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WASTEWATER MANAGEMENT PLAN, COLORADO RIVER AND TRIBUTARIES, TEXAS.

VOLUME II. Basin Plan Appendix.

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BASIN PLAN APPENDIX

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POPULATION PROJECTION METHODOLOGY

The basic population forecasts used in this study were developed by the Texas Water Development Board (TWDB) in conjunction with the recent revision and updating of their Population Projections for the State of Texas. The projections were developed on three separate yet related levels: the county, representative cities (urban and rural) within the county, and selected rural areas within the county. The projections for selected rural areas were developed specifically for this study and are not a part of the basic TWDB Population Projections.

Essentially, the county projections are an extrapolation of the county projections dated May 1972 (Table A-1) developed for the period 1975-1990 by the Population Research Center (PRC), the University of Texas at Austin for the Office of Information Services in the Governor's Office. The PRC projections will generally serve as "baseline" projections for State planning agencies in the same way as OBERS projections are considered "baseline" projections for Federal planning agencies.

The representative city projections were essentially an updating of the municipality's projections published in the TWDB's 1965 Population Projections (Table A-2). The county projections obtained above were used in the updating.

For the purpose of this study, "selected rural area" was defined as any area not included in the representative city classification which now has or will possibly need municipal wastewater treatment facilities during the study period. These forecasts were developed based on the assumption that these areas will grow at the same rate as the rural portion of the Basin county population.

The stepwise procedure used in the development of the forecasts at the various levels is outlined as follows:

County Population Projections

1. Based on the assumption that the State population will increase from 1990 to 2020 at the same rate as projected by the PRC from 1985 to 1990, the PRC projections of the State population were extrapolated to 2020. (The PRC projections of the State population and the projections extrapolated in this step are considered the State population control totals.)

2. Thirteen alternative procedures were used to extrapolate the PRC county projections to 2020. The procedures were:

a. From the PRC 1990 projection, derive the percentage that each county is of the State total. Project the change in that percentage at the same rate as projected by the PRC from 1985 to 1990. Multiply the projected percentage times the extrapolated State control totals for 2000, 2010, and 2020.

b. Project from 1990 to 2020 using the absolute difference between 1960 and the PRC 1990 estimate.

c. Project from 1990 to 2020 using the absolute difference between 1960 and the PRC 1990 estimate. Force the county projections to sum to the projected State control totals, based on each county's proportionate share of the State projection.

d. Project from 1990 to 2020 using the rate of change between 1960 and the PRC 1990 estimate.

e. Project from 1990 to 2020 using the rate of change between 1960 and the PRC 1990 estimate. Force the county projections to sum to the projected State control totals, based on each county's proportionate share of the State projection.

f. Project from 1990 to 2020 using the rate of change between 1960 and 1970.

g. Project from 1990 to 2020 using the rate of change between 1960 and 1970. Force the county projections to sum to the projected State control totals, based on each county's proportionate share of the State projection.

h. Project from 1990 to 2020 using the absolute difference between 1970 and the PRC 1990 estimate. Force the county projections to sum to the projected State control totals, based on each county's proportionate share of the State projection.

i. Project from 1990 to 2020 using the absolute difference between 1970 and the PRC 1990 estimate. Force the county projections to sum the projected State control totals, based on each county's proportionate share of the State projection.

j. Project from 1990 to 2020 using the rate of change between 1970 and the PRC 1990 estimate.

k. Project from 1990 to 2020 using the rate of change between 1970 and the PRC 1990 estimate. Force the county projections to sum to the projected State control totals, based on each county's proportionate share of the State projection.

l. Project from 1990 to 2020 using the absolute difference between the PRC 1984 and 1990 estimates.

m. Project from 1990 to 2020 using the absolute difference between the PRC 1985 and 1990 estimates. Force the county projections to sum to the projected State control totals, based on each county's proportionate share of the State projection.

3. Based on indicators of economic activity for each county, such as personal income, employment, earnings, retail sales, wholesale sales, the best alternative projection for the year 2020 was selected.

4. Assuming a linear growth within the county between 1970 and 2020, the population for each intermediate decade was projected.

5. The State population for each decade was then determined by summing the values determined in steps 3 and 4 for the respective decades.

6. The ratio of the State population obtained in step 5 to the State population control totals was calculated for each decade.

7. County totals were then forced to agree with the State control totals; that is, for each decade, the county projection obtained in steps 3 and 4 were adjusted (multiplied) by the respective ratio (obtained in step 6) for that decade. The results of these calculations shall hereafter be referred to as the total county population.

NOTE: The following procedure was used to determine and subsequently forecast the Basin county population. The Basin county population is defined as the population located in that portion of the county that lies within the Basin.

8. Detailed county census tract maps were used to determine the following for each county:

(1)

a. The 1970 urban population within the Basin.
b. The 1970 rural population within the Basin.
   (The values obtained in a. and b. were summed to obtain the 1970 Basin county population.)
c. The percent of each urban area's 1970 population in the Basin.
d. The percent of the county's 1970 rural population in the Basin.

9. The projected population[2] for each decade for each urban area within the county was adjusted (multiplied) by the respective percentage determined in Step 8.c.

10. The projected rural population[3] of the county (for each decade) was adjusted (multiplied) by the respective percentage calculated in Step 8.d.

11. The projected Basin county population for each decade was obtained by summing the respective values obtained in Steps 9 and 10.

12. The values obtained in Step 11 were rounded to the nearest ten.

EXAMPLE: Colorado County

Steps 1 - 7

The procedure employed in these steps are intricately tied to similar calculations for the other 253 counties in the State, and it is not within the scope of this example to present the various calculations and assumptions for each county. The end result of Steps 1 - 7 is shown in Table A-3.

Step 8	1970 Population		% of 1970
	Total	In-Basin	Population in Basin
Colorado Co.	17,638	11,632	-
Columbus	3,342	3,342	100
Eagle Lake	3,587	1,793	50
Other*	10,709	6,497	60.67

(1) Urban area is defined by the Bureau of the Census as an area having a population of 2500 or more.
(2) Respective values given in Table A-3.
(3) The projected rural population obtained by subtracting the projected urban area(s) population from the projected total county population.
*Rural Population

Steps 9 and 10

Projected Population x percentage of 1970 Population in Basin = In-Basin Population

As obtained in Step 8, the percentages are:

Columbus - 100
Eagle Lake - 50
Other (Rural - 60.67

Year	Projected Population			In-Basin Population		
	Columbus	Eagle Lake	Other	Columbus	Eagle Lake	Other
1980	3,500	3,800	10,200	3,500	1,900	6,188
1990	3,700	4,000	9,800	3,700	2,000	5,946
2000	3,700	4,000	9,500	3,700	2,000	5,764
2010	3,800	4,100	8,900	3,800	2,050	5,400
2020	3,800	4,100	8,300	3,800	2,050	5,036

Step 11

Sum of In-Basin population of Columbus, Eagle Lake and Other equals Basin County Population.

Year	In-Basin Population			Basin County Population
	Columbus	Eagle Lake	Other	
1980	3,500	1,900	6,188	11,588
1990	3,700	2,000	5,946	11,646
2000	3,700	2,000	5,764	11,464
2010	3,800	2,050	5,400	11,250
2020	3,800	2,050	5,036	10,886

REPRESENTATIVE CITY POPULATION PROJECTIONS

1. The percent the projected 1970 city population[1] was of the 1970 projected total county population[1] was calculated.
2. Step 1 was repeated respectively for each decade through 2020.
3. The percent the observed 1970 census city population was of the observed 1970 census total county population was calculated.

[1] Source - TWDB's 1965 Population Projection (Table A-2)

4. The percent obtained in Step 3 was divided by the percent obtained in Step 1.

5. The percentages determined in Step 2 were adjusted (multiplied) by the value obtained in Step 4.

6. Assuming that the relation between the city and county population would be as projected in the 1965 projections[1], the total county population[2] for each decade was multiplied by the respective percentage calculated in Step 5 to obtain the projected city population.

7. The figures obtained in Step 6 were rounded to the nearest ten.

EXAMPLE: City of Eagle Lake, Colorado County.

Steps 1 and 2

Year	Population		Percent
	Eagle Lake(A)	Colorado Co. (B)	A ÷ B
1970	4,526	21,366	21.2
1980	5,752	25,431	22.6
1990	7,317	31,101	23.5
2000	9,307	38,055	24.4
2010	11,839	46,580	25.4
2020	15,059	57,041	26.4

Step 3

$$\frac{\text{1970 Eagle Lake Census Population}}{\text{1970 Colorado Co. Census Population}} = \frac{3,587}{17,638} = 0.203$$

Step 4

$$\frac{0.203}{0.212} = 0.96 = 96\%$$

---

(1) Source - TWDB's 1965 Population Projection (Table A-2.)

(2) Total county figures obtained in Step 7 in the County Population Projections (Table A-3.)

Step 5

Value from Step 2 x Value from Step 4 = Adjusted Percentage

Year	Values from Step 2	Values from Step 4	Adjusted Percentages
1980	22.6	96	21.7
1990	23.5	96	22.6
2000	24.4	96	23.4
2010	25.4	96	24.4
2020	26.4	96	25.3

Step 6

Eagle Lake Population = Total County Population x Adjusted Percentage

Year	Colorado Co. Population	Adjusted Percentage	Eagle Lake Population
1980	17,500	21.7	3,799
1990	17,500	22.6	3,956
2000	17,200	23.4	4,025
2010	16,800	24.4	4,102
2020	16,200	25.3	4,108

This methodology was used to project the population of the following cities:

Andrews
Austin
Bastrop
Ballinger
Big Lake
Big Spring
Brady
Brownfield
Brownwood
Burnet
Coleman
Colorado City
Columbus
Denver City
Eagle Lake
Eden
Eldorado
Elgin
El Campo
Fredericksburg
Gail
Garden City
Giddings
Goldthwaite
Johnson City
Junction
La Grange
Lamesa
Llano
Mason
Menard
Mertzon
Midland
Odessa
Paint Rock
Robert Lee
Rock Springs
San Angelo
San Saba
Seminole
Smithville
Snyder
Stanton
Sterling City
Wharton
Winters

SELECTED RURAL AREAS

1. The 1970 urban Basin population within the county was subtracted from the 1970 Basin county population to obtain the 1970 rural Basin population ("Other").

2. Step 1 was repeated for 1980, 1990, 2000, 2010 and 2020.

3. The ratio (percent) of the 1970 population of the selected rural area to the 1970 "other" population (obtained in Step 1) was calculated.

4. The population of the selected rural area for each decade was then projected by multiplying the projected Basin "other" county population (obtained in Step 2) by the respective percentage calculated in Step 3.

5. The projections obtained in Step 4 were rounded to the nearest ten.

EXAMPLE: Selected rural areas in Colorado County.

Steps 1 and 2

	Population					
	1970	1980	1990	2000	2010	2020
Colorado Co.	11,632	11,590	11,650	11,460	11,250	10,890
Columbus	3,342	3,540	3,670	3,740	3,790	3,780
Eagle Lake	1,793	1,900	2,000	2,000	2,050	2,050
Garwood*	961					
Weimar*	2,104					
Other	6,497	6,150	5,980	5,720	5,410	5,060

Step 3

$$\text{Garwood: } \frac{961}{6,497} = 0.148 = 14.8\%$$

$$\text{Weimar: } \frac{2,104}{6,497} = 0.324 = 32.4\%$$

* Selected Rural Areas

Step 4

Garwood Projections -

Year	Other		%		Projection
1980	6,150	x	0.148	=	910
1990	5,980	x	0.148	=	885
2000	5,720	x	0.148	=	846
2010	5,410	x	0.148	=	801
2020	5,060	x	0.148	=	749

Weimar Projections

Year	Other		%		Projection
1980	6,150	x	0.324	=	1993
1990	5,980	x	0.324	=	1938
2000	5,720	x	0.324	=	1853
2010	5,410	x	0.324	=	1753
2020	5,060	x	0.324	=	1639

MUNICIPAL AND INDUSTRIAL WATER REQUIREMENT PROJECTION METHODOLOGY

The municipal and industrial water requirements[1] used in this study were developed by the Texas Water Development Board (TWDB) in conjunction with their continuing update of the water resources plan for the State. Basically, the projections are an evaluation of actual 1970 water use and simple extrapolation of these 1970 uses.

Due to the usually close relationship between municipal and industrial supply, the projection methodologies utilized are similar and requirements often combined (i.e., an industry buying water from the municipal water supply). In an effort to define specific requirements in those instances, the TWDB utilized two criteria:

1. Smaller industries and commercial establishments currently obtaining or projected to obtain their water from municipal systems have been included in municipal requirements.

[1] See Table A-4 for projected requirements.

TABLE A-1

POPULATION PROJECTIONS FOR TEXAS COUNTIES*
1975 - 1990

	1970 Census	1975	1980	1985	1990
State Totals	11,196,730	12,000,700	13,068,600	14,256,300	15,450,000
Anderson	27,789	27,700	28,000	28,100	27,700
Andrews	10,372	10,500	10,600	10,800	11,000
Angelina	49,349	55,900	62,900	70,700	78,600
Aransas	8,902	11,700	13,600	15,700	17,900
Archer	5,759	5,800	5,400	4,900	4,400
Armstrong	1,895	1,900	1,700	1,500	1,300
Atascosa	18,696	18,500	19,100	19,700	20,000
Austin	13,831	13,900	14,000	14,200	14,500
Bailey	8,487	10,200	10,900	11,600	12,200
Bandera	4,747	4,500	4,300	4,100	3,900
Bastrop	17,297	16,700	16,400	15,900	15,200
Baylor	5,221	4,700	4,500	4,300	4,100
Bee	22,737	22,300	24,500	27,000	29,300
Bell	124,483	131,500	144,700	159,500	174,500
Bexar	830,460	862,900	933,100	1,007,100	1,073,900
Blanco	3,567	3,300	3,200	3,100	3,000
Borden	888	900	800	800	800
Bosque	10,966	10,400	10,000	9,500	8,800
Bowie	67,813	71,700	76,500	81,100	84,400
Brazoria	108,312	127,500	148,600	172,700	198,200
Brazos	57,978	61,100	67,200	73,700	80,000
Brewster	7,780	8,000	8,100	8,200	8,300
Briscoe	2,794	3,000	2,800	2,600	2,300
Brooks	8,005	9,200	9,300	9,500	9,400
Brown	25,877	24,000	23,000	22,500	22,000
Burleson	9,999	9,600	9,100	8,600	8,200
Burnet	11,420	11,600	12,000	12,400	12,600
Caldwell	21,178	20,300	19,400	18,000	17,300
Calhoun	17,831	19,700	21,500	23,200	25,000
Callahan	8,205	7,900	7,700	7,400	7,100
Cameron	140,368	135,800	127,100	122,300	119,100
Camp	8,005	8,100	8,200	8,400	8,300
Carson	6,358	6,700	6,600	6,500	6,300
Cass	24,133	24,600	24,600	24,400	23,600
Castro	10,394	11,400	12,600	13,800	15,000
Chambers	12,187	14,300	15,500	16,500	17,100
Cherokee	32,008	31,800	32,000	32,000	31,500
Childress	6,605	5,400	4,900	4,700	4,100
Clay	8,079	7,700	7,000	6,500	5,900
Cochran	5,326	5,700	5,700	5,600	5,500
Coke	3,087	3,100	2,800	2,500	2,100
Coleman	10,288	9,500	8,500	8,000	7,200
Collin	66,920	71,900	78,300	84,400	89,300
Collingsworth	4,755	4,300	4,000	3,600	3,200
Colorado	17,638	17,300	16,800	16,100	15,500
Comal	24,165	25,600	27,100	28,400	29,000
Comanche	11,898	11,600	11,000	10,200	9,600
Concho	2,937	2,500	2,200	1,800	1,400
Cooke	23,471	23,300	22,800	22,000	21,300
Coryell	35,311	38,100	42,600	47,700	53,100
Cottle	3,204	3,000	2,600	2,200	2,000
Crane	4,172	4,500	4,600	4,500	4,400
Crockett	3,885	4,100	4,300	4,500	4,600
Crosby	9,085	10,100	10,000	9,800	9,400
Culberson	3,429	3,900	4,200	4,400	4,500

*Population projections series I-C, Population Research Center, the University of Texas at Austin, May 1972.

TABLE A-1 (Cont'd.)

	1970 Census	1975	1980	1985	1990
Dallam	6,012	5,800	5,100	4,700	4,100
Dallas	1,327,321	1,483,800	1,730,500	2,014,400	2,316,100
Dawson	16,604	17,900	16,700	15,300	13,400
Deaf Smith	18,999	25,400	29,600	34,300	39,000
Delta	4,927	4,300	3,700	3,300	3,100
Denton	75,633	85,300	100,300	117,600	136,200
De Witt	18,660	18,600	16,500	13,900	10,600
Dickens	3,737	3,500	3,000	2,700	2,200
Dimmit	9,039	9,000	8,700	8,500	8,300
Donley	3,641	3,200	2,800	2,600	2,200
Duval	11,722	12,700	12,200	11,500	10,500
Eastland	18,092	17,400	16,200	14,800	13,500
Ector	91,805	119,400	135,700	153,700	171,600
Edwards	2,107	2,300	2,300	2,300	2,200
Ellis	46,638	46,100	46,600	47,000	46,600
El Paso	359,291	395,200	455,000	523,500	595,900
Erath	18,141	18,100	18,200	18,300	18,100
Falls	17,300	15,000	12,800	10,500	7,900
Fannin	22,705	21,300	20,000	18,600	16,900
Fayette	17,650	15,400	12,800	11,300	10,200
Fisher	6,344	5,800	5,000	4,600	3,900
Floyd	11,044	12,800	13,100	13,400	13,500
Foard	2,211	1,800	1,500	1,500	1,400
Fort Bend	52,314	62,900	69,000	75,600	82,000
Franklin	5,291	5,300	5,400	5,400	5,400
Freestone	11,116	10,200	9,400	8,400	7,400
Frio	11,159	13,100	13,800	14,500	15,100
Gaines	11,593	13,000	13,500	13,800	13,800
Galveston	169,812	175,000	184,000	191,200	195,400
Garza	5,289	5,900	5,800	5,600	5,400
Gillespie	10,553	10,200	10,100	10,100	10,000
Glasscock	1,155	1,300	1,400	1,500	1,500
Goliad	4,869	4,400	4,100	3,700	3,200
Gonzales	16,375	15,500	14,600	13,700	12,800
Gray	26,949	30,300	29,800	29,000	27,600
Grayson	83,225	84,900	88,500	91,600	93,400
Gregg	75,929	81,300	86,700	92,200	96,900
Grimes	11,855	11,100	10,400	9,600	8,600
Guadalupe	33,554	33,800	34,500	34,800	35,100
Hale	34,137	41,000	43,300	45,700	47,800
Hall	6,015	5,500	5,300	5,000	4,900
Hamilton	7,198	6,300	5,800	5,400	5,100
Hansford	6,351	6,800	7,400	7,900	8,400
Hardeman	6,795	6,400	5,900	5,300	4,800
Hardin	29,996	35,000	40,500	46,800	53,300
Harris	1,741,912	1,933,900	2,240,700	2,952,500	2,963,400
Harrison	44,841	45,100	44,500	43,300	41,000
Hartley	2,782	3,200	3,300	3,500	3,600
Haskell	8,512	7,800	7,400	6,600	6,000
Hays	27,642	29,400	30,900	33,100	36,400
Hemphill	3,084	3,300	3,200	3,100	3,000
Henderson	26,466	27,300	28,700	30,000	30,800
Hidalgo	181,535	175,600	166,400	161,600	157,200
Hill	22,596	20,500	18,700	16,600	14,300
Hockley	20,396	21,000	20,600	20,200	19,800
Hood	6,368	6,500	6,700	6,900	7,000
Hopkins	20,710	21,200	22,000	22,700	23,100
Houston	17,855	17,000	16,400	15,800	14,800
Howard	37,796	45,500	48,500	51,600	54,400
Hudspeth	2,392	2,200	2,100	2,000	1,900
Hunt	47,948	48,700	50,100	51,300	51,700
Hutchinson	24,443	21,900	19,300	16,600	15,200

TABLE A-1 (Cont'd.)

	1970 Census	1975	1980	1985	1990
Irion	1,070	1,000	900	800	800
Jack	6,711	7,000	6,700	6,400	5,900
Jackson	12,975	12,800	12,400	12,000	11,600
Jasper	24,692	27,700	30,900	34,500	38,000
Jeff Davis	1,527	1,600	1,400	1,300	1,100
Jefferson	244,773	254,100	260,300	262,800	263,100
Jim Hogg	4,654	5,200	5,200	5,200	5,100
Jim Wells	33,032	33,500	35,900	38,600	40,800
Johnson	45,769	48,500	51,900	55,200	57,600
Jones	16,106	14,200	12,300	10,000	7,200
Karnes	13,462	14,000	12,700	11,200	9,300
Kaufman	32,392	32,300	33,100	33,700	33,900
Kendall	6,964	7,000	7,200	7,400	7,400
Kenedy	678	700	700	600	600
Kent	1,434	1,200	1,000	900	800
Kerr	19,454	20,200	21,200	22,100	22,700
Kimble	3,904	3,800	3,700	3,600	3,500
King	464	400	400	400	400
Kinney	2,006	1,900	1,800	1,700	1,600
Kleberg	33,166	34,800	38,400	42,200	46,000
Knox	5,972	5,700	5,200	5,000	4,600
Lamar	36,062	36,200	36,800	37,100	36,900
Lamb	17,770	17,800	17,200	16,800	16,400
Lampasas	9,323	9,200	9,000	8,900	8,800
La Salle	5,014	5,800	5,900	6,100	6,200
Lavaca	17,903	16,500	14,700	12,800	11,300
Lee	8,048	7,500	6,900	6,400	5,700
Leon	8,738	8,100	7,500	6,900	6,200
Liberty	33,014	34,400	35,700	36,900	37,500
Limestone	18,100	16,300	14,700	12,900	10,900
Lipscomb	3,486	3,400	3,200	3,100	3,000
Live Oak	6,697	6,400	6,300	6,000	5,500
Llano	6,979	7,100	7,200	7,300	7,300
Loving	164	200	100	100	100
Lubbock	179,295	231,900	263,200	297,600	331,900
Lynn	9,107	9,200	9,000	8,800	8,600
McCulloch	8,571	7,600	6,500	5,300	3,800
McLennan	147,553	148,800	152,500	155,600	156,200
McMullen	1,095	900	800	600	500
Madison	7,693	7,600	7,500	7,400	7,200
Marion	8,517	8,900	9,300	9,700	9,900
Martin	4,774	4,900	4,800	4,700	4,700
Mason	3,356	3,000	2,600	2,100	1,500
Matagorda	27,913	29,200	30,400	31,900	33,400
Maverick	18,093	20,200	23,400	26,100	28,400
Medina	20,249	22,700	23,000	23,300	23,100
Menard	2,646	2,500	2,200	2,100	2,000
Midland	65,433	66,000	67,000	67,600	68,200
Milam	20,028	18,800	17,900	16,800	15,400
Mills	4,212	3,700	3,100	2,500	1,800
Mitchell	9,073	9,000	7,800	6,400	6,000
Montague	15,326	14,600	14,000	13,600	13,200
Montgomery	49,479	55,200	63,200	72,300	81,700
Moore	14,060	15,400	15,500	15,500	15,200
Morris	12,310	12,200	12,200	12,100	12,000
Motley	2,178	2,000	1,800	1,600	1,500
Nacogdoches	36,362	39,500	41,400	44,100	46,200
Navarro	31,150	29,200	27,600	25,800	23,600
Newton	11,657	12,600	13,900	15,100	16,300
Nolan	16,220	15,400	15,000	14,500	14,000
Nueces	237,544	256,100	274,300	291,800	307,300
Ochiltree	9,704	10,400	11,100	11,800	12,400
Oldham	2,258	2,800	3,200	3,600	4,000
Orange	71,170	82,200	95,200	110,100	125,800
Palo Pinto	28,962	31,500	34,400	37,200	39,500
Panola	15,894	15,300	14,300	12,900	10,900

TABLE A-1 (Cont'd.)

	1970 Census	1975	1980	1985	1990
Parker	33,888	37,200	37,300	39,500	41,200
Parmer	10,509	11,300	12,400	13,000	13,900
Pecos	13,748	15,900	16,800	17,700	18,100
Polk	14,457	14,300	13,900	13,300	12,200
Potter	90,511	93,100	94,200	94,800	95,200
Presidio	4,842	4,900	4,800	4,700	4,600
Rains	3,752	3,700	3,800	3,900	3,900
Randall	53,885	64,100	78,800	96,200	115,300
Reagan	3,239	3,200	2,900	2,600	2,200
Real	2,013	2,000	2,000	2,000	1,900
Red River	14,298	13,400	12,700	11,800	10,800
Reeves	16,526	16,500	16,400	16,400	16,300
Refugio	9,494	9,700	9,600	9,400	9,100
Roberts	967	1,000	1,000	1,000	1,000
Robertson	14,389	12,900	11,500	10,000	8,400
Rockwall	7,046	7,300	8,100	9,600	9,700
Runnels	12,108	11,800	11,000	10,200	9,600
Rusk	34,102	32,600	31,500	30,100	28,200
Sabine	7,187	7,300	7,400	7,400	7,200
San Augustine	7,858	7,900	8,100	8,300	8,500
San Jacinto	6,702	6,900	7,000	7,100	7,100
San Patricio	47,288	47,500	46,000	45,400	44,900
San Saba	5,540	4,800	4,100	3,300	2,300
Schleicher	2,277	2,200	1,900	1,700	1,300
Scurry	15,760	15,200	14,800	14,200	13,500
Shackelford	3,323	3,000	2,800	2,400	2,000
Shelby	19,672	20,000	20,700	21,200	21,400
Sherman	3,657	4,100	4,300	4,500	4,600
Smith	97,096	104,300	133,000	121,300	127,700
Somervell,	2,793	2,800	3,000	3,100	3,200
Starr	17,707	19,600	21,800	22,400	23,800
Stephens	8,414	8,100	7,700	7,200	6,400
Sterling	1,056	1,000	900	800	700
Stonewall	2,397	2,400	2,200	1,900	1,700
Sutton	3,175	3,100	2,900	2,700	2,500
Swisher	10,373	10,800	11,000	11,100	11,400
Tarrant	716,317	764,900	859,600	965,200	1,071,300
Taylor	97,853	99,600	100,200	102,600	105,100
Terrell	1,940	1,500	1,400	1,300	1,200
Terry	14,118	16,300	16,500	16,700	16,700
Throckmorton	2,205	2,100	1,800	1,500	1,200
Titus	16,702	17,200	18,000	18,700	19,100
Tom Green	71,047	79,800	86,100	89,300	91,400
Travis	295,516	316,600	354,000	395,600	437,300
Trinity	7,628	7,000	6,500	5,900	5,200
Tyler	12,417	13,700	15,000	16,400	17,800
Upshur	20,976	21,600	22,400	23,000	23,500
Upton	4,697	4,800	4,400	4,100	3,600
Uvalde	17,348	19,900	20,400	20,900	21,100
Val Verde	27,471	30,500	33,300	35,800	38,400
Van Zandt	22,155	22,600	23,300	23,900	24,100
Victoria	53,766	58,400	62,400	65,900	69,500
Walker	27,680	31,600	35,100	38,300	40,200
Waller	14,285	14,900	15,400	15,700	16,100
Ward	13,019	13,100	13,100	13,000	12,900
Washington	18,842	18,300	17,700	17,000	16,400
Webb	72,859	92,700	105,100	118,900	132,700
Wharton	36,729	36,400	36,400	36,300	35,400
Wheeler	6,434	6,100	5,800	5,200	4,800
Wichita	121,862	129,100	135,800	140,700	145,200
Wilbarger	15,355	14,800	14,100	13,300	12,800
Willacy	15,570	14,500	13,600	12,700	12,100
Williamson	37,305	36,500	35,500	34,200	33,000

TABLE A-1 (Cont'd.)

	1970 Census	1975	1980	1985	1990
Wilson	13,041	12,900	12,800	12,600	12,300
Winkler	9,640	9,600	9,200	8,800	8,500
Wise	19,687	20,400	21,400	22,400	23,000
Wood	18,589	18,400	18,500	18,500	18,100
Yoakum	7,344	8,500	9,200	9,700	10,100
Young	15,400	14,400	13,800	12,700	12,000
Zapata	4,352	5,300	5,700	6,200	6,700
Zavala	11,370	13,900	15,400	17,100	18,700

TABLE A-2

TEXAS WATER DEVELOPMENT BOARD
POPULATION PROJECTIONS
DECEMBER 1965

COUNTY CITY	1970	1980	1990	2000	2010	2020
Andrews County	16,284	18,854	20,866	23,098	25,574	28,324
Andrews	12,971	14,553	15,725	16,992	18,361	19,840
Austin County	14,252	15,965	19,365	23,509	28,559	34,720
Bastrop County	16,532	16,797	17,757	18,788	19,895	21,080
Bastrop	3,067	3,273	3,650	4,069	4,537	5,059
Elgin	3,701	4,021	4,503	5,043	5,647	6,324
Smithville	3,300	3,724	4,215	4,771	5,401	6,113
Blanco County	3,791	3,969	4,196	4,436	4,690	4,960
Johnson City	714	825	941	1,074	1,225	1,398
Borden County	1,131	1,185	1,237	1,291	1,349	1,409
Gail	262	330	398	480	580	700
Brown County	32,105	38,803	43,656	49,117	55,262	62,174
Brownwood	22,497	27,429	30,763	34,503	38,697	43,401
Burnet County	9,314	9,603	10,154	10,740	11,364	12,028
Burnet	2,354	2,580	2,915	3,292	3,718	4,200
Caldwell County	17,945	19,493	21,996	24,877	28,188	31,992
Callahan County	7,574	7,565	7,889	8,227	8,581	8,953
Cochran County	6,571	6,797	7,072	7,379	7,721	8,100
Coke County	3,500	3,516	3,637	3,764	3,894	4,030
Robert Lee	975	992	1,042	1,095	1,151	1,209
Coleman County	14,975	17,324	19,289	21,476	23,911	26,623
Coleman	7,415	8,351	9,101	9,919	10,809	11,780
Colorado County	21,366	25,431	31,101	38,055	46,580	57,041
Columbus	4,653	5,912	7,497	9,507	12,055	15,287
Eagle Lake	4,526	5,752	7,317	9,307	11,839	15,059
Comanche County	4,002	4,025	4,147	4,273	4,403	4,538
Concho	3,546	3,544	3,667	3,794	3,926	4,062
Eden	1,517	1,582	1,684	1,792	1,908	2,031
Crane County	6,666	8,652	10,270	12,189	14,467	17,173
Crockett County	4,002	4,025	4,147	4,273	4,403	4,538
Dawson County	20,958	22,552	23,905	25,338	26,857	28,468
Lamesa	13,967	15,290	16,319	17,417	18,589	19,840
Eastland	19,158	19,362	20,151	20,983	21,857	22,778
Ector County	108,128	125,159	140,782	158,356	178,125	200,362
Odessa	99,061	116,611	131,049	147,275	165,510	186,002
Edwards	2,142	2,125	2,215	2,320	2,439	2,573

Note: Projections were made for the entire state; however, only those counties within the Colorado River Basin are delineated in this listing.

TABLE A - 2 (Cont'd.)

COUNTY CITY	1970	1980	1990	2000	2010	2020
Rocksprings	1,355	1,519	1,666	1,828	2005	2,200
Fayette County	19,450	19,526	20,633	21,833	23,137	24,552
LaGrange	4,306	5,160	6,235	7,534	9,103	11,000
Gaines County	13,278	14,349	15,480	16,700	18,016	19,436
Seminole	6,551	7,372	8,177	9,071	10,061	11,160
Garza County	6,842	7,112	7,426	7,753	8,095	8,452
Gillespie County	9,405	9,315	9,758	10,224	10,713	11,226
Fredericksburg	5,503	6,329	7,042	7,835	8,718	9,700
Glascock County	1,586	2,057	2,438	2,891	3,431	4,076
Garden City	481	729	939	1,208	1,554	2,000
Hays County	24,813	30,760	37,938	46,881	58,026	71,921
Hockley County	27,036	30,881	33,254	35,811	38,566	41,536
Howard County	57,384	72,309	80,285	89,141	98,976	109,895
Big Spring	48,264	63,447	70,942	79,335	88,714	99,201
Irion County	1,131	1,125	1,164	1,205	1,247	1,290
Mertzon	571	576	601	628	655	684
Kendall County	5,480	5,423	5,666	5,934	6,226	6,549
Kerr County	19,601	22,731	26,145	30,085	34,634	39,888
Kimble County	3,712	3,687	3,863	4,047	4,241	4,443
Junction	2,536	2,707	2,968	3,254	3,567	3,911
Lampasas County	10,808	12,301	13,863	15,628	17,625	19,880
Lee County	8,499	8,486	8,847	9,342	9,983	10,788
Giddings	3,380	4,013	4,722	5,556	6,537	7,692
Llano County	5,409	5,652	5,977	6,320	6,684	7,068
Llano	2,810	2,982	3,174	3,379	3,598	3,830
Lynn County	11,272	11,704	12,220	12,750	13,322	13,910
McCulloch County	10,447	12,268	14,276	16,613	19,332	22,496
Brady	6,991	8,786	10,598	12,784	15,420	18,600
Martin County	4,955	5,019	5,264	5,522	5,792	6,076
Stanton	2,717	3,161	3,509	3,895	4,324	4,800
Mason County	3,531	3,491	3,656	3,831	4,015	4,210
Mason	1,870	1,944	2,146	2,370	2,617	2,889
Matagorda County	30,338	36,369	44,181	53,690	65,266	79,361
Menard	2,867	2,868	2,968	3,071	3,178	3,289
Menard	1,971	2,058	2,180	2,308	2,445	2,589
Midland County	79,504	91,676	103,814	117,564	133,136	150,770
Midland	73,730	84,886	95,573	107,604	121,150	136,402
Mills County	4,748	5,208	5,894	6,688	7,604	8,664
Goldthwaite	1,709	2,116	2,623	3,252	4,033	5,000

TABLE A-2 (Cont'd.)

COUNTY CITY	1970	1980	1990	2000	2010	2020
Mitchell County	11,520	12,245	13,515	14,917	16,464	18,172
Colorado City	6,814	7,459	8,470	9,617	10,920	12,400
Nolan County	23,230	26,586	28,327	30,183	32,160	34,269
Reagan County	5,360	6,953	8,252	9,795	11,626	13,799
Big Lake	1,526	2,021	2,400	2,858	3,413	4,088
Real County	1,955	1,940	2,031	2,128	2,231	2,339
Runnels County	15,451	16,254	17,481	18,814	20,259	21,824
Ballinger	5,662	6,388	7,240	8,205	9,300	10,540
Winters	3,862	4,512	5,206	6,008	6,933	8,000
San Saba County	7,106	7,989	9,064	10,283	11,667	13,237
San Saba	3,144	3,612	4,138	4,740	5,431	6,221
Schleicher County	2,659	2,672	2,763	2,859	2,959	3,063
Eldorado	2,125	2,351	2,456	2,566	2,680	2,800
Scurry County	21,873	23,702	25,911	28,329	30,978	33,878
Snyder	15,470	17,218	19,094	21,174	23,481	26,040
Sterling County	1,129	1,125	1,164	1,205	1,246	1,290
Sterling City	868	897	941	989	1,038	1,090
Sutton County	3,588	3,576	3,685	3,798	3,913	4,033
Taylor County	122,108	143,693	164,604	188,590	216,102	247,659
Terry County	20,635	24,208	26,276	28,523	30,962	33,612
Brownfield	14,379	17,825	19,597	21,544	23,688	26,040
Tom Green	79,787	97,153	116,686	140,145	168,320	202,160
San Angelo	73,402	90,134	108,902	131,578	158,975	192,078
Travis County	309,748	421,491	534,542	678,024	860,145	1,091,337
Austin	270,095	367,901	471,442	604,121	774,142	992,012
Upton County	8,875	11,538	13,694	16,254	19,294	22,901
Washington County	20,999	24,273	29,550	35,974	43,796	53,321
Wharton County	43,005	50,757	61,800	75,253	91,639	111,601
El Campo	9,767	12,040	14,424	17,280	20,701	24,800
Wharton	8,028	10,569	13,080	16,189	20,037	24,800
Williamson County	36,995	40,627	46,410	53,017	60,566	69,193
Winkler County	16,041	18,575	21,196	24,187	27,600	31,494
Yoakum County	8,282	8,593	8,973	9,368	9,782	10,213
Denver City	5,250	5,968	6,319	6,690	7,084	7,500

TABLE A-3

TEXAS WATER DEVELOPMENT BOARD
POPULATION PROJECTIONS
NOVEMBER 1972

COUNTY CITY	1960	1970	1980	1990	2000	2010	2020
Andrews County	13,450	10,372	10,900	11,400	11,900	12,200	12,400
Andrews	11,135	8,625	8,800	9,000	9,100	9,100	9,100
Other	2,315	1,747	2,100	2,400	2,800	3,100	3,300
Bastrop County	16,925	17,297	18,400	19,700	20,700	21,600	22,400
Bastrop	3,001	3,112	3,500	3,900	4,300	4,800	5,200
Elgin	3,511	3,832	4,400	4,900	5,500	6,100	6,700
Smithville	2,933	2,959	3,500	4,000	4,500	5,000	5,600
Other	7,480	7,394	7,000	6,900	6,400	5,700	4,900
Blanco County	3,657	3,567	3,500	3,500	3,400	3,400	3,200
Johnson City	611	767	800	900	900	1,000	1,000
Other	3,046	2,800	2,700	2,600	2,500	2,400	2,200
Borden County	1,076	888	900	900	900	800	800
Gail	*	178	200	300	300	300	300
Other	–	710	700	600	600	500	500
Brown County	24,728	25,877	26,500	27,300	27,700	27,800	27,800
Brownwood	16,974	17,368	17,900	18,400	18,600	18,600	18,600
Other	7,754	8,509	8,600	8,900	9,100	9,200	9,200
Burnet County	9,265	11,420	12,000	12,700	13,300	13,700	14,100
Burnet	2,214	2,864	3,200	3,600	4,000	4,400	4,900
Other	7,051	8,556	8,800	9,100	9,300	9,300	9,200
Caldwell County	17,222	21,178	23,700	26,700	29,600	32,500	35,500
Lockhart	6,084	6,489	8,000	9,700	11,400	13,400	15,600
Luling	4,412	4,719	5,600	6,300	7,000	7,700	8,400
Other	6,726	9,970	10,100	10,700	11,200	11,400	11,500
Callahan County	7,929	8,205	8,400	8,600	8,700	8,700	8,700
Baird	1,633	1,538	1,800	1,900	2,000	2,100	2,200
Other	6,296	6,667	6,600	6,700	6,700	6,600	6,500
Cockran County	6,417	5,326	5,300	5,300	5,300	5,100	5,000
Morton	2,731	2,738	3,000	3,200	3,400	3,500	3,600
Other	3,686	2,588	2,300	2,100	1,900	1,600	1,400
Coke County	3,589	3,087	2,700	2,400	2,000	1,700	1,500
Robert Lee	990	1,119	1,000	900	800	700	600
Other	2,599	1,968	1,700	1,500	1,200	1,000	900
Coleman County	12,458	10,288	8,600	7,100	5,900	4,800	3,900
Coleman	6,371	5,608	4,600	3,700	3,000	2,400	1,900
Other	6,087	4,680	4,000	3,400	2,900	2,400	2,000
Colorado County	18,463	17,638	17,500	17,500	17,200	16,800	16,200
Columbus	3,656	3,342	3,500	3,700	3,700	3,800	3,800
Eagle Lake	3,565	3,587	3,800	4,000	4,000	4,100	4,100
Other	11,242	10,709	10,200	9,800	9,500	8,900	8,300
Comanche County	11,865	11,898	11,800	11,700	11,400	11,100	10,700
Comanche	3,415	3,933	4,200	4,300	4,300	4,300	4,300
Other	8,450	7,965	7,600	7,400	7,100	6,800	6,400
Concho County	3,672	2,937	2,300	1,800	1,400	1,000	800
Eden	1,486	1,291	1,100	800	700	500	400
Paint Rock	*	193	200	100	100	100	100
Other	–	1,453	1,000	900	600	400	300
Crockett County	4,209	3,885	3,800	3,700	3,500	3,300	3,100
Ozona	3,361	2,864	2,900	2,900	2,700	2,600	2,400
Other	848	1,021	900	800	800	700	700
Dawson County	19,185	16,604	15,400	14,400	13,200	12,000	10,900
Lamesa	12,438	11,559	10,900	10,300	9,500	8,700	7,900
Other	6,747	5,045	4,500	4,100	3,700	3,300	3,000
Eastland County	19,526	18,092	16,800	15,700	14,400	13,100	11,800
Cisco	4,499	4,160	4,000	3,900	3,700	3,500	3,300
Eastland	3,292	3,178	3,200	3,100	3,000	2,800	2,600

Note: Projections were made for the entire state; however, only those counties within the Colorado River Basin are delineated in this listing.

TABLE A-3 (Cont'd.)

COUNTY CITY	1960	1970	1980	1990	2000	2010	2020
Ranger	3,313	3,094	3,000	2,900	2,700	2,600	2,400
Other	8,422	7,660	6,600	5,800	5,000	4,200	3,500
Ector County	90,995	91,805	105,300	121,200	137,300	154,400	172,500
Odessa	80,338	78,380	91,500	105,200	119,100	133,800	149,400
Other	10,657	13,425	13,800	16,000	18,200	20,600	23,100
Edwards County	2,317	2,107	2,000	2,000	1,900	1,800	1,700
Rocksprings	1,182	1,221	1,300	1,400	1,400	1,400	1,300
Other	1,135	886	700	600	500	400	400
Fayette County	20,384	17,650	15,000	12,700	10,600	8,800	7,300
La Grange	3,623	3,092	3,100	3,000	2,900	2,700	2,600
Other	16,761	14,558	11,900	9,700	7,700	6,100	4,700
Gaines County	12,267	11,593	11,400	11,300	10,900	10,600	10,100
Seminole	5,737	5,007	5,100	5,200	5,200	5,200	5,100
Other	6,530	6,586	6,300	6,100	5,700	5,400	5,000
Gillespie County	10,048	10,553	11,100	11,700	12,100	12,500	12,800
Fredericksburg	4,629	5,326	6,500	7,300	8,000	8,800	9,500
Other	5,419	5,227	4,600	4,400	4,100	3,700	3,300
Glasscock County	1,118	1,155	1,200	1,300	1,400	1,500	1,500
Garden City	*	286	300	400	500	600	600
Other	–	869	900	900	900	900	900
Hays County	19,934	27,642	34,800	44,100	54,900	67,800	83,200
San Marcos	12,713	18,860	25,200	33,400	43,100	55,500	70,700
Other	7,221	8,782	9,600	10,700	11,800	12,300	12,500
Hockley County	22,340	20,396	20,100	19,800	19,300	18,600	17,800
Levelland	10,153	11,445	12,300	12,400	12,300	12,100	11,800
Other	12,187	8,951	7,800	7,400	7,000	6,500	6,000
Howard County	40,139	37,796	40,400	43,400	45,800	48,100	50,100
Big Spring	31,230	28,735	32,000	34,700	36,900	39,000	40,900
Other	8,909	9,061	8,400	8,700	8,900	9,100	9,200
Irion County	1,183	1,070	1,000	1,000	900	900	800
Mertzon	584	513	500	500	400	400	400
Other	599	557	500	500	500	500	400
Kendall County	5,889	6,964	7,600	8,400	9,100	9,800	10,400
Boerne	2,169	2,432	2,900	3,400	3,900	4,400	4,900
Other	3,720	4,532	4,700	5,000	5,200	5,400	5,500
Kerr County	16,800	19,454	22,600	26,300	30,200	34,400	38,800
Kerrville	8,901	12,672	16,100	19,500	23,200	27,400	32,000
Other	7,899	6,782	6,500	6,800	7,000	7,000	6,800
Kimble County	3,943	3,904	3,700	3,600	3,400	3,200	3,000
Junction	2,441	2,654	2,700	2,800	2,700	2,700	2,600
Other	1,502	1,250	1,000	800	700	500	400
Lampasas County	9,418	9,323	9,800	10,200	10,600	10,900	11,100
Lampasas	5,061	5,922	6,700	7,200	7,800	8,300	8,700
Other	4,357	3,401	3,100	3,000	2,800	2,600	2,400
Lee County	8,949	8,048	7,300	6,600	5,900	5,200	4,600
Giddings	2,821	2,783	3,000	3,100	3,000	3,000	2,900
Other	6,128	5,265	4,300	3,500	2,900	2,200	1,700
Llano County	5,240	6,979	7,800	8,800	9,700	10,700	11,600
Llano	2,656	2,608	3,000	3,400	3,700	4,100	4,500
Other	2,584	4,371	4,800	5,400	6,000	6,600	7,100
Lynn County	10,914	9,107	8,900	8,700	8,400	8,000	7,600
Tahoka	3,012	2,956	3,200	3,300	3,300	3,300	3,400
Other	7,902	6,151	5,700	5,400	5,100	4,700	4,200
McCulloch County	8,815	8,571	7,400	6,400	5,400	4,600	3,800
Brady	5,338	5,557	5,100	4,600	4,000	3,600	3,000
Other	3,477	3,014	2,300	1,800	1,400	1,000	800
Martin County	5,068	4,774	4,800	4,900	4,900	4,800	4,800
Stanton	2,228	2,117	2,400	2,600	2,800	2,900	3,100
Other	2,840	2,657	2,400	2,300	2,100	1,900	1,700
Mason County	3,780	3,356	2,700	2,200	1,800	1,500	1,200
Mason	1,910	1,806	1,500	1,300	1,100	1,000	800
Other	1,870	1,550	1,200	900	700	500	400

TABLE A-3 (Cont'd.)

COUNTY CITY	1960	1970	1980	1990	2000	2010	2020
Matagorda County	25,744	27,913	31,600	35,800	40,000	44,300	48,800
Bay City	11,656	11,733	14,200	16,000	17,900	19,900	21,900
Palacios	3,676	3,642	4,500	5,500	6,400	7,600	8,800
Other	10,412	12,538	12,900	14,300	15,700	16,800	18,100
Menard County	2,964	2,646	2,400	2,200	1,900	1,700	1,500
Menard	1,914	1,740	1,600	1,500	1,400	1,300	1,100
Other	1,050	906	800	700	500	400	400
Midland County	67,717	65,433	68,700	72,400	75,100	77,400	79,100
Midland	62,625	59,463	62,300	65,300	67,400	69,000	70,100
Other	5,092	5,970	6,400	7,100	7,700	8,400	9,000
Mills County	4,467	4,212	3,500	3,000	2,500	2,000	1,700
Goldthwaite	1,383	1,693	1,600	1,500	1,400	1,200	1,100
Other	3,084	2,519	1,900	1,500	1,100	800	600
Mitchell County	11,255	9,073	7,800	6,800	5,800	4,900	4,100
Colorado City	6,457	5,227	4,600	4,200	3,600	3,200	2,700
Other	4,798	3,846	3,200	2,600	2,200	1,700	1,400
Nolan County	18,963	16,220	15,300	14,500	13,500	12,500	11,500
Sweetwater	13,914	12,020	11,800	11,200	10,500	9,800	9,000
Other	5,049	4,200	3,500	3,300	3,000	2,700	2,500
Reagan County	3,782	3,239	2,800	2,500	2,100	1,800	1,500
Big Lake	2,668	2,489	2,200	2,000	1,700	1,500	1,300
Other	1,114	750	600	500	400	300	200
Real County	2,079	2,013	1,900	1,800	1,700	1,500	1,400
Camp Wood	879	660	600	600	500	500	400
Leakey	587	393	400	400	400	400	400
Other	613	960	900	800	800	600	600
Runnels County	15,016	12,108	10,900	9,800	8,700	7,700	6,800
Ballinger	5,043	4,203	4,100	3,900	3,600	3,400	3,100
Winters	3,266	2,907	2,900	2,800	2,700	2,500	2,400
Other	6,707	4,998	3,900	3,100	2,400	1,800	1,300
San Saba County	6,381	5,540	4,400	3,500	2,800	2,100	1,700
San Saba	2,728	2,555	2,100	1,700	1,300	1,000	800
Other	3,653	2,985	2,300	1,800	1,500	1,100	900
Schleicher County	2,791	2,277	1,900	1,500	1,200	1,000	800
Eldorado	1,815	1,446	1,300	1,100	900	700	600
Other	976	831	600	400	300	300	200
Scurry County	20,369	15,760	14,600	13,500	12,400	11,200	10,100
Snyder	13,850	11,171	10,600	10,000	9,300	8,500	7,800
Other	6,519	4,589	4,000	3,500	3,100	2,700	2,300
Sterling County	1,177	1,056	900	800	700	600	600
Sterling City	854	780	700	600	600	500	500
Other	323	276	200	200	100	100	100
Sutton County	3,738	3,175	2,800	2,500	2,200	1,900	1,600
Sonora	2,619	2,149	2,000	1,800	1,600	1,400	1,200
Other	1,119	1,026	800	700	600	500	400
Taylor County	101,078	97,853	103,600	110,000	115,000	119,400	123,100
Abilene (P)	90,147	89,259	95,700	102,400	107,500	112,500	116,700
Other	10,931	8,594	7,900	7,600	7,500	6,900	6,400
Terry County	16,286	14,118	14,800	15,600	16,100	16,600	16,900
Brownfield	10,286	9,647	10,700	11,400	11,900	12,500	12,800
Other	6,000	4,471	4,100	4,200	4,200	4,100	4,100
Tom Green County	64,630	71,047	81,500	93,900	106,400	119,700	133,800
San Angelo	58,815	63,884	74,100	85,700	97,600	110,500	124,200
Other	5,815	7,163	7,400	8,200	8,800	9,200	9,600
Travis County	212,136	295,516	383,300	498,800	639,200	812,900	1,026,800
Austin	186,545	251,808	326,900	429,900	556,400	714,900	912,100
Other	25,591	43,708	56,400	68,900	82,800	98,000	114,700
Upton County	6,239	4,697	3,900	3,200	2,600	2,100	1,700
McCamey	3,375	2,647	2,100	1,700	1,400	1,100	900
Other	2,864	2,050	1,800	1,500	1,200	1,000	800

TABLE A - 3 (Cont'd.)

COUNTY / CITY	1960	1970	1980	1990	2000	2010	2020
Wharton County	38,152	36,729	37,000	37,500	37,300	36,900	36,300
El Campo	7,700	8,563	9,100	9,000	8,800	8,600	8,300
Wharton	5,734	7,881	8,900	9,200	9,300	9,300	9,300
Other	24,718	20,285	19,000	19,300	19,200	19,000	18,700
Yoakum County	8,032	7,344	7,300	7,300	7,100	6,900	6,700
Denver City	4,302	4,133	4,500	4,600	4,500	4,400	4,400
Other	3,730	3,211	2,800	2,700	2,600	2,500	2,300

The figures for 1960 and 1970 are from the Census of Population.

* 1960 population not available - 1970 population is an estimate from the Texas Almanac.

(P) City lies in more than one county.

2. Large-scale industrial users (10 thousand gallons per day or more) who purchased their water from municipal systems were included in the industrial requirements.

The projections were specifically developed for certain representative cities and towns within each county, as well as a lumping of all requirements within the remaining portion of the county in the Basin under an "other" classification. The methodology utilized is outlined below.

MUNICIPAL

Representative Cities and Towns

1. The 1970 per-capita water use (PCWU) for each community was determined by dividing the community's 1970 recorded water use by the respective observed 1970 Census population.

2. Using the value obtained in Step 1 as the base PCWU, the projected PCWU for the specific years was obtained by extrapolating the base PCWU to increase at the same percent as used for the community in determining its water requirements for use in the Texas Water Plan.

3. The respective requirement of the community for each specific future year was calculated by multiplying the respective PCWU obtained in Step 2 by the community's projected population. (For population projections, see Table A-3.)

Others

1. The 1970 PCWU was determined by averaging the PCWU of all those towns and areas within the entire county.

2. Using the value obtained in Step 1 as the base PCWU, the projected PCWU for the specific years was obtained by extrapolating the base PCWU to increase at the same percent as used for the "other" in determining its water requirements for use in the Texas Water Plan.

3. The respective requirement of the "other" for each specific future year was calculated by multiplying the respective PCWU obtained in Step 2 by the "others" projected population. (For population projections, see Table A-3.)

TABLE A-4

HISTORIC AND PROJECTED MUNICIPAL AND INDUSTRIAL WATER REQUIREMENTS IN THE COLORADO RIVER BASIN*

County/City	1970	1980	1990	2020
Andrews				
Andrews				
Mun.	2,206	2,395	2,514	2,747
Ind.	261	285	299	344
Other				
Mun.	226	282	315	415
Ind.	896	1,500	1,760	2,688
Austin				
Other				
Mun.	3	4	4	5
Ind.	–	–	–	–
Bastrop				
Elgin				
Mun.	650	890	1,062	1,787
Ind.	–	–	–	–
Smithville				
Mun.	359	475	560	859
Ind.	–	–	–	–
Bastrop				
Mun.	578	699	804	1,170
Ind.	7	13	14	20
Other				
Mun.	844	930	958	715
Ind.	3,402	6,158	6,896	9,696
Blanco				
Johnson City				
Mun.	127	151	181	239
Ind.	1	1	1	1
Other				
Mun.	183	194	205	225
Ind.	–	–	–	–
Borden				
Gail				
Mun.	29	35	54	58
Ind.	–	–	–	–
Other				
Mun.	96	102	89	80
Ind.	–	–	–	–
Brown				
Brownwood				
Mun.	4,504	4,739	4,934	5,181
Ind.	753	937	1,084	1,677
Other				
Mun.	1,003	1,045	1,272	1,505
Ind.	–	–	–	–
Burnet				
Burnet				
Mun.	488	587	678	1,010
Ind.	–	–	–	–
Other				
Mun.	637	769	839	1,004
Ind.	670	778	899	1,379

*Acre-feet/year

TABLE A-4 (Cont'd.)

County/City	1970	1980	1990	2020
Caldwell				
Other				
Mun.	41	47	55	66
Ind.	–	–	–	–
Callahan				
Other				
Mun.	315	387	402	533
Ind.	–	–	–	–
Cochran				
Other				
Mun.	69	69	62	36
Ind.	201	217	228	266
Coke				
Robert Lee				
Mun.	199	196	185	141
Ind.	–	–	–	–
Other				
Mun.	302	289	263	176
Ind.	1,018	1,662	1,975	3,171
Coleman				
Coleman				
Mun.	1,099	964	798	446
Ind.	–	–	–	–
Other				
Mun.	652	609	517	305
Ind.	6	7	8	12
Colorado				
Columbus				
Mun.	594	673	734	829
Ind.	1	1	1	2
Eagle Lake				
Mun.	451	546	604	717
Ind.	–	–	–	–
Other				
Mun.	615	608	592	531
Ind.	1,743	2,076	2,351	3,413
Comanche				
Other				
Mun.	4	5	5	5
Ind.	–	–	–	–
Concho				
Paint Rock				
Mun.	27	30	15	17
Ind.	–	–	–	–
Eden				
Mun.	184	176	136	81
Ind.	–	–	–	–
Other				
Mun.	204	151	139	50
Ind.	–	–	–	–
Crockett				
Other				
Mun.	2	2	2	2
Ind.	–	–	–	–

TABLE A-4 (Cont'd.)

County/City	1970	1980	1990	2020
Dawson				
Lamesa				
Mun.	1,508	1,593	1,587	1,428
Ind.	18	22	22	24
Other				
Mun.	518	492	461	365
Ind.	21	25	26	28
Eastland				
Other				
Mun.	10	8	6	2
Ind.	–	–	–	–
Ector				
Odessa				
Mun.	13,111	16,485	19,535	30,363
Ind.	2,369	4,139	5,254	10,755
Other				
Mun.	1,547	1,571	1,789	2,429
Ind.	2,215	2,634	3,028	4,277
Edwards				
Other				
Mun.	92	95	112	196
Ind.	–	–	–	–
Fayette				
La Grange				
Mun.	483	520	519	491
Ind.	–	–	–	–
Other				
Mun.	972	941	835	528
Ind.	–	–	–	–
Gaines				
Seminole				
Mun.	1,149	1,171	1,193	1,170
Ind.	–	–	–	–
Other				
Mun.	1,123	1,053	1,022	836
Ind.	465	459	502	653
Gillespie				
Fredericksburg				
Mun.	1,175	1,530	1,765	2,490
Ind.	–	–	–	–
Other				
Mun.	456	400	401	327
Ind.	25	28	29	37
Glasscock				
Garden City				
Mun.	26	29	40	65
Ind.	–	–	–	–
Other				
Mun.	79	96	101	118
Ind.	–	–	–	–
Hays				
Other				
Mun.	281	349	398	489
Ind.	–	–	–	–

TABLE A-4 (Cont'd.)

County/City	1970	1980	1990	2020
Hockley				
Other				
Mun.	114	99	93	75
Ind.	917	998	1,090	1,421
Howard				
Big Springs				
Mun.	5,387	6,569	7,403	9,815
Ind.	2,308	2,927	3,333	4,928
Other				
Mun.	1,393	1,336	1,411	1,553
Ind.	182	231	263	389
Irion				
Mertzon				
Mun.	47	49	50	42
Ind.	–	–	–	–
Other				
Mun.	51	51	54	50
Ind.	28	32	35	44
Kendall				
Other				
Mun.	5	6	7	10
Ind.	–	–	–	–
Kerr				
Other				
Mun.	16	16	17	19
Ind.	–	–	–	–
Kimble				
Junction				
Mun.	718	784	817	847
Ind.	598	665	709	860
Other				
Mun.	176	162	136	76
Ind.	–	–	–	–
Lampasas				
Other				
Mun.	91	104	104	89
Ind.	–	–	–	–
Lee				
Giddings				
Mun.	563	678	737	801
Ind.	–	–	–	–
Other				
Mun.	94	93	76	39
Ind.	–	–	–	–
Llano				
Llano				
Mun.	723	868	1,014	1,459
Ind.	–	–	–	–
Other				
Mun.	365	433	530	831
Ind.	–	–	–	–
Lynn				
Other				
Mun.	27	25	23	18
Ind.	–	–	–	–

TABLE A-4 (Cont'd.)

County/City	1970	1980	1990	2020
McCulloch				
Brady				
Mun.	1,506	1,382	1,246	813
Ind.	473	496	532	657
Other				
Mun.	322	226	177	77
Ind.	221	232	248	307
Martin				
Stanton				
Mun.	213	257	286	369
Ind.	–	–	–	–
Other				
Mun.	283	271	267	213
Ind.	6	6	6	6
Mason				
Mason				
Mun.	352	316	283	191
Ind.	–	–	–	–
Other				
Mun.	218	183	142	69
Ind.	–	–	–	–
Matagorda				
Other				
Mun.	176	205	230	457
Ind.	6,717	11,587	14,905	31,684
Menard				
Menard				
Mun.	330	358	359	323
Ind.	–	–	–	–
Other				
Mun.	128	133	125	87
Ind.	–	–	–	–
Midland				
Midland				
Mun.	11,773	13,223	14,260	16,655
Ind.	83	159	190	322
Other				
Mun.	700	823	888	1,066
Ind.	587	706	799	1,152
Mills				
Goldthwaite				
Mun.	577	586	566	455
Ind.	–	–	–	–
Other				
Mun.	117	106	101	69
Ind.	–	–	–	–
Mitchell				
Colorado City				
Mun.	942	894	843	593
Ind.	31	34	36	47
Other				
Mun.	321	271	223	118
Ind.	667	724	786	1,002
Nolan				
Other				
Mun.	91	95	89	64
Ind.	–	–	–	–

TABLE A-4 (Cont'd.)

County/City	1970	1980	1990	2020
Reagan				
Big Lake				
Mun.	423	409	388	287
Ind.	–	–	–	–
Other				
Mun.	126	110	96	44
Ind.	1,173	1,420	1,591	2,237
Real				
Other				
Mun.	8	9	10	7
Ind.	–	–	–	–
Runnels				
Ballinger				
Mun.	736	775	759	662
Ind.	20	22	24	29
Winters				
Mun.	418	439	430	384
Ind.	–	–	–	–
Other				
Mun.	450	391	323	142
Ind.	–	–	–	–
San Saba				
San Saba				
Mun.	694	613	510	262
Ind.	–	–	–	–
Other				
Mun.	353	288	200	59
Ind.	20	22	22	22
Schleicher				
Eldorado				
Mun.	204	197	171	102
Ind.	–	–	–	–
Other				
Mun.	93	65	49	27
Ind.	76	93	101	133
Scurry				
Snyder				
Mun.	2,132	2,172	2,113	1,794
Ind.	–	–	–	–
Other				
Mun.	326	346	314	234
Ind.	724	817	887	1,132
Sterling				
Sterling City				
Mun.	71	69	61	55
Ind.	–	–	–	–
Other				
Mun.	25	20	20	11
Ind.	–	–	–	–
Sutton				
Other				
Mun.	53	45	40	25
Ind.	–	–	–	–
Taylor				
Other				
Mun.	236	235	230	210
Ind.	29	29	30	31

TABLE A-4 (Cont'd.)

County/City	1970	1980	1990	2020
Terry				
Brownfield				
Mun.	1,534	1,809	2,007	2,543
Ind.	–	–	–	–
Other				
Mun.	422	411	439	483
Ind.	537	620	677	881
Tom Green				
San Angelo				
Mun.	10,106	12,566	14,953	23,596
Ind.	318	421	472	664
Other				
Mun.	657	672	749	863
Ind.	682	902	1,011	1,423
Travis				
Austin				
Mun.	49,937	68,593	92,589	212,164
Ind.	3,048	3,850	4,350	6,267
Other				
Mun.	4,308	6,143	7,823	14,899
Ind.	587	741	838	1,207
Upton				
Other				
Mun.	49	48	42	27
Ind.	188	204	212	212
Washington				
Other				
Mun.	5	7	8	12
Ind.	–	–	–	–
Wharton				
Wharton				
Mun.	100	119	130	153
Ind.	5	5	6	7
El Campo				
Mun.	207	245	254	272
Ind.	–	–	–	–
Other				
Mun.	592	593	624	670
Ind.	62	78	87	121
Yoakum				
Denver City				
Mun.	890	1,033	1,084	1,120
Ind.	64	74	79	99
Other				
Mun.	540	463	450	386
Ind.	3,129	3,605	3,877	4,828

INDUSTRIAL

The industrial requirements for both the respective towns and cities and "other" were projected using a very simple and basic methodology.

1. The 1970 industrial water use for each respective area was obtained.

2. The projected industrial requirements for the area were then determined by using 1970 figure as the base and extrapolating the base at the same percent increase as used for that respective area in determining its industrial water requirements for use in the Texas Water Plan.

IRRIGATION WATER REQUIREMENT PROJECTION METHODOLOGY

1. Used 1969 Irrigation Inventory data to get county percentages of acreage supplied by surface and ground water within the Basin.

2. Used 1969 Irrigation Inventory maps to group counties and parts of counties into Basin zones.

3. Used 1969 data to get county percentage of irrigation within each Basin zone.

4. Used zone projections from the Texas Water Development Board Preliminary Plan for the Colorado River Basin for acreage and acre-feet for year 1990 and 2020. Used county percentages to distribute to counties.

5. Where increased irrigated acreage was involved, used 1969 maps to check and redistribute acreage increase based on availability of irrigable soils.

6. Used interpolation of data between 1969 and 1990 to give the 1975 and 1980 projections.

Projections* are delineated in Table A-5.

* The projections were developed by the Texas Water Development Board.

Table A-5

HISTORIC AND PROJECTED IRRIGATION WATER REQUIREMENTS IN THE COLORADO RIVER BASIN

County	1980 Surface		1980 Ground		1975 Surface		1975 Ground		1990 Surface		1990 Ground		1995 Surface		1995 Ground		2000 Surface		2000 Ground	
	As	As-Pt	As	As-Pt	As	As-Pt	As	As-Pt	As	As-Pt	As	As-Pt	As	As-Pt	As	As-Pt	As	As-Pt	As	As-Pt
Andrews	0		2,389	1,198	0		1,705	856	0		1,135	571	0		0		0		0	
Bastrop	2,689	1,281	388	248	2,849	2,520	0		2,942	3,562	0		3,747	9,630	0		6,269	9,313	0	
Blanco	0		98	83	0		0		0		0		0		0		0		0	
Borden	0		760	377	0		534	269	0		354	178	0		0		0		0	
Brown	9,739	24,886	727	1,832	9,691	22,686	637	951	9,651	20,766	562	894	9,579	17,691	403	747	9,574	17,691	403	720
Burnet	701	1,914	61	121	696	1,894	0		693	1,051	0		686	1,690	0		682	1,520	0	
Caldwell	0		0		0		0		0		0		0		0		0		0	
Callahan	383	638	187	311	388	616	247	437	386	600	297	542	331	589	403	747	330	589	403	720
Cochran	0		10,880	12,843	0		13,814	10,881	0		10,869	8,446	0		6,852	5,180	0		1,734	1,566
Coke	886	1,128	163	178	397	804	0		286	534	0		0		0		0		0	
Coleman	1,339	1,487	0		1,282	1,677	0		1,282	1,902	0		1,321	2,386	0		1,321	2,386	0	
Colorado	1,789	7,884	4,842	13,888	2,884	8,344	4,873	13,384	2,349	8,794	4,099	12,788	2,946	9,896	4,166	11,818	4,879	14,924	2,286	6,469
Comanche	50	46	0		0		0		0		0		0		0		0		0	
Concho	1,003	1,442	827	426	1,000	1,836	481	816	997	1,812	461	891	991	1,787	403	747	990	1,787	403	720
Crane	0		0		0		0		0		0		0		0		0		0	
Crockett	0		0		0		0		0		0		0		0		0		0	
Dawson	30	23	74,439	42,685	0		62,526	37,469	0		52,806	33,804	0		32,760	28,900	0		8,670	7,830
Eastland	0		671	984	0		0		0		0		0		0		0		0	
Ector	0		3,100	2,466	0		2,212	1,716	0		1,472	1,141	0		0		0		0	
Edwards	0		0		0		0		0		0		0		0		0		0	
Fayette	1,146	884	130	116	1,430	1,880	0		1,880	2,105	0		2,141	3,212	0		2,148	3,222	0	
Gaines	0		319,820	146,836	0		287,762	136,983	0		224,362	126,903	0		137,592	108,780	0		38,414	32,886
Garza	0		0		0		0		0		0		0		0		0		0	
Gillespie	1,802	1,819	358	340	1,808	1,186	0		1,013	1,341	0		1,029	1,636	0		1,428	2,280	0	
Glasscock	0		23,139	34,186	0		20,891	31,131	0		18,851	28,586	0		14,580	23,506	0		12,176	20,943
Hays	109	117	727	884	115	147	628	795	120	172	546	738	137	218	382	624	190	304	309	530
Hockley	0		14,500	16,023	0		12,232	12,927	0		10,342	10,347	0		6,852	5,180	0		1,734	1,566
Howard	98	124	1,870	1,266	0		1,336	886	0		881	585	0		0		0		0	
Irion	1,674	2,318	559	884	1,888	2,488	517	858	1,883	2,848	482	828	1,851	2,946	403	747	1,850	2,946	403	720
Kendall	6	5	0		0		0		0		0		0		0		0		0	
Kerr	0		0		0		0		0		0		0		0		0		0	
Kimble	2,195	3,221	331	615	2,177	3,286	0		2,162	3,303	0		2,127	3,381	0		2,951	4,712	0	
Lampasas	285	416	10	16	282	420	0		280	428	0		274	436	0		381	608	0	
Lee	0		0		0		0		0		0		0		0		0		0	

Table A-5 (Cont'd)

	1950				1975				1990				1995				2020			
	Surface		Ground		Surface		Ground		Surface		Ground		Surface		Ground		Surface		Ground	
County	As	As-Ft	As	As-Ft	As	As-Ft	As	As-Ft	As	As-Ft	As	As-Ft	As	As-Ft	As	As-Ft	As	As-Ft	As	As-Ft
Lipan	289	634	848	2,663	276	577	707	1,837	276	629	900	1,262	274	436	353	576	381	605	266	469
Lynn	0		0		0		0		0		0		0		0		0		0	
McCulloch	883	648	1,269	1,845	897	766	1,339	1,814	827	927	1,297	1,866	889	1,170	1,211	2,241	889	1,170	1,211	2,169
Martin	0		20,852	20,187	0		24,422	23,805	0		20,867	19,329	0		13,104	10,380	0		3,468	3,132
Mason	242	384	6,186	16,429	233	370	7,057	13,868	220	345	6,127	11,723	288	326	4,245	7,468	288	456	3,899	6,899
Matagorda	9,899	22,269	169	321	6,783	25,292	0		7,830	27,703	0		9,904	32,788	0		11,000	33,110	0	
Menard	2,969	3,739	30	69	2,918	4,189	0		2,933	4,666	0		2,973	5,301	0		2,971	5,301	0	
Midland	0		28,505	33,429	0		24,449	27,477	0		21,089	22,517	0		14,315	12,801	0		4,879	5,292
Mills	2,883	4,662	0		2,039	3,902	0		2,019	3,777	0		1,981	3,534	0		1,981	3,534	0	
Mitchell	139	69	4,563	2,668	0		4,473	2,580	0		4,073	2,570	0		3,276	2,569	0		867	783
Nolan	177	179	1,494	1,467	0		1,044	1,044	0		694	695	0		0		0		0	
Reagan	0		16,451	15,434	0		14,833	16,358	0		13,118	17,128	0		10,083	10,675	0		10,086	10,099
Real	0		0		0		0		0		0		0		0		0		0	
Runnels	2,861	4,695	561	778	2,791	4,841	516	770	2,741	4,766	479	760	2,842	4,712	403	747	2,841	4,712	403	720
San Saba	5,285	4,970	535	695	5,241	6,131	492	667	5,196	7,581	456	617	5,105	9,009	382	624	4,931	9,310	309	539
Schleicher	122	164	2,899	2,647	162	284	2,387	2,969	232	369	2,127	2,979	331	589	1,815	2,969	330	589	1,816	2,899
Scurry	0		3,894	2,282	0		3,720	2,370	0		3,575	2,447	0		3,276	2,569	0		867	783
Sterling	95	199	1,998	4,634	161	319	1,764	3,950	216	410	1,579	3,389	331	589	1,211	2,241	330	589	1,211	2,169
Sutton	169	359	0		160	329	0		145	289	0		137	216	0		199	394	0	
Taylor	335	439	599	429	335	489	482	513	333	515	470	599	331	589	403	747	330	589	403	720
Terry	0		162,899	55,542	0		136,000	55,212	0		113,600	54,937	0		68,795	54,399	0		18,207	16,443
Tom Green	6,483	6,715	8,257	6,804	5,412	7,489	7,399	7,492	5,370	8,154	6,894	8,232	5,285	9,424	5,248	9,711	5,283	9,424	5,250	9,389
Travis	2,337	1,510	267	176	2,481	2,338	0		2,601	3,029	0		2,847	4,408	0		2,847	4,408	0	
Upton	0		5,676	5,438	0		5,094	5,804	0		4,808	6,169	0		3,834	6,723	0		3,835	6,480
Wharton	3,845	11,889	6,594	18,629	4,515	14,853	6,624	18,818	5,240	17,122	6,674	18,970	6,892	22,057	6,778	19,282	19,385	53,976	3,750	10,540
Winkler	0		0		0		0		0		0		0		0		0		0	
Yoakum	0		66,749	74,285	0		74,616	61,947	0		62,846	51,857	0		39,312	31,080	0		10,404	9,388
TOTAL	98,199	110,339	839,056	880,892	58,836	120,014	705,823	497,125	61,419	128,400	597,833	464,622	66,700	146,300	381,800	389,600	66,500	169,700	136,500	171,300

MUNICIPAL WASTEWATER RETURN FLOW PROJECTION METHODOLOGY

The projection of municipal wastewater return flows was performed by the Texas Water Quality Board. In addition to projecting the return flows per se, the respective biochemical oxygen demand (BOD_5) and suspended solids (SS) loadings were also calculated. As seen in Table A-6, projections were developed for those communities which currently have wastewater collection and treatment facilities, or conceivably could need such facilities during the study period 1970-2020. It is noted that these projections do not include industrial flows to the municipal systems.

