UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF AGRICULTURAL ECONOMICS

Operations Guidance Report on

WATER FACILITIES FOR

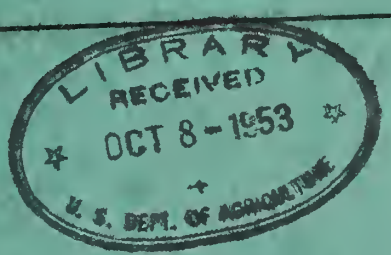
BRADY AREA

TEXAS

Prepared by

WATER UTILIZATION SECTION
DIVISION OF LAND ECONOMICS

August 1939



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Under the Provisions of the
Water Facilities Act
(Public Law No. 399, 75th Congress)

August 1939

ACKNOWLEDGMENTS

Acknowledgment is made to the United States Geological Survey for data on discharge and hydrographs of run-off for storms of 1930 and 1938, at Brady on Brady Creek; to Brady Chamber of Commerce for data on flood damage; and to Agricultural Conservation Program for economic information concerning the area.

AUTHORIZATION

This Operations Guidance Report on Water Facilities for Brady Area, Texas, has been prepared under the authority of provisions of the Water Facilities Act (Public No. 899-75th Congress) approved August 28, 1937, and the Secretary of Agriculture's memorandum of July 1, 1938, on Administration of the Water Facilities Program. The area was authorized for planning and operations by the Water Facilities Board on January 18, 1950, published in Texas State Memorandum No. 3, dated January 1[illegible], 1950.

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WATER FACILITIES FOR BRADY AREA, TEXAS

SUMMARY AND CONCLUSIONS

1. Weighted mean annual precipitation for the area is about 25 inches.
2. The average temperature for the area is 65°F.
3. The average gross evaporation is 62 inches annually.
4. An average surface discharge of 60 acre-feet per square mile throughout the area may be expected annually.
5. Recovery of ground water can be depended on in only a small percent of the area.
6. Present water facilities for stock and domestic use are inadequate both as to number and distribution.
7. There is not sufficient maladjustment in present land use to constitute a major problem.
8. Surface tank development must be depended on for stock and domestic water in an optimum area utilization.
9. Irrigation in the area is not recommended.

I

INTRODUCTION

Location of Area

The area which is reported herein is located in the counties of McCulloch, Concho, Menard and San Saba, in the state of Texas. It is bounded approximately by latitude 31°00' and 31°30', and by longitude 99°00' and 100°05'. The area contains approximately 800,000 acres or 1250 square miles. Principal towns are Eden in Concho County, and Brady in McCulloch County.

Purpose of Report

This report has been prepared to act as guidance to the operations agency in the types of water facilities that are most applicable in the area under consideration. Since the area was approved by the Water Facilities Board for immediate operation, the report is necessarily reconnaissance in character and the recommendations are intentionally conservative. The report consists of a compilation of the physical factors which will limit or assist in the proper development of the area.

Scope of Report

The report is divided into five parts. Part I is introductory; Part II is a physical inventory of agriculturally usable resources;

Part III shows the present agricultural utilization of resources; Part IV proposes a plan for future resource utilization; Part V is a cost analysis of proposed works for proper area utilization.

The single plate which accompanies the report shows: precipitation data at stations in and adjacent to the area, isoheytal lines (lines connecting points of equal precipitation) through the area, and ground-water areas.

There is a scarcity of available information for this area making it necessary to compare this area with other areas of similar characteristics in order to arrive at some of the conclusions.

II

PHYSICAL DESCRIPTION OF AREA

Physiography

Physiographically the area is located in the Central Texas Section of the Great Plains province. The Brady Mountains, which extend east and west through the center of the area, constitute the only outstanding physical feature. These mountains were formed by the erosion of soft, more easily eroded formations which underlie the harder and more resistant limestone. The topography is undulating to rolling except near the Brady Mountains where it becomes rough. Land slopes are generally from about 1 per cent to 6 per cent except near the mountains where the slopes are quite steep - being from 15 to 20 per cent in places.

The area includes more than a single drainage basin. The major drainage basin is that of Brady Creek, a tributary of the San Saba River, which, in turn, is a tributary of the Colorado River of Texas. Also included in the area, however, are several small streams which are direct tributaries of the Colorado River. These streams include Mustang, Salt, Elm, Cow, Cedar, Corn, and Bluff Creeks. The gradients of these minor streams average about 0.4 per cent, while the gradient of Brady Creek approximates 0.2 per cent.

The drainage basin of Brady Creek is shaped long and narrow with the length about four times the width. The long axis bears almost directly east and west. The other streams in the area have

drainage basins of varying shapes, and flow is in a northerly direction. The Brady Mountains form the divide between those streams which flow north, and Brady Creek which flows east. All streams follow definite channels throughout most of their length. They are not perennial; flow occurs only after precipitation. Some water is generally present in the natural pools in Brady Creek even though there are periods of no flow. Low flow in this creek is probably furnished by natural discharge from the Cretaceous sediments in Concho County. There is little economic possibility of channel or off-channel storage due to the scarcity of suitable sites for impounding structures.

