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TRINITY RIVER BOTTOM SEDIMENT RECONNAISSANCE STUDY. PHASE I. PL--ETC(U)
NOV 76 S R QASIM, V H SORGEE, A T ARMSTRONG

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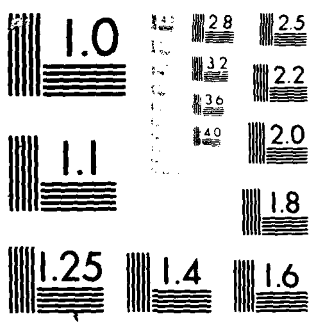

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

FINAL REPORT

TRINITY RIVER BOTTOM SEDIMENT RECONNAISSANCE STUDY

PHASE I – PLAN OF WORK

To

FORT WORTH DISTRICT CORPS OF ENGINEERS
FORT WORTH, TEXAS

Prepared Under Contract No. DACW 63-76-C-0140

By

Syed R. Qasim,
Vern H. Sorgee, and
Andrew T. Armstrong

November 30, 1976

Contributors

Max Spindler, Tom Petry, Jerry Motly
and Saiid Darbandi

THE UNIVERSITY OF TEXAS AT ARLINGTON
Arlington, Texas 76019

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20. ABSTRACT (*Continue on reverse side if necessary and identify by block number*) Phase I Trinity River Bottom Sediment Reocnnaissance Study was conducted to develop a plan of work in order to determine the physical and chemical quality of the bottom sediments in the Trinity River. This plan includes selection of sampling sites that represented the following: typical land use, point and nonpoint source discharges, velocity profiles and sediment transport, suitable landmarks, geological formations, existing USGS gauging stations, existing TWQB sediment monitoring stations and accessibility. Chemical analyses were conducted in the laboratory on filtered and unfiltered river water, filtered and unfiltered elutriates using river

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20. water, and bottom sediment.

Findings are included in the accompanying volume of appendices; charts, formulas, diagrams and tables relating to Final Report, Trinity River Bottom Sediment Reconnaissance Study-Phase I-Plan of Work.

FINAL REPORT

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Grateful acknowledgment is made to all agencies and personnel who provided information and technical assistance for use in this program. These agencies are:

U. S. Environmental Protection Agency, Region VI

Fort Worth District, U. S. Corps of Engineers

Texas Department of Highways and Public Transportation

Soil Conservation Service

U. S. Geological Survey

Texas Water Quality Board

Trinity River Authority

The North Central Texas Council of Governments

Hydroscience, Incorporated

Special thanks to Mr. Bob Lyman of Fort Worth District, Corps of Engineers, Dr. Richard Browning of the Trinity River Authority and Mr. Peter Dunsavage of the Environmental Protection Agency, Region VI for their assistance during this program.

EXECUTIVE SUMMARY

In order to determine the physical and chemical quality of the bottom sediments in the Trinity River, Phase I Study was conducted to develop a plan of work. The plan of work included the selection of sampling sites in the Trinity River that represented the conditions typical of the land use activity, and point and nonpoint source discharges. A rationale was developed for selection of sampling sites. Consideration was given to point and nonpoint source discharges, land use activity, velocity profiles and sediment transport, suitable landmarks, geological formations, existing USGS gauging stations, existing TWQB sediment monitoring stations, and accessibility.

The river length was divided into four reaches:

(a) The reach from the Beach Street Bridge in Fort Worth downtown to the mouth of the East Fork of the Trinity River (Corps River Mile 551-460).

(b) The reach from the East Fork Confluence downstream to the Highway 31 Bridge at Trinidad (Corps River Mile 460-392).

(c) The reach from the Highway 31 Bridge downstream to the head waters of Lake Livingston (Corps River Mile 392-183), and

(d) The reach from the Lake Livingston Dam downstream to River Mile 0. (Corps River Mile 123-0).

A total of 13 sampling sites have been selected. For sites 7, 8, 9, 10 and 12, alternate sites have also been proposed. A summary of these sites is given below.

Precedures for sampling and testing the river water, bottom sediments and standard elutriates, have been developed in accordance with the recent interim guidance for the implementation of Section 404(b)(1) of Public Law 92-500 published by the Department of the Army, Waterway

SUMMARY OF SAMPLING SITES

River Reach	Sampling Site Number	Description of Sampling Station	Prop. L&D Site*
a	1	CRM 536.5 Precinct Line Rd. Bridge	L&D 21
a	2	CRM 525 Bridge on S.H.360	L&D 20
a	3	CRM 509.5 Meyers Bridge	L&D 19
a	4	CRM 507.5 West Loop 12 Bridge	L&D
a	5	CRM 503 Hampton Road Bridge	
a	6	CRM 478 South Belt Line Rd. Bridge	L&D 17
a	7 or	CRM 466 Bridge on Malloy County Rd.	L&D 16
	7A	CRM 452 Bridge on S.H.34	
b	8 or	CRM 442 Bridge on S.H.34	L&D 13
	8A	CRM 432 Bridge on S.H.85	
c	9 or	CRM 343 Coeffield State Prison Farm	Prop'd Tennessee Colony Dam
	9A	CRM 376 Bridge on S.H.287	
c	10 or	CRM 300 Glaze Lake, 5 mi. east of Oakwood	L&D 9
	10A	CRM 313 Bridge on S.H.84	
c	11	CRM 268.5 Bridge on S.H.7	L&D 7
c	12 or	CRM 200 Upstream from Bedias Ck.	L&D 6
	12A	CRM 182 Bridge on S.H.19	
d	13	CRM 121 Bridge on U.S.59	L&D 5A & 5B

*Proposed Corps of Engineers Lock and Dam
CRM = Corps River Mile

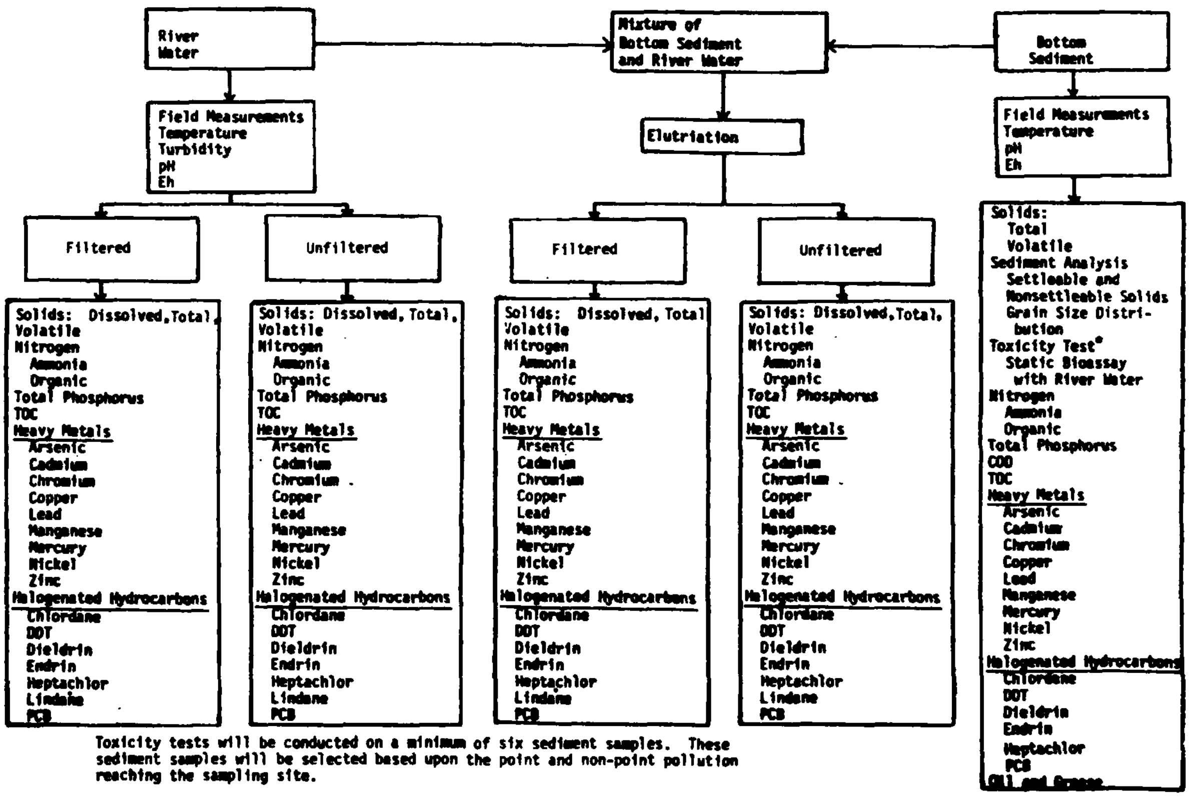
Experiment Station, Corps of Engineers*; and Approved EPA Analytical Methods for Dredged or Fill Materials**.

River water and sediment samples will be collected from each of the 13 proposed sites. Meteorological, river stage and velocity data, and physical condition of the river including photographic evidence will be collected at the time of sampling. Several field measurements will be

*Ecological Evaluation of Proposed Discharge of Dredged or Fill Material into Navigable Waters, Interim Guidance for Implementation of Section 404(b)(1) of PL 92-500. Environmental Effects Laboratory, U.S. Army Engineers Waterways Experiment Station, Vicksburg, Mississippi, May, 1976.

**Appendix A, Approved EPA Analytical Methods for Dredged or Fill Material, (Undated).

made on water and sediment samples. Chemical analysis will be conducted in the laboratory on (1) river water, filtered and unfiltered, (2) bottom sediment, and (3) filtered and unfiltered elutriates using river water. The EPA approved procedures will be used in all analyses. Various tests that will be performed are summarized as follows.



*Toxicity tests will be conducted on a minimum of six sediment samples. These sediment samples will be selected based upon the point and non-point pollution reaching the sampling site.

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INTRODUCTION

Background

Over the years, pollutants have been building up in the sediments of the ports, harbors, and waterways of the United States. These pollutants come from a variety of sources, including municipal and industrial wastewater outfalls, non-point sources, accidental spills, and dredge material disposal. Since many of the pollutants naturally adsorb and chemisorb to the fine sediment particles (clay, silt), the pollutants often are transported considerable distances by the water before settling out. When such particles eventually settle, the result can be a system of in-place pollution or "hot spots" where the level of pollution is considerably higher than in adjacent areas. As a consequence, many of these sediments, when dredged to maintain shipping channels, are classified as "source of pollution".

Recognizing the problems of in-place pollutants in natural water systems, Congress enacted Title I, Section 115 of the Federal Water Pollution Control Act Amendment of 1972, PL 92-500, requiring the following action of the Environmental Protection Agency:

> Sec. 115. The Administrator is directed to identify the location of in-place pollutants with emphasis on toxic pollutants in harbors and navigable waterways and is authorized, acting through the Secretary of the Army, to make contracts for the removal and appropriate disposal of such materials from critical port and harbor areas.

The Administrator of EPA subsequently proposed guidelines, pursuant to Section 404(b) of PL 92-500 for the purpose of providing guidance to be applied in evaluating proposed discharge of dredged or fill material in navigable waters*. The guidelines are applicable to all activities involving the discharge of dredged or fill material in navigable waters. Such discharges are unlawful except when in compliance with permits issued by the Secretary of the Army**. These guidelines are applicable to all Federal projects or activities.

Purpose of the Study

The U. S. Corps of Engineers, Fort Worth District, Texas, in connection with the proposed Trinity River Project, is collecting information on bottom sediment quality in the Trinity River. The proposed Trinity River Project is a multiple purpose project consisting of four physically interrelated features: the Dallas Floodway Extension and the West Fork Floodway for flood control in the Dallas-Fort Worth Metropolitan Area; Tennessee Colony Lake for lower basin flood control, upper basin water supply, navigation, and hydroelectric power; and the Multi-Purpose Channel for flood control from Fort Worth to Trinity Bay and navigation from Fort Worth to the Houston Ship Channel. Another purpose of the proposed project is recreation and fish and wildlife conservation. The project would also provide river bank stabilization and economic redevelopment benefits.

The work described in this report was performed under contract number DACW 63-76-C-0140, entitled "Trinity River Bottom Sediment Reconnaisance", between the Fort Worth District Corps of Engineers and the University of Texas at Arlington. This is the Phase I report and presents the plan of work of bottom sediment sampling and analysis program for the Trinity River.

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*Navigable Waters Discharge of Dredged or Fill Material, EPA, Federal Register, Friday, September 5, 1975.

**Permits for Activities in Navigable Waters or Ocean, Department of Defense, Corps of Engineers, Federal Register, Friday, July 25, 1975.

Scope of Work

The report provides details of selected sampling stations, rationale for selecting those stations, sampling procedures, various physical and chemical tests to be conducted on bottom sediments, and laboratory procedures.

A search of pertinent formal technical literature available from Trinity River Authority; Army Corps of Engineers, Fort Worth; Texas Water Quality Board; Environmental Protection Agency Region VI; North Central Texas Council of Governments; U. S. Geological Survey; and Hydroscience Inc.; was made. Supplementary contacts with various personnel in these offices were also made and the verbal and written material collected provided the basic information for this study.

Organization of the Report

The technical material was reviewed under the following general headings:

1) Point Sources of Pollution
2) Velocity Profile
3) Sediment Transport
4) Proposed Multi-Purpose Channel Alignment and Locks and Dams
5) Geological Formation
6) Rural and Urban Land Use
7) Sample Collection Methods
8) Laboratory Test Procedures

Most of the relevant information is included in the main body of this report. Details employed as back-up information are covered in several appendices.

Program Coordination

During preparation of the Plan of Work, the project personnel worked closely with the U. S. Corps of Engineers, Fort Worth District, Texas, the Environmental Protection Agency, Region VI, Texas Water Quality Board, and the Trinity River Authority in an effort to utilize their comments and modifications. The draft report was submitted to the Environmental Protection Agency and Texas Water Quality Board for Review. The comments received on the draft report have been incorporated into this report. These comments are included in the last section of this report.

PROCEDURE FOR SELECTION OF SAMPLING SITES

Pollution enters into the Trinity River from a variety of sources. These include: industrial and municipal waste discharges; surface runoff from urban, farming, pasture, forest and barren lands. These pollutants are naturally adsorbed or chemisorbed onto the fine sediment particles which, depending upon the flow conditions in the channel, and dispersion characteristics of the contaminants and sediments, eventually settle on the bottom. In order to select sampling sites for bottom sediment analysis from the Trinity River, a procedure was developed which utilized the following basic criteria for site selection:

1) Municipal and industrial wastes discharged
2) Characteristics of land use activity, urban, pasture, agricultural, forest and others (i.e., rivers, lakes)
3) Velocity profile of the river
4) Existing channel alignment, lock and dam
5) Effects of major tributaries
6) Geologic formations
7) Effects of reservoirs
8) Landmarks and accessibility
9) Existing USGS gauging stations
10) Existing TWQB sediment monitoring stations

A detailed literature search was conducted to establish data on each of the above criteria. A summary table (Table 1) was prepared for the entire river length. Most of the above criteria were listed in different columns of this table with respect to the river miles. Various reaches of the river were then evaluated in terms of each of these criteria prior to selection of the sampling sites. A brief description of each of the criteria used in selection of sampling sites and technical data developed for Table 1 is given below:

TABLE 1 SUMMARY TABLE OF WASTE DISCHARGES, VELOCITY PROFILE, EXISTING USGS AND TWQB STATIONS, AND LAND USE ACTIVITY ALONG THE TRINITY RIVER, USED FOR SAMPLING SITE SELECTION

(1) Corps River Mile	(2) TWQB WCO	(3) SIC & Description	(4) Flow MGD	(5) Aug. Vel.* 1) 2) 3)	(6) Lock & Dam	(7) USGS Station	(8) TWQB Station	(9) Landmark & Access	(10) Soil Type	(11) Land Use Activity	(12) Remarks
557						0804800		Ft. Worth, Tx.			
553	00570-01	29110 Petro	0.043								
550							805.07	Beach St, Ft. Worth	Alfisols		Sycamore Creek
548	10494-01	93495 STP	19.2								
548	10494-02	93495 STP	13.1	.33							
543	10103-01	93495 STP	1.2								
543	10605-01	93495 Pwr.Plt.	0.24	0.20							
542							805.06	Handley-Ederville Rd			Little & Big Fossil Creeks
536					#21				Sandstone Sand & Clay		Sampling Site #1
534	00367-01	37210 MFG	0.35					Precinct Line Rd.		35% Pasture Range	
534	10494-13	93495 STP	45.0								
534	10886-01	93495 STP	0.012					Village Creek Stp.		7%Forest	Village Creek
534	11002-01	93495 STP	0.009							35% Crop	
534	11009-01	93495 STP	0.1							15% Urban	
534	11036-01	93495 STP	0.006	.51						8% Other	
534	11106-01	93495 STP	0.0094								
534	11110-01	93495 STP	0.064								
534	11244-01	93495 STP	0.004								
528								SH157 Arlington			
525	10494-14	93495 STP	0.5	1.07	#20				Vertisols Sand & Clay		Sampling Site #2
520											
517	10324-01	93495 STP	6.5					SH360 Arlington	Vertisols Sand & Clay		
515				.40-.63		08049500	805.05	Beltline Rd.			
512				.50 Est. 1.28				Grand Prairie Meyers Rd.			
510	10235-01	93495 STP	0.135		#19					28% Pasture Range	Little Bear, Big Bear, Estelle Creeks
510	10486-03	93495 STP	0.2						Vertisols		
510	11032-01	93495 STP Mobile Home	0.008							6%Forest	
510	11035-01	93495 STP Mobile Home	0.015							40% Crop	
510	11175-01	93495 STP Mobile Home	0.014	.65						16% Urban	
510	11585-01	93495 STP	0.25	.49						10% Other	
509.5				1.13							Sampling Site #3

*United States Geological Survey Time-of-Travel Studies (ft/sec). 1) 1972 data, 2) 1973 data, 3) 1974 data (Appendix E).

