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MEMPHIS LIGHT, GAS AND WATER DIVISION
INDUSTRIAL FUEL GAS
DEMONSTRATION PLANT PROGRAM

MASTER

ENVIRONMENTAL REPORT

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VOLUME II
THE ENVIRONMENT

(Deliverable No. 27)

August 1979

Submitted By
Memphis Light, Gas and Water Division
to
U.S. Department of Energy
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Prepared By
Energy Impact Associates
for
Foster Wheeler Energy Corporation

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MEMPHIS INDUSTRIAL FUEL GAS

DEMONSTRATION PLANT PROJECT

DEMONSTRATION PLANT ENVIRONMENTAL ANALYSIS - VOLUME II
(Deliverable #27)

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FOR THE
MEMPHIS LIGHT, GAS AND WATER DIVISION
INDUSTRIAL FUEL GAS DEMONSTRATION PLANT

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FOREWORD

This document is an Environmental Report on the Memphis Light, Gas and Water Division Industrial Fuel Gas Demonstration Plant. This report was prepared for Memphis Light, Gas and Water Division for submission to the U.S. Department of Energy under Contract ET-77-C-01-2582.

This document is Volume II of a three-volume Environmental Report. Volume I consists of the Summary, Introduction and the Description of the Proposed Action. Volume II consists of the Description of the Existing Environment. Volume III contains the Environmental Impacts of the Proposed Action, Mitigating Measures and Alternatives to the Proposed Action.

REVISIONS TO THE ENVIRONMENTAL REPORT

November, 1979

As a result of review comments on the August, 1979 Environmental Report by the Department of Energy and Oak Ridge National Laboratory and the completion of the air quality monitoring program in September, 1979, it became necessary to issue numerous page revisions to the original document. These revisions address all questions and concerns of the Department of Energy. Their incorporation will permit approval of the Environmental Report by the government.

Revisions have been noted by: (a) identifying each revised page in the upper right hand corner with "Revised November 1979", (b) underscoring all new text with a broken line, and (c) locating each revised line with the letter "R" in the right hand margin. Pages indicated "Revised November 1979" but appearing without "R's" in the margin resulted from text relocation required by a previous revision.

The next page lists the page number for all pages revised from the original Report. The holder of this document should replace all original pages cited on a page-by-page basis with the revised pages.

The following pages were issued in November 1979 to replace their original counterparts in the August 1979 issue of the Memphis IFGDP Environmental Report.

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4-19 4-20 4-23 4-24 4-44 4-61 4-78 4-79 4-89 6-8 6-10 through 6-19 6-26 R-7	Issued for Volume Three

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3.1 PHYSIOGRAPHY

SECTION 3.0
ENVIRONMENTAL SETTING

The proposed site of the Industrial Fuel Gas Demonstration Plant (IFGDP) is located on a small peninsula extending eastward into Lake McKeller from the south shore. The peninsula is located west-southwest of the City of Memphis near the confluence of Lake McKeller and the Mississippi River. The environmental setting of this site and the region around this site is reported in terms of physical, biological and human descriptions. Within the physical description, this report divides the environmental setting into sections on physiography, geology, hydrology, water quality, climatology, air quality and ambient noise. The biological description is divided into sections on aquatic and terrestrial ecology. Finally, the human environment description is reported in sections on land use, demography, socioeconomics, culture and visual features.

This section concludes with a discussion of physical environmental constraints.

3.1 PHYSIOGRAPHY

Regional and on-site physiographic features are described in this section as they apply to the potential impacts of the proposed IFGDP.

3.1.1 REGIONAL PHYSIOGRAPHY

The site is located in the center of the "Mississippi Embayment" region in the Gulf Coastal Plain. Figure 3-1 is a generalized physiographic map of the northern Mississippi embayment. The Tennessee River, located approximately 50 miles east of the site, almost coincides with the boundary between two of the great physiographic provinces of the United States: (1) the Interior Low Plateaus to the east of the Tennessee River (in central Tennessee called the Highland Rim Plateau) and (2) the Gulf Coastal Plain.[1]

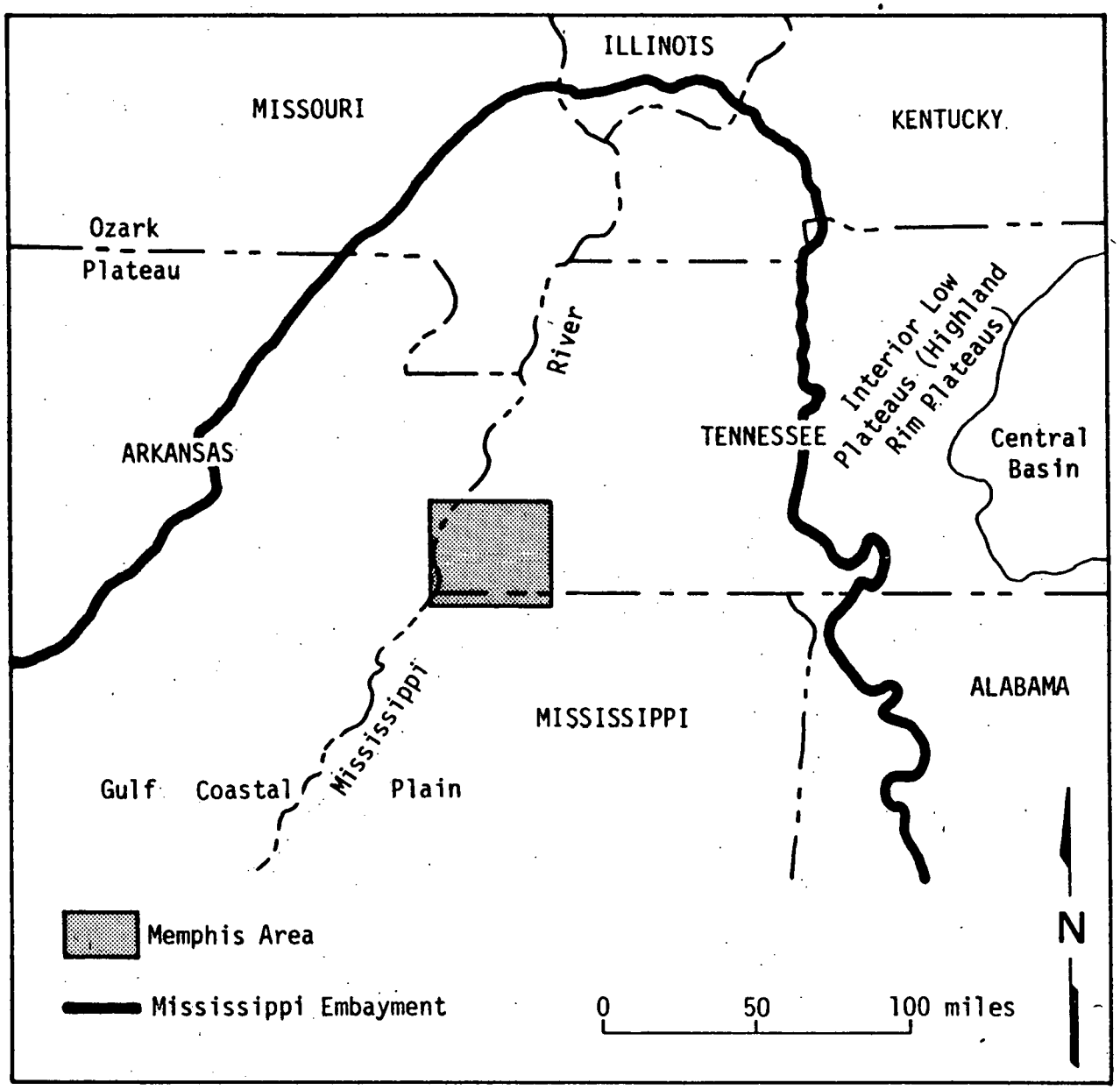

Figure 3-1. Generalized Physiographic Map of the Northern Mississippi Embayment (2)

Four major surface forms occur within the region that lies between the Mississippi and the Tennessee Rivers: (1) Residual Ridge, (2) Tennessee-Mississippi Divide, (3) Hills of Erosion and (4) Alluvial Region.[2]

Residual Ridge -- Extending northward from the Mississippi River into southwestern McNairy County, Tennessee, is a ridge about half a mile wide. The ridge subsides toward the north.

Tennessee-Mississippi Divide -- This divide is the high land just west of the Tennessee River. It forms the highest part of western Tennessee and represents the remnant of the original plateau surface. This divide separates the short and steep eastward-flowing rivers that empty into the Tennessee River from the low gradient and broad valleys forming westward-flowing rivers that empty into the Mississippi River.

Hills of Erosion -- Extending from the western part of Hardeman County northward to Henry County is an unusually hilly belt composed of Holly Springs sand (discussed in Section 3.2.1.1 - Eocene time). The flat tops of many of these hills are parts of the old plateau surface. Owing to the sandy, porous nature of the ground, rain water readily sinks into the permeable sands and has not yet eroded them. Any slopes formed by stream cutting are subject, however, to rapid erosion. The loose sand washes easily, and the slopes are quickly eaten away. Thus, the flat tops of the hills remain unaltered, while the slopes are steep and deeply incised.

Alluvial Region -- Lying at the foot of the Chickasaw Bluffs, the western boundary of the slope of western Tennessee, is the Mississippi River floodplain, a low tract covered by the extremely high waters of the Mississippi River. Nowhere in western Tennessee is this plain very wide.

3.1.2 ON-SITE TOPOGRAPHY

The IFGDP site is located in the alluvial region of the northern Mississippi Embayment. This site is nearly flat, with the exception of several hilly

areas formed as a result of depositing dredge spoils from dredging activities in the Lake McKellar channel. The normal pool elevation of the Mississippi River is 185 feet above mean sea level (msl). Elevation at the site is approximately 200 feet above mean sea level. In comparison, at the TVA Allen Generating Plant and the industrial development on Presidents Island adjacent to Lake McKellar, elevations reach 240 feet above mean sea level. At Fuller State Park, located approximately 3.5 kilometers southeast of the site, the elevation of the Memphis Bluffs is 315 feet above mean sea level.

3.2 GEOLOGY

3.2 GEOLOGY

Geologic features, mineral resources, soils and seismicity are described in this section.

3.2.1 REGIONAL GEOLOGY

The geology in the region has been described thoroughly.[1-11] Most of the information in this section comes from Reference 1.

Western Tennessee is situated in the part of the Gulf Coastal Plain commonly called the Mississippi Embayment. This embayment is a down-warped trough of Paleozoic rocks pitching gently to the south, whose upper end is in southern Illinois and whose axis roughly parallels the Mississippi River, but lies a few miles west of it. This trough has been filled with sediments of Cretaceous and Eocene age that rest on the older rock floor. The Paleozoic rocks crop out around the periphery of the trough. Table 3-1 is a generalized stratigraphic column of the geologic formations in western Tennessee, which lists the formations, their era and system (age). In the subsequent section a short description of formations is given in a descending age order.

3.2.1.1 HISTORICAL GEOLOGY

The information provided in this section is quoted from Reference 1.

Paleozoic time -- The geologic history of western Tennessee, as recorded in the exposed rocks of the area, begins with Mohawkian time, or the middle of the Ordovician period. During this time, western Tennessee was a part of an inland sea that covered much of the interior United States. The western shore of the land to the east just crossed the eastern boundary by the state. The rivers from the low-lying land to the east brought to this sea limy mud, which the currents and waves spread out in broad flat layers over the sea floor, forming the limestones and shales of today. In late Ordovician time, the Cincinnati arch began to form. This was a low dome that extended from Cincinnati,

TABLE 3-1

GENERALIZED STRATIGRAPHIC COLUMN OF THE GEOLOGIC FORMATIONS IN WESTERN TENNESSEE

Era	System	Series	Subdivisions	
Cenozoic.	Quaternary.	Recent.	Alluvium.	
		Pleistocene.	Loess.	
	Tertiary.	Pliocene.	Gravel (some of the terrace may be Pleistocene).	
		Eocene.	Jackson formation.	
			Wilcox group.	Grenada formation.
				Holly Springs sand.
				Ackerman formation.
			Mid-Way group.	Porters Creek clay.
				Clayton formation.
Mesozoic.	Cretaceous.	Upper cretaceous.	Ripley formation.	Owl Creek tongue.
				McNairy sand member.
				Coon Creek tongue.
			Selma clay.	
			Eutaw formation	Coffee sand member.
				Tombigbees sand member.
			Tuscaloosa formation.	
Paleozoic.	Carboniferous.	Mississippian.	St. Louis limestone.	
			Fort Payne chert.	
			Ridgetop shale.	
	Carboniferous or Devonian.	Mississippian or Upper Devonian.	Chattanooga shale.	
			Pegram limestone.	
		Middle Devonian.	Camden chert.	

(Continued)

TABLE 3-1 (Continued)

Era	System	Series	Subdivisions			
Paleozoic.	Devonian.	Lower Devonian.	Harriman chert.			
			Quall limestone.			
			Linden group.	Decaturville chert.		
				Birdsong shale.		
				Olive Hill formation.	Flat Gap limestone member.	
					Bear Branch limestone member.	
					Ross limestone member	
				Rockhouse shale.		
	Silurian.		Decatur limestone.			
			Brownsport formation.	Lobelville shaly limestone member.		
				Bob crystalline limestone member.		
				Beech River shaly limestone member.		
	Silurian.		Wayne formation.	Dixon early limestone member.		
				Lego limestone member.		
				Waldron clay member.		
				Laurel limestone member.		
				Osgood earthy limestone member.		
			Brassfield limestone.			
	Ordovician.	Upper Ordovician (Cincinnatian).	Fernvale formation.			
			Arnheim limestone.			
		Middle Ordovician (Mohawkian)	Hermitage formation.			

Ohio, to Nashville, Tennessee. As a result, the region southwest of Nashville was also gently raised above sea level, and it remained as a low-lying land mass until Silurian time, when the sea once more covered its comparatively level surface.

A long period of deposition followed. Owing to slight movements of the earth's surface, minor oscillations in the shore line took place, and from time to time different parts of the area were lifted slightly above sea level and were then submerged again. Hence, the beds of limestone and shale that were laid down in Niagaran time are not continuous over the area, and their thickness varies from place to place. The material brought to the sea in this time did not differ very much from that of the Ordovician period. The Silurian system followed the Ordovician system.

At the end of the Silurian period, the region was raised slightly above sea level and subjected to moderate erosion, so that the sea that returned in early Devonian time spread over an extremely flat limestone country, depositing newer limestone on the old. Throughout the Devonian period, gentle warping caused the sea to change its position at intervals. Early in Devonian time, the submerged portion of western Tennessee rose above water, but toward the end of the Lower Devonian, the water from the Appalachian trough inundated the area. Then followed another brief emergence, and again the waters swept in from the south. Another period of emergence and erosion followed and was terminated when the Chattanooga Sea spread over Tennessee. During much of the Mississippian time, the rivers brought sediment to the sea.

Some time after the end of the Mississippian epoch, the region was lifted above sea level and so remained until Cretaceous time.

Cretaceous time -- It was not until Upper Cretaceous time that downwarping of the land along an axis approximately coincident with the present Mississippi River allowed the sea to submerge this region. The downwarping caused a tilting of the land mass to the southwest, thus increasing the gradient of the streams, which began to rapidly erode the deeply weathered land and carry

much coarse material toward their mouths. The drainage was to the southwest following the structural folds. Along the shore, these streams built deltas, which constitute what is known as the Tuscaloosa formation. The coarse material was dropped near the land, and the finer material was carried seaward. The Cretaceous Tennessee River was the largest of these streams and contributed much material to the Tuscaloosa delta. Continued warping caused the sea to gradually transgress the land. The coarser materials were deposited over the gravel downstream. So Tuscaloosa time changed into Eutaw time, and more of the land was covered by the sea. During the Tuscaloosa and Eutaw epochs, western Tennessee was never deeply submerged, and much of the deposition was subareal. Later, the sea covered the area to a shallow depth. The rivers were no longer active and flowed to the northwest. In the shallow waters, marine life swarmed, and the deposits then formed consisted of limestone containing abundant fossil remains. Minor warping caused oscillations in the shore line so that conditions of sedimentation were locally different. A slight elevation of the area followed, and the waters became so shallow that waves could reach and erode the bottom. The sands that washed to the sea were swept from place to place and show much cross-bedding.

Eocene time -- The great diastrophic movements that convulsed much of North America at the end of the Cretaceous period did not greatly disturb the Mississippi Embayment region. It was gently elevated above sea level and exposed to erosion. Some of the material that had been deposited during Cretaceous time was removed. In Eocene time, the sea crept up the embayment, inundated a relatively level surface and penetrated as far north as southern Illinois. The region was submerged to only moderate depth; in southern Tennessee limestones were deposited, but toward the north glauconitic sands were deposited. This phase caused the deposition of fine clay. Shark teeth have been found in this clay from well drillings at Jackson, Tennessee. Then, the sea receded, and a period of erosion followed, good evidence of which is found in the basal clay conglomerates of the Holly Springs formation.

The sea returned in Lower Wilcox time but did not reach as far up the embayment nor did it attain as great a depth as it had before. Littoral and

estuarine conditions prevailed, and the sand and clay brought in by the streams were swept along by strong currents and laid down in irregular cross-bedded deposits. These conditions prevailed until the end of Wilcox time, when the region once more became land. During Jackson time, swamp conditions existed over the area south and west of Tennessee and covered the westernmost part of this state. Sand, clay and lignite were deposited.

Eocene to recent time -- By the end of Eocene time, all of Tennessee was dry land, and the rivers began to erode the recently deposited sand and clay. As these deposits were unconsolidated, they yielded readily to the erosive action of the streams, and thus much of the material was carried away. Though erosion was active from the end of the Eocene epoch until Pliocene time, the area was not reduced to a peneplain, and therefore, the subsequent formation was laid down on an irregular surface.

Some time during the Pliocene epoch, the land was sufficiently lowered to allow the heavily loaded streams that came from surrounding highlands to cover the area with sand and gravel. The exact conditions of deposition are not known, but it is probable that the material was derived from high land where erosion was active and was carried by streams of high gradient and large transporting power. The eroded material was dropped as a subareal deposit on the low-lying lands where the flow of the streams was checked and their transporting power greatly reduced.

In Pleistocene time, the northern part of the United States was covered by continental ice sheets, which advanced and retreated in accordance with the changes in climate. The great quantities of water liberated by the melting ice carried large amounts of glacial debris, which was spread out as outwash plains or carried down the rivers and deposited on their floodplains. When these deposits were dry, wind lifted the fine silty material and dropped it on adjacent regions. Such wind-transported material, called loess, was laid down in the land in western Tennessee. Erosion had been resumed in this area after the deposition of the Pliocene gravel, and it was on an irregular erosion surface that the loess was deposited. At the end of the Pleistocene epoch active erosion cut through the loess deposits in many places.

The streams soon adjusted their channels, but in comparatively recent time, a slight uplift has caused them to intrench themselves a few feet.

3.2.1.2 STRUCTURES

The Paleozoic rocks, in general, lie flat, although they have been elevated and depressed many times. The shape of the rock floor of the upper Mississippi Embayment was described as a spoon, with the tip extending northward into Illinois and the other half underlying Tennessee and Kentucky. The younger sediments of the Cretaceous and Eocene age were deposited in successive layers on this surface, and the slope of these beds is that of the underlying floor.

The plateau of western Tennessee has a general downslope to the northwest, but in the northwestern part of the area the land rises again, forming the high tract in the western part of Obion County. Surface warping has elevated this tract until its general level is about 100 feet higher than the general surface level of the south.

3.2.2 GEOLOGY OF THE SITE

The IFGDP site is primarily covered with dredged material from Lake McKellar. The soils beneath the site are generally alluvium deposited by the Mississippi River. A subsurface investigation was conducted during 1978, and the locations of the borings are shown in Figure 3-2.[12] Sections A-A and B-B are shown in Figures 3-3 and 3-4. These sections illustrate the composition of the layers of soil from 0 to 80 feet below the surface.

Two borings from the soils investigation penetrated deeper than the remainder; these were borings 9A and 14A, which reached depths below the surface of 282 feet and 267 feet, respectively. The approximate stratigraphic profiles obtained from these borings are shown in Figure 3-5. The elevations shown in Figure 3-5 are approximate, pending a field survey. In general, these profiles show the site to be comprised of layered material as follows: dredged material from 6 to 10 feet, 20 to 40 feet of sand and gravel, 40 to 80 feet

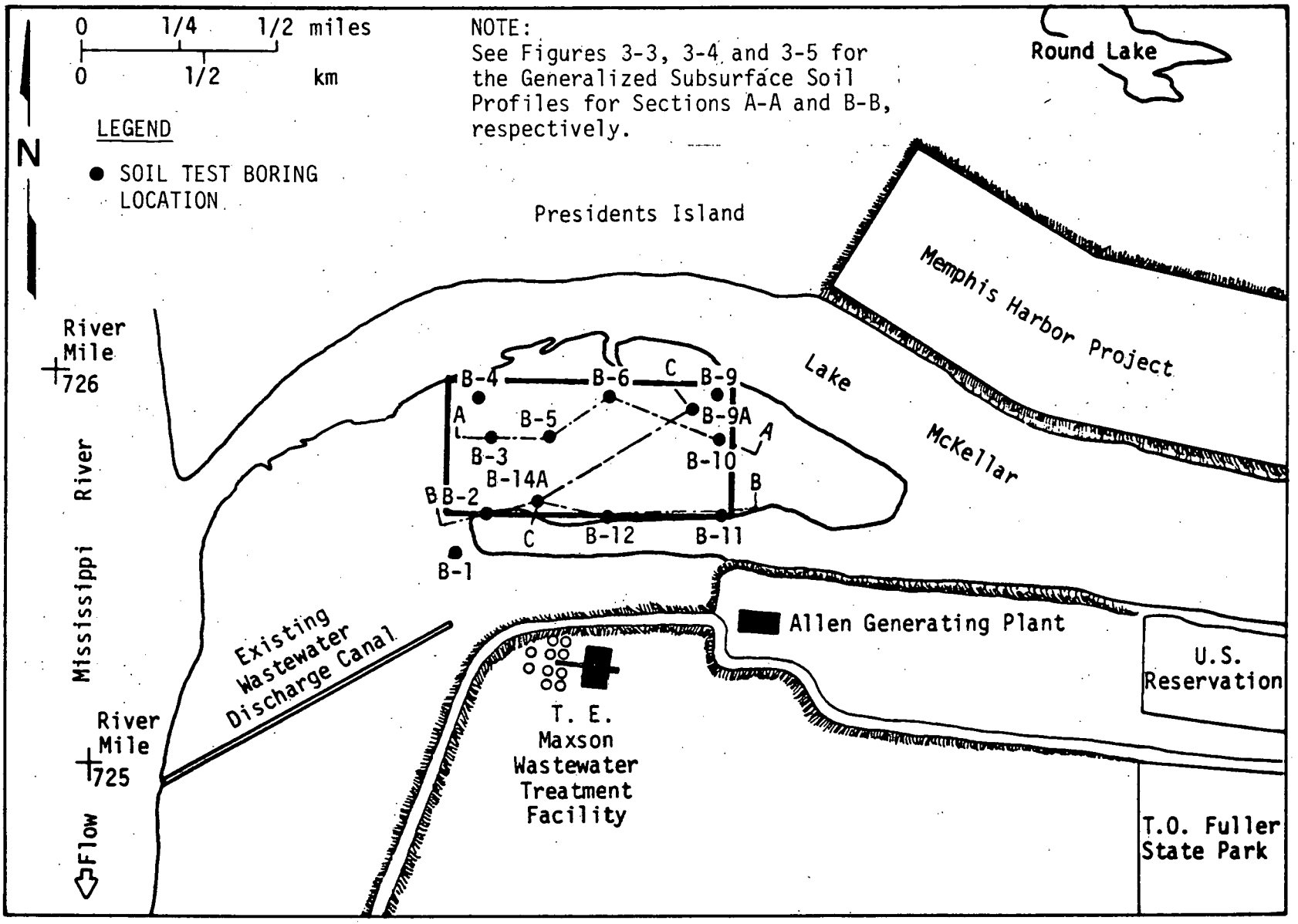

Figure 3-2. Boring Location Plan

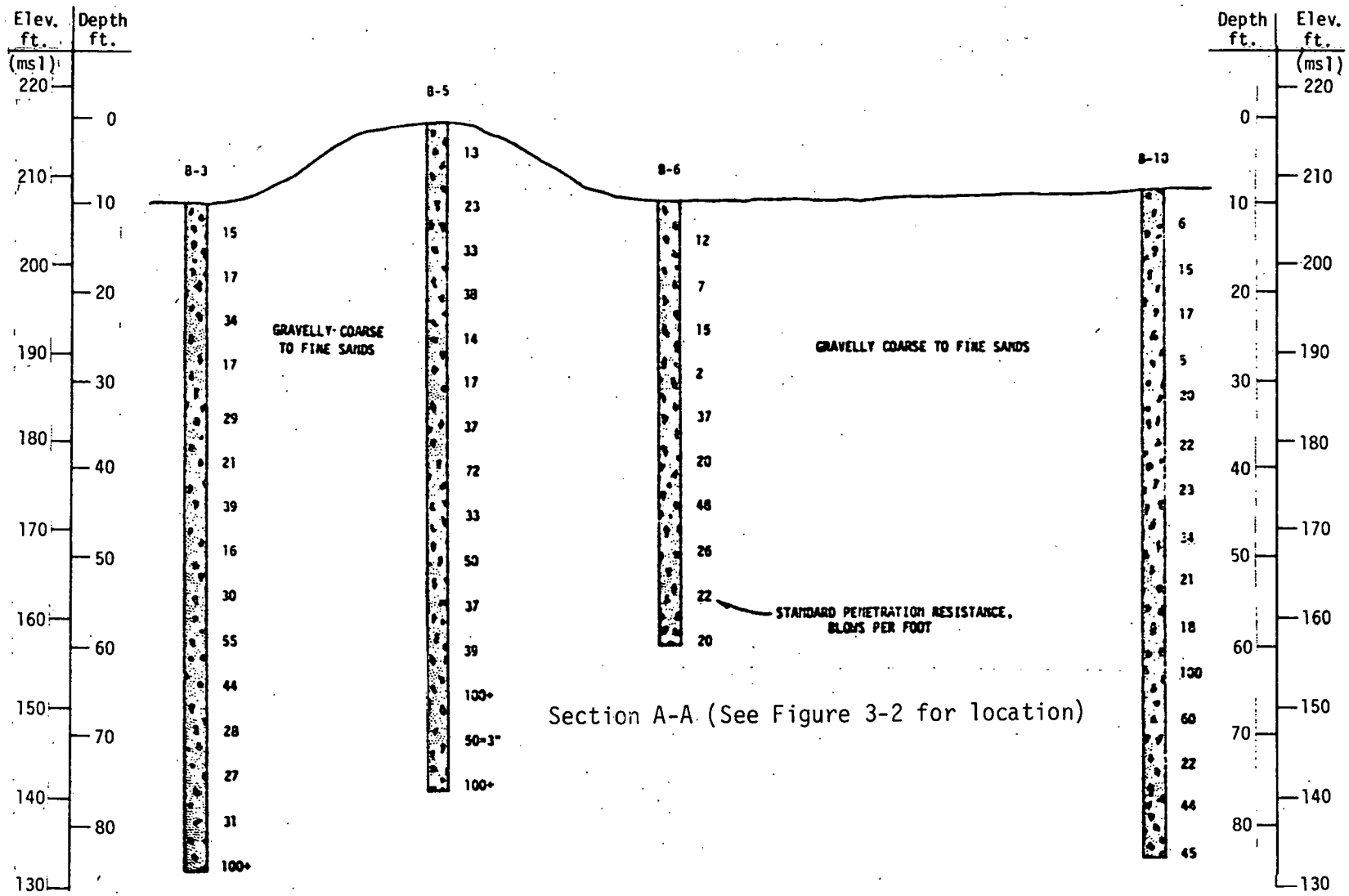

Figure 3-3. Generalized Subsurface Profile along Section A-A.

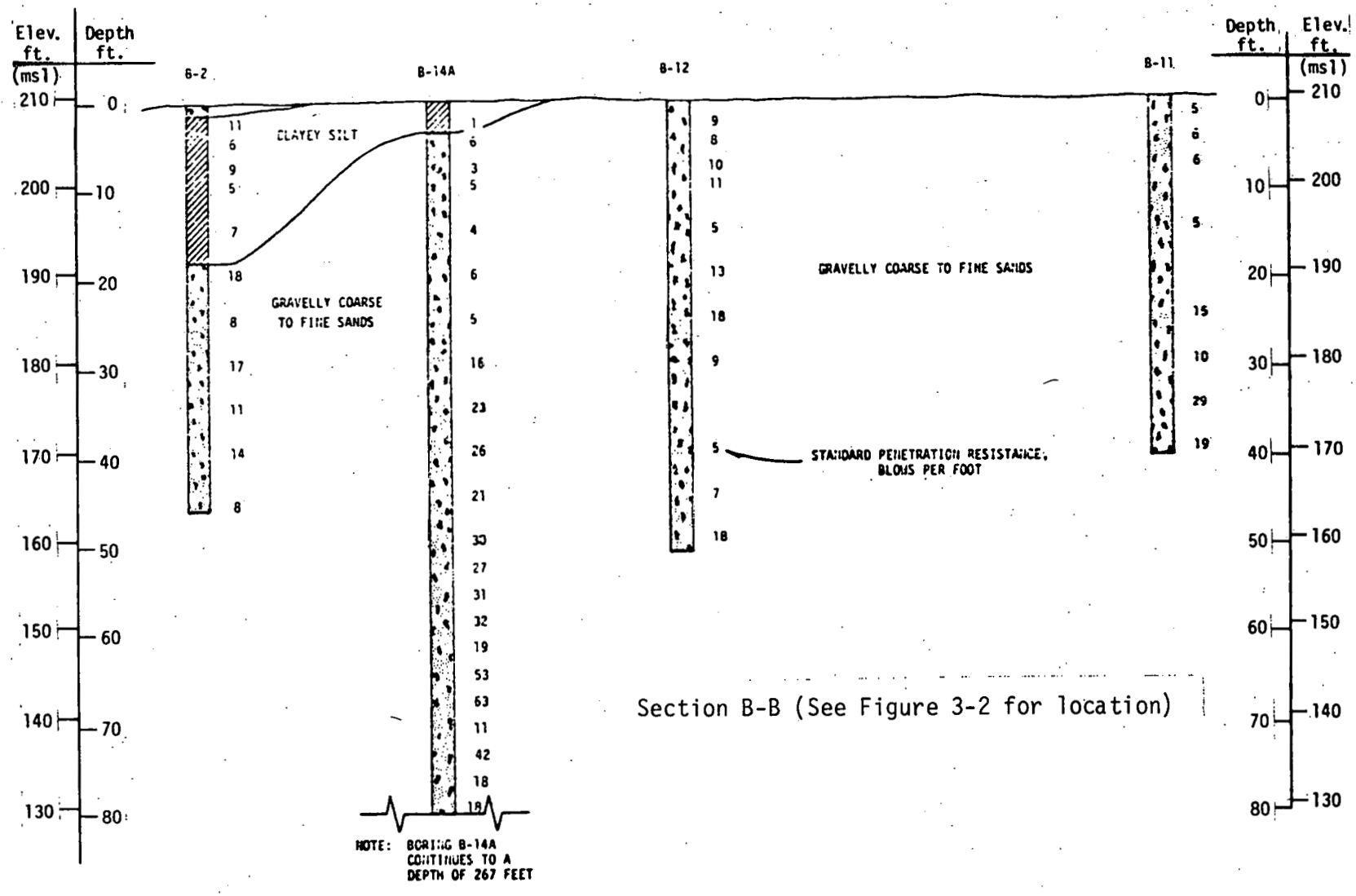

Figure 3-4. Generalized Subsurface Profile along Section B-B.

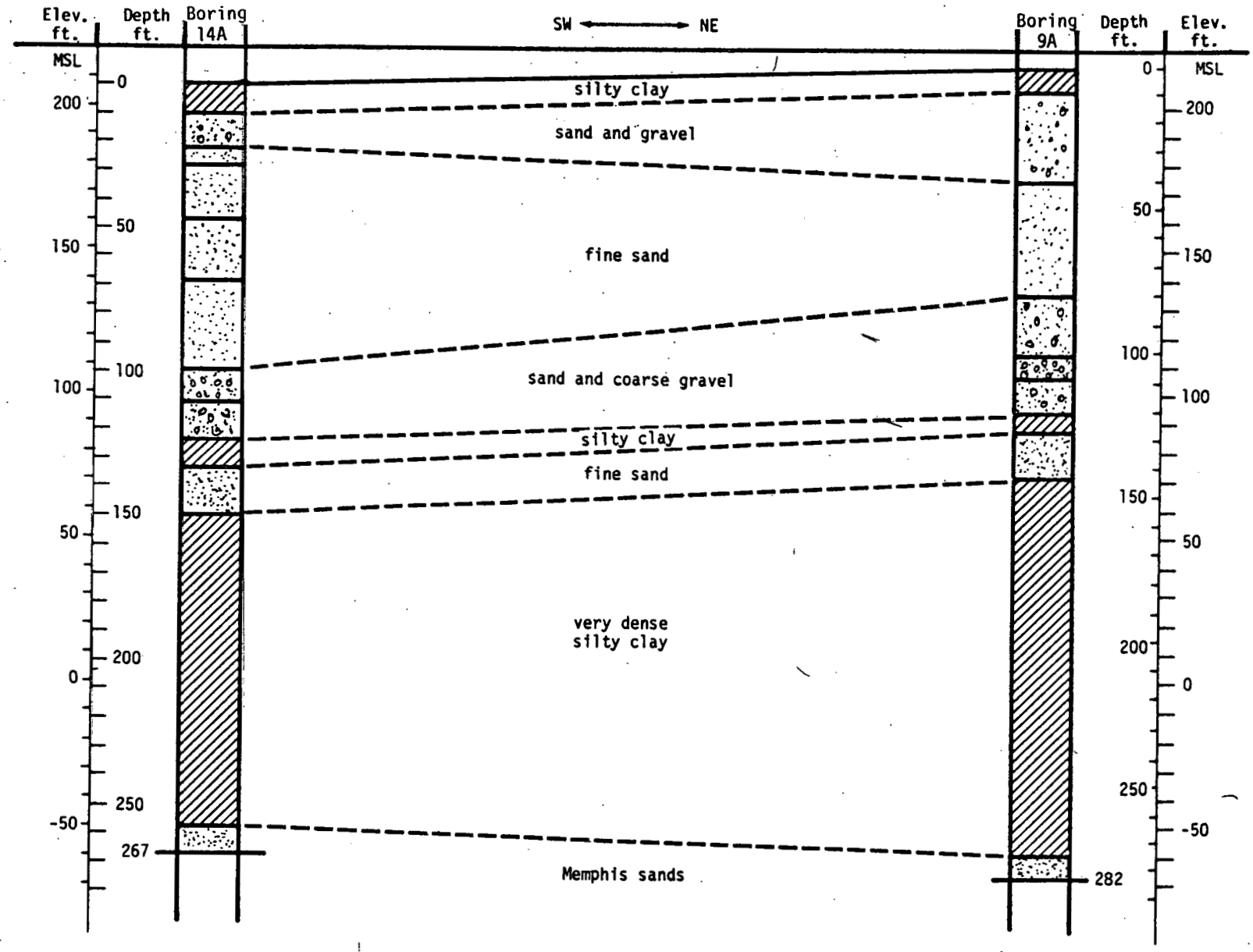

Figure 3-5. Generalized Subsurface Profile along Section C-C (see Figure 3-2)

of fine sand, 25 feet of sand and coarse gravel, a relatively thin layer of silty clay and 15 feet of fine sand.

At an elevation of approximately 60 feet above mean sea level, a very dense silty clay was encountered and continued to approximately 50 feet below mean sea level (a total of 110 feet) after which the Memphis Sands or "500-foot" sands began. Based upon data supplied in the literature[3] and observations while drilling, it is probable that this is the sand used by the City of Memphis for their primary supply of drinking water.

The dashed lines on Figure 3-5 are intended to show relative changes in elevation between similar soils. Considering the historical variations in river level, location and deposition of glacial material, the two borings are very similar.

3.2.3 MINERAL RESOURCES

Mineral resources in the region are scanty. Although the clay production presently is limited to Henry County, there are clay deposits in other parts of western Tennessee. The sand deposits of western Tennessee are very large and varied, and the quantity of building sands is almost unlimited. Road building material is plentiful in much of the area. The cherts of the Devonian and Mississippian age that occur in Benton, Decatur and Hardin Counties form good road material. The terrace gravel in the valley of the Tennessee River and the Pliocene gravel also form good road material.

The Mississippi River is a source of sand and gravel. Dredged material from portions of this river provide good fill material.

Low-grade phosphate rock occurs in Decatur County; and tripoli, a weathering product of the Fort Payne chert, and St. Louis limestone are found in Hardin County. Although iron ore has been worked in Decatur County, it is doubtful that the quantity and quality warrant exploitation by modern methods. Some of the limestones of the area might be used as polished stone, and others

could be used in the manufacture of cement. Deposits of these raw materials are so abundant throughout the United States, however, that exploitation depends largely on the proximity of markets or on cheap transportation.[1]

At the IFGDP site, there are no known deposits of minerals. The only known sand and gravel quarry within the vicinity of this site is located on Presidents Island, approximately 5 miles northeast of the site.

3.2.4 SOILS

The IFGDP site is mainly covered with dredged material. On approximately 20 acres (12.5 percent of site) located in the western edge of the site, there occurs a natural soil named Crevasse fine sand[13] by the Soil Conservation Service (SCS). The SCS describes this soil type as follows: "This soil occurs along the Mississippi River, as tracts 40 to 100 acres in size. It has the profile described as typical for the series. Most areas have a hummocky surface. Crevasse fine sand has a very low available water capacity and, consequently, is extremely droughty. It is slightly acid to neutral in reaction and is flooded every few years. Only small areas have been cleared. Most of the cleared area is idle or in bermudagrass pasture. Droughtiness limits the choice of crops to small grain, pasture and other crops that grow in winter and spring when moisture is most plentiful. Some of these soils support woodland. The trees are mainly cottonwood, black willow and hackberry. In places, the sand is thin, although it is moderately good for cottonwood and black willow. Because of droughtiness, the loss of a fourth to a half of the seedlings in both planted and natural stands is to be expected. The droughty nature of this soil limits the choice of plants that can be grown to provide food for wildlife. Suitable plants are those that grow in spring and winter when available moisture is most plentiful. Small winter grains grow well if flooding is not severe. Sunflowers and sorghum also grow well."[13] Descriptions of the soils at the site, beneath and including the dredged material, and their chemical and physical properties are given in Section 3.3.2.2.

3.2.5 SEISMICITY

Seismic events are rated according to the maximum intensity in the area of the epicenter (originating location). The intensity follows the modified Mercalli Intensity Scale and is a measure of the damage caused by the event. Table 3-2 gives the Mercalli Intensity Scale and the expected damage for each intensity. Damage done by an earthquake is related to the energy released at the epicenter and the distance from the epicenter. Other important factors include the geologic setting of the area, the frequency of the seismic waves, the depth of the epicenter and the amount of earthquake resistance built into man-made structures. The more commonly known Richter Magnitude Scale is a measure of energy released at the epicenter of the earthquake. Table 3-3 compares the modified Mercalli Intensity Scale and the Richter Magnitude Scale.

The Memphis area is located in Zone 3 of the U.S. Seismic Risk Map[15] as shown in Figure 3-6. An earthquake corresponding to 0.19 g* motion can occur at the site[16] as shown in Figure 3-7. An earthquake of 0.19 g corresponds to a magnitude of 6.3 on the Richter Scale as is shown in Figure 3-8.[17]

Under the influence of isotatic tilting, the Mississippi Embayment contains old fault zones trending northeast-southwest and northwest-southeast. A northeast-southwest inferred fault line along the Big Creek fault zone apparently controls the Mississippi River course from the Obion River 75 miles northeast of Memphis to the Arkansas River 100 miles southwest of Memphis. A second inferred fault zone, the White River fault zone, trending northwest-southeast from the White River in Arkansas past Helena, Arkansas, toward Meridian Mississippi, passes approximately 25 miles southwest of the site.[15]

Within 20 kilometers of the proposed IFGPD, four seismic events registering IV or greater on the modified Mercalli scale were reported.[18] These events were as follows: (1) March 30, 1922, centered 12 kilometers southwest of the

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* See List of Abbreviations for definition.

TABLE 3-2

MODIFIED MERCALLI INTENSITY SCALE AND EXPECTED DAMAGE FOR EACH INTENSITY (AFTER C. F. RICHTER, 1958) [14]

I. Not felt. Marginal and long-period effects of large earthquake.

II. Felt by persons at rest, on upper floors, or favorably placed.

III. Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.

IV. Hanging objects swing. Vibration like passing of heavy trucks; or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV, wooden walls and frames creak.

V. Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Door swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.

VI. Felt by all. Many frightened and run outdoors. Persons walking unsteadily. Windows, dishes, glassware broken. Knickknacks, books, etc., off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken.

VII. Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices (also unbraced parapets and architectural ornaments). Some cracks in masonry C. Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.

VIII. Steering of motor cars affected. Damage to masonry C; partial collapse. Some damage to masonry B; none to masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, tower, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground on steep slopes.

IX. General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. (General damage to foundations). Frame structures, if not

(Continued)

TABLE 3-2 (Continued)

bolted, shifted off foundations. Frames racked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluviated areas sand and mud ejected, earthquake fountains, sand crater.

X. Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.

XI. Rails bent greatly. Underground pipelines completely out of service.

XII. Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.

Masonry A, B, C, D, are specified by Richter as follows:

Masonry A. Good workmanship mortar and design; reinforced, especially laterally, and bound together by using steel, concrete, etc.; designed to resist lateral forces.

Masonry B. Good workmanship and mortar; reinforced, but not designed in detail to resist lateral forces.

Masonry C. Ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at corners, but neither reinforced nor designed against horizontal forces.

Masonry D. Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.

TABLE 3-3

RICHTER MAGNITUDE SCALE AND APPROXIMATE MERCALLI INTENSITY SCALE EQUIVALENTS (AFTER RICHTER, 1958) [14]

Richter Magnitude	Mercalli Intensity
2	I - II
3	III
4	IV - V
5	VI - VII
6	VII - VIII
7	IX - X
8	XI

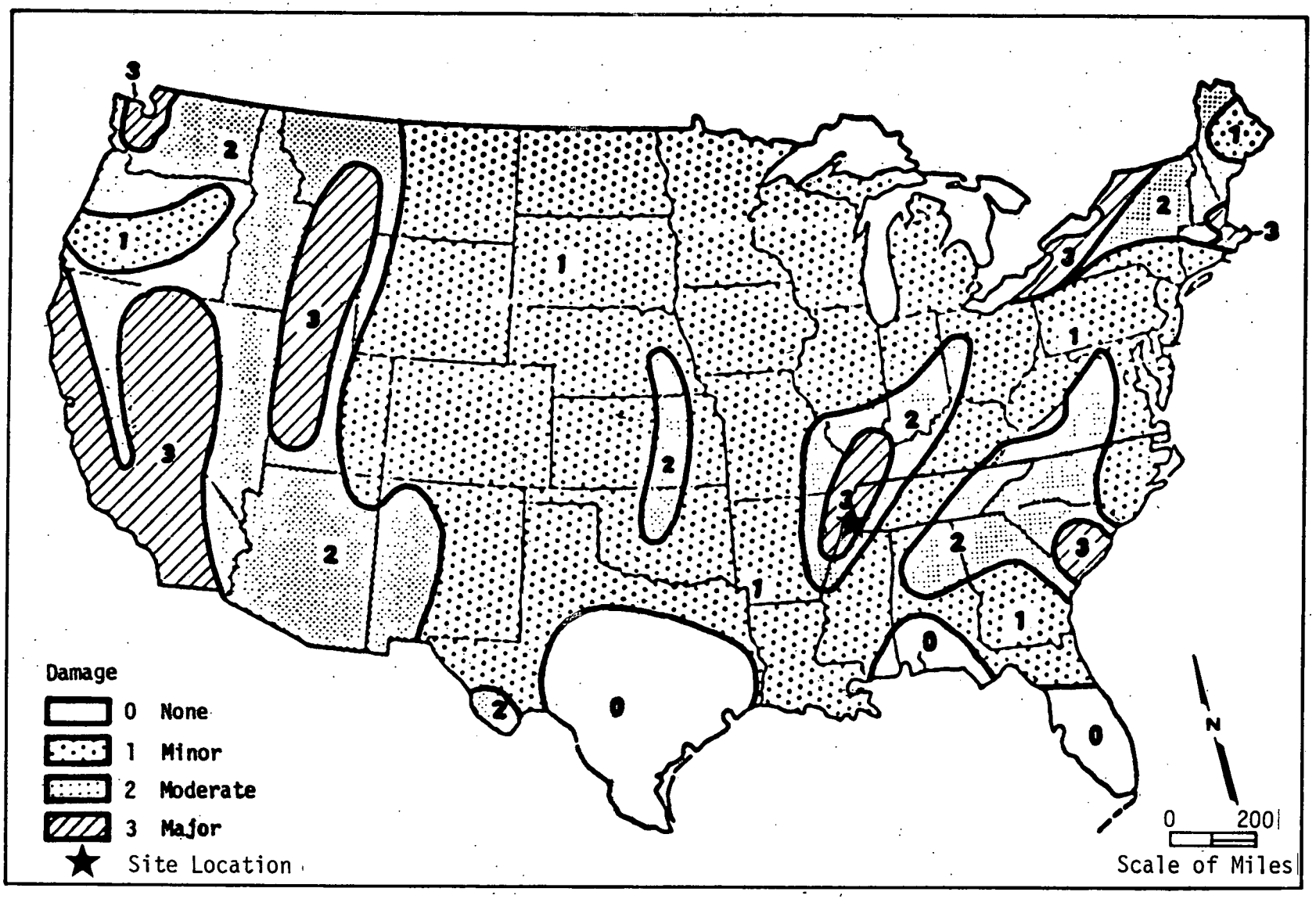

Figure 3-6. Seismic Risk Map of the United States [15]

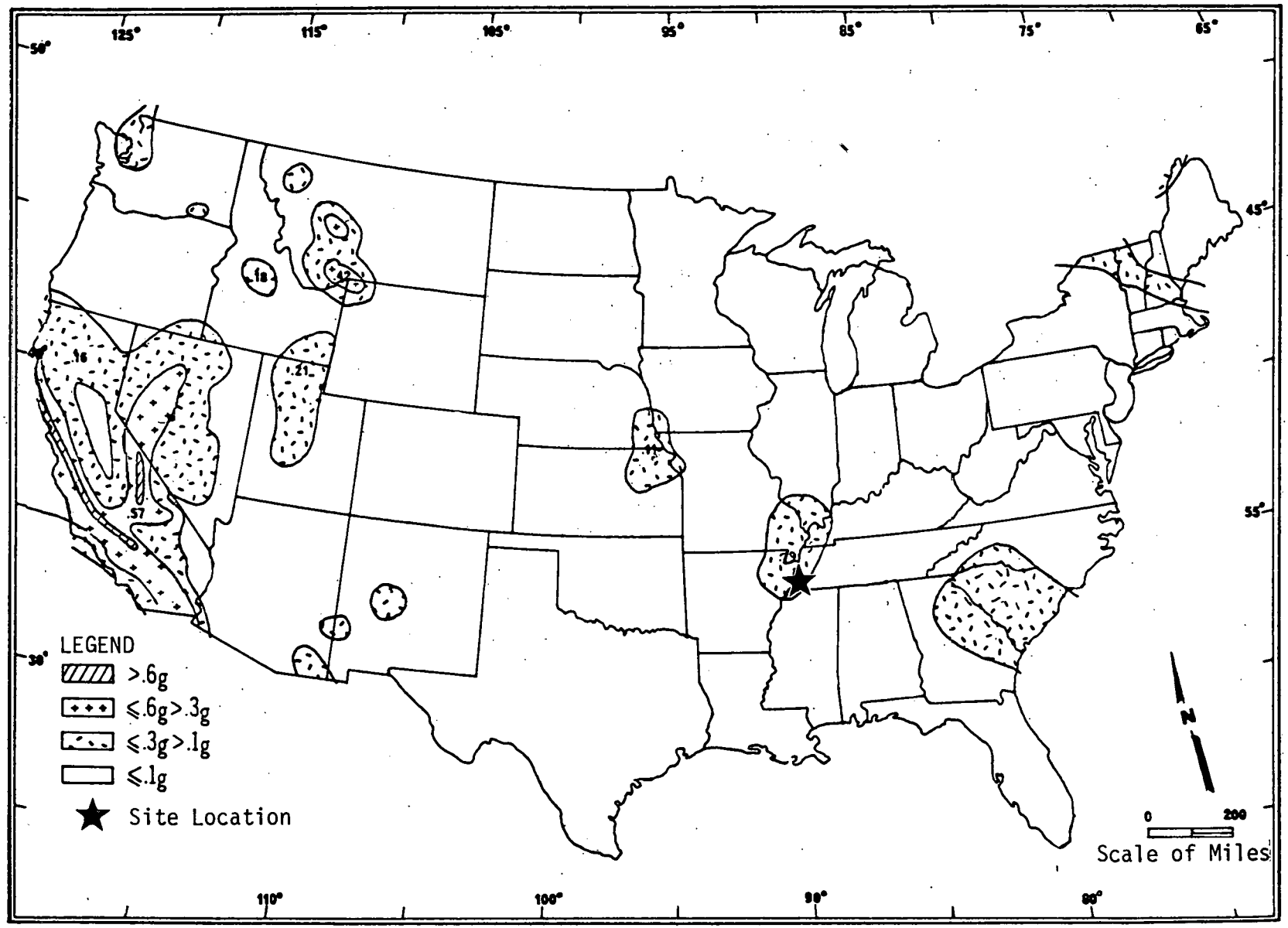

Figure 3-7. U.S. Seismic Zone Map[16]

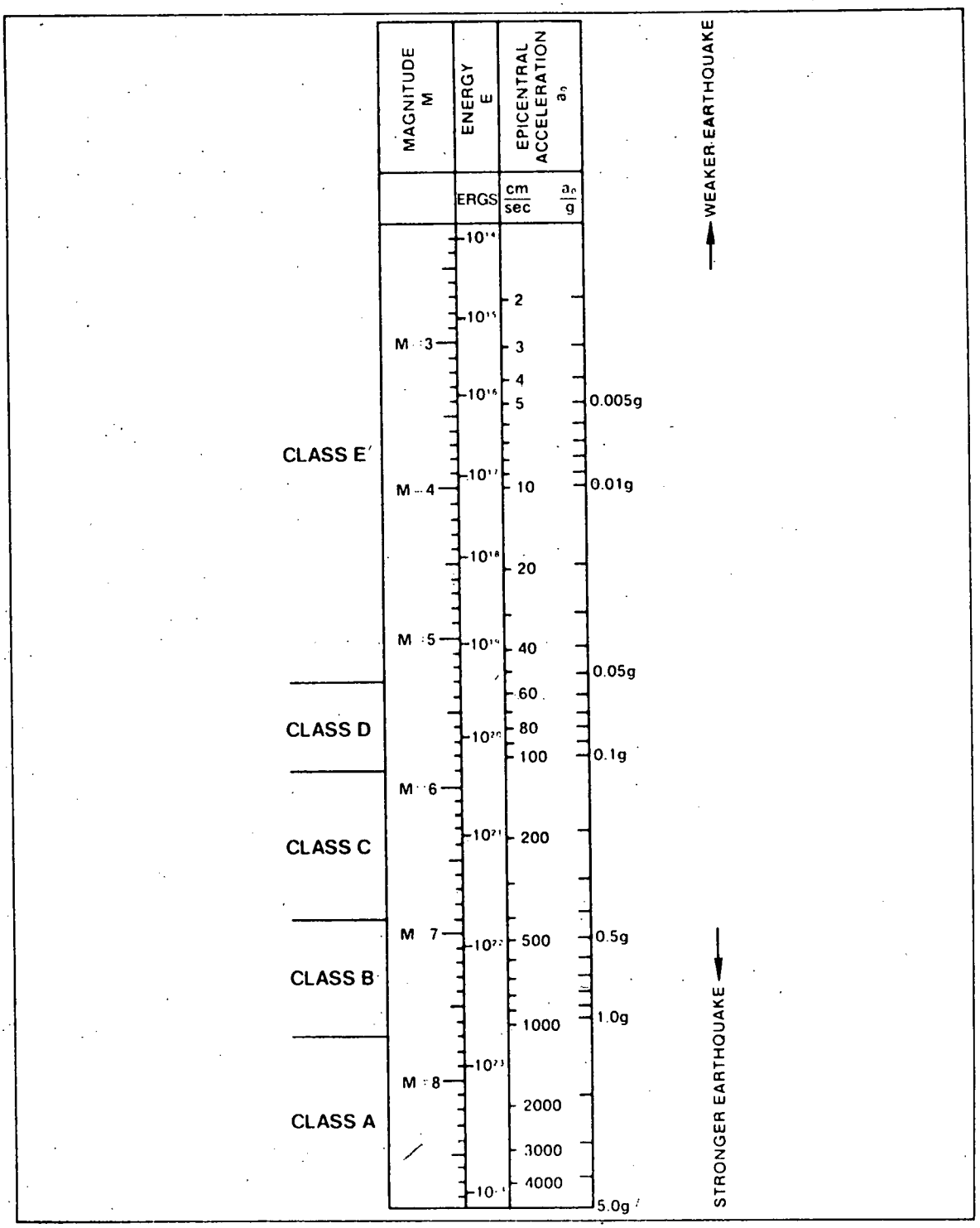

Figure 3-8. Approximate Relation Between Earthquake Magnitude and Energy Release and Epicentral Acceleration (17)

site, registering V on the Mercalli scale; (2) November 26, 1923, centered 13 kilometers north of the site registering VI on the Mercalli scale; (3) July 3, 1934, centered 6 kilometers northeast of the site registering IV on the Mercalli scale; and (4) January 26, 1958, centered 13 kilometers east of the site registering V on the Mercalli scale.

An event registering IV on the Mercalli scale can be felt indoors by many people and, as listed in Table 3-2, will disturb dishes, windows and doors. An event registering V on the Mercalli scale can be felt by most people and will cause breakage of dishes, windows and weak plaster. An event registering VI on the Mercalli scale can be felt by all people and will cause plaster and weak chimneys to fall.

Recurrence data for the Memphis region indicate that a felt seismic event of magnitude VI on the Mercalli scale will occur six times per 100 years on the average and will result primarily from seismic events centered near New Madrid, Missouri, approximately 165 kilometers north-northeast of the site.[18] Reference 18 concludes: "It is further concluded that the maximum credible earthquake expected to occur in the area will have a Richter Magnitude of 7.4 (epicentral Mercalli Intensity of X) and will have a repetitive occurrence about every 500 to 700 years."

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3.3 HYDROLOGY AND WATER QUALITY

Hydrological and water quality characteristics of the surface water bodies and the groundwater resources in the vicinity of the IFGDP site are described in this section. Major emphasis was placed on those characteristics that apply in the assessment of impacts of the proposed plant on these hydrological and water quality resources.

3.3.1 SURFACE WATER

Three major surface water bodies are located within the vicinity of the proposed IFGDP site: (1) the Mississippi River, (2) Lake McKellar and (3) Nonconnah Creek. Hydrological characteristics of these water bodies, as well as water quality, are discussed in this section. Users of these water resources and dischargers into them within 3 miles of the proposed site are listed.

3.3.1.1 MISSISSIPPI RIVER

Hydrological and water quality characteristics of the Mississippi River are discussed in this section. Users of this river and dischargers into it are also listed.

3.3.1.1.1 GENERAL DRAINAGE DESCRIPTION

The Mississippi River is the largest drainage basin in the United States, draining a total area of 1,244,000 square miles[1] including approximately 932,735 square miles as it passes the mouth of Lake McKellar at river mile (RM) 725.5. The river at this point is walled in between flood control levees on the west side in Arkansas and the levee protecting Frank C. Pidgeon Industrial Development on the east side of the river as shown in Figure 3-9. These levees are part of the U.S. Army Corps of Engineers Mississippi River main-stem levee system that extends along both banks of the river for over 2000 miles.[2] High water is confined between the east and west levees at Memphis to a width of 10,000 feet.

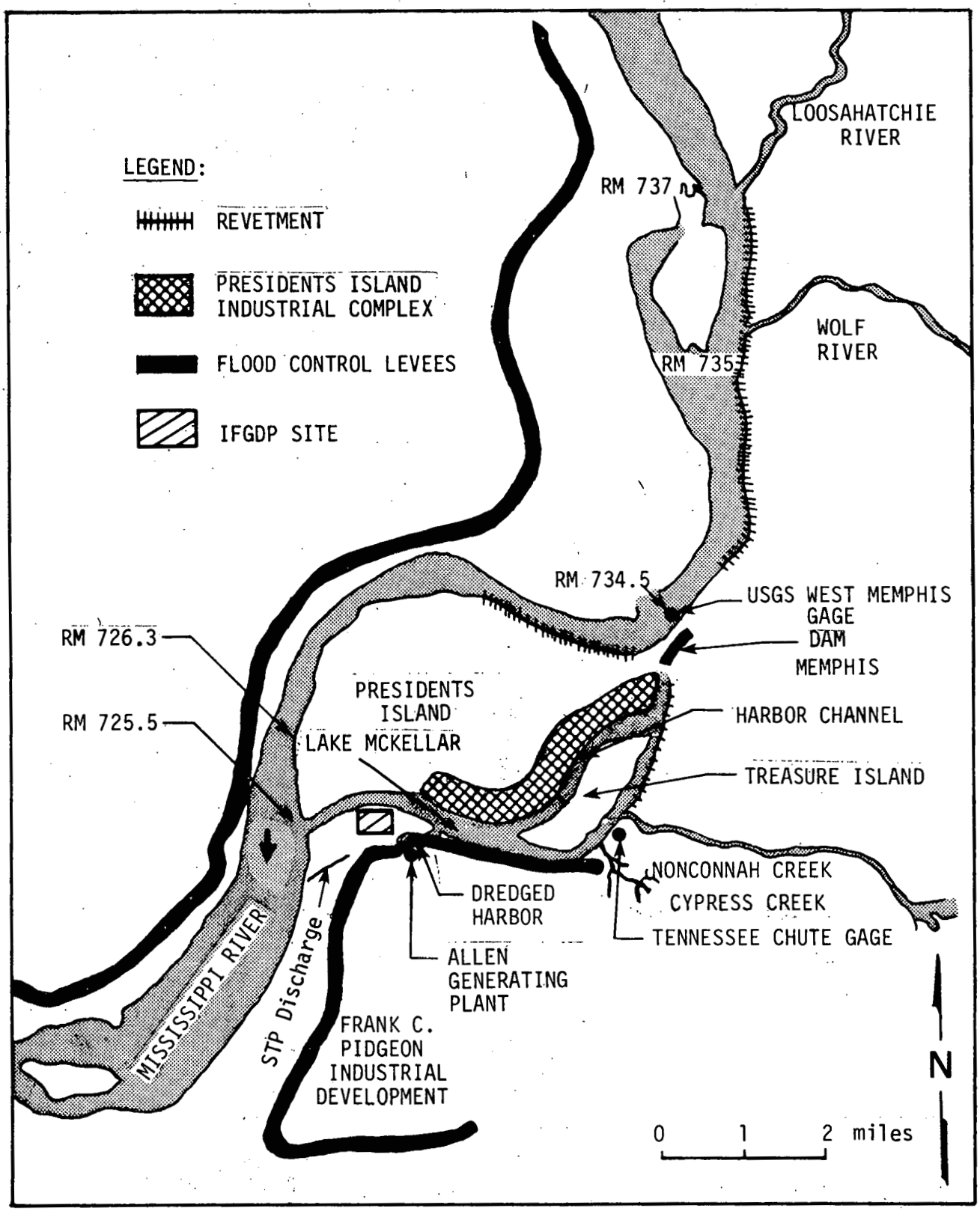

Figure 3-9. Mississippi River in the Vicinity of the IFGDP Site

The Loosahatchie River (river mile 737), draining 742 square miles, and Wolf River (river mile 735), draining 819 square miles, enter the Mississippi River upstream of Memphis (Figure 3-9). These are minor tributaries to the river contributing average flows of 600 to 800 cubic feet per second (cfs) to the main stem of the Mississippi River. Nonconnah Creek, another minor tributary draining 182 square miles with an average flow of less than 100 cubic feet per second, enters through Lake McKellar, a man-made backwater arm of the Mississippi River (Figure 3-9).

3.3.1.1.2 WATER USE

The Mississippi River is not used directly for domestic or industrial purposes within 3 miles of the plant site since groundwater provides the major source of water for drinking and industrial uses. The river system indirectly supplies cooling water to the Tennessee Valley Authority's (TVA) Allen Generating Plant, since this plant drains its cooling water from Lake McKellar.

The Mississippi River carries tremendous volumes of water past Memphis, with an average flow passing Memphis of 360,000 cubic feet per second (cfs) or about 232,674 million gallons per day (mgd).

Seven point source elements consisting of five industries and two wastewater treatment plants discharge into the Mississippi River near the plant site at a combined flow of 722.22 million gallons per day. These dischargers are listed in Table 3-4 along with their effluent flow and permitting status. Sixty-nine percent of the total effluent is cooling water from the Allen Generating Plant, and 30 percent is from the Memphis North and South Wastewater Treatment Plants. Of these point source elements, all but the Memphis North Wastewater Treatment Plant have NPDES Permits to discharge to the Mississippi River.

3.3.1.1.3 LOW AND HIGH FLOW ESTIMATES

Flow data from the United States Geological Survey (USGS) recorded at the West Memphis gage (river mile 734.8) for the period 1950 to 1978 were used

TABLE 3-4

POINT SOURCE DISCHARGERS INTO THE MISSISSIPPI RIVER, LAKE MCKELLAR AND NONCONNAH CREEK WITHIN 3 MILES OF THE IFGDP SITE

Discharger	Effluent Flow (mgd)	NPDES Permit
MISSISSIPPI RIVER		
International Harvester Company	1.620	TN 0000167
Meeman Shelby State Park	0.100	TN 0027600
T. E. Maxson Wastewater Treatment Plant (Memphis South)	80	TN 0020729
Memphis North Wastewater Treatment Plant	135	*
Allen Generating Plant	500	TN 0005355
City of West Memphis	5.4	AR 0022039
Chemform Corporation	>0.1	AR 0037770
TOTAL	722.22	
LAKE MCKELLAR		
AMOCO Oil Company	**	*
Armour & Company, Inc.	0.200	TN 0000329
Cargill Corn Plant	**	TN 0029068
Cargill Soybean Plant	**	TN 0001201
CBI Nuclear, Inc.	0.150†	TN 0000116
General Electric Company	0.340	TN 0000345
Allen Generating Plant Ash Pond	2.3	*
Fiberfine	0.040	*
U.S.S. Agri-Chemicals	0.030	*
TOTAL	3.06	

* No NPDES Permit on file

** Unmonitored storm water drainage or runoff

† Monthly batch release

†† NPDES Permit being written

Δ Tennessee State Discharge Permit

(Continued)

TABLE 3-4 (Continued)

Discharger	Effluent Flow (mgd)	NPDES Permit
NONCONNAH CREEK		
Air Products & Chemicals	0.100	TN 0000124
Burk-Hall Paint Company	0.002	TN 0000485
Central Soya	0.005	TN 0001244
Conley Frog & Switch	0.009	TN 0000787
Federal Compress & Warehouse	**	††
Fruehauf Corporation	**	TN 0022314
Gulf Oil Sales Terminal	**	TN 0024023
Hunt-Wesson Foods, Inc.	0.350	TN 0000132
Kellogg Company	0.280	*
Memphis Compress & Storage	0.001	TN 0000337
Memphis Plywood Corporation	0.018	TN 0001210
Miss-Ark-Tenn Packaging Corporation	**	*
PNB Corporation	**	*
Pro-Serve, Inc.	0.130	Δ
Ripley Industries	**	*
Standard Redi-Mix Concrete	0.022	TN 0001040
St. Louis - San Francisco Railroad	0.004	TN 0001236
Carruthers Redi-Mix	**	*
Hack's Crossroads Lagoon	0.018	*
Windyke Country Club	0.020	*
Carrier Excavation Company	0.003	*
Construction Aggregates, Inc.	0.960	††
Delta Refining Company	0.450	††

* No NPDES Permit on file

** Unmonitored storm water drainage or runoff

† Monthly batch release

†† NPDES Permit being written

Δ Tennessee State Discharge Permit

(Continued)

TABLE 3-4 (Continued)

Discharger	Effluent Flow (mgd)	NPDES Permit
NONCONNAH CREEK (Continued)		
Refined Metals (Memphis Lead)	0.014	*
Standard Brake Shoe	0.025	*
Bella Vista Country Club	0.020	*
Holiday Inns (Olive Branch Indus'l Park)	0.090	*
Joseph Schlitz Brewing Company	**	*
MLGW, Allen Station	**	*
MLGW, Lichterman Station	**	*
MLGW, Sheahan Station	**	*
American Electric Corporation	0.034	*
Illinois Central - Gulf Railroad	0.033	††
TOTAL	2.59	

* No NPDES Permit on file

** Unmonitored storm water drainage or runoff

† Monthly batch release

†† NPDES Permit being written

Δ Tennessee State Discharge Permit

to estimate the relationship between river flow (cubic feet per second) and river pool elevation in feet above mean sea level. This relationship is shown by the stage-discharge curve in Figure 3-10. A comparison was made between the USGS gage (river mile 734.8) upstream of Lake McKellar and the next USGS river gage 20 miles downstream to determine the average slope elevation. The average slope of the entire river is 0.4 foot per mile which should cause a 3 to 4 foot drop in elevation from West Memphis, around Presidents Island, to the mouth of Lake McKellar (Figure 3-9). The actual drop in elevation is approximately 2.5 feet from mean sea level. Using the Tennessee Chute gage located in Lake McKellar below Nonconnah Creek (Figure 3-9) and the average slope elevation, an estimated relationship between lake elevation and river flow at the mouth of the lake was calculated. This estimated curve is shown in Figure 3-10. River cross-section at the USGS West Memphis gage was used to estimate velocity of the river at different elevations, and this curve is also shown in Figure 3-10. For a particular lake elevation adjacent to the IFGDP site, the Mississippi River discharge and velocity proximate to the site can be estimated by entering the graph with the lake elevation.

Maximum instantaneous flow at the West Memphis USGS gage was 2,020,000 cubic feet per second recorded on February 7, 1937, at a river elevation of 232.22 feet above mean sea level, and minimum instantaneous flow was 78,000 cubic feet per second on August 25, 1936, at a river elevation of 183.92 feet above mean sea level. The average flow past Memphis is 360,000 cubic feet per second.

Tennessee Chute gage records for the duration of its existence (1950 to 1978) were used to compute an elevation/time of duration curve for the Mississippi River at the mouth of Lake McKellar as shown in Figure 3-11. The curve shows the high and low elevation extremes and the percent duration of these extremes. Percent duration indicates the percent of time an elevation taken off the curve is not exceeded.

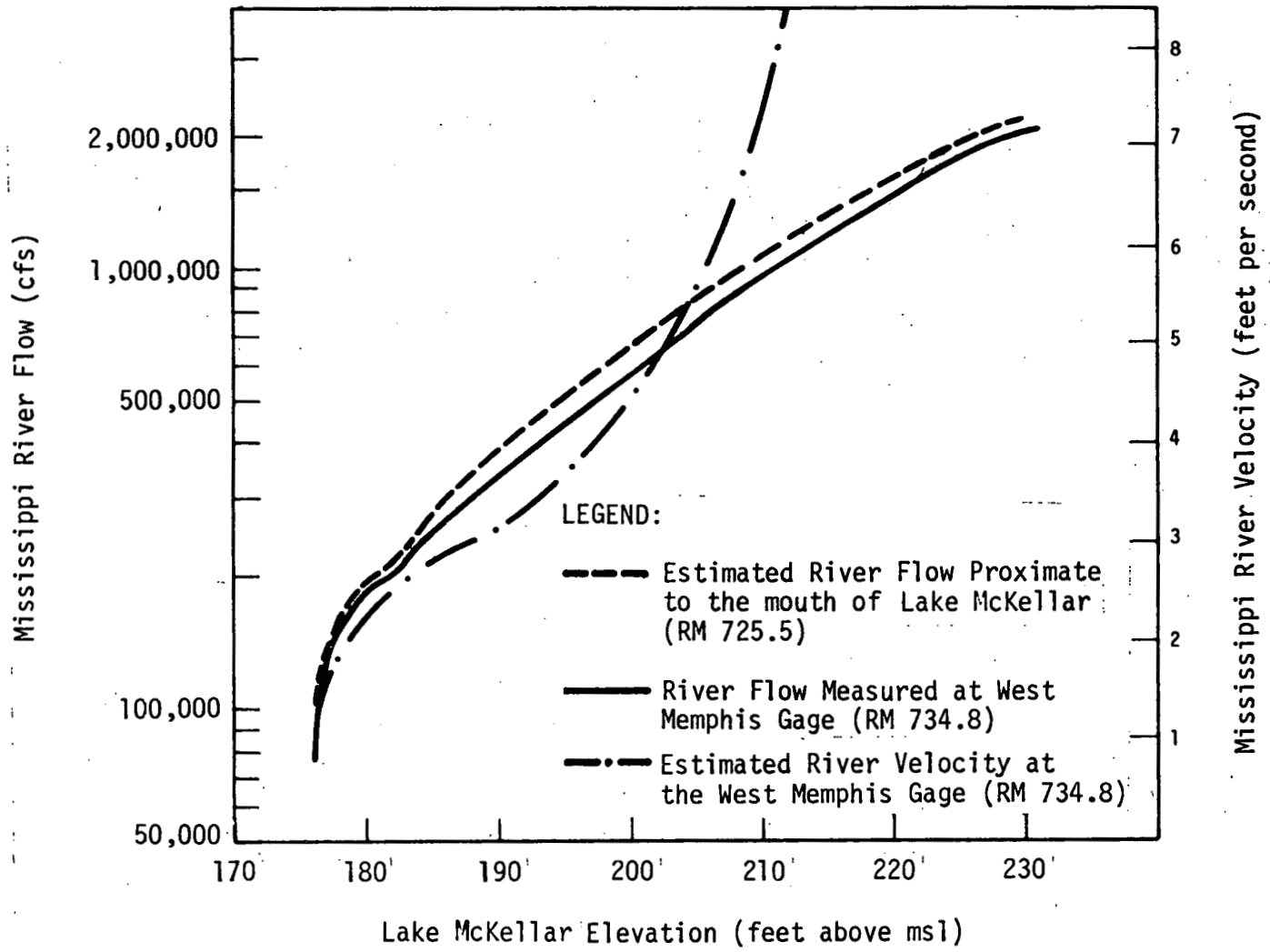

Figure 3-10. Estimated Elevation Flow and Velocity Relationship for the Mississippi River at the USGS Gage (RM 734.8) and Downstream at the Mouth of Lake McKellar (RM 725.5), 1950 to 1978

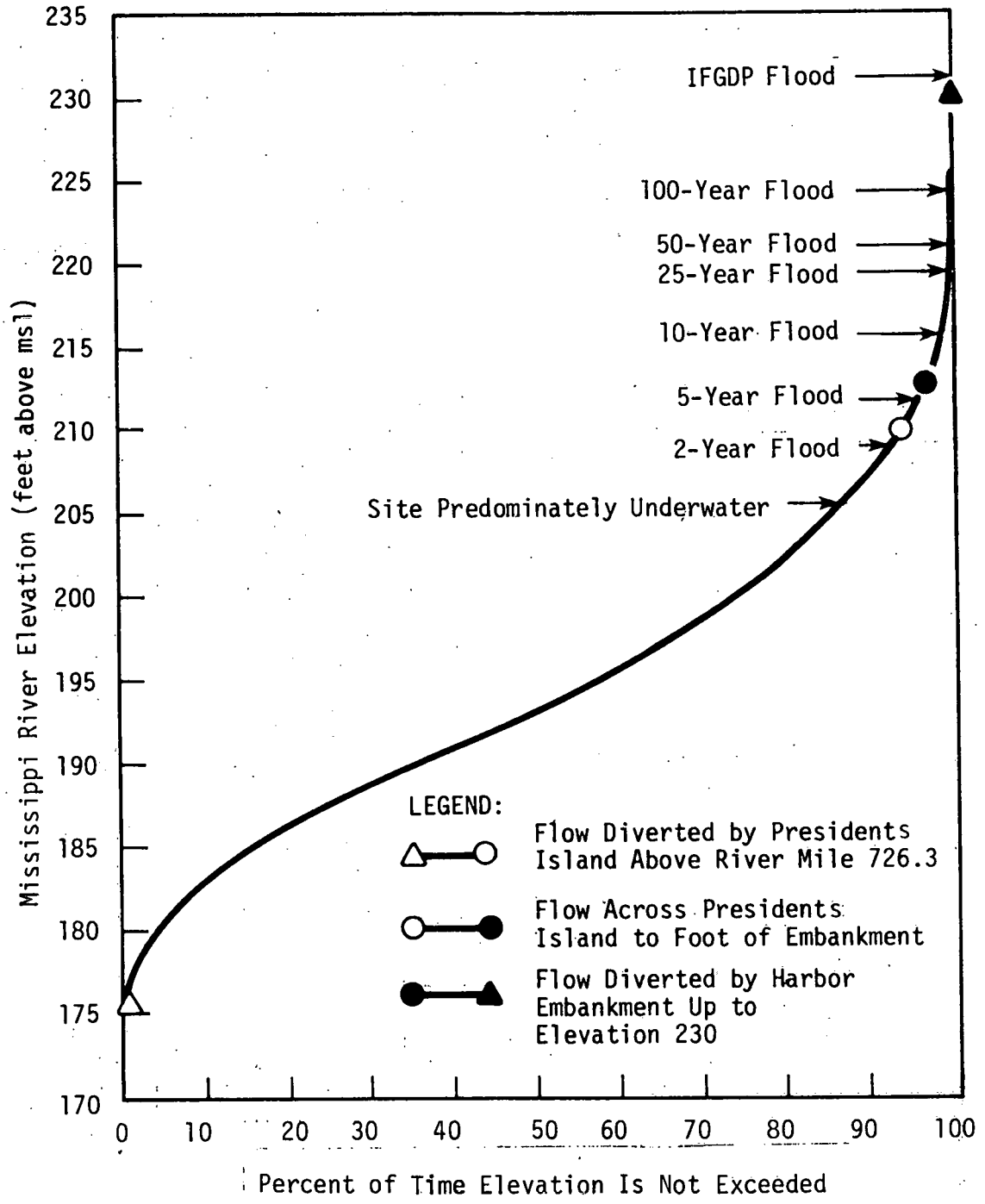

Figure 3-11. Elevation/Time Duration Curve of the Mississippi River Near Lake McKellar as Measured on the Tennessee Chute Gage, 1950 to 1978

A hydrograph of monthly average values for the period 1950 to 1978 was compiled using data from the Tennessee Chute as shown in Figure 3-12. Data in this figure indicate that the highest lake and river stages occur from March to May, and low stages occur from August to November.

3.3.1.1.4 FLOOD RECORD AND FLOOD CONTROL

Flood flow frequencies for the Mississippi River near the proposed IFGDP site were determined using the Pearson Type III distribution with log transformation of data obtained from the USGS gage at West Memphis (river mile 734.8). Figure 3-13 shows the 3-day high-flow frequency and Figure 3-14 shows the 3-day low-flow frequency for the Mississippi River upstream at the West Memphis gage. The Pearson Type III log plots relate frequency to flow in a particular return period, and duration of flow can then be accurately predicted. For example, the Q_{3-20}, the once-in-20-year, 3-day consecutive high or low flow, can be determined from these plots.

The U.S. Army Corps of Engineers (U.S. ACE) did a flow frequency analysis for the Mississippi River from USGS flow data along with upstream reservoir capacity and backwater profiles. From this analysis, the U.S. ACE calculated the 2-, 5-, 10-, 25-, 50- and 100-year instantaneous floods (maximum flood, not a daily average) at the proposed IFGDP site. This flood series is shown on the rating curve in Figure 3-15 and summarized in Table 3-5. Also shown in Table 3-5 is the IFGDP flood and the river elevation and flow that currently causes flooding at the proposed IFGDP site. Based on the log-Pearson Type III plots, flooding at the current site occurs approximately 1.05 to 1.25 years, when river elevations approach 205 feet above mean sea level and river discharge is approximately 825,000 cubic feet per second.

Under present conditions at the proposed IFGDP site, as the Mississippi River rises in elevation up to 210 feet above mean sea level, the river is diverted by Presidents Island above river mile 726.3 (Figure 3-9) as shown on the elevation time of duration curve in Figure 3-11. As the river continues to rise in elevation above 210 feet above mean sea level and flow begins to

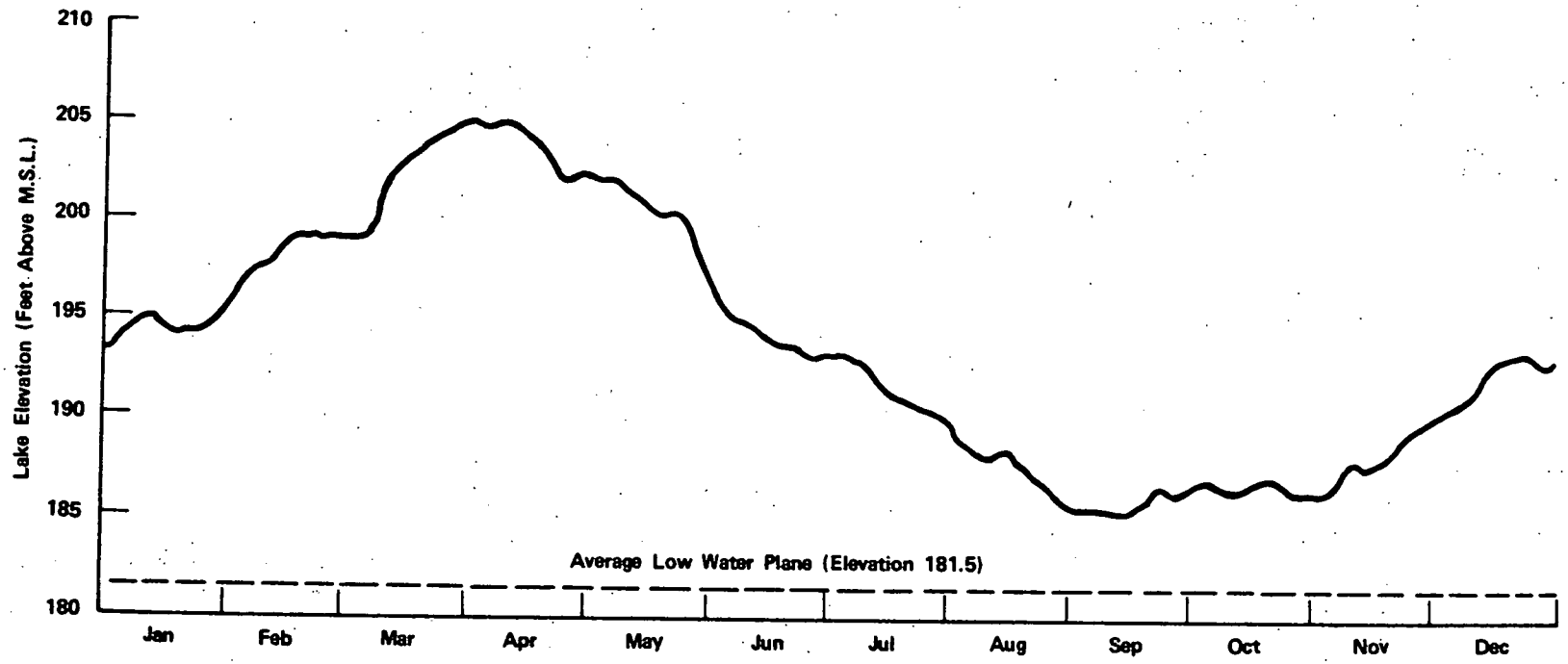

Figure 3-12. Average Monthly Elevation of Lake McKellar and Mississippi River as Measured on the Tennessee Chute Gage, 1950 to 1978

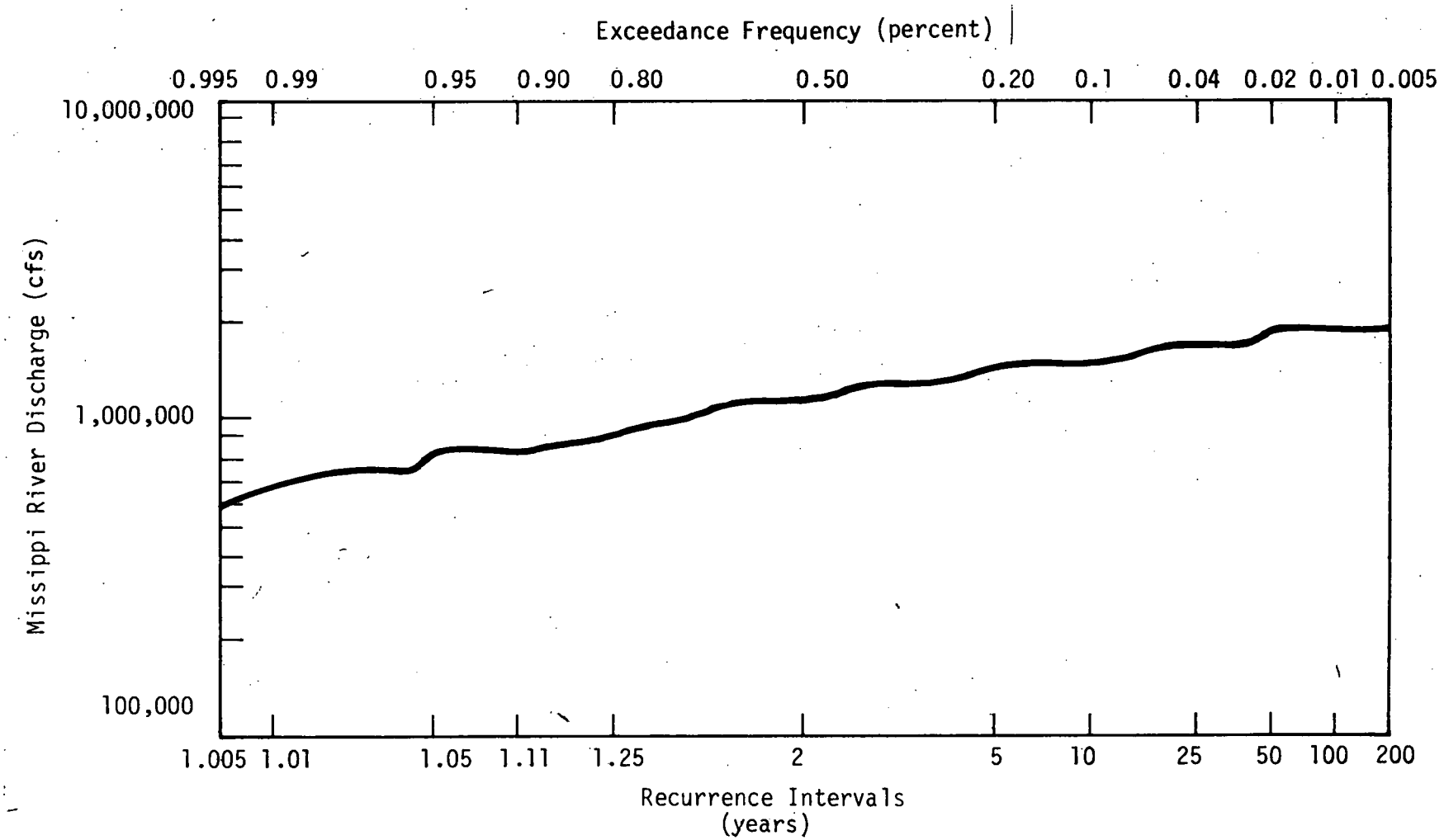

Figure 3-13. Three-Day, High-Flow Frequency Curve for the Mississippi River at USGS Gage (RM 734.8) for 43 Year Period of Record, 1934 to 1977

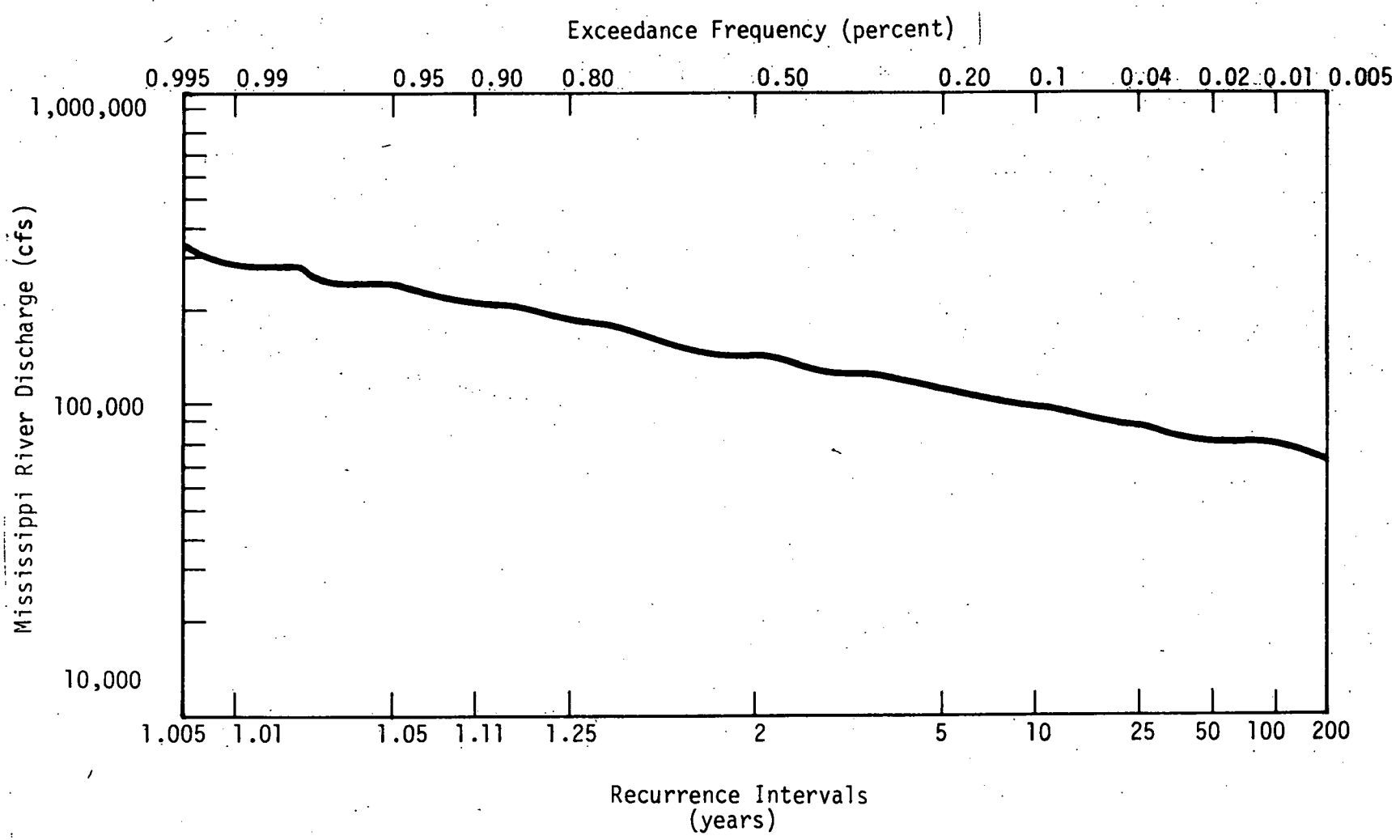

Figure 3-14. Three-Day, Low-Flow Frequency Curve for the Mississippi River at USGS Gage (RM 734.8) for 43 Year Period of Record, 1934 to 1977

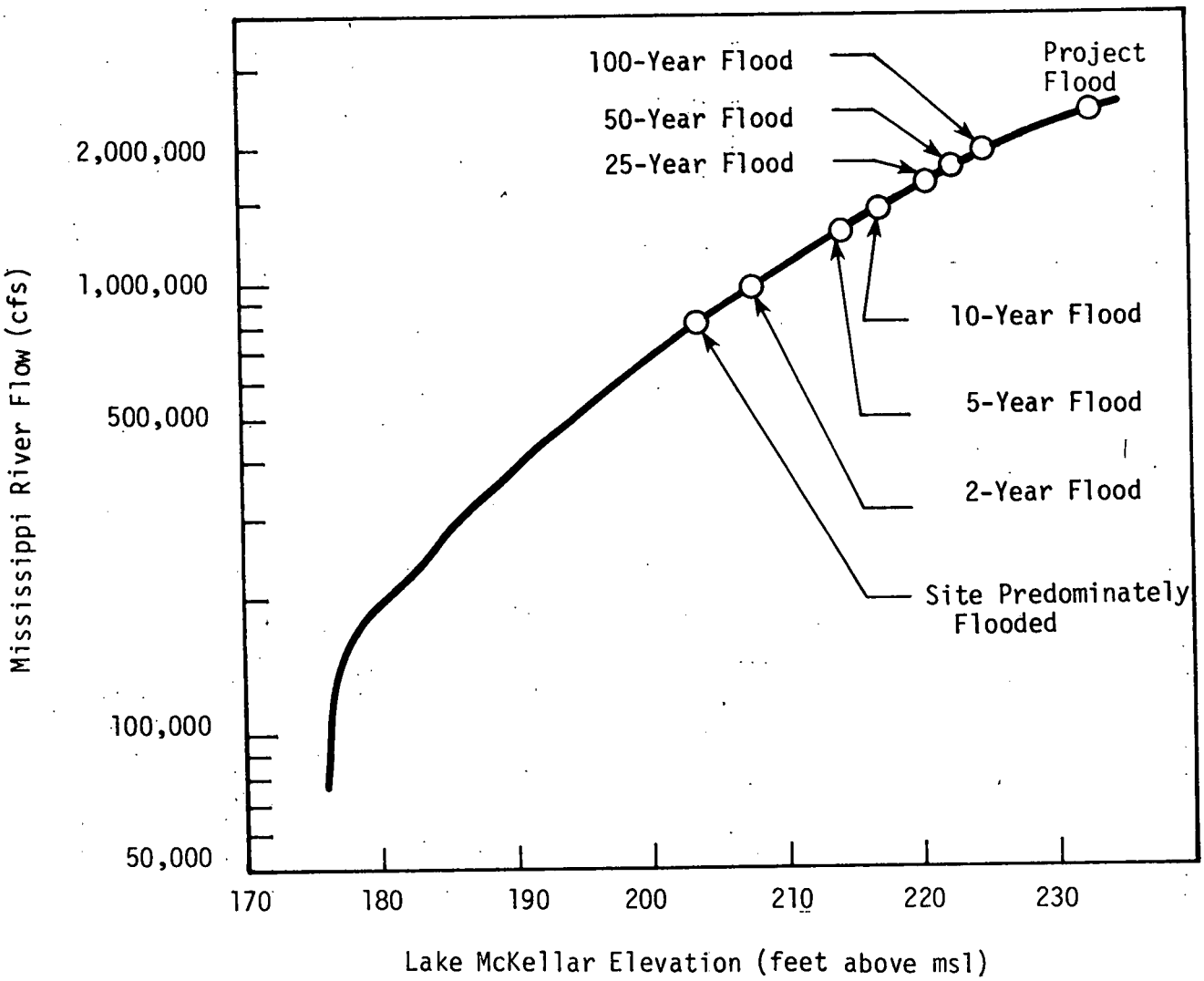

Figure 3-15. Rating Curve Showing Flood Series at the Proposed IFGDP Site

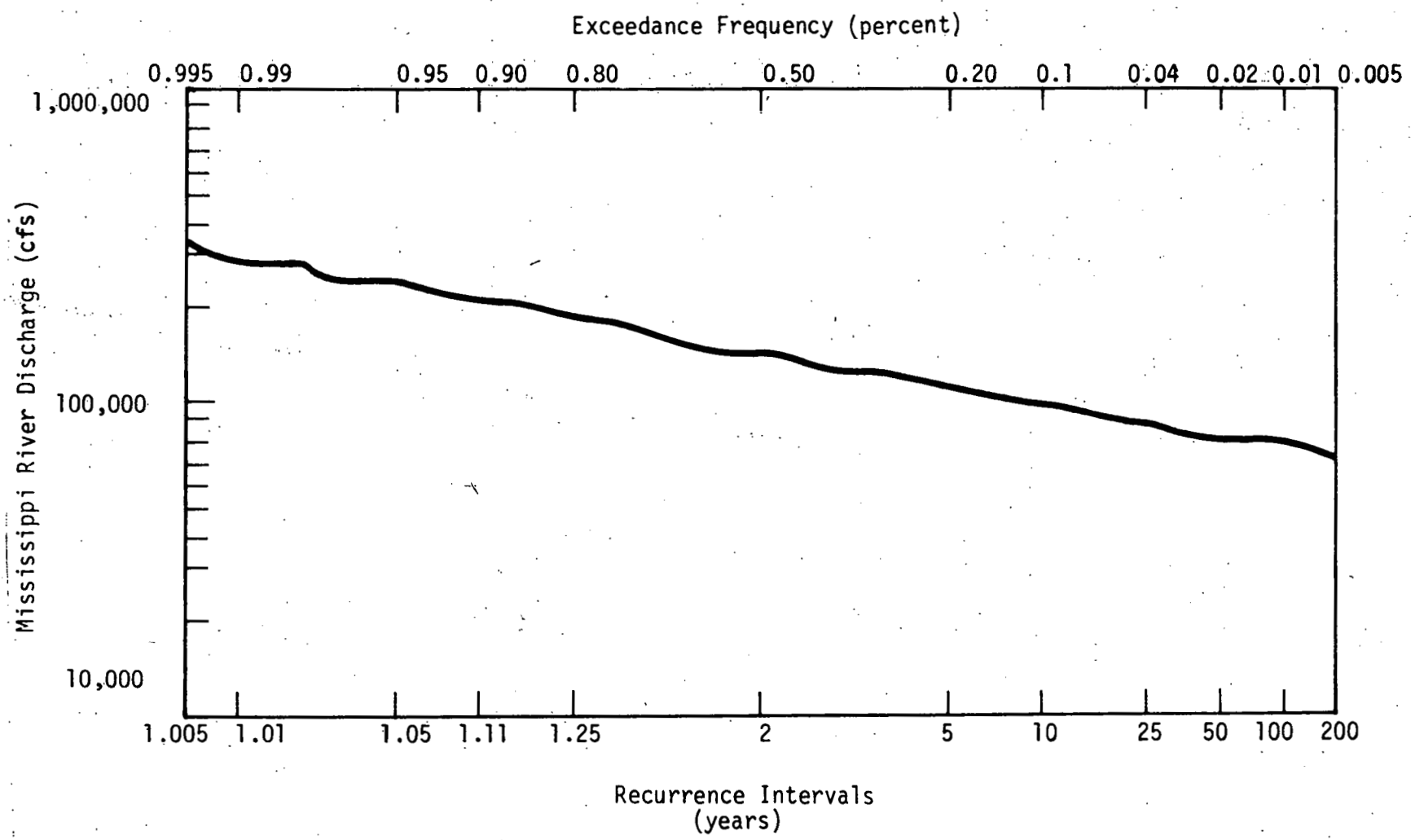

Figure 3-14. Three-Day, Low-Flow Frequency Curve for the Mississippi River at USGS Gage (RM 734.8) for 43 Year Period of Record, 1934 to 1977

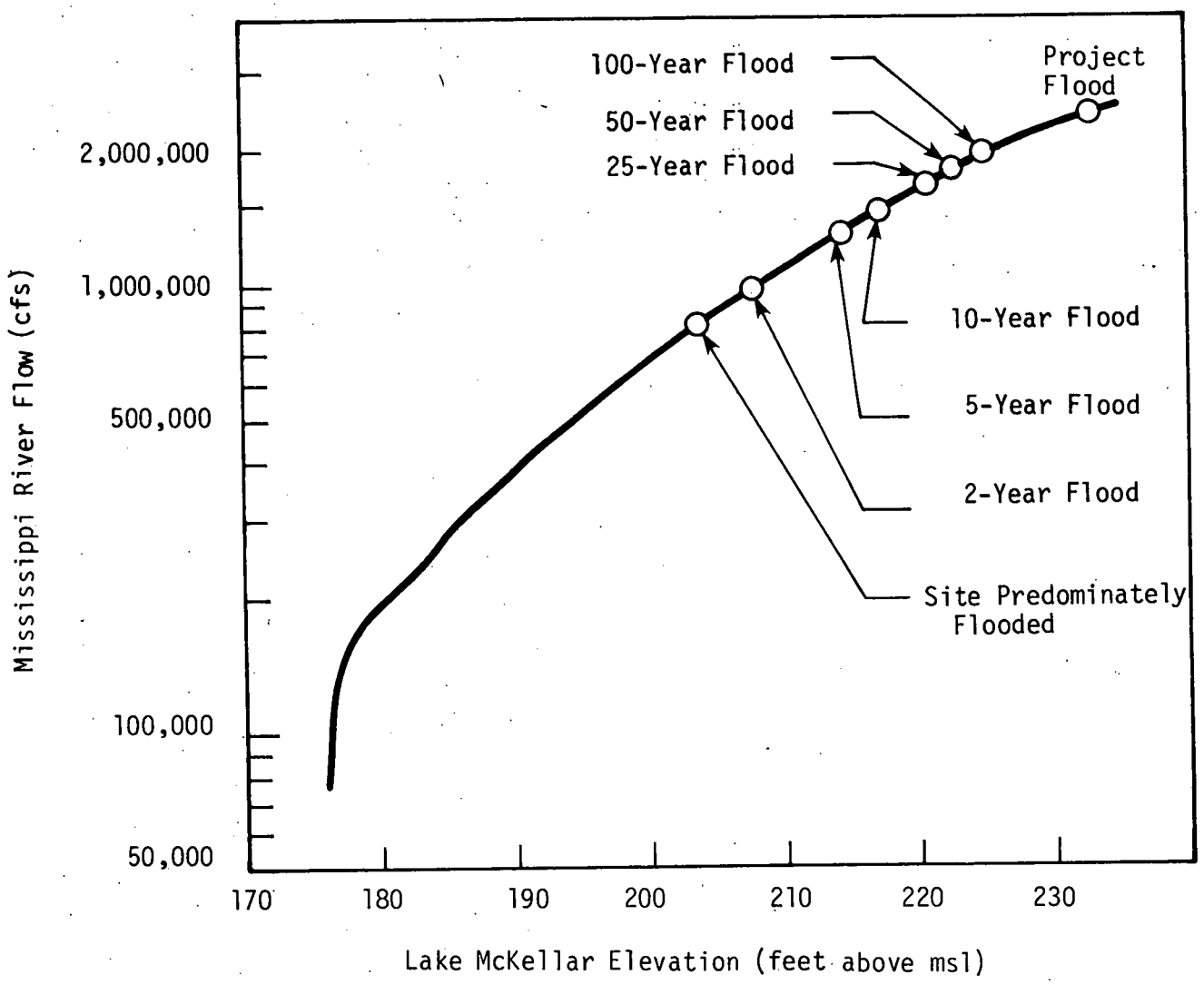

Figure 3-15. Rating Curve Showing Flood Series at the Proposed IFGDP Site

TABLE 3-5

MISSISSIPPI RIVER FLOOD FREQUENCIES AND CORRESPONDING ELEVATIONS AND DISCHARGES ADJACENT TO THE PROPOSED IFGDP SITE

Flood Frequency	Mississippi River Elevation (feet above msl)	Mississippi River Discharge (cfs)
Project Design Flood	232.8	2,450,000
100-year	224.9	1,950,000
50-year	222.6	1,800,000
25-year	220.0	1,650,000
10-year	216.4	1,400,000
5-year	213.5	1,300,000
2-year	207.8	960,000
Present Site Flooding	205.0	825,000

move across Presidents Island and up to an elevation of 230 feet above mean sea level, the river flow is diverted by the Memphis Harbor Embankment (Figures 3-9 and 3-11). The flood series above, calculated by the U.S. ACE, has also been related to river elevations as shown in Figure 3-11. The 2-year flood is diverted by Presidents Island above river mile 726.3, the 5-year flood causes flow across Presidents Island and the 10-, 25-, 50- and 100-year floods are all diverted by the Presidents Island Harbor Embankment, which is at a elevation of 230 feet above mean sea level. The embankment for the proposed IFGDP site will be at an elevation of 233 feet above mean sea level, well above the 100-year flood and 0.3 foot above the project design flood calculated by the U.S. ACE. The corresponding Mississippi River discharges for this series of floods are given in Table 3-5, and as shown, only a Mississippi River discharge of approximately 2,450,000 cubic feet per second will inundate the completed IFGDP. The maximum instantaneous flow of the Mississippi River near the site since 1937 has been 2,020,000 cubic feet per second, which represents a flood greater than the 100-year instantaneous flood.

3.3.1.1.5 WATER QUALITY NEAR MEMPHIS

Water quality in the Mississippi River was assessed by examination of existing literature and recent site-specific EIA field survey data (1978-79 surveys) to define baseline water quality in proximity to the proposed site. Details of the methods and results of the 1978-79 surveys and a review of pertinent literature are presented in Appendix 3A. Existing stresses were determined by comparison of literature information and data from the 1978-79 surveys with water quality criteria established by the State of Tennessee[3] and quality criteria for water with regard to aquatic life established by the United States Environmental Protection Agency (EPA), since all surface waters near the site are classified as suitable for fish and aquatic life.[4] Where aquatic life criteria are presented in terms of bioassay results, EPA criteria on water supply (health and welfare) were used for water quality assessment. By using this approach, strictest applicable criteria (Criteria) were compiled with which Mississippi River water quality was compared (Appendix 3A, Table 3A-1).

Water quality in the Mississippi River is influenced by industrial discharges and urban and agricultural nonpoint runoff throughout its vast watershed area.[5] Most of these effects are localized and reduced in severity by the river's large dilution capacity, and resultant water quality is generally within Criteria for most parameters. In the Memphis area, sewage effluents and discharges from river tributaries result in inferior water quality in comparison with upstream and downstream reaches. For instance, the Wolf and Loosahatchie Rivers, located as shown in Figure 3-16, contribute high suspended solid, organic and industrial waste loads to the Mississippi River above West Memphis.[6]

Mississippi River chemistry was investigated at river miles 785 (upriver of Memphis), 730 (West Memphis) and 522 in 1976.[7] Of the 18 parameters considered, concentrations at West Memphis were highest for sulfates, nutrients and coliform bacteria. Water quality has also been monitored by the United States Geological Survey (USGS) since 1973 at Memphis, river mile 734.8 (Figure 3-16).[8] During this monitoring period, there were no significant water quality trends in coliform concentrations, in major ion concentrations (such as iron, calcium or bicarbonate) or in trace element concentrations (such as cobalt, chromium or lead).

Seasonal site-specific water quality field surveys were conducted by EIA in May, July and October 1978 and January 1979 (see 1978-79 surveys - Appendix 3A, Tables 3A-15 to 3A-19). Figure 3-17 shows the sampling stations studied in this effort. In-situ measurements and laboratory analyses were made of samples collected near the left shore of the Mississippi River above the confluence with Lake McKellar (MR1) and along the same shore below the lake's confluence (MR2). Survey results showed that well-mixed conditions occurred during all seasons at both locations. In-situ parameters (pH, dissolved oxygen and temperature) were within Criteria at all times. Within each seasonal survey, there were few differences in concentration between MR1 and MR2, indicating that Lake McKellar discharge was not substantially affecting the quality of river water during these times.

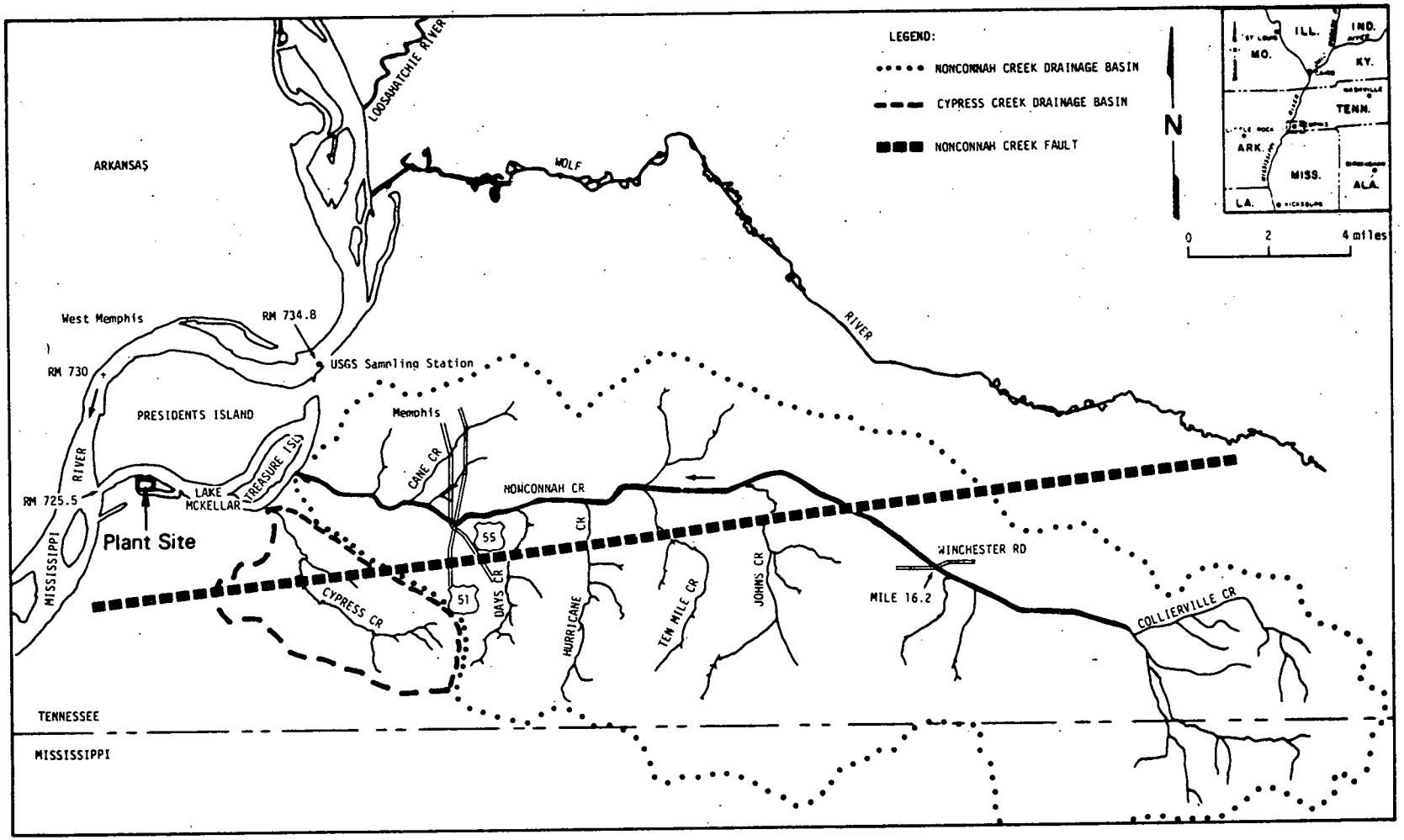

Figure 3-16. Proposed Site Location in Relation to Regional Surface Water Systems

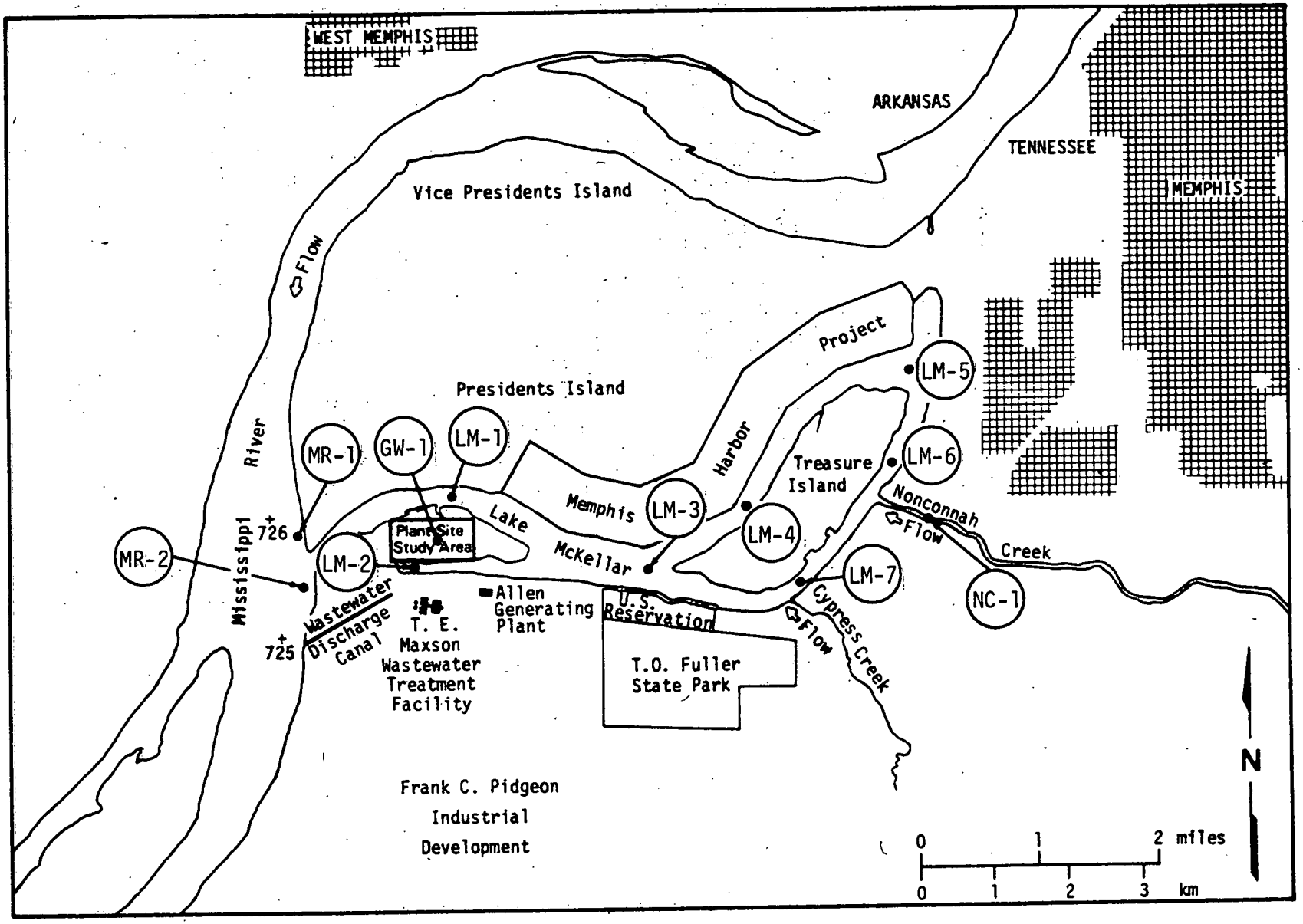

Figure 3-17. Water Quality Sampling Locations During 1978-79 EIA Field Surveys

Calcium and bicarbonate were the dominant ions at both stations. Linear regression analysis was used as a tool to investigate functional relationships between water quality parameters and to provide a quantitative description of baseline conditions. Data for MR1 obtained during the 1978-79 surveys were used with details of the results presented in Appendix 3A, Table 3A-22. Of the six relationships investigated, the correlation coefficient, r, was significantly different from zero above the 80 percent level in the cases of: (1) calcium and magnesium, (2) biochemical and chemical oxygen demands, (3) total organic carbon and chemical oxygen demand and (4) total organic carbon and total kjeldahl nitrogen. Calcium and magnesium showed a stable relationship, suggesting that principal geochemical sources release both ions in reasonably constant proportions.

Organic relationships expressed in cases 2, 3 and 4 above indicate that although there are many water quality degrading inputs that vary between seasons, there is an apparent stability in the response of the river to the organic load. River mixing and chemical stability of the river waters are likely causes.

For both river sampling stations (MR1, MR2), biochemical oxygen demand concentrations [annual mean of all survey samples (mean) 3.7 milligrams per liter, annual maximum (maximum) 12.0 milligrams per liter] were consistently and substantially lower than chemical oxygen demand concentrations (mean 28.0 milligrams per liter, maximum 38.0 milligrams per liter), indicating that most of the demand is not amenable to biological degradation. These data were within the range of the USGS data[8] for parameters considered, indicating that water quality is not substantially different between river mile 730 and the mouth of Lake McKellar (river mile 726).

Analysis for 15 polycyclic aromatic hydrocarbons (PAH), potential by-products of the coal gasification process, was performed for in-water samples collected from MR1 and MR2 during each seasonal survey. None were noted at the detection limit of 0.01 part per million at any time during the sampling effort.

In terms of existing stresses, it was noted that phenol concentrations exceeded the Criteria of 0.001 milligram per liter during May, July and October (1978-79 surveys), as a result of water quality degrading inputs from nearby industrial plants. Iron (mean 7.2 milligrams per liter, maximum 13.8 milligrams per liter) and manganese (mean 0.31 milligram per liter, maximum 0.40 milligram per liter) were the only parameters consistently above the Criteria of 0.3 milligram per liter and 0.05 milligram per liter, respectively. Both anthropogenic and natural activities contribute to the iron and manganese loads near Memphis. Acid mine drainage and other industrial discharges may be significant; however, the principal sources are natural, including aquifer solution and incorporation of these metals in suspended sediment. Selenium, mercury, cadmium and cyanide occasionally and marginally exceeded Criteria. USGS data[8] indicate that iron, manganese and phenol consistently exceeded Criteria, with nitrate-nitrogen and cadmium occasionally in excess.

3.3.1.1.6 SEDIMENT QUALITY

Mississippi River sediment chemistry was evaluated from available literature and results of EIA's site-specific field surveys (see 1978-79 surveys - Appendix 3A, Tables 3A-26 to 3A-32). Sediments from the Mississippi River at West Memphis (river mile 730) were investigated by CDM/Limnetics[7] in 1977 and the USGS[8] in 1973 and 1977 for pesticides and heavy metals. No pesticides were found above the detection limit. The USGS reported total iron and manganese in concentrations above 0.02 milligram per kilogram, while cadimum, chromium, copper, lead, mercury and zinc were above 0.02 milligram per kilogram in the CDM/Limnetics report.

During the November 1978 field survey (Appendix 3A), EIA collected sediment samples from above the confluence with Lake McKellar at MR1 and analyzed the samples for routine chemical parameters and 15 polycyclic aromatic hydrocarbons. Analytical results were compared to the sediment classification designed by Prater and Anderson.[9] This classification is useful as a general index, but must be applied with some caution since it was developed on bioassays from Great Lakes harbor sediment. Ninety-three percent of the parameters

investigated at MR1 were considered to be representative of unpolluted conditions by the Prater/Anderson classification. Of the polycyclic aromatic hydrocarbons, napthalene (mean <0.019, maximum, 0.058) alone was found to be above the detection limit of 0.005 parts per million.

Elutriate tests were conducted on MR1 sediment, providing an indication of the concentrations of materials that may be released into the water column due to physical disturbance (e.g., dredging) of the sediment. Resulting elutriate waters were of similar quality as Mississippi River waters. Phenol, cadmium and ammonia-nitrogen exceeded Criteria. Organic demands were low, and no polycyclic aromatic hydrocarbons were detected, indicating that dredging or similar physical disturbances would probably have little impact on the water quality at MR1.

3.3.1.2 LAKE MCKELLAR

Lake McKellar hydrological and water quality characteristics and water users and dischargers are discussed in this section. Bathymetry of Lake McKellar near the proposed IFGDP site as of January 1979 is also included.

3.3.1.2.1 GENERAL DRAINAGE DESCRIPTION

Lake McKellar is a man-made slack water arm of the Mississippi River. The lake rises and falls in response to the fluctuating stages of the river at its point of confluence with the Mississippi River near the southwest end of Presidents Island (Figure 3-9). Lake McKellar was created when the Tennessee Chute portion of the Mississippi River flowing along the east side of Presidents Island was closed off in 1951.[10] Before closure, approximately equal flows moved through the Tennessee Chute and the Arkansas Chute north of Presidents Island. The Arkansas Chute is presently the main stem of the Mississippi River.*

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* Based on communication between J. W. Bodamer, Jr., EIA, and S. Lear, U.S. Army Corps of Engineers, May 1979.

A dam was constructed across the north end of Tennessee Chute to serve as a road bed for a railroad and street extending from the mainland to a new flood-free embankment supporting the industrial complex on Presidents Island (Figure 3-9). The dam consists of a dredged hydraulic fill embankment protected on the upstream and downstream slopes by revetment pavement to prevent erosion from river currents and wave wash.

Since closure in 1951, two navigation channels have been dredged in Lake McKellar. The Harbor Channel adjacent to Presidents Island serves the industrial complex, which is located on an embankment standing at an elevation of 230 feet above mean sea level (Figure 3-9). Material for the flood-free plateau on Presidents Island was provided from dredged material obtained during excavation of the channel. The Harbor Channel is connected to the northernmost end of Lake McKellar, resulting in the creation of Treasure Island. The channel was created by hydraulic dredging to depths designed to permit passage of river barges at all stages of the lake between low and high water. A smaller artificial channel was dredged by similar methods to provide a barge canal for coal transport to the Allen Generating Plant (Figure 3-9). Periodic maintenance dredging must be done in the channel adjacent to the Allen Generating Plant and the main channel of Lake McKellar, from its confluence with the Mississippi River up to Nonconnah Creek, in order to maintain a 12-foot navigation channel. Nonconnah Creek contributes heavy sediment loading to both these areas, which is why the periodic dredging must be done. This maintenance dredging is not necessary in the Harbor Channel. When dredging does occur, the soil is deposited in the triangular area above Cypress Creek and below Nonconnah Creek (Figure 3-9).

Overall length of Lake McKellar from its confluence with the Mississippi River at river mile 725.5 to the closure dam is approximately 7 miles (Figure 3-9). The main source of drainage into the lake is from Nonconnah Creek, which enters about 2 miles south of the dam. Cypress Creek, many small tributaries and overland runoff in and around the lake also contribute some in-flow into the lake. This combined drainage provides the main source of flow through Lake McKellar and thus the source of water for "flushing" the lake. The

flushing of the lake is important in moving stagnated water that may accumulate pollutants, and this will be discussed further in Section 3.3.1.3.4. Back-flushing and flushing of the lake due to seasonal rising and falling of Mississippi River elevations will also occur, and when heavy precipitation occurs in headwaters of the Mississippi River basin, occasional flushes will result.

3.3.1.2.2 WATER USE

The only user of Lake McKellar water is the TVA Allen Generating Plant, which uses approximately 500 million gallons per day for cooling water purposes. Since 503 million gallons per day of surface water constitutes the total usage of all surface waters in the Memphis area, the Allen Generating Plant alone uses 99.4 percent of the total surface water used. The other water users along Lake McKellar depend on groundwater from shallow and deep wells.* Water from shallow wells is not used for human consumption.

Nine industries discharge into Lake McKellar at a combined flow of 3.06 million gallons per day as shown in Table 3-4. Seventy-five percent of this effluent is from the Allen Generating Plant ash pond; CBI Nuclear, Inc. releases about 0.15 million gallons per day on a monthly basis. Three of the industries, AMOCO Oil Company, Cargill Corn Plant and Cargill Soybean Plant, discharge storm water and surface runoff only, and do not contribute to the 3.06 million gallons per day. Five of these industries have NPDES Permits to discharge to the lake.

3.3.1.2.3 ANNUAL AND MONTHLY LAKE VARIATION

The period of record for Lake McKellar begins at the time of closure in 1951. Stage fluctuations for the period of record from December 1950 to July 1978 (27.5 years) are based on the Tennessee Chute gage located on the eastern shore of the lake below the mouth of Nonconnah Creek (Figure 3-9). Zero on

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* Based on personal communication between J. W. Bodamer, Jr., EIA and B. Alexander, Tennessee Department of Health, Water Quality Control Division, May 1979.

the gage is 178.01 feet above mean sea level. For the period of record, annual high water marks varied between 200.2 and 220 feet above mean sea level in 1954 and 1976, respectively. Annual low water marks varied from 177.4 to 186.3 feet above mean sea level in 1977 and 1972, respectively. The year of greatest variation was 1963, when the range was 36.4 feet (179.4 to 215.8 feet above mean sea level), while 1972 provided the least variation of 24.4 feet (186.3 to 210.7 feet above mean sea level).

The monthly average elevations of Lake McKellar are shown in Figure 3-12, which indicates a distinct seasonal pattern consistent with high stages in spring from March to May and low stages in summer and fall from August to November. Under high flow conditions in the river, the greatest single monthly variation was recorded in March 1963, a 27.9-foot change in elevation stage, from 188 to 216 feet above mean sea level. October of that same year showed the least monthly variation during a period of base flow, with the water mark rising only 1.2 feet, from 180.3 to 181.5 feet above mean sea level.

3.3.1.2.4 BATHYMETRIC CHARACTERISTICS NEAR THE IFGDP SITE

In January 1979, bathymetry was investigated adjacent to the proposed IFGDP site in Lake McKellar and the dredged harbor used as a barge delivery and turning basin for the Allen Generating Plant. The bottom profile of this area is shown in Figure 3-18. Cross sections are also shown in Figure 3-19 for the transect locations indicated in Figure 3-18. The configuration of the river bed profile near the site is characterized by a rapid increase in depth away from the Presidents Island bank and the bank adjacent to the Allen Generating Plant (Figures 3-18 and 3-19). The bank slope along the peninsula where the proposed IFGDP site will be located shows a more gradual increase in depth (Figures 3-18 and 3-19). Lake McKellar depth and the harbor depth is uniform, ranging from 35 to 40 feet, as a result of the dredging programs in the lake and harbor for maintenance of a 12-foot navigation channel. Biological studies done in this area show that the bottom materials are primarily soft muds (see Section 3.7).

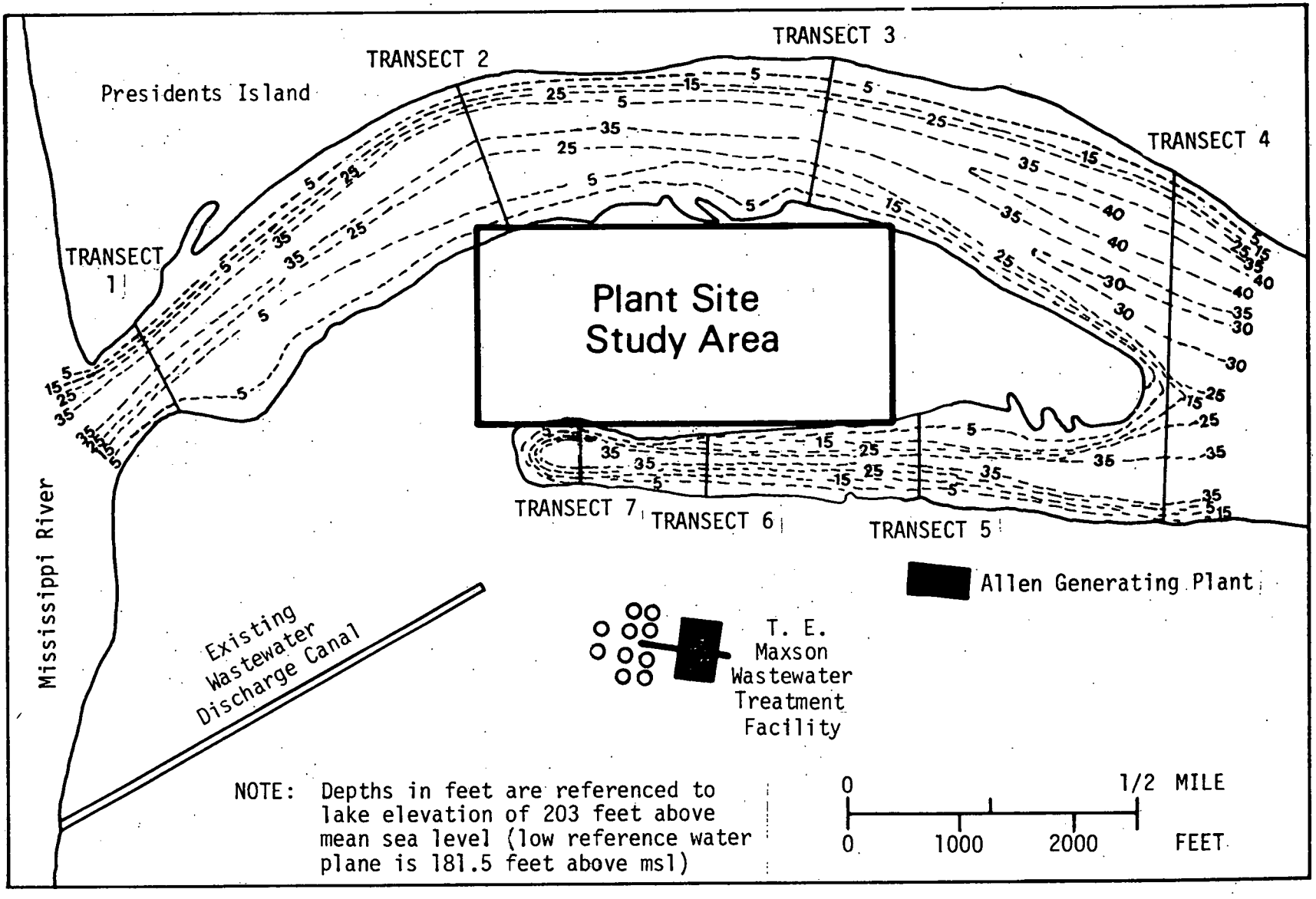
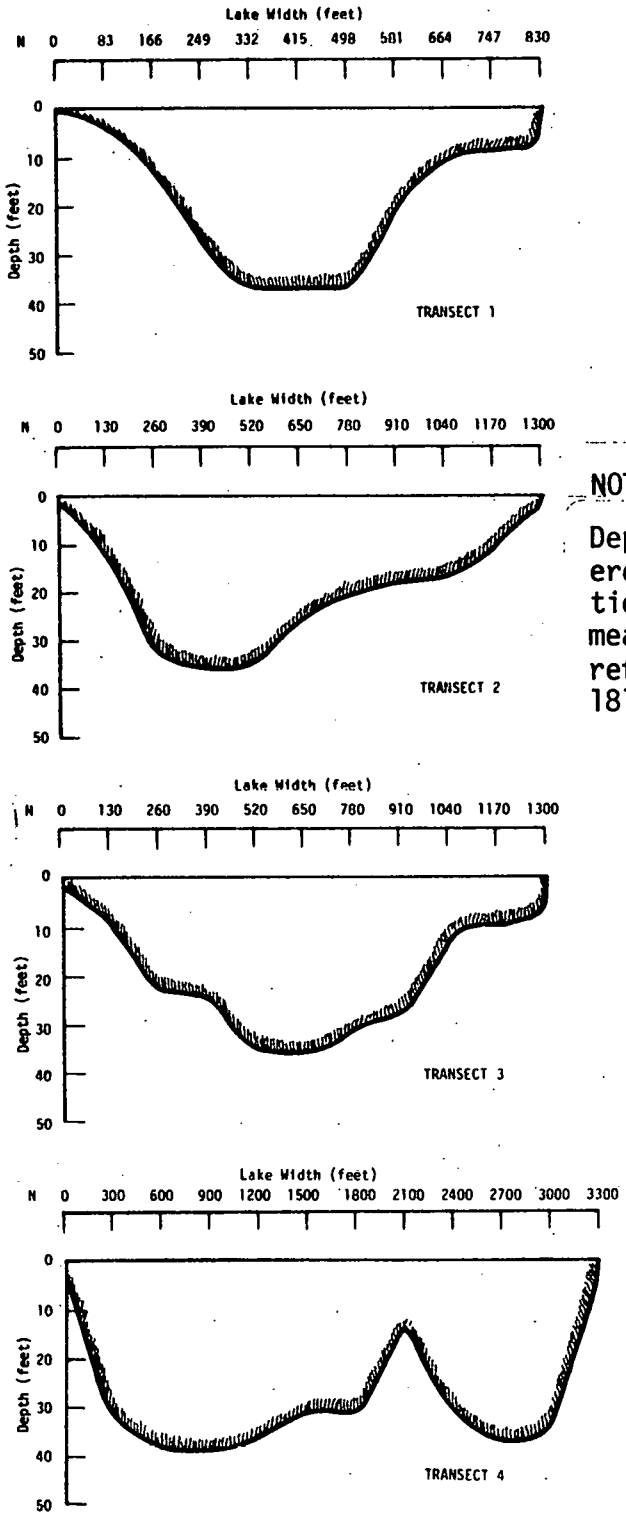


Figure 3-18. Bottom Profile of Lake McKellar in the Vicinity of the IFGDP Site



NOTE:

Depths in feet are referenced to lake elevation of 203 feet above mean sea level (low reference water plane is 181.5 feet above msl)

Figure 3-19. Cross Sections of Lake McKellar and the Dredged Harbor in the Vicinity of the IFGDP Site, (transect locations are shown in Figure 3-18)

(Continued)

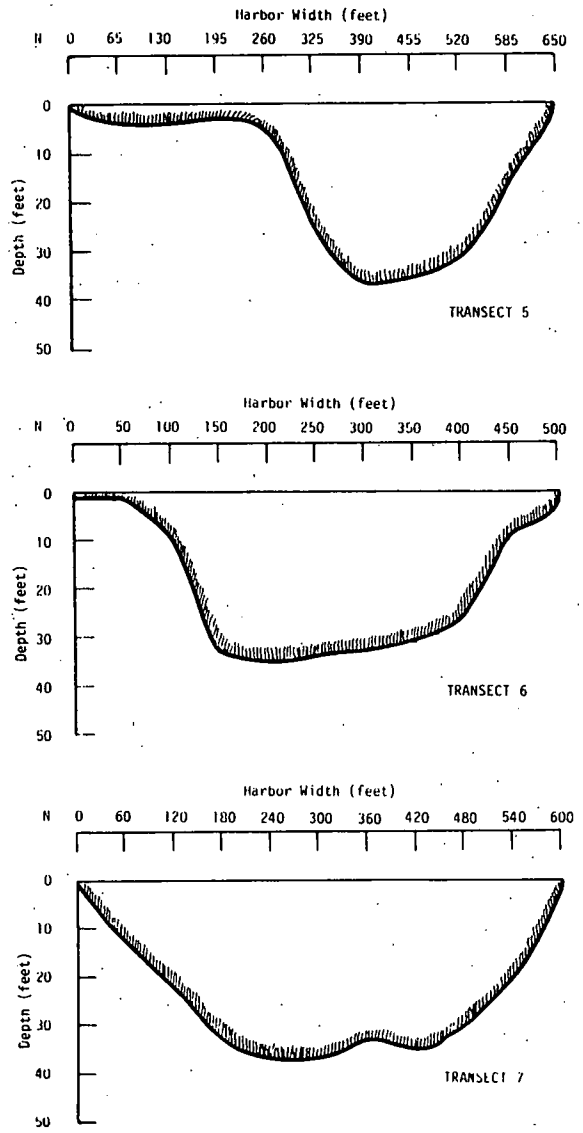


Figure 3-19. (Continued)

3.3.1.2.5 WATER QUALITY

Lake McKellar water quality was assessed from available literature and site-specific EIA field survey data (1978-79 survey) to describe baseline conditions. A detailed presentation of pertinent literature and the 1978-79 survey results are provided in Appendix 3A, Tables 3A-11 to 3A-19. Definition of existing stresses was achieved by comparison with Criteria as defined in Section 3.3.1.1.5 and reported in Appendix 3A, Table 3A-1.

