rio Grande, practically no recent deposit is found.

Structure

The general dip of the formations in this region is from northwest to southeast. Thus we find the deepest exposures of the Devil's River formation in the northwestern part of the county. To the southeast it is overlain by the Del Rio clay, the Buda limestone, and the Eagle Ford shales. The latter formation attains a maximum thickness of 310 feet in the southeastern part of the county, in Lozier Canyon, four miles from the Rio Grande. The average dip of the strata is approximately forty-five feet to the mile to the southeast.

It has been found from observations made to the west of Terrell County, that there exists an unconformity between the Pennsylvanian and the Comanchean Cretaceous formations. Any folding of the Pennsylvanian that may have taken place during the time represented by this unconformity is now buried by the overlying Cretaceous formation.

In an area so near to the Marathon disturbance it is quite natural to expect that anticlines and synclines exist in the older formations. The presumption is that any structures existing in the Pennsylvanian may also show slightly in the Cretaceous formation, since any disturbance that occurred during late Paleozoic times would be apt to continue at a decreased rate during the later Cretaceous periods. In any case, where folding began

during Pennsylvanian times, and continued into Cretaceous times, the Pennsylvanian would be folded more than the Cretaceous limestones.

About four miles east of Sanderson in Sanderson Canyon, there appears to be an anticline through which the canyon has cut its channel. In the same canyon a few miles east of Emerson, there appears to be another fold but it is less prominent than the first mentioned.

Evidence of some local minor disturbances was seen in several small areas covered by the Eagle Ford formation. About one mile west of Watkins on the south bank of Dryden canyon, the shales were seen standing on edge in a belt about 150 feet long and from 30 to 60 feet wide. The general direction of this belt was from northeast to southwest. Other evidences of small folding were observed about two and a half miles southeast of the Johnson ranch and again about a quarter mile to the west of Lozier Canyon, three miles from the Rio Grande. This fact suggests that such a condition was more than likely brought about by some force other than such as result in tectonic movements. It is probable that this tilting of the Eagle Ford was brought about by the solution of underlying rock materials by percolating waters, which formed underground caverns into which the flags have gradually settled.

The only fault seen in the course of our field work was on the Elders Ranch road in Putman Canyon, 11.6 miles south from Sanderson. The trend of this fault is from northeast to southwest. In the fault plane there occurs a vein of crystals of calcite and selenite. The displacement is only a few feet.

ECONOMIC NOTES

Water Supply

The most vital economic problem in Terrell County is that of water supply. The greater part of the annual rainfall comes as heavy local showers at irregular intervals, and flows off down the canyons. The permanent springs are limited to a very small area in the northeastern part of the county on the Pecos River.

WELLS

There are in all about seventy-five wells in the whole county. All these wells have windmills and tanks, with the exception of the railroad wells and the water well of the Southwest Texas Oil and Gas Company, which are equipped with engines. At a majority of the wells, round earth tanks or reservoirs are used for the storage of water. The windmills are allowed to run practically all the time. At a few wells, however, large rock or cement tanks are used for reservoirs.

The amount of water furnished by the wells varies from 5 to 25 gallons per minute. The quality of the water in all of these wells is excellent.

The data which have been collected on the wells of Terrell County, for brevity of statement have been tabulated below. In the table the wells have been arranged in consecutive numbers from south to north, according to their location in the county, number 1 being the well farthest south, number 2 the next well north of number 1, and so on.

In the southeast part of the county, in wells Nos. 1, 2, and 3, and also in well No. 26, located in the northern part of the county at the Free postoffice, water appears to be obtained from a layer of porous limestone in the Comanchean formation. This porus layer is about 600 feet below the surface in wells Nos. 1, 2, and 3, and 320 feet in the well at the Free postoffice. The water secured from this porous limestone is of good quality, and the amount varies from 5 to 20 gallons per minute.

The source of the water in many other wells must be left to conjecture. Some wells may have reached the basal sands of the Comanchean, which probably lie at from 600 to possibly 1800 feet below the surface. The water obtained is everywhere of good quality. The quantity of water obtained in these wells varies from 5 to 20 gallons per minute.

In a small area which begins about nine miles north of Sanderson and extends north and east a few miles beyond the Big Canyon ranch, water is probably obtained in the Pennsylvanian. From the logs of the wells in this area, Nos. 16, 20, and 21, it is believed that the Pennsylvanian here lies higher than anywhere else in the county. The log of the well at the Big

Canyon ranch house and that of Mr. Downie's well in Downie Canyon, show that after going through some 250 or 300 feet of the Lower Cretaceous, a formation consisting of dark gray sandstone, blue shale, and arenaceous clay was penetrated, which in all probability represented the Tesnus formation.

The water secured from these wells is of about the same quality and quantity as in other wells.

TABLE OF WELL DATA

No.	Location and owner	Situation	Elev. ft.	Depth ft.	Materials Penetrated	Depth in ft. From	to	Gals. per min.	Height of water	When drilled
1	Southwest Texas Oil & Gas Company. Section 148, Bl. D-7, East Line and Red River R. R.	Near creek-bed	1710 Est. 25 ft.	600	Surface soil	0-	6	20	224	1917
					Buda limestone	6-	46			
					Blue shale	46-	52			
					Blue mud	52-	55			
					Limestone	55-	70			
					Brown shale and limestone	70-	97			
					Shell limestone	97-	100			
					Shale and pyrite	100-	114			
					Shale (oil odor)	114-	121			
					Black shale, trace of oil	121-	203			
					Crystalline limestone (Edwards?)	203-	216			
					White limestone	216-	354			
					Yellow limestone	354-	388			
					Gray limestone	388-	480			
					White limestone	480-	557			
					Gray limestone	557-	566			
					Gray sandstone (gas)	566-	598			
					Gray limestone	598-	600			
					Crystalline limestone with water	600-				
2	Galveston, Harrisburg & San Antonio R. R. Dryden, Texas.	Level upland near Dryden creek	Exact 2119	1117	Surface soil	0-	7	20	442	1903
					Limestone	7-	120			
					Yellow mud	120-	145			
					Limestone	145-	604			
					Porous limestone	604-	615			
					Limestone	615-	870			
					Shale	870-	872			
					Dark gray water-sand	872-	915			
					Shell with breaks	915-	975			
					Limestone	975-	1010			
					Limestone shells	1010-	1030			
					Limestone	1030-	1050			
					White water-sand	1050-	1070			
					Limestone	1070-	1117			

TABLE OF WELL DATA—Continued

No.	Location and owner	Situation	Elev. ft.	Depth ft.	Materials Penetrated	Depth in ft. From to	Gals. per min.	Height of water	When drilled
3	Fletcher well 4 miles east of Dryden, 2 miles west of Thurston, and half mile south of railroad	On side of gently sloping hill	Est. 10 ft. 1992	664	White limestone	0- 600	8	60	old well
					Yellow sandstone	600- 605			
					Gray sandstone	605- 644			
4	F. K. Harrell, 7 miles southeast of Sanderson, on Dryden road, half mile north of Feodora Canyon	In Sanderson	Est. 10 ft. 2480	800	Edwards limestone	0- 400	5	200	1917
					Yellow sandstone	400- 440			
					Thin-bedded blue shale	440- 600			
					Cream-colored shales	600- 620			
					Blue shale	620- 650			
					Hard gray granite?	650- 670			
					Blue shale	670- 780			
					Blue mud	780- 800			
5	Cochran, two miles southeast of Sanderson, Dryden road	In Sanderson Canyon about 50 ft. above bed of creek	2690	530	Edwards limestone	0- 400	¼		1918
					Blue shale	400- 450			
					Yellow sandstone	450- 465			
					Blue shale	465- 530			
6	Galveston, Harrisburg & San Antonio Ry., Sanderson. Four wells together	On side of Sanderson Canyon, near creek bed	2820	500	Limestone	0- 130	All four wells yield 100 gals.	137	1909
					Clay and boulders	130- 145			
					Limestone	145- 315			
					Sandstone and shale	315- 380			
					Limestone, stratified	380- 405			
					Limestone	405- 460			
					Limestone and soapstone	460- 490			
					Limestone	490- 600			
11	Courthouse well, Sanderson	In Sanderson Canyon	2778	438	Clay and boulders	0- 212	5	78	1916
					Limestone	212- 360			
					Yellow sandstone	360- 400			
					Blue shale	400- 422			
					Yellow sandstone	422- 438			