The stepwise procedure utilized in the development of the projections is as follows:

1. The average daily volume (mgd) of the return flow for each community was calculated by multiplying the community's population (as shown in Table II-3 Volume 1) by the appropriate per-capita value. For those communities above the Highland Lakes, a per-capita contribution of 85 gallons was used, whereas a per-capita contribution of 100 gallons was used in those areas adjacent to and below the Highland Lakes. The per-capita contribution used in each county is delineated on page A-34.

2. The biological loadings, BOD_5 and SS, for each community were determined by multiplying the respective population by the noted per-capita loadings. The per-capita loadings used were:

year	lbs BOD/capita	lbs SS/capita
1970	0.17	0.20
1980	0.18	0.21
1990	0.18	0.22
2020	0.19	0.23

These per-capita loadings were used throughout the entire Basin.

Daily per-capita return flow contributions used within the counties were:

85 gallons per capita - Andrews, Brown, Callahan, Cochran, Coke, Coleman, Concho, Dawson, Ector, Edwards, Gaines, Gillespie, Glasscock, Hockley, Howard, Irion, Kimble, Lampasas, McCulloch, Martin, Mason, Menard, Midland, Mitchell, Nolan, Reagan, Runnels, Schleicher, Scurry, Starling, Taylor, Terry, Tom Green, Yoakum

100 gallons per capita- Bastrop, Blanco, Borden, Burnet, Colorado, Fayette, Hays, Lee, Llano, Mills, San Saba, Travis, Wharton

Table A-6

PROJECTED MUNICIPAL WASTEWATER RETURN FLOWS AND LOADS[1]

COLORADO RIVER BASIN

COUNTY	CITY	1970[2] Avg. Flow (mgd)	1970[2] BOD (lbs/day)	1970[2] SS (lbs/day)	1980 Avg. Flow (mgd)	1980 BOD (lbs/day)	1980 SS (lbs/day)	1990 Avg. Flow (mgd)	1990 BOD (lbs/day)	1990 SS (lbs/day)	2020 Avg. Flow (mgd)	2020 BOD (lbs/day)	2020 SS (lbs/day)
ANDREWS	Andrews*	.73	1,466	1,725	.75	1,580	1,844	.76	1,615	1,913	.77	1,723	2,086
BASTROP	Bastrop*	.31	529	622	.34	625	729	.39	707	865	.52	990	1,198
	Elgin*	.38	651	766	.44	785	916	.49	889	1,087	.66	1,264	1,530
	McDade	.03	51	60	.03	52	61	.03	50	62	.02	36	44
	Smithville*	.30	503	592	.35	628	733	.40	722	882	.55	1,058	1,281
BLANCO	Johnson City*	.08	130	153	.08	149	174	.09	162	198	.10	196	237
BORDEN	Gail	.02	30	36	.02	40	46	.02	47	57	.03	65	78
BROWN	Bangs*	.10	206	243	.10	220	256	.11	227	277	.11	247	299
	Blanket	.03	59	69	.03	63	74	.03	65	79	.03	70	85
	Brownwood*	1.48	2,953	3,474	1.52	3,229	3,767	1.57	3,317	4,055	1.58	3,532	4,276
	Early**	.09	186	219	.09	198	231	.10	205	251	.10	224	271
	May	.03	51	60	.03	54	63	.03	56	68	.03	61	74
	Zephyr	.02	35	41	.02	36	42	.02	38	46	.02	42	51
BURNET	Burnet*	.29	487	573	.32	576	672	.36	652	796	.49	929	1,125
	Granite Shoals	.03	58	68	.03	59	69	.03	59	73	.03	61	74
	Marble Falls*	.22	376	442	.23	407	475	.23	414	506	.22	426	515
CALLAHAN	Clyde*	.14	278	327	.14	302	353	.15	310	378	.15	329	398
	Cross Plains*	.10	203	238	.10	220	256	.11	225	275	.11	239	290
COCHRAN	Whiteface*	.03	67	79	.03	63	74	.03	58	70	.02	40	48
COKE	Bronte*	.08	157	185	.07	144	168	.06	128	156	.04	82	99
	Robert Lee*	.10	190	224	.08	178	208	.08	160	196	.05	112	136
COLEMAN	Coleman*	.48	953	1,122	.39	821	958	.31	664	812	.16	361	437
	Santa Anna*	.11	223	262	.10	203	237	.08	171	209	.05	106	129
COLORADO	Columbus*	.33	568	668	.35	637	743	.37	661	807	.38	718	869
	Eagle Lake*	.36	610	717	.38	684	798	.40	713	871	.41	781	945
	Garwood*	.10	163	192	.08	153	178	.08	144	176	.06	114	138
	Weimar*	.21	358	421	.19	342	399	.18	324	396	.13	255	308

[1] *Does not include industrial contribution to municipal systems.*

[2] *1970 values are approximations.*

**Has existing wastewater collection and treatment facilities.*

***City of Early's sewage is treated by the City of Brownwood.*

Table A-6 (Cont'd)

COUNTY	CITY	1970 Avg. Flow (mgd)	1970 BOD (lbs/day)	1970 SS (lbs/day)	1980 Avg. Flow (mgd)	1980 BOD (lbs/day)	1980 SS (lbs/day)	1990 Avg. Flow (mgd)	1990 BOD (lbs/day)	1990 SS (lbs/day)	2020 Avg. Flow (mgd)	2020 BOD (lbs/day)	2020 SS (lbs/day)
CONCHO	Eden*	.11	219	258	.09	191	223	.07	153	187	.03	78	94
DAWSON	Ackerly	.03	59	70	.03	56	65	.02	50	62	.02	38	46
	Lamesa*	.98	1,965	2,312	.93	1,964	2,291	.87	1,849	2,259	.67	1,509	1,826
ECTOR	Goldsmith	.03	66	77	.03	67	78	.03	68	84	.03	76	92
	Odessa*	6.66	13,325	15,677	7.78	16,472	19,217	8.94	18,943	23,153	12.69	28,376	34,350
EDWARDS	Rocksprings	.10	208	244	.11	234	273	.12	252	308	.10	247	299
FAYETTE	Carmine	.05	87	102	.04	74	86	.03	61	75	.02	30	37
	Ellinger*	.02	34	40	.02	29	34	.01	23	29	.01	11	14
	Fayetteville*	.04	68	80	.03	59	69	.03	49	59	.01	25	30
	LaGrange*	.31	526	618	.31	563	657	.30	547	669	.26	492	596
GAINES	Loop	.03	54	63	.03	54	63	.02	52	64	.02	46	55
	Seagraves*	.21	415	488	.19	410	479	.19	405	495	.16	353	428
	Seminole*	.43	851	1,001	.44	923	1,077	.44	941	1,151	.43	965	1,168
GILLESPIE	Fredericksburg*	.45	905	1,065	.55	1,170	1,365	.62	1,310	1,602	.81	1,813	2,194
	Harper	.03	65	77	.03	61	71	.03	58	70	.02	46	55
GLASSCOCK	Garden City	.02	49	57	.03	59	69	.03	72	88	.05	114	138
HAYS	Buda*	.05	85	100	.06	99	116	.06	110	134	.07	137	166
	Dripping Springs	.05	84	99	.06	99	116	.06	110	134	.07	137	166
HOCKLEY	Sundown*	.10	192	226	.08	178	208	.08	169	207	.06	144	175
HOWARD	Big Spring*	2.44	4,835	5,747	2.72	5,769	6,730	2.94	6,241	7,627	3.47	7,769	9,405
	Coahoma*	.10	197	232	.09	196	229	.10	205	251	.10	228	276
	Forsan	.02	40	47	.02	40	46	.02	41	51	.02	46	55
	Sand Springs	.08	154	181	.07	151	176	.07	157	191	.08	175	212
IRION	Mertzon	.04	87	103	.04	88	103	.04	88	108	.03	76	92
KIMBLE	Junction*	.23	452	532	.23	486	567	.23	495	605	.22	500	605
LAMPASAS	Lometa	.05	108	127	.05	104	122	.05	101	123	.04	86	104
LEE	Giddings	.21	355	418	.22	405	472	.23	419	513	.22	414	501
LLANO	Kingsland	.13	214	252	.14	252	294	.16	284	348	.20	390	472
	Llano*	.26	443	522	.30	533	622	.34	605	739	.45	859	1,040
	Sunrise Beach	.08	136	160	.09	157	183	.10	176	216	.13	241	292
McCULLOCH	Brady*	.47	945	1,111	.44	923	1,077	.39	828	1,012	.26	578	699
	Melvin	.02	49	58	.02	41	48	.02	32	40	.01	15	18
MARTIN	Stanton*	.18	360	423	.21	439	512	.22	475	581	.26	583	706

Table A-6 (Cont'd)

COUNTY	CITY	1970 Avg. Flow (mgd)	1970 BOD (lbs/day)	1970 SS (lbs/day)	1980 Avg. Flow (mgd)	1980 BOD (lbs/day)	1980 SS (lbs/day)	1990 Avg. Flow (mgd)	1990 BOD (lbs/day)	1990 SS (lbs/day)	2020 Avg. Flow (mgd)	2020 BOD (lbs/day)	2020 SS (lbs/day)
MASON	Mason*	.15	307	361	.13	275	321	.11	236	288	.07	160	193
MENARD	Menard*	.15	296	348	.14	297	346	.13	279	341	.10	215	260
MIDLAND	Midland*	5.05	10,109	11,893	5.29	11,221	13,091	5.55	11,756	14,368	5.96	13,325	16,130
MILLS	Goldthwaite*	.17	288	339	.16	286	334	.15	268	328	.11	211	255
MITCHELL	Colorado City*	.44	889	1,045	.39	833	972	.35	747	913	.23	517	626
	Loraine*	.06	119	140	.05	103	120	.04	86	106	.02	48	58
	Westbrook	.02	51	60	.02	45	52	.02	38	46	.01	21	25
NOLAN	Blackwell	.02	47	56	.02	41	48	.02	40	48	.01	32	39
REAGAN	Big Lake*	.21	423	498	.19	398	464	.17	360	440	.11	238	288
RUNNELS	Ballinger*	.36	715	841	.34	729	850	.33	693	847	.26	591	715
	Miles*	.05	107	126	.04	95	111	.03	74	90	.01	32	39
	Rowena	.04	76	89	.03	65	76	.02	50	62	.01	23	28
	Winters*	.25	494	581	.25	522	609	.24	504	616	.20	454	550
SAN SABA	Richland Springs*	.04	72	85	.03	59	69	.03	47	57	.01	23	28
	San Saba*	.26	434	511	.21	373	435	.17	299	365	.08	158	191
SCHLEICHER	Eldorado*	.12	246	289	.11	241	281	.09	193	235	.05	112	136
SCURRY	Hermleigh	.06	121	142	.06	110	128	.05	97	119	.03	68	83
	Ira	.04	79	93	.03	70	82	.03	63	77	.02	44	53
	Snyder*	.95	1,899	2,234	.90	1,913	2,232	.85	1,795	2,193	.66	1,478	1,789
STERLING	Sterling City	.07	133	156	.06	124	145	.05	112	136	.04	93	113
SUTTON	Lawn	.03	58	69	.03	58	67	.03	56	68	.02	49	60
	Tuscola	.04	84	99	.04	85	99	.04	81	99	.03	72	87
TERRY	Brownfield*	.82	1,640	1,929	.91	1,924	2,245	.97	2,054	2,510	1.09	2,440	2,953
	Meadow*	.04	83	98	.04	85	99	.04	86	106	.04	87	106
TOM GREEN	Christoval	.02	37	43	.02	40	46	.02	45	55	.02	55	67
	San Angelo*	5.42	10,860	12,776	6.29	13,329	15,550	7.28	15,419	18,845	10.56	23,608	28,578
	Sanatorium	.04	76	90	.04	81	94	.04	88	108	.05	108	131
TRAVIS	Austin*	25.18	42,807	50,362	32.69	58,838	68,645	42.99	77,386	94,582	91.21	173,301	209,785
	Del Valle	.03	51	60	.04	70	82	.05	86	106	.08	154	186
	Elroy	.01	21	25	.02	31	36	.02	38	46	.03	65	78
	Jonestown	.12	202	238	.14	248	290	.16	297	363	.20	380	460
	Lago Vista*	.01	15	18	.45	810	945	1.12	2,021	2,471	3.30	6,270	7,590
	Lakeway*	.07	124	146	.50	900	1,050	.93	1,674	2,046	2.19	4,159	5,035
	Manor*	.09	160	188	.12	212	248	.14	259	317	.24	456	552
	Oak Hill	.04	72	85	.06	101	118	.07	124	152	.15	283	343

Table A-6 (Cont'd)

COUNTY	CITY	1970 Avg. Flow (mgd)	1970 BOD (lbs/day)	1970 SS (lbs/day)	1980 Avg. Flow (mgd)	1980 BOD (lbs/day)	1980 SS (lbs/day)	1990 Avg. Flow (mgd)	1990 BOD (lbs/day)	1990 SS (lbs/day)	2020 Avg. Flow (mgd)	2020 BOD (lbs/day)	2020 SS (lbs/day)
TRAVIS (Cont'd.)	Pflugerville	.05	93	110	.07	131	153	.09	160	196	.14	260	315
	Point Venture*	.04	68	80	.20	360	420	.27	479	585	.42	798	966
	Rollingwood	.08	133	156	.10	182	212	.12	223	273	.21	391	474
	Sunset Valley	.03	50	58	.04	70	82	.05	86	106	.08	152	184
	West Lake Hills	.15	253	298	.19	344	401	.23	421	515	.39	739	895
WHARTON	Wharton	.08	134	158	.09	160	187	.09	166	202	.09	177	214
YOAKUM	Denver City	.35	703	827	.38	810	945	.39	821	1,003	.37	830	1,005
	Plains	.09	185	217	.08	171	200	.08	167	205	.07	150	182

River Mile Key - Colorado River

0.0	Mouth of Colorado River at Gulf of Mexico
6.4	Intracoastal Waterway
6.9	Main Street of Matagorda (projected)
7.4	Culver Cut
13.7	West Branch
14.7	Bridge, county road, Palacios to Matagorda
15.9	Draw bridge, F.M. * 521 north of Matagorda
22.8	Turning basin
26.6	Bridge, MPRR near Buckeye
32.5	USGS gage #81625 near Bay City
32.9	Gulf Coast Water Co. Pumping Plant #3 Right Bank
33.7	Bridge, State Hwy. 35 near Bay City
33.9	Bridge, Southern Pacific RR near Bay City
37.1	Blue Creek
48.9	Jones Creek
55.3	Gulf Coast Water Co. Pumping Plant #2 Left Bank
59.5	Pipeline crossing
66.6	Bridge, U.S. Hwy. 59 at Wharton; USGS gage #81620 at Wharton
66.7	Bridge, SPRR at Wharton
69.0	Pierce Estate Pumping Plant Right Bank
74.4	Pipeline crossing
74.9	Pipeline crossing
75.1	Bridge, F.M. 960 at Glenflora
77.0	Pipeline crossing
86.5	Pipelines crossing
100.5	Bridge, F.M. 950 near Garwood
107.4	Garwood Irrigation Co. Pumping Plant
109.3	Skull Creek
112.3	Lakeside Irrigation Co. Pumping Plant
112.4	USGS gage #81615 near Eagle Lake
113.6	Bridges, U.S. Hwy. 90A and SPRR near Altair
113.9	Pipeline crossing
123.3	Conveyor Bridge
125.6	Conveyor cable
127.7	Point opposite Alleton
135.1	Bridge, U.S. Hwy. 90 at Columbus; USGS gage 81610 at Columbus
135.2	Bridge, SPRR at Columbus
137.5	Cummins Creek
141.4	Bridge, State Hwy. 71 at Columbus
143.6	Columbus Bend Dam Diversion Structure (USBR)

*F.M. - State Farm or Ranch to Market Road

146.8	Columbus Diversion Structure (C of E)
149.5	Harveys Creek
161.3	Pecan Creek
162.7	Ross Creek
164.8	Williams Creek
174.5	Bridge, U.S. Hwy. 77 at LaGrange; USGS gage #81605 at LaGrange
175.5	Buckner Creek
176.0	Bridge, State Hwy. 71 at LaGrange
176.3	Bridge MKTRR at LaGrange
177.2	LaGrange Diversion Structure
186.3	Rabbs Creek
191.8	Millers Creek
198.7	Bridge SPRR opposite West Point
199.9	Pin Oak Creek
202.2	Cedar Creek
202.5	Barton's Creek
209.8	P.D. Creek
212.0	USGS gage #81595 at Smithville
212.1	Bridge, State Hwy. 71 at Smithville
216.0	Alum Creek
224.7	Cedar Creek
231.7	Bridge, MK&TRR near Bastrop
236.8	Bridge, State Hwy. 71 at Bastrop; USGS gage #81592 at Bastrop
237.1	Bridge, State Hwy. 21 at Bastrop
237.8	Piney Creek
245.2	Big Sandy Creek
248.3	Wilbarger Creek
251.4	Bridge, F.M. 969 south of Utley
261.7	Dry Creek
263.8	Coleman Branch
269.5	Webberville
271.7	Elm Creek (Gilleland Creek)
275.5	Onion Creek
280.5	Bridge, F.M. 973 near Del Valle
286.7	Walnut Creek
287.8	Boggy Creek
288.7	Bridge at gravel pit
290.3	Bridge, U.S. Hwy. 183 at Montopolis; USGS gage #81580 at Austin
291.6	Low water dam
293.1	Bridge, Interstate Hwy. 35 at Austin

293.8	Waller Creek
294.1	Bridge, State Hwy. 275, Congress Ave. at Austin
294.3	Bridge, South First Street at Austin
294.7	Bridge, Missouri Pacific RR at Austin
294.8	Bridge, U.S. Hwy. 290 at Austin
295.1	Barton Creek
297.4	Bridge, Red Bud Trail at Austin
297.6	Tom Miller Dam (Lake Austin)
301.8	Bull Creek
310.9	Santa Monica
315.7	Lakewood
317.5	Low water bridge
318.0	Mansfield Dam (Lake Travis); USGS gage #81545 near Austin
323.7	Cypress Creek
325.2	Sandy Creek
349.9	Cow Creek
354.6	Pedernales River
378.9	Hamilton Creek
381.8	Starke Dam (Lake Marble Falls)
383.4	Bridge, U.S. Hwy. 281 at Marble Falls
388.0	Wirtz Dam (Lake Lyndon B. Johnson)
393.7	Sandy Creek
400.3	Llano River
400.4	Bridge, T&NORR near Kingsland
400.5	Bridge, F.M. 1431 near Kingsland
409.4	Inks Dam (Inks Lake)
412.3	Bridge, State Hwy. 29 between Llano and Burnet
413.6	Buchanan Dam (Lake Buchanan)
431.0	Point Opposite Tow
441.8	Tanyard Crossing Diversion Structure
443.3	Post Oak Diversion Structure
456.4	Cherokee Creek
458.0	Bridge, F.M. 580 at Bend
474.3	Bridge, U.S. Hwy. 190 on San Saba - Lometa Rd.; USGS gage #81470 near San Saba
479.8	San Saba River
481.6	Fox Crossing Diversion Structure
501.6	Bridge, State Hwy. 16 north of San Saba
513.1	Pecan Bayou
519.5	Renfro Dam
528.3	Bridge, county road near Regency
537.3	Bridge, F.M. 45 north of Richland Springs
549.1	Clear Creek
554.6	Deep Creek

560.7	Bridge, U.S. Hwy. 377 at Winchell; USGS gage #81380 at Winchell
560.8	Bridge, GC&SFRR near Winchell
566.6	Home Creek
567.6	Winchell Dam site
582.1	Bridge, U.S. Hwy. 283 south of Santa Anna
586.5	Bridge, county road near Waldrip
604.8	Bridge, F.M. 503 near Stacy
615.1	Stacy Dam site
618.4	Elm Creek
623.5	Bridge, F.M. 2134 near Leaday
623.8	Grape Creek
628.9	Concho River
642.5	Bridge, county road SE of Ballinger
649.4	Mustang Creek
658.9	Elm Creek
659.4	Bridge, U.S. Hwy. 83 at Ballinger; USGS gage #81265 at Ballinger
660.25	Bridge, U.S. Hwy. 67 at Ballinger
660.35	Bridge, GC&SFRR at Ballinger
666.1	Valley Creek
677.3	Antelope Creek Dam site
677.8	Bull Creek
684.0	Bridge, county road south of Maverick
685.9	Mule Creek
687.7	Oak Creek
694.9	Kickapoo Creek
695.3	Bridge, U.S. Hwy. 277 near Bronte
695.7	Bridge, P&SFRR near Bronte
697.0	Live Oak Creek
700.3	Double Barrel Creek
701.2	Turkey Creek
703.3	Cow Creek
703.6	Indian Creek
705.0	Buffalo Creek (Buffalo Creek Dam site)
706.4	Machae Creek
712.4	Bridge, State Hwy. 208 at Robert Lee; USGS gage #81240 at Robert Lee
716.1	Bridge, State Hwy. 158 near Robert Lee
718.5	Robert Lee Dam site
731.1	Rough Creek
733.7	Pecan Creek
747.8	Bridge, F.M. 2059 SW of Silver
756.6	Bridge, private oil field road SW of Silver
762.5	Mitchell Co. Diversion Structure

764.8	Doule Creek (Silver Cr.)
765.9	Silver Creek (Red Bank Cr.)
769.0	Rose Creek (Willow Cr.)
769.8	Beals Creek
774.0	Bridge, county road south of Colorado City
780.8	Champlin Creek (Champion Creek)
786.4	Morgan Creek (Cherry Creek)
794.9	Bridge, State Hwy. 163 at Colorado City
795.5	Bridge, T&PRR at Colorado City
795.5	Bridge, U.S. Hwy. 80 at Colorado City
796.3	USGS gage #81210 at Colorado City
804.4	Bridge, county road NW of Colorado City
810.5	Old low water bridge
810.6	Bridge, F.M. 1808 east of Cuthbert
814.3	Deep Creek
819.0	Low water crossing SE of Ira
824.0	Willow Creek
826.3	USGS gage #81195 near Ira
826.4	Bridge, State Hwy. 350 SW of Ira
828.8	Bluff Creek
831.8	Bull Creek
836.6	Bridge, F.M. 1298 at Lake J.B. Thomas
837.0	J.B. Thomas Dam (Lake J.B. Thomas)
844.5	USGS gage #81180 near Vincent
849.0	Bridge, F.M. 1205 W. of Lake J.B. Thomas
856.0	Bridge, county road south of Gail
858.4	Kate Creek
860.7	Bridge, F.M. 669 south of Gail
865.2	Gold Creek
877.0	Bridge, U.S. Hwy. 180 east of Lamesa
880.2	Spring Creek
893.2	P&SF Railroad near Hindman; U.S. Hwy 87 between Lamesa and O'Donnell
894.2	Source

River Mile Key - Pedernales River

0.0	Confluence of Pedernales and Colorado Rivers
8.56	Bridge, State Highway 93
10.5	Fall Creek
14.9	Cypress Creek
15.75	Low water crossing
24.2	Flat Creek
34.9	Miller Creek

48.22	Bridge, U.S. Hwy. 281 and USGS gage #81535 near Johnson City
51.06	Rodway Dam site
51.5	Pedernales Dam site
51.6	Buffalo Creek
52.09	Wolf Diversion Structure (LCRA)
52.2	Hickory Creek
53.6	Ahrens Diversion Structure (LCRA)
54.8	North Grape Creek
60.2	Rocky Creek
60.95	Bridge, F.M. 1320
62.9	Iron Rock Creek
64.2	Williams Creek
65.6	Bridge, county road
67.9	Bridge, county road
69.3	Bridge, county road at Stonewall
70.8	Low water crossing, county road
72.0	Cave Creek
74.3	South Grape Creek
75.7	Bridge, county road
77.7	Palo Alto Creek
78.9	Low water crossing, county road
82.6	Bridge, U.S. Hwy. 290
85.1	Barrons Creek
86.0	Bridge, county road
88.0	Bridge, U.S. Hwy. 87
90.2	Live Oak Creek
93.3	Bear Creek
95.5	Wolf Creek
95.6	Bridge, State Hwy. 16
97.6	Spring Creek
101.8	White Oak Creek
108.5	Flag Creek
110.0	Scott Branch
117.1	Crossing, F.M. 783
119.4	Bridge, U.S. Hwy. 290 near Harper
121.2	Bridge, U.S. Hwy. 290
123.2	Source

River Mile Key - Llano River

0.0	Confluence of Llano and Colorado Rivers
6.8	Low water bridge, county road
8.2	Pennington Creek
16.87	Little Llano River

18.13	Little Sandy Creek
19.64	Wrights Creek (Mitchell Creek)
24.19	USGS gage #81515 at Llano
24.59	Bridge, State Hwy. 16 at Llano
24.62	Low water dam
24.89	Flagg Creek
25.65	Pecan Creek
26.3	Dam (Llano City Lake)
27.2	Low Llano Dam site
27.4	Cook Dam site
27.82	Johnson Creek
29.3	Llano Dam site
29.88	San Fernando Creek
30.45	Six Mile Creek
33.53	Low water concrete bridge, county road
33.90	Hickory Creek
38.16	Low water crossing, county road
38.48	Lie Festa Creek (Vasterling Creek)
39.06	Rhodes Creek (Leinden Creek)
40.4	Elm Creek
42.75	Low water bridge at Castell, county road
43.94	Martin Creek (Deep Creek)
46.62	Herman Creek (12-mile Creek)
47.37	Stone Creek (Mulberry Creek)
50.99	Willow Creek
53.48	Beaver Creek
54.5	Bridge, U.S. Hwy. 87, SE of Mason
56.45	Comanches Creek
58.3	Low water bridge county road
63.9	Mason-James Dam site
64.4	Low water bridge, county road
64.5	James River
68.22	Honey Creek
69.07	Low water bridge, F.M. 1871
73.72	Bluff Creek
83.52	Saline Creek (Salinas Creek)
91.3	Low water bridge, State Hwy. 385
91.37	Red Creek
95.65	Sycamore Creek
96.8	Low water bridge, county road
99.57	Gentry Creek
102.4	Johnson Fork
106.74	USGS gage #81500 near Junction
107.54	Low water crossing, county road
110.62	Confluence of North & South Llano Rivers

River Mile Key - South Llano River

0.0	Confluence with Llano and North Llano Rivers
0.46	Bridge, U.S. Hwy. 290 at Junction
0.92	Cedar Creek
2.0	Low water bridge at Junction, county road
5.92	Potter Creek
7.77	Joy Creek
9.96	Chalk Creek
13.3	Batley Creek
14.75	Kyak Creek
15.8	Low water bridge, U.S. Hwy. 377
17.16	Salina Creek
17.28	Low water bridge, U.S. Hwy. 377
20.1	Paint Creek Dam site
20.32	Paint Creek
22.21	Bowie Creek
23.38	Seven Hundred Springs
24.58	Bluff Creek
25.15	Boyles Creek
25.48	Pecan Hollow
26.8	Contrary Creek
29.2	Bridge, U.S. Hwy.377
30.0	Dry Draw
64.0	Source

River Mile Key - North Llano River

0.0	Confluence of North Llano & South Llano Rivers
1.68	Bridge, U.S. Hwy. 290 at Junction
4.1	USGS gage #81485 near Junction
4.7	Bear Creek
5.8	Bridge, U.S. Hwy. 290 west of Junction
9.5	North Llano Dam site
11.0	Bridge, U.S. Hwy. 290 west of Junction
14.2	Stark Creek
15.1	Bois d'Arc Creek
16.6	Copperas Creek
19.7	Maynard Creek
19.8	Bridge, U.S. Hwy. 290 near Roosevelt
30.3	Low water dam
32.0	Ten Mile Draw
43.7	Buffalo Draw
52.10	Source

River Mile Key - San Saba River

0.0	Confluence of San Saba and Colorado Rivers
2.5	Bridge, county road
7.3	Rabbit Creek
7.7	Jerrys Branch
11.2	Simpson Creek
14.7	Bridge, county road at San Saba
16.6	Bridge, State Hwy. 16 at San Saba; USGS gage #81460 at San Saba
19.2	Bridge, county road
21.6	China Creek
24.8	Bridge, county road
25.0	Richland Creek
25.7	Bridge, county road
26.3	Bridge, GC&SF RR near Harkeyville
26.33	Bridge, U.S. Hwy. 190 near Harkeyville
27.6	Wallace Creek
32.5	Dry Creek
38.0	Harvey Creek
38.5	Low water bridge, county road
42.6	Low water bridge, county road
44.8	San Saba diversion structure (USBR)
46.2	San Saba Dam site (C of E)
46.7	Brady Creek
48.1	Deep Creek
48.15	Low water bridge, county road
50.3	Low water bridge, county road
54.5	Deer Creek
59.7	Los Creek (Loafer Creek)
59.9	Concrete ford, county road
65.6	Bridge, old county road near Voca
65.62	Bridge, new county road near Voca
66.0	Low water crossing
69.3	Katemcy Creek
70.6	Hudson Branch
70.9	Bridge, U.S. Hwy. 87 near Camp San Saba
79.2	Branch Creek
83.2	Camp Creek
83.6	Low water crossing, county road
86.4	Low water crossing, F.M. 1311
86.5	Low water dam
96.5	Concrete ford, county road
104.9	Low water crossing, F.M. 2092
110.32	Low water bridge at Menard

110.45	Bridge, U.S. Hwy. 83 at Menard; USGS gage #81445 at Menard
111.1	Las Moras Creek
115.3	Low water bridge, county road
117.0	Menard Dam site
119.6	Low water crossing, county road
119.6	Dry Creek
119.9	Clear Creek
122.4	Rocky Creek
126.4	Low water crossing, county road
127.3	Low water crossing, county road
129.3	Campbell Draw
132.0	Low water bridge, F.M. 864 near Ft. McKavett
132.6	Low water crossing, county road
133.4	Source

River Mile Key - Brady Creek

0.0	Confluence of Brady Creek with San Saba River
0.4	County road crossing
7.57	Little Brady Creek
13.95	Onion Creek
28.76	Bridge, GC&SF RR at Brady
28.85	Low water bridge
29.4	Low water crossing
29.53	Bridge, U.S. Hwy. 377 at Brady; USGS gage #81450 at Brady
29.98	Live Oak Creek
30.08	Bridge, U.S. Hwy. 87 at Brady
30.49	Richards Park Dam site
30.73	Low water dam
32.86	Brady Dam site (C of E)
34.0	Brady Dam
38.4	Concrete ford, county road
40.6	Bridge, GC&SF RR near Whiteland
42.3	Bridge, county road near Whiteland
44.1	South Brady Creek
46.9	Bridge, county road near Melvin
49.7	Bridge, county road at Melvin
50.1	Bridge, F.M. 2028 at Melvin
50.25	Bridge, county road at Melvin
53.8	Concrete ford, county road
57.3	Bridge, county road
58.1	Concrete ford, county road
58.2	Concrete ford, county road

60.3	Maverick Creek
60.4	Bridge, county road
61.6	Concrete ford, county road
61.7	Old mouth of Maverick Creek
62.5	Concrete ford, county road
64.75	Bridge, county road east of Eden
66.6	Bridge, GC&SF RR east of Eden
66.7	Harden Branch
66.8	Bridge, county road
69.1	Private road crossing
69.3	Bridge, U.S. Hwy. 83, south of Eden; USGS gage #81448 near Eden
70.0	Fitzgerald Creek
71.1	Concrete ford, county road
72.8	Concrete ford, county road
75.2	Bridge, F.M. 176
77.4	Concrete ford, county road
83.6	Source

River Mile Key - Concho River

0.0	Confluence of Concho River and Colorado River
4.4	Winkler Ford
7.0	Duck Creek
7.7	Low water dam
9.7	Amos Creek
11.1	Low water dam and crossing
19.3	Low water crossing, county road
19.32	Low water dam
19.6	Bridge, U.S. Hwy. 83 at Paint Rock USGS gage #81365 near Paint Rock
22.3	Kickapoo Creek
24.2	Little Concho Creek
26.0	Dry Creek
28.3	Lipan Creek
32.8	Bridge, F.M. 381
40.5	Bridge, F.M. 1692
40.8	Willow Creek
44.0	Low water bridge, county road
49.8	Redbank Creek
53.9	Low water dam
55.7	Bridge, F.M. 380

56.4	Low water dam
59.0	Bridge, State Hwy. 306 near San Angelo
60.9	USGS gage #81360 near San Angelo
61.0	Low water bridge and dam at San Angelo (Bell Avenue)
61.3	Confluence of North and South Concho and Concho Rivers

River Mile Key - South Concho River

0.0	Confluence of South and North Concho Rivers
0.6	Bridge, P&SF RR spur
0.8	Low water dam, West Texas Utilities Co.
0.9	Bridge, State Hwy. 388 at San Angelo
2.4	Bridge, U.S. Hwy. 87 at San Angelo
3.75	Low water crossing, Ben Ficklin Road
3.94	Ben Ficklin Dam
5.2	Metcalf Dam
6.7	Bridge, P&SF RR
7.6	Nasworthy Dam
8.1	Middle Concho River
11.6	Pecan Creek
13.3	Low water crossing, county road
13.7	Twin Buttes Dam
21.6	Low water crossing, county road
23.7	Bridge, P&SF RR at Christoval; USGS gage #81280 at Christoval
23.9	Bridge, U.S. Hwy. 277 at Christoval
23.9	Low water dam at Christoval
35.9	Low water crossing, county road
41.6	Bridge, U.S. Hwy. 277 south of Christoval
46.8	Source

River Mile Key - Middle Concho River

0.0	Confluence of Middle Concho and South Concho Rivers
0.42	Bridge, county road
2.26	Spring Creek
4.0	Twin Buttes Dam site
4.1	Low water dam
11.85	Bridge, U.S. Hwy. 67; USGS gage #81285 near Tankersly
13.75	Low water dam
17.65	Low water dam
18.05	Low water dam - Arden Dam site

18.45	Brushy Creek (Live Oak Creek)
20.9	East Rocky Creek (Jug Creek); USGS gage #81284
24.3	West Rocky Creek (Rocky Creek)
27.5	Low water crossing, F.M. 853
28.6	Dry Creek
32.1	Low water crossing, county road
47.6	Bridge, State Hwy. 163, Barnhart to Sterling City
50.0	Kiowa Creek
52.3	Tepee Draw
62.35	Source, Confluence of Centralia Draw & Big Jim Creek

River Mile Key - North Concho River

0.0	Confluence with Concho River
0.8	Bridge, P&SF RR in San Angelo
1.5	Low water dam in San Angelo
1.52	Bridge, Oakes St. in San Angelo
1.64	Bridge, Chadbourne St. in San Angelo, U.S. Hwy. 87
1.7	Bridge, Irving St. in San Angelo (low water bridge)
2.11	Bridge, Abe St. in San Angelo
2.7	Bridge, Beauregard St. in San Angelo, U.S. Hwy. 67
2.886	Low water bridge, First St. in San Angelo
2.894	Low water dam
3.24	Bridge, 6th St. in San Angelo; USGS gage #81350 at San Antelo
3.9	Bridge, 14th St.
5.7	Low water dam
6.6	San Angelo Dam (San Angelo Reservoir)
15.1	Bridge, F.M. 2288
17.9	Grape Creek
20.3	Low water crossing, county road
22.9	Bridge, county road near Carlsbad; USGS gage #81340 near Carlsbad
25.3	Low water dam
26.4	Low water crossing, private road
27.0	Low water dam
30.2	Monument Hill Dam site
32.6	Bridge, F.M. 2034 near Water Valley
33.1	Water Valley Dam site
36.95	Walnut Creek
37.2	Mulberry Creek
51.2	Low water crossing, county road
51.8	Sterling Creek
54.8	Bridge, county road at Sterling City

55.3	Bridge, State Hwy. 163 at Sterling City; USGS gage #81335 at Sterling City
57.0	Sterling City Dam site
58.3	Low water crossing, county road
59.5	Lacy Creek
60.5	Bridge, State Hwy. 158, Sterling City to Garden City
80.0	Low water crossing, county road
90.6	Source

River Mile Key - Beals Creek

0.0	Confluence of Beals Creek and Colorado River
9.6	Renderbrook Creek
19.9	Bridge, State Hwy. 163; USGS gage #81238 near Westbrook
22.2	Crystal Creek
42.3	Bridge, old county road
43.3	Bridge, F.M. 821
48.1	Powell Creek
54.8	Moss Creek
55.2	Pipeline crossing
58.2	Sandy Hollow
62.0	Low water bridge, county road
66.6	Low water crossing, county road
67.52	Bridge, F.M. 700
67.79	Big Sandy Creek
67.89	Low water crossing
68.14	Bridge, U.S. Hwy. 80
68.16	Bridge, U.S. Hwy. 80
68.25	Little Sandy Creek
68.95	Bridge, Birdwell Lane
69.12	Bridge, T&P RR
69.92	Bridge, Benton Street
70.02	Bridge, T&P RR
70.46	Bridge, U.S. Hwy. 87 (Gregg St. overpass)
70.88	Bridge, T&P RR
70.91	Bridge, T&P RR
71.04	Bridge, T&P RR spur
71.10	USGS gage #81236.5 above Big Spring
72.33	U.S. Hwy. 80 Bypass
76.39	Bridge, U.S. Hwy. 80
76.41	Bridge, U.S. Hwy. 80
77.05	Bridge, county road
79.07	Sulphur Draw

79.07	Beals Creek changes to Mustang Draw
79.5	Bridge T&P RR
81.8	Elbow Creek
87.1	Low water crossing, F.M. 818
95.3	Polecat Creek
101.4	Low water crossing, county road
110.0	Source at confluence of Johnson and Mustang Draws

C. GROUND WATER AVAILABILITY[1]

Introduction.

The primary sources drawn upon for the data presented in this report are those listed under "References." The data have been refined and updated using the results of recent detailed ground water studies. Figure 1 shows the extent to which portions of the Colorado River Basin have been studied in detail, and also shows the extent of the older well and spring inventories.

An aquifer is defined as a geologic formation, a group of formations, or a part of a formation that is water bearing, and use of the term is usually restricted to those water-bearing units that are capable of yielding water in quantities sufficient to constitute a usable supply. An impermeable formation - a geologic formation which, although porous and capable of absorbing water slowly, will not transmit it rapidly enough to furnish significant quantities for a well or spring - is called an aquiclude.

The Basin is underlain by nine primary or secondary ground water reservoirs as shown in Figure 2. In the following pages are described for each of these aquifers the geologic characteristics, occurrence and movement of ground water, natural recharge and discharge, water levels, water-bearing characteristics, ground water available for development, and the possibilities for properly treated wastewater recharge. A number of smaller aquifers, not shown in Figure 2, are also discussed in less detail. Water quality and utilization are not discussed in detail, as these subjects are to be covered under other work tasks.

It should be kept in mind that it is difficult to discuss ground water availability in terms of a surface-water basin. Often the primary recharge and discharge areas are outside of the Colorado River Basin, and the ground water only passes through the Basin on a transient basis.

[1] Prepared by Texas Water Development Board

Ogallala Aquifer.

The Ogallala aquifer covers about 7,500 square miles of the Colorado River Basin (see Figure 2). It rests unconformably on Triassic and Cretaceous rocks and is composed of alternating beds of Pliocene clay, caliche, and unconsolidated and mostly poorly-sorted gravel and sand. The relative amounts of sand and gravel vary considerably from place to place, but average 60 to 70 percent. The formation is generally overlain by about 40 feet of Pleistocene sand, clay, and caliche.

The saturated thickness of the Ogallala is generally less than 100 feet, but varies widely from 0 to more than 150 feet in isolated areas. The saturated thickness is largely controlled by the configuration of its base. Thicker saturated intervals occur in ancient buried stream channels cut into the pre-Ogallala surface. The larger clastics and probably the greater permeabilities are governed by these channel deposits.

The altitude of the base of the aquifer generally ranges from about 2,400 feet above mean sea level in Howard County to about 3,700 feet in Cochran County. The general slope of the base of the Ogallala is approximately 11 feet per mile to the southeast, but because the base of these deposits is an ancient eroded land surface, slopes vary considerably over short distances.

Ground water in the aquifer generally occurs under water-table conditions but, locally, artesian conditions are created by impermeable confining layers. Movement of water is generally in a southeasterly direction. The rate of movement varies throughout the aquifer, depending on the configuration of the base of the aquifer and permeability and saturated thickness. The regional water-level gradient is approximately 10 feet per mile to the southeast.

The Ogallala aquifer receives recharge from precipitation on the land surface, deep percolation from irrigation, and underflow from the aquifer in New Mexico. The amount of water moving into Texas from New Mexico in the Basin is calculated to be about 40,000 acre-feet per year. Because most of the surface, including the playa-lakes, is sealed by clay layers, it is estimated that less than 0.5 inch of precipitation is recharged into the aquifer annually. Including precipitation, the many attempts at artificial recharge, deep percolation from irrigation, and the ground water flow into the state from New Mexico, total recharge may be on the order of 200,000 acre-feet per year.

Water is discharged from the aquifer both naturally and artifically. Natural discharge occurs by evaporation and transpiration where the water table is close to the land surface in areas of draws and alkaline lakes. Examples of evapotranspiration discharge areas are Cedar, McKenzie, and Shafter Lakes; water-table lakes and near-surface saturated deposits in southwestern Lynn and Northwestern Dawson Counties; the Los Draw complex in Terry and Dawson Counties; the Sulphur Springs Creek in Martin County; and small springs and seeps at the escarpment in Borden and Dawson Counties. The most significant discharge from the Ogallala is artificial, from the approximately 8,000 irrigation, municipal, and industrial wells that pump ground water from this aquifer - far exceeding the recharge.

Depths to water range from the land surface along some draws to as much as 250 feet below it in Cochran County. Except in the northern-most part of the basin, the depth to water is less than 150 feet below the surface.

Declines in water levels are related to withdrawal of ground water from storage. Declines range from less than 1 foot to more than 6 feet per year. Yields of wells, which average about 300 gpm (gallons per minute), have been declining with the lowering water table. In some localities, the bottom of the reservoir has already been pumped dry.

The two most important properties of a water-table aquifer are its ability to store and to transmit water. These two properties are commonly designated as the coefficient of transmissibility (or a comparable property, the coefficient of permeability), and specific yield. The units for the coefficient of transmissibility are gallons per day per foot and include consideration of the aquifer's thickness. Because saturated intervals within the Ogallala aquifer range from 0 to more than 150 feet, it is evident that the coefficients of transmissibility may vary widely throughout the aquifer. The approximately coefficient of transmissibility for any one locality is determined by multiplying the saturated thickness of the aquifer by the average coefficient of permeability.

As a result of the statistical analysis of numerous pumping tests, the average coefficient of permeability for the Ogallala aquifer throughout the Southern High Plains has been calculated to be approximately 400 gpd (gallons per day) per square foot.

The specific yield is defined as the ratio of the volume of water a saturated material will yield under gravity to the total volume of material drained. The specific yield of the Ogallala aquifer is approximately 0.15. This value applies to the complete saturated interval of the aquifer, making no distinction between the noncontributing clays or silts and the contributing sands and gravels.

The perennial yield is limited to the annual recharge, or about 200,000 acre-feet. Also available for development on a one-time basis only is the water in storage in the aquifer. About 29,000,000 acre-feet of ground water is in storage in the aquifer in the Colorado River Basin, as determined from an estimated average specific yield of 0.15. Not all of this stored water is considered recoverable under present economics and methods of well construction. Assuming that 50 to 75 percent of the water in storage could economically be recovered, then 15,000,000 to 22,000,000 acre-feet could be developed from the Ogallala.

Not all of the water pumped from the Ogallala aquifer is removed from storage; an undetermined amount of irrigation pumpage, possibly as much as 20 percent, is returned to the aquifer each year by deep percolation. Also, some of the natural discharge which existed prior to large-scale development of the aquifer is not being captured by wells. However, this amount is small in comparison with the total pumpage.

Large amounts of ground water are available for future development in Western Gaines County, in southwestern and northwestern Yoakum County and in parts of south-central Cochran County.

Many entities such as Midland, Lamesa, and the Colorado River Municipal Water District have had reasonable success in recharging relatively clear water (not playa-lake water) through wells. Many attempts have been made by landowners to recharge playa-lake water through multiple-purpose wells. These latter attempts have generally been unsuccessful because of the high silt and clay content of the water. Means of removing the suspended material before using the water for recharge are far too expensive for the average landowner. Recharge wells using playa-lake water generally become plugged with clay in about 6 years, and their number has decreased in recent years. It is assumed that treated wastewater could be cleared of suspended matter before use for recharge.

In some areas where the surface is not sealed by clay layers, artificial recharge through basins and pits appears promising. Such basins or pits can be drained and the sediment scraped out periodically to rejuvenate them. Properly treated wastewater can be recharged through wells, pits or basins. Some cities in the Basin are now using treated sewage for irrigation. Much of this water finds its way back into the aquifer.

Edwards-Trinity (High Plains) Aquifer.

The Edwards-Trinity (High Plains) aquifer of the Colorado River Basin extends across the northwestern portion of the Basin from Gaines, Dawson, and Borden Counties northward, and embraces an area of approximately 4,750 square miles (see Figure 2). It consists of permeable strata of the Trinity and Fredericksburg Groups, which are the Paluxy Sand and, in places, the overlying saturated Comanche Peak and Edwards Limestones.

The Paluxy Sand portion of the aquifer occurs generally between 300 and 400 feet below the land surface, and is composed primarily of fine-to-medium-grained, well sorted, quartz sand. The net porous sand interval ranges in thickness from 15 to 60 feet and averages about 30 feet. The Paluxy Sand, deposited upon Triassic bedrock, grades upward into the arenaceous Walnut Clay. These strata are overlain by argillaceous Comanche Peak and Edwards Limestones. These strata are overlain by the Kiamichi Clay except in Dawson and Borden Counties, where the Comanche Peak and Edwards Limestones are at or near the surface. The relatively thick Kiamichi Clay forms an effective aquiclude between the Ogallala aquifer and the Paluxy Sand portion of the Edwards-Trinity (High Plains) aquifer.

In an area of about 150 square miles in the northeastern corner of Dawson County and northwestern corner of Borden County, the Kiamichi Clay is either missing or very thin. In this area, the Comanche Peak and Edwards Limestones have sufficient permeability to supply water to irrigation wells. The base of the Edwards-Trinity (High Plains) aquifer is the irregular eroded surface of the Triassic bedrock upon which the Cretaceous sediments were deposited, with several ancient buried channels traversing the area from northwest to southeast. These channels, which occur in the Triassic bedrock, closely resemble the present-day drainage network of the High Plains. In general, the slope of the base of the Edwards-Trinity (High Plains) aquifer is to the southeast.

Ground water in the Paluxy Sand portion of the Edwards-Trinity (High Plains) aquifer probably exists under artesian conditions throughout most of the aquifer's extent, and is probably moving southeasterly in some conformity with the slope of the base of the aquifer.

In northeastern Dawson and northwestern Borden Counties, ground water in the Comanche Peak and Edwards Limestones is under water-table conditions, and occurs in solution channels of the limestones which are hydraulically separated from the underlying Paluxy Sand by the Walnut Clay aquiclude. Water in these limestones appears to be moving in a south-southeasterly direction, and issues as springs and seeps along the eastern escarpment of the High Plains in Borden County.

Recharge to the Paluxy Sand portion of the Edwards-Trinity (High Plains) aquifer probably occurs in New Mexico where the Paluxy subcrops beneath saturated Ogallala deposits. Quality-of-water data indicate that the Paluxy Sand portion also receives some recharge from the Lost Draw complex and the alkaline lake areas within the Brazos River Basin in Lynn County. Natural recharge to the Comanche Peak and Edwards Limestones portion of the aquifer in northeastern Dawson and northwestern Borden Counties probably occurs as infiltration through the thin overlying Ogallala sediments.

Water moving through the Paluxy Sand portion of the Edwards-Trinity (High Plains) aquifer is probably discharged into the overlying Ogallala aquifer at the terminus of the Edwards-Trinity (High Plains) aquifer beneath the Ogallala deposits in Gaines and Dawson Counties. Springs at the base of the eastern escarpment in Borden County also account for some of the natural discharge from this aquifer. Water is naturally discharged from the Comanche Peak and Edwards Limestones through numerous seeps and springs at the escarpment in Dawson and Borden Counties.

Water levels throughout the extent of this section of the Edwards-Trinity (High Plains) aquifer are generally less than 50 feet below land surface. Water in the Paluxy Sand portion of the Edwards-Trinity (High Plains) aquifer is under artesian pressure and rises above the top of the aquifer when penetrated by wells. In some places, the hydraulic head is sufficient to cause the water in the wells to rise above the base of the Ogallala Formation.

In order to estimate the magnitude of water available from storage in the Edwards-Trinity (High Plains) aquifer one time only, the following assumptions were made. For the Paluxy Sand portion of the aquifer, an average sand thickness of 30 feet and a specific yield of 0.15 were assumed. A 250-square-mile area of poor quality water in the eastern part of the region was not included in the calculations; thus the area considered embraces approximately 4,500 square miles. For the Comanche Peak and Edwards Limestones portion, a specific yield of 0.015 was assumed and a saturated section of approximately 20 feet was used. From the above assumptions, approximately 13,000,000 acre-feet of water is estimated to be stored in the Edwards-Trinity (High Plains) aquifer. Because of the thin saturated section, and considering that well-construction methods and economics of well operation prohibit the complete dewatering of the saturated interval, it is assumed that about 25 percent of the water in storage can be produced. Therefore, it is estimated that about 3,300,000 acre-feet of water could be developed. In addition, about 22,000 acre-feet are available annually from recharge (Brune, 1970).

As in the case of the Ogallala Formation, attempts have been made to recharge the Edwards-Trinity (High Plains) underground reservoir with playa-lake water through wells. This aquifer, especially the limestone portion, is not quite as susceptible as the Ogallala to clogging with sediment. It is likely that treated wastewater could be recharged without serious trouble, using wells, shafts, pits, or basins.

Santa Rosa Aquifer.

The Santa Rosa Formation is present either at the surface or in the subsurface in the upper Colorado River Basin. It crops out east of the Colorado River in parts of Scurry, Mitchell, and Nolan Counties. The areas in which the Santa Rosa Formation is known to produce usable water are shown in Figure 2. Water containing up to 4,000 milligrams per liter (mg/l) dissolved solids has been included as usable in the Santa Rosa aquifer where it occurs in Gaines, Andrews, and Ector Counties.

In general, the formation is composed of interbedded lenses of sand, hard sandstone, gravel, and shale. Near the base of the formation, in a few places, a tightly-cemented quartz conglomerate occurs. The Santa Rosa was deposited upon an eroded surface of older Triassic and Permian rocks under non-marine conditions. The individual sand beds of the Santa Rosa Formation are highly lenticular and their physical and hydrologic characteristics can change within short distances. Sand and

gravel constitute approximately 35 percent of the formation's thickness in most of the region. The thickness of the aquifer ranges from a featheredge in its eastern extremity to about 400 feet in the western part of the region. The average thickness is about 200 feet.

On the eastern side, the aquifer dips southwest at a rate of approximately 50 feet per mile in Scurry County and west-northwest at 25 to 35 feet per mile in Mitchell County. On the western side it dips to the northeast. It forms a north-trending basin. The Santa Rosa thickens toward the axis of the Basin.

The aquifer in its eastern part is actually made up of two hydraulically distinct water-bearing units in northern Mitchell and Scurry Counties, a lower and an upper sand, separated by a shale or clay section. In east-central Mitchell and Nolan Counties only the lower reservoir is present as the source for many of the irrigation wells in this area, and ground water generally moves toward the Colorado River. In parts of Scurry County, the water moves generally toward the Colorado River but locally toward small tributaries. In the western portion, ground water in the aquifer is assumed to be moving generally in an easterly direction.

In its eastern part, recharge or replenishment of water in the aquifer is probably derived from regional precipitation on the sand and gravel outcrop areas of the formation and from downward percolation through Tertiary and Cretaceous materials overlying the aquifer above the water table. Precipitation on the outcrop areas probably percolates directly to the water table. Where Tertiary rocks overlie the Santa Rosa Formation in northwestern Nolan County, the sediments are above the regional water table but appear to constitute an effective recharge conduit to saturated sand and gravel of the aquifer. Precipitation on Cretaceous outcrops which overlie the Santa Rosa Formation is absorbed and moves southwest, west, and northwest, ultimately moving into the Santa Rosa aquifer in areas where it is in contact with the Paluxy Sand.

Ground water is being discharged from the aquifer in the eastern portion through springs and seeps at its eastern extremity in Mitchell, Nolan, and Scurry Counties, and in outcrop areas within the Brazos River Basin. Water is lost also by evaporation from areas where the water table is near the land surface, and by transpiration of plants having roots that extend to or through the capillary fringe above the water table. Pumpage from wells provides for the discharge of some of this aquifer's water. This pumpage is primarily confined to Mitchell, Nolan, and Scurry Counties.

In the eastern part of the aquifer, depths to water range from the land surface in the areas of springs and seeps to about 300 feet below the land surface in northwestern Scurry County. In the western part, water levels in the aquifer range between 400 and 600 feet below the land surface. The yields of large-capacity wells average about 250 gallons per minute but range from 35 to 1,150 gpm. Wells in one area have far greater yields than those producing from a much greater saturated thickness in other areas, indicating that the permeability of the aquifer varies greatly.

In the western part of the aquifer, the primary recharge areas are probably in the Santa Rosa outcrop in New Mexico and in the adjacent Rio Grande Basin where sands are truncated against overlying saturated sediments.

Methods of natural discharge from the aquifer are somewhat obscured in this area. However, water-quality zonation suggests that some ground water is being discharged from the aquifer into the overlying Chinle Formation.

In the western part, ground water in the aquifer is under artesian conditions and generally moves in an easterly direction. There is probably a considerable amount of water available from artesian storage; however, it may not be economically feasible to recover much of this because of low well yields and deep pumping lifts. Some water should be available on a perennial basis, depending on conditions of recharge and aquifer transmission capacity.

It appears that recharge to the aquifer is sufficient to sustain an annual pumpage of 30,000 to 40,000 acre-feet. Brune's (1970) data indicate that about 1.5 million acre-feet are available from the Santa Rosa aquifer within the Basin on a one-time-only basis. In addition, the Santa Rosa aquifer can produce large quantities of saline, otherwise unusable water for water-flooding and other industrial operations.

Artificial recharge has not been attempted in this aquifer. However, there is no reason why properly treated wastewater could not be recharged into it. In the western portion, because of the depth at which it occurs, wells would be needed and care required to remove material from the recharge water which might clog the aquifer. In the eastern portion where the aquifer outcrops, simpler methods of recharge such as basins or canals could be used. These can be cleaned periodically to remove sediment deposits. A considerable amount of recharge also undoubtedly occurs from deep percolation from irrigation in the outcrop area.

Edwards-Trinity (Plateau) Aquifer.

The Edwards-Trinity (Plateau) aquifer is so named because it is often composed of two different aquifers, water-bearing units of the Edwards and Associated Limestones and the underlying sand of the Trinity Group. Because these units are so often concurrently present, and because of the nature of the hydraulic relationship between them, they are considered as a single aquifer.

The limestone part of the aquifer, usually referred to as the Edwards and Associated Limestones, consists of the Comanche Peak and Edwards Limestones and in some cases the Georgetown Limestone of the Washita Group. The Edwards consists of limestone and dolomite beds. Well-developed solutional openings are common both above and within the zone of saturation. The thickness of the Edwards may exceed 500 feet in parts of the high plateau area in the southern part of the region where it is overlain by shale and limestone of the Washita Group. Where the Edwards is exposed at the surface in plateau terrain, it is characterized by numerous sinkholes, some of them scores of feet in diameter, through most of which surface water flows freely into the subsurface. These sinks serve as recharge areas to the zone of saturation.

Sands of the Trinity Group, the Paluxy Sand and the Travis Peak Formation are not coexistent. The Paluxy occurs in the northwestern part of the Basin and the Travis Peak in the southeastern part. An intervening area is occupied by a buried ridge. The Paluxy, where it exists, occurs directly beneath the Edwards, but the Travis Peak is separated from the Edwards by the Glen Rose Formation and Walnut Clay.

The Paluxy Sand consists of fine-grained sand and consolidated sandstone with occasional beds of clay. It attains a maximum thickness of more than 100 feet. In southern Reagan and Irion Counties, the sand is in direct contact with the underlying Santa Rosa Formation. The two sand units in this area appear to behave as a single hydrologic unit of 200 to 300 feet thickness.

The Travis Peak Formation consists of lenses of clay, silt and coarse sand, with occasional layers of conglomerate at the base. The physical composition of the Travis Peak is heterogeneous, and water-bearing sands usually comprise less than 50 percent of the total thickness which is, in places, as much as 400 feet. The Travis Peak Formation grades both laterally and vertically into the Glen Rose Formation, which does not yield appreciable quantities of water. In parts of Gillespie and Kimble Counties, it is in contact with water-bearing rocks of

Cambrian and Ordovician age and is hydraulically in connection with them. Both the Travis Peak Formation and the Paluxy Sand were deposited on an erosional surface of pre-Cretaceous rocks.

Sands of the Trinity Group occur mostly in the subsurface. Their outcrops are relatively small areas which flank the Edwards Plateau and occupy valleys of some streams which have eroded deeply enough into the Edwards Plateau to strip away the overlying limestones. Edwards and Trinity rocks dip uniformly to the southeast at approximately 50 feet per mile.

Ground water in the Edwards-Trinity (Plateau) aquifer occurs under both water-table and artesian conditions. In sands of the Trinity Group, the water is under artesian conditions where the sands are completely saturated and are overlain by clay or nonporous limestone. Otherwise, water-table conditions prevail, generally in areas of outcrop and in areas of major pumpage. In the limestones, solution openings generally are continuous above and into the zone of saturation, and therefore water-table conditions prevail.

In the northwestern part of the basin, the Paluxy Sand is hydraulically in connection with the overlying Edwards. Here, the two units generally are under common hydrologic conditions and the limestones supply most of the sand's recharge regionally. In the southeastern part of the region, the Travis Peak Sands Member is separated from the Edwards by the Glen Rose Formation and the Walnut Clay, and therefore the Travis Peak and the Edwards are under different hydrologic conditions.

Ground water in the Edwards-Trinity (Plateau) aquifer moves regionally from northwest to southeast. It moves locally from the areas of recharge to surface drainage courses, where the ground water is discharged into and supports the base flow of streams. Generally, the altitude of the water table correlates with that of the surface topography.

As previously indicated, direct recharge to the Edwards occurs chiefly through sinkholes, except in high plateau areas where the Edwards is overlain by relatively impermeable strata of the Washita Group. The Paluxy receives recharge mostly from the overlying Edwards, which is hydraulically in connection with the Paluxy. The Travis Peak, which is not hydraulically in connection with the Edwards, probably receives most of its recharge from its outcrop area and smaller amounts from vertical percolation through overlying Glen Rose limestones. Some

water in the Travis Peak possibly originates from underlying Cambrian, Ordovician and Pennsylvanian aquifers where they are in contact with the Travis Peak.

Ground water is discharged naturally from the Edwards-Trinity (Plateau) aquifer through springs and seeps along drainage courses and by evapotranspiration along the periphery of the Edwards Plateau. Pumping from wells constitutes the artificial discharge.

Depths to water range from the land surface in areas of natural discharge to more than 500 feet in the higher-altitude areas of Upton, Reagan, and Irion Counties. Available data indicate that there is little regional fluctuation of water levels in the aquifer. Water-level fluctuations in response to pumpage and climatic conditions are recorded for areas of major development in southern Glasscock and northern Reagan Counties. Yearly declines of as much as 1.9 feet have occurred in areas of heavy pumping.

Solutional or cavernous openings developed in the Edwards limestones are similar to a system of conduits, and water is readily transmitted by them. Such a system is not necessarily conducive to storage of large quantities of water, but locally it may contain moderate to large supplies. Because of the non-uniformity of the openings, a quantitative determination of storage and transmission capacities of the limestones is difficult.

Sands of the Travis Peak and Paluxy are generally fine-grained and are therefore considerably less permeable than the overlying Edwards limestones, but the storage capacity of the sands is indicated to be regionally much greater than that of the limestones. Yields of large-capacity wells average about 250 gpm and some reach 1,800.

The hydrologic properties of the Trinity Group sands will probably limit future development to spaced, low-yield wells. Declines in water levels have caused considerable reduction in well yields in the city's well field just northwest of Odessa and in the performance of wells in southwestern Midland County. In the Pegasus area of southwestern Midland County, a 7-foot decline in water levels was associated with a reduction in well yields of about 31 percent.

Because of differences in geologic and hydrologic conditions encountered throughout the areal extent of the Edwards-Trinity (Plateau) aquifer in the Basin, availability of ground water for future development has been estimated separately for the parts of the aquifer that are, respectively, north and south of the Middle Concho River.

North of the Middle Concho River, most of the aquifer's water occurs in sands of the Trinity Group and associated Triassic sands. In parts of the area where appreciable development has occurred (in southern Glasscock, northern Reagan, and northeastern Upton Counties), the rates of withdrawal of water from the aquifer exceed the available recharge. In the area north of the Middle Concho River, it is estimated that 25,000,000 to 36,000,000 acre-feet of water is stored in the Trinity sands. This estimate is based on an average saturated sand thickness of 100 feet and an assumed specific yield of 0.15. Of the total amount of water in storage, probably 15,000,000 to 23,000,000 acre-feet may be economically withdrawn. An additional amount of recharge is available for future development. Principal qualifications on concentrated development of water in any relatively small area in this part of the Basin are that, in effect, water will be "mined" and that the aquifer will probably be locally depleted in the future.

South of the Middle Concho River the Paluxy Sand becomes thinner and eventually disappears, and saturation is principally in the limestones. Because of the nature of cavernous openings in these limestones, the amount of water in storage is difficult to determine. Therefore, consideration of ground water available for development is approached on the perennial-yield basis, involving determination of annual recharge as indicated by measurements of natural discharge. On the basis of flow measurements of the Llano River, it was determined that about 6 percent of the average annual precipitation recharges the Edwards in its outcrop area in the South Llano River drainage basin. Assuming that from 4 to 6 percent of the average annual precipitation infiltrates into the Edwards throughout its extent south of the Middle Concho River, it is estimated that 300,000 to 400,000 acre-feet of ground water per year moves through the Edwards in this area. It appears that at least 50 percent of this amount is available on a perennial basis for development by a system of wells spaced over the area. Such large-scale development of the Edwards would, of course, reduce significantly the base flow of major streams.

As discussed in a previous section, the Travis Peak is also waterbearing south of the Middle Concho River. However, because of lack of data, availability of water from the Travis Peak sands is difficult to estimate. Indications are that its yield is small, perhaps less than 50,000 acre-feet per year. In view of the low order of magnitude of water that might be available from the Travis Peak as compared with the amount available from the Edwards, the estimated 150,000 to 200,000 acre-feet of ground water available from the Edwards on a perennial basis appears to be within the order of magnitude of ground water available from the Edwards-Trinity (Plateau) aquifer.

Recharge of the underground reservoir has been experimented with using wells, as at Kerrville. The most effective method of recharge appears to be through reservoirs which detain flood flows and back the water over open sinkholes. Treated waste water can similarly be recharged into sinkholes. There is no problem of clogging of the aquifer with suspended material as in the case of sand aquifers. However, there is more danger of pollution by the recharge water because the filtering action of sand beds is absent.

Hickory Aquifer.

The Hickory Sandstone crops out intermittently around the periphery of the Precambrian core of the Llano uplift in the Central Mineral Region, as shown in Figure 2. In some areas adjacent to the core of the Llano uplift, Hickory outcrops are absent due to faulting or because of overlap by Cretaceous sediments. The aquifer dips away from the Llano uplift in all directions and is cut by numerous faults. The average dip is approximately 100 feet per mile. However, abrupt changes in dip may occur locally near faults.

The Hickory Sandstone is principally a cross-bedded sandstone, medium-to-fine grains, and contains shale beds which become more numerous toward the top. It was deposited upon a very uneven Precambrian topography, and its thickness varies considerably over short distances. However, average thicknesses of the Hickory Sandstone do not change appreciably over large areas. The average thickness of the aquifer is on the order of 400 feet, but only 50 to 75 percent of the total thickness can be depended upon to be water bearing.

The Hickory Sandstone grades upward and laterally into the Cap Mountain Limestone, thins, and disappears, and the Hickory Sandstone is in contact with overlying Cambrian sandstones.

Although the Hickory Sandstone crops out intermittently around the Llano uplift, its distinction as an important aquifer is only north and west of the uplift. However, it yields water to small-diameter wells in other areas of its occurrence. The extent of the aquifer is not definitely known, but on the basis of chemical analyses of water from wells in Concho County, it is presumed to be at least 45 miles outward from the outcrop north and west of the Llano uplift.

The lower part of the aquifer yields water more readily than the upper part. Water-table conditions generally occur in outcrop areas. Artesian conditions probably exist in individual sands where water in them is

is confined by overlying shale beds. All of the aquifer is under artesian conditions downdip, where both the Hickory and the Cap Mountain are overlain by other rocks.

Direction of water movement varies with geologic and topographic conditions. In outcrop areas, the configuration of the water table generally conforms to the contour of the land surface, and ground water moves toward the center of the Llano uplift. Downdip, water moves generally in the direction of dip and also laterally.