Raw sewage and untreated industrial effluents have been discharged directly to Lake McKellar since the Tennessee Chute was closed in 1951, resulting in generally poor water quality.[11] Historically, the primary water quality degrading inputs have been associated with flow from Nonconnah Creek and Cypress Creek at the eastern end of the lake, as well as from industries located on the lake shores and Presidents Island (Figure 3-16).[6,12]

Before 1970, the basic water quality problems in Lake McKellar were associated with low dissolved oxygen levels and high concentrations of suspended solids, coliform bacteria, oils and some toxic chemicals.[11] A substantial improvement since this time was effected by the operation of the Nonconnah and Presidents Island interceptor system and the treatment of industrial effluents to comply with EPA and state discharge permits.[12]

Several water quality studies have been done in Lake McKellar since the completion of the interceptor system in 1970. The U.S. Army Corps of Engineers, in a 1977 study, found high levels of phosphates and orthophosphates in the Tennessee Chute of Lake McKellar adjacent to Presidents Island.[13] TVA monitored water quality in the dredge harbor adjacent to the Allen Generating Plant and reported iron and manganese in high concentrations.*

On a quarterly basis since 1974, the Memphis and Shelby County Health Department[14] has been conducting laboratory analyses and in-situ measurements to establish water quality at eight locations distributed throughout Lake McKellar

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* Based on Tennessee Valley Authority water quality data, supplied to EIA by Memphis Light, Gas and Water Division, Memphis, Tennessee, January 1979.

(Appendix 3A, Figure 3A-1). During this period, the lake experienced high fecal coliform concentrations and low dissolved oxygen concentrations, especially under thermally stratified conditions during summer. No consistent trends were noted in changes in annual average conditions during the monitoring period.

From May 1978 to January 1979, EIA investigated Lake McKellar water quality once each season at the seven sampling stations throughout the lake as indicated in Figure 3-16 (see 1978-79 surveys - Appendix 3A). During each survey, in-situ depth profiles were recorded at all stations, while samples for laboratory analyses were collected from the lake mouth station LM1. Additional samples for laboratory analyses were collected from up-lake stations LM6 and LM7 during the May survey alone.

Laboratory analyses of samples collected during the May 1978 field survey indicate little substantial difference between the quality of up-lake stations LM6 and LM7 and the lake mouth station, LM1. The most obvious exception was organic loading (as biochemical and chemical oxygen demands), which was approximately three times higher at LM1 than at the up-lake stations. This was caused by overland runoff and Nonconnah Creek streamflow, which are affected by industrial activities.

Regression analysis was used to examine functional relationships between certain water quality parameters by combining data for all seasons. In comparison with the Mississippi River in the vicinity of the proposed site, lake waters (LM1) had lower r (correlation coefficient) values. However, the relationship between magnesium and calcium displayed an r value which was significantly different from zero above the 80 percent level. Poorer fits for the other relationships investigated were caused by the changing temporal balance between uplake and Mississippi River origins of waters at this location, as well as changes in water quality caused by stratification of the lake during summer months.

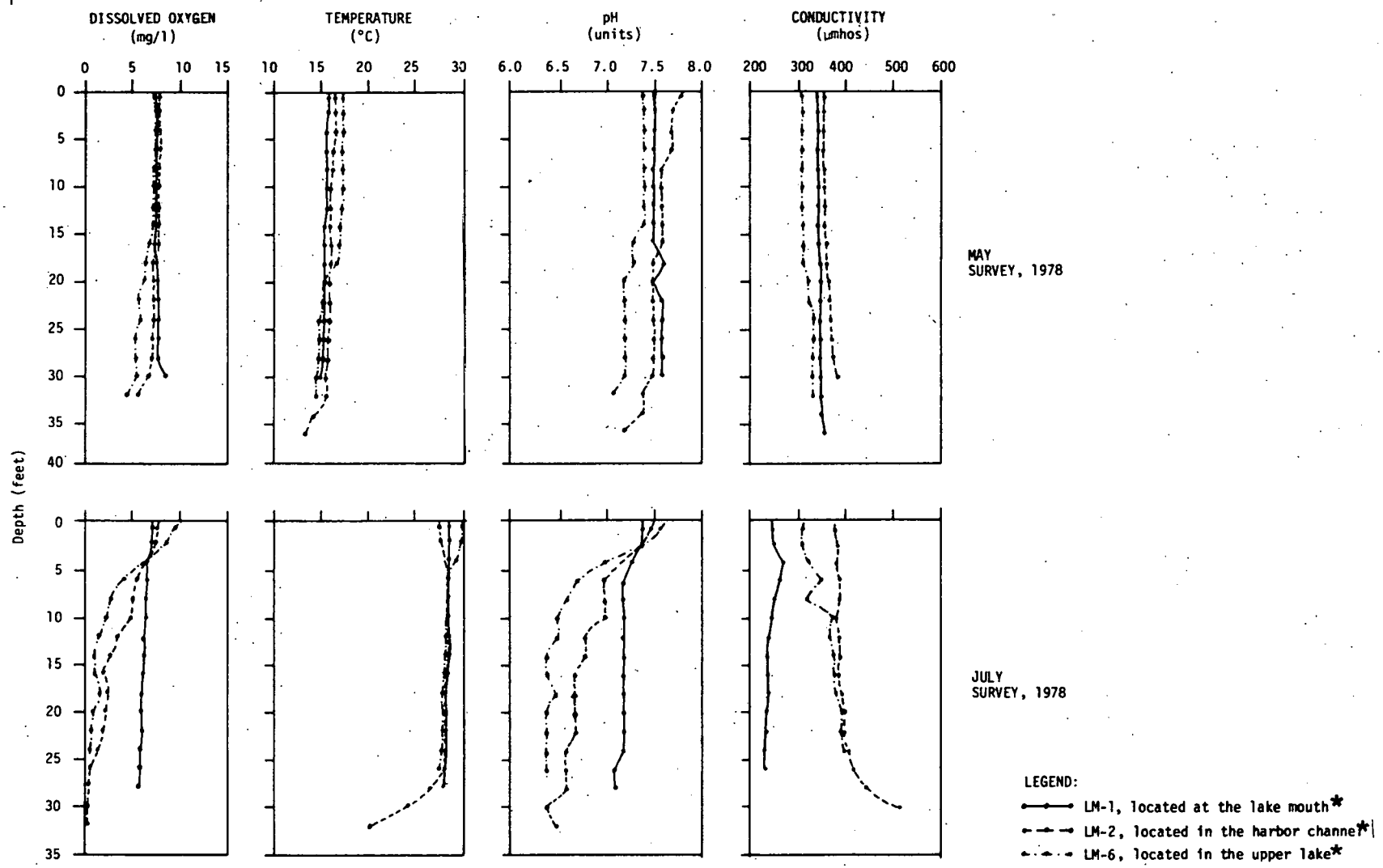
In terms of existing stresses, phenol, iron and manganese concentrations exceeded Criteria at all stations (with selenium slightly above Criteria at LM6

and LM7). These parameters continued to exceed Criteria during the July, October and January surveys at LM1. Substantial agreement exists between these 1978-79 survey data and Memphis and Shelby County Health Department[14] data for the same period, where dissolved oxygen concentrations were below Criteria. Similar concentrations of iron and manganese were reported by TVA.* Polycyclic aromatic hydrocarbons were investigated during the 1978-79 surveys, but none were present above detection limits.

In Figures 3-20 and 3-21, depth profiles of the in-situ parameters (temperature, pH, dissolved oxygen and conductivity) for a representative lake mouth station (LM1), the dredged harbor station (LM2) and a representative up-lake station (LM6) are presented to provide a synoptic view of Lake McKellar throughout the year. During the May survey, physical mixing was pronounced throughout the lake as indicated by negligible increase in conductivities with depth. Temperature, pH and dissolved oxygen concentrations displayed a similar consistency, with slight decreases in dissolved oxygen concentrations occurring with depth throughout the lake.

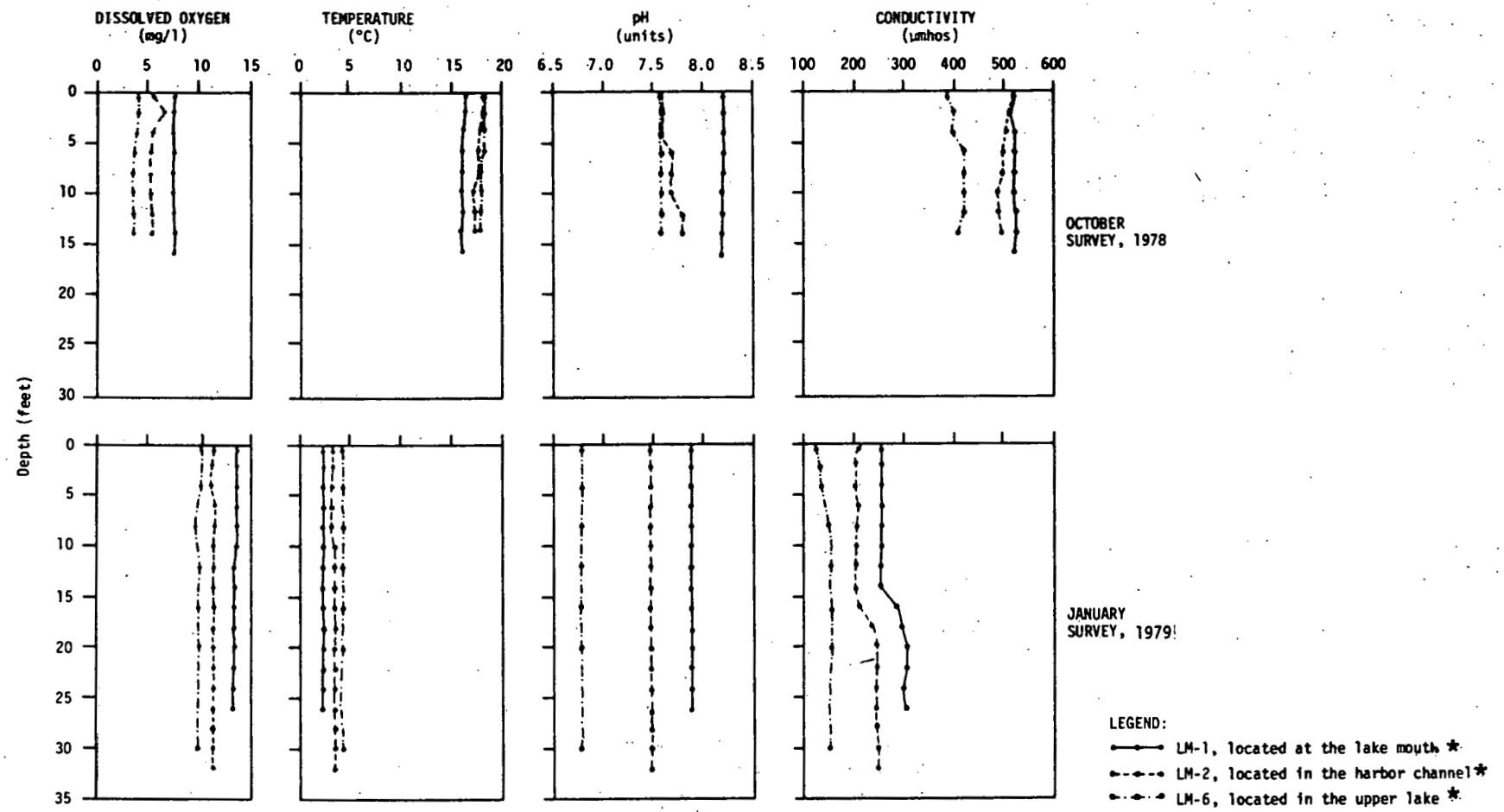
By the time of the July survey, Lake McKellar was thermally stratified at all stations except at the lake mouth station (LM1). In the upper lake reaches (e.g., LM6) thermoclines (point of maximum temperature change with depth) were located above 10-foot depth, but reached approximately 15 feet at the remaining stations. Stratification of temperature, dissolved oxygen and pH in the main channel is illustrated in Figure 3-22. Lower dissolved oxygen and pH together with higher conductivity values were noted in the hypolimnion (the lowermost cold layer) under thermally stratified conditions. At LM3, complex variations of temperature with depth resulted in a double thermocline. Thermoclines in the upper lake would probably have been deeper had it not been for wind action and ship passage. At all stations during the July survey, dissolved oxygen (DO) was depleted below the Criteria of 5 milligrams per liter at depths greater than 10 feet. Oxygen demands in the hypolimnion and in the bottom sediment showed dissolved oxygen concentrations of less than 1 milligram per liter near the substrate throughout the

* Based on Tennessee Valley Authority water quality data, supplied to EIA by Memphis Light, Gas and Water Division, Memphis, Tennessee, January 1979.



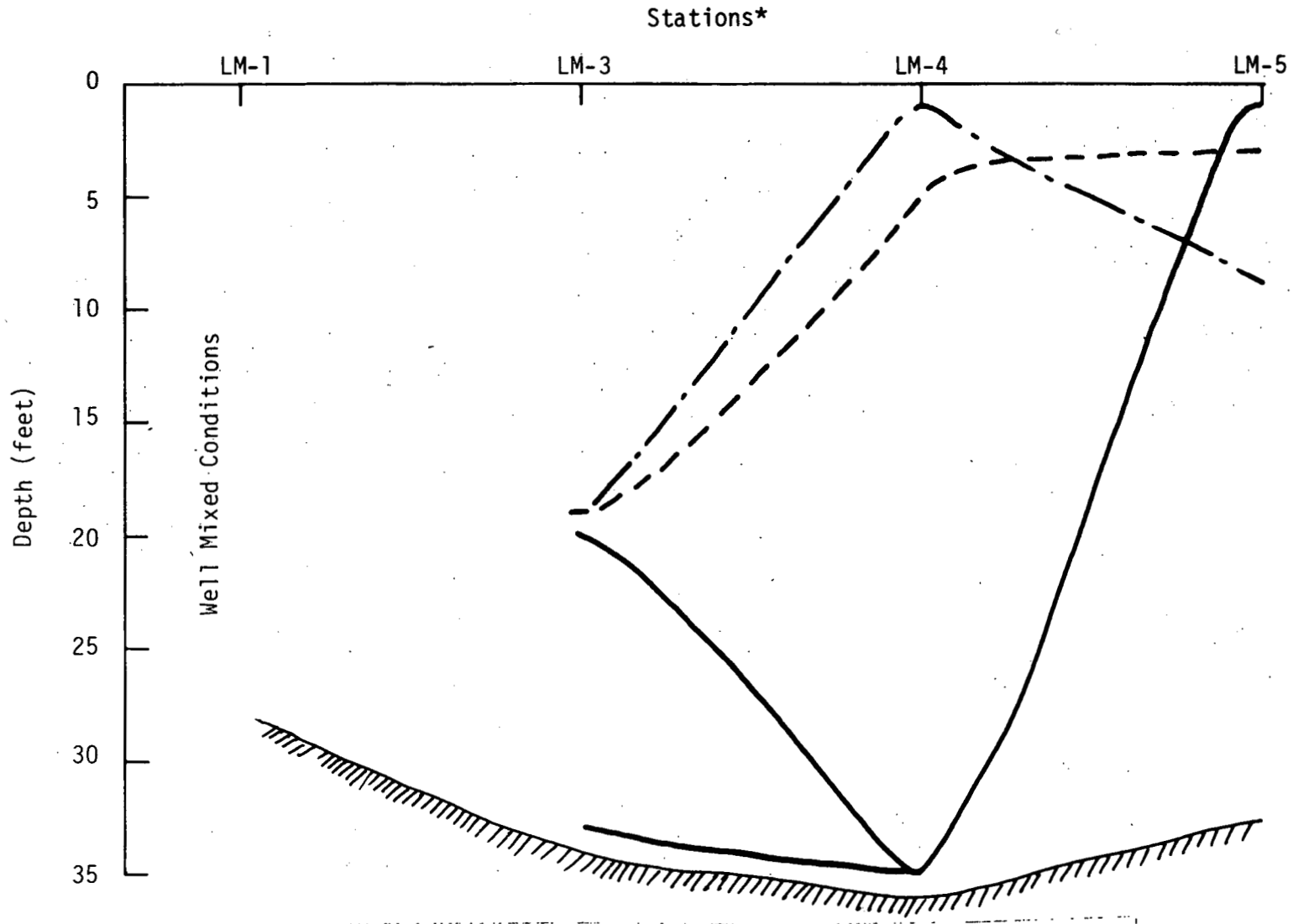
*For specific locations, see Figure 3-16.

Figure 3-20. Depth Profiles of In-Situ Parameters at Lake McKellar Stations LM1, LM2 and LM6 During 1978



*For specific locations, see Figure 3-16.

Figure 3-21. Depth Profiles of In-Situ Parameters at Lake McKellar Stations LM1, LM2 and LM6 During 1978-79



Points of maximum drop in temperature within water column
Point of maximum drop in dissolved oxygen within water column
Point of maximum drop in pH within water column

* Refer to Figure 3-16.

Figure 3-22. Points of Maximum Change in Temperature (Thermoclines), Oxygen and pH with Depth in the Main Channel of Lake McKellar During the July 1978 Survey

lake. This is not a particularly uncommon event in large lakes that experience turnovers and receive degraded water quality inputs.

In-situ recordings taken during the October survey indicated that a turnover had recently occurred, mixing the lake and producing uniform conductivity values throughout (Figure 3-21). However, dissolved oxygen values remained low at upper lake stations (e.g., LM6). By January, mixing with depth was even more pronounced and dissolved oxygen concentrations were above Criteria.

3.3.1.2.6 SEDIMENT QUALITY

Nature and quality of Lake McKellar bottom sediment is influenced by many sources, including suspended sediment and bedload contributions from Nonconnah Creek and from the Mississippi River during backflushing events. Nonconnah Creek adds 90,000 tons per year of eroded soils to the lake.[11] Nonpoint source runoff from Nonconnah Creek watershed area also contributes to the suspended solid load of the lake.

The U.S. Army Corps of Engineers[13] found fourteen pesticides in low concentrations (parts per billion) in sediments taken in 1977 from the main channel of Lake McKellar. Their source is likely to be agricultural runoff from Presidents Island. Lake sediments from points above and below the mouth of Nonconnah Creek were investigated in 1975 for total organic carbon, three metals and eight pesticides by the Memphis and Shelby County Health Department.[14] Pesticides were again present at low concentrations (parts per billion), as were the metals lead (mean 16 milligrams per liter, maximum 24 milligrams per liter), mercury (mean 0.004 milligram per liter, maximum 0.05 milligram per liter) and chromium (mean 12.8 milligrams per liter, maximum 14.3 milligrams per liter).

During the October 1978 field survey, EIA collected sediment from the lake mouth station (LM1) for chemical analyses (see 1978-79 surveys - Appendix 3A, Tables 3A-27 to 3A-29). Concentrations of most heavy metals and nutrients investigated were approximately an order of magnitude higher in concentration for lake sediments than that found in the Mississippi River sediment. A

comparison with the Prater/Anderson classification[9] indicated that Lake McKellar sediments were of poorer quality than those found in the Mississippi River. Manganese and ammonia-nitrogen were in the heavily polluted category with total kjeldahl nitrogen, iron and arsenic displaying a moderate pollution level.

Of fifteen polycyclic aromatic hydrocarbons investigated during the 1978-79 surveys, benzo(a)pyrene, chrysene, anthracene, fluourene pyrene and flouranthene were found at levels between three and nineteen times the detection limit of 0.005 part per million.

The elutriate test performed on LM1 sediment collected during the 1978-79 surveys, yielded water of similar water quality to that normally found in the overlying lake waters. Phenol, cadmium and manganese were present at concentrations that exceeded Criteria. However, no polycyclic aromatic hydrocarbons were detected in the elutriates, thus indicating that polycyclic aromatic hydrocarbons are tightly bound in the sediment and are not being released by dredging or other similar physical disturbances.

3.3.1.3 NONCONNAH CREEK

Hydrologic and water quality characteristics of this stream, as well as the users and dischargers into Nonconnah Creek, are discussed in this section.

3.3.1.3.1 GENERAL DRAINAGE DESCRIPTION

Nonconnah Creek is the only large stream in the vicinity of the proposed plant site. Nonconnah Creek drains an area of approximately 182 square miles, or 117,000 acres, of mostly urban and farm lands with some pasture and forest land. Nonconnah Creek drainage basin is shown in Figure 3-23. The elongated basin is about 30 miles long and 8 to 10 miles wide, with the mainstream originating in Marshall County, Mississippi. Major tributaries are Johns Creek, Colliersville Creek and Days Creek, with numerous smaller tributaries draining less than 10 square miles (Figure 3-23).

Drainage is a pinnate pattern, where flows follow a featherlike branching, and tributaries intersect the mainstream at angles that are slightly acute upstream. Particularly in the upper basin, this results in tributaries delivering their runoff almost simultaneously to create high crests during heavy storms of uniform distribution. Development of the pinnate drainage pattern is normally associated with soils having a high silt content and is typically found in loess floodplains.

Nonconnah Creek flows in a nearly straight line, since many of its meanders were removed after World War II.[10] The creek flows through terrain that has comparatively little slope. Except for the headwater reaches, the gradient averages 5 feet per mile of stream bed. In the upper half of the basin, it flows in a west-northwest direction until it reaches the Nonconnah Creek Fault, which diverts the creek in a westerly direction for approximately 8 miles to Route 51 (Figure 3-23). From this point, the creek resumes its west-northwest direction to its confluence with Lake McKellar.

Most of the floodplain area, which averages about one-half mile in width, was used for agricultural purposes prior to World War II. Since then, the floodplain has become heavily industrialized and urbanized, and heavy sudden runoff and effluent flows have changed the creek primarily to a drainage ditch.

Cypress Creek is the only other stream in the vicinity of the proposed site, entering Lake McKellar about one mile below the mouth of Nonconnah Creek (Figure 3-23). Cypress Creek drains an area of approximately 13 square miles adjacent to the Nonconnah Creek drainage basin.

3.3.1.3.2 WATER USE

Due to the abundance of groundwater and the relatively poor quality of Nonconnah Creek, waters of this stream are not used for domestic or industrial purposes. Nonconnah Creek is heavily industrialized from mile 16.2 at Winchester Road (Figure 3-23) to its confluence with Lake McKellar, and all the

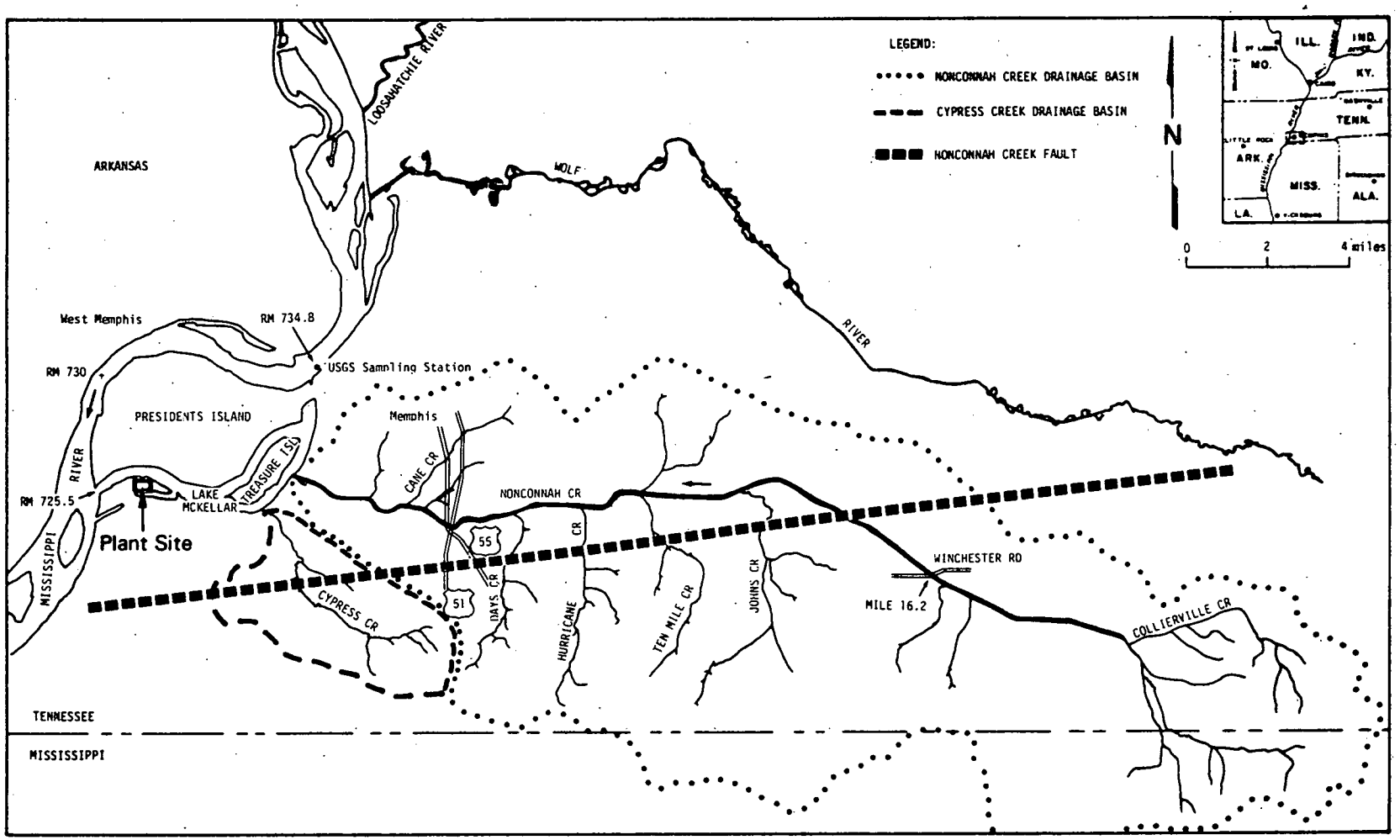


Figure 3-23. Nonconnah Creek Drainage Basin

industries located in this reach, except Construction Aggregates, Inc., utilize groundwater from private wells or MLGW wells primarily for cooling, process and sanitary purposes.* Construction Aggregates, Inc., the second major surface water user in the Memphis area, uses approximately 960,000 gallons per day for process purposes in hydraulically dredging and washing sand and gravel products.

Thirty-three industries and commercial establishments discharge approximately 2.59 million gallons per day to Nonconnah Creek, of which 75 percent is the combined effluents from Construction Aggregates, Inc., Delta Refining Co., Hunt-Wesson Foods, Inc. and Kellogg Company (Table 3-4). Discharges from eleven of the 33 industries consist of unmonitored storm water and surface runoff only. Of the 22 other dischargers that monitor their flow, each also has additional discharges going directly to the Nonconnah Interceptor system, a sanitary sewer system built in 1970. Initially, the interceptor system discharged directly to the Mississippi River, but now is connected to the T. E. Maxson Wastewater Treatment Plant (South Plant). Presently, 16 of the 33 dischargers have NPDES Permits or are in the process of acquiring them. Miss-Ark-Tenn Packaging Corporation has the only Tennessee State Permit for discharging cooling water.

3.3.1.3.3 FLOOD RECORD AND FLOOD CONTROL

Nonconnah Creek experienced frequent flooding from the Mississippi River before the closing of Tennessee Chute in 1951. Before closure, revetments were constructed for flood protection upstream for 3 miles from the mouth of the creek; and following closure, the Mississippi River backwater was lowered by 2.5 feet at the mouth of Nonconnah Creek.[10] Flood hazards still exist due to the encroachment into, and modification of, the floodplain by industrialization and urbanization, plus the resultant increased volumes of runoff. Gaging of Nonconnah Creek was only begun in 1969; therefore, only recent flood

* Based on personal communication between J. W. Bodamer, Jr., EIA, and B. Alexander, Tennessee Department of Health, Water Quality Control Division, May 1979.

information is available. The largest documented flood occurred on May 9, 1958,[10] and flood stages reached during this flood provided much of the later data for altitudes of fill in the floodplain.

Based on unpublished data from the Army Corps of Engineers,* a rating curve was developed showing flood frequencies from 10 to 500 years and the corresponding elevations and discharges at the mouth of Nonconnah Creek. This curve is shown in Figure 3-24.* Presently, any construction in the floodplain must fill to an altitude above the 100-year flood.

3.3.1.3.4 FLUSHING CAPACITY OF NONCONNAH CREEK

The amount of discharge through Lake McKellar, or the ability of Nonconnah Creek to "flush" the lake, was determined using flow data from a USGS gage installed in 1969 at Winchester Road (Figure 3-23) and the basin drainage area. Lake McKellar receives drainage from approximately 199 square miles, with Nonconnah Creek contributing the largest drainage area of 182 square miles, Cypress Creek adding 13 square miles and miscellaneous small branches and sheet drainage in and around the lake contributing approximately 4 square miles.

Flow data from Nonconnah Creek for the period 1969 to 1977 gives an average yearly discharge at the Winchester Road gage of 104 cubic feet per second. Relating this average flow to the 68.2 square miles of area being drained upstream of this gage, average runoff is equivalent to 1.52 cubic feet per second per square mile. When this runoff unit of 1.52 cubic feet per second per square mile is projected to the total area draining into Lake McKellar (199 square miles), the average yearly discharge from the lake into the Mississippi River is 302 cubic feet per second or 218,000 acre-feet per year. This 302 cubic feet per second value is somewhat of an underestimation, since much of the area above the gage is agricultural, and the infiltration rate is high, while the ungaged area below the gage is urbanized and industrialized, and runoff rates are high.

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* Based on personal communication between J. W. Bodamer, Jr., EIA, and S. Lear, U.S. Army Corps of Engineers, May 1979.

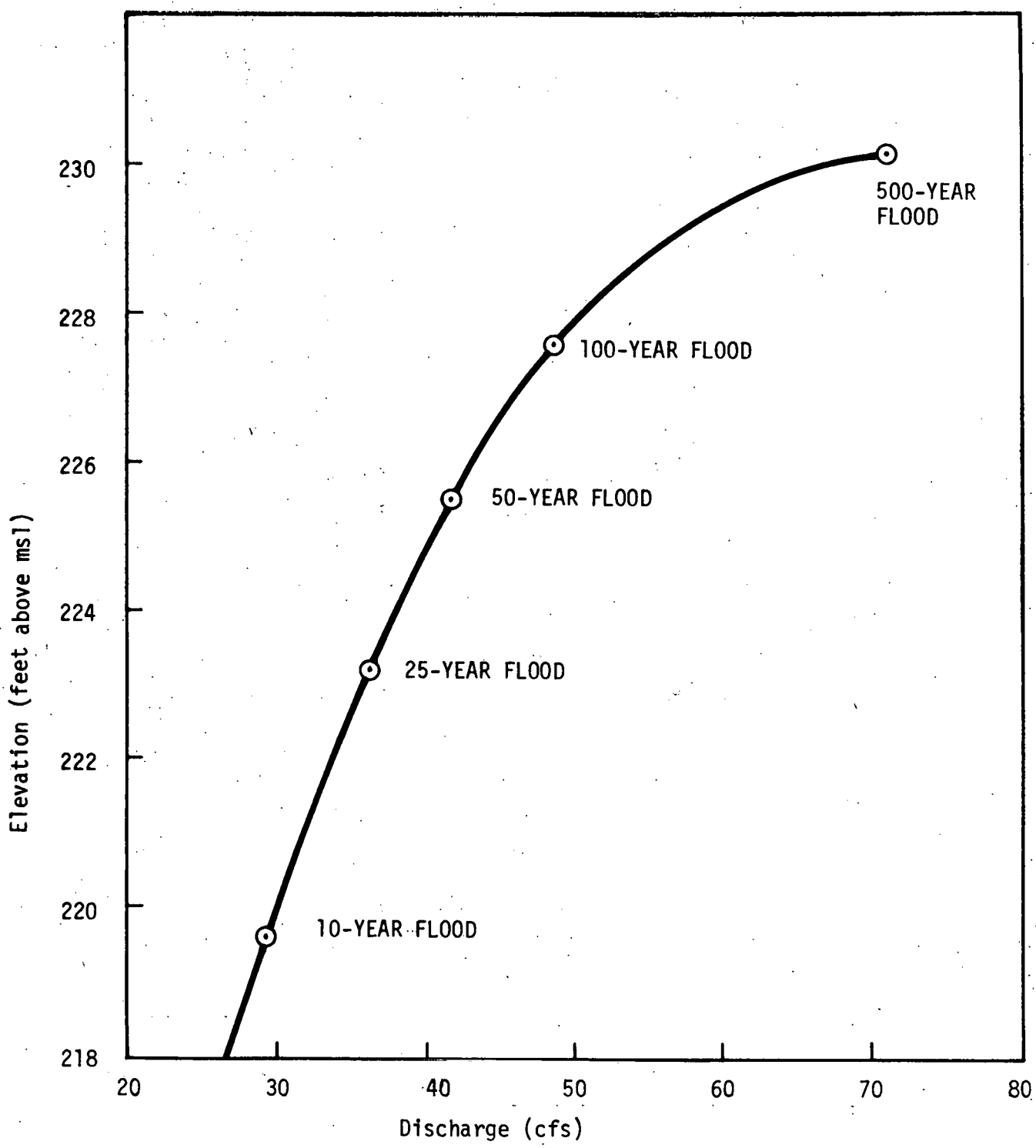

Figure 3-24. Rating Curve for Mouth of Nonconnah Creek

The volume of water in Lake McKellar under average elevation corresponds to an average flow of 50 cubic feet per second. Thus, based on the average calculated flow of 302 cubic feet per second draining into Lake McKellar, this quantity of water would be sufficient to flush that part of the original Tennessee Chute extending from Nonconnah Creek to the river about six times per year at average stage. Critical periods would occur during the low water seasons when outflow from Lake McKellar is at a minimum.

The main channel section of the lake above the mouth of Nonconnah Creek will be flushed less regularly because of smaller inflows to the lake in this area.

Minimum flow at the Nonconnah Creek gage for the 7-year period occurred in July 1976, when the average flow was 0.7 cubic foot per second, which corresponds to only 121 acre-feet for this month. When the river stands at Low Water Reference Plain,* the volume of water in the reach of Lake McKellar from the creek to the river is 15,000 acre-feet per month. Thus, during July 1976, only 0.8 percent of the volume of the lake was replaced.

3.3.1.3.5 WATER QUALITY

For Nonconnah Creek and Cypress Creek and the small streams proximate to the site entering into the southeastern end of Lake McKellar (Figure 3-16), water quality was assessed from available literature and EIA site-specific field data (1978-79 surveys). A detailed presentation of these data is contained in Appendix 3A. A comparison of existing literature and field survey data with Criteria (Appendix 3A, Table 3A-1) was carried out in the manner described for the Mississippi River (see Section 3.3.1.1.5).

Poor water quality existed in Nonconnah Creek between 1945 and 1970,[12] a condition created principally because of entry of untreated industrial and municipal sewage effluents and uncontrolled urban and agricultural runoff.

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* Based on personal communication between J. W. Bodamer, Jr., EIA, and B. Alexander, Tennessee Department of Health, Water Quality Control Division, May 1979.

Since 1970, some improvement in water quality has occurred due to the upgrading of the sanitary sewer system and improvement in industrial effluent treatment.[12] However, several recent water quality studies have noted that dissolved oxygen, suspended solids, oils and fecal coliform concentrations still remain a concern.[11,12]

The Memphis and Shelby County Health Department[14] has collected bimonthly water quality data since 1974 at four locations along Nonconnah Creek. A distinct deterioration in water quality is evident as the stream flows westward toward Lake McKellar. No significant improvement was noted from 1974 to 1978. Below milepoint 16.2 near Kirby Road (Figure 3-16), dissolved oxygen concentrations are significantly lower and coliform concentrations are higher than at upstream reaches.

Depth profiles of in-situ parameters were recorded during each of the 1978-79 surveys at NC1 (Figure 3-17) near the confluence with Lake McKellar. Resultant temperature data indicate well-mixed conditions throughout the year at this location. Laboratory analyses of water quality parameters were carried out for water samples collected from NCI during the May 1978 survey. The data indicate that Nonconnah Creek contained a higher organic loading, as indicated by higher concentrations of total organic carbon (TOC), dissolved organic carbon (DOC) and phenol than found at any other sampling location in the Mississippi River or Lake McKellar.

In terms of existing stresses, the Memphis and Shelby County Health Department data[14] indicate low dissolved oxygen and high coliform concentrations that exceed Criteria in the lower reaches of Nonconnah Creek. Data obtained during 1978-79 surveys indicate that surface water temperatures fell at all times except in July 1978 when an exceedence of Criteria by 0.1°C was noted. Dissolved oxygen was seriously depleted during the May and July 1978 surveys, exceeding Criteria in May and July. Phenol concentrations were over two hundred times higher than the Criteria of 0.001 milligram per liter. Total dissolved solids (TDS) concentrations were low (mean, 104 milligrams per liter), indicating that urban runoff was adequately controlled during the May 1978 survey period.

Although organic loading still causes dissolved oxygen depletions, Nonconnah Creek has few apparent trace element problems. Iron (mean, 2.39 milligram per liters) was substantially above the Criteria of 0.3 milligram per liter, while selenium and lead, were marginally in excess. No other parameters were exceeded during the May 1978 survey.

Cypress Creek is the only other tributary in the vicinity of the proposed site. This stream enters Lake McKellar about 1 mile south of Nonconnah Creek (Figure 3-16), and has historically (until 1976) been the source of a serious health problem due to the raw sewage being discharged directly to the stream and the resultant high fecal coliform levels.[15] However, operation of the Cypress Creek interceptor since 1976 has alleviated this problem.

3.3.1.3.6 SEDIMENT QUALITY

As mentioned previously, Nonconnah Creek receives high sediment loading due to the increased runoff from urbanization and the easily erodible soils common to the Memphis area. In 1972, the U.S. ACE investigated heavy metals and pesticides in bottom deposits of Nonconnah Creek.[15] Pesticides were not detected and only very low levels of heavy metals were reported. A Memphis and Shelby County Health Department report in 1975[14] noted that Nonconnah Creek sediment contained low pesticide levels but higher metal concentrations than reported in the U.S. ACE study. Lead had a concentration of 28 milligrams per liter and chromium 12.7 milligrams per liter in the bottom sediments.

3.3.2 GROUNDWATER

Regional and on-site groundwater conditions, as well as groundwater quality and groundwater uses are described in this section. Hydrogeologic terms used in this section are defined or explained in Appendix 3B.

3.3.2.1 REGIONAL GROUNDWATER CHARACTERISTICS

Three aquifers of importance are found in the Memphis area: (1) the shallow alluvium aquifer, (2) the Claiborne "500-foot" sand aquifer also known as

the "Memphis sand" and (3) the Wilcox "1400-foot" sand. Table 3-6 gives the stratigraphic relation between these three main water bearing formations and Figure 3-25 shows them graphically. A brief geologic description of these formations is given in Section 3.2, Geology.

Memphis is one of the largest cities in the nation that depends solely on groundwater for its water supply. The sole source of this water supply is groundwater from two artesian aquifers. The aquifer that supplies about 95 percent of the water for municipal use is the "500-foot" sand, which is confined throughout most of the Memphis area by thick layers of overlying and underlying clay. A deep aquifer, the "1400-foot" sand, supplies the remaining 5 percent of the water. The additional aquifer, the alluvium, occurs at shallow depth, but is not used for municipal supply, chiefly because of the susceptibility to contamination from the land surface. Also, water in the alluvium is not desirable because of its high content of iron and its hardness.[1,2]

3.3.2.1.1 ALLUVIUM AQUIFER

Within the alluvium aquifer, fluctuations in the water table respond generally to that of the river with some time lag.[16] Flow in this aquifer is also influenced by the river stage.

3.3.2.1.2 "500-FOOT" SAND AQUIFER

The "500-foot" sand in the Memphis area is delineated as a hydrologic unit although it includes all the deposits of the Claiborne Group (Figure 3-25). This aquifer is a continuous hydrologic unit through western Tennessee and adjacent parts of eastern Arkansas and northern Mississippi. The Claiborne Group ranges in thickness from 500 to 850 feet. It is mostly a heterogeneous deposit consisting of beds of coarse, medium and fine sand intercolated with thin beds of clay.

TABLE 3-6

GEOLOGIC UNITS UNDERLYING THE MEMPHIS AREA[17]

System	Series	Group	Stratigraphic unit	Thickness (feet)	Description and relation to water
Quaternary	Recent		Alluvium	0-200	Alluvial sand, clay, and gravel. Yields water to a few domestic wells. Could be an important source of water for certain industrial uses. Water is a calcium bicarbonate type, very hard, and high in dissolved solids and iron
	Pleistocene		Loess	0-100	Wind-deposited silt. (Topographically higher than alluvium.) Low permeability. Not a source of ground water
	Pleistocene and (or) Pliocene		Terrace deposits	0-160	Alluvial sand and gravel. Supplies several domestic wells. Could be a major source of water for industrial and irrigation uses. Water in eastern half of area is predominantly a sodium bicarbonate type, soft, and moderately high in dissolved solids and iron. In the western half, predominantly a calcium magnesium bicarbonate type, moderately hard to very hard, and high in dissolved solids and iron
Tertiary	Eocene		Jackson (?) Formation (lower part may include some Claiborne beds)	0-330	Gray, bluish-gray, greenish-gray, and tan clay; minor amounts of lignite and fine sand. Generally impermeable and considered to be the upper confining bed for water in the "500-foot" sand
		Claiborne	"500-foot" sand (upper part may include some Jackson (?) beds)	500-800	Fine to coarse sand; minor amounts of lignite and tan clay and silt; thin clay and lignite lenses. Coarse channel sands locally at base. Very good aquifer from which 95 percent of water used in Memphis area is obtained. Water is a calcium magnesium sodium bicarbonate type, generally soft, low in dissolved solids, and high in iron and carbon dioxide. The water contains some hydrogen sulfide and is slightly corrosive. A sodium bicarbonate water characterizes the eastern and southern parts of the area, where the water is softest and least mineralized; a calcium bicarbonate water with substantial amounts of magnesium characterizes the remainder of the area
		Wilcox	Upper clay unit	200-395	Gray, greenish-gray, and brown carbonaceous clay. Thin lignite and fine sand lenses locally. Low permeability confines water in "500-foot" sand
			Middle sand unit ("1,400-foot" sand)	150-300	Fine to medium sand; minor amounts of lignite and clay lenses. A secondary aquifer which supplies about 5 percent of water used in Memphis area. Water is a sodium bicarbonate type, soft, low in dissolved solids, and high in iron, and contains some carbon dioxide. It is softer but more mineralized than water in the "500-foot" sand
			Lower clay unit	190-250	Gray, greenish-gray, and brown carbonaceous clay, and lignite; sandy near top. Forms impermeable lower confining bed for water in "1,400-foot" sand

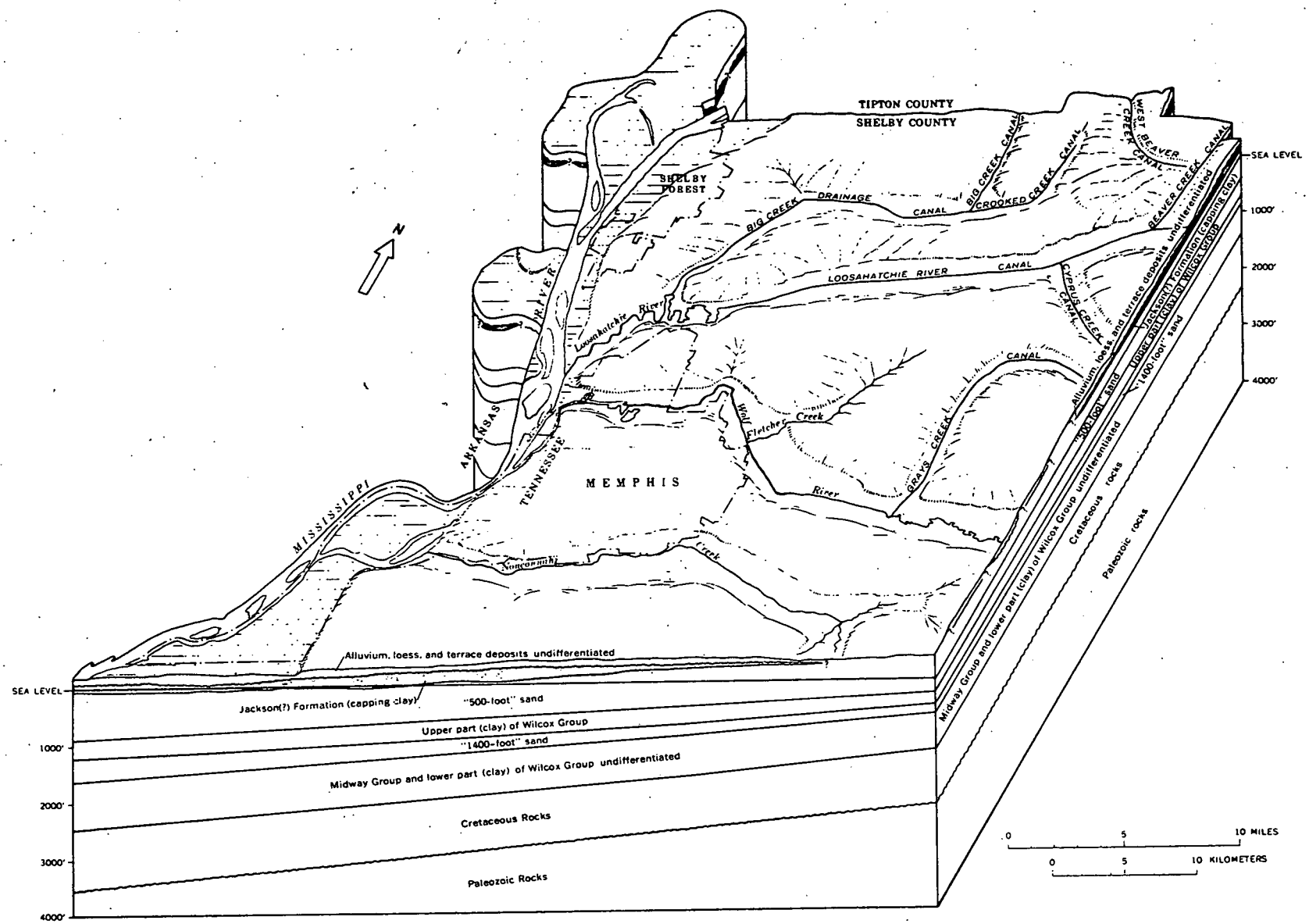

Figure 3-25. Block Diagram Showing Physiographic and Geologic Features of the Memphis Area, Tennessee(18)

Recharge to the "500-foot" sand is mainly from rainfall on the outcrop areas. The outcrop area of the "500-foot" sand occupies a broad belt striking northeastward across western Tennessee and includes the southeastern part of Shelby County. Most of the recharge to the "500-foot" sand in the Memphis area enters the aquifer in the part of the intake area that is southeast of Memphis.[18]

Specific capacity of wells ranges from 10 to 100 gallons per minute per foot of drawdown. The transmissibility ranges from 100,000 to 410,000 gallons per day per foot, and the coefficient of storage ranges from 1×10^{-4} to 3×10^{-3}. The average adjusted values of the "500-foot" sand for the total thickness of the aquifer throughout the entire area are about 400,000 gallons per day per foot and 3×10^{-3} for transmissibility and storage coefficient, respectively.

Flow movement within the "500-foot" sand is generally westerly towards Arkansas. The estimated present rate of movement in this direction is approximately 70 feet per year under a hydraulic gradient of about 5 feet per mile. Closer to well-fields where waters are withdrawn at high rates, the rate of movement increases.

In Arkansas, the "500-foot" sand is not being utilized because of its high iron and manganese content and its hardness. Instead, the "1400-foot" aquifer is heavily utilized there.

3.3.2.1.3 "1400-FOOT" SAND AQUIFER

This aquifer is continuous throughout the same area as the "500-foot" aquifer, and it dips toward the west at a rate of approximately 25 feet per mile. The thickness of the aquifer increases from about 150 feet in the eastern part of the Memphis area to about 300 feet in the western part. The volume of the aquifer in the 1300 square mile area it occupies is about 7 trillion (7×10^{12}) cubic feet. This aquifer crops out 60 to 80 miles east of Memphis.[1]

The numerical values of the hydraulic characteristics of the "1400-foot" sand determined from seven tests in three well-fields in Memphis were:[1]

	Minimum	Maximum
Transmissibility, gpd per foot	90,000	140,000
Coefficient of Storage	1.5×10^{-4}	4×10^{-4}

The yields of the wells used in the tests ranged from 400 to 1600 gallons per minute. The wells ranged in diameter from 8 to 24 inches.

The aquifer test results indicate that the "1400-foot" sand is almost an ideal artesian aquifer. The changes of water level in observation wells in response to changes in the rate of withdrawal were almost instantaneous, indicating near-perfect vertical confinement between the clay boundaries.[1]

Water level data from 1924 show that the coefficient of storage before development of wells in the "1400-foot" sand was 2.5×10^{-4}, and that the transmissibility was 1.2×10^{5} gallons per day per foot. Based on these figures, the average amount of water that moved westward across a 1-mile section of the "1400-foot" sand aquifer was about 0.16 million gallon per day, compared to 1 million gallon per day for the "500-foot" sand aquifer.[1]

3.3.2.2 GROUNDWATER CHARACTERISTICS AT THE SITE

The presence of groundwater at the site is dependent upon the subsurface geology at various depths. The geologic strata beneath the site are shown in Figure 3-26.

3.3.2.2.1 HISTORY OF THE SHALLOW AQUIFER

The composition of soils above the Jackson clay at the IFGDP site is governed by relatively recent hydrologic and geologic events. This is illustrated in Figure 3-27, which shows the approximate locations of the Mississippi River during various periods of time. The numbers between the solid lines indicate

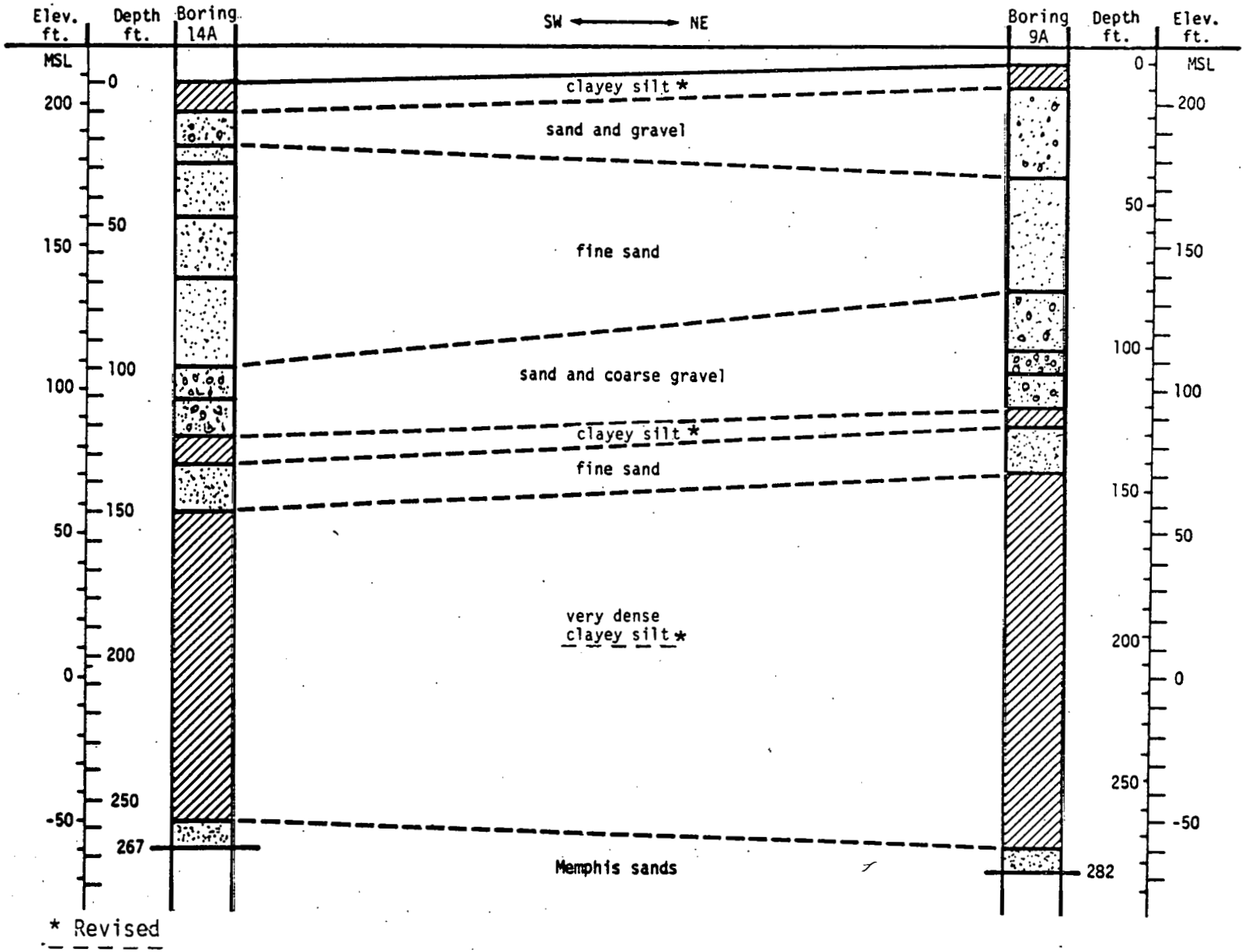

Figure 3-26. Geologic Strata Beneath the IFGDP Site

REVISED November 1979

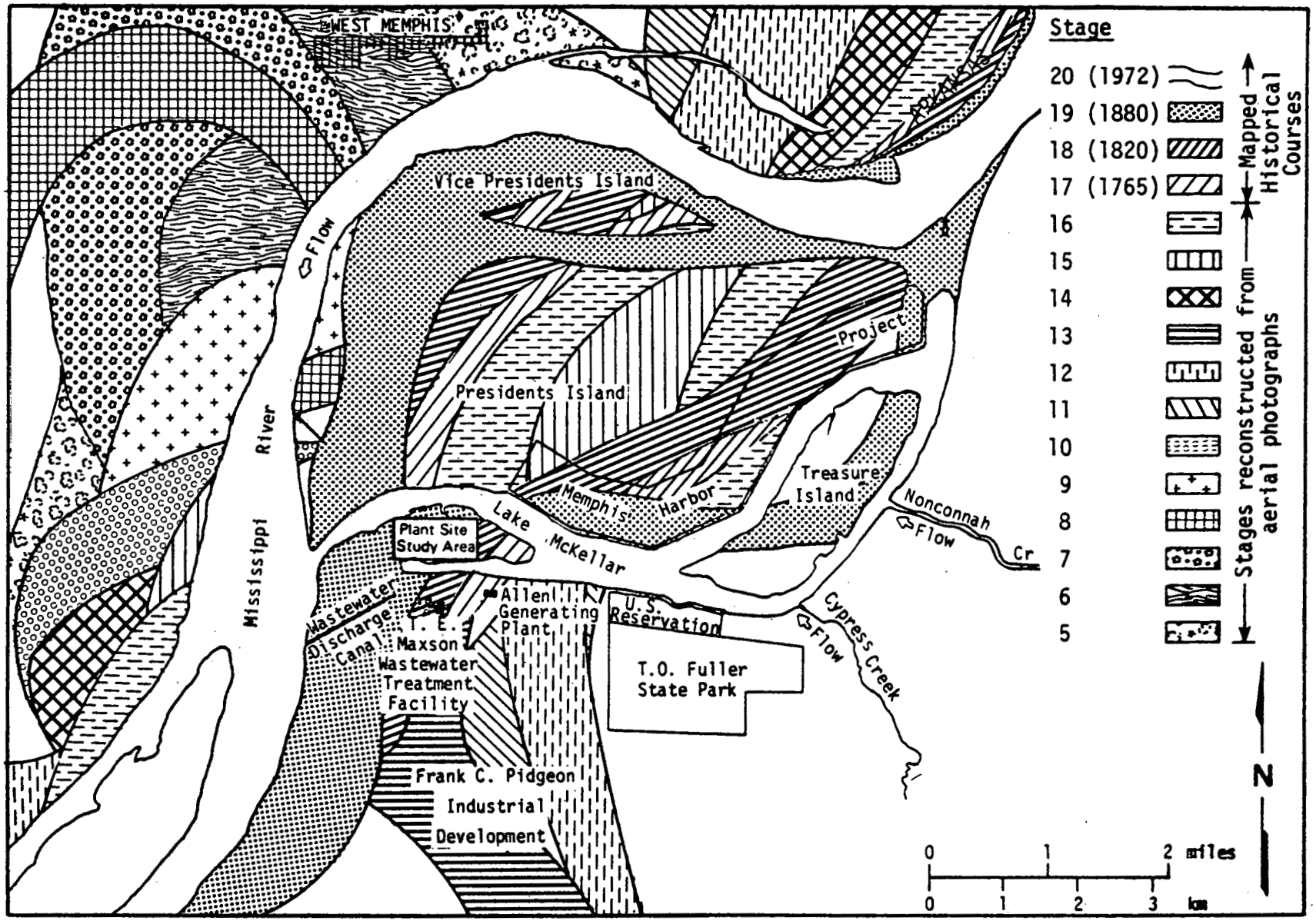

Figure 3-27. Ancient Courses Mississippi River Meander Belt

the relative time period during which the Mississippi River channel occupied the area between the lines. According to this figure, the channel of the Mississippi River passed through the area of the IFGDP as recently as 1880. Since the central channel of the Mississippi River ranges in depth from 40 to 90 feet in this area, the upper 50 feet of the site have probably been deposited within the past 300 years. This could explain, in part, the variability in composition of these upper soils.

3.3.2.2.2 HYDROLOGIC CHARACTERISTICS OF STRATA

The sands and gravels are varied in location composition and the most site-specific description is found in Section 3.2.2, Geology of the Site. Drilling at the site, at locations shown in Figure 3-28, indicates that virtually all of the soils from 0 to 120 feet below the surface of the site are very permeable. Table 3-7 summarizes the estimated hydraulic conductivities of the various strata shown in the stratigraphic columns in Figure 3-26.

The potential total groundwater yield of the strata at 0 to 50 feet below the surface is primarily limited by the depth of the Mississippi River, because the sand alternately discharges water to the river during high flows and receives recharge from the river during low flows. The site area is typically recharged during the spring, and it recharges the Mississippi River during the late summer and fall.

A previous study performed by Kellogg[19] in the proximity of the site, but not on the site itself, studied the response of the upper sands to changes in the level of Lake McKellar. Based on measured data, when the river rises, the water table in the sands rises at a lagging rate. When the lake stage decreases, the water table elevation decreases more slowly and remains above the river level.

The sands at the site are also recharged by rainfall and groundwater flowing from areas of higher gradient. However, because of the proximity of the site to the river, these other contributions are difficult to measure and

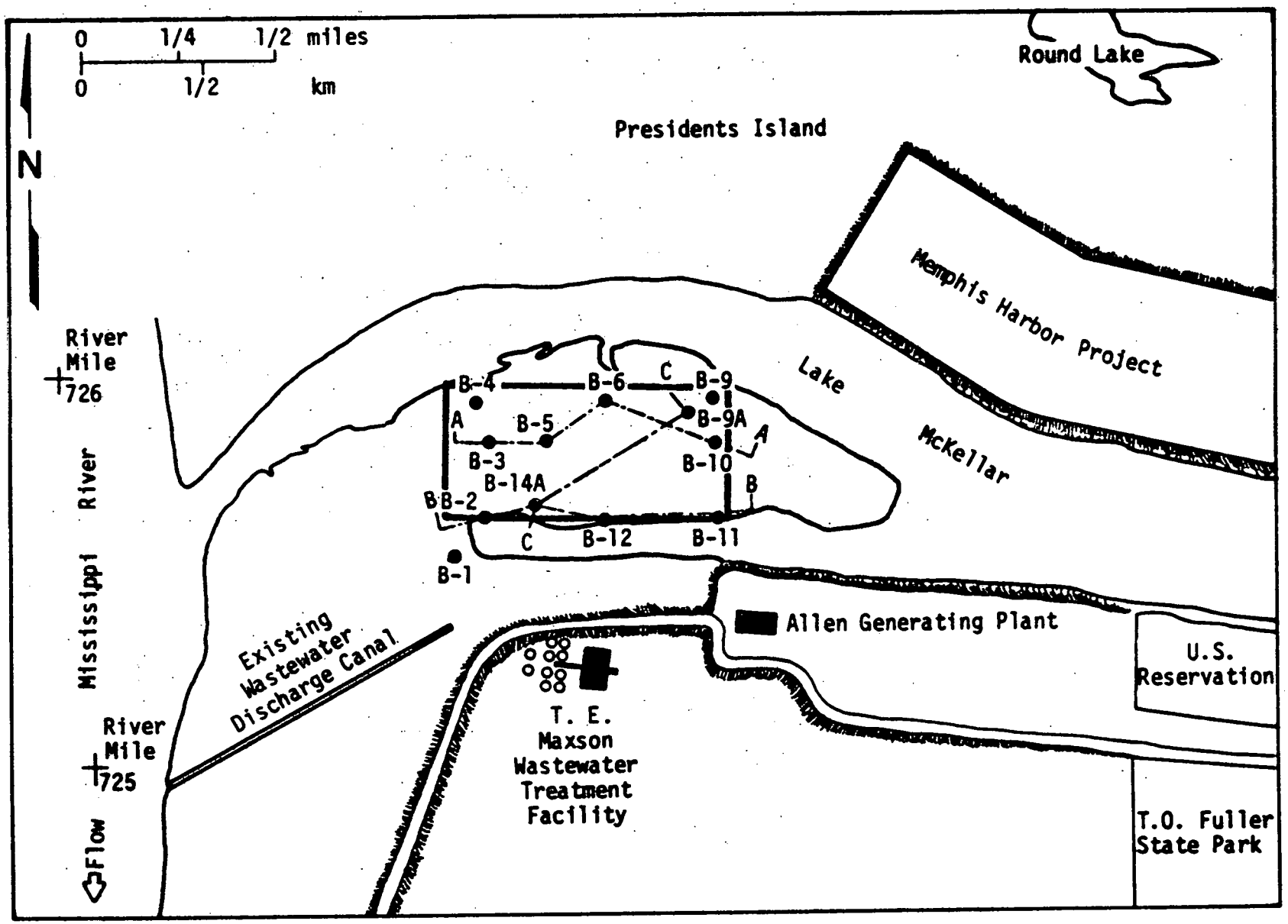

Figure 3-28. Boring Location Plan

TABLE 3-7

ESTIMATED HYDRAULIC CONDUCTIVITY FOR THE IFGDP SITE[20]

Soil Type	Approximate Depth Beneath Surface (feet)	Approximate Elevation (feet msl)	Hydraulic Conductivity (cm/sec)
Upper Sands	0 to 50	165 to 215	1.0 to 3.5×10^{-1}
Gravels	50 to 134	81 to 165	2.0 to 8.5×10^{-2}
Silty Clay (Jackson formation)	135 to 260	-35 to 82	10^{-7} to 10^{-9}
Lower Sands (Memphis sand)	261 to 282	-67 to -35	1.0 to 2.0×10^{-2}

are of a much lower magnitude. The hydraulic conductivities of the alluvial aquifer were estimated by Kellogg[19] for the Allen Generating Plant, and these values are shown in Table 3-8. The values measured by Kellogg are approximately one order of magnitude lower for the same mean sea level elevation than those estimated by Law Engineering,[20] who conducted the study on the site.

The fine sands from depths of 50 to 134 feet have slightly lower permeabilities than the upper sands. This is most likely a result of the finer grain size for these strata.

At depths of 135 to 260 feet below the site, a dense, gray-green silty clay layer was encountered during the site soils investigation. This is commonly referred to as the Jackson formation or "Jackson clay." It forms the confining layer for the Memphis sands or "500-foot" sands which serve as the primary source of drinking water for the City of Memphis. This is clearly evidenced by the subsurface profile at the site shown in Figure 3-27.

The silty-clay layer (Jackson formation) has an estimated hydraulic conductivity of 10^{-7} to 10^{-9} centimeters per second (cm/sec) which is essentially impermeable. Information obtained from borings at the site indicates that this layer ranges in thickness from 100 to 130 feet. This stratum is continuous until the Memphis sands are encountered starting at depths of 257 and 275 feet in borings 14A and 9A, respectively (Figure 3-26).

Hydraulic conductivities of the Memphis sands encountered ranged from 0.01 to 0.02 centimeters per second. These values are the same order of magnitude as the fine sands above the Jackson clay but are slightly lower. The somewhat lower hydraulic conductivity of the Memphis sands, in comparison with the alluvium material, could be attributed to the fact that the Memphis sands have a greater degree of compaction due to the weight of soil from above and have a slightly smaller grain size.

TABLE 3-8

ESTIMATED HYDRAULIC CONDUCTIVITIES
FOR THE ALLEN GENERATING PLANT[19]

Soil Type	Elevation (feet, msl)	Depth (feet)	Direction	Hydraulic Conductivity (cm/sec)
Upper sands	190 to 195	25 to 30	horizontal	$9 \text{ to } 70 \times 10^{-3}$
			vertical	$7 \text{ to } 60 \times 10^{-3}$

3.3.2.2.3 CHEMICAL QUALITY OF SITE SOILS

Concentrations of sulfate and sulfide ions and pH (hydrogen ion concentration) were determined for five shallow alluvium soil samples. Locations of the samples are shown in Figure 3-28, and the results of these analyses are given in Table 3-9. The pH values for the soils ranged from 6.2 to 7.4. Sulfates were less than 1 milligram per liter (mg/l) and sulfide concentrations ranged from 0.012 to 0.035 milligram per liter.

3.3.2.3 GROUNDWATER QUALITY

Groundwater quality near the proposed site was assessed from review of pertinent, available literature and recent, site-specific EIA field survey data (1978-79 surveys). This information is presented in detail in Appendix 3A. Figure 3-29 displays aquifers underlying the Memphis area and their recharge areas. Only the shallowest terrace gravel zone is recharged from the surface zones near Memphis, with the deeper Memphis sands aquifers being recharged farther east.[21]

Water quality in the deeper aquifers near the site was reported by the U.S. Geological Survey in 1933.[22] There are important variations with depth which are caused mainly by changes in geochemical conditions. In the "1400-foot" sand or Claiborne group, sodium and bicarbonate are the dominant ions. The waters in this aquifer are very soft and low in dissolved solids, iron and calcium.[16,22,23,24] In the "500-foot" sands or Wilcox group, bicarbonate is the dominant anion, and calcium, sodium and magnesium are generally the principal cations depending on location. In the Memphis area, these waters are low in dissolved solids but high in iron and free carbon dioxide which makes them slightly corrosive but fit for human consumption.[16,22,23,24]

The terrace gravel aquifer of Quaternary age is located at a depth of between 3 and 160 feet. TVA examined water quality in this shallow aquifer below the Allen Generating Plant and reported waters dominated by calcium and bicarbonate.[25] Sulfate, iron and manganese were at much higher levels than that

TABLE 3-9

CHEMICAL ANALYSIS OF IFGDP SITE SOILS[20]

Boring No.*	Soil Type	Depth (feet)	Approximate Elevation (msl, feet)	pH (units)	Sulfate (mg/l)	Sulfide (mg/l)
B-2	clayey silt	7-1/2 to 9	206.0 to 207.5	7.2	<1	0.024
B-4	sand	3 to 4-1/2	210.5 to 212.0	6.5	<1	0.022
B-5	sand	23 to 24-1/2	190.5 to 192.0	7.4	<1	.012
B-9	sand	8 to 9-1/2	205.5 to 207.0	6.2	<1	.035
B-12	sand	1-1/2 to 3	210.5 to 213.5	7.3	<1	.035

* Boring locations are shown in Figure 3-28.

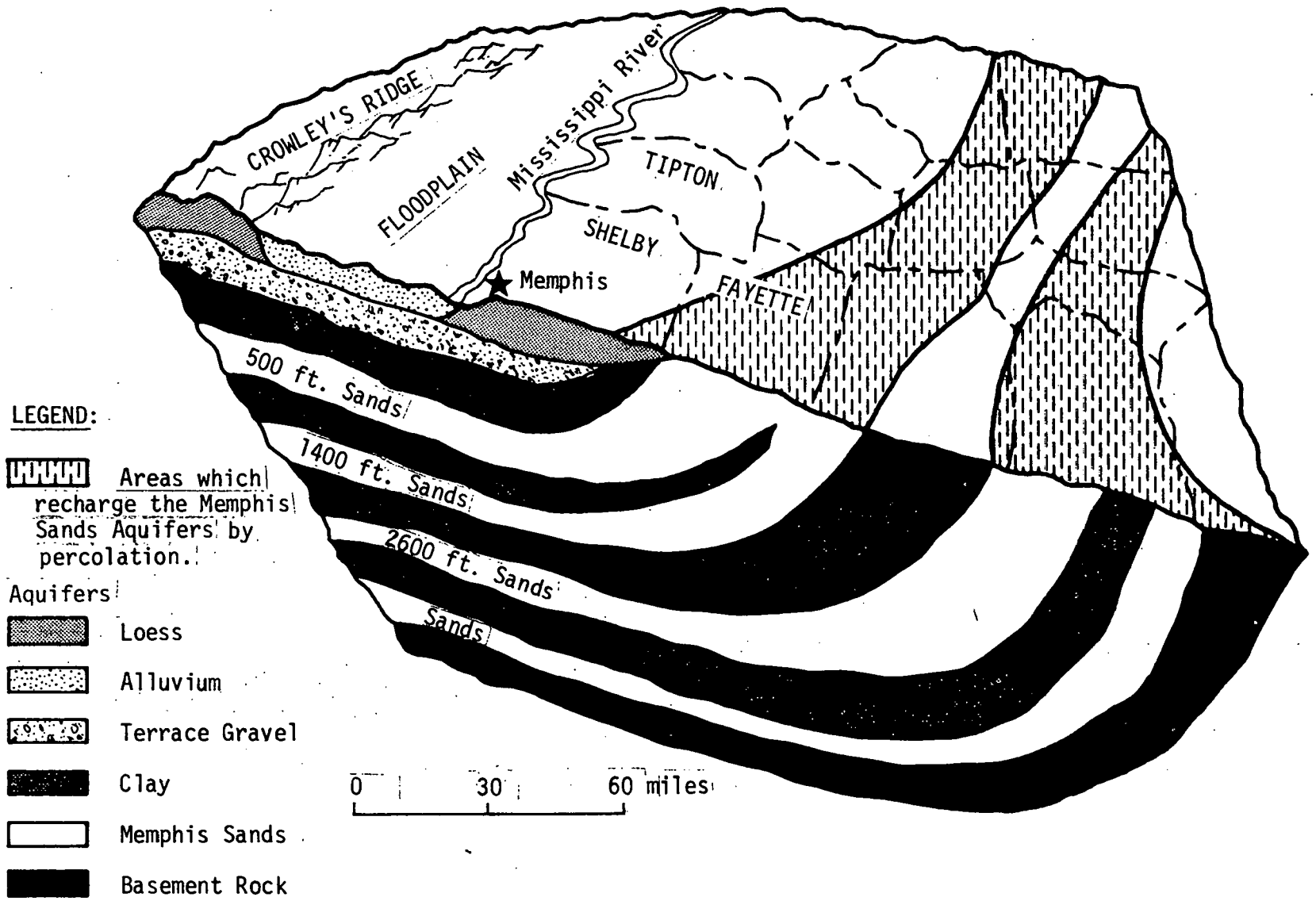

Figure 3-29. Recharge Areas of Aquifer Underlying the Memphis Region[22]

found at greater depths. The terrace deposit aquifer was also sampled by EIA (1978-79 surveys) once a season between May 1978 and January 1979 from a test well approximately 40 feet deep at location GW1 on the proposed site (Figure 3-17). In addition, a water sample was collected at this location in February 1979 to determine the buffering capacity of the aquifer. Water quality information from this well was compared with U.S. Environmental Protection Agency (EPA) Drinking Water Standards[26] (DW Standards) and the strictest applicable criteria (Criteria),[4] as compiled from the EPA criteria for public health and welfare and irrigation waters. Iron (mean 19.4 milligrams per liter, maximum 21.5 milligrams per liter) and manganese (mean 9.4 milligrams per liter, maximum 3.90 milligrams per liter) concentrations were above Criteria during all seasonal surveys, and barium (mean 1.0 milligram per liter, maximum 1.73 milligram per liter) exceeded Criteria and Drinking Water Standards in November 1978 and January 1979. High concentrations of iron and manganese in the aquifer recharge water along with geochemical solution of iron, manganese and barium are the principal causes. Strontium was the most abundant trace element during all surveys (mean 0.27 milligram per liter, maximum 0.34 milligram per liter), indicating the important influence of geochemical interactions on water quality. It is associated with minerals commonly associated with calcite and enters the aquifer waters via solution or ion exchange.

A chemical oxygen demand concentration averaging 12.7 milligrams per liter with a maximum of 26.0 milligrams per liter most likely results from the effects of leaching of overlying lake sediments and anthropogenically influenced recharge waters. Phenol exceeded Criteria consistently, a condition indicative of the effect of industrial activities on the quality of recharge waters. Nutrient concentrations were low, reflecting minimal effects from agricultural activities. During the 1978-79 surveys, the groundwaters were found to be consistently anaerobic, a condition produced by the rate of organic and inorganic demands exceeding the rate of reaeration of the aquifer introduced by recharge waters. Polycyclic aromatic hydrocarbon were investigated seasonally during the 1978-79 surveys and were not detected at any time.

Functional relationships based on regression analyses between chemical parameters were employed to describe the baseline water quality of groundwaters. Relationships with r, the correlation coefficient, significant above the 80 percent level were: (1) alkalinity and sulfate and (2) calcium and magnesium. Interestingly, some regressions with direct relationships in the surface waters have inverse relationships in the aquifer. This is probably due to preferential solution and deposition. For instance, as calcium becomes more abundant, magnesium declines, and as bicarbonate increase in concentration, sulfate declines.

Buffer capacity (resistance to pH change) of the groundwater was high, averaging 332.08 parts per million as $CaCO_3$/pH. In comparison, surface water averages were only 16.57 and 26.13 parts per million as $CaCO_3$/pH for Lake McKellar (LM1) and Mississippi River (MR1), respectively. This well-balanced condition is a function of pH, alkalinity and ionic strength. These waters react rapidly and powerfully with the solid surface of the aquifer, dissolving and precipitating various compounds and ions to maintain their pH. This results in very little seasonal variation in the concentrations of major ions and trace elements.

3.3.2.4 GROUNDWATER USERS

As previously mentioned, Memphis is one of the largest cities in the nation that depends solely on groundwater for its water supply, most of the water presently being pumped from the "500-foot" aquifer.

The Memphis Light, Gas and Water Division (MLGW) is an operating arm of the City of Memphis government and is the largest supplier of water in the area. Portions of Shelby County are also supplied by MLGW. The entire water supply for Memphis is pumped from wells drilled to depths ranging from 400 to 1400 feet and tapping natural artesian water sources.

The water plants now serving the City of Memphis are: Parkway Station, constructed in 1924; Sheahan Station, constructed in 1933; Thomas H. Allen Station, constructed in 1953; C. M. McCord Station, constructed in 1958; Ira

Lichterman Station, constructed in 1965; J. J. Davis Station, constructed in 1971; and two pumping stations acquired when neighboring utility districts were annexed. These include the Palmer Station (Holmes), acquired from the Whitehaven Utility District in 1970, and the Egypt-Central Station, acquired from the Raleigh Utility District in 1973. All well-fields are shown in Figure 3-30. The Allen and Davis well fields are the closest to the proposed coal gasification plant, but neither is located within 3 miles of the site. The maximum daily capacity of existing wells and treatment facilities is 189 million gallons per day. In 1982, a new pumping station currently being designed will be on-stream increasing MLGW's maximum daily capacity to 204 million gallons per day. These rates are on a daily basis and may be exceeded approximately 20 percent on an hourly basis during periods of peak demand. The 1979 average daily consumption is 118 million gallons per day.

Groundwater is being used extensively throughout the Memphis area for domestic, industrial, commercial, agricultural and other uses. Several lists of users have been compiled in reports produced by the Mississippi-Arkansas-Tennessee Council of Governments (MATCOG), and a variety of compilations have been made by the Memphis and Shelby County Health Department. Tables 3-10 through 3-13 were extracted from these documents.

These lists were compiled for Fayette, Hardeman, Shelby and Tipton counties, the closest locations to the proposed IFGDP, because potential impacts from this plant, should they occur, could mainly affect areas within these distances. Special care was taken to determine existing wells within a 3-mile radius of the proposed plant, because at such a distance, potential impacts could be observed sooner and at a higher degree that at farther distances from the plant. Tables 3-10 and 3-11 list the water companies or the municipalities that supply the waters, the total amount supplied and the populations served by these water companies. Tables 3-12 and 3-13 list the self-supplying industries and commercial installations in Shelby and Fayette counties.

A listing of the known, existing industrial water wells within 3 miles of the proposed coal gasification plant is shown in Table 3-14.

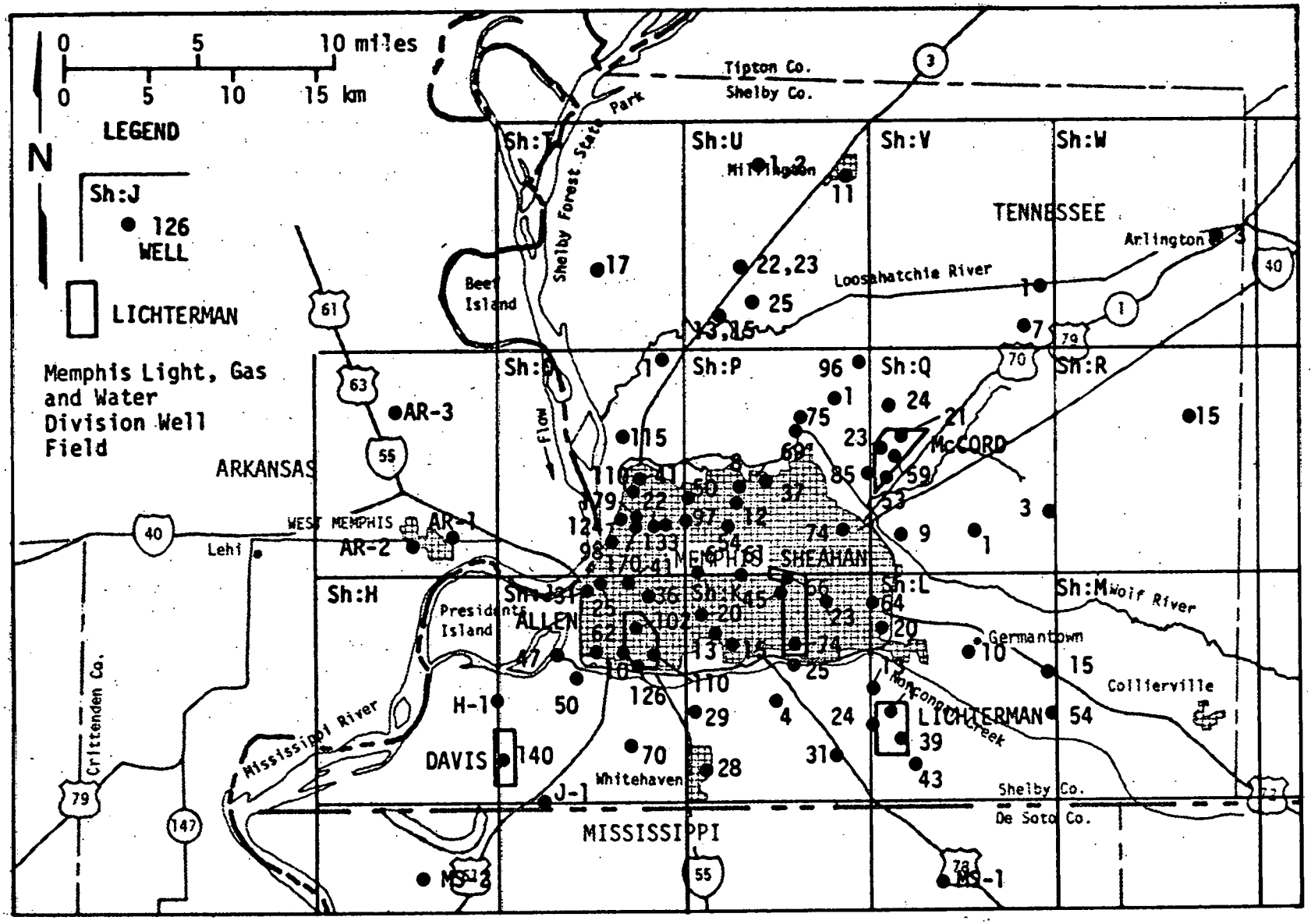

Figure 3-30. Memphis Area, Tennessee, with Locations of Observation Wells and Memphis Light, Gas and Water Division Well-Fields

TABLE 3-10

URBAN AND SUBURBAN WATER USE IN THE MEMPHIS AREA BASIN

Ground Water Supplies

County	Water Company or Municipality	1970 Population	Estimated Population Served	Number of Connections	Water Source	Average Daily Use Gallons	Per Capita GPD	Storage Capacity Gallons
Fayette	Gallaway	304	300	52	Well	18,000	53.3	200,000
	LaGrange	213	208	50	Well	20,800	100.0	0
	Moscow	448	390	165	Well	31,000	51.2	0
	Oakland	353	305	155	Well	36,000	107.8	200,000
	Rossville	410	450	110	Well	23,000	44.4	330,000
	Somerville Light, Gas & Water	816	3,148	787	Well	218,100	42.8	600,000
Hardeman	Grand Junction	427	600	200	Well	32,400	46.6	0
Shelby	Arlington	1,349	800	290	Well	186,000	62.5	620,000
	Bartlett	508	2,800	808	Well	300,000	96.4	0
	Cloverhaven U.D.	1,800	1,600	410	Well	104,000	48.1	0
	Collierville	3,625	4,000	1,102	Well	606,000	75.0	200,000
	Ellendale U.D.	8,100	9,000	2,232	Well	480,000	35.5	600,000
	Germantown	3,474	3,450	1,070	Well	96,875	95	500,000
	Lucy-Woodstock U.D.		2,500	515	Well	250,000	72.0	100,000
	Memphis Light, Gas and Water		630,299	167,785	Well	90,450,000	52.3	98,800,000
	Millington	21,106	8,500	2,000	Well	950,000	107.6	1,300,000
	Millington Naval Air Station		14,429	1,550	Well	3,500,000	243.0	
	Raleigh U.D.		26,000	6,500	Well	2,500,000	92.3	1,500,000
Tipton	Mason	443	430	190	Well	62,000	104.6	55,000
	Munford	1,281	1,500	425	Well	104,000	43.3	75,000

Source: Fayette, Hardeman, Shelby and Tipton County Health Departments

TABLE 3-11

SCHOOLS, CAMPS AND OTHER DOMESTIC WATER USE IN THE MEMPHIS AREA BASIN

County	Water Company or User	Est. Pop. Served	Number of Connections	Water Source	Average Daily Use in Gallons
Fayette	Arlington Mobile Park	90	30	Well	6,750
	Braden Elem. School	300	1		6,000
	Braden Sinai	68	1	Well	1,360
	Bernard Elem. School	140	1		2,800
	Camp Pine Crest (Resident)	2,000	10	Well	100,000/yr
	Central Elem. School	1,200	1	Well	24,000
	Fisherville Lake Girl Scout Camp	500	1	Well	8,000/yr
	Herb Parsons Lake	200	1	Well	6,000/yr
	Longtown Gulf	3,000/yr	3	Well	30,000/yr
	McGraws Trailer Court	15	5	Well	1,100
	Middlecoff Trailer Court	37	16	Well	2,775
	Pinelake Subdivision	250	80	Well	11,750
	Sandy Creek Ranch Camp	100	1	Well	2,000/yr
	Southwest Elem. School	700	1	Well	14,000
	Springhill Elem. School	345	1	Well	6,900
	A. L. Ward Trailer Court	70	22	Well	5,250
	Young Life Camp	1,000	5	Well	50,000/yr
	Stanton I-40 Exit	--	--	Well	2,000**
Hardeman	Hardeman Academy	150	1	Well	4,000
Shelby	Alberts Cabin	--	1	Well	1,000**
	Bella Vista Country Club*	--	1	Well	7,500**
	Circle A Stables	10	1	Well	1,000**

Source: Fayette, Hardeman, Shelby and Tipton County Health Departments

* Water used for irrigation

** Estimated

(Continued)

TABLE 3-11 (Continued)

County	Water Company or User	Est. Pop. Served	Number of Connections	Water Source	Average Daily Use in Gallons
Shelby	Chickasaw Country Club*	--	1	Well	7,500**
	Colonial Country Club*	--	1	Well	7,500**
	Farmington Country Club*	--	1	Well	7,500**
	Green Acres Mobile Homes	5	2	Well	500**
	Holly Hills Country Club*	--	1	Well	7,500**
	Houston Levee Golf Club*	--	1	Well	7,500**
	McCool Horse Fram	--	1	Well	1,000**
	Mallard Lake Association	--	1	Well	500**
	Memphis Country Club*	--	1	Well	7,500**
	McKellar Woods Village	--	2		1,200**
	Meadow Lake Apartments	--	7	Well	1,200**
	Edmond Orgill Park*	--	1	Well	7,500**
	Paradise Lake	--	1	Well	500**
	Pleasant View Trailer Village	245	82	Well	24,500**
	Ridgeway Country Club*	--	1	Well	7,500**
	Stone bridge Country Club*	--	1	Well	7,500**
	Windyke Country Club*	--	1	Well	7,500**
	Westwood Subdivision*	--	--	Well	1,000**
Tipton	Highway 51 Trailer Court	50	20	Well	2,500
	Hanks Trailer Court	38	15	Well	1,900
	Hunter's Trailer Court	25	10	Well	1,250
	Orman's Trailer Court	250	100	Well	12,500
	Twin Circle Trailer Court	100	40	Well	5,000
	Joyner's Trailer Court	88	35	Well	4,400
	Rodger's Trailer Court	30	12	Well	1,500

Source: Fayette, Hardeman, Shelby, and Tipton County Health Departments.

* Water used for irrigation

** Estimated

TABLE 3-12

INDUSTRIAL GROUNDWATER USED BY SELF-SUPPLYING INDUSTRIES

MEMPHIS AREA BASIN

County	City	Industry	Employees	Principal Product	Water Source	Average Daily Use-GPD	Type Use*
Fayette	Collierville	Alpha Chemical Company	35	Polyester Resins	Well	3,600	C, S, W
	Hickory Withe	Fayette Packing Company	4	Meat	Well	20,000	C, W
	Moscow	Troxel Manufacturing Co., Inc.	520	Bicycle Seats	Well	250,000	P, C, S, W
	Rossville	Tennessee Foods	250	Produce Prepared	Well	630,000	C, P, S
	"	Winter Garden, Inc.	325	Frozen Vegetables	Well	7,200,000	P, C, S
Shelby	Eads	Adams Brothers Company, Inc.	50	PVC Pipe	Well	231,000	C
	Memphis	Anderson-Tully Company	275	Hardwood Lumber Frn.	Well	83,950	C, S
	"	Allen Materials Co.	--	Metal Products	Well	--	C, P
	"	Armour and Co.	650	Slaughter Cattle and Hogs	Well	931,000	C, P, S
	"	E. L. Bruce and Co., Inc.	685	Oak Flooring & Frn.	Well	170,000	P, S, W
	"	Buckeye Cellulose Corp.	550	Cellulose	Well	10,593,000	P, C, S
	"	Philip Carey Mfg. Co.	120	Asphalt Shingled and Roofing	Well	396,000	C, P
	"	Cargill, Inc.	78	Processed Soybean	Well	4,610,000	C
	"	Cedar Grove Dairy	--	Dairy Products	Well	--	C, P
	"	Chromium Mining & Smelting	300	Ferrochrome-Ferromanganese	Well	131,250	C, P, S
	"	Charles O. Cox Corp.	55	Wood Turning	Well	4,750	P, S, W

*Code: C-cooling, P-process, S-sanitary, W-washing

(Continued)

TABLE 3-12 (Continued)

County	City	Industry	Employees	Principal Product	Water Source	Average Daily Use-GPD	Type Use*
Shelby	Memphis	Delta Refining Company	200	Gasoline-Oil-Asphalt	Well	716,619	C, P, S, W
	"	Delta Tool Company	27	Dies & Stampings	Well	--	P, C
	"	Desoto Hardwood Flooring	275	Hardwood Flooring	Well	32,000	C, S
	"	Desoto Redi-Mix Company	16	Concrete	Well	5,000	P, W
	"	E. I. Dupont Denemours and Co.	710	Industrial Organic	Well	16,400,000	C, P, S
	"	Firestone Tire & Rubber Co.	2,700	Tire and Rubber	Well	6,070,000	C, P, S, W
	"	Fisher Concrete - Glasgow	--	Sand and Gravel	Well	150,000	P, W
	"	General Electric Company	1,300	Miniature Lamps	Well	308,000	C, P, S, W
	"	W. R. Grace	300	Ammonia and Urea	Well	2,240,000	C, P, S, W
	"	Hartwell Brother	97	Hickory Handles and Night Sticks	Well	4,000	C, S
	"	Hume - Pope	--	Fatty Chemicals	Well	690,000	C, P, S, W
	"	Hume - Thomas	--	Cooking Oil	Well	1,308,480	C, P, S, W
	"	Hunt - Wesson Foods, Inc.	225	Vegetable Oil and Shortening	Well	2,240,000	P, C
	"	Illinois Central Gulf RR. Johnson Yard	550	Rail Transportation	Well	280,000	C, P, S
	"	John Morrel and Company	365	Pork, Beef and Process Meat	Well	414,000	P, S, W
	"	Jordan & Sols Sand & Gravel	15	Sand and Gravel	Well	--	W
	"	Joseph Schlitz Brewing Co.	400	Beer	Well	3,000,000	C, P, S, W
	"	Kellogg Company	600	Dry Cereals	Well	10,800	C, P, S, W
	"	Kimberly-Clark Corp.	1,600	Sanitary Napkins and Paper Products	Well	7,240,000	P, S
	"	Memphis Frosted Food	500	Frozen Foods	Well	192,544	C, P, S, W
	"	Memphis Ice Cream Co.	24	Frozen Dairy Products	Well	218,250	C, S
	"	Memphis Plywood Company	103	Plywood Panels	Well	6,129	P, W

*Code: C-cooling, P-process, S-sanitary, W-washing

(Continued)

TABLE 3-12 (Continued)

County	City	Industry	Employees	Principal Product	Water Source	Average Daily Use-GPD	Type Use*
Shelby	Memphis	Memphis Stone & Gravel Co.	20	Stone and Gravel	Well	237,600	P, S
	"	Midwest Farms	0	Frozen Dairy Products	Well	160,380	C, W
	"	Midwest Farms - Union Ave.	31	Frozen Dairy Products	Well	360,000	C
	"	Prest Manufacturing Co.	250	Wooden Caskets and Flooring	Well	104, 250	P, S
	"	Quaker Oats Company	200	Flurfural and Furfuryl Alcohol	Well	2,900,000	C, P, S
	"	Royal Oak Charcoal	88	Charcoal Briquets	Well	75,000	C, W
	"	Smalley Magnesium Co.	6	Magnesium Battery Casings	Well	144,000	P, C
	"	Southern Fabricatiors, Inc.	140	Trailer Parts	Well	2,250	S, W
	"	Standard Construction Co., Inc.	19	Sand and Gravel	Well	470,000	W
	"	Tennessee Veneer Co.	50	Plywood	Well	32,400	P
	"	U. S. Steel Corp.	42	Mixed Fertilizer	Well	--	C
	"	Union Carbide Corp.	15	Acetylene	Well	10,000	C, S, W
	"	Valley PRoducts, Inc.	35	Tallow	Well	139,000	C, P, S
	"	Velsicol Chemical Co.	151	Endrin, Heptachlor and Chlorine	Well	3,100,000	C, P
	"	C. F. Work and Sons	95	Tool Handles and Golf Club Heads	Well	9,900	C, S
	Woodstock	Taylor-Forge Division	90	Pipeline Fittings	Well	80,000	P, C, S
Tipton	Rural	Tipon Foods, Inc.	15	Country Ham	Well	--	S, W

*Code: C-cooling, P-process, S-sanitary, W-washing

TABLE 3-13

SELF-SUPPLYING COMMERCIAL WATER USERS IN THE MEMPHIS AREA BASIN

County	Name	Number of Employees	Water Source	Est. Avg. Daily Use (gpd)	Type Use*
Shelby	Catfish Farm	-	Well	-	Lake
	Catfish Motel	2	Well	576,000	P
	Cedar Grove Dairy	-	Well	-	P, C
	Circle A Stables	-	Well	-	Stock water
	Collierville Servisoft	-	Well	-	W
	Dixie National Stockyards	11	Well	17,280	W
	Dixon Grocery	2	Well	-	W
	Flora Hill Motel	-	Well	-	C, D, S, W
	John Gerber Company	177	Well	612,000	C
	Green Acres Mobile Home	5	Well	-	Stock water
	Green Thumb Nursery	1	Well	730,000	D
	Goldsmiths Dept. Store	-	Well	-	C
	Goodwyn Inst. Bldg.	100	Well	-	C
	Gulf Atlantic Warehouse	75	Well	10,000	C
	Hungry Fisherman Res.	-	Well	-	Lake
	ICRR	-	Well	-	C, P, S, W
	Kearn Brothers Groc.	-	Well	-	C, P, S, W
	Malco Theater	78	Well	-	C
	McCool Horse Farm	-	Well	-	Stock water
	Memphis International Rwy.	-	Well	-	S
	Mikes Sports World	3	Well	-	S
	Milton Pickard	1	Well	-	C
	Pulliam Nursery	-	Well	-	Stock water
	Roadway Express	300	Well	2,250	C, S, W

*Code: C-cooling, P-process, S-sanitary, W-washing

(Continued)

TABLE 3-13 (Continued)

County	Name	Number of Employees	Water Source	Est. Avg. Daily Use (gpd)	Type Use*
Shelby	Shelby County Airport	-	Well	-	C, P, S, W
	Southern Investors	-	Well	-	C, P
	Snowden Express	-	Well	-	C
	Tom Hunt Sales	-	Well	-	C
	William A. Wiley Auto	-	Well	-	C, P, S, W
	White Rose Linen	150	Well	120,000	C, P, S, W
	W. O. Whitmore	1	Well	500,000	P
	White Haven Animal Hosp.	4	Well	-	C, W

*Code: C-cooling, P-process, S-sanitary, W-washing

TABLE 3-14

INDUSTRIAL WELLS WITHIN 3 MILES OF IFGDP

Owner	Address	Depth (feet)	Well Diameter (inches)	Flow (gpm)	Aquifer
Bengal Water Co. (Piper)	1175 Harbor Ave.	121	8	120	Alluvium
Cargill, Inc.	2330 Buoy Ave.	582	12 x 8	-	Memphis sand
Cargill, Inc.	1877 Channel Ave.	419	20 x 12	-	Memphis sand
Cargill, Inc.	1877 Channel Ave.	386	16 x 10	-	Memphis sand
Cargill, Inc.	1877 Channel Ave.	400	18 x 12	-	Memphis sand
Gaskell Company	1555 Harbor Ave.	94	4	125	Alluvium
Mid-American Industries	2365 Harbor Ave.	111	6	-	Alluvium
National Distillers	2459 Channel Ave.	118	16 x 10	-	Alluvium
Presidents Island Planting Company	1039 Port, Ext'd	95	2	-	Alluvium
H. B. Reed, Inc.	2170 Steam Plant Rd.	132	6	-	Alluvium

Examination of data reported in Tables 3-10 through 3-13 indicates that only one well related to agriculture, the well owned by the Presidents Island Planting Company, is in the area of the proposed IFGDP.

Based on a review of the area and interviews at selected locations, there appear to be no other "private" wells within 3 miles of the plant site.

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3.4 METEOROLOGY, CLIMATOLOGY AND AIR QUALITY

3.4 METEOROLOGY, CLIMATOLOGY AND AIR QUALITY

This section describes the existing environment in terms of meteorology, climatology and air quality.

3.4.1 METEOROLOGY

The proposed plant site is located in Shelby County, Tennessee. There are five official U.S. Government meteorological stations[1-4] that record only temperature and precipitation data within a 50-mile radius of the site location. In addition, a first order National Weather Service meteorological station is located at Memphis, the city of the proposed plant site. Wind speed, wind direction, solar radiation, visibility, pressure and relative humidity (as well as temperature and precipitation) are recorded at the first order station.[5] Table 3-15 lists the locations of the six weather stations relative to the plant site and the period of record for each station. Further meteorological data are available from a meteorological tower operated by the Tennessee Valley Authority in the vicinity of the Allen Generating Plant and the proposed site.

3.4.2 REGIONAL CLIMATOLOGY (SOUTHWESTERN TENNESSEE)

The climate of Southwestern Tennessee[5,6] is affected by weather systems of both Gulf and western Canadian origin and thereby has comparatively frequent changes in weather. Summers are generally warm and humid while winters are generally mild. The average annual temperature is in the low sixties and varies between monthly averages in the low forties in January to the low eighties in July. Extreme temperatures are relatively rare, as there are only about 65 days per year with maximum temperatures above 90°F and 60 days per year with minimum temperatures less than 32°F. Relative humidity averages 70 percent for the whole year.

Precipitation of near 50 inches per year is fairly well distributed throughout the year, with the greatest amounts falling during winter and early spring

TABLE 3-15

LOCATION OF METEOROLOGICAL STATIONS WITH RESPECT TO THE PROPOSED SITE AND CORRESPONDING PERIOD OF CLIMATOLOGICAL RECORD[1-5]

Station	Distance and Direction from Site	Type of Summarized Data and Period of Record
Arkansas		
Marked Tree	35.1 miles NW (35°30'N, 90°20'W)	Temperature and precipitation (1931 to 1960)
Mississippi		
Holly Springs	43.6 miles ESE (34°49'N, 89°26'W, elevation 480')	Temperature and precipitation (1941 to 1970)
Tunica	27.6 miles SW (34°41'N, 90°23'W, elevation 189')	Temperature and precipitation (1941 to 1970)
Tennessee		
Covington	41.4 miles NE (35°34'N, 89°40'W, elevation 310')	Temperature and precipitation 1931 to 1965)
Memphis*	4.3 miles ENE	All meteorological data (1941 to 1975)
Moscow	39.3 miles E (35°04'N, 89°24'W, elevation, 352")	Temperature and precipitation (1931 to 1965)

* First order weather station. Long-term averages are available only for the period 1941 to 1970. Extreme values are available for the entire period.

(December through March). During this period, both widespread flooding and local flash floods can occur. Rains of 3.3, 2.8, 2.2 and 1.4 inches per hour can be expected to occur on the average 1, 4, 20 and 100 times, respectively, as determined from 100 years of measurements at the station at Covington, Tennessee.[1]

Most precipitation falls in the form of rain. Average annual snowfall varies from 4 to 6 inches. Due to relatively mild winter temperatures, a snow cover rarely persists for more than a few days.

3.4.2.1 LOCAL CLIMATOLOGY (MEMPHIS AREA)

The local climatology or meso-climate of the site can be characterized by observations of temperature, relative humidity, precipitation, winds, air pollution climatology and extreme events taken from the Memphis International Airport meteorological station.[5]

3.4.2.2 TEMPERATURE

A summary of the temperature data for the Memphis area is presented in Table 3-16.

The annual average total of heating degree days (base 65°F) in the Memphis area is 3227. Degree days indicate demands for energy to heat during cooler months.

In regard to extremes, the record high temperature for Memphis is 106°F, while the record low is minus (-) 13°F.

3.4.2.3 HUMIDITY

Relative humidity values are recorded 4 times a day at first order meteorological stations and are presented in Table 3-17 for Memphis.[5] Relative humidity varies inversely with temperature if the water vapor content of the

TABLE 3-16

TEMPERATURE DATA FOR MEMPHIS*, TENNESSEE[5,6]

Parameter	Average Temperature (°F)												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Daily Minimum	31.6	34.4	41.1	52.3	60.6	68.5	71.5	70.1	62.8	51.1	40.3	33.7	51.5
Daily Maximum	49.4	53.1	60.8	72.7	81.2	88.7	91.6	90.6	84.3	74.9	61.5	51.7	71.7
Monthly	40.5	43.8	51.0	62.5	70.9	78.6	81.6	80.4	73.6	63.0	50.9	42.7	61.6

* Period of Record - 1941 to 1970

TABLE 3-17

SUMMARY OF RELATIVE HUMIDITY RECORDED AT MEMPHIS, TENNESSEE[5,6]*

Time	Annual Average Relative Humidity (%)
0000 HR C.S.T.	77
0600 HR C.S.T.	82
1200 HR C.S.T.	57
1800 HR C.S.T.	61

* Period of Record - 1941 to 1970.

air is constant. Therefore, relative humidity is generally lowest at the time of maximum temperature (afternoon) and highest at the time of minimum temperature (early morning).

Wet bulb temperature is another meteorological variable indicative of the water vapor content of the air. A summary of average monthly relative humidity, average monthly wet- (calculated) and dry- (observed) bulb temperature (°F) for Memphis, Tennessee, is presented in Table 3-18.

3.4.2.4 RAINFALL

A summary of average annual and average precipitation[5] is given in Table 3-19. The average annual precipitation for the Memphis area is 49.10 inches.

For a 24-hour period, the maximum record rainfall is 5.95 inches, occurring on March 11, 1975. The record monthly rainfall is 12.29 inches, occurring in April 1955.

3.4.2.5 SNOWFALL

Annual average, record monthly and record 24-hour snowfall amounts are presented in Table 3-20 for Memphis.[5] Over a 40-year period, the annual average snowfall is 5.7 inches.

3.4.2.6 WIND

The average annual wind speed at Memphis is 9.2 miles per hour and the prevailing direction is generally from the south.[5] Table 3-21 gives monthly average wind speed and prevailing direction along with data on extreme winds (fastest mile). Figure 3-31 presents wind data in the form of wind roses based on hourly observations from Memphis for a 10-year period (1951 to 1960) and from the meteorological tower maintained by the TVA in the vicinity of the Allen Generating Plant for one year, 1977. Both figures (wind roses) indicate a relatively frequent occurrence of wind from the south to southwest.

TABLE 3-18

SUMMARY OF DATA FOR RELATIVE HUMIDITY, WET BULB TEMPERATURE (CALCULATED) AND DRY BULB TEMPERATURE FOR MEMPHIS, TENNESSEE[5,6]

Month	Average Relative Humidity (%)*	Average Observed Dry Bulb Temperature (°F)*	Average Calculated Wet Bulb Temperature (°F)
January	72	40.5	37.2
February	69	43.8	39.7
March	66	51.0	45.9
April	65	62.5	55.1
May	68	70.9	63.8
June	69	78.6	71.0
July	70	81.6	74.3
August	71	80.4	73.0
September	71	73.6	66.9
October	69	63.0	56.2
November	69	50.9	46.0
December	72	42.7	39.5

* Period of Record - 1941 to 1970

TABLE 3-19

SUMMARY OF PRECIPITATION DATA FOR MEMPHIS, TENNESSEE[5,6]

Parameter	Precipitation (inches)												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Monthly Average	4.93	4.73	5.10	5.42	4.39	3.46	3.53	3.53	3.01	2.58	3.92	4.70	49.10

*Period of Record - 1941 to 1970

TABLE 3-20

SUMMARY OF SNOWFALL DATA FOR MEMPHIS, TENNESSEE[5]

Parameter	Snowfall (inches)
Annual Average*	5.7
Record Monthly Maximum**	17.3
Record 24-Hour Maximum**	16.1

* Period of Record - 1941 to 1970

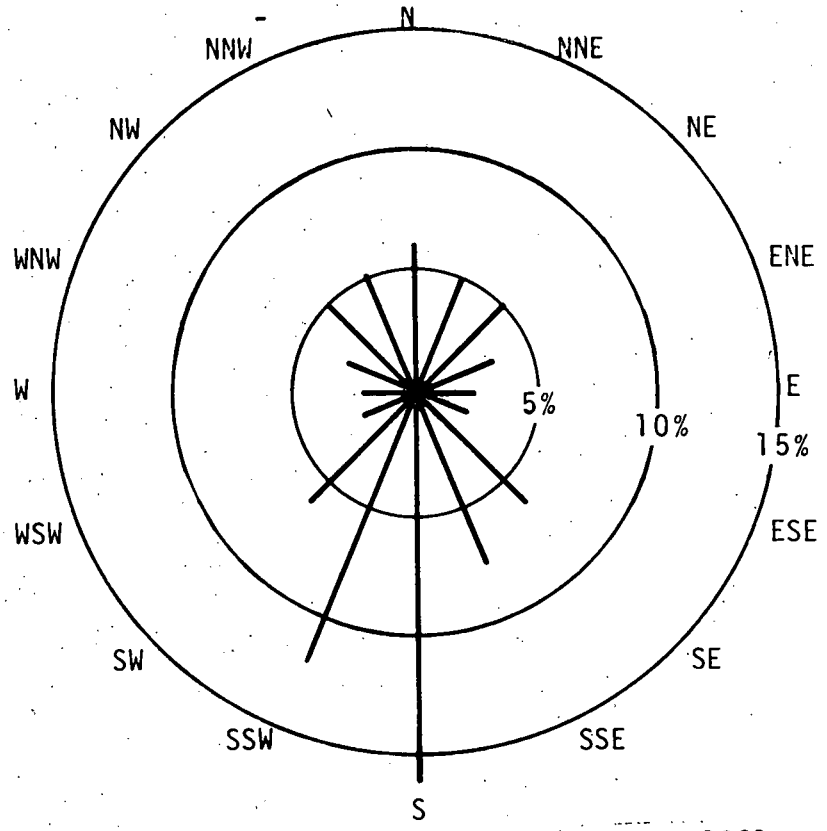
** Period of Record - 1941 to 1975

TABLE 3-21

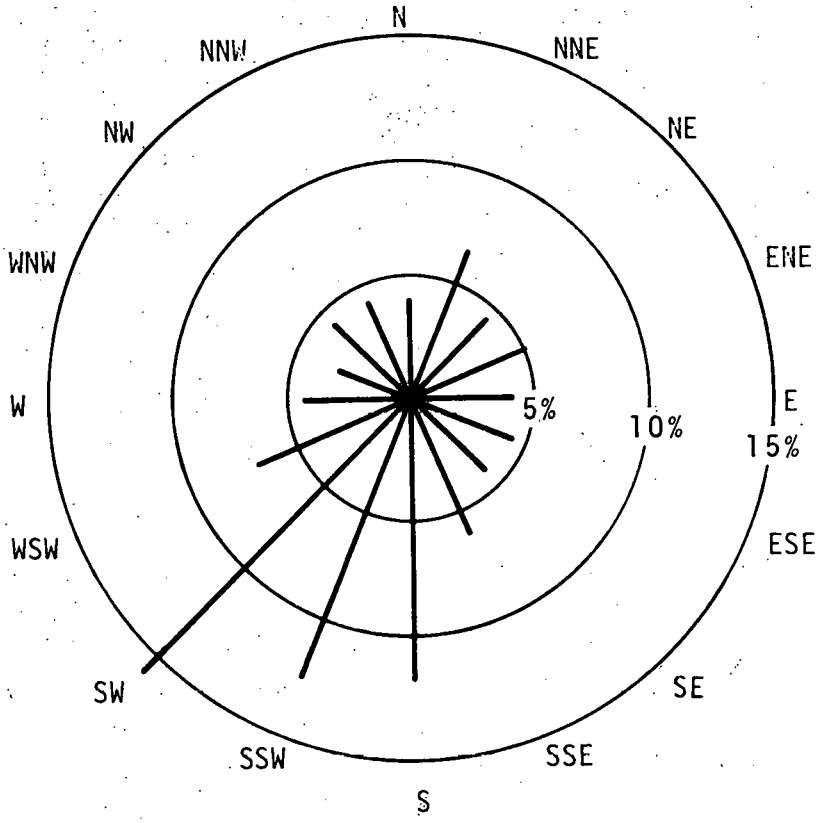
SUMMARY OF WIND DATA FOR MEMPHIS, TENNESSEE[5,6]

Parameter	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Monthly Average Wind Speed (mph)	10.6	10.6	11.3	10.8	9.0	8.1	7.6	7.1	7.6	7.8	9.4	10.1	9.2
Prevailing Wind Direction	S	S	S	S	S	S	S	S	E	S	S	S	S
Fastest Mile:													
Speed (mph)	43	49	54	57	50	50	56	42	47	47	43	43	--
Direction	NW	SW	S	W	NW	NW	NW	NE	SE	W	S	N	--
Year of Occurrence	1956	1951	1952	1970	1953	1951	1964	1967	1968	1955	1952	1954	--

* Period of Record - 1941 to 1970



U.S. Weather Bureau - Memphis Data 1951 to 1960



TVA Allen Data - 1977

Figure 3-31. Wind Roses for the Memphis Area.

3.4.2.7 AIR POLLUTION CLIMATOLOGY

G. C. Holzworth[7] has analyzed weather records of the upper air temperature structure above many United States stations with the objective of characterizing the average depth of the vigorously vertically mixed layer above the ground (mixing depth) on both a seasonal and an annual basis. This mixing occurs by both mechanical and thermal transport processes. By interpolation from maps presented by Holzworth, it is possible to estimate regional morning and afternoon mixing depths and average wind speed through the mixing layer over southwestern Tennessee. Table 3-22 shows that the mean morning mixing heights in the Memphis area vary from 350 to 550 meters through the seasons, while mean afternoon mixing heights vary from 1000 to 1800 meters. Table 3-23 gives the mean wind speeds associated with these mixing depths. The higher the mixing height and the higher the wind speed, the greater the dispersion (dilution) of pollutants emitted into the atmosphere.

Holzworth has also studied the potential for high air pollution for the United States. High air pollution potential is defined as an elevated inversion based at or below 2000 meters (~6600 feet) above ground level with an average wind speed through the layer of six meters per second (13 miles per hour) or less. These conditions must persist for 36 hours or more (with no occurrences of precipitation) in order to trigger an air pollution alert (episode). Table 3-24 presents the total number of episode days in 5 years for southwestern Tennessee. Two episode durations, 2 days and 5 days, are included in this table. Table 3-24 is cumulative, so that the number of days of more limiting conditions is included again in the number of days of less limiting conditions.

The most general or least limiting dispersion episode conditions are defined as mixing heights of 2000 meters or less and wind speeds 6 meters per second or less. As Table 3-24 indicates, southwestern Tennessee had 400 episode days occurring for alerts lasting at least 2 days and 71 episode days for alerts lasting at least 5 days in a 5-year period. Southwestern Tennessee experience the greatest number of episode days under these least limiting

TABLE 3-22

SEASONAL AND ANNUAL MIXING HEIGHTS
THROUGH THE MIXING LAYER FOR MEMPHIS, TENNESSEE[7]

Mean Daily Mixing Mixing Height (m)	Winter	Spring	Summer	Autumn	Annual Average
Morning	550	550	395	350	460
Afternoon	1000	1700	1800	1400	1475

TABLE 3-23

AVERAGE WIND SPEEDS THROUGH THE MIXING LAYER

Average Wind Speed Through the Mixing Layer (m/sec)	Winter	Spring	Summer	Autumn	Annual Average
Morning	5.0	5.5	3.0	4.0	4.4
Afternoon	6.4	6.8	4.8	5.0	5.8

TABLE 3-24

TOTAL NUMBER OF EPISODE DAYS IN A 5-YEAR PERIOD FOR SOUTHWEST TENNESSEE

Wind Speed (m/sec)	Mixing Height in Meters for Episodes Lasting at Least 2 Days*				Mixing Height in Meters for Episodes Lasting at Least 5 Days*			
	≤ 500	≤ 1000	≤ 1500	≤ 2000	≤ 500	≤ 1000	≤ 1500	≤ 2000
≤ 2	0	0	2-A	3-A	0	0	0	0
≤ 4	2-W	20-W	49-A	107-A	0	0	0	B-SU
≤ 6	4-W	50-W	190-A	400-A	0	5-A	13-A	71-A

* The number on the left indicates how many episode days occurred. The letter on the right indicates the season in which the episode occurred. Values are interpolated. W - Winter SP - Spring SU - Summer A - Autumn

dispersion conditions. Although an episode may occur under these conditions, the likelihood of high ground-level pollutant concentrations is not as great as the likelihood under the other dispersion conditions.

A subset of this general episode condition is the "most limiting" condition. The most limiting episode conditions considered on Table 3-24 consist of mixing heights of 500 meters or less and wind speeds 2 meters per second or less (with no precipitation during the episode). As shown on Table 3-24, these conditions never prevailed for 2 days or more during the 5-year period.

The subset of "intermediate limiting" conditions of mixing heights 1500 meters or less and wind speeds four meters per second or less (with no precipitation) occurred for 49 episode days for episodes lasting at least 2 days. There were no episodes lasting 5 days or more at these conditions during the 5 five years considered.

It is apparent from Table 3-24 that air pollution episodes over southwestern Tennessee are more likely to occur in autumn and winter than in spring and summer. However, on an annual basis, the atmosphere over the southwestern Tennessee region has fairly good dispersion characteristics, that is, pollutants emitted to the atmosphere will disperse at a moderate rate.

3.4.2.8 EXTREME EVENTS

Based upon climatological data from Memphis, the mean number of days per year for thunderstorms is 53. These storms occur most frequently during summer and spring.[5]

The Memphis area is approximately 750 miles from the Atlantic coast and 400 miles north of the Gulf coast. Therefore, the threat of severe damage from hurricanes is slight.[6]

The annual expectancy of tornadoes anywhere in southwestern Tennessee averages less than four. The month that has the largest frequency of observed tornadoes is March.[5,6]

Heavy fog (visibility 1/4 mile or less) occurs on an average of 11 days per year.[5]

3.4.3 AIR QUALITY

This section presents the air quality data monitored at the MLGW/EIA site for the period February 1978 through September 1979. R

Ambient air quality monitoring by MLGW/EIA has supported the fact that the 1-hour ozone standard is being exceeded at the monitoring site. Only one excursion of the 8-hour standard for CO and the 24-hour standard for particulate matter was observed for the period February 1978 through September 1979. R This one excursion for each pollutant does not constitute nonattainment for either the CO or particulate matter standard. Furthermore, short-term SO_2, NO_2 and quarterly lead concentrations are well below federal standards in the area of the proposed IFGDP.

3.4.3.1 ATTAINMENT STATUS OF SHELBY COUNTY

According to the Federal Register, the attainment status of Shelby County for the National Ambient Air Quality Standards currently is as follows:

- Particulate matter (TSP) -- Those portions of Shelby County within two sections of downtown Memphis are nonattainment for TSP. (Presidents Island is nonattainment for TSP).

- Carbon monoxide (CO) -- That portion of Shelby County located in metropolitan Memphis is nonattainment for CO.

- Ozone (O_3) -- All of Shelby County is nonattainment for ozone.

- Sulfur dioxide (SO_2) -- All of Shelby County is attainment for SO_2.

- Nitrogen dioxide (NO_2) -- All of Shelby County is attainment for NO_2.

3.4.3.2 AMBIENT AIR QUALITY MONITORING PROGRAM

A comprehensive air monitoring program has been conducted by the Tennessee Valley Authority (TVA) in the proximity of the proposed IFGDP since 1973. Seven TVA air quality stations have been utilized to monitor the air near the Allen Generating Plant. Gaseous pollutants are measured continuously, while particulate matter is measured every 6 days according to an EPA schedule. Table 3-25 identifies these TVA air quality monitoring stations in regard to station number, types of monitoring instruments and dates of instrument installation. TVA air quality data presented in this report are for the period 1976 to June 1979. Figure 3-32 gives the location of each TVA site R by station number.

Figure 3-32 also shows the locations of monitoring sites operated by the Memphis and Shelby County Health Department (MSCHD). This agency monitors sulfur dioxide (SO_2), nitrogen dioxide (NO_2), particulate matter (TSP), ozone (O_3) and carbon monoxide (CO) at several locations within Shelby County as is shown in Table 3-26. Data from MSCHD are also included from 1976 to June 1979. R

In February 1978, MLGW and EIA began an air quality field program that continued through September 1979. The MLGW/EIA program augments the data R base provided by the TVA and MSCHD programs by furnishing data on pollutants in the immediate vicinity of the proposed IFGDP. MLGW/EIA data presented in this section are for the period February 1978 to September 1979. R

The MLGW/EIA air quality monitoring program was conducted in accordance R with present regulations and guidelines issued by the U.S. Environmental Protection Agency (EPA) on air quality monitoring and quality assurance.[8,9,10] These regulations and guidelines define instrumental probe siting criteria, pollutants to be monitored, duration of monitoring and quality assurance procedures. For quality assurance, MLGW/EIA calibrated each instrument R monthly according to EPA procedures and specifications. An independent audit by the Memphis and Shelby County Health Department was performed quarterly. R

TABLE 3-25

TENNESSEE VALLEY AUTHORITY AIR MONITORING STATIONS (ALLEN GENERATING PLANT)

Station No.*	Parameter Measured	Date Instruments Installed	(Removed)
M-1	Meteorological (wind speed, wind direction, wind direction persistence, dewpoint, temperature at 3 levels)	6/18/73	(2/25/76)
M-2	Meteorological (horizontal wind direction sigma, prevailing wind direction, wind direction persistence, wind speed, temperature at 3 levels)	12/4/75	(ongoing)
1	SO_2	1/3/76	(5/4/77)
	Suspended particulate	1/3/76	(3/26/77)
2	Suspended particulate	2/24/69	(ongoing)
	Settled particulate	3/1/69	(ongoing)
3	SO_2	8/15/73	(ongoing)
	NO_2	4/26/78	(ongoing)
4	SO_2	8/16/73	(ongoing)
	Suspended particulates	8/15/73	(ongoing)
	Settled particulates	8/15/73	(ongoing)
	Soiling index	10/11/73	(ongoing)
	Corrosion effects	8/9/76	(ongoing)
	NO_2	4/26/78	(ongoing)
5	SO_2	10/2/75	(ongoing)
	Suspended particulates	9/3/76	(ongoing)
	NO_2	4/25/78	(ongoing)
6	SO_2	10/2/75	(ongoing)
	Suspended particulates	9/3/76	(ongoing)
7	SO_2	5/4/77	(ongoing)
	Suspended particulates	7/18/77	(ongoing)
	Settled particulates	6/1/77	(ongoing)
	Corrosion effects	6/1/77	(ongoing)
	NO_2	4/26/78	(ongoing)
	Ozone	4/26/78	(ongoing)

* Station locations are shown in Figure 3-32.

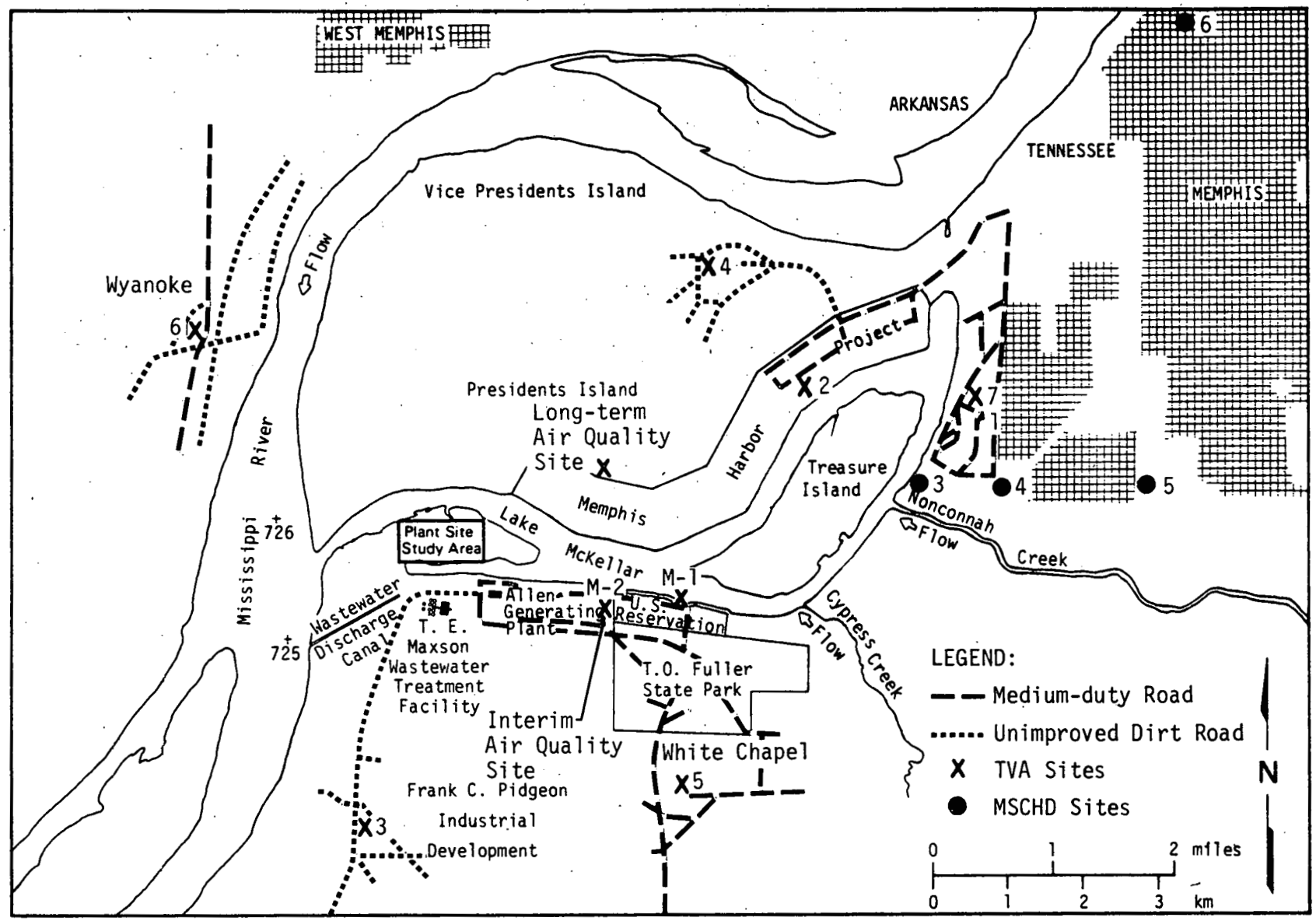


Figure 3-32. Locations of TVA, MSCHD and MLGW/EIA Air Quality Monitoring Stations with Respect to the Proposed Site

TABLE 3-26

MEMPHIS AND SHELBY COUNTY HEALTH DEPARTMENT AIR QUALITY MONITORING STATION

Location*/Site Address	Coordinates	Starting and Ending Dates of Monitoring*				
		CO**	O_3**	TSP†	SO_2††	NO_2††
1. Memphis - 416 Alabama	35° 08' 04"N 40° 02' 30"W	1973-ongoing	2/73-ongoing	2/73 to 3/78	--	--
2. Memphis - Post Office, 1 North Front Street	35° 09' 0"N 90° 03' 43"W	--	--	12/67-ongoing	6/71 to 3/78	6/71 to 3/78
3. Memphis - Dr. Martin L. King Park, 1875 Riverside	35° 05' 33"N 90° 04' 37"W	--	--	1971-ongoing	1971 to 3/78	1971-ongoing
4. Memphis - Pine Hill Park, 885 Alice	35° 05' 33"N 90° 04' 37"W	--	--	1971-ongoing	1971 to 3/78	1971 to 3/78
5. Memphis - Sharpe School, 3431 Sharpe Avenue	35° 05' 09"N 89° 56' 51"W	--	--	1971-ongoing	--	--
6. Memphis - Gas Service Center, Meagher Street	35° 22' 30"N 89° 57' 47"W	--	--	1967-ongoing	--	1971 to 3/78
7. Memphis - Fire Station, North Thomas Street	35° 22' 32"N 90° 01' 41"W	--	--	1967-ongoing	--	1971-ongoing
8. Memphis - 1330 Frayser Blvd.	35° 07' 30"N 90° 03' 41"W	1972 to 3/78	2/73-ongoing	2/73-ongoing	--	-ongoing
9. Lucy - Lucy School, 6269 Amherst Road	35° 29' 35"N 89° 57' 55"W	--	--	1967 to 3/78	--	--
10. Arlington - Water Plant, Memphis & Arlington Road	35° 30' 15"N 29° 39' 46"W	--	--	1970-ongoing	1971 to 3/78	1971 to 3/78
11. Collierville - Fire Station, 99 Walnut Street	35° 15' 08"N 89° 39' 16"W	--	--	1970-ongoing	1971 to 3/78	1971 to 3/78

* Locations as of October 1978 and shown on Figure 3-32.

