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TEXAS BOARD OF WATER ENGINEERS

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BRINE PRODUCTION AND DISPOSAL ON THE LOWER WATERSHED OF CHAMBERS AND RICHLAND CREEKS, NAVARRO COUNTY, TEXAS

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with
a section on the quality of water

by

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BRINE PRODUCTION AND DISPOSAL ON THE LOWER WATERSHED OF CHAMBERS AND RICHLAND CREEKS, NAVARRO COUNTY, TEXAS

ABSTRACT

Navarro County, which is located on the blacklands of North-Central Texas in the Trinity River watershed, had a population of 39,916 in 1950. Its economy is based primarily on oil production, agriculture, and manufacturing. This report covers an area of about 270 square miles in the south-central part of the county.

The area of investigation is underlain by sedimentary rocks consisting of alternating beds of glauconitic sandstone and shale and a locally thin limestone, which belong to the Gulf Series of Cretaceous age and the Midway group of Tertiary age which dip at approximately 115 feet per mile until interrupted by a huge structural graben in the center of the area. The principal brine producing strata are the Woodbine formation, the Nacatoch formation of the Navarro group, the Wolfe City sand, Pecan Gap Chalk of the Taylor group, and the Pettet member of the Glen Rose formation. Approximately 88% of the total daily brine yield of 95,300 barrels is from the Woodbine formation - about 76% is produced from the Powell-Woodbine field alone. The remaining 12%, excepting 45 barrels from the Pettet member of the Glen Rose formation, is extracted from the shallower horizons.

Approximately 83,700 barrels of the total daily brine yield (95,300 barrels) is disposed of on the surface. Most of the brine drains directly to tributaries which flow into Chambers and Richland Creeks. The remaining 11,600 barrels is directed to the subsurface through injection wells partially for disposal but mainly to induce a stronger water drive to oil wells in order to facilitate production. The largest volume of brine disposed of to the surface occurs in the Powell-Woodbine field and is diverted to Crab and Cedar Creeks at the rate of approximately 61,550 barrels per day.

Variations in the quality of water occur throughout the Corsicana area. Concentrations of total solids range from 3,800 to 30,000 ppm in the Woodbine, to 34,790 to 39,727 ppm in the Wolfe City sand. An analysis of produced brine from the Powell-Woodbine field, which contributes 76% of the total yield in the area, indicates concentrations of about 13,800 ppm total solids and 7,400 ppm chloride ion. This concentration represents 60 to 70% of the total calculated mineralization reaching the watershed. The chloride ion in formations stratigraphically above the Woodbine formation contributes 55 to 65% of the total dissolved solids concentration of the brine produced from those horizons.

A total average quality of brine received by the watersheds, inclusive of all contributing horizons, is computed to be 15,174 ppm total solids and 8,245 ppm chloride ion. Calculations based on weighted average analyses show that approximately 223 and 121 tons per day of these constitutents respectively reach the drainage.

The total amount of mineralization in the flow of Richland Creek at points below its confluence with Chambers Creek is derived from disposed oil field brines and the minerals in natural runoff on the watersheds, Calculations based on averages determined from flow measurements and analyses of samples at a point 5 miles downstream from the confluence of the two streams indicate an average daily increment of minerals passing this point to be 1,049 tons of total solids and 275 tons of chloride ion of which increment approximately 827 tons of total solids and 154 tons of chloride ion were estimated to have been contributed by natural runoff. It is possible, however, that the runoff sampled under flood conditions prevailing in 1957 contained abnormal releases of impounded brines and mineralization from the leaching of brine saturated soils in areas where surface disposal had been practised in the past.

INTRODUCTION

Purpose and Scope

This investigation was undertaken to obtain pertinent data about mineral contamination of ground and surface water resulting from disposal of oil field brines on the lower watershed of Chambers and Richland Creeks, Navarro County, Texas. This contamination problem is of particular concern to the Board of Water Engineers, which agency is jointly responsible with the Railroad Commission and the State Department of Health to protect the quality of water resources of the State. The investigation was made in cooperation with the City of Fort Worth, which is planning a long-range, surface-water development program on this part of the watershed.

The report tabulates the amount of brine produced from oil fields in the area, describes geologic horizons from which oil and brine are produced, enumerates and discusses methods employed to dispose of brine, and describes the chemical character of the brine in relation to the amount produced and disposed on the watershed. The report also includes a tabulation of tank batteries at which oil and brine are separated (table 2); flow measurements in Crab and Cedar Creeks (table 4); a map showing the locations of the tank batteries, sampling stations, and other features described (plate 1); a map showing the location of tank batteries in the City of Corsicana (figure 3); a cross section showing the generalized subsurface geology (plate 2); and chemical analyses of water from five surface stations and from four subsurface horizons (table 5).

Location and Extent

This investigation covers about 270 square miles in Navarro County. Navarro County is situated on the blacklands of north-central Texas in the Trinity River watershed, and is bounded on the north by Ellis and Henderson Counties, on the west by Hill County, and on the south by Limestone and Freestone Counties (figure 1).

There are six oil fields in the area of study: (1) Corsicana Shallow, (2) Powell-Woodbine, (3) Richland, (4) Currie, (5) Reka, and (6) South Kerens (plate 1). The Corsicana Shallow field extends from the city limits of Corsicana approximately eight miles north, east, and south. The producing limits of the field include, by arbitrary definition, and productive oil horizon of the Gulf Series of Cretaceous age younger than (stratigraphically above) the Woodbine formation. The Powell-Woodbine field is an elongate area, 1 mile wide by 7 miles long, about 6 miles southeast of Corsicana, producing from the Woodbine formation. Considerable study was made of the production of fluids from this field because of the unfavorable oil-brine ratio. The Richland and Currie fields are southwest extensions of the Powell-Woodbine field. Their locations are approximately 12 miles and 17 miles southwest of Corsicana, respectively. Each covers an area of about one square mile and produces from the upper part of the Woodbine sand. Of lesser importance is the Reka field, approximately 16 miles southeast of Corsicana, which produces oil from the Pettet member of the lower Glen Rose formation of the Comanche Series of Cretaceous age. The South Kerens field, in south-central Navarro County, $4\frac{1}{2}$ miles north of the Reka field, produces from the Woodbine formation. Most of the brine produced is reinjected in waterflood operations.

GEOGRAPHY

Topography, Vegetation, and Drainage

The land surface of the Trinity River watershed in this area is flat to gently rolling and slopes generally southeast at about 8 feet per mile. The total relief is approximately 330 feet, with a range in altitude from 270 to 600 feet. Topographic features include a prominent westward facing escarpment capped by Tehuacana limestone of the Kincaid formation, the channels of minor streams, and the broad, shallow, alluvial floodplains of Chambers and Richland Creeks.

Black and Grand Prairie grasses comprise the principal vegetation of the area, except for the Trinity River floodplain in the extreme eastern part of the area where a heavy growth of oak is found. The blackland soils support pasture and meadow grasses, including big and little bluestem, indian grass, sideoats grama, and switch grass. Scattered oaks grow along the streams in Navarro County, and some salt tolerant grasses are found along tributary drainage.

Most of the area is drained by Chambers and Richland Creeks, which rise in Hill and Ellis Counties, respectively, and flow southeasterly across Navarro County. They meet about two miles north of the Freestone County line, and flow into the Trinity River.

Crab and Cedar Creeks in the central part of the area are continuously supplied by brine produced from the Powell-Woodbine field, otherwise they would flow only during and immediately after periods of precipitation.

Climate

The climate of Navarro County is humid and temperate, characterized by hot summers and mild winters. According to records of the U. S. Weather Bureau, the 78-year average annual precipitation at Corsicana is 36.5 inches (figure 2), and the mean annual temperature for the same period is 66.3 degrees. Annual precipitation and cumulative departure from the average are presented graphically in figure 2. Rainfall from 1947 to 1956 averaged 29.78 inches, which is less than recorded for any other period of 10 consecutive years (figure 2, A).

The evaporation rate in the area is recorded by Bloodgood and others (1954) on a map comparing evaporation losses from free-water surfaces with rainfall by a series of isograms. The 60-inch isogram is drawn through the western part of Navarro County.

Economy

The economy of Navarro County is based on oil production, agriculture, and manufacturing. The production of crude oil in 1956 was 2,522,600 barrels, which contributed approximately $12,000,000 to the annual income. Cotton, corn, and small grains are the principal crops grown in the county; and beef cattle, dairying, and poultry raising are important agricultural activities. Industrial manufacturing at Corsicana includes the manufacture of oil field machinery, cotton textiles, clothing, hats, and plastics.

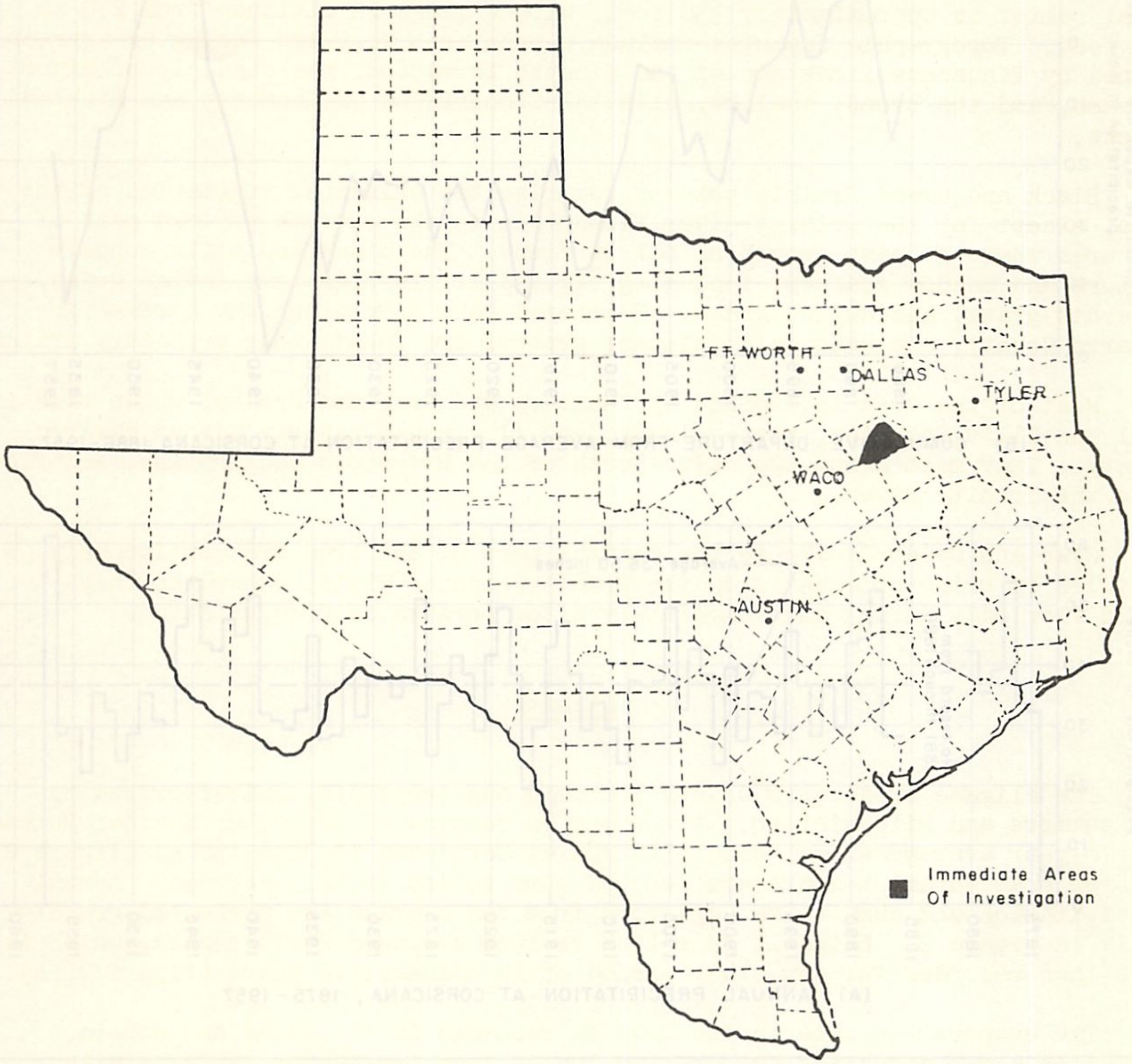

FIGURE I. - MAP OF TEXAS SHOWING AREAL EXTENT OF INVESTIGATION WITH RESPECT TO NAVARRO COUNTY AND PRINCIPAL SURROUNDING CITIES

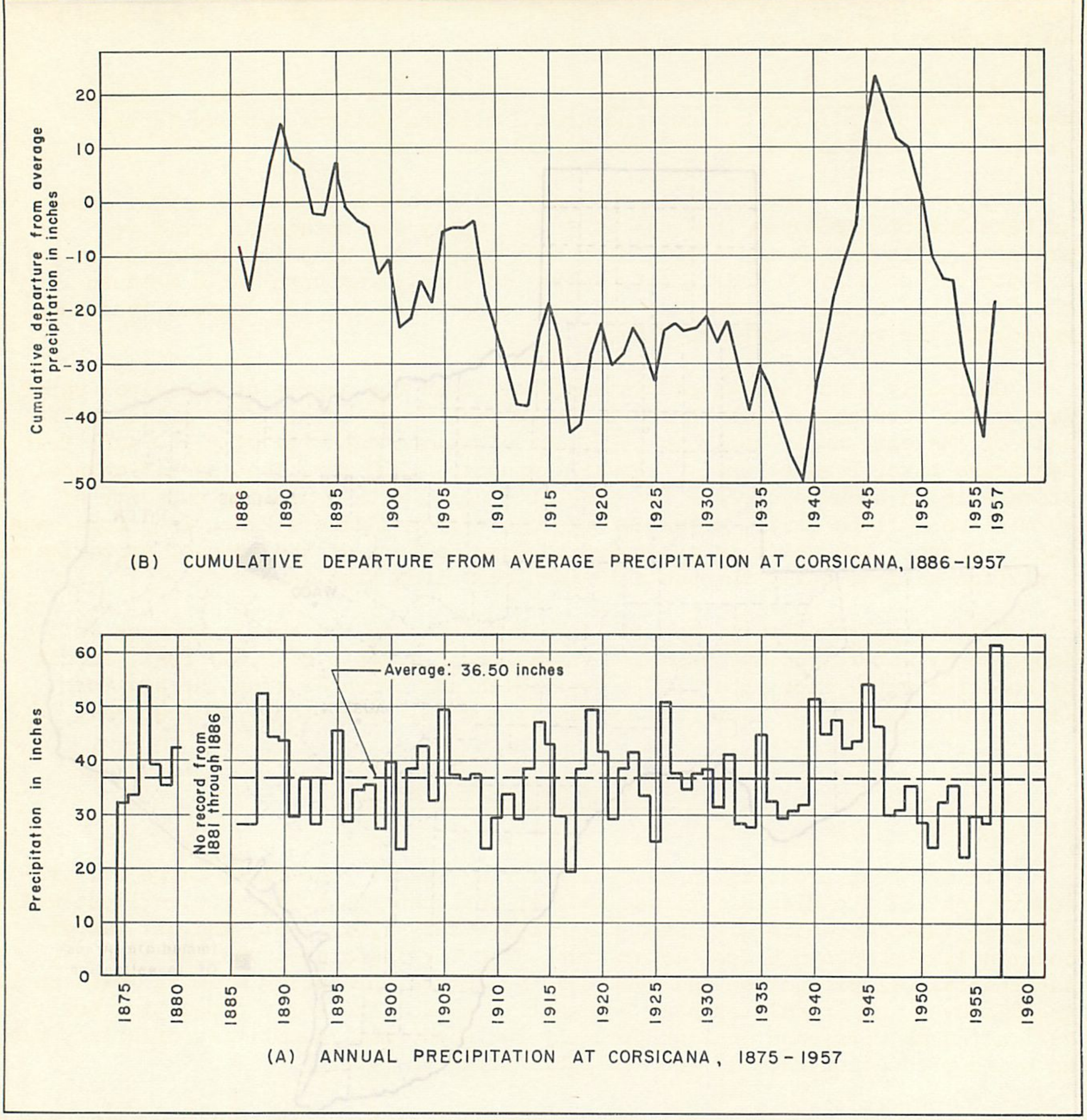

FIGURE 2 – ANNUAL PRECIPITATION AND CUMULATIVE DEPARTURE FROM THE AVERAGE AT CORSICANA, TEXAS

According to the U. S. Bureau of the Census, Navarro County had a population of 39,916 in 1950, of which 19,211 resided in Corsicana. Corsicana had an estimated population of 25,000 in 1956.

Municipal water use and supply.- Corsicana has a treated water storage capacity of 5.5 million gallons and uses 2 million gallons per day in the winter to 4 million gallons per day during the summer.

Prior to 1894, the city water supply was obtained from a reservoir known as Lake Beaton. Between 1894 and 1923 the supply was obtained from five artesian wells within the city limits that tapped the Woodbine formation at a depth of about 2,500 feet. This source of supply was unsuitable because the water was highly mineralized and the temperature was 120 degrees Fahrenheit. Moreover, the wells ceased to flow.

Currently a surface-water system constitutes the source of municipal water supply for Corsicana: Lake Halbert, an impounding reservoir five miles southeast of the city hall, built in 1923, has a maximum capacity of 9,350 acre feet. Corsicana Lake, 2 miles west of Powell impounds 4,000 acre feet of off-channel storage in an unnamed creek. Two low-lift pumps, with a pumping capacity of 30 million gallons daily, divert flood runoff from Chambers Creek into Corsicana Lake. Thence, the water is conducted to Lake Halbert at the rate of approximately 4 million gallons daily through a 16-inch cast iron pipeline.

Wells supply water to the smaller communities in the area. Emhouse is supplied by water from the Woodbine formation at a depth of 2,017 feet, Purden by Woodbine water from about 1,774 feet, Richland by water from the Nacatoch sand at a depth of 109 feet, and Eureka from a well reportedly 50 feet deep.

HISTORY OF OIL DEVELOPMENT

Oil has been produced in this area for 63 years. The first large oil discovery west of the Mississippi was made at Corsicana in 1894. The earliest wells produced from the Wolfe City sand at approximately 1,027 feet, and oil was discovered in the Nacatoch soon afterwards. The Corsicana area was the site of substantial oil production and remained the largest producing area in Texas until the discovery of Spindletop near Beaumont in 1901. The early production now designated as Corsicana Shallow probably included small quantities of brine, but no brine production records are available prior to 1921.