TABLE 1 (CONT'D)

(1) Corps River Mile	(2) TWQB WCO	(3) SIC & Description		(4) Flow MGD	(5) Avg. Vel.* 1)	2)	3)	(6) Lock & Dam	(7) USGS Station	(8) TWQB Station	(9) Landmark & Access	(10) Soil Type	(11) Landuse Activity	(12) Remarks
509	10303-01	93495	STP	30.0	.49									
509	11703-01	93495	STP	0.024		.65								
507.5												Vertisols		Mountain Creek
505.75	10060-05	93494	WTP	5.0							LP12W, Dallas	Clay Marl		Sampling Site #4
505.75	10060-07	93495	STP	3.0								Shale w/Lime- stone		Elm Fork Confluence
505.75	10662-01	93495	STP	9.0										
505.75	10805-02	93495	STP	0.015			1.13							
505.75	11321-01	93495	STP	0.7										
505.75	11543-01	93495	STP	0.015										
503					.61						Hampton Road			
501	01248-01	49110	Pwr.Plnt.	0.6										Sampling Site #5
501	01248-02	49110	Pwr.Plnt.	0.2							Continental Av Commerce St.			
500									08057000	805.04	Dallas Toll Rd, DFW	Mollisols	28% Pasture	
499							1.15					Clay,Marl	& Range	
497								#18			I.H. 35E		7% Forest	
495	10060-01	93495	STP	93.8							& US 75	Limestone	43% Crop 14% Urban 8% Other	
493	01251-01	49110	Pwr.Plnt.	0.05			1.46							
493	01251-01	49110	Pwr.Plnt.	0.8										White Rock Creek
493	01251-03	49110	Pwr.Plnt.	0.03										
493	01251-04	49110	Pwr.Plnt.	0.5										
492									08057410	805.03	SLP12S, Dallas			
487	01474-01	35330	Petrol.	0.05							IH 20	Mixed		Five Mile Creek
487	10192-01	93495	STP	0.18								Alluvial Soils		
484	11166-01	93495	STP	0.025								Limestone		
483												& Shale		Prairie Creek
481	10060-06	93495	STP	7.0										
480.5							.81	#17						
478														Sampling Site #6
476					.69						S.Belt Line Rd Malloy County Rd			
474							.93			805.02	SW Seagoville Tx.	Mixed Alluvial Soils		

TABLE 1 (CONT'D)

(1) Corps River Mile	(2) TWQB WCO	(3) SIC & Description		(4) Flow MGD	(5) Avg. Vel.* 1)	3)	(6) Lock & Dam	(7) USGS Station	(8) TWQB Station	(9) Landmark & Access	(10) Soil Type	(11) Landuse Activity	(12) Remarks
474													
471	10316-01	93495	STP	0.122							Mixed Alluvial Soils Marl, Clay Sandy, Calcareous		Ten Mile Creek
471	10984-01	93495	STP	6.78		1.12							
466							#16			10 Miles East Ferris, Tx.			
462	10061-01	93495	STP	0.6									Sampling Site #7
462	10554-01	93495		0.5									
460	10028-01	93495	STP	0.4								28% Pasture & Range 3% Forest 46% Crop 6% Urban 4% Other	East Fork Confluence
460	10060-03	93495	STP	93.8									
460	10090-01	93945	STP	10.0									
460	10221-01	93945	STP	5.5	.77						Mixed Alluvial (MAS)Soils Alternating Sandy, Cal-careous Clay, Marly Sand & Thin Beds of Cal-careous Sand-stone		
460	10370-01	93495	STP	1.2		1.12							
460	10834-01	93495	STP	0.3									
460	11209-01	93495	STP	0.125									
457	10594-01	93495	STP	0.071									Red Oak Creek
457	11118-01	93495	STP Mob. Home	0.024									
457	11119-01	93495	STP	0.1									Sampling Site #8
452										FM34E, Sonoma	M.A.S.		
451.5								08062500	805.01		Marl & Clay		
442					.58	.89	#13						
434										SH 85	M.A.S.		
422					.83		#12				Sand & Shale		Grays Creek
412										21 miles N.E.	M.A.S.		Caney Creek
394	01029-01	28730	MFG	0.267						Corsicana	Clay & Silt		
393										5 ml SW Malakoff,			
392					.82	.98		08062700	804.06	SH31 E. Kerens/Tx.			
391											M.A.S.		
388	10745-01	93495	STP	0.14	.70	.93					Sand, Silt, & Clay		Rush Creek

TABLE 1 (CONT'D)

(1) Corps River Mile	(2) TWQB WCO	(3) SIC & Description		(4) Flow MGD	(5) Avg. Vel.* 1)	(5) Avg. Vel.* 3)	(6) Lock & Dam	(7) USGS Station	(8) TWQB Station	(9) Landmarks & Access	(10) Soil Type	(11) Landuse Activity	(12) Remarks
387	00947-01	49110	Pwr.Plnt.	0.02									
						.93							
385	10143-02	93495	STP	0.92									
385	10467-02	93495	STP	0.15									Cedar & Walnut Creeks
385	10738-01	93495	STP	0.216									
378													
374.5											M.A.S.		
354									804.05	U.S.287	Sand,		Saline Branch
348	10168-01	93495	STP	0.2							Silt, & Clay		
347	10300-02	93495	STP	0.105									
347	10471-01	93494	WTP	0.003									Tehuacano Creek
347	10551-01	93495	STP	0.195									
347	10551-03	93494	WTP	0.006									
						1.01							
343							Tenn. Dam			Coeffield State Prison Farm			Sampling Site #9
342.5							#10 B						
341							#10A						
337	10823-01	93495	STP	0.24									Catfish Creek
318	01288-01	20110	proc.plt	0.001									
317	01444-01	32210	MFG	0.16									Keechi & Town Creeks
317	10244-01	93495	STP	0.8							M.A.S.		
314	01911-01	29110	Petro	0.032							Clay & Silts		
314	01911-02	29110	Petro	0.032						10 mi. SW of Palestone Tx			
314	01911-03	29110	Petro	0.032									
314	10933-01	93494	WTP	0.003									
					.70								
313								0806500	804.04	U.S. 79 & U.S. 84			
					.55	.80							

TABLE 1 (CONT'D)

(1) Corns River Mile	(2) TWQB WCO	(3) SIC & Description	(4) Flow MGD	(5) Avg. Vel.* 1) 3)	(6) Lock & Dam	(7) USGS Station	(8) TWQB Station	(9) Landmarks & Access.	(10) Soil Type	(11) Landuse Activity	(12) Remarks
313											
309					#9			Glaze Lake 5 mi E of Oakwood 8 mi W of Elkhart Tx			
302	10578-01	93495 STP	0.09								
300											
297											Sampling Site #10
293	10735-01	93495 STP	0.123								Manson Creek
287	11586-01	93495 STP	0.075	.80					M.A.S. Quartz Sand w/ beds of Clay		Box Creek
273	10022-01	93495 STP	0.2								
273	10168-02	93495 STP	0.2								
273	11577-01	93495 STP	0.003								
271											Upper Keechi Creek
268.5					#7					42% Pasture & Range 32% Forest 20% Crop 4% Urban 2% Other	Little & Big Elkhart Creeks
266	10154-01	93495 STP	1.0	.55							Sampling Site #11
266	10871-01	93494 WTP	0.06								
265						08065350	804.03	Hwy. 7 W. Crockett			
245				.53					M.A.S. Sand		Keechi Creek
241	10147-01	93495 STP	0.105						M.A.S. Clay, Marl, Sand		Boggy Creek
238											
230							804.02	Hwy. 21 SW Crockett			
212											
209	10356-01	93495 STP	0.05					St. Prison Fm (Ferguson)	M.A.S.		Bedias Creek
208	01896-01	20330	0.1						Clay & Sand		
208	10215-01	93495 STP	0.4								
208	11176-01	93495 STP	0.18								
203											
201	11181-01	93495 STP	0.242					12 mi N of Huntsville,Tx	M.A.S.		Sampling Site #12
200					#6				Fine Sand		
198	11325-01	93495 STP	0.003								
198	11326-01	93495 STP	0.003								Nelson Creek
192											
183								Hwy.19 NE Huntsville	M.A.S. Sand & Clay		

TABLE 1 (CONT'D)

(1) CorpsRiver Mile	(2) TWQB WCO	(3) SIC & Description	(4) Flow MGD	(5) Avg. Vel. 1) 3)	(6) Lock & Dam	(7) USGS Station	(8) TWQB Station	(9) Landmark & Access	(10) Soil Type	(11) Landuse Activity	(12) Remarks
170	10617-01	93495 STP	0.25						M.A.S. Sand Fine & Med.		
170	11300-01	93495 STP	0.03								
170	11350-01	93495 STP	0.012						M.A.S. Mudstone & Sand		
170	11644-01	93495 STP	0.01								
169	10154-02	93495 STP	0.25								
169	10734-01	93495 STP	0.05								
156											
128								US 190 Livingston Dam	M.A.S. 151 Mud-stone & Sand		
124	11223-01	93495 STP	0.003						M.A.S.	20% Pasture & Range	
123					5A				Clay, Silt Sand	70% Forest 4% Crops	
120					5B					3% Urban 3% Other	Sampling Site #13
118	10208-01	93495 STP	0.72					U.S. 59 SW Livingston			
118	11139-01	93495 STP	0.72					3 mi S of Goodrich Tx	M.A.S. Silt & Sand		Long King Creek
118	11288-01	93495 STP	0.023								
118	11722-01	93495 STP	0.035								
117						08066250	802.02	6 mi NE of Shepherd Tx		24% Pasture & Range	
116				.85						74% Forest	
98	11380-01	93495 STP	0.2							1% Crop 5% Urban 5% Other	Copeland Creek
97					#4				M.A.S. Clay, Silt, & Sand		
94.5						08066500		Hwy 105 NE Cleveland			
77									M.A.S. Clay Silt, Sand		
72	11377-01	93495 STP	0.03					Hwy 162 E. Cleveland			
63					#3				M.A.S. Unconsol. Clay, Silt Sand		
50				.60							
47	11277-01										
40											
38						0867000	802.01	U.S. 90 E. Dayton			
32	10108-01	93495 STP	0.656						M.A.S. Unconsol. Clay, Silt Sand		
32	10108-03	93495 STP	0.0364								

TABLE 1 (CONT'D)

(1) Corps River Mile	(2) TWQB WCO	(3) SIC & Description	(4) Flow MGD	(5) Avg. Vel. 1) 3)	(6) Lock & Dam	(7) USGS Station	(8) TWQB Station	(9) Landmark & Access	(10) Soil Type	(11) Landuse Activity	(12) Remarks
29	01969-01	28430	0.006								
29	10564-01	93495. STP	0.2								
29	10564-02	93495 STP	0.353								
26	10495-80	93495 STP	0.002							40% Pasture & Range	Dayton & Lychburg Canals
8	0952-01	14770	0.041					IH 10 E.	M.A.S. Unconsol. Clay,Silt, & Sand	40% Forest 10% Crop 5% Urban 5% Other	
8	0952-02	14770	4.5								
7							801.01				
4					Wallis-ville						
0											

Municipal and Industrial Wastes

Discharged into the Trinity River

Information concerning point sources of industrial and municipal waste effluents were obtained from the computer print-out of "Waste Control Orders" (WCO's) issued by the Texas Water Quality Board (TWQB) to municipalities and industries that discharge effluents into the Texas streams. These orders are kept current by TWQB and were obtained from TWQB Office in Austin.

The following procedure was utilized in developing data on point discharges in various reaches of the Trinity River.

1. All WCO's in the Trinity River Basin were obtained that indicated some type of discharge.
2. These WCO's were arranged according to the TWQB segments. All segments that did not directly affect the water quality of the main stem of the Trinity River were excluded. As an example, those segments that were upstream of a reservoir would have pollutants settling into the reservoir, and the discharges from the reservoirs would be considered relatively free of pollution by the time they reached the Trinity River.
3. The WCO's contained in the segments that directly influenced the quality of water and sediments in the Trinity River were studied. These segments were:

    1) Segment 805 - Beach Street Bridge in Fort Worth to the confluence of the East Fork of the Trinity River.
    2) Segment 822 - Elm Fork of the Trinity River from Garza Little Elm Reservoir to the confluence of the Elm Fork and West Fork of the Trinity River.
    3) Segment 819 - East Fork of the Trinity River from Lake Ray Hubbard Reservoir to the confluence of East Fork and the Trinity River.
    4) Segment 804 - From the East Fork confluence down stream to the headwaters of Lake Livingston.
    5) Segment 803 - Livingston Reservoir located on the Trinity River.

6) Segment 802 - From the Livingston Reservoir down stream to the Bay Tidal Region.
7) Segment 801 - River Tidal Region.

4. The WCO's were then plotted on county maps obtained from the Texas Highway Department. On the same map, Corps River Mile, latitude and longitude of the point of entry of the effluent from each WCO into the Trinity River were also plotted.

5. As an additional aid in determining the pollutional characteristics of these WCO's, the Standard Industrial Classification (SIC) numbers assigned to each of these WCO's were obtained from TWQB.

6. The final step involved arrangement of this information into Summary Table 1; Columns (1), (2), (3), and (4). These columns summarized the point sources that influence the quality of water and sediment with respect to Corps River Mile. Appendix A provides backup information on point source discharge into the Trinity River.

Characteristics of the Land Use Pattern

The characteristics of the land use pattern for a particular region of a river basin influence the water and sediment quality of the stream. If the relative percentages between (1) pasture and range land, (2) forest, (3) cropland, (4) urban, (5) barren, and (6) others are obtained for a river section, an estimate of predominant pollutant entering the river at that section can be made.

For example, near a large metropolitan area, the storm runoff from the streets would be expected to be high in heavy metals. Likewise, in a region of a basin dominated by cropland, concentrations of insecticides and herbicides would be expected to display prominence over heavy metals. A review of sediment quality data developed by Texas Water Quality Board and McCullough and Champ for metropolitan and agricultural regions of the Trinity

River clearly shows such a trend. (See Appendices B and C).

In order to determine the percentages of land use activity in various segments of the Trinity River, a basin map was utilized which graphically indicated land use activity with basin miles.* From this map, the percentages of land use activity between any two sections of the river reach were directly obtained by planimetering the respective areas of each land use activity. Appendix D gives the breakdown of land use activity for various segments of the river. This information is included in column (11) of Table 1.

Velocity Profiles

Once the pollutants enter the natural waters, they are removed from the water by oxidation, bioflocculation and sedimentation. Sedimentation is considered to be important due to the ability of silt and clayey sediments to adsorb and chemisorb heavy metals, herbicides and pesticides and accumulate into the bottom deposits.

One of the most important parameters affecting the rate of sedimentation is the river velocity. In regions of high velocity and subsequent turbulance and scouring, poor sedimentation is expected. Likewise, good sedimentation would occur in low velocity areas.

To obtain the regions of the Trinity River where low velocity occured, the data obtained by the United States Geological Survey for time-of-travel (TOT) of tracers injected into the river was utilized. These tests were conducted at low flow (critical sedimentation) months of late July and early September of 1972, 1973, and 1974. These velocity profiles obtained under

*Status Report of Environmental Evaluation, Trinity River Project, Appendix A, FWD, Plate 13.

low flow conditions are considered to be representative of the normal July-September conditions and thus represent fairly dependable data on which to determine regions of low velocity under similar conditions of flow. The necessary data on TOT studies is given in Appendix E. Column (5) of Table 1 lists the velocity in various reaches of the Trinity River.

Geological Formations

The geological formations underlying a river bed characterize the storage potential of the contaminants into the soil column beneath the river bed. Silt and clayey formations retain the heavy metals and pesticides and other toxic compounds. This is mainly due to adsorption, ion exchange and filtering ability of clays and silts. In sandy formations, these contaminants percolate through, with little accumulation. Thus, the geological formation beneath the river bottom is an indication of high or low storage capacity for the pollutants in the underlying soil formations.

To determine the permeable properties of the soils located along the Trinity River, data on soil surveys published by the Soil Conservation Service*, and core samples made by the Corps of Engineers, Fort Worth District** were utilized. The geological formations characterized as alfisols, sandstones, limestone, sands, vertisols, mollisols, mixed alluvial soils, shale and clays were delineated for various segments of the Trinity River. This information is arranged in Column (10) of Table 1 with respect to the Corps River Miles. This information indicates to some extent the "storage capacity" for the contaminants into the underlying soils at various sections of the river.

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*Status Report of Environment Evaluation; Trinity River Project, Appendix A, FWD (Plate 13).

**Corps of Engineers (Core Samples) - Trinity River and Tributaries, Texas 89th Congress 1st Session - House Document No. 276, Volume IV.

Proposed Multipurpose Channel Alignment and Lock and Dam Sites

Another factor which influenced the selection of sampling sites was the Corps of Engineers proposed multipurpose channel alignment, and lock and dam sites. This factor was important as extensive dredging and excavation would be necessary in these regions. The necessary information in the Corps of Engineers proposed multipurpose channel alignment and lock and dam site was obtained from the status report of Environmental Evaluations, Appendix A*. The information is summarized in Appendix F of this report.

The proposed channel alignment and locks and dams were plotted on county maps along with WCO's. This information was then summarized in Table 1, Column (6) for comparison purposes along with other factors of interest.

Texas Water Quality Board (TWQB) Sediment Monitoring Stations

The Texas Water Quality Board currently operates seven sediment monitoring stations along the Trinity River. The sediment chemical quality data includes heavy metals and pesticides and other routine tests such as TOC, COD, total phosphorus, total organic nitrogen, oil and grease, etc. These data for the year October 1, 1974 to September 30, 1975 are given in Appendix B.

In selection of sampling sites, the existing TWQB sediment monitoring stations were given consideration. Since sediment quality data was available for seven locations on the Trinity River, the sampling sites selected for

*Status Report of Environmental Evaluation, Trinity River Project, Appendix A, FWD.

this study excluded those locations. In Column (8) of Table 1, the TWQB sediment monitoring stations are indicated with respect to the Corps River Miles.

