TEXAS WATER COMMISSION

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BULLETIN 6506

BASE-FLOW STUDIES

LAMPASAS RIVER, TEXAS

Quantity and Quality, June 3-6, 1963

By

Willard B. Mills and Jack Rawson
United States Geological Survey

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TABLE OF CONTENTS

TABLES

ILLUSTRATIONS

Figures

TABLE OF CONTENTS (Cont'd.)

Plates

B A S E - F L O W   S T U D I E S

L A M P A S A S   R I V E R ,   T E X A S

Q u a n t i t y   a n d   Q u a l i t y ,   J u n e   3 - 6 ,   1 9 6 3

INTRODUCTION

This investigation was made by the U.S. Geological Survey under the provisions of the 1963 cooperative agreement with the Texas Water Commission which provides for investigations of the water resources of Texas.

The purpose of this investigation was to determine, under base-flow conditions, the quantity and the quality of water, including suitability for use, and the interchange of surface and ground water in an 80.1-mile reach of the Lampasas River. Another purpose was to determine whether the flow through the Stillhouse Hollow Reservoir area (dam under construction) increases or decreases. The reach studied extends from a point 1.1 miles upstream from the mouth of Sulphur Creek to the confluence of the Lampasas and Leon Rivers. (See Figure 1.)

The Corps of Engineer, U.S. Army, is now building Stillhouse Hollow Dam at mile 16.5. The multiple-use reservoir when completed will submerge the Lampasas River channel to mile 45 when water is at spillway crest, elevation 666.0 feet. (See Plate 1.)

At the time this investigation was made, conditions were favorable for determining gains and losses in the riverflow. A prolonged dry period preceded the investigation; therefore, only two tributaries had significant flow. These were Sulphur Creek, with 8.58 cfs (cubic feet per second) at mile 79.0, and Salado Creek, with 9.29 cfs at mile 0.8. All other tributaries had discharges of less than 0.7 cfs. Diversions were found at only two points. The maximum and minimum daily air temperature during the investigation was 96 and 62 degrees Fahrenheit, respectively, at Belton Dam located 3.2 miles upstream from stream-gaging station 8-1025, Leon River near Belton, Tex. Conditions were favorable, therefore, for evapotranspiration from vegetation along the riverbanks.

Throughout most of the reach the river channel is cut in limestone and has steep banks bordered by large trees and thick underbrush. Long pools, formed by gravel bars, are common along most of the reach. Photographs at several sites in the study area are shown in Figure 2.

The continuous record of flow at the gaging station, Lampasas River near Belton, Tex., showed that the flow receded gradually from about 10 cfs to about 8 cfs at that station during the study period.

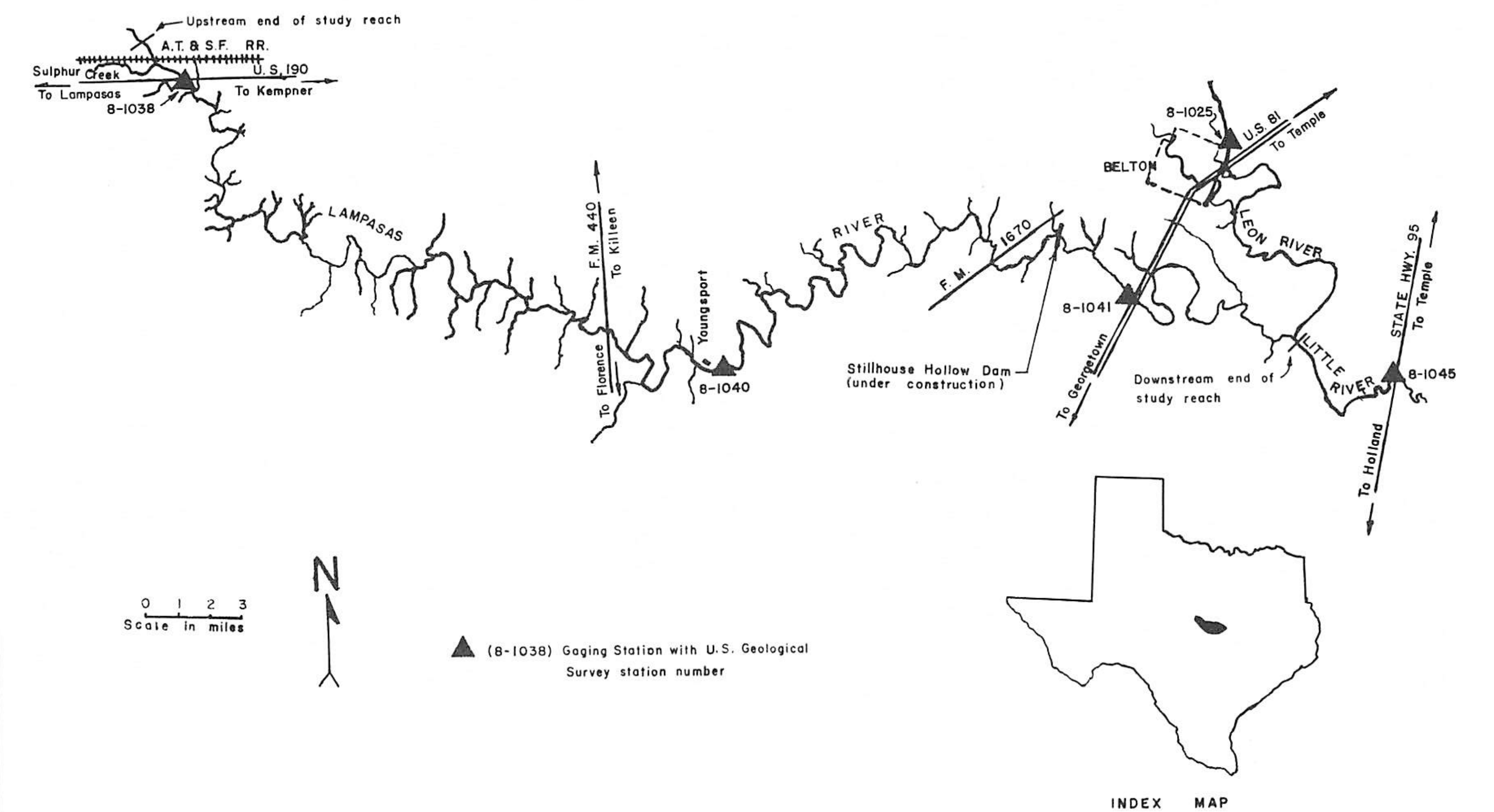
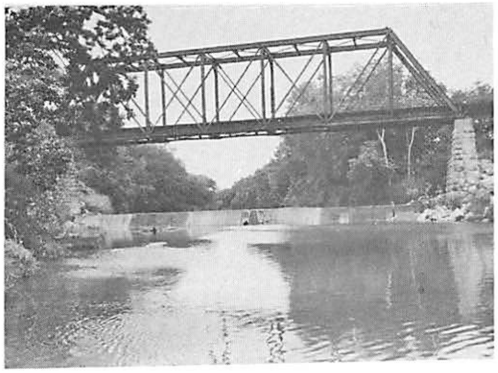