TABLE OF WELL DATA—Continued

No.	Location and owner	Situation	ft. Elev.	ft. Depth	Materials Penetrated	Depth in ft. From to	Gals. per min.	Height of water	When drilled
12	Mansfield-Sanderson	In Sanderson Canyon	2778	582	Clay and boulders	0- 212	140		1917
					Limestone	212- 360			
					Yellow limestone	360- 400			
					Blue shale	400- 422			
					Yellow limestone	422- 438			
					Blue shale	438- 575			
					Gray limestone	575- 582			
13 14	Sanderson Water and Light Co., Sanderson. Two wells	In Sanderson Canyon	2790	400	No log obtainable		120 for both	350	?
15	R. H. Murrah, 2 miles from Sanderson, on railroad	On side of Sanderson Canyon	2895	642	Limestone	0- 300	20	380	1918
					Blue shale	300- 600			
					Water sand	600- 640			
16	Mr. Downie, Section 21, Block M. M.	In Downie Canyon, at foot of hill			Clay and boulders	0- 225	7		1918
					Yellow limestone	225- 297			
					Sand	297- 307			
					Pink clay	307- 314			
					Sandstone and clay	314- 342			
					Blue shale	342- 520			
					Gray sandstone	520- 741			
					Gray sandstone and black shale	741- 763			
17	Prosser & Brown Ranch, Section 82, Block 1	On side of Big Canyon		583	Limestone	0- 430	20	183	
					Blue rock	430- 510			
					Sand	516- 583			
18	Prosser & Brown, Sec. 60, Block 1	In canyon		617	Limestone	0- 370	18	292	
					Blue rock	370- 515			
					Yellow sand	515- 605			
					Blue shale	605- 817			
19	Prosser & Brown Ranch, Section 78, Block 1	In side of canyon		628	White limestone	0- 260	13	128	Old
					Blue limestone	260- 320			
					White limestone	320- 465			
					Blue rock	465- 570			
					Blue sand	570- 628			

TABLE OF WELL DATA—Continued

No.	Location and owner	Situation	Elev. ft.	Depth ft.	Materials Penetrated	Depth in ft. From	to	Gals. per min.	Height of water	When drilled
20	Big Canyon Ranch, Section 41, Block 3	In canyon valley		458	Rock and clay	0	10	14		Old
					Blue conglomerate	10	80			
					White limestone	80	120			
					Gritty red rock	120	170			
					Blue shale	170	280			
					Dark sandstone	280	320			
					Yellow sandstone	320	380			
					Sandstone and clay	380	410			
					Water sandstone	410	430			
					Red clay	430	458			
21	Big Canyon Ranch, Section 59, Block 3	In canyon valley		628	Clay and boulders	0	15	17		Old
					Limestone	15	240			
					Blue rock	240	290			
					Red rock	290	350			
					Limestone	350	520			
					Sandstone	520	628			
22	N. H. Corder, Section 1, Block 2	In Dry Creek		475	Limestone	0	367	15		Old
					Water sand	367	452			
					Soft limestone	452	475			
23	N. H. Corder, Corder Ranch headquarters	In side of low hill		510	Hard and soft limestone	0	430	10		1916
					Sandstone	430	510			
24	N. H. Corder, Section 55, Block 1	In canyon valley		559	Limestone	0	450	15		Old
					Sandstone	410	559			
25	N. H. Corder, Section 63, Block 1	In valley		400	Limestone	0	225	15		Old
					Blue shale	225	270			
					Yellow sandstone	270	320			
					Clay stone	320	389			
					Clay and sand	389	400			
26	Free postoffice well, Free, Texas	In Independence Canyon		320	White limestone	0	300	15		Old
					Gray sand	300	326			

SPRINGS

There are only six permanent springs in the county and these are situated near the Pecos River. Two of these springs are in Independence Canyon. One rises about 7½ miles from the mouth of Independence Canyon, and flows down the canyon, emptying into the Pecos River. The estimated flow is 2,500 gallons per minute. The other spring is located just back of Mr. Chandler's house at the mouth of the Independence Canyon. This spring is impounded and used by Mr. Chandler for irrigation and household purposes.

The water is of excellent quality and is clear at all times, except during periods of heavy floods.

There are two springs in the mouth of Richland Canyon. One is about three-quarters of a mile up the canyon from the Pecos River and the other is near Mr. S. F. Frank's house on the Pecos River. This latter spring is used by Mr. Frank for irrigating a small tract of land. The estimated flow of these two springs is 1,500 gallons each per minute. Samples of water from these two springs have been collected for analysis. These analyses are given below.

Two springs are located at the mouth of the Geddes Canyon close to the Pecos River. One of these springs is situated close by Mr. Banner's house, and has been impounded by him for irrigation purposes and also for household uses. The estimated flow is 2,000 gallons per minute. The other spring is about one mile from the Pecos River up the Geddes Canyon. The estimated flow of this spring is about 2,500 gallons per minute. The water from this spring flows about 50 yards down the canyon and then sinks away in a gravel bar. Mr. Banner intends to impound and use this water for irrigation also.

There is quite a number of "wet weather" springs located in the county. These springs are seeps which run during wet weather. During dry weather the water stands in small holes dug in the gravel. Meyer's spring is located about five miles northwest of Thurston. This was an old watering place for the Indians and also for General Bullis while in this part of the country fighting Indians. The remains of the old fort are still standing at this place. In Cedar Arroyo near the ranch house

of Mr. Rutledge, there is a spring. This water is the only water between the railroad and the Rio Grande with the exception of that at the oil boring. At Mr. Johnson's place on Indian Creek are several of these springs. Also in Sanderson Canyon, at Mr. Gatlin's place, is a seep spring. All these wet weather springs are found in the canyon beds or at the foot of some bluff. The old settlers in this county say that these springs heretofore have never been dry, for a period of thirty or forty years. However, this last year (1918), owing to the three years of unprecedented drouth which has afflicted nearly all of western Texas, most of these springs have dried up.

ANALYSES OF SPRING WATERS

Analysis of water from the Sulphur Springs at the mouth of Independence Canyon, one-half mile from the Pecos River. Collected by O. C. Wheeler, July 18, 1918. Analysis by J. E. Stullken, Chemist, Bureau of Economic Geology and Technology.

Total dissolved solids: 9,109 parts per million parts of water.

Basic salt components (ions)	Parts per million parts of water	Gram equivalent per 1000 liters	Acid salt components (ions)	Parts per million parts of water	Gram equivalent per 1000 liters
Aluminium ..	None	None	Carbonates ..	6.7	0.22
Iron	None	None	Bicarbonates .	99.5	1.63
Manganese ...	None	None	Sulphates ...	2750.5	57.21
Calcium	739.1	36.88	Chlorides	2852.0	80.42
Magnesium ..	119.0	9.78	Nitrates	None	None
Sodium	2133.8	92.82			
Potassium ...	None	None			
Total basic ion units..		139.48	Total acid ion units...		139.48

On partial evaporation—which occurs when the water is used for irrigation or in steam boilers—the following salts will separate from the water in the amounts and order given:

		Parts per million
(1)	Calcium carbonate (0.22 units).....	11.1
	Calcium bicarbonate (1.63 units).....	132.2
(2)	Calcium sulphate (35.02) units.....	2386.1
	Total.....	2529.4

The remaining salts are all very soluble. They amount to 6580.3 parts per million, and they could form mostly sodium chloride 4700.7 parts per million (90.42 units). From these figures it follows that the water is totally unfit for any use, and cannot, by means of any treatment, be made useful.

Analysis of water from Wolf Springs, near the ranch house of Mr. S. F. Franks, in the mouth of Richland Canyon, near the Pecos River. Collected by O. C. Wheeler, August 21, 1918. Analysis by J. E. Stullken, Chemist, Bureau of Economic Geology and Technology.

Total dissolved solids: 744 parts per million parts of water

Basic salt components (ions)	Parts per million parts of water	Gram equivalent per 1000 liters	Acid salt components (ions)	Parts per million parts of water	Gram equivalent per 1000 liters
Aluminium	None	None	Carbonates	24.5	0.82
Iron	None	None	Bicarbonates	126.7	2.08
Manganese	None	None	Sulphates	20.72	4.31
Calcium	152.8	7.62	Chlorides	128.8	3.63
Magnesium	40.7	3.35	Nitrates	8.0	0.13
Sodium	None	None			
Potassium	None	None			
Total basic ion units		10.97	Total acid ion units		10.97

On partial evaporation—which occurs when water is used for irrigation or in steam boilers—the following salts will separate from the water in the amounts and order given:

	Parts per million
Calcium carbonate (0.82 units)	40.9
Calcium bicarbonate (2.08 units)	168.4
Calcium sulphate (4.31 units)	293.6
Total	502.9

The remaining salts are all very soluble. They amount to 185.8 parts per million and they could form mostly chlorides of calcium and magnesium 176.2 parts per million (3.61 units).

The water forms hard scale in boilers (very much in proportion to its total solids), but can be made harmless by proper treatment.

It is good for irrigation. For laundry use, it needs softening. As far as the mineral content is concerned, it is good for drinking.

Analysis of water from Richland Spring, in Richland Canyon, three-fourths mile from the Pecos River. Collected by O. C. Wheeler, August 21, 1918. Analysis by J. E. Stullken, chemist, Bureau of Economic Geology and Technology.

Total dissolved solids: 8,666 parts per million parts of water.

