APPENDIX 16
WATER QUALITY

YAZOO BACKWATER AREA REFORMULATION

APPENDIX 16
WATER QUALITY

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YAZOO BACKWATER AREA REFORMULATION

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INTRODUCTION

1. The Yazoo Backwater Area is located in west-central Mississippi and encompasses the area within the Mississippi Delta subject to inundation by the 100-year frequency flood on the Mississippi River. This area extends from the Yazoo Basin escarpment on the east to the left descending bank Mississippi River mainline levee on the west. The backwater area includes Steele Bayou, Deer Creek, Big Sunflower River, and the Little Sunflower River up to approximately the latitude of Belzoni, Mississippi. The proposed Yazoo Backwater Project plan includes a combination of structural and nonstructural measures to reduce flooding and enhance the environmental conditions within the project area. The primary structural feature includes the construction of a pumping plant near the mouth of Steele Bayou. This structure would provide for the reduction in interior flooding during those times in which gravity outflow through the existing Steele Bayou structure is not possible. The nonstructural feature includes the reforestation of some of the lower lying lands within the project area.

BACKGROUND INFORMATION

2. Prior to 1990, very little water quality data were available for the Steele Bayou Basin. During 1990 and 1991, the U.S. Army Engineer Research and Development Center (ERDC) (formerly the U.S. Army Engineer Waterways Experiment Station) and the U.S. Geological Survey (USGS) collected water and/or sediment samples from 14 stations within the Yazoo Backwater Area of the Steele Bayou Basin. From 1992 through 1995, the U.S. Army Corps of Engineers, Vicksburg District, collected water and/or sediment

samples from 32 stations within the Big Sunflower River Basin. Samples were collected from the Big Sunflower River, Little Sunflower River, Dowling Bayou, and from four area lakes--Howlett Bayou, Lost Lake, Fish Lake, and Plaquemine Bayou. All of the sampling stations within both the Steele Bayou and Big Sunflower River Basins are located on Figure 16-1 and identified in Table 16-1. For this analysis, the water and sediment samples are divided into four groups. The groups are based on selected reaches in which the sampling sites are located. The first group includes the Steele Bayou Basin from its mouth to the vicinity of the Highway 12 bridges over Black Bayou, Granicus Bayou, and Granny Baker Bayou. The second group includes the Big Sunflower River from its mouth to Dowling Bayou (Big Sunflower River Mile (RM 33), the downstream most 2 miles of Dowling Bayou, and the Little Sunflower River. The third group includes the Big Sunflower River from Dowling Bayou to the upper limit of the backwater area near Big Sunflower RM 65. The fourth group includes the four sampled lakes. These groupings were selected due to significant differences in various water and sediment quality parameters between the reaches of the Big Sunflower River upstream and downstream of Dowling Bayou. These differences were discovered in previous water quality studies of the Big Sunflower area. These may be due to differences in the land use and land cover. The upper Steele Bayou Basin and the Big Sunflower Basin above Dowling Bayou consist primarily of cleared agricultural lands. The lower Sunflower Basin has considerable forest cover, and three of the four lakes are located in the Delta National Forest.

SURFACE WATER QUALITY

3. A summary of the water quality data for the Steele Bayou Basin, the Big Sunflower River Basin, and for the four backwater lakes is contained in Table 16-2. Table 16-2 includes the in-situ data, turbidity, and the physicochemical parameters of total Kjeldahl nitrogen (TKN), total phosphorus, nitrate nitrogen, ammonia nitrogen, sulfate, total solids, and total suspended solids. The Steele Bayou Basin data were collected from

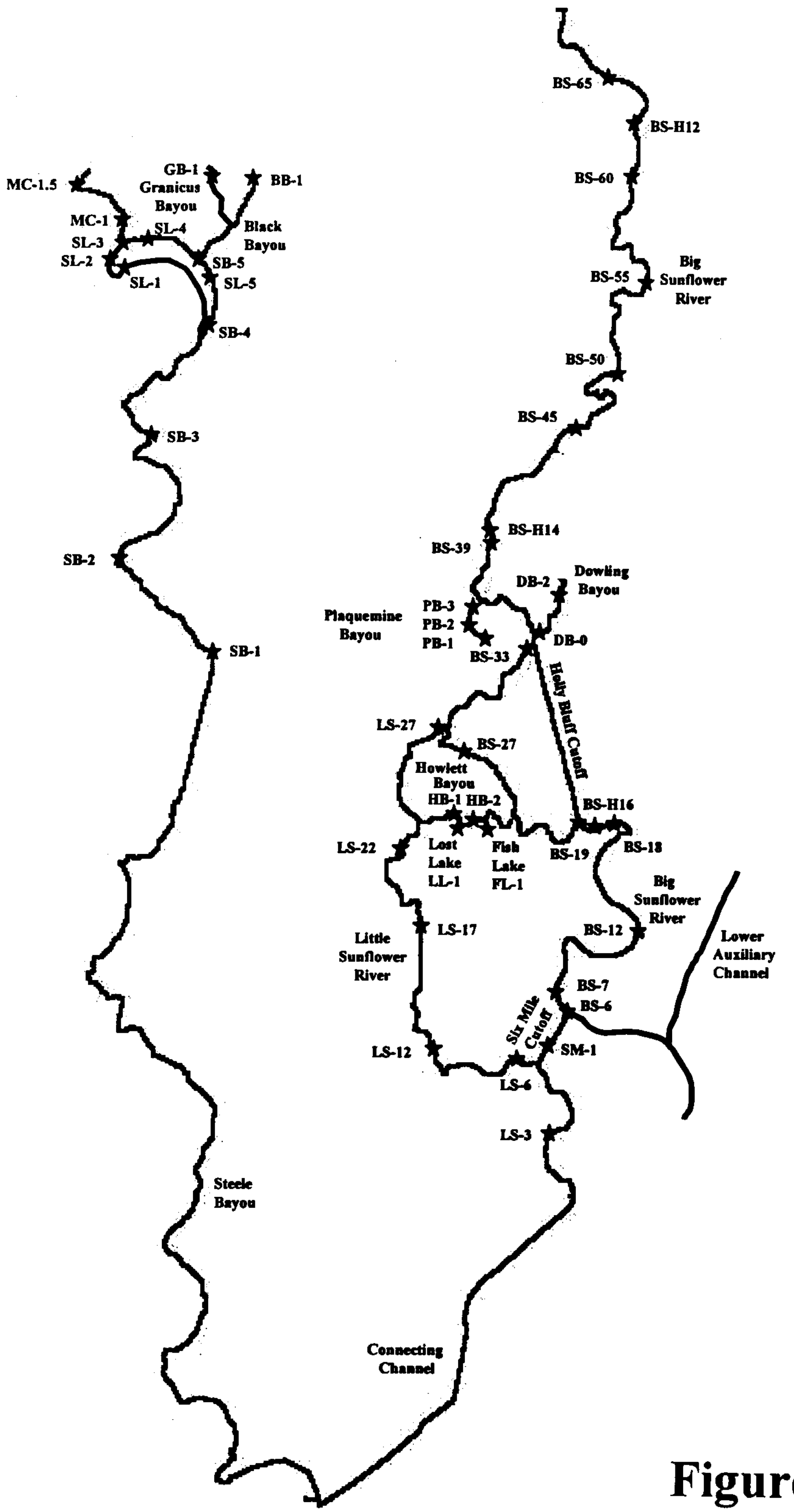


Figure 16-1
Water Quality Sampling Locations

TABLE 16-1
WATER QUALITY SAMPLING LOCATIONS

Station	Sampling Location
SB-1	Steele Bayou at Highway 14
SB-2	Steele Bayou at Hopedale
SB-3	Steele Bayou at Hampton
SB-4	Steele Bayou at Eifling
SB-5	Black Bayou near Percy
SL-1	Swan Lake Slough
SL-2	Long Dump
SL-3	Silver Lake
SL-4	No. 9 Dredge Ditch
SL-5	Black Bayou at wildlife refuge
BB-1	Black Bayou at Highway 12
GB-1	Granicus Bayou at Highway 12
MC-1	Pryor Impoundment
MC-1.5	Granny Baker Bayou near James
LS-3	Little Sunflower River at RM 3
LS-6	Little Sunflower River at RM 6
LS-12	Little Sunflower River at RM 12
LS-17	Little Sunflower River at RM 17
LS-22	Little Sunflower River at RM 22
LS-27	Little Sunflower River at RM 27
SM-1	Six Mile Cutoff at RM 1
BS-6	Big Sunflower River at RM 6
BS-7	Big Sunflower River at RM 7
BS-12	Big Sunflower River at RM 12
BS-18	Big Sunflower River at RM 18
BS-19	Big Sunflower River at RM 19
BS-H16	Big Sunflower River at Highway 16 (Holly Bluff)
FL-1	Fish Lake
LL-1	Lost Lake
HB-1	Howlett Bayou
HB-2	Howlett Bayou
BS-27	Big Sunflower River at RM 27
BS-33	Big Sunflower River at RM 33
DB-0	Dowling Bayou near its mouth
DB-2	Dowling Bayou at RM 2
PB-1	Plaquemine Bayou
PB-2	Plaquemine Bayou
PB-3	Plaquemine Bayou
BS-39	Big Sunflower River at RM 39
BS-H14	Big Sunflower River at Highway 14 (near Anguilla)
BS-45	Big Sunflower River at RM 45
BS-50	Big Sunflower River at RM 50
BS-55	Big Sunflower River at RM 55
BS-60	Big Sunflower River at RM 60
BS-H12	Big Sunflower River at Highway 12 (Little Callao)
BS-65	Big Sunflower River at RM 65

TABLE 16-2
WATER QUALITY DATA

Water Quality Parameter	Steele Bayou Basin				Big Sunflower River				Backwater Lakes				MDEQ Criteria
	Det Obs	**Mean**	**Minimum**	**Maximum**	**Det Obs**	**Mean**	**Minimum**	**Maximum**	**Det Obs**	**Mean**	**Minimum**	**Maximum**	
Temperature (degrees Celcius)	75	21.07	7.0	33.0	22	23.46	8.4	32.8	7	8.07	6.7	10.2	32 Deg C (max)
pH (Standard Units)	72	7.57	6.5	8.4	22	7.41	6.85	8.07	7	6.59	5.9	7.26	6.5 – 9.0
Dissolved Oxygen (mg/l)	76	6.98	1.6	16.1	3	7.15	6.6	7.84	7	7.66	5.3	10.9	5.0 (min)
Alkalinity (mg/l)					8	83.14	17.4	183.0					
Conductivity (umhos/cm)	76	406.	119.0	950.0	22	235.8	76.0	385.0	7	113.9	49.0	199.0	1,000
Turbidity (NTU)	74	110.9	7.0	400.0	19	131.9	19.0	726.0	6	40.3	13.0	83.0	150
Total Solids (mg/l)	78	483.3	200.0	1,444.0	23	341.7	262.0	584.0	7	116.3	6.0	282.0	
Total Suspended Solids (mg/l)	78	190.1	16.0	1,300.0	20 23	118.5	2.0	484.0	7	45.14	4.0	206.0	<80
Total Organic Carbon (mg/l)	79	6.12	2.7	11.0	22 23	7.33	3.4	17.1	6 7	6.28	4.2	9.9	<15
Total Phosphorus (mg/l P)	78	0.402	0.11	1.8	15 23	0.403	0.215	0.602	7	0.241	0.032	0.357	0.2
Total Kjeldahl Nitrogen (mg/l N)	76	2.209	0.7	8.0	23	1.163	0.684	1.87	7	1.157	0.415	2.15	1.0
Nitrate Nitrogen (mg/l N)					23	0.560	0.072	1.12	4 7	0.031	0.023	0.049	1.0
Ammonia Nitrogen (mg/l N)	77 79	0.198	0.01	0.99	19 23	0.125	0.042	0.315	0 7				
Sulfate (mg/l)					11 23	13.79	5.34	23.0	4 7	21.7	11.4	28.0	

NOTE:
Det = number of detections
Obs = total number of samples
Mean, Minimum, and Maximum values are for detected values only
There were no significant differences for these parameters for Big Sunflower reaches 1 and 2; therefore, the data are pooled in this table.

10 different locations during 1990 and 1991. The Big Sunflower River data were collected at the Highways 12, 14, and 16 crossings. These sites were sampled during November and December 1992 and January, May, July, August, September, and October 1993. Water quality data for the backwater lakes were collected during January 1995.

4. The Mississippi Department of Environmental Quality (MDEQ) has established benchmark levels for some parameters to assess water bodies for the biannual Clean Water Act Section 305(b) Report. The MDEQ does not list benchmark levels for total solids, ammonia nitrogen, or sulfate. The MDEQ uses its benchmarks to determine if a water body is supporting the designated use of fish and wildlife propagation. Currently, MDEQ classifies most of the streams and lakes within the backwater area as being only partially supportive for the propagation of wildlife, fish, and other aquatic life. MDEQ cites nontoxic, nonpoint source pollution containing high loads of suspended solids and nutrients as the primary reason for this classification.

5. Table 16-2 shows that water temperature was measured 104 times within the project area. Water temperature, as expected, varied with time of year. Water temperatures ranged from 6.7 to 33 degrees C. Two of these 104 temperature measurements exceeded the MDEQ maximum temperature benchmark of 90 degrees F (32.2 degrees C). One of these temperatures was recorded in late August while the other was recorded in early September. The pH ranged from 5.9 to 8.4 with a mean of 7.47. All of the 101 pH readings were circum neutral and within the MDEQ benchmark range for pH. Dissolved oxygen ranged from 1.6 to 16.1 milligram per liter (mg/l) with a mean of 7.04 mg/l. Of the 86 dissolved oxygen readings, 10 fell below the MDEQ minimum benchmark of 5 mg/l. Specific conductance ranged from 49 to 950 umhos/centimeter (umhos/cm) with a mean of 350.9 umhos/cm. None of the 105 specific conductance readings exceeded the MDEQ benchmark of 1,000 umhos/cm. Turbidity ranged from 7 to 726 nephelometric turbidity unit (NTU) with a mean of 110.7 NTU. Of the 99 turbidity measurements, 15 exceeded the MDEQ benchmark of 150 NTU.

6. Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen and is the product of the transformation of inorganic nitrogen into organic nitrogen by plants. Since the Yazoo Backwater Area is located within an active agricultural area, high nitrogen levels within the streams are expected due to rainfall runoff from cultivated fields. TKN values measured within the Yazoo Backwater Area ranged from 0.415 to 8.0 mg/l N with a mean of 1.91 mg/l N. Of the 106 TKN samples, 93 exceeded the MDEQ benchmark of 1 mg/l. Nitrate Nitrogen (NO3) concentrations ranged from 0.023 to 1.12 mg/l N with a mean of 0.482 mg/l N. Of the 27 samples with detectable levels of nitrate nitrogen, 5 samples exceeded the MDEQ benchmark of 1 mg/l. Total phosphorus levels ranged from 0.032 to 1.8 mg/l P with a mean of 0.391 mg/l P. Of the 100 samples with detectable levels of total phosphorus, 88 exceeded the MDEQ benchmark of 0.2 mg/l P.

7. The water samples collected from the Yazoo Backwater Area were analyzed for the 19 priority pollutant pesticides identified in Table 16-3. Of these pesticides, only ppDDE, ppDDT, Heptachlor, Dieldrin, B-Endosulfan, and Endrin Aldehyde were detected. These pesticides were generally reported in trace amounts. The most common pesticides detected were ppDDE, ppDDT, Heptachlor, and Dieldrin. The three pesticides, ppDDE, Heptachlor, and Dieldrin, were detected in 20 of the 30 samples. The pesticide ppDDT was detected in 19 of the 30 samples. B-Endosulfan and Endrin Aldehyde were detected in only 2 of the 30 samples. All of the detected concentrations were trace amounts except a single sample collected from the Big Sunflower River at Highway 14, which had detectable concentrations of ppDDT (0.290 microgram per liter (μg/l) and B-Endosulfan (0.490 μg/l).