Figure I

Location Map of Lampasas River Low-Flow Investigation

U.S. Geological Survey in cooperation with the Texas Water Commission

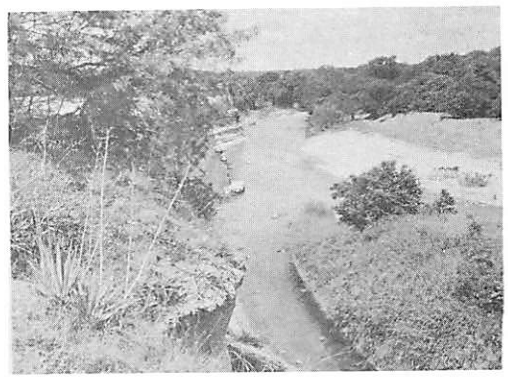
157



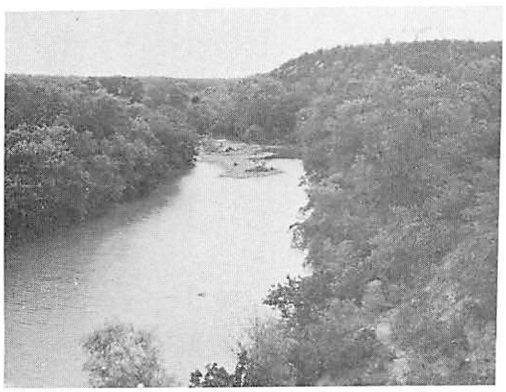
Dam on Lampasas River which forms a mile-long pool above the mouth of Sulphur Creek. At mile 79.0.

Mouth of Rocky Creek. Note channel through limestone outcrop. At mile 65.0.

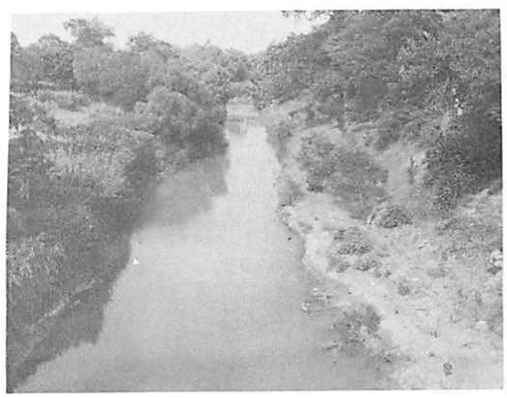
Lampasas River at mouth of Rocky Creek. Channel is composed of gravel bars and limestone. At mile 65.0.



Reese Creek at mouth. Note limestone channel in Lampasas River. At mile 51.0.



Lampasas River at FM 1670. Note typically long pool and profuse growth. At mile 19.3.



Lampasas River near confluence with Leon River. Long pool is caused by backwater from the Leon River. At mile 0.3.

Figure 2

Photographs at Several Sites Along the Lampasas River

U.S. Geological Survey in cooperation with the Texas Water Commission

GENERAL GEOLOGY

The Lampasas River watershed is a part of the Lampasas Cut Plain of the East Central Texas province. Rocks ranging in age from Pennsylvanian to Recent crop out in the drainage area. (See Plate 2.)

The upper part of the study area, from the mouth of Sulphur Creek to about 4 miles northeast of Youngsport, is underlain largely by the Glen Rose Limestone of Early Cretaceous age. The Glen Rose consists of soft beds of impure limestone, alternating with layers of shaly lime, clay, and sandstone. It is relatively impermeable and is not a significant aquifer, although it yields small quantities of fresh water to shallow wells in places in the outcrop. The Glen Rose Limestone is a part of the Trinity Group, which also includes the older Travis Peak Formation and the younger Paluxy Sand. At its outcrop near Lampasas, the Travis Peak consists of a basal conglomerate successively overlain by gravel, sand, marl, and calcareous sandstone. No outcrop of Paluxy Sand is found in the Lampasas River watershed, nor do the available well records indicate any sand stratum at the Glen Rose-Walnut Clay contact.