Basic salt components (ions)	Parts per million parts of water	Gram equivalent per 1000 liters	Acid salt components (ions)	Parts per million parts of water	Gram equivalent per 1000 liters
Aluminium	None	....	Carbonates	11.1	0.37
Iron	None	....	Bicarbonates	203.6	3.34
Manganese	None	....	Sulphates	461.1	9.59
Calcium	213.2	10.66	Chlorides	None	...
Magnesium	31.7	2.64	Nitrates	None	...
Total basic ion units		13.30	Total acid ion units		13.30

On partial evaporation—which occurs when the water is used for irrigation or in steam boilers—the following salts will separate from the water in the amounts and order named:

	Parts per million
1. Calcium carbonate (0.37 units)	18.5
2. Calcium bicarbonate (3.34 units)	270.5
3. Calcium sulphate (6.95 units)	473.3
	762.3

The remaining salt, magnesium sulphate, is very soluble. It amounts to (2.64 units)=158.6 parts per million.

This water produces hard boiler scale (very much in proportion to total solids), but proper treatment will render it harmless.

It needs softening for laundry use. It is not bad for irrigation. There is nothing in its mineral content to spoil its use for drinking.

IMPOUNDED WATERS

The only other impounded waters beside the two springs mentioned above, are waters stored in "tanks" for watering stock. These tanks are constructed by making a dirt dam across the bed of some stream or canyon. The only source of supply of water for these tanks is, of course, rainfall. The length of time that water will remain in these tanks depends upon several circumstances, such as the amount of precipitation, the impervious-

ness of the rock forming the bottom of the tank, and the number of animals that water there. Generally speaking, the water stands in these tanks for a period of five or six months while some of them never go dry.

Occasionally, in the beds of the largest canyons, solution pits have been formed in the limestone. These pits are partly filled with gravel and usually contain water. Only during extremely dry weather do they dry up. These water holes are called "tinajas," a Spanish word meaning "earthern water-jar."

PUBLIC SUPPLIES

The only source of public supply of water in the county is at Sanderson. The Sanderson Water and Light Company has two wells located on the western edge of Sanderson. Water is pumped from these wells by two steam engines into a wooden tank of about 10,000 gallons capacity. At present, these two wells give 80 gallons of water per minute. However, they would give 150 gallons of water per minute with stronger pumps. These wells supply the town of Sanderson with water for household use. One mile west of Sanderson, the Galveston, Harrisburg and San Antonio Railroad owns four wells. The water is pumped from these wells by two steam engines, one 80-horsepower, and the other 100-horsepower. The water is pumped into a tank with a capacity of 350,000 gallons. The four wells together give 6,000 gallons of water per hour. The water is excellent for drinking purposes.

The Galveston, Harrisburg and San Antonio Railroad also owns two wells at Dryden. The wells are very strong and the water is pumped into a 50,000 gallon tank by means of a steam engine. An analysis of this water was furnished by the engineer of the company and is as below:

ANALYSIS OF WATER FROM DRYDEN WELL

Incrusting solids,	grains per U. S. gal.
Calcium carbonate	2.34
Calcium sulphate	1.34
Magnesium carbonate	5.73
Silicon dioxide	.87

Iron and aluminum	None
Total	10.28

Non-incrusting solids,	grains per U. S. gal.
Sodium chloride	2.30
Sodium sulphate	2.22
Total	4.52

STREAM WATERS

The only running streams in Terrell County are the Rio Grande, the Pecos River, and Independence Creek for the last 7½ miles of its course to where it empties into the Pecos River. The Rio Grande forms the southern boundary of the county. The water in Independence Creek is supplied by the spring mentioned above. The amount is estimated to be about 2,500 gallons per minute. The water in this creek is of good quality the year around. The water of the Pecos River cannot be used for drinking purposes because it contains a large amount of gypsum in solution, but it is good stock water.

The water in the Rio Grande is of good quality but it is not easily accessible, especially in the western part of the county, because the gorge through which the river runs is steep and precipitous, being about 600 feet high in places. At the old Nichols pump, a trail has been made down to the water. At all the other roads in the county, leading to the Rio Grande, are crossings for stock. No wagons can cross the river, however.

WATER TABLE

From a study of the logs of the different wells in the county it is evident that water may be obtained at almost any place in the county by drilling deep enough for it. The depth varies considerably. In the northern part of the county water is secured in a porous layer of the Edwards limestone at a depth of 320-400 feet. Farther south, this porous stratum is deeper, owing to the general dip of the rocks to the southeast. The depth of the water-bearing horizon along the railroad varies from 400 to 800 feet. Only four wells have been drilled south of the railroad,

and these wells are not more than four miles from the railroad. However, water could probably be obtained by drilling deep enough for it; probably to a depth of eight or nine hundred feet.

The difference between the level of the underground water during wet weather and the level during dry weather does not vary more than fifty feet. All the wells drilled in the county have supplied good drinking water, and, so far as is known, only one weak well has been drilled.

Structural Materials

Sand and Gravel

Gravel is found in all the canyon beds. In places these deposits are deep and in other places only a few feet in depth. This gravel is made up of the Edwards limestone and flint. The pebbles are in general well rounded. Most of the gravel is coarse and hardly any sand is found in the canyons. However, along the Pecos River and the Rio Grande large deposits of fine sand occur. The sand is mixed with silt, but along the Rio Grande, deposits of fine flour-sand are found. One of these deposits occurs at the Paso Verde cable. It occurs in the mouth of the canyon and is so white and pure that it greatly resembles snow-banks.

Nine miles west of Dryden on the Sanderson road is a mantle of old terrane gravel. This gravel contains many pebbles of quartz and other hard rocks. The deposit covers an area of about three square miles. The depth is unknown, but in a road excavation on the side of a hill the depth of the gravel was seen to be eight feet. Another deposit of this gravel occurs east of Watkins. It runs in a wide belt from a point about ten miles north of Watkins and extends almost to the Rio Grande, running in a northwest-southeast direction. The gravel is like that described above, and occurs on the hilltops and along the canyon divides. As the railroad runs in Sanderson Canyon for a considerable distance, an abundant supply of gravel could be obtained along the route and could be loaded at a switch at Feodora.

ROCK

The Edwards limestone occurs in the county in large outcrops and since it is very hard and massive, it promises an ample supply of building stone. Numerous places where it might be quarried profitably are contiguous to the railroad.

PETROLEUM

Due to the relation existing between the great oil-bearing formation, the Pennsylvanian, which immediately underlies the Comanchean, and the thick overlying Cretaceous formations, the location of a structure favorable for the accumulation of oil will always be uncertain. As has already been pointed out, it is possible that structures in the Pennsylvanian may not show in the Cretaceous. There is very little probability of there being any oil in the Comanchean. So far very little oil has been found in this formation. Chances are no doubt better in the Pennsylvanian, wherever favorable structures may exist.

Only one attempt has been made to find oil in Terrell County. At present, a well is being drilled by the Southwest Texas Oil and Gas Company, 7½ miles southeast of Watkins, and 21 miles southeast of Dryden. A seep of water that comes from a depth of 600 feet is reported to have a slight taste of oil. In all probability this comes from the Comanchean. It is reported that a strong odor of gas was encountered at a depth of 1,841 feet.

Very little is known concerning the nature of the strata penetrated in this exploration. In the summer of 1918 it was reported that the depth of 1970 feet had been reached. In November of the same year a sample of cuttings was submitted as having come from the depth of about 2600 feet. Dr. Udden, who has examined this sample, believes that it is from the Tesnus formation of the Pennsylvanian. His description of the sample is as follows:

"Dark gray silt and fine sand, with grains very rarely exceeding one-fourth mm. in diameter. All grains are angular. Considerable mica present. Effervesces very faintly and slowly in strong acid. Gives fumes of ammonia, when heated in a closed tube. With the sand are numerous dark, opaque, rounded, elongate bodies with a

smooth outer surface, varying in relative diameteral dimensions from short rod-like bodies through much-elongated, pear-shaped forms to oval and spherical bodies, with a transverse diameter of about 0.08 mm. or less, and having a maximum length of less than 0.6 mm. Some of these bodies were seen to be flat. Others showed dim constrictions of transverse segments. General aspect of the sample is that of the Tesnus of the Pennsylvanian."

So far as the present writers know, no reliable record was kept of the strata penetrated in this boring. From conversations we have had with parties who have had more or less opportunity to be informed on the matter, it would appear that there is an almost unbroken succession of Comanchean limestone down to near 650 feet. From here down some 250 feet, there are argillites and arenaceous beds, with very little limestone. Then follow some two hundred feet of limestone, and marl partly interbedded down to 1110 feet. Below this the marls become sandy, and limestone is almost absent in the section for 150 feet. From 1250 to 1400 feet there is again limestone and shale or marl, apparently alternating. From 1520 down to 1860 feet, is mostly argillite and arenaceous material. It is also reported that a conglomerate was found at about 1945 feet below the surface and this is said to have had gas. With such inadequate information it is not possible to determine the depth of the Comanchean with any certainty. It is probable that the reported conglomerate near 1945 feet is the basal Trinity. That the Comanchean at any rate extends down as far as to 1250 feet seems certain. It has also been reported to us that sands have been penetrated as follows (in feet below the surface): 632-692, 840-860, 1210-1250, 1405-1500, 1770-1800, 1855-1970; but for accurate information on the formations explored in this boring it will be necessary to await report by the drillers.