** Continuous monitoring

† Sample every 6th day

†† Bubbler method

Table 3-27 identifies the types of monitoring instruments and the dates of installation of the MLGW/EIA equipment. Note that a relocation of the MLGW site occurred on November 4 to November 6, 1978. Prior to these dates, the location was referred to as the interim site and afterward as the long-term site. Figure 3-32 includes the location of the interim and long-term MLGW/EIA air quality monitoring sites with respect to the proposed plant site.

3.4.3.3 PARTICULATE MATTER

Concentrations of total suspended particulates (TSP) were determined at R
the MLGW/EIA site with the use of the high volume (Hi-Vol) sampler, which is approved as a reference method by EPA. Air is drawn through a preweighed (under EPA specified conditions) filtering medium at a known rate for a period of 24 hours. This filter paper is then reweighed after conditioning. Particulate mass concentration is then obtained by dividing the net weight of the collected mass by the total volume of air drawn through the filter with proper correction for barometric pressure and ambient temperature.

Total suspended particulate concentrations have been determined for the
MLGW/EIA sites for the period February 1978 through August 1979 according to R
the EPA 6th day schedule (Table 3-28).

As noted in Table 3-28, the highest 24-hour particulate concentration was 175.3 $\mu g/m^3$ (micrograms per cubic meter) on February 14, 1979, and the second highest was 135.1 $\mu g/m^3$ on June 20, 1979. The corresponding meteorological data (weather types, precipitation, wind speed, wind direction and relative humidity) for each of the sampling days are given in Appendix 3C.

The highest 24-hour particulate concentration of 175.3 $\mu g/m^3$ represents an excursion, but not a violation of the federal 24-hour secondary particulate matter standards, since federal air quality regulations allow one excursion above the 150 $\mu g/m^3$ secondary standard. On this day, no precipitation was
observed and the winds were moderately strong (Appendix 3C). These condi- R
tions are conducive to the generation of airborn fugitive dust originating R

TABLE 3-27

INSTRUMENTATION AT INTERIM AND LONG-TERM MLGW/EIA MONITORING SITES*

Site	Type of Monitoring Instruments	Date Installed	
Interim (2/19/78 to 11/3/78)	SO_2-Meloy Lab Model SA-185	2/22/78	
	NO_2-Meloy Lab Model NA-520	2/19/78	
	NO_2-Monitor Labs Model 8440E	7/11/78	
	CO-Bendix Model 8501-5CA	3/22/78	
	O_3-Meloy Lab Model OA-350-2R	8/10/78	
	High-Volume Sampler-General Metals Work Lab Model GMWL-2000 with Sierra Instrument Model 310 Accu-Vol control	2/19/78	
Long-Term (11/6/78 to September 1979 for CO and particulates and through September 1979 for NO_2 and O_3)	NO_2-Monitor Labs Model 8440E	11/6/78	
	CO-Bendix Model 8501-5CA	11/6/78	R
	O_3-Meloy Lab Model OA-350-2R	11/6/78	R
	High-Volume Sampler-General Metals Work Lab Model GMWL-2000 with Sierra Instrument Model 310 Accu-Vol control	11/6/78	R R R

* Site was relocated November 4 to 6, 1978, and new site was then referred to as the long-term site (see Figure 3-32 for locations).

TABLE 3-28

TWENTY-FOUR-HOUR CONCENTRATIONS OF PARTICULATE AND PARTICULATE SIZE DISTRIBUTIONS AT THE MLGW/EIA MONITORING SITE

Collection Date	24-hour Particulate Concentration ($\mu g/m^3$)
2/19/78	34.7
2/25/78	39.6
3/3/78	48.8
3/9/78	48.8
3/15/78	47.9
3/21/78	38.1
3/27/78	40.4
3/29/78	99.8
4/8/78	101.8
4/14/78	57.1
4/20/78	43.5
4/26/78	95.8
5/2/78	65.1
5/8/78	34.8
5/14/78	61.7
5/20/78	52.3
5/26/78	126.7
6/1/78	106.3
6/8/78	38.2
6/13/78	100.6
6/19/78	45.1
6/26/78	65.1
7/1/78	77.6
7/7/78	78.2
7/13/78	62.3
7/19/78	92.0

(Continued)

TABLE 3-28 (Continued)

Collection Date	24-hour Particulate Concentration (μg/m³)
7/25/78	38.9
7/31/78	73.6
8/6/78	74.4
8/12/78	38.8
8/18/78	40.4
9/11/78	33.3
9/23/78	62.3
9/29/78	89.3
10/5/78	60.6
10/23/78	90.9
10/29/78	72.2
11/22/78	54.9
11/28/78	*
12/10/78	76.8
12/16/78	57.1
12/22/78	36.2
1/2/79	101.7
1/15/79	41.0
1/21/79	25.5
2/2/79	70.3
2/2/79	65.6
2/8/79	69.7
2/14/79	175.3
2/20/79	67.2
2/26/79	40.3
3/4/79	22.8
3/4/79	19.9
3/10/79	36.3

* Sample void

(Continued)

TABLE 3-28 (Continued)

Collection Date	24-hour Particulate Concentration ($\mu g/m^3$)	
3/16/79	66.0	
3/22/79	42.8	
3/28/79	102.0	
4/3/79	46.4	
4/3/79	45.1	
4/9/79	51.1	
4/15/79	40.7	
5/3/79	56.5	
5/3/79	54.1	
5/9/79	72.7	
5/21/79	51.1	
5/15/79	57.9	
5/27/79	60.3	
6/2/79	47.5	
6/2/79	50.6	
6/8/79	93.6	
6/14/79	89.9	
6/20/79	135.1	
6/26/79	LR*	
7/2/79	LR*	R
7/14/79	70.5	R
7/20/79	109.5	R
7/26/79	108.0	R
8/1/79	44.7	R
8/7/79	102.1	R
8/19/79	61.6	R
8/25/79	63.3	R

* Denotes Lost Record

NOTE: Federal 24-hour primary standard for particulate is 260 $\mu g/m^3$.
Federal 24-hour secondary standard for particulate is 150 $\mu g/m^3$.
Both are not to be exceeded more than once per year.

from native soil. However, a microscopical analysis of the filter showed that starch was the primary particulate component accounting for 63 percent of the total concentration. R R R

Therefore it is not clear whether the observed excursion above the 24-hour secondary standard was caused by anthropogenic sources or was due to fugitive dust. In either event, the excursion does not constitute a violation of the standard as is pointed out above. R R R R

Table 3-29 presents 24-hour particulate size distributions as collected by a cascade impaction segregator for the period August 1978 through August 1979. R In Table 3-29, a total 24-hour particulate concentration is given for each sampling day. The total particulate concentration is then broken down into a particle size distribution for five size ranges. The highest 24-hour particulate concentration was 138.7 $\mu g/m^3$ on June 20, 1979. As can be seen from Table 3-29, 89 percent of the total particulate concentration for that day consisted of particulates less than 7.0 microns in diameter. From a particulate size distribution, the percentage of respirable particles may be determined. Although not documented as of yet, the current definition of a respirable particle is one with a diameter less than 15 microns. Table 3-29 shows that most of the sampled particulate matter is less than 7 microns in diameter.

Information on particulate matter concentrations collected by TVA and MSCHD for 1976 through June 1979 are presented in Tables 3-30 and 3-31, respectively. R TVA Stations 2 and 4 are on Presidents Island, which is presently designated as nonattainment for particulate matter. However, the Memphis and Shelby County Health Department is in the process of requesting that EPA designate Presidents Island as unclassifyable on the basis that the bulk of the particulate are from nontraditional sources (fugitive dust and reintrained dust). R R R R R R The highest particulate matter concentration was 414 $\mu g/m^3$ on November 4, 1978, at Site 6. The second-highest particulate matter concentration was 364 $\mu g/m^3$ at TVA Site 4. In 1979, the highest particulate matter concentration was 221 $\mu g/m^3$ on February 14, at Site 2. The second highest concentration was 184 $\mu g/m^3$ at Site 6. Table 3-30 offers additional information about the TVA data such as annual geometric means, geometric standard deviations and the R R R R R

TABLE 3-29

TWENTY-FOUR-HOUR PARTICULATE SIZE DISTRIBUTIONS
AT THE MLGW/EIA MONITORING SITE

Collection Date	Total Concentration ($\mu g/m^3$)	Percentage (%) of Total Concentration for Each Size Range (μ)					
		0-1.1	1.2-2.0	2.1-3.3	3.4-7.0	> 7.0	
8/24/78	42.5	12	16	17	32	23	
8/30/78	42.6	12	16	14	28	30	
9/5/78	115.4	28	11	12	18	31	
9/17/78	32.4	9	11	14	29	37	
10/11/78	53.9	43	8	3	15	31	
10/17/78	59.2	20	14	12	17	37	
11/10/78	62.6	37	9	8	16	30	
12/4/78	70.3	17	7	8	19	49	
12/28/78	110.8	22	9	8	16	45	
1/5/79	46.1	8	5	11	28	38	
1/27/79	26.1	39	18	9	17	17	
2/20/79	78.2	27	36	16	10	11	
3/10/79	50.9	20	55	15	6	4	
3/28/79	125.9	23	41	17	10	9	
4/9/79	62.2	29	46	14	5	6	
5/15/79	76.5	33	33	15	11	8	
5/21/79	69.6	25	25	32	7	11	
6/8/79	131.5	30	30	16	13	11	
6/20/79	138.7	22	35	20	12	11	
7/8/79	46.0	9	9	17	34	31	R
7/20/79	73.4	8	9	14	27	42	R
8/7/79	80.7	16	9	11	20	44	R
8/19/79	52.2	12	13	17	30	28	R

TABLE 3-30

INFORMATION ON SUSPENDED PARTICULATE CONCENTRATIONS AS MEASURED BY THE TENNESSEE VALLEY AUTHORITY IN THE VICINITY OF THE ALLEN GENERATING PLANT

Year	Station Number*	Start Date	End Date	Max 24-Hr (μg/m³)**	Date of 24-Hr Max	Annual Geometric Mean (μg/m³)†	Geometric Standard Deviation	Number of Days >150 μg/m³	Number of Days >260 μg/m³
1976	1	1/6	12/27	146	6/10/76	63	--	0	0
	2	1/6	12/27	345	6/10/76	115	--	15	3
	4	1/6	12/27	364	8/16/76	74	--	7	2
	5	9/3	12/27	75	10/15/76	45	--	0	0
	6	9/3	12/27	177	10/3/76	59	--	2	0
1977	1	1/1	3/26	144	3/26/77	56	--	0	0
	2	1/1	12/28	222	6/6/77	76	--	8	0
	4	1/1	12/28	360	6/24/77	74	--	5	3
	5	1/1	12/28	229	6/6/77	63	--	3	0
	6	1/1	12/28	241	9/4/77	71	--	10	1
	7	7/13	12/28	118	8/5/77	49	--	0	0
1978	2	1/2	12/28	317	4/8/78	95	1.6	11	1
	4	1/2	12/28	246	10/5/78	67	1.8	7	0
	5	1/2	12/28	169	1/8/78	52	1.6	2	0
	6	1/2	12/28	414	11/4/78	76	2.1	13	2
	7	1/2	12/28	179	4/20/78	57	1.6	1	0
1979	2	1/3	3/16	221	2/14/79	82	1.7	2	0
	4	1/3	6/14	123	6/14/79	50	1.5	0	0
	5	1/3	6/26	92	6/14/79	49	1.4	0	0
	6	1/3	6/8	184	6/8/79	56	1.7	2	0
	7	1/3	6/26	93	6/14/79	51	1.4	0	0

* Station locations are shown in Figure 3-32.

** Federal maximum 24-hour primary standard for particulate is 260 μg/m³, not to be exceeded more than once per year.

Federal 24-hour secondary standard for particulate matter is 150 μg/m³, not to be exceeded more than once per year.

† Annual primary and secondary are 75 μg/m³, respectively (geometric means).

R
R
R
R
R

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TABLE 3-31

INFORMATION ON SUSPENDED PARTICULATE CONCENTRATIONS AS MEASURED BY THE MEMPHIS AND SHELBY COUNTY HEALTH DEPARTMENT IN THE VICINITY OF THE MLGW PLANT

Station Location	1976 Particulate Matter Concentrations (μg/m³)			1977 Particulate Matter Concentrations (μg/m³)			1978 Particulate Matter Concentrations (μg/m³)			1979† Particulate Matter Concentrations (μg/m³)			
	Maximum 24-hour*	2nd Highest 24-hour*	Annual Geometric Mean**	Maximum 24-hour*	2nd Highest 24-hour*	Annual Geometric Mean**	Maximum 24-hour*	2nd Highest 24-hour*	Annual Geometric Mean**	Maximum 24-hour*	2nd Highest 24-hour*	Annual Geometric Mean**	
416 Alabama	205	149	77	200	192	81	Discontinued			Discontinued			R
Post Office	134	131	67	169	149	69	177	146	71	100	87	NA	R
Pine Hill	131	110	57	183	132	66	113	112	64	82	62	NA	R
Gas Service Center	152	144	69	171	168	81	171	152	80	127	107	NA	R
Frayser	142	90	62	154	139	68	170	153	69	115	104	NA	R
King Riverside Park	183	139	71	215	155	80	139	132	79	131	126	NA	R
Fire Station - N. Thomas Street	156	130	78	223	194	86	150	137	73	148	147	NA	R
Sharpe School	175	150	60	184	178	66	134	127	69	96	67	NA	R
Lucy School	122	88	44	147	119	51	Discontinued			Discontinued			R

* Federal maximum 24-hour primary standard for particulate is 260 μg/m³. Federal 24-hour secondary standard for particulate is 150 μg/m³. Both are not to be exceeded more than once per year.

** Annual primary and secondary standards are 75 μg/m³ and 60 μg/m³, respectively (geometric means).

† 1979 particulate matter concentrations available for January 1979 through June 1979. Annual geometric means are not applicable.

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number of times the federal primary (260 $\mu g/m^3$) and secondary (150 $\mu g/m^3$) standards for particulate matter were exceeded. Similar data for the MSCHD sites are presented in Table 3-31. The highest 24-hour particulate concentration for 1978 was 177 $\mu g/m^3$.

A further comparison of TVA, MSCHD and MLGW/EIA particulate data is given in Table 3-32. The MSCHD site chosen for comparison in Table 3-32 was the King Park site because it is located nearest the MLGW/EIA site (Figure 3-32). Two TVA sites were also chosen for comparison because they are located on Presidents Island (as is the MLGW/EIA long-term site), and the particulate concentrations measured at the TVA sites support the designation of Presidents Island as nonattainment for particulates. However, particulate concentrations as measured by MLGW/EIA show no excursions of the federal primary or secondary 24-hour particulate standards on any of the same days that the TVA stations are indicating particulate violations. This is probably because the portion of Presidents Island in the vicinity of the MLGW/EIA site is not as strongly influenced by local major sources of particulate emissions. As discussed above, there was one excursion (no violation) of the 24-hour secondary particulate standard at the MLGW/EIA site on February 14, 1979.

Table 3-33 summarizes MLGW/EIA particulate matter data on a monthly basis. Although federal standards for particulate matter are not applicable to the monthly case, monthly geometric means and geometric standard deviations are presented so seasonal variations of particulate matter may be observed. Geometric means and geometric standard deviations for the periods before site relocation (February to October 1978), after site relocation (November 1978 to June 1979) and for the annual period (July 1978 to August 1979) are also R
presented in Table 3-33. Federal standards are applicable to the annual period.

3.4.3.4 SULFUR DIOXIDE

Sulfur dioxide (SO_2) concentrations were measured with a Meloy Labs Model SA-185 SO_2 analyzer at the interim air quality site for the period February 22,

TABLE 3-32

COMPARISON BETWEEN 24-HOUR PARTICULATE CONCENTRATIONS AS MEASURED BY TVA, MSCHD AND MLGW/EIA (FEBRUARY 1978 TO AUGUST 1979) R

Date	24-Hour Particulate Concentrations (μg/m³) TVA Site* 2	TVA Site* 4	MSCHD King Park Site*	MLGW/EIA Site*	
February 19, 1987	109	62	88	35	
25	72	43	65	40	
March 3, 1978	68	59	68	49	
9	87	68	57	49	
15	97	65	55	48	
21	88	42	77	38	
27	99	79	59	40	
April 2, 1978	(151)**	102	107	111	
8	(234)**	(188)**	144	102	
14	138	LR†	129	57	R
20	77	LR†	60	44	R
26	111	102	87	96	R
May 2, 1978	79	116	129	65	R
8	72	36	82	35	R
14	59	82	64	62	R
20	82	80	84	52	R
26	(194)**	(187)**	132	127	R
June 1, 1978	(155)**	129	(159)†	106	R
8	84	33	54	38	R

* See Figure 3-32 for locations.

** ( ) number exceeded federal 24-hour secondary standard of 150 μg/m³.

† Denotes lost record.

†† ( ) number exceeded federal 24-hour primary standard of 260 μg/m³.

(Continued)

TABLE 3-32 (Continued)

Date	24-Hour Particulate Concentrations (μg/m³) TVA Site* 2	TVA Site* 4	MSCHD King Park Site*	MLGW/EIA Site*	
June 13, 1978	115	(164)**	119	101	R
19	103	69	75	45	R
26	117	LR†	79	65	R
July 1, 1978	124	109	79	78	R
7	145	135	123	78	R
13	112	92	105	62	R
19	124	140	117	92	R
25	74	57	72	39	R
31	88	(164)**	89	74	R
August 6, 1978	82	87	LR†	74	R
12	(182)**	53	59	39	R
18	LR†	72	78	40	R
24	LR†	115	118	43	R
30	56	17	31	43	R
September 5, 1978	116	93	96	115	R
11	93	43	54	33	R
17	124	44	54	32	R
23	81	72	68	62	R
29	(153)**	99	106	89	R
October 5, 1978	(190)††	(201)†	90	61	R
11	(317)††	105	112	54	R

* See Figure 3-32 for locations.

** ( ) number exceeded federal 24-hour secondary standard of 150 μg/m³.

† Denotes lost record.

†† ( ) number exceeded federal 24-hour primary standard of 260 μg/m³.

(Continued)

TABLE 3-32 (Continued)

Date	24-Hour Particulate Concentrations (μg/m³) TVA Site* 2	TVA Site* 4	MSCHD King Park Site*	MLGW/EIA Site*	
October 17, 1978	121	99	87	59	R
23	81	(183)†	121	91	R
29	(153)**	76	67	72	R
November 4, 1978	(212)**	124	139	LR†	R
10	(179)**	75	117	62	R
16	58	40	73	LR†	R
22	91	73	95	55	R
28	LR†	LR†	84	LR†	R
December 4, 1978	61	22	32	70	R
10	100	24	59	77	R
16	54	41	35	57	R
22	131	35	LR†	36	R
28	125	47	LR†	111	R
January 3, 1979	131	25	LR†	102	R
9	75	31	LR†		R
15	(158)**	47	LR†	46	R
21	54	34	LR†	26	R
27	43	LR†	LR†	26	R
February 2, 1979	128	58	113	70	R
8	89	46	LR†	70	R
14	(221)**	83	131	(175)**	R

* See Figure 3-32 for locations.

** ( ) number exceeded federal 24-hour secondary standard of 150 μg/m³.

† Denotes lost record.

†† ( ) number exceeded federal 24-hour primary standard of 260 μg/m³.

(Continued)

TABLE 3-32 (Continued)

Date	24-Hour Particulate Concentrations (μg/m³) TVA Site* 2	TVA Site* 4	MSCHD King Park Site*	MLGW/EIA Site*	
February 20, 1979	103	62	LR†	67	R
26	42	28	LR†	40	R
March 4, 1979	37	19	38	23	R
10	67	LR†	41	51	R
16	72	LR†	126	66	R
22	OL	LR†	79	43	R
28	OL	52	81	126	R
April 3, 1979	OL	54	--	46	R
9	OL	LR†	--	62	R
15	OL	LR†	--	41	R
21	OL	LR†	--	LR†	R
27	OL	LR†	--	LR†	R
May 3, 1979	OL	32	--	57	R
9	OL	52	--	73	R
15	OL	71	--	77	R
21	OL	66	--	51	R
27	OL	62	--	60	R
June 2, 1979	OL	78	--	51	R
8	OL	104	--	132	R

* See Figure 3-32 for locations.

** ( ) number exceeded federal 24-hour secondary standard of 150 μg/m³.

† Denotes lost record.

†† ( ) number exceeded federal 24-hour primary standard of 260 μg/m³.

-- Data not presently available from the corresponding agencies.

OL Denotes TVA site was closed because of the bias from nearby industrial sources. R

(Continued)

TABLE 3-32 (Continued)

Date	24-Hour Particulate Concentrations (μg/m³) TVA Site* 2	TVA Site* 4	MSCHD King Park Site*	MLGW/EIA Site*	
June 14, 1979	OL	123	--	99	R
20	OL	--	--	139	R
26	OL	--	--	LR†	R
July 2, 1979	OL	--	--	LR†	R
14	OL	--	--	71	R
20	OL	--	--	110	R
26	OL	--	--	108	R
August 1, 1979	OL	--	--	45	R
7	OL	--	--	102	R
19	OL	--	--	62	R
25	OL	--	--	63	R

* See Figure 3-32 for locations.

** ( ) number exceeded federal 24-hour secondary standard of 150 μg/m³.

† Denotes lost record.

†† ( ) number exceeded federal 24-hour primary standard of 260 μg/m³.

-- Data not presently available from the corresponding agencies.

OL Denotes TVA site was closed because of the bias from nearby industrial sources. R

TABLE 3-33

AVERAGE MONTHLY PARTCULATE CONCENTRATIONS IN THE VICINITY OF THE PROPOSED IFGDP SITE AS MEASURED BY MLGW/EIA (FEBRUARY 1978 TO AUGUST 1979)

Month	Geometric Mean ($\mu g/m^3$)	Geometric Standard Deviation ($\mu g/m^3$)	
February 1978	36.8	1.0	
March	55.4	1.1	
April	69.6	1.1	
May	61.7	1.1	
June	64.9	1.1	
July	67.6	1.0	
August	46.7	1.0	
September	58.1	1.1	
October	65.8	1.0	
November	58.3	1.0	
December	58.5	1.1	
January 1979	47.7	1.1	
February	73.8	1.5	
March	48.5	1.1	
April	48.5	1.2	
May	56.5	1.1	
June	70.5	1.1	
July	94.1	1.7	R
August	64.9	1.4	R
February to October 1978 (Interim Site)	59.1	1.1	
November 1978 to August 1979 (Long-Term Site)	59.2	1.4	R
September 1978 to August 1979 (Combined Data for Both Sites)	59.8	1.2	R

Note: Federal primary standard for annual particulate concentrations is 75 $\mu g/m^3$ (geometric mean).

Federal secondary standard for annual particulate concentrations is 60 $\mu g/m^3$ (geometric mean).

1978, to May 31, 1978. These measurements were discontinued after May 31, 1978, due to the sufficient number of TVA SO_2 monitoring sites already existing in the area. Table 3-34 summarizes the SO_2 data collected at the interim site for the period. Highest, second highest and third highest 3- and 24-hour concentrations are given. None of the SO_2 concentrations exceeded the federal primary or secondary standards.

Annual average SO_2 concentrations at the TVA sites for 1976, 1977 and 1978 are presented in Table 3-35. All SO_2 concentrations are well below the federal annual standard of 80 $\mu g/m^3$. Although not shown, all 24-hour and 3-hour SO_2 concentrations at the TVA sites were well below the primary and secondary federal standards.

Similar SO_2 data collected by bubbler samplers for 1976 to 1978 at the MSCHD sites will not be presented in this report because it is recognized that bubbler data can not be compared to data obtained from a continuous SO_2 sampler.

3.4.3.5 NITROGEN DIOXIDE

Nitrogen dioxide (NO_2) concentrations were measured by MLGW/EIA with a Meloy Labs Model NA-520 analyzer for the period February 1978 to July 1978 and by a Monitor Labs analyzer Model 8440E for the period July 1978 to September 1979. R
Table 3-36 summarizes the maximum, second highest and third highest 1-, 3- and 24-hour NO_2 concentrations. Table 3-37 presents one-hour and annual average R
NO_2 concentrations as observed by TVA. MLGW/EIA data are in basic agreement with those observed by TVA.

For the annual period July 1, 1978, to June 1979, the annual NO_2 concentration of 30.1 $\mu g/m^3$ was well below federal primary and secondary standards.

3.4.3.6 OZONE

Ozone (O_3) concentrations were measured by MLGW/EIA with a Meloy Labs Model OA-350-2R analyzer beginning in August 1978, and ending in September 1979. R

TABLE 3-34

SUMMARY OF MAXIMUM, SECOND AND THIRD HIGHEST SO_2 CONCENTRATIONS, WITH ASSOCIATED DATES AND TIMES, AS MEASURED BY MLGW/EIA

Month	Maximum Concentration ($\mu g/m^3$) 3-hour	Maximum Concentration ($\mu g/m^3$) 24-hour	Second Highest Concentration ($\mu g/m^3$) 3-hour	Second Highest Concentration ($\mu g/m^3$) 24-hour	Third Highest Concentration ($\mu g/m^3$) 3-hour	Third Highest Concentration ($\mu g/m^3$) 24-hour
February	78 2/27/78 1900	26 2/27/78 1900	78 2/27/78 2000	10 2/26/78 1200	60 2/27/78 2100	10 2/26/78 1300
March	523 3/9/78 1400	214 3/7/78 2000	505 3/7/78 2300	193 3/9/78 0500	497 3/8/78 1000	193 3/9/78 0600
April	505 4/15/78 1100	81 4/15/78 1100	348 4/15/78 1200	65 4/18/78 1600	193 4/19/78 0700	62 4/18/78 1300
May*	471 5/27/78 1100	68 5/26/78 1900	392 5/27/78 1000	68 5/26/78 2000	348 5/30/78 1300	68 5/26/78 2100

* SO_2 monitoring discontinued after May 31, 1978.

Note: Federal primary 24-hour standard for SO_2 is 365 $\mu g/m^3$ and the 3-hour secondary standard is 1300 $\mu g/m^3$, both not to be exceeded more than once per year.

TABLE 3-35

ANNUAL AVERAGE SO_2 CONCENTRATIONS IN THE VICINITY OF THE ALLEN GENERATING PLANT AS MEASURED BY TVA; CORRESPONDING DATA RECOVERY

TVA Site Identification*	1976 SO_2 Concentration ($\mu g/m^3$)	Data Recovery (%)	1977 SO_2 Concentration ($\mu g/m^3$)	Data Recovery (%)	1978 SO_2 Concentration ($\mu g/m^3$)	Data Recovery (%)
1	24	94.7	13	99.8	**	--
3	13	98.5	13	90.2	16	96.7
4	16	98.6	24	96.5	25	96.8
5	11	98.9	11	99.4	13	87.5
6	5	98.9	8	99.3	12	96.5
7	†	†	34	64.5	34	96.1

* See Figure 3-32 for locations.

** SO_2 analyzer removed January, 1978.

† SO_2 analyzer installed May 4, 1977.

Federal annual standard for SO_2 is 80 $\mu g/m^3$.

TABLE 3-36

SUMMARY OF MAXIMUM, SECOND AND THIRD HIGHEST NO_2 CONCENTRATIONS, WITH ASSOCIATED DATES AND TIMES AS MEASURED BY MLGW/EIA

Month	Maximum NO_2 Concentration ($\mu g/m^3$)			Second Highest NO_2 Concentration ($\mu g/m^3$)			Third Highest NO_2 Concentration ($\mu g/m^3$)		
	1-hour	3-hour	24-hour	1-hour	3-hour	24-hour	1-hour	3-hour	24-hour
February	94	82	52	75	60	50	75	41	26
	2/27/78	2/27/78	2/26/78	2/27/78	2/27/78	2/26/78	2/27/78	2/27/78	2/26/78
	1800*	1600	1900	1500	1500	1800	1700	1400	1700
March	85	72	35	85	72	31	75	72	28
	3/30/78	3/29/78	3/6/78	3/30/78	3/29/78	3/6/78	3/2/78	3/30/78	3/14/78
	0000	2200	1800	0300	2300	1900	1600	0000	2000
April	85	75	30	75	66	30	75	66	30
	4/27/78	4/27/78	4/27/78	4/28/78	4/27/78	4/27/78	4/28/78	4/27/78	4/27/78
	2300	2300	0200	0100	2200	0300	2100	2000	0600
May	160	116	60	132	113	60	113	107	60
	5/27/78	5/27/78	5/17/78	5/27/78	5/27/78	5/17/78	5/27/78	5/27/78	5/18/78
	0800	0800	2200	1200	1000	2300	0900	1000	0200
June	93	81	58	84	81	58	84	75	58
	6/3/78	6/3/78	6/2/78	6/18/78	6/18/78	6/2/78	6/19/78	6/19/78	6/2/78
	0300	0100	0800	2300	2300	0900	0000	0000	1000
July	131	103	52	122	81	52	112	81	52
	7/17/78	7/17/78	7/11/78	7/27/78	7/6/78	7/11/78	7/27/78	7/11/78	7/11/78
	0800	1700	0700	1400	1100	0900	1500	2300	1000
August	131	125	43**	122	122	41**	122	103	33**
	8/22/78	8/22/78	8/22/78	8/22/78	8/22/78	8/21/78	8/22/78	8/10/78	8/21/78
	1800	0700	0100	0700	0800	0200	0900	2000	0200

* Times indicate starting hour of the averaging interval during which the concentration occurred, based on a 24-hour clock.

** Automatic analyzer zero and span occurred during the 24-hour period; therefore, 24-hour concentration based upon 24-hours of nonconsecutive data. No federal standards exist for 1-, 3- or 24-hour NO_2 concentrations at the present time.

(Continued)

TABLE 3-36 (Continued)

Month	Maximum NO_2 Concentration ($\mu g/m^3$)			Second Highest NO_2 Concentration ($\mu g/m^3$)			Third Highest NO_2 Concentration ($\mu g/m^3$)		
	1-hour	3-hour	24-hour	1-hour	3-hour	24-hour	1-hour	3-hour	24-hour
September	206	156	53	178	137	49	169	128	42
	9/29/78	9/29/78	9/5/78	9/28/78	9/5/78	9/9/78	9/8/78	9/25/78	9/8/78
	0900*	0800	0000	1000	0700	0000	0900	0700	0000
October	319	253	81	281	243	62	206	171	57
	10/28/78	10/28/78	10/28/78	10/28/78	10/28/78	10/30/78	10/20/78	10/28/78	10/27/78
	0900	0800	0000	0800	0700	0000	1300	0600	0000
November	479	415	211	451	381	134	422	363	104
	11/4/78	11/4/78	11/4/78	11/4/78	11/9/78	11/3/78	11/4/78	11/9/78	11/9/78
	0300	0200	0000	0800	0200	0000	0200	0100	0000
December	498	340	89**	357	328	88**	169	109	87**
	12/17/78	12/17/78	12/17/78	12/17/78	12/17/78	12/17/78	12/18/78	12/17/78	12/17/78
	2200	2200	0700	2300	2100	0500	0000	2000	0400
January	169	137	75**	159	131	74**	150	127	73**
	1/17/79	1/25/79	1/25/79	1/25/79	1/25/79	1/25/79	1/25/79	1/25/79	1/25/79
	1800	1100	1000	1100	2000	1200	2000	1000	1100
February	272	240	93**	253	206	91**	244	189	88**
	2/19/79	2/19/79	2/20/79	2/28/79	2/19/79	2/20/79	2/19/79	2/19/79	2/20/79
	2000	1900	1600	1200	1800	1700	1900	2000	1800

* Times indicate starting hour of the averaging interval during which the concentration occurred, based on a 24-hour clock.

** Automatic analyzer zero and span occurred during the 24-hour period; therefore, 24-hour concentration based upon 24-hours of nonconsecutive data. No federal standards exist for 1-, 3- or 24-hour NO_2 concentrations at the present time.

(Continued)

TABLE 3-36 (Continued)

Month	Maximum NO_2 Concentration ($\mu g/m^3$) 1-hour	3-hour**	24-hour**	Second Highest NO_2 Concentration ($\mu g/m^3$) 1-hour	3-hour	24-hour	Third Highest NO_2 Concentration ($\mu g/m^3$) 1-hour	3-hour	24-hour
March	357 3/26/79 0600*	246 3/26/79 0500	86 3/26/79 0200	253 3/8/79 2200	229 3/8/79 2100	66 3/19/79 1200	226 3/8/79 2300	216 3/8/79 2200	47 3/8/79 1400
April	367 4/16/79 0000	297 4/15/79 2200	92 4/19/79 1200	329 4/20/79 0300	259 4/20/79 0300	75 4/20/79 0200	273 4/15/79 2300	254 4/20/79 0200	
May	404 5/18/79 0100	330 5/18/79 0400	135 5/17/79 0800	357 5/18/79 0500	329 5/18/79 0100	133 5/17/79 0700	348 5/18/79 0400	325 5/18/79 0000	126 5/17/79 0600
June	179 6/1/79 2300	179 6/1/79 2300	105 6/1/79 0700	179 6/2/79 0000	175 6/2/79 0000	94 6/2/79 0600	179 6/2/79 0100	169 6/2/79 0100	56 6/1/79 0500
July††	--	--	--	--	--	--	--	--	--
August	150 8/17/79 0900	135 8/17/79 0800	59 8/17/79 0800	141 8/10/79 0000	116 8/17/79 0900	52 8/23/79 2200	141 8/17/79 1000	94 8/9/79 2200	49 8/20/79 0700
September	169 9/10/79 2100	150 9/10/79 2100	69 9/10/79 2100	141 9/10/79 2200	128 9/10/79 2200	37 9/18/79 2000	141 9/10/79 2300	119 9/10/79 2300	29 9/16/79 1500

Annual Average 30.1†
(July 1978 to June 1979)

* Time indicate the starting hour of the averaging interval during which the concentration occurred, based on a 24-hour clock.

** No federal standards exist for 1- 3- or 24-hour NO_2 concentrations at the present time.

† Federal annual standard for NO_2 is 10 $\mu g/m^3$ (primary and secondary).

†† Analyzer returned to manufacturer for maintenance during month of July.

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TABLE 3-37

SUMMARY OF NO_2 CONCENTRATIONS IN THE VICINITY OF THE ALLEN GENERATING PLANT AS MEASURED BY TVA R

Parameter*	Site**				
	TVA 3	TVA 4	TVA 5	TVA 7	
Maximum 1-hour NO_2 concentration ($\mu g/m^3$)	169	395	226	564	R
Second Highest 1-hour NO_2 concentration ($\mu g/m^3$)	150	357	207	470	R
Annual Average† NO_2 concentration for April 25, 1978, to March 26, 1979 ($\mu g/m^3$)	28	38	32	41	R R

* Period of record for TVA data is April 26, 1978, to March 26, 1979. R

** Site locations are shown in Figure 3-32.

† The only standard for NO_2 in existence at this time is the primary and secondary annual average of 100 $\mu g/m^3$. R R

Table 3-38 summarizes the maximum, second highest and third highest O_3 concentrations as measured by MLGW/EIA and the associated dates and times. On September 6, 1978, April 17, 1979, and August 31, 1979 the federal primary R
and secondary 1-hour standard for ozone (0.12 parts per million) was exceeded at 1700, 1300 and 1500 local time, respectively. This does not constitute R
nonattainment of the ozone standard, as explained in the footnote to Table 3-38.

3.4.3.7 CARBON MONOXIDE

Carbon monoxide (CO) concentrations were measured by MLGW/EIA with a Bendix Model 8501-5CA analyzer during the period from March 1978 to August 1979. R

Maximum, second highest and third highest 1- and 8-hour observed CO concentrations for each month are presented in Table 3-39. Federal 1- and 8-hour standards for CO not to be exceeded more than once per year are 40,000 $\mu g/m^3$ and 10,000 $\mu g/m^3$, respectively. All 1-hour concentrations were below standards. Only once, on March 29, 1978, was the 8-hour standard exceeded. This one excursion of the federal 8-hour CO standard does not constitute nonattainment of the CO standard.

3.4.3.8 TRACE METALS, POLYCYCLIC AROMATIC HYDROCARBONS (PAH), TOTAL ORGANIC CARBON (TOC)

During the period from August 1978 to August 1979, samples for polycyclic R
aromatic hydrocarbons (PAH) and trace metals analysis were taken by MLGW/EIA with the Hi-Vol sampler using specially treated filters. According to EPA procedures on sampling and analysis for screening of industrial effluents for priority pollutants*, trace elements are analyzed by atomic absorption or neutron activation while polycyclic aromatic hydrocarbons were analyzed by gas chromatography.

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* "Sampling and Analysis Procedures for Screening of Industrial Effluent for Priority Pollutants," EPA, April 1977, Effluent Guideline Division.

TABLE 3-38

SUMMARY OF MAXIMUM, SECOND HIGHEST AND THIRD HIGHEST OZONE CONCENTRATIONS, WITH ASSOCIATED DATES AND TIME AS MEASURED BY MLGW/EIA

Month	Maximum* O_3 Concentration $\mu g/m^3$ (ppm) 1-hour	Second Highest O_3 Concentration $\mu g/m^3$ (ppm) 1-hour	Third Highest O_3 Concentration $\mu g/m^3$ (ppm) 1-hour
August 1978	196 (.099) 8/23/78 1700**	186 (.095) 8/23/78 1600	176 (.089) 8/23/78 1400
September	242 (.123) 9/6/78 1700	214 (.109) 9/4/78 1200	214 (.109) 9/4/78 1300
October	167 (.085) 10/22/78 1400	167 (.085) 10/22/78 1500	167 (.085) 10/22/78 1600
November	150 (.076) 11/2/78 1500	120 (.076) 11/2/78 1600	141 (.072) 11/1/78 1300
December	86 (.044) 12/22/78 1400	86 (.044) 12/23/78 0800	78 (.039) 12/22/78 1500
January 1979	80 (.041) 1/28/79 1100	80 (.041) 1/28/79 1200	80 (.041) 1/28/79 1600

* Federal 1-hour ozone standard is 0.12 ppm. For attainment, the number of exceedances per year of this concentration at a given monitor averaged over a 3-year period must be less than or equal to 1.

** Times indicate the starting hour of the averaging interval during which the concentration occurred, based on a 24-hour clock.

(Continued)

TABLE 3-38 (Continued)

Month	Maximum* O_3 Concentration $\mu g/m^3$ (ppm) 1-hour	Second Highest O_3 Concentration $\mu g/m^3$ (ppm) 1-hour	Third Highest O_3 Concentration $\mu g/m^3$ (ppm) 1-hour
February	155 (.079) 2/12/79 1600**	155 (.079) 2/12/79 1700	147 (.075) 2/12/79 1800
March	196 (.100) 3/30/79 2000	128 (.065) 3/28/79 1200	128 (.065) 3/28/79 1300
April	245 (.125) 4/17/79 1300	196 (.100) 4/16/79 1600	186 (.095) 4/16/79 1700
May	226 (.115) 5/29/79 2100	186 (.095) 5/11/79 1600	186 (.095) 5/16/79 1400
June	137 (.070) 6/1/79 1200	137 (.070) 6/1/79 1300	137 (.070) 6/1/79 1400
July	†	†	†

* Federal 1-hour ozone standard is 0.12 ppm. For attainment, the number of exceedances per year of this concentration at a given monitor averaged over a 3-year period must be less than or equal to 1.

** Times indicate the starting hour of the averaging interval during which the concentration occurred, based on a 24-hour clock.

† Analyzer returned to manufacturer for maintenance during month of July.

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R

TABLE 3-38 (Continued)

Month	Maximum* O_3 Concentration µg/m³ (ppm) 1-hour	Second Highest O_3 Concentration µg/m³ (ppm) 1-hour	Third Highest O_3 Concentration µg/m³ (ppm) 1-hour	
August	245 (.125)	235 (.120)	186 (.095)	R
	8/31/79	8/31/79	8/26/79	R
	1500	1600	1700	R
September	167 (.085)	108 (.055)	98 (.050)	R
	9/4/79	9/4/79	9/4/79	R
	1600	1100	1200	R

* Federal 1-hour ozone standard is 0.12 ppm. For attainment, the number of exceedances per year of this concentration at a given monitor averaged over a 3-year period must be less than or equal to 1.

** Times indicate the starting hour of the averaging interval during which the concentration occurred, based on a 24-hour clock.

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TABLE 3-39

SUMMARY OF MAXIMUM, SECOND HIGHEST AND THIRD HIGHEST CARBON MONOXIDE CONCENTRATIONS, WITH ASSOCIATED DATES AND TIMES, AS MEASURED BY MLGW/EIA

Month	Maximum* CO Concentration (μg/m³)		Second Highest CO Concentration (μg/m³)		Third Highest CO Concentration (μg/m³)	
	1-hour	8-hour	1-hour	8-hour	1-hour	8-hour
March 1978	10,300 3/29/78 0600**	10,300 3/29/78 0600	10,300 3/29/78 0700	10,200 3/29/78 0500	10,300 3/29/78 0800	9,730 3/29/78 0400
April	9,100 4/1/78 0100	9,100 4/1/78 0600	9,100 4/1/78 0200	9,000 4/1/78 0500	9,100 4/1/78 0600	8,800 4/1/78 0400
May	2,200 5/16/78 0800	1,200 5/18/78 1700	2,200 5/16/78 0900	780 5/17/78 2200	2,200 5/31/78 1900	715 5/16/78 0800
June	3,400 6/1/78 0400	2,700 6/1/78 0000	2,800 6/1/78 0300	2,700 6/1/78 0100	2,800 6/1/78 0500	2,700 6/1/78 0200
July	2,200 7/18/78 2300	1,200 7/18/78 2200	2,200 7/19/78 2300	1,200 7/18/78 2100	1,700 7/12/78 2200	1,100 7/18/78 2000
August	4,500 8/28/78 2300	3,200 8/28/78 1700	4,000 8/29/78 0700	3,200 8/28/78 1800	3,400 8/28/78 2200	3,200 8/28/78 1900

* Federal 1-hour standard for CO is 40,000 μg/m³, not to be exceeded more than once per year.
Federal 8-hour standard for CO is 10,000 μg/m³, not to be exceeded more than once per year.

** Times indicate the starting hour of the averaging interval during which the concentration occurred, based on a 24-hour clock.

TABLE 3-39 (Continued)

Month	Maximum* CO Concentration (μg/m³) 1-hour	Maximum* CO Concentration (μg/m³) 8-hour	Second Highest CO Concentration (μg/m³) 1-hour	Second Highest CO Concentration (μg/m³) 8-hour	Third Highest CO Concentration (μg/m³) 1-hour	Third Highest CO Concentration (μg/m³) 8-hour
September	2,200 9/7/78 0300**	1,400 9/7/78 0000	2,200 9/8/78 0800	1,400 9/7/78 0100	2,200 9/8/78 0900	1,300 9/6/78 2200
October	4,000 10/28/78 0800	2,200 10/17/78 2200	3,400 10/18/78 0000	2,100 10/17/78 2000	3,400 10/18/78 0100	2,100 10/17/78 2100
November	6,800 11/4/78 0300	4,800 11/4/78 0200	6,200 11/9/78 0400	4,400 11/4/78 0100	5,700 11/4/78 0200	4,200 11/4/78 0300
December	4,500 12/17/78 2200	1,600 12/17/78 1800	4,500 12/17/78 2300	1,600 12/17/78 1900	2,200 12/14/78 0700	1,600 12/17/78 2000
January 1979	1,700 1/12/79 0800	1,000 1/12/79 1100	1,700 1/12/79 1700	1,000 1/12/79 1200	1,100 1/12/79 0900	1,000 1/12/79 1300
February	3,400 2/19/79 0700	1,600 2/19/79 0200	2,800 2/10/79 0100	1,400 2/19/79 0100	2,800 2/19/79 0800	1,400 2/19/79 0300

* Federal 1-hour standard for CO is 40,000 μg/m³, not to be exceeded more than once per year.
Federal 8-hour standard for CO is 10,000 μg/m³, not to be exceeded more than once per year.

** Times indicate the starting hour of the averaging interval during which the concentration occurred, based on a 24-hour clock.

(Continued)

TABLE 3-39 (Continued)

Month	Maximum* CO Concentration (μg/m³) 1-hour	Maximum* CO Concentration (μg/m³) 8-hour	Second Highest CO Concentration (μg/m³) 1-hour	Second Highest CO Concentration (μg/m³) 8-hour	Third Highest CO Concentration (μg/m³) 1-hour	Third Highest CO Concentration (μg/m³) 8-hour	
March	2,860 3/8/79 2200**	1,503 3/8/79 2000	2,860 3/26/79 0600	1,430 3/8/79 2100	2,290 3/8/79 2300	1,290 3/8/79 2200	
April	3,440 4/16/79 0100	2,150 4/15/79 2100	3,440 4/16/79 0200	2,000 4/15/79 2200	2,860 4/16/79 0000	1,790 4/15/79 2300	
May	3,440 5/1/79 2300	1,790 5/17/79 2300	2,860 5/2/79 0000	1,650 5/1/79 2200	2,290 5/2/79 0100	1,500 5/1/79 2300	
June	2,290 6/27/79 0100	1,430 6/26/79 0000	2,290 6/27/79 0200	1,430 6/26/79 0100	2,290 6/27/79 0300	1,290 6/27/79 0300	
July	1,145 7/9/79 2100	572.5 7/9/79 2100	1,145 7/9/79 2200	429.4 7/9/79 2200	1,145 7/9/79 2300	286.3 7/9/79 2300	R R R
August	1,145 8/23/79 0100	715 8/23/79 0000	1,145 8/23/79 0200	644 8/23/79 0100	1,145 8/23/79 0300	500 8/23/79 0300	R R R

* Federal 1-hour standard for CO is 40,000 μg/m³, not to be exceeded more than once per year.
Federal 8-hour standard for CO is 10,000 μg/m³, not to be exceeded more than once per year.

** Times indicate the starting hour of the averaging interval during which the concentration occurred, based on a 24-hour clock.

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Table 3-40 gives the results of analysis of the filters for trace elements. These concentrations, as measured by MLGW/EIA, indicate that relatively high ambient concentrations of iron (Fe), lead (Pb), titanium (Ti) and zinc (Zn) exist in the area. This may be attributable to industrial activities in the vicinity. There are no ambient air quality standards for these trace elements except for lead which is 1.5 $\mu g/m^3$ (arithmetic mean) averaged over a calendar quarter. It is apparent from Table 3-40 that the average lead concentrations for the three quarters of the MLGW/EIA sites are well below this standard.

Polycyclic aromatic hydrocarbons are classified as potentially hazardous atmospheric pollutants. Table 3-41 presents the polycyclic aromatic hydrocarbons concentrations measured by MLGW/EIA. In 13 of the 16 cases, no polycyclic aromatic hydrocarbons were found. Three cases yielded small concentrations which may also be attributable to industrial activity in the area. Presently, there are no federal standards for polycyclic aromatic hydrocarbons.

Total organic carbons are another indication of potentially hazardous atmospheric pollutants. Concentrations of total organic carbon (TOC), as measured by MLGW/EIA, are presented in Table 3-42. It is noted that the total organic carbons concentrations were slightly higher during November and December 1978, the same months when polycyclic aromatic hydrocarbons concentrations were also detected.

The higher concentrations of total organic carbons may be related to natural sources (vegetation), industrial activity and/or the site relocation that took place in early November. No federal standards presently exist for total organic carbons.

3.4.3.9 SULFATES

Although no federal standards presently exist, atmospheric sulfates are under study by the EPA as a threat to human health and welfare. Atmospheric sulfates are generally a "secondary" pollutant. Secondary pollutants are formed through

TABLE 3-40

TRACE ELEMENT CONCENTRATIONS AS MEASURED BY MLGW/EIA

Date	Trace Element Concentrations ($\mu g/m^3$)												
	Cr	Co	Fe	Hg	Pb	Mn	Ni	Ti	V	Zn	As	Be	Cd
August 1978													
15-16	0.0006	0.003	0.025	<0.002	0.01	0.0002	0.0	<2.1	<0.009	0.0	0.0	0.0	0.0
26-27	0.002	0.003	0.43	<0.002	0.17	0.013	0.0	<2.1	<0.009	0.0	0.0	0.0	0.0
September													
7-8	0.0001	0.003	0.39	<0.002	1.28	0.013	0.001	<2.1	<0.02	0.0	0.0	0.0	0.002
26-27	0.001	0.005	0.86	<0.002	0.17	0.02	0.013	<1.7	<0.009	0.0	0.0	0.0	0.0
October													
2-3	0.0	<0.001	0.67	<0.002	0.08	0.006	0.0	<1.1	0.0	3.07	0.005	0.0	0.004
13-14	0.0	0.001	0.43	<0.007	0.05	0.009	0.02	<1.1	0.0	1.53	0.022	0.0	0.003
25-26	0.0	<0.001	0.89	<0.006	0.06	0.146	0.0	<1.1	0.002	0.31	0.0003	0.0	0.002
November													
1-2	0.0	0.001	1.04	<0.002	1.03	0.022	0.0	<1.1	0.007	3.07	0.0	0.0	0.009
December													
1-2	0.0	0.004	0.70	0.005	0.73	0.014	0.004	2.2	0.008	1.2	0.011	0.0002	0.002
12-13	0.0	0.005	1.26	0.004	0.11	0.012	0.009	2.2	0.008	0.0	0.038	0.0002	0.0001
January 1979													
30-31	0.01	<0.006	<0.27	<0.01	0.12	0.002	0.0003	<1.1	<0.002	3.3	<0.0003	0.0	0.0
February													
6-7	0.007	<0.001	<0.27	<0.001	0.17	0.013	0.029	<1.1	<0.002	1.5	0.0	0.0	0.0
17-18	0.022	0.001	0.29	<0.002	0.12	0.019	0.002	<0.13	0.0	15.6	<0.002	0.002	0.0
March	--	--	--	--	--	--	--	--	--	--	--	--	--
April													
18-19	0.018	0.002	<0.15	<0.002	1.8	0.043	0.087	<0.51	0.0	15.9	0.0	0.0	0.004

-- Denotes results from the laboratory have not been received yet due to an oversight on their part.

TABLE 3-40 (Continued)

Date	Trace Element Concentrations ($\mu g/m^3$)													
	Cr	Co	Fe	Mg	Pb	Mn	Ni	Tl	V	Zn	As	Be	Cd	
May														
5-6	0.007	0.001	<0.12	<0.002	0.21	0.013	0.007	<0.48	0.0	15.9	0.001	0.0	0.005	
16-17	0.017	0.002	<0.12	<0.002	2.4	0.049	0.079	<0.54	0.0	15.3	0.0	0.0	0.005	
June														
5-6	0.03	0.004	<0.12	<0.005	0.31	0.0	0.02	<0.51	0.0	15.0	0.02	0.0	0.0	
16-17	0.013	0.003	1.3	<0.001	0.06	0.02	0.0	1.4	0.005	15.3	0.009	0.0	0.0	R
July														
4-5	0.06	0.002	0.77	0.001	0.13	0.039	0.0	1.2	0.008	7.7	0.006	0.0	0.001	R
17-18	0.01	0.001	0.95	0.003	0.14	0.011	0.0	1.7	0.005	13.2	0.0	0.0	0.0	R
August														R
4-5	0.03	0.002	3.6	<0.001	0.24	0.02	0.0	<0.005	1.83	13.2	0.005	0.0	0.00	R

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TABLE 3-41

POLYCYCLIC AROMATIC HYDROCARBON CONCENTRATIONS
AS OBSERVED BY MLGW/EIA

Sampling Date	Polycyclic Aromatic Hydrocarbon Concentration ($\mu g/m^3$)	
August 20-22, 1978	ND*	
September 13-15, 1978	ND	
September 19-21, 1978	ND	
October 7-9, 1978	ND	
November 12-14, 1978	Fluoranthene	7.7×10^{-5}
	Pyrene	7.7×10^{-5}
	Phenanthrene Anthracene	9.2×10^{-5}
	Benzo(a) Anthracene	2.7×10^{-4}
	Benzo(K) Anthracene	2.2×10^{-4}
	Benzo(a) Pyrene	1.0×10^{-4}
November 24-26, 1978	Fluoranthene	2.7×10^{-4}
	Pyrene	2.7×10^{-4}
	Phenanthrene Anthracene	2.2×10^{-4}
	Benzo(a) Anthracene	7.2×10^{-4}
	Benzo(K) Anthracene	5.5×10^{-4}
	Benzo(a) Pyrene	2.7×10^{-4}
December 6-8, 1978	Fluoranthene	2.2×10^{-4}
	Pyrene	1.9×10^{-4}
	Phenanthrene Anthracene	1.6×10^{-4}
	Benzo(a) Anthracene	3.1×10^{-4}
	Benzo(K) Anthracene	5.5×10^{-4}
	Benzo(a) Pyrene	2.7×10^{-4}
December 19-21, 1978	ND	
January 30-February 1, 1979	ND	

* ND = None Detected

(Continued)

TABLE 3-41 (Continued)

Sampling Date	Polycyclic Aromatic Hydrocarbon Concentration (μg/m3)	
February 10-12, 1979	ND*	
February 22-24, 1979	ND	
March 6-8, 1979	ND	
April 11-13, 1979	ND	
April 23-25, 1979	ND	
May 11-13, 1979	ND	
May 23-25, 1979	ND	
June 10-12, 1979	ND	R
June 28-30, 1979	ND	R
July 10-12, 1979	ND	R
July 28-30, 1979	ND	R
August 9-11, 1979	ND	R

* ND = non-detected

TABLE 3-42

TOTAL ORGANIC CARBON CONCENTRATIONS
AS OBSERVED BY MLGW/EIA

Sampling Date	Total Organic Carbon Concentration ($\mu g/m^3$)
August 15-16, 1978	15.8
August 26-27, 1978	51.2
September 7-8, 1978	38.1
September 26-27, 1978	51.2
October 2-3, 1978	20.4
October 13-14, 1978	34.3
October 25-26, 1978	29.9
November 1-2, 1978	29.6
November 7-8, 1978	61.7
November 12-14, 1978	47.3
November 24-26, 1978	96.3
December 1-2, 1978	81.4
December 6-8, 1978	57.8
December 12-13, 1978	76.2
December 18-20, 1978	21.0
January 30-31, 1979	34.6

physical and chemical transformation of primary pollutants in the atmosphere. In the case of sulfates, SO_2 is the primary pollutant.

Sulfates as measured by MLGW/EIA are given in Table 3-43. These sulfate concentrations were determined from filters used during the Hi-Vol sampling for total suspended particulates.

The highest 24-hour concentration of sulfate measured by MLGW/EIA was 33.1 $\mu g/m^3$. This concentration, however, can not be compared with any applicable federal air quality standards since no such standards exist.

3.4.3.10 SUMMARY

The proposed plant site is located within an officially designated attainment R
area for particulate matter. Nearby Presidents Island is presently designated R
nonattainment for particulate matter.[11] However, the Memphis and Shelby R
County Health Department is in the process of requesting that EPA designate R
Presidents Island as unclassifyable on the basis that the bulk of the particu- R
lates are from nontraditional sources (fugitive dust and reentrained dust). R
TVA monitoring sites located on Presidents Island show violations of the R
primary and secondary 24-hour NAAQS at their respective locations. However, R
particulate concentrations measured by MLGW/EIA at the long-term monitoring R
site (located on the southern portion of Presidents Island) show only one ex- R
cursion over the secondary 24-hour NAAQS. The exact origin of the particulate R
matter for this day (whether anthropogenic or native soil) is not clear at R
this time. In either case, the NAAQS allow one excursion above the 24-hour R
standard and therefore no violation has been noted by the MLGW/EIA monitoring R
program. Thus, the MLGW/EIA data warrant consideration to reclassify a repre- R
sentative portion of Presidents Island near the site to attainment status for R
particulate matter. R

All areas of Shelby County, within the range of significant impact of the R
proposed plant, are in attainment for carbon monoxide.[11] The area which R

TABLE 3-43

TWENTY-FOUR HOUR CONCENTRATIONS OF SULFATES
AS MEASURED BY MLGW/EIA

Collection Date	24-Hour Sulfate Concentration ($\mu g/m^3$)	
5/8/78	11.3	
5/20/78	12.9	
6/1/78	14.7	
6/13/78	14.1	
7/7/78	15.3	
7/19/78	23.1	
8/6/78	28.3	
9/11/78	9.0	
9/23/78	19.2	
11/22/78	20.9	
11/28/78	9.0	
12/22/78	7.3	
1/21/79	12.4	
1/27/79	13.5	
2/8/79	19.6	
2/14/79	33.1	
2/26/79	11.0	
3/16/79	12.9	
4/3/79	17.2	
4/9/79	4.3	
5/9/79	14.1	
5/21/79	21.5	
6/8/79	14.7	
6/20/79	19.6	
7/2/79	14.1	R
7/20/79	36.2	R
8/7/79	29.7	R
8/25/79	14.1	R

is nonattainment for carbon monoxide is the area within the perimeter express- R
ways. The MLGW/EIA monitoring program noted an excursion is permitted under R
the NAAQS for carbon monoxide, and therefore this one excursion does not R
constitute a violation. EIA data for carbon monoxide are therefore in agree- R
ment with the current attainment designation of the area for carbon monoxide. R

All of Shelby County is officially designated to be in nonattainment status R
for ozone.[11] Ambient air quality monitoring by MLGW/EIA has indicated that R
the 1-hour NAAQS for ozone is being exceeded at the monitoring site. However, R
these excursions do not constitute a violation of the 1-hour NAAQS since, at R
this time, it cannot be demonstrated that the expected number of excursions R
(concentrations greater than 0.12 ppm) at the site averaged over a three-year R
period is greater than one per year. Therefore, concentrations of ozone R
measured to date by MLGW/EIA would neither support nor refute the present R
nonattainment designation of this area of Shelby County for ozone. R

MLGW/EIA measurements of short-term sulfur dioxide concentrations and long- R
term sulfur dioxide and nitrogen dioxide concentrations are well within the R
applicable NAAQS. These data are in agreement with the current attainment R
status for all of Shelby for these pollutants.[11] R

There are no NAAQS for trace constituents except for lead. Average lead R
concentrations for the three calendar quarters measured at the MLGW/EIA sites R
are well within this standard.[11] R

3.5 NOISE

3.5 AMBIENT NOISE

An assessment of ambient sound levels in the vicinity of the Memphis Industrial Fuel Gas Demonstration Plant was conducted August 11 to 14, 1978. August was selected to represent the fair weather period when outdoor activities are common. Sound level measurements were made at nine locations in the plant site vicinity. The locations are shown in Figure 3-33. Location 1, the Chucalissa Indian Village Reconstruction, is 1.9 miles southeast of the plant site and represents the nearest recreational area. This location has a direct line of sight to the plant site. Location 2 is on the levee west of the T. E. Maxson Wastewater Treatment Plant, 0.6 mile south of the site. Location 3 is at the Wilbur Johns Farming Camp, 1.1 miles south of the site, and represents the nearest permanently inhabited dwelling. Location 2 is in a direct line from the plant site to location 3 and was chosen as a means to ascertain any effects the levee may have on noise from the plant site reaching location 3 and to indicate the degree of attenuation with distance. Location 4 is in the parking area of the CB&I Nuclear Company, 1 mile northeast of the site, and is the nearest developed area on Presidents Island where a substantial number of people could be affected. Location 5 is approximately 100 feet to the east of the T. E. Maxson Wastewater Treatment Plant parking lot, 0.6 mile south-southeast of the site. This location is between the treatment plant and the Allen Generating Plant and was chosen to determine the combined noise effects of the two plants. Locations 6, 7, 8 and 9 are on higher ground (i.e., the road) at the approximate midpoints of the sides of the property boundary.

Sound measurements were made with a precision grade (American National Standards Institute, Type 1) instrument in a manner consistent with good field measurement practices. The omni-directional microphone was located approximately 4 feet above the ground when measurements were made. All measurements were made on the "slow" meter scale under calm wind conditions. Measurements were taken on the A-weighted scale,* the C-weighted scale and the flat (unweighted

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* Noise levels have the units of decibels (dB) re: $20\mu N/m^2$. The A-weighted values are designated dBA. The A-weighted scale modifies the true sound spectrum in a prescribed manner to give a response that simulates that of the human ear.

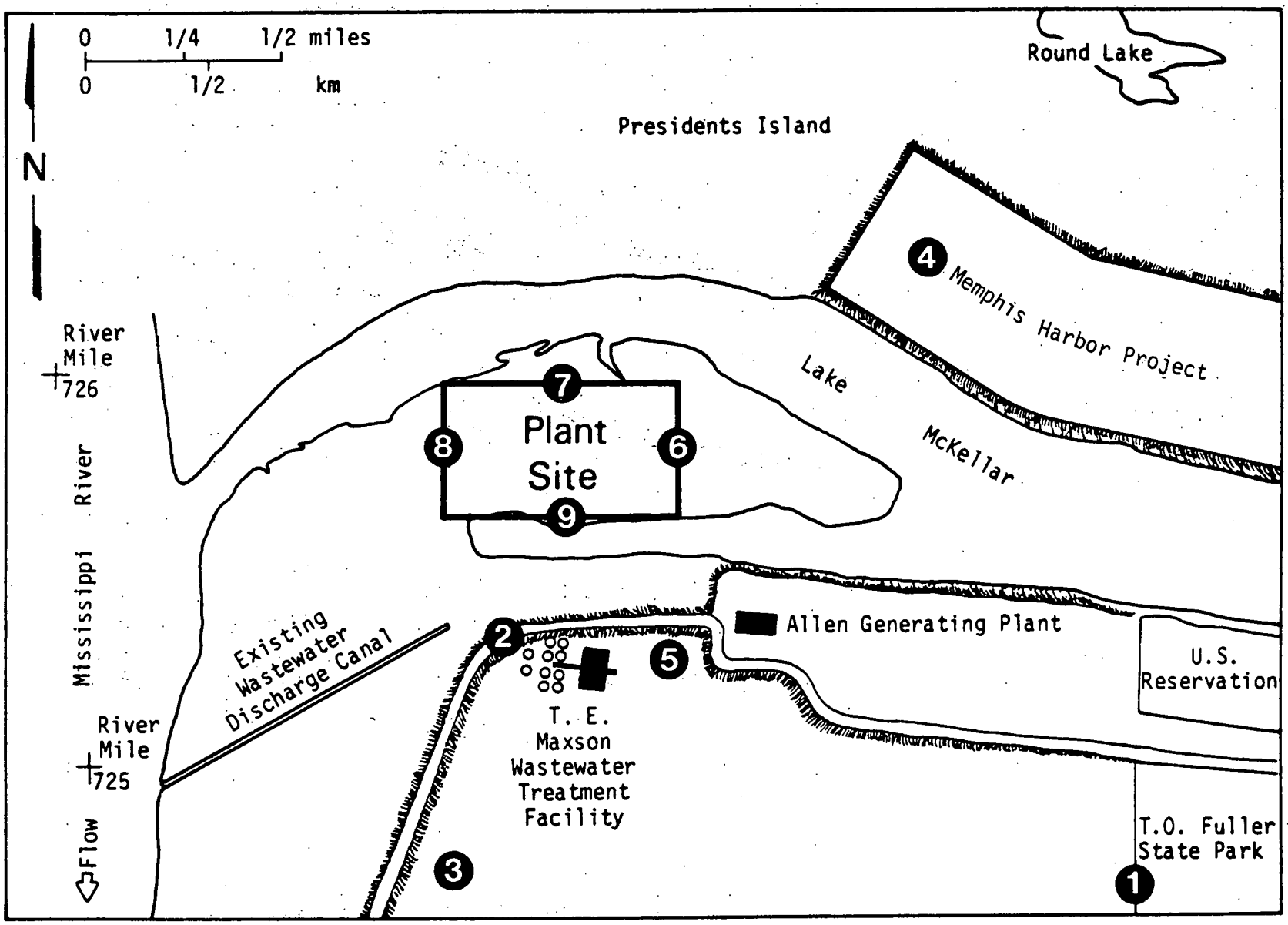

Figure 3-33. Sound Level Measurement Locations

or linear) scale. At each location, the A-weighted sound levels were recorded at 15-second intervals over a minimum time period of 15 minutes. At the beginning and end of each observation period, the flat and C-weighted levels were measured. Comparisons of the differences between the A-weighted and the flat and C-weighted levels were used to verify: (1) that excessive wind speeds were not present and (2) that the background noise spectrum had not changed significantly over the period of measurement.* Measurements were taken on four occasions - once in the daytime and once in the nighttime, both during the week and on the weekend. Daytime is defined as 7:00 a.m. to 7:00 p.m., and nighttime is defined as 7:00 p.m. to 7:00 a.m. Daytime measurements were made when the average wind speed was less than 10 miles per hour, and nighttime measurements were made when the average wind speed was less than 5 miles per hour.

Average ambient noise levels measured at each location are presented in Table 3-44. These levels were determined by taking a weighted average of all measured values over the 15-minute time period. Table 3-44 also includes maximum levels of intermittent noises, the sources observed at each location and the maximum daytime and nighttime wind speeds measured at each location. These levels are included in the average ambient noise levels, but since the occurrences of these levels were of short duration, they did not contribute significantly to the average values.

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* The A-weighted scale strongly attenuates low frequency noise; whereas, the C-weighted scale provides only modest low frequency attenuation. Hence, the differences between the A-weighted and the flat and C-weighted levels provide measure of the amount of noise present in the low frequency region. Since wind noise is predominantly a low frequency phenomenon, this comparison is an effective means to evaluate the wind speed effects on the measured noise. In general, large differences between the A-weighted and the flat and C-weighted levels are indicative of high wind speeds; small differences are indicative of low wind speeds. Differences between the flat and C-weighted scales at the beginning and end of the observation period indicate whether the frequency content of the noise signal has changed significantly.

TABLE 3-44

AMBIENT NOISE LEVELS AND MAXIMUM WIND SPEEDS

Location	Average Noise Levels (dBA re: 20 μN/m²) Weekday Day	Weekday Night	Weekend Day	Weekend Night	Maximum Noise Levels (dBA re: 20 μN/m²) Source	Level	Maximum Wind Speeds (mph) Day	Night
1	54	56	55	56	Train	67	6	1
2	53	53	53	57	Traffic	64	4	1
					Airplane	66		
					Insects	64		
3	49	51	46	42	Airplane	61	4	5
					Animals	65		
4	56	43	52	56	Traffic	61	4	5
5	58	60	59	53	Airplane	63	4	1
6	59	76	66	70	Airplane	64	3	4
					Barge	74		
					Insects	78		
7	57	63	62	62	Barge	66	1	4
8	56	59	57	58			1	1
9	67	58	62	57	Traffic	68	5	1
					Airplane	69		

3.5.1 NOISE GUIDELINES

No existing state or local noise regulations affect the proposed plant site. Noise guidelines have been published for use in cases where no such regulations exist; these are presented in Tables 3-45 and 3-46. These guidelines can be used to interpret the data in Table 3-44. Steady state sound level values in Table 3-45 are consistent with recommendations in both the United States and Europe.[1] If a sound is present for only a portion of the time, as in the case of passing trains, then the values in Table 3-45 may be increased by the amounts shown in Table 3-46. Table 3-47 presents a comparison between familiar sounds and their associated noise levels, measured in dBA.

3.5.2 DESCRIPTION OF THE EXISTING ENVIRONMENT

The background ambient noise at all locations, except location 4, consisted primarily of insect noises and a steady hum from the Allen Generating Plant. The nighttime insect noise levels on the eastern site boundary (location 6) were extremely high (averages of 76 and 70 dBA). These values probably represent about the highest expected naturally caused background noise levels at this site. The background ambient noise at location 4 originated from industrial processes at the CB&I Nuclear Company Plant. Background noises from the T. E. Maxon Wastewater Treatment Plant were discernable at locations 2 and 5. Earthmoving equipment had an effect on background daytime noise levels observed at locations 6 and 9. A passing barge raised background levels at locations 6 and 8.

Based on the guidelines in Table 3-45 and the data in Table 3-44, all nine locations can be classified as suburban-urban during the daytime, on both weekdays and weekends. The nighttime levels tend to be in the urban-industrial-heavy industrial range. However, the guidelines do not account for natural noise sources such as insects, whose noises are seasonal and are generally accepted. Hence, the nighttime levels at the site can be characterized as being in the urban range (based on observed levels not dominated by the insect

TABLE 3-45

GUIDELINES FOR COMMUNITY NOISE LEVELS[2]

Area	Sound Level (dBA re: 20 μN/m^2) Day*	Night	Other
Rural (residential)	50	40	45
Suburban (residential) also hospital, church and similar zones	55	45	50
Urban (residential) also apartment	60	50	55
Urban (residential) with some commerical, retail or light industry	65	55	60
Predominantly industrial	70	60	65
Heavy industrial, few dwellings	75	65	70

* "Day" represents the period 0700 to 1700 hours on weekdays and "night" 2200 to 0700 hours. "Other" includes 1700 to 2200 hours and on weekends and holidays 0700 to 1700 hours.

TABLE 3-46

COMMUNITY NOISE LEVEL LIMITS FOR NOISE PRESENT ONLY A PORTION OF THE TIME PERIOD UNDER CONSIDERATION[2]

Time Present (%)	Amount of Level Increase (dB)
1	15
2	15
3	15
4	14
5	13
8	11
10	10
20	7
30	5.5
40	3.9
50	2.8
80	1.0
100	0

TABLE 3-47

SOUND LEVELS AND HUMAN RESPONSE[3]

	NOISE LEVEL (dBA)	Response	Hearing Effects	Conversational Relationships
	150			
CARRIER DECK JET OPERATION	140			
		PAINFULLY LOUD	CONTRIBUTION TO HEARING IMPAIRMENT BEGINS	
	130	LIMIT AMPLIFIED		
		SPEECH		
JET TAKEOFF (200 feet) DISCOTHEQUE	120			
AUTO HORN (3 feet)		MAXIMUM VOCAL EFFORT		
RIVETING MACHINE	110			
JET TAKEOFF (2000 feet)				SHOUTING IN EAR
GARBAGE TRUCK	100			
N.Y. SUBWAY STATION		VERY ANNOYING		
		HEARING DAMAGE		SHOUTING AT 2 FT.
HEAVY TRUCK (50 feet)	90	(8 hours)		
PNEUMATIC DRILL (50 feet)				VERY LOUD CONVERSATION, 2FT.
	80	ANNOYING		
ALARM CLOCK FREIGHT TRAIN (50 feet)				LOUD CONVERSATION, 2FT.
	70	TELEPHONE USE		
FREEWAY TRAFFIC (50 feet)		DIFFICULT		
		INTRUSIVE		LOUD CONVERSATION, 4FT.
AIR CONDITIONING UNIT (20 feet)	60			
		QUIET		NORMAL CONVERSATION, 12FT.
LIGHT AUTO TRAFFIC (100 feet)	50			
LIVING ROOM BEDROOM LIBRARY	40			
SOFT WHISPER (15 feet)	30			
BROADCASTING STUDIO	20			
		JUST AUDIBLE		
	10			
		THRESHOLD OF HEARING		
	0			

noises). The highest nighttime levels were found at the plant boundary locations, which are the areas least disturbed by human activity and most likely to have the greatest concentration of insects. Several of the significant background noise sources operate continuously (e.g., the Allen Generating Plant and the T. E. Maxson Wastewater Treatment Plant), producing essentially a constant noise level. As a consequence, there are smaller variations in the background noise levels between weekday and weekend, and day and night than otherwise would be expected.

3.6 TERRESTRIAL ECOLOGY

Ecological components of the terrestrial systems found on and near the Industrial Fuel Gas Demonstration Plant (IFGDP) site are described in detail in the following sections. Section 3.6.1 describes the vegetation of the site and surrounding area. In Section 3.6.2, the components of the wildlife habitats are described. Technical details and tables that are too lengthy for inclusion in the text are presented in Appendix 3D. Metric units may be converted to English units by using conversion factors in Table 3D-1, Appendix 3D.

Terrestrial ecological field surveys were conducted in four seasons beginning in May and ending in December of 1978. Field surveys included systematic investigations of vascular plants, amphibians and reptiles in the three warm seasons and of mammals and birds in all four seasons. Details of field investigations are included in Appendix 3D. Field investigations for vascular plants included evaluation of plots for trees, saplings, shrubs and herbs in each habitat type and searches for species present in each habitat type. Mammal field investigations included spring, summer, fall and winter small mammal live trapping in successional bottomland forest and meadow vegetation types (the two habitats on the site) and searches for tracks, nests, rubbings, scats and sightings in all habitats. Bird, amphibian and reptile investigations included observations along transects in successional bottomland forest and meadow and searches for sightings, nests and calls in all site habitats. Field surveys were as follows: spring, May 1 to 9; summer, July 17 to 21; fall, October 10 to 17; and winter, December 14 to 19.

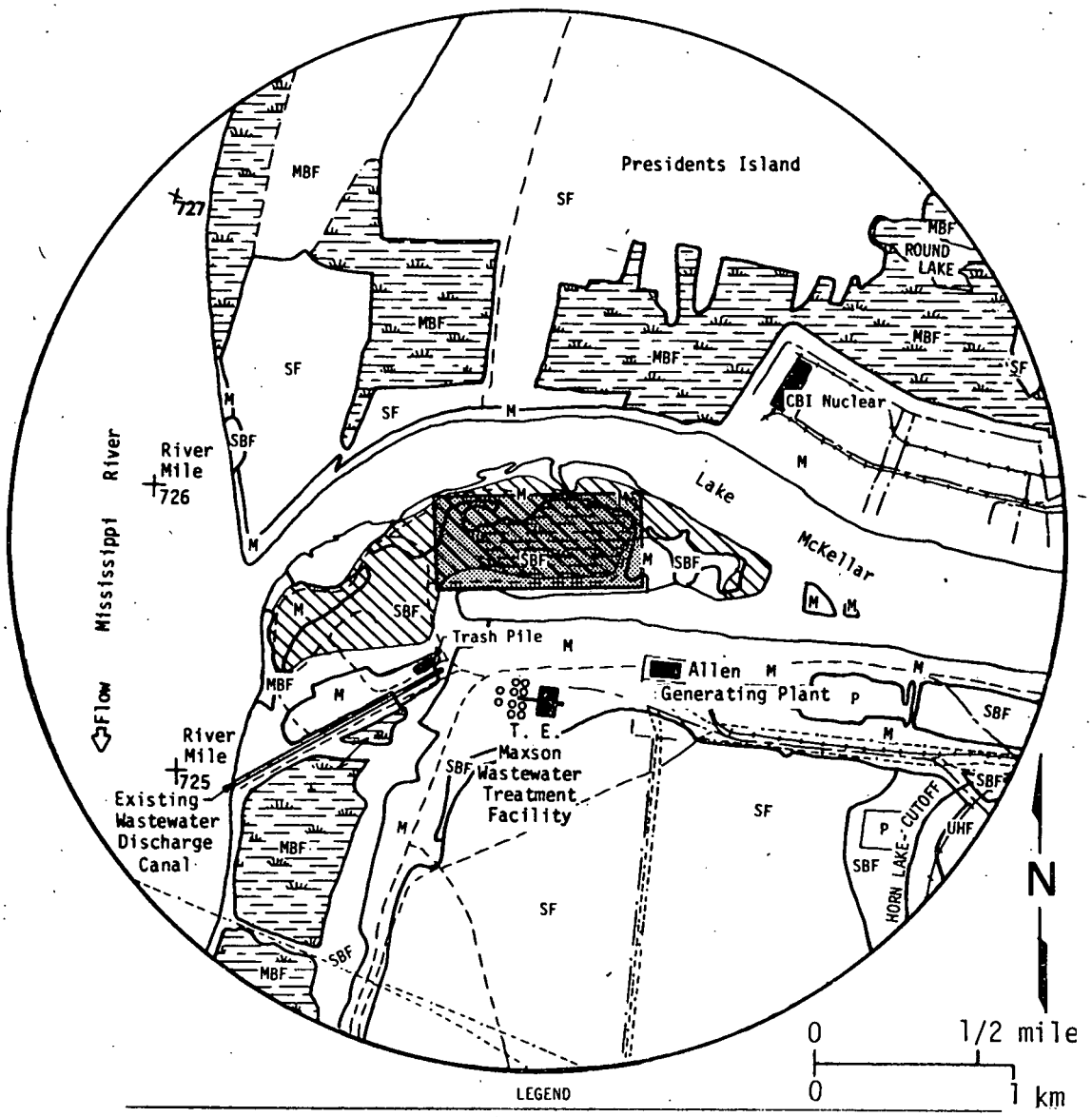
Vegetation in the local region consists of soybean cultivated fields, black willow successional forest, boxelder-sugarberry mature forest and herbaceous meadow on the Mississippi River floodplain. The Memphis bluffs bordering the floodplain on the east, 3 kilometers (km) from the site, are vegetated with mixed mesophytic forest, which is more characteristic of the mountains of central and eastern Tennessee.[1] The floodplain contains numerous poorly drained, elongated depressions that contain standing water in the winter and spring either from rainfall or Mississippi River flooding. Floodplain topography ranges from normal pool river elevation of 56 meters (185 feet) above

mean sea level (msl) to 73 meters (240 feet) above mean sea level.[2] The Memphis bluffs reach an elevation of 96 meters (315 feet) about 3.3 kilometers (2.1 miles) southeast of the site. Rooting substrates for local vegetation are sandy to clayey unconsolidated materials (see Section 3.2). Soybean fields and local industrial developments to the east and south of the site are either surrounded by a levee or built on dredge fill to prevent flooding. The Mississippi River, during the field survey period, was observed to range in elevation above mean sea level from approximately 62 meters (204 feet) in late December, to 58 meters (197 feet) in May and July and a low of 55 meters (180 feet) in October.

Annually in late September, the U.S. Army Corps of Engineers dredges the channel connecting Lake McKellar to the Mississippi River and hydraulically pumps the sediment onto the site peninsula west of the site which is shown in Figure 3-34. Water flows eastward across the site through flow control structures back to Lake McKellar. Sediments in the water settle out during this sluggish flow and in the process increase the elevations of the site and bury herbaceous vegetation. From the 1978 dredging operation, depth of sediment deposition ranged from 1 meter, 1.4 kilometers west of the site, to only a few milimeters on the site near the outfall to Lake McKellar, at the inlet on the north site border (Figure 3-34). In the summer of 1979, a large R
depression approximately 400 feet long and 30 feet deep was excavated in meadow R
and successional bottomland forest near the Mississippi River on the site pen- R
insula for use as a dredge sediment basin. Excavated material was used to R
expand the T.E. Maxson Wastewater Treatment Facility. R

3.6.1 TERRESTRIAL VEGETATION

Section 3.6.1.1 includes a general description of vegetative resources in a region within 3 kilometers of the site. Sections 3.6.1.2 through 3.6.1.6 include descriptions of specific vegetation types in the region based on field studies and published literature.[1-10] The topics of endangered species and sensitive areas are covered in Section 3.6.1.7 and are based on published literature.[11-14] A vegetation map (Figure 3-34) for the region covering a radius of 3 kilometers from the IFGDP site is based on visual



LEGEND

SF - Soybean Field

M - Meadow

SBF- Successional Bottomland Forest (Black willow, leading dominant)

MBF- Mature Bottomland Forest (Boxelder and sugarberry, leading dominant)

UHF- Upland Hardwood Forest (Minor Type) (Mixed oaks, hickories and tulip poplar)

P - Pond

Plant

Wetland

Dredge Spoil

Buried Gas Pipeline

Electrical Transmission Line

Surfaced Highway

Trail

Railroad

Figure 3-34. Vegetation Types Within 3 Kilometers of the IFGDP Site Center

observations from the ground and airplane[15-19] and on standard U.S. Geological Survey maps.[2,3] A radius of 3 kilometers was chosen to adequately characterize local habitats within the area of expected facility impact.

3.6.1.1 REGIONAL VEGETATION

Vegetation within 3 kilometers of the IFGDP site is typical of the region. Vegetation types, identified and mapped in Figure 3-34, include soybean field, herbaceous meadow, black willow successional bottomland forest and boxelder-sugarberry mature bottomland forest. A tiny piece of upland hardwood forest occurs 3 kilometers southeast of the site and is too small to treat separately. Data from the 1978 terrestrial surveys provide the input for these descriptive sections. Selected characteristics of the four sampled vegetation types that dominate this region are given in Table 3-48. Species observed during baseline monitoring are listed in Appendix 3D, Table 3D-2. A total of 226 plant taxa were observed within 3 kilometers of the site including 26 trees, 41 shrubs and vines and 160 grasses and forbs.

Vegetation on the Mississippi River floodplain and terraces gradually changes in response to river flooding and stream course changes. The river transports huge quantities of sediments suspended in the water and as bedload along the bottom. Portions of this sediment load are deposited in slack water on stream bends and on the floodplain during flooding. In this process, the river slowly builds the nearby land surface in the form of linear strips of higher land separated by narrow depressions termed sloughs. Much of the higher topography has been cleared by man for soybean fields. Land unsuitable for agriculture has been developed into industrial sites on which vegetation is periodically mowed, has been allowed to remain in forest or has been cleared and allowed to again develop into forest.

Forest development on the Mississippi River floodplain near Memphis begins as black willow or cottonwood forest on newly deposited sandy soil. Through the process of sediment deposition and natural succession, the land surface is topographically raised, and the forest develops into one dominated by shade tolerant species on better drained sites or pecan-bald cypress swamp forest in sloughs.

TABLE 3-48

SELECTED CHARACTERISTICS OF VEGETATION TYPES WITHIN 3 KM OF THE IFGDP SITE

Characteristic	Soybean Field	Meadow	Bottomland Forest	
			Successional	Mature
Topographic Slope (%)	0.5 (0 to 2)*	10.0 (2 to 25)	2.0 (0 to 5)	1.5 (0 to 3)
Spring Leaf Litter Depth (cm)	0.0 (0.0 to 0.1)	0.4 (0.0 to 6.0)	0.4 (0.0 to 0.5)	0.5 (0.0 to 1.5)
Canopy Height (m)	0.8 (0.2 to 1.0)	0.1 (0.08 to 0.25)	25.4 (15.2 to 33.5)	22.5 (18.0 to 29.3)
Strata (% Cover)				
Canopy - Large Trees	--	--	44 (25-75)	89 (85-95)
Subcanopy - Small Trees	--	4 (0-15)	35 (0-75)	30 (0-65)
Shrub	--	3 (0-10)	20 (0-49)	73 (46-104)
Ground Cover	100	60 (36-95)	77 (0-201)	42 (1-93)
Litter - Dead Leaves and Stems	5 (0-15)	21 (10-35)	89 (60-98)	58 (30-97)
Bare soil	80 (35-90)	51 (40-70)	3 (0-10)	35 (0.5-68)
Percent of Area (%)**	26.5	15.2	7.1	12.7

* Average (range of observations in parentheses)

** Water and upland hardwood forest comprise approximately 38.2 and 0.3 percent of the area, respectively.

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Periodically, flooded lands may be classified as wetland if they have significant wildlife values and characteristic plant indicator species. Wetlands classified by the U.S. government within 3 kilometers of the IFGDP site center[19,20,21] are shown in Figure 3-34. Wetland on the site proper is of low to medium quality because of limited food availability.[21] Species indicative of wetlands, buttonbush (Cephalanthus occidentalis), cutgrass (Leersia lenticularis, L. oryzoides and L. virginica), mallow (Hibiscus nilitaris), smartweed (Polygonum lapathifolium and P. longistylum) and arrowleaf (Sagittaria sp.), are most abundant in the eastern portion of this wetland where water stays for the longest time. The remainder of the wetland has only isolated indicator plants in topographic depressions. However, wetland on Presidents Island, especially that area surrounding Round Lake and along the Mississippi River southwest of the site, is of medium to high quality due to its greater food availability, value to threatened and endangered animals and relatively undisturbed nature.[19,21]

3.6.1.2 SOYBEAN FIELD

Soybean fields are planted both north and south of the site on nearly level floodplain silt loam, silty clay and fine sandy loam soils (Table 3-48).[21] Soybeans are commonly planted as a cash crop in the local region and comprise approximately 40 percent of land within 3 kilometers of the site (Figure 3-34). Soybean fields typically are planted in late May or early June and harvested in October. In the fall or spring, the fields are plowed or disced and left fallow until planting time. During the growing season, soybean stems average 0.8 meter tall and shade 80 percent of the soil surface (Table 3-48). Soybean fields are essentially free of weeds except along access roads. The summer season density included approximately 400,000 stems per hectare (ha) as is shown in Table 3-49.

The Shannon-Weaver diversity index (H') was computed from plant density data. Computation involves dividing the number of individuals of a species by the total number of individuals of all species, multiplying this proportion by the natural logarithm of this proportion and summing these products for all

TABLE 3-49

DENSITY, BASAL AREA, COVER AND DIVERSITY INDICIES OF VEGETATION TYPES WITHIN 3 KM OF THE IFGDP SITE

Characteristic	Soybean Field	Meadow	Bottomland Forest	
			Successional	Mature
Tree Size Class				
Density (stems/ha)	--	13	325	250
Basal Area (m^2/ha)	--	1.80	23.36	19.49
Sapling Size Class				
Density (stems/ha)	--	81	310	1,100
Basal Area (m^2/ha)	--	0.22	1.21	1.94
Shrub Size Class				
Density (stems/ha)	--	1,400	45,920	29,450
Cover (%)	--	3.4	7.8	15.1
Ground Cover				
Density (stems/ha)				
Spring	--	1,706,500	1,478,000	490,500
Summer	378,000	558,500	823,400	173,500
Fall	--	324,000	9,500	102,000
Cover (%)				
Spring	--	25.0	20.7	43.8
Summer	100.0	68.3	77.0	42.4
Fall	--	74.5	4.0	70.5
Number of Taxa Observed	13	148	69	71
Diversity Index (H')	0.000	1.856	1.711	1.741

species.[22] A diversity index of 1.000 indicates low diversity, and an index of 5.000 indicates high diversity. A diversity index of zero indicates that all plants are of the same species. The soybean field had a diversity index of zero (0.000), the lowest diversity of any community sampled. A total of only 13 herbaceous taxa was observed in the soybean field vegetation type.

3.6.1.3 MEADOW

Meadow vegetation consists of a herbaceous type that occurs along fences, on levees, on dredge sediment, in intermittently flooded lowlands and around buildings. Individual meadow vegetation pieces are too small and variable to subdivide on the vegetation map (Figure 3-34). The site is bounded on the north and east sides with meadow. Meadow north of the site is of the inland sand dune type, while that to the east of the site is of the seasonally emergent marsh type.[24] Sand dropseed (Sporobolus ucyptiandrus) and golden R
aster (Heterotheca spp.) characterize the inland sanddune type on sandy dredge R
spoil piles. The seasonally emergent marsh type is characterized by numerous R
sedge and forb species during summer low water flows. R

Meadow occurs on gently to moderately sloping topography and has only scattered shrubs and trees (Table 3-48). Dead leaves and stems covered an average 21 percent of the soil surface to a depth of only 0.4 centimeter. Stems averaged 0.1 meter tall and shaded an average of 60 percent of the soil surface. More than half of the soil surface was devoid of vegetative cover.

Reflecting the predominately herbaceous nature of the vegetation, ground cover consisted of approximately 1.7 million stems per hectare in the spring that gradually decreased to approximately 0.3 million by fall as soil dried and plant stems withered and died (Table 3-49). However, during the same period, average cover increased from approximately 25 to 75 percent as individual plants became larger. Tree- and sapling-size woody plants accounted for only 94 stems per hectare. A total of 148 taxa were observed in the meadow vegetation type, producing a diversity index (H') of 1.856, the highest for any vegetation type sampled.

3.6.1.4 SUCCESSIONAL BOTTOMLAND FOREST

The successional bottomland forest (Figure 3-34) is dominated by black willow (Salix nigra) and occurs on recently disturbed floodplains having standing water for part of the year. Mature black willow trees range in age from 38 to 62 years with an average of 55 years and have an uneven canopy height averaging 25.4 meters and ranging from 15.2 to 33.5 meters (Table 3-48). The forest consists of either two or three distinct strata -- overstory, ground cover and an intermittent subcanopy (5 meters tall) of saplings. The canopy only shades an average of 44 percent of the soil surface because numerous trees have died and others are dying apparently from excessive sediment deposition resulting from annual dredging activities. Highest tree mortality is where sediment deposition is thickest. Land surface is gently sloping (2 percent) and is nearly covered with a thin (0.4 centimeter) layer of matted, decaying leaves.

Tree and sapling densities are approximately equal, 325 and 310 stems per hectare, respectively (Table 3-49). Tree basal area equals 23.36 square meters per hectare corresponding to 719 square centimeters (111.4 square inches) per tree. The largest stem diameters were black willow, 64 centimeters (25.2 inches) and cottonwood, 50 centimeters (19.6 inches) in diameter. Sapling basal area (1.21 square meters per hectare) represents an average stem basal area of 39 square centimeters (6.0 square inches) an expected condition in relatively even-aged black willow forest. Approximately 46,000 shrub and vine stems per hectare were observed in the shrub size class, a reflection of the abundance of bur cucumber (Sicyos angulatus), grape (Vitis spp.) and poison ivy (Rhus radicans). Ground cover accounted for nearly 1.5 million and 0.8 million stems in the spring and summer, respectively, but only 0.01 million stems in the fall after dredging operations had either flooded them under slurry or buried them under sediment. A total of only 69 taxa were observed in this community. The Shannon-Weaver diversity index (H') equaled 1.712 in this community indicating moderately low diversity.

Tree-sized individuals representing five species were sampled in the black willow successional bottomland forest as is shown in Table 3-50. Black willow trees are the most important overstory tree species, comprising 69 percent of total tree importance (Table 3-50). The community is changing in composition, as evidenced by sapling-size woody stem data in Table 3-51. Black willow sapling importance is only 29 percent, while boxelder (Acer negundo) and American sycamore (Platanus occidentalis) represent 33 and 17 percent of sapling importance, respectively. Sugarberry (Celtis laevigata) represents 8 percent of sapling importance.

Importance values give a measure of the species ranking in the ecological community. The species with the highest importance values dominate the community in terms of numbers, area covered and stem size. Species with low importance values occur in small numbers of individuals, occur in only a portion of the community or consist of small individuals widely dispersed within the community. The maximum importance value for a species in a community is 100.

The number of individuals per area was converted to density per hectare. The stem diameter per species data was converted to basal area per hectare. From these densities and basal area data, the relative density and relative basal area were calculated. The frequency of occurrence of the species considered, recorded as percentages of plots containing tree- and shrub-size individuals, was also calculated from the data collected. The sum of the relative density, relative basal area and relative frequency divided by three is the importance value of a species. Therefore, the maximum possible value for one species is 100, and the sum of all values is 100.

3.6.1.5 MATURE BOTTOMLAND FOREST

Mature bottomland forest occupies infrequently flooded land on Presidents Island and land adjacent to the Mississippi River southwest of the site (Figure 3-34). The community is all-aged forest having an average canopy height of 22.5 meters (Table 3-48). The ground surface is nearly level and thinly covered with decaying leaves over 58 percent of its surface. Bare soil is visible on an average of 35 percent of the surface.

TABLE 3-50

FOREST TREE IMPORTANCE VALUES OF VEGETATION TYPES

WITHIN 3 KM OF THE IFGDP SITE

Species	Meadow	Successional Bottomland Forest	Mature Bottomland Forest
Cottonwood	100*	11	--
Black willow	--	69	--
Boxelder	--	10	40
Silver maple	--	6	11
American sycamore	--	4	8
Slippery elm	--	--	18
Sugarberry	--	--	23
TOTALS	100	100	100

* Includes all sampled stems at least 16.5 centimeter stem diameter at 1.4 meters height. See text for explanation of importance values.

TABLE 3-51

FOREST SAPLING IMPORTANCE VALUES OF VEGETATION TYPES WITHIN 3 KM OF THE IFGDP SITE

Species	Meadow	Successional Bottomland Forest	Mature Bottomland Forest
TREES			
Black willow	43*	29	--
Cottonwood	57	7	--
Boxelder	--	33	4
American sycamore	--	17	--
Silver maple	--	3	--
Sugarberry	--	8	21
Slippery elm	--	--	8
Flowering dogwood	--	--	11
Red mulberry	--	--	9
VINES			
Grape	--	3	28
Poison ivy	--	--	10
Trumpet creeper	--	--	6
Virginia creeper	--	--	3
TOTALS	100	100	100

* Includes all sampled stems between 1.2 and 16.4 centimeter stem diameter at 1.4 meter height. See text for explanation of importance values.

The forest consists of four distinct strata -- canopy, subcanopy, shrub and ground layers. The densest of these strata, the canopy, shades approximately 89 percent of the forest floor. As a result of the dense canopy, light intensities inside the forest are low; consequently, only shade-tolerant species can successfully reproduce. Both shrub and ground cover layers are dominated by woody-stemmed plants.

Tree density and basal area per hectare were 250 and 19.49 square meters, respectively (Table 3-49). Average basal area per tree was 780 square centimeters (120.8 square inches). Sapling density was high (1100 stems per hectare) indicating that the tree species are actively reproducing. Shrub density and cover were moderately high at nearly 30,000 stems per hectare and 15 percent, respectively. Ground cover contributed substantially more stems than the larger woody species, but substantially less total biomass. Spring ground cover included nearly 0.5 million stems per hectare that decreased to 0.1 million stems per hectare by fall. During the same seasonal change, cover remained stable at approximately 43 percent in spring and summer and then increased to 70 percent as fall-flowering herbs matured. A total of 71 woody and herbaceous taxa were observed in the mature bottomland forest community. The Shannon-Weaver diversity index (H') equaled 1.741 in this community, indicating a moderately low diversity.

Tree-size individuals representing five species were sampled in this community. Boxelder and sugarberry were the most important overstory tree species and represented 63 percent of total importance (Table 3-50). The community appears to be changing in composition toward a sugarberry-slippery elm (*Ulmus rubra*) forest as evidenced by sapling-size woody stem data (Table 3-51). Boxelder sapling importance only equals 4 percent, but sugarberry and slippery elm are 21 and 8 percent, respectively. Flowering dogwood and red mulberry are only genetically capable of reaching small tree size. Woody vines constitute a substantial part of total sapling importance.

3.6.1.6 THREATENED AND ENDANGERED PLANT SPECIES

Under the Endangered Species Act of 1973 as amended, the U.S. Department of Interior was granted the authority to promulgate a list of threatened and endangered plant and animal species and regulations governing both the species and the habitat in which they occur. The State of Tennessee has similar authority under the same act.

No plant species either on or proposed for these lists[11-14] were observed within 3 kilometers of the site after a careful search of this area.

3.6.2 TERRESTRIAL WILDLIFE

Sections 3.6.2.1 through 3.6.2.4 contain discussions of wildlife resources within 3 kilometers of the IFGDP site based on field studies and literature review.[21-34] Endangered and threatened species are discussed in Section 3.6.2.5.

3.6.2.1 REGIONAL FAUNA

Wildlife in the site region are influenced by the Mississippi River and the nearly level floodplain habitats described in Section 3.6.1. Wildlife of the IFGDP site are considered under the subheadings of mammals (Section 3.6.2.2), avifauna (Section 3.6.2.3) and amphibians and reptiles (Section 3.6.2.4). Many species fly, swim or run over large parts of the local region within 3 kilometers of the site. Many migrant birds (avifauna) fly past the site following the Mississippi River flyway northward in the spring and southward in the fall. Consequently, the discussion evaluates the species' importance in the whole ecosystem, not just one portion of it. Vegetation types have been described in Section 3.6.1.

The close proximity of the site to the City of Memphis enables numerous local residents to run their dogs, hunt, fish, shoot clay pigeons and drive dune buggies near it. Stray cats and dogs also hunt in the area. These activities

have a significant effect on wildlife resources of the site and will be discussed where they apply in following sections. Waste material from the Allen Generating Plant is disposed at a waste disposal site 1.2 kilometers southwest of the IFGDP site. Local residents have been permitted to dispose of trash in a portion of this waste disposal site. This trash pile provides a special habitat for small mammals.

3.6.2.2 MAMMALS

Mammals of the IFGDP site are typical of those expected on the Mississippi River floodplain as indicated by a literature search,[25-27] personal observations and conversations with local residents. Two species observed of special concern are the bobcat and swamp rabbit, discussed in Section 3.6.2.5. During the field wildlife surveys, general observations for mammals were made in each of the vegetation types discussed in Section 3.6.1 and in open water and the nonvegetated trash pile 1.2 kilometers southwest of the site. The most common species observed were the eastern cottontail (*Sylvilagus floridanus*), house mouse (*Mus musculus*) and domestic dog (*Canis domesticus*). These species occurred in nearly all vegetation types investigated.

Mammals may be categorized as game mammals, furbearers and nongame species. Species observed are listed according to these categories in Table 3-52. Qualitative abundance for large mammals (larger than rats) was estimated for each of the four major seasonal surveys. Surveys were conducted in conjunction with transect observations, driving the roads and general observations. Species were given a rating of abundant, common, uncommon and special concern (Table 3-52). Frequency levels were based on road kills, tracks, scats, dens, burrows and organism sightings. Quantitative data were collected for small mammal species (rats and smaller species) utilizing live-traps on approximately one hectare grids in vegetation types found on the site. Semiquantitative data were obtained utilizing transects of snap-traps and live-traps in all five terrestrial habitats.

TABLE 3-52

MAMMALS OBSERVED WITHIN 3 KM OF THE INDUSTRIAL FUEL GAS DEMONSTRATION PLANT SITE

Common Name	Habitat Location					
	Water	Trash Pile	Soybean Field	Meadow	Bottomland Forest Successional	Bottomland Forest Mature
Game Mammals						
Eastern cottontail			C*	A	A	A
Swamp rabbit					S	S
White-tailed deer			C	C	C	C
Gray squirrel					U	
Fox squirrel					U	
Furbearers						
Opossum		C		C	C	
Beaver	C			C		
Muskrat	U			U		
Red fox		U	U	U	U	U
Gray fox		U	U	U	U	U
Raccoon		U	U	U	U	U
Bobcat		S		S	S	S
Nongame Mammals						
Shorttail shrew				C	C	
Eastern mole				C	C	
Marsh rice rat			U	U	U	
Cotton mouse				C		
Hispid cotton rat			U	C	C	
White-footed mouse			U	C	C	C
Pine vole				C	C	
Norway rat		C	U			
House mouse		A	U	A	C	C
Eastern chipmunk						U
Coyote		U	U	U	U	
Cat		C	C	C	C	C
Dog		A	A	A	A	A
Man			C	C		

* A - Abundant - An abundant mammal is very likely to be present in large numbers every time a person visits its habitat at the proper season.

C - Common - A common mammal is likely to be present in moderate numbers nearly every time a person visits its habitat at the proper season.

U - Uncommon - An uncommon mammal is likely to be present in low numbers occasionally when a person visits its habitat at the proper season.

S - Special concern - A mammal of special concern is rare in all or part of its range and may be listed as threatened or endangered by the U.S. Fish and Wildlife Service and State of Tennessee.

3.6.2.2.1 GAME MAMMALS

The primary game species on the proposed site in terms of numbers present was the eastern cottontail. The cottontail was observed in all vegetation types and was most abundant in meadow. The white-tailed deer (Odocoileus virginianus) was the only big game species to occur within 3 kilometers of the site. Signs of deer were commonly seen throughout this region. However, deer were not common on tilled soybean fields during the winter and spring. White-tailed deer feed on twigs, shrubs, fungi, acorns, grass and forbs in season.

The swamp rabbit (Sylvilagus aquaticus), locally termed cane-cutter, occurs uncommonly in mature bottomland forest and is rare in Tennessee (See Section 3.6.2.5). The swamp rabbit feeds on green vegetation when available and on bark and twigs in the winter.

The gray squirrel (Sciurus carolinensis) and fox squirrel (Sciurus niger) were observed uncommonly in black willow successional bottomland forest. These squirrels feed on nuts, seeds, fungi, fruits and cambium beneath tree bark. Other species that are locally hunted for food are the opossum (Didelphis marsupialis) and raccoon (Procyon lotor). The opossum was common near water as found in parts of the meadow and successional bottomland forest vegetation type and at the trash pile. The opossum feeds on fruits, nuts, vegetables, insects, meat, eggs and carrion. The raccoon is very enthusiastically hunted in the local region. The raccoon feeds on nearly any food available including fruits, nuts, grains, insects, frogs, crayfish and bird eggs.

3.6.2.2.2 FURBEARERS

Species hunted or trapped for their fur somewhere in their range are furbearers. Furbearers observed within 3 kilometers of the IFGDP site include opossum, beaver (Castor canadensis), muskrat (Ondatra zibethica), red fox (Vulpes fulva), gray fox (Urocyon cinereoargenteus), raccoon and bobcat (Lynx rufus) (Table 3-52). Of these species, the opossum and beaver were common,

and the bobcat was of special concern; the other four species were uncommon. Beaver dams and lodges were observed in the small stream 3 kilometers southeast of the site (Figure 3-34), and beaver-cut woody stems were observed near water throughout the area. The beaver feeds on bark and small twigs of willow, maple and cottonwood. Muskrats were observed along Horn Lake Cutoff, a small stream 3 kilometers southeast of the site. They feed primarily on aquatic vegetation, but also eat clams, frogs and fish. Red and gray foxes were observed infrequently throughout the local region. The red fox feeds on available animals ranging in size from insects to rabbits and on berries and other fruit. The gray fox chiefly eats small mammals but will eat insects, fruits, acorns, birds and eggs. Local farmers, TVA security personnel and the Tennessee wildlife officer indicated that bobcat adults and kittens were observed in the area and that several adults were killed for their fur on Presidents Island. The bobcat feeds on small mammals, birds and untainted carrion.

3.6.2.2.3 NONGAME MAMMALS

Common nongame mammals of the local region included domestic dog (*Canis familiaris*), house mouse (*Mus musculus*), house cat (*Felis domestica*), short-tail shrew (*Blarina brevicauda*), eastern mole (*Scalopus aquaticus*), hispid cotton rat (*Sigmodon hispidus*) and white-footed mouse (*Peromyscus leucopus*). Quantitative data were collected for small mammal species. Small mammals were live-trapped with Sherman box traps baited with oatmeal. Trapping was conducted on 76 meter by 152 meter grids (1.16 hectare) with traps spaced at 15.24 meter intervals for a density of approximately 48 traps per hectare. Trapping was conducted in the spring and repeated in the fall. However, shortly before the fall survey, annual dredging operations deposited sediments approximately 1 meter thick on portions of the two grids. Only five trap positions of the grid in meadow vegetation were affected; five new positions were established on the opposite end of this grid. However, 20 trap positions on the grid in black willow successional bottomland forest were affected. A third grid of the same dimensions was established near the trash pile in successional bottomland forest not affected by dredging sediment. To determine

seasonal population changes with and without dredging impact, both forest grids were trapped in the fall season, and all three grids were trapped again in the winter season.

Museum-special snap traps and Sherman box traps were placed in five habitat types within 3 kilometers of the site to determine species presence. Pit traps made from cans buried in the soil to their rims and commercially available mechanical mole traps were used for the same purpose.

As expected, small mammal population estimates per hectare, as shown in Table 3-53, were low in the spring and on fresh dredging sediment and were high in the fall and winter. The white-footed mouse, house mouse and hispid cotton rat were most abundant on the site and occurred in both meadow and forest. The shorttail shrew (Blarina brevicauda) and pine vole (Pitymys pinetorum) occurred in successional bottomland forest in small numbers. Mouse densities increased in the meadow from spring to winter as seeds and insects, their primary food sources, became more abundant, vegetative cover became more dense and river flooding shifted populations from lower to higher floodplain topography. The hispid cotton rat, normally found in dense herbaceous growth in or near forest, may have been shifted into the more open meadow by dredging operations in the fall. The cotton rat primarily feeds on green vegetation, but also eats eggs of ground-dwelling birds.

In successional bottomland forest, dredging operations reduced fall and winter white-footed mouse populations by approximately one-half and apparently displaced shorttail shrew and pine vole populations. The shorttail shrew lives in nearly any habitat and feeds on insects, worms, snails and other invertebrates, while the pine vole lives in a forest with a thick, dead leaf layer and feeds on root bark, bulbs, tubers and seeds. The successional forest not affected by dredging had a dramatic increase in house mouse and cotton mouse populations from fall to winter, reflecting population growth and displacement from the flooding of low habitat near the river.

TABLE 3-53

SMALL MAMMAL POPULATION ESTIMATES PER HECTARE WITHIN 3 KM OF THE IFGDP SITE (SPRING, FALL AND WINTER SEASONS)

Vegetation Type	Season	White-footed Mouse	Shorttail Shrew	House Mouse	Pine Vole	Hispid Cotton Rat
Meadow	Spring	--*	--	--	--	--
	Fall	1.7**	--	1.7	--	0.9
	Winter	4.3	--	12.9	--	--
Successional Bottomland Forest	Spring	2.6	--	--	--	--
	Fall	1.7	1.7	--	--	--
	Winter	2.6	--	--	0.9	--
Successional Bottomland Forest	Fall	4.3	--	6.0	--	0.9
	Winter	4.3	--	19.0	--	6.0

* A dash indicates that this species was not captured in the indicated vegetation type and season combination.

** Population estimates were obtained by dividing the number of new captures by the area sampled -- 1.16 hectare.

Other trapping efforts identified the marsh rice rat (Oryzomys palustis) and cotton mouse (Peromyscus gossypinus) on Presidents Island north of the site where they feed on seeds and green vegetation. The eastern mole was most abundant in meadow (Table 3-52) where it feeds on worms, insects and plant roots a few centimeters beneath the soil surface. The Norway rat was observed on the margin of soybean fields and in the trash pile (Table 3-52) where it feeds on anything edible.

Other nongame mammals observed included the eastern chipmunk (Tamias striatus), coyote (Canis latrans), domestic cat and domestic dog. The chipmunk was observed in mature bottomland forest (Table 3-52) where it feeds on seeds, bulbs, fruits, nuts, insects, meat and eggs. The coyote was reported to be migrating toward the south and east, according to local residents. It primarily feeds on rodents and rabbits, but will eat almost anything edible. Domestic cats and dogs occur with or without human companions. Cats feed on small mammals and birds, while dogs feed on larger mammals ranging in size from rabbits to deer. Of all mammals near the site, dogs and cats probably have the greatest influence on site wildlife.

Man (Homo sapiens) was observed residing in houses in soybean fields and working in or traveling through meadow vegetation. Local residents consume vegetables, fish, larger mammals and game birds from the region near the site.

3.6.2.3 AVIFAUNA

The region within 3 kilometers of the IFGDP site provides excellent habitat for many avian species as shown by four seasonal surveys conducted in May, July, October and December 1978. Qualitative surveys noted the location of maximum habitat use, as well as relative abundance for all species encountered within each habitat. Abundance ratings were based primarily on song, call note, nest count and actual sighting.[27-33] Records were maintained for all species encountered.

Relative densities were determined by walking measured transects. All birds identified within the transect were tallied. Stations were placed along a transect at 63.4 meter intervals, representing the edge of a 0.4 hectare square. Each count began as early in the day as conditions permitted and continued until a count was completed on each transect. The order of transects visited was varied to offset the differences in count efficiency at different time periods. Each count was conducted by starting at one end of the transect and walking at a rate of 1 to 3 miles per hour along the transect. At each station, a stop of 1 minute was made in the summer and 3 minutes in the winter. The winter counts were made using the same basic technique as that used in the summer, except that in the last 1.5 minute at each stop, the observer made squeaking and shushing sounds in an attempt to elicit a response from the birds that would enable the observer to see or hear them.

In addition to surveying birds along measured transects in each habitat type, general observations were made along roadways, forest margins and fields within 3 kilometers of the site. The number of species observed within each habitat type and the species' relative abundance and seasonal occurrence are indicated in Table 3-54. Nomenclature follows the Shelby County checklist.[32] A complete list of bird species observed on the IFGDP site is included in Appendix 3D, Table 3D-3. The section is divided into subsections discussing habitat preferences, raptorial birds and game birds.

3.6.2.3.1 HABITAT PREFERENCES

Habitat preference and relative abundance were observed during the four seasonal field surveys -- spring, summer, fall and winter (Table 3-54). Seasonal occurrence data are from the checklist of Shelby County birds.[32] Semiquantitative abundance ratings are as follows: A = 1 to 10, B = 11 to 25, C = 26 to 50, D = 51 to 100 and E = more than 100 individuals.

A total of 134 bird species were observed within 3 kilometers of the site during the four-season baseline survey including 45 permanent residents, 36 summer residents, 28 winter residents, 4 winter visitors and 21 transient

TABLE 3-54

BIRD SPECIES RELATIVE ABUNDANCE, SEASONAL OCCURRENCE AND HABITAT PREFERENCE WITHIN 3 KM OF THE IFGDP SITE

Common Name	Season*	Water	Soybean Field	Meadow	Successional Forest	Mature Forest
Horned grebe	WV	A**			A	
Pied-billed grebe	PR	A			A	
Great blue heron	PR	A	A	A	A	A
Green heron	SR	A		A	A	
Common egret	SR	A		A	A	
Yellow-crowned night heron	SR	A		A		
Canada goose	WR	B-C				
Mallard	WR	C-E		C-E		
Gadwall	WR	A		A		
American wigeon	WR	B		B		
Northern shoveler	WR	A		A		
Wood duck	PR	C		C	C	
Ring-necked duck	WR	C		C		
Lesser scaup	WR	C		C		
Common goldeneye	WR	A		A		
Bufflehead	WR	B		B		
Ruddy duck	WR	B		B		
Black vulture	PR		A	A	A	A
Turkey vulture	PR		A	A	A	A
Mississippi kite	SR				A	A
Sharp-shinned hawk	WV	A		A		
Red-tailed hawk	PR		A	A	A	
Broad-winged hawk	SR				Z	
Marsn hawk (harrier)	WR	A		A	A	
Merlin (Pigeon hawk)	WV			A	A	
American kestrel	PR		A	A	A	
Bobwhite	PR		B-C	B-C	B-C	
Turkey	PR			A-C	A-C	
American coot	PR	B-E		B-E	B-E	
Killdeer	PR	A-B	A	A-B	A-B	A

* Season of occurrence and residency status where S = summer, W = winter, P = permanent, T = transient, V = visitor, R = resident.

** Abundance where A = 1-10, B = 11-25, C = 26-50, D = 51-100 and E = more than 100.

(Continued)

TABLE 3-54 (Continued)

Common Name	Season*	Water	Soybean Field	Meadow	Successional Forest	Mature Forest
American woodcock	SR				A	A
Common snipe	WR	A**		A		
Semipalmated sandpiper	T	A		A		
Spotted sandpiper	T	A		A		
Pectoral sandpiper	T	A		A		
Solitary sandpiper	T	A		A		
Greater yellowlegs	T	A		A		
Lesser yellowlegs	T	A		A		
Herring gull	WR	A				
Ring-billed gull	WR	A				
Mourning dove	PR	B	B-C	B-C	B	
Rock dove	PR		A-B	A-B	B	
Yellow-billed cuckoo	SR	B	B-C	B-C	B-C	B
Barn owl	PR			A	A	
Great horned owl	PR				A	A
Screech owl	PR			A	A	
Whip-poor-will	T				A	A
Common nighthawk	SR	A				
Chimney swift	SR	A	B	A-B	A-B	
Ruby-throated hummingbird	SR			A	A	
Belted kingfisher	PR	A		A	A	
Common flicker	PR			A	B	B
Pileated woodpecker	PR				A	A
Red-bellied woodpecker	PR			A	A	A
Red-headed woodpecker	PR			A	A-B	A-B
Yellow-bellied sapsucker	WR			A	A	A
Hairy woodpecker	PR			A	A	
Downy woodpecker	PR				A	
Eastern kingbird	SR		A	A	A	
Least flycatcher	T			A	A	A
Acadian flycatcher	T			A	A	A
Great crested flycatcher	SR				A	
Yellow-bellied flycatcher	T			A	A	
Eastern phoebe	PR			A	A	A

* Season of occurrence and residency status where S = summer, W = winter, P = permanent, T = transient, V = visitor, R = resident.

** Abundance where A = 1-10, B = 11-25, C = 26-50, D = 51-100 and E = more than 100.

(Continued)

TABLE 3-54 (Continued)

Common Name	Season*	Water	Soybean Field	Meadow	Successional Forest	Mature Forest
Horned lark	PR		E	E		
Eastern wood pewee	SR		C	B	B	B
Rough-winged swallow	SR		C	C	C	
Bank swallow	T				B	
Barn swallow	SR		B	B	B	
Purple martin	SR	A**				
Blue jay	PR		A	A	A-B	A-B
Common crow	PR	A-B		A-B	A-B	
Fish crow	SR	A		A	A	
Carolina chickadee	PR			B	B	B
Tufted titmouse	PR			A	A	
White-breasted nuthatch	PR				A	A
Brown creeper	WR				A	
House wren	T		A	A	A	
Winter wren	WR			A	A	
Carolina wren	PR			A-B	A-B	
Mockingbird	PR	A	A-B	A-B	A-B	
Gray catbird	SR	A		A	A	
Brown thasher	PR				A	A
American robin	PR		B-C	B-C	B-C	
Wood thrush	SR					
Swainson's thrush	T				A	A
Eastern bluebird	PR			A	A	A
Golden-crowned kinglet	WR				A	
Ruby-crowned kinglet	WR			A	A	
Water pipit	T	A		A		
Blue-gray gnatcatcher	SR				A	A
Loggerhead shrike	PR			A		
Starling	PR		A-B	A-B	B	
White-eyed vireo	SR			A	A	
Solitary vireo	WV			A	A	
Philadelphia vireo	T			A	A	A
Red-eyed vireo	SR				A	A

* Season of occurrence and residency status where S = summer, W = winter, P = permanent, T = transient, V = visitor, R = resident.

** Abundance where A = 1-10, B = 11-25, C = 26-50, D = 51-100 and E = more than 100.

(Continued)

TABLE 3-54 (Continued)

Common Name	Season*	Water	Soybean Field	Meadow	Successional Forest	Mature Forest
Warbling vireo	SR			A	A	
Black-and-white warbler	T			A	A	A
Prothonotary warbler	SR				A	
Worm-eating warbler	T				A	A
Tennessee warbler	T			B	B	
Nashville warbler	T			A	A	
Northern parula warbler	SR			A	A	A
Yellow warbler	T			A	A	
Yellow-rumped warbler	WR				A	A
Cerulean warbler	SR				A	A
Kentucky warbler	SR					A
Blackburnian warbler	T				A	A
Common yellowthroat	SR			A	A	
Chestnut-sided warbler	T				A	A
Bay-breasted warbler	T			A	A	
Blackpoll warbler	T			A	A	A
Pine warbler	T			A		
Prairie warbler	T			B		
Palm warbler	T				A	A
Northern waterthrush	T	A**		A	A	A
Louisiana waterthrush	T	A		A	A	A
Hooded warbler	T				A	A
American redstart	T			A	B	A
Yellow-breasted chat	SR				A	
House sparrow	PR		A			
Bobolink	T(spring)		B			
Eastern meadowlark	PR		A-B	A-B		
Red-winged blackbird	PR	E	E	E	E	E
Orchard oriole	SR			B	B	
Northern oriole	SR			A	A	
Rusty blackbird	WR				A-B	
Common grackle	PR	C-D	C-E	C-E	C-E	C-E

* Season of occurrence and residency status where S = summer, W = winter, P = permanent, T = transient, V = visitor, R = resident.

** Abundance wher A = 1-10, B = 11-25, C = 26-50, D = 51-100 and E = more than 100.

(Continued)

TABLE 3-54 (Continued)

Common Name	Season*	Water	Soybean Field	Meadow	Successional Forest	Mature Forest
Brown-headed cowbird	PR			A-B	A-B	
Scarlet tanager	T			A	A	
Summer tanager	SR			A	A	
Cardinal	PR			B-C	B-C	B-C
Rose-breasted grosbeak	T			A	A	
Blue grosbeak	T			A	A	
Indigo bunting	SR		C**	C	C	B
Painted bunting	R			A	A	
Dickcissel	SR			A	A	
American goldfinch	WR				A-B	
Rufous-sided towhee	PR			A-B	A-B	A-B
Savannah sparrow	T			A	A	
Grasshopper sparrow	T			A	A	
Vesper sparrow	T			A	A	
Lark sparrow	T		B			
Dark-eyed junco	WR			B	B	
Field sparrow	PR			B-C	B	
White-throated sparrow	WR			B-D	B-D	B
White-crowned sparrow	WR			A	A	
Chipping sparrow	T				A	A
Fox sparrow	WR			A	A	A
Swamp sparrow	WR			A-C	A-C	A
Song sparrow	WR		B-D	B-D		

* Season of occurrence and residency status where S = summer, W = winter, P = permanent, T = transient, V = visitor, R = resident.

** Abundance where A = 1-10, B = 11-25, C = 26-50, D = 51-100 and E = more than 100.

species (Table 3-54). The most abundant species were the mallard (Anas platyrhynchos), wood duck (Aix sponsa), bobwhite (Colinus virginianus), American coot (Fulica americana), mourning dove (Zenaidura macroura), yellow-billed cuckoo (Coccyzus americanus), horned lark (Eremophila alpestus), rough-winged swallow (Stelgidopteryx ruficollis), red-winged blackbird (Agelaius phoeniceus), common grackle (Quiscalus quiscula), Indigo bunting (Passerina cyanea) and white-throated sparrow (Zonotrichia albicollis). Of these, seven species are permanent residents, three are summer residents and two are winter residents. The most abundant of these was the red-winged blackbird, and the next most abundant was the common grackle. These two bird species were abundant in every habitat available.

Forty-three bird species floated on, waded in or nested in trees growing in standing or flowing water (Table 3-54). The mallard and red-winged blackbird utilized this habitat most extensively.

Of the local habitats, soybean fields were utilized by the fewest number of species (27) as shown in Table 3-54. The red-winged blackbird, horned lark and common grackle were the most abundant species observed in this habitat. Numerous migratory wildlife stopped in this habitat to rest and feed. R

Meadow and successional forest were utilized by the most species. Meadow was utilized by 101 species and successional forest by 102 (Table 3-54). Many of these species utilized the ecotone between forest and field and were counted in both vegetation types. The most abundant species utilizing these types were mallard, American coot (in the fall), horned lark, red-winged blackbird and common grackle (Table 3-54). These species were most common in or near standing water in one or both of these vegetation types. Mature bottomland forest was utilized by only 43 bird species (Table 3-54).

3.6.2.3.2 RAPTORIAL BIRDS

Among the raptorial birds, the most commonly observed species was the American kestrel (Falco sparverius). This small falcon hunts in open stands of trees and in meadow where it preys on insects, small birds and small mammals. It has adapted to man and commonly occurs in cities where it feeds on house sparrows.

A second small falcon encountered was the merlin (Falco columbarius). This is an uncommon falcon that is similar in appearance to the American kestrel, but can be identified by its lack of black facial markings and more direct flight. It feeds on small birds, mammals and insects and is an uncommon winter visitor to Shelby County.[32]

The most common winter resident raptor was the marsh hawk (Circus cyaneus), listed as threatened in Tennessee.[13] This species hunts by flying close to the ground and taking rodents by surprise.

The Mississippi kite (Ictinia mississipensis), a summer resident, was observed flying or soaring over mature bottomland forest in search of large insect prey. Individual birds were observed flying near the site on several occasions, and a group of four were observed soaring over the mature bottomland forest 2 kilometers southwest of the site. Based on a 1968 study in the Memphis[38] area, the species breeds successfully in trees over 30 centimeters in diameter that occur in groups of at least 200 per hectare averaging 30 meters tall. This combination of conditions occurs in mature bottomland forest 2 kilometers southwest of the site and on Presidents Island north of the site, especially along the Mississippi River shore. In 1968, 38 adult kites were observed along the Mississippi River floodplain from Memphis south to the Mississippi-Tennessee border.[38] This species is listed as endangered by the State of Tennessee.[13]

The red-tailed hawk (Buteo jamaicensis), a permanent resident, nests in moist, hardwood forest and feeds in forest and open vegetation. It primarily feeds on small rodents, but occasionally takes insects, songbirds and amphibians.

The sharp-shinned hawk (Accipiter striatus), a winter visitor, was observed flying over Lake McKellar north of the site during the winter field survey. It is a small hawk that feeds primarily on song birds and insects. The sharp-shinned hawk is listed as threatened in the State of Tennessee.[13]

The broad-winged hawk (Buteo platypterus), a summer resident, was observed during the spring survey. It generally hunts from a perch, swooping down to capture small rodents, insects, amphibians and reptiles.

Two carrion feeding raptors, the black vulture (Coragyps atratus) and turkey vulture (Cathartes aura), were observed near the site. They catch thermal updrafts and soar for miles searching for carrion.

A large raptor, the great horned owl (Bubo virginianus) is a common owl of forestland. It searches at night for its prey, which includes cottontail rabbits, skunks, rats and other small mammals. A single individual was heard calling during the spring survey.

Barn owl (Tyto alba) droppings were observed beneath a highway bridge 3 kilometers southeast of the site, indicating the species presence. An individual was seen in the same location on a separate occasion. The barn owl is a permanent resident and hunts rats and mice in fields and marshes at night.

A screech owl (Otus asio) was observed perching in black willow saplings on the north and south portions of the site. A screech owl nest was observed in a wind-thrown black willow tree on the northwest corner of the site. It is a permanent resident and hunts for rodents and other small mammals.

3.6.2.3.3 GAME BIRDS

Numerous game birds reside on the site either permanently or only in the winter. They include the Canada goose (Branta canadensis), 10 duck species, bobwhite (Colinus virginianus), turkey (Meleagris gallopavo), mourning dove (Zenaida macraura), American woodcock (Philohela minor), common snipe (Capella gallinago), rock dove (Columba livia) and American coot (Fulica americana). The Canada goose and assorted ducks are winter residents near the IFGDP site. One of these, the wood duck (Aix sponsa), is also a summer resident. These species feed on leafy vegetation, seeds, aquatic insects and algae.

The bobwhite and turkey occur in meadow and black willow forest on the site where they feed on seeds, insects and plant leaves. The mourning dove and rock dove reside near farm buildings and in forest edge and feed on seeds and waste grain. American woodcock, common snipe and American coot are shallow water and shore birds. They feed on seeds, insects, snails and plant leaves in shallow water, on densely vegetated shores and in moist woodlands.

3.6.2.4 AMPHIBIANS AND REPTILES

Three seasonal surveys, conducted in May, July and October 1978, show that the region within 3 kilometers of the IFGDP site provides habitat for a number of amphibian and reptile species. Amphibians and reptiles hibernate during the winter and are not observable. Qualitative surveys noted the location of maximum habitat use, as well as relative abundance for all species encountered within each habitat. Both diurnal and nocturnal surveys were used to characterize species presence. A total of 7 amphibian and 13 reptile species were observed within 3 kilometers of the site.[34-36]

Species observed, relative abundance, seasonal occurrence and habitat preference are noted in Table 3-55. Species observed included two toad species, five frog species, three lizard species, three turtle species and seven snake species. The most abundant species were the toads and the six-lined racerunner, a lizard. The American (*Bufo americanus*) and Fowler's (*Bufo woodhousei*) toad species were intergrades indicating that they are a hybrid complex possessing individuals with characteristics of both species. The six-lined racerunner (*Cnemidophorus sexlineatus*) was abundant on open, dredge spoil hills having sparse to dense herbaceous vegetation. These toads and the lizard were observed in spring, summer and fall. The toads occurred in meadow and lowland forest habitat where they consumed the abundant mosquitoes and other insects. They were most active in spring and fall and on cool days. The six-lined racerunner was restricted to meadow, sandy roads and the margin of successional bottomland forest. This racerunner is most active on hot summer and fall days (optimum body temperature of 40°C). They eat insects, spiders, scorpions and similar tiny animals.[36]

TABLE 3-55

AMPHIBIAN AND REPTILE SPECIES' RELATIVE ABUNDANCE, SEASONAL OCCURRENCE AND HABITAT PREFERENCE WITHIN 3 KM OF THE IFGDP SITE

Common Name	Scientific Name	Season*	Habitat: Water	Soybean Field	Meadow	Successional Forest	Mature Forest
Amphibians							
American toad	Bufo americanus	Sp, Su, F			A**	A	C
Fowler's toad	Bufo woochousei	Sp, Su, F			A	A	C
Bull frog	Rana catesbeiana	Sp, Su, F	C		C		
Green tree frog	Hyla cinerea	Sp, Su			U		
Northern cricket frog	Acris crepitans	Sp, Su	C		C		
Southern leopard frog	Rana utricularia	Sp, Su, F	C		C		
Spring peeper	Hyla crucifer	Sp, Su	C		C		
Reptiles							
Five-lined skink	Eumeces fasciatus	Su, F			U	U	U
Northern fence lizard	Sceloperces undulatus	Sp, Su			C		
Six-lined racerunner	Cnemidophorus sexlineatus	Sp, Su, F			A		
Eastern box turtle	Terrapene carolina	Su			C		
Red-eared pond slider	Pseudemys scripta	Su	U				
Snapping turtle	Chelydra serpentina	Sp, Su	U		U		
Cottonmouth	Agkistrodon piscivorous	Su	VU				
Diamondback water snake	Natrix rhombifera	Su, F	C		C		
Eastern hognose snake	Heterodon platyrhinos	F			C	C	
Southern black racer	Coluber constrictor	Sp, Su, F			C		
Speckled kingsnake	Lampropeltis getulus	F			U	U	
Western ribbon snake	Thanophis proximus	F			U		
Yellow-bellied water snake	Natrix erythrogaster	F	U		U		

* Season where Sp = Spring, Su = Summer and F = Fall

** A - Abundant: an abundant animal is very likely to be present in large numbers **every time** a person visits its habitat at the proper season.

C - Common: a common animal is likely to be present in moderate numbers nearly every time a person visits its habitat at the proper season.

U - Uncommon: an uncommon animal is likely to be present in low numbers occasionally when a person visits its habitat at the proper season.

VU - Very Uncommon: a very uncommon animal is seldom observed even when a person visits its habitat at the proper season.

In general, amphibians were active in cool, moist habitats in the spring and summer and consumed insects. The reptiles were generally most active in the hot summer and fall and consumed a variety of foods. Lizards consumed small insects, small arthropods and similar sized animals and lived in meadow or forest. Turtles consumed larger insects, larger arthropods and vegetation and stayed in or near water, snapping turtle (Chelydra serpentina) and pond slider (Pseudemys scripta), or ranged widely, box turtle (Terrapene carolina). Snakes consumed small mammals, birds' eggs, amphibians, lizards and other snakes. Snake habitat usage varied from primarily aquatic, cottonmouth (Agkistrodon piscivorous), diamondback water snake (Natrix rhombifera) and yellow-bellied water snake (Natrix erythrogaster), to primarily upland in meadow and open successional forest habitat, southern black racer (Coluber constrictor), eastern hognose (Heterodon platyrhinos), speckled kingsnake (Lampropeltis getulus) and western ribbon snake (Thanophis proximus).

3.6.2.5 ENDANGERED AND THREATENED FAUNAL SPECIES

Under the Endangered Species Act of 1973, animal species cited as threatened or endangered by the U.S. Department of Interior, Fish and Wildlife Service are protected to the extent that individuals may not be destroyed and their critical habitat may not be disturbed.[11,37] The State of Tennessee also maintains an official list of endangered and threatened fauna.[13] The state of Tennessee also maintains a category termed "special management." The special management category indicates that the species may be abundant locally in Tennessee, but the habitat is so restricted that special management is required to maintain both habitat integrity and high populations within the restricted habitat. Species fitting one or more of these categories are listed in Table 3-56.