Between 1921 and 1924, oil was discovered in the Currie, North Currie, Powell-Woodbine, and Richland fields. During this period, which was prior to the establishment of the Railroad Commission in 1930, oil was produced without regard to well spacing or flow regulations. The peak oil production of 37,616,102 barrels for the entire area was reached in 1924. Of this total, 33,856,381 barrels were produced from the Powell-Woodbine field, along with 35,724,000 barrels of "salt" water. Since 1924 oil production throughout the area has declined rapidly, and the brine-oil ratio has increased in the Powell-Woodbine field from less than 1 percent in 1924 to 46 percent in 1949 to a reported 98 percent at the present time.

Drilling activities subsided until the discovery of the South Kerens field in March 1952 and the Reka field in May 1953. The initial yearly oil production was 27,433 barrels from the South Kerens field and 74,033 barrels from the Reka field, and by the end of 1957 the total cumulative production, as reported by the Texas Railroad Commission, was 2,131,103 and 769,050 barrels, respectively. No records of past brine production were obtainable for these two fields.

During the latter part of 1955 and early 1956 there was an oil boom in the city limits of Corsicana. City lots were hastily bought and sold to numerous individual operators throughout the eastern section of the city, and drilling began on individual city lots. Close spacing of the wells, without regard to flow rates, resulted in a rapid depletion of reservoir pressures and the wells rarely paid for the cost of drilling and operation. Plugging began in early 1957, and at present many wells are either inoperative or set on a vacuum, which is a common procedure during the latter phase of recovery in an oil field.

Three deep exploratory wells were drilled in 1957 and 1958, tapping the Smackover limestone of lower Cretaceous age at a depth of approximately 9,100 feet. One of these Smackover tests was "dry hole," one a gas well which was capped and never produced, and the third, drilled by the Texas Company, et al, on the Mary Cunningham lease, was plugged back and produced from the Woodbine sand.

GEOLOGY

Rocks in the area of study are sedimentary and consist of alternating beds of glauconitic sandstone and shale and locally thin fossiliferous marine limestone. The rocks belong to the Taylor and Navarro groups of the Gulf Series of Cretaceous age and the Midway group of Tertiary age (table 1). No recent surface maps of the outcrops of individual stratigraphic units were available for this study. Detailed discussion of the stratigraphy in the area is limited to geologic horizons that produce oil and brine. Strata older than the Woodbine formation are not included in table 1, because, except for the Pettet member of the Glen Rose formation, older formations do not presently yield oil or brine.

The regional dip of the strata is east-southeast at the rate of approximately 115 feet per mile (plate 2). The strata are displaced by faults in the Luling-Talco-Mexia fault system which trends north across the central part of the map area (plate 1). The rocks have been dropped and locally folded into a deep graben, and oil and brine have accumulated on both sides of the graben in favorable horizons. Oil wells range in depth from 522 feet in the Nacatoch sand to 3,904 feet in the Woodbine formation.

Pettet member of the Glen Rose formation

The Pettet member is a highly oolitic, gray, crystalline-to-fine textured limestone. Oil with a relatively small amount of brine is produced from the Pettet at depths ranging from 6,800 to 6,900 feet in the Reka field. The thickness of the formation in the Reka field was not determined, but electric logs of wells that penetrate the Pettet limestone in the South Kerens field show a thickness of about 180 feet. In the latter field, the formation has little porosity and yields no oil.

Table 1.-Geologic formations in Navarro County, Texas

System	Group	Formation and member		Thickness	Physical Characteristics	Water-bearing Characteristics
Quaternary		Alluvium		0-55'	Sand, gravel, clay, and silt.	Does not yield potable water in Navarro County.
Tertiary	Midway group	Wills Point Clay	Kerens member	0-50+	Dark gray silty sand sandy clay.	do
			Wortham member	0-1	Impure concretionary limestone consisting predominantly of aragonite arranged in rosettes.	do
			Mexia member	0-215	Dark, thinly laminated, compact fossiliferous clay.	do
		Unconformity				
		Kincaid formation	Tehuacana	0-50+	White to cream-colored, glauconitic, sandy, limestone, locally highly fossiliferous.	do
			Littig member	0-50	Fine-grained gray to white fossiliferous, glauconitic sandstone containing reworked Navarro shale boulders.	do
Unconformity						
Cretaceous	Navarro group	Upper-including the Kemp clay and the Corsicana marl undivided		0-275+	Shale, light gray silty calcareous locally containing lignite seams.	do
		Nacatoch formation		0-200	Fine to very fine grain subangular cherty phosphatic glauconitic sandstone interbedded with thick beds of light gray shale.	In the outcrop area yields small quantities of potable water that are used mostly for domestic purposes. The potable water zones are limited due to interfingering lenses of brine.
		Neylandville marl		0-140	Dark gray and greenish-gray calcareous clay, locally sandy, glauconitic and fossiliferous.	Does not yield potable water in Navarro County.

Table 1.-Geologic formations in Navarro County, Texas--Continued

System	Group	Formation and member	Thickness	Physical Characteristics	Water-bearing Characteristics
Cretaceous	Taylor group	Upper: Marlbrook formation	0-580	Tan fossiliferous calcareous marl, containing irregular beds of gray silty shale and fine grained glauconitic sandstone.	do.
		Upper: Pecan gap chalk	0-110	Highly fossiliferous, white chalk.	Yields small quantities of brine in association with oil.
		Lower: Taylor formation: Wolfe City member	200+	Fine-grained glauconitic sandstone.	do.
		Lower: Taylor formation: Undifferentiated	0-450	Light gray silty shale interbedded with a fine-grained glauconitic sandstone.	Does not yield potable water in Navarro County.
		Austin chalk	300-480	Soft gray fossiliferous chalk 30 feet thick weathered zone, at top. Contains several thin gray shale breaks. The lower part is composed of matted brown, and white shaly chalk.	Does not yield potable water in Navarro County.
		Eagle Ford shale	320-480	Dark gray to black thinly laminated shale containing thin beds of impure limestone.	do.
		Woodbine formation	272-650	Fine to medium grained sandstone, containing chlorite crystals along the upper contact. Contains thin lignitic shale lenses throughout.	Yields large amounts of brine with oil in the central and eastern parts of Navarro County. Small supplies of usable quality water are obtained from the Woodbine formation by municipalities in the western part of the county.
	Unconformity				

Woodbine formation

The Woodbine formation is encountered in wells throughout the area at depths ranging from 1,042 feet at Frost to 3,904 feet in the South Kerens field. The formation has a maximum thickness of 650 feet and is predominantly sand, but contains lenticular beds of shale and limestone.

Oil and brine from the Woodbine is produced mainly from a continuous bed of fine to medium-grained sand, 45 feet thick and lying about 60 feet below the top of the formation. This sand contains many shale breaks, but forms an oil production reservoir on the upthrown side of the Powell fault with a reported porosity of 28 percent and relatively high permeability. Wells yield oil and brine under similar stratigraphic and structural conditions in the Richland and Currie fields, which are southwest of the Powell-Woodbine field. In the South Kerens field, the Woodbine reservoir sand yields oil from a gentle anticlinal structure.

Pressure in oil reservoirs of the Woodbine formation is maintained by a strong water drive. Reservoir pressure remains constant, to the extent that the liquids involved are essentially incompressible. The result is a natural water flooding condition, and equilibrium is maintained by percolation of brine through the oil producing zone. When first drilled, the oil wells produced a relatively high recovery of oil, but ratios of oil production to brine soon became less favorable as oil pockets lost initial gas pressures and were flushed by brine percolation.

Taylor Group

Rocks of the Taylor group crop out along the western margin of the area, and are encountered in the subsurface east of the outcrop. These rocks consist mainly of shale with irregular beds of sandstone, marl, and chalk and are divisible into four stratigraphic units: the Marlbrook, Pecan Gap in the upper Taylor, Wolfe City, and an undifferentiated section in the lower part of the group (table 1). The combined maximum thickness of the Taylor group in Navarro County is 780 feet.

The correlation of stratigraphic horizons within the Taylor group of Navarro County is uncertain because of irregular distribution of the sands and complex faulting. Sands occur at various levels in the upper part of the Taylor, many of which are of local extent. The relative stratigraphic positions of the Pecan Gap and the Wolfe City may be observed in the cross section (plate 2). Other Taylor sands are not discussed further in this report, because no brine is produced from them in this area.

Pecan Gap chalk.- The Pecan Gap chalk crops out just west of the report area and is penetrated by wells at depths ranging downward to 2,200 feet throughout the area. The average thickness of the Pecan Gap chalk is approximately 70 feet. Small quantities of brine are produced with oil from this horizon.

Wolfe City sand. - The Wolfe City sand crops out in the western part of Navarro County, and is encountered in all the wells in the area of study. The producing horizon is a glauconitic sandstone 60 to 70 feet in thickness.

The average net thickness of the producing horizon in the Wolfe City sand ranges from 10 to 30 feet in the Corsicana Shallow field and is 12 feet in the area north of Corsicana. Porosity varies from 12 to 28 percent, the greater porosities being associated with the thicker sections. Increasing shale content causes local variations in porosity. In the western edge of the Corsicana pool, this lack of continuity of porosity in the reservoir rocks, forms traps in the gently sloping porous zones. In other localities, which are more closely associated with the major fault zones, faulting and convex folding are the main factors for trapping the oil and brine.

The Wolfe City sand has a weak water and gas drive to wells. Therefore, in the Corsicana Shallow field operators have established an artificial water drive by water flooding, utilizing brine produced from the Wolfe City, supplemented by brine and highly mineralized water from the Woodbine formation.

Navarro Group

The Navarro group crops out in central Navarro County. It is composed of beds of calcareous, sandy, glauconitic, and fossiliferous clay and several thick beds of fine to medium-grained glauconitic sand. It extends beneath the surface eastward from the outcrop and underlies the remainder of the area, with a maximum thickness of 235 feet in the South Kerens field. The Navarro group is divided into three formations (table 1), but only the Nacatoch formation is considered here because it is the only one that produces oil and brine in the area.

Nacatoch formation.- The Nacatoch formation consists of lenticular sand zones interbedded with a light gray shale. The maximum thickness of the formation is estimated at 163 feet in the South Kerens field, although on electric logs of wells in the region it is not differentiated from the underlying Neylandville member of the Navarro group. Locally, the Nacatoch contains four well-developed sand lenses.

Thicknesses of the reservoir rocks in the Nacatoch, range from 10 to 20 feet throughout the area, and porosity values range from 12 to 25 percent. Downdip from the outcrop, sands in the Nacatoch formation produce small quantities of highly mineralized brine with oil.

In the outcrop area and extending downdip, lenticular beds of sand in the Nacatoch yield fresh water at depths ranging from 50 to approximately 150 feet. Meager information obtained about the interface between brine and fresh water indicates that no uniform contact is present. Reported information reveals that in some localities along the outcrop the fresh water zones become brackish after water is withdrawn.

Geologic Structure

The major structural feature in the area is the Mildred-Powell graben, a complex structural trough trending northeast. The graben is part of the Mexia-Talco-Luling fault system which in this area is a network of normal faults arranged en echelon, and its trace in this area is taken from the geologic map of Texas. The range in dip on the fault planes is from 45 to 70 degrees.

The graben is bounded on the northwest by the Mildred fault and on the southeast by the Powell fault. Displacements on the two fault planes range from 150 to 1,000 feet and the amount of displacement increases with depth. Numerous step faults with 50 to 200 feet displacement occur within and parallel to the graben. Also, branch faults and right angle faults are present along the boundary and within the graben. The displacement along these faults ranges from about 40 to 250 feet. The smaller faults were not mapped on the surface, but their presence in the subsurface was determined from electric logs.

The accumulation of oil and brine is partly controlled by faulting. Formations above the Woodbine contain productive oil pools in and northwest of the graben. There is little or no circulation of either brine or frest water in producing horizons in the area between the outcrop and the graben, and hydrostatic pressure in these horizons is developed artifically by water flood operations.

Oil and large amounts of brine accumulated in the Woodbine formation on the southeast (upthrown) side of the Powell fault. The reservoir rocks have moderate permeability, and a strong natural water drive is maintained. The oil-brine ratio is unfavorable and is becoming less favorable with continued production.

Folding is associated with the faulting, and traps for accumulation of oil, gas, and brine have been formed locally. Formations younger than the Woodbine yield oil and brine from convex folds on both the upthrown and downthrown side of the Mildred fault. Folding on the upthrown side of the Powell fault is partly responsible for trapping the oil, and influences the movement of brine in the Powell-Woodbine field. In the South Kerens field, a gentle anticlinal fold accounts for the oil accumulation.

BRINE PRODUCTION

The estimated daily brine producing rate for all oil fields in this area is 95,300 barrels or approximately 4 million gallons (table 2). This figure is based upon field measurements and estimates. Oil operators reported a daily brine producing rate of 77,000 barrels to the Railroad Commission in December 1957, 18,300 barrels less than the amount estimated in this investigation. This discrepancy results from the fact that rates of brine production are estimated by operators, and no measuring devices have been installed at tank batteries where oil and brine are separated.

Approximately 88 percent, or 83,500 barrels, of the total daily brine yield is from the Woodbine formation which produces oil and brine in the Currie, Richland, South Kerens, and Powell-Woodbine fields. The remaining 12 percent, excepting 45 barrels produced from the Pettet limestone in the Reka field, is from producing horizons younger than the Woodbine in the Corsicana Shallow field.

The largest quantity produced from a single field is 72,600 barrels from 88 wells in the Powell-Woodbine field. This amount is 76 percent of the total areal daily production and 87 percent of the total Woodbine production.

Brine is produced from the Currie, South Kerens, and Richland fields at the rate of approximately 11,000 barrels per day, which is 11.5 percent of total areal Woodbine production. About 6,400 barrels per day are produced in the South Kerens field from 44 wells. The Currie field with 5 wells contributes 3,400 barrels, and the Richland field contributes 1,100 barrels from 4 wells. Approximately 11,600 barrels per day are produced from the Reka field and the Corsicana Shallow field, which rate is 12.2 percent of the daily brine production.

BRINE DISPOSAL

Of the total daily brine production of 95,300 barrels, 83,700 barrels are disposed of on the surface largely into streams but partly into pits, and 11,600 barrels are disposed of in the subsurface under pressure.

Of the daily surface disposition of brine, 82,000 barrels goes directly into drainageways, with Crab and Cedar Creeks receiving the largest volume. Rights-of-way to these creeks are owned by the Powell Salt Water Company, which conducts brine to the creeks by earthen trenches and small diameter drain pipes. Open pits are used by the company, but they overflow almost continuously and are ineffective. According to figures compiled by the author during a field inventory of tank batteries (table 2), approximately 61,550 barrels of brine are disposed of into Crab and Cedar Creeks by the Powell Salt Water Company. This compares with a figure of 50,000 barrels of brine per day obtained by averaging a series of current meter measurements made on Crab and Cedar Creeks (table 4). The difference of 11,550 barrels per day results from: (1) water loss by evaporation, (2) possible errors in the current meter measurements, and (3) inaccuracies in estimating disposal rates. This difference is discussed further in a later section of the report. (See page 18.)

Approximately 20,400 barrels of brine per day are disposed of directly into Cummins, Post Oak, Chambers and Richland Creeks and their tributaries exclusive of Crab and Cedar Creeks. Brine is periodically drained from the tank bases and allowed to flow on the surface to these creeks from tank batteries throughout the area.

The remaining 1,750 barrels of brine are disposed of on the surface daily into pits. Although many more leases dispose of brine into pits than directly into the drainageways, the quantity of brine thus disposed of is much smaller. Numerous small, shallow pits have been dug throughout each of the oil fields except the South Kerens field. Most of the brine is reportedly drained from the pits into the streams during flood stages. The pits are drained by centrifugal pumps, by 2-inch outlet drains from the base of the earthen pits, and by trenches which allow the brine to flow onto the surface before the pit becomes full. Some brine may percolate into the shallow subsurface from the pits and move to areas of natural discharge along the banks of drainageways. Loss of brine by this method is believed negligible as the area is underlain by clay. Evaporation of brine from pit surfaces is probably minimal in Navarro County because of the small surfaces exposed and the humidity of the climate. Evaporation of brine as a means of disposal is questionable, because mineralization remains on the watershed as precipitated salts.

The total daily volume of brine disposed of in the subsurface is 11,600 barrels of which 7,600 barrels are injected into oil sands to create an artificial water drive to force the oil to the wells, and 4,000 barrels are injected in the subsurface for the sole purpose of brine disposal.

