

**SPRINGS
OF
TEXAS**

GUNNAR BRUNE

VOLUME I
PART 3



BRANCH-SMITH, INC.
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local recharge, primarily where the Blanco River, Sink, Purgatory, York, and Alligator Creeks, Guadalupe River, and Dry Comal Creek cross the Balcones fault zone.

The first Europeans to see San Marcos Springs were probably the members of the Espinosa-Olivares-Aguirre expedition in 1709. They found abundant grapes, nuts, hemp, and streams teeming with fish. They encountered herds of deer, bears, wolves, foxes, mountain lions, and turkeys, but very few buffalo in this area. They also made the acquaintance of a large number of ticks. The Indians were friendly when first encountered and exchanged nuts for tobacco and lumps of brown sugar. In 1755 the San Xavier missions of Milam County were moved to San Marcos. Because of a severe drought and no facilities for irrigation, the mission was moved to Comal Springs in 1756. A historical marker is located at San Marcos Springs. They were an important stop on the Spanish Camino Real, or *Kings Highway*, from Nacogdoches to Mexico. In 1807 Mexico established the settlement of San Marcos de Neve six kilometers downstream. Horse stealing by the Indians and a severe flood caused its abandonment in 1812.

In 1835 settlers from the United States began to move into this area with Mexican land grants. One of the best early descriptions of San Marcos Springs was that of McClintock, who described them as they were in 1846:

2 miles north of St. Marks we crossed the Blanco, a mountain torrent of purest water, narrow and deep, there is the finest spring or springs, (for they are not less than 50 in a distance of 200 yds.) I ever beheld. These springs gush from the foot of a high cliff and boil up as from a well in the middle of the channel. One of these, the first you see in going up the stream, is near the center, the channel is here 40 yds. wide, the water 15 or 20 feet deep, yet so strong is the ebullition of the spring, that the water is thrown two or three feet above the surface of the stream. I am told that by approaching it in canoe, you may see down in the chasm from whence the water issues. Large stones are thrown up, as you've seen grains of sand in small springs, it is unaffected by the driest season ... Great numbers of the finest fish; and occasionally an alligator may be seen sporting in its crystal waters ... In the eddies of the stream, water cresses and palmettoes grow to a gigantic size. Great quantities of game in the neighborhood. It was a few months since, a favourite resort and camping ground for roving bands of Comanches.

Power plants, gins, corn, saw, and grist mills and an ice factory used the water power. San Marcos Springs were a stop on the Chisholm cattle trail from 1867 to 1895. In recent years an amusement park has developed around them. More than 40 species of water plants live in the spring waters. Discharge records, in

liters per second by water years, are as follows:

1892	at least 1,300	1943	5,100
1895	4,200	1944	5,100
1896	2,500	1945	5,900
1897	5,300	1946	4,800
1898	1,400	1947	5,700
1900	4,200	1948	3,100
1903	4,300	1949	3,700
1906	4,100	1950	3,100
1910	2,700	1951	3,100
1915	7,900	1952	2,800
1916	4,200	1953	3,500
1917	3,100	1954	4,000
1918	2,700	1955	2,700
1919	3,600	1956	2,000
1920	5,400	1957	3,300
1921	4,800	1958	6,100
1922	6,200	1959	4,800
1923	4,200	1960	5,000
1924	6,200	1961	5,900
1925	4,500	1962	3,800
1926	5,100	1963	3,500
1927	3,700	1964	2,600
1928	5,100	1965	4,400
1929	5,100	1966	4,600
1930	3,400	1967	2,900
1931	5,400	1968	5,500
1932	4,000	1969	4,600
1933	2,800	1970	5,400
1934	3,400	1971	3,900
1935	3,800	1972	4,500
1936	3,700	1973	5,400
1937	3,800	1974	5,700
1938	3,700	1975	6,700
1939	2,500	1976	5,500
1940	2,800	1977	7,100
1941	5,100	1978	3,500
1942	4,000		

The discharge for 1892 was estimated by R. T. Hill. The maximum recorded discharge of San Marcos Springs was 8,940 liters per second on June 12, 1975. The minimum was 1,300 lps August 15, 1956. The average annual discharge has been 4,300 lps. Daily measurements of the discharge have been made by the U.S. Geological Survey since May 1956. According to Guyton and Associates (1979), the records before 1916 are of doubtful accuracy, as they were affected by various dams and diversion structures upstream from the point of measurement. The flow of the springs is being increasingly threatened by well pumping to the southwest.

In addition to the constituents shown in the table of Selected Chemical Analyses, the water contains about 0.6 milligram of strontium per liter, 0.1 mg/l of boron, and 0.02 mg/l of zinc. Tests have shown that contamination by nutrients, bacteria, pesticides, and herbicides has not been serious to date. But care needs to be taken to prevent such pollution.

Willow Springs (16) were six kilometers southwest of San Marcos. They issued from cavernous Edwards limestone, feeding Willow Springs Creek. They have not flowed since 1910, according to Bill Taylor of

the Upper San Marcos Watershed Reclamation and Flood Control District. Now the rock channel is dry except during storms, in a live oak and juniper wood.

Nine kilometers south-southwest of Wimberley are **Purgatory Springs (15)**, the source of Purgatory Creek. They issue primarily on Elmo Jonas' ranch, but also on Edwin Preusser's and Otto Stoepler's ranches. They trickle from Glen Rose limestone, reaching a discharge of 0.85 lps on October 15, 1978. On this date the water coursed downstream for about two kilometers, where it disappeared into a fault in the Edwards limestone, probably to re-emerge at San Marcos Springs.

According to Stoepler, the water was much used by settlers. Projectile points found here indicate that this was a popular spot much earlier. The spring waters pass through four ponds, where milfoil, cattails, marsh pars-lane, water shields, manna grass, and sunflowers are numerous. The many fish are preyed upon by ducks, blue herons, and raccoons. Abundant small deer hide among the live oaks, willows, and grapevines. Some of the springs cease flowing when Stoepler's windmill is pumping.

Fern Bank Springs (5), also called **Little Arkansas** or **Krueger Springs**, are eight kilometers east of Wimberley on the south bank of Blanco River on Liza Howell's property. They flow in an area that is still quite isolated, with few roads, but many rock shelters, caves, and archeological sites. The springs burst from the base of a high bluff where the Hidden Valley Fault crosses Blanco River. They gush under artesian pressure from the Edwards and associated limestones. On May 31, 1975, they poured out 140 lps, but on May 1, 1978, only 9.1. The large group of springs cascades about 20 meters down to the river through banks of maidenhair fern, water cress, and blue dayflowers. Travertine deposits form pools among the falls, shaded by cypress trees.

Some of the flow of Fern Bank Springs passes through a large stone box for use as drinking water. (See Plate 9,e). The area is popular for picnics and camping, for which a small charge is made. The tiny Fern Bank salamander is very much dependent upon the springs and their ecosystem for its survival. Three low-water crossings of Blanco River which must be negotiated to reach the springs can be dangerous during high river flows, but the natural beauty of this spot is well worth the difficulty of reaching it.

Wimberley Spring (6) is in Wimberley, just west of the Cypress Creek crossing. In 1850 the Winters mill was built here, and stood until a flood on Cypress Creek

washed it away in 1869. The spring provided drinking water for the mill operators and other early Wimberley residents. In the 1890s a hydraulic ram was used to pump the water into Wimberley. The spring produced 0.50 lps from Glen Rose limestone on August 15, 1975.

Twelve kilometers west-northwest of Wimberley are some moderately large springs (17) on the Blanco River. They rise from lower Cretaceous Hensel sand where an important fault crosses the river, bringing the sand to the surface from this point upstream. They appear chiefly in the **Blue Hole**, a 300-meter-long pool of deep blue water in the Blanco River channel. A few smaller springs occur upstream, but usually the head of the Blanco River is at the Blue Hole.

The springs are in a 16-hectare park managed by Kenneth Munson for the residents of Bumett Acres. On the south side is a high bluff of Glen Rose limestone with large boulders at its base. Water cress is abundant in the pool, shaded by large cypress, live oak, and cedar trees. The discharge was 200 lps on July 18, 1977.

HEMPHILL COUNTY

Hemphill County's springs issue chiefly from Ogallala sand, gravel, and caliche, Canadian River terrace sand and gravel, and windblown sand. Especially in the northeast part of the county there are also beds of clay. Springs often emerge on top of the clay layers. Shallow flowing wells (5 to 10 meters deep) can be completed by penetrating the sand beneath a clay bed. As the entire county is quite hilly, springs formerly gushed forth nearly everywhere, but the largest springs still flowing are along the Canadian River.

The springs have been used as campsites for at least 10,000 years. Mastodon bones of a species that has been extinct for that length of time have been found pierced by flint projectile points fashioned by a Paleo-Indian people. Just before the dawn of history in the New World, the Plains Village people were building stone slab houses along the Canadian River and irrigating crops with spring waters. In historic times early explorers such as Oñate in 1601 were guided to the better springs by the Indians.

Long before the time of anyone now living, the county was literally bursting with springs. In the sand-hills area in the northeast there were many seep-fed tree-shaded ponds. Tall grasses dominated the prairie. The areas near springs and spring-fed creeks teemed with bison, deer, antelope, bears, wolves, turkeys, prairie chickens, geese, ducks, and countless other animals.

This natural environment with which man lived in



Part of the Spring Creek Springs

harmony for so many thousands of years has now been largely destroyed. Overgrazing by the cattle barons and plowing up of steep hillsides by the early farmers left the soil open to attack by wind and water. Huge gullies began to cut headward and roadside ditches deepened. Enormous volumes of sediment moved downstream to clog the channels, cover old swimming and fishing holes, and bury springs. But much greater damage was done to the groundwater reservoir by the drilling and pumping of wells, especially for irrigation, which consumes appalling amounts of water.

As the water table declined, most springs greatly decreased in discharge or failed completely. Many windmill wells are finding themselves high and dry, and must either be deepened or abandoned. And of course many of the plants and animals that depended upon abundant fresh water cannot now survive in the area.

The county's spring waters are generally of a calcium bicarbonate type, fresh, very hard, and alkaline. Most of the writer's field studies were made during the period June 20-25, 1977. As the preceding several months had been very wet, the spring discharges ob-

served are believed to be higher than normal for this season.

Let us discuss the springs north of the Canadian River first, taking them from west to east. In the north-west corner of the county, both branches of Horse Creek were described in 1932 (Reed and Longnecker) as flowing from the county line more than three kilometers south. In 1885 West Horse Creek very likely flowed at least eight kilometers south of the county line, past Gerlock's store. Now it is dry, dotted with dead and dying cottonwoods, and surrounded by evidence of severe erosion and sediment deposition.

East Horse Creek has fared a little better. Here, on Roy Sessions' ranch, springs (2) produced 1.3 liters per second in 1977 which coursed two kilometers downstream. The springs supply a swimming pool and fish pond among cottonwood and willow trees. According to Mrs. Sessions, 8,000-year-old fossils of a terrapin and an antelope have been unearthed here.

A little farther east, six kilometers northwest of Canadian on Norman Magill's ranch, are **Bent Springs (4)**. One-half kilometer west is an old foundation, probably the location of Bent's 1849 trading post and fort. In the 1920s many motorists on Highway 83 stopped here for a refreshing drink. The springs ceased flowing in the 1930s but seepage still feeds a small stock pond. Beavers continue to work among the cattails, shaded by a grove of huge cottonwoods, plum thickets, and grapevines.

Thirteen kilometers north-northwest of Canadian on the Dale Nix ranch were **Big Timber Springs (3)**, which fed Big Timber Creek. According to ranch manager Scott Evans they formerly ran four kilometers down the creek. Now there are only some seeps which feed stock ponds, and many dying cottonwoods.

In the 1880s railroad workers laying track for the Santa Fe railroad swam in deep pools along Clear Creek. **Clear Springs (7)** still flow on the Urschel ranch eight kilometers northeast of Canadian. But they have moved five kilometers downstream, and the channel is now so choked with sand that swimming would be impossible. In 1977 the flow was 1.0 lps, which disappeared one kilometer downstream. Many irrigation and oil wells dot the surrounding hills.

About seven kilometers farther east is Persimmon Creek, whose lower portion was reported by Reed and Longnecker to flow in 1932. It is now essentially dry.

On Boggy Creek four kilometers north of Lake Marvin are **Springer Springs (8)**. Downstream, distinguished by a historical marker, was the site of Jim Springer's 1875 hotel, stagecoach stand, and store.

Many travelers on the Ft. Elliott to Ft. Dodge trail stopped here. On June 21, 1977 the discharge in a sand-choked channel reached a maximum of 4.8 lps and fed several lakes, including Lake Marvin, with no overflow. Bullfrogs and fish are numerous.

Ten kilometers east of Lake Marvin, on the Big Bull ranch, is a group of springs (9) on Spring Creek. On June 22, 1977, they produced 10 lps from river terrace sands, feeding five stock tanks and flowing to the Canadian River. In this wildlife refuge deer, red-wing blackbirds, and other animals live among Russian olive trees, sumacs, and rushes. In 1601 Juan de Onate and his colonizing caravan may have stopped here.

Oasis Springs (10), seven kilometers northeast of the **Spring Creek Springs** on Oasis Creek, are the largest in the county. On June 23, 1977, they produced 13 lps from river-terrace sands at an elevation of 695 meters, the water flowing through several lakes to the Canadian River. According to Raymond Miller of the Big Bull ranch, there were once several Indian camps near the springs. Dark gray soils which extend far up the surrounding slopes indicate that there were originally many more springs and a large swamp here. Now deer and wild turkeys inhabit this refuge of water-cress-filled streams and large trees.

South of the Canadian River, at latitude 35°50' and longitude 100°09', is the very small **Jo Spring (11)**. Here wild turkeys prowl in the sand-choked draw among cottonwood trees. Cabin Creek, just to the west, formerly flowed but now has only a few seeps.

Three kilometers south-southeast of Jo Spring there were formerly springs (12) along Cat Creek, marked now by dark gray organic soils. Similarly Hay Creek, a few kilometers farther east, was once spring-fed.

In 1932 the upper Washita River was a running stream fed by springs. Now it is usually dry above the confluence with Gageby Creek, although the floodwater retarding structures built by the U. S. Soil Conservation Service tend to prolong the runoff from storms.

On Hackberry Creek ten kilometers north-northeast of Allison are **Hackberry Springs (13)**. They produced 0.65 lps in 1977, which flowed to the Washita River. Extensive areas of dark gray soils indicate that there were once many more springs and a large swamp here. Laramie McEntire of the Soil Conservation Service believes that these springs are coming back as a result of improved grassland management.

Seventeen kilometers east-southeast of Canadian were **Needmore Springs (15)**, the source of Needmore Creek. The Needmore store once stood at these springs. According to Mrs. John Isaacs, the present

owner, the springs flowed until the 1920s. There are still small seeps at the site.

Elk Creek ten kilometers south-southeast of Canadian was used for baptizing in 1894. In 1932 Reed and Longnecker reported that the lower five kilometers were flowing as well as some shorter sections in the upper reaches. In 1977 there was only a flow of 0.45 lps near the lower road crossing (14). A large abandoned bridge here is no longer needed, as a small culvert can easily pass the flow. The same is true of many other bridges in the county. Big Timber Creek, a few kilometers farther east, is now dry.

The Fletcher-Dailey stage station, identified by historical markers, was on the Ft. Elliott to Ft. Dodge trail in 1875 - 1890 just south of the Washita River crossing. Located on the Dick Waterfield ranch at latitude 34°43' and longitude 100°17', the station likely was watered by springs (18) in a draw immediately to the west which flowed from gravel and sand. Irrigation wells are numerous, but these springs probably failed before irrigation began in the area.

Four kilometers south-southwest of the stage station, where Threemile Creek crosses Highway 277, are **Threemile Springs (17)**. Bordered by cottonwoods and plum thickets, they produced 0.32 lps in 1977, which coursed about 500 meters downstream. According to Elmer Sparks, a local historian, the springs were much used by travelers on the Ft. Elliott-Ft. Dodge trail.

The ghost town of Gageby was five kilometers south-southwest of Threemile Springs. Many springs (21) still emerge along Gageby Creek three kilometers southeast of the cemetery. It is likely that when Gageby was settled springs also poured from sand in the draw just to the east of the settlement.

Seven kilometers south-southeast of the intersection of Highways 60, 83, and 33 were **Molly's Springs (19)**, on the Minerva Hobart ranch. Here a woman named Molly operated a roadhouse and store which catered to soldiers in the 1870s, according to Elmer Sparks. An old building, probably not the original one, stands at the site. According to ranch manager Jack Vines, the springs have been dry for many years.

Seven kilometers southwest of Molly's Springs was the 1874 headquarters of Gen. Nelson Miles during an Indian campaign. His dugout command post, identified by historical markers, was located on a terrace adjacent to the upper Washita River, on Frank Young's ranch. **Miles Springs (20)**, undoubtedly much larger in those times, produced 0.32 lps in 1977, which flowed a short distance downstream before disappearing. Wild turkeys and bullfrogs make their home among the

hackberry and cottonwood trees and grapevines. Two kilometers south-southeast there was formerly another large, deep spring, according to Laramie McEntire of the Soil Conservation Service. And five kilometers east SCS floodwater retarding structure No. 8 is fed by numerous springs.

In a high, hilly area 17 kilometers south-southwest of Canadian and three west of Highway 83 there were formerly springs (6) which afford a welcome stop on the Jones and Plummer trail from Palo Duro to Dodge City, Kansas. According to landowner Ray Risley they still ran about one kilometer between 1927 and 1934 but by 1937 they were dry. Cottonwoods and plum thickets mark the location of this and several other former springs nearby.

Canadian Springs (1) were located two kilometers east of Canadian on E. C. Payne's ranch. They were used by early explorers along the river such as Josiah Gregg in 1840, and were of great value to the settlers at Canadian when they arrived in 1887. Flowing from gravel, they are now only seeps which feed a deep hole containing many water plants.

Gregg, traveling east, wrote of Red Deer Creek (Archambeau, 1954):

This evening we are encamped on the east side of one of those singularly dry creeks which abound in this sandy country. Its bed, which is about 200 yards wide, is loose sand and shows no appearance of water, though I have no doubt it is a stout running creek some distance up.

In 1850 Captain Marcy also found no water in Red Deer Creek in present Hemphill County, and called it Dry Creek. But it did flow continuously from springs upstream in Roberts and Gray Counties.

HIDALGO COUNTY

Springs have never been large or numerous in Hidalgo County. This is due to the lack of topographic relief in this flat land and also to the lack of good water-carrying aquifers. However, before intensive well pumping and overgrazing of the land, there were more flowing springs than now. During the great drought of 1889 - 95, most of the springs' flow was interrupted.

There is much evidence of prehistoric Americans who lived in this area. Numerous burial sites have been found along the north side of the *Arroyo Colorado* (Red Creek). The hunting and gathering Coahuiltecs probably lived along the south side of the arroyo, as well as elsewhere. That there were formerly many springs along the arroyo, where the edges of sand

terraces were exposed, is probable. They can now no longer be distinguished if they still exist, because of the levees, drainage channels, and other works which have completely altered the topography along the arroyo.

Those Indians who lived away from natural springs probably dug shallow holes or wells to the water table, which was usually close to the surface. They also used the unpalatable but drinkable water from oxbow lakes or meander cutoffs, variously called *esteros* or *resacas*.

The spring waters are usually of a sodium sulfate or chloride type, slightly saline, hard, and alkaline. Most of the writer's field studies were made during the period November 9 - 14, 1976.

In northeastern Hidalgo County there was once running water. According to Bernardo Solis, long-time resident in the area, in the late nineteenth century the flow from San Francisco, Las Animas, and other springs in southwest Brooks County coursed southeast through Tasajala Lake into Callo Pedrones (Pedrones Depression) in Hidalgo County.

Nineteen kilometers west-northwest of Linn on Highway 1017, at the McAllen ranch, were **San Juanito Springs (3)**. Ruins of an old settlement dating from the early 1800s have been found here. Various articles of soldiers' equipment discovered in the vicinity may indicate that this was a water stop on the trail from Fort Ringgold to Sal del Rey. Probably during a drought a well was dug at the springs. This was later deepened and pumped by a gasoline engine and windmill. As a result the water level has declined to about 15 meters below the surface, and the springs no longer flow. The analysis given in the table of Selected Chemical Analyses is for water from the well.

Eight kilometers west-northwest of Linn on Highway 1017 were **Santa Anita Seeps (20)**, on the Santa Anita ranch. They were widely known as a watering place in early settlement days, being shown on an 1854 map by the U.S. War Department. Undoubtedly the Coahuiltecs and Karankawas used them in preceding millennia. An old nearby cemetery discloses that there was a Spanish settlement here in the late 1700s. Flowing from Quaternary caliche, the seeps, which no longer flow, once furnished water for a limestone watering trough or *pila* which still stands. According to Davenport and Wells (1918), a shallow well dug by the Indians was found near here in 1794 by land inspectors. They also found

... many very dense thickets of brush and nopals ... and tigers, lions, wolves, coyotes, and snakes, very long and very thick, *javelines*, deer, antelope, hares, and rabbits.

Sal del Rey (King's Salt) Springs (4) and the lake of the same name are located seven kilometers east of Linn and one north of Highway 1017, on Eloise Campbell's ranch. A historical marker is on the highway. Many ancient trails led to the springs, where Indians mined salt for use and trade. It was valued for the treatment of skin diseases. The Spaniards began using the salt in the mid-eighteenth century, wearing some trails two meters deep. Commercial salt production continued until the 1930s. As the five preceding years had been very wet, on November 11, 1976, the springs were flowing copiously from the Quaternary sand, producing 3.2 lps of very saline water. The lake level was high, and the salt deposits usually exposed by evaporation were under water. At low lake stages the concentrated brine becomes pink or purple in color. The lake is an important rest stop for migrating birds, including various ducks, teals, snow geese, sandhill cranes, and hawks. The water teems with tiny brine shrimp. Near the springs is a flowing well which produces water from a depth of 26 meters that is only moderately saline, and is drunk by livestock.

According to Guadalupe Nerio of the International Boundary and Water Commission, springs exist in the bottom of Lake Tampaguas, five kilometers north of Mercedes. A cemetery just to the west marks the location of an old settlement which probably depended on **Tampaguas Springs (25)** for water.

Four kilometers north of Hidalgo, on the south side of a floodway and just west of the railroad tracks, are some springs (23) which flowed 2.4 lps of slightly saline water on December 8, 1976. In 1749 the mission San Joaquin del Monte was located a few kilometers to the south. It is reasonable to suppose that at that time there were also very small springs at the mission.

Seven kilometers south of Mission is the old restored La Lomita (The Little Hill) chapel. In its earliest days, before a well was dug around 1865, springs (22) probably flowed from sand at the base of the terrace here.

Eight kilometers southwest of Mission is the village of Abram. It is also known as **Ojo de Agua** for the springs (5) which formerly flowed from a low river terrace into an oxbow lake or estero one kilometer west. A ranch was established here late in the eighteenth century, and was depicted on a map by F.C. Pierce in 1917. In 1915, when 16 U.S. soldiers were stationed here, the village was raided twice by bandits. The springs no longer flow.

At the nearby town of Penitas, perhaps the oldest in Texas, are a group of relatively strong springs (21). Father Zamora and five other Spaniards from the ill-fated Panfilo de Narvaez expedition settled with the Indians here in the 1520s. Of course the Coahuiltecan



Restored outdoor oven at the site of former La Lomita Springs.

had lived at this place and used the spring waters for thousands of years previously. Flowing from gravel pits in the river terrace, they discharge through a pipe into the Edinburg pumping plant basin. On December 8, 1976, they produced 6.0 liters per second.

One kilometer east of Sullivan City on William Flores' property is **Ojo de Agua de Arriba (Upper Spring) (1)**. At the Sheldon archeological site nearby, hearths, projectile points, bones, and shells point to long prehistoric use of the springs by early Americans. Spanish settlers probably began using the water in the 1740s, when they came over by way of Los Ebanos crossing a few kilometers south. In 1875 nearby Las Cuevas (The Caves) were used as a refuge by cattle rustlers. The water was probably not always as saline as it is now. Downstream are bogs of cattails, which probably gave their name to the nearby village of Carrizelos. Sand-bar willows are also numerous, and rattlesnakes are a constant threat. Gravel is mined from the Goliad gravel nearby. On November 10, 1976, the springs discharged 0.15 lps, and on March 2, 1979—0.27 lps.

HOCKLEY COUNTY

The springs of Hockley County issue primarily from Tertiary Ogallala sand and caliche. Groundwater moves through this formation at about 50 meters per year toward the southeast. Some springs also seep from Quaternary Tahoka sand and Lower Cretaceous Duck Creek limestone around the larger lakes.

As long as 15,000 years ago the county's springs were popular living sites. Bones of mammoths such as were hunted by the Paleo-Indians have been found near Indian burial grounds. Spanish explorers as early as the sixteenth century probably stopped at some of the springs. A Spanish copper pot and dagger were found in the county.

Groundwater levels have fallen greatly since irrigation pumping began in the 1930s. In 1974 the water table was declining as much as 0.35 meter per year. During that year this pumping discharged 0.42 cubic kilometer of water. This has been the primary cause of the failure of most of the countys' springs.

The springs and spring-fed creeks and lakes harbored a complex ecosystem. Plants such as willow and cottonwood trees shaded pools where cattails, ferns, rushes, milfoil, and water cress grew. Fish, frogs, snakes, crawfish, lizards, and water insects thrived in this environment, along with the larger animals which preyed upon them. Ducks, geese, cranes, herons, and many other waterfowl found refuge on the lakes, which were usually brimful. When most of the springs, creeks, and lakes dried up except for surface runoff, a large part of this plant and animal assemblage disappeared.

The remaining spring waters are normally of a calcium or magnesium bicarbonate type, slightly saline, very hard, and alkaline. The content of silica and fluoride is usually high.

Most of the writer's field studies were made during the period October 18-23, 1978.

In the northwest corner of the county is Silver Lake or *Laguna Plata*. It was formerly called *Laguna Quemada* or Burned Lake. **Silver Springs (1)** still issue from Tahoka sand on clay at various points around the lake, mostly as seeps. Those in Hockley County are on Ray Decker's ranch.

On the southeast side of Silver Lake is a large bed of bison bones, probably the same as that described by Pedro de Castaneda in 1641 on his return trip from Quivira with part of Coronado's army. Some of the bones are broken, and burned caliche and Folsom points have been found there. Probably the bison were driven into the lake where they mired down and could easily be slaughtered by the prehistoric Folsom people.

In 1875 Lt. Col. William Shafter described "fine large springs in the bank" at Silver Lake, with good grass but no timber (Crimmins, 1933). In 1877 there was a fight with Comanches, who were reluctant to give up this choice living site. The springs were depicted on A. W. Spaight's 1882 *Official map of the state of Texas*.

On April 13, 1977, Silver Springs in Hockley County yielded 0.31 lps, covering about one-fourth of the lake surface with water. On October 21, 1978, the discharge was 0.05 lps, and the lake was dry. The spring water is moderately saline, with a hydrogen sulfide odor. According to Decker, the springs usually dry up during the irrigation pumping season. The lake bed is fringed with salt cedar. Naturally there are no longer any fish or brine shrimp, and few birds.

The **Devil's Ink Well (2)** is a pool of water in Lower Cretaceous limestone. It lies in Sucker Rod Draw on the Yellow House ranch, managed by James Linson, six kilometers east-southeast of Pep and two southwest of the ranch headquarters. Shafter in 1875 described it as a "spring-fed tank". Meigs (1922) mentioned fresh-water springs here. Springs still flow from Ogallala sand on top of the limestone in winter, according to Thomas Albus of the Yellow House ranch. Rock shelters surround the pool, and on the ledges above are bedrock mortar holes. This was evidently a preferred living site when water flowed abundantly. On October 4, 1978, there was only some seepage into the pool. A few hackberry trees shade the site.

Seven kilometers east of Pep is a historical marker at the Yellow House ranch headquarters. The Yellow Houses or *Casas Amarillas* were caves carved in the soft yellow limestone cliffs by Indians long ago. Below the cliffs was their water supply — two very small springs called **Yellow House Springs (5)**. Seventeenth-century Spanish missionaries visited the site. In 1874 there was a Mexican village here and a private fort just above the springs. The fort was attacked by Comanches soon afterward. In 1875 Shafter found "two dug springs at the base of the bluff". Later buffalo hunters had an adobe camp here, and a store was established. Several important early roads joined at the site. The spot was shown on an 1884 Texas General Land Office map of Lamb County.

In 1885 this became the headquarters of part of the XIT ranch. In 1901 the springs were drying up, and a windmill 38 meters high was built at the site to catch the wind above the bluff and pump water from a well. It later blew down. O. R. Watkins, Levelland historian, remembers the springs in the early twentieth century. Now there is only a dry grove of hackberry trees at the site, behind the ranch headquarters. Several other small springs, now dry, formerly issued around Yellow Lake in Hockley County.

Seven kilometers northeast of Pettit on Dan Cobb's ranch, very small springs (3) once flowed from Ogallala sand. Here, in a small outcrop of Kiamichi sandstone, are five bedrock mortar holes. Together with a cave in caliche upstream, they indicate that a prehistoric people once lived here. According to Cobb, the gypseous water is now about four meters below the surface. Mesquite and broomweed are abundant.

Near Anton, where several tributaries join Yellow House Draw, seeps (4) probably existed at the dawn of history in the area. A short distance downstream in Lubbock County were the abundant Lubbock Springs. No one remembers any springs or seeps on Yellow



Devil's Ink Well at the Yellow House ranch.

House Draw in Hockley County since around 1920. Those which did seep evidently dried up when the first wells were dug. Now the entire draw is cultivated.

Seven kilometers southeast of Sundown on Mrs. Christine Devitt's property was the old Slaughter ranch pasture. Seeps (7) probably issued from Ogallala sand here in the past. The Amoco Slaughter pumping plant is located here now. Mesquite, yucca, and oil wells cover the field.

On Sulphur Draw in the southwest corner of this county is John Sones' ranch. Sones has heard old-timers talk of very small springs and seeps (6) which once flowed here. Now there is only a dry draw covered with mesquite, broomweed, shinnery, and many oil wells.

HOOD COUNTY

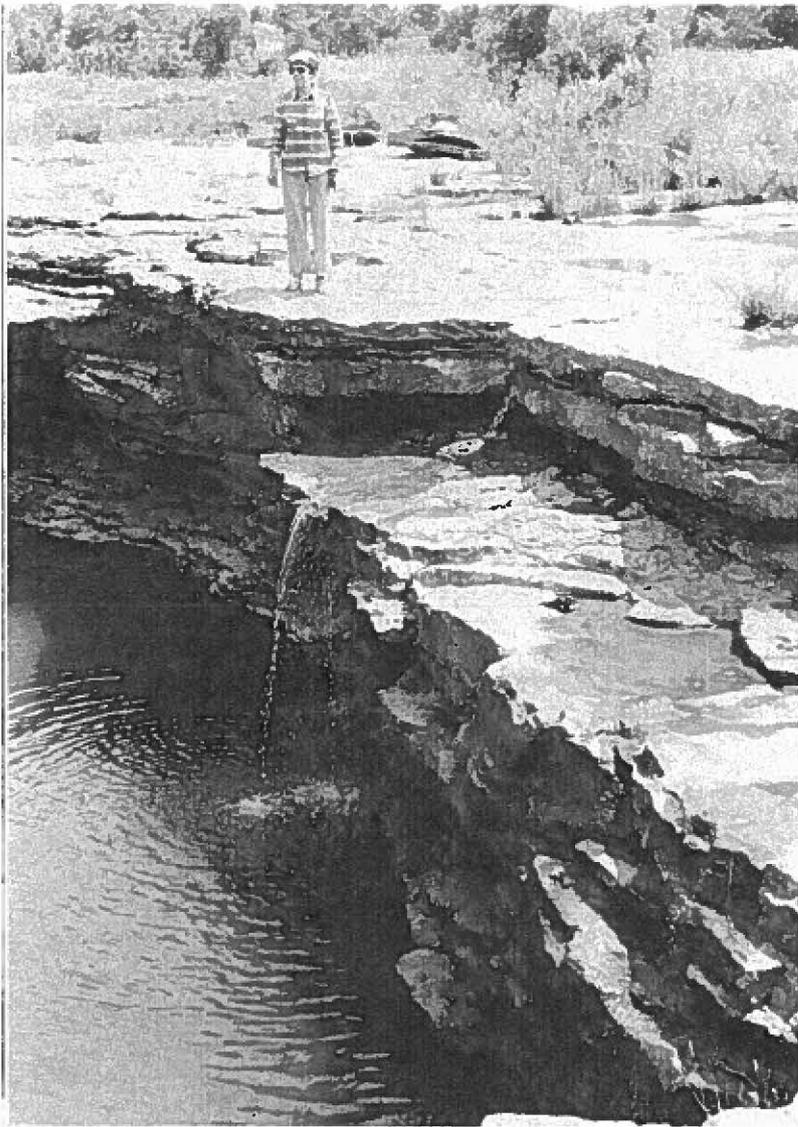
Hood County was endowed with many fine springs, which were used for a very long period of time without damage to them by the Wichitas and other tribes and their predecessors. Many stone axes and other artifacts have been found near the springs of the county.

Spanish missionaries may have worked along the Brazos River as early as 1611. In 1662 Governor Diego de Penalosa of New Mexico Territory visited the area. In the eighteenth century De Mezieres and Vial passed through the county. These early explorers, who used Indian guides, were probably led to all of the better springs in the area.

The groundwater table has declined considerably since the area was first explored. This decline has accelerated in the last 50 years with the increasing use of deep wells. The county lies largely in the West Cross Timbers belt. When this timber was cleared and the land plowed up, much irreparable damage was done to the easily erodible soils. Stream channels were clogged with sand. Many springs have failed, due both to declining water tables and to burial under sand deposits. Most of the writer's field studies were made on July 3-8, 1976.

The spring water is generally of a calcium bicarbonate type, and is fresh, very hard, and alkaline.

In the northwest corner of the county names such as Kickapoo and Lipan attest to the use of this area and its



Kickapoo Falls.

springs by these tribes and their ancestors. According to Roy Clary of Lipan, there were formerly many springs in this area, flowing from Twin Mountains sand. Most now have been buried by sand or failed. One example is the springs (2) which formerly flowed two kilometers southeast of Lipan and 200 meters east of the Baptist cemetery on Crockery Creek. These have now been covered by sand deposits. The situation is similar on Weaver and Kickapoo Creeks to the west. However, at the beautiful Kickapoo Falls seven kilometers northeast of Lipan, a flow of 0.25 liter per second emerged from the sand in 1976 to fall over Pennsylvanian limestones.

Dripping Springs (3) are similar, a little farther east, at latitude 32°32' and longitude 97°57'. They flowed 0.60 lps from Glen Rose limestone on July 5, 1976.

Thorp and Sulphur Springs (1) were probably the best known in the county. They were about one kilometer east of the town of Thorp Spring on Highway 4. An old Ionie village was located here. In 1863 Pleasant Thorp settled at the springs. During the Civil War

HOPKINS COUNTY

the Confederate 20th Battalion was stationed here. In 1871 a health resort and cotton gin opened to make use of the mineralized water. In 1873 Add-Ran College (now TCU in Fort Worth) began using the water. The springs were covered by the waters of Lake Granbury in 1969. Mack Bird, an old resident of Thorp Spring, says that the springs continued flowing (from Glen Rose limestone) until they were inundated. A group of dead cottonwoods in the lake marks the site.

On Highway 167, very close to the Parker County line at latitude 32°33' and longitude 97°44', are **Parkinson Springs (4)**. Mrs. Zelma Parkinson Bennett states that her grandfather, Thomas Parkinson, built a water-powered flour and grist mill here in 1845. The building still stands at the springs. On July 8, 1976, the flow was 0.25 lps from Paluxy sand.

Two kilometers northeast of Acton are the many **Walnut Springs (7)**, on Walnut Creek and its tributaries. In 1855 the water from these springs powered the downstream Farris grain mill. Their combined flow, from Paluxy sand, was 6.5 lps on July 7, 1976.

Probably the most important springs in the county historically were **Fort Spunky Springs (5)**. They were at latitude 32°20' and longitude 97°40', near the left bank of the Brazos on Village Creek. Here Charles Barnard operated a very profitable trading post from 1843 to 1856, according to information provided by Mrs. O.C. Cheek, owner of the property. Across the creek was a village of Anadarkos, Ionies, Kadodachos, Delawares, Shawnees, Hais, and remnants of other tribes which had been expelled from areas to the east. The springs "flowed constantly" from Glen Rose limestone, the water probably originating in the overlying Paluxy sand. Now there is a pool of standing water here, but no flow. The old stone spring house, as well as the trading post, have disappeared except for a few foundation stones. The springs are said to flow in wet weather only since the 1950s. Many large grapevines surround them.

HOPKINS COUNTY

Most of Hopkins County's springs issue from Tertiary Eocene sands, especially the Carrizo and Wilcox formations, which crop out in the southeastern part. The water-bearing sands dip toward the southeast at about 10 meters per kilometer. A few springs flow from Upper Cretaceous Navarro sand in the north and from Quaternary river-terrace sands. The remainder of the county is underlain largely by clays which cannot carry appreciable quantities of water.

The springs were used by prehistoric people for

many thousands of years. Many ancient middens and burials, with 6,000-year-old projectile points, celts, and pottery, have been discovered near springs.

Wild animals thrived in the area. Fifteen-kilogram turkeys were common. Bears were killed solely for the grease their fat provided. Wolves and many varieties of birds abounded. Wine was made from wild grapes. Most of the animals which formerly haunted the springs are now gone. In early days great damage was done to the land and springs by clearing and plowing. Today there is hardly any cultivated land, but the scars of former plowing remain as gullied areas, partially healed and recovered with woods. Sand-choked channels and buried springs are a part of this legacy.

The spring waters are usually of a calcium or sodium bicarbonate type, fresh, soft, and acid. The iron or manganese content may be high. The writer's field studies were made chiefly during the period December 19-24, 1977. As the weather had been very dry for the preceding six months, the observed spring flows are probably below normal for this season.

Sulphur Springs (2), from which the city took its name, are near the intersection of Main Street and T.J. Alley. The Caddoes lived here in early historic time. They were pushed out by the Cherokees, who in turn were driven out by the settlers in 1841. There were "more than 100 bubbling springs" in the early days, shaded by water oak, live oak, and bois d'arc trees. At the junction of two roads, the "spring lot" was a popular campground. In 1845 a store was located here. Dr. O.S. Davis advertised the medicinal properties of the sulphur water, and soon it was bottled and sold. In 1871 sulphur-water baths were given at the Hoskins House.

Now most of Sulphur Springs' water flows in a rock-lined channel just west of the water tower. According to Norman Dykes, director of public works for Sulphur Springs, some small springs seep into the basements of the Junior High School and Coca Cola plant northwest of the main springs. Others have been diverted into a sewer line. The total flow, from Wilcox sand, was estimated to be 3.6 liters per second on December 20, 1977.

Sulphur Bluff Springs (1) were three kilometers north of present Sulphur Bluff, mostly on Gene Beale's ranch. An Indian village was located here. As early as 1837 John Gregg and other settlers arrived. Steamboats came up the Sulphur River almost to the settlement at times. A water-powered flour mill was located nearby. Several seeps still issue from Navarro sand along the base of the bluff.

Nine kilometers north-northwest of Saltillo, on

Eugene Tisso's farm, were **Valley Springs (3)**. The Valley Springs school nearby operated until 1928, according to Hubert Glaze of Saltillo. Now several seeps from terrace sand, one walled up, supply a small stock pond fringed with water pennywort.

Seven kilometers south-southwest of Saltillo, on the Branch estate, are **Willow Springs (4)**. About 0.4 kilometer south of the former Willow Springs church, 0.15 lps trickled from Wilcox sand in a grove of willow and other trees in 1977.

Greenwood Springs (5) are at the Greenwood Community nine kilometers south of Saltillo. They were vital as early as 1859 to residents here. The source of Greenwood Creek, the many springs produced 1.0 lps in 1977 from Wilcox sand. About one kilometer north is the Culpepper archeological site, where people of the Archaic stage lived for thousands of years.

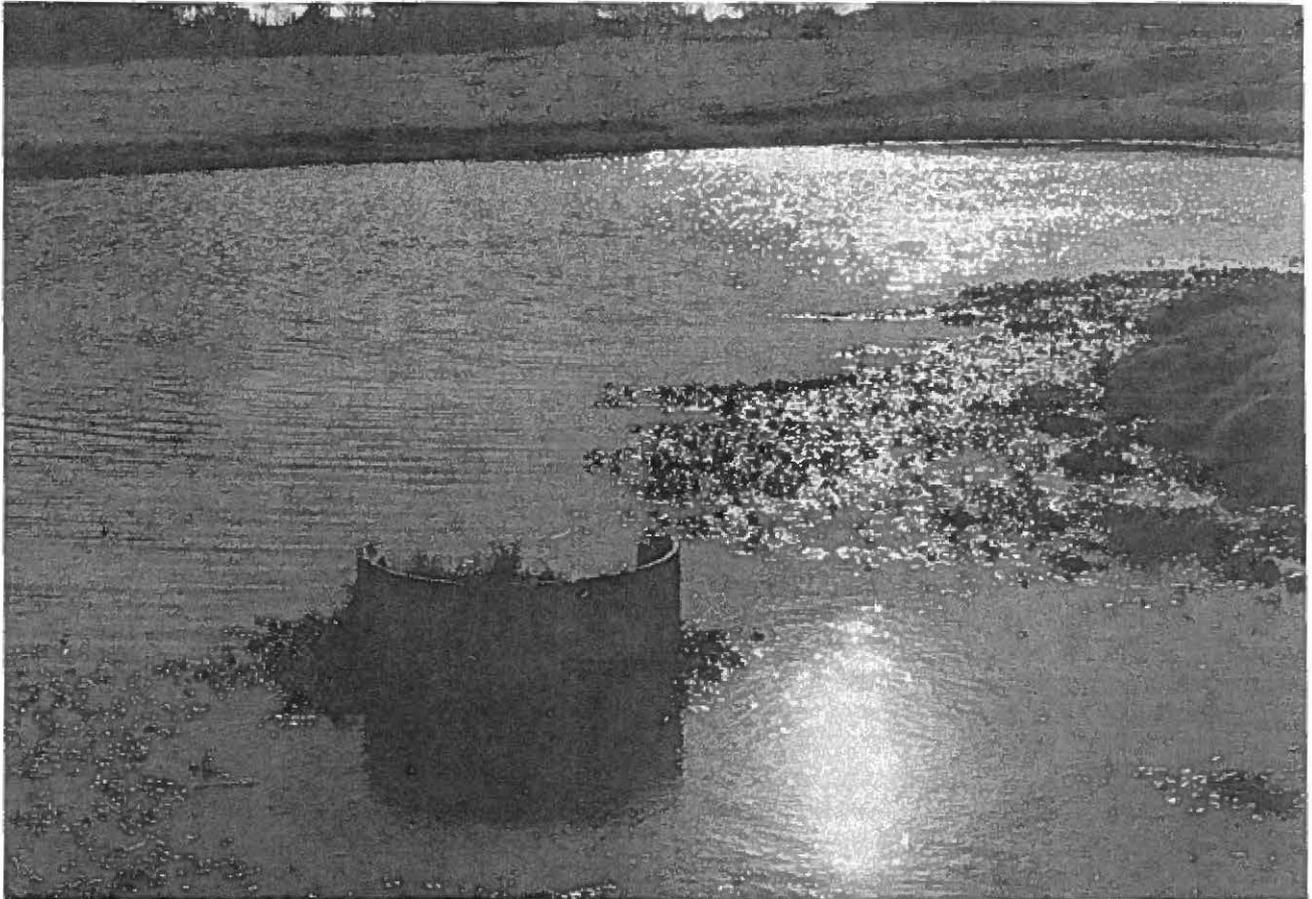
Ten kilometers east of Sulphur Springs on Eris Gilpin's property in the Brinker community are **Brinker Springs (6)**. According to Dewey Butler of Sulphur Springs, Brinker Springs were very reliable and much used by the residents of the area during drought periods. In 1977 0.65 lps ran from Wilcox sand in a gullied pasture.

Five kilometers north-northwest of Como, on W.O. Smith's dairy farm, are **Smith Springs (7)**. The several springs formerly supplied fresh water to a house, but are now used only for stock. Some, walled up in large concrete pipe sections, produce underwater sand "boils". They feed a pond which is fringed with water pennywort. About two kilometers west was another spring, in the Thermo community, which Jeff Campbell of Sulphur Springs used when he lived there in 1916.

Martin Springs (9) are in the community of that name six kilometers southeast of Sulphur Springs. They were important to the first settlers in the 1870s. Now many seeps into ponds provide water for livestock.

Seven kilometers south-southwest of Sulphur Springs are **Park Springs (8)**. The Park Springs school once used the water, which now seeps into a duck pond on Hugh and Linda Sprague's place. A whiskey still was later located here. Considerably larger groups of springs flow 0.4 kilometer east and west of these, each yielding 0.25 lps in 1977.

Reilly Springs (10) are in the community of that name 15 kilometers south-southeast of Sulphur Springs. They were named for James Reily, an 1841 landowner. Since that time the spelling has been modified to include two "l"s. They have also been called **McGill Springs**. They are larger than Sulphur Springs and were probably more important to early settlers and



Smith Springs.

travelers. They were depicted on A.W. Spaight's 1882 *Official map of the state of Texas and the Indian territory* and F.A. Gray's 1885 *New map of Texas*.

Reilly Springs were used in prehistoric times by the Caddoes as a campground on their way to the plains to hunt buffalos. The springs later provided water for a gin, tanyard, swimming, fishing, baptizing, and washing clothes. They also became the site of a stage stand on the Sulphur Springs-Mineola line. The spring water was formerly used in making "Hopkins County stew", which was canned and widely distributed, according to Mrs. Ellie Swindell, a noted historical writer in the area. One of the largest springs, under an oak tree on Dozier Thornton's property, was used for cooling dairy products. The Thomtons and Woodbert Wallaces still obtain domestic water from the springs. Many of the channels and springs have now been filled with sand from upstream erosion. But the numerous springs still poured 3.0 lps from Wilcox sand on December 23, 1977, at an elevation of about 150 meters. The channels and pools are fringed with parrot's feather, water pennywort, and pondweed.

Twelve kilometers south of Sulphur Springs are **Union Springs (11)**, on Doyle Glossup's farm. Located 0.5 kilometer south of the cemetery, they served the early settlers of the Union community. According to nearby resident E.R. McKeever, barrels were set in the spring in early times. In 1977 water seeped 1.6 lps from a gullied area amid much pennywort. (See Plate 16, c). Spring-fed Bassett Branch to the west yielded 4.5 lps. A copperas (ferrous sulfate) spring is reported west of the cemetery.

On Highway 1567 fifteen kilometers south-south-east of Sulphur Springs and two north of Arbala were **Arbala Springs (12)**. Here two springs formerly flowed from brick enclosures. Dewey Butler, who taught school at Arbala in 1938, hauled water from these springs, as did many early residents. In 1942 they produced 0.12 lps of fresh water. Now the water level is one meter below the ground surface and does not flow from the original springs. There is, however, seepage of iron-bearing water into a duckweed-covered pond just to the east.

Sherley or Barker Springs (14) are in the Old

Sherley community 12 kilometers southwest of Sulphur Springs. They were the site of many early gatherings, and were vital to the first settlers around 1870. They trickled 0.50 lps from Wilcox sand in 1977, south of the cemetery and old Barker Springs church. Reddish inflated duckweed covers the surface of pools below the springs. (See Plate 4, e).

In 1880 B.M. Camp built an artificial lake with a bathhouse, with orchards and vineyards six kilometers south-southwest of Sulphur Springs. Camp Lake, fed by springs (13), was very popular for recreation in early days. Jeff Campbell swam here in the early 1920s and recalls large crowds, especially on the Fourth of July. Now the lake, fringed with pennywort and frequented by ducks and herons, is used mainly for fishing. Owned by Ben Camp, the lake still contains some weak springs, but its level declines during drought periods. On December 22, 1977, the rate of flow was computed to be less than 0.37 lps, which was the amount necessary to counteract the net evaporation.

HOWARD COUNTY

The western part of Howard County is occupied by the *Llano Estacado* (the Stockaded or Palisaded Plains, not Staked Plains). Around the eastern edge of these Plains, springs flow from Tertiary Ogallala sand, gravel, and caliche. The eastern part of the county is underlain by lower Cretaceous Edwards limestone and Antlers sand, Triassic shales, and Quaternary sand, gravel, and caliche. Here springs are common in the lower Cretaceous limestone and sand and in the Quaternary deposits.

Often the water appears at the surface on top of the underlying Triassic shale and clay. Faults have influenced the formation of springs. Big Springs, for example, are in the center of a collapse area in which the strata have dropped some 85 meters, with a slight dip toward the springs.

There is much evidence that early man camped at the county's springs. At the dawn of history in the area the Apaches lived here, but around 1750 were driven out by the Comanches.

At that time most of the creeks were running streams. The lakes were brimful and swarming with fish and waterfowl. During the drought of the middle 1880s most of the springs dried up temporarily.

Irrigation pumping has never been important because of the very limited supply of groundwater. but municipal and industrial pumpage have played havoc with the groundwater reservoirs. In 1937 recharge to the various sinks or collapse areas was estimated to be

20 liters per second, while pumpage was 44 lps. Hence it was not surprising that between 1928 and 1937 the groundwater level in the "section 33" sink, 11 kilometers southeast of Big Spring, fell 20 meters. Later when the well fields in the county were essentially exhausted, Big Springs was forced to begin buying surface water from outside the county. With the decline in the water table, naturally the springs weakened or failed.

There has also been severe man-made soil erosion. This has filled many stream channels with sand and buried some springs.

The spring waters originally supported a lush growth of such plants as water milfoil, water cress, marsh purslane, rushes, and cattails. Trees such as cottonwoods, willows, and seep-willows fringed the pools. Maiden-hair ferns clung to the damp cliff walls. As the water has been contaminated by salt, plants such as salt cedar and saltwort have increased. And as springs dried up, many plants, and the animals dependent upon the springs, have disappeared.

The spring waters are normally of a calcium bicarbonate type, fresh, very hard, and alkaline. The fluoride, iron, and silica contents may be high.

Much groundwater has been contaminated by oil-field operations. Much of this contamination was caused by practices which are no longer permitted, such as disposal of brine in unlined pits, inadequate casing of wells, and use of abnormal pressures in injection wells. Oil-field contamination usually caused a large increase in the sodium chloride content of the water. It is regrettable also that valuable fresh water rather than saline water has sometimes been used for repressuring oil fields. Contamination of groundwater from other sources such as waste water from a slaughterhouse has also occurred.

Most of the writer's field studies were made during the period May 25-31, 1979.

Two kilometers southwest of Vealmoor are the largest of the group called **Rattlesnake Springs (18)**, on Jerry Iden's ranch. Rattlesnake Springs are described in more detail under Borden County, where most of them are located. The springs in Howard County rise from Ogallala caliche into an earth stock tank. On May 31, 1979, 0.70 liter per second passed the tank, running 2.5 kilometers to Rattlesnake Creek.

German Springs (15) are just west of Highway 669 very near the Borden County line on Sonny Anderson's ranch. A Slaughter ranch headquarters was located here in the late nineteenth century. Two Englishmen who tried to swindle Col. S. S. Slaughter out of his ranch are said to have disappeared near these springs. One spring is still walled up near the old head-

quarters site.

German Springs pour from Quaternary caliche and gravel on Triassic shale. On May 28, 1979, the discharge was 3.4 lps, giving rise to Dorward Creek. A bog with an impenetrable growth of pink-blossomed salt cedar and seep willows surrounds the springs. Several caliche pits have been dug here. Minnows, crawfish, frogs, and rabbits abound. In 1964 the springs were found to have been contaminated by oil-field brine. Many chemical analyses of the water were made at the various springs, two of which are listed in the table of Selected Chemical Analyses. The dissolved solids content, chiefly sodium chloride, was found to range from 1,320 to 12,000 milligrams per liter.

Wildhorse Springs (16) are eleven kilometers east-northeast of Fairview on Kent Morgan's ranch. Here were found the remains of a mammoth, such as were hunted by early men some 10,000 to 15,000 years ago. Many Indian sites are nearby. Wildhorse Springs were shown on Smither's and Eggleston's 1880 map of a *Reconnaissance of the Colorado River through Mitchell, Howard, Martin, and adjoining counties*. They also appeared on W.R. Livermore's 1883 *Military map of the Rio Grande frontier*.

The water of Wildhorse Springs flows from Ogallala gravel on Triassic sandstone and shale. On May 28, 1979, after a heavy rain the preceding day, there was barely a flow for 50 meters down Wildhorse Creek. According to Morgan, most of the discharge stopped in the 1930s. Willow trees are numerous, as well as red and yellow firewheel, purple horsemint, and yellow sleepy daisy blossoms in spring.

Thirteen kilometers west-southwest of Vincent are some seeps (17) into pools on H.C. Harrington's ranch. They are in a canyon edged with caliche caprock and surrounded by large boulders. Several burned-rock middens or ancient fireplaces have been found here. In the 1890s, according to Harrington, 1,400 head of cattle were watered at these plentiful springs. Trampling of the soil in the recharge area may have contributed to the failure of the springs. Now the seeps dry up in summer. Willows, hackberries, cedars, and algerita shrubs grow here.

Wolf Springs (9) are six kilometers north-northeast of Coahoma on Charlie and Mattie Wolf's ranch. Many Indian sites have been found in this vicinity. The slightly saline water seeps from Ogallala sand and gravel on Triassic clay. On May 27, 1979, it barely flowed 50 meters before disappearing. Raccoon tracks are numerous. Other similar seeps occur nearby.

One kilometer south of the Sand Springs community, in Sandy Hollow, are **Sand Springs (10)**. A

mastodon tusk and several Indian sites have been found here. In 1849 Capt. R.B. Marcy wrote of these springs:

a spring in a beautiful timbered valley, with excellent grass. The spring is in the limestone rocks to the south of the road, and furnishes a good supply of water.

In 1879 the U.S. Engineer Department called the springs **Day Springs** on their map *Map of the vicinity of Fort Concho, Texas*. Later they were dubbed Sand Springs by William Harris, who operated the store here. Early residents carried water from the springs, and in the 1930s their water was used in the construction of Highway 80. Thomas Moreno guided the writer to the springs. Many springs trickle from Ogallala gravel and lower Cretaceous limestone on Triassic clay. On May 27, 1979, the discharge of slightly saline water was 3.9 lps. Waste water from the Sand Springs community probably helps to recharge the springs. Salt cedar, salt-wort, and cattails abound. Minnows dart in the pools, where raccoon, turkey, and deer tracks may be seen.

Six kilometers south-southeast of Coahoma are **Powell Springs (8)** on R.L. and Bobbie Powell's ranch. On May 27, 1979, about 0.25 lps of slightly saline water trickled from Ogallala sand on Triassic clay, flowing 200 meters to Beals Creek. Frogs and tiny shrimp dart among the water milfoil. There are much mesquite, cockleburs, and some algerita shrubs, and in spring white prickly poppy and purple and yellow trompillo blossoms.

Nine kilometers southeast of Coahoma are some seeps (7) on O.D. O'Daniel's ranch. On April 16, 1936, they produced 2 barrels per day (0.0037 lps) and irrigated a garden. They are still reported to seep in wet weather from Ogallala sand and gravel, but on May 27, 1979, they were dry. An earth tank is located here now, fringed with salt cedar, where killdeers devour tiny



Moss Springs.

shrimp. Many oil wells pump nearby.

Moss Springs (6) are seven kilometers southwest of Coahoma and just upstream from Moss Lake, which helps supply water for the city of Big Spring, on Gary Turner's ranch. In 1877 buffalo hunters camped here, calling the place Mossy Rock Springs. Smither's and Eggleston's 1880 and Livermore's 1883 maps showed Moss Springs. Bedrock mortars and various artifacts of a prehistoric people have been found here. The fresh water pours from Antlers conglomerate on Triassic shale at an elevation of 723 meters. The conglomerate forms a cliff around a large pool, into which boulders have fallen.

Jim Byers, who operates the Moss Lake concession, guided the writer to Moss Springs. He states that the pool was very popular for swimming and fishing in the 1930s. On April 20, 1936, the discharge was 1.6 lps. During 1937 it ranged from 3.2 to 6.3 lps. On May 29, 1979, it was 1.1 lps. Maidenhair ferns cling to the rock walls and cattails and willow trees fringe the pools. Many raccoons and rattlesnakes haunt the area. A historical marker at the springs has been used for target practice by so-called sportsmen.

Barnett Springs (11) are 14 kilometers east-southeast of the city of Big Spring on Dorothy Garrett's ranch. These very small springs are at the head of Chimney Creek. Similar springs from Antlers sand occur three kilometers south of Barnett Springs.