A small Marble Falls Limestone inlier of Pennsylvanian age crops out along Sulphur Creek near Lampasas. At the surface the Marble Falls is chiefly a fossiliferous limestone containing thin beds of shale. It supplies moderate quantities of water to springs and wells in the vicinity of Lampasas.

About 12 miles east of Youngsport, the Glen Rose dips southeastward beneath the Walnut Clay of Early Cretaceous age. The lower part of the Lampasas drainage area is underlain largely by the Walnut Clay, which consists of blue or blackish clay and marl with subordinate amounts of impure limestone. The Walnut Clay is a part of the Fredericksburg Group, which also includes the younger Comanche Peak Limestone and Edwards Limestone. The Comanche Peak is an impure, chalky limestone that is poorly bedded. It crops out mainly in steep scarps beneath the more resistant caprocks of Edwards Limestone. Both the Walnut Clay and the Comanche Peak are incapable of absorbing and storing significant quantities of water.

The Edwards Limestone crops out as an irregular strip in the lower part of the Lampasas River watershed. North of the Lampasas River it caps drainage divides and outliers, while south of the river it forms a strip of rocky upland. At its outcrop the Edwards is a hard limestone, well bedded in strata of thin to medium thickness.

Rocks of the Washita Group of Cretaceous age crop out in small areas near the eastern limit of the drainage basin. Included in this group are the Gerogetown Limestone, Grayson Shale (Del Rio Clay of former usage), and Buda Limestone. These rocks consist of limestone, nodular limestone, marl, and calcareous clay. Also cropping out in this reach are small areas of Eagle Ford Shale and Austin Chalk of Late Cretaceous age. These rocks consist of shale, limestone, chalky limestone, and marl.

GEOHYDROLOGY

Discharge was measured and samples for chemical analyses were collected at 20 sites in the Lampasas River watershed (Plate 1). The results of discharge measurements are given in Table 1 and chemical analyses are shown in Table 2. These data, which are also shown graphically on Figure 3, define changes in chemical quality and amount of flow throughout the reach. Analyses of five samples collected from the river and of three samples from tributary streams are shown graphically in Figure 4. The total height of each vertical bar graph is proportional to the total concentration of anions (negatively charges constituents) or cations (positively charged constituents) expressed in equivalents per million. The bar is divided into segments to show the concentrations of the cations and anions which make up the total.

The flow of 10.1 cfs measured at mile 77.8, and 7.52 cfs measured at mile 12.6, indicates no significant gains or losses in flow through this reach. Eight measurements of riverflow, six measurements of tributary inflow, and two estimates of pump diversion were made within this 65.2-mile river reach. Tributary inflow totaled 1.46 cfs as compared to total diversion of 2.00 cfs. The steady overall decline of the discharge profile between mile 79.0 and mile 0.8 is attributed principally to evapotranspiration. One spring flow measurement of 0.03 cfs was made upstream from the mouth of an unnamed tributary near mile 15; however, this flow did not reach the Lampasas River as surface water. The tributary stream intermittently lost water to, and received water from, the underlying aquifer. The flow would disappear into the ground, reappear downstream, only to disappear again. This interchange of ground and surface water seems to be prevalent throughout most of the study reach.

The composition of a river water and the amount of flow are potentially controlled by the geological formations that are traversed by the streams and tributaries. In the following discussion the study reach has been subdivided where significant changes in geology occur.

Reach from Mile 80.1 to Mile 77.8

Investigation was begun on June 3 above a mile-long pool that was formed by a dam across the solid-rock channel of the Lampasas River. (See Figure 2.) In the first 2 miles of the reach the streamflow increased from 2.27 to 10.1 cfs, and the dissolved-solids content increased more than 250 percent due to the inflow of highly mineralized water from Sulphur Creek.

At mile 80.1 (site 1) the discharge of the Lampasas River was 2.27 cfs, and the water contained 247 ppm (parts per million) dissolved solids. A chemical analysis of the water, shown graphically in Figure 4, shows that the principal dissolved constituents are bicarbonate, magnesium, and calcium. Magnesium and calcium are present in approximately equivalent amounts, and together they are approximately equivalent to the bicarbonate. This chemical relationship is typical of waters that drain a terrane of dolomite or impure limestone, such as the Glen Rose Limestone.

At mile 79.0 the Lampasas River received inflow from Sulphur Creek, the major contributor of water and dissolved solids to the upper reach of the river. At its confluence with the Lampasas River, Sulphur Creek had a discharge of 8.58 cfs and a dissolved-solids content of 1,180 ppm. Sodium and chloride are the principal dissolved constituents of the water. Most of the water in Sulphur

Creek comes from springs that issue from fissures in an outcrop of the Marble Falls Limestone near Lampasas. The high sodium and chloride concentrations of the water are derived from these springs.

The inflow from Sulphur Creek increased the flow of the Lampasas River at mile 77.8 (site 3) to 10.1 cfs and the dissolved-solids content of the water to 887 ppm. The river water is altered in chemical character from calcium bicarbonate water to a sodium chloride water (Figure 4); sodium constitutes about 62 percent of the cations (positively charged ions), while chloride constitutes about 78 percent of the anions (negatively charged ions).