8. The Environmental Protection Agency (EPA) provides national criteria for acceptable levels of certain metals in water under Section 304(a) of the Clean Water Act. The Section 304(a) criteria are published as the "Toxic Substance Spreadsheet." EPA released the most recent national criteria in 1997. Each state is required to adopt criteria

TABLE 16-3
ANALYZED WATER QUALITY PARAMETERS

In Situ Parameters	Physico-Chemical Parameters
Temperature	Turbidity
pH	Total Solids (TS)
Dissolved Oxygen	Total Suspended Solids (TSS)
Specific Conductance	Total Kjeldahl Nitrogen (TKN)
Non-Priority Pollutant Metals	Total Phosphorus (TP)
Barium	Total Organic Carbon (TOC)
Cobalt	Sulfate
Iron	Nitrate Nitrogen
Manganese	Ammonia Nitrogen
Priority Pollutants	
Metals	**Pesticides**
Arsenic	Aldrin
Cadmium	Alpha-BHC
Chromium	Beta-BHC
Copper	Delta-BHC
Lead	Gamma-BHC
Mercury	ppDDD
Nickel	ppDDE
Selenium	ppDDt
Zinc	Heptachlor
Silver	Dieldrin
Thallium	A-Endosulfan
PCB’s	B-Endosulfan
PCB-1016	Endosulfan Sulfate
PCB-1221	Endrin
PCB-1232	Endrin Aldehyde
PCB-1242	Heptachlor Epoxide
PCB-1248	Methoxychlor
PCB-1254	Chlordane
PCB-1260	Toxaphene
Other Pollutants	
Diazinon	Methomyl
Ethyl parathion	Azinphosmethyl
Ethyl trithion	Sulprofos
Ethion	Methamidophos
Malathion	2,4-D
Methyl parathion	2,4,5-T
Chlorpyrifos	2,4,5-TP
Dicrotophos	2,4-DB
Azodrin	Trifluralin

for their waters that are at least as stringent as the EPA criteria. The most recent State of Mississippi fresh water acute (FWA) and fresh water chronic (FWC) criteria were published in 1996. A comparison of the EPA national criteria versus the Mississippi criteria shows that for most contaminants the criteria are the same. For those few contaminants that are not the same, the differences are not significant. The EPA freshwater aquatic life criteria are provided as Criteria Maximum Concentration (CMC) and Criteria Continuous Concentration (CCC). The CMC was previously termed acute (short term) while the CCC was called chronic (long term). The impact of some trace metals is dependent upon the hardness of the water. In general, the impact of some trace metals decreases as the hardness of the water increases. These metals include cadmium, chromium, copper, lead, nickel, silver, and zinc. The EPA Section 304(a) Spreadsheet provides formulas based on hardness to calculate the CMC and CCC criteria for these metals. Only limited hardness data for the major streams within the Yazoo Backwater Area are available. The data show that hardness varied from below 50 to over 200 mg/l. Since a hardness of 50 mg/l has been measured within the study area and previous studies within the Mississippi Delta have used this hardness, the criteria dependent upon hardness were calculated using this value.

9. The metals concentrations for each of the water samples collected within the backwater area are contained in Table 16-4 along with the EPA and the State of Mississippi criteria. This table separates the data into three areas in which the sampling stations are located. These areas include the lower Big Sunflower, upper Big Sunflower, and backwater lakes. The metals analyzed include 11 priority pollutant metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, silver and thallium) and 4 nonpriority pollutant metals (barium, cobalt, iron, and manganese).

10. Arsenic was detected in 17 of the 33 water samples. The detected arsenic concentrations ranged from 2.2 to 7.6 μg/l with a mean of 5.29 μg/l. All of the arsenic concentrations were well below both national and state acute and chronic criteria for aquatic life.

TABLE 16-4
METALS IN WATER SAMPLES

Sample	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Tl	Zn	Ba	Co	Fe	Mn
	Concentration (µg/l)														
Lower Big Sunflower Area															
LS-3	<5	0.3	1.	10.	<1	<0.2	<1	<5			<5	70.	<10	1090.	43.
LS-8(93)	5.	0.2	1.	10.	<1	<0.2	<1	<5			<5	96.	<10	1200.	43.
LS-8(95)	7.4	<0.2	<1	2.1	<1	<0.2	<1	<2	<1	<2	<9				
LS-12(93)	6.	0.1	1.	11.	<1	<0.2	<1	<5			<5	76.	<10	1130.	44.
LS-12(95)	7.6	0.6	<1	2.4	<1	<0.2	<1	<2	<1	<2	<9				
LS-17	<5	0.2	13.	14.	4.	<0.2	13.	<5			11.	77.	<20	902.	137.
LS-22	5.	0.2	13.	<10	4.	<0.2	13.	5.			<10	74.	<20	949.	78.
LS-27	<5	0.2	13.	10.	4.	<0.2	15.	<5			13.	85.	<20	1200.	93.
SM-1	<5	0.2	1.	11.	<1	<0.2	<1	<5			<5	72.	<10	969.	40.
BS-6	<5	0.1	1.	9.	1.	<0.2	<1	<5			<5	65.	<10	942.	38.
BS-7(93)	5.	0.2	3.	12.	1.	<0.2	<1	<5			<5	63.	<10	963.	46.
BS-7(95)	6.6	<0.2	<1	2.4	<1	<0.2	1.1	<2	<1	<2	<9				
BS-12(93)	<5	0.4	4.	10.	<1	<0.2	<1	<5			<5	99.	<10	1720.	62.
BS-12 (95)	6.8	<0.2	<1	2.2	<1	<0.2	1.1	<2	<1	<2	<9				
BS-18	<5	0.2	5.	24.	<1	<0.2	<1	<5			<5	77.	<10	1340.	60.
BS-19	<5	0.3	5.	12.	<1	<0.2	<1	<5			<5	72.	<10	1280.	57.
BS-24	<5	0.2	3.	10.	<1	<0.2	38.	<5			31.	72.	<10	1320.	59.
BS-33	<5	0.2	2.	10.	<1	<0.2	65.	<5			5.	70.	<10	1270.	57.
DB-0	<5	0.2	13.	<10	3.	<0.2	13.	<5			<10	82.	<20	1100.	95.
DB-2	<5	0.1	13.	10.	3.	<0.2	13.	<5			<10	92.	<20	1510.	114.
Det/Obs	8/20	17/20	16/20	18/20	7/20	0/20	9/20	1/20	0/4	0/4	4/20	16/16	0/16	16/16	16/16
Mean	6.175	0.23	5.75	9.56	2.86		19.13	5.			15.	77.63		1180	66.63
Minimum	5.	0.1	1.	2.1	1.		1.1				5.	63.		902.	38.
Maximum	7.6	0.6	13.	24.	4.		65.				31.	99.		1720.	137.
EPA															
CMC	340.	4.3	984.	9.2	33.8	2.4	789.	20.	1.23		65.0				
CCC	150.	2.2	117.	6.5	1.3	0.012	87.7	5.			58.9			1000.	
Mississippi															
FWA	360.	1.74	984.	8.85	30.	2.1	787.	20.	1.05		63.6				
FWC	190.	0.62	117.	6.28	1.18	0.012	87.	5.			58.1			1000.	

TABLE 16-4 (Cont)

Sample	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Tl	Zn	Ba	Co	Fe	Mn
	Concentration (μg/l)														
Upper Big Sunflower Area															
BS-39	<5	0.3	2.	10.	<1	<0.2	<1	<5			5.	70.	<10	1230.	53.
BS-45	5.	<0.2	1.	11.	6.	<0.2	<1	<5			<10	81.	<20	1350.	64.
BS-50	5.	0.2	3.	13.	5.	<0.2	<1	<5			<10	79.	<20	1440.	71.
BS-55	6.	0.2	1.	12.	5.	<0.2	<1	<5			<10	81.	<20	1440.	66.
BS-60	5.	0.2	1.	11.	3.	<0.2	<1	<5			<10	83.	<20	1380.	77.
BS-65	5.	0.2	2.	1.	4.	<0.2	<1	<5			<10	85.	<20	1430.	82.
Det/Obs	5/6	5/6	6/6	6/6	5/6	0/6	0/6	0/6			1/6	6/6	0/6	6/6	6/6
Mean	5.2	0.22	1.667	9.667	4.6						5	79.8		1378.	68.8
Minimum	5.	0.2	1.	1.	3.							70.		1230.	53.
Maximum	6.	0.3	3.	13.	6.							85.		1440.	82.
Backwater Lakes															
HB-1	<2	2.13	3.6	19.6	4.	4.3	12.2	<2	<1	<2	4020.				
HB-2	6.1	0.91	5.7	13.3	6.1	0.35	10.8	<2	<1	<2	2640.				
LL-1	<2	0.42	2.2	8.6	2.	0.1	4.6	<2	<1	<2	2840.				
PB-1	2.4	0.4	1.3	4.3	2.2	<0.2	5.3	<2	<1	<2	1040.				
PB-2	<2	0.81	<1	10.2	2.6	<0.2	4.2	<2	<1	<2	660.				
PB-3	2.2	0.39	<1	5.1	1.3	0.22	1.9	<2	<1	<2	1120.				
FL-1	3.8	0.37	2.4	6.6	2.1	<0.2	4.7	<2	<1	<2	549.				
Det/Obs	4/7	7/7	5/7	7/7	7/7	4/7	7/7	0/7	0/7	0/7	7/7				
Mean	3.625	0.776	3.04	9.671	2.9	1.243	6.243				1838.				
Minimum	2.2	0.37	1.3	4.3	1.3	0.1	1.9				549.				
Maximum	6.1	2.13	5.7	19.6	6.1	4.3	12.2				4020.				
EPA															
CMC	340.	4.3	984.	9.2	33.8	2.4	789.	20.	1.23		65.0				
CCC	150.	2.2	117.	6.5	1.3	0.012	87.7	5.			58.9				
Mississippi															
FWA	360.	1.74	984.	8.85	30.	2.1	787.	20.	1.05		63.6				
FWC	190.	0.62	117.	6.28	1.18	0.012	87.	5.			58.1				

As = Arsenic Cd = Cadmium Cr = Chromium Cu = Copper Pb = Lead Hg = Mercury Ni = Nickel Se = Selenium
Ag = Silver Tl = Thallium Zn = Zinc Ba = Barium Co = Cobalt Fe = Iron Mn = Manganese

Mean, Minimum, and Maximum include only detected concentrations
CMC = EPA Criteria Maximum Concentration
CCC = EPA Criteria Continuous Concentration
FWA = State of Mississippi Freshwater Acute criteria
FWC = State of Mississippi Freshwater Chronic criteria
Concentrations in darker shading exceed EPA CMC
Concentrations in lighter shading exceed EPA CCC

11. Cadmiun was detected in 29 of the 33 water samples. The detected cadmium concentrations ranged from 0.1 to 2.13 μg/l with a mean of 0.36 μg/l. The concentrations for cadmium were higher in the samples collected from the backwater lakes than those collected from the Big Sunflower River. None of the samples collected from the Big Sunflower River exceeded either national or state criteria. However, one of the three samples collected from Plaquemine Bayou (PB-2) and one of the two samples collected from Howlett Bayou (HB-2) exceed the FWC. The other sample collected from Howlett Bayou (HB-1) exceeded both the FWC and FWA.

12. Chromium was detected in 27 of the 33 water samples. The detected chromium concentrations ranged from 1.0 to 13.0 μg/l with a mean of 4.34 μg/l. Like arsenic, the chromium concentrations in all of the water samples were well below both national and state criteria.

13. Copper was detected in 31 of the 33 water samples. The detected copper concentrations ranged from 1.0 to 24.0 μg/l with a mean of 9.61 μg/l. Of the 31 detections, 21 exceeded the FWC, FWA, and the CCC and CMC. One other concentration exceeded all criteria except the EPA CMC. Two concentrations exceeded the Mississippi FWC and the EPA CCC.

14. Lead was detected in 19 of the 33 water samples. The detected lead concentrations ranged from 1.0 to 6.1 μg/l with a mean of 3.33 μg/l. Seventeen of the 19 detections exceeded the FWC and the CCC. However, all concentrations are well below the acute criteria.

15. Mercury was detected in 4 of the 33 samples. The detected mercury concentrations ranged from 0.1 to 4.3 μg/l with a mean of 1.24 μg/l. All 4 of the mercury detections were found in the backwater lake samples. These include both samples from Howlett

Bayou (HB-1 and HB-2), the sample collected from Lost Lake (LL-1), and one of the three samples collected from Plaquemine Bayou (PB-3). The concentrations of all four of the samples with detectable mercury exceeded both the national and state chronic criteria. The sample collected from HB-1 also exceeded both the national and state acute criteria.

16. Nickel was detected in 16 of the 33 water samples. The detected nickel concentrations ranged from 1.1 to 65 μg/l with a mean of 13.49 μg/l. Of these 16 detections, 9 (9 of 20) occurred in the lower Big Sunflower area and 7 (7 of 7) occurred in the backwater lakes. None of the six water samples collected within the upper Big Sunflower area contained detectable levels of nickel. All 16 of the detections were well below both acute and chronic criteria.

17. Selenium was detected in only 1 of the 33 water samples. The detected selenium concentration of 5 μg/l is equivalent to the FWC and the CCC.

18. Zinc was detected in 12 of the 33 water samples. Of these 12 sample detections, 4 (4 of 20) occurred in the lower Big Sunflower area, 1 (1 of 6) in the upper Big Sunflower area, and 7 (7 of 7) in the backwater lakes. Within the lower and upper Big Sunflower areas, the detected zinc concentrations ranged from 5 to 31 μg/l. This range is well below the national and state chronic and acute criteria. The seven detected concentrations reported within the backwater lakes ranged from 549 to 4,020 μg/l with a mean of 1,838 μg/l. These concentrations are two to three orders of magnitude higher than the concentrations detected in the Big Sunflower areas. Concentrations detected in the backwater lakes are as much as one to two orders of magnitude higher than both national and state acute and chronic criteria for aquatic life. Since these concentrations are so far out of range, the backwater lakes are to be resampled in order to verify or refute these results.

19. The water samples collected from the lower and upper Big Sunflower areas were also analyzed for barium, cobalt, iron, and manganese. Of these metals, barium, iron, and manganese were detected in all 22 of the water samples collected. Iron is the only one of these three metals that has national and state criteria. Iron concentrations ranged from 902 to 1,720 µg/l with a mean of 1,236 µg/l. Seventeen of the 22 detected concentrations exceed EPA and Mississippi chronic criteria. Iron does not have acute criteria. Even though barium and manganese were detected in all 22 water samples, neither national nor state criteria exist for these metals. Cobalt was not detected in any of the 22 water samples. Eleven water samples were analyzed for silver and thallium. Neither of these two metals was detected in any of the 11 samples.

