Comparative Ecological and Human Health Risk Assessment Big Sunflower River Maintenance Project

November, 2001

Prepared for:

U.S. Army Corps of Engineers
Waterways Experiment Station
3909 Halls Ferry road
Vicksburg, MS 39180

Prepared by:

Menzie-Cura & Associates, Inc.
One Courthouse Lane, Suite Two
Chelmsford, MA 01824

Katherine von Stackelberg, Sc.M.
Project Manager

Jerome J. Cura, Ph.D.
Project Reviewer

Ward T. Wickwire, M.F.S.
Ecological Project Scientist

Donna J. Vorhees, Sc.D.
Human Health Project Scientist

Sandra J.S. Baird, Ph.D.
Human Health Project Scientist

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

ACRONYMS

BSRMP	Big Sunflower River Maintenance Project
CDF	Confined Disposal Facility
COC	Contaminant of Concern
CTE	Central Tendency Exposure
DDD	p, p'-Dichlorodiphenyldichloroethane
DDE	p, p'-Dichlorodiphenyldichloroethylene
DDT	p, p'-Dichlorodiphenyltrichoroethane
DDTs	Generic reference to DDT and the breakdown products, DDE and DDD
EPA	United States Environmental Projection Agency
EPC	Exposure Point Concentration
GDM	General Design Memorandum
GSD	Geometric Standard Deviation
ITEM	USACE River Reach Project Area Designation
LOAEL	Lowest Observed Adverse Effect Level
NOAEL	No Observed Adverse Effect Level
RME	Reasonable Maximum Exposure
ROI	Region of Influence
SEIS	Supplement No. 2 to the Final Environmental Impact Statement
Sum DDT	DDT + DDD + DDE
TLD	Thin Layer Disposal

TRV	Toxicity Reference Value
UF	Uncertainty Factor
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service

EXECUTIVE SUMMARY

This risk assessment addresses the potential aquatic ecological and human health effects from exposures to DDT, DDD, and DDE originating from sediments of the Big Sunflower River Basin. It relies on measured and estimated concentrations of these chemicals in sediment, water, soil, and fish tissue. It estimates and compares potential exposure and risk in the Big Sunflower River Basin under two general long-term conditions (approximately 40 years):

> No dredging conditions that used measured concentrations in sediment and water, for the initial year, and modeled concentrations for all subsequent years.
>
> Dredging conditions that used measured concentrations in sediment and modeled concentrations in water for the initial year (during which the dredging activity occurs) and modeled sediment and water concentrations in all subsequent years.

Predicted Environmental Concentrations

The analyses and conclusions in this assessment depended heavily upon a bioaccumulation model, the FISHRAND model. The model performed well. Specifically, it predicted aquatic organism body burdens within a factor of 1.5 of observed concentrations 56 percent of the time and within a factor of 2 approximately 81% of the time. Only two comparisons exceeded a factor of three. The highest deviation was for predicted body burdens of DDT in gar.

The bioaccumulation model relied on the results of several fate and transport models that provided predicted sediment and water exposure concentrations under the different conditions. The existing sediment and water data are inadequate to provide confidence in the predictions to within an order of magnitude. This is an important source of uncertainty in the estimates of absolute risk, but less so for the risk comparison because the uncertainties apply equally to each condition.

Predicted effects of dredging and disposal on water quality, sediment concentrations, and biological body burdens were minimal and would be under all circumstances for the likely range of modeling assumptions (e.g. flow rate, percent lipid, K_{ow}). There is greater uncertainty in the absolute predicted results than in the relative predicted results for the two general conditions because the rate constants in the modeling that govern physical and biological processes are not concentration-dependent.

Estimated Ecological Risks

The ecological assessment indicated that generally:

> There is no potential risk to the fish community in Items 1,2,5,6, 7, and 10, based on the

measurement endpoints, invertebrate body burdens and fish body burdens of DDT, DDD, and DDE under either the no dredging or dredging conditions.

In Item 8, there is potential for risk to the fish community based on body burdens in invertebrates and body burdens in all modeled fish species. The predicted dredging conditions in Item 8 neither ameliorate nor exacerbate this potential risk.

There is potential risk to wildlife in Items 1,7,8, and 10 based on the measurement endpoint, doses of DDT, DDD, and DDE to osprey and in all Items based on the measurement endpoint, doses of DDT, DDD, and DDE to mallard duck. The dredging conditions ameliorate this risk Item 2 for the mallard duck.

There is no potential risk to mammals, as represented by mink in any of the Items, under either condition.

Estimated Human Health Risks

The human health risk assessment showed that generally:

There is potential for risk to anglers consuming fish from the rivers in the Big Sunflower River Basin; and,

The proposed dredging project neither exacerbates nor ameliorates these risks.

Specifically:

Estimates of hazard and risk vary among project items by about a factor of ten, depending on different predicted fish tissue concentrations;

Estimates of hazard and risk vary within an item by about a factor of ten, depending on assumptions made about fish ingestion rates and characteristics of people consuming fish;

The use of region-specific fish ingestion rates rather than rates from the general population or another geographic region reduces uncertainty in the estimates of absolute risk; and,

Sources of uncertainty in this assessment, including those associated with fish tissue concentration estimates, affect absolute estimates of risk for each Item, but have less effect on estimates of relative risk between dredging and no dredging conditions.

1.0 PROBLEM FORMULATION/ HAZARD IDENTIFICATION

1.1 Objectives

This risk assessment addresses the potential aquatic ecological and human health effects from exposures to DDT, DDD, and DDE originating from sediments of the Big Sunflower River Basin. It relies on measured and estimated concentrations of these chemicals in sediment, water, soil, and fish tissue. It estimates and compares potential exposure and risk in the Big Sunflower River Basin under two general long-term conditions (approximately 40 years):

> No dredging conditions that used measured concentrations in sediment and water, for the initial year, and modeled concentrations for all subsequent years.
>
> Dredging conditions that used measured concentrations in sediment and modeled concentrations in water for the initial year (during which the dredging activity occurs) and modeled sediment and water concentrations in all subsequent years.

Note that, in this assessment, the term “DDTs” refers generically to DDT and its breakdown products (DDD and DDE) while the term “sum DDT” refers explicitly to the arithmetic sum of the concentrations of DDT, DDD, and DDE as opposed to the concentration of any one of these compounds.