Disposal of brine into the subsurface for the purpose of increasing the

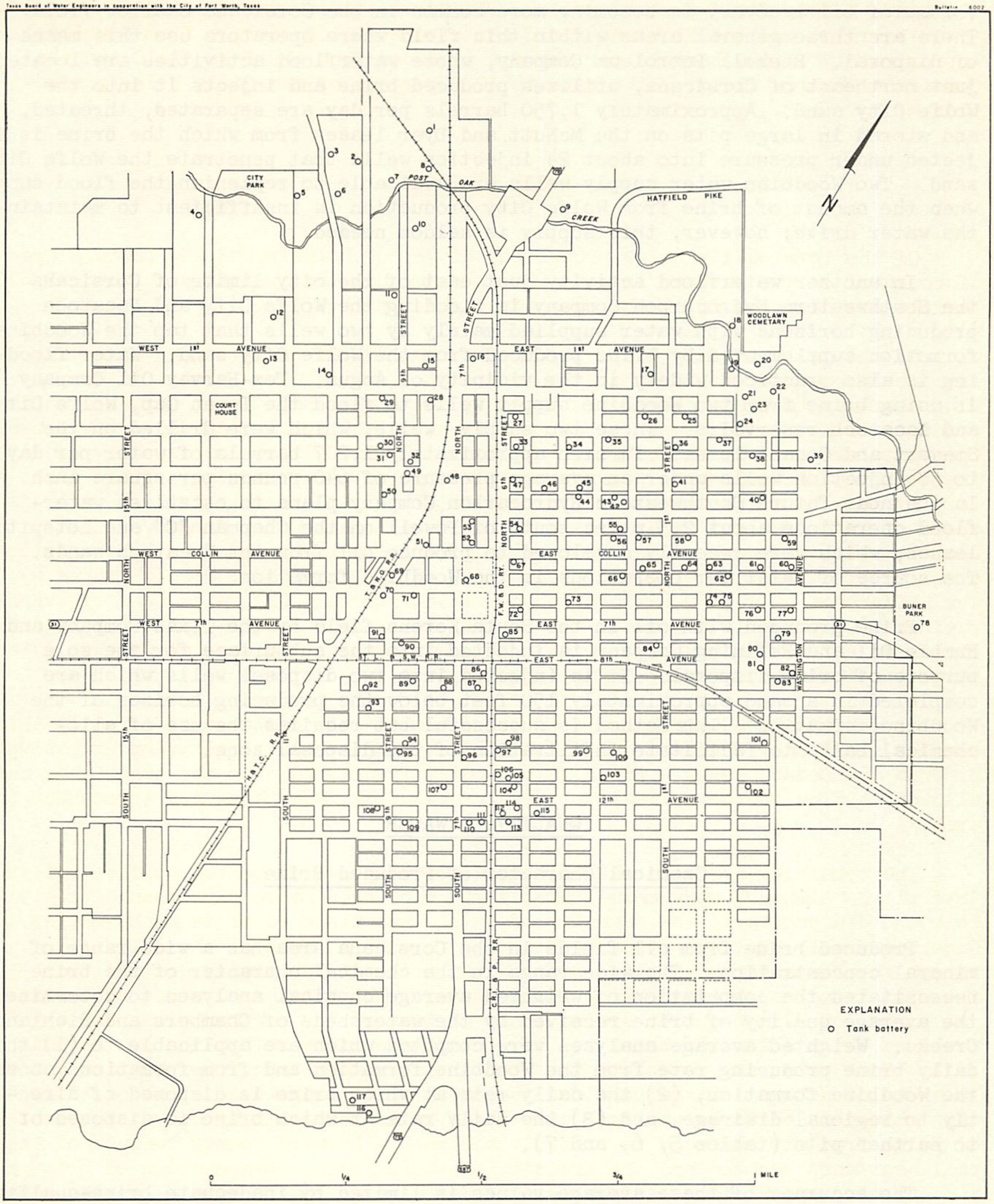

FIGURE — 3 MAP OF PART OF THE CITY LIMITS OF CORSICANA SHOWING LOCATIONS OF TANK BATTERIES volume of oil recovery is becoming more common in the Corsicana Shallow field. There are three general areas within this field where operators use this means of disposal. Stekoll Petroleum Company, whose waterflood activities are located just northeast of Corsicana, utilizes produced brine and injects it into the Wolfe City sand. Approximately 1,750 barrels per day are separated, threated, and stored in large pits on the McNutt and Dyer leases from which the brine is injected under pressure into about 24 injection wells that penetrate the Wolfe City sand. Two Woodbine water supply wells are available to replenish the flood supply when the amount of brine from Wolfe City production is insufficient to maintain the water drive; however, this supply is seldom needed.

In another waterflood activity just east of the city limits of Corsicana the Southwestern Hydrocarbon Company is flooding the Wolfe City and Nacatoch producing horizons with water supplied mainly by two wells that tap the Woodbine formation supplemented by brine produced from the Wolfe City sand. Water flooding is also practiced widely in the vicinity of Angus. Tex-Harvey Oil Company is using brine from two Woodbine supply wells to flood the Pecan Gap, Wolfe City, and Nacatoch reservoirs. These two supply wells, which were drilled on the Stewart and Conant leases, furnish approximately 1,207 barrels of water per day to 57 injection wells under an average pressure of 640 pounds per square inch. In the near future Southwestern Hydrocarbon Company plans to establish waterflood operations about 2.5 miles south of Powell on the Chepman "C" and Lotspitch leases, which were recently developed to produce oil from the Nacatoch sands. The source of water for operations is the Woodbine formation.

Brine produced with oil in the South Kerens field by the Texas Company and Humble Oil and Refining Company is injected into the subsurface for the sole purpose of brine disposal. It is injected into two disposal wells which are completed in a sand approximately 150 feet below the producing horizon of the Woodbine formation. This method is successful but requires the use of allochemical balls to facilitate infiltration of the disposal zone.

QUALITY OF WATER

Chemical Character of Produced Brine

Produced brine from oil fields in the Corsicana area has a wide range of mineral concentration. The wide range in the chemical character of the brine necessitated the computation of weighted average chemical analyses to determine the average quality of brine received by the watersheds of Chambers and Richland Creeks. Weighted average analyses were computed which are applicable to (1) the daily brine producing rate from the Woodbine formation and from formations above the Woodbine formation, (2) the daily rate at which brine is disposed of directly to regional drainage, and (3) the daily rate at which brine is disposed of to earthen pits (tables 5, 6, and 7).

The accuracy of these average values is limited by inadequate brine-quality control for some reservoirs and by the accuracy of reported brine-producing rates on individual leases (table 2).

Brine Produced from the Woodbine Formation.- The chemical character of brine from the Woodbine formation is apparently associated with geologic structure. Analyses show a progressive increase in total dissolved solids down the regional dip of the formation from approximately 3,800 ppm at Emhouse in the western part of the area to approximately 30,000 ppm in the South Kerens field in the southeast part of the area (table 3). Total dissolved solids increase from approximately 8,000 to 14,000 ppm from the west to the east side of the Powell fault in the Powell-Woodbine field, with the more highly mineralized brine occurring in the upthrown block.

The Woodbine formation in the Powell-Woodbine field yields about 76 percent of all brine produced in the area. An analysis of brine from the field indicates concentrations of approximately 13,800 ppm total solids and 7,400 ppm chloride ion (sample 5, table 3). Lesser quantities of brine are produced from the Woodbine formation in the South Kerens, Richland, and Currie oil fields. Brine from the South Kerens field contains approximately 30,000 ppm total solids and 17,450 ppm chloride ion (sample 6, table 3). Samples of the brine from the Richland and Currie fields were not obtained.

Brine produced from formations above the Woodbine.- Brine is produced with oil from horizons in the Wolfe City sand, Pecan Gap chalk, and Nacatoch sand. Approximately 500 barrels per day of brine ranging in total dissolved solids from 32,002 ppm to 34,974 ppm are produced from the Pecan Gap chalk. Approximately 1,500 barrels of brine are produced daily from the Nacatoch sand ranging between 13,400 ppm and 22,100 ppm in total dissolved solids, depending upon the structural reservoir in which it occurs.

The Wolfe City sand produces approximately 9,700 barrels of brine per day which is approximately 10 percent of total daily brine production in the area. Brine produced from the Wolfe City sand ranges from 34,790 to 39,727 ppm in total dissolved solids (table 3).

The chloride concentrations of brines from formations above the Woodbine formation range between 55 and 65 percent of the total dissolved solids concentration.

Chemical Character of Disposed Brine

To compute the average quality of brine disposed of to the watersheds of Chambers and Richland Creeks, representative analyses of brine were obtained for the various structural reservoirs of each oil producing formation in the area (table 3). The daily brine-producing rates shown in table 2 were related to the chemical analyses in table 3. Plate 1 shows approximate locations and producing horizons of all wells where subsurface samples of brine were obtained.

Weighted average analyses of brine.- A hypothetical chemical analysis which is applicable to the daily brine producing rate (95,300 barrels) on the Richland-Chambers watersheds was computed by averaging analyses which are representative of the average quality of brine produced from each formation, weighted according to amounts of brine produced. These analyses were computed by averaging the chemical analyses in table 3 for each formation, weighted according to amounts of brine assigned to each analysis in table 2.

The weighted average analyses of brine disposed of directly to regional drainage (table 6) and of brine disposed of to pits (table 7) were determined in the same manner as the weighted average analysis for all produced brine. The average of the two, weighted according to daily volumes disposed of, gives the average quality of brine entering the Chambers-Richland watershed daily. Total solids (15,174 ppm) and chloride ion (8,245 ppm) concentrations from this analysis are equivalent to 223 and 121 tons per day of these constituents, respectively, based on a daily surface disposal rate of 83,691 barrels.

Brine disposed of to surface drainage.- According to data reported to the Texas Railroad Commission, or determined during this investigation, approximately 83,700 barrels of brine are disposed of directly to surface drainage daily in the Chambers-Richland watersheds (table 2). This figure includes approximately 61,550 barrels of brine disposed of daily to Crab and Cedar Creeks by the Powell Salt Water Company, approximately 20,400 barrels disposed of daily to Cummins, Post Oak, Chambers, and Richland Creeks and their tributaries and approximately 1,750 barrels disposed of daily to surface pits.

As a partial check on reported brine disposal rates, flow measurements were made on Crab and Cedar Creeks with a current meter and corresponding brine samples were taken during the spring and summer of 1958 (plate 2, and table 4). Flow measurements were made once daily for each creek at intervals of 2 to 10 days, and the measured rates of flow were assumed to be representative of the average daily flow rates of the creeks.

Weighted average total solids and chloride ion concentrations of the waters of the two creeks, based on this series of determinations, are 14,902 and 8,312 ppm, respectively. The creeks' combined average flow is 50,028 barrels per day. These figures indicate that 130 tons per day of total solids and 72 tons per day of chloride ion are disposed of daily to Crab and Cedar Creeks. These tonnages compare to 149 and 80 tons per day of these constituents computed by using the daily volume (61,500 barrels) reported disposed of to these creeks (table 2) and applying to it chemical concentrations which reflect the quality of brine in the Powell-Woodbine reservoir (analysis No. 5, table 3). The discrepancy between these two sets of values indicates that inaccuracies exist in production rates reported in table 1, or that chemical analysis No. 5, table 2, is not representative of the average quality of brine disposed of to Crab and Cedar Creeks, or that the average measured flow of the two creeks is inaccurate. The tonnages of total solids and chloride ion computed above represent 60 to 70 percent of the calculated amount of mineralization which the watersheds receive daily, depending upon which of the two rates is used. The estimated rate (from table 2) was used in computing the weighted average concentrations of disposed brine.

Graphic presentation of results of sampling and measuring the flows of Crab and Cedar Creeks indicates that flow in these creeks during the period of record, except during and shortly after local rainfall is derived almost entirely from oil field disposal of brine (figure 4). There is an apparent erratic relationship between flow and precipitation, indicating that brine disposal rates vary appreciably from day to day. However, total mineral concentrations of waters of these creeks are indicated, in general, to be inversely proportional to rainfall, as might be expected, assuming a fairly constant brine disposal rate.

Approximately 20,800 barrels per day of brine are disposed of to other tributaries or directly to Chambers and Richland Creeks, according to reported figures.

Included in the daily rate of disposal to drainage are 1,750 barrels of brine which are disposed of to earthen pits on the watershed. It is possible, due to undertermined hydrologic factors controlling the effectiveness of pits, that minerals contained in this brine enter drainage at a daily rate somewhat less than the daily rate at which they are produced, although all minerals thus disposed of eventually enter the watersheds. For purposes of this report, the rates are assumed to be equal.

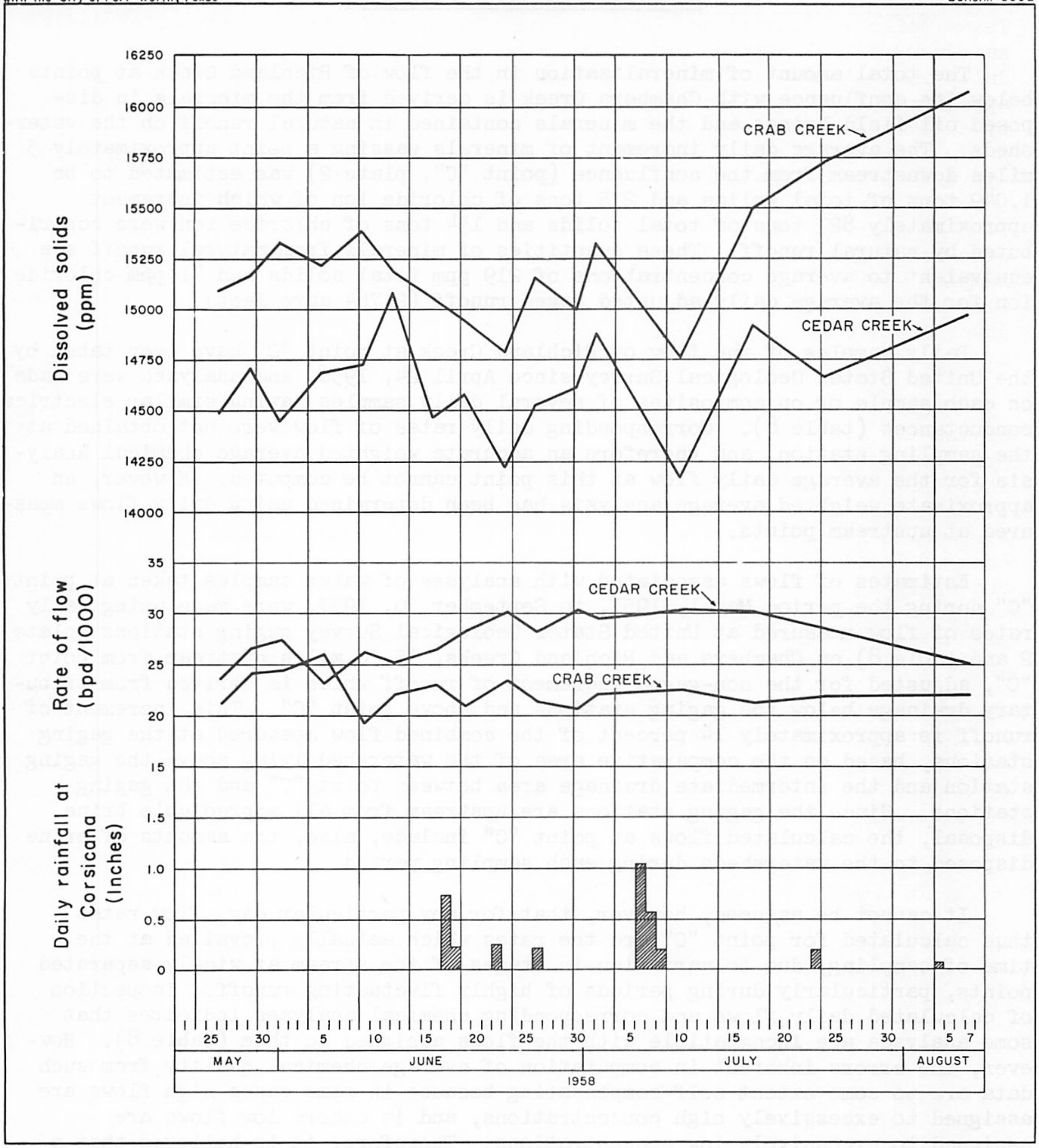

FIGURE 4 - GRAPHS SHOWING RELATION OF DISSOLVED SOLIDS, RATES OF FLOW, AND RAINFALL, CRAB AND CEDAR DRAINAGE-WAYS, NAVARRO COUNTY, TEXAS

Chemical Character of Runoff

The total amount of mineralization in the flow of Richland Creek at points below its confluence with Chambers Creek is derived from the minerals in disposed oil field brines and the minerals contained in natural runoff on the watersheds. The average daily increment of minerals passing a point approximately 5 miles downstream from the confluence (point "C", plate 2) was estimated to be 1,049 tons of total solids and 275 tons of chloride ion of which increment approximately 827 tons of total solids and 154 tons of chloride ion were contributed by natural runoff. These quantities of minerals from natural runoff are equivalent to average concentrations of 219 ppm total solids and 41 ppm chloride ion for the average daily adjusted gaged runoff (2,764 acre feet).

Daily samples of the flow of Richland Creek at point "C" have been taken by the United States Geological Survey since April 24, 1956, and analyses were made on each sample or on composites of several daily samples having similar electrical conductances (table 8). Corresponding daily rates of flow were not obtained at the sampling station, and therefore an accurate weighted average chemical analysis for the average daily flow at this point cannot be computed. However, an approximate weighted average analysis has been determined using daily flows measured at upstream points.

Estimates of flows associated with analyses of water samples taken at point "C" during the period May 1, 1951, to September 30, 1957, were made using daily rates of flow measured at United States Geological Survey gaging stations (plate 2 and table 8) on Chambers and Richland Creeks, 15-20 miles upstream from point "C", adjusted for the non-gaged increment of runoff which is derived from tributary drainage below the gaging stations and above point "C". This increment of runoff is approximately 14 percent of the combined flow measured at the gaging stations, based on the comparative area of the watershed lying above the gaging station and the intermediate drainage area between point "C" and the gaging stations. Since the gaging stations are upstream from all appreciable brine disposal, the calculated flows at point "C" include, also, the amounts of brine disposed to the watersheds during each sampling period.

It cannot be assumed, however, that for any particular day, flow rates thus calculated for point "C" are the rates which actually prevailed at the time of sampling, due to variation in stages of the stream at widely separated points, particularly during periods of highly fluctuating runoff. Inspection of calculated daily flows and corresponding chemical analyses indicates that some analyses are incompatible with the flows assigned to them (table 8). However, the errors inherent in computation of average chemical quality from such data are to some extent self-compensating because in some cases high flows are assigned to excessively high concentrations, and in others low flows are assigned to excessively low concentrations. Therefore, it is believed that a reasonable estimate of the average quality of water in Richland Creek is afforded by these data. Accordingly, weighted average total solids and chloride ion concentrations were determined from these data (table 8), assuming that daily flow rates at point "C" remain essentially proportional to adjusted gaged flows upstream.

Samples were not obtained at point "C" on 55 days during the period May 1, 1956, to September 30, 1957. On 46 of those days no flows were gaged on Chambers and Richland Creeks. These days are included in table 8 by assigning to each a flow and concentration equal to the average daily rate (5.3 DSF) and concentration (15,174 ppm total solids) of disposed brine in the area. Nine days were excluded from the weighted average computation because analyses were unavailable for recorded gaged flows.

Calculations based on the determined averages indicate that natural runoff contributed 370 percent more total solids and 127 percent more chloride ion to drainage than did disposal of produced brine during the period of record. It is possible, however, that runoff, under flood conditions which prevailed in the spring of 1957 contained appreciable increments of minerals derived from abnormal releases of impounded brine and from the leaching of brine-saturated soils in areas where pit disposal or direct disposal onto the surface had been practiced.

During the period of record over which the weighted averages were computed, the average gaged flow of Richland Creek was approximately 155 percent more than the long-term average gaged flow from March 1939, through September 1956. Had average conditions of runoff prevailed, the computed average concentrations would have been appreciably higher than those obtained, probably approaching 400 ppm dissolved solids and 100 ppm chloride ion.