SEDIMENT QUALITY

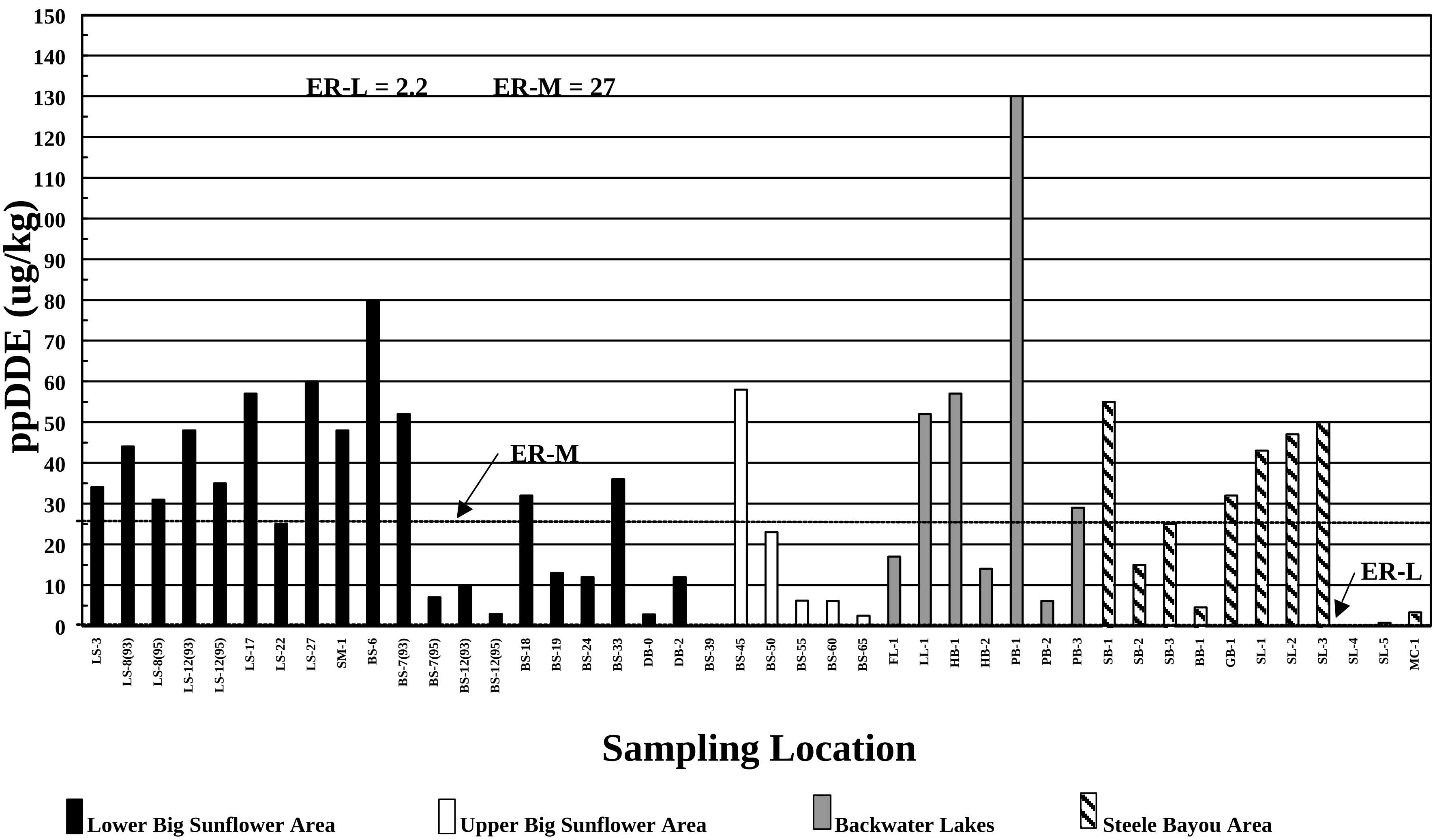
20. The major problem in assessing the quality of sediment is that no nationally accepted sediment criteria currently exist. While various criteria have been applied or proposed on a regional basis, none have been officially accepted on a national scale. Only recently has EPA proposed sediment criteria for any contaminants. These include endrin, dieldrin, and three PAH's. In March 1990, the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), National Ocean Service, Office of Oceanography and Marine Assessment, published Technical Memorandum (NOS OMA 52), "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program." This report utilizes a sufficiently large data set to determine two statistically calculated benchmarks for many contaminants. These benchmarks are referred to as Effects Range-Low (ER-L) and Effects Range-Medium (ER-M). The ER-L is the 10th percentile level of accumulated environmental effects data. It represents a low-level benchmark. The ER-M represents the 50th percentile of the range of contaminant levels that produce environmental effects.

pSediments with contaminant concentrations less than the ER-L represent a minimal effects range in which adverse biological effects would be rarely observed. Contaminant concentrations equal to and greater than the ER-L, but less than the ER-M represent a possible effects range in which effects would occasionally occur. Sediments with contaminant concentrations that exceed the ER-M represent a probable effects range in which effects would frequently occur. It must be noted that these benchmarks were calculated from bioeffects tests on marine sediments, and their applicability to freshwater sediments is unknown.

21. Pesticide analysis of sediments from the backwater area comprised the collection. Of these samples, 20 were collected from the lower Big Sunflower area, 6 from the upper Big Sunflower area, 7 from the backwater lakes, and 11 from the Steele Bayou Basin. These sediment samples were analyzed for the 19 priority pollutant pesticides identified in Table 16-3.

22. The four pesticides, Alpha-BHC, delta-BHC, chlordane, and Toxaphene, were not detected in any of the sediment samples. Heptachlor epoxide, and methoxychlor were each detected in a single sample. Aldrin and A-Endosulfan were detected in two samples. Beta-BHC was detected in 4 samples, B-Endosulfan in 5 samples, endrin aldehyde in 6 samples, gamma-BHC in 7 samples, endosulfan sulfate in 10 samples, endrin in 13 samples, dieldrin in 20 samples, and heptachlor in 23 samples. Even though these pesticides were detected, most occurred only in trace amounts. The most frequently detected pesticides were ppDDT in 34 samples and both ppDDD and ppDDE in 42 of the 44 samples analyzed. It is not surprising that DDT and its derivatives (DDD and DDE) were so frequently detected even though the use of DDT has been banned in the United States for over 25 years. The Mississippi Delta is an area of heavy agricultural production in which DDT was commonly used prior to 1972. DDT has a half-life of over 15 years (Howard, 1991), thus allowing for its continued presence in surface waters and sediment. Figure 16-2 is a plot of the ppDDE concentrations. The detectable

Figure 16-2
PPDDE in Sediment



concentrations of ppDDE exceeded the ER-L benchmark of 2.2 microgram per kilogram (μg/kg) in 41 of the 42 samples. The detectable concentrations of ppDDE exceeded the ER-M of 27 μg/kg in 22 of the 42 samples. The ER-M for ppDDE was established from an incidence of effects of 50 percent. This means that one-half of the data entries reporting biological effects had concentrations above 27 μg/kg. Therefore, since ppDDE concentrations in some of the sediment samples collected from the lower Big Sunflower area, the upper Big Sunflower area, the backwater lakes, and the Steele Bayou area, exceeded the ER-M, it is likely that biological effects due to ppDDE occur throughout the Yazoo Backwater Area. Figure 16-3 is a plot of the total DDT (ppDDE + ppDDD + ppDDT) concentrations. Total DDT concentrations exceeded the ER-L of 1.58 μg/kg in all 44 of the sediment samples. The total DDT concentrations in 26 of the samples exceeded the ER-M of 46.1 μg/kg.

23. In order to determine the variability of pesticide concentrations with depth, sediment cores were collected at four locations within the Steele Bayou basin. These locations are Steele Bayou at Highway 14 (SB-1), Swan Lake Slough (SL-1), Silver Lake (SL-3), and Black Bayou at wildlife refuge (SL-5). The depth of the cores varied for each sampling location. Each core sample was segmented into 4-inch layers and numbered. Layer 1 extended from the surface to 4 inches below the surface. The deepest layer was layer 6, which extended from 20 to 24 inches below the surface. The core for SB-1 extended to 24 inches (6 layers), SL-1 to 16 inches (4 layers), SL-3 to 16 inches (4 layers), and SL-5 to 20 inches (5 layers).

24. Each core sample was analyzed for the 19 priority pollutant pesticides identified in Table 16-3. The pesticides, ppDDD, ppDDE, and ppDDT, were detected most frequently. Figures 16-4 and 16-5 are plots of the ppDDE and the total DDT concentrations for the core samples, respectively. The highest concentrations for both ppDDE and total DDT were detected in layer 1 at SL-1, SL-3, and SL-5. For these three locations, the higher concentrations were detected in the layers nearest the surface and the

Figure 16-3
Total DDT in Sediment

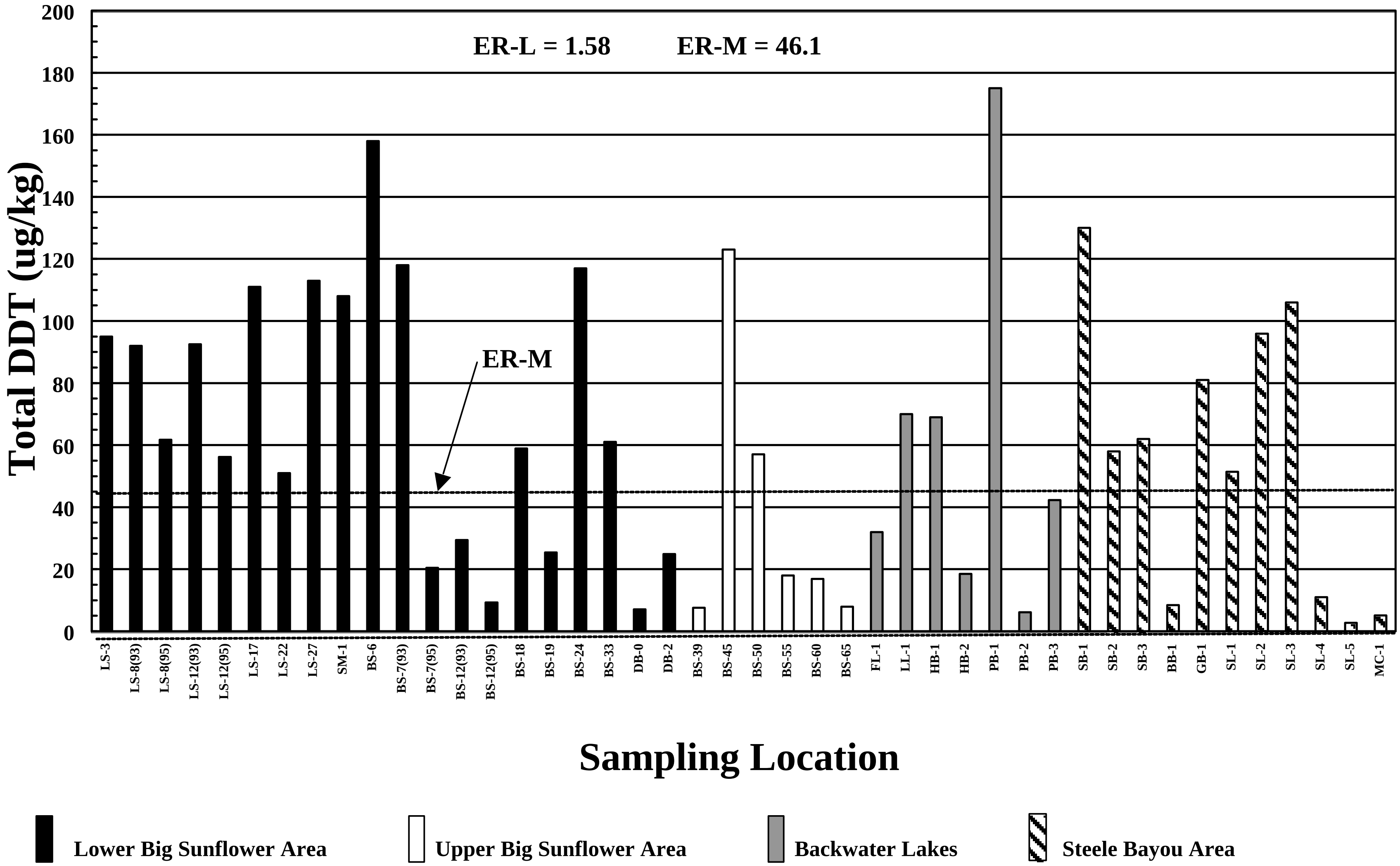


Figure 16-4
ppDDE Concentrations At Varying Depth In Sediment

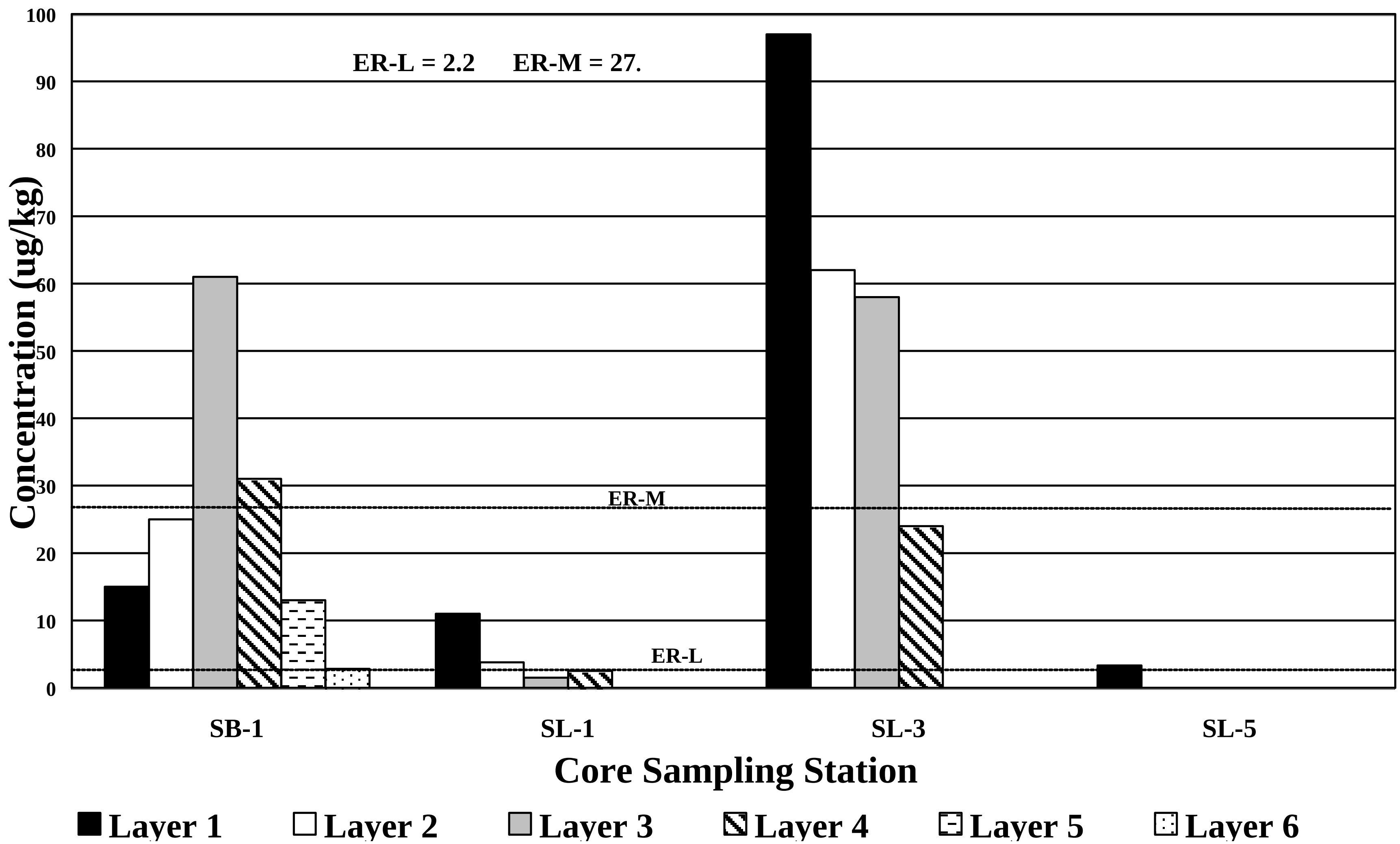
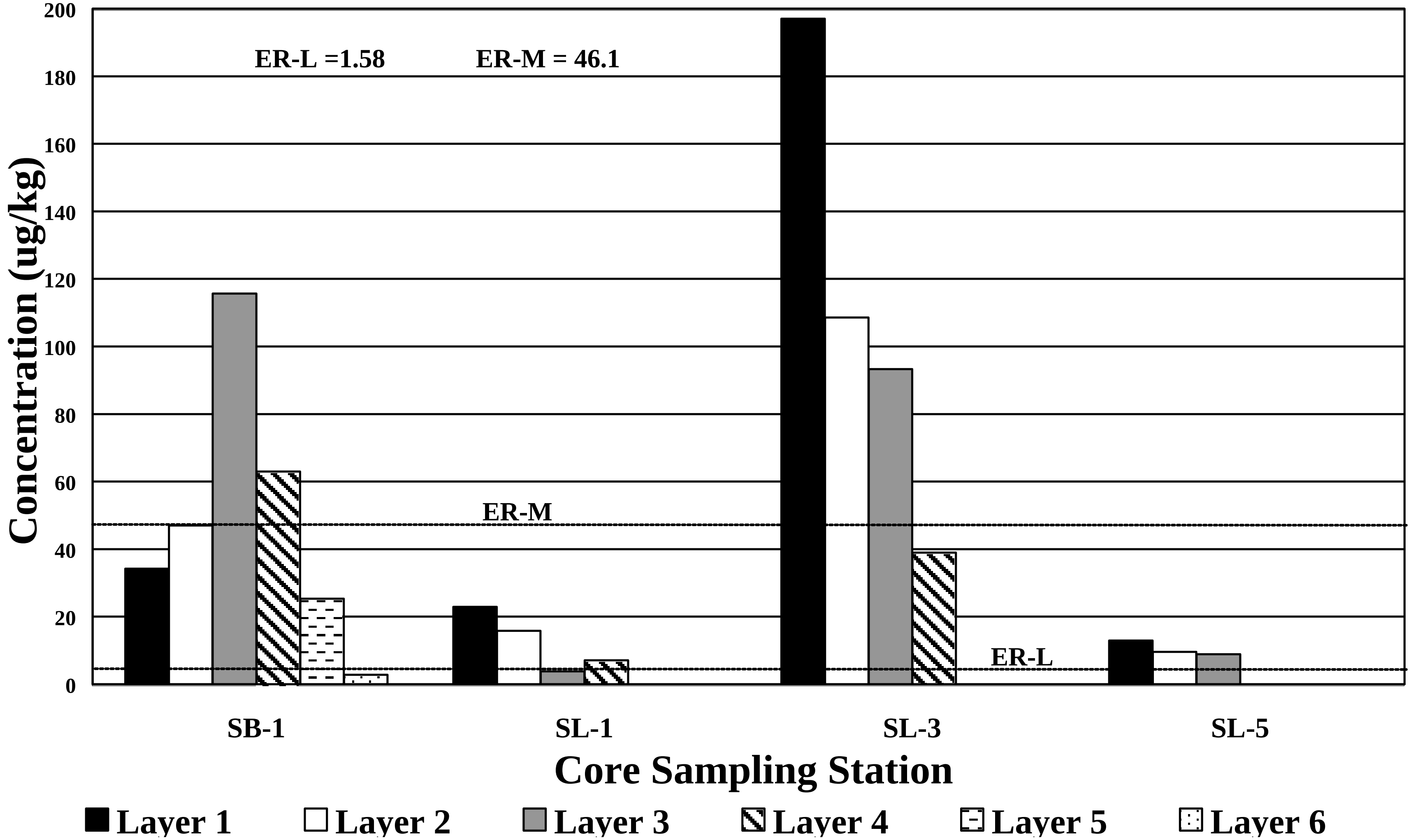


