UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PREPARED BY THE U.S.
GEOLOGICAL SURVEY IN COOPERATION
WITH THE U.S. ARMY CORPS OF ENGINEERS
AND THE TRINITY RIVER AUTHORITY OF TEXAS

OPEN-FILE REPORT 75-558
(SHEET 1 OF 3)

TIME-OF-TRAVEL OF SOLUTES IN THE TRINITY RIVER BASIN, TEXAS
SEPTEMBER 1973 AND JULY-AUGUST 1974

The U.S. Geological Survey, in cooperation with the U.S. Army Corps of Engineers and the Trinity River Authority of Texas, conducted time-of-travel studies in the Trinity River basin during a period of low flow September 19-23, 1973, and during a period of moderate flow July 23-August 1, 1974. The purpose of these two studies was to provide data that could be used by the Trinity River Authority as part of the basic input to a mathematical water-quality model of the river. The model is being developed as part of a comprehensive water-quality management plan for the basin.

The time-of-travel of solutes in the Trinity River and West Fork Trinity River was determined by injecting a fluorescent dye (Rhodamine WT, 20-percent solution) that could be detected by fluorometric analysis of water samples collected at selected downstream sites. Plots of observed dye concentration versus time were made for each injection and sampling site, and a smooth curve was drawn. The resulting curves were then used to determine arrival times of the leading edge, the peak, and the trailing edge of the dye cloud. The trailing edge was defined as the concentration value equal to 10 percent of the peak concentration.

Measurements of the concentration and dispersion of the dye provide information on the probable behavior of soluble contaminants that might be introduced in the reaches studied. The methods and equipment used in these studies were similar to those described by Wilson (1968).

The study in September 1973 was conducted on the West Fork Trinity River between Fort Worth and Dallas. The discharge during the study period has been equaled or exceeded about 75 percent of the time during the 11-year period (1963-73) at the gaging station West Fort Trinity River at Grand Praire. The river reach under study was divided into two subreaches to reduce the time required to complete the study. Figure 1 shows the location of the area, the two subreaches, locations of gaging stations, and the curves of time versus dye concentration for each injection and sampling site. The data given in table 1 summarize the results of the study.

The study in July and August 1974 included parts of the West Fork Trinity and Trinity Rivers. This study reach was divided into five subreaches, and the dye injections were made in downstream order. The discharge during this period has been equaled or exceeded about 24 percent of the time in subreach 1, about 50 percent of the time in subreach 2, about 56 percent of the time in subreach 3, about 60 percent of the time in subreach 4, and about 66 percent of the time in subreach 5. These percentages apply to 11 years of records (1963-73) at gaging stations near the upper ends of the five subreaches. Figure 2 shows the study location, the five subreaches, locations of gaging stations, and the time-concentration curves for each injection and sampling site. The data given in table 2 summarize the results of the study.

The subdivision and injection pattern was designed to keep time requirements to a minimum and to allow the release-augmented flow to stabilize within a subreach before the dye injection was made. The augmentation of flow was accomplished by a constant release of water from Benbrook Lake, which is operated by the Corps of Engineers. The release of about 230 cubic feet per second (6.5 cubic metres per second) was designed to approximate the amount of sewage effluent that would be flowing from the Fort Worth metropolitan area in about 10 to 15 years.

Streamflow conditions were stable during both study periods. Small diurnal variations in flow were caused by the discharge of effluents from sewage-treatment plants located upstream from and within the reaches studied.

Previous time-of-travel data and water-quality data were obtained in the Trinity River basin during an extreme low-flow period in July 1972 (Ollman, 1973). These data were obtained for approximately the same river reaches used in the moderate-flow study of July-August 1974.

METRIC CONVERSIONS

The English units used in this report may be converted to metric units by the following conversion factors:

From			To obtain	
Unit	Abbreviation	Multiply by	Unit	Abbreviation
cubic feet per second	ft^3/s	0.02832	cubic metres per second	m^3/s
feet per second	ft/s	.3048	metres per second	m/s
miles	--	1.609	kilometres	--

REFERENCES CITED

Ollman, Ralph H., 1973, Time-of-travel of solutes, field observations of water quality, and suspended-sediment data for stream reaches in the Trinity River basin, Texas, July 31 to August 14, 1972: U.S. Geological Survey, open-file rept., 2 sheets.

Wilson, J. F., Jr., 1968, Fluorometric procedures for dye tracing: U.S. Geological Survey, Techniques of Water Resources Investigation, book 3, ch. A12, 31 p.

TABLE 1.-SUMMARY OF LOW-FLOW STUDY, SEPTEMBER 19-23, 1973

No a/	Reach Description	Subreach From	Subreach To	Distance b/ (river miles)	Streamflow (ft^3/s) c/	Dye cloud: Leading edge Travel time from upstream site (hours)	Leading edge Average velocity (ft/s)	Peak Travel time from upstream site (hours)	Peak Average velocity (ft/s)	Trailing edge Travel time from upstream site (hours)	Trailing edge Average velocity (ft/s)
1	Riverside sewage-treatment plant in Fort Worth to Precinct Line Drive	--	--	11.4	58	43.58	.38	51.22	.33	60.62	.28
2	Precinct Line Drive to Singleton Road	Precinct Line Drive	Arlington sewage-treatment plant	18.5	115	46.05	.59	52.88	.51	58.76	.46
		Arlington sewage-treatment plant	Meyers Road	5.0	119	10.33	.71	11.52	.63	12.20	.59
		Meyers Road	Singleton Road	4.3	160	8.83	.71	9.75	.65	12.62	.50