U. S. Geological Survey Gauging Stations

USGS currently operates eleven stream gauging stations on the Trinity River between Fort Worth, Texas and Liberty, Texas. The stage-discharge rating curves for all these gauging stations have been obtained. By using these curves and time of sampling stage data, the flow rate in the Trinity River can be obtained at the appropriate station.

The location of the USGS gauging stations is given in Appendix G. Column (7) of Table 1 summarizes the location of USGS gauging stations with Corps River Miles.

Meteoroligical Stations in the Trinity River Basin

At the time of sampling, meteorological conditions such as sky cover, air temperature, and precipitation conditions on the day of sampling and during the past six days will be obtained. The U. S. Weather Bureau and other agencies operate approximately 39 meteorological stations in various counties in the Trinity River Basin. These stations and the persons or agency that maintain data are given in Appendix H.

Many of these weather stations upstream from the sampling sites will be contacted and necessary climatological data will be obtained during the sediment sampling program.

Effects of Tributaries

The effects of tributaries were of concern for two significant factors: 1) Land use activity and nonpoint pollution, and 2) point source pollution, that reached the Trinity River from different tributaries. It was stated earlier that the Texas Water Quality Board (TWQB) WCO's were plotted on county maps and the discharge of each was traced via tributaries to the point at which each entered the Trinity River. By this method, the relative importance of each tributary could be determined. In an effort to include the effects of tributaires, therefore, sampling sites were chosen downstream of major confluences. Major tributaries are marked in Column (12) of Table 1.

Effects of Reservoirs

The effects of reservoirs are considered important due to the change in stream velocities when discharges are made from the reservoirs. The rate of discharge from different reservoirs on the tributaries of the Trinity River had little effect upon selection of sampling sites since the time of interest of this study is one of low flow conditions.

Landmarks and Accessibility

To facilitate the easy access and location of each proposed sampling site, suitable landmarks such as bridges, highways, tributary confluences and nearby cities were identified. In addition to locating each sampling site, priority was given to the best avenues of accessibility. In each case accessibility was usually made from two avenues of approach. The suitable landmarks and bridges on the Trinity River are indicated in Column (9) of Table 1.

SELECTED SAMPLING SITES FOR BOTTOM SEDIMENT ANALYSIS

Based upon the rationale developed previously and a review of the factors affecting the quality of bottom sediment in the Trinity River, a total of 13 sampling sites have been selected. These sampling sites represent the typical conditions that are associated with pollution resulting from municipal and industrial waste discharges, urban runoffs, and drainage from agricultural areas. Also, factors such as existing TWQB sediment monitoring status, USGS gauging stations, accessibility to the sampling site and existing landmarks were given full consideration.

For each sampling site, a river reach of approximately 4 miles has been recommended for sample collection. The actual location from where the sample will be collected along each reach will be based upon the survey of the site and existing conditions. Areas showing stagnant pools where heavy sedimentation is expected to occur will be selected for water and sediment sampling. In case, however, the river cannot be entered from the bridge easement, the water and sediment sampling will be done from the top of the bridge.

A summary of 13 selected stations is given in Table 2. Figure 1 indicates the locations of these sampling points with respect to Corps River Miles. Detailed description of each of the selected sampling sites in light of the rationale developed is given below.

TABLE 2: SUMMARY OF SELECTED SAMPLING SITES

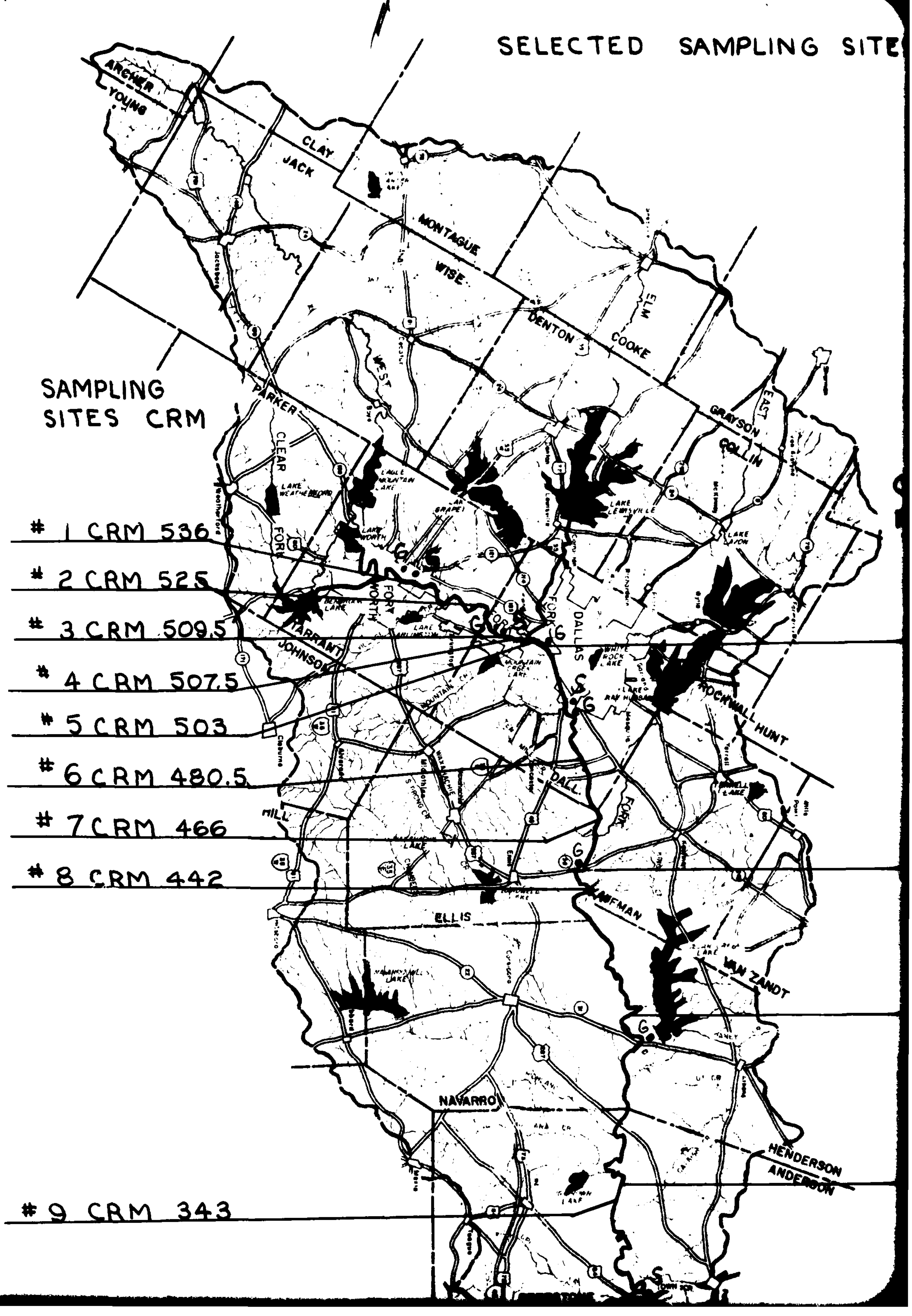
Sampling Site and River Reach	Corps River Mile	Channel Mile	Total Point Source Discharge*	Velocity Profile** 1)	2)	3)	Proposed Lock & Dam Sites	USGS Stations	TWQB Stations	Meteorological Stations	Landmarks Accessibility	Predominant Land Use
1-Reach (a)	536.5	360	3-STP 32MGD	0.20	0.51		#21	Upstream 80480 Downstream 80495	805.06	1)Benbrook Dam 2)Meacham Fld. 3)Ft.Wth.Fed. Bldg.	Precinct Line Rd. Bridge	Metropolitan Area of Ft. Worth, Hurst, Euless, Bedford
2-Reach (a)	525.0	353	8-STP 46MGD		0.51	1.07	#20	Upstream 80480 Downstream 80495	805.05	1)Benbrook Dam 2)Meacham Fld. 3)Ft.Wth.Fed. Bldg. 4)Arlington	SH360 Bridge	Metropolitan Area of Ft. Wth, Hurst Euless, Bedford, Arlington
3-Reach (a)	509.5	342.3	8-STP 7.2MGD	0.49	0.65	1.13	#19	Upstream 80495 Downstream 80570	805.05	1)Meacham Fld 2)Ft.Wth Fed. Bldg. 3)Arlington 4)DFW Airport	Meyers Rd. Bridge TRA Central STP	Metropolitan Area of Ft. Worth, Hurst, Euless, Bedford Arlington, Irving, Grand Prairie
4-Reach (a)	507.5	340.5	2-STP 30MGD	0.49	0.65	1.13		Upstream 80495 Downstream 80570	1)805.05 Gr.Prairie 2)805.04 Dallas	1)Ft.Wth Fed. Bldg. 2)Arlington 3)DFW Airport	W. Loop 12 Bridge	Metropolitan Area of Ft. Worth, Hurst, Euless, Bedford, Arlington, Irving, Grand Prairie
5-Reach (a)	503	336	5-STP 17.7MGD	0.61		1.13		Upstream 80495 Downstream 80570	805.04	1)Ft.Wth. Fed. Bldg. 2)Arlington 3)DFW Airport	1)W Loop 12 Bridge 2)Hampton Rd Bridge 3)Sylvan Ave Bridge 4)2.75 Mi. downstream of Elm Fork	Metropolitan Area of West Dallas
6-Reach (a)	478	315.5	4-STP 100.8MGD	0.69		0.93	#17	Upstream 805741 Downstream 80625	805.02	1)DFW Airport 2)Richardson	Bridge on S. Belt Line Road	Metropolitan Area of S. Dallas
7-Reach (a)	466	306.6	2-STP 6.9MGD	0.77		1.12	#16	Upstream 805741 Downstream 80625	805.02	1)DFW Airport 2)Richardson	Malloy County Bridge	Predominantly cropland & pasture

*Point Source Discharges were totaled between sampling sites.
**United States Geological Survey Time-of-Travel Studies. 1) 1972 data, 2) 1973 data, 3) 1974 data (Appendix E)

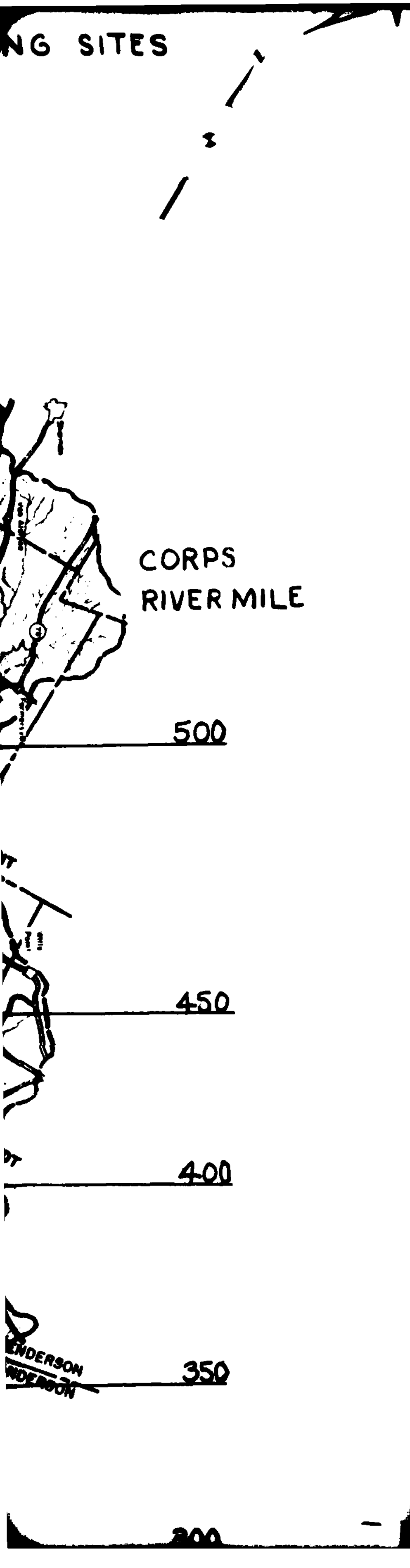
TABLE 2 (CONT'D)

Sampling Site and River Reach	Corps River Mile	Channel Mile	Total Point Source Discharge*	Velocity Profiles** 1)	2)	3)	Proposed Lock & Dam Sites	USGS Stations	TWQB Stations	Meteorological Stations	Landmarks Accessibility	Predominant Land Use
8-Reach (b)	442	292.6	11-STP 113MGD	0.58		0.89	#13	Upstream 80625 Downstream 80627	805.01	1)DFW Airport 2)Avalon 3)Bardwell Dam 4)Crandall 5)Rosser	SH 34 Bridge SH 85 Bridge	Predominantly cropland & pasture
9-Reach (c)	343	234	7-STP 1.9MGD	0.70		1.01	Tennessee Colony Dam #10B #10A	Upstream 80627 Downstream 80650	804.05	1)Longlake 5SW 2)Palestine	Coeffield State Prison Farm	Predominantly Pasture & Forest
10-Reach (c)	300	216.4	3-STP 1.13MGD 1-MFG 0.16MGD 3-Petro .09MGD 1-WTP .003MGD	0.55		0.80	#9	Upstream 80650 Downstream 806535	804.04	1)Longlake SSW 2)Palestinw 3)Buffalo 4)Centerville 5)Jewell	Glaze Lake 5 mi. E of Oakwood Tx	Predominantly Pasture & Forest
11-Reach (c)	268.5	197.5	5-STP 0.6MGD	0.55		0.80	#7	Upstream 80650 Downstream 806535	804.03	1)Buffalo 2)Centerville 3)Jewell 4)Crockett 5)Lovelady	Bridge on SH7	Predominantly Pasture & Forest
12-Reach (c)	200	147.9	5-STP 1.98MGD 1-WTP 0.06MGD	No studies conducted in this region			#6	Upstream 806535	804.02	1)Crockett 2)Lovelady 3)Madisonville	Nelson Creek Bridge on SH 19	Predominately Forest
13-Reach (d)	121	95	1-STP .003MGD	0.85			5A & 5B	Downstream 806625	802.02	1)Coldspring 5SSW	1)Livingston Dam 2)Bridge on US 59	Predominantly Forest

SELECTED SAMPLING SITE



NG SITES



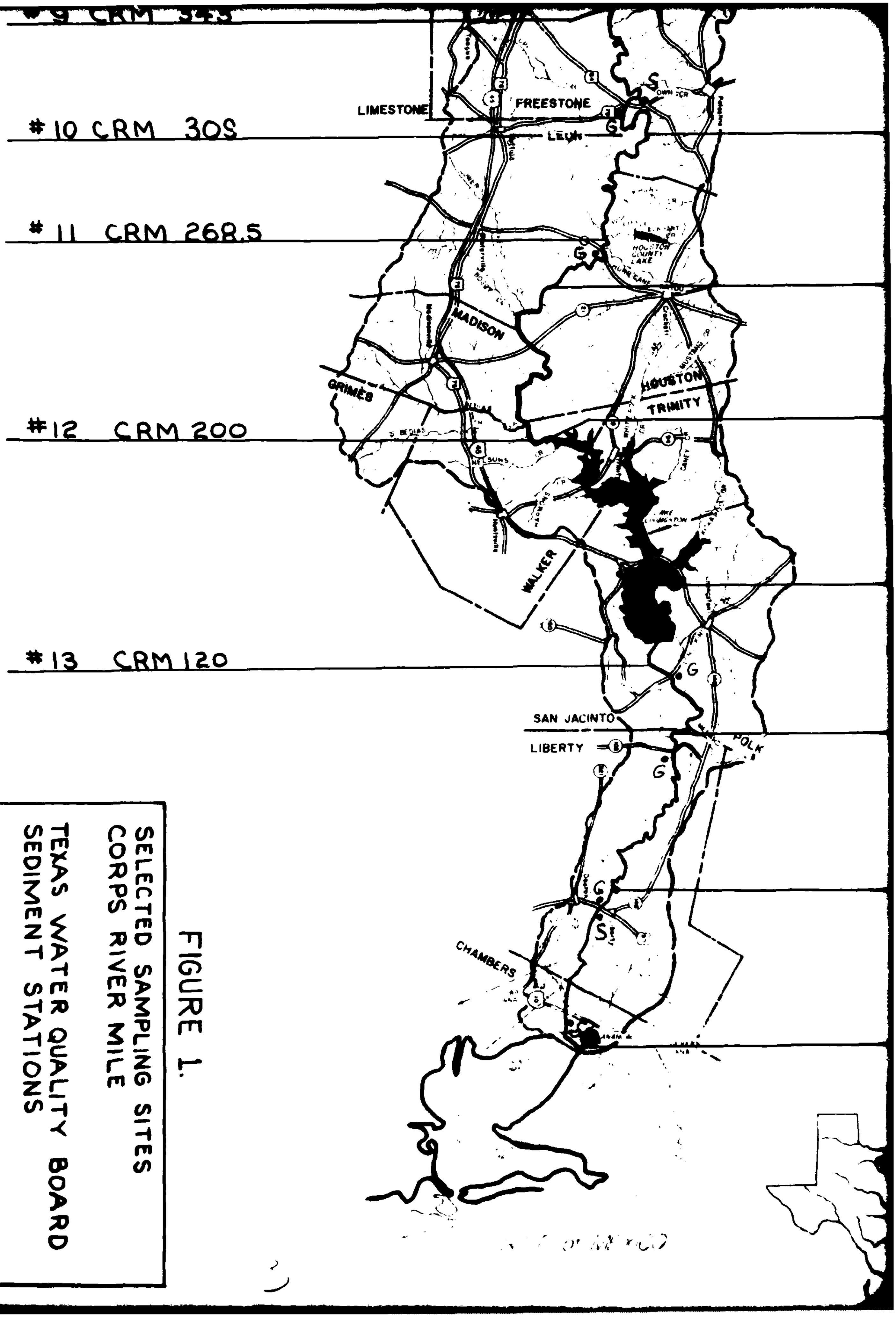
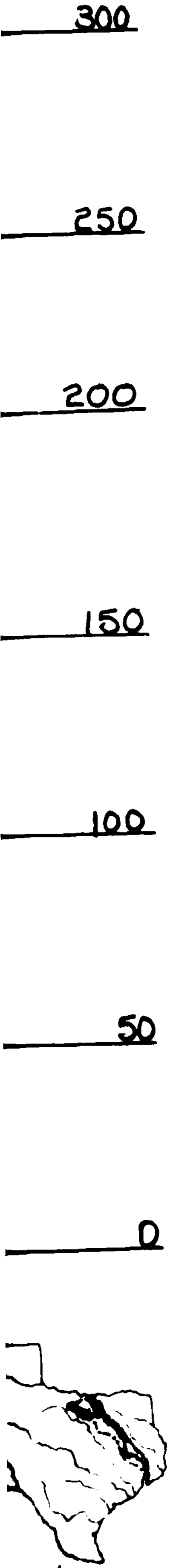


FIGURE 1.