Figure 16-5
Total DDT Concentrations At Varying Depth In Sediment



lowest concentrations were in the deepest layers. For SB-1, the highest concentrations were detected in a middle layers (layers 3 and 4) with the lowest two concentrations being found in the deepest two layers (layers 5 and 6). It is difficult to draw definitive conclusions from only four samples. However, at least for these samples, the trend is for the higher concentrations to be located in the upper layers while the lower concentrations are found in the under lying, deeper layers. An additional 25 segmented core samples were collected from the Little Sunflower Basin in 1998 and 1999. A statistical analysis of pesticide concentration with depth found no significant differences with depth. This analysis is reported in a separate report (USACE, 2000).

25. Trace metals were analyzed on 37 surface sediment samples collected within the backwater area. Twenty of these samples were collected from the lower Big Sunflower area, 6 from the upper Big Sunflower area, 7 from the backwater lakes, and 4 from the Steele Bayou basin. The sediment samples were analyzed for the 11 priority pollutant metals and the 4 nonpriority pollutant metals identified in Table 16-3. Table 16-5 provides a summary of the surface sediment data. This table also includes the mean, minimum, and maximum concentrations that occur naturally in the earth's crust as reported by Bowen and/or the U.S. Geological Survey (USGS). For most of the metals analyzed, concentrations were within the ranges that occur naturally. However, some of the samples contained arsenic, cadmium, and mercury in concentrations that exceeded the maximum concentrations as reported by Bowen and/or the USGS.

26. Three samples, all within the lower Big Sunflower area, contained arsenic concentrations that exceeded the Bowen maximum and one which also exceeded the USGS maximum. Five samples reported cadmium concentrations above the maximum reported by Bowen. Three of these five samples were collected from the backwater lakes. All seven of the samples collected from the backwater lakes contained mercury concentrations that exceeded the Bowen maximum. One of these seven concentrations exceeded the USGS maximum.

TABLE 16-5
SUMMARY OF SURFACE SEDIMENT DATA

Parameter	Steele Bayou Area		Lower Big Sunflower Area		Upper Big Sunflower Area		Backwater Lakes		Earth's Crust: Bowen	Earth's Crust: USGS	ER-L ER-M
Inorganics (mg/kg)											
	No. Samples	**Mean Minimum Maximum**	**No. Samples**	**Mean Minimum Maximum**	**No. Samples**	**Mean Minimum Maximum**	**No. Samples**	**Mean Minimum Maximum**			
TKN			16	876. 95.5 1,800.	6	747.6 28.1 2,610.	7	5.99 4.04 9.07			
TP			16	882.9 492. 1,330.	6	5,50.2 164. 1,110.	7	1.97 1.47 2.24			
TOC			20	10,025 1,191. 18,496	6	8,301. 2,285. 15,500	7	21,749 11,146 32,865			
% Fines			9	62.43 9.3 99.3	5	33.04 2.3 98.1	7	89.1 65. 97.4			
Trace Metals (mg/kg)											
	Det Obs	**Mean Minimum Maximum**	**Det Obs**	**Mean Minimum Maximum**	**Det Obs**	**Mean Minimum Maximum**	**Det Obs**	**Mean Minimum Maximum**	**Mean Minimum Maximum**	**Mean Minimum Maximum**	
Arsenic	4 4	6.25 4. 10.	20 20	28.55 3.69 73.6	6 6	9.6 3.2 16	7 7	5.02 2.83 6.04	6.0 1.0 40	7.4 <0.1 73	8.2 70
Cadmium	1 4	0.9	20 20	0.417 0.059 0.68	6 6	0.423 0.13 1.11	7 7	0.695 0.451 1.08	0.06 0.01 0.70		1.2 9.6
Chromium	4 4	31.23 23.6 44.6	20 20	21.29 4.90 34.7	6 6	14.33 3.5 28.	7 7	20.36 10.9 28.5	100 5 3,000	52 1 1000	81 370
Copper	4 4	17.93 12.4 29.3	20 20	20.86 1.40 36.5	6 6	13. 1.4 29.2	7 7	27.36 13.4 36.8	20 2 100	22 <1 700	34 270
Lead	4 4	22.9 18.3 33.7	20 20	17.62 6.60 34.7	5 6	12.52 4.1 23.1	7 7	20.59 13.3 28.2	10 2 200	17 <10 300	46.7 218
Nickel	4 4	24.95 19.7 30.4	20 20	24.02 9.60 39.1	6 6	17.4 6.3 30.1	7 7	26.41 18.7 34.6	40 10 1,000	18 <5 700	20.9 51.6
Mercury	0 4		4 20	0.223 0.14 0.29	0 6		7 7	1.26 0.323 4.89	0.03 0.01 0.30	0.12 0.01 3.40	0.15 0.71

TABLE 16-5 (Cont)

Parameter	Steele Bayou Area		Lower Big Sunflower Area		Upper Big Sunflower Area		Backwater Lakes		Earth's Crust		ER-L ER-M
									Bowen	USGS	
Trace Metals (mg/kg)											
				0.497		0.6		0.729		0.45	
Selenium			11	0.24	2	0.5	7	0.41		<0.1	
			20	0.76	6	0.7	7	1.73		3.9	
		85.38		93.75		63.67		163.	50	52	
Zinc	4	60.1	20	1.09	6	14.7	7	93.3	10	<5	150
	4	145.	20	250.	6	129.	7	302.	300	2,900	410
		178.8		198.4		151.5				420	
Barium	4	141.	16	109.	6	20.4				10	
	4	254.	16	255.	6	395.				1,500	
		6.95		10.43		6.75				9.2	
Cobalt	4	5.2	12	8.7	6	2.6				<0.3	
	4	8.3	12	12.2	6	11.				70	
		20,350		25,300		15,185			38,000	25,000	
Iron	4	16,000	16	15,800	6	3,620				100	
	4	27,300	16	37,800	6	28,700				>100,000	
		316.8		5,47.9		334.3				640	
Manganese	4	246.	16	5.52	6	67.9				<2	
	4	457.	16	1,820	6	711.				7,000	

No. Samples = number of samples analyzed for a given parameter
Det = number of samples with detectable concentrations
Obs = total number of samples

Mean = mean of detected concentrations
Minimum = minimum detected concentration
Maximum = maximum detected concentration

The concentrations for metals in the earth's crust determined by the USGS are for the eastern United States (east of the 96^{th} meridian).

27. Figures 16-6 through 16-11 are plots of the trace metal concentrations in the sediment samples. Arsenic (Figure 16-6) was detected in all 37 of the sediment samples. The arsenic concentrations ranged from 2.83 to 73.6 milligram per kilogram (mg/kg) with a mean of 18.6 mg/kg. Concentrations in 23 of the 37 samples exceeded the ER-L of 8.2 mg/kg. In one sample (BS-12(93)), the concentration exceeded the ER-M of 70 mg/kg. However, this station was resampled during 1995. The concentration in the 1995 sample (BS-12(95)) was only 3.69 mg/kg. This discrepancy is extremely large and raises questions as to the validity of the sample concentrations. Also, a large discrepancy exists between the arsenic concentrations from the 1993 sample LS-12(93) and the 1995 sample LS-12(95). The LS-12(93) concentration is 40 mg/kg while the LS-12(95) concentration is 6.8 mg/kg. While the difference is not as large as that for the BS-12 samples, the difference is significant. A review of the remaining concentrations for the samples collected from the lower Big Sunflower area does not provide definite evidence as to the correct concentrations. Figure 16-6 shows that the arsenic levels were significantly higher in the samples collected from the lower Big Sunflower area than those from the other three areas. The mean of the samples collected from the lower Big Sunflower area was 28.55 mg/kg. Eighteen of the 20 samples exceeded the ER-L and the one sample concentration that exceeded the ER-M was located within this area. For comparison, the mean concentrations in the upper Big Sunflower area, the backwater lakes, and the Steele Bayou area were 9.6, 5.02, and 6.25 mg/kg, respectively.

28. Cadmium (Figure 16-7) was detected in 34 of the 37 sediment samples. The detected cadmium concentrations ranged 0.059 to 1.11 mg/kg with a mean of 0.49 mg/kg. None of the cadmium concentrations exceeded the ER-L of 1.2 mg/kg.