The aquifer is recharged partly by precipitation which falls on the outcrop and which is readily absorbed by thick sandy soils. Because of a system of vertical fractures developed in the overlying Cap Mountain Limestone where it crops out, it is believed that water also enters the Hickory aquifer from Cap Mountain Limestone outcrops.

Natural discharge of ground water from the aquifer in outcrop areas is through seeps along surface drainage courses. Nothing is known of the means of natural discharge from the aquifer in the subsurface. Water is also discharged artifically by wells. The heaviest concentration of wells is in southeastern McCulloch and northern Mason Counties.

Although altitudes of water levels in wells completed in the Hickory aquifer do not vary greatly over short distances, the actual depths below land surface to water in individual wells often vary considerably due to differences of land-surface altitudes. In outcrop areas, water levels are within several feet of the surface. Depth to water from the land surface generally ranges between 100 and 500 feet in the downdip portion of the aquifer. In some topographically low places, wells may flow naturally.

Water-level fluctuations in wells completed in the Hickory are the result of both natural and artificial causes. Natural water-level fluctuations result from changes in evapotranspiration and recharge. Water levels are lowest during summer months when evaporation and transpiration rates are highest and precipitation is usually low. Seasonal water-level fluctuations from these natural causes are usually small in the aquifer and rarely exceed 5 feet.

Water-level fluctuations due to pumping may become quite large, especially under artesian conditions. Water levels at Brady have declined 90 feet since development from the Hickory aquifer began in 1930.

Values of coefficients of storage and transmissibility for the Hickory were obtained only in the northwestern part of the aquifer. A coefficient of storage of approximately 0.0001 was obtained at Brady, which is about 12 miles downdip and northwest of a Hickory outcrop. Coefficients of transmissibility obtained from wells in McCulloch and Mason Counties range from 18,000 to 40,000 gpd per foot. The lower values generally occur at greater distances from the outcrop areas.

Because of complicated geologic and hydrologic conditions in the aquifer and because of lack of basic data, the quantity of water available for development from the aquifer can be only roughly estimated. It is presumed that the aquifer can furnish much more water to wells than has been developed. It seems reasonable that, with adequately-spaced wells, at least 50,000 acre-feet per year are available perennially for development and perhaps even larger quantities of water could be safely withdrawn. Brune (1970) estimated that about 1 million acre-feet are available for a one-time use only.

No attempts at recharge have been made in the Hickory ground water reservoir. However, with precautions to remove suspended sediment, treated wastewater could probably be recharged into the aquifer. As little of the aquifer is exposed at the surface, recharge could probably be best accomplished through wells.

Ellenburger - San Saba Aquifer.

The Ellenburger Group, of Ordovician age, and the San Saba Member of the Wilberns Formation, of Upper Cambrian age, are two separate geologic units, but because of the difficulty in distinguishing between them, especially in the subsurface, they are considered in this report as one aquifer. Ellenburger rocks are principally limestone and dolomite. San Saba rocks, predominantly limestone to the northwest of the Llano uplift, grade to dolomite to the southeast.

The Ellenburger-San Saba dips away from the Llano uplift on all sides and is absent over much of the uplift because of erosion. Also, because of intense faulting, structural conditions are very complex. Basic data which would indicate the extent of the fresh-water-bearing (containing water having less than 3,000 mg/l dissolved solids) portion of the Ellenburger-San Saba aquifer are scarce and available only north, west, and southeast of the Llano uplift. On the basis of available chemical analyses, the aquifer is generally presumed to extend less than 20 miles from the outcrop on all sides of the uplift.

Except where truncated below the Cretaceous rocks or at the surface, the Ellenburger-San Saba is known to vary in thickness from less than 1,000 feet northwest of the Llano uplift to more than 2,000 feet southeast of the uplift. The depth to the top of the aquifer where it contains fresh water varies from the land surface in its outcrop areas to more than 2,000 feet below the land surface in northern McCulloch County.

Water in the aquifer occurs in vugular, or cavernous, zones which are common throughout the aquifer and in fractures and joints that in places are solution-enlarged.

Water can be produced from any unit in the aquifer. However, dolomitic portions indicate the greatest favorability for supplying water to wells. Water-bearing zones generally are not horizontally continuous over large areas and are, with probably a few exceptions, under artesian pressure.

The general direction of movement of water is believed to be away from the Llano uplift. At or near the outcrop, water entering the aquifer from the land surface moves downward to the water-bearing zones, and then more or less horizontally toward points of discharge. In many cases the cavernous Marble Falls Limestone is hydraulically connected with the Ellenburger-San Saba aquifer through faults, and contributes to the ground water reservoir.

Recharge to the aquifer is derived from precipitation on upland areas of the outcrop where vugular zones are exposed at the land surface and from streams where they flow over permeable rocks of the aquifer. Because San Saba and Ellenburger outcrops generally form rugged terrain with thin stony soils, surface runoff is favored over infiltration. Water may also enter the aquifer in the subsurface through fault zones and from water-bearing units juxtaposed against the Ellenburger-San Saba by faulting. Significant recharge probably occurs where the aquifer is overlain by sands of the Trinity Group and alluvium.

Ground water is discharged naturally from the aquifer at springs along drainage courses, but some of the water discharged at the higher elevations may re-enter the aquifer in a lower zone. Base flows of many of the streams in the Llano uplift region are supported substantially by ground water discharge from the aquifer. Discharge also occurs in the subsurface by leakage into other rock units. Flowing and pumping wells constitute the artifical discharge from the aquifer. Some wells yield 1,000 gpm but most yield less than 500.

Depths to water in the aquifer vary considerably and depend somewhat on the altitude of the land surface at a particular site. Water levels in wells in the lower stream valleys generally are much closer to the land surface than those in wells in upland areas. In some topographically low areas, wells flow naturally. Fluctuations of water levels result mainly from climatic variations. Water-level variations exceeding 40 feet over a 7-year period have been recorded in upland areas and reflect changes in aquifer storage during dry and wet years. Significant local changes in water levels due to pumping have not occurred.

Water occurs in solution openings. Because of variations in the size of these openings and the degree of connection between them, storage and transmission capabilities of the aquifer cannot be accurately evaluated. Where solution openings are extensively developed, large well yields are common. However, aquifer properties can change markedly over short horizontal distances.

Because of complicated geologic and hydraulic conditions, the amount of ground water available for development can be only roughly estimated. On the basis of flow measurements of streams passing through Ellenburger-San Saba outcrops, it is estimated that 20,000 acre-feet of water per year are discharged from the aquifer in its outcrop areas. It is therefore believed that the aquifer is potentially capable of yielding on a perennial basis at least 20,000 acre-feet per year, and probably more. However, it should be realized that because of the complex and intricate pattern of water-bearing zones in the aquifer, yields of wells vary markedly. In order to develop large water supplies, a test-drilling program may be necessary. In addition, Brune (1970) estimated that about 2 million acre-feet are available on a one-time-only basis.

No artificial recharge has been attempted. However, there should be no problem in recharging properly treated wastewater. Well recharge would probably be the most efficient method. There should be no problem of clogging the aquifer with sediment.

Edwards (Balcones Fault Zone) Aquifer.

The Edwards (Balcones Fault Zone) aquifer extends across the central part of Travis County in a narrow band. The aquifer, several hundred feet thick, is made up of the Edwards and Associated Limestones in which the fresh water is under artesian pressure.

The cavernous limestone reservoir occurs along the Balcones Fault Zone, dipping to the southeast at about 30 feet per mile. The more western faults in the zone provide access channels through which recharge can enter the reservoir from streams to the west and partly outside of the Colorado River Basin. The eastern faults have placed the impervious Austin Chalk and Eagle Ford Shale against the Edwards Limestones, forming a subsurface dam which holds the artesian flow in check.

The aquifer contains well-developed solution cavities and caverns, many of which have been explored for miles outside of the Basin. The Kiamichi Clay and other impervious formations overlie the reservoir, causing artesian pressures to develop downdip. The large Barton Springs represent a part of this water escaping to the surface along fault planes. The water moves generally from west to east in the aquifer.

Depth to the water level can be at the surface, as at the many springs, or up to 500 feet below the surface. Changes in the water table fluctuate with precipitation. Few major wells produce from the aquifer.

It is difficult to estimate the capacity of the underground reservoir in the Colorado River Basin. However, based upon Brune's (1970) data, about 450,000 acre-feet are estimated to be available from storage. In addition, the perennial yield is at least 38,000 acre-feet, which is the annual flow of Barton Springs. A high rate of withdrawal might, however, damage or dry up the springs.

Artificial recharge of the Edwards Limestone is easily accomplished. It is best done by diverting surface water into the sinkholes and crevices which lead to the underground reservoir, using reservoirs and diversion dikes. Studies have shown that the underground reservoir is enlarging itself through solution. Sediment in the recharge water is not a problem, but grating is needed over openings to prevent large trash from entering the aquifer. Some of the recharge area affecting the Colorado River Basin, however, is outside of the Basin to the west. Properly treated wastewater could be recharged, as well as flood water. Care must be taken to avoid pollution of the aquifer because the natural filtration of sand aquifers is absent.

Carrizo-Wilcox Aquifer.

The Carrizo-Wilcox aquifer crops out in a broad band through a large part of Bastrop County. Beds dip approximately 100 to 150 feet per mile toward the coast. Thickness of the part of the Carrizo-Wilcox which contains water having less than 3,000 milligrams of dissolved

solids per liter ranges from near zero at the western edge of the outcrop to more than 2,500 feet in the southeastern part of Bastrop County. The aquifer is typically composed of lenses of sand and clay with beds of lignite that occur mostly in the lower part of the Wilcox. At and near the surface, the sands are generally cemented with iron. Sands comprise more than 50 percent of the Carrizo-Wilcox unit.

Both water-table and artesian conditions exist. Where sands crop out, water-table conditions occur. Artesian conditions are generally encountered downdip from outcrop areas of sands, where water in the sands is confined beneath relatively impervious overlying materials.

Where water-table conditions exist, ground water moves downdip and laterally from the area of recharge to points of discharge in topographically low areas, where the water is discharged at seeps. Where artesian conditions exist, movement of water is generally in the direction of the regional dip, toward the Gulf Coast. Because individual sands crop out and are recharged at different elevations, waters in individual sands are under different hydraulic heads, and there is some interformational movement of water. The rate of this movement depends on vertical permeability, thickness of confining layers, and differences in hydraulic head.

Fresh water in the aquifer is believed to be derived almost entirely from precipitation which falls on the outcrop. The aquifer does not appear to receive water from other geologic formations because it is underlain by very tight clay of the Midway Group and overlain by tight clay of the Reklaw Formation. However, the rate of recharge to the aquifer is perhaps large, since the outcrop is covered with deep sandy soils and rainfall on it is plentiful. Much of the potential recharge is rejected.

Water is discharged from the aquifer by both artificial and natural means. Artificial discharge is by wells which screen the aquifer. A large amount of water is produced by municipal and irrigation wells in the region, and an undetermined but significant amount of water is produced by domestic and livestock wells. Natural discharge is by springs and seeps along principal surface drainage courses.

Depth of water in wells in the Carrizo-Wilcox aquifer depends mostly upon the topography at the well site. Along topographic highs, depth to water is often more than 200 feet, and in low areas - such as along the flood plain of the Colorado River - flowing wells are present. Because individual sands in the Carrizo-Wilcox aquifer are under different hydraulic heads, depth to water depends also upon the section of sand

screened by the well. Available data on water levels in wells in the Carrizo-Wilcox aquifer show that very little net change in water levels has occurred in the past two decades in this Basin.

Water-bearing characteristics of the aquifer are highly variable, because permeability and thickness of water-bearing sands vary greatly from place to place. Coefficients of transmissibility generally range from 25,000 to 80,000 gpd per foot; storage coefficients range from 0.0003 to 0.0012. Larger coefficients of transmissibility and storage are expected in areas having greater sand thickness. Yields of large-capacity wells average 200 gpm, although some are greater than 600.

It is estimated that the aquifer is capable of sustaining increased pumpage and that if as much as 10 percent of the average annual precipitation on the outcrop is recharged to the aquifer, about 60,000 acre-feet of water per year would be available on a perennial basis. During development, additional water would be available from aquifer storage, perhaps about 2.5 million acre-feet, based upon Brune's (1970) data.

Several short-term attempts at artificial recharge through wells have been made. Indications are that the sediment in the recharge water would in a short time clog the aquifer, unless nearly all of it were removed before recharge. Surface reservoirs are probably more effective than wells for recharge into this formation, including recharge of treated wastewater. However, this aquifer, in the Colorado River Basin, is not presently in need of recharge.

Gulf Coast Aquifer.

The Gulf Coast aquifer is made up of six geologic formations, ranging in age from Miocene to Pleistocene. However, owing to the difficulty in differentiating these formations in the subsurface, they are commonly grouped into three units for discussion. The three groups, from oldest to youngest in age, are: (1) the Catahoula Sandstone, Oakville Sandstone, and Lagarto Clay, (2) the Goliad Sand and Lissie Formation, and (3) the Beaumont Clay.

The Catahoula-Oakville-Lagarto unit dips toward the Gulf Coast at about 50 to 60 feet per mile. The Catahoula Sandstone, consisting of sand, conglomerate, and interbedded clay, silt, and tuff, is the basal formation of this unit. Excessive clay content limits the development potential of the Catahoula in the Colorado River Basin. The Oakville Sandstone,

which overlies the Catahoula, is a massive light-colored sand containing minor interbeds of clay. The Lagarto Clay is principally a massive clay with interbedded sand and sandy clay.

The Goliad-Lissie unit overlies the Catahoula-Oakville-Lagarto unit. These formations dip toward the Gulf at a rate ranging from 10 to 45 feet per mile. The basal formation of this unit, the Goliad Sand, is characteristically a coarse-grained sand interbedded with layers of gravel and clay. The Lissie Formation is composed of massive beds and lenses of fine-to-coarse-grained sand which grade into and are interbedded with clay, sandy clay, and gravel.

The Beaumont Clay is principally a poorly bedded calcareous clay containing thin stringers and beds of silt and fine sand.

The sand units of the Gulf Coast aquifer, which contain water with less than 3,000 mg/l (milligrams per liter) dissolved solids range in thickness from less than 100 feet inland to more than 1,000 feet in Wharton County. Water containing less than 3,000 mg/l dissolved solids may be obtained from zones as deep as 2,600 feet. From southeastern Colorado County toward the coast, the depth to the base of water containing less than 3,000 mg/l dissolved solids becomes progressively shallower, and at the mouth of the Colorado River is less than 600 feet.

Both water-table and artesian conditions exist. Where sands of the aquifer are at the surface, water-table conditions generally occur.

Artesian conditions are generally encountered downdip from outcrop areas of the sands, where water in the sands is confined beneath relatively impervious overlying materials. Most of the water in the aquifer is under artesian conditions.

Where water-table conditions exist, ground water moves downdip and laterally from the area of recharge to points of discharge in topographically low areas, where the water is discharged at seeps. Where artesian conditions exist, movement of water is generally in the direction of the regional dip, from the outcrop area toward the Gulf Coast. Water levels in wells screened through deeper sands are higher than those in wells screened through shallower sands. There is an upward vertical movement of water through confining beds, the rate of movement depending on vertical permeability, thickness of confining layers, and difference in hydraulic head.

Conditions affecting recharge in the aquifer are generally favorable, and it is likely that potentially available recharge is rejected in many of the sand outcrops.

Discharge from the aquifer is by both artificial and natural means. Artificial discharge occurs from wells which screen the aquifer, the greatest amount being produced by municipal, industrial, and irrigation wells of the region. An undetermined but significant amount of water is produced from domestic and livestock wells. Natural discharge occurs through seeps along drainage courses and through vertical interformational leakage.

Water levels in the Gulf Coast aquifer are generally less than 100 feet below the land surface. Significant regional fluctuation of water levels is mostly seasonal, occurring in the irrigated areas of southern Colorado County and northwestern Wharton County.

Water-bearing characteristics of the aquifer are highly variable because permeability and thickness of water-bearing sands vary greatly from place to place. Available data indicate that in sands containing less than 3,000 mg/l dissolved solids, coefficients of transmissibility range from less than 50,000 to more than 300,000 gpd per foot. The largest transmissibilities occur where the net sands of the aquifer are thickest.

Yields and specific capacities of wells vary greatly, depending on permeability, thickness of the sand penetrated, and well construction. Specific capacities generally are less than 50 gpm per foot of drawdown, although wells in central Wharton County have specific capacities as high as 140 gpm per foot of drawdown. Individual well yields of 2,000 gpm are common. Few wells penetrate the entire thickness of the aquifer. In general, the Goliad-Lissie unit is the most prolific portion of the aquifer.

Future increases in development in areas downdip from outcrops of water-bearing sands will cause increases in hydraulic gradients. It is estimated that under maximum gradients about 33,000 acre-feet of water per year, considerably more than the amount now being withdrawn, would move through the aquifer and thus be available on a perennial basis. About 3 of the 40 inches of annual rainfall would be needed as recharge to support maximum conditions of development. It is believed that aquifer outcrop conditions are such that even at maximum development, recharge would be greater than the amount needed for withdrawals. Additional water would be produced from storage during development

from present to maximum conditions, but this additional water would not be available on a perennial basis. Based upon Brune's (1970) data, about 6 million acre-feet would be available one time only.

In this aquifer, special problems can arise. If ground water levels are drawn down too far, saline water can be drawn in to contaminate the reservoir. Also, ground water withdrawal can cause land subsidence with great damage to buildings, pipe lines, and other structures, as well as increased hazard from flooding during hurricanes. Neither of these problems has arisen to date in this Basin.

Artificial recharge through wells into this aquifer was experimented with by the King Ranch in Kleberg County. Rates of recharge up to 450 gpm were found to be feasible, but a large diatomaceous earth filtration plant was required to remove the sediment from the recharge water. Surface reservoirs have proved to be very effective for recharge into this aquifer and could be used to recharge treated wastewater. In this Basin, there is no present need for artificial recharge.

Other Aquifers.

Several other aquifers supply relatively small amounts of ground water. These are described in the following paragraphs. They are not shown on Figure 2.

Alluvium.

Alluvial deposits consisting mostly of sand and gravel occur along the Colorado River and its tributaries. These deposits, though often limited in area, are capable of supplying domestic and livestock wells and in some places are developed for public supply and irrigation uses.

Thin sand and gravel beds, believed to be river terrace deposits, in southwestern Scurry County supply limited amounts of potable water for domestic and livestock-watering purposes. The water table in these sands and gravels is very near the land surface, creating numerous seeps at the edges of the deposits. Thin sand and gravel deposits within the Colorado River flood plain in Borden County supply water for refining of liquified petroleum products. Overflow from the Colorado River and water from precipitation provide the necessary recharge for sustaining this operation.

Of particular interest to this study is the alluvium in association with the Concho River drainage system west of San Angelo. These deposits form terraces along the Concho River where they are believed to be as much as 250 feet thick in places. They are hydrologically in connection with the Edwards-Trinity (Plateau) aquifer. In the Lipan Flats area of eastern Tom Green County, saturated alluvial gravels furnish ground water to most of the irrigation wells. Although persistent water-table declines in these deposits will probably limit more widespread irrigation in this area, the supply should remain adequate for domestic and livestock wells.

In the central part of the Llano uplift, stream gravels derived from the granitic terrain are usually the only reliable source of ground water for domestic use. The city of Bastrop obtains its water supply from Colorado River alluvium.

Trinity Group (North-Central Texas).

Sands of the Trinity Group (North-Central Texas), which occur over a large area in the Brazos River Basin, extend into the Colorado River Basin and yield potable water to wells in Travis County. These fine-grained sands seldom attain thicknesses greater than 30 feet. They generally do not yield large quantities of water to wells; however, they are an important source of water for small communities near the City of Austin. The City of Manor, which is several miles east of Austin, obtains water from a depth of approximately 3,000 feet below land surface. The wells at Manor yield approximately 100 gpm. When first drilled, they were reported to have had a static water level greater than 80 feet above land surface, but they no longer flow.

Queen City Formation.

The Queen City Formation crops out in a narrow band across the Colorado River Basin between Bastrop and Smithville. The aggregate thickness of sands within the Queen City is as much as 200 feet along the eastern margin of the basin where the Queen City is best suited for development. It adequately supplies the cities of Smithville in Bastrop County and Giddings in Lee County.

Yegua Formation.

The Yegua Formation crops out across the Basin principally in northwest Fayette County. It consists of sand and clay and furnishes water to a few irrigation wells. Southwest of the Basin area, in southwest Fayette County, the City of Flatonia has developed an adequate public-supply system from sands of the Yegua. Several irrigation wells in the Flatonia vicinity also produce water from the Yegua.

Jackson Group.

Sands of the Jackson Group, which crops out across a large area of central Fayette County north of La Grange, yield small to moderate supplies of water. Because the Jackson consists mostly of fine-grained materials associated with volcanic activity, most of its strata are not capable of furnishing adequate water for large-yield wells. However, lenticular sands in the upper Jackson furnish water for the City of La Grange as well as for irrigation purposes.

Chinle Formation.

Sand and gravel in the Chinle Formation of the Dockum Group (Triassic) yield water to wells in parts of Scurry, Borden, Ector, Andrews, and Dawson Counties. Wells producing usable water from these deposits are generally on or very near the outcrop or subcrop areas. The producing section consists of about 30 feet of sand and gravel, and occurs at depths of about 230 to 360 feet below land surface.

Sand and gravel of the Chinle Formation occur beneath all of the High Plains part of the Basin, conforming somewhat to the dip and strike of the underlying Santa Rosa Formation. Subsequent investigations may reveal additional water supplies in Chinle deposits, particularly in water-short areas.

Permian Rocks.

Several stratigraphic units of the Permian System are known to yield small to large amounts of usable water to wells in parts of Coke, Runnels, Coleman, Tom Green, and Concho Counties. Generally, Permian rocks are either too tight to yield water to wells or they yield only small amounts of mineralized water. However, exceptions to the foregoing generalizations are found in the Standpipe Limestone Member of the Arroyo Formation and the Bullwagon Dolomite Member of the Vale Formation, both of which belong to the Clear Fork Group and crop

out in eastern Tom Green and western Runnels Counties. The Standpipe Limestone, a marly limestone approximately 15 feet thick, yields small amounts of usable water near outcrop areas. The Bullwagon Dolomite consists of 75 feet of massive dolomitic limestone interbedded with shale, and yields usable water in amounts up to 1,000 gpm to a few wells downdip and west of its outcrop.

Pennsylvania Rocks.

Although usable ground water is occasionally obtained from most of the Pennsylvanian rocks, the units which are most significant are in the Strawn and Bend Groups.

Sands of the Strawn Group yield small quantities of potable water to domestic and livestock wells in and near outcrop areas. These sands occur in southeastern Brown, southwestern Mills, northern San Saba, and northeastern McCulloch Counties.

Cavities and fractures in the Marble Falls Limestone of the Bend Group supply water to many wells in the Llano uplift area, but it is in San Saba County that this aquifer is most prolific. The cities of San Saba and Richland Springs, in San Saba County, obtain water from large springs in the Marble Falls Limestone, and an irrigation well yielding more than 2,000 gpm produces from a cavity in this limestone.

Welge Sandstone.

The Welge Sandstone Member of the Wilberns Formation, a medium-to-coarse-grained sandstone averaging about 20 feet in thickness, yields small amounts of water where it crops out around and in the Llano uplift. It is a dependable source of water for domestic and livestock-watering purposes.

Precambrian Rocks.

In the central part of the Llano uplift where Precambrian rocks crop out at the surface, fractures developed in these rocks are often the only source of ground water for domestic supplies. Although water of good chemical quality is usually obtained, the amount available is small.

Summary.

The ground water reservoirs of the Colorado River Basin include nine primary and secondary aquifers - principally sand, gravel, and cavernous limestone - and a number of less important aquifers. These reservoirs can furnish on an annual basis about 666,000 acre-feet of fresh and slightly saline water containing less than 3,000 or 4,000 mg/l of dissolved solids, as shown in Table 1. In addition, they can produce from storage, one time only, over 57,000,000 acre-feet of water.

Ground water recharge with properly treated wastewater is feasible in all of these aquifers, but some are not presently in need of recharge. Various methods of recharge, including wells, shafts, pits, basins, canals, and reservoirs can be used, depending upon the individual aquifer characteristics. Removing sediment from recharge water is highly important in sand aquifers but less important in cavernous limestone. The risk of contamination of the ground water is greatest in cavernous limestone reservoirs where there is no natural sand filtration.

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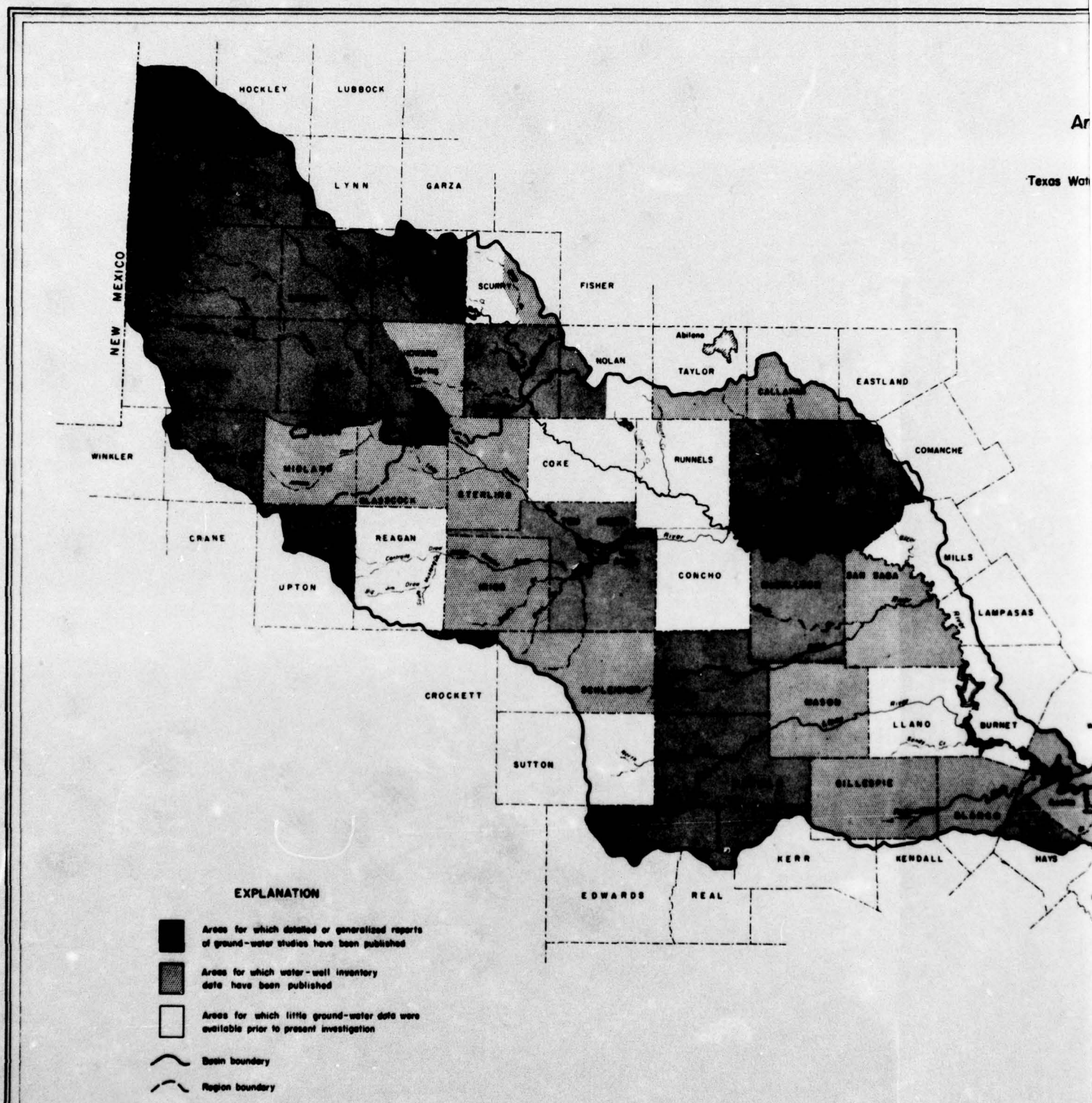
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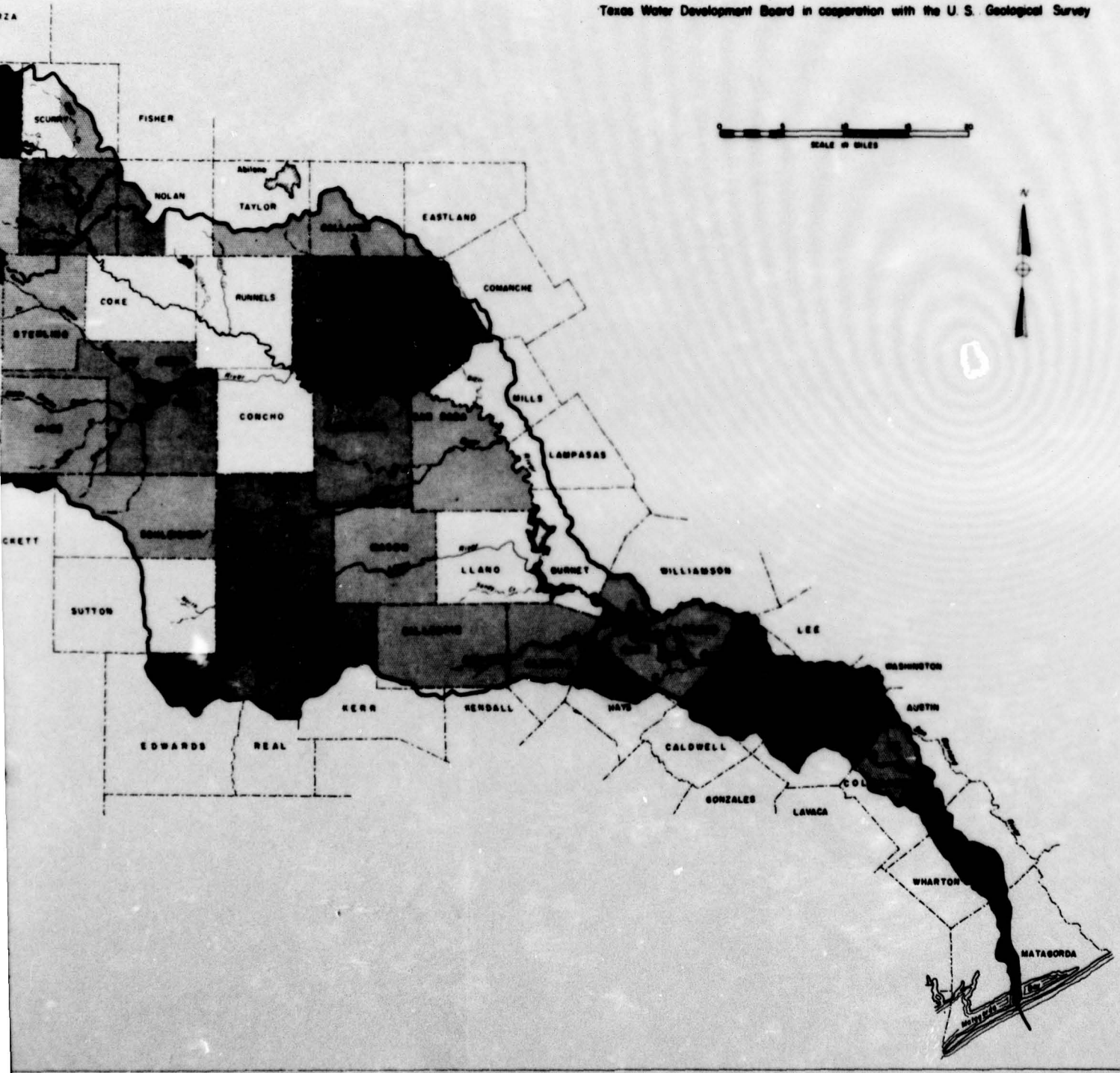
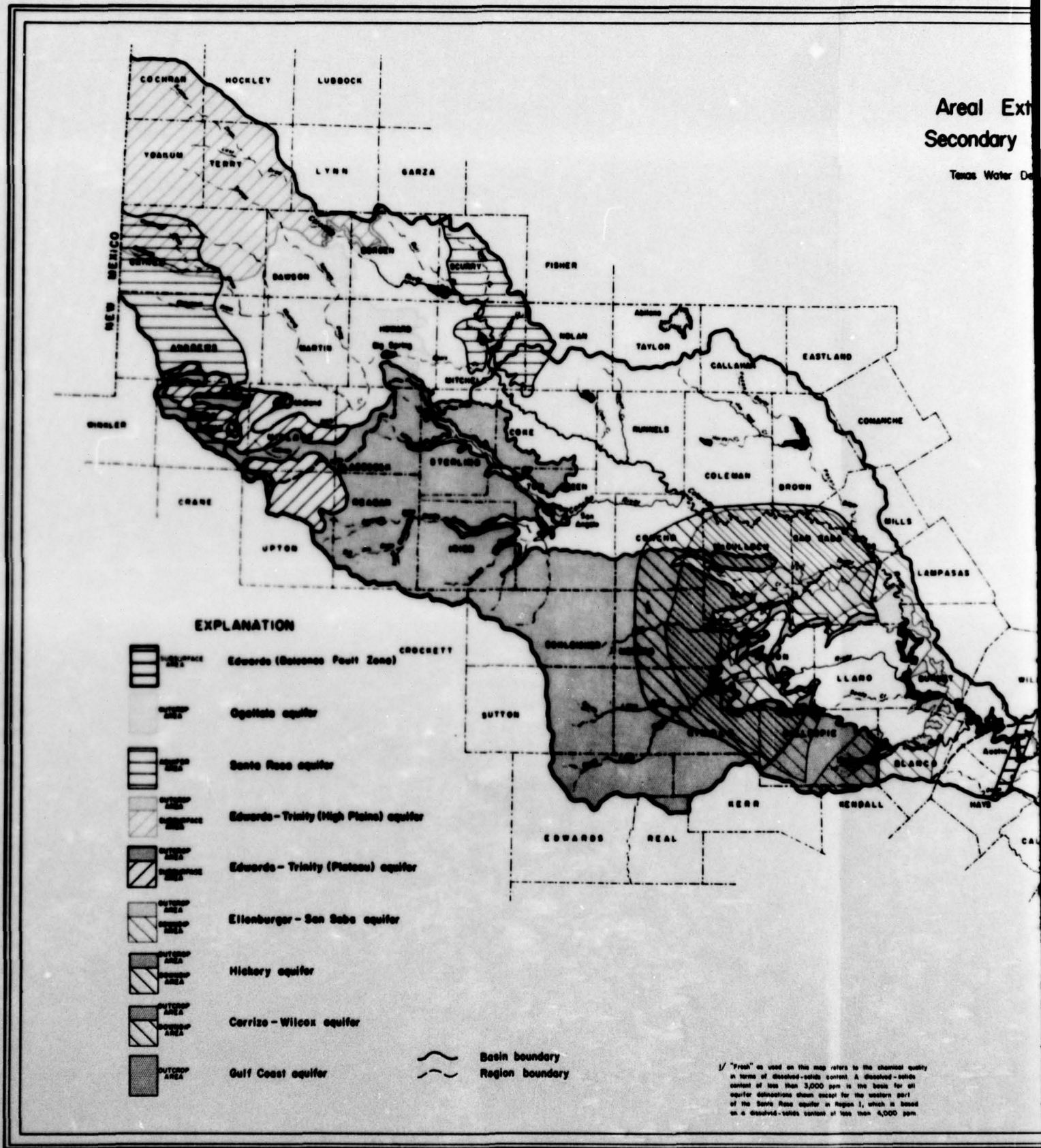
MIDLAND
COKE
RUNNELS
GLASSCOCK
STERLING
CRANE
REAGAN
CONCHO
MILLS
UPTON
SAN SABA
LAMPASAS
CROCKETT
MASON
LLANO
BURNET
SUTTON
GILLESPIE
KERR
KENDALL
HAYS
EDWARDS
REAL
EXPLANATION
Areas for which detailed or generalized reports of ground-water studies have been published
Areas for which water-well inventory data have been published
Areas for which little ground-water data were available prior to present investigation
Basin boundary
Region boundary

Figure 1

Areas of Colorado River Basin Included in Published Ground-Water Reports

Texas Water Development Board in cooperation with the U. S. Geological Survey

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HOCKLEY
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GARZA
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DAWSON
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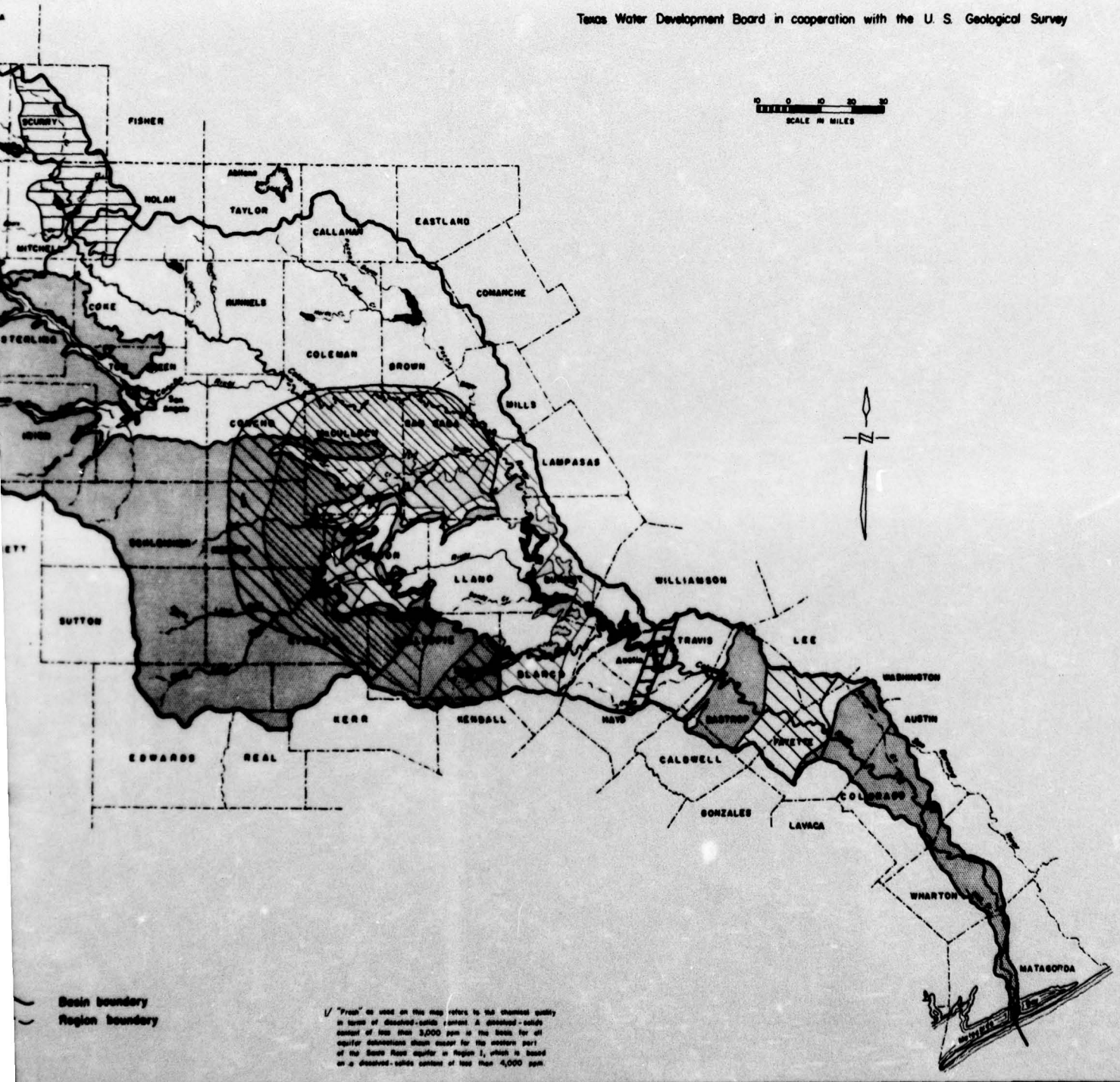
SCURRY
FISHER
MARTIN
HOWARD
MITCHELL
NOLAN
TAYLOR
CALLAHAN
EASTLAND
ANDREWS
GLASSCOCK
STERLING
COKE
RUNNELS
COLEMAN
BROWN
COMANCHE
CRANE
UPTON
CROCKETT
CONCHO
MILLS
SAN SABA
LAMPASAS
SCHLEICHER
SUTTON
LLANO
MASON
BLANCO
KERR
KENDALL
HAYS
EDWARDS
REAL
EXPLANATION
Edwards (Balcones Fault Zone)
Ogallala aquifer
Santa Rosa aquifer
Edwards-Trinity (High Plains) aquifer
Edwards-Trinity (Plateau) aquifer
Ellenburger-San Saba aquifer
Hickory aquifer
Carrizo-Wilcox aquifer
Gulf Coast aquifer
OUTCROP AREA
SUBCROP AREA
Basin boundary
Region boundary
1/ "Fresh" as used on this map refers to the chemical quality in terms of dissolved-solids content. A dissolved-solids content of less than 3,000 ppm is the basis for all aquifer delineations shown except for the western part of the Santa Rosa aquifer in Region I, which is based on a dissolved-solids content of less than 4,000 ppm.

Figure 2

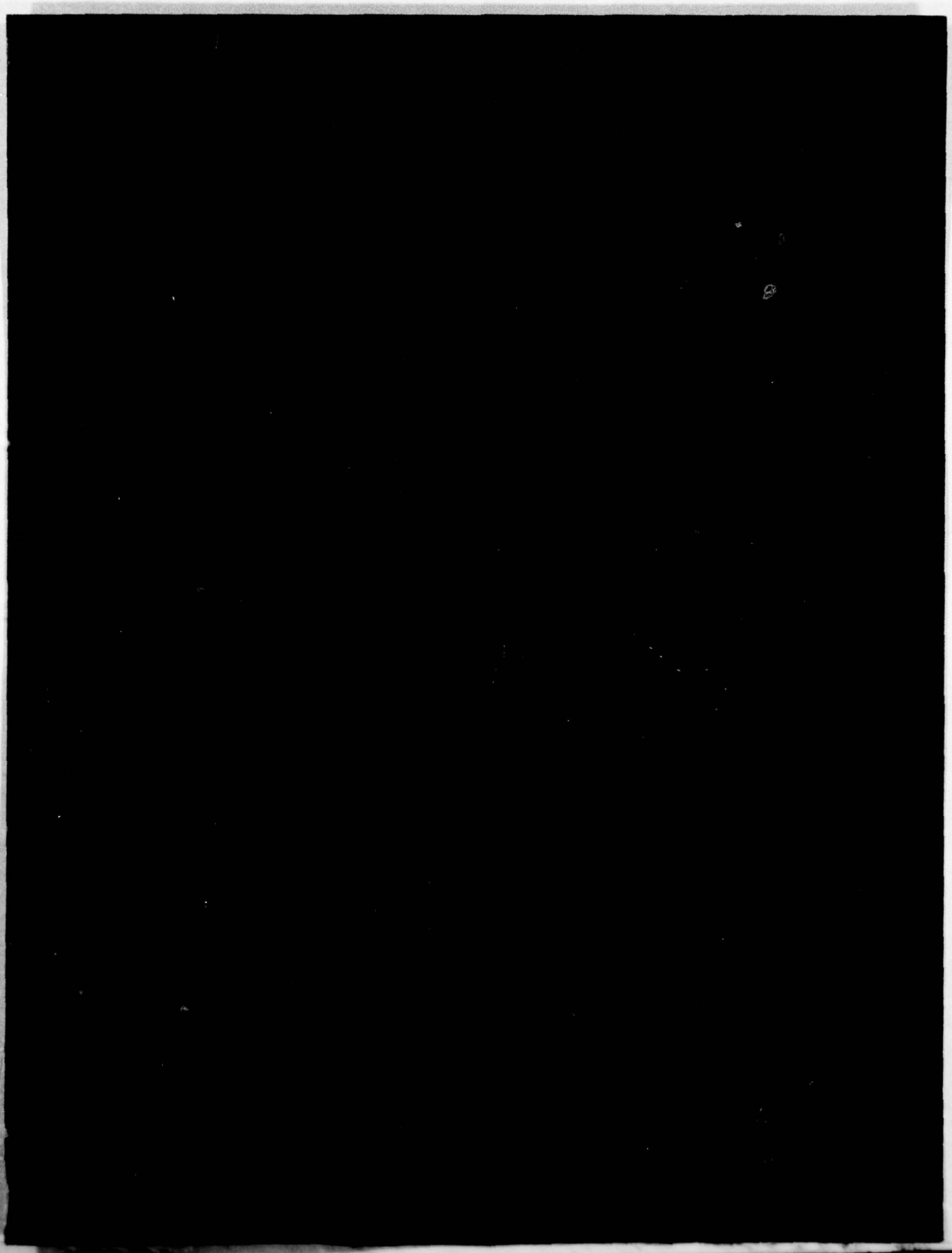
Areal Extent of Fresh Water in Primary and Secondary Aquifers of the Colorado River Basin

Texas Water Development Board in cooperation with the U. S. Geological Survey



1/ "Fresh" as used on this map refers to the chemical quality in terms of dissolved-solids content. A dissolved-solids concept of less than 3,000 ppm is the basis for all aquifer delineations shown except for the western part of the Santa Rosa aquifer in Region I, which is based on a dissolved-solids content of less than 4,000 ppm.

2



D. INVESTIGATIONS OF OIL & GAS PRODUCING LEASES (1)

DISTRICT NO. 1

Bastrop County - Reference: General Highway Map, 1964
Scale 1" = 2 miles

Oil fields investigated are clearly shown in the southwest corner of this map.

Travis County - Reference: General Highway Map, 1963
Scale 1" = 2 miles

Elroy Oil Field, investigated for this study, is shown in the southeast corner of this map.

DISTRICT NO. 3

Lee County - Reference: General Highway Map, 1963
Scale 1" = 2 miles

Fayette County - Reference: General Highway Map, 1965
Scale 1" = 2 miles

Colorado County - Reference: General Highway Map, 1965
Scale 1" = 2 miles

Matagorda County - Reference: General Highway Map, 1968
Scale 1" = 2 miles

Wharton County - Reference: General Highway Map, 1965
Scale 1" = 2 miles

All oil and gas fields in above counties were investigated for this study. Although a number of leases inspected were found to be in violation of RRC rules, all violations were of an operational nature and have since been corrected. These include accidential spills of oil and salt water due to equipment failure or careless operation. No problems involving a flow of oil, gas or salt water on the surface of the ground or below the ground were noted.

(1) Prepared by Railroad Commission of Texas

DISTRICT NO. 7B

Nolan County - Reference: General Highway Map, 1960
Scale 1" = 2 miles

Oil fields investigated are shown in the western one-half and southeastern one-quarter of the county.

Taylor County - Reference: General Highway Map, 1960
Scale 1" = 2 miles

Oil fields investigated are shown in the south one-half of the county.

Callahan County - Reference: General Highway Map, 1960
Scale 1" = 2 miles

Oil fields investigated are shown in the south one-half and the north-central section of the county.

Eastland County - Reference: General Highway Map, 1964
Scale 1" = 2 miles

Oil fields investigated are shown in the southwestern corner of the county.

Coleman County - Reference: General Highway Map, 1964
Scale 1" = 2 miles

All oil fields in the county were investigated.

Brown County - Reference: General Highway Map, 1964
Scale 1" = 2 miles

All oil fields in the county were investigated.

Mills County -

Only the three wells listed in the attached report were investigated. There is no oil or gas production in Mills County.

Please refer to the attached report for a description of the leaking wells and complex problems found, as well as the current action being taken. Pit and operational problems found included unauthorized pits being used for salt water disposal and oil and salt water which had been allowed to escape from tanks or flow lines. All pit use has been eliminated and all oil or salt water spills cleaned up.

DISTRICT 7C

Coke and Runnels Counties - Reference: General Highway Map, 1963

Oil fields shown on these maps were investigated for the Colorado River Basin Wastewater Management Study, since these two counties are where poor quality ground and surface water exist.

Operational problems usually develop from equipment failures and these are generally corrected before any damage occurs.

Of the five leaking wells, data have been collected on two wells and the files forwarded to the Attorney General's office for his action, and investigations are in progress to collect information for similar submissions on the remaining three wells. These wells are located as shown below:

Lease & Well	Location	Flow Characteristics
A. F. Lee #1	Runnels County, near Maverick, Texas	Flow shut off at present - referred to AG - 10-8-71
J. D. Smith #1	Coke Co. on bank of Colorado River, 9 mi. ESE of Robert Lee, Tex.	Slight flow of salt water at surface - Referred to AG-4-10-70
Pearl Wright #1	Runnels Co., 7 mi. NE of Winters, Texas	Salt water seep at surface. Approved for plugging with State funds.
Frank Percival #1	Coke Co., 5 mi. SE of Robert Lee, Texas	Slight flow of salt water at surface. Approved for plugging with State funds.
King #4	Runnels Co., 6 mi. NE of Ballinger, Texas	Estimated 30 bbls. salt water per day. Approved for plugging with State funds.

AD-A036 845 ARMY ENGINEER DISTRICT FORT WORTH TEX F/G 13/2
WASTEWATER MANAGEMENT PLAN. COLORADO RIVER AND TRIBUTARIES, TEX--ETC(U)
SEP 73

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2 OF 4
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DISTRICT NO. 8

Andrews, Ector, Glasscock, Howard, Martin, Midland, Mitchell and Sterling Counties - Reference: General Highway Maps Scale 1" = 2 miles

The oil and gas production areas investigated are shown on these maps. Operational problems found include such as excessive fluid in burn pits, line leaks and tank overflows. From a standpoint of water pollution, these irregularities were all minor, and were quickly corrected.

DISTRICT NO. 8A

Cochran, Hockley, Yoakum, Terry, Lynn, Gaines, Dawson, Borden, Scurry and Mitchell Counties - Reference: General Highway Maps

These maps show the oil and gas fields investigated for this study. Only those oil and gas fields lying within the Basin were inspected.

The Randal's Corner Area

An investigation in this area of salt pollution of ground water has been under way for some time. All producing wells in the vicinity have been evaluated carefully and no irregularities which might result in ground water pollution have been found. No conditions were observed which might contribute to surface water pollution. Currently, the most likely source of ground and surface water contamination appears to be residual salt deposited in open pits and stream beds prior to 1969 when open pit disposal of gas and oil well brines was discontinued. The investigation of possible pollution sources is continuing and will continue until we are satisfied that we have identified the correct source.

The Knapp Area

An investigation of high salt concentrations in seeps is being initiated. Since this problem has just come to our attention, no schedule for the conduct of this problem has been formulated.

Proposed solutions to eliminating the source of salt pollution, prior to determining the actual source, would be premature. If the source is unplugged or improperly plugged wells, the solution is relatively uncomplicated. If the problem is the result of residual salt or natural salt deposits in the soil, the solution becomes much more complex.

No specific date for re-entering and plugging the four wells mentioned in this report. Data must be collected, files forwarded for action and public hearings held prior to the actual operation.

It would be premature to predict the extent and magnitude of the remaining salt problem after these four wells are plugged. This is due to the extensive use of open pit disposal of oil and gas well brines and the uncertainties as to the current location and extent of the salt deposits left by this disposal method.

RAILROAD COMMISSION OF TEXAS
Oil and Gas Division

ABILENE, TEXAS
June 28, 1973

MEMORANDUM TO: MR. ROY D. PAYNE, DIRECTOR OF FIELD OPERATIONS

Re: Colorado River Watershed Authority Project

SUBJECT: SUPPLEMENTARY REPORT

The following is submitted pursuant of Mr. J. C. Herring's call requesting status of leaking wells and suspected leaking wells in the Colorado River Watershed.

MILLS COUNTY

REEVES COMPLAINT

Frank Griggs, S. A. Reeves Well No. 1, Rhyne Survey No. 67, D&A 7-18-54, Southwest part of Mills County, Texas

Pat Slaven et al, W. Hubert Reeves Well No. 1, Rhyne Survey No. 67, D&A 9-10-56, Southwest part of Mills County, Texas

Burk Royalty, Reeves Well No. 1, Rhyne Survey No. 67, D&A 1-16-51, Southwest part of Mills County, Texas (The Landowner has obtained authority to use this well as a water well.)

(These wells are referred to as sulphur wells. The Colorado River Authority was contacted in March, 1969, regarding contributions to defray the cost of plugging. The chloride concentration of these wells averaged 3500 ppm. These wells have not been submitted for approval to plug with State funds.)

BROWN COUNTY

A. A. Peard, E. D. Cross Well No. 1, E. D. Prewitt Survey, 6 miles east of Indian Creek near Mills County Line, TD 2803', D&A 7-19-19, Brown County, Texas

(This well has been submitted to Austin for approval to plug with State funds under Article 6005, Revised Civil Statues of Texas.)

Pippen Oil Company, Knox Andrews Well No. 1, H. H. Hall Survey No. 49, Brown County, Texas (DOCKET 7B-61,396, Wooldridge-Stasney-City of Brownwood Complaint)

(This well is now in litigation as indicated in Mr. J. Brooks Peden's letter of March 27, 1972.)

H. D. Creath, J. M. Perry Well No. 1, James Kinney Survey No. 624, Brown County, Texas (Leaking Well Code 626)

(On June 21, 1972, the Commission approved our request to plug the well with State funds under Article 6005, Revised Civil Statutes of Texas.)

PAUL-SHELTON COMPLAINT-BROWN COUNTY WATER IMPROVEMENT DISTRICT

H. F. Pettigrew, J. H. Byrd Well No. 1, HT&B RR Co. Survey, Brown County, Texas

(The landowner has expressed a desire to keep this well to water deer and cattle. The well is leaking a very small amount.)

K. S. Richards, Newton Well Co. 6, Brown County, Texas

(This well was not found on the ground. It is now covered by Brownwood Lake water.)

COLEMAN COUNTY

Maynard Oil Company, Talpa Fry Sand Flood Unit (08718), Wells 3-1 and 3-3, Burt-Ogden-Mabee Field, Coleman County, Texas

(The operator has plugged these wells and problem has been closed since Colorado River Watershed investigation.)

Brady, Texas Municipal Gas Corporation, S. C. Stewardson Lease, Well No. 1 (18365), Well No. 4 (18366), Stewardson (Alex, Gardner) Field, Coleman County, Texas

(This operator has been contacted regarding plugging these wells.)

L & L Producing Company, C. T. McClatchey Lease, Well No. 1 (17530), Coleman County Regular (Gas) Field, Coleman County, Texas

(The operator was written a formal plugging letter on March 14, 1972. To the present, no action has been taken to plug or produce.)

Texas Company, or Producers Oil Company, W. F. Guthrie Well No. 1, Bond & Sanders Survey, Coleman County, Texas (Leaking Well Code 602)

(The above well has been submitted for approval to plug with State funds; however, the landowner is keeping the well for fresh water well.)

W. L. Vaughn, W. L. Vaughn Lease (00983), Wells 1, 2, and 7 (leaking), Wells 3 and 5 (abandoned), Coleman County Regular Field, Coleman County, Texas

(The operator was written a formal plugging letter on March 23, 1972. To the present, no action has been taken to plug or produce.)

W. L. Vaughn, W. L. Vaughn "A" Lease (07960), Well No. 6 (leaking), Wells 2 and 4, (abandoned), Coleman County Regular Field, Coleman County, Texas

(The operator was written a formal plugging letter on March 23, 1972. To the present, no action has been taken to plug or produce.)

Stuart & Barrett, Stacey Lease, Well No. 1, A. S. Lipscomb Survey, Section 81, Coleman County, Texas (Anonymous Complaint)

(The subject well has been submitted for approval to plug with State funds under Article 6005. At present, this office is in the process of contacting the landowner for contribution.)

EASTLAND COUNTY

The following wells are located in a complex seep area associated with the Old Pioneer Field. This problem has been carried in our files as the Dillard-Eakins-Alexander Complaint. Four wells have been plugged recently in this area using State funds and contributions from the landowners. The following wells are not leaking at the top, but could possibly be contributing to a very, very large seep area nearby.

T. B. SLICK

B. L. Eaken Well No. 1, 312' from N & 312' from E lines of West 50 acres of 100-acre tract, W. G. Watkins Survey, Elevation 1684', TD 2490', Completed 4-25-22, (350 BOPD)(OH 2445'-90')

B. L. Eaken Well No. 2, 350' from N & W lines of West 50 acres of 100-acre tract, W. G. Watkins Survey, Elevation 1692', TD 2482', Completed 6-13-22, (000 BOPD) (OH 2463' - 82')

B. L. Eaken Well No. 3, 350' from S & E lines of West 50 acres of 100-acre tract, W. G. Watkins Survey, Elevation 1679', TD 249', Completed 4-27-22.

B. L. Eaken Well No. 4, 350' from S & W lines of West 50 acres of 100-acre tract, W. G. Watkins Survey, Elevation 1677', TD 2438', Completed 5-26-22, Top of pay 2435'.

B. L. Eaken Well No. 5, 800' from S line and 350' from W line of West 50 acres of 100-acre tract, W. G. Watkins Survey.

B. L. Eaken Well No. 6, 1200' from S line & 150' from E line of West 50 acres of 100-acre tract, W. G. Watkins Survey.

STATES OIL CORPORATION

W. R. W. Smith Well No. 1, 2776' from S & 300' from W Lines of W. B. O'Neal Survey, Elevation 1716', TD 2553'.

W. R. W. Smith Well No. 2, 300' from W line & 3376' from N line of W. B. O'Neal Survey, Elevation 1700', TD 2508'.

W. R. W. Smith Well No. 3, 325' from N line & 625' from E line of South 80 acres of W. B. O'Neal Survey.

W. R. W. Smith Well No. 4, 1100' from N line & 310' from E line of South 80 acres of W. B. O'Neal Survey, TD 2489'.

W. R. W. Smith Well No. 5, (filed under W. O. Tolbert & Green Well No. 1) 300' from E line & 1600' from N line of South 80 acres of W. B. O'Neal Survey, Elevation 1695', TD 3669', BP&D 2525', D&A 7-15-47.

DUQUESNE OIL CORPORATION

W. R. W. Smith Well No. 1, 1717' from N Line & 290' from E line of W. B. O'Neal Survey, Elevation 1708', TD 2490'.

W. R. W. Smith Well No. 2, 1190' from N & 200' from E lines of W. B. O'Neal Survey.

W. R. W. Smith Well No. 3, 775' from N 7 175' from E lines of W. B. O'Neal Survey.

W. R. W. Smith Well No. 4, 1750' from N & 300' from W lines of W. B. O'Neal Survey, Elevation 1705', TD 2497', Completed 6-7-22.

W. R. W. Smith Well No. 5, 1150' from N & 300' from W lines of W. B. O'Neal Survey, Elevation 1707', TD 2499', completed 6-13-22.

W. R. W. Smith Well No. 6, 330' from N & W Lines of W. B. O'Neal Survey, TD 2507', Completed 9-15-22.

W. R. W. Smith Well No. 7, 200' from N & E lines of W. B. O'Neal Survey, Elevation 1729', TD 2501', Completed 7-13-22

W. R. W. Smith Well No. 8, 765' from N Line & 300' from W line of W. B. O'Neal Survey, TD 2512', Completed 8-31-22.

Please note attachments regarding the status of various wells mentioned in this report.

sgd/_____
Earl Burns
District Director

MEW/ns

Attachments

March 20, 1969

Lower Colorado River Authority
3700 Lake Austin Blvd.
Austin, Texas

Re: Leaking Wells
Mills and Brown Counties,
Texas

Gentlemen:

On April 5, 1968 this office wrote to you about some abandoned oil wells that were leaking salt water into the Colorado River drainage system. We have identified these wells as follows:

A. H. Peard #1 E. D. Cross
E. D. Prewitt Survey
Brown County, Texas
Dry and abandoned: 7-19-19
6 miles east of Indian Creek near Mills County line.
Flowing 70 barrels a day into Pecan Bayou
Water tested 6000 ppm chlorides

Frank Griggs #1 S. A. Reeves
Rhyne Survey #67
Mills County, Texas
Dry and abandoned: 7-18-54
Southwest part of Mills County
Flowing 75 barrels a day into Buffalo Creek, approximately five miles from the Colorado River
Water tested 1200 ppm chlorides

Pat Slaven et al #1 W. Hubert Reeves
Rhyne Survey #67
Southwest part of Mills County
Dry and abandoned: 9-10-56
Flowing 60 barrels a day into small creek about two miles from the Colorado River
Water tested 2680 ppm chlorides

Burk Royalty #1 Reeves
Rhyne Survey #67
Southwest part of Mills County
Dry and abandoned: 1-16-51'
Flowing 75 barrels a day into the Colorado River
Water tested 1120 ppm chlorides

The wells are causing pollution of fresh water and we desire to plug them. However, we have met some land owner resistence and may not be able to plug two of these wells at this time without creating a lot of static. Estimated cost of the plugging is $2000.00 per well. To expedite the plugging would the LCRA contribute $500.00 per well towards the cost of plugging?

We have not had an answer to our letter of last April. We again ask that you review the problem and advise us of your position in regard to help in our pollution abatement program. Your assistance will be appreciated.

If you desire further information, please advise.

Very truly yours,

Phillip R. Russell
District Director 7-B

PRR/dm

cc: Mr. Roy D. Payne, Director of Field Operations

REF: Reeves Complaint, Mills County, Texas

E. SEGMENT RANKING METHODOLOGY

The methodology utilized in the ranking of the segments Statewide was developed by the Texas Water Quality Board in accordance with the Continuing Planning Process as required by Section 303 (e) of the Federal Water Pollution Control Act as amended. In developing this methodology, three primary factors were considered:

Compliance with proposed stream standards;
Water use;
Population affected.

Considering the lack of sufficient data and the short time constraints, the TWQB has attempted to develop a methodology which will, in effect, adequately flag problem areas in the State. There are definitely inadequacies in the data source. Therefore, the Texas Water Quality Board does plan to review and improve the methodology upon receipt of additional data, and it is not unreasonable to say that there will be a considerable change in this update ranking.

The basic methodology used by the TWQB is as follows:

Note: The following quality criteria were selected for use in determination of stream compliance with the proposed stream standards:

pH	Single monthly value
TDS	Yearly average
DO	(1) Single monthly value
	(2) 3-month moving average

1. Ranking of Water Quality Limited segments with data.

a. Water quality segments with data were placed into one of the following 11 groups according to the type of parameter(s) violated:

(1) pH
(2) TDS
(3) pH and TDS
(4) DO (once)
(5) pH and DO (once)

(6) TDS and DO (once)
(7) pH, TDS, and DO (once)
(8) DO (Avg)
(9) pH and DO (Avg)
(10) TDS and DO (Avg)
(11) pH, TDS, and DO (Avg)

b. The initial segment rank (ISR) was determined for every segment. The formula used to calculated the ISR was dependent on which group the segment was in. For example, the formula used to calculate the ISR of those segments in group (7) was:

$$\frac{4\,(DO_{std}-DO)}{DO} + \frac{2(TDS-TDS_{std})}{TDS_{std}} + \frac{(pH-pH_{std})}{pH_{std}}$$

As seen in the above equation, each of parameters is given a weight which is based on their Statewide effect on stream quality. These weights were 1 for pH, 2 for TDS, 4 for DO (once), and 8 for DO (3-month moving average).

c. The ISR was then adjusted by weighting it according to the population affected and the actual water use. Weights were as follows:

Population Affected	
High Density Population	8
Low Density Population	6
Rural	4
Industrial	2
Water Use	
Drinking Water	8
Contact	6
Non-contact	2
Fish and Wildlife	1
Shipping	0.1

The formula used to weight the segments' ISR was:

PA x WU x ISR = ITSR

d. The intermediate segment ranking (ITSR) numbers were then summed and segment percentages determined. These percentages became the final segment ranking numbers for the Water Quality Limited segments with data.

2. Ranking of Water Quality Limited segments without data.

a. The segments were placed in a group "0". (This made twelve groups of Water Quality Limited segments.)

b. The total BOD loading, BOD concentration, COD loading, COD concentration, and pH variation was calculated for each segment. BOD loading and BOD concentrations were evaluated for all municipal dischargers, whereas all five parameters were evaluated for industrial discharges. BOD loading and BOD concentrations for individual discharges were determined respectively by the formulas:

$$\frac{\text{BOD (lbs)}}{\Sigma\text{BOD (lbs)}} \quad , \quad \frac{\text{BOD (conc)} - \text{BOD std}}{\Sigma\text{BOD (conc)} - \text{BOD std}}$$

Where: BOD (lbs)	Loading from discharge
ΣBOD (lbs)	Total BOD discharged to segment
BOD (conc)	Concentration of discharge, mg/l
BOD (std)	Statewide standard of 20 mg/l

Similar equations were used for the remaining parameters. The proposed Statewide standard used for COD concentration and pH range are 150 mg/l and 6.0-9.0 respectively.

c. The percent each segment contributes to each parameter was determined.

d. These percents were then added across with the sum representing the initial segment ranking (ISR).

e. The ISR was then adjusted as shown in Step 1.c. to obtain the intermediate segment ranking (ITSR).

f. Final segment rankings within group 0 were derived as shown in Step 1.d.

3. Ranking of Effluent Limitation Segments.

a. Segments were placed in a special group.

b. The segments within the group were ranked using the procedures outlined in Step 2. b. -f.

4. Statewide ranking of all segments.

a. Weight factors indicating the relative position of the three segment groups to each other were added to the segment ranking obtained in Steps 1. d., 2. f., and 3. b respectively. The weights were: "0" for Effluent Limitation, "1" for Water Quality Limited (without data), and "2" for Water Quality Limited (with data).

b. The new segment ranking values obtained in Step 4. a. yielded the final Statewide segment ranking.

F. DISCHARGER RANKING METHODOLOGY

The Texas Water Quality Board (TWQB) developed the methodology used in the development of the discharger ranking lists. Ranking lists were developed on both the segment and State levels. Two lists, one for municipal dischargers and one for industrial dischargers, were developed on both the segment and Statewide levels. In developing the ranking per segment, the following proposed Statewide standards were used as a base:

BOD concentration = 20 mg/l

COD concentration = 150 mg/l

pH range = 6.0-9.0

The basic methodology used in the development of the lists is as follows:

I. Ranking of Dischargers by Segment

A. Municipal Ranking

1. The dischargers within the segment were identified.

2. For each discharger in the segment, the following values were determined:

$$\frac{\text{BOD (lbs.)}}{\Sigma\text{BOD (lbs.)}} \quad , \quad \frac{\text{BOD (conc.)} - \text{BOD (std)}}{\Sigma\text{BOD (conc.)} - \text{BOD (std)}}$$

where: ΣBOD (lbs.) represents the sum of the loadings from all municipal dischargers in the segment.

3. The values obtained in Step 2 were then added across, and the total was used to determine the discharger ranking within the segment.

B. Industrial Ranking

1. Industrial dischargers within the segment were identified.

2. Same procedure as outlined in A.2, except that values were also determined for three additional parameters - COD concentration, COD loading, and pH.

3. The values obtained in Step 2, were then added across, and the total was used to determine the discharger's ranking within the segment.

II. Ranking of Dischargers Statewide

A. Municipal Ranking

1. The discharger's statewide ranking value (Di) was obtained using the following equation:

$$D_{RV} \times S_{RV} = Di$$

Where:

D_{RV} = Discharger's rank within segment

S_{RV} = Segment ranking

Di = Dischargers statewide ranking value

2. The discharger's statewide value was then used to determine the discharger's statewide ranking.

B. Industrial Ranking

The procedure is the same as outlined in A. 1. and 2. above.

MAXIMUM DAILY WASTE LOADS

AND LOAD ALLOCATIONS

FOR

pH

A CALCULATION OUTLINE

Developed By The
TEXAS WATER QUALITY BOARD

METHOD FOR EVALUATING CAUSES OF NONCOMPLIANT STREAM pH LEVELS

Effluent standards will be set at the same range as stream standards for the receiving water. For example, if industry "x" and municipalities "y" and "z" discharge to segment A, and if the stream standards for segment A call for a pH range of 6.5 - 8.5, then x, y, and z will be required by permit to maintain effluent pH between 6.5 - 8.5 also.

If a stream segment is noncompliant with regard to the pH parameter, self-reporting data, and return-flow data will be reviewed in an attempt to evaluate the cause of noncompliance. Since the stream standards for pH were established from an evaluation of historic laboratory data, engineering judgment should be applied when field data are compared against the stream standards. The majority of segments which are noncompliant with pH were out due to a field determination and, in most cases, can probably be attributed to natural causes such as photosynthesis, runoff, etc.