Four-Mile Spring (3) was 10 kilometers southeast of Big Spring on Kent Morgan's ranch. Presumably the name derived from the fact that the spring was four miles upstream from Moss Springs on Moss Creek. W. Merritt's 1874 map of a *Scout from Fort Concho to Big Spring* showed Four-Mile Spring. This was a strong spring until the city of Big Spring drilled wells two kilometers west in 1929. On February 15, 1936, there was only a weak seep (one barrel per day or 0.002 lps). Soon after, the spring dried up completely. Two abandoned windmill wells are adjacent. Moss Creek channel has been largely filled with sand in this reach. Live oak, mesquite, sumac, and algerita shrubs cover the site, colored by yellow prickly pear and pink cholla blossoms in spring. (See Plate 2, e).

Four kilometers north-northwest of Ross City on the H.R. Clay estate were **Blue Springs (2)**. They are probably the same as the **White Springs** on Smither's and Eggleston's 1880 map and E.D. Dorchester's 1927 map of *Trails made by Gen. R.S. Mackenzie in Texas, Indian territory, New Mexico, and old Mexico in 1871-75*. Several Indian sites have been found here. According to A.J. McNallen, a nearby resident, three graves of cavalymen killed by Indians are located here. This was

an important watering place for deer and cattle. In 1973 the springs were dynamited in an effort to revive them. The attempt failed and the springs dried up.

Three kilometers north-northeast of Ross City are **Kane Springs (1)**, on Doris Chalk Cole's ranch. They were portrayed on Capt. A.S.B. Keyes' 1879 map of *Scouts of Company D, 10th Cavalry*. The moderately saline water seeps from lower Cretaceous limestone and sandstone. On May 27, 1979, the discharge was 0.06 lps, running 100 meters before sinking into the sand. Raccoon and turkey tracks are numerous among the salt cedars. Many oil wells pump nearby.

Fox Springs (5) were five kilometers southeast of the city of Big Spring at Kent Morgan's ranch headquarters. They poured from Antlers sand on Triassic shale. On August 14, 1936, 0.13 lps flowed through a pipe to a concrete stock tank. In 1941 when Morgan arrived here there was still a small discharge, but the springs have now been dry for many years.

Big Springs (4) were in the city park on the south side of the city of Big Springs. This was a favorite haunt of Comanches and their prehistoric predecessors, whose trails radiated from here in all directions. The springs were a great watering place for buffalo, antelope, and deer. In the 1840s Comanches and Pawnees, displaced by the white men, fought over possession of Big Springs. In 1849 Lt. Nathaniel Michler wrote (U.S. Senate, 1850):

We encamped at the "Big Springs of the Colorado", and remained there the following day to rest our animals. These springs are very large, and a considerable quantity of water is obtained from them; they cover a space of about 20 feet square, and in some places the water is 15 feet in depth by measurement. They are walled in by a ledge of high rocks, forming a concave surface, within which the basin of the springs lies. The water is impregnated with lime, and is cool, fresh, and perfectly clear. It is carried away in a bold, running stream, which in a short distance sinks below the surface.

In 1853 the Rhine party stopped here. Their impression of Big Springs (Anonymous, 1954) follows:

The next curiosity with which we met of importance was a very pleasant one indeed as well as a most lovely sight — well gentle reader, imagine forty seven thirsty and almost famished men, arriving to a splendid spring of pure cool water about 12 o'clock of a real hot day, over shadowed with a cliff of Rock, and you may form some idea. Such was our fortune, at the commencement of the great Sandy Desert, which from the scarcity of water thereafter, it seems as though the God of nature had placed it there for the weary and thirsty traveller on the road to California.

This large spring of pure water should be known to all emigrants, as the next watering point called by Capt. Marcy the "Logoonos," is quite brackish indeed, and hardly can be used: many of our command could not use the coffee made with it.

In 1854 Capt. John Pope remarked on the "excellent water" of Big Springs. In the 1870s buffalo hunters camped here. In 1875 Lt. Col. W.R. Shafter wrote (Crimmins, 1933):

Big Spring is a very large spring of excellent water, in a rocky gorge between two very high hills.

In 1881 the Texas and Pacific Railroad came through Big Spring. The spring water was piped to the railroad. It was also hauled to town and sold for 25¢ per barrel. At that time the springs produced about 4.4 lps. But as the springs did not yield enough water to meet the demands of the railroad and the growing town, around 1900 the railroad began drilling wells near the springs. After heavy pumping from the wells, the springs ceased to flow. Additional wells were put down close by to supply the city with water. By 1925 the city park well field around the springs was pumped dry.

Big Springs flowed from lower Cretaceous limestones and sands in a sink or collapse area, at an elevation of 765 meters. Since 1967 well water has been piped to the springs to form a waterfall and restore some of the recreational value to the area. A dam just downstream now backs water over the former springs pool. (See Plate 14, e).

Cardwell Springs (13) were four kilometers northeast of Big Spring on Highway 700 on Jim and Cheryl Cahill's ranch. In 1936 the fresh water was used to irrigate 8 hectares of cotton. Now surface flow has ceased, and a tank has been excavated, in which the groundwater level stood about one meter below the surrounding surface on May 28, 1979. Large goldfish swim in the tank, which is now used to irrigate pasture.

One kilometer west of Cardwell Springs are **Bolinger Springs (14)** on Sam Bolinger's ranch. They issue from Ogallala caliche on Triassic clay. A deep pool 30 meters in diameter, shaded by salt cedar, has been formed below the caliche ledge in a valley trench. On May 28, 1979, 0.05 lps of slightly saline water ran from the pool a short distance down the channel. Red-horse shiners dart in the water while many birds sing in the trees.

About 15 kilometers west of Big Spring is Sulphur Springs Draw (12), which flows through Natural Dam

Salt Lake. Capt. R.B. Marcy passed this place in 1849, writing:

We marched twenty-three miles to-day in a course N. 72° 22' E., which brought us to the Laguna, or Salt Lake. The country has been similar to that of yesterday, over the high rolling table lands of the Mesa, with no wood except the small mezquite brush. The water in the Laguna is brackish, but there is a small pond south of the road where we are encamped, which, although it is slightly sulphurous, is not unpalatable.

Should travellers come to this place, on their way to New Mexico, in an extremely dry season of the year, I would recommend them to carry from here in their wagons a supply of drinking water sufficient for two days, as this would last them until they reached the sand hills, if, by any accident, they did not discover the Mustang pond.

According to Mrs. Bill McElvane, who lives along the draw, in wet weather seepage causes the draw to flow. A chain of lakes fringed with salt cedar follows the draw. The water is too saline for cattle to drink. On April 20, 1979, there was a large spring-fed discharge passing Highway 176 upstream from Natural Dam Salt Lake. On May 28, 1979, there was no flow in Sulphur Springs Draw at Interstate 20 below the lake.

HUDSPETH COUNTY

For many thousands of years mankind has made good use of the springs in Hudspeth County. Evidence of their occupation has nearly always been found close to the springs. When Spanish explorers began to arrive in the late sixteenth century, they found an agricultural people called the Jumanos or Mansos, who knew how to employ water for irrigation in this hostile climate.

At the end of the glacial age, about 10,000 years ago, the Salt Lakes reached their highest level, about 12 meters above the lowest point. Indian campsites were located on the lake shores near springs such as Crow Springs. In the 1920s the flats were still largely covered with water. Since then irrigation pumping has completely dried them up. Now they are used as a racetrack for recreational vehicles.

According to King (1948), until about 1905 there were no channels in the smaller draws — only swampy swales covered with deep grass. When overgrazing destroyed the grasses and the trees were removed, valley trenches or gullies began cutting headward, lowering the water table and burying downstream springs under sediment.

The springs of Hudspeth County issue from a great variety of rocks. These include Precambrian sandstone, Cretaceous limestone, and some Tertiary igneous in-

trusive rocks. The hot springs along the Rio Grande are believed to lie in a rift zone or area of diverging crustal plates (Mattison and others, 1978). Water tables have been declining because of a number of factors, chiefly well pumping and overgrazing. Overgrazing has reduced the capacity of the soil to recharge the aquifers by destroying the formerly lush grasses and their layer of organic mulch. Consequently many springs have declined in flow or failed. However, following about 25 centimeters of rain in September, 1978, most springs revived temporarily.

The quality of the spring waters is generally high. They are usually fresh, hard, and of neutral pH, being of a sodium bicarbonate type. The water of hot springs such as Indian Hot Springs can be very high in minerals such as iron, sodium, sulfate, and chloride. The analyses of the hot springs' water shown in the table of Selected Chemical Analyses were taken from Christopher Henry's study of geothermal resources. Two to three milligrams per liter of lithium were also found in the hot springs' water by Henry. Mattison and others (1978) found strontium contents of as much as 3.9 milligrams per liter in the hot springs' water.

The writer's field studies were made, unless otherwise noted, during the period April 22-30, 1976. In this area the best rains fall in the period July through September, and this or a little later is also the period of greatest spring flow. Near the higher mountains snow melt also causes a rise in spring flow during the spring.

On Washburn Peak in the Comudas (Homed) Mountains close to the New Mexico line were **Washburn** and **Persimmon Springs (13)**. That they were important to early travelers is evidenced by their appearance on several maps of the 1860s and 1870s. Dry now, they flowed from Tertiary intrusive rocks. A few kilometers north, in New Mexico, a small seep still flows at the Butterfield stage stand ruins.

Cove Spring (14) was also shown on several maps of the 1860s and 1870s. It was on the south side of the Sierra Tinaja Pinta (Paint Waterhole Mountains) on Nelson Puett's ranch at latitude 31° 51' and longitude 105° 26'. This very small spring, formerly used as a goat camp, ceased flowing in the 1950s, but still seeps intermittently.

In the Antelope or Red Hills 22 kilometers southwest of Salt Flat were **Shot Springs (15)**. Also called **Shirt** or **Short Springs**, they were depicted on several maps of the late 1800s. They formerly flowed from rhyolite boulders among the hills. Indians lived in the caves beneath the boulders, and left several bedrock mortar holes.

Thirteen kilometers east of Dell City and one south

of the New Mexico line on the Salt Flats were **Crow Springs** or **Ojos del Cuervo (8)**. The water probably was recharged through sinkholes to the north, possibly passing through the Bone Spring and Victoria Peak limestone. In 1849 Bryan described the springs and surrounding area:

The dry bed of what seems to have been a salt lake appears. It is a perfectly smooth bed of white sand. At 1 o'clock arrived at Ojo del Cuervo, which is a spring of brackish water in the open prairie. The grazing is very poor, and there is no wood. We found a hole, dug under the bushes by some California party, which furnished us tolerable water. The spring of Ojo del Cuervo is quite strongly impregnated with sulphur.

In the words of Captain Marcy (1851),

...we turned almost due east, and traveled towards the southern peak of a high range of mountains called the "Sierra Guadalupe." For the first five miles we passed directly at the foot of a low range of hills running northeast and southwest, after leaving which we struck out upon the high prairie, and found the road most excellent the entire distance to the Ojo del Cuervo, or Crow Spring. The spring is upon the open plain, and contains a large supply of water at all seasons; and, although it sulphurous, yet animals are very fond of it, and we found it to answer, in the absence of better, for drinking and cooking.

In 1854 Captain John Pope wrote:

...the spring and two small lakes, slightly sulphureous, known as the "Ojo de Cuervo", or Crow spring. These lakes cover four or five acres of ground, and although shallow, contain abundance of living water. Many wells have been dug in the vicinity, which supply water less impregnated with sulphur than the lakes.

From 1846 on the springs were a very important stop in this desert country for wagon trains. In 1850 John Bartlett, exploring for the U.S. government, could not find Crow Springs, but did find drinkable water here, "smelling strongly of sulphuretted hydrogen", presumably in one of the shallow wells. In 1858 there was a stage stand here on the Butterfield Overland mail route, before the more southerly Davis Mountains route was adopted. In 1870 the Ninth Cavalry captured 30 horses and the supplies of an Indian village at Crow Springs. During the Apache "wars" in the 1880s, U.S. cavalry and Texas rangers camped here.

On November 28, 1948, Crow Springs still trickled 0.19 lps. In the 1950s a large irrigation well was put down at the springs, which of course immediately spelled the end for this oasis in the desert. The depres-



Irrigation well at the site of former Crow Springs.

sion where the springs flowed may still be seen, and a few trees still exist there, but probably not for long at the rate that salt water is being drawn into the area by pumping. A historical marker is located on Highway 62 to the south. The crows for which the springs were named have disappeared with the springs and their biotic community. As may be seen in the table of Selected Chemical Analyses, the water was slightly saline. An analysis made in 1904 showed it to contain 350 milligrams of organic matter per liter in addition to 1,290 mg/l of dissolved mineral solids.

Farther south on the east side of the Salt Flat were **Sulphur Springs (17)**. Col. B. H. Grierson's command spent some time here in 1880 while chasing Apache Chief Victorio and his band. The springs were shown on Livermore's and Butterfield's 1881 *Military map of the Rio Grande frontier*. One was just south of Highway 62; another was seven kilometers north, and two northwest of the old Ables post office. There was much grass around these springs, which flowed saline water until about 1925.

Four kilometers southeast of Salt Flat were **Cottonwood Springs (16)**, at the base of an old lake-shore beach. This was probably the spot where Capt. Francisco Amangual camped in 1808 on his journey from San Elizario to San Antonio. He described the springs as

two pools of sulfur water with a large amount of copperas.

The drinkable water of Cottonwood Springs later issued from a spring box, surrounded by cottonwoods and willows. Cottonwood Springs were used by the cavalry during the Salt War of 1877, and were also employed as a stage stop when Indians were present at Crow Springs to the north, according to Isobel Gilmore

of Salt Flat. Settlers at Salt Flat in 1929 obtained their water here until a well could be dug. The springs have long been dry.

Twenty-two kilometers south-southwest of Salt Flat, on the south side of *Sierra Prieta* or Black Mountains, are **Aparejo** or **Harness Springs (18)**. In the 1860s and 1870s they were shown on several maps of the area. They are now only wet-weather seeps from volcanic rock on Nelson Puett's ranch.

Fifty-one kilometers north of Van Horn and just west of the Culberson County line on the Figure 2 ranch, operated by James Garlick, were **Apache Springs (9)**. In 1857 Rogers and Johnston depicted them as **Ojo del Tucson**. A 1904 topographic map indicated that they were still flowing at that time. They appeared through a fault in the Bone Spring limestone. A well drilled just to the east was probably the main cause of the springs' demise. Bighorn sheep which formerly thrived in this area have been extirpated in Texas. Some attempts are being made to reestablish them, but lack of water is a problem.

Sixteen kilometers northwest of Van Horn in an extremely interesting geologic area are **Cowan Springs (6)**. They are in a much-mined area in the Millican Hills on the south flank of the *Sierra Diablo* (Devil Mountains). They can be driven to on fairly good mining roads. They flowed 0.65 lps from much-jointed and faulted Precambrian Hazel sandstone in 1976. The water collects in pools in the rock and has formed an oasis in this desert country, with many trees at the spring and downstream. The abandoned Sancho Panza copper mine is 2 kilometers southwest. In 1880 Victorio and his band stopped here after being denied the use of Rattlesnake Springs to the north.

Buck Springs (23) are located 13 kilometers west-northwest of Van Horn in a talc-mining area called Red Valley. Gen. Henry Sibley's command called them **Buckskin Springs** (Faulkner, 1951). They seep from Precambrian Allamoore volcanic rocks which have been intensely folded and faulted. One of the springs was formerly walled up and the water piped downstream. An owl was making its home at the springs at the time of the writer's visit.

Ten kilometers northwest of Van Horn on the Culberson County line are **Bass Springs (32)** in Bass Canyon. They are on Sam Mann's ranch, leased by Jess Taber. Butterfield stagecoaches stopped here in the 1850s. Needless to say, there were many skirmishes with Indians who concealed themselves on the canyon walls. The water issues from gravel behind an outcrop of Precambrian metamorphosed arkose which dips steeply downstream. The spring reportedly flowed well

after the heavy September, 1978, rains. But on June 17, 1979, there were only stagnant pools in the channel.

An old dam, now broken, once collected Bass Springs' flow. A windmill pumps nearby. White cabbage butterflies, rabbits, and doves frequent the pools, where deer tracks may be seen. Chinaberry and desert willow trees and nut grass thrive here. According to Taber, a similar, slightly stronger spring is located five kilometers north.

Wilson Springs (10) are about 30 kilometers southwest of Van Horn on the Hoosier ranch, leased by Jess Taber, in a rather wild area at latitude 30° 48' and longitude 104° 58'. Fresh water seeps from gravel on top of Yucca conglomerate. A fairly large cedar tree grows at the lower spring, which is three kilometers southwest of the old ranch house. Two kilometers upstream is the upper spring, also only a seep, which issues through a fault in the Yucca. Wayne Robinson, who formerly leased the ranch, kindly lent the writer a four-wheel-drive vehicle to reach the springs. Two other small springs in this area are **Squaw Springs (24)** eight kilometers west of the ranch house, and **Mesquite Springs (25)** 13 kilometers south on Green River. The latter produced 4.2 lps of fresh water in 1974.

Twenty-one kilometers southeast of Sierra Blanca and three southwest of the Eagle Mountain ranch headquarters are **Alamo or Cottonwood Springs (5)**, at latitude 30° 54' and longitude 105° 04'. Here in 1880, in the last Indian campaign in Texas, a small patrol of the Ninth Cavalry encountered Victorio's band returning from Mexico and engaged it in a running fight. The springs can be reached only by hiking over some high mountains from the ranch house. They flowed 0.05 lps from Tertiary rhyolite and gravel in 1976. Other nearby springs include **Oxford Springs**, nine kilometers south of the ranch house, reportedly flowing 0.50 lps, and **Syphon Springs**, one kilometer north, reported to be flowing 0.30 lps which is used by the ranch headquarters.

Eagle Springs or Ojos del Aguila (11) are 28 kilometers southeast of Sierra Blanca on the Espy ranch, at latitude 30° 59' and longitude 105° 06'. Owen Gray, who leases the ranch, kindly directed the writer to the springs, which can be reached by automobile over about 10 kilometers of private road from the ranch house at Hot Wells. The geology at the site is complex, with many faults and intrusive igneous dikes, but the springs flow from the Cox sandstone.

In 1849 Major Robert Neighbors called them *Puerto de la Cola del Aguila* or Eagle Tail Haven. As they were

described in 1850 by Lt. S.G. French (U.S. Senate 1850):

Eagle springs are found in a ravine formed by the spurs of the mountains. Although the precaution was taken to march the train in four divisions, each on consecutive days, yet water was not found sufficient for one-third of the animals: consequently, they had to travel seventy miles without water. The water did not run, but merely oozed out of the ground, and was collected in numerous holes dug for that purpose. During most of the year, perhaps, more water might be found; and now, at all seasons there *will be* found in the pits that were sunk enough for ordinary trains.

From 1854 to 1882 stages and wagon trains using the Overland-Chihuahua or Old Spanish trail stopped here for water. The ruins of the stage stand and a historical marker still stand one-half kilometer downstream from the springs.

In 1854 Apaches stole the stock of a traveling party who were camped at Eagle Springs. In 1857 the Leach wagon train passed the springs. According to Williams (1953), they wrote:

at a distance of 5 miles we came to "Eagle Springs" but did not stop there on account of Indians whose regular stopping place it is reputed to be. Continuing our march camp was ordered to be pitched on the plains 7 miles west of Eagle Springs where we found good grazing.

In 1862 Eagle Springs were occupied by Union troops. In 1867 Major Edward Meyer described them as follows (Duke, 1973):

Fair camping Grounds at Stage Station on the Road 500 yards south of which is the "Spring" with a limited supply of not very good water, grazing very poor and wood scarce.

The stagecoaches were frequent victims of the Apaches, reluctant to give up this choice living area. In 1879-80 a cavalry subpost was located here, part of a 5,000-man force in two nations trying to catch up with that brilliant tactician and last holdout of the Mescalero Apaches, Victorio.

In 1972 the discharge of Eagle Springs was 0.22 lps of fresh water. On April 25, 1976, the flow of 0.15 lps disappeared into gravel 50 meters downstream from the springs.

Carpenter Springs, 5 kilometers southeast of Eagle Springs, was reported to be flowing 0.18 lps; **Indian Springs** 8 kilometers west, produced 0.05 lps; and **Panther Springs**, three kilometers southwest,

only seeped in 1976.

Tinaja de los Palmas or Rocky Point, about 22 kilometers west of Eagle Springs, is not a spring but a water hole in the rocks. Here Col. Benjamin Grierson's forces in 1880 killed two of Apache chief Victorio's party coming into the area from Mexico.

Probably the best known springs in the county are **Indian Hot Springs** or **Ojos Calientes de los Indios (2)**. They rise at an elevation of 1,010 meters on the Rio Grande, some 40 kilometers south of Sierra Blanca, at latitude 30° 49' and longitude 105° 19'. The springs are probably fed by surface-recharged waters that circulate to moderate depths in lower Cretaceous limestone, become heated, return upward through the Caballo fault, and emerge through bolson sand and

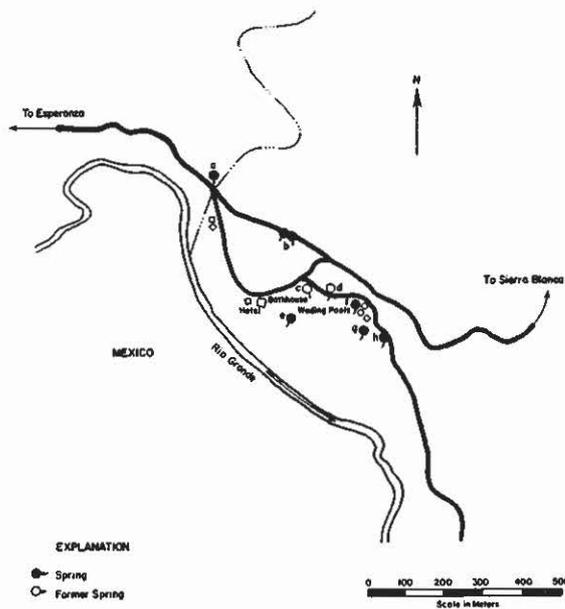
gravel. Travertine deposits in the bolson sediments indicate that the springs once flowed from the terrace as much as 6 meters higher than at present.

Indian Hot Springs' healthful value was known long ago to the prehistoric people of the area, who cut out a stone trough to use them for bathing. The Mendoza-Lopez expedition of 1683 probably passed this way. Later the Mescalero Apaches, when they were the lords of the area, depended upon the heavily mineralized waters together with muds and mosses to heal wounds in a hurry. Victorio and his band used these springs between some of the last battles for their land in Texas. During the Pancho Villa campaign General Pershing had a small airport near the springs and used the Indian Hot Springs ford to cross the Rio Grande.

A resort and hotel has operated here since the 1920s. Recently it has been purchased by Joe Brown of Houston, and is operated by Sid and Mary Lee. It is hard to imagine a better place to get away from it all than this remote spot. Large agates, onyx, and mineralized wood lure rock hounds to the area. Crimson ocotillo blossoms bloom in spring. (See Plate 13, c).

The accompanying map shows the location of the various Indian Springs. **Soda Springs (a)** are cold and less mineralized. Their water is used internally for its therapeutic effects. **Beauty or Horse Trough Springs (b)** are near the main entrance. **Chief Springs (c)**, the largest, are used for steam baths in the bathhouse. **Squaw Springs (d)** are said to have been used by Indian women in the past. **Dynamite Springs (e)** were dynamited around 1970 in a futile effort to increase their flow. **Stump Springs (f)** are used in wading pools. **Mexican Springs (g)** are utilized mainly by Mexican-American workers. **Masons or Fishing Hole Springs (h)** are the farthest east.

Location of the various Indian Hot Springs.



The discharge records of the various Indian Springs in lps are as follows:

	Soda	Beauty	Chief	Squaw	Dynamite	Stump	Mexican	Fishing Hole	Total
Dec. 4, 1961	0.01		(pumped)		0.63	0.76			1.40
May 5, 1971			"						0
July, 1971			"						0
May 22, 1973	0.13		"	0.38	0.13	0.88			1.52
Apr. 22, 1976	0	0	"	0	0	0	0	0	0
Jun. 18, 1979	1.7	0.06	"	0	Seep	0.12	1.2	0.28	3.36

Although Chief Springs no longer flow, being pumped constantly, they maintain a water level near the top of the travertine mound and bubble vigorously because of the contained gases. At Chief, Squaw, and Stump Springs large mounds of travertine have been built up by the precipitation of solids from the water upon cooling. The entire area is covered with a white residue where the springs formerly overflowed. Stearns and others (1937) reported that the flow of the main springs ceased after the earthquake of 1931. While this is certainly possible, there are other forces at work here which are more likely causes of the springs' decline. Pumps have been installed in the larger springs, and other pumping wells are nearby.

At some of the Indian Hot Springs a decrease in discharge has been accompanied by a decrease in temperature. For example, in 1934 Sellards and others reported Chief Springs to have a temperature of 49° Celsius, in 1937 Stearns and others recorded it as 48°, and in 1976, Henry found it to be 44°. The reason for the decline in temperature may be that with a declining discharge the water takes more time to reach the surface, losing some of its heat along the way. Another reason may be that since Chief Springs no longer flow, some of the water's heat is lost in the pool from which it is pumped. The temperatures indicate that the water of the hot springs circulates through depths of up to 900 meters below the surface. Henry found a temperature of 47° C at Stump Springs, 34° C at Squaw Springs, 40° C at Beauty Springs, and 27° C at Soda Springs in 1976.

About six kilometers northwest of Indian Hot Springs, on the Talley ranch, is **Red Bull Spring (3)**, the largest remaining in the county. As the water is warm (37°C), its origin is probably related to that of Indian Hot Springs. The fresh water flows from Lower Cretaceous sandstones at the intersection of the Red Bull fault zone and the Caballo fault. The flow of 1.9 lps disappears into the stream bed before it reaches the road one kilometer south. The small rock house of the first settlers still stands nearby.

Farther north, four kilometers west of Highway 1111 at latitude 31° 27', is a former wet-weather seep (19). Still marked by a cottonwood tree, it last seeped in 1974 according to Jim Baylor.

Davis Springs (30) are 18 kilometers south-southwest of Sierra Blanca, on Nelson Puett's property, leased by J.B. Bean. According to Puett, they were used in Spanish gold-mining operations in the eighteenth century. In the early twentieth century they were much used by the U.S. Army. Issuing from near-vertical beds of the Lower Cretaceous Yucca formation, they

are now only wet-weather seeps. A small pond at the springs has been largely filled with gravel.

Barlow Springs (31) were 11 kilometers west-northwest of Sierra Blanca near the north end of the Quitman Mountains. The land is leased by Ed and Flo Love. A prehistoric people who used the spring water left several crown-polished boulders nearby, on which they worked animal skins to remove the fat and hair. The springs, now usually dry, issued from Tertiary intrusive igneous rocks at an elevation of about 1,465 meters. Cedars, thorny brush, and a few live oaks cover the site.

Twelve kilometers northeast of McNary are **Diablo Springs (21)**. They are in Diablo Arroyo just downstream from a floodwater retarding structure and at the west end of Campo Grande Mountain (actually a hill). They were much used by an ancient people. Petroglyphs, burned-rock middens, crown-polished boulders and pottery have been found upstream on the Wilkie ranch. Bedrock mortars existed at the springs according to Leo Threadgill of McNary, but apparently were destroyed during construction of the floodwater retaining dam. An old masonry dam was formerly located below the springs.

The water comes out of Quaternary gravel, being forced to rise and flow over steeply dipping beds of Cox sandstone and limestone. On May 10, 1978, the discharge was 0.75 lps, when the level of the lake upstream was just below the pipe outlet. On June 17, 1979, with a very low lake level, the springs were dry. Evidently the lake helps to maintain the springs at something like their former discharge. Bullfrogs croak among the willows and salt cedars.

Many other small springs formerly existed in southwestern Hudspeth County. Arturo Hernandez of Fort Hancock remembers a small spring (22) in a gravel pit just north of the town which flowed until about 1965. The Spaniard De Sosa may have paused here in 1590 while traveling down the Rio Grande to La Junta de los Rios.

Thaxton Springs (20) are 22 kilometers north-northeast of Fort Hancock. Bedrock mortars and paintings in nearby rock shelters testify to the use of the springs by a prehistoric people. They now only seep intermittently from Lower Cretaceous Cox sandstone. Horned toads run among the pink blossoms of eagle-claw cactus. As the road has been washed out, it is necessary to walk the last two kilometers to the site. (See Plate 16, a).

Ojos del Alamo or Cottonwood Springs (1) were in Alamo Canyon at the headquarters of the MacGuire ranch, operated by Salvador Fierro. Flowing

from Finlay limestone, they were much used by an ancient people. Mortar holes nearby have been enlarged over five centimeters by weathering, indicating that they are very old. The springs should not be confused with another Alamo Springs (5) in the Eagle Mountains.

In 1849 William Whiting, exploring routes to the west, stated:

Near here is an arroyo at this point dry ... we could see cottonwoods upon it far into the hills, an almost unfailing sign of water.

In 1850 the springs became a stop for wagon trains heading west. When the writer visited them in 1960 they were still flowing, but in 1976 and later the springs and the downstream tank were dry. Antelope are finding existence increasingly difficult in this area.

HUNT COUNTY

Most of Hunt County's springs issue or did issue from two belts of sand. The first is the Wolfe City and Pecan Gap sands, a narrow strip stretching from Wolfe City to Farmersville. The second is the Nacatoch sand, a wider belt extending from Commerce through Terrell. A few other springs existed in river terrace sands and in Tertiary Eocene sand in the southeast corner. The other geologic formations are mostly clays which cannot carry appreciable quantities of water.

The springs were much used by prehistoric people, and supported an abundant array of plant and animal life. Natural lakes were numerous.

The setting has greatly changed now. Ditches have drained all of the lakes and sediment from cultivated land has filled them. Flowing and pumping wells have so lowered the water table that few springs still flow. In the Commerce municipal well field, for example, the water table fell 56 meters in the 57-year period from 1914 to 1971. The wildlife which depended upon the springs and lakes has largely disappeared.

The water is, or was, chiefly of a sodium bicarbonate type, fresh, soft, and very alkaline. Most of the writer's field studies were made during the period October 29-November 3, 1977. Because of heavy rains, the observed discharges in this period were probably higher than normal for this season.

Swift Springs (1) were 10 kilometers southwest of Celeste and three northeast of the Merit community, on the old Swift place. Mrs. Howard Duck of Greenville remembers these very small springs flowing around

1920 in a spring house or cooler at the head of Clendenning Creek. They are now dry.

Nine kilometers south-southwest of Wolfe City is an area where seeps (2) issue from Pecan Gap limestone on top of chalk. Some maintain the water level in Horace Moore's willow-fringed pond.

Four kilometers west of Wolfe City a number of seeps (3) trickle from Quaternary sand on top of Ozan clay. On Wade McWhirter's property they suffice to keep water holes full along Spring Creek.

Black Cat Springs (4) were 12 kilometers south-southwest of Wolfe City on the E.M. Nelson ranch and to the north. The Black Cat Indian village was located here. Seeps and very small springs formerly flowed from terrace silts on the east side of the South Sulphur River. The wooded site is dry now.

Three kilometers southwest of Commerce, in the Riley Grove community, were **Riley Springs (5)**. Here Isaac Riley settled in 1844. The springs issued from a thin layer of Nacatoch sand. They have been dry since at least 1917, according to A.C. Talley, a long-time resident. Many wells nearby have drawn down the water table.

Nine kilometers south-southeast of Commerce were **Smith Springs (7)**, on James Thornton's farm. Godfrey Smith settled here in 1844. A.C. Talley remembers some seeps from a thin Nacatoch sand here about 1925. They are now dry.

Stewart Springs (6) were near the Stewart cemetery, seven kilometers south of Commerce, on the Juniper place. The source of Dunbar Creek, they also still seeped around 1925, according to Talley. They have long been dry.

Four kilometers northeast of Campbell, on Wiley Babb's ranch, are **Babb Springs (8)**. Appearing from Nacatoch sand on top of sandstone, they produced 0.07 lps on November 1, 1977, after heavy rains, from an elevation of about 170 meters. Although they are quite small, they are the largest still flowing in the county. They give rise to Dunbar Creek in a Texas oak wood. Artifacts found here indicate that the springs were popular with prehistoric people. A cotton gin was located at the springs. According to Mr. Babb, the pools of live water on Dunbar Creek never go dry. A smaller spring is located on the Craig estate to the west.

Allen Springs (9) were one kilometer west of Allen. Here Dixon Allen built his cabin in 1845. Formerly giving rise to Timber Creek, they rose from Nacatoch sand at a fault line. They have been dry for many years.

Hooker Springs (10) were six kilometers south-

southwest of Lone Oak on the J.P. McNatt ranch. Undoubtedly they were much used by prehistoric people. In 1760 a Tawakoni and Iscani (Waco) village was located here. Pedro Vial may have stopped here in 1788 en route from Santa Fe to Natchitoches, Louisiana. In 1842 James Hooker settled at the springs. A mill was later located here, and the springs were a stop on the Clarksville-Austin road. Mr. O.J. Lynch, a descendant of Hooker, was told by an early resident that the springs still flowed from a wooden box around 1915. Formerly flowing from Eocene Kincaid fine sand, they have long been dry.

HUTCHINSON COUNTY

The springs of Hutchinson County usually drain from Tertiary Ogallala sand and gravel, which can be up to 200 meters thick. The formation dips gently toward the east. The springs normally pour from the base of the Ogallala where it rests upon underlying Permian shales, sandstones, and dolomites, and in some cases from Quaternary dune sand. Most springs are found in the hilly terrain adjacent to the Canadian River.

The springs have been used for many thousands of years by various ancient people. At the Lake Creek site in northeastern Hutchinson County, near some small springs, pottery, stone tools, and the remains of bison, terrapin, and other animals date from 950 to 1,300 A.D. At the Black Dog village site between Borger and Stinnett there are also small springs. The remains of dolomite slab houses and petroglyphs were found here. Dating of timbers indicates that the village was occupied from 970 to 1,670 A.D. Other Indian villages were found in historic times on various spring-fed creeks in the county.

Plowing of land that should never have been plowed, and overgrazing have resulted in huge gullies and valley trenches, many of which are still not healed. Sediment from this erosion has choked many stream channels and buried some springs. In addition the water table has declined drastically. In the 15-year period from 1956 to 1971, the average decline for the county was 8.7 meters. As a result most of the springs have weakened and many have dried up.

Cottonwood, willow, salt cedar, and to some extent hackberry trees depend upon the spring waters for their existence. Similarly grapevines and plum thickets flourish around the springs. Many sawmills cut cottonwoods around the turn of the century. The trees have come back to some extent, but not in their former size and numbers. Although the buffalo, bear, and panther are gone, many other animals still rely upon the

springs. These include mule and white-tailed deer, antelope, turkeys, coyotes, quail, killdeers, pheasants, waterfowl, and fish.

The spring waters are of a calcium bicarbonate type, generally fresh, alkaline, and very hard. The content of silica and fluoride may be high. Contamination of the water by oil-field wastes has occurred in the past, especially by open-pit disposal of brines and improper casing of wells. Although these practices have been stopped, salt will continue to enter the groundwater for many years as a result of past actions.

Most of the writer's field studies were made during the period June 7-12, 1978. As much rain had fallen during the preceding several weeks, the observed spring discharges are probably above normal for this season.

South Palo Duro Creek was once spring-fed. According to W.E. Ford of Sunray, the creek flowed until about 1928 from Highway 1060 (in Moore County) downstream, and contained many fish.

Yake Springs (13) are on Mary Yake's ranch 12 kilometers southwest of Stinnett. These very small springs on Willow Branch appear partly in a spring house which once served the ranch house. This was a favorite campsite of Indians journeying to the Alibates flint quarries to the southwest. Burials, flint points and tools, and old corn cobs indicate that an agricultural people lived here once. A high hill nearby was reportedly used as a lookout. The springs produced 0.06 liter per second in 1978 from Ogallala sand on top of Quartermaster shale. The flow has declined in recent years, and other small springs in the vicinity have failed. Nearby have been found the remains of a mammoth which probably bogged down in the red clay.

Two kilometers north are **Camp Springs (14)**, the source of Camp Creek. On June 11, 1978 they poured out 4.7 lps from Ogallala sand among many rushes. Normally the Creek flows to Big Creek but according to Mary Yake the flow may sink into the sand in the heat of a summer day (because of evapotranspiration).

Big Springs (12) feed Big Creek about eight kilometers southwest of Stinnett. They rise chiefly on the Yake ranch and to some extent on the C.C. Burgess ranch upstream. The water once powered the Horace gristmill on the Yake ranch. Now a private park with tables and fireplaces is located here. In the 1930s the stream was dammed to provide water for the town of Phillips. The reservoir is now filled with sand and gravel.

On June 11, 1978, there was a discharge of 8.2 lps in Big Creek at the Highway 687 bridge. Minnows play in rush-fringed pools shaded by cottonwoods and salt

cedars. According to Tommy Ferguson of Stinnett, before 1960 Big Creek started at a beautiful swimming hole 1.6 kilometers downstream from Highway 152. Now the creek is dry above a point about five kilometers downstream from the highway, especially in summer. Borger municipal and industrial wells in the northern part of the watershed have probably had a part in reducing the spring flow.

Eight kilometers south-southwest of Stinnett on Hugo Riemer's ranch were **Riemer Springs (16)**. A 6,000-year-old skeleton found here attests that this was a popular spot many years ago. The ruins of Paul Riemer's stone half-dugout, built in 1900, may be seen here. The springs were reported to be flowing in 1953, but are now dry.

Tar Box Springs (15) are five kilometers south of Stinnett near Jimmy Guinn's house. When Stinnett was first organized the residents obtained their water from these springs, which feed Tar Box Creek on the Tar Box ranch. The ruins of an old stone house which stand near the springs date from before 1899, according to Ona Bryan of Stinnett. In those days the springs began farther up the creek and closer to Stinnett. In 1978 0.55 lps originated from Ogallala sand on Permian shale. Rushes, cattails, and cottonwood trees fringe the water. The site is now leased by the M and M Cattle Company.

Five kilometers south-southeast of Stinnett are **Forty-two Steps Springs (6)** on the M and M Cattle Company's ranch, managed by Eddie Hickman. This is a beautiful spot, much used by local people for outings and by boys hunting crawfish. The 1978 discharge of 4.8 lps originated from Ogallala sand and fell over a bed of Quartermaster sandstone underlain by clay about five meters high. Downstream are many smaller drops which gave rise to the name, Forty-two Steps. Yellow day primroses adorn the site in June, shaded by elm trees. (See Plate 11, e). Below the falls are the remains of a pumping installation which supplied water to an oil-field camp and drilling rigs from the 1920s to the 1950s. Many oil wells surround the springs and may have contaminated the water, which is relatively high in chloride content.

Cottonwood Creek, just to the east, formerly flowed continuously at the Highway 1526 bridge east of Stinnett, according to Tommy Ferguson. On June 11, 1978, after much rain, there was no flow here. There was, however, a discharge of 0.55 lps at Highway 2277, four kilometers south.

Eight kilometers east-northeast of Stinnett are **Smokehouse Springs (2)**, which feed Smokehouse Creek. They rise on the Spool ranch, managed by T.R. Evans. They flow into a stock tank fringed with cot-

tonwoods, with a picnic table nearby. Plum thickets and grapevines are numerous. In 1978 0.20 lps flowed from Ogallala sand and Quaternary dune sand. According to Evans, the springs dry up during the irrigation season, and the stock tank went dry recently for the first time.

Twelve kilometers east of Stinnett is Bugbee Fort, a rock house built by Col. T.S. Bugbee in 1878. Mrs. Bugbee often shot buffalo from the doorway. Now Bob Shelton and his wife live here. **Bugbee Springs (8)** were walled up in a springhouse close by. In 1882, during a tornado and torrential rains, Bugbee Creek changed its course and carried away the springhouse. In 1922 the springs discharge reportedly filled a two-inch pipe. Bugbee Springs still seep from Ogallala sand on Quartermaster sandstone into a swimming pool. According to Evans, the flow has declined greatly since he lived in the rock house in 1948-58, due to irrigation pumping.

The ghost town of Plemons is 12 kilometers east-southeast of Stinnett. Here J. A. Whittington built his dugout in 1898, and in 1901 the county seat was here. There were springs close by then which attracted the settlers. In 1906 "a number of strong springs" were reported west of Plemons. These springs were **Plemons (7)**, **Edgel (9)**, **Tub (10)**, and **Howell (11)**, which were one, two, four, and five kilometers respectively west of Plemons. All are only seeps now from Ogallala coarse sand on Quartermaster sandstone and shale. Martin Beasley, the last resident of Plemons, says that Plemons Springs were still flowing when he came here in 1943. A windmill which formerly pumped nearby undoubtedly hastened the springs' demise. Irrigation pumping has greatly affected all of these springs. They are also surrounded by oil wells. The sites, still haunted by deer, are marked by cottonwood, willow, and hackberry trees and grapevines.

In eastern Hutchinson County near the Turkey Track ranch, at latitude 35° 53' and longitude 101° 10', was the old Bent trading post and fort, also called Adobe Walls. No doubt Bent selected this location because of the numerous springs in the vicinity. Here two battles were fought with the Indians, in 1864 and 1874. And here may be seen something very rare in these times: a monument to the Comanches and Cheyennes who died in the second battle defending their homeland. **Adobe Walls Springs (1)** are now only a series of seeps from Ogallala sand at the base of a ridge about 300 meters west of the monument. Five swampy areas exist here, containing many rushes and wetland grasses. Where the northernmost swamp is cut by the road ditch, 0.10 lps emerged on June 9, 1978. The water contains 250 milligrams of sulfate per liter,

indicating that it percolates through gypsum, probably the Quartermaster.

Two kilometers west of the Adobe Walls monument are **Bent Springs (4)**, the source of Bent Creek, on the Turkey Track ranch. Here traces of a very early irrigation system have been found, which represent possibly the use of the spring waters by the Village agricultural people of pre-Columbian times. In 1898 Hutson reported that the spring waters irrigated "several hundred acres" of alfalfa, vegetables, and fruit. They produced 17 lps from Ogallala sand on June 10, 1978, after much rain. These largest springs in the county appear at an elevation of around 840 meters. Surrounded by a large grove of cottonwood and other trees, they supply a six-hectare lake.

Curiously, other creeks in this vicinity such as Carson and Lake Creeks to the west of Bent Creek and Adobe Creek to the east are nearly dry or exhibit only very small springs. **Turkey Track Springs (3)** are near the Turkey Track ranch house and on the adjacent Adobe Creek, about three kilometers north of the Adobe Walls monument. They are now only wet-weather seeps and swampy areas in Ogallala sand and Quaternary sand dunes. Cottonwoods, salt cedars, grapevines, and plum thickets are abundant here.

Johns Springs (5) were nine kilometers northeast of the Adobe Walls monument on Mrs. Elsie Mathews' ranch. Feeding Johns Creek, the springs were once the site of an Indian village and burial ground. They issued from coarse Ogallala sand, but are now dry. Cottonwood and hackberry trees and gourds mark the site. Many windmills pump in the vicinity.

In the southeast corner of the county on Traylor Price's ranch are **White Deer Springs (21)**, at latitude 35° 41' and longitude 101° 07'. The springs, which feed White Deer Creek, formerly flowed three kilometers south (upstream), from their present head. Many artifacts such as pottery, metates, and flint points and tools attest that an Indian village existed at these more southerly springs. Cottonwood trees still grow about five kilometers south of the present spring headwaters. Lt. James Abert and his mule train stopped here in 1845, while travelling east. He described the site as follows, calling White Deer Arrow Creek:

We moved pleasantly along with but little obstruction, until obliged to cross the sandy bed of "Arrow creek," a fine stream of pure water, remarkably straight, and well timbered with characteristic cottonwood, and lined along its banks with excellent pasturage. Stopping here a few moments in order to refresh our horses, we resumed our journey, but soon found ourselves involved in sand-hills, some of which we noticed on our right of considerable height.

In 1850 Capt. Randolph Marcy stopped at White Deer Springs while exploring the route from Fort Smith to Santa Fe, and wrote:

June 6 — We made a drive of twenty-two and a half miles to-day, but did not follow the "Divide" far, as it turned too much south. We crossed several dry ravines, where there will generally be water found, as it is but a few days since they became dry. We, however, found no water until we arrived at our present camp. This is upon a very beautiful, clear stream of spring water. The valley through which the stream runs is about five miles wide, and has a great deal of large cottonwood timber upon it. The grass is of the best quality, (mezquite) and there is little arable soil upon the banks of the creek. This is the largest affluent of the Canadian we have passed since leaving Spring creek. Notwithstanding it runs over a very wide bed of quicksand, yet there will always be running water found here, as the stream is fed by numerous large springs. It is one of the best camping places upon the road, and as some of our wagon tires are loose and require resetting, I shall "lie over" tomorrow for that purpose. From the fact of this stream having so much more timber upon its banks than the others we have passed, I have called it Timbered creek upon my map.

Later the Mobeetie-Tascosa mail route passed the springs. According to Price, there has been much decline in the discharge since he came here in 1934. The spring flow decreases markedly in summer during irrigation pumping.

A second **Tub Springs (25)** are located in a remote area on John Allen's ranch 16 kilometers northeast of Phillips. They trickle from Ogallala gravel on Permian shale in a bluff south of the Canadian River and east of Spring Creek. An archeological site here has yielded Plainview points, possibly 9,000 years old, as well as many other artifacts 700 to 800 years old. In the late 1920s and early 1930s the water was used in a bootleg whiskey still. On July 8, 1978, the discharge was 0.83 lps from a pipe amid fern beds. The dog of Charlie Bell, who guided the writer to the springs, routed a porcupine from a thicket here and received a nose full of quills for his trouble.

Spring Creek Springs (17) are 12 kilometers east of Phillips on Jim Nix's ranch. In 1850 the spring headwaters were several kilometers farther upstream (south) on Carl Meyer's ranch. In that year Marcy said of them:

June 8. — At seven miles from our last camp we crossed another stream of pure spring water, where there is wood and grass in abundance.

Cottonwoods are still present at this upper location, but are doomed as the water table continues to fall. The stream channel here is choked with sand. Many wells

pump the groundwater from upper Spring Creek watershed to a gravel pit to the west and Skellytown to the southeast. The springs now head around Nix's fishing lake, producing a discharge in Spring Creek from Ogallala sand of 5.1 lps on June 12, 1978 at the county road two kilometers north. But on July 8, 1978, there were only pools of standing water here. At this crossing the remains of an old bridge, no longer needed because large flows are now rare, may be seen. Reddish colored minnows called red-horse shiners and water striders dart among rushes and cattails, shaded by cottonwoods and salt cedars.

The water contains 1,800 milligrams of chloride per liter and has probably been contaminated by oil-field wastes, according to Nix. Since he came here in 1938, it has become unfit for drinking or garden irrigation and rapidly corrodes pipes.

About three miles from the mouth of Spring Creek Wyndham Harvey and his family built a cabin in 1901. The "clear, beautiful, spring-fed" creek is now choked with sand. On July 8, 1978, it was dry in this section. In winter it is reported to flow all the way to the Canadian River, but may dry up in places during the day.

Bear Springs (20) were eight kilometers east-southeast of Borger, near where Bear Creek crosses Highway 152 on Vernon Payton's Crutch ranch. In 1850 Marcy wrote of them:

At our present camp we have another small spring creek, which will always afford sufficient water for the traveler's purposes.

Now, however, there are only some pools of standing salty water.

Three kilometers farther north, behind the Spring Creek school on Highway 2171, springs (18) formerly ran from Ogallala gravel. According to school district superintendent L.E. Dyer, the water was formerly carried to the school. Around 1953 the water became salty and soon afterward the springs dried up. A well is located here now.

Dixon Springs (19) are four kilometers east-southeast of Borger on the Crutch ranch. Coronado's army may have paused at these springs in 1542 on its return to New Mexico. In 1850 Marcy, traveling west, stopped here, stating:

June 9. — After marching three miles this morning, we arrived upon the border of a deep valley, with high rocky bluffs upon each side, which we at once pronounced to be the stream Gregg calls "Bluff creek." Indeed, after we had passed it and ascended to the high plain on the opposite side, we fell into an old wagon trace which confirmed me in the belief.

"Bluff creek" has good wood and grass upon its banks, and water plenty. It is of the same character as Dry river [Red Deer Creek], with quicksand bed and poor soil in its valley. We followed Gregg's trace for several miles, and encamped in a ravine, where we found large pools of water coming from springs, with excellent grass and fuel. One of our gentlemen killed an antelope to-day which we made our dinner from, and found it equally as good as venison.

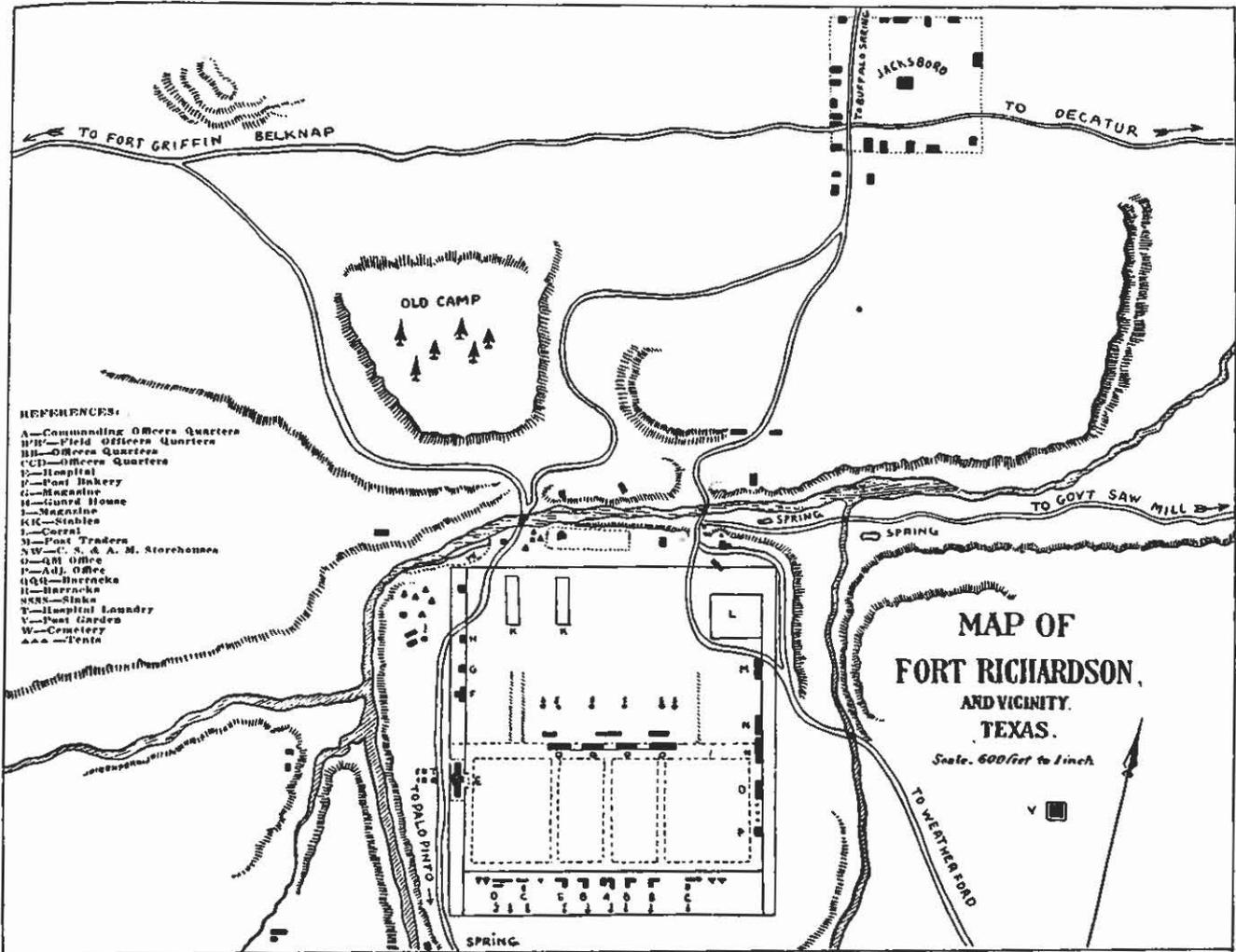
Josiah Gregg had passed this way in 1840. Dixon Springs still run from Ogallala sand on Permian shale, amid salt cedar and cottonwood trees. On June 12, 1978, 0.70 lps was flowing in Dixon Creek at the Highway 152 bridge, but on July 8, 1978, there were only pool of standing water. The channel has largely been filled with sand. According to Vernon Payton, the water has been contaminated by oil-field activities, but not as badly as that in Bear Creek to the east.

Weatherly Springs (22) were on Rock Creek three kilometers southwest of Borger. Here John and Maggie Weatherly settled in 1898, operating the Isom post office, also called Granada. A hydraulic ram was used to pump the spring water to the dugout house. Mrs. J.B. (Weatherly) Howe, who guided the writer to the site, has had a replica of the dugout built at nearby Phillips College. In the early 1900s many picnics were held at the springs. The springs, which seeped from Permian gypsum and sandstone, are now beneath Weatherly Lake and probably no longer flow. Many oil wells and pipe lines surround the site.

Along and near Antelope Creek many springs once sparkled. Here an agricultural people of the Antelope Creek focus lived from about 1100 to 1450 A.D. They left bedrock mortars at several of their living sites. One former spring (23) and bedrock mortars were located in a draw three kilometers south-southwest of Sanford, according to Dean Forest of Sanford. Lt. A.W. Whipple, surveying for a railroad route in 1853, wrote (Archaibeau, 1971):

we found a spring where we watered the mules and filled the canteens. We then proceeded nearly south to White Sandy [Antelope] creek, where, finding abundance of water in pools, we encamped. By the survey we have travelled eighteen miles, and ascended five hundred feet. The grass looks parched and dry; and, since leaving the river, scarce a tree has appeared to relieve the landscape.

Other mortars were found at a very small spring (24) which still seeps seven kilometers east of Fritch. This is on the Johnson ranch, managed by Jerry Lewis. The boulder containing these mortars is now at the home of Vern Wisdom, 501 Oak Street, in Panhandle.



JACK COUNTY

Most of the springs in Jack County issue from Pennsylvanian Cisco sandstone, conglomerate, and limestone, and Permian Wolfcampian sandstone. These formations dip to the northwest at 5 to 9 meters per kilometer. In the southeast corner of the county is an area of younger, lower Cretaceous sands and limestones, which dip gently to the east-southeast.

In early historic times the Wichitas lived at the springs. Later many other tribes, forced out of their homes in the east, lived here briefly.

At one time there are said to have been 18 springs within 1.6 kilometers of the courthouse in Jacksboro. During the great drought of 1886-87, most of the county's springs dried up temporarily. More recently, numerous pumping wells have seriously lowered the water table. As a result, many springs have weakened or failed. Severe man-made gully erosion, especially in the southeast part of the county, has choked many

stream channels with sediment and buried some springs.

The springs once supported a complex ecological system of water plants, water loving trees and shrubs, aquatic animals, and animals which fed on aquatic animals and vegetation. With the drying up of the springs, many of these plants and animals have disappeared. Some, such as algae, have increased as a result of man's pollution.

The spring waters are generally of a calcium bicarbonate type, fresh, very hard, and alkaline. The content of fluoride or iron may be high. Contamination of the water has occurred in some instances because of man's activities.

Most of the writer's field studies were made during the period May 10-15, 1979.

In and near Jacksboro on Lost Creek are a number of strong fresh-water springs which pour from Cisco limestone at an elevation of 330 meters. Some of them (1-4) are called **Fort Richardson Springs**, for the fort

which existed here from 1866 to 1878. They formed a "beautiful, clear, running creek of water meandering along the south side of Jacksboro". These springs receive their recharge in an area up to six kilometers to the southeast. The more important ones are shown on the accompanying old map of Fort Richardson and vicinity, from Huckabay (1949).

Some of the largest of these springs (2) are located behind Bill Birdwell's Gulf service station at 435 South Main Street. They are now called **Murphy Springs**, according to Jacksboro historian Russell Jones. They were the principal source of water for the fort, "always providing abundant supply of excellent sweet water". The post water wagon ran constantly. Although drainage from the post reached Lost Creek upstream from the point where water was obtained, there was little contamination or disease due to impure water. This was probably because of the constant flushing action of the many springs along the creek. One of the Murphy Springs emerges from a cavern in a Cisco limestone bluff. On May 11, 1979, 14 liters per second gushed from these springs. In the pool are marsh purslane, water cress, brookweed, and water milfoil.

Even larger are **Rumbling Springs (1)**, which give rise to Lost Creek just south of the site of the fort. According to historian Bill Dennis, these springs produced a stream of water nine meters wide as late as the 1930s. This was formerly a popular spot for picnics. On May 11, 1979, the many springs here produced 15 lps. In the running water grows much smartweed, while white wild onions and purple wine cups blossom nearby in spring. Live oak, elm, chinaberry, and hackberry trees and briars are numerous.

In a tributary to Lost Creek southwest of the fort is another group of springs (4) which flow through a small lake. On May 11, 1979, they produced 11 lps.