Figure 16-6
Arsenic in Sediment

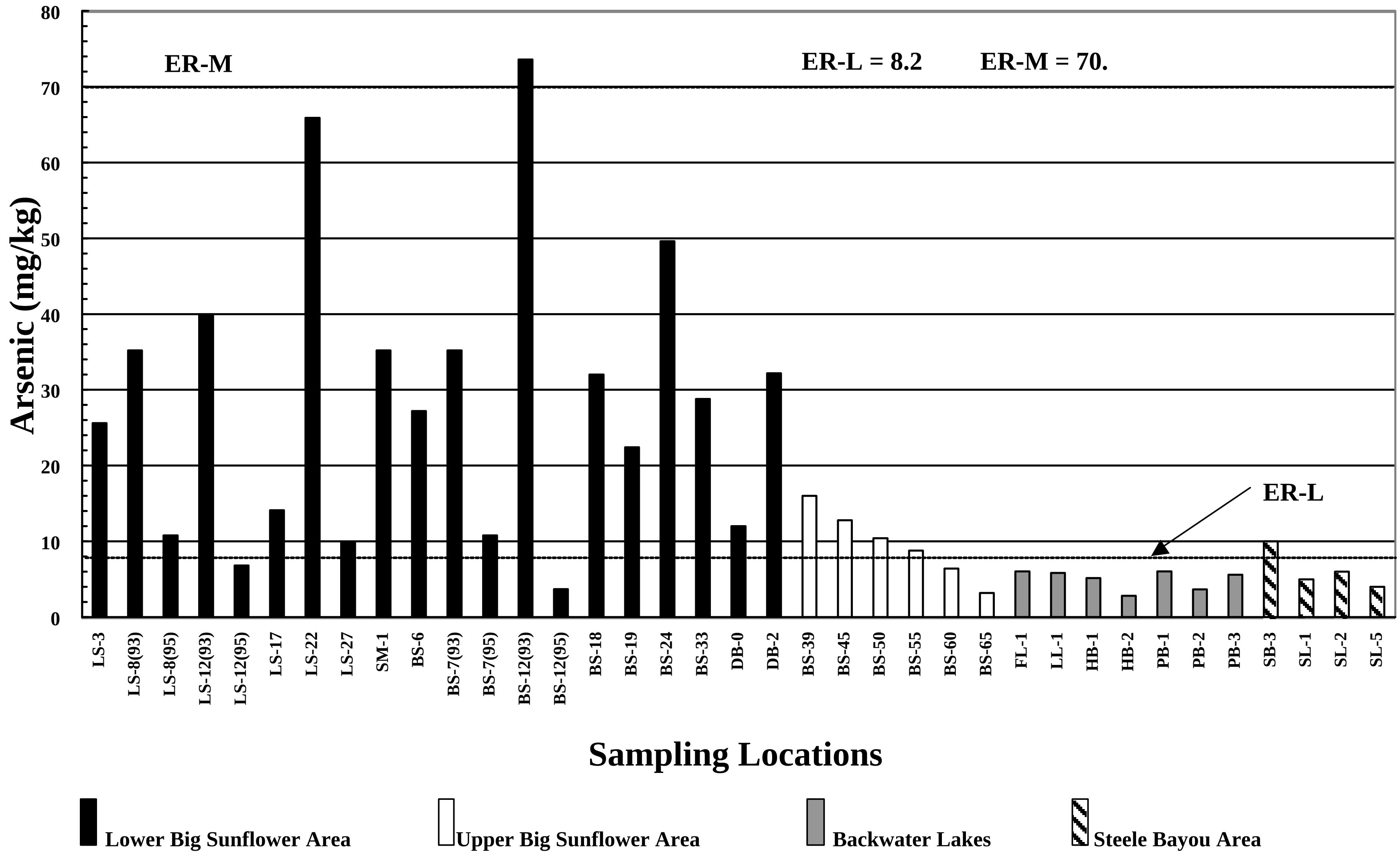


Figure 16-7
Cadmium in Sediment

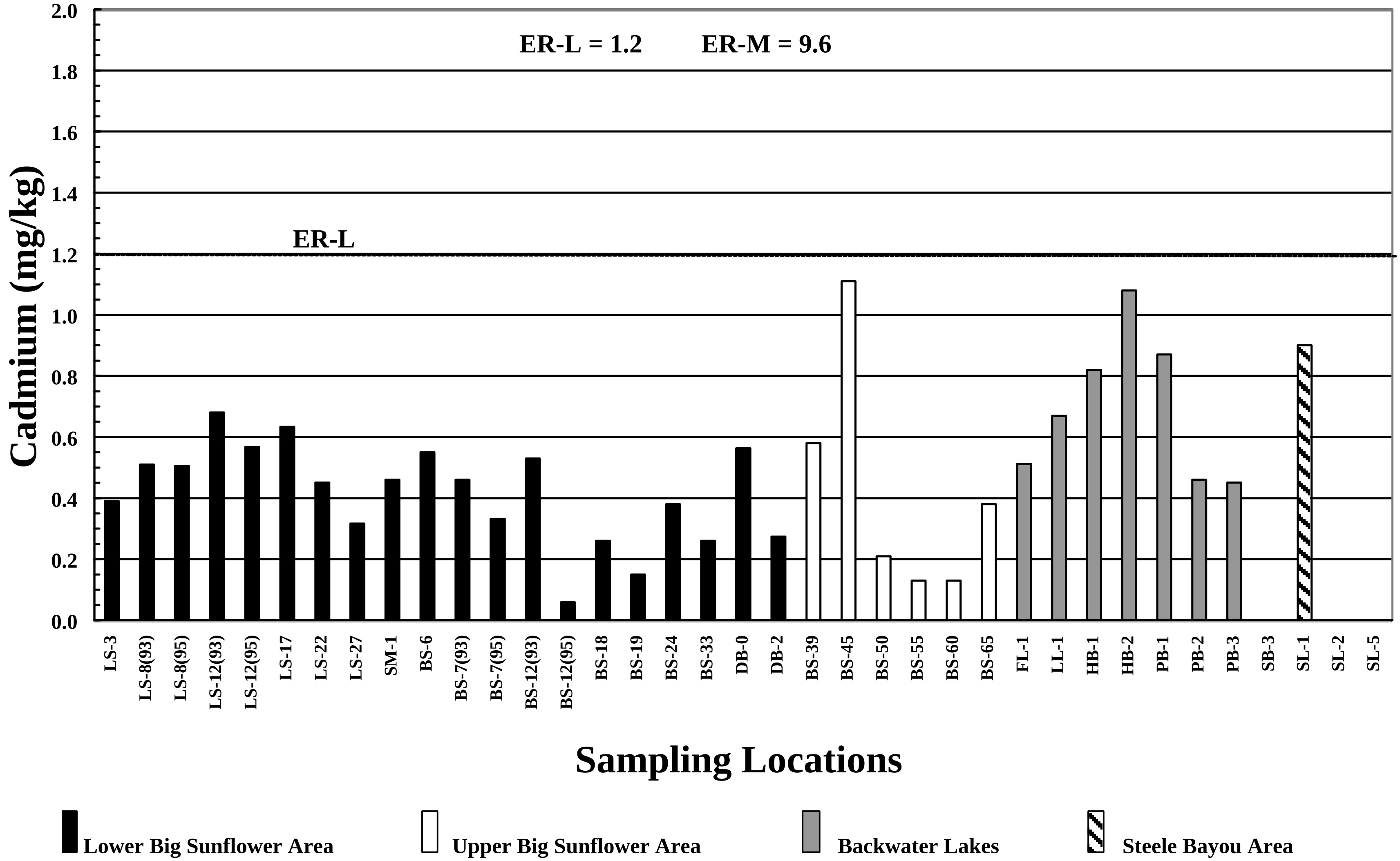


Figure 16-8
Copper in Sediment

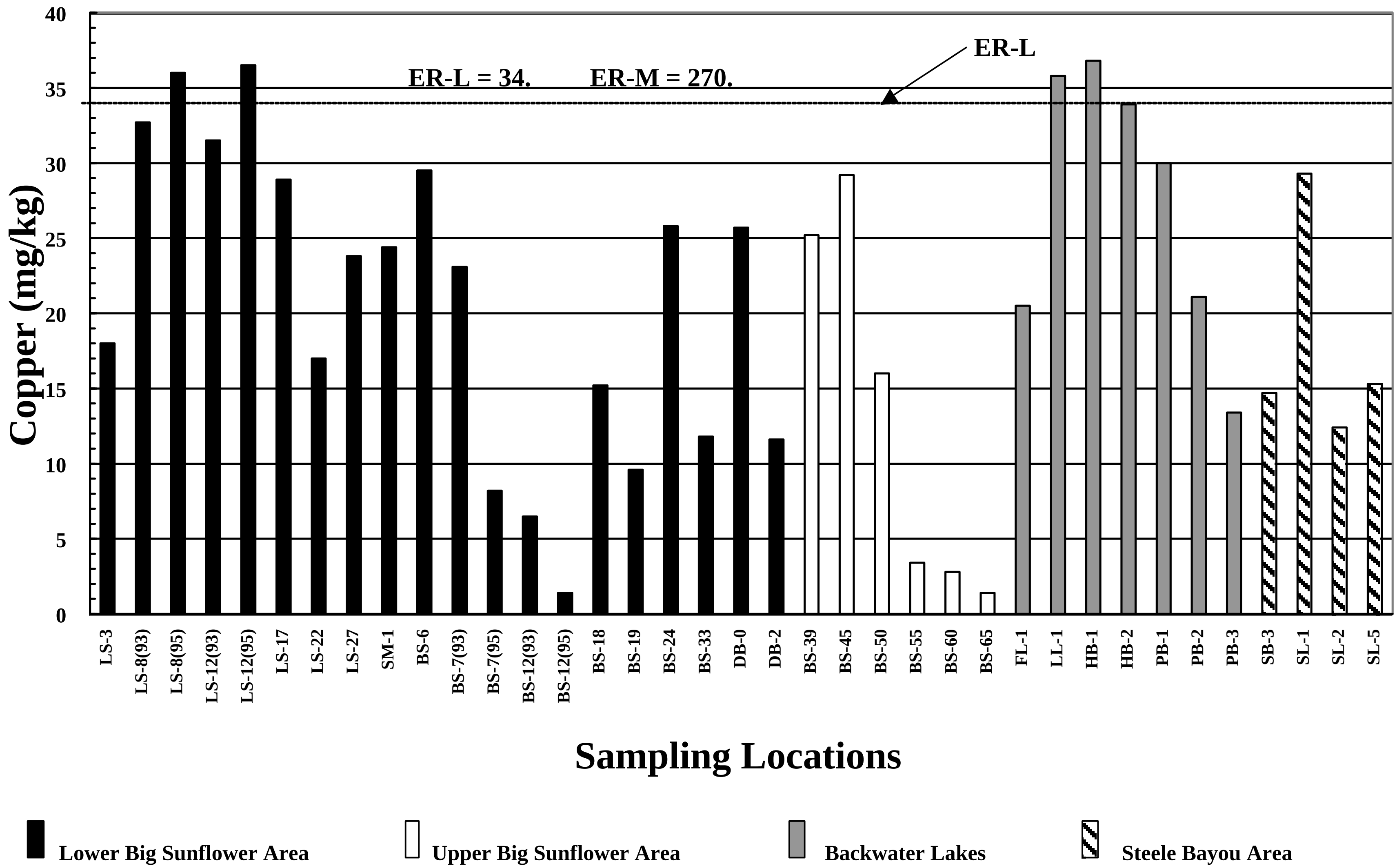


Figure 16-9
Mercury in Sediment

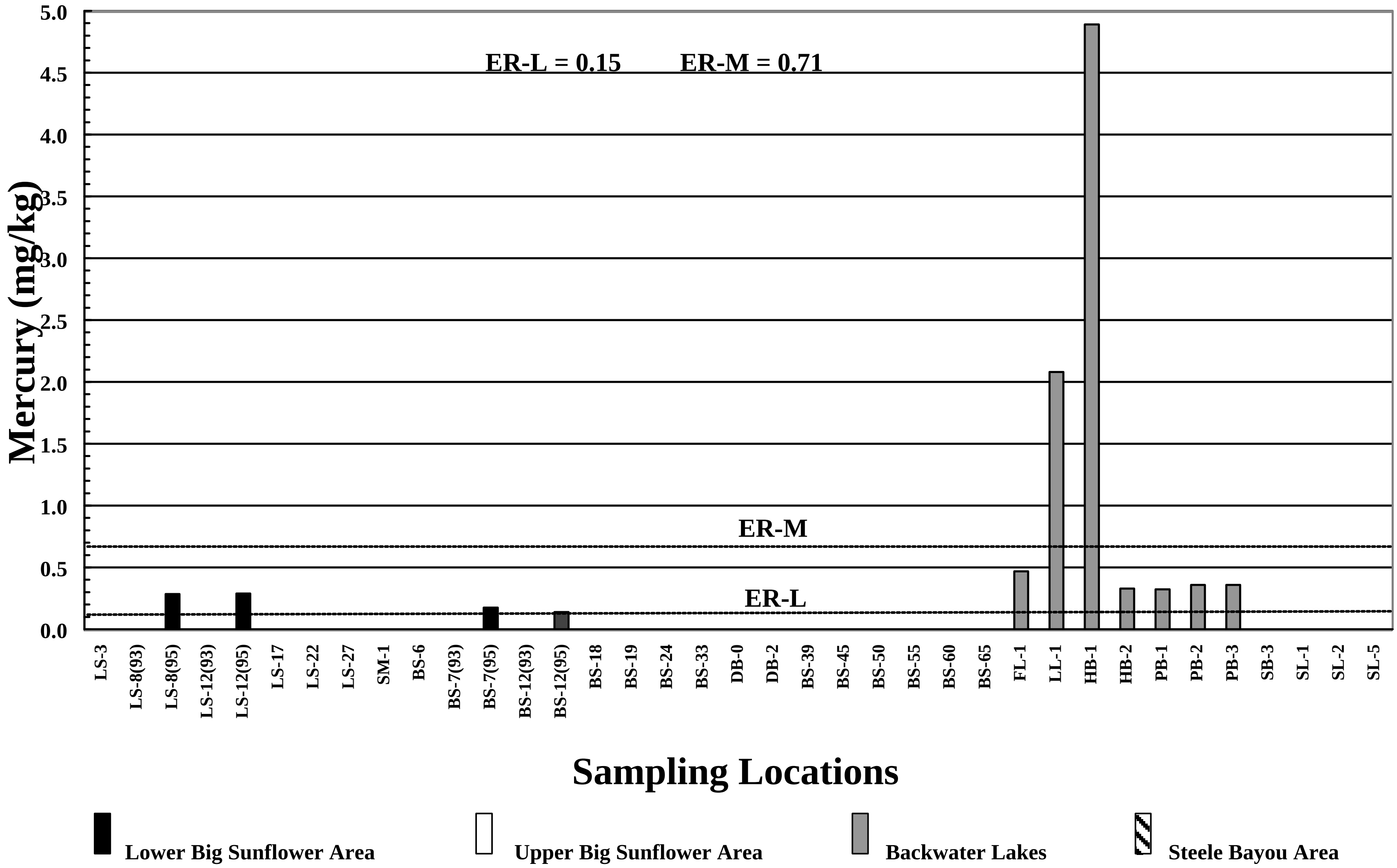


Figure 16-10
Nickel in Sediment

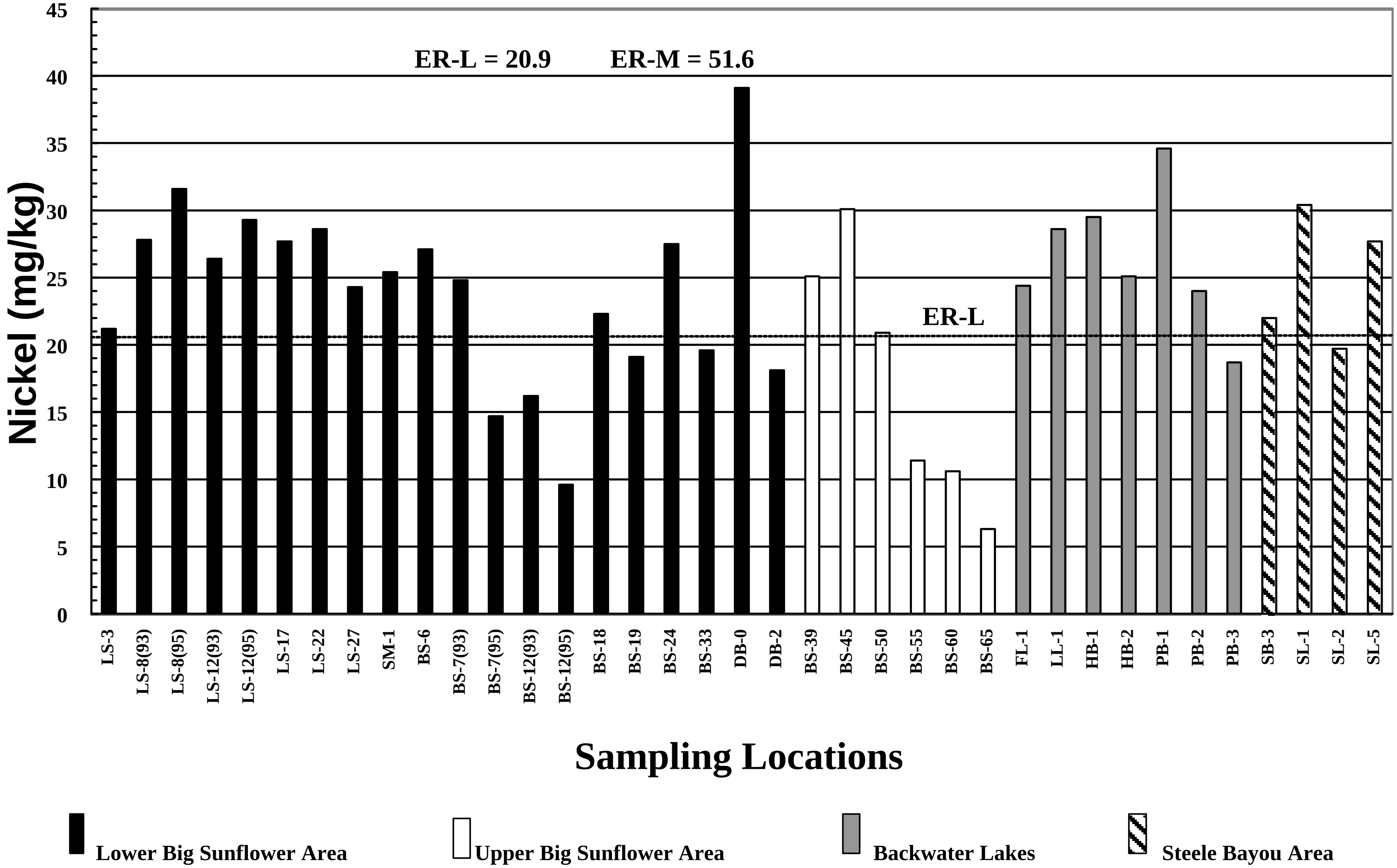
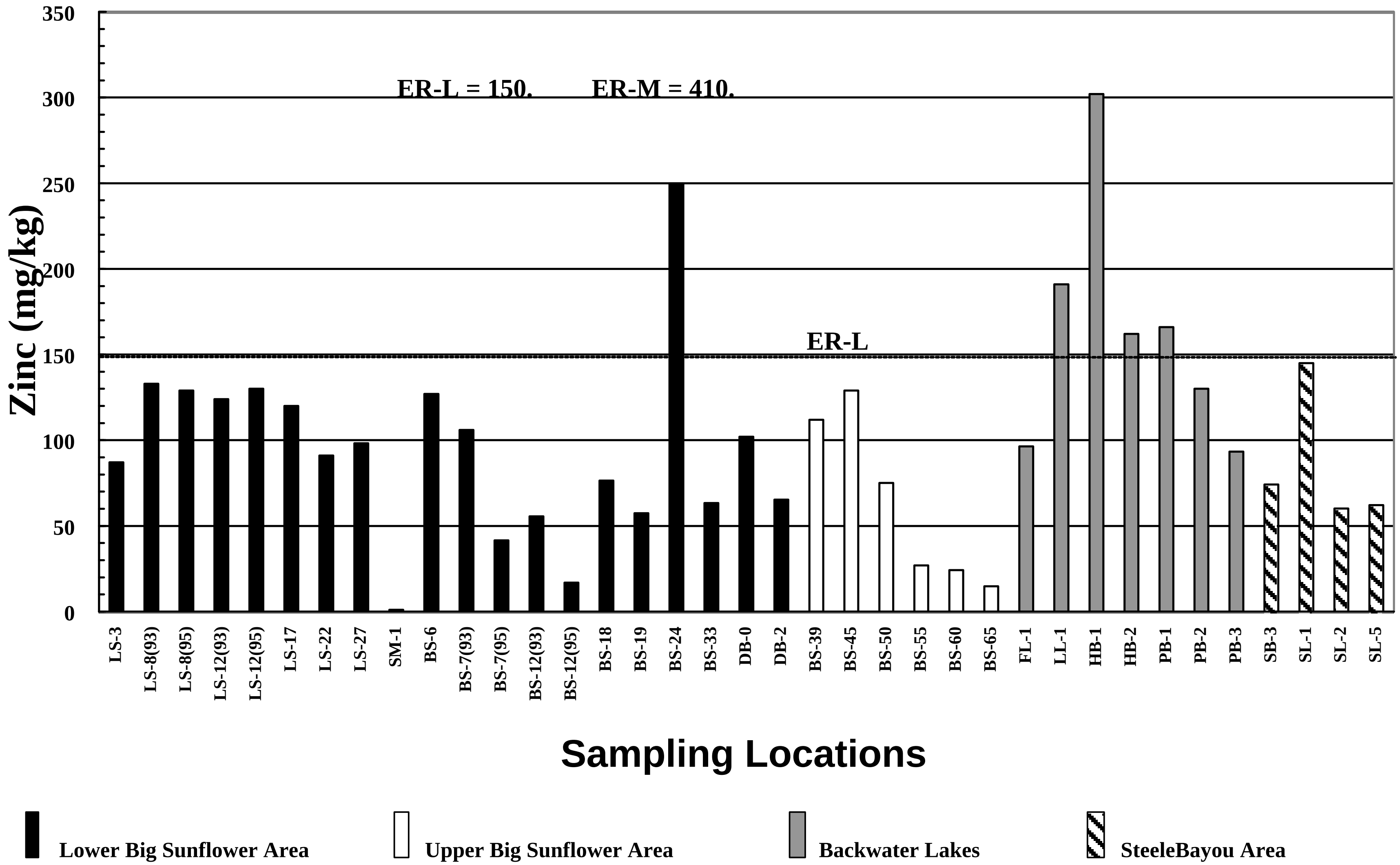


Figure 16-11
Zinc in Sediment



29. Copper (Figure 16-8) was detected in all 37 of the sediment samples. The copper concentrations ranged from 1.4 to 36.8 mg/kg with a mean of 20.5 mg/kg. Two of the 20 samples collected from the lower Big Sunflower area and 2 of the 7 samples collected from the backwater lakes exceeded the ER-L of 34 mg/kg.