There are few sites in the area which could be adapted to storage of any appreciable quantities of water since justification for storage would have to come from agricultural utilization of such water. The same factors affect the construction of any structures for diversion of flood flow for utilization on adjacent lands. Although the area generally is not favorable for such structures, it is possible that individual instances might be found that would merit this type of facility. There are lands in the area which are topographically situated for irrigation, but the absence of ground water and the lack of storage possibilities practically eliminate the possibility of their utilization for irrigation.

The elevation of the area varies from about 1275 feet at the Colorado River in the northeast corner of the area to about 2370 feet at the western edge of the area which is approximately the southwest corner of Concho County. The elevation of the mouth of Brady Creek at the eastern end of the area is about 1525 feet.

Natural vegetation in the area is rather sparse a[illegible] of semi-arid regions of the Great Plains. The eastern edge of the area is more thickly vegetated than the west, with a gradual change between. Trees native to the area are mesquite, live oak, [illegible] grasses are rescue, curly mesquite, buffalo, needle and spear; and weeds are broom, tallow and filaree.

Climatology

Table I is a tabulation of precipitation data for the three stations located within the boundaries of the area, and of four additional stations which are close to, but outside of, the area. The records are fairly long, except for those at Mason and Eden which are short, and indicate that the entire area receives an average of about 25 inches of rainfall annually. The maximum monthly precipitation for any station was 19.28 inches which occurred at Eden in July 1938, and maximum annual was 41.40 inches at Brady in 1919. A large percentage of precipitation in the area occurs erratically both as to amount and intensity. Daily rainfall records are not available to illustrate the erratic occurrence, but it is reflected though to a lesser extent, in the monthly totals. The occurrence of high monthly rainfall at Brady is shown in the following table in total inches and as a per cent of the average amount of 24.95 inches:

Inches	6"	7"	8"	9"	10"	11"	12"	13"	14"	15"
Percent of Annual Rainfall	24	28	32	36	40	44	48	52	56	[illegible]
Number of Times Equaled or Exceeded in 72 years	39	15	7	4	[illegible]	2	1	1	[illegible]	[illegible]

	Elev. Above Sea	Years of Record		Max. Observed Precip.		Annu Precipi	
		Mo. & Year	Last Year Incl.	24 Hours	Month	Min.	
Brady	1672	35	1938		14.33	8.83	24
Rochelle	1670	19	1934		11.74	11.27	24
Eden	2050		1938	6.89	19.28	19.88	26
Average		20			15.12	13.33	25.
Paint Rock	1631	19	1938	8.04	17.17	14.08	24
Mason		10	1882		13.90	19.73	27.
Ft. McKavett	2155	49	1937	5.50	10.97	8.51	22.
San Saba	1712	16	1917		8.63	12.93	25.
Average		23			12.67	13.81	25.

*For 11 years.

T A B L E I.

P R E C I P I T A T I O N D A T A

	Elev. Above Sea	Years of Record: Mo. & Year	Years of Record: Last Year Incl.	Max. Observed Precip.: 24 Hours	Max. Observed Precip.: Month	Annual Precipitation: Min.	Annual Precipitation: Ave.	Annual Precipitation: Max.	Mean daily depth on days of rainfall	January: Mean	January: Max.	February: Mean	February: Max.	March: Mean	March: Max.	April: Mean	April: Max.	May: Mean	May: Max.	June: Mean	June: Max.	July: Mean	July: Max.	August: Mean	August: Max.	September: Mean	September: Max.	October: Mean	October: Max.	November: Mean	November: Max.	December: Mean	December: Max.	% rain during growing season
Grady	1672	35	1938		14.33	8.83	24.95	41.40	.49*	1.30	4.00	1.20	4.15	1.24	4.06	2.45	8.90	3.43	10.10	2.57	8.08	2.11	14.33	2.05	6.63	3.05	11.17	2.49	7.85	1.69	7.80	1.37	5.04	79
Rochelle	1670	19	1934		11.74	11.27	24.74	49.39	.56	1.41	3.92	1.39	5.15	1.82	6.36	3.01	11.74	3.06	6.87	2.13	7.18	1.53	6.28	1.91	5.54	3.35	10.92	2.24	9.80	1.50	3.70	1.21	3.10	76
Eden	2050		1938	6.89	19.28	19.88	26.24	34.25	.52	1.79	3.85	1.51	3.20	1.25	4.75	1.87	4.69	3.67	6.30	2.16	5.13	4.09	9.28	1.23	3.45	4.23	13.02	1.64	3.10	1.11	2.25	1.68	4.05	76
Average		20			15.12	13.33	25.31	41.68	.52	1.50	3.92	1.37	4.17	1.44	5.06	2.44	8.44	3.39	7.76	2.29	6.80	2.58	13.30	1.73	5.21	3.54	11.70	2.12	6.92	1.43	4.58	1.42	4.06	
Paint Rock	1631	19	1938	8.04	17.17	14.08	24.50	36.76	.48	0.99	2.64	1.26	3.49	1.32	3.66	1.85	5.22	3.40	6.16	2.27	6.26	2.08	5.02	1.76	6.23	3.51	17.17	3.37	17.00	1.39	4.21	1.24	3.33	80
Mason		10	1882		13.90	19.73	27.03	39.50		1.39	4.10	1.33	2.93	1.04	2.85	2.48	6.89	3.30	8.94	2.00	7.58	2.88	6.64	3.22	13.90	4.35	10.39	2.02	4.46	1.22	3.90	1.80	6.70	80
Ft. McKavett	2155	49	1937	5.50	10.97	8.51	22.83	37.05	.57	0.91	3.64	1.24	5.56	1.13	4.14	1.62	5.77	2.83	6.77	2.38	9.34	2.21	6.78	2.16	7.54	3.44	10.97	2.33	10.34	1.42	5.09	1.18	6.24	80
San Saba	1712	16	1917		8.63	12.93	25.93	33.54	.39	0.65	2.33	1.54	3.88	1.68	4.77	3.34	7.04	3.71	8.10	2.45	8.63	1.93	5.79	1.62	5.77	2.57	4.38	2.60	5.64	2.51	8.42	1.33	3.58	80
Average		23			12.67	13.81	25.07	36.71	.48	0.98	3.18	1.34	4.21	1.29	3.85	2.32	5.98	3.31	7.49	2.27	7.95	2.27	6.06	2.19	8.36	3.47	10.73	2.58	9.36	1.63	5.40	1.39	4.96	