SELECTED SAMPLING SITES CORPS RIVER MILE

TEXAS WATER QUALITY BOARD SEDIMENT STATIONS

UNITED STATES GEOLOGICAL SURVEY GAUGING STATIONS


300
250
200
150
100
50
0

Sampling Site #1

1. Location: Reach (a) Beach St. Bridge in Ft. Worth to confluence of the East Fork.

   a. Latitude 32°47'

   b. Longitude 97°10'

   c. Corps River Mile (CRM) 536.5

   d. Channel Mile (CM) 360

   e. County Tarrant

   f. Landmarks:
      Precinct Line Road Bridge over West Fork Trinity River

   g. Nearby Cities:
      Sampling site #1 is located approximately 5 miles northwest of Arlington, Texas and 3 miles south-southwest of Hurst, Texas

   h. Range of Sampling Site:
      This site may be sampled from Loop 820 upstream to Village Creek Sewage treatment plant downstream (at CRM 534).

2. Reasons for Sampling Site Selection:

   a. Characteristics of Land Use Pattern and Point Source Pollution:

      1) Land use activity in this basin region
         35% pasture & range
         7% forest
         35% crops
         15% urban*
         8% other

*This site is located approximately 15 miles downstream from downtown Fort Worth.

      2) Major Point Sources of Pollution in this sampling reach:
         The Riverside Sewage Treatment Plant at CRM 548 discharges approximately 32.0 MGD.

   b. Velocity Profiles, United States Geological Survey (USGS) Time-of-Travel (TOT) studies:

      1) The USGS TOT study in 1972 indicated a velocity in this reach of 0.20 feet per second.

      2) The USGS TOT study in 1973 indicated a velocity in this reach of 0.33 feet per second.

These velocities are lower than other velocities located farther down the River.

c. The Trinity River in this sampling reach is intersected by the proposed Multipurpose Channel at CRM 540 and CRM 536.5.

d. The Sampling Site #1 is at the designated location of proposed lock & dam site #21.

e. Major tributaries entering the West Fork in the reach above sampling site #2:

   1) Little Fossil and Big Fossil Creeks enter the Trinity River at CRM 543.

f. Flow From Reservoirs:

   1) Benbrook Reservoir

   2) Lake Worth Reservoir

g. Main Landmark(s) of interest in the vicinity of sampling site:

   1) Precinct Line Road Bridge over the West Fork of the Trinity River near intersection of Precinct Line Road & Randoll Mill Road.

h. Access to Sampling Site

   1) Access to Sampling Site #1 will be made at Precinct Line Road Bridge at CRM 536.5 or at Loop 820 Bridge at CRM 541.

i. Geologic Formation in area of sampling site:

   1) The soil formation in this area is alfisols composed of sandy clay.

3. United States Geological Survey (USGS) Gauging Station(s):

   a. The USGS stations to be used for sampling site #1 will be 80480 upstream and 80495 downstream. See Appendix G for locations.

4. Texas Water Quality Board (TWQB) Station(s) in area:

   a. The TWQB station 805.06 in this sampling area is located at intersection of Randol Mill Road & Handley-Ederville Rd., CRM 542.

5. Meteorological Stations for Sampling Site #1:

County	Site	Observer
Tarrant	Benbrook Dam	Pro. Eng. Benbrook Proj. O
Tarrant	Meacham WSO Airport	National Weather Service
Tarrant	Federal Building	National Weather Service

6. Remarks:

Site #1 was selected primarily bacause it is located downstream of a major point source of pollution Riverside STP). It also includes the effects of two tributaries, Little and Big Fossil Creeks, which receive storm runoff from the city of Fort Worth. This region of the river also has low velocities. Other factors that were given consideration were the proposed location of Lock and Dam site #21 and the accessibility provided to the area by Precinct Line Road. This site is located approximately 14 miles downstream of the TWQB Sediment Monitoring Station of 805.07 at CRM 550.

Sampling Site #2

1. Location: Reach (a) Beach St. Bridge in Ft. Worth to mouth of East Fork.

   a. Latitude $32^{o}47'$

   b. Longitude $97^{o}05'$

   c. Corps River Mile (CRM) 525

   d. Channel Mile (CM) 352

   e. County Tarrant

   f. Landmarks:
      SH 360 Bridge over West Fork of the Trinity River

   g. Nearby Cities:
      Site #2 is located approximately 5 miles north of Arlington, Texas

   h. Range of Sampling Site:
      This site may be sampled anywhere downstream of sampling site #2 to Arlington Sewage Treatment Plant located at CRM 517.

2. Reasons for Sampling Site Selection:

   a. Characteristics of Land Use Pattern and Point Source Pollution

      1) Land use activity in this basin region:
         35% pasture and range
         7% forest
         35% crops
         15% urban*
         8% other

*This sampling station is located approximately midway between Fort Worth and Dallas.

      2) Major Point Sources of Pollution in this sampling reach:
         The major point source of pollution in this site is the village Creek Sewage Treatment plant located at CRM 534.

   b. Velocity Profiles, United States Geological Survey (USGS) Time-of-Travel (TOT) studies:

      1) The USGS TOT study in 1973 indicated a velocity in this reach of 0.51 feet per second.

      2) The USGS TOT study in 1974 indicated a velocity in this reach of 1.07 feet per second.

c. This sampling site reach is in the area of the proposed Multipurpose Channel. The West Fork is intersected by the proposed channel at CRM 523.5.

d. This sampling site is located at the proposed lock & dam site #20.

e. Major tributaries entering the West Fork in the reach above this sampling site:

1) Village Creek enters the West Fork at CRM 534.

2) Walker Branch enters the West Fork at CRM 534.5

f. Flow from Reservoirs:

1) Benbrook Reservoir

2) Lake Worth Reservoir

g. Main landmark(s) of interest in the vicinity of sampling site:

1) SH 360 Bridge over the West Fork of the Trinity River

h. Access to sampling site

1) access to sampling site #2 will be made either at SH 157 upstream or SH 360 downstream.

i. Geological Formations in area of sampling site:

1) The formation in this area is vertisols composed of sand & clay.

3. United States Geological Survey (USGS) Gauging Stations:

a. The USGS gauging stations to be used for site #2 will be 80480 upstream and 80495 downstream. See Appendix G for locations.

4. Texas Water Quality Board (TWQB) stations in area:

a. The TWQB station 805.05 in this sampling area is located at Belt Line Road in Grand Prairie, Texas at CRM 515.

5. Meteorological stations for sampling site #2:

County	Site	Observer
Tarrant	Benbrook Dam	Pro. Eng. Benbrook Pro. O.
Tarrant	Meacham Field	National Weather Service
Tarrant	Fort Worth Federal Bldg.	National Weather Service
Tarrant	Arlington	Charles T. Hawkls

6. Remarks:

Site #2 was selected primarily becuase it is located downstream of major point sources of pollution (Village Creek STP and urban storm runoffs from Village and Walker Creeks) and the velocity of this river reach was low compared to the other velocities downstream. Other factors that were dominant included the location of Lock and Dam site #20, the accessibility provided by State Highway 360 and the fact that site #2 is located approximately in the center of the metropolitan area.

Sampling Site #3

1. Location: Reach (a) Beach St. Bridge in Ft. Worth to confluence of East Fork.

   a. Latitude 32°47'

   b. Longitude 96°58'

   c. Corps River Mile (CRM) 509.5

   d. Channel Mile (CM) 342.3

   e. County Dallas

   f. Landmarks:

      1) Meyers Road Bridge over West Fork at CRM 510.5

      2) Trinity River Authority Sewage Treatment Plant at CRM 509

   g. Nearby Cities:
      Site #3 is located approximately 3 miles northeast of Grand Prairie and 3 1/2 miles south of Irving, Texas.

   h. Range of Sampling Site:
      This site may be sampled anywhere from sampling site #2 upstream to TRA STP downstream at CRM 509.

2. Reasons for Sampling Site Selection:

   a. Characteristics of Land Use Pattern and Point Source Pollution:

      1) Land Use Activity in this basin region:
         28% pasture and range
         6% forest
         40% crop
         16% urban*
         10% other

   *This site is located on the west side of Dallas.

      2) Major Point Sources of Pollution in this sampling reach:

         a) Arlington Sewage Treatment plant is located at CRM 517 with approximately 6.5 MGD discharge

         b) Numerous small sewage treatment plants on Little Bear, Big Bear and Estelle Creeks empty into the West Fork of the Trinity River at CRM 511.

b. Velocity Profiles, the United States Geological Survey (USGS) Time-of-Travel (TOT) studies:

1) The USGS TOT study in 1972, 1973, and 1974 indicated velocities in this reach at 0.49, 0.65 and 1.13 feet per second respectively.

c. The proposed Multipurpose Channel intersects the West Fork at Site #3

d. The Sampling Site #3 is located at the proposed lock & dam #19.

e. Major tributaries entering the West Fork in the reach above the sampling site:

1) Little Bear Creek enters Big Bear Creek. The tributary thence flows to Estelle Creek and thence to the West Fork of the Trinity River at CRM 511.

f. Flow from Reservoir:

1) Benbrook Reservoir

2) Lake Worth Reservoir

g. Main landmark(s) of interest in vicinity of Site #3.

1) Meyer Road Bridge is located 1 mile upstream and T.R.A. sewage treatment plant is located 1/2 mile downstream.

h. Access to Sampling Site:

1) Access to sampling site #3 will be made from Meyer's Road or Loop 12 west of Dallas.

i. Geologic Formation in area of sampling site:

1) The formation in this area is vertisols composed of clay, marl, shale and limestone.

3. United States Geological Survey (USGS) Gauging Stations:

1) The USGS stations to be used for sampling site #3 will be 80495 upstream and 80520 downstream. See Appendix G for locations.

4. Texas Water Quality Board (TWQB) Station(s) in area:

a) The TWQB station 805.05 in this sampling area is located at Belt Line Road in Grand Prairie, CRM 515.

5. Meteorological Stations for sampling site #3:

County	Site	Observer
Tarrant	Meacham Field	National Weather Service
Tarrant	Ft. Worth Federal Bldg.	National Weather Service
Tarrant	Arlington	Charles T. Hawkls
Tarrant	Dallas-Ft. Worth AP	FAA Flight Service Station

6. Remarks:

Site #3 was selected because it is downstream of major point sources of pollution (Arlington STP* and urban storm runoffs from Little Bear, Big Bear and Estelle Creeks). In addition, TWQB Sediment Station 805.05 is located at CRM 515 and is situated midway between Site #2 and #3. Site #3 is also situated in the vicinity of proposed Lock and Dam site #19 and access is available from either Meyers Road or West Loop 12. The soil in this reach is predominately sand and clay.

*The wastewater flow from the City of Arlington STP has been diverted recently to TRA central STP. The effects of this plant may still be significant upon the sediment quality.

Sampling Site #4

1. Location: Reach (a) Beach St. Bridge in Ft. Worth downstream to the confluence of the East Fork.

   a. Latitude $32^{0}47'$

   b. Longitude $96^{0}55'$

   c. Corps River Mile (CRM) 507.5

   d. Channel Mile (CM) 340.5

   e. County Dallas

   f. Landmarks:
   West Loop 12 Bridge over West Fork of the Trinity River west of Dallas.

   g. Nearby Cities:
   This site is located approximately 6 miles west of Dallas, 3 miles southeast of Irving, and 5 miles northeast of Grand Prairie.

   h. Range of Sampling Site:
   This site may be sampled anywhere from site #3 upstream to CRM 503 downstream.

2. Reasons for Sampling Site Selection:

   a. Characteristics of Land Use Pattern and Point Source Pollution

      1) Land use activity in this basin region:
      28% pasture and range
      6% forest
      40% crops
      16% urban
      10% other

      2) Major Point Sources of pollution in this sampling reach:

         a) The Trinity River Authority Central Sewage treatment plant located at CRM 509 discharges 30 MGD.

         b) Delaware Creek Channel from Irving, Texas area enters the West Fork at CRM 508.25

   b. Velocity Profiles, the United States Geological Survey Time-of-Travel studies:

1) The USGS TOT studies for 1972, 1973 and 1974 indicated velocities in this reach of 0.49, 0.65 and 1.13 feet per second, respectively.

c. The area of Site #4 is adjacent and parallel to the proposed Multipurpose Channel.

d. No proposed lock and dam site is located in the immediate vicinity.

e. Major tributaries entering the Trinity River in the reach above this sampling site:

1) Delaware Creek enters the West Fork at CRM 508.25

f. Flow from Reservoirs:

1) Lake Worth*

2) Benbrook*

*Flow from these two reservoirs is considered to play a minor role in the flowrate of this reach during low flow conditions.

g. Main Landmark(s) of interest in vicinity of sampling site:

1) West Loop 12 Bridge over the West Fork of the Trinity River west of Dallas.

h. Access to sampling site:

1) Access to site #4 will be made from Loop 12 or Westmoreland Avenue Bridge.

i. Geologic Formation in area of sampling site:

1) The formation in the area of site #4 is vertisols composed of clay, marl and limestone.

3. United States Geological Survey (USGS) Monitoring Stations:

1) The USGS stations to be used for sampling site #5 will be 80495 upstream and 80570 downstream. See Appendix G for locations.

4. Texas Water Quality Board (TWQB) Station(s) in Area:

1) The TWQB stations in the area of site #5 are 805.05 in Grand Prairie and 805.04 in Dallas.

5. Meteorological Stations for Sampling Site:

County	Site	Observer
Tarrant	Ft. Worth Fed. Bldg.	National Weather Service
Tarrant	Arlington	Charles T. Hawkls
Dallas & Tarrant	DFW Airport	FAA Flight Service Sta.

6. Remarks:

Site #4 was selected because it is downstream of major noint sources of pollution (TRA Central STP and urban storm runoff from Delaware Creek Channel) and it is situated upstream of the confluence of Elm Fork and the West Fork. In addition to these factors, the site selected is adjacent to the proposed Multipurpose Channel and has low velocitv profiles. Excellant access is abailable from either West Loon 12 or Westmoreland Avenue.

Sampling Site #5

1. Location: Reach (a) Beach St. Bridge in Ft. Worth downstream to the confluence of the East Fork of the Trinity River.

   a. Latitude 32°48'

   b. Longitude 96°51'

   c. Corps River Mile (CRM) 503

   d. Channel Mile (CM) 336

   e. County Dallas

   f. Landmarks:

      1) Loop 12 Bridge West of Dallas

      2) Hampton Road Bridge in West Dallas

      3) Sylvan Avenue Bridge in West Dallas

   g. Nearby Cities:

      1) This site is located in West Dallas, Texas

   h. Range of Sampling Site:

      1) This site may be sampled anywhere from site #4 CRM 507 upstream to CRM 498 downstream.

2. Reasons for Sampling Site Selection:

   a. Characteristics of Land Use Patterns and Point Source Pollution:

      1) Land use activity in this basin region:
         28% pasture and range
         7% forest
         43% crops
         14% urban
         8% other

      2) Major Point Sources of Pollution in this sampling reach:
         Elm Fork Tributary enters the West Fork at CRM 505.75 with an average 17.7 MGD discharge of effluents.

   b. Velocity Profiles, the United States Geological Survey (USGS) Time-of-Travel studies:

1) The USGS TOT studies in 1972 and 1974 indicated velocity in this reach of 0.61 and 1.13 feet per second, respectively.

c. The area of Site #5 is adjacent to and runs parallel to the proposed Multipurpose Channel.

d. No lock and dam site is to be located in the immediate area.

e. Major tributaries entering the Trinity River in the reach above this sampling site:

1) The Elm Fork and West Fork confluence is located 2.75 TRM upstream of Site #5.

f. Flow from Reservoirs:

1) Garza Little Elm Reservoir

2) Grapevine Lake

3) Mountain Creek Lake

g. Main landmark(s) of interest in vicinity of the sampling site:

1) Hampton Bridge over the West Fork of the Trinity River.

h. Access to sampling site:

1) Access to Site #5 will be from either Hampton Road, Westmoreland Avenue or Sylvan Avenue.

i. Geological Formation in area of sampling site:

1) The formation in this area is mollisols composed of clay, marl and limestone.

3. United States Geological Survey (USGS) Gauging Station:

a. The USGS gauging stations to be utilized for site #5 will be 80495 upstream and 80570 downstream. See Appendix G for locations.

4. Texas Water Quality Board (TWQB) stations in area:

a. The nearest TWQB station to site #5 is 805.04. See Appendix B for location.

5. Meteorological Stations for Sampling Site:

County	Site	Observer
Tarrant	Ft. Worth Federal Building	National Weather Service
Tarrant	Arlington	Charles T. Hawkls
Dallas & Tarrant	Dallas-Ft. Worth Airport	FAA Flight Service Sta.