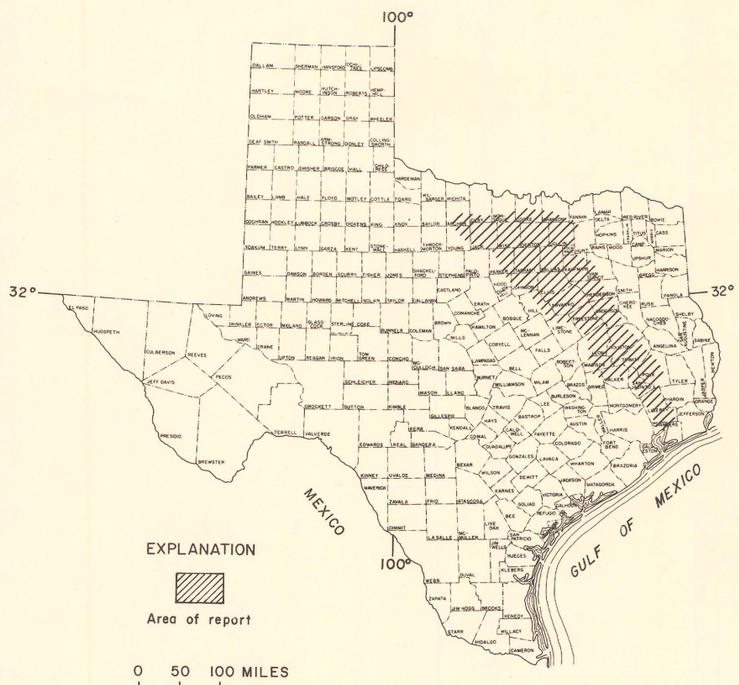
a/ Number of reach corresponds to the reach number on figure 1.
b/ Data provided by Trinity River Authority.
c/ The average flow at each site for the period the dye cloud was in the subreach was computed from instantaneous measurements and the record of a nearby continuous-record gaging station.

TABLE 2.-SUMMARY OF MODERATE-FLOW STUDY, JULY 23 TO AUGUST 1, 1974

No a/	Reach Description	Subreach From	Subreach To	Distance (river miles) b/	Streamflow (ft^3/s) c/	Dye cloud: Leading edge Travel time from upstream site (hours)	Leading edge Average velocity (ft/s)	Peak Travel time from upstream site (hours)	Peak Average velocity (ft/s)	Trailing edge Travel time from upstream site (hours)	Trailing edge Average velocity (ft/s)
1	Village Creek sewage-treatment plant near Fort Worth to Dallas sewage-treatment plant at Dallas	Village Creek sewage-treatment plant	Arlington sewage-treatment plant	15.6	340	18.88	1.21	21.35	1.07	23.98	.96
		Arlington sewage-treatment plant	Gifford-Hill Co. private bridge	7.7	345	8.25	1.37	8.83	1.28	9.50	1.19
		Gifford-Hill Co. private bridge	Commerce St. viaduct	8.4	390	10.25	1.20	10.92	1.13	11.42	1.08
		Commerce St. viaduct	Dallas sewage-treatment plant	4.1	400	5.00	1.21	5.25	1.15	5.58	1.08
2	Dallas sewage treatment plant at Dallas to S.H. 34 near Rosser	Dallas sewage-treatment plant	Dowdy-Ferry Road	13.4	580	12.32	1.60	13.52	1.46	15.02	1.31
		Dowdy-Ferry Road	So. Belt Line Road	5.0	581	8.02	.92	9.05	.81	10.25	.72
		So. Belt Line Road	Malloy Bridge Road	4.1	582	5.92	1.02	6.50	.93	7.00	.86
		Malloy Bridge Rd.	Confluence East Fork Trinity River	13.7	583	17.35	1.16	17.92	1.12	18.87	1.07
		Confluence East Fork Trinity River	S.H. 34 near Rosser	8.4	618	10.95	1.13	11.05	1.12	11.05	1.12
3	S.H. 34 near Rosser to 0.9 mile downstream from S.H. 31 at Trinidad	S.H. 34 near Rosser	F.M. 85	17.8	640	25.95	1.01	29.35	.89	34.17	.77
		F.M. 85 near Rosser	0.9 mile downstream from S.H. 31 at Trinidad	40.3	696	55.67	1.06	60.42	.98	64.42	.92
4	0.9 mile downstream from S.H. 31 at Trinidad to U.S. Hwy 79-84 near Oakwood	0.9 mile downstream from S.H. 31 at Trinidad	U.S. Hwy. 287	17.1	698	23.27	1.08	27.12	.93	31.28	.80
		U.S. 287	U.S. 79-84 near Oakwood	59.8	700	82.42	1.07	86.75	1.01	91.23	.96
5	U.S. 79-84 near Oakwood to S.H. 7 near Crockett	U.S. 79-84 near Oakwood	S.H. 7 near Crockett	47.2	800	79.58	.87	87.20	.80	97.72	.71

a/ Number of reach corresponds to the reach number on figure 2.
b/ Data provided by Trinity River Authority.
c/ The average flow at each site for the period the dye cloud was in the subreach was computed from instantaneous measurements and the record of a nearby continuous-record gaging station.

LOCATION MAP



U.S. GEOLOGICAL SURVEY
RESTON, VA.
FEB 27 1976
LIBRARY

M(200)
R290
no.75-558
Sheet 1
c.2

TIME-OF-TRAVEL OF SOLUTES IN THE TRINITY RIVER BASIN, TEXAS, SEPTEMBER 1973 AND JULY-AUGUST 1974

By
Ralph H. Ollman
November 1975

Texas (Trinity River basin). Water quality.
sheet 1
cop. 2

USGS LIBRARY - RESTON
3 1818 00177415 5