1.2 Site Description

The Big Sunflower River Maintenance Project (BSRMP) is in the Big Sunflower River Basin in the Mississippi delta, in the northwest portion of Mississippi. The Big Sunflower, Little Sunflower, Hushpuckena and Quiver Rivers and their tributaries, Deer Creek, Steele Bayou and Bogue Phalia drain the basin. The United States Army Corps of Engineers (USACE) provides a map of the basin (plate 1 in USACE, 1996). It is approximately 4,100 square miles, 140 miles long in a north-south direction, and 30 miles wide on average. The east bank levee of the Mississippi River is west of the basin, and the Yazoo-Tallahatchie River is east (USACE, 1996, p. 1).

The project area is on the nearly flat floodplain of the Mississippi River where relief is low (88 feet National Geodetic Vertical Datum (NGVD) in the south to 116 feet NGVD in the north) (USACE, 1996, p. 15). The average slope of the basin is 0.5 foot per mile. The river and tributaries in the Big Sunflower River Basin are generally slow flowing and turbid with water levels that may fluctuate more than 20 feet annually. Low water stages generally occur in fall and early winter with high stages occurring in late winter and early spring. The Sunflower system is a low energy system where backwater flooding creates slack water that promotes deposition of sediments (Supplement No. 2 to the Final Environmental Impact Statement (USACE, 1996), Appendix B, p. 3).

1.2.1 Land Use

The Big Sunflower River Basin is primarily agricultural lands and bottomland hardwood forests. There are 1,054,715 acres of farmland in the project area within Humphreys, Sharkey, Sunflower, Washington and Yazoo counties. The main agricultural crops are soybeans, cotton, rice, wheat, grain sorghum and corn (USACE, 1996, p. 3-13).

The southern portion of the project area lies within the 59,000 acre Delta National Forest, the only bottomland hardwood National Forest. The national forest along with the privately owned Delta Wildlife Area (21,000 acres) and the state's Twin Oaks Wildlife Management Area (6,000 acres) is a large contiguous tract of bottomland hardwood (USACE, 1996, Appendix B, p. 3). Several other state, federal and privately owned natural resource areas in the basin include:

Lake George Wildlife Management Area;

Sunflower Wildlife Management Area;

Mahannah Wildlife Management Area;

Yazoo National Wildlife Refuge;

Panther Swamp National Wildlife Refuge;

Leroy Percy State Park (lake in the park);

Holmes County State Park (lake in the park).

These are fishing, boating, camping and hunting areas, and are also valuable wildlife habitat, especially for migratory waterfowl (USACE, 1996, p.3-14).

1.2.2 Habitat Characterization

The bottomland hardwood wetlands and winter flooded agricultural land of the Big Sunflower River Basin are extremely important to wintering waterfowl, especially for the mallard and wood duck populations. A wide variety of other wildlife also uses these wetland habitats including songbirds, shorebirds, furbearers, and many other game and nongame animals (USACE, 1996, Appendix B, p. 4).

Aquatic Habitat

Many of the streams receive large amounts of sediment and other agricultural contaminants and nutrients resulting in high turbidity, and in fair to poor water quality (USGS, 2001). Average low flow in the Big Sunflower River at the town of Sunflower has decreased from 150 cubic feet per second (cfs) in 1970 to 15 cfs in the 1990's due to declines in the Mississippi River Alluvial Aquifer (MS delta, 2001). The annual average stream flow for 1999 in Bogue Phalia at Leland (www.usgs.gov) was 690 cfs, with the lowest flows in the fall (monthly mean of 32 cfs in October) and highest flows in January during the rainy winter season (monthly mean of 1,353 cfs).

Most fish species collected in the Big Sunflower River system are characteristic of the Mississippi delta. An estimated fifty-five fish species occur, including 13 species of minnows and 12 species of sunfish. Larger fish include blue catfish, flathead catfish, smallmouth buffalo and gar. Species diversity is moderate to low while species richness is moderately high (USACE, 1996, Appendix B, p. 4). [Table 1 of Appendix B to the SEIS report (p. 5 & 6) lists the Fishes of the Big Sunflower River. Table 2 shows the dominant fish species collected from the Big Sunflower River (USACE, 1996, Appendix B, p. 6).]

Recent studies (in 1992 and 1994) of mussel resources in the BSR project area found 31 species of native mussels and the Asian clam. [Table 3 of Appendix B to the SEIS report lists the freshwater mussel species in the Big Sunflower River (USACE, 1996, Appendix B, p. 8).]

Terrestrial Habitat

The adjacent terrestrial habitat includes a combination of agricultural applications including soybean, cotton, rice, wheat, grain sorghum and corn and bottomland hardwood forest. The majority (71%) of the adjacent land is in agricultural production, while the remaining 29% is bottomland hardwood forest. The agricultural land is in cotton (38%) and soybean (43%), and to a lesser extent wheat (7%), rice (8%) and corn/grain sorghum (4%). Bottomland hardwood forests dominate the vegetative cover in the Delta National Forest in the southern portion of the project area. Bottomland hardwood forests. Land use activities may impact the species that access the rivers. For example, grain fields would likely attract migratory birds and fields that are intermittently flooded would provide quality waterfowl habitat.

1.2.3 Human Population

The overall human population density is 46 persons per square mile in the region of influence (ROI which includes Humphreys, Sharkey, Sunflower, Washington and Yazoo counties and the cities of Holly Bluff, Anguilla, Indianola, Leland, Greenville and Rolling Fork). The population is 59 percent African American and 40 percent Caucasian. The remaining one- percent is a combination of Native American, Asian, Hispanic and others. The majority of the people in the ROI reside in rural areas, except for Washington County that has the highest population and the highest population density. Washington County is 70 percent urban and 67 percent of the total population in Washington County is Greenville (USACE, 1996, p. 3-11). USACE summarizes the population and demographic information for the ROI (USACE, 1996 Table 3-4). .

The three leading employment sectors include services (20%), manufacturing (19.5%) and government/government services (19 %). The farm sector is 8% of the total, which is noteworthy because this is significantly higher than the national average (2.3%) (USACE, 1996, p. 3-11). Per capita income for 1990 was $12,472, which was below the 1990 national average of $17, 592 (USACE, 1996, p. 3-13).