*For 11 years.

It can be seen that roughly 25 per cent of the annual precipitation may be expected to occur in one month on an average of every second year, and higher percentages have a correspondingly lower expectancy.

The following tabulation indicates the average number of days with .01 inch or more precipitation:

Station	Years of Record	Days
Point Rock	11	53
Brady	8	52
Rochelle	19	44
San Saba	17	67
Fort McKavett	30	39

Conditions are favorable for crop production since about 80 per cent of the average annual rainfall occurs during the growing season. This is ample for growing wheat, oats, grain sorghums, cotton and corn, which are the main crops grown in the area, if the distribution of the rain during the season is favorable.

The average annual temperature for the area is about 65°F, and varies from a high of about 110°F to a low of about -2°F. Table II shows data on temperature at the stations in the area, and Table III is a compilation of Frost Data. A growing season of about 230 days between the latter part of March and the first part of November is indicated, with an extreme minimum of about 200 days for the area.

Evaporation data in Texas is scattered and inconclusive, but indicates that an average gross evaporation of about 62 inches annually

TABLE II

TEMPERATURES

Station	Elevation	Temperature - °F				
		Average Annual	Average Maximum	Average Minimum	Highest	Lowest
Point Rock	1631					
Brady	1672	64.2				
Rochelle	1670	65.8	78.8	52.7	109	-2
San Saba	1712	66.0	78.8	52.5	109	5
Ft. McKavett	2155	64.8	79.6	49.9	114	-6

TABLE III

FROST DATA

Station	Length of Record	Aver. Date of Last Frost in Spring	Aver. Date of First Frost in Autumn	Average Length Growing Season	Latest Date Killing Frost in Spring	Earliest Date of Killing Frost in Autumn
Brady	8	March 22	Nov. 11	234	Apr. 5	Oct. 25
Rochelle	19	March 26	Nov. 14	233	Apr. 18	Oct. 9
San Saba	16	April 3	Nov. 1	212	May 1	Oct. 10
Ft. McKavett	38	March 30	Nov. 9	224	May 1	Sept. 26

...ay be expected in this area.

The prevailing wind direction throughout the area is south at an average annual velocity of about 10 miles per hour. The wind blows at a fairly constant velocity for the entire year---the low average monthly velocity being about 8.5 miles per hour, and the high average monthly velocity about 11.5 miles per hour. There is relatively little time in this area when there is not enough wind for successful windmill operation, as evidenced by the predominate use of windmills for power, but there are no data available to show the exact percentage of time wherein wind velocities are too low for windmill operation.

Soils

The most common soils found in this area are: (1) Valera -- Rough Stony Land group; (2) Denton -- Rough Stony Land group; (3) Abilene-Roscoe-Foard group; and (4) the Frio-Spur-Lodge group. The Valera Rough Stony Land group covers approximately 75 per cent of the area and is described as follows:

The Valera soils are mostly shallow and calcareous and the principal type is the stony clay. Small areas of clay and clay loam are also found. The surface is moderately rolling to very rolling and some slopes are steep. The steep slopes of the large areas are in many places so eroded and stony that they are included with the type of land called rough stony land. The deeper soils, clay and clay loam, which are intermixed with the large areas of stony clay,

are fairly productive when moisture conditions are favorable, and they are well suited to general farm crops. Most of these soils are in ranches on which cattle, sheep, and goats graze. Small amounts of Abilene clay and clay loam occur in this section on the smooth, nearly flat places on some divides and in some valleys. A very small amount of alluvial soils occur, these being chiefly of the Frio series. The natural vegetation of the rough stony land comprises chiefly a thin growth of trees and shrubs, with only very small amounts of grasses. The growth decreases in abundance from east to west. In the western part of this area the same growth occurs as in the east but oaks are less abundant and various shrubs become more prominent.