The only species found within 3 kilometers of the site that appears on the U.S. List of Endangered and Threatened Fauna is the bobcat (threatened).[37] The bobcat is a spotted cat and is threatened as a result of trapping and sale of pelts for use in fur coat manufacturing. The bobcat ranges widely in the site vicinity, but is most common near water and in or near mature bottomland forest north and south of the site. Critical habitat has not R
been determined for this species.[37] R

TABLE 3-56

ENDANGERED, THREATENED AND SPECIAL CONCERN SPECIES OBSERVED WITHIN 3 KM OF THE IFGDP SITE

Common Name	Scientific Name	Classification* United States	Classification* State of Tennessee
MAMMALS			
Swamp rabbit	Sylvilagus aquaticus		S(16)
Bobcat	Lynx rufus	T(37)	
BIRDS			
Marsh hawk	Circus cyaneus		T(13)
Mississippi kite	Ictinia mississipensis		E(13)
Sharp-shinned hawk	Accipiter striatus		T(13)
AMPHIBIANS AND REPTILES			
Six-lined racerunner	Cnemidophorus sexlineatus		S(16)

* E = Endangered - the species is in danger of becoming extirpated in all or part of its range.

T = Threatened - the species population is declining and protection is required to prevent species endangerment in all or part of its range.

S = Special - the species is restricted to a very uncommon habitat and special management is required to maintain both habitat integrity and current populations within the habitat.

The Mississippi kite, a bird of prey that is endangered in Tennessee,[13] eats large insects and nests in the upper branches of large trees 30 to 45 centimeters stem diameter and 30 meters tall.[38] A total of 38 summer resident Mississippi kites were observed in the Mississippi River bottomlands from the City of Memphis to the northern border of the State of Mississippi during the summer of 1978.[38] Removal of dense stands of large trees by logging, especially in mature bottomland forest, is the most important reason for the species' endangerment in Tennessee.[38]

Both the marsh and sharp-shinned hawks are listed as threatened in Tennessee.[13] The marsh hawk feeds on rodents in marshy and bottomland habitats. The sharp-shinned hawk feeds on songbirds, small game birds and occasionally small rodents.[31] The marsh hawk is a winter resident and the sharp-shinned hawk an occasional visitor in Shelby County, Tennessee.[32]

The swamp rabbit and six-lined racerunner are listed as requiring special management.[16] Swamp rabbits are most abundant in mature bottomland forest and adjoining edge habitats where they eat honeysuckle, grasses and forbs. This habitat occurs both north and south of the site. The six-lined racerunner occurs on sandy dredge sediments and sandy floodplains. Dredging operations provide excellent habitat for this species and are an effective management tool to maintain high populations. Six-lined racerunner populations on dredge R
sediment are estimated at 4.4 adult individuals per hectare based on numbers R
observed per field sampling area extrapolated to numbers per hectare. R

The habitat within 3 kilometers of the site that is most sensitive to disturbance is mature bottomland forest. This forest is home to the bobcat, Mississippi kite and swamp rabbit and is extensively used by the marsh and sharp-shinned hawks.

The portion of the meadow vegetation type most sensitive to disturbance is the one formed by sandy dredging sediment extending along Lake McKellar from the Mississippi River to the eastern peninsular tip. The six-lined racerunner is most abundant in this portion of the meadow vegetation type.

The site contains meadow and successional bottomland forest, habitats not critical for the endangered and threatened mammals and birds.

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3.7 AQUATIC ECOLOGY

3.8 LAND USE
CHARACTERISTICS

3.7 AQUATIC ECOLOGY

This section describes the existing aquatic biological communities in the major water bodies proximate to the proposed IFGDP site, shown in Figure 3-35. The major water bodies considered are the Mississippi River and Lake McKellar.

Description of major biological components of the aquatic ecosystems are based primarily on data obtained during site-specific field surveys conducted by EIA during May, July and October 1978 and January 1979 (1978-79 surveys). Detailed procedures and results of these surveys are presented in Appendix 3E. Figure 3-36 shows the approximate locations at which sampling was executed. Two sampling transects were established out from the eastern shoreline of the Mississippi River between river miles (RM) 725 and 727. One transect (MR1) was upstream of the mouth of Lake McKellar, the second (MR2) was downstream of Lake McKellar but upstream of the existing common discharge of the City of Memphis sewage treatment plant (STP) and the Tennessee Valley Authority's (TVA) Allen Generating Plant. In Lake McKellar, transect LM1 extended from shore to shore in the Tennessee Chute (the entrance to Lake McKellar) while LM2 extended across the turning basin dredged between the IFGDP site and the Allen Generating Plant. These transects were established with the intention of providing baseline information on existing aquatic biota for assessment of potential impacts attendant to MLGW's proposed plant. In the Mississippi River, MR1 was to serve as an upstream control, while MR2 was located in the potential discharge area. In Lake McKellar, transect LM1 was positioned to be (1) representative of conditions in the Tennessee Chute proximate to the site, and (2) in an area potentially affected by placement of the product pipeline. Transect LM2 was established to provide data in an area (1) representative of the backwater proximate to the site, (2) potentially affected by coal-barge unloading operations and (3) where an intake might be located if Lake McKellar were to be used as a water source.

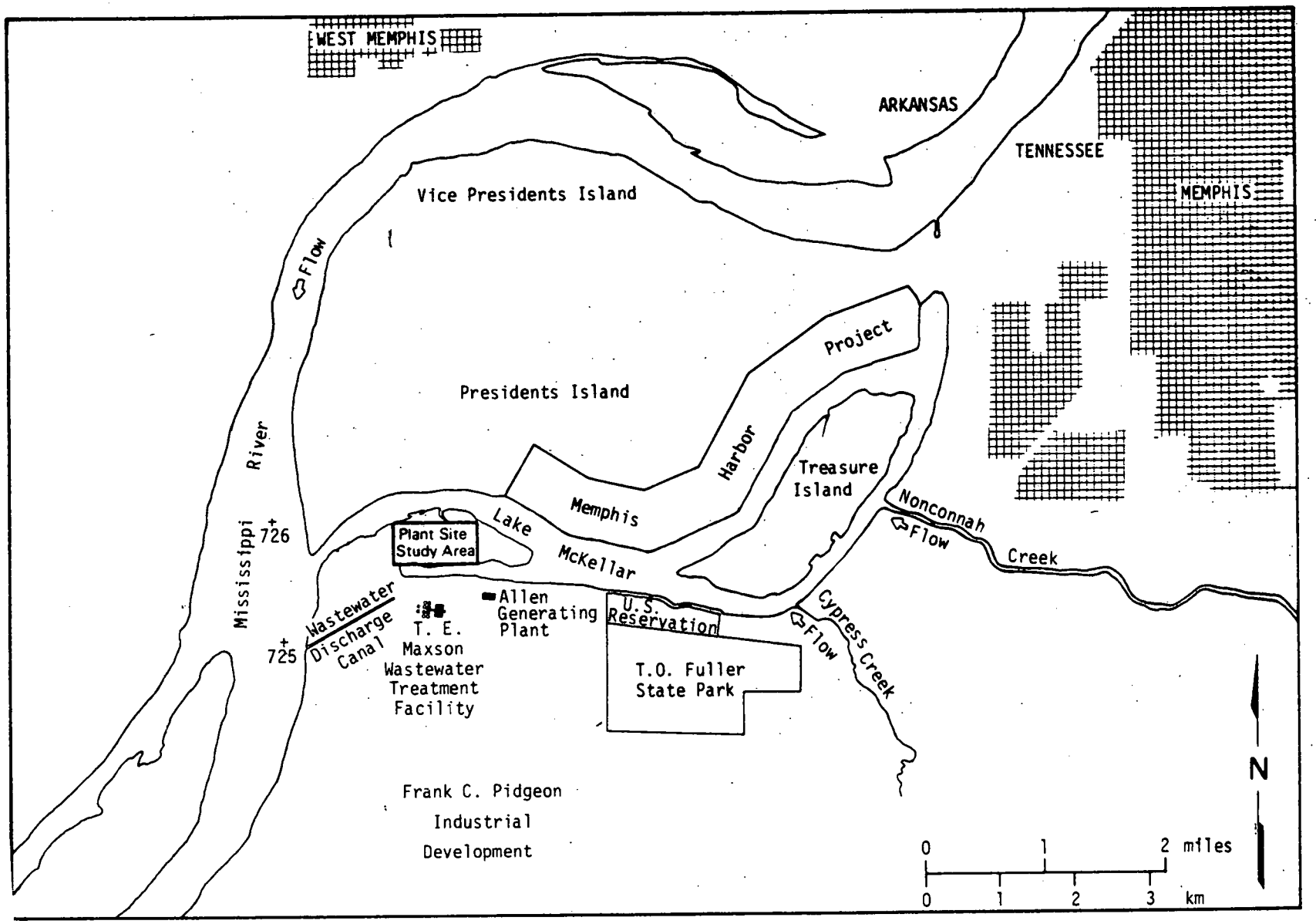

Figure 3-35. Location of the Proposed IFGDP Site

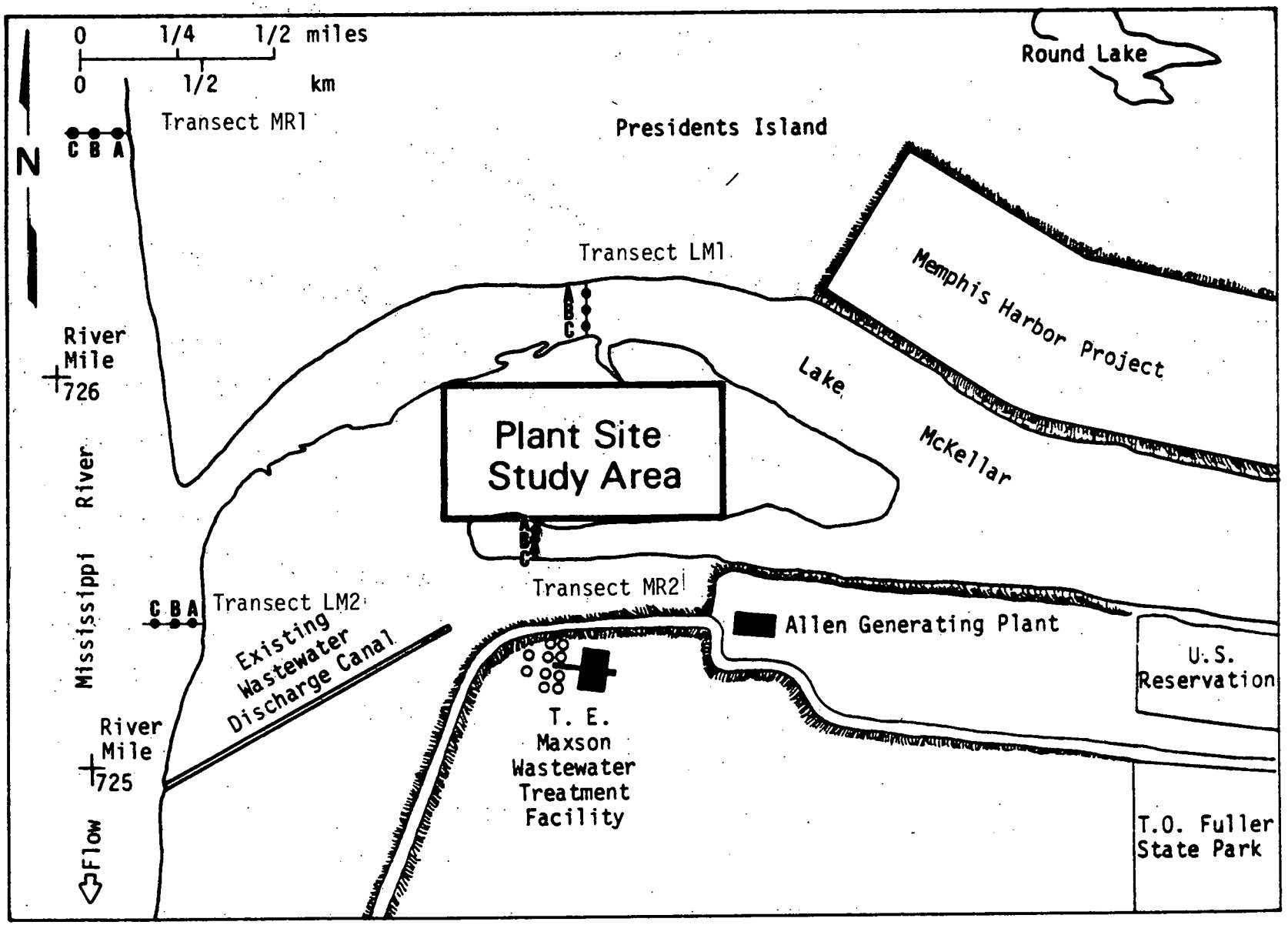

Figure 3-36. Location of Major Transects (MR1, MR2, LM1, LM2) and Stations (A,B,C) for Sampling of Aquatic Biota During 1978-79 Surveys

Limited literature information on the aquatic biota of Lake McKellar and nearby sections of the Mississippi River was available and was used where pertinent to supplement data obtained in the 1978-79 surveys.

In each of the following sections, major biological components of both aquatic ecosystems (Mississippi River and Lake McKellar) are discussed. The relationships between these components are illustrated by a simplified food web, Figure 3-37. This food web depicts generally applicable, major pathways of energy transfer via feeding relationships in North American aquatic ecosystems; the specific food web for a particular ecosystem will vary from this general figure, depending upon the species present. Producer components (phytoplankton, periphyton, macrophytes) are green plants that fix light energy from the sun by means of photosynthesis. Except for macrophytes, which are seldom directly used as food, the producers are eaten by invertebrate consumers (zooplankton and benthic macroinvertebrates) which in turn fall prey to fish. It can be seen that the composition of each component depends upon the composition of the components to which it is linked, and that a fuller understanding of the aquatic ecosystem results from a consideration of all the components.

3.7.1 MISSISSIPPI RIVER

Biota of the Mississippi River, especially the middle Mississippi (from Cairo, Illinois, to Vicksburg, Mississippi), are poorly known.[1,2] The following discussions are based mainly on the seasonal 1978-79 surveys (Appendix 3E) and on a study performed in 1975 and 1976[3] which included an area (river mile 723 to river mile 731) proximate to the proposed site. Sampling areas (transects) in the Mississippi River used during the 1978-79 surveys were both located along the eastern shore of the river (Figure 3-36) in relatively protected areas with reduced water velocities, although the current was still such that the river bottom was predominantly sandy. River banks were steep, sandy and vegetated with trees or grasses. Based upon the limited information available, the biological communities found near the MLGW site are not unique in the middle Mississippi River. The biota described in the following subsections is what would generally be expected in a large, turbid, swiftly

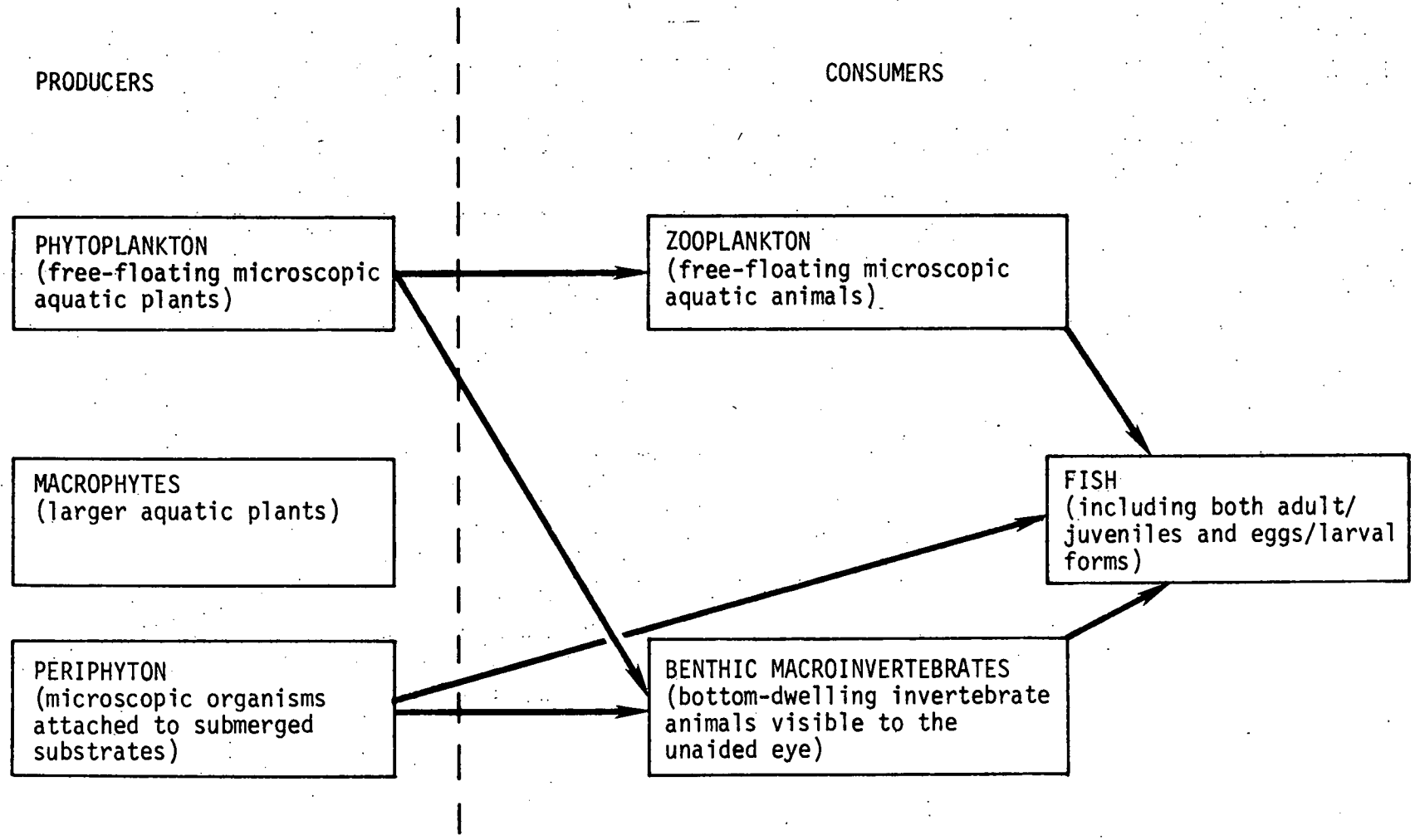

Figure 3-37. Simplified Aquatic Food Web Illustrating Major Feeding Relationships Between Biological Components of Aquatic Ecosystems

flowing, warmwater river: macrophytes were absent, bottom fauna was depauperate, plankton was diverse but relatively sparse and the fish community was a warmwater type dominated by rough and forage species.

3.7.1.1 FISH

In the following discussion, adult and juvenile fish are treated separately from ichthyoplankton (fish eggs and larvae). Distribution of ichthyoplankton gives information on reproductive importance of an area to supplement information on general community structure provided by collections of adults and juveniles.

3.7.1.1.1 ADULT AND JUVENILE FISH

Adult and juvenile fish were collected from the Mississippi River during the 1978-79 surveys on May 25, July 17 to 19 and October 17 to 19, 1978, and January 12 to 14, 1979 (Appendix 3E). Collection methods used were electroshocking and baited hoop nets.

Table 3-57 shows that a total of 272 fish of 20 species, weighing 68,607 grams (151 pounds) were caught (see Appendix 3E, Section 3E.3.1.1). The most abundant fish species collected was gizzard shad (except in July when it was absent from the river collections), while the bulk of the total biomass was accounted for by river carpsucker and a relatively small number of bigmouth and black buffalo, carp and flathead and channel catfish. Few minnows or sport fish species were encountered, and there appeared to be little difference between catches at the two Mississippi River locations, upstream and downstream of Lake McKellar.

Hoop, gill and trammel nets and bag seines were used to collect adult and juvenile fish from several areas of the Mississippi River near West Memphis, Arkansas, and Memphis, Tennessee, during 1975-76.[3] Table 3-58 summarizes the catch. A total of 3171 fish (47 species) was collected, with dominant

TABLE 3-57

TOTAL NUMBER OF FISH COLLECTED IN THE MISSISSIPPI RIVER DURING MAY, JULY AND OCTOBER 1978 AND JANUARY 1979 SURVEYS BY MEANS OF ELECTROSHOCKING AND HOOP NETS

Scientific Name	Common Name	Number	Percent
Atherinidae			
Menidia audens	Mississippi silversides	1	0.4
Catostomidae			
Carpiodes carpio	River carpsucker	27	9.9
Ictiobus cyprinellus	Bigmouth buffalo	4	1.5
Ictiobus niger	Black buffalo	1	0.4
Centrarchidae			
Lepomis macrochirus	Bluegill	1	0.4
Pomoxis annularis	White crappie	1	0.4
Clupeidae			
Alosa chrysochloris	Skipjack herring	3	1.1
Dorosoma cepedianum	Gizzard shad	182	66.9
Cyprinidae			
Cyprinus carpio	Carp	3	1.1
Notemigus crysoleucas	Golden shiner	1	0.4
Notropis atherinoides	Emerald shiner	3	1.1
Notropis blennius	River shiner	1	0.4
Notropis volucellus	Mimic shiner	1	0.4
Hiodontidae			
Hiodon alosoides	Goldeye	15	5.5
Ictaluridae			
Ictalurus furcatus	Blue catfish	1	0.4
Ictalurus punctatus	Channel catfish	4	1.5
Pylodictus olivaris	Flathead catfish	4	1.5
Percichthyidae			
Morone chrysops	White bass	2	0.7
Percidae			
Stizostedion canadense	Sauger	2	0.7
Scicenidae			
Aplodinotus grunniens	Freshwater drum	15	5.5
TOTAL		272	100.2

TABLE 3-58

TOTAL NUMBER OF FISH COLLECTED IN THE MISSISSIPPI RIVER NEAR WEST MEMPHIS, ARKANSAS, DURING JUNE 1975 TO FEBRUARY 1976 SURVEYS USING GILL, TRAMMEL AND HOOP NETS AND BAG SEINES*

Scientific Name	Common Name	Number	Percent
Acipenseridae			
Scaphirhynchus platorynchus	Shovelnose sturgeon	27	.9
Amiidae			
Amia calva	Bowfin	3	<.1
Anguillidae			
Anguilla rostrata	American eel	3	<.1
Aphredoderidae			
Aphredoderus sayanus	Pirate perch	2	<.1
Atherinidae			
Labidesthes sicculus	Brook silversides	1	<.1
Menidia audeus	Mississippi silversides	5	.2
Catostomidae			
Carpiodes carpio	River carpsucker	472	14.9
Carpiodes cyprinus	Quillback	11	.3
Ictiobus bubalus	Smallmouth buffalo	51	1.6
Ictiobus cyprinellus	Bigmouth buffalo	2	<.1
Ictiobus niger	Black buffalo	7	.2
Minytrema melanops	Spotted sucker	3	<.1
Centrarchidae			
Centrarchus macropherus	Flier	1	<.1
Lepomis humilis	Orangespotted sunfish	77	.22
Lepomis macrochirus	Bluegill	12	.4
Pomoxis annularis	White crappie	31	1.0
Pomoxis nigromaculatus	Black crappie	4	.1
Clupeidae			
Alosa chrysochloris	Skipjack herring	19	.6
Dorosoma cepedianum	Gizzard shad	592	18.7
Dorosma petenense	Threadfin shad	34	1.1

* Adapted from data in Reference 3.

(Continued)

TABLE 3-58 (Continued)

Scientific Name	Common Name	Number	Percent
Cyprinidae			
Cyprinus carpio	Carp	135	4.3
Hybognathus nuchalis	Silver minnow	5	.2
Hybopsis aestivalis	Speckled chub	11	.3
Hybopsis storeriana	Silver chub	50	1.6
Notemigonus crysoleucas	Golden shiner	2	<.1
Notropis atherinoides	Emerald shiner	31	1.0
Notropis blennius	River shiner	718	22.6
Notropis lutrensis	Red shiner	3	<.1
Notropis shumardi	Silverband shiner	9	.3
Notropis venustus	Blacktail shiner	2	<.1
Notropis volucellus	Mimic shiner	35	1.1
Pimephales vigilax	Bullhead minnow	3	<.1
Hiodontidae			
Hiodon alosoides	Goldeye	71	2.2
Hiodon tergisus	Mooneye	7	.2
Ictaluridae			
Ictalurus melas	Black bullhead	2	<.1
Ictalurus nebulosus	Brown bullhead	1	<.1
Ictalurus punctatus	Channel catfish	413	13.0
Noturus flavus	Stonecat	1	<.1
Pylodictus olivaris	Flathead catfish	46	1.5
Lepisosteridae			
Lepisosteus osseus	Longnose gar	11	.3
Lepisosteus platostomus	Shortnose gar	11	.3
Percichthyidae			
Morone chrysops	White bass	10	.3
Morone mississippiensis	Yellow bass	18	.6
Percidae			
Percina shumardi	River darter	1	<.1
Stizostedion canadense	Sauger	60	1.9
Polyodontidae			
Polyodon spathula	Paddlefish	9	.3
Sciaenidae			
Aplodinotus grunniens	Freshwater drum	219	6.9
TOTAL		3171	<100.6

forms (those contributing greater than 5 percent of the total) being the river shiner, gizzard shad, river carpsucker, channel catfish and freshwater drum. Except for the catfish, sport fish were relatively uncommon, although substantial numbers of sauger were also collected.

These collections indicate that the fish community of the Mississippi River in proximity to the proposed site is dominated by rough and forage fish, with infrequent occurrences of warmwater sport fish.

3.7.1.1.2 ICHTHYOPLANKTON

Ichthyoplankton (fish eggs and larvae) were collected during daylight at approximately weekly intervals from March 15 to June 15, 1978 (Appendix 3E). Thirteen taxa of larvae were identified in samples from the Mississippi River, with clupeids (gizzard shad, threadfin shad, skipjack herring), suckers and freshwater drum most abundant. Densities were moderately low, averaging 9 to 15 larvae per 100 cubic meters, with transect MR1 (upstream of Lake McKellar) appearing to have slightly lower numbers than at MR2 (downstream of Lake McKellar). Nonparametric statistical tests disclosed no exceptional trends in larval densities calculated from catch data at these locations (Appendix 3E, Section 3E.3.1.2).

Comparison of one set of morning-evening collections indicated no pronounced differences in larval density with time of day.

In a study of ichthyoplankton in the middle Mississippi River performed in 1975 and 1976,[3] 25 taxa were identified, with dominance by freshwater drum, clupeids, carp and minnows. Densities reported for the West Memphis, Arkansas, area were approximately four times higher than those observed in the 1978-79 surveys (Appendix 3E). Larval density was also reported as being significantly lower in the West Memphis region of the river than that observed 55 river miles upstream, and significantly greater than densities observed 100 miles to the south, near Greenville, Mississippi.

3.7.1.2 BENTHIC MACROINVERTEBRATES

The most poorly known biological group in the middle and lower Mississippi River is the benthic macroinvertebrates,[1] bottom-dwelling invertebrate animals generally visible to the unaided eye. Available literature[2] indicates that important forms present include fly larvae (Diptera), mayfly nymphs (Ephemeroptera) and fingernail clams (Sphaeriidae). Caddisflies (Trichoptera) were notable for their absence from routine collections.[2]

During the May, July, October and January 1978-79 surveys, benthic macroinvertebrates were collected by ponar grab at three stations along a transect in the Mississippi River upstream of Lake McKellar (MR1) and one downstream of Lake McKellar (MR2 in Figure 3-36). Seasonal and local variation in species composition and abundance was apparent (Appendix 3E, Section 3E.3.2). In May, collections at MR1 were dominated by aquatic earthworms, while MR2 produced more insect larvae. Fauna was very sparse in July, when no animals were collected at MR1, and very few (mainly insects and the fingernail clam Musculium transversum) were collected at MR2. In the October collections, insect larvae (notably caddisflies of the family Hydropsychidae) were abundant at MR2 and accounted for the majority of organisms collected at MR1 (where total densities remained low). A decline in abundance was notable in January, with insect larvae again dominating the MR2 fauna as well as the MR1-A fauna, while immature aquatic earthworms comprised the entire samples at MR1-B and C.

Temporal variations in densities of the above collections seem to be related to a common life cycle for insects, in which terrestrial adults occur during the summer while autumn witnesses production of aquatic larvae. These larvae then decline in abundance due to death by predation and other causes.[4]

Bottom sediments were collected during the October 1978 survey for analysis of particle size distribution and organic content in an attempt to determine relationships between fauna and habitat. No distinct patterns were noted.

Synoptic surveys of benthic macroinvertebrates using a Shipek corer carried out in 1975 and 1976 included a site near West Memphis, Arkansas.[3] Total average densities reported for benthic fauna were five to ten times those reported from the 1978-79 surveys. This may have been due to the inclusion of a variety of habitats, including quiet backwaters, that provide better habitats for benthic organisms than the unstable sandy bottoms observed at MR1 and MR2. Dominant forms reported in the 1975-76 study were aquatic earthworms (Oligochaeta), caddisflies (Trichoptera), true flies (Diptera), clams (Pelecypoda) and mayflies (Ephemeroptera). It was also noted that the benthic fauna was more abundant and diverse at a collection area 55 miles upstream of the West Memphis area, while the fauna 100 miles downstream was less abundant and diverse.

3.7.1.3 PLANKTON

Plankton is a generic term referring to small (generally microscopic) organisms that are found freely floating in the water column. Although many forms are capable of behaviors (swimming, buoyancy control) that affect their location in the water, their small size makes their distribution dependent mainly upon water currents. The two main groups of planktonic organisms are zooplankton (animals) and phytoplankton (plants). Ichthyoplankton (fish eggs and larvae) are treated with adult and juvenile fish in Section 3.7.1.1.

3.7.1.3.1 ZOOPLANKTON

Zooplankton was sampled in May, July, October and January during the 1978-79 surveys in the Mississippi River near Lake McKellar using stratified oblique tows with an 80 micron mesh plankton net (Appendix 3E). Temporal variation in zooplankton density was apparent from these collections. Total density of zooplankton varied from about 300 organisms per cubic meter in July and October downstream of the confluence with Lake McKellar (MR2) to over 8500 organisms per cubic meter (MR1) in May. On the whole, rotifers (especially Brachionus and Keratella species) and copepods (nauplii and Cyclops sp.) dominated the collections. Ciliates (Carchesium sp.) were occasionally numerous at MR1, although in general there appeared to be little difference between the two Mississippi River locations sampled.

Dominant zooplankton species reported[2] from the middle and lower Mississippi River include rotifers of the genera Keratella, Polyartha and Trichocerca, and copepods of the genera Cyclops, Euclops, Paracyclops and Diaptomus.

An examination of the zooplankton near West Memphis, Arkansas, was included in a study of the biota of the middle Mississippi River conducted in 1975-76.[3] A centrifugal pump was used to sample surface waters. Although the dominant zooplankton groups were similar (copepods, especially nauplii, and rotifers), total densities (261,000 to over 3 million per cubic meter) were much higher than those found during the 1978-79 surveys. The authors also noted that their densities were higher than those observed farther south in the river.[3]

3.7.1.3.2 PHYTOPLANKTON

Populations of these microscopic plants are the best documented of all organisms in the Mississippi River, due to U.S. Public Health Service[5] and U.S. Geological Survey (USGS)[6] sponsored studies. It is thought that productivity of these organisms is severely restricted by the high turbidity of the Mississippi River, which reduces light penetration.[2]

In the 1958-61 study (a survey covering major water bodies country-wide),[5] the phytoplankton of the Mississippi was reported to be dominated by diatoms. The five most common species were Melosira ambigua, Stephanodiscus hantzschii, Melosira granulata, Stephanodiscus astraea v. minutula and Cyclotella meneghiana. The total density of phytoplankton generally varied between 300 and 3000 units per milliliter, with a total range of 100 to over 10,000 phytoplankton units per milliliter.

Limited phytoplankton data was gathered in association with other water quality information at the USGS gauging station at Memphis, Tennessee (river mile 730).[6] From November 1974 to September 1977, total density estimates ranged from approximately 1000 to 26,000 cells per milliliter, with maxima occurring in autumn and minima in winter. Diatoms (especially the genera Melosira and

Cyclotella) generally dominated the collections, although occasionally green algae (Scenedesmus sp., Tetrastrum sp.) or blue-greens (Anacystis sp., Lyngbya sp.) were abundant.

Subsurface phytoplankton samples collected near West Memphis, Arkansas, in 1975 and 1976[3] were also dominated by diatoms, followed by green algae and blue-green algae (dominant species were not reported). Total density varied from approximately 4000 organisms per milliliter in February to nearly 25,000 per milliliter in August.

During the 1978-79 surveys, phytoplankton was sampled by subsurface grabs at two Mississippi River transects upstream and downstream of the confluence of Lake McKellar (MR1 and MR2 on Figure 3-36) in May, July and October and January (Appendix 3E). Total density (number of cells per milliliter) of individual samples varied from approximately 200 in January to over 1600 in October. Dominant taxa varied with season, but there appeared to be little difference between sampling transects. In May, blue-green algae (Schizothrix calcicola, Aphanizomenon flos-aquae and Oscillatoria sp.) predominated, although diatoms (especially Melosira granulata) were also relatively abundant. In July, Melosira granulata was the most abundant form, followed by the flagellate Chroomonas sp.; blue-green algae were sparse except for an indeterminate form. October collections were most diverse, but seemed to be dominated by green algae (especially Scenedesmus dimorphus, Actinastrum hantzschii and an unidentified species), followed by the diatoms Cyclotella meneghiana and Melosira granulata and the blue-green alga Aphanizomenon flos-aquae. The sparse January collections were dominated by the blue-green Aphanizomenon flos-aquae and Schizsothrix calcicola. These collections appear indicative of moderately organically enriched water.

3.7.1.4 PERIPHYTON

Periphyton is a generic term that refers to organisms living attached to surfaces of submerged substrates such as plant stems, logs and rocks. In practice it is usually the algal component of this community that is of most interest.

Periphyton of the Mississippi has not been addressed to any substantial degree. This community is probably very limited in extent due to such factors as the turbidity of the water, which inhibits photosynthesis, and the scouring action of this fast-moving river.

Periphyton was scraped from natural substrates in the Mississippi River near the shorelines of transects above and below the confluence of Lake McKellar (MR1 and MR2 in Figure 3-36) during the July 1978 aquatic field survey (Appendix 3E). Total density varied from approximately 20,000 to 9 million periphyton units (one individual, one colony or one filament of cells, depending upon the species) per 10.5 square centimeters. Transect MR2 samples were higher in density (mean of 6.5×10^6 units per 10.5 square centimeters) than those collected at MR1 (mean 1.6×10^6 units per 10.5 square centimeters). Diatoms dominated the samples, with an unidentified Navicula species most similar to Navicula tripunctata var. schizonemoides the most abundant form. The blue-green alga Schizothrix calcicola was also moderately abundant, as were certain green algae (Microspora stagnarum and Stigeocloneum sp.) at MR1.

In general, these assemblages appear indicative of slightly alkaline water and moderate to high levels of organic enrichment.

3.7.1.5 MACROPHYTES

No macrophytes (larger aquatic plants) were observed growing in the water of the Mississippi River during the 1978-79 surveys. The scouring action of the water current, the characteristically fluctuating water levels and the high turbidity of the Mississippi make it unsuitable for such organisms.

3.7.2 LAKE MCKELLAR

Literature information on the aquatic organisms of Lake McKellar is very sparse. This section describes the results of site-specific 1978-79 surveys conducted during May, July and October 1978 and January 1979 (details of surveys are presented in Appendix 3E). Also discussed is information from

studies conducted relative to the Tennessee Valley Authority's Allen Generating Plant, southeast of the proposed IFGDP site (see Figures 3-35 and 3-36).

Approximate locations of sampling transects and stations used during 1978-79 surveys in Lake McKellar are shown in Figure 3-36 (precise locations varied somewhat with parameter and water level, see Appendix 3E). Transect LM1 extended across the entrance to Lake McKellar, known as the Tennessee Chute, adjacent to the northern border of the proposed site. The U.S. Army Corps of Engineers routinely dredges this waterway to maintain a navigation channel into Memphis Harbor (Figure 3-35). Banks have gradual slopes with farmland to the north and a wooded area to the south.

Transect LM2 was located across a dredged area south of the proposed site, between the site and the Allen Generating Plant. This waterway is used as a turning basin for watercraft supplying materials to the generating plant. Shorelines are sandy, steep on the north and gently sloping on the south. A heavily wooded area, often inundated with water, borders this basin's western edge.

In general, the biota of Lake McKellar (described below) is characteristic of warm backwaters, with regular dredging affecting some components of the ecosystem. The fish community is a varied, warmwater type dominated by rough and forage fish, although a number of sportfish are also present. Lower water velocities allow more abundant and diverse bottom-dwelling fauna and zooplankton assemblages than in the Mississippi River, but all types of vegetation are restricted by the reduced light penetration due to high turbidity (see Appendix 3A).

3.7.2.1 FISH

As in Section 3.7.1.1, discussion of adult and juvenile fish of Lake McKellar is separated from that of ichthyoplankton.

3.7.2.1.1 ADULT AND JUVENILE FISH

Adult and juvenile fish were collected quarterly (May, July, October and January) during the 1978-79 surveys in shoreline areas of the Tennessee Chute (LM1) and turning basin (LM2), using gill nets and an electroshocker (Appendix 3E). Table 3-59 summarizes the numerical catch, listing a total of 988 fish representing 37 species. These fish weighed a total of 177,146 grams (390 pounds). Gizzard shad was the most abundant fish species collected, contributing an average of 55 percent of the total number of fish, followed by threadfin shad (8.2 percent) and longear sunfish (6.3 percent). A number of sport fish species were collected, including largemouth bass, sauger, white bass, yellow bass, channel catfish, sunfish and crappies.

Table 3-59 suggests some differences between transects, with LM2 accounting for 61 percent of the catch and LM1 only 39 percent. This appears to be due to some differences among less abundant taxa, notably the greater catches of longear sunfish, largemouth bass, bluegill and white crappie in the turning basin (LM2). Furthermore, in three seasons out of four, station LM2-A (northern shoreline of the turning basin) yielded substantially more fish than LM2-B (Appendix 3E, Section 3E.3.1.1).

Some seasonal variation in catches was noticeable. July collections had more species than others, and January collections consisted predominantly of relatively low numbers of larger fish, especially bigmouth buffalo. In general, however, the predominance of gizzard shad and, in the turning basin, centrarchids (sunfish) was relatively consistent.

Similarity between stations within each season was analyzed using cluster analysis (Appendix 3E, Section 3E.3.1.1). Stations (A and C) within transects clustered together, except during October when much variation in species composition between stations was evident.

Fish impingement at the Allen Generating Plant was studied from August 1974 to July 1976.[7] Fish were collected from traveling screens at the water intake

TABLE 3-59

TOTAL NUMBER OF FISH COLLECTED IN LAKE MCKELLAR DURING MAY, JULY AND OCTOBER 1978 AND JANUARY 1979 SURVEYS BY MEANS OF ELECTROSHOCKING AND GILL NETS

	Location*					
	LM1		LM2		Total	
Common Name	Number	Percent	Number	Percent	Number	Percent
Brook silverside	1	0.3	4	0.7	5	0.5
Mississippi silverside	8	2.1	22	3.6	30	3.0
River carpsucker	4	1.0	13	2.2	17	1.7
Quillback	1	0.3			1	0.1
Smallmouth buffalo			4	0.7	4	0.4
Bigmouth buffalo	14	3.6	13	2.2	27	2.7
Black buffalo			5	0.8	5	0.5
Flier			1	0.2	1	0.1
Green sunfish	1	0.3			1	0.1
Orangespotted sunfish	3	0.8	2	0.3	5	0.5
Bluegill	1	0.3	10	1.7	11	1.1
Dollar sunfish	4	1.0	2	0.3	6	0.6
Longear sunfish	3	0.8	59	9.8	62	6.3
Redear sunfish			1	0.2	1	0.1
Largemouth bass	2	0.6	17	2.8	19	1.9
White crappie	3	0.8	10	1.7	13	1.3
Black crappie	1	0.3	3	0.5	4	0.4
Skipjack herring	4	1.0	15	2.5	19	1.9
Gizzard shad	255	66.2	288	47.8	543	55.0
Threadfin shad	8	2.1	73	12.1	81	8.2
Carp	2	0.6	3	0.3	5	0.5
Golden shiner	3	0.8	17	2.8	20	2.0
Emerald shiner	6	1.6	2	0.3	8	0.8
Red shiner	6	1.6			6	0.6
Silverband shiner	2	0.6			2	0.2
Bullhead minnow	12	3.1	2	0.3	14	1.4
Goldeye	1	0.3	4	0.7	5	0.5
Blue catfish	1	0.3	4	0.7	5	0.5
Channel catfish	5	1.3	7	1.2	12	1.2
Flathead catfish	2	0.6			2	0.2
Spotted gar	1	0.3	2	0.3	3	0.3
Shortnose gar	5	1.3	4	0.7	9	0.9
Rainbow smelt			1	0.2	1	0.1

(Continued)

TABLE 3-59 (Continued)

Common Name	Location* LM1 Number	LM1 Percent	LM2 Number	LM2 Percent	Total Number	Total Percent
White bass	7	1.8	3	0.5	10	1.0
Yellow bass			2	0.3	2	0.2
Sauger	7	1.8	8	1.3	15	1.5
Freshwater drum	12	3.1	2	0.3	14	1.4
TOTAL	385	100.6	603	101.0	988	99.7

* See Figure 3-36 for approximate locations, and Appendix 3E, Section 3E.3.1.1 for details.

of the plant near the mouth of the turning basin (east of LM2 in Figure 3-36). Threadfin shad and gizzard shad accounted for 92.5 percent of the total number of fish impinged, while freshwater drum made up 5.4 percent of the total. Other fish species, most of which were also collected during the 1978-79 surveys and in other studies of the area (see Tables 3-57, 3-58 and 3-59), were impinged in relatively low numbers. It was also noted that young of the year paddlefish comprised a substantial proportion of the catch. These data indicate that the turning basin contains a variety of fish species with domination by the shads.

In summary, available information indicates that Lake McKellar harbors a varied assemblage of warmwater fishes, predominantly forage fish such as shads. Several sportfish species occur, although only members of the sunfish family (small sunfishes, crappie, largemouth bass) appear to make a more than minor contribution to the total fauna.

3.7.2.1.2 ICHTHYOPLANKTON

Fish eggs and larvae were collected near both shorelines of each transect in Lake McKellar (LM1 and LM2 on Figure 3-36) during the 1978-79 surveys (Appendix 3E). Samples were collected during daylight hours 14 times from March 15 to June 15. No larvae appeared until April 5, when one sucker larva was caught at the southern station (C) of LM1. Over the period from April 5 to June 15, the average density was approximately 17 eggs and larvae per 100 cubic meters.

Nonparametric statistical tests were applied to calculated densities of total catch and selected single taxa to compare sampling locations (Appendix 3E, Section 3E.3.1.2. No significant differences were observed between stations for total catch. Similarly, neither the predominant taxon (the gizzard shad, threadfin shad, skipjack herring group) nor freshwater drum exhibited differences between stations. Larvae of the sunfish family (largemouth bass and crappie as well as common sunfishes) were significantly more abundant in the turning basin (LM2 area), while sucker larvae were absent from that area. The observation that all fish eggs collected were from the Tennessee Chute area (LM1) was statistically untestable due to the small number of times they were encountered.

A single dawn-dusk comparison survey was performed on July 8, 1978 (Appendix 3E). A single comparison cannot be considered definitive, but the following observations were made: (1) no differences were noted between day and night samples at LM1 (Tennessee Chute), (2) larval densities at LM2-A and LM2-C during the day were similar to each other and about double those at the LM1 stations (due to a substantial contribution to catches at the LM2 stations by sunfish larvae) and (3) a 10- to 15-fold increase in calculated densities occurred at night at LM2, due to increased catches of both clupeids and sunfish larvae.

Ichthyoplankton in Lake McKellar was studied in April to July 1975 as part of a 316(b) demonstration for the Allen Generating Plant.[8] As in the 1978-79 surveys, samples taken from Lake McKellar were dominated by clupeidae larvae, followed by freshwater drum. Minnow, sucker and sunfish larvae were minor components of the catch. Densities reported in the study were slightly higher than those observed during the 1978-79 surveys (up to 100+ organisms per 100 cubic meters).

The moderately high densities of larvae collected indicate that Lake McKellar serves as a nursery area for a number of forage fish species as well as some commercially attractive species (i.e., freshwater drum, paddlefish). In addition, data from the 1978-79 surveys indicate that the turning basin area (LM2) is a sunfish nursery area. There is no evidence indicating the lake is an important gamefish nursery area.

3.7.2.2 BENTHIC MACROINVERTEBRATES

Bottom-dwelling invertebrate animals were sampled from Lake McKellar during the 1978-79 surveys in May, July, October and January (Appendix 3E). Ponar grab was used to collect samples at each of three stations (A, B, C) across transects LM1 and LM2 (Figure 3-36). Bottom sediments were also collected during the October survey for analysis of particle size distribution and organic content.

Collections were dominated by aquatic earthworms (Tubificidae), especially immature forms (Appendix 3E, Section 3E.3.2). Appreciable numbers of aquatic insects were also collected, notably nonbiting midge (Chironomidae) and phantom midge (Chaoboridae) larvae. Small numbers of burrowing mayflies (Ephemeridae) were also found. Fingernail clams (Musculium spp.) and other mollusks were also collected, but only at transect LM1. Most of these organisms characteristically burrow into soft sediments and feed on detritus, which was substantiated by sediment analyses. Sandy-silty bottoms predominated in Lake McKellar, with organic contents generally below 30 percent of total weight.

Total density of organisms was usually greater than that in the Mississippi River, ranging from 6 to over 5000 organisms per square meter of bottom, with considerable variation between samples (Appendix 3E). Few generalities emerged from the data, except that benthic populations appeared depressed during the January collection period. In addition, seasonal cluster analyses of indices of similarity between samples (based on species composition and abundance) indicated that samples from near the north and south shores of the turning basin (LM2-A and LM2-C) were usually quite similar (Appendix 3E, Section 3E.3.2). These analyses also supported the general impression of variability among samples.

3.7.2.3 PLANKTON

As in Section 3.7.1.3, the plankton of Lake McKellar is separated into animals (zooplankton) and plants (phytoplankton) for discussion.

3.7.2.3.1 ZOOPLANKTON

Eighty-micron mesh plankton nets were towed in a stratified oblique fashion in mid-channel near transects LM1 and LM2 during the 1978-79 surveys conducted in May, July, October and January (Appendix 3E). Total density of zooplankters varied from 10,000 to nearly 200,000 organisms per cubic meter and were always considerably higher than those observed in the Mississippi River. Densities were highest in May and July and declined in the October and again

in the January samples. Densities were several times higher at transect LM2 (turning basin) than at LM1 (Tennessee Chute), except in January when densities were similar.

Dominant forms were generally similar between stations but showed seasonal variations. Copepod nauplii (very young stages) was usually the most abundant taxon. In May, immature copepods (especially Cyclops sp.) and the cladocerans Daphnia parvula and Bosmina longirostris were also abundant. In July, rotifers increased in abundance (notably Conochilus unicornis, Pedalia mira and Keratella cochlearis) as most crustaceans declined. The cladoceran Diaphanosoma leuchtenbergianum, however, was abundant. A ciliate, Codonella sp., also was abundant at LM2. Most of these organisms are relatively small forms, suggesting that increased fish predation on larger forms during the warm months may have been affecting zooplankton community structure.[9]

In October, crustaceans such as Bosmina longirostris and juvenile Diaptomus sp. increased in abundance at LM2, but not at LM1, while nauplii and rotifer densities remained high. January collections showed an overall decline in zooplankton abundance as rotifer, cladoceran and (to a lesser extent) copepod populations reacted to cooler winter temperatures. The ciliate Carchesium sp. was abundant in one sample from transect LM1.

Zooplankton entrainment at TVA's Allen Generating Plant was monitored on May 21 and 22, 1974,* providing some additional information on the populations in Lake McKellar. Results were similar to those obtained during the 1978-79 surveys: density estimates ranged from 37,000 to 70,000 organisms per cubic meter, with dominance by immature copepods and immature Daphnia sp.

In summary, the zooplankton of Lake McKellar is abundant and generally dominated by crustaceans (cladocerans and copepods). Rotifers and ciliates are occasionally abundant.

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* Unpublished data, D. Dycus, Tennessee Valley Authority

3.7.2.3.2 PHYTOPLANKTON

Water was collected from subsurface, mid-depth and near-bottom at mid-channel of transects LM1 and LM2 during the quarterly 1978-79 surveys (Appendix 3E). A mixed assemblage of diatoms, green algae, blue-green algae and a variety of other smaller groups (cryptomonads, euglenoids, etc.) was found, with seasonal and spatial variation in community composition.

In the May 1978 samples, densities averaged 493 organisms per milliliter, with the flagellate Cryptomonas ovata dominant. Densities were higher in the July samples, averaging 3523 organisms per milliliter; the blue-green alga Schizothrix calcicola predominated. In October, densities fell to an average of 1823 organisms per milliliter sampled, with a variety of algal types commonly encountered. Schizothrix calcicola again dominated the relatively sparse samples (average 251 organisms per milliliter) collected in January 1979. In all of the collections, a number of other species were well represented, including Cyclotella meneghiana, Melosira granulata, M. binderana, Stephanodiscus hantzschii, Scenedesmus dimorphus, S. quadricauda, Aphanizomenon flos-aquae, Actinastrum hantzschii and Chroomonas sp.

These phytoplankton assemblages are generally indicative of moderate levels of organic enrichment.

3.7.2.4 PERIPHYTON

The periphyton community in Lake McKellar was sampled in July 1978 (Appendix 3E). Samples were scraped from predominant natural substrates (submerged tree stumps, trunks, etc.) on the shorelines adjacent to the proposed site (LM1-C and LM2-A in Figure 3-36).

A total of 59 taxa were collected in Lake McKellar, 52 of which were diatoms (Appendix 3E, Section 3E.3.5). An unidentified member of the genus Navicula dominated all samples. This species appeared to be most similar to Navicula

tripunctata var. schizonemoides,* which is considered to prefer water with a fairly high mineral content. The green alga Oedogonium sp. and the blue-green Oscillatoria sp. were locally abundant taxa. Other commonly encountered species were the diatoms Cyclotella meneghiana, C. stelligera, Gomphonema parvulum, Melosira distans, M. granulata, Nitzschia palea and Stephanodiscus astraea var. minutula. There were only minor variations in species composition of collections between stations.

In general, the periphyton community in Lake McKellar was indicative of slightly alkaline, moderately to highly organically enriched conditions.

3.7.2.5 MACROPHYTES

No larger aquatic plants were observed or collected from Lake McKellar in the vicinity of transects LM1 and LM2 during the 1978-79 surveys (Appendix 3E). Lake fluctuations and high turbidity probably inhibit these organisms.

3.7.3 THREATENED AND ENDANGERED AQUATIC SPECIES

No species included in either the U.S. Fish and Wildlife Service's[10] or the Tennessee Wildlife Resources Agency's[11] list of threatened and endangered species were encountered in Lake McKellar or the Mississippi River during the 1978-79 surveys, nor were any noted in other studies reported upon here.

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* Based on information from personal communication between D. J. Wagner, EIA, and R. Lowe, Bowling Green State University, May 9, 1979.

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3.8 LAND USE CHARACTERISTICS

In this section, land use is examined for both the site and the surrounding region (Shelby County). Land use controls applicable to the site are also discussed.

3.8.1 EXISTING AND PROJECTED SITE LAND USE

The site is owned by MLGW, but is currently not in productive use. Under current zoning classifications, the site is within an M-3 or heavy industrial district. Other industrial facilities are adjacent to the site such as the Allen Generating Plant and T. E. Maxson Wastewater Treatment Plant. The M-3 classification extends to the areas south of the site which make up the Frank C. Pidgeon Industrial Park. Figure 3-38 depicts the zoning classifications in the immediate vicinity of the site. In 1977, a report prepared for the Mississippi-Arkansas-Tennessee Council of Governments projected land use at the site as nonurban.[1]

3.8.2 EXISTING AND PROJECTED REGIONAL LAND USES

In this section, regional (i.e., Shelby County) land uses are discussed categorically.

3.8.2.1 URBANIZED AREAS

The primary urbanized area within Shelby County is the City of Memphis. In 1970, Memphis accounted for 37 percent of the county's area (281 of 755 square miles).[2] Other urbanized areas (1970 population of 2500 or greater) in Shelby County include the cities of Collierville, Germantown and Millington.[3] If population change follows projected trends within the county, an increasing share of urbanized land will result.

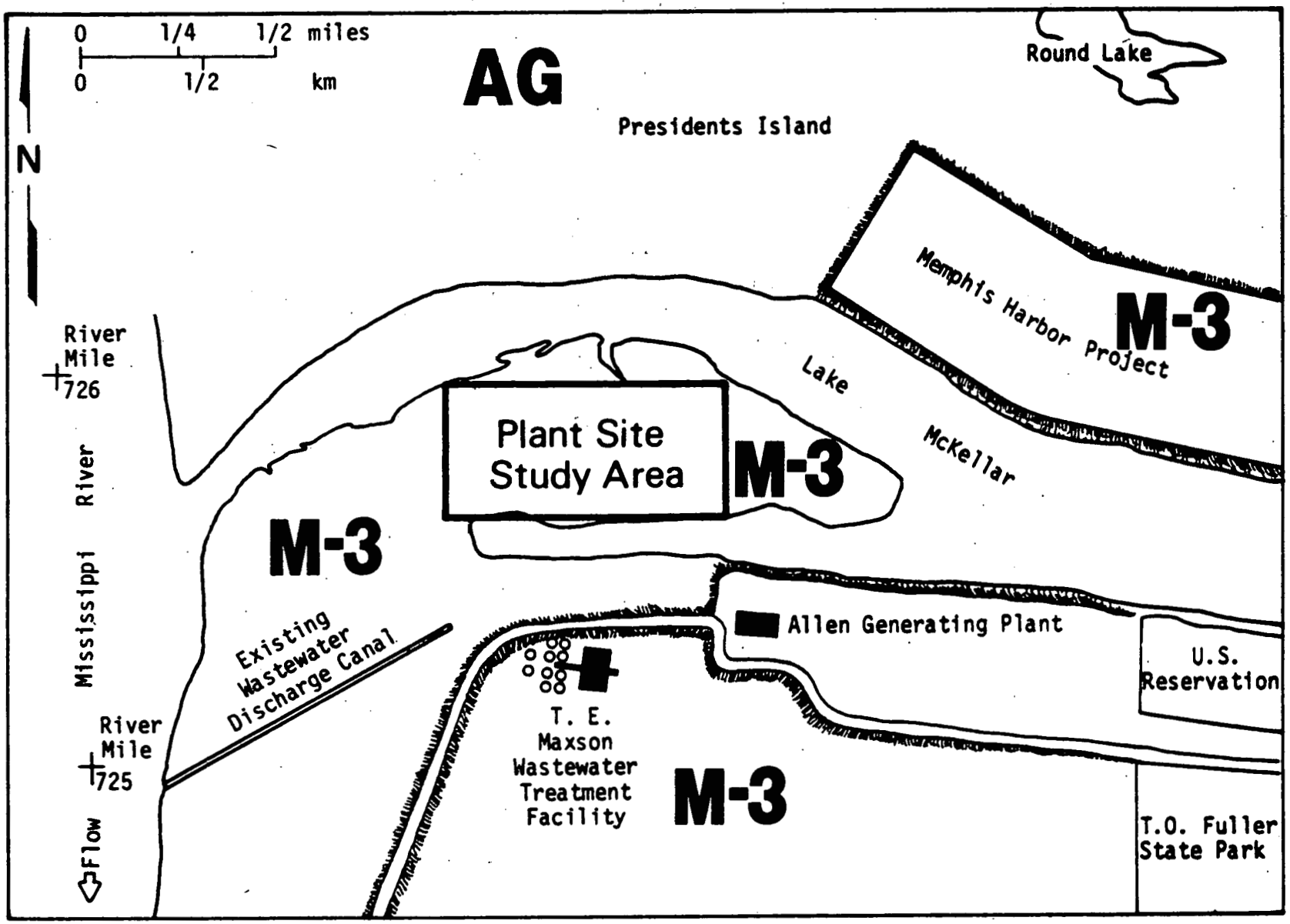

Figure 3-38. Zoning Classifications in the Vicinity of the IFGDP Site

3.8.2.2 INDUSTRIAL LAND USE

A wide range of industrial sites, both public and private, are found within Memphis and Shelby County. Existing and future industrial sites are also numerous in the general vicinity of the IFGDP site: the Presidents Island Complex, Frank C. Pidgeon Industrial Park and Rivergate Industrial Complex and others. These facilities are shown in Figure 3-39. Major growth is projected to take place in industrial land use over the next two decades. By the mid-1990's, this land use category is expected to double in area in Shelby County.*

3.8.2.3 AGRICULTURE

Agricultural land use is a primary constituent of the regional economy. In 1974, nearly 228,000 acres or 47.2 percent, of Shelby County's total area of 483,000 acres consisted of farms. The amount of farmland is down from 1969, when it totaled over 249,000 acres, or 51.5 percent. Primary crops in the county are soybeans and cotton, with substantially less importance placed on livestock, vegetables and corn. The major markets for soybeans and cotton are within the Memphis-Shelby County region.**

3.8.3 LAND USE CONTROLS

Primary land use controls affecting the IFGDP site are the zoning regulations prepared by the Memphis and Shelby County Planning Commission. Development and use of land in the county are regulated according to the specific district zoning assigned to an area. Sixteen zoning classifications are in use in the county, covering residential districts, office districts, shopping/commercial districts, wholesale districts, industrial districts and agricultural districts. As mentioned earlier, the site is in a district zoned for heavy industrial use (M-3).

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* Based on unpublished data through Memphis State University, Bureau of Business and Economic Research from Mississippi-Arkansas-Tennessee Council of Governments and Memphis Delta Development District, Memphis, Tennessee, 1978.

** Based on personal communication between G.C. Pangburn, EIA, and R. Wilkerson, Shelby Agricultural Extension Service, June 18, 1979.

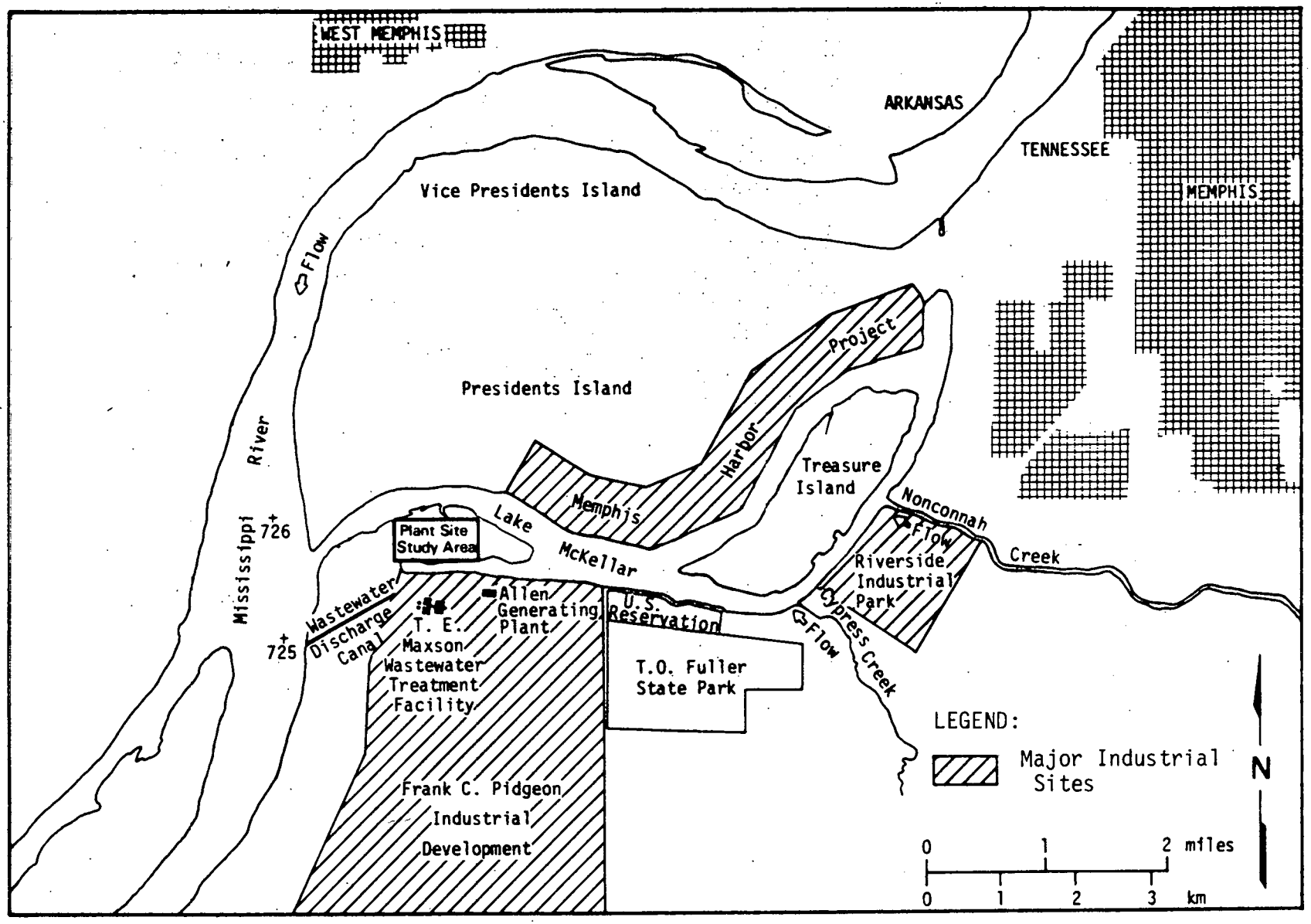

Figure 3-39. Major Industrial Sites in Proximity to the IFGDP Site

3.9 DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS

The purpose of this section is to provide an understanding of socioeconomic conditions and trends needed for predicting the impact of construction and operation of the IFGDP. The socioeconomic section of this report will examine data from a two-tiered study area. Assessments of the general labor force in the area, the general availability of housing accommodations in the area and accessibility to the construction site are the criteria for determining the study area. Based on these factors, the first tier was selected to be Shelby County, Tennessee. This immediate area is where most of the socioeconomic impact from the construction and operation of the proposed facility will fall. Also considered is a second tier, as part of the general study area in this analysis, the Memphis Standard Metropolitan Statistical Area (SMSA).* The Memphis SMSA includes Shelby County, Tennessee, as well as Crittenden County, Arkansas, and DeSoto County, Mississippi. Although the impact to these bordering counties will be even less significant than the impact to Shelby County, they are included because of the availability of data and for consistency in presentation.

The degree of socioeconomic changes felt in the area depends on the size of the construction and operations workforce and, most importantly, the number of people who will relocate in the area.

Since there is an abundance of labor within the Memphis and Shelby County area suitable to fill the positions created by the construction and operation of the proposed plant, little relocation is expected. Interviews were conducted with relevant union officials and Human Resources Development Institute representatives in Memphis to determine the availability of labor. Although the number of unemployed laborers of each union can vary widely, the unanimous opinion was that the newly created jobs could be filled from the Shelby County

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* The Memphis SMSA is considered as the study area in this analysis, except where otherwise noted, due to the fact that projections given by the Regional Economic Projections Series are based on the area encompassed by the Memphis SMSA. The Memphis SMSA includes Crittenden County, Arkansas; Shelby County, Tennessee; and DeSoto County, Mississippi.

labor force. Therefore, no significant amount of labor will need to be brought into Shelby County. As a result, there will be little, if any, additional demand for housing created within Shelby County. An ample supply of housing exists today within the Shelby County area. The general consensus is that there will be no shortage in the foreseeable future.

Another important consideration in limiting the immediate study area to Shelby County was accessibility to the IFGDP site. It can only be reached by passing through Shelby County. If relocation of any segment of the labor force is required, relocating families would probably select Shelby County as their choice of residence, given travel times and highway site. Finally, in outlining the study area, the political entities which could be affected by immigrating workers for the project were identified. Within Shelby County, there are five incorporated municipalities. These areas are considered separately throughout this analysis, in addition to consideration of the political entity of the Shelby County government. These incorporated areas are the cities of Memphis, Bartlett, Collierville, Germantown and Millington.

Based on the assessment of these criteria, the immediate study area will be confined to within the county lines of Shelby County. Any leakage of relocators into other counties will have so minor an effect that the impact would be negligible.

3.9.1 DEMOGRAPHIC CHARACTERISTICS: 1960 TO 1990

The purpose of this section is to describe the baseline demographic characteristics, past, present and forecasted for the Memphis and Shelby County area. In this section, population trends, projections and areas of growth are presented along with age, sex and racial composition of the population in the general area. It should be noted that this area is urbanized and well populated and, in general, has been increasing in population. This trend is expected to continue.

Table 3-60 shows that the total population of the Memphis SMSA is projected to reach 1,077,200 by 1990, an increase of 28.8 percent over the 1970 total of

TABLE 3-60

TOTAL RESIDENT POPULATION BY AGE AND SEX
FOR THE MEMPHIS SMSA, 1960 TO 1990 (1)

Sex	Age	Population (Thousands) 1960	1965	1970	1975	1980	1985	1990
Total	Total	728.9	788.5	835.2	873.8	933.5	1012.4	1077.2
	0-4	93.7	88.9	75.8	70.3	77.0	87.1	88.1
	5-9	85.7	92.1	88.4	77.0	73.1	81.0	90.0
	10-14	72.3	84.8	92.2	89.3	79.2	76.4	83.5
	15-19	57.4	72.4	87.1	94.2	93.3	84.3	80.6
	20-24	46.5	59.7	72.9	85.6	94.5	94.9	85.3
	25-34	95.6	95.4	105.4	127.1	154.4	179.5	187.7
	35-44	92.8	94.9	91.7	89.9	102.4	128.1	155.4
	45-54	76.2	78.7	86.3	92.1	92.1	93.8	106.2
	55-64	54.2	60.6	66.9	70.1	78.6	86.9	87.3
	65+	54.1	61.1	68.4	78.1	88.9	100.3	113.1
Male	Total	352.2	380.6	401.8	419.3	447.0	484.1	514.6
	0-4	47.1	45.0	38.4	35.7	39.1	44.2	44.7
	5-9	43.3	46.4	44.8	39.0	37.0	41.0	45.6
	10-14	36.3	43.0	46.5	45.2	48.1	38.8	42.3
	15-19	29.9	37.5	45.2	48.5	48.2	43.6	41.8
	20-24	21.7	29.8	35.1	41.5	45.7	46.1	41.3
	25-34	44.5	42.9	50.2	62.0	74.2	86.2	90.1
	35-44	44.2	45.0	42.6	41.1	49.3	62.9	74.8
	45-54	36.3	37.5	40.7	43.1	42.5	42.7	50.8
	55-64	25.5	28.3	30.8	32.4	36.3	39.9	39.6
	65+	23.5	25.2	27.6	30.8	34.6	38.7	43.5
Female	Total	376.7	408.8	433.4	454.4	486.5	528.3	562.6
	0-4	46.6	43.9	37.4	34.6	38.0	42.9	43.4
	5-9	42.4	45.7	43.7	38.0	36.0	40.0	44.4
	10-14	36.0	41.8	45.7	44.1	39.1	37.7	41.2
	15-19	27.5	34.9	42.0	45.8	45.1	40.7	38.8
	20-24	25.2	29.9	37.8	44.1	48.8	48.8	44.0
	25-34	51.1	52.4	55.2	65.0	80.3	93.3	97.5
	35-44	48.6	49.9	49.1	48.8	53.0	65.2	80.7
	45-54	39.9	41.2	45.6	49.0	49.5	51.1	55.3
	55-64	28.7	32.3	36.1	37.7	42.3	47.1	47.8
	65+	30.6	35.9	40.8	47.3	54.3	61.5	69.6

835,200. The geographic boundaries of the Memphis SMSA are shown in Figure 3-40. For the years 1980, 1985 and 1990, the 25 to 34 age group will be the largest, with the 35 to 44 age group following close behind. The only age group which will show any significant decreasing trend will be the 15 to 19 age group.

The female population is projected to reach 562,600 in 1990, an increase of 29.8 percent since 1970. Females will account for 52.2 percent of the total population as compared to the 1970 figure of 51.9 percent.

Males are expected to account for 47.8 percent of the population in 1990 as compared to the 1970 figure of 48.1 percent. The white male population in 1990 will account for 65.1 percent of the total male population as compared to 63.7 percent in 1970.

The nonwhite population of the area is expected to reach 390,800 in the year 1990, an increase of 25.6 percent over the 1970 figure. Table 3-61 shows that the white population is expected to reach 686,400 in 1990, an increase of 31.0 percent over the 1970 figure.

The components of total resident population change for the years 1960 to 1990 are shown in Table 3-62. Until the present time, the increase in total population was due to a natural increase which compensates for the net out-migration. However, in the future, in-migration will account for a significant amount of the population change.

Table 3-63 lists the historical and projected number of total households, families and unrelated individuals by type and age for the years 1960 to 1990. The total number of households will increase by just over 100 percent by the year 1990, while the number of consumer units will increase by 96.8 percent.

The terms used in Table 3-63 are defined in the Dictionary of Economic and Statistical Terms published by the U.S. Department of Commerce. Consumer units include the head of the household and immediate relatives which make

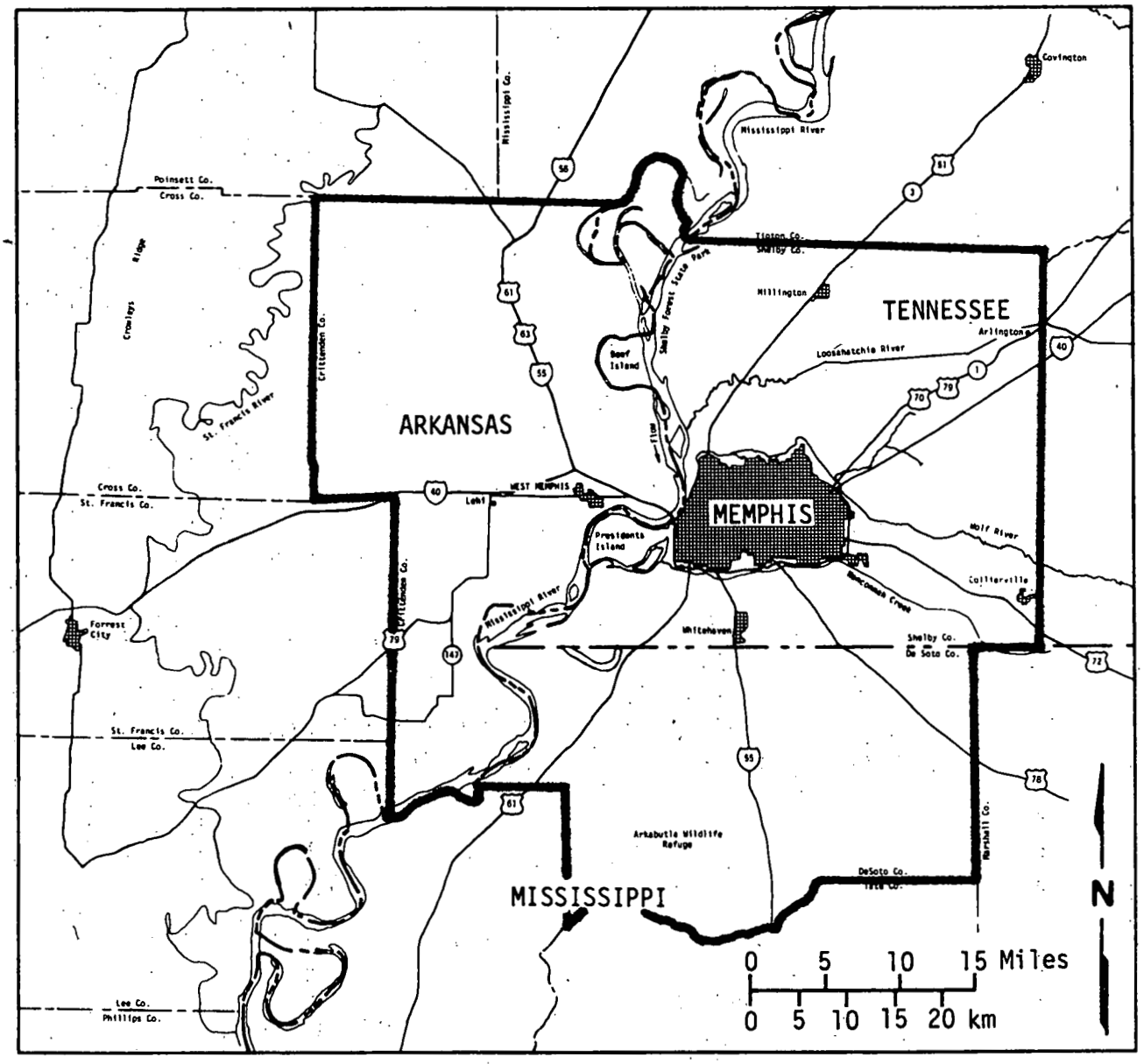

Figure 3-40. Constituent Counties of the Memphis Standard Metropolitan Statistical Area

TABLE 3-61

TOTAL RESIDENT POPULATION BY RACE FOR THE MEMPHIS SMSA: 1960 TO 1990[1]

	Population (Thousands)						
	1960	1965	1970	1975	1980	1985	1990
Total Population	728.9	788.5	835.2	873.8	933.5	1012.4	1077.2
White Population	445.8	488.2	524.1	551.9	592.0	644.2	686.4
Nonwhite Population	283.1	300.3	311.1	321.9	341.5	368.2	390.8

TABLE 3-62

COMPONENTS OF TOTAL RESIDENT POPULATION CHANGE FOR THE MEMPHIS SMSA, 1960 TO 1990[1]

Component	Population (Thousands)					
	1960 to 1965	1965 to 1970	1970 to 1975	1975 to 1980	1980 to 1985	1985 to 1990
Population at beginning of period	728.9	788.5	835.2	873.8	933.5	1012.4
Births	98.0	85.3	79.0	84.4	93.6	95.7
Deaths	33.8	35.7	38.1	40.4	43.9	48.1
Natural Increase	64.2	49.6	41.0	44.0	49.7	47.6
Net Migration	-4.6	-2.9	-2.4	15.7	29.2	17.2
Net Change	59.6	46.7	38.5	59.7	78.9	64.9
Population at end of period	788.5	835.2	873.8	933.5	1012.4	1077.2

TABLE 3-63

TOTAL HOUSEHOLDS, FAMILIES AND UNRELATED INDIVIDUALS, BY TYPE AND AGE, FOR THE MEMPHIS SMSA, 1960 TO 1990[1]

Household Type		Population (Thousands) 1960	1970	1980	1990
Households		200.5	244.1	316.8	402.1
Total Families		172.9	201.6	252.6	313.0
Age of Head:	00-34 (yrs)	50.6	62.4	90.7	105.7
	35-44	44.0	43.8	51.0	77.9
	45-64	59.4	71.7	80.2	92.2
	65+	19.0	23.7	30.7	37.2
Husband-Wife Families		146.4	165.8	203.0	247.2
Age of Head:	00-34 (yrs)	44.8	53.4	73.1	81.0
	35-44	38.0	35.6	39.9	59.4
	45-64	49.4	58.9	65.9	76.6
	65+	14.2	18.0	24.1	30.2
Other Male-Headed Families		5.1	5.8	5.8	7.5
Age of Head:	00-34 (yrs)	1.1	1.2	1.4	1.7
	35-44	1.0	1.1	1.2	2.1
	45-64	1.9	2.3	2.2	2.7
	65+	1.1	1.1	1.0	1.1
Female-Headed Families		21.4	30.0	43.8	58.3
Age of Head:	00-34 (yrs)	4.7	7.8	16.2	23.1
	35-44	5.0	7.0	10.0	16.4
	45-64	8.0	10.5	12.1	13.0
	65+	3.7	4.6	5.5	5.8
Unrelated Individuals		38.5	56.6	80.5	103.3
Male		14.3	22.2	33.7	44.8
Female		24.2	34.3	46.8	58.5
Primary Individuals		27.9	43.1	64.9	89.6
Male		9.0	15.1	23.8	34.6
Female		19.0	27.9	41.0	55.0
Secondary Individuals		10.6	13.5	15.6	13.7
Male		5.3	7.1	9.9	10.1
Female		5.2	6.4	5.7	3.5
Consumer Units		211.5	258.1	333.1	416.3

up the primary family. Also included is the secondary family, individuals related to each other but not to the primary family. Households are defined as all persons occupying a housing unit or separate living quarters. Unrelated individuals are persons not members of either the primary or secondary family. Primary individuals are unrelated individuals who are the head of a household and secondary individuals are those who are not the head of a household.

3.9.2 SOCIOECONOMIC CHARACTERISTICS

The purpose of this section is to identify key socioeconomic characteristics of the study area. Among these characteristics are labor force and employment, income, taxes, major growth influences and key construction projects.

3.9.2.1 LABOR FORCE AND EMPLOYMENT

The labor force required for construction and operation of the MLGW facility is likely to be supplied almost entirely from the local civilian labor force. The civilian labor force has not shown a predictable trend over the last 5 or 6 years in Shelby County. The influx of new participants, change in the composition and fluctuation of economic conditions have caused the labor force to fluctuate moderately. This is of little concern, since the area is urbanized and provides an adequate and diversified supply of labor. Since little, if any, labor will have to be drawn from outside the study area, changes in the existing labor force and the associated changes in the need for various public and private services are also expected to be minor.

3.9.2.1.1 PARTICIPATION RATES AND PERCENTAGES, 1970 TO PRESENT

An overview of the summary labor force participation characteristics for Shelby County from 1970 to 1977 and projections for 1978 and 1979 are given in Table 3-64. The annual average total civilian labor force has risen

TABLE 3-64

SHELBY COUNTY SUMMARY OF PARTICIPATION CHARACTERISTICS OF THE LABOR FORCE, 1970 TO 1977, AND PROJECTIONS FOR 1978 TO 1979[2]

	1970*	1972*	1974*	1975*	1976*	1977*	Projected* 1978*	Projected* 1979*
Civilian Labor Force (annual average)	278,900	331,300	338,700	329,900	326,800	339,800	340,800	347,800
Employment (annual average)	265,900	320,800	323,900	306,200	307,800	318,600	320,400	332,200
Unemployment (annual average)	13,000	11,200	14,800	23,700	19,000	21,200	20,400	15,600
Unemployment Rate (%)	4.7	3.4	4.4	7.2	5.8	6.2	6.0	4.5

* The following excerpt was obtained from John Robertson, Annual Planning Information for Shelby County, Tennessee, for Year 1979 (Nashville: Tennessee Department of Employment Security, Research and Statistics Section, May 1978). Unfortunately, the discussion covers only the time period from 1970 to 1979. While comparable statistics for earlier years may be desirable, the Department of Employment Security redefined the "civilian work force" of previous years to a "civilian labor force." This, in effect, takes into consideration a "residence adjustment factor." Additionally, the Department changed its method of data collection, which for the first time allowed publication of statistics on a county basis, beginning with the 1970 data.

from a 1970 low of 278,900 to a 1977 high of 339,800. By 1979, this total is expected to be 347,800 people. At this point, 323,900 people will be employed, an increase of 24.9 percent since 1970. Unemployment is shown to be highest in 1975 with 23,700 people unemployed or 7.2 percent of the existing labor force. The total number of people unemployed in Shelby County, based on the 1977 annual average, was 21,200, reflecting an unemployment rate of 6.2 percent. Though not favorable in comparison with 1970, this unemployment rate does reflect a decrease since 1975. The number of unemployed is projected to continue to decrease to 15,600 by 1979 with a rate of 4.5 percent.

Table 3-65 presents a breakout of the Shelby County labor force by age, sex and race from 1970 to 1979. Employment is projected to reach its highest total of the 1970 decade in 1979. Several factors contribute to this increase. First, the large number of youths who are expected to be entering the labor market in 1979 should have an influence on employment. By 1979, the location of new industry in Shelby County and expansions in existing industries should be able to provide enough jobs for these new entrants. Second, the rate of inflation has caused more than one individual per family unit to seek employment. The Consumer Price Index (1967 = 100.0) had an annual average in 1977 of 181.5, and the trend is continuing upward. As the costs of necessary goods continue to increase, more families are projected to have both spouses working in order to maintain a comfortable standard of living. Third, the role change of the female from housewife to working mother is expected to have a minor influence on 1979's employment increase. The high rate of divorce is also causing more females to enter the labor market. The female part of the total labor force will increase substantially to 43.5 percent of total, while the nonwhite female part of this labor force will drop by one percentage point during this time. In keeping with their entry into the labor force, females will compose 43.3 percent of the total employment, an increase of 2.5 percent since 1970.

It is estimated that the minority labor force will increase by 25.4 percent to a total of 113,355; this will be 32.6 percent of the total labor force in 1979. The minority employment in 1979 is projected to be the same percentage

TABLE 3-65

SHELBY COUNTY CIVILIAN LABOR FORCE, 1970 AND PROJECTIONS FOR 1979[2]

Race/Sex/Age	Civilian Labor Force 1970	Civilian Labor Force 1979	Civilian Labor Force Percent Change	Employment 1970	Employment 1979	Employment Percent Change	Unemployment 1970	Unemployment 1979	Unemployment Percent Change	Unemployment Rate 1970	Unemployment Rate 1979
LABOR FORCE											
Total	278,926	347,821	24.7	265,876	332,165	24.9	13,050	15,656	20.0	4.7	4.5
16-17	5,590	9,634	72.3	4,665	8,445	81.0	925	1,189	28.5	16.5	12.3
18-19	12,315	16,313	32.5	10,408	14,290	37.3	1,907	2,023	6.1	15.5	12.4
20-24	39,057	56,103	43.6	35,809	51,893	44.9	3,248	4,210	29.6	8.3	7.5
25-34	63,047	92,972	47.5	60,729	89,684	47.7	2,318	3,288	41.8	3.7	3.5
35-44	58,465	63,513	8.6	56,760	61,730	8.8	1,705	1,783	4.6	2.9	2.8
45-64	89,874	99,024	10.2	87,410	96,358	10.2	2,464	2,666	8.2	2.7	2.7
65 & Over	10,578	10,262	-3.0	10,095	9,765	-3.3	483	497	2.9	4.6	4.8
WHITE											
Total	188,522	234,466	24.4	182,773	228,105	24.8	5,749	6,361	10.6	3.0	2.7
16-17	3,740	6,469	73.0	3,278	5,897	79.9	462	572	23.8	12.4	8.8
18-19	7,969	9,392	17.9	7,250	8,770	21.0	719	622	-13.5	9.0	6.6
20-24	26,371	36,312	37.7	25,119	34,868	38.8	1,252	1,444	15.3	4.7	4.0
25-34	41,406	63,164	52.5	40,420	61,719	52.7	986	1,445	46.6	2.4	2.3
35-44	39,792	42,817	7.6	39,005	42,080	7.9	787	737	-6.4	2.0	1.7
45-64	62,052	69,355	11.8	60,730	68,004	12.0	1,322	1,351	2.2	2.1	1.9
65 & Over	7,192	6,957	3.3	6,971	6,767	-2.9	221	190	-14.0	3.1	2.7
WHITE MALES											
Total	115,407	136,937	18.7	112,477	133,807	19.0	2,930	3,130	6.8	2.5	2.3
16-17	2,547	4,139	62.5	2,224	3,755	68.8	323	384	18.9	12.7	9.3
18-19	4,013	4,209	4.9	3,618	3,898	7.7	395	311	-21.3	9.8	7.4
20-24	13,733	18,956	38.0	13,101	18,245	39.3	632	711	12.5	4.6	3.8
25-34	27,195	37,982	39.7	26,756	37,340	39.6	439	642	46.2	1.6	1.7
35-44	24,846	25,217	1.5	24,570	24,957	1.6	276	260	-5.8	1.1	1.0
45-64	38,568	42,086	9.1	37,835	41,374	9.4	733	712	-2.9	1.9	1.7
65 & Over	4,505	4,348	-3.5	4,373	4,238	-3.1	132	110	-16.7	2.9	2.5
WHITE FEMALES											
Total	73,115	97,529	33.4	70,296	94,298	34.1	2,819	3,231	14.6	3.9	3.3
16-17	1,193	2,330	95.3	1,054	2,142	103.2	139	188	35.3	11.7	8.1
18-19	3,956	5,183	31.0	3,632	4,872	34.1	324	311	-4.0	8.2	6.0
20-24	12,638	17,356	37.3	12,018	16,623	38.3	620	733	18.2	4.9	4.2
25-34	14,211	25,182	77.2	13,664	24,379	78.4	547	803	46.8	3.8	3.2
35-44	14,946	17,600	17.8	14,435	17,123	18.6	511	477	-6.7	3.4	2.7
45-64	23,484	27,269	16.1	22,895	26,630	16.3	589	639	8.5	2.5	2.3
65 & Over	2,687	2,609	-2.9	2,598	2,529	-2.7	89	80	-10.1	3.3	3.1

(Continued)

TABLE 3-65 (Continued)

Race/Sex/Age	Civilian Labor Force 1970	Civilian Labor Force 1979	Civilian Labor Force Percent Change	Employment 1970	Employment 1979	Employment Percent Change	Unemployment 1970	Unemployment 1979	Unemployment Percent Change	Unemployment Rate 1970	Unemployment Rate 1979
NONWHITE											
Total	90,404	113,355	25.4	83,103	104,060	25.2	7,301	9,295	27.3	8.1	8.2
16-17	1,850	3,165	71.1	1,387	2,548	83.7	463	617	33.3	25.0	19.5
18-19	4,346	6,921	59.2	3,158	5,520	74.8	1,188	1,401	17.9	27.3	20.2
20-24	12,686	19,791	56.0	10,690	17,025	59.3	1,996	2,766	38.6	15.7	14.0
25-34	21,641	29,808	37.7	20,309	27,965	37.7	1,332	1,843	38.4	6.2	6.2
35-44	18,673	20,696	10.8	17,755	19,650	10.7	918	1,046	13.9	4.9	5.1
54-64	27,822	29,669	6.6	26,680	28,354	6.3	1,142	1,315	15.1	4.1	4.4
65 & Over	3,386	3,305	-2.4	3,125	2,998	-4.0	262	307	17.2	7.7	9.3
NONWHITE MALES											
Total	48,463	59,477	22.7	44,869	54,609	21.7	3,594	4,868	35.4	7.4	8.2
16-17	1,282	2,052	60.1	1,023	1,725	68.6	259	327	26.3	20.2	15.9
18-19	2,537	3,965	56.3	1,915	3,137	63.8	622	828	33.1	24.5	20.9
20-24	6,414	10,330	61.1	5,518	8,956	62.3	896	1,374	53.3	14.0	13.3
25-34	11,233	14,956	33.1	10,623	14.101	32.7	610	855	40.2	5.4	5.7
35-44	9,490	10,435	10.0	9,087	9,956	9.6	403	479	18.9	4.2	4.6
45-64	15,543	15,930	2.5	14,926	15,169	1.6	617	761	23.3	4.0	4.8
65 & Over	1,964	1,809	-7.9	1,777	1,565	-11.9	187	244	30.5	9.5	13.5
NONWHITE FEMALES											
Total	41,941	53,878	28.5	38.234	49,451	29.3	3,707	4,427	19.4	8.8	8.2
16-17	568	1,113	96.0	364	823	26.1	204	290	42.2	35.9	26.1
18-19	1,809	2,956	63.4	1,243	2,383	91.7	566	573	1.2	31.3	19.4
20-24	6,272	9,461	50.8	5,172	8,069	56.0	1,100	1,392	26.5	17.5	14.7
25-34	10,408	14,852	42.7	9,686	13,864	43.1	722	988	36.8	6.9	6.7
35-44	9,183	10,261	11.7	8,668	9,694	11.8	515	567	10.1	5.6	5.5
45-64	12,279	13,739	11.9	11,754	13,185	12.2	525	554	5.5	4.3	4.0
65 & Over	1,422	1,496	5.2	1,347	1,433	6.4	75	63	-16.0	5.3	4.2

of total employment as it was in 1970, 31.3 percent. The total number of minorities employed in 1979 is estimated to be 104,060, an increase of 25.2 percent over the 83,103 employed in 1970. Of the minority employment in 1979, females are projected to comprise 14.9 percent and males 16.4 percent.

The number of unemployed is expected to decrease appreciably by 1979. Female unemployment will drop 1.1 percent. Minority females will follow this drop, but minority male unemployment will increase to 8.2 percent. As a result, minorities will comprise 59.4 percent of the total unemployment. To attain this projection by 1979, several factors will have to be considered. New jobs will have to be developed for the large number of new entrants in 1979. Federally funded projects to train the unemployed and underutilized disadvantaged in marketable skills are also projected to have an impact on reducing Shelby County's unemployment rate.[2]

3.9.2.1.2 CURRENT AVERAGE HOURLY EARNINGS

The U.S. Department of Labor has records of public notice which describe the actual wages and salaries of various job classifications. Table 3-66 presents a listing of the union wage rates in the building trades for the Memphis area. Included within this listing are the groups that would be employed in the construction of the proposed plant. These can be used as estimates of salaries and wages that will be paid to construction and operations workers associated with the proposed facility. The average wage rates will differ among crafts and occupations and between construction and operations employees. These estimates will be used in subsequent analyses to show the effects of the added wages generated from the proposed facility on the local economy. Table 3-67 gives a listing of professional and technical occupations and weekly salaries of possible employees for such a plant. Table 3-68 shows the average earnings for selected office occupations in the area. The average earnings for maintenance, toolroom, powerplant, material movement and custodial occupations are presented in Table 3-69.

TABLE 3-66

UNION WAGE RATES PER HOURS IN THE BUILDING TRADES, BASED ON 40 HOUR WORKWEEK, MEMPHIS, JULY 1, 1976, AND JULY 1, 1977[3]

Job Classification	Rate Per Hour* July 1, 1976	Rate Per Hour* July 1, 1977
JOURNEYMEN		
Asbestos Workers	$ 9.300	$10.400
Boilermakers	8.800	9.300
Bricklayers	9.600	9.850
Pointers and Caulkers	9.350	9.600
Carpenters	9.000	9.150
Floor Layers	9.000	9.150
Piledrivers	9.000	9.150
Cement Finishers	8.600	9.125
Machine Operators	8.850	9.375
Drywall Tapers (Finishers)	--	9.000
Electricians (Inside Wirers)	9.530	10.480
Elevator Constructors	9.430	11.020
Engineers--Power Equipment Operators:		
Class A--Cranes, Derricks, Draglines, Trenching Machines (18 in. and over), Piledrivers, Hoists (3 Drums), Shovels, Bulldozers	8.650	9.175
Class B--Trenching Machines (18 in. and smaller), Elevating or Blade Graders, Hoists (1 or 2 Drums), Mixers	8.220	8.745
Class C--Air Compressors (Stationary), Pumps (larger than 4 in.), Tractors (40 HP or Less)	7.520	8.045
Class D--Air Compressor Operators (Portable)	7.120	7.645
Glaziers	9.000	9.000
Lathers	9.300	9.850
Marble Setters	7.750	8.200
Mosaic and Terrazzo Workers	7.750	8.200
Painters:		
Residential	8.600	9.000
Commercial:		
Brush, Roller Applicator	8.600	9.000
Spray, Steel	8.850	9.250
Paperhangers	8.600	9.000
Pipefitters	9.720	10.970
Plasterers	9.400	9.900
Plumbers	9.870	11.020
Reinforcing Iron Workers	9.150	9.600
Roofers, Composition	8.700	9.400
Roofers, Slate and Tile	8.950	9.650
Sheet-Metal Workers	9.610	10.040
Stonemasons	9.600	9.850
Structural-Iron Workers	9.150	9.600
Sheeters	9.400	9.850
Tile Layers	7.750	8.200

(Continued)

TABLE 3-66 (Continued)

Job Classification	Rate Per Hour* July 1, 1976	Rate Per Hour* July 1, 1977
HELPERS AND LABORERS		
Bricklayers' Tenders	6.700	7.050
Mortar Mixer Operations	6.800	7.150
Building Laborers	5.750	6.375
Composition Roofers' Helpers	5.750	6.375
Elevator Constructor's Helpers	6.600	6.860
Plasterers' Tenders	6.700	7.050
Plumbers' Laborers	5.750	6.375

* Basic (minimum) rates, excluding holiday, vacation, or other benefit payments made or regularly credited to the employee. Wage rates shown represent rates available and payable on July 1 of the survey year and do not include increases made later that are retroactive to July 1 or before.

TABLE 3-67

AVERAGE EARNINGS FOR SELECTED PROFESSIONAL AND TECHNICAL OCCUPATIONS IN SIX INDUSTRY DIVISIONS, MEMPHIS, TENNESSEE--ARKANSAS--MISSISSIPPI, NOVEMBER 1977

Occupation in Six Divisions* and Class**	Weekly Salaries†
Computer Systems Analysis (Business)	$ 351.00
Class A	--
Class B	346.00
Class C	--
Computer Programmers (Business)	277.50
Class A	293.50
Class B	275.00
Class C	--
Computer Operators	192.00
Class A	275.00
Class B	171.50
Class C	170.50
Drafters	217.50
Class A	271.50
Class B	222.00
Class C	177.50
Drafters--Tracers	--
Electronics Technicians	275.50
Class A	--
Class B	291.00
Class C	--
Registered Industrial Nurses	250.50

* Manufacturing; transportation, communication and other public utilities; wholesale trade; retail trade; finance, insurance and real estate; and services.

** For occupations with more than one level, data are included in the overall category even when a level is not shown or information to subclassify is not available.

† Regular straight-time salaries that are paid for standard workweeks.

TABLE 3-68

AVERAGE EARNINGS* FOR SELECTED OFFICE OCCUPATIONS IN SIX INDUSTRY DIVISIONS
MEMPHIS, TENNESSEE--ARKANSAS--MISSISSIPPI,** NOVEMBER 1977(1977)

Occupation in Six Industry Divisions† and Class††	Weekly Earnings
Secretaries	$175.00
Class A	216.50
Class B	194.50
Class C	171.00
Class D	156.50
Class E	--
Stenographers	181.00
General	182.50
Senior	179.50
Transcribing Machine Typists	150.50
Typists	161.50
Class A	185.00
Class B	153.00
File Clerks	132.00
Class A	--
Class B	172.00
Class C	112.00
Messengers	126.50
Switchboard Operators	158.50
Switchboard Operators-Receptionists	150.00
Order Clerks	164.50
Class A	179.50.
Class B	158.50
Accounting Clerks	167.00
Class A	193.00
Class B	151.00
Bookkeeping Machine Operators	--
Class A	--
Class B	--

(Continued)

TABLE 3-68 (Continued)

Occupation in Six Industry Divisions† and Class††	Weekly Earnings
Machine Billers	$136.50
Billing Machine	143.50
Bookkeeping Machine	--
Payroll Clerks	184.50
Keypunch Operators	151.50
Class A	151.00
Class B	151.50
Tabulating Machine Operators	--
Class A	--
Class B	--
Class C	--

* Regular straight-time salaries that are paid for standard workweeks.

** In this area, a revised two-level occupational description for order clerks has been introduced. Data in the overall category of this revised two-level description are not comparable to data for the old job description.

† Manufacturing, transportation, communication and other public utilities; wholesale trade; retail trade; finance, insurance and real estate; and services.

†† For occupations with more than one level, data are included in the overall category even when a level is not shown or information to subclassify is not available.

TABLE 3-69

AVERAGE EARNINGS* FOR SELECTED MAINTENANCE, TOOLROOM, POWERPLANT, MATERIAL MOVEMENT AND CUSTODIAL OCCUPATIONS IN SIX INDUSTRY DIVISIONS, MEMPHIS, TENNESSEE--ARKANSAS--MISSISSIPPI, NOVEMBER 1977(3)

Occupation in Six Industry Divisions**	Hourly Earnings
MAINTENANCE, TOOLROOM AND POWERPLANTS	
Maintenance Carpenters	$ 6.87
Maintenance Electricians	7.88
Maintenance Painters	7.34
Maintenance Machinists	7.72
Maintenance Mechanics (Machinery)	7.08
Maintenance Mechanics (Motor Vehicles)	7.91
Maintenance Pipefitters	7.80
Maintenance Sheet-Metal Workers	--
Millwrights	8.45
Maintenance Trades Helpers	5.91
Machine-Tool Operators (Toolroom)	--
Tool and Die Makers	7.18
Stationary Engineers	7.14
Boiler Tenders	5.17
MATERIAL MOVEMENT AND CUSTODIAL	
Truckdrivers†	5.84
Truckdrivers, Light Truck	3.41
Truckdrivers, Medium Truck	4.99
Truckdrivers, Heavy Truck	5.77
Truckdrivers, Tractor-Trailer	7.01
Shipping Clerks	6.52
Receiving Clerks	5.69
Shipping and Receiving Clerks	--
Warehousemen	4.95

(Continued)

TABLE 3-69 (Continued)

Occupation in Six Industry Divisions**	Hourly Earnings
Order Fillers	$ 4.42
Shipping Packers	4.49
Material Handling Laborers	4.13
Forklift Operators	5.50
Power-Truck Operators (Other than Forklift)	--
Guards	--
Class A	--
Class B	--
Guards and Watchmen	3.27
Janitors, Porters and Cleaners	2.98

* Hourly earnings excluding premium pay for overtime and work on weekends, holidays and late shifts.

** Manufacturing; transportation, communication and other public utilities; wholesale trade; retail trade; finance, insurance and real estate; and services.

† Includes all drivers regardless of size and type of truck operated.

Incremental changes in the average hourly earnings for the selected occupations can not be predicted at this time and are subject to the President's Wage and Price Guidelines. Wages generally, however, have a strong rigidity downward, so it is likely that the wage rates for the selected occupations at the time of plant construction and operation will be equal to or higher than they were in 1977.

3.9.2.1.3 MAJOR OCCUPATIONS AND INDUSTRIES

Employment by industry in the Memphis SMSA for the years 1960 to 1975 and projections to 1990 are presented in Table 3-70. In order to analyze the impact of the proposed facility on the study area, it is necessary to depict the key private and public components comprising the economic foundation of the affected region. Direct employment changes associated with both the construction and operation stages of the proposed facility combined with material purchases constitute the direct effects of constructing and operating the plant. The Memphis area has a strong and diversified economic base. Therefore, individuals associated with the proposed facility engaging in economic activity within the study area are expected to have only minor effects on such an urbanized area.

The strongest sectors of employment are trade, services and civilian government followed by manufacturing. The employment in the trade sector, both retail and wholesale, shows an increasing trend to 1990 as do services and government. By 1990, all of these areas are expected to increase significantly. Manufacturing does not follow as definite a pattern; however, and employment in this sector is projected to decline slightly by 1990. Employment in agriculture will continue to follow a downward trend for this time period.

The income figures and trends for these respective economic sectors are presented in Table 3-71 for the years 1960 to 1975. Total earnings include income received by employees from wages and salaries, other labor income and proprietor income. Proprietor income measures earnings of unincorporated businesses, (i.e., proprietorships, partnerships and producer cooperatives) from current business operations. This does not include supplemental income

TABLE 3-70

EMPLOYMENT BY INDUSTRY IN MEMPHIS SMSA, 1960 TO 1990[1]

Industry	Thousands of Jobs						
	1960	1965	1970	1975	1980	1985	1990
All Industry	276.2	289.9	335.3	371.6	434.0	482.3	518.3
Agriculture, Forestry, Fisheries	15.0	13.6	10.7	10.2	8.6	7.1	6.3
Mining	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Contract Construction	13.7	15.1	16.5	17.0	19.3	19.7	17.4
Manufacturing	52.7	52.5	61.2	56.9	60.3	55.3	49.5
Durable	22.8	23.8	27.8	23.9	22.4	17.8	14.0
Nondurable	29.9	28.6	33.3	33.0	37.9	37.6	35.5
Transportation, Communication, Public Utilities	18.7	18.7	22.0	22.7	25.6	26.7	29.5
Trade	67.4	68.3	79.4	96.0	121.8	134.1	156.3
Retail	44.7	45.3	52.5	64.2	79.7	86.8	99.6
Wholesale	22.7	23.0	26.9	31.8	42.1	47.4	56.7
Finance, Insurance, Real Estate	12.0	14.1	16.9	17.8	21.1	23.0	26.2
Services	61.4	64.9	73.9	86.3	97.4	114.8	112.6
Civilian Government	35.1	42.6	54.5	64.5	79.7	101.4	120.3

TABLE 3-71

MEMPHIS SMSA PERSONAL INCOME BY MAJOR SOURCE AND EARNINGS BY INDUSTRY, 1960 TO 1990[1]

	Millions of 1972 Dollars						
	1960	1965	1970	1975	1980	1985	1990
Personal Income	$1,840.8	$2,402.0	$3,118.5	$3,870.2	$4,923.8	$6,234.0	$7,737.3
Wages & Salaries	1,297.1	1,655.5	2,217.7	2,685.4	3,555.6	4,339.8	5,378.8
Other Labor Income	50.0	73.5	117.2	175.3	330.5	554.4	679.2
Proprietor Income	208.9	251.0	246.0	239.7	268.0	285.0	298.2
Farm	42.5	56.9	52.0	25.3	19.8	18.0	15.2
Nonfarm	166.4	194.1	194.0	214.5	248.2	267.1	283.0
Property Income	210.7	323.0	371.8	474.1	523.1	682.2	878.6
Transfer Payments	120.8	161.2	281.3	476.0	503.8	706.2	952.7
Less: Personal Contributions for Social Insurance	46.7	62.0	115.4	180.4	257.1	333.6	450.2
Total Earnings	$1,556.0	$1,980.0	$2,580.9	$3,100.4	$4,154.0	$5,179.2	$6,356.2
Farm	53.0	61.7	52.4	28.2	22.7	22.8	22.3
Nonfarm	1,503.0	1,918.3	2,523.4	3,072.2	4,131.3	5,156.4	6,333.9
Government	277.1	353.9	476.5	572.1	743.8	1,016.5	1,435.2
Federal Government	158.0	178.8	245.1	271.0	389.2	544.2	835.5
Federal Civilian	82.8	99.1	133.2	184.4	295.2	451.4	726.6
Federal Military	75.2	79.7	111.9	86.6	94.0	92.8	109.0
State & Local Government	119.1	175.1	231.5	301.1	354.6	472.3	599.7
Private Nonfarm Earnings	1,225.9	1,564.3	2,051.9	2,500.1	3,387.5	4,139.9	4,898.7
Manufacturing	328.4	431.2	573.7	623.1	749.3	811.8	836.7
Mining	3.8	3.5	2.9	5.5	5.7	5.6	5.8
Construction	85.2	120.4	144.0	195.6	247.0	314.5	333.8
Transportation, Communications, Public Utilities	140.1	166.6	211.3	252.0	320.7	379.5	455.7
Trade	352.0	433.2	547.1	702.3	1,031.5	1,257.3	1,651.9
Finance, Insurance, Real Estate	87.1	109.1	140.9	188.7	290.8	358.5	484.6
Services	227.8	296.9	427.8	525.9	720.6	1,004.3	1,119.4
Other	2.3	3.3	4.2	7.0	7.2	8.4	10.8

of individuals derived from rent, capital gains and losses and includes deductions made for depletion. Projections through 1990 for personal consumption expenditures by project for the Memphis SMSA can be found in Table 3-72 for 1960 to 1985. Both income and consumption tables are presented in 1972 dollars.

3.9.2.2 INCOME

Consumer units, families and unrelated individuals by census money income class for the years 1960 to 1990 are presented in Table 3-73 for the Memphis SMSA. The mean income is also included for the time period mentioned in 1972 dollars.

3.9.2.2.1 MEDIAN FAMILY INCOME: 1960 TO 1970

The median family income for Shelby County as compiled by the Bureau of Business Research, Memphis State University for 1960 was $4903. This figure nearly doubled by 1970 to $8671. Projections for 1975, 1980 and 1985 show the median income increasing steadily from $11,497 to $12,428 to $20,364, respectively.

3.9.2.2.2 POVERTY LEVEL PERCENTAGES: 1960 TO 1970

The poverty levels for Shelby County and the Memphis SMSA are determined from the national figures. Table 3-74* presents the level of income, considered the cutoff level for poverty for farm and nonfarm residents as presented by the U.S. Department of Labor in April 1978.

3.9.2.3 CURRENT AND PROJECTED GROWTH SECTORS

Based on the tables presented in Section 3.9.2.1.3, the economy of the Memphis SMSA reflects moderate and steady growth. The trade, service and government

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* Based on personal communication between B. Gaines, EIA, and G. Mickle, Memphis State University, May 21, 1979.

TABLE 3-72

PERSONAL CONSUMPTION EXPENDITURES BY PRODUCT FOR THE MEMPHIS SMSA,* 1960 TO 1985[1]

	Millions of 1972 Dollars					
	1960	1965	1970	1975	1980	1985
Total Consumption**	$1,510.0	$1,894.3	$2,368.7	$2,828.0	$3,538.4	$4,271.7
Food & Tobacco	414.1	503.5	599.8	679.2	788.0	888.5
Clothing & Accessories	137.4	171.2	213.0	245.9	307.5	365.4
Personal Care	27.2	32.1	37.5	42.3	49.8	57.6
Housing	197.5	259.0	340.8	422.2	555.9	691.7
Household Operation	210.5	258.8	326.0	387.5	508.5	637.2
Medical Care Expenses	98.7	142.3	186.5	236.4	301.4	377.2
Personal Business	85.6	106.1	131.4	156.1	198.6	239.3
Transportation	196.3	247.8	311.8	373.5	470.2	569.9
Recreation	84.9	104.3	135.0	182.6	231.2	292.6
Private Education Research	23.0	27.5	36.8	44.7	57.7	71.0
Religious Welfare Activities	26.9	32.2	38.0	42.7	49.3	55.4
Foreign Travel & Other Net	7.8	9.5	12.2	15.1	20.5	26.0

* Figures available for the Memphis SMSA only.

** Columns may not add up due to rounding.

TABLE 3-73

INCOME CLASSES OF CONSUMER UNITS, FAMILIES AND UNRELATED INDIVIDUALS FOR THE MEMPHIS SMSA,* 1960 TO 1990[1]

Income Class	Thousands of Consumer Units** by Income Class					
	1960	1970	1975	1980	1985	1990
Consumer Units - All Classes	211.5	258.1	294.8	331.1	377.9	416.3
Less than $ 4,000	82.8	76.7	77.4	74.4	75.0	69.2
$ 4,000 - $ 4,999	21.0	17.1	16.4	15.3	14.0	17.0
$ 5,000 - $ 5,999	19.5	16.7	17.1	15.4	14.6	13.4
$ 6,000 - $ 6,999	18.2	16.4	15.8	16.2	14.9	13.6
$ 7,000 - $ 7,999	19.9	16.0	15.0	15.6	15.3	13.9
$ 8,000 - $ 8,999	9.8	16.2	15.8	13.8	17.0	13.4
$ 9,000 - $ 9,999	10.3	13.9	14.7	14.6	12.8	19.4
$10,000 - $11,999	10.7	30.4	27.9	28.1	28.8	23.3
$12,000 - $14,999	7.9	20.9	40.6	49.0	38.2	39.2
$15,000 - $24,999	7.9	25.9	37.6	59.5	97.5	123.9
$25,000 - $49,999	1.9	6.4	13.2	25.5	41.7	59.1
$50,000 and Over	1.5	1.6	3.4	5.7	8.2	10.8
Mean Income (1972 Dollars)	6,846.0	9,212.7	10,757.2	12,831.5	14,943.4	17,401.9

(Continued)

TABLE 3-73 (Continued)

Income Class	Thousands of Families by Income Class**					
	1960	1970	1975	1980	1985	1990
Families - All Classes	172.9	201.6	222.8	252.6	285.1	313.0
Less than $ 4,000	54.2	40.0	34.8	31.3	29.0	26.6
$ 4,000 - $4,999	17.7	12.4	11.3	9.8	9.0	7.3
$ 5,000 - $ 5,999	17.4	13.1	11.6	10.8	9.2	8.7
$ 6,000 - $ 6,999	16.9	13.8	11.8	10.6	10.5	8.4
$ 7,000 - $ 7,999	18.7	13.9	12.5	11.0	9.8	9.7
$ 8,000 - $ 8,999	9.2	14.6	12.7	11.7	10.6	9.0
$ 9,000 - $ 9,999	10.0	12.6	13.1	12.0	10.9	9.9
$10,000 - $11,999	10.2	29.0	24.9	24.1	22.8	20.0
$12,000 - $14,999	7.6	19.8	38.6	45.2	34.7	31.4
$15,000 - $24,999	7.7	25.0	35.8	56.1	90.9	115.1
$25,000 - $49,999	1.9	6.1	12.5	24.5	40.0	56.7
$50,000 and Over	1.5	1.4	3.2	5.4	7.8	10.2
Mean Income (1972 Dollars)	7,530.8	10,478.4	12,430.8	14,803.2	17,281.9	20,158.0

(Continued)

TABLE 3-73 (Continued)

Income Class	Thousands of Unrelated Individuals** by Income Class					
	1960	1970	1975	1980	1985	1990
Unrelated Individuals - All Classes	38.5	56.6	72.0	80.5	92.8	103.3
Less than $ 4,000	28.6	36.8	42.6	43.0	45.9	42.6
$ 4,000 - $ 4,999	3.3	4.7	5.1	5.6	5.0	9.8
$ 5,000 - $ 5,999	2.1	3.6	5.5	4.6	5.4	4.8
$ 6,000 - $ 6,999	1.3	2.7	4.0	5.7	4.5	5.2
$ 7,000 - $ 7,999	1.2	2.1	2.5	4.6	5.5	4.2
$ 8,000 - $ 8,999	0.6	1.6	3.0	2.1	6.4	4.4
$ 9,000 - $ 9,999	0.3	1.3	1.6	2.6	1.9	9.5
$10,000 - $11,999	0.5	1.4	3.0	4.0	6.0	3.3
$12,000 - $14,999	0.3	1.1	2.0	3.7	3.4	7.8
$15,000 - $24,999	0.3	0.9	1.7	3.3	6.6	8.8
$25,000 - $49,999	0.1	0.3	0.6	1.0	1.7	2.4
$50,000 and Over	0.1	0.1	0.2	0.3	0.4	0.6
Mean Income (1972 Dollars)	3,773.7	4,703.8	5,580.3	6,645.2	7,757.9	9,049.0

* Figures available for the Memphis SMSA only.

** Columns may not add up due to rounding.

TABLE 3-74

POVERTY LEVEL INCOME CUTOFFS, 1978

Family Size	Nonfarm Residents	Farm Residents
1	$3140	$2690
2	4160	3550
3	5180	4410
4	6200	5270
5	7220	6130
6	8240	6990

sectors reflect the strongest areas as is evidenced by increasing income and employment. Activity in real estate, finance and insurance is also increasing. Economic activity in agriculture has been declining and is projected to continue this trend through 1985. The other sections of the Memphis economy reflect minor fluctuations of increasing and decreasing activity. Mining alone appears to be constant with no projected changes in employment, although incomes in this industry are increasing.

3.9.2.4 MAJOR POTENTIAL INFLUENCES ON GROWTH

The Memphis-Shelby County economy is largely based on the provision of goods and services to the agricultural sector of a 46-county market area. Growth in the trade and services sectors of the economy is contingent upon a number of factors:

- Favorable climatic and economic conditions for agriculture regionally and nationally
- High accessibility to the urban core of Shelby County to facilitate use of services and distribution of goods
- Growth in population and labor force
- Continued favorable tax rates to attract industry

3.9.2.5 SUMMARY OF OTHER KEY CONSTRUCTION PROJECTS

An inquiry was made with the Memphis and Shelby County Office of Planning and Development to identify key construction projects that may occur contemporaneously with the IFGDP. At this time, the office could not identify any major private sector projects that would conflict with plant construction. However, there are four public sector projects slated to occur in the same time period: (1) a sledge waste disposal and energy conversion system, (2) the Frank C. Pidgeon Industrial Development, (3) Volunteer Park and (4) a new Acute Care Hospital.[4] Total manpower required for construction of these projects is between 600 and 650 persons.

3.9.2.6 TAX STRUCTURE AND RATES

Tax structures and rates are major factors in estimating changes in expected revenue. Added population and economic activity, as a consequence of industrial expansion, leads to changes in the tax base. Changes in the tax base are used in financial impact analyses to estimate changes in expected revenues. Added population and added economic activity lead to changes in property valuation, corporate taxes and taxable income. Property valuation changes are used to estimate revenues generated for school districts and other governmental jurisdictions.

"Tennessee imposes a general property tax on all real estate, tangible personal property and money on hand or on deposit at uniform rates in the taxing district where such property is located. There is no state levy. The property tax is supplemented by (1) state taxes on sales, use, income, franchises, privileges and occupations and (2) municipal taxes and inspection fees."(5)

The property tax rate for residential and commercial property is applied to the assessed evaluation of the particular property. Property assessment is done by an on-site real estate assessor. The appraised value is determined in accordance with the current market value. In Tennessee, the assessment percentage varies according to the particular classification of property. Table 3-75 gives a summary of the property tax rates in Shelby County and local metropolitan areas. Table 3-76 presents the assessment percentages and classifications of property. The effective tax rates are then determined based upon the appraised property value and the classification of the property. Table 3-77 gives the effective tax rates. For example, a residential home in Memphis appraised at $80,000 would be assessed at 25 percent of the current value. The home owner would pay $3.74/$100 of assessed value Memphis city tax and $4.00/$100 of assessed value Shelby County county tax or (3.74/$100 and $4.00/100) x (.25 x $80,000 = $1548). Residential and farm real estate has the lowest assessment percentage (25 percent) and public utilities the highest (55 percent). The principal exemptions include property owned by

TABLE 3-75

TAX RATES[6]

Political Entity	City Tax Rate/$100	County Tax Rate/$100	Total Tax Rate/$100
Shelby County	--	$4.00	$4.00
Memphis	$3.74	4.00	7.74
Germantown	2.50	4.00	6.50
Collierville	2.00	4.00	6.00
Bartlett	2.00	4.00	6.00

TABLE 3-76

ASSESSMENT PERCENTAGES BY PROPERTY CLASSIFICATION[6]

Commercial and Industrial Real Estate	40% (appraised value)
Residential and Farm Real Estate	25% (appraised value)
Tangible Personalty	30% (appraised value)
Public Utilities	55% (appraised value)

TABLE 3-77

EFFECTIVE TAX RATES[6]

	40% Commercial & Industrial Real	25% Residential & Farm Real	30% Tangible Personalty	55% Public Utilities
Shelby County	$1.60	$1.00	$1.20	$2.20
Memphis	3.10	1.94	2.32	4.26
Germantown	2.60	1.63	1.95	3.58
Collierville	2.40	1.50	1.80	3.30
Bartlett	2.40	1.50	1.80	3.30

governments, inventories taxable under the business tax and inventories of manufacturers.

As a substitute to property taxes on inventory, local governments are authorized to levy a tax on gross receipts of specified businesses. The businesses are classified into five categories in which the tax rates vary from one-eighth of one percent to one-sixtieth of one percent.

The sales tax rate in Shelby County is 6 percent. The sales tax in the state of Tennessee is 4.5 percent, and there is a local sales tax of 1.5 percent, not to exceed $7.50 tax on the sale of any single item.

A tax is levied on corporations organizing in Tennessee. For domestic corporations, the rates vary according to the amount of capital stock authorized. For par value stock, the range is one cent for the first 20,000 shares, one-half cent for the next 180,000 and one-fifth cent for authorized shares over 200,000. For no par value stock, the first 20,000 shares are taxed at one-half cent per share, the next 1,980,000 at one-fourth cent per share and any amount over 2,000,000 shares at one-fifth center per share. Foreign corporations must pay a flat entrance fee of $305.

A tax of 6 percent is levied on net corporate earnings arising from business done within the state.

Income from stocks and bonds in excess of $25 is taxable to individuals, partnership and trusts. The rate of tax is 4 percent on domestic corporations and 6 percent on others. Individuals 65 and over are exempted if annual income is under $4800; couples are exempt if combined income is under $6000.

Domestic and foreign corporations must file an annual informational report and pay an annual corporation tax. The corporation has the option of paying a tax on gross receipts or on capital stock outstanding. If the gross receipts method is chosen, one-half of one percent of gross interstate business receipts from the preceding fiscal year, with a minimum of $25, must

be paid. With the capital stock method, the taxes range from $5 for corporations with capital stock less than $25,000 to $150 for corporations having outstanding stock of $1,000,000 or more.

Foreign and domestic corporations doing business in the state must pay a franchise tax of $.15 per $100 of the corporation's outstanding stock, surplus and undivided profits, apportioned to the state, at the close of the last fiscal year, with a minimum of $10. The basis cannot be less than the book value of the property owned plus the value of the rented property. The annual rental multiplied times eight for real property, three for machinery and equipment, two for office furniture and equipment and one for delivery or mobile equipment will determine the value of the rented property.

Table 3-78 shows the operating revenues and expenditures by political entity and Table 3-79 presents the percentage of revenue received from federal, state and local sources. Table 3-80 gives the average expenditure per resident by the particular local government. The allocation of revenues received from the property tax to various funds is shown in Table 3-81. It should be noted that the majority of the operating revenues in Shelby County are generated from local (79 percent), then state (11 percent) sources, with ten percent coming from federal funding.

3.9.3 EXISTING AND PROJECTED FACILITIES AND SERVICES

In this section, key aspects of community facilities and services are discussed. These include current and future housing conditions, educational facilities, medical and health conditions, police and fire protection and cultural amenities.

3.9.3.1 HOUSING

Housing will be demanded by those who move into the area for the construction and operation of the IFGDP. Available housing able to accommodate the needs of the temporary construction work force and the permanent operations work force appears to be in great enough supply to meet potential needs.

TABLE 3-78

OPERATING REVENUES AND EXPENDITURES (1976)[6]

Political Entity	Revenues	Expenses
Shelby County	$179,213,000	$183,572,000
Memphis	303,253,515	302,128,000
Germantown	3,047,000	2,679,000
Collierville	1,292,686	1,171,374
Bartlett	1,335,547	1,165,839

TABLE 3-79

OPERATING REVENUE RECEIVED BY SOURCE (1976)[6]

Political Entity	Federal (%)	State (%)	Local (%)
Shelby County	10.0	11.0	79.0
Memphis	8.0	27.0	65.0
Germantown	10.0	11.0	79.0
Collierville	1.2	40.8	58.0
Bartlett	3.9	17.9	78.2

TABLE 3-80

AVERAGE EXPENDITURE PER RESIDENT (1976)[6]

Political Entity	Population*	Expenses	Average Expenditure/ Resident
Shelby County	764,500	$183,572,000	$240
Memphis	667,150	302,128,000	453
Germantown	9,153	2,679,000	292
Collierville	5,165	1,171,374	227
Bartlett	6,737	1,165,839	173

* The population figure for Shelby County is estimated. The figures for Memphis, Germantown, Collierville and Bartlett are the certified populations of each.

TABLE 3-81

ALLOCATION OF PROPERTY TAX TO VARIOUS FUNDS (1976)[6]

Political Entity	General Fund	Schools	Debt Service	General Improvement	Total*
Shelby County	$1.87	$1.79	$.34	--	$4.00
Memphis	1.68	1.52	.53	$.01	3.74
Germantown	2.50	--	--	--	2.50
Collierville	2.00	--	--	--	2.00
Bartlett	2.00	--	--	--	2.00

* Totals based on municipal and county tax rates per $100 assessed value as shown in Table 3-75.

3.9.3.1.1 HOUSING TRENDS

Table 3-82 shows housing indicators for Shelby County from January 1970 to September 1978. This table presents yearly totals for permits issued, residential starts and residential completions for all of Shelby County. It should be noted in comparing yearly totals that 1978 figures reflect only a 8-month period of activity. Housing growth has been most significant in Memphis and unincorporated Shelby County.

Residential starts are considered the most reliable indicator of housing development and can be found along with residential completions in Tables 3-83 and 3-84. Table 3-83 shows single-family starts and completions for 1977-78 by incorporated cities, with unincorporated Shelby County shown for completeness. Because 1978 totals in Table 3-83 are for only 8 months, comparison to 1977 totals would prove inaccurate. However, housing activity during 1978 declined slightly from activity experienced in 1977, but the market was expected to remain strong.

Table 3-84 displays multifamily starts and completions during 1977 and the first eight months of 1978 for the same areas discussed above. The majority of multifamily development experienced in recent years, however, has been for construction of apartment complexes for the elderly.

During the early 1970's, development in the apartment market was extremely rapid, resulting in an overabundance of available apartment units. Apartment construction has actively declined since that time, making it possible for Memphis to absorb this surplus of apartment units. Although the vacancy rate has declined from 18 percent in 1974-75 to 6.1 percent in 1978, Memphis still exhibits "soft" market conditions for a city of its size and population growth.

The 1978 apartment market was composed of 50,039 completed, nonassisted units with monthly rental rates varying from $150 to $300 plus.* Average

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* Rental units surveyed consisted of projects with 12 or more nonassisted units. Old houses that had been subdivided, college housing facilities, group quarters and rooming structures that are not typical apartment projects were excluded.

TABLE 3-82

SHELBY COUNTY HOUSING INDICATORS, JANUARY 1970 TO SEPTEMBER 1978[7]

Housing Indicator	1970	1971	1972	1973	1974	1975	1976	1977	1978 (8 months)
Total Residential Permits Issued	6,351	12,878	17,284	13,084	2,890	2,590	2,433	5,976	3,865*
Total Single-Family Permits	4,138	4,959	3,689	2,802	2,197	1,994	2,417	4,168	3,063*
Total Multifamily Permits**	2,213	7,919	13,596	10,282	693	596	16	1,808	802*
Total Residential Starts	7,455	8,126	9,030	8,372	2,630	2,129	3,167	5,579	2,982*
Total Residental Completions	4,392	5,780	7,296	5,014	8.192	6.462	3,250	3,724	3,249*

* Year-to-date

** Multifamily includes duplexes, condominiums and townhouses.

TABLE 3-83

SINGLE-FAMILY STARTS AND COMPLETIONS, SHELBY COUNTY, TENNESSEE, 1977 AND JANUARY TO SEPTEMBER, 1978[7]

Political Entity	Starts		Completions	
	1977	1978	1977	1978
Memphis	686	517*	903	642*
Germantown	887	742*	457	454*
Bartlett	282	209*	275	207*
Arlington	0	12*	0	0
Millington	0	0	0	0
Collierville	180	165*	118	123*
Unincorporated Shelby County	1684	903*	1543	1545*

* 8-month totals

TABLE 3-84

MULTIFAMILY STARTS AND COMPLETIONS, SHELBY COUNTY, TENNESSEE, 1977 AND JANUARY TO SEPTEMBER 1978[7]

Political Entity	Starts		Completions	
	1977	1978	1977	1978
Memphis	1614	366*	12	205*
Germantown	0	17*	0	0
Bartlett	0	0	0	0
Arlington	0	0	0	0
Millington	0	0	0	0
Collierville	0	0	0	0
Unincorporated Shelby County	126	0	44	86*

* 8-month totals

monthly rental prices (July 1978) were as follows: One-bedroom units, $176; two-bedroom units, $206; and three-bedroom units, $256.[8]

There were 4138 single-family permits issued during 1977, with an unsold inventory of 743 completed homes and 2635 uncompleted homes at year's end. For the three quarters recorded in 1978, 3063 permits for new single-family units were issued. The inventory of unsold single-family units revealed 772 completed homes and 2738 uncompleted homes in the Shelby County market.[7]

The Shelby County housing market has recently begun a slight decline in its activity for new single-family units. During the third quarter of 1978, 932 new single-family units were sold at an average price of $58,352. There were 986 sales of new single-family homes during this same period in 1977 at an average price of $51,082. From these figures, the decline in sales transactions was computed at 5 percent, while the average sales price increased by 14 percent.

Sales information for existing as well as new single-family units and duplexes indicate that there were 13,848 sales transactions in 1978 at an average sales price of $39,772. In 1977, 14,700 sales transactions were recorded at an average annual price of $36,565.

3.9.3.1.2. HOUSING PROJECTIONS

Table 3-85 shows housing units in Shelby County in 1960, 1970 and 1975. A projection of the number of units necessary in 1985 to satisfy effective private demand, public units which will be added and demolitions are also shown.

The estimate of effective demand for privately constructed new single-family and multifamily housing units is given in Table 3-86. The estimate of new units needed for 1979 assumes the absorption of some of the current inventory to fill the effective demand for that year. It is estimated that by 1980 the market will have returned to a normal level of rentals, vacancies and new

TABLE 3-85

HOUSING UNITS, SHELBY COUNTY, TENNESSEE, 1960 TO 1985[9]

Year	Total Units	Owner Units	Renter Units	Number Renter Vacancies	Vacancy Rate
1960	184,868	105,108	79,760	4,555	5.7%
1970	222,628	126,714	95,914	5,113	5.3%
1975	267,256	138,710	128,546	18,640	14.5%
1985	315,200	166,700	148,500	8,900	6.0%

TABLE 3-86

ESTIMATE OF NEW HOUSING CONSTRUCTION NEEDED TO SUPPLY EFFECTIVE DEMAND FOR THE MARKET, SHELBY COUNTY, TENNESSEE, 1977 TO 1990

Year	Single-Family	Multifamily	Total Units*
1977	2,800	--	2,800
1978	3,400	--	3,400
1979	3,400	1,600	5,000
1980	3,400	2,800	6,200
1981	3,600	3,400	7,000
1982	3,600	3,600	7,200
1983	3,600	3,800	7,400
1984	3,600	3,800	7,400
1985	3,400	4,000	7,400
1986-1990	18,000	20,250	38,250
TOTAL	48,800	43,250	92,050

* Does not include housing units for the elderly

housing inventory. These estimates are based on population projections and the assumption of a continued economic growth trend experienced in Shelby County in the 1971 to 1976 period.

The Shelby County new housing market consists of eight sub-market areas. Seven of the areas are outside the circumferential I-240 highway with east-west and north-south boundaries along zip code or census tract boundaries. The area numbers and generally accepted names follow:

Submarket Area	Name
1	Frayser
2	Raleigh
3	Bartlett
4	Northeast
5	Germantown
6	Southeast
7	Whitehaven
8	Memphis City

These areas are located on Figure 3-41.

Submarket areas 3, 4 and 5 exhibit the greatest potential for housing growth in the near future. These areas are well supported by developed and planned transportation and utility facilities and are served by present and planned future commercial centers.

Submarket area 6 will be the location of much of the new housing development. The area south of Winchester Road is rapidly developing in low and medium-low price units. The northeastern sector between Winchester and Kirby Roads and Nonconnah Creek is a prime area for housing in the $60,000 to $70,000 range. Area 6 also has one of the largest concentrations of multifamily rental units.