1.3 Project Description

In recent years, extensive annual flooding has occurred in the Big Sunflower River Basin. Between 1940 to 1960, the USACE established a certain drainage capability of the Big Sunflower River Basin, as outlined in General Design Memorandum (GDM) No. 1. Since 1960, vegetation growth and sedimentation in the channels has resulted in flooding of residential areas, rural areas (agricultural land) and public facilities. In response to complaints from residents, landowners and others, the USACE is undertaking the Big Sunflower River Maintenance Project (BSRMP) to restore the drainage capability of the basin to the conditions outlined in GDM No. 1 (USACE, 1996, p. i).

Figure 1.1 is a map of the project area. The BSRMP proposes channel maintenance on approximately 133.1 miles of streams to minimize the impact of flooding. This includes removing approximately 8.42 million cubic yards of material along 104.8 miles of channel (2 to 4 feet excavation of stream bottom) and clearing and snagging on 28.3 miles of channel. The project area includes the lower 75.6 miles of the Big Sunflower River (including Holly Bluff Cutoff), the lower 24.2 miles of Bogue Phalia, the lower 8.0 miles of Dowling Bayou, and all of the Little Sunflower River, Big Sunflower Bendway, and Bogue Phalia Cutoff. These project streams drain approximately 3,340 square miles within the counties of Sunflower, Washington, Humphreys, Sharkey and Yazoo (USACE, 1996, p. 1). The project area includes ten areas or "items of work", listed in Table 5 of the Project Report (USACE, 1996). This risk assessment addresses only seven Items because: work in Item 3 is complete; Item 9 is scheduled for only clearing and snagging; and, Item 4 is scheduled for mostly clearing and snagging. The USACE map shows all the work items in the Big Sunflower River Basin (USACE, 1996 plate 48).

1.3.1 Dredging and Removal Methods

The BSRMP includes three general types of removal activities:

clearing and snagging;

hydraulic dredging; and,

draglining.

Sediment removal from the river channels includes a combination of hydraulic dredging and dragline methods. Hydraulic dredges will excavate the majority of material (7.75 million cubic yards). However the dragline method will excavate where dredge operations are difficult (i.e. shallow streams less than 3 feet and low clearance bridges), where right-of-way is currently available, or where the excavated quantities are too small to economically justify the construction of disposal facilities (USACE, 1996).

Clearing and Snagging

Clearing and snagging involves removing fallen trees, undergrowth, snags, and selected trees which block channel conveyance as well as small trees and shrubs along the bank above the low water line using a dragline (USACE, 2001). This process includes debris removal by placement along the top bank of the channels, burning, or offsite removal in barges (USACE, 1996, p. 26). It does not include sediment removal. Maintenance to prevent the re-establishment of vegetation on the cleared bank will be required, but is the responsibility of the local levee board.

Hydraulic Dredging

Hydraulic dredge refers to a method of channel excavation in which a floating barge supports a cutterhead assembly. The cutterhead and suction pipe are at the end of a ladder and submerged to the desired depth. The cutterhead sweeps across the channel bottom while pumps force the water-sediment slurry through a floating pipeline to a diked containment area (CDF or TLD) (USACE, 1996, Appendix L, p. 15-16).

Draglining

Dragline is a land-based method of channel excavation that uses a large bucket or clamshell to remove sediment from the river. The bucket is suspended from the end of a long boom and the operator makes repeated cuts into the channel bottom to a desired depth (USACE, 1996, Appendix L). The excavated sediment will be deposited a minimum of 50 feet from the previously cleared top bank of the river in strips/berms/piles approximately 100 feet wide parallel to the river channel. For Bogue Phalia (Items 7 & 8), the material will be placed behind the existing berm. The USACE plans to excavate a trench behind the berm, place the new material in the trench, and cap it with the material removed to make the trench. For all other dragline disposal areas over 1 acre (i.e. in Item 4, Holly Bluff Cutoff), a stormwater management plan will be written to address erosion control. Riverbank vegetation must be cleared and access roads constructed because of the size and mobility requirements of the dragline. Wherever possible, the USACE will limit clearing to one bank of the river to minimize impacts to the river and surrounding land (USACE, 1996, Appendix L, p. 15).

1.3.2 Management Areas

The descriptions of dredging and post dredging activities and conditions are essential to identifying exposure pathways in the risk assessment. The sediment excavated from Items 1, 2 , 4 (Holly Bluff Cutoff), 5, 6 and 10 will be disposed in one of three ways:

a traditional confined disposal facility (CDF);

thin layer confined disposal (TLD) facility (specific type of CDF); or, a dragline pile on the riverbank.

Material from Items 7 and 8 in Bogue Phalia will be deposited in a trench landward of the existing berm (from previous dredge disposal), capped and seeded.

The CDFs or TLDs may be up to 2 miles from the dredge location. Dikes will be constructed from soil at the disposal facility site. The CDF and TLD locations will be obtained from willing sellers. The CDFs will contain about six-feet of dredged material and TLDs will contain about a three-feet of dredged material. The average size of each CDF is likely to be greater than 33 acres. Approximately 34 CDFs will be needed to contain the volume of material excavated from the rivers in the project area (USACE, 1996).

Immediately following dredging, the CDF or TLD will contain turbid, ponded water from 2 to 6 feet deep, depending on the footprint of the containment area. The material will settle for a minimum of 30 days (but more likely 60 days) after dredging stops. After settling, the dewatering weir crest can be lowered 3.5 inches per day, resulting in effluent release from the disposal facility. This effluent will discharge to the river. After dewatering and consolidation in a traditional CDF, the facility will remain on the land and capped. Thus, that land will be permanently removed from agricultural production (USACE, 1996, p. 5-2).

Alternatively, landowners may offer land for TLD facilities. These facilities will have a cap from existing soil, stockpiled for that purpose, or from the dike material after dewatering and consolidation. The landowner can then spread the material to return the land to agricultural use. Generally, a landowner will offers land that is somewhat lower than the surrounding land, thus when the TLD material is spread over it, the elevation is brought out to that of the surrounding area. CDFs will have outlets for effluent or overland runoff.