If an evaluation of the self-reporting and return-flow data indicates that noncompliance may have resulted from an effluent discharge, the following equations[1] will be used to test that hypothesis:

Equation #1:

$$B = 2.3 \frac{[H_3O^+]\left[[alk]-[OH^-]+[H_3O^+]\right]}{[H_3O^+] + 2K_2} \cdot \frac{[H_3O^+] + \frac{K_1+K_2}{[H_3O^+]} + 4K_2}{[H_3O^+] + \frac{K_1K_2 + K_1}{[H_3O^+]}} + [H_3O^+] + [OH^-]$$

Where:

B = Buffering capacity of receiving water; in milli equivalent/pH unit

$K_1 = 10^{-6.4}$

$K_2 = 10^{-10.4}$

---

[1] Walter J. Weber, Jr., Chemical Equilibria In Natural Waters, Course notes of 1969 "Stream and Estuarine Analysis" Course taught at Summer Institute for Water Pollution Control, Manhatten College, New York, N.Y.

alk = Alkalinity of receiving water[1]

note: Brackets indicate equivalents/1 of receiving water.

Equation #2: $C = B \cdot \Delta pH$

Where:

C = the increment of acid (or base) required to effect a pH change of ΔpH in one liter of receiving water

pH = the permissible pH drop (or rise); pH of stream water at the outfall, minus (or plus) the lower (or upper) pH limit stipulated in stream standards

Equation #3: $q' \cdot e = Q \cdot E$

$$q' = Q\frac{E}{e}$$

Where:

Q = stream flow above outfall

q' = maximum effluent discharge rate which receiving H_2O can assimilate

E = number of equivalents/1 which receiving water can assimilate

e = number of equivalents/1 contained in effluent

Compare q' with the actual effluent discharge rate (q). If $q' > q$, the effluent discharge was definitely responsible for the noncompliant stream standard.

If noncompliance is not considered to have resulted from natural causes, and if self-reporting data or return-flow data do not show any effluents which may have caused the violation of stream standards, an intensive field survey will be conducted in an effort to isolate the causes.

---

[1] 100 mg/1 (as $CaCO_3$) of alkalinity = 2×10^{-3} equivalents/1

MAXIMUM DAILY WASTE LOADS

AND LOAD ALLOCATIONS

FOR

CONSERVATIVE MINERALS

A CALCULATION OUTLINE

Developed By The
TEXAS WATER QUALITY BOARD

METHOD FOR EVALUATING CAUSES OF NONCOMPLIANT STREAM CONSERVATIVE MINERALS LEVELS

Definition.

A conservative mineral is one that is assumed to have no sources or sinks other than local inflows or diversions. The mineral is not significantly affected by changes in temperature or any other chemical, biological or other process. Water quality parameters that are considered conservative include, but are not limited to, total dissolved solids, chlorides, and sulfate.

Stream Conditions.

Conservative substances (TDS) - use stream and coastal monitoring data or USGS data at a monitoring station close to the uppermost boundary of the segment. Use measured conservative substances (TDS) concentrations at low flow conditions only.

Stream Flow.

Stream flows will be those obtained from USGS records and will represent the 7-day, 2-year low flow condition. For those segments lacking a gaging station or sufficient data, stream flow at the segment boundaries will be estimated from data collected at the upstream and/or downstream gaging stations. Flows of tributary streams without a gaging station will be estimated by the salt-dilution method, or by other appropriate means.

Target Load.

The target load based on the segment water quality standard will be that load calculated from the equation:

$$A(\#/day) = Q(mgd) \times C\ (mg/l) \times 8.34$$

Where:

A = conservative substance expressed in pounds per day
Q = stream flow at the downstream segment boundary expressed in million gallons per day.
C = concentration of the conservative substance found in the water quality standards for that segment expressed in milligrams per liter

Loads from Waste Dischargers Entering the Stream.

Average the daily discharge of TDS for each known point source within the segment using the self-reporting data and municipal return flow data.

Mass Balance to Find Existing Loads.

Using the following equation, a mass balance will be performed on the segment having a number of dischargers.

$$A' \text{ (\#/day)} = (Q_s C_s + Q_1 C_1 + \cdots + Q_n C_n) \times 8.34$$

Where:

A' = actual load of the conservative substance at the downstream segment boundary expressed in pounds per day.

Q_s = flow in the stream at the upstream segment boundary expressed as million gallons per day.

Q_1 = flow from discharger 1 expressed in million gallons per day.

Q_n = flow from the nth discharger expressed in million gallons per day.

C_s = concentration of the conservative substance in the stream at upstream segment boundary expressed in mg/l.

C_1 = concentration of the conservative substance discharged from discharger 1 expressed in mg/l.

C_n = concentration of the conservative substance discharged from the nth discharger expressed in mg/l.

Compare Existing Loads with Target Loads.

If the existing load is less than the target load, then no waste load allocation is required.

If existing loads are greater than target loads, then the following procedure for waste load allocations will be utilized.

1) Compare the target load to the upstream load (Q_sC_s). If the upstream load is nearly equal or greater in magnitude than the target load, then an evaluation of the upstream segment(s) will be required similar to the procedure outlined in the preceding pages until the upstream discharger(s) causing the problem can be identified. Then a waste load allocation can be made as described in 2 below.

2) If the upstream load Q_sC_s is significantly less than the target load or if upstream dischargers are determined to be a contributing factor to the conservative substance problem in the segment, then all affected dischargers will be required to meet secondary treatment for municipal dischargers and best practicable control technology for industry. If, after applying the degree of treatment described above, the segment is still noncompliant, then waste load allocations will be proportioned among the contributing dischargers to the extent practical. Small dischargers that contribute an insignificant amount to the problem may be ignored when the above described waste load allocations are distributed so long as they are at the equivalent level of treatment, secondary or best practicable control technology for municipal and industrial discharges respectively.

In the above described allocation process, a percentage of the waste load allocation will be reserved for future growth and uncontrollable nonpoint sources.

ANALYSIS OF MAXIMUM PERMISSIBLE DAILY LOADS
OF CONSERVATIVE MINERALS
IN
SEGMENT 1410

Segment 1410 - Colorado River - San Saba River Confluence to E. V. Spence Reservoir (Robert Lee Dam).

Total dissolved solids (TDS) violations have been monitored at all three TWQB monitoring stations in the segment. However, the specific basis of the water quality classification was the yearly TDS concentration of 1,500 mg/l as monitored at the TWQB station (1403.37) south of Bronte.

Streamflow in the Segment.

The segment extends from river mile 479.8 to river mile 716.1, and there are four USGS gaging stations located within the reach. The stations are:

Station	Location	River Mile	7-day, 2-yr. low flow (cfs)
081240	Robert Lee	712.0	0.0
081265	Ballinger	659.4	0.5
081367	Stacy	604.8	n.a.
081380	Winchell	560.7	0.1

Segment Target Load.

A (lbs./day) = Q (mgd) X (mg/l) X 8.34

Where: A = conservative substance (TDS) expressed in pounds per day

Q = stream flow at the downstream segment boundary expressed in million gallons per day

C = concentration of the conservative substance found in the water quality standards for that segment expressed in milligrams per liter

Substituting into the above equation

$A = (0.1)\ (0.646317)\ (1250)\ 8.34$

$= 673.8$ lbs./day

Determination of Existing Loads.

The existing TDS loads on the stream can be obtained by performing a mass balance analysis. The mass balance can be readily evaluated by the following equation:

$$A' (\#/day) = (Q_s C_s + Q_1 C_1 + \cdots + Q_n C_n \times 8.34$$

Where:

A' = actual load of the conservation substance at the downstream segment boundary expressed in pounds per day.

Q_s = flow in the stream at the upstream segment boundary expressed as million gallons per day.

Q_1 = flow from discharger 1 expressed in million gallons per day.

Q_n = flow from the nth discharger expressed in million gallons per day.

C_s = concentration of the conservative substance in the stream at upstream segment boundary expressed in mg/l.

C_1 = concentration of the conservative substance discharged from discharger 1 expressed in mg/l.

C_n = concentration of the conservative substance discharged from the nth discharger expressed in mg/l.

There are only four known permitted discharges within this segment, none of which discharge directly to the Colorado River. All four consist of effluent from municipal wastewater treatment facilities, and no data is available on the TDS concentration of the effluents. The TDS concentration within effluent from municipal wastewater treatment plants is

dependent on numerous conditions, and thus the values may vary notably from plant to plant. However, for the purposes of this analysis it is assumed that the TDS concentration in effluent from a secondary wastewater treatment plant will typically range between 300-350 mg/l. Consequently, the loadings from the dischargers are estimated to be as follows:

Discharger	Average Daily Flow (mgd)	TDS Concentration (mg/l)	TDS Load (lbs./day)
Ballinger	0.22	325	596
Bangs	0.08	325	217
Santa Anna	0.09	325	244
Winters	0.15	325	406
		Total	1,463

In addition to the above four dischargers, the Railroad Commission of Texas noted in a recent survey[1] that there are eight oil wells within the immediate drainage area of the segment which are leaking brines. Two of the wells (see Plate V-9) are located upstream from TWQB station 1403.37 (the station at which the TDS violation was evidenced) with one well located on the bank of the Colorado River. Although there were no data submitted as to the volume or quality of the flow from each well, it is probable that one of these wells could be responsible for the high TDS concentrations monitored in the segment. The lack of data on the quantity and quality of the flow from the wells prohibits an accurate determination of the existing loads entering the segment. However, it can be noted that the estimated loading from the municipal discharges is greater than twice the segment target load.

Comparison of Target Load and Existing Load.

Although the approximated existing load is more than twice the target load of the segment, waste load allocations are not appropriate for several reasons. First, the lack of data on the quantity and quality of the flow from the leaking wells does not permit a fair appraisal of the existing TDS loads to the segment. Second, all of the municipal wastewater treatment plants discharge below the most upstream TWQB monitoring station (1403.37) south of Bronte, where the yearly TDS violation was recorded.

(1) Railroad Commission of Texas, Oil and Gas Division, "Resume of Railroad Commission District's Investigation of Oil & Gas Production Leases in Colorado River Basin," July 1972.

In fact, the average TDS concentration decreases 500 mg/l in that reach of the segment within which the discharges occur. Third, the typical secondary treatment process does not normally affect the concentration of the mineral constituent, the major constituent of total dissolved solids. Finally, flow in the upper portion of the segment is largely regulated by Robert Lee Dam, and a review of the water quality in E. V. Spence Reservoir (as monitored at TWQB station 1404.13) revealed an average TDS concentration of only 557 mg/l.

Therefore, it is recommended that any waste load allocations in this segment be deferred until such time that comprehensive data is available which will permit a more realistic evaluation of conditions in the segment.

MAXIMUM DAILY WASTE LOADS

AND LOAD ALLOCATIONS

FOR

OXYGEN DEMANDING MATERIALS

A CALCULATION OUTLINE

Developed By The
TEXAS WATER QUALITY BOARD

METHOD FOR EVALUATING STREAM ASSIMILATIVE CAPACITY

Segment Geometry and Hydraulics.

Surface Area

Obtain the width of the stream bed at the USGS gaging station for the 7-day, 2-year low flow and assume this width is representative of the segment. If more than one station exists within the segment, average the appropriate widths. Use published mileage data for the length of the segment or measure it.

Area = length x width (expressed in sq. ft.)

Stream velocity

Using the 7-day, 2-year flow data and the cross-sectional area measured by USGS, calculate the average velocity in the stream by:

$$V = Q/A$$

If more than one gaging station is available for the segment, average the velocities thus obtained.

7-Day, 2-Year Low Flow

For these segments containing a USGS gaging station with sufficient data, the proper flow can be interpolated from the computer printout for return flow frequency. For segments lacking a gaging station or sufficient data, upstream gaging station data must be utilized.

Average Time of Travel

Use the average stream velocity previously calculated to estimate the average time of travel through the segment.

$$\text{Time of travel (days)} = \frac{\text{Length of segment (ft.)}}{\text{average velocity (ft/sec) } 86,400 \text{ (sec/day)}}$$

Stream Conditions.

BOD_5 Concentration

Use stream and coastal monitoring data or USGS data at a monitoring station close to uppermost boundary of the segment. Use measured BOD_5 concentrations at low flow conditions only.

Saturation Temperature.

For estuaries and tidal segments, use the average for summer temperature from stream and coastal monitoring and add a summer temperature differencial of 1.5° F. The average salinity of tidal segments must be estimated from the data and considered when determining saturation D.O. values. For inland waters, use the maximum temperature as published in the standards.

Saturation Dissolved Oxygen

Saturation values for D.O. may be determined for the appropriate values of salinity and temperature by referring to "Standard Methods."

Maximum D.O. Deficit.

$D_{(max.)}(mg/l)$ = sat. D.O. - Stream Standard $_{(min.)}$

$1 mg/l = 6.238 \times 10^{-5}$ lb./cu. ft.

Assimilative Capacity Calculation.[1]

Governing Equation.

$$dm/_{dt} \frac{(lbs.\ O_2)}{day} = K_{L(min.)}\ D_{(max.)}\ A$$

Where:

$K_{L(min.)}$ may be obtained directly from the nomograph[1] or it may be calculated from K2 as:

$$K_{L(min.)}\ (ft/day) = K_{2\ (min.)}\ (day^{-1}) \times H\ (ft)$$

[1] Busch, A.W., "A Five-Minute Solution for Stream Assimilative Capacity," Journal WPCF, Vol. 44, No. 7.

H is average depth of the stream and K_2 may be calculated from the appropriate formula, obtained from the literature. (1)

$D_{(max.)}$ is the maximum dissolved oxygen deficit as previously defined.

A is the total surface area of the segment in square feet.

(1) "Simulation of Water Quality in Streams and Canals," Texas Water Development Board, Report No. 128, pg. 15-17.

METHOD FOR DETERMINING WASTE LOAD ALLOCATIONS[1]

Determination of Oxygen-Demanding Load from the Upstream Segment.

Average BOD_5 and NH_3 Concentration:

Determine average BOD_5 concentration and NH_3 concentration at monitoring station nearest to uppermost boundary of stream segment. These parameter concentrations should be determined for flows near the 7-day, 2-year low flow.

Entering BOD_5.

Calculate the BOD_5 load entering the segment each day from the upstream segment. Use the average BOD_5 concentration and the 7-day, 2-year low flow. Do likewise for the NH_3 load.

lbs./day = 8.34 x Flow (mgd) x Concentration (mg/l)

Calculate daily oxygen demand-:

Daily oxygen demand = BOD_u + NH_3 demand

Where: $BOD_u = \frac{BOD_5 \text{ (lbs./day)}}{0.8}$

NH_3 demand = NH_3 (lbs./day) x 4.56

The resulting daily oxygen demand on the segment is:

$$\Delta L = L_o (1 - e^{-kt})$$

Where: K^{20} is approximately 0.2 day^{-1} at 20° C

and $K^T = K^{20} (1.075)^{(T-20)}$

(1) Methodology developed by the TWQB.

ΔL = daily oxygen requirement on the segment due to the waste load entering from the upstream segment.

Lo = ultimate oxygen demand of materials entering the segment each day which are contributed by the upstream segment.

t = average time of travel through the segment at the 7-day, 2-year flow condition.

Waste Discharges Entering Segment.

Average the daily discharges of BOD_5 for each known point source within the segment.

Nitrogenous Oxygen Demand.

The nitrogenous oxygen demand is relatively constant for most municipal effluents and can be estimated as 8 mg/l. Since self-reporting does not include this parameter, it would be difficult to handle on an individual basis. Therefore, the total municipal nitrogenous oxygen demand for the segment will be subtracted from the stream's assimilative capacity in the target load calculation as described in Section F.

Nitrogenous demand (lbs./day) = total daily municipal return flow (mgd) x 8.34 x 8 (mg/l NH_3) x 4.56

Projected Increase in Waste Discharges.

This information will be made available by the planning section.

Non-Point Source Contribution.

Will be considered when guidelines are made available.

Segment Target Loads.

The segment target load, will be that portion of the segments' assimulative capacity that is to be allocated among the existing discharging entities. The target load will be expressed as pounds of BOD_5 per day.

Segment Target Load (lbs. BOD_5/day) = Assimulative Capacity-contribution of upstream segment - nitrogenous demand - portion reserved for municipal and industrial expansion-uncontrolable non-point sources.

Compare Target Load with Existing Load.

If the target load is greater than the existing daily load of BOD_5, no allocation is necessary.

If the target load is less than the existing daily load of BOD_5, an equivalent level of treatment must be established for all dischargers before an allocation is made.

Establish Equivalent Waste Treatment Level.

It is believed that all waste contributing entities should be making an equivalent effort in reducing their waste load prior to the implementation of advanced waste treatment. For the present, an equivalent treatment level will mean good secondary treatment for municipalities and best practical technology for industries. Good secondary treatment for municipalities will be considered to produce an effluent containing no more than 20 mg/l BOD_5 and 20 mg/l TSS. Best practical technology for industries will be arrived at through cooperation with the Industrial Services Section.

Compare Target Load with Equivalent Treatment Level.

If the target load is greater than the equivalent treatment load, it will be sufficient to reduce only those dischargers not presently utilizing good secondary treatment or best practical technology. No allocation and no implementation of advanced treatment will be necessary.

If the target load is less than the equivalent treatment load, the necessary reduction to achieve target load levels will be proportioned among the contributing dischargers to the extent practical. Small dischargers that contribute an insignificant amount to the problem may be ignored when further load reductions are distributed so long as they are at the equivalent treatment levels.

ANALYSIS OF MAXIMUM PERMISSIBLE DAILY LOADS
OF OXYGEN DEMANDING MATERIALS IN
SEGMENTS 1401 and 1417

Segment 1401 - Colorado River Tidal.

Description.

The tidal segment extends from approximately the turning basin (river mile 22.8) to the mouth of the river at the Gulf of Mexico. This segment is navigable to light barge traffic. The main channel is 100 feet wide and 9 feet deep. There are no USGS monitoring stations in the reach, however, the TWQB has a quality monitoring station north of Matagorda.

Segment Geometry and Hydraulics.

The nearest USGS station number 081625, located at Bay City (river mile 32.5), has a 7-day, 2-year low flow of 16.7 cfs and the following characteristics under low flow:

width =11.0 ft.
Depth = 0.88 ft.
Area = 8.8 sq. ft.
Velocity= 1.9 ft./sec.

For simplicity, tidal action is neglected. It is assumed that the flow entering the segment is the same volume as monitored at the upstream USGS station. Using this assumption:

$$Q_{\text{segment 1402}} = Q_{\text{segment 1401}}$$

$$V_{1402} A_{1402} = V_{1401} A_{1401}$$

$$V_{1402} (900 \text{ ft.}^2) = 1.9 \text{ fps } (8.8 \text{ sq. ft.})$$

$$\therefore V_{1402} = 0.0186 \text{ ft./sec.}$$

Therefore the segment characteristics used are:

Length = 22.8 miles
Average Width = 100.0 ft.
Average Depth = 9.0 ft.
Surface Area = 12,038,400 sq. ft.
Average Slope of the Streambed - 0.00004 ft./ft.

Stream Conditions.

Maximum temperature = 86°F + 1.5° F (allowance) = 87.5°F = 30.6°C

Saturation of dissolved oxygen = 6.8 mg/l [1]

Dissolved Oxygen stream standard = 5.0 mg/l

Maximum dissolved oxygen deficit = 1.8 mg/l

= 0.00011 lb./cu.ft.

Maximum Segment Assimilative Capacity.

1. Calculate reaeration coefficient at 20°C, K_2^{20}, using the relationship proposed by Churchill, Elmore and Buckingham[2]

$$K_2^{20} = 5.026\ \bar{u}^{0.969}\ D^{1.673} \times 2.31$$

Where: $\bar{u}$ = average velocity in stream, ft/sec.
D = average depth of stream, ft.

Substituting into the above equation:

$$K_2^{20} = 5.026\ (0.0186)^{0.969}\ (9)^{-1.673}\ (2.31)$$

$$= (0.021)\ (0.025)\ (2.31)$$

$$= 0.006$$

[1] APHA, AWWA, and WPCF, Standard Methods for the Examination of Water and Wastewater (12th Edition, Boyd Printing Co., Inc., Albany, New York (1965) (Chloride concentration in water = 10,000 mg/l)

[2] "Simulation of Water Quality in Streams and Canals," Texas Water Development Board, Report No. 128 (August 1971).

2. Calculate reaeration coefficient at stream temperature, $K_2^{30.6}$, of 30.6°C.

$$K_2^{30.6} = K_2^{20} (1.047)^{30.6-20}$$

$$= (0.006)(1.047)^{10.6}$$

$$= 0.01$$

3. Calculate the mass transfer coefficient, K_L

$$K_L = K_2^{30.6} H \text{ (1)}$$

$$= (0.01)(9)$$

$$= 0.9 \text{ ft./day}$$

4. Determine the maximum segment assimilative capacity

$$dm/dt = K_{L(min)} D_{(max)} A \text{ (1)}$$

$$= (0.9)(0.00011)(12,038,400)$$

$$= 1191 \text{ lbs./day}$$

Where: $K_{L(min)} = K_L$, ft./day

$D_{(max)}$ = maximum dissolved oxygen deficit, $lb/ft.^3$

A = segment surface area, $ft.^2$

Determine Oxygen Demanding Load from Upstream Segment.

1. Estimated natural flow in stream during low flow = 16.7 cfs

2. Determine time of travel through the segment:

$$\text{Time of travel (days)} = \frac{\text{Length of Segment (ft)}}{\text{Average Velocity} \times 86,400}$$

$$= 22.8 (5280)/0.0186 (86,400)$$

$$= 74.9 \text{ days}$$

(1) Busch, A.W., "A Five-Minute Solution for Stream Assimilative Capacity," Journal WPCF, Vol. 44, No. 7 (July 1972).

3. No current data were available on stream quality entering the segment. Therefore, the following values were estimated:

BOD_u = 4.0 mg/l; NH_3 concentration virtually nil

Using the above values, the respective loadings (lbs./day) were calculated as follows:

BOD_u (lbs./day) = 8.34 x stream flow (mgd) x concentration (mg/l)

= 8.34 x (16.7/1.55) x 4

= 359 lbs./day

NH_3 (lbs./day) = 0

∴ Total load = 359 lbs./day

4. Calculate the resultant daily oxygen demand on the segment using the following equation:

$$\Delta L = L_o (1-e^{-kt})$$

Where:

ΔL = daily oxygen requirement on the segment due to the waste load entering from the upstream segment.

L_o = ultimate oxygen demand of materials entering the segment each day which are contributed by the upstream segment.

t = average time of travel through the segment at the 7-day, 2-year flow condition.

$k = K^T$, day^{-1}

$[K^T = K^{20} (1.075)^{T-20}$ and $K^{20} = 0.2\ day^{-1}$ at 20°C]

substituting into the above equation:

$\Delta L = (359)\ 1-e^{-(0.44)(74.9)}$

= 359 lbs./day

Wastewater Discharge to Segment.

Name	WCO No.	Avg. Q (mgd)	Carbonaceous Oxygen Demand (lbs./day)
Celanese Chemical Company	00455	1.21	81

Projected Increase in Wastewater Discharges.

There is no projected increase in the quantity or quality of wastewater discharged to the stream during the next five years.

Non-Point Source Contribution.

The use of minimum reaeration coefficients inherently provides for some loading resulting from non-point sources. Exact information on non-point sources of pollutants in this segment is not currently available. Specific considerations for non-point sources should be included upon receipt of appropriate support data.

Segment Target Load:

Segment Target Load = 1,191 - 359 = 832 lbs./day

There are 832 lbs./day of reserve stream assimilative capacity available for the discharge of carbonaceous BOD.

Comparison of Target Load and Existing Load.

The 832 lbs./day of reserve stream assimilative capacity is greater than the existing discharge carbonaceous demand of 81 lbs./day, thus no waste load allocations are required in this segment.

Segment 1417 - Pecan Bayou.

Description:

The segment, from the Colorado River Confluence to Lake Brownwood Dam, was in violation of the dissolved oxygen standard of 5 mg/l on two occasions at each of the two TWQB monitoring stations in the segment.

Segment Geometry and Hydraulics.

Station No.	7-day, 2-year (cfs)	Width[1] (ft.)	Depth[1] (ft.)	Area[1] (sq. ft.)	Velocity[1] (fps)
081435	0.1	1.7	0.09	0.16	0.64
081436	4.6	20.0	0.32	6.40	0.72

Length = 57.0 miles
Average Width = 10.85 ft.
Average Depth = 0.21 ft.
Surface Area = 3,265,416 sq. ft.
Average Slope of the streambed = 0.00007 ft./ft.

Stream Conditions.

Stream temperature standard = 95°F = 35°C

Saturation of dissolved oxygen @ 35°C = 7.1 mg/l[2]

Dissolved Oxygen Stream standard = 5.0 mg/l

Maximum dissolved oxygen deficit = 2.1 mg/l
= 0.000131 lb./cu. ft.

(1) Values interpolated from data in USGS open files.
(2) APHA, AWWA and WPCF, Standard Methods for the Examination of Water and Wastewater (12th Edition), Boyd Printing Co., Inc., Albany, New York (1965).

Maximum Segment Assimilative Capacity.

1. Calculation of reaeration coefficent at 20°C, K_2^{20}, using the relationship proposed by Thackston and Krenkel[1].

$$U^* = (DSeg)^{1/2}$$

$$= (0.21)(0.00007)(32.2)^{1/2}$$

$$= 0.022$$

Where:

U* = shear velocity, ft./sec.
D = mean depth, ft.
Se = slope of energy gradient
g = acceleration of gravity, ft./sec.^{2}

$$F = U^* / (gD)^{1/2}$$

$$= (0.022) / (32.2)(0.21)^{1/2}$$

$$= 0.00846$$

Where:

F = Froude number

$$K_2^{20} = 10.8\ (1 + F^{1/2})(U^*/D)\ 2.31$$

$$= 10.8\ (1 + 0.00846^{1/2})(0.022/0.21)\ 2.31$$

$$= 2.85\ day^{-1}$$

(1) "Simulation of Water Quality in Streams and Canals," Texas Water Development Board, Report No. 128 (August 1971).

2. Calculate Reaeration Coefficient at Stream Temperature.

K_2^{35}, of 35°C

$$K_2^{35} = K_2^{20}(1.047)^{35-20}$$

$$= (2.85)(1.047)^{15}$$

$$= 5.68 \text{ day}^{-1}$$

3. Calculate the Mass Transfer Coefficient, K_L

$$K_L = K_2^{35} H^{(1)}$$

$$= (5.68)(0.21)$$

$$= 1.19 \text{ ft./day}$$

Where: H = average depth of stream, ft.

4. Determine Maximum Segment Assimilative Capacity

$$dm/dt = K_{L(min)} D_{(max)} A^{(1)}$$

$$= (1.19)(0.000131)(3,265,416)$$

$$= 509 \text{ lbs./day}$$

Where:

$K_{L(min)} = K_L$, ft./day

$K_{(max)}$ = maximum dissolved oxygen deficit, lb./cu. ft.

A = segment surface area, sq. ft.

(1) Busch, A. W., "A Five-Minute Solution for Stream Assimilative Capacity," Journal WPCF. Vol, 44, No. 7 (July 1972).

Significant[1] Wastewater Discharge to Segment.

Name	WCO No.	Avg. Q (mgd)	Oxygen Demand (lbs/day) Carbonaceous	Nitrogenous
Brownwood, City of (main plant)	10565-01	2.2	366[2]	669[3]

Determine Oxygen Demanding Load from Upstream Segment.

The oxygen demanding load from the upstream segment is negligible (periodic reservoir flow).

Projected Increase in Wastewater Discharges.

Population projections used in this study were developed by the Texas Water Development Board (see Table II-3). These projections indicate a very minor growth, less than 3%, for Brownwood during the 10-year period 1970-1980. Industrial activity is projected to remain stable during the period.

Five-year municipal discharge increase:

Brownwood, City of (main plant) -

Return Flow Increase = 0.043 mgd
Increase in carbonaceous oxygen demand = 7 lbs./day
Increase in nitrogenous oxygen demand = 13 lbs./day

Five-year industrial discharge increase:

There is currently no significant industrial dischargers to the segment and this condition is not expected to change during the next five years.

(1) As defined by the Texas Water Quality Board (see Table VI-3, Vol. I)
(2) Carbonaceous Oxygen Demand (lbs./day) = 8.34 x Flow (mgd) x BOD_5 (mg/l)
(3) Nitrogenous Oxygen Demand (lbs./day) = 8.34 x Flow (mgd) x 8 mg/l NH_3 x 4.56

Non-Point Source Contribution.

The use of minimum reaeration coefficients inherently provides for some loading resulting from non-point sources. Exact information on non-point sources of pollutants in this segment is not currently available. Specific considerations for non-point sources should be included upon receipt of appropriate support data.

Segment Target Load:

Target Load = Capacity - Existing Load - Load Increase
= 509 - 669 - 20
=-180 lbs/day

Note: There is a theoretical deficit in stream assimilative capacity.

Comparison of Target Load and Existing Load:

The theoretical deficit (-180 lbs/day) indicates that no stream assimilative capacity is available for discharge of carbonaceous oxygen demanding materials; therefore, a wasteload allocation cannot be made. However, the City of Brownwood has expressed their preference for a no discharge treatment alternative (irrigation system) with a resultant 0 (zero) lbs/day wasteload allocation.

PRIORITY LISTING METHODOLOGY

At the time of submission of the draft of this report, an approved Statewide priority listing methodology did not exist. In conjunction with this study, a methodology was therefore drafted which would provide a rational method of ranking all construction needs developed in the areawide studies associated with this report. Since publication of the draft report, the TWQB has finalized the State priority listing methodology and the State rankings have been incorporated into the priority listing included in Volume 1, Basin Plan. The Statewide Project Funding Priority List prepared twice per year by the TWQB will be the controlling document for Federal funding priorities.

Report Priority Methodology.

As seen in the following discussion, the priority listing methodology developed for the report is very basic and straightforward. However, its simplicity should not be misleading, as it is based on one of the basic premises of PL 92-500--that of having all discharges from public wastewater treatment facilities achieving prescribed levels of treatment by 1977, 1983, and 1985.

Obviously, there are numerous factors which could be considered in the development of a priority list. However, in the case of the Colorado River Basin, it was felt that a representative priority list could be obtained by evaluating three basic criteria. These criteria are as follows:

1. Facility Construction Element - the type and nature of the proposed construction need.

2. Discharge Location - the priority of the stream segment to which the facility discharges (non-discharges were placed in a special category).

3. Discharge status - simply, is or will there be a discharge from the facility.

As seen on Table H-1, a specific weight value has been assigned to each criterion. It should be noted that these weight values have been designed to reflect the relative priority of both discharger and non-discharger construction needs.

The procedure is outlined as follows:

Step 1. The proposed construction need was classified under one of the seven facility construction elements. Based on this classification, an element weight was assigned to the proposed construction element.

Step 2. The stream segment which the facility discharges into was determined. Based on the segment ranking, a segment weight value was assigned to the proposed construction need.

Step 3. Based on the method of effluent disposal, either discharge or no discharge, a discharge weight was assigned to the proposed construction need.

Step 4. The three weights assigned to the need in steps 1 - 3 were added to obtain the total need weight. The total need weights were then used to rank the various needs throughout the Basin. In those instances where the total need weight of two or more projects were numerically the same, the projects with identical need weights were ranked, based on the respective influent BOD loadings (see Appendix A) to the facility.

TABLE H-1

WEIGHTING VALUES USED IN DEVELOPMENT
OF REPORT PRIORITY LIST

FACILITY CONSTRUCTION ELEMENT

Element	Element Weight
Upgrade Existing Secondary Facilities	45
Expand Existing Secondary Facilities	40
Replace Existing Secondary Facilities	35
Construct New Secondary Facilities	30
Install Stormwater Clarification Facilities	25
Install Partial Tertiary Facilities	20
Install Complete Tertiary Facilities	15
Control of Urban Runoff	10
Control of Non-Urban Runoff	5

DISCHARGE STATUS ELEMENT

Status	Discharge Weight
Facility Has/Will Have No Discharge	20
Facility Has/Will Have a Discharge	10

TABLE H-1 (CONT'D)

DISCHARGE LOCATION ELEMENT

Segment Ranking [1]

Segment No.	Basin	State	Segment Weight
1417	1	15	25
1413	2	46	24
1402	3	56	23
1401	4	63	22
1412	5	71	21
1420	6	78	20
1410	7	87	19
1404	8	115	18
1403	9	137	17
1408	10	138	16
1407	11	139	15
1406	12	140	14
1419	13	144	13
1418	14	145	12
1425	15	146	11
1423	16	147	10
1416	17	213	9
1415	18	226	8
1405	19	240	7
1414	20	249	6
1411	21	265	5
1409	22	266	4
1422	23	272	3
1424	24	273	2
1421	25	274	1

Note: Non-dischargers received no segment weight.

[1] Refer to Table VI-2, Basin Plan, Vol. 1.

Texas Water Quality Board
Municipal Construction Grant Priority Methodology.

The actual priority rating list is based on a maximum possible score of 1000 points. Points are accumulated from two equally weighted "systems", each system having a maximum point total of 500.

The first system is derived from the Municipal Ranking List which considered severity of pollution, population affected, and the need to preserve clean water. The maximum 500 points is awarded to the city appearing first on the Municipal Ranking List. Each successive city on the list is awarded a proportionate percentage of 500 points.

The second system, also with a maximum of 500 points, considers advanced waste treatment requirements, enforcement actions, regionalization, and health nuisances. This system is derived below.

Advanced Waste Treatment (maximum 200 points).

$$\text{Score} = \frac{20}{BODp + SSp} Vp + a + B + c$$

Where

BODp = Biochemical Oxygen Demand parameters in mg/l specified in the waste control order

SSp = Total Suspended Solids in mg/l specified in the waste control order

Vp = Volume of discharge specified in the waste control order in mgd.

a = 1 point for excess Cl_2 (i.e. 1 mg/l for 30 minutes or 2 mg/l for 20 minutes)

B = 1 point for nitrate removal

c = 1 point for phosphorous removal

For "No Discharge" waste control orders, BODp and SSp will be assumed to be 30 mg/l unless more restrictive parameters are stated in the waste control order. Vp will be derived as if the city were actually making a discharge. Use of the effluent for irrigation purposes constitutes "No Discharge."

Regional Systems (maximum 100 points).

Project to further regionalize - 100 points

Complete new system (excluding collection system) to eliminate septic tanks or other systems of a primary nature (i.e. private individual sewage systems) - 25 points

A project to further regionalize would include interceptor projects served by a regional system, a complete new regional system to serve two or more communities (complete new system being defined as a system to eliminate septic tanks for a community previously having no wastewater treatment system), or a project to divert wastewater from one treatment facility to another in order that one of the facilities be abandoned. In all cases where one or more treatment facilities will be phased out, the points awarded from the municipal ranking list will be those points accumulated by the City in which the facility was phased out, not by the City which will accept the diverted flow.

Enforcement (maximum 150 points):

TWQB/EPA Enforcement order or state and/or Federal Court order - 150 points

Other State and/or Federal enforcement order - 100 points

Permit Schedule order:

Up to 2 years - 50 points

2-3 years - 35 points

3-5 years - 15 points

(points are not cumulative).

State Court shall mean a district or higher court enforcing State or Federal water pollution control legislation. Other State enforcement order shall mean a formal order from a State agency responsible for State and/or Federal legislation on water, air or health control.

Health Nuisances (50 points maximum):

TWQB files reflect overflow/odor complaints - 50

Lift stations/interceptors overflow - 35

Regular - 35

Intermittent - 25
Only during rains - 15

Septic tanks overflow

General - 35
Limited - 25
Only during rains - 15

Note: Points not cumulative.

New Interceptors/Collection Systems (Maximum 50 points):

Interceptors (maximum 50 points)

$$\% \text{ Served} = \frac{\text{New Connections}}{\text{Total Connections}} \times 100$$

then

% Served	Points
75 - 100	50
50 - 74	35
25 - 49	20
24 - less	5

Collection systems (maximum 50 points)

$$\% \text{ Served} = \frac{\text{Population served}}{\text{Total Population}} \times 100$$

% Served	Points
75 - 100	50
50 - 74	35
24 - 49	20
24 - less	5

Note: Points not cumulative on the two sections.

New interceptors are those projects that do not have a direct effect on enhancement of the receiving waters; that is, projects that are primarily to improve the living standards of the citizens.

New connections means only those connections served by the project compared to the total existing connection for the area served by the wastewater treatment facility while on collection systems; existing population means the population that could be served by the area wastewater treatment facility.

The score from the "Municipal Priority Ranking" will not be applied to this section.

I. INTRODUCTION

BACKGROUND

The Texas Water Development Board (TWDB) was contacted in May 1972 by the Corps of Engineers, Fort Worth District and asked to participate, along with the Texas Water Quality Board (TWQB) and other state agencies in the Water Quality Management Study of the Colorado River, Texas. It was decided that the TWDB would undertake the responsibility for the development, calibration, and application of a stream water quality simulation model and, in addition, provide staff support for discharge measurements and reconnaissance of the river. The TWQB was asked to provide personnel to collect water quality data and to perform time of travel studies in support of the modeling effort. The results of the modeling effort were to be presented to the Corps' consultant, Turner, Collie, and Braden, Inc.

SCOPE AND OBJECTIVES

The general objective of this study was to develop a mathematical water quality simulation model for the Water Quality Management Study, Colorado River Basin, Texas. The simulation model included carbonaceous biochemical oxygen demands, nitrogenous oxygen demands, dissolved oxygen, and chlorides.

It was decided at an early stage in the study that only the portion of the Colorado River Basin downstream of Austin, Texas would be included in the mathematical model. The upper Colorado River Basin was not included in the study because the intermittent streamflows and few waste discharges did not justify model development. The chain of lakes from Lake Buchanan to Lake Austin, collectively known as the Highland Lakes, was not included in the modeling effort because of the incomplexity and the limited time and resources available for the study.

ORGANIZATION

This study was conducted by William A. White, Systems Engineer and Charles Chandler, Hydrologist, of the Texas Water Development Board. Coordination with the Corps of Engineers, Turner, Collie, and Braden, and other participants was maintained through Charles Nemir, Assistant to the Executive Director of the Texas Water Development Board.

Several individuals and organizations have assisted in the collection of data necessary for this mathematical model. Dick Respess and Al Tomsoff of the Texas Water Quality Board organized and carried out the sample collection efforts and time-of-travel studies on the river. The lower Colorado River Authority and the City of Austin assisted in maintaining a constant flow in the river below Austin for the period August 21 to August 30, 1972 when the flow measurements were carried out and water quality samples were collected. The U.S. Geological Survey collected flow records and provided stage-discharge relationships at gaging stations under their supervision. The Texas Water Development Board made flow measurements at several other locations during the study.

ACKNOWLEDGEMENTS

The mathematical water quality model used in this study was adapted from the TWDB's stream quality model, QUAL-I. This model was originally developed by Frank D. Masch and Associates under contract to the Texas Water Development Board.

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WATER QUALITY MODEL

FOR THE

COLORADO RIVER BELOW AUSTIN, TEXAS

DEVELOPMENT AND CALIBRATION

Texas Water Development Board
July 1973

PREFACE

This study was performed as a part of the Colorado River Basin Water Quality Management Study conducted by the Fort Worth District, U.S. Army Corps of Engineers. The analyses presented herein were partially funded by the Corps of Engineers and partly by the Texas Water Development Board and the Texas Water Quality Board as contributing state agencies.

Unfortunately, certain potentially significant water quality considerations such as diurnal dissolved oxygen variations, urban runoff, and agricultural runoff were omitted from the analyses due to the lack of supportive data. However, it is felt that the results of this study are conservative with respect to the critical water quality predictions because of the use of extremely low streamflows, high ambient temperatures, and elevated biological reaction rates. The reader should be cautioned to carefully consider the limitations of this study as discussed in the text.

sgd

William A. White
Systems Engineering Division
Texas Water Development Board
July 5, 1973

II. MODELING APPROACH

MODELING OBJECTIVES

Water quality considerations are extremely broad and varied in a river basin, and the problems associated with the effects of municipal, industrial, and agricultural wastes are of major importance. Probably the most critical aspect of waste disposal is the disposition of an effluent from a waste process discharge. Eventually, many waste discharges enter some stream, river, or reservoir and may contribute significantly to altering the water quality of the receiving body of water. While a field data survey provides information about what has happened, it cannot predict what will happen under future conditions of development in a river basin. Thus, the purpose of this modeling study was to be able to simulate future conditions, such that environmental changes due to various alternatives of river basin development could be evaluated.

THE WATER QUALITY MODEL

The fundamental concepts and utilities of the water quality model that was used as an analytical tool in this study have been presented previously by Masch, et. al. (1970). The following paragraphs describe the general methodology.

A mathematical model is a functional representation of the response of a system or process to a given input, and is presented in a form which lends itself to solution by any acceptable means. The mathematical statement of a process consists of an input, a transfer function, and an output or response. The output from a given system is related to the input through the transfer function.

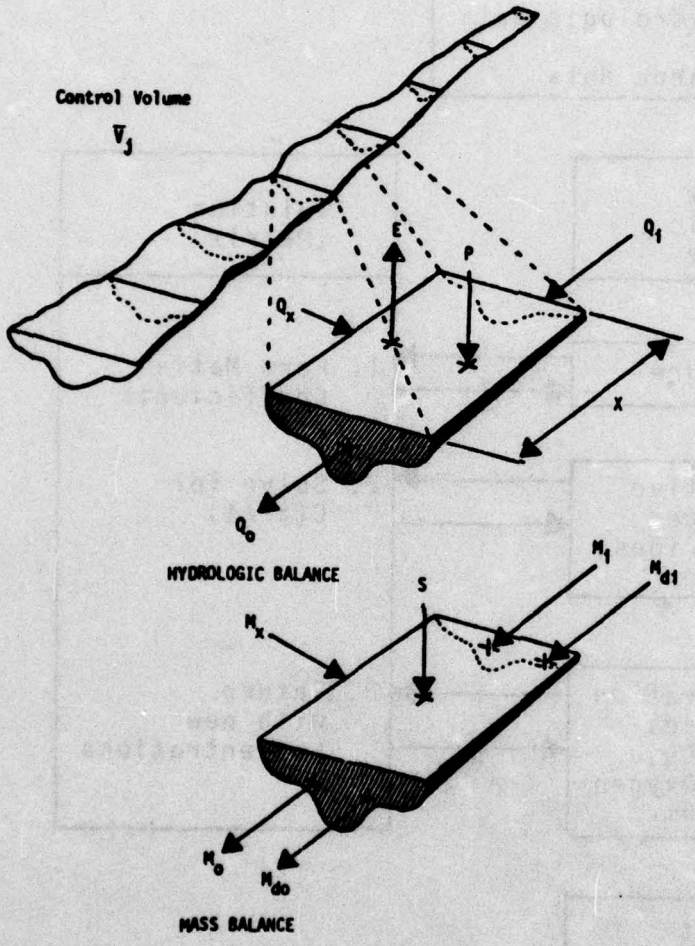
A mathematical water quality model of a river consists of a series of elements, each corresponding to a discrete river segment, arranged so that the output from one element becomes the input to the next, etc., as illustrated in Figure II-I. The transfer function is determined by performing a mass balance for a given water-quality parameter, C, over a time interval, Δt, on a river segment of cross-sectional area, A, and of lengths Δx, along the longitudinal axis of the river. S represents the non-conservative nature, if any, of the given water quality

parameter. The results of performing the mass balance of a given water quality parameter for each and every discretized element in the system is a set of simultaneous equations which can be solved with the help of a computer in a continuum over space and time to produce a simulation (a mathematical representation) of the behavior of the prototype river.

The computational sequence proceeds according to the master flow chart diagram illustrated by Figure II-2. After reading all the necessary control and other input data, the model generates a longitudinal advective flow in the system between elements in accordance with continuity requirements.

Based on this flow regime, the model proceeds to perform mass balance calculations for any or all of the water quality parameters selected by the user. Those options available to the user are as follows:

1. conservative mineral (TDS, Chloride, or Sulfate),
2. temperature,
3. dissolved oxygen (carbonaceous biochemical oxygen demand, nitrogenous oxygen demand, and dissolved oxygen), and
4. coliform bacteria.



HYDROLOGIC BALANCE

$$\frac{d\bar{V}_j}{dt} = Q_1 - Q_o + P - E \pm Q_x$$

- $\bar{V}_j$ = volume of control
- Q_1 = inflow rate along the x-axis
- Q_o = outflow rate along the x axis
- P = precipitation rate on volume surface
- E = evaporation rate from volume surface
- Q_x = local inflow or withdrawal rate
- t = time

MASS BALANCE

$$\frac{dM_j}{dt} = M_1 - M_o + M_{di} - M_{do} + S + M_x$$

- M_j = mass stored within the control volume
- M_1 = mass transfer associated with inflowing water
- M_o = mass transfer associated with outflowing water
- S = mass transfer by nonconservative processes
- M_{di} = mass transfer by inward diffusional transfer
- M_{do} = mass transfer by outward diffusional transfer
- M_x = mass transfer by local inflow or withdrawal
- t = time
- $C_j = \frac{M_j}{\bar{V}_j}$ = concentration of material in control volume

Figure II-1. Discretized Stream System After Water Resources Engineers, Inc. (1967)

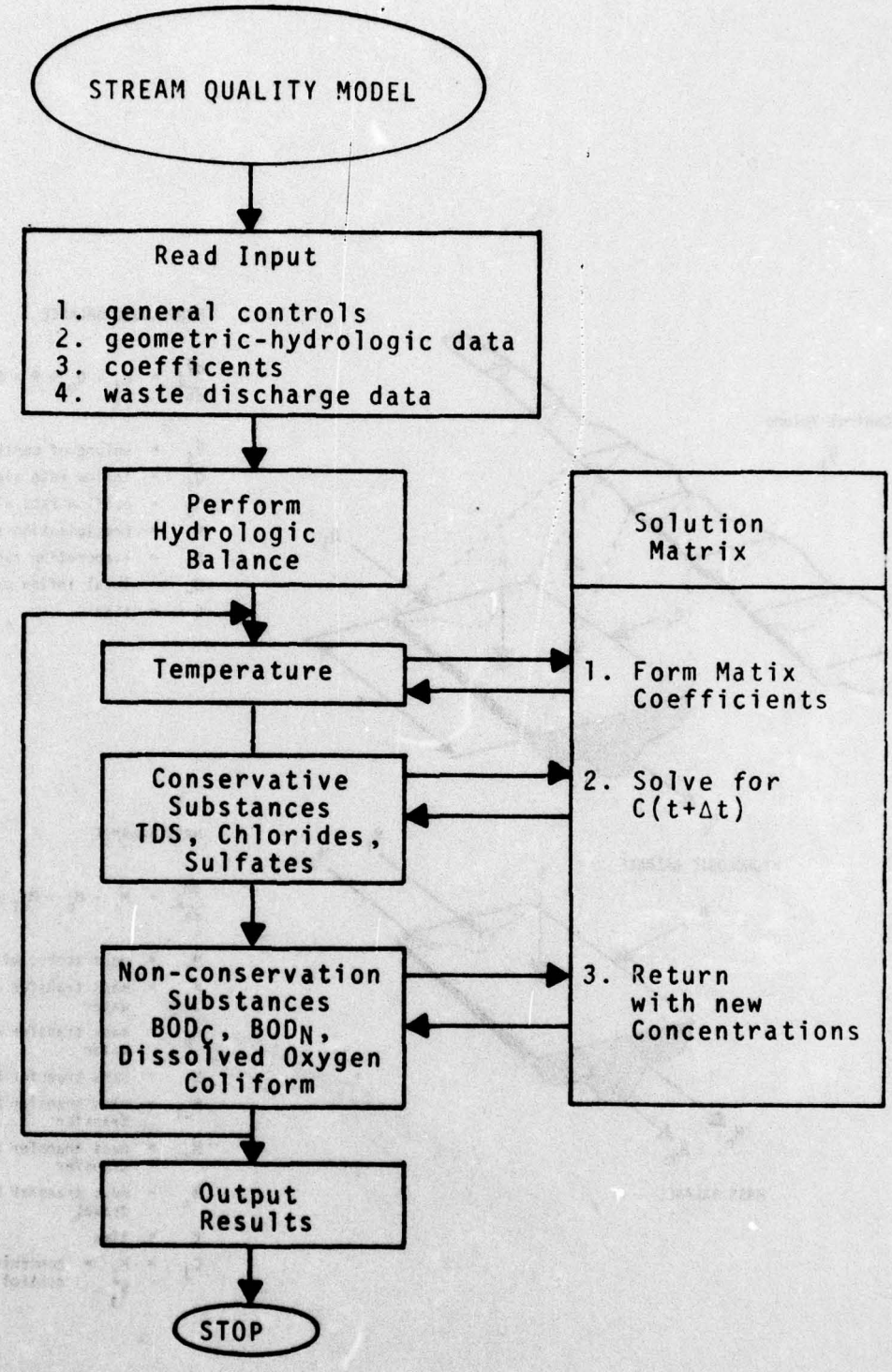


FIGURE II-2

Flow Chart Diagram for
Streamflow Model

The program user must supply the necessary coefficients, hydrologic inputs, waste discharges, etc., to perform each type of simulation. The data required for each type of simulation is shown in Table II-1.

TABLE II - 1

WATER QUALITY MODEL DATA REQUIREMENTS

	Physical	Hydraulics	Weather	Biological Coefficients	Waste Discharges
Temperature	●	●	●		●
Conservative Mineral	●	●			●
Coliforms	●	●		●	●
BODc, BODn Dissolved Oxygen	●	●		●	●

III. STUDY AREA DESCRIPTION

WASTE DISCHARGES

The section of the Colorado River Basin studied consists of 260 river miles of the Colorado River between Austin and Bay City, Texas. Table III-1 shows the six sewage treatment plants of significance that discharge their treated effluents into this portion of the Colorado River. These are the cities of Austin, Bastrop, Smithville, La Grange, Columbus, and Wharton. The effluent from the Austin Govalle sewage treatment plant is the dominating factor influencing the water quality of the Colorado River below Austin.

TABLE III-1

PERMITTED WASTE LOADS

FOR SIGNIFICANT DISCHARGES

WASTE LOAD	PERMIT NUMBER	FLOW (MGD)	MONTHLY AVERAGE 5-DAY BOD (MG/L)	24-HOUR DAILY COMPOSITE 5-DAY BOD (MG/L)
Austin Govalle	10543-3	40.0	20.0	25.0
Bastrop	11076	0.245	20.0	25.0
Smithville	10286	0.525	20.0	25.0
La Grange	10019	1.0	20.0	25.0
Columbus	10025	0.72	20.0	25.0
Wharton*	10381	0.7	20.0	25.0

*Wharton has applied for a permit to discharge 1.5 MGD.

WATER QUALITY

The lower Colorado River is highly regulated as a result of impoundment and releases of water from the Highland Lakes in the middle Colorado River Basin and consequently the chemical quality of water in the main stem below Austin is comparatively uniform.

The organic loading throughout the lower Colorado River Basin is generally low, and no serious dissolved-oxygen deficits have been observed for extended periods of time. However, as a result of municipal return flows in the main stem of the river below Austin, seasonal dissolved oxygen depressions have occurred. TWDB Report #120(1969) gives water quality data collected by the U.S. Geological Survey for several locations on the main stem of the river below Austin.

SURVEY DATA

The hydrology and water quality data used in calibrating the model was collected in a field survey of the lower Colorado River during the period August 21-30, 1972. To supplement this data a time-of-travel dye study was also made during the same period. This survey was a cooperative effort between the U.S. Geological Survey, the Texas Water Quality Board, the Texas Water Development Board, and the Lower Colorado River Authority.

During the period midnight, August 18, through midnight, August 24, 1972, the Lower Colorado River Authority released water from Tom Miller Dam at a constant rate of 1500 cfs.

This constant release of water was monitored by personnel of the Field Operations Division of the Texas Water Quality Board. Scheduling of quality sampling was based on an estimated travel time of 7.5 days from Austin, Texas to Lane City, Texas. Field measurements, using Rhodomine WT dye and fluorometric procedures, showed the actual travel time to be 8.7 days.

Water Quality data was collected at twelve (12) locations on the river as shown in Figure III-1 and these data are summarized in Table III-2. Water quality data was also collected at six (6) sewage treatment plant outfalls and at eight (8) tributary streams. These data are summarized in Table III-3 and III-4, respectively. In addition, discharges from the sewage treatment plants and the tributary streams

as well as the flows in the river were also measured. Quality of the river water and the sewage treatment plant outfalls were measured over a 72-hour period, while the quality of the tributary streams was monitored over a 24-hour period.

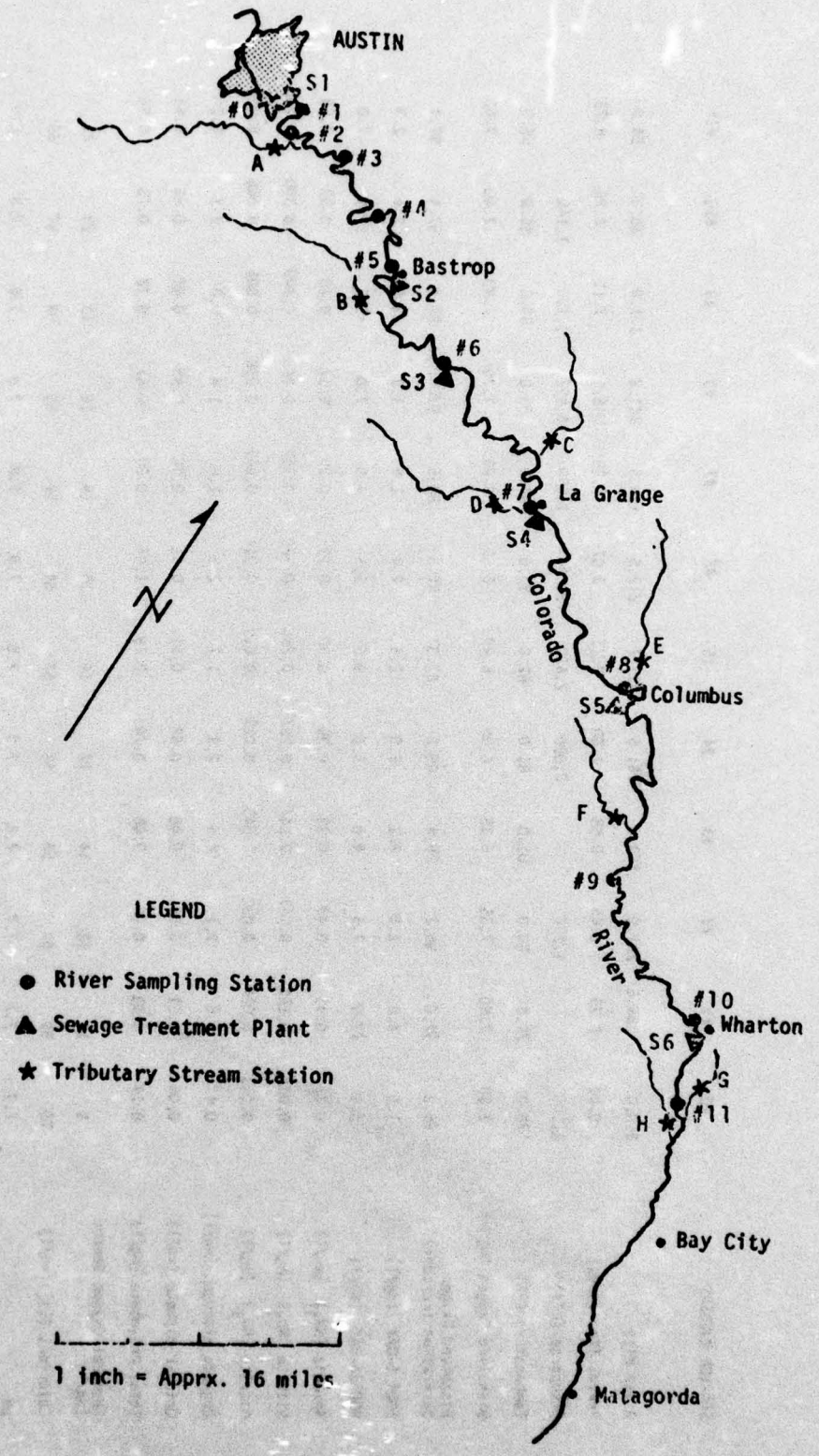


Figure III-1
Lower Colorado River Basin

Table III-2

WATER QUALITY DATA FOR SELECTED STATIONS ON THE COLORADO RIVER BELOW AUSTIN, TEXAS
AUGUST 21-30, 1972

STATION NUMBERS	#0	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11
River Mile	290.0	285.0	281.0	269.0	251.5	237.7	212.5	175.5	141.2	101.0	65.0	54.0
Travel Time (Days)	0.00	0.25	0.45	0.88	1.60	2.11	3.07	4.28	5.50	7.11	8.26	8.73
Discharge (cfs)	1,500		1,730		2,020	2,420	2,030	1,890	1,992	1,120	1,140	
Temperature (°F)	78.0	79.5	80.0	81.0	81.0	82.0	83.0	84.0	85.0	86.0	86.0	86.0
Dissolved Oxygen (mg/l)	7.90	7.50	7.35	6.35	6.90	6.90	6.50	6.90	7.30	7.40	7.40	7.60
Dissolved Oxygen Saturation (Percent)	96.3	92.0	90.2	78.4	85.2	87.3	82.3	88.5	93.6	97.4	97.4	97.4
BOD* 5-DAY (mg/l)	1.5	4.0	2.0	2.2	2.0	2.5	2.4	1.5	1.3	1.6	2.4	2.3
BOD*26-DAY (mg/l)	1.8	13.0	7.5	4.0	5.5	9.5	9.5	4.0	7.0	5.5	12.0	7.0
Ammonia (NH_3) (mg/l)	0.23	0.43	0.43	0.33	0.30	0.30	0.33	0.20	0.17	0.20	0.30	0.23
Nitrate (NO_3) (mg/l)	0.093	0.163	0.147	0.247	0.267	0.265	0.370	0.357	0.440	0.440	0.360	0.286
Nitrite (NO_2) (mg/l)	0.043	0.024	0.032	0.049	0.029	0.019	0.014	0.009	0.006	0.006	0.006	0.007
Organic Nitrogen (mg/l)	0.4	2.6	2.1	2.5	2.3	1.7	2.3	1.8	1.6	0.8	2.7	1.2
Ortho-Phosphate (mg/l)	0.04	0.52	0.56	0.48	0.52	0.61	0.61	0.50	0.45	0.44	0.43	0.43
Total Phosphate (mg/l)	0.14	0.99	0.73	0.68	0.74	0.79	1.04	0.90	0.67	0.72	0.78	0.85
Chemical Oxygen Demand (mg/l)	5	19	13	14	17	16	16	19	15	13	23	25
Chlorides (Cl) (mg/l)	66	59	59	58	58	57	54	57	59	58	57	60
pH	7.7	7.7	7.7	7.8	7.9	7.8	7.9	7.8	7.9	7.8	7.8	8.0
Specific Conductivity (micromhos)	562	562	570	560	563	549	556	546	538	543	553	571
Volatile Solids (mg/l)	4	36	5	9	16	18	26	22	15	8	25	20
Total MF Coliform Count (100 ml)	10,000	4,300	13,000	3,900	2,000	3,600	3,800	2,600	1,000	1,600	900	1,500
Fecal MF Coliform Count (100 ml)	1,500	180	370	90	170	180	800	100	20	50	<10	20

* Denitrification Suppressed.

Table III-3

MUNICIPAL SEWAGE TREATMENT PLANT EFFLUENT QUALITY DATA
FOR THE COLORADO RIVER BELOW AUSTIN, TEXAS
AUGUST 21-30, 1972

	S1 Govalle D	S1 Govalle A+C	S2 Bastrop	S3 Smithville	S4 LaGrange	S5 Columbus	S6 Wharton
Permit Number	10543	10543	11076	10286	10019	10025	10381
River Mile	289.8	289.8	237.0	212.0	175.0	134.0	65.0
Discharge (mgd)	12.36	16.96	0.43	0.60	0.34	0.40	1.0
Temperature (°F)	84.0	84.5	82.0	83.0	84.0	86.0	84.0
Dissolved Oxygen (mg/l)	2.4	2.6	1.7	1.4	1.5	0.1	3.5
Dissolved Oxygen Saturation (%)	----	----	----	----	----	----	----
BOD* 5-DAY (mg/l)	19.0	----	25.0	34.0	24.0	100.0	62.5
BOD* 26-DAY (mg/l)	18.0	22.0	35.0	60.0	----	----	60.0
Ammonia (NH_3) (mg/l)	9.3	12.8	24.7	25.1	10.1	22.3	14.8
Nitrate (NO_3) (mg/l)	1.04	0.47	0.04	0.19	5.6	0.0	0.04
Nitrite (NO_2) (mg/l)	0.40	0.42	0.11	0.32	0.65	0.0	0.7
Organic Nitrogen (mg/l)	2.2	4.2	2.0	30.0	9.9	5.0	8.8
Orthophosphate (mg/l)	18.1	17.3	39.8	36.5	37.0	31.8	31.5
Total Phosphate (mg/l)	20.3	19.2	42.2	40.8	40.8	39.3	37.7
Chemical Oxygen Demand (mg/l)	47	62	97	170	77	198	173
Chlorides (Cl) (mg/l)	96	93	82	72	140	132	94
pH	7.5	7.4	7.6	7.7	7.7	7.3	7.4
Specific Conductivity (micromhos)	774	805	1,115	996	1,384	1,237	950
Total Solids (mg/l)	12	20	29	41	21	111	54
Volatile Solids (mg/l)	8	14	23	33	14	75	41
MF Total Coliform Count (100 ml)	----	----	----	----	----	----	----
MF Fecal Coliform Count (100 ml)	----	----	----	----	----	----	----

* Denitrification suppressed

Table III-4

TRIBUTARY INFLOW QUALITY DATA
FOR THE COLORADO RIVER BELOW AUSTIN, TEXAS
AUGUST 21-30, 1972

	A Onion Creek	B Cedar Creek	C Rabbs Creek	D Buckner's Creek	E Cummins Creek	F Skull Creek	G Jarvis Creek	H Jones Creek
River Mile	276	225	188	174	138	110	52	48
Discharge (cfs)	11.2	<0.5	6.4	4.4	8.2	4.0	---	20.7
Temperature (°F)	81.0	84.5	84.0	85.0	83.0	84.0	82.0	82.0
Dissolved Oxygen (mg/l)	7.05	7.95	5.60	5.80	7.20	6.50	5.50	6.10
Dissolved Oxygen Saturation (%)	87.0	101.9	71.8	75.3	91.1	83.3	68.8	76.2
BOD* 5-DAY (mg/l)	1.0	5.0	5.5	4.5	1.4	0.8	3.5	2.7
BOD* 26-DAY (mg/l).	1.4	8.5	65.0	8.5	3.0	---	15.0	14.0
Ammonia (NH_3) (mg/l)	0.2	0.4	1.8	0.3	<0.1	0.2	0.3	0.4
Nitrate (NO_3) (mg/l)	0.47	0.04	1.50	0.06	<0.03	0.06	0.09	0.07
Nitrite (NO_2) (mg/l)	<0.005	<0.005	0.087	0.007	<0.005	<0.005	<0.005	0.005
Organic Nitrogen (mg/l)	1.7	2.0	4.0	4.3	1.8	2.6	1.5	1.4
Orthophosphate (mg/l)	<0.03	0.20	7.7	0.05	0.04	0.04	0.08	0.25
Total Phosphate (mg/l)	0.07	0.40	8.5	0.37	0.15	0.22	0.43	0.25
Chemical Oxygen Demand (mg/l)	5	23	45	23	15	18	26	38
Chlorides (Cl) (mg/l)	39	60	38	81	41	21	33	72
pH	7.6	7.7	7.4	7.8	8.2	7.4	7.5	7.5
Specific Conductivity (micromhos)	573	768	420	792	531	222	468	640
Total Solids (mg/l)	<10	24	339	41	19	14	67	57
Volatile Solids (mg/l)	---	6	45	17	3	5	20	6
MF Total Coliform Count (100 ml)	---	---	---	---	---	---	---	---
MF Fecal Coliform Count (100 ml)	---	---	---	---	---	---	---	---

* Denitrification suppressed

IV. MODEL CALIBRATION AND APPLICATION

APPLICATION TO STUDY AREA

The portion of the Colorado River Basin for which the stream quality model was calibrated is shown schematically in Figure IV-1. This portion consisted of a stretch of the Colorado River between river mile 290 and river mile 30. For calibration purposes, this stretch of the Colorado River was broken down into seventeen reaches, each reach having its own physical, hydraulic, chemical, and biological characteristics. This idealization of the prototype was principally dictated by the amount of data that was available for describing the characteristics of the river.

DISCUSSION OF RESULTS

The results of the calibration of the QUAL-I stream quality routing model for the lower Colorado River are displayed graphically in Figure IV-2. The figure demonstrates that the model can closely simulate observed conditions if it is provided with the appropriate coefficients. The method developed by Langbein and Durum (1967) was used to compute the reaeration coefficient in each of the seventeen reaches. Degradation rates for the biochemical oxygen demand and nitrogenous oxygen demand (oxygen required to convert ammonia to nitrate) were determined from the survey data and travel times given in Table III-2. Based on stoichiometry, 4.57 mg of oxygen is required to convert 1.0 mg of ammonia to nitrate. This multiplier was used to convert the ammonia data to nitrogenous oxygen demands.

Figure IV-2 indicates that the only serious oxygen sag occurred immediately below the Austin Govalle Sewage Treatment Plant from river mile 290 to 250. The minimum dissolved oxygen concentration occurred at river mile 270, whereupon the rate at which oxygen was coming back into the stream by surface reaeration became greater than the rate at which oxygen was being taken out by deoxygenation. After river mile 270 the dissolved concentrations began to increase, approaching the saturation level. The discrepancies between observed and computed dissolved oxygen concentrations in the vicinity of Bastrop, Texas are due to runoff from a rainstorm that occurred between Austin and Bastrop during the survey. The predicted values reflect the situation that would exist had the runoff not occurred.