The Denton Rough Stony land group occupies about 5 per cent of the area and may be described in the following manner:

The Denton soils are found mostly in the eastern part of the area. The soils are granular and the subsoils, though heavy, are crumbly and readily penetrated by water. The land is generally rolling to strongly rolling and hilly in places. Natural drainage is rapid and erosion is severe in many places. The clay and stony clay types are the most extensive of the series. The Denton soils where the surface layers are deep are moderatley strong and productive. These soils are not strongly resistant to drought, especially on the shallow and more steeply sloping areas, as there is a considerable loss of rainwater by run-off; while the thin subsoil layers afford no large storage of moisture. The stony soils as a rule are better suited to grazing than to crops, and are used largely for livestock range.

The principal non-stony soil, Denton clay, is used to a considerable extent for cotton, corn, small grains, sorghums, and a few other crops, to all of which it is well suited, and good yields are secured when moisture conditions are favorable.

The Abilene-Roscoe-Foard group occupies approximately 18 per cent of the area. The Abilene and Roscoe series of this group are found in this area.

The Abilene soils are granular and the subsoils though quite heavy, are of fairly open and permeable in character. The soils contain a moderately large amount of organic matter. Although the clay loam is the most extensive soil of the series there are some other textural classes represented, the lighter textured soils being of lighter color. For the most part, the soils are deep. The surface is undulating to nearly flat, though on some slopes the soils have been thinned by erosion. The soils and subsoils readily absorb water and the deep, heavy clay subsoils and substrata act as a reservoir to hold a large amount of water for growing crops. These soils are among the most highly esteemed soils of the region for farming and are extensively utilized for the general farm crops.

The chief soils of the Roscoe series are of clay and clay loam textures. The soils are moderately granular, but the subsoils are rather heavy and slowly penetrated by water. The soils occupy very flat and some slightly depressed areas, having very slow natural drainage. As the surface where these soils occur is nearly flat, they collect and retain a very large proportion of the rain water and

are fairly drought-resistant, provided a supply of moisture is beneath the soil before dry seasons begin.

The Frio-Spur-Leona group which occurs along the stream beds occupies approximately 2 per cent of the area. The Frio series are deep soils. On account of flat surface, natural drainage is slow, although the lighter textured soils, generally lying near the streams and in places underlain by beds of gravel, are slightly higher and have fairly rapid surface drainage and free underdrainage. These soils are very productive and the subsoils afford a good reservoir for soil moisture, which gives them a good drought resistance. They are highly productive and suited to many crops. Several types of Spur soils ranging in texture from sandy to clay loam, occur. These soils occupy bottom land and are overflowed occasionally. They are deep, well drained soils, friable and permeable and are quite productive, though not highly so. These soils hold large amounts of water and have very favorable moisture conditions for crop growth. They are suited to many crops and a large part is farmed.

The Leona soils are deep, granular soils, containing considerable organic matter and are underlain in places by beds of rounded gravel. The surface is flat and drainage is readily effected through the soil and subsoil material. The soils are productive and suited to the general farm crops.

Hydrology

Precipitation data for the stations in and near the area is shown in Table I, and a graphical presentation of the average monthly and annual precipitation is shown on Plate I. There is no long time record of daily precipitation in the area, but from the 27 year record at Coleman, Texas, just north of the area, the longest period between rains of 0.5 inch or more in 24 hours is over four months. There has been one period of over ten months in which less than 1.0 inch has been received in any one day, and 15 periods of four or more consecutive months in which less than 1.0 inch in 24 hours has been received. In the type of country under consideration — including land slopes, vegetal cover, soil types, etc. — it is considered that more than 0.5 inch of rainfall in 24 hours is necessary to produce any appreciable run-off. This is not strictly true, of course, because of variation in the rate of precipitation and the many other factors which affect run-off, but is considered to be closely applicable for general use in the area. The design of any works for the utilization of surface run-off must take this into consideration, and must be of capacity to provide for evaporation, seepage, and required use for the maximum length of time in which it may be expected that there will be little or no surface run-off.

Surface Discharge

There are no records of discharge from Brady Creek at any place along its length. A station was established in 1925 at Brady

by the United States Geological Survey, but sufficient records were not kept at the time to establish a rating curve. However, the United States Geological Survey has developed hydrographs of three floods by the slope-area method based on information of local residents -- two of which occurred in October, 1930, and one in July, 1938. These are of value mainly in obtaining the momentary peak discharge and not the quantity of discharge due to the unreliability of data. Since there are no available discharge data for Brady Creek the data from the San Saba River, the river just south of Brady, and to which it is tributary, will be used to obtain run-off factors which may be applied to the Brady Creek drainage area. The drainage area of the San Saba River has very similar characteristics to those of the Brady Creek drainage area. Land slopes, stream slope, topography, soil types, vegetal cover, and elevations are all sufficiently comparable that very good discharge relations may be obtained. The two basins are in the same precipitation belt, but temperatures in the San Saba basin are higher than in the Brady Creek basin. The drainage characteristics for the San Saba River are shown in Table IV for the stream gaging stations at Menard and at San Saba. The average discharge at both stations has been corrected to include the amount of water diverted from the river for irrigation purposes. Although this water was not recorded by gage, it was taken from the river where it had arrived by surface discharge or sub-surface seepage. The exact amount of water that is used for irrigation is not known, but the number of acres irrigated are known and United States