1.4 Development of the Conceptual Models

The conceptual model is an integration of existing information which describes the:

Humans and wildlife species that may use the Big Sunflower River;

Potential fate and transport mechanisms for DDT, DDE, and DDD; and,

Potential routes of exposure for humans and ecological receptors.

In this assessment, the conceptual models are diagrams, with an accompanying narrative. They describe the links between contaminant sources and receptors along explicit fate and transport pathways that may influence human and ecological exposure to the contaminants. The conceptual models include:

Figure 1.2 that shows exposure routes specific to the selected human receptor, the angler, and provides notes describing the various exposure pathways;

Figure 1.3 that details the ecological exposures in the aquatic system from sediments and surface water through the food web; and,

Figures 1.4 and 1.5 that show the exposure routes specific to the selected ecological receptors (considered in this assessment) through piscivores and waterfowl respectively;

The assumed sources of contaminants for the conceptual models change with alternatives and activities. Specifically:

The no dredging condition assumes that the aquatic environment (i.e. rivers in the BSRMP area) is the primary sources of DDT and its derivatives to which people or organisms may be exposed;

During dredging, the disposal locations (dragline piles, CDFs or TLDs) will also become potential contaminant sources in addition to the aquatic environment; and,

Following dredging, the terrestrial environment (i.e. runoff of soils) is the primary source of contaminants (the terrestrial environment includes upland soil, dewatered dredged materials disposed of on land, or soil mixed with dredged materials (TLD), all of which may contain varying concentrations of DDT, DDD, and DDE)).

The assessment does not address terrestrial exposure and risk because:

The terrestrial receptor exposure to the containment structures will be insignificant compared to the available habitat in the watershed. Less than 0.1% of the watershed will be impacted by disposal of dredged material, in terms of land area (i.e., from assumed CDFs, drag piles, and TLDs).

A comparison of the soil sum DDT concentrations (average = 0.577 mg/kg; range 0.00675 - 2.7) and sediment sum DDT concentrations (average = 0.11 mg/kg; range 0.00276 - 0.611) indicate that dredged material managed in the terrestrial environment will not increase concentrations in soil, and therefore, will not affect current terrestrial exposures.

1.4.1 Humans and wildlife species that may use the Big Sunflower River

Humans

People living in the Big Sunflower River Basin may use one or more of the project rivers for recreational purposes or as a source of food. For example, families may swim, boat or fish in the river. Some people may fish just for recreation, but other people catch fish as a source of food for their families.

People may also hunt aquatic game, such as ducks, geese or turtles. This assessment addresses the potential exposure of people engaged in these activities in the rivers in the Big Sunflower River Maintenance Project (BSRMP) area before, during and after dredging.

Wildlife Species

The Big Sunflower River, and the surrounding bottomland hardwood wetlands and winter flooded agricultural lands, host a variety of wildlife including, native and introduced species, and residential and migratory occupants.

Invertebrates

A total of 27 species of bivalves were collected from the Big Sunflower River in a 1993 survey (USACE, 1996,Volume III, Appendix I). These species included the Asian clam (*Corbicula fluminea*), an invasive species. Threeridge (*Amblema plicata plicata*) and the bankclimber (*Plectomerus dombeyanus*) dominate mussel beds in the Sunflower River. Both occur in mud, gravel and sand. The threeridge inhabits small to large rivers and impoundments, while the bankclimber tends to populate medium and large rivers with low gradients and oxbow lakes (Natureserve, 2001). An especially high-density bed of mussels is downstream of Lock and Dam No.1 around River Mile 54. The bed is 100m long by 61m wide and is scheduled for channel cleanout (USACE, 1996, Volume III, Appendix I).

Two species of crayfish, the White River crayfish (*Procambarus acutus*) and the Red swamp crayfish (*Procambarus clakii*), are said to be common to the Big Sunflower River. Both crayfish inhabit low gradient rivers as well as riverine pools and are tolerant of low oxygen and high temperature (Natureserve, 2001). These crayfish tend to burrow in the sediment.

Fish

Fifty-five species of fish inhabit the Big Sunflower River system. Minnows (13 species), sunfish (12 species) and catfish (7 species) are dominant (USACE, 1996, Volume III, Appendix H). Shoreline fish assemblages are dominated by mosquitofish, orangespotted sunfish, gizzard shad and small juvenile buffalo fish while demersal populations are dominated by smallmouth buffalo fish, common carp, gizzard shad and shortnose gar (USACE, 1996, Volume III, Appendix H). Most of these species prefer slow water, whether in low gradient rivers with sluggish water or in oxbow lakes and floodwaters (Natureserve, 2001). They can also tolerate moderate levels of turbidity. Mosquitofish tend to seek out standing water with vegetative cover (Natureserve, 2001). Orangespotted Sunfish usually occur in sandy, mud-bottomed or silty pools of small rivers and oxbow lakes (Natureserve, 2001). Gizzard Shad are generally found in quiet open waters of large rivers, swamps and flooded lands (Natureserve, 2001). Smallmouth Buffalo, a benthic sucker, inhabits large streams and rivers (Natureserve, 2001). Catfish are also prominent in the Big Sunflower River (USACE, 1996). Channel and Blue Catfish are invertebrate and small fish predators, whereas the Flathead Catfish, called the tiger of the murky depths, preys almost exclusively on fish from covered structures on the river bottom (Natureserve, 2001). Catfish are tolerant of turbidity.

Waterfowl

Wintering waterfowl using the seasonally flooded agricultural lands and swamps include the dabbling ducks, consisting primarily of the mallard (*Anas platyrhynchos*), northern pintail (*Anas acuta*), gadwall (*Anas strepera*), American widgeon (*Anas americana*), green-winged teal (*Anas crecca*) and the northern shoveler (*Anas clypeata*) (USACE, 1996). By far the most dominant duck wintering in the Mississippi Alluvial Valley is the mallard, followed by the northern pintail (USACE, 1996). Wood duck (*Aix sponsa*) also inhabits the Sunflower River Area but, unlike the other dabbling ducks, it is a year-round resident in both Delta National Forest and the Yazoo National Wildlife Refuge (i-bird.com, 2001). Wood ducks prefer the cover of the bottomland hardwood forest, where water is within 0.3 miles of their nesting cavities in trees (USDA Forest Service, 2001).