ROADS OF TERRELL COUNTY

BY O. C. WHEELER

INDEX TO THE ROADS OF TERRELL COUNTY

INTRODUCTORY

The field work in preparation for the report on the geology of Terrell County was done at the time when military activities in Texas were at their height. Recognizing the value in military operations of a clear view of the road system of our border counties, the data in the following report was compiled during the course of our geologic field work, and is presented in the following pages as part of the economic notes on Terrell County.

For the convenience of the reader, the outline of the course followed in tracing the roads of the county is given below in detail. The roads are classified as county roads and ranch roads north and south of the railroad. County roads are those that are maintained by the county. Ranch roads are those that are maintained by individuals. Only four of the roads are maintained by the county. There are several roads that cannot be traversed by a motor vehicle and that are very difficult to traverse in a wagon. Such roads are marked "abandoned" on the road map.

ROADS NORTH OF THE RAILROAD

The best roads in the county are those north of the railroad. The beds of all these roads consist almost entirely of hard rock material. Most of the roads can be easily traveled in a motor vehicle, and all can be traversed in a wagon. Any of the canyons along any road might be impassable for a few hours after a heavy downpour of rain, but such downpours are infrequent.

County Roads

The courses of three of the four county roads are confined solely to north of the railroad. The road extending east and west across the county runs both north and south of the track, but since the greater part of its lies on the south side, it will be treated with the road south of the track.

Sanderson-Sheffield Road.

The Sanderson-Sheffield road is a hard rock and gravel road that can be used either for wagon or motor transportation at all seasons. The only barrier along the road is a high ridge known as Big Hill, 9.2 miles north of Sanderson, on the south side of Downie Canyon. This

hill is 470 feet high. The ridge is most difficult to climb from the north side, where the slope is considerably steeper than on the south side.

The road to Emerson leads off to the west of the Sanderson-Sheffield road about half a mile from Sanderson. The main road continues in a northwesterly direction, running up a tributary of Sanderson Canyon. An abandoned road that leads to the Carter Ranch turns off up a short canyon on the east side of the main road, three miles from Sanderson. The "3 mile" well is 0.2 mile up this branch road. The main road goes over the divide known as Big Hill 9.2 miles from Sanderson and crosses into Downie Canyon. The Downie headquarters ranch road turns off to the west of the main road at the foot of this Big Hill. A road leading to the Carter, Allen, Robertson, Kings Springs, and Eldridge ranches, and from the Eldridge Ranch to the Dryden-Sheffield road, turns off on the east side of the main road 10.8 milles from Sanderson, and runs down Downie Canyon. The main road runs out of Terrell into Pecos County a short distance beyond the Carter Ranch road. The "41 Ranch" is 15 miles from Sanderson, in Pecos County. There is a good well at this ranch house, pumping 14 gallons of water per minute. The road runs back into Terrell County near the Big Canyon Ranch, 22.3 miles north of Sanderson. There are two good wells at this ranch, each pumping from 5 to 20 gallons of water per minute. The road forks 24.7 miles from Sanderson. The north fork is a county road going to the Free Postoffice. The east road, going down Big Canyon, is the main Sheffield road. There is a small tank on the Sheffield road 28.3 miles from Sanderson. The "91 Ranch" is on this road, 32.2 miles from Sanderson. There is a good well at the house. A short distance beyond this ranch the main road turns north out of Big Canyon. The road that continues east down the canyon leads to the Dryden-Sheffield road via the Brown Ranch. A road leading to the Corder Ranch turns to the west of the main road 39.1 miles from Sanderson, and runs up Dry Creek. The last ranch along this road in Terrell County is the Mitchell Ranch, 49.8 miles from Sanderson. There is a good well at the house. The road runs down a canyon from the Mitchell Ranch into Independence Canyon, 3 miles beyond this ranch, and 52.8 miles from Sanderson. There is a road turning off down Independence Canyon that leads to the Packingham Ranch and thence to the Dryden-Sheffield road. The main road crosses Independence Canyon and continues north, running out of Terrell County about 58.5 miles from Sanderson.

Dryden-Sheffield Road

The Dryden-Sheffield road is a good road consisting mainly of dirt for the first three or four miles north of Dryden, but from that dis-

tance on to the Terrell-Pecos county boundary line, the bed is composed almost altogether of rock and gravel. Transportation can be carried on at all seasons of the year, but is somewhat difficult during wet weather over the first few miles north of Dryden. The roughest section along the course of the road is in the canyon that it follows north of Independence. There are large amounts of heavy limestone rock at all points on the road, available for repairing the bed.

The first branch roads are 5.9 miles north of Sanderson. The road on the west side goes to the Farley Ranch and to the Sanderson-Sheffield road via the Eldridge, Kings Springs, Allen, and Carter ranches. The road turning off to the east is an old abandoned road leading to the Basset Ranch, about five miles away. The main road crosses Downie Canyon 10 miles north of Dryden. The sides of the canyon have been graded at the crossing so that there is a gentle slope on either side. The Carpenter Ranch is 11.6 miles from Dryden. There is a weak well at the house. A rough road leading to the Votaw Ranch in Big Canyon turns east at the Carpenter Ranch. There is a good well at the Votaw ranch house. Crow's Nest and Cocklebur, two wells along this road, are respectively 16.8 and 20.2 miles from Dryden. A road running to the Strickland well leads off to the east of the main road 22.6 miles from Dryden. A road going to the Brown Ranch and thence to the Sanderson-Sheffield road turns off to the west of the main road 24.9 miles from Dryden. The road that goes to the Banner Ranch on the Pecos River, 16.2 miles away, turns off the Sheffield road 25.4 miles from Dryden. A rough road going to the Franks and the Trotter ranches on the Pecos, leads off to the east 28.1 miles north of Dryden.

The road runs into Dry Creek 32 miles north of Dryden. There is a road running southeast up a branch canyon to the Scott Ranch. Another road runs 2 miles up Dry Creek to the Cecil Ranch. There is a good well at the Cecil ranch house. There is another good well on the main road near the center of the creek. The Turk Ranch is on a short branch road that turns off in Dry Creek 34.4 miles from Dryden. A well pumping about 15 gallons of water per minute is located at the house. The Bean Well is on the west side of the Sheffield road about 2 miles beyond the Turk Ranch. The road runs into Independence Creek 40 miles from Dryden. After it crosses the creek bed of the canyon, there is a road leading east down the canyon to the Hicks and the Chandler ranches, 3.5 and 7.5 miles, respectively, down the canyon. There are several strong springs a short distance down the canyon from the road. The main road continues west 4.8 miles farther up the canyon, to a branch canyon that runs into Independence from the north. The Sheffield road turns north up this canyon. There is a side road that continues west up Independence to the Packingham Ranch, and from the Packingham Ranch into the Sanderson-Sheffield road. There is a road 49.2 miles from Dryden leading east to the

Johnson Ranch on the Pecos River, 3 miles beyond the Packingham road. A well is located at the fork of the two roads. The main road continues north up the canyon and runs into Pecos County about 57 miles north of Dryden.

Road to Free from the forks of the Sanderson-Sheffield and Sanderson-Free Roads, 24.7 miles from Sanderson

The road to the Free Postoffice is the best in the county. The roadbed is smooth and consists almost entirely of hard rock and gravel. It can be traveled at all seasons. The old abandoned Free road was formerly a short distance east of the present road, but is now fenced in by the Corder Ranch.

The first ranch along this road is one of the old Campbell ranches, 26.1 miles from Sanderson. There is a good well at the house. The Corder headquarters ranch house is located about a quarter mile to the east of the road 29.1 miles from Sanderson. There is a well pumping 15 gallons of water per minute at the Headquarters Ranch. The road to the Mansfield Ranch, in Independence Canyon, turns off 34.1 miles from Sanderson. The ranch is 8 miles from the main road. The ranch is equipped with a good well. A well is located about 150 yards to the left of the Free road, 36.6 miles north of Sanderson. The Free Postoffice is situated in Independence Canyon, in the extreme northwest corner of the county, 40 miles from Sanderson. The postoffice is the only house at Free. There is a 15 gallon well at the house.

Ranch Roads

Roads that are not maintained by the county are classed as ranch roads in this paper. Roads that lead to several ranches, wells, tanks, etc., will be treated as Main Ranch Roads. Those leading to a single ranch will be considered Lateral Ranch Roads.

Main Ranch Roads

Road From Watkins to Pumpville

The road from Watkins to Pumpville turns off to the east of the Watkins-Sheffield road 2.25 miles north of Watkins. The entire roadbed is composed of Eagle Ford rock material and gravel. A well called "White Hat" is situated in Lozier Canyon north of Malvado and 6.2 miles from Watkins by this road. One of the Bassett ranch houses is located on this road about 1 mile from the Terrell-Val Verde County boundary line. There is a good well at the house.

Watkins-Sheffield Road

The Watkins-Sheffield road is the one leading north out of Watkins that runs into the Dryden-Sheffield road 15.5 miles from Watkins and

9 miles north of Dryden. It is a smooth rock and gravel road that can be traveled at all seasons.