Reach from Mile 77.8 to Mile 33.8

Between mile 77.8 and mile 33.8 the riverflow decreased about 26 percent, and the dissolved-solids content decreased about 40 percent. About 20 percent of the flow loss is attributed to two diversions in this reach. The decrease in mineralization is probably caused by an accretion of water from the underlying Glen Rose Limestone. Losses from evaporation, transpiration, and seepage probably compensate for the inflow of ground water in this reach.

At mile 64.9 (site 6) the discharge of the Lampasas River was 9.25 cfs. Tributary inflow between miles 77.8 and 64.9 from Rocky and Taylor Creeks was 0.53 cfs, and the net loss in this reach was 1.38 cfs. No diversion was noted. An analysis of the water shows a decrease in dissolved-solids content of about 29 percent; sodium and chloride decreased the most. The decrease in dissolved solids and the decrease in streamflow indicate that the river in this area is intermittently losing water to, and receiving water from, the underlying Glen Rose Limestone, which results in a dilution of the river water. The inflows from Rocky and Taylor Creeks are calcium bicarbonate waters, and are low in sodium and chloride (Figure 4). This chemical composition is typical of water that drains a limestone terrane and is probably indicative of the chemical character of shallow ground water in the area. The flow of Rocky Creek was entirely from springs at its mouth, through limestone outcrop (Figure 2).

Between miles 64.9 and 52.1 (site 7) the river channel is cut in limestone. Gravel bars, lying in and across parts of the channel, form several large pools; consequently, evaporation losses are probably significant in this reach. No tributary flow was noted; however, the flow of the river increased to 9.71 cfs, and the dissolved-solids content decreased to 510 ppm. This indicates an inflow of ground water from seeps or springs in the bed of the river.

At mile 49.6 (site 10) the flow of the Lampasas River decreased to 8.95 cfs, an apparent loss of 0.76 cfs. About 0.6 cfs of the loss is attributed to a diversion by the Texas Highway Department at mile 49.7. Evaporation from large pools along this reach probably accounts for the remainder of the loss. Tributary inflow was 0.01 cfs from Reese Creek. A chemical analysis shows that the inflow from Reese Creek is a calcium bicarbonate water, indicative of the limestone terrane which Reese Creek drains (Figure 2).

In the next 8 miles the riverflow increased to 9.37 cfs, and the dissolved solids increased slightly. An analysis of the river water at mile 41.6 (site 12) shows that the principal dissolved constituents are sodium and chloride

(Figure 4). Tributary inflow from Rocky Creek at mile 46.1 was 0.08 cfs. The principal dissolved constituents of water from Rocky Creek are calcium and bicarbonate.

The wide river channel from mile 41.6 to mile 33.8 is floored with alluvium. Large pools formed by gravel bars are common. Water was being diverted for irrigation from one of these pools at mile 33.9. Below this diversion (site 14) the flow of the Lampasas River decreased to 7.52 cfs, and the dissolved solids decreased to 490 ppm. In this reach the Glen Rose Limestone dips southeastward beneath the Walnut Clay, and the decrease in mineralization of the water is probably due to inflow of ground water from the Walnut Clay.

Reach from Mile 33.8 to Mile 0.3

In the final 33.5 miles of the study reach, the flow of the Lampasas River increased from 7.52 cfs to 16.0 cfs, and the water decreased in dissolved-solids content, largely due to the inflow of less concentrated water from Salado Creek. Most of the drainage area in this reach is underlain by the Walnut Clay.

From mile 33.8 to mile 22.0 the river flows in an alluvial channel with a steep gradient. No tributary inflow was noted in this reach; however, the flow increased to 8.28 cfs at mile 22.0 (site 15), and the dissolved-solids content decreased to 366 ppm. A chemical analysis of the water shows a decrease in all of the principal dissolved constituents; sodium and chloride decreased the most. The river water in this reach is a mixed type in which no single constituent predominates. The principal dissolved constituents are sodium, calcium, magnesium, chloride, and bicarbonate. This change in chemical composition probably results from ground-water inflow from the underlying Walnut Clay.

Between miles 22.0 and 12.6 the channel of the Lampasas River is composed alternately of solid rock and gravel. Throughout this reach there are long pools in the river channel, and vegetation grows profusely on the alluvial terraces (Figure 2). The flow at mile 12.6 (site 20) decreased to 7.52 cfs, and the dissolved solids decreased to 336 ppm, with sodium and chloride showing the most significant decrease. Apparently, the river is intermittently losing water to, and receiving water from, the underlying Walnut Clay. This results in an exchange of water and a dilution of the river water. The type of shallow ground water in this area is probably similar in chemical character to the inflow from an unnamed tributary, which consists entirely of spring flow, at mile 13.9 (site 18) and from a spring at mile 12.6 (site 19). These waters have dissolved-solids concentrations of 259 and 308 ppm; they are calcium bicarbonate waters and are low in sodium and chloride.

At mile 0.8 the Lampasas River receives inflow from Salado Creek, the major contributor of water to the lower reach of the river. At its confluence with the Lampasas River, Salado Creek had a flow of 9.29 cfs, and the water contained 223 ppm dissolved solids. Calcium and bicarbonate are the principal dissolved constituents of the water. This type of water is typical of the Edwards Limestone that crops out in most of the area drained by Salado Creek.