Geological Survey Water Supply Paper No. 608 has a 12 year record of one of the canals on the river which irrigates 4,300 acres. Of the 12,000 acres irrigated from the San Saba River 4,300 acres are above the Menard gaging station and 7,700 acres are below — all 12,000 acres are above the San Saba gaging station. The run-off factors for the stations at Menard and San Saba were averaged and used as the run-off factor for Brady Creek at Brady. From Table IV it may be seen that 4.6 per cent of the precipitation in the area may be expected to occur as run-off, and that the average annual discharge of a stream gaging station at Brady might be expected to be 45 c.f.s. The maximum peak discharge at Brady occurred on July 23, 1938. The peak reached at this time was calculated to be 86,000 second feet. This calculation was made by the United States Geological Survey by using the high water elevation and the slope-area method. Two other floods at this point for which measurements were made occurred October 5-7, 1930, and October 13-14, 1930. The first was calculated to have a peak of 48,300 second-feet, and the second a peak of 18,400 second-feet. There are insufficient data available to show the frequency at which these floods might be expected to occur.

Ground Water

Those formations which may be relied upon to furnish water for stock and domestic use are encountered at reasonable depths over only a very small part of the area. The four aquifers as mentioned under "Geology" — Hickory sands, Ellenberger group, Trinity group

TABLE IV

DRAINAGE CHARACTERISTICS OF BRADY CREEK AND SAN SABA AREAS

Station and River	General	Average Discharge	Maximum Recorded Discharge			
			Yearly	Monthly	Daily	Momentary Peaks
Menard, San Saba River						
Cubic feet per second		76.2	267.0	2,720	28,300	68,600
c.f.s. per sq. mi.		0.066	0.2320	2.360	24.60	59.50
Inches on drainage area		.90	3.14	2.665	0.92	(per hr.) 0.092
Date of record		—	1936	9/19/36	9/16/36	9/16/36
Gage elevation, feet	1,865					
Drainage area, sq. mi.	1,151					
No. years record	21					
Final record year	1936					
Precipitation, inches	23					
Run-off factor $\frac{R}{P}$	3.9%					
San Saba, San Saba River						
Cubic feet per second		295	697	4,460	50,300	57,000
c.f.s. per sq. mi.		0.097	0.2290	1.470	16.50	18.70
Inches on drainage area		1.318	3.11	1.660	0.62	(per hr.)0.029
Date of record		—	1922	4/1922	4/26/22	4/26/22
Gage, elevation feet	1,152					
Drainage area, sq. mi.	3,046					
No. years record	21					
Final record year	1936					
Precipitation, inches	24.5					
Run-off factor $\frac{R}{P}$	5.5%					
Brady, Brady Creek River[1]						
Cubic feet per second		45.0				86,000
c.f.s. per sq. mi.		.083				159
Inches on drainage area		1.13				(per hr.)0.246
Date of record		—				7/23/38
Gage, elevation feet	1,672					
Drainage area, sq. mi.	540					
Precipitation, inches	24.5					
Run-off factor $\frac{R}{P}$	4.6%					

[1] Calculated by comparison with records on San Saba River

and Fredricksburg group — occur so that there is ground water underlying the entire area, but the dip of the first two mentioned is so great that they rapidly pass the reaches of practical recovery. Water could be recovered from the two older formations at any point they could be reached, but the two younger formations do not produce water throughout their occurrence. In this area these aquifers are dry several miles back from their margin.

The recharge of the aquifers is from direct precipitation or from water lost by streams in traversing the outcrop of the formations. The possible exception is in the case of the Hickory and Ellenberger which may have an interchange of waters between them. Due to the pronounced dip of these formations, and the presence of overlying impermeable formations, artesian water is found in these aquifers. Since the Hickory sand is under a greater artesian pressure than the Ellenberger it is probable that it furnishes an artesian recharge to the Ellenberger. A few flowing wells are found in the southeastern part of the area where the wells have been drilled into these artesian aquifers. These are few, however, and are found where the surface elevation is lower than the outcrop elevation of the formations. The discharge and recharge rates of any of the aquifers in the area are undetermined. The older Cambrian formations are not heavily drawn upon because of their depth, and in the Brady city well, the largest single draught on these formations, there has not been any change in the water supply in the eighteen years of its existence. Wider spread use is made of the waters of the younger Cretaceous formations. They furnish water to the city of Eden, in addition to many wells over their area for various farm uses. This water is under a normal

pressure head, and stands at the level in the well at which it is encountered by the drill. Discharge and recharge rates are not known, but recharge in this case is derived directly from precipitation. Recharge is not necessarily within the area but probably comes, in part, from the western and southern extension of the Cretaceous beyond the area under consideration. The lower Cretaceous in the area represents only a small part of its entire areal extent, and, since the dip is to the southeast, the large water body to the west probably has a slight hydraulic gradient toward the area which will result in recharge of the formations which occur in the area. Little is known about the rate or direction of underground water in any of the aquifers in the area.

There are no permanent springs in the area, but "wet weather" springs sometimes appear after a rainy season. These all disappear during the succeeding dry season and are not relied upon as a dependable water source.

Quality of Water

The quality of surface water and ground water from the principal aquifers is generally satisfactory for domestic use. Where surface water flows over gypsiferous or saline strata it sometimes becomes too highly mineralized for human consumption, and where shallow wells are drilled through these same strata they generally produce water that is even more highly mineralized. However, impotable ground water is more prevalent than impotable surface water.