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Table 2. Records of tank batteries and brine produced
in lower watershed of Chambers and Richland Creeks, Navarro County, Texas

Brine production: r, reported; m, measured; e, estimated.
Remarks: NRD, no evidence of release to drainage.

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Producing horizon Top	Brine production (bbls/day)	Methods of brine disposal and remarks
A-1	H. C. Hervey	W. S. Guthrie	4	Wolfe City	656	7r	Pit - NRD.
A-2	Mrs. F. Goodwyn	Fair Oil Company	3	Wolfe City	680	4r	Pit-seeps into road ditch.
A-3	Goodwyn	W. S. Guthrie	5	Wolfe City	680	40r	Pit-seeps into field nearby.
A-4	Goodwyn "B"	W. S. Guthrie	1	Wolfe City	---	Trace e	Pit - NRD.
A-5	Wilder	N. E. Burroughs	5	Wolfe City	658	3r	Pit - NRD.
A-6	Bradley Bros.	Wilder & Underwood	15	Wolfe City	---	5r	Pit overflows into a tributary of Cummins Creek.
A-7	C. W. Lockhart	A. L. Lockhart	2	Wolfe City	---	8r	Pit-overflows into pasture.
A-8	A. S. Robinson	Heller Oil Company	3	Wolfe City	793	199m	Brine is pumped directly into a tributary of Chambers Creek.
A-9	Yeldell	Copeland-Ray	1	Wolfe City	---	34m	A trench drains the pit into a tributary of Cummins Creek.
A-10	H. Summit	Homer T. Glover	3	Wolfe City	760	30e	Pit - NRD.
A-11	H. Summit	C. E. Penn	9	Wolfe City	750	60r	Pit - NRD.
A-12	R. Robinson	Percy Andrews	2	Wolfe City	---	20r	Pit - NRD.
C-1	J. B. Cooksey	Spencer Elliott, Jr.	1	Wolfe City	1,011	1r	Pit - NRD.
C-2	Gabino Aldama	Spencer Elliott, Jr.	1	Wolfe City	---	0	Pit - NRD.
C-3	G. W. Sutherlin	Homer T. Glover	1	Wolfe City	---	15r	Direct disposal to drainage.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon		Brine production (bbls/day)	Methods of brine disposal and remarks
				Name	Top		
C-4	F. M. Allison	Allison-Stroube	2	Wolfe City	965	0	Pits - NRD.
C-5	Wilbanks	Phillip R. Cravens	1	Wolfe City	1,011	0.5r	Closed earthen trench-NRD.
C-6	G. H. Sutherland	Stroube Spencer	1	Wolfe City	984	0	Battery is inoperative.
C-7	Josephine Cooksey	Spencer Elliott, Jr.	1	Wolfe City	986	--	Pits - NRD.
C-8	R. M. Cooksey	Spencer Elliott, Jr.	3	Wolfe City	---	0.5r	Pits - NRD.
C-9	Chorafis	Thompson	2	Wolfe City	1,004	2r	Pit - evidence of occasional release to drainage.
C-10	B & RI RR	Guthrie & Guthrie	1	Wolfe City	1,033	1r	Pit - NRD.
C-11	Pena	John R. Corley	1	Wolfe City	1,015	1r	Pit used for gathering; brine is then hauled by tank truck for further disposal.
C-12	Clowe	C. E. Orr	1	Wolfe City	1,078	0.3r	Closed earthen trench - NRD.
C-13	Atkinson	C. E. Orr	1	Wolfe City	1,081	0.3r	Pit - NRD.
C-14	F. C. Stewart	F. C. Stewart	1	Wolfe City	1,002	1r	Pit - NRD.
C-15	Albritton	Cook & Fields	1	Wolfe City	987	0	Closed earthen trench - NRD.
C-16	Nellie Morrison	Goldston Oil Corp.	1	Wolfe City	973	0	Closed earthen trench - NRD.
C-17	Ernest Betts	Lee Hicks	1	---	---	0	Pit - NRD.
C-18	City of Corsicana	Bowser & Bertram	1	Wolfe City	978	0	Closed earthen trench - NRD.
C-19	---	---	-	Wolfe City ?	---	0e	Battery inoperative.
C-20	City of Corsicana	Tiger Minerals, Inc.	3	Wolfe City	962	0	Direct release to Post Oak Creek.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon		Brine production (bbls/day)	Methods of brine disposal and remarks
				Name	Top		
C-21	Callicut & McGriff	J. C. Thompson, Jr.	1	Wolfe City	---	0	Closed earthen trench - NRD.
C-22	Strode	Southwestern Hydro. Co.	5	Wolfe City	---	11.3m	Direct release to Post Oak Creek.
C-23	Judith Bennett	Guthrie & Guthrie	1	Wolfe City	1,005	0	Battery inoperative.
C-24	Freedman "A"	J. A. Jenkins	1	Wolfe City	---	0.3r	Closed earthen trench - NRD.
C-25	Willie Kelly	C. E. Orr	1	Wolfe City	---	0.1r	Direct release to Post Oak Creek.
C-26	Chandler	Browning & Harris	1	Wolfe City	998	0.1r	Pit - NRD.
C-27	M. P. Williams	Caraston Oil Co. Ltd., et al.	1	Wolfe City	1,017	Trace r	Pit - NRD.
C-28	C. G. S. M.	T & W Oil Co.	1	Wolfe City	992	0.5r	Closed earthen trench - NRD.
C-29	Pearl Cohen	Stewart Oil & Gas Co.	1	Wolfe City	1,012	1r	Pit - NRD.
C-30	Rosenbert	Ivan Rosenbert	1	Wolfe City	1,014	0	Battery inoperative - NRD.
C-31	Humphries	Kelton, Brazelton & Kelton	1	Wolfe City	1,010	0.5r	Pit - NRD.
C-32	Herod	W. J. Oil Co.	1	Wolfe City	1,060	0.5r	Pit - NRD.
C-33	Lucas	Caraston Oil Co.	1	Wolfe City	1,016	Trace r	Pit - NRD.
C-34	Clinton Moye	Pleas E. Dawson	1	Wolfe City	1,016	0	Battery inoperative.
C-35	Banks	Guthrie & Guthrie, et al.	1	Wolfe City	1,002	1r	Pit - NRD.
C-36	Angus	Southwestern Hydro. Co.	1	Wolfe City	---	0	Battery inoperative.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon		Brine production (bbls/day)	Methods of brine disposal and remarks
				Name	Top		
C-37	Alex Lee	Independent Drlg. Co.	1	Wolfe City	1,038	0	Battery inoperative.
C-38	O. Hall and James Edwards	McKinney & McKinney	1	Wolfe City	1,092	2r	Pit - NRD.
C-39	West	Southwestern Hydro. Co.	6	Wolfe City	---	14.7m	Direct disposal to Post Oak Creek.
C-40	Jewel Graham	H. G. & V. L. Summerall	1	Wolfe City	1,024	0	Battery inoperative.
C-41	Douglas	J. A. Reilly	1	Wolfe City	1,035	0	Pit - NRD.
C-42	Roy Albritton	Caraston Oil Co. Ltd.	1	Wolfe City	1,010	0.1r	Direct disposal to Post Oak Creek.
C-43	W. J. Coit	Pleas E. Dawson	1	Wolfe City	1,023	Trace r	Closed earthen trench - NRD.
C-44	Bennie E. Adair	Short & Hudnall	1	Wolfe City	1,018	0	Battery is inoperative.
C-45	Lizzie Woodard	J. C. Thompson	1	Wolfe City	---	0	Pit and earthen trench - NRD.
C-46	Ida V. McBride	Pleas E. Dawson	1	Wolfe City	---	Trace r	Closed earthen trench - NRD.
C-47	Will Thompson "B"	Thompson Oil Co.	1	Wolfe City	1,034	Trace r	No evidence of brine disposal.
C-48	T & NO RR	Stewart Oil & Gas Co.	1	Wolfe City	1,025	1.3r	Pit - NRD.
C-49	Blanding	Whiteselle Brick & Lumber Co. and Dave Kelton	1	Wolfe City	1,016	0.2r	Pit - NRD.
C-50	Wilson	Bill Cook	1	Wolfe City?	---	21.5r	Pit - NRD.
C-51	J. A. Penney	McKinney & McKinney	1	Wolfe City	1,028	2.5r	Pit - NRD.
C-52	Freedman	Thomas A. Phillips, Jr.	1	Wolfe City?	---	2r	Pit - NRD.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon		Brine production (bbls/day)	Methods of brine disposal and remarks
				Name	Top		
C-53	C. S. McClanahan	C. S. McClanahan	1	Wolfe City	1,023	0.3r	Closed earthen trench - NRD.
C-54	Wm. Rogers	McKinney & McKinney	1	Wolfe City	1,021	3r	Pit - NRD.
C-55	Wesley Chapel	C. E. Orr	1	Wolfe City	---	0.1r	Closed earthen trench - NRD.
C-56	George Ware	Caraston Oil Co. Ltd.	1	Wolfe City	1,018	Trace r	Pit - NRD.
C-57	G. W. Griggs	Lee Hicks et al	1	Wolfe City	1,026	0	Pit - NRD.
C-58	Annie P. Turner	J. R. Lind	1	Wolfe City	---	0	Pit - NRD.
C-59	Haley	Ware Well Servicing Co.	1	Wolfe City	---	1r	Pit - occasional overflow to drainage.
C-60	Charles Williams	Copeland - Ray	1	Wolfe City	1,021	1r	Pit - NRD.
C-61	Moore	T & W Oil Co.	1	Wolfe City	1,035	0.5r	Closed earthen trench - NRD.
C-62	Ellison	C. E. Orr	1	Wolfe City	---	0	Pit - NRD.
C-63	George Alford	J. C. Thompson, Jr.	1	Wolfe City	---	0	Pit - NRD.
C-64	Williams	Fields and Hartman	1	Wolfe City	1,023	0	Battery is inoperative.
C-65	Clara Pope	McKinney & McKinney	1	Wolfe City	---	1.5r	Pit - NRD.
C-66	Callie Crisp	John L. Pope et al	1	Wolfe City	1,032	0	Closed earthen trench - NRD.
C-67	Sanders, Jr.	Lynn Sanders, Jr.	1	Wolfe City	1,026	0.5r	Pit - NRD.
C-68	Burlinton "A"	Guthrie & Guthrie	1	Wolfe City	1,033	1r	Pits - NRD.
C-69	T & NO RR	Stewart Oil & Gas Co.	1	Wolfe City	1,031	1.3r	Pit - NRD.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Producing horizon Top	Brine production (bbls/day)	Methods of brine disposal and remarks
C-70	T & NO RR	Stewart Oil & Gas Co.	1	Wolfe City	1,031	1.3r	Pit - NRD.
C-71	Unit #1	Metzer Dairies	1	Wolfe City	---	1r	Pit - NRD.
C-72	Mary Guy	J. A. (Jim) Reilly	1	Wolfe City	1,018	0	Pit - NRD.
C-73	Alonzo Durham	Bill T. McCracken	1	Wolfe City	1,043	0.2r	Closed earthen trench - NRD.
C-74	Lillie Harper Johnson	Ware Drlg. Co.	1	Wolfe City	1,022	0	Pit - NRD.
C-75	Andrew Brown	J. L. Pope, et al	1	Wolfe City	1,049	0	Battery is inoperative.
C-76	Copley	T W S Oil Co.	1	Wolfe City	1,046	0	Battery is inoperative.
C-77	Birdsong	Ware Drilling Co.	1	Wolfe City	1,048	0.2r	Pit - NRD.
C-78	Stardust Negro Park	United Mfg. Co.	4	Wolfe City	1,045	4r	Pit - NRD.
C-79	Bruce Moye	Pleas E. Dawson	1	Wolfe City	1,055	0	Battery is inoperative.
C-80	A. W. Frey	J. A. Jenkins	1	Wolfe City	1,058	1r	Closed earthen trench - NRD.
C-81	Bertha Bunert	J. A. Jenkins	1	Wolfe City	1 055	0	Battery is inoperative.
C-82	Rubbin & Isabell Colbert	J. R. Lind, et al	1	Wolfe City	1,044	0	Pit - NRD.
C-83	A. C. Conley	Combination Drlg. Co.	1	Wolfe City	---	0.1r	Pit - NRD.
C-84	A. O. Conley	R. C. Suttle	1	Wolfe City	1,054	0.5r	Pit - NRD.
C-85	Allen George	Stewart Oil & Gas Co.	1	Wolfe City	1,034	0	Pit - NRD.
C-86	Nevels	Stroube-Spencer	1	Wolfe City	1,031	0	Pit - NRD.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon		Brine production (bbls/day)	Methods of brine disposal and remarks
				Name	Top		
C-87	J. R. Hawthorne	J. N. Edens, Jr.	1	Wolfe City	1,039	1r	Pit - evidence of occasional overflow.
C-88	W. H. Hayes	C. H. Johnson	1	Wolfe City	1,034	0	Battery is inoperative.
C-89	J. Maldonado	Braselton & Kelton	1	Wolfe City	1,037	0.1r	Pit - NRD.
C-90	Carlisle & Roberts	John R. Corley	1	Wolfe City	1,047	0.5r	No pit or trench, hauled.
C-91	Stroud-Stell	H. M. Settle, Jr. for S & S Co.	1	Wolfe City	1,066	0.5r	Closed earthen trench-NRD.
C-92	Will Thompson	Thompson Oil Co.	1	Wolfe City	1,020	Trace r	Pit - NRD.
C-93	Will Thompson	Thompson Oil Co.	1	Wolfe City?	---	Trace r	Pit - NRD.
C-94	Thelma J. Mitchem	Atwood & Franks	1	Wolfe City	1,034	0	Closed earthen trench - NRD.
C-95	J. C. Roe	Pleas E. Dawson	1	Wolfe City	1,043	1r	Pits - NRD.
C-96	W. F. Morris	Caraston Oil Co., Ltd.	1	Wolfe City	1,036	0	Battery inoperative.
C-97	Dunn-Betterton	Triumph Oil Corp.	1	Wolfe City	1,055	0	do.
C-98	W. A. Poe	Stroube-Allison	1	Wolfe City	1,045	0	do.
C-99	O. C. Barron	A. R. Sissom	1	Wolfe City	1,019	1.5r	Pit - NRD.
C-100	L. L. Williams	B. & O. Production Co.	1	Wolfe City	1,074	0	Pit - NRD.
C-101	George Compton	Campbell, Leggett & Garner	1	Wolfe City	1,056	2.5r	Pit - evidence of occasional release to drainage.
C-102	B. H. Elliott	Jack T. Perkins	1	Wolfe City	1,042	2r	Pit - NRD.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Producing horizon Top	Brine production (bbls/day)	Methods of brine disposal and remarks
C-103	Sam Sikes	Caraston Oil Co., Ltd.	1	Wolfe City	1,055	Trace r	Pit - NRD.
C-104	Grover Hart	Caraston Oil Co., Ltd.	1	Wolfe City	1,034	Trace r	Pit - NRD.
C-105	Ray Woodruff	Powell & Williams	1	Wolfe City	1,045	0	Battery is inoperative.
C-106	---	---	1	Wolfe City?	---	0	do.
C-107	Ethel Wortham	Stroube-Stewart & Henderson	1	Wolfe City	1,033	0	Pit - NRD.
C-108	Corsicana Cotton Mills	Corsicana Cotton Mills	3	Wolfe City	1,027	1r	Pit - NRD.
C-109	Cora Hardy	Stroube-Spencer	1	Wolfe City	1,025	0	Pit - NRD.
C-110	Ollie Lewis	J. A. Kenney	1	Wolfe City	1,022	1r	Pit - NRD.
C-111	Penolopia Brown	H. R. Stroube	1	Wolfe City	---	0	Pit - NRD.
C-112	Jesse Daniels	Ewing & Holliday	1	Wolfe City	1,032	0	Battery is inoperative.
C-113	Waller	M. Ulmer	1	Wolfe City,	1,042	0	do
C-114	Nancy Jessie	Caraston Oil Co., Ltd.	1	Wolfe City	1,037	Trace r	Pit - NRD.
C-115	E. R. Robinson	Independent Drlg. Co.	1	Wolfe City	---	0	Pit - NRD.
C-116	Millie Elder	N. E. Burroughs	1	Wolfe City	1,088	1r	Direct disposal to Mesquite branch.
C-117	Burleson "B"	J. A. Reilly	1	Wolfe City	---	0	Closed earthen trench - NRD.
D-1	Baum	E. L. McNeil, et al	7	Wolfe City	862	12r	Pit - NRD.
D-2	Fortson "B"	H. A. Holtzer, et al	6	Wolfe City	872	26m	Pit - NRD.

Table 2.-Records of tank batteries and brine produced
in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon		Brine production (bbls/day)	Methods of brine disposal and remarks
				Name	Top		
D-3	Hall #1	Stekoll Petroleum Co.	3	Wolfe City	904	8r	Brine used in waterflood operations. Pumped from a large central pit to a treating station on the McNutt lease. NRD.
D-4	Hall #2	Stekoll Petroleum Co.	5	Wolfe City	864	257m	do.
D-5	Baum #1	Stekoll Petroleum Co.	1	Wolfe City	917	1r	Pit - brine is bled off at intervals from tank base.
D-6	Hagar	Stekoll Petroleum Co.	5	Wolfe City	860	13r	Brine used in waterflood operations. Pumped from a large central pit to a treating station on the McNutt lease. NRD.
D-7	Baum #2	Stekoll Petroleum Co.	14	Wolfe City	881	103m	do.
D-8	Baum #4	Stekoll Petroleum Co.	5	Wolfe City	905	65m	do.
D-9	Baum #3	Stekoll Petroleum Co.	14	Wolfe City	915	12r	do.
D-10	Brown #2	Stekoll Petroleum Co.	2	Wolfe City	957	58m	do.
D-11	Brown #3	Stekoll Petroleum Co.	3	Wolfe City	910	42m	do.
D-12	Brown #1	Stekoll Petroleum Co.	6	Wolfe City	894	36r	do.
D-13	Tatum	Stekoll Petroleum Co.	6	Wolfe City	852	17m	do.
D-14	Truelove	Stekoll Petroleum Co.	2	Wolfe City	973	7m	do.