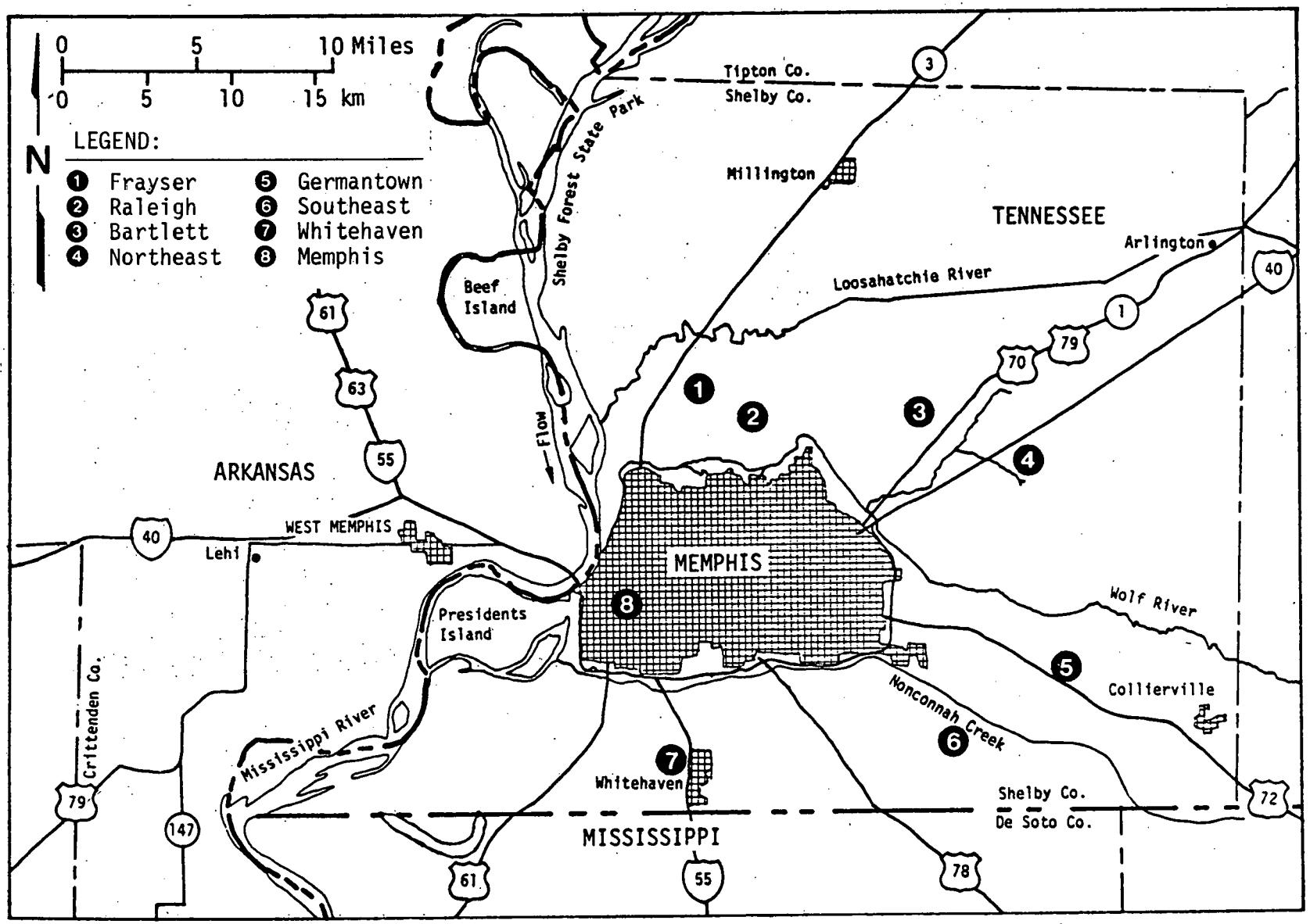

Figure 3-41. Memphis Housing Market: Submarket Areas

3.9.3.2 EDUCATION

The main focus of this study on educational services is to identify the geographical location of schools and approximate the potential classroom capacity of each school. This information outlines the existing supply of educational services in the Shelby County area. Students who are children of the new IFGDP employees will create little if any additional demand within the study area, because only limited relocation of the labor force is expected. The ability of the existing school systems to handle the influx of new pupils will be addressed in the impact analysis section.

There are basically three school systems located within Shelby County. These are Memphis City School System, Shelby County School System and various private and parochial school systems. The elementary, junior high and high schools are listed in Table 3-87 for the Memphis City School System, along with capacity and enrollment characteristics. There are a total of 108 public elementary schools located throughout the City of Memphis. There are 32 junior high schools and 30 high schools in this same system. Tables 3-88 and 3-89 show the same information for the Shelby County School System and the private and parochial system, respectively. It should be noted that where the private and parochial schools are concerned, data were not available concerning capacity. In most instances, data on present enrollment were also not available.

There are 21 other public elementary schools located in Shelby County, 4 public junior high schools and 5 public high schools. There are a total of 125 private and parochial schools located in this area, offering a wide range of availability for private enducation.

Table 3-90 shows a summary of present capacities and enrollments for the Memphis City and Shelby County School Systems. With only a few individual exceptions, the public schools do not appear to be overcrowded. The Memphis City Schools are operating with 66.5 percent of the total available seats filled, and the other Shelby County Schools are operating at 79.3 percent of

TABLE 3-87

MEMPHIS CITY SCHOOL SYSTEM: CAPACITY AND ENROLLMENT SUMMARY 1977-1978 SCHOOL YEAR

ELEMENTARY SCHOOLS

School Name	Grades	Present Capacity	Present Enrollment
Alcy	K,1-3	900	726
Alton	K,1-3	900	740
Avon	(S.E.)	510	146
Balmoral	K,4-6	480	165
Berclair	5-6	570	241
Bethel Grove	K,3-4	750	367
Brookmeade	K,1-3	840	609
Brownsville	K,1-6	900	917
Bruce	K,1-6	600	542
Caldwell	K,1-6	2,010	1,128
Campus	1-6	540	524
Carnes	K,1-6	1,680	1,098
Charjean	K,4-6	690	573
Cherokee	K,1-6	1,020	1,131
Chicago Park	K,1-3	660	278
Coleman	K,1-8	930	1,019
Colonial	K,5-6	1,020	355
Corning	K,1-3	600	509
Coro Lake	K,1-6	600	377
Cromwell	K,1-3	720	483
Cummings	K,1-6	1,440	865
Delano	K,5-6	480	345
Denver	K,1-6	810	554
Double Tree	K,1-6	N/A	500
Douglass	K,4-6	1,320	401
Dunbar	K,1-3	870	375
Dunn Avenue	K,4-6	780	290
East	K,4-6	960	540
Egypt	K,1-8	1,230	1,369
Evans	K,4-6	1,080	433
Fairley	K,1-6	1,170	1,080
Florida	K,1-6	1,440	507
Ford Road	K,4-6	1,350	804
Fox Meadows	K,1-2	600	404
Frayser	K,1-6	780	624
Gardenview	K,3-4	720	642
Georgia Avenue	K,1-6	2,370	1,212
Georgian Hills	K,4-6	750	263
Goodlett	k,4-6	870	532
Gordon	K,4-6	990	478
Grahamwood	K,1-3	960	647
Grandview Heights	K,1-3	990	626
Grant	K,1-3	810	451
Graves	K,1-6	900	718
Guthrie	K,4-6	1,080	452
Hamilton	K,4-6	1,230	813
Hanley	K,3-4	1,710	430
Hawkins-Mill	K,1-6	1,080	795
A. B. Hill	K,1-6	1,650	810
Hollywood	K,3-4	1,020	576
Idlewild	K,1-3	570	397
Jackson	K,1-3	750	471
Kansas	K,1-6	1,050	503
Kingsbury	K,5-6	1,110	622
Klondike	K,3-4	1,470	461
Knight Road	K,1-3	960	742
Lakeview	K,1-6	630	437
LaRose	K,1-6	2,010	1,093
Lauderdale	K,1-6	930	592
Leath	K,1-6	660	317
Levi	K,1-3	750	588
Lincoln	K,1-6	1,140	496
Locke, Alonzo	K,1-6	1,200	597
Longview	K,4-6	870	561
Macon	K,1-2	510	310
Magnolia	K,4-6	1,320	412
Manor Lake	K,1-6	N/A*	865
Newberry	K,5-6	480	315
Norris	K,1-3	720	540
Oakhaven	K,4-6	990	528
Oakshire	K,4-6	930	409
Orleans	K,1-6	930	543
Peabody	K,1-6	630	494
Prospect	K,1-2	510	260
Raineshaven	K,1-6	560	N/A*
Raleigh-Bartlett Meadows	K,1-6	N/A*	995
Richland	K,1-6	1,020	682
Ridgeway	K,1-6	480	469
Riverview	K,1-6	1,470	936
Rozelle	K,4-6	660	345
Scenic Hills	K,1-6	N/A*	481
Sea Isle	K,1-2	1,350	328
Shady Grove	K,1-6	720	206
Shannon	K,4-6	1,110	482
Sharpe	K,1-6	480	450
Sheffield	K,1-6	600	840
Sherwood	K,1-3	1,230	697
Shrine	1-12	N/A*	120
South Park	K,1-2	720	463
Spring Hill	K,1-6	660	804
Springdale	K,1-6	690	427
Stafford	K,1-6	840	614
Treadwell	K,1-6	1,110	917
Vollintine	K,1-3	630	683
Walker	K,1-6	840	792
Wells Station	K,1-2	1,020	541
Westhaven	K,1-6	1,140	1,179
Westside	K,4-6	870	468
Westwood	K,1-6	1,500	1,223
White Station	K,1-6	780	441
Whitehaven	K,1-6	840	496
White's Chapel	K,1-5	780	509
Whitney	K,1-2	450	393
Willow Oaks	K,3-6	1,200	455
Winchester	K,1-2	N/A*	843

(Continued)

TABLE 3-87 (Continued)

JUNIOR HIGH SCHOOLS

School Name	Grades	Present Capacity	Present Enrollment
Airways	7-9	950	706
Bellevue	7-9	1,000	574
Chickasaw	7-9	950	1,002
Colonial	7-9	1,200	630
Corry	7-9	1,100	579
Craigmont	7-9	--*	1,110
Cypress	7-9	2,000	1,089
Fairview	7-9	775	442
Geeter	7-9	1,100	897
Georgian Hills	7-9	950	695
Graceland	7-9	1,070	735
Gragg-Alternative	7-12	N/A	98
Hamilton	7-9	2,100	738
Havenview	7-9	900	638
Humes	K,7-9	1,800	1,393
Kingsbury	7-9	--*	971
Lanier	7-9	950	1,081
Lester	K,7-9	1,070	662
Lincoln	7-9	1,800	1,068
Longview	7-9	1,000	526
Melrose	7-9	1,200	373
Messick	K,7-9	--*	315
Patterson-Alternative	7-12	N/A	119
Porter	7-9	1,600	1,098
Richland	7-9	850	383
Riverview	7-9	1,200	877
Sherwood	7-9	1,300	1,148
Snowden	K,4-9	1,175	1,083
Trezevant	7-9	--*	744
Vance	7-9	1,075	654
White Station	7-9	--*	385
Wooddale	7-9	1,550	854

HIGH SCHOOLS

School Name	Grades	Present Capacity	Present Enrollment
Carver	10-12	2,100	1,057
Central	10-12	1,400	798
Craigmont	10-12	2,000	841
Douglass	10-12	1,700	470
East	10-12	924	471
Fairley	10-12	1,300	989
Frayser	7-12	1,900	1,229
Hamilton	10-12	2,400	1,283
Hillcrest	7-12	1,700	1,487
Kingsbury	10-12	2,830	862
Manassas	7-12	1,600	1,009
Melrose	10-12	1,550	1,197
Memphis Tech	10-12	1,200	887
Messick	10-12	1,800	633
Mitchell Road	10-12	1,150	834
Northside	10-12	1,800	1,382
Oakhaven	7-12	1,400	949
Overton	10-12	1,600	802
Raleigh-Egypt	9-12	N/A	1,340
Ridgeway	7-12	1,100	911
Sheffield	7-12	1,700	1,390
Southside	10-12	1,650	1,202
Treadwell	7-12	1,800	963
Trezevant	10-12	2,000	718
Washington, B. T.	10-12	1,800	1,036
Westside	7-12	1,010	642
Westwood	7-12	1,300	1,351
White Station	10-12	2,100	709
Whitehaven	10-12	1,300	826
Wooddale	10-12	1,800	1,014

* Total school plant capacity is under high school capacity.

N/A - Not available.

Source: Compiled by the Bureau of Business and Economic Research from data provided by the respective school systems.

TABLE 3-88

SHELBY COUNTY SCHOOL SYSTEM: CAPACITY AND ENROLLMENT SUMMARY
1977-1978 SCHOOL YEAR

School Name	Grades	Present Capacity	Present Enrollment
Altruria	K-6	750	683
Arlington	K-8	450	289
Barret's	K-8	1150	483
Bartlett	K-5	800	665
Capleville	K-8	650	649
Collierville	K-5	1275	1041
Dogwood	K-8	1100	753
Ellendale	K-6	750	729
Elmore Park	K-5	550	526
Farmington	K-8	1075	795
Germantown	K-6	1075	958
E. A. Harrold	K-6	600	395
E. E. Jeter	K-8	375	253
Lucy	K-8	275	283
Millington	K-6	600	559
Millington East	K-6	775	705
Millington South	K-6	750	617
Mt. Pisgah	K-8	1000	755
Riverdale	K-8	1100	1035
Ross*	K-7	750	904
Woodstock	K-8	1200	1153
Collierville	6-8	750	454
Germantown	7-8	900	463
Millington	7-8	1000	596
Shadowlawn	6-8	1500	833
Bartlett	9-12	1974	1374
Bolton	9-12	725	377
Collierville	9-12	1269	877
Germantown*	9-12	2079	2272
Millington	9-12	2002	1709

* Where enrollment outweighs capacity, portable classrooms are used.

Source: Compiled by the Bureau of Business and Economic Research from data provided by the respective school systems.

TABLE 3-89

CITY OF MEMPHIS PRIVATE AND PAROCHIAL SCHOOLS: ENROLLMENT SUMMARY
1977-1978 SCHOOL YEAR

School Name	Grades	Present Enrollment
Ardmore Baptist Church	1-8	N/A
Audubon Park Baptist School	1-8	N/A
Bethel Baptist Schools	K-12	309
Beverly Hills Baptist School	1-8	N/A
Bishop Byrne High School	9-12	787
Blessed Sacrament School	1-8	205
(The) Bodine School	Spec. Ed.	24
Briarcrest Baptist High School	9-12	N/A
Briarcrest Baptist School System	1-12	3,464
Broadmoor Baptist School	1-8	N/A
Central Baptist Church	K-9	80
Cherokee Baptist School	1-8	N/A
Christ Methodist Day School	K-6	210
Christ the King Lutheran School	K-8	161
Christian Brothers High School	9-12	933
Colonial Baptist School	1-8	N/A
Cottonwood Heights Baptist School	1-8	N/A
(The) Country Day School	1-12	212
Crestview Baptist School	1-8	N/A
Crosstown Day School	K-6	21
DeNeuville Heights for Girls	8-12	41
East Park Baptist School	1-8	N/A
Elliston Baptist Academy	K-12	1,442
Evangelical Christian School	7-12	520
Evangelical Christian School	K-6	N/A
Evangelical Christian School	K-6	N/A
Evangelical Christian School	K-6	N/A
Evangelical Christian School	K-6	N/A
Evangelical Christian School	K-6	N/A
Father Bertrand Elementary School	1-8	206
First Assembly Christian School	K-10	502
First Christian Assembly Academy	K-12	512
First Montessori School of Mid-Sough	Ungraded	66
(The) Frady's School, Inc.	K-6	126
Franklin Christian Academy	K-12	50
Frayser Academy of Christian	K-12	142
Frayser Assembly Christian School	1-12	188
Frayser Baptist Church	K-6	N/A
Frayser Baptist Schools, Inc.	Main Off.	1,013
(The) Gaelery School	7-12	15

N/A = Not Available

(Continued)

TABLE 3-89 (Continued)

School Name	Grades	Present Enrollment
Georgian Hills Baptist Church	9-12	N/A
Glenmore Academy	1-12	323
Gordon's Private School	4-8	21
Grace St. Luke's Episcopal	K-12	569
Graham Heights Academy	K-12	210
Hammond Hills Baptist School	K-12	446
Harding Academy (Main Office)	7-12	2,909
Harding Academy	K-6	N/A
Harding Academy	K-3	N/A
Harding Academy	K-3	N/A
Harding Academy	4-6	N/A
Harding Academy	4-6	N/A
Harding Academy	1-6	N/A
Harding Academy	K-6	N/A
Harding Academy	K-6	N/A
Harding Academy	K-6	N/A
Harding Academy	K-6	N/A
Hollywood Baptist Church	1-6	N/A
Holy Cross Lutheran School	K-8	245
Holy Rosary School	1-8	583
(The) Hutchison School	K-12	563
Immaculate Conception Elementary	Spec. Ed.	244
Immaculate Conception High School	9-12	514
Immanuel Lutheran School	K-8	201
Jackson Avenue Baptist School	K-12	580
LaBelle Haven Baptist Christian School	K-9	186
Lamplighter Montessori School	K-4	27
Laurelwood School, Inc.	K-12	312
Lausanne School	K-12	393
(A) Learning Place	Nongraded	69
Leawood Baptist School	1-8	N/A
Little Flower School	1-8	206
Longview Hgts. 7th Day Adventist School	K-8	78
Lowry's Private School	7-12	10
Macon Road Baptist School	K-11	141
Madonna Day School	Ungraded	38
Mann-Private School	6-12	19
Marie Kensington Day School	1-6	247
Memphis Catholic High School	9-12	680
Memphis Christian Academy	K-9	216
Memphis Hebrew Academy	1-8	195
Memphis Junior Academy	1-10	103
Memphis Oral School for the Deaf	K-3	10
Memphis Preparatory School	7-12	653

N/A = Not Available

(Continued)

TABLE 3-89 (Continued)

School Name	Grades	Present Enrollment
Memphis University School	7-12	568
Messiah Lutheran Church School	K-8	121
Miss Lee's School of Childhood	1-6	78
Mitchell's Private School	3-9	4
Mt. Terrace Baptist Church	K-6	N/A
New Allen Road Baptist Church	K-3	N/A
Oakhaven Baptist Academy	K-12	796
Our Lady of Sorrows	1-8	490
Presbyterian Day School	K-6	577
Randall Christian Academy	K-12	250
Ridgeway Baptist School	1-8	N/A
Rosebud Kindergarten & Private School	K-1	4
Rose Hill Christian Academy	K-12	N/A
Saint Agnes Academy	9-12	390
Saint Agnes Elementary	K-8	189
Saint Anne School	1-8	204
Saint Dominic School for Boys	1-8	193
Saint John School	1-8	232
Saint Joseph Catholic School	1-8	397
Saint Louis School	1-8	486
Saint Mary Episcopal School	K-12	564
Saint Michael School	1-8	269
Saint Paul School	1-8	765
Shady Oaks School	Ungraded	48
Sky View Baptist Academy	1-12	1,081
Southern Baptist Educational Center	1-12	1,279
Southmoor Baptist Christian School	K-12	269
Surgeon, C. H., Acadmey	K-12	489
(The) Threshold, A Montessori School	1-4	27
Thrifthaven Baptist School	K-12	338
Towering Oaks - Balmoral School	1-8	103
Towering Oaks Baptist School	1-12	1,070
Trafalgar Village School	1-8	N/A
Trenor School, Inc.	1-8	208
Trinity Baptist Christian School	K, 4-8	234
Whitehaven Methodist Day School	K-6	433
Whitehaven Presbyterian School	K-6	293
Whitten Hgts. Christian School	2-11	20
Woodland Presbyterian School	4-8	352
Yeshiva of the South	9-12	78
Yeshiva of the South for Girls	9-12	N/A

N/A = Not Available

TABLE 3-90

SUMMARY OF 1978 CAPACITIES AND ENROLLMENTS FOR THE MEMPHIS CITY AND SHELBY COUNTY SCHOOL SYSTEMS

System	1978 Capacity	1978 Enrollment	Percent of Capacity Filled
Memphis City Schools			
Elementary Schools	93,330*	61,296**	65.7
Junior High Schools	30,665†	23,667	77.2
High Schools	47,914††	29,282	61.1
	171,909	114,245	66.5
Shelby County Schools			
Elementary Schools	17,050	14,230	83.5
Junior High Schools	4,150	2,346	56.5
High Schools	8,049	6,621	82.3
	29,249	23,197	79.3

*Capacity for Double Tree, Manor Lake, Raleigh Bartlett Meadows, Scenic Hills, Shrine and Winchester are not available.

**Enrollment for Raineshaven is not available.

†Capacities for Gragg Alternative and Patterson Alternative are not available. Craigmont, Kingsbury, Messick, Trezevant and White Station are computed under high schools.

††Capacities for Raleigh Bartlett are not available.

their present capacity. Individual system enrollment trends, teacher-pupil ratios and average annual costs per pupil for the 1977-1978 school year are provided in Table 3-91.

3.9.3.3 MEDICAL AND PUBLIC HEALTH

The City of Memphis and Shelby County have an abundance of health institutions situated throughout the county. They constitute one of the finest and most complete medical centers in the country. Since Memphis is a major medical center, a wide span of services is available. In general, the health care system can expect little stress from the development of the proposed facility. The major hospitals mentioned here are identified by name and location in Table 3-92. Most of the major medical-surgical services are provided within the respective institutions. Complementing these services, the various health institutions collectively provide therapy services, radiation services and special units. These hospitals also provide mental health facilities, miscellaneous health care facilities and services and the supportive facilities and services common to most hospitals. Table 3-93* presents a summary of these services and facilities.

To provide these services and to staff the facilities to an efficient level requires a great number of qualified individuals. Table 3-94* provides a summary of the number of technicians and nurses who are employed by the hospitals in Shelby County. To provide summary information on physicians and dentists, Table 3-95* lists the number of each by specialty for the Shelby County area.

A statistical summary of the number of hospital beds available and the occupancy rate is shown in Table 3-96.** As can be seen from this table, hospital

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* Based on Memphis State University, Bureau of Business and Economic Research, unpublished data from Mid-South Medical Center Council, Memphis, Tennessee, 1978.

** Based on Memphis State University, Bureau of Business and Economic Research, unpublished data from Tennessee Department of Public Health, State Center of Health Statistics, Memphis, Tennessee, 1978.

TABLE 3-91

INDIVIDUAL SCHOOL SYSTEM ENROLLMENT CAPACITY TRENDS, TEACHER/PUPIL RATIOS AND AVERAGE ANNUAL COSTS PER PUPIL

School System by Grade Level	Enrollment Trends	Teacher/Pupil Ratios*	Costs Per Student*
Memphis City Schools	Decreasing by 2000 pupils/year		$1208
Grades 1 - 3		1:25	
Grades 4 - 6		1:30	
Grades 7 - 12		1:35	
Shelby County Schools	Not Available		$1120
Grades 1 - 12		1:22	

* 1977-1978 school year.

TABLE 3-92

HOSPITALS IN MEMPHIS AND SHELBY COUNTY

Hospital	Address
Baptist Hospital	899 Madison Avenue
City of Memphis Hospital	860 Madison Avenue
Doctors Hospital	2990 Getwell Road
Lakeside Hospital	2911 New Brunswick Road
LeBonheur Hospital	848 Adams Avenue
Memphis Eye and Ear Hospital	1060 Madison Avenue
Memphis Mental Health Institute	865 Poplar
Methodist Hospital	1265 Union Avenue
Mid-South Hospital	135 Pauline North
Naval Hospital	Millington, Tennessee
St. Joseph - Downtown	220 Overton St.
St. Joseph - East	5959 Park Avenue
St. Jude	Lauderdale
University of Tennessee Hospital	800 Madison Avenue
Veterans Administration Hospital	1030 Jefferson Avenue

TABLE 3-93

SUMMARY OF SERVICES AVAILABLE IN MEMPHIS AND/OR SHELBY COUNTY HOSPITALS

Medical-Surgical Services

Abortion Service(In-Patient)
Abortion Service (Out-Patient)
Audiology
Autopsies
Autoanalyzer
Blood Bank
Clinical Laboratory
Cardiovascular Diagnostic Clinic
Chemotherapy
Dental Facilities
Echoencephalography
Electrocardiology
Electroencephalography
Electromyography
Family Planning
Genetic Counseling
Hystopathology Lab
Obstetrical Delivery Room
Operating Suite
Open Heart Surgical Facilities
Organ Bank (Type)
Outpatient Department
Pathology Department
Pharmacy
Post Operative Recovery Room
Podiatrist Facilities
Pulmonary Function
Renal Dialysis (Out-Patient)
Speech Pathology
Kidney Transplant
Tumor Registry

Therapy Services

Inhalation
Occupational
Physical
Other

Radiation Services

Diagnostic
Therapeutic
Cobalt Therapy
Linear Accelerator
Radioactive Isotope
(1) diagnostic
(2) therapeutic
Radium Therapy

Mental Health Services

Psychiatric In-patient Units
Psychiatric Out-Patient Units
Psychiatric Emergency Units
Psychiatric Partial Hospitalization
Psych. Foster and/or Home Care
Psych. Consultation and Education
Clinical Psychology Service

Special Units

Alcohol Unit
Burn Care Unit
Coronary Care Unit
Detoxification Unit
Drug Treatment Center
Intensive Care Unit
Intensive Care (Mixed)
Premature Nursery
Critical Care Nursery
Rehabilitation (In-Patient)
Rehabilitation (Out-Patient)

Supportive Facilities and Services

Electronic Data Process.
Hospital Auxiliary
Medical Library
Social Service Department
Laundry Service
Food Service
Housekeeping Service
Volunteer Service Department

Miscellaneous Health Care Facilities

Hospital has a nursing home or extended care facility in the planning process
Hospital operates a home care program
Hospital refers patients to an organized home care program
Hospital has a transfer agreement with a Medicare certified extended care facility
Hospital-based ambulance service
Hospital owns or operates free standing outpatient facility
Hospital is connected with a Health Maintenance Organization (HMO)
Hospital has a doctors' office building

TABLE 3-94

HOSPITAL EMPLOYEE SUMMARY, MEMPHIS AND SHELBY COUNTY, 1977

Category	Number of Employees
Registered Nurses	2,284
Licensed Practical Nurses	1,152
Nurses Technicians	171
Nurses Aides	1,826
Orderlies	285
Other Ward Unit Personnel	847
Medical Lab Directors	7
Medical Lab Supervisors	67
Medical Lab Technologists	354
Medical Lab Technicians	289
Radiologic Technologists	165
Radiologic Technicians	86
Other Radiologic Personnel	270
Licensed Physical Therapists	52
Physical Therapists	6
Physical Therapy Assistants and Aides	57
Occupational Therapists	12
Occupational Therapy Assistants and Aides	7
Inhalation Therapists	204
Recreational Therapists	9
Registered Pharmacists	132
Pharmacy Technicians	158
Medical Social Workers	43
Other Social Workers	17
Registered Records Administrators	16
Accredited Records Technicians	26
Administrators and Assistants	54
Administrative Staff	558
Registered Dieticians	50
Dietary Employees	1,024
Housekeeping	1,016
Maintenance and Grounds	476
Laundry	224
Other	4,013
Residents	566
Interns	159
Externs	20
Radiologists	40
Pathologists	28
Dentists	9
Dental Interns and Assistants	11
Other Physicians	146
Total	16,943

TABLE 3-95

SUMMARY OF MEDICAL DOCTORS AND DENTISTS ON ACTIVE STATUS IN SHELBY COUNTY IN 1978 BY SPECIALTY

Specialty	Number	Specialty	Number
Aerospace Medicine	2	Psychiatry	73
Allergy	8	Psychiatry, Child	6
Anesthesiology	76	Psychoanalysis	1
Broncho-Esophagology	1	Public Health	14
Cardiovascular Diseases	23	Pulmonary Diseases	18
Dermatology	28	Radiology	34
Diabetes	1	Radiology, Diagnostic	38
Endocrinology	7	Radiology, Pediatric	2
Emergency Medicine	14	Radiology, Therapeutic	7
Family Practice	84	Rheumatology	8
Gastroenterology	17	Rhinology	1
General Practice	65	Surgery, Abdominal	5
General Preventive Medicine	1	Surgery, Cardiovascular	10
Geriatrics	5	Surgery, Colon & Rectal	2
Gynecology	7	Surgery, General	152
Hematology	7	Surgery, Hand	1
Infectious Diseases	4	Surgery, Head & Neck	2
Internal Medicine	274	Surgery, Neurological	43
Neoplastic Diseases	6	Surgery, Orthopedic	58
Nephrology	6	Surgery, Pediatric	5
Neurology	13	Surgery, Plastic	19
Neurology - Child	4	Surgery, Thoracic	17
Neuropathology	2	Surgery, Urological	49
Obstetrics	1	Other or Unspecified Specialty	128
Obstetrics and Gynecology	92		
Ophthalmology	51		
Otology	4		
Otorhinolaryngology	38		
Pathology	60	Dentists	488
Pathology, Clinical	8	Endodontics	5
Pathology, Forensic	2	Oral Surgery	18
Pediatrics	119	Orthodontists	24
Pediatrics, Allergy	7	Pedodontics	14
Pediatrics, Cardiology	6	Periodontics	11
Physical Medicine and Rehabilitation	3	Prosthodontics	5

TABLE 3-96

A LISTING OF HOSPITALS' BED CAPACITIES AND AVERAGE OCCUPANCY LEVELS

Hospital	Licensed Beds	Survey Beds	Operational Beds	Yearly Admissions	In-Patient Days	Average Length of Stay (days)	Occupancy Rate (%)
Baptist	1,920	1,925	1,915	59,528	561,474	9.4	80.1
City of Memphis	848	836	622	10,707	170,222	8.2	66.8
Doctors	126	126	126	2,470	34,067	9.7	52.2
Lakeside*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
LeBonheur	140	131	131	8,982	35,202	3.9	68.7
Memphis Eye & Ear	25	30	25	1,808	6,263	3.5	68.4
Memphis Mental Health*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Methodist	1,180	1,148	1,132	45,155	358,896	7.9	86.6
Mid-South	190	190	190	2,740	28,853	10.5	48.5
Naval Hospital Millington			114	4,217	29,808	7.1	64.7
St. Joseph Downtown	440	316	304	7,679	70,045	9.1	63.0
St. Joseph East	529	529	529	20,497	150,237	7.3	79.5
St. Jude*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
University of Tennessee	320	331	230	1,085	25,865	23.8	61.1
Veterans			923	14,678	286,424	19.5	84.8
Total	5,718	5,562	6,241	179,546	1,757,356	9.9	68.7

* Figures for Lakeside and St. Jude hospitals and Memphis Mental Health Institute are not available; therefore, they are not included in the total.

facilities are adequate for the population of Memphis and Shelby County, while still providing services to a large regional area.

There are four major emergency ambulance services in Memphis and Shelby County. These services are provided by the Memphis Fire Department, Medic Ambulance Services, Inc., Weaver Ambulance Service and Paramedic Ambulance Service, Inc. These agencies provide emergency medical technicians who are stationed with each ambulance and work in conjunction with the hospitals within the city and county. Table 3-97* lists the various services, addresses of each, areas served and the number of vehicles in service in 1978.

3.9.3.4 FIRE AND POLICE PROTECTION

Fire protection within the Shelby County area is provided by both municipal and volunteer fire departments. The IFGDP program could indirectly cause additional need for increased fire protection. The additional commercial activity, as well as additional residential dwelling units that can be attributed to the proposed facility, should not significantly increase the amount of property or number of lives requiring protection.

Memphis currently holds a Class II fire insurance rate. This is due to the fire prevention program that has been incorporated within the city by the Memphis Fire Department (MFD). In 1978, the MFD employed approximately 1600 uniformed firemen and had 48 strategically located fire stations which utilized 114 pieces of fire-fighting equipment. Additional fire protection outside the Memphis city limits is provided by several volunteer and municipal fire departments. A summary of relevant information concerning these is given in Table 3-98.*

Agencies providing law enforcement support to the Shelby County area include municipal police forces, county sheriff forces and the State Highway Patrol.

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* Based on Memphis State University, Bureau of Business and Economic Research, unpublished data from Memphis Fire Department and other Shelby County fire departments, Memphis, Tennessee, 1978.

TABLE 3-97

EMERGENCY AMBULATORY SERVICES IN MEMPHIS AND SHELBY COUNTY PROVIDING EMERGENCY MEDICAL TECHNICIANS

Agency Name	Address	Area Served	Number of Vehicles
Memphis Fire Department			
Unit 1	1017 Jefferson	City of Memphis	1
Unit 2	3345 Millington	City of Memphis	1
Unit 3	287 East McLemore	City of Memphis	1
Unit 4	333 E. Parkway North	City of Memphis	1
Unit 5	4472 Powell	City of Memphis	1
Unit 6	2147 Elvis Presley	City of Memphis	1
Unit 7	550 East Mendenhall	City of Memphis	1
Unit 8	3903 Knight Arnold	City of Memphis	1
Unit 9	4715 Horn Lake Road	City of Memphis	1
Unit 10	2231 East Shelby Drive	City of Memphis	1
Unit 11	688 Breedlove	City of Memphis	1
Unit 12	832 Mississippi	City of Memphis	1
Unit 13	8510 Coleman	City of Memphis	1
Unit 14	2161 Ridgeway	City of Memphis	1
Unit 15*	1510 Chelsea	City of Memphis	
Medic Ambulance Service, Inc.			
Unit 1	Germantown City Hall	Shelby County	1
Unit 2	Collierville - Hwy. 72 @ Hwy. 57	Shelby County	1
Unit 3	Hwy. 51 - South of Millington	Shelby County	1
Unit 4	Ellendale - Hwy. 64 @ Hwy. 70	Shelby County	1
Unit 5	Headquarters - 1950 Madison	Shelby County	7
Unit 6	Tchulahoma @ Winchester	Shelby County	1
Weaver Ambulance Service	55 N. Claybrook	Long Distance Available	
Paramedic Ambulance Service, Inc.	8254 Pinebrook Drive	Out-of-Town Service Available	

* Reserve Unit - Not in Service

TABLE 3-98

ADDITIONAL FIRE DEPARTMENTS WITHIN SHELBY COUNTY

Agency Name	Location of Stations	Personnel	Equipment	Area Served
Collierville Volunteer Fire Department	128 North Main St. 391 N. Byhalia Road	8 to 25*	5 pumpers 1 grass fire unit	City limits, subscribers
Millington Fire Department	4836 Navy Road	14 to 25*	5 pieces	City limits
Bartlett Fire Department	2939 Alturia	27 to 34*	7 pieces 1 rescue squad	City of Bartlett
Germantown Fire Department	7726 Farmington Ave. 7553 Poplar Pike Ext.	18	8 pieces	City limits + residential subdivision east of city which is on Germantown water system and will be annexed.

* Volunteer

The increased activity due to the proposed plant is not likely to significantly affect the need for law enforcement in the impact area.

In 1978, the Memphis Police Department employed approximately 1630 persons of which 1234 were commissioned officers. The city is divided into four precincts, each patrolled by 36 cars during the day and night hours and 48 cars in the evening. These cars are from a total fleet inventory of 533 vehicles. The area served by the Memphis Police Department encompasses the Memphis area within the boundary of the city limits. Communication between offices and officers is handled via a 12-channel communication (radio) system of which ten channels are UHF and two are VHF.

The Shelby County Sheriff's Department had approximately 425 employees in 1978 of which 375 were commissioned officers. The Department possessed a fleet of 139 vehicles which patrolled the Shelby County area. There are four other police departments of importance within the Shelby County area. These are listed in Table 3-99.*

3.9.3.5 CULTURAL AMENITIES

The Memphis and Shelby County Park Commissions have, over the years, developed an extensive park system. The system, designed to meet the needs of the large population found throughout Shelby County, contains four major types of parks: neighborhood parks, district parks, large urban parks and regional parks. A brief description of these parks is contained below.

Neighborhood parks usually serve a residential neighborhood of approximately one square mile. The types of facilities generally provided are: small area for preschool children, play apparatus for older children, area for free play, multi-use paved area, area for field games, shaded area, area for

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* Based on Memphis State University, Bureau of Business and Economic Research, unpublished data from Memphis Police Department and other Shelby County police departments, Memphis, Tennessee, 1978.

TABLE 3-99

A LIST OF OTHER POLICE DEPARTMENTS WITHIN SHELBY COUNTY

Agency Name	Address
Collierville Police Department	101 Walnut Street Collierville, TN 38017
Millington Police Department	4836 Navy Road Millington, TN 38053
Bartlett Police Department	5727 Woodlawn Bartlett, TN 38134
	2969 Court Bartlett, TN 38134
Germantown Police Department	7553 Poplar Pike, Ext. Germantown, TN 38138

lawn games, pool area, picnic area, area for older people, shelter house or recreation building and a landscaped area. This type of park usually ranges in size from 5 to 20 acres.

District parks are larger scale neighborhood parks which supply the same basic facilities as neighborhood parks. These parks usually serve a population ranging from 10,000 to 50,000 located within a 3 mile radius of the park. The specific facilities which might be supplied by a district park are: game courts, sports fields, picnic areas, a landscape park, children's play areas, a fieldhouse, a track, an outdoor swimming pool and a center for day camping. Certain areas may also be lighted. The minimum size for this type of park is 20 acres.

Large urban parks are designed to supply a varied array of facilities in a natural setting for large numbers of people. Features which should be in these parks include: natural landscaping, large picnic areas, athletic fields, playgrounds, nature trails, bandstands, comfort stations, winter sports areas, day camps and off-street parking. Added facilities may include golf courses, bridle paths, boating and swimming facilities, zoo, botanical gardens and museums. These parks usually contain a minimum of 100 acres and serve a population of 50,000 or more. The recommended standard for these large parks is approximately 5 acres per 1000 population with a minimum of 100 acres.[10]

Regional parks serve a large geographic region which usually covers an area within one hour's driving time of the park. Total area and locations vary among parks, but they tend to be located outside a city's boundaries and range in size from 250 acres to several thousand acres. The activities provided at these parks include: overnight and long-term camping facilities, picnic areas, swimming facilities, fishing, boating and naturally wooded areas. Large sections are usually reserved for hiking and horseback riding. The recommended standard for these parks is 20 acres per 1000 population with a minimum of 250 acres.[10]

In 1976, the Tennessee Department of Conservation conducted a survey of all recreational facilities throughout the state. The quantity of parks, by category, for Shelby County is given in Table 3-100. Ownership and operation is predominantly the responsibility of the Memphis Park Commission. Table 3-101 gives an overview of activities available at recreational facilities throughout Shelby County in 1978.

In addition to the public facilities found within the county, there are numerous private and semiprivate facilities as is shown in Table 3-102. Accompanying these facilities are numerous smaller groups involved in well-defined areas such as music, ballet and art. A partial listing of these cultural and recreational facilities and organizations is provided in Table 3-103.

The Memphis Queen Riverboat Line offers riverboat excursions daily, and Gray Line Tours offers counterpart services on land. A number of other facilities offer individual and group tours. These include the Memphis Cotton Exchange; the Schlitz Belle, featuring brewery tours and refreshments in a replica of a Mississippi River steamboat saloon; and the Memphis Navy base at Millington. Other points of general interest include the Memphis Belle, a World War II B-17 "Flying Fortress"; the Auditorium and Cook Convention Center; Graceland (the Elvis Presley estate); and Overton Square, with its restaurants and specialty shops.[13]

Leisure pursuits of an academic and scientific nature are available at eight major colleges, universities and technical institutes. The Memphis Botanical Garden and the Memphis Zoological Gardens and Aquarium are also of considerable interest to a substantial number of visitors.[13]

3.9.4 EXISTING AND PROJECTED INFRASTRUCTURES

This section provides baseline data on study area infrastructure components including transportation, utilities and water and sewer systems.

TABLE 3-100

AN INVENTORY OF RECREATIONAL FACILITIES IN SHELBY COUNTY BY THEIR GENERAL DESCRIPTIONS[11]

Facility	Number of Facilities	Percent of Total
Neighborhood Parks	205	71.92
Community Parks	43	15.08
Regional Parks	10	3.50
National Parks	0	0.00
Historical Areas	4	1.40
National/State Forest	0	0.00
Parkway Special Area	1	0.35
Private Development	21	7.36
Not Reported	1	0.35
Total	285	100.00

TABLE 3-101

A LISTING AND SUMMATION OF THE PRIMARY ACTIVITIES OFFERED AT RECREATIONAL FACILITIES IN SHELBY COUNTY (1978)[11]

Activity	Number of Activity Locations in Shelby County	Percent of Total
Camping	2	0.72
Field Sports	168	61.09
Fishing	2	0.72
Golf	13	4.72
Historical Site	26	9.45
Hunting	1	0.36
Scenic Areas	2	0.72
Picnicking	6	2.18
Rodeo, Zoo, etc.	3	1.09
Hunt Stocked Game	1	0.36
Trails	6	2.18
Vacationing	1	0.36
Water Sports	1	0.36
Gymnasium Sports	43	15.63
Total	275	100.00

TABLE 3-102

A PARTIAL LISTING OF PRIVATE AND SEMIPRIVATE RECREATIONAL FACILITIES[10]

Name	Facilities
Bella Vista Country Club	golf course, swimming pool, clubhouse
Boy's Club of Memphis	gymnasium, clubhouse, camp
Briargate Country Club	swimming pool, clubhouse
Chickasaw Country Club	golf course, tennis courts, swimming pool, clubhouse
Colonial Country Club	golf courses, tennis courts, swimming pool, clubhouse
Farmington Country Club	golf course, tennis courts, swimming pool, clubhouse
Girls' Club of Memphis	gymnasium, game and meeting rooms
Graceland Recreation Club	swimming pool, tennis courts, playgrounds
Houston Levee Golf Club	golf course, clubhouse
Jewish Community Center	swimming pools, gymnasium, handball courts, health club, meeting rooms, playfields
Lakeland Amusement Park	fishing, boating, camping, swimming pool, riding facilities, stockcar racing
Memphis Athletic Club	tennis courts, gymnasiums, swimming pool, handball courts, exercise room, steam room
Memphis Country Club	golf course, swimming pool, tennis court, clubhouse
Memphis Hunt and Polo Club	tennis courts, swimming pool
Memphis Yacht Club	boating
Ridgeway Country Club	golf course, swimming pool, tennis courts, clubhouse
University Club of Memphis	tennis courts, swimming pool, health club
Whitehaven Country Club	golf course, tennis courts, swimming pool, clubhouse
Windyke Country Club	golf course, tennis courts, swimming pool, clubhouse
YMCA (5 branches)	gymnasiums, swimming pools, meeting and club rooms, health facilities
YWCA (4 branches)	meeting and club rooms

TABLE 3-103

A PARTIAL LISTING OF CULTURAL AND RECREATIONAL FACILITIES AND ORGANIZATIONS WHICH ARE PUBLICLY FUNDED OR OPEN TO THE PUBLIC[12]

Name	Address
Memphis Arts Council	263 McLean Blvd., South
Brooks Memorial Art Gallery	Overton Park
Memphis Academy of Arts	Overton Park
Theatre Memphis	630 Perkins St. Extended
Circuit Playhouse	1947 Poplar Avenue
Cook Convention Center	255 North Main
Memphis Symphony Orchestra	1503 Monroe Avenue
Memphis Ballet Society	3383 Summer Avenue
Ballet South	3355 Poplar Avenue
Arts Appreciation Foundation	Southern Avenue
Memphis Opera Theatre	Memphis State University
The Beethoven Club	263 S. McLean Blvd.
The Goodwyn Institute	127 Madison Avenue
Memphis "Pink Palace" Museum	Central Avenue
The Mid-South Coliseum	Fairgrounds
Chucalissa Indian Village	1987 Indian Village Drive
Fuller State Park	Mitchell Boulevard
Beale Street	Beale Street
Graceland	Elvis Presley Blvd.
The Magevney House	198 Adams Avenue
The Fontaine House	680 Adams Avenue
Cotton Carnival	Fairgrounds
Mid-South Fair	Fairgrounds
Memphis Zoological Garden and Aquarium	Overton Park
Memphis Botanic Garden	Audubon Park
Goldsmith's Civic Garden Center	Audubon Park
Libertyland	Fairgrounds
Overton Square	Madison Avenue

3.9.4.1 TRANSPORTATION

Highway access into Shelby County is provided by 11 major highways which provide an excellent pattern for convergence into and divergence away from the city. These highways are linked to the city by means of a 67-mile circumferential expressway system. Table 3-104* lists traffic at key intersections which might be used by plant personnel during construction and operation. These intersections are shown in Figure 3-42 and illustrate a number of alternative routes to reach Mitchell Road, the key access road to the site.

Local facilities provide access for 73 fixed-route regularly scheduled motor carriers operating in the city, more than 150 other motor carriers operating in and around the area and vast numbers of private and commercial vehicles and buses. Fixed-route motor carriers in the area provide direct service to points in 27 states, while other carriers provide such special services as local cartage, liquid bulk transportation, heavy hauling, express and transfer service and freight forwarding and consolidating. The area is also served by two major interstate bus lines (Continental Trailways and Greyhound) and by six smaller lines. The municipally owned Memphis Transit Authority provides local bus service to Memphis and specified points in Shelby County. The West Memphis Transit Company provides scheduled bus service across the Mississippi River to West Memphis every 40 minutes.[13]

Eight trunkline railroads operate out of Memphis, providing freight service to all principal cities in the United States, in addition to furnishing direct on-line service to 25 states.[13]

In addition to Memphis International Airport, located nine miles southeast of the downtown area, there are eight general aviation airports in the metropolitan area: Shelby County, Arlington Municipal, Wilson Field, Crittenden County, West Memphis Municipal, DeSoto County, DeSoto Twinkle Town and Millington Naval Air Station. Airports in the area are served by five air trunk-

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* Based on Memphis State University, Bureau of Business and Economic Research, unpublished data from Tennessee Department of Transportation, Research and Planning Division, Memphis, Tennessee, 1978.

TABLE 3-104

TRAFFIC COUNTS ON MAJOR THOROUGHFARES

Thoroughfare	Date	North	South	East	West
Brooks & Third	10-21-75	45,487	36,866	16,341	6,680
Horn Lake & I-55	4-23-75	8,613	11,594		2,384
Mitchell & Weaver	8-19-76	4,000	4,976	5,992	5,624
Mitchell & Horn Lake	4-15-76	4,848	1,840	12,808	9,720
Mitchell & Highway 61	4-12-76	4,848	1,840	12,808	9,720
Peebles & Third	10-6-77	57,003	50,843	2,496	6,070

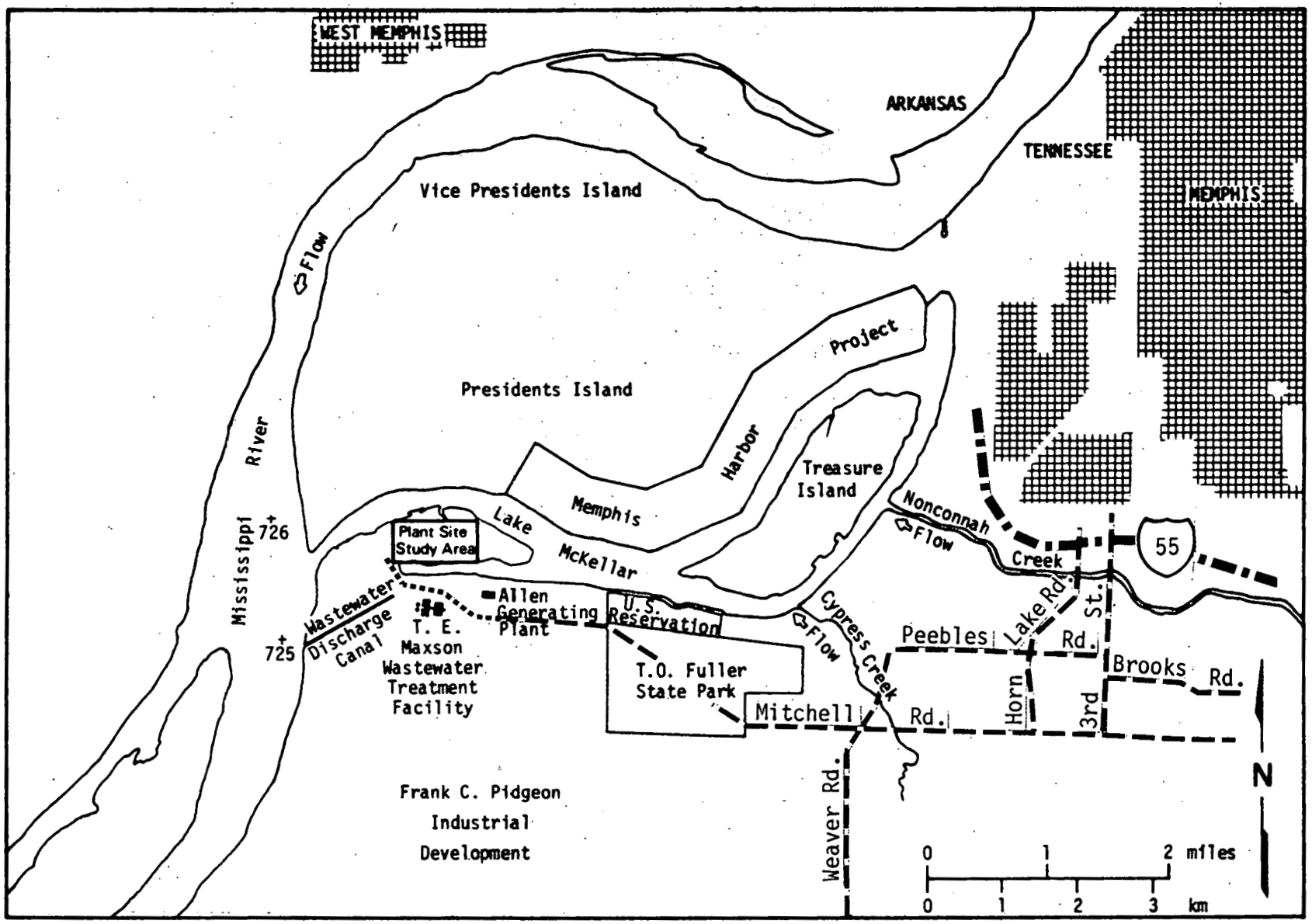

Figure 3-42. Location of Key Roads and Intersections in Plant Vicinity

lines and five regional carriers, which operate about 300 inbound and outbound flights daily for passengers and cargo traffic. Principal commercial carriers include: Allegheny, American, Braniff, Delta, Eastern, Frontier, Piedmont, Southern, Texas International and United.[13]

Seven major carrier barge lines operate scheduled service between Memphis and navigable points along the Mississippi, Missouri and Ohio Rivers and their tributaries and the Gulf Intracoastal Waterway. Memphis Harbor is bordered by the existing Presidents Island industrial area and the proposed 6800-acre Frank C. Pidgeon Industrial Park.[13]

It is apparent from the preceding discussion that the Memphis-Shelby County area is accessible to a number of transportation modes. Similarly, the IFGDP site may be reached by three different forms of transportation: road, rail and water. The site is accessible to river transport via the Mississippi River and Lake McKellar. Railway traffic can reach the site by means of a spur from the Illinois Central Railroad that connects with the Allen Generating Plant. Most heavy equipment for the plant will be delivered via barge and rail as will coal during the operational period. The primary road leading to the plant site is Mitchell Road, an east-west trending two-lane road which connects to a number of major highways. In 1976, Mitchell Road had an average daily traffic in the vicinity of the plant site of 5624 vehicles. Traffic heading to the plant site along Mitchell Road during construction and operation will ultimately reach the site via a new access road to be built in the vicinity of the Allen Generating Plant.

3.9.4.2 UTILITIES

Included in this discussion of the utilities components of the study area are electic power, natural gas and telephone service.

3.9.4.2.1 ELECTRIC POWER

Electric power is supplied to the Memphis-Shelby County area by the municipally owned Memphis Light, Gas and Water Division, which is linked to the TVA system

of electrical generation. As a distributor of TVA power, MLGW is connected to the TVA system by seven 161,000-volt direct-supply lines and through a step-down substation with 2,400,000 kilowatt (kw) capacity to three 500,000-volt transmission lines. In addition, TVA operates the Allen Generating Plant, an electrical generating station, through a lease arrangement with MLGW. The station is situated on a site adjacent to the proposed IFGDP site and operates with a gross capacity of approximately 1400 megawatts (MW).

MLGW has 37 electrical substations serving Memphis and Shelby County that are manually or remotely controlled. Transmission is normally at 161 kilovolts (kv). Substation capacities vary from 10,000 kilovolt amperes (kva) to 180,000 kilovolt amperes, while power is ultimately distributed at 12 kilovolts and 23 kilovolts, with higher primary voltages possible for larger industries.

3.9.4.2.2 NATURAL GAS

MLGW is supplied with natural gas by Texas Gas Transmission Corporation. The gas is received through two 26-inch and two 18-inch transmission lines from gas fields in Texas and Louisiana. Heating value of the gas is not less than 1000 British thermal units (Btu) per standard cubic foot.

There are, at present, six gas pumping stations within Shelby County. It should be noted that while customers on existing facilities are being offered service, there is no gas available for new or additional service. This includes industrial and residental customers requiring extension of existing gas mains.

3.9.4.2.3 TELEPHONE SERVICE

There are two telephone companies serving the Memphis-Shelby County area. The smaller of the two, Millington Telephone Company, is somewhat restricted to the City of Millington; while the larger, South Central Bell, has international connections. Both, however, are linked to all telephone communication facilities.

3.9.4.3 WATER AND SEWER SYSTEMS

Water is provided to the City of Memphis by the Memphis Light, Gas and Water Division mainly from an artesian water supply known as the Memphis sand or "500-foot" sand. Water pumped from 139 MLGW wells is aerated, filtered and stored in concrete reservoirs before entering the distribution system. MLGW's nine pumping stations pump an average of 100,000,000 gallons per day. Surface water and groundwater resources are described in detail in Section 3.3.

The trend in Shelby County has been for or toward a consolidation of wastewater management functions. The City of Memphis has two recently constructed major wastewater treatment facilities; the North Plant and the South Plant. Table 3-105* indicates the specifications and the actual operation conditions of each plant. The plants were designed as part of a major sewage system program which included major sewer interceptor facilities to serve Shelby County. Treatment plants and oxidation lagoons for the remainder of Shelby County are found in larger communities throughout the county.

The ever-expanding number of industries situated within the City of Memphis and Shelby County are major sources of wastewater. The original planning and construction of the two new city plants included accommodation for existing wastewater flows from the industries and an allowance for future growth. However, since the construction program begam. a new and different set of circumstances has emerged: (1) new water pollution control laws by both the U.S. government and State of Tennessee have come into existence, (2) a smaller than originally anticipated growth of the area has occurred and (3) outlying communities, because of the application of more stringent discharge standards to area streams by regulatory agencies, are being forced to accelerate the upgrading of their systems.[14]

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* Unpublished data Memphis State University, Bureau of Business and Economic Research, City of Memphis Planning and Development Office, Wastewater Planning Division, Memphis, Tennessee, 1978.

TABLE 3-105

CITY OF MEMPHIS WASTEWATER TREATMENT FACILITIES AND SPECIFICATIONS

	Design	Actual Operations
NORTH PLANT		
Flow*	135 mgd	75 mgd
BOD**	244 mg/l	450 mg/l
SS†	332 mg/l	450 mg/l
Population††	700,000	
SOUTH PLANT		
Flow	80 mgd	55 mgd
BOD	279 mg/l	560 mg/l
SS	267 mg/l	315 mg/l
Population	480,000	

* Flow in million gallons per day

** 5-day biochemical oxygen demand

† Suspended solids

†† Population served

Note: All wastewater conveyance systems are separate sanitary sewers relying on gravity flow.

The smaller communities surrounding Memphis are faced with the same problems, only on a smaller scale. Their wastewater discharges need to be upgraded, and sewers need to be rehabilitated. Some communities have no existing sewage collection systems.

Discharges into surface water bodies in the vicinity of the proposed IFGDP are listed in Section 3.3.1.

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3.10 SIGNIFICANT CULTURAL AND VISUAL FEATURES

3.10 SIGNIFICANT CULTURAL AND VISUAL FEATURES

In this section, cultural and visual features of significance in this project are discussed.

3.10.1 CULTURAL FEATURES

The project area lies within the 1881 to 1893 channel of the "Tennessee Chute" (now Lake McKellar), which forms the southern boundary of Presidents Island. It is also most likely that the 1820 to 1830 channel of the Tennessee Chute flowed through the project area. This would indicate that the project area is recently (post-1893) formed and that any prehistoric or early historic sites that might have existed in the project area would have almost certainly been destroyed by the recent meanders of the Tennessee Chute.

Telephone consultation with the State Historic Preservation Officer indicated that there are no cultural resources in the project area that are listed on, or nominated for, the National Register.[1]

Both documentary evidence and field testing indicate that the project area contains no evidence of prehistoric, architectural or historic remains, significant or otherwise.[1]

3.10.2 VISUAL FEATURES

The IFGDP site is composed of channel alluvium which has been dredged from Lake McKellar. As described in Section 3.6, this material supports a successional bottomland forest as well as meadow vegetation. However, the site contains no significant or unique visual features.

In the area surrounding the site and including the City of Memphis, there are numerous designated and undesignated areas of visual interest as shown in Figure 3-43. In the former category are: Fuller State Park (including Chucalissa Indian Village), Martin Luther King (Riverside) Park and Meeman-Shelby Forest State Park and others.

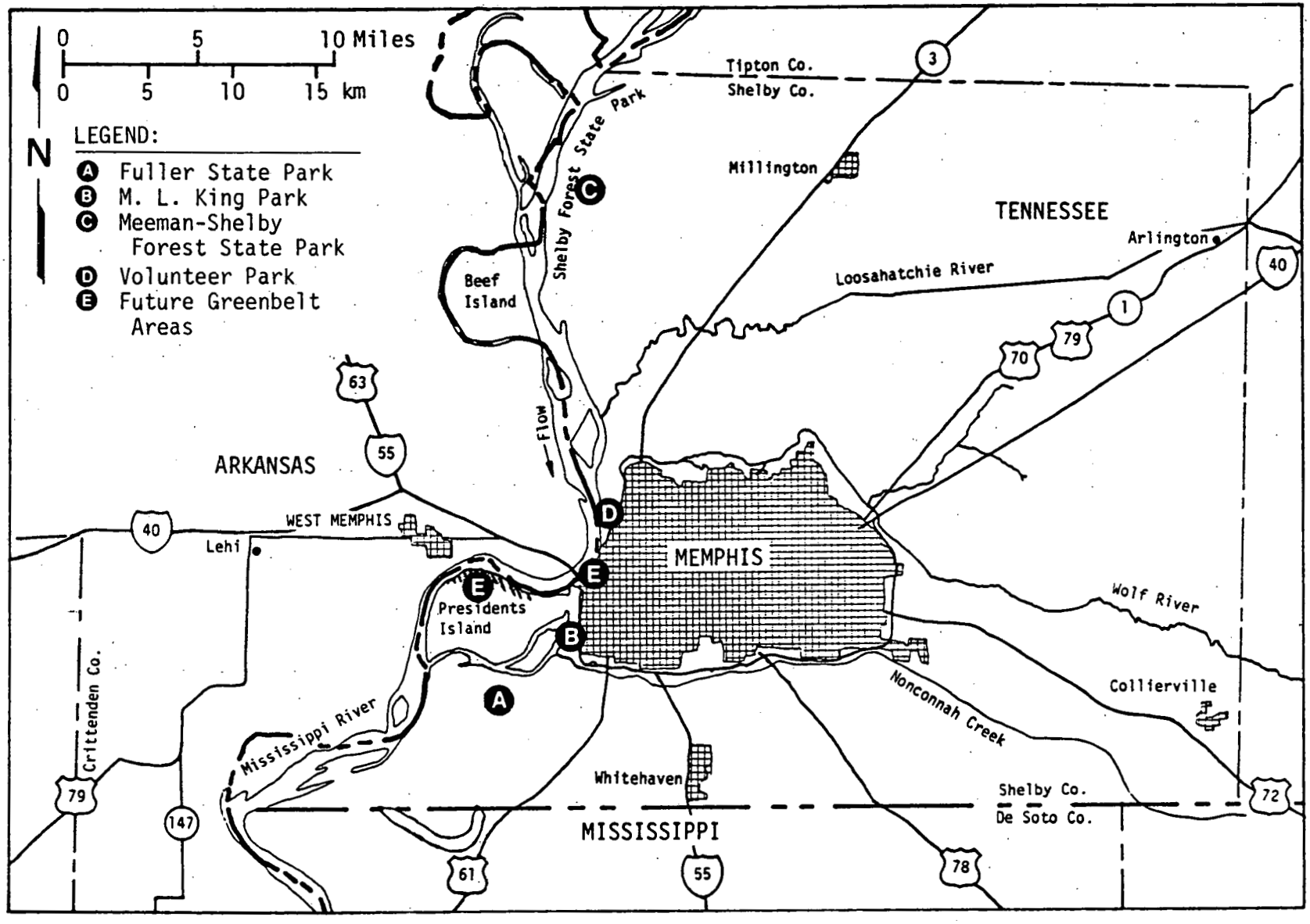

Figure 3-43. Major Parks and Projected Greenbelt Areas Near Memphis

Fuller State Park includes a golf course, a 56-site motor vehicle camping area and the reconstructed Chucalissa Indian Village. The swimming pool in the park is not currently available for use as it is being expanded. Annual visitation for 1978 was 107,591 persons.* The park is open year-round from 8:00 a.m. until nightfall (with the exception of the campsites). Mitchell Road-the primary access route to the IFGDP site-traverses the park and has an average daily two-way traffic level of 5624 vehicles.*

Martin Luther King (Riverside) Park is operated by the Memphis Park Commission on a year-round basis. Facilities at the 379-acre park include a boat ramp and dock to Lake McKellar, picnic areas and a golf course. Visitor data is not maintained for this park.**

Meeman-Shelby Forest State Park, located 15 miles north of Memphis, offers year-round outdoor recreational experiences. Within this southern hardwood forest are facilities for swimming, riding, hiking, fishing and forest management instruction. There are also sites available for 50 camper vehicles. Annual visitation is estimated at over 1,000,000 persons. Hours at the park are from 6:00 a.m. to 10:00 p.m.†

There are also areas proposed for public designation as future parks, greenbelts and other open space. Such areas include a greenbelt strip along the east bank of the Mississippi River from a point below Memphis to the Tennessee Chute and around Presidents Island and the Volunteer Bicentennial Park (under construction) on Mud Island.[2]

Undesignated areas are perhaps just as important from a visual standpoint. Such areas include those used for activities such as hunting, fishing and hiking or nature watching. The west bank of the Mississippi River has proved particularly popular among outdoorsmen in recent years.[2]

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* Based on personal communication between G. C. Pangburn, EIA and E. Hardy, Fuller State Park, August 7, 1979.

** Based on personal communication between G. C. Pangburn, EIA and staff members, Memphis Park Commission, June 12, 1979.

† Based on personal communication between G. C. Pangburn, EIA and V. Montgomery, Meeman-Shelby State Park, June 12, 1979.

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3.11 PHYSICAL ENVIRONMENTAL CONSTRAINTS

3.11 PHYSICAL ENVIRONMENTAL CONSTRAINTS

In this section, the main potential physical environmental constraints of the site are summarized. These potential constraints are in the areas of groundwater levels, flooding, seismicity and soil stability. It must be emphasized that the site will undergo significant engineering treatment prior to the construction of the IFGDP. These changes are highlighted in this section, and other sections in this report are referenced as needed.

3.11.1 GROUNDWATER LEVELS AND FLOODING POTENTIAL

Groundwater conditions at the site are described in Section 3.3.2.2, Groundwater Characteristics at the Site. Data provided in Section 3.3.2.2 indicate that presently almost all of the soils from 0 to 120 feet below the surface of the site are very permeable, and that total groundwater yields of the strata at 0 to 50 feet below the site are limited by the depth of the Mississippi River. The site area is typically recharged during the spring, and it recharges the Mississippi River during the late summer and fall. When the river rises, the water table in the sand rises at a lagging rate. After site preparation, when the site is elevated to 71 meters above mean sea level (233 feet, which is 0.5 foot above the U.S. Army Corps of Engineers defined Project Flood, Section 2.3.1.1.4), graded and compacted, the water table fluctuations will continue to follow the same pattern. The water table in the alluvial fill, however, should not rise to levels that would interfere with construction or operation activities at the site.

Present flooding conditions are detailed in Section 3.3.1.1.4, Flood Record and Flood Control. Data presented in that section indicate that presently the 2-year flood is contained within the Mississippi River levee system, the 5-year flood causes flow across Presidents Island and the 10-, 25-, 50- and 100-year floods are diverted by Presidents Island embankment that reaches an elevation of 230 feet above mean sea level. After elevating the site to 233 feet above mean sea level, it will be located above the 100-year flood.

3.11.2 SEISMIC RISK

Seismicity at the site is detailed in Section 3.2.5, Seismicity. In that section relevant historical earthquakes are described and located with respect to the site. Data given in that section indicate that the site is located in Zone 3 of the U.S. Seismic Risk Map, and an earthquake corresponding to 0.19g* motion can occur at the site. Such an earthquake corresponds to an event of a 6.3 magnitude on the Richter Scale.

Recurrence data for the Memphis region indicate that a felt seismic event of magnitude VI on the Modified Mercalli scale will occur 6 times per 100 years on the average and will result primarily from seismic events centered near New Madrid, Missouri, approximately 165 kilometers north of the site. It is further concluded by a seismic study conducted for this area and referenced in Section 3.2.5 that the maximum credible earthquake expected to occur in the area will have a Richter Magnitude of 7.4 (epicentral Modified Mercalli Intensity of X) and will have a repetitive occurrence of approximately every 500 to 700 years.

The IFGDP will be constructed to sustain seismicity events corresponding to Zone 3; and therefore, should such earthquakes occur, the plant is expected to sustain them without damage.

3.11.3 SOIL CONSTRAINTS

Soils at the site are described in Section 3.2.4, Soils, and Section 3.3.2.2.2, Hydrologic Characteristics of Strata. Data presented in those sections indicate that over 87 percent of the site is presently covered with from 0 to 6 feet of accumulated spoils from dredging. In addition, in the site preparation phase of this project, the site will be covered and graded with sand dredged from the Mississippi River.

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* See List of Abbreviations for definition.

According to the soil foundation study conducted on the site and summarized in Section 2.3.1.1.5, Foundations, most structures will be supported on shallow spread footings with bearing capacities of up to 4000 pounds per square foot. These capacities, subject to change pending further tests on the engineering properties of the fill material, are based on a maximum column load not to exceed 300,000 pounds. Detailed design will determine if pilings are necessary for tall structures with concentrated loads.

Shallow spread footings will bear at a minimum of 2 to 3 feet below final grade for frost protection and to provide for adequate confinement at the bearing soils. The bottom of the footings will be compacted to densities equivalent to 98 percent of the Modified Proctor maximum dry density (ASTM Specification D-1557). The footing excavations will not extend below the groundwater table. Construction of foundations will begin after a sufficient time to allow the site to settle (approximately 2 to 6 months).

These practices will reduce any soil constraints that might presently be at the site.

3.11.4 SOIL LIQUEFACTION

During Phase II of the soils investigation, a study of liquefaction potential of the final MLGW site shall be performed by the soils consultant. This study entails laboratory analysis consisting of a cyclic triaxial shear testing program which will define the required soil properties. Based upon these soil properties (density, shear strength, shear modulus, etc.), the probability of liquefaction during a severe earthquake shall be determined. It should be pointed out that a liquefaction occurrence cannot be designed for, the probability can only be estimated.

APPENDICES

APPENDIX 3A
WATER QUALITY

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3A.1 INTRODUCTION

This appendix provides detailed information in support of water quality Sections 3.3.1.1.5 (Mississippi River Water Quality Near Memphis), 3.3.1.1.6 (Mississippi River Sediment Quality), 3.3.1.2.5 (Lake McKellar Water Quality), 3.3.1.2.6 (Lake McKellar Sediment Quality), 3.3.1.3.5 (Small Streams in the Study Area Water Quality) 3.3.1.3.6 (Small Streams in the Study Area Sediment Quality) and 3.3.2.3 (Groundwater Quality).

3A.2 SURFACE WATER QUALITY

To assess surface water quality, available literature and data from the recent 1978-79 site-specific EIA field surveys of the Mississippi River near Memphis, Lake McKellar and Nonconnah Creek were examined to describe baseline conditions and were compared with applicable water quality criteria to address existing stresses. State of Tennessee Water Quality criteria(1) and U.S. Environmental Protection Agency (EPA) criteria(2) for the protection of fish and aquatic life were considered in this evaluation. These criteria are reported in Table 3A-1. Where the criteria are presented in the form of bioassays, comparison was made with EPA criteria for public water supply (Table 3A-1). By using this approach, strictest applicable criteria (Criteria) were derived (Table 3A-2).

3A.2.1 LITERATURE INFORMATION

A wide variety of historical sources are available that address water quality in the vicinity of the proposed site. Since 1973, the U.S. Geological Survey has collected water quality data in the Mississippi River at Memphis, river mile 734.8, for the parameters indicated in Table 3A-3.(3) Within this monitoring period, iron and manganese were the only parameters which consistently exceeded Criteria, while nitrate-nitrogen and cadmium were occasionally in excess. Throughout the period, there were no consistent detectable trends in the representative parameters of iron, cobalt, lead, total organic carbon, bicarbonate, turbidity, fecal coliform and sulfate. This is possibly due to

TABLE 3A-1

APPLICABLE WATER QUALITY STANDARDS AND CRITERIA

Parameter	Tennessee Water Quality Criteria[1] Nonconnah Creek*	Lake McKellar**	Mississippi River†	Water Quality[2] Criteria for Aquatic Life	Water Quality Criteria for[2] Domestic Water Supply (Health and Welfare)	Water Quality[2] Criteria for Agricultural Use	Drinking Water[2] Standards
pH (units)	>6.5-<8.5	>6.5	>6.5-<8.5	>6.5-<9.0	>5-<9		
Dissolved Oxygen (mg/l)	>5	>5	>5	>5			
Temperature (°C)	<30.5	<30.5	<30.5				
Coliform (colonies/ 100 ml)Δ	<1,000	<1,000	<1,000				
Total Alkalinity (mg/l as $CaCO_3$)				>20			
Ammonia, un-ionized (mg/l)				<0.02			
Arsenic (μg/l)					<50	<100	<50
Barium (mg/l)					<1.0	<1.0	<1.0
Beryllium (μg/l)				<1.1		<0.1	
Boron (mg/l)						<0.75	
Cadmium (μg/l)				<1.2	<10		<10
Chromium (μg/l)				<100	<50		<50
Copper (mg/l)				ΔΔ	<1.0		
Cyanide (μg/l)				<5			
Iron, filterable (mg/l)				<1.0	<0.3		
Lead, filterable (mg/l)				ΔΔ	<0.05		<0.05
Manganese (mg/l)					<0.05		
Mercury (μg/l)				<0.05	<2		<2
Nitrates (mg/l)					<10.0		<10.0
Phenol (mg/l)				<0.001***	<0.001		
Selenium (mg/l)				ΔΔ	<0.01		<0.01
Total Dissolved Solids (mg/l)					<250†††		
Zinc (mg/l)				ΔΔ	<5.0		

* For use by aquatic life and livestock watering and wildlife.
** For industrial water supply, aquatic life and recreation.
† For industrial water supply, aquatic life, irrigation water supply, navigation, and livestock watering and wildlife.
†† To a depth of five feet below water surface.
Δ A geometric mean based on not less than 10 samples. No individual sample should exceed 5,000 per 100 ml.
ΔΔ Determined from a 96-hour LC_{50} bioassay of most sensitive species.
*** To protect against fish flesh tainting.
††† As chlorides or sulfates.

TABLE 3A-2

MOST STRINGENT APPLICABLE WATER QUALITY CRITERIA

	Surface Waters (1,2) (Aquatic Life) *	Groundwater (1,2) (Health & Welfare Agriculture)
pH (units)	>6.5-<9	>5-<9
Dissolved Oxygen (mg/l)	>5	
Temperature (°C)	<30.5	<30.5
Coliform (colonies/100 ml)†	<1,000	<1,000
Total Alkalinity (mg/l as $CaCO_3$)	>20	
Ammonia, un-ionized (mg/l)	<0.02	
Arsenic (μg/l)		<50
Barium (mg/l)		<1.0
Beryllium (μg/l)	<1.1	<0.1
Boron (mg/l)		<0.75
Cadmium (μg/l)	<1.2	<10
Chromium (μg/l)	<100	<50
Copper (mg/l)	<1.0	<1.0
Cyanide (μg/l)	<5	
Iron, filterable (mg/l)	<1.0	<0.3
Lead, filterable (mg/l)	<0.05	<0.05
Manganese (mg/l)	<0.05	<0.05
Mercury (μg/l)	<0.05	
Nitrates (mg/l)	<10.0	<10.0
Phenol (mg/l)	<0.001	<0.001
Selenium (mg/l)	<0.01	<0.01
Total Dissolved Solids (mg/l)	<250 **	<250 **
Zinc (mg/l)	<5.0	<5.0

* U.S. EPA Criteria on Public Health and Welfare considered if aquatic life criteria presented in the form of a bioassay.

** As chlorides and sulfates

† A geometric mean based on not less than 10 samples. No individual sample should exceed 5000 per 100 ml.

TABLE 3A-3

RESULTS OF U.S. GEOLOGICAL SURVEY WATER QUALITY SAMPLING OF THE MISSISSIPPI RIVER AT WEST MEMPHIS, ARKANSAS FROM 1973 TO 1978[3]

Parameter**	1973*				1974*				1975*			
	No. of Values	Mean	Std. Dev.	Max.	No. of Values	Mean	Std. Dev.	Max.	No. of Values	Mean	Std. Dev.	Max.
PHYSICAL												
Turbidity (JTU)	4	82.5	80.2	200	5	48	25	80	12	51.0	21.0	90
Total Alkalinity (mg/l as $CaCO_3$)	4	129.5	9.1	139	5	106.8	22.1	139	12	105.2	15.4	129
Hardness (Ca and Mg) (mg/l as $CaCO_3$)	4	170	21.6	190	5	150	24	180	12	153.3	19.7	180
Non-Carbonate Hardness (mg/l as $CaCO_3$)	4	40.2	12.3	55	5	42.2	5.0	50	12	47	7	58
Conductivity (μmhos/cm)	11	381.1	51.4	468	12	383.9	51.1	447	12	381.2	62.3	464
pH (units)	4	8	0.36	8.3	5	7.82	0.38	8.4	12	7.6	0.3	8.2
Temperature (°C)	11	17.4	7.8	27.5	12	16.4	8.1	29	11	16.5	9.4	27.5
Dissolved Oxygen	4	7.35	1.06	8.9	2	11.1	3.1	13.3		Δ	Δ	Δ
Percent Saturation of Dissolved Oxygen	4	90.7	13.1	108	2	90.5	14.8	101		Δ	Δ	Δ
Carbon Dioxide	4	3.05	2.78	7.2	5	3.72	2.20	6.1	12	7.0	5.3	17
Total Suspended Solids	4	245.5	272.2	649	2	138	55	177	11	130.6	47.0	224
Suspended Solids Discharge (tons/day)	4	297550	37966	862000	1	455000	0	455000		Δ	Δ	Δ
Suspended Solids (Diameter % < 0.062 mm)	3	95.3	2.1	97	2	85	17	97	11	92.8	4.6	99
Total Dissolved Solids (at 180°C)	4	289.7	38.1	339	5	228.2	46.0	286	12	235.4	39.2	288
Dissolved Solids (sum of contituents)	1	213†	††	213†	5	214	42	276	12	220.1	40.0	270
Dissolved Solids (tons/acre-foot)	4	0.395	0.05	0.46	5	0.31	0.06	0.39	12	0.32	0.05	0.39
Dissolved Solids Discharge (tons/day)	4	295250	802968	393000	5	356000	150713	535000	9	355889	132109	616000
NUTRIENTS												
Total Phosphate	4	0.247	0.074	0.70	5	0.25	0.04	0.31	12	0.19	0.07	0.31
Nitrate, total	4	1.382	0.621	2.1	2	1.5	0.1	1.6		Δ	Δ	Δ
Nitrite, total	4	0.015	0.01	0.03	2	0.045	0.02	0.06		Δ	Δ	Δ
Total NO_2 and NO_3	4	1.392	0.611	2.1	5	1.13	0.42	1.7	12	1.27	0.76	3.2
Total Kjeldahl - N	1	1.3†	††	1.3†	5	0.736	0.207	0.98	12	0.90	0.28	1.7
Total Nitrogen	1	2.3†	††	2.3†	5	1.88	0.63	2.7	12	2.18	0.74	3.8
Nitrate - N	1	10†	††	10†	5	8.3	2.7	12	12	9.6	3.3	17
ORGANICS												
BOD (5 day)	3	3.0	0.72	3.8	2	2.3	0.7	2.8		Δ	Δ	Δ
TOC	1	7.0*	††	7.0*	1	5.3†	††	5.3†	2	6.6	0.7	7.1
DOC		Δ	Δ	Δ	1	5.1†	††	5.1†		Δ	Δ	Δ
Suspended Organic Carbon		Δ	Δ	Δ	1	1.1†	††	1.1†		Δ	Δ	Δ
Total Coliform (colonies/100 ml)	4	35075*ΔΔ	††	86000		Δ	Δ	Δ		Δ	Δ	Δ
Fecal Coliform (colonies/100 ml)	4	26575*ΔΔ	††	6700	5	3452*ΔΔ	††	16000	8	781.5*ΔΔ	††	3000
Streptococci (colonies/100 ml)	4	545	453	1000	5	236.6*ΔΔ	††	610	10	168.5*ΔΔ	††	540
MAJOR ANIONS												
Bicarbonate	4	158.2	11.2	170	5	129.6	25.7	166	12	128.4	18.8	15.7
Carbonate	4	0.0	0.0	0.0	5	0.4	0.9	2	12	0.0	0.0	0.0
Sulfate, dissolved	4	54.7	7.5	63	5	55.4	11.3	74	12	62.2	19.6	93
Chloride, dissolved	4	15.5	1.3	17	5	15.6	5.2	20	12	14.5	2.0	18
Fluoride, dissolved	4	0.35	0.13	0.5	5	0.36	0.30	0.9	12	0.23	0.06	0.3
MAJOR CATIONS												
Iron, total	2	10.300	8.061	16.000	2	3.700	3.6769	6.300	4	3.300	1.304	5.100
Iron, dissolved	2	0.035	0.0071	0.040	2	0.950	1.3435	1.900	4	0.015	0.017	0.040
Iron, suspended	1	4.500**	†	4.500**		Δ	Δ	Δ		Δ	Δ	Δ
Calcium, dissolved	4	44.5	5.0	48	5	40.2	7.0	49	12	40	5	47
Magnesium, dissolved	4	14.2	1.7	16	5	11.6	2.0	14	12	12.7	2.4	16
Sodium, dissolved	4	18.2	1.7	20	5	17.2	6.2	26	12	18.3	6.8	29
Potassium, dissolved	4	3.23	0.15	3.4	5	2.8	0.7	3.9	12	2.97	0.65	3.7
Percent Sodium	4	18.5	2.6	22	5	19.4	3.2	24	12	19.8	5.06	28
OTHER												
Silicon, dissolved	4	5.9	2.1	7.3	5	6.24	0.84	7.5	12	5.7	0.9	6.8
Manganese, total	2	0.595	0.445	0.910	2	0.235	0.07	0.290	4	0.1725	0.061	0.250
Manganese, suspended	2	0.590	0.438	0.900	2	0.225	0.063	0.270	4	0.1425	0.0287	0.160
Manganese, dissolved	2	0.004	0.006	0.008	2	0.010	0.014	0.020	4	0.0300	0.0469	0.100
Arsenic, total	2	0.0095	0.007	0.010	2	0.255	0.027	0.045	4	0.0025	0.0017	0.004
Arsenic, suspended	2	0.007	0.0	0.007	2	0.0205	0.0247	0.038	4	0.0015	0.0010	0.002
Arsenic, dissolved	2	0.0025	0.007	0.003	2	0.005	0.003	0.007	4	0.001	0.001	0.002
Cadmium, total	2	<0.015	††	<0.01	2	<0.010	††	<0.010	4	<0.2175	††	0.840
Cadmium, suspended	2	<0.01	††	<0.01	2	<0.0095	††	<0.010	4	<0.169	††	0.650
Cadmium, dissolved	2	0.0005	0.0007	0.001	2	0.0005	0.00071	0.0010	4	0.0485	0.0943	0.190
Chromium, total	2	0.015	0.021	0.030	2	0.0	0.0	0.0	4	0.0075	0.0096	0.020
Chromium, suspended	2	0.015	0.021	0.030	2	0.0	0.0	0.0	4	0.0075	0.0096	0.020
Chromium, dissolved	2	0.0	0.0	0.0	2	0.0	0.0	0.0	4	0.0	0.0	0.0
Cobalt, total	2	<0.025	††	<0.025	2	0.0	0.0	0.0	4	<0.050	††	0.050
Cobalt, suspended	2	<0.025	††	<0.025	2	0.050	0.0	0.050	4	<0.0497	††	0.050
Cobalt, dissolved	2	0.0	0.0	0.0	2	0.0	0.0	0.0	4	0.0	0.0005	0.001
Copper, total	2	0.050	0.028	0.070	2	0.205	0.219	0.360	4	0.070	0.032	0.110
Copper, suspended	2	0.041	0.028	0.061	2	0.1905	0.2114	0.340	4	0.0572	0.0227	0.085
Copper, dissolved	2	0.009	0.0	0.009	2	0.0125	0.0049	0.016	4	0.013	0.009	0.025
Lead, total	2	0.075	0.035	0.100	2	0.200	0.141	0.300	4	0.125	††	0.200
Lead, suspended	2	0.074	0.03	0.100	2	0.199	0.143	0.300	4	0.012	††	0.200
Lead, dissolved	2	0.001	0.001	0.002	2	0.0035	0.0021	0.005	4	0.001	0.001	0.003
Mercury, total	1	0.0001†	††	0.0001†	2	0.00005	0.00007	0.0001	3	0.00003	0.00006	0.0001
Mercury, suspended	1	0.0001†	††	0.0001†	2	0.00005	0.00007	0.0001	3	0.0	0.0	0.0001
Mercury, dissolved	2	0.0	0.0	0.0	2	0.0	0.0	0.0	4	0.00025	0.00005	0.0001
Selenium, total	2	0.008	0.003	0.010	2	0.001	0.001	0.002	4	0.001	0.001	0.10
Selenium, suspended	2	0.004	0.003	0.006	2	0.0	0.0	0.0	4	0.0	0.0	0.0001
Selenium, dissolved	2	0.004	0.0	0.004	2	0.002	0.003	0.004	4	0.0005	0.00058	0.001
Zinc, total	2	0.355	0.039	0.630	2	0.125	0.049	0.160	4	0.06	0.038	0.1
Zinc, suspended	2	0.310	0.438	0.620	2	0.080	0.042	0.110	4	0.0375	0.033	0.070
Zinc, dissolved	2	0.045	0.049	0.080	2	0.045	0.007	0.050	4	0.0225	0.0150	0.040

(Continued)

TABLE 3A-3 (Continued)

Parameter**	1976* No. of Values	1976* Mean	1976* Std. Dev.	1976* Max.	1977* No. of Values	1977* Mean	1977* Std. Dev.	1977* Max.	1978* No. of Values	1978* Mean	1978* Std. Dev.	1978* Max.
PHYSICAL												
Turbidity (JTU)	9	76.4	74.1	250		Δ	Δ	Δ	4	55.25	38.96	110.0
Total Alkalinity (mg/l as $CaCO_3$)	12	97.8	11.0	112	13	93.38	13.71	110.0	7	109.86	10.33	120.0
Hardness (Ca and Mg) (mg/l as $CaCO_3$)	12	144.2	15.0	170	14	138.57	18.75	160.00	7	156.40	5.90	180.00
Non-Carbonate Hardness (mg/l as $CaCO_3$)	12	46.6	10.4	70	13	43.77	9.59	62.00	7	50.50	4.46	61.00
Conductivity (μmhos/cm)	12	385.6	42.3	445	12	373.92	40.13	431.0	9	376.0	17.02	425.0
pH (units)	12	7.76	0.25	8.2	14	7.66	0.27	8.10	7	7.70	0.35	8.20
Temperature (°C)	11	17.3	8.7	25.5	11	18.27	10.25	29.50	9	16.06	10.94	27.50
Dissolved Oxygen		Δ	Δ	Δ	10	7.90	2.18	12.60	5	7.10	0.23	7.30
Percent Saturation of Dissolved Oxygen		Δ	Δ	Δ	10	83.50	6.82	94.00	5	87.60	5.22	93.00
Carbon Dioxide	12	3.8	2.1	8.8	13	4.82	3.41	14.00	2	7.60	3.39	10.00
Total Suspended Solids	12	193.6	186.6	740	14	208.14	150.61	658.00	7	174.57	136.55	744.00
Suspended Solids Discharge (tons/day)		Δ	Δ	Δ		Δ	Δ	Δ		Δ	Δ	Δ
Suspended Solids (Diameter % < 0.062m)	12	95.2	5.0	99	14	94.00	5.96	99.00	7	84.86	4.81	95.00
Total Dissolved Solids (at 180°C)	12	235.2	23.1	276	14	215.50	30.39	269.00	7	232.71	25.00	258.00
Dissolved Solids (sum of constituents)	12	215.2	30.1	263	13	203.23	32.42	254.00	7	232.43	26.47	265.00
Dissolved Solids (tons/acre-foot)	12	0.32	0.032	0.38	14	0.29	0.04	0.37	7	0.32	0.035	0.35
Dissolved Solids Discharge (tons/day)		Δ	Δ	Δ		Δ	Δ	Δ		Δ	Δ	Δ
NUTRIENTS												
Total Phosphate	12	0.26	0.13	0.64	14	0.25	0.12	0.55	7	0.22	0.13	0.50
Nitrate, total		Δ	Δ	Δ		Δ	Δ	Δ		Δ	Δ	Δ
Nitrite, total		Δ	Δ	Δ		Δ	Δ	Δ		Δ	Δ	Δ
Total NO_2 and NO_3	12	1.28	0.58	2.1	14	1.16	0.43	2.10	6	1.28	0.70	2.50
Total Kjeldahl - N	12	1.09	0.67	3.0	10	0.93	0.36	1.80	6	1.00	0.38	1.70
Total Nitrogen	12	2.40	1.11	5.1	10	1.91	0.53	2.50	6	2.28	1.03	4.20
Nitrate - N	12	10.52	5.02	23.0	10	8.47	2.37	13.00	6	10.23	4.69	19.00
Total Organic N		Δ	Δ	Δ		Δ	Δ	Δ	7	0.92	0.42	1.60
Total NH_3 (N)		Δ	Δ	Δ	4	0.065	0.080	0.180	6	0.095	0.11	0.31
NH_3 - Organic Dissolved Nitrogen		Δ	Δ	Δ	4	0.70	0.39	1.20	6	0.59	0.22	0.82
NH_3 - Organic Suspended Nitrogen		Δ	Δ	Δ		Δ	Δ	Δ	6	0.41	0.24	0.88
Dissolved Phosphate		Δ	Δ	Δ	4	0.14	0.08	0.28	7	0.06	0.01	0.07
ORGANICS												
BOD (5 day)		Δ	Δ	Δ		Δ	Δ	Δ		Δ	Δ	Δ
TOC	2	7.2	1.1	8.0	1	1.8	0.0	1.8	2	4.70	5.37	8.50
DOC		Δ	Δ	Δ	1	5.2	0.0	5.2	2	4.7	0.9	5.3
Suspended Organic Carbon		Δ	Δ	Δ	9	6.97	3.09	14.00	4	7.03	0.82	8.20
Total Coliform (colonies/100 ml)	10	1653.5ΔΔ	††	9000ΔΔ		Δ	Δ	Δ		Δ	Δ	Δ
Fecal Coliform (colonies/100 ml)	8	211.6ΔΔ	††	900ΔΔ	13	579.2ΔΔ	††	2200.00ΔΔ	7	1878.8ΔΔ	633.7	6600.00ΔΔ
Streptococci (colonies100 ml)	2	7.2	1.1	8.0	14	285.7ΔΔ	††	2000.00	7	1789.7ΔΔ	††	1200.0ΔΔ
MAJOR ANIONS												
Bicarbonate	12	119.2	13.2	136	13	114.54	17.77	140.00	2	130.0	0.0	130.0
Carbonate	12	0.0	0.0	0.0	14	0.0	0.0	0.0	2	0.0	0.0	0.0
Sulfate, dissolved	12	61.7	15.5	88	14	55.64	12.33	82.00	7	60.43	15.16	81.00
Chloride, dissolved	12	17.7	4.3	27	14	17.14	5.48	30.00	7	18.14	3.53	22.00
Fluoride, dissolved	12	0.22	0.07	0.3	14	0.23	0.08	0.40	7	0.20	0.06	0.30
MAJOR CATIONS												
Iron, total	4	5.877	0.519	6.600	4	3.6	1.9	5.1	2	8.5	9.2	15.0
Iron, dissolved	4	0.020	0.008	0.030	4	0.02	0.01	0.03	7	0.03	0.01	0.04
Iron, suspended		Δ	Δ	Δ		Δ	Δ	Δ		Δ	Δ	Δ
Calcium, dissolved	12	38.7	3.6	45.0	14	37.57	4.62	43.00	7	43.57	3.31	47.00
Magnesium, dissolved	12	11.6	1.6	14.0	13	11.14	1.83	14.00	7	12.86	1.35	15.00
Sodium, dissolved	12	18.9	6.0	28.0	14	16.86	4.67	25.00	7	17.57	6.21	26.00
Potassium, dissolved	12	3.1	0.4	3.8	14	3.26	0.60	4.20	7	3.34	0.56	4.00
Percent Sodium	12	21.2	6.5	28	14	20.14	3.16	25.00	7	18.29	4.46	24.00
Total Barium		Δ	Δ	Δ	1	400.0†	††	400.0†	2	200.0	141.4	300.0
Suspended Barium		Δ	Δ	Δ	1	300.0†	††	300.0†	2	0.0	0.0	0.0
Dissolved Barium		Δ	Δ	Δ	1	100.0†	††	100.0†	2	200.0	141.4	300.0
OTHER												
Silicon, dissolved	12	4.6	1.8	7.1	14	5.35	1.71	7.80	7	10.19	12.42	38.00
Manganese, total	4	0.3425	0.0680	0.410	4	0.208	0.102	0.310	2	0.340	0.368	0.600
Manganese, suspended	4	0.3375	0.0737	0.410	3	0.180	0.131	0.300	2	0.330	0.368	0.590
Manganese, dissolved	4	0.005	0.0058	0.010	4	0.020	0.018	0.040	2	0.010	0.0	0.010
Arsenic, total	4	0.0032	0.0022	0.006	2	0.003	0.001	0.004	2	0.003	0.001	0.004
Arsenic, suspended	4	0.0017	0.0021	0.004	2	0.002	0.001	0.003	2	0.0005	0.0001	0.0010
Arsenic, dissolved	4	0.0015	0.0013	0.003	4	0.0008	0.0005	0.0010	2	0.0025	0.0007	0.0030
Cadmium, total	4	<0.010	††	<0.010	4	<0.010	††	<0.010	2	0.0015	0.0007	0.002
Cadmium, suspended	4	<0.095	††	<0.010	3	0.00967	††	<0.010	2	0.0	0.0	0.0
Cadmium, dissolved	4	0.0005	0.0006	0.001	4	0.0005	0.0058	0.0010	2	0.0015	0.0007	0.0020
Chromium, total	4	0.0075	0.0050	0.010	4	0.005	††	0.010	2	0.020	0.0	0.020
Chromium, suspended	4	0.0075	0.0050	0.010	2	0.005	0.007	0.010	2	0.020	0.0	0.020
Chromium, dissolved	4	0.0	0.0	0.0	4	0.0	0.0	0.0	2	0.0	0.0	0.0
Cobalt, total	4	<0.050	††	<0.050	4	0.050	0.0	0.050	2	0.0025	0.0035	0.0050
Cobalt, suspended	4	<0.04925	0.0	<0.0500	3	0.049	††	<0.050	2	0.0025	0.0035	0.0050
Cobalt, dissolved	4	0.0007	0.001	0.002	4	0.0005	0.0005	0.001	2	0.0	0.0	0.0
Copper, total	4	0.055	0.021	0.080	4	0.055	0.017	0.070	2	0.059	0.057	0.100
Copper, suspended	4	0.0477	0.0211	0.075	3	0.052	0.015	0.062	2	0.053	0.052	0.090
Copper, Dissolved	4	0.0072	0.0026	0.010	4	0.0075	0.0065	0.0110	2	0.0065	0.0649	0.0100
Lead, total	4	<0.100	††	<0.100	4	<0.1	††	<0.1	2	0.014	0.12	0.021
Lead, suspended	4	<0.0995	††	<0.100	3	<0.099	††	<0.100	2	0.013	0.009	0.020
Lead, dissolved	4	0.0005	0.0006	0.001	4	0.0009	0.0009	0.0020	2	0.0005	0.0007	0.0010
Mercury, total	4	0.00025	0.00005	0.0001	2	0.0001	0.0001	0.0002	2	0.0	0.0	0.0
Mercury, suspended	4	0.00025	0.00005	0.0001	2	0.0	0.0	0.0	2	0.0	0.0	0.0
Mercury, dissolved	4	0.0	0.0	0.0	4	0.0001	0.0001	0.0002	2	0.0	0.0	0.0
Selenium, total	4	0.0005	0.0006	0.0010	4	0.0005	0.0005	0.0010	2	0.0006	0.0007	0.0010
Selenium, suspended	4	0.0	0.0	0.0	3	0.0003	0.0006	0.0010	2	0.0006	0.0007	0.0010
Selenium, dissolved	4	0.0005	0.0006	0.001	4	0.0	0.0	0.0	7	0.0	0.0	0.0
Zinc, total	4	0.080	0.022	0.110	4	0.0475	0.0957	0.0600	2	0.0490	0.0196	0.0600
Zinc, suspended	4	0.075	0.024	0.110	4	0.028	0.015	0.060	2	0.040	0.028	0.060
Zinc, dissolved	4	0.005	0.006	0.010	4	0.011	0.006	0.020	2	0.015	0.007	0.020

* Water years. Extend from October of preceeding year to September of stated year e.g., Water Year 1976 extended from October 1975 to September 1976.

** Units expressed as mg/l unless otherwise noted.

† Base on one observation

†† Cannot be calculated due to insufficient or imprecise data.

Δ Data not available

ΔΔ Outside ideal range for plate count or calculation based on estimates outside this range.

the diverse nature of the source origins of river water and ranging industrial and sanitary waste loads.

At eight locations in Lake McKellar, the Memphis and Shelby County Health Department has conducted water quality surveys on a quarterly basis since 1974, as shown in Figure 3A-1. This data base is presented in Table 3A-4. Fecal coliform concentrations at stations located near Nonconnah Creek and Presidents Island exceeded Criteria. Dissolved oxygen profiles indicated low concentrations in contravention of Criteria in the summer, with almost anaerobic conditions occurring at the bottom of the lake during periods of stratification.[4]

Tennessee Valley Authority (TVA) also collected data near the intake of the Allen Generating Plant from 1974 to 1976,[5] as indicated in Table 3A-5. Iron and manganese consistently exceeded Criteria and mercury exceeded occasionally.

In Nonconnah Creek, the most extensive water quality monitoring study was conducted by the Memphis and Shelby County Health Department[4] (Table 3A-6). Data collected twice monthly since 1974 at four locations along Nonconnah Creek show a deterioration in water quality as the stream flows westward toward Lake McKellar and no significant improvement in these conditions from 1974 to 1978. Dissolved oxygen and fecal coliform concentrations most consistently exceeded Criteria especially in the lower reaches of the Creek. Other studies which have recorded water quality information for Nonconnah Creek are the Nonconnah Creek Basin Environmental Inventory prepared for the U.S. Army Corps of Engineers (U.S. ACE),[6] and the Areawide Waste Treatment Management Plan (208 study).[7] For both the U.S. ACE and 208 studies, grab samples were collected at three locations in the lower basin of Nonconnah Creek (results as indicated in Tables 3A-7 and 3A-8).

3A.2.2 EIA 1978-79 FIELD SURVEY DATA

EIA conducted water quality field surveys on a seasonal basis (one survey per season) in May, July and October 1978 and in January 1979 during spring, summer, fall and winter seasons, respectively. Table 3A-9 summarizes the

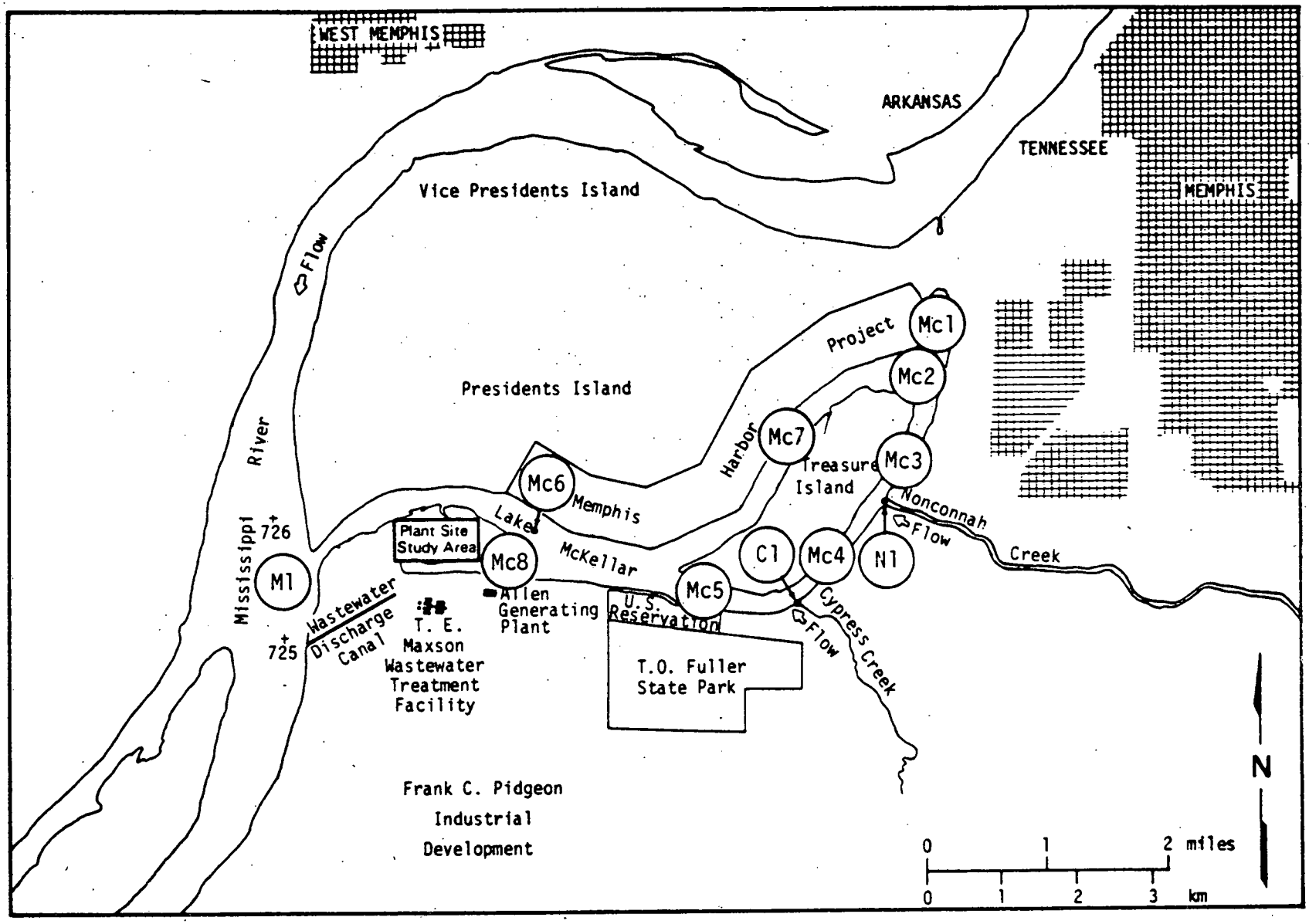

Figure 3A-1. Memphis and Shelby County Health Department Sampling Stations[4]

TABLE 3A-4

RESULTS OF MEMPHIS AND SHELBY COUNTY HEALTH DEPARTMENT WATER QUALITY SAMPLING OF LAKE MCKELLAR, NONCONNAH CREEK AND CYPRESS CREEK FROM 1975 TO 1978[4]

Parameters**	MC-1*				MC-2*				MC-3*				MC-4*				MC-5*				MC-6*			
	No. of Values	Mean	Std. Dev.	Max.	No. of Values	Mean	Std. Dev.	Max.	No. of Values	Mean	Std. Dev.	Max.	No. of Values	Mean	Std. Dev.	Max.	No. of Values	Mean	Std. Dev.	Max.	No. of Values	Mean	Std. Dev.	Max.
1974																								
pH units	5	7.24	0.13	7.4	5	7.1	0.40	7.4	5	7.26	0.15	7.4	5	7.22	0.35	7.8	5	7.16	0.23	7.4	5	7.28	0.28	7.5
COD	2	8.25	5.73	12.3	2	10.9	5.8	15	2	15.1	6.1	19.4	2	20.85	15.34	31.7	2	11.5	8.9	17.8	2	7.55	5.02	11.1
BOD (5 day)	5	2.26	0.84	3.5	5	2.8	1.3	5	5	3.26	1.25	4.3	5	4.4	1.4	5.8	5	3.1	0.9	3.9	5	2.56	1.53	5.0
Conductivity (µmhos/cm)	5	233.8	65.5	335	5	235.8	69.7	346	5	223.2	49.8	295	5	200.2	46.7	252	5	226.6	59.7	318	5	251.6	48.1	381
Ammonia - N	5	0.60	0.26	0.94	5	0.486	0.170	0.75	5	0.5	0.4	0.5	5	0.50	0.34	1.0	5	0.4	0.34	0.9	5	0.258	0.206	0.55
Turbidity (JTU)	2	32.3	34.9	57	2	32.8	35.6	58	2	47	7.1	52	2	92.0	50.9	128	2	48.5	19.1	62	2	40	32.5	63
1975																								
COD	1	28+	++	28+	1	16+	++	16+	1	48+	++	40+	1	20+	++	20+	1	16+	++	16+	1	24-	++	24-
BOD (5 day)	2	2.7	0.424	3	2	2.5	0.9899	3.2	2	4.5	2.4	6.2	2	4.0	1.8	5.3	2	2.1	0.7	2.6	2	2.1	0.57	2.5
Conductivity (µmhos/cm)	2	134	8.49	140	2	130.5	0.707	±	2	122	2.8	124	2	139	15	150	2	169.5	28.9	190	2	188	59.4	230
Ammonia - N	2	0.42	0.255	0.6	2	0.26		0.26	2	0.18	0.57	0.22	2	0.31	0.13	0.4	2	0.27	0.18	0.4	2	0.25	0.18	0.38
Turbidity (JTU)	2	185	91.92	250	2	190	92	255	2	210	71	260	2	190	113	270	2	140.5	161.9	255	2	143.5	150.6	250
Total Suspended Solids	2	117	117.38	200	2	137	120.2	222	2	171.5	47.4	205	2	142	82	200	2	112.5	85.6	173	2	124	121	210
Nitrate	1	4.1+	++	4.1+	±	±	±	±	±	±	±			3.9+	++	3.9+	±	±	±	±	1	3.9-	++	3.9+
Phosphate	1	0.47-	++	0.47-	±	±	±	±	±	±	±			0.52+	++	0.52+	±	±	±	±	1	0.31-	++	0.31+
Oil and Grease	±	±	±	±	±	±	±	±	1	0.05	++	0.05		0.08+	++	0.08-	±	±	±	±	±	±	±	±
1976																								
COD	3	10.61	6.04	15.84	3	10.63	6.1	16	3	14.6	6.09	20	3	19.9	12	32	3	15	4	20	3	27.9	4.1	32
BOD (5 day)	3	2.67	0.94	3.4	3	2.37	1.30	3.7	3	2.57	1.41	3.9	3	3.17	1.21	4.1	3	2.7	1.5	4	3	2.77	1.31	3.8
Conductivity (µmhos/cm)	3	143.3	75.7	230	3	145	82	240	3	141.7	68.2	220	3	159	58.6	210	3	176.7	72.5	260	3	164.3	94.5	270
Ammonia - N	3	0.37	0.16	0.46	3	0.37	0.16	0.46	3	0.25	0.20	0.48	3	0.31	0.22	0.56	3	0.24	0.17	0.44	3	0.23	0.18	0.44
Turbidity (JTU)	3	125.7	97.4	230	3	116.0	84	205	3	127.3	89.2	220	3	114	80	200	3	90	48.6	140	3	90	48	140
Total Suspended Solids	3	118.3	9.5	128	3	255	125	369	3	133.7	41.8	178	3	145	24	172	3	108.7	141	122	3	100	19	112
Nitrate	3	3.77	1.11	4.8	±	±	±	±	±	±	±		3	2.97	0.9	4	±	±	±	±	3	4.09	0.10	4.2
Phosphate	2	0.6	0.6	1.0	±	±	±	±	±	±	±		3	0.84	0.56	1.28	±	±	±	±	3	0.44	0.10	0.5
Oil and Grease	±	±	±	±	1	0.20+	++ 0	0.20+	2	0.15	0.071	0.2	3	0.03	0.02	0.05	±	±	±	±	±	±	±	±
1977																								
COD	3	30.9	5.26	34.1	3	34.8	20.06	57.8	3	32.8	16.3	51.4	3	20.27	5.72	25.7	3	22.9	16.9	42	3	12.37	9.23	22.2
BOD(5 day)	3	3.27	3.52	7.3	3	2.5	2.31	5.2	3	3.37	3.88	7.8	3	3.2	3.6	7.4	3	2.77	2.97	6.2	3	1.87	0.71	2.5
Conductivity (µmhos/cm)	3	255	39.7	285	3	233.3	72.3	280	3	231.7	71.1	280	3	251.7	44.8	280	3	253.3	28.9	270	3	279.3	18.5	290
Ammonia - N	3	0.35	0.26	0.5	3	0.35	0.26	0.5	3	0.31	0.23	0.49	3	0.32	0.28	0.6	3	0.40	0.14	0.6	3	0.22	0.24	0.5
Turbidity (JTU)	3	97.7	102.9	210	3	111.0	118.2	240	3	129.3	136.8	280	3	95.3	96.5	200	3	94.0	82.7	180	3	76.7	56.2	125
Total Suspended Solids	3	41.7	50.5	100	3	54.3	67.7	132	3	22	20	44	3	33.3	52.5	94	3	35.3	32.5	72	3	24.7	39.3	70
Nitrate	±	±	±	±	±	±	±	±	±	±	±			±	±	±	±	±	±	±	±	±	±	±
Phosphate	3	0.25	0.30	0.6	±	±	±	±	±	±	±		3	0.203	0.224	0.46	±	±	±	±	2	0.28	0.14	0.38
Oil and Grease	±	±	±	±	±	±	±	±	2	0.8	0.99	1.5	2	4.4	4.4	7.5	±	±	±	±	±	±	±	±
1978																								
Conductivity (µmhos/cm)	4	250.8	116.9	408	4	267.5	104.1	410	4	266.8	110.2	402	4	268.8	109.4	410	4	283.3	107.3	418	4	315.5	115.4	462
Ammonia - N	4	0.475	0.394	0.97	4	0.56	0.46	1.20	4	0.61	0.45	1.20	4	0.51	0.41	0.97	4	0.36	0.31	0.73	4	0.33	0.29	0.73
BOD (5 day)	4	2.9	0.5	3.5	4	2.35	0.81	3.2	4	4.2	1.9	6.9	4	4.1	2.2	6.9	4	1.8	1.3	3.7	4	1.8	0.7	2.4
Total Suspended Solids	4	95	160	335	4	27.5	21.4	58	4	85.3	132.8	284	4	96.8	155.5	330	4	26	15.9	49	4	20.3	12.6	34
Turbidity (JTU)	4	58	92	195	4	29.2	32.6	77	4	54.3	80.7	175	4	35.5	49.9	110	4	26.8	27.9	68	4	22	17	45
Fecal Coliform (colonies/100 ml)	4	1525	2917.4	5900	4	14.2	143	310	4	443	[illegible]	1254	4	758	±	2900	4	144	±	420	4	193.	±	400
Temperature (°C)	4	19	7	26	4	17.7	8.8	26.4	4	18.2	8.43	26.1	4	18.6	8.74	26.5	4	18.35	9.28	26.4	4	17.6	9.4	23.0
Dissolved Oxygen	4	6.3	2.83	10.2	4	5.95	1.86	8.6	4	6.25	1.87	8.2	4	6.95	1.96	8.5	4	6.95	2.67	9.6	4	6.5	2.5	9.2
pH units	4	6.9	0.302	7.40	4	6.9	2.40	6.88	4	6.8	0.14	7.0	4	6.5	0.14	7.1	4	6.975	0.126	7.10	4	7.07	0.12	7.2

* See Figure 3A-1 for location of sampling stations.
** Units expressed as mg/l unless otherwise noted.
\+ Based on one observation.
++ Can not be calculated due to insufficient data or data outside ideal range.
± Data no ilable.

(Continued)

TABLE 3A-4 (Continued)

Parameters**	MC-7 No. of Values	MC-7 Mean	MC-7 Std. Dev.	MC-7 Max.	MC-8 No. of Values	MC-8 Mean	MC-8 Std. Dev.	MC-8 Max.	M-1 No. of Values	M-1 Mean	M-1 Std. Dev.	M-1 Max.	N-1 No. of Values	N-1 Mean	N-1 Std. Dev.	N-1 Max.	C-1 No. of Values	C-1 Mean	C-1 Std. Dev.	C-1 Max.
1974																				
pH units	5	7.2	0.2	7.4	2	7.15	0.78	7.7	5	7.74	0.09	7.8	5	7.02	0.27	7.2	5	7.22	0.33	7.7
COD	2	3.35	3.61	5.9		-			2	12.9	9.8	19.8	2	24.2	25.2	42	2	22.2	21.8	37.6
BOD (5 day)	5	3.48	2.59	7.4	2	2.05	0.64	2.5	5	1.86	0.49	2.2	5	4.34	1.74	6.1	5	5.5	3.7	10.2
Conductivity (μmhos/cm)	5	244.2	75.8	365	2	330	70	380	5	349.4	60.5	420	5	205.6	99.7	255	5	228.4	77.5	321
Ammonia - N	5	0.428	0.137	0.65	2	0.140	0.141	0.24	5	0.108	0.069	0.21	5	0.93	1.11	2.9	5	0.54	0.41	1.06
Turbidity (JTU)	2	32	26	51	2	41.5	38.8	69	2	61	33	85	2	69.5	23.3	86	2	51	4	54
1975																				
COD	1	12†	††	12†	1	12†	††	12†	1	4†	††	4†	1	30.7†	††	30.7†	1	28†	††	28†
BOD (5 day)	1	2†	††	2†	1	1.9†	††	1.9†	1	2.2†	††	2.2†	1	10.8†	††	10.8†	1	1.9†	††	1.9†
Conductivity (μmhos/cm)	1	160†	††	160†	1	210†	††	210†	1	255†	††	255†	1	115†	††	115†	1	175†	††	175†
Ammonia - N	1	0.16†	††	0.16†	1	0.12†	††	0.12†	1	0.12†	††	0.12†	1	0.28†	††	0.28†	1	0.10†	††	0.10†
Turbidity (JTU)	1	86†	††	86†	1	44†	††	44†	1	29†	††	29†	1	170†	††	170†	1	96†	††	96†
Total Suspended Solids	1	70†	††	70†	1	28†	††	28†	1	42†	††	42†	1	158†	††	158†	1	100†	††	100†
Nitrate	1	4.1†	††	4.1†	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Phosphate	1	0.04†	††	0.04†	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Oil and Grease	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
1976																				
COD	3	14.59	9.96	23.76	3	23.9	8.1	32	3	9.3	4.6	12	3	21.2	12.9	36	3	22.6	15.2	40
BOD (5 day)	3	2	0	3	3	2.6	0.9	3.2	3	3.8	2.9	7	3	4.3	3.1	7.7	3	2.67	1.16	3.5
Conductivity (μmhos/cm)	3	189.3	44.6	240	3	205.3	47.2	250	3	135	73	220	3	164.3	108.9	290	3	243.3	75.1	330
Ammonia - N	3	0.24	0.21	0.48	3	0.23	0.17	0.42	3	0.44	0.04	0.46	3	0.78	0.21	0.9	3	0.27	0.02	0.25
Turbidity (JTU)	3	67.3	23.1	89	3	87.7	38.1	110	3	159.7	70.6	210	3	111.7	82.8	190	3	113	33	135
Total Suspended Solids	3	124.7	67.9	198	3	126.7	33.5	146	3	129.0	37.2	172	3	127.3	8.3	134	3	198.3	101.0	293
Nitrate	3	4.02	0.04	4.07	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Phosphate	3	0.22	0.10	0.28	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Oil and Grease	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	2	0.015	0.007	0.02	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
1977																				
COD	3	26.2	1.5	27.7	3	15.0	6.2	18.9	3	26.8	4.5	30.1	3	32.77	16.83	45.9	3	24.9	11.6	38
BOD (5 day)	3	2.67	3.42	6.6	3	1.4	0.9	2.2	3	1.8	0.6	2.5	3	3.77	2.12	5.7	3	4.03	3.63	8.2
Conductivity (μmhos/cm)	3	236.7	20.8	260	3	266.7	11.6	280	3	264	125	370	3	206.7	130.5	310	3	224.0	24.3	315
Ammonia - N	3	0.45	0.35	0.8	3	0.22	0.24	0.5	3	0.17	0.19	0.4	3	0.52	0.61	0.3	3	0.39	0.29	0.61
Turbidity (JTU)	3	111.7	95.7	200	3	70.3	46.3	100	3	142.3	83.2	200	3	395	528	1000	3	70	47	100
Total Suspended Solids	3	63.0	74.8	148	3	21.3	16.8	36	3	113.7	76.6	178	3	637	1012	1815	3	59.7	60.9	130
Nitrate	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Phosphate	3	0.237	0.2558	0.53	1	2.9†	††	2.9†	1	0.15†	††	0.15†	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Oil and Grease	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	1	2.9†	††	2.9†	Δ	Δ	Δ	Δ
1978																				
Conductivity (μmhos/cm)	4	230	106	430	4	310	108	440	4	224.3	123.5	344	4	278.8	91.9	400	4	372	70	459
Ammonia - N	4	0.45	0.38	0.97	4	0.33	0.29	0.73	4	1.26	0.99	2.40	4	0.39	0.33	0.73	4	0.21	0.12	0.36
BOD (5 day)	4	2.55	0.87	3.3	4	1.6	1.2	2.9	4	7.3	2.7	10.9	4	3.45	1.48	5.10	4	1.7	0.5	2.3
Total Suspended Solids	4	21.5	14.1	39	4	20.3	15.3	40	4	292.8	537.6	1099	4	26.5	21.3	58	4	257.8	206.4	518
Turbidity (JTU)	4	24.5	24.9	60	4	23.3	17.5	47	4	125.5	216.4	450	4	27.8	29.9	72	4	94.3	70.3	160
Fecal Coliform (colonies/100 ml)	4	189	Δ	510	4	159	Δ	390	4	2011	Δ	6000	4	89	Δ	210	4	1538	1064	2800
Temperature (°C)	4	18.2	8.7	26.2	4	17.6	9.3	26.1	4	18.65	7.26	25.0	4	18.4	9.3	26.5	4	17.3	9.8	26.7
Dissolved Oxygen	4	5.75	2.18	9.0	4	6.55	2.10	9.1	4	7.5	4.3	12.8	4	6.8	2.2	9.0	4	8.4	2.0	11.0
pH units	4	6.9	0.1	7.0	4	7.03	0.04	7.08	4	6.8	0.5	7.3	4	6.96	0.20	7.14	4	7.4	0.2	7.6

TABLE 3A-5

RESULTS OF TENNESSEE VALLEY AUTHORITY WATER QUALITY SAMPLING FROM LAKE MCKELLAR NEAR THE ALLEN GENERATING PLANT INTAKE FROM 1974 TO 1976[5]

Parameter*	1974					1975					1976				
	Number of Values	Mean	Std. Dev.	Max.	Min.	Number of Values	Mean	Std. Dev.	Max.	Min.	Number of Values	Mean	Std. Dev.	Max.	Min.
PHYSICAL															
Temperature (°C)	3	14.2	5	19.4	9.4	12	19.5	7.5	28.9	8.9	11	16.5	7.0	28.1	7.2
Conductivity (μmhos/cm)	4	298	98	410	170	12	287	120	440	20	11	310	69	420	210
pH (units)	4	**	0.4	7.7	6.9	12	**	0.2	7.6	7.0	11	**	0.4	7.8	6.7
Total Alkalinity	4	80	29	110	40	12	86	31	130	48	11	87	26	120	45
Total Dissolved Solids	4	35	4.1	39	31	12	42	45	150	3	11	40	25	69	10
Turbidity (J.T.U.)	4	79	45	140	32	12	86	96	300	5	11	56	42	135	7
Color (P.T.U.)	4	83	113	250	10	12	42	33	100	10	11	20	14	50	5
NUTRIENTS															
Total Nitrogen (NO_2 and NO_3)	4	1.37	0.41	1.90	1.00	12	0.94	0.34	1.70	0.54	11	0.96	0.42	1.70	0.33
Organic Nitrogen	4	0.40	0.20	0.65	0.17	12	0.347	0.145	0.550	0.170	11	0.329	0.219	0.810	0.110
Ammonia Nitrogen	4	0.18	0.13	0.29	0.03	12	0.13	0.18	0.59	0.01	11	0.34	0.63	2.20	0.02
Total Phosphorus	4	0.28	0.18	0.49	0.06	12	0.17	0.09	0.33	0.07	11	0.174	0.111	0.380	0.02
Dissolved Phosphorus											2	0.06	0.05	0.10	0.03
ORGANICS															
COD	4	13	5	19	9	12	13.8	4.5	23	8	11	12.7	3	18	10
TOC	4	5.1	2.1	7.9	2.9	5	4.1	1.3	5.7	2.2	3	4.5	0.7	5.0	3.7
Total Coliform (#/100 ml)	2	645	205	790	500	**	**	**	**	**	**	**	**	**	**
Fecal Coliform (#/100 ml)	2	160	212	310	<10K	**	**	**	**	**	**	**	**	**	**
MAJOR ANIONS															
Chloride, total	4	11.8	3.1	16	9	12	11	3	15	7	11	14	3	18	8
Sulfate, total	4	46	5	52	40	12	189	476	1700	21	11	57	26	100	11
Fluoride, total	4	0.14	0.10	0.23	<0.01K	10	0.2	0.1	0.3	<0.1K	10	0.2	0	0.2	0.1
MAJOR CATIONS															
Calcium, total	4	27.50	9.47	38	15	12	30.7	12.2	45	11.0	11	31.1	10.6	44	6
Magnesium, total	4	10.00	2.98	14	6.80	12	10.1	3.9	18	5.4	11	10.1	3	16	6.4
Sodium, total	4	11.5	4.6	18	7.1	12	15.65	7.05	29	6.20	11	14.43	5.55	24	7.10
Potassium, total	4	4	0.7	5.1	3.4	12	3.22	0.50	3.90	6.30	11	2.82	0.69	3.70	1.10
Aluminum, total	4	6125	5393	14000	1900	4	6350	6783	15000	600	4	1875	1621	4300	900
Iron (μg/l), total	4	6550	5198	14000	2400	12	5182	4377	13000	670	11	3245	2250	7100	690
Barium (μg/l), total	4	175	50	200	100	4	100	0	100	<100K	4	125	50	<100K	500
OTHER METALS															
Copper, total (μg/l)	4	137.50	66.52	220	60	4	88	42	130	30	4	58	22	90	40
Manganese, total (μg/l)	4	343	169	530	120	12	228	92	420	90	11	202.7	193	740	50
Chromium, total (μg/l)	4	16.75	16.98	41	5K	4	8	4	13	<5K	4	9	8	20	<5K
Nickel, total (μg/l)	4	50	0	5.0	50K	4	50	0	<50K	<50K	4	50	0	<50K	<50K
Lead, total (μg/l)	4	21	9	32	10	4	24	18	47	<10K	4	12	5	19	<10K
Zinc, total (μg/l)	4	75	42.03	130	30	4	88	15	100	70	4	43	39	100	20
Boron, total (μg/l)	4	100	0	<100K	<100K	4	153	75	260	<100K	4	80	38	130	50
Silicon, total (mg/l)	4	6.9	1.1	7.9	5.4	2	6.3	1.1	7.1	5.6	**	**	**	**	**
Arsenic, total (μg/l)	4	6	3	10	5K	4	10	11	26	< 5K	4	6	3	10	<5K
Berillium, total (μg/l)	4	10	0	10K	10K	4	10	0	<10K	<10K	4	10	0	<10K	<10K
Cadmium, total (μg/l)	4	1	0	1K	1K	4	1	1	2	<1K	4	2	2	4	<1K
Lithium, total (μg/l)	4	10	0	10K	10K	4	13	5	20	<10K	4	18	15	40	<10K
Selenium, total (μg/l)	4	3	1	4	2K	4	2	1	<2K	<1K	4	2	1	<2K	<1K
Titanium, total (μg/l)	4	1000	0	<1000K	<1000K	4	1000	0	<1000K	<1000K	4	1000	0	<1000K	<1000K
Mercury, total (μg/l)	4	0.5	0.7	1.6	0.2K	4	0.2	0	<0.2K	<0.2K	4	0.2	0	<0.2K	<0.2K
Silver, total (μg/l)	4	10	0	<10K	<10K	4	10	0	<10K	<10K	4	10	0	<10K	<10K
Silicon, dissolved (mg/l)						10	6.4	1.4	8.8	4.8	11	6.9	3.1	14	2.2

* Units expressed as mg/l unless otherwise noted

** Data not available

TABLE 3A-6

RESULTS OF MEMPHIS AND SHELBY COUNTY HEALTH DEPARTMENT WATER QUALITY SAMPLING OF NONCONNAH CREEK FROM 1975 TO 1978[4]

1975

Parameters	Sampling Station* N-1 Mean	N-1 Min.	N-1 Max.	N-2 Mean	N-2 Min.	N-2 Max.	N-3 Mean	N-3 Min.	N-3 Max.	N-4 Mean	N-4 Min.	N-4 Max.
PHYSICAL												
Temperature (°C)	17.9	8.5	28.0	17.1	3.9	28.0	18.9	4.9	34.2	17.5	4.0	30.2
pH (units)	**	6.44	7.59	**	6.63	7.42	**	6.50	7.95	**	6.54	7.56
Dissolved oxygen (mg/l)	6.8	3.9	9.2	5.8	1.7	11.4	8.7	4.8	11.8	8.3	1.6	11.9
Conductivity (μmhos/cm)	211	102	425	211	54	360	140	49	330	70	28	120
Suspended solids (mg/l)	173	87	274	167	22	524	255	18	1675	88	6	732
Turbidity (FTU)	145	21	265	147	9	340	148	35	360	75	9	290
NUTRIENTS												
Ammonia-Nitrogen (mg/l)	0.27	0.12	0.36	0.80	0.06	2.75	0.18	0.10	0.60	0.21	0.01	1.20
ORGANICS												
BOD_5 (mg/l)	4.5	1.8	10.8	4.8	1.9	9.8	3.2	1.0	8.8	3.2	0.9	8.8
COD (mg/l)	30.7†		30.7†	**	**	**	**	**	**	**	**	**
Fecal Coliform (colonies/100 ml)	9050	100	103000	29600	100	200000	4850	400	29000	1400	100	12100

1976

Parameters	Sampling Station* N-1 Mean	N-1 Min.	N-1 Max.	N-2 Mean	N-2 Min.	N-2 Max.	N-3 Mean	N-3 Min.	N-3 Max.	N-4 Mean	N-4 Min.	N-4 Max.
PHYSICAL												
Temperature (°C)	20.0	13.0	28.5	17.0	2.1	28.6	18.2	2.9	22.0	17.2	4.5	27.2
pH (units)	**	7.36	7.74	**	6.00	7.35	**	6.10	8.28	**	6.18	7.26
Dissolved Oxygen (mg/l)	6.8	4.6	8.0	6.2	1.2	13.4	9.0	5.6	12.9	8.3	4.1	14.1
Conductivity (μmhos/cm)	164	98	290	186	63	390	104	56	194	60	40	92
Suspended Solids (mg/l)	127	118	134	520	18	990	357	40	5099	82	19	324
Turbidity (FTU)	111	25	190	340	86	2340	270	75	780	132	32	325
NUTRIENTS												
Ammonia-Nitrogen (mg/l)	0.78	0.54	0.90	1.59	0.13	6.10	0.15	0.01	0.50	0.18	0.01	0.84
ORGANICS												
BOD_5 (mg/l)	4.3	1.8	7.7	4.4	1.6	8.4	3.7	9.7	0.6	3.1	0.5	7.1
COD (mg/l)	21.29	11.88	36.00	**	**	**	**	**	**	**	**	**
Fecal Coliform (colonies/100 ml)	9,800	100	210,000	27,015	100	310,100	6,680	300	35,400	2,700	100	22,000

(Continued)

TABLE 3A-6 (Continued)

1977

Parameters	Sampling Station* N-1 Mean	N-1 Min.	N-1 Max.	N-2 Mean	N-2 Min.	N-2 Max.	N-3 Mean	N-3 Min.	N-3 Max.	N-4 Mean	N-4 Min.	N-4 Max.
PHYSICAL												
Temperature (°C)	18.5	11.0	27.5	16.5	3.0	26.0	17.3	1.0	30.0	16.5	1.5	29.0
pH(units)	**	6.72	7.51	**	6.69	7.90	**	6.68	7.97	**	4.46	7.48
Dissolved Oxygen (mg/l)	6.6	5.5	7.6	6.5	2.3	10.2	8.3	4.1	12.8	6.6	1.5	11.6
Conductivity (µmhos/cm)	207	60	310	175	30	470	120	40	210	92	40	260
Suspended Solids (mg/l)	637	10	1815	203	7	2040	365	10	5120	242	7	2430
Turbidity (FTU)	395	25	1000	136	10	500	223	9	2000	178	10	1360
Oil and Grease (mg/l)	2.9	2.9	2.9									
NUTRIENTS												
Ammonia-Nitrogen (mg/l)	0.52	0.15	1.20	0.41	0.02	1.46	0.28	0.02	0.61	0.40	0.02	1.46
ORGANICS												
BOD5 (mg/l)	3.77	1.5	5.7	3.7	0.2	8.3	3.3	0.3	10.4	4.0	0.2	9.4
COD (mg/l)	32.8	13.8	45.9	**	**	**	**	**	**	**	**	**
Fecal Coliform (colonies/100 ml)	320	180	460	19,347	200	125,000	12,419	100	83,000	10,788	60	150,000

1978

Parameters	Sampling Station* N-1 Mean	N-1 Min.	N-1 Max.	N-2 Mean	N-2 Min.	N-2 Max.	N-3 Mean	N-3 Min.	N-3 Max.	N-4 Mean	N-4 Min.	N-4 Max.
PHYSICAL												
Temperature (°C)	18.7	10.0	25.0	13.4	-1.5	27.2	13.7	-4.5	28.0	12.9	-2.5	24.7
pH (units)	**	6.20	7.30	**	6.40	7.40	**	6.00	8.40	**	4.45	6.70
Dissolved oxygen (mg/l)	7.5	2.2	12.8	7.0	2.1	12.4	8.4	2.3	14.5	5.7	0.4	13.8
Conductivity (µmhos/cm)	224	53	344	224	23	410	147	36	220	172	34	480
Suspended solids (mg/l)	293	15	1099	142	9	2090	154	10	1840	125	5	840
Turbidity (FTU)	126	13	450	89	10	525	117	12	750	109	30	510
NUTRIENTS												
Ammonia-Nitrogen (mg/l)	1.26	0.36	2.40	1.82	0.36	5.35	0.61	0.10	2.70	2.80	0.20	13.9
ORGANICS												
BOD (mg/l)	7.3	4.5	10.9	4.9	1.8	9.1	4.5	2.0	9.5	7.2	0.4	24.0
Fecal coliform (colonies/100 ml)	2011	400	>6000	26045	60	231000	3414	<100	28000	**	**	**

* Sampling stations were established in Nonconnah Creek by Memphis and Shelby County Health Department where:

Station N1 - mouth of Nonconnah Creek
" N2 - mile 1.7
" N3 - mile 11.5
" N4 - mile 20.8

** Data not available

Based on one observation

TABLE 3A-7

RESULTS OF WATER QUALITY SAMPLING FROM NONCONNAH CREEK AS REPORTED BY THE U.S. ARMY CORPS OF ENGINEERS/U.S. DEPARTMENT OF AGRICULTURE FOR JUNE 1972[6]

Parameter**	Sampling Stations*		
	N-1	N-2	N-3
PHYSICAL			
Dissolved oxygen	6.3	6.1	7.3
pH (units)	7.5	7.3	7.6
Total alkalinity (mg/l as $CaCo_3$)	82	42	26
Total solids	424	414	630
Suspended solids	228	324	572
Volatile solids	88	10	34
ORGANICS			
BOD (5 day)	13.2	5.0	4.2
COD	61	54	46
Phenol	0.09	†	†
OTHER			
Phosphates	0.25	†	†
Sulfates	5000	4800	4160

* Location of sampling stations as follows:

N-1 = Horn Lake Road
N-2 = Highway 51
N-3 = Lamar Road

** Units expressed as mg/l unless otherwise noted.

† Data not available

TABLE 3A-8

WATER QUALITY DATA COLLECTED IN NONCONNAH CREEK FOR THE 208 AREA PROGRAM FROM JUNE TO DECEMBER 1975[7]

Parameter**	Sampling Station*								
	N-1			N-2			N-3		
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
PHYSICAL									
Depth (feet)	10.9	4.5	26.7	6.2	0.3	10.2	0.8	0.1	3.0
Flow (cfs)	†	94	15.620	†	5	244	†	0.14	9.0
Temperature (°C)	25.8	23.0	28.0	25.8	23.0	28.0	24.3	23.0	25.0
pH (units)	†	6.5	7.1	†	6.2	7.6	†	6.2	7.0
Dissolved oxygen	3.5	1.7	6.5	6.2	4.5	7.4	5.4	4.0	6.5
Suspended solids	1113.3	7.0	4913.0	1029	62	4925	96	2.0	228
Turbidity (JTU)	272.5	40	275	300	110	500	183	30	310
NUTRIENTS									
Nitrate	4.0	1.6	6.2	3.7	1.0	5.5	2.1	1.0	5.0
Phosphate	5.6	0.9	23.8	2.2	1.0	4.7	1.5	0.6	3.3
ORGANICS									
BOD (5 day)	12.0	5.0	22.0	6.6	3.0	11.0	4.6	3.0	6.0
COD	57.5	33.0	104.0	47.1	18.0	84.0	22.7	12.0	34.0

* Sampling station locations on Nonconnah Creek are as follows:

N-1 = mile 1.7 at Highway 61
N-2 = mile 11.5 at Perkins Road
N-3 = mile 20.8 at Forest Hill Road

** Units expressed as mg/l unless otherwise noted.

† Data not available

TABLE 3A-9

SAMPLING FREQUENCY AND LOCATION FOR CHEMICAL PARAMETERS BY EIA IN THE VICINITY OF THE PROPOSED SITE OF THE IFGDP DURING 1978 TO 1979

	SPRING											SUMMER												
	May 2		May 1									July 19											August 2	
Stations*	MR-1	MR-2	LM-1	LM-2	LM-3	LM-4	LM-5	LM-6	LM-7	MC-1	GW-1	MR-1	MR-2	LM-1	LM-2	LM-3	LM-4	LM-5	LM-6	LM-7	MC-1	GW-1	MR-1	GW-1
Parameters																								
IN-SITU																								
pH	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x		x	
Conductivity	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x			
Dissolved Oxygen	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x		x	
Temperature	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x		x	
PHYSICAL																								
pH	x	x	x																					
Total Dissolved Solids	x	x	x					x	x	x	x	x	x	x								x		
Total Suspended Solids	x	x	x					x	x	x	x	x	x	x								x		
Alkalinity, total	x	x	x					x	x	x	x	x	x	x								x		
Oil and Grease	x	x	x					x	x	x	x	x	x	x								x		
NUTRIENTS																								
Total Kjeldahl-Nitrogen	x	x	x					x	x	x	x	x	x	x										
Nitrite-Nitrogen	x	x	x					x	x	x	x	x	x	x								x		
Nitrate-Nitrogen	x	x	x					x	x	x	x	x	x	x								x		
Ammonia-Nitrogen	x	x	x					x	x	x	x	x	x	x								x		
Phosphorus, total	x	x	x					x	x	x	x	x	x	x								x		
Organic phosphorus												x	x	x								x		
Ortho-phosphate												x	x	x								x		
ORGANICS																								
Biochemical Oxygen Demand	x	x	x					x	x	x	x	x	x	x								x		
Chemical Oxygen Demand	x	x	x					x	x	x	x	x	x	x								x		
Total Organic Carbon	x	x	x					x	x	x	x	x	x	x								x		
Dissolved Organic Carbon	x	x	x					x	x	x	x	x	x	x								x		
Phenol	x	x	x					x	x	x	x	x	x	x								x		
MAJOR ANIONS																								
Chloride	x	x	x					x	x	x	x	x	x	x								x		
Cyanide	x	x	x					x	x	x	x	x	x	x								x		
Fluoride	x	x	x					x	x	x	x	x	x	x								x		
Sulfate	x	x	x					x	x	x	x	x	x	x								x		
MAJOR CATIONS																								
Aluminum	x	x	x					x	x	x	x	x	x	x								x		
Barium	x	x	x					x	x	x	x	x	x	x								x		
Calcium	x	x	x					x	x	x	x	x	x	x								x		
Iron, total	x	x	x					x	x	x	x	x	x	x								x		
Magnesium	x	x	x					x	x	x	x	x	x	x								x		
OTHER METALS																								
Antimony, total	x	x	x					x	x	x	x													
Arsenic, total	x	x	x					x	x	x	x	x	x	x								x		
Beryllium, total	x	x	x					x	x	x	x													
Boron, total	x	x	x					x	x	x	x													
Cadmium, total	x	x	x					x	x	x	x													
Chromium, total	x	x	x					x	x	x	x	x	x	x								x		
Chromium (hexavalent)	x	x	x					x	x	x	x													
Cobalt, total	x	x	x					x	x	x	x	x	x	x								x		
Copper, total	x	x	x					x	x	x	x	x	x	x								x		
Lead, total	x	x	x					x	x	x	x	x	x	x								x		

(Continued)

TABLE 3A-9 (Continued)

	SPRING											SUMMER												
	May 2		May 1									July 19											August 2	
Stations*	MR-1	MR-2	LM-1	LM-2	LM-3	LM-4	LM-5	LM-6	LM-7	NC-1	GW-1	MR-1	MR-2	LM-1	LM-2	LM-3	LM-4	LM-5	LM-6	LM-7	NC-1	GW-1	MR-1	GW-1
Manganese, total	x	x	x					x	x	x	x	x	x	x								x		
Mercury, total	x	x	x					x	x	x	x	x	x	x								x		
Molybdenum, total	x	x	x					x	x	x	x													
Nickel, total	x	x	x					x	x	x	x													
Selenium, total	x	x	x					x	x	x	x											x		
Strontium, total	x	x	x					x	x	x	x	x	x	x								x		
Titanium, total	x	x	x					x	x	x	x	x	x	x										
Uranium, total																								
Vanadium, total	x	x	x					x	x	x	x											x		
Zinc, total	x	x	x					x	x	x	x	x	x	x										
Zirconium, total																								
POLYNUCLEAR AROMATIC HYDROCARBONS																								
Benzo(a)anthracene (1,2-benzanthracene)	x	x	x					x	x	x	x												x	x
Benzo(a)pyrene (3,4-benzopyrene)	x	x	x					x	x	x	x												x	x
3,4-benzofluoranthene	x	x	x					x	x	x	x												x	x
Benzo(k)fluoranthane (11,12-benzofluoranthene)	x	x	x					x	x	x	x												x	x
Chrysene	x	x	x					x	x	x	x												x	x
Acenaphthylene	x	x	x					x	x	x	x												x	x
Anthracene	x	x	x					x	x	x	x												x	x
Benzo(ghi)perylene (1,12-benzoperylene)	x	x	x					x	x	x	x												x	x
Fluorene	x	x	x					x	x	x	x												x	x
Phenathrene	x	x	x					x	x	x	x												x	x
Dibenzo(a,h)anthracene (1,2,5,6-dibenzanthracene)	x	x	x					x	x	x	x												x	x
Indeno(1,2,3-cd)pyrene (2,3-o-phenylenepyrene)	x	x	x					x	x	x	x												x	x
Pyrene	x	x	x					x	x	x	x												x	x
Napthalene	x	x	x					x	x	x	x												x	x
Fluoranthene	x	x	x					x	x	x	x												x	x

(Continued)

TABLE 3A-9 (Continued)

	FALL											WINTER										
	Oct. 18										Nov. 19	Jan. 10										
Stations*	MR-1	MR-2	LM-1	LM-2	LM-3	LM-4	LM-5	LM-6	LM-7	NC-1	GW-1	MR-1	MR-2	LM-1	LM-2	LM-3	LM-4	LM-5	LM-6	LM-7	NC-1	GW-1
Parameters																						
IN-SITU																						
Conductivity	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x
Dissolved Oxygen	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x
pH Units	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x
Temperature	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x
PHYSICAL																						
pH	x	x	x									x	x	x								
Total Dissolved Solids	x	x	x								x	x	x	x								x
Total Suspended Solids	x	x	x								x	x	x	x								x
Alkalinity, total	x	x	x								x	x	x	x								x
Oil and Grease	x	x	x								x	x	x	x								x
NUTRIENTS																						
Total Kjeldahl-Nitrogen	x	x	x								x	x	x	x								x
Nitrite-Nitrogen	x	x	x								x	x	x	x								x
Nitrate-Nitrogen	x	x	x								x	x	x	x								x
Ammonia-Nitrogen	x	x	x								x	x	x	x								x
Phosphorus, total	x	x	x								x	x	x	x								x
Organic phosphorus	x	x	x								x	x	x	x								x
Ortho-phosphate	x	x	x								x	x	x	x								x
ORGANICS																						
Biochemical Oxygen Demand	x	x	x								x	x	x	x								x
Chemical Oxygen Demand	x	x	x								x	x	x	x								x
Total Organic Carbon	x	x	x								x	x	x	x								x
Dissolved Organic Carbon	x	x	x								x	x	x	x								x
Phenol	x	x	x								x	x	x	x								x
MAJOR ANIONS																						
Chloride	x	x	x								x	x	x	x								x
Cyanide	x	x	x								x	x	x	x								x
Fluoride	x	x	x								x	x	x	x								x
Sulfate	x	x	x								x	x	x	x								x
MAJOR CATIONS																						
Aluminum	x	x	x								x	x	x	x								x
Barium	x	x	x								x	x	x	x								x
Calcium	x	x	x								x	x	x	x								x
Iron, total	x	x	x								x	x	x	x								x
Magnesium	x	x	x								x	x	x	x								x
OTHER METALS																						
Antimony, total	x	x	x								x	x	x	x								x
Arsenic, total	x	x	x								x	x	x	x								x
Beryllium, total	x	x	x								x	x	x	x								x
Boron, total	x	x	x								x	x	x	x								x
Cadmium, total	x	x	x								x	x	x	x								x
Chromium, total	x	x	x								x	x	x	x								x
Chromium (hexavalent)	x	x	x								x	x	x	x								x
Cobalt, total	x	x	x								x	x	x	x								x
Copper, total	x	x	x								x	x	x	x								x
Lead, total	x	x	x								x	x	x	x								x

(Continued)

TABLE 3A-9 (Continued)

	FALL											WINTER										
	Oct. 18										Nov. 19	Jan. 10										
Stations*	MR-1	MR-2	LM-1	LM-2	LM-3	LM-4	LM-5	LM-6	LM-7	NC-1	GW-1	MR-1	MR-2	LM-1	LM-2	LM-3	LM-4	LM-5	LM-6	LM-7	NC-1	GW-1
Manganese, total	x	x	x								x	x	x	x								x
Mercury, total	x	x	x								x	x	x	x								x
Molybdenum, total	x	x	x								x	x	x	x								x
Nickel, total	x	x	x								x	x	x	x								x
Selenium, total	x	x	x								x	x	x	x								x
Strontium, total	x	x	x								x	x	x	x								x
Titanium, total	x	x	x								x	x	x	x								x
Uranium, total	x	x	x								x	x	x	x								x
Vanadium, total	x	x	x								x	x	x	x								x
Zinc, total	x	x	x								x	x	x	x								x
Zirconium, total	x	x	x								x	x	x	x								x
POLYNUCLEAR AROMATIC HYDROCARBON																						
Benzo(a)anthracene (1,2-benzanthracene)	x	x	x								x	x	x	x								x
Benzo(a)pyrene (3,4-benzopyrene)	x	x	x								x	x	x	x								x
3,4-benzofluoranthene	x	x	x								x	x	x	x								x
Benzo(k)fluoranthane (11,12-benzofluoranthene)	x	x	x								x	x	x	x								x
Chrysene	x	x	x								x	x	x	x								x
Acenaphthylene	x	x	x								x	x	x	x								x
Anthracene	x	x	x								x	x	x	x								x
Benzo(ghi)perylene (1,12-benzoperylene)	x	x	x								x	x	x	x								x
Fluorene	x	x	x								x	x	x	x								x
Phenathrene	x	x	x								x	x	x	x								x
Dibenzo(a,h)anthracene (1,2,5,6-dibenzanthracene)	x	x	x								x	x	x	x								x
Indeno(1,2,3-cd)pyrene (2,3-o-phenylenepyrene)	x	x	x								x	x	x	x								x
Pyrene	x	x	x								x	x	x	x								x
Naphthalene	x	x	x								x	x	x	x								x
Fluoranthene	x	x	x								x	x	x	x								x

* See Figure 3A-2 for location of sampling stations.

sampling schedule by parameter, survey date and location. Table 3A-10 lists detection limits and reporting units for each parameter examined.