Just west of Depot Street and south of Lost Creek is



Murphy Springs.

an old spring enclosed in a circular concrete wall. Many fish and crawfish can be seen here, as well as raccoon tracks. On May 11, 1979, the discharge was 1.7 lps.

Downstream, on the south side of Lost Creek and "Cooper Hole" and just upstream from Lake Jacksboro, are **McConnell Springs (14)**. McConnell and Fort Richardson Springs feed Lake Jacksboro, the city water supply. On July 4, 1876, a temperance picnic was held here. In 1877 surveyor Oscar Williams described McConnell Springs thus:

Roasted bacon on green stocks for dinner — in a little valley east of town out of which comes a beautiful spring in an old deserted ranch house. The story goes that it is an old cattleman's ranch built long ago to serve against Indian attacks. Its appearance indicates the truth of the story, for it is a very solid stone house built around the mouth of the spring, to prevent water famine and guarded by loopholes opening in every quarter.

According to Dennis the springs were formerly called **Stone Springs**. The surrounding area, known as Cooper's Grove, was a popular lovers' rendezvous. The ruins of the old stone walls around the springs can still be seen, but they have largely been destroyed by vandals. On May 13, 1969, the springs produced 1.3 lps.

Across Lost Creek from McConnell Springs are **Dennis Springs (15)**, on Bill Dennis' property. Shallow bedrock mortars indicate that this was a living spot long before white man appeared on the scene. The springs issue from a hole in the bluff of Cisco limestone and feed a minnow pond. Pondweed and water cress are abundant. On May 13, 1979, 0.55 lps poured out.

Ham Springs (21) are eight kilometers west of Jacksboro on John Lowrance's ranch. The great-grandfather of Payton Jones of Jacksboro took care of the horses at the Butterfield stage station here around 1858. The springs seep from limy Cisco sandstone in a broad swale of very fine sand and silt. There was formerly a swamp downstream, and this area still is boggy at times.

The water-bearing rock at Ham Springs is about two meters below the surface. At one time a hole was carved in the soft stone so that water could be dipped out in buckets. Now a pool about 8 meters in diameter has been excavated down to rock. On May 14, 1979, seepage fed the pool but there was no overflow. Swamp rushes thrive here. Nearby is an old stone fence and cemetery. Indian artifacts have been found in the vicinity.

Ranger Springs (5) are six kilometers east of

Jermyn on Charles Hayhurst's ranch. Also called **Dripping Springs**, they produce fresh iron-bearing water from Cisco sandstone. On May 12, 1979, 0.12 lps trickled from between boulders, feeding a pond containing water milfoil and cattails. Willow, live and post oak, and elm trees and briars thrive here.

Three kilometers east of Antelope are **Flat Rock Springs (6)** on R.E. Voyles' ranch, leased by L.H. Kuykendall. They were shown on G.L. Gillespie's 1875 *Map of portions of Texas, New Mexico, and Indian territory*, Granger's 1878 *Map of Texas*, and Rand McNally's 1883 *Map of Texas and Indian territory*. According to W.E. Cantrell, a nearby rancher, these springs kept Spring Branch flowing constantly until the 1950s drought. On May 12, 1979, there was a discharge of 0.06 lps from Cisco sandstone, which ran 200 meters before sinking into the alluvium. Nearby are outcrops of flat sandstone, from which the springs took their name. Water striders dart among the rushes.

Six kilometers east-northeast of Antelope are some springs (7) on the Clerihew ranch. These are probably the **Mesquite Springs** shown on H.O. Hedgcoxe's 1854 *Map of the surveyed part of the Peters colony, Texas*. They were the source of Lodge Creek. Mr. Clerihew found a metate here. Evidently people lived here in the distant past. Now an earth tank covers the springs, but seepage still maintains a constant water level in the pond. An old dug, stone-lined well is close by. Mesquite trees are still here, as well as willows.

Flag Springs (8) are 14 kilometers north-northeast of Jacksboro on Lucille Gowdy's and John and Jean Lindsay's ranches. Burned-rock middens and shaft-straightening grooves in the Cisco sandstone boulders confirm that this was an ancient living site. Many more recent names and dates have also been carved in the soft rock. In 1863 Alf Lane was killed by Indians near here. In 1865 Young County courthouse records were taken to Flag Springs for temporary safekeeping. In 1881 George or Jim Bookout was shot at the springs.

According to Lucille Gowdy, who has lived at Flag Springs since 1908, during the 1886-87 drought, cattle were brought here from the surrounding counties for water. During this severe overuse of the springs, the flags or irises which once grew here were trampled and killed. On May 12, 1979, 0.08 lps of iron-bearing water poured over small waterfalls and through pools. Deer tracks are numerous around the water, which contains rushes and algae.

Rock Springs (10) are two kilometers south of Newport on Elbert Leek's ranch. In 1876 the Rock Springs church, just to the west, used the water. On May 13, 1979, 1.4 lps was trickling from Cisco sand-

stone. According to Leek, the springs dry up in summer. One small cottonwood, a few cedars, elms, and other trees line the creek below the springs. Other similar springs flow nearby.

Burton Springs (9) are six kilometers north of Maryetta on Elmer Lewis' ranch. In 1881 the Burton Springs school was here. According to Lewis, a post office, store, and gin were also located at the springs. In early days many residents were baptized in a hole below the springs. On May 13, 1979, 2.1 lps poured from Cisco sandstone, running 2.5 kilometers before disappearing. The springs sometimes fail in summer in recent years. Smartweed and beggar ticks thrive in the wet soils.

Near Wizard Wells are several strong springs gushing from Pennsylvanian Devil's Den limestone. One of the largest (11) is two kilometers southeast on the M.E. Church ranch. In 1787 Jose Mares may have stopped here on his trip from the Taovayas villages on the Red River to Bexar. On May 13, 1979, the discharge was 5.1 lps. The water is fresh and not mineralized like the shallow well water for which Wizard Wells is famous. Minnows swim among the smartweed and beggar ticks.

Westbrook Springs (13) are just north of the Westbrook community and six kilometers southeast of Joplin on Avril Sartain Holley's ranch. A large Indian village was once located here. In 1881 the Westbrook Springs school was nearby. On May 14, 1979, 0.60 lps emerged on top of a thin Twin Mountains limestone ledge in the creek bed. Several other nearby springs have been buried beneath modern sediment. In the creek bank at Westbrook Springs can be seen 2.1 meters of sediment deposited during the last 100 years or so over the original black soil. Willows, cottonwoods, briars, and plum thickets are numerous.

In 1873 there was a community about ½ kilometer southwest of present Joplin called **Haley Springs (12)**. The site is now on Herschel Eichler's ranch. The springs were very important to the early settlement. A cotton gin, saw mill, and corn mill used the water to fill their boilers, according to neighbor T.J. Spencer. The water poured from lower Cretaceous Twin Mountains sand.

Being relatively high topographically, Haley Springs failed early. On May 13, 1979, there were still some pools of water near two cottonwood trees. The springs were originally at the head of a ravine. In modern times, with clearing of the timber, huge gullies have extended the ravine several hundred meters upstream from the springs.

Mud Springs (16) are one kilometer south of Perrin on Pete Cranford's lease. In the 1850s two Manly

boys were killed by Indians when they were filling a barrel with water from the springs. Two other boys were captured and later ransomed. According to Tommy Dillon of Perrin, this was later a great cattle watering place. The water, now beneath an earth tank, seeps from Canyon sandstone on shale. There are many algae and rushes, shaded by pecan and elm trees and grapevines.

Eight kilometers northwest of Perrin were **Sparks Springs (17)**. In 1881 the Sparks Springs school used the spring water. Later the water was carried to the church which still stands south of the springs. On May 14, 1979, there was only seepage from Canyon sandstone on shale into two earth tanks at an abandoned house. But at the county road crossing 1.5 kilometers southwest, these and other springs including the small **Indian Springs** were producing 1.9 lps. Many frogs, snakes, whirligig beetles, and dragonflies live here. Raccoon and deer tracks are abundant. A few willow and post oak trees shade the site.

Ten kilometers west-northwest of Perrin was the 1873 community of Springdale. The ghost town is now on Aldon and Catherine Nash's ranch, managed by Olan Teague. On May 14, 1979, **Springdale Springs (18)**, which once supplied the settlement, still produced 0.23 lps from Canyon sandstone at the Highway 2210 crossing.

Thurman Springs (20) were 13 kilometers east-southeast of Bryson on Mrs. Henry Bryson's ranch. In 1873 Howell Walker and his son were killed by Indians while filling water barrels here. On May 14, 1979, there was only a seep from Cisco sandstone.

Six kilometers east-southeast of Bryson is a very small spring (19) marked by much orange precipitant, indicating a high iron content. This is probably one of the **Sulphur Springs** shown on Adam Kramer's 1869 *Plot of itinerary map from Fort Griffin to Greenville*. At that time West Salt Creek was called Indian Creek. On May 14, 1979, 0.24 lps trickled from Cisco sandstone.

JACKSON COUNTY

Springs were never numerous or large in Jackson County because the topography is relatively flat. They were more common in the northwest quarter of the county because here the permeable Lissie sands are found. Some were found also in the southeast in the thinner sands and silts of the Beaumont formation. Although the Beaumont springs were small and rare, they were very important to early explorers and settlers because of their proximity to the Gulf and water-borne transportation.

There is no doubt that along the spring-fed streams were favorite campsites of Paleo-Indian people many thousands of years ago. Plainview projectile points found along Sandy and Mustang Creeks, for example, may be 9,000 years old. Also on Carancahua Creek and at the Anaqua site on the Lavaca River, evidence has been found of prehistoric people living near the springs. In historic times the Karankawas lived along the coast and the Lipans and Tonkawas farther inland.

The springs were very important to early explorers, such as De Vaca around 1530, who were undoubtedly guided to them by the Indians. La Salle's colonists on Garcitas Creek in 1685 spent much of their time at springs in Jackson County.

Around 1900 many flowing wells were drilled in the county. These were usually allowed to flow constantly, wasting much groundwater. Nearly all have ceased flowing now with a declining potentiometric surface. Since the 1940s, pumpage of groundwater for irrigation and other uses has become heavy, causing ground-water levels to decline drastically. Baker (1965) pointed out that from 1949 to 1964 pumping by the Alcon plant 13 kilometers south of La Ward caused a decline of around 30 meters in groundwater levels. It is no wonder that most of the county's springs have not flowed since the drought of the 1950s, when very heavy pumping for rice irrigation began. Baker also stated that the Lavaca River in 1947 in the reach from 5.6 kilometers northwest of Edna to 10.5 kilometers south of Edna gained 156 liters per second from springs and seepage. He stated:

It is possible that the aquifer could eventually capture the base flow of the streams by reducing the level of the water table in the outcrop below the level of the stream channels.

This apparently has now happened, as there no longer are any but wet-weather springs in the county.

The county's springs supported an ecosystem which is now threatened. The vegetation formerly included an abundance of plums, cherries, wild grapes, persimmons, haws, blackberries, and nuts. The bison, wild horses, and antelopes which frequented the springs are gone. Other species such as the red wolf, peregrine falcon, tree duck, and whooping crane are endangered. How long they can survive is questionable, especially since their habitats around the springs have been destroyed. Now instead of clear spring water, irrigation return flows muddy the streams, killing the fish and silting up the deep holes.

The spring waters which remain are generally of a sodium bicarbonate type, fresh, hard, and alkaline.

They may be high in iron or silica content. Large withdrawals of groundwater for irrigation and industrial use have caused water levels to fall deeper and deeper below sea level since 1948. As a result, salt water from the Gulf is moving inland and contaminating the groundwater. Improperly completed oil and gas wells have also caused groundwater pollution.

The writer's field studies were carried out chiefly during the period February 11-16, 1977, after several months of above-normal rainfall.

Seven kilometers northwest of Ganado, near a bridge over Sandy Creek, **Sandy Springs (6)** formerly existed. Here a Lipan and Tonkawa village stood until 1832, when it was attacked by the settlers and the Indians driven out. According to J.E. Shackelford, who lives one kilometer west, many springs flowed from sand along the creek until the 1950s. There were then deep pools on Sandy Creek with an abundance of fish. Now the creek is dry except during storms and the holes are filled with sediment.

The springs with the most colorful historical background are undoubtedly those encountered by General Martin de Alarcon in 1719 (2). In his words (Celiz, 1935):

Having arrived at the sea, we saw two Indians, and when we called them with signs, in order to talk to them about peace, they became afraid and threw themselves into the water and crossed the cove by swimming, which [cove] is a fourth of a league wide, more or less. We continued along the same shore on which, at about a league, we came unexpectedly upon a spring of fresh water which was very useful as we had no hope of finding any. There we halted. This spring of water rises in a clump of reeds near a small wood of mesquites, nopals, and some oaks and palms. The governor gave this spring of water the name of Santo Domingo.

Alarcon's party was traveling in a westward direction, detouring around the various bays and inlets.



Santo Domingo Springs, flowing into Carancahua Bay.

Santo Domingo Springs appear to be a group 17 kilometers west of Palacios and two south of the Carancahua community, at latitude 28° 41' and longitude 96° 24'. On February 15, 1977, the main group was producing 0.48 lps from thin sands on top of a clay bed. A second, smaller group about 1/2 kilometer to the north was flowing 0.19 lps. Field tests showed the water to be fresh. The springs now flow only in wet weather.

Austin Springs (1), named for Stephen F. Austin, were another group of historically important springs. Three kilometers west of Lolita on Quinton Thedford's ranch, they were a favorite campsite of the Karankawas. Later they were described as a "life saver and a great gathering place for cowmen". The Mitchell branding pens were located here from 1880 to 1900. The springs issued from Beaumont sand. They have not flowed since the 1920s, but some pools of water still stand in a grove of live oaks.

In 1690 and 1691 the Spaniard Cardenas camped at Red Bluff, six kilometers northwest of Lolita, and found good water. Many artifacts indicate that an Indian village was located here earlier, usually a good indication that springs were present. The springs (7) flowed from Beaumont sand west of the Red Bluff cemetery, but have been dry for many years. When Palmetto Bend reservoir is completed just upstream, they may start flowing again. Mexican treasure from a scuttled ship is reported to have been buried here.

Texana Springs (3) are located at the base of the bluff on the west side of the Navidad River, just upstream from the Palmetto Bend dam. An Indian village was located at the springs. La Salle and his party may have stopped here in 1685 on their ill-fated journey from Fort St. Louis to Quebec, Canada. In 1832 the old town of Texana was founded here, commemorated by a historical marker. On February 16, 1977, a flow of 0.20 lps was issuing from a partially excavated deep sand bed. According to Brownson Malsch, a historical authority in Edna, cisterns were used for a water supply in Texana's later years, but the first settlers as well as the native Americans who preceded them, must have found the springs very useful. They now flow only in wet weather, and will be inundated when Palmetto Bend reservoir fills.

The **Brick Factory Springs (4)** were on the west bank of the Lavaca River ten kilometers south of Edna, on James Reid's farm at latitude 28° 52' and longitude 96° 39'. The Mexican army was stationed here in 1831 and established a brick factory, using the red clay from the 16-meter-high bluff. Below the clay beds and close to the river are silt and sand beds from which the small

springs once flowed. The recharge area is one kilometer to the west, where these beds crop out at the surface. The springs have been dry for many years. Nearby some bones of a mammoth, such as were hunted by the ancient Paleo-Indian people, were found.

Independence Springs (5) were on the bank of the Lavaca River six kilometers south of Edna. Here a historical marker commemorates Camp Independence, where part of the first army of the Texas Republic trained in 1836 for the Revolution. The springs were undoubtedly used by the men stationed here. According to Tom Sayles, who lives nearby, they flowed from sand until about 1950.

JASPER COUNTY

Jasper County's springs discharge chiefly from Tertiary Oligocene and Miocene, and Quaternary sands. The Quaternary sands are also called the Chicot aquifer beneath the surface. These formations dip toward the south-southeast at 10 to 20 meters per kilometer. The best water-bearing aquifers, and consequently the largest and most numerous springs, are in the Tertiary sands of the north half of the county. Most of the springs discharge more than twice as much water in winter as in summer, because of plant transpiration in the summer.

For many millennia early Americans camped or lived by the county's springs. At the dawn of history in the area the springs were occupied chiefly by Caddoan tribes.

In the early days of settlement there was plentiful water in all of the creeks. In 1850 six sawmills and a number of gristmills used spring-fed stream waters for power. Clearing the virgin timber and plowing the land did great damage. Partially healed gullies can still be seen in second-growth woods. Many springs were buried beneath modern sediment.

Water tables have declined because of well pumping, uncapped flowing wells, and other causes. In industrial areas and around cities the decline has been especially severe. Pumping by the paper mill at Evadale caused a drop in the water table of 61 meters up to 1965. As a result salt water is moving inland from the Gulf of Mexico and invading the formerly fresh-water aquifers. Careless disposal of oil-field brines has also damaged groundwater in the past. As a result both the quantity and quality of spring waters has fallen. In addition to the damage to groundwater, the heavy pumping at Evadale caused 0.39 meter of land subsidence up to 1963. This causes many problems such as settlement and cracking of buildings and breaking of pipe lines.

The water is generally of a sodium bicarbonate type, fresh, soft, and of neutral pH. The iron content may be high, and saline springs sometimes occur.

Most of the writer's field studies were made during the period February 18-23, 1978. As much rain had fallen just previously, the observed spring discharges are probably higher than normal for this season.

Fifteen kilometers west of Jasper was the town of Bevilport, an important river port on the Angelina River from 1830 to 1860. The copious **Bevil Springs (8)** poured from Beaumont sand and gravel along the river. Vital to the early town residents, they were remarked upon by Bonnell in 1840. One of the largest was at the mouth of Jenny Branch just west of O.J. Roach's home. Mr. Roach remembers the surrounding residents coming to these springs to wash clothes until they were covered by the waters of Steinhagen Lake in 1951. A monument regarding the settlement is just east of the spring site.

Indian Creek (7), about eight kilometers northwest of Jasper, was a favorite haunt of early Americans, and with reason. It carries an abundant flow provided by many springs in the Montgomery and Fleming sands. The large Texas Parks and Wildlife Department fish hatchery uses the water. On February 20, 1978, there was a discharge at the lowest road crossing of 360 liters per second, including the water diverted to the fish hatchery.

Doom Springs (3) are seven kilometers northeast of Rockland in a wood northeast of lower Falls Creek. The seeps drain from Whitsett sand into a circular two-hectare depression covered with white sand and no vegetation. A few piles of sandstone and some old logs are all that remain of the Doom salt works which once used the water. Some excavated pools still exist where the water was probably collected to be boiled in the salt-making process. As shown in the table of Selected Chemical Analyses, the water is moderately saline, containing 3,540 milligrams of dissolved solids per liter.

Twelve kilometers northeast of Rockland, near the Angelina County line in Angelina National Forest, are **Boykin Springs (2)**. Archeological studies indicate that this was a favorite haunt of early Americans. On February 20, 1978, Boykin Springs proper flowed 8.5 lps from an outlet in Catahoula sandstone and from four pipes in an attractive Forest Service park. (See Plate 5, a). Many initials and dates have been carved in the sandstone. Other springs supply the 8-hectare lake which is used for swimming and fishing. The 20°C spring water has been found to be just right for stocking rainbow trout.

Sixteen kilometers northwest of Jasper, at Hamilton

cemetery and distinguished by a monument, is the site of old Zavala. The town, which had its beginnings in an 1829 grant, was a river port and stage stop. The springs (1) upon which the early residents depended issued from the bluff of Beaumont sand. The largest remaining are 1/2 kilometer east of the cemetery, seeping 0.07 lps in 1978.

Blue Spring (6) was on Blue Spring Branch four kilometers north-northwest of Jasper. It is now only a seep from Willis sand. A disastrous amount of erosion has taken place here. The channels and bottom lands are buried under enormous quantities of sand, which has killed many trees.

Four kilometers south-southeast of Brookeland, in the Browndell community, is Spring Hill. On the north-east side of the hill are **Spring Hill Springs (5)**, to which the writer was guided by Elaine Greenwood, and which are owned by Ray Fletcher. They were formerly used as a water supply by residents of a wide area, and still furnish water to an adjacent house. They once poured into a large concrete box, but now run from a pipe at a lower elevation into a smaller wooden box. The flow in 1978 was 0.75 lps from Catahoula sandstone.

Falls Springs (4) are three kilometers east of Browndell on Madie Roberts' property. Containing much sulphur and iron, the water was consumed by many people for its healthful effects. In 1914 Deussen found them to be discharging 0.38 lps from Catahoula sandstone. Now there is only a seepy area near Rock Creek with much marsh purslane where cows sometimes get bogged down.

The community of **Holly Springs** grew up around the springs of the same name (19) in about 1850. Located on Jim Adams' and Leon Powell's land, they were vital to the early residents. The water was once used in a syrup mill, and later was piped to the Powell house. The springs were depicted on Granger's 1878 *Map of Texas*. They produced 0.55 lps in 1978 from Fleming sand amid many shepherd's purse plants.

One kilometer northwest of Roganville is the 1840 Turner house, now owned by John Blake. **Indian Springs (18)**, upon which the early residents depended, were about 100 meters north of the house, but have now receded downstream to a point 200 meters from the house. The largest Eastern red cedar and crape myrtle trees in Texas are at the house. A panther with two cubs was recently sighted near the springs, according to Mrs. Blake. Deer, coyotes, and bobcats also frequent the springs. Several springs trickled 0.32 lps from Willis sand in 1978 amid moss and violets in a wooded area.

Beulah Springs (16) are 12 kilometers northwest of Kirbyville on the county road northwest of the old Beulah Springs church and Davis cemetery. They are enclosed in a concrete box on the west side of Boggy Creek. They were formerly used by a school and by many travelers. Some residents of the area still come here for water. L.G. Richardson, a nearby landowner, keeps the spring box cleaned out. The discharge was 0.45 lps in 1978 from Willis sand and gravel.

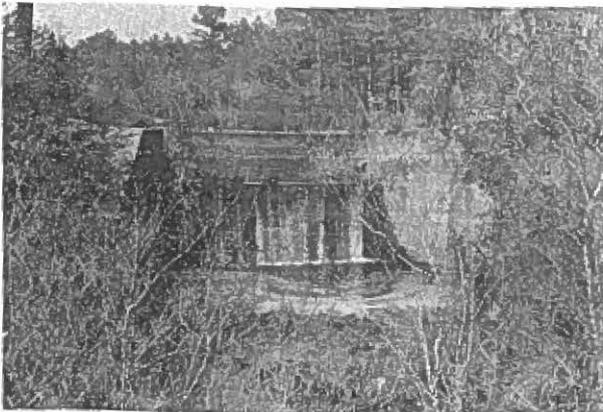
Temple Springs (17) are seven kilometers north-northwest of Kirbyville in the old Temple Springs community. On February 21, 1978, they produced 3.7 lps from Bentley sand 1/2 kilometer east of Mount Zion church (the old Temple Springs church). Temple Springs school moved six kilometers north-northwest before it burned.

Wiess Bluff, 10 kilometers south of Evadale and distinguished by a historical monument, was the head of tidewater navigation on the Neches River in early days. The residents probably made good use of the spring here which trickled from Beaumont silt. According to B.E. Fancher, **Government Springs (11)**, two kilometers north, still flowed in 1944. Now they are only seeps. Heavy industrial pumping in the Evadale area has caused a great decline in the water table here. Many domestic and stock wells have had to be deepened when they dried up.

One kilometer west of Evadale, between Highway 96 and the railroad, were **Richardson Springs (12)**. They were much used by settlers at Richardson's Bluff and travelers on the ferry here in the 1830s. Lillie McAnelley remembers the springs still flowing in 1963. Now there are only seeps into pools of standing water from Beaumont silt. Killdeers frequent the spot, where moss fringes the pools, and Spanish moss drapes the trees. A historical marker commemorates the settlement here.

Eleven kilometers northwest of Buna, on James Withers' property, are **Cairo Springs (13)**. Mrs. Aubrey Cole guided the writer to the very small springs, which still trickle from an old cypress box. Travelers on the Withers ferry a few kilometers west stopped here to slake their thirst. Thousands of blackbirds frequent the beech and holly woods in winter, and deer tracks are numerous. According to Mrs. Maurice Withers Cousins, another Cairo Springs three kilometers north was once used by a church there. These springs are now dry.

Three kilometers south of the present Magnolia Springs community are the **Magnolia Springs (14)** around which the settlement, also called Pinetucky, grew in 1824. Distinguished by a historical marker, the springs are in a wood containing large magnolia and



Mill pond at Tanyard Springs.

beech trees on Mrs. J.J. Martin's property. They were portrayed on A.W. Spaight's 1882 *Official map of the state of Texas* and on the New York and Texas Land Company's 1883 *Map of the state of Texas*. A steel drum was sunk into the springs, surrounded by peat moss, and a cup hangs from a nearby limb. The discharge from Montgomery sand was 0.15 lps in 1978. Many initials and dates have been carved on the beech trees. Numerous other springs flow in the area.

Tanyard Springs (15) are two kilometers east of the Magnolia Springs community. A tanyard and gristmill used the abundant flow of water in the 1870s. On February 21, 1978, 11 lps flowed from Fleming sand into the mill pond and over the spillway, forming an attractive waterfall at the roadside.

The Spring Hill community is seven kilometers south-southwest of Jasper. Here the **Spring Hill Springs (20)** flow, especially on the north side of the hill. This was a favorite haunt of Indians in prehistoric times. According to Mrs. Spurgeon Newman, one spring which formerly flowed in a hollowed-out cypress log was much used by early settlers for drinking water and washing clothes. Spring Branch on the north side of the hill produced about 1.0 lps from Fleming sand in 1978. Sandhill cranes frequent the springs.

Byerly Springs (9) are seven kilometers west-southwest of Jasper, just west of Byerly's Camp Ground cemetery. A historical marker commemorates the camp meetings which began here in 1835. Later a church and school used the water. In 1978 0.86 lps emerged from Bentley sand, shaded by large magnolia trees.

JEFF DAVIS COUNTY

There are still many springs in the Davis Mountains which are relatively undisturbed by modern civilization, although they are not as numerous nor as large as they

once were. There is ample evidence that they were much used in past millennia by early Americans. In many localities in the county, usually near springs, Kirkland found pictographs of deer, hunters, and handprints (Kirkland and Newcomb, 1967). At the Rockpile, 35 kilometers northwest of Fort Davis, numerous pictographs, mortar holes in the bedrock, and polished boulders used for rubbing the fat off hides, indicate that this was a living site. Here, however, water was probably obtained from *tinajas* in the rocks rather than from springs.

The Demaree rose for which Wild Rose Pass, 18 kilometers northeast of Fort Davis, was named, grows only at springs and seeps in the Davis Mountains. Much wildlife formerly made use of the springs. Two men stationed at Fort Davis in its early times killed 80 blue-winged teal in one day.

The springs were of paramount importance to the early explorers of this generally dry area, such as Antonio de Espejo in 1583. Much later, around 1849, Francis Bryan, Jefferson Van Home, and S.G. French explored the springs when mapping routes to the West Coast.

The springs in the county flow chiefly from Comanchean limestone and volcanic rocks. Since settlement of the area, groundwater tables have declined more than 50 meters in places. This has been caused mainly by well pumping and by reduction of recharge through overgrazing. The water-table decline has of course caused many springs to dry up. Another factor in this area appears to be valley trenching. Originally the streams were all lined with large trees. When these trees, which provided excellent protection against erosion, were removed, the streams began cutting downward, or trenching. Some of these channels are now five meters deep. Downstream the sediment from these trenches or gullies has filled formerly deep channels.

Limpia (Clear) Creek no longer flows the year around as it did when Fort Davis used it as a water supply. Now except during an occasional storm, the discharge is limited chiefly to August and September.

The springs which remain are for the most part of excellent quality. They are primarily of a calcium bicarbonate type, fresh, very hard, and alkaline. Phantom Lake Springs are somewhat higher in dissolved matter, primarily sodium sulfate, and are classed as slightly saline (See Table of Selected Chemical Analyses).

Most of the writer's field studies were made during the period June 7-16, 1976.

Starting at the northern tip of the county, let us proceed around it in a clockwise direction. At the junc-



1879 survey map showing San Martin and other springs.

tion of Reeves, Culberson, and Jeff Davis Counties is **San Martin Spring (37)**, on Banky Stocks' ranch. It is of special importance because it was employed as the corner of the three counties which then joined here in the survey of the Pecos County line in 1879. The accompanying map shows its position in this survey. The field notes read:

... To a stone mound marked P.E. Co. on one side and P.R. Co. on the other side at the head of San Martin Spring, corner of El Paso Co., Presidio Co., and Pecos Co. . . .

San Martin Spring flows from volcanic rocks, chiefly rhyolite, on top of a bentonitic tuff. Numerous projectile points, including some of Alibates flint and obsidian, metates, bedrock mortars, pictographs, and pottery fragments attest to the long use of this site by prehistoric people. Of special interest is a hollowed-out rhyolite boulder in Mr. Stocks' collection which may have been used for a jug before pottery was introduced into the area. In historic time the Mescalero Apaches lived at San Martin Spring. It was called Peach Spring on early county maps. S.A. Mitchell used the same name in Spanish (*Ojo Duraznos*) on his 1880 *County map of the state of Texas*. Probably the Jumanos, and later the Mescaleros, used these spring waters to irrigate their peaches as they did at San Solomon Springs. Other early maps called the spring Apache Spring.

Dark gray soils disclose that there was once a bog surrounding the spring. The spring house through which the water formerly emerged, three meters higher than its present outlet, is very old and suggestive of Spanish architecture. This was an Overland stagecoach stop for a time. In 1974 the discharge was 3.1 lps and in June 1976 it was 0.65. An attempt is being made to establish mouflon sheep here.

Twelve kilometers southeast of Kent on Bill and Mary Cowden's ranch is **Indian Spring (35)**. Located on the west flank of Gomez Peak, it is at latitude $31^{\circ} 01'$ and longitude $104^{\circ} 06'$. It flowed 0.30 lps on June 11, 1976 from landslide material consisting of rhyolite boulders and finer material. Many manos and metates have been found here. One-half kilometer downstream is an ancient campground with 16 bedrock mortars in rhyolite. Deer are usually seen in the vicinity.

Similar nearby springs include **Woodrow** (only a seep now) one kilometer west; **Cherry**, two kilometers south; **Walnut**, one kilometer south; **Forty-two**, flowing 0.13 lps on the above date, one kilometer north-east; and **Hidden Spring**, producing 0.19 lps, one kilometer east-northeast of Indian Spring. The Cowdens are to be commended for drilling no wells on their property which would use up the groundwater reservoir. Springs supply the needs of the entire ranch.

Thirteen kilometers southwest of Kent on Mrs. Berry Hart's ranch there were formerly springs (45) in a rhyolite canyon. A boulder containing five bedrock mortars and many metates and manos were taken from the site to the ranch house. Crown-polished boulders, which were used to dress animal hides, are present. Many flint and chalcedony flakes also testify that this was an important campsite of early Americans. Several wells now pump at the site, in a grove of live oaks and algerita shrubs.

Fifteen kilometers southeast of Kent are **Oak Springs (26)** on the Reynolds ranch operated by Jess Sorrels. They are probably the same as **Antelope Springs** which were shown on several maps of the 1870s through 1890s. They are used as a water supply for Kent, but in recent years have been insufficient in summer, and the town has had to drill a well to supplement them. The discharge from Tertiary volcanic rocks is piped to a tank on the ranch and to Kent. The average discharge is estimated by Sorrels to be 0.62 lps. A windmill well is near the springs. Orange and black Bullock's orioles live in the live oak trees and algerita shrubs. Two other former nearby springs, **Onion** and **Moody**, are now dry.

The Reynolds ranch headquarters five kilometers farther west is supplied with fresh water from **Garden**

Springs (25) which issue from volcanic rocks. Many bedrock mortars, metates, and manos have been found here. The springs' average discharge is estimated to be 3.5 lps. Some of this water is also used by the Kent community. Another small spring at the headquarters supplies a small pond containing bullfrogs, large tadpoles, and minnows. Swallows flit through the large cottonwood trees.

Horse Camp Springs (24), ten kilometers southwest of Kent on the county line, were a favorite haunt of Indians. They have been dry since about 1967, and a well is located there now. They were formerly walled up with rock in a grove of cottonwoods and salt cedars.

Also on the Reynolds ranch are **Jones Canyon Springs (39)**, 15 kilometers northwest of Mount Livermore. They were called **Rincon** or **Corner Springs** by the U.S. Army Engineers on their 1915 *Progressive military map of the United States*. According to Jess Sorrels, the flow from volcanic rocks fills a two-inch (5.1 centimeter) pipe in winter, producing a flow of about 1.1 lps.

The very small **Little Willow Springs (38)** are 17 kilometers southeast of Kent on the east flank of Gomez Peak. At latitude 31° 01' and longitude 104° 03', they are on the Lenord Lethco ranch. They flow from landslide boulders and gravel, with much water cress. Many worked flint and chalcedony flakes, metates, and bedrock mortars have been found here. The ranch is used for deer hunting. Aoudad sheep and mountain lions also frequent the springs. One mountain lion is kept as a pet by the Lethcos.

Similar nearby springs include **Hackberry** (which has failed), one kilometer north; **Willow**, one kilometer south; **House**, one kilometer southeast; and **Cold Springs**, four kilometers northwest. The last may be the same as **Ojo Gomez** or **Gomez Spring (36)** shown by S.A. Mitchell on his 1880 *Map of Texas*.

Twenty-three kilometers west of Toyahvale are **Orchard Springs (27)**, near Joe Rounsaville's KC ranch headquarters in Casey Draw. They have been highly valued by residents since the ranch was settled in 1879. They flow into a water cress-bordered pool shaded by trees, a favorite haunt of deer. Many smaller springs emerge nearby.

The largest springs in the county are **Phantom Lake Springs (12)**, which pour from a cavern at the foot of a lower Cretaceous limestone bluff six kilometers west of Toyahvale. An 1880 map by S. A. Mitchell calls them **Ojo la Loma** or **Hill Spring**, in recognition of the hill from the base of which they surge. Located on the Joe Kingston ranch, they have an elevation of 1,080 meters. A fault here has placed impervious strata

opposite the water-bearing limestone, forcing the water to the surface. It is used for irrigation, chiefly by the Reeves County Water Control and Improvement District No. 1, along with that from San Solomon, Giffin, and other springs in Reeves County.

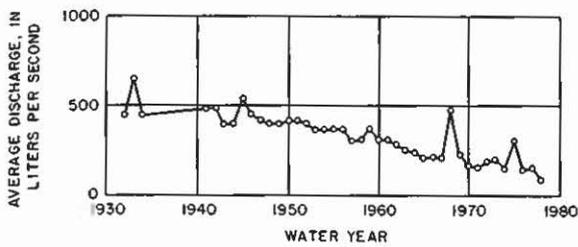
In 1859 an officer stationed at Fort Davis described the lake and springs as follows (Scobee, 1963):

In 1855 or '56 Phantom Lake was discovered [by Anglo-Americans]. It is a peculiar body of water, in a slight depression, or little valley, surrounded by small hills that look exactly alike. The lake was not more than 70 yards long. It had been seen by several parties but could not be found by them a second time, from which fact it finally got the name of Phantom Lake. It is about 30 miles north of Davis. The water ran out of a cave and on into an underground passage and by standing quietly one could hear it pouring into a cave under one's feet. The pond has no known connection with other water, still it was filled with splendid bass.

As we did not know of any limestone near the Post, Lt. Taylor was sent out to build a lime kiln at the pond. While there he caught a great many fine fish and sent for me to come out and explore the cave. . . . We had gone only a short distance when an orderly overtook us and said the Commanding Officer wanted to see me. I returned and was told that I could not go on the trip. I was terribly disappointed, for I had gone to a great deal of trouble to get things ready for the excursion. A party had tried to explore the cave from which the stream ran, but the water was so deep they had to swim and the canteens on which they had placed lighted candles tipped over and left them in darkness. . . . I had prepared long boards with holes in which to stick the candles, and we had intended to go to the end of the cave if possible. . . . The colonel told me he wanted me to go to San Antonio for horses.

Phantom Lake Springs were a favorite campground of prehistoric people, who are believed to have used the waters to irrigate crops. Very likely the Spanish explorer Espejo stopped to quench his thirst here. The water was used to power a cotton gin in early settlement days. The lake has long vanished, chiefly because the spring water is carried off in a concrete-lined ditch. (See Plate 13, b).

As pointed out by White, Gale, and Nye in 1941, rainfall in the recharge area causes a large increase in Phantom Lake Springs flow and suspended sediment concentration, and a large decrease in dissolved-solids concentration and temperature. For example, on April 28, 1971, with a flow of 160 liters per second, the concentration of dissolved solids was 2,250 milligrams per liter. On October 7, 1932, following a rain, a flow of 2,320 lps and dissolved-solids concentration of 144mg/l were measured. These relationships indicate that the recharge is from a relatively small, nearby area. The principal intake area is on the Comanchean limestones to the southwest, dipping toward the northeast, on the flanks of the Davis Mountains. The normal low-flow



Discharge of Phantom Lake Springs.

temperature of the water is warm, 26° Celsius, indicating that the water reaches depths of 300 to 400 meters. Following the earthquake of August 13, 1931, centered at Mount Livermore 50 kilometers southwest, the water was yellowish and roiled for a while (Scobee, 1963).

Discharge records are shown on the accompanying graph. The maximum recorded discharge of Phantom Lake Springs was 3,230 lps on October 3, 1932. As the graph shows, the springs appear to be gradually failing. Wells in the area are draining the recharge water away from the springs. Since these are the highest springs in the Balmorhea district, they may be expected to be the first to suffer from a water-table decline.

Because several persons were drowned in attempting to explore the cavern called Kingston's wet cave, from which the springs flow, it has now been closed with a barred gate. Numerous cave bats make their home here.

The Comanche Springs pupfish and several rare invertebrate animals still make their home at Phantom Lake Springs, but for how long is questionable.

Dark Canyon Springs (18) are in Madera Canyon 20 kilometers southwest of Toyahvale. Located at latitude 30° 51' and longitude 103° 47', they are on the D.H. Kingston ranch. They poured out 14 to 42 lps in 1932, but only 0.65 lps in 1976, from volcanic rocks. Some believe that these are the springs where Lt. Reuben Mays and his 14 men were killed in 1861 when they attacked an Indian band. Bedrock mortars have been found here.

Madera (Wood) Springs (32) one and one-half kilometers northeast, which formerly supplied the Madera Springs resort, have failed. The rare shrub, *Warnock viburnum*, has been found only near these springs in the United States. The town of Madera Springs has some claim to fame, being the smallest in Texas with a 1970 population of two.

Fishing Springs (11) are 23 kilometers north of Fort Davis, between Black and Big Aguja (Needle) Mountains. They are on the Espy ranch at latitude 30° 48' and longitude 103° 54'. About a dozen springs

flowed 7.5 lps, on June 12, 1976 from igneous boulders to a point about three kilometers downstream, whence the water is piped to the entire ranch. In 1932 the discharge was 96 lps, including several other springs. Manager Tommy Lara is justly proud that the ranch uses no pumps or wells. The fresh-water springs are covered with water cress and surrounded by walnut and other trees. The very rare water plant, *Potamogeton clystocarpus* is found here. A raccoon was fishing in the springs at the time of the writer's visit. The many projectile points, metates, and manos that have been found here attest to long occupation of the site by prehistoric people.

Another **Orchard Spring** is three kilometers northwest of Fishing Springs. **House Pasture Spring** is one kilometer northwest and **Airplane Tank Spring** three kilometers north of Fishing Springs.

Big Aguja Springs (16), which provide drinking water for Balmorhea and Toyah, are 20 kilometers south of Toyahvale. Located at latitude 30° 46' and longitude 103° 51', they flow into a reservoir five kilometers downstream in Big Aguja Canyon. Pouring from igneous extrusive rocks, they discharged 29 lps in 1933 (White, Gale, and Nye, 1941). In 1967 they produced 34 lps, and other springs above the reservoir yielded 57 lps, according to the water works superintendent, C.T. Gray. On June 1, 1976, they flowed 25 lps. Often the flow falls to 13 lps in summer, which is not enough to meet the demand. In these periods water must be drawn from storage in the reservoir. Many trees surround the springs.

Ten kilometers south of Toyahvale on the Agua Grande ranch are **Old Camp Springs (15)**. Flowing 0.18 lps from volcanic rocks, the springs are covered with duckweed and grass. A grove of pecan, willow, hackberry, and walnut trees with much bird life surrounds them. The water disappears about 200 meters downstream. At the springs are the ruins of some old stone buildings. Similar nearby springs include **Augustine**, three kilometers west; **Cottonwood**, one kilometer east; and **Dual Springs**, two kilometers east.

Seven Springs (10) are 28 kilometers north of Fort Davis, on the old 7 Springs ranch on Highway 17. The main springs flow into a pool full of cattails 300 meters southeast of the ranch house, at latitude 30° 50' and longitude 103° 47'. Four other very small springs in the vicinity still flow, including **Walnut** and **Cow Heaven Springs**. The water pours from the Seven Springs lava beds. In water year 1932, according to White, Gale, and Nye (1941), the discharge of Seven Springs Creek at Highway 1832 averaged 3.7 lps, and in 1933 it was 4.5 lps. On June 10, 1976, it was 4.4 lps, of which 3.0

came from the main springs. In 1883 a detachment of cavalry from Fort Davis was stationed here. Now the springs provide water for the entire ranch, including a recreational lake at the ranch house and irrigation water.

Barrilla Spring (9) was on the Robert McKnight ranch very close to the junction of Reeves, Pecos, and Jeff Davis Counties. It flowed from a fault in the Jeff conglomerate. In 1849 W.H.C. Whiting (1938) stated:

shortly came upon a spring of clear, cool water issuing from the hillside. Here was the *caballada* [horse herd] of the Indians and their large drove of cattle.

The earliest maps and references, including Lt. William Echols' 1859 *Topographical reconnaissance map of the Comanche trail*, called this spring Varela (pronounced Bah-ray-lah) Spring, for one Francisco Varela, an early settler in the region. Later the name was corrupted to Barrilla Spring. Various writers have attempted to tie salt-wort (*barrilla*) or a barrel (*barril*) with the springs.

According to J.W. Williams (1962), the Spanish explorer Mendoza, while searching for the River of Pearls in 1683, stopped at Barrilla Spring. In Mendoza's words, "a beautiful spring" came down "from the slope of a hill". The spring was a welcome stop on the Old Spanish Trail from El Paso to San Antonio. In 1859 it became a Butterfield stage stop. In 1859, 1874, and probably at other times the Indians ran off herds of stock from the station. A barrel was sunk into the gravel to collect the water. At one time a station guard was killed by Indians and thrown into the barrel.

Barrilla Spring was used as a turning point in the 1879 survey of the line between Pecos and Presidio Counties, which then joined. The field notes describe a stone mound erected at the head of *Barela Spring* by the survey party, marked BPE Co. on one side and PR Co. on the other. Later it was also used as the corner between Reeves, Pecos, and Jeff Davis Counties.

On June 10, 1976, Barrilla Spring was only a seep, with a very small hole of standing water in a grove of cottonwood, willow, and hackberry trees. The outwash far below the spring for a distance of one kilometer is very productive of projectile points and flakes made from various kinds of flint and chalcedony. Agates and geodes (hollow rocks with crystal centers) are also numerous.

Twelve kilometers southeast of Barrilla Spring is **Indian Spring (46)**, on Ben Tanksley's ranch. It was shown on an 1897 U.S. Geological Survey topographic map. A well drilled here during the 1950s reduced the

spring flow. It is now only a seep in a walled-in box from Tertiary volcanic rocks.

Sixteen kilometers southeast of Fort Davis and two northwest of Mitre Peak are **Tippett or Templeton Springs (2)**. They are on the Caldwell ranch, managed by Joel Nelson, at latitude 30° 28' and longitude 103° 48'. They flowed from rhyolite porphyry at 3.2 lps in 1976. In 1902 Taylor reported them to discharge 9.3 lps. They emerge at an elevation of 1,505 meters. Raht (1963) described them well:

The Tippett orchard is located on a bench of rich loam, which, at some former age, had washed down from the mountains above. Between the mountains and the orchard are a series of broken hills, at the foot of which is a magnificent spring, the source of water used at present to irrigate the orchard. This spring at one time had been sealed up by the Indians, and even to-day the flow of water comes from a partly dammed up exit. Although the orchard is thirty years old, or more, signs still remain of the former Indian rancheria. From the spring to the back of the orchard there is a gradual slope, and the Indians had terraced this, using walls of rock to retain the water on each terrace, each terrace forming a semicircle, with the spring as the center of circumference. There were perhaps a dozen terraces, all forming a semicircle facing the spring. On the east side of the orchard, farthest from the spring, Mr. Tippett excavated for a reservoir and found the bones of a number of Indians, and several implements peculiar to the Apaches. He also found a number of arrow points, similar to those taken from the crypt on Mount Livermore. In the broken hills just above the springs are scores of molinos, or handmills, hollowed out of the igneous rock, which were used to grind corn.

Gold nuggets were reportedly found in Tippett Springs in the 1850s, when the springs issued from a hole 13 meters deep. They are still used to irrigate a small orchard and also to supply a swimming pool and a recreational lake filled with catfish and bass. A grove of large pecan and other trees surrounds them. Other smaller springs occur in the vicinity.

Murphy Springs (34) are 13 kilometers south of Fort Davis on Bill Weston's Camp Musquiz ranch. Capt. F.D. Baldwin portrayed them on his 1889 map of the *Route of Company K, 5th Infantry*. About 0.10 lps trickles from rhyolite boulders in an exceedingly scenic area. The water forms water cress-covered pools amid rock pillars and crags on which lizards dart. Among the oaks and maples a hawk screeches at the intrusion of a stranger. Several bedrock mortar holes near here attest to the long use of this site by prehistoric people.

Seven kilometers southeast of Fort Davis, on the Clay Evans ranch, is **Know Nothing Spring (33)**. Shown on A.J. Johnson's 1879 *Map of Texas*, it was evidently connected with the Know Nothing political movement of those days. In a cottonwood grove and

surrounded by yellow sneezeweed and white thelypody, it still furnished 0.65 lps to the ranch house and stock tanks in 1976. A number of other very small springs and seeps flow from diorite boulders in the hills to the southeast. Some of the boulders are crown-polished, having been used by prehistoric people for dressing animal skins. Several windmill wells have doubtless reduced the spring discharge.

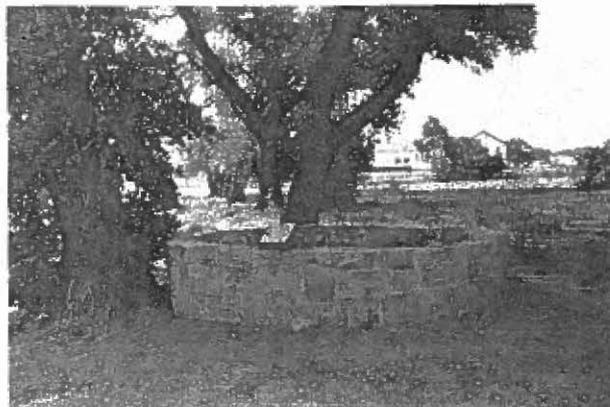
Fort Davis Spring (7) was at the southeast edge of the fort, which has now been restored, just north of the town of the same name. It rose from alluvial gravel and sand at an elevation of 1,535 meters. It was well known to prehistoric people, and in 1849 was called the Painted Comanche Camp, because the Indians painted pictures on many trees. Nearby are some crown-polished boulders. The Spanish explorer Espejo stopped here in 1583.

Later Fort Davis Spring was an important stop on the Old Spanish Trail from San Antonio to El Paso. From 1854 to 1875 the fort hauled water from Limpia Creek, two kilometers north. From 1875 to 1883 the spring was used for drinking water and irrigation of a garden at Fort Davis. The water caused much dysentery among the troops, probably because it was polluted by the fort and stock upstream. As the post surgeon, Ezra Woodruff, said in 1878 (Scobee, 1963),

I have the honor to respectfully call attention to the condition of the spring from which all water used at the Post is derived. There is a defect in that the water passes through the wall below the surface and rises directly into the drainage ditch. This ditch becomes higher than the spring by rapid pumping and as a consequence the ditch drains back into the spring nearly every time a water tank is filled. This ditch is a resort of pigs and I have observed them wallowing in it within six feet of the spring, besides being the receptacle of other rubbish. I suggest that the wall enclosing the spring should be made watertight by hydraulic cement so that the water once escaped from the spring cannot flow back ... The condition of the spring is bad, to say nothing of the discomfort of using impure water.

After 1883 water was pumped with a steam engine from Limpia Creek to the fort, ending the pollution problem. Fort Davis Spring stopped flowing in the 1930s, probably as a result of heavy well pumping in the vicinity. The circular stone wall which enclosed it may still be seen on the western edge of a large circle of cottonwoods.

Twenty kilometers west-southwest of Fort Davis and just north of Highway 166 is the old landmark called *Point of Rocks*. Here, at the base of a hill of igneous boulders, amid gray and Emory oaks, are **Bald Rock Springs (3)**. Located on Rust Largent's ranch, they are



Site of former Fort Davis Spring.

at latitude 30° 32' and longitude 104° 04'. Some of the boulders are crown-polished. In 1850 Lt. S.G. French stated (U.S. Senate, 1950),

By the road side, fourteen miles distant, beneath a large boulder of granite, water may be found; but it was unfit for use when we passed it, having been completely trodden up with mud by the animals of the advance trains.

In 1857 Edward Beale, in command of a camel train, remarked that there was excellent water at Bald Rock Springs but no wood or grass. In 1878 a mail rider and two other men were killed by Indians here. Now the springs are only a seep which supplies a stock-watering trough.

Thirty-five kilometers west of Fort Davis and about one north of Highway 166 are **Barrel Springs (5)**. They are on the Barrel Springs ranch at latitude 30°32' and longitude 104° 14'. Their altitude is 1,700 meters. French described the springs as reliable, with good grazing. Many antelope were found here then. In 1857 Beale described the spring as "a scanty supply of tolerably good water," but with no wood available. Gen. Henry Sibley's forces in 1861 called them **Burial Springs**. In 1867 Capt. Edward Meyer wrote (Duke, 1973):

Good camping Ground at Barrel Station (on the road) with a fine spring of abundance of good water 200 yds northeast of station, fine grazing — wood scarce.

In the same year a man was killed by Indians here. The Conklings in 1947 wrote:

Barrel Spring is located about a quarter mile up a ravine northwest of the station site. It is said to provide a permanent

supply of water though limited in quantity at times. The water which appears to seep from fissures in the rocky hillside, is now collected in masonry tanks. The name Barrel Spring does not appear on the earliest maps, and it is possible that officers from Fort Davis sank barrels in the bed of the ravine to collect the water, hence, the name.

Tom Robison of the Barrel Springs ranch guided the writer to the springs. The foundation stones of the old Butterfield Overland stage stand of 1859 may still be seen ½ kilometer to the southeast. The spring flowed 0.35 lps from extrusive igneous rock in 1976. Many algerita shrubs, whose berries make excellent jam, surround them. Chalcedony specimens are abundant.

El Muerto Springs (6) are 22 kilometers northeast of Valentine. Located on the Gratton Tagliaferro ranch, they are located at latitude 30°40' and longitude 104°18'. The water seeped from a bluff of rhyolite at about 0.06 lps in 1976. The Conklings (1947) wrote:

The spring to which the name of Dead Man's Hole has been given, is located at the foot of a bold rocky bluff less than half a mile east of the station ruins. Tradition has it that a man was found dead near the spring, in 1854 - 1855 when the first coach mails between Santa Fe and San Antonio were carried over this route. Here as at other places on the route, there are numerous weathered petroglyphs on the boulders and faces of the cliff near the spring.

In spite of the sinister sounding name, it would be difficult to find a lovelier or more romantic location than the site of this old mail station in the shadow of gloomy El Muerto (The Dead man) peak, which stands like an outpost on the western extension of the Davis Mountains.

Scobee (1963) had a somewhat different impression:

The spring itself is a weedy, reedy pool of a size, now, that a frog could jump across, at the base of a rock bluff. It is roughly walled in with boulders and fenced with a few strands of wire to keep out livestock. Tracks of deer show that the animals drink there. Iron piping carries ample water for cattle. No ranch house is in sight anywhere; it is a lonely land.

In the 1850s Big Foot Wallace, carrying the mail, was surprised by Indians watching him while he mended his buckskin breeches at El Muerto Springs. He escaped and made his way to El Paso with the mail, but without his breeches. In 1854 M. H. Erskine, driving a herd of cattle from Texas to California, "nooned it" at El Muerto. His party filled their kegs and watered the oxen and horses, but could not water the herd here. In 1862 a cavalry report stated that there was "sufficient water for the animals but not enough for the com-

pany." In 1867 Capt. Edward Meyer described the site as follows (Duke, 1973):

An excellent camping ground at the stage 100 yards S.W. of the Del Muerto springs. Abundance of exceedingly fine water, grazing in the valley is excellent and sufficient wood close by.

In 1868 some stock was stolen from an army camp at El Muerto by Indians. In 1877 a stage driver and one passenger were killed by Apaches, unwilling to yield easily this choice living and hunting area. In 1879, according to Scobee, 29 bars of stolen gold, several bags of gold coins, silver ingots, and jewels were buried near the springs. Since that time there has been much trouble with trespassers digging for this supposed treasure, with the result that the owner is now reluctant to allow anyone on the property.

Thirteen kilometers north of Valentine, at latitude 30°27' and longitude 104°27', were the **Nine-Mile Waterholes (1)**. Presumably they were so called because they were nine miles west of El Muerto on the Butterfield Overland stage route. Some very small springs evidently existed here formerly. Now they are dry, due probably to a windmill well at the site. Pronghorn antelope which may be seen are making a comeback under controlled hunting.

High on the slopes of Mount Livermore, about 25 kilometers west of Fort Davis, are a number of small springs at around 1,900 meters elevation. Among these are **Lost (31)**, **Ford (8)**, **Bridge (30)**, **Toab (29)**, and **Pine (28) Springs**. A cache of 1,200 Livermore arrow points, dating from around 1,000 A.D., bedrock mortars, and pictographs, have been found in this area. Near these springs is found an unusual biotic community which includes quaking aspen, limber and ponderosa pines, Gambel, emory, and net-leaf oaks, and wild cherries. Many rare and endangered species of animals (for Texas) live here, including band-tailed pigeons, Stellar's jays, Clark's nutcrackers, silver-haired bats, shorthorned lizards, and Mearns's quail.

There are many other small springs in the county, too numerous to list. Some which should be mentioned are those near the adobe ruins of the 1854 Manuel Musquiz homestead 10 kilometers southeast of Fort Davis. These springs are still flowing well. Other freshwater springs in the extreme western part of the county include **Catclaw (20)** and **Ash (21)**, which produced 0.19 and 1.0 lps respectively on March 13, 1974, and **Stinking Springs (23)**. According to Red Paschal of the Gulf Real Estate Ranch, the springs (22) 20 kilometers west of Valentine which formerly furnished all

water for the 96 ranch camp, are now dry. Bloys camp-meeting grounds, in a grove of trees at the base of a mountain 27 kilometers west of Fort Davis on Highway 166, appear to have been watered originally by natural holes in the rock, or *tinajas*, rather than springs.

JEFFERSON COUNTY

Springs are not numerous or large in Jefferson County, owing to its relatively flat situation. They do occur, however, in certain favorable spots, such as on the flanks of salt domes, at the base of bluffs along the Neches River, and on the landward side of beach ridges. The springs were originally the heritage of the Atakapa Indians and their predecessors, who traveled the rivers and bays in dugout canoes. They left large shell mounds (unfortunately destroyed and used for road material) especially at Grigsby's plantation, 20 kilometers southeast of Beaumont on the Neches River, and along the intracoastal canal. They speared fish at night with torches, using alligator oil for their lamps and also on their bodies to repel mosquitoes. If a spring amounted to only a seep, these people would dig a shallow hole to increase the flow, a device which the early explorers and settlers soon learned also.

When the Spanish explorer Alonzo Alvarez de Pineda sailed along the coast and mapped it in 1519, he may have sent parties ashore to fill water casks from springs and seeps in Jefferson County. Other Spanish and French explorers camped at the county's springs beginning around 1730.

The springs flow from Quaternary sands and silts, some of which are of recent origin, having been deposited by hurricanes within the last few hundred years. Well pumping has been the primary cause of the water-level decline of up to 10 meters in the shallow, non-artesian aquifers. This has dried up many springs and caused incipient salt-water intrusion.

Springs existed at many localities where they cannot be found now. These include the old French trading post at 2995 French Road and the 1824 homesite of Noah and Nancy Tevis at Tevis Bluff, both in Beaumont. Modern construction has so altered these sites that, along with the effects of lowered water tables, the springs can no longer exist.

Most of the writer's field studies were made on February 21 - 26, 1976. The water is generally of a sodium bicarbonate type, fresh or slightly saline, very hard, and alkaline. The iron, silica, and chloride content may be high.

In the 1880s, when local springs could no longer supply the population, Beaumont residents were dig-

ging shallow wells. These, however, were easily contaminated, and epidemics of smallpox and other diseases resulted. Drinking water then began to be brought in by barge from artesian wells up the river at Lakeview, and sold for \$0.25 per five gallons.