Table 2.-Records of tank batteries and brine produced
in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon		Brine production (bbls/day)	Methods of brine disposal and remarks
				Name	Top		
D-15	Womack	Stekoll Petroleum Co.	8	Wolfe City	919	23r	Brine used in waterflood operation. Pumped from a large central pit to a treating station on the McNutt lease. NRD.
D-16	Muns	Stekoll Petroleum Co.	3	Wolfe City	957	65m	do.
D-17	Blankenship	Stekoll Petroleum Co.	2	Wolfe City	1,002	9r	Pit - NRD.
D-18	Unitization #2	Stekoll Petroleum Co.	16	Wolfe City	990	161m	Return waterflood from the treating station on the McNutt lease. See D-3.
D-19	Barlow	Stekoll Petroleum Co.	1	Wolfe City	982	26r	do.
D-20	Dyer	Stekoll Petroleum Co.	17	Wolfe City	972	86m	do.
D-21	McNutt	Stekoll Petroleum Co.	14	Wolfe City	971	147m	do.
D-22	Unitization #3	Stekoll Petroleum Co.	14	Wolfe City	938	186r	do.
D-23	Devant #2	Stekoll Petroleum Co.	4	Wolfe City	937	38r	do.
D-24	Millender	Stekoll Petroleum Co.	5	Wolfe City	993	258m	do.
D-25	Lassiter	Stekoll Petroleum Co.	3	Wolfe City	967	65m	do.
D-26	Park	Stekoll Petroleum Co.	2	Wolfe City	939	48m	do.
D-27	Petty	Stekoll Petroleum Co.	2	Wolfe City	996	27r	do.
D-28	Thompson	Southwestern Hydro. Co.	4	Wolfe City	---	45m	Pit- seeps onto surface.
D-29	---	---	1	Wolfe City?	---	0	No evidence of brine disposal.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Producing horizon Top	Brine production (bbls/day)	Methods of brine disposal and remarks
D-30	---	---	2	Wolfe City?	---	0	do.
D-31	---	---	1	Wolfe City?	---	0	do.
D-32	Darwood	Southwestern Hydro. Co.	1	Pecan Gap?	---	0	do.
D-33	---	---	1	Pecan Gap?	---	0	do.
D-34	Julia Mirus	---	1	Pecan Gap?	---	0	do.
D-35	Suella Williams	Guthrie & Guthrie	2	Pecan Gap?	---	1r	Pit - NRD.
D-36	Whiteselle	Southwestern Hydro. Co.	2	Pecan Gap	---	1e	Disposal to a tributary of Post Oak Creek.
D-37	J. C. Buie	Thompson Oil Co.	1	---	---	1r	do.
D-38	Castillo	Thompson Oil Co.	1	Wolfe City	1,005	0	Battery is inoperative.
D-39	Albritton	Southwestern Hydro. Co.	4	Wolfe City	984	30r	Pits - drained into a tributary of Post Oak Creek.
D-40	Eckleman	Southwestern Hydro. Co.	6	Wolfe City	---	86m	do.
D-41	North Mirus	Southwestern Hydro. Co.	5	Wolfe City	1,007	86e	do.
D-42	Staley Barnsdall	Southwestern Hydro. Co.	24	Wolfe City	---	257m	Pits - seeps into tributary of Post Oak Creek.
D-43	Mills & Garrity	Southwestern Hydro. Co.	46	Wolfe City	975	515m	Pits - drained into a tributary of Post Oak Creek.
D-44	Frank Szenasy Est.	Mrs. Genevieve Johnston	8	Wolfe City	1,008	0.5r	Pits - NRD.
D-45	M. L. Brown	C. L. Brown, Jr.	2	Wolfe City?	---	17e	Pit - NRD.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Producing horizon Top	Brine production (bbls/day)	Methods of brine disposal and remarks
D-46	Mitten	Southwestern Hydro. Co.	5	Pecan Gap		3m	Pits - overflow into a tributary of Post Oak Creek.
D-47	C. C. Roberts	Guthrie & Guthrie	1	Wolfe City	---	50r	Pits - probably drained into Post Oak Creek.
D-48	Spenser	So. Tex. Oil & Transm. Co.	1	Wolfe City?	---	0	Battery is inoperative.
D-49	Mirus	So. Tex. Oil & Transm. Co.	1	Wolfe City?	---	0.5r	Large pit - NRD.
D-50	Burnett	So. Tex. Oil & Transm. Co.	1	Wolfe City?	---	0.5r	Pit - NRD.
D-51	Homer E. Gardner	W. B. Robinson	2	Wolfe City	---	1r	Pit - drained into a tributary of Post Oak Creek.
D-52	R. L. Copley	Burton Weenick	1	Wolfe City	---	0.5r	Drained into a tributary of Post Oak Creek.
D-53	Mills	R. L. Copley	2	Wolfe City	---	60e	Disposal to Mesquite Creek.
D-54	St. Louis SW RR Co.	Southwestern Hydro. Co.	3	Wolfe City	1,170	60e	Direct disposal into Mesquite Creek.
D-55	W. H. Chewning	W. W. Ficklin	7	Wolfe City	1,010	58m	Pit - NRD.
D-56	Chewning	Mrs. T. P. Kerr	2	Wolfe City?	---	7m	Disposal to Mesquite Creek.
D-57	Mills & Garrity	Southwestern Hydro. Co.	5	Wolfe City	---	7m	Pit - overflows into a tributary of Mesquite Creek.
D-58	C. L. Jester	W. E. Butler, et al	4	Wolfe City	1,175	129m	Pit - probably drained by pump to a tributary of Post Oak Creek.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Top	Brine production (bbls/day)	Methods of brine disposal and remarks
D-59	St. Louis SW RR Co.	W. E. Butler, et al	5	Wolfe City	1,114	30m	Brine is used in waterflood operations. It is collected into pits and injected into the Wolfe City sand. NRD.
D-60	C. C. Roberts	W. E. Butler, et al	27	Wolfe City	1,111	2,810r	do.
D-61	Mrs. Bertha McKinney	J. P. McKinney	1	Wolfe City	1,186	3r	Pit - brine is bled off at irregular intervals into a road ditch.
D-62	Waterworks	Southwestern Hydro. Co.	32	Wolfe City	1,137	617m	Brine is used in waterflood operations. It is collected into pits and injected into the Wolfe City sand. NRD.
D-63	South Mirus	Southwestern Hydro. Co.	20	Wolfe City	1,085	260m	do.
D-64	Amy Barth	Southwestern Hydro. Co.	27	Wolfe City	1,053	1,030r	do.
D-65	B. B. Munsey	Southwestern Hydro. Co.	26	Wolfe City	1,063	1,122m	do.
D-66	B. J. & R. J. Paschal	Paschal & Paschal	1	Wolfe City?	---	0	Battery is inoperative.
D-67	Mrs. T. Castles	Peggy O'Harrell	1	Wolfe City?	1,271	0	do.
D-68	Roy Bunch	Dr. Will Miller	2	Wolfe City?	---	0.3r	Brine is allowed to flow on the surface.
D-69	L. L. & B. S. Goldman	Combination Drlg. Co.	2	Wolfe City	1,255	0.6e	Pit - NRD.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon		Brine production (bbls/day)	Methods of brine disposal and remarks
				Name	Top		
D-70	R. B. Richardson	Cortex Oil & Gas Co.	2	Wolfe City	1,130	0.1r	Brine is intermittently released from base of tanks into an unnamed tributary of Lake Halbert Creek.
D-71	T. Moore	---	2	Wolfe City?		0	Battery is inoperative.
D-72	Allen Parr	---	2	Wolfe City?		0	do.
D-73	Donaho	A. C. Smith, R.F. & F. D. Myers	6	Wolfe City	1,266	15r	Pit - NRD.
D-74	D. L. Parr	G. E. Ramseyer	9	Wolfe City	1,268	2r	Brine discharges into a pit which is allowed to overflow into a tributary of Lake Halbert Creek.
D-75	J. B. Paschal	Edwards Petroleum Co.	1	Wolfe City	---	0.5r	Pit - overflows into a tributary of Lake Halbert Creek.
D-76	J. B. Paschal	R. J. Paschal	4	Wolfe City	1,030	0.1e	Brine is drained into a tributary of Lake Halbert Creek.
D-77	D. A. Donaho	J. E. Burkholder	2	Wolfe City	1,300	2r	Pit - overflows into a tributary of Lake Halbert Creek.
D-78	B. L. Gallaway	Roman & Boyd Bros.	3	Wolfe City	1,300	2r	Pit - NRD.
D-79	Tilton	Slade Oil & Gas Co.	2	Wolfe City	1,350±	3e	Pit - NRD.
D-80	T. W. Martin	Slade Oil & Gas Co.	4	Wolfe City	1,350±	12m	Pit - NRD.
D-81	Bessie A. Edens "B"	Slade Oil & Gas Co.	1	Wolfe City	1,350±	2e	Pit - NRD.
D-82	E. E. Newman	Lee Hicks, et al	1	Nacatoch	606	0	Battery is inoperative.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon: Name	Producing horizon: Top	Brine production (bbls/day)	Methods of brine disposal and remarks
D-83	J. R. English	Tex-Harvey Oil Co.	2	Nacatoch	585	1e	Pit - NRD.
D-84	Allen Edens "A"	Tex-Harvey Oil Co.	2	Nacatoch	605	1e	Brine is drained into a road ditch.
D-85	Allen Edens	W. H. Clements	5	Wolfe City?	1,398	4r	Pit - probably drained into a tributary of Richland Creek at intervals. See D-89. The two are reported to make 15 b/d brine.
D-86	A. Edens "B"	Tex-Harvey Oil Co.	2	Nacatoch	798	1r	Pit - NRD.
D-87	C. M. Gillespie	Tex-Harvey Oil Co.	22	Nacatoch Pecan Gap	552 1,382	254m	Pit - drained into an unnamed tributary of Richland Creek. The lease contains 3 Nacatoch wells & 19 Pecan Gap wells. A Woodbine water supply well services 25 injection wells, which flood the Pecan Gap production.
D-88	L. H. Stewart est.	Tex-Harvey Oil Co.	5	Nacatoch Pecan Gap	734 1,340?	12r	Pit - NRD.
D-89	Allen Edens	W. H. Clements	8	Nacatoch Pecan Gap	600 1,398	11r	Pit - drained into a tributary of Richland Creek. See also D-85.
D-90	Reed	United Manufacturing Co.	1	Nacatoch	820	0.4r	Pit - NRD.
D-91	Reed	United Manufacturing Co.	1	Nacatoch	806	0.4r	Pit - NRD.
D-92	Reed	United Manufacturing Co.	1	Nacatoch	799	0.4r	Pit - NRD.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Producing horizon Top	Brine production (bbls/day)	Methods of brine disposal and remarks
D-93	Reed	United Manufacturing Co.	1	Nacatoch	---	0.4r	Pit - NRD.
D-94	Reed	United Manufacturing Co.	1	Nacatoch	---	0.4r	Pit - NRD.
D-95	J. R. English "A"	Tex-Harvey Oil Co.	2	Nacatoch Pecan Gap	790 1,440	1.0r	Pit - NRD. Woodbine water supplies 1 injection well which floods the Nacatoch.
D-96	W. A. Earley "B"	Tex-Harvey Oil Co.	3	Nacatoch	752	1.0r	Pit - NRD. Woodbine water supplies 2 injection wells which flood the Nacatoch.
D-97	Agnes Reed	Campbell, Leggett & Garner	2	Nacatoch	828	2.5r	Pit - NRD.
D-98	E. D. Reed	Clark & Clark	3	Nacatoch	802	2.5r	Pit - drained into a tributary of Richland Creek.
D-99	T. W. R. Harrison	Tex-Harvey Oil Co.	1	Nacatoch	862	2e	Pit - NRD.
D-100	Kate G. Wright	B. Baldridge	10	Nacatoch	856	12r	Pit - NRD.
D-101	T. W. R. Harrison	B. Baldridge	4	Nacatoch	856	0	Pit - NRD.
D-102	B. F. Wilson, Jr.	Lee Hicks, et al	1	Nacatoch	---	2e	Pit - NRD.
D-103	B. F. Wilson, Jr.	Lee Hicks, et al	1	Pecan Gap	---	1e	Pit - NRD.
D-104	Pollard	C. H. Allen	1	---	---	0	Battery is inoperative.
D-105	G. C. Conant "A-B"	Tex-Harvey Oil Co.	3	Pecan Gap	1,392	33m	Pit - NRD. The combined brine discharge at D-105 & D-106= 1.9 gpm.
D-106	G. C. Conant "C"	Tex-Harvey Oil Co.	4	Pecan Gap	1,282	33m	Pits - NRD. See D-105.

Table 2.-Records of tank batteries and brine produced
in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon		Brine production (bbls/day)	Methods of brine disposal and remarks
				Name	Top		
D-107	J. L. Jackson	Tex-Harvey Oil Co.	2	Pecan Gap	1,375	20r	Pit - Evidence of seepage into a tributary of Richland Creek.
D-108	D. C. Bray "B"	Roy Thompson	2	Nacatoch	620	5r	Pit - NRD.
D-109	D. C. Bray	Chi-Tex Oil Co.	2	Nacatoch	---	5r	Pit - NRD.
D-110	Otto Baker	Lee Hicks, et al	2	Nacatoch	610	0.1e	Pit - NRD.
D-111	Otto Baker	Tex-Harvey Oil Co.	1	Pecan Gap	1,402	0.3r	Pit - NRD.
D-112	Stewart	---	1	---	---	0	No pits or evidence of brine.
D-113	C. C. McClung	Lee Hicks, et al	8	Nacatoch Pecan Gap	620 1,414	2e	Pit - NRD. Well #2 is a Pecan Gap well & the other 7 wells are Nacatoch.
D-114	C. C. McClung	Lee Hicks, et al	1	Nacatoch	690	0	Pit - NRD.
D-115	C. C. McClung	Lee Hicks, et al	0	---	---	0	Two 100-bbl storage tanks for D-113. NRD.
D-116	Lennon & Fauber	Lee Hicks, et al	4	---	---	0	No pits or evidence of brine.
D-117	D. C. Bray	Lee Hicks, et al	3	Nacatoch	522	0	do.
E-1	King #1	Southwestern Hydro. Co.	1	Nacatoch	822	2r	Pit - NRD.
E-2	King #2	Southwestern Hydro. Co.	1	Nacatoch	822	1r	Pit - overflows onto the surface.
E-3	Barry	Southwestern Hydro. Co.	13	Nacatoch	700?	2r	Pit - drains onto the surface.
E-4	Cotton Belt Ry."A"	W. E. Butler & E. L. Wilson	4	Nacatoch	707	0.5e	Pit - drained to a tributary of Chambers Creek.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon		Brine production (bbls/day)	Methods of brine disposal and remarks
				Name	Top		
E-5	Dreeben est.	Southwestern Hydro. Co.	6	Nacatoch	---	4r	do.
E-6	Dreeben est.	Thompson Oil Co.	4	Nacatoch	949	1e	Pit - drained into Chambers Creek.
E-7	Love, C. E.	Copeland-Ray	2	Nacatoch?	---	4m	Pit - drained into a tributary of Chambers Creek.
E-8	Cotton Belt Ry.	W. E. Butler & E. L. Wilson	5	Nacatoch	904	171m	do.
E-9	R. Bunch, et al	Thompson Oil Co.	6	Nacatoch	926	5r	Pit - NRD. E-9 & E-10 are for the same 6 wells.
E-10	R. Bunch, et al	Thompson Oil Co.	See E-9	Nacatoch	926	34m	do.
E-11	Charlie Bee, et al	Thompson Oil Co.	2	Nacatoch?	---	0.5r	Disposal to a tributary of Chambers Creek.
E-12	Burke	W. E. Butler & E. L. Wilson	4	Nacatoch	900	7e	Pit - overflows to a tributary of Chambers Creek.
E-13	Charlie Bee, et al	Thompson Oil Co.	4	Nacatoch	920	128m	Pit just below the dam of Lake Corsicana. The brine overflows into a tributary of Chambers Creek.
E-14	F. M. Mitcham "A"	Thompson Oil Co.	4	Pecan Gap	1,715	4r	do.
E-15	Townes Estate	Louis & Lorette Weenick	4	---	---	0	Battery is inoperative.
E-16	Stout	Southwestern Hydro. Co.	10	Nacatoch	---	17m	Pits - drained into a tributary of Chambers Creek.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Producing horizon Top	Brine production (bbls/day)	Methods of brine disposal and remarks
E-17	Hardy-Halbert	Southwestern Hydro. Co.	1	Nacatoch	---	0	Battery is inoperative.
E-18	Big Central	Southwestern Hydro. Co.	10	Nacatoch	---	10m	Pit - NRD.
E-19	Little Central	Southwestern Hydro. Co.	6	Nacatoch	800±	3e	Disposal into a tributary of Post Oak Creek.
E-20	Helen H. Pierce	C. H. Coffield	1	---	---	0	Battery is inoperative.
E-21	John A. Pierce	J. A. Jenkins	1	---	---	0	do
E-22	Walker	Southwestern Hydro. Co.	3	Nacatoch	700±	3r	Disposal into a tributary of Chambers Creek.
E-23	Cora Hardy	Southwestern Hydro. Co.	10	Pecan Gap	1,400±	12m	Direct disposal into a tributary of Chambers Creek.
E-24	Breithaupt	Caraston Oil Co.	2	Nacatoch	782	3r	Pit - drained into Post Oak Creek.
E-25	Breithaupt	Caraston Oil Co.	2	Nacatoch	706	0	No evidence of brine disposal.
E-26	Garvin	Caraston Oil Co.	3	Nacatoch?	---	0	Pit - NRD.
E-27	Garvin	Caraston Oil Co.	4	Nacatoch?	---	13m	Pit - NRD.
E-28	G. Hill	Wheelock Oil Co.	4	Nacatoch?	---	10r	Pit - drained into Post Oak Creek.
E-29	Moore	Southwestern Hydro. Co.	14	Nacatoch	800±	25.7m	Pit - Direct disposal to Post Oak Creek.
E-30	Wright	Southwestern Hydro. Co.	4	Nacatoch	---	2r	Brine is drained onto the surface.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Producing horizon Top	Brine production (bbls/day)	Methods of brine disposal and remarks
E-31	Garvin	Southwestern Hydro. Co.	9	Nacatoch	---	2.5r	Direct disposal to Post Oak Creek.
E-32	Garvin	Southwestern Hydro. Co.	10	Nacatoch	---	2.5r	Brine is drained onto the surface.
E-33	Munsey & Munsey	Southwestern Hydro. Co.	9	Nacatoch	---	0	No evidence of brine disposal.
E-34	Stroube "A"	H. R. Stroube, Jr.	2	Pecan Gap	1,600	0.1e	Pit - drained to Post Oak Creek.
E-35	Blackburn	Southwestern Hydro. Co.	1	Pecan Gap	1,600	0	Pit - NRD.
E-36	Blackburn	Southwestern Hydro. Co.	12	Nacatoch	750	25.7m	Pit - NRD.
E-37	McKinney	Southwestern Hydro. Co.	4	Pecan Gap	1,502	15r	Pit - drained to Post Oak Creek.
E-38	McKinney	Southwestern Hydro. Co.	37	Nacatoch	678	133r	do.
E-39	J. J. W. & H. Wright	Southwestern Hydro. Co.	25	Nacatoch	692	102.9m	do.
E-40	Hickey	Southwestern Hydro. Co.	17	Nacatoch	741	44.7m	do.
E-41	Kerr	Southwestern Hydro. Co.	8	Nacatoch?	---	2r	Disposal to a tributary of Lake Halbert.
E-42	Derden	Southwestern Hydro. Co.	1	Nacatoch	---	0	No evidence of brine disposal.
E-43	Kerr	Southwestern Hydro. Co.	6	Nacatoch?	---	2r	Pit - drained to a tributary of Lake Halbert.
E-44	Wright	Southwestern Hydro. Co.	4	Nacatoch	---	2r	Pits - NRD.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon		Brine production (bbls/day)	Methods of brine disposal and remarks
				Name	Top		
E-45	Benton	Southwestern Hydro. Co.	4	Nacatoch	---	1r	Pit - overflow to a tributary of Lake Halbert.
E-46	Little Gibson	Southwestern Hydro. Co.	7	Nacatoch	---	5r	Pit - NRD.
E-47	Gibson	Southwestern Hydro. Co.	16	Nacatoch	---	10r	Disposal to a tributary of Lake Halbert.
E-48	R. D. Fleming	W. S. Guthrie	1	---	---	0	Battery is inoperative.
E-49	R. D. Fleming	P. Bilbrey & W. Albritton	2	Nacatoch	795	4r	Pit - NRD.
E-50	R. D. Fleming	Heller Oil Co.	4	Pecan Gap	1,685	1r	Pit - NRD.
E-51	Robinson 3rd	Chi-Tex Oil Inc.	1	---	---	5r	Pit - NRD.
E-52	Mrs. Ira H. Boyd	Heller Oil Co.	4	Nacatoch	950	2r	Pit - NRD.
E-53	J. M. Wright	Guthrie & Guthrie	3	Nacatoch	817	0.1e	Pit - overflow onto surface.
E-54	M. N. Wright	O. P. Forsythe	2	Nacatoch	857	1r	Pits - NRD.
E-55	Ellis "B"	Southwestern Hydro. Co.	4	Nacatoch	813	2.5r	Pit - NRD.
E-56	Ellis "A"	Southwestern Hydro. Co.	4	Nacatoch	750±	2.5r	Pit - NRD.
E-57	Coggins	Barrow Kidd	3	Nacatoch	855	0	Pit - NRD.
E-58	Stroube, Jr.	H. R. Stroube, Jr.	3	Nacatoch?	920	Trace e	Pit - NRD.
E-59	Stroube	J. R. Stroube, Jr.	11	Nacatoch	728	Trace e	Pit - NRD.
E-60	Lospitch	Moore & Dobkins	12	Nacatoch	869	25.7m	Pit - NRD.
E-61	Chapman "C"	Southwestern Hydro. Co.	17	Nacatoch	900±	1.9r	Pit - NRD.