Predatory Birds

Piscivorous birds of the area include the Bald eagle, *Haliaeetus leucocephalus* and the osprey, *Pandion haliaetus*. Both the eagle and osprey are raptors that inhabit riparian areas and forested wetlands near medium and large rivers (Natureserve, 2001). The Bald eagle eats fish, reptiles, birds, small mammals, invertebrates and carrion, while the osprey is primarily a piscivore (Natureserve, 2001). Both birds roost, perch and nest in treetops near the water, and sometimes utilize wooden posts and utility poles (Natureserve, 2001).

Aquatic Mammals

The American mink, *Mustela vison*, and the River otter, *Lontra canadensis* occur in the river basin. The mink inhabits forested wetlands, both permanent and semi-permanent, and riparian areas (Natureserve, 2001). It dens in burrows along the riverbank and preys on small mammals, waterfowl, fish and crayfish (Natureserve, 2001).

River otter use medium to large rivers with low to moderate gradients as well as the surrounding forested wetlands (Natureserve, 2001). They feed primarily on mid-sized fishes, frogs, crayfish, turtles, insects and sometimes birds and small mammals (Natureserve, 2001).

Reptiles and Amphibians

Reptiles and amphibians of the Big Sunflower River include the American alligator, *Alligator mississippiensis*, turtles and frogs. The American alligator inhabits low gradient rivers, riverine pools, and forested wetlands such as swamps and bayous (Natureserve, 2001). They bask on land next to water and dig dens in river margins (Natureserve, 2001). Adult alligators eat birds, reptiles, mammals up to the size of deer, and fish (Natureserve, 2001). A variety of turtles and frogs also occur in the Big Sunflower River area.

Endangered Species

U.S. Army Corps of Engineers found three endangered species within the bounds of the Big Sunflower River Maintenance Project: Pondberry (*Lindera melissifolia*), Louisiana Black Bear (*Ursus americanus luteolus*) and Pallid Sturgeon (*Scaphirhynchus albus*).

Pondberry is a deciduous aromatic shrub, 0.5 to 2 meters tall, which grows in seasonally flooded wetlands such as the bottomland hardwood forest (USACE, 1996). It is usually associated with small sand dunes and competes poorly with shade-intolerant species (USACE, 1996). Threats to the pondberry include clearing of bottomland hardwood forests, draining of wetlands, habitat alteration due to logging and agricultural activities, and reproductive weakness due to small populations and a low reproductive rate (Missouri Department of Conservation, 2001). The Delta National Forest, where colonies have been located on the banks of the Holly Bluff Cutoff and of the Big Sunflower River (USACE, 1996, Volume III, Appendix K), contains Mississippi's largest pondberry population (U.S. Fish and Wildlife Service, 2001).

The Louisiana Black Bear inhabits heavily wooded bottomland hardwood forests and requires areas with diverse food resources and little to no human activity (Natureserve, 2001). They are omnivorous bears, but primarily eat oak mast, field corn, muscadines, blackberries and honey when available (Natureserve, 2001). Illegal killing and alteration/elimination of habitat are the most significant threats to the black bear (USACE, 1996).

The Pallid Sturgeon is one of the largest fish known to occur in the middle and lower Mississippi River. It inhabits large turbid rivers with low to moderate gradients and is associated with rocky or sandy substrates (Natureserve, 2001). The sturgeon is an opportunistic feeder associated with the benthos which concentrates its feeding on aquatic insects, crustaceans, mollusks, annelids, eggs of other fish and fish (Natureserve, 2001). River channelization and the construction of impoundments have altered most of the fish's habitat. The Pallid Sturgeon is present at the mouth of the Big Sunflower only occasionally (USACE, 1996, Volume III, Appendix K).

1.4.2 Potential Fate and Transport of DDT, DDD, DDE

Under no dredging conditions we assume exposure to *in situ* sediments and ambient surface water.

During dredging we assume that DDT-, DDD- and DDE-contaminated sediment will be resuspended and that effluent release and/or runoff from an open CDF, TLD or drag pile will impact aquatic exposure concentrations. Fate and transport models provided estimates of DDT, DDD, and DDE concentrations in sediment and surface water. Following dredging, the dredging condition will incorporate estimates of DDT concentrations in newly deposited channel sediments.

1.4.3 Potential Routes of Exposure for Human and Ecological Receptors

Human exposure pathways

Potential human exposures include contact with surface water or sediment in the rivers, and exposure through consumption of fish or aquatic game (e.g., ducks). There are two primary human exposure routes in surface water, sediment or food items: ingestion and dermal contact. Water or sediment may be accidentally swallowed, while fish and wild game are eaten as food. People are exposed through dermal contact when contaminants in water or sediment are absorbed through their skin. We assume that inhalation (vapors and particulates) and dermal contact with fish are minimal and therefore are not included on the conceptual model as exposure routes of concern.

Ecological exposure pathways

The exposure pathway and exposure route describe how ecological receptors contact DDT, DDD and DDE. Ecological receptors including aquatic plants, water column invertebrates, benthic invertebrates, warm water fish, waterfowl, piscivorous birds and piscivorous mammals all contact sediment and surface water. In addition, higher-order species consume lower-order species. For example, a benthic invertebrate may accumulate DDT through direct sediment contact. A forage fish may consume the benthic invertebrate. The forage fish may be consumed by a piscivorous fish. A piscivorous mammal may ultimately consume the fish. Following these routes of exposure, DDT, DDD and DDE may be transferred through the food chain. Many of the receptors may also accumulate DDT, DDD and DDE through direct contact with contaminated media and surface water.

1.4.4 Sources of information for developing conceptual model

Table 1.1 provides information sources used to develop the conceptual model.

1.5 Selecting and Characterizing Representative Receptors

This section identifies and describes the humans and the representative ecological receptors used to develop exposure scenarios and estimate risks in the assessment.

1.5.1 Human Receptors

Anglers are assumed to be using the rivers in the BSRMP area. Section 3 provides detailed descriptions of exposure pathways for this receptor by exposure scenario.