The inflow from Salado Creek increased the flow of the river at mile 0.3 (site 22) to 16.0 cfs. The dissolved-solids content of the water decreased to 265 ppm, and the water was altered in chemical composition (Figure 4). The principal dissolved constituents of the river water are calcium and bicarbonate. This water does not differ greatly in chemical composition from the inflow from Salado Creek.

RELATION OF QUALITY OF WATER TO USE

The standards generally quoted in evaluating the quality and safety of water supplies for domestic and municipal use are the U.S. Public Health Service Drinking Water Standards (1962). According to these standards, the suggested limits for dissolved solids, sulfate, and chloride are 500 ppm, 250 ppm, and 250 ppm, respectively. Waters of the tributary streams, with the exception of Sulphur Creek, are of better domestic quality than the Lampasas River water. These tributary waters meet the U.S. Public Health Service standards for dissolved solids, chloride, and sulfate. Sulphur Creek exceeds the suggested limits for chloride and dissolved solids. Three of the first four sources that were sampled on the Lampasas River--the reach between miles 79.0 and 64.9--contained more than 250 ppm chloride; five of the first six sources--the reach between miles 79.0 and 33.8--contained more than 500 ppm dissolved solids. It is noted, however, that waters containing more than 500 ppm dissolved solids have been used for years in many parts of the United States for domestic use without adverse effects.

The U.S. Salinity Laboratory Staff has established standards for determining the suitability of water for irrigation in arid areas. According to the Salinity Laboratory Staff (1954, p. 69), the characteristics of an irrigation water that appear to be most important in determining its quality include (1) total concentration of soluble salts, and (2) relative proportion of sodium to other cations. An evaluation of some of the waters investigated in this report are given in Table 3. The table indicates that the water in the upper 50 miles of the study reach is generally of questionable quality for some types of irrigation, and that the water in the lower 30 miles of the Lampasas River is satisfactory.

The chemical-quality data discussed in this report were collected during a period when most of the streamflow was sustained by effluent ground water. Ground water is usually more concentrated than surface runoff; consequently, the data probably represent the maximum concentrations of dissolved solids likely to occur in the Lampasas River and its tributaries. Flood runoff will have much lower concentrations.

SUMMARY AND CONCLUSIONS

The base-flow investigation on the Lampasas River reach indicated a fairly stable channel for water conveyance. There is no indication of any large gain or loss in the Stillhouse Hollow reservoir area. A minor interchange between ground water and surface water was evident throughout the reach. This interchange caused small gains and losses between the measuring sites.

The chemical analyses indicate that the mineralization of the Lampasas River generally decreases below the mouth of Sulphur Creek (mile 79.0), with the dissolved-solids content ranging from 887 ppm at mile 77.8 to 265 ppm at mile 0.3. Principal chemical constituents in water of the upper reach of the river are sodium and chloride, but principal chemical constituents in the lower reach are calcium and bicarbonate. The decrease in mineralization and the change in chemical character of the water are attributed to an inflow of less concentrated water from tributaries and to an interchange of surface and ground water.

The tributary waters of the Lampasas River, with the exception Sulphur Creek, meet limits set by the U.S. Public Health Service Drinking Water Standards. Sulphur Creek, the major contributor of water to the upper reach of the river, exceeds the suggested limits for chloride and dissolved solids. The water of the upper 46 miles of the study reach generally exceeds the limits for chloride or dissolved solids, but the water of the lower 34 miles of the reach generally meets the limits set by the U.S. Public Health Service. Under the U.S. Salinity Laboratory Staff standards for irrigation waters, the water in the upper 50 miles of the study reach is generally of questionable quality for irrigation; the water in the lower 30 miles appears to be satisfactory.

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Table 1.--Summary of discharge measurements, Lampasas River and tributaries, June 3-6, 1963

Site No.	Date 1963	Stream	Location	River Miles	Water Temp. (°F)	Discharge in cfs			Remarks
						Main Stream	Tributary	Diversion	
1	June 3	Lampasas River	Lat 31°05'50", long 98°02'23", about 1 mile above mouth of Sulphur Creek. (First measuring site above Sulphur Creek.)	80.1	87	2.27			Limestone channel
2	3	Sulphur Creek	Lat 31°05'07", long 98°01'49", at mouth 150 ft below AT&SF Rwy. Co bridge over Lampasas River.	[a]79.0	83		8.58		Channel is limestone covered with small gravel.
3	3	Lampasas River	Lat 31°04'38", long 98°00'45", 1400 ft below gaging station Lampasas River near Kempner.	77.8	89	10.1			Channel composed of alternate solid rock and gravel. Gravel bars form pools.
4	6	Taylor Creek	Lat 31°04'02", long 97°59'39", at mouth, 1100 ft downstream from county road	[a]76.2	75		.01		Channel is soft mud.
5	3	Rocky Creek	Lat 30°59'39", long 97°55'34", at mouth.	[a]65.0	77		.52		Flow is entirely from springs at mouth.
6	3	Lampasas River	Lat 30°59'41", long 97°55'32", 100 ft below mouth of Rocky Creek	64.9	82	9.25			Channel is small gravel with some large gravel. Banks composed of rock outcrop.
7	4	Lampasas River	Lat 30°58'39", long 97°47'51", 1/2 mile upstream from Bennett Branch, 1.3 miles west of Ding Dong.	52.1	85	9.71			Channel is alternate limestone and gravel. Gravel bars form pools.
8	4	Reese Creek	Lat 30°58'29", long 97°47'12", at mouth, 1.4 miles upstream from bridge on Farm Road 440.	[a]51.0	85		.01		Channel is thin layer of mud on limestone.
9	4	Texas Highway Dept. pumping	At bridge on Farm Road 440.	49.7	-			[b].6	Intermittent pumping, yet the full effect shows at the next downstream measurement.
10	4	Lampasas River	Lat 30°58'20", long 97°46'38", at Ding Dong, 450 ft below bridge on Farm Road 440.	49.6	83	8.95			Channel is alternate limestone and gravel.
11	4	Rocky Creek	Lat 30°56'44", long 97°45'18", at mouth. 2.3 miles southeast of Ding Dong.	[a]46.1	78		.08		Channel of mud.