Some springs still exist in the county. At the Beaumont Country Club, five kilometers north of the city on the Neches River, are **Collier Springs (1)**. An Atakapa village was located here in the 1700s. This was the site of Collier's ferry in 1846 and earlier. Many of the first travelers through the area stopped here to refresh themselves and their animals. Several springs containing much iron flow from the base of a five-meter-high terrace. They have now been mostly reduced to seeps by heavy well pumping nearby.

Eight kilometers southeast of Beaumont on the northern flank of the Spindletop dome at latitude 30°01' and longitude 94°04', are **Spindletop Springs (3)**. In 1748 Capt. Joaquin Orobio y Bazterra may have stopped here. Near here in 1901 the Lucas gusher brought in the oil boom. The springs discharge 0.25 lps from Beaumont silt near an abandoned sulfur mine. There were probably many copious springs on the sides of this salt dome in past years. However, large removals of sulfur, oil, gas, and water have caused the dome to subside at least six meters. The subsidence, declining water tables, and use of salt water for repressuring the oil field, have all damaged the springs.

In the old town of Sabine, discharging from the landward side of a sand and shell ridge, were **Sabine Springs (4)**. Old residents say that they formerly flowed more abundantly. Now they are only seeps. They were probably deepened to form a shallow well and increase their flow. The area was settled as early as 1832. Rumors of pirate treasure buried near here abound. In 1847 Bryan's stagecoach was making the two-day run between Sabine and Bolivar. In 1863 a small fort at Sabine achieved some fame by repelling a force of federal gunboats, sinking two. Near here formerly oil springs were said "to flow so plentifully as to make the sea calm to a considerable distance, even during storms."

Big Hill Springs (2) flow from Beaumont silt and fine sand on the Big Hill dome, 15 kilometers southeast of Winnie. This was the site of an early settlement. Lines and squares of old live oak trees still stand here, reportedly planted around 1860. The main springs, containing much iron, flowed 0.18 lps on the northwest flank of the dome on February 24, 1976. They are reported to fail in dry weather. Only seeps remain at the Grayson Lee and Pipkin ranch homesites on the north-



Big Hill Springs (northeast).

east flank. Heavy pumping of oil, gas, and water has undoubtedly caused subsidence of the land surface and decline of the groundwater table here.

JIM HOGG COUNTY

Jim Hogg County's springs flow or did flow chiefly from Miocene, Pliocene, and Quaternary sands. These formations dip toward the east-southeast at 5 to 15 meters per kilometer. Groundwater can move through these sands at three to five meters per day. In the northwest part of the county, along the Bordas Escarpment, conditions are favorable for the development of springs.

The springs were usually based upon perched water tables. The main water table is often hundreds of meters below the surface. Many ranchers must haul water considerable distances because of the scarcity of groundwater.

In 1842 Lt. Col. Ramon Valera left Mier for San Antonio. He found no water between the Rio Grande and Nueces Rivers, and called this area the *Desierto de los Muertos* (Desert of the Dead). This must have been an extremely dry year, or else he had a very poor guide, as there are still good springs along this route.

There were also many fresh-water lakes in the county at one time. Most are now dry. Flowing wells contributed significantly to the drying up of the springs and lakes. Pumping wells and overgrazing also contributed. Water tables have declined considerably in recent years. During the terrible drought of 1892 - 94, when thousands of cattle perished, the flow of most springs was interrupted.

The springs once supported an abundant ecosystem of interdependent plants, trees, fish, amphibians, reptiles, crustaceans, insects, birds, and mammals. As the springs dried up, most of these plants and animals disappeared.

The water is generally of a sodium bicarbonate or chloride type, slightly saline, very hard, and alkaline. The content of silica is usually high.

Most of the writer's field studies were made during the period February 26 - March 3, 1979.

In the northwest part of the county, one kilometer northeast of the intersection of Highways 649 and 3073, are **Albercas de Abajo (Lower Pools) (3)**. Albercas de Arriba are in Webb County. These springs are on Roderick Bordelon's and Alec Holbein's ranches. They were portrayed on the U.S. Engineer Bureau's 1867 *Map of the states of Kansas and Texas and Indian territory*, and on A. J. Johnson's 1879 *Map of Texas*.

On February 27, 1979, a discharge of 0.25 liter per second was seeping from Goliad caliche on Catahoula tuff, to form the only running stream in the county, which coursed 300 meters before disappearing. Water bugs and mosquito larvae dart in the moderately saline water. Mannagrass and sand-bar willows cover the floodplain. Dark gray soils, some buried beneath modern sediment, indicate that a large swamp once existed here. Many oil and gas wells now pump in the vicinity.

Three kilometers south-southeast of Albercas de Abajo were the similar but smaller **Alberquitas (Little Pools) (4)** on Alex Holbein's ranch. They were indicated on the U.S. Engineer Office's 1892 *Map of the Rio Grande frontier, Texas*. Nearby rancher Robert Fulbright swam in the pools in the 1950s. Since then the springs have been buried beneath drilling mud from oil-field operations and have dried up. Dark gray soils provide evidence of a swamp which once surrounded the springs. Much mannagrass covers the site.

Three kilometers east-southeast of Alberquitas was the seep-fed *Las Animas (The Spirits) Lake (5)*, on John and Ruth Russell's ranch. The water moved from Goliad sand into the lake. In 1717 the *Las Animas*



Albercas de Abajo.

mission was established here, according to John Russell, who has restored some of the old buildings. Later the lake was an important stop on the San Antonio-Rio Grande City road. A. J. Johnson portrayed it on his 1879 *Map of Texas*. Lt. Nathaniel Michler probably stopped at Las Animas in 1850. Until the 1920s the lake was a popular swimming hole. In 1949 there was still some water in it. Now it is dry, with scattered huisache trees in the lake bed.

On Noriacitas (Shallow Wells) Creek just west of Hebbronville were **Hinojosa Springs (1)** on Isidro Gutierrez's ranch. Soon after the 1740 grant by the King of Spain, the Hinojosa family established a ranch here. The springs trickled from Goliad caliche and sand on the surrounding hillsides at an elevation of about 170 meters, where black soils may still be seen. A dam was built (since washed out), which impounded a lake where many herds were watered and frequent outings were held. Travelers on the San Antonio-Rio Grande City road stopped here and watered their animals. Robert E. Lee is said to have stopped here. In 1906 Robert Fulbright's grandfather used to fish in the lake. By 1930 the springs had failed, but seeps in the creek channel still provide live water in pools.

The water has evidently been contaminated, as shown in the table of Selected Chemical Analyses. In 1913 Alexander Deussen tested the water in a shallow well in the alluvium near Hinojosa Springs and found it to contain 450 mg/l (milligrams per liter) of chloride and 246 mg/l of sulfate. In 1979 the writer found 5,200 mg/l of chloride and 400 mg/l of sulfate in the pool water. Minnows and killdeers thrive among the cattails and sand-bar willows. In spring the surrounding fields are covered with yellow wild indigo and blue-violet phacelia blossoms.

Charco Windmill (8) is on W. W. Jones' ranch at latitude 27°04' and longitude 98°37'. Here seepage from Goliad sand once fed a natural water hole. Pre-historic people who used the water left flint artifacts in the vicinity. The charco has long been dry, and a windmill pumps out groundwater. Deer, coyotes, and other animals now use the windmill water.

Eleven kilometers south-southeast of Charco Windmill was a seep-fed lake called *La Salada* (The Brackish One) (7). It and several similar lakes were on property now owned by Ray Holbein, Wistano Hinojosa, and others. Although the water was slightly saline, this was a popular watering place in the 1880s. The lakes are now dry, but the old stone watering trough may still be seen.

On Highway 1017 about 13 kilometers north of the Starr County line is the old settlement of Agua Nueva. Here is *Tres Lagunas* (Three Lakes) (6), where Jose

Ramirez obtained a land grant in 1740. A fortress-like house with gun ports, built here, is now owned by Florencio Ramirez. Seepage from Quaternary sand formerly kept the lakes brimful. This was a popular location for picnics and festivals. The U.S. Engineer Office in 1892 showed Agua Nueva on its *Map of the Rio Grande frontier, Texas*.

Before Hurricane Beulah in 1967 the lakes were almost dry. The heavy rains accompanying the hurricane restored them almost to their former size. Now they are drying up again. Frogs, ducks, and herons are active among the cattails, shaded by willow and hackberry trees. Many wells pump nearby.

The old community of Cuevitas is on Highway 649 in southwest Jim Hogg County. The name *Cuevitas* refers to the *small caves* which a prehistoric people dug in Goliad caliche. These people obtained their water from seeps (2) along *Charco Largo* (Long Pool) Creek. According to Sigifredo Munoz, a long-time resident of Cuevitas, the seeps dried up around 1918. Now the water level is about five meters below the surrounding surface. Charco Largo, on the creek on S. P. Guerra's ranch near the Starr County line, now collects water chiefly after rains.

JIM WELLS COUNTY

Most of Jim Wells County's springs and seeps issued from Pliocene Goliad sand and caliche and Quaternary Lissie sand. These formations dip toward the east-southeast at 8 to 16 meters per kilometer. The drainage channels along which springs occurred are often imperfectly developed, and sometimes "bifurcate" or split in a downstream direction.

The water table in the Goliad sand declined as much as 57 meters from 1933 to 1969 in the area east of Premont. Flowing wells which wasted water caused much decline. Later pumping of wells for industrial and other uses hastened the fall of the water table. As a result nearly all of the springs and seeps have ceased flowing.

Formerly a complex ecosystem depended upon the spring and lake waters. Plants such as rushes, marsh purslane, water milfoil, water hyacinths, marsileas, cattails, and maidenhair ferns grew in and around the pools. Willows and grapevines relished the water. Live oaks required a little less moisture. In the water were fish, frogs, crawfish, snakes, mussels, snails, and various insects. Feeding upon them were ducks, herons, killdeers, raccoons, wolves, panthers, and bear. Dependent upon the vegetation were beaver, deer, and other animals. When springs and lakes dried up, most of these plants and animals disappeared.

The spring and seep waters were chiefly of a sodium bicarbonate or chloride type, fresh to slightly saline, very hard, and alkaline. The iron and fluoride content could be high. Much salt waste water from oil fields was formerly discharged directly into streams or unlined pits. Although this practice is no longer permitted, seepage of brine has caused contamination of groundwater.

Most of the writer's field studies were made during the period March 18-23, 1979.

At San Diego in Duval County are Casa Blanca Springs. Other springs (8) probably still flow on San Diego Creek just east of San Diego in Jim Wells County. But they are now obscured by the waste-water discharge from San Diego. In the table of Selected Chemical Analyses is shown an analysis of the groundwater in this vicinity as it was in 1913. This water was from a shallow alluvial well adjacent to the creek.

Sixteen kilometers north-northwest of Alice were **Amargosa (Bitter) Springs (9)**. Near the junction of Amargosa and Chiltipin Creek, they trickled from Goliad sand. A Clovis projectile point has been found near here, according to Alice archeologist Alvin Boldt. Evidently man made use of the springs for at least 12,000 years. More recently, a way station for stagecoaches on the San Antonio to Brownsville route was located here. Now marked by a cemetery, it was much beleaguered by bandits and Indians. Cattle drives also paused at the springs. A few seep-fed water holes still exist just upstream on Bob Pickle's ranch and downstream on Chiltipin Creek. Anaqua, elm, and hackberry trees shade the pools.

A few kilometers west of Highway 281 on *Lagarto* (Alligator) Creek in northern Jim Wells County are a number of former Indian campgrounds. Here numerous springs (10) once flowed from Goliad gravel on the S. T. Freeborn ranch. According to Willie Hinnant, who has lived on Lagarto Creek all his life, the creek ran



Seep-fed Chiltipin Creeknorth of Alice.

constantly for 50 kilometers in the 1890s, with many deep, fish-filled holes. Now it is very dry and shaded by mixed woods.

A second Casa Blanca, the oldest settlement in the county (about 1750) was located on a point on Penitas (now often spelled *Pemitas*) Creek on Fred Long's ranch. Here were very small springs (6) from Goliad sand. The springs were doubtlessly used by the residents of the sub-mission which was located here. Much later, in 1855, a caliche fort was built at the site and equipped with a well. The former springs are now-beneath Lake Corpus Christi. Some live-oak-shaded water holes fed by seepage still exist upstream on Penitas Creek. Rumors persist of buried treasure in the vicinity.

Five kilometers south of Alfred, on J. S. Ragland's farm, was formerly a large seep-fed lake (7). The overflow from the lake ran into Aqua Dulce Creek. Indian camps were situated on the northwest side. In early settlement days cattle were held here while awaiting rail transportation, according to Ragland. Early residents drove wagons out into the lake and filled their water barrels. Most of the seeps from Lissie sand dried up around 1900. Ragland recalls some water, and ducks, in the lake in 1938. Now it is dry, filled with sediment, and cultivated.

Nine kilometers northeast of Alice there was formerly a 120-hectare seep-fed lake (5), on Max Richter's farm. Many Indian artifacts have been found here, according to Boldt, including Plainview points, possibly 11,000 years old. Until 1924 there were many fish in the lake. At that time Richter placed the area in cultivation, and the lake gradually filled with sediment and dried up. A few hackberry, live oak, anaqua, and seep-willow trees still stand here.

Collins Springs (4) were six kilometers east-northeast of Alice on Chiltipin Creek. About 250 meters upstream from the Texas Mexican Railroad, they were on Newell Atkinson's property at an elevation of 55 meters. An 1831 map showed springs here as the source of Chiltipin Creek. Later the town of Collins grew up at the site. The springs, which drained from Lissie sand, ran until the 1940s and would probably be dry now. But leakage from the upstream Terminal Reservoir together with waste-water discharge from Alice obscure the picture.

On Highway 281 eight kilometers south of Ben Bolt is an archeological site on Santa Gertrudis Creek. Very likely there was once permanent live water here (3), upon which the ancient people who lived here depended. Now there are only a few pools of muddy surface-runoff water.

Lagunas Negras (Black Lakes) (1) are in southwest Jim Wells County, 10 kilometers northwest of Falfurrias, on Fino Garcia's ranch. According to Jose Lemus of Falfurrias, these natural lakes were brimful with live water until about 1928. Now they are fed only by surface water after rains. Cattails and mesquite trees are abundant.

Eight kilometers west-northwest of Premont are several archeological sites. Here were very small springs (2) from Quaternary sand on Ralph Stolzhus' farm. In 1852 John Bartlett found here

a chain of lagunas called Los Olmos.
The water was sweet and the grass abundant.

They and other springs kept Los Olmos Creek flowing until around 1900. Now the creek is dry except during hurricanes such as Beulah in 1967. White-flowered anaqua, ebony, and live oak trees thrive along the creek channel. Many irrigation wells pump nearby.

KAUFMAN COUNTY

Springs have never been large or numerous in Kaufman County. Most of the exposed formations are clay or marl which cannot carry much groundwater. But some springs flow, or did flow, from the upper Cretaceous Nacatoch sand and Eocene Tehuacana limestone and Pisgah sand. These formations dip toward the east at around 8 to 12 meters per kilometer. Faults in the eastern part of the county control the location of some springs. Quaternary terrace sand and gravel, especially along the Trinity River, are the main source of springs in the county.

Many archeological sites have been found near the springs, mostly along the Trinity River. Around 1700 the hunting and gardening Wichita Indians entered the area from the north, establishing villages near the springs.

The usual springs vegetation includes marsh purslane, cattails, common reeds, plum thickets, grapevines, and cottonwood, willow, sycamore, hackberry, and post oak trees. The springs were once frequented by numerous fish, reptiles, mammals, and birds. Most of these animals are now gone.

The groundwater table has fallen, due chiefly to well pumping. As a result, many springs have weakened or dried up.

The spring waters are generally of a calcium bicarbonate type, fresh, very hard, and alkaline. The iron content may be high.



Pleasant Springs.

Most of the writer's field studies were made during the period September 26 - October 1, 1979.

In the northwest corner of the county, five kilometers north-northwest of Fomey, are **Pleasant Springs (1)**, on Governor Bill Clements' property. The Pleasant Springs cemetery is just west of the springs. The community of Pleasant Springs once clustered around the springs, according to nearby resident Frank Rublee. On September 29, 1979, 1.3 liters per second of fresh water poured from terrace sand and gravel on top of Wolfe City marl. The springs probably now receive recharge from Lake Ray Hubbard, completed in 1969 just upstream on the East Fork Trinity River. Minnows swim among the water milfoil in the pools. Sunflowers and purple eryngo adorn the adjacent slopes. Pecan, willow, and cedar trees shade the site.

In the northeast corner of the county, 11 kilometers south of Quinlan, are **Ables Springs (2)**, on the property of the Ables Springs Church of Christ. Mounds indicate that an Indian village once existed at the springs. In 1853 James Ables built a cabin here. He made a will declaring that the springs should never be fenced, and they have not been.

On September 29, 1979, Ables Springs produced 0.52 lps of fresh water from Tehuacana limestone at an elevation of 150 meters, which ran about 500 meters before disappearing. One of the springs has been walled up. They reportedly were much stronger in the past, but now usually dry up in summer. Several limestone quarries nearby are reported to have affected the flow. Minnows, water striders, turtles, and some algae live in the pools. Nearby are cardinal flowers, purple ironweed flowers, poison ivy, and American Beauty-berry shrubs, shaded by post oak and cedar trees. (See Plate 15, f).

Nine kilometers northeast of Elmo on Highway 2728 was an Indian campsite. Springs (3) evidently

existed here. On September 29, 1979, there was still seepage from a fault in Pisgah sand. Minnows dart in the pools among marsh purslane and cattails. Raccoon tracks may be seen. Willow, post oak, and a few cottonwood trees surround the site.

College Mound is 11 kilometers southeast of Terrell, just south of Interstate 20. According to Mrs. James Miller, county historian, there were springs (4) here at one time. Guy Tankersly, who was born here in 1893, does not remember any springs. But prior to that time there probably were very small springs or seeps in a wooded draw near the College Mound waterworks and just west of the church and cemetery.

In 1844 Capt. John Beck and a party from Indiana arrived at College Mound. Indians soon stole their livestock. The water is believed to have trickled from Tehuacana limestone. The site is now quite dry.

Cottonwood Springs (5) are five kilometers east of Rosser, feeding Big Sandy Creek on H. E. Goodman's ranch. Many Indian relics have been found here. There are also rumors of buried Spanish gold near the springs. The 1882 Cottonwood cemetery, an old log cabin, and a historical marker are just south of the springs. The springs, issuing from terrace sand and gravel, are now mostly beneath the surface of a lake. Many fish, turtles, and frogs live among the marsh purslane and water milfoil. Persimmon trees are numerous here.

In 1851 Rosser was a river port on the Trinity River. Later it was a railroad town called Sand Switch. No doubt the abundance of springs in this vicinity (6) was one reason the settlement grew up. At that time the Trinity River flowed adjacent to the bluff at Rosser, whereas it is now at least two kilometers away.

The largest springs are two kilometers east of Rosser on O. H. Freeman's property. An old abandoned road passes them in a wood of pecan, post oak, live oak, cottonwood, willow and bois d'arc trees, American Beauty-berry shrubs, and poison ivy. Marsh purslane and algae abound in the pools, and the banks are covered with moss and raccoon tracks. Many frogs jump into the minnow-filled waters on the approach of a stranger. Squirrels and rabbits scurry through the woods. On October 20, 1979, 0.35 lps trickled from terrace sand and gravel on clay, running about 500 meters before sinking into the alluvium. Smaller springs emerge nearby on Randy Johnson's and Mrs. Stanley Pratt's ranches.

KENEDY COUNTY

The small springs and seeps of Kenedy County flow largely from Quaternary sand deposits. Because the

area is so flat, there has never been the opportunity for large springs to develop. Hurricanes and other natural forces have caused great changes in the land, with the result that springs or seeps naturally have a short life or reappear in other locations. Padre Island began to form only about 5,000 years ago when the melting of the continental ice sheets brought the sea level to within 10 meters of its present level.

Seeps are most common on the landward side of sand dunes, especially where live-oak mottes are present, both on Padre Island and on the mainland. The Borrado Indians knew that fresh water could be found in these locations by digging shallow holes. In 1766 the Spanish surveyor Diego Ortiz Parilla found such holes at abandoned Indian campsites on Padre Island. Usually fresh groundwater was found in them at depths of 0.2 to 1.1 meters. Later settlers adopted this procedure, sinking open-ended barrels into seep areas to make shallow wells.

The smaller, shallow ephemeral lakes which appear after rains usually contain only slightly saline water. Such was the case during the writer's visit of January 2 - 7, 1977, after several months of above-normal rainfall. On the other hand, the larger, deeper, permanent lakes are generally very saline or briny as a result of constant evaporation of the water.

Around the turn of the century many deep flowing wells began to be drilled. Most of these were allowed to flow freely, wasting the fresh water. As a result, the potentiometric surface has declined, and most of these wells no longer flow. In addition, much of the "perched" reservoir of shallow fresh groundwater was soon removed by windmill pumping. As a result very few fresh-water seeps remain.

Formerly there were good grasses and willow, laurel, and oak trees on Padre Island. The terrible overgrazing by cattle in the late 1800s removed much of this vegetation. Blowing sand began to fill Laguna Madre. By 1841 no trees remained on the island. In 1846 on his march from Corpus Christi to Brownsville, Gen. Zachary Taylor encountered herds of wild mustangs "the size of the state of Delaware." Wild cattle, burros, wolves, and elk also used the seeps and lakes but have since been largely exterminated. Still to be found are deer, javelinas, wild hogs, bobcats, wild turkeys, and hawks. The lakes are a winter gathering place for ducks, geese, pelicans, ibises, cranes, and other waterfowl.

The seep water which still exists is generally of a sodium sulfate or chloride type, hard and of neutral hydrogen ion concentration (pH). Because of various activities of man such as removal of the shallow fresh water, salt-water intrusion, and oil-field contamination

of groundwater, the remaining shallow groundwater is usually slightly to moderately saline.

In early times, according to Hector Lopez of Alice, spring-fed Palo Blanco and Baluarte Creeks overflowed Laguna Salada in northeast Brooks County. This flow, fed by additional springs and seeps in northwest Kenedy County, continued perennially through Cayo Lake to Baffin Bay. Twelve kilometers southwest of Sarita and two southeast of the Santa Rosa Viejo ranch headquarters there were reportedly small springs (5), according to Randy Brown, who lives nearby. They apparently issued from sands near Cayo Lake, but are now dry. A few kilometers west the skeleton of a mammoth has been excavated by Texas A and I University.

Evidence indicates that Los Olmos Creek once was a flowing stream. There are still pools of live water (6) in the lower reaches of the channel. Capt. Jose Elias de Garza Falcon probably paused here in 1766. The federal Civil War Camp Boveda was on the creek three kilometers east of Highway 77.

According to Louis Turcotte of Sarita, there was formerly a small spring called **Ojo de Agua** (Eye of Water, or Spring) (1) about five kilometers southwest of Griffins Point on the Kenedy ranch in northeastern Kenedy County. Located at latitude 27°13' and longitude 97°27', the water probably flowed from the base of sand dunes to the west. In the 1930s a windmill was pumping here, causing the spring to fail. Since then the windmill has been destroyed by hurricanes.

A similar seep (2) once existed at *Carnestolendas* (Carnival) camp 10 kilometers south. Here fresh or slightly saline water formerly flowed from the base of sand deposits. A windmill now pumps stock water here, and the seeps have dried up.

On the *Norias* (Shallow Wells) ranch there were formerly some shallow, wood-lined wells, according to John Cypher of the King ranch. They were located near a lake seven kilometers west of Rudolph, at latitude 26°42' and longitude 97°50'. It is possible that seeps (3) existed here before the wells were installed. The wells have since been filled.

A study of Armstrong Ranch Lake for about two years following hurricane Beulah of 1967 was made by the U. S. Geological Survey and the Texas Water Development Board. The lake is about five kilometers south of Armstrong station in southern Kenedy County. During the first year and four months following Beulah, water moved from the lake, which was at unusually high levels, recharging the sandy formations beneath. In a return to more normal conditions in the following eight months, groundwater moved into the lake through seepage (4) around its shores at the computed

rate of 0.48 liter per second. Such factors as change in lake stage, precipitation, runoff, and evaporation were taken into account in the study, which throws much light on the relation between surface lakes and groundwater in this area. The figures shown in the table of Selected Chemical Analyses (taken from a shallow well near the lake) show the groundwater to be brine, saltier than sea water.

KENT COUNTY

Kent County lies in the Rolling Red Plains. Small springs emerge from Permian gypsum and sandstone in the Quartermaster, Whitehorse, and Cloud Chief formations. Some seep from Quaternary wind-blown sand deposits and sand and gravel terraces along the major streams. In the southwestern part of the county a few springs trickle from Triassic Dockum sandstone and conglomerate.

During droughts such as those of 1886 - 87, 1943, and 1952 - 56, many springs dried up temporarily. Unfortunately groundwater levels have fallen, chiefly because of well pumping. As a result, many springs have weakened or failed permanently. In addition, there has been severe gully erosion in modern times. This has choked many stream channels, filling the deep holes and burying some springs.

At several prehistoric sites as well as historic Indian villages, people lived by and used the spring waters. The usual vegetation at the springs includes cottonwood, willow, and hackberry trees, plum thickets, grapevines, cattails, and rushes.

The spring water is generally of a calcium or magnesium sulfate type, slightly saline, very hard, and alkaline. The water from Triassic sandstone is usually fresh and of a calcium bicarbonate type. Some spring water is high in sodium chloride (salt), usually from natural sources but in some cases from oil-field brines.

Most of the writer's field studies were made during the period August 12 - 17, 1979.

Two D Springs (5) are five kilometers southwest of Clairemont on Leroy Spires' ranch, managed by Bobby Byrd. They were much used by early residents in the Clairemont area. The water seeps from Quaternary gravel on top of a one-meter-thick bed of Dockum sandstone, which in turn rests on Permian shale. On August 13, 1979, the discharge was 0.03 liter per second, which ran about 50 meters before sinking into the sand. An earth tank just upstream no doubt helps to recharge the springs, but an adjacent windmill was pumping 0.20 lps on this date. Dragon flies and wasps congregate at the pools.

Seventeen kilometers west of Clairemont were

some springs (10) feeding Spring Creek, on Odell Lowe's ranch, managed by Dink Johnson. On August 14, 1979, there was only seepage into several earth tanks.

Salt Creek Brine Springs (7) are 13 kilometers west-northwest of Clairemont on the North Fork of Salt Creek on Larry Lowe's ranch. With a dissolved-solids content sometimes as high as 238,000 milligrams per liter, or seven times as salty as sea water, these springs are among the most saline in Texas. They issue from the Quartermaster formation in a deep canyon in gypsum and siltstone. The brine deposits crystals of halite in the pools, and a thick salt crust is present on the floodplain. In addition to the constituents shown in the table of Selected Chemical Analyses, the water contains 11 milligrams of strontium per liter, 28 mg/l of lithium, and 22 mg/l of bromide. No animal or plant life is present, but salt cedars grow at the edges of the bottomland. On August 14, 1979, the discharge was 1.3 lps.

In northwest Kent County were **Spring Creek Springs (9)** on a second Spring Creek on J. B. Morrison's ranch, at latitude 33°21' and longitude 100°56'. In the 1880s Lon Barkley built a cabin here. On August 15, 1979, there were only seeps from Quartermaster gypsum and sandstone in Spring Creek at its junction with Red Mud Creek. Red Mud Creek was producing 0.65 lps here, which ran for more than one kilometer downstream. Seep-willow baccharis shrubs are numerous. Minnows and frogs dart in the pools, around which raccoon tracks may be seen. Owls, doves, and killdeers make their home here. The mud nests of swallows were present on the cliffs, but no swallows on the above date.

Carlisle Springs (8) were eight kilometers west-northwest of Girard on Duck Creek on Durward and Gertie Pickens' ranch. They were well known in early days. Many nesters obtained water here. Later picnics were held at the springs, and many names were carved on the gypsum bluff, according to neighbor Mildred Loe. There was a waterfall in Duck Creek near the springs. The water issued from terrace sand and gravel on Permian shale and gypsum.

Before the Pickens arrived here in 1944, bank erosion caused the high bluff to cave in, burying Carlisle Springs. Duck Creek has now been filled with sand also, and the waterfall is covered with sediment from accelerated erosion. On August 15, 1979, there was still a very small live pool with raccoon tracks nearby. Many birds were eating plums from the heavily laden bushes.

Twelve kilometers west of Jayton are some very small springs (11) near the mouth of Duck Creek on Bilby Wallace's ranch. In the early 1870s Gen. Ranald

Mackenzie had a supply camp here while chasing Indians. In the 1880s Charley Lanter camped here. The springs seep from terrace sand and gravel.

In northeast Kent County on Hot Springs and Short Croton Creeks are two areas of brine springs which have developed salt flats. The salt flats are anomalous floodplains in a region of deeply dissected short ridges and narrow canyons. The local widening of the ravines into salt flats has been caused by the sapping action of the springs at the base of the bluffs. The water issues from Whitehorse siltstones and gypsum. The flats are usually seepy and boggy and encrusted with salt "flow-ers" through which salt water is slowly rising under artesian pressure.

The first, **Hot Brine Springs (3)**, are eight kilometers east of Girard on Hulen Lemon's ranch, managed by Charlie Lackey. The seeps occur over an area 2.1 kilometers long and 0.3 kilometer wide. The water is not "hot" in temperature, but is high enough in dissolved salts to burn and kill any vegetation. On October 6, 1960, the chloride content was 63,300 milligrams per liter. Minnows live in the water although there is no vegetation. On the above date and on August 13, 1979, there was no flow, only seepage into pools.

The second area, **Short Croton Brine Springs (1)**, are eight kilometers north of Jayton, also on the Lemon ranch. The salt flat here is somewhat larger, measuring 3.2 by 0.8 kilometer. The seeps occur at an elevation of 545 meters. The dissolved-solids content reaches 100,000 milligrams per liter at times. Here also minnows appear to thrive. Discharge records in liters per second by water years are:

1961	0.25	1969	1.7
1962	0.60	1970	2.6
1963	0.57	1971	2.8
1964	1.7	1972	0.71
1965 - 67	0	1975 - 76	0
1968	0.28	1977	0.57

Often there is only seepage into pools with no out-flow from the flat. Salt cedars fringe the edges of the flat. It has been estimated that Hot and Short Croton Brine Springs contribute an average of 70 tons of chloride and 100 tons of sulfate daily to the Salt Fork of the Brazos River. The U.S. Corps of Engineers plans to pump the brine to Kiowa Peak Lake in northeast Stonewall County, where the water will be allowed to evaporate.

Putoff Springs (2) are six kilometers north of Jayton in Putoff Canyon on E. M. Jones' ranch. From 1900 to 1914 this was a resort for artists and writers. Zane Grey's *Thundering Herd* was based on this area. Many projectile points found here indicate that the



Short Croton salt flat.

springs were also popular in prehistoric times.

Putoff Springs emerge in a ravine of Whitehorse sandstone and gypsum, with a prominent bed of gypsum around the edge. On August 14, 1979, 0.18 lps gurgled into a deep pool. The slightly saline water is "good to drink" in this area of salt springs. Cottonwoods once grew here but are now dead. The pool contains minnows and turtles. The springs are frequented by raccoons, foxes, and coyotes. Many mud swallow nests cover the cliffs, but in 1979 there were no swallows. According to Jones, this year they went to an old building in Girard instead.

Eleven kilometers south-southwest of Jayton on the northeast side of the Salt Fork of the Brazos River is a living site of prehistoric people. Here, on Claud and Clara Senn's farm, springs (4) which were used by these people once flowed from terrace sand and gravel. They have long been dry.

Elkins Springs (13) are in southwestern Kent County on Leroy Spires' ranch, at latitude 32°59' and longitude 100°53'. In 1877 G. K. Elkins brought his cattle to these springs. The water flows from Triassic sandstone on Permian shale, forming a beautiful pool surrounded by large boulders. On August 16, 1979, 0.07 lps of fresh water trickled from the pool. Bullfrogs croaked amid the water milfoil and algae. Water striders skated on the surface. A large Texas spiny lizard darted into a crevice. Damsel flies and dragon flies hovered over the water.

Mackenzie Springs (12) are eight kilometers farther west-northwest and three kilometers north of Mackenzie Mountain on Elizabeth Connell's ranch, looked after by Weldon Johnson. In 1883 George Elkins built a house here. The springs issue from Triassic sandstone on Permian shale. On August 16, 1979, there were only some seep-fed pools of rather muddy water. Seep-willow baccharis shrubs are numerous.

Thirteen kilometers west-southwest of Clairmont were some springs on Bennie Carriker's ranch. This was the site of the first settlement in the county. A stage

stop was located here. The remains of a dugout and old chimney can still be seen. Only a wet-weather seep survives.

KING COUNTY

Springs have never been numerous or large in King County. But they once flowed more freely than now. They originate chiefly from Permian gypsum and sandstone in the Whitehorse, Cloud Chief, and Blaine formations. Some, especially in the northern part of the county, trickle from Quaternary windblown sand deposits and river terrace sand and gravel. The area is known physiographically as the Rolling Red Plains.

As gypsum is quite soluble, water moving through it tends to dissolve out caverns. These caverns are numerous in King County. The county's River Styx Cave is the fifteenth longest gypsum cave in the world, of those that have been measured, at 2,557 meters. Many springs flow from these caverns. As the caverns enlarge, sinkholes and collapse areas develop on the surface above them.

Numerous Indian living sites have been found near the springs, especially in the northeast part of the county. The usual spring vegetation includes willow, hackberry, and salt cedar trees, plum thickets, rushes, and cattails. On the nearby slopes are many cedar and mesquite trees.

During the drought of 1886-87, many springs dried up temporarily. The water table has declined in historic time, primarily because of well pumping. As a result many springs have weakened or failed permanently. In addition, severe modern gully erosion has choked stream channels with sand, burying some springs.

The spring water is generally of a calcium sulfate type, slightly saline, very hard, and alkaline. Oil-field brines have contaminated groundwater in the past. But some brine springs produce water that is naturally very high in sodium chloride (halite) content.

Most of the writer's field studies were made during the period August 3 - 8, 1979.

Camp Hollar Springs (15) are four kilometers southeast of Dumont on Charlie Layton's ranch. According to Layton, in 1964 there were still good fishing holes on Camp Hollar Creek. But on August 8, 1979, the creek was dry. Cottonwood Creek, three kilometers farther southeast, is similar, but still has a few small holes of live water among the cottonwoods. Both creeks have largely been filled with sand from accelerated erosion. Turkeys were once numerous here, but are now mostly gone.

Water Canyon Springs (14) are seven kilometers east of Dumont in Water Canyon on Jim Bob Bigham's ranch, operated by James Lee. The springs trickled from vugular gypsum in a ravine. On August 8, 1979, there were seep-fed pools containing minnows. An old road once passed the springs.

Finney Springs (16) are three kilometers east-northeast of the Finney community on Roy Keith's farm. They are the source of Finney or Buford Branch. In the 1870s S. B. Street, a buffalo hunter, built a dugout near the springs. On August 8, 1979, after much rain during the preceding month, the discharge was 2.5 liters per second, running for three kilometers before sinking into the sand. Although the channel has mostly been filled with sediment, there are still some holes containing minnows.

Eight kilometers north of Guthrie on the 6666 ranch was once Hamm Lake. South of the lake and east of present Highway 83 were **Hamm Springs (13)**. In the early 1880s a Mr. Lewis built a dugout here. When Jack Spencer of Guthrie arrived here in 1910, the lake was already gone. The springs or seeps were in a ravine in Blaine gypsum where an earth tank now stands. They and the cottonwoods which surrounded them have long been gone. Two windmills pump the groundwater nearby.

Five kilometers north-northwest of Guthrie near Four Mile Hill was an Indian camp in historic time. Evidently the Indians made use of seeps or very small springs (5) from gypsum in the hills. They have long been dry, and are now marked only by a few hackberry and many cedar trees.

Farres Springs (1) are five kilometers southwest of the Cottle-Foard-King Counties corner and 1.5 southwest of Whitehorse Mountain, on Floyce Masterson's ranch, managed by Dean Nolan. In 1877 pioneer surveyor O. W. Williams found a "hunter's camp near some fine springs" here. At that time the springs were probably about six kilometers farther up Farres Creek near the Cottle County line, where large deposits of sand fed water into them. Indians once lived at the springs also.

On July 14, 1979, 1.3 lps of slightly saline water poured from Farres Springs. Many sinkholes in the surrounding hills indicate where gypsum caverns have been dissolved out by the circulating groundwater. Minnows dart among the water milfoil and algae. Hawks, wild hogs, and some deer frequent the site. Rock pens and the ruins of an old rock house are nearby.

Pouring Springs (3) are seven kilometers south-southwest of the Cottle-Foard-King Counties corner on Edward Lowrance's ranch. This was a popular spot with Indians, and later with travelers. An old fence, built to keep cattle out, still surrounds the springs. On August 5, 1979, 0.13 lps trickled from gypsum. According to Lowrance, the water is satisfactory for cattle, but not so good for humans because of its high gypsum content. Large catfish swim in the milfoil in a downstream tank. Bluebells bloom close by in summer. Wild hogs, introduced in 1974, do well here. Cedar flies, mosquitoes, and dragonflies sip the water.

Lowrance Springs (2) are eight kilometers south-southeast of the Cottle-Foard-King Counties corner at the Lowrance ranch headquarters. On August 5, 1979, the discharge was 0.28 lps from Blaine gypsum. Scarce bluebells color the site. Dragonflies dart over the milfoil and algae-filled pools. Mountain lions, which probably have their dens in gypsum caves in the hills, have been sighted here.

Two kilometers northeast of the Lowrance ranch house on Love Creek are additional springs. Here there was a mail camp at one time. South of the house 1.6 kilometers were **Gunter Springs**. Here a gang of thieves once hid out, living in several dugouts.

Along a nine-kilometer stretch of the Middle Fork of the Wichita River in extreme northeast King County is an area of salt seeps (4). The salt (halite) appears to be leached chiefly from the Dog Creek shale. The chloride content of the water ranges from 10,000 to 25,000 milligrams per liter. The discharge was estimated to average 28 lps during water years 1961 and 1962. On August 5, 1979, the writer found a flow of 140 lps in the Middle Fork near Pouring Springs.

From six to ten kilometers east of Guthrie along the South Wichita River is an area of small salt springs and seeps, including **Cave Springs (12)**. The brine contains 44,000 milligrams of dissolved solids per liter. In addition to the constituents shown in the table of Selected Chemical Analyses, the water contains 24 milligrams of strontium per liter, 34 of lithium, 1.4 of bromine, and 0.4 of iodine. The discharge was estimated to average 57 lps during the 1961 and 1962

KING COUNTY

water years. On August 7, 1979, the writer found a flow of 82 lps.

The Cave Springs salt is apparently leached from Dog Creek shale and Blaine gypsum. During dry periods the alluvium along the river becomes crusted over with salt. Recharge to the springs is through broken dolomite and weathered gypsum on the nearby uplands. Tritium testing indicates that most of the water is very young and has not migrated from great distances. A project was recently completed which will pump the brine 35 kilometers northeast to Truscott Reservoir where it will be allowed to evaporate. A species of bright blue minnow appears to thrive in the brine, and is stalked by great blue herons.

Thirteen kilometers east-southeast of Guthrie on Ed Bateman's and Caroline Mongrain's ranch are **Lee Springs (11)**. In 1883 John Lee built a rock spring-house over the springs, which trickle from a bluish-gray gypsum. On August 7, 1979, 0.07 lps of the slightly saline water ran 50 meters before disappearing into a sinkhole in the channel of Newman Creek. Tiny crustaceans burrow in the mud in the bottom of the pools. A cemetery and some rock-walled pens are nearby.

Seeps (9) occur on Dikes Creek four kilometers east of the Bateman ranch house. The remains of an old dugout can be seen here. On August 7, 1979, seepage from the bluffs of gypsum and dolomite was feeding pools in the creek. A green anole lizard scurried across the rocks while bullfrogs gave their deep, sonorous call. Turtles were numerous, along with cedar flies and millions of grasshoppers. Spring Creek, three kilometers east on the Ross ranch, is similar.

In southeastern King County at latitude 33°33' and longitude 100°02' was a small spring (10) on Tom Moorhouse's ranch. According to J. C. Moorhouse, Tom's father, a dugout was once located downstream from the spring. He states that it flowed well until the 1920s.

In 1979 the spring, long dry, was converted into a shallow, rocked-up well. On August 7, 1979, water stood 0.5 meter below the ground surface. The well refills quickly when pumped, according to Tom Moorhouse. The water is only slightly saline, even though it originates from cavernous gypsum. Some blue quail frequent the vicinity.

Two kilometers northeast of Tom Moorhouse's spring were **Blaine Springs (18)**, on J. C. Moorhouse's ranch. These may be the springs where Major R. S. Neighbors and Capt. R. B. Marcy stopped in 1854 while exploring for locations for Indian reservations.



Ruins of Blaine house at Blaine Springs

According to Williams and Lee (1947), they

were rejoiced to find a miniature spring of fresh water dripping slowly out from under a rock near the crest of the ridge dividing the waters of the Wichita from those of the Brazos.

In 1889 Mrs. Walter Blaine and her baby girl died in childbirth here. Their graves are near the former springs. According to Moorhouse, Blaine Springs stopped flowing in the 1920s. The water trickled from Blaine dolomite on top of a shale bed. When an earth tank was built just upstream, it developed a leak. The water reappeared in the former springs below. When the leak was sealed, the springs dried up again except for some seepage. Just below the dam are the ruins of the old Blaine rock house.

One-half kilometer south of Blaine Springs were the similar **Rock Springs**. The old rock wall around the springs, and a trough, can still be seen. Sediment has largely filled the springs and trough. On September 3, 1979, there was a seep-fed pool, but no flow. Cattails, salt cedar, and white snow-on-the-mountain flowers thrive here.

On Pen Branch in southeast King County springs (6) once flowed about 10 kilometers east of Highway 83. In 1854 Capt. R. B. Marcy wrote that the water was "clear, deep, and covered with water grasses." He described the creek water as saline, 30 yards wide, and 2 to 15 feet deep. The water was "alive with large cats and buffalo fish."

On August 6, 1979, the creek was dry. The site is on Norwood Parramore's ranch, leased by Foster Hill, and looked after by Louis Burfiend. According to Burfiend, there are still some seep-fed pools in wet weather.

In the southwestern part of the county on Glenn Springer's ranch are several natural brine springs. **Haystack Brine Springs (7)** are near the mouth of Haystack Creek at latitude 33°24' and longitude 100°25'. The salt is leached from the Dog Creek shale. The springs appear at an elevation of about 515 meters

at the base of the bluffs. In dry periods a crust of salt (halite) up to six centimeters thick covers the surface. (See Plate 14,a). The brine discharge records in liters per second by water years are:

1957	11	1969	7.1
1961	8.5	1970	5.4
1962	3.0	1971	4.2
1963	6.2	1972	5.8
1964	5.7	1973	9.9
1965	3.1	1974	4.2
1966	4.2	1975	6.5
1967	2.0	1976	3.4
1968	11	1977	5.7

The dissolved solids concentration of some of the springs ranges as high as 200,000 milligrams per liter. About 30 tons of chloride and 3 tons of sulfate per day originate from Haystack Brine Springs.

Upper Haystack Creek, according to Springer, has seeps of water from Blaine gypsum that is only slightly saline. On August 6, 1979, there were only a few damp spots in this ravine. A windmill here pumping 0.25 lps was no doubt the primary cause of the drying up of these seeps.

Dove Brine Springs (8) are about three kilometers west of Haystack Brine Springs on Dove Creek near the Stonewall County line, and flow partly in Stonewall County. Numerous seeps occur at the base of the bluffs and some small springs flow from caves. The shallow pools contain cubical halite crystals measuring one centimeter or more on an edge. Recharge is through collapse areas and sinkholes in the gypsum and gypseous shale on the neighboring uplands.

During water year 1957 the discharge of Dove Brine Springs was 13 lps. On August 6, 1979, it was 0.48. The chloride concentration ranges as high as 153,000 milligrams per liter. In 1955 an exploration drill hole near the springs tapped the saline water at a depth of about 21 meters. The water flowed initially from this hole to a height of more than 13 meters. Plans are underway to pump the brine from Dove and Haystack Brine Springs to Kiowa Peak Lake in northeastern Stonewall County, where the water will be evaporated.

No vegetation grows on the salt flats on Dove Creek, although salt cedar grows at the edges. Two kinds of minnows, some bright blue and the others greenish tan, were present on August 6, 1979. Brine shrimp darted in the water while tiger beetles patrolled the shores. Wasps also sipped the water.

In the 1880s George Simmons built a dugout for a cattle ranch on North Croton Creek about 18 kilometers southwest of Guthrie. Springs (17) poured from Cloud Chief gypsum at that time. The site is now on the Pitchfork ranch, managed by Jim Humphreys. On Au-

gust 8, 1979, there were a few pools of stagnant water surrounded by crusts of gypsite. Tiny brine shrimp darted in the pools, while tiger beetles prowled the shores. Raccoon tracks were abundant, and cedar flies and wasps sipped the water. Most of the channel has been filled with sand.

KINNEY COUNTY

The springs in Kinney County have always been popular with the human race. Projectile points as old as the Plainview type have been found near Las Moras (The Mulberries) Springs by Houston archeologist L. W. Patterson, indicating that a hunting and gathering people lived here 8,000 years ago or earlier. Spanish explorers began to camp at the county's springs in the sixteenth century, and more recently, in the eighteenth century, a mission is said to have used the waters of Las Moras Creek. The first settlement by Europeans was made at Dolores on the banks of Las Moras Creek about 15 kilometers downstream from the springs. Although this settlement lasted only a few years, it did construct grist and sawmills which used the spring water for power.

The springs of Kinney County flow chiefly from the Edwards and associated limestones in the northern half of the county. These limestones are cavernous and dip toward the south. Water enters the formations in Edwards and northern Kinney Counties, moving down the dip to the springs, where it returns to the surface, often through faults in the rock. On October 10 - 15, 1976, the time of the writer's principal visit, the West Nueces River was dry from Moran Springs downstream. The water had evidently entered the cavernous limestone aquifer as recharge. Many dry caverns represent former channels through which the groundwater flowed. One of these is the large and beautiful Kickapoo Cave one kilometer west of Highway 674 just south of the Edwards County line, on Judge Tom Seargeant's ranch. At a depth of about 30 meters a little underground spring still flows among stalactites and stalagmites.

Naturally the flow of groundwater from Edwards and northern Kinney Counties can be intercepted and siphoned off by wells located between the recharge areas and the springs. If these wells are irrigation wells, very large amounts of groundwater can be removed by pumping. Already the larger springs have shown signs of failing during the irrigation season. This is reminiscent of Comanche Springs at Fort Stockton where, six years before they ceased flowing forever, they began to falter during irrigation pumping. It is to be hoped that the same fate will not overtake Kinney County's

springs, but very likely it will.

The spring water is of very good quality, being of a calcium bicarbonate type, usually fresh, very hard, and alkaline.

As in most areas of Texas, the ranchers are gradually moving into the towns. Often a Mexican-American foreman is left in charge of the ranch when the owner leaves it. Some knowledge of Spanish is very helpful to the visitor who desires to obtain information.

The largest and best-known springs in the county are **Las Moras Springs (13)**, on the grounds of Fort Clark in Brackettville. The mulberry trees for which the springs were named were described by Whiting (1938) during his visit in 1849. These springs rise at an elevation of 334 meters under artesian pressure from the Edwards and associated limestones, passing through a fault in the overlying formations. Burned-rock middens and stone artifacts testify to long prehistoric use of Las Moras Springs by early Americans. In 1840 a cavalry unit drove the Comanches from their village at the springs, killing many Indian women and children in the process. At that time many bison, antelope, and wild mustangs roamed the area. In 1852 Fort Clark and neighboring Brackettville began using the spring waters. They were used to irrigate the post gardens and other lands downstream. They also once supplied the power to run an ice manufacturing plant. They were a stop on the Old Spanish Trail from San Antonio to El Paso, and later also on the military road running north from Eagle Pass. As late as 1877, Indian fights occurred in the vicinity.

Discharge records, in liters per second by water years, follow:

1896	590	1954	710
1899	1,700	1955	620
1900	1,400	1956	680
1902	310	1957	850
1904	790	1958	990
1905	400	1959	1,400
1906	510	1960	880
1910	400	1961	760
1912	240	1962	540
1925	260	1963	310
1928	160	1964	160
1939	760	1965	850
1940	760	1966	590
1941	680	1967	570
1942	650	1968	710
1943	710	1969	200
1944	590	1970	480
1945	510	1971	99
1946	310	1972	790
1947	930	1973	850
1948	590	1974	790
1949	820	1975	540
1950	760	1976	760
1951	200	1977	880
1952	270	1978	420
1953	180		

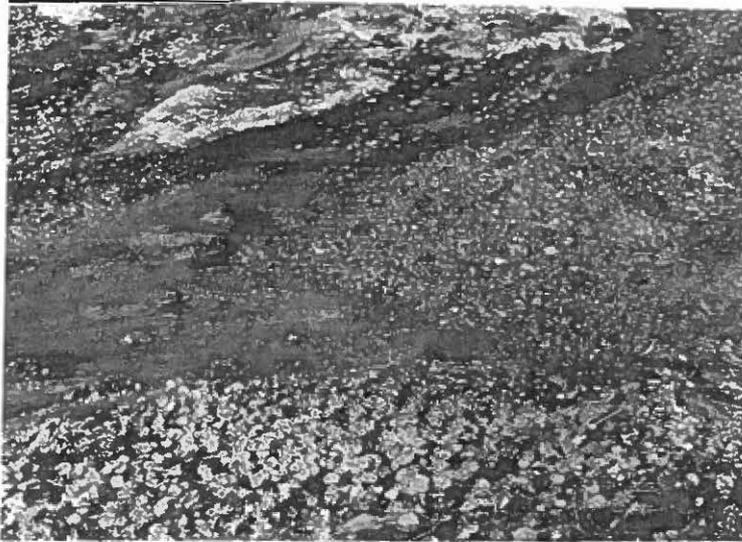
The average annual discharge has been 620 lps. Rains in the West Nueces River drainage area in Edwards County are followed by rises in the spring flow in about three days. In parts of July, August, and September, 1964, the springs dried up completely, probably due to heavy irrigation pumping in the area north of Brackettville. The Alaskan earthquake was blamed by some, but as it occurred several months before the springs' failure, there was likely no connection between the two events. Following this emergency the Fort Clark Springs Association drilled two wells into the Edwards aquifer at the springs. Together they flow about 31 lps at the surface. The town of Brackettville also drilled a well at this time to replace the springs as its water supply. The springs also stopped flowing for a time in June, 1971.

Fort Clark was closed in 1946, and is now being developed as a residential area. The springs rise in a large walled-in pool filled with water milfoil. (See Plate 9, f). In the outlet channel is a growth of spikerush. The springs supply water for a 100-meter-long swimming pool. Semi-tame deer roam the grounds of the fort. The University of Texas at Austin is studying the various fish found in the springs, which include Rio Grande perch, bass, catfish, and carp. Ten kilometers north of Brackettville was the Six Mile water hole, much used by the cavalry in the 1870s but now dry.

Northwestward from Las Moras Springs are a number of other springs which also issue from the Edwards and associated limestones in a zone of echelon faults. **Pinto (Paint) Springs (12)**, twelve kilometers north of Brackettville on "Happy" Shahan's ranch, give rise to Pinto Creek. In the midst of fields of buttercups, the springs burst from fissures and faults in the Buda limestone. Much water milfoil and floating hearts grow in the spring waters. The water was formerly used for irrigation. Discharge records, in lps by water years, follow:

1939	120	1969	0
1940	190	1970	68
1941	110	1971	59
1952	100	1972	450
1953	0	1973	250
1962	57	1974	420
1965	230	1975	31
1966	100	1976	160
1967	57	1977	570
1968	71	1978	57

Pinto Springs stop flowing when irrigation pumping from wells is taking place nearby. An increase in this pumping could well spell the end of these springs. A few kilometers south, on Elm Creek, is a hole in Buda limestone from which another spring formerly issued.



Pennywort at Schwandner Springs.

Downstream on Pinto Creek, almost to the railroad crossing, are the small **Stricklin Springs (9)**, which flow from Austin chalk amid much giant cutgrass.

A little farther northwest are **Pecan Springs (2)**, at latitude 29°28' and longitude 100°32', the source of West Pinto Creek. Many projectile points, manos, and metates were left here by former occupants. The springs flowed 6.0 lps at the time of the writer's visit. Seven kilometers downstream a smaller spring was flowing 1.6 lps from a concrete box on the James Bader ranch.

On the Jack Beasley ranch, at latitude 29°24' and longitude 100°34', some springs (1) begin to rise along *Perdido* (Lost) Creek, forming many marshes. On October 11, 1976, the flow increased to 12 lps at the upper crossing of Highway 3008, six kilometers north of Highway 90. It decreased to 5.0 lps at the lower crossing of Highway 3008, and disappeared into the Eagle Ford formation before reaching Highway 90.

Still farther northwest, on Frank Mey's ranch, are **Mud Springs (11)**, the source of Mud Creek, at latitude 29°27' and longitude 100°37'. Mud Creek was probably named for the Eagle Ford shale through which it flows, but the spring water, emerging at an elevation of 360 meters in a grove of live oaks and pecans, is very clear. The water has been much used for crop irrigation. A flowing well is located two kilometers downstream on Sid Martin's ranch. Many partially drained swamps may be found downstream, with much tall grass and rushes. The old road from Del Rio to Rocksprings passed the springs. At one time a wagon load of silver was stolen there. Discharge records in lps by water years are:

1939	110	1969	76
1940	71	1970	280
1941	28	1971	140
1952	0	1972	680
1953	0	1973	570
1962	280	1974	400
1965	400	1975	170
1966	200	1976	260
1967	150	1977	820
1968	130	1978	590

Dutch Water Hole (18) is on the West Nueces River at Dutch Mountain, on W. L. Moody's Silver Lake ranch. During the Civil War about 80 German Union sympathizers were killed here while trying to escape to Mexico and the North. They are rumored to have buried a cache of gold here before they were killed. Seeps still feed the clear water hole. Sycamores, live oaks, cedars, mountain laurel, and algerita fringe the pool. About one kilometer east on Sycamore Creek is the similar **Blue Water Hole**.

Lost Springs (17) are in the northeast corner of the county 16 kilometers west-southwest of Camp Wood. Five shallow mortar holes have been found in a rock shelter near the springs. In 1884 the Weavers built a log cabin here. According to Preston Sights, a nearby rancher, the springs still flow well.

On W. L. Moody's ranch, leased by Clay Hunt, are **Silver Springs (7)**, at latitude 29°33' and longitude 100°16'. The springs burst from the base of a limestone bluff on the West Nueces River. It contains many rock shelters, some with prehistoric paintings. At this very scenic spot, which obviously was very popular with early Americans, have been found burned-rock middens, burials, and artifacts. The point where the spring flow enters Silver Lake, a natural lake in the West Nueces River channel, was the site of an Indian village. Water pennyworts are abundant in the springs. A hunting lodge is maintained here, and the vicinity teems with wildlife, including deer, javelinas, turkeys, ducks, and hawks. Discharge measurements, in lps, include:

June 19, 1931	170	Oct. 14, 1976	200
Dec. 14, 1954	0		

Two kilometers east of Silver Springs are the similar, moderately large **Schwandner Springs (14)**, on Bob Shepperd's ranch. They flow from a large opening in the Georgetown limestone as well as through gravel and cobble deposits. A forest of large trees decorated with ballmoss surrounds the springs. Water milfoil and pennywort grow in the water. Numerous burned-rock middens, especially on the terrace between the springs and the West Nueces River, attest to long occupation of the site by early Americans. Deer and fish are plentiful. Discharge measurements in lps by water years follow:

1939	62	1955	110
1940	79	1962	93
1941	85	1976	110

Five kilometers downstream from Schwandner Springs the West Nueces River flow disappeared on October 14, 1976, into cobbles and gravel. Two

kilometers farther downstream it reappeared with a flow of 840 lps (15). This is a good example of *underflow springs*, in which the water passes beneath shallow alluvial deposits for only a short distance before reappearing as springs. Such springs are common along the West Nueces River.

A little farther downstream on the left side of the West Nueces are **Moran Springs (3)** on Pat Bailey's ranch at latitude 29°30' and longitude 100°12'. They issued at 6.2 lps from the base of a bluff of cavernous Comanche Peak limestone on October 12, 1976. Several burned-rock middens are nearby. Water cress grows in the springs, surrounded by large pecans, elms, and live oaks. The springs supply water to several houses and to livestock. The ranch is used by hunters.

Ten kilometers north-northeast of Moran Springs are **Elm Springs (10)**. On October 16, 1976, these and the upstream **Garden Springs** and others produced a flow of 170 lps in Live Oak Creek which ran almost to the West Nueces River, where it disappeared into coarse alluvium. Wild turkeys are very numerous in the vicinity. Many smaller springs flow from the cavernous Georgetown limestone in the northern portion of the county.