1.5.2 Representative Ecological Receptors

This subsection describes the ecological receptors chosen to represent the various components of the aquatic ecosystem. The selected species represent different feeding guilds. A guild is a group of animals within a habitat that use resources in the same way. Coexisting members of guilds are similar in terms of their habitat requirements, dietary habits, and functional relationships with other species in the habitat. Guilds may be organized into potential receptor groups. The use of the guild approach allows focused integration of many variables related to potential exposure. These variables include characteristics of DDT and its derivatives (toxicity, bioaccumulation, and mode of action) and characteristics of potential receptors (habitat, range and feeding requirements, and relationships between species). This approach evaluates potential exposures by considering the major feeding guilds found in a habitat. We assume that evaluation of the potential effects of DDT, DDD and DDE on the representative species will be indicative of the potential effects of DDT, DDD, and DDE to individual member classes of organisms within each feeding guild.

The selected receptors represent those types of organisms most likely to encounter the contaminants of concern in the Big Sunflower River Basin within a sediment-based food web. They include a reasonable (although not comprehensive) cross-section of the major functional and structural components of the ecosystem under study based on:

Relative abundance and ecological importance within the selected habitats;

Availability and quality of applicable toxicological literature;

Relative sensitivity to the contaminants of concern;

Trophic status;

Likely exposure to sediment and/or prey items exposed to sediment;

Relative mobility and local feeding ranges;

Ability to bioaccumulate contaminants of concern.

The selected species represent the ecological community and its sensitivity to the contaminants of concern and were arrived at based, in part, on knowledge of the area and on discussions with the USEPA and local professional fishermen. The ecological receptors selected for evaluation include: local warm water fish, osprey, mallard duck and mink.

Warm Water Fish Species

Warm water resident fish species reflect local sediment and water quality conditions. The typical warm water fish species such as the mosquitofish, buffalofish, blue catfish, flathead catfish and shortnose gar are abundant local residents (USACE, 1996). These organisms are potential receptor species representing local fish because they are:

Common Big Sunflower River residents;

Exposed to sediment as well as surface water;

Represent fish and higher order predators feeding on smaller fish and invertebrates; and

Serve as a prey base for avian and mammalian species.

In this assessment, the selected species represent major groups of fish in the Big Sunflower River. They represent a forage fish (mosquitofish), a bottom feeder (smallmouth buffalofish), and a predator/piscivore (blue catfish).

Mosquitofish (*Gambusia affinis*)

The mosquitofish is a common resident in the Big Sunflower River Basin. It is a small forage fish with a diverse diet of aquatic insects and larvae. Mosquitofish inhabit slow moving or standing waters (Natureserve, 2001).

Mosquitofish are a potential receptor species because they are:

An abundant species; and

Are a common insectivorous forage fish consumed by predators such as channel catfish and mink.

Mosquitofish represent forage fish in the river system.

Smallmouth Buffalofish (*Ictiobus bubalus*)

The smallmouth buffalofish is a common resident of southern freshwater rivers. This species is an abundant resident in the Big Sunflower River Basin. Smallmouth buffalofish are bottom feeders are known to incidentally ingest large amounts of sediment (Texas Park & Wildlife, 2001). They are a potential receptor species because they:

Are exposed to surface water;

Incidentally ingest large amounts of sediment;

Are a common bottom-feeding fish species in Mississippi; and,

May be consumed by higher order predators such as the osprey.

Smallmouth buffalofish represent bottom dwelling fish in the river system.

Blue Catfish (*Ictalurus furcatus)*

The blue catfish is an abundant catfish in Mississippi waterways. The blue catfish prefers deep waters of main channels with structures, river backwaters (Natureserve, 2001), and rock, gravel or sand substrates (Arkansas Game Fish, 2001). It is a bottom feeder with a diverse diet including fish, insects, crayfish, fingernail clams and freshwater mussels. Adults tend to concentrate their feeding on fish and large invertebrates (Natureserve, 2001). Blue catfish are a potential receptor species because they:

Are exposed directly to surface water and sediment and feed on prey that inhabit the sediments;

Are a common species;

Consume fish and invertebrates; and,

Are prey for higher trophic predators in the Big Sunflower River Basin.

Blue catfish represent predatory fish in the river system.

Flathead Catfish (*Pylodictis olivaris*)

The flathead catfish is a common inhabitant of southern freshwater rivers and is abundant in the Big Sunflower River Basin. This species is most successful in medium sized low-gradient rivers, especially those with high turbidity. It is a large bottom-dweller that usually takes cover in deep pools and under submerged logs. The flathead catfish is an opportunistic predator and active forager that mainly feeds on fish and crawfish (Natureserve, 2001).

Flathead Catfish are a potential receptor species because they:

Are an abundant species;

Are a top order predator in the rivers of Mississippi; and,

Are exposed to the sediment of the Big Sunflower River.

Flathead Catfish represents a piscivorous fish in the river system.

Shortnose Gar (*Lepisosteus platostomus*)

The shortnose gar is common to Mississippi waterways and is abundant within the Big Sunflower River Basin. It inhabits open, slow-moving rivers and river backwaters, where it frequents surface waters near vegetation. The shortnose gar feeds on crustaceans, emerging insects, crayfish and small forage fish (Natureserve, 2001).

Shortnose Gar are a potential receptor species because they:

Are an abundant species;

Are exposed to surface water; and,

May be consumed by higher order predators such as mink and osprey.

Shortnose Gar represents a water column fish in the river system.

Piscivorous Bird Species

Osprey (*Pandion haliaetus*)

The osprey is a large bird of prey that is almost exclusively piscivorous. Osprey nest in dead trees or human-made structures in close proximity to open, shallow water and plentiful supplies of fish (USEPA, 1993). They are associated with larger rivers, lakes and reservoirs (USEPA, 1993). Osprey hover and then dive at shallow swimming fish which they capture using their talons (USEPA, 1993). They commonly consume the entire fish except the larger bones. The home range for an osprey is variable.

Osprey are a potential receptor species because they:

Consume fish such as smallmouth buffalofish;

Live near the water; and

Represent a higher trophic level predator in the Big Sunflower River Basin.

Osprey represent piscivorous birds in the river system.