30. Mercury (Figure 16-9) was detected in only 11 of the 37 sediment samples. The detected mercury concentrations ranged from 0.14 to 4.89 mg/kg with a mean of 0.88 mg/kg. Four of the 11 detected concentrations were collected from the lower Big Sunflower area. The remaining seven detected concentrations were collected from the backwater lakes. The concentrations of three of the four samples collected from the lower Big Sunflower area exceeded the ER-L of 0.15 mg/kg. All seven of the samples collected from the backwater lakes exceeded the ER-L and two of these concentrations exceeded the ER-M of 0.71 mg/kg.

31. Nickel (Figure 16-10) was detected in all 37 of the sediment samples. The nickel concentrations ranged from 6.3 to 39.1 mg/kg with a mean of 23.5 mg/kg. One of the 37 sample concentrations equaled the ER-L of 20.9 mg/kg and 25 other concentrations exceeded the ER-L.

32. Zinc (Figure 16-11) was detected in all 37 of the sediment samples. The zinc concentrations ranged from 1.09 to 302 mg/kg with a mean of 101.1 mg/kg. Five of the concentrations exceeded the ER-L of 150 mg/kg. Of these five concentrations, one was from the lower Big Sunflower area and the other four were from the backwater lakes. The mean concentration for the samples collected from the backwater lakes was significantly higher than that collected from the other three areas.

33. Chromium was detected in all 37 of the sediment samples. The chromium concentrations ranged from 3.5 to 44.6 mg/kg with a mean of 21.06 mg/kg. All of the 37 chromium concentrations were well below the ER-L of 81 mg/kg.

34. Lead was detected in 36 of the 37 water samples. The detected concentrations of lead ranged from 4.1 to 34.7 mg/kg with a mean of 18.1 mg/kg. All 36 of the detected lead concentrations were below the ER-L of 46.7 mg/kg.

35. The remaining metals were not analyzed in all 37 of the sediment samples. Selenium was analyzed in 33 of the samples and detected in 20 of those samples. The selenium detected concentrations ranged from 0.24 to 1.73 mg/kg with a mean of 0.535 mg/kg. Silver and Thallium were analyzed in 15 of the sediment samples. Silver was not detected in any of the analyzed samples. Thallium was detected in ten of the analyzed samples. Thallium detected concentrations ranged from 0.2 to 0.33 mg/kg with a mean of 0.23 mg/kg. Barium, iron, and manganese were analyzed in 26 sediment samples. All 3 of these metals were detected in all 26 of the samples. The barium concentrations ranged from 20.4 to 395 mg/kg with a mean of 184.6 mg/kg. The iron concentrations ranged from 3,620 to 37,800 mg/kg with a mean of 22,204 mg/kg. The manganese concentrations ranged from 5.5 to 1,820 mg/kg with a mean of 463 mg/kg. Cobalt was analyzed in 22 sediment samples and was detected in all 22 of the samples. The cobalt concentrations ranged from 2.6 to 12.2 mg/kg with a mean of 8.8 mg/kg. No national benchmark levels exist for selenium, thallium, barium, iron, manganese, and cobalt.

36. In summary, some of the sediment concentrations of some trace metals exceeded their ER-L's and ER-M's. Arsenic exceeded its ER-L in 23 samples, copper in 9, mercury in 10, nickel in 25, and zinc in 5. One of the arsenic concentrations and two of the mercury concentrations exceeded their ER-M's. Therefore, based on the NOAA report, the locations in which the concentrations exceeded the ER-L, but not the ER-M, biological effects due to that level of contamination would be expected to occasionally occur. At the locations where the concentrations exceed the ER-M, biological effects due to that level of contamination would be expected to frequently occur. In general, the highest sediment trace metal concentrations were observed in the seven sediment samples

collected from the backwater lakes. In addition, the zinc concentrations in the water samples collected from the backwater lakes were much higher than had been previously observed. Since these lakes are isolated and there is no apparent reason for the high trace metal findings, further testing of these lakes will be performed in order to verify or refute these results.

37.   In the previous paragraph, the observed sediment metals concentrations were compared to the NOAA ER-L and ER-M benchmarks. These observed concentrations exceeded the ER-L and the ER-M for several trace metals. The methods used to derive these benchmarks may be reasonable for manmade organic compounds, but they failed to take into account the naturally occurring levels of the trace metals. It is unlikely that aquatic organisms will be susceptible to trace metals in the range of concentrations that they occur naturally. A measure of the reasonableness of an ER-L for trace metals might be the difference between the ER-L and the mean concentration that occurs naturally in the earth's surface of that trace metal. As previously stated, Bowen and USGS provide a range of naturally occurring concentrations for trace metals (Table 16-5). Three metals whose observed sediment concentrations frequently exceeded their respective ER-L's were arsenic, nickel, and mercury. For each of these metals, their mean concentrations as reported by USGS that occur in the earth's crust are very close to the ER-L level. For arsenic, the mean concentration in the earth's crust is 7.4 mg/kg and the ER-L is 8.2 mg/kg. The observed concentrations for arsenic exceeded the ER-L in 23 of the 37 samples collected for the Yazoo Backwater study. For nickel, the USGS mean concentration is 18 mg/kg and the ER-L is 20.9 mg/kg. Twenty-six of the 37 samples contained nickel concentrations that equaled or exceeded the ER-L. For mercury, the mean concentration is 0.12 mg/kg while the ER-L is 0.15 mg/kg. Mercury was detected in only 11 of the 37 sediment samples. However, the concentrations in 10 of these 11 samples exceeded the ER-L.

38. The accuracy of the benchmarks was tested in a study published in 1995 (Long, et al.). The study evaluated the incidence of biological effects to the benchmarks. The authors used four criteria to evaluate the reliability of the benchmarks. Those criteria are (a) the benchmarks agreed closely with the results of other studies (within factors of 3.0 or less); (b) the incidence of effects was low (<25 percent) in the minimal effects ranges; (c) the incidence of effects increased consistently and markedly in concordance with increasing chemical concentrations; and (d) the incidence of effects was very high (>75 percent) in the probable effects ranges. Arsenic, nickel, and mercury all had a low observed percent incidence of effects (<25 percent) in the range for samples with concentrations between their respective ER-L's and ER-M's. The low incidences of effect and the closeness of the ER-L's to the respective means that occur naturally in the earth's surface suggest that the benchmark levels for these three metals may be too low. The observed incidences of effects for all the trace metals are based primarily on co-occurrence analyses. When a biological effect of a sediment sample is observed, all contaminants present in that sample are assumed responsible, when in fact, the effect may be due to only one or two of the contaminants. This method likely produces many false positive results.

FISH TISSUE QUALITY

39. Fish tissue quality tends to reflect sediment and water quality. Contaminant levels in fish are important because of the potential impacts to both fish and humans. High contaminant levels can result in acute or chronic responses in the fish. Also, contaminant levels provide a gage for consideration by human consumers. Because of the impact to humans, EPA recommends a tiered sampling program for contaminants. Initially, water and sediment samples are collected and analyzed for pollutants such as metals and

pesticides. If concentrations are within national and/or state criteria, no additional testing is required. However, if concentrations are high, the EPA recommends fish tissue sampling. Since the water and sediment samples collected within the backwater area contained high levels of several contaminants, a fish tissue sampling program was conducted within the Big Sunflower River basin during 1993 and 1994. The sampling included the collection of 49 fish specimens. These specimens included 5 paddlefish, 5 blue catfish, 5 flathead catfish, 10 short nose gar, 14 smallmouth buffalo, and 10 bigmouth buffalo. These specimens were analyzed for both metals and pesticides. Table 16-6 provides the pertinent data for the analyzed fish. The data include the species, the sample name, the sampling location, the date collected, and the length and weight of each fish.

40. The primary concern with high sediment pesticide levels within the Mississippi Delta is the potential for bioaccumulation and biomagnification in the aquatic food chain. The effects of pesticides upon fish and other aquatic organisms have been intensely studied and documented. Pesticide levels, especially DDT, in fish collected from the Delta have been monitored for years. Cotton and Herring conducted one of the first studies in 1969. Total DDT fish tissue levels in that study ranged from 0.5 mg/kg to 29.0 mg/kg. A subsequent study in 1974 found DDT fish tissue levels ranging from 0.05 to 9.1 mg/kg. Fish tissue levels exceeding the Food and Drug Administration (FDA) action levels in three Delta lakes (Wolf, Mossy, and Washington) forced their closing to commercial fishing in 1973. Mossy Lake and Lake Washington were reopened in 1977 after their fish tissue levels dropped below the FDA maximum allowable levels. Wolf Lake remained closed until 1982.

TABLE 16-6
PERTINENT DATA FOR ANALYZED FISH

Species	Sample	Sampling Location	Date Collected	Length (cm)	Weight (kg)
Blue Catfish	BCF03	Station 9	14-Oct-93	43.5	0.60
Blue Catfish	BCF05	Station 9	14-Oct-93	42.6	0.71
Blue Catfish	BCF06	Station 9	14-Oct-93	51.2	0.96
Blue Catfish	BCF07	Station 9	14-Oct-93	43.0	0.62
Blue Catfish	BCF18	Station 11	15-Oct-93	62.5	2.72
Flathead Catfish	FC06	Station 2	14-Sep-94	66.9	2.86
Flathead Catfish	FC07	Station 3	16-Sep-94	64.1	2.61
Flathead Catfish	FC08	Station 4	19-Sep-94	70.3	3.32
Flathead Catfish	FC09	Station 1	19-Sep-94	72.0	3.80
Flathead Catfish	FC10	Station 1	19-Sep-94	70.0	4.99
Paddlefish	PF01	Station 1	02-Nov-94	141.0	9.10
Paddlefish	PF02	Station 1	02-Nov-94	124.0	7.77
Paddlefish	PF03	Station 1	02-Nov-94	127.6	8.48
Paddlefish	PF04	Station 1	02-Nov-94	128.7	8.16
Paddlefish	PF05	Station 1	02-Nov-94	126.0	3.88
Shortnose Gar	SGF01	Station 9	14-Oct-93	50.5	0.62
Shortnose Gar	SGF04	Station 9	14-Oct-93	63.0	1.39
Shortnose Gar	SGF08	Station 9	14-Oct-93	50.2	0.57
Shortnose Gar	SGF16	Station 11	14-Oct-93	60.5	1.02
Shortnose Gar	SGF17	Station 11	14-Oct-93	60.3	0.91
Shortnose Gar	SG11	Station 3	18-Sep-94	84.0	2.84
Shortnose Gar	SG12	Station 3	18-Sep-94	80.0	2.15
Shortnose Gar	SG13	Station 2	18-Sep-94	64.0	0.71
Shortnose Gar	SG14	Station 1	12-Oct-94	76.0	1.47
Shortnose Gar	SG15	Station 1	12-Oct-94	69.8	1.13
Smallmouth Buffalo	SBF02	Station 9	14-Oct-93	46.0	1.36
Smallmouth Buffalo	SBF10	Station 11	14-Oct-93	46.5	1.28
Smallmouth Buffalo	SBF11	Station 11	14-Oct-93	45.1	1.25
Smallmouth Buffalo	SBF12	Station 11	14-Oct-93	57.1	3.06
Smallmouth Buffalo	SBF13	Station 11	14-Oct-93	40.0	0.96
Smallmouth Buffalo	SBF19	Station 11	15-Oct-93	39.6	0.96
Smallmouth Buffalo	SBF21	Station 11	15-Oct-93	49.1	1.42
Smallmouth Buffalo	SBF23	Station 11	15-Oct-93	34.0	0.60
Smallmouth Buffalo	SBF24	Station 11	15-Oct-93	38.0	0.82
Smallmouth Buffalo	SB19	Station 3	16-Sep-94	40.8	1.02
Smallmouth Buffalo	SB20	Station 3	16-Sep-94	40.0	0.57
Smallmouth Buffalo	SB16	Station 2	18-Sep-94	46.0	1.47
Smallmouth Buffalo	SB17	Station 2	18-Sep-94	45.8	1.47
Smallmouth Buffalo	SB18	Station 1	02-Nov-94	51.0	2.04
Bigmouth Buffalo	BBF09	Station 11	14-Oct-93	53.0	2.21
Bigmouth Buffalo	BBF15	Station 11	14-Oct-93	51.8	2.38
Bigmouth Buffalo	BBF15	Station 11	14-Oct-93	40.3	0.99
Bigmouth Buffalo	BBF20	Station 11	15-Oct-93	52.4	2.15
Bigmouth Buffalo	BBF22	Station 11	15-Oct-93	42.7	1.16
Bigmouth Buffalo	BB21	Station 4	10-Sep-94	57.0	3.12
Bigmouth Buffalo	BB24	Station 2	18-Sep-94	62.9	4.31
Bigmouth Buffalo	BB22	Station 1	12-Oct-94	59.1	3.97
Bigmouth Buffalo	BB23	Station 1	12-Oct-94	60.1	4.54
Bigmouth Buffalo	BB25	Station 1	12-Oct-94	57.9	3.43

Table 16-6 (Cont)

Station Locations

Station 1 is located on the Big Sunflower River (Washington County), Mississippi, at Osceola Gravel Pit, 3.8 river miles downstream of the mouth of Bogue Phalia. Section 21, Township 16 North, Range 5 West.

Station 2 is located on the Big Sunflower River (Sunflower County), Mississippi, near Dutch Bayou, 0.8 river miles downstream of Kinlock. Section 27, Township 17 North, Range 5 West.

Station 3 is located on the Big Sunflower River (Sunflower County), Mississippi, 2.4 river miles northeast of Highway 49 West bridge. Section 10, Township 18 North, Range 4 West.

Station 4 is located on the Big Sunflower River (Sunflower County), Mississippi, 1.1 river miles southwest of Highway 49 West bridge. Section 18, Township 18 North, Range 4 West.

Station 9 is located on the Holly Bluff Cutoff (Sharkey County), Mississippi, at the Dowling Bayou Greentree Reservoir pump station. Section 6, Township 12 North, Range 5 West.

Station 11 is located on the Big Sunflower River (Sharkey County), Mississippi, near Choctaw Bayou. Section 22, Township 12 North, Range 5 West.

41. EPA has developed screening values (SV) for certain contaminants based on risk assessment. The SV for total DDT is 0.3 mg/kg. This SV is based on the risk of one person in 100,000 contracting cancer from a lifetime of exposure. Exposure includes ingestion. Also, the FDA has developed an action limit of 5.0 mg/kg for DDT and its metabolites. The FDA action limits were created to protect humans that consume fish from high levels of pesticides. This action limit is not meant to imply that fish with tissue levels less than the action limit are necessarily safe. Table 16-7 lists the pesticides with detectable concentrations found within the tissue of the analyzed fish collected from the Big Sunflower River Basin during 1993 and 1994. Table 16-7 provides the mean, minimum, and maximum concentrations for groups consisting of all fish and of each species. All 49 of the fish were tested for aldrin, A-BHC, D-BHC, methoxychlor, and chlordane. None of these pesticides were detected in any of the sampled fish. Endosulfan sulfate and endrin were detected in 1 fish, B-BHC and endosulfan I were detected in 2 fish, endosulfan II in 5 fish, heptachlor epoxide in 6 fish, G-BHC in 8 fish, heptachlor in 16 fish, dieldrin in 21 fish, toxaphene in 22 fish, and endrin aldehyde and ppDDE in 25 fish. Both ppDDD and ppDDT were detected in all 49 fish. Therefore, total DDT (DDE + DDD + DDT) was calculated for each fish. Figure 16-12 is a plot of the total DDT detected in the tissue of each analyzed fish. The total DDT concentrations ranged from 0.052 to 12.37 mg/kg with a mean of 2.016 mg/kg. Forty of the 49 sampled fish contained total DDT concentrations that exceeded the SV and 6 contained concentrations that exceeded the FDA action limit.