6. Remarks:

Site #5 was chosen primarily to obtain the affects caused by the major pollution contributed by the Elm Fork tributary. Access to this site is excellent and can be gained from Hampton Road, Westmoreland and/or Sylvan Avenues. In addition, this site is located approximately 10 miles upstream of TWQB Sediment Station 805.03 at CRM 492.

Sampling Site #6

1. Location: Reach (a) Beach St. Bridge in Ft. Worth downstream to the confluence of the East Fork.

   a) Latitude 32°37'

   b) Longitude 96°38'

   c) Corps River Mile (CRM) 478

   d) Channel Mile (CM) 315.5

   e) County Dallas

   f) Landmarks:

      1) Bridge on south Belt Line Road over Trinity River

   g) Nearby Cities:

      1) Site #6 is located approximately 4 miles east of Wilmer and 4 miles west-southwest of Seagoville, Texas.

   h) Range of Sampling Site

      1) This site may be sampled from CRM 478 4 miles upstream and 4 miles downstream

2. Reasons for Sampling Site Selection

   a) Characteristics of landuse patterns and point source pollution

      1) Landuse activity in this basin region

         41% pasture and range
         3% forest
         46% crops
         6% urban
         4% other

      2) Major point sources of pollution in this sampling reach

         a) South Dallas Sewage Treatment Plant averages 7 MGD discharge

         b) Five Mile Creek enters the Trinity River at CRM 486

         c) Prairie Creek enters the Trinity River at CRM 482

   b) Velocity Profiles, the United States Geological Survey Time-of-Travel studies:

1) The USGS TOT studies conducted in 1972 and 1974 indicated velocities in this reach of 0.69 and 0.81 feet per second, respectively.

c) The area of Site #6 is adjacent to the proposed Multipurpose Channel.

d) Lock and Dam site #17 is located at CM 317.8 and CRM 480.5.

e) Major tributaries entering the Trinity River in the Reach above this sampling site

1) Five Mile Creek enters the Trinity River at CRM 486

2) Prairie Creek enters the Trinity River at CRM 482

f) Flow from Reservoirs

1) The flowrate from reservoirs is considered to be a minimal influence in this region due to the distances.

g) Main Landmarks of Interest in vicinity of Sampling Site

1) Bridge on South Beltline Road over the Trinity River at CRM 478

h) Access to sampling site

1) Access to sampling site #6 will be from South Belt Line Road at CRM 478 or Malloy County Road located at CRM 474.

i) Geologic Formations in area of Sampling Site

1) The formation in this area is mixed alluvial soils composed of marl, clay and sand.

3. United States Geological Survey (USGS) Gauging Stations

a) The USGS gauging stations to be utilized for Site #6 will be 8057410 upstream and 80625 downstream. See Appendix G for location.

4. Texas Water Quality Board (TWQB) Stations in area

a) The TWQB nearest to Site #6 is 805.02 located at CRM 474. See Appendix B for information.

5. Meteorological Stations for Sampling Site

County	Site	Observer
Dallas	Dallas FAA Ap	FAA Flight Service Sta.
Dallas	Richardson	City of Richardson

6. Remarks:

Site #6 was selected because it is downstream of major point sources of pollution (South Dallas STP and urban storm runoff from Five Mile and Prairie Creeks) and velocities were low. This site selection should be representative of sediment quality in metropolitan areas and is located approximately 14 miles downstream of TWQB Sediment Station 805.03. Excellent access is provided via South Belt Line Road. Sediment quality in this area is expected to be representative of that to be found at the proposed Lock and Dam site #17 at CRM 480.5.

Sampling Site #7 and Alternate Site #7A

Sampling Site #7

1. Location: Reach (a) Beach St. Bridge in Ft. Worth to confluence of East Fork.

   a) Latitude 32°32'

   b) Longitude 96°32'

   c) Corps River Mile (CRM) 466

   d) Channel Mile (CM) 306.6

   e) County Dallas

   f) Landmarks:

      1) Bridge on Malloy County Road at CRM 474

   g) Nearby Cities:

      1) Site #7 is located approximately 8 miles east of Ferris, Texas and 8 miles northwest of Rosser, Texas.

   h) Range of Sampling Site

      1) Site #7 may be sampled anywhere in the region from CRM 466 upstream 5 miles to 10 Mile Creek and downstream 6 miles to the confluence of the East Fork.

2. Reasons for Sampling Site Selection:

   a) Characteristics of land use patterns and point source pollution

      1) Land use activity in this basin region

         41% pasture and range
         3% forest
         46% crops
         6% urban
         4% other

      2) Major Point Sources of Pollution in this sampling reach

         a) Ten Mile Creek enters the Trinity River at CRM 472

         b) Trinity River Authority Ten Mile Creek Sewage Treatment Plant discharges 6.8 MGD

   b) Velocity Profiles, the United States Geological Survey (USGS), Time-of-Travel (TOT) studies:

1) The USGS TOT studies conducted in 1972 and 1974 indicated velocities in this region of 0.77 and 1.12 feet per second, respectively.

c) The area in the vicinity of Site #7 is intersected by the proposed Multipurpose Channel

d) Lock and dam site #16 is to be located at CRM 466

e) Major tributaries entering the Trinity River in the reach above this sampling site

1) Ten Mile Creek enters the Trinity River at CRM 472

f) Flow from Reservoirs is neglected due to distances from sources.

g) Main landmarks of interest in vicinity of sampling site

1) Bridge on Malloy County Road at CRM 474

h) Access to sampling site

1) Access to site #7 will be made from Malloy County Road or SH34 west of Rosser.

i) Geologic Formations in this area of sampling site

1) The formation at Site #7 is mixed alluvial soils composed of marl, clay and sand.

3. United States Geological Survey (USGS) Gauging Stations

a) The USGS gauging stations to be used for Site #7 will be 8057410 upstream and 80625 downstream. See Appendix G for location.

4. Texas Water Quality Board (TWQB) Stations in area

a) The nearest TWQB station to site #7 is 805.02. See Appendix B for information.

5. Meteorological Stations for Sampling Site

County	Site	Observer
Dallas	Dallas FAA Ap	FAA Flight Service Sta.
Dallas	Richardson	City of Richardson

6. Remarks:

Site #7 is located downstream of major point sources of pollution (TRA Ten Mile STP and urban storm runoff from Ten Mile Creek). In addition, site #7 is approximately 6 miles upstream of the East Fork confluence and is in the vicinity of proposed Lock and Dam site #16. Excellent access to the site is available from Malloy County Road.

Alternate Sampling Site #7A

When in the judgement of the field crew, the river is found to be too hazardous to take the boat to the proposed sampling site #7, the alternate sampling site #7A will be used. The site is located at CRM 452, approximately 14 miles downstream from the proposed site #7. This site is in the vicinity of SH 34 bridge crossing the Trinity River. The land use is predominantly crop and pasture range. The East Fork confluence is upstream from site #7A. This tributary discharges approximately 111 mgd effluent to the Trinity River.

Sampling Site #8 and Alternate Site #8A

Sampling Site #8

1. Location: Reach (b) confluence of East Fork downstream to Highway 31 Bridge near Trinidad, Texas.

   a) Latitude 32°22'

   b) Longitude 96°27'

   c) Corps River Mile (CRM) 442

   d) Channel Mile (CM) 292.6

   e) Counties Ellis and Kaufman

   f) Landmarks:

      1) Bridge on SH34 west of Rosser

      2) Bridge on SH85

   g) Nearby Cities:

      1) Site #8 is located approximately 11 miles east-northeast of Ennis, Texas and 7 miles south of Rosser

   h) Range of Sampling Site

      1) Site #8 may be sampled anywhere in the reach from CRM 456 upstream near Red Oak Creek, downstream to CRM 440 near Village Creek.

2. Reasons for Sampling Site Selections

   a) Characteristics of land use patterns and point source pollution

      1) Land use activity in this basin region

         41% pasture and range
         3% forest
         46% crops
         6% urban
         4% other

      2) Major Point Sources of Pollution in this Sampling reach

         a) The east Fork of the Trinity River having effluents averaging 111 MGD enters the Trinity River at CRM 460

         b) Red Oak Creek enters the Trinity River at CRM 457

b) Velocity Profiles, the United States Geological Survey (USGS) Time-of-Travel (TOT) studies:

1) The USGS TOT studies in 1972 and 1974 indicated velocities in this reach of 0.58 and 0.89 feet per second, respectively.

c) The Trinity River site #8 is intersected by the Multipurpose Channel

d) Lock and dam site #13 is located at CRM 442

e) Major tributaries entering the Trinity River in the reach above this sampling site

1) Red Oak Creek enters the Trinity River at CRM 457

f) Flow from Reservoirs

1) Lake Ray Hubbard Reservoir

g) Main Landmarks of interest in vicinity of sampling site

1) Bridge on SH34 west of Rosser

2) Bridge on SH85

h) Access to Sampling Site

1) Access to Site #8 will be from SH34 or SH85

i) Geological formation in area of sampling site

1) The formation located at Site #8 is mixed alluvial deposits composed of sand and shale

3. United States Geological Survey (USGS) Gauging Stations

a) The USGS gauging stations to be used for site #8 will be 80625 upstream and 80627 downstream. See Appendix G for location.

4. Texas Water Quality Board (TWQB) stations in area

a) The nearest TWQB station to Site #8 is 805.01 at CRM 451.5

5. Meteorological Stations for Sampling Site

County	Site	Observer
Dallas	Dallas FAA Ap	FAA Flight Service Sta.
Ellis	Avalon	Henschel H. Smith
Ellis	Bardwell Dam	Corps of Engineers
Kaufman	Crandall	Mrs. Vallie Sue Sonnells
Kaufman	Rosser	Mrs. Opal L. Taliaferro

6. Remarks:

Site #8 is located downstream of the East Fork and Red Oak Creek tributaries in the vicinit of lock and dam site #13. The velocity in this reach is low and the Sediment Quality in this area is expected to be representative of the metropolitan region of East Dallas County. The land use activity below this site changes from predominately metropolitan to cropland. The next downstream Sediment Quality Station is TWQB 804.06 at CRM 392.

Alternate Site #8A

When in the judgement of the field crew, the river is found to be too hazardous to take the boat to the proposed sampling site #8, the alternate sampling site #8A will be used. This site is located at CRM 432, approximately 10 miles downstream from the proposed site #8. This site is in the vicinity of SH 85 Bridge crossing the Trinity River. The land use is predominantly crop and pasture range.

Sampling Site #9 and Alternate Site #9A

Sampling Site #9

1. Location: Reach (c) Bridge on Highway 31 downstream to the Headwaters of Livingston Reservoir.

   a) Latitude 31°46'

   b) Longitude 95°57'

   c) Corps River Mile (CRM) 343

   d) Channel Mile (CM) 235

   e) Counties Freestone and Anderson

   f) Landmarks:

      1) Coffield State Prison Farm at CRM 342

   g) Nearby Cities

      1) Site #9 is located approximately 19 miles west-northwest of Palestine and 7 miles southwest of Tennessee Colony, Texas

   h) Range of Sampling Site

      1) This site should be sampled within 2 miles either side of CRM 343

2. Reasons for Sampling Site Selection

   a) Characteristics of land use patterns and point source pollution

      1) Land use activity in this basin region
         42% pasture and range
         32% forest
         20% crops
          4% urban
          3% other

      2) Major Point Sources of Pollution in this sampling reach

         a) 100 river miles of land use as described in 2.a)1), above. No major sources of pollution.

   b) Velocity Profiles, the United States Geological Survey (USGS) Time-of Travel (TOT) studies:

      1) The USGS TOT studies in 1972 and 1974 indicated velocities in this reach of 0.70 and 1.01 feet per second, respectively.

c) The area of site #9 is designated as heavy channelization work.

d) Proposed lock and dam sites #10A and 10B are at CRM 343.5 and 342 respectively. Tennessee Colony Dam site is at CRM 343.5

e) Major tributaries entering the Trinity River in the reach above this sampling site

1) Tehuacano Creek enters the Trinity River at CRM 347

2) Richland Walker Creek enters the Trinity River at CRM 373

3) Cedar Creek enters the Trinity River at CRM 385

f) Flow from Reservoirs

1) Cedar Creek Reservoir

g) Main landmarks of interest in vicinity of sampling site

1) Coeffield State Prison Farm at CRM 340

h) Access to sampling site

1) Access to Site #9 will be coordinated through officials at the Coeffield State Prison Farm

i) Geologic formation in area of sampling site

1) The formation at site #9 is mixed alluvial deposits composed of sand, silt and clay

3. United States Geological Survey (USGS) Gauging Stations

a) The USGS gauging stations to be utilized for site #9 will be 80627 upstream and 80650 downstream. See Appendix G for locations.

4. Texas Water Quality Board (TWQB) Stations in area

a) The nearest TWQB station to Site #9 is 804.05. See Appendix B for information.

5. Meteorological Stations for Sampling Site

County	Site	Observer
Freestone	Longlake 5 SW	Noyl Anders
Anderson	Palestine	Mrs. Jimmie Dale Trezise

6. Remarks:

Site #9 was chosen at the Tennessee Colony Lake Dam Site in order to determine Sediment Quality in this area. In addition, proposed lock and dam sites 10A and 10B are nearby. The land use in this area is predominately pasture and range with approximately 20% cropland. Several major tributaries empty into the river above this site and include Tehuacano, Richland Walker and Cedar Creeks. The soil in this region is predominately silt and clay and the velocity is relatively low, therefore sedimentation is expected to be good.

Alternate Sampling Site #9A

When in the judgement of the field crew, the river is found to be too hazardous to take the boat to the proposed sampling site #9, the alternate sampling site #9A will be used. This site is located at CRM 376, approximately 33 miles upstream from the proposed site #9. This site is in the vicinity of SH 287 Bridge crossing the Trinity River. Also this site falls approximately in the middle of the proposed Tennessee Colony Lake. The land use is predominantly pasture, forest and cropland. There are no major point sources of pollution that enter this site.

Sampling Site #10 and Alternate Site #10A

Sampling Site #10

1. Location: Reach (c) from Highway 31 at Trinidad to the Headwaters of Livingston Reservoir.

   a) Latitude 31°35'

   b) Longitude 95°46'

   c) Corps River Mile (CRM) 300

   d) Channel Mile (CM) 216.4

   e) County Leon

   f) Landmarks:

      1) Private road to Glaze Lake 5 miles east of Oakwood, Texas

   g) Nearby Cities:

      1) Site #10 is located approximately 5 miles east of Oakwood and 15 miles east of Oakwood and 15 miles SSW of Palestine, Texas

   h) Range of Sampling Site

      1) Sampling Site #10 may be sampled in a reach extending from CRM 300, upstream 2 miles and downstream 3 miles to CRM 297.

2. Reasons for Sampling Site Selection

   a) Characteristics of land use patterns and point source pollution

      1) Land use activity in this basin region

         42% pasture and range

         32% forest

         20% crops

         4% urban

         3% other

      2) Major Point Sources of Pollution in this sampling reach

         a) There are no major point sources in this sampling reach from site #9 to Site #10. Small STP's and some petroleum refining discharge, only 1.3 MGD.

b) Velocity Profiles, the United States Geological Survey (USGS) Time-of-Travel (TOT) studies:

   1) The USGS TOT studies in 1972 and 1974 indicated velocities in this reach of 0.70 and 0.80 feet per second, respectively.

c) The area chosen for site #10 is Glaze Lake which is located at the base of a large meander of the river.

d) Proposed lock and dam site #9 will pass through Glaze Lake

e) Major tributaries entering the Trinity River in the reach above this sampling site

   1) Catfish Creek enters the Trinity River at CRM 340

   2) Numerous small tributaries enter the Trinity River below Site #9.

f) Flow from Reservoirs was considered to have a minimal effect on this region during low flow conditions.

g) Main landmarks of interest in vicinity of sampling site

   1) Glaze Lake located east of Oakwood, Texas

h) Access to Sampling Site

   1) Access to Site #10 will be along a private road to Glaze Lake from Oakwood, Texas

i) Geologic formation in area of sampling site

   1) The formation at Site #10 is mixed alluvial soils composed of quartz, sand with beds of clay.

3. United States Geological Survey (USGS) Gauging Stations

   a) The USGS gauging stations to be utilized for Site #10 will be 80650 upstream and 806535 downstream, see Appendix G for information.

4. Texas Water Quality Board (TWQB) stations in area

   a) The nearest TWQB station to site #10 is 804.04. See Appendix B for information.

5. Meteorological stations for sampling site

County	Site	Observer
Freestone	Long Lake 5 SW	Noyl Anders
Anderson	Palestine	Mrs. Jimmie Dale Trezise
Leon	Buffalo	Henry M. Harris
Leon	Centerville	Royce Wilson
Leon	Jewell	Mrs. Elna E. Leazar

6. Remarks:

Site #10 was chosen near proposed Lock and Dam site #9. There were no major point sources of pollution upstream and the major upstream tributaries contributed pollution indicative of the land use pattern of 20% cropland and 74% forest and pasture land. The soil in this region is composed mostly of sand and clay; in addition, the velocities in this reach during low flow condition is conducive to good sedimentation.

Alternate Sampling Site #10A

When in the judgement of the field crew, the river is found to be too hazardous to take the boat to the proposed sampling site #10, the alternate sampling site #10A will be used. This site is located at CRM 313, approximately 13 miles upstream from the proposed site #10. This site is in the vicinity of SH 84 Bridge crossing the Trinity River. The land use is predominantly pasture, forest and cropland. There are no major point sources of pollution that enter this site.

Sampling Site #11

1. Location: Reach (c) from Highway 31 at Trinidad to the Headwaters of Livingston Reservoir.

   a) Latitude 31°21'

   b) Longitude 95°40'

   c) Corps River Mile (CRM) 268.5

   d) Channel Mile (CM) 197.5

   e) Counties Leon and Houston

   f) Landmarks

      1) Bridge on SH 7 at CRM 265

   g) Nearby Cities:

      1) Site #11 is located approximately 20 miles east-northeast of Centerville on SH7 and 13 miles west of Crockett, Texas on SH 7.

   h) Range of Sampling Site

      1) Site #11 may be sampled in a reach extending from CRM 268.5 upstream 3 miles to upper Keechi Creek Confluence, downstream 3 miles to SH 7.