Waterfowl

Mallard (*Anas platyrhynchos*)

The mallard is the most common freshwater duck of the United States, found on lakes, rivers, ponds, etc. It is a dabbling duck, and feeds (usually in shallow water) by “tipping up” and eating food off the bottom of the water body. Primarily, it consumes aquatic plants and seeds, but it will also eat aquatic insects, other aquatic invertebrates, snails and other mollusks, tadpoles, fishes, and fish eggs. Ducklings and breeding females consume mostly aquatic invertebrates. The mallard’s home range is variable, but an approximate range is 500 hectares. It prefers to nest on ground sheltered by dense grass-like vegetation, near the water (USEPA, 1993).

Mallards are a potential receptor species because they:

Consume aquatic plants and aquatic invertebrates;

Live on or near the water; and,

Are a lower trophic level duck in the creek and in the Mississippi River.

Mallards represent waterfowl and consume aquatic invertebrates and aquatic plants.

Aquatic Mammals

This assessment assumes that American mink represents aquatic mammals in the Big Sunflower River Basin.

American Mink (*Mustela vison*)

Mink are found in a diversity of aquatic habitats including rivers, streams, lakes, ditches, swamps and marshes. They den close to water bodies (5 to 100m) (USEPA, 1993). Mink are opportunistic predators and will feed on whatever prey items are most abundant (USEPA, 1993). The diet includes fish, amphibians, crustaceans, snakes, frogs, birds, bird eggs and other small mammals (USEPA, 1993). In this case we assume that the mink diet is dominated by forage fish and also includes a limited invertebrate component.

Mink are a potential receptor species because they:

Consume fish and aquatic invertebrates;

Live in or near the water; and

Are a higher trophic level predator in the Basin.

Mink represent higher trophic level, fish-eating, sensitive aquatic mammal species.

1.6 Select and Evaluate Assessment and Measurement Endpoints for Ecological Risk

The final step in the problem formulation is the selection of Assessment and Measurement Endpoints for ecological risk. An assessment endpoint is an explicit expression of the actual environmental value to be protected (USEPA, 1992a) under current conditions, during dredging and under post dredging conditions. The assessment endpoints cannot be directly measured. Therefore, we select measurement endpoints that are measurable biological responses to DDT, DDD and DDE that can be used to make inferences about the assessment endpoint.

1.6.1 Selection of Assessment and Measurement Endpoints

This subsection specifies the assessment endpoints and their associated measurement endpoints.

Assessment Endpoint 1: Sustainability of warm water fish in the Big Sunflower River Basin

> Measure of effect 1a: Sustainability of a benthic macroinvertebrate community that can serve as a prey base for fish as represented by modeled body burdens of DDT, DDD, and DDE in representative benthic invertebrates.
>
> Measure of effect 1b: Modeled and measured body burdens of DDT, DDD, and DDE in selected fish species (bottom feeder, forage fish, and predator fish) as a measure of exposure and effects (compared to benchmark values).

Assessment Endpoint 2: Survival, growth, and reproduction of local populations of aquatic wildlife as represented by the osprey, mallard duck and mink in the Big Sunflower River Basin

> Measure of effect 2: The dose of DDT, DDD and DDE based on modeled concentrations in sediment, surface water, benthic and water column invertebrates, forage fish, predator and bottom feeding fish for use in evaluating exposure via the food chain for osprey, mallard duck and mink.

1.6.2 Evaluation of Assessment and Measurement Endpoints

We selected these assessment endpoints following the six evaluation criteria provided in USEPA Guidance (USEPA, 1992a and references cited therein):

> Ecological relevance - Fish and the representative wildlife species comprise the aquatic food web in the Big Sunflower River Basin. Disruption of components of the food web may impact other species within the web.

Economic importance - The assessment endpoints are economically important in terms of recreation (hunting and fishing). Species such as waterfowl and fish species may also have economic value as food sources.

Measurable - Through the measurement endpoints it is possible to evaluate the assessment endpoints in relation to DDT, DDD and DDE exposure.

Susceptible and sensitive to chemical induced stress or other stresses - DDT, DDD and DDE biomagnify and bioaccumulate in the food chain. In addition, DDT and its derivatives have been known to thin the eggs of avian species.

Unambiguously defined - The assessment endpoints are clear in terms of the component of the aquatic food chain to be protected and how the status of the endpoint will be evaluated using the measurement endpoints.

Logically and practically related to the management decision - In terms of the ecological community, any dredging activity impacts will be focused on the aquatic environment.

1.6.3 Evaluation of Measurement Endpoints

We selected measurement endpoints based on USEPA recommended considerations. The measurement endpoints:

Correspond closely to the assessment endpoint - The measurement endpoints are representative of, correlated with, and applicable to the assessment endpoint.

Are specific to the Site - The species we evaluate are residents of the Big Sunflower River Basin.

Are specific to the stressor - While other contaminants may influence the measurement endpoints, we specifically focus on measured and modeled DDT, DDD and DDE concentrations to assess each measurement endpoint. The effects values we apply are specific to DDT, DDD and DDE.

Include an objective measure for judging environmental harm - Toxicity Reference Values (TRVs), sediment criteria and surface water criteria specific to DDT, DDD and DDE are independently derived benchmarks.

Are sensitive for detecting changes – the benchmarks against which we judge the measures of effect have a dose response relationship to the contaminants indicating sensitivity to changes in concentration or dose.

Are Quantitative - the estimates of body burden and dose are quantitative estimates of exposure.

Include a correlation between stressor and response. The assessment will include an analysis of correlation between levels of exposure to a stressor and levels of response, and will evaluate the strength of that correlation through sensitivity analyses.

Use standard methods – there are no externally recognized methods for benchmark development in USEPA or USACE regulations. We used methods suggested in the current toxicological literature.

The selected assessment and measurement endpoints meet the selection criteria. We use the assessment endpoints and measurement endpoints to decide whether there is risk under current conditions, during dredging or post dredging in seven Items based on whether the activity will alter the assessment or measurement endpoint.

1.7 Data Description and Management

The contaminants of concern are the pesticide, DDT (1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane), and its derivatives DDD (1,1-dichloro-2,2-bis(*p*-chlorophenyl ethane) and DDE (1,1-dichloro-2,2-bis(*p*-chlorophenyl)ethylene).