Table 2.-Records of tank batteries and brine produced
in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Producing horizon Top	Brine production (bbls/day)	Methods of brine disposal and remarks
E-62	Laura Sloan	W. E. Butler	4	Nacatoch	812	17.1e	Pit - NRD.
E-63	Church	Butler - Calhoun	3	Nacatoch	---	4r	Disposal to De Arman Branch.
E-64	Laura Sloan	Butler - Calhoun	1	Nacatoch	---	0	No evidence of brine disposal.
E-65	J. H. Burke	R. J. Paschal	2	Nacatoch	882	Trace	Brine is released into a road ditch.
E-66	Church	Butler - Calhoun	1	Nacatoch?	---	--	No evidence of brine disposal - NRD.
E-67	Moncrief	Butler - Calhoun	1	Nacatoch	832	Trace e	Brine is released into a road ditch.
E-68	J. O. Burke	R. J. Paschal	6	Nacatoch	790	0	No evidence of brine disposal - NRD.
E-69	Moncrief	Butler - Calhoun	3	Nacatoch	812	Trace e	Brine is released into a road ditch.
E-70	Brown	Copeland - Ray	1	Nacatoch	710	0	No evidence of brine disposal - NRD.
E-71	Tatum	C. M. Copeland	2	Nacatoch	684	0	do.
E-72	Richey (on Kerr lease)	Copeland - Ray	2	Nacatoch	---	0	do.
E-73	Kerr	Butler - Calhoun	4	Nacatoch	782	0	do.
E-74	A. Brown	Copeland - Ray	2	Nacatoch	721	0	do.
E-75	Ray, Harriett Brown	Ennis Oil & Develop. Co.	6	Nacatoch	758	0	do.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon		Brine production (bbls/day)	Methods of brine disposal and remarks
				Name	Top		
E-76	J. A. Burke	Ennis Oil & Develop. Co.	3	Nacatoch	770	0	do.
E-77	W. N. Kenner	R. J. Paschal	7	Nacatoch	820	0	do.
E-78	Moncrief	Butler - Calhoun	5	Nacatoch	---	Trace e	Disposal to De-Arman Branch.
E-79	Church (?)	H. R. Stroube, Jr. (?)	1	Nacatoch?	---	0	Battery is inoperative.
E-80	Clement	Southwestern Hydro. Co.	4	Nacatoch?	---	1r	Pit - drained into tributary of Post Oak Creek.
E-81	Buchanan	Southwestern Hydro. Co.	6	Nacatoch	---	1r	Disposal to a tributary of Post Oak Creek.
E-82	Cerf	Thompson Oil Co.	4	Nacatoch	940	3r	Pit - seeps onto the surface.
E-83	Will Thompson "B"	Thompson Oil Co.	1	Nacatoch?	---	Trace r	Pit - NRD.
E-84	James Cerf	Smith & Breyer	2	Nacatoch?	---	4r	Pits - NRD.
E-85	J. E. Butler	Smith & Breyer	13	Nacatoch?	---	58.3m	Pit - NRD.
E-86	Mrs. Jessie Humphries	Smith & Breyer	5	Nacatoch	930	10r	Pits - NRD.
E-87	E. L. Wilson	Heller Oil Co., et al	2	Nacatoch	907	1r	Pit - NRD.
E-88	Vaught	S. & M. Oil Co.	1	Nacatoch?	---	Trace e	Pit - NRD.
E-89	Mrs. Ira H. Boyd	Heller Oil Co.	5	Nacatoch	890	2r	Pit - NRD.
E-90	G. B. Matlock	Smith & Breyer	2	Nacatoch	---	6r	Pit - NRD.
E-91	R. D. Fleming	Great Western Drlg. Co.	1	Nacatoch?	---	3r	Disposal to Cedar Creek.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Top	Brine production (bbls/day)	Methods of brine disposal and remarks
E-92	R. D. Fleming	C. H. Coffield	1	Nacatoch	830±	0	Battery is inoperative.
E-93	J. N. Edens, Jr.	W. S. Guthrie	1	Nacatoch	853	0.5r	Pit - NRD.
E-94	J. N. Edens, Jr.	Stewart Oil & Gas Co.	5	Nacatoch	800	5r	Pit - NRD.
E-95	Laura B. Allen	P. Bilbrey & W. Albritton	1	Nacatoch	1,069	7r	Pit - NRD.
E-96	J. F. Allen est.	R. W. Gutzler, et al	4	Nacatoch	1,081	3.4e	Pit - NRD.
E-97	L. B. Allen est. "A"	P. Bilbrey & W. Albritton	2	Nacatoch	1,061	3r	Pit - NRD.
E-98	L. B. Allen est.	David Frame, Jr.	4	Nacatoch	902	2r	Pit - NRD.
E-99	Lizzie Ward	David Frame, Jr.	5	Nacatoch	891	3r	Pit - NRD.
E-100	T. W. R. Harrison	Lee Hicks, et al	4	Nacatoch	910	Trace e	Disposal to a tributary of Richland Creek.
E-101	Boyd A & B	Roman & Boyd Bros.	4	Nacatoch?	---	Trace e	Pit - NRD.
E-102	O. V. Harvard "B"	McNeill-Rice, et al	3	Nacatoch	1,007	2r	Pit - NRD.
E-103	C. C. Hudson	O. M. Rector	5	Nacatoch	1,015	2r	Pit - NRD.
E-104	Tidewater "Brassie"	O. G. Fletcher	1	Nacatoch	980	Trace e	Pit - NRD.
E-105	R. H. Boyd	J. D. Davis Co.	1	Woodbine	2,520±	685m	Pit - drained into tributary of Crab Creek.
E-106	Harrell	E. L. Wilson	1	Nacatoch	974	1r	Pit - NRD.
E-107	H. B. Boyd	Ace Oil Co.	1	Woodbine	2,976	302m	Pit - drained to Crab Creek.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Top	Brine production (bbls/day)	Methods of brine disposal and remarks
E-108	Monark O. & R. Corp.	E. L. Wilson	1	Nacatoch	948	3.4e	Pit - NRD.
E-109	Harwell	Southwestern Hydro. Co.	2	Nacatoch	800	0	No evidence of brine disposal - NRD.
E-110	Harwell	C. H. Coffield	5	Nacatoch	878	10r	Pit - drained to a tributary of Crab Creek.
E-111	Arlington, Rock-Is. RR	McNeill-Rice, et al	2	Nacatoch	1,005	2.5r	Pit - drained to Crab Creek.
E-112	C. Harwell	---	2	Nacatoch?	---	3.4e	Pit - drained to a tributary of Crab Creek.
E-113	J. M. Harvard	---	1	Nacatoch?	---	Trace e	Pit - NRD.
E-114	J. T. Rose	Joseph Davis Co.	5	Woodbine	2,974	858e	Pit - drained to Crab Creek.
E-115	Laura Lovett	Earnest B. Wilson	5	Nacatoch	880	3.4e	Pit - drained into a tributary of Crab Creek.
E-116	Laura Lovett	Three States Oil Co.	4 1	Woodbine Nacatoch	2,707 967	635r	Direct disposal to a tributary of Crab Creek.
E-117	Laura Lovett	Southwestern Hydro. Co.	4	Nacatoch	900	Trace e	Pits - NRD.
E-118	Kellum "A"	Beren, Jaffe, et al	3 1	Woodbine Nacatoch	2,975 1,100	5,150m	Direct disposal into a tributary of Crab Creek.
E-119	Kellum "B"	Beren, Jaffe, et al	1	Woodbine	2,975	1,286m	Pit - drained into a tributary of Crab Creek.
E-120	Hill	J. Olsan est.	1	Woodbine	2,765	1,029e	Crab Creek.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Producing horizon Top	Brine production (bbls/day)	Methods of brine disposal and remarks
E-121	Hill	Stroube & Stroube	5	Woodbine	2,828	5,490e	Disposal to a tributary of Crab Creek.
E-122	Miller	Miller Oil Co.	4	Woodbine	---	1,000r	Direct disposal to Crab Creek.
E-123	Hill - Fee	J. Olsan est.	1	Woodbine	2,916	936m	Pit - drained to a tributary of Crab Creek.
E-124	P. H. Alexander	J. Olsan est.	1	Woodbine	2,850	1,000r	Pit - drained to a tributary of Crab Creek.
E-125	R. D. Fleming	Three States Nat. Gas Co.	4	Woodbine	2,860	645m	do.
E-126	R. D. Fleming	Beren, Jaffe, et al	2	Woodbine	2,940	1,142m	do.
E-127	R. D. Fleming	J. C. Sitton	2	Woodbine Wolfe City	2,880 1,545	250m	Direct disposal to a tributary of Crab Creek.
E-128	R. D. Fleming	Blue Bonnet Prod. Co.	1	Nacatoch	1,100	0	No evidence of brine disposal - NRD.
E-129	Davis	J. Olsan est.	2	Woodbine	2,902	2,060m	Pit - drained to a tributary of Crab Creek.
E-130	B & M Cerf	J. Olsan est.	1	Woodbine	2,841	888m	Pits - drained to a tributary of Crab Creek.
E-131	Eugene Cerf	Stroube & Stroube	2	Woodbine	2,850	514e	do.
E-132	J. N. Cerf	Three States Nat. Gas Co.	1	Woodbine	2,859	412m	do.
E-133	James Cerf	Tex. Jersey Oil Corp. D. P. Dean	5	Wolfe City	1,140	2r	Pit - NRD.
E-134	Varner Humphries	J. Olsan est.	1	Woodbine	---	1,142m	Pits - drained into Cedar Creek.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Top	Brine production (bbls/day)	Methods of brine disposal and remarks
E-135	J. B. Bush	Thompson Oil Co.	1	Wolfe City?	---	1r	Pits - NRD. Well originally penetrated the Woodbine sand, but present production is from a shallower pay-possibly the Wolfe City sand.
E-136	Humphries	J. Olsan, est.	8	Woodbine	2,839	5,140m	Pits
E-137	I. N. Cerf	J. Olsan, est.	4	Woodbine	2,841	4,400r	Pits - drained into Crab or Cedar Creek.
E-138	Murchinson	Blue Bonnet Prod. Co.	3	Wolfe City	1,586	3r	Pits - NRD.
E-139	Geo. Robertson	Blue Bonnet Prod. Co.	4	Wolfe City	1,566	4.1m	Pits - NRD.
E-140	R. I. Kent	Fred C. Ohlenbusch	2	Wolfe City	1,602	3.4e	Pit - NRD.
E-141	R. I. Kent	Blue Bonnet Prod. Co.	5	Wolfe City	1,607	3.4e	Pit - NRD.
E-142	R. I. Kent	Fred C. Ohlenbusch	3	Wolfe City	1,635	4e	Pit - NRD.
E-143	W. P. Miller	Sam Trant	1	Wolfe City	1,596	3.4e	Pit - NRD.
E-144	Fred Thompson	Rambo-Miller-Stein	1	Wolfe City	1,628	Trace e	Disposal to a nearby road ditch.
E-145	Ramsey Est. "A"	Sam Trant	2	Wolfe City	1,602	8r	Pits - NRD.
E-146	R. I. Kent	Niblack	11	Wolfe City?	---	3.4e	Pits - NRD.
E-147	Ramsey "B"	Sam Trant	4	Wolfe City	1,498	18r	Pits - NRD.
E-148	S. D. Ramsey est.	Wm. W. Dyer, Trustee	4	Wolfe City	1,510	0	Battery is inoperative.
E-149	S. D. Ramsey est.	Valley Ridge Oil Co.	7	Wolfe City	1,500	3.4e	Pits - NRD.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Producing horizon Top	Brine production (bbls/day)	Methods of brine disposal and remarks
E-150	Sitton	J. C. Sitton	3	Nacatoch	1,140	Trace e	Pits - NRD.
E-151	J. B. Bush	Frances Oil Co.	4	Woodbine	2,900	6,870m	Direct disposal to a tributary of Cedar Creek.
E-152	M. Cunningham	Beren, Jaffe, et al	1	Woodbine	---	1,142m	Pits - drained into Cedar Creek.
E-153	Ramsey Acct. #1	Frances Oil Co.	3	Woodbine	---	1,142m	do.
E-154	Ramsey Acct. #2	J. Olsan est.	5	Woodbine	2,823	6,870m	Pits - drained into Cedar Creek.
E-155	I. T. Kent "A"	Frances Oil Co.	6	Wolfe City	1,483	5.1e	Direct disposal to Cedar Creek.
E-156	Ramsey Acct. #3	J. Olsan est.	1	Woodbine	2,875	1,285m	Pit - drained to Cedar Creek.
E-157	I. T. Kent	Frances Oil Co.	2	Woodbine	---	2,060e	Disposal into Cedar Creek.
E-158	G. C. Kent	J. Olsan est.	2	Woodbine	2,845	2,060e	Pits - drained into Cedar Creek.
E-159	W. J. McKie "A"	Francis Oil Co.	4	Woodbine	---	5,150m	do.
E-160	W. J. McKie "B"	J. Olsan est.	2	Woodbine	2,843	2,060e	Pits - drained to a tributary of Post Oak Creek.
E-161	McKie	Mid-Tex Oil Co. (A. C. Smith)	6	Nacatoch	970	36.7m	do.
E-162	W. J. McKie	Glenrose Oil Co.	12	Nacatoch	954	85.8m	do.
E-163	McKie	Joseph Davis Co.	5	Woodbine	2,900	3,500r	Pits - drained into a tributary of Chambers Creek.