III

PRESENT USE OF AREA

Water Use

Water for stock and domestic use is obtained mainly from small individual surface tanks and from shallow wells. Wells are scattered over the area, being located in the Cretaceous and Cambrian aquifers as well as in valleys and draws where water is obtained from alluvial deposits. These latter wells draw on water which percolates down through the soil until it reaches the underlying rock, then flows along the rock surface or in surface cracks and crevices until it seeps into the shallow well. Such wells are wet weather wells and generally undependable. However, some are so located that they are fairly dependable although they generally show some seasonal variation. Surface tanks or ponds are found scattered all over the area. They are located in small draws or on a gentle slope with diversion ditches carrying water to them. There has been a great deal of surface tank construction in the area because the supply of ground water is unreliable, and this construction is proceeding at the present time mainly under the sponsorship of the Agricultural Conservation Program.

That existing water facilities are not adequate for meeting present stock and domestic needs is evidenced daily on the highways by the numerous wagons, trailers, and trucks which are hauling water. The many wells and tanks, although serving to alleviate part of the

need, are not properly distributed nor sufficiently numerous to promote a proper land and water utilization.

Municipalities in the area which have public water supplies are:

Municipality	Water Supply	Consumption	
		Annually	Per person/day
Brady	2 wells - 2112'	202,600,000 gallons	140 gallons
Eden	2 wells - 65'		140 ?
Melvin	1 well - 18'		140 ?

The Brady supply comes from the Hickory sandstone; Eden's supply from the Cretaceous formations; and the other from alluvium in the river channel. The Brady supply is the only one measured, but the others are believed to have about the same unit consumption. Although this unit consumption seems somewhat high it is accounted for by the fact that there is a very high summer consumption in irrigation of lawns, flowers, and gardens. Any future development at any of these towns will probably be from the same source as used at present since all aquifers are capable of further development. In case of extraordinary increase in population, Brady Creek might be developed by both Brady and Eden, but the present plan for expansion at both places is the construction of additional reservoir capacity with additional ground-water development as necessity arises.

There is no irrigation in the area from either surface or ground water with the exceptions of small garden plots.

There are no industries in the area which use consequential amounts of water. Cotton gins formerly used a large quantity of water seasonally in their boilers, but they have all been changed to either diesel or electric motive power.

There is a single recreational dam in the area, located at Brady on Brady Creek, and which stores only about three acre-feet of water. It was constructed at the Brady Park for recreational purposes.

There are no structures in the area which utilize water for the generation of power.

There have been two floods of major intensity on Brady Creek within the last decade which have caused a large amount of damage in both the urban and rural districts. These occurred in October 1930 and in July 1938. The latter flood had the higher peak intensity but the relative quantities of run-off are not known. Comparing monthly precipitation records for the two dates, since there are no dailies, we find 5.60 inches for October 1930 and 14.33 inches for July 1938. This would indicate that the 1938 flood probably was of larger volume than the 1930 flood. The damage done by these floods was as follows, estimates having been made by local newspapers, Chamber of Commerce and other interested agencies:

FLOOD DAMAGE

	1930	1938
City of Brady	$300,000	$217,700
Country		170,000
Total McCulloch County	?	387,700
Total Concho County	?	75,000
Total Brady Creek	?	$462,700

No attempt was made to check the accuracy of these figures since this report does not deal primarily with flood control. The smaller loss in the city of Brady in 1938 when the greater flood occurred is accounted for as showing the results of previous experience. With the results of the previous flood still well remembered the people were able to take some precaution against the 1938 flood. There have been other, smaller floods on Brady Creek which have caused some damage, but no records have been kept of them. They are reportedly small, however, and would not add an appreciable amount to an annual or a total monetary damage.

Land Use

The area has approximately 800,000 acres, 80 per cent of which is in pasture. Some over-grazing has been done during drouths but generally the ranchmen have protected the native grasses very well. Mesquite and cedar have encroached upon the grass in some sections but no great damage has been done to date. The present carrying capacity is 15 acres per annual unit. It is believed that the area will continue to carry that amount without injury. There are no abandoned lands in the area.

Less than 20 per cent of the area is under cultivation. In McCulloch County there are 686,720 acres of which about 162,000 acres, or 23.5 per cent are in cultivation. There are sections, however, in the west and northwest part of the county which have nearly 50 per cent of farm land in cultivation. Sections in the

watershed in adjacent counties are similar to McCulloch County. The main crops grown are cotton, corn, small grains, grain sorghum, and sudan.

The yield of cotton is approximately 136 lbs. per acre average. Some sections run up to 165 lbs. while others drop to 90 or 95 lbs. per acre. Corn yields averaged 17.2 bushels, wheat 12.7 bushels, grain sorghum 13.3 bushels, and oats 22.2 bushels for a 5 year period.

Erosion by water is taking place rather rapidly in the cultivated sections. Erosion control is needed. Broadcast crops of wheat and oats have helped to reduce erosion. Little or no wind erosion has taken place. Depletion of soil fertility has been due largely to water erosion. If water erosion were controlled it is believed that soil fertility would be better maintained.