Table 1.--Summary of discharge measurements, Lampasas River and tributaries, June 3-6, 1963.--Continued

Site No.	Date 1963	Stream	Location	River Miles	Water Temp. (°F)	Discharge in cfs: Main Stream	Discharge in cfs: Tributary	Discharge in cfs: Diversion	Remarks
12	June 4	Lampasas River	Lat 31°42'30", long 97°57'25", 1,000 ft below gaging station Lampasas River at Youngsport.	41.6	85	9.37			Channel is alternate limestone and gravel.
13	5	Irrigation pumping	2.4 miles above Trimmer Creek	33.9	-			b1.4	Pumping time unknown, but full effect shows at the next downstream measurement.
14	5	Lampasas River	Lat 30°59'09", long 97°39'07", 2.3 miles above Trimmer Creek	33.8	82	7.52			Geology changes from Trinity Glen Rose above measurement to Fredericksburg Walnut below measurement.
15	5	Lampasas River	Lat 31°01'40", long 97°35'00", 2.6 miles above bridge on Farm Road 1670.	22.00	82	8.28			Channel is large stones, medium gravel. Pools are numerous.
16	5	Lampasas River	Lat 31°00'37", long 97°33'53", 600 ft below bridge on Farm Road 1670.	19.2	84	7.82			Channel of alternate limestone and gravel. Gravel forms pools.
17	5	Lampasas River	Lat 31°01'14", long 97°30'44", 4.7 miles below bridge on Farm Road 1670	14.8	83	8.77			Channel of alternate limestone and gravel. Gravel forms pools.
18	6	Unnamed tributary	Lat 31°00'41", long 97°30'12", at mouth, 1.3 miles upstream from bridge on U.S. Hwy. 81 on Lampasas River.	a13.9	70		.68		Entire flow is from springs on Boy Scout Camp Tahuaga. Channel is mud.
19	6	Spring flow	Lat 31°00'06", long 97°29'32", right bank of Lampasas River 50 ft upstream from bridge on U. S. Hwy. 81.	a12.6	76		.06		
20	6	Lampasas River	Lat 31°00'06", long 97°29'32", 300 ft below gaging station Lampasas River near Belton.	12.6	88	7.52			Channel is alternate limestone and gravel. Gravel forms long pools.
21	6	Salado Creek	Lat 30°58'38", long 97°24'48", at mouth	a.8	83		9.29		Channel is small gravel.
22	6	Lampasas River	Lat 30°59'02", long 97°24'23", 0.3 mile upstream from confluence with Leon River to form Little River.	.3	87	16.0			Channel is limestone and gravel.

a River mile shown is to mouth of tributary.
b Estimated.

Table 2.--Chemical analyses of streams in the Lampasas River watershed, June 3-6, 1963

[Results in parts per million except as indicated]

Site No.	Stream	Date 1963	Dis-charge (cfs)	Silica (SiO_2)	Cal-cium (Ca)	Mag-ne-sium (Mg)	So-dium (Na)	Po-tas-sium (K)	Bicar-bonate (HCO_3)	Sul-fate (SO_4)	Chlo-ride (Cl)	Fluo-ride (F)	Ni-trate (NO_3)	Dissolved solids: Parts per mil-lion	Dissolved solids: Tons per acre-foot	Hardness as $CaCO_3$: Cal-cium, magne-sium	Hardness as $CaCO_3$: Non-carbon-ate	Per-cent so-dium	So-dium adsorp-tion ratio	Specific conduct-ance (micro-mhos at 25° C)	pH
1	Lampasas River	June 3	2.27	9.0	38	26	18		220	25	23	0.4	0.0	247	0.34	202	21	16	0.6	440	7.6
2	Sulphur Creek	do.	8.58	4.3	72	47	318		218	22	610	.3	1.2	1,180	1.60	373	194	65	7.2	2,220	7.6
3	Lampasas River	do.	10.1	5.3	56	40	230		192	21	440	.4	.1	887	1.21	302	144	62	5.8	1,680	7.5
4	Taylor Creek	June 6	.01	13	98	26	14		393	22	26	.3	.0	392	.53	352	30	8	.3	682	7.0
5	Rocky Creek	June 3	.52	7.5	58	19	6.8	2.0	256	15	10	.3	.0	245	.33	223	13	6	.2	437	7.1
6	Lampasas River	do.	9.25	8.0	56	33	140		234	20	258	.4	1.0	631	.86	275	83	53	3.7	1,180	7.5
7	do.	June 4	9.71	--	--	--	--		221	--	190	--	--	a510	.69	244	63	--	--	962	7.5
8	Reese Creek	do.	.01	21	43	9.2	16		162	12	24	.3	.0	206	.28	145	12	19	.6	340	7.6
10	Lampasas River	do.	8.95	--	--	--	--		217	--	202	--	--	a525	.71	245	67	--	--	988	7.5
11	Rocky Creek	do.	.08	14	90	16	11		316	25	20	.3	.0	331	.45	290	32	7	.3	576	7.1
12	Lampasas River	do.	9.37	6.2	52	29	124		201	17	238	.3	1.5	567	.77	249	84	52	3.4	1,080	7.5
14	do.	June 5	7.52	--	--	--	--		196	--	195	--	--	a490	.67	230	70	--	--	925	7.5
15	do.	do.	8.28	6.7	44	20	68		190	15	119	.3	.2	366	.50	192	37	43	2.1	689	7.5
16	do.	do.	7.82	--	--	--	--		183	--	114	--	--	a350	.48	189	39	--	--	665	7.5
17	do.	do.	8.77	--	--	--	--		191	--	108	--	--	a345	.47	191	34	--	--	653	7.5
18	Unnamed tributary	June 6	.68	9.1	53	21	15		251	14	17	.3	6.7	259	.35	218	13	13	.4	462	7.3
19	Spring flow	do.	.06	12	79	21	6.3	1.1	313	16	10	.8	8.1	308	.42	284	27	5	.2	555	6.9
20	Lampasas River	do.	7.52	7.3	46	19	55		195	14	98	.3	.0	336	.46	193	33	38	1.7	625	7.6
21	Salado Creek	do.	9.29	11	47	16	11		194	16	16	.3	11	223	.30	183	24	12	.4	389	7.5
22	Lampasas River	do.	16.0	10	50	16	26		201	16	42	.3	6.0	265	.36	191	26	23	.8	469	7.5