During each survey, in-situ measurements of dissolved oxygen, temperature, conductivity and pH were made at seven stations in Lake McKellar, two stations in the Mississippi River and one station in Nonconnah Creek (Figure 3A-2). Depth profiles with measurements at 2-foot intervals were made at each Lake McKellar sampling station, except during the January survey when intervals between readings were extended to 10 feet to prevent probe malfunction at low temperature. A Hydrolab Surveyor Model 6D In-situ Water Quality Analyzer was the primary monitoring device for the surface waters; this instrument being calibrated prior to and after use in the field. Water temperature and dissolved oxygen measurements were also periodically cross-checked in the field using a hand-held mercury thermometer for temperature and the azide modification of the Winkler method for dissolved oxygen. In-situ results are presented in Tables 3A-11 through 3A-15.

Dissolved oxygen concentrations were below Criteria at all locations up-lake of LM2 (including NC1) during the July survey under thermally stratified conditions and at all stations up-lake of LM4, excluding NC1, during the November survey, which apparently took place immediately after a turnover. At LM2, the most severe oxygen depletion occurred in July, while at LM5, LM6 and LM7 the most severe depletions took place in October. Of the river waters, NC1 was affected in May and July, while MR1, MR2 and LM1 were above Criteria concentrations during all measurements. Temperature marginally exceeded Criteria at LM7 and NC1 during the July survey, but was in concurrence at all other times.

Duplicate water grab samples from a depth of approximately 2 feet were collected for laboratory analyses from MR1, MR2, LM1, LM2, LM6, LM7 and NC1 during the July survey, and at LM1, MR1 and MR2 during the remaining seasonal surveys. Appropriate preservation was observed, and samples were delivered for analysis within appropriate holding times. Laboratory analysis were conducted in conformance with either Standard Methods for the Examination of Water and

TABLE 3A-10

DETECTION LIMITS AND REPORTING UNITS FOR SURFACE WATER QUALITY PARAMETERS MEASURED DURING 1978-79 FIELD SURVEYS

Parameters	Detection Limits	Reporting Units
IN-SITU		
pH	0.5	standard units
Conductivity	1	µmhos/cm
Dissolved Oxygen	0.5	mg/l
Temperature	0.5	°C
PHYSICAL		
pH	0.1	standard units
Total Dissolved Solids	1.0	mg/l
Total Suspended Solids	1.0	mg/l
Alkalinity, total	1.0	mg/l as $CaCO_3$
Oil and Grease	0.05	mg/l
NUTRIENTS		
Total Kjeldahl-Nitrogen	0.05	mg/l
Nitrite-Nitrogen	0.01	mg/l
Nitrate-Nitrogen	0.1	mg/l
Ammonia-Nitrogen	0.01	mg/l
Phosphorus, total	0.01	mg/l
Organic phosphorus	0.01	mg/l
Ortho-phosphate	0.01	mg/l
ORGANICS		
Biochemical Oxygen Demand, 5 day		
Chemical Oxygen Demand	1.0	mg/l
Total Organic Carbon	1.0	mg/l
Dissolved Organic Carbon	1.0	mg/l
Phenol	0.001	mg/l
MAJOR ANIONS		
Chloride	1.0	mg/l
Cyanide	0.005	mg/l
Fluoride	0.1	mg/l
Sulfate	1.0	mg/l
MAJOR CATIONS		
Aluminum	0.01	mg/l
Barium	0.1	mg/l
Calcium	0.1	mg/l
Iron	0.01	mg/l
Magnesium	0.1	mg/l
TRACE ELEMENTS		
Antimony, total[1]	0.01	mg/l
Arsenic, total	0.01	mg/l
Beryllium, total	0.002	mg/l
Boron, total	0.02	mg/l
Cadmium, total[2]	0.001	mg/l
Chromium, total	0.01	mg/l
Chromium (hexavalent)	0.01	mg/l
Cobalt, total[3]	0.01	mg/l
Copper, total[4]	0.01	mg/l
Lead, total[5]	0.01	mg/l
Manganese, total	0.01	mg/l
Mercury, total[6]	0.0002	mg/l
Molybdenum, total[7]	0.01	mg/l
Nickel, total[8]	0.01	mg/l
Selenium, total[9]	0.01	mg/l
Strontium, total	0.1	mg/l
Titanium, total	0.1	mg/l
Uranium, total	0.1	mg/l
Vanadium, total	0.08	mg/l
Zinc, total	0.01	mg/l
Zirconium, total[10]	0.1	mg/l
POLYNUCLEAR AROMATIC HYDROCARBONS		
Benzo(a)anthracene (1,2-benzanthracene)	0.01	ppm
Benzo(a)pyrene (3,4-benzopyrene)	0.01	ppm
3,4-benzofluoranthene	0.01	ppm
Benzo(k)fluoranthane (11,12-benzofluoranthene)	0.01	ppm
Chrysene	0.01	ppm
Acenaphthylene	0.01	ppm
Anthracene	0.01	ppm
Benzo(ghi)perylene (1,12-benzoperylene)	0.01	ppm
Fluorene	0.01	ppm
Phenathrene	0.01	ppm
Dibenzo(a,h)anthracene (1,2,5,6-dibenzanthracene)	0.01	ppm
Indeno(1,2,3-cd)pyrene (2,3-o-phenylenepyrene)	0.01	ppm
Pyrene	0.01	ppm
Napthalene	0.01	ppm
Fluoranthene	0.01	ppm

[1] 0.1 mg/l detection limit for May survey
[2] 0.01 mg/l detection limit for May survey
[3] 0.005 mg/l detection limit for July survey
[4] 0.005 mg/l detection limit for July survey
[5] 0.03 mg/l detection limit for May survey
0.02 mg/l detection limit for July survey
[6] 0.0005 mg/l detection limit for May survey
0.0008 mg/l detection limit for July survey
[7] 0.03 mg/l detection limit for July survey
[8] 0.02 mg/l detection limit for July survey
[9] 0.1 mg/l detection limit for July survey
[10] 2.0 mg/l detection limit for July survey

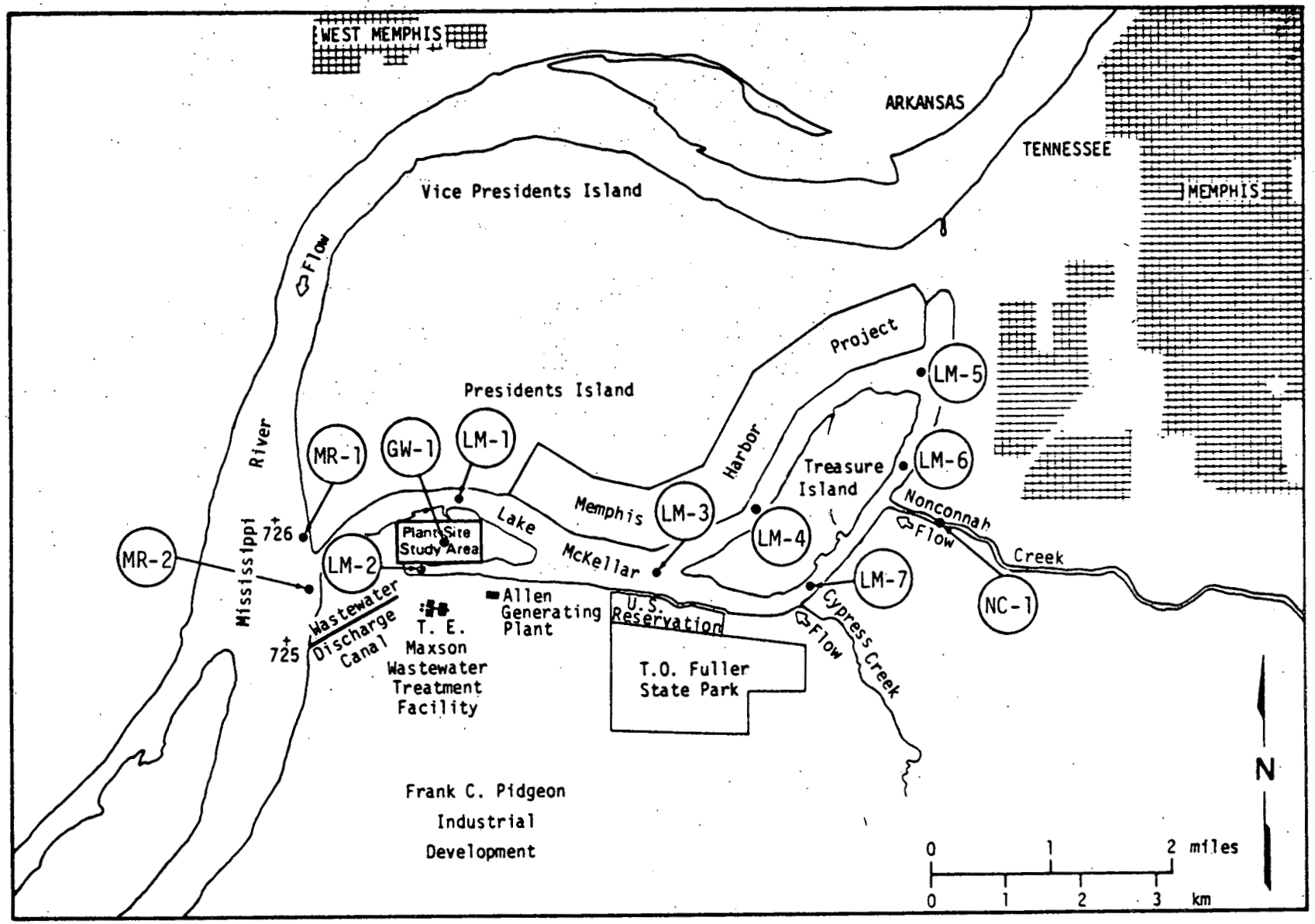

Figure 3A-2. Water Quality Sampling Locations During the 1978-79 Surveys

TABLE 3A-11

RESULTS OF EIA IN-SITU WATER QUALITY SAMPLING IN LAKE MCKELLAR AND NONCONNAH CREEK ON MAY 1 AND 2, 1978

	Sampling Station*															
	LM-1				LM-2				LM-3				LM-4			
Depth (feet)	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)
Subsurface	15.7	352	7.5	7.5	16.5	345	7.8	8.1	16.7	325	7.5	7.2	17.2	320	7.5	7.4
2	15.6	355	7.5	7.5	16.5	345	7.7	8.0	16.7	325	7.5	7.2	17.0	320	7.5	7.4
4	15.5	355	7.5	7.5	16.5	345	7.7	8.0	16.8	325	7.5	7.2	17.1	320	7.5	7.4
6	15.5	355	7.5	7.5	16.2	345	7.7	8.0	16.7	325	7.5	7.2	17.0	322	7.5	7.4
8	15.5	355	7.5	7.5	16.2	345	7.6	7.9	16.7	325	7.5	7.2	17.0	322	7.5	7.5
10	15.5	358	7.5	7.5	16.2	345	7.6	7.8	16.8	325	7.5	7.1	17.0	322	7.4	7.5
12	15.5	360	7.5	7.5	16.0	345	7.6	7.6	16.7	330	7.5	7.1	16.8	325	7.4	7.5
14	15.4	360	7.5	7.5	16.0	345	7.6	7.5	16.5	330	7.5	7.1	16.5	330	7.4	7.4
16	15.4	365	7.5	7.5	16.0	345	7.6	7.5	16.3	335	7.5	6.9	16.5	330	7.4	7.4
18	15.3	365	7.6	7.5	16.0	350	7.5	7.4	16.0	338	7.5	6.9	16.3	330	7.4	7.3
20	15.3	370	7.5	7.5	16.0	350	7.5	7.3	16.0	342	7.5	6.8	15.5	340	7.4	7.1
22	15.1	370	7.6	7.5	15.8	350	7.5	7.3	15.6	345	7.5	6.8	15.4	340	7.4	6.9
24	15.1	372	7.6	7.5	15.8	350	7.5	7.1	15.6	350	7.5	6.8	15.3	340	7.4	6.9
26	15.1	377	7.6	7.5	15.7	350	7.5	7.0	15.5	350	7.5	6.8	15.1	348	7.4	6.9
28	15.0	380	7.6	7.5	15.7	350	7.5	6.9	15.4	350	7.5	6.7	15.0	355	7.4	7.0
30	14.8	390	7.6	7.9	15.5	355	7.5	6.5	15.0	360	7.5	6.7	14.5	370	7.5	7.0
32					15.5	355	7.4	5.5	15.0	363	7.5	6.7	14.5	370	7.5	7.1
34					14.0	355	7.4	†	14.8	365	7.5	6.6	14.4	376	7.5	7.0
36					13.2	360	7.2	†	14.7	368	7.5	6.6	14.3	380	7.5	6.9
38									14.4	378	7.5	6.3	14.2	380	7.5	6.8
40									14.2	380	7.5	6.2	14.2	382	7.5	6.8
42													14.0	382	7.4	6.7
43													13.9	384	7.4	6.7

(Continued)

TABLE 3A-11 (Continued)

Depth (feet)	Sampling Station*															
	LM-5				LM-6				LM-7				NC-1			
	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)
Subsurface	17.4	313	7.5	7.5	17.3	310	7.4	7.5	17.5	310	7.4	7.5	19.9	228	6.9	4.8
2	17.4	313	7.5	7.5	17.4	310	7.4	7.5	17.5	310	7.4	7.5	19.8	225	6.9	4.7
4	17.4	313	7.5	7.5	17.4	310	7.4	7.5	17.5	310	7.4	7.5	19.8	225	6.9	4.6
6	17.4	315	7.5	7.5	17.4	310	7.4	7.5	17.4	310	7.4	7.5	19.9	223	6.9	4.6
8	17.4	313	7.5	7.5	17.3	310	7.4	7.5	17.4	310	7.4	7.4	19.6	223	6.9	4.6
10	17.2	315	7.4	7.4	17.3	310	7.4	7.4	17.3	310	7.4	7.3	19.6	223	6.9	4.6
12	17.0	315	7.4	7.0	17.1	310	7.4	7.4	17.3	312	7.4	7.2	19.5	230	6.9	4.3
14	16.8	317	7.4	6.7	17.0	312	7.4	7.3	17.1	312	7.4	7.1	19.5	230	6.9	4.3
16	16.5	318	7.3	6.6	16.7	314	7.3	6.8	17.0	314	7.4	6.9				
18	16.0	321	7.3	6.5	16.5	315	7.3	6.4	16.5	318	7.3	6.9				
20	15.5	330	7.3	6.3	15.5	322	7.2	6.1	16.5	318	7.3	6.6				
22	15.0	338	7.3	5.9	15.2	328	7.2	5.6	15.7	320	7.3	6.2				
24	14.7	340	7.3	5.7	14.7	332	7.2	5.6	15.5	326	7.3	6.0				
26	14.5	344	7.3	5.6	14.7	332	7.2	5.3	15.0	335	7.2	5.9				
28	14.5	350	7.3	5.6	14.6	332	7.2	5.2								
30	14.3	352	7.3	5.5	14.5	334	7.2	5.2								
32	14.2	355	7.3	5.4	14.4	334	7.1	4.2								
34	14.0	360	7.3	5.4												

* See Figure 3A-2 for location of sampling stations.

** μmhos/cm at 25°C

† Dissolved oxygen probe became fouled.

TABLE 3A-12

RESULTS OF EIA IN-SITU WATER QUALITY SAMPLING IN LAKE MCKELLAR AND NONCONNAH CREEK ON JULY 19, 1978

	Sampling Station*															
	LM-1				LM-2				LM-3				LM-4			
Depth (feet)	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)
Subsurface	28.5	410	7.9	6.8	27.5	380	8.0	7.4	28.9	398	7.7	6.4	29.0	370	7.9	7.5
2	28.5	410	7.9	6.7	27.5	385	7.9	7.2	28.5	394	7.6	6.2	29.0	375	7.8	7.4
4	28.4	420	7.8	6.4	28.5	385	7.8	6.2	28.5	400	7.5	5.5	28.8	361	7.5	6.2
6	28.4	450	7.7	6.1	28.5	390	7.5	5.2	28.5	390	7.4	4.7	28.5	361	7.4	5.4
8	28.4	420	7.7	6.1	28.5	390	7.5	4.7	28.5	390	7.4	4.3	28.5	360	7.3	4.5
10	28.2	475	7.7	6.1	28.5	385	7.5	4.5	28.5	385	7.3	4.0	28.5	360	7.2	3.9
12	28.1	472	7.7	6.1	28.5	390	7.3	3.2	28.5	385	7.3	3.9	28.4	355	7.2	3.0
14	28.1	472	7.7	6.1	28.4	390	7.3	2.5	28.5	385	7.3	3.9	28.3	360	7.1	2.1
16	28.1	478	7.7	6.0	28.2	389	7.2	1.8	28.5	385	7.3	3.9	28.0	351	7.1	1.3
18	28.0	482	7.7	5.9	28.1	395	7.2	2.3	28.5	385	7.3	3.9	28.0	350	7.0	1.1
20	28.0	490	7.7	5.9	28.0	400	7.2	2.1	28.0	280	7.1	1.7	28.0	350	7.0	0.9
22	28.0	491	7.7	5.9	28.0	395	7.2	1.7	27.7	365	7.1	1.3	27.8	348	7.0	0.8
24	28.0	498	7.7	5.7	27.9	408	7.1	1.2	27.6	360	7.1	0.9	27.6	340	7.0	0.5
26	27.8	500	7.6	5.6	27.7	420	7.1	0.4	27.5	350	7.0	0.5	27.5	338	6.9	0.2
28	27.7	500	7.6	5.5	26.5	450	7.1	0.2	27.5	355	7.0	0.3	27.4	321	6.9	0.2
30					24.0	520	6.9	0.1	27.2	353	7.0	0.2	27.0	315	6.9	0.2
32					20.0	580	7.0	0.1	27.0	330	6.9	0.2	26.9	300	6.9	0.2
34									26.5	330	6.9	0.2	26.5	280	6.9	0.2
36													26.0	275	6.9	0.2

(Continued)

TABLE 3A-12 (Continued)

Depth (feet)	Sampling Station* LM-5 Temp. (°C)	LM-5 Conductivity**	LM-5 pH (units)	LM-5 D.O. (mg/l)	LM-6 Temp. (°C)	LM-6 Conductivity**	LM-6 pH (units)	LM-6 D.O. (mg/l)	LM-7 Temp. (°C)	LM-7 Conductivity**	LM-7 pH (units)	LM-7 D.O. (mg/l)	NC-1 Temp. (°C)	NC-1 Conductivity**	NC-1 pH (units)	NC-1 D.O. (mg/l)
Subsurface	29.6	341	8.2	8.7	29.9	348	8.1	9.2	30.5	350	8.7	11.4	30.6	319	7.55	7.6
2	29.2	340	7.9	8.2	29.8	350	8.0	8.3	30.0	350	8.5	10.1	30.0	320	7.2	6.0
4	29.0	335	7.2	7.2	29.1	368	7.5	6.5	29.8	370	8.2	8.4	29.0	368	7.0	4.1
6	28.8	330	7.4	5.8	28.5	360	7.2	3.8	29.2	372	7.5	5.7	28.5	363	6.95	3.0
8	28.5	340	7.2	4.3	28.4	350	7.1	2.4	28.5	380	7.3	3.6				
10	28.5	343	7.1	2.9	28.2	348	7.0	1.9	28.5	380	7.2	3.2				
12	28.2	341	7.0	1.9	28.1	340	7.0	1.3	28.2	385	7.2	2.5				
14	28.1	340	7.0	1.9	28.0	338	6.9	0.8	28.1	380	7.1	1.9				
16	28.0	340	7.0	1.7	28.0	338	6.9	0.9	28.0	370	7.1	1.5				
18	28.0	339	7.1	2.3	27.8	340	7.0	1.5	27.8	360	7.0	1.2				
20	27.9	340	7.1	2.1	27.8	339	6.9	0.6	27.7	350	6.9	0.7				
22	27.7	340	7.1	2.2	27.6	338	6.9	0.5	27.6	350	6.9	0.7				
24	27.6	342	7.1	2.2	27.5	330	6.9	0.3	27.5	347	6.9	0.5				
26	27.6	340	7.1	2.0	27.2	331	6.9	0.2	27.3	339	6.9	0.4				
28	27.5	335	7.0	1.1												
30	27.2	320	6.9	0.4												
32	26.8	280	6.9	0.2												

* See Figure 3A-2 for location of sampling stations.
** µmhos/cm at 25°C

TABLE 3A-13

RESULTS OF EIA IN-SITU WATER QUALITY SAMPLING IN LAKE MCKELLAR AND NONCONNAH CREEK ON OCTOBER 18, 1978

	Sampling Station*															
	LM-1				LM-2				LM-3				LM-4			
Depth (feet)	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)
Subsurface	16.5	520	8.2	7.8	18.3	515	7.6	5.8	17.5	415	7.7	5.3	18.3	430	7.7	5.3
2	16.5	515	8.2	7.7	18.3	515	7.6	6.7	17.2	420	7.7	5.0	18.3	445	7.7	5.1
4	16.4	520	8.2	7.7	18.0	510	7.6	5.6	17.0	425	7.7	5.0	17.9	450	7.7	4.7
6	16.3	520	8.2	7.7	17.7	500	7.7	5.5	17.0	430	7.7	5.1	17.7	455	7.7	4.6
8	16.2	520	8.2	7.7	17.7	500	7.7	5.5	17.2	435	7.7	5.1	17.6	460	7.6	4.5
10	16.1	520	8.2	7.6	17.3	490	7.7	5.5	17.2	440	7.7	5.1	17.6	460	7.7	4.5
12	16.2	525	8.2	7.7	17.4	490	7.8	5.5	17.2	440	7.7	5.2	17.6	470	7.7	4.5
14	16.0	525	8.2	7.7	17.4	495	7.8	5.5	17.2	440	7.7	5.2	17.5	470	7.7	4.6
16	16.1	520	8.2	7.6					17.2	440	7.7	5.2	17.5	475	7.7	4.7
18									17.0	455	7.8	5.5	17.5	465	7.7	4.7
20									17.1	460	7.8	5.6	17.5	470	7.7	4.9
22									16.9	465	7.8	5.7	17.4	480	7.7	5.0
24													17.3	485	7.7	5.2
26													17.3	490	7.8	5.3

(Continued)

TABLE 3A-13 (Continued)

Depth (feet)	Sampling Station* LM-5 Temp. (°C)	LM-5 Conductivity**	LM-5 pH (units)	LM-5 D.O. (mg/l)	LM-6 Temp. (°C)	LM-6 Conductivity**	LM-6 pH (units)	LM-6 D.O. (mg/l)	LM-7 Temp. (°C)	LM-7 Conductivity**	LM-7 pH (units)	LM-7 D.O. (mg/l)	NC-1 Temp. (°C)	NC-1 Conductivity**	NC-1 pH (units)	NC-1 D.O. (mg/l)
Subsurface	18.7	410	7.6	4.5	18.5	390	7.6	4.3	18.5	410	7.7	4.6	14.7	340	7.3	5.9
2	18.7	440	7.6	4.2	18.5	400	7.6	4.2	18.5	410	7.7	4.6	14.0	345	7.3	5.9
4	18.5	438	7.6	3.9	18.2	400	7.6	4.1	18.2	415	7.7	4.5				
6	18.4	450	7.6	3.5	18.1	420	7.6	3.9	18.2	415	7.7	4.4				
8	18.3	450	7.5	3.1	18.0	420	7.6	3.7	18.1	440	7.7	4.4				
10	18.3	450	7.6	3.1	18.0	420	7.6	3.6	18.1	435	7.7	4.3				
12	18.3	450	7.6	3.2	18.0	420	7.6	3.6	18.0	430	7.6	4.3				
14	18.3	450	7.6	3.2	18.0	415	7.6	3.6	18.0	430	7.6	4.2				
16	18.3	450	7.6	3.2												
18	18.3	450	7.6	3.2												
20	18.3	450	7.6	3.2												
22	18.2	450	7.6	3.2												
24	18.1	450	7.6	3.2												
26	18.0	450	7.5	3.2												

* See Figure 3A-2 for location of sampling stations.

** µmhos/cm at 25°C

TABLE 3A-14

RESULTS OF EIA IN-SITU WATER QUALITY SAMPLING IN LAKE MCKELLAR AND NONCONNAH CREEK ON JANUARY 10, 1979

	Sampling Station*															
	LM-1				LM-2				LM-3				LM-4			
Depth (feet)	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)	Temp. (°C)	Conductivity**	pH (units)	D.O. (mg/l)
Subsurface	2.5	260	7.9	13.8	3.5	210	7.5	11.4	3.6	60	7.0	10.4	3.8	170	6.9	10.0
2	2.5	260	7.9	13.8	3.5	205	7.5	11.4								
4	2.5	260	7.9	13.8	3.5	205	7.5	11.4	3.7	65	7.0	10.6	4.0	175	6.9	10.3
6	2.5	260	7.9	13.8	3.5	210	7.5	11.6								
8	2.5	260	7.9	13.8	3.5	210	7.5	11.6	3.7	60	7.1	10.6	4.0	175	6.8	10.2
10	2.5	260	7.9	13.8	3.8	210	7.5	11.6								
12	2.5	260	7.9	13.6	3.8	210	7.5	11.6	3.7	130	7.1	10.7	4.0	190	6.8	10.1
14	2.5	260	7.9	13.6	3.8	210	7.5	11.6								
16	2.5	290	7.9	13.6	3.8	215	7.5	11.6	3.7	140	7.2	10.7	4.0	195	6.8	10.1
18	2.5	300	7.9	13.6	3.8	240	7.5	11.6								
20	2.5	310	7.9	13.6	3.8	250	7.5	11.6	3.7	145	7.2	10.8	4.0	195	6.8	10.0
22	2.5	310	7.9	13.6	3.8	250	7.5	11.6								
24	2.5	305	7.9	13.6	3.8	250	7.5	11.6	3.7	155	7.2	10.8	4.0	195	6.8	10.0
26	2.5	310	7.9	13.6	3.8	250	7.5	11.6								
28					3.8	250	7.5	11.6	3.7	185	7.3	11.1	4.0	190	6.8	9.9
30					3.8	255	7.5	11.6								
32					3.8	255	7.5	11.6	3.7	170	7.3	11.2	4.0	185	6.8	9.9
34																
36									3.7	175	7.4	11.4	4.0	185	6.8	10.0
38																
40									3.7	220	7.4	11.7	4.0	185	6.8	10.0
42																
44									3.7	185	7.4	11.8	4.0	180	6.7	9.9

(Continued)

TABLE 3A-14 (Continued)

Depth (feet)	Sampling Station* LM-5 Temp. (°C)	LM-5 Conductivity**	LM-5 pH (units)	LM-5 D.O. (mg/l)	LM-6 Temp. (°C)	LM-6 Conductivity**	LM-6 pH (units)	LM-6 D.O. (mg/l)	LM-7 Temp. (°C)	LM-7 Conductivity**	LM-7 pH (units)	LM-7 D.O. (mg/l)	NC-1 Temp. (°C)	NC-1 Conductivity**	NC-1 pH (units)	NC-1 D.O. (mg/l)
Subsurface	4.7	115	6.9	10.5	4.5	130	6.8	10.1	3.7	155	6.8	10.4	1.6	160	6.8	13.1
2																
4	4.8	135	6.9	10.4	4.5	140	6.8	10.1	4.0		6.8	10.2	3.5	120	6.7	11.0
6																
8	5.0	145	6.9	10.2	4.5	155	6.8	9.9	4.0		6.7	10.2	4.0	130	6.7	10.5
10																
12	5.0	150	6.8	10.1	4.5	160	6.8	10.1	4.0	170	6.7	10.1	4.2	135	6.7	10.3
14																
16	5.0	155	6.9	10.1	4.5	160	6.8	10.2	4.0		6.7	10.2	4.4	170	6.7	10.2
18																
20	5.0	160	6.9	10.1	4.5	160	6.8	10.2	4.0		6.7	10.2				
22																
24																
26																
28																
30	5.0	170	6.9	10.0	4.5	160	6.8	10.1	4.0	160	6.7	10.2				
32																
34																
36																
38																
40	5.0	175	6.9	10.0					4.0	190	6.8	10.0				
42																
44	5.0	185	6.9	10.1												

* See Figure 3A-2 for location of sampling stations.

** µmhos/cm at 25°C

TABLE 3A-15

RESULTS OF EIA IN-SITU WATER QUALITY SAMPLING IN THE MISSISSIPPI RIVER AND SHALLOW GROUNDWATER DURING 1978-79

	Sampling Station*											
	MR-1				MR-2				GW-1			
Date	Temperature °C	Conductivity umhos	pH units	Dissolved Oxygen mg/l	Temperature °C	Conductivity umhos	pH units	Dissolved Oxygen mg/l	Temperature °C	Conductivity umhos	pH units	Dissolved Oxygen mg/l
May 1-2, 1978	13.6	432	7.8	8.3	13.5	430	7.8	8.3	**	**	**	**
July 19, 1978	27.0†	455†	7.6	5.6	28.0	450	7.6	5.6	18.0	600	6.7	**
October 18, 1978	15.5	515	8.2	7.7	16.3	520	8.2	7.8	17.0	600	6.4	0.0
January 10, 1979	2.5	260	7.9	13.6	2.5	260	7.8	13.8	16.6	600	6.4	0.0
Winter††	**	**	**	**	**	**	**	**	18.0	575	6.7	**

* See Figure 3A-2 for location of sampling stations.

** Data not available

† These parameters were measured during collection of groundwater samples for determination of buffering capacity.

†† Mean of subsurface and mid-depth values

Wastewater[8] or EPA Methods for Chemical Analysis of Water and Wastes[9] with results as indicated in Tables 3A-16 through 3A-19. Polycyclic aromatic hydrocarbons (PAH) were analyzed by the Gas Chromatograph/Mass Spectrometer (GC/MS) System following EPA Protocol.[10] No polycyclic aromatic hydrocarbons were found in the surface waters. Frequencies of exceedance of Criteria are presented in Table 3A-20, as percentage occurrence for each seasonal survey.

Tables 3A-16 through 3A-19 indicate that in all surface waters investigated, calcium and bicarbonate were the dominant ions. Consistent relationships between the abundances of major cations (calcium > magnesium > iron > aluminum) and anions (bicarbonate - as estimated from alkalinity concentrations - > sulfate > chloride > fluoride) were displayed throughout all locations sampled. Of the major metallic parameters, iron and manganese concentrations exceeded Criteria in Mississippi River waters (MR1), where they averaged 8.38 milligrams per liter and 0.31 milligram per liter, respectively. In Lake McKellar waters (at LM1), the average concentrations were 1.86 milligrams per liter and 0.08 milligram per liter. Criteria for both iron and manganese were exceeded at all locations and for all survey samples, except in the case of manganese at LM1 during July 1978. Likely sources of these parameters are iron- and manganese-rich suspended sediments from the Mississippi River basin, as well as mining and other industrial effluents in this vast watershed area.

Strontium was the most consistently occurring trace element in the surface waters and often had the highest concentration of this chemical group. Zinc, copper, cobalt and chromium were also commonly above detection limits in the river waters at MR1. Concentrations of trace elements were generally lower in lake waters at LM1, with copper, zinc and strontium above the detection limit on more than 75 percent of the total annual samples. A seasonal pattern in the occurrence of trace elements above detection limits was notable at LM1, with the smallest number of these elements being detected in July 1978, when the lake was stratified at all stations (LM2 to LM7) uplake of LM1, but well mixed at LM1 itself. Ionic strength, an index of the electrostatic activity of a water body, was substantially higher in Mississippi River waters (MR1)

TABLE 3A-16

RESULTS OF WATER QUALITY SAMPLING OF THE MISSISSIPPI RIVER, LAKE MCKELLAR AND SHALLOW GROUNDWATER IN MAY 1978

Sampling Stations*

Parameter**	MR-1 No. of Values	MR-1 Mean	MR-1 Std. Dev.Δ	MR-1 Max.	MR-2 No. of Values	MR-2 Mean	MR-2 Std. Dev.Δ	MR-2 Max.	LM-1 No. of Values	LM-1 Mean	LM-1 Std. Dev.Δ	LM-1 Max.	LM-6 No. of Values	LM-6 Mean	LM-6 Std. Dev.Δ	LM-6 Max.
GENERAL AND PHYSICAL																
pH (units)	2	7.00	0.28	7.20	2	7.15	0.35	7.40	2	7.15	0.21	7.30	+	+	+	+
Total Dissolved Solids	4	231.8	37.3	280.0	4	251.0	12.8	267.0	4	215.5	9.1	225.0	2	158.0	16.9	170.0
Total Suspended Solids	4	322.5	39.9	360.0	4	315.25	16.8	336.0	4	32.5	8.7	40.0	2	11.0	4.2	14.0
Alkalinity, total	4	120.0	2.8	124.0	4	119.0	2.0	120.0	4	99.0	1.2	100.0	2	84.5	0.70	85.0
Oil and Grease (mg/l as $CaCO_3$)	2	0.6	0.3	0.8	2	0.7	0.1	0.8	2	0.8	0.2	0.9	2	0.65	0.07	0.70
NUTRIENTS																
Total Kjeldahl-Nitrogen	4	1.26	0.36	1.71	4	1.15	0.23	1.40	4	1.19	0.56	1.73	2	0.97	0.05	1.0
Nitrite-Nitrogen	4	0.06	0.02	0.08	4	0.06	0.03	0.09	4	0.08	0.03	1.10	2	0.05	0.001	0.05
Nitrate-Nitrogen	4	2.44	0.43	3.00	4	2.26	0.11	2.42	4	1.60	0.18	1.75	2	1.30	0.14	1.40
Ammonia-Nitrogen	4	0.19	0.11	0.23	4	0.18	0.03	0.22	4	0.44	0.20	0.64	2	0.305	0.007	0.310
Phosphorus, total	4	0.35	0.13	0.52	4	0.35	0.12	0.46	4	0.17	0.02	0.20	2	0.52	0.68	1.00
ORGANICS																
BOD (5 day)	4	3.73	3.23	7.00	4	2.75	1.26	4.0	4	2.48	2.40	6.00	2	1.05	0.07	1.10
COD	4	28.00	3.60	31.70	4	29.45	3.74	33.30	4	16.00	2.86	20.70	2	13.00	1.41	14.00
TOC (percent)	4	11.60	2.78	14.00	4	8.55	2.54	11.00	4	5.98	1.27	7.50	2	5.80	0.0	5.80
DOC	2	8.3	2.4	10.0	2	6.3	0.6	6.7	2	5.7	2.1	7.2	2	5.50	0.28	5.70
Phenol	4	0.008	0.004	0.015	4	0.016	0.008	0.025	4	0.013	0.007	0.023	2	1.40	0.0	1.40
MAJOR ANIONS																
Chloride	4	16.00	0.0	16.00	4	17.00	0.41	17.5	4	13.88	0.25	14.00	2	13.00	0.0	13.00
Cyanide	2	0.006	0.0	0.006	2	0.006	0.001	0.007	2	0.006	0.0028	0.008	2	<0.005	++	<0.005
Fluoride	4	0.34	0.08	0.40	4	0.36	0.11	0.50	4	0.29	0.08	0.40	2	0.23	0.0	0.23
Sulfate	4	87.00	27.74	110.00	4	83.50	27.73	114.00	4	55.75	5.06	60.00	2	43.00	0.0	43.00
MAJOR CATIONS																
Aluminum	4	7.64	0.37	8.10	4	7.10	0.80	8.10	4	2.14	0.28	2.40	2	1.40	0.0	1.40
Barium	4	0.28	0.09	0.36	4	0.28	0.09	0.36	4	0.17	0.08	0.24	2	0.10	0.0	0.10
Calcium	4	49.15	0.98	50.00	4	48.00	1.36	49.00	4	37.45	1.68	39.40	2	33.80	0.28	34.00
Iron	4	8.36	2.43	10.56	4	8.49	2.01	10.65	4	1.05	0.17	1.22	2	1.10	0.0	1.10
Magnesium	4	14.43	0.22	14.60	4	14.28	0.17	14.50	4	10.15	0.51	10.80	2	8.40	0.0	8.40
OTHER																
Antimony, total	2	<0.1	++	<0.1	2	<0.1	++	<0.1	2	<0.1	++	<0.1	2	<0.1	++	<0.1
Arsenic, total	4	<0.01	++	<0.01	4	<0.01	++	<0.01	4	<0.01	++	<0.01	2	<0.01	++	<0.01
Beryllium, total	2	<0.002	++	<0.002	2	<0.002	++	<0.002	2	<0.002	++	<0.002	2	<0.002	++	<0.002
Boron, total	2	<0.02	++	<0.02	2	<0.02	++	<0.02	2	<0.02	++	<0.02	2	<0.02	++	<0.02
Cadmium, total	4	<0.001	++	<0.001	4	<0.001	++	<0.001	4	<0.001	++	<0.001	2	<0.01	++	<0.01
Chromium, total	4	0.009	0.001	0.010	4	0.009	0.002	0.010	4	<0.01	++	<0.01	2	<0.01	++	<0.01
Chromium, hexavalent	2	<0.01	++	<0.01	2	<0.01	++	<0.01	2	<0.01	++	<0.01	2	<0.01	++	<0.01
Cobalt, total	4	<0.01	++	<0.01	4	<0.01	++	<0.01	4	<0.01	++	<0.01	2	<0.01	++	<0.01
Copper, total	4	0.0100	0.0	0.0100	4	0.0095	0.0006	0.0100	4	0.0040	0.0040	0.0100	2	0.0100	0.0	0.0100
Lead, total	4	<0.03	++	<0.03	4	<0.03	++	<0.03	4	<0.03	++	<0.03	2	<0.03	++	<0.03
Manganese, total	4	0.360	0.33	0.401	4	0.359	0.035	0.393	4	0.076	0.005	0.080	2	0.010	0.0	0.010
Mercury, total (ug/l)	2	0.81	0.01	0.82	2	<0.75	++	1.0	2	<0.55	++	0.6	2	<0.77	++	1.03
Nickel, total	4	<0.015	++	0.02	4	<0.02	++	<0.02	4	<0.02	++	<0.02	2	<0.02	++	<0.02
Molybdenum, total	2	<0.03	++	<0.03	2	<0.03	++	<0.03	2	<0.03	++	<0.03	2	<0.03	++	<0.03
Selenium, total	2	<0.01	++	<0.01	2	<0.01	++	<0.01	2	<0.01	++	<0.01	2	0.01	0.0	0.01
Strontium, total	2	0.04	0.0	0.04	2	0.05	0.0	0.05	2	0.06	0.0	0.06	2	0.06	0.0	0.06
Titanium, total	2	<0.01	++	<0.01	2	<0.01	++	<0.01	2	<0.01	++	<0.01	2	<0.01	++	<0.01
Vanadium, total	2	<0.08	++	<0.08	2	<0.08	++	<0.08	2	<0.08	++	<0.08	2	<0.08	++	<0.08
Zinc, total	4	0.055	0.017	0.08	4	0.041	0.001	0.042	4	0.01	0.0	0.01	2	0.02	0.0	0.02
Zirconium, total	2	<2.0	++	<2.0	2	<2.0	++	<2.0	2	<2.0	++	<2.0	2	<2.0	++	<2.0

Parameter**	LM-7 No. of Values	LM-7 Mean	LM-7 Std. Dev.Δ	LM-7 Max.	NC-1 No. of Values	NC-1 Mean	NC-1 Std. Dev.Δ	NC-1 Max.	GW-1 No. of Values	GW-1 Mean	GW-1 Std. Dev.Δ	GW-1 Max.
GENERAL AND PHYSICAL												
pH (units)	+	+	+	+	+	+	+	+	+	+	+	+
Total Dissolved Solids	2	180.5	12.0	189.0	2	104.0	5.7	108.0	2	442.0	8.5	448.0
Total Suspended Solids	2	19.5	0.71	20.0	2	69.5	2.1	71.0	2	62.0	22.6	78.0
Alkalinity, total	2	85.5	0.70	86.0	2	73.0	1.41	74.0	2	334.0	2.83	336.0
Oil and Grease (mg/l as $CaCO_3$)	2	0.85	0.70	0.90	2	1.2	0.3	1.4	2	0.8	0.0	0.8
NUTRIENTS												
Total Kjeldahl-Nitrogen	2	0.91	0.13	1.0	2	1.5	0.0	1.5	2	0.17	0.01	0.18
Nitrite-Nitrogen	2	0.05	0.002	0.05	2	0.03	0.005	0.03	2	0.03	0.01	0.04
Nitrate-Nitrogen	2	1.30	0.0	1.30	2	0.48	0.06	0.52	2	0.19	0.007	0.19
Ammonia-Nitrogen	2	0.280	0.028	0.300	2	0.265	0.007	0.270	2	0.07	0.0	0.07
Phosphorus, total	2	0.12	0.04	0.15	2	0.29	0.01	0.29	2	0.21	0.04	0.23
ORGANICS												
BOD (5 day)	2	1.30	0.0	1.30	2	9.25	0.35	9.50	2	0.95	0.07	1.00
COD	2	16.00	5.66	20.00	2	44.50	0.71	45.00	2	16.90	12.87	26.00
TOC (percent)	2	6.40	0.71	6.90	2	17.50	[illegible]	18.00	2	4.80	0.99	5.50
DOC	2	6.15	0.63	6.60	2	10.00	[illegible]	10.00	2	4.80	0.99	5.50
Phenol	2	1.65	0.07	1.70	2	2.65	[illegible]	2.70	2	0.009	0.001	0.010
MAJOR ANIONS												
Chloride	2	13.50	0.71	14.00	2	11.50	0.71	12.00	2	<2.00	--	<2.00
Cyanide	2	<0.005	--	<0.005	2	<0.005	--	<0.005	2	<0.005	++	<0.005
Fluoride	2	0.24	0.0	0.24	2	0.30	0.01	0.31	2	0.23	0.02	0.24
Sulfate	2	39.00	1.41	40.00	2	21.00	2.83	23.00	2	75.00	0.0	75.00
MAJOR CATIONS												
Aluminum	2	1.65	0.07	1.70	2	2.65	0.07	2.70	2	0.40	0.0	0.40
Barium	1	0.10	0.0	0.10	2	0.10	0.0	0.10	2	0.40	0.0	0.40
Calcium	2	33.30	0.14	33.40	2	22.20	0.28	22.40	2	96.5	0.01	97.0
Iron	2	1.26	0.02	1.27	2	2.39	0.01	2.40	2	16.05	0.07	16.10
Magnesium	2	8.45	0.07	8.50	2	4.80	0.14	4.90	2	29.50	0.0	29.50
OTHER												
Antimony, total	2	<0.1	--	<0.1	2	<0.1	--	<0.1	2	<0.1	++	<0.1
Arsenic, total	2	<0.01	--	<0.01	2	<0.01	--	<0.01	2	<0.15	++	0.020
Beryllium, total	2	<0.002	--	<0.002	2	<0.002	--	<0.002	2	<0.002	--	<0.002
Boron, total	2	<0.02	--	<0.02	2	<0.02	--	<0.02	2	<0.02	--	<0.02
Cadmium, total	2	<0.01	--	<0.01	2	<0.01	--	<0.01	2	<0.01	++	<0.01
Chromium, total	2	<0.01	--	<0.01	2	0.01	0.0	0.01	1	<0.01	++	<0.01
Chromium, hexavalent	2	<0.01	--	<0.01	2	<0.01	--	<0.01	2	<0.01	++	<0.01
Cobalt, total	2	<0.01	--	<0.01	2	<0.01	--	<0.01	2	<0.01	++	<0.01
Copper, total	2	<0.01	--	<0.01	2	0.01	0.0	0.01	1	0.01	--	0.01
Lead, total	2	<0.03	--	<0.03	2	0.05	0.0	0.05	1	<0.03	++	<0.03
Manganese, total	2	<0.01	++	<0.01	2	0.01	0.0	0.01	1	0.01	++	0.01
Mercury, total (ug/l)	2	<0.5	--	<0.5	2	<0.5	++	<0.5	2	<0.50	++	<0.50
Nickel, total	2	<0.02	--	<0.02	2	<0.02	++	<0.02	1	0.02	++	0.02
Molybdenum, total	2	<0.03	++	<0.03	2	<0.03	++	<0.03	2	<0.03	++	0.03
Selenium, total	2	0.01	0.0	0.01	2	0.025	0.007	0.030	2	<0.01	++	<0.01
Strontium, total	2	0.06	0.0	0.06	2	0.03	0.0	0.03	2	0.22	0.02	0.23
Titanium, total	2	<0.01	++	<0.01	2	<0.01	++	<0.01	2	<0.01	++	<0.01
Vanadium, total	2	<0.08	++	<0.08	2	<0.08	++	<0.08	2	<0.08	++	<0.08
Zinc, total	2	0.02	0.0	0.02	2	0.06	0.0	0.06	1	0.03	0.0	0.03
Zirconium, total	2	<2.0	++	< 2.0	2	<2.0	++	<2.0	2	<2.0	++	<2.0

* See Figure 3A-2 for location of sampling stations.

** Units expressed as mg/l unless otherwise noted.

\+ Data not available.

++ Can not be calculated due to insufficient data on the occurrence of nondetectable concentrations.

Δ Standard deviation based on <4 samples not statistically valid. Presented as indication of quality control.

TABLE 3A-17

RESULTS OF WATER QUALITY SAMPLING OF THE MISSISSIPPI RIVER, LAKE MCKELLAR AND SHALLOW GROUNDWATER IN JULY 1978

	Sampling Stations*															
	MR-1				MR-2				LM-1				GW-1			
Parameter**	No. of Values	Mean	Std. Dev.Δ	Max.	No. of Values	Mean	Std. Dev.Δ	Max.	No. of Values	Mean	Std. Dev.Δ	Max.	No. of Values	Mean	Std. Dev.Δ	Max.
PHYSICAL																
Total Dissolved Solids	2	241.0	1.4	242.0	2	234.0	5.7	238.0	2	224.5	10.6	232.0	2	413.5	7.8	419.0
Total Suspended Solids	2	387.0	41.0	416.0	2	375.0	21.2	390.0	2	27.0	4.2	30.0	2	44.5	3.5	47.0
Alkalinity, total (mg/l as $CaCO_3$)	2	130.0	0.0	130.0	2	133.0	9.9	140.0	2	124.0	2.8	126.0	2	357.0	1.4	358.0
Oil and Grease	2	1.5	0.1	1.6	2	2.0	1.4	3.0	2	1.1	0.14	1.2	2	<1.0	††	<1.0
NUTRIENTS																
Total Kjeldahl-Nitrogen	4	0.39	0.21	0.70	4	0.52	0.31	0.80	4	0.49	0.44	0.98	2	0.55	0.19	0.69
Nitrite-Nitrogen	4	0.018	0.017	0.04	4	0.019	0.016	0.040	4	0.052	0.009	0.059	2	0.02	0.0	0.02
Nitrate-Nitrogen	4	2.11	0.21	2.25	4	2.17	0.12	2.27	4	1.62	0.11	1.71	2	0.02	0.0	0.02
Phosphorus, total	4	0.255	0.110	0.390	4	0.265	0.061	0.350	4	0.145	0.017	0.170	2	0.41	0.04	0.44
Organic phosphorus	4	0.027	0.015	0.040	4	0.049	0.023	0.065	4	0.034	0.013	0.050	2	0.07	0.03	0.09
Ortho-phosphate	2	0.310	0.060	0.350	2	0.275	0.007	0.280	2	0.124	0.037	0.150	2	0.36	0.0	0.36
ORGANICS																
BOD (5 day)	2	8.0	2.80	10.0	2	10.5	2.1	12.0	2	5.5	2.1	7.0	2	7.5	0.7	8.0
COD	2	34.0	1.40	35.0	2	35.5	3.5	38.0	2	19.0	0.0	19.0	2	6.0	2.8	8.0
TOC (percent)	2	5.9	0.20	6.1	2	9.2	0.64	9.6	2	6.5	0.99	7.2	†	†	†	†
DOC	2	5.7	0.07	5.8	2	8.6	0.14	8.7	2	5.9	0.35	6.2	†	†	†	†
Phenol	2	0.010	††	0.019	2	0.005	††	0.010	2	0.008	0.006	0.013	2	0.008	0.001	0.009
MAJOR ANIONS																
Chloride	2	12.25	3.18	14.50	2	14.25	3.18	16.50	2	13.50	0.0	13.50	2	8.65	0.49	9.00
Cyanide	2	<0.005	††	<0.005	2	<0.005	††	<0.005	2	<0.005	††	<0.005	2	<0.005	††	<0.005
Fluoride	2	0.295	0.063	0.340	2	0.360	0.028	0.380	2	0.270	0.028	0.290	2	0.180	0.014	0.190
Sulfate	2	37.00	4.24	40.00	2	47.00	12.73	56.00	2	36.00	0.0	36.00	2	24.00	0.0	24.00
MAJOR CATIONS																
Aluminum	2	9.07	0.53	9.45	2	8.39	0.04	8.42	2	0.99	0.05	1.03	2	0.1	0.0	0.1
Barium	2	0.38	0.01	0.39	2	0.42	0.03	0.44	2	0.29	0.01	0.30	2	0.82	0.0	0.82
Calcium	2	50.30	7.20	57.00	2	44.65	0.01	44.70	2	39.95	0.36	40.20	4	95.68	4.26	99.80
Iron	4	11.80	2.18	13.80	2	9.80	0.22	10.00	2	0.92	0.14	0.93	4	19.50	0.90	20.40
Magnesium	4	16.15	0.65	16.70	2	15.95	0.07	16.00	2	14.10	1.56	15.20	4	32.65	0.76	33.40
OTHER																
Arsenic, total	2	<0.01	††	<0.01	2	<0.01	††	<0.01	2	<0.01	††	<0.01	2	<0.01	††	<0.01
Chromium, total	2	0.015	0.001	0.016	2	0.014	0.0	0.014	2	<0.01	††	<0.01	2	<0.01	††	<0.01
Cobalt, total	2	0.011	0.001	0.011	2	0.008	0.001	0.009	2	<0.005	††	<0.005	2	0.008	††	0.010
Copper, total	2	0.014	0.001	0.014	2	0.012	0.001	0.012	2	<0.005	††	<0.005	2	<0.005	††	<0.005
Lead, total	2	<0.02	††	<0.02	2	<0.02	††	<0.02	2	<0.02	††	<0.02	2	<0.02	††	<0.02
Manganese, total	2	0.355	0.007	0.360	2	0.335	0.007	0.340	2	0.037	0.007	0.037	2	4.26	0.07	4.31
Mercury, total	2	<0.0008	††	<0.0008	2	<0.0008	††	<0.0008	2	0.0009	†	0.0010	2	0.0014	0.0008	0.0020
Strontium, total	2	0.035	0.007	0.040	2	0.045	0.021	0.060	2	0.050	0.028	0.070	2	0.245	0.007	0.250
Zinc, total	2	0.041	0.004	0.044	2	0.041	0.003	0.043	2	0.023	0.009	0.030	2	0.028	0.008	0.033

* See Figure 3A-2 for location of sampling stations.

** Units expressed as mg/l unless otherwise noted.

† Data not available.

†† Can not be calculated due to the occurrence of nondetectable concentrations.

Δ Standard deviation based on <4 samples not statistically valid. Presented as indication of quality control.

TABLE 3A-18

RESULTS OF WATER QUALITY SAMPLING OF THE MISSISSIPPI RIVER, LAKE MCKELLAR AND SHALLOW GROUNDWATER IN OCTOBER 1978

	Sampling Stations*															
	MR-1				MR-2				LM-1				GW-1			
Parameter**	No. of Values	Mean	Std. Dev.Δ	Max.	No. of Values	Mean	Std. Dev.Δ	Max.	No. of Values	Mean	Std. Dev.Δ	Max.	No. of Values	Mean	Std. Dev.Δ	Max.
PHYSICAL																
pH units	2	8.05	†	8.1	2	8.1	0.0	8.1	2	8.15	†	8.2	†	†	†	†
Total Dissolved Solids	2	277.0	2.8	279.0	2	274.5	12.0	283.0	2	279.0	8.5	285.0	†	†	†	†
Total Suspended Solids	2	101.5	26.2	120.0	2	93.0	0.0	93.0	2	55.0	7.1	60.0	2	33.5	2.1	35.0
Alkalinity, total	2	145.5	0.7	146.0	2	151.0	1.4	152.0	2	150.0	2.8	152.0	2	361.0	1.4	362.0
Oil and Grease	2	2.6	0.4	2.9	2	3.2	1.1	4.0	2	4.1	0.1	4.2	2	0.34	0.19	0.48
NUTRIENTS																
Total Kjeldahl-Nitrogen	2	1.02	0.04	1.05	2	1.16	0.17	1.28	2	1.12	0.19	1.25	2	0.85	0.29	1.06
Nitrite-Nitrogen	2	0.045	0.009	0.052	2	0.044	0.002	0.045	2	0.053	0.006	0.057	2	0.016	0.001	0.017
Nitrate-Nitrogen	2	0.705	0.005	0.708	2	0.764	0.038	0.790	2	0.810	0.015	0.823	2	0.009	0.0	0.009
Ammonia-Nitrogen	2	0.290	0.021	0.305	2	0.270	0.28	0.290	2	0.470	0.261	0.65	2	0.35	0.06	0.39
Phosphorus, total	2	0.404	0.170	0.524	2	0.530	0.177	0.656	2	0.311	0.055	0.350	2	0.415	0.007	0.420
Organic phosphorus	2	0.165	0.177	0.290	2	0.290	0.169	0.410	2	0.020	0.014	0.030	2	0.05	0.01	0.06
Ortho-phosphate	2	0.235	0.035	0.260	2	0.255	0.007	0.260	2	0.230	0.028	0.250	2	0.36	0.01	0.37
ORGANICS																
BOD (5 day)	2	1.0	0.0	1.0	2	1.5	0.7	2.0	2	2.0	0.0	2.0	2	7.0	0.0	7.0
COD	2	22.5	7.8	28.0	2	19.0	7.1	24.0	2	37.0	18.4	50.0	2	9.5	0.7	10.0
TOC (percent)	2	8.4	0.9	9.1	2	9.2	1.1	10.0	2	8.8	0.5	9.2	2	7.7	4.7	11.0
DOC	2	8.3	1.1	9.1	2	9.1	0.9	9.8	2	8.7	0.6	9.1	2	5.5	1.6	6.6
Phenol	2	0.012	0.005	0.015	2	0.007	0.005	0.010	2	0.008	0.004	0.010	2	0.016	0.004	0.019
MAJOR ANIONS																
Chloride	2	15.0	0.7	15.5	2	14.3	0.4	14.5	2	14.3	0.4	14.5	2	<0.5	††	<0.5
Cyanide	2	<0.007	††	0.008	2	<0.007	††	0.009	2	<0.005	††	<0.005	2	<0.005	††	<0.005
Fluoride	2	0.31	0.01	0.32	2	0.29	0.01	0.30	2	0.31	0.04	0.34	2	0.165	0.007	0.170
Sulfate	2	79.3	0.4	79.5	2	83.8	10.9	91.5	2	87.5	3.5	90.0	2	29.0	7.1	34.0
MAJOR CATIONS																
Aluminum	2	2.38	0.22	2.53	2	2.39	0.16	2.51	2	1.83	0.13	1.92	2	<0.1	†	<0.1
Barium	2	0.28	0.0	0.28	2	0.27	0.0	0.27	2	0.27	0.0	0.27	2	1.08	0.0	1.08
Calcium	2	50.0	0.6	50.4	2	49.2	0.07	49.3	2	50.2	1.2	51.0	2	90.2	0.0	90.2
Iron	2	2.95	0.50	3.30	2	3.00	0.11	3.08	2	3.25	1.51	4.32	2	20.5	0.2	20.6
Magnesium	2	18.7	0.0	18.7	2	18.6	0.14	18.7	2	18.8	0.0	18.8		28.9	0.2	29.0

* See Figure 3A-2 for location of sampling stations.

** Units expressed as mg/l unless otherwise noted.

† Data not available.

†† Can not be calculated due to the occurrence of nondetectable concentrations.

Δ Standard deviation based on <4 cases, not statistically valid. Presented as indication of quality control.

TABLE 3A-18 (Continued)

Parameter**	Sampling Stations*															
	MR-1				MR-2				LM-1				GW-1			
	No. of Values	Mean	Std. Dev.Δ	Max.	No. of Values	Mean	Std. Dev.Δ	Max.	No. of Values	Mean	Std. Dev.Δ	Max.	No. of Values	Mean	Std. Dev.Δ	Max.
OTHER																
Arsenic, total	2	<0.01	††	<0.01	2	<0.01	††	<0.01	2	<0.01	††	<0.01	2	<0.01	††	<0.01
Antimony, total	2	<0.1	††	<0.1	2	<0.1	††	<0.1	2	<0.1	††	<0.1	2	<0.1	††	<0.1
Beryllium, total	2	<0.002	††	<0.002	2	<0.002	††	<0.002	2	<0.002	††	<0.002	2	<0.002	††	<0.002
Boron, total	2	0.15	0.03	0.17	2	0.13	0.03	0.15	2	0.15	0.0	0.15	2	0.18	0.01	0.19
Cadmium, total	2	<0.01	††	<0.01	2	<0.01	††	<0.01	2	<0.01	††	<0.01	2	<0.01	††	<0.01
Chromium, total	2	<0.01	††	<0.01	2	<0.01	††	<0.01	2	<0.01	††	<0.01	2	<0.05	††	<0.05
Chromium, hexavalent	2	<0.01	††	<0.01	2	<0.01	††	<0.01	2	<0.01	††	<0.01	2	<0.01	††	<0.01
Cobalt, total	2	0.007	†	0.008	2	0.005	†	0.005	2	<0.005	††	<0.005	2	0.0065	0.0007	0.0070
Copper, total	2	0.011	0.001	0.012	2	0.009	0.001	0.009	2	0.011	0.006	0.015	2	0.036	0.043	0.066
Lead, total	2	0.016	0.009	0.022	2	0.019	0.001	0.019	2	0.015	0.003	0.017	2	<0.02	††	<0.02
Manganese, total	2	0.192	0.023	0.208	2	0.189	0.006	0.193	2	0.113	0.003	0.115	2	28.85	0.21	29.0
Mercury, total	2	<0.0002	††	<0.0002	2	<0.0002	††	<0.0002	2	<0.0002	††	<0.0002	2	<0.0002	††	<0.0002
Molybdenum, total	2	<0.03	††	<0.03	2	<0.03	††	<0.03	2	<0.03	††	<0.03	2	<0.03	††	<0.03
Nickel, total	2	<0.011	††	0.012	2	<0.0105	††	0.011	2	0.012	0.0	0.012	2	0.010	††	0.010
Selenium, total	2	0.01	0.0	0.01	2	0.01	0.0	0.01	2	0.01	0.0	0.01	2	<0.01	††	<0.01
Strontium, total	2	0.085	0.007	0.090	2	0.085	0.007	0.090	2	0.029	0.023	0.046	2	0.275	0.007	0.280
Titanium, total	2	<0.1	††	<0.1	2	<0.1	††	<0.1	2	<0.1	††	<0.1	2	<0.1	††	<0.1
Uranium, total	2	<1.0	††	<1.0	2	<1.0	††	<1.0	2	<1.0	††	<1.0	2	<1.0	††	<1.0
Vanadium, total	2	<0.08	††	<0.08	2	<0.08	††	<0.08	2	<0.08	††	<0.08	2	<0.08	††	<0.08
Zinc, total	2	0.042	0.016	0.053	2	0.026	0.009	0.032	2	0.029	0.023	0.046	2	0.025	0.007	0.030
Zirconium, total	2	<2.0	††	<2.0	2	<2.0	††	<2.0	2	<2.0	††	<2.0	2	<2.0	††	<2.0

* See Figure 3A-2 for location of sampling stations.

** Units expressed as mg/l unless otherwise noted.

† Data not available.

†† Can not be calculated due to the occurrence of nondetectable concentrations.

Δ Standard deviation based on <4 cases, not statistically valid. Presented as indication of quality control.

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REVISED
November 1979

TABLE 3A-19

RESULTS OF WATER QUALITY SAMPLING OF THE MISSISSIPPI RIVER, LAKE MCKELLAR AND SHALLOW GROUNDWATER IN JANUARY 1979

Parameter*	MR-1				MR-2				LM-1				GW-1			
	No. of Values	Mean	Std. Dev.Δ	Max.	No. of Values	Mean	Std. Dev.Δ	Max.	No. of Values	Mean	Std. Dev.Δ	Max.	No. of Values	Mean	Std. Dev.Δ	Max.
PHYSICAL																
pH Units	2	7.50	0.0	7.50	2	7.53	÷	7.55	2	7.40	0.0	7.40	2	6.70	0.0	6.70
Total Dissolved Solids	2	238.5	7.8	244.0	2	213.0	1.4	214.0	2	237.5	2.12	239.0	2	447.0	4.2	450.0
Total Suspended Solids	2	184.5	13.4	194.0	2	200.0	5.7	204.0	2	56.5	12.0	65.0	2	41.0	1.4	42.0
Alkalinity, total	2	85.0	1.4	86.0	2	85.0	1.4	86.0	2	82.0	0.0	82.0	2	364.0	1.4	365.0
Oil and Grease	2	0.9	0.4	1.2	2	1.8	0.9	2.4	2	1.1	0.7	1.1	2	0.7	0.6	1.1
NUTRIENTS																
Total Kjeldahl-Nitrogen	2	0.845	0.035	0.870	2	0.965	0.276	1.160	2	0.850	0.297	1.160	2	0.510	0.424	0.540
Nitrite-Nitrogen	2	0.08	0.0	0.08	2	0.065	0.212	0.080	2	0.064	0.020	0.078	2	0.088	0.011	0.095
Nitrate-Nitrogen	2	1.05	0.14	1.15	2	1.06	0.12	1.15	2	1.03	0.18	1.16	2	1.09	0.08	1.15
Ammonia-Nitrogen	2	0.330	0.057	0.370	2	0.585	0.361	0.840	2	0.62	0.42	0.92	2	0.460	0.071	0.510
Phosphorus, total	2	0.390	0.0	0.390	2	0.390	0.0	0.390	2	0.230	0.283	0.250	2	0.425	0.007	0.430
Organic phosphorus	2	0.020	0.014	0.030	2	0.060	0.014	0.070	2	0.040	0.042	0.070	2	<0.015	++	0.020
Ortho-phosphate	2	0.110	0.014	0.120	2	0.115	0.212	0.120	2	0.130	0.0	0.130	2	<0.040	++	0.050
ORGANICS																
Biochemical Oxygen Demand	2	1.60	0.14	1.70	2	2.10	0.14	2.20	2	2.15	1.20	3.00	2	5.50	2.12	8.00
Chemical Oxygen Demand	2	27.0	2.8	29.0	2	27.0	0.0	27.0	2	22.0	1.4	23.0	2	18.5	3.5	21.0
Total Organic Carbon	2	5.500	0.141	5.600	2	7.000	1.131	7.200	2	5.750	0.071	5.800	2	8.550	0.636	9.000
Dissolved Organic Carbon	2	3.25	1.34	4.20	2	4.00	1.41	5.00	2	3.50	0.71	4.00	2	5.150	2.899	7.200
Phenol	2	<0.0025	++	<0.0025	2	<0.0025	--	<0.0025	2	<0.0025	++	<0.0025	2	0.0175	0.0049	0.0210
MAJOR ANIONS																
Chloride	2	11.05	0.04	11.07	2	10.90	0.24	11.07	2	11.39	0.06	11.44	2	6.78	0.13	6.87
Cyanide	2	<0.005	++	<0.005	2	<0.005	--	<0.005	2	<0.005	--	<0.005	2	<0.005	++	<0.005
Fluoride	2	0.155	0.021	0.170	2	0.014	0.028	0.016	2	0.095	0.007	0.100	2	0.060	0.0	0.060
Sulfate	2	42.0	0.0	42.0	2	41.5	2.1	43.0	2	43.0	2.8	45.0	2	42.5	0.7	43.0
MAJOR CATIONS																
Aluminum	2	5.080	0.140	5.180	2	5.305	0.247	5.480	2	3.650	1.655	4.820	2	<0.050	++	<0.050
Barium	2	0.553	0.011	0.560	2	0.560	0.0	0.560	2	0.495	0.007	0.500	2	1.710	0.028	1.730
Calcium	2	34.95	1.34	35.90	2	37.25	1.77	38.50	2	31.35	1.06	32.10	2	103.25	0.35	103.50
Iron	2	7.035	0.304	7.250	2	0.010	0.0	0.010	2	3.025	0.035	3.050	2	21.45	0.07	21.50
Magnesium	2	8.855	0.205	9.000	2	8.175	0.049	8.750	2	8.075	0.064	8.120	2	10.095	0.134	10.190
OTHER METALS																
Arsenic, total	2	<0.0100	++	<0.0100	2	0.0100	--	<0.0100	2	<0.0100	++	<0.0100	2	0.0135	0.0007	0.0140
Antimony, total	4	<0.01	++	<0.01	4	<0.01	--	<0.01	4	<0.01	++	<0.01	4	<0.01	++0.0	<0.01
Beryllium, total	2	<0.002	++	<0.002	2	<0.002	--	<0.002	2	<0.002	++	<0.002	2	<0.002	++0.0	<0.002
Boron, total	2	0.030	0.0	0.030	2	0.030	0.014	0.040	2	<0.040	++	<0.040	2	0.070	0.041	0.080
Cadmium, total	4	0.0015	0.0007	0.0020	4	0.002	0.0	0.0020	2	0.0023	0.0063	0.0025	4	0.0025	0.0	0.0025
Chromium, total	2	0.0105	0.0007	0.0110	2	0.0065	0.0021	0.008	2	0.0135	0.0120	0.0220	2	0.0060	0.0028	0.0080
Chromium, hexevalent	2	<0.01	++	<0.01	2	<0.01	--	<0.01	2	<0.01	++	<0.01	2	<0.01	0.0	<0.01
Cobalt, total	2	0.00325	0.00106	0.00400	2	0.00350	0.00087	0.00400	2	0.00350	0.00070	0.00400	2	0.00325	0.00106	0.00400
Copper, total	2	0.0145	0.0021	0.016	2	0.0110	0.0028	0.0130	2	0.007	0.0028	0.0090	2	0.0090	0.0014	0.0100
Lead, total	2	0.012	++	<0.013	2	<0.010	++	<0.010	2	<0.010	++	<0.010	2	<0.012		0.013
Manganese, total	2	0.285	0.007	0.290	2	0.295	0.007	0.300	2	0.090	0.0	0.090	2	4.550	0.071	4.600
Mercury, total	2	<0.00025	++	0.0003	2	<0.0002	--	<0.0002	2	<0.0002	++	<0.0002	2	<0.0005		0.0007
Molybdenum, total	2	<0.03	0.0	<0.03	2	<0.03	++	<0.03	2	<0.03		<0.03	2	<0.03	0.0	<0.03
Nickel, total	2	0.008	0.003	0.010	2	0.01	0.0	0.01	2	0.007	0.0	0.007	2	0.007	0.0	0.007
Selenium, total	2	<0.005	++	<0.005	2	<0.005	++	<0.005	2	<0.005	++	<0.005	2	<0.005		<0.005
Strontium, total	2	0.073	0.0	0.073	2	0.078	0.002	0.080	2	0.082	0.004	0.085	2	0.336	0.004	0.339
Titanium, total	2	<0.1	++	<0.1	2	<0.1	++	<0.1	2	<0.1	++	<0.1	2	<0.1	++	<0.1
Uranium, total	2	<1.0	++	<1.0	2	<1.0	++	<1.0	2	<1.0	++	<1.0	2	<1.0	++	<1.0
Vanadium, total	2	<0.08	++	<0.08	2	<0.08	++	<0.08	2	<0.08	++	<0.08	2	<0.08	++	<0.08
Zinc, total	2	0.0370	0.0	0.0370	2	0.0375	0.0007	0.0380	2	0.0130	0.0014	0.0140	2	0.0170	0.0141	0.0270
Zirconium, total	2	<2.0	++	<2.0	2	<2.0	++	<2.0	2	<2.0	0.0	<2.0	2	<2.0	0.0	<2.0

* See Figure 3A-2 for location of sampling stations.
** Units expressed as mg/l unless otherwise noted
\+ Data not available.
++ Can not be calculated due to the occurrence of nondetectable concentrations.
Δ Standard deviations based on <4 samples not statistically valid. Presented as indication of quality control.

TABLE 3A-20

PERCENTAGE OF OCCASIONS ON WHICH CRITERIA WERE EXCEEDED (SEE TABLE 3A-2)

	GW-1				MR-1				MR-2				LM-1				LM-6				LM-7				NC-1			
	May	Jul	Nov	Jan	May	Jul	Oct	Jan	May	Jul	Oct	Jan	May	Jul	Oct	Jan	May	Jul	Oct	Jan	May	Jul	Oct	Jan	May	Jul	Oct	Jan
Criteria(1,2)																												
pH	†	†	†	†	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dissolved Oxygen (Tennessee(1))	†	†	†	†	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	100	0	0	0
Dissolved Oxygen (EPA(2))	†	†	†	†	0	0	0	0	0	0	0	0	0	0	0	0	6	78	100	-	0	71	100	-	100	50	-	-
Temperature	†	†	†	†	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	50	0	0
Alkalinity	†	†	†	†	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	0	-	-	-	0	-	-	-
Ammonia	†	†	†	†	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	0	-	-	-	0	-	-	-
Arsenic	0	0	0	0	†	†	†	†	†	†	†	†	†	†	†	†	†	-	-	-	†	-	-	-	†	-	-	-
Barium	0	0	100	100	†	†	†	†	†	†	†	†	†	†	†	†	†	-	-	-	†	-	-	-	†	-	-	-
Beryllium	†	†	†	†	0	-	0	0	0	-	0	0	0	-	0	0	0	-	-	-	0	-	-	-	0	-	-	-
Boron	0	-	0	0	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†	†
Cadmium*	0	-	0	0	0	-	0	50	0	-	50	100	0	-	50	100	0	-	-	-	0	-	-	-	0	-	-	-
Chromium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	0	-	-	-	0	-	-	-
Copper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	0	-	-	-	0	-	-	-
Cyanide	†	†	†	†	50	0	50	0	100	0	50	0	50	0	0	0	0	-	-	-	0	-	-	-	0	-	-	-
Iron	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	-	-	-	100	-	-	-	100	-	-	-
Lead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	0	-	-	-	100	-	-	-
Manganese	100	100	100	100	100	100	100	100	100	100	100	100	100	0	100	100	100	-	-	-	100	-	-	-	100	-	-	-
Mercury**	†	†	†	†	100	0	0	50	50	0	0	0	50	50	0	0	50	-	-	-	0	-	-	-	0	-	-	-
Nitrates	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	0	-	-	-	0	-	-	-
Phenol	100	100	100	100	100	50	100	0	100	50	100	0	100	100	100	50	100	-	-	-	100	-	-	-	100	-	-	-
Selenium	0	-	0	0	0	-	100	0	0	-	100	0	0	-	100	0	100	-	-	-	100	-	-	-	100	-	-	-
Total Dissolved Solids	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	0	-	-	-	0	-	-	-
Zinc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	0	-	-	-	0	-	-	-
Drinking Water Standards(11)																												
Arsenic	0	0	0	0																								
Barium	0	0	100	100																								
Cadmium	0	-	0	0																								
Chromium	0	0	0	0																								
Lead	0	0	0	0																								
Mercury	0	0	0	0																								
Selenium	0	-	0	0																								

Not Applicable for Surface Waters

	LM-2				LM-3				LM-4				LM-5			
	May	Jul	Oct	Jan	May	Jul	Oct	Jan	May	Jul	Oct	Jan	May	Jul	Oct	Jan
Criteria(1,2)																
pH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dissolved Oxygen (Tennessee(1))	0	0	50	0	0	0	100	0	0	0	100	0	0	0	100	0
Dissolved Oxygen (EPA(1))	0	76	0	0	83	17	0	0	0	79	36	0	0	76	100	-
Temperature	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

- Data Not Available
* Cadmium reported as percentage above 0.01 mg/l detection limit in May and above Criteria at other times
** Mercury reported as percentage occurrence above 0.0005 mg/l detection limit in May and 0.0008 mg/l detection limit in July, and 0.0002 mg/l in November and January.
† Not Applicable

where its annual average value was approximately 7.18, than in Lake McKellar, at LM1, which had an average value of 5.79. This is caused by a generally higher concentration of most chemical constituents in the river water, rather than markedly higher values of a small number of parameters.

Organic loading was highest in Nonconnah Creek, at NC1, as indicated by chemical oxygen demand (COD) and phenols which displayed mean concentrations of 44.5 milligrams per liter and 2.65 milligrams per liter, respectively, when analyses were made on May 1978 survey samples. Mississippi River water (MR1), with a (mean chemical oxygen demand) concentration of 27.9 milligrams per liter and phenol mean concentration of <0.008 milligram per liter, was not substantially different from lake water (LM1), where chemical oxygen demand displayed a mean concentration of 28.4 milligrams per liter and phenol a mean concentration of <0.008 milligram per liter. Phenol consistently exceeded Criteria.

Total kjeldahl nitrogen (TKN) was the most abundant nutrient parameter, with nitrate-nitrogen and ammonia-nitrogen also prevalent. Total phosphorus concentrations were less than half the values of total nitrogen concentrations. total kjeldahl nitrogen was not significantly different in concentration between Lake McKellar, LM1 (mean, 0.89 milligram per liter), and the river at MR1 (mean, 0.86 milligram per liter). Nitrate-nitrogen and total phosphorus were of higer concentrations at MR1 than at LM1, while for ammonia-nitrogen, the relationship between those locations was reversed.

As part of the definition of baseline conditions, functional relationships between certain chemical parameters were evaluated by regression analyses. Input data for these calculations is presented in Table 3A-21 with results as shown in Table 3A-22. No causal dependences were postulated by this approach; rather, the objective was to obtain a series of equations with known confidence limits, against which potential impacts could be assessed. Future divergences without confidence limits established by this method should be evaluated in terms of changing conditions in the entire watershed or recharge areas, of which the proposed plant site is a small but important part.

TABLE 3A-21

INPUT DATA FOR LINEAR REGRESSION EQUATIONS BETWEEN WATER QUALITY PARAMETER CONCENTRATIONS FROM THE MISSISSIPPI RIVER (MR1), LAKE MCKELLAR (LM1) AND GROUNDWATER (GW1)

	Sampling Stations*																										
	MR1									LM1										GW1							
Number of Cases	Chemical Oxygen Demand (COD)	Biochemical Oxygen Demand (BOD)	Total Organic Carbon (TOC)	Sulfate (SO_4)	Alkalinity (ALK)	Total Kjeldahl Nitrogen (TKN)	Dissolved Organic Carbon (DOC)	Calcium (CA)	Magnesium (MG)	Chemical Oxygen Demand (COD)	Biochemical Oxygen Demand (BOD)	Total Organic Carbon (TOC)	Sulfate (SO_4)	Alkalinity (ALK)	Total Kjeldahl Nitrogen (TKN)	Dissolved Organic Carbon (DOC)	Calcium (CA)	Magnesium (MG)	Chemical Oxygen Demand (COD)	Biochemical Oxygen Demand (BOD)	Total Organic Carbon (TOC)	Sulfate (SO_4)	Alkalinity (ALK)	Total Kjeldahl Nitrogen (TKN)	Dissolved Organic Carbon (DOC)	Calcium (CA)	Magnesium (MG)
1	33	6	0.39	40	130	0.7	5.7	44.4	16	19	4	5.8	36	126	0.98	6.2	39.7	13	4	7	4.1	24	358	0.18	4.1	99.8	33.4
2	35	10	0.70	34	130	0.39	5.8	43.7	15.3	19	7	7.2	36	122	0.74	5.7	40.2	15.2	8	8	5.5	24	356	0.16	5.5	98.9	33.2
3	24	0.5	14	70	120	0.98	10.0	50	14.6	14	0.5	4.4	60	100	0.70	4.2	39.4	10.8	7.8	0.5	9.0	75	332	0.54	7.2	96	29.5
4	25	1	9.4	60	118	0.97	6.6	50	14.5	18	1	7.5	50	98	0.71	7.2	38.2	10.3	26	1	8.1	75	336	0.48	3.1	97	29.5
5	29	1.7	5.6	42	86	0.87	4.2	34	8.71	23	1.3	5.8	42	82	0.64	4.0	32.1	8.12	16	5	11	43	363	0.64	6.6	103.5	10.19
6	25	1.5	5.4	42	84	0.82	2.3	35.9	9	21	3	5.7	45	82	1.06	3.0	30.6	8.03	21	8	4.3	42	365	1.06	4.3	103	10
7	17	1	9.1	79.5	146	1.05	7.5	49.6	18.7	17	1	8.4	79	148	0.98	8.3	31.0	18.8	9	7		24	360			90.2	29
8	28	1	7.7	79	145	0.99	9.1	50.4	18.7	28	1	9.2	79.5	152	1.25	9.1	49.3	18.8	10	7		34	362			90.2	28.8
9	30.3	6	9	110	124	1.71	10	48.4	14.1	20.7	2	2	60	90	1.60	6	36.6	9.7									
10	31.7	7	14	108	118	1.39	7	48.2	14.5	19.1	4	8	53	100	1.73	6	35.6	9.8									

* See Figure 3A-2 for location of sampling stations.

TABLE 3A-22

FUNCTIONAL RELATIONSHIPS BETWEEN WATER QUALITY PARAMETER CONCENTRATIONS FROM THE MISSISSIPPI RIVER (MR1), LAKE MCKELLAR (LM1) AND GROUNDWATER (GW1)

Parameters	Sampling Stations*		
	MR-1	LM-1	GW-1
Total Organic Carbon (TOC) and Total Kjeldahl Nitrogen (TKN)	TOC = 3.786 + 4.887 TKN r** = 0.54 (85.1%)†	TOC = 6.358 - 0.133 TKN r = 0.02 (4.9%)	TOC = 0.412 + 0.14 TKN r = 0.37 (14.8%)
Dissolved Organic Carbon (DOC) and Total Kjeldahl Nitrogen (TKN)	DOC = 33.975 - 22.315 TKN r = 0.50 (81.3%)	DOC = 4.417 + 1.494 TKN r = 0.29 (56.0%)	DOC = 4.153 + 1.921 TKN r = 0.40 (48.9%)
Magnesium (Mg) and Calcium (Ca)	Mg = -6.982 + 0.471 Ca r = 0.84 (98.6%)	Mg = -11.0 + -0.592 Ca r = 0.96 (99.9%)	Mg = 135.42 - 1.13 Ca r = -0.59 (81.6%)
Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD)	BOD = -10.75 + 0.515 COD r = 0.80 (97.8%)	BOD = 3.004 - 0.026 COD r = -0.05 (9.8%)	BOD = 7.051 - 0.126 COD r = -0.31 (50.1%)
TOC and COD	TOC = 30.718 - 0.374 COD r = -0.34 (61.6%)	TOC = 16.936 + 0.460 COD r = 0.26 (49.9%)	TOC = 13.326 + 0.234 COD r = 0.09 (11.3%)
Alkalinity (ALK) and Sulfate (SO_4)	ALK = 102.138 + 0.270 SO_4 r = 0.36 (64.5%)	ALK = 69.465 + 0.793 SO_4 r = 0.52 (78.9%)	ALK = 375.11 - 0.495 SO_4 r = -0.84 (95.7%)

* See Figure 3A-2 for location of sampling stations.

** Correlation coefficient = $\frac{\Sigma xy}{\sqrt{\Sigma x^2 \Sigma y^2}}$; where y is the first parameter and the second parameter in each grouping

† Level at which r is significantly different from zero, using Fisher's Z test

Generally higher r values evident in the river waters of MR1 as compared to the lake waters of LM1 are primarily due to greater and consistent mixing in the river in comparison to inconsistent lake conditions. Particular relationships between organic parameters (total organic carbon and total kjeldahl nitrogen; dissolved organic carbon and total kjeldahl nitrogen; and biochemical oxygen demand and chemical oxygen demand) displayed higher r values (greater correlation) in the river waters than in the lake waters. Stratification of the lake during summer months leads to atypical values at that time which reduce the r values of most relationships. Movement of water from the river to the lake provides a different chemistry than does generation of surface runoff from within the lake watershed, producing inconsistent conditions also contributing to lower r values.

3A.3 GROUNDWATER QUALITY

Groundwaters below the site were treated in a similar fashion to surface waters, with historical data and EIA field survey data being compared with applicable Standards and Criteria. As the Memphis sand aquifers are a source for the City of Memphis water supply, groundwaters were compared with EPA Drinking Water Standards (DW Standards).[11] Since EPA Criteria for health and welfare and EPA Criteria for irrigation waters[2] were also relevant, the strictest applicable EPA criteria (Criteria) were determined for comparative purposes (Table 3A-2).

3A.3.1 LITERATURE INFORMATION

Groundwater quality in the "1400-foot" sands or Claiborne group and in the "500-foot" sands or Wilcox group have been investigated by the U.S. Geological Survey (USGS) and typical parameter concentrations have been established.[12,13,14,15] Tennessee Valley Authority (TVA) data for a shallow terrace deposit aquifer of Quaternary Age[16] is presented with the USGS data in Table 3A-23. Distinct differences are apparent in the concentrations of major ions with depth. Sodium is the dominant cation in the "1400-foot" aquifer, with calcium and sodium in greater concentration in the "500-foot"

TABLE 3A-23

TYPICAL CHEMICAL ANALYSIS OF GROUNDWATER AS REPORTED BY USGS[12,13,14,15] AND TVA[16]

Parameter*	TVA Boring Below Allen Site	"500 foot" Sand	"1400 foot" Sand
PHYSICAL			
Total Alkalinity, ppm, $CaCO_3$	334	+	+
Total Hardness, ppm, $CaCO_3$	+	48	12
Total Suspended Solids	61	+	+
Total Dissolved Solids	442	81	112
NUTRIENTS			
Nitrite-Nitrogen	0.033	+	+
Nitrate-Nitrogen	0.19	0.4	0.5
Ammonia-Nitrogen	0.07	+	+
Total Organic Nitrogen	0.10	+	+
Total Kjeldahl Nitrogen	0.17	+	+
Orthophosphate	0.21	+	+
ORGANIC			
Biochemical Oxygen Demand	1.0	+	+
Chemical Oxygen Demand	16.9	+	+
Total Organic Carbon	4.8	+	+
Dissolved Organic Carbon	4.8	+	+
Total Cyanide	<0.005	+	+
Oils	0.8	+	+
Phenol	0.009	+	+
MAJOR CATIONS			
Aluminum	0.4	0.0	0.7
Barium	0.4	+	+

(Continued)

TABLE 3A-23 (Continued)

MAJOR CATIONS (Continued)			
Calcium	96.5	10.0	2.7
Iron	16.05	0.44	0.60
Magnesium	29.5	5.5	1.3
Potassium	+	1.8	2.5
Sodium	+	8.2	35.0
MAJOR ANIONS			
Bicarbonate	+	72.0	101.0
Chloride	<2.0	3.0	2.0
Fluoride	0.25	0.0	0.1
Sulfate	75.0	3.2	5.1
TRACE ELEMENTS**			
Arsenic	0.01	+	+
Cobalt	0.01	+	+
Copper	0.01	+	+
Manganese	4.30	+	+
Strontium	0.22	+	+
Zinc	0.04	+	+

* Units expressed as mg/l unless otherwise noted.

** Boron, Berylluim, Chromium, Mercury, Molybdenum, Nickel, Lead, Tin, Selenium, Titanium and Vanadium were below detection limits at the Allen Site.

\+ Data not available

sands, and with calcium dominant in the terrace deposit. Bicarbonate is the dominant anion throughout.

3A.3.2 EIA 1978-79 FIELD SURVEY DATA

During each EIA seasonal survey, the shallow Quaternary aquifer was sampled from a test well drilled to approximately 40 feet. In-situ measurements of temperature, dissolved oxygen, conductivity and pH were made by portable meters, and duplicate grab samples for laboratory analyses were collected after pumping for a period of more than 2 hours. Again, recommended preservations were made, and delivery to analytical laboratories was completed in holding times. Parameters investigated with their detection limits and reporting units are specified in Table 3A-10. Analysis followed Standard Methods for the Examination of Water and Wastewater[8] or EPA Methods for Chemical Analysis of Water and Wastes[9] with polycyclic aromatic hydrocarbons examined following EPA Protocol.[10] Results may be found in Tables 3A-15 through 3A-19.

Exceedance frequency, presented in Table 3A-20, indicates that iron, manganese and phenol were consistently above Criteria, while barium exceeded Criteria and Drinking Water Standards in November and January surveys. Baseline groundwater conditions have been described by significant correlations above the 80 percent level between: (1) magnesium and calcium and (2) alkalinity and sulfate as shown in Table 3A-22. This illustrates the chemical stability of the aquifer waters.

A fairly constant composition of major ions in the shallow aquifer throughout the year implied a high aquifer buffering capacity as the chemistry of lake and river water, chief sources of recharge water varied considerably. EIA conducted a field survey in February 1979 to collect data which would clarify the ionic strength and buffering capacity of the aquifer. After 2 hours of pumping, duplicate samples were collected, preserved as before and analyzed for the parameters in Table 3A-23 using Standard Methods for the Examination of Water and Wastewater[8] or EPA Methods for Chemical Analysis of Water and Wastes.[9] Results of this field effort are also presented in Table 3A-24.

TABLE 3A-24

BUFFERING FIELD SURVEY

JANUARY 22, 1979

Parameters	Detection Limit	Reporting Units	Results
In-situ			
pH	0.1	units	6.6
Temperature	0.1	^{o}C	18
Conductivity	1.0	µmhos	575
Laboratory			
Alkalinity	1.0	ppm $CaCO_3$	332
Bicarbonate Alkalinity	1.0	ppm $CaCO_3$	332
Carbonate Alkalinity	1.0	ppm $CaCO_3$	0
Calcium	0.1	mg/l	86.2
Iron	0.01	mg/l	18.7
Lithium	0.1	mg/l	<0.10
Manganese	0.01	mg/l	3.51
Potassium	0.01	mg/l	1.96
Silica	0.01	mg/l	21.5
Sodium	0.01	mg/l	2.29
Conductivity	0.1	µmhos	588.5
Total Dissolved Solids	1.0	mg/l	317
Total Suspended Solids	1.0	mg/l	41

Potassium, lithium and sodium were investigated to more accurately determine the ionic strength of the aquifer waters. Some in-situ and other routine parameters were also measured to ensure that the values obtained were representative of other seasons. Calcium, manganese, iron and conductivity concentrations again illustrated pronounced chemical stability of the aquifer waters. Alkalinity was subdivided into bicarbonate and carbonate fractions to aid assessment of the bicarbonate ion concentration. From these results it was possible to apply the potassium, lithium and sodium concentrations as representative of other seasons. As a comparison, surface water buffer capacities were estimated for the Mississippi River (MR1) and Lake McKellar (LM1). A slight underestimation of the buffer capacity of surface waters is caused by lack of data for potassium, sodium and lithium.

Buffer capacity (β) was then calculated, using a procedure presented by Loewenthal and Marais,[17] from estimates of ionic strength, alkalinity, temperature and pH. The β values, thus derived, are presented in Table 3A-25, and indicate that the groundwaters have a much higher buffer capacity than the surface waters. This is caused by higher alkalinity (averaging 354.0 milligrams per liter as $CaCO_3$), higher ionic strength (averaging 12.33) and a well-adjusted pH at approximately 6.4 units. In the aquifer, solution and precipitation reactions will occur to maintain equilibrium. For instance, sufficiently acidic influent waters would result in a solution of around 300 milligrams per liter of calcium-based compounds before the average pH in the aquifer would fall by one unit.

3A.4 SEDIMENT QUALITY

Sediment quality is discussed from available literature and field survey data on both sediment chemistry and elutriate quality. A classification developed by Prater and Anderson is used to evaluate sediment quality, while elutriate quality is examined by comparison with Criteria for surface waters (discussed in Section 3A.2).

TABLE 3A-25

BUFFER CAPACITY VALUES (β)

(in ppm as $CaCO_3$/pH)

	GW1	LM1	MR1
Spring	280.9	31.20	54.74
Summer	300.29	10.561	15.916
Fall	371.91	7.96	7.73
Winter	375.23	*	*
Average	332.08	16.57	26.13

* Temperature too low for calculation of β value.

3A.4.1 LITERATURE INFORMATION

Table 3A-26 is a summary of the historical data including U.S. Geological Survey[3] and CDM/Limnetics[18] data for the Mississippi River and U.S. Army Corps of Engineers[6,19] and the Memphis and Shelby County Health Department[4] surveys on Nonconnah Creek and Lake McKellar bottom sediments.

Results of these studies indicate that in Mississippi River sediments, iron and manganese were at high levels with no pesticides above detection limits. However, pesticides were detected in the part per billion range. Lead, mercury and chromium were in high concentrations in Lake McKellar and Nonconnah Creek bottom sediments.

3A.4.2 EIA 1978-79 FIELD SURVEY DATA

Elutriate tests were performed on sediment samples obtained from Lake McKellar and the Mississippi River on October 18, 1978. This is a process designed by the U.S. Army Corps of Engineers[20] to assess the impacts of dredging on the chemistry of natural waters. Dredging site water and sediment are mixed together to approximate the dredged material slurry. The elutriate is the supernatant resulting from vigorous 30-minute shaking of 1 part bottom sediment from the dredging site with 4 parts water (volume/volume) collected from the dredging site followed by a 1-hour settling time and appropriate centrifugation and 0.45-micron filtration.

For the elutriate test, sediment was collected in duplicate using a Ponar grab sampler and duplicate water samples were collected using a Van Dorn sampler from MR1 and LM1. The elutriate was then prepared in triplicate using the method described above. Sediment, elutriate and filtered water were then subjected to analyses following Standard Methods,[8] EPA Methods[9] or EPA Protocol[18] for the parameters in Table 3A-27 with the indicated detection limits and reporting units. Results of these analyses are given in Tables 3A-28 through 3A-31.

TABLE 3A-26

LITERATURE REVIEW OF SEDIMENT CHEMISTRY DATA NEAR THE PROPOSED SITE

	USGS[3] Data for West Memphis (1973) Number of Cases: 1	CDM/Limnetics[18] Data for Mississippi River (1977) Number of Cases: 3	Memphis and Shelby County Health Department Data[4] (1975) Mc3†† Number of Cases: 1	Mc4†† Number of Cases: 1	N-1†† Number of Cases: 1	Corps of Engineers[6] Data (1977) Number of Cases: 1	Corps of Engineers Data[19] for Nonconnah Creek (1975) Highway 51-S Number of Cases: 1	Hornlake Road Number of Cases: 1
ORGANICS								
Total Organic Carbon (percent)	*	*	0.73	1.33	0.29	*	0.0008	0.001
Cyanide (mg/Kg)	*	*	*	*	*	*	0.06	0.03
NUTRIENTS (mg/Kg)								
Kjeldahl Nitrogen	*	*	*	*	*	*	0.007	0.006
Nitrite and Nitrate, total	3.0	*	*	*	*	*	*	*
Total Phosphorous	*	*	*	*	*	*	0.0096	0.006
METALS (mg/Kg)								
Arsenic	0.001	<0.04	*	*	*	*	0.0008	0.0013
Cadmium	0.0	1.7	*	*	*	*	0.0003	0.0004
Chromium	0.01	19.9	14.3**	11.3**	12.7**	*	0.0001	0.0002
Cobalt	<2.0	*	*	*	*	*	*	*
Copper	0.0	12.2	*	*	*	*	0.0006	0.0004
Iron	0.85	*	*	*	*	*	*	*
Lead	<5.0	6.5	24.0**	8.0**	28.0**	*	0.0002	0.001
Manganese	0.026	*	*	*	*	*	*	*
Mercury	0.0	0.054	0.05**	0.030*	0.047**	*	0.00004	0.00033
Selenium	0.0	*	*	*	*	*	*	*
Zinc	0.006	58.6	*	*	*	*	*	*

* Data not available

† Concentration less than detection limit

** Originally reported as mg/l and converted to mg/Kg on the assumption of unitary density.

†† See Figure 3A-1 for station location

(Continued)

TABLE 3A-26 (Continued)

	USGS[3] Data for West Memphis (1973) Number of Cases: 1	CDM/Limnetics[18] Data for Mississippi River (1977) Number of Cases: 3	Memphis and Shelby[4] County Health Department Data (1975) Mc3†† Number of Cases: 1	Mc4†† Number of Cases: 1	N-1†† Number of Cases: 1	Corps of Engineers[6] Data (1977) Number of Cases: 1	Corps of Engineers Data[19] for Nonconnah Creek (1975) Highway 51-S Number of Cases: 1	Hornlake Road Number of Cases: 1
PESTICIDES (ppm)								
Lindane	*	<0.5	*	*	*	†	*	*
Heptachlor	*	<0.5	*	*	*	†	*	*
Aldrin	*	<0.5	*	*	*	†	*	*
Heptachlor epoxide	*	<0.5	*	*	*	†	*	*
Dieldrin	*	<0.5	*	*	*	0.00187	*	*
Endrin	*	<0.5	*	*	*	†	*	*
Chlordane	*	<0.5	0.640	0.010	0.032	0.000826	*	*
DDE	*	<0.5	0.023	0.018	0.030	0.002304	*	*
DDD (TDE)	*	<0.5	0.087	0.062	0.056	0.001565	*	*
DDT	*	<0.5	0.026	*	0.036	0.002089	*	*
Demeton	*	*	0.035	*	*	*	*	*
Diuron	*	*	0.073	*	*	*	*	*
BHC	*	*	*	*	0.013	*	*	*
Atrazine	*	*	*	*	*	*	*	*
Diazinon	*	*	*	*	*	*	*	*
Dieldrin	*	*	0.023	0.010	0.032	0.00187	*	*
Methyloxychlor	*	*	*	*	*	0.018435	*	*
Toxaphene	*	*	*	*	*	0.018435	*	*
PCB (AR 1254)	*	*	*	*	*	0.001304	*	*
Organophosphates	*	*	*	*	*	†	†	†

* Data not available

† Concentration less than detection limit

** Originally reported as mg/l and converted to mg/Kg on the assumption of unitary density.

†† See Figure 3A-1 for station location

TABLE 3A-27

CHEMICAL PARAMETERS MEASURED, DETECTION LIMITS, REPORTING UNITS AND SAMPLING LOCATIONS FOR SEDIMENT SAMPLES COLLECTED ON OCTOBER 18, 1978

Parameters	Detection Limits		Reporting Units		Parameters Determined		Filtered Water	Sampling Stations	
	Sediment Chemistry	Elutriate* Chemistry	Sediment Chemistry	Elutriate* Chemistry	Sediment Chemistry	Elutriate Chemistry		MR-1	LM-1
PHYSICAL									
pH (units)	**	0.1		units	X	X	X	X	X
Total Solids	**		mg/g		X			X	X
Total Volatile Residue	**		mg/g		X			X	X
Total Dissolved Solids	**	1.0		mg/l		X		X	X
Oil and Grease	**	0.05	mg/g	mg/l	X	X		X	X
NUTRIENTS									
Total Kjeldahl Nitrogen	**		mg/g		X			X	X
Ammonia Nitrogen	**	0.01	mg/g	mg/l	X	X	X	X	X
Phosphorus, total	**	0.01	mg/g	mg/l	X	X	X	X	X
Ortho phosphate	**			mg/l		X	X	X	X
ORGANICS									
BOD (5 day)	**	1.0	mg/Kg	mg/l	X	X		X	X
COD	**	1.0	mg/Kg	mg/l	X	X		X	X
TOC	**	1.0	percent	mg/l	X	X		X	X
Phenols	**	0.001	mg/g	mg/l	X	X		X	X
MAJOR ANIONS									
Cyanide, total	**	0.005	mg/g	mg/l	X	X		X	X
MAJOR CATIONS									
Iron, total	**		mg/g		X			X	X
TRACE METALS									
Arsenic	**		mg/g		X			X	X
Cadmium		0.001	mg/g	mg/l	X	X	X	X	X
Chromium	**		mg/g		X			X	X
Copper	**	0.01	mg/g	mg/l	X	X	X	X	X
Lead		0.01	mg/g	mg/l	X	X	X	X	X
Manganese	**	0.01	mg/g	mg/l	X	X	X	X	X
Mercury	**	0.0002	mg/g	mg/l	X	X	X	X	X
Zinc	**	0.01	mg/g	mg/l	X	X	X	X	X
POLYNUCLEAR AROMATIC HYDROCARBONS									
Benzo(a)anthracene (1,2-benzanthracene)	0.005	0.01	ppm	ppm	X	X		X	X
Benzo(a)pyrene (3,4-benzopyrene)	0.005	0.01	ppm	ppm	X	X		X	X
3,4-benzofluoranthene	0.005	0.01	ppm	ppm	X	X		X	X
Benzo(k)fluoranthane (11,12-benzofluoranthene)	0.005	0.01	ppm	ppm	X	X		X	X
Chrysene	0.005	0.01	ppm	ppm	X	X		X	X
Acenaphthylene	0.005	0.01	ppm	ppm	X	X		X	X
Anthracene	0.005	0.01	ppm	ppm	X	X		X	X
Benzo(ghi)perylene (1,12-benzoperylene)	0.005	0.01	ppm	ppm	X	X		X	X
Fluroene	0.005	0.01	ppm	ppm	X	X		X	X
Phenathrene	0.005	0.01	ppm	ppm	X	X		X	X
Dibenzo(a,h)anthracene (1,2,5,6-dibenzanthracene)	0.005	0.01	ppm	ppm	X	X		X	X
Indeno(1,2,3-cd)pyrene (2,3-o-phenylenepyrene)	0.005	0.01	ppm	ppm	X	X		X	X
Pyrene	0.005	0.01	ppm	ppm	X	X		X	X
Napthalene	0.005	0.01	ppm	ppm	X	X		X	X
Fluoranthene	0.005	0.01	ppm	ppm	X	X		X	X

* Detection Limits and Reporting Units for Filtered Water are equivalent with these for Elutriate Chemistry.

** Detection limits depend upon the constitutents of the solid sample matrix. In all cases except Cyanide, which had a consistent detection limit of 0.0002 mg/g, concentrations were above detection limits.

TABLE 3A-28

CHEMISTRY OF SEDIMENT COLLECTED FROM THE MISSISSIPPI RIVER AND LAKE MCKELLAR BY EIA ON OCTOBER 18, 1978

	Station*							
	MR-1				LM-1			
Parameter**	No. of Values	Mean	Std. Dev.	Max.	No. of Values	Mean	Std. Dev.	Max.
PHYSICAL								
Total Solids	2	0.9429	0.0158	0.9541	2	0.4493	0.0319	0.4719
Total Volatile Residue	2	0.0036	0.0	0.0036	2	0.077	0.003	0.079
Oil and Grease	2	0.081	0.084	0.041	2	0.7	0.4	1.0
NUTRIENTS								
Total Kjeldahl Nitrogen	2	0.105	0.021	0.120	2	1.71	0.19	1.84
Ammonia Nitrogen	2	0.041	0.009	0.048	2	0.210	0.0	0.210
Phosphorus, total	2	0.072	0.018	0.085	2	0.285	0.042	0.315
ORGANICS								
BOD, 5 day (mg/Kg)	2	565.0	63.6	610.0	2	4100.0	1414.2	5100.0
COD (mg/Kg)	2	1780.0	42.4	1810.0	2	3155.0	403.1	3440
TOC (percent)	2	0.146	0.105	0.220	2	0.685	0.077	0.74
Phenols	2	0.000079	0.000012	0.000087		0.0027	0.0004	0.0003
MAJOR ANIONS								
Cyanide, total	2	<0.0002	†	<0.0002	2	<0.0002	†	<0.0002
MAJOR CATIONS								
Iron, total	2	3.29	0.23	3.46	2	20.80	0.14	20.90
OTHER METALS								
Arsenic	2	0.006	0.0	0.006	2	0.053	0.001	0.054
Cadmium	2	0.0001	0.0	0.0001	2	0.0009	0.0	0.0009
Chromium	2	0.0027	0.0001	0.0028	2	0.0160	0.0004	0.0164
Copper	2	0.0015	0.0002	0.0016	2	0.0206	0.0001	0.0207
Lead	2	0.0033	0.0004	0.0035	2	0.0323	0.0004	0.0325
Manganese	2	0.0625	0.0064	0.0670	2	0.945	0.106	1.020
Mercury	2	0.0015	0.0007	0.0002	2	0.0009	0.0002	0.0011
Zinc	2	0.015	0.001	0.016		0.016	0.001	0.106

* See Figure 3A-2 for location of sampling stations

** Reporting units in mg/g unless otherwise noted

† Cannot be calculated due to the occurrence of non-detectable concentrations.

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TABLE 3A-29

CONCENTRATIONS OF POLYCYCLIC AROMATIC HYDROCARBON IN MR1 AND LM1 SEDIMENT

(parts per million on a dry weight basis)

Parameter	MR1* No. of Replicates	MR1* Mean	MR1* Maximum	LM1* No. of Replicates	LM1* Mean	LM1* Maximum
Benzo(a)anthracene	6	<0.005	<0.005	6	<0.005	<0.005
Benzo(a)pyrene	6	<0.005	<0.005	6	0.038	0.083
3,4-benzo fluoranthene	6	<0.005	<0.005	6	<0.005	<0.005
Benzo(K)fluoranthene	6	<0.005	<0.005	6	<0.005	<0.005
Chrysene	6	<0.005	<0.005	6	0.029	0.063
Acenaphthylene	6	<0.005	<0.005	6	<0.005	<0.005
Anthracene	6	<0.005	<0.005	6	0.073	0.087
Benzo(ghi)perylene	6	<0.005	<0.005	6	<0.005	<0.005
Flourene	6	<0.005	<0.005	6	0.004	0.023
Phenathrene	6	<0.005	<0.005	6	<0.005	<0.005
Dibenzo(a,b)anthracene	6	<0.005	<0.005	6	<0.005	<0.005
Indeno(1,2,3-cd)pyrene	6	<0.005	<0.005	6	<0.005	<0.005
Pyrene	6	<0.005	<0.005	6	0.049	0.097
Fluoranthene	6	<0.005	<0.005	6	<0.005	<0.005
Napthalene	6	<0.019	<0.058	6	0.035	0.073

* Refer to Figure 3A-2 for location of sampling stations.

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November 1979

TABLE 3A-30

ELUTRIATE CHEMISTRY FOR SEDIMENT COLLECTED BY EIA ON OCTOBER 18, 1978

Parameter**	Stations* MR-1 No. of Values	MR-1 Mean	MR-1 Std. Dev.	MR-1 Max.	LM-1 No. of Values	LM-1 Mean	LM-1 Std. Dev.	LM-1 Max.
PHYSICAL								
pH (units)								
Total Dissolved Solids	6	259.8	28.3	292.0	6	236.2	20.5	264.0
Oil and Grease	6	0.28	0.19	0.50	6	0.18	0.13	0.30
NUTRIENTS								
Ammonia Nitrogen	6	3.15	3.43	7.80	6	0.83	0.47	1.49
Phosphorus, total	6	0.074	0.031	0.136	6	0.051	0.087	0.229
Orthophosphate	6	0.042	0.013	0.068	6	0.010	0.006	0.018
ORGANICS								
BOD, 5 day (mg/Kg)	6	1.25	†	2.00	6	5.17	3.43	12.00
COD (mg/Kg)	6	8.5	3.2	12.0	6	28.2	5.9	38.0
TOC (percent)	6	20.3	2.3	23.0	6	18.0	2.4	21.0
Phenols	6	0.006	0.001	0.009	6	0.005	0.002	0.009
MAJOR ANIONS								
Cyanide, total	6	<0.005	†	<0.005	6	<0.005	†	<0.005
OTHER METALS								
Cadmium	6	0.001	†	0.001	6	0.0016	†	0.004
Copper	6	0.007	0.001	0.008	6	0.008	0.001	0.009
Lead	6	0.012	†	0.012	6	0.010	†	0.011
Manganese	6	0.028	0.009	0.044	6	2.170	0.431	2.790
Mercury	6	<0.0002	†	<0.0002	6	0.0003	†	0.0009
Zinc	6	0.014	0.001	0.015	6	0.010	0.006	0.018

* See Figure 3A-2 for location of sampling stations.

** All reporting units in mg/l unless otherwise noted.

† Cannot be calculated due to the occurrence of nondetectable concentrations.

TABLE 3A-31

WATER CHEMISTRY OF FILTERED SITE WATER USED IN ELUTRIATE TEST OF MISSISSIPPI RIVER AND LAKE MCKELLAR SEDIMENT

Parameter (mg/l unless otherwise noted)	Station			
	MR-1		LM-1	
	No. of Values	Mean	No. of Values	Mean
pH (units)	2	7.15	2	7.5
Ammonia-nitrogen	2	0.145	2	0.445
Orthophosphate	2	0.102	2	0.070
Cadmium, total	2	<0.001	2	<0.001
Copper, total	2	0.009	2	0.011
Lead, total	2	<0.01	2	<0.01
Manganese, total	2	<0.063	2	0.59
Mercury, total	2	<0.003	2	<0.002
Zinc, total	2	0.042	2	0.042

Markedly higher concentrations of all detectable parameters were found in LM1 sediment. Prater/Anderson's[21] classification was used as a means of comparing sediments (Table 3A-32), with 15 percent of all parameters falling into the heavily polluted category in LM1 sediment, whereas no parameters were in this category at MR1.

Of the polycyclic aromatic hydrocarbons investigated, only napthalene was detected in MR1 sediments, while benzo (a) pyrene, chrysene, anthracene, fluorene, pyrene and fluoranthene were detected in sediments from LM1. Levels of these compounds were between three and nineteen times the detection limit of 0.005 parts per million (Table 3A-28).

Elutriate from both MR1 and LM1 sediments were of a similar quality as that normally found in lake and river waters and were at concentrations which were mere fractions of those found in the parent sediment. Except for ammonia-nitrogen, phenols and manganese, concentrations were not substantially different from those of the filtered water. Phenol and cadmium exceeded Criteria for surface waters at both locations, while manganese at LM1 and ammonia-nitrogen at MR1 were also in excess. No polycyclic aromatic hydrocarbons were found in the elutriates at either location. This suggests that although dredging may have a localized and immediate effect on river and lake oxygen demands, its impact is of the same magnitude as other processes acting on the aquatic system.

TABLE 3A-32

CLASSIFICATION OF MEMPHIS SEDIMENT BY PRATER/ANDERSON METHOD[21]

Parameter	MR-1 Mean Concentration	MR-1 Prater/Anderson Classification	LM-1 Mean Concentration	LM-1 Prater/Anderson Classification
Oil and Grease	0.081 mg/g	Nonpolluted	0.7 mg/g	Nonpolluted
Total Kjeldahl Nitrogen	0.105 mg/g	Nonpolluted	1.71 mg/g	Moderately polluted
Ammonia Nitrogen	0.041 mg/g	Nonpolluted	0.21 mg/g	Heavily polluted
Phosphorus, total	0.072 mg/g	Nonpolluted	0.285 mg/g	Nonpolluted
Chemical Oxygen Demand	1780 mg/Kg	Nonpolluted	3155 mg/Kg	Nonpolluted
Cyanide	<0.0002 mg/g	Nonpolluted	<0.0002 mg/g	Nonpolluted
Iron	3.29 mg/g	Nonpolluted	20.8 mg/g	Moderately polluted
Arsenic	0.006 mg/g	Moderately polluted	0.053 mg/g	Moderately polluted
Chromium	0.0027 mg/g	Nonpolluted	0.016 mg/g	Nonpolluted
Copper	0.0015 mg/g	Nonpolluted	0.0206 mg/g	Nonpolluted
Lead	0.0033 mg/g	Nonpolluted	0.0323 mg/g	Nonpolluted
Manganese	0.0625 mg/g	Nonpolluted	0.945 mg/g	Heavily polluted
Mercury	0.00015 mg/g	Nonpolluted	0.0009 mg/g	Nonpolluted
Zinc	0.015 mg/g	Nonpolluted	0.016 mg/g	Nonpolluted

PERCENTAGE OF PARAMETER IN CLASSIFICATION CATEGORIES

	Nonpolluted	Moderately Polluted	Heavily Polluted
MR-1	93	7	0
LM-1	64	21	15

APPENDIX 3B
DEFINITION OF TERMS

Following are definitions or explanations of terms used in Section 3.3.2, Groundwater. Definitions were adopted from Lohman, S. W., Groundwater Hydraulics, U.S. Geological Survey Professional Paper 708, 1972, and from Campbell, M. D., and Lehr, J. H., Water Well Technology, McGraw-Hill Book Company, 1974.

Coefficient of Storage -- The volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head. This definition indicates that the storage coefficient is dimensionless.

Hydraulic Conductivity -- (Replaces the old term of "coefficient of permeability"). A medium has a hydraulic conductivity of unit length per unit time if it will transmit in unit time a unit volume of groundwater at the prevailing viscosity through a cross-section of unit area, measured at right angles to the direction of flow, under a hydraulic gradient of unit change in head through unit length flow. Hydraulic conductivity is given in feet per day or meters per day.

Permeability -- The permeability of a rock or soil is a measure of its ability to transmit fluid under a hydropotential gradient.

Specific Capacity -- The discharge of the well expressed as the rate of yield per unit of drawdown. Units are generally gallons per minute per foot of drawdown.

Specific Yield -- Specific yield of a rock or soil is the ratio of the volume of water which after being saturated it will yield by gravity to its own volume. This ratio is usually expressed as a percentage.

Transmissibility -- Hydraulic conductivity multiplied by thickness of the aquifer. Units used are gallons per day per foot. See definition of transmissivity.

Transmissivity -- (Replaces the term "transmissibility," Note: 1 gallon per day per foot = 0.134 square feet per day.) The rate at which water of a prevailing kinematic viscosity is transmitted through a unit width of the aquifer under a unit hydraulic gradient. Units used are square feet per day or square meters per day.

APPENDIX 3C

METEOROLOGICAL DATA CORRESPONDING TO HI-VOL COLLECTION DAYS

TABLE 3C-1

METEOROLOGICAL DATA CORRESPONDING TO HI-VOL (PARTICULATE AND SULFATE) COLLECTION DAYS

Station: Memphis (International Airport), Tennessee

Collection Date	Weather Types*	Daily Precipitation Water Equivalent (inches)	Wind Direction (°)	Average Daily Wind Speed (mph)	Mean Daily Relative Humidity (%)
2/19/78		0.0	20	2.9	51
2/25/78	4	<0.01	10	8.5	44
3/3/78	1,8	<0.01	360	13.2	69
3/9/78	1,8	0.16	340	8.6	79
3/15/78	1,3,8	0.50	30	8.6	68
3/21/78	1,3	0.34	250	9.1	64
3/27/78		0.0	320	9.1	49
3/29/78		0.0	300	6.8	36
4/8/78	3	<0.01	230	5.5	68
4/14/78		0.0	110	8.5	45
4/20/78		0.0	300	11.9	58
4/26/78		0.0	350	15.7	36
5/2/78		0.0	40	11.4	58
5/8/78	1,3	0.41	200	9.1	81
5/14/78		0.0	290	14.8	46
5/20/78	3	0.39	280	5.3	82
5/26/78	1,8	0.0	130	4.6	68
6/1/78	1,3	0.52	160	7.3	67
6/8/78	1,3	0.03	300	7.1	89
6/13/78		0.0	30	8.8	52
6/19/78	1	0.0	160	6.2	83
6/26/78		0.0	210	10.6	70
7/1/78		0.0	220	5.0	67
7/7/78	1,3,8	0.20	150	8.5	81
7/13/78	3,8	<0.01	190	7.8	70
7/19/78		0.0	130	3.9	66
7/25/78		0.02	230	6.9	74
7/31/78	3,8	0.0	280	7.5	74
8/6/78	1,8	0.01	10	6.0	79
8/12/78	3	0.18	210	5.6	81
8/18/78		0.0	200	7.3	70
8/24/78	8	0.0	190	4.6	63
8/30/78	1	0.11	210	9.9	97
9/5/78	1,8	0.0	40	5.0	75
9/11/78	1,8	0.32	210	5.8	88
9/17/78		0.0	200	8.1	81
9/23/78		0.0	20	7.9	70
9/29/78	8	0.0	190	3.3	75

* Weather types: 1 Fog, 3 Thunderstorm, 4 Ice Pellets, 8 Smoke/Haze

(Continued)

TABLE 3C-1 (Continued)

Collection Date	Weather Types*	Daily Precipitation Water Equivalent (inches)	Wind Direction (°)	Average Daily Wind Speed (mph)	Mean Daily Relative Humidity (%)
10/5/78		<0.01	250	9.1	63
10/11/78		0.0	200	9.2	60
10/17/78		0.0	60	5.2	68
10/23/78		0.0	350	7.8	77
10/29/78		0.0	40	5.3	58
11/10/78		0.0	170	6.6	49
11/16/78	1,8	1.91	80	8.2	82
11/22/78	1,8	0.79	90	5.8	76
11/28/78		0.0	10	6.5	56
12/4/78		0.0	290	8.9	62
12/10/78		0.0	220	4.5	54
12/16/78	1	0.08	270	9.4	71
12/22/78		0.0	220	7.1	51
12/28/78		0.0	120	9.6	42
1/3/79		0.0	220	5.2	55
1/15/79		0.0	140	6.5	50
1/21/79	1	0.05	300	16.5	71
1/27/79	1,8	0.01	270	11.5	74
2/14/79**		0.00	220	20.0	52
3/28/79	1	<0.01	220	13.0	50
6/8/79		0.0	220	9.0	54
6/20/79		0.0	220	12.0	50

* Weather types: 1 Fog, 3 Thunderstorm, 4 Ice Pellets, 8 Smoke/Haze

** Partial climatological data for February through June 1979 obtained from the National Weather Service in Memphis. Official climatological summaries have not been received from the National Climatic Center as of this writing. The information will be included in the update report.

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APPENDIX 3D

TERRESTRIAL ECOLOGY FIELD INVESTIGATIONS

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3D.1 INTRODUCTION

Field investigations included vegetation and wildlife surveys within 3 kilometers of the IFGDP site center. Since field samples were collected and reported in metric units, a table of metric to English unit conversion factors is included in Table 3D-1. For convenience, vegetation and wildlife investigations are discussed separately.

3D.2 VEGETATION SURVEY INVESTIGATIONS

Vegetation data were obtained, including habitat types, importance values of dominant species in these types, presence and location of endangered species and species lists. Species lists and habitat of occurrence are included in Table 3D-2. Field activities are included in Table 3D-3. Other data are included in Section 3.6. Vegetation types and the approximate areal extent of each type were visually mapped during flying, driving and walking inspections of the area. During these inspections, a species list of each habitat type was prepared, and locations for any endangered species were noted. Each site habitat type was sampled by using quantitative techniques. These techniques consisted of evaluating nested circular plots of overstory, understory, shrubs and vines and ground cover.

Overstory (if present)

Four 400-square-meter plots

Data collected -- For each stem 6.5 inches in diameter at breast height (DBH - approximately 4.5 feet above the ground) and larger, recorded the species and DBH to nearest 0.1 inch.

Understory (if present)

Four 200-square-meter plots

Data collected -- For each stem 0.5 inch DBH and larger, recorded the species and DBH to the nearest inch, i.e., 1-, 2-, 3-, 4-, 5- and 6-inch categories.