There is a small dirt tank on the east side of the road 7.7 miles from Watkins. One of the Bassett ranch houses known as "Windmill Tank" is on the west side of the road 10.3 miles from Watkins. There is a dirt tank at the house. No one lives at the house at the present time. An old abandoned road leading to the Dryden-Sheffield road turns east outside a gate just beyond "Windmill Tank." This old road can be traveled in a wagon but not in a car. A well known as "Paint Mare" is on the main Watkins-Sheffield road 13 miles from Watkins. The Watkins-Sheffield road meets the Dryden-Sheffield road, 15.5 miles from Watkins and 9 miles from Dryden.

Road Connecting the Sanderson-Sheffield and the Dryden-Sheffield Road

This is a road that branches off the former road 10.85 miles north of Sanderson and runs into the latter 5.9 miles north of Dryden. This is a good road, leading past several ranches and wells. The road bed consists of gravel, clay, boulders, and bare layers of limestone. The road turns east down Downie Canyon 10.85 miles north of Dryden. It is impossible to get out of the canyon except in those places where there are roads leading out.

The first two wells along the road belong to Mr. Downie. The first well is 1.4 miles down the road, and the second is 4 miles beyond the first. The first Carter well along this road is 7.2 miles from the Sanderson-Sheffield road. The second Carter well is at the first Carter ranch house, 10 miles from the Sanderson-Sheffield road. All these wells pump from 10 to 15 gallons of water per minute. There is a branch road leading to the second Carter ranch house that turns off to the right of this main road about 2.8 miles beyond the first house. The first Robertson well is 5 miles beyond the first Carter ranch house on the main road. It is a good, strong well. At a place 0.6 mile beyond the first Robertson well, the main road turns east. The road that continues north leads to the Robertson ranch house, about 4 miles away. The main road turns east and goes via the Allen ranch house, about 5.5 miles from the place where the Robertson road branches off. There is a well at the Allen ranch house which pumps from 15 to 20 gallons of water per minute. The main road runs from the Allen Ranch to the Kings Springs Ranch 4 miles to the southeast. There is a good well at this house. From the Kings Springs Ranch the road continues southeast to the Eldridge Ranch, about 9 miles away. There is a branch road leading west from the Eldridge Ranch to the Farley Ranch. The main road runs into the Dryden-Sheffield road 1.5 miles southeast of the Eldridge Ranch. The point where this road meets the Dryden-Sheffield road is 5.9 miles north of Dryden.

Road from Sanderson-Sheffield to Dryden-Sheffield Road, via the Packingham Ranch

This road turns off the Sanderson-Sheffield road 52.8 miles north of Sanderson and runs down Independence Canyon. It is impossible to get out of this canyon in a vehicle at any point other than those where the road runs in and out of the canyon. The roadbed is composed of clay and gravel. The road can be traveled at all seasons. There is a well 3 miles down this road. A second well is one mile below the first. The Packingham ranch house is located 7 miles down this road from the Sanderson-Sheffield road. There is a good well at the house. This road runs into the Dryden-Sheffield road 1.4 miles beyond the Packingham house.

Lateral Roads

Road to the Second Carter Ranch

The road to the second Carter Ranch runs down Downie Canyon. It is a smooth, gravel road that can easily be traveled during all seasons. A vehicle cannot get out of the canyon at any place along the side. This road turns to the right off the road between the first Carter Ranch and the Allen Ranch, about 2.8 miles beyond the former ranch. There are two good wells along this road. The first is about five miles from the place where the road turns off the main road. The second well is about 3.5 miles beyond the first. There is also another well at the second Carter Ranch house, about 8 miles down this road.

Road leading to the First Carter Ranch via the "3-mile Well"

This road turns off the Sanderson-Sheffield road 3 miles north of Sanderson. The first three miles of the road are good, but the remainder of the road is so rough that it cannot be traversed by a motor vehicle. It is almost impossible to travel the road in a wagon. There are several rough steep hills that make the road practically useless. This road is marked "abandoned" on the map.

Roads to the Votaw Ranch

There are two roads leading to the Votaw ranch. One turns east off the Dryden-Sheffield road at the Carpenter Ranch, 11.6 miles north of Dryden. The other turns east off the same road a short distance beyond "Crow's Nest." Both of these roads are difficult to travel, but the one that leads off at the Carpenter Ranch is the one that is always used. The other that turns off near "Crow's Nest" is marked abandoned. This abandoned road leads past a tank, two miles from the

main road, and also past one of the Carpenter wells and the Heaton well, about 5.5 miles from the main road. The road that turns off at the Carpenter Ranch is the better, and the more direct road to the Votaw Ranch. The house is situated in Lozier Canyon, 7 miles from the Carpenter Ranch. There is a good well at the house. A Mexican family lives at the house.

Road from the Campbell 91 Ranch on the Sanderson-Sheffield Road to the Dryden-Sheffield Road via the Brown Ranch

This road turns off to the east of the Sanderson-Sheffield Road a short distance beyond the Campbell 91 Ranch and runs down Big Canyon. It is a good, smooth gravel road. The Brown Ranch house is about 9 miles east of the Campbell 91 Ranch. A road leading to the Scott Ranch and from the Scott Ranch to the Dryden-Sheffield road, turns north a few miles beyond the Brown Ranch. There is a well about five miles beyond the Brown Ranch on the main road. Another road leading to the Scott Ranch turns off this road about 1.5 miles from the Dryden-Sheffield road. The main road from the Sanderson-Sheffield road runs into the Dryden-Sheffield road 24.9 miles north of Dryden.

Road to the Scott Ranch

The road to the Scott Ranch turns north off the Brown Ranch road, about 1.5 miles from the Dryden-Sheffield road. It is a good rock and gravel road, and is smooth except in the place where it goes down into a canyon, three miles from the house. The road can be easily traveled at all seasons. There is a plenty of heavy rock material available for repairs. One of the Scott wells is on this road, about five miles from the Sheffield road. There is a road from the Brown Ranch that meets this road about six miles from the Dryden-Sheffield road. The Scott road runs down the head of a canyon and follows the canyon to the Scott house, 3 miles away. There is a good well at the house. The road continues northeast from the house and runs back into the Dryden-Sheffield road in Dry Creek, 32 miles north of Dryden.

Road to the Corder Ranch in Dry Creek

This is a good, smooth, rock and gravel road leading up Dry Creek. There is an abundance of heavy rock material available in the canyon for repairing the roadbed. The road can be traveled during any season of the year. It is impossible to get out of this canyon in any vehicle except by following the road.

This road turns off the Sanderson-Sheffield road 39.1 miles from Sanderson.

There is a good well on this road half a mile from the Sheffield road. At this well there is a cement reservior and a long cement

trough for watering stock. There is another good well at the Corder ranch house, 5½ miles up the creek from the Sheffield road. A road leads from this Corder Ranch to the Corder Headquarters Ranch, about 8 miles away.

Road to the Hicks and Chandler Ranches on Independence Creek

This road runs east down the north side of Independence Creek. There is no place along the side of this canyon where a vehicle can get out. It is a good smooth road that can be traveled during wet or dry weather. There is an ample supply of gravel in Independence Creek that is available for the repair of its bed.

The Hicks Ranch is 3.5 miles down this road. There is a good strong spring at the house. The Chandler Ranch is 7.5 miles down this road at the mouth of Independence in the Pecos River valley.

Road to the Trotter and Franks ranches in Richland Canyon.

The road to the Trotter and the Franks ranches turns off to the east of the Dryden-Sheffield road 28.1 miles north of Dryden. The road to these ranches is rough and difficult to travel. The roadbed is composed of bare ledges of limestone and large boulders. The road runs into Richland Canyon about 3.5 miles from the Sheffield road, and follows the canyon to the Pecos River. The only place a vehicle can get out of this canyon is by following the present road.

The Trotter Ranch is located 14 miles down this road. Richland Springs rise a short distance below the house. The Franks ranch house is located at the mouth of Richland Canyon, 17.1 miles from the Sheffield Road. Wolf Springs rise at the Franks ranch house.

Road to the Banner Ranch on the Pecos River

The road to the Banner Ranch is very rough. The roadbed is made of heavy limestone and loose boulders. The road runs into Main Geddes Canyon about 5.5 miles from the Sheffield road and follows the canyon to the Pecos River. It is impossible to get out of this canyon in a vehicle at any place along the side of the canyon.

An abandoned road from Strickland well to the Trotter and Franks ranch road, intersects this road a short distance from the head of Main Geddes Canyon. The Banner ranch house is south of the mouth of Main Geddes Canyon in the Pecos River valley. There is a strong spring at the house.

ROADS SOUTH OF THE RAILROAD

The roads south of the railroad are the roughest in the county. All can be traveled at any season, but travel is very difficult over

most of them at all seasons. There is an abundance of heavy limestone rock available for road repair in the southwestern part of the county, but in the southeastern part, good repair material is not so abundant. The rocks of the Eagle Ford formation, of the southeast, form poor roadbeds as they are easily cut up and washed out by rains. There is some gravel to be found in the canyons in this section of the county, and also some massive Buda limestone, but the latter is difficult to procure.