2. Reasons for Sampling Site Selection

   a) Characteristics of land use patterns and point source pollution

      1) Land use activity in this basin region

         42% pasture and range
         32% forest
         20% crops
         4% urban
         3% other

      2) Major Point Sources of Pollution in this sampling reach

         a) No major point sources of pollution with the exception of the major tributaries.

   b) Velocity Profiles, the United States Geological Survey (USGS) Time-of-Travel (TOT) studies:

      1) The USGS TOT studies in 1972 and 1974 indicated velocities in

this reach of 0.55 and 0.80 feet per second, respectively.

c) The Trinity River area selected is intersected by the proposed Multipurpose Channel proposed.

d) Lock and dam site #7 will be located at CRM 269.

e) Major tributaries entering the Trinity River in the Reach above the sampling site

1) The upper branch of Keechi Creek enters the Trinity River at CRM 273

2) Little & Big Elkhart Creeks enter the Trinity River at CRM 270

f) Flow from Reservoirs was considered to be negligible

g) Main landmarks of interest in vicinity of sampling site

1) Bridge on SH 7 at CRM 265

2) Intersection of FM 542 and SH 7 4 miles from lock and dam site

h) Access to sampling site

1) Access to site #11 will be from SH 7 at CRM 265

i) Geologic formation in area of sampling site

1) The formation at site #11 is mixed alluvial soils composed of quartz sand with beds of clay.

3. United States Geological Survey (USGS) Gauging Stations

a) The USGS gauging stations to be utilized for site #11 will be 80650 upstream and 8065350 downstream. See Appendix G for locations.

4. Texas Water Quality Board (TWQB) stations in area

a) The nearest TWQB Station to site #11 is 804.03. See Appendix B for information.

5. Meteorological Stations for Sampling Site

County	Site	Observer
Leon	Buffalo	Henry M. Harris
Leon	Centerville	Royce Wilson
Leon	Jewell	Mrs. Elna E. Leazar
Houston	Crockett	James H. Gibbs
Houston	Lovelady	Lester Jones

6. Remarks:

Site #11 was selected near Lock and Dam site #7 and is downstream of two major tributaries, Upper Keechi Creek, and Little and Big Elk Creeks. The velocities in this region are low and good sedimentation conditions should exist during low flow conditions. The land use in this area should reflect the 20% cropland with extensive use of herbicides and pesticides.

Sampling Site #12 and Alternate Site #12A

Sampling Site #12

1. Location: Reach (c) from Highway 31 at Trinidad to the Headwaters of Livingston Reservoir.

   a) Latitude 30°55'

   b) Longitude 95°33'

   c) Corps River Mile (CRM) 200

   d) Channel Mile (CM) 147.9

   e) County Walker

   f) Landmarks:

      1) Confluence of Nelson Creek and Trinity River at CRM 199

      2) Bridge on SH 19 over Trinity River at CRM 184

   g) Nearby Cities

      1) Site #12 is located approximately 14 miles north of Huntsville, Texas

   h) Range of Sampling Site

      1) Site #12 should be sampled in a reach extending from CRM 200 upstream no farther than Bedias Creek and downstream to Nelson Creek.

2. Reasons for Sampling Site Selection

   a) Characteristics of land use pattern and point source pollution

      1) Land use activity in this basin region

         20% pasture and range
         70% forest
         4% crops
         3% urban
         3% other

      2) Major point sources of pollution in this sampling reach

         a) Minor sources of pollution from sewage treatment plants average 2.1 MGD discharge.

b) Velocity Profiles, the United States Geological Survey (USGS) Time-of-Travel studies:

   1) Velocity profile studies were not performed in this region.

c) The area selected for Site #12 is a section of the proposed Multi-purpose Channel

d) Proposed lock and dam site #6 is located at CRM 200

e) Major tributaries entering the Trinity River in the reach above this sampling site

   1) Bedias Creek enters the Trinity River at CRM 208

   2) Big and Lost Creeks enter the Trinity River at CRM 226

   3) Wright Creek enters the Trinity River at CRM 200.5

f) Flow from Reservoirs was considered to play a negligible role.

g) Main landmarks of interest in vicinity of sampling site

   1) Confluence of Bedias Creek and Trinity River at CRM 200

h) Access to sampling site

   1) access to site #12 will be along FM 247 to FM 980, thence to Mt. Olive thence to Bedias Creek and thence to the Trinity River.

i) Geologic Formations in area of sampling site

   1) Formation in area of sampling site #12 is mixed alluvial soils composed of fine sands.

3. United States Geological Survey (USGS) Gauging Stations

   a) The USGS gauging stations to be utilized for site #12 will be 8065350. See Appendix G for location.

4. Texas Water Quality Board TWQB) Stations in area

   a) The nearest TWQB station to site #12 is 804.02. See Appendix B for information.

5. Meteorological Stations for sampling site

County	Site	Observer
Houston	Crockett	James H. Gibbs
Houston	Lovelady	Lester Jones
Madison	Madisonville	Ross Madole

6. Remarks:

Site #12 was selected near Lock and Dam Site #6 and the Headwaters of Lake Livingston. Major point sources of pollution upstream of this site will result from: Bedias, Big, Lost and Wright Creeks. The predominate land use in this region is Forest.

Alternate Sampling Site #12A

When in the judgement of the field crew, the river is found to be too hazardous to take the boat to the proposed sampling site #12, the alternate sampling site #12A will be used. This site is located at CRM 182, approximately 18 miles downstream from the proposed site #12. This site is in the vicinity of SH 19 Bridge crossing the Trinity River. The land use is predominantly pasture, forest and cropland. There are no major point sources of pollution entering this site.

Sampling Site #13

1. Location: Reach (d) Livingston Reservoir dam to mouth of Trinity River.

   a) Latitude 30°35'

   b) Longitude 95°01'

   c) Corps River Mile (CRM) 121

   d) Channel Mile (CM) 95

   e) Counties San Jacinto and Polk

   f) Landmarks

      1) Lake Livingston dam at DRM 129

      2) Bridge on US 59 at CRM 117

   g) Nearby Cities

      1) Site #13 is located approximately 7 miles east of Coldspring, Texas and 5 miles north of Shepherd, Texas.

   h) Range of Sampling Site

      1) Site #13 should be sampled in a reach from Livingston Dam downstream to US 59 at CRM 117

2. Reasons for Sampling Site Selection

   a) Characteristics of land use patterns and point source pollution

      1) Land use activity in this basin region

         24% pasture and range
         74% forest
         1% crops
         0.5% urban
         0.5% other

      2) Major point sources of pollution in this sampling reach

         none

   b) Velocity Profiles, the United States Geological Survey (USGS) Time-of-Travel studies:

      1) The USGS TOT study in 1972 indicated velocity in this reach of 0.85 feet per second.

c) The Trinity River area of Site #13 is intersected by the proposed Multipurpose Channel

d) Proposed lock and dam site #5A and 5B are located upstream 2 miles.

e) Major tributaries entering the Trinity River in the reach above the sampling site

   1) None

f) Flow from Reservoirs

   1) Livingston Reservoir

g) Main Landmarks of interest in vicinity of sampling site

   1) Lake Livingston Dam at CRM 129

   2) Bridge on US 59 at CRM 117

h) Access to sampling site

   1) Access to site #13 will be via FM222 to Spring Ridge north of Shepherd, Texas

i) Geologic formation in area of sampling site

   1) The formation at site #13 is mixed alluvial soils composed of clay, silt and sand.

3. The United States Geological Survey (USGS) Gauging Stations

   a) The USGS gauging station to be utilized for site #13 will be 806625. See Appendix G for location.

4. Texas Water Quality Board (TWQB) Stations in area

   a) The nearest TWQB station to site #13 is 802.02. See Appendix B for information.

5. Meteorological stations for sampling site

County	Site	Observer
San Jacinto	Coldspring 5 SSW	Leroy S. Dibney

6. Remarks:

Site #13 was chosen at Lock and Dam site #5A and 5B. The sediments in the river below this area are sampled at TWQB stations 802.01 and 801.01. This site, located downstream from Livingston Dam site, should reflect the water quality from Livingston Reservoir discharges.

SAMPLING AND DATA COLLECTION

Bottom Sediments from Main Channel

Number of Samples

The bottom sediments to be taken from the Trinity River for replicate analyses must be carefully considered because of the extremely heterogeneous nature of samples and comparatively low background concentrations of some constituents in the samples. The U. S. Army recommends* that the sediments be collected from at least three sites within the area under consideration. At a river section, lower velicities are normally expected nearer the banks. It is, therefore, desirable to collect the sediment samples at three locations along the river width. For composit samples, three grab samples at one-quarter, midwidth and three-quarter width from the river bank should be taken and pooled. The composit samples resulting by pooling these grab samples will be considered representative of sediment quality at a river section. All field sampling equipment and containers will be rinsed with sample water prior to collecting samples.

Sampling Equipment

The sediment samples will be taken with a grab sampler. A standard 9" x 9" square Wildco-Eckman Dredge or Ponar Grab Dredge** will be used to collect the samples from all selected locations.

Procedure

In deep water, the sediment sampling will be done from a boat***. The boat will be anchored and the sampler will be lowered from the front end of the boat. The sampler will be lowered slowly in order to cause the least

*Environmental Effects Laboratory, U.S. Army Engineers Waterways Experiment Station, "Ecological Evaluation of Proposed Discharge of Dredged or Fill Material into Navigable Waters", Miscellaneous Papers D-76-17, May, 1976, page C-2.

**"Wildco Instruments and Aquatic Sampling Supplies", Catalog No. 74A, 1974, pp. 9A and 11.

***If river conditions are not favorable to place a boat into the water, the sampling will be done from the nearest bridge.

possible disturbance to the water-sediment interface. In shallow depths when the required boat draft is too large, the sampling will be done by wading. Wading and lowering of the sampler will be done carefully so as not to disturb the sediments. Three grab samples collected from the river bottom will be pooled into a container and thoroughly mixed. At this time, tests will be performed to include: Sediment temperature, pH, Eh, and DO. Two one-gallon glass sample bottles will be carefully filled with the mixed sediment sample in a manner to exclude air bubbles being trapped in the container. The containers will then be stored immediately in an ice box at 2° to 4°C. Different equipment that will be used for sediment sampling, field measurement and sample storage are listed in Appendix I.

Soil Samples from the River Banks

Two soil samples, one from each bank of the Trinity River, will be obtained at each sampling site. These samples will be collected approximately 200 feet inland measured from the edges of the main channel. An auger sample of approximately 12" deep will be removed and sealed in a plastic bag. These auger samples will be stored in a deep freezer for future use. No tests will be performed on these soil samples as part of this program, however, necessary chemical and biological tests will be conducted as need may arise in future programs.

In case the 200 feet inland point lies on private property and indications are that the sampling may be difficult, auger sampling will be done at the nearest bridge easement.

Water Samples

Water samples will be collected from each location in the main channel soon after collecting the bottom sediments. Standard Alpha Stype-Vertical PVC bottles (see Appendix I for specification) will be used. The bottles will be lowered from the boat or from the bridge, to approximately one meter above the stream bed and sample bottles filled.* DO, pH, Eh and temperature records will be taken at the site. Three grab samples will be pooled in a container and mixed to obtain composit samples. Five one-gallon glass bottles will be filled in a manner to exclude air bubbles. These bottles will be placed in an ice box at 2° to 4°C.

Mid-Stream Velocity Measurement

The requirement for a representative mid-stream velocity data point will be accomplished as follows:

If the stream is sufficiently shallow for wading, the representative velocity measurement will be made with a Teledyne-Gurley Price type current meter on a cable or wading rod for depths of flow greater than 1/2 foot. For depts less than 1/2 foot, the Pigmy Price type current meter on a wading rod will be used. The meter will be placed upstream at arm's length and at 45° from the observer to avoid velocity interference caused by the observer.

Where the depths are too large for wading, measurements will be taken from a boat on the aft section, anchored such that the calbes are at least 40° with the axis of the boat and observations will be made at arm's length upstream of the boat. A Teledyne-Curley Price type current meter suspended by cable with a 15 lb. weight or greater, as needed, will be used for measurement.

The velocity will be obtained from a rating table, for each instrument, giving the velocity as a function of the number of electric contacts in a sixty second period.

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*For shallow depths, the water sampling will be done by wading. Alpha-Style bottles will be lowered by hand to a point just above the bottom sediments and samples taken.

Velocity measurements will be made according to the following table:

Meter Type	Water Depth	Meter Position & Comment
Standard Price type	>0.5 ft. >3.0 ft. <0.5 ft.	0.6 depth from surface 0.8 depth and 0.2 depth, velocity will be averaged 0.5 depth from surface
Pigmy	>0.35 ft. <0.35 ft	0.6 the depth from surface 0.5 the depth from surface

Where the observers deem the mid-stream velocity unrepresentative of the stream as a whole, a location more representative of the mean velocity will be selected. If water and sediment sampling is done from a bridge, the river velocity will also be measured from the bridge at midstream section.

River Stage Data

The stage data will be collected from the nearest U. S. Geological Survey recording station. Table 2 lists the U.S.G.S. Recording Stations from where stage data will be obtained for each sampling station. Based upon the river stage, the flow and velocity at the gauging station at the time of the sampling will be determined.

Meteorological Data

Precipitation information will be collected from the U. S. Weather Bureau stations and climatological data stations for a period of six days preceeding the date of sampling. Other meteorological data collected at the time of the sampling will include:

Cloud Cover

Temperature - Maximum, Minimum and Average

Humidity - Maximum, Minimum and Average

The weather stations to be contacted for each sampling station are indicated in Table 2.

Physical Condition of the River

At the time of sampling, several visual data will be recorded. These data will include:

Appearance in bulk (overall appearance)
Color
Turbidity
Floating material
Current conditions
Vegetation growth
Suspended solids
Scour along banks
Sedimentation along the banks

These data will be recorded for each sampling station at the time of sampling.

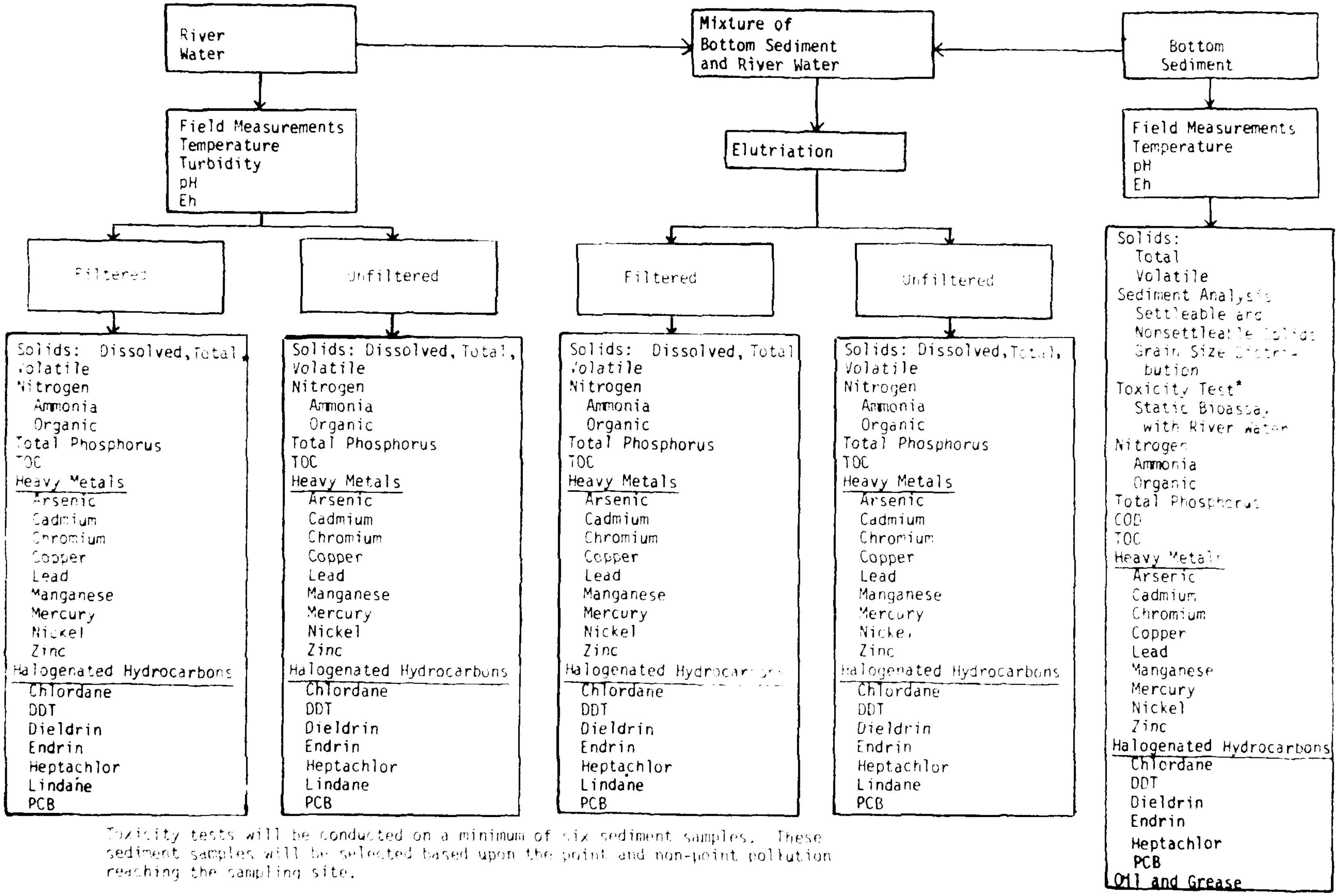
Photographic Evidence

Black and white polaroid or color photographs will be taken to record the stream condition, landmarks, vegetation, sampling procedures, etc. If necessary, thirty-five mm slides and 8 mm color movies will be taken to record as many details as possible for the sampling stations, river conditions and sampling procedures.