TABLE 3D-1

CONVERSION FACTORS

To Convert From	To	Multiply by
Length		
millimeters (mm)	inches (in.)	0.03937
centimeters (cm)	inches (in.)	0.3937
inches (in.)	centimeters (cm)	2.54
meters (m)	feet (ft)	3.2808
feet (ft)	meters (m)	0.3048
kilometers (km)	miles (mi)	0.62137
miles (mi)	kilometers	1.60935
Area		
square centimeters (cm^2)	square inches ($in.^2$)	0.15500
square inches ($in.^2$)	square centimeters (cm^2)	6.4516
square feet (ft^2)	square meters (m^2)	0.09292
square meters (m^2)	hectares (ha)	0.0001
hectares (ha)	acres (A)	2.471
square kilometers (km^2)	square miles (mi^2)	0.18610
square miles (mi^2)	square kilometers (km^2)	2.5900

TABLE 3D-2

PLANT SPECIES OBSERVED WITHIN 3 KM OF THE IFGDP SITE

Scientific Name	Common Name	Relative Abundance in Shelby County*	Bottomland Forest Mature	Bottomland Forest Successional	Meadow	Soybean Field
LARGE TREES						
Acer negundo	Boxelder	C	x	x	x	
Acer rubrum	Red maple	A		x		
Acer saccharinum	Silver maple	A	x	x	x	
Carya illinoensis	Pecan	C		x		
Celtis laevigata	Sugarberry	C	x	x	x	
Celtis occidentalis	Hackberry	C	x	x	x	
Fraxinus americana	White ash	C			x	
Fraxinus pennsylvanica var. subintegerrima	Green ash	A	x	x	x	
Gleditsia aquatica	Water locust	C			x	
Gleditsia triacanthos	Honey locust	C		x	x	
Juglans nigra	Black walnut	A	x			
Platanus occidentalis	Sycamore	C	x	x	x	
Populus deltoides	Cottonwood	A	x	x	x	
Prunus serotina	Black cherry	C		x		
Robinia pseudoacacia	Black locust	C			x	
Salix nigra	Black willow	A	x	x	x	
Taxodium distichum	Bald cypress	U		x		
Ulmus americana	American elm	U	x			
Ulmus rubra	Slippery elm	C	x	x		
SMALL TREES						
Ailanthus altissima	Tree-of-heaven	U		x	x	
Cornus florida	Flowering dogwood	A	x	x	x	
Diospyros virginiana	Persimmon	C		x		

* Relative Abundance Where: A = Abundant, C = Common, U = Uncommon, V = Very Uncommon

(Continued)

TABLE 3D-2 (Continued)

Scientific Name	Common Name	Relative Abundance in Shelby County*	Bottomland Forest Mature	Bottomland Forest Successional	Meadow	Soybean Field
Forestiera acuminata	Swamp privet	U	x		x	
Gymnocladus dioica	Kentucky coffee tree	U	x	x		
Morus rubra	Red mulberry	C	x	x	x	
Ostrya virginiana	Hop hornbeam	C		x		
SHRUBS AND VINES						
Amorpha fruticosa	False indigo	U			x	
Ampelopsis arborea	Pepper vine	A	x	x	x	
Ampelopsis cordata	Heart-leaf ampelopsis	C	x			
Asimina triloba	Pawpaw	C	x			
Berchemia scandens	Supple jack	C	x		x	
Brunnichia cirrhosa	Buckwheat vine	C			x	
Campsis radicans	Trumpet creeper	A	x	x	x	
Cardiospermum halicacabum	Balloon vine	U		x	x	
Cephalanthus occidentalis	Buttonbush	C		x		
Cocculus carolinus	Coral beads	U	x		x	
Cornus stricta	Stiff dogwood	C	x			
Cuscuta umbrosa	Dodder	V	x			
Cynanchum laeve	Honey vine	A			x	x
Eclipta alba	Yerba de tajo	C	x			
Forestiera ligustrina	Swamp privet	V			x	
Ipomoea hederacea	Ivy-leaved morning glory	A	x	x	x	
Ipomoea hederacea var. integriuscula	Morning glory	A		x	x	
Ipomoea lacunosa	Small flowered morning glory	A			x	
Ipomoea pandurata	White potato vine	C			x	
Ligustrum vulgare	Privet	C		x		
Lindera benzoin	Spicebush	C	x			

* Relative Abundance Where: A = Abundant, C = Common, U = Uncommon, V = Very Uncommon

(Continued)

TABLE 3D-2 (Continued)

Scientific Name	Common Name	Relative Abundance in Shelby County*	Bottomland Forest Mature	Bottomland Forest Successional	Meadow	Soybean Field
Lonicera japonica	Japanese honeysuckle	A	x	x	x	
Menispermum canadense	Canada moon vine	U	x		x	
Mikania scandens	Climbing false hempweed	C		x	x	
Parthenocissus quinquefolia	Virginia creeper	A	x	x	x	
Rhus radicans	Poison ivy	A	x	x	x	
Rubus allegheniensis	Blackberry	U		x	x	
Rubus phoenicolasius	Red raspberry	V		x	x	
Rubus procumbens	Dewberry	C		x		
Rubus trivialis	Dewberry	C	x		x	
Salix interior	Sandbar willow	C		x	x	
Sambucus canadensis	Elderberry	A	x	x		
Sicyos angulatus	Bur cucumber	C	x	x	x	
Smilax bona-nox	Bristly greenbrier	C	x		x	
Smilax hispida	Hispid greenbrier	C	x			
Smilax rotundifolia	Greenbrier	A	x		x	
Vitis aestivalis	Summer grape	C	x	x	x	
Vitis cinerea	Fox grape	C		x	x	
Vitis labrusca	Fox grape	U	x			
Vitis palmata	Grape	C		x		
Vitis rotundifolia	Muscadine	C	x	x	x	
GRASS-LIKE PLANTS						
Agrostis hyemalis	Rough hair grass	C			x	
Andropogon virginicus	Broomsedge	A			x	
Aristida sp.	Threeawn grass	U			x	
Arundinaria gigantea	Cane	C	x			
Brachiaria platyphylla	Flat-leaved brachiaria	V			x	
Bromus sp.	Brome grass	C			x	
Carex sp.	Sedge	A	x	x	x	x
Cenchrus longispinus	Sandbur	V			x	
Cynodon dactylon	Bermuda grass	A			x	x

* Relative Abundance Where: A = Abundant, C = Common, U = Uncommon, V = Very Uncommon

(Continued)

TABLE 3D-2 (Continued)

Scientific Name	Common Name	Relative Abundance in Shelby County*	Bottomland Forest Mature	Bottomland Forest Successional	Meadow	Soybean Field
Cyperus erythrorhizos	Red nutgrass	A		x	x	
Cyperus esculentus	Yellow nutgrass	A			x	x
Cyperus lancastriensis	Lancaster's sedge	U			x	
Cyperus odoratus	Coarse sedge	C			x	
Cyperus ovularis	Globose sedge	A	x			
Cyperus pseudovegetus	Nut grass	C		x		
Cyperus strigosus	Straw colored sedge	A		x	x	x
Digitaria ischaemum	Purple crab grass	C			x	
Digitaria sanguinalis	Crab grass	A			x	
Echinochloa microstachya	Barnyard grass	C			x	
Echinochloa occidentalis	Barnyard grass	C			x	
Eleusine indica	Wire grass	A			x	
Elymus virginicus	Virginia wild rye	C		x	x	
Eragrostis cilianensis	Stink grass	C			x	
Eragrostis hirsuta	Love grass	U			x	
Eragrostis hypnoides	Creeping love grass	U			x	
Eragrostis pectinacea	Love grass	U			x	
Eragrostis pilosa	Love grass	C			x	
Eragrostis refracta	Love grass	V			x	
Eragrostis spectabilis	Love grass	A			x	
Festuca octoflora	Slender fescue	U			x	
Frochlichia gracilis	Cotton grass	U			x	
Leersia lenticularis	Cut grass	C	x			
Leersia oryzoides	Cut grass	C	x			
Leersia virginica	Cut grass	C	x			
Leptochloa attenuata	Slender grass	V			x	
Leptochloa filiformis	Slender grass	C			x	
Leptochloa panicoides	Slender grass	V			x	
Panicum agrostoides	Red top panic grass	C		x	x	
Panicum clandestinum	Corn grass	C		x	x	
Panicum dichotomiflorum	Spreading witch grass	A		x	x	
Panicum scoparium	Velvety panic grass	C		x		
Paspalum ciliatifolium	Hairy paspalum	U			x	
Paspalum dilatatum	Dallis grass	A			x	

* Relative Abundance Where: A = Abundant, C = Common, U = Uncommon, V = Very Uncommon

(Continued)

TABLE 3D-2 (Continued)

Scientific Name	Common Name	Relative Abundance in Shelby County*	Bottomland Forest Mature	Bottomland Forest Successional	Meadow	Soybean Field
Paspalum laeve	Field paspalum	C			x	
Poa compressa	Canada bluegrass	A			x	
Poa pratensis	Kentucky bluegrass	A			x	
Setaria geniculata	Foxtail grass	A			x	
Setaria viridis	Green foxtail grass	C			x	
Sorghum halepense	Johnson grass	A	x	x	x	x
Sporobolus cryptandrus	Sand dropseed	U			x	
Tridens flavus	Purpletop	A			x	
Triplasis purpurea	Sand grass	V			x	
Typha latifolia	Cattail	U		x		
FORBS						
Acalypha rhomboidea	Three-seeded mercury	C	x	x	x	
Acalypha virginica	Mercury-weed	A			x	
Amaranthus arenicola	Amaranth	C		x	x	
Amaranthus hybridus	Pigweed	C			x	
Amaranthus spinosus	Thorny amaranth	C			x	
Amaranthus tamariscinus	Water hemp	C			x	
Ambrosia artemisiifolia	Ragweed	A			x	
Ambrosia trifida	Great ragweed	A	x	x	x	
Ammania coccinea	Long-leaved ammania	U		x	x	
Aster dumosus	Bushy aster	U			x	
Aster ericoides	Heath-like aster	U			x	
Aster pilosus	Hairy aster	A			x	
Aster simplex	Panicled aster	C			x	
Aster simplex var. interior	Panicled aster	C	x	x		
Bidens bipinnata	Spanish needles	C		x		
Bidens frondosa	Beggar ticks	A		x		
Bidens polylepis	Beggar ticks	A		x		
Boehmeria cylindrica	False nettle	A	x	x		
Campanula americana	Bluebell	U	x			
Cassia fasciculata	Partridge pea	A			x	
Cassia nictitans	Wild sensitive plant	A			x	

* Relative Abundance Where: A = Abundant, C = Common, U = Uncommon, V = Very Uncommon

(Continued)

TABLE 3D-2 (Continued)

Scientific Name	Common Name	Relative Abundance in Shelby County*	Bottomland Forest Mature	Bottomland Forest Successional	Meadow	Soybean Field
Cerastium sp.	Chickweed	C			x	
Chenopodium album	Lamb's quarters	A	x	x	x	
Cicuta maculata	Water hemlock	U		x		
Cirsium discolor	Bull thistle	C			x	
Commelina virginica	Virginia dayflower	C	x	x		
Conyza canadensis	Horseweed	A			x	x
Croton capitatus	Wooly croton	C			x	
Croton glandulosus	Grandular croton	C			x	
Cycloloma atriplicifolium	Winged pigweed	U			x	
Datura stramonium	Jimson weed	U				x
Desmanthus illinoensis	Desmanthus	U			x	
Desmodium dillenii	Tick trefoil	C			x	
Dicliptera brachiata	Dicliptera	C	x			
Diodia teres	Rough button weed	C			x	
Diodia virginiana	Large button weed	A			x	
Duchesnea indica	Indian strawberry	A	x			
Erigeron philadelphicus	Fleabane daisy	C		x		
Erigeron strigosus	Fleabane daisy	A		x		
Eupatorium coelestinum	Mist flower	C	x			
Eupatorium incarnatum	Pink thoroughwort	C	x			
Eupatorium rugosum	White snakeroot	C	x			
Eupatorium serotinum	Late thoroughwort	C	x			
Euphorbia chamaesyce	Prostrate spurge	A			x	x
Euphorbia maculata	Spotted spurge	A			x	x
Euphorbia supina	Creeping spurge	C			x	x
Galium circaezans	Bedstraw	C	x	x		
Geranium carolinianum	Wild geranium	C	x		x	
Geum sp.	Avens					
Glycine max	Soybean	C				x
Helianthus annuus	Annual sunflower	A	x		x	
Helianthus hirsutus	Sunflower	C			x	
Helianthus petiolaris	Sunflower	C			x	
Heterotheca latifolia	Golden aster	A		x	x	

* Relative Abundance Where: A = Abundant, C = Common, U = Uncommon, V = Very Uncommon

(Continued)

TABLE 3D-2 (Continued)

Scientific Name	Common Name	Relative Abundance in Shelby County*	Bottomland Forest Mature	Bottomland Forest Successional	Meadow	Soybean Field
Hibiscus nilitaris	Mallow	C			x	
Hydrophyllum sp.	Waterleaf	U	x	x		
Iva annua	Ragweed	C			x	
Lactuca canadensis	Wild lettuce	A	x	x	x	
Lactuca floridana	Wild lettuce	C	x			
Laportea canadensis	Stinging nettle	C	x			
Lepidium virginicum	Pepper weed	A	x		x	
Lespedeza cuneata	Lespedeza	A			x	
Lobelia nuttallii	Nuttall's lobelia	V			x	
Lycopus virginicus	Water hoarhound	C			x	
Melilotus alba	White sweet clover	C			x	
Mollugo verticillata	Carpetweed	A			x	
Oenothera biennis	Evening primrose	A			x	
Oenothera laciniata	Evening primrose	A			x	
Oenothera speciosa	Evening primrose	C			x	
Oxalis dillenii	Wood sorrel	A			x	
Oxalis stricta	Yellow wood sorrel	A			x	
Physalis angulatus	Ground cherry	C			x	
Phytolacca americana	Pokeweed	A	x	x		
Pilea pumila	Clearwood	C	x	x		
Polygonum lapathifolium	Smartweed	C		x	x	
Polygonum longistylum	Long-styled smartweed	U			x	
Polygonum pennsylvanicum	Pennsylvania persicaria	C			x	
Polygonum scandens	Climbing false buckwheat	C	x	x	x	
Prunella vulgaris	Selfheal	A			x	
Ranunculus abortivus	Small-flowered crowfoot	C		x		x
Ranunculus acris	Buttercup	C			x	x
Rumex crispus	Curly dock	C		x		
Sanicula canadensis	Short-styled snakeroot	A	x			
Saururus cernuus	Lizard tail	U	x	x		
Scuttellaria sp.	Skullcap	C			x	
Senecio glabellus	Butterweed	C			x	
Sesbania exaltata	Sicklepod	C			x	
Sida spinosa	Prickly mallow	C			x	x

* Relative Abundance Where: A = Abundant, C = Common, U = Uncommon, V = Very Uncommon

(Continued)

TABLE 3D-2 (Continued)

Scientific Name	Common Name	Relative Abundance in Shelby County*	Bottomland Forest Mature	Bottomland Forest Successional	Meadow	Soybean Field
Solanum carolinense	Horse nettle	A		x	x	
Solidago altissima	Tall goldenrod	C			x	
Solidago canadensis	Canada goldenrod	A		x	x	
Solidago speciosa	Goldenrod	C	x	x		
Specularia perfoliata	Venus' looking glass	C		x	x	
Spermacoce glabra	Buttonweed	C			x	
Strophostyles helveola	Wild bean	C			x	
Strophostyles leiosperma	Wild bean	C			x	
Strophostyles umbellata	Wild bean	C			x	
Taraxacum officinale	Dandelion	A			x	
Teucrium canadense	Wood sage	U	x	x	x	
Tovara virginiana	Virginia jumpseed	C	x			
Urtica chamaedryoides	Stinging nettle	U	x			
Urtica dioica	Stinging nettle	V	x		x	
Valerianella radiata	Cornsalad	U		x		
Verbascum thapsus	Moth mullein	C			x	
Verbesina alternifolia	Wingstem	C			x	
Viola missouriensis	Missouri violet	C	x			
Xanthium strumarium	Cockle bur	A		x	x	x
TOTALS		227	77	84	162	16

* Relative Abundance Where: A = Abundant, C = Common, U = Uncommon, V = Very Uncommon

TABLE 3D-3

TIME SCHEDULE OF TERRESTRIAL VEGETATION SURVEYS

Survey Period	Trees, Saplings, Shrubs and Vines	Ground Cover
Spring, May 1 to 9, 1978	Sample plots Species list	Sample plots Species list Endangered species
Summer, July 17 to 21, 1978	Species list updates	Sample plots Species list updates Endangered species
Fall, October 10 to 17, 1978	Species list updates	Sample plots Species list updates Endangered species

In addition to observations in specific survey areas, all general observations were recorded.

Shrubs and Vines (if present)

Four 50-square-meter plots

Data collected -- For each species, recorded the number of stems and percent of plot covered.

Ground Cover

Four 5-square-meter plots

Data collected -- For each species, recorded the approximate number of stems, number of individual plants (where possible) and percent cover.

Products of survey:

- Map showing vegetation types
- Species list for each habitat type
- Density, dominance and importance values of major species in these habitat types
- Presence of endangered species
- Donation of frozen tissue specimens to Memphis State University

3D.3 WILDLIFE SURVEY METHODOLOGY

3D.3.1 MAMMALS

Qualitative abundance for large mammals (deer, fox, opossum, raccoon, rabbits squirrel etc.) was estimated during each of the four major seasonal surveys. Surveys were conducted in conjunction with bird transect observations as well as by driving the roads, walking through representative areas and general observations as described in Table 3D-4. The species were given a rating of abundant, common, uncommon and very uncommon. Frequency levels were based on road kills, tracks, scats, dens, burrows and organism sightings. Small mammal specimens were collected to verify species presence. Habitat preference was also determined. Mammal data are discussed in Section 3.6.

TABLE 3D-4

TIME SCHEDULE OF TERRESTRIAL WILDLIFE FIELD SURVEYS

Survey Period	Mammals	Birds	Reptiles/Amphibians
Spring, May 1 to 9, 1978	Trap small mammals Observations for other species at selected sampling points	Bird Transects (Migrants)	Surveys in potential habitat
Summer, July 17 to 21, 1978	Observations at selected sampling points	Bird Transects (Residents)	Surveys in potential habitat
Fall, October 10 to 17, 1978	Trap small mammals Observations for other species at sampling points	Bird Transects (Migrants)	Surveys in potential habitat
Winter, December 14 to 19, 1978	Trap small mammals Observations at sampling points	Bird Transects (Residents)	--

In addition to observations in specific survey areas, all general observations were recorded. Specimens of small mammals and selected bird and reptile/amphibian species from the fall and winter surveys were frozen.

Quantitative data were collected for small mammals and game species. Small mammals were live-trapped on grids of traps during the spring, fall and winter. These grids were located to sample the major habitat types within 3 kilometers of the site. Each grid sampled approximately 1.16 hectares.

Products of survey:

- List of mammals on the site and habitat preference
- Relative abundance of all mammals
- Density of small mammals
- Relative density of large mammals
- Breeding areas or critical habitats
- Presence of endangered species
- Donation of frozen tissue specimens to Memphis State University

3D.3.2 BIRDS

Qualitative abundance for bird species was determined for each species based primarily on road kills, song, call notes, nests and actual sightings during field surveys described in Table 3D-4. Records were maintained of all species observed or heard. An abundance rating (see Section 3.6) and habitat preference were given to each species.

Bird densities were determined in major habitat types on measured transects. Distance covered by observations on either side of the transect was estimated, and the area covered was calculated. Each transect was covered at least twice during each survey period. Field data are discussed in Section 3.6. Species observed are listed in Table 3D-5.

TABLE 3D-5

BIRD SPECIES OBSERVED WITHIN 3 KM OF THE IFGDP SITE

Common Name	Scientific Name
Horned grebe	Podiceps auritus
Pied-billed grebe	Podilymbus podiceps
Great blue heron	Ardea herodias
Green heron	Butorides virescens
Great egret	Casmerodius albus
Yellow-crowned night heron	Nyctanassa violacea
Canada goose	Branta canadensis
Mallard	Anas platyrhynchos
Gadwall	Anas strepera
American wigeon	Mareca americana
Northern shoveler	Spatula clypeata
Wood duck	Aix sponsa
Ring-necked duck	Aythya collaris
Lesser scaup	Aythya affinis
Common goldeneye	Bucephala clangula
Bufflehead	Bucephala albeola
Ruddy duck	Oxyura jamaicensis
Black vulture	Corogyps atratus
Turkey vulture	Cathartes aura
Mississippi kite	Ictinia mississipensis
Sharp-shinned hawk	Accipiter striatus
Red-tailed hawk	Buteo jamaicensis
Broad-winged hawk	Buteo platypterus
Marsh hawk (harrier)	Circus cyaneus
Merlin (pigeon hawk)	Falco columbarius
American kestrel	Falco sparverius
Bobwhite	Colinus virginianus
Turkey	Meleagris gallopavo
American coot	Fulica americana
Killdeer	Charadrius vociferus
American woodcock	Philohela minor
Common snipe	Capella gallinago
Semipalmated sandpiper	Calidris pusilla
Spotted sandpiper	Actitis macularia
Pectoral sandpiper	Calidris melanotos
Solitary sandpiper	Tringa solitaria
Greater yellowlegs	Tringa melanoleuca
Lesser yellowlegs	Tringa flavipes
Herring gull	Larus argentatus
Ring-billed gull	Larus delawarensis
Mourning dove	Zenaidura macroura
Rock dove	Columba livia
Yellow-billed cuckoo	Coccyzus americanus
Barn owl	Tyto alba

(Continued)

TABLE 3D-5 (Continued)

Common Name	Scientific Name
Great horned owl	Bubo virginianus
Screech owl	Otus asio
Whip-poor-will	Caprimulgus vociferus
Common nighthawk	Chordeiles minor
Chimney swift	Chaetura pelagica
Ruby-throated hummingbird	Archilochus colubris
Belted kingfisher	Megaceryle alcyon
Common flicker	Coloptes auratus
Pileated woodpecker	Dryocopus pileatus
Red-bellied woodpecker	Centurus carolinus
Red-headed woodpecker	Melanerpes erythrocephalus
Yellow-bellied sapsucker	Sphyrapicus varius
Hairy woodpecker	Picoides villosus
Downy woodpecker	Picoides pubescens
Eastern kingbird	Tyrannus tyrannus
Least flycatcher	Empidonax minimus
Acadian flycatcher	Empidonax virescens
Great crested flycatcher	Myiarchus crinitus
Yellow-bellied flycatcher	Empidonax flaviventris
Eastern phoebe	Sayornis phoebe
Horned lark	Eremophila alpestris
Eastern wood pewee	Contopus virens
Rough-winged swallow	Stelgidopteryx ruficollis
Bank swallow	Riparia riparia
Barn swallow	Hirundo rustica
Purple martin	Progne subis
Blue jay	Cyanocitta cristata
Common crow	Corvus brachyrhynchos
Fish crow	Corvus ossifragus
Carolina chickadee	Parus carolinensis
Tufted titmouse	Parus bicolor
White-breasted nuthatch	Sitta carolinensis
Brown creeper	Certhia familiaris
House wren	Troglodytes aedon
Winter wren	Troglodytes troglodytes
Carolina wren	Tryothorus ludovicianus
Mockingbird	Mimus polyglottos
Gray catbird	Dumetella carolinensis
Brown thasher	Toxostoma rufum
American robin	Turdus migratorius
Wood thrush	Hylocichla mustelina
Swainson's thrush	Catharus ustulatus
Eastern bluebird	Sialia sialis
Golden-crowned kinglet	Regulus satropa
Ruby-crowned kinglet	Regulus calendula
Water pipit	Anthus spinoletta
Blue-gray gnatcatcher	Polioptla caerulea

(Continued)

TABLE 3D-5 (Continued)

Common Name	Scientific Name
Loggerhead shrike	Lanius ludovicianus
Starling	Sturnus vulgaris
White-eyed vireo	Vireo griseus
Solitary vireo	Vireo solitarius
Philadelphia vireo	Vireo philadelphicus
Red-eyed vireo	Vireo olivaceus
Warbling vireo	Vireo gilvus
Black-and-white warbler	Mniotilta varia
Prothonotary warbler	Prothonotaria citrea
Worm-eating warbler	Helmitheros vermivorus
Tennessee warbler	Vermivora peregrina
Nashville warbler	Vermivora ruficapilla
Northern parula warbler	Parula americana
Yellow warbler	Dendroica petechia
Yellow-rumped warbler	Dendroica coronata
Cerulean warbler	Dendroica cerulea
Kentucky warbler	Oporornis formosus
Blackburnian warbler	Dendroica fusca
Common yellowthroat	Geothlypis trichas
Chestnut-sided warbler	Dendroica pensylvanica
Bay-breasted warbler	Dendroica castanea
Blackpoll warbler	Dendroica striata
Pine warbler	Dendroica pinus
Prairie warbler	Dendroica discolor
Palm warbler	Dendroica palmarum
Northern waterthrush	Seiurus noveboracensis
Louisiana waterthrush	Seiurus motacilla
Hooded warbler	Wilsonia citrina
American redstart	Setophaga ruticilla
Yellow-breasted chat	Icteria virens
House sparrow	Passer domesticus
Bobolink	Dolichonyx oryzivorus
Eastern meadowlark	Icteria virens
Red-winged blackbird	Agelaius phoeniceus
Orchard oriole	Icterus spuruis
Northern oriole	Icterus galbula
Rusty blackbird	Euphagus carolinus
Common grackle	Quiscalus quiscula
Brown-headed cowbird	Molothrus ater
Scarlet tanager	Piranga olivacea
Summer tanager	Piranga rubra
Cardinal	Richmondena cardinalis
Rose-breasted grosbeak	Pheucticus ludovicianus
Blue grosbeak	Guiraca caerulea
Indigo bunting	Passerina cyanea
Painted bunting	Passerina ciris

(Continued)

TABLE 3D-5 (Continued)

Common Name	Scientific Name
Dickcissel	Spiza americana
American goldfinch	Spinus tristis
Rufous-sided towhee	Pipilo erythrophthalmus
Savannah sparrow	Passerculus sandwichensis
Grasshopper sparrow	Ammodramus savannarum
Vesper sparrow	Pooecetes grammacus
Lark sparrow	Chondestes gramineus
Dark-eyed junco	Junco hyemalis
Field sparrow	Spizella pusilla
White-throated sparrow	Zonothrichia albicollis
White-crowned sparrow	Zonothrichia leucophrys
Chipping sparrow	Spizella pusilla
Fox sparrow	Passerella iliaco
Swamp sparrow	Melospiza georgiana
Song sparrow	Melospiza melodia

Game bird densities were determined in association with the preceding transects. Fresh road kills and trap kills were frozen for future analysis.

Products of survey:

- List of birds on the site and habitat preference
- Relative abundance of all birds
- Density of song birds and game birds on transects
- Breeding areas or critical habitat
- Presence of endangered species
- Donation of frozen tissue specimens to Memphis State University

3D.3.3 AMPHIBIANS AND REPTILES (HERPTILES)

Amphibians and reptiles were surveyed by direct sightings and calls as described in Table 3D-4. Habitats where the species were expected were searched thoroughly by systematic walking surveys. All observations, recorded by habitat and relative abundance, are discussed in Section 3.6.

Products of survey:

- List of herptiles and habitat preference
- Relative abundance
- Breeding areas or critical habitat
- Donation of frozen tissue specimens to Memphis State University

APPENDIX 3E
AQUATIC ECOLOGY

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3E.1 INTRODUCTION

This appendix provides detailed information in support of Section 3.7 (Aquatic Ecology). Included in the following sections is a presentation of the scope, methods and results of site-specific aquatic field surveys conducted by Energy Impact Associates (EIA) during 1978-79 as part of the aquatic ecology study for the proposed Memphis Light, Gas and Water Division (MLGW) Industrial Fuel Gas Demonstration Plant (IFGDP).

3E.1.1 SCOPE

Four seasonal aquatic field surveys were conducted in Lake McKellar and the Mississippi River adjacent to the proposed IFGDP site during May, July and October 1978 and January 1979. Fish, benthic macroinvertebrates, phytoplankton and zooplankton samples were collected during these four surveys. In addition, periphyton and macrophyte samples were collected once, during the July 1978 survey, and bottom substrate samples were collected during the October 1978 survey. Weekly ichthyoplankton surveys were conducted from March 15, 1978, to June 15, 1978.

3E.1.2 DESCRIPTION OF THE STUDY AREA

The proposed site for the MLGW Industrial Fuel Gas Demonstration Plant is located in the city of Memphis, Shelby County, Tennessee. The site is on a peninsula that is east of the confluence of Lake McKellar and the Mississippi River at river mile 725.7 as is shown in Figure 3E-1. A broad floodplain averaging 75 miles in width bounds the meandering river channel.[1]

Lake McKellar is an oxbow lake extending in a general easterly direction for approximately 6 miles from its confluence with the Mississippi River at river mile 725.7 (Figure 3E-1) and serves as Memphis Harbor. Lake McKellar was completed in 1959 when the United States Army Corps of Engineers (U.S. ACE) constructed a dam across the northeastern portion of the Tennessee Chute (river

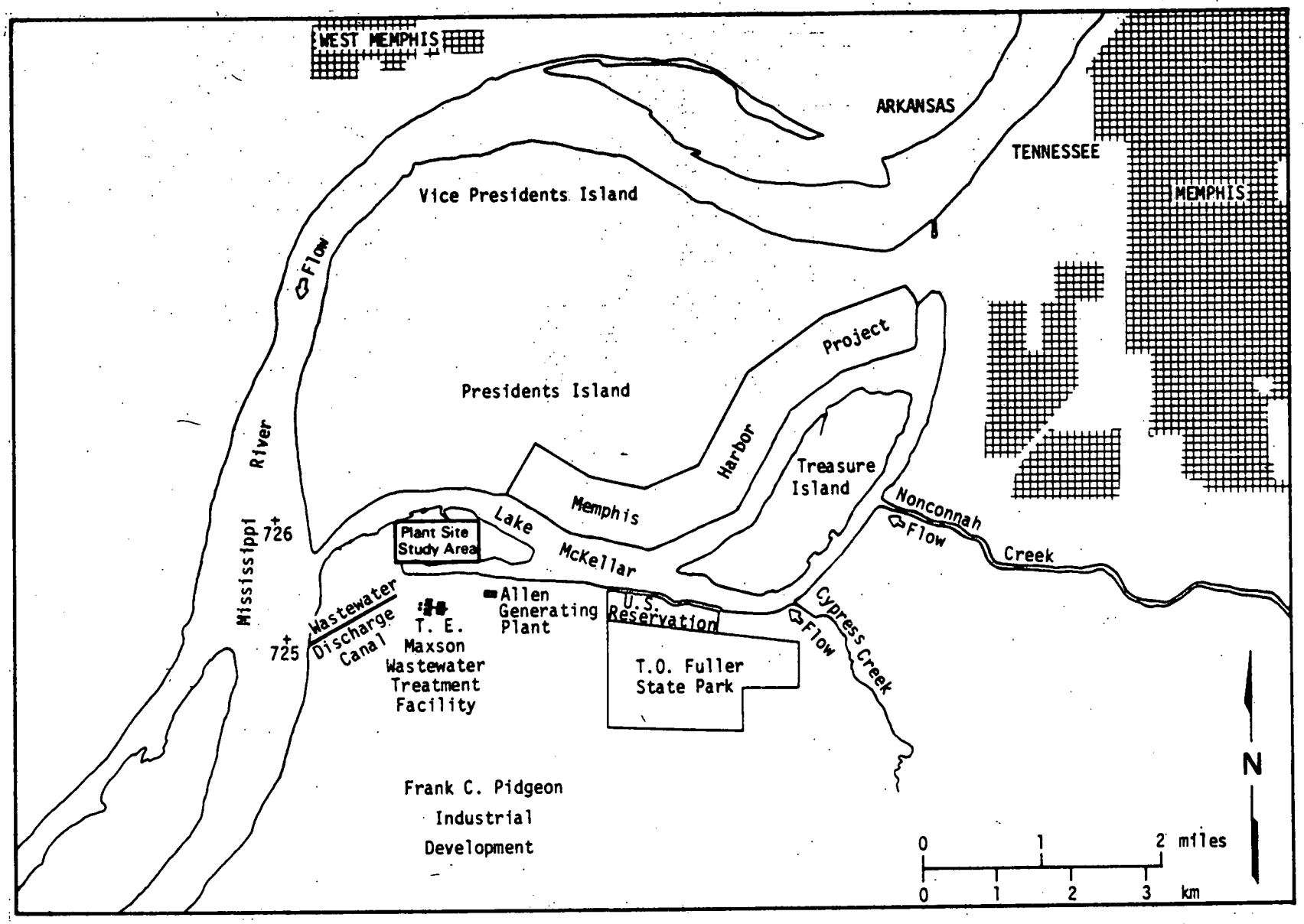


Figure 3E-1. Location of Proposed Site for the Industrial Fuel Gas Demonstration Plant

mile 731) to provide improved navigation and flood control and provide additional port facilities.[2] Shorelines of the lake, especially the northeastern shoreline, are heavily industrialized. Banks are generally abrupt and steep and, with the exception of Martin Luther King City Park and Fuller State Park, essentially lacking overhanging vegetation.

Sampling locations for the 1978-79 aquatic ecology surveys (Figure 3E-2) were selected in the Mississippi River and Lake McKellar in the vicinity of the proposed site to determine the aquatic organisms associated with various habitats in the area. Transects were established to document existing conditions in waterways most likely to be influenced by construction and operation of MLGW's proposed Industrial Fuel Gas Demonstration Plant. These included the portion of Lake McKellar north of the site (LM1), the turning basin adjacent to the southern edge of the site (LM2), and locations in the Mississippi River upstream (MR1) and downstream (MR2) of the mouth of Lake McKellar.

A series of stations designated A, B and C were established along each of these transects (see Figure 3E-2). Station designations in Lake McKellar were based on approximate fractions of the width across the lake while looking to the east. Station A was located approximately one-fifth of the way across the transect; Station B was located approximately halfway across the transect; and Station C was located approximately four-fifths of the way across the transect.

Station designations in the Mississippi River were based on approximate distance from the east bank of the river. Station C was located approximately 150 feet from the east bank; Station B was located approximately 75 feet from the east bank of the river; and Station A was located approximately 20 feet from the east bank of the river.

Detailed descriptions of the transects follow.

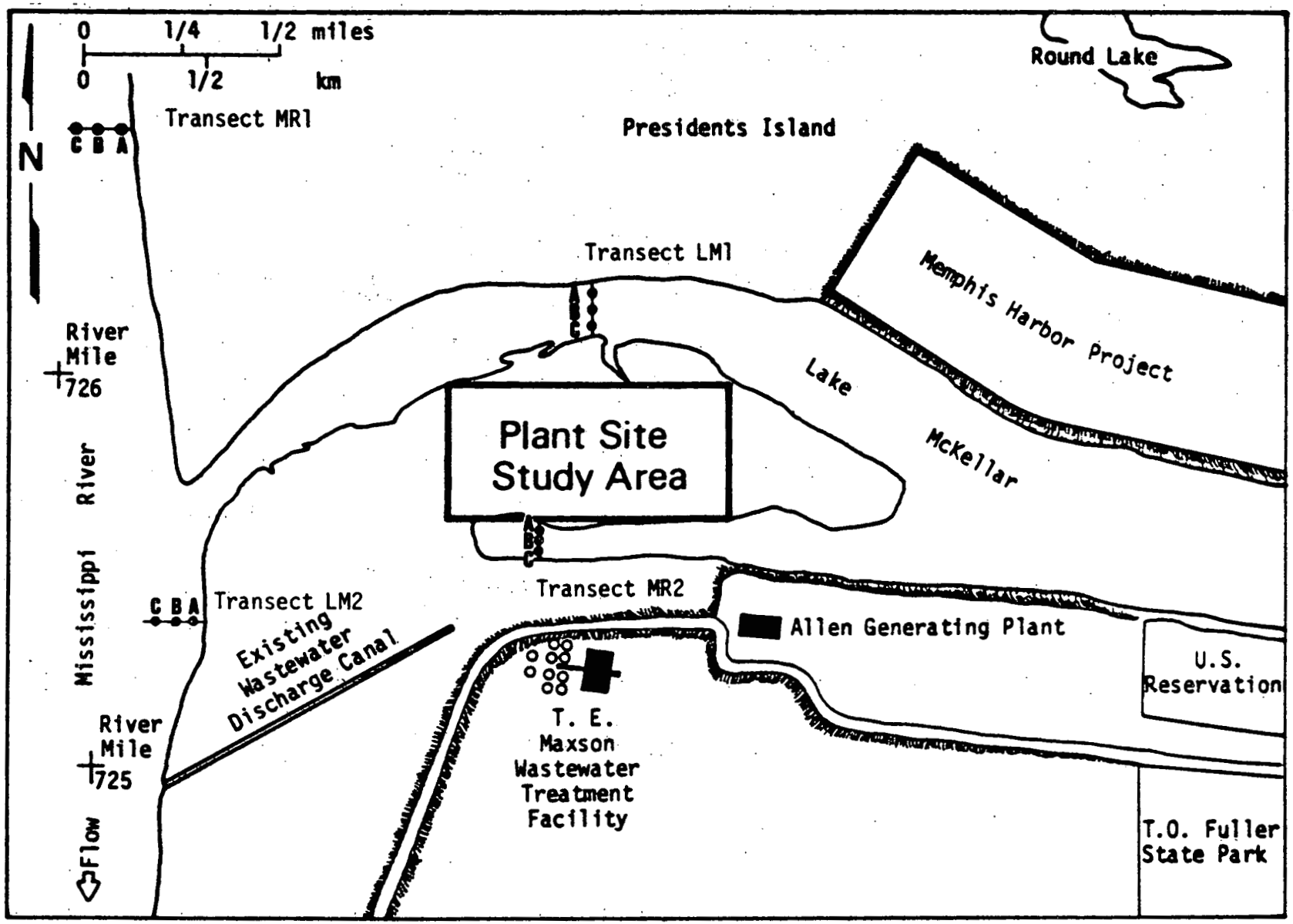


Figure 3E-2. Location of Major Transects (MR1, MR2, LM1, LM2) and Stations (A, B, C) for Sampling of Aquatic Biota During 1978-79 Surveys

3E.1.2.1 MISSISSIPPI RIVER

Transect MR1 -- Transect MR1 in the Mississippi River was located approximately 5000 feet upstream from the mouth of Lake McKellar on the east bank of the river (Figure 3E-2). This transect served as a control to determine existing aquatic communities in the river upstream of the influences of Lake McKellar and the proposed site. The river makes a long 90 degree west-to-south bend in this region, forming a relatively small protected area on the east side that is characterized by reduced river velocities. Shoreline to the north of Transect MR1 was tree covered to the edge of the water line while the shoreline south of Transect MR1 to the mouth of Lake McKellar was characterized by steep clay banks. Land to the east and south of Transect MR1 was used for farming when river elevations drop below flood stage in the spring. Heavy barge traffic was encountered in the vicinity of Transect MR1.

Transect MR2 -- Transect MR2 in the Mississippi River was located approximately 1200 feet downstream of the mouth of Lake McKellar (Figure 3E-2). This transect was located upstream of the discharge from the T. E. Maxson Wastewater Treatment Plant so that potential effects of the water discharge of the proposed fuel gas plant could be differentiated from the effects of the wastewater plant discharge. The river was relatively straight in this location, but velocities were somewhat reduced due to the extension of the wastewater plant discharge canal into the channel of the river, creating a backwater. Shoreline in this area was a steep, tree-lined slope.

3E.1.2.2 LAKE MCKELLAR

Transect LM1 -- Transect LM1 in Lake McKellar was located in the area known as the Tennessee Chute, approximately 7000 feet east of the confluence of the lake with the Mississippi River and north of the proposed site (Figure 3E-2). This transect was located adjacent to the plant site so that the potential effects of construction and operation of the proposed plant could be examined. The transect also was located near the proposed product pipeline crossing in the lake, so that information obtained at this location could be used to assess the potential effects of the construction and operation of

this pipeline. The northern shoreline was muddy and gradually sloping and was bordered by farm land while the southern shoreline (toward the site) was sandy with a gradual slope and was tree covered. A navigation channel is maintained in the Tennessee Chute by the U.S. ACE to provide access to Memphis Harbor. The channel is routinely dredged in late summer and early fall by the U.S. ACE to maintain a 9-foot deep navigation channel under low river elevation conditions.[3] Water depth in the lake is primarily affected by elevation of the Mississippi River, with only a small flow from Nonconnah and Cypress Creek to the east.

Transect LM2 -- Transect LM2 in Lake McKellar was located approximately 5000 feet west of the eastern end of the turning basin adjacent to TVA's Allen Generating Plant (Figure 3E-2). This location was considered to represent a backwater type area and was sampled because of its proximity to the proposed plant site and its potential use as a water intake location for the proposed plant. The area was bordered on the north by the sandy, relatively steep shorelines of the proposed MLGW site. The south shoreline was sandy, gently sloping and tree lined. A heavily forested area, often inundated with water, bordered the western edge of the turning basin. Water in this area is calm with water levels that vary as a function of the change in river elevation.

3E.1.3 SAMPLING PARAMETERS, LOCATIONS AND SCHEDULE

Biological parameters were sampled during four major aquatic field surveys conducted during May 2 to 6, July 17 to 19 and October 16 to 19, 1978, and January 10 to 14, 1979. Phytoplankton (free-floating microscopic plants), zooplankton (free-floating microscopic animals), benthic macroinvertebrates (bottom dwelling invertebrate animals generally visible to the naked eye) and adult and juvenile fish were collected during each survey. Periphyton (microscopic plants growing attached to submerged surfaces) was sampled only during the July survey. Macrophyte (larger aquatic plants) distribution was also determined during the July survey since growth of these organisms would be more extensive at this time than during the other surveys. Weekly ichthyoplankton (fish eggs and larvae) surveys were conducted through the spawning season from March 15, 1978, to June 15, 1978.

Locations of sampling for each parameter are summarized in Table 3E-1, and shown in Figures 3E-2, 3E-3, 3E-4 and 3E-5. These sampling locations varied somewhat (primarily just for fish) due to fluctuations in the water level of the Mississippi River.

3E.2 METHODS

This section details the methodology used to collect and analyze samples during the 1978-79 aquatic field surveys conducted near the proposed IFGDP site.

3E.2.1 FISH

Methods for collecting adult and juvenile fish differ from those for collecting ichthyoplankton and are treated separately below.

3E.2.1.1 ADULT AND JUVENILE FISH

Adult and juvenile fish were collected in the Mississippi River and Lake McKellar near the proposed site using an electroshocker, gill nets and baited hoop nets. Electroshocking was done using a Smith-Root electroshocking boat equipped with a Model VI Electrofisher. Three spring-loaded antennae were suspended from booms located on the port and starboard sides of the bow of the boat to serve as anodes and cathodes. The electroshocker was operated in a pulsed DC mode at 60 pulses per second and at a voltage sufficient to maintain a 7 ampere output. Zones approximately 900 feet long were electroshocked along the east shore at Transects MR1 and MR2 in the Mississippi River and along the northern and southern shores at Transects LM1 and LM2 in Lake McKellar. In addition, a lagoon east of Transect LM2 was in existence and was electroshocked in May 1978, while an inlet just east of Transect LM1 in Lake McKellar was electroshocked during the July 1978 field survey. Figures 3E-3, 3E-4 and 3E-5 illustrate zones that were electroshocked at existing water levels during the May 1978, the July 1978 and the October 1978 and January 1979 surveys, respectively. Each zone was electroshocked for approximately 15 minutes during each survey.

TABLE 3E-1

SAMPLING SCHEDULE FOR AQUATIC ECOLOGY PARAMETERS NEAR THE IFGDP SITE

MAY

Location:	MR1†			MR2			LM1			LM2			
	A	B	C	A	B	C	A	B	C	A	B	C	Totals
Phytoplankton			3			3		3			3		12
Zooplankton			3			3		3			3		12
Periphyton	*			*					*	*			
Benthic macroinvertebrates	3	3	3	3	3	3	3	3	3	3	3	3	36
Substrate analysis	*	*	*	*	*	*	*	*	*	*	*	*	
Adult and juvenile fish	1			1			1		1	1		1	6
Macrophytes	*			*			*		*	*		*	

JULY

Location:	MR1			MR2			LM1			LM2			
	A	B	C	A	B	C	A	B	C	A	B	C	Totals
Phytoplankton			2			2		2			2		8
Zooplankton			2			2		2			2		8
Periphyton	3			3					3	3			12
Benthic macroinvertebrates	2	2	2	2	2	2	2	2	2	2	2	2	24
Substrate analysis	*	*	*	*	*	*	*	*	*	*	*	*	
Adult and juvenile fish	1			1			1		1	1		1	6
Macrophytes	**			**			**		**	**		**	

OCTOBER

Location:	MR1			MR2			LM1			LM2			
	A	B	C	A	B	C	A	B	C	A	B	C	Totals
Phytoplankton			2			2		2			2		8
Zooplankton			2			2		2			2		8
Periphyton	*			*					*	*			
Benthic macroinvertebrates	2	2	2	2	2	2	2	2	2	2	2	2	24
Substrate analysis	1	1	1	1	1	1	1	1	1	1	1	1	12
Adult and juvenile fish	1			1			1		1	1		1	6
Macrophytes	*			*			*		*	*		*	

JANUARY

Location:	MR1			MR2			LM1			LM2			
	A	B	C	A	B	C	A	B	C	A	B	C	Totals
Phytoplankton			2			2		2			2		8
Zooplankton			2			2		2			2		8
Periphyton	*			*					*	*			
Benthic Macroinvertebrates	2	2	2	2	2	2	2	2	2	2	2	2	24
Substrate analysis	*	*	*	*	*	*	*	*	*	*	*	*	
Adult and juvenile fish	1			1			1		1	1		1	6
Macrophytes	*			*			*		*	*		*	

* Parameter observed and condition noted.

** Macrophyte distribution in general area sketched.

† These designations refer to sampling locations identified in Figure 3E-2.

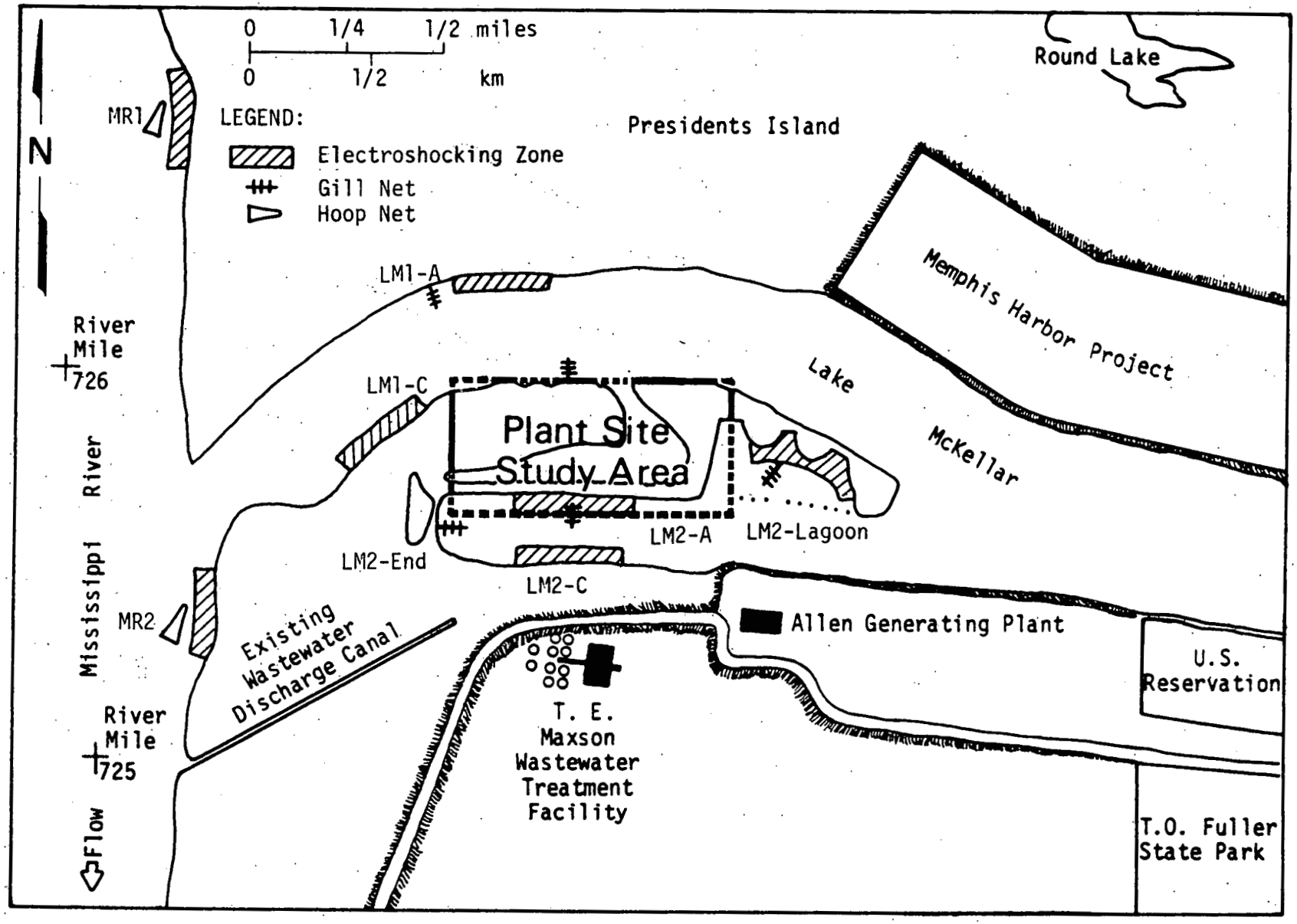


Figure 3E-3. Location of Fish Collection Areas During May 1978 Aquatic Field Survey

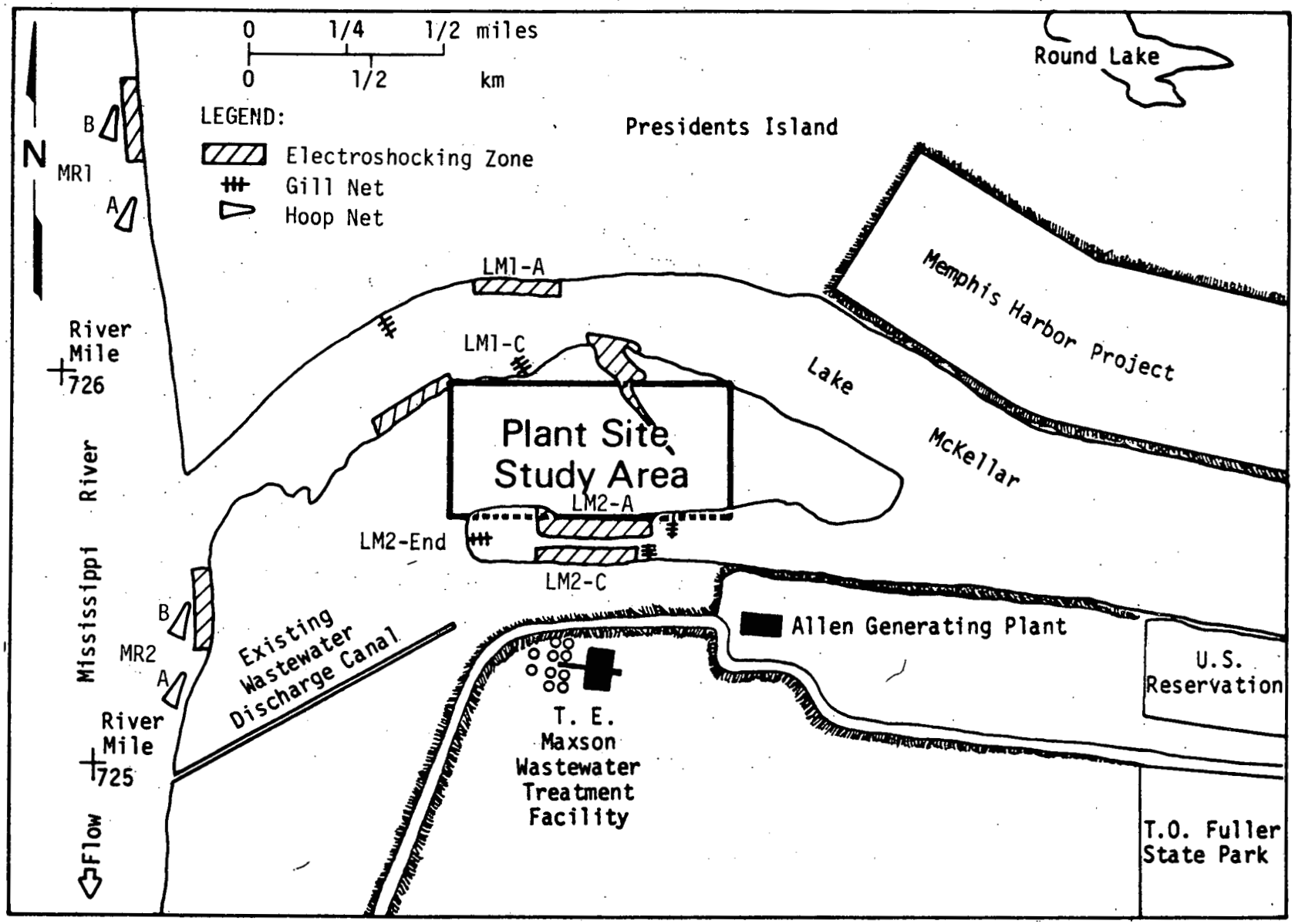


Figure 3E-4. Location of Fish Collection Areas During July 1978 Aquatic Field Survey

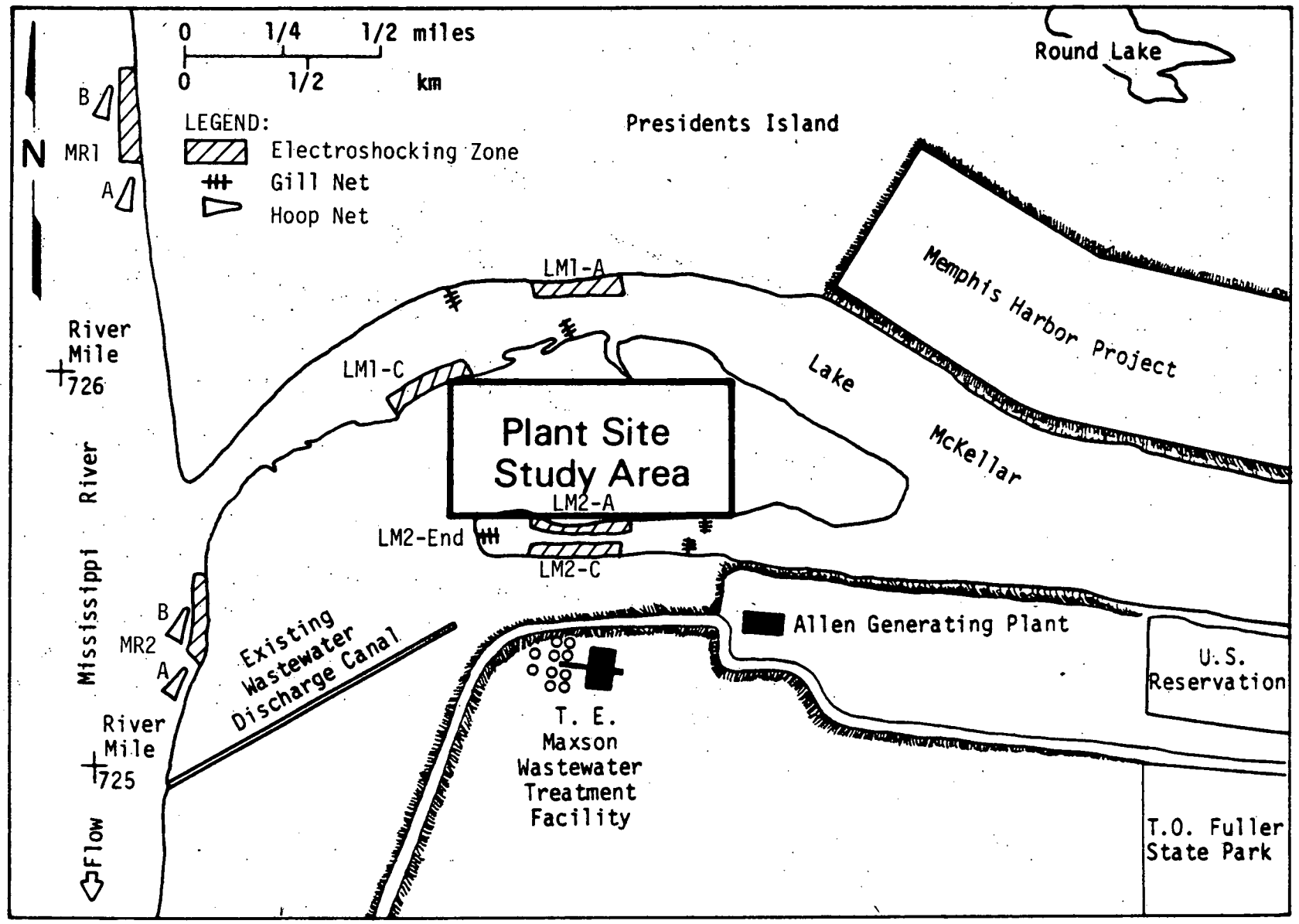


Figure 3E-5. Location of Fish Collection Areas During October 1978 and January 1979 Aquatic Field Surveys

Gill netting was done using 125-foot long, 6-foot high sinking gill nets. Each net contained five 25-foot panels with bar mesh sizes of 3/4, 1, 1-1/4, 1-1/2 and 2 inches respectively. Nets were set at 90 degree angles along the northern and southern banks of Transects LM1 and LM2 in Lake McKellar and at a 90 degree angle from the western end of the turning basin adjacent to the Allen Generating Plant. Figure 3E-3 shows the locations where gill nets were set during May 1978 field surveys while Figure 3E-4 and Figure 3E-5 show the locations of gill net placement during July 1978 and October 1978 and January 1979 field surveys, respectively. Gill nets were allowed to fish approximately 4 to 6 hours.

Four 4-foot diameter hoop nets were baited with catfish bait and were set in the Mississippi River. Two nets were set near shore at each transect in the river and allowed to fish approximately 24 hours.

Large fish collected were field identified[4,5,6] to species, counted, weighed (grams) and standard length measured (centimeters). Representative voucher specimens were retained for verification. Minnows and other small fish were placed in jars, preserved with 10 percent formalin and returned to the laboratory for analysis.

3E.2.1.2 ICHTHYOPLANKTON

Ichthyoplankton samples were collected weekly during daylight hours from March 15 through June 15, 1978, to evaluate habitats near the proposed site as potential fish spawning and nursery areas. Duplicate samples were collected at Stations A and C of Transects LM1 and LM2 in Lake McKellar and at Station B at Transects MR1 and MR2 in the Mississippi River. During the June 8, 1978, field survey, ichthyoplankton samples were collected at both dawn and dusk to obtain information on the potential diurnal fluctuations in ichthyoplankton density and composition. Figure 3E-2 shows the transect and station locations.

Multi-level samples were collected by towing a 0.5 mhter diameter, 500 micron mesh plankton net in a stratified oblique fashion through the water column. The net was generally towed at three depths in succession with the first level being at approximately one-third of the total depth of the water column, the second at approximately two-thirds of the total depth, and third near the bottom. The net was towed for 2 minutes at each level. A General Oceanics Digital Flowmeter was suspended in the center of the net to measure the volume of water sampled. Net depth was maintained by a cable depressor attached to the towing bridle of the plankton net and monitored using a cable clinometer. Organisms retained by the net were washed into a labelled sample bottle and preserved with a 10 percent formalin solution.

Larvae and eggs were enumerated and identified[7-14] using a fixed magnification scope. Internal structures of opaque specimens were cleared in a 2 percent aqueous potassium hydroxide solution. An ocular micrometer was used to make linear measurements of the specimens.

3E.2.2 BENTHIC MACROINVERTEBRATES

Benthic macroinvertebrates were sampled with a 23 by 23 centimeter (0.0529 square meter) Ponar grab sampler. Duplicate samples were collected at Stations A, B and C at all transects in Lake McKellar and the Mississippi River (Figure 3E-2) during July and October 1978 and January 1979. Triplicate samples were collected at Stations A, B and C at all transects in the lake and the river (Figure 3E-2) during May 1978. This additional sample was used in the quality assurance cross-check. General substrate type (i.e. sand, mud, gravel, etc.) was noted for each sample. Samples were washed in the field using a Number 30 sieve (0.595 millimeter opening) and preserved with a 10 percent formalin solution. All samples were stained with a 0.2 percent solution of Rose Bengal in 70 percent ethyl alcohol and sorted in the laboratory. After sorting, 70 percent ethyl alcohol was used to remove excess Rose Bengal stain. Aquatic oligochaetes were cleared with Amman's lactophenol. All organisms were mounted when required and identified[15-22] to species when practicable.

3E.2.3 BOTTOM SUBSTRATE

A single bottom substrate sample was collected at Stations A, B and C at all transects in the river and in the lake (Figure 3E-2) in October 1978. Samples were collected with a 23 by 23 centimeter (0.059 square meter) Ponar grab sampler, placed in heavy plastic bags and returned to the laboratory. After drying at room temperature, samples were analyzed to determine particle size and percent volatile residue.[23-27]

3E.2.4 ZOOPLANKTON

Duplicate zooplankton samples were collected at Station B of Transects LM1 and LM2 in Lake McKellar and Station C of Transects MR1 and MR2 in the Mississippi River (Figure 3E-2) during July and October 1978 and January 1979. Zooplankton samples were collected in triplicate (additional sample for quality assurance cross-check) at the locations during May 1978.

Multi-level samples were collected by towing a 0.5 meter diameter, 80 micron mesh plankton net through the water column. The net was generally towed at four depths in succession (i.e., a stratified oblique tow) within 5 feet of the water surface, approximately one-third of the total depth of the water column, approximately two-thirds of the total depth of the water column and near the bottom, for 2 minutes at each level. A General Oceanics Digital Flowmeter was suspended in the center of the net to measure the volume of water sampled. Net depth was maintained by attaching a cable depressor to the towing bridle of the plankton net. A cable clinometer was used to monitor the tow depth. Organisms retained by the net were washed into a 1 liter sample bottle and preserved with formalin.

Zooplankton samples were concentrated to 500 milliliters. Aliquots of the thoroughly mixed concentrate were pipetted into a Sedgewick-Rafter cell and the zooplankton present were identified[22,28-33] and enumerated using 100X magnification. Enough aliquots were examined so that a minimum of 300 zooplankters were identified.

3E.2.5 PHYTOPLANKTON

Duplicate phytoplankton samples were collected at Station B of Transects LM1 and LM2 in Lake McKellar and at Station C of Transects MR1 and MR2 in the Mississippi River (Figure 3E-2) during July and October 1978 and January 1979. Triplicate samples (additonal sample for quality assurance cross-check) were collected at the same locations listed above during May 1978. Samples obtained from Lake McKellar were collected with a 3 liter Van Dorn water bottle from subsurface, (within 1 foot of the surface) one-third (of total depth), two-thirds (of total depth) and near bottom locations within the water column. From each level 250 milliliters of water were transferred to a 1 liter sample bottle resulting in composite samples. Preservation was by addition of 10 milliliters of Lugol's iodine solution. Subsurface phytoplankton samples were collected from the Mississippi River with a 3 liter Van Dorn water bottle, transferred to 1 liter bottles and preserved as mentioned above.

Each phytoplankton sample was placed into a 1000 milliliter graduated cylinder and allowed to settle for at least 24 hours. Each was then concentrated to 100 milliliters by decanting the excess water. The concentrated sample was thoroughly mixed and a 0.1 milliliter aliquot was pipetted into a Palmer-Maloney cell and covered with a cover slip. A minimum of 400 organisms were examined using 450X magnification and identified[22,34-37] to species when practicable.

3E.2.6 PERIPHYTON

Periphyton samples were collected in triplicate at Station A of Transects MR1 and MR2 in the Mississippi River, at Transect LM2 in Lake McKellar and at Station C of Transect LM1 in the lake during July 1978. Visual observations of the periphyton community in the river and lake were noted during May and October 1978 and January 1979 field surveys. A 10.5 square centimeter area of submerged substrate (wood, tree stumps, rock, etc.) was scraped with a pocket knife and placed in a vial containing 10 drops of Lugol's iodine solution.

Periphyton samples were initially scanned in a Palmer-Maloney cell to evaluate the general condition of the sample and to determine the major groups of algae present. Nondiatom algae were identifed to species (if possible) in the Palmer-Maloney cell using 450X magnification, and the relative abundance of each species was determined. Abundant forms are defined here as comprising numerically more than 20 percent of the sample, while moderate forms comprise from 5 to 20 percent of the sample and uncommon forms less than 5 percent. Diatoms were mounted on a slide using Hyrax mounting medium and scanned in a random manner using 1000X oil immersion microscopy. The first 500 diatoms encountered were identified[34,35,38-41] and their relative abundance was determined.

3E.2.7 MACROPHYTES

Aquatic macrophytes were examined in the vicinity of Station A of Transects MR1 and MR2 in the Mississippi River and Stations A and C of Transects LM1 and LM2 in Lake McKellar during May, July and October 1978 and January 1979. Any specimens observed were collected, identified, mounted on herbarium paper, labelled and stored in a herbarium cabinet as a voucher collection.

3E.3 RESULTS

This section details results of field surveys and analyses performed to describe aquatic biota near the proposed IFGDP site.

3E.3.1 FISH

In the following discussion, adult and juvenile fish are treated separately from ichthyoplankton (fish eggs and larvae). Distribution of ichthyoplankton gives information on reproductive importance of an area to supplement information on general community structure provided by collections of adults and juveniles.

3E.3.1.1 ADULT AND JUVENILE FISH

Tables 3E-2 through 3E-13 detail the catch composition of each fishing technique at each location during each survey. Selected aspects of this data are summarized below.

3E.3.1.1.1 CATCH COMPOSITION

A total of 1260 adult and juvenile fish weighing 245,753 grams (approximately 540 pounds) were collected from Lake McKellar and adjacent areas of the Mississippi River during the four aquatic field surveys (Table 3E-14). Thirty-nine species representing twelve families of fish were collected. Gizzard shad was the most abundant species, accounting for 57.6 percent of the total numerical catch. The only other fish making up more than 5 percent of the catch was its close relative, threadfin shad (6.4 percent).

In terms of biomass, bigmouth buffalo predominated with 37.5 percent of the total weight of fish collected. Gizzard shad accounted for 21 percent of the total biomass, followed by carp (10.2 percent) and river carpsucker (9.3 percent).

TABLE 3E-2

TOTAL NUMBER AND BIOMASS OF FISH CAUGHT IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER BY ELECTROSHOCKING DURING THE SPRING SURVEY ON MAY 2 AND 3, 1978

Location:	LM1-A*		LM1-C*		LM2-A*		LM2-C*		LM2-Lagoon*		MR1*		MR2 *		TOTAL	
Common Name	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)
River carpsucker					3	344	2	563	1	640					6	1547
Quillback			1	1120											1	1120
Smallmouth buffalo					3	2780			1	725					4	3505
Bigmouth buffalo									1	1630	1	1751			2	3381
Black buffalo					2	1420									2	1420
Longear sunfish	1	44													1	44
White crappie							1	85							1	85
Skipjack herring											2	425	1	129	3	554
Gizzard shad	46	4227	53	6064	55	5873	25	2243	11	1308	80	7211	63	5882	333	32808
Carp									1	3100					1	3100
Golden shiner					2	4									2	4
Emerald shiner	1	4	1	6	1	7	1	5			1	4			5	26
Goldeye							1	58							1	58
Flathead catfish													1	105	1	105
Spotted gar					1	1010									1	1010
Shortnose gar							1	520	2	1120					3	1640
Freshwater drum													1	138	1	138
TOTAL	48	4275	55	7190	67	11438	31	3474	17	8523	84	9391	66	6254	368	50545
Total Shocking Time:	26 min		15 min		15 min		15 min		15 min		15 min		15 min			

* Refer to Figure 3E-3.

TABLE 3E-3

TOTAL NUMBER AND BIOMASS OF FISH CAUGHT IN LAKE MCKELLAR BY GILL NETS DURING SPRING SURVEY ON MAY 4, 1978

Location:	LM1-A*		LM1-C*		LM2-A*		LM2-End*		LM2-Lagoon*		TOTAL	
Common Name	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)
Gizzard shad							1	125	1	100	2	225
Channel catfish	1	350			4	2630	1	1400			6	4380
Shortnose gar			No Fish Taken						1	735	1	735
Sauger							1	550			1	550
Freshwater drum	3	295	–	–	–	–	1	220	–	–	4	515
TOTAL	4	645	0	0	4	2630	4	2295	2	835	14	6405
Total Time Net Set:	4 hr	8 min	4 hr	5 min	4 hr	5 min	4 hr	10 min	4 hr	8 min		

* Refer to Figure 3E-3.

TABLE 3E-4

TOTAL NUMBER AND BIOMASS OF FISH CAUGHT BY HOOP NETS IN THE MISSISSIPPI RIVER DURING THE SPRING SURVEY ON MAY 4 AND 5, 1978

Location:	MR1*		MR2*		TOTAL	
Common Name	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)
River Carpsucker	No Fish Taken		19	14240	19	14240
Gizzard Shad			1	210	1	210
Channel Catfish			2	850	2	850
Total	0	0	22	15300	22	15300
Total Time Net Set:	24 hr 40 min		24 hr 45 min			

* Refer to Figure 3E-3.

TABLE 3E-5

TOTAL NUMBER AND BIOMASS OF FISH CAUGHT IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER BY ELECTROSHOCKING DURING SUMMER SURVEY ON JULY 19, 1978

Location:	LM1-A*		LM1-C**		LM2-A*		LM2-C*		MR1*		MR2*		TOTAL	
Common Name	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)
Brook silverside	1	1											1	1
Mississippi silverside	3	3											3	3
River carpsucker					1	800	3	673					4	1473
Orangespotted sunfish	2	7	1	5			1	10					4	22
Bluegill	1	170											1	170
Longear sunfish	1	60					14	217					15	277
Largemouth bass	1	18					2	23					3	41
White crappie			1	470					1	125			2	595
Skipjack herring	1	1											1	1
Gizzard shad	15	311	53	1165	17	106	62	1668					147	3250
Threadfin shad	4	6	3	3									7	9
Carp					2	3120							2	3120
Golden shiner	2	4	1	3			14	37					17	44
Red shiner	6	8											6	8
Silverband shiner	1	4	1	4									2	8
Bullhead minnow	12	31											12	31
Goldeye									3	3	3	6	6	9
Channel catfish	1	2									1	155	2	157
Flathead catfish	2	525											2	525
Spotted gar			1	615			1	420					2	1035
Shortnose gar			5	2270									5	2270
White bass	2	11	3	29	1	23	1	13					7	76
Sauger	1	4	1	9	1	400			1	3			4	416
Freshwater drum			2	38							1	180	3	218
TOTAL	56	1166	72	4611	22	4449	98	3061	5	131	5	341	258	13759
Total Shocking Time:	15 min.		31 min.		15 min.		15 min.		15 min.		15 min.			

* Refer to Figure 3E-4.

** Two locations combined.

TABLE 3E-6

TOTAL NUMBER AND BIOMASS OF FISH CAUGHT IN LAKE MCKELLAR BY GILL NETS DURING SPRING SURVEY ON JULY 18, 1978

Location:	LM1-A*		LM1-C (Slough)*		LM2-A*		LM2-C*		LM2-END*		TOTAL	
Common Name	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)
River carpsucker									1	640	1	640
Flier							1	140			1	140
Longear sunfish			1	60							1	60
Redear sunfish									1	10	1	10
White crappie	2	39									2	39
Skipjack herring	2	690			1	310			1	140	4	1140
Gizzard shad	1	210							1	40	2	250
Threadfin shad	1	40									1	40
Blue catfish	1	80					1	430			2	510
Channel catfish	1	110			1	300					2	410
Sauger							1	125			1	125
TOTAL	8	1169	1	60	2	610	3	695	4	830	18	3364
Total Time Net Set:	5 hr	40 min	6 hr	15 min	5 hr	55 min	6 hr	0 min	5 hr	55 min		

* Refer to Figure 3E-4.

TABLE 3E-7

TOTAL NUMBER AND BIOMASS OF FISH CAUGHT BY HOOP NETS IN THE MISSISSIPPI RIVER DURING THE SUMMER SURVEY ON JULY 17 AND 18, 1978

Location:	MR1-A*		MR1-B*		MR2-A*		MR2-B*		TOTAL	
Common Name	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)
River carpsucker					No Fish Taken		1	620	1	620
Carp			1	6000					1	6000
Blue catfish	1	400							1	400
Flathead catfish	1	350					2	1920	3	2270
Freshwater drum	4	1240	3	1105					7	2345
TOTAL	6	1990	4	7105	0	0	3	2540	13	11635
Total Time Net Set:	23 hr 15 min		23 hr		23 hr 15 min		22 hr 55 min			

* Refer to Figure 3E-4.

TABLE 3E-8

TOTAL NUMBER AND BIOMASS OF FISH COLLECTED IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER BY ELECTROSHOCKING DURING THE FALL SURVEY ON OCTOBER 17, 1978

Location:	LM1-A*		LM1-C*		LM2-A*		LM2-C*		MR1*		MR2*		TOTAL	
Common Name	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)
Brook silverside					3	9	1	4					4	13
Mississippi silverside			1	3	13	55	5	18	1	3			20	79
River carpsucker	1	80							2	780			3	860
Green sunfish	1	9											1	9
Bluegill					7	172	1	25					8	197
Dollar sunfish	1	11	2	26			2	49					5	86
Longear sunfish					38	1398	6	213					44	1611
Largemouth bass	1	74			11	1744	4	2230					16	4048
Gizzard shad	1	90	58	2340	14	570	37	1131			4	514	114	4645
Carp	1	2950											1	2950
Emerald shiner	3	12							1	4	1	4	5	20
River shiner											1	4	1	4
Mimic shiner									1	2			1	2
Bullhead minnow					2	3							2	3
Goldeye									1	30			1	30
Channel catfish									1	12			1	12
White bass			1	52			1	140	1	20	1	12	4	224
Sauger			3	135	1	190	3	890					7	1215
Freshwater drum	6	43							3	268	2	180	11	491
TOTAL	15	3269	65	2556	89	4141	60	4700	11	1119	9	714	249	16499
Total Shocking Time	15 min		15 min		15 min		15 min		15 min		15 min			

* Refer to Figure 3E-5.

TABLE 3E-9

TOTAL NUMBER AND BIOMASS OF FISH CAUGHT IN LAKE MCKELLAR BY GILL NETS DURING THE FALL SURVEY ON OCTOBER 19, 1978

Location:	LM1-A*		LM1-C*		LM2-A*		LM2-C*		LM2-END*		TOTAL	
Common Name	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)
River carpsucker	1	210	1	21	2	620			1	520	5	1371
Skipjack herring			1	270			1	20	5	157	7	447
Gizzard shad			4	515	2	360	5	393	4	268	15	1536
Dollar sunfish			1	13							1	13
Blue catfish					2	1140	1	820			3	1960
Channel catfish	2	510			1	250					3	760
White bass			1	585							1	585
Sauger	2	760			1	200					3	960
Freshwater drum	1	275									1	275
TOTAL	6	1755	8	1404	8	2570	7	1233	10	945	39	7907
Total Time Net Set:	5 hours 10 min		5 hours 5 min		4 hours 50 min		5 hours 10 min		4 hours 35 min			

* Refer to Figure 3E-5.

TABLE 3E-10

TOTAL NUMBER AND BIOMASS OF FISH CAUGHT BY HOOP NETS IN THE MISSISSIPPI RIVER DURING THE FALL SURVEY ON OCTOBER 16 AND 17, 1978

Location:	MR1-A*		MR1-B*		MR2-A*		MR2-B*		TOTAL	
Common Name	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)
Gizzard shad	2	305	1	275	No Fish Taken		No Fish Taken		3	580
TOTAL	2	305	1	275	0	0	0	0	3	580
Total Time Net Set:	22 hr	50 min	22 hr	25 min	22 hr	25 min	22 hr	25 min		

* Refer to Figure 3E-5.

TABLE 3E-11

TOTAL NUMBER AND BIOMASS OF FISH CAUGHT IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER BY ELECTROSHOCKING DURING THE WINTER SURVEY ON JANUARY 12 AND 13, 1979

Location:	LM1-A*		LM1-C*		LM2-A*		LM2-C*		MR1*		MR2*		TOTAL	
Common Name	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)
Mississippi silverside	4	18			4	17							8	35
River carpsucker											4	1,945	4	1,945
Bigmouth buffalo	3	8,200	11	34,900	3	11,300	9	22,603			3	11,850	29	88,853
Black buffalo					1	1,200	2	1,805			1	3,600	4	6,605
Orangespotted sunfish					1	4							1	4
Bluegill					1	3	1	56			1	46	3	105
Longear sunfish							1	38					1	38
White crappie					7	462	2	660					9	1,122
Black crappie			1	180	3	36							4	216
Skipjack herring					7	43							7	43
Gizzard shad	7	123	15	2,180	38	2,376	6	901	16	573	15	1,068	97	7,221
Threadfin shad					14	162							14	162
Carp	1	2,700					1	3,850			1	3,200	3	9,750
Golden shiner											1	48	1	48
Emerald shiner	1	3											1	3
Goldeye			1	40					2	74	6	455	9	569
Rainbow smelt					1	1							1	1
Yellow bass							2	540					2	540
Sauger											1	50	1	50
Freshwater drum							1	49					1	49
TOTAL	16	11,044	28	37,300	80	15,604	25	30,502	18	647	33	22,262	200	117,359
Total Shocking Time:	15 min		15 min		15 min		15 min		15 min		15 min			

* Refer to Figure 3E-5.

TABLE 3E-12

TOTAL NUMBER AND BIOMASS OF FISH CAUGHT IN LAKE MCKELLAR BY GILL NETS DURING WINTER SURVEY ON JANUARY 13, 1979

Location:	LM1-A*		LM1-C*		LM2-A*		LM2-END*		LM2-C*		TOTAL	
Common Name	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)
Gizzard shad	1	12	1	35	3	219	2	319	4	301	11	886
Threadfin shad					16	318	3	53	40	763	59	1134
Golden shiner							1	35			1	35
Goldeye					3	112					3	112
TOTAL	1	12	1	35	22	649	6	407	44	1064	74	2167
Total Time Net Set:	4 hr	35 min	5 hr	30 min	6 hr	5 min	7 hr	15 min	5 hr	40 min		

* Refer to Figure 3E-5.

TABLE 3E-13

TOTAL NUMBER AND BIOMASS OF FISH CAUGHT BY HOOP NETS IN THE MISSISSIPPI RIVER DURING THE WINTER SURVEY ON JANUARY 13 and 14, 1979

Location:	MR1-A*		MR1-B*		MR2-A* River		MR2-B* Discharge		TOTAL	
Common Name	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)	No.	Biomass (grams)
River carpsucker	No Fish Taken		1	111	No Fish Taken		No Fish Taken		1	111
Freshwater drum	–	—	1	122	–	—	–	—	1	122
TOTAL	0	0	2	233	0	0	0	0	2	233
Total Time Net Set:	22 hr	15 min	22 hr	25 min	22 hr	30 min	22 hr	25 min		

* Refer to Figure 3E-5.

TABLE 3E-14

TOTAL NUMBER AND BIOMASS OF FISH COLLECTED IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER DURING THE AQUATIC SURVEYS IN MAY, JULY AND OCTOBER 1978 AND JANUARY 1979 BY ELECTROSHOCKING, BAITED HOOP NETS AND GILL NETS

Scientific Name	Common Name	Total Number of Fish	Percent of Total Number	Total Biomass of Fish (grams)	Percent of Total Biomass
ATHERINIDAE	(Silversides)				
Labidesthes sicculus	Brook silverside	5	.4	14	<.1
Menidia audens	Mississippi silverside	31	2.5	117	<.1
CATOSTOMIDAE	(Suckers)				
Carpiodes carpio	River carpsucker	44	3.5	22,807	9.3
Carpiodes cyprinus	Quillback	1	.1	1,120	.5
Ictiobus bubalus	Smallmouth buffalo	4	.3	3,505	1.4
Ictiobus cyprinellus	Bigmouth buffalo	31	2.5	92,234	37.5
Ictiobus niger	Black buffalo	6	.5	8,025	3.3
CENTRARCHIDAE	(Sunfish)				
Centrarchus macropterus	Flier	1	.1	140	.1
Lepomis cyanellus	Green sunfish	1	.1	9	<.1
Lepomis humilis	Orangespotted sunfish	5	.4	26	<.1
Lepomis macrochirus	Bluegill	12	1.0	472	.2
Lepomis marginatus	Dollar sunfish	6	.5	99	<.1
Lepomis megalotis	Longear sunfish	62	4.9	2,030	.8
Lepomis microlophus	Redear sunfish	1	.1	10	<.1
Micropterus salmoides	Largmouth bass	19	1.5	4,089	1.7
Pomoxis annularis	White crappie	14	1.1	1,841	.7
Pomoxis nigromaculatus	Black crappie	4	.3	216	.1
CLUPEIDAE	(Herrings)				
Alosa chrysochloris	Skipjack herring	22	1.7	2,185	.9
Dorosoma cepedianum	Gizzard shad	725	57.6	51,611	21.0
Dorosoma petenense	Threadfin shad	81	6.4	1,345	.5
CYPRINIDAE	(Minnows)				
Cyprinus carpio	Carp	8	.6	24,920	10.2
Notemigonus crysoleucas	Golden shiner	21	1.7	131	.1
Notropis atherinoides	Emerald shiner	11	.9	49	<.1
Notropis blennius	River shiner	1	.1	4	<.1
Notropis lutrensis	Red shiner	6	.5	8	<.1
Notropis shumardi	Silverband shiner	2	.2	8	<.1
Notropis volucellus	Mimic shiner	1	.1	2	<.1
Pimephales vigilax	Bullhead minnow	14	1.1	34	<.1
HIODONTIDAE	(Mooneyes)				
Hiodon alosoides	Goldeye	20	1.6	778	.3
ICTALURIDAE	(Catfish)				
Ictalurus furcatus	Blue catfish	6	.5	2,870	1.2
Ictalurus punctatus	Channel catfish	16	1.3	6,569	2.7
Pylodictis olivaris	Flathead catfish	6	.5	2,900	1.2
LEPISOSTEIDAE	(Gars)				
Lepisosteus oculatus	Spotted gar	3	.2	2,045	.8
Lepisosteus platostomus	Shortnose gar	9	.7	4,645	1.9
OSMERIDAE	(Smelts)				
Osmerus mordax	Rainbow smelt	1	.1	1	<.1
PERCICHTHYIDAE	(Temperate bass)				
Morone chrysops	White bass	12	1.0	885	.4
Morone mississippiensis	Yellow bass	2	.2	540	.2
PERCIDAE	(Perches)				
Stizostedion canadense	Sauger	17	1.4	3,316	1.3
SCIAENIDAE	(Drums)				
Aplodinotus grunniens	Freshwater drum	29	2.3	4,153	1.7
TOTALS		1,260	<100.4	245,753	<101.3

A number of sport fish species were collected, including largemouth bass; sauger; white bass; yellow bass; white and black crappie; bluegill and other sunfish; and channel, blue and flathead catfish. Individually, these species were not substantial components of the catch; but collectively, they constituted approximately 14.6 percent of the total number and 10.6 percent of the total biomass of the catch.

3E.3.1.1.2 EFFECTIVENESS OF FISHING GEAR

Types of fishing gear employed in the 1978-79 aquatic surveys were not equally effective at capturing fish as is shown in Table 3E-15. Electroshocking was the most effective method, averaging 159 fish caught per hour. Gill nets caught an average of 1.5 fish per hour and hoop nets only 0.64 fish per hour.

Despite the variation of efficiencies, use of a variety of techniques contributes to a more complete survey. Twenty of the thirty-nine species collected were caught only by electroshocking. Of the species taken in gill nets, only flier and redear sunfish were not collected by another technique. Hoop nets contained no unique species. Finally, blue catfish were not represented in electroshocking collections, but were captured in both hoop and gill nets.

3E.3.1.1.3 SEASONAL AND LOCAL VARIATION IN FISH COLLECTIONS

Table 3E-16 shows that the total fish catch varied seasonally. The total number of species caught was similar during the May (19 species), October (20 species) and January (20 species) surveys, but was higher during July (27 species). Total number of fish in the collections was highest in May (404 fish), followed by October (291 fish), July (289 fish) and January (276 fish). Total biomass differed, being greatest (119,759 grams) in the January catch, followed by May (72,250 grams), July (28,758 grams) and October (24,986 grams).

TABLE 3E-15

CATCH OF FISH PER HOUR IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER FOR ELECTROSHOCKING, GILL NETS AND HOOP NETS

Survey	Electroshocking	Gill Nets	Hoop Nets
May 1978	191	1.3	0.45
July 1978	146	0.6	0.14
October 1978	166	1.6	0.03
January 1979	133	2.5	0.02
Average	159	1.5	0.64

TABLE 3E-16

SEASONAL VARIATION IN THE TOTAL FISH CATCH FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER DURING 1978-79 FIELD SURVEYS

Survey	Number Species	Total Number Fish Caught	Total Biomass of Catch	Average Size (grams/fish)
May 1978	19	404	72,250	179
July 1978	27	289	28,758	100
October 1978	20	291	24,986	86
January 1979	20	276	119,759	434

These variations indicated that: (1) the July catch was most diverse, (2) average fish size was greatest in the nearshore regions of the study area in January and (3) abundance and average fish size decreased from May through October. Examination of Tables 3E-2 to 3E-13 provides some insight for the interpretation of these variations. For example, the January collection was strongly influenced by the capture of a number of large bigmouth buffalo in Lake McKellar. The May collection reflects the influence of several species of suckers (Catastomidae) that were probably spawning in April and early May (refer also to Section 3E.3.1.2). The July and October collections contained more minnows and small sunfish than the others.

A reorganization of the data indicates some overall differences between locations (Tables 3E-17 and 3E-18). Data from transects MR1 and MR2 were combined since they appeared to be quite similar. Fewer fish of fewer taxa were collected in the Mississippi River than in Lake McKellar.

A total of 272 fish of 20 species, weighing 68,607 grams (151 pounds) were caught (Table 3E-17). The most abundant fish in these collections was gizzard shad (except in July when it was absent from the river collections) while the bulk of the total biomass was accounted for by river carpsucker, and a relatively small number of bigmouth and black buffalo, carp and flathead and channel catfish. Few minnows or sport fish species were encountered. These collections indicate that the fish community of the Mississippi River is dominated by rough and forage fish, with infrequent occurrences of warmwater sport fish.

In Lake McKellar, a total of 988 fish in 37 species (Table 3E-18), weighing a total of 177,146 grams (390 pounds) was collected. Gizzard shad was the most abundant fish in the collections, contributing an average of 55 percent of the total number of fish, followed by threadfin shad (8.2 percent) and longear sunfish (6.3 percent). A number of sport fish species were collected, including largemouth bass, sauger, white bass, yellow bass, channel catfish and sunfish and crappies.

TABLE 3E-17

TOTAL NUMBER OF FISH COLLECTED IN THE MISSISSIPPI RIVER DURING MAY, JULY AND OCTOBER 1978 AND JANUARY 1979 SURVEYS BY MEANS OF ELECTROSHOCKING AND HOOP NETS

Scientific Name	Common Name	Number	Percent
Atherinidae			
Menidia audens	Mississippi silversides	1	0.4
Catostomidae			
Carpiodes carpio	River carpsucker	27	9.9
Ictiobus cyprinellus	Bigmouth buffalo	4	1.5
Ictiobus niger	Black buffalo	1	0.4
Centrarchidae			
Lepomis macrochirus	Bluegill	1	0.4
Pomoxis annularis	White crappie	1	0.4
Clupeidae			
Alosa chrysochloris	Skipjack herring	3	1.1
Dorosoma cepedianum	Gizzard shad	182	66.9
Cyprinidae			
Cyprinus carpio	Carp	3	1.1
Notemigus crysoleucas	Golden shiner	1	0.4
Notropis atherinoides	Emerald shiner	3	1.1
Notropis blennius	River shiner	1	0.4
Notropis volucellus	Mimic shiner	1	0.4
Hiodontidae			
Hiodon alosoides	Goldéye	15	5.5
Ictaluridae			
Ictalurus furcatus	Blue catfish	1	0.4
Ictalurus punctatus	Channel catfish	4	1.5
Pylodictus olivaris	Flathead catfish	4	1.5
Percichthyidae			
Morone chrysops	White bass	2	0.7
Percidae			
Stizostedion canadense	Sauger	2	0.7
Scicenidae			
Aplodinotus grunniens	Freshwater drum	15	5.5
TOTAL		272	100.2

TABLE 3E-18

TOTAL NUMBER OF FISH COLLECTED IN LAKE MCKELLAR DURING MAY, JULY AND OCTOBER 1978 AND JANUARY 1979 SURVEYS BY MEANS OF ELECTROSHOCKING AND GILL NETS

	Location*					
	LM1		LM2		Total	
Common Name	Number	Percent	Number	Percent	Number	Percent
Brook silverside	1	0.3	4	0.7	5	0.5
Mississippi silverside	8	2.1	22	3.6	30	3.0
River carpsucker	4	1.0	13	2.2	17	1.7
Quillback	1	0.3			1	0.1
Smallmouth buffalo			4	0.7	4	0.4
Bigmouth buffalo	14	3.6	13	2.2	27	2.7
Black buffalo			5	0.8	5	0.5
Flier			1	0.2	1	0.1
Green sunfish	1	0.3			1	0.1
Orangespotted sunfish	3	0.8	2	0.3	5	0.5
Bluegill	1	0.3	10	1.7	11	1.1
Dollar sunfish	4	1.0	2	0.3	6	0.6
Longear sunfish	3	0.8	59	9.8	62	6.3
Redear sunfish			1	0.2	1	0.1
Largemouth bass	2	0.6	17	2.8	19	1.9
White crappie	3	0.8	10	1.7	13	1.3
Black crappie	1	0.3	3	0.5	4	0.4
Skipjack herring	4	1.0	15	2.5	19	1.9
Gizzard shad	255	66.2	288	47.8	543	55.0
Threadfin shad	8	2.1	73	12.1	81	8.2
Carp	2	0.6	3	0.3	5	0.5
Golden shiner	3	0.8	17	2.8	20	2.0
Emerald shiner	6	1.6	2	0.3	8	0.8
Red shiner	6	1.6			6	0.6
Silverband shiner	2	0.6			2	0.2
Bullhead minnow	12	3.1	2	0.3	14	1.4
Goldeye	1	0.3	4	0.7	5	0.5
Blue catfish	1	0.3	4	0.7	5	0.5
Channel catfish	5	1.3	7	1.2	12	1.2
Flathead catfish	2	0.6			2	0.2
Spotted gar	1	0.3	2	0.3	3	0.3
Shortnose gar	5	1.3	4	0.7	9	0.9
Rainbow smelt			1	0.2	1	0.1

(Continued)

TABLE 3E-18 (Continued)

Common Name	Location* LM1 Number	LM1 Percent	LM2 Number	LM2 Percent	Total Number	Total Percent
White bass	7	1.8	3	0.5	10	1.0
Yellow bass			2	0.3	2	0.2
Sauger	7	1.8	8	1.3	15	1.5
Freshwater drum	12	3.1	2	0.3	14	1.4
TOTAL	385	100.6	603	101.0	988	99.7

* See Figure 3E-2 for approximate locations

Table 3E-18 also suggests some differences between transects, with LM2 accounting for 61 percent of the catch and LM1 only 39 percent. This seems to be due to some differences among less abundant taxa, notably the greater catches of longear sunfish, largemouth bass, bluegill and white crappie in the turning basin (LM2). Furthermore, in three seasons out of four, station LM2-A yielded substantially more fish than LM2-B.

It appears that Lake McKellar harbors a varied assemblage of warmwater fishes, predominantly forage fish such as shads. Several sportfish species occur, although only members of the sunfish family (small sunfishes, crappie, largemouth bass) appear to be of more than minor importance.

In an attempt to detect differences in fish community composition between stations within each season, electroshocking catches were compared using a measure of the similarity between samples, the index of sample association (I):

$$I = 100\ (1 - 0.5\ \Sigma|a_i - b_i|) \qquad \text{(3E-1)}$$

where a_i and b_i are the proportions of species i in samples A and B. Using this index, two samples with no species in common will produce a zero value of I, while identical samples will yield 100. Only electroshocking results were used in these analyses because this technique was the only one used at all locations and is therefore properly comparable. Tables 3E-19 through 3E-22 present the matrices of comparisons of all locations for the May, July and October 1978 and January 1979 surveys. These similarity matrices were used as input for clustering analysis,[42,43] which graphically presents the resemblance between locations (Figure 3E-6).

In Figure 3E-6, locations that yielded the most similar fish catches are paired with the uppermost horizontal line. The next most similar location, in terms of fish captured by electroshocking, is then matched with this pair, and so on. The level of the horizontal line describes the level of similarity, from 0 to 100 percent.

TABLE 3E-19

INDICES OF SAMPLE ASSOCIATION* AMONG ELECTROSHOCKING CATCHES FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER FOR THE MAY 1978 SURVEY

Location**	LM1-A	LM1-C	LM2-A	LM2-C	LM2 Lagoon	MR1	MR2
LM1-A		97.7	83.6	82.7	64.7	96.4	95.5
LM1-C			83.6	82.4	64.7	96.4	95.5
LM2-A				86.6	73.7	83.3	82.1
LM2-C					73.8	81.8	80.7
LM2-Lagoon						65.9	64.7
MR-1							96.8
MR-2							

* Extent to which two samples are alike, ranging from zero for samples with no species in common to 100 for identical samples

** Refer to Figure 3E-3 for location descriptions.

TABLE 3E-20

INDICES OF SAMPLE ASSOCIATION* AMONG ELECTROSHOCKING CATCHES FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER FOR THE JULY 1979 SURVEY

Location**	LM1-A	LM1-C	LM2-A	LM2-C	MR1	MR2
LM1-A		40.1	32.1	36.0	1.8	1.8
LM1-C			79.2	67.7	2.8	2.8
LM2-A				67.3	4.5	0
LM2-C					0	0
MR-1						60
MR-2						

* Extent to which two samples are alike, ranging from zero for samples with no species in common to 100 for identical samples

** Refer to Figure 3E-4 for location descriptions.

TABLE 3E-21

INDICES OF SAMPLE ASSOCIATION* AMONG ELECTROSHOCKING CATCHES FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER FOR THE OCTOBER 1978 SURVEY

Location**	LM1-A	LM1-C	LM2-A	LM2-C	MR1	MR2
LM1-A		9.7	13.3	16.7	43.0	46.0
LM1-C			20.2	72.4	3.1	40.8
LM2-A				45.2	9.1	26.1
LM2-C					10.0	41.0
MR-1						53.6
MR-2						

* Extent to which two samples are alike, ranging from zero for samples with no species in common to 100 for identical samples

** Refer to Figure 3E-5 for location descriptions.

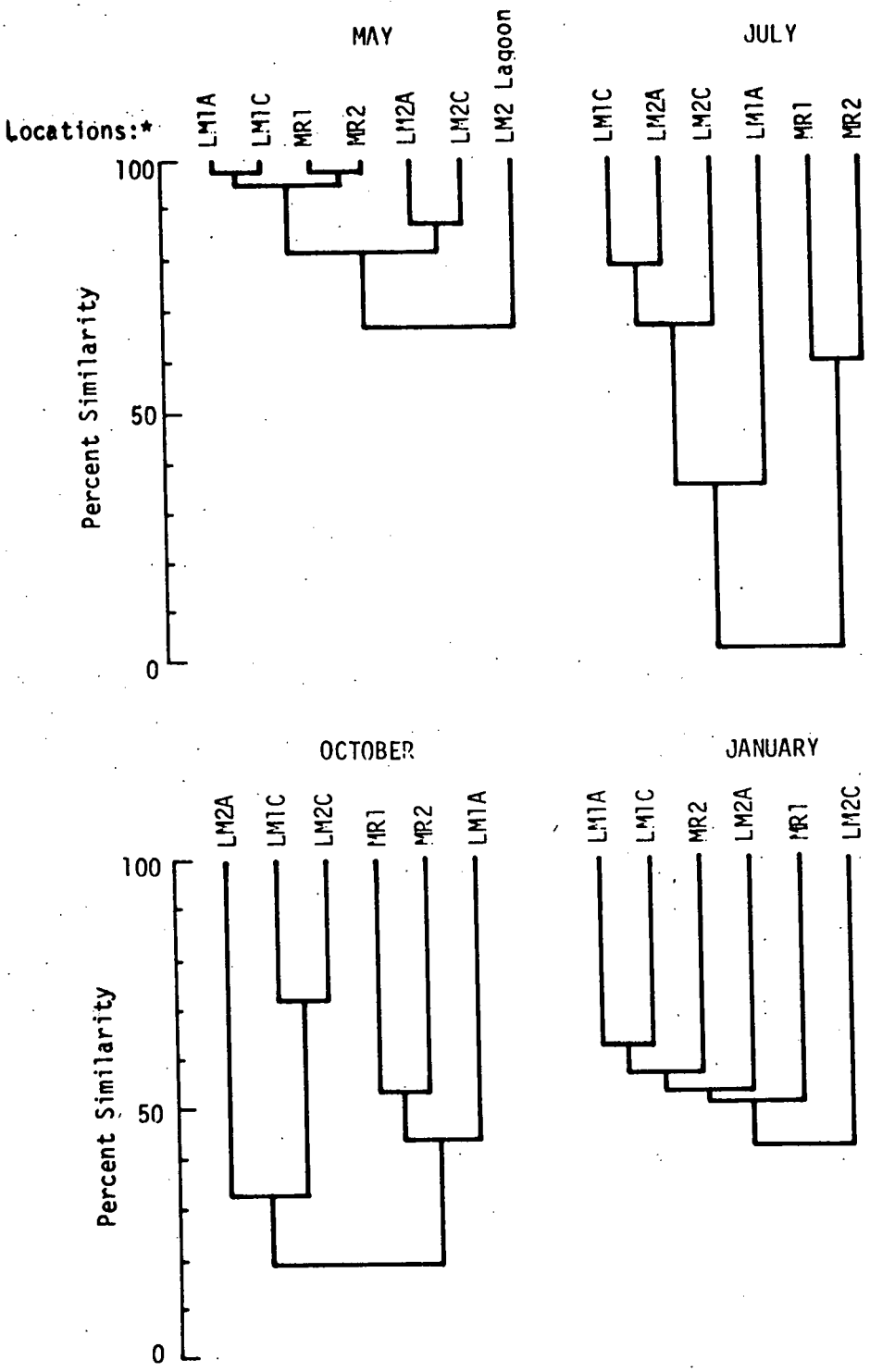
TABLE 3E-22

INDICES OF SAMPLE ASSOCIATION* AMONG ELECTROSHOCKING CATCHES FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER FOR THE JANUARY 1979 SURVEY

Location**	LM1-A	LM1-C	LM2-A	LM2-C	MR1	MR2
LM1-A		62.5	52.5	46.8	43.8	55.9
LM1-C			54.8	60	57.1	58.1
LM2-A				38.3	47.5	51.7
LM2-C					24	42.2
MR-1						56.6
MR-2						

* Extent to which two samples are alike, ranging from zero for samples with no species in common to 100 for identical samples

** Refer to Figure 3E-5 for location descriptions.



* Refer to Figures 3E-3, 3E-4 and 3E-5 for location descriptions.

Figure 3E-6. Cluster Analysis of Index of Association Data for Fish Caught by Electroshocking During Field Surveys of Lake McKellar and the Mississippi River in May, July and October 1978 and January 1979

In the May 1978 samples, the stations at the mouth of Lake McKellar (LM1 in Figure 3E-3), i.e. the Tennessee Chute, are very similar (I = 97.7) as are the two Mississippi River transects, MR1 and MR2 (I = 96.8). In turn, these two pairs are about 96 percent similar. The stations in the turning basin (LM2-A and LM2-C) form another pair (I = 86.6) that is approximately 82 percent similar to the others. The lagoon area, a temporary habitat formed by high-water levels, is only about 68 percent similar to the other stations. In general, these are high values, reflective of a general onshore movement of many fish attendant to spawning activities.

In the July 1978 fish samples, stations LM1-C, LM2-A and LM2-C cluster at 65 to 80 percent similarity. This is best explained by the fact that the first three stations were dominated by gizzard shad (see Table 3E-5). The Mississippi River assemblages form a second cluster (I = 60), due to the preponderance of goldeyes in these sparse samples. The sample from the north shore area of the Tennessee Chute (LM1-A) is only about 36 percent similar to those taken at other Lake McKellar stations, since more minnow species, the silversides and several catfish were caught at LM1-A (Table 3E-5), making the sample more diverse than the others.

Fish samples collected in the October electroshocking had generally lower similarities than previous samples (Figure 3E-6). LM2-C and LM1-C in Lake McKellar again were clustered (I = 72), as were the two Mississippi River stations (I = 54). LM2-A yielded a sample only 33 percent similar to LM2-C and LM2-A, caused mainly by a higher proportion of sunfish and largemouth bass at the north shore of LM2 (adjacent to the proposed site). The sample taken at LM1-A was more similar to those from Mississippi River stations (I = 44.5) than to those from other Lake McKellar stations. The resulting two main branches seen in Figure 3E-6 seem to reflect high (LM2-A, LM2-C and LM1-C) versus low (LM1-A, MR1 and MR2) catches of gizzard shad (see Table 3E-8).

Finally, January samples were not very similar (I = 42 to 62) to one another, and fall into no easily interpretable pattern. The clustering illustrated in Figure 3E-6 seems to be related to the proportionate representation of

bigmouth buffalo and gizzard shad (the two predominant species) in the samples (see Table 3E-11).

3E.3.1.2 ICHTHYOPLANKTON

Tables 3E-23 through 3E-37 detail catch data for the fourteen ichthyoplankton sampling surveys from March 15 to June 15, 1978, plus one additional dusk survey on the evening of June 8, 1978. This data is the basis of discussion of the topics treated in the following paragraphs. Note that one-half of each sample was counted, so each count was doubled for total density calculations.

3E.3.1.2.1 CATCH COMPOSITION

The total catch for the fourteen regular daylight sampling trips is summarized in Table 3E-38. Seventeen taxa of larvae in nine fish families were collected during this period. More or fewer species may actually be represented in the samples, but the current state of ichthyoplankton taxonomy in many cases does not allow specific identification, especially of younger specimens. Thus the "family" designation under "percidae" (for example) may include other percids (yellow perch, for example), or may be limited to the sauger/walleye group. Also, larvae counted under sauger/walleye may be either species or both may be included. This difficulty also explains the anomolous "Catostomidae or Cyprinidae" grouping: very young or damaged specimens which cannot be assigned to either family decisively are listed here. A final grouping is "eggs". In most cases, eggs cannot be classified beyond designation as fish eggs. An exception is eggs of freshwater drum; however, none of these were noted.

Major components of the ichthyoplankton were the clupeids (gizzard shad, threadfin shad and skipjack herring), accounting for 38.3 percent of the catch; freshwater drum, 16 percent; members of the sunfish family (including crappie), 12.6 percent; suckers (Catostomidae), 10.1 percent; carp, 9.5 percent; and eggs, 8.1 percent.

TABLE 3E-23

ICHTHYOPLANKTON DATA FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER ON MARCH 15, 1978

Sample Number	Location*	Total Depth (ft)	No. Levels Sampled	Water Temperature (°C)	Sample Volume Meters^3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100 Meters^3
030	LM1-A		3	6.5	45.1	No fish eggs, larvae or juveniles collected.		0	
025	LM1-A		3	6.5	56.5	No fish eggs, larvae or juveniles collected.		0	
050	LM1-C		3	6.5	43.4	No fish eggs, larvae or juveniles collected.		0	
040	LM1-C		3	6.5	38.1	No fish eggs, larvae or juveniles collected.		0	
010	LM2-A		3	7.0	46.1	No fish eggs, larvae or juveniles collected.		0	
020	LM2-A		3	7.0	41.1	No fish eggs, larvae or juveniles collected.		0	
005	LM2-C		3	7.0	45.5	No fish eggs, larvae or juveniles collected.		0	
015	LM2-C		3	7.0	40.8	No fish eggs, larvae or juveniles collected.		0	
055	MR1		3	5.0	81.5	No fish eggs, larvae or juveniles collected.		0	
060	MR1		3	5.0	74.7	No fish eggs, larvae or juveniles collected.		0	
045	MR2		3	5.0	83.7	No fish eggs, larvae or juveniles collected.		0	
035	MR2		3	5.0	84.2	No fish eggs, larvae or juveniles collected.		0	
Totals					680.7			0	

Average Number of Organisms per 100 m^3 = 0

* Refer to Figure 3E-2 for location

** In one-half sample

TABLE 3E-24

ICHTHYOPLANKTON DATA FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER ON MARCH 22, 1978

Sample Number	Location*	Total Depth (ft)	No. Levels Sampled	Water Temperature (°C)	Sample Volume Meters^3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100 Meters^3
090	LM1-A	45	3	10.0	43.7	No fish eggs, larvae or juveniles collected.		0	
095	LM1-A		3		45.4	No fish eggs, larvae or juveniles collected.		0	
080	LM1-C	25	3	10.0	49.7	No fish eggs, larvae or juveniles collected.		0	
100	LM1-C		3		42.5	No fish eggs, larvae or juveniles collected.		0	
070	LM2-A	30	3	10.0	44.8	No fish eggs, larvae or juveniles collected.		0	
085	LM2-A		3		44.7	No fish eggs, larvae or juveniles collected.		0	
075	LM2-C	50	3	10.0	43.5	No fish eggs, larvae or juveniles collected.		0	
065	LM2-C		3		46.4	No fish eggs, larvae or juveniles collected.		0	
105	MR1	51	3	6.0	52.0	No fish eggs, larvae or juveniles collected.		0	
110	MR1		3		54.2	No fish eggs, larvae or juveniles collected.		0	
115	MR2	53	3	6.0	44.0	No fish eggs, larvae or juveniles collected.		0	
120	MR2		3		46.3	No fish eggs, larvae or juveniles collected.		0	
Totals					557.2			0	

Average Number of Organisms per 100 m^3 = 0

* Refer to Figure 3E-2 for location

** In one-half sample

TABLE 3E-25

ICHTHYOPLANKTON DATA FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER ON MARCH 28, 1978

Sample Number	Location*	Total Depth	No. Levels Sampled	Water Temperature (°C)	Sample Volume Meters^3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100 Meters^3
155	LM1-A	48	3	9.8	43.0	No fish eggs, larvae or juveniles collected.		0	
165	LM1-A		3		43.0	No fish eggs, larvae or juveniles collected.		0	
125	LM1-C	29	3	9.5	41.4	No fish eggs, larvae or juveniles collected.		0	
140	LM1-C		3		43.3	No fish eggs, larvae or juveniles collected.		0	
130	LM2-A	56	3	9.5	43.8	No fish eggs, larvae or juveniles collected.		0	
145	LM2-A		3		42.9	No fish eggs, larvae or juveniles collected.		0	
150	LM2-C	51	3	9.5	45.7	No fish eggs, larvae or juveniles collected.		0	
135	LM2-C		3		45.4	No fish eggs, larvae or juveniles collected.		0	
175	MR1	52	3	7.0	60.3	No fish eggs, larvae or juveniles collected.		0	
170	MR1		3		71.6	No fish eggs, larvae or juveniles collected.		0	
160	MR2	54	3	7.0	50.0	No fish eggs, larvae or juveniles collected.		0	
180	MR2		3		45.9	No fish eggs, larvae or juveniles collected.		0	
Totals					576.3			0	

Average Number of Organisms per 100 m^3 = 0

* Refer to Figure 3E-2 for location

** In one-half sample

TABLE 3E-26

ICHTHYOPLANKTON DATA FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER ON APRIL 5, 1978

Sample Number	Location*	Total Depth	No. Levels Sampled	Water Temperature (°C)	Sample Volume Meters^3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100 Meters^3
235	LM1-A	48	3		45.8	No fish eggs, larvae or juveniles collected.		0	
240	LM1-A		3		47.7	No fish eggs, larvae or juveniles collected.		0	
200	LM1-C	43	3	13.5	46.3	Catostomidae/sucker (family)	Mid-prolarva	1	4
225	LM1-C		3		49.1	No fish eggs, larvae or juveniles collected.		0	
230	LM2-A	55	3	14.5	46.6	No fish eggs, larvae or juveniles collected.		0	
190	LM2-A		3		47.6	No fish eggs, larvae or juveniles collected.		0	
185	LM2-C	54	3	14.0	47.6	No fish eggs, larvae or juveniles collected.		0	
195	LM2-C		3		46.4	No fish eggs, larvae or juveniles collected.		0	
220	MR1	54	3	11.0	58.2	No fish eggs, larvae or juveniles collected.		0	
215	MR1		3		82.3	No fish eggs, larvae or juveniles collected.		0	
205	MR2	60	3	11.0	64.6	No fish eggs, larvae or juveniles collected.		0	
210	MR2		3		60.2	No fish eggs, larvae or juveniles collected.		0	
Total					642.0			1	

Average Number of Organisms per 100 m^3 = 0.3

* Refer to Figure 3E-2 for location

** In one-half sample

TABLE 3E-27

ICHTHYOPLANKTON DATA FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER ON APRIL 11, 1978

Sample Number	Location*	Total Depth	No. Levels Sampled	Water Temperature (°C)	Sample Volume Meters^3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100 Meters^3*
250	LM1-A	47	3	15.0	46.2	Cyprinidae/Minnow	Mid-prolarvae	2	9
280	LM1-A		3		44.6	No fish eggs, larvae or juveniles collected.		0	
275	LM1-C	29	3	15.5	46.3	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	4
						Cyprinidae/Carp	Mid-prolarvae	2	9
						Cyprinidae/Carp	Late-prolarva	1	4
285	LM1-C		3		45.4	Catostomidae/Sucker (family)	Mid-prolarvae	3	13
						Catostomidae/Sucker (family)	Late-prolarva	1	4
						Cyprinidae/Carp	Late-prolarva	1	4
270	LM2-A	51	3	16.0	45.8	Cyprinidae/Carp	Mid-prolarva	1	4
						Cyprinidae/Carp	Early-postlarvae	11	48
295	LM2-A		3		47.0	Cyprinidae/Carp	Mid-prolarvae	5	21
						Cyprinidae/Carp	Late-prolarva	1	4
245	LM2-C	47	3	16.0	47.9	Cyprinidae/Carp	Mid-prolarva	1	4
						Cyprinidae/Carp	Late-prolarvae	2	8
						Cyprinidae/Carp	Early-postlarvae	2	8
265	LM2-C		3		45.7	Cyprinidae/Carp	Late-prolarva	1	4
						Cyprinidae/Carp	Early-postlarvae	2	9
260	MR1	45	3	15.2	60.4	Cyprinidae/Carp	Mid-prolarva	1	3
300	MR1				61.7	No fish eggs, larvae or juveniles collected.		0	
255	MR2	50	3	15.0	59.7	Cyprinidae/Carp	Mid-prolarva	1	3
290	MR2		3		62.9	No fish eggs, larvae or juveniles collected.		0	
Totals					613.6			39	

Average Number of Organisms per 100 m^3 = 12.7

* Refer to Figure 3E-2 for location

** In one-half sample

TABLE 3E-28

ICHTHYOPLANKTON DATA FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER ON APRIL 18, 1978

Sample Number	Location*	Total Depth	No. Levels Sampled	Water Temperature (°C)	Sample Volume Meters^3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100 Meters^3
340	LM1-A	38	3	16.5	49.7	Catostomidae or Cyprinidae/Sucker or Minnow	Early-postlarva	1	4
345	LM1-A		3		48.9	Catostomidae/Sucker (family)	Late-prolarvae	3	12
310	LM1-C	22	3	16.7	47.6	Catostomidae/Sucker (family)	Early-postlarva	1	4
						Cyprinidae/Minnow group	Mid-prolarva	1	4
325	LM1-C		3		47.8	Cyprinidae/Minnow (probably Notropis sp.)	Early-postlarva	1	4
330	LM2-A	43	3	17.0	46.3	Cyprinidae/Minnow group	Early-postlarva	1	4
315	LM2-A		3		47.4	No fish eggs, larvae or juveniles collected.		0	
305	LM2-C	43	3	17.0	44.8	No fish eggs, larvae or juveniles collected.		0	
355	LM2-C		3		45.2	No fish eggs, larvae or juveniles collected.		0	
335	MR1	38	3	15.0	60.1	Catostomidae/Sucker (probably Carproidesoi Ictiobus)	Early-postlarva	1	3
360	MR1		3		58.0	No fish eggs, larvae or juveniles collected.		0	
320	MR2	39	3	14.9	63.0	Catostomidae/Sucker (probably Carproides or Ictiobus)	Early-postlarvae	2	6
						Catostomidae/Sucker (family)	Mid-prolarvae	5	16
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	3
						Cyprinidae/Carp	Mid-prolarva	1	3
						Percidae/Perch (probably Stizostedian sp.)	Mid-prolarva	1	3
350	MR2		3		57.9	Catostomidae/Sucker (probably Carproides or Ictiobes sp.)	Early-postlarva	1	3
						Catostomidae/Sucker (family)	Mid-prolarva	1	3
						Catostomidae/Sucker (family)	Early-postlarvae	4	14
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	2	7
						Cyprinidae/Carp	Mid-prolarva	1	3
Totals					616.7			28	

Average Number of Organisms per 100 m^3 = 9.1

* Refer to Figure 3E-2 for location

** In one-half sample

TABLE 3E-29

ICHTHYOPLANKTON DATA FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER ON APRIL 25, 1978

Sample Number	Location*	Total Depth	No. Levels Sampled	Water Temperature (°C)	Sample Volume Meters^3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100 Meters^3
385	LM1-A	34	3	15.0	46.8	Catostomidae/Sucker (family)	Late-prolarva	1	4
395	LM1-A		3		44.2	No fish eggs, larvae or juveniles collected.		0	
390	LM1-C	17	2	15.0	19.4	No fish eggs, larvae or juveniles collected.		0	
370	LM1-C		2		22.0	No fish eggs, larvae or juveniles collected.		0	
400	LM2-A	40	3	16.5	47.7	Cyprinidae/Carp	Late-prolarva	1	4
375	LM2-A		3		45.9	No fish eggs, larvae or juveniles collected.		0	
365	LM2-C	36	3	16.8	47.9	No fish eggs, larvae or juveniles collected.		0	
380	LM2-C		3		50.3	No fish eggs, larvae or juveniles collected.		0	
405	MR1	38	3	14.0	60.1	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	3
						Cyprinidae/Minnow group	Early-postlarva	1	3
420	MR1		3		46.3	No fish eggs, larvae or juveniles collected.		0	
415	MR2	41	3	14.0	58.0	Catostomidae/Sucker (family)	Late-prolarva	1	3
						Catostomidae/Sucker (family)	Early-postlarva	1	3
						Cyprinidae/Carp	Mid-prolarva	1	3
						Cyprinidae/Carp	Late-prolarvae	2	7
410	MR2		3		62.2	Catostomidae/Sucker (family)	Early-postlarvae	2	6
						Cyprinidae/Carp	Mid-prolarva	1	3
						Cyprinidae/Minnow group	Late-prolarvae	2	6
						Percichthyidae/White, Yellow or Striped bass	Mid-postlarva	1	3
Totals					550.8			15	

Average Number of Organisms per 100 m^3 = 5.4

* Refer to Figure 3E-2 for location

** In one-half sample

TABLE 3E-30

ICHTHYOPLANKTON DATA FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER ON MAY 1, 1978

Sample Number	Location*	Total Depth	No. Levels Sampled	Water Temperature (°C)	Sample Volume Meters^3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100 Meters^3
445	LM1-A	40	3	15.5	42.2	No fish eggs, larvae or juveniles collected.		0	
470	LM1-A		3		42.5	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	5
450	LM1-C	18	2	15.5	32.0	No fish eggs, larvae or juveniles collected.		0	
440	LM1-C		2		31.9	Centrarchidae/Sunfish (family)	Late-prolarvae	4	25
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	12	75
435	LM2-A	44	3	17.0	52.3	No fish eggs, larvae or juveniles collected.		0	
465	LM2-A		3		45.5	No fish eggs, larvae or juveniles collected.		0	
425	LM2-C	40	3	17.0	45.4	No fish eggs, larvae or juveniles collected.		0	
460	LM2-C		3		50.7	No fish eggs, larvae or juveniles collected.		0	
455	MR1	46	3	14.0	72.8	Catostomidae/Sucker (family)	Early-postlarva	1	3
480	MR1		3		68.4	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	3
430	MR2	44	3	13.5	71.2	Catostomidae/Sucker (family)	Late-prolarvae	2	6
						Catostomidae/Sucker (family)	Early-postlarva	1	3
475	MR2		3		70.3	Catostomidae/Sucker (family)	Mid-prolarvae	2	6
						Catostomidae/Sucker (family)	Early-postlarva	1	3
Totals					625.2			25	

Average Number per Organisms per 100 m^3 = 8.0

* Refer to Figure 3E-2 for location.

** In one-half sample

TABLE 3E-31

ICHTHYOPLANKTON DATA FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER ON MAY 7, 1978

Sample Number	Location*	Total Depth	No. Levels Sampled	Water Temperature (°C)	Sample Volume Meters^3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100 Meters^3
495	LM1-A	36	3	16.0	49.1	No fish eggs, larvae or juveniles collected.		0	
520	LM1-A		3		53.1	No fish eggs, larvae or juveniles collected.		0	
535	LM1-C	17	2	16.0	34.2	No fish eggs, larvae or juveniles collected.		0	
500	LM1-C		2		37.9	No fish eggs, larvae or juveniles collected.		0	
525	LM2-A	40	3	18.0	56.0	Centrarchidae/Sunfish (family)	Mid-prolarvae	2	7
485	LM2-A		3		53.8	Centrarchidae/Sunfish (family)	Mid-prolarvae	12	45
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	2	77
510	LM2-C	40	3	18.0	52.8	No fish eggs, larvae or juveniles collected.		0	
490	LM2-C		3		52.6	No fish eggs, larvae or juveniles collected.		0	
505	MR1	40	3	15.0	51.6	Catostomidae/Sucker (family)	Mid-prolarvae	4	16
						Centrarchidae/Sunfish (family)	Mid-prolarva	1	4
						Percidae/Perch (family)	Late-prolarva	1	4
540	MR1		3		52.3	Catostomidae/Sucker (family)	Mid-postlarva	1	4
530	MR2	41	3	16.0	66.3	Hiodontidae/Mooneye (family)	Early-postlarva	1	3
515	MR2		3		62.2	Catostomidae/Sucker (family)	Late-prolarva	1	3
Totals					621.9			25	

Average Number of Organisms per 100 m^3 = 8.0

* Refer to Figure 3E-2 for location

** In one-half sample

TABLE 3E-32

ICHTHYOPLANKTON DATA FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER ON MAY 16, 1978

Sample Number	Location*	Total Depth	No. Levels Sampled	Water Temperature (°C)	Sample Volume Meters^3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100 Meters^3
575	LM1-A	40	3	19.5	46.9	Catostomidae/Sucker	Mid-prolarva	1	4
						Hiodontidae/Goldeye	Early-prolarva	1	4
555	LM1-A		3		43.9	No fish eggs, larvae or juveniles collected.		0	
590	LM1-C	34	3	20.0	42.2	No fish eggs, larvae or juveniles collected.		0	
580	LM1-C		3		44.5	No fish eggs, larvae or juveniles collected.		0	
545	LM2-A	47	3	20.0	47.2	Centrarchidae/Crappie; *Pomoxis* sp.	Early-postlarva	1	4
560	LM2-A		3		47.8	Catostomidae/Sucker	Early-postlarva	1	4
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	2	8
						Sciaenidae/Freshwater drum	Mid-prolarvae	5	21
570	LM2-C	42	3	20.0	48.0	Polyodontidae/Paddlefish	Mid-postlarva	1	4
550	LM2-C		3		49.0	Polyodontidae/Paddlefish	Mid-postlarva	1	4
565	MR1	37	3		50.8	No fish eggs, larvae or juveniles collected.		0	
585	MR1		3		56.3	No fish eggs, larvae or juveniles collected.		0	
595	MR2	44	3	16.0	57.8	No fish eggs, larvae or juveniles collected.		0	
600	MR2		3		55.8	No fish eggs, larvae or juveniles collected.		0	
Total					590.2			13	

Average Number of Organisms per 100 m^3 = 4.4

* Refer to Figure 3E-2 for location

** In one-half sample

TABLE 3E-33

ICHTHYOPLANKTON DATA FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER ON MAY 23, 1978

Sample Number	Location*	Total Depth	No. Levels Sampled	Water Temperature (°C)	Sample Volume Meters^3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100 Meters^3
610	LM1-A	40	3	20.0	47.2	Catostomidae-Cyprinidae/Sucker or Minnow	Late-prolarva	1	4
						Centrarchidae/Sunfish (family)	Late-prolarva	1	4
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	5	21
						Cyprinidae/Carp	Late-prolarva	1	4
						Hiodontidae/Mooneye	Mid-postlarva	1	4
						Eggs (unknown)		3	13
625	LM1-A		3		46.8	Catostomidae/Sucker	Late-prolarva	1	5
						Centrarchidae/Sunfish (family)	Late-prolarvae	2	9
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	6	26
						Egg (unknown)		1	4
615	LM1-C	22	2	20.5	34.1	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	5	29
						Sciaenidae/Freshwater drum		1	6
650	LM1-C		2		32.5	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	7	43
630	LM2-A	30-45	3	24.5	48.4	Centrarchidae/Sunfish (family)	Late-prolarvae	4	17
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	18	74
640	LM2-A		3		46.3	Centrarchidae/Sunfish (family)	Late-prolarvae	5	22
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	9	39
						Percichthyidae/White, Yellow or Striped bass	Early-postlarva	1	4
655	LM2-C	35	3	24.5	52.0	Centrarchidae/Sunfish (family)	Late-prolarvae	4	15
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	3	12
660	LM2-C		3		39.9	Centrarchidae/Sunfish (family)	Late-prolarvae	4	20
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	4	20
605	MR1	40	3	18.0	57.2	Catostomidae-Cyprinidae/Sucker or Minnow	Early-postlarva	1	3
						Centrarchidae/Sunfish (family)	Late-prolarva	1	3
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	4	14
620	MR1				58.8	Clupediae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	6	20

TABLE 3E-33 (Continued)

Sample Number	Location*	Total Depth	No. Levels Sampled	Water Temperature (°C)	Sample Volume Meters^3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100 Meters^3
635	MR2	48		18.0	50.5	Catostomidae/Sucker	Late-prolarva	1	4
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	4
						Cyprinidae/Carp	Late-prolarvae	2	8
						Cyprinidae/Minnow	Late-prolarva	1	2
645	MR2				43.1	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	5
						Sciaenidae/Freshwater drum	Mid-prolarva	1	5
Totals					556.8			106	

Average Number of Organisms per 100 m^3 = 38.1

* Refer to Figure 3E-2 for location

** In one-half sample

TABLE 3E-34

ICHTHYOPLANKTON DATA FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER ON MAY 31, 1978

Sample Number	Location*	Total Depth	No. Levels Sampled	Water Temperature (°C)	Sample Volume Meters^3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100 Meters^3
715	LM1-A	40	3	24.5	44.1	Clupeidae/Gizzard shad, Skipjack herring, Threadfin shad	Early-postlarvae	4	18
						Hiodontidae/Mooneye (family)	Late-prolarva	1	5
						Sciaenidae/Freshwater drum	Mid-prolarva	1	5
685	LM1-A		3		41.7	Clupeidae/Gizzard shad, Skipjack herring, Threadfin shad	Early-postlarvae	5	24
						Cyprinidae/Minnow	Late-prolarva	1	5
						Sciaenidae/Freshwater drum	Early-prolarvae	2	10
						Egg (unknown)		1	5
705	LM1-C	20	2	24.5	30.7	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	3	20
						Cyprinidae/Carp	Early-postlarva	1	7
						Sciaenidae/Freshwater drum	Late-prolarva	1	7
675	LM1-C		2		31.2	Centrarchidae/Sunfish (family)	Mid-prolarva	1	
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	5	
						Sciaenidae/Freshwater drum	Mid-prolarva	1	
695	LM2-A	42	3	25.0	45.4	Centrarchidae/Sunfish (family)	Late-prolarvae	5	22
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	4
						Sciaenidae/Freshwater drum	Mid-prolarva	1	4
670	LM2-A		3		41.5	Centrarchidae/Sunfish (family)	Late-prolarvae	7	34
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	2	10
						Sciaenidae/Freshwater drum	Late-prolarva	1	5
665	LM2-C	40	3	25.0	39.7	Centrarchidae/Sunfish	Late-prolarva	1	5
						Percidae/Perch (*Stizostedion* sp.)	Mid-postlarva	1	5
						Sciaenidae/Freshwater drum	Early-prolarvae	2	10
						Sciaenidae/Freshwater drum	Mid-prolarvae	2	10
680	LM2-C		3		40.3	Sciaenidae/Freshwater drum	Mid-prolarva	1	5
700	MR1	36	3	22.0	58.3	No fish eggs, larvae or juveniles collected.		0	
720	MR1		3		59.4	Clupeidae/Gizzard shad	Early-postlarva	1	3
						Cyprinidae/Minnow	Late-prolarva	1	3

TABLE 3E-34 (Continued)

Sample Number	Location*	Total Depth	No. Levels Sampled	Water Temperature (°C)	Sample Volume Meters3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100 Meters3
690	MR2	45	3	22.0	59.3	Clupeidae/Gizzard shad, Skipjack herring, Threadfin shad	Early-postlarvae	3	10
						Cyprinidae/Carp	Early-postlarva	1	3
						Cyprinidae/Carp	Mid-postlarva	1	3
710	MR2		3		68.3	Catostomidae/Sucker	Late-prolarvae	2	6
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	3	9
Totals					559.9			63	

Average Number of Organism per 100 m^3 = 22.5

* Refer to Figure 3E-2 for location

** In one-half sample

TABLE 3E-35

ICHTHYOPLANKTON DATA FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER ON JUNE 8, 1978 (A.M.)