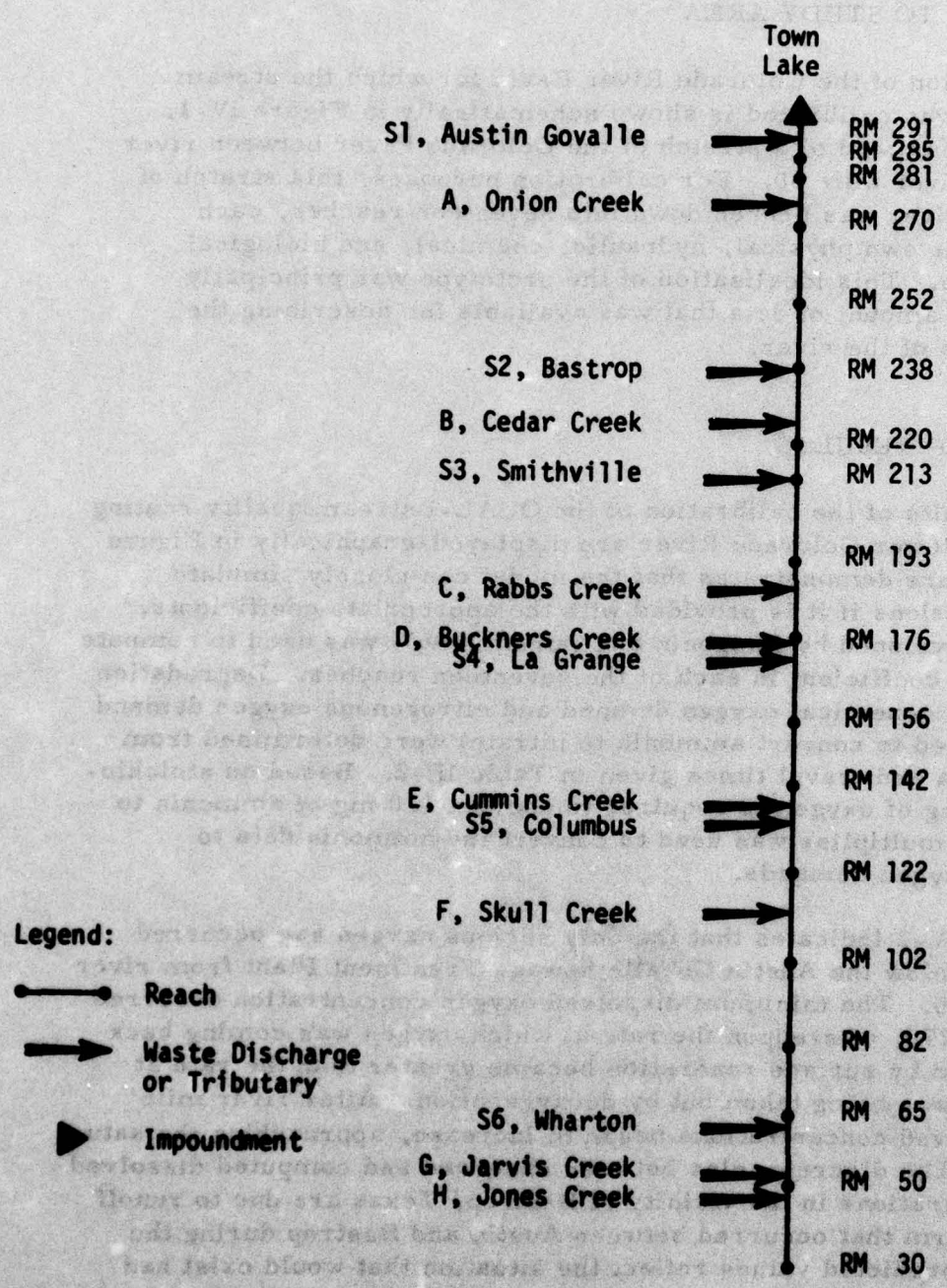
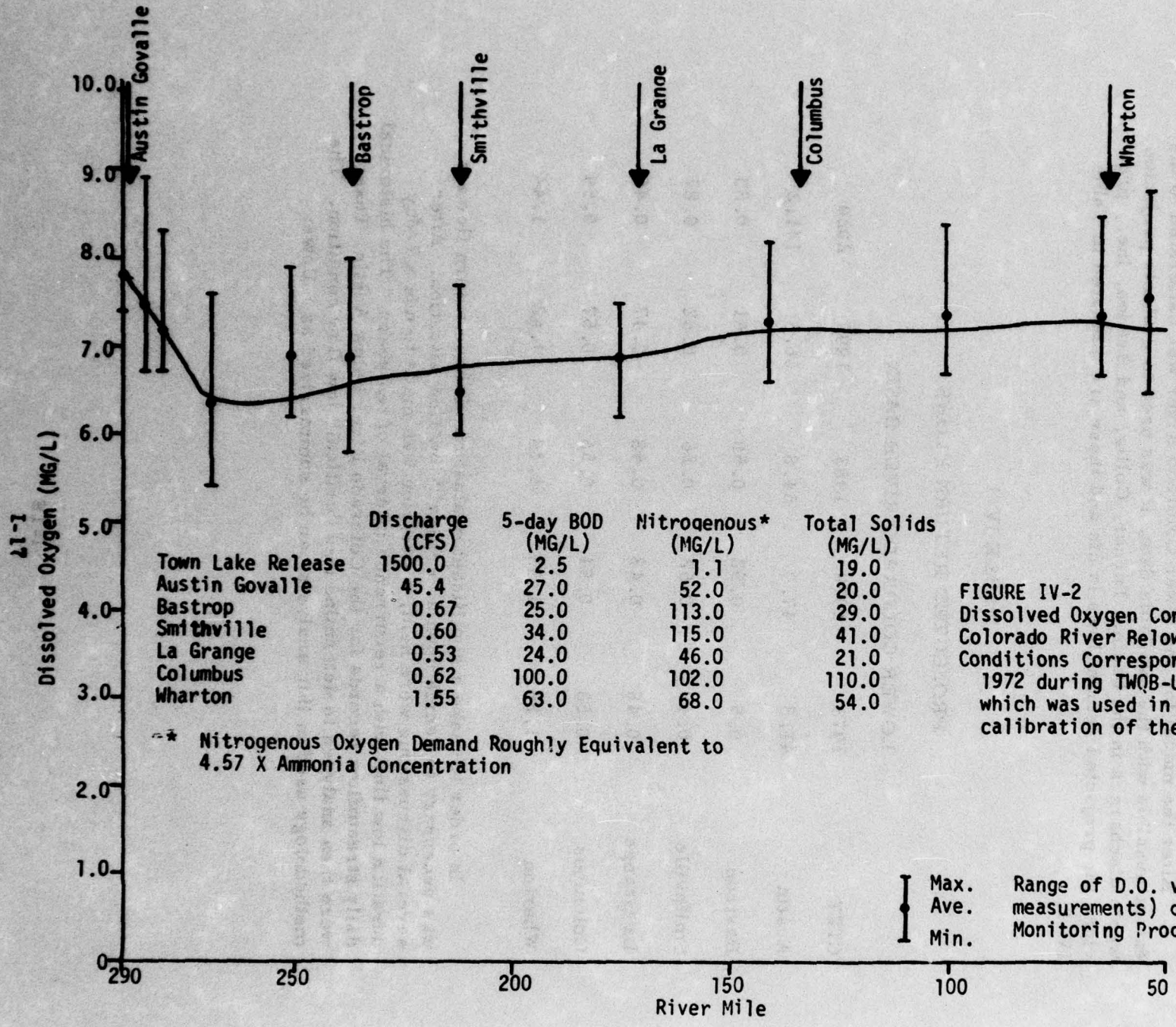


Figure IV-1. Schematic of Lower Colorado River Basin



	Discharge (CFS)	5-day BOD (MG/L)	Nitrogenous* (MG/L)	Total Solids (MG/L)
Town Lake Release	1500.0	2.5	1.1	19.0
Austin Govalle	45.4	27.0	52.0	20.0
Bastrop	0.67	25.0	113.0	29.0
Smithville	0.60	34.0	115.0	41.0
La Grange	0.53	24.0	46.0	21.0
Columbus	0.62	100.0	102.0	110.0
Wharton	1.55	63.0	68.0	54.0

* Nitrogenous Oxygen Demand Roughly Equivalent to 4.57 X Ammonia Concentration

FIGURE IV-2
Dissolved Oxygen Concentration
Colorado River Below Austin
Conditions Correspond to August 20-31, 1972 during TWQB-USGS-TWDB Survey which was used in the initial calibration of the model.

FUTURE CONDITIONS

After the model for the lower Colorado River was calibrated to the extent possible with the available data, it was used to evaluate projected waste discharges in the basin. Turner, Collie, and Braden, Inc., provided the projected return flows in cfs and these are tabulated in Table IV-1.

TABLE IV-1

PROJECTED RETURN FLOWS

LOWER COLORADO RIVER BASIN

CITY	1973	1978	1983	1990	2020
Austin	41.8	47.9	54.8	66.6	141.2
Bastrop	0.5	0.52	0.56	0.61	0.80
Smithville	0.48	0.52	0.56	0.62	0.87
La Grange	0.48	0.48	0.48	0.47	0.40
Columbus	0.53	0.54	0.56	0.57	0.59
Wharton	1.25	1.32	1.39	1.42	1.44

In order to make a significant evaluation of these return flows it was necessary to decide upon a "critical" low flow situation. After several discussions were held, a decision was made to use a 7-day duration low flow with a recurrence interval of ten years. The historical daily streamflow records for the Colorado River below Austin, Texas were then analyzed to determine this "critical" low flow condition. The methodology used in this analysis can be summarized as follows:

1. perform a 7-day moving average of the daily flows for each year in the record,

2. select the minimum 7-day average that occurred in each year,

3. rank the minimum 7-day averages in ascending order, and

4. determine the recurrence interval by the relationship.

$$Tr = \frac{\text{Rank}}{\text{Length of record} + 1.0}$$

The flows in cfs derived from this analysis are given in Table IV-2.

TABLE IV-2

7-DAY LOW FLOW DURATION ANALYSIS

LOWER COLORADO RIVER BASIN

STATION NO.	PERIOD OF RECORD	RECURRENCE INTERVAL 1-YEAR	2-YEAR	5-YEAR	10-YEAR
8-1580	1916-1968	1563.0	173.1	58.4	40.0
8-1592	1960-1968	656.4	124.0	84.6	84.3
8-1610	1938-1968	1891.0	589.1	200.1	180.4
8-1620	1939-1968	1320.0	504.0	246.6	213.0
8-1625	1949-1967	890.0	16.7	1.8	1.4

The streamflows presented in Table IV-1 and Table IV-2 were then used in the model to perform nine separate analyses of projected return flow conditions in the lower Colorado River Basin. These analyses are presented graphically in Figure IV-3 thru Figure IV-11.

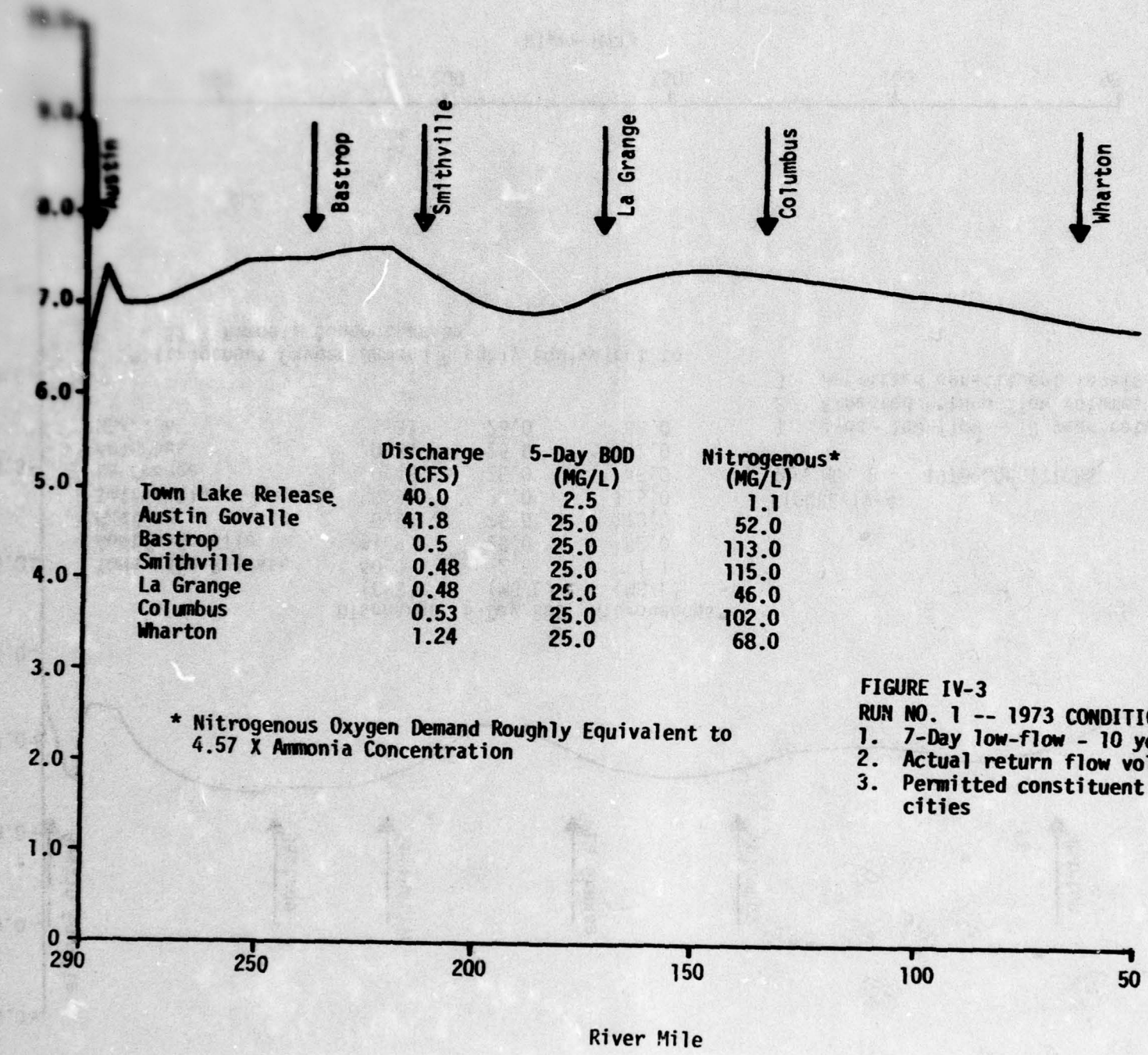
These analyses indicate that under all projected return flow conditions and in a 10 year-7 day low flow situation, the Colorado River below Austin, Texas should have sufficient waste assimilative capacity to meet minimum dissolved oxygen standards (5 mg/l).

Figures IV-3 thru IV-11 indicate that the minimum dissolved oxygen concentrations occur at river mile 290 which is at the location of the Austin Govalle outfall. The dissolved oxygen concentration increases for a short distance downstream then it is depressed again. Under the projected low flow conditions the reaeration capacity of the river is much greater than in the survey condition because of the shallower depths. Thus, although there is much less dilution of the waste loads under low flow conditions, the significantly higher reaeration rates tend to immediately overcome the deoxygenation process at the point where the waste enters the river. However, in reaches of the river where the flow becomes more sluggish and deeper the reaeration process is reduced, and if there is still a significant organic load in the river, another dissolved oxygen depression will occur.

CAVEAT

It should be noted that the calibration carried out in this study represents only one point in time and the validity of the model is only as good as the data used to calibrate it. Certainly, as more data becomes available, further refinements in the model can be made.

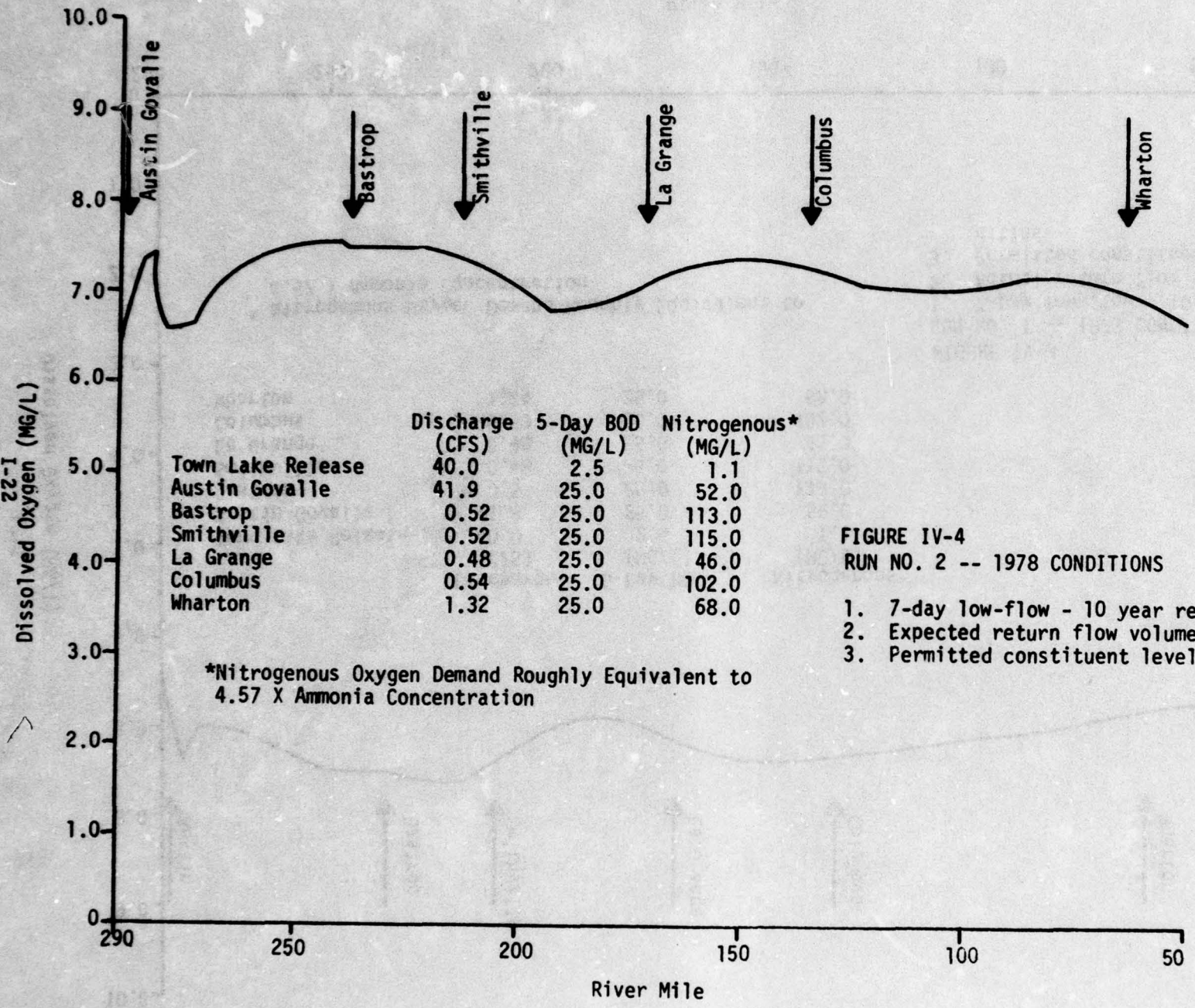
Furthermore, it should be recognized that the stream quality model is a gross simplification of the prototype system. Two obvious simplifications are the neglect of diurnal fluctuations in dissolved oxygen concentrations due to photosynthesis and respiration, which might be as much as $\pm$ 2.0 mg/l, and the neglect of the effects of urban runoff. Potentially, the impact of increased urban runoff on water quality in the Colorado River could be either good or bad. Unfortunately, there is not sufficient data on urban runoff to make any rational analysis. Also, no attempt was made to simulate the effects of agricultrual runoff; however, there is some unpublished information (TWDB, 1973) which indicates the return flows from rice irrigation (predominant irrigated agriculture in the lower Colorado River Basin) are generally of high quality.



	Discharge (CFS)	5-Day BOD (MG/L)	Nitrogenous* (MG/L)
Town Lake Release	40.0	2.5	1.1
Austin Govalle	41.8	25.0	52.0
Bastrop	0.5	25.0	113.0
Smithville	0.48	25.0	115.0
La Grange	0.48	25.0	46.0
Columbus	0.53	25.0	102.0
Wharton	1.24	25.0	68.0

* Nitrogenous Oxygen Demand Roughly Equivalent to 4.57 X Ammonia Concentration

FIGURE IV-3
RUN NO. 1 -- 1973 CONDITIONS
1. 7-Day low-flow - 10 year return period
2. Actual return flow volumes - all cities
3. Permitted constituent levels - all cities

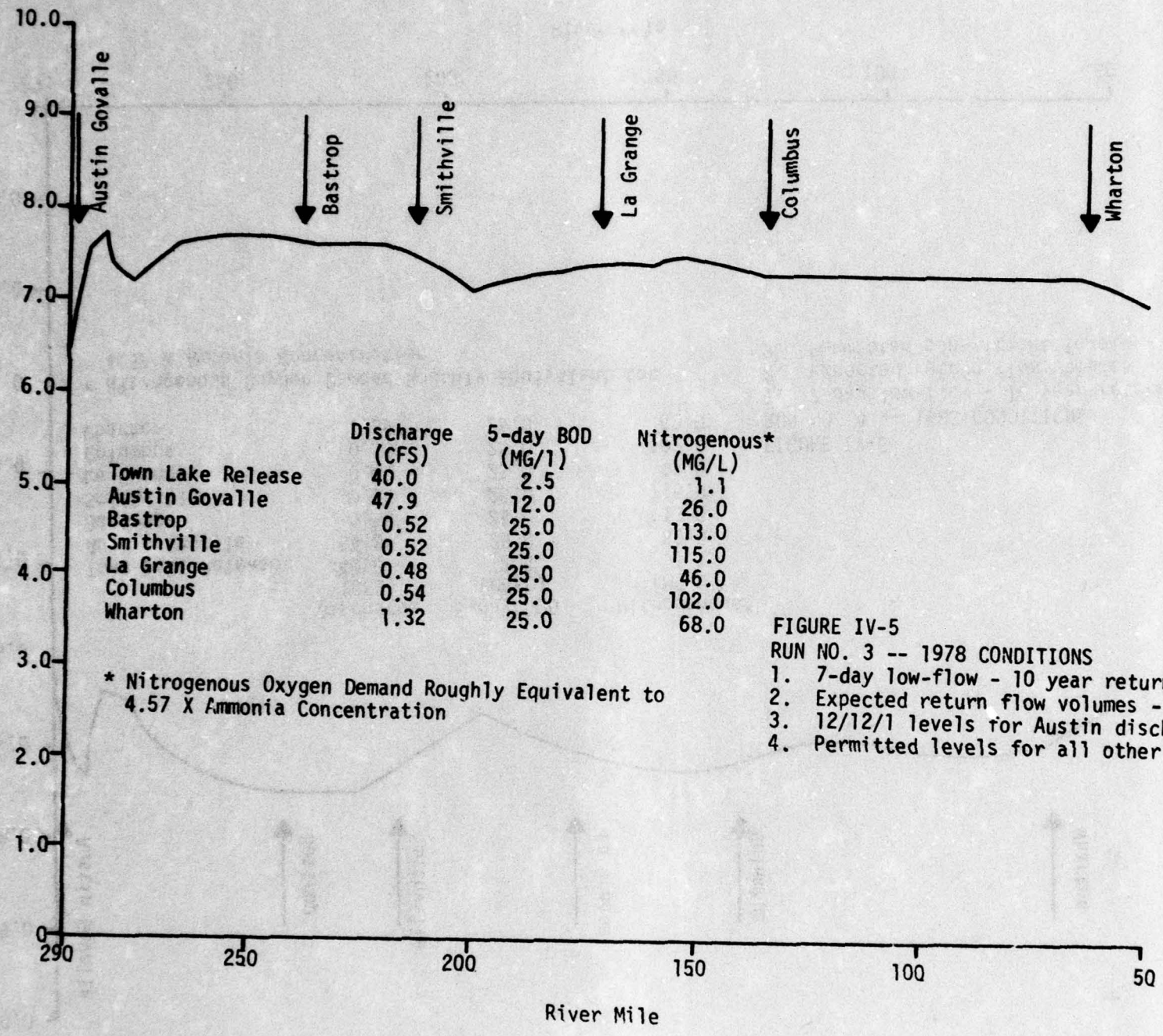


	Discharge (CFS)	5-Day BOD (MG/L)	Nitrogenous* (MG/L)
Town Lake Release	40.0	2.5	1.1
Austin Govalle	41.9	25.0	52.0
Bastrop	0.52	25.0	113.0
Smithville	0.52	25.0	115.0
La Grange	0.48	25.0	46.0
Columbus	0.54	25.0	102.0
Wharton	1.32	25.0	68.0

*Nitrogenous Oxygen Demand Roughly Equivalent to 4.57 X Ammonia Concentration

FIGURE IV-4
RUN NO. 2 -- 1978 CONDITIONS

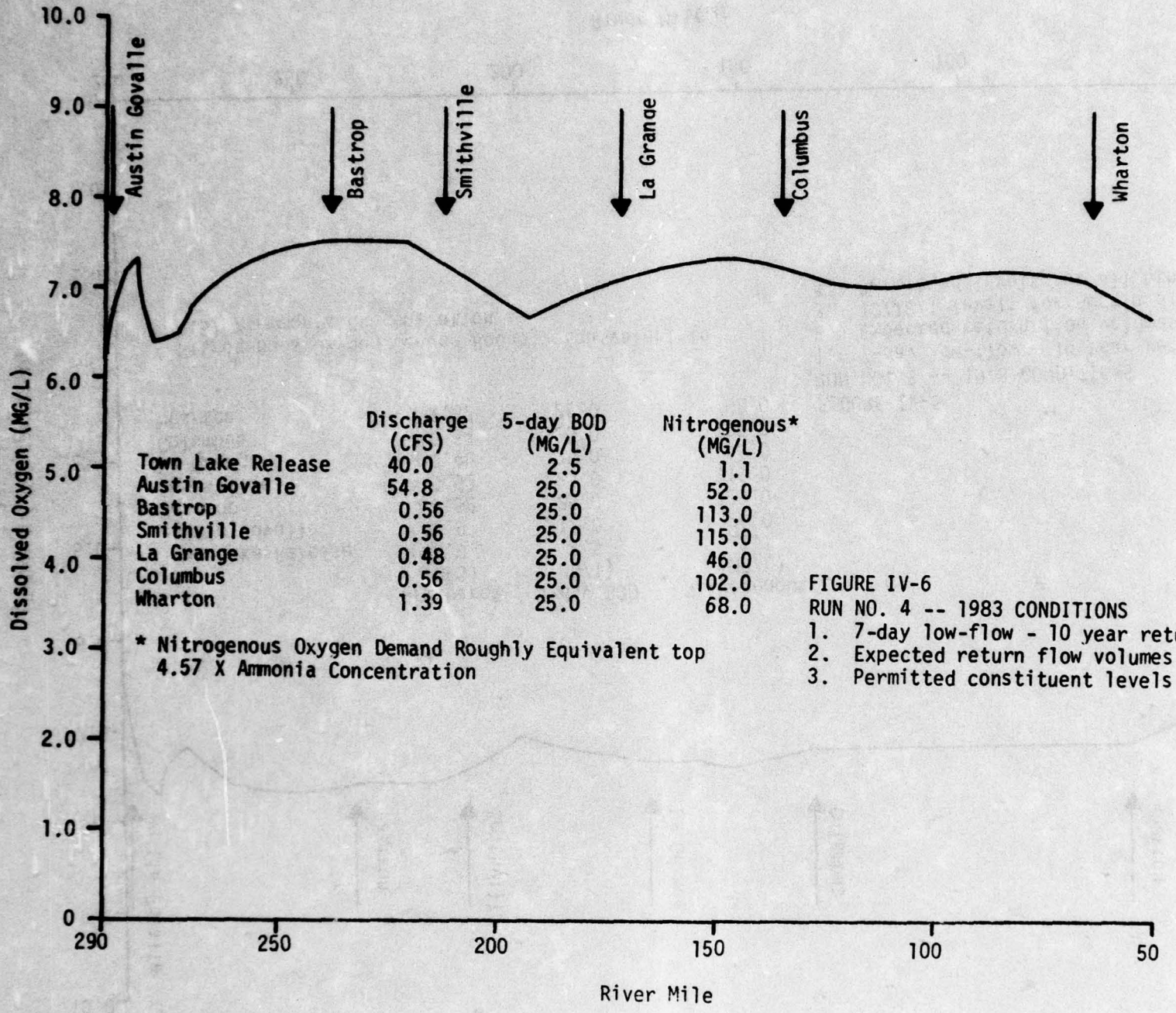
1. 7-day low-flow - 10 year return period
2. Expected return flow volumes - all cities
3. Permitted constituent levels - all cities



	Discharge (CFS)	5-day BOD (MG/1)	Nitrogenous* (MG/L)
Town Lake Release	40.0	2.5	1.1
Austin Govalle	47.9	12.0	26.0
Bastrop	0.52	25.0	113.0
Smithville	0.52	25.0	115.0
La Grange	0.48	25.0	46.0
Columbus	0.54	25.0	102.0
Wharton	1.32	25.0	68.0

* Nitrogenous Oxygen Demand Roughly Equivalent to 4.57 X Ammonia Concentration

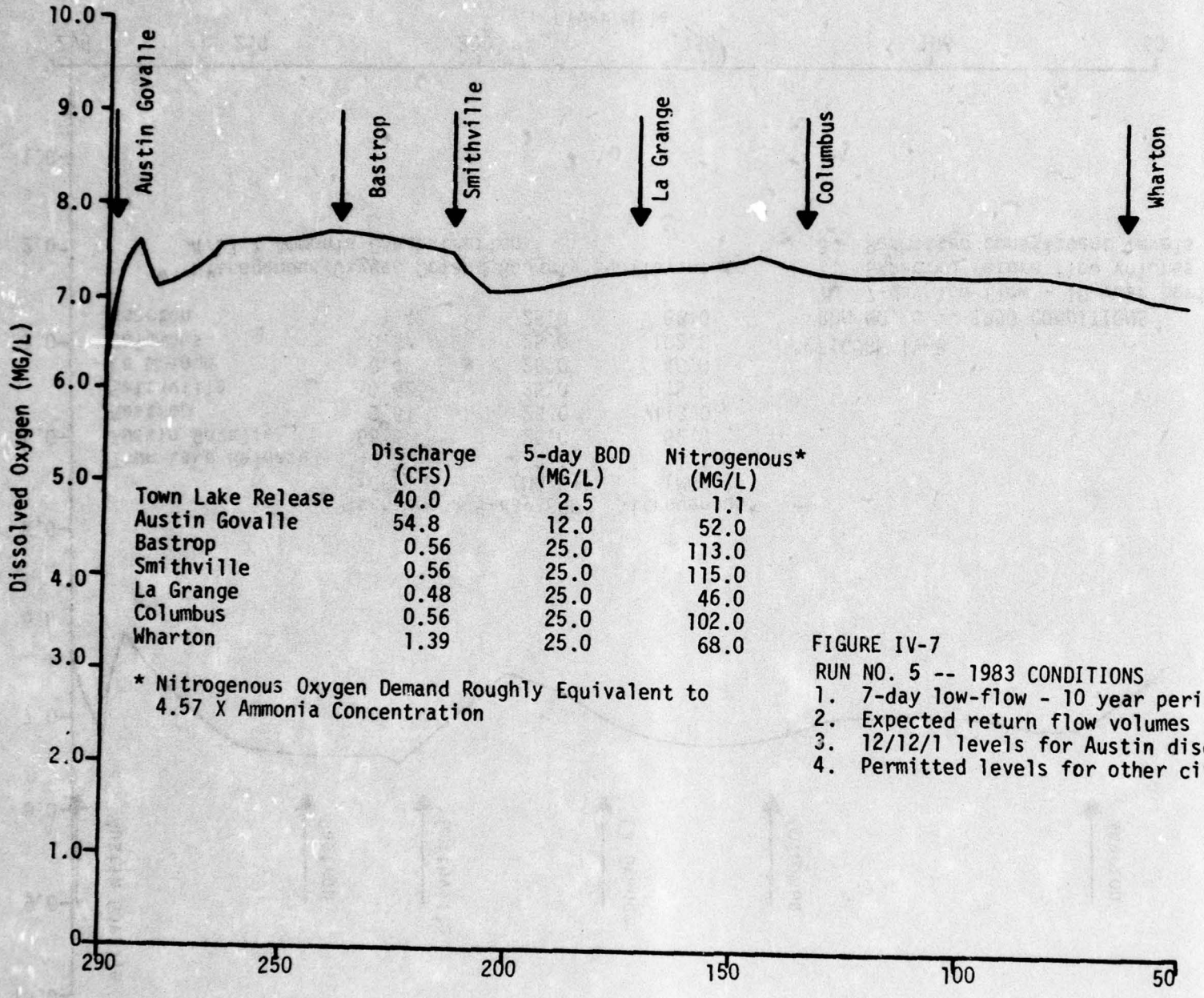
FIGURE IV-5
RUN NO. 3 -- 1978 CONDITIONS
1. 7-day low-flow - 10 year return period
2. Expected return flow volumes - all cities
3. 12/12/1 levels for Austin discharges
4. Permitted levels for all other cities



	Discharge (CFS)	5-day BOD (MG/L)	Nitrogenous* (MG/L)
Town Lake Release	40.0	2.5	1.1
Austin Govalle	54.8	25.0	52.0
Bastrop	0.56	25.0	113.0
Smithville	0.56	25.0	115.0
La Grange	0.48	25.0	46.0
Columbus	0.56	25.0	102.0
Wharton	1.39	25.0	68.0

* Nitrogenous Oxygen Demand Roughly Equivalent top 4.57 X Ammonia Concentration

FIGURE IV-6
RUN NO. 4 -- 1983 CONDITIONS
1. 7-day low-flow - 10 year return period
2. Expected return flow volumes - all cities
3. Permitted constituent levels - all cities



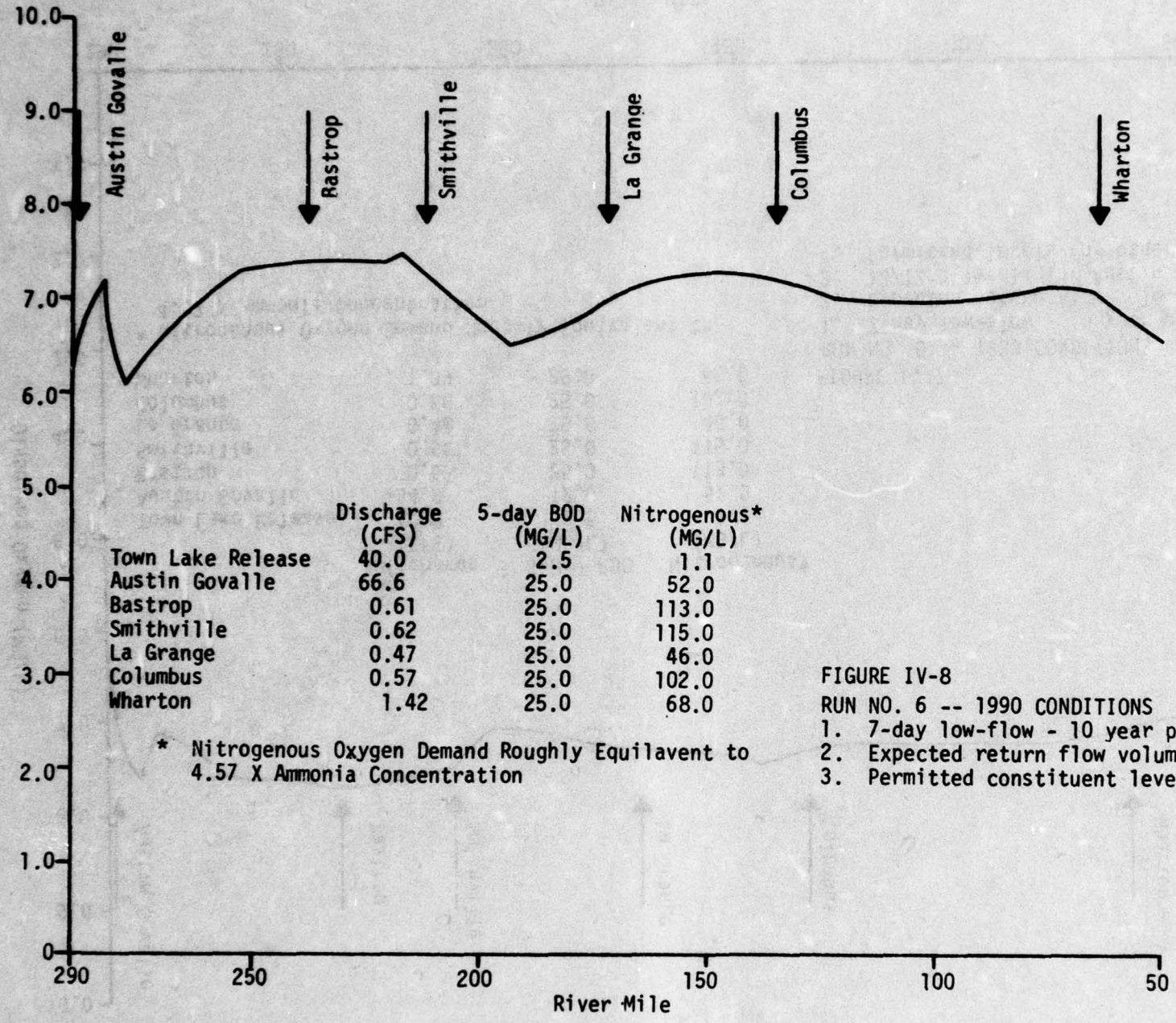
	Discharge (CFS)	5-day BOD (MG/L)	Nitrogenous* (MG/L)
Town Lake Release	40.0	2.5	1.1
Austin Govalle	54.8	12.0	52.0
Bastrop	0.56	25.0	113.0
Smithville	0.56	25.0	115.0
La Grange	0.48	25.0	46.0
Columbus	0.56	25.0	102.0
Wharton	1.39	25.0	68.0

* Nitrogenous Oxygen Demand Roughly Equivalent to 4.57 X Ammonia Concentration

FIGURE IV-7

RUN NO. 5 -- 1983 CONDITIONS

1. 7-day low-flow - 10 year period
2. Expected return flow volumes - all cities
3. 12/12/1 levels for Austin discharges
4. Permitted levels for other cities

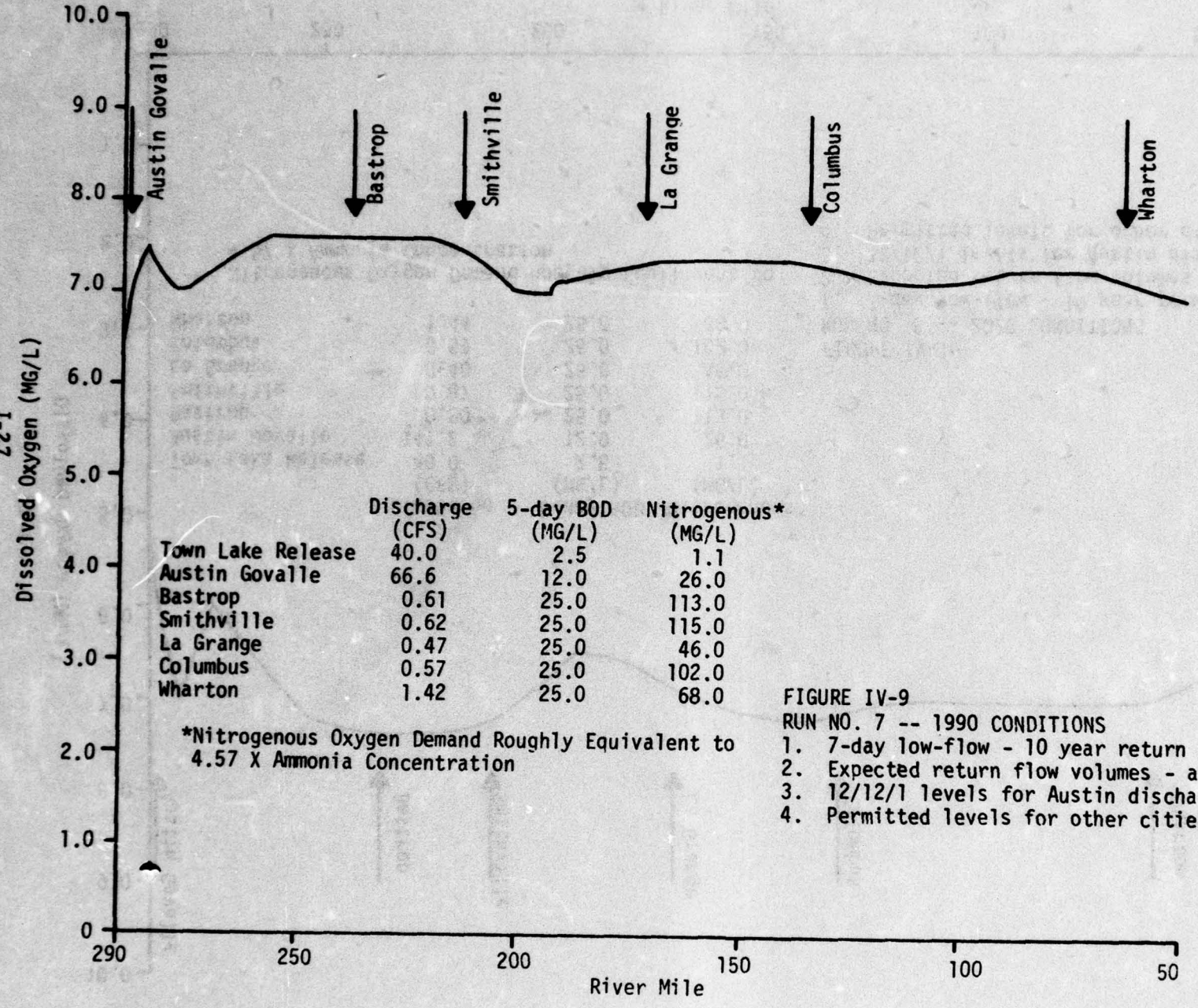


	Discharge (CFS)	5-day BOD (MG/L)	Nitrogenous* (MG/L)
Town Lake Release	40.0	2.5	1.1
Austin Govalle	66.6	25.0	52.0
Bastrop	0.61	25.0	113.0
Smithville	0.62	25.0	115.0
La Grange	0.47	25.0	46.0
Columbus	0.57	25.0	102.0
Wharton	1.42	25.0	68.0

* Nitrogenous Oxygen Demand Roughly Equilavent to 4.57 X Ammonia Concentration

FIGURE IV-8

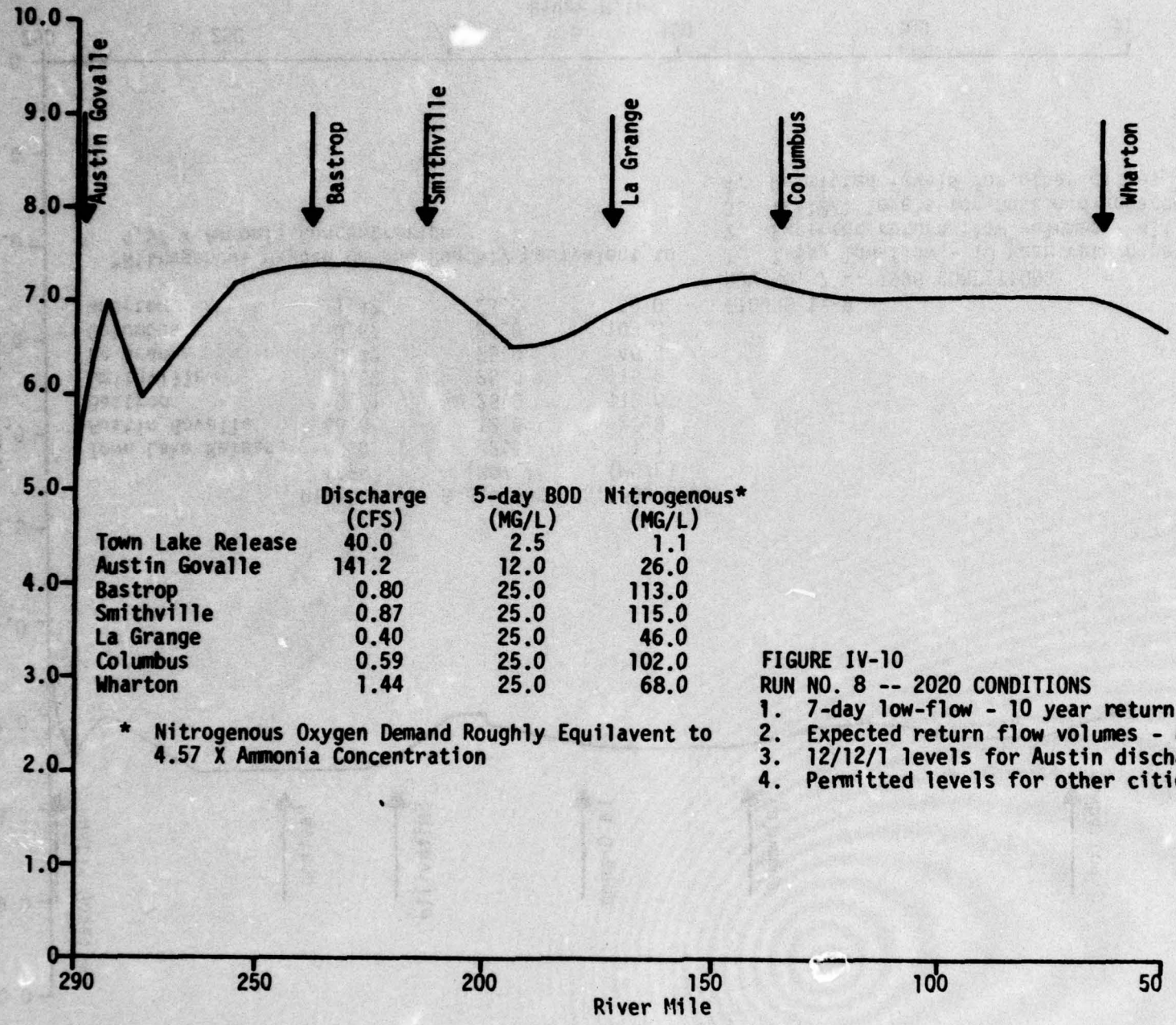
RUN NO. 6 -- 1990 CONDITIONS
1. 7-day low-flow - 10 year period
2. Expected return flow volumes - all cities
3. Permitted constituent levels - all cities



	Discharge (CFS)	5-day BOD (MG/L)	Nitrogenous* (MG/L)
Town Lake Release	40.0	2.5	1.1
Austin Govalle	66.6	12.0	26.0
Bastrop	0.61	25.0	113.0
Smithville	0.62	25.0	115.0
La Grange	0.47	25.0	46.0
Columbus	0.57	25.0	102.0
Wharton	1.42	25.0	68.0

*Nitrogenous Oxygen Demand Roughly Equivalent to 4.57 X Ammonia Concentration

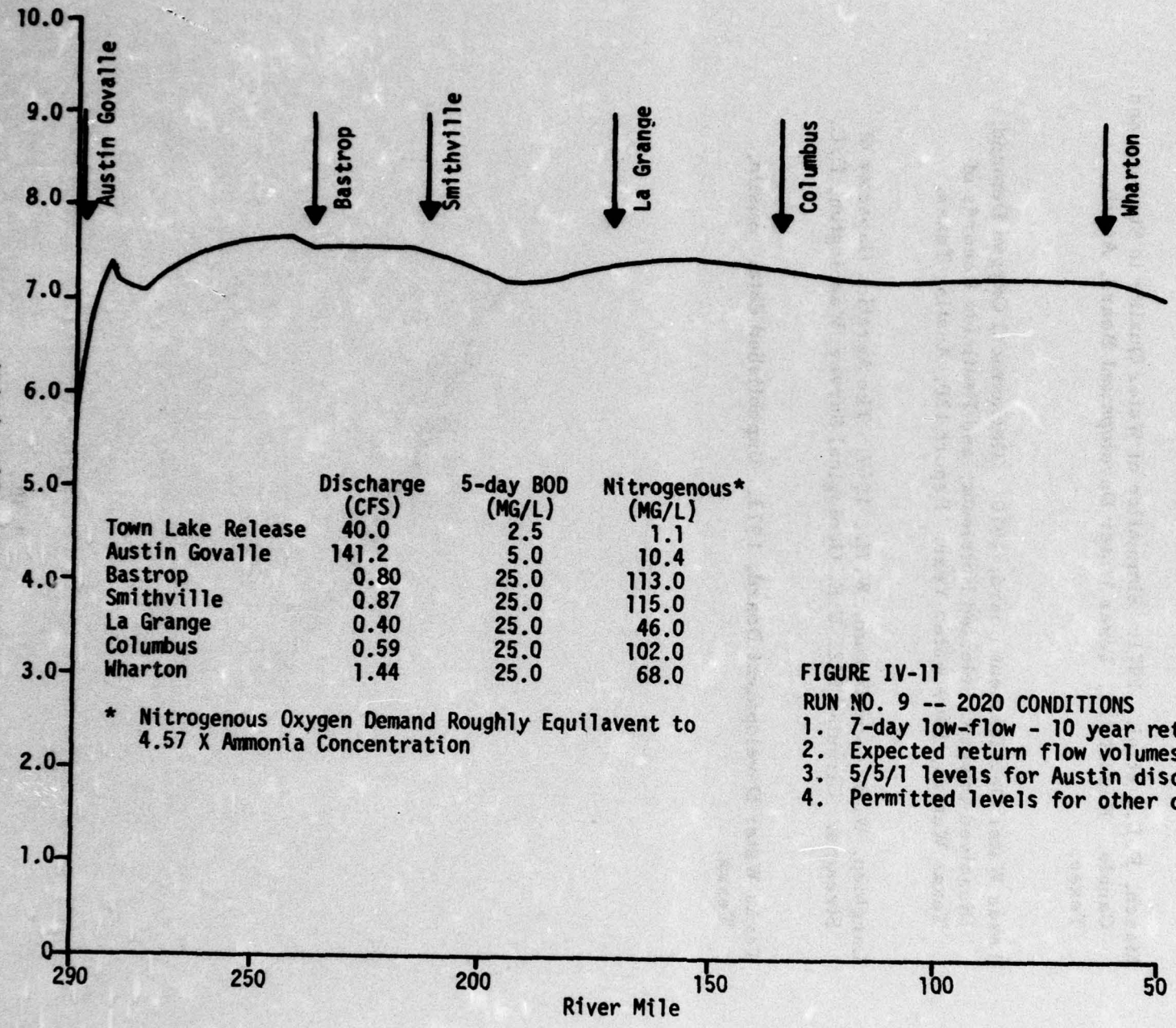
FIGURE IV-9
RUN NO. 7 -- 1990 CONDITIONS
1. 7-day low-flow - 10 year return period
2. Expected return flow volumes - all cities
3. 12/12/1 levels for Austin discharges
4. Permitted levels for other cities



	Discharge (CFS)	5-day BOD (MG/L)	Nitrogenous* (MG/L)
Town Lake Release	40.0	2.5	1.1
Austin Govalle	141.2	12.0	26.0
Bastrop	0.80	25.0	113.0
Smithville	0.87	25.0	115.0
La Grange	0.40	25.0	46.0
Columbus	0.59	25.0	102.0
Wharton	1.44	25.0	68.0

* Nitrogenous Oxygen Demand Roughly Equilavent to 4.57 X Ammonia Concentration

FIGURE IV-10
RUN NO. 8 -- 2020 CONDITIONS
1. 7-day low-flow - 10 year return period
2. Expected return flow volumes - all cities
3. 12/12/1 levels for Austin discharges
4. Permitted levels for other cities



	Discharge (CFS)	5-day BOD (MG/L)	Nitrogenous* (MG/L)
Town Lake Release	40.0	2.5	1.1
Austin Govalle	141.2	5.0	10.4
Bastrop	0.80	25.0	113.0
Smithville	0.87	25.0	115.0
La Grange	0.40	25.0	46.0
Columbus	0.59	25.0	102.0
Wharton	1.44	25.0	68.0

* Nitrogenous Oxygen Demand Roughly Equilavent to 4.57 X Ammonia Concentration

FIGURE IV-11

RUN NO. 9 -- 2020 CONDITIONS

1. 7-day low-flow - 10 year return period
2. Expected return flow volumes - all cities
3. 5/5/1 levels for Austin discharges
4. Permitted levels for other cities

REFERENCES

Masch, F. D., et. al., 1971. Simulation of Water Quality in Streams and Canals. Report 128, Texas Water Development Board, Austin, Texas.

Texas Water Development Board, 1970. Biochemical Oxygen Demand, Dissolved Oxygen, Selected Nutrients, and Pesticide Records of Texas Waters, 1969 Water Year. Report 120, Austin, Texas.

Langbien, W. B., and Durum, W. H., 1967. The Aeration Capacity of Streams. Circular 542, U.S. Geological Survey, Washington, D. C.

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Appendix J has been copied verbatim from Selected Texas Water Quality Board Regulations.

J. SELECTED TEXAS WATER QUALITY BOARD REGULATIONS

REGULATION FOR REGISTRATION OF COMMERCIAL SWINE PRODUCTION WASTE CONTROL FACILITIES

Adopted by the Texas Water Quality Board on August 28, 1970

DEFINITIONS:

1. Feeder animal - Any swine weighing 50 pounds or more which is fed for market.
2. Breeder Animal - Any swine weighing 50 pounds or more which is intended for breeding purposes.
3. Piglet - Any swine weighing less than 50 pounds
4. Commercial Swine Production Operation - Any confined area or enclosure used for the production or feeding of swine.
5. Animal Unit - One feeder animal or one breeder animal or ten piglets.
6. Surface Water Supply - All ponded waters which are not on property owned or controlled by the applicant (e.g., private lakes and stock tanks).
7. Flowing Stream - All streams that carry water at least ten months of the calendar year.

APPLICATION OF REGULATION:

This regulation applies to all Commercial Swine Production Operations with 50 or more animal units when the pen area allotted per animal unit is 2,000 square feet or less. This regulation also applies to those Commercial Swine Production Operations which are located less than 5.0 linear feet per animal unit from a flowing stream or surface water supply when the number of animal units present equals 20 or more and the pen area allotted per animal unit is 4,000 square feet or less.

At the discretion of the Executive Director, any Commercial Swine Production Operation may be required to comply with these regulations if in his opinion such compliance is necessary in order to achieve the

policy and purposes enumerated in Section 1.02, Article 7621d-1 and Section 1 of Article 4477-7, Vernon's Texas Civil Statutes. In the event a Commercial Swine Production Operation is located in an area sufficiently sensitive that the environmental protections provided by this order are not sufficient, the Executive Director may require those additional protections to be implemented which he feels necessary to protect the water in the State.

I. REGISTRATION REQUIRED:

Owners or operators of Commercial Swine Production Operations which come under the purview of this regulation shall register in accordance with this regulation unless the facilities are presently regulated under a Waste Control Order of the Water Quality Board. In order to be considered properly registered, the owner or operator of the Commercial Swine Production Operation must apply for and receive a Certificate of Registration approved and issued by the Executive Director. Before issuing the Certificate of Registration, the Executive Director will confirm that the facilities provided comply with all requirements of this regulation. The Board will furnish forms on which to apply for a Certificate of Registration upon request. All of the information requested by the application must be provided before the Executive Director will consider an application.

When a completed application has been received, and after a staff evaluation has been made, the Executive Director shall either issue a Certificate of Registration or refuse to do so. In the event a Certificate of Registration is refused, the Executive Director shall set out his reasons for so doing in writing to the applicant. The applicant whose Certificate of Registration has been denied may appeal the denial to the Board in accordance with the procedures established in Rule 600.2, Rules of the Texas Water Quality Board, and appeal to the Board shall be a prerequisite to judicial appeal.

II. SURFACE WATER PROTECTION:

This segment of the regulation is designed to prevent pollution of surface waters caused by drainage of waste from Commercial Swine Production Operations which come under this regulation into surface drainage features. This regulation does not attempt to provide protection from catastrophic events which cannot be reasonably

anticipated. The degree of protection provided is sufficient if the waste control facilities are designed to contain all feedlot runoff from the maximum probable 24-hour rainfall which will be expected to occur once in 25 years at the location of the Commercial Swine Production Operation.

A. Offsite Drainage Diversion: To prevent pollution of rainfall runoff originating outside the feeding area, feedlot wastes must be isolated from outside surface drainage by ditches, dikes or other suitable structures where necessary to provide adequate environmental protection. These diversion structures shall be designed to carry peak flows expected at times when maximum rainfall, as described above, may occur.

B. Waste Retention Facilities: This provision applies to dikes, lagoons, playa lakes or other structures relied on to hold waste materials and rainfall runoff contaminated by waste materials from the Commercial Swine Production Operation area. The capacity of the retention facilities shall be sufficient to retain all runoff from uncovered Commercial Swine Production Operations resulting from the maximum probable 24-hour rainfall with a return frequency of 25 years and shall be sufficient to retain all wastewater produced within covered swine production facilities for a 30-day period (to allow storage of the wastewater during rainy periods when irrigation with the wastewater is not feasible). All rainfall values used for design purposes shall be in accordance with values published by Hershfield, Rainfall Frequency Atlas of the United States, U.S. Weather Bureau, Technical Paper No. 40, 1961 or the latest revision thereof. For design purposes, runoff is considered to be at least 75% of the volume of the rainfall. This specification assumes that the retention facilities will be equipped with equipment capable of dewatering the retention facilities within 14 days after the rainfall. If the dewatering equipment is not capable of dewatering the retention facilities within 14 days, additional storage capacity may be provided in lieu of dewatering capabilities. This additional storage capacity, which will be required, will depend upon circumstances peculiar to each application and will be decided by the Executive Director.

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WASTEWATER MANAGEMENT PLAN. COLORADO RIVER AND TRIBUTARIES, TEX--ETC(U)
SEP 73

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III. GROUNDWATER PROTECTION:

This segment of the regulation is directed toward control of seepage of liquid waste from the wastewater holding lagoons. Feeding pens and other areas from which liquid wastes drain readily are not normally assumed to present substantial groundwater contamination hazards because of the limited time in which liquid wastes are in contact with the ground. Areas underlain by clean sands, fractured limestones, and other strata with exceptionally high permeabilities are subject to additional seepage control regulation at the discretion of the Executive Director.

A. Seepage Control: Wastewater retention facilities shall be constructed in clay soils or lined with a minimum of one foot of compacted clay or lined with other suitable lining materials to adequately control seepage of contaminated wastewater into groundwaters which are acceptable for use as a domestic or livestock water supply.

B. Permeability Data: At the discretion of the Executive Director, permeability tests may be required to show that pond liners are adequately impermeable to prevent excessive seepage. When questions arise, the desirable seepage rate from the ponds will be less than 0.1 acre-foot of wastewater per surface acre of pond per year.

C. Existing Wastewater Retention Facilities: Wastewater retention facilities which are in existence on the date of adoption of this order are presumed to provide adequate protection to usable groundwater resources until shown otherwise. Any wastewater retention facilities which are especially constructed to come under this provision are subject to the same requirements of lining as those constructed after the effective date of the order.

IV. WASTE DISPOSAL PRACTICES:

Both solid and liquid waste materials from a swine producing area have very strong water pollution potentials, and treatment of these wastes to the degree which would be required if they are to be discharged into water in the State is not considered to be feasible. Both solid and liquid wastes, however, have some value as fertilizers and soil builders if applied in the proper

way. This regulation, therefore, assumes that all feedlot wastes will be disposed of by spreading them on farmlands. The land spreading program is not an absolute requirement of this regulation since other acceptable methods of disposal or use of the waste product may be found in the near future. If the applicant proposes to use methods of disposal other than land spreading, he must first obtain approval of the proposed disposal method from the Executive Director.

A. Disposal Methods: Liquid and solid waste materials shall be distributed on farm or pasture lands so that neither the waste nor rainfall contaminated by the waste will enter any surface drainage features from which it will eventually enter the water in the State in such quantities as to cause an appreciable adverse effect in receiving waters.

B. Application Rates: The wastes shall be distributed on the land in such a way as to insure that no potential hazard to groundwaters which are acceptable for use as a domestic or livestock water supply is created by this process. Since the transfer of nitrogen compounds through the upper soil layers is partially influenced by the amount of nitrogen removed by surface vegetation, the waste shall not be applied in concentrations nor applications made at intervals which kill or inhibit growth of surface vegetation.

C. Management of Wastes: Collection, storage, and disposal of liquid and solid waste shall be managed so as to prevent nuisance conditions and insect problems. All solid waste material stockpiled outside the swine producing area, whether for final disposition or while awaiting transfer to a land-spreading area, shall be isolated by the use of dikes from all outside drainage waters and shall be so diked to retain all rainfall which comes in contact with the stockpiled solid waste material. Waste disposal practices conducted by Commercial Swine Production Operations shall be managed to minimize the occurrence of situations that cause the production of objectionable odors and flies.

V. PESTICIDE USES:

The Swine producer is encouraged to minimize the use of pesticides which can cause degradation of the water in the State and is encouraged to follow the manufacturers recommendations for the use of the pesticide precisely. The swine producer should take every precaution to guard against the discharge of waters which have been contaminated by pesticides and shall notify the Texas Water Quality Board immediately if such discharge occurs.

EXCEPTION TO APPLICATION OF REGULATIONS:

Any owner or operator of Commercial Swine Production Operations who does not wish to be governed by the provisions of these regulations shall file an application for a Waste Control Order.

REGULATION CONCERNING MEAT PROCESSING OPERATIONS AND DISCHARGES THEREFROM

Section 1.01 DEFINITIONS: As used in this regulation, the following terms have the following meanings unless the context clearly requires a different meaning:

(1) "person" means individual, corporation, organization, government or governmental subdivision or agency, business trust, partnership, association, or any other legal entity;

(2) "Board" means the Texas Water Quality Board;

(3) "Executive Director" means the Executive Director of the Texas Water Quality Board;

(4) "meat processing operation" means a plant, facility, establishment or enterprise operated in the business of slaughtering cattle, sheep, swine, goats, horses, mules, equines, poultry, domestic rabbits, or domesticated game birds or in the business of canning, salting, packing, or rendering carcasses or parts of carcasses of the above-named species for sale as human or animal food;

(5) "wastewater" means water that is routed to drains or sewers associated with a meat processing operation, including but not limited to process water, wash water, and drainage from livestock unloading areas and holding pens and/or poultry unloading areas; provided, however, that nothing in this definition shall be interpreted as requiring the construction of drainage systems for essentially uncontaminated areas, such as areas used solely as parking lot areas where trucks transporting such livestock and/or poultry may be parked prior to entering unloading areas.

(6) "water in the state" means groundwater, percolating or otherwise, lakes, bays, ponds, impounding reservoirs, springs, rivers, streams, creeks, estuaries, marshes, inlets, canals, and the Gulf of Mexico within the territorial limits of the State of Texas, and all other bodies of surface water, natural or artificial, inland or coastal, fresh or salt, navigable or non-navigable, and including the beds and banks of all watercourses and bodies of surface water, that are wholly or partially within or bordering the state or within the jurisdiction of the State.

Section 2.01 APPLICATION OF REGULATION: This regulation applies to all meat processing operations and to any person engaged in the business of slaughtering cattle, sheep, swine, goats, horses, mules, equines, poultry, domestic rabbits, or domesticated game birds and to any person engaged in the business of canning, salting, packing, or rendering carcasses or parts of carcasses of the above-named species for sale as human food or animal feed.

Section 2.02 EXCEPTION TO APPLICATION OF REGULATION: Any person to whom this regulation applies who does not wish to utilize the procedure for registration established by this regulation shall submit to the Board an application for a waste control order. This regulation shall continue to apply to any such person except in matters as to which the provisions of a valid waste control order from the Board supersede provisions of this regulation.

Section 3.01 PERSONS REQUIRED TO REGISTER: Every person to whom this regulation applies whose meat processing operation:

(a) discharges wastewater to a treatment and/or holding system, and/or
(b) discharges wastewater, either treated or untreated, into or adjacent to any water in the state

must comply with the provisions of this regulation and any such meat processing operation must properly be registered in accordance with this regulation unless such discharge is authorized under a valid waste control order of the Texas Water Quality Board. Those persons whose meat processing operations discharge wastewater only to city sewage collection and treatment systems operated pursuant to a valid waste control order issued by the Board or only to septic-tank, soil-absorption systems with no discharge to any water in the state are not required to register in order to comply with this regulation.

Section 3.02 APPLICATION FOR REGISTRATION: In order for his meat processing operation properly to be registered a person must hold a valid certificate of registration issued by the Executive Director. Upon request, the central office of the Board will furnish forms on which a person may make an application for a certificate of registration.

Section 3.03 PROVISION FOR NOTIFICATION: Any application for registration under this regulation must include a statement of notification. The statement shall indicate that the applicant has given notice of the application to interested parties. These interested parties must include all persons who own property within 1,000 feet in any direction from the

meat processing operation. If the meat processing operation discharges wastewater into or adjacent to any water in the state, these interested parties must also include all owners of property which adjoins any receiving water within one mile downstream from any proposed point of discharge.

Section 3.04 REVIEW OF APPLICATION: The Executive Director or personnel acting under his direction will review the application and any accompanying maps, data, information, and materials. The Executive Director or those acting under his direction may request additional information reasonably required for an adequate understanding of the application, and the applicant must provide such additional information.

Section 3.05 ISSUANCE OR REFUSAL OF CERTIFICATE OF REGISTRATION: After a review of the application has been completed, the Executive Director shall either issue a certificate of registration or refuse to do so. Whenever the information provided by the application indicates that:

(a) pertinent circumstances are such that registration is the appropriate method for regulation, and

(b) that the applicant's meat processing operation will comply with this regulation and with other rules, regulations, orders and policies of the Board, and

(c) that adequate protection will be provided to the property of others, to public property and rights-of-way, to any water in the state, and to other rights requiring protection,

the Executive Director shall enter registration of the meat processing operation in the official records of the Board and shall issue a certificate of registration to the applicant. Whenever the Executive Director refuses to register a meat processing operation, he shall promptly set out his reasons for so doing in writing to the applicant.

Section 3.06 IMPOSITION OF CONDITIONS: The Executive Director may impose on a registrant in connection with and at the time of taking formal action on his application for registration any condition, restriction, limitation, or provision reasonably necessary for the administration and enforcement of the Acts administered by the Board, as applicable, and the orders, rules, regulations and policies of the Board.

Section 3.07 APPEAL TO THE BOARD: Any person aggrieved by any action or refusal to act by the Executive Director on any application may appeal to the Board in accordance with the procedures established in Rule 600.2 of the Rules of the Texas Water Quality Board, and appeal to the Board shall be a prerequisite to judicial appeal.

Section 3.08 EFFECT OF APPLICATION AND REGISTRATION: Acceptance of registration by any person to whom this regulation applies constitutes an acknowledgement and agreement that he will comply with all of the terms, conditions, limitations, and restrictions imposed on him in connection with the registration, and will comply with the rules, regulations, and orders of the Board.

Section 3.09 CERTIFICATE BASED ON INCORRECT INFORMATION: If any applicant for registration shall submit material incorrect information, any certificate of registration issued as a result of such submission shall be void ab initio.

Section 4.01 PROTECTION OF SURFACE WATER: Any person to whom this regulation applies shall provide sufficient protection of surface waters. The degree of protection provided is sufficient if waste control facilities are designed and operated in accordance with the following subsections, where applicable:

(1) Discharge to Water in the State: If a meat processing operation discharges wastewater into or adjacent to any water in the state, such a meat processing operation must include waste treatment facilities designed and operated to produce an effluent having a quality suitable for discharge as defined in Section 4.02 which is entitled "QUALITY OF WATER SUITABLE FOR DISCHARGE" in this regulation.

(2) Wastewater Holding Facilities: If a meat processing operation utilizes holding facilities, any holding facilities shall be designed and operated to retain all wastewater produced by the meat processing operation for a 30-day period plus all rainwater which would enter the holding facilities as a result of a 25-year, 24-hour rainfall as defined by Hershfield, Rainfall Frequency Atlas of the United States, U.S. Weather Bureau, Technical Paper No. 40, 1961 or the latest revision thereof. Wastewater holding facilities shall be dewatered within 14 days after any one of the following events occurs:

(a) Collection of a quantity of rainwater in excess of 20% of the quantity of rainfall which would enter the holding facility as a result of an above-defined 25-year, 24-hour rainfall.

(b) Collection of more than 50% of the volume of wastewater which the pond was designed to retain such that sufficient capacity is no longer available to retain an addition of all rainwater that would enter the holding facilities as a result of a 25-year, 24-hour rainfall plus all wastewater produced by the meat processing operation for a 15-day period.

(3) Evaporation Facilities: If a meat processing operation utilizes evaporation facilities, any evaporation facilities shall be designed to retain wastewater with no overflow during a 10-year period of above-normal rainfall. Local weather bureau rainfall data may be used in designing these facilities.

(4) Irrigation Facilities: If a meat processing operation utilizes irrigation facilities, any irrigation facilities shall be of adequate capacity to dewater all wastewater holding facilities within a 14-day period. If farmland or pasture land is irrigated with wastewater from the meat processing operation or its waste control facilities, the annual application rate (including rainfall) shall not exceed 200% of the expected consumptive use for the particular crop as defined by McDaniels, Consumptive Use of Water by Major Crops in Texas, Texas Board of Water Engineers, Bulletin No. 6019, 1960.

(5) Isolation of Wastewater: Wastewater must be isolated from outside surface drainage by ditches, diking, or other suitable structures where necessary to provide adequate environmental protection. Such diversion structures shall be designed to be effective during peak flows expected at times when a 25-year, 24-hour rainfall, as described above, may occur.

Section 4.02 QUALITY OF WATER SUITABLE FOR DISCHARGE: All wastewater whether treated or untreated which is discharged from meat processing operations into or adjacent to water in the state shall have a quality described by the values specified on the following page:

Item	NOT TO EXCEED Monthly Average	24-hour Daily Composite	Individual Sample
pH	6.5-8.0	6.2-8.5	6.0-9.0
Total residue, mg/l	1,000	1,200	1,500
Chloride, mg/l	250	300	350
Sulphate, mg/l	250	300	350
Total Suspended Solids, mg/l	15	20	25
Volatile Suspended Solids, mg/l	10	15	20
Settleable Matter, mg/l	5	6	7
Immediate Oxygen Demand, mg/l	0.5	0.6	0.7
Biochemical Oxygen Demand, mg/l	15	20	25
Chemical Oxygen Demand, mg/l	150	200	250
Oil & Grease, mg/l	8	10	12
Free or Floating Oil	none	none	none
Color, APHA Units	60	80	100
Temperature, ^{o}F	90	93	96
Debris	none	none	none

Toxic Compounds - None in such amounts as will cause the receiving waters to be toxic to human, animal or aquatic life.

Foaming or Frothing Materials - None in such amounts as will cause foaming or frothing of a persistent nature in the receiving waters.

At the direction of the Executive Director additional or different quality parameters may be imposed if an evaluation of the quality of raw water supply and/or receiving waters indicates a need for additional or different quality parameters.