County Roads

East and West County Road

The road running east and west across the county via Dryden and Sanderson, is the only county highway south of the railroad. This road lies on the north side of the track for a distance of 18.8 miles. It crosses from the south to the north side of the track 11.3 miles east of Sanderson, and continues 7.5 miles west of Sanderson, where it crosses under the track and extends to the Pecos County boundary line. The total length of the road is approximately 54.8 miles. The roadbed consists mainly of hard rock, gravel, and soft dirt. The section of this road that lies west of Sanderson is composed mostly of dirt material. The part of the road between Sanderson and the place where the road crosses Sanderson Canyon, is composed of gravel and bare ledges of hard limestone. From Sanderson Canyon to Dryden the roadbed consists altogether of dirt material. East of Dryden to the Val Verde County boundary line, the road is composed almost altogether of thin blocks and chips from the Eagle Ford formation. A heavy shower easily washes these blocks away, and renders the road very rough for a short time.

West of Sanderson, this road turns off the Sanderson-Sheffield road about half a mile from Sanderson and continues down Sanderson Canyon into Pecos County. The R. H. Murrah Ranch is located near this road on the south side of the railroad, 2 miles west of Sanderson. The Murrah well is on the north side of the track between the track and the road. Gavilan, a siding on the railroad, is 3.9 miles from Sanderson. The total length of the siding is 3,147 feet. A road running through the Downie Ranch turns to the north a short distance from Gavilan and runs back into this road 7.4 miles from Sanderson near the railroad bridge. A ranch house belonging to Mr. Charles Downie, and a well known as the "Six mile well" are six miles west of Sanderson, on this road. The road crosses under the railroad track 7.5 miles from Sanderson. Emerson, a station, is located 7.8 miles west of Sanderson. There is a siding at this station 2,670 feet long. A small dirt tank is situated 8.9 miles from Sanderson to the left of the road. The largest tank in the county is located 9.6 miles from Sanderson between the road and the railroad track.

Both of the tanks just mentioned belong to Mr. Chas. A. Downie. A rough road leading south to the Shepbaugh Ranch in Brewster County turns south down a canyon 9.6 miles from Sanderson. The road runs out of Terrell into Pecos County 13.2 miles west of Sanderson. The boundary line is marked on the railroad track.

The section of this road between Sanderson and Dryden follows the Sanderson Canyon for a distance of about 125 miles. The roadbed in the canyon consists mainly of gravel and small boulders. Outside the canyon, the bed is composed of dirt and clay. The road runs roughly parallel to the railroad between Sanderson and Dryden.

The Cochran Ranch is located 1.5 miles east of Sanderson on the south side of the railroad. There is a weak well at the house, pumping about one quart of water per minute. There is a road leading south to the Stencell and Elders ranches and to the Nichols pump on the Rio Grande, that turns to the south of this road 4.5 miles from Sanderson. The F. K. Harrell Ranch is located 6.5 miles from Sanderson on the north side of the road. There is a well at the house pumping 5 gallons of water per minute. The road crosses under the railroad 11.3 miles east of Sanderson and runs on the south side of the track the remainder of the distance in Terrell County. There is a small, weak well 12.45 miles from Sanderson between the road and the track. The road crosses Sanderson Canyon 12.5 miles from Sanderson near the railroad station, Mofeta. There is a siding at Mofeta 2,027 feet long. From Mofeta to Dryden, the roadbed is composed of dirt and clay. Rain makes this part of the road difficult to travel. There are several old abandoned ranch houses between Mofeta and Dryden. Dryden, a small town, is located 21 miles from Sanderson.

From Dryden, this road extends in a southeasterly direction to the Terrell-Val Verde County boundary line. The Dryden tank is about a quarter mile east of Dryden. This is the second largest tank in the county. The Doak ranch house is located 6 miles southeast of Dryden on this road. A short distance beyond the Doak Ranch, there is a road turning off to the south that leads to the Taylor Ranch, to one of the Cook Ranch roads and finally into the Johnson Ranch road. There is an old abandoned road leading to Watkins that turns off to the north of this main road about 16 miles from Dryden. A road to the Rutledge Ranch turns south about 19 miles from Dryden. There is a road from the ranch house to the Cedar Springs, which is only a short distance away in Cedar Arroyo. The well of the Southwest Texas Oil and Gas Company is situated in La Palma Creek, a short distance north of the main road, 21 miles from Dryden. The roughest part of this road in the county is between the oil well and the Terrell-Val Verde County boundary line. The road runs into Val Verde County about 30 miles from Dryden.

Ranch Roads

All roads south of the railroad are ranch roads except the road which runs east and west across the county.

Main Ranch Roads

Road to the Shepbaugh Ranch in Brewster County

This road turns south off the county road running east and west across the county 9.6 miles west of Sanderson. The road is good over the first three miles of its course, but from that distance on to the Terrell-Brewster County boundary line it is so rough that it is almost impassable. The bed consists almost altogether of bare Edwards limestone which weathers into a very rough surface. There is an abundance of heavy limestone all along the road that is available for repair material.

There is a rough road 0.7 mile down this road leading east down Putman Canyon to a small dirt tank. The tank is 5.1 miles down the canyon. Another road turns east off the main Shepbaugh ranch road about 16 miles from Sanderson and runs to a small dirt tank. The main road runs into Brewster County about 18 miles from Sanderson.

Road to Brewster County via the Stencell and Elders ranches

This road is composed of rock and gravel, but is very rough and difficult to travel in some places. The road can be used at all seasons of the year. It branches off of the Sanderson-Dryden road 4.5 miles east of Sanderson, where it turns south, goes under a railroad bridge and runs toward the Rio Grande. There is a small tank on the west side of the road half a mile from the place where it crosses under the railroad. About 4.5 miles south of the place where the road crosses under the railroad and 9 miles from Sanderson, there is a road turning off to the southeast that leads to the Nichols Pump, Bone Watering and to Paso Colorado on the Rio Grande. The main road continues south and crosses the Putman Canyon 11.6 miles from Sanderson. The Stencell Ranch is on this road, 16 miles from Sanderson. There is a small tank at the Stencell house. There is a road that turns to the east at the Stencell Ranch and runs into the road to the Nichols pump. This road is very rough and is seldom traveled. The Elders Ranch is about 19 miles from Sanderson on this Brewster County road. The Brewster County line is about 2 miles by the road from the Elders Ranch.

Road to the Nichols Pump on the Rio Grande

The road to the Nichols Pump turns off the road to the Stencell and the Elders ranches about 9 miles from Sanderson. About 13 miles from Sanderson along this road there is a bench mark of the U. S. Geological Survey on the north side of the road. The elevation at this point is 2,423 feet. There is another bench mark about 15 miles from Sanderson on this road. The elevation at this second point is 2,375 feet. Near this second bench mark, about 15 miles from Sanderson, there is a road turning off to the southeast that leads to the Bone Watering and to the Paso Colorado crossing on the Rio Grande. About 16.5 miles from Sanderson on the road to the Nichols Pump, there is a road that runs southeast to the old Nichols ranch house. No one is living at the house at the present time. About 18 miles from Sanderson along the Nichols Pump road there are several branch roads. The first road on the west side is the one that comes from the Stencell ranch. This road is very rough and is seldom used. The second road that turns west leads to the Palo Blanco Ranch about two miles away. The road leading east goes to the old Nichols Ranch. The road to the Nichols Pump continues south toward the Rio Grande.

The Nichols Pump is about 24 miles from Sanderson. There is an old engine at this place that was formerly used for pumping water out of the river. It is possible to climb down the cliffs to the water by going down the canyon on the east side of the road, but the descent is difficult and dangerous as the walls of the canyons are almost perpendicular. The distance from the top of the cliffs to the water in the river is over 600 feet. It is impossible to cross the river into Mexico at this point.

Roads from Sanderson to the Bone Watering and the Paso Colorado Crossing on the Rio Grande

These two roads form the forks of one road about 15 miles from Sanderson that turns southeast off the road to the Nichols Pump. The road going to Bone Watering and to the Paso Colorado Crossing does not fork until it has run about six miles from the Nichols Pump road. The west fork of the road goes to the Bone Watering, while the east fork goes to the Paso Colorado Crossing. The roads to both of these crossings are composed of solid rock and gravel. The beds are rough and difficult to travel, but could easily be repaired and made into good roads.

The Bone Watering, as the name implies, is a watering place for stock. The break in the cliffs of the river is so narrow that it is necessary to lead horses down to the water one at a time. The height of the banks is 120 feet. It is impossible to cross the river at this place.

The fork of the road that goes to the Paso Colorado Crossing is somewhat rougher than the Bone Watering road. There are three bench marks along this road that are set two miles apart. The elevations recorded by each bench mark are successively as follows, going in the direction of the river; 2,195, 2,054, and 1,928. There is a road which leads to Dryden that turns off to the north of this road about one and a half miles from the crossing. The river can be crossed at Paso Colorado only on horse. The water in the river is gradually washing the crossing deeper and deeper. The water is now so deep that a horse must swim in order to cross.