LABORATORY PROCEDURES

A summary of laboratory procedures to be utilized to determine the quality of the filtered and unfiltered river water, filtered and unfiltered elutriate and bottom sediments, are given in this section of the report. The detailed procedures are presented in Appendices J, K. L, M and N.

Figure 2 summarizes the various tests that will be conducted on river water, bottom sediments and elutriates.



*Toxicity tests will be conducted on a minimum of six sediment samples. These sediment samples will be selected based upon the point and non-point pollution reaching the sampling site.

FIGURE 2: LABORATORY TESTS CONDUCTED ON RIVER WATER AND SEDIMENTS

Quality Control

Quality control and documentation of analytical results will be incorporated into the reconnaissance study. The EPA manual, Handbook for Analytical Quality Control in Water and Wastewater Laboratories, will be used as the reference for the quality control program. The following specific procedures will be incorporated at the beginning of the survey where appropriate.

a. Precision -- Data shall not be collected until the analyst is familiar with the method and has obtained reproducible results. Duplicate analyses shall be run at least ten percent of the time.

b. Accuracy -- Known amounts of a particular constituent will be added to actual concentrations where the precision of the method is satisfactory. Accuracy will be reported as the percent recovery at the final concentration of the spiked sample. The percent recovery should be calculated as described in Standard Methods for Examination of Water and Wastewater (APHA). Spiked samples will be run at least ten percent of the time.

c. Quality Control Charts -- Control charts will be utilized for permanently recording precision and accuracy data. These control charts will serve as an indicator to the analyst if his laboratory procedures are in or out of control. If the charts indicate that a system is out of control, the analyst shall take the necessary corrective actions. The construction and use of the quality control charts will be made in accordance with those methods cited in the EPA manual Handbook for Analytical Quality Control in Water and Wastewater Laboratories.

d. Spot Checks -- In addition to the use of duplicate samples, spiked samples, and quality control charts, spot checks should be made to validate standard curves utilizing at least two standards (a high and a low) and a blank. Resulting data should agree favorably with known validation of reagent concentrations, preventive maintenance and utilization of internal quality control check samples should also be performed as dictated by good laboratory practice.

Elutriate Test for Determining Leachate Constituents in Bottom Sediments

Significance

The purpose of the elutriate test is to simulate the affects of hydraulic dredging conditions on resolubilization of many accumulated constituents from bottom sediments into the receiving water. The constituents that go into resolution include: (1) soluble and partly soluble constituents in sediments, (2) readily soluble fractions of the solid phase, and (3) the constituents loosely adsorbed on solid phases of the sediment.

The Elutriate Test is conducted by combining one volume of bottom sediments with four volumes of water. The mixture is agitated vigorously for 30 minutes and allowed to settle for one hour. The supernatant is decanted. Unfiltered, and centrifuged and filtered samples are used for testing. The increase in constituents over filtered and unfiltered river water are an indication of resolution and resuspension of chemicals from sediment into the elutriated water.

Three types of elutriate tests will be performed. The individual type will be based upon the dominant condition that exists at the sampling site.

1. If it is expected that anoxic condition (zero dissolved oxygen) will not occur at the dredging site, the elutriate test will be performed under aerobic condition and bottom sediments will be elutriated with river water sample taken from the same site.

2. If zero dissolved oxygen is expected at the dredging site, the elutriate test will be performed under anaerobic condition and bottom sediments will be elutriated with river water sample taken from the same site. This will be done in a nitrogen atmosphere as discussed later.

Procedure*

A. Elutriate Test with Receiving Water Under Aerobic Condition

1. The sediment and water samples will be stored at $4^{o}C$ soon after collection, and elutriate test will be performed as soon as possible.

2. Filter an appropriate portion of the receiving water through a 0.45 micron membrane filter. If necessary, centrifuge the river water prior to filtration.

3. Store the filtrate at $4^{o}C$ until analyzed for the constituents listed in Figure 2.

4. Before the elutriate test is performed place the river water and bottom sediment containers (step 1) at room temperature ($22^{o} \pm 2^{o}C$) and allow sufficient time for the contents to reach equilibrium temperature.

5. Place 100 ml of well-mixed unfiltered river water into a 1 liter glass graduated cylinder.

6. Carefully add 200 ml well-mixed bottom sediment sample into the cylinder.

7. Fill the cylinder to the 1000 ml mark with well mixed river water.

8. The mixture should contain 1 part bottom sediment and 4 parts river water at this point.

9. Transfer the contents into a 2 liter Erlenmeyer flask. Cap tightly with rubber stopper wrapped in Teflon sheet. (See Appendix I.)

10. Bubble compressed air through the flask contents and begin shaking.

11. Shake vigorously on an automatic shaker at about 100 excursions per minute for 30 minutes (See Appendix I for shaker specification).

12. After shaking, allow the suspension to settle for one hour.

13. After settling, decant supernatant carefully. Use supernatant for desired tests. Centrifuge and filter the supernatant with a 0.45 micron filter assembly to give a clear final solution. This solution is the standard elutriate, and also used for further testing.

14. Store in a glass container until the desired tests given in Figure 2 are performed.

15. If it appears that the total volume required for all measurements is greater than one liter, use proportionately larger volumes of bottom sediments and river water. Alternatively, elutriate solution preparation (steps 5 - 14) may be performed several times and the standard elutriate solutions combined.

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*Apparatus and equipment details are given in Appendix I.

B. Elutriate Test with Receiving Water under Anaerobic Condition

The procedure steps 1 through 9 are identical to A. Displace air in the Erlenmeyer Flask by passing nitrogen gas into the flask. This can be achieved by providing two tubes into the stopper, one tube connected to the nitrogen source and the other exhausted to atmosphere. After displacing the air, both tubes are clamped to exclude air entry. Proceed with steps 11 through 14 as in A.

Solids Determination

Significance

Waters containing dissolved solids are generally inferior with respect to palatability, as they may induce an unfavorable taste. Highly mineralized waters are also unsuitable for many industrial applications. For these reasons, a dissolved solids content of less than 500 mg/l is desirable for drinking waters.

Natural inland waters usually contain relatively small quantities of mineral salts in solution, but in waters polluted by brines and various wastes, salt concentrations may rise to levels harmful to living organisms because of a change in osmotic pressure. During dredging operations, the salt concentration may increase due to mixing action. Elutriate tests will indicate the increase in salt content that may occur when bottom sediments are disturbed during dredging operations.

Dissolved and Total (Suspended and Dissolved) Residue in River Water and In Elutriate

To determine the dissolved and total solids content, well mixed aliquots of filtered river water and unfiltered river water or the elutriate are evaporated in a steam bath. The evaporating dish is dried at 103°C. From the weight of residue, total dissolved solids, and total dissolved and suspended solids are determined. (See Appendix J for detailed procedure.)

Volatile Residue in River Water and in Elutriate

The dishes from the above tests are ignited at 550°C for 15 minutes in a muffle furnace. The loss of weight on ignition is reported as mg/l volatile residue. (See Appendix J for detailed procedure). The volatile matter is not distinquished precisely as organic.

Total and Volatile Solids in Bottom Sediments

Total and volatile solids in bottom sediments are determined by drying a known weight of bottom sediment in an oven at 103°C. The increase in weight over that of the empty dish represents the total solids. The volatile solids is determined by igniting the total solids in a muffle furnace for 1 hour at 600°C. The loss of weight represents the volatile solids.

The total solids in bottom sediment is an important test as most of the determinations in mg/kg are represented by using the total solids in the sediment. The screening level concentration of volatile solids in bottom sediments is 80,000 mg/kg. Each sample is well mixed before solids determinations are made. A detailed procedure is given in Appendix J.

Nitrogen

Significance

Nitrogen is an essential constituent of protein in all living organisms. It undergoes changes of decomposition from complex proteins through amino acids to ammonia, nitrite, and nitrates. In natural and polluted waters and bottom sediments, nitrogen may be present in many forms. For aquatic life, the total concentration of nitrogen is not as important as the form in which it exists. Organic nitrogen, amino acids, and ammonia may inhibit biological growth whereas nitrates stimulate phytoplankton.

The bottom sediments in polluted streams are normally rich in nitrogen. Mixing of sediments during dredging operations releases nitrogen into overlying waters. Of the forms of nitrogen released, ammonia and organic nitrogen are of greatest significance. Organic nitrogen generally remains in particulate forms in sediments and is not expected to remain in solution. However, ammonia present in both dissolved and sorbed states, is released to the water during dredging. The screening levels of total Kjeldahl nitrogen in bottom sediment is 1,000 mg/kg. The total organic nitrogen (TON) is used in determining the organic sludge index (OSI) as recommended for Region VI.

Ammonia Nitrogen in Water and Elutriate (Distillation- Nesslerization)

The ammonia nitrogen in water and elutriate is determined by distilling a known volume of buffered sample at a pH of 7.5. The distillate collected in a solution of boric acid and the ammonia content is determined by titration, or colorimetrically by nesslerization. See Appendix J.

Total Kjeldahl Nitrogen in Water and in Elutriate

An aliquot of water or elutriate is digested in 800 ml Kjeldahl flask with potassium sulfate, sulfuric acid and trace mercuric oxide as digestion reagent. The digested solution is distilled in presence of hydroxide-thiosulfate reagent. The distillate is collected into a boric acid solution. Kjeldahl nitrogen in the distillate is determined colorimetrically by Nesslerization.

The procedure is discussed in Appendix J.

Ammonia Nitrogen in Bottom Sediment

Free ammonia nitrogen is recovered from a known volume of bottom sediment by distillation at pH 7.4. Since bottom sediments exhibit varying pH values and buffering properties, a phosphate buffer is applied to maintain the required pH during the distillation process. The free ammonia distillate is collected in boric acid solution to minimize ammonia losses. The ammonia in the distillate is determined by titration, or colorimetrically by Nesslerization.

The procedure is discussed in Appendix J.

Total Kjeldahl Nitrogen in Bottom Sediment

A sample of bottom sediment is digested with sulfuric acid to which potassium and mercuric sulfates have been added. These additives raise the boiling point of the solution and provide a catalyst action. After digestion, the solution is diluted and distilled under alkaline conditions produced by adding sodium hydroxide. The distillate is collected into a boric acid solution. The ammonia nitrogen in the distillate is determined by titration, or colorimetrically by Nesslerization.

Phosphorus

Significance

Phosphorus does not occur in the free state in nature but is found as phosphates and in other organic forms. In these forms it exists in solution, in particles of detritus, or in aquatic organisms. Phosphorous is a constituent of fertile soils, plants, protoplasm, nervous tissue and bones of animals. It is an essential nutrient for plant and animal growth and, like nitrogen, phosphorus passes through processes of decomposition and photosynthesis

Phosphorus is present in bottom sediments of natural waters in a variety of inorganic and organic forms.

Total Phosphorus in Water and in Elutriate

A sample of water or standard elutriate is digested on a hot plate with sulfuric acid and potassium persulfate. After digestion, the sample is diluted and neutralized with the addition of sodium hydroxide. Concentration of total phosphorus is determined colorimetrically by the Ascorbic Acid Method.

The procedure is discussed in Appendix J.

Total Phosphorus in Bottom Sediments

A sample of well-blended bottom sediment is digested with magnesium nitrate in the presence of hydrogen peroxide. The digested sample is then extracted with concentrated hydrochloric acid and diluted before filtering through a membrane filter. The filtrate is then treated with perchloric acid and sodium sulfite. Concentration of total phosphorus is determined colorimetrically by Ascorbic Acid Method.

The procedure is duscussed in Appendix J.

Chemical Oxygen Demand (COD)

Significance

The chemical oxygen demand (COD) determination provides a measure of the oxygen equivalent to that portion of the organic matter in a sample that is susceptible to oxidation by a strong chemical oxidant. The COD test is used to represent the content of organic matter in natural waters, sewage and industrial wastes. For many types of wastes, it is possible to correlate COD with BOD and total organic carbon. This correlation is very useful because COD can be determined in 3 hours, compared with 5 days required for BOD.

In natural waters organic matter is precipitated to the bottom by sedimentation and bioflocculation. Therefore, the bottom sediments normally contain detritus which exert insoluble COD. Microorganisms continue to convert insoluble COD into soluble form and therefore during dredging operations certain parts of dissolved or loosely adsorbed COD may go back into solution. The screening level of COD in bottom sediment recommended for Region VI is 50,000 mg/kg.

COD in Water and Elutriate

The organic substances in a water sample are oxidized by potassium dichromate in the presence of sulfuric acid, silver sulfate and mercuric sulfate. The solution is refluxed for 2 hours. The excess dichromate is titrated with ferrous ammonium sulfate. The amount of oxidizable organic matter, measured as oxygen equivalent, is proportional to the potassium di-chromate consumed.

The procedure is discussed in Appendix J.

COD in Bottom Sediments

The procedure for COD in bottom sediments is the same as that given for water and elutriate with the exception that a smaller amount of bottom sediments must be used.

The procedure is discussed in Appendix J.

Total Organic Carbon

Significance

Total organic carbon provides a measure of the organic matter present in water and bottom sediments. When an empirical relationship can be established between the total organic carbon, the BOD, the COD the total organic carbon provides a speedy and convenient way of estimating the parameters that express the degree of organic contamination.

Natural streams that receive organic pollution normally show high amounts of organic carbon in bottom sediments. The organic matter introduced into bottom sediments by pollution eventually decomposes causing odors and depleting oxygen in the river water. Often, the settled solids are lifted to the surface causing unsightly conditions.

During dredging operations, if bottom sediments containing high amounts of organic carbon are distrubed, the dissolved oxygen level in the river water will drop creating unpleasant taste, odors, and general septic conditions. Under these conditions, fish and most aquatic life dependent on adequate levels of oxygen may soon cease to exist.

Total Organic Carbon in Water and Bottom Sediments

Organic carbon in a sample is converted to carbon dioxide (CO_2) by catalytic combustion or wet chemical oxidation. The CO_2 formed is measured by an infrared detector, or converted to methane (CH_4) and measured by a flame ionization detector. The amount of CO_2 or CH_4 is directly proportional to the concentration of carbonaceous material in the sample. Certain resistant organic compounds may not be oxidized however and the measured TOC value will be slightly less than the actual amount present in the sample. Detailed procedure for TOC determination is given in Appendix J.

Sediment Analysis

Sediment analysis will be conducted to determine the settling and dispersion characteristics of the bottom sediments. The analysis will include:

1. Settleable and non-settleable solids, and
2. Grain - size distribution

Settleable and Non-Settleable Solids

The non-settleable solids in the sediment samples are determined by transferring a well-mixed bottom sediment and river water in proportion of 1:4 by weight into a graduated cylinder and allowing settlement to occur overnight. The volume of supernatant and the volume of settled solids are recorded. The supernatant is decanted.

Known weight of supernatant is centrifuged, and filtered through pre-dried and weighed Gooch crucible. After filtration, the crucible is dried at $103^{o}C$ for 1 hour and the increase in weight is determined. The suspended solids are determined as mg/kg. If settleable solids content is desired, it is taken as the difference between total solids and nonsettleable solids.

The nonsettleable portion of the bottom sediment will indicate that part of the bottom sediment that will not settle and consequently will be carried long distances downstream of the dredging site. The settleable portion will give that portion of the bottom sediments that will settle within a reasonable distance from the dredged site.

Grain - Size Distribution

Wet sediment samples will be tested for determination of the particle size distribution using standard soil mechanics laboratory procedures. After the samples are drained of excess waters, the sample is wet sieved through a 0.074 mm mesh screen. From that portion passing the sieve, a representative sample containing approximately 50 grams of dry solids will be taken for hydrometer testing.

Each sample of fines will be treated with 10 sodium hexa-metaphosphate and dispersed in a clean graduated cylinder with distilled demineralized water and the volume will be made up to 1000 cc. This suspension will be mixed by repeated inversions, after which the cylinder will be placed in a constant temperature water bath. At appropriate times, hydrometer readings will be taken to determine solids in suspension at recorded levels below the original suspension surface. Using the data of corresponding readings of the hydrometer in a control cylinder, and a Casagrande nomograph, points will be developed to plot the samples' grain-size distribution curves. Detailed procedure is given in Appendix J.

Static Bioassay Tests with Elutriate for Acute Toxicity

Significance

Bioassays are conducted to evaluate the affects on aquatic organisms of toxicity produced by the elutriation of sediments. Acute toxicity tests with *Daphnia magna* with 96 hours of exposure will be accomplished. The static bioassay technique provides the measure of toxicity and it is often the only practical means of estimating the harmful effects upon the aquatic life that may result from the effluent discharge or due to dredging operation. The static bioassay tests will be conducted on 6 percent and 20 percent elutriates.

Procedure

The river water and the bottom sediments are elutriated. The sediment to water volume ratios that will be used are 6% and 20%. The mixtures are aerated for 30 minutes at 5 psi while simultaneously shaken into an automatic shaker. The aerated mixtures are settled for one hour and the supernatants are carefully obtained for the bioassay test. Bioassay Tests will be conducted on both filtered and unfiltered elutriates, using respectively the filtered and unfiltered river waters as controls. If turbidity in unfiltered elutriate is high enough that the test organism could not be observed clearly, the elutriate will be centrifuged to clarify the elutriate to a point at which the organism can be observed.

Two 200 ml aliquots of each prepared elutriate sample are placed in two separate 250 ml beakers. A desired number of young Daphnia magna are added to each test beaker. The organisms must be selected at random from a culture previously developed for at least two weeks on autoclaved and reaerated river water from the same site. The mortality data of Daphnia magna is recorded after two hours and every 12 hours of exposure throughout the 96-hour test period. Tests are run on a 14-hour light and 10-hour dark regime. At least two replicates must be run simultaneously for each elutriate test, including the controls. The lethal concentration (96 hr. LC50) can be interpolated or extrapolated from a plot of this data. The procedure is discussed in Appendix J.