a Calculated from specific conductance.

Table 3.--Quality of water for irrigation, Lampasas River

Stream	Site No.	River Miles	Irrigation Quality		
			Classification		Rating
			Salinity	Sodium	
Lampasas River	1	80.1	C2	S1	Satisfactory
do.	3	77.8	C3	S2	Questionable
do.	6	64.9	C3	S1	Questionable
do.	12	41.6	C3	S1	Questionable
do.	15	22.0	C2	S1	Satisfactory
do.	20	12.6	C2	S1	Satisfactory
do.	22	.3	C2	S1	Satisfactory

Explanation

C2 (Medium-Salinity Water) - can be used if a moderate amount of leaching occurs.

C3 (High-Salinity Water) - cannot be used on soils with restricted drainage.

S1 (Low-Sodium Water) - can be used on almost all soils.

S2 (Medium-Sodium Water) - can be used on coarse-textured or organic soils with good permeability.

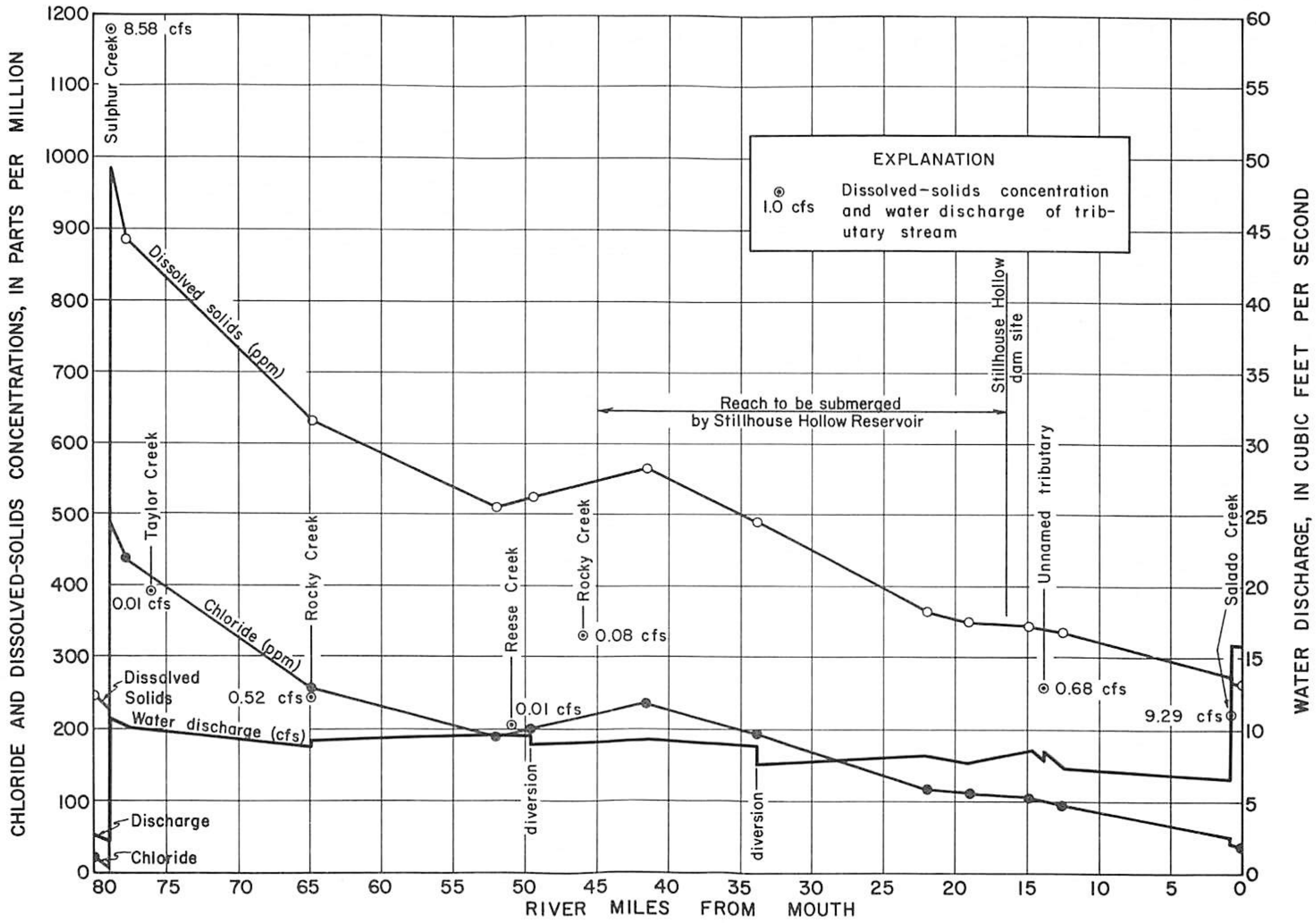

Figure 3

Profiles of Chloride and Dissolved-Solids Concentrations and Water Discharge, Lampasas River, June 3-6, 1963, with Dissolved-Solids Concentrations and Discharges of Tributary Streams

U. S. Geological Survey in cooperation with the Texas Water Commission

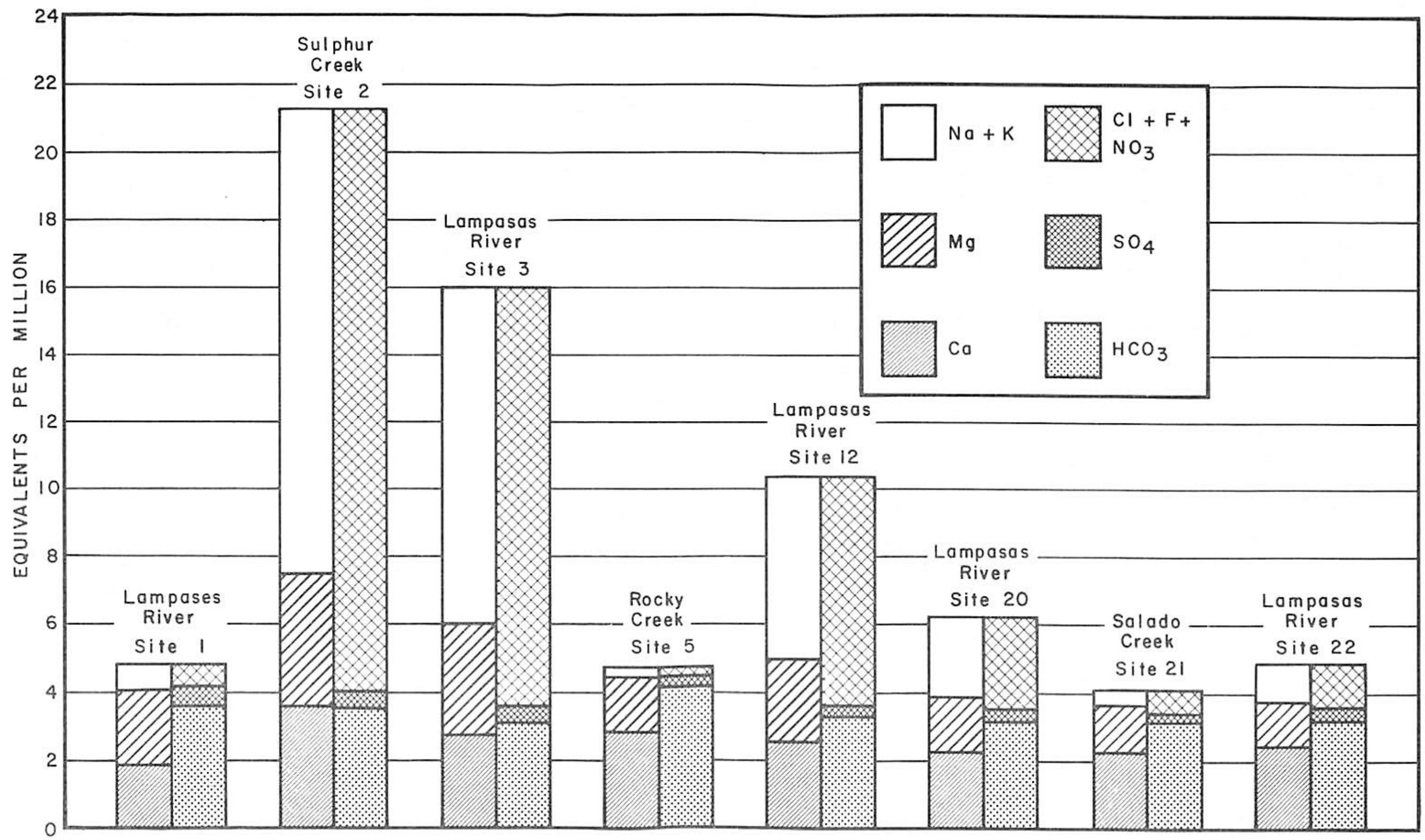

Figure 4

Chemical Analyses of Water of the Lampasas River Watershed

U.S. Geological Survey in cooperation with the Texas Water Commission