Section 5.01 PROTECTION OF GROUNDWATER: Any wastewater holding facilities shall conform to the requirements for seepage control enumerated below. Any such facility in areas underlain by clean sands, fractured limestone, or other strata with exceptionally high permeabilities may be subjected to additional seepage control requirements at the discretion of the Executive Director.

(1) Seepage Control: Wastewater retention facilities shall be constructed in clay soils or lined with a minimum of one foot of compacted clay or lined with other suitable lining materials for adequate control of seepage of contaminated wastewater into groundwaters of a better chemical quality than the water which is retained.

(2) Permeability Data: At the discretion of the Executive Director, permeability tests may be required to show that pond liners are adequately impermeable to prevent excessive seepage. The acceptable seepage rate from the ponds shall be less than 0.1 acre-foot of wastewater per surface acre of pond per year. The acceptable permeability coefficient shall be 1.0×10^{-7} cm/sec. at 1 foot of head and with 1 foot of permeable material or the equivalent thereof. The permeability coefficient shall be determined by constant head laboratory permeameter tests.

Section 6.01 DISPOSAL OF SOLID WASTES: Disposal of solid wastes (hoof, hair, hide, bone, sludge, salt, etc.) shall comply with the applicable portions of the Texas State Health Department regulations. Evidence of an acceptable method of disposal of all solid process waste not covered specifically by Texas State Health Department regulations shall be presented with each application for a certificate of registration.

Section 7.01 SELF-REPORTING: All persons to whom this regulation applies shall submit reports to the Board in compliance with the procedure established by Order No. 69-1219-1 of the Texas Water Quality Board for holders of waste discharge permits.

Section 8.01 REVOCATION OR SUSPENSION OF REGISTRATION: Registration does not become a vested right. For good cause the Executive Director may provide for revocation or suspension of any registration in accordance with Chapter IV of the Rules of the Texas Water Quality Board.

Section 8.02 REVOCATION OR SUSPENSION WITH CONSENT: With the written consent of the holder of a certificate of registration, the Executive Director may provide for revocation or suspension of any registration in accordance with Rule 405.1 of the Rules of the Texas Water Quality Board. If the holder of a certificate of registration no longer desires operation under this regulation, or is agreeable to a suspension of the authority to do so for a specified period of time, the holder should file

a written waiver or consent with the central office of the Board. Upon a request, the central office of the Board will prepare a written waiver or consent and will send it to any holder of a certificate of registration for execution.

Section 8.03 AMENDMENT OR CORRECTION: The Executive Director may provide for amendment or correction of the provisions concerning any registration in accordance with Section 405 and Section 410 of the Rules of the Texas Water Quality Board.

Section 8.04 APPROVAL REQUIRED FOR TRANSFER OF REGISTRATION: Registration is granted in personam, does not attach to the operation or realty to which it relates, and cannot be transferred without prior notification to the Executive Director in accordance with Section 415 of the Rules of the Texas Water Quality Board.

Section 8.05 APPEAL TO THE BOARD: Any person aggrieved by any action taken by the Executive Director in revoking, suspending or amending any registration or any provision concerning any registration or in refusing to do so may appeal to the Board in accordance with the procedures established in Rule 600.2 of the Rules of the Texas Water Quality Board, and appeal to the Board shall be a prerequisite to judicial appeal.

Section 9.01 COMPLIANCE WITH RULES OF BOARD: Any application, action, procedure, or operation under this regulation shall be in accordance with the Rules of the Texas Water Quality Board.

Section 10.1 SEVERABILITY: If any provision of this regulation or the application thereof to any person or circumstances is held invalid, the validity of the remainder of the regulation and of the application of such provisions to other persons and circumstances shall not be affected thereby.

Section 11.1 EFFECTIVE DATE: This regulation takes effect on July 15, 1971.

REGULATION CONCERNING SAND AND GRAVEL WASHING OPERATIONS AND DISCHARGES THEREFROM

Section 1.01 DEFINITIONS: As used in this regulation, the following terms have the following meanings unless the context clearly requires a different meaning:

(1) "person" means individual, corporation, organization government or governmental subdivision or agency, business trust, partnership, association, or any other legal entity;

(2) "Board" means the Texas Water Quality Board;

(3) "Executive Director" means the Executive Director of the Texas Water Quality Board;

(4) "sand and gravel washing operation" means any person, operation, facility, establishment, or enterprise which washes sand and gravel in such a manner as to separate the sand and gravel from other materials present in the mixture in which the sand and gravel was originally taken from the ground and which makes no discharge into or adjacent to any water in the state other than discharges resulting exclusively from such washing. This definition specifically excludes any operation which introduces into such discharges any material other than material resulting from such washing of sand and gravel and this regulation does not apply to any discharges into which there has been introduced material other than material resulting from such washing of sand and gravel.

(5) "water in the state" means groundwater, percolating or otherwise, lakes, bays, ponds, impounding reservoirs, springs, rivers, streams, creeks, estuaries, marshes, inlets, canals, and the Gulf of Mexico within the territorial limits of the State of Texas, and all other bodies of surface water, natural or artificial, inland or coastal, fresh or salt, navigable or non-navigable, and including the beds and banks of all watercourses and bodies of surface water, that are wholly or partially within or bordering the state or within the jurisdiction of the State.

Section 2.01 APPLICATION OF REGULATION: This regulation applies to any and all sand and gravel washing operations, as defined above.

Section 2.02 EXCEPTION TO APPLICATION OF REGULATION: Any person to whom this regulation applies who does not wish to utilize the procedure for registration established by this regulation shall submit to the Board an application for a waste control order. This regulation shall continue to apply to any such person except in matters as to which the provisions of a valid waste control order from the Board supersede provisions of this regulation.

Section 3.01 PERSONS REQUIRED TO REGISTER: Every person whose sand and gravel washing operation discharges washwater into or adjacent to any water in the state must comply with the provisions of this regulation and any such sand and gravel washing operation must properly be registered in accordance with this regulation unless such discharge is authorized under a valid waste control order of the Texas Water Quality Board.

Section 3.02 APPLICATION FOR REGISTRATION: In order for his sand and gravel washing operation properly to be registered a person must hold a valid certificate of registration issued by the Executive Director. Upon request, the central office of the Board will furnish forms on which a person may make an application for a certificate of registration.

Section 3.03 PROVISION FOR NOTIFICATION: Any application for registration under this regulation must include a statement of notification. The statement shall indicate that the applicant has given notice of the application to interested parties. If the sand and gravel washing operation discharges wastewater into or adjacent to any waters in the state, these interested parties must include all owners of property which adjoins any receiving water within one mile downstream from any proposed point of discharge.

Section 3.04 REVIEW OF APPLICATION: The Executive Director or personnel acting under his direction will review the application and any accompanying maps, data, information, and materials. The Executive Director or those acting under his direction may request additional information reasonably required for an adequate understanding of the application, and the applicant must provide such additional information.

Section 3.05 ISSUANCE OR REFUSAL OF CERTIFICATE OF REGISTRATION: After a review of the application has been completed, the Executive Director shall either issue a certificate of registration or refuse to do so. Whenever the information provided by the application indicates that:

(a) pertinent circumstances are such that registration is the appropriate method for regulation, and

(b) that the applicant's sand and gravel washing operation will comply with this regulation and with other rules, regulations, orders, and policies of the Board, and

(c) that adequate protection will be provided to the property of others, to public property and rights-of-way, to any water in the state, and to other rights requiring protection,

the Executive Director shall enter registration of the sand and gravel washing operation in the official records of the Board and shall issue a certificate of registration to the applicant. Whenever the Executive Director refuses to register a sand and gravel washing operation, he shall promptly set out his reasons for so doing in writing to the applicant.

Section 3.06 IMPOSITION OF CONDITIONS: The Executive Director may impose on a registrant in connection with and at the time of taking formal action on his application for registration any condition, restriction, limitation, or provision reasonably necessary for the administration and enforcement of the Acts administered by the Board, as applicable, and the orders, rules, regulations and policies of the Board.

Section 3.07 APPEAL TO THE BOARD: Any person aggrieved by any action or refusal to act by the Executive Director on any application may appeal to the Board in accordance with the procedures established in Rule 600.2 of the Rules of the Texas Water Quality Board, and appeal to the Board shall be a prerequisite to judicial appeal.

Section 3.08 EFFECT OF APPLICATION AND REGISTRATION: Acceptance of registration by any person to whom this regulation applies constitutes an acknowledgement and agreement that he will comply with all of the terms, conditions, limitations, and restrictions imposed on him in connection with the registration, and will comply with the rules, regulations, and orders of the Board.

Section 3.09 CERTIFICATE BASED ON INCORRECT INFORMATION: If any applicant for registration shall submit material incorrect information, any certificate of registration issued as a result of such submission shall be void ab initio.

Section 4.01 QUALITY REQUIREMENTS: The concentration of settleable matter in discharges into or adjacent to any water in the state from sand and gravel washing operations registered under this regulation shall not exceed a level of 5 mg/l for a monthly average, 6 mg/l for a 24-hour composite sample, or 7 mg/l for an individual sample. The concentration of the suspended solids in discharges into or adjacent to any water in the state from sand and gravel washing operations registered under this regulation shall not exceed a level of 20 mg/l for a monthly average, 25 mg/l for a 24-hour composite sample, or 30 mg/l for an individual sample.

Section 5.01 MAINTENANCE REQUIREMENTS: If a retention facility is utilized to achieve the quality requirements established by this regulation, whenever the settled solids occupy thirty percent (30%) of the volume of the retention facility or some other percentage approved by the Executive Director, no sand and gravel washing operation which is registered under this regulation and which has utilized the retention facility shall make any further discharge of washwater into or adjacent to any water in the state until the retention facility shall have been restored to its original capacity.

Section 6.01 SELF-REPORTING: All persons to whom this regulation applies shall submit reports to the Board in compliance with the procedures established by Order No. 69-1219-1 of the Texas Water Quality Board for holders of waste discharge permits.

Section 7.01 REVOCATION OR SUSPENSION OF REGISTRATION: Registration does not become a vested right. For good cause the Executive Director may provide for revocation or suspension of any registration in accordance with Chapter IV of the Rules of the Texas Water Quality Board.

Section 7.02 REVOCATION OR SUSPENSION WITH CONSENT: With the written consent of the holder of a certificate of registration, the Executive Director may provide for revocation or suspension of any registration in accordance with Rule 405.1 of the Rules of the Texas Water Quality Board. If the holder of a certificate of registration no longer desires operation under this regulation, or is agreeable to a suspension of the authority to do so for a specified period of time, the holder should file a written waiver or consent with the central office of the Board. Upon request, the central office of the Board will prepare a written waiver or consent and will send it to any holder of a certificate of registration for execution.

Section 7.03 AMENDMENT OR CORRECTION: The Executive Director may provide for amendment or correction of the provisions concerning any registration in accordance with Section 405 and Section 410 of the Rules of the Texas Water Quality Board.

Section 7.04 APPROVAL REQUIRED FOR TRANSFER OF REGISTRATION: Registration is granted in personam, does not attach to the operation or realty to which it relates, and cannot be transferred without prior notification to the Executive Director in accordance with Section 415 of the Rules of the Texas Water Quality Board.

Section 7.05 APPEAL TO THE BOARD: Any person aggrieved by any action taken by the Executive Director in revoking, suspending, or amending any registration or any provision concerning any registration or in refusing to do so may appeal to the Board in accordance with the procedures established in Rule 600.2 of the Rules of the Texas Water Quality Board, and appeal to the Board shall be a prerequisite to judicial appeal.

Section 8.01 COMPLIANCE WITH RULES OF BOARD: Any application, action, procedure or operation under this regulation shall be in accordance with the Rules of the Texas Water Quality Board.

Section 9.01 SEVERABILITY: If any provision of this regulation or the application thereof to any person or circumstances is held invalid, the validity of the remainder of the regulation and of the application of such provisions to other persons and circumstances shall not be affected thereby.

Section 10.01 EFFECTIVE DATE: This regulation takes effect on July 15, 1971.

NOTE: The following pages have been extracted verbatim from the "Proposed Water Quality Standards submitted to Environmental Protection Agency" (dated April 1973) by the Texas Water Quality Board.

K. TEXAS WATER QUALITY BOARD GENERAL STATEMENT AND PROPOSED WATER QUALITY STANDARDS FOR THE COLORADO RIVER AND TRIBUTARIES

NOTICE

These Water Quality Standards were adopted for the State of Texas by the Texas Water Quality Board on April 12, 1973. These standards will be submitted to the Environmental Protection Agency Region VI, Dallas, Texas, from the Governor's Office by April 18, 1973.

A public hearing was held on April 6, 1973 to adopt proposed water quality standards prepared by the staff of the Texas Water Quality Board. Presentations and testimonies submitted during and immediately following this public hearing resulted in amendments to the proposed water quality standards. These changes are underlined in the general statement. On the tables, these changes are shown by marking through the old data and inserting the new data immediately above. Any new segments are noted in the left hand column.

GENERAL STATEMENT

I. Authority

Pursuant to the authority contained in Sections 21.075 through 21.078 of the Texas Water Code (60th Legislature, Chapter 313, Sections 3.14 through 3.17, as amended by House Bill 343 during the regular session of the 62nd Legislature in 1971), the Texas Water Quality Board adopts the following stream standards.

II. Policy Statement

It is the policy of this state and the purpose of this chapter to maintain the quality of water in the state consistent with the public health and enjoyment, the propagation and protection of terrestrial and aquatic life, the operation of existing industries, and the economic development of the state; to encourage and promote the development and use of regional and area-wide waste collection, treatment, and disposal systems to serve the waste disposal needs of the citizens of the state; and to require the use of all reasonable methods to implement this policy. (Texas Water Code Chapter 21, Section 21.002, 60th Legislature, Chapter 313, Section 1.02, as amended).

III. Antidegradation Statement

In implementing the legislative policy expressed in the Texas Water Quality Act, it is the policy of the Texas Water Quality Board that the waters in the state whose existing quality is better than the applicable water quality standards described herein as of the date when these standards become effective will as provided hereafter be maintained at their high quality, and no waste discharges may be made which will result in the lowering of the quality of these waters unless and until it has been demonstrated to the Texas Water Quality Board that the change is justifiable as a result of desirable economic or social development. Therefore, the Board will not authorize or approve any waste discharge which will result in the quality of any of the waters in the state being reduced below the water quality standards without complying with the federal and state laws applicable to the amendment of water quality

standards. Anyone making a waste discharge from any industrial, public or private project or development which would constitute a new source of pollution or an increased source of pollution to any of the waters in the state will be required, as part of the initial project design, to provide the highest and best degree of waste treatment available under existing technology consistent with the best practice in the particular field affected under the conditions applicable to the project or development. The Board will keep the Environmental Protection Agency informed of its activities and will furnish to the agency such reports in such form, and containing such information as the Administrator of the Environmental Protection Agency may from time to time reasonably require to carry out his functions under the Water Pollution Control Act Amendments of 1972. Additionally, the Board will consult and cooperate with the Environmental Protection Agency on all matters affecting the federal interest.

IV. Classification of Surface Waters

The surface waters of the state have been divided into the following categories for ease of classification. Where the geographical coverage of a particular identified water or segment is subject to interpretation, e.g., West Bay, the segment limits shall be as defined by the maps included in the standards.

1. River Basin Waters - those surface inland waters comprising the major rivers and their tributaries, <u>including listed impounded waters</u>, and including the tidal portion of the river to the extent that it is confined in a channel.

2. Coastal Basin Waters - those surface inland waters, <u>including listed impounded waters,</u> exclusive of 1 above discharging or flowing or otherwise communicating with bays or the gulf including the tidal portion of streams to the extent that they are confined in channels.

3. Bay Waters - all tidal waters exclusive of those included in river basin waters, coastal basin waters, and gulf waters.

4. Gulf Waters - those waters which are not included in or form a part of any bay or estuary but which are a part of the open waters of the Gulf of Mexico to the limit of Texas' jurisdiction.

V. Description of Standards

The General Statement is an integral part of the standards and the standards shall be interpreted in accord with the General Statement.

These standards consist of three parts:

1. General Criteria applicable to all surface waters for which standards are established

2. Numerical Criteria applicable to specific surface waters designated in the standards

3. Water Uses

In determining the suitability of waters of the state for various uses, the following water quality criteria were used as guidelines. Nothing in these water quality standards limits the authority of the Commissioner of Health of the State of Texas to take such public health protective measures as he may deem necessary.

a. Contact recreation waters

Surface waters suitable for contact recreation shall not exceed a logarithmic mean (geometric mean) fecal coliform content from a representative sampling of not less than 5 samples collected over not more than 30 days, as determined by either multiple-tube fermentation or membrane filter techniques, of 200/100 ml, nor shall more than 10 percent of total samples during any 30-day period exceed 400/100 ml.

Simple compliance with bacteriological standards does not insure that waters are safe for primary contact recreation, such as swimming. Long-standing public health principles mandate that watershed sanitary surveys be conducted in order to adequately evaluate the sanitary hazards potentially present on any natural water course.

b. Noncontact recreation waters

Surface waters for general or noncontact recreation should with specific and limited exceptions, be suitable for human use in recreation activities not involving significant risks of ingestion. These waters shall not exceed a logarithmic mean (geometric mean) fecal coliform content of 2,000/100 ml and a maximum of 4,000/100 ml, except in specified mixing zones adjacent to outfalls.

These waters should not exceed a logarithmic mean (geometric mean) fecal coliform content of 1,000/100 ml, nor equal or exceed 2,000/100 ml in more than 10 percent of the samples, except in specified mixing zones adjacent to outfalls.

c. Domestic raw water supply

It is the goal that the chemical quality of all surface waters used for domestic raw water supply conform to the U.S. Public Health Service Drinking Water Standards, revised 1962, or latest revision. However, it must be realized that some surface waters are being used that cannot meet these standards. Since in these cases it is the only source available, these surface waters may be deemed suitable for use as a domestic raw water supply, where the chemical constituents do not pose a potential health hazard.

It is desirable that the total coliform content should not exceed 100/100 ml and the fecal coliform content 20/100 ml. The monthly arithmetic averages should not exceed 10,000/100 ml total coliforms or 2,000/100 ml fecal coliforms.

The evaluation of raw water cannot be reduced to simply counting bacteria of any kind and the foregoing must be used with judgment and discretion and this paragraph is not intended to limit the responsibilities and authorities of responsible local governments or local health agencies.

d. Irrigation waters

The suitability of water for use as irrigation water is influenced by:

(1) the total salt concentration or salinity hazards;

(2) the amount of sodium and its relation to other cations;

(3) the concentration of boron and other constituents that may be toxic; and

(4) the bicarbonate content in relation to calcium and magnesium.

The suitability of water for irrigation will be based on the irrigation water classification system prepared by the USDA salinity laboratory. The various salinity classes are:

Class #1 - low-salinity water can be used for irrigation with most crops on most soils with little likelihood that soil salinity will develop.

Class #2 - medium-salinity water can be used if a moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown in most cases without special practices for salinity control.

Class #3 - high-salinity water cannot be used on soil with restricted drainage.

Class #4 - very high-salinity water is not suitable for irrigation under ordinary conditions but may be used occasionally under special circumstances. The soil must be permeable, drainage must be adequate, irrigation water must be applied in excess to provide considerable leaching and highly salt-tolerant crops must be selected.

The SAR (sodium adsorption ratio) should not exceed 8 for waters safe for irrigation. Sampling and analytical procedures and schedules are not specified but would be as appropriate for adequate protection of irrigation waters.

e. Shellfish waters

In shellfish areas in the bays and outside the buffer zones, the coliform criteria shall be limited and guided by the U.S. Public Health Service Manual, "Sanitation of Shellfish Growing Areas," 1965 revision, or latest revision.

VI. General Criteria

The general criteria enumerated below are applicable to surface waters for which standards are established and specifically apply with respect to substances attributed to waste discharges or the activities of man as opposed to natural phenomena. Natural waters may, on occasion, have characteristics outside the limits established by these criteria; in which case these criteria do not apply. The criteria adopted herein relate to the condition of waters as affected by waste discharges or man's activities. The criteria listed following do not override a specific exception to any one or more of the following if the exception is specifically stated in a specific water quality standards.

1. Taste and odor producing substances shall be limited to concentrations in the waters of the state that will not interfere with the production of potable water by reasonable water treatment methods, or impart unpalatable flavor to food fish, including shellfish, or result in offensive odors arising from the waters, or otherwise interfere with the reasonable use of the waters.

2. Essentially free of floating debris and settleable suspended solids conducive to the production of putrescible sludge deposits or sediment layers which would adversely affect benthic biota or other lawful uses.

3. Essentially free of settleable suspended solids conducive to changes in the flow characteristics of stream channels, to the untimely filling of reservoirs and lakes, and which might result in unnecessary dredging costs.

4. The surface waters in the state shall be maintained in an aesthetically attractive condition.

5. There shall be no substantial change in turbidity from ambient conditions due to waste discharges.

6. There shall be no foaming or frothing of a persistent nature.

7. There shall be no discharge of radioactive materials in excess of that amount regulated by the Texas Radiation Control Act, Article 4590(f), Revised Civil Statutes, State of Texas and Texas Regulation for Control of Radiation.

Radioactivity levels in the surface waters of Texas, including the radioactivity levels in both suspended and dissolved solids for the years 1958 through 1960, were measured and evaluated by the Environmental Sanitation Services Section of the Texas State Department of Health in a report prepared for and at the direction of the Health Department by the Sanitary Engineering Research Laboratory at the University of Texas. The document is entitled, Report on Radioactivity -- Levels in Surface Waters -- 1958-1960 pursuant to contract No. 4413-407 and is dated June 30, 1960. This document comprises an authoritative report on background radioactivity levels in the surface waters in the state and quite importantly sets out the locations where natural radioactive deposits have influenced surface water radioactivity. The impact of radioactive discharges that may be made into the surface waters of Texas will be evaluated and judgments made on the basis of the information in the report which was at the time made, and may still be, the only comprehensive report of its kind in the nation.

Radioactivity in fresh waters associated with the dissolved minerals (measurements made on filtered samples) shall not exceed those enumerated in U.S. Public Health Service Drinking Water Standards, revised 1962, or latest revision, unless such conditions are of natural origin.

8. The surface waters of the state shall be maintained so that they will not be toxic to man, fish and wildlife, and other terrestrial and aquatic life.

   With specific reference to public water supplies, toxic materials not removable by ordinary water treatment techniques shall not exceed those enumerated in U.S. Public Health Service, 1962 edition, or later revision.

   For a general guide, with respect to fish toxicity, receiving waters outside mixing zones should not have a concentration of nonpersistent toxic materials exceeding 1/10 of the 96-hour TLm, where the bioassay is made using biota indigenous to the receiving waters. Similarly, for persistent toxicants, the concentrations should not exceed 1/20 of the 96-hour TLm. In general, for evaluations of toxicity, bioassay techniques will be selected as suited to the purpose at hand.

9. As detailed studies are completed, limiting nutrients identified, and the feasibility of controlling excessive standing crops of phytoplankton or other aquatic growths by nutrient limitations is determined, it is anticipated that nutrient standards will be established on the surface waters of the state. Such decisions will be made on a case-by-case basis by the Board after proper hearing and public participation. The establishment of a schedule for decisions as to the need for nutrient standards for specific waters and what standards should be adopted is not feasible at this time.

10. The surface waters of the state shall be maintained so that no oil, grease, or related residue will produce a visible film of oil or globules of grease on the surface, or coat the banks and bottoms of the watercourse.

VII. Numerical Criteria

The numerical criteria apply to the specific waters identified. Stream standards apply only to waters where standards are established and specifically apply with respect to substances attributed to waste discharges or the activities of man as opposed to natural phenomena.

Chemical concentration parameters, with the exception of dissolved oxygen and pH, apply to the approximate midpoint of the segment with reasonable gradients applying toward segment boundaries. The numerical values shown represent arithmetic average conditions over a period of one year. Whenever an unusual chemical concentration is found, an investigation of its origin will be made and such action as is warranted initiated.

The dissolved oxygen values are minimum values which are applicable except as qualified in Section VIII. For short periods of time, diurnal variations of 1.0 mg/l below the standard specified in the table shall be allowed for not more than 8 hours during any 24-hour period.

The pH range represents maximum and minimum conditions throughout the segment except as qualified in Section VIII.

The temperature limitations are intended to be applied with judgment and are applicable to the waters specifically identified herein with the qualifications enumerated in Section VIII. Temperature standards for fresh water are composed of two parts, a maximum temperature and a maximum temperature differential attributable to heated effluents. Temperature standards for tidal river reaches, bay and gulf waters, consist only of a maximum temperature differential.

The maximum temperatures enumerated in the tables for specific waters represent the ordinary maximum natural temperatures known to occur from existing data (excluding up to about 5% of the highest temperatures measured presumed to be associated with low flow or other abnormal conditions) plus the temperature differential shown following for the particular class of water under consideration. Natural high temperatures, in excess of 96° F, occur regularly in Texas waters during the summer months. For example,

2. 3% of United States Geological Survey measurements made during the summer months on the Double Mountain Fork of the Brazos River near Aspermont, Texas, during the period 1958 through 1971 exceeded 96°F. In order to avoid precluding legitimate and beneficial use of Texas waters for industrial cooling, should a lawful permit be issued for this use, temperature differentials over natural temperatures are necessary and have been included in the standards. It is consequently concluded that the 90°F maximum temperature suggested by the National Technical Advisory Committee is not applicable to Texas conditions.

Fresh Water Streams:

Maximum Temperature	See Table for Specific Waters
Maximum Temp. Diff.	5°F rise over ambient

Fresh Water Impoundments:

Maximum Temperature	See Table for Specific Waters
Maximum Temp. Diff.	3°F rise over ambient

Tidal River Reaches, Bay and Gulf Waters:

	Fall, Winter, and Spring	Summer
Maximum Temp. Diff.	4°F	1.5°F

The temperature requirements shall not apply to off-stream or privately owned reservoirs, or reservoirs constructed primarily for industrial cooling purposes and financed in whole or in part with funds supplied by the entity or successor entity using the lake for cooling purposes.

Appreciable quantities of heated wastes will not be discharged into the waters listed in Table K-1 without individual evaluation. These waters are construed to be cool waters and thereby potentially or presently suitable for cool water fisheries.

In effluent dominated streams, the specified temperature differentials shall not apply where the temperature increase is due to the discharge of a treated sewage effluent.

Bacteriological water quality standards consist of two parts: (1) a measure of general quality, and (2) a limit on variations from the general quality.

For all waters except gulf and bay waters, the measure of general quality is the logarithmic mean (geometric mean) of fecal coliform determinations. The number specified in the tables applies to the logarithmic mean (geometric mean) of the data from a representative sampling of not less than 5 samples collected over not more than 30 days. All aspects of the sampling shall be such that a truly representative result is obtained. For routine observation and evaluation of water quality, lesser numbers of samples collected over longer periods will be used. In bay waters (exclusive of bay waters in the buffer zone), the number specified in the tables applies to the median total coliform density as specified in the "National Shellfish Sanitation Program Manual of Operation, Part 1, Sanitation of Shellfish Growing Areas", 1965 Revision, or latest revision.

The limit on variations from the general bacteriological quality on all waters except gulf and bay waters is a fecal coliform density which shall not be equaled or exceeded in more than 10% of the samples. This density is twice the numerical criteria specified in the table. In the instance of gulf and bay waters (exclusive of the buffer zones), the criteria for shellfish growing water shall apply.

TABLE K-1

San Marcos River	- Headwaters to confluence at Blanco River
Blanco River	- Headwaters to Halifax Creek
Guadalupe River	- Headwaters to Ingram
Guadalupe River	- Canyon Dam to Mountain Creek Confluence
Llano River	- Headwaters to S. H. 16 bridge in Llano
Nueces River	- Headwaters to Northern Uvalde County Line
Brazos River	- Below Possum Kingdom dam for approximately ten miles
Frio River including Leona River	- Headwaters to I. H. 35 bridge crossing
Sabinal River	- Headwaters to Southern Bandera County Line
Medina River	- Headwaters to Southern Bandera County Line
Lampasas River	- Headwaters to Stillhouse Hollow Dam
Canyon Reservoir	- Comal County
Lake Meredith	- Hutchinson County
Greenbelt Lake	- Donley County
Somerville Reservoir	- Burleson County
Belton Reservoir	- Bell County
Medina Reservoir	- Medina County

TABLE K-1 (cont'd)

Lake Lewisville	- Denton County
Diversion Reservoir	- Archer County
San Angelo Reservoir	- Tom Green County
Twin Buttes Reservoir	- Tom Green County
Lake Conroe	- Montgomery County
Tule Canyon Lake	- Swisher County
Lake J. B. Thomas	- Scurry County
Lake Cypress Springs	- Franklin County

VIII. Application of Standards

1. Flow Conditions

The flow conditions specified herein apply to river and coastal basin waters. They do not apply to bay and gulf waters, or lakes and reservoirs.

a. Chemical parameters: The water quality standards for chemical parameters, exclusive of dissolved oxygen, represent annual arithmetic mean concentrations which will not be exceeded for any year where the sampling median flow for the year under consideration equals or exceeds 50% of the median flow for the period of record for the existing hydrological conditions.

The sampling median flow for the year under consideration is defined for the purposes of this section to be the median of the flow measurements made on the days samples were collected. The "median flow for the period of record" is defined as the 50% value secured from a flow-probability graph constructed from available data. Existing hydrologic conditions means for the purpose of this section, the existing major physical features of the watershed, i.e., dams, diversion structures, etc.; the existing consumptive water uses; or any other factor which would significantly affect the hydraulic regime of the flow measuring station or other point under consideration.

When the flow is zero, no data will be collected and the annual arithmetic mean concentration is defined as the mean of the data collected when a flow exists.

b. The dissolved oxygen concentrations represent minimum values and shall apply at all times that the daily flow exceeds the 7-day minimum average flow for the existing hydrologic conditions with a recurrence interval of two years, except where this flow is zero. When the flow is zero, the dissolved oxygen standards shall not apply.

c. Temperature: Same as dissolved oxygen

d. Other Parameters and General Criteria: The general criteria and the numerical criteria not specifically discussed above shall apply at all times regardless of flow unless specifically excepted under Section VIII - 2, 3, and 4.

2. Mixing Zones

Where mixing zones are specifically defined in a valid waste control order issued by the Texas Water Quality Board or a National Pollutant Discharge Elimination System permit, the defined zone shall apply.

Where the mixing zone is not so defined, a reasonable zone shall be allowed. Because of varying local physical, chemical, and biological conditions, no single criterion is applicable in all cases. In no case, however, where fishery resources are considered significant, shall the mixing zone allowed preclude the passage of free-swimming and drifting aquatic organisms to the extent of significantly affecting their populations.

3. Buffer Zones in Bay and Gulf Waters

For all bay and gulf waters, exclusive of those contained in river or coastal basins as defined in Section IV, a buffer zone of 1000 feet measured from the shoreline at ordinary high tide is hereby established. In this zone, the bacteriological requirements enumerated in other sections of these standards shall not apply. In these zones, the logarithmic mean (geometric mean) density of fecal coliform organisms shall not exceed 200/100 ml, nor shall more than 10% of the total samples exceed 400/100 ml. The foregoing percentages are applicable when examining data from not less than 5 samples collected over not more than 30 days. For routine observation and evaluation of water quality, lesser numbers of samples collected over longer periods will be used.

4. Exceptions

The water quality standards will not apply to:

a. effluents,

b. water in mixing zones as defined in this section or in a valid waste control order issued by the Texas Water Quality Board or a National Pollutant Discharge Elimination System permit, or

c. inland effluent dominated streams during periods when the daily flow is totally composed of effluent excluding minor amounts of bank seepage.

d. dead-end barge and dead-end ship channels constructed for navigation purposes unless specifically designated in the tables.

In cases where the exceptions enumerated in VIII - 4. c. and VIII - 4. d. are applicable, such waste treatment as is required to maintain a minimum of 2.0 mg/l of dissolved oxygen will be required, taking full recognition of other provisions of the General Statement. Nothing in this statement precludes requiring waste treatment over and above that required to meet a 2 mg/l dissolved oxygen standard.

e. the upper portion of the Houston Ship Channel, Segments 1006 and 1007, with respect to the toxicity clause, Section VI. 8., insofar as this clause relates to the propagation of fish and wildlife.

The waters of the upper Houston Ship Channel shall be maintained in such a condition as to pose no health hazard to men working in or near these waters.

IX. Determination of Compliance

In making any tests or analytical determination on classified surface waters to determine compliance or noncompliance with water quality standards, representative samples shall be collected at locations approved by the Texas Water Quality Board.

1. Collection and Preservation of Samples

Samples for determining compliance with the standards, excepting temperature as explained below, will be collected one foot below the water surface unless the water depth is less than 1.5 feet, in which case the collection depth shall be one-third of the water depth measured from the water surface.

For impoundments, the temperature standards enumerated shall apply to the representative temperature of the receiving water outside the mixing zone measured by averaging temperature measurements made at equal and appropriate intervals from the surface to the bottom except where the impoundment is stratified. In these cases, the bottom is defined as the thermocline and the temperature measurements for determining compliance shall be confined to the epilimnion. The thermocline shall be that point of rapid temperature change with vertical depth as defined in standard textbooks on the subject. (The thermocline as defined in A Treatise on Limnology, Volume I, page 428, by G. Evelyn Hutchinson is the plane of maximum rate of decrease in temperature.)

In tidal river reaches, the temperature standards apply to the fresh water layer in stratified situations similar to impoundments above.

Samples will be collected from the present established sampling stations to insure continuance in monitoring with that done in the past. In those cases where there are not sufficient established points, it may be necessary to establish additional stations. This statement does not preclude sampling at other points in the conduct of field investigations.

Collection and preservation of samples will be in accordance with accepted procedures to assure representative samples of the water and to minimize alterations prior to analysis.

2. Analysis of samples

Numerical values in the water quality standards will be determined by analytical procedures outlined in the latest edition of "Standard Methods for the Examination of Water and Waste Water" as prepared and published jointly by the American Public Health Association, the American Waterworks Association, and the Water Pollution Control Federation. Also, tests may be in accordance with other acceptable methods which have proven to yield reliable data to the satisfaction of the Texas Water Quality Board.

PROPOSED WATER QUALITY STANDARDS

Basin Numbers	Basin
01	Canadian River Basin
02	Red River Basin
03	Sulphur River Basin
04	Cypress Creek Basin
05	Sabine River Basin
06	Neches River Basin
24	Sabine-Neches Estuary
07	Neches-Trinity Coastal Basin
08	Trinity River Basin
09	Trinity-San Jacinto Coastal Basin
24	Trinity-San Jacinto Estuary
10	San Jacinto River Basin
11	San Jacinto-Brazos Coastal Basin
12	Brazos River Basin
13	Brazos-Colorado Coastal Basin
24	East Matagorda Estuary
14	Colorado River Basin
15	Colorado-Lavaca Coastal Basin
24	Lavaca-Tres Palacios Estuary
16	Lavaca River Basin
17	Lavaca-Guadalupe Coastal Basin
18	Guadalupe River Basin
24	Guadalupe Estuary
19	San Antonio River Basin
24	Mission-Aransas Estuary
20	San Antonio-Nueces Coastal Basin
21	Nueces River Basin
24	Nueces Estuary
22	Nueces-Rio Grande Coastal Basin
24	Laguna Madre Estuary
23	Rio Grande Basin
25	Gulf of Mexico

PROPOSED WATER QUALITY STANDARDS
FRESH & TIDAL WATERS

COLORADO RIVER BASIN*		WATER USES QUALITY DEEMED SUITABLE/ KNOWN USES				CRITERIA						
SEGMENT NUMBER	DESCRIPTION	CONTACT RECREATION	NON-CONTACT RECREATION	PROPAGATION OF FISH & WILDLIFE	DOMESTIC RAW WATER SUPPLY	CHLORIDE (mg/l) avg. not to exceed	SULPHATE (mg/l) avg. not to exceed	TOTAL DISSOLVED SOLIDS (mg/l) avg. not to exceed	DISSOLVED OXYGEN (mg/l) not less than	pH RANGE	COLIFORM FECAL/ (100ml) - log. avg. not more than (see Gen. Statement)	TEMPERATURE °F (see Gen. Statement)
1401	Colorado River Tidal	s/k	s/k	s/k					5.0	6.7-8.5	200	X
1402	Colorado River - above tidal to Tom Miller Dam, including Town Lake	s/	s/k	s/k	s/k	100	75	500	5.0	6.5-8.5	200	95
1403	Lake Austin	s/k	s/k	s/k	s/k	100	75	400	5.0	6.5-8.5	200	90
1404	Lake Travis	s/k	s/k	s/k	s/k	100	75	400	5.0	6.5-8.5	200	90
1405	Lake Marble Falls	s/k	s/k	s/k	s/k	100	75	400	5.0	6.5-8.5	200	94
1406	Lake Lyndon B. Johnson	s/k	s/k	s/k	s/k	100	75	400	5.0	6.5-8.5	200	94
1407	Inks Lake	s/k	s/k	s/k	s/k	100	75	400	5.0	6.5-8.5	200	90
1408	Lake Buchanan	s/k	s/k	s/k	s/k	100	75	400	5.0	6.5-8.5	200	90
1409	Colorado River - Lake Buchanan headwater to San Saba River confluence	s/k	s/k	s/k	s/k	200	200	500	5.0	6.5-8.5	200	95

* Standards to be reviewed upon completion of Corps of Engineers Colorado River Study, if necessary

PROPOSED WATER QUALITY STANDARDS
FRESH & TIDAL WATERS

COLORADO RIVER BASIN		WATER USES QUALITY DEEMED SUITABLE/ KNOWN USES				CRITERIA						
SEGMENT NUMBER	SEGMENT DESCRIPTION	CONTACT RECREATION	NON-CONTACT RECREATION	PROPAGATION OF FISH & WILDLIFE	DOMESTIC RAW WATER SUPPLY	CHLORIDE (mg/l) avg. not to exceed	SULPHATE (mg/l) avg. not to exceed	TOTAL DISSOLVED SOLIDS (mg/l) avg. not to exceed	DISSOLVED OXYGEN (mg/l) not less than	pH RANGE	COLIFORM FECAL/ (100ml) - log. avg. not more than (see Gen. Statement)	TEMPERATURE °F (see Gen. Statement)
1410	Colorado River - San Saba River confluence to E.V. Spence Reservoir (Robert Lee Dam)	s/k	s/k	s/k	s/k	400	300	1,250	5.5	6.5-8.5	1,000	96
1411	E.V. Spence Reservoir	s/k	s/k	s/k	s/k	500	500	1,500	5.0	6.5-8.5	200	93
1412	Colorado River - FM 2059 near Silver to Lake J.B. Thomas (Colorado River Dam)		s/k	s/k		8,000	2,500	20,000	5.0	6.5-8.5	1,000	98
1413	Lake J.B. Thomas	s/k	s/k	s/k	s/k	50	60	500	5.0	6.5-8.5	200	** 93
1414	Pedernales River		s/k	s/k	s/k	80	50	500	5.0	6.5-8.5	1,000	98
1415	Llano River		s/k	s/k	s/k	50	50	300	5.0	6.5-8.5	1,000	98
1416	San Saba River	s/k	s/k	s/k	s/k	80	50	500	5.0	6.5-8.5	200	95
1417	Pecan Bayou - Colorado River confluence to Lake Brownwood Dam		s/k	s/k	s/k	250	200	1,000	5.0	6.5-8.5	1,000	95

* Standards to be reviewed upon completion of Corps of Engineers Colorado River Study, if necessary

**Subject to revision

PROPOSED WATER QUALITY STANDARDS
FRESH & TIDAL WATERS

COLORADO RIVER BASIN		WATER USES QUALITY DEEMED SUITABLE/ KNOWN USES				CRITERIA						
SEGMENT NUMBER	DESCRIPTION	CONTACT RECREATION	NON-CONTACT RECREATION	PROPAGATION OF FISH & WILDLIFE	DOMESTIC RAW WATER SUPPLY	CHLORIDE (mg/l) avg. not to exceed	SULPHATE (mg/l) avg. not to exceed	TOTAL DISSOLVED SOLIDS (mg/l) avg. not to exceed	DISSOLVED OXYGEN (mg/l) not less than	pH RANGE	COLIFORM FECAL/ (100ml) - log. avg. not more than (see Gen. Statement)	TEMPERATURE °F (see Gen. Statement)
1418	Lake Brownwood	s/k	s/k	s/k	s/k	100	100	500	5.0	6.5-8.5	200	93
1419	Lake Coleman	s/k	s/k	s/k	s/k	100	100	500	5.0	6.5-8.5	200	93
1420	Pecan Bayou - above Lake Brownwood	s/k	s/k	s/k		500	500	1,500	5.0	6.5-8.5	200	90
1421	Concho River - Colorado River confluence to fork in San Angelo, including South Fork to Lake Nasworthy Dam and North Fork to San Angelo Reservoir Dam		s/k	s/k	s/k	600	500	2,000	5.0	6.5-8.5	1,000	95
1422	Lake Nasworthy	s/k	s/	s/k		450	400	1,500	5.0	6.5-8.5	200	93
1423	Twin Buttes Reservoir	s/k	s/k	s/k	s/k	150	150	700	5.0	6.5-8.5	200	** 93
1424	South and Middle Concho Rivers -above Twin Buttes Reservoir	s/k	s/k	s/k	s/k	150	150	700	5.0	6.5-8.5	200	90
1425	San Angelo Reservoir	s/k	s/k	s/k	s/k	150	150	700	5.0	6.5-8.5	200	** 93

* Standards to be reviewed upon completion of Corps of Engineers Colorado River Study, if necessary

** Subject to revision,

L. PUBLIC INVOLVEMENT PROGRAM.

General.

Public involvement in the Colorado River Basin Wastewater Management Study was a continuous process that utilized many of the public participation devices that have been advanced for use in water resources planning techniques. These devices included public meetings, workshops, newspaper releases, radio and television coverage, brochures and newsletters and individual contacts. In addition to these elements, the Governor's Planning Committee -- Colorado River Water Quality Study-- served as a built-in public involvement tool for the public-participation phase of the study.

The Governor's Planning Committee was composed of representatives of Federal, State, regional and local governmental agencies, as well as individual citizens who were designated to speak for the general public. The general public group included citizens interested in the environmental disciplines, educational institutions, and labor, management, agricultural and industrial economic spheres. Because of the geographic magnitude of the Basin, great care was taken in the selection of the Governor's Planning Committee to insure that all areas of the Basin were represented by a member of the committee. In view of the great travel distances involved in the study area, these committee members were intended to serve as a ready means of communication between the study team and the general public in specific areas.

In addition, the Planning Committee assisted in the compilation of a mailing list of interested individuals and organizations, arranged for meeting places, provided personnel to conduct workshop meetings and to work with the communications media to inform the general public of the study's progress and activities. The Committee also made available reproduction facilities for the printing of study brochures and information releases.

The basic philosophy of the public involvement program was centered on the premise that the overall study was a non-controversial element. It was felt that the end result of clean water was an overriding factor in the evaluation of the study elements, and the attainment of this end result was considered to be paramount to the objectionable features that may be encountered in the planning process. This is not to say that the planning process ignored the public desires, but rather that the process conformed to the public demand for a clean-water formula. In this regard, it became evident early in the study that the general public

contribution to the planning process would be minimal at best. This lack of input from the general public to the study may be traced to three general factors: (1) apathy to the entire investigation; (2) lack of knowledge concerning the wastewater management process; (3) a prevalent attitude that the provision of these services and planning concepts were wholly the prerogative and obligation of Federal and State governmental agencies. With this background, the public involvement phase of the study concentrated on an educational effort to explain the study goals and the ways and means to be employed to achieve these end products.

In the formation of an organizational structure for the public involvement program, strong emphasis was placed on the participation of the Governor's Planning Committee. As part of the 50 percent non-Federal study effort sharing requirement, the Governor's Planning Committee was charged with the responsibility of "compilation of a mailing list of interested individuals and organizations, arrangements for meeting places, provision of personnel to conduct workshop meetings and to work with the communications media to inform the general public of the study's progress and activities." In this capacity, the Planning Committee assumed a lead role in the arrangements and conduct of the workshop program for the study. The Planning Committee arranged for utilization of State reproduction facilities for the printing of the formal study brochure. The Planning Committee also acted as the contact and liaison agent between the study team, including the consultant, and the affected State, regional and local governmental bodies.

In its role in the public involvement program, the Fort Worth District furnished the information input and necessary manpower to carry out the education and information phase of the study. In this capacity, the Fort Worth District pursued an information program designed to assist the public by defining the wastewater management planning process and by suggesting methods in which the public could participate in this process. The program established contacts through which expressions of purposes and recommended solutions could be incorporated into the Corps planning process and the programs of other Federal, State, regional and local agencies. The elements that were used in the pursuit of this program were public meetings, brochures, newsletters, news releases, and public contacts with individuals and organizations -- both in the private and public sector.

In addition to the Governor's Planning Committee, other established avenues of public participation were utilized in the study. A brief description of these activities is given in the following paragraphs.

Mailing List.

The preparation of the mailing list was initiated by a canvass of the State and Federal agencies for the available information regarding the interested organizations and individuals in the Colorado River Basin. Information was also sought from various environmental and conservation groups as to the mailing lists used by their organizations. These lists were supplemented by available information on the Colorado River Basin in the Fort Worth District. The task of compiling and maintaining the final list was undertaken by the Fort Worth District and resulted in a tabulation exceeding 1750 names and/or addresses. Maintenance of the list in an up-to-date manner was a considerable undertaking due to numerous name and address changes, particularly in the environmental and political sectors of the roster. The list was used for the mailing of notices to the public meetings and for dissemination of the study newsletter.

Public Meetings.

Two public meetings were held at the initiation of the study to inform the general public of the purpose of the study and the methods and procedures which would be followed to produce the end result. The meetings were held in Austin and San Angelo, Texas, on 11 and 13 July 1972, respectively. These meetings were co-chaired by the Governor's Planning Committee and by the Corps. Arrangements for the meetings were the responsibility of the Governor's Planning Committee, while the Corps issued the notices and news releases and provided background data for informative purposes for the meetings.

Despite the widespread circulation of the news releases and the comprehensive coverage afforded by the mailing list, attendance at these public meetings was smaller than desired, as less than 150 persons were in attendance at the meetings. In addition to the small attendance, the response from the attendees was severely limited, thereby limiting the effectiveness of the meetings as a sounding board for local concerns and interests. The limited attendance and lack of interest displayed at these meetings were factors in a decision to concentrate involvement efforts on an education program which would feature a public contacts and newsletter approach.

An additional formal public hearing was held on 24 August 1973 prior to the submission of the report to the Governor. The purpose of this meeting was to discuss the recommended plan with the public and to receive comments from the public as to its acceptability prior to the

submission of the report to the Governor. This meeting was arranged and conducted by the Texas Water Quality Board (TWQB) as part of that agency's legally required study procedures. The TWQB issued a meeting notice 30 days in advance of the meeting, using the mailing list furnished by the Corps. The Corps participated in and was a party to the TWQB meeting as part of the public involvement program for this study. Records of public meetings at Austin and San Angelo are included in this appendix.

Brochures.

A formal brochure was issued in August 1972 which described the format of the study and established a communication contact point for the public. The editorial and illustrative work for the brochure was prepared by the Fort Worth District and the reproduction of the brochure was handled by the Planning Committee. The brochure was furnished to all affected State agencies, Chambers of Commerce, river authorities, members of the Planning Committee and organizations connected with the study. A copy of the brochure was included in all correspondence regarding the wastewater management study. If funds are available, another brochure will be published at the close of the study which will define the end result of the study and outline a future course of action for the using public.

Workshops.

The responsibility for the arrangements and conduct of the workshops rested with the Planning Committee as described earlier. The intent of the workshops was to present and to obtain more detailed information regarding the study direction and input than would be obtained at a larger-size gathering. In September 1972, workshops were held at Midland-Odessa, San Angelo, Wharton and Austin, Texas. These meetings, which were held in the early stages of the study, were aimed at gathering information as to trouble spots in the Basin. Handouts at the meeting requested information on such items of potential stream pollution as feed lots, industrial wastes, lake contamination, operational difficulties, etc. The attendees were more than willing to share thoughts and ideas on the improvements they desired and problem areas they felt should be addressed in the study. Although the attendance did not reflect the full spectrum of the general public, as discussed earlier, the interchange of ideas was of the highest order in regards to the legal and technical complexities that were an integral part of the study.

A second round of workshops were held in the latter stages of the study when finalized treatment system proposals were prepared for the non-metro areas of the Basin. In order to afford a centralized location for discussion of these proposals, the Governor's Planning Commitee arranged for the workshops through the Council of Governments' office that embraced the specific areas. Under this arrangement, six workshops were held in April, May and June 1973 at Midland-Odessa, Ballinger, San Angelo, Burnet, Smithville, and Wharton. For this series of workshops, invitations were issued and summaries of alternative treatment system proposals were prepared for a total of 76 non-metro areas. The meetings were attended by representatives of 29 of the invited communities. Although the volume of participation was small for these workshops, the quality of input and dialogue was exceedingly high. The communities which were not represented at the workshops were notified by the concerned Council of Governments officials and the plans were forwarded to them for appropriate action. It is pertinent to note that in all instances where the communities were represented at the meetings, preferred alternatives were indicated and all problems were resolved to the satisfaction of the local interests. All communities that attended expressed appreciation for a planning service that was rendered to their area.

The third round of workshops that were held in the study were conducted in July 1973 in the cities of Odessa, Midland, Big Spring, San Angelo, Brownwood and Austin. At these workshops, alternatives were presented and a decision was reached on the selection of the proposed alternative that would satisfy the needs of these six metropolitan areas in the Basin. It should be noted that the close coordination between the consultant and study team members with the various planning agencies of these cities laid the groundwork for harmonious meetings with these cities and their choice of the alternative that met their respective requirements. Records of all workshop meetings are available in the offices of the Texas Water Quality Board.

Newsletters.

The newsletter program for the study was aimed at an educational effort that would keep the public abreast of the study progress, and to instill an awareness of the wastewater procedures and standards. The newsletters were not issued on a regular basis, but rather at intervals when the study progress warranted their circulation. Four newsletters were issued during the course of the study, and emphasis was placed on soliciting local input into the study process. Addresses of the Governor's Planning Committee and of the Corps study team were prominently

displayed in the newsletters as points of contact. Although favorable comments were received on the quality of the letter and the pertinence of the subject matter, meaningful response to the request for information was minimal.

Public Contacts.

After the initial workshop meetings in September 1972, local sources indicated that lack of individual contact was contributing to a sense of unawareness on the part of the public towards the study as a whole. As a result of this opinion, the study team personnel were assigned to visitation efforts which reached all levels of government, Chambers of Commerce, educational institutions, service and fraternal clubs, and private individuals. These visitations were conducted in coordination with the data-gathering trips of the study team members as well as the technical inspection trips of the consultant staff to the treatment plants throughout the Basin. During the period of October-November 1972, the FWD study team alone averaged 23 man-days per month on the visitation effort. It was in this program that the public involvement effort reached its highest peak for informing the public of the study aims and purposes. In appearances at service and civic clubs throughout the Basin, a questionnaire was passed out to the assembly containing questions about wastewater and wastewater management procedures. It was evident from the answers received in these questionnaires that the wastewater management problem, while of interest to the general public, did not rank in priority with other needs of the community.

Conclusions.

The following conclusions have been made regarding the wastewater management public involvement effort as it pertains to the Colorado River Basin Wastewater Management Study:

The public regards wastewater management as a tax-provided service that is available on an everyday basis at no trouble to the users.

Wastewater management is a highly desirable and commendable feature of local government activities.

Technical features and terms of wastewater management (BOD, TSS, digesters, DO, etc.) are generally not understood by the public, which feels that the task of dealing with these terms and parameters is not only the prerogative but the obligation of the proper governmental units.

Other features of local improvements, such as parks, streets, law enforcement and schools rate just as high or higher in the public's rankings of its priorities.

The dynamic state of Federal legislation, State legislation, county laws, city ordinances and other legal documents that affect the management of the wastewater program is of more concern to the public than the actual operation and maintenance of their facilities.

The most effective means of obtaining meaningful public involvement is to have individual personal visits on an informal basis. Individuals are more willing to discuss their problems, offer their suggestions, and appreciate the effort being expended on the study.

DEPARTMENT OF THE ARMY

FORT WORTH DISTRICT, CORPS OF ENGINEERS

PUBLIC MEETING

FOR

COLORADO RIVER WASTEWATER MANAGEMENT STUDY

Texas State Department of Health Auditorium
1100 West 49th Street
Austin, Texas
Tuesday, July 11, 1972

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Austin, Texas
Tuesday, July 11, 1972

MAJOR ALLEN: Good morning. I am Major C. A. Allen of the Fort Worth District Corps of Engineers. It's a pleasure to be here today, and I want to welcome you to this public meeting. This public meeting is an integral element in our program to encourage and foster public participation in our wastewater management study for the Colorado River Basin.

First, I would like to express my thanks to the Texas State Department of Health for providing us with this auditorium to hold our meeting in today. In deference to the building and Department regulations, I would like to request that you heed the "no smoking" signs you see posted throughout the auditorium. If you feel the need to smoke, please step outside. I assure you I will not be offended.

At this time I would like to introduce my staff I have with me today. Seated here on the stage, Milburn Smith, our Sanitary Engineer. Walking in the back door, Mr. Jim Herbert, our Public Involvement Specialist. Seated up here in front is Jack Thompson. Jack is our Economics Specialist. Adele Smith, our Program Analyst. She was outside at the registration desk when you came in. Chris Maynard, Sanitary Engineer. Also seated up here with Mr. Milburn Smith is Mr. Don VanSickle, Vice President of Turner, Collie and Braden, who we have engaged to assist us during the conduct of this study.

As you came in the door you were given an attendance card to fill out. I hope you have. If you have filled one out but haven't turned it in, please hold it up and some of my staff will collect it from you. Is there anyone who did not fill out an attendance card? If so, if you will just hold up your hand we will see that you get one. This card is a record of your attendance at the public meeting, and will become part of the public record of this meeting.

Our meeting today is being held pursuant to a public announcement which was issued by our office on June 9, 1972. I assume that you are here because you had an opportunity to read this announcement, so I will not read it at this time; however, the announcement will be made part of the public record.

This public meeting is being held so that we may obtain your reactions and suggestions to the wastewater management study which we envision for the Colorado River Basin. We have no plan to present since we have just initiated our actual conduce of the study. Our purpose today is to inform you of the data and considerations, and the method of operation which we intend to pursue in the evolvement of a wastewater mangement plan for the Colorado River Basin. We are actively today soliciting your constructive criticisms and suggestions so that we may not overlook any consideration which the public feels is important to the conduct of this study.

Perhaps first I should explain how the meeting will proceed. First, I will summarize the project and our goals and objectives in the conduct of the study. Following this explanation, the meeting will be opened up for testimony. The order in which parties are called will, to a certain extent be determined by protocol. The Governor or his representative will be invited to speak first. Then National Senators and Congressmen, or their representatives, then State Legislators, then official spokesmen for Federal Agencies, State Agencies and local government. Following these official statements, we will take statements from the public at random, without regard to whether they are in favor or disfavor of any particular phase of the study. Written comments received in the Fort Worth District Office by the close of business on 28 July will also be considered a part of the meeting here today.

Before I begin discussion of the wastewater management study, I wish to preface my remarks by saying that this study is not another dam study. The purpose of the study is to develop a wastewater management plan for the Colorado River Basin. It is not intended to serve as a forerunner of a document that will serve as an instrument for dam construction. In this regard I would appreciate that all comments at this meeting be limited to wastewater management problems and ideas. We will be glad to entertain any suggestions on the development of other water resources in the Colorado River Basin, but these matters are within the scope of the comprehensive Basin survey of the Colorado River Basin, and are not properly a part of the meeting here today.

I believe that all of you are more familiar with the geographic aspects of your Basin than I am, even though I am a native Texan myself. So I will only say it is the largest river basin wholly within the state. As such, it represents the largest basinwide study from the geographic standpoint taken on by the Corps of Engineers in the field of wastewater management. If you have an inquiry as to why this study is being made, it is in response to public concern over the quality of the water in the Colorado.

Although this quality is generally acceptable for municipal, agricultural, and most industrial uses, there are seasonal degradations of water quality in some areas. These degradations have resulted from agricultural and saline runoffs in the upper reaches, and from municipal and industrial discharges in the populated areas. Pollution from urban sources will certainly increase with continuing population development and urbanization.

Bacterial contamination of some of the basin lakes has also been a source of public concern. In recognition of this concern, Congress directed the Corps of Engineers to proceed with a review investigation of wastewater management facilities in the Colorado River Basin in a resolution which was adopted 29 July 1971. The Corps experience and long professional expertise in closely related fields provide us, I feel, with much to contribute to these endeavors.

We have been working on the principles of broad river basin planning for more than 100 years. In the 1920's and 30's, we carried out the first systematic, comprehensive river basin surveys in the nation's history. Because of the broad purview of our interests and our mission--broader than that of any other Federal Agency -- we were investigating and evaluating things like recreation, water supply and pollution abatement long before they were considered to be federal functions at all. So when, at length, the people and their government began to get interested in such areas, they found that we had a considerable body of fact and experience ready at hand. Thus, we were really in the field, so to speak, before the field really developed itself.

I would like to say here that our ultimate goal is not merely a cleaner river, but the broader one of managing river basin resources to achieve the greatest increase in the well being of all the nation's people.

In recognition of the importance of this study, and the need for a closely coordinated study effort, the State of Texas appointed a planning committee, which is entitled Colorado River Basin Water Quality Management Study. Mr. Harry Burleigh, Executive Director of the Texas Water Development Board, is the Chairman of this committee. This committee is composed of representatives of Federal, State and local governmental agencies, as well as individuals from the private sector. The Governor has charged this committee to provide overall planning direction and assure that the study reflects the views of the State and a broad cross section of the general public.

Our basic philosophy in the conduct of this study is that we are providing a planning service to the State of Texas and to the public and the views of the Governor's Planning Committee as well as those of the general public will be our primary concern.

Our study will consist of an investigation to assist the State of Texas in the determination of a wastewater management plan for the Colorado River Basin. The end result of the study will be the preparation of a plan at a sufficient level of detail required to meet federal intra-agency for planning in connection with federal grants for construction of treatment works.

In order to comply with current federal regulations the required planning documents must be submitted to the EPA by the State of Texas by 1 July 1973. Now, in order to meet this deadline, we have scheduled our studies to be completed by 1 May 1973 with the submission of a plan to the State scheduled for mid-May 1973. We feel this will allow the State time for review and comments prior to the 1 July 1973 submission date.

The objective of this particular study is to develop a wastewater management plan that will prevent water quality degradation from water-borne wastes and provide maximum efficient wastewater reuse.

The plan will include an overall basin plan to allocate stream waste loads and describe general basin trends and more detailed plans for areawide planning areas to provide conceptual design for treatment facilities. These areawide planning areas have been designated by the Governor to be those places embraced by the Regional Councils of Government that extend throughout the basin. Plans will be delineated in terms of areawide planning areas and presented to the affected Councils of Government for use in their respective areas.

In this effort we will rely on the Governor's Planning Committee to provide us with a statement of objectives to guide the selection of alternative wastewater treatment methods, facilities, and systems, as well as public reactions to our proposals.

We will develop alternatives that will consider the most cost-effective means to meet current federal regulations for basinwide and areawide planning programs to meet requirements for the federal grants for construction of treatment works. This will be an early action program to meet current requirements within the first five year period, and to develop alternatives to achieve the goal of highest levels of wastewater

treatment by the year 1990, and to continue to meet this goal through the year 2020. The option of achieving this objective immediately will also be presented.

But before I continue I might like to explain here a couple of the terms I have just used. First, by "most cost effective" I mean the most economical plan to accomplish the required objectives through the designated time frames.

By the "highest level of treatment" I mean the use of the best available technology that will provide the highest quality renovated water for many purposes, not only to protect and enhance the water quality of the basin lakes and streams, but also for specifically planned reuse to satisfy foreseeable water supply deficiencies. Renovated water can satisfy needs for agriculture, irrigation purposes for example, and many industrial and in-stream uses, which will thereby release limited supplies of higher quality natural surface and ground water for domestic uses.

In arriving at any recommended plan to meet highest level of treatment, we will develop alternatives which will include the following: Land treatment processes, biological and physical-chemical processes, and a combination of these two.

In the land treatment process we study a method that uses land as a natural filtering media for recycling organic and mineral wastes thereby converting the wastewater to high quality water which could be recovered and reused for other purposes.

This system at the Campbell Soup Company Plant in Texas, is an example of treatment.

The biological treatment process, which is in wide-spread use in this country, is a system which basically utilizes air and bacteria within the wastewater to break down, stabilize, and remove organic pollutants in the waste stream. This plant in the Dallas-Fort Worth area is an example of the biological treatment process.

I apologize to the members of the Colorado Basin for not having a picture of the system in the Basin, but it just wasn't possible within the short time frame. So we had to use one of the Trinity River.

The physical-chemical treatment processes involve combinations of treatment methods utilizing coagulation, sedimentation, filtration and selected physical unit processes which effectively remove pollutants to an acceptable degree.

In the consideration of alternatives we will study the propriety and effectiveness of combining these two systems. All of these techniques will be investigated to their reasonably expected technical limits. We will provide levels of detail for areawide planning that will include definition of service areas and conceptual design and general location, including cost estimates, for truck waste collection systems, treatment facilities, liquid and/or solid waste disposal areas and for major outfalls. However, detailed design of sewage collection systems, treatment facilities, required pumping stations and other items necessary for complete sewerage facility planning will not be done at this time.

It is expected that subsequent or concurrent planning studies by local governmental agencies will be necessary to provide this next level of detail if existing plans are not adequate for this purpose.

I think that you are aware of the extensive studies that have been made by various elements of the state and local government throughout the basin in the area of wastewater management. We intend to make extensive use of these existing available data of this nature, and insofar as practical incorporate these into our system.

Our technical design criteria we will be using will consider the following five items:

First, each system will be capable of handling all types of waste load generated in its service area, including storm runoff, agricultural, domestic, and compatible industrial wastes.

Incorporation of existing short range plans as I have previously mentioned.

Third, design of a system that will meet study goals at minimum cost and maximum effectiveness.

Fourth, where appropriate, non-structural measures will be considered in formulating each system. These measures may reduce the volumes a system must handle or may be used to control the waste loads that are placed on the system.

Fifth, assess beneficial and detrimental impacts of the plans on ecological, hygienic, social, aesthetic and economic elements of the basin.

In order to develop and test these systems from the standpoint of compatibility between the basinwide plan and the areawide plan, the interrelationship of these systems and their effects will be determined by the use of a mathematical model, which will be refined to Colorado River Basin conditions for use in this and subsequent studies. After the recommended system for each areawide planning area in the basin, has been developed, studies will be made, from the basin viewpoint, to determine the schedule of implementing various components in each system to meet the highest priority short range goal, so that an orderly installation of facilities may take place. An institutional arrangement will be developed which will provide for implementation of the recommended plan, and also give guidance on financing and cost sharing procedures.

In the evaluation of the environmental impact of this study we will rely completely on state and local cooperation to advise us of environmental and ecological factors that we must consider in the development of the wastewater systems we foresee. Any comments we receive on these matters will be considered in our investigation.

To this end I might mention that, along with the Governor's Planning Committee, we are proposing a series of workshops to be held throughout the course of the study, at various locations throughout the basin. These workshops will be arranged and staffed by the Governor's Planning Committee, and will be used as a sounding board for public opinion in regard to the conduct of the study and the results produced by the investigation. Your attendance and participation in these workshops will help us greatly in our study.

By mid-May we intend to present the most promising wastewater plans to the Governor's Planning Committee. The Governor's Planning Committee will, in turn, coordinate these plans with the affected state agencies, institutions, Councils of Government, and the general public. The Governor's Planning Committee will then recommend one plan to the Governor, who will forward this plan to the Environmental Protection Agency for certification.

I realize that my presentation has been in generalities today, and that I do not have a specific plan to present. I have tried to explain what we are attempting to do in the study, and what our end product will be, and what you may expect it to be. I assure you that we will have another public meeting to present recommended plans to you. Today we are asking your help in pointing out problems and problem areas that we need to consider in our study.

We want everyone to have the opportunity to speak today, and if you cannot be with us until your turn comes up, please let one of my staff members know so that we can change the order in which you are asked to speak.

When you are called upon, please furnish the recorder with five copies of your prepared testimony, if this is possible, and then step up to the microphone here. At your pleasure, you may use this one at the lectern, or if you prefer, the one on the floor. Please bear in mind that this public meeting is to obtain your views, suggestions and criticisms for developing the best possible wastewater management plan for the Colorado River Basin.

When you do speak, please state your name clearly and any affiliation you have, any agency or organization for which you are speaking. There is no time limit on any testimony, you can speak as long as you wish. However, in the interest of courtesy to your neighbors, I would ask you to keep it as short as possible. If you have a long written statement, you can be assured that we will consider it in full. You may therefore safely condense your verbal presentation.

If it happens that your views are the same as others who have testified before you, you may so state and make any additional comments that you would care to make.

The suggestions I have made just now are for the benefit of yourself, your friends and neighbors who are here, and not for my benefit or for my staff's benefit. If you do not wish to speak publicly, you can file a statement with my office within the next two weeks, and it will be considered part of the meeting here today. We will be happy to remain as long as anyone cares to remain. We will hear any that desire to be heard.

Before we have our open testimony I would like to acknowledge letters that we have received prior to today in connection with this public meeting.

We have a letter from Clark Hubbs, Texas Academy of Science. We have a letter from Warren H. Pulich from the University of Dallas. These letters are also added to the official record of this meeting.

At this time I would like to call on the Governor of Texas representative, Mr. Joe Bob Harris.

MR. HARRIS: Thank you, Major Allen.

Ladies and Gentlemen, I am Joe Harris, Coordinator of Natural Resources, Office of the Governor, Division of Planning Coordination.

On behalf of Governor Preston Smith, I wish to thank the U. S. Army Corps of Engineers and their co-sponsors of this public meeting, the Governor's Planning Committee for the Colorado River Basin Water Quality Management Study, for their efforts to date in organizing this important resource management study and planning service. It will not only provide a direct benefit to those in this great natural basin, but to the State of Texas and all its citizens.

Governor Smith regrets that he cannot be here in person today to extend his continuing support to this study. He wishes to express his complete confidence in your ability to successfully complete this essential task. The remainder of this statement represents the remarks the Governor wishes to be made on his behalf.

I commend your efforts to bring before the public at each opportunity the full and open discussion of any plans or actions relating to the use, development and improved quality of the water resources of our great Colorado River Basin. The opportunity for each citizen and interested group to express their views and concerns on such proposed public or governmental actions is a necessary element in our democratic process. The resulting exchange of information and ideas, identification of problems and needs, and improved understanding on both sides is a vital link in securing the needed public support for your planning efforts.

To partially accomplish this same objective of enlightened public participation, the Governor appointed a Planning Committee for the Colorado River Basin Water Quality Management Study. This Committee not only makes provision for representation of the general public, but for local and regional governments throughout the Colorado

Basin, along with State and Federal agencies that have program responsibilities related to resource management and environmental protection. The principle purpose of the Committee is to provide overall planning direction and to assure the study reflects the views and needs of a broad cross section of the general public.

I would like to set the tone of this meeting with these few remarks. We in Texas are a fortunate people in that we relate strongly to the land. Many Texans need only go back a generation or two to find a forebear who homesteaded his land. A majority of those who came later to Texas did so out of a love of the land and the opportunities related to it. Land without sufficient and good water to support our people and their many activities is not a good land. We have been doubly blessed in Texas with both good land and good water. How long this remains true will depend largely on our efforts now to protect and improve our land and water resources.

This study is another in a long history of progress in developing and maintaining the quality of our surface waters. This progress has included practical surveys to establish the quantity and quality of the water resources available to us. Based on these data, stream standards have been set to establish practical objectives for water quality in each of our rivers and streams. These standards provide us with a guide for ensuring the availability of adequate supplies of good water. This is a good program and is resulting in improving the quality of our waters. We can continue to improve and are firmly committed to that goal.

As Governor of the State of Texas, I charge you with these responsibilities in achieving that goal for the Colorado River Basin.

One, to consider all aspects of water quality management in the Colorado River Basin, both natural and man induced; two, to use the best techniques available to evaluate and resolve each problem; three, to develop strategies to manage the activities of man and the results of natural processes in order to achieve the highest quality of water possible commensurate with practical economic and technological capabilities; four, to evaluate all alternative and select those which best fit the needs of the entire basin, its many competing uses and the best interests of our State and Nation.

I realize this is a large order. As I stated previously, I am fully confident of your ability to meet this challenge.