Type of Farming

Cotton is produced over the entire area as a cash crop but no section depends on cotton alone. Pasture land is distributed too well over the area for any section to depend upon cash crops altogether. A combination of cotton, small grains, feed crops and livestock represents the main type of farming. Several large ranches are found in the area, particularly in the eastern, south, and southwest part. All of the ranches have some land in cultivation.

Land Ownership

Ninety-four per cent of the owners of land in the area also live in the area. Some do not live directly on the land they own, but live near enough to give close supervision to farming operations. Of the non-resident owners very few are companies or corporations, but are mainly individual owners. Thirty-three per cent of the operators are tenants. Tenancy in the area has been decreasing in the last 5 or 6 years. One reason for this is the policy of the Agricultural Conservation Program to make benefit payments directly to the operator of the land. This policy has influenced owners to dismiss their tenants and to operate the land themselves by means of hired labor.

Land Value, Tax Rates, and Institutional Facilities

Land values vary considerably. Since much of the land is in pasture the average value is rather low, being less than $30.00 per acre. The best farm land is valued from $40.00 to $50.00 per acre. The average assessed value of the entire area is slightly below $7.00 per acre which would probably make the average market value around $17.50 per acre. The tax rate by counties is: McCulloch $1.37, Concho $1.11, Menard $1.06, San Saba $1.30 per $100.00 valuation plus school district tax.

Present institutional facilities are adequate for the area. Some of the smaller schools have been consolidated, which has made it possible for all the inhabitants to have affiliated high school

advantages. The rural areas also have telephone lines, roads and churches well enough distributed to satisfactorily meet the need. Rural electric lines are being built at the present time by Rural Electrification Administration. When they are completed the majority of the area will be served.

Productivity

A comparison of present and past fertility of the land indicates that there has been no appreciable change in the range carrying capacity of the area. This is mainly a range country and has been well managed as a general rule. The cultivated lands have slightly decreased in productivity due to improper cropping practices.

Population Trends

The population seems to be rather stable at the present time. McCulloch County gained 17.8 per cent in population from 1920 to 1930, but the increase from 1910 to 1930 is only about 4 per cent. Concho County gained 30.8 per cent in population from 1920 to 1930, and 15 per cent from 1910 to 1930.

IV

PROJECTED ADJUSTMENT AND RECOMMENDED FUTURE AREA UTILIZATION

Land Utilization

Present land use in the area is, in general, compatible with the physical and economic limitations of area utilization. There is some evidence of misuse in the area both in ranching and cultivation practices which should be abated and corrected, but these represent a very small per cent of the total and can be remedied before they reach alarming proportions. Minor revisions in cropping and ranching practices which will include a reduction in animal units per acre, improved grazing schedules, rotation and better selection of crops, etc., can be made to the improvement of practically every farm in the area. Although wind erosion is negligible in the area, water erosion is prevalent here, as everywhere. Works for its control are needed in every part of the area.

Water Utilization

Water is, and has always been, the limiting factor to the development and use of this area. Development of water supply has been constant through the years but the relative difficulty in obtaining a satisfactory supply has kept the area from being as fully developed as it otherwise would have been. Ground water from the reliable aquifers is found at recoverable depths over only a small part of the

area. There are at present some wells over the area drilled into gravel lenses or fissures of limestone which supply some water. These are generally of doubtful dependability and unpredictable as to location. On Plate I the areas are delineated from which ground waters can be recovered for stock and domestic uses. The outlines of these areas are necessarily conservative to conform to the available data. There will be locations close to the edge of the delineated areas which upon specific investigation will also be able to obtain satisfactory stock and domestic water from wells. Generally, however, ground water can be depended on to furnish only a small percentage of the supply necessary for maximum area utilization.

The ground-water areas are divided into three classifications on Plate I. Classification No. I denotes the sections of the area in which ground water can be economically recovered from the major aquifers in the area. In these locations any well which penetrates the water body of the aquifer will furnish a water supply for stock and domestic use which will meet the requirements as to quantity, quality, and dependability. It is expected that very few, if any, failures will result from drilling in these sections. Classification No. II denotes the sections of the area from which there is a fairly general recovery of ground water at the present time, but which differ from the first classification either because they are not furnished by a regional aquifer or because they are near the ground-water limits of a regional aquifer. These sections lack the reliability and dependability of the first classification. Those sections which are not supplied by a regional aquifer obtain water

from the alluvium or from lenses of sand and gravel, which are localized aquifers and of unknown extent and condition. Water recovery from these sections will be questionable as to quantity, quality and dependability. The capacity of wells here will vary greatly, but where water is encountered, will generally be sufficient for stock and domestic purposes. Due to the type of aquifer these wells are sometimes called "wet weather" wells because they reflect the amount of precipitation which, as seepage, furnishes their supply. There is also a possibility that wells drilled in the sections where formations of Permian and Pennsylvanian periods will be penetrated will produce water which is highly mineralized. The section which is near the ground-water limits of a regional aquifer will furnish water of good quality, quantity, and dependability when it can be found. The limitation in this section is the high probability of drilling a completely dry hole. The combination of these factors reduce the probability of obtaining a good supply of usable ground-water in the sections sesignated as No. II to almost 50 per cent. It is expected, therefore, that there would be a fairly high percentage of failure of wells drilled in these sections. Classification No. III covers the part of the area which is not covered in the first two classes. This section has few places in which ground-water can be recovered, and, over a large extent, it is practically impossible to obtain any ground water. Any drilling done here may be expected to have a very high percentage of failure.