Seven kilometers west of Cline on Turkey Creek was the **Government Water Hole (16)**. In 1867 Captain Edward Meyer wrote (Duke, 1973):

a fair camp on north side of road just west of a very large pool of water — no running stream, . . . abundance of Mesquite wood, and excellent grazing east of camp.

Evidently there was still live water here in 1891, when the water hole was shown on a U.S. Geological Survey topographic map. It has long been dry, but a few live oaks still survive among the mesquite and sage.

Several small springs occur in the southern part of the county, issuing chiefly from the Austin chalk. **Morison Springs (4)** at the west end of the Anacacho Mountains on L. R. French's ranch flowed 0.63 lps in 1939, but are dry now, no doubt because of a nearby well. They were quite possibly at a village of Yorica and Jeape Indians who were encountered by the Spaniard Fernando del Bosque in 1675 (Bolton, 1908).

A second **Elm Springs (5)** are at the roadside park ten kilometers east of Brackettville on Highway 90. Lt. S. G. French described them as forming Elm Creek (U.S. Senate, 1850). They flow only intermittently now, probably because of well pumping from the Austin chalk in the park.

Tequesquite Springs (6) are chiefly on Wayman

Percifull's ranch, at latitude 29°06' and longitude 100°36'. The source of Tequesquite Creek, they flowed from Uvalde gravel, mostly cemented by lime into a conglomerate, on top of the Austin chalk at 0.13 lps on October 13, 1976. Downstream there are many bogs and water holes. The flow increased to 0.45 lps on this date at the ranch road crossing three kilometers downstream.

A number of springs can be found on Cow Creek, causing a flow on October 13, 1976 of 2.5 lps at the crossing of Highway 693 about 26 kilometers southwest of Brackettville. A few kilometers farther downstream, at the Highway 277 crossing, the discharge had all disappeared into the Austin chalk.

Another small group of springs (8) occurs on the Max Herbst ranch very near the Val Verde County line at latitude 29°18'. They flow only intermittently now from Eagle Ford limestone and marl. Farther up Sycamore Creek, Captain Edward Meyer in 1867 found a "large pool of good water, North of Road in Bed of Stream" (Duke, 1973).

KLEBERG COUNTY

Springs and seeps in Kleberg County flow from Quaternary sands and silts. Their location is often determined by underlying clay beds which force the groundwater to issue from the surface. Since the topography is so flat, there has never been the opportunity for large springs to form.

On the landward side of sand dunes, especially where hackberry thickets occurred, both on Padre Island and on the mainland, small springs and seeps were most apt to be found. The Coahuiltecan Indians and early explorers found that shallow holes dug in such places would often yield fresh water. In 1846 Gen. Zachary Taylor and his army used this method, sinking seven shallow cypress-lined wells in sandy soil adjacent to a lake five kilometers east of Riviera (8). Small ephemeral lakes which form after rainfalls are usually fresh or only slightly saline. The larger, deeper, and more permanent lakes have usually become very saline because of evaporation. Because the coastal area is subject to constant change by hurricanes and other natural forces, spring locations may be expected to change in relatively short periods, geologically speaking.

The Coahuiltecan Malaquites and their predecessors inhabited this area in prehistoric times. Subsisting largely on seafood, they were especially attached to the Baffin Bay and *Cayo del Grullo* (Crane Key) area. Many of their artifacts have also been found on lower Santa Gertrudis, San Fernando, Valderos, and Los

Olmos Creeks. Santa Gertrudis Creek has never been known to fail to flow in historic times. These early Americans undoubtedly made use of the many small springs and seeps which trickle from the bases of hills along these creeks. They were fond of oysters, which were numerous in the bays at that time. Now the oyster beds have been largely buried by silt resulting from man-made soil erosion. The bays have also become much more saline, perhaps because of the heavy pumping of fresh groundwater to the west.

In 1899 the drilling of flowing wells began. Artesian water was sold in Kingsville for \$0.50 a barrel. The proliferation of these wells caused the water pressure to decline, so that today there are no longer any flowing wells in the county. When wells ceased flowing, pumping began, with the result that water levels in the Goliad sand, the principal aquifer, declined more than 60 meters in some places in the 1933 - 1969 period. This lowering of the water level in addition to drying up springs, results in the intrusion of salt water from the sea into the area. Groundwater has also been contaminated by oil-field brines.

In early historic times enormous herds of wild mustangs joined the other wildlife which depended on the spring-fed streams. Now the principal wildlife includes deer, wild turkeys, and javelinas. Numerous waterfowl such as geese, ducks, ibis, and pelicans make their winter home here. Exotic animals such as axis deer, blackbuck, nilgai, and mouflon have been introduced in recent years.

Much of the shallow fresh water, which formed small "perched" reservoirs of groundwater, has been pumped out, chiefly for livestock and domestic use. Because of this and salt-water intrusion and oil-field contamination, the remaining spring water is mostly slightly to moderately saline. It is usually of a sodium sulfate or chloride type, hard and alkaline. The writer studied the county's springs in the field mainly during the period January 2 - 7, 1977.

Perhaps the most important springs in the county from a historical point of view are **Santa Gertrudis Springs (1)**. At these "strong seep springs" Jose Lorenzo de la Garza settled in 1803. Although he was killed by Indians in 1814, the springs were a wayfarers' stopping place for many years. Later, in 1852, Capt. Richard King set up a cow camp here which became the nucleus of the King ranch. In 1866 - 69 a *mantanza* or slaughterhouse was located here to obtain hides and tallow from cattle carcasses. The springs flowed from sand deposits along Santa Gertrudis Creek. Whether they still flow is questionable. As they are beneath the

surface of several lakes, their flow, if any, is difficult to measure.

Many other small springs and seeps, very saline, can be found in the area southeast of Kingsville, where there are steep sandy slopes adjacent to streams. Some small springs (2) west of San Fernando Creek 10 kilometers southeast of Kingsville were flowing 0.55 lps on January 4, 1977. Some (4) adjacent to the Highway 77 bypass crossing of Santa Gertrudis Creek five kilometers south of Kingsville, were producing 0.30 lps. Here in 1852 John Bartlett noted good water in a "chain of small ponds known as Santa Gertrude." About one kilometer farther south at the Escondido Creek crossing small seeps (5) were yielding 0.12 lps on this date. On Valderos Creek 10 kilometers southeast of Ricardo seeps were producing 0.50 lps of very saline water.

Another important spring in former times was one known as **Ojo de Agua (Eye of Water, or Spring) (3)** on the old Laureles ranch, now part of the King ranch, in northeastern Kleberg County. It was just south of Laguna Larga, at latitude 27°28' and longitude 97°26'. Captain Jose Elias de Garza Falcon may have obtained fresh water here in 1766. When the spring failed during a dry period a windmill well was installed. Naturally the spring never flowed again, with a pumping well adjacent. The water apparently issued from sand beach deposits which lie to the east, on top of the Beaumont clay. The windmill now supplies water to a tank for cattle.

Probably the largest springs remaining in the county are what the writer calls **Malaquite Springs (9)** for the Indians who inhabited this area. They are four kilometers east of Vattmann, on the west side of Vattmann Creek. They issue from the base of a sand formation on top of clay. The land slopes upward to a relatively high ridge two kilometers west. On January 7, 1977, the flow was 0.65 liter per second, probably higher than normal because of much rainfall in the preceding three months. Field tests showed the water to be slightly saline, containing 750 milligrams per liter of chloride. Many other similar springs can be found in this area. A Malaquite burial ground is located about two kilometers downstream.

At Loyola Beach, seven kilometers east of Vattmann and on the north bank of Vattmann Creek, seeps of moderately saline water (7) amounted to 0.30 lps in 1977. These last seeps are at an archeological site recently explored by Thomas Hester, where a fishing, oyster-gathering people lived at various times for many thousands of years.

Six kilometers west-southwest of Ricardo is a lake

(11) on *Ebanito* (Little Ebony) Creek. Formerly brimful, it still holds water from seepage most of the time. Near here in 1888 - 98 was a stage stand on the Brownsville-Oakville route. Huisache trees border the shores, where dock and purple portulaca bloom. Ducks, herons, egrets, and killdeers frequent the spot.

KNOX COUNTY

Knox County lies in the Rolling Red Plains, which are underlain by Permian formations such as the Clear Fork, San Angelo, and Blaine, dipping toward the west-northwest. Small springs issue from gypsum, sandstone, and dolomite in these formations. Large areas of the Permian are covered with deposits of Seymour sand and gravel, which are ancient stream deposits up to 18 meters thick. Most of the stronger springs pour from the Seymour at its contact with underlying Permian shales. Except where otherwise noted, springs flow from the Seymour formation. Many of these trickle from bluffs along the south side of the Brazos River.

Some 10,000 or more years ago the springs were frequented by a megafauna of mammoths, camels, dire wolves, and saber-toothed tigers which were hunted by Paleo-Indians. Mastodon bones have been found in the county. At the dawn of historic time, other animals flourished around the springs. Thousands of wild turkeys, for example, roosted in the trees.

The usual spring vegetation includes willow, cottonwood, salt cedar, and hackberry trees, cattails, and rushes. Mesquite trees abound on the surrounding land. Cedar trees thrive on the Permian red-bed formations in the "breaks."

In 1886 - 87, 1902, 1917 - 18, 1943, and 1952 - 56, droughts occurred which caused most springs to dry up temporarily. A permanent decline in spring flow has been caused by well pumping, chiefly irrigation well pumping which began in earnest around 1950. In 1956 the discharge from the Seymour aquifer was four times the estimated recharge. Hence, it was no surprise that groundwater levels began to fall as much as 2.4 meters in the southern part of the county from 1956 to 1957. As a result many springs have disappeared.

Numerous seep-fed lakes once existed in the county. Sedimentation from accelerated sheet erosion on cultivated land, together with the falling water table, has caused most of the lakes to disappear.

The Seymour spring waters are generally of a calcium bicarbonate type, fresh, very hard, and alkaline. The Permian spring waters are usually more mineralized. Contamination of groundwater by oil-field brines has been documented in a number of cases. Pollution by nitrates and coliform organisms has been

caused by septic tanks in some instances.

Most of the writer's field studies were made during the period August 29-September 3, 1979. As most of the county received around 10 centimeters of rain during the preceding two weeks, the observed spring discharges are probably higher than normal for this season.

Grapevine Croton Spring (21) is nine kilometers west-northwest of Benjamin on Paul Engler's ranch, managed by Louis Spinks. In 1878 Sill Sweney, a buffalo hunter, accidentally shot and killed himself, or perhaps was murdered by someone else, at this spring. There is now only a wet-weather seep here.

About three kilometers south of Grapevine Croton Spring is **Cedar Mountain Spring (20)**. Here Sweney was buried by other buffalo hunters camped at this spring. The grave and marker, to which the writer was guided by nearby rancher J. C. "Togo" Moorhouse, are about 800 meters south of the spring. Near the grave is Dead Man's Tank.

Cedar Mountain Spring, also called **Weatherly Spring**, was later a boon to travelers on the old Benjamin-Guthrie road. On September 1, 1979, water seeped from San Angelo sandstone into a pool containing many frogs. Mountain plovers flew among the willow and hackberry trees. Nearby is an abandoned house and dugout.

Naptha (Naphtha) Spring (22) is 13 kilometers west-southwest of Benjamin. Here the ill-fated Santa Fe expedition is believed to have camped in 1841 at the head of Smelter Creek. One member of the party wrote (Carroll, 1951):

encamped by a small spring and creek of bitter water, strongly impregnated, to judge from the taste, with copperas and magnesia. Whatever the substances held in solution by this water may have been, it operated as a powerful cathartic; but the men, unable to find any other partook of it in large quantities.



J. C. Moorhouse at Cedar Mountain Spring.

Another wrote:

We came to some mountains which stopped our headway for a few days; at the foot of those mountains, the water was of a brackish and sulphur taste; we came to a sulphur spring where we remained several days the water had great effect both upon the men and beasts.

Naptha Spring was shown on several early maps, including G. W. Colton's 1872 *New map of the state of Texas* and G. L. Gillespie's 1876 *Map of western territories*. In later years cattlemen called it **One Minute Spring** because of the diarrhetic effect of its water. The gypseous water issues from the San Angelo formation. The spring is now beneath an earth tank on the Engler ranch.

On Sidney and Patty Alexander's ranch were two springs (5 and 6). **Sheek Springs (6)** were 10 kilometers southwest of Truscott. Now they are only wet-weather seeps from Clear Fork sandstone and gypsum.

Craig Springs (5) were eight kilometers west-northwest of Truscott. Here J. R. Craig built a dugout in 1885, finding the water foul-tasting and hardly fit to drink. A mountain lion sometimes frightened family members away from the springs. Copper mines were later located here. The Seymour-Fort Elliott road passed the springs. The water now seeps from San Angelo sandstone and gypsum into an earth tank.

Seven kilometers south-southwest of Truscott were **Browder Springs (2)** on Margaret Todd's ranch. Numerous flint projectile points have been found here. Three dugouts were here when Charles Browder, Mrs. Todd's grandfather, arrived in 1881. At that time the springs watered 500 cattle. They issued from San Angelo sandstone, but probably were recharged by water from the Seymour sand and gravel to the north. They are now dry, but wild plum bushes still grow at the site.

Speers Springs (3) are about 1.5 kilometers east of Browder Springs on Leon Speers' ranch. they are now only wet-weather seeps.

China Springs (4) were three kilometers southwest of Truscott on Newell Looney's farm. In 1885 the springs formed a lake on China Creek. The China Lake community grew up here. Previously a buffalo hunters' trail passed the springs. Settlers came here to fill barrels with the gypseous water. Many camped and picnicked at the springs.

The chinaberry trees which gave their name to China Springs are still there, along with hackberry trees, pink smartweed flowers, and cockleburs. A small cemetery and the remains of an old engine and pump are at the site. But the springs are dry. Pools of surface

runoff water collect in the channel after rains.

Big Four Springs (7) were eight kilometers northwest of Truscott on Elton and Claudie Carroll's ranch. Now there are only wet-weather seeps into a tank from San Angelo sandstone. An abandoned windmill is nearby. Bullfrogs, raccoons, skunks, doves, and quail frequent the site.

Six kilometers northeast of Truscott are some very small springs (17) on Robert Kincaid's and Woody Frank Lemon's ranch. The slightly saline water seeps into a pool containing water milfoil in which minnows and frogs dart. Scarce bluebells bloom nearby. Coyotes can sometimes be heard howling and talking to each other. Blue quail, bobwhites, and turkeys also frequent the springs.

Turner Springs (10) are two groups of springs two kilometers southeast of Gilliland on J. T. Cook's and Bruce Burnett's ranch. They were much used by Indians. They were named for Bull Turner, murdered near Seymour in 1887. Many early residents around Gilliland obtained their water here. During the 1902 and 1918 droughts cattle were driven to these springs. The Seymour-Ft. Elliot stage line passed the springs, where water troughs formerly stood. On September 2, 1979, 2.5 liters per second flowed from Seymour sand and gravel. Minnows, frogs, and dragonflies darted around the pools.

Seven kilometers east-southeast of Gilliland are some attractive springs (11) on the Waggoner ranch, managed by Jim and Judy Horton. On October 9, 1936, the discharge was 1.9 lps. On September 2, 1979, 2.9 lps of fresh water emerged to fall in a 3-meter-high cascade over a sandstone ledge, feeding a downstream earth tank. Frogs and rattlesnakes hide among the vauquelbushes.

A former spring about one kilometer southwest is now only a seep. On October 9, 1936, it discharged 0.31 lps.

About three kilometers northwest of Vera are a number of small and very small springs (12) on Winston Feemester's and Carl Coulston's ranches. Randy Gore of Vera guided the writer to these springs, which include **Hash Knife Springs**. They trickle from Seymour sand and gravel on Permian shale. A Touwias (Taovayas) Indian village was located here in the eighteenth century.

On the South Wichita River two kilometers west of Highway 267 are some "gyp" springs (9) on John Ed Jones' ranch, leased by Lamoyne Patterson. These are very likely the springs at which Capt. R. B. Marcy

stopped in 1854 while exploring for locations for Indian reservations. In his words,

we had the good fortune to discover a small spring of cold pure water near the bank of the river, and here we bivouacked for the night.

In 1884 the L Bar ranch used the springs, according to Patterson. A tin cup was kept at the springs, which trickled from Clear Fork gypsum and sandstone. The water contained hydrogen sulfide, giving off a "rotten egg" odor. A shallow well, later abandoned, was dug near the springs. Chittum or silver-bell shrubs, rare in this area, grow nearby.

Riley Springs (14) were just east of Goree on Lake Creek. They were used by the first settlers at Goree in the 1880s. B. B. Hendrix, a long-time county rancher, remembers the springs, but on September 2, 1979, there were only some seeps into pools. Many projectile points have been found nearby. Numerous irrigation wells in the vicinity have taken their toll of the groundwater. Two kilometers northeast, on John Moore's ranch, are similar springs which still flow slightly in winter.

Farther north, two kilometers west of Highway 266, are **Coltharp** or **Franklin Springs (13)** just south of the Brazos River. They refreshed travelers and their animals at the old river crossing here. Seeps are also present at Highway 266.

H Cross Springs (15) were four kilometers northeast of Rhineland on Frank Steinbach's farm. There are only wet-weather seeps here now. Many irrigation wells pump nearby.

Redder Springs (16) are one kilometer northwest of Rhineland on Mrs. Angela Redder's ranch. An Indian campsite was located here. According to Mrs. Redder's son Edward, the springs formerly started at the house, ½ kilometer upstream from their present location, and were much stronger. On September 2, 1979, 0.55 lps of slightly saline water poured into pools filled with water milfoil and algae. Many bluebells and white snow-on-the-mountain flowers adorn the site in summer. The water usually runs to the Brazos River. About 1.5 kilometers west are the similar **Watkins Springs**, according to long-time resident Ulric Lea.

Seven kilometers west-southwest of Rhineland are **W Cross Springs (18)** on Gene Thompson's ranch. In the late 1920s C. M. McNutt used the water to irrigate a vegetable garden. On September 3, 1979, 0.35 lps was passing through a small pond. A green heron, scissor-tail flycatcher, and dragonflies darted among

the cattails, rushes, and vauquelbushes. Raccoon tracks were numerous.

Nine kilometers north-northeast of Knox City are **Mansfield Springs (8)** on Marvin Mansfield's farm. Many Indian artifacts, including metates and pendants, have been found here. Mansfield has developed three lakes, fed by the springs, as a swimming and fishing park. In the 1960s, according to Mansfield, the water was contaminated by oil-field brine disposal into open pits. The fish were killed, but the contamination has since been stopped.

On February 16, 1957, the discharge of Mansfield Springs was 6.3 lps. On September 1, 1979, there was no visible flow, but probably some seepage into the lakes. Many irrigation wells pump to the south.

Wild Horse Springs (19) are seven kilometers north-northeast of Knox City on Mat Verhalen's farm. His mother counted 17 springs feeding Wild Horse Creek in the 1930s. The creek is known to have stopped flowing only once in 60 years. On September 3, 1979, the discharge was 5.1 lps.

Originally Wild Horse Springs started three kilometers upstream (south) on Mrs. Helen McClure's farm. An Indian camp was located here, and in 1890 the Kasoga store. Irrigation pumping has dried up the upper reaches of Wild Horse Creek.

Six kilometers northwest of Knox City are three groups of springs (1) on Tom Campbell's ranch on the southeast side of the Brazos River. Tom's brother, B. B. Campbell, guided the writer to the springs. The northernmost group is called **Chalk Springs**. Here the Chalk Springs community grew up at the old river crossing. A Mr. Chalk had a dugout nearby.

Chalk Springs issue from a thick bed of Clear Fork gypsum just above the river which dips gently west-northwest. It is probably recharged from Seymour sand and gravel which overlies the gypsum to the southeast. The water has a strong diarrhetic effect. On October 9, 1936, the discharge was 2.5 lps. On August 31, 1979, it was 0.95 lps.

The second group of springs is 0.7 kilometer south of Chalk Springs. On August 31, 1979, it produced 1.4 lps of fresh water from Seymour sand and gravel on Permian shale at an elevation of about 425 meters.

The third and largest group is 0.9 kilometer southwest of the second. On August 31 it flowed 1.9 lps. According to B. B. Campbell, this group of springs originated when a large gully was eroded here in the 1930s. All three groups are surrounded by bluebells, pink ironweed and white snow-on-the-mountain flowers in summer.

Cypress Springs (23) are eight kilometers west of

Knox City on Stella Ferguson's ranch. According to B. B. Hendrix, there was once a cypress tub here. An Indian camp also was located here in bygone days. On September 3, 1979, there was only seepage into an earth tank.

One kilometer south of Cypress Springs are **Mockingbird Springs (24)**, also on the south bluff of the Brazos River, on the Bush and Burnett ranch, leased by Hendrix. This also was a popular place for Indians. Fishing was once very good in the pools, according to Hendrix, but now the channel has been filled with sediment. On September 3, 1979, there was a flow of 1.3 lps. Giant cane, pink-flowered ironweed, and plum bushes thrive here in addition to the usual spring vegetation.

Bluff Springs (25) are 13 kilometers west of Knox City on the Bush and Burnett ranch, managed by Ray Escobar. On September 4, 1979, the discharge from the base of a high bluff was 0.62 lps. In 1908 one of Quanah Parker's Comanche braves was buried here.

Trough Springs (26) were three kilometers farther up the Brazos River on the southeast bluff on Odell Carver's lease. They are now only seeps, largely covered by modern sediment. Many irrigation wells nearby no doubt hastened the springs' demise.

LAMAR COUNTY

The Kadohadacho tribe of the Caddo confederacy and their predecessors occupied what is now Lamar County for many thousands of years. These mound-building, largely agricultural people liked to locate their villages near the better springs. By 1750 French traders began to come into the area, no doubt using the same springs as the Caddoes with whom they traded. In the 1820s and 1830s many tribes of Indians, displaced from their homelands to the east, camped near springs in the county for a time until they were again forced out by the Anglo-American settlers. In the late 1830s, for example, 500 Choctaws from east of the Mississippi River camped on Bee Bayou east of Pattonville. In 1820 the first Anglo-American settlers began to enter the county, usually selecting good springs for their homesites.

The springs of the county issue from upper Cretaceous Woodbine, Blossom, Bonham, and Ozan sand and silt, and from river terrace sand and gravel. Groundwater levels have fallen considerably in some areas, primarily because of well pumping. As a result, many springs have declined in flow or failed completely. Most of the writer's field studies were made on March 7 - 12, 1976.

The spring water is of a sodium bicarbonate type,

usually fresh, soft to moderately hard, and of neutral pH. The content of iron or sulfate may be high.

Ten kilometers northeast of Direct and three west of the Garretts Bluff community are **Garrett Springs (6)**. On March 10, 1976, the main springs (there are many more nearby) flowed 2.1 lps south of a lake at the base of a terrace on the Alma Parson ranch. They provided a refreshing stop for early travelers using the ferry here. The river has moved away from its former location close to the bluff.

Eight kilometers east of Direct, on Victor Foster's property in Ragtown, are **Ragtown Springs (7)**. On March 11, 1976, they flowed 4.8 lps from a uniform medium sand at the base of a river terrace along a 1,000-meter reach. Many Indian artifacts have been found here, indicating quite ancient use of the springs. In the 1840s wagon trains heading west stopped here to wash clothes. As many of the clothes resembled rags, the village was named for them.

About one kilometer northwest of Arthur City are the remains of the 1834 Cravens-Fulton trading post and ferry landing. Between here and an old log cabin still standing one kilometer farther west on the Brunson ranch, are **Fulton Springs (5)**, undoubtedly much used by the early residents and travelers. Flowing from the base of a bluff of Woodbine sand, they are the largest springs still flowing in the county, at 6.5 liters per second on March 11, 1976. At the time of Fulton's trading post the Red River flowed close to the bluff. Now it is over one kilometer away.

Pierson Springs (1) are 11 kilometers northeast of Novice, close to the Red River County line. Here in 1820 was the first Anglo-American settlement in the county. A historical marker is 200 meters south of the springs. The settlement was short-lived, as all were killed by Indians within a year. The springs have almost ceased flowing from Woodbine sand (0.10 lps in 1976).

The springs at Spring Hill (3) are the most interesting in the county. They are three kilometers west of Novice on a county road in the Medill community. The main spring is enclosed by brick walls. The springs trickled 0.75 liter per second in 1976 from Bonham sand on top of Eagle Ford shale at an elevation of 150 meters. The water, which tastes fresh, forms the source of Moran Branch. Many residents from the surrounding area still come here to fill containers, according to J. M. Cross, a local historical authority.

In northeast Paris, near the junction of Ballard Street and Highway 195, are **Record Springs (4)**. The Aays (Hais) Indian village described by Moscoso in 1542 may have been located here. In the 1850s the Record tanyard used the spring waters in treating hides. They

LAMB COUNTY

produced 0.65 lps in 1976 from Blossom sand.

Moore Springs (2) were seven kilometers east of Paris in a pasture near the railroad. Near here Newton Record and James Mosely operated a grist mill in 1857. The springs were much used by settlers in the surrounding area. They have ceased flowing from the Blossom sand.

About seven kilometers west of Roxton on the R. C. Humphries farm is **Long Spring (8)**. Many Indian artifacts have been found at the spring, which was formerly in some woods but is now in a pasture. Until the 1950s it was used by many residents of the area up to 15 kilometers away. Flowing from Ozan sand on top of the Roxton limestone, the spring now supplies water to two houses at the rate of 0.25 lps.

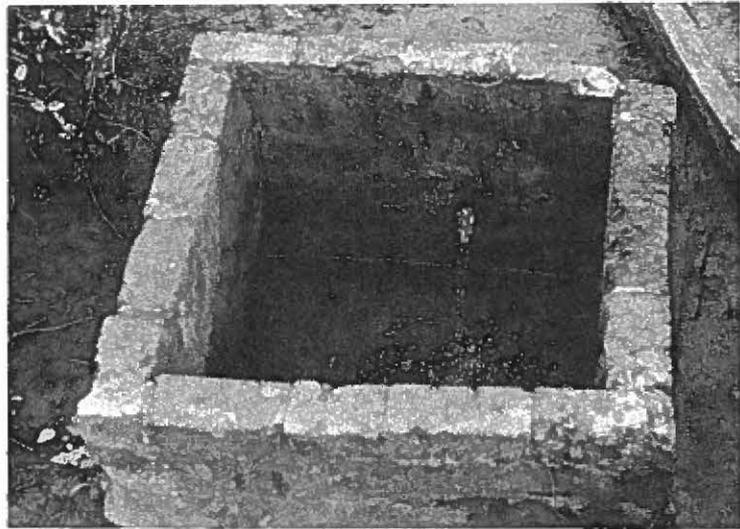
LAMB COUNTY

Only a few springs still flow in Lamb County. At one time many issued from Tertiary Ogallala sand, gravel, and caliche, which dips gently toward the southeast. The formation, which was once largely saturated with water, ranges in thickness up to 85 meters. Much water is recharged into the Sand Hills belt in central Lamb County. Formerly there were springs and lakes in the Sand Hills, but now the water passes downward into the Ogallala formation, through which it moves at about 50 meters per year to the southeast. A few springs issue from Quaternary Tahoka sand and Lower Cretaceous limestone near the larger lakes.

The springs-fed streams and lakes were used as campsites by Paleo-Indians 15,000 years ago and earlier. Bones of extinct bison which these people hunted have been found along Blackwater Draw. Flint points, knives, scrapers, and hearths dating from Paleo-Indian to historic times are numerous.

Many plants depended upon the spring waters for their lives. These included cottonwood and willow trees, plum thickets, grapevines, cattails, rushes, ferns, water cress, and milfoil. Animals similarly relied upon the water. Most notable were fish, frogs, snakes, turtles, crawfish, and aquatic insects, as well as the larger animals which preyed upon them. Brimful lakes, fed by springs and seeps, made excellent havens for ducks, geese, cranes, and other waterfowl. When many of the springs and lakes dried up, most of this biosystem disappeared.

Although there were other causes of the great decline in the water table, irrigation pumping of groundwater is by far the most important. Irrigation pumping started in 1902 from a shallow well on the Halsell ranch west of Earth, and greatly accelerated in the 1950s. In



Main Spring Hill Spring

1964 irrigation wells discharged 0.84 cubic kilometer of water, more than 15 times the annual amount of natural recharge. In addition, the well fields around the Plant X electric generating plant in the Sand Hills consume large quantities of groundwater. In 1974 the annual rate of decline of the water table was as much as 1.0 meter in the northeast. The fall in the water table has necessitated the deepening of most windmill wells. It is also the primary cause of the failure of most of the county's springs.

In addition, cultivation of steeply sloping land near the draws and lakes has caused disastrous erosion. The sediment from this erosion filled many channels and buried springs. Most channels are now farmed across and cannot be recognized as former water courses.

The spring waters are of a calcium or magnesium bicarbonate or sulfate type, usually fresh or slightly saline, very hard, and alkaline. The content of silica or fluoride may be high. Spring waters which collect in the larger lakes may become quite saline because of evaporation.

Most of the writer's field studies were made during the period September 30 - October 6, 1978. As the preceding several months had been very dry, the observed spring discharges were probably lower than normal for this season.

On Running Water Draw springs formerly flowed. Emroy Sadler of the Sunnyside community remembers springs (2) which ran in the 1920s about 10 kilometers east-southeast of Sunnyside. The channel here, on Preston Upshaw's farm, has been buried under enormous quantities of sand. Some dying willows and other trees still fringe the dry site.

Farther east, 11 kilometers north of Olton on Sam Thomas' ranch, were **King Springs (1)**. A large Indian campsite was located just upstream. The spring waters, which poured from Ogallala sand and caliche, coursed down Running Water Draw for about one kilometer in the 1940s. Three-kilogram catfish were numerous at that time. The pool into which the springs issued was

popular for swimming. According to Thomas, the springs failed around 1954, but some seepage into the pool continued in the 1960s. Since the pool is no longer naturally cleaned out by spring flow, it has been partially filled with sediment. Usually dry, it contained some runoff water on September 30, 1978. Most of the surviving willows and cottonwoods downstream are dying.

Many springs once flowed on Blackwater Draw. In early settlement days it was possible to travel by boat from Muleshoe to Earth through a chain of spring-fed lakes. Mustang Lake was 1.5 kilometers east of the Bailey County line on Blackwater Draw. Located on Guy Viss' farm, it is now dry and all in irrigated cultivation.

Three kilometers farther east was *Laguna la Mita* (Mythology Lake). On Ronnie Holt's farm, it also is dry and in cultivation now.

Seven kilometers east of the Bailey County line on Blackwater Draw were **Alamosa Springs (3)** and Lake. The Spanish word *Alamosa*, roughly translated, means *cottonwoody* or *characterized by cottonwoods*. The springs were depicted on an 1884 Texas General Land Office map of Lamb County. According to Harold Allison of Earth, the draw flowed through Alamosa Lake until around 1940. Now the lake is only a dry swale of irrigated cultivated land on Gene Edwards' farm.

Soda Lake and Springs (4) were two kilometers farther southeast on Jearl James' and Jack Young's properties. Eddie Guffee, director of the Museum of the Llano Estacado at Plainview, has found artifacts here dating back to 10,000 years ago, disclosing that this was long a living site of early Americans. Old rock ruins here are probably those of a Comanchero trading post. The lake formerly held much water, being fed by springs. In 1921 it was six meters deep, according to Ray Roubinek of Muleshoe. A Rand McNally map of 1883 called the springs **Tarabe Springs**. *Taraje* (Salt Cedar) was probably meant. Many salt cedars still fringe the dry lake bed. Fishing was good here in former times. Lime has been excavated from the lake bed to seal a reservoir at the Plant X generating plant to the southeast.

The springs flowed in 1937, but even then were reported to fail during droughts. Gray soils indicate that large swampy areas existed around the springs, both east and west of the lake. In 1937 the spring water was moderately saline, containing 9,720 milligrams of dissolved solids per liter. The lake water, subject to evaporation and concentration, contained 31,000 milligrams of dissolved solids per liter at that time.

Spring Lake, fed by strong springs (7), was located

on Blackwater Draw eight kilometers west of Earth on what is now Spring Lake Farms, managed by Henry Ford. An Indian camp was situated here. The deep lake was used as a watering place by buffalo hunters and, starting in 1882, by cattle barons. In 1891 W. F. Cummins portrayed the lake on his *Geological map of the staked plains and adjacent area*. V. M. Peterman of Littlefield recalls a large flow continuously passing over the Earth-Amherst road (now Highway 1055) in 1918. This flow came from Spring Lake and other springs. In the 1920s the lake was very popular for swimming and fishing. In 1937 an analysis showed the water to be fresh (see table of Selected Chemical Analyses).

According to Douglas Parish of Earth, the last flow from these springs on Blackwater Draw was around 1942, but some seeps persisted in Spring Lake until the early 1960s. The lake has nearly been filled with sediment, but on October 2, 1978, a small pool of runoff water existed. A windmill pumps near a dying willow and a few elm trees. A historical marker on Highway 70 provides information on the former lake.

In the Sand Hills many lakes were once fed by seeps and springs from the dune sand. Typical were Long or Lost, Silver, and other Lakes and their springs (8) on J. T. Gibson's ranch 10 kilometers south of Earth. Here Blackwater Draw is ill-defined and rarely flowed. One of the former lakes, studied by the Archeology Department of Texas Tech University, shows evidence of long use by prehistoric people. Long Lake extended almost two kilometers along Blackwater Draw. According to Gibson, the springs stopped flowing about 1952 and the lakes dried up soon afterward. A few salt cedars, chinaberry trees, and dying cottonwoods still mark the shores of the old lakes. Plant X to the northwest consumes huge quantities of groundwater.

Sod House Spring (5), ten kilometers north of Amherst on Blackwater Draw, was also on Gibson's ranch. According to the nearby historical monument, well rubbed by cattle, this was an important Indian camp and watering place. In 1876 a half dugout sod house was built here by buffalo hunters. The excavation may still be seen. The spring flowed until the 1950s. Now there is only a dry swale covered with broomweed, yucca, and yellow-flowered threadleaf groundsel. A windmill pumps among prairie dog holes.

About two kilometers downstream on Blackwater Draw, on Ralph Cocanougher's land, were other springs (6). Below these springs a dam once existed on the draw, providing a lake with large catfish. The draw here has long been dry and is all in cultivation.

Rocky Ford Springs (9) were just upstream from the Highway 385 crossing of Blackwater Draw, 11

kilometers northeast of Amherst. These springs were recognized by G. L. Gillespie on his 1875 *Map of portions of Texas, New Mexico, and Indian Territory*. According to V. M. Peterman, in the early nineteenth century the spring flow was so strong at Rocky Ford crossing that the creek could not be crossed three or four months of the year.

The springs began to falter in the 1940s. On May 1, 1952, the Texas Board of Water Engineers recorded a discharge of 4.7 liters per second. On August 28 and in November of the same year there was no flow, but pools of live water. Soon after, the flow ceased entirely. The channel has now been filled with sediment and is mostly cultivated.

Many springs (10) also trickled six kilometers west-southwest of Fieldton. Fishing in the creek was good here. According to Jesse Collins of Amherst and Elmer Dixon of Dimmitt, these springs started to decline in the 1930s and failed soon afterward.

Fieldton Springs (11) were south of Fieldton in Blackwater Draw. A lake 1.5 kilometers downstream impounded the water, providing good fishing for catfish. According to Bobby Short of Amherst, the springs and draw here stopped running around 1949. A few elm trees still fringe the channel.

Hart Springs (12) were farther downstream, about one kilometer southeast of Hart Camp on Bill Johnson's ranch. Many spear points of an ancient people have been found here, according to V. L. Foster. A buffalo hunters' camp was located here. Johnson fishing lake was just downstream. The springs, draw, and lake dried up in the 1930s. According to Pete Norfleet of Hale Center, many of these springs issued through crawfish holes. A few cottonwoods still stand here.

Bull Springs (13) are at Bull Lake 13 kilometers west of Littlefield. Those on the south side are on land leased by the Jake Diel Dirt and Paving Co., managed by Sam Sisk. Several others around the north end of the lake are on Dr. T. P. Wallace's property. They issue from Tahoka sand and caliche on top of a blue clay bed. Indian artifacts found here reveal that this was a living site in past millenia. The 1884 county map showed springs surrounding the lake.

The south Bull Springs were only seeping on October 3, 1978. The lake was about 85 per cent covered with water on this date. It is preferred by most migratory waterfowl over the other nearby lakes because it contains a more constant supply of water. According to Sisk, the south springs produce as much as 0.75 lps after rains, especially in the morning, when evapotranspiration is low. The water is moderately saline. (See table of Selected Chemical Analyses.) The north

springs are similar in quantity and quality. The lake water was found to be very saline in 1952, containing 19,000 milligrams of dissolved solids per liter. Salt cedar, rushes, and saltwort surround the springs. Brine shrimp, crawfish, and frogs are numerous. Near the south springs is a recreational area maintained by the city of Littlefield.

Six kilometers southwest of Bull Lake are **Roland Springs and Ponds (14)** on Glenn Batson's ranch. The springs trickle from Ogallala sand on Lower Cretaceous shale, forming a chain of pools in Bull Draw. An Indian campsite was located just east. In 1875 Lt. Col. William Shafter found "large pools of living water" here, with plenty of wood. On October 3, 1978, after much dry weather, there were only seeps in the pools. According to Batson the springs normally run in winter. Many frogs hop among the cattails. The surrounding hillsides are covered with yellow-flowered broomweed and mesquite.

Five kilometers north-northeast of Pep are **Glumpler Springs (18)** on James Glumpler's ranch. They issue from Ogallala sand on top of Lower Cretaceous Duck Creek limestone. On October 21, 1978 a discharge of 0.52 lps, surrounded by light salt crusts, flowed 500 meters down Goat Creek. Milfoil and algae are abundant in the pools, fringed with cattails. Ducks, cranes, hawks, quail, and turtles frequent the site.

Just south of Glumpler Springs on another branch of Goat Creek are the similar **Green Springs (19)** on Franklin Green's ranch. On October 21, 1978, the flow of 0.75 lps of slightly saline water ran 800 meters before disappearing. These and Glumpler Springs reportedly flow to Illusion Lake in winter. Severe gullies developed in the 1950s, intersecting the water table and causing an increase in the discharge of Green Springs. Several swimming holes are fed by the springs, including one called Aquarium Pond. Cattails and salt cedars fringe the pools. Catfish, snakes, porcupines, and coyotes are numerous.

Illusion Springs (15) are at the north end of Illusion Lake in southwestern Lamb County on the Yellow House ranch, managed by James Linson. On October 4, 1978, they produced 1.6 lps of moderately saline water from Tahoka sand which flowed into the lake. About 20 percent of the lake's surface was covered by water on this date but two weeks later it was dry again. In former times the lake was much fuller, when the springs were stronger. According to Thomas Albus of the Yellow House ranch, most cattle will not drink the mineralized spring water. Salt cedar, rushes, and saltwort fringe the springs. Brine shrimp and minnows dart in the pools. Bobcat and coyote tracks are numerous.



Illusion Springs.

Ducks, geese, sandhill cranes, and a few whistling swans, golden eagles, and bald eagles have been known to stop here.

At the north end of Yellow Lake, also on the Yellow House ranch, are **Yellow Springs (16)**. These springs were much used in the 1880s, according to Patrick Boone of Littlefield. Meigs and others (1922) described fresh-water springs along the entire east shore of Yellow Lake. On October 4, 1978, only moderately saline springs at the north end of the lake were running, yielding 0.14 lps from Tahoka sand. The spring water flows into the lake, which was 15 percent covered with water on October 4, 1978, but dry two weeks later. The vegetation and animal life here is very similar to that at Illusion Springs to the north.

Three kilometers west of Yellow Lake and close to the Hockley County line are some slightly saline springs (17). They were noted on the 1884 Lamb County map. On October 4, 1978, they poured out 0.71 lps from Ogallala sand on Lower Cretaceous limestone. Rising in a hackberry grove, the water runs about one kilometer before disappearing. Several other former springs in this area are now dry, according to Albus. A weakly flowing well is nearby.

LAMPASAS COUNTY

Lampasas County is unusual geologically in that it contains a great variety of rocks on the surface. In the vicinity of Lampasas there is what is known as an inlier in the more recent Cretaceous formations, in which the much older Pennsylvanian Marble Falls limestone is present at the surface. This limestone is cavernous and carries much water, which gives rise to most of the springs in this vicinity.

As may be seen in the table of Selected Chemical Analyses, the water can vary considerably in chemical content, even though it comes from the same aquifer.

Generally the water which moves more rapidly through the underground formations has less chance to pick up dissolved minerals, and vice versa. The smaller springs, and those farther to the east, where the groundwater must travel farther before rising as springs, are more mineralized. In general the water is a calcium bicarbonate type, but it may contain large amounts of sodium chloride. It ranges from fresh to moderately saline, is hard to very hard, and alkaline. It may contain much hydrogen sulfide gas, which imparts a "rotten egg" odor. Sulphur Creek of course obtained its name from the sulfur content of some of the springs which discharge into it.

Most of the writer's field studies were made during the period November 12 - 17, 1975.

Prehistoric people left many artifacts near these springs, indicating that they used them over a long period. In historic times the Tonkawas had a great reverence for the springs and fought to keep them when white settlers moved into the area. As was stated in an anonymous brochure in 1886,

Indian traditions inform us that the curative powers of these springs have been known to the red men for ages, and that they have journeyed from all parts of the South and Southwest to allow their invalids, their aged and afflicted to bathe in the mysterious waters. Remains of their camps and lodges may yet be found here, though the extermination of the game, and the restrictions laid upon the Indians by the government, have prevented them from coming here for years past.

Later, the springs along Sulphur Creek were also used for water power. They powered the Hughes and Donovan mills in Lampasas, the Bradley mill near Hughes Spring, and the Durrent mill near Kempner. These mills ground wheat and corn, sawed lumber, ginned cotton, and later generated electricity.

Swenson Saline Springs (8) are about 13 kilometers west-southwest of Lometa on Salt Creek and two kilometers from the Colorado River. In 1975 they trickled 0.30 lps from Strawn sandstones and shales, which apparently contain salt beds. A crust of salt still forms on top of the brine which flows from the springs. During Civil War days salt was manufactured here. The spring flow in 1864 was 0.60 lps. The brine was spread on cedar boughs to aid evaporation. The concentrate was then boiled in vats to produce the salt. The foundations and some stone walls of the factory may still be seen. The Tonkawas also obtained salt here in early historic days.

Indian Springs (9) formerly flowed from Strawn sandstone 16 kilometers west of Lometa, just south of

Highway 190 on the east side of the Colorado River. Here bed-rock mortars or metates, where the Tonkawas ground corn, mesquite beans, and acorns, may be seen, as well as a burial mound. The old Chadwick mill was two kilometers north. Other springs still flow in the vicinity.

Senterfitt Springs (7) were on Salt Creek just across Highway 581 from Senterfitt cemetery, which is five kilometers west of Lometa. The settlement grew up around these springs, which flowed from the Marble Falls limestone, in the 1850s. In 1877 there was a stage stand here. The town died when the railroad went through Lometa.

Beef Pen Springs (12) are in the northern corner of the county, seven kilometers southwest of Evant, on Herman Kreid's ranch. This was a favorite campground of Indians, and later supplied water for a nearby school. They are of interest because Arch Sneed, who later wrote of his experiences with the XIT ranch, was born here. On May 22, 1977, after much rainfall, 0.95 lps of water emerged from them, passing over a waterfall downstream. Amid cattails and water pennywort, and shaded by live oaks, many deer come to drink here.

Townsen Springs (10) were three kilometers southeast of Adamsville, and just north of the present Townsen cemetery. Some residents can remember when the springs still flowed from the Glen Rose limestone. For a time, in the 1870s especially, a thriving community existed around these springs.

Hughes and Gooch Springs (4) were three kilometers east of Lampasas on Highway 190. They were north of a historical marker on the highway. Moses Hughes brought his wife here in 1853. In poor health, she quickly recovered after drinking the spring water for a few weeks. Mr. Hughes used the spring water for crop irrigation. Later, a gathering of ex-slaves held an emancipation picnic at Gooch Springs. Both

springs have long been dry.

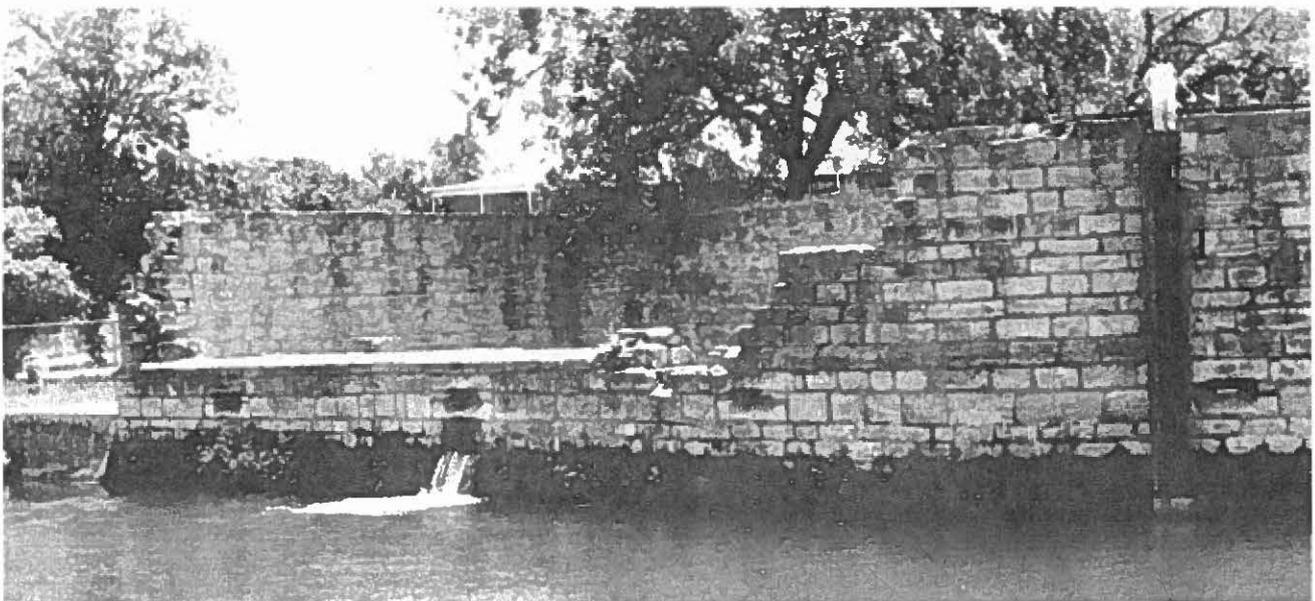
Hancock Springs (2) are the most notable of the Lampasas Springs. They issue at an elevation of 310 meters in Hancock Park in southwestern Lampasas. The Spaniard Bustillo y Ceballos probably stopped here for refreshment in 1732. The city grew up around the springs in the 1850s, and still obtains its water supply from them. The discharge values given in the accompanying table include amounts pumped by the city. The values are in liters per second by water years (October 1 to September 30). The discharge of Swimming Pool Springs is included in the figures for 1886, 1958 - 61, 1963 - 70, and 1972 - 73.

1886	250	1962	230
1900	250	1963	250
1901	260	1964	180
1902	180	1965	250
1906	190	1966	120
1910	200	1967	190
1924	190	1968	250
1931	190	1969	310
1957	110	1970	370
1958	280	1971	120
1959	170	1972	310
1960	230	1973	370
1961	300	1975	110

Because a dam backs water over the springs, they can no longer be seen. In 1882, with the arrival of the railroad, the springs gained wide fame as a health resort. The 200-room Park Hotel was built on a hill to the north, with hot baths and a dance hall. Hydraulic rams forced the spring water up to the hotel. A mule-drawn street car ran from the depot to the hotel, and also to Hanna Springs. The hotel burned in 1895. A historical marker is located at the park.

Swimming Pool Springs (3) rise in a rock enclosure on the right bank of Sulphur Creek about 200 meters downstream from Hancock Springs. They were once a stage stop, and were well known for their me-

Swimming Pool Springs.



dicinal value in the 1880s when a bathhouse surrounded them. The water now supplies the swimming pool in Hancock Park. Discharge records in lps by water years follow:

1900	45	1931	5.7
1901	48	1942	31
1902	37	1957	37
1906	40	1962	48
1910	37	1971	42
1924	48	1975	20

Gold, Rock, and other springs (1) are another moderately large group which rise in Sulphur Creek about one kilometer upstream from Hancock Springs, on the property of Fred Willis and Burrell Roitch. In this case also a low-water dam backs water over the springs so that they cannot be seen. A grove of pecan and willow trees shades the creek. Following are the available discharge records in lps by water years:

1886	170	1966	160
1957	57	1967	150
1958	57	1968	85
1959	57	1969	140
1960	140	1970	170
1961	130	1971	85
1962	85	1972	140
1963	57	1973	71
1964	28	1975	37
1965	85		

Hanna or Sulphur Springs (6) in northeastern Lampasas are on Henry Campbell's property, leased by Early O'Neal. They were formerly surrounded by a bog. Many wagon loads of bison bones were removed from this swamp. The animals probably bogged down when they came to the springs to drink, or perhaps were driven into the bog and slaughtered by early Americans.

Hanna Springs were depicted on Johnson's and Ward's 1863 *New map of the state of Texas* and on A. R. Roessler's 1876 *Map of San Saba County*. They shared the fame of Hancock Springs as a health resort during the 1880s. A large pavilion and bathhouse were built over the springs. As described in 1886 (Anonymous),

There is, outside of the building, a pool of the sulphur water some sixty feet in size, varying in depth from ten to sixteen feet, which is not used for bathing purposes, but is surrounded by an ornamental iron railing, and attracts the attention of all visitors.

Last year, during the season, over 6,000 baths were taken here, as reported by the superintendent. Four hydrants, with ever-running mineral water, stand near the pavilion. Here, morning and evening, groups of citizens may be seen sipping the water or filling bottles and jugs with it. The company makes no charge for what is thus used, all being privileged to help themselves.

In 1895 the pavilion was converted into an opera house. In 1904 a power plant was generating electricity from the spring water. Nothing remains now but a rock enclosure from which Hanna Springs flow, the foundations of the old bathhouse, and a recently built small gazebo. The water is very clear, coats its channels with a white residue, and gives off a strong hydrogen sulfide odor. No fish and few water plants survive in the highly mineralized water. (See Plate 9,c.) The discharge in lps by water years follows:

1900	110	1963	34
1901	42	1964	31
1902	40	1965	57
1906	45	1966	51
1910	25	1967	45
1942	40	1968	88
1957	28	1969	62
1958	48	1970	62
1959	51	1971	42
1960	48	1972	48
1961	79	1973	40
1962	54	1975	14

Just east of Hanna Springs, in the former Cooper Park, are the much smaller **Cooper Springs (11)** which belong to W. T. Campbell of Houston. They issue from the Marble Falls limestone, forming a ½-hectare swamp on the north side of Burleson Creek. They were well known for their medicinal qualities during the 1880s, but now it is difficult to find any resident of Lampasas who has heard of them. In 1975 they trickled 0.62 lps.

LA SALLE COUNTY

Springs were never numerous or large in La Salle County. At one time, however, there were seeps and very small springs from Eocene sands, especially the Laredo, Yegua, and Jackson. These formations dip toward the southeast at about 15 to 30 meters per kilometer. Water can move through these sands at about 100 meters per year. A few springs also trickled from river terrace sand and gravel.

Coahuiltecan Indians lived at these seeps and springs for thousands of years. In fact the sites of their villages usually pinpoint the location of former permanent water where none now exists. In 1907 Diego Ramon found bands of Indians called Pacques and Assares in the county. Later there were fierce battles when the Indians were asked to give up their favorite water holes.

Flowing wells, some of which still flow, caused a decline in the water table. Irrigation pumping also had a great effect. From 1925 to 1970 the potentiometric surface of water in the Carrizo aquifer declined by as much as 75 meters. The decline was less in the surface

aquifers, but was still significant because of leakage between aquifers through old rusted well casings.

Overgrazing has probably also been an important factor in the decline of the water table of the surface aquifers. Cattle are commonly seen so desperately hungry that they eat unburned prickly pear cactus. This abuse of the land has led to the gradual destruction of the more desirable grasses and their replacement by thorny brush. The thick mat of vegetation once formed by the grasses, which absorbed rainfall and aided recharge into the underground reservoirs, is now largely gone. As a result the streams which once contained numerous lakes and water holes are nearly all dry. One exception is Sevenmile Creek near Fowlerton, whose stream is maintained by a flowing well.

The rocks around the springs were draped with maidenhair ferns, and the waters supported aquatic plants such as milfoil, water shields, and water lilies. The pools were shaded by willows, seep willows, hackberry and live oak trees. The springs and water holes once harbored huge fish, crawfish, mussels, frogs, turtles, and various insects. Feeding upon this aquatic life were enormous alligators, panthers, bears, armadillos, raccoons, coyotes, bobcats, cranes, herons, ducks, and killdeers, among others. Dependent upon the springs for water were herbivorous animals such as deer, huge turkeys, javelinas, and beavers. When the springs dried up, most of this assemblage of plant and animal life perished. Often a stand of live oaks persists for years after a spring has disappeared, but eventually it too succumbs in the face of a constantly falling water table.

The spring waters are generally of a sodium bicarbonate type, fresh to slightly saline, moderately hard, and alkaline. The content of iron may be high. The analyses given in the table of Selected Chemical Analyses may be on the low side, because the water holes from which the samples were taken were probably diluted by surface runoff.

Most of the writer's field studies were made during the period February 1 - 6, 1979.

The old settlement of Iuka was 12 kilometers west of Cotulla on the north bank of the Nueces River, partly on M. C. Whitewell's ranch. Across the river was spring-fed *Cochina* (Sow) Lake, in early days large, deep, blue, and full of fish, a favorite stopping place for travelers. Several Spanish travelers in the eighteenth century camped here. Seeps and very small springs (7) evidently trickled from the Laredo sandstone on both sides of the river, but have long been dry. Abandoned windmills now testify to a falling water table. Some live oaks and elms survive among the brush.



Old live oak at Pike Water Hole.

Five kilometers northwest of Millette on Charles Sloan's ranch on Cibolo Creek was **Pike Water Hole (1)**. Here is a grove of live oak, persimmon, and hackberry trees at the junction of two tributaries. The largest live oak is 7.8 meters in circumference and may be 1,000 years old. Beneath these trees a prehistoric people lived, as testified by the many flint points and tools found at the site. In 1807 Lt. Zebulon Pike stopped here, at the first live oaks he had seen since leaving Mexico. Later many gatherings were held here. Seeps from Eocene Laredo very fine sand evidently supplied the water hole. The creek is now filled with sand, and a bridge downstream is almost buried.

Oulline Seeps (3) were four kilometers north-northeast of Gardendale on C. C. Taylor's ranch. According to Dow White, who formerly leased the land, there were two seep-fed lakes here until the 1950s. Now the channel is filled with as much as 6.7 meters of modern sediment. An ancient people lived here and used the water, some as long as 9,000 years ago. The seeps originated from Laredo sand.

Smith Water Hole (2) is two kilometers north-northeast of Gardendale on Floyd Tyler's ranch. Several prehistoric archeological sites have been found here. Pools of clear, fresh water are still fed by seepage from Laredo fine sand on clay. Raccoon tracks and crawfish holes may be seen among the marsh purslane and water plantain. Ducks and herons frequent the pool. Live oaks grow four kilometers downstream.

Nogate Water Hole (4) is four kilometers northeast of Los Angeles on Frank Plocek's farm on Nogate Creek. An archeological site indicates that people lived here in prehistoric times. Fresh water still seeps into the pools from Yegua sand. Spatterdocks thrive here, and seep willows fringe the banks. Sandhill cranes stop at the water hole, where skunk tracks can be seen.

In the northeast corner of the county on *Esperanza* (Hope) Creek many live oaks grow. Apparently there was more water here at one time than now.

About 25 kilometers southeast of Cotulla is **Charco Marrano** (Pig Water Hole) Creek (6). The creek drains much river terrace sand and gravel, from which seepage feeds several water holes. Live oaks are sometimes found near these seeps, as on William Meuth's ranch, where they grow on a hill. Crawfish holes surround the pools, and coyotes roam the area.

Charco Largo (Long Water Hole) (5) is on Mrs. Bob Coquat's ranch at latitude 28°07' and longitude 99°03'. Four kilometers northeast, on the Nueces River, was Fort Ewell, used at various times from 1852 to 1879. Travelers on the 1755 San Antonio-Laredo road, and on the Indian trail over this route in earlier times, stopped here for water. The *charco* was shown on an 1877 General Land Office map of the county. Seepage from river terrace sand feeds the water hole. During drought years it was necessary to clean out and deepen the pool.

Caiman Creek to the west of Fort Ewell was once, as its name implies, a haven for alligators. The pools in which these alligators lived are now all dry. Live Oak Creek, about 14 kilometers southwest of Charco Largo, apparently also once held pools of live water. It is dry now.