Table 2.-Records of tank batteries and brine produced
in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Producing horizon Top	Brine production (bbls/day)	Methods of brine disposal and remarks
E-164	Chapman	Southwestern Hydro. Co.	4	Woodbine	2,814	4,800e	Direct disposal to Post Oak Creek.
E-165	Burke	Moore, Dobkins & Crabtree	1	Woodbine	2,852	686e	Pits - drained into Chambers Creek.
E-166	Blumrosen	Rowland Savage	6	Pecan Gap	1,248	8.6m	Pits - NRD.
E-167	Fair est.	Moore & Dobkins	3	Pecan Gap	1,245	9.3m	Pits - NRD.
E-168	W. J. McKie	W. J. Hunter	3	Pecan Gap	1,228	7r	Pits - NRD.
E-169	W. J. McKie	W. M. Skinner, et al	6	Pecan Gap	1,232	2r	Direct disposal into tributary of Chambers Creek.
E-170	Mrs. Wills	Thompson Oil Co.	2	Pecan Gap	1,230	0	Battery is inoperative.
E-171	W. J. McKie "C"	Geo. D. Blaylock?	2	Pecan Gap	---	0	do.
E-172	W. J. McKie "B"	Blaylock-Titus	3	Pecan Gap	1,228	0	do.
E-173	W. J. McKie "A"	Blaylock-Titus	1	Pecan Gap	---	0	Pits - NRD.
E-174	C. Beard "A"	G. E. Penn	1	Wolfe City	1,530	0.3r	Brine is probably drained onto the surface.
E-175	C. Beard "C"	G. E. Penn	1	Wolfe City	1,530	0.3r	do.
E-176	Joe D. Graves	Guy & J. C. Sitton	8	Wolfe City	1,482	1r	Pits - Drained to Cedar Creek.
E-177	C. Beard "B"	G. E. Penn	2	Wolfe City	1,512	0.3r	Pits - NRD.
E-178	Jane Smith #2	A. C. Smith	2	Wolfe City	1,560	0	Battery is inoperative.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Producing horizon Top	Brine production (bbls/day)	Methods of brine disposal and remarks
E-179	N. Bryant	W. J. Oil Co.	1	Wolfe City?	1,598	0.5r	No evidence of brine disposal.
E-180	Wade Smith	B. Boldridge	6	Wolfe City	1,545	12r	Pits - drained onto the surface.
F-1	W. M. Montgomery	The Texas Co.	4	Woodbine	3,392	607r	Pits - NRD.
F-2	P. T. Fullwood	J. Olsan est.	3	Woodbine	3,395	619r	Pits - drained to a tributary of Chambers Creek.
F-3	J. L. Davidson	Four W. Oil Co.	2	Woodbine	3,394	40r	Pits - NRD.
F-4	Greenlee	Wheelock Oil Co.	2	Woodbine	3,389	50r	Pits - NRD.
F-5	1st Nat'l Bank of Corsicana	Humble Oil & Refining Co.	1	Woodbine	3,380	60r	Pit - NRD.
F-6	Davidson	J. Olsan est.	1	Woodbine	3,393	257m	Pits - drained into a tributary of Chambers Creek.
F-7	P. T. Fullwood	Humble Oil & Refining Co.	6	Woodbine	3,366	240r	Brine is pumped to a salt water disposal well, which injects it into a lower Woodbine sand - about 250 feet below the pay horizon.
F-8	Naomi D. Blaize	Humble Oil & Refining Co.	2	Woodbine	3,364	189r	do.
F-9	Naomi D. Blaize	Humble Oil & Refining Co.	4	Woodbine	3,370	39r	do.
F-10	1st Nat'l Bank of Corsicana	Humble Oil & Refining Co.	7	Woodbine	---	607r	do.
F-11	R. D. Grantham	Humble Oil & Refining Co.	5	Woodbine	3,366	565r	do.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Producing horizon Top	Brine production (bbls/day)	Methods of brine disposal and remarks
F-12	W. M. Montgomery	The Texas Company	5	Woodbine	3,371	2,350r	do.
F-13	Ray	Carter and Jones	1	Woodbine	3,380	257m	Pits - drained into Chambers Creek.
F-14	Stockton	Carter and Jones	1	Woodbine	3,380	514m	do.
G-1	J. T. Jackson	Crawford Heddon Bros.	3	Pecan Gap	1,356	19r	Pits - NRD.
G-2	Lennon	Lee Hicks	4	Nacatoch	554	Trace e	Pits - NRD.
G-3	Fesmire	Southwestern Hydro. Co.	3	Nacatoch	---	Trace e	Direct disposal to a tributary of Richland Creek.
G-4	Highnote	Southwestern Hydro. Co.	4	Nacatoch	---	3r	Pits - NRD.
G-5	J. H. Williams	Bill T. McCracken	3	Nacatoch	---	0.5r	Brine is drained onto the surface.
G-6	J. H. Williams	Bill T. McCracken	6	Nacatoch	648	0	No evidence of brine disposal.
G-7	McGage	Southwestern Hydro. Co.	1	Pecan Gap	1,500	0	do.
G-8	Latta	Southwestern Hydro. Co.	4	Nacatoch	700	0	do.
G-9	Love	Tex-Harvey Oil Co.	1	Pecan Gap	1,300	0	do.
G-10	Rice	Tex-Harvey Oil Co.	6	Pecan Gap	1,315	2r	Pit - probably drained to a tributary of Richland Creek.
G-11	Earley-Rice Community	Tex-Harvey Oil Co.	3	Pecan Gap Nacatoch	1,300 470	Trace e	Pits - drained into tributary of Richland Creek.
G-12	W. A. Earley	Tex-Harvey Oil Co.	12	Pecan Gap	1,322	30r	do.

Table 2.-Records of tank batteries and brine produced in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Producing horizon Top	Brine production (bbls/day)	Methods of brine disposal and remarks
G-13	Love #4	Tex-Harvey Oil Co.	1	Nacatoch	568	0	Battery is probably inoperative
G-14	Lurline Hines	Southwestern Hydro. Co.	8	Nacatoch	702	13.7m	Pit - Drained into a tributary of Richland Creek.
G-15	Graves	Southwestern Hydro. Co.	9	Nacatoch	800	4.1m	do.
G-16	Hines	Southwestern Hydro. Co.	10	Nacatoch	633	17.1m	do.
G-17	Maise	Major Production Co.	3	Nacatoch	---	0.5e	Pit - NRD.
G-18	W. P. Brown	Johnston & Owen	2	Woodbine	2,900	810r	Pit - drained into a tributary of Little Pinoak Creek.
G-19	Swink	Johnston & Owen	1	Woodbine	2,900	168m	do.
G-20	Davis	Johnston & Owen	1	Woodbine	2,900	168m	do.
G-21	Garrett	C. L. Keeling, Childs, Pope	5	Nacatoch	700	113m	do.
G-22	Tyner	W. A. Reiter, et al	4	Nacatoch	705	113m	do.
G-23	Garrett	W. A. Reiter, et al	9	Nacatoch	720	85.8m	do.
G-24	Ebb Bounds	Smith & Breyer	2	Nacatoch	720	0	No evidence of brine disposal.
G-25	Meador	W. A. Reiter	2	Nacatoch	728	0	Battery is inoperative.
G-26	Longbottom	Reed Oil Co.	5	Woodbine	3,000	3,420m	Pit - drained to a tributary of Richland Creek.
J-1	I. T. Kent	Carter-Gragg Oil Co.	1?	Pettet	6,834	0.5r	Pit - NRD.
J-2	A. V. Neal "B"	Color. Oil & Gas Corp.	1	Pettet	6,840	0	Battery is inoperative.

Table 2.-Records of tank batteries and brine produced
in lower watershed of Chambers and Richland Creeks, Navarro County--Continued

Map No.	Lease	Operator	No. of wells	Producing horizon Name	Producing horizon Top	Brine production (bbls/day)	Methods of brine disposal and remarks
J-3	A. V. Neal "A"	Color. Oil & Gas Corp.	1	Pettet	6,832	3.4e	Pit - NRD.
J-4	M. Johnson "A"	Color. Oil & Gas Corp.	1	Pettet	6,815	1.7e	Pit - NRD.
J-5	M. H. Anderson	Carter-Gragg Oil Co.	2	Pettet	6,828	3.4e	Pits - NRD.
J-6	G. C. Baker "A"	Color. Oil & Gas Corp.	1	Pettet	6,872	0	Battery is inoperative.
J-7	J. P. Anderson	Tex. Crude Oil Co. & Landa Oil Co.	1	Pettet	6,829	3.4e	Pit - NRD.
J-8	Les Quals	Color. Oil & Gas Corp.	1	Pettet	6,800	8r	Pits - NRD.
J-9	Les Quals "B"	Color. Oil & Gas Corp.	1	Pettet	6,828	4r	Pit - NRD.
J-10	Mrs. J. E. Edens	Carter-Gragg Oil Co.	1	Pettet	6,886	1r	Pit - NRD.
J-11	Mrs. J. E. Edens	Carter-Gragg Oil Co.	1	Pettet	6,901	1e	Pit - Drained into a tributary of Richland Creek.
J-12	U. F. Roberts "A"	Color. Oil & Gas Corp.	1	Pettet	6,826	0	No evidence of brine disposal.
J-13	W. L. Redwine "A"	Color. Oil & Gas Corp.	1	Pettet	6,872	0	do.
J-14	M. J. Hail	Color. Oil & Gas Corp.	1	Pettet	6,873	11r	Pit - drained into a tributary of Richland Creek.
J-15	C. J. Folmar "A"	Color. Oil & Gas Corp.	1	Pettet	6,862	3.4e	Pit - NRD.
J-16	Gibbs Bros.	Carter-Gragg Oil Co.	1	Pettet	6,887	5.1m	Pit - NRD.

Table 3.-Analyses of formation waters near Corsicana
(Analyses by City of Fort Worth, unless otherwise designated)

Sample no. /1	Description and location of sampling point	Date sampled	Formation sampled	Depth below surface (ft.)	Geologic structure	Chemical Constituents (parts per million): Total solids /2	Chlorides /2	Sodium /2	Calcium /2	Magnesium /2	Silica and insolubles /2	Iron /2	Sulphate /2	Carbonate /2	Bicarbonate /2	Iron and alum. oxides /2
1	Municipal water well town of Purdon	3/ 1/57	Woodbine	1,774	--	3,680 /3	1,358	1,475	10	5	--	0.22	127	0	1,152	--
2	Municipal well, Emhouse Community	11/ 2/56	Woodbine	1,750	--	3,840 /3	1,038	1,180	6	3	--	4.00	273	0	1,152	--
3	Southwestern Hydrocarbons, R. D. Fleming lease: water-flood supply well for Wolfe City production; J. Peoples Survey	5/28/58	Upper Woodbine	2,497	Upthrown block	7,134	3,239	2,567	19	7.9	25.2	0.13	1.2	57.6	1,215.1	2.0
4	Tex Harvey Oil Co. Stewart lease: water-supply well: Michael Shire Survey	6/13/58	Woodbine	3,081	In graben	8,117	3,850	2,937	24.6	8.5	20.0	0.20	0.4	9.6	1,263.9	2.4
5	W. J. McKie, estate of J. Olson dec., well No. "B" 9; A. Buffington Survey	7/ 2/58	Woodbine	2,843	Upthrown block-east	13,867	7,400	5,103	75.6	36.8	28.4	0.88	0.4	0	1,220	1.6
6	South Kerens field; Wheelock Oil Co. Greenlee Well No. 2; Robert Caradine Survey	6/ 4/58	Woodbine	3,389	Upthrown east of graben	30,003	17,450	11,305	182.5	86.9	27.2	0.52	51.9	0	893.0	5.6
7	Composite sample-wells 1-4; Thompson Oil Company, Dreben lease; S. F. McCauless Survey	7/23/58	Nacatoch	949	Upthrown west of graben	13,375	8,000	4,900	217	58.4	10.4	0.26	0.4	0	187.9	2.4
8	Composite sample-10 wells; Southwestern Hydrocarbons Big Central lease; W. J. Cairns Survey	5/28/58	Nacatoch	800±	Downthrown block	20,488	12,095	7,393	383.6	98.7	15.5	0.88	1.2	0	463.6	35.5

Table 3.-Analyses of formation waters near Corsicana--Continued
(Analyses by City of Fort Worth, unless otherwise designated)

Sample no. /1	Description and location of sampling point	Date sampled	Formation sampled	Depth below surface (ft.)	Geologic structure	Chemical Constituents (parts per million)										
						Total solids /2	Chlorides /2	Sodium /2	Calcium /2	Magnesium /2	Silica and insolubles /2	Iron /2	Sulphate /2	Carbonate /2	Bicarbonate /2	Iron and alum. oxides /2
9	Domestic well, Richland Community	8/26/57	Nacatoch	60	--	786 /3	126	315	3	--	--	.06	36	0	537	--
10	Municipal well, Richland Community	8/12/57	Nacatoch	109	--	834 /3	132	343	1	1	--	.34	12	96	409	--
11	Composite sample-6 wells; Southwestern Hydrocarbons, Buchanan lease; M. J. Tidwell Survey	5/28/58	Nacatoch	800	Down-thrown block	16,590	9,969	6,084	281.0	61.2	16.5	0.32	2.8	0	146.4	6.5
12	Composite sample; R. J. Paschal, W. M. Kenner well No. 1; P. Lane Survey	7/ 9/58	Nacatoch	820+	Upthrown block	21,027	12,650	7,682	363	101	6.0	0.4	1.0	0	222	1.5
13	Municipal test well, town of Richland	7/31/57	Nacatoch?	250	--	4,902 /4	2,080	1,790	22	7	--	2.4	109	0	609	--
14	Composite sample-wells 1A, 2A & 6A Southwestern Hydrocarbons, McKinney lease: W. R. Brown Survey A-57	5/28/58	Pecan Gap	1,502	Down-thrown block	34,974	21,254	12,576	806.9	175.8	17.0	1.7	1.2	0	131.8	10.0
15	Rowland Savage, Bloomrosen well No. 2; W. P. Lane Survey	7/ 9/58	Pecan Gap	1,248	Upthrown east of graben	32,002	19,500	11,452	524	343	11.0	1.6	1.0	0	164	5.0
16	Stewart Oil and Gas Co., M. N. & O RR lease, well No. 18; J. Peoples Survey	7/ 2/58	Wolfe City	1,031	Upthrown block	34,790	21,200	12,368	855.9	233.9	11.0	1.54	0.8	0	112.2	6.0
17	Frances Oil Company I. L. Kent well No. 41; J. Smith Survey	7/ 9/58	Wolfe City	2,031	In graben	35,686	21,700	12,870	406	428	21.0	5.5	1.6	0	244	9.0
18	Frances Oil Company, I. L. Kent well No. 36; J. Smith Survey	7/ 9/58	Upper Wolfe City	1,501	Upthrown east of graben	33,150 /4	17,800	--	--	--	--	3.9	--	--	--	--

Table 3.-Analyses of formation waters near Corsicana--Continued
(Analyses by City of Fort Worth, unless otherwise designated)

Sample no. /1	Description and location of sampling point	Date sampled	Formation sampled	Depth below surface (ft.)	Geologic structure	Chemical Constituents (parts per million) Total solids /2	Chlorides /2	Sodium /2	Calcium /2	Magnesium /2	Silica and insolubles /2	Iron /2	Sulphate /2	Carbonate /2	Bicarbonate /2	Iron and alum. oxides /2
19	Blue Bonnet Production Company, R. D. Fleming Well No. 1; Jno. Werner Survey	7/17/58	Nacatoch	±1,100	Downthrown block	22,310	13,000	8,232	166	153	11.0	1.6	1.2	0	742	4.0
20	Blue Bonnet Production Company, R. I. Kent well No. 6; J. B. Barry Survey	7/17/58	Wolfe City	1,634	Upthrown	39,727 /5	21,250	12,424	832	242	13.0	0.3	1.0	0	146	8.0

/1 Numbers correspond to the numbers of sampling points on Plate 1.

/2 Values derived from sum of determined constituents unless otherwise noted.

/3 Incomplete analysis by Texas Department of Health; total solids determined by evaporation; sample represents Woodbine water away from oil producing area.

/4 Incomplete analysis; total solids determined by evaporation.

/5 Total solids determined by evaporation.

Table 4.--Chemical analyses of brine disposed in Crab and Cedar Creeks near Corsicana
(Analyses by City of Fort Worth)

Sampling-measurement date	Rainfall at Corsicana (inches)		Rate of flow (bbls. per day)		Partial analyses (chemical constituents in parts per million)																	
					Total solids*		Chloride		Sodium		Calcium		Magnesium		Sulfate		Carbonate		Bicarbonate		Iron	
	Date	Amount	Crab	Cedar	Crab	Cedar	Crab	Cedar	Crab	Cedar	Crab	Cedar	Crab	Cedar	Crab	Cedar	Crab	Cedar	Crab	Cedar	Crab	Cedar
5/26/58			21,236	23,929	15,098	14,484	8,653	7,996	5,737	5,471	78	42	36	32	3.3	1.4	96	134.4	488	786	0.37	0.09
5/29/58			24,252	26,930	15,162	14,711	8,653	8,046	5,738	5,527	56	33	37	40	4.9	2.8	96	86	551	927	0.37	0.27
6/2/58			24,560	27,407	15,342	14,450	8,700	7,900	5,810	5,438	53	34	42	37	72.4	36.0	86	96	551	878	0.28	0.10
6/5/58			26,191	23,360	15,231	14,682	8,700	8,100	5,779	5,535	49	41	40	38	2.9	1.7	67	125	571	805	0.16	0.16
6/9/58			19,528	26,453	15,388	14,728	8,750	8,100	5,798	5,546	63	34	44	40	1.0	0.6	29	101	678	873	0.30	0.48
6/12/58			22,144	25,283	15,184	15,077	8,600	8,100	5,733	5,856	50	46	42	40	0.8	0.8	43	72	688	932	2.04	0.18
6/16/58			23,129	26,776	15,051	14,461	8,550	7,950	5,694	5,440	53	44	37	36	0.8	0.4	48	96	644	869	0.12	0.28
	6/17 6/18	0.72 0.22																				
6/19/58			21,021	28,407	14,951	14,587	8,500	8,000	5,652	5,487	61	35	61	37	1.0	1.4	48	82	624	913	0.24	0.20
	6/22	0.24																				
6/23/58			23,590	30,192	14,791	14,224	8,400	7,800	5,575	5,347	64	41	64	38	7.6	8.4	53	106	625	859	0.40	0.56
6/26/58	6/26	0.21	21,559	28,299	15,155	14,524	8,600	8,000	5,732	5,454	52	52	52	40	2.7	3.9	82	106	615	844	0.36	0.40
6/30/58			20,975	30,577	15,001	14,615	8,550	8,050	5,678	5,477	45	55	45	40	1.2	1.6	48	82	610	878	0.28	0.68
7/2/58			22,129	29,731	15,337	14,875	8,700	8,200	5,770	5,603	67	41	44	39	0.6	0.8	53	110	673	854	1.04	1.04
	7/6 7/7 7/8	1.04 0.57 0.02																				
7/10/58			22,760	30,485	14,767	14,168	8,400	7,700	5,619	5,260	38	85	42	41	2.1	5.1	110	96	551	912	0.04	0.80
7/17/58			21,405	30,023	15,488	14,915	8,800	8,200	5,873	5,644	41	26	43	38	1.2	0.4	72	144	134	835	0.18	0.08
	7/23	0.02																				
7/24/58			22,036	28,824	15,725	14,664	9,000	8,050	5,958	5,518	64	41	45	39	1.0	1.0	101	115	537	874	0.12	0.12
	8/4	0.05																				
8/7/58			22,082	25,176	16,060	14,967	9,100	8,200	6,034	5,593	53	41	43	40	0.8	1.2	86	120	551	810	0.04	0.08
Averages			22,412	27,616	15,233	14,633	8,666	8,025	5,761	5,512	55	43	45	38	6.5	4.2	70	104	568	865	0.40	0.35
Weighted averages concentrations of combined flow					14,902		8,312															

*Values represent the sum of determined constituents.