These classifications are generalized descriptions of the possibilities of ground-water recovery in the delineated sections

of the area, and it must be remembered that the various factors to be considered will bear a changed ratio to each other in different parts of each section. It is necessary, therefore, that each individual facility be examined in relation to its particular location rather than to its sectional location. A careful examination of the physical factors at each individual site and a study of the results of similar projects in the surrounding area will reduce the probable percentage of failure to a minimum.

In the majority of the area continued development must depend on surface retention works for an adequate supply of water. There is sufficient rainfall and resulting run-off in the area to keep surface tanks supplied without requiring abnormal size of tank or drainage area. Sites for tanks, although not ideal, are adequate and sufficiently numerous to provide a location at almost any place desired. Siltation will be an important factor, but judicious selection of sites can reduce this hazard. There is a possibility of rehabilitating some of the present works in the area. In the case of a well that needs cleaning out or new casing the procedure will probably be justified if the well record shows that the supply has been adequate during its existence and shows no present sign of diminution. In the case of a surface tank, however, it is doubtful that rehabilitation can be justified. It will generally be found more advantageous to construct a new unit. An average of approximately 60 acre-feet of surface discharge per square mile may be expected annually.

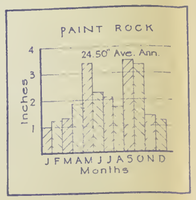
Irrigation from either surface or ground water is not recommended for this area.

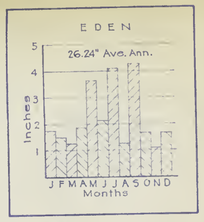
COST OF WATER INSTALLATIONS PROPOSED UNDER ILLUSTRATION OF WATER FACILITIES ACT

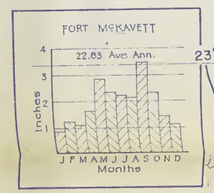
The average cost of individual installations for furnishing stock and domestic water is expected to be about $500.00 when the supply is from surface storage structures, and about $800.00 when the supply is from a well. These costs will include the water supply, the pump and motive power, and a limited distribution system. Materials for the construction of storage works are available throughout the area. All soil types are suitable for incorporation in the structures with a minimum of selection. The sub-surface soils will generally be sufficiently impermeable to serve as a seal for the bottom of the tank, but, since localized conditions will deviate from the general, the subsurface of each individual site must be investigated before final location. Rock is available over a large part of the area for use as riprap over the spillway or other surface slopes. The major part of the cost of surface retention structures, therefore, will be for labor with some equipment expense and little, if any, expense for materials. It is expected that there will be few, if any, group facilities in the area. There have been two districts organized in the area under the new Soil Conservation Law of the state of Texas which are planning works for soil and water conservation and flood control, but, from the present objectives of the districts, they will not, as a group, require the advantages of the Water Facilities Program. These districts have been recently organized under a new law and their aims and purposes have not as yet become crystalized along any definite line. It may be that they will later become interested in the program.

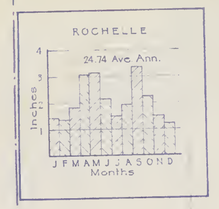
Hydrologic map

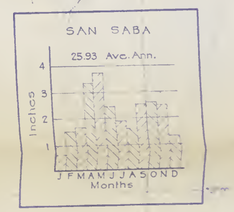
Aug 1937 #2

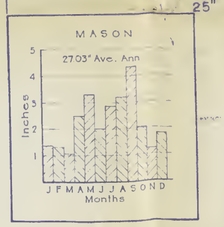


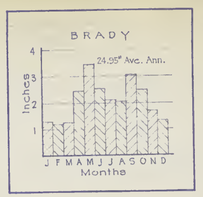












25" 26" 26" 24" 23" 22" 22" 23" 24" 25" 25" 25"

COLEMAN CO.

CONCHO CO.

McCULLOCH CO.

MENARD CO

CONCHO CO.

McCULLOCH CO.

SAN SABA CO.

Colorado River

Brady Creek

Brady

Millersview

Paint Rock

Eden

Fort McKavett

Mercury

Rochelle

Pear Valley

Lohn

Melvin

Menard

II 40-70

III

II 40-70

II 50-300

III

I 30-250

II 25-100

III

I 50-250

BRADY AREA

HYDROLOGIC MAP

Prepared By
WATER UTILIZATION SECTION
DIVISION OF LAND ECONOMICS
BUREAU OF AGRICULTURAL ECONOMICS
UNITED STATES DEPARTMENT OF AGRICULTURE

Under the Provisions of the Water Facilities Act, Public Law No. 393 - 75th Congress

2 0 2 4 6
SCALE MILES

MAY, 1939

Base Compiled from:
U.S. Quadrangle Sheets
Texas State Highway Maps

LEGEND

~ ISOHYETAL LINES

II / 35-85 CLASSIFICATION / DEPTH TO WATER

PLATE NO. 1