TABLE 16-7
DETECTABLE FISH TISSUE PESTICIDE CONCENTRATIONS

	Pesticide Concentration (mg/kg)						
Pesticide	**All Fish**	**Paddlefish**	**Flathead Catfish**	**Blue Catfish**	**Shortnose Gar**	**Small Mouth Buffalo**	**Big Mouth Buffalo**
B-BHC							
Mean	0.0419					0.0419	
Minimum	0.0017					0.0017	
Maximum	0.082					0.082	
Det/Obs	2/49	0/5	0/5	0/5	0/10	2/14	0/10
G-BHC							
Mean	0.0018			0.0017	0.0017	0.0018	0.0024
Minimum	0.0009			0.0009	0.0011	0.0011	
Maximum	0.0026			0.0026	0.0022	0.0024	
Det/Obs	8/49	0/5	0/5	3/5	2/10	2/14	1/10
ppDDD							
Mean	0.6541	0.838	0.274	0.268	1.1549	0.6892	0.3952
Minimum	0.038	0.29	0.11	0.05	0.291	0.048	0.038
Maximum	3.13	1.39	0.58	0.788	3.13	2.91	1.22
Det/Obs	49/49	5/5	5/5	5/5	10/10	14/14	10/10
ppDDE							
Mean	2.1116	1.376	0.732		4.304	2.47	1.676
Minimum	0.29	0.52	0.29		0.79	0.36	0.48
Maximum	7.83	2.28	1.12		7.35	7.83	4.37
Det/Obs	25/49	5/5	5/5	0/5	5/10	5/14	5/10
ppDDT							
Mean	0.2844	0.193	0.0988	0.0559	0.3893	0.3371	0.3584
Minimum	0.0015	0.055	0.051	0.0015	0.054	0.011	0.021
Maximum	1.65	0.3	0.21	0.198	0.99	1.63	1.65
Det/Obs	49/49	5/5	5/5	5/5	10/10	14/14	10/10
Heptachlor							
Mean	0.0040			0.0014	0.0034	0.0037	0.0053
Minimum	0.0014				0.0014	0.0014	0.0035
Maximum	0.0092				0.0046	0.0071	0.0092
Det/Obs	16/49	0/5	0/5	1/5	3/10	7/14	5/10
Dieldrin							
Mean	0.0397	0.0464	0.028	0.028	0.0304	0.0578	0.0336
Minimum	0.0083	0.011	0.023		0.018	0.016	0.0083
Maximum	0.14	0.092	0.033		0.05	0.14	0.077
Det/Obs	21/49	5/5	2/5	1/5	5/10	4/14	4/10
Endosulfan I							
Mean	0.0675					0.113	0.022
Minimum	0.022						
Maximum	0.113						
Det/Obs	2/49	0/5	0/5	0/5	0/10	1/14	1/10
Endosulfan II							
Mean	0.0203		0.016		0.0092	0.025	0.042
Minimum	0.0053				0.0053		
Maximum	0.042				0.013		
Det/Obs	5/49	0/5	1/5	0/5	2/10	1/14	1/10
Endosulfan Sulfate							
Mean	0.0017			0.0017			
Minimum							
Maximum							
Det/Obs	1/49	0/5	0/5	1/5	0/10	0/14	0/10
Endrin							
Mean	0.18					0.18	
Minimum							
Maximum							
Det/Obs	1/49	0/5	0/5	0/5	0/10	1/14	0/10
Endrin Aldehyde							
Mean	0.0485			0.0107	0.0243	0.0794	0.0539
Minimum	0.0015			0.0022	0.007	0.0016	0.0015
Maximum	0.25			0.036	0.043	0.21	0.25
Det/Obs	25/49	0/5	0/5	5/5	5/10	9/14	6/10

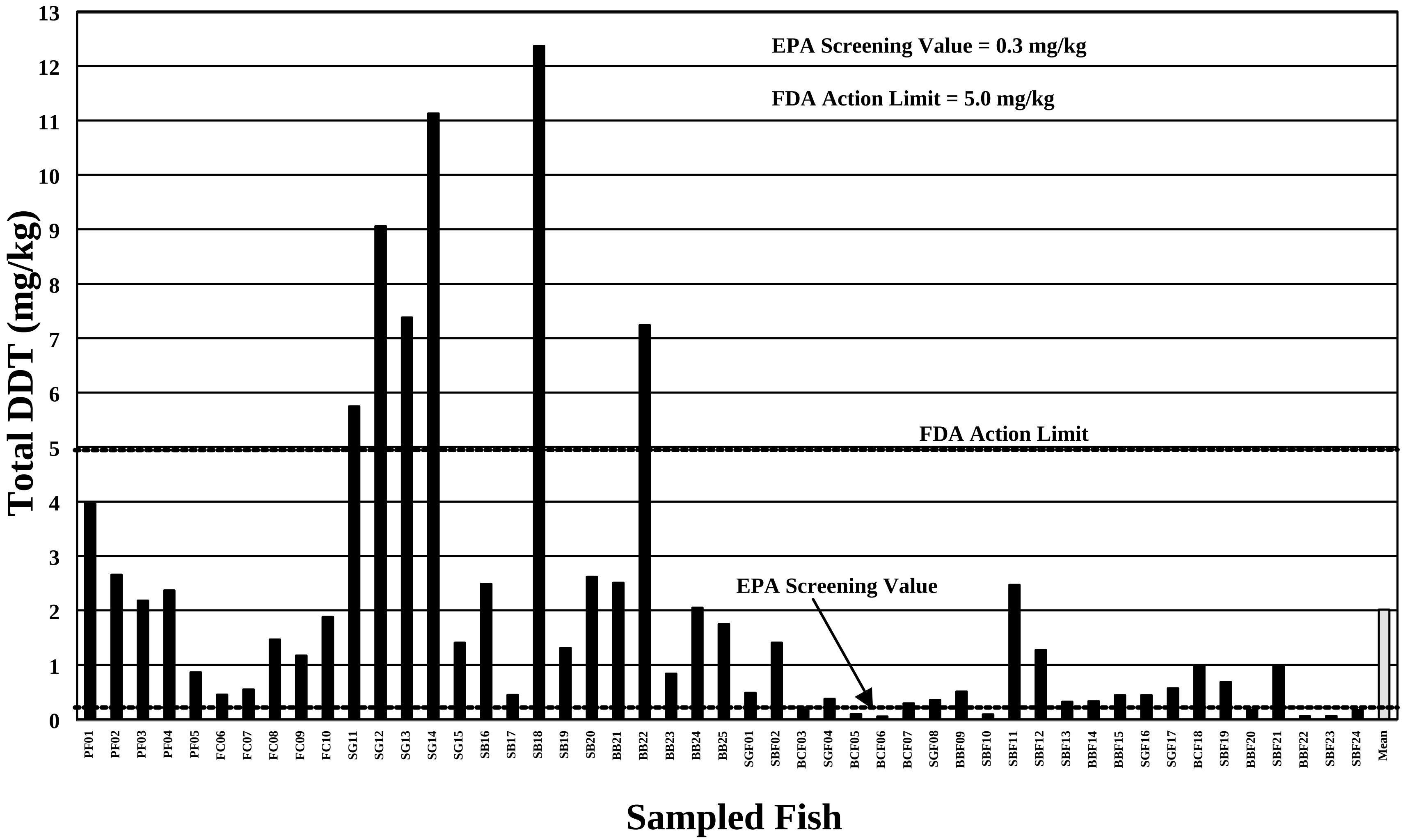
TABLE 16-7 (Cont)

Pesticide	Pesticide Concentration (mg/kg)						
	All Fish	**Paddlefish**	**Flathead Catfish**	**Blue Catfish**	**Shortnose Gar**	**Small Mouth Buffalo**	**Big Mouth Buffalo**
Heptachlor Epoxide							
Mean	0.0067	0.034		0.0014	0.0012	0.0013	
Minimum	0.0005			0.0013	0.0005		
Maximum	0.034			0.0014	0.002		
Det/Obs	6/49	1/5	0/5	2/5	2/10	1/14	0/10
Toxaphene							
Mean	1.5127	2.272	0.752		1.98	1.79	0.7225
Minimum	0.22	0.72	0.32		0.57	0.45	0.22
Maximum	4.9	4.9	1.62		2.92	3.8	1.03
Det/Obs	22/49	5/5	5/5	0/5	5/10	3/14	4/10

Mean = mean of detectable concentrations
Minimum = minimum detectable concentration
Maximum = maximum detectable concentration
Det/Obs = number of fish with detectable concentrations/total number of sampled fish

All fish were tested for Aldrin, A-BHC, D-BHC, Methoxychlor, and Chlordane. None of these pesticides were detected in any of the sampled fish.

Figure 16-12
Total DDT in Fish Tissue



42. Although some of the observed metals levels in the sediment samples were high, these concentrations have not led to high metals concentrations in fish tissue. This is due to the fact that most metals in the sediments are not readily bioavailable. Thus, the sediment concentrations of metals are not necessarily a good indicator of fish tissue quality. For example, arsenic was detected in all 37 of the sediment samples and as discussed previously, the concentrations in these samples were high. However, arsenic was detected in only 9 of the 49 sampled fish. On the other hand, mercury was detected in only 11 of the 37 sediment samples but mercury was detected in all 49 of the sampled fish. In the fish tissue, mercury levels ranged from 0.06 to 1.56 mg/kg with a mean of 0.42 mg/kg. Two of the fish contained mercury levels that exceeded the FDA action level of 1.0 mg/kg. Other metals were also detected in the fish samples. Chromium was detected in 8 of the 49 sampled fish, lead in 11, nickel in 30, manganese in 32, cadmium in 37, copper in 40, iron and selenium in 46, and zinc in all 49. The fish tissue samples were also analyzed for barium and cobalt, but neither of these two metals was detected in any of the fish. Table 16-8 provides the fish tissue data for these priority pollutant metals.

43. The State of Mississippi has established "levels of concern" for six trace metals. These levels of concern are not regulatory levels and there are no known health risks associated with them. They are simply levels that were selected for use in screening the data and for regional comparison of data. The levels of concern are 1.0 mg/kg for arsenic lead, selenium, cadmium, and chromium and 5.0 mg/kg for copper. None of the fish tissue samples collected from the backwater area contained concentrations that equaled or exceeded the state levels for arsenic, copper, lead, and selenium. For cadmium, one sample concentration equaled its level. For chromium, one sample concentration exceeded its level of concern.

TABLE 16-8
PRIORITY POLLUTANT METAL CONCENTRATIONS IN FISH TISSUE

Fish	Metal (mg/kg)										
	AS	**CD**	**CR**	**CU**	**PB**	**HG**	**NI**	**SE**	**ZN**	**FE**	**MN**
All Fish											
Mean	0.301	0.138	0.348	0.419	0.153	0.422	0.556	0.422	25.32	18.85	0.695
Minimum	0.031	0.02	0.1	0.1	0.1	0.06	0.1	0.18	4.4	3.15	0.1
Maximum	0.64	1	1.32	1.93	0.4	1.563	2.84	0.98	159.	106.	2.58
Det/Obs	9/49	37/49	8/49	40/49	11/49	49/49	30/49	46/49	49/49	46/49	32/49
Paddlefish											
Mean	0.344	0.290		0.394		0.091	0.138	0.404	25.52	7.796	0.115
Minimum	0.031	0.025		0.31		0.06	0.11	0.31	18.6	4.6	0.1
Maximum	0.64	0.44		0.64		0.173	0.16	0.56	40.6	16.3	0.13
Det/Obs	5/5	3/5	0/5	5/5	0/5	5/5	4/5	5/5	5/5	5/5	4/5
Flathead Catfish											
Mean		0.055	0.1	0.37		0.76	0.27	0.288	37.7	4.75	0.205
Minimum		0.026		0.33		0.332	0.12	0.21	19.9	3.15	0.11
Maximum		0.098		0.41		1.563	0.57	0.36	46.2	5.62	0.3
Det/Obs	0/5	5/5	1/5	5/5	0/5	5/5	5/5	4/5	5/5	4/5	2/5
Blue Catfish											
Mean		0.074	0.45	0.87		0.228	1.36	0.21	17.92	25.98	1.076
Minimum		0.029		0.29		0.107	0.1	0.18	7.09	12.2	0.585
Maximum		0.153		1.93		0.419	2.84	0.23	50.1	64.6	2.58
Det/Obs	0/5	5/5	1/5	4/5	0/5	5/5	4/5	3/5	5/5	5/5	5/5
Shortnose Gar											
Mean	0.253	0.202	0.488	0.419	0.215	0.495	0.441	0.294	25.69	40.68	0.861
Minimum	0.21	0.039	0.13	0.1	0.1	0.337	0.1	0.22	4.54	5.27	0.1
Maximum	0.3	0.929	1.32	0.67	0.4	0.858	0.97	0.45	86.3	106.	1.98
Det/Obs	3/10	7/10	4/10	9/10	4/10	10/10	7/10	10/10	10/10	10/10	10/10
Small Mouth Buffalo											
Mean		0.081	0.16	0.346	0.123	0.388	0.618	0.634	28.76	14.50	0.652
Minimum		0.02		0.1	0.1	0.129	0.1	0.26	4.4	6.84	0.15
Maximum		0.29		0.78	0.18	1.137	1.67	0.98	159.	34.5	1.36
Det/Obs	0/14	12/14	1/14	10/14	4/14	14/14	6/14	14/14	14/14	14/14	9/14
Big Mouth Buffalo											
Mean	0.23	0.24	0.12	0.316	0.11	0.489	0.635	0.38	17.55	8.7	0.75
Minimum		0.03		0.1	0.1	0.266	0.35	0.23	4.77	4.18	0.5
Maximum		1.		0.45	0.13	0.918	1.39	0.61	32.5	17.5	1.
Det/Obs	1/10	5/10	1/10	7/10	3/10	10/10	4/10	10/10	10/10	8/10	2/10
FWS National Contaminant Study											
Mean	0.16	0.04		0.86	0.19	0.11		0.46	25.63		
Minimum	0.04	0.01		0.29	0.10	0.01		0.09	7.69		
Maximum	2.08	0.41		38.75	6.73	1.10		3.65	168.1		
EPA Safe Value for Human Consumption	3.0	10.0				0.6		50.0			
State of Mississippi Levels of Concern	1.0	1.0	1.0	5.0	1.0			1.0			

Mean = mean of detectable concentrations
Minimum = minimum detectable concentration
Maximum = maximum detectable concentration
Det/Obs = number of fish with detectable concentrations/total number of sampled fish

All fish were tested for Barium and Cobalt. Neither of these two metals were detected in any of the sampled fish.

RISK ASSESSMENT FOR FISH CONSUMPTION

44. The accumulation of pesticides and trace metals in fish poses a potential human health risk. Some of the organochlorine pesticides are proven carcinogens. Many of these pesticides and some trace metals can also cause chronic health problems in human consumers of the fish. In order to evaluate these risks, EPA has established procedures for estimating the risk of cancer or chronic ailments to human consumers (USEPA, 1995). As part of the assessment procedure, EPA has developed equations for determining screening values (SV's) for contaminants in fish tissue. This paragraph will use EPA procedures to calculate the SV's for carcinogenic (SVC) and noncarcinogenic (SVN) contaminants. The observed contaminant levels for these compounds will be compared to the SV's. In addition, the maximum number of meals that can safely be consumed per month of the carcinogens and the noncarcinogens will be calculated. Some of the organochlorine pesticides pose both a chronic and a carcinogenic risk to human consumers, the maximum number of meals consumed per month will be calculated for both of these cases. The equation used to determine the SVC is calculated with the following equation:

$$SVC = [(RL/SF) * BW] / CR \quad \text{Eqn. WQ1}$$

Where:

RL = Risk Level or Maximum Acceptable Risk,

SF = Slope Factor or Cancer Potency Factor in (mg/kg/day)-1; derived from EPA’s IRIS database,

BW = Body Weight; assumed to be 70 kg and,

CR = Consumption Rate in kg/day.