Road from Dryden to the Paso Colorado Crossing on the Rio Grande

This is a good road as far as the Gatlin Ranch, but beyond that ranch there are several places that are almost impassable. The crossings of Sanderson and Seminole canyons are extremely rough and difficult to cross. A light motor vehicle or a wagon can cross these places, but no heavy transportation can be carried on until the crossings at these canyons have been repaired. There is a plenty of good gravel and rock material in the canyons that is available, and with a little expense the bad places in the road could easily be repaired. The roadbed consists mainly of thin blocks of rock from the Eagle Ford formation.

This road turns south off the Sanderson-Dryden road, 0.8 mile from Dryden. There is a small tank to the east of this road 1.3 miles from Dryden. The road forks 3 miles from Dryden. The left fork is a good road, leading to the McClain Ranch, about 6.5 miles from Dryden. The other fork leads to the Paso Colorado Crossing on the Rio Grande via the Gatlin Ranch. The Gatlin Ranch is on this road 10 miles from Dryden. A short distance south of the Gatlin ranch house, where the road goes down into Sanderson Canyon, there is a bench mark on the side of the road. The elevation at this point is 2,017 feet. This road runs into the road from Sanderson to Paso Colorado about one and a half miles from the crossing.

Road from Dryden to the Paso Verde Cable and the Shafter Crossing on the Rio Grande

The roads to the Paso Verde Cable and to the Shafter Crossing are the forks of one road that leads south out of Dryden. The forks are 14.3 miles by the road from Dryden. The roads to each of these places are fairly good, but are very rough after a heavy rain, as the water cuts numerous small gullies in loose material from the Eagle Ford formation. The only material available for the repair of these roads is gravel and Buda limestone from the canyons and thin blocks of Eagle Ford limestone along the road side.

There are several bench marks along the road before it forks and along the road to the Paso Verde Cable. No bench marks were seen along the fork of the Shafter road. The distance of the bench marks from Dryden and the elevations are:

0.5 miles south of Dryden----------elevation 2,182 feet
2.65 miles south of Dryden----------elevation 2,179 feet
8.65 miles south of Dryden----------elevation 2,120 feet
13.45 miles south of Dryden----------elevation 1,878 feet
14.45 miles south of Dryden----------elevation 1,958 feet
19.65 miles south of Dryden----------elevation 2,000 feet

The road to Val Verde County turns to the left of this road just beyond a gate about 0.1 mile from Dryden. There is a road 8.65 miles south of Dryden leading off southeast to the Johnson Ranch, 17.5 miles from Dryden. The Miller Ranch house is 13.45 miles south of Dryden on the main road. There are two short roads leading to the house. No one is living at the house at the present time. The roads that lead to the Paso Verde Cable and to the Shafter Crossing on the Rio Grande fork 14.3 miles from Dryden. The left fork goes to Shafter crossing and the right fork to the Paso Verde Cable.

At Paso Verde, there is only a small cable which is used to transport goods across the river. It is possible to swim the river at this place and get out of the canyon on either side of the river. The banks of the river here are 30 feet high. The river cannot be crossed in a vehicle.

At Shafter, the river can be crossed horseback. Deep sand on each side of the river makes the crossing impassable in a wagon or in a motor vehicle. There are two very steep hills, one about half a mile and the other about a mile from Shafter, that are almost impossible to ascend from the south side, even in a light motor car.

Road from the well of the Southwest Texas Oil and Gas Company to Watkins

This is a good gravel road that can be traveled at all seasons of the year. The distance from the well to Watkins is about 8.5 miles. It crosses Dryden Canyon at Watkins and runs into the Watkins-Sheffield road. There is an old abandoned road from the east and west county road, that meets this road just before it runs into Dryden Canyon near Watkins. The crossing at the canyon is somewhat rough on the north side, but on the south side it is fairly good. There is ample gravel and rock material in the canyon that is available for repairing the crossing. There is a good well at Watkins.

Lateral Roads

Road to the Johnson Ranch

The road to the Johnson Ranch turns off the road south of Dryden to Paso Verde and to the Shafter Crossing 8.65 miles from Dryden.

The roadbed consists of rock from the Eagle Ford formation. The road runs down Balcony Canyon from a place about two miles east of the Paso Verde and Shafter road to the Johnson ranch house.

There is a road that runs into the main east and west county road via the Taylor ranch, turning north off the Johnson Ranch road at the head of Balcony Canyon. The Johnson ranch house is 17.5 miles from Dryden by this road. There is a small wet weather spring in Indian Creek a short distance west of the house.

Road to the Taylor Ranch

This is a good smooth road that turns off the east and west county road a short distance beyond the Doak ranch house. The Taylor Ranch is about ten miles from Dryden on this road. One of the roads to the Cooke Ranch turns east off this Taylor Ranch road a short distance south of the ranch house. The road runs into the Johnson Ranch road at the head of Balcony Canyon, about seven miles from the Johnson Ranch.

Roads to the Cooke Ranch

There are two roads to the Cooke Ranch. One turns south off the east and west county road about 15 miles southeast of Dryden, and runs almost due south to the Cooke ranch house. The other turns off the Taylor Ranch road about one mile beyond the Taylor ranch house. One of these roads is about as good as the other. Both are made of rock material from the Eagle Ford. Both roads run together about two miles north of the house. The ranch house is situated in the bottom of Cooke Canyon, about 22 miles from Dryden. It is impossible for a motor vehicle to pull out of the canyon at the ranch house. At the place where the road comes from the house of the canyon, the canyon walls are steep and measure almost 300 feet from top to bottom. No one is living at the ranch house at the present time.

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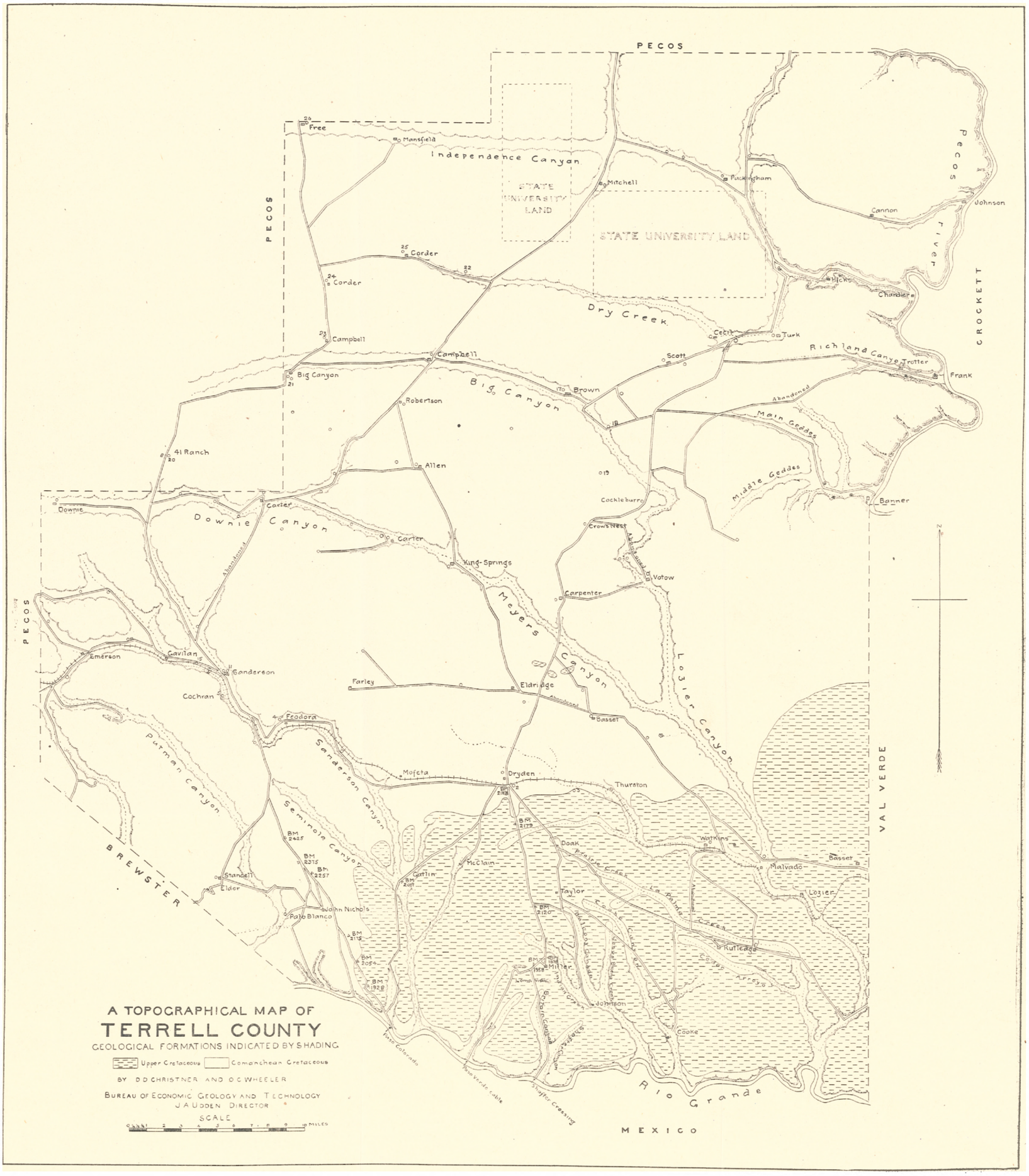
PLATES



A TOPOGRAPHICAL MAP OF
TERRELL COUNTY
GEOLOGICAL FORMATIONS INDICATED BY SHADING

Upper Cretaceous | Comanchean Cretaceous

BY D D CHRISTNER AND O C WHEELER

BUREAU OF ECONOMIC GEOLOGY AND TECHNOLOGY
J A UDDEN DIRECTOR

SCALE
0 1 2 3 4 5 6 7 8 9 10 MILES

Plate I. Topographical and geological map of Terrell County.