In closing, I wish you good luck in this very important element of our State water quality program. The successful completion of this study will provide Texas with the tools to enhance the quality of life and maintain a sound foundation for economic progress, both in the Colorado Basin and in the entire State.

Thank you.

MAJOR ALLEN: Thank you, Mr. Harris.

Next I would like to call on Congressman Jake Pickle's representative, Mr. Cliff Drummond.

MR. DRUMMOND: Thank you, Major. Good Morning Ladies and Gentlemen:

I have a brief statement from the Congressman I would like to read into the record this morning.

I am pleased to have this opportunity to express to you my views on the Colorado River Basin Study, and the goals and accomplishments we hope to see fulfilled here.

To my thinking, it is a beneficial requirement that all rivers have a plan or survey for the total water uses of that stream. If it is true that we're not making any more water, and if the corollary is also true that we are making a lot more people, then every ounce of water becomes more and more important each year. This is true across the land. But it is even more obvious when we look at our river here.

The Colorado River of Texas traverses the entire State. It cuts across or through parts of over 52 counties. As such, it is not a meandering stream that should be looked at only for recreational purposes, but it is the heart of the water resources, and indeed of the water authorities, of Texas; and particularly so since it flows through the very heart of Texas.

The requirement that each river authority in Texas establish a complete plan for the use of their stream is necessary not alone because Congressional mandate has ordered the plan before participating or matching grants can be obtained. The total plan is necessary also because the plains of West Texas are entitled to the use of this stream--and so are the estuaries of the Gulf Coast. The cotton fields of West Texas and the rice fields of the coastal areas both need, both are entitled to use the waters of the Colorado.

Cutting across these extremes are countless towns and cities whose very lives depend on this river.

From a Congressional view point, I hope to see a total water management study made, encompassing the total resources of the Colorado, how they can be best used, best preserved, and best passed along to those downstream and to those who will use it in the future. I do not approach this study alone from the standpoint of trying to establish waste disposal systems, or power for generation, or water for thirsty cities, or recreation for an area. The study should be for the total use of the river by man and by nature.

For that reason, I envision this study of the Colorado River Basin as a partnership between local communities, state and federal governments. I see it as working together for a total plan for our river from source to mouth and from the littlest authority to the largest.

I hope here we will do far more than satisfy statutory requirements. I hope we can set precedents of inter-governmental cooperation and total planning that will serve as the standard for other similar projects across the land. And I hope most of all that here we will lay the groundwork toward full use and best preservation of our own Colorado River.

Thank you.

MAJOR ALLEN: Thank you, Cliff.

Next I would like to introduce Mr. Charlie Nemir, who will be speaking for Mr. Harry Burleigh, who is Chairman of the Governor's Planning Committee.

MR. NEMIR: Good morning. My name is Charles E. Nemir. I'm Assistant to Executive Director Harry P. Burleigh, of the Texas Water Development Board. Mr. Burleigh is also Chairman of the Governor's Planning Committee for the Colorado River Basin Water Quality Management Study.

Mr. Burleigh asked me to express his regrets at being unable to attend personally today, because of other commitments. But I have a statement that I would like to present for him.

Governor Smith in December 1971 appointed a planning advisory committee to assist the Corps of Engineers in the Colorado River Basin Water Quality Management Study. This Committee is composed of leaders from several State agencies, river authorities and water districts in the Basin, regional councils of government in the Basin, interested Federal agencies, and members of the general public.

Mr. Burleigh has been honored by being appointed Committee Chairman; Hugh Yantis, Executive Director of the Texas Water Quality Board, is Vice-Chairman; United States Representatives Jake Pickle, John Young, Omar Burleson, and O. C. Fisher are honorary Co-Chairmen.

I see many members of the Planning Commission in the audience today, and we anticipate many of the others will attend the meeting in San Angelo on Thursday.

In accordance with the desires of the Congressmen and the Corps of Engineers, the Governor charged the Committee with providing overall planning assistance and guidance to the Corps and assuring that the views of a wide cross section of the general public are sought and reflected during the course of the study.

The role of the Planning Committee has, however, since its original organization, been expanded. Following authorization of the study by Congress in August 1971, the Office of Management and Budget in Washington ruled that before funds could be released, and before it could proceed, a study plan would have to be developed that would meet Environmental Protection Agency guidelines for such a study. These guidelines generally include the provision that Federal expenditures on such a study must be matched on a 50/50 participation basis by non-Federal interests.

Representatives of the Planning Committee worked diligently with the Corps of Engineers during the development of the study plan to identify work elements that could be provided by various non-Federal interests. Work descriptions were prepared and commitments were obtained from all participants to contribute the necessary support. Through a series of meetings and correspondence, the Governor's Planning Committee members have been active in the study development to this point.

Speaking for the Planning Committee, as its Chairman, I wish to re-affirm the commitment of this Committee to serve this study. The Committee will continue to coordinate the activities associated with the non-Federal contributions to the study in cooperation with and through the Division of Planning Coordination in the Governor's Office. The Committee will also continue its efforts to assure that the study, as it progresses, reflects the views of a broad cross section of the general public. To this end, the Committee earnestly solicits the views, advice, suggestions, and comments from any and all persons interested in the Colorado River Basin Water Quality Management Study. All information received will be transmitted to the Corps of Engineers for their consideration. The Planning Committee members and their respective staffs will regularly review the study progress and provide guidance and assistance as necessary.

In closing, I would like to furnish further assurance, speaking as Executive Director of the Texas Water Development Board, that the Texas Water Development Board intends to cooperate fully in the progress of this study and to fulfill its obligations by providing guidance and assistance as necessary and completing the work items for which it is committed.

Thank you very much.

MAJOR ALLEN: Thank you, Charlie.

At this time I would like to call on Garner Jones, representing the Texas Water Quality Board:

MR. JONES: I'm Garner Jones, with the Water Quality Board. And today I'm representing Mr. Hugh Yantis, who is the Vice-Chairman of the Governor's Planning Advisory Committee, who has been appointed to work with the Corps of Engineers. Mr. Yantis has likewise expressed his regrets at not being present today, and he extends his support, as he has in the past, to this study.

The necessity for this study, as has already been expressed, will be felt throughout the Colorado River Basin in the years to come, because Federal regulations require such a comprehensive basin-wide management plan before grants can be approved for the construction of sewage treatment facilities. That's been reiterated previously, but I want to try to impress that upon you, that this final plan will have to be made, not only in this basin, but in other basins throughout the State. The Water Quality Board has spent much time and effort, and the State

Legislature has appropriated considerable money to the end so we can meet this requirement. The completion and adoption of this fully developed plan is therefore most critical for future funding of projects that lie in this basin.

This project will not only be funded by EPA under the 660 Grant Program, but also is promised to be funded under the Department of Housing and Urban Development. This plan will also be used as a useful guide to the water quality management decisions which our Board will use in striving toward the abatement of man-made pollution throughout the basin.

I see one of the members of our Board sitting in the back of the room, and he will be one of the ones that will be using the plan in making the decision.

Mr. Yantis, through experiences he's had in other situations, or other subjects, presently in the Highland Lakes study that has already been funded, and was mentioned by the Major earlier as one of the plans to be incorporated in this study, through the experiences that he has had during the course of that study, in that it was completed and adopted, and public meetings were held, the plan was adopted, and then when we started to implement the actions that were recommended in the plan, the people then were quite alarmed, or seemingly were quite alarmed that a plan had been adopted, and they weren't quite in agreement with the plan.

So from those experiences he's had, and some others, he would like to make it clearly understood to the people present here, and the people throughout the basin, that it is desired that this planning effort be representative of the desires of the people in the basin. And accordingly, that the comments of the general public are most encouraged.

He would also like to pose these questions to you. What kind of regulatory action will spring from this study? How will it be upheld and enforced? And most importantly, who will pay for the regulatory action? Also, what is the nature and extent of the desired regional systems for sewage treatment that will be recommended, and who should pay for those?

He thinks these questions should be raised at this time, and the public express their desires regarding these important questions.

I think most of you are quite familiar with the -- some of the routine functions of the Water Quality Board, in that the Board is an agency that sets and recommends the stream standards for all of the streams within the State, that the Board issues waste control orders for every waste discharge that's discharged within the State. And that we also manage or administer the 660 Grant Program of the Federal Government in the Water Quality Board. And I won't go into a discussion of these functions of the Agency, unless questions are raised about them.

So in conclusion, the Texas Water Quality Board realizes the importance of this study, and will do its utmost to cooperate in the completion and adoption of this basin management plan.

Thank you.

MAJOR ALLEN: At this time I would like to call on Mrs. L. H. Butler, who would like to make a statement at this time.

Through this time the Corps has given their presentation. We've had statements from the Governor's Office, and Congressman Pickle, and some public testimony, and we're nearing the end. And the floor is now open to public testimony.

MRS. BUTLER: I'll say what I have to say, and hope that it's germane.

MAJOR ALLEN: You may use the lectern, or the microphone on the floor, either one you prefer.

MRS. BUTLER: I'll use the lectern.

MAJOR ALLEN: All right.

MRS. BUTLER: Good morning. I am Mrs. L. H. Butler, and I have come today mostly to listen and learn, but I do have some thoughts regarding water development in general.

The main thing that I wanted to say was that, in considering better means for re-use, let us not neglect research and development of better use. For example, in our approach to disposal of human waste, starting in our own bathrooms, let's take another look at the flush toilet.

It's adding one part of sewage to ninety-nine parts of clean water and ending with a total product which even the most efficient treatment plant cannot do a perfect job of renovating, no longer makes sense.

I understand that in Sweden they are using a system called a dry toilet. And we would like to see some experimenting and research encouraged in that regard.

We would like to see effluent used for irrigation. There is a plan in Chicago called the Prairie Plan, and I'm sure all of you are aware of that. And I do have some articles on the use of waste effluent, if anyone would like to see it.

Thank you.

MAJOR ALLEN: Thank you, Mrs. Butler.

I have a card that states that Mr. Bean from the Capitol Area Planning Council will hand in a statement. Would you care to make a statement along with it, or just turn one in?

MR. BEAN: Thank you. You mentioned earlier that we have two weeks in which to submit written comments to you, and we do have several questions we would like to pose.

We have two that come to mind right off. In one portion of the study design, I believe you stated that the interesting question is to whether this final plan will satisfy the Farm and Home Administration.

MAJOR ALLEN: Yes, it will.

MR. BEAN: And there's another statement in there of one of your work elements, that there would be no environmental impact statement prepared?

MAJOR ALLEN: At the present time, the funding -- the preparation of the environmental impact statement has not been funded at the present time.

MR. BEAN: Is this in your last year's work program, or how do you propose to handle this?

MAJOR ALLEN: At the present time it has not been funded.

UNIDENTIFIED SPEAKER: What was the question?

MAJOR ALLEN: In our plan of study we have stated there will be no environmental impact statement prepared in connection with this study. The final approved version of the plan that was finally approved by OMB did not include funds to prepare an environmental impact statement at this time.

When and if it will be funded, I have no information.

MR. BEAN: We would like the opportunity to submit these questions to you in writing.

MAJOR ALLEN: Fine. We appreciate it.

Is there anyone else, public or representing an institution that would like to make a statement?

UNIDENTIFIED SPEAKER: Are you going to read the letters from Dr. Hubbs and Warren Pulich into the record? I'd like to hear what they have to say.

MAJOR ALLEN: I had not planned on reading them publicly today, no.

UNIDENTIFIED SPEAKER: Would you mind doing it?

MAJOR ALLEN: No, not at all.

The first one I have is from Carl Hubbs, President of the Texas Academy of Science. I may have to get my Sanitary Environmentalist, Mr. Milburn Smith, to read some of these terms, because I'm not familiar with them.

It's dated 16 June 1972, addressed to Col. Floyd Henk, District Engineer, Fort Worth, Texas.

Dear Col. Henk: I have received two copies of the announcement of the Colorado River Basin Water Quality meeting, having one as an individual, and the other as President of the Texas Academy of Science. As I will be speaking at the University of Oklahoma on both dates, I cannot attend. As a consequence, I asked the Conservation Committee to comment on behalf of the Texas Academy of Science. I also comment briefly below.

The aquatic system is obviously susceptible to perpetration of natural waters. Perhaps the most critical consumptive use is release of raw pollutants, consequently, treatment and repeated re-use of water is likely to mitigate potential harm. When re-used water should be returned to the natural water (typically a system) that water should be as similar as possible to the intake water physically and chemically. The Colorado River flows through a variety of formations, and the fish in each segment that are unique species that are not at or near other Colorado River segments. Many changes in the water chemistry are likely to be the basis of distractions; therefore, an equivalent change in any extremity in the fish from the river system. In many a fish can be shown to tolerate the physical and chemical environment, but is unable to successfully compete with the related fishes which could be present. I encourage a tentative draft of the rare endangered Texas fishes for the use of your staff. Three are in the Colorado River System, and may be important to your considerations. They are -- and I'm sorry to say I can't read them. They are technical names.

UNIDENTIFIED SPEAKER: I would like to see those after the meeting.

MAJOR ALLEN: Fine. And it's signed, Sincerely, Carl Hubbs.

The other letter I have is from Warren M. Pulich, Assistant Professor of Biology, University of Dallas.

It's addressed to the Department of Army, Fort Worth District Corps of Engineers.

Dear Sir: The statement of your meeting as applies to the announcement dated 9 June 1972 of the Colorado River Basin Wastewater Management Study being sponsored by the Office of the Governor's Planning Committee. Prior commitments will prevent me from being present at both meetings; therefore, I am submitting this statement in reference to the proposed study.

The Colorado River Drainage System entering the vicinity of San Saba County, known locally as Hill County, through a vegetated area of extreme importance to the Golden Cheeked Warbler. This Golden Cheeked Warbler breeds nowhere else in the world, except those areas covered by mature stands of ash juniper, known locally as Cedar breaks. The Golden Cheeked Warbler is one of the few species of North American birds restricted in breeding areas. The Golden Cheeked Warbler is exclusively a Texas species, and one whose habitat requirements should

be carefully considered. So rare is this bird, it has been placed in the U.S. Fish and Wildlife Services list of Rare and Endangered Fish and Wildlife in the United States.

In 1964 I estimated the total Golden Cheeked Warbler population to be between 15,000 and 17,000 birds. However, since this time the population is slowly declining as habitats are destroyed through public and private programs of the juniper extraction. If this decline continues, it will be only a matter of time until the Golden Cheeked Warbler will be placed on the endangered list, along with other Texas species, the whooping crane, prairie chickens, and the ivory billed woodpecker.

The Golden Cheeked Warbler is a narrow tolerant species. That is, one that cannot adjust to disturbances of the climate cedar breaks. It will not occupy sub-climate growth. Because this species is so unique and the current program of cedar break management are in direct conflict with the habitat requirements of the Golden Cheeked Warbler, careful consideration should be given in developing your project.

If any of your plans call for removal of a vegetation species, inhabitant surveys should be undertaken to determine whether or not the Golden Cheeked Warbler population exists, and if so to provide maximum protection of existing population, in order to preserve the Golden Cheeked Warbler. All surveys of this species should be undertaken during the period of mid-March through the end of May, when the species is present in Texas in nesting grounds. At other times of the year it will be enroute to its winter home in Central America. Lastly, any surveys undertaken by your agency should be made by someone extremely familiar with the Golden Cheeked Warbler, since the species is so sensitive in its habitat requirements. Respectfully submitted and signed, Warren M. Pulich.

UNIDENTIFIED SPEAKER: Thank you.

MAJOR ALLEN: I'll have both of these. You may look at them at your convenience.

Yes, ma'am.

MRS. BUTLER: I'm Mrs. L.H. Butler from El Paso. I would like to go on record as asking for the environmental impact statement for this project.

MAJOR ALLEN: Could everyone hear? Would you like to come up to the microphone and make those statements?

MRS. BUTLER: I'm Mrs. L. H. Butler from El Paso, Texas. I'm President of GASP, Group Against Smog and Pollution, and Environmental Quality Chairman for the League of Women Voters of El Paso.

I would like to go on record, please, as asking for an environmental impact statement for this project.

Thank you.

MAJOR ALLEN: Thank you.

UNIDENTIFIED SPEAKER: Is it in order to ask a question?

MAJOR ALLEN: Certainly.

UNIDENTIFIED SPEAKER: You mentioned the fact that work shop meetings will be held throughout the State.

MAJOR ALLEN: Yes.

UNIDENTIFIED SPEAKER: At what stage in the development of the plan will these work shops be held? In other words, will you be asking questions of local people in the basin on things to be included, or will it be a review of what's already been prepared?

MAJOR ALLEN: I envision that this will be conducted by the Governor's Planning Committee, and I will have a staff member present, and myself.

But what we envision is being able to present to the local people, in their language, what has gone on so far, trying to find out what they have in mind, what they desire for their particular locale, and showing them and working with them in showing them how this can be worked into the overall program. Telling them what's going on, educating them if need be on how it will be conducted, what's been done, what we are considering, and how they in their community actually fit into the program. And drawing from them their desires, needs and wants for their particular area.

UNIDENTIFIED SPEAKER: Will this be the application then for you folks of the questionnaires that have been sent out by your group? Digest these and put them in some type form for the work shop presentation?

MAJOR ALLEN: Yes, certainly.

Would anyone like to make a statement, or are there any more questions?

On behalf of the Governor's Planning Committee and the Corps of Engineers, I appreciate everyone attending this morning. I certainly appreciate the interest that's been shown by the statements and questions.

If there are no further statements or questions, this public meeting is adjourned.

CERTIFICATE

This is to certify that the attached proceedings in the matter of the Colorado River Wastewater Management Study, July 11, 1972, in the Texas State Department of Health Auditorium, 1100 West 49th Street, Austin, Texas, were held as herein appears, and that this is the transcript thereof for the file of the Department.

sgd/ _____

Shirley M. Stinebaugh
Official Reporter

DEPARTMENT OF THE ARMY

FORT WORTH DISTRICT, CORPS OF ENGINEERS

PUBLIC MEETING

FOR

COLORADO RIVER WASTEWATER MANAGEMENT STUDY

SAN ANGELO MUNICIPAL AUDITORIUM
CITY HALL PLAZA
SAN ANGELO, TEXAS
THURSDAY, JULY 13, 1972 AT 10:00 o'clock A. M.

REPORTER
MAUDIE RUTLEDGE

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SAN ANGELO, TEXAS, THURSDAY, JULY 13, 1972

10:00 A.M.

MAJOR ALLEN: Will the meeting please come to order?

Good morning. I am Major C. A. Allen of the Fort Worth District Corps of Engineers. I want to welcome you to this public meeting and say that it is an extreme pleasure for me to be here this morning. This public meeting is an integral element in our program to encourage and foster public participation in our wastewater management study for the Colorado River Basin.

First of all, I want to express my thanks to the City of San Angelo for providing us with this auditorium to use for our meeting this morning.

At this time I'd like to introduce some of my staff that is here with me today.

Seated on my right is Milburn Smith, Sanitary Engineer. Mr. Jim Herbert, our PAO Specialist. I think he just stepped out. Jim? He just stepped out the back.

We're picking up a little feedback from the radio station, I think.

Mr. Jack Thompson, who is sitting back here running our slide projector, our Economist. Adele Smith. She was the lady sitting at the registration table. She is our program analyst. And also with us this morning I have Mr. Paul Barker from Turner, Collie and Braden who will be assisting us throughout the study. Mr. Barker. Seated on my left first is Mr. Garner Jones of the Texas Water Quality Board, and Mr. Charlie Nemir of the Texas Water Development Board.

As you came in the door, you were given cards to fill out. If there is anyone who was not able to hand in your card and still have them, please hold them up. One of my staff will collect them. These are attendance cards that will record your attendance here at the meeting. If you did not get a card, please hold up your hand at this time and I'll be sure that you get one. One man right here. Anyone else?

Will you see that he gets an attendance card, Jim?

Our meeting today is being held pursuant to a public announcement issued by our office on the 9th of June, and I'm sure you've all read the announcement and that's the reason you're here today. So I will not take the time to read it, but I will say it will be made a part of the public record of this meeting.

This meeting is being held so that we may obtain your reactions and suggestions to the wastewater management study which we endeavor to introduce for the Colorado River Basin. We have no plan to present since we have just initiated the actual conduct of this study. Today we wish to inform you of the data and considerations and the method of operation which we intend to pursue in the evolvement of a wastewater management plan for the Colorado River Basin. We are actively soliciting your constructive criticisms and suggestions so that we have not overlooked any consideration which the public feels is important to the progress of this study.

First perhaps I should explain just how this meeting will proceed. As I said, I will summarize the project and goals and objectives that we plan to pursue in the conduct of the study. Following this explanation, I will open up the meeting to public testimony.

The order in which parties are called will be to a certain extent determined by protocol. The Governor or his representative will be invited to speak first; then national senators and congressmen, or their representatives; then state legislators, and official spokesmen for federal agencies, state agencies and local government. Next I will call on official statements from the public at random. The public will be called on to make statements if they so desire without regard to whether they are for or against any phase of the study. This meeting will continue as long as any individual remains who wishes to be heard. Written comments received in the Fort Worth District Office by the close of business on the 28th of July will also be considered as part of this meeting and will be entered in the public record.

Before I begin discussion of the wastewater management study, I wish to preface my remarks by saying that this study is not another dam study. The purpose of the study is to develop a wastewater management plan for the Colorado River Basin. It is not intended to serve as a forerunner of a document that will serve as an instrument for dam construction. In this regard I would appreciate that all comments at this meeting to be limited to wastewater management problems and ideals. We will be glad to entertain any suggestions on the development of other water resources within the Colorado River Basin, but

these matters are within the scope of the comprehensive basin survey of the Colorado River Basin and are not properly a part of our meeting here today.

I believe that all of you are more familiar with the geographical aspects of your basin than I am, even though I'm a native Texan myself. I'm from the Dallas area. So I'll not dwell on a statistical description of the basin other than to say that it's the largest river basin wholly within the state. And as such, it represents the largest basinwide study from the geographical standpoint taken on by the Corps of Engineers in the wastewater management field. If you have an inquiry as to why this study is being made, it is in response to public concern over the quality of the water in the Colorado River. Although this quality is generally acceptable for municipal, agricultural, and most industrial use, there are seasonal degradations of water quality in some areas. These degradations have resulted from agricultural and saline runoffs in the upper reaches and from municipal and industrial discharges in the metropolitan areas. Pollution from urban sources will certainly increase with the continuing population growth and urbanization. Bacterial contamination of some of the basin lakes has also been a concern to the public in the basin. In recognition of this concern, Congress directed the Corps of Engineers to proceed with a review investigation of wastewater management facilities in the Colorado River Basin in a resolution which was adopted on the 29th of July in 1971. The Corps' experience and long professional expertise in this closely related field provide us, I feel, with much to contribute to these endeavors. We have been working on the principals of broad river basin planning for more than one hundred years. Back in 1920's and 30's, we carried out the first systematic, comprehensive river basin surveys in the nation's history. And because of the broad purview of our interests and our mission which is broader than any other federal agency, we are investigating -- we were investigating and evaluating things like recreation, water supply, and pollution abatement long before they were considered to be a federal function at all. So when, at length, the people and their government began to get interested in such areas, they found that we had a considerable body of facts and experience already at hand. Thus we were already in the field, so to speak, before the field really developed.

I'd like to say here that our ultimate goal is not merely a cleaner river, but the broader one of managing the river-basin resources to achieve the greatest increase in the well-being of all the nation's people.

In recognition of the importance of this study and the need for a closely coordinated study effort, the Governor of the State of Texas appointed a planning committee, entitled the "Colorado River Basin Water Quality Management Study Committee." Mr. Harry Burleigh, who is the Director of the Texas Water Development Board, is the Chairman of this Committee. This committee is composed of representatives of federal, state and local governmental agencies as well as individuals from the private sector. The Governor has charged this committee to provide overall planning direction and assure that the study reflects the views of the state and a broad cross-section of the general public.

Our basic philosophy in the conduct of this study is that we are providing a planning service to the State of Texas and to the public, and I assure you that the views of the Governor's Planning Committee as well as those of the general public will be our primary concern in conducting this study.

Our study will consist of an investigation to assist the State of Texas in the determination of a wastewater management plan for the Colorado River Basin, Texas. The end result of the study will be the preparation of a plan at a sufficient level of detail required to meet federal interagency guidelines for planning in connection with federal grants for construction of treatment works. In order to comply with the current federal regulations, the required planning documents must be submitted to the EPA by the State by 1 July, 1973. In order to meet this deadline we have scheduled our studies to be completed by 1 May of 1973 with the submission to the State scheduled for mid-May of 1973. We feel this will allow the State -- allow for state review and comments prior to the 1 July, 1973 submission date.

Our objectives -- the objective of this study is to develop a wastewater management plan that will prevent water quality degradation from waterborne wastes and provide maximum efficient wastewater reuse.

The plan will include an overall basin plan to allocate stream waste loads and describe general basin trends and more detailed plans for area-wide planning areas to provide conceptual design for treatment facilities. These area-wide planning areas have been designated by the Governor to be those which are presently embraced by the Regional Councils of Government that extend throughout the basin. Plans will be delineated in terms of area-wide planning areas and presented to the affected councils of Government for use in their respective areas. In this this effort we will rely on the Governor's planning committee to provide us with a statement of objectives to guide the selection of alternative

wastewater treatment methods, facilities, and systems, as well as public reactions to our proposals.

We will develop alternatives that will consider the most cost-effective means to meet current federal regulations for basinwide and area-wide planning programs to meet requirements for federal grants for construction of treatment work. This will be an early action program to meet current requirements within a five-year period and to continue to meet these requirements to year 2020. We will also develop alternatives to achieve the goal of highest levels of wastewater treatment by the year of 1990 and to continue to meet this goal through the year of 2020. The option of achieving this objective immediately will also be presented.

Before I continue, I might explain some of the terms I have just used, particularly two of these. By the "most cost effective" I mean the most economical plan to accomplish the required objectives through the designated time frames.

And the other, by the "highest level of treatment," I mean the use of best available technology that will provide a high quality renovated water for many purposes, not only to protect and enhance the water quality of the basin lakes and streams, but also specifically planned reuse to satisfy foreseeable water supply deficiencies. Renovated water can satisfy needs for agriculture, for irrigation, for example, and many industrial and in-stream uses, thereby releasing limited supplies of higher quality natural surface and ground water for domestic uses.

In arriving at any recommended plan to meet highest level of treatment, we will develop alternatives which will include the following:

Land treatment processes;
Biological and physical-chemical processes;
Combination of processes above.

In the land treatment process we study a method that uses land as a natural filtering media for recycling organic and mineral wastes, thereby converting the wastewater to high quality water which could be recovered and reused for other purposes.

This system at the Campbell Soup Plant in Paris, Texas, is an example of a land treatment process.

The biological treatment process, which is in widespread use in this country, is a system which basically utilizes air and bacteria within the wastewater to break down, stabilize, and remove organic pollutants in the waste stream. This plant in the Dallas-Fort Worth area is an example of the biological treatment process.

The physical-chemical treatment processes I mentioned involve combinations of treatment methods utilizing coagulation, sedimentation, filtration and selected physical unit processes which effectively remove pollutants to an acceptable degree.

In the consideration of alternatives, we will study the propriety and effectiveness of combining these two systems I have just previously mentioned. All of these techniques will be investigated to their reasonable expected technical limits. We will provide levels of detail for area-wide planning that will include definition of service areas and conceptual design and general location, including cost estimates, for trunk waste collection systems, treatment facilities, liquid and/or solid waste disposal areas and for major outfalls. Detailed design of sewage collection systems, treatment facilities, required pumping stations and other items necessary for complete sewerage facility planning will not be done.

It is expected that subsequent or concurrent planning studies by local governmental agencies will be necessary to provide this level of detail if existing plans are not adequate for this purpose.

I think you are aware, as well as I am, of the extensive studies that have been made by various elements of state and local government throughout the basin in the area of wastewater management. We intend to make extensive use of existing available data of this nature, and insofar as practical, incorporate these into the system.

Our technical design criteria we will be using in developing our alternative plans will include the following five items but will not necessarily be limited strictly to these five.

First, each system will be capable of handling all types of waste load generated in its service area including storm runoff, agricultural, domestic, and compatible industrial discharges.

Incorporation of existing short-range plans that I have mentioned previously.

Design of system that will meet study goals at minimum cost and maximum effectiveness.

Where appropriate, non-structural measures will be considered in formulating each system. These measures may reduce the volumes a system must handle or may be used to control the waste loads that are placed on the system.

And five, assess beneficial and detrimental impacts of the plans on ecological, hygienic, social, aesthetic and economic elements of the basin.

In order to develop and test these systems from the standpoint of compatibility between the basin-wide plan and the area-wide plan, the interrelationship of these systems and their effects will be determined by the use of a mathematical model, which will be refined to Colorado River Basin conditions for use in this and subsequent studies of the basin. After the recommended system for each area-wide planning area in the basin has been developed, studies will be made, from the basin viewpoint, to determine the schedule for implementing various components in each system to meet the highest priority short-range goals, so that an orderly installation of facilities may take place. An institutional arrangement will be developed which will provide for implementation of the recommended plan and also give guidance on financing and cost-sharing procedures.

In the evaluation of the environmental impact of this study, we will rely completely on state and local cooperation to advise us of environmental and ecological factors that must be considered in the development of the wastewater systems we foresee in the Colorado River Basin. Any comments we receive on these matters will be considered in our investigation and become a part of the public record.

To this end, I might mention here that, along with the Governor's planning committee, we are proposing a series of workshops to be held throughout the course of the study at various locations throughout the basin. These workshops will be arranged and staffed by the Governor's planning committee and will be used as a sounding board for public opinion in regards to the conduct of the study and the results produced by the investigation. Your attendance and participation in these workshops will help us greatly in the conduct of our study.

Now, by mid-May we intend to present the most promising waste-water plans to the Governor's planning committee. And the Governor's planning committee will, in turn, coordinate these plans with affected

state agencies, institutions, councils of governments, and the general public. Then the Governor's planning committee will recommend one plan to the Governor, who in turn will forward this plan to the Environmental Protection Agency for certification.

I realize that my presentation has been in generalities today and that I do not have a specific plan to present to you. I have tried to explain what we are attempting to do in the study and what our end product will be and what you may expect it to be. I assure you that we will have another public meeting to present recommended plans to you. At that time we can discuss these alternatives that we have developed. Today we are asking your help in pointing out problems that we need to consider in our study.

We want everyone to have the opportunity to speak today, and if you cannot remain with us until your turn comes up, please let one of my staff know so that we can change the order in which you will be called, so you will have an opportunity to speak. When you're called upon, please furnish the reporter, who is sitting on my far left, five copies of prepared testimony, if this is possible, and then please step up to the microphone if you wish to make public testimony. You may use the microphone. We have one on the floor, or on the podium here, the one I'm using myself.

When you speak, please state your name clearly and any affiliation you have with any agency or organization for which you are speaking. There is no time limit on any testimony; you can speak as long as you wish. However, in the interest of courtesy to your neighbors, I would ask you to please keep it short if you can. If you have a long written statement, you can be assured that it will be considered in full. You may therefore safely condense your verbal testimony, if you like.

If your views happen to be the same as others who have testified before you, you may so state any additional comments that you would like to make.

The suggestions that I have just made are for the benefit of you and your friends and not for the benefit of myself and my staff. We of the Corps will be here until everyone has had his say, no matter how long it takes. If you do not wish to speak publicly, you can file a statement or send it to my office within two weeks and it will receive equal consideration with all other testimony submitted here today.

First, I want to acknowledge some letters that we have received prior to this public meeting. I have two of them here. The first one I have is from Clark Hubbs, who is President of the Texas Academy of Science. This will be made part of the public record of the meeting today. The next letter I have is from Warren M. Pulich, University of Dallas, Professor, and this letter will also be made part of the public record of the meeting today.

At this time I'd like to call upon the representative of the Governor's planning committee, Mr. Charlie Nemir.

MR. NEMIR: Thank you, Major.

Good morning. My name is Charles Nemir. I'm Assistant to the Executive Director, Harry Burleigh, of the Texas Water Development Board. Mr. Burleigh wanted to come himself today, because of other commitments, he couldn't and asked me to express his regrets to you for not being able to attend.

Mr. Burleigh's statement I presented for him in Austin on Tuesday, but would like to repeat it today for the benefit of those of you who weren't able to be in Austin.

Governor Smith in December, 1971, appointed a planning advisory committee to assist the Corps of Engineers in the Colorado River Basin Water Quality Management Study. This committee is composed of leaders from several state agencies, river authorities and water districts in the Basin, regional councils of governments in the Basin, interested federal agencies, and the general public. Mr. Burleigh was honored by being appointed Committee Chairman; Hugh Yantis, Executive Director of the Texas Water Quality Board, is Vice Chairman; and United States Representatives J. J. Pickle, John Young, Omar Burleson, and O. C. Fisher are honorary Co-Chairmen.

Several members and representatives of the members of the planning committee are in the audience today and several others were at our meeting in Austin.

In accordance with the desires of the Congressmen and the Corps of Engineers, the Governor charged the committee with providing overall planning guidance to the Corps and assuring that the views of a wide cross-section of the general public are sought and reflected during the course of the study. The role of the planning committee has, since its original organization, been expanded. Following authorization of the study by Congress in August, 1971, the Office of Management and Budget in Washington ruled that before funds could be released, and the study proceed, a study plan would have to be developed that would meet Environmental Protection Agency guidelines for such a study. These guidelines generally include the provision that federal expenditures on such a study must be matched on a fifty-fifty participation basis by non-federal interests.

Representatives of the Governor's planning committee worked diligently with the Corps of Engineers during the development of the study plan to identify work elements that could be provided by various non-federal interests to make up the fifty-fifty participation. Work descriptions were prepared and commitments were obtained from all participants to contribute the necessary support. Through a series of meetings and correspondence, the Governor's planning committee members have been active in the study development to this point.

Speaking for the planning committee, as a representative of its Chairman, I wish to reaffirm the commitment of this committee to serve this study. The committee will continue to coordinate the activities associated with the non-federal contributions to the study in cooperation with and through the division of planning coordination in the Governor's Office. The committee will also continue its efforts to assure that the study, as it progresses, reflects the views of a broad cross-section of the general public. To this end, the committee earnestly solicits the views, advice, suggestions, and comments from any and all persons interested in the Colorado River Basin Water Quality Management Study. All information received will be transmitted to the Corps of Engineers for their consideration. The planning committee members and their respective staffs will regularly review the study progress and provide suggestions, guidance and assistance to the Corps as necessary.

In closing, I would like to furnish further assurance, speaking for the Executive Director of the Texas Water Development Board, that the Texas Water Development Board intends to cooperate fully in the progress of this study and to fulfill its obligations by providing guidance and assistance as necessary and in completing the work items for which our agency is committed.

Thank you.

MAJOR ALLEN: Thank you, Charlie. Next I'd like to call on Mr. Garner Jones of the Water Quality Development Board -- excuse me, Texas Water Quality Board. Garner.

MR. JONES: Thank you, Major.

I am Garner Jones, representing the Water Quality Board, and today I'm representing the Executive Director of the Water Quality Board, Mr. Yantis, who has been mentioned as the Vice Chairman of this planning advisory committee that has been appointed by the Governor to assist the Corps of Engineers in the Colorado River Basin Water Quality Management Study. Mr. Yantis likewise regrets that he cannot be present at this meeting today, and extends his -- but he extends his continuing support to this study.

As the state agency in Texas who administers the Public Law 660 Grants Program for the construction of sewage treatment work, I guess we're the agency that's more directly involved in what might be the outcome of the study than perhaps any other agency, and because of this, we can tell you that the necessity of the study will be felt throughout the basin in the years to come because of the new federal regulations that require such a comprehensive basinwide management plan before any grants can be made for both EPA 660 grants, so called 660 grants or Department of Housing and Urban Development grants for the sewage treatment facilities before they can be funded for construction. Now, the completion and adoption of this fully developed plan is therefore most critical for future funding of these projects in the basin. As the -- since the Water Quality Board also makes many water quality management decisions within the basin throughout the state, this plan will also be used -- useful as a guide in making water quality management decisions which will strive toward the abatement of man-made pollution throughout the basin. Because of -- also because of the experiences that we've had, we have developed similar plans to this one in other areas of the state. After the plan has been adopted, or completed and adopted and approved, we have many people who come to us and complain after the plan has once been adopted that it's not exactly what they had desired, so therefore it's important that you make some expression of your views earlier, and it's through this experience that Mr. Yantis has had, the Executive Director of the Water Quality Board, he would like to have it--or make it clearly understood that it is desired that this planning effort

be representative of the desires and interests of the people in the basin. And accordingly, the comments to the general public are encouraging, as I mentioned, but he would like to pose these questions to you: What kind of regulatory action will spring from this study? I would like for you to make the comments concerning them. And how will they be upheld and enforced? And most importantly, who will pay for this regulatory action? Who do you think should pay for them? Also, what is the nature and extent of desired regional sewage systems and who should pay for them?

As all of you know -- I assume most of you know, some of the-- most of the programs of the Water Quality Board, those involved in waste control orders or permits for the discharge of sewage treatment or any kind of waste for sewage treatment facilities, both municipal and domestic, the control of livestock feeding -- feedlot operations and this sort of thing, I'll not go into that aspect of the programs of the Water Quality Board. And also we have the stream monitoring program that is conducted throughout the state. I'll not get into those at this time, but I will tell you that the Water Quality Board realizes the importance of this study and will do its utmost to cooperate in the completion and adoption of this basin management plan.

Thank you.

MAJOR ALLEN: Thank you, Garner.

The meeting is now open to public testimony. First, I would like to call on Mr. W. P. Odom of the Colorado River Municipal Water District.

Would you care to use the lectern?

MR. ODOM: This will be fine to use this one, sir.

I'm W. P. Odom with the Colorado River Water District, representing Mr. O. H. Ivie, General Manager, who was not able to attend this meeting today. This letter is addressed to U.S. Corps of Engineers, Fort Worth District, Fort Worth, Texas. "Gentlemen: The Colorado River Municipal Water District is charged with the responsibility of meeting the municipal water requirements of the cities of Odessa, Big Spring, Snyder, Midland, Stanton, and a specified quantity of the requirements of the city of San Angelo, as well as supplying certain industries' water requirements, located throughout the area served by the District.

"The primary source of supply of water for the municipalities and the industrial customers served by the District is Lake J. B. Thomas and Lake E. V. Spence, both located on the main stream of the Colorado River and both being owned and operated by the District. Lake Thomas has a capacity of 204,000 acre feet and Lake Spence has a capacity of 488,760 acre feet.

"Through the years the District has been monitoring the quantity and quality of flow in the Colorado River above the city of Robert Lee, and has conducted extensive water quality surveys throughout the drainage areas of the reservoirs. It is widely known that the normal flow of the Colorado River below Lake J. B. Thomas and above the city of Robert Lee is high in total dissolved solids with chlorides being the predominant factor.

"The surveys made firmed-up our belief that the primary source of chloride contamination was brought about by the improper disposition of salt water that was being produced along with oil, as well as improperly plugged abandoned oil wells.

"In order to insure that the water impounded in Lake E. V. Spence would be of high quality and suitable for municiapl use, the District, through the cooperation of the Railroad Commission, was instrumental in eliminating the use of salt water disposal pits and further set out to properly plug abandoned oil wells that were contributing to the pollution of the river. It also constructed facilities known as "Low Flow Diversion Works' on the Colorado River immediately above Colorado City. These facilities cost in the neighborhood of $1,200,000 and enables the District to divert the normal flow from the river into a 2500-acre foot side storage reservoir. The quality -- this low quality water diverted from the river into the side storage reservoir is then delivered to oil companies for secondary recovery purposes.

"It is the desire of the Colorado River Municipal Water District to make water of the highest quality possible available to the municipalities served by it.

"We appreciate the efforts of the Corps of Engineers and the Governor's Planning Committee in investigating the quality conditions throughout the Colorado River Basin and wish to take this opportunity to let you know that we will cooperate with you in every way possible and will be happy to make available copies of all reports and other pertinent information we have that will assist you in your study."

Thank you.

MAJOR ALLEN: Thank you, Mr. Odom.

No one else indicated as they came in the door their attendance cards that they desired to make a public statement. Is there anyone that's changed their mind and would like to make a statement or ask a question?

Ladies and Gentlemen, if there are no questions and no further statements, this public meeting is adjourned.

Thank you.

(Meeting adjourned at 10:50 A. M.
July 13, 1972.)

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This is to certify that the attached proceedings in the matter of the public meeting for the Colorado River Wastewater Management Study, held on July 13, 1972 in the San Angelo Municipal Auditorium, City Hall Plaza, San Angelo, Texas, was held as herein appears and that this is the transcript thereof for the files of the Department.

sgd/ _____

MAUDIE RUTLEDGE
OFFICIAL REPORTER

HEARING COMMISSION REPORT

SYNOPSIS

I. Subject

Proposed Basin Plan for the Colorado River Basin

II. Hearing

A. Date: August 24, 1973
B. Location: Austin, Texas
C. Hearing Commission: Hugh C. Yantis, Jr., Executive Director
John P. Sutton, Presiding Officer
Charles Nemir, Texas Water Development Board (representing the Governor's Planning Committee)
Major C. A. Allen, U.S. Corps of Engineers, Fort Worth
Milburn D. Smith, U.S. Corps of Engineers, Fort Worth

III. Findings

A. The Water Quality Management Plan for the Colorado River Basin has been prepared as part of the Texas Water Quality Board's Continuing Planning Process which was approved by the Environmental Protection Agency on July 10, 1973. The process has evolved in response to Section 303(e) of the Federal Water Pollution Control Act Amendments of 1972 and the regulations in 40 CFR, Part 131.

B. A public hearing, preceded by timely public notice, on this proposed Water Quality Management Plan has occurred in the affected area.

IV. Recommendations

A. Disposition: The Hearing Commission recommends that the Board approve the Wastewater Management Plan for the Colorado River Basin.
B. Date of Board Consideration: September 12, 1973

SUMMARY OF THE EVIDENCE

The proposed Water Quality Management Plan for the Colorado River Basin has been prepared by the staff of the Texas Water Quality Board as one facet of the federally approved Continuing Planning Process. Much of the data and other information have been supplied by the Governor's Planning Committee, U.S. Army Corps of Engineers, and the consultant Turner, Collie, and Braden, Inc., which initiated wastewater planning 18 months ago. The effort was financed by state and federal funds on a matching basis. The accumulated data base is evaluated and projected in computed models at the Water Quality Board. The results of modeling and other required information are assembled and processed according to the guidelines of Section 303(e) of the Water Pollution Control Act Amendments of 1972 and 40 CFR, Part 131.

Prior to the adoption of the plan by the Governor's Planning Committee on August 15, 1973 and the informal public hearing on August 24, 1973 in Austin, numerous workshop meetings were held throughout the basin. These conferences were held in Odessa, Midland, Big Springs, San Angelo, Ballinger, Brownwood, Austin, Burnet, Smithville, and Wharton. The comments presented at those sessions were incorporated into the plan prior to the hearing in Austin.

Mr. R. H. Maurer, speaking for the Celanese Chemical Company reserved the right to present data to the Environmental Protection Agency and to the Texas Water Quality Board at a later date.

Mrs. Howard Kittel complimented the work done and the people who have accomplished it.

A public hearing on the proposed Water Quality Management Plan has been held in Austin, Travis County, Texas on August 24, 1973. The location reflects the federal guidelines for public hearings listed in Section 105.7 of the Federal Register, Volume 38, Number 36. The site is in the central area of the basin. It is readily accessible by public transportation. The intracity and intercity transportation facilitates attendance and testimony by a cross section of affected and interested persons. The hearing was announced by a public hearing notice which was published at least 30 days before the event. Interested and affected persons were also mailed notice of the hearing on the same time schedule.

The proposed plan is a product of the Continuing Planning process. The process is implemented in response to the Water Pollution Control Act Amendments of 1972 and the guidelines in 40 CFR, Part 130. A public hearing on June 4, 1973 was a formal prerequisite for adoption of the process. On June 12, 1973 the Texas Water Quality Board modified the plan in response to testimony at the initial hearing and then approved it. The objective of this particular plan as part of the planning process is to provide for maximum improvement of the water quality in the basin and to set forth procedures and guidance for the Board to follow in complying with federal guidelines concerning the preparation and continuing revision of it.

As required by federal law and as listed in the notice of the public hearing, the purpose of the basin plan is threefold. The plan shall provide the information the state needs to make centralized, coordinated water quality management decisions. It shall provide the strategic guidance for developing the state program submitted under Section 106 of Public Law 92-500. It shall encourage water quality objectives which take into account overall state policies and programs.

The concept of the plan is to process information such as the Water Quality Standards, monitoring data concerning both the quality and the flow of the river and the characteristics of the discharges into it to obtain segment classifications and segment plans. Due to the number of variables and the changes inherent to stream flow, the segment classification will be reviewed continuously by the staff of the Board. An additional reason for the review envisioned in the concept is that current projections are valid until 1977 because there are no federally approved guidelines for treatment after that date.

The results of the plan affect both the priorities for grants and the degree of treatment for the segments and the discharges of the entire basin. The priority ranking for federal grants will be determined by segment ranking and by the effect of the discharge on that segment.

The plan will also influence the degree of treatment and the specific parameters on waste control orders issued to dischargers into a particular segment. This particular area is subject to amendment and revision when the post 1977 treatment guidelines become available.

After due consideration, the Hearing Commission believes that the proposed Water Quality Management Plan for the Colorado River Basin is an accepted vehicle to implement the policy and purpose of the Texas Water Quality Act as expressed in Section 1.02, which reads as follows: "POLICY AND PURPOSE. It is the policy of this State and the purpose of this Act to maintain the quality of the water in the state consistent with the public health and enjoyment, the propagation and protection of terrestrial and aquatic life, the operation of existing industries, and the economic development of the state; to encourage and promote the development and use of regional and area-wide waste collection, treatment, and disposal systems to serve the waste disposal needs of the citizens of the state; and to require the use of all reasonable methods to implement this policy."

Therefore, the Commission recommends the Board approve the proposed plan and transmit it to the Office of the Governor for submission to the Environmental Protection Agency.

John P. Sutton, Presiding Officer

Garner E. Jones, Administrative Operations, Planning

September 11, 1973

JPS:ha

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Workshop Meetings-Wharton, Texas
7 September 1972 and Austin, Texas 8 September 1972.

Workshop meetings for the Colorado River Basin Wastewater Management Study were held at Wharton and Austin on 7 and 8 September 1972, respectively. These meetings were arranged and chaired by Mr. Ward Goessling, Governor's Office, as part of the State participation program in the study. The contact agency utilized by the State for the arrangements for the meetings was the Houston-Galveston Area Council for the Wharton meeting and the Capitol Area Planning Council for the Austin meeting. The basic philosophy for workshop attendance was the inclusion of county and city officials and Council of Governments Directors. List of attendants at these meetings is inclosed.

Wharton Meeting.

Introductory remarks were made by representatives of the Governor's Office, Corps of Engineers, Texas Water Quality Board, and the Texas State Department of Health. In response for comments that may be helpful to the conduct of the study, the following ideas were advanced by the attendants.

Judge Cranek, Colorado County, voiced objection to the projected population decline noted for his county and Wharton County and cited search for a 9,000-acre industrial site in Colorado County, as well as the increasing development of 3-5 acre sites for domestic dwellings. The majority of the development is taking place along the Colorado River. This population-increase trend was also noted by the Mayor of Bay City. (Inasmuch as Poston projections indicate a declining population for these areas, these remarks should be considered in the study.) Judge Cranek also indicated in his remarks that the county judge lacked sufficient authority to adequately enforce sewage regulations and operational procedures.

All counties represented (Wharton, Colorado, and Matagorda) reported trouble with septic tanks in their portion of the Basin. The heavy clay soil in the area is generally impermeable and not conducive to the best results for proper operation of septic tanks. (The extent of this problem in relation to the overall wastewater management study is yet to be determined.) Judge Nickle, Wharton County, firmly stated that septic tanks were not the answer in Wharton County. In response to a question from the chair, the Judge stated that the County Commissioners' Court has the authority to regulate sewage disposal.

The Mayor of Bay City noted that septic tank conditions in Matagorda County were similar to those experienced in the other two counties. He stated that the sewage treatment plant in Bay City was adequate, but that unscheduled release caused by the Coastal Drainage District draining its canals resulted in malodorous conditions at the plant during these periods.

Mayor Guffey, Wharton, discussed a plan proposed by the City of Wharton to improve its sewage plant by dumping first-stage treatment into irrigation canals near the city. This plan is being investigated in lieu of enlarging the existing plant. (Since this plan could tie into the proposed land disposal studies, it could present an opportunity to be investigated. Mayor Guffey's phone number is AC 713-532-2170.) There were twelve citizens at the meeting, three of whom left after the coffee break.

Austin Meeting.

The Austin meeting was attended by 25 individuals. List of attendants is attached. A questionnaire regarding the study and a glossary of terms were handed out to attendants. At this meeting, the introductory remarks were limited to a brief discussion of the study by the Governor's Office. No statements were made by the participating Federal and State agencies--a decided improvement over the Wharton meeting.

The following comments were received:

The glossary of terms handout was a good document but needed some editing and clarification. (This is a good idea but easier said than done.)

Judge Griesenbeck, Bastrop County, reported a sand-and-gravel operation in his county was badly degrading river water quality in that area and causing discoloration of the water. He also noted that the City of Bastrop was holding a bond election for a new sewage plant.

County Judge, Gillespie County, reported that the city of Fredericksburg was planning a new plant, in conformance with a county-wide plan for wastewater treatment. The Fayette County representative reported a possibility of La Grange and Fayetteville regionalizing their system.

Mr. Smallhorst, Austin, noted that stormwater runoff in Town Lake resulted in a greater pollution and debris problem than sewage effluent in the lake. Stormwater studies are being made by the City of Austin, EPA, Fruh and Texas A&M/TWQB.

Considerable discussion was held as to the extent of inclusion of on-going FHA programs in the Basin. Mr. Drummond, Congressman Pickle's aide, stated that he was under the impression that all plans were to be considered and tied into the plan. After much argument over the extent of this phase of the study, Mr. Drummond stated that he felt we should consider all sources, regardless of "whose toes we step on." At this point, Mr. Goessling stated he would set up a meeting with the Governor's Planning Committee and the Capital Area Planning Council to resolve these differences.

Mr. Graves, Austin, requested that an in-depth look be taken at the urban runoff problems, particularly as caused by such large paved surfaces as presented in shopping centers and other similar areas.

Comments on meetings.

Good response was obtained from persons in attendance. Although the attendance represented people in positions of civic authority and responsibility, and none of the so-called individual and environmental conservation groups, it appears that these are the people who are aware of problem areas and situations that should be observed. Follow-up meetings at the time of presentation of conceptual plans and designs should include persons outside of the so-called "power structure."

The informal approach to the meeting that was obtained at the Austin workshop was a marked improvement over the speaker-stand idea used at Wharton. An introduction of all persons in attendance would result in placing the attendees more at ease.

The questionnaires were not distributed at the Wharton meeting but were used at the Austin meeting. Completed questionnaires are to be returned to the Governor's Planning Committee. Only two of these questionnaires were returned to FWD personnel. Information in these questionnaires, as well as remarks contained in this report, should be forwarded to TCB as soon as possible.

Attendance at these meetings was not considered to be inadequate for a workshop session. The broad spectrum of participants that we hope to achieve, however, was not accomplished. The invitation to local governing officials is more than appropriate; however, in order to meet our commitments to the public participation program, we must reach the individual citizenry and the environmental/conservation groups. Whether these elements attend the meetings or not, we must give them the opportunity to refuse to attend. COG newsletters and personal contacts with

its executive boards are not sufficient to reach the full body of the public we should be encouraging. More intensive newspaper coverage could result in extending the scope of the meeting beyond the workshop level that is intended. Greater emphasis should be placed on the personal-contact phase of attendance stimulation.

Follow-up meetings should be scheduled to coincide with presentation of conceptual designs. Although the need for input data is still mandatory, the basic catalyst for public response and input is going to be the presentation of a plan showing what will be built, how it will be done, and who's going to pay for it.

The philosophy of workshops predicated on the jurisdictional territory of COG's is not necessarily going to present a full coverage of the Basin. Here, again, we are confronted with our commitment to reach all areas of the Basin. If the meetings at Midland and San Angelo do not attract a wider geographical representation than presently foreseen, it is recommended that additional first-round workshops be held at Snyder, Big Spring and Brownwood. Attendance at the next two workshops will be used to forecast and schedule further workshops.

Persons Attending Workshop Meeting

Leland Wilson	CE	Ft. Worth
Jim Herbert	CE	Ft. Worth
Lester J. Cranek	County Judge	Columbus
N. C. Gusma	Mayor	Bay City
W. R. Carradine	Head Utilities Dept.	Bay City
Maner Stafford	Commissioner	Wharton
Gene Guffey	Mayor	Wharton
D. T. Fordham	City Inspector	Wharton
Henry Brenek	City Manager	Wharton
Delfin Marek	County Clerk	Wharton Co.
Andrew Dittert	County Auditor	Wharton Co.
R. D. Wright	Security Bank & Trust Co.	Wharton
J. G. McDaniel	Commissioner	El Campo
W. C. Goessling	Governor's Ofc.	Austin
Mac Weaver	EPA	Dallas
David M. Cochran	State Health Dept.	Austin
Garner E. Jones	Water Quality Bd.	Austin
John A. Fazzino	HGAC	Houston
Dorman Nickels	County Judge	Wharton

Workshop Meeting - Midland, Texas
20 September 1972.

After the introductory remarks, the first comments from the audience were delivered by Mr. O. H. Ivie, General Manager, Colorado River Municipal Water District. Mr. Ivie directed the following questions:

> Why did the Corps of Engineers utilize only one consultant for a study with such a strict deadline?
>
> Why was a Houston firm selected when it was not familiar with the geographic area that is involved?
>
> Could other firms be utilized at this time?

These questions were answered by the statement that numerous firms were considered and TC&B was selected as the firm that could deliver the required product within the designated time frame and that the firm possessed the necessary facilities and personnel to perform the task. The utilization of additional consultants is a discretionary matter for TC&B. It was pointed out that TC&B is using other consultant firms and that the Corps has negotiated a contract with TWDB for model work on the study.

Mr. Ivie answered these remarks by stating that, from the time standpoint, the study had gone from bad to worse by the utilization of only one consultant. He felt that considering the time and constraints and the immensity of the data collection and design program, there is no way that TC&B can produce a good report. He added that no effort was made to contact him for data input for the study. He felt that he had valuable information that could be used but no effort had been made by the Corps or TC&B to obtain these data.

Mr. Dillard, Odessa Director of Utilities, asked for a brief description of the scope of the study. He also asked the following:

> Will EPA hold city accountable for effluent as long as health standards are met?
>
> Will TWQB accept Corps findings in this report? (Answer was yes.)

Judge Toombs, Borden County, asked if the study would encompass the salt water problem caused by oil well operations, and if studies were to be made on injection operations. He noted the prevalence of brine disposal pits in Borden County and the county program to control the salt cedars in the area.

Judge Moore, Upton County, expressed concern over salt brines and their entrance into ground water, expressly in the area of Fluvanna.

Mr. Ivie stated that the report would not reflect chloride contamination.

Midland County representative stated that the main problem was the natural pollution from chlorides, not the man-made pollution.

Mr. Brooks, TSDH, asked if the study would address itself to solid waste disposal. In this connection, he noted the need for the upgrading of dump grounds, citing one particular area near Stanton. He was told that this would be considered as it pertained to the wastewater management program.

At this point, Mr. Ivie stated that not enough employees were being utilized to present a report that the EPA will approve.

Mr. Smith, Permian Basin COG, asked for a report on the status of the study. This was furnished by Mr. Wilson, along with a description of the furnishing of alternative plans for the six metro areas and the Basin plan for the smaller cities. Mr. Smith stated that he felt the agencies in his COG area were not being contacted and that much information could be obtained from these groups. He noted that his agency was willing to meet at any time with study group members.

Mr. Dillard requested a recommendation of effluent standards for arid regions.

Mac Weaver pointed out that the study was to concentrate on municipal and industrial effluent pollution while just sighting and discussing the non-point (agricultural and natural) problems.

Persons Attending Workshop Meeting

Ward Goessling	Governor's Office	Austin
James M. Lindsey	TWQB	Austin
Joe J. McEntire	SCS	Big Spring
Van C. Mills	SCS	Andrews
Hugh R. Lackey	SCS	Sterling City
Walter Bertsch	SCS	Seminole
Gerald A. Miller	SCS	Big Spring
Herbert Stone	SCS	Midland
Jake D. Hodges	SCS	Stanton
James McAllister	City of Lamesa	Lamesa
Nedy Brookes	TSDH	Lubbock
Curtis Heaton	Health Dept.	Odessa
Jack O. Dilland	City of Odessa	
Willis V. Brown	Big Spring	Big Spring
Fred W. Poe	City of Midland	Midland
John B. Lowe	City of Midland	Midland
Wyatt Lipscomb	SCS	Odessa
Bob Steakley	Sandhills SWCD	Odessa
Neil Bridges	Stanton	
Bob Kral	SCS	Lamesa
Leslie C. Pratt	Co. Judge	Lamesa
O. H. Ivie	CRMWD	Big Spring
Harley Reeves	P. B. R. P. C.	Midland
Robert H. Wilson	City of Seminole	Seminole
Bryan Henderson	City of Odessa	Odessa
Glenn Toombs	Co. Judge Borden Co.	Gail
W. E. Smith	PBRPC	Midland
Ernie Crawford	PBRPC	
Allen Moore	Co. Judge Upton Co.	Rankin
Jim Herbert	Corps of Engineers	Fort Worth
Mac A. Weaver	EPA	Dallas
Leland R. Wilson	Corps of Engineers	Fort Worth

Workshop Meeting-San Angelo, Texas
21 September 1972.

A workshop meeting for the Colorado River Basin Wastewater Management Study was held in the Angeles Room of the Central National Bank, San Angelo, Texas, on 21 September 1972. There were 18 persons in attendance. List of attendants is attached.

In response to a question regarding the proposed new treatment plants, Mr. Krueger, TWQB, furnished the following: City of Coleman has plans for new plant; Brownwood and Ballinger are having study made to rehabilitate old plant; Brady is extending service to a minority neighborhood and a new subdivision is being planned at Lake Brady; Winters and Bangs have new plants and Brownwood State Park is installing package units.

The City of San Angelo reports that land disposal treatment used by the City is performing adequately, noting a need for additional lands. Although minor problems had been observed, BOD count was within standards. Effluent was high in nitrates but no higher than ground water in the region. It was pointed out that chemical monitoring of all shallow wells in the area would show coliform organisms present but that the wells in the area are mainly used for irrigation and not for domestic use.

The City of Robert Lee reported that it sells activated sludge for use in parks and for fertilizing trees.

In a report on lake conditions, it was noted that Hords Creek has a long-established monitoring station and that the quality of the water in the lake is excellent. Lake Nasworthy water is acceptable, not critical, but all wells in the area are brackish.

Mr. Roberts, San Angelo, reported abandoned wells in his property were discharging salt water. He described efforts he had made to have this condition corrected and he had not met with success in this endeavor. He suggested that a clear definition be made of an abandoned well and a time limit be placed on its remaining in uncared-for condition. He also noted the overlapping authority that exists on water quality in the case of abandoned wells and suggested that some effort be made to define and appoint a single authority for this matter.

Mention was made that the City of Ballinger has salt problems, and a suggestion has been made that the entire ground water situation in Runnels County should be reevaluated.

The following studies were suggested as being helpful to the study:

Dr. Sneed's Texas A&M study on urban runoff at San Angelo (one copy at Concho Valley COG).

West Texas Utilities thermal study on Lake Nasworthy.

The City of Millerview has a FHA water supply study underway which will encompass some of the features of the wastewater management study.

Persons Attending Workshop Meeting

J. T. Herbert	Corps of Engineers	Ft. Worth
Leland R. Wilson	Corps of Engineers	Ft. Worth
Mac A. Weaver	Environmental Protection Ag.	Dallas
Ward Goessling	Governor's Office	Austin
Jim Lindsey	TWQB	Austin
Gus Clemens	Ionics, Inc.	San Angelo
J. E. Williams	City of San Angelo	San Angelo
R. H. Weiss	Texas Health	Kerrville
Wylie O. Webb	City of San Angelo	San Angelo
Tom Koederitz	City Water Dept.	San Angelo
Stephen Brown	City of San Angelo	San Angelo
Kenneth W. Krueger	TWQB	San Angelo
Fred Gunther	KCTV	San Angelo
Fred Conn	EPA Water Pollution Cont. Com.	San Angelo
Tom Adams	Concho Valley COG	San Angelo
Ralph Hallway	City of San Angelo	San Angelo
W. D. Howard	City of San Angelo	
J. K. Roberts	Self	San Angelo
Charles J. Dankworth	Concho County	Paint Rock
Norma Joe Williams	Standard-Times	San Angelo
George R. Hopsin	City Commissioner	San Angelo
James E. Swain	Reg. Services Coord. W. C. T. COG	

Workshop Meeting - Midland-Odessa
10 April 1973.

A workshop meeting was held in the Midland-Odessa Airport on 10 April 1973 to discuss the proposed treatment systems for the non-metro areas of the Permian Basin Regional Planning Commission and the South Plains Association of Governments region. There were 39 persons in attendance at the meeting. A list of attendants is attached. There were representatives from five of the nine communities in the Permian Basin Regional Planning Commission and one of the six from the South Plains Association of Governments. The assistant planning director of the South Plains Association of Governments was present and represented the cities that were not in attendance.

Mr. Goessling, Governor's Office, opened the meeting with a brief discussion of its purpose in presenting treatment system proposals. Mr. Wilson, FWD, then described the contents of the handouts for each city and noted that these data were prepared on the best available information. He emphasized that the plans were subject to change and were not intended as a hide-bound document that would have to be accepted under any condition. Mr. Wilson presented the individual system proposals to the attending communities, as well as a complete set of the documents to the COG representative, and requested them to review the proposals for their adequacy and conformity to community needs. He also requested that they pose general-type questions that would be applicable to the entire assemblage prior to presenting questions that would pertain to individual cities.

After Mr. Wilson's presentation, Mr. Nemir explained the background of the study, the formation of the Governor's Planning Committee, and the process and need for the final report. Mr. VanSickle, TC&B, explained his firm's rationale in the development of the proposals and the techniques that were used to come up with the presentations. He urged input from the affected communities, stating their knowledge of their area would aid in the formulation of the proposed systems. After these introductory remarks, the individual proposals were distributed to the communities in attendance for examination of their content. There were no general questions posed by the assemblage.

Judge Moore, Upton County, inquired for proposals for the Cities of Rankin and McCamey. He was informed by Mr. VanSickle that these cities were in the Rio Grande-Pecos Basin and were not a part of the Colorado River Basin Wastewater Study. Mr. VanSickle also informed Judge Moore that plans for these communities would have to be formulated in a study for the Rio Grande Basin.

Representatives of the City of Goldsmith pointed out to the consultants that an additional 100 homes had been constructed in the city which were not reflected in the map presented for the workshop. Mr. Barker informed the representatives that the additional homes would be considered prior to the issuance of the final report.

Mr. Ivie, Colorado River Municipal Water District, questioned the source of the population figures that were used for the proposals. Mr. Nemir replied that the base for the population projections was furnished by the University of Texas as a result of a contract with the Governor's Office for planning purposes. This contract called for projections only to the year 1990, while the need for planning purposes extended to the year 2020. Consequently, the TWDB, using the University of Texas formulation procedures, projected the figures to the year 2020. In the projection of figures for the smaller towns (less than 2000 population) TC&B made these projections, using TWDB methodology. Mr. Ivie asked if the base for the projections was the University of Texas formulation. Mr. Nemir replied that this was correct.

Mr. Taylor, city manager, Lamesa, voiced his objections to the population projections for the City of Lamesa to Mr. Nemir.

Mr. Ivie questioned Mr. Herbert as to the status of Corps negotiations with the USGS for the investigations of the total dissolved solids in the Upper Colorado River Basin. Mr. Herbert replied that the USGS agreed to install quality measuring devices in the existing gaging station at Beals Creek above Big Spring. Mr. Ivie stated that he would like to see the quality gaging station located in a reach of Beals Creek in downtown Big Spring. He questioned if he could negotiate with USGS for a change in location of the quality gaging station. Mr. Herbert replied that he felt the Corps would have no objection, but the final decision would have to come from the Fort Worth District Office in conjunction with the USGS, since the sampling station is part of the USGS data collection program for the Corps contract. Mr. Ivie stated that he appreciated the work in the program and would contact the USGS about the proposed change in the station. Mr. Ivie stated that he had been asked to represent the City of Big Spring in the workshop program and that he would like to set

up the meeting for that city. Mr. Herbert replied that arrangements for the meetings were the responsibility of the Governor's Planning Committee and that he would relay Mr. Ivie's message to the Planning Committee.

In a discussion with Mr. Barker, Mr. Harrison of Coahoma stated that the City of Sand Springs had contacted the City of Coahoma on the regionalization of treatment facilities between the two cities. This was passed on as a mater of information since no action was taken for Sand Springs to tie into the existing Coahoma facilities.

The plans for the cities not in attendance at the meeting were presented to Mr. Smith, Permian Basin Regional Planning Commission, and Mr. Bubenik, South Plains Association of Governments, for dissemination to these cities. It was emphasized that the plans should be examined by the cities and returned to FWD by 17 April 1973 with appropriate comments as to their adequacy and conformity to city needs.

Persons Attending Workshop Meeting

Donald VanSickle	Turner, Collie & Braden, Inc.
Ned V. Brookes	Lubbock State Health Dept.
Jim Herbert	Corps of Engineers
Mac A. Weaver	EPA, Dallas
Raymond Mittel	TWQB - Lubbock
Kenneth W. Krueger	TWQB - San Angelo
Ray Browder	Goldsmith Utility Manager
S. C. Tanner	Goldsmith, Texas - Mayor
Jim Davis	Sterling City - Rancher
Donald G. Viktorin	Sterling City - SCS
Clifton Harrison	Coahoma
Robert Helm	Water-Sewer Supt. Coahoma
F.O. Rhodes	City of Stanton Council
Charles Nemir	Texas Water Development Board
Leland Wilson	Corps of Engineers
Paul A. Seals	Texas Water Quality Board
Ward Goessling	Governor's Office
Paul Barker	Turner, Collie & Braden, Inc.
Herbert Stoner	USDA Soil Conservation Service
Joe J. McEntire	USDA Soil Conservation Service
Allen Moore	County Judge, Upton Co., Rankin, TX
Bryan Henderson	City of Odessa
C.A. Taylor	City of Lamesa
H. Bennett Reaves	Park, Smith & Cooper, Inc.
Harold C. Jones	City of Brownfield
James M. Waddell	Upper Pecos S. & W.C.D.
Billy H. Boggs	Texas Water Quality Board - Pecos
Curtis Heaton	Health Department - Odessa
S.F. Henderson	Sandhill S.W.C.D. - Odessa
Wyatt Lypscomb	Soil Conservation Service - Odessa
Geo. H. Medley	City of Midland
John B. Lowe	City of Midland
Jack Elrod	SCS, Stanton
Jack Dillard	City of Odessa
Paschal Odom	Colorado River Municipal Water Dist.
O.H. Ivie	Colorado River Municipal Water Dist.
Jackie Bubenik	South Plains Assoc. of Govt. - Lubbock
Jerry Cowden	Soil & Water Conservation District
W. E. "Bill" Smith	Permian Basin Regional Planning Comm.

Workshop Meeting-Ballinger, Texas
11 April 1973.

A workshop meeting was held in the Community Center of Ballinger on 10 April 1973 to discuss the proposed treatment systems for the non-metro areas of the West Central Texas COG region. There were 35 persons in attendance at the meeting. A list of attendants is attached. There were representatives from 10 of the 12 cities in the COG and the TWQB representative from Lubbock stated that he could represent Snyder in an unofficial capacity. Only Cross Plains was not represented at the meeting.

Mr. Goessling opened the meeting and introductory remarks were made by Mr. Wilson, Mr. Nemir and Mr. Barker. These remarks followed the same context as those presented at the Midland workshops on the previous day. Again, Mr. Wilson asked for general questions prior to the submittal of specific questions pertaining to the individual communities. The individual packets were distributed to the attendant cities and Mr. McGinn, Planning Director, WCTCOG, accepted the packets for the cities of Snyder and Cross Plains.

The following general questions were asked from the floor:

Dr. Johnson, Loraine, asked if cities could apply for construction grants prior to submittal of the report. Mr. Seals, TWQB, replied that there was no objection to this practice but that the information on this should be relayed to TC&B for inclusion in the report. Mr. Seals explained the review process which the report would undergo, and emphasized that there would be no objection to applications for construction grants at the present time.

Mr. McCorkle, Coleman, asked if funds were available now for construction grants. Mr. Weaver, EPA, replied that they were not.