Trace Metals in Water and Bottom Sediment

All forms of the ecological system are effected by metals to varying extents. Metals are the most insidious pollutants because of their non-biodegradable nature. Only a few metals are completely nontoxic at any level.

Even these metals could be harmful if they unbalance or displace the essential levels in the eco-system. Some heavy metals are of concern due to the concentration effect in the food chain.

The study will involve the determination of the total concentration (acid solution) of selected metals. A brief presentation of the significance of each substance, the current EPA standards for both water and sediment, is given. Appendix K contains the specific laboratory procedure for the sample preparation on bottom sediment. Appendix L contains the detailed procedure as recommended by EPA for each substance to be determined.

Significance, Standards and Procedure

Arsenic, As: Has no known requirements in the body; is an accumulative poison which causes dermatitis, bronchitis, and is carcinogenic.

Standards - Arsenic - Water

EPA (1973b)	Drinking water max. = 0.1 mg/l
EPA (1975)	Drinking water max. = 0.05 mg/l

Standards - Arsenic - Sediment

EPA (1973a)	Max. = 5.0 mg/kg

Toxicity to humans is the main reason for the standards on arsenic. Arsenic can accumulate in the body faster than it is excreted, and thus it can gradually increase to toxic levels.

Arsenic will be determined by standard atomic absorption techniques. Appendix L gives the detailed procedure.

Cadmium, Cd: Is toxic to man, depresses growth and reduces protein and fat digestion; causes hypertension and cardio-vascular problems; accumulates in the kidney and liver.

Standards for Cadmium in Water

EPA (1972, 1973b, 1975)	Drinking water max. = 0.01 mg/l

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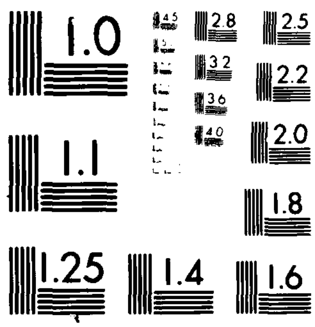


MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS 1963-A

Standards for Cadmium in Sediment

EPA (1973a)	Max. = 2.0 mg/kg.

The low limits are largely precautionary, since cadmium is not removed from water by conventional treatment. In concentrations much greater than 0.01 mg/l, cadmium may be very toxic to humans, causing vomiting, increased salivation, choking, diarrhea, and abdominal pain.

Cadmium will be determined by standard atomic absorption techniques (See Appendix L for detailed procedure).

Chromium, Cr: Is an essential metal for normal metabolism of glucose; Cr (VI) is more toxic that Cr (III); combines γ-globulins; causes hyperemia, emphysema and cancer of the respiratory track.

Standards for Chromium in Water

EPA (1973b, 1975)	Drinking water max. = 0.05 mg/l (Total Chromium)

Standards for Chromium in Sediment

EPA (1973a)	Max. = 100 mg/kg

Chromium, particularly hexavalent chromium, is chronically toxic to aquatic life. Toxicity of chromium varies widely with species, temperature, pH, and valence of the chromium.

Chromium will be determined by standard atomic absorption as total chromium. (see Appendix L for detailed procedures.)

Copper, Cu: Is essential in trace amounds; in large concentrations may cause liver damage and hemolysis.

Standards for Copper in Water

EPA (1973b)	Drinking water max. = 1.0 mg/l

Standards for Copper in Sediment

EPA (1973a)	Max. = 50 mg/kg

The drinking water maximum is based upon taste objections, rather than on hazard to health. Copper is essential for human metabolism, and small amounts may be beneficial. In concentrations greater than 1 mg/l, however, copper may cause taste and corrosion problems.

Copper will be determined by standard atomic absorption procedures. (See Appendix L for detailed procedure.)

Lead, Pb: Is toxic; will accumulate in bone and soft tissue, particularly in the brain resulting in reduced functioning; has been linked to increased dental cavities.

Standards for Lead in Water

EPA (1973b)	Water max. = 0.03 mg/l
EPA (1973b, 1975)	Drinking water max. = 0.05 mg/l

Standards for Lead in Sediment

EPA (1973a)	Max. = 50 mg/kg

The reason for the limit of 0.03 mg/l is due to the chronic toxicity of lead to aquatic life. Toxicity varies directly with solubility which varies directly with the hardness of the water.

Lead will be determined by standard atomic absorption techniques. (See Appendix L for detailed procedures.)

Manganese, Mn: Affects the central nervous system causing cramps, tremors and hallucinations; poisoning is clearly characterized disease from inhalation of fumes or dust.

Standards for Manganese in Water

EPA (1973b)	Drinking water max. = 0.05 mg/l

Manganese concentrations should be limited to prevent aesthetic and economic damage (taste and staining) as well as possible physiological effects to humans. Also, soluble manganese is not removed by conventional treatment. Manganese oxide, MnO, (and sulfate ion) should be controlled when the water contains iron in the hypolimnion to prevent the release of phosphorus (EPA, 1973b)

Manganese will be determined by standard atomic absorption techniques. (See Appendix L for detailed procedures.)

Mercury, Hg: Is toxic, Hg(I) salts oxidixed in body to highly toxic Hg(II); inhibits chlorinesterase activity and damages central nervous system.

Standards for Mercury in Water

EPA (1973b)	Max. = 0.0002 mg/l
EPA (1973b)	Max. Average = 0.00005 mg/l
EPA (1973b, 1975)	Drinking water max. = 0.002 mg/l

Standards for Mercury in Sediment

EPA (1973a)	Max. = 1.0 mg/kg

Mercury is extremely toxic to humans and other animals. Also, conventional treatment does not remove mercury (EPA, 1973b). These two factors together account for the low levels set as standards. Also, organic forms of mercury, particularly methyl mercury, are much more toxic than inorganic forms.

Mercury will be determined by standard cold vapor atomic absorption techniques. See Appendix L for detailed procedures.

Nickel, Ni: Is an essential metal; is involved in enzyme activity and hormonal action; may cause dermatitis, respiratory disorders and cancer.

No standards encountered for nickel in water.

Standards for Nickel in Sediment

EPA (1973a)	Max. = 50 mg/kg

Nickel metal, per se, poses no pollution problem; however, nickel salts may be acutely and chronically toxic to aquatic life.

Nickel will be determined by standard atomic absorption techniques. (See Appendix L for detailed procedure.)

Zinc, Zn: Is essential for humans; large amounts cause malaise, dizziness, vomiting and diarrhea.

Standards for Zinc in Water

EPA (1973b)	Drinking water max. = 5.0 mg/l

Standards for Zinc in Sediment

EPA (1973a)	Max. = 75 mg/kg

The toxicity of zinc is related to the hardness of the water. In addition zince concentrations in excess of 5 mg/l result in undesirable taste; this is the primary reason for the standard set at that level.

Zinc will be determined by standard atomic absorption techniques. See Appendix L for detailed procedure.

Halogenated Hydrocarbons

The substitution of a chlorine (or other halogen) atom for a hydrogen atom greatly increases the anesthetic action of a member of the aliphatic hydrocarbons. In addition, the chlorine derivative is usually less specific in its action and may affect other tissues of the body in addition to those of the central nervous system; in many cases the chlorine derivative is quite toxic. Thus, chloroform, in addition to its narcotic qualities, may cause liver, heart, and kidney damage.

As a general rule, the unsaturated chlorine derivatives are highly narcotic but less toxic than the saturated derivatives, thus causing degenerative changes in the liver and kidneys less frequently.

In dealing with these chlorinated hydrocarbons, it must be remembered that a toxic action may result from repeated exposure to concentrations which are too low to produce a narcotic effect, and which, consequently, are too low to give warning of danger. Individual susceptibility is also important when poisoning by this group of solvents is being considered. Certain workmen may be seriously affected by concentrations that seem to have no effect on fellow employees in the same exposure.

The halogenated hydrocarbons will be concentrated by an extraction procedure and then analyzed by gas chromatography with an electron capture detector. See Appendix M for detailed procedure for water, standard elutriate and bottom sediments. Specific standards for the selected compounds are given below.

Significance and Standards

Chlordane is used as an insecticide and is very toxic. Chlordane poisoning results in convulsions, irritability, and deep depression.

Standard - Chlordane - Water

EPA (1975) Drinking water max. = 0.03 mg/l

No sediment standards are available.

DDT -- Synonyms: Dichloro-diphenyl-trichlorothane; chlorophenothane, dicophane, 1,1,1-trichloro-2,2-bix (p-chlorophenyl) ethane, "Gesarol"; "Neocoid"; Persisto Spray"; "Suntobane" and many other trade names.

DDT is readily absorbed from the intestinal tract and, if it occurs in the air in the form of an aerosol or dust, it may be taken into the lung and readily absorbed. DDT is not, however, absorbed from the skin unless it is in solution. DDT acts on the central nervous system, but the exact mechanism of this action either in man or in animals has not been elucidated.

Standards - DDT - Water

EPA (1975) Drinking water max. = 0.05 mg/l

No standards for sediment concentration are available.

Acute poisoning sysptoms include tremors of the head and neck muscles, convulsions, cardiac or respiratory failure, and death. Chronic sypmtoms include hepatic damage, CNA degeneration, agranuclocytosis, dermatitis, weakness, convulsions, coma and death.

Deildrin -- Synonum: 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,-8a-octahydro-1,4,5,8-dimethano-naphthalene; compound 497; Octalox, and other trade names.

Dieldrin is absorbed readily from the skin as well as through other portals. It acts as a central nervous system stimulant, but the exact mechanism of this action is entirely unknown. It also greatly reduces or eliminates appetite, apparently by an action on the central nervous system.

Standards - Dieldrin - Water

EPA (1975) Drinking water max. = 0.0001 mg/l

No sediment standards are available.

Endrin -- Synonym: 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-endo-endo-dimethanonaphthalene.

Toxicity of Endrin is similar to that of DDT.

Standards - Endrin - Water

EPA (1975) Drinking water max. = 0.0002 mg/l

No sediment standards are available.

Heptachlor -- Synonyms: 1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene.

Highly toxic upon ingestion, inhalation or skin absorption. Acute exposure causes liver damage. Chronic doses have caused liver damage in experimental animals.

Acute toxicity symptoms include tremors, ataxia, convulsions, renal damage, respiratory failure, and death. Heptachlor is similar in structure to Chlordane.

Standards - Heptachlor - Water

EPA (1975) Drinking water max. = 0.0001 mg/l

No sediment standards are available.

Lindane, 1,2,3,4,5,6-Hexachlorocyclohexane -- Synonyms: Benzene hexachloride; gammahexane; streunex; BHC, DBH, HCCH, HCH; "666"; "Gammexane"; "Benzahex"; "Chemhex"; "Gamoxol"; "Hexadon"; and other trade names.

Lindane poisoning may occur by ingestion, inhalation, or percutaneous absorption. Acute poisoning sysntoms are headache, dizziness, nausea, vomiting, diarrhea, tremors, weakness, convulsions, dyspnea, cyanosis, and circulatory collapse.

Standards - Lindane - Water

EPA (1975)	Drinking water max. = 0.004 mg/l

No sediment standards are available.

Polychlorinated Biphenyls (PCB) -- Primarily used as transformer cooling fluids PCB's are complex mixtures of several similar compounds.

The low limit is largely an attempt to protect aquatic life, since PCB's are highly cumulative (up to 200,000 x). No limit of acceptability has been set for drinking water, since "too little is known about the levels in water, the retention and the accumulation in humans, and the effects of very low rates of ingestion", (EPA, 1973b).

Standards - PCB's - Water

EPA (1973b)	Max. = 0.000002 mg/l

No sediment standards are available.

Oils and Grease

Oil and grease determination is important due to the high solubility of halogenated hydrocarbons in the oils and grease. Low level oils and grease are in general non-toxic but provide an indication as to overall quality of the sample.

Standards - Oil and Grease

None available for water or sediment. Detailed procedure for Oils and Grease analysis is given in Appendix N.

COMMENTS RECEIVED ON DRAFT REPORT

ENVIRONMENTAL PROTECTION AGENCY
REGION VI
~~1600 PATTERSON, SUITE 1100~~
~~DALLAS, TEXAS 75201~~
First International Building
1201 Elm Street
Dallas, Texas 75270

OFFICE OF THE
REGIONAL ADMINISTRATOR

September 30, 1976

Colonel John F. Wall
District Engineer
Department of the Army
Fort Worth District - Corps of Engineers
P. O. Box 17300
Fort Worth, Texas 76102

Dear Colonel Wall:

We have reviewed your Draft Report, Trinity River Bottom Sediment Reconnaissance Study, Phase I - Plan of Work and have the following comments:

1. The purpose of this study is to determine the quality of the bottom sediments in the Trinity River in accordance with EPA's guidelines, 40 CFR 230, Discharge of Dredged or Fill Material, and to determine if the sediments contain adverse quantities of toxic substances. The Corps of Engineers is collecting this information for the Trinity River Project. The term Trinity River Project should be defined in more detail to assure an adequate description of the project.

2. On page v of the Executive Summary and on page 66 the column of the test entitled mixture of bottom sediment and distilled water should be changed. This column should be replaced by mixture of bottom sediment with river water and elutriation without filtration and centrifuging. All other pertinent paragraphs in the text should also be changed.

3. Since the chemical tests are done on both filtered and unfiltered elutriates, it is requested that the bioassay tests be done on both filtered and unfiltered elutriates from the same original sample in order to aid in the interpretation of analytical results.

4. Quality control and documentation of analytical results need to be incorporated into the reconnaissance study. The EPA manual, Handbook for Analytical Quality Control in Water and Wastewater Laboratories, should be used as one reference for the quality control program. It is important that the following specific procedures be incorporated at the beginning of the survey:

a. Precision (reproducibility among replicate observations) -- Data shall not be collected until the analyst is familiar with the method and has obtained reproducible results. Duplicate analyses shall be run at least ten percent of the time.

b. Accuracy (observed difference between measured and known values) -- Known amounts of a particular constituent should be added to actual concentrations where the precision of the method is satisfactory. Accuracy should be reported as the percent recovery at the final concentration of the spiked sample. The percent recovery should be calculated as described in Standard Methods for Examination of Water and Wastewater (APHA). Spiked samples shall be run at least ten percent of the time.

c. Quality Control Charts -- Control charts shall be utilized for permanently recording precision and accuracy data. These control charts shall serve as an indicator to the analyst if his laboratory procedures are in or out of control. If the charts indicate that a system is out of control the analyst shall take the necessary corrective actions. The construction and use of the quality control charts shall be made in accordance with those methods cited in the EPA manual Handbook for Analytical Quality Control in Water and Wastewater Laboratories.

d. Daily Checks -- In addition to the use of duplicate samples, spiked samples, and quality control charts, daily checks should be made to validate standard curves utilizing at least two standards (a high and a low) and a blank. Resulting data should agree favorably with known precisions. Calibration of instruments and other laboratory equipment, validation of reagent concentrations, preventive maintenance and utilization of internal quality control check samples should also be performed as dictated by good laboratory practice.

5. Elutriate tests should be run within one week of collection (page 62), and the static bioassay test should be done immediately after return to the laboratory (page 63).

6. It is stated on page 77 that static bioassay tests will be run on "6 percent and 20 percent sediment concentrations." From the discussion of the procedure on page 77 it appears that only two concentrations will be used for testing. Standard dilutions plus a control should be used for conducting the bioassay tests as per our Standard Methods.

We appreciate the opportunity to review your report. Please keep us informed of the progress of this project.

Sincerely yours,

~~John~~ C. White
Regional Administrator

TEXAS WATER QUALITY BOARD

PH. (512) 475-2651

1700 NORTH CONGRESS AVE.
P.O. BOX 13246 CAPITOL STATION 78711
AUSTIN, TEXAS

September 16, 1976

RE: Trinity River Bottom Sediment Reconnaissance Study

Mr. Robert E. Lyman, P.E.
Engineering Division
Corps of Engineers, Fort Worth Dist.
P. O. Box 17300
Fort Worth, Texas 76102

Dear Mr. Lyman:

We have reviewed the draft work plan for the Trinity River Bottom Sediment Reconnaissance Study. The following comments are offered for your consideration:

1. The purpose of the study could be more fully explained.
2. Unless the flow regime and stream geometry are well documented, it is extremely difficult to characterize the velocity using only a mid-stream measurement. USGS recommends at least 10 measurements for most streams.
3. Elutriate analyses:
   a. Value of data derived is somewhat doubtful
      1. bubbling of compressed air through flask contents (page 68, no. 10) will cause an incorrect ammonia analysis due to the diffusion of free ammonia
      2. no mention is made (page 62, no. 14) of preserving samples for time or temperature sensitive analyses (NH_3, PO_4, COD, TOC)
      3. portion of elutriate to be analysed for metals should be acidified with NO_3 at the time it is filtered
      4. a total solids determination is needed to relate the results to a dry-weight basis (page 68, no. 6).

The remarks concerning elutriate analyses may be addressed in the mentioned appendices which we did not receive.

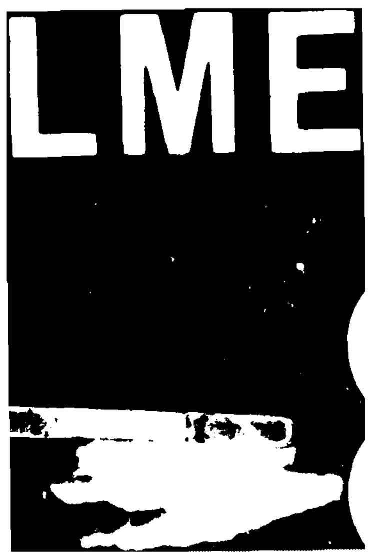
Thank you for the opportunity to review the draft study plan. If we may be of service, please let me know.

Sincerely,

Linda B. Wyatt

Linda B. Wyatt, P.E., Chief
Stream, Reservoir, & Estuary Monitoring
Field Operations Division

LBW:gsa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