Plate II-A. Cliff of the Edwards limestone in the east bluff of Mangin Creek, about three miles above the junction of the Mangin and San Francisco Creeks. Looking east. Photograph by Christner.

Plate II-B. View of west bluff of Indian Creek, showing in the distance the contact between the Buda and the Eagle Ford. The dark overlying rock is the Eagle Ford. The light rock immediately underlying this is the Buda. Looking southwest from the Johnson ranch. Photograph by Christner.

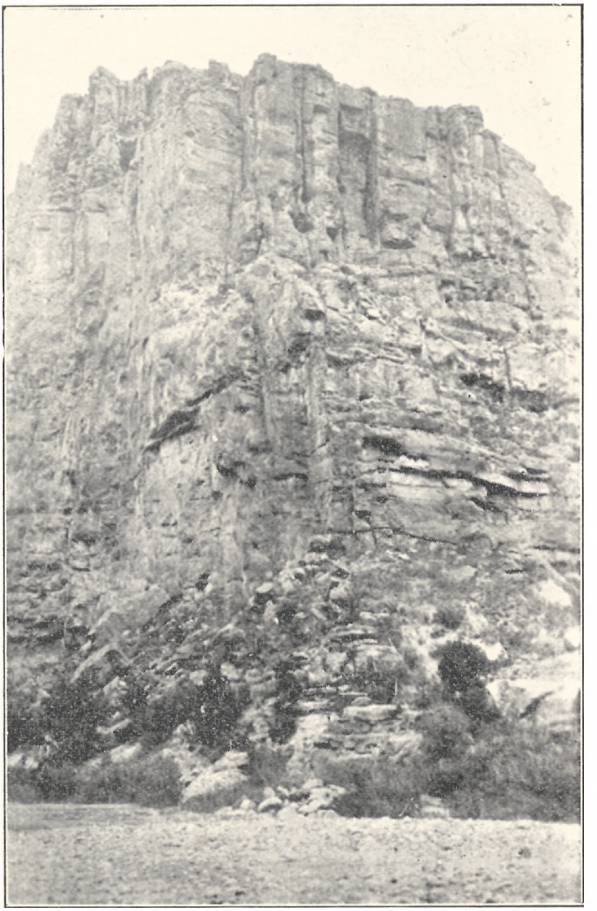


Plate III. Bluff of Edwards limestone 500 feet high. North side of Rio Grande at the Nichols pump, looking northwest. Photograph by Christner.

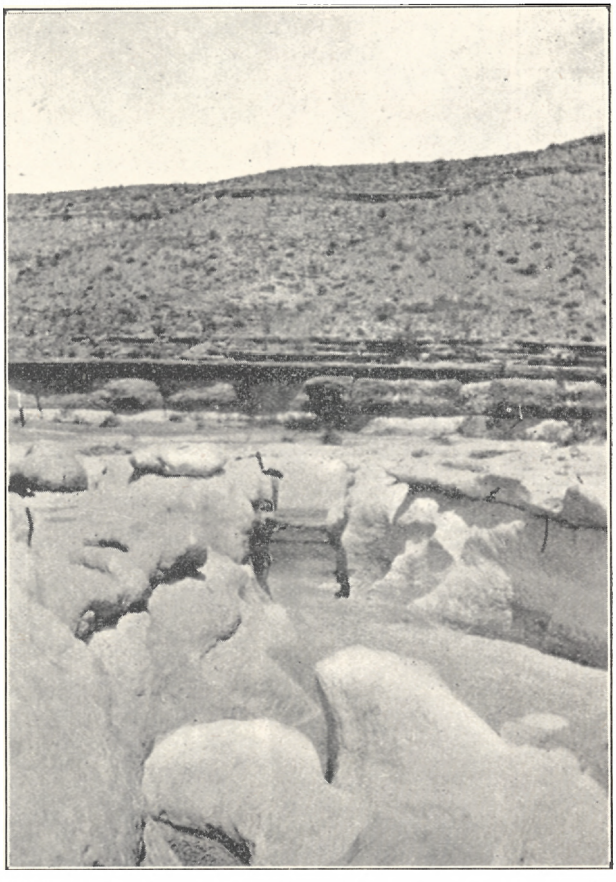


Plate IV. Corrasion and solution in a canyon in the Edwards limestone at the junction of Mangin and San Francisco creeks. Looking east. Photograph by Christner.

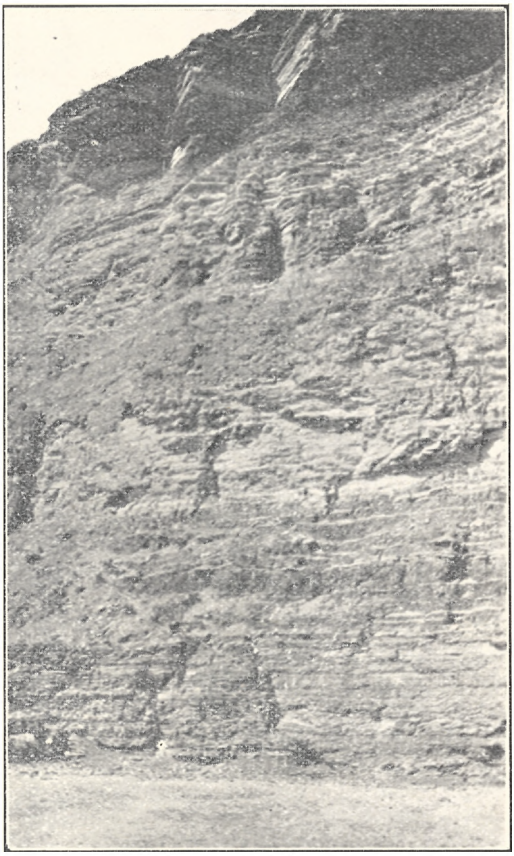


Plate V. Wall of the Eagle Ford formation, 310 feet high. Buda limestone underlies in the immediate foreground. In the Lozier Canyon, four miles north of the Rio Grande. Looking southwest. Photograph by Christner.

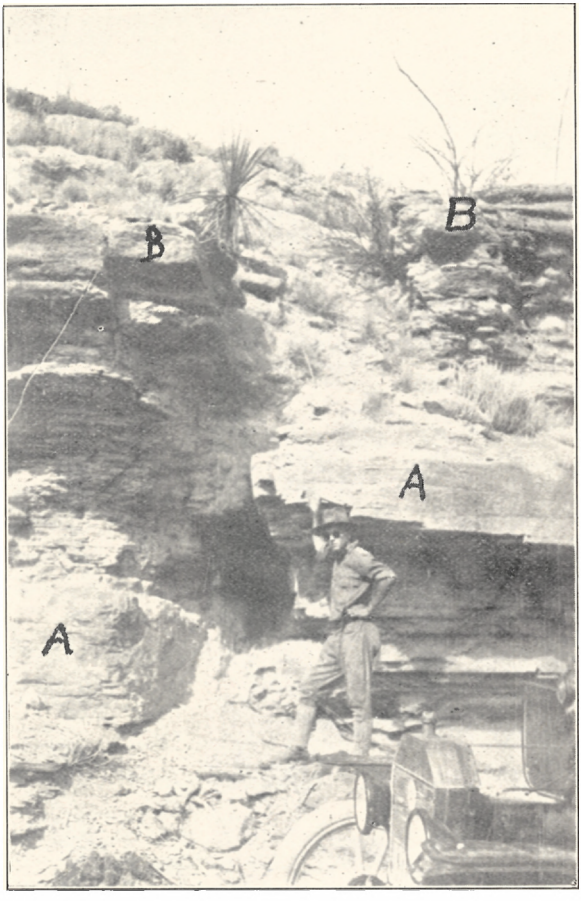


Plate VI. Small fault in the Edwards limestone in Pitman Canyon, 11 miles south of Sanderson. Looking northeast. Ledges A-A and B-B correspond, showing the amount of dislocation. The fault is fissured and the fissure is filled with calcite. Photograph by Christner.

Plate VII. Ripple marks and so called "fucoid" markings, which appear in this case, probably are trails from animals traversing the sand.

Plate VIII. A flag of sandy calcareous rock, showing imbedded tests of Nodosaria texana, which have been etched out by weathering.