Sample Number	Location*	Total Depth	No. Levels Sampled	Water Temperature (°C)	Sample Volume, Meters^3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100 Meters^3
765	LM1-A	30	3	23.0	51.1	Catostomidae/Sucker (family)	Late-prolarva	1	4
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	4
						Sciaenidae/Freshwater drum	Early-postlarva	1	4
740	LM1-A		3		44.4	Catostomidae/Sucker (family)	Late-prolarva	1	5
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	2	9
750	LM1-C	14	2	23.0	31.4	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	6
735	LM1-C		2		33.0	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	2	12
730	LM2-A	34	3	23.0	50.0	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	4
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Mid-postlarva	1	4
						Sciaenidae/Freshwater drum	Early-postlarva	1	4
760	LM2-A		3		47.1	Centrarchidae/Sunfish (family)	Late-prolarva	1	4
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	6	25
						Sciaenidae/Freshwater drum	Early-postlarvae	2	8
						Sciaenidae/Freshwater drum	Mid-postlarva	1	4
725	LM2-C	34	3	23.0	47.0	Centrarchidae/Sunfish (probably *Pomoxis* sp.)	Late-prolarva	1	4
						Centrarchidae/Sunfish (probably *Pomoxis* sp.)	Early-postlarva	1	4
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	4
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Mid-postlarva	1	4
						Sciaenidae/Freshwater drum	Mid-prolarva	1	4
						Sciaenidae/Freshwater drum	Early-postlarva	1	4
745	LM2-C		3		45.1	Centrarchidae/Sunfish (family)	Early-postlarva	1	4
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	4
						Cyprinidae/Carp	Mid-prolarvae	2	9
						Sciaenidae/Freshwater drum	Mid-prolarvae	2	9

TABLE 3E-35 (Continued)

Sample Number	Location*	Total Depth	No. Levels Sampled	Water Temperature (°C)	Sample Volume Meters^3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100 Meters^3
775	MR1	36	3	24.0	59.6	Clupeidae/Gizzard shad	Late-postlarvae	3	10
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Mid-postlarvae	2	7
						Sciaenidae/Freshwater drum	Mid-prolarvae	3	10
780	MR1		3		49.3	Catostomidae-Cyprinidae/Sucker or Minnow	Late-prolarva	1	4
						Clupeidae/Gizzard shad	Late-postlarva	1	4
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	4
						Sciaenidae/Freshwater drum	Late-prolarva	1	4
770	MR2	35	3	24.0	64.0	Clupeidae/Gizzard shad	Late-postlarvae	2	6
						Clupeidae/Gizzard shad, Skipjack herring, Threadfin shad	Early-postlarva	1	3
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Mid-postlarvae	27	84
						Hiodontidae/Goldeye		1	3
755	MR2		3		65.3	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	
						Sciaenidae/Freshwater drum	Early-postlarva	1	
Totals					587.3			79	

Average Number of Organisms per 100 m^3 = 26.9

* Refer to Figure 3E-2 for location

** In one-half sample

TABLE 3E-36

ICHTHYOPLANKTON DATA FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER ON JUNE 8, 1978 (P.M.)

Sample Number	Location*	Total Depth	No. Levels Sampled	Water Temperature (°C)	Sample Volume, Meters^3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100$_3$ Meters
795	LM1-A	30	3	24.0	37.1	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	5
						Hiodontidae/Goldeye	Mid-postlarva	1	5
810	LM1-A		3		49.3	Clupeidae/Gizzard shad	Late-postlarvae	2	8
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Mid-postlarva	1	4
						Sciaenidae/Freshwater drum	Mid-postlarva	1	4
820	LM1-C	14	2	24.0	30.8	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	6
						Sciaenidae/Freshwater drum	Late-postlarva	1	6
805	LM1-C		2		30.3	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	7
						Percidae/Perch (probably Stizostedion sp.)	Late-postlarva	1	7
825	LM2-A	34	3	24.0	45.0	Centrarchidae/Sunfish (family)	Early-postlarvae	9	40
						Clupeidae/Gizzard shad	Late-postlarvae	6	27
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	26	116
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Mid-postlarvae	17	76
						Cyprinidae/Minnow	Early-postlarva	1	4
						Hiodontidae/Goldeye	Mid-postlarvae	2	9
						Percichthyidae/White bass	Late-postlarva	1	4
						Sciaenidae/Freshwater drum	Late-prolarvae	2	9
						Sciaenidae/Freshwater drum	Early-prolarvae	3	13
840	LM2-A		3		49.1	Centrarchidae/Pomoxis sp.	Mid-postlarvae	6	24
						Centrarchidae/Sunfish (familyO	Ealry-postlarvae	3	12
						Clupeidae/Gizzard shad	Late-postlarvae	4	16
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	8	33
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Mid-postlarvae	39	159
						Sciaenidae/Freshwater drum	Early-postlarvae	2	8

TABLE 3E-36 (Continued)

Sample Number	Location*	Total Depth	No. Levels Sampled	Water Temperature (°C)	Sample Volume Meters^3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100 Meters^3
830	LM2-C	34	3	24.0	43.8	Centrarchidae/Sunfish (family)	Early-postlarvae	37	169
						Centrarchidae/Sunfish (family)	Mid-postlarvae	4	16
						Clupeidae/Gizzard shad	Late-postlarvae	6	27
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	8	37
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Mid-postlarvae	47	215
						Percidae/Perch (Stizostedion sp.)	Mid-postlarva	1	5
						Sciaenidae/Freshwater drum	Late-prolarvae	2	9
835	LM2-C		3		51.2	Centrarchidae/Black crappie	Late-postlarvae	3	12
						Centrarchidae/Sunfish (probably Pomoxis sp.)	Mid-postlarvae	4	16
						Centrarchidae/Sunfish (family)	Early-postlarvae	27	
						Clupeidae/Gizzard shad	Late-postlarva	1	4
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	19	74
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Mid-postlarvae	40	156
						Sciaenidae/Freshwater drum	Early-postlarvae	3	12
815	MR1	36	3	24.0	59.2	Centrarchidae/Pomoxis sp.	Mid-postlarva	1	3
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	2	7
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Mid-postlarvae	5	17
						Sciaenidae/Freshwater drum	Late-prolarva	1	3
790	MR1		3		58.6	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	3	10
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Mid-postlarvae	6	20
						Sciaenidae/Freshwater drum	Early-postlarvae	2	7
785	MR2	35	3	24.0	64.6	Catostomidae-Cyprinidae/Sucker or Minnow	Late-prolarvae	3	9
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	2	6
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Mid-postlarvae	3	9
800	MR2				59.9	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	3
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Mid-postlarvae	3	10
						Sciaenidae/Freshwater drum	Early-postlarvae	2	7
Totals					578.9			375	

Average Number of Organisms per 100 m^3 = 129.6

* Refer to Figure 3E-2 for location

** In one-half sample

TABLE 3E-37

ICHTHYOPLANKTON DATA FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER ON JUNE 15, 1978

Sample Number	Location*	Total Depth	No. Levels Sampled	Water Temperature (°C)	Sample Volume Meters^3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100 Meters^3
855	LM1-A	30	3	25.5	50.4	Sciaenidae/Freshwater drum	Early-postlarvae	2	8
						Sciaenidae/Freshwater drum	Mid-postlarvae	3	12
						Eggs (unknown)		10	40
870	LM1-A		3		53.9	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	4
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Mid-postlarva	1	4
						Sciaenidae/Freshwater drum	Mid-prolarvae	12	42
						Eggs (unknown)		9	33
895	LM1-C	14	2	25.5	30.3	Sciaenidae/Freshwater drum	Mid-postlarvae	3	20
						Eggs (unknown)		9	59
885	LM1-C		2		30.1	Sciaenidae/Freshwater drum	Early-prolarvae	2	13
						Eggs (unknown)		6	40
865	LM2-A	34	3	24.8	45.3	Sciaenidae/Freshwater drum	Late-prolarva	1	4
850	LM2-A		3		50.5	Centrarchidae/*Pomoxis* sp.	Mid-postlarvae	2	8
845	LM2-C	34	3	24.8	46.1	Clupeidae/Gizzard shad	Early-postlarva	1	4
						Centrarchidae/*Pomoxis* sp.	Mid-postlarva	1	4
880	LM2-C				43.3	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarva	1	5
875	MR1	36	3	24.5	60.1	Clupeidae/Gizzard shad	Late-postlarvae	2	7
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	2	7
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Mid-postlarvae	2	7
						Sciaenidae/Freshwater drum	Mid-prolarva	1	3
						Sciaenidae/Freshwater drum	Late-prolarva	1	3
						Sciaenidae/Freshwater drum	Early-postlarvae	9	30
						Sciaenidae/Freshwater drum	Mid-postlarvae	2	9

TABLE 3E-37 (Continued)

Sample Number	Location*	Total Depth	No. Levels Sampled	Water Temperature (°C)	Sample Volume Meters^3	Scientific Name (family)/Common Name (species)	Developmental Stage	Number Counted**	Number per 100 Meters^3
900	MR1		3		57.2	Catostomidae/Sucker (family)	Late-prolarva	1	3
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Mid-postlarva	1	3
						Sciaenidae/Freshwater drum	Late-prolarva	1	3
860	MR2	35	3	24.3	60.7	Sciaenidae/Freshwater drum	Late-prolarvae	4	13
890	MR2				59.7	Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Early-postlarvae	2	7
						Clupeidae/Gizzard shad, Threadfin shad, Skipjack herring	Mid-postlarvae	2	7
						Sciaenidae/Freshwater drum	Early-postlarvae	2	7
						Sciaenidae/Freshwater drum	Mid-postlarvae	3	10
Totals					587.6			99	

Average Number of Organisms per 100 m^3 = 33.7

* Refer to Figure 3E-2 for location.

** In one-half sample

TABLE 3E-38

SUMMARY OF TOTAL ICHTHYOPLANKTON CATCH IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER FROM APRIL 5* TO JUNE 15, 1978

Transect:	LM1-A**		LM1-C**		LM2-A**		LM2-C**	
Total Volume (m^3):	1031.2		799.9		1051.4		1026.2	
Taxon	Total No. Counted†	Average No. per 100 m^3	Total No. Counted†	Average No. per 100 m^3	Total No. Counted†	Average No. per 100 m^3	Total No. Counted†	Average No. per 100 m^3
Catostomidae								
Carpsucker/Buffalo Family	8	1.6	6	1.5	1	0.2		
Catostomidae or Cyprinidae	2	0.4						
Centrarchidae								
Crappie					3	0.6	3	0.6
Sunfish Family	3	0.6	5	1.3	36	6.8	10	1.9
Clupeidae								
Gizzard shad/Threadfin shad/Skipjack herring	26	5.0	36	9.0	42	8.0	11	2.1
Gizzard shad							1	0.2
Cyprinidae								
Carp	1	0.2	5	1.3	19	3.6	10	1.9
Minnow group	3	0.6	1	0.3	1	0.2		
Shiner subgroup			1	0.3				
Hiodontidae								
Family	1	0.2						
Goldeye	1	0.2						
Mooneye	1	0.2						
Percichthyidae								
Family					1	0.2		
Percidae								
Family								
Sauger/Walleye							1	0.2
Polydontidae								
Paddlefish							2	0.4
Sciaenidae								
Freshwater drum	21	4.0	8	2.0	12	2.3	9	1.8
Eggs (unknown)	25	4.8	15	3.8				
TOTALS	92	17.8	77	19.2	115	21.9	45	8.8

(Continued)

TABLE 3E-38 (Continued)

Transect:	MR1**		MR2**		Total		
Total Volume (m^3):	1298.2		1343.0		6549.9		
Taxon	Total No. Counted†	Average No. per 100 m^3	Total No. Counted†	Average No. per 100 m^3	Total No. Counted†	Average No. per 100 m^3	Percent Total No.
Catostomidae							
Carpsucker/Buffalo	1	0.2	3	0.4	4	0.1	0.8
Family	7	1.1	24	3.6	46	1.4	9.3
Catostomidae or Cyprinidae	2	0.3			4	0.1	0.8
Centrarchidae							
Crappie					6	0.2	1.2
Sunfish Family	2	0.3			56	1.7	11.4
Clupeidae							
Gizzard shad/Threadfin shad/Skipjack herring	20	3.1	44	6.6	179	5.5	36.3
Gizzard shad	7	1.1	2	0.3	10	0.3	2.0
Cyprinidae							
Carp	1	0.2	11	1.6	47	1.4	9.5
Minnow group	2	0.3	3	0.5	10	0.3	2.0
Shiner subgroup					1	<0.1	0.2
Hiodontidae							
Family			1	0.1	2	<0.1	0.4
Goldeye			1	0.1	2	<0.1	0.4
Mooneye					1	<0.1	0.2
Percichthyidae							
Family			1	0.1	2	<0.1	0.4
Percidae							
Family	1	0.2			1	<0.1	0.2
Sauger/Walleye					1	<0.1	0.2
Polydontidae							
Paddlefish					2	<0.1	0.4
Sciaenidae							
Freshwater drum	18	2.8	11	1.6	79	2.4	16.0
Eggs (unknown)	—	—	—	—	40	1.2	8.1
TOTALS	61	9.4	101	15.0	493	15.2	99.8

* No ichthyplankton present in collections of March 15, 22 and 29.

** Refer to Figure 3E-2 for location

† Summation of counts of half of each sample.

3E.3.1.2.2 DISTRIBUTION OF ICHTHYOPLANKTON AMONG SAMPLING STATIONS

The differences in density (number per 100 square meters) of major groups of ichthyoplankton between sampling locations were statistically examined using the non-parametric Kruskal-Wallis test.[44] This test is analogous to the parametric one-way analysis of variance, but it does not require the assumption of normally-distributed data, which most probably is violated by data on the distribution of aquatic animals. Comparisons were made using data from all stations over the time period in which the taxon of interest was collected. Dates were considered replicates, while all data from duplicate tows were lumped.

Because of the irregular distribution of ichthyoplankton, a number of data sets included large numbers of zeroes. These were treated as ties, and the test were suitably adjusted,[44] but the exact precision of the probability statements in some cases is questionable. It was assumed that errors tended to be conservative ones, such that nominally significant differences between locations were truly significant.

In the following comparisons, a test statistic is calculated for the specific data set and compared to a critical value. The critical value is the minimum value of the test statistic which allows the conclusion that some locations had greater densities of ichthyoplankton than others. The decision level used was 0.05, which specifies that the particular data set is expected to occur less than 1 time in 20 if only random variation is in effect. This is sufficiently unlikely that it allows the conclusion that the differences are real, not random occurrences.

TOTAL CATCH

The Kruskal-Wallis test for differences in density of total ichthyoplankton between locations is summarized in Table 3E-39. The null hypothesis was that there are no differences in density of ichthyoplankton as a whole between the locations sampled. The test statistic H'(adjusted for ties)

TABLE 3E-39

KRUSKAL-WALLIS TEST OF THE DIFFERENCES IN DENSITY (NUMBER PER 100 CUBIC METERS) OF TOTAL ICHTHYOPLANKTON BETWEEN LOCATIONS IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER

Location*		Date 4/5	4/11	4/18	4/25	5/1	5/7	5/16	5/23	5/31	6/8	6/15	ΣR_i
LM1-A	Density:	0	4.405	8.114	2.198	2.361	0	4.405	46.809	34.965	12.565	72.867	
	Rank (R):	8.5	30.5	35	23	24	8.5	30.5	61	55	39	65	380
LM1-C	Density:	2.096	17.448	6.289	0	50.078	0	0	39.039	38.772	9.317	66.225	
	Rank (R):	20	43	33	8.5	62	8.5	8.5	59	57	37	64	400.5
LM2-A	Density:	0	38.793	2.134	2.137	0	29.144	18.947	78.141	39.125	26.777	6.263	
	Rank (R):	8.5	58	21	22	8.5	52	45	66	60	51	32	424
LM2-C	Density:	0	17.094	0	0	0	0	4.124	32.644	20.0	26.059	6.711	
	Rank (R):	8.5	42	8.5	8.5	8.5	8.5	29	54	46	50	34	297.5
MR1	Density:	0	1.638	1.693	3.759	2.833	11.550	0	20.690	3.398	22.039	37.511	
	Rank (R):	8.5	18	19	28	25	38	8.5	47	27	49	56	324
MR2	Density:	0	1.631	31.431	18.303	8.481	3.113	0	14.957	15.674	52.591	21.595	
	Rank (R):	8.5	17	53	44	36	26	8.5	40	41	63	48	385

$n_i = 11$; $\sum n_i = 66$; $t_1 = 16$, $t_2 = 2$

1) $H = \frac{12}{\Sigma n_i (\Sigma n_i + 1)} \sum \frac{(\Sigma R_i)^2}{n_i} - 3(\Sigma n_i + 1) = 2.845$

2) $D = 1 - \frac{\Sigma T_i}{(\Sigma n_i - 1)\Sigma n_i(\Sigma n_i +)}$, where $T_i = t_i^3 - t_i$; $T_1 = 1320$, $T_2 = 6$

$= 0.9954$

3) Test Statistic: $H' = H/D = 2.858$

4) Critical Value: $\chi^2_{0.05,5} = 11.070$

5) 26858 < 11.070; not significant

* Refer to Figure 3E-2 for location description

was 2.858, which did not exceed the critical value of 11.070. Therefore, the null hypothesis was accepted, and it was concluded that there are no differences in overall ichthyoplankton density between stations.

CLUPEIDAE

Clupeids (gizzard shad and its relatives) were the most abundant larvae collected. Table 3E-40 summarizes the Kruskal-Wallis test for location differences in density of this group. The test statistic (adjusted for ties) is 9.613, which is less than the critical value of 11.070. The conclusion is that there were no differences in density of clupeids between the stations tested.

FRESHWATER DRUM

The second most abundant taxon of larvae in the collection taken from the Mississippi River and Lake McKellar is freshwater drum, which constituted 16 percent of the total catch (Table 3E-38). A Kruskal-Wallis test for differences in density of these organisms between stations was performed and is presented in Table 3E-41. The conclusion drawn was that there are no significant differences in density of these larvae between locations. In fact, the data indicate a relatively more even distribution of these larvae between stations than any other group.

SUNFISH

The sunfish family (which includes the crappie and largemouth bass) was the third most abundant component of the ichthyoplankton. Table 3E-42 summarizes the Kruskal-Wallis test for location differences in density for this group. The test statistic, 20.07, exceeds the critical value, 11.070. This indicates that there were differences in density of sunfish larvae between locations.

TABLE 3E-40

KRUSKAL-WALLIS TEST OF THE DIFFERENCES IN DENSITY (NUMBER PER 100 CUBIC METERS) OF CLUPEIDAE LARVAE BETWEEN LOCATIONS IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER

Location*		Date 4/11	4/18	4/25	5/1	5/7	5/16	5/23	5/31	6/8	6/15	ΣR_i
LM1-A	Density	0	0	0	2.361	0	0	23.404	20.979	6.283	3.835	
	Rank (R)	16	16	16	35	16	16	56	55	43	38	307
LM1-C	Density	2.180	0	0	18.779	0	0	36.036	25.848	9.317	0	
	Rank (R)	34	16	16	54	16	16	58	57	47	16	346
LM2-A	Density	0	0	0	0	3.643	4.211	57.022	6.904	16.478	0	
	Rank (R)	16	16	16	16	36	39	60	46	52	16	329
LM2-C	Density	0	0	0	0	0	0	15.233	0	6.515	4.474	
	Rank (R)	16	16	16	16	16	16	51	16	44	41	248
MR1	Density	0	0	3.759	1.416	0	0	17.241	1.699	12.856	11.935	
	Rank (R)	16	16	37	32	16	16	53	33	50	49	318
MR2	Density	0	4.963	0	0	0	0	4.270	9.404	44.857	6.645	
	Rank (R)	16	42	16	16	16	16	40	48	59	45	314

$n_i = 10,\ \sum n_i = 60,\ t_1 = 31$

1) $H = \frac{12}{\Sigma n_i\ (\Sigma n_i + 1)} \sum \frac{(\Sigma R_i)^2}{n_i} - 3(\Sigma n_i + 1) = 8.2885$

2) $D = 1 - \frac{\Sigma T_i}{(\Sigma n_i - 1)\Sigma n_i(\Sigma n_i + 1)}$ where $T_i = t_i^3 - t_i$; $T_1 = 29{,}760$

$= 0.8622$

3) Test Statistic: $H' = H/D = 9.613$

4) Critical Value: $\chi^2_{0.05,5} = 11.070$

5) $9.613 < 11.070$, not significant

* Refer to Figure 3E-2 for location descriptions.

TABLE 3E-41

KRUSKAL-WALLIS TEST OF THE DIFFERENCES IN DENSITY (NUMBER PER 100 CUBIC METERS) OF FRESHWATER DRUM LARVAE BETWEEN LOCATIONS IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER

Location*		Date 5/16	5/23	5/31	6/8	6/15	ΣR_i
LM1-A	Density:	0	0	6.993	2.094	32.598	
	Rank (R):	7	7	21	17	30	82
LM1-C	Density:	0	1.332	6.462	0	16.556	
	Rank (R):	7	14	20	7	28	76
LM2-A	Density:	10.526	0	4.603	8.239	2.088	
	Rank (R):	25	7	19	23	16	90
LM2-C	Density:	0	0	12.5	8.686	0	
	Rank (R):	7	7	26	24	7	71
MR1	Density:	0	0	0	7.346	23.789	
	Rank (R):	7	7	7	22	29	72
MR2	Density:	0	2.137	0	1.547	14.950	
	Rank (R):	7	18	7	15	27	74

$n_i = 5,\ \sum n_i = 30,\ t_1 = 13$

1) $H = \frac{12}{\Sigma n_i\ (\Sigma n_i + 1)} \sum \frac{(\Sigma R_i)^2}{n_i} - 3(\Sigma n_i + 1) = 0.680$

2) $D = 1 - \frac{\Sigma T_i}{(\Sigma n_i - 1)\Sigma n_i(\Sigma n_i +)}$, where $T_i = t_i^3 - t_i$; $T = 2184$

$= 0.9159$

3) Test Statistic: $H' = H/D = 0.742$

4) Critical Value: $\chi^2_{0.05,5} = 11.070$

5) $0.742 < 11.070$; not significant

* Refer to Figure 3E-2 for location descriptions.

TABLE 3E-42

KRUSKAL-WALLIS TEST OF THE DIFFERENCES IN DENSITY (NUMBER PER 100 CUBIC METERS) OF SUNFISH LARVAE BETWEEN LOCATIONS IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER

Location*		Date 5/1	5/7	5/16	5/23	5/31	6/8	6/15	ΣR_i
LM1-A	Density:	0	0	0	3.191	0	0	0	
	Rank (R):	14	14	14	34	14	14	14	118
LM1-C	Density:	12.520	0	0	0	3.231	0	0	
	Rank (R):	38	14	14	14	35	14	14	143
LM2-A	Density:	0	25.501	2.105	19.007	27.618	2.060	4.175	
	Rank (R):	14	41	31	40	42	30	36	234
LM2-C	Density:	0	0	0	17.410	2.50	6.515	2.237	
	Rank (R):	14	14	14	39	33	37	32	183
MR1	Density:	0	1.925	0	0.862	0	0	0	
	Rank (R):	14	29	14	28	14	14	14	141
MR2	Density:	0	0	0	0	0	0	0	
	Rank (R):	14	14	14	14	14	14	14	94.5

$n_i = 7$, $\sum n_i = 42$, $t_1 = 27$

1) $H = \frac{12}{\Sigma n_i (\Sigma n_i + 1)} \frac{(\Sigma R_i)^2}{n_i} - 3(\Sigma n_i + 1) = 14.74$

2) $D = 1 - \frac{\Sigma T_i}{(\Sigma n_i - 1)\, n_i (\Sigma n_i +)}$, where $T_i = t_i^3 - t_i$; $T_1 = 19{,}656$

$= 0.7345$

3) Test Statistic: $H' = H/D = 20.07$

4) Critical Value: $\chi^2_{0.05,5} = 11.070$

5) 20.07 > 11.070; there are significant differences between locations

* Refer to Figure 3E-2 for location descriptions.

Because this family includes a number of sport fish and therefore is of special interest, an additional test was applied to the data. The Median Test[45] is a more conservative test than Kruskal-Wallis (i.e., requires larger differences than the Kruskal-Wallis test to detect those differences), and is less affected by large number of ties than the Kruskal-Wallis test. Table 3E-43 summarizes this test. Again, the test statistic exceeds the critical value, supporting the conclusion that some locations had higher densities of sunfish larvae than others.

Selected pairwise comparisons using the Mann-Whitney U-test indicated that this difference is due to the density of sunfish larvae at LM2-A, which is significantly higher than all other stations except LM2-C. These tests support the contention that the turning basin area (LM2) is the best nursery area for sunfish of the locations examined.

SUCKERS

Members of the sucker family (Catostomidae), including both larvae identifiable as belonging to the carpsucker-buffalo subgroup as well as those identifiable only to the family level, made up 10.1 percent of the total ichthyoplankton catch (Table 3E-38). Table 3E-44 presents the Kruskal-Wallis test for location differences in density of this group. The conclusion is that there are significant differences in density between some locations.

By inspection of the data, it can be seen that no sucker larvae were collected in the turning basin (stations LM2-A and LM2-C). To test whether this area was the cause of the above conclusion (that some areas support densities significantly different from other areas), a second Kruskal-Wallis test was performed, omitting these two stations. This test is summarized in Table 3E-45. As expected, this test supports the conclusion that there were no differences in density of sucker larvae between the Mississippi River stations and those in the Tennessee Chute of Lake McKellar (LM1-A and LM1-C).

TABLE 3E-43

MEDIAN TEST OF THE DIFFERENCES IN DENSITY (NUMBER PER 100 CUBIC METERS) OF SUNFISH LARVAE BETWEEN LOCATIONS IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER

[Data is shown in Table 3E-40]

1. Grand Median = 0

2.

Location*:	LM1-A	LM1-C	LM2-A	LM2-C	MR1	MR2	Totals		
> median (O_{1i}) :	1	2	5	4	2	0	14	=	a
≤ median :	6	5	2	3	5	7	28	=	b
TOTALS (n_i):	7	7	7	7	7	7	42	=	N

3. Test Statistic: $T = \frac{N^2}{ab} \Sigma \frac{O_{1i}^2}{ni} - \frac{Na}{b} = 11.1429$

4. Critical value = $\chi^2 0.05,5 = 11.070$

5. 11.1429 > 11.07; There are significant differences between locations.

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* Refer to Figure 3E-2 for location descriptions.

TABLE 3E-44

KRUSKAL-WALLIS TEST OF THE DIFFERENCES IN DENSITY (NUMBER PER 100 CUBIC METERS) OF SUCKER LARVAE BETWEEN LOCATIONS IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER

Location*		Date 4/5	4/11	4/18	4/25	5/1	5/7	5/16	5/23	5/31	6/8	6/15	ΣR_i
LM1-A	Density:	0	0	6.085	2.198	0	0	2.203	2.128	0	4.188	0	
	Rank (R):	24.5	24.5	61	57	24.5	24.5	58	55	24.5	60	24.5	438
LM1-C	Density:	2.096	8.724	0	0	0	0	2.105	0	0	0	0	
	Rank (R):	53	64	24.5	24.5	24.5	24.5	54	24.5	24.5	24.5	24.5	367
LM2-A	Density:	0	0	0	0	0	0	0	0	0	0	0	
	Rank (R):	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	269.5
LM2-C	Density:	0	0	0	0	0	0	0	0	0	0	0	
	Rank (R):	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	269.5
MR1	Density:	0	0	1.693	0	1.416	9.625	0	0	0	0	1.705	
	Rank (R):	24.5	24.5	51	24.5	49	65	24.5	24.5	24.5	24.5	52	388.5
MR2	Density:	0	0	21.505	6.656	8.481	1.556	0	2.137	3.135	0	0	
	Rank (R):	24.5	24.5	66	62	63	50	24.5	56	59	24.5	24.5	478.5

$n_i = 11$; $\sum n_i = 66$; $t_1 = 48$

1) $H = \frac{12}{\Sigma n_i (\Sigma n_i + 1)} \sum \frac{(\Sigma R_i)^2}{n_i} - 3(\Sigma n_i + 1) = 9.112$

2) $D = 1 - \frac{\Sigma T_i}{(\Sigma n_i - 1)\Sigma n_i(\Sigma n_i +)}$, where $T_i = t_i^3 - t_i$; $T_1 = 110,544$

$= 0.6154$

3) Test Statistic: $H' = H/D = 14.806$

4) Critical Value: $\chi^2_{0.05,5} = 11.070$

5) 14.806 > 11.070; There are significant differences between locations.

* Refer to Figure 3E-2 for location descriptions.

TABLE 3E-45

KRUSKAL-WALLIS TEST OF THE DIFFERENCES IN DENSITY (NUMBER PER 100 CUBIC METERS) OF SUCKER LARVAE BETWEEN LOCATIONS IN THE TENNESSEE CHUTE AND THE MISSISSIPPI RIVER

Location*		Date 4/5	4/11	4/18	4/25	5/1	5/7	5/16	5/23	5/31	6/8	6/15	ΣR_i
LM1-A	Density:	0	0	6.085	2.198	0	0	2.203	2.128	0	4.188	0	
	Rank (R):	13.5	13.5	39	35	13.5	13.5	36	33	13.5	38	13.5	262
LM1-C	Density:	2.096	8.724	0	0	0	0	2.105	0	0	0	0	
	Rank (R):	31	42	13.5	13.5	13.5	13.5	32	13.5	13.5	13.5	13.5	213
MR1	Density:	0	0	1.693	0	1.416	9.625	0	0	0	0	1.705	
	Rank (R):	13.5	13.5	29	13.5	27	43	13.5	13.5	13.5	13.5	30	223.5
MR2	Density:	0	0	21.505	6.656	8.481	1.556	0	2.137	3.135	0	0	
	Rank (R):	13.5	13.5	44	40	41	38	13.5	39	37	13.5	13.5	291.5

$n_i = 11$; $\sum n_i = 44$; $t_1 = 26$

1) $H = \frac{12}{\Sigma n_i (\Sigma n_i + 1)} \sum \frac{(\Sigma R_i)^2}{n_i} - 3(\Sigma n_i + 1) = 2.1556$

2) $D = 1 - \frac{\Sigma T_i}{(\Sigma n_i - 1)\Sigma n_i (\Sigma n_i +)}$, where $T_i = t_i^3 - t_i$; $T_1 = 17{,}550$

$= 0.7939$

3) Test Statistic: $H' = H/D = 2.715$

4) Critical Value: $\chi^2_{0.05,3} = 9.488$

5) $2.715 < 9.488$; not significant.

* Refer to Figure 3E-2 for location descriptions.

In summary, these tests indicate that the turning basin, where no sucker larvae were collected, is significantly poorer as a sucker nursery than the other stations tested.

CARP

Although carp larvae contributed 9.5 percent of the total ichthyoplankton catch, most of those collected were taken on one date, April 11, 1978 (see Table 3E-27). Further examination of Tables 3E-23 through 3E-37 shows that a large number (approximately 80 percent) of collections during the total period of their occurrence (April 11-June 8) contained no carp larvae. Thus, although carp larvae were an important component of the total ichthyoplankton, it was decided that these data were not suitable for statistical treatment. No conclusions, therefore, may be drawn about the distribution of these larvae between sampling stations.

EGGS

As with the carp larvae, fish eggs of indeterminable taxonomy made up a significant portion of the total ichthyoplankton catch, with 8.1 percent (Table 3E-38). These eggs were found on only three dates (May 23, May 31 and June 15) in a total of four samples. Again, as with carp larvae, these data are too few to permit statistical evaluation of distribution patterns. It may be pointed out that all eggs were collected in the Tennessee Chute area (LM1-A and LM1-C in Table 3E-38), but it must be stressed that conclusions cannot be drawn from these limited data.

3E.3.1.2.3 DAWN-DUSK COMPARISONS

On one occasion (June 8), ichthyoplankton collections were made during the morning (0600 to 1000 hours) and again in the evening (1900 to 2200 hours). The total catches of these two samplings are presented in Table 3E-46.

TABLE 3E-46

ICHTHYOPLANKTON COLLECTED EARLY MORNING AND EARLY EVENING, JUNE 8, 1978, IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER

Location*:	LM1-A				LM1-C			
Time**:	AM		PM		AM		PM	
Total Volume (m^3):	95.5		86.4		64.4		61.1	
Taxon	Total No. Counted†	Average No. per 100 m^3	Total No. Counted†	Average No. per 100 m^3	Total No. Counted†	Average No. per 100 m^3	Total No. Counted†	Average No. per 100 m^3
Catostomidae								
Sucker Family	2	4.2						
Catostomidae or Cyprinidae								
Centrarchidae								
Crappie								
Sunfish Family								
Clupeidae								
Gizzard shad/Threadfin shad/Skipjack herring	3	6.3	2	4.6	3	9.3	2	6.5
Gizzard shad			2	4.6				
Cyprinidae								
Carp								
Minnow group								
Hiodontidae								
Goldeye			1	2.3				
Percichthyidae								
White bass								
Percidae								
Sauger/Walleye							1	3.3
Sciaenidae								
Freshwater drum	1	2.1	1	2.3			1	3.3
TOTALS	6	12.6	6	13.9	3	9.3	4	13.1

(Continued)

TABLE 3E-46 (Continued)

Location*:	LM2-A				LM2-C			
Time**:	AM		PM		AM		PM	
Total Volume (m^3):	97.1		94.1		92.1		95	
Taxon	Total No. Counted†	Average No. per 100 m^3	Total No. Counted†	Average No. per 100 m^3	Total No. Counted†	Average No. per 100 m^3	Total No. Counted†	Average No. per 100 m^3
Catostomidae								
Sucker Family								
Catostomidae or Cyprinidae								
Centrarchidae								
Crappie			6	12.8	2	4.3	7	14.7
Sunfish Family	1	2.1	12	25.5	1	2.2	68	143.2
Clupeidae								
Gizzard shad/Threadfin shad/Skipjack herring	8	16.5	90	191.3	3	6.5	114	240.0
Gizzard shad			10	21.3			7	14.7
Cyprinidae								
Carp					2	4.3		
Minnow group			1	2.1				
Hiodontidae								
Goldeye			2	4.3				
Percichthyidae								
White bass			1	2.1				
Percidae								
Sauger/Walleye							1	2.1
Sciaenidae								
Freshwater drum	4	8.2	7	14.9	4	8.7	5	10.5
TOTALS	13	26.8	129	274.2	12	26.1	202	425.3

(Continued)

TABLE 3E-46 (Continued)

Location*:	MR1				MR2			
Time**:	AM		PM		AM		PM	
Total Volume (m^3):	108.9		117.8		129.3		124.5	
Taxon	Total No. Counted†	Average No. per 100 m^3	Total No. Counted†	Average No. per 100 m^3	Total No. Counted†	Average No. per 100 m^3	Total No. Counted†	Average No. per 100 m^3
Catostomidae Sucker Family								
Catostomidae or Cyprinidae	1	1.8					3	4.8
Centrarchidae Crappie Sunfish Family			1	1.7				
Clupeidae Gizzard shad/Threadfin shad/Skipjack herring	3	5.5	16	27.2	29	44.9	9	14.5
Gizzard shad	4	7.3			2	3.1		
Cyprinidae Carp Minnow group								
Hiodontidae Goldeye					1	1.5		
Percichthyidae White bass								
Percidae Sauger/Walleye								
Sciaenidae Freshwater drum	4	7.3	3	5.1	1	1.5	2	3.2
TOTALS	12	22.0	20	34.0	33	51.0	14	22.5

(Continued)

TABLE 3E-46 (Continued)

Location*:	Totals			
Time**:	AM		PM	
Total Volume (m^3):	587.3		578.9	
Taxon	Total No. Counted†	Average No. per 100 m^3	Total No. Counted†	Average No. per 100 m^3
Catostomidae				
Sucker Family	2	0.7		
Catostomidae or Cyprinidae	1	0.3	3	1.0
Centrarchidae				
Crappie	2	0.7	14	4.8
Sunfish Family	2	0.7	80	27.6
Clupeidae				
Gizzard shad/Threadfin shad/Skipjack herring	49	16.7	233	80.5
Gizzard shad	6	2.0	19	6.6
Cyprinidae				
Carp	2	0.7		
Minnow group			1	0.3
Hiodontidae				
Goldeye	1	0.3	3	1.0
Percichthyidae				
White bass			1	0.3
Percidae				
Sauger/Walleye			2	0.7
Sciaenidae				
Freshwater drum	14	4.8	19	6.6
TOTALS	79	26.9	375	129.6

* Refer to Figure 3E-2 for location.

** AM = 0600 - 1000 hours
PM = 1900 - 2200 hours

† In one-half sample

Although these data are too limited for statistical treatment, examination of Table 3E-46 elicits the following comments:

- The average density was over five times higher in the evening than in the morning.

- The largest increase was in the centrarchids (sunfish family and crappie), where the density increased from 1.4 per 100 square meters to 32.4 per 100 square meters.

- The location showing the largest increases was the turning basin area. Density at LM2-A increased from 26.8 per 100 square meters to 274.2, while that at LM2-C increased from 26.1 to 425.3.

- Other locations at best showed only modest increases in density in the evening.

Potential causes for these differences include light-mediated local migrations and decreased net avoidance by the larvae at lower light levels. Further analysis is not warranted given the limited data available.

3E.3.2 BENTHIC MACROINVERTEBRATES

Bottom dwelling invertebrates were sampled in duplicate at three stations on each transect in the Mississippi River and Lake McKellar (see Figure 3E-2) in May, July and October 1978 and January 1979. Tables 3E-47 through 3E7-50 summarize the total seasonal collections, while Tables 3E-51 through 3E-54 express the density of organisms with replicates at each station combined. Note problems with units in Tables 3E-51 to 3E-54.

In general, all collections are dominated by immature aquatic earthworms with occasional local abundances of phantom midge (*Chaoborus punctipennis*) or non-biting midge (Chironomidae) larvae. Some temporal and spatial variations in species composition and relative abundances are apparent. The October samples (Tables 3E-49 and 3E-53) contained the largest number of taxa. This may be due to the life histories of many invertebrates in which terrestrial adults occur in the warmer months of the year, followed by the appearance of the aquatic larvae of the next generation in the fall.[46]

It is also notable that samples from the Mississippi River usually contained fewer organisms than those taken from Lake McKellar. This may be due to the scouring effect of the current in the river, which produces an unstable substrate unsuitable for habitation.

Similarity in assemblages was investigated using an index of association (I) between two samples (A and B) defined:

$$I = 100\ (1 - 0.5\ \Sigma\ a_i - b_i\ ) \qquad (3E\text{-}2)$$

where a_i and b_i are the numerical proportions of species i in samples A and B. All pairwise comparisons were calculated each season, the results of which are presented in Tables 3E-55 through 3E-58. These similarity matrices were subjected to a cluster analysis,[42,43] the results of which are shown graphically in Figure 3E-7.

TABLE 3E-47

BENTHIC MACROINVERTEBRATES COLLECTED BY PONAR GRAB IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER ON MAY 5, 1978

Location:	LM1*						LM2*						MR1*						MR2*						
Scientific Name	A-1	A-2	B-1	B-2	C-1	C-2	A-1	A-2	B-1	B-2	C-1	C-2	A-1	A-2	B-1	B-2	C-1	C-2	A-1	A-2	B-1	B-2	C-1	C-2	Total
ANNELIDA																									
Oligochaeta																									
Naididae																									
Dero sp.									1																1
Tubificidae																									
Bothrioneurium vejdovskyanum					1	2		1									2								6
Branchiura sowerbyi					3	2											2								5
Ilyodrilus templetoni		5	23	14				5	1		1	1					2								52
Limnodrilus cervix										2					1		2	1							6
Limnodrilus hoffmeisteri	1				1	1			5	1	3			1	1	2	1	2						1	20
Limnodrilus maumeensis			17	32			1	8																	58
Limnodrilus udekemianus			2																						2
Immature Tubificidae WITH capilliform chaetae	1	2	31	161				2	1								2								200
Immature Tubificiade WITHOUT capilliform chaetae	4	2	128	97	1	1	2	12	11	4						1	1	3							267
Megadriles					1																1				2
ARTHROPODA																									
Insecta																									
Diptera																									
Chaoboridae																									
Chaoborus punctipennis									40	3					1				1	1	1		2	1	50
Chironomidae													1												1
Coelotanypus concinnus				1				1	2																4
Coelotanypus tricolor			3																						3
Coelotanypus scapularis			3					6																	9
Cryptochironomus cf. *fulvus*				1																					1
Cryptochironomus sp.			1																						1
Endochironomus sp.								1																	1
Procladius sp.	1			2				1	1	1															6
Empididae																						1			1
Unidentifiable Empididae sp.																									
Muscidae																									1
Unidentifiable Muscidae sp.		1																							
Ephemeroptera																									
Ephemeridae																									
Hexagenia limbata																			3		1				4
MOLLUSCA																									
Bivalvia																									
Lymnaeidae																									
cf *Lymnaea*	1	—	16	3	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	21
TOTAL	8	10	224	311	7	6	3	37	62	12	4	1	1	1	3	3	10	6	4	1	3	1	2	2	722

* Refer to Figure 3E-2 for location.

TABLE 3E-48

BENTHIC MACROINVERTEBRATES COLLECTED BY PONAR GRAB IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER ON JULY 19, 1978

Scientific Name / Location:	LM1*						LM2*						MR1*						MR2*						Total
	A-1	A-2	B-1	B-2	C-1	C-2	A-1	A-2	B-1	B-2	C-1	C-2	A-1	A-2	B-1	B-2	C-1	C-2	A-1	A-2	B-1	B-2	C-1	C-2	
ANNELIDA																									
Oligochaeta																									
Tubificidae																									
Bothrioneurum vejdovskyanum	3						1																		4
Limnodrilus hoffmeisteri			7	1	2	3				5															18
Limnodrilus maumeensis	1			1																					2
Limnodrilus udekemianus	1																								1
Immature Tubificidae WITH capilliform chaetae			1						6	2															9
Immature Tubificidae WITHOUT capilliform chaetae	3	2	19	27	9	17	2		6	5		1										1			92
Hirundinea																									
Glossiphoniidae																									
Unidentifiable Glossiphoniidae sp.			3	4	3	1																			11
ARTHROPODA																									
Insecta																									
Diptera																									
Chaoboridae																									
Chaoborus punctipennis									69	37	2	4													112
Chironomidae																									
Coelotanypus scapularis						1	1																		2
Coelotanypus tricolor						1																			1
Cryptochironomus sp.											1														1
Procladius sp.					1																			1	2
Ephemeroptera																									
Caenidae																									
Caenis sp.							1																		1
Ephemeridae																									
Hexagenia limbata					1	1		1																	3
Trichoptera																									
Hydropsychidae																									
Hydropsyche sp.																						1			1
MOLLUSCA																									
Bivalvia																									
Sphaeridae																									
Musculium transversum	3		3	2	8	1															3				20
Gastropoda																									
Hydrobiidae																									
Amnicola sp.	1					1																			2
TOTAL	12	2	33	35	24	26	5	1	81	49	3	5	0	0	0	0	0	0	0	0	3	2	0	1	282

* Refer to Figure 3E-2 for location.

TABLE 3E-49

BENTHIC MACROINVERTEBRATES COLLECTED BY PONAR GRAB IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER ON OCTOBER 18, 1978

Location:	LM1*						LM2*						MR1*						MR2*						
Scientific Name	A-1	A-2	B-1	B-2	C-1	C-2	A-1	A-2	B-1	B-2	C-1	C-2	A-1	A-2	B-1	B-2	C-1	C-2	A-1	A-2	B-1	B-2	C-1	C-2	Total
ANNELIDA																									
Oligochaeta																									
Tubificidae																									
Branchiura sowerbyi					1	1																			2
Limnodrilus cervix												2								1					3
Limnodrilus hoffmeisteri			5	4																					9
Limnodrilus maumeensis			1								1	1													3
Limnodrilus udekemianus											1	3							1	5	2	2			14
Immatures WITH capilliform chaetae			5	2		2				4	1	7													21
Immatures WITHOUT capilliform chaetae		4	27	26			2	2	4		11	39	1	1		1				32	4	1			155
ARTHROPODA																									
Crustacea																									
Amphipoda																									
Gammaridae																									
Gammarus sp.																			3						3
Cladocera																									
Unidentifiable Cladocera sp.									1		2														3
Insecta																									
Diptera																									
Ceratopogonidae																									
Unidentifiable Ceratopogonidae sp.											2				3							1	1		7
Chaoboridae																									
Chaoborus punctipennis									21	26															47
Chironomidae																									
Chironomus sp.												3													3
Coelotanypus scapularis	1		24	12		1	2	2			17	1													60
Coelotanypus tricolor			12	14				1			1	1													29
Corynoneura sp.																		1							1
Cryptochironomus cf *fulvus*																		1	2						3
Glyptotendipes sp.											2	1													3
Procladius sp.												1													1
Polypedilum sp.												2													2
Unidentifiable Tanypodinae								1																	1
Xenochironomus rogersi																			6		5				11
Ephemeroptera																									
Caenidae																									
Caenis sp.												1				1									2
Ephemeridae																									
Hexagenia limbata						2													8	4	1				15
Trichoptera																									
Hydropsychidae																									
Hydropsyche oris									1										6		15				22
Potamyia sp.																			29		64				93
COELENTERATA																									
Hydrozoa																									
Hydroida																									
Clavidae																									
Cordylophora lacustris												2													2
MOLLUSCA																									
Bivalvia																									
Corbiculidae																									
Corbicula sp.	4	3													1		1		4		3			2	18
Sphaeriidae																									
Musculium transversum			28	24	2	2																			56
Gastropoda																									
Hydrobiidae																									
Amnicola sp.																							1		1
PLATYHELMINTHES																									
Tubellaria																									
Planeriidae																									
Unidentifiable Planeriidae sp.											2														2
TOTAL	5	7	102	82	3	8	4	6	27	30	40	64	1	1	4	2	1	2	59	42	94	4	1	3	592

* Refer to Figure 3E-2 for location.

TABLE 3E-50

BENTHIC MACROINVERTEBRATES COLLECTED BY PONAR GRAB IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER ON JANUARY 10, 1979

Scientific Name / Location:	LM1*						LM2*						MR1*						MR2*						Total
	A-1	A-2	B-1	B-2	C-1	C-2	A-1	A-2	B-1	B-2	C-1	C-2	C-1	C-2	B-1	B-2	A-1	A-2	C-1	C-2	B-1	B-2	A-1	A-2	
ANNELIDA																									
Oligochaeta																									
Tubificidae																									
Ilyodrilus templetoni	76	51	1	3			3	1			2		1												138
Limnodrilus claparedianus							2																		2
Limnodrilus hoffmeisteri	6																								6
Limnodrilus maumeensis	24	3					3	3			4														37
Limnodrilus udekemianus	8	4					3				1														16
Peloscolex multisetosus longidentus	9	2					1				3														15
Immature Tubificidae WITH capilliform chaetae	29	39	1	1			3	1		1	10	1													76
Immature Tubificidae WITHOUT capilliform chaetae	79	88	4	1	1	1	31	8			2	3		1	1	1			2		5	1	4	2	235
ARTHROPODA																									
Crustacea																									
Amphipoda																									
Gammaridae																									
Gammarus sp.																			1						1
Insecta																									
Diptera																									
Chaoboridae																									
Chaoborus punctipennis							1				1														2
Chironomidae																									
Chironomus sp.							1				1	1													3
Coelotanypus scapularis		2					4				3														9
Cryptochironomus cf. *fulvus*																					5				5
Procladius sp.		2																							2
Xenochironomus sp.																			4		2				6
Tipulidae																									
Unidentifiable Tipulidae g. sp.			1																						1
Ephemeroptera																									
Ephemeridae																									
Hexagenia limbata	1	5																							6
Pentagenia cf. *vittigera*																		1	14	1	31		1		48
Trichoptera																									
Hydropsychidae																									
Potamyia sp.																	2								2
MOLLUSCA																									
Bivalvia																									
Sphaeriidae																									
Musculium sp.	3		1		1																				5
TOTAL	235	196	8	5	2	1	52	13	0	1	27	5	1	1	1	1	2	1	21	1	43	1	5	2	625

* Refer to Figure 3E-2 for location.

TABLE 3E-51

DENSITY (NUMBER PER SQUARE METER) OF BENTHIC MACROINVERTEBRATES IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER IN MAY 1978

Location:	LM1*			LM2*			MR1*			MR2*		
	A	B	C	A	B	C	A	B	C	A	B	C
Total Area Sampled (m^2)	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.159	0.106	0.106	0.106	0.159
Scientific Name												
ANNELIDA												
Oligochaeta												
Naididae												
Dero sp.					9							
Tubificidae												
Bothrioneurium vejdovskyanum			28	9					19			
Branchiura sowerbyi			47									
Ilyodrilus templetoni	47	349		47	9	19			19			
Limnodrilus cervix					19			6	28			
Limnodrilus hoffmeisteri	9		19		57	28	9	19	28			6
Limnodrilus maumeensis		462		85								
Limnodrilus udekemianus		19										
Immature Tubificidae WITH capilliform chaetae	28	1811		19	9				19			
Immature Tubificiade WITHOUT capilliform chaetae	57	2123	19	132	142			6	38			
Megadriles			9								9	
ARTHROPODA												
Insecta												
Diptera												
Chaoboridae												
Chaoborus punctipennis					406		9	6		19	9	19
Chironomidae												
Coelotanypus concinnus		9		9	19							
Coelotanypus tricolor		28										
Coelotanypus scapularis		28		57								
Cryptochironomus cf. fulvus		9										
Cryptochironomus sp.		9										
Enfieldia sp.				9								
Procladius sp.	9	19		9	19							
Empididae												
Unidentifiable Empididae sp.											9	
Muscidae												
Unidentifiable Muscidae sp.	9											
Ephemeroptera												
Ephemeridae												
Hexagenia limbata										28	9	
MOLLUSCA												
Bivalvia												
Lymnaeidae												
cf Lymnaea	9	179			9							
TOTAL NUMBER PER m^2	170	5047	123	337	698	47	19	38	151	47	38	25

* Refer to Figure 3E-2 for location.

TABLE 3E-52

DENSITY (NUMBER PER SQUARE METER) OF BENTHIC MACROINVERTEBRATES IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER IN JULY 1978

Location:	LM1*			LM2*			MR1*			MR2*		
	A	B	C	A	B	C	A	B	C	A	B	C
Total Area Sampled (m^2)	0.106	0.106	0.106	0.106	0.106	0.106	0.159	0.212	0.106	0.159	0.265	0.106
Scientific Name												
ANNELIDA												
Oligochaeta												
Tubificidae												
Bothrioneurum vejdovskyanum	28			9								
Limnodrilus hoffmeisteri		75	47		47							
Limnodrilus maumeensis	9	9										
Limodrilus udekemianus	9											
Immature Tubificidae WITH capilliform chaetae					75							
Immature Tubificidae WITHOUT capilliform chaetae	47	434	245	19	104	9					4	
Hirundinea												
Glossiphoniidae												
Unidentifiable Glossiphoniidae sp.		66	38									
ARTHROPODA												
Insecta												
Diptera												
Chaoboridae												
Chaoborus punctipennis					1000	57						
Chironomidae												
Coelotanypus scapularis			9	9								
Coelotanypus tricolor			9									
Cryptochironomus sp.						9						
Procladius sp.			9									9
Ephemeroptera												
Caenidae												
Caenis sp.				9								
Ephemeridae												
Hexagenia limbata			19	9								
Trichoptera												
Hydropsychidae												
Hydropsyche sp.											4	
MOLLUSCA												
Bivalvia												
Sphaeridae												
Musculium transversum	28	47	85								11	
Gastropoda												
Hydrobiidae												
Amnicola sp.	9		9									
TOTAL NUMBER PER m^2	132	642	472	57	1226	75	0	0	0	0	19	9

* Refer to Figure 3E-2 for location.

TABLE 3E-53

DENSITY (NUMBER PER SQUARE METER) OF BENTHIC MACROINVERTEBRATES IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER IN OCTOBER 1978

Location:	LM1*			LM2*			MR1*			MR2*		
	A	B	C	A	B	C	A	B	C	A	B	C
Total Area Sampled (m^2)	0.106	0.106	0.106	0.106	0.106	0.106	0.159	0.106	0.212	0.212	0.265	0.159
Scientific Name												
ANNELIDA												
Oligochaeta												
Tubificidae												
Branchiura sowerbyi			19									
Limnodrilus cervix						19				5		
Limnodrilus hoffmeisteri		85										
Limnodrilus maumeensis		9				19						
Limnodrilus udekemianus						38				28	15	
Immatures WITH capilliform chaetae		66	19		38	75						
Immatures WITHOUT capilliform chaetae	38	500		38	38	472	13	9		151	19	
ARTHROPODA												
Crustacea												
Amphipoda												
Gammaridae												
Gammarus sp.										14		
Cladocera												
Unidentifiable Cladocera sp.					9	19						
Insecta												
Diptera												
Ceratopogonidae												
Unidentifiable *Ceratopogonidae* sp.						19		28			4	6
Chaboridae												
Chaoborus punctipennis					443							
Chironomidae												
Chironomus sp.						28						
Coelotanypus scapularis	9	340	9	38		170						
Coelotanypus tricolor		245		9		19						
Corynoneura sp.									5			
Cryptochironomus cf *fulvus*									5	9		
Glyptotendipes sp.						28						
Procladius sp.						9						
Polypedilum sp.						19						
Unidentifiable Tanypodinae				9								
Xenochironomus rogersi										28	19	
Ephemeroptera												
Caenidae												
Caenis sp.						9		9				
Ephemeridae												
Hexagenia limbata			19							57	4	
Trichoptera												
Hydropsychidae												
Hydropsyche oris					9					28	57	
Potamyia sp.										137	242	
COELENTERATA												
Hydrozoa												
Hydroida												
Clavidae												
Cordylophora lacustris						19						
MOLLUSCA												
Bivalvia												
Corbiculidae												
Corbicula sp.	66							9	5	19	11	13
Sphaeriidae												
Musculium transversum		491	38									
Gastropoda												
Hydrobiidae												
Amnicola sp.												6
PLATYHELMINTHES												
Tubellaria												
Planeriidae												
Unidentifiable Planeriidae sp.						19						
TOTAL NUMBER PER m^2	113	1736	104	94	538	981	13	57	14	476	370	25

* Refer to Figure 3E-2 for location.

TABLE 3E-54

DENSITY (NUMBER PER SQUARE METER) OF BENTHIC MACROINVERTEBRATES IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER IN JANUARY 1979

Location:	LM1*			LM2*			MR1*			MR2*		
	A	B	C	A	B	C	A	B	C	A	B	C
Total Area Sampled (m^2)	0.106	0.106	0.159	0.106	0.159	0.106	0.159	0.159	0.265	0.106	0.265	0.159
Scientific Name												
ANNELIDA												
Oligochaeta												
Tubificidae												
Ilyodrilus templetoni	1198	38		38		19			4			
Limnodrilus claparedianus				19								
Limnodrilus hoffmeisteri	57											
Limnodrilus maumeensis	255			57		38						
Limnodrilus udekemianus	113			28		9						
Peloscolex multisetosus longidentus	104			9		28						
Immature Tubificidae WITH capilliform chaetae	642	19		38	6	104						
Immature Tubificidae WITHOUT capilliform chaetae	1575	47	13	368		47		13	4	57	23	13
ARTHROPODA												
Crustacea												
Amphipoda												
Gammaridae												
Gammarus sp.												6
Insecta												
Diptera												
Chaoboridae												
Chaoborus punctipennis				9		9						
Chironomidae												
Chironomus sp.				9		19						
Coelotanypus scapularis	19			38		28						
Cryptochironomus cf. *fulvus*											19	
Procladius sp.	19											
Xenochironomus sp.											8	25
Tipulidae												
Unidentifiable Tupulidae g. sp.		9										
Ephemeroptera												
Ephemeridae												
Hexagenia limbata	57											
Pentagenia cf. *vittigera*							6			9	117	94
Trichoptera												
Hydropsychidae												
Potamyia sp.							13					
MOLLUSCA												
Bivalvia												
Sphaeriidae												
Musculium sp.	28	9	6									
TOTAL NUMBER PER m^2	4066	123	19	613	6	302	19	13	8	66	166	138

* Refer to Figure 3E-2 for location.

TABLE 3E-55

INDICES OF ASSOCIATION* BETWEEN BENTHIC MACROINVERTEBRATE SAMPLES COLLECTED IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER DURING THE MAY 1978 FIELD SURVEY

Location**	LM1-A	LM1-B	LM1-C	LM2-A	LM2-B	LM2-C	MR1-A	MR1-B	MR1-C	MR2-A	MR2-B	MR2-C
LM1-A		60.8	20.9	53.8	32.6	33.3	5.9	30.6	55.6	0	0	5.6
LM1-B			15.4	57.2	24.9	6.9	0	25.0	44.4	0	0	0
LM1-C				17.9	23.5	15.4	15.4	30.8	43.3	0	7.7	15.4
LM2-A					28.0	12.5	0	16.7	45.0	0	0	0
LM2-B						9.5	58.1	44.1	33.8	40.0	25.0	66.2
LM2-C							50.0	50.0	31.3	0	0	25.0
MR1-A								66.7	18.8	40.0	25.0	75.0
MR1-B									52.1	16.7	16.7	41.7
MR1-C										0	0	18.8
MR2-A											50.0	40.0
MR2-B												25.0
MR2-C												

* Extent to which two samples are alike, ranging from zero for samples with no species in common to 100 for identical samples

** Refer to Figure 3E-2 for location descriptions.

TABLE 3E-56

INDICES OF ASSOCIATION* BETWEEN BENTHIC MACROINVERTEBRATE SAMPLES COLLECTED IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER DURING THE JANUARY 1979 FIELD SURVEY

Location**	LM1-A	LM1-B	LM1-C	LM2-A	LM2-B	LM2-C	MR1-A	MR1-B	MR1-C	MR2-A	MR2-B	MR2-C
LM1-A		84.0	39.4	62.1	15.8	66.1	0	38.8	68.2	38.8	13.6	9.1
LM1-B			46.2	50.8	15.4	55.8	0	38.5	69.2	38.5	13.6	9.1
LM1-C				60.0	0	9.6	0	66.7	50.0	66.7	13.6	9.1
LM2-A					6.2	41.9	0	60.0	56.2	60.0	13.6	9.1
LM2-B						21.2	0	0	0	0	0	0
LM2-C							0	9.6	51.9	9.6	9.6	9.1
MR1-A								0	0	14.3	33.3	33.3
MR1-B									50.0	85.7	13.6	9.1
MR1-C										50.0	13.6	9.1
MR2-A											27.9	23.4
MR2-B												81.8
MR2-C												

* Extent to which two samples are alike, ranging from zero for samples with no species in common to 100 for identical samples

** Refer to Figure 3E-2 for location descriptions.

TABLE 3E-57

INDICES OF ASSOCIATION* BETWEEN BENTHIC MACROINVERTEBRATE SAMPLES COLLECTED IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER DURING THE OCTOBER 1978 FIELD SURVEY

Location**	LM1-A	LM1-B	LM1-C	LM2-A	LM2-B	LM2-C	MR1-A	MR1-B	MR1-C	MR2-A	MR2-B	MR2-C
LM1-A		37.1	8.3	41.7	7.0	41.7	33.3	33.3	33.3	35.6	8.2	50.0
LM1-B			41.2	58.4	10.8	52.4	28.8	16.7	14.1	28.8	5.1	0
LM1-C				9.1	7.0	16.8	0	0	0	11.9	1.0	0
LM2-A					7.0	59.2	40.0	16.7	0	31.7	5.1	0
LM2-B						15.8	7.0	7.0	0	8.8	6.9	0
LM2-C							48.1	19.6	0	36.5	10.0	1.9
MR1-A								16.7	0	31.7	5.1	0
MR1-B									16.7	20.6	9.2	41.7
MR1-C										5.9	3.1	33.3
MR2-A											53.0	4.0
MR2-B												4.1
MR2-C												

* Extent to which two samples are alike, ranging from zero for samples with no species in common to 100 for identical samples

** Refer to Figure 3E-2 for location descriptions.

TABLE 3E-58

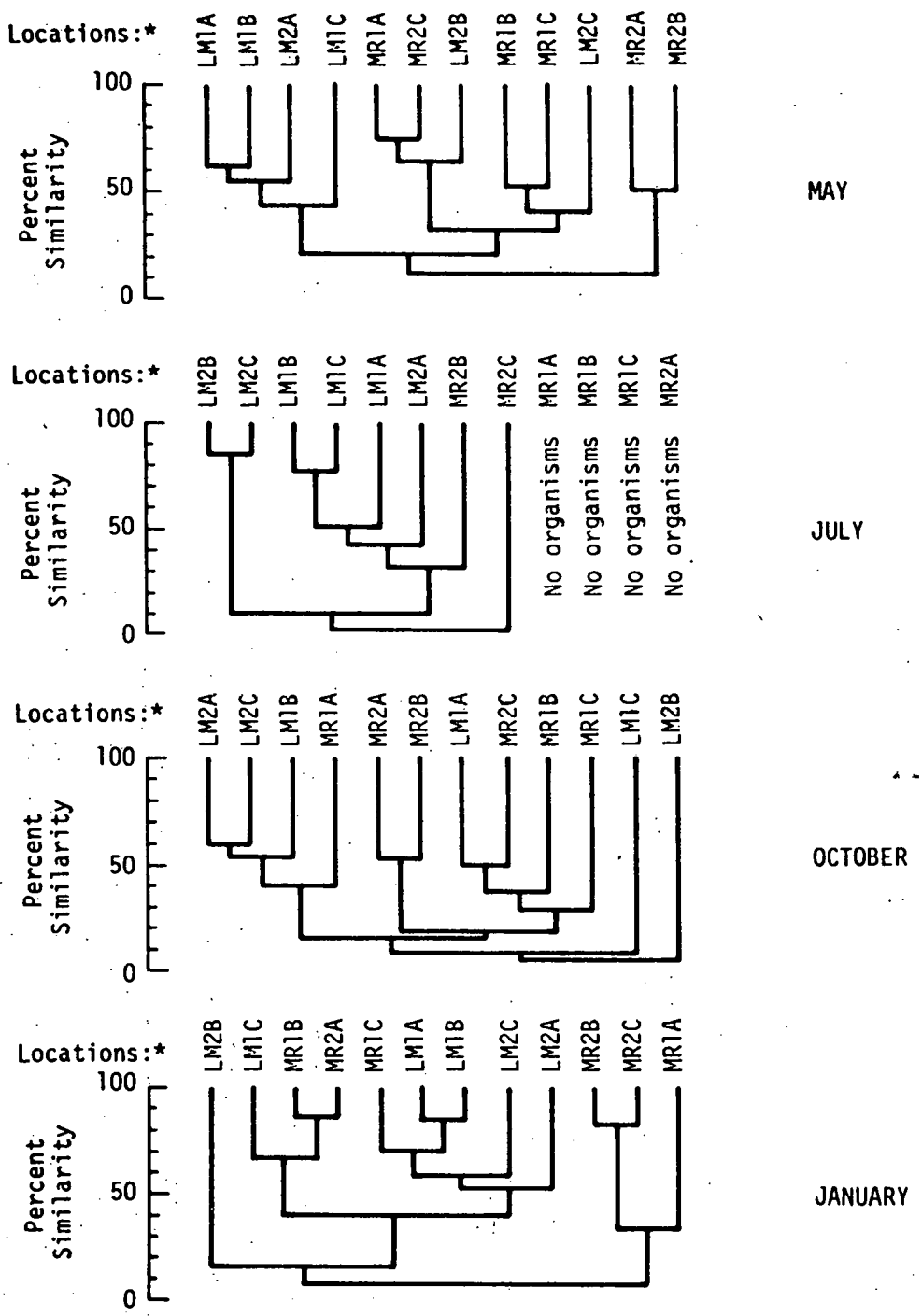
INDICES OF ASSOCIATION* BETWEEN BENTHIC MACROINVERTEBRATE SAMPLES COLLECTED IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER DURING THE JULY 1978 FIELD SURVEY

Location**	LM1-A	LM1-B	LM1-C	LM2-A	LM2-B	LM2-C	MR1-A	MR1-B	MR1-C	MR2-A	MR2-B	MR2-C
LM1-A		44.3	55.7	50.0	8.5	12.5	†	†	†	†	41.4	0
LM1-B			77.1	33.3	13.7	12.5	†	†	†	†	27.1	0
LM1-C				39.3	12.3	12.5	†	†	†	†	38.0	2
LM2-A					8.5	12.5	†	†	†	†	20.0	0
LM2-B						86.5	†	†	†	†	8.5	0
LM2-C							†	†	†	†	12.5	0
MR1-A								†	†	†	†	†
MR1-B									†	†	†	†
MR1-C										†	†	†
MR2-A											†	†
MR2-B												20
MR2-C												

* Extent to which two samples are alike, ranging from zero for samples with no species in common to 100 for identifical samples

** Refer to Figure 3E-2 for location descriptions.

† Indices of association cannot be calculated for empty samples



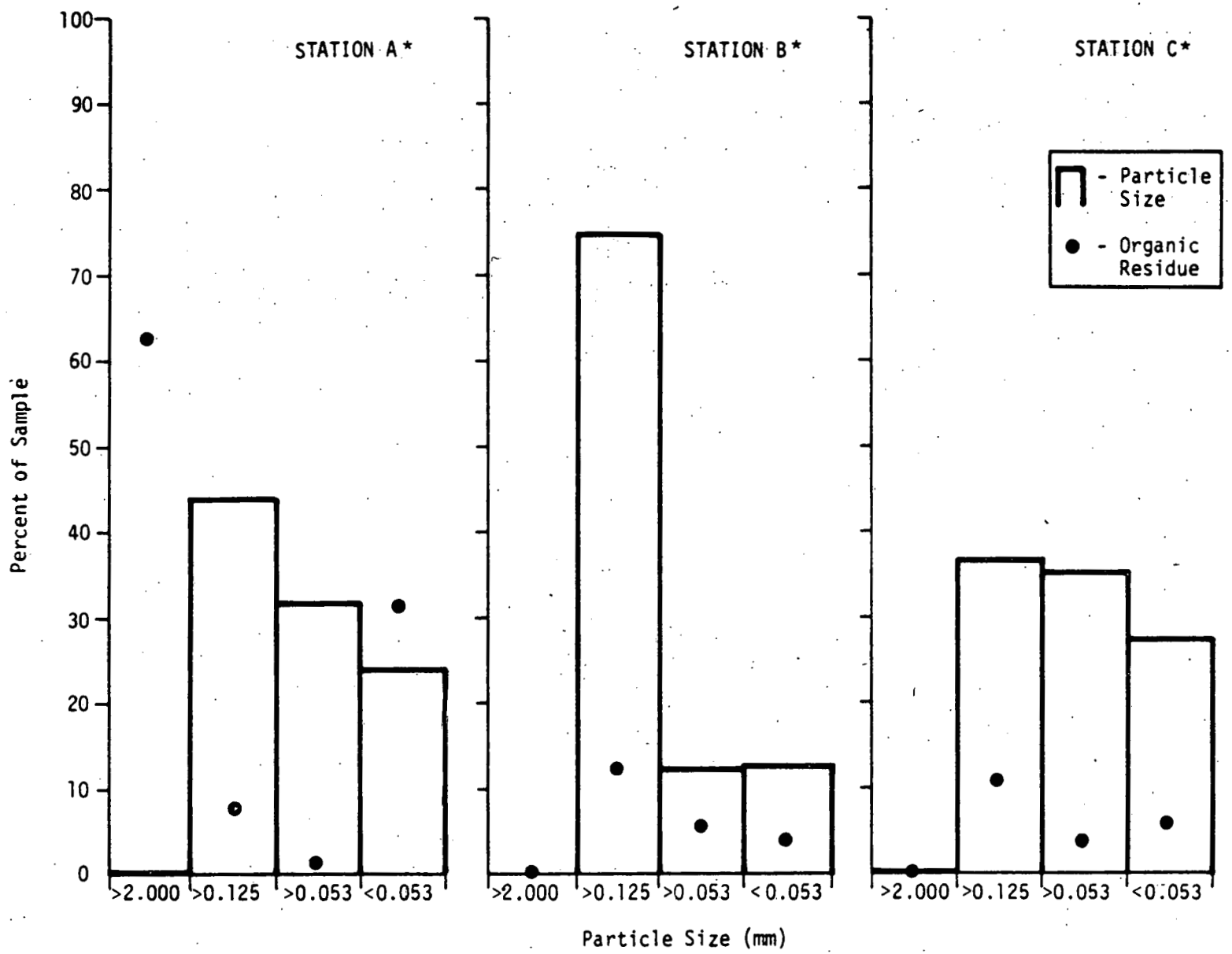
* Refer to text for location descriptions

Figure 3E-7. Cluster Analysis of Index of Association Data for Benthic Macroinvertebrates Collected During Field Surveys of Lake McKellar and the Mississippi River in May, July and October 1978 and January 1979

The cluster diagram indicates that in general there was rather low similarity in benthic macroinvertebrate samples from different stations. In a general way, the Mississippi River stations tended to cluster, and LM1-A and LM1-B in the Tennessee Chute of Lake McKellar tended to be similar (at the 50 percent or greater level). However, strong patterns are not apparent in these data.

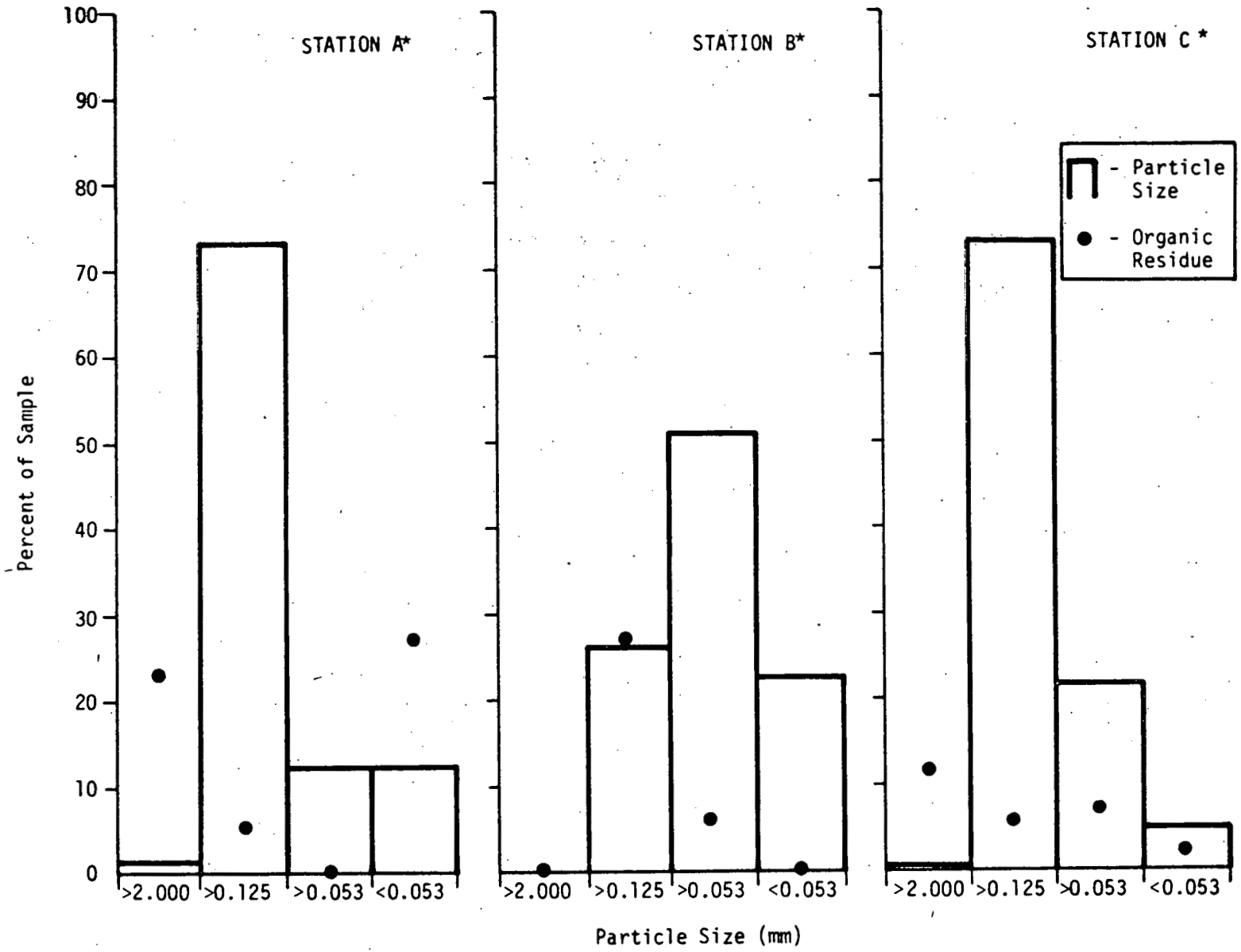
During the October field survey, sediments were collected concurrently with benthic macroinvertebrate samples. These sediments were analyzed for particle size composition and percent organic residue. Results for each transect are illustrated in Figures 3E-8 through 3E-11. In general, sediments at all locations consisted of predominantly sandy sediments (<2 millimeters) of moderate to low organic content. All but 3 of the total of 48 fractions contained less than 30 percent volatile organic fraction.

A comparison of the sediment analyses with species assemblages clustering for October yielded no readily discernible relationship between them.



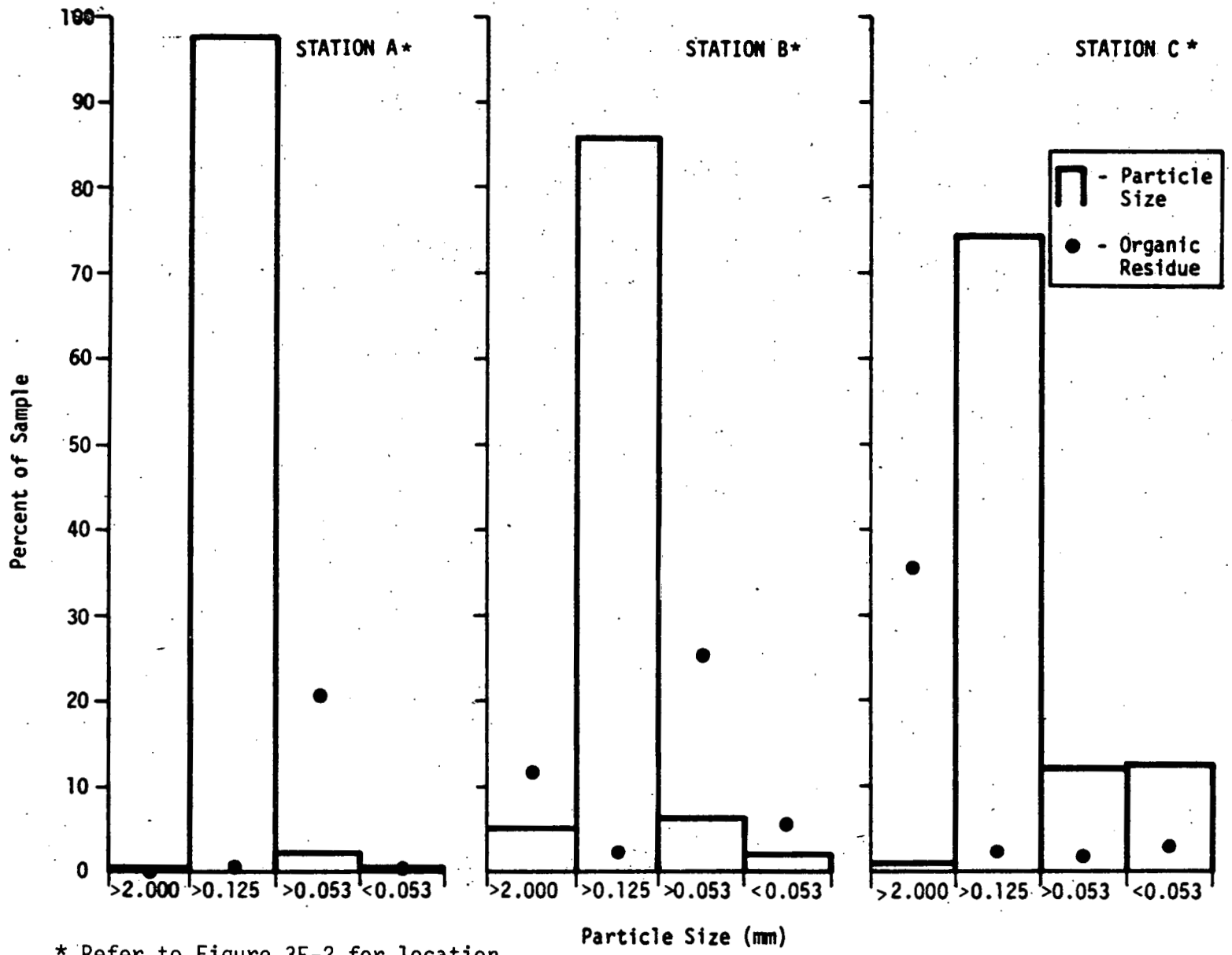
* Refer to Figure 3E-2 for locations.

Figure 3E-8. Analyses of Sediment Samples Collected in the Tennessee Chute of Lake McKellar (LM1*) During October 1978



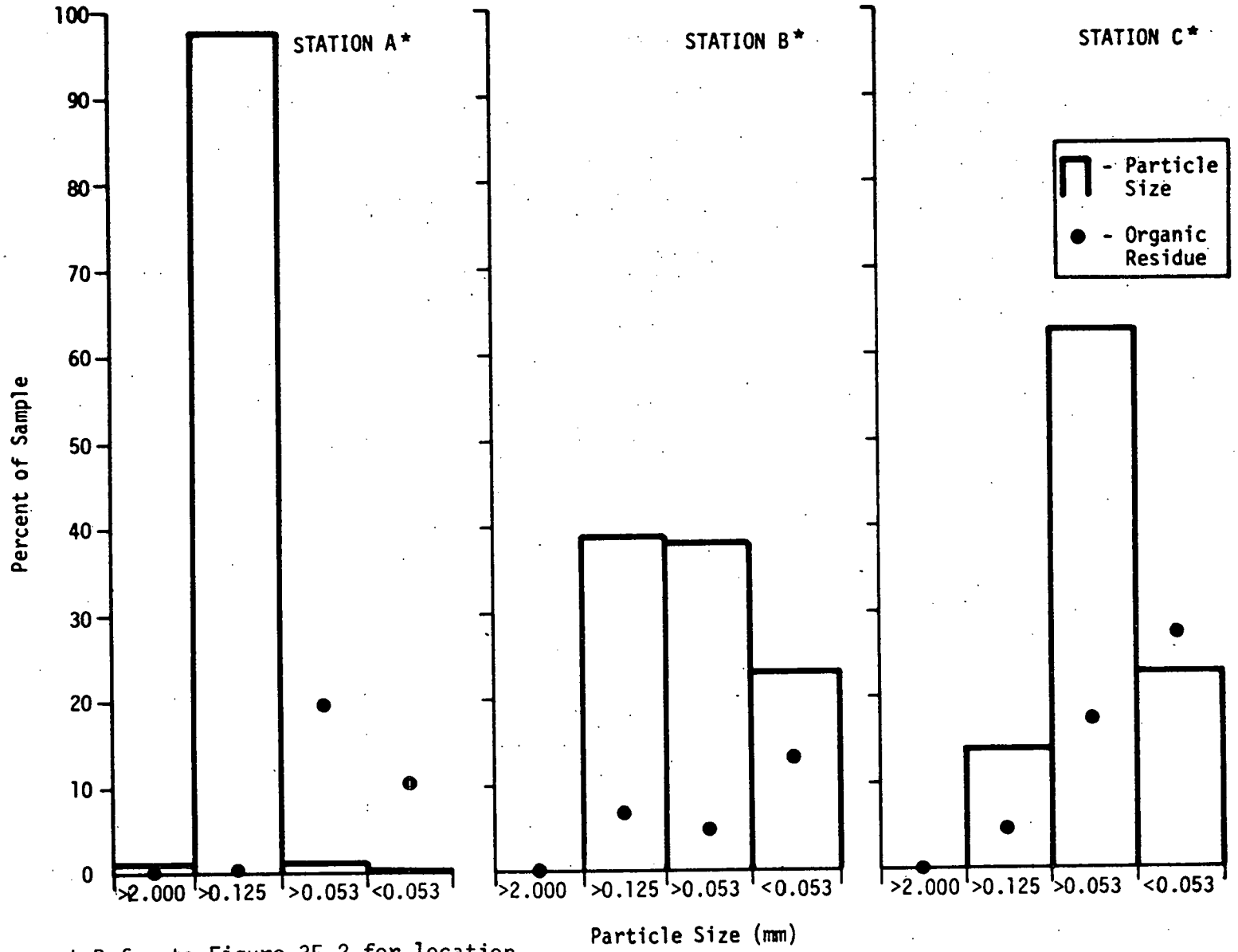
* Refer to Figure 3E-2 for location.

Figure 3E-9. Analyses of Sediment Samples Collected in the Turning Basin of Lake McKellar (LM2*) During October 1978



* Refer to Figure 3E-2 for location.

Figure 3E-10. Analyses of Sediment Samples Collected in the Missippi River Upstream of Lake McKellar (MR1*) During October 1978



* Refer to Figure 3E-2 for location.

Figure 3E-11. Analyses of Sediment Samples Collected in the Missippi River Downstream of Lake McKellar (MR2*) During October 1978

3E.3.3 ZOOPLANKTON

Zooplankton samples were collected in Lake McKellar and the Mississippi River seasonally at the most offshore station of each transect. Results of these collections are presented in Tables 3E-59 through 3E-62.

Examination of these tables shows that there were both seasonal and local variation between zooplankton assemblages. Total densities were generally highest in the May and July samples, followed by the October samples and minimum densities in January. Samples from Lake McKellar indicated higher densities than the Mississippi River, with highest densities generally occurring in the turning basin area (LM2-B). These are typical patterns for this group of organisms, since: (1) populations grow faster at warmer temperatures and (2) these weakly-swimming organisms are better adapted to calmer waters.[22]

Dominant taxa also varied among seasons and locations. In the May samples (Table 3E-59), the crustaceans (cladocerans and copepods) dominated the Lake McKellar samples, with immature copepods (nauplii and juvenile Cyclops sp.) and Daphnia parvula most abundant. Rotifers dominated the Mississippi River collections, with Brachionus calyciflorus and Keratella cochlearis (two common, widespread organisms) most numerous.

In July (Table 3E-60), rotifers were relatively more abundant in Lake McKellar than they had been in May, with Conochilus unicornis (another common form) very abundant. Immature copepods (nauplii and juvenile Cyclops sp. and Diaptomus sp.) were also abundant as was the cladoceran Diaphanosoma leuchtenbergianum. Except for the last named organism, these are all relatively small organisms. This may be due to increased predation (by fish) on the larger organisms.[47,48] All zooplankters were scarce in the Mississippi River, again with copepod nauplii most abundant.

Crustaceans increased in relative abundance again in the October collections (Table 3E-61). In the turning basin (LM2-B) dominant forms were again nauplii and juvenile Diaptomus sp., followed by the rotifer Keratella

TABLE 3E-59

ZOOPLANKTON (NUMBER PER CUBIC METER) COLLECTED IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER DURING SPRING SURVEY ON MAY 6, 1979

Location:	LM1*		LM2*		MR1*		MR2*	
Scientific Name	B-1	B-2	B-1	B-2	C-1	C-2	C-1	C-2
CLADOCERA								
Alona affinis	47				35			
Bosmina longirostris	1789	4269	2432	3855	416	270	301	175
Ceriodaphnia sp.	47		49					
Chydorus sphaericus			195	79			75	
Daphnia ambigua	47		49	157				
Daphnia parvula	4331	7970	15953	21243	347		38	
Daphnia sp.	47	95	195	157				
Scapholeberis kingi				39				
COPEPODA								
Cyclops bicuspidatus	612	3131	9630	5114	173	90	75	70
Cyclops vernalis	283	95	195	472			188	35
Cyclops sp. (juv.)	15725	11765	41440	17496	1006	992	790	805
Diaptomus ashlandi				79				
Diaptomus reighardi (?)		47	681	236				
Diaptomus siciloides	283	95	292	393				
Diaptomus sp. (juv.)	1083		2918	2832		30	38	
Mesocyclops edax		95	584	472				
Mesocyclops edax (juv.)		95	584	708				
Nauplius	22401	24763	60798	33832	2080	1953	2331	2381
ROTIFERA								
Asplanchna priodonta	141	285		39	139	120	38	70
Bdelloidea g. sp.			49				38	35
Brachionus angularis	330	237	97	79	69	301	188	245
Brachionus calyciflorus	612	1471			1214	1322	1353	1786
Brachionus quadridentatus	94	95	389		104	150		35
Brachionus urceolaris	141	237			312	150	526	210
Cephalodella sp.								35
Conochilus unicornis	47	142	195	39			38	35
Filinia longiseta	188	190		79		60		
Kellicottia longispina	47	142			69	30		105
Keratella cochlearis	1507	2467	486	393	1110	1022	865	700
Keratella cochlearis tecta	47				35	30	38	
Keratella quadrata	1177	1186	292	315	728	361	338	385
Notholca labis	47	95			35	90		140
Notholca squamula	47				35	60		
Platyias patulus			49					
Polyarthra dolichoptera		142		39				
Rotatoria sp.	94	237	486	472	69	301	226	175
Synchaeta sp.	1177	1708	1556	865	312	301	150	245
OTHER								
Carchesium sp.				629	277			385
Codonella sp.			97					
Macrobiotus sp.								35
Nematoda							75	
TOTAL	57391	61054	139691	90113	8565	7633	7709	8087

* Refer to Figure 3E-2 for location.

TABLE 3E-60

ZOOPLANKTON (NUMBER PER CUBIC METER) COLLECTED IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER DURING SUMMER SURVEY ON JULY 17, 1978

Location:	LM1*		LM2*		MR1*		MR2*	
Scientific Name	B-1	B-2	B-1	B-2	C-1	C-2	C-1	C-2
CLADOCERA								
Bosmina longirostris	206	84	3077	1531	27			
Ceriodapnia sp.	147	112	1978	918				
Daphnia ambigua			330	306				
Daphnia parvula	147	84	3297	2449				
Daphnia sp.			330	102				
Diaphanosoma leuchtenbergianum	4236	1124	10879	5816	13		13	
Moina macrocopa	323							
COPEPODA								
Cyclops vernalis	88	84	1319		13		13	28
Cyclops sp.				5510				
Cyclops sp. (juv.)	1147	140	7582	306	13	14	13	28
Diaptomus pallidus	29		165					
Diaptomus reighardi (?)	206		3297	2449				
Diaptomus siciloides			495	51				
Diaptomus sp. (juv.)	1059	140	13517	10714				
Mesocyclops edax	147		989	1225				
Mesocyclops edax (juv.)	118	56	5604					
Nauplius	17294	3371	69231	29082	186	264	175	18
Tropocyclops prasinus				51				
ROTIFERA								
Asplanchna priodonta	676	506	440	969				
Brachionus angularis	88	843	440	561	27			
Brachionus budapestinensis	1500	281	110	102				
Brachionus calyciflorus	882	140	989	510				
Brachionus caudatus	971	1011	440	1633	27	56	13	28
Brachionus havanensis	2824	2444	1703	1429	40	69	13	
Brachionus quadridentatus			109					
Conochilus unicornis	11559	5225	39890	25714				
Filinia opoliensis			220	51				
Gastropus sp.	59	140	385	102				
Keratella cochlearis	2118	2275	4286	5204		42	13	
Keratella cochlearis tecta	353	281	330	153	27	28	13	28
Keratella quadrata	29		165	153				14
Lecane sp.	29	28						14
Pedilia mira	3000	2017	5934	3980	13	28		
Platyas patulas			55	51				
Pleosoma truncatum					13			
Polyarthra dolichoptera	500	506	1978	1531			27	
Polyarthra vulgaris	1176	758	989	918				
Synchaeta sp.	2735	2865	55	1837		28		
Trichocerca sp.	118	56	659	51			13	
Unidentifiable Rotifer	882	169	220	1531	27			
OTHER								
Carchesium sp.								351
Chironomidae (larvae)			55				13	
Codonella sp.			11868	2755				
Corethra sp.			55					
Difflugia sp.	1059	1432	3626	2755	40	14		
Hydropsyche sp.						14		
Nemotoda g. sp.						14		
Vorticella sp.	29	28						
TOTAL	55734	26200	197091	112500	466	571	319	674

* Refer to Figure 3E-2 for location.

TABLE 3E-61

ZOOPLANKTON (NUMBER PER CUBIC METER) COLLECTED IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER DURING FALL SURVEY ON OCTOBER 18, 1978

Location:	LM1*		LM2*		MR1*		MR2*	
Scientific Name	B-1	B-2	B-1	B-2	C-1	C-2	C-1	C-2
CLADOCERA								
Bosmina longirostris	2029	1362	8372	2364	386	472	323	210
Ceriodaphnia sp.	66	169	977	1119	39	47	28	8
Dapnia parvula	33		2233	1297				
Diaphanosoma Teuchtenbergianum			1814	848				
Leptodora kindii			23					
Moina micrura	11	28	140		15		21	
COPEPODA								
Canthocamptus sp.		14				7		
Cyclops vernalis		28	140	126	46	53	14	31
Cyclops sp. (juv.)	230	169	2791	1841	23	53	119	8
Diaptomus reighardi(?)	11		1954	2599	15			
Diaptomus siciloides			302	433		7		
Diaptomus sp. (juv.)	66		18558	13755				
Eragasilus chatauquaensis			47	199				
Mesocyclops edax	11		279				7	
Mesocyclops edax (juv.)	22		419	1390				
Nauplius	1480	1025	27907	30415	262	273	302	78
ROTIFERA								
Asplancha priodonta	164	112	23	36	23	20	14	15
Bdelloidea g. sp.			23					
Brachionus angularis	219	281	70	18	39	27	56	8
Brachionus bidentatus	55	42			8			
Brachionus budapestinensis	307	309			100	47	70	23
Brachionus calyciflorus	307	197	23		54	47	70	16
Brachionus caudatus	22	28						
Brachionus forficula			23					
Brachionus quadridentatus	143	56				7	7	8
Brachionus urceolaris							7	
Cephalodella gibba	11	14						
Conochilus unicornis			698	560				
Gastropus sp.	11							
Kellicottia bostoniensis	22		279	108				
Keratella cochlearis	4156	2809	14372	866	316	266	513	101
Keratella cochlearis tecta	2029	1615	837	217	185	120	492	85
Keratella quadrata	252	183	558	433	15	20	28	
Lecane ohioensis						7		
Lecane sp.		14	23	18		7		
Pedalia mira	11	42	418	307		7		
Platyas patulus	329	14				13		
Ploesoma truncatum	274	169			46	27	70	23
Polyarthra dolichoptera	296	267	1674	1264	31	7	21	
Polyarthra vulgaris	11	14						
Pompholyx sulcata	55	84		108	8	7	28	
Rotatoria g. sp.	219	98	279	108	5	7	84	
Synchaeta sp.	471	323	279	758	39	47	28	8
Trichocera sp.	88	14						
OTHER								
Arcella sp.							14	
Carchesium sp.	3509	983	1117		440	160	56	
Codonella sp.	55	42	6698	2599	31	7		
Difflugia sp.	186	154	2233	217	31	20	112	16
Nematoda g. sp.					8			
Tintinnidium	22	14	23		31	7		
Vorticella sp.							3	
TOTAL	17183	10673	95606	65963	2196	1789	2487	638

* Refer to Figure 3E-2 for location.

TABLE 3E-62

ZOOPLANKTON (NUMBER PER CUBIC METER) COLLECTED IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER DURING WINTER SURVEY ON JANUARY 11, 1979

Location:	LM1*		LM2*		MR1*		MR2*	
Scientific Name	B-1	B-2	B-1	B-2	C-1	C-2	C-1	C-2
CLADOCERA								
Bosmina longirostris	157	148	1092	1173		9	35	
Chydorus sphaericus		37	17		27		18	
Daphnia ambigua				10				
Daphnia parvula	31		171	514	36			
Ilyocryptus sordidus		19	9					
COPEPODA								
Canthocamptus sp.			9					
Cyclops bicuspidatus	47	74	51	1173	36	91	18	30
Cyclops vernalis	63	130	43	41				
Cyclops sp. (juv.)	519	556	879	926	179	15	21	69
Diaptomus ashlandi		19						
Diaptomus reighardi(?)	31	37	102	370		18		8
Diaptomus pallidus								3
Diaptomus siciloides	63	37	26	267				
Diaptomus sp. (juv.)	94	93	879	905	107		8	13
Ergasilus chatauguaenis		19						
Nauplius	3475	3852	6945	14105	402	71	35	195
Tropocyclops prasinus		19	34	103		9		
ROTIFERA								
Asplancha priodonta	79	56	9	72	36	32		
Bdelliodea g. sp.	31		9	41				36
Brachionus angularis	157	259	17	20	45			
Brachionus calyciflorus	63	148	179	266	223			41
Brachionus urceolaris		56	17	31		12		
Collotheca sp.		37						
Euchlanis dilatata			9					
Filinia longiseta	16	56	17	41			15	
Kellicottia bostoniensis	346	407	102	607				10
Kellicottia longispina	283	185						
Kellicottia sp.		19						
Keratella cochlearis	770	852	145	617	134	15		51
Keratella quadrata	94	56	26	267				
Keratella tecta		19						
Keratella ticiensis	16							
Lecane bulla	16							
Lecane sp.		19						
Notholca acuminata	16	37			36			26
Polyarthra dolichoptera		56						
Pomphlonyx sucata			9					
Synchaeta sp.	79	93	34	185			29	13
Trichotria tetractis		19						
Rotatoria g. sp.	1226	1685	77	412	357	82	32	62
OTHER								
Arcella sp.		19						
Carchesium sp.	11934	407			1518	156		354
Chironomidae (larvae)		19						
Difflugia						44	62	38
Epistilis sp.		37						
Macrobius sp.								3
Nematoda	110	259				9	59	13
Oligochaeta g. sp.								3
Strombidium sp.	16							
Suctoria g. sp.	47	56						
Tanytarsus (larva)	16							
Tintinnidium sp.	31	204		10				
Vorticella sp.			60					26
TOTAL	19826	10099	10967	22156	3136	563	332	994

* Refer to Figure 3E-2 for location.

cochlearis. The zooplankton of the Tennessee Chute (LM1-B) was dominated by Keratella cochlearis, the ciliate Carchesium sp. and the crustaceans Bosmina longirostris and copepod nauplii. Mississippi River collections were more dense than in July, but still depauperate relative to those from Lake McKellar. Dominant forms in the river were Keratella cochlearis, Bosmina longirostris, copepod nauplii and Carchesium sp.

Densities of zooplankton decreased again in the January collections (Table 3E-62), no doubt in response to winter temperatures. Copepod nauplii were among the most abundant organisms at all stations. Other important forms included Bosmina longirostris at LM2-B, Carchesium sp. in the Tennessee Chute and the Mississippi River and an unidentified rotifer at LM1-B. In general, the assemblages in Tables 3E-59 through 3E-62 are characteristic of warmer, somewhat enriched habitats.

3E.3.4 PHYTOPLANKTON

Phytoplankton samples were collected in Lake McKellar and the Mississippi River seasonally at the most offshore station of each transect. Taxa identified in collections from Lake McKellar and the Mississippi River are presented in Tables 3E-63 through 3E-66. One-hundred sixteen algal taxa were identified in these collections including diatoms (47 taxa), green algae (38 taxa), blue-green algae (10 taxa) and a variety of other forms (21 taxa).

Abundance and composition of phytoplankton varied between seasons and locations. Phytoplankton densities in May samples from Lake McKellar averaged 493 organisms per milliliter. The dominant plankter was the flagellate Cryptomonas ovata. Cyclotella meneghiana, Melosira granulata, Chlamydomonas globosa, Coelastrum cambricum, Schizothrix calcicola and Chroomonas sp. were other relatively common taxa present in the May collections.

Phytoplankton densities in July collections from Lake McKellar were much higher than those observed in May, averaging 3523 organisms per milliliter of sample. Compositionally, the blue-green algae Schizothrix calcicola was the dominant phytoplankter among the collections. Other relatively common taxa present in July included Melosira granulata, Stephanodiscus hantzschii, Actinastrum hantzschii, Merismopedia sp. and Chroomonas sp.

In the October collections, phytoplankton densities averaged 1823 organisms per milliliter of sample. Although no single taxa appeared to dominate these collections, the more common taxa present were Cyclotella meneghiana, Melosira binderana, M. granulata, Stephanodiscus hantzschii, Dyctiosphaerium pulchellum, Scenedesmus dimorphus, S. quadricauda, Aphanizomenon flos-aquae, Coelosphaerium naegelianum, Microcystis aeruginosa and Cryptomonas ovata.

Phytoplankton densities were lowest in the January collections from Lake McKellar averaging 251 organisms per milliliter. Schizothrix calcicola was the dominant species in the collections with Asterionella formosa, Cyclotella meneghiana, Melosira binderana and M. granulata being relatively common.

TABLE 3E-63

PHYTOPLANKTON (NUMBER PER MILLILITER) COLLECTED IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER IN MAY 1978

Scientific Name	Location: LM1-B* 1	LM1-B* 2	LM2-B* 1	LM2-B* 2	MR1-C* 1	MR1-C* 2	MR2-C* 1	MR2-C* 2
BACILLARIOPHYCEAE (diatoms)								
Amphiprora sp.							1	
Asterionella formosa	14	14	2		64	18	41	38
Cyclotella menenghiana	17	58	16	40	44	19	11	21
Cycloteila sp.					2			
Cymatopleura solea						1		
Cymbella sp.			1					
Diatoma vulgaris						1		
Fragilaria crotonensis						12		
Fragilaria sp.							8	
Gomphonema olivaceum				1				
Gomphonema sp.			1	1	4			2
Gyrosigma scalproides						2		
Melosira binderana	10	34	2	5	16	20	10	25
Melosira granulata	21	78	9		88	58	116	87
Melosira varians					4	4		4
Navicula cryptocephala							2	1
Navicula radiosa							1	
Navicula tripunctata							1	
Navicula sp.		2	1	1	2			3
Neidium sp.						1		
Nitzschia acicularis		4		3	6	7	6	8
Nitzschia holsatica	8		3		12		11	10
Nitzschia linearis					6	3	2	7
Nitzschia longissima v. *longissima*		2						
Nitzschia palea				1			2	
Nitzschia sigmoidea						1		
Nitzschia sp.		2		1		3		4
Stauroneis sp.	1							
Stephanodiscus astrea	2	2	2	1		1	2	
Stephanodiscus hantzschii		6	3	16	12	1	12	10
Stephanodiscus sp.								2
Surirella angustata		2			2			
Surirella sp.				1			3	
Synedra acus	5	2			4	3	4	6
Synedra ulna		2			4	7	1	7
Synedra sp.		2	1					
CHLOROPHYCEAE (green algae)								
Actinastrum hantzschii			7				18	4
Ankistrodesmus falcatus	8	12	3	7	8	9	11	9
Carteria sp.			1	1				

(Continued)

TABLE 3E-63 (Continued)

Scientific Name	Location: LM1-B* 1	LM1-B* 2	LM2-B* 1	LM2-B* 2	MR1-C* 1	MR1-C* 2	MR2-C* 1	MR2-C* 2
CHLOROPHYCEAE (Continued)								
Chlamydomonas globosa	14	38	54	42	6		6	6
Chlorogonium sp.			1	5				
Closterium acerosum						1		
Coelastrum cambricum			10	60				
Coelastrum sp.	20							
Crucigenia sp.	8							
Haematococcus sp.				1				
Microactinium pusillum		8						4
Oocystis sp.		8		4				
Pandorina morum	16							
Scenedesmus acuminatus		16			6		8	2
Scenedesmus dimorphus					16	3		8
Scenedesmus quadricauda	28	16	4	6	36	11	14	14
Schroederia setigera							1	
Selenastrum westii	2	2		2	8		8	1
Unidentifiable Chlorophyta sp.	3	18	17	61	28			
MYXOPHYCEAE (blue-green algae)								
Anabaena flos-aquae							58	
Aphanizomenon flos-aquae	15	20			198		30	25
Oscillatoria sp.	55				70	57	112	133
Schizothrix calcicola	71	80			228	59	151	90
OTHER ALGAE								
Ceratium hirundinella							1	
Chroomonas sp.	40	36	34	63	2			
Cryptomonas ovata	183	280	52	66	38	11	22	28
Euglena sp.	6	10	1		8	3	4	4
Glenodinium sp.			1	16				
Lepocinclis sp.	2							
Ochromonas sp.	2	6	6	3				
Peridinium sp.			1					
Phacus pleuronectes		2						
Trachelomonas sp.	8	6	2		1	2		3
Unidentifiable Chrysophyta sp.					4			
TOTAL NUMBER ORGANISMS PER MILLILITER	559	768	235	408	928	320	678	566
TOTAL NUMBER TAXA IDENTIFIED	25	30	26	25	30	28	32	30

* Refer to Figure 3E-2 for location.

TABLE 3E-64

PHYTOPLANKTON (NUMBER PER MILLILITER) COLLECTED IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER IN JULY 1978

Location:	LM1-B*		LM2-B*		MR1-C*		MR2-C*	
Scientific Name	1	2	1	2	1	2	1	2
BACILLARIOPHYCEAE (diatoms)								
Asterionella formosa	8							
Cyclotella menenghiana	52	320	49	15	28	16	16	12
Gyrosigma scalproides						2		
Hantzschia amphioxa							1	
Melosira binderana	8		3					
Melosira granulata	308	400	211	259	151	133	186	70
Melosira italica			13		16	12	40	
Melosira varians					4		13	
Navicula sp.		2	2			1		
Nitzchia acicularis	6	4	7		1			41
Nitzschia holsatica	31	22	28	8	6		10	13
Nitzschia linearis						2		
Nitzschia sp.	1		4	17	6	6	2	
Pleurosigma sp.					2			
Stephanodiscus astrea	1	1			1			
Stephanodiscus hantzschii	63	270	32	114	33	1	6	96
Surirella sp.						1		
Synedra acus	2		9	13	12	2	4	
Synedra ulna	2							2
CHLOROPHYCEAE (green algae)								
Actinastrum hantzschii	176	260	120	88		8		
Ankistrodesmus falcatus	17	64	32	18	4	3		
Chlamydomonas globosa	15	357	3	2				8
Closterium gracile			3	1		3	6	
Closterium sp.	1							
Coelastrum cambricum		640	40					
Coelastrum sp.				30				
Crucigenia rectangularis							16	
Dyctiosphaerium pulchellum			16	36	46			64
Eudorina elegans	30							
Microactinium pusillum		130						
Oocystis sp.	2		6	12				
Pandorina morum		84						16
Pediastrum duplex				16	32		32	32
Pediastrum simplex					16			
Scenedesmus dimorphus		16	20	4				
Scenedesmus quadricauda	16	195	18	68	32			
Scenedesmus sp.	3		2	4			4	
Schroederia setigera	10	59		4				
Selenastrum westii		32		2				
Sphaerocystis schroeteri		20	4		20	8		
Unidentifiable Chlorophyta sp.	18	487	49	65		25		

(Continued)

TABLE 3E-64 (Continued)

Scientific Name / Location:	LM1-B* 1	LM1-B* 2	LM2-B* 1	LM2-B* 2	MR1-C* 1	MR1-C* 2	MR2-C* 1	MR2-C* 2
MYXOPHYCEAE (blue-green algae)								
Anabaena flos-aquae	24			130				16
Aphanizomenon flos-aquae		60	24	25				78
Lyngbya sp.	40							
Merismopedia sp.	128	520		32				
Microcystis aeruginosa		30		60				
Oscillatoria sp.		48	40	30				22
Schizothrix calcicola	1021	4742	324	406				24
Unidentifiable Cyanophyta			40		20	50	68	100
OTHER ALGAE								
Chroomonas sp.	27	32	2	168	162	81	67	
Cryptomonas ovata	122	357	16	34	4	5	4	29
Euglena acus		1						
Euglena oxyuris								2
Euglena sp.	1		1	1		1		1
Glenodinium gymnodinium	1							
Glenodinium sp.	1							
Peridinium sp.	3		3	1			4	
Phacus longicauda				1				
Phacus sp.					1			
Trachelomonas giardiana			1					
Trachelomonas sp.	5	4	1	4		2	1	
TOTAL NUMBER ORGANISMS PER MILLILITER	2143	9157	1123	1668	597	362	480	626
TOTAL NUMBER TAXA IDENTIFIED	32	28	32	32	21	20	18	18

* Refer to Figure 3E-2 for location.

TABLE 3E-65

PHYTOPLANKTON (NUMBER PER MILLILITER) COLLECTED IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER IN OCTOBER 1978

Scientific Name	Location: LM1-B* 1	LM1-B* 2	LM2-B* 1	LM2-B* 2	MR1-C* 1	MR1-C* 2	MR2-C* 1	MR2-C* 2
BACILLARIOPHYCEAE (diatoms)								
Achnanthes sp.			2					
Asterionella formosa		1						
Cyclotella menenghiana	180	97	40	197	93	146	189	260
Diatoma vulgaris							1	
Fragilaria crotonensis					8			
Gyrosigma scalproides	1							
Melosira binderana			145	487	41	6		
Melosira granulata	117	128	22	162	57	130	103	111
Melosira italica		2		3		5		
Navicula cryptocephala	1							
Navicula sp.	1	16			3	17	20	
Nitzschia acicularis		1			5	1	1	3
Nitzschia holsatica	26	13	1		38	26	10	12
Nitzschia linearis							2	
Nitzschia palea	1				2			
Nitzschia tryblionella	1	2			2	1	1	
Nitzschia sp.	16	18	9	66	6	6	15	16
Stephanodiscus astrea	1	1	4		6	1	1	1
Stephanodiscus dubius		1						
Stephanodiscus hantzschii	32	65	2	617		50	51	49
Stephanodiscus niagarae					1			
Surirella sp.			1			1		
Synedra acus	1	1			1			1
CHLOROPHYCEAE (green algae)								
Actinastrum hantzschii	58	40	8		88	96	54	32
Ankistrodesmus falcatus	3	17	7	65	11		18	16
Carteria sp.			17					
Chlamydomonas globosa	36	49			6	4	16	15
Chlorogonium sp.				1				
Closterium gracile	4	5		2	2	1		6
Closterium sp.			1					
Coelastrum cambricum						24		
Coelastrum sp.	10	15			10			
Cosmarium sp.			1					
Crucigenia rectangularis			4					
Crucigenia tetrapedia					12			
Crucigenia sp.					8			
Dyctiosphaerium pulchellum	198	20		32		40		40
Euastrum sp.			1			1		1
Haematococcus sp.	1							
Microactinium pusillum					2		65	

(Continued)

TABLE 3E-65 (Continued)

Scientific Name	Location: LM1-B* 1	LM1-B* 2	LM2-B* 1	LM2-B* 2	MR1-C* 1	MR1-C* 2	MR2-C* 1	MR2-C* 2
CHLOROPHYCEAE (Continued)								
Oocystis solitaria			1			1		
Oocystis sp.	2					20	97	32
Pandorina morum							16	6
Pediastrum boryanum		16				16		16
Pediastrum duplex					32		32	42
Pediastrum simplex								16
Quadrigula lacustris							8	
Scenedesmus brasiliensis					4		8	
Scenedesmus dimorphus	202	195		4	72	324	42	2
Scenedesmus opoliensis	69					16	16	
Scenedesmus quadricauda	195	390	6	12		44	98	
Scenedesmus sp.			6		4	97	4	36
Schroederia setigera				1	1			1
Sphaerocystis schroeteri		21						
Tetraedron limneticum	1							
Unidentifiable Chlorophyta sp.	159	146	275		71	65	76	211
MYXOPHYCEAE								
Anabaena flos-aquae	5							
Aphanizomenon flos-aquae	101	149	18		215	292	110	128
Chroococcus limneticus			4					
Coelosphaerium naegelianum		300						
Merismopedia sp.				656	48		196	
Microcystis aeruginosa	60	500				150		660
Oscillatoria sp.	70	70			10	10	64	130
Schizothrix calcicola	35		6	15	51	24	20	
Unidentifiable Cyanophyta sp.			6					
OTHER ALGAE								
Chroomonas sp.	50	38	56	49	9	49		18
Cryptomonas ovata	33	66	55	130	35	16	18	34
Euglena acus	2							
Euglena sp.		2			3	1	1	
Glenodinium sp.	1							
Lepocinclis sp.						1		
Mallomonas sp.			1					
Peridinium sp.		1		16		1	10	
Phacus pyrum					1			
Phacus sp.	1							
Tetraedron minimum					1			
Trachelomonas giardiana	1					1		4
Trachelomonas hispida	1							
Trachelomonas sp.	4		1	4		1		1
TOTAL NUMBER ORGANISMS PER MILLILITER	1680	2387	708	2518	958	1585	1363	1900
TOTAL NUMBER TAXA IDENTIFIED	38	32	29	19	36	37	32	30

* Refer to Figure 3E-2 for location.

TABLE 3E-66

PHYTOPLANKTON (NUMBER PER MILLILITER) COLLECTED IN LAKE MCKELLAR AND THE MISSISSIPPI RIVER IN JANUARY 1979

Scientific Name	Location: LM1-B* 1	LM1-B* 2	LM2-B* 1	LM2-B* 2	MR1-C* 1	MR1-C* 2	MR2-C* 1	MR2-C* 2
BACILLARIOPHYCEAE (diatoms)								
Asterionella formosa	35	64	21	32	38	41	42	37
Cyclotella menenghiana	8	16	16	8	13	8	4	15
Cymbella sp.		2				1	1	
Diatoma vulgaris		1		2	3	1	1	
Epithemia sp.	1							
Fragilaria crotonensis						6		
Gomphonema sp.	1							
Hantzschia amphioxa						1		
Melosira binderana	17	14	21	6	3	13	4	21
Melosira granulata	19	14	8	19	27	13	11	2
Melosira italica						4	3	
Melosira varians		1				3	1	
Melosira sp.							1	
Navicula cryptocephala	1			1			2	1
Navicula radiosa					1		1	
Navicula tripunctata						1		
Navicula sp.	1	1		2	2	1	1	
Nitzschia acicularis	2	2	1			1	1	1
Nitzschia holsatica					2		2	
Nitzschia linearis	1			2		2	1	
Nitzschia palea				2	1	1	1	
Nitzschia sigmoidea				1				
Nitzschia sp.	1	1		5		1	2	
Pinnularia sp.		1				1		
Pleurosigma sp.							1	
Rhoicosphenia curvata				1	1	1	1	
Stephanodiscus astrea					1	1		
Stephanodiscus hantzschii	3	1		4		2	1	7
Surirella sp.					1		1	
Synedra acus						1	1	1
CHLOROPHYCEAE (green algae)								
Actinastrum hantzschii			2					
Ankistrodesmus falcatus	5	8	3		2	2	3	1
Chlamydomonas globosa	4	6	9	1	1	1	2	23
Microactinium pusillum								2
Pediastrum simplex					8			
Scenedesmus dimorphus			1					
Scenedesmus quadricauda						2		
Selenatrum westii		1						
Staurastrum paradoxum							1	
Unidentifiable Chlorophyta sp.	2		1					

(Continued)

TABLE 3E-66 (Continued)

Scientific Name / Location:	LM1-B* 1	LM1-B* 2	LM2-B* 1	LM2-B* 2	MR1-C* 1	MR1-C* 2	MR2-C* 1	MR2-C* 2
MYXOPHYCEAE (blue-green algae)								
Aphanizomenon flos-aquae	30		32		123	28		5
Lyngbya sp.					10	28	20	
Oscillatoria sp.	10	45		10	10	10		1
Schizothrix calcicola	104	112	18	162	57	61	102	27
OTHER ALGAE								
Chroomonas sp.			2				1	3
Cryptomonas ovata	3	2	4	2	2	1	2	3
Euglena sp.	1	2	1		1			1
Glenodinium sp.	2		1					
Lepocinclis sp.				1				
TOTAL NUMBER ORGANISMS PER MILLILITER	251	349	141	261	307	237	215	151
TOTAL NUMBER TAXA IDENTIFIED	21	20	16	18	21	29	29	17

* Refer to Figure 3E-2 for location.

Phytoplankton abundance and composition in the Mississippi River differed from that observed in Lake McKellar. Densities in collections from the river in May averaged 623 organisms per milliliter. The dominant phytoplankter was Schizothrix calcicola with Asterionella formosa, Melosira granulata, Oscillatoria sp. and Aphanizomenon flos-aquae also being common.

In the July river collections, phytoplankton densities averaged 616 organisms per milliliter. Melosira granulata was the dominant plankter in these collections. Stephanodiscus hantzschii, Pediastrum duplex, Chroomonas sp. and an indeterminate blue-green algae were other relatively common species.

Phytoplankton densities were highest in the October collections from the Mississippi River averaging 1452 organisms per milliliter. As was the case in Lake McKellar, no single taxa appeared to dominate these collections. The more common taxa present were Cyclotella meneghiana, Melosira granulata, Actinastrum hantzschii, Scenedesmus dimorphus, Aphanizomenon flos-aquae, Merismopedia sp., Microcystis aeruginosa and an indeterminate green algae.

Phytoplankton densities were lowest in the January collections from the Mississippi River. Densities averaged 228 organisms per milliliter and the blue-green algae Aphanizomenon flos-aquae and Schizothrix calcicola were the most abundant organisms present in the collections. Other common species present were Asterionella formosa and Melosira granulata.

In summary, the phytoplankton communities of Lake McKellar and the Mississippi River are characterized by a mixed assemblage of diatoms, green algae, blue-green algae and a variety of other smaller groups (cryptomonads, euglenoids, etc.). The densities and species composition vary seasonally with noticeable differences being apparent between lake and river communities. The phytoplankton communities in both Lake McKellar and the Mississippi River are generally indicative of moderate levels of organic enrichment.

3E.3.5 PERIPHYTON

Periphyton were collected in July of 1978 from the predominant natural substrates (submerged tree stumps, trunks and roots) in Lake McKellar on the shorelines adjacent to the proposed plant site (LM1-C and LM2-A) and along the shoreline of the Mississippi River above and below the entrance of Lake McKellar.

Taxa identified in collections from Lake McKellar and the Mississippi River are presented in Table 3E-67. Diatoms were the predominant group in the periphyton community (68 taxa) with green and blue-green algae occurring less frequently (nine taxa and three taxa respectively). Periphyton density ranged from a minimum of 0.02×10^6 to a maximum of 9.0×10^6 units per 10.5 square centimeters (mean = 3.39×10^6 units per 10.5 square centimeters).

The dominant diatom taxon in all of the collections was an unidentified species in the genus Navicula that most closely resembled Navicula tripunctata var. schizonemoides.* This species is poorly known ecologically but is considered to prefer water with a fairly high mineral content. Other diatom taxa commonly encountered included: Amphora submontana, Cyclotella meneghiniana, C. stelligera, Gomphonema parvulum, Melosira distans, M. granulata, M. varians, Navicula luzonensis, Nitzschia filiformis, N. palea and Stephanodiscus astraea var. minutula. This assemblage represents species typical of a wide range of environmental conditions but are generally indicative of alkaline waters.[50] The most commonly encountered blue-green algal taxa was Schizothrix calcicola which is a widely distributed form of little value as an indicator of water quality. Green algae were a poorly developed component of the periphyton community.

Spatial differences in the periphyton collections from Lake McKellar and the Mississippi River were minor due to the dominance of Navicula tripunctata

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* Based on personal communication between D. J. Wagner, EIA, and R. Lowe, Bowling Green State University, May 9, 1979.

TABLE 3E-67

PERIPHYTON COLLECTED FROM LAKE MCKELLAR AND THE MISSISSIPPI RIVER DURING THE SUMMER SURVEY IN JULY 1978

Scientific Name / Location:	LM1-C*			LM2-A*			MR1-A*			MR2-A*		
	1	2	3	1	2	3	1	2	3	1	2	3
BACILLARIOPHYCEAE (Diatoms)												
Achnanthes lanceolata											3	
Actinocyclus normanii				1								
Amphora submontana								18	122	57	58	
Amphora sp.				1								
Bacillaria paradoxa			2									
Caloneis bacillum				4		1					2	
Coscinodiscus lacustris						1						
Cyclotella atomus			6			7						3
Cyclotella meneghiniana	6	5	16	40	30	15	2	1			2	
Cyclotella pseudostelligera			8		2	10						
Cyclotella stelligera	2		11	5	26	50						
Cymbella minuta	5	9	5	4	4	2						
Cymbella triangulum			2									
Cymbella sp.	2											
Gomphonema affine	2	46		3								
Gomphonema gracile	4				2							
Gomphonema insigne			1					2			2	
Gomphonema olivaceum							2					
Gomphonema parvulum	29	50	15	46	22	9		59	27		9	4
Gomphonema tenellum											4	
Gyrosigma scalproides	2	2	4									
Gyrosigma spenserii			1	2								
Melosira ambigua		7			9							
Melosira distans			11	26	38	60	2		2		4	
Melosira granulata		8	8	92	68	33	1	1				
Melosira varians	25	3	15					7		52	153	6
Navicula accomoda	3		15									
Navicula accomodata											2	
Navicula biconica		4			5							
Navicula cryptocephala	24		13	12	7	26		2	2			
Navicula cryptocephala v. exilis						2			3			
Navicula cryptocephala v. veneta								2	1			
Navicula elginensis			1									
Navicula lanceolata		5		2	2							
Navicula luzonensis	36	64	24	1	5			2	38	3	2	
Navicula minuscula	2		1			1						
Navicula mutica			1								2	
Navicula mutica v. undulata											1	
Navicula paucivisitata						1						

(Continued)

TABLE 3E-67 (Continued)

Location:	LM1-C*			LM2-A*			MR1-A*			MR2-A*		
Scientific Name	1	2	3	1	2	3	1	2	3	1	2	3
BACILLARIOPHYCEAE (cont.)												
Navicula pelliculosa								1				
Navicula salinarum										2		
Navicula salinarum v. *intermedia*				2								
Navicula symmetrica	8		4					12		4	6	
Navicula viridula						2						
Navicula viridula v. *rostellata*	2	21									2	
Navicula sp. #1	299	238	250	137	140	167	8	245	229	348	202	483
Navicula sp. #2						2						
Nitzschia amphibia	16	2	1	3	12	6			1		15	2
Nitzschia clausii									2		4	
Nitzschia dissipata											2	
Nitzschia filiformis	12			2	16			100		6		
Nitzschia frustulum	2			22				2				
Nitzschia frustulum v. *perpusilla*			2			4			42			
Nitzschia linearis						1						
Nitzschia palea	7	23	65	38	45	67		40	31	26	10	2
Nitzschia parvula								2			2	
Nitzschia sp.	1	2		6	3			2				
Opephera martyi							2					
Rhoicosphenia curvata				2							5	
Stephanodiscus astraea											1	
Stephanodiscus astraea v. *minutula*	4	8	7	15	54	29	4	2		1		
Stephanodiscus hantzschii				1								
Stephanodiscus invisitatus	4	7	6	30	4	3					2	
Synedra rampens											2	
Synedra ulna			3	2	6						2	
Thalassiosira lacustris				1								
Thalassiosira pseudonana						1						
Thalassiosira sp.	1											
TOTAL NUMBER DIATOMS COUNTED	500	502	500	498	504	499	21**	500	500	499	499	500
CHLOROPHYCEAE (Green algae)†												
Closterium ehrenbergii	I	I	I									
Cosmarium sp.	I	I										
Kirchneriella subsolitaria								I				
Microspora stagnarum								M				
Oedogonium sp.	I	I	I	I	I	A						
Scenedesmus bijuga								I				
Scenedesmus quadricauda		I	I	I	I			I				
Stigeoclonium sp.								I	M			

(Continued)

TABLE 3E-67 (Continued)

Location:	LM1-C*			LM2-A*			MR1-A*			MR2-A*		
Scientific Name	1	2	3	1	2	3	1	2	3	1	2	3
CHLOROPHYCEAE (Green algae)† (cont.)												
Ulothrix sp.												I
MYXOPHYCEAE (Blue-green algae)†												
Merismopedia punctata		I										
Oscillatoria sp.	I		I		I	M	I		I			
Schizothrix calcicola		I		I	I		M	M		M	A	
TOTAL PERIPHYTON UNITS $x10^6$ per 10.5 cm^2	1.5	2.4	0.8	4.8	2.0	4.9	.02	1.2	3.5	9.0	7.1	3.5
TOTAL NUMBER TAXA OBSERVED AT LOCATION		45			44			32			32	

* Refer to Figure 3E-2 for location.

** Low number counted because diatoms were very rare in this sample.

† Numbers not counted. Relative abundances classified as follows:

A = abundant (more than 20 percent of sample)

M = moderate (5-20 percent of sample)

I = infrequent (less than 5 percent of sample)

var. schizonemoides (?) at all locations. Generally, however, more taxa were identified in collections from Lake McKellar (45 and 44 taxa from LM1-C and LM2-A respectively) than from Mississippi River collections (32 taxa from both MR1-A and MR2-A).

In general, the periphyton community in Lake McKellar and the Mississippi River indicated the presence of slightly alkaline water quality conditions and high to moderate levels of organic enrichment.

3E.3.6 MACROPHYTES

No aquatic macrophytes were observed in the permanent bed of the Mississippi River or Lake McKellar.

REFERENCES

REFERENCES

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LIST OF ABBREVIATIONS

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~	approximately
@	at
β	buffer capacity
°F	degrees Fahrenheit
≤	less than or equal to
'	minutes
μg/m³	micrograms per cubic meter
μmhos/cm	micromhos per centimeter
x	multiplied by
%	percent
A	abundance where A = 1-10
A	abundant
A	autumn
a_o	epicentral acceleration
AAG	ash-agglomeration gasifier
ACE	U.S. Army Corps of Engineers
ACI	American Concrete Institute
ADA	Anthraquinone disulphonic acid
Ag	silver
AG	agricultural
AIEE	American Institute of Electrical Engineers
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
Al_2O_3	alumina
ALK	alkalinity
AMCA	Air Moving and Conditioning Association
ammonia-N	ammonia-nitrogen
ANSI	American National Standards Institute
As	arsenic
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
Avg	average
B	abundance where B = 11-25
BACT	Best Available Control Technology
BaO	barium oxide
Be	beryllium
BFW	boiler feed water
BHC	1,2,3,4,5,6-hexachlorocyclohexane
BOD	biological oxygen demand
BOD_5	five-day biological oxygen demand
Btu	British thermal unit
Btu/hr-ft²	Btu per hour per foot squared
Btu/lb	Btu per pound
Btu/scf	Btu per standard cubic foot
C	abundance where C = 26-50
C	carbon
C	centigrade
C	common
Ca	calcium
$CaCO_3$	calcium carbonate
CaO	lime
$Ca(OH)_2$	calcium hydroxide
$CaSO_3$	calcium sulfite
Cd	cadmium
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CH_4	methane
cm/sec	centimeters per second
cm²	square centimeters
CN	cyanide
CO	carbon monoxide
Co.	county
CO_2	carbon dioxide
COD	chemical oxygen demand
COE	U.S. Army Corps of Engineers
COS	carbonyl sulfide
Cr	chromium
Cr	creek
$Cr(OH)_3$	chromium hydroxide
CS_2	carbon disulfide
C.S.T.	Central standard time
Cum wt	cumulative weight
D	abundance where D = 51-100
DAF	dissolved air flotation
dB	decibel
dBA	A-weighted decibel
DBH	diameter at breast height
DEA	diethanolamine
DO	dissolved oxygen
DOC	dissolved organic carbon
DOE	Department of Energy
DRC	Delta Refining Company
DSCF	dry standard cubic feet
DW Standards	Drinking Water Standards
E	abundance where E = more than 100
E	east
E	endangered
E	energy
e.g.	for example
EIA	Energy Impact Associates
Elemental S	Elemental sulfur
elev.	elevation
EPA	U.S. Environmental Protection Agency
EPA Criteria	U.S. Environmental Protection Agency "Quality Criteria for Water
ER	Environmental report
Est.	estimated
F	fall
Fe	iron
FAA	Federal Aviation Agency
FCC	Federal Communications Commission
$Fe(OH)_3$	iron hydroxide
Fe_2O_3	ferric oxide

(Continued)

LIST OF ABBREVIATIONS (Continued)

FSI	free swelling index
ft	foot
ft/sec	feet per second
FWEC	Foster Wheeler Energy Corp.
g	acceleration of gravity
GC/MS	Gas Chromatograph/Mass Spectrometer
gpd	gallons per day
gpm	gallons per minute
GW	groundwater
H	hydrogen
H'	Shannon-Wheaver diversity index
H_2	hydrogen
H_2O	water
H_2S	hydrogen sulfide
ha	hectare
HCN	hydrogen cyanide
HCOOK	potassium formate
Hg	mercury
HHV	higher heating value
Hi-Vol	high volume
HMO	Health Maintenance Organization
HP	horse power
hr	hour
IFG	industrial fuel gas
IFGDP	industrial fuel gas demonstration plant
IGT	Institute of Gas Technology
in.	inch
ISA	Instrument Society of America
JTU	Jackson tubidity units
K_2CO_3	potassium carbonate
K_2O	potassium oxide
kips	1000 pounds
km	kilometer
kv	kilovolts
kva	kilovolt amperes
lb/cf	pounds per cubic feet
LM	Lake McKellar
LNG	liquid natural gas
LR	lost record
m	meter
M	Richter magnitude
m^2ha	square meters expressed in hectares
m^3	cubic meters
M-3	heavy industrial district
MAF	moisture and ash free
MATCOG	Mississippi-Arkansas-Tennessee Council of Governments
max	maximum
MBAS	methylene blue active substances
mcf	thousand cubic feet
MF	moisture free
MFD	Memphis Fire Department
Mg	magnesium
mgd	million gallons per day
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
MgO	magnesia
mi	miles
min	minimum
MLGW	Memphis Light, Gas and Water
mm	millimeter
MMBtu	million Btu
Mn	manganese
Mn_3O_4	manganese oxide
mph	miles per hour
MR	Mississippi River
MSCHD	Memphis and Shelby County Health Department
m/sec	meters per second
MSHA	Mine Safety and Health Administration
msl	mean sea level
mva	megavolt amperes
MW	megawatts
N	nitrogen
N	north
N_2	nitrogen
N/A	not applicable
N/A	not available
$NaHCO_3$	sodium bicarbonate
$NaHSO_3$	sodium bisulfite
Na_2CO_3	sodium carbonate
Na_2O	sodium oxide
Na_2SO_3	sodium sulfite
Na_2SO_4	sodium sulfate
NC	Nonconnah Creek
ND	none detected
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NH_3	ammonia
NH_3-N	ammonia nitrogen
Ni	nickel
NIOSH	National Institute for Occupational Safety and Health
N.N.F.	normally no flow
No.	number
NO_2	nitrogen dioxide
NO_3-N	nitrate nitrogen
No_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
O_2	oxygen
O_3	ozone
OSHA	Occupational Safety and Health Administration
p	permanent
P	phosphorus
P_2O_5	phosphorus pentoxide
PAH	polycyclic aromatic hydrocarbons
Pan	remaining in the pan

(Continued)

LIST OF ABBREVIATIONS (Continued)

Pb	lead
PCB	polychlorinated biphenyls
PCS	potassium chloroplatinate standards
pH	hydrogen ion concentration
Pop.	population
ppm	parts per million
ppmv	parts per million by volume
Project COED	Project Char-Oil-Energy-Development
psf	pounds per square foot
psia	pounds per square inch absolute
psig	pounds per square inch gage
P.T.U.	platinum-cobalt units
Q_{3-20}	once-in-twenty-year 3-day consecutive high or low flow
r	correlation coefficient
R	resident
re	regarding
RFP	request for proposal
RM	river mile
ROW	right-of-way
S	south
S	special
S	special concern
S	sulfur
S	summer
Sb	antimony
scf	standard cubic foot
scfm	standard cubic feet per minute
SCN^-	thiocyanate
SCOT	Shell Claus Off-gas Treatment
Se	selenium
SiO_2	silica
SMSA	Standard Metropolitan Statistical Area
SNG	synthetic natural gas
SO_2	sulfur dioxide
SO_3	sulfur trioxide
SO_4	sulfate
sp	species
Sp	spring
spp	species (pl.)
SrO	strontium oxide
SRU	sulfer recovery unit
SS	suspended solids
Std. dev.	standard deviation
STP	sewage treatment plant
Su	summer
T	threatened
T	transient
T/D	tons per day
TDE	1,1,-dichloro-2,2-bis (p-chlorophenyl) ethane
TDS	total dissolved solids
TEMA	Tubular Exchange Manufacturers Association
Tennessee Criteria	Tennessee Water Quality Criteria
Ti	titanium
TiO_2	titania
TKN	total kjeldahl nitrogen
Tl	thallium
TOC	total organic carbon
TSP	total suspended particulates
TSS	total suspended solids
TVA	Tennessee Valley Authority
U	uncommon
U-GAS™ Process	medium Btu industrial fuel gas
UL	Underwriters Laboratories
U.S.	United States
U.S. ACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USS	U.S. standard sieve
V	vanadium
V	very uncommon
v	visitor
V_2O_5	vanadium pentoxide
var.	variety
viz	that is
W	west
Wt	weight
yr	year
Zn	zinc
$Zn(OH)_2$	zinc hydroxide