Mr. Switzer, Bangs, asked when funds would be available. Mr. Weaver replied that he did not know. Mr. Switzer noted that his city had already committed itself to a bond issue that would provide its share for a grant program and seemed concerned that any change in legislation could affect the bonded indebtedness of the city in regards to its treatment program. Mr. Weaver replied that the possibility exists that cities can be credited for funds they have expended on the program and that the new legislation did provide for refunds to the cities in instances where they have exceeded the prescribed local contribution to the program.

Mr. Baldwin, Winters, asked if the smaller cities would have to conform to the criteria of the new legislation regardless of the cost to the community. Mr. Weaver replied that all cities would have to comply with the requirements of the new legislation.

Mr. Sanchez, Colorado City, stated that his city had just updated its system to comply with a study that had been conducted by WCTCOG, and he felt that the many agencies that were involved in the process were confusing the smaller cities. He specifically asked if his city would have to comply with the recommendations of the WCTCOG study or the current Colorado River Basin Wastewater Study. Mr. Wilson replied that the current study will be the accepted study for the Basin and will be used as the basis for the application for construction grants. Mr. Barker noted that the formation of the Planning Committee for the study precluded the need for the communities to have to contact numerous agencies and that they could contact only one group -- the Planning Committee. Mr. Barker also informed the Colorado City representative that the current study indicated that his town did not need the extensive treatment system that was outlined in the WCTCOG study. It was emphasized that the main criterion for the cities was their compliance with the State-established stream standards and waste allocations. Adherence to these criteria was the basic item for the smaller communities to consider.

Mr. Holden, Clyde, objected to the population projections, and Mr. Nemir explained the formulation of these figures.

Mr. Everett, Ballinger, brought up the subject of the pollution of ground water by brine injections. Mr. Wilson explained that this problem was recognized and that a study of salt pollution was being undertaken as part of the comprehensive Basin study.

In response to a question from the floor, Mr. Weaver and Mr. Barker explained the difference in primary and secondary treatment. In the course of this discussion, the subject of the use of wastewater for irrigation was introduced. Mr. Krueger, TWQB, cautioned as to the complications that may arise from water rights in the pursuit of this irrigation. It was mentioned by Mr. Goessling that the legal aspects of water rights could lead to another workshop and study of the same magnitude as the wastewater management study.

All cities were asked to return their proposals to the FWD with appropriate comment by 18 April 1973.

(Writer's note: This meeting represented the workshop philosophy at its best. The attendants were knowledgeable, interested in the study, and posed questions that were pertinent to the technical, legal, and administrative and operational phases of the program.)

Persons Attending Workshop Meeting.

Elves Cook	Ballinger
Werner Harsch	Miles
Dr. Bruce H. Johnson	Loraine
Royce Mahon	Loraine
Everett Henderson	Loraine
J. W. Jackson	Miles
Chas. Switzer	Bangs
Bud Everett	Ballinger
Roy Barnes	Bangs
Louis Glassan	Coleman
Roy McCorkle	Coleman
C. A. Sanchez, Jr.	Colorado City
Darwin Lovelady	Santa Anna
Buford Baldwin	Winters
W. D. Waggoner	Winters
J. T. Isbell	Winters
William Goetz	Ballinger
Harold Holden	Clyde
C. Lee Smith	Clyde
Harry W. Jones	Lake Brownwood State Park
Richard H. McQuinn	WCT COG
Mike Orrick	TWQB - Lubbock
Bob Gallagher	WCT COG - Abilene
Ned V. Brookes	Texas State Dept. of Health
Thomas P. Rogers, P.E.	Abilene Health Dept.
Kenneth Krueger	TWQB - San Angelo
David P. Whatley	Ballinger
Paul Barker	TC&B
Don VanSickle	TC&B
Mac Weaver	EPA
Charles Nemir	TWDB
Ward Goessling	Governor's Office
Paul Seals	TWQB
Leland Wilson	FWD
James Herbert	FWD

Workshop Meeting-San Angelo, Texas
12 April 1973.

A workshop meeting was held in the Angeles Room of the Central National Bank of San Angelo on 12 April 1973 to discuss the proposed treatment systems for the non-metro areas of the Concho Valley COG region. There were 15 persons in attendance at the meeting. Two of the 12 cities in the COG were represented and one city (Paint Rock) had representatives, although no specific proposal had been prepared for that city. Mr. Grimes, Mayor of Menard, and Mr. Fox, professional engineer, representing Sterling City, were the only two representatives of the affected communities. Proposal packets for the cities that were not in attendance were given to Mr. Adams, Planning Director, Concho Valley COG, for coordination with these communities. Mr. Adams noted that this was his last day of employment with the COG and that Mr. Hinds of the Concho Valley COG would have the responsibility of coordination.

Because of the scarcity of attendance, the interchange of ideas was practically nonexistent. Following the usual presentations by Messrs. Goessling, Wilson, Nemir, and Barker, the only question directed from the floor was by Mr. Adams questioning the population projection for Junction. Mr. Nemir explained the methodology involved in the projection. Representatives from the City of Paint Rock were mainly concerned that their city would have to be responsible for the construction, operation and maintenance of a treatment facility in lieu of their existing septic system. Mr. Barker informed them that as long as they met stream standards, no additional facility would be required.

Mr. Wilson asked that all proposals be returned with comment to the Fort Worth District by 19 April 1973.

Persons Attending Workshop Meeting.

Kenneth Krueger	TWQB - San Angelo
Tom Adams	CVCOG - San Angelo
William E. Fox	P. E. - San Angelo
Tom Grimes	Mayor, Menard
Jim Hinds	CVCOG
Ben Sims	Concho Co. WCID #1 - Paint Rock
Phillip Hartgrove	Concho Co. WCID #1 - Paint Rock (sec.)
Mac Weaver	EPA, Dallas
Charles Nemir	TWDB
Ward Goessling	Governor's Office
Don VanSickle	TC&B
Paul Seals	TWQB
Jim Herbert	FWD
Leland Wilson	FWD
Paul Barker	TC&B

Workshop Meeting Burnet City Hall
17 May 1973.

A workshop meeting was held in the Burnet City Hall on 17 May to discuss the proposed treatment systems for the non-metro areas of the Capital Area Planning Council, Alamo Area Council of Governments, and Central Texas Council of Governments. There were 21 persons in attendance at the meeting. A list of attendants is attached. There were representatives from 4 of the 14 CAPCO entities, only one of the invited Alamo Area entities, and none of the 4 Central Texas COG entities. The Planning Director for CAPCO and engineering consultants for that organization were in attendance.

Mr. Goessling, Governor's Office, opened the meeting with a brief discussion of its purpose. Mr. Wilson, FWD, emphasized the need for local input and ideas into the proposals. Mr. Barker, TC&B, explained the rationale of the study, the priorities and constraints that were established, and the goals of meeting new law requirements by 1977 and best available treatment by 1983. Mr. Barker noted that no clear-cut definition of best available effluent quality was available, and TC&B at its discretion allocated 20-20 discharge for secondary treatment as the target discharge. Major Allen emphasized the need for information from the cities in order to assure that the presentations had the backing of the local entities. Mr. Nemir, TWDB, explained the history of the study, the formation of the Governor's Planning Committee, the Basin plan and the area-wide plans, and the routing of the report. At this point Mr. Wilson asked for general questions from the floor.

Mr. Randle, Sunrise Beach, asked when the report will be published. Mr. Wilson replied that the draft of the Basin plan would be ready by 1 July 1973 and the area-wide plans would be ready by 30 August 1973.

Mr. Marsh, Lakeway, inquired as to the influence of the presented data, and as to when the influence of the data will be felt. Mr. Wilson replied that the presented plans should be adequate for planning purposes and if growth exceeded projections, updates could be made on an annual basis as required by the new law.

Mr. Marsh, Lakeway, stated that his development would not need Federal funds but planned to construct with its own funds. Mr. Weaver, EPA, noted that as a result of new legislation, there was a change in permit requirements, and that every entity must apply for a new permit based on waste load allocations. Major Allen, FWD, emphasized this statement by adding that all facilities must meet Federal requirements whether Federal funds are used or not.

Mr. DiFilipo, Forrest and Cotton, asked for population projection methodology for smaller communities. Mr. Nemir, TWDB, replied that TWDB did not develop projections for communities below 2,000 population, but that TC&B used the base methodology as related to County guidelines.

In answer to a question by Mr. DiFilipo, Mr. Barker replied that no sewer lines were provided for cities in the 200 - 2,000 population bracket.

Mr. Wooldridge,CAPCO, suggested revisisons to legends in the proposal maps and inquired if maps would be included in final report. Mr. Barker noted that all cities will have maps with two-color printing delineating 1975 immediate needs and 1977 requirements of the new legislation.

Mrs. Glass, Forrest and Cotton, was informed by Mr. Barker that 1980 allocations were used if they would meet 2020 needs. Mrs. Glass and Mr. Barker exchanged views on quality standards for the study period to the year 2020. Mr. Wilson noted that the systems were designed to provide the least expensive plant that would be compatible with Federal standards.

Mr. Marsh, Lakeway, inquired if holding ponds should be fenced, for safety and health precautions. Mr. Tiner, State Health Department, replied that this action depends upon location and that the Health Department was currently preparing guidelines for this specific area. Mr. Marsh stated that real estate developers were concerned that pond locations and operations could seriously hamper real estate development operations by negating the use of some of the land proposed for development.

Mr. Fuhrmann, Fredericksburg, asked when permits will be issued. Mr. Weaver replied that no permits will be issued by end of FY 73, but must be issued by 30 December 1974. It was anticipated that 3,000 permits would be issued next year.

Mr. Barker informed Mrs. Glass that although the exhibited cost charts did not reflect denitrification costs, they would be shown in final report.

After the conclusion of the general questions, specific discussions were held with Mr. Rogers, Llano, Mr. Fuhrmann, Fredericksburg, and Mr. Marsh, Lakeway. At these discussions, all questions regarding the proposals for the specific entries were resolved and the proposals were accepted.

Persons Attending Workshop Meeting

Federal Agencies

Major C. A. Allen, Fort Worth District, Corps of Engineers
Leland R. Wilson, Fort Worth District, Corps of Engineers
Jim Herbert, Fort Worth District, Corps of Engineers
Mac A. Weaver, Region VI, Environmental Protection Agency

State Agencies

Joe B. Harris, Governor's Office
Ward Goessling, Governor's Office
Charles E. Nemir, Texas Water Development Board
Jim Lindsey, Texas Water Quality Board
Bill Duncan, Texas Water Quality Board
Thomas D. Tiner, State Health Department

Regional Agencies

Joel Wooldridge, Capital Area Planning Council

Consulting Firms

Paul Barker, Turner, Collie & Braden, Inc. - FWD
Gordon E. Sparks, Turner, Collie & Braden, Inc. - FWD
John DiFilippo, Forrest and Cotton, Inc. - CAPCO
Peggy Glass, Forrest and Cotton, Inc. - CAPCO

Local Interests

Walter O. Fuhrmann, City of Fredericksburg
J. K. Dixon, Sunrise Beach MUD #1
Henry E. Randle, Sunrise Beach MUD #1
George A. Rogers, City of Llano
Gerald E. Marsh, Lakeway Corp.
Roy N. Bennett, City of Burnet

Workshop Meeting- Smithville, Texas
18 May 1973.

A workshop meeting was held in the Smithville City Hall on 18 May 1973 to discuss the proposed treatment systems for 12 communities in the Capital Area Planning Council area. The only attendant at this meeting, outside of the Federal, State and consultant personnel, was Mayor Albert Crawford, Smithville. No attendance list is attached. Mr. Don Stence, CAPCO regional planner, was requested by Mr. Wilson and Mr. Goessling of the Governor's Office, to contact the cities not represented and to have them forward any comments to FWD by 25 May 1973. If no comments are received, the proposals as presented will be considered as acceptable.

In the absence of the other 11 communities, the group held informal discussion with Mayor Crawford regarding the proposal, funding procedures, establishment of priorities, permits and allocations. Mayor Crawford furnished the consultant with an updated map of the City of Smithville which will be used to revise the proposal. As Mayor Crawford was the only attendant at the meeting, he received the benefit of the full attention of the study group.

(Writer's note: This meeting must rank as the most futile of the public contact and involvement programs. Great effort was expended by the study team in the preparation of handouts and proposal packages in time for the affected communities to review them prior to the meeting. The low attendance must be interpreted as a complete lack of interest in the study and an overall attitude of indifference on the part of the general public regarding the entire program.)

Workshop Meeting-Wharton, Texas
22 June 1973.

A workshop meeting of the non-metro communities in the Houston-Galveston Area Council area of responsibility was held in Wharton, Texas on 22 June 1973. There were five communities involved in invitations to the workshop. Three of the communities (Wharton, Eagle Lake, and Columbus) were in attendance and two communities (Weimar and Garwood) were not represented. There was no representative from the Council of Governments at the meeting. A list of attendants is attached.

Mr. Nemir, Texas Water Development Board, opened the meeting with a discussion of the study and the role of the Governor's Planning Committee. Mr. Wilson, FWD, followed with a discussion of the technical background of the study and the role of the Corps of Engineers in its development. Mr. Barker, Turner, Collie & Braden, Inc., discussed his firm's rationale and methods of developing plans for the various communities. Mr. Barker noted that the City of Wharton had been rated as the number one priority city on his firm's priority list for wastewater improvement in the Basin.

In questions and statements from the attendant representatives, the following items were brought out by the participants.

Mr. Smith, Eagle Lake, noted that his community discharged into Eagle Lake, a private body of water varying from 4 to 9 feet in depth; in effect, using the lake as a holding pond. He declared that this situation had been in operation for many years under an agreement with the lake owner. Mr. Barker stated that this situation had not been disclosed during the investigative period and that the writeup would be revised to reflect this situation.

Mayor Guffey, Wharton, questioned the population projection for the City of Wharton and cited the existence of the junior college and two hospitals as factors to be considered in planning objectives of the city. Mr. Nemir, TWDB, replied that the population projections were taken from the University of Texas Population Research program and that all aspects of Wharton's development (schools and hospitals) had been considered in the projections.

Mr. Goessling, Governor's Office, stated that he would forward the plans for the communities of Weimar and Garwood to the HGAC for their consideration and asked that they be returned to the Fort Worth District as soon as possible.

This was the last of the workshops to be conducted for the non-metro areas in the Basin. In a series of 6 workshops held to present plans for the non-metro area, 76 communities were invited to attend and 29 communities participated in the sessions. Attendance ranged from 11 of 12 invited communities at Ballinger to 1 of 12 at Smithville. While the attendance record leaves much to be desired, the basic purpose of the meeting to obtain interchange and views of the public is still very good. In all instances where the communities showed the interest to attend, their questions were answered and their input to the study was very constructive. It should also be noted that all communities who did attend accepted the plans as presented and were satisfied with the planning effort that had gone into the study.

Persons Attending Workshop Meeting

Jim Herbert	Corps of Engineers, Fort Worth Dist.
Leland Wilson	Corps of Engineers, Fort Worth Dist.
Gene Guffey	City of Wharton
Ward Goessling	Governor's Office
David M. Cochran	Texas State Department of Health
T. J. Smith	City of Eagle Lake
Raymond Peters	City of Columbus
Charles E. Nemir	Texas Water Development Board
V. O. Hollingsworth	City of Wharton
Harold Hayhurst	City of Wharton
Paul Barker	Turner, Collie & Braden, Inc.
Gordon Sparks	Turner, Collie & Braden, Inc.
Randy Baylor	Texas Water Quality Board
Jim Lindsey	Texas Water Quality Board

Workshop Meeting-Odessa, Texas
9 July 1973.

A workshop meeting was held in the Odessa City Hall on 9 July 1973 to discuss proposed alternative treatment systems for the City of Odessa. A list of attendants at the meeting is attached.

Mr. Goessling, Governor's Office, opened the meeting with a brief discussion of its purpose. Mr. Nemir, TWDB, explained the function of the Planning Committee, noted the short review time that was allocated for the study, and the constraints that had been placed on the study. He also emphasized that all comments should reach the Governor's Planning Committee by 23 July and discussed the schedule remaining for the submission of the report.

Mr. Wilson, FWD, discussed the summary sheets for the selection and consideration of alternatives, the relationship of EPA guidelines, and the need for the presentation of alternatives for local-interest consideration. Mr. Barker, TC&B, explained the rationale developed in the study for the formulation and presentation of alternatives.

Mr. Smith, Permian Basin Regional Planning Commission, questioned the validity of the population projections and noted that only 3 of the 9 counties in his Council of Governments area were represented adequately in the population projections. Mr. Nemir explained the population projection methodology and noted that the study team was aware that all references to Howard County had been an editorial omission and would be corrected. It was pointed out that the population of Howard County was included in the total figure shown for the Council of Governments area.

Mr. Wilson outlined the alternatives that were to be presented to the city for consideration and noted that EPA evaluation and review of grant requests would be considered if alternatives were studied prior to the selection of a preferred system.

Mr. Dillard, City of Odessa, asked if the alternatives proposed a degree of quality for irrigation water. Mr. Barker replied that they did not. Mr. Dillard then explained the City of Odessa's sale of effluent for irrigation purposes and noted that, in many instances, the customers did not want the beneficial pollutants removed from the effluent. He requested that a statement on quality standards for effluent for irrigation water be obtained. Mr. Wilson replied that TWQB and EPA would be contacted for a definition of legal limits of water for irrigation.

Mr. Dillard explained the city's operation of their disposal plant in connection with the El Paso Industries industrial complex at the city. Mr. Lish, City of Odessa, questioned the population projections as they pertained to future growth of the city as related to its urban area. Mr. Nemir replied that planning was predicated on the urban area growth. Mr. Henderson, City of Odessa, inquired as to the methodology used in establishing total worth of the alternatives as presented in the handouts. Captain Asta explained the fiscal considerations that were used in the compilation of alternative costs, with the accent being placed on the derivation of present worth for comparison purposes.

Mr. Dillard suggested the following corrections and/or revisions to the text of the draft report: page 0-13, questioned the pollution statement regarding storm runoff in the city; page 0-35, requested deletion of statement referring to flow to Colorado River; page 0-41, revise statement on capital improvements proposed for existing plant; page 0-42, delete paragraph on digester supernatant; page 0-42, check permit conditions of EPNGP Co. permit.

Mr. Wilson replied to Mr. Dillard that all of his comments would be considered in the compilation of the final report.

Mr. Smith, PBRPC, requested revisions to numbers of membership of Council of Governments on page PB-1 and requested identification of sources used in establishments of loadings and treatments as mentioned on page PB-9. The City of Odessa selected Alternative A for presentation in the report. This alternative provides for an expansion of the existing plant to meet conditions projected for the life of the study.

Persons Attending Workshop Meeting

Arthur F. Lish	City of Odessa, Planning Department
John F. Phipps	City of Odessa, Planning Department
Bryan N. Henderson	City of Odessa, Public Works Adm.
Bob L. Hanover	City of Odessa, Public Works Engineer
Paul Barker	Turner, Collie & Braden, Inc.
Leland Wilson	Corps of Engineers, Fort Worth
Jack D. Dillard	Director of Utilities, Odessa
Ward C. Goessling, Jr.	Governor's Office
John Church	Superintendent of Water & Sewage Treat.
Don Morris	Texas Water Quality Board
Charles E. Nemir	Texas Water Development Board
John Asta	Corps of Engineers, Fort Worth
Jim Herbert	Corps of Engineers, Fort Worth
W. E. "Bill" Smith	Permian Basin Regional Planning Comm.

Workshop Meeting-Midland, Texas
9 July 1973.

A workshop meeting was held in the Midland City Hall on 9 July 1973 to discuss proposed alternative treatment systems for the City of Midland. A list of attendants at the meeting is attached.

After the initial introductory remarks by Messrs. Goessling, Nemir, Wilson, and Barker, the first response from the attendants was a remark by Mr. Lowe, City of Midland, regarding population projections. He felt that the projections were on the pessimistic side but would not contest them as a base for planning purposes. Mr. Nemir explained the reasoning and study behind the projections.

Mr. Lowe then made the following comments in regards to the draft report of Volume 3, pertaining to the Midland portion of the report: Page M-7, delete reference to Paul Davis and McMillen Fields as partial supply for City of Odessa. This statement was followed by a discussion of the water supply sources that were available for the City of Midland; page M-9, suggested that statement "no reservations for consumption" be changed to "potable" and requested revision of industrial use projections; page M-10, noted that the waste load projection does not include the air terminal and should be revised to reflect this omission; page M-12, Mr. Lowe questioned the source of the list of industries that could produce significant industrial wastes -- he was informed by Mr. Barker that the information was obtained from a State-furnished research report and was listed in the bibliography in the technical appendix -- Mr. Nemir confirmed this statement; page M-14, Mr. Lowe asked for a clarification of "no discharge of critical pollutants" since Midland does not discharge into any existing stream course. It was pointed out that conformance to the conditions of the State permit would qualify the city for adherence to the "no discharge" criterion; page M-17, in a discussion of sewer connection lines and service areas, changes in line sizes from 24" to 27" were noted and revisions were made accordingly to the affected map; page M-23, Mr. Lowe asked for a definition of the term "highest level of treatment." Mr. Wilson quoted from the existing guidelines and legislation the definition of the term and noted that it was subject to interpretation that may vary for each individual case; page M-29, Mr. Lowe questioned the numerical matrix format utilized for comparative impact and was informed that a narrative account would be used for the final report.

As the City of Midland is currently constructing a new treatment system, Mr. Lowe asked the following questions regarding costing and personnel requirements for the plant and suggested that these items be correlated with a report prepared by Black and Veatch for the city; page M-30, personnel requirements for the plant and addition of testing requirements for heavy metals and insecticide; page M-35, change in size of aeration basin from 26' to 76'; page M-41, correlation of present worth of system proposed in Alternative A with Black and Veatch costs.

Mr. Wilson noted that all comments would be considered in the preparation of the final report. It was agreed by the city that Alternative A was their selection for inclusion in the report. This alternative provides for usage of the new plant currently under construction, with provisions for future expansion as dictated by proper time frames.

Persons Attending Workshop Meeting

Ward Goessling	Governor's Office
Charles Nemir	Texas Water Development Board
Leland Wilson	Corps of Engineers, Fort Worth
Fred Baker	City of Midland, Director of Public Wks.
Don Morris	Texas Water Quality Board
John Lowe	Director of Utilities-Midland
George Wolfe	Director of Planning & Traffic-Midland
Captain John Asta	Corps of Engineers, Fort Worth
Fred Poe	Assistant City Manager - Midland
Paul Barker	Turner, Collie & Braden, Inc.
W. E. "Bill" Smith	Permian Basin Regional Planning Comm.
Jim Herbert	Corps of Engineers, Fort Worth

Workshop Meeting-Big Spring, Texas
10 July 1973.

A workshop meeting was held in the Big Spring City Hall on 10 July 1973 to discuss proposed alternative treatment systems for the City of Big Spring. A list of attendants at the meeting is attached.

After introductory remarks by Messrs. Goessling, Nemir, Wilson and Barker, Mr. Nagel, City Manager, Big Spring, asked if Federal requirements would demand that discharge effluent reach 20-20 in less than a year. Mr. Wilson replied that this was a current State standard and would have to be complied with as soon as possible.

Mr. Ivie, Colorado River Municipal Water District, stated that his agency was initiating a program that was intended to eliminate underground flow in Beals Creek through Big Spring. This program consisted of dewatering the playa lakes adjacent to Beals Creek and pumping the water into Natural Dam Lake above town. A permit application had been filed with the TWRC for this work. The entire program is scheduled to be in operation in October 1973. Mr. Ivie congratulated the Corps on the presentation of the draft report and said it was outstanding that the job could be accomplished under the difficulties of changing legislation and standards that had occurred during the course of the study. He mentioned the possibility of the Hubert Humphrey Bill, now in legislative consideration, which may even further change water quality standards and criteria.

Mr. Ivie stated that he did not feel that we have a good report. He made the following comments in regard to specific statements made in Volume 3: page PB-2, in regards to water resources, add that other lakes were available such as Lake Stamford of the Canadian River Authority, the existence of the alluvial Quanternery formation in Monument Draw and the availability of the Ward County field provided a subsurface supply in excess of 2.5 million acre-feet; he also mentioned the surface water supply that was available in E. V. Spence Lake that was omitted from the report; page PB-3, suggested deletion of statement regarding scarcity of water in the region; page PB-6, Mr. Ivie stated that while he did not specifically agree with the population projections, they generally were in line with a projection study that his agency had conducted; he mentioned the omission of Howard County from the population figures and stated that he felt that the construction of the University of Texas-Permian Basin would have a greater emphasis on the Ector County figures than

had been predicted; page B-2, the statement that the growth of Big Spring was caused by the Webb AFB construction was not entirely true as the city had experienced a 3.8% annum growth rate during the period 1940-1966; in line with the population projection, he felt that the water usage projection should be upgraded slightly to coincide with this growth factor. Mr. Ivie offered the use of an area vicinity map for the Permian Basin area that would show sources of water supply for the region. (This map was furnished FWD personnel in a trip to CRMWD office following the workshop meeting.)

Persons Attending Workshop Meeting

Jim Herbert	Corps of Engineers, Fort Worth
O. H. Ivie	Colorado River Municipal Water Dist.
W. V. Brown	Big Spring Manager of Utilities
Jon Snider	Big Spring Admin. Asst. to City Mgr.
W. E. "Bill" Smith	Permian Basin Reg. Planning Comm.
H. W. Nagel, Jr.	City Manager, Big Spring
John Asta	Fort Worth Dist., Corps of Engineers
Leland Wilson	Corps of Engineers, Fort Worth
Don Morris	Texas Water Quality Board
Charles E. Nemir	Texas Water Development Board
Paul Barker	Turner, Collie & Braden, Inc.
Ward C. Goessling	Governor's Office
Eddie Acri	Mayor Pro-Tem
C. R. Crim	Crim Engineering, Big Spring, Texas

Workshop Meeting-San Angelo, Texas
10 July 1973.

A workshop meeting was held in the San Angelo National Bank on 10 July 1973 to discuss proposed alternative treatment systems for the City of San Angelo. A list of the attendants at the meeting is attached.

Introductory remarks on study history, purpose, methodology and conformance to legislative requirements were made by Messrs. Goessling, Nemir, Wilson and Barker.

Mr. Hinds, Concho Valley Council of Governments, inquired as to how important the report is to the funding process. Mr. Morris, TWQB, replied that the report is a prerequisite to the funding process and without it no grants would be awarded. Mr. Wilson added to these remarks by noting the existence of the priority list that would be taken into account in the granting of funds for construction of treatment works.

Mr. Williams, City of San Angelo, stated that he felt the report was an outstanding contribution and that his comments on the study were mainly of an editorial nature. He stated that he did not agree completely with population projections, but in realization of the need for a planning base he would go along with them. His comments in regard to Volume 4 were as follows: page B-4, change name to San Angelo State University with an enrollment in excess of 4,000; page B-11, change well field depth from 4,000' to 2,500' and add pipeline to E. V. Spence; page B-13, feels that restudy is needed of wasteload analysis as presented figures appear to be low; page B-15, organic loadings appear to be too high; page B-16, reword wastewater runoff statement as drainage ditches are not present in the area; page B-24, statement that 48" outfall is immediately needed appears incongruous in that existing 36" outfall is currently never loaded to capacity; page B-27, did not agree with statement that Mathis Field facility should be phased out unless Lake Nasworthy development could be regionalized with city treatment plant -- did not feel that this could be economically justified; page B-32, change 673 acres to 640 acres and emphasize that additional land is needed, since city is in process of acquiring additional land; (Mr. Wilson informed Mr. Williams that the cost of land acquisition for disposal purposes was a permissible feature in the treatment program according to EPA rulings); page B-33, recommended that cost figures shown be correlated with Freese, Nichols and Endress (this was accomplished in a meeting with Mr. Ullrich of that firm in Austin on 17 July 1973); page B-35, Mr. Williams stated that

the city is planning a chlorination pond at its facility; page B-45, Mr. Williams agreed with premise that decentralization would be too costly. Mr. Williams approved the institutional arrangement appendix and emphasized that he would like to see the report reworded to show the need for additional land that the city is attempting to acquire for disposal purposes. In the discussion of alternatives, Mr. Williams voiced objections to the use of spray irrigation methods and stated that he preferred to continue the flooding techniques that he has employed in the past. In the evaluation of the alternatives, the city expressed a preference for Alternative A which calls for the use of the upgraded facility currently being designed by Freese, Nichols, and Endress.

In a discussion of the report as a whole, Mr. Hinds, CVCOG, made the following comments: page CV-2, add several school districts to implementing agencies; page CV-6, objected to declining growth projected for Brady as Lake Brady has proven a popular recreation area; page B-9, added several industries to list of industries for San Angelo; page CV-2-1, expected growth of Robert Lee to expand because of proximity to E. V. Spence Lake; page CV-5-3, outlined an expansion to the collection system for the city of Junction.

Persons Attending Workshop Meeting

Name	Representing
Kenneth Krueger	Texas Water Quality Board
Philip Bryant	City of San Angelo
Louis Kordek	KCTV News
Jim Hinds	Concho Valley Council of Governments
Tom Koederitz	City of San Angelo
Don Morris	Texas Water Quality Board
John Asta	Corps of Engineers, Fort Worth
Paul Barker	Turner, Collie & Braden, Inc.
Leland Wilson	Corps of Engineers, Fort Worth
Norma Joe Williams	San Angelo Standard-Times
Ward C. Goessling, Jr.	Governor's Office
Charles E. Nemir	Texas Water Development Board
J. E. Williams	City of San Angelo
Wylie Webb	Governor's Planning Committee-San Angelo

Workshop Meeting-Brownwood, Texas
16 July 1973

A workshop meeting was held in the Brownwood City Hall on 16 July 1973 to discuss proposed alternative treatment systems for the City of Brownwood. A list of attendants at the meeting is attached.

Introductory remarks regarding the purpose of the meeting, the history of the study, the methodologies involved and the legislative procedures were made by Messrs. Goessling, Wilson, and Neugebauer.

In an opening interrogatory, Mr. Neugebauer inquired if the city had previously considered land disposal as a treatment method. Mr. Miller, City Manager, replied that it had not, in that water was not the commodity in his region that it was in points further west in the State. He also pointed out that the Brown County Water Control and Improvement District already had an effective irrigation system in existence, utilizing the water of Lake Brownwood, and that any land adjacent to the existing plant that could be made available for land disposal was already in residential occupancy.

Mr. Coleman, BCWCID, stated that the nearest available land for disposal purposes would be approximately 5 miles to the southeast. Mr. Miller asked the land cost estimate that was used in figuring the price of the facility. Captain Asta replied that it was $250/acre. Mr. Coleman replied that this figure was too low, to which Captain Asta stated that although $250 was used for study figures, more than adequate funds had been earmarked in the cost estimate for the acquisition of lands for disposal purposes. Mr. Miller inquired as to the levels of treatment and was informed by Mr. Lindsay, TWQB, that State standards provided for 20-20 treatment. Mr. Miller then asked if this was the quality of discharge into the stream or from the treatment facility. Mr. Lindsay replied that this was facility requirements.

Mr. Miller asked if the plant needed modification. Mr. Neugebauer quoted the Forrest and Cotton report for the WCTCOG, added that the Brownwood plant was rated No. 1 on the TWQB priority system, and discussed the need to clean up the water in the Pecan Bayou reach under the State's stream segmentation program. Mr. Lindsay then explained the State's effort in the segmentation of streams as required by PL 92-500. He also reviewed the monitoring programs and noted the additional work that would be required for construction grants. He pointed out that in Pecan Bayou the seasonal dissolved oxygen problem classified that reach as a water quality segment, and noted that there was not enough water for dilution effect.

Mr. Miller asked if funds were available for rectifying measures. Mr. Lindsay explained the necessity for the completion of Basin plans for funding purposes and the compilation of the State priority list that would dictate the availability of funds for grant purposes.

Mr. Paul, BCWCID, asked if a plan were presented for the Lake Brownwood area. Mr. Lindsay replied that a plan was presented only for the State Park area. Mr. Paul noted that the WCID was purchasing improved monitoring equipment for sampling purposes in the lake. Mr. Lindsay explained the procedures and techniques that were utilized by the LCRA in its septic tank program for the Highland Lakes area.

Mr. Miller informed the attendants that the city could not reach an agreement on the alternatives until adequate study had been made of the proposals. (On 20 July Mr. Jones, TWQB, by telephone conversation with Mr. Wilson, FWD, notified that the City of Brownwood selected Alternative A. This alternative provides for the retention of the existing facility, immediate renovation of two currently-inoperable trickling filters, and upgrading for expansion to include utilization of land disposal methods.)

Persons Attending Workshop Meeting

Jim Herbert	Corps of Engineers, Ft. Worth
Pablo Sonido	Corps of Engineers, Ft. Worth
Levie Old	Brown County Water Improvement Dist.
Charlie Trigg	Brown County Water Improvement Dist.
Marion Baugh, Jr.	Brown County Water Improvement Dist.
Stuart S. Coleman	Brown County Water Improvement Dist.
William H. Pruitt	Brown County Water Improvement Dist.
Joe B. Paul	Brown County Water Improvement Dist.
T. C. Wilkinson	Brown County Water Improvement Dist.
Bob Gallagher	West Central Texas Council of Gov'ts.
M. Harlow	City of Brownwood
Virgil C. Gray	City of Brownwood
Harry Miller, Jr.	City of Brownwood
Kenneth Krueger	Texas Water Quality Board
Charles White, Jr.	City of Brownwood
John Asta	Corps of Engineers, Ft. Worth
Leland Wilson	Corps of Engineers, Ft. Worth
Ward C. Goessling, Jr.	Governor's Office
James Lindsey	Texas Water Quality Board
Len Neugebauer	Turner, Collie & Braden, Inc.

Workshop Meeting-Austin, Texas
17 July 1973.

A workshop meeting was held in the Austin City Hall on 17 July 1973 to discuss proposed alternative treatment systems for the City of Austin. Since the Austin long-range plan provides for the future regionalization of seven satellite towns in the Austin area, the cities of Del Valle, Manor, Oak Hill, Pflugerville, Rollingwood, Sunset Valley and West Lake Hills were also invited to attend this meeting. A list of attendants is attached.

Introductory remarks were made by Messrs. Goessling, Wilson, and VanSickle regarding study history, legislation, and methodology. Mr. Wilson noted that the meeting process would be speeded up if all of the smaller towns would present their views prior to the discussion of the City of Austin alternatives.

Mayor Shaw, Rollingwood, stated she felt the proposal for her city did not adequately address the problems to be encountered and felt the cost estimate was too low. It was explained that the designs were conceptual and were not intended to present a preliminary engineering study and estimate of the system. (Following the meeting, Mayor Shaw met with Messrs. Wilson, Goessling, and Sonido and all specific questions regarding the proposal for Rollingwood were resolved.)

Mr. Putnam, West Lake Hills, asked if costs were an on-ground estimate or a map estimate. He was notified that it was a map estimate. He further asked if environmental consideration could be given to the terrain of West Lake Hills if earth-moving equipment were involved in the installation of the treatment system.

Mayor Krink, Pflugerville, stated he would submit revised plans showing an additional 64 acres which have been added to the city limits. He also asked for advice on the handling of a 200-acre development that was proposed for the city. He was informed that the TWQB possessed regulations concerning the water quality segment of the development.

Mr. White, Austin, asked if the plan will help toward Federal funding. Mr. Lindsay, TWQB, quoted from Sec. 303e of PL 92-500 and stated the need for the filing of the Basin plan to serve as the framework for the granting of Federal funds.

Mr. White, Austin, asked the basis for the costs presented in their report. Mr. VanSickle replied that the costs were taken from a curve which was updated to 1972 prices and verified for the particular system. Costs which are shown in Volume 6 are for the evaluation of alternatives. Mr. White also asked if costs included solids handling and disposal and noted that the report did not address this matter in great detail. Mr. VanSickle replied that this matter would be resolved in the final report.

In a discussion of alternatives, Messrs. White and Alexander of the city stated that for the time being the city would prefer Alternative A-1, since this plan is basically the format which has been adopted by the city for its future programs. However, the city representatives stated that they would like additional review time to evaluate other alternatives. Alternative A-1 was closely coordinated by the consultants with the City of Austin during the investigative stage of the study, and it was evident from the small amount of questioning from the Austin delegation that the consultant had worked closely with the city in the formulation of this alternative.

Mr. Goessling asked that all comments be returned to the Governor's Planning Committee by 23 July 1973, for inclusion in the final report.

Persons Attending Workshop Meeting

John Hill	Corps of Engineers, Tulsa
David Steele	Corps of Engineers, Tulsa
Don Dillon	Corps of Engineers, Dallas
Mayor Helen Shaw	City of Rollingwood
Ward C. Goessling	Governor's Office
George D. Putnam	West Lake Hills
Paul S. Wakefield	West Lake Hills
Jim Herbert	Corps of Engineers, Fort Worth
R. E. Stansberry	Snowden & Meyer, Inc., Austin
W. S. Rider	Rider Shaw
Nolan Sims	Sunset Valley
Joseph J. Beal	F & C - CAPCO
Ray Colvin	West Lake Hills
Jack M. Alexander	City of Austin
Euna Faye Pryor	West Lake Hills City Council
S. B. Krink	Pflugerville, Mayor
T. A. Tombrello	West Lake Hills
Pablo Sonido	Corps of Engineers, Fort Worth
Rodger H. White	City of Austin
Joel C. Wooldridge	Capital Area Planning Council
John Asta	Corps of Engineers, Ft. Worth
Len Neugebauer	Turner, Collie & Braden, Inc.
Donald VanSickle	Turner, Collie & Braden, Inc.
Leland Wilson	Corps of Engineers, Ft. Worth
Garner E. Jones	Texas Water Quality Board
James M. Lindsey	Texas Water Quality Board

MEMORANDUM

TO: Members, Governor's Colorado River Basin Wastewater Management Study Planning Committee

FROM: Harry P. Burleigh, Chairman

SUBJECT: Results, First Planning Committee Meeting

The subject meeting was called by the Chairman; it was held at the TWDB offices; started at 1000 hours and concluded at 1230 hours, 1 February 1972.

Attached are:

meeting agenda,

meeting attendance record, and

a list of appointees who did not attend and were not represented by designated alternates.

The Chairman opened the meeting and reviewed events leading to study authorization and appointment of the Planning Committee by Governor Smith. The study report is to be prepared by the Corps of Engineers. The Committee's function is to:

provide the Corps with views on existing problems and suggest means for solving them,

assure public involvement, and

provide planning guidance reflecting the views of the general public.

Committee Vice-Chairman Yantis briefed the Committee on utilization of the report and stressed that the study must provide immediate solutions to presently known quality problems and must be a means to achieve positive action, as opposed to an academic study that would not produce an action program. He stated that the report should, as nearly as possible, include construction plans and specifications for subsequent submission to appropriate sources for the necessary construction funding.

Colonel Henk led a discussion by the Corps of Engineers, describing the plan of study. He noted that the Corps' objective in this effort is to assist the State in development of a Basin water quality management plan; he stressed necessity of public involvement.

Major Allen, Study Manager for the Corps' effort, stated the need for reactions, suggestions, and objectives from the Planning Committee; noted that public guidance would assist the Corps in assuring that the study is sound, would meet public objectives, and be completed by the target date--July 1, 1973. Major Allen described the Corps' views as to objectives and goals of the study.

Engineer Dillon of the Corps reviewed tentative work contributions desired from State and local agencies, and stated that response was needed within the next two weeks to establish the willingness of all involved to participate. Major Allen presented a study flow chart indicating interrelationship of study integrals; copies thereof were provided conferees.

Following the Corps' presentation, the Chairman asked for comments on the Corps' plan of study from the Committee as a whole.

Vice-Chairman Yantis made a strong plea that emphasis be given by the Corps and the Committee to "action now," and expressed apprehension about long-range studies that would not lead to--or might delay--solution of problems demanded for resolution by the public now.

The group broke into five separate subcommittees for review of the Corps' presentation, and then reassembled. Subcommittee reports were as follows:

State Subcommittee.

Mr. Ed Grisham, Director, Division of Planning Coordination, Office of the Governor, was elected subcommittee chairman.

Mr. Grisham announced that Mr. Joe Bob Harris will serve as coordinator of the activities of all involved State agencies. The Division of Planning Coordination will also provide the full-time services of a staff member from the Natural Resources Section of the Division of Planning Coordination to assist on the project. In response to subcommittee discussion, the Corps of Engineers explained that their study and report would concentrate on early action efforts that would also fit in with long-term Basin management objectives.

This explanation on the part of the Corps tended to resolve what had earlier appeared to be a difference of views as between elements of State-level Committee membership and the Corps as to precise results the Committee would expect from the completed Corps report. More specifically: State-level agencies concerned with water quality management face mounting pressure from a broad cross-section of the public for action that can be taken as quickly as possible for elimination of Basin pollution, particularly pollution throughout the Highland Lakes area. Subcommittee opinion in this regard was to the end that the Corps' report, when completed, should contain specific recommendations for remedial measures that could be undertaken at once. Although the subcommittee recognized desirability of long-range Basin quality management plans that would guide Basin operations in decades ahead, feeling was evident that the Corps' report should embrace remedial measures for demonstrable circumstances presently polluting the Basin. In short, the subcommittee felt that many factors presently contributing to Basin pollution are identifiable now; it desires emphasis in the Corps' report on such areas in order that remedial actions can be taken as soon as possible.

Federal Subcommittee.

Mr. O. W. Lively, alternate for Mr. Dean S. Mathews, accepted chairmanship on behalf of Mr. Mathews. He stated that the Federal agencies will contribute to the study in every way possible by providing access to all available data.

River Authorities Subcommittee.

Mr. Harry Shapiro was elected chairman and appointed John Babcock (of the L. C. R. A.) as Executive Secretary. He stated that the river authorities were united in their views regarding desired study results and pledged the full and complete backing of the Lower Colorado River Authority for the study. Mr. Shapiro reported that the river authorities expected to expend about $510,000 in the next 18 months in support of the project.

Regional Councils of Governments Subcommittee.

Judge Jack A. Griesenbeck was elected chairman, and Mr. Donald L. Stence was designated as correspondent. Judge Griesenbeck stated that the Councils of Governments would participate in the study, but that they had a number of questions and needed more information as to what the extent of their participation could be, and how such can be funded. He

stated that the COG's will need additional time to develop information on their anticipated work contributions and expenditures.

General Public Subcommittee.

Professor Corwin W. Johnson was elected chairman. Prof. Johnson stated that the general public group was enthusiastic and willing to participate in the study, but is uncertain as to whether or not the small group on the Planning Committee is truly representative of the general public.

In the preceding regard, Professor Johnson's remark is probably correct. His conclusion may be surmounted as the Corps, throughout the course of its study, conducts public hearings on objectives and proposals throughout the Basin. Public involvement in the subject study is one of the prime objectives and functions of the Planning Committee. The public demanded the study, and every effort must be made to obtain highest level of involvement possible. Public attendance at this first meeting of the Planning Committee, it was observed, was less than desirable.

Chairman Burleigh announced that elements of the Executive Committee will meet with the Corps in the immediate future to determine specific assignments that will be given to the five separate subcommittees. Further contact with the separate subcommittees will be made by the Corps or by the Executive Committee through the Chairman.

A date for the next Planning Committee meeting was not set. Inasmuch as the Corps will seek to secure release of funds for the study at a February 15, 1972 meeting with the OMB, it was felt that the next meeting could more logically be scheduled after that date, when the study course is more firmly established. You will be advised in this regard.

sgd/

Harry P. Burleigh

May 2, 1972

MEMORANDUM

TO: Members, Governor's Colorado River Basin Wastewater Management Study Planning Committee

FROM: Harry P. Burleigh, Chairman

SUBJECT: Summary of April 28, 1972 Committee Meeting
Attendance list attached.

Chairman Burleigh opened the meeting and stated that the purpose was to determine if new criteria which had been imposed on the Corps by EPA and OMB could be met. Congressman Pickle was introduced and requested to hear a report on the Corps' revised study plan before commenting.

Major Allen reported for the Corps and reviewed events since the February 1 committee meeting. The original draft study plan was finalized and forwarded to Washington on February 15, 1972. Approval of the study plan was delayed and during the week of April 10, Don Dillon and Pilar Pena went to Washington to determine from OMB the reasons for the delay. At that time they learned of the requirements for (1) 50/50 non-Federal cost sharing and (2) inclusion of areawide planning in the study. Subsequently, meetings were held with representatives of the State agencies on April 17 and with the Executive Committee of the Governor's Planning Committee on April 18. Further revisions of work tasks were made in subsequent meetings with the representatives of State agencies and resulted in identification of work items that the agencies had the capability and qualifications to perform and which would bring the non-Federal participation to the 50/50 level. Major Allen said all that is now needed is (1) a statement from the Planning Committee that it is in agreement with the study plan as revised and (2) firm commitments from the State agencies to perform the work items in which their capability had been identified. He summed up by saying that in the current version of the study plan the State and Federal costs are each $850,000, making the total study cost $1,700,000. Under this plan, the Corps would produce a Basinwide plan and areawide plans certifiable by both HUD and EPA by the deadline date July 1, 1973.

Congresman Pickle then asked if there was any question whether the funds necessary for 50/50 cost sharing could be provided. Vice-Chairman Yantis said that yes, there is such a question. He said that prior to inclusion of the matching requirement, the non-Federal agencies and organizations had put together a compilation of funds which had been expended in the Basin beginning about 2-2 1/2 years ago for work which would apply to this study. This total amounted to $2-$3 million, and in subsequent discussions with Federal representatives it was declared that these funds were not eligible to be counted as matching funds. Mr. Yantis said that the Texas Water Quality Board had previously committed $39,000 to be diverted from other programs in the State to work on this study in the Colorado River Basin. Under the new breakdown to reach the 50/50 match, the Water Quality Board's contribution would be a total of $180,000. This was presented at a regular meeting of the Texas Water Quality Board, and it was indicated that the Board would not approve such a diversion of effort. The Board might in the future approve some additional diversion of effort after it is determined from just where and what programs this effort will be diverted. He stated that as of now, the Texas Water Quality Board does not believe it is the proper thing to do and will not approve this level of study effort in the Colorado River Basin. This position by the Water Quality Board would reduce the non-Federal effort by $141,000.

Mr. Nemir stated that the above would result in about a 40/60 split of State/Federal participation, but that reduction of contribution greater than $141,000 would result because some of the efforts of other agencies could not be completed without the participation of the Texas Water Quality Board.

Congressman Pickle told the group of his interest in the project and how the appropriation came into being through the Congressional Resolution. He asked the question, "Are we as a group generally in agreement that it is desirable to do this larger study?" Since there was no negative response, it was assumed that the study plan as currently written met approval of the Committee.

A general discussion took place regarding various levels of study and means for meeting EPA requirements. The possibility of securing funds from other sources such as from individual cities in the Basin or from the COG's was discussed.

It was pointed out that the Highland Lakes portion of the Basin from San Saba to Bastrop is already covered by a plan under which LCRA can seek construction funds. This plan has <u>interim</u> approval by EPA. It was

suggested that the study concentrate in the area below Bastrop and above Lake Buchanan, leaving the Highland Lakes portion as is but filling in a few gaps. Major Allen said that actually this is what is proposed in the current study and that the Highland Lakes plans and other completed plans would be worked into the total Basin plan. Mr. Weaver of EPA said that the Highland Lakes plan is one of the highest quality plans yet received by EPA and that if the rest of the Basin was brought up to this standard, then he could see no reason why an acceptable plan would not result. It was brought out, however, that a Basinwide plan is required by current EPA rules if EPA construction grants are to be obtained after July 1, 1973.

Mr. Yantis suggested that maybe a plan of study should be developed that the State is able to match to restructure to a lesser plan or minimum plan rather than to proceed with the full plan which exceeds EPA requirements. Stated differently, this means to identify what the non-Federal interests can contribute (basically those items previously agreed to) and then to double the amount and to design a study to meet minimum EPA requirements. It was pointed out that such a procedure would require (1) EPA approval of the lesser plan, (2) Corps of Engineers' willingness to proceed on this basis, and (3) OMB's approval. Mr. Yantis stated that everything could be done to meet minimum requirements but maybe less completely and with not quite as complete data.

Dean Mathews stated that EPA is firmly committed to working with the Corps of Engineers and the State of Texas in providing a plan that is acceptable. Mr. Pickle asked Mr. Mathews if he was speaking for Washington EPA. Mr. Mathews replied that he was speaking as Regional Administrator which was acceptable to the Washington level. Major Allen said that the Corps is willing to sit down and try to work out such a study plan with the interested parties.

Mr. Richard Bean of Capitol Area Planning Council made a motion, seconded by Wylie Webb of San Angelo, that the Corps of Engineers, EPA, HUD, and representatives of the State agencies through the Governor's Office, Division of Planning Coordination, meet to try to develop a study plan that will meet EPA minimum requirements within the amount of funds available. The motion carried. The meeting was set for 9:00 a.m., Tuesday, May 2, in the Water Development Board's offices. This group will attempt to prepare an acceptable study plan by the end of the week.

Louis McDaniels addressed Congressman Pickle and stated the position of the Texas Water Rights Commission in opposition to the 50/50 matching requirement for this study. Their objection is based upon the fact that this study as provided in the Congressional Resolution is broader than just a strict water quality study and that matching funds are being required for the other elements of the study not previously funded in this manner. Mr. McDaniels stated that the Commission would provide a statement of protest to Congressman Pickle for insertion in the Federal Register.

There was no further business and the meeting was adjourned at 4:30 p.m.

sgd/

Harry P. Burleigh

ATTENDANCE LIST

Name	Organization	Position
Dean S. Mathews	Environmental Protection Agency, Dallas	Director, A.W.P. Division
Milburn Smith	Corps of Engineers, Fort Worth District	Sanitary Engineer
Pilar Pena	Corps of Engineers, Fort Worth District	Civil Engineer
Jack Thompson	Corps of Engineers, Fort Worth District	Economist
Jim Herbert	Corps of Engineers, Fort Worth District	Public Involvement Specialist
Leland Wilson	Corps of Engineers, Fort Worth District	Civil Engineer
Major C.A. Allen	Corps of Engineers, Fort Worth District	Study Manager
Don Dillon	Corps of Engineers, Southwestern Division, Dallas	Civil Engineer
John Fazzino	Houston-Galveston Area Council of Governments	Staff Engineer
Charles E. Nemir	Texas Water Development Board	Assistant to Executive Director
Louis L. McDaniels	Texas Water Rights Commission	Executive Director
Alfred J. D'Arezzo	Texas Water Rights Commission	Environmental Science Analyst

W. C. Goessling	Office of the Governor	Division of Planning Coordination
Wylie O. Webb	San Angelo	Mayor
Hugh C. Yantis, Jr.	Texas Water Quality Board	Executive Dir.
Sonny Kretzschmar	State Soil and Water Conservation Board	Planning Engineer
Mrs. Jean Williams	Texas Water Development Board	Program Controller
W. W. Thetford	Concho Valley Council of Governments	President
C. R. Baskin	Texas Water Development Board	Principal Engineer Data & Technical Review
W. Frank Blair	University of Texas	Professor
Richard Bean	Capital Area Planning Council	Executive Dir.
Jack A. Griesenbeck	Capital Area Planning Council	Chairman
Joel C. Wooldridge	Capital Area Planning Council	Director of Regional Planning
Mac A. Weaver	Environmental Protection Agency, Dallas	Civil Engineer
Tom Adams	Concho Valley Council of Governments	Director of Regional Serv.
Judge Leslie Pratt	Permian Basin Regional Planning Commission	Chairman
W. E. Smith	Permian Basin Regional Planning Commission	Assistant Executive Dir.

Garner Jones	Texas Water Quality Board	Planning Engineer
Ed Grisham	Office of the Governor	Director, Division of Planning Coordination
Joe Bob Harris	Office of the Governor	Division of Planning Coordination
Harry P. Burleigh	Texas Water Development Board	Executive Dir.
Seth C. Burnitt	Texas Water Development Board	Director, Operations Division
Lewis B. Seward	Texas Water Development Board	Principal Engineer Project Development
Lutcher B. Simmons	Texas Water Development Board	General Counsel
John E. Babcock	Lower Colorado River Authority	Department Manager
John DiFilippo	Forrest and Cotton Engineers	CAPCO Consultant
Weldon W. Hammond	Alamo Area Council of Governments	Geologist
J. J. "Jake" Pickle	United States Congressman	
Clif Drummond	Congressman Pickle's Office	
Stuart Long	San Angelo Standard Times	Reporter
A. E. Howell, Jr.	Alamo Area Council of Governments	Chairman

Walter Ashley	Permian Basin Regional Planning Commission	
Bob Thompson	KTBC	Newsman
Pat Patterson	Sierra Club	Planning Comm.

MEMORANDUM

TO: Members, Governor's Colorado River Basin Wastewater Management Study Planning Committee

FROM: Charles E. Nemir

SUBJECT: Summary of November 13, 1972 Committee Meeting (Attendance List and Agenda enclosed)

Chairman Burleigh opened the meeting with a review of major events since the previous meeting. The final study plan was developed following the April 28 meeting, and OMB released funds to the Corps of Engineers to proceed with the study. Mr. Burleigh introduced two new Committee members: Mr. G. R. Herzik, Jr., Deputy Commissioner for Environmental Health, Texas State Department of Health, and Mr. Heber T. Stewart, representing Mr. J. Lynn Futch, State Director, Farmers Home Administration.

A summary of the current study status was presented in three parts. Fist, Major C. A. Allen, Study Manager, reported for the Corps of Engineers. A copy of the transcript of his remarks is enclosed. Next, Mr. Nat Turner, Chairman of the Board, Turner, Collie & Braden, Inc., described the background of the consulting firm. Don VanSickle, Vice President of Turner, Collie & Braden, Inc., then reported on the status of the consultant's work to date on the study. A copy of the transcript of Mr. VanSickle's remarks is enclosed. Mr. Nemir reported for the Governor's Planning Committee on the status of non-Federal contributions to the study effort. He reviewed the 31 October 1972 monthly report showing the percentage completion of each item for which the Planning Committee or member agencies are committed. A copy of this report is enclosed.

Mac Weaver of the Region VI Office of the Environmental Protection Agency reported on the new Federal Water Pollution Control Act Amendments of 1972. He stated that it has been only three weeks since passage of this Act and that many of the directives that will be promulgated in response to the Act have as yet not been received in the Region Office. Mr. Weaver pointed out that one question is the deadline for completion of Basin and areawide plans and how this date will tie to the construction grant program of EPA. Under the previous Act, the deadline date had been July 1, 1973. The new law did not speak to this issue, so until

such time as new regulations have been published or until new directives are received from the Administrator of EPA, the old directives continue to be in force, including the July 1, 1973 completion date. Mr. Weaver also pointed out that another primary concern is consideration of any modifications in the scope of work that will be required. The new Amendments are complex and far-reaching and EPA headquarters is now preparing new guidelines and regulations; however, it is too early to report any provisions positively.

Regarding the completion schedule and Planning Committee tasks and responsibilities as reviewed in the status report, Mr. Nemir pointed out that the question is when these will be required. The problems mentioned in the status reports have largely been the result of time delays for obtaining some of the data and it was pointed out that portions of the study may be as much as two to three months behind schedule. The advisability of requesting a time extension for the study is dependent upon the deadline date set by EPA guidelines. Any delay in funding of projects in the Basin because of failure to meet the deadline date would be detrimental to the Basin. If it is determined to request an extension of time, the procedure would be for the Planning Committee to formally request the Corps of Engineers to undertake additional study. The Corps, through their channels, would likely seek funding from the Washington level.

Congressman Pickle was asked to comment on the procedure for securing additional funding. He pointed out that this was a first-of-a-kind study and the first to involve such a level of coordination between all levels of government and the people in the Basin. The study, the Congressman pointed out, had a stormy beginning and various negotiations caused a nine-month delay in the beginning. He emphasized that the question is whether or not we can complete the study by July 1973 and should or can we extend it and what would be the results. Congressman Pickle said that he had been advised unofficially on the morning of the meeting from the EPA Washington office that the July 1, 1973 date is no longer applicable and that the date would be extended.. EPA confirmed that the new law supersedes both the old law and such regulations that were on the books at that time. That would mean that if it were so ordered by regulation under the new law, that the date could be extended. It would also mean that we could extend the date and ask for additional studies. The real question is: Does the Committee want to do that and is it advisable at the present time?

Congresman Pickle pointed out that before answering this question we would need the recommendations of both the Corps of Engineers and the consultant. The scope of the study was originally set on a limited basis because we did not have time by July 1, 1973 to do all the things that the Corps wanted to accomplish. The Corps originally wanted to go into much more detailed studies of alternatives and do a broader-based study than is required by EPA. At the completion of the July 1, 1973 date, if additional studies are needed, the arrangements with OMB were that funds would be available at 100% Federal cost.

Clif Drummond confirmed the Congressman's understanding of the EPA position and related details of his conversation with Joe Krivak of the Water Programs Planning Division of EPA in Washington, D. C.

Congressman Pickle said that it boils down to the basic question: Do we need to make the decision now? Does the Corps need to know now if we are to proceed with the original date or are we going to shoot for another date? Major Allen responded that at the present time the study is behind, but he felt that if the additional data needed can be obtained by December 1 and there are no further delays that we can complete the present study as outlined by July 1, 1973.

Colonel Henk expressed his view that we should try to finish by July because it does appear that it is possible, and it does appear that we can produce a worthwhile product that will meet EPA approval unless the new Act does produce some new requirements. He suggested that we proceed on the current course of study and that if within the next 30 to 60 days it becomes apparent that the scope of the study should be expanded, we could try at that time to obtain approval.

Mr. Owen H. Ivie of the Colorado River Municipal Water District expresse the concern that the problem of total dissolved solids in the upper portion of the Basin is not being adequately considered. Colonel Henk responded that while this is technically true, the wastewater management plan that will be developed will be satisfactory for meeting the grant program. He suggested that another approach to the total dissolved solids problem would be the possibility of a natural pollution study under some other authorization rather than under the wastewater management study. He also stated that the Corps does have a comprehensive study of the Colorado River Basin in progress in which it would be more appropriate to study the dissolved solids problem. He mentioned time and funds as barriers to complete solution of the total dissolved solids problem in the wastewater management study.

In summary, the consensus of the meeting was that the study can be completed on time. It was recommended that the consultant should wait for the final population projections for the cities to be completed before proceeding with certain study phases rather than to use the preliminary figures and make revisions later. Even though portions of the contract are behind schedule, it is felt that this lost time can be made up by expeditious review of results and selection of alternatives by the Planning Committee. The suggestion was made that this review could begin early on completed portions of the study rather than waiting on completion of the final report. It was concluded that the study should proceed on the same schedule as previously planned and to defer any request for time extension.

sgd/
Charles E. Nemir
for Harry P. Burleigh, Chairman
Governor's Planning Committee

ATTENDANCE LIST

Name	Organization	Position
J. J. "Jake" Pickle		Congressman
Clif Drummond	Congressman Pickle's Office	
Harry P. Burleigh	Texas Water Development Board	Executive Dir.
Charles E. Nemir	Texas Water Development Board	Assistant Executive Dir.
Major C. A. Allen	Corps of Engineers, Fort Worth District	Study Manager
Milburn Smith	Corps of Engineers, Fort Worth District	Sanitary Engineer
Adele K. Smith	Corps of Engineers, Fort Worth District	Program Analyst
Don Dillon	Corps of Engineers, Southwestern Division, Dallas	Civil Engineer
Harry Shapiro	Lower Colorado River Authority	Director
Richard H. McGinn	West Central Texas Council of Governments	Director of Reg. Planning Services
Mac A. Weaver	Environmental Protection Agency, Dallas	Special Projects Officer
Ken Schroeder	Department of the Interior, Albuquerque	Southwest Planning Officer
Donald VanSickle	Turner, Collie & Braden	Vice President

Leland Wilson	Corps of Engineers, Fort Worth District	Civil Engineer
Colonel Floyd Henk	Corps of Engineers, Fort Worth District	District Engineer
Capt. Asta	Corps of Engineers, Fort Worth District	Sanitary Engineer
Jack Thompson	Corps of Engineers, Fort Worth District	Economist
Jim Herbert	Corps of Engineers, Fort Worth District	Technical Writer
Pablo Sonido	Corps of Engineers, Fort Worth District	Sanitary Engineer
Howard R. Bare	Corps of Engineers, Southwestern Division	Chief, Planning Division
Norman G. Flaigg	Bureau of Reclamation	Area Planning Officer
Wylie O. Webb	San Angelo	
Heber T. Stewart	Farmers Home Adm.	Community Program Specialist
O. H. Ivie	Colorado River Municipal Water District	General Manager
T. C. Adams	Concho Valley Council of Governments	Director Regional Serv.
G. R. Herzik, Jr.	Texas State Department of Health	Deputy Comm.
Jack M. Alexander	City of Austin	Assist. Director of Planning

Jim Herring	Texas Railroad Commission	Senior Staff Engineer
Joe Harris	Office of the Governor	Coordinator of Natural Resources
H. Alden Deyo	South Plains Association of Governments	Executive Director
Ward Goessling	Office of the Governor	Division of Planning Coordination
John B. McCammon	Office of the Governor	Staff, Natural Resources
Howard Lee	Texas Parks and Wildlife Department	Environmental Division Head
Garner Jones	Texas Water Quality Board	Director of Planning & Research
Joseph J. Beal	Forrest & Cotton	Engineer
Robert Fleming	Texas Water Quality Board	Director of Central Operations Div.
John E. Babcock	Lower Colorado River Authority	Environmental Research Dept. Manager
Lawrence D. Zuehlke	Central Texas Council of Governments	Coordinator of Reg. Planning
Dave Smallhorst	City of Austin	Staff Engineer
Dixie Shipp	American-Statesman	
Sharon Smith	KHFI-TV	

Mike Gein	Austin Chamber of Commerce	Business Manager
Al D'Arezzo	Texas Water Rights Commission	Environmental Science Analyst
N. P. Turner	Turner, Collie & Braden	
P. E. Barker	Turner, Collie & Braden	
M. E. Cavaner	Turner, Collie & Braden	
Corwin W. Johnson	Austin, Texas	
Richard Boykin	Alamo Area Planning Council	Water Resource Specialist
Joel Wooldridge	Capital Area Planning Council	Director of Planning
Seth Burnitt	Texas Water Development Board	Director of Operations Division

AGENDA

1. Review of Study Organization
2. Current Work Status Reports
   a. Corps of Engineers
   b. Consultant
   c. Planning Committee
3. Federal Water Pollution Control Act Amendments of 1972 - EPA
4. Completion Schedule - Planning Committee Tasks and Responsibilities
5. Problems
6. Committee Response

MEETING RECORD

GOVERNOR'S PLANNING COMMITTEE

COLORADO RIVER BASIN WASTEWATER MANAGEMENT STUDY

The August 15, 1973 meeting of the Governor's Planning Committee for the Colorado River Basin Wastewater Management Study convened at 10:00 a.m. in the Texas Water Development Board auditorium. An attendance list is attached.

Chairman Burleigh opened the meeting and welcomed those in attendance. He stated the primary purpose of the meeting was to consider the report of the Basin Plan for final approval by the Committee.

Congressman J. J. Pickle addressed the meeting and expressed his appreciation to all involved in making the study, especially the Corps of Engineers, the consulting engineers, and the Planning Committee, for their efforts in the completion of the study. These efforts are especially commendable in view of the time frame and circumstances under which the study was made. Recent discussions and agreements with the Environmental Protection Agency have resulted in assurance that there are no obstacles to prevent EPA certification of the Basin Plan.

Following introduction of those present, Mr. Owen H. Ivie of the Colorado River Municipal Water District pointed out that Congressman Pickle's efforts had been most important in getting the study underway. His continued interest and support during the study were instrumental in its successful completion. Without Congressman Pickle's assistance it is likely that the study would not have been completed. Mr. John Babcock of the Lower Colorado River Authority expressed complete agreement about the importance of the Congressman's efforts.

James M. Rose, Director of the Division of Planning Coordination of the Governor's Office, said that Governor Briscoe was also pleased about the completion of the study and commended the Corps of Engineers, the consultant, Turner, Collie & Braden, Inc., and the members of the Planning Committee for their cooperative efforts in pursuing the work.

Major C. A. Allen presented the Committee with two copies of the revised draft report and explained actions that had taken place in review of the preliminary draft report that was distributed to all Committee members on July 29, 1973. He explained effects that the passage of the Federal Water Pollution Control Act Amendment of 1972 had on the direction of the study. Major Allen described revisions that had been made in the study to meet requirements under the new law and to conform to EPA guidelines. It was pointed out that although the areawide plans that were made exceed the requirements under which the study was initiated, they are not in their present form certifiable under the new law. Funding grants will require more detailed plans under Section 201 (facility plans) or Section 208 (areawide plans) of the new Federal law. It was decided to complete the areawide plans in their present form after considering comments received to date. Although not certifiable, these plans will provide basic information which can later be expanded to meet the requirements of Section 201 or 208.

Following Major Allen's explanation, the final completion schedule was discussed. After adoption, the revised draft plans will be furnished to the Texas Water Quality Board as the basis for their August 24, 1973 public hearing. The Texas Water Quality Board will then consider approval of the Basin Plan at a September 11, 1973 special Board meeting. After TWQB approval, the Basin Plan will be forwarded through Governor Briscoe to the Environmental Protection Agency as the State's formal Basin Plan for Water Quality Management in the Colorado River Basin. About 600 final copies will be printed, and distribution will be made to each Planning Committee member.

After discussion of the revised draft, a short recess was called during which time members had an opportunity to examine the report. The meeting resumed and Mr. Wylie O. Webb of San Angelo moved that the report be adopted by the Planning Committee. The motion was seconded by Mr. Heber T. Stewart of Farmers Home Administration. Mr. Charles H. Hembree, representing the Environmental Protection Agency, said that the EPA, as a Committee Member, would like to be recorded as abstaining from voting. He said that this did not in any sense mean that EPA thinks the report cannot be approved, but it means that at a later date, after the hearings and after it is formally submitted to EPA, it can be passed on officially. He further said that as far as they can tell from indications from EPA staff members, the document embodies all requirements necessary to make it an acceptable 131 plan and that he sees no obstacle in its path at all. With Mr. Hembree abstaining, this motion passed by unanimous vote. The meeting was adjourned.

ATTENDANCE LIST

Name	Organization	Position
J. J. "Jake" Pickle		Congressman
Clif Drummond	Congressman Pickle's Office	
Col. Floyd Henk	Corps of Engineers, Fort Worth District	District Engineer
Major Cornelius Allen	Corps of Engineers, Fort Worth District	
Milburn Smith	Corps of Engineers, Fort Worth District	Sanitary Engineer
Jack Thompson	Corps of Engineers, Fort Worth District	Economist
Leland Wilson	Corps of Engineers, Fort Worth District	Civil Engineer
Jim Herbert	Corps of Engineers, Fort Worth District	Technical Writer
Capt. John Asta	Corps of Engineers, Fort Worth District	Sanitary Engineer
Adele K. Smith	Corps of Engineers, Fort Worth District	Program Analyst
Pablo Sonido	Corps of Engineers, Fort Worth District	Sanitary Engineer
Don Dillon	Corps of Engineers, Dallas	Civil Engineer
Charles H. Hembree	Environmental Protection Agency, Dallas	

Norman Flaigg	Bureau of Reclamation, Austin	Area Planning Officer
H. A. Schweers	Bureau of Reclamation, Austin	
Heber T. Stewart	Farmers Home Adm., Temple	Community Program Specialist
Harry P. Burleigh	Texas Water Development Board	Executive Director
Charles E. Nemir	Texas Water Development Board	Asst. Executive Director
Seth Burnitt	Texas Water Development Board	Director of Operations Division
James Rose	Office of the Governor	Division of Planning Coordination
Joe B. Harris	Office of the Governor	Division of Planning Coordination
Ward Goessling	Office of the Governor	Division of Planning Coordination
Garner Jones	Texas Water Quality Board	Director of Planning and Research
John Sutton	Texas Water Quality Board	
Robert Misso	Texas Parks and Wildlife Department	
David M. Cochran	Texas State Department of Health	
Alfred D'Arezzo	Texas Water Rights Commission	Environmental Science Analyst

Paul Barker	Turner, Collie & Braden	
Thomas Rolen	Turner, Collie & Braden	
John E. Babcock	Lower Colorado River Authority, Austin	Environmental Research Department Manager
Owen H. Ivie	Colorado River Municipal Water District, Big Spring	General Manager
Wylie O. Webb	City of San Angelo	Mayor
Richard G. Bean	Capital Area Planning Council	Executive Director
Joel C. Wooldridge	Capital Area Planning Council	Director of Planning
Corwin Johnson	University of Texas Austin	Professor of Law