In 1884 there was a grove of live oak and hackberry trees two kilometers southeast of Encinal. It was from this oak grove that Encinal got its name. Stagecoaches stopped here, and water was obtained from Laredo sand seeps by digging a shallow hole. **Encinal Seeps (12)** were on land now on the A. E. Schletze ranch, operated by Trinidad Garcia. The oak grove is gone, but a few hackberry trees remain.

Six kilometers north-northwest of Encinal is **Charco Escondido (Hidden Water Hole) (11)** on J. M. Burkholder's ranch, managed by Gary Lyons. The pool, near the headwaters of *Jabonoso* (Soapy) Creek, was adjacent to an Indian campsite long ago. It was deepened in 1974 to form an earth tank, and is now kept full by pumping water from a well into it. Fish swim among the milfoil and algae. Large mesquite trees shade a picnic table.

Eight kilometers southwest of Artesia Wells on Roy Hearn's ranch there was once a lake (8) on *Las Raices* (The Roots) Creek. A live oak tree 6.7 meters in circumference still stands here. Many Indian projectile points and tools have been found nearby. The lake, which was fed by seepage from Laredo sand, has been dry since about 1900, according to Mr. Hearn.

LEE COUNTY

In pre-Columbian times springs were much more numerous and copious in Lee County. Paleo-Indians were possibly living in the county as early as 30,000 years ago. Certainly there is abundant evidence of early occupation of the area, in the form of arrow, dart, and spear points (including the older Folsom points), drills, and knives. These have nearly always been found near springs or along spring-fed creeks.

At Suehs Lake near the old Hranice settlement, passenger pigeons were so numerous in historic time that they broke tree branches with their weight. Many natural lakes are associated with springs in the county. These lakes often have peat bogs adjacent to them. Such peat moss has gradually changed over a period of millions of years to form the lignite or "brown coal" which is common here.

The springs issue chiefly from Quaternary gravel and sand terraces along the major rivers, and from Tertiary Eocene sands such as the Wilcox, Carrizo, and Sparta in the northwest part of the county. The Tertiary sands dip to the southeast at about 25 meters per kilometer. The location of many springs is controlled by the Luling-Mexia fault zone. Not many springs are found in the southeast part of the county, as the formations here are largely composed of clay.

As shown in the table of Selected Chemical Analyses, the county's spring waters are generally of the sodium bicarbonate type, fresh, soft, and acid. Iron content is likely to be high. Most of the writer's field studies were made on October 15 - 20, 1975.

Eight kilometers west of Fedor and near the remains of the old Moab community are **Darden Springs (4)**. They issue from a fault in the Queen City sand. They were once believed to have healing qualities and drew people from great distances to drink and bathe in the waters. However, the water is not now highly mineralized and is classed as "fresh." The springs were depicted on an 1899 Geological Survey topographic sheet. In 1937 they produced 0.32 lps and in 1975 about 0.40.

In western Lee County there is a row of hills known as the Yegua Knobbs (Knobs). They are formed of resistant Carrizo sandstone. **Knobbs Springs (2)** flow from this sandstone at the base of the north hill, at latitude 30°20' and longitude 97°11'. They were well described by the Lee County Historical Survey Committee (1974):

From under the base of the First Knobb, on the west side, once gushed a spring, and it solved the water problem for the early settlers. . . . Being the sole water supply for the settlement, it

was a community responsibility to keep the spring clean. A reservoir about five feet across and five feet deep was dug and walled up with split post oak logs. Surrounding the area where the spring bubbled from the hill was a blackberry thicket set in seepy quicksand. A hollow log was pushed back under the berry vines and water poured through it in a clear, beautiful stream. People came with barrels on sleds and in wagons to haul water. They stretched covers over the barrel tops and fastened them down with ropes or hoops to keep the water from sloshing out. In the summertime women from the neighborhood would bring their washings, children, lunches and melons and spend the day scrubbing and gossiping.

Knobbs Springs flow has declined considerably in recent years. The springs were used by settlers in the area until about 1939. In 1937 they yielded 1.3 lps, and in 1975 only 0.20. They are now difficult to reach, as several roads in the area have been abandoned and closed.

Endor or Black Springs (5) are seven kilometers northwest of Fedor on Clarence Boriack's ranch. They issue from a fault in Queen city sand at an elevation of 128 meters. They have had an interesting history. Fossil pollen cores were taken from the peat bog here by Vaughn Bryant of the Texas A and M University Biology Department. He determined by radiocarbon dating that about 15,560 years ago, during the Fullglacial period, a forest of spruce, maple, dogwood, alder, and birch grew here. The many projectile points and shards found here suggest that the springs were a popular camping ground for prehistoric men and their families. Later they were the only source of water for the settlers for miles around. Many brought clothing here to be washed and hauled water home. From 1949 to 1957 peat moss was mined from the bog at the springs. They are now used to irrigate grassland. In 1937 they flowed 1.9 lps, and in 1975 the flow was 3.3 lps. Beavers make their home here.

King Springs (3) are 16 kilometers west-southwest



Irrigation pump at Endor Springs.

of Lexington and three southwest of the Blue community. They flow from Wilcox sands. When Blue Branch was settled about 1846, these springs were widely used. A heavy concentration of pumping water wells in the area has greatly lowered water tables, with the result that these springs hardly flow at present. In 1937 they discharged 1.3 lps.

Lawhon Springs (1) are in western Lee County, five kilometers north of Highway 696 on Highway 619, and one south of Lawhon Springs cemetery. On Oscar Lawhon's farm, they supply water to his house as well as that of L. C. Roberts. When a Tonkawa Indian camp was located here, the springs were called **Yegua (Mare) Springs**. Later they were known as **Smith Springs**, after John Smith who settled here about 1848. Pioneer women from miles around brought clothes to be washed. Later the springs supplied water to a school. Flowing 1.4 liters per second from Wilcox sand in 1975, they are reported never to fail. Ducks stop on the two ponds into which the water flows. Many smaller springs trickle in the vicinity.

Indian Camp Branch was an area very well liked by prehistoric men, as demonstrated by burial mounds, projectile points, stone knives, and tomahawks found along it. **Indian Camp Springs (7)**, about in the center of this area, are one kilometer east of Lexington. They were also used by early settlers such as James Shaw, who built a log cabin at Lexington in 1835. Reportedly there were formerly many more springs in the vicinity, and they extended farther up the branch. Their discharge was 0.30 lps in 1975.

Eleven kilometers north-northeast of Lexington and about two east of Tanglewood are **Roberts Springs (6)**. Flowing from Sparta sand, they were formerly much used. Their flow has declined sharply from 1.9 lps in 1937, but they still supplied 0.20 lps to a small pond in 1975.

Doak Springs (9) are located about 6 kilometers southeast of Lexington. Flowing from a fault in the Sparta sand, they contain much sulfate and chloride, as shown in the table of Selected Chemical Analyses. They supplied water to the Doak Springs school in the years following 1897. Later the school was moved three kilometers southeast. The springs are now only seeps.

Nine kilometers northeast of Lincoln, adjoining the old Copperas cemetery, are **Copperas Springs (10)**. These well-known springs flow from Sparta sand. The Teran-Massanet expedition may have stopped here in 1691. Although the name means *ferrous sulfate*, there is now very little sulfate in the water. The springs' flow has remained at 0.06 lps in 1937 and 1975.

Gum Springs (8), six kilometers northwest of Lincoln, flow from the Sparta sand. They were formerly well known and were the site of Confederate reunions for a time. They discharged 0.19 lps in 1937 and 0.32 in 1964.

On the south bank of West Yegua Creek and just east of Highway 21 in Lincoln, are **Lincoln Springs (11)**. Early use of these springs is demonstrated by potsherds, stone axes, and spearheads found nearby. Travelers on the Camino Real used the springs as early as 1715. Its marker is about 30 meters south of the springs. Surrounded by large live oaks and flowing from Cook Mountain sand, the springs were formerly enclosed with a brick wall and furnished water to early settlers in the area. They are now difficult to see, as the channel of West Yegua Creek has moved over them.

LIBERTY COUNTY

Among the early Americans who have left evidence of their presence in Liberty County were those who lived at the Jamison and Daniel sites located opposite each other on the west and east banks of the Trinity River five kilometers north of Liberty. Here mass burials, projectile points, pottery, and other artifacts date back to 3,000 or more years ago. These prehistoric sites were located near springs or former springs, as their inhabitants knew the value of pure water.

The Trinity River at that time was a dangerous body of water in Liberty County. It harbored 90-kilogram turtles, 5-meter alligators, and huge gar "armed with teeth like our pike," according to an early account. It was consequently dangerous to enter this river or its tributaries.

The county's spring waters are generally of the calcium or sodium bicarbonate type, fresh, hard, and alkaline. Most of the writer's field studies were made on August 25 - 30, 1975.

Dolen Springs (8) flowed fresh water from a gravel terrace near Dolen Station, seven kilometers southwest of Romayor. In 1945 they yielded 0.32 lps, but by 1965, like many other springs in the county, they had disappeared.

The **C and S Springs (7)** are two medium-size springs four kilometers north of Romayor. They flow from river-terrace sands, discharging 16 lps in August, 1965.

Concord Spring (6) is four kilometers north of Clark. It was used by the old Concord Church, organized by Mrs. Sam Houston and others in 1845, and the school. It rises from Trinity River terrace sands. It discharged 0.63 lps in 1945, but in 1965 had declined to 0.16 lps.

Five kilometers south of Clark is a historical marker which commemorates the town of Grand Cane, where General Sam Houston lived from 1843 to 1845. The springs of the same name (5) which served the town, later called Ironwood, flowed 0.05 lps in 1975 from sand in the Trinity River terrace.

According to noted Liberty historian Miriam Partlow, the Spanish authorities constructed a military trail called the Atascosito Road from Goliad to Opelousas, Louisiana, in 1756. In 1757 a settlement was established on this road at **Atascosito (Little Boggy) Springs (1)** about six kilometers northeast of Liberty. Its purpose was to prevent French trade with the Indians in the area. The springs, which were used by the early settlers as a water supply, flow from sand and gravel deposits in a terrace of the Trinity River. They are now called **Woods Springs**. Their flow has probably declined because of a pumping well immediately south but still measured 5.0 liters per second in 1975. A historical marker is located at the intersection of Highways 146 and 1011.

The writer is indebted to Mr. J. C. McManus of the Texasgulf sulfur mining company for helping him to find **Los Horconcitos (Little Forks) Springs (2)**. They issue 8 meters above sea level, six kilometers south of Shiloh, northwest of two large reservoirs owned by Texasgulf, in a dense wood. Here was located the *rancheria* or village of Akokisa Chief *Calzones Colorados* (Red Breeches). Around 1764 he requested that the Orcoquisac mission in present Chambers County be moved to Los Horconcitos Springs. The Spanish Marquis de Rubi made a study of the site, but the mission was never moved there. The springs flowed 1.0 lps in 1975 from sand in a Trinity River terrace, surrounded by cypress trees. Large swamp spiders, four centimeters or more in size, abound in these woods and, although they appear to be harmless, their webs can seriously impede movement.

Moss Spring (4) is located two kilometers south of the community of Moss Bluff at latitude 29°55' and longitude 94°46'. It flowed from sand at the base of a Trinity River terrace at 1.1 lps in 1975. In 1831, when the first Anglo-American settlers arrived at Moss Bluff, it was their chief source of water. In 1832, when war with Mexico threatened, a force of colonists camped at the springs.

In Liberty, on the east bank of the Trinity River just south of Highway 90, can still be seen the **Champ d'Asile (Field of Refuge) Springs (3)**. This was the site of a short-lived French colony established in 1818 by Generals Charles Lallemand and Antoine Rigaud.



Moss Spring.

The United States and Mexican governments, when they learned that the colonists were actually training to rescue Napoleon from exile, forced the abandonment of the colony. Although no evidence of the settlement remains, the springs still flowed 0.91 lps in 1975 from a bed of gravel in the river terrace.

LIPSCOMB COUNTY

Lipscomb County's springs flow, or did flow, from Ogallala sand and caliche and more recent windblown sand deposits. They are most numerous along the larger streams such as Wolf Creek where the topographic relief is greater.

The springs have been valued as campsites for at least 10,000 years by prehistoric people. Much evidence of these people has been found in the county, including the famed Lipscomb bison quarry, where Folsom projectile points were discovered associated with bones of an extinct bison. The remains of numerous other extinct animals which were hunted by these people have been found in the area. These include the camel, saber-tooth tiger, mastodon, and mammoth. Just before the dawn of history in the New World, Plains Village Indians were using waters from the springs and spring-fed creeks to irrigate maize and other crops. And in historic time a network of trails connected all of the more important springs.

In those times the water table was very high, and springs and seeps burst out almost all the way up to the watershed divides. Tall grasses such as western-wheat and sand-reed grass covered the prairies. Plums, grapevines, currants, and wild rose were abundant. In this lush environment lived deer, antelope, elk, bear, bison, wolves, turkeys, prairie chickens, and numberless other animals. Turkeys were so thick in their roost on Commission Creek that they could be knocked down and killed with a stick in 1887. All of the larger

streams flowed continuously through deep, clear holes loaded with fish.

With the coming of "civilization" all this has changed. Grasses were destroyed by overgrazing. Steep hillsides were plowed up and severely eroded. Large gullies began to cut headward, removing enormous volumes of soil which filled the downstream channels and buried springs. Buried fences and trees may still be seen at many places. But the greatest damage was caused by well pumping, especially for irrigation, which has greatly lowered the groundwater table.

As a result many springs have dried up, and more fail each year. Many stock ponds at higher elevations, formerly fed by springs, are dry now except when they catch some surface runoff. Many of the animals and plants which depended upon the springs for their livelihood could not survive when the springs disappeared.

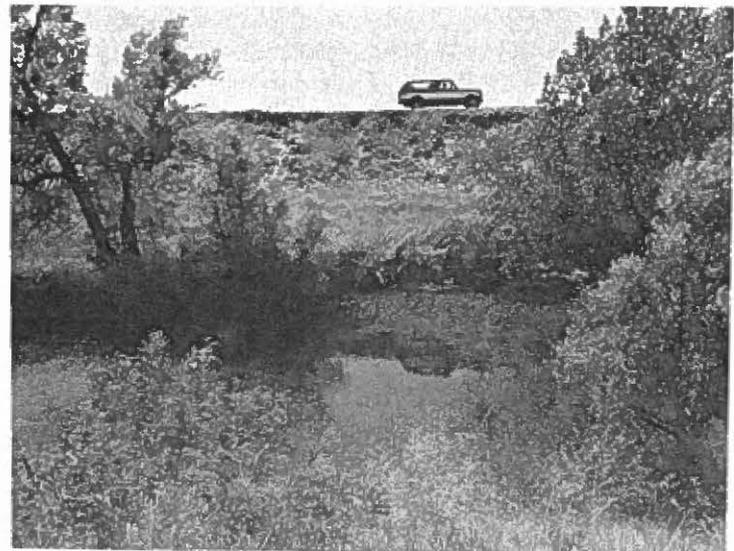
The water is generally of a calcium bicarbonate type, fresh, very hard, and alkaline. Most of the writer's field studies were made during the period June 16 - 21, 1977, after much rain in the preceding few months.

On the north side of Wolf Creek, **Gilhula Springs (2)** are on Gilhula Creek two kilometers east of Highway 23, on Wallace Hamker's ranch. Here was a large Indian camp on a terrace, covering about 70 hectares. Now there is only seepage from sand into a few deep holes containing water milfoil and shaded by cottonwoods and willows. According to Hamker, Gilhula Creek was formerly fed by many springs, and for this reason never froze. Fishing, swimming, and baptizing were popular here.

On the south side of upper Wolf Creek, there were also formerly good springs (22) on the Cleo Barton ranch a few kilometers east of Highway 23.

In 1890 C. B. Bowan moved from some springs near Darrouzett to **First Springs (1)** at the head of First Creek. Located at latitude 30°20' and longitude 100°29', the springs fed several fish-filled water holes.

Gilhula Springs.



The site, surrounded by oil wells, is now dry but indicated by a clump of cottonwoods, plums, and grapevines. A lake existed in the 1880s at the mouth of First Creek. It is now filled with sediment and dry.

Twin Grove Springs formerly broke forth in a large grove of trees where the two main branches of Second Creek join 18 kilometers northwest of Lipscomb. Pedro Vial may have stopped here in 1792 en route from Santa Fe, New Mexico, to St. Louis, Missouri. E. A. Winters of Booker remembers them emerging here in 1916. In 1977 the flow of 0.13 lps started five kilometers downstream on the C. T. Duke ranch (10), and ran to Wolf Creek. Second Creek has been dammed here to provide water for irrigation. Bullfrogs, minnows, and killdeers cavort among the cattails, with oil wells on all sides.

Fourth Creek no longer has any flow, but has many deep holes fed by seepage, especially on Jim Laurie's ranch (11). These are occupied by fish, turtles, water plants, and herons, and shaded by cottonwoods and willows. Many prairie dogs live nearby. Fifth Creek also has only some seeps now. It must have had plentiful springs in the past, as Indian campsites have been found along it.

On Kiowa Creek there were once many springs which kept the creek flowing throughout its length. Timms City was established in 1887 at some springs (9) on Kiowa Creek ten kilometers southwest of Darrouzett. Ed Wenette of Darrouzett states that these springs still flowed in 1922. They are dry now.

On Bowan Creek two kilometers southwest of Darrouzett C. B. Bowan built a cabin in 1886 by some springs. **Bowan Springs (8)**, on the Harry Jergenson farm, are dry now, but Kiowa Creek just downstream still flows about 0.19 liter per second most of the time for a distance of two kilometers. The springs were in a hilly headwater area still marked by cottonwoods, willows, and plum thickets.

Ivanhoe Creek in the northeast corner of the county also flowed constantly until the 1930s, according to Paul Babitzke of Follett. Three kilometers northeast of Follett Michael Jones settled at some good springs (6), in 1900. According to his grandson Leonard Elmore, they have been dry since about 1937. A grove of cottonwoods and willows still stands here.

On Ivanhoe Creek about eight kilometers east of Follett there were formerly strong springs (4) on Walter Gadberry's ranch. Seeps still supply some water in pools for his cattle, but the flow is decreasing constantly.

At the Oklahoma state line east of Follett there was a spring (21) at the home of Mrs. Leola Travis which was

used in 1909 by many neighbors who hauled the water in barrels. It is only a seep now.

Ten kilometers east-southeast of Follett were the **Lone Star Springs (5)**, at the school of the same name. When Mrs. Travis taught school here in 1921 the springs supplied water to the school and the teacher's home. Dry for some 40 years, the site is now distinguished by a grove of trees and a windmill.

Mammoth Creek in eastern Lipscomb County was formerly spring-fed and flowed continuously. Thirteen kilometers south-southeast of Follett R. S. Porter and C. E. Akers settled near some slightly gypseous springs in the early 1900s. Previously the fish-laden creek had been a favorite campsite of Indians. Mammoth Creek and **Mammoth Springs (7)** have not flowed since at least 1952, according to Mrs. Robert Akers. A hole caused by an outcrop of sandstone was long popular for swimming, and still has not been silted up. Here owls and raccoons make their home amid wild plum thickets. Skunk Creek to the southwest is also reported to have been fed by springs at one time.

Six kilometers south of Higgins, along Commission Creek on the Hoover ranch, are the largest remaining springs in the county, **Cold Springs (14)**. This was an important stop on the Ft. Elliott to Ft. Dodge trail from 1874 to 1887, and was the site of Polly's hotel and stage station. The several springs issue in a hilly area of Ogallala sand, producing a combined discharge of 10 lps on June 19, 1977. According to ranch operator Joe Wheeler, the formerly largest springs are now in an irrigation reservoir from which only evaporation and seepage escapes. The largest spring produced 2.2 lps on this date from a water-cress-lined channel which is used to irrigate a garden. Several fishing lakes supplied by the springs contain duckweed and water milfoil and are shaded by cottonwoods, willows, plum thickets, and grapevines. Beavers make their home here. (See Plate 3, d.) The spring flow is reported to fall off greatly in summer.

Nearby in Sleepy Hollow, four kilometers south-southeast of Higgins, there are still small intermittent springs (15). On Ray Hughes' ranch, they discharge around 0.65 lps in winter.

In 1886 at Gray's Pond two kilometers east of Higgins there was a spring (16) whose waters reportedly contained a small amount of oil. Another spring formerly fed the Quarter-Mile swimming hole just north of Higgins. Both have long been dry.

Eight kilometers northwest of Higgins are **Camp Springs (17)**, which feed Camp Creek, on Elga Page's ranch. Among plum thickets, they produced 3.7 lps on

June 20, 1977, which supplied a pond stocked with catfish. They maintain a flow in the creek to its mouth in winter months. Many projectile points found here indicate that this was a favorite Indian campsite. Canyon Creek a few kilometers west still contains a few holes fed by seepage.

Eleven kilometers east of Lipscomb are some seeps (18) on Wayne Paul's ranch. They ooze into a hole and reservoir among a grove of cottonwoods and willows. Springs very likely flowed here at one time.

Willow Springs (20) give rise to Willow Creek ten kilometers southeast of Lipscomb, south of Highway 213 on the J. R. Wheat ranch. According to Mr. Wheat, they originally appeared two kilometers farther south in a large cottonwood grove among sand and gravel hills. During the drought of the 1950s the springs moved downstream, and Willow Creek permanently ceased flowing to its mouth. In 1977 they produced 0.31 lps which flowed three kilometers through the Wheat and Trooper ranches. Many irrigation and oil wells surround the site.

There are springs (19) on Plum Creek which rise eight kilometers south of Lipscomb, west of Highway 305, and flow for seven kilometers. They feed several stock ponds on Ernest Haller's ranch. Indian camps formerly existed here, and Plum Creek reportedly once flowed all the way to Wolf Creek.

Sand Springs (13), on Jerry Peery's ranch, are the source of Sand Creek 15 kilometers southwest of Lipscomb. About 30 pools have been formed by dams and the water is used for irrigation. The ponds have been stocked with bass, catfish, and perch, and turkeys and pheasants are protected here. Large cottonwood, willow, plum and mulberry trees shade the area. The discharge of 5.5 lps on June 19, 1977, not including evaporation, appeared at an elevation of 785 meters and ran down Sand Creek for two kilometers. In the sandy recharge area are numerous depressions 5 to 10 meters in diameter where runoff water enters the aquifer. Many Indian artifacts have been found at the springs.

Smaller springs (12) issue about four kilometers east-northeast on Garner Schoenhals' ranch. In 1977 they supplied 0.20 lps to several reservoirs containing turtles and snakes and frequented by herons, ducks and geese. Fish are no longer common because the springs periodically dry up. A Kiowa lookout was located on a nearby hill. Emerson Martin, who lives a few kilometers north, remembers when Sand Creek flowed constantly in 1928 all the way to its mouth and provided good swimming holes. Now it is largely dry.

LIVE OAK COUNTY

Most of Live Oak County's springs and seeps issued from Eocene Jackson sandstone, Miocene Catahoula tuff, Oakville sandstone, and Fleming sandstone; Pliocene Goliad sand, and Quaternary terrace sand and gravel. These formations dip toward the southeast at 4 to 20 meters per kilometer. Faults, some with displacements up to 100 meters, traverse the central part to the county from southwest to northeast. The Oakville sandstone forms the Oakville Escarpment, facing northwest, which passes through Oakville. The Reynosa Escarpment is formed by Goliad sandstone about 25 kilometers farther southeast.

Originally much of the county was grassland. Recharge to the groundwater reservoir was assisted by the thick mat of vegetal material in these grasses. Overgrazing destroyed this vegetative mat and assisted in bringing in the omnipresent brush which now occupies the area. Flowing wells, some of which still flow, also wasted much groundwater. Well pumping has caused much of the decline in water tables. As a result, most of the county's springs have ceased flowing. During the great drought of 1886 - 87 the Nueces River, and presumably most of the springs in the county, stopped running temporarily. Some springs have also been covered by Choke Canyon and Corpus Christi Lakes.

For many thousands of years the Coahuiltecan Indians lived at the springs. And for millions of years before, a complex ecosystem of plants and animals was centered on the spring waters. When the springs and seeps dried up, most of these life forms disappeared. As the county's name indicates, live oak trees were numerous and signified an abundant groundwater supply. As the water table falls, the live oaks have an increasingly difficult time, and many are falling prey to disease and parasites.

The spring and seep waters were chiefly of a sodium bicarbonate or chloride type, fresh, very hard, and alkaline. The content of iron and silica may be high. Man's activities have caused some contamination of the water.

Most of the writer's field studies were made during the period March 22 - 27, 1979.

Along the Nueces River just west of Simmons at least four springs (12) formerly ran from terrace sand. According to C. L. McMahon, they dried up during the 1950s drought. There is still some seepage in very wet weather. Several Indian campgrounds have been found here.

Six kilometers north of Three Rivers at the junction of Interstate 37 and Highway 281, the remains of a very

large Indian village have been found on R. H. Hazzard's and other properties. Here, on Hackberry Creek, springs (11) flowed from terrace sand and gravel. According to Paschal Murray of Three Rivers, a barrel was installed at one of these springs in historic times. Two children were buried at the springs. On March 27, 1979, there were a few pools of water in the creek, mostly from surface runoff. Some live oak and hackberry trees stand here.

Fifteen kilometers north of Three Rivers were **San Christoval Springs (10)** on San Christoval Creek. They poured from Quaternary terrace sand on Richard Dobie's ranch. According to long-time resident Harry Pullin, the springs flowed into deep pools until about 1930. Three 208-liter (55-gallon) drums of projectile points were taken from a nearby Indian site. There are still small pools of live water containing minnows and snails. Willows, live oaks, grapevines, and red-fruited dock fringe the ponds.

In northern Live Oak County, two kilometers east of Peggy, were some very small springs (9) on Bell Creek. On Richard Rudolph's ranch, they trickled from Jackson sandstone. In 1689 the Spanish explorer Alonso de Leon found "good water" here. According to Robert Thonhoff, Fashing historian, a stagecoach stand on the San Antonio-Oakville route was located here from 1871 to 1874. **Bell Seeps** still feed algae-filled holes where minnows swim. A few hackberry and mesquite trees shade the site.

Rock Pool (14) was seven kilometers north-northeast of Oakville. This pool on Sulphur Creek, surrounded by outcrops of Oakville sandstone, was once a popular spot for fishing and swimming. Now it has been covered by water from a downstream dam, and much sand has been deposited in the channel. Some seepage still feeds the pool, where small fish and frogs dart. Willows, grapevines, and water plantains are numerous.

Oakville Springs (13) were just south of Oakville on Sulphur Creek, on Cecil Harrod's ranch. They spouted from a bluff of Oakville sandstone at an elevation of about 35 meters. A stage center here, with routes radiating to San Antonio, Corpus Christi, Brownsville, and Laredo, used the water. According to W. H. Rosebrock, who lives in the old Oakville jail, a deep swimming and fishing hole existed here until the 1950s. An Indian living site was found here by archeologists excavating before construction of Interstate 37. The channel and pools are now largely filled with sand. On March 28, 1979, there was still a small pool of live water at the springs site, but no signs of animal life. Large willow, live oak, and hackberry trees, and cane, fringe

the channel.

Eight kilometers east-southeast of George West was the settlement of Gussettville, established in the 1830s by McMullen and McGloin. Here also is *Charter Oak*, where Live Oak County was organized in 1856. Two hundred meters north of the oak, on Homer Morgan's ranch, were some springs (7) in Gamble Gully. Pouring from terrace gravel, they are now beneath two meters of water in Lake Corpus Christi. An Indian campground was located here. This was also a stagecoach stop on the Oakville-Brownsville run. The adjacent fields are covered with bluebonnets in spring.

Three kilometers north of Dinero there were springs (5) in a draw near the Nueces River on Mrs. J. N. Jones' property. Trickling from terrace gravel, they had become intermittent before they were inundated by Lake Corpus Christi in 1958.

Three kilometers southeast of these springs was **McGloin Water Hole (4)**. Fed by seeps from terrace gravel, it too is now beneath the lake. Patrick McGloin is said to have killed an Indian here. This was a favorite camping and watering place for travelers, according to nearby resident Boyd Whitworth.

On Louise McCumber's ranch two kilometers north-east of Dinero were two good springs (3) adjacent to the Nueces River. Emerging from Deweyville sand, they were used for drinking water for many years. They also are now beneath Lake Corpus Christi.

The settlement of Lagarto began in 1858 near the mouth of *Lagarto* (Alligator) Creek. Here a historical marker commemorates the 1884 Lagarto school. On Mrs. Olla Railey's ranch springs (1) formerly flowed adjacent to Lagarto Creek from Goliad sand and caliche. Several Indian living sites have been found nearby. According to Mrs. Railey, an old Spanish pistol was unearthed here. A mountain lioness with cubs has recently been reported in the area.

About five kilometers up the creek is Willie and Jessie Hinnant's ranch. Mr. Hinnant, who has lived here since 1887, remembers that Lagarto Creek had many springs and ran for about 50 kilometers when he was a boy. He describes it as formerly 12 meters wide with many deep holes containing alligators and fish. One boy drowned in a two-meter-deep hole. Dewberries were abundant along the creek. Now it is all very dry.

Ojo de Agua de Ramirena (Ramirez Spring) (2) was on Ramirena Creek five kilometers northwest of Lagarto, on the Harold Shore estate. The creek was called Carreaso Creek on some old maps. Possibly *Carrasco* (Holm Oak) Creek was meant. Here an old stone house called Fort Ramirez was abandoned in

1813. Willie Hinnant remembers when Ramirez Spring (2) flowed around 1900. A granite monument marks the site. The fort was torn down during construction of a pipe line. Treasure hunters have also done much digging here.

Two kilometers downstream on Ramirena Creek was another important spring, now on the H. G. Turner ranch. It flowed from Goliad sand and caliche into a large hole just west of the old Lagarto-Oakville road, according to Hinnant. It too is now dry.

The 1850s Fort Merrill was about six kilometers northwest of Dinero on Ralph Jackson's ranch. Springs (6) which trickled from Fleming sand on sandstone in the adjacent Gerhard Hollow supplied water. The wooden fort and the spring are now gone, but a historical monument remains. A few live oaks and mesquite trees with much ball moss, and yuccas, cover the scene.

Spring Creek, south of George West, was once well watered by springs (8). The springs coursed from faulted Fleming and Oakville sandstone. The creek was also called Ygnacioseno Creek for an early settler. In 1844 William Bollaert described it as follows (Hollon and Butler, 1956):

Two miles farther after going thro' a tremendous brush and tropical valley, came to a clear running stream — five miles from its junction with Nueces. Fresh meat and cool running water! Allah Kereem!! Chilitpin, or green red pepper, first seen here.

According to County Judge William Kendall, wild horses formerly watered at Spring Creek Springs. In the 1920s Opal Miller's husband caught fish as a boy in Spring Creek. The springs started at the Lyne ranch. These and other springs kept the creek running to its mouth. On April 21, 1951, a discharge of 1.1 liters per second was observed at its mouth. It has been dry since the 1950s drought except for storm runoff and largely filled with sand. Some pools near the upper end still hold surface runoff briefly. Willows fringe the channel, and bluebonnets, pink phlox, and white prickly poppies fill the adjacent fields in spring.

LOVING COUNTY

Loving County is the most sparsely populated county in Texas, with only 112 residents in 1976. There is of course a reason: lack of good water. According to Edna Clayton, county secretary, there are only two wells containing water suitable for drinking in the county. Water must be hauled to Mentone, the only town in the county, from Pecos.

But it was not always so. Burial mounds and artifacts such as projectile points, metates, and manos found near Mentone suggest that the area once had many springs of pure, fresh water.

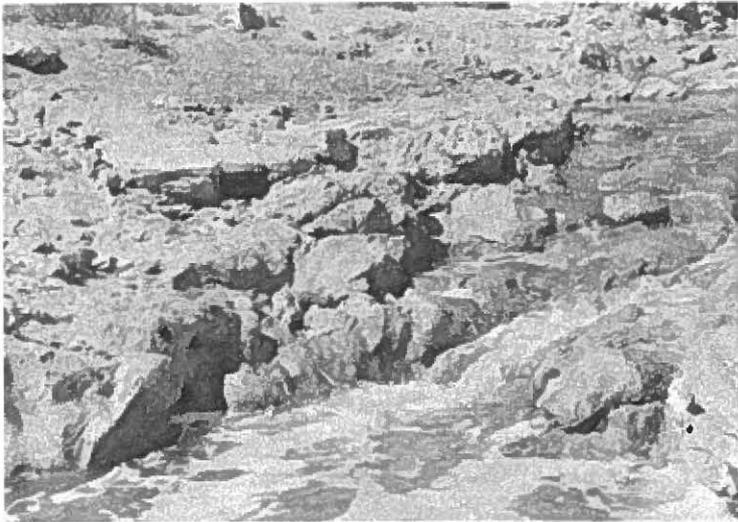
When Lieutenant Antonio de Espejo passed through the county in 1583, he found the Pecos River to be very deep and formidable to cross, with steep banks, and he lost some of his horses in it. This is interesting, because the Pecos River can now be waded easily nearly anywhere. What has happened is that irrigation wells, mostly in Reeves County, greatly lowered the water table, causing springs to cease flowing. Then the Pecos River in this reach changed from a "gaining" to a "losing" stream. In other words, where it formerly was fed by springs, now it must feed the groundwater reservoir. And since the river water is quite salty, the groundwater is also now becoming salty.

The fall of groundwater levels, together with overgrazing, caused many of the better grasses to die out. They have been largely replaced by mesquite, salt cedar, creosote bush, and other shrubs. Mesquite, which can send its roots down more than 53 meters according to Phillips (1963), is well adapted to a falling water table.

The county's spring waters were generally of a calcium sulfate type, and were slightly saline, very hard, and alkaline. In some cases the sodium chloride content was high.

In 1854 Captain John Pope, surveying for a railroad route, crossed the Pecos River near the New Mexico line. Here, 100 meters from the river, "a seep spring of fine water" (2) was located. It must have quenched the thirst of many early explorers and their animals traveling on the east bank of the Pecos, or crossing here on the trail west. In an attempt to increase the water supply at this point, Pope tried to drill several deep wells, using the primitive wooden drilling equipment of his day, but without success. From 1858 to 1861 a Butterfield stage way station was maintained here. A small garrison of soldiers was stationed at the spring at times. As the Clay Allison ranch headquarters were later located at this point, the spring became known as **Allison Spring**. It is now normally covered by Red Bluff Lake.

Red Bluff Springs (3) flow four kilometers upstream from Allison Spring. They issue in the upper end of Red Bluff Reservoir and up the Pecos River to Amerada Falls, 1.6 kilometers north of the New Mexico state line. These springs of moderately saline water issue from Permian Rustler limestone conglomerate and dolomite which dip in various directions in a col-



Amerada Falls on the Pecos River.

lapse zone. Killifish, brine shrimp, and turtles play among salt cedars and rushes here.

Castaneda (1936) described some springs called **Coyote Springs (1)** which formerly existed near Mentone about six leagues (25 kilometers) north of the Pecos River. In 1763 the Christianized Indians Francisco Romero and Joseph Antonio Miraval stopped at a Lipan village here. This location is near the present RUD Tanks, 23 kilometers northeast of Mentone, at latitude 31°54' and longitude 103°29'. The springs were on the W. D. Johnson Slash ranch, now operated by Julian Sanchez. Here there are Triassic Dockum red sandstone cliffs and large boulders, overlain by Quaternary sands and gravels. The situation was favorable for the reception of a large amount of recharge from the area to the north. The springs flowed from the sandstone at an elevation of about 970 meters until pumping wells drew the water table below this level, many years ago. Similar springs probably existed formerly 15 kilometers northeast of Coyote Springs, at another outcrop of Triassic sandstone near the Seeping Springs windmill.

LUBBOCK COUNTY

Lubbock County must have been a beautiful sight to behold when springs were flowing everywhere along Yellow House and Blackwater Draws. As revealed by excavations at the Lubbock Lake archeological site, man frequented these springs from the time of the elephant hunter 20,000 years ago to that of the Comanche 100 years ago. Many extinct species of mammals such as the elephant, saber-toothed tiger, camel, horse, ground sloth, dire wolf, and *Bison antiquus*, thrived in the area. About 12,000 years ago all of these animals became extinct except *Bison antiquus*. About 1,000 years ago *Bison antiquus* was replaced by the modern bison. All of these animals were hunted by prehistoric man, who often drove them into bogs near the springs in order to kill them.

LUBBOCK COUNTY

When Coronado visited the area in 1542 he found many spring-fed lakes surrounded by switch grass, side-oats grama, and bluestem, which reached "to the stirrups of the saddles." On the drier plains grew buffalo grass and blue grama 15 to 30 centimeters high.

In the 1860s the Comanches were trading with Comancheros in Yellow House Canyon, also known then as *Canon del Rescate* (Rescue Canyon). Myres (1966) relates O. W. Williams' account of Yellow House and Blackwater Draws as they appeared in 1877:

On the next day about 9 o'clock, we got back on running our line and ran some 7 miles, stopping east of a large ravine which appeared to course a little west of south. On August 1st we ran our county line into the ravine, then left it, and surveyed down the ravine itself, which we decided later was the North Fork of the Yellowhouse Creek [Blackwater Draw]. At nightfall we came to some springs around which were a great number of buffaloes and antelopes. There were many relics of Indian camps here rather recently abandoned, and I picked up a peculiar saddle supposed to have been used by Indians, which I have kept to this day . . .

We continued on down the valley below the junction of the two forks, finding the stream bed furrowed in stretches to a depth of 3 feet a width of 5 feet, while in other parts there was a wide, unfurrowed bed, with occasional dry ponds choked with the skeletons of buffaloes. In some places good springs fed the bed, and a great abundance of small catfish were to be seen. Some of these springs came up in the creek bed, but others came into it from the high hills of the Plains in the north.

In the 1880s, according to Graves (1962),

The overflow from the lake [Lubbock Lake] was sufficient to cause Yellow House Canyon to run a stream of clear, cold water a dozen feet wide and a foot deep all the way down its course.

Since the 1930s, irrigation pumping of groundwater has greatly lowered the water table. In 1974 the rate of decline was as much as one meter per year in the northeast corner of the county. This has been the primary reason for the weakening and failure of the county's springs.

The springs in the county flow chiefly from the Ogallala sand and gravel, and to some extent from the underlying Edwards and associated limestones or Triassic Dockum sandstone. The water is a calcium bicarbonate type, usually fresh, very hard, and alkaline. In some cases the content of sodium sulfate may be high, causing the water to be classed as "slightly saline." Most of the writer's field studies were made during the period December 10 - 15, 1975.

Lubbock Springs (2) were at the Lubbock Lake archeological site in northwest Lubbock at the intersection of Loop 289 and Highway 84. This nationally-known site has revealed the most complete record of prehistoric man available in the New World. From Clovis Man on, diverse groups of humans have lived and hunted at these springs.

At various times for the last 5,000,000 years there has been a lake at the site. Early Spanish maps and Gillespie's 1875 map called these springs **La Punta de Agua** or **The Source of Water**. In 1881, when George Singer established his store on the southwest shore, the spring-fed lake covered several acres.

In the 1930s pumpage from municipal and irrigation wells had so lowered the water table that Lubbock Lake dried up. The city purchased the site and dredged it to restore the lake. At this time the bones of extinct animals along with Clovis and Folsom projectile points were found, and the archeological project was launched. In 1944 Lubbock Springs were described as "discharging into a small lake which has been excavated below the water table." By the early 1950s the water table had dropped sufficiently that the springs failed permanently. Thus was brought to a close a period of at least 20,000 years during which man had lived in harmony with his natural surroundings, without destroying the environment.

Buffalo Springs (1) are in Yellow House Canyon 16 kilometers southeast of Lubbock. They were first used by white men in 1874, when buffalo hunters camped there and skirmished with the Comanches. About one year later sheep ranchers moved into the area. Picnics and outings at the springs were very popular with the early settlers. In 1926 several of the springs were brought together to feed a swimming pool, and a dam was built to form a small lake. The lake has been



Lubbock Lake archeological site at the former Lubbock Springs.

raised several times, the last being in 1960. The present lake put the main springs under three meters of water. Divers have determined that the springs are still flowing, and fishermen find most of the fish near them.

Measurements of Buffalo Springs' flow can now be made only by comparing the discharge above and below Buffalo Lake and making an allowance for evaporation. The Buffalo Springs subdivision has five large municipal wells just north of the springs. They undoubtedly have affected the spring flow. But at the same time the springs have benefited from the large amount of recharge to their aquifer afforded by water percolating downward from lawn and garden irrigation in and around Lubbock — water brought largely from Lake Meredith near Borger. The discharge in liters per second by water years, and since 1969 including all springs in the lake area, is as follows:

1937	8.5	1972	57
1939	19	1973	42
1969	96	1974	42
1970	93	1975	62
1971	85	1976	85

The bottle-brush plant of the Horsetail family is found only at Buffalo Springs in Texas.

Johnson Springs (4) are at Lake Ransom Canyon just downstream from Buffalo Lake, developed by J. W. Chapman and Sons. Located on Brookhollow Road, they were once at the old Robertson or Johnson ranch headquarters. Florence (1936) ably described the area as it looked in 1900:

Late that evening we came to a grove of tall sycamore and cotton wood trees with a residence nestled among them. There was a branch running through the yard into a pool close by full of fish. There was fruit trees loaded with fruit and some boys mowing and raking hay. There were hydrants in the yard and a house to which good cool water was piped from a spring upon the hill. It was the Robertson Ranch and it looked glorious to us after driving over that dry country behind. We drove a little farther and camped where there were other springs and branches, and wood better than we had in the wagon. We kept on crossing spring branches running from those hill sides, some of them through wild plum thickets loaded with fruit. The green valley between the mountainous walls of that canyon was a mile wide and little mounds of various shapes and colors decorated its floor.

In a ravine bordered by caliche cliffs, the water has been dammed to form a series of ponds. On December 12, 1975, the discharge was 1.0 lps. On August 13, 1978, it was 0.05 lps. The springs probably receive some recharge from Buffalo Lake.

Tinsley Springs (3) are six kilometers farther downstream in Yellow House Canyon. They appear in three draws on Mrs. Paul Tinsley's and Olin Long's ranches. Numerous yellow fluttermill flowers adorn

them in addition to the usual water-loving plants. Gray soils on the surrounding hills indicate that there were once swamps here, later dissected and drained by gullies. On August 13, 1978, there was a discharge of 0.73 lps. According to Max Thomas, foreman of the Tinsley ranch, other springs emerge downstream, especially on the north side of Yellow House Canyon.

LYNN COUNTY

Lynn County is unusual for the High Plains in that it has the canyon of the Double Mountain Fork of the Brazos River on its eastern edge, and also a number of large lakes. Both in the canyon and in the hilly country around the lakes, conditions were favorable for the formation of springs. These springs were watering places on Indian, Spanish, U. S. Army, and cattle-driving trails. In the 1850s sheep ranchers began settling around the better springs.

The spring water flows chiefly from Ogallala sand and gravel, and to a lesser extent from Triassic Dockum sandstone. As the water table is falling in most places because of heavy irrigation pumping, the springs are not as copious as they once were. Most of the writer's field studies were made during the period December 11 - 16, 1975.

The water is generally fresh, of a calcium bicarbonate type, very hard, and alkaline. Occasionally the spring waters may be saline, containing sodium sulfate or chloride.

Double Lakes Springs (4) are located on the north side of Double Lakes about 14 kilometers northwest of Tahoka. The fresh-water springs are at the headquarters of the T-Bar ranch, established in 1883 and still operated by the Edwards family. In 1874 R. S. Mackenzie had a battle with Comanches near here. In 1877 Captain Nicholas Nolan and his men became lost while pursuing Comanches southwest of here. Crazy from lack of water, the men killed disabled horses and tried to drink their blood. Finally Nolan and a few soldiers reached Double Lakes Springs and their life-saving water. They carried water back to the men along the trail, but four died.

During the severe drought of 1885 - 86, the springs and lakes dried up and many cattle died. In 1922 Meigs reported salt springs all around the northeast lake of the Double Lakes in addition to the fresh-water springs near the ranch house. On December 12, 1975, 1.0 liter per second trickled from Tahoka sand on top of Creaceous shale at Double Lakes Springs. On September 9, 1978, after much dry weather, there were only seeps into standing pools of water. According to Cass Edwards, severe overgrazing in the past caused the gullies

which have partly buried the springs under sediment. A windmill well now pumps near the springs. Bullfrogs live among the cattails and rushes, and horned toads prowl the banks. Sandhill cranes and even the rare yellow-crowned night heron stopped here, but now Double Lakes are dry most of the time and avoided by the waterfowl.

Tahoka Springs (3) are on the west side of Tahoka Lake, about 10 kilometers north of Tahoka, on the May estate, leased by Carl Griffing. The largest spring, near the north end of the lake, flowed 3.4 liters per second on December 13, 1974. Several other springs farther south contributed to the total discharge of 6.0 lps on this date. The main Tahoka Spring issues from Ogallala gravel and sand and flows about 200 meters south, where the water falls into a gully five meters deep and flows to the lake.

Tahoka is a Comanche word for *fresh water*. It applies to the springs, which are fresh. However, the water in Tahoka Lake is very saline, containing over 34,000 milligrams of dissolved solids per liter. The reason, of course, is that the lake has no outlet. Water which runs into it is evaporated and over a period of thousands of years the dissolved minerals become more and more concentrated in the remaining water.

Tahoka Springs were a stop on an old Indian trail. As Hill (1935) says,

The Apache of the west received his last plains water here before going down the caprock. A well-beaten Indian trail was recognizable in the '70's from Yellow House River to Tahoka Lakes, west to Double Lakes, Sulphur Draw, across the Texas border to Ranger Lake, Four Lakes, Mescalero Springs, and on to the Pecos.

At the dawn of history in the area, the Apaches lived at Tahoka Springs. Later the Comanches camped here. The Indians' right to the springs was gradually usurped, beginning with Spanish explorers in the 1700s. Later the Comancheros, buffalo hunters, trail drivers, and freighters made camp at the springs. In 1874 a Comanche village here was destroyed by Col. Mackenzie. In 1879 a sheep ranch was established at the springs.

Moore Springs (2) are four kilometers southeast of Grassland in Moore's Draw. Issuing from the Dockum sandstone, they have maintained their flow well in recent years, producing 1.6 liters per second in 1949 and 1975. Boys have often used them as a swimming hole. They are rather difficult to reach.

Guthrie Springs (5) were in Chimney Draw northwest of Guthrie Lake, six kilometers southwest of Tahoka. Lt. Col. William Shafter in 1875 noted "fresh-



Moore Springs.

water springs" here. They were designated **Ojo Blanco** or **White Spring** on A. W. Spaight's 1882 map. They also were on the T-Bar ranch. Dry now, they are reported to have last flowed about 50 years ago. They were, however, important to the Indians and early travelers.

About 15 kilometers west-southwest of Tahoka are Twin Lakes on the Edwards ranch. They were formerly called *Lagunas Cuatro* (Four Lakes), including two other small lakes. In 1875 Shafter described "several springs of good water" here (8) at two large, very salty lakes. The previous year Col. Ranald Mackenzie had attacked the Comanches here. The largest springs issued from Tahoka sand south of the largest or north-west lake. The springs and lakes have been dry for many years except for surface runoff. Mesquite-shaded pasture now covers the area.

In southwestern Lynn County are three spring-and-seep-fed lakes. They are situated in the area where South Lost Draw disappears. In 1875 Shafter described two of them, Gooch and Saleh Lakes, as "one very salty, the other fresh, both never going dry."

Saleh Lake and Seeps (1) are six kilometers southeast of New Moore of Sam Saleh's property. These seeps are the freshest of the three, the slightly saline water issuing from Ogallala sand beneath the lake surface. Around the lake was a village which has been occupied since Paleo-Indian times, according to Lamesa archeologist Alyce Hart. On October 26, 1978, the lake was nearly full. Many ducks were using the salt-cedar-fringed water. The shoreline, showing many raccoon tracks, was littered with shotgun shells.

Gooch Lake, two kilometers farther east, is owned by Fred Higginbotham and Sam Saleh. **Gooch Springs (6)** also were favored by Paleo-Indians many millenia ago. The spring water is more saline than that at Saleh Seeps (see table of Selected Chemical An-

alyses) and the lake water, concentrated by evaporation, may contain more than 31,000 milligrams of dissolved solids per liter. The largest springs, on the northeast side, produced 0.78 lps on October 26, 1978. The lake bed was about 90 percent covered with water on this date. Other very small springs and seeps surround it. Brine shrimp are abundant, as are crows, ducks, geese, cranes, and other waterfowl. Salt cedars shade the springs.

Frost or Goose Lake is seven kilometers south-southwest of New Moore at the intersection of Highways 179 and 2053, on Hal Singleton's land. Here also Indian sites have been found, according to Alyce Hart. The foundations of an old salt mine building may be seen on the east side. **Frost Springs (9)**, which enter from the northwest, discharged 4.2 lps on October 26, 1978 into the nearly full lake. It is fringed with salt cedars and cattails. Minnows, ducks, and other waterfowl are numerous.

Three kilometers west-northwest of New Moore are **New Moore Springs (7)** on Pat Childress' farm. These springs were suddenly rejuvenated in 1968, partly due to high rainfall but also perhaps due to injection of water brought in from Rich Lake at the upstream Ozark-Mahoning mine. On December 13, 1975, the flow of moderately saline water was 7.5 lps, running six kilometers, or past Highway 179. On October 25, 1978, the discharge was 5.7 lps, which flowed four kilometers before disappearing. According to Don Blair of O'Donnell, the discharge increases in winter when the salt cedars and other vegetation become dormant. The water flows from Ogallala sand in a large swamp containing many blackbirds and other wildlife. Salt cedars and bulrushes are numerous.

MARION COUNTY

Long before the arrival of the European explorers, the people of the Caddo Confederacy were living in the area of the present Marion County. Their villages of large conical thatched houses were usually located near the largest and most reliable springs. When the first explorers arrived, they were guided by the Caddoes to these springs to refresh themselves and their horses. The Frenchman Henri Joutel spent some time with the Caddoes in 1687.

Around 1790 the Caddo villages on the Red River were wiped out by Osage raids from the north and by epidemics of diseases brought by the white men. Remnants of the Kadohadacho tribe relocated near springs at Caddo Lake. By 1859 the last of them had moved to Oklahoma.

Nearly all of the county's springs flow from Eocene sands and gravels. The water is usually of the sodium bicarbonate type, and is fresh, acid, and soft. It is sometimes high in silica, iron, magnesium, sulfate, or chloride. Most of the writer's field studies were made on January 12 - 17, 1976.

Rock Springs (2), 18 kilometers west of Jefferson, are 200 meters south of the Rock Springs church, at latitude 32°47' and longitude 94°32'. The old community grew up around the springs. They flowed 0.35 lps in 1976 from Queen City sand on top of a bed of sandstone, which forms a beautiful cove draped with ferns. A downstream pump now supplies water to several houses.

Kelly Springs (3) are eight kilometers west of Jefferson and on the west side of the Kellyville community. Here a marker commemorates George Kelly's foundry, which, starting in 1855, produced plows, cowbells, and cannon balls. The springs which were used by the foundry flowed 0.30 lps in 1976 from Queen City sand into a bog just west of the foundry site. The iron ore used in the foundry may also be seen nearby.

Two kilometers west of Jefferson on Highway 49 are **Rogers Springs (6)**, the largest and best known in the county. They were much used by early area residents, and in 1874 their water was used in the first artificial ice plant in Texas. A marker 200 meters east commemorates the ice plant. The springs are enclosed in two large concrete pipes. Flowing 0.65 lps from Queen City sand in 1976, their origin was probably influenced by a fault just to the east.

Sulphur Springs (4) are in the west part of Jefferson on Gus Armstrong's farm, near the intersection of Owens and Delta Streets. Flowing from Reklaw sand, they were popular in early days. In 1868 several blacks were regrettably lynched here. The springs once supplied water for a house nearby. Now they flow from a section of concrete pipe one meter in diameter among much smartweed in a pasture, furnishing water for several horses.

Four kilometers southwest of Lodi, across Highway 248 from the Old Foundry cemetery, are the **Old Foundry Springs (5)**. An old iron foundry once used the water, which flowed 0.20 lps from the Queen City sand in 1976.

Jefferson Springs (7) were in south Jefferson, near the foot of Main Street at Big Cypress Bayou. They were popular with users of the nearby ferry in 1837. In 1868 the Jefferson Army post or stockade, on the hill just east of the springs, used the water. Nearby resident Lester Fitzpatrick remembers drinking from the springs

as a boy around 1905 while fishing for buffalo in the bayou.

An old road once passed Jefferson Springs. Nearby are some stone ruins. The site is difficult to reach now in a wood containing cypress, pine, and birch trees and many briars. On October 21, 1979, there was only a wet area in a draw adjacent to Big Cypress Bayou. Cypress knees and pennywort cover the area. Frequent flooding and deposition of silt by Big Cypress Bayou have buried the springs.

Potter or Ames Springs (1) are at Potters Point on Caddo Lake, 15 kilometers southeast of Smithland. The Caddoes had a village here in historic times, and probably much earlier. In 1837 Robert Potter, a signer of the Texas Declaration of Independence, built a cabin here. He was shot to death in the lake nearby. Harriet Ames and her family later lived here. During the great pearl hunt at Caddo Lake in 1909 - 1911, when pearls were extracted from fresh-water mussels, as many as 500 campers used the spring waters for drinking and cooking. The lake was used for washing clothes and bathing. The springs produced 0.31 liter per second in 1968 and 1976 from Wilcox sand in a bluff above the lake. A pump has now been installed in them to supply water to Lakeview Lodge and cottages.

MARTIN COUNTY

Most of Martin County's springs issue from Quaternary and Tertiary (Ogallala) sand and caliche. A few may have flowed from Edwards and associated limestones in the past.

At least as long as 20,000 years ago, Paleo-Indians lived at the springs while hunting mastodons, 100-kilogram turtles, small three-toed horses, and other now-extinct animals. In early historic time the Lipan Apaches occupied the area, later to be evicted by the Comanches. Mustang and Sulphur Springs Draws



Rogers Springs.

MARTIN COUNTY

were at that time chains of spring-fed lakes connected by running water.

In 1885 - 86 and 1907 - 10, severe droughts struck, causing most of the springs to dry up temporarily. More recently man's activities, especially pumping of groundwater for irrigation, greatly lowered the water table. Between 1937 and 1967 the decline was as great as 25 meters. As a result, most of the county's springs have failed.

The springs formerly harbored animals such as fish, waterfowl, antelope, buffalo, mustangs, and wolves, and plants such as maidenhair ferns, water cress, and willow trees. As the springs dried up, these life forms disappeared.

Many of the larger lakes were seep- and spring-fed. Roads had to detour around them. Now that they are nearly always dry, these roads could be straightened to traverse the lake beds.

The spring waters are largely of a calcium or sodium sulfate type, slightly saline, very hard, and alkaline. The fluoride content is usually high. In many cases the groundwater has been contaminated by man's activities in recent years.

Most of the writer's field studies were made during the period April 19 - 24, 1979.

Thirteen kilometers west-southwest of Flower Grove (not Flower Grove school) in northern Martin County is Gresham Lake. Surrounded by bluffs of white sand, it is fed by seeps (8) from Ogallala sand on clay. An early Neo-American living site has been found here. At that time the seep water must have been much fresher than at present. It now contains 9,100 milligrams per liter of chloride. Many oil wells pump nearby. On April 20, 1979, the lake was full. Water striders darted on the seep waters amid salt cedars.

Soda Springs (9) are nine kilometers southwest of Flower Grove on Ellis Everts' ranch. They were depicted on F. G. Blau's 1877 *Map of the Texas and Pacific Railway Company reserve west of the Colorado River*. G. W. Colton's 1876 *New map of the state of Texas* and others called them **Mineral Springs**. According to Max Everts, the slightly saline water once trickled from a barrel.

On April 20, 1979, these springs and others as far upstream as Flower Grove produced a discharge of 3.8 liters per second in Sulphur Springs Draw at Soda Springs. This flow continued out of the county and into Natural Dam Lake. The springs in coarse Ogallala sand respond rapidly to rainfall, such as had occurred recently. Water striders, tiny shrimp, small fish, and kill-deers thrive in and around the waters. Dock and salt cedar are plentiful. The channel of Sulphur Springs



Sulphur Springs.

Draw has been largely filled with sand from modern erosion.

Sulphur Springs (10) are 11 kilometers north of Lenorah on Mark Clemmer's ranch, leased by Don Holcomb. They flow into a lake from an outcrop of hard Ogallala caliche containing much opalized chert. For this reason they were also called **Ojo Piedra** or **Laguna Piedra** (Rock Spring or Rock Lake). In 1854 Capt. John Pope, exploring for a route for the Pacific railroad, wrote:

The Sulphur Springs of the Colorado, five in number, issue from one side of a ravine, the water of one spring tinged slightly with sulphur; the remainder contain pure and fresh water, which holds a small portion of lime in solution. Below the springs there is a large pond, where the animals can be watered with much ease. The east side of this ravine is composed of layers of limestone, which is found to be mixed (in a decomposed state) with the surrounding soil. The grass is young and good; it is eaten with much avidity by the animals. Our wood (mezquite-root) is obtained in abundance by sending wagons a couple of miles from camp for it . . .