The SVN for noncarcinogens is calculated with this equation:

$$SVN = RfD * BW / CR \quad \text{Eqn. WQ2}$$

Where:

RfD = Oral reference dose in mg/kg/day.

The RfD's and SF's for the pesticides and trace elements of concern are listed in Table 16-9. Also included in the table are the two SV's for each contaminant calculated using a RL of 10^{-5}, a BW of 70 kg, and a CR of .0075 kg which is equal to one 8-ounce meal a month (30.4 days). These parameters were used based on EPA's recommendations. When the information to calculate both SV's was available, both were calculated and the more conservative is printed in bold type. Table 16-9 also provides the mean and maximum observed concentrations of the contaminants from this study. In the final two columns, the mean and maximum observed concentrations of each contaminant are divided by the more conservative SV. When the result is greater than one, the contaminant concentration exceeds the SV. The maximum observed contaminant concentrations for the three contaminants, mercury, hexachlorobenzene, and heptachlor Epoxide, exceed the SV. The mean and the maximum concentrations reported for arsenic, DDT, dieldrin, and Toxaphene exceeded their respective SV's.

TABLE 16-9
FISH TISSUE CONTAMINANT SCREENING VALUES

Pesticide	RfD	SV-N	SF	SV-C	Mean	Maximum	Mean/SV	Maximum/SV
Arsenic	0.0004	3.7	1.75	0.05	0.301	0.64	5.6	12.0
Cadmium	0.001	9.3	N/A	N/A	0.138	1	0.0	0.1
Mercury	0.00006	0.6	N/A	N/A	0.422	1.56	0.8	2.8
Nickel	0.02	186.7	N/A	N/A	0.556	2.84	0.0	0.0
Selenium	0.005	46.7	N/A	N/A	0.422	0.98	0.0	0.0
HCB	0.0008	7.5	1.6	0.06	0.042	0.082	0.7	1.4
Lindane	0.0003	2.8	1.3	0.07	0.0018	0.0026	0.0	0.0
DDT	0.0005	4.7	0.34	0.3	1.9	13.2	6.9	48.1
Dieldrin	0.00005	0.5	16	0.006	0.04	0.14	6.9	24.0
Endosulfan	0.0015	14.0	N/A	N/A	0.07	0.113	0.0	0.0
Endrin	0.0003	2.8	N/A	N/A	0.18	0.25	0.1	0.1
Heptachlor	0.0005	4.7	4.5	0.02	0.004	0.0092	0.2	0.4
Heptachlor Epox	0.000013	0.1	9.1	0.01	0.0067	0.034	0.7	3.3
Toxaphene	0.00025	2.3	1.1	0.08	1.51	4.9	17.8	57.8

20. Another way to examine this information is to calculate the risk associated with the consumption of fish based on the measured concentrations. If the mean contaminant concentration is substituted for the SV in equation WQ1 and the equation is then solved for RL, the following equation is generated:

$$RL= \frac{MCC * SF * CR}{BW} \quad \text{Eqn. WQ3}$$

Where:

MCC = Mean Contaminant Concentration (mg/kg)

SF = Slope Factor (mg/kg/day)-1,

CR = Consumption Rate (kg/day),

BW = Body Weight, 70 kg assumed.

Risk values for each pesticide that was detected in fish tissue has been calculated for four different consumption rates. Consumption rates of 7.5, 30, and 140 grams per day were selected. These rates represent the mean consumption rates by adults, recreational fishermen and subsistence fishermen in the United States. The 7.5 grams per day also represents one 8-ounce meal a month. The 30 grams per day is approximately equal to one meal a week, while the 140 grams per day is approximately equal to 4.3 meals per week. These risk values are found in Table 16-10. EPA suggests that states develop criteria within a range of 10^{-4} to 10^{-7} and originally recommended 10^{-5}, but EPA Region 4 now recommends using 10^{-6}. A risk of 10^{-5} is one additional case of cancer in 100,000 individuals. The State of Mississippi has adopted a rate of 10^{-6} as the acceptable rate of risk, while Louisiana has adopted a rate of 10^{-4} as the acceptable rate. The risk values associated with consumption of fish from the Yazoo Backwater Area exceed the State of Mississippi's criteria by one to three orders of magnitude for three pesticides--DDT, dieldrin, and toxaphene. The order of magnitude difference is

TABLE 16-10
FISH TISSUE CONSUMPTION RISK RATES

Chemical	Mean Conc.	CPF	Consumption Rates in kg/day			
			0.0075	0.015	0.03	0.14
b-BHC	0.0419	1.8	8.08E-06	3.23E-05	3.23E-05	1.51E-04
g-BHC	0.0018	1.3	2.51E-07	1.00E-06	1.00E-06	4.68E-06
DDT	2	0.34	7.29E-05	2.91E-04	2.91E-04	1.36E-03
Dieldrin	0.0397	16	6.81E-05	2.72E-04	2.72E-04	1.27E-03
Heptachlor	0.004	4.5	1.93E-06	2.71E-06	7.71E-06	3.60E-05
Heptachlor Epox	0.0067	9.1	1.78E-04	2.61E-05	2.61E-05	1.22E-04
Toxaphene	1.51	1.1	3.56E-04	7.12E-04	7.12E-04	3.32E-03
			6.71E-04	1.34E-03	1.34E-03	6.27E-03
	Maximum Conc.					
b-BHC	0.082	1.8	1.58E-05	3.16E-05	6.33E-05	2.95E-04
g-BHC	0.0026	1.3	3.62E-07	7.24E-07	1.45E-06	6.76E-06
DDT	12.1	0.34	4.41E-04	8.82E-04	1.76E-03	8.23E-03
Dieldrin	0.0397	16	6.81E-05	1.36E-04	2.72E-04	1.27E-03
Heptachlor	0.0092	4.5	4.44E-06	8.87E-06	1.77E-05	8.28E-05
Heptachlor Epox	0.034	9.1	3.32E-06	6.63E-05	1.33E-04	6.19E-04
Toxaphene	4.9	1.1	5.78E-04	1.16E-03	2.31E-03	1.08E-02

dependent upon the consumption rate. Using a CR of 7.5 (one 8-ounce meal per month) the increased rates of risk for these three pesticides respectively are 7.3, 6.8, and 33.6 additional cases of cancer per 100,000 individuals. The increased rates of risk for sportsmen consuming one 8-ounce meal of fish per week are: 29, 27 and 134 additional cases of cancer per 100,000 individuals. Finally, the increased rates of risk for subsistence fishermen are: 136, 127, and 332 additional cases of cancer per 100,000 individuals for DDT, dieldrin, and toxaphene, respectively. These rates are based on the consumers eating fish from the Backwater area at the assumed rates for 70 years. DDT has been used in the Delta since the 1940's, and it was used heavily in the late 1960's and early 1970's. Several lakes were closed to commercial fishing in the 1970's and 1980's due to high pesticide levels in fish. Fish from the Delta have probably been contaminated with DDT for 30 to 40 years. If these chemicals are indeed this toxic, there should be some clinical evidence of that in medical records. The Delta may be a locale that EPA could test the value of their risk assessment procedures.

PROJECT IMPACTS

21. There are two types of impacts to water quality from projects--direct and indirect. The direct impacts can be subdivided into short- and long-term impacts. In general, the major short-term direct impact to water quality is the localized increases in turbidity and suspended solids due to rainfall runoff at construction sites. The clearing of existing vegetation and the disturbance of the soils during construction provide the potential for increased erosion. Erosion of exposed soils delivers suspended sediments to local lakes and streams. If the eroded soil contains contaminants, then an increase in the contaminant levels in the receiving waters can occur. The impacts from vegetation

removal and soil disturbance will be localized to a 220-acre area in the immediate vicinity of the pump plant. The size of the impacted area of the receiving water is dependent upon the quantity and particle size of delivered sediment and on hydraulic characteristics of the receiving water. For this project, most of the cleared lands will be isolated from neighboring water bodies by dikes and the Backwater levee. The impacts will be further minimized by the application of best management practices for nonpoint source pollution at the construction site. These nonpoint source control measures include silt screens, buffer zones, containment dikes, etc. A Stormwater Prevention Plan will be filed with MDEQ. This plan will outline the steps that will be utilized to reduce nonpoint source runoff from the construction site and thus, minimize the direct impacts to water quality. This impact to water quality will be short term, lasting until construction is completed and new vegetation can be established on disturbed areas.

22. The second direct impact to water quality is a long-term impact, and it is the proposed reforestation of 17,500 to 107,000 acres of currently farmed land within the project area. Reforestation of this magnitude would result in a 15 to 40 percent increase in the total forested lands that currently exist within the project area. This impact is almost the direct opposite of the previous impact, in that lands would be vegetated not cleared and will result in an improvement in water quality. Water quality will benefit from reduced nonpoint source pollution from agricultural lands. This will include a reduction in suspended sediment and nutrients. The magnitude is significantly greater because the affected area is from 90 to more than 500 fold greater. In addition to the proposed project-induced reforestation, lands added to the Federal Conservation Reserve Program (CRP) and the Wetlands Reserve Program (WRP) will impact water quality. These programs and the project required reforestation remove agricultural lands from production and convert them into forested lands. This type conversion improves water

quality by reducing the amount of sediment, pesticides, herbicides, and nutrients (fertilizers) that are washed into area lakes and streams by rainfall runoff. In addition, to the direct impacts from "unclearing" land, there are indirect benefits to water quality as well. Converting agricultural land to forest land increases the area available to trap suspended sediments, nutrients and contaminants, as these low-lying lands tend to be sediment sinks. Therefore water quality benefits twice from the conversion of agricultural land to forest, from the reduction of a direct source and from the creation of a trap of suspended sediments, nutrients and contaminants. The quantitative reductions in total nitrogen and phosphorus in the Big Sunflower and Yazoo River Basins due to reductions in the amount of fertilizer applied are likely to be minimal. The low-lying agricultural lands in the basin are planted primarily in soybeans, which generally are not treated with fertilizer. The degree of indirect reductions in nutrients will depend on the aerial extent and period of inundation of the newly forested lands. The reduction in suspended sediment should be considerable. There will be from 12 to 37 percent of the agricultural lands converted from crop to forest. Hopefully, this will result in a 12 to 37 percent reduction in suspended sediment delivered to the basins streams and the Mississippi River by nonpoint source runoff.

23. A second indirect impact to water quality from reforestation is the probable increases in the amount of methyl mercury produced on an annual basis. Studies by Canadian researchers show that inundation of forested lands for as little as 4 weeks under certain conditions results in the change of inorganic mercury to methyl-mercury (St. Louis, Jackson). These findings have been confirmed by other groups and with studies conducted by the Vicksburg District. The Vicksburg District and USGS have been collecting total and methyl mercury samples from the Ouachita River in Arkansas and Louisiana over the past 3 years. Methyl-mercury levels in the Ouachita River increase approximately five-fold within weeks of the water being ponded in the

Felsenthal National Wildlife Refuge (NWR). Felsenthal NWR is operated as a greentree reservoir, with the water level raised annually in winter to benefit migrating waterfowl. It is believed that the large amount of detritus on a forest floor provides the organic precursors for the methyl group in methyl-mercury. Therefore, croplands, that contain limited detritus under current conditions, would provide substantially more detritus when converted to forest with trees, under brush, and leaf litter. The amount of methyl-mercury produced is dependent on the amount of precursors available and the period of inundation. If inundated for extended periods of time, this newly created forest could result in the creation of additional methyl-mercury. Methyl-mercury is passed through the food chain and eventually passed to man primarily through the consumption of fish. This form of mercury impacts the kidneys and the nervous system and is especially dangerous to babies, young children, and pregnant or breast-feeding women. Methyl-mercury contamination is becoming a widespread problem within the United States. Currently, more than 35 states have issued fish consumption advisories for mercury in lakes and streams within their borders. The mean fish tissue mercury level in the Big Sunflower Basin is below the FDA action level of 1.0 mg/kg, but the maximum levels for some fish did exceed the FDA action level. The addition of 40,000 to 130,000 acres of forested lands (17 to 57 percent increase in forested acres) would undoubtedly increase fish tissue mercury levels, but it would be difficult to estimate the degree of the increase.

24. So far the discussion on impacts to water quality has been generalized and not quantitative. This study is considering seven alternative plans and the magnitude of the impacts to water quality will vary among the plans. The current operation of the Steele Bayou control structure calls for the gates to be closed during periods when the riverside water surface elevation is higher than the landside elevation and the landside elevation is above 75 feet, National Geodetic Vertical Datum (NGVD). During the times that the

gates are closed, water ponds on the landside of the structure and suspended sediments settle. Therefore, under current conditions, some of the contaminants contained within the water and transported sediment may have time to settle out of the water. Once the backwater project is in operation, some of these contaminants that previously settled out may be pumped into the Yazoo River and subsequently transported to the Mississippi River. Therefore, the potential exists to increase the level of contaminants in the Yazoo and Mississippi Rivers. However, any potential increase is expected to be offset by decreases due to proposed reforestation. These types of increases or decreases in contaminant levels are extremely difficult to quantify. Therefore, a contaminant monitoring program will be implemented to determine these impacts. Monitoring will be initiated during detailed design in order to establish baseline conditions. Once the project is complete and in operation, monitoring will be continued to accurately quantify impacts. Plan 1, the "No Action" plan, will not have any impacts to water quality. Plan 2 is a wholly nonstructural plan. It offers the longest duration of flooding, which will maximize the retention of sediment, nutrients, and contaminants on flooded lands, but this will also maximize the period of time that is available for the production of methyl-mercury. Plan 2 also has the potential to impact Eagle Lake, because it will not provide it protection from flooding. All the plans which include pumps will provide protection to Eagle Lake. Plans 3 through 7 all have a 14,000-cubic-foot-per-second pump, but differ in the amount of reforestation and the on/off elevation for pump operation. In general, the larger areas of reforestation will have greater direct and indirect impacts to water quality. Higher on/off pump elevations will increase the duration of floodwater ponding and increase sediment retention and methyl-mercury production.

WATER QUALITY SUMMARY

25. Based on all available data, the water quality in the Yazoo Backwater area streams and lakes is largely affected by extensive agricultural development. All the collected data support the MDEQ assessment that toxic and nontoxic nonpoint pollutants impair the

surface waters. Toxic pollutants include mercury and several agricultural pesticides including DDT. The chlorinated pesticides used years earlier persist in the water, soils, and fish tissue in the project area. Nontoxic pollutants include nutrients and suspended solids. The surface waters are high in turbidity and have high concentrations of nitrates and phosphorous. Nutrients and suspended solids are highest in reaches draining mostly agricultural runoff. Most of the streams and lakes within the backwater area have been reported by the state to be only partially supportive for the propagation of wildlife, fish, and other aquatic life. The predominant reason cited for partial support is nontoxic, nonpoint source pollution containing high loads of suspended solids and nutrients.

26. Water quality and sediment data collected within the backwater area indicate a greater tendency for pesticides to be found in the sediments than in the surface waters. The pesticides most frequently detected in the sediments were DDT, DDD, DDE, dieldrin, and heptachlor. Other pesticides detected in the sediments were endosulfan (A&B), endosulfan-sulfate, endrin, endrin aldehyde, aldrin, G-BHC, B-BHC, D-BHC, and heptachlor epoxide. Comparison to historical samples reveals that the levels reported and the frequency of detection of pesticides were considerably lower than those reported 20 to 25 years ago.

27. The major long-term water quality problems in the Yazoo Backwater Area are the result of the basin's intensive agricultural development. Thus, nonpoint source pollution control practices should be used. Control structures serving as sediment traps and the use of vegetative buffer strips around streams and ditches would help improve the area's water quality. The reforested project lands, as well as future USDA's set-aside program lands, that are located along streams and ditches could significantly improve water quality. These lands will turn croplands into grass covered or forest lands. Conversion of cropland to grassland or forest reduces the amount of contaminants that are available

to be washed into area water bodies. Grasslands and forest lands act as traps for contaminants instead of providing a source of contaminants. Conversion of cropland to forestland will likely increase the amount of methyl-mercury produced and could lead to increased mercury levels in fish tissue. In addition, enhanced education of the agricultural community regarding the importance of proper tillage practices on improving water quality within the Yazoo Backwater area should be developed.

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