Table 5.--Weighted average chemical analyses of brine produced near Corsicana
(Analyses by City of Fort Worth)

Brine producing formation	Brine producing rate (bbls per day)	Percent of total brine produced	Partial analyses (constituents in ppm): Total solids	Chlorides	Sodium	Silica and insolubles	Calcium	Magnesium	Iron and aluminum oxides	Iron	Sulphate	Bicarbonate
Woodbine	83,549	87.67	15,109	8,174	5,581	28.3	84.1	40.7	1.9	.85	4.40	1,195
Wolfe City	9,724	10.21	34,830	21,200	12,368	11.0	856.0	234.0	6.0	1.53	.80	112
Nacatoch	1,496	1.57	18,654	11,038	6,839	13.6	250.2	97.3	9.4	.79	1.70	398
Pecan Gap	479	.50	34,819	21,163	12,518	16.6	792.0	187.0	9.8	1.70	1.15	134
Pettet	46	.05	232,600	144,400	60,276	36.0	24,565.0	2,822.0	136.0	65.60	228.00	81
Weighted average analysis of produced brine			17,385	9,682	6,356	26.2	181.3	63.4	2.7	.96	4.09	1,066

Table 6.--Weighted average analyses of brine disposed in surface drainageways near Corsicana
(Chemical analyses by City of Fort Worth)

Brine producing formation	Disposal rate (bbls/day)	Percentage of daily volume disposed to drainageways	Chemical constituents (parts per million)									
			Total solids	Chlorides	Sodium	Silica and insolubles	Calcium	Magnesium	Iron and aluminum oxides	Iron	Sulphate	Bicarbonate
Woodbine	78,802	96.20	14,206	7,611	5,233	28.4	78	38	1.6	0.87	1.50	1,213
Wolfe City	1,600	1.95	34,849	21,201	12,370	11.1	856	234	6.0	1.52	0.80	113
Nacatoch	1,177	1.44	19,027	11,227	6,981	13.2	238	104	9.1	0.33	1.60	447
Pecan Gap	354	0.40	34,959	21,246	12,570	17.0	806	177	10.0	1.70	1.20	132
Pettet	12	0.01	232,600	144,400	60,276	36.0	24,565	2,822	136.0	65.60	228.0	81
Weighted average analysis of all brine disposed to surface drainageways.			14,783	7,996	5,432	27.8	101	44	1.8	.89	1.51	1,176

Table 7.--Weighted average chemical analyses of brine disposed in earthen pits near Corsicana
(Chemical analyses by City of Fort Worth)

Brine producing formation	Daily rate of pit disposal (bbls)	Percentage of total volume disposed to pits daily	Partial analyses (constituents in ppm)									
			Total solids	Chlorides	Sodium	Silica and insolubles	Calcium	Magnesium	Iron and aluminum oxides	Iron	Sulphate	Bicarbonate
Woodbine	757	43.4	30,003	17,450	11,305	27.0	183	87	5.6	0.52	5.2	893
Wolfe City	505	28.9	35,358	21,206	12,374	11.2	854	235	6.2	1.39	0.8	116
Nacatoch	325	18.6	17,358	10,286	6,268	15.4	286	71	10.5	0.43	2.2	216
Pacan Gap	125	7.2	34,379	20,903	12,495	15.8	751	210	9.0	1.70	1.2	139
Pettet	34	1.9	232,600	144,400	60,276	36.0	24,565	2,822	136.0	65.60	228.0	81
Weighted average analysis of all pit-disposed brine			33,361	19,862	11,688	19.5	899	187	9.4	2.07	27.5	470

Table 8.--Rates of flow and chemical character of runoff in Richland Creek, Freestone County/1

Analysis number	Period represented by water analysis: Dates (inclusive)	Period represented by water analysis: No. of days	Gaged flow for period /2 (DSF)	Adjusted flow for period /3 (DSF)	Partial analysis: Total dissolved solids (ppm)	Partial analysis: Chloride ion (ppm)
1	-	46 /4	0	244	15,174	8,245
2	May 1, 1956	1	499.0	574	6,850	3,870
3	May 2	1	13,140.0	14,985	905	460
4	May 3-6	4	25,384.0	28,959	189	20
5	May 7-9	3	167.0	206	316	72
6	May 10-11	2	41.8	58	597	235
7	May 12-16	5	41.8	74	1,610	778
8	May 17-31	15	6.0	86	3,870	2,150
9	June 1-4	4	1,158.3	1,342	6,650	3,790
10	June 5	1	2,394.0	2,734	408	76
11	June 6-7	2	772.0	891	304	60
12	June 8-10	3	65.3	90	615	230
13	June 11-20	10	6.6	61	1,760	900
14	June 21-25	5	0	27	5,300	3,000
15	June 26-30, July 1-17	22	0	117	8,000	4,640
16	July 18-31	14	10.6	86	10,100	5,860
17	Aug. 1-10	10	0	53	12,600	7,380
18	Aug. 11-31	21	280.0	430	13,500	7,870
19	Sept. 1-3	3	61.0	85	12,951	7,550
20	Sept. 4-8	5	1.0	28	1,140	540
21	Oct. 2-5, 7, 8, 10	7	0	37	11,599	6,730
22	Oct. 11-17	7	172.0	233	12,139	7,110
23	Oct. 18	1	7.1	13	6,537	3,700
24	Oct. 19-20	2	0	11	1,150	560
25	Oct. 21, 23-26	5	0	27	2,270	1,240
26	Oct. 27-28, 31, Nov. 1, 3-4	6	600.0	716	6,350	3,640
27	Nov. 5-8	4	11,582.0	13,224	222	43

Table 8.--Rates of flow and chemical character of runoff in Richland Creek, Freestone County (Continued)

Analysis number	Period represented by water analysis: Dates (inclusive)	Period represented by water analysis: No. of days	Gaged flow for period /2 (DSF)	Adjusted flow for period /3 (DSF)	Partial analysis: Total dissolved solids (ppm)	Partial analysis: Chloride ion (ppm)
28	Nov. 9, 11-12	3	44.1	66	635	260
29	Nov. 14-17, 19	5	1.0	27	1,470	770
30	Nov. 21-24	4	0	21	3,920	2,180
31	Nov. 26-29, Dec. 2, 3, 5-10	12	0	64	6,760	3,870
32	Dec. 11-13, 17-19	6	0	32	8,842	5,130
33	Dec. 20	1	219.0	255	1,527	800
34	Dec. 22	1	121.0	143	324	64
35	Dec. 23, 25-28	5	61.8	97	771	318
36	Jan. 1-5, 1957	5	1.1	28	2,170	1,150
37	Jan. 6, 8-10	4	3.6	25	4,690	2,620
38	Jan. 13-22	10	431.0	544	7,370	4,170
39	Jan. 23	1	234.0	272	521	222
40	Jan. 24-25	2	37.4	53	1,300	660
41	Jan. 26-31	6	288.1	360	2,950	1,630
42	Feb. 1, 10-13	5	2,982.3	3,426	1,220	580
43	Feb. 2-5	4	8,977.0	10,254	208	23
44	Feb. 6-9	4	156.9	200	511	168
45	Feb. 15-20	6	8.6	42	2,910	1,600
46	Feb. 22	1	1.7	7	4,970	2,820
47	Feb. 21, 23-28, Mar. 1-3	10	146.1	220	5,150	2,880
48	Mar. 4-11, 14	9	239.0	320	882	412
49	Mar. 12-13, 15-19	7	546.4	660	2,050	1,100
50	Mar. 20-21, 26, 30-31	5	3,286.7	3,773	341	106
51	Mar. 22-25, 27-29	7	8,280.0	9,476	186	20
52	Apr. 1-7	7	17,185.0	19,628	269	51
53	Apr. 8-10,20	4	15,707.0	17,926	430	120
54	Apr. 11-15	5	64.7	100	1,160	518

Table 8.--Rates of flow and chemical character of runoff in Richland Creek, Freestone County (Continued)

Analysis number	Period represented by water analysis: Dates (inclusive)	Period represented by water analysis: No. of days	Gaged flow for period /2 (DSF)	Adjusted flow for period /3 (DSF)	Partial analysis: Total dissolved solids (ppm)	Partial analysis: Chloride ion (ppm)
55	Apr. 16-19	4	323.9	390	2,080	1,050
56	Apr. 21-30	10	293,580.0	334,734	131	10
57	May 1-7	7	61,442.0	70,081	202	12
58	May 8-12	5	5,447.0	6,236	376	58
59	May 13-15	3	45,850.0	52,285	226	23
60	May 16-17, 24-27	6	44,997.0	51,329	188	13
61	May 18-23	6	16,655.0	19,019	444	70
62	May 28-31	4	4,075.0	4,667	281	32
63	June 1-8	8	29,962.0	34,199	225	22
64	June 9-12	4	1,425.0	1,646	403	84
65	June 14-15, 17-28	14	3,199.0	3,721	704	245
66	June 16	1	211.0	246	195	21
67	June 29-30, July 1-9	11	162.5	244	1,080	468
68	July 10, 12-20	10	8.0	62	2,110	1,080
69	July 21-29	9	322.0	415	3,290	1,800
70	July 30-31, Aug. 1-6, 12-13	10	12.0	67	1,740	850
71	Aug. 7-11	5	60.0	95	3,060	1,660
72	Aug. 18-19, 25	3	0	16	1,610	852
73	Aug. 20-24, 26-31, Sept. 1-2	13	0	69	3,100	1,700
74	Sept. 3-10	8	0	42	5,830	3,300
75	Sept. 11-22	12	147.0	232	7,880	4,540
76	Sept. 23-24	2	178.0	214	986	470
77	Sept. 25-28	4	28.1	53	440	148
78	Sept. 29-30	2	0.9	12	975	440
TOTALS		509	623,498.0	713,484		
WEIGHTED AVERAGE CHEMICAL CONCENTRATIONS					278	73

Table 8.--Rates of flow and chemical character of runoff in Richland Creek, Freestone County (Continued)

/1 Samples taken at a point 1.5 miles below Navarro-Freestone County line; analyses reported by U. S. Geological Survey.

/2 Represents combined gaged flow of Richland and Chambers Creeks at points upstream from sampling station, as reported by U. S. Geological Survey.

/3 Includes 5.3 DSF of disposed brine per day.

/4 Days for which no flows and no analyses were available; concentrations and flows assigned to each of them equal the average rate and concentration of disposed brine in the area.

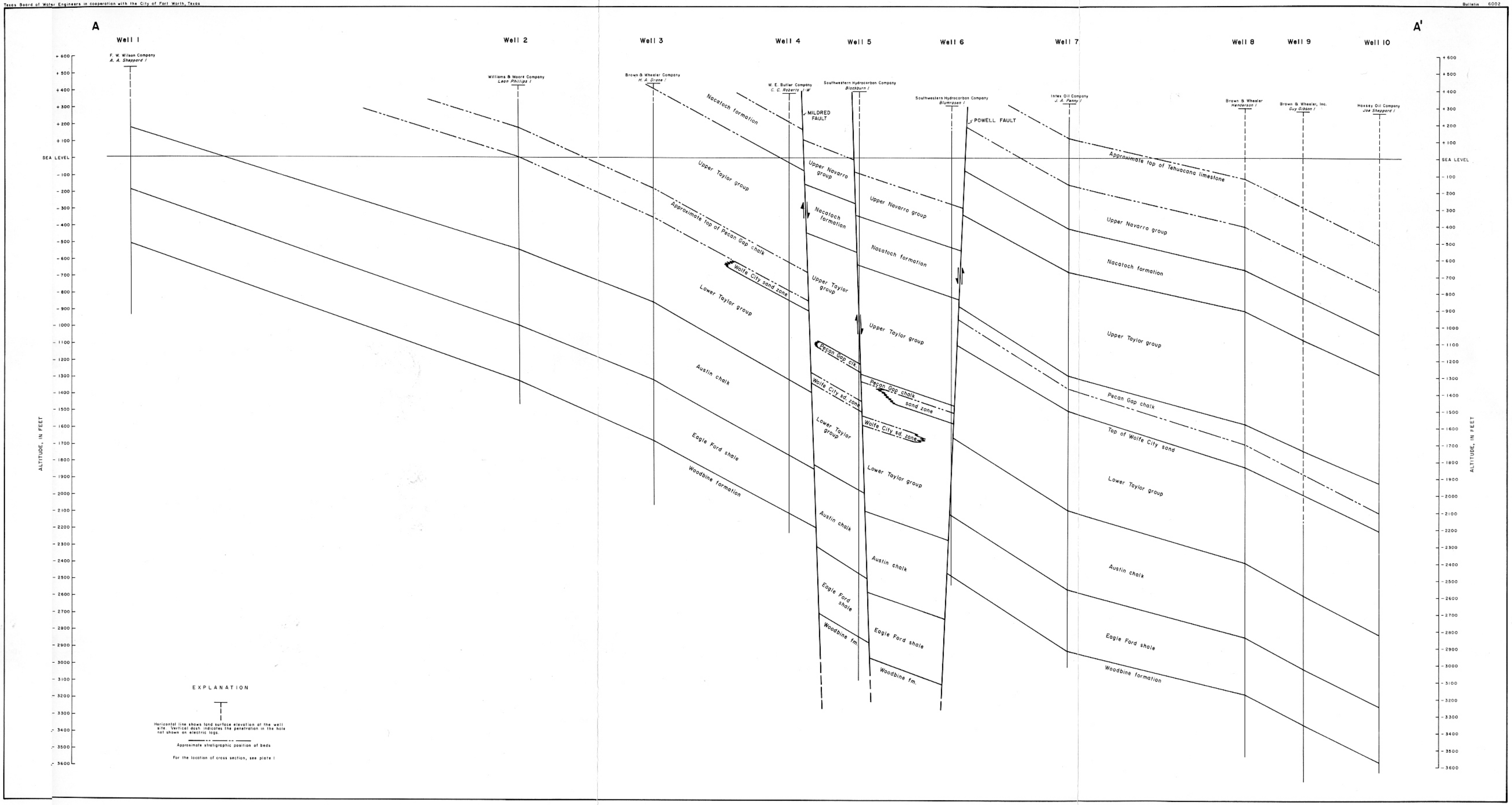

PLATE 2 – GENERALIZED GEOLOGIC CROSS SECTION ALONG A-A', NAVARRO COUNTY, TEXAS

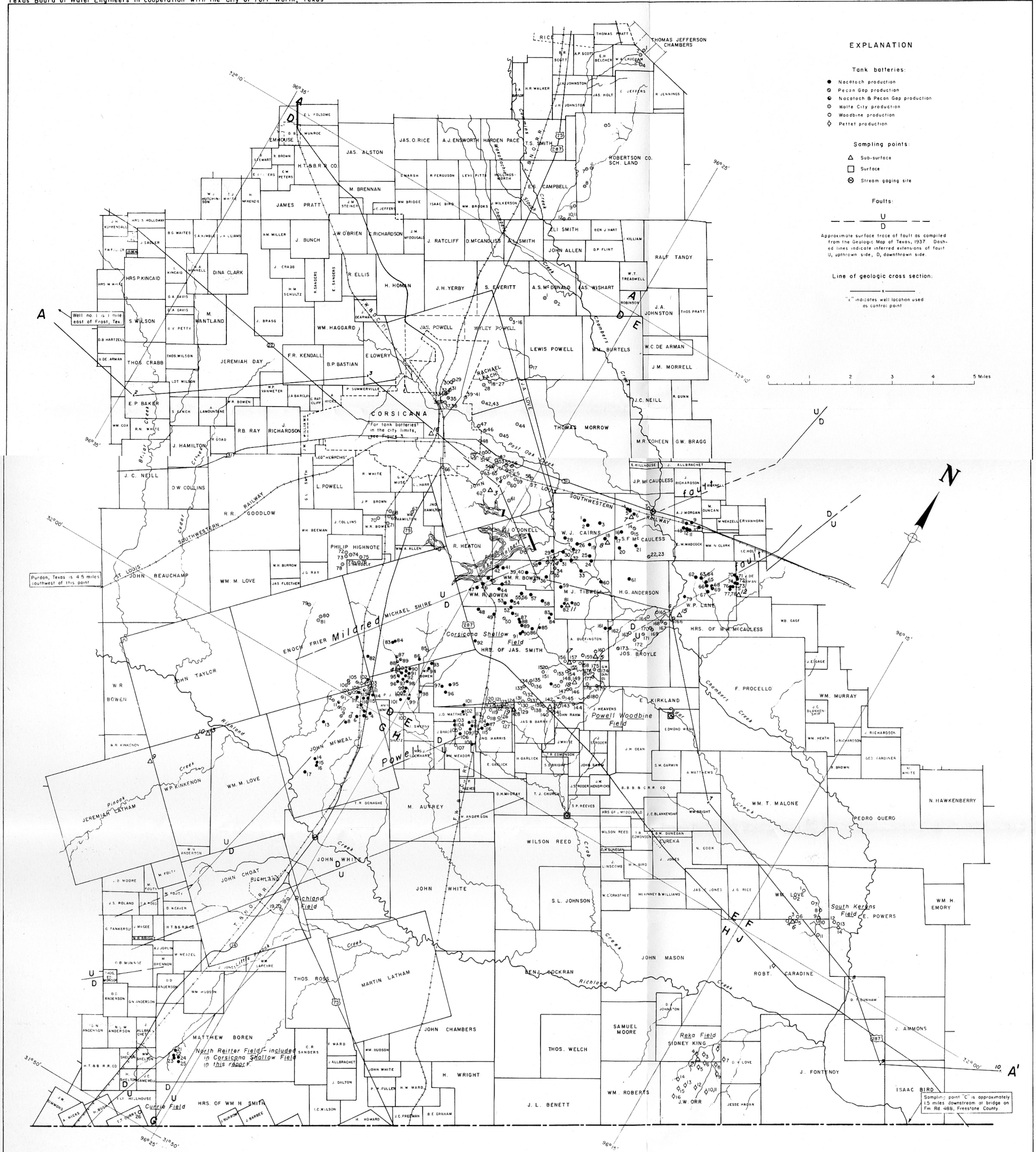

PLATE I - MAP OF LOWER WATERSHED OF CHAMBERS AND RICHLAND CREEKS SHOWING TANK BATTERIES, SAMPLING POINTS, AND GEOLOGIC STRUCTURE, NAVARRO COUNTY, TEXAS