Capt. Charles Taplin, who accompanied Pope, described Sulphur Springs as follows:

We struck a fresh trail leading down to the springs in the ravine, which we reached at 9 a.m. Some of these are highly tinged with sulphur and salt-petre — others perfectly fresh and pure. They issue out from under a bed of limestone rocks. These springs are no doubt one of the sources of the Colorado. About a hundred yards below the head spring there is a large pond, at which animals can be watered with great facility. There had been recently a large party of Indians at this place; it is their regular camping ground. The scarcity of grass and fuel in the vicinity is thus accounted for.

In 1875 Lt. Col. W. R. Shafter described Sulphur Springs as containing "excellent water in inexhaustible quantities." In 1877 F. G. Blau portrayed them on his map, previously mentioned. In 1881 Marshall Hurd, a surveyor, killed some friendly Indians here when they

reportedly refused to let him approach the springs. In 1891 the Texas Geological Survey described the springs as follows (Liles, 1953):

several springs, nearly all of which contain pure fresh water. One of them is slightly tinged with sulphur, and when they all flow together, and form a large pool below, the water becomes more or less impregnated with it. . . The owners have built a dam across the ravine a few hundred yards below, making a large deep reservoir for the storage of the water, and at the time of our visit thousands of cattle watered there daily.

In 1936 Sulphur Springs were reported by the Texas Board of Water Engineers to be producing 0.63 lps "during a very dry season." On April 20, 1979, the discharge was 0.13 lps, from an elevation of about 795 meters. The water is slightly saline (see table of Selected Chemical Analyses). Field tests made in 1979 showed it to be a little more saline than in 1936. One cottonwood tree still grows among the elms and salt cedars where many birds flutter. Two old wooden windmills stand close to the springs.

Ten kilometers north-northeast of Stanton was the site of a large Indian village on W. D. Bryant's ranch. Here there are over 50 boat-shaped mortars in Triassic sandstone boulders. Some are shallow, some quite deep, and the shape of some has been greatly altered by weathering. The site was evidently used by a pre-historic people over a very long period of time. Many metates, manos, projectile points, and tools have also been found here. Obviously springs (2) once flowed from the Ogallala bluff to the west at that time, collecting in Calf Creek to run past this site. In 1936 the water table in a shallow alluvial well here was 2.4 meters below the surface. Now, according to Bryant, it is 9.1 meters to the water. The creek channel has been filled with sediment. Purple aster and sagebrush and yellow bitterweed blossoms cover the site in spring.

Cap Rock Springs (1) were five kilometers north-east of Stanton on J. L. Kargl's land. They poured from Ogallala sand on Antlers sandstone. Mortar holes in the sandstone testify that this was a living site in past ages. In early settlement days the springs watered 500 cattle. In 1883 many residents of Marienfeld (later called Stanton) used the water. According to Cliff Hazlewood of Stanton, Cap Rock Springs dried up around 1940. Many cedar trees now cover the site.

Mulkey Springs (3) were five kilometers east of Stanton on Tom Newman's ranch. Burned-rock middens, metates, manos, and projectile points indicate that this was an Indian village at one time. The springs poured from Ogallala sand on Antlers sandstone on the

north side of Hamilton Draw near the old Mulkey house. Glen Petree, who formerly lived here, states that the springs flowed most of the year until the 1950s, running about 0.4 kilometer. Here also cedar trees are abundant.

Baldwin Springs (4) were located on Mustang Draw about three kilometers upstream from the Midland County line. Some early travelers confused these springs with Mustang or Sulphur Springs. Most map makers, however, showed them as separate springs. Livermore and Butterfield, on their 1881 *Military map of the Rio Grande frontier*, portrayed both Mustang Springs (in Midland County) and Baldwin Springs. A. W. Spaight's 1882 *Official map of the state of Texas* and others also depicted Baldwin Springs.

According to Hazlewood, Baldwin Springs, which were not as large as Mustang Springs to the northwest, failed around 1940. The analysis shown in the table of Selected Chemical Analyses was made on water taken from a shallow well in the alluvium nearby, with a water table 2.1 meters below the surface. The springs helped to feed the chain of lakes along Mustang Draw. Now there is only a dry caliche pit nearby, and many purple asters in spring.

Mustang Springs (5) are marked by a historical monument 13 kilometers west of Stanton on Mustang Draw. Paleo-Indian projectile points found here indicate that this was a popular spot many thousands of years ago. Capt. Randolph Marcy in 1851 wrote of the springs, which he visited in 1849:

About halfway between this place and our last camp, we discovered a small lake about one mile to the north of our road, where it is thought there will be water at all seasons; it is about three feet deep, covers several acres of ground, and has rushes growing in it. There are also numerous trails made by mustangs leading to it, showing that it is much frequented by them; and as the horse requires water every day, he would not probably stay at a place where it could not be found at all times. This lake I have called "Mustang pond;" and as it is situated about halfway between the sand hills and the laguna, (which is ahead of us,) I conceive it to be very important for travellers.

About two months later Lt. Nathaniel Michler stopped here, describing Mustang Springs as follows (U. S. Senate, 1850):

There was nothing to indicate their presence; a few scattering chaparral bushes were growing within half a mile of them, but in proximity to the water there were no trees or bushes of any kind. A low prairie about a hundred acres in extent, in form very nearly circular, and bounded by low bluffs, composed

principally of white limestone, contains several small ponds of water — one or two pretty deep, and the rest not containing much water. The taste of the water is flat and sweet, being slightly brackish. From the number of trails leading to them, and the number of mustangs which came to water there, and the quantity of flag and other vegetable matter growing in and about them, I judge the water to be permanent. Several springs were found bubbling in the ponds.

In 1854 Pope described Mustang Springs:

We arrived at the Mustang springs at half past 10 o'clock a.m. Last night our sheep (32 in number) were stampeded by wolves, and our exertions for the recovery were in vain . . .

The Mustang springs form several lakes or large pools, which are highly saline. The one on which we camped, the most easterly, is less salty than the others, and is by far the best for use. It is slightly sulphurous, but not unpalatable. There are some holes dug around, in which the water is somewhat better than in the bottom. These lakes are about three miles in length, and run north 20° west, and south 20° east. They are enclosed by gentle eminences, on which the grass is better than in the bottom.

We met a party of Kiowas, who had a large number of horses and ponies, and were returning with them to their own country from Mexico. It is needless to say these animals had been stolen.

In 1878 - 79 buffalo hunters camped here, but killed only 800 buffalo that year, as the slaughter was nearly over. In 1890 Palmer, on his *Map of Texas*, showed these springs as Mustang Fountain, depicting also Mustang Springs in present Midland County and Mustang Water Holes in Reagan County, often confused with the Mustang Springs described here.

The old Slaughter ranch house was located near Mustang Springs. According to Hazlewood, the springs nearly dried up in the summer of 1914. They failed permanently in the early 1940s. The lakes are now dry, filled with sediment, and partly cultivated. Oil wells and a caliche pit are nearby. The site is now on Billy Loudner's farm.

Farther up Mustang Draw, two to six kilometers south-southwest of Tarzan, were **Kilpatrick Springs (7)**. Included in this group was a spring two kilometers southwest of Tarzan on H. D. Howard's farm. Kilpatrick Springs were shown on Livermore's and Butterfield's 1881 map and other early maps. According to Hester Badgett, a nearby rancher, Mustang Draw had running water at this point a few years before he came here, in 1926. Hazelwood remembers a salt lake here in the 1920s. Mustang Draw in this reach is imperfectly developed, and consisted of a series of spring-fed lakes which overflowed from one to the next. Now the draw is dry and mostly cultivated.

On the George Glass ranch in southwest Martin County, managed by Bob Matthews, is a large dry lake bed, formerly a salt lake. On the west side are steep bluffs. An Indian living site was located at the north end of the lake. Nearby were some very small springs (6) which trickled from Ogallala caliche on Antlers sandstone. In 1936 the Texas Board of Water Engineers noted "wet weather springs" here. They probably dried up permanently soon afterward. Now the lake bed is a dry pasture with many oil wells around it.

MATAGORDA COUNTY

At the dawn of history the tall, well-built Karankawas roamed these coastal lands, making use of the many small springs which then existed. Although larger and more numerous at that time, springs have never been spectacular in the county, because of the flatness of the land surface. The earliest European explorers such as De Pineda in 1519 must also have used these springs, perhaps deepening seeps on the landward side of dunes on Matagorda Peninsula to form shallow wells.

Matagorda Peninsula was formed less than 5,000 years ago. It should be kept in mind that geologic forces such as hurricanes and river sedimentation have also wrought great changes in the shape of Matagorda County in the 500 years since it was discovered by men from the old world. *Matagorda* is Spanish for *dense growth*, probably referring chiefly to the thickness of cane growths found here in those days, but all types of vegetation, including wild peaches, were very luxuriant.

In 1690 Manuel Joseph de Cardenas y Magana mapped Matagorda Bay. He showed the bay to extend some 15 kilometers up the Colorado River from where Matagorda was later located. By 1824, when Matagorda was settled, a great raft of logs had formed from the settlement upstream, filling this part of the channel and bay with sediment. Between 1856 and 1956, the Colorado River delta advanced eight kilometers across the bay to Matagorda Peninsula, cutting the bay in half. Much of this advance was due to the 1929 dislodging of the raft, which was swept into the bay. As a result Matagorda, formerly an important seaport, is no longer on the coast. Such rapid changes in the physiography of the area have not only destroyed most of the evidence of early races who lived here, but have also in many cases destroyed old springs and created new ones.

That there never were any springs of consequence near Matagorda is documented by the fact that the earliest settlers in 1824 collected water from building roofs in cisterns, and drinking water was brought here

from as far as New Orleans. Two of the earliest settlers, Esther and Benjamin Wightman, died of typhoid fever as a result of drinking the river water.

The very small springs and seeps in the county originally flowed chiefly from terrace sands and silts. Very heavy pumping of groundwater for irrigation of rice has been the greatest cause of water-table declines, hastening the extinction of most springs. In the Big Hill area northeast of Matagorda, water tables had declined up to 34 meters in 1969 since drilling for oil, gas, and sulfur began in 1904.

In addition to lowering the water table, heavy pumping of water and petroleum products has caused land subsidence. Some writers have indicated that Big Hill has subsided by as much as 20 meters. This appears excessive, although Big Hill is no longer a hill, and is now called Old Gulf. Another problem caused by heavy pumping is salt-water encroachment into formerly fresh groundwater areas. Where this happens, even if the large withdrawals were discontinued, it would take centuries to flush the salt water from the invaded sands.

Most of the writer's field studies were made during the period March 18 - 23, 1976.

The spring and seep waters are of a sodium bicarbonate type, generally fresh or slightly saline, very hard, and alkaline. The chloride content may be high.

Lee Springs (5) are eight kilometers northwest of Bay City along the west bank of the Colorado River. They once provided water for travelers on Lee's Ferry, located here. Seeps still trickle from sand on top of clay.

Pledger Springs (4) are three kilometers south of Pledger, in Caney Creek. From 1845 to 1885, when the settlement moved north to be on the railroad, the springs were in Pledger. Probably the largest springs still flowing in the county, they are on Ed Horvath's place. They form a sand boil, usually beneath the water of Caney Creek, at about 15 meters above sea level.

Caney Springs (2) were along Caney Creek near Cedar Lane. Discharging from terrace sands, they were probably much used by the early Bay Prairie settlers around 1829. The postmaster at Cedar Lane remembers many springs in this vicinity when he was a boy in the 1930s. They are now gone.

Seven kilometers west of Cedar Lane, on Caney Creek, were **Mt. Pilgrim Springs (3)**. They were on the 1827 R. H. Williams plantation. Flowing from river terrace silts, they are only seeps now. The Mt. Pilgrim church still stands across the creek.

Elliott Springs (1) were located on the east bank of the Colorado River at the Highway 35 bridge west of Bay City. In 1528 De Vaca may have stumbled onto

these springs in his wanderings through Texas. Flowing from terrace sands, they provided welcome refreshment to travelers on Elliott's Ferry here in more recent days. Lower Colorado River Authority officials, whose office is nearby, state that there were still seeps here in the 1930s. They are now dry.

Springs probably once existed also at several other localities. These include the old Deming's Bridge settlement (now Hawley cemetery) northeast of Blessing and the old Watkins ferry west of Wadsworth on the Colorado River.

MAVERICK COUNTY

Maverick County has never been favored with many or large springs. This is due to the geologic setting. Most of the county is underlain by shales and marls which cannot carry much water. A small area of water-bearing Austin chalk is present in the northwest corner, and some sand and gravel aquifers occur in terraces along the Rio Grande and near the eastern boundary of the county. Another factor which has prevented much spring development in the county is the structure of the rocks. The dip of the rock formations is toward the east, and the Rio Grande flows generally southeast. As a result there is on the Mexican side of the river a continuous succession of fine springs, but on the United States side very few.

There were in the past more springs than remain at present. Most streams and springs are now quite dry. This is due to several factors. One is irrigation pumping, which has drawn down water tables in eastern Maverick County as much as 25 meters. Another is overgrazing, which has killed off the desirable grasses, substituting blackbrush and mesquite, thus reducing the recharge capacity of the soils.

There is little evidence that significant springs ever existed at Eagle Pass. In early settlement days barrels of water from the Rio Grande were carted around town and sold. The usual piece of prickly pear leaf was used to settle the sediment from the water.

On the other hand some small springs and seeps have resulted from man's activities. Along the large canal built in 1938 for irrigation and power development there has been much leakage of water which reappears below as springs and seeps.

The water of the remaining springs in the county is generally of a calcium bicarbonate type, very hard, alkaline, and fresh. Most of the writer's field studies were made during the period October 24 - 29, 1976.

Seven kilometers north-northwest of Quemado are **Frenchman Springs (3)**, among the few still flowing in the county. They are on the right bank of Las Moras

Creek just west of Highway 277 on Fred Forster's ranch. They flow from a bed of gravel and possibly from the underlying Austin chalk in a grove of hackberry and huisache trees. They are probably recharged upstream by the spring-fed Las Moras Creek. At the time of the writer's visit (October 28, 1976) surface waters from recent rains were flowing over the springs, so that their discharge could not be measured. Mr. L. O. McKee, a nearby longtime resident, estimates their average flow at 0.65 lps. Many metates, manos, and projectile points found here disclose that the location has been popular for thousands of years. According to local historical authority Ben Pingnot, a French trading post was located here in the 1720s.

Among the largest springs now existing in the county are **Wipff Springs (1)** on Karl Wipff's ranch four kilometers northeast of Normandy. Here fifteen to twenty springs flow from high river-terrace gravel on top of a clay bed. On October 27, 1976, they discharged 1.8 liters per second. Numerous metates, manos, and projectile points have been found here, indicating that the springs were a favorite campground of early Americans. The remains of irrigation ditches point to use of the water for crops in later years. Now the springs supply water to several stock ponds and the ranch house.

Near the Zavala County line at latitude 28°43' to 28°47' is an outcrop of Carrizo sand. Very likely there were springs here in the nineteenth century, especially on Chacon Creek, similar to those which fed the creeks of western Zavala County. Owner N. J. Chittim remembers no springs since he arrived in 1911, but a few seeps still exist.

The small **Rosita Springs (4)** are 14 kilometers southeast of Eagle Pass near the mouth of Rosita Creek. In the Rosita Gardens development, they are on Lyle Ernster's ranch. The terrace sand and gravel from which they run are now recharged by leakage from irrigation ditches to the east, which makes the water slightly saline. But the springs were there before the irrigation project. L. M. Haupt's 1910 map, *Ringgold barracks to Fort Clark*, depicted them. The pools contain marsh purslane and algae, and are fringed with willows, huisache, and seep willows or *jaras*.

Cuevas, Indio, and other small creeks south of El Indio are fed by small springs. Typical are **Indio Springs (5)**, eleven kilometers south of El Indio on Highway 1021, on A. T. Gill's ranch. These springs also are recharged through the terrace gravel by leakage from irrigation ditches to the east. But "permanent water" was shown here on a 1915 U. S. Geological Survey topographic map, before the irrigation ditches



Indio Springs.

were built. On January 12, 1979, their discharge was 13 lps of iron-bearing water amid cane, cattails, and seep willows.

There is abundant evidence along San Ambrosia Creek in the southeast and Comanche Creek in eastern Maverick County that these streams once flowed continuously and were the homes of the Coahuiltecos whose land this was. In the words of Fray Damian Massanet who accompanied the Teran expedition of 1691 (Ximenes, 1963),

We continued in the same direction and headed to the northeast-by-east along a ridge of small hills covered with mesquite woods. We reached the banks of said creek (San Ambrosia Creek) where there is much water, and at a distance of a musket-shot there are four large, tufted oak trees close together. Here we stopped.

At the upper end of San Ambrosia Creek, 10 kilometers east of El Indio on G. E. Winship's ranch, was **Ojo Encinal (6)** or **Oak Grove Spring**. On later maps the spelling was corrupted to *Ojo O Sinal*. This spring, which trickled from Eocene Kincaid sandstone, has been dry for many years. An earthen tank now occupies the site. Mesquite, huisache, blackbrush, cat-claw, and prickly pear cactus have replaced the live oaks.

In 1836 Santa Anna's army crossed San Ambrosia Creek about 15 kilometers downstream from Ojo Encinal, finding no water, but hundreds of rabbits which could be caught by hand.

MCMULLEN COUNTY

Springs were never numerous or large in McMullen County. But at one time there were very small springs and seeps from Eocene and Miocene sands and sandstones, especially the Yegua, Jackson, Catahoula, and

Oakville. These formations dip toward the southeast at about 15 to 30 meters per kilometer. In the southeastern part of the county is the Bordas Escarpment or Devils Waterhole Hills. Here the hilly topography was favorable to the development of very small springs and seeps. A few seeps and small springs also issued from Quaternary terrace sand and gravel. Most of these seeps and springs were associated with perched water tables, usually appearing on top of clays high above the main water table. The main water table is generally several hundred meters below the surface.

Coahuiltecan Indians lived at the springs and seeps for thousands of years, using the water. In fact the sites of their villages usually pinpoint the location of former permanent water where none now exists.

Several factors have contributed to the decline and disappearance of the county's springs and seeps. One was pumping from wells. Overgrazing was very harmful in destroying the thick mat of grasses and organic matter which once aided recharge of the groundwater reservoirs. Even now it is not unusual to see desperately hungry cattle eating unburned prickly pear cactus, where no grass any longer survives.

The springs and their environment once supported water-loving plants such as maidenhair ferns, water pennywort, and water cress. Willow, hackberry and live oak trees and seep willows shaded the pools. The water holes harbored fish, crawfish, mussels, frogs, turtles, and various insects. Feeding upon this aquatic life were alligators, panthers, bears, armadillos, raccoons, coyotes, bobcats, and various water birds. Dependent upon the water holes were herbivorous animals such as deer, turkeys, javelinas, beavers, and later wild horses, cattle, and hogs which escaped from Spanish colonizers. When the springs and seeps dried up, most of this assemblage of plants and animals perished. Often a stand of live oaks persists for years after a spring or water hole has dried up, but eventually it too succumbs.

The spring and seep waters are or were generally of a sodium bicarbonate type, fresh to slightly saline, moderately hard, and alkaline. The content of iron and silica is usually high.

Most of the writer's field studies were made during the period February 4 - 9, 1979.

One kilometer southwest of Tilden on the Frio River on Sylvia Swisher's ranch was **Wheeler Hole (2)**. Springs from river terrace sand and gravel fed the water hole. In 1858 when the Rio Frio settlement was established at Tilden, there were large groves of cottonwoods, ash, and live oak trees here. In 1880, when the San Antonio-Laredo stagecoaches stopped here, a ferry was required to cross the heavy flow of the river.



Wheeler Hole in the Frio River.

Clifton Wheeler, Sr., a long-time Tilden resident, swam in the water hole as a boy. On May 16 - 17, 1949, a study by the Texas Board of Water Engineers showed that the discharge of the Frio River increased by 680 liters per second between Fowlerlerton and Tilden, presumably mostly as a result of spring flow and seepage. No significant springs or seeps are believed to exist now along this stretch of the river. The channel is largely filled with modern sediment. The river is only three meters wide now at the old ferry crossing.

In northwest McMullen County along *Maguey* (Agave) Creek there are numerous live oaks. Probably there were seeps here at one time from Yegua sand. Now the water holes are maintained largely by surface runoff.

West of Cross in the north part of the county was the Franklin ranch, established in 1870. Here several streams (5), fed by seepage from Yegua and Jackson sands, flow into San Miguel Creek from the south. Indian and Live Oak Creeks to the west are on Claude Franklin's ranch. Far Live Oak Creek is on Murray Franklin's. Far Live Oak Creek appears to be the most productive of water. According to Murray Franklin, early residents obtained their drinking water from shallow pits dug along San Miguel Creek, which did not fail even in drought years. Some seepage still occurs along these tributaries. Live oaks are numerous on the sandy soil.

Twelve miles northeast of Tilden on James Teal's ranch the remains of many ancient living sites have been found along San Miguel Creek (4). In those times the creek must have been fed by numerous seeps and very small springs, providing a constant supply of clear, pure water. The area is now inundated by Choke Canyon Lake.

Four kilometers south-southeast of Tilden on J. H. Dickinson's ranch is an area of hillside seeps (1). Seep-

age from Jackson sand maintains live water in an earth tank here. Many Indian artifacts found in the vicinity indicate that the seeps have been used for millenia.

In southeastern McMullen County on Clifton Wheeler, Jr.'s, Encino ranch were **Colmena (Beehive) Seeps (7)**, at latitude 28°14' and longitude 98°24'. Colmena Tank on Hill Creek was fed by these seeps from Catahoula sand from the late nineteenth century until 1940, when it was washed out, according to Charles Caron, a nearby rancher. The seeps are now gone, but the live oaks which gave their name to the ranch persist, along with some hackberries and elms.

Devils Water Hole (8) was 10 kilometers southwest of Colmena Seeps on Steve Lindholm's ranch. Here very small springs formed a waterfall over a rock ledge into the water hole, according to Caron. The remaining seepage, from Oakville sandstone, is now trapped in a large tank just upstream. There has been much digging for treasure supposedly buried here in bygone days. A few hackberry, elm, and huge mesquite trees still stand at the site.

Three kilometers southwest of Devils Water Hole is a very similar situation where Cow Creek descends through the Bordas Escarpment. Here, on Mrs. Ruby Whitley's ranch, seeps (10) once trickled from Oakville sandstone. A rock-crushing plant is located nearby now. A few hackberry trees shade the site.

In the southwest corner of the county on O. D. Dooley's San Jose ranch, was the site of the Stringfield settlement, at latitude 28°12' and longitude 98°40'. Here Thomas Stringfield and his family built a cabin in 1869. They probably used water from seeps (9) in the terrace sands rather than Nueces River water. The following year several members of the family were killed by Indians or bandits. Many flint projectile points and tools found here confirm that the site was a popular place long before the Stringfields arrived. Although the seeps are dry now, a few live oak and hackberry trees still stand.

About 15 kilometers southwest of Tilden on the headwaters of Mule Creek are a group of archeological sites, on James Donnell's ranch. The prehistoric people who lived here had to have water. Evidently there were seeps (6), now dry, from Jackson sand. In 1766 the Spaniard Parilla may have paused here en route from Presidio San Juan Bautista near Eagle Pass to La Bahia (Goliad).

On the south side of the Frio River seven kilometers southwest of Tilden, George Bright obtained a land grant in 1841. The Brights probably used seepage water from the Manning sand here (3) rather than river

water. A pond has now been built here, surrounded by willows and jaras.

MIDLAND COUNTY

Most of Midland County's springs trickled from Quaternary sand and caliche along the major draws and around the larger lakes, which were then usually full of water and fish. In the southern part of the county good springs emerged also from the Fredericksburg (Edwards) limestones and Antlers sandstone.

As long as 20,000 years ago aboriginal family groups lived at the springs, hunted small prehistoric horses, mammoths, and other now-extinct animals, and sat around their campfires fashioning flint tools and spear points. During historic time the Comanches took over control of the area and its springs.

In 1886-87 a severe drought dried up most of the springs temporarily. More recently man's activities, especially irrigation pumping of groundwater, have greatly lowered the water table. As a result, nearly all of the county's springs have failed.

The spring waters were largely of a calcium sulfate type, slightly saline, very hard, and alkaline. The fluoride content was usually high. The water was probably fresher in the past. There have been a number of documented cases of contamination of the groundwater by man's activities.

Most of the writer's field studies were made during the period April 15-20, 1979.

Midland Draw (8) lies just northeast of Midland. Here a number of Indian sites have been found. Very likely there were seeps and water holes along the draw in the past, which were fed from Quaternary sand. In 1937 the water table in a shallow well in the draw near the Mobil pumping station, south of Highway 80, was 5.2 meters below the surface. Now it is approximately 15 meters beneath the surface here. Upstream from the Midland sewage plant the draw is now quite dry. Most of the channel has been filled and is cultivated. Some sections have been channelized for flood control.

Along Mustang Draw in northeast Midland County and in Martin County were at one time many springs. There was some confusion among early explorers and map makers in naming these springs. While the main group of Mustang Springs was in Martin County, another group of **Mustang Springs (9)** was frequently described at a location now seven kilometers southwest of Stanton in Midland County. Palmer's 1890 *Map of Texas* showed Mustang Springs at the latter location and Mustang Fountain in present Martin County. Livermore's and Butterfield's 1881 *Military map of the*

Rio Grande frontier showed Mustang Springs in present Midland County. Evidently there were at least two groups of springs called Mustang Springs. In addition there was Mustang Water Hole in Reagan County.

The Mustang Springs in Midland County were on Curtis Erwin's ranch. In the 1930s, as a youth, he hunted ducks from a raft on the lake here, which was 1.6 kilometers long. Until about 1942 Mustang Draw ran constantly through Midland County. Until 1951 there was a flow in winter below Interstate 20, with some lakes and small fish. Now, according to Erwin, the water table is about eight meters below the surface in the draw. Some hackberry and dying salt cedar trees may still be seen.

Midland Draw near the Glasscock County line once contained very small springs (7) on the Boone ranch. Several Indian sites have been found here, as well as the bones of mastodons which Paleo-Indians hunted. The water table in 1937 was about one meter below the surface of the draw in a nearby shallow well. Now, according to "Boots" Brown, who leases the ranch, it is down to about three meters. A few hackberry trees survive.

Seven kilometers southwest of Spraberry in eastern Midland County was Stephenson Lake (6). Several Indian sites have been found around this lake. Evidently the lake was fed by springs or seeps from Quaternary sand on Antlers sandstone. Now the lake and springs are dry and many oil wells pump in the vicinity. The surrounding slopes are covered with yellow bitterweed and purple aster flowers in spring. Consavvy Lake, eight kilometers west-northwest, was also the site of Indian campgrounds, and was very likely spring-fed.

Peck's Lake is 12 kilometers south-southwest of Spraberry. The lake was formerly kept full by **Peck Springs (1)**, on James and Ann Walton's and David Payne's ranches. Here Teddy Stickney, noted Midland archeologist, has found evidence of very old, Paleo-Indian habitation. In 1875 Lt. Andrew Geddes and his party stopped here. The main springs on the south side of the lake were walled up by Walton's grandfather to keep cattle from bogging down in them. These springs, issuing from Quaternary sand, are reported to have flowed briefly in 1970 after heavy rains. On April 17, 1979, the springs were all dry and the lake bed only damp. Dying salt cedars and swamp grasses fringe the shores. On the surrounding slopes yellow bitterweed, purple asters and white prickly poppies blossom in spring. Many oil wells surround the lake. In 1926 a small meteorite was found nearby.

Salt Lake is 17 kilometers southeast of Midland on



Spring flow entering Salt Lake.

Mrs. Andrew Bradford's ranch, managed by John Blair. On the west and south sides of the lake are several springs of slightly saline water (3), the only springs still flowing in the county. They issue from Edwards limestone at an elevation of 820 meters. Eight mortar holes near a small rock shelter have been found at the western springs. The spring at the south end of the lake was formerly boxed in.

On April 17, 1979, the total discharge was 0.07 liter per second. According to Blair, the springs dry up in summer. Although the lake rarely holds water, on the above date it was 80 percent covered with very saline water and fringed with a crust of salt. The springs support a lush growth of water milfoil, cattails, algae, sacaton grass, and salt cedars. The tracks of deer, javelinas, turkeys, and raccoons are numerous. Frogs, snakes, killdeers, ducks, coyotes, and bobcats also frequent the springs.

In the southeast corner of the county, three kilometers north-northeast of Midkiff, is Midkiff Lake (2) on T.O. Midkiff's ranch. It was once fed by very small springs and seeps from Quaternary sand. In the 1940s there was still sufficient water in the lake for much boating and water skiing, according to Handley Driver of Midland. The lake is now usually dry, only occasionally collecting surface runoff. Yellow bitterweed blossoms cover the basin in spring. Many oil wells pump here.

In the southern part of the county, about 1.6 kilometers east of Highway 349 on Johnson Draw, were **Rock Springs (4)**. On the Bradford ranch, they once poured from Quaternary sand on Antlers sandstone. Many burned-rock middens have been found here. Numerous mortar holes are present in the sandstone boulders. Foreman John Blair found a mano stone in one of the mortar holes. Some of the mortars are shallow and some have been ground or weathered all

the way through the boulders. Some are round and some boat-shaped. The shape of some has been greatly changed by weathering. It seems clear that this place was a favorite campground over a very long period of time, probably used by several different tribes at different times. In 1650 Captains Hernan Martin and Diego del Castillo, traveling from Santa Fe to the Concho River in present Tom Green County, may have visited here.

Rock Springs were shown on G.F. Cram's 1890 *Railroad and county map of Texas*. According to Blair, the former owner, Leona Bryant Smith, remembers that when she was a child around 1910 the springs still flowed. Now they are quite dry and the depth to water at a windmill well here is about 11 meters. The analysis given in the table of Selected Chemical Analyses is of this windmill water.

Ten kilometers south-southeast of Midland Air Terminal, on Monahans Draw, is the Scharbauer archeological site (5), now on Jack Ellison's property. Here the remains of Midland man (actually a woman) were carbon 14-dated at 20,400 years old. Some archeologists believe that this date is too old, but there is little doubt that Paleo-Indians were in the area at that time. Then the climate was cool and wet, and Monahans Draw was probably a continuous watercourse with shallow lakes and marshes, fed by many springs.

Even in the drier climate of more modern times, there is reason to believe that some seeps persisted along Monahans Draw. But by 1937 the water table in a nearby well in the draw had declined to 5.4 meters below the surface. In 1979 it was 7.6 meters below the surface. Waste water from Odessa is now recharging the Monahans Draw alluvium, but natural seepage has long since stopped.

MILAM COUNTY

Most of Milam County's springs issue from Tertiary Eocene sands, especially the Carrizo and Wilcox. These formations dip toward the southeast at about 10 meters per kilometer. In the south part of the county the Luling-Mexia fault zone controls the location of some springs. Others originate from Quaternary terrace gravel and sand along the major rivers.

In the early 1700s the Tonkawa Indians, along with several other tribes, lived near the Brazos River at a place the Spaniards called *Rancheria Grande* (Big Camp). As Newcomb and others (1971) state,

in 1716, the Domingo Ramon expedition, which was sent into east Texas when it was feared the French might encroach upon Spanish territory, found the *Rancheria Grande* village

located two or three leagues [8 to 12 kilometers] west of the Brazos in what is now Milam County.

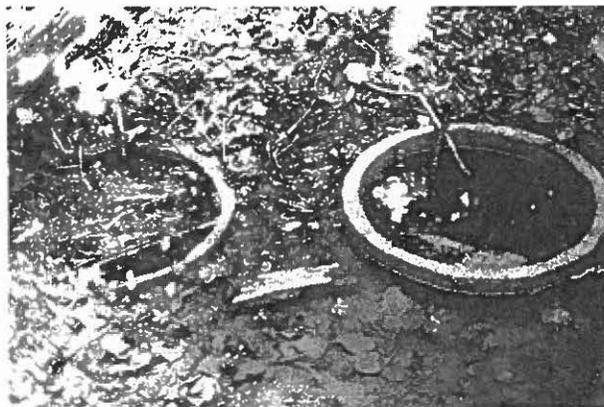
It is not difficult to imagine these early inhabitants of the area camping by and using the waters from the many springs which then existed in the county. Some of the best aquifers in the state underlie the area. At that time they were full of water, and overflowing everywhere through springs.

Flowing wells and heavy well pumping have caused a great decline in the water table. As a consequence the springs in the county now flow at greatly decreased rates, and a large number have ceased flowing at all.

The spring waters which still exist in the county are usually of a calcium and sodium bicarbonate type, and are fresh, of neutral pH (hydrogen ion concentration) and moderately hard. They frequently contain much iron. Most of the writer's field notes were made during the period October 24-29, 1975.

Ross Springs (13) are just east of the water plant in Cameron. Here, in 1841, Shapely Ross and others built their cabins. At that time, when water levels were higher, the springs flowed in what is now the city park to the north-northwest. Ross' stable was near the old spring location, where a historical marker now stands. In 1871 Dr. G.C. McGregor wrote about the "large spring of water" in Cameron. Later the springs fed a walled-in pool in the park, which has now been filled and covered with grass. Although there are no longer springs in the park, there was still a discharge of 0.24 lps from terrace sand in the draw 200 meters south-southeast on April 8, 1978.

Hefley Springs (6) are in Cameron near Cleveland Avenue and East Ninth Street, on Harold Riley's property. These springs also were important to early Cameron settlers in the 1840s. On April 17, 1936, the discharge was 3.2 lps. The springs are now mostly



Hefley Springs.

beneath a lake, but on February 9, 1978, the seepage below the dam plus computed evaporation indicated a discharge of 0.37 lps. The springs flow from terrace sand. They were curbed with large concrete pipe sections, four of which can still be seen. The waters were also used for a swimming pool at one time, shaded by two huge live oak trees. The lake, which has an island, gazebo, and the remains of a bridge, contains large catfish. A housing project is being developed around it.

Tappan or Post Oak Springs (5) five kilometers southeast of Buckholts, were formerly the chief water supply for the Ad Hall settlement. In 1837 a skirmish with Comanche Indians took place here. Flowing at a reduced rate of 0.12 lps from a sand bed in the Midway group in 1975, they now supply a stock tank.

Ten kilometers northeast of Cameron are **Allen Springs (4)**, the site of a prehistoric Indian village. Here W.H. Walker built a cabin in 1836. The springs continued to flow from the Wilcox sands during the droughts of the 1930s and 1950s, and residents of the area came many miles to obtain this water. They discharged 0.72 lps on October 25, 1975.

About 18 kilometers northeast of Burlington and 1.5 northeast of the Caddo cemetery are some springs which were once the focal point of a band of Caddo Indians. **Caddo Springs (1)**, flowing from high terrace sand, also supplied early European settlers with drinking water. In 1936 they discharged 1.8 liters per second. They flowed into a stock tank at 0.24 lps in 1975.

Vineville Springs (3) are 14 kilometers east of Cameron on Hart Creek. Important to settlers in the 1850s, they are now dry.

Nashville, the oldest settlement in Milam County, was on the west bank of the Brazos River seven kilometers northeast of Gause. The reason for settling at this particular spot was the "several springs of clear water which gushed from under the bluff"(2). As the Old Settlers Association of Bell County (1902) reported,

Just below was the dear old spring frescoed by beautiful festoons formed by the long and verdant wild grapevines. Would that I could, as in days of yore, stoop and dip a drink with the old long-handled gourd, and then turn and watch the sparkling water flow down the precipice, dashing and dissolving itself into a cloud of mist and vapor, catching up the sunbeams and winding their rays of rose, violet, and vermilion into its silvery spray, forming beautiful rainbows that arched the dark abyss below.

One of the **Nashville Springs** still survives, but it no longer "gushes" as it did when the first settlers arrived in 1835. Trickling 0.13 lps from river terrace

sand and gravel on October 25, 1975, it is located just north of the railroad bridge. A historical monument stands to the south on Highway 79.

Lee Garden Springs (12) are five kilometers south-southeast of Milano, on J. B. Clark's property, leased by Joe Willingham. They were an important source of water to early area residents. Hugh Stewart, who lives about one kilometer east, hauled water from the springs in the 1920s. The water flows from a fault in Queen City sand, reportedly never failing. The discharge was 0.95 lps on May 14, 1936 and 0.73 on February 9, 1978. There is no longer a flow from an old sandstone spring box, but many seeps nearby still trickle. The pools are filled with water pennywort and surrounded by blackberry bushes. **Smyrna Springs**, eight kilometers northeast, were also much used as a source of water and for washing clothes, according to Willingham.

Five kilometers south-southwest of Milano, on J. C. Hairston's property, are **Taylor Springs (7)**. They issue from a fault at the base of a post-oak-covered bluff of Carrizo sandstone. Many Indian artifacts have been found here, and early settlers made good use of the springs. The discharge was 1.9 lps on May 11, 1936, 0.52 on October 26, 1975, and 1.0 on February 9, 1978. The springs, surrounded by swamp grasses, have been partially buried by sand from past erosion of the fields above. The area is now being developed for residential use. The similar **Buer Springs (10)** are three kilometers east on Buer Creek.

Sipe Springs (11) are eight kilometers southwest of Milano. The old Sipe Springs school formerly obtained water from one of them. On February 9, 1978, the combined discharge was 1.7 lps from Wilcox sand. A barred owl was watching the site.

Eleven kilometers west of Rockdale, on the divide between the San Gabriel River and Brushy Creek at latitude 30°41' and longitude 97°06', is a highly significant historical area. Archeologist Kathleen Gilmore in 1969 definitely identified here the remains of three missions established by Spain in 1748 and 1749. The missions were constructed for the Tonkawa, Atakapa, and Karankawa Indians. Fray Juan Agustin de Morfi (1781), quoting the earlier words of Athanaze de Mezieres, said:

Few rivers can compare with the San Xavier in the cleanness of its waters and the abundance of delicious fish. The surrounding country can be irrigated to avoid the uncertainty of the weather, and mills can be erected. The number of wild horses and cattle that graze here and which could be utilized as beasts of burden or as food is incredible. The buffalo is not lacking for variety; while with thyme, lavender, sage, winter savory, and

other aromatic plants, goats and sheep would thrive. The fragrant flowers that abound in the fields offer splendid facilities for the culture of bees. Hogs could be fattened freely with the acorns, without the costly expense of grain. Prime oil could be obtained from nuts, and bears will furnish a not inferior quality of lard. In the woods will be found lumber, in addition to abundant game, and in the quarries all kinds of stone for building.

But from 1752 to 1755 a terrible drought struck the area. In Morfi's words,

Then there came a drought that dried up the river, something never seen before; the water of the pools became impure; and brambles and briars now abound everywhere; mysterious noises are heard, and other portentous signs are evident.

Although irrigation ditches had been built, when the river went dry the crops failed. In addition the Indians were soon decimated by small pox and other European diseases. Hence the missions were transferred to San Marcos in 1755.

This area is located on river terrace sands and gravels. A study of the vicinity indicates that there were probably in 1749 many springs surrounding the missions at an elevation of 115 meters. These must have been used by the Indians who lived here first, and were probably a factor in deciding the location of the missions. Some small springs which the writer calls **San Ildefonso Springs (8)** still exist about 1.3 kilometers southwest of the mission of that name, flowing 1.0 lps on October 26, 1975. The rest have dried up because of heavy pumping and irrigation of crops. The mission site was about 700 meters southeast of the historical marker on Highway 908.

Clement Springs (9) were 9.5 kilometers south of San Gabriel on the San Gabriel River. Here Peter and Jesse Mercer built their log cabins in the 1840s. The springs are now dry.

MONTAGUE COUNTY

At the dawn of history in Montague County the Taovaya or Wichita Indians were growing crops such as corn, pumpkins, and beans, using spring waters for irrigation. Enormous numbers of ducks, geese, turkeys, and prairie chickens also made good use of the springs and spring-fed creeks and swamps.

The county's springs issue chiefly from Permian sandstones in an area characterized by sandstone-capped mounds, from lower Cretaceous sands, and from river terrace sands. Groundwater levels have declined greatly because of modern man's activities, and



Boren Springs and floodwater diversion wall.

many springs have dried up. Most of the wildlife which depended upon the springs has also vanished.

The majority of the creeks are reported to have flowed continuously in the past, but now flow only during rainstorms. Severe erosion, caused not only by unwise farming and ranching practices, but also by oil-field wastes, has caused huge gullies to form. These have dumped their sediment downstream, clogging channels and burying springs.

The water is generally of a sodium bicarbonate type, fresh, very hard, and alkaline. Sulfate or fluoride content may be high. In some cases the water has been contaminated by oil-field brines.

Most of the writer's field studies were made during the period October 6 - 11, 1977. As the preceding six months had been the driest in many years, the spring discharges observed were probably below normal for this season.

In 1913 Gordon reported small soft-water springs near Ringgold. Those five kilometers southeast of Ringgold, on the T. C. Grimsley ranch, are now known as **Boren Springs (5)**. Louise Addington, who guided the writer and his wife to these springs, had last seen them 60 years previously. She was appalled at the amount of sediment that had been washed into the springs, even though a rock diversion wall had been built around them. On October 8, 1977, about 0.04 liter per second of fresh water seeped from sandstone ledges, and was much used by wildlife. The old Yeager house still stands nearby. Three kilometers northwest of Ringgold were Beaver Springs, now dry.

Barrel Springs (12) are nine kilometers southwest of Nocona on Bruce Bybee's property. Capt. R. B. Marcy said in 1854:

We camped on Turkey Creek (now Barrel Springs Creek). . . . We had capital spring water. Two barrels had been sunk by some of our predecessors, in which the water was delightfully pure and clear.

In 1857 the U. S. Cavalry found the flow weak. The nearby Barrel Springs school later used the water. Now seeps from Permian sand and sandstone on top of clay form a pool 100 meters long, fringed with cattails and salt cedar. Raccoons and waterfowl frequent the springs. They have been polluted by an adjacent oil well. A field test showed the water now to contain 4,100 milligrams of chloride per liter, making it unfit for human use. Many dead trees are scattered over the site.

At Red River Station, 12 kilometers northwest of Nocona, are **Red River Springs (7)**. On Thomas Stillwell's land, they were in the past very important to the buffalo and Indians at this crossing. Later the town of Red River Station (first called Salt Creek), a Civil War Army post, and users of the ferry made good use of them. According to historian G. O. Wilson,

There were many fine springs along the creek which furnished water to the settlement even during the worst dry years.

Originally the Red River was adjacent to the springs, but it has now moved one kilometer north. The main springs, shaded by cottonwoods, produced only 0.03 lps from terrace sand in 1977. A monument stands 200 meters northeast of the springs.

Crownover Springs (8), also very small, are seven kilometers northeast of Red River Station. The nearby Panther Creek flowed throughout its length in the 1800s, but now only near its mouth.

At the dawn of historic times there existed at Spanish Fort a large village of Taovaya or Wichita Indians. Here **Taovaya Springs (9)** gushed from river terrace sands. In 1719 the Frenchman Bernard de la Harpe found these people to be living in permanent reed houses, raising crops such as melons, tobacco, and corn, and probably irrigating them with spring water. In 1759 the Spanish Col. Diego Ortiz Parilla attacked the village in retaliation for the San Saba massacre, and was badly defeated. The village was fortified by the French and the Indians had French arms. In 1781 Fray Juan Agustin de Morfi, on an inspection tour of Spanish missions, wrote:

The land, if not better, is as fertile as the preceding lands. There are many springs of good water used by the inhabitants that enable them to irrigate profusely their extensive fields. The water of the river, which is slightly salty, is also a powerful attraction for the cattle [buffalo] which in large herds feed on its banks. The Indians kill large numbers of them annually. Nor is it less rich in fish of the best kinds, which the natives do not appreciate.

Quarries nearby were used by the villagers to obtain sandstone for metates and manos and chert for arrow points and knives. Firewood was abundant along the river and spring-fed streams. A salt deposit on the river was used by the Taovayas and provided salt for use in trade with other tribes.

Many very small springs and seeps still exist here, chiefly on Donley Reid's ranch north of Spanish Fort. Their flow, which seeps from sand on top of a conglomerate, ranged up to 0.06 lps for individual springs in 1977. Shaded by pecan trees and plum thickets, they issue among pink canelas and purple asters. Originally the springs probably extended up Village Creek also, although it is now dry.

Ten kilometers southwest of Illinois Bend, on Bob Haralson's property, are **Rock Springs (10)**. Shown on an 1898 topographic map, they were much used by early settlers. Now there is only a small pool of water with frogs below the massive sandstone outcrop. Persimmons and dogwood thrive here.

Dripping Springs (11) are five kilometers east-northeast of Nocona on Harold and Brenda Marmaduke's place. Many Indian artifacts have been found here. These springs also were depicted on an 1898 map. Many names and dates have been carved in the sandstone cliffs. Around 1900 a dam was built to form a swimming pool, but it was washed out long ago. A diversion ditch was also cut in the rock to direct flood flows around the springs, but it is now eroded and no longer effective. Water drips from the moss-covered sandstone beneath an overhang, surrounded by huge boulders. It forms pools in a grassy swale, shaded by willows and cottonwoods. Foxes, bobcats, and coyotes frequent the springs. The Marmadukes have made some attractive trails through the woods to the springs.

Two kilometers north of Saint Jo on the Aston ranch are **Chancey Springs (18)**. They were formerly very popular for picnics. Porcupines once lived here, but have now been exterminated. In 1977 the springs poured 0.065 lps into a concrete box. Many redbuds bloom in the wooded canyon.

Head of Elm Springs (17) are in Saint Jo near the head of Elm Fork of the Trinity River. Saint Jo was once called Head of Elm because of the springs. In 1854 Marcy wrote:

Reached our camp, on the east edge of the Cross Timbers, . . . on a well-timbered ravine, in which there is a beautiful spring of water.

According to Cecil Boggess the springs have flowed

only intermittently since 1969. A former spring in Bog-gess Park is now dry.

Bluff Springs (16) are eight kilometers south of Saint Jo, just north of the Gladys (formerly Bluff) community. On the Brock ranch, leased by Jerral Goff, they produced 0.075 lps in 1977 from Lower Cretaceous sands to feed several reservoirs.

At Dye Mounds, 11 kilometers northwest of Forestburg, are **Dye Springs (15)**, probably the largest in the county. In 1870 a band of Indians camped here. Dark gray soils reveal that a swamp formerly extended from Willawalla Creek to the mounds. Now the creek has entrenched itself to a depth of about eight meters, draining the swamp. On October 10, 1977 the springs, partly on Otis Mullins' property, produced 1.5 lps from an elevation of 335 meters, among willows, cattails, and cottonwoods. Hawks and other wildlife thrive here.

Forestburg Springs (14) are one kilometer southwest of Forestburg on John Willis' ranch. Other very small springs are nearby. They were used by Hagler's store in the 1850s and by many other early settlers. In 1913 Gordon described a spring near Forestburg which "yields a never-failing supply of warm water." The writer found these springs to have a temperature of 19° Celsius on October 9, 1977. This is about normal for a cold spring in this vicinity. It is doubtful that warm springs ever existed here. During a cold winter the water might seem warm, as it remains at about the same temperature the year around. Metates and other Indian artifacts have been found here. In 1977 there were only seeps of 0.03 lps from a sandstone bluff amid cedar and redbud trees.

Seven kilometers northwest of Bowie and southeast of Brushy Mound are **Brushy Springs (4)**. Dark gray soils on Homer Jackson's ranch reveal that a large swamp once existed here. The Santa Fe expedition is believed to have camped here in 1841. In 1859 a ranger station on Brushy Mound used the water. Mr. Jackson remembers swimming in Middle Belknap Creek a few kilometers downstream. Now there is only seepage from sand and gravel colluvium near the base of the mound, amid dying cattails. A historical marker is present on the mound.

Victoria Springs (3) were eight kilometers north of Bowie on Victoria Creek just east of Queen's Peak. Indians who used Queen's Peak as a lookout no doubt used the springs also. Captain Randolph Marcy and his party stopped here in 1854. The springs flowed from Permian sandstone and conglomerate but are now dry, marked only by willow and cottonwood trees. A historical monument is located on Queen's Peak.

Stoneburg Springs (2) were three kilometers

southwest of Stoneburg. They were described as "small, soft-water springs" in 1913 by Gordon. Some old residents remember a swimming hole here. Now they are beneath Bowie Lake.

Six kilometers west of Montague on Sammy Poe's ranch are another **Rock Springs (13)**. Mortar holes ground by Indians may be seen in the sandstone here. An Indian burial was found three kilometers north, according to Sevier Clark, a nearby resident. In 1857 Col. James Leach wrote of these springs:

We pitched our camp on Belknap Creek near [but not at] what was known as Barrel Springs. Here are found plenty of water for stock but very little in the springs for camp use. The springs might however if cleaned out and boxed up be made to yeald a fair quantity of good water.

In 1876 the Rock Springs school used the water. An old road formerly passed the springs. Now there is only seepage from sandstone bluffs and pools of water below. An oil well is nearby.

MONTGOMERY COUNTY

Montgomery County's springs flow mostly in the hillier northwest portion. They stream chiefly from Tertiary Miocene sands called the Fleming, and from Quaternary Willis and river terrace sands. These formations dip gently toward the southeast. Bogs or baygalls are commonly associated with the springs.

Archeological studies made in the Lake Conroe basin before it filled indicate that people were living at the springs in the Archaic and Neo-American stages, up to 8,000 years ago. These early Americans were primarily hunters, gatherers, and fishermen, but they also cultivated some maize in later periods. At the dawn of historic time the Atakapan Bidais were found camping near running water.

In the 1840s Sam Houston hunted bear in the virgin forests of Bear Bend, now under Lake Conroe. The clearing of these forests and plowing of the land caused great damage. Sand from eroded fields choked stream channels and buried springs. Water that was formerly recharged through thick, porous forest soils now ran off instead. In addition, many springs and streams have been used as dumping grounds for trash.

Flowing wells drilled into the Jasper aquifer (Fleming sand) in the early 1900s wasted as much as 50 liters per second each. A flowing well near Tamina had a static water level 15 meters above the land surface. Most of the formerly flowing wells no longer flow. Because of flowing wells, well pumping, land clearing, and other

reasons, water tables have declined. In southern Montgomery County, which is affected by pumping in Harris County, the water level in the Fleming sand declined 0.64 meter per year from 1943 to 1967. Some land subsidence in the southern part, with its damage to buildings and pipelines, has also been caused by the large groundwater withdrawals in the Houston district. With the decline of the water table, it is not surprising that the flow of many springs and spring-fed streams has lessened or ceased, even in this area of relatively high rainfall.

The spring waters are generally of a sodium bicarbonate type, fresh, soft, and acid. The content of silica or iron may be moderately high. The fluoride content is usually less than desirable. Most of the writer's field studies were made during the period March 21 - 26, 1978.

Eight kilometers southeast of Montgomery and 0.6 kilometer north-northwest of Spring tabernacle are some small springs (10). Their flow of 0.21 lps in 1978 was sufficient to counteract evaporation and keep three lakes full, but there was no overflow. They were probably formerly higher and closer to the tabernacle.

One Seventy-seven Springs (9) are seven kilometers south of Montgomery in One Seventy-Seven Lakes Estates. Near Keenan Road and Thousand Oaks Loop, they give rise to Spring Branch. On March 23, 1978, 1.7 lps gushed from Willis gravel into a ravine. According to owner O. A. Gerloff, the old Keenan Road curves here in order to "head" the springs and ravine. The water was once used by a dairy and was also used to fill some lakes to the south. The springs were formerly very popular for outings, according to Bessie Owens, a well-known Montgomery historian. Dogwoods bloom nearby in spring. Sensitive, lady, and cloak ferns as well as mosses fringe the water. Three kilometers downstream the flow of Spring Branch was 2.1 lps on this date. Here minnows play among iron-bearing seeps, shaded by redbud trees. (See Plate 15,b).

Seven kilometers south of Dobbin on Allen Griffith's farm are **Griffith Springs (6)**. Here Noah Griffith built a log house in 1832. On one occasion, while he was away, Indians camped near the springs. His wife and children, afraid to leave the house, shot some sandhill cranes in the yard for food. Projectile points found here indicate that the springs had been used by the Indians for a long time. In 1978, 1.0 lps trickled from Fleming sand.

Beckworth Springs (5) are four kilometers south of Dobbin on George Lingenfelter's place. These sulfur springs were much used by area residents in the past,

and were noted by Deussen in 1914. Several springs with orange iron-oxide deposits feed a small pond with a bridge across it. Its surface is covered with duckweed and water pennywort. The adjacent fields bloom with spring beauties and bluets in March. In 1978, 0.54 lps trickled from Fleming sand. A domestic well pumps nearby.

Rocky Springs (4) are two kilometers west-northwest of Dobbin on George Herzog's farm. Here the Bidais used to come to Jacob Shannon's home for milk, leaving wooden bowls in exchange, according to writer Robin Montgomery. In 1978 the springs issued at 0.76 lps from Fleming sand on top of a bed of sandstone and clay, forming Rocky Creek. They are 0.4 kilometer north of the Shannon homesite, but appear to have been higher and closer to the house in the past. Raccoon tracks are numerous amid the redbud trees. According to John Herzog and Evelyn Shannon, the Bidai village was about 0.8 kilometer east of Rocky Springs. Similar springs discharge here. Shortly after the arrival of the settlers, smallpox killed most of the Bidais, and the survivors left the area.

Five kilometers south of Montgomery were **Mineral Springs (20)** on the old Rogers place, now owned by R. P. McCants. They were also called **Double Springs**, according to Mrs. Willis Cameron of Houston, because there was one fresh and one mineral spring. They were once much valued for their therapeutic effects. Some people stayed for a month partaking of the waters. On April 12, 1978, the flow of 0.77 lps from Willis sand appeared to be entirely fresh water. Willows and sensitive ferns shade the pools where fish play. A short distance west, on John Martin's ranch, were some saline springs which were used to produce salt during the Civil War. Near Mineral Springs a diamond mine swindle relieved many residents of their cash in 1911, according to Mrs. Cameron.



Rocky Springs.

In 1828 Andrew Montgomery established a trading post at the junction of two Indian trails, the Lower Coushatta trace and the Bidai trail, about 1.2 kilometers north of Montgomery. Numerous springs (8) upstream from this point on Town Creek provided a reliable supply of pure water. The discharge was still 2.5 lps at Highway 149 on March 23, 1978, amid numerous redbud trees.

Highway Springs (1) used to be a popular stop for travelers five kilometers north of Conroe on Highway 75. They have now been reduced to iron-bearing, oily seeps from Willis sand in front of John Latham's Fiction House.

Silver Springs (2) are nine kilometers north-northwest of Conroe in Panorama Village. The iron-bearing springs supply several recreational lakes on Stewarts Creek. The water is used to irrigate the Panorama Village golf course. The springs poured out about 14 lps on March 22, 1978, from Willis sand amid many palmetto plants. The downstream Girl Scout "Camp Silver Springs" was named for some of the springs.

Willis Springs (3) are one kilometer north of Willis on the Missouri Pacific railroad. According to Deussen, they were used to fill locomotive boilers in 1914. The algae-filled water seeped 0.07 lps from Willis gravel and sand on the east side of the tracks in 1978.

Spring Lake Springs (11) are 15 kilometers northeast of Conroe in Spring Lake Estates. Many springs flow from Willis sand in the small lake drainage area. Some discharge beneath the lake surface, causing cool spots in summer. A discharge of 52 lps passed the dam on March 24, 1978. Water lilies and pennywort thrive in the lake.

Nineteen kilometers east of Conroe and seven east-southeast of Cut 'n Shoot are the headwaters of a second Spring Branch (12). Where the branch crosses the Santa Fe railroad there is a winter flow of about 0.15 lps from Bentley sand. The brownish water is fringed with pennywort and shaded by trees. Other tributaries of Spring Branch are similarly springfed.

In the Spring Hills community 20 kilometers south of Conroe many springs (13) ran until the drought of the 1950s. In 1766 Marquis Cayetano Maria Rubi may have stopped here on his inspection trip of Spanish presidios and missions. Tom Hillegeist remembers several springs along Spring Creek. Now only seeps exist, and as there are hundreds of shallow pumping wells in this area, it is doubtful that these springs will ever flow again.

Similarly, springs (14) flowed until the 1950s in the area about eight kilometers upstream along Spring

Creek and Panther Branch. John Bonin, a long-time resident here, remembers them. Here also, only seeps remain from Montgomery sand. Spring-fed Bedias Lake, eight kilometers west of Tamina, was once a favorite haunt of the Bidais.

Six kilometers south-southwest of Pinehurst are **Walnut Springs (17)**, in Tom Marek's Walnut Springs subdivision. The water flow of 0.04 lps from Willis sand supplies a small pond on Marek's property.

Stagecoach Springs (16) are three kilometers southwest of Pinehurst in the Stagecoach Farms subdivision. The stagecoach from Anderson to Harrisburg probably stopped here in 1834 and later. Several springs in Hardin Branch produced a discharge of 1.3 lps on March 25, 1978, over the Lake Hardin spillway. According to writer Pearl Meath, several springs in the lake produce cool spots in summer. Nearby resident Roger McRoberts has explored several of these springs as well as others nearby on Sulphur Branch.

Sulphur Springs (15) were four kilometers southeast of Magnolia on Cecil Beyette's farm. An Indian village which once stood here is now beneath a small lake. The Anderson-to-Harrisburg stagecoach passed the springs. The several springs furnished water for an early sawmill, according to Beyette. They have been dry since the 1950s. Other springs upstream in Willis sand on Sulphur Branch still produce a winter discharge of 1.3 lps on the Beyette farm, but the creek has dried up in summer since 1968.

MOORE COUNTY

The springs of Moore County usually drain from the base of Tertiary Ogallala sand and gravel, which can be up to 230 meters thick. The formation dips gently toward the east. The springs normally pour from the Ogallala where it rests upon the underlying Permian shales and dolomites. In some cases they run from Triassic Dockum sandstone. Nearly all are in the southeast quarter of the county, where the plains break off toward the Canadian River (now Lake Meredith).

The springs have been used for at least 15,000 years by various ancient peoples beginning with the big-game hunters. Around 1,100 to 1,550 A.D. the Village agricultural people lived near the springs, probably using them for irrigation, and building permanent slab-rock houses. They were replaced by the Lipan Apaches, who divided their time between raising crops and hunting buffalo. Finally the Comanches took over the area.

Severe erosion due to overgrazing and plowing has left unsightly scars in the form of gullies. Sediment from

this erosion choked many channels and buried some springs. In addition the water table has declined sharply. In the 15-year period from 1956 to 1971, the average decline for the county was 10 meters. As a result, most of the springs have weakened considerably and many have dried up.

Although the buffalo, panther, and bear are gone, many other animals still depend upon the springs. These include mule and white-tailed deer, antelope, turkeys, quail, killdeers, waterfowl, bass, and catfish.

The spring waters are of a calcium bicarbonate type, generally fresh, alkaline, and very hard. The content of silica and fluoride may be high.

Most of the writer's field studies were made during the period June 3 - 8, 1978. As much rain had fallen during the preceding several weeks, the observed spring discharges may be considered to be above normal for this season.

North Palo Duro Creek was formerly fed by many springs. Marvin Harrison of Stratford recalls springs which flowed in the creek near Highway 287 in 1906.

Similarly, South Palo Duro Creek was once spring-fed. W. E. Ford of Sunray states that the creek flowed on Mrs. Carl McDowell's ranch, 17 kilometers east-southeast of Sunray (1), until about 1928, and contained many fish. Now there is no base flow.

Ten kilometers southeast of Dumas on the W. H. Coon ranch, numerous springs (8) appear on Big Blue Creek at an elevation of about 1,005 meters. A large Indian camp existed here. According to Collier Phillips of Dumas, there are also old Pueblo ruins downstream near Lake Meredith. G. L. Gillespie's 1875 *Map of portions of Texas, New Mexico, and Indian Territory* called these springs **Agua Azul**, or Blue Water. The water is no longer blue, being fouled now with sediment from farm land. In winter the creek flows from the springs to Lake Meredith. In summer, during the irrigation season, the discharge is much less, and most of Big Blue Creek dries up. A large cottonwood grove shades the springs, with several cattail-fringed lakes.

Five kilometers farther downstream, at the Robinett Camp on the Sneed Ranch, are **Riley Springs (6)**. They formerly supplied the ranch house here, but according to owner Elizabeth Sneed Robinett, they no longer produce the water that they once did. In 1978, 0.06 liter per second trickled from Ogallala sand in a springhouse. Mint and yellow cress fringe the water, shaded by a grove of huge cottonwoods. A windmill well above the springs steals water from them.

On Ludlow Creek, 12 kilometers east-southeast of Dumas, are **Ludlow Springs (5)**. They are on the W. H. Taylor ranch, leased by Harvey Garrison. About 3.2

lps issues from Ogallala sand amid rushes and yellow day primroses, shaded by cottonwood and other trees. According to Fred Squyres of Dumas, there was once a row of stones on the caprock to the north, pointing to the springs. Possibly early travelers placed them to assist others in finding the springs.

Four kilometers farther east are **Stage Stand Springs (4)** in a large grove of cottonwood and walnut trees. Dry now, the springs were in 1877 a welcome first stop out of Tascosa on the stagecoach run to Dodge City. A historical marker is located on Highway 152 five kilometers northeast. Old stone ruins still stand at the springs site. The creek channel is now largely filled with sand. Girl Scouts use the grove as a campground.

Farther east, 17 kilometers east-southeast of Dumas, are **Gober Springs (3)**. They are on the Sneed Estate, managed by Raynell Woodson. Around 1.9 lps runs from Ogallala sand on top of Permian Quartermaster shale. Here in 1898 Otis and Elvira Gober settled and planted the cottonwoods which still surround the springs.

Record Springs (2) are at the old Record house near the Hutchinson County line at latitude 35°44'. According to Delina Young, one of the owners, the springs flowed in a springhouse and provided water for the house and a school in 1897. They have not flowed in recent years.

In the southeastern corner of the county in several canyons now beneath Lake Meredith, there were many springs. Here several living sites of ancient people have been found. Bedrock mortars were found at the Osier site near springs in Martins Canyon. In these canyons also the Levertons, Spurllocks, and Foremans built their cabins near springs in the 1880s.

Spring Creek Springs (7) are on the Sneed ranch at latitude 35°44' and longitude 102°46'. On June 5, 1978, they produced 2.0 lps from Ogallala sand on top of Permian shale. Rushes line the stream, shaded by cottonwood and other trees.

Eighteen kilometers southeast of Dumas on the George Brown ranch are **Brown Springs (10)**. They appear where Grapevine Creek falls off the caliche caprock of the plains. According to Mrs. Brown, the creek formerly flowed continuously to the Canadian River. But on June 8, 1978, after much rain in the preceding few weeks, and five centimeters the previous night, there was only a flow of 0.10 lps in places and none in most of the channel near the springs, now buried in sand. Dark gray soils indicate that there was once a swamp here, now dissected by gullies. The creek banks are fringed with rushes, yellow ragwort, purple wine cups, and firewheels, shaded by cottonwood and

PLATE 1.



a. *Pedernales Spring (9), Blanco County.*



c. *One of the Krause Springs (9), Burnet County.*



b. *Water milfoil at Rebecca Springs (23), Comal County.*

d. *Main outlet of San Marcos Springs (1), Hays County.*

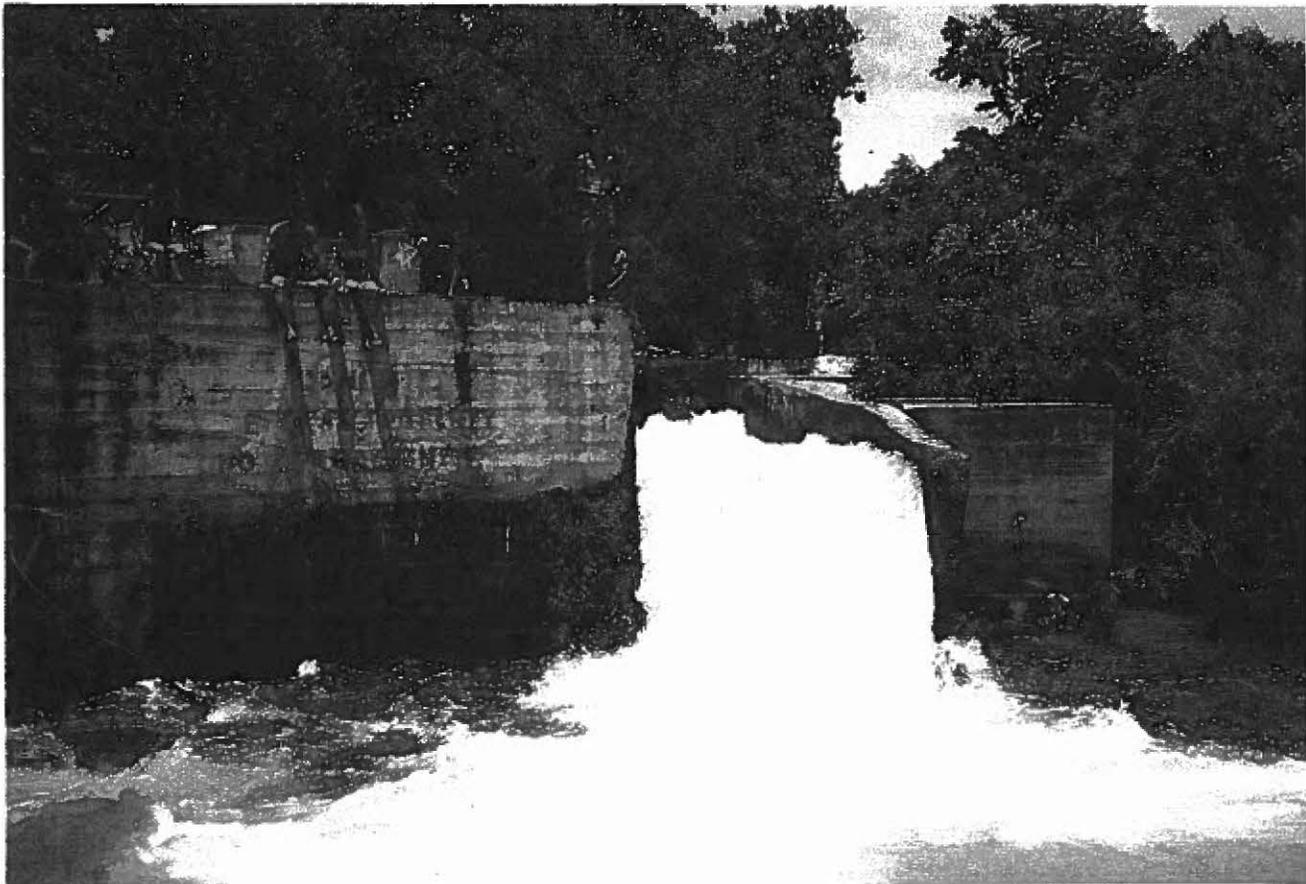


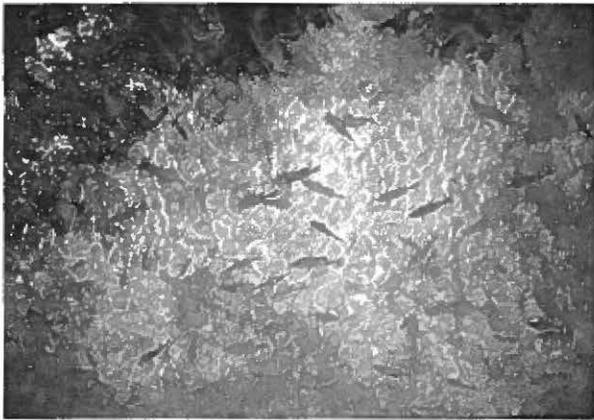
PLATE 2.



a. Spring-fed Burger Lake (5), Tarrant County.



b. Submerged limestone ledges, San Solomon Springs (15), Reeves County.



c. Fish in spring-fed reservoir, Ballard Springs (3), Motley County.



d. Ice-laden trees, Buzzard Roost Springs (29), Rusk County.

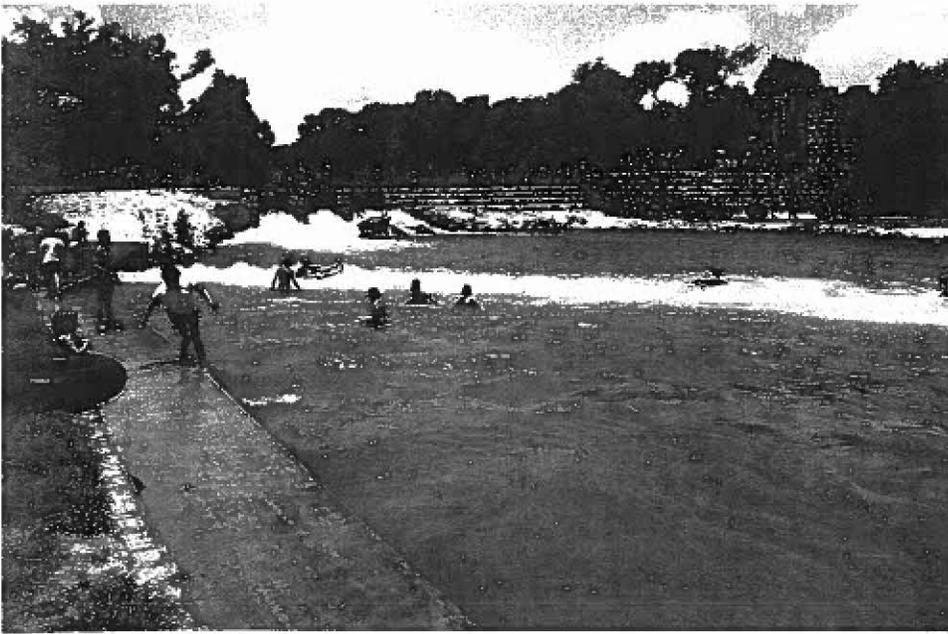


e. Site of the former Four-Mile Spring (3), Howard County.



f. Orange iron-bacteria deposits in Crumpler Springs (17), Tyler County.

PLATE 3.



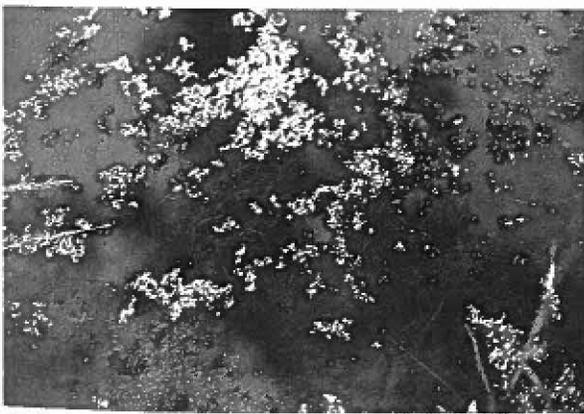
a. Clemens mill dam below Comal Springs (29), Comal County.



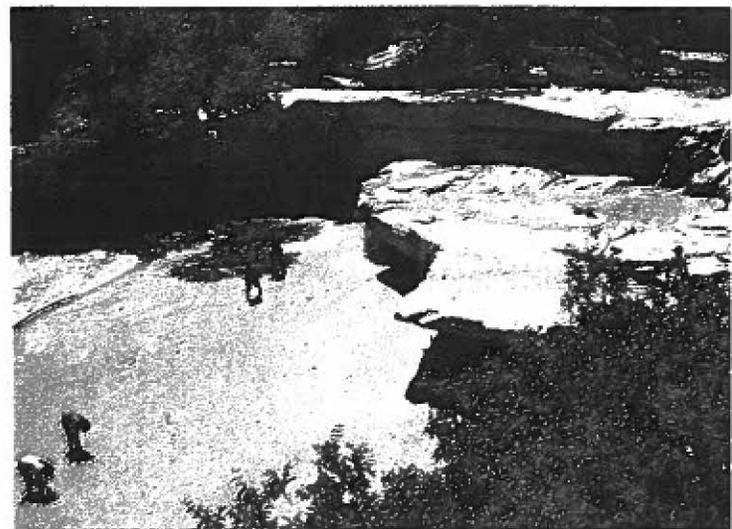
b. Childers Springs (8), Bell County.



c. The monument which guided early travelers to Monument Hole Springs (4), Foard County.



d. Duckweed at Cold Springs (14), Lipscomb County.

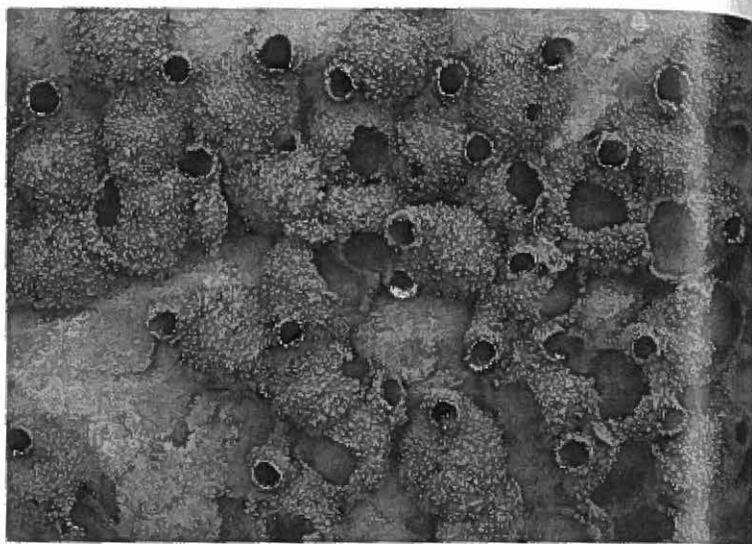


e. Site of Silver Falls, formerly fed by springs, Crosby County.

PLATE 4.



a. Waterfall and stalactites at Dead Man's Hole (11), Hays County.



b. Swallow nests on cliff at Rocky Dell Springs (21), Oldham County.



c. Salt-encrusted vegetation at Balch Springs (5), Gaines County.



d. Water hyacinths in pond at Smith springs (5), Galveston County.



e. Inflated duckweed at Sherley Springs (14), Hopkins County.



f. Frying Pan ranch manager Robert Groves at Tecovas Springs (10), Potter County.

PLATE 5.



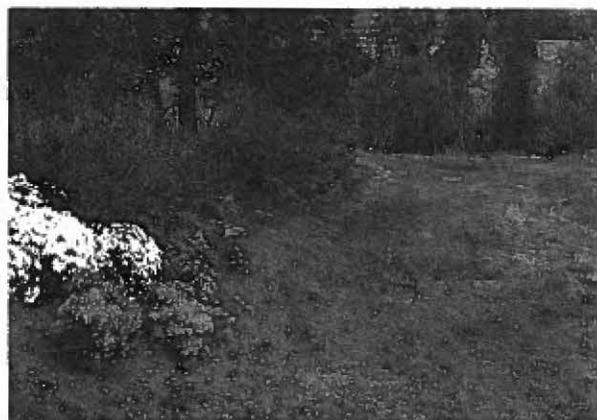
a. Boykin Springs (2), Jasper County.



b. Snow Springs (12), Upshur County. Note open area in pond ice where the springs rise.



c. Shirley Kennedy and pictographs at Meyers Springs (20), Terrell County.

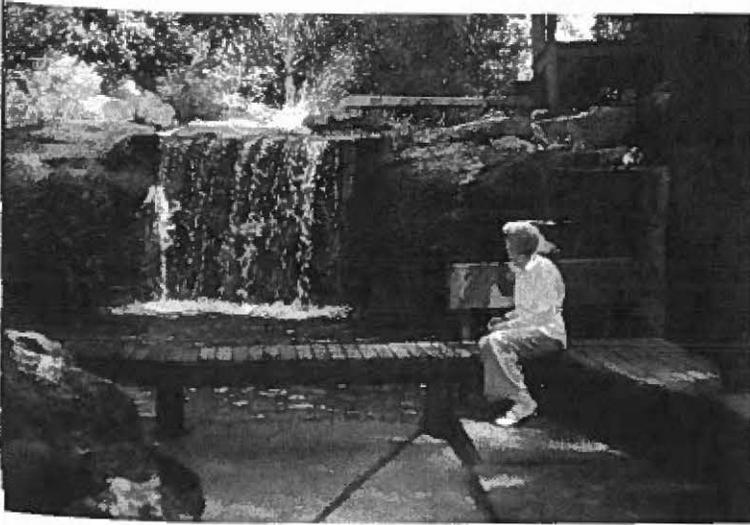


d. Azaleas at Smith Springs (7), Harris County.



e. Tadpoles at Blue Hole Springs (2), Armstrong County.

PLATE 6.



a. Waterfall at Roaring Springs (1), Motley County.



b. Lily pads at Holly Springs (9), Wood County.



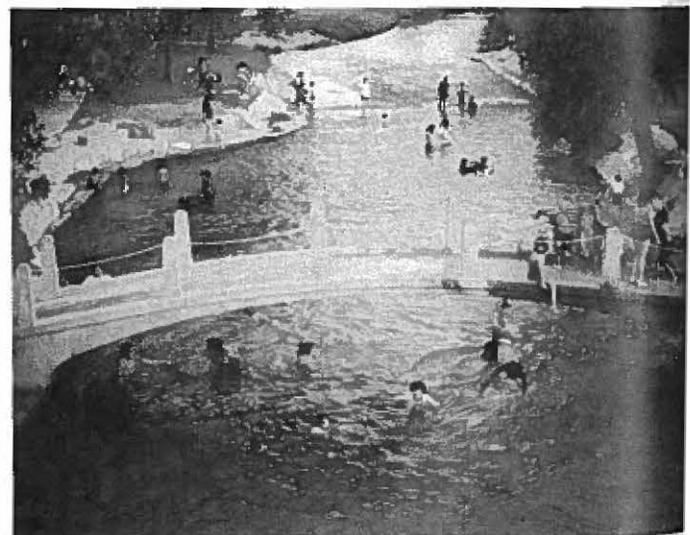
c. Slides and steps at Greene Springs (1), Scurry County, used by Indian children long ago when water flowed over these rocks.



d. Chorro Canyon below Madrid Springs (56), Presidio County.

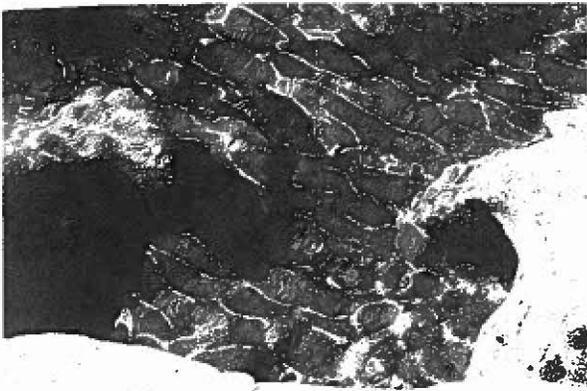


e. Sandstone canyon draped with maidenhair ferns at Indian Springs (6), Parker County.



f. Swimming pool fed by San Felipe Springs (1-10), Val Verde County.

PLATE 7.



a. Spring water in Frio River near Cold Springs (22), Uvalde County.



b. Archeological dig near Massie Springs (1), Floyd County.



c. Bathing pool at Boquillas Hot Springs (6), Brewster County.

d. Spring waters dripping from stalactites fringing the rock shelter at Hamilton Pool (2), Travis County.

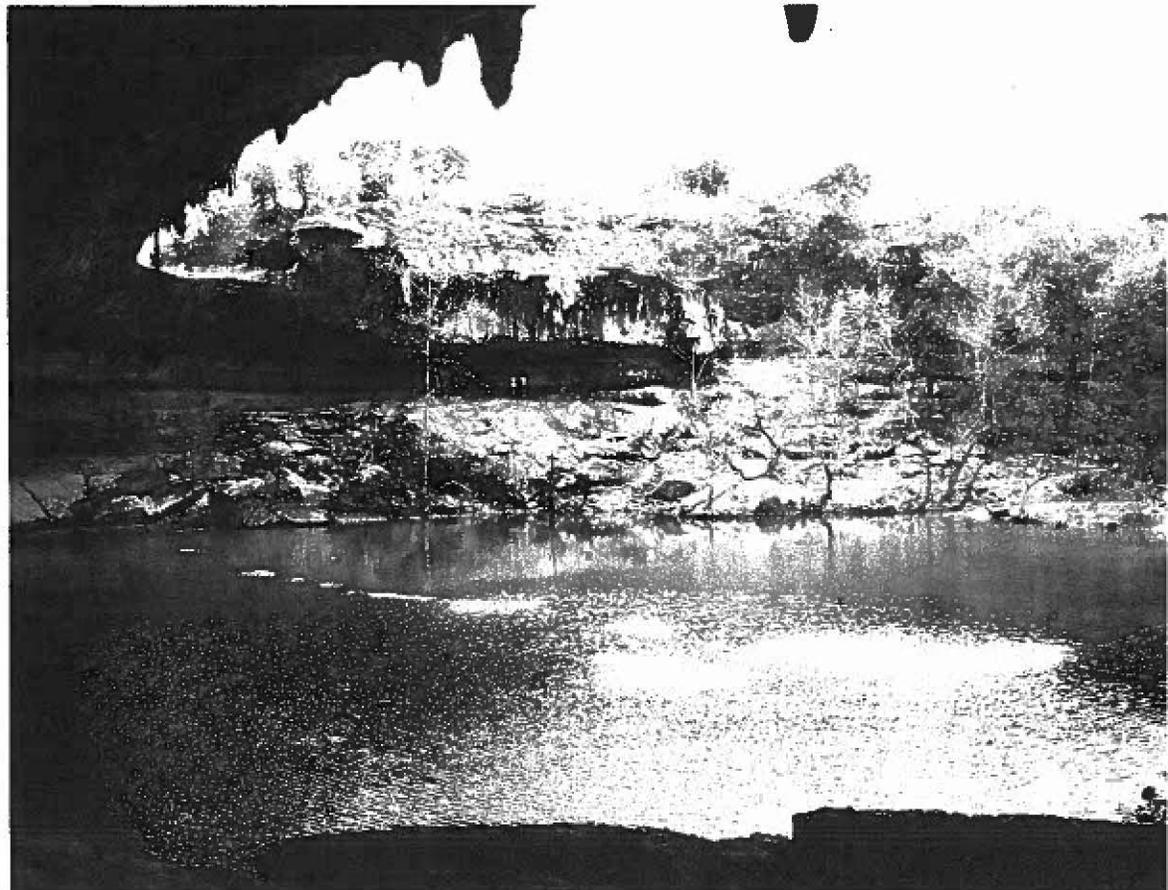
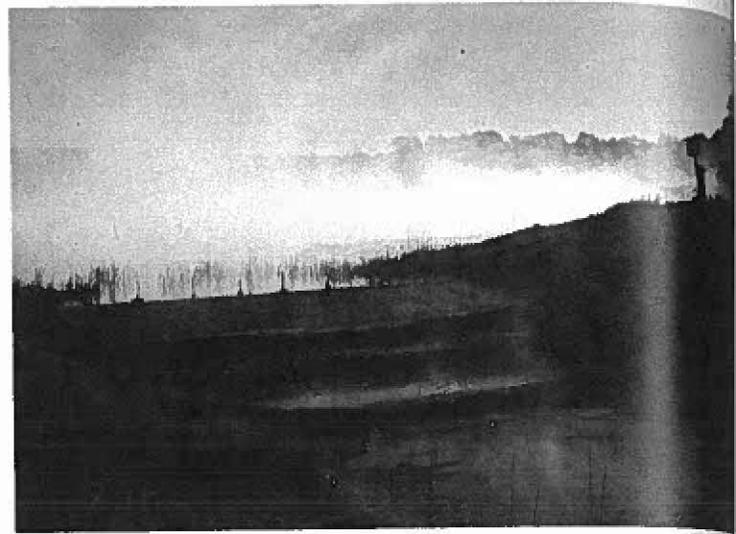


PLATE 8.



a. Pool constructed over Estelline Salt Springs (11), Hall County, to prevent outflow of salt water.

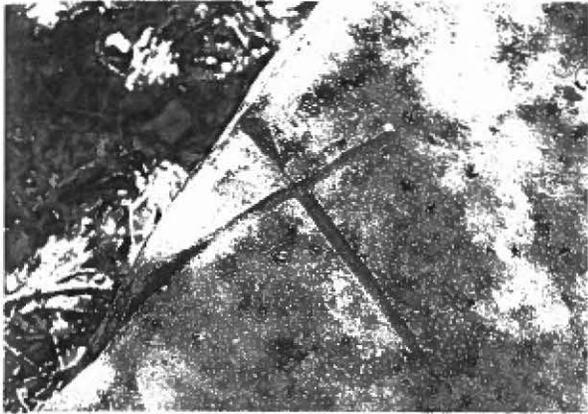


b. Steam rising from spring-fed lake at Big Woods Springs (13), Wood County.

c. Falls on Miller Creek, Blanco County, below which Mill Seat Springs (10) pour out.



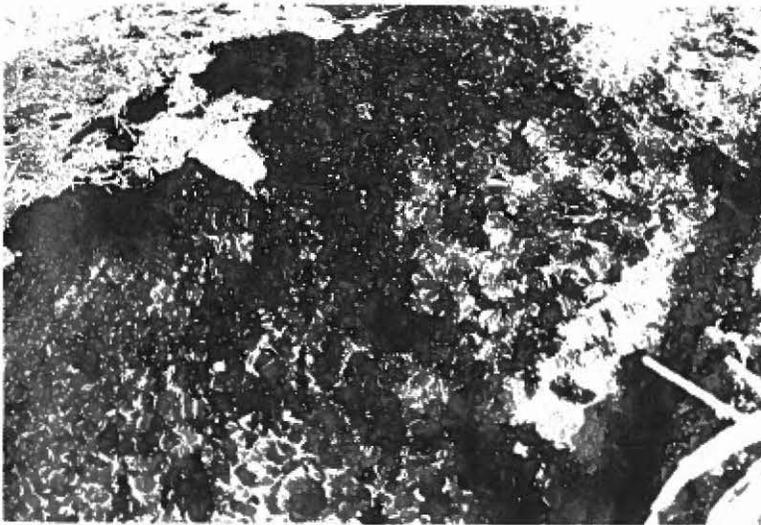
PLATE 9.



a. Shaft-straightening grooves in sandstone at Harrell Springs (13), Armstrong County.



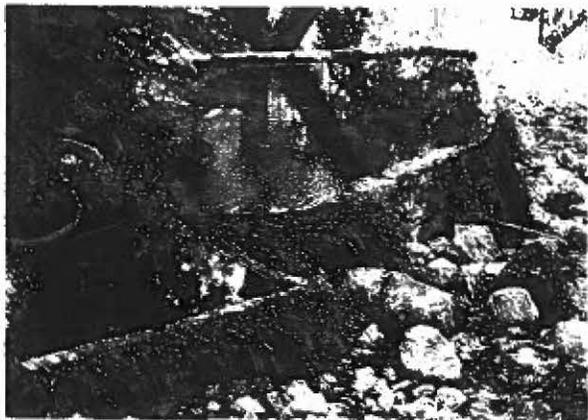
b. Beaver pond at O'Hair Springs (4), Collingsworth County.



c. Algal Growths in Hanna Springs (6), Lampasas County.



d. Cooper Springs (9), Garza County.

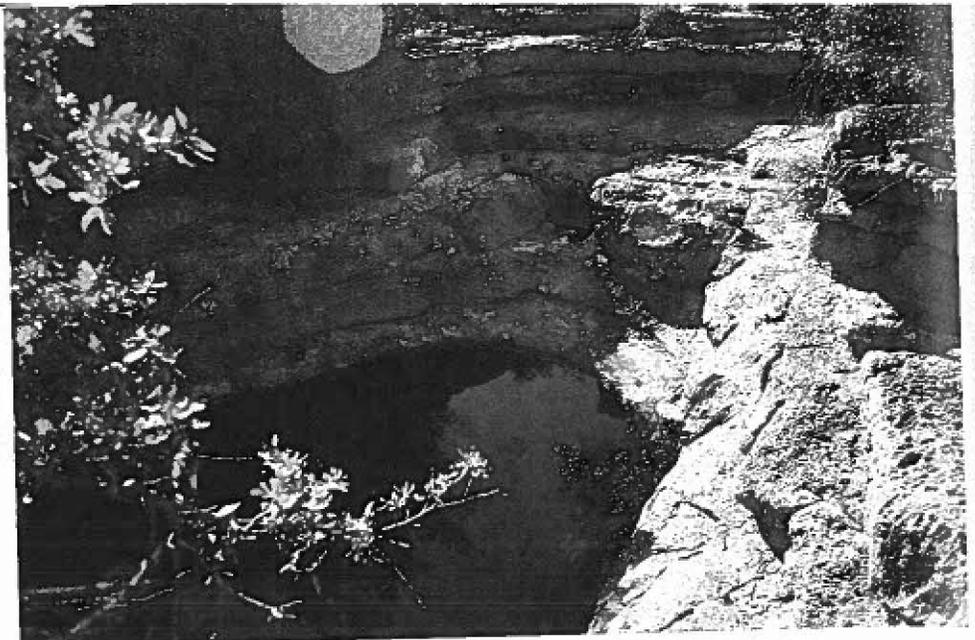


e. Maidenhair ferns draping pool walls at Fern Bank Springs (5), Hays County.



f. Pool and part of the outflow of Las Moras Springs (13), Kinney County.

PLATE 10.



a. Escondido Water Hole (4), Crockett County.



b. Watercress-covered Storey Springs (1), Caldwell County.



c. Red marsh purslane in Concan Springs (23), Uvalde County.

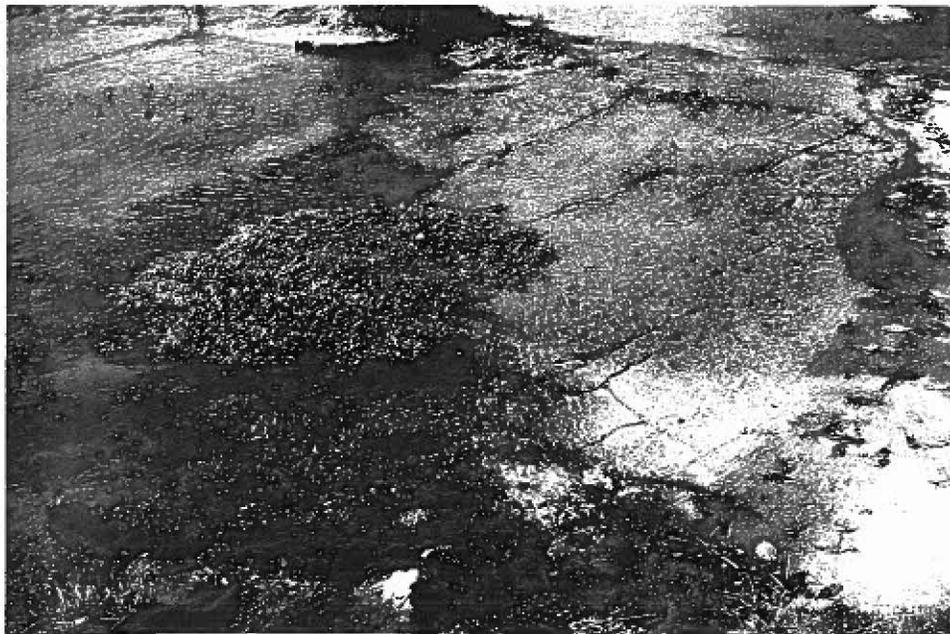
d. Park at Rock Springs (2), Harrison County.



e. Dickens Springs (3), Dickens County.



PLATE 11.



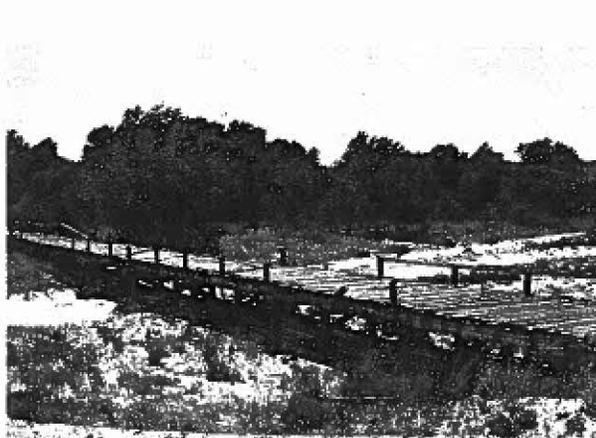
a. Logan Springs (5), in the North Llano River, Sutton County.



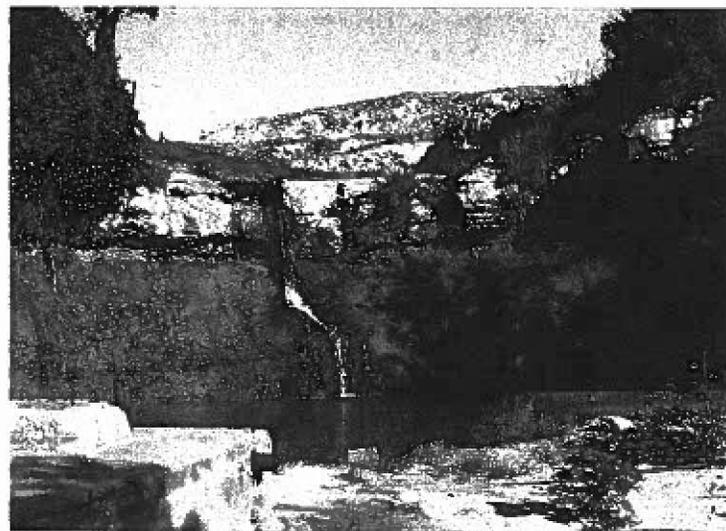
b. Irises at Alleyton Springs (4), Colorado County.



c. Roadside park at Crystal Springs (11), Franklin County.



d. Abandoned bridge over formerly spring-fed Wagon Creek, Roberts County.



e. Falls at Forty-two Steps Springs (6), Hutchinson County.

PLATE 12.



a. Discharge from Wolf Springs (7),
Terrell County.



b. Kickapoo Springs (15), Edwards County.



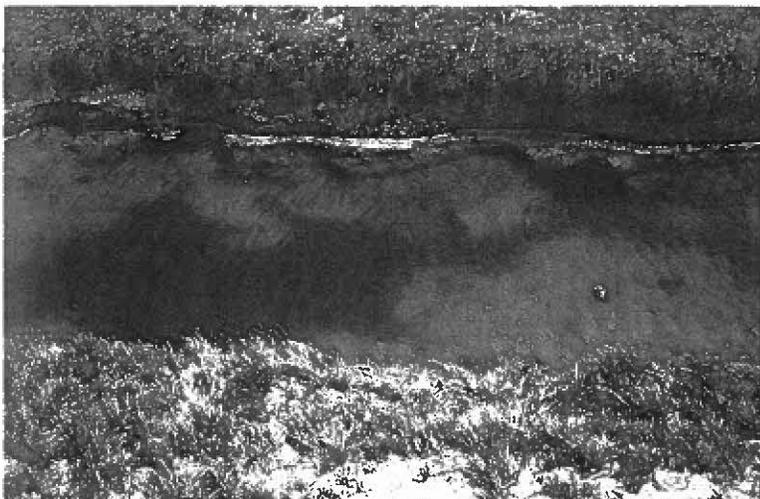
c. Cold Springs (22), Uvalde County



d. "The world's longest footbridge" in Rusk,
Cherokee County.

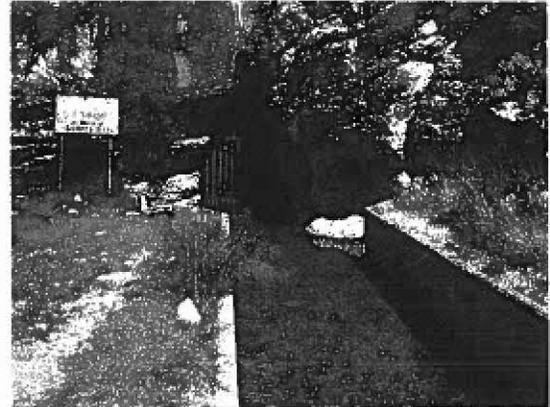


e. Yellow daisies and an ancient bedrock mortar hole at
Camp Springs (2), Scurry County.

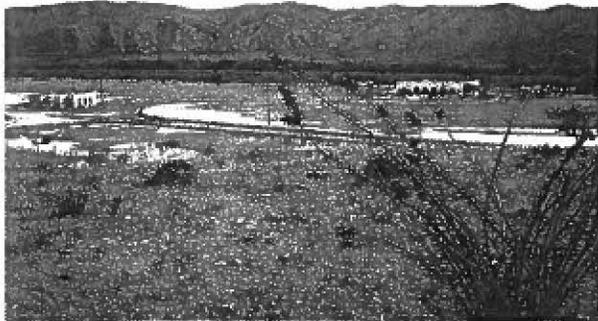


a. Green, gypsum-charged water of Maverick Springs (19), Culberson County.

PLATE 13.



b. Phantom Lake Springs (12), Jeff Davis County, supplying irrigation canal.



c. Indian Hot Springs (2), Hudspeth County.



d. Seep water rich in iron bacteria, Austin County.

e. Mammoth leg bone at Mullins Springs (2), Dawson County.



f. Vegetation in Big Boiling Springs, Salado Springs (2), Bell County.

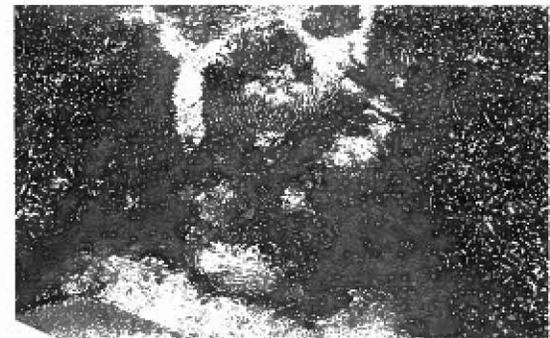


PLATE 14.



a. Salt-encrusted floodplain at Haystack Brine Springs (7), King County.



b. Geese and ducks at spring-fed City Park Lake, Childress Springs (8), Childress County.



c. Cannas and ferns at Crofts Springs (3), Blanco County.



d. Abandoned hydroelectric power dam at Hueco Springs (28), Comal County.



e. Site of former Big Springs (4), Howard County.



a. Saw-leaf daisies at Condon springs (49), Spring Hill, Wilbarger County.

PLATE 15.



b. Redbud trees on Spring Branch below One Seventy-seven Springs (9), Montgomery county.



c. Petroglyphs of serpents at the site of former Flat Rock Springs (3), Upton County.



d. Earth tank at Buffalo springs (7), Dallam County.

e. Rancherías Springs (19), Presidio County.



f. Ables Springs (2), Kaufman County.

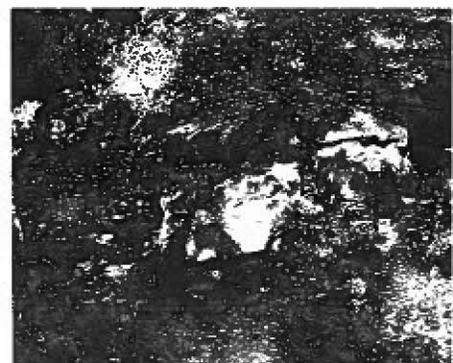
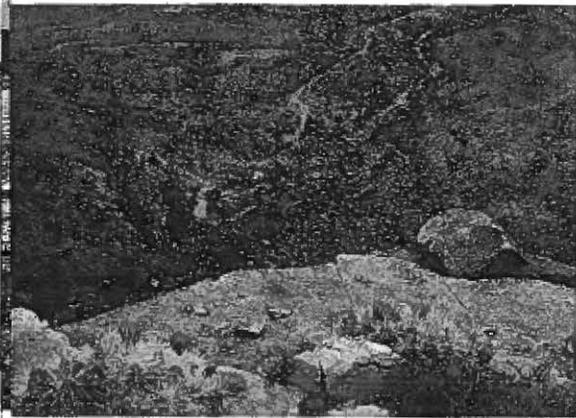


PLATE 16



a. Eagle-claw cactus blossoms on the bluff above Thaxton Springs (20), Hudspeth County.



b. Abandoned gazebo at Midyett Springs (3), Panola County.



c. Pennywort and other vegetation in Union Springs (11), Hopkins County.

d. Steam rising from Llano Springs (4), Edwards County, on a cold winter day.



e. The remains of Las Lenguas Falls (13), Briscoe County.



willow trees. Bullfrogs and snapping turtles live here, and raccoon and ringtail tracks are numerous.

Vincent Springs (12) are 18 kilometers east-northeast of Masterson. They feed Spring Creek on the Weymouth ranch, managed by Ollie Phillips. Numerous tools and projectile points of varicolored Alibates chert bear evidence that ancient people lived here for thousands of years. On June 8, 1978, 3.7 lps poured from Ogallala sand and steeply dipping, faulted Triassic sandstone, flowed 500 meters through a bog, and fell over an outcrop of Permian Alibates dolomite which dips steeply downstream. About 0.55 lps reached the mouth of Spring Creek. According to Phillips, the springs falter when heavy irrigation pumping is in progress to the northwest. Two old bridges, upstream from the present springs, are no longer needed and are bypassed by the ranch road as the flow is no longer as plentiful as it once was. The bog is filled with rushes, cattails, ferns, and cresses, shaded by cottonwoods. Tadpoles swim in the pools and killdeers screech nearby.

North Plum Springs (9) are 12 kilometers east-northeast of Masterson on North Plum Creek on the Brent and Smith ranch. In 1845 Lt. James Abert and company camped near here. He reported that a Kiowa camp was 0.4 kilometer upstream. The discharge in 1978 was 0.65 lps from Ogallala sand and Triassic sandstone on Permian shale. According to Philip Brent, the springs are drying up because of irrigation pumping.

South Plum Springs (11) are eight kilometers east-northeast of Masterson on South Plum Creek. Similar to North Plum Springs, they poured out 2.5 lps among many cottonwoods in 1978.

MORRIS COUNTY

Most of Morris County's springs issue from Tertiary Eocene sands, especially the Weches, Queen City, Reklaw, and Wilcox formations. The water-bearing sands dip toward the south at about 10 meters per kilometer.

The springs have been used by early Americans for at least 15,000 years. Ralph Nicholas of Daingerfield has found Paleo-Indian projectile points at various sites throughout the county.

Many springs may be found, but in this book only those of some historical importance have been included. In the southern end of the county the springs have been largely destroyed by iron strip-mining operations, reservoirs, mill tailings lakes, and industrial development.

The spring waters are usually of a calcium or sodium

bicarbonate type, quite fresh, soft, and acid. The iron and manganese content is often high. The writer's field studies were made primarily during the period December 10 - 14, 1977. As this was a rainy period, the spring flows observed are probably higher than normal for this season.

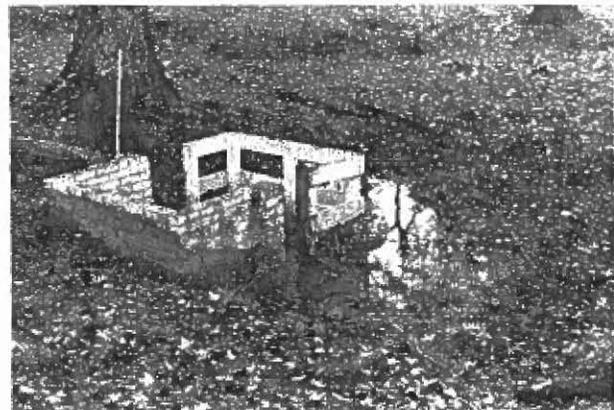
Daingerfield Springs (8) are just south of the intersection of Hughes Street and Highway 259 in north Daingerfield. There was an Indian village here, and naturally the Choctaws resisted when Capt. London Daingerfield and his company tried to take over the springs in 1838. Soon afterward the town began to form here, with most settlers using the springs until they could dig wells. In 1977 the springs trickled 0.15 liter per second into Calaboose Creek at an elevation of 135 meters. Originally the springs flowed in a ravine edged by sandstone ledges, but the original setting has now been covered by the highway.

Near Cramer Street and Highway 11 in southwest Daingerfield is another group of springs (7). Here Ben Gooch built a cabin in 1843. On December 13, 1977, they trickled 0.13 lps from Queen City sand, including some surface runoff from recent rains.

Seven kilometers southwest of Omaha, on Carl Davis' farm, are **Coffey Springs (14)**. Around the turn of the century they were very popular for outings and picnics. A cane syrup mill was located here. Now they are only seeps in pools from a thin layer of Wilcox sand on clay. Pine, birch, and other trees surround the site on Boggy Creek.

Three kilometers east of Omaha, in some woods on the east side of the Glass Club Lake, are **Glass Club Springs (13)**. Enclosed by a large semicircular stone wall, they formerly flowed at a higher elevation. In 1977 the discharge of 0.72 lps was used by some nearby homes. Several other springs feed the lake on the south and southwest sides.

Indian or Chalybeate Springs (9) are on the



Indian Springs.

Russell farm seven kilometers north of Daingerfield. Here several springs, some walled up, trickled 0.17 lps in 1977 in a pine wood. They were much used by early settlers in the area. They issue from Reklaw sand on ironstone ledges. As the name indicates, the water contains iron.

The **Spring Hill Springs (10)** are seven kilometers southeast of Omaha, on J. R. Traylor's property. Many projectile points and other artifacts found here indicate long use of the springs by early Americans. The first settlers arrived in 1852. Several springs, the largest 100 meters northeast of Spring Hill cemetery, discharged 0.55 lps from Queen City sand in 1977.

Last Chance Springs (11) are seven kilometers south of Naples on Lawrence McMichael's farm. Last Chance school was located 200 meters east. In the 1890s and later two boys were usually sent to the springs (then in some woods) for a bucket of water. The students all drank from a gourd. J. H. McDaniel, who lives nearby, went to school here in 1910 and later cleared the woods from around the springs. The several springs discharged 1.3 lps on December 13, 1977.

Four kilometers east-southeast of Daingerfield were **Hervey Springs (6)**, on Thurman Boyd's farm. The springs flowed 0.13 lps from sand on a ledge of iron ore in a gully in 1942. Now they are dry, the gully is partially healed and covered with woods, and moss covers the sand banks.

Six kilometers southeast of Daingerfield, on Gene Morris' property, are **Devil's Den Springs (12)**. In 1977 they seeped 0.07 lps from Weches sand on iron ore ledges in a rough area. The hills here have been strip-mined for iron ore and have since grown up in pines. State Park Lake, two kilometers northwest, is spring-fed.

Rock Springs (5) were near Rock Springs school seven kilometers northeast of Lone Star. The school is gone now, and the area has all been strip-mined for iron ore. The pools in the strip-mined pits are still fed by springs. About four kilometers west was the site of Peacock's mill in 1849, powered by spring-fed waters.

Turner Springs (3) were three kilometers east of Lone Star. They were known for their mineral content, and probably were used by travelers on Spearman's ferry to the southwest. In the 1840s an old settler was killed and thrown into the springs. In 1942 they produced 0.063 lps. Now they are beneath an ore plant tailings lake.

Iron Bluff Springs (2) are in Lone Star, 100 meters northwest of the City Hall in a wooded draw. An Indian village was located here. Two Indian mounds may still be seen as islands two kilometers north in

Ellison Creek Reservoir. The Iron Bluff community grew up around the springs. They were still very popular with the residents of the area in the 1920s, according to Tom Byrd of Daingerfield. In 1977, 0.15 lps flowed from Queen City gravel and sand.

Holt Springs (4) are four kilometers south-southwest of Daingerfield on Bobby Walker's property. The road passing the springs is called Whiskey Still Road, in memory of a still which once operated here. The fresh water flowed 0.31 lps in 1942 and about the same in 1977 from Weches sand. Many early residents of the area came here to wash clothes and obtain water. A former spring, now dry, issued from a large concrete pipe section a short distance downstream. Now the water appears beneath a sweet gum tree, and flows through woods of white oak, holly, black gum, and pine trees. The springs furnish domestic water to Walker's home.

Five kilometers southwest of Daingerfield, north of the old Sycamore school, are **Sycamore Springs (1)**. They flow from Queen City sand in a draw of mixed hardwood and pine trees. An orange deposit indicates that the water contains much iron. The school is now used as a hay barn. Discharge records in lps are:

March 13, 1942	0.03
August 27, 1963	0
December 12, 1977	0.50

MOTLEY COUNTY

Thousands of years ago prehistoric men and their families were living at and using the water from the springs in Motley County. Evidence of their occupation survives in the metates or bed-rock mortars which may be seen in the sandstone at Roaring Springs. These mortars were used to grind corn, hackberries, and other fruits and nuts. As one mortar hole became too deep to use easily, another was started. Thus the large group of grinding holes at Roaring Springs probably represents a considerable period of time.

In 1878 Dutchman, Mott, Chimney, Teepee, and many other creeks were beautiful running streams filled with perch and catfish. Wild plums, grapes, currants, black walnuts, and pecans were numerous. Cottonwood, willow, hackberry, mulberry, and chinaberry trees surrounded the springs. By 1914 many of the deep holes along the creeks were already filled with sand.

Nearly all of the springs in the county flow from the Ogallala sand and Triassic Dockum sandstone, which are in hydrologic contact. Because of heavy pumping, especially for irrigation, from the Ogallala, water tables

have fallen and spring flows have declined. Quitaque Creek was once considered as a water supply for Childress. In the late 1940s it was estimated that it could furnish 3,000,000 gallons per day (131 liters per second). Now its flow has been greatly reduced.

Most of the writer's field studies were made during the period December 6 - 11, 1975. As shown in the table of Selected Chemical Analyses, the spring water is of high quality. It is fresh, of the calcium bicarbonate type, very hard, and alkaline. The Roaring Springs analyses seem to show a slight deterioration in water quality between 1938 and 1962.

Ballard Springs (3), two kilometers south of Matador, are at the headquarters of the Matador Ranch, which in 1882 covered most of four counties. It is owned by Charles Koch of Wichita and operated by Dale Bumgardner. The springs were named for a buffalo hunter named Ballard who camped here in 1876. In early days bears, mountain lions, and wolves roamed the vicinity. A hydraulic ram formerly pumped the water from the 11 springs to the residences, mess house, stables, orchard, and garden.

Now Ballard Springs feed an earth stock tank which is full of large perch, bass, catfish, and turtles. (See Plate 2,c). The water is also used in the corrals. The springs issue from Dockum sandstone on Quartermaster shale, feeding Ballard Creek. Discharge measurements in lps are:

Nov. 8, 1939	0.95	Jun. 16, 1975	1.0
Jun. 5, 1968	0.95	Jul. 16, 1978	0.85

Priest Springs (8) are four kilometers southwest of Matador on the Matador ranch on Hackberry Creek. Joe Dean Bumgardner guided the writer to these springs, which issue from a cove of Dockum conglomerate and flow 400 meters through a swamp of cattails and rushes. The tract on which they flow was originally surveyed for Frank Priest. The springs supply domestic water to the ranch headquarters and stock water as far as 10 kilometers distant. Maidenhair ferns adorn the cliffs and boulders, shaded by hackberry trees. On August 13, 1978, the discharge was 1.3 lps.

Willow Springs (5) are six kilometers southwest of Matador. Longs Branch downstream was a favorite spot for swimming and fishing in early settlement days. Now there are bogs filled with cattails, rushes, and water parsnips, where minnows and frogs live. Discharge records in lps are as follows:

Sep. 17, 1938	1.5	Dec. 8, 1975	1.3
Jun. 5, 1968	0.31	Jul. 15, 1978	0.13
Dec. 20, 1968	1.3	Jul. 11, 1979	0.95

Dripping Springs (6) were 10 kilometers west-southwest of Matador, in the Matador ranch's Salt Creek pasture. Early-day picnics were popular here. The springs are now very dry.

Lost Canyon Springs (11) are nine kilometers west of Matador in Lost Canyon on L. B. and Lucretia Campbell's ranch. These small springs issue from Ogallala sand on Triassic shale. Many Indian projectile points have been found here.

Mott Camp Springs (7) were 17 kilometers west of Matador, in the breaks below the caprock of the High Plains at latitude 34°01' and longitude 101°00'. One of the first Matador ranch camps, around 1880, was established here. The springs were also a well-liked picnic area. The old stone wall which enclosed the springs may still be seen on the Burleson ranch, but in 1975 the springs were dry. In 1938 and 1968 the flow was 0.63 lps. Water still flowed in Mott Creek, about three meters lower than the former springs, in 1975.

Chimney Springs (14), two kilometers northwest of Mott Camp Springs, were also well known in early ranching days. They are now only wet-weather seeps.

Burleson Springs (4), 14 kilometers west-southwest of Whiteflat, were in the "breaks" just below the caprock of the High Plains. Because of heavy pumping of the Ogallala sands on the plains, the springs have ceased flowing. The recorded flow was 8.8 lps in 1938 and 1968.

Miller Springs (10) are 12 kilometers west of Whiteflat on J. M. and Marjory Hill's ranch, managed by T. W. and Juanita Jennings. The source of Miller Springs Creek, the springs produced 0.10 lps on July 11, 1979. The water ran about 50 meters down the canyon edged with vertical bluffs of sandstone. The springs flow all year, according to Jennings. Many bedrock mortar holes have been left here by a prehistoric people. More recently names and dates have been carved in the rock. An old watering trough was once fed by the springs. Maidenhair ferns drape the rocks amid dripping springs. Rattlesnakes are numerous amid the rushes and cattails. Cottonwood trees, plum thickets, and grapevines shade the pools.

About 500 meters downstream are the stone ruins of the old Miller house. Two kilometers southeast of Miller Springs were other springs until around 1940. The remains of an Indian village were still located here when the first settlers arrived. Dark gray soils indicate a former swampy area near the village.

Teepee City (12) is marked by a granite monument near the junction of Teepee Creek and the Middle Pease River, at latitude 34°06' and longitude 100°34'. On July 11, 1979, both of these streams were dry, but