1.7.1 Field Data

Field data for the years 1993 to 1994 provide synoptic measurements of sediment, water, and biota (Tables 1.2 to 1.5) collected from various locations throughout the project area (Figures 1.6 to 1.9). The USACE collected the sediment and water samples, and most of the fish samples. The State of Mississippi and the US Fish and Wildlife Department collected one-third of the fish samples. We relied on these data as the primary basis for the fate and transport modeling (Appendix A) to validate the bioaccumulation modeling (Appendix B).

Table 1.2 provides a summary of the available sediment, water, and fish data, and Tables 1.3 to 1.5 show contaminant concentrations in water, sediment, and fish respectively. The compounds, DDD, DDE, and DDT, occurred above detection limits in all sediment samples except for one sample from Item 6. The compounds, DDE and DDT, occurred above detection limits in all water samples, but DDD was only detected in samples from Items 7, 8 and 10.

1.7.2 Estimating DDE in Fish

For the fish samples, DDD and DDT were detected in all samples. DDE was non-detect in all samples from Items 1 and 4, a highly suspect result because DDE is a metabolite of DDT with a long half-life. Thus, it is implausible that one wouldn't find this compound in fish tissues. There is the possibility of analytical error, but it was not possible to rerun the samples (Johnson, personal communication, 8/24/01).

Therefore, we estimated the concentrations using a regression based on a database of nearly a thousand samples from numerous projects in the Delta region. In all cases, the correlation coefficients ranged from 0.76 to 0.99, indicating that it is almost never possible to find DDD and DDT without DDE. Applying the regression relationship developed from a large dataset (Johnson, personal communication, 8/24/01) for each individual fish sample from Items 1 and 4 resulted in the concentration distribution shown in Tables 1.2 and 1.5.

Note that it was not possible to validate the bioaccumulation model without this step. Either predicted fish concentrations would have been significantly overpredicted for Item 1, or significantly underpredicted for the remaining Items at which DDE was always detected.

2.0 ECOLOGICAL EXPOSURE ASSESSMENT, EFFECTS ASSESSMENT, AND RISK CHARACTERIZATION

2.1 Exposure Assessment

The ecological exposure assessment extends the qualitative descriptions of exposure pathways in the conceptual model to calculate quantitative estimates of the exposure of selected receptors to DDT, DDE and DDD in sediment, surface water and biota (Appendices A and B). It uses predicted concentrations of contaminants in sediment, water, and biota to calculate body burdens of DDT, DDE, and DDD in fish and invertebrates (Appendix C), based on a bioaccumulation model. A simple food chain model (Appendix D) used these predicted body burdens and the modeled sediment and water concentrations (Tables 1.2 to 1.5) to return doses of each compound or doses of the sum of two or more compounds to higher order predators (Appendix E). We use the sum of two or more compounds when corresponding toxicity data are unavailable for individual compounds.

These exposure estimates for the first ten years do not include a Total Maximum Daily Load (TMDL) adjustment to the runoff estimates. The estimates for the latter 30 years include such an adjustment in the no dredging and dredging conditions. The models generate exposure estimates for each year on a per year basis. We did not average the exposure estimates across the entire timeframe (40 years) because, in general, the life spans of ecological receptors are shorter, and the source studies for corresponding toxicity reference values (TRVs) are completed within two years or less. In addition, year by year assessment provides greater flexibility in examining population effects.

The specific exposures for each of seven items and the two conditions include:

Concentrations of DDT, DDE, and DDD in sediment as 40 years of annual average concentrations in seven items for no dredging and dredging conditions (Appendix B);

Concentrations of DDT, DDE, and DDD dissolved in surface water as a single value that does not change with time for the no dredging and dredging conditions (Appendix B);

Concentrations of DDT, DDE, and DDD in whole surface water for use in the drinking water pathway (Appendix B);

The sum of DDT, DDD, and DDE concentrations in mosquito fish, buffalo fish, blue catfish, flathead catfish, shortnose gar, aquatic plants, and aquatic invertebrates (Appendix B which provides the body burdens as individual concentrations and Appendix C which provides the body burdens as sum DDT) based on a bioaccumulation model;

Doses of the sum of DDT, DDD, and DDE through the food chain to mallard, osprey and mink (Appendix E) based on modeled sediment, surface water, benthic invertebrate, and aquatic plant and fish concentrations using a simple food chain model;

Doses of DDE through the food chain to mallard and osprey (Appendix E) based on modeled sediment, surface water, benthic invertebrate, aquatic plant and fish concentrations using a simple food chain model; and,

Doses of the DDT through the food chain to mink (Appendix E) based on modeled sediment, surface water, benthic invertebrate, and aquatic plant and fish concentrations using a simple food chain model.

The fate and transport modeling (Appendix A) showed that the:

Incremental contribution of remobilization of bottom sediments during dredging is less than five percent, and typically within one or two percent of existing resuspension;

Predicted freely dissolved water concentrations are within a few percent of water concentrations under current conditions; and,

Sediment and water concentrations during dredging are effectively no different than current conditions.

Also, the bioaccumulation and food chain modeling showed that concentrations and doses tend to level off after ten to fifteen years.

2.1.1 Estimating Mean and Upper Bound Concentration Body Burdens

We used the FISHRAND model (Appendix B) to estimate body burdens in aquatic plants, benthic invertebrates, and the fish species based on sediment and water exposure concentrations predicted by the fate and transport models (Appendix A). Those models predicted annual average sediment concentrations for the no dredging and dredging conditions for each of 40 years. The water concentrations are a 40-year average because the fate and transport modeling predicted that water concentrations do not vary over time (Appendix A).

Mean Value Estimates

The output of the FISHRAND model is a distribution of predicted body burdens. We obtained an expected value (mean) from the FISHRAND distributional output by:

Log-transforming the model output for the 25^{th}, 50^{th} and 95^{th} percentiles and plotting the results against the inverse of the normal cumulative distribution to yield a straight line;

Obtaining the parameters of the regression to estimate a μ and geometric standard deviation (GSD) where μ equals the intercept * GSD and GSD equals 1/slope; and, Obtaining the mean (expected value, or E[x], of the distribution) as $E[x] = e^{\ln(x)+s^2/2}$ where σ equals the GSD.

The mean value is typically slightly higher than the median value predicted by FISHRAND and falls at approximately 65th percentile of the FISHRAND output.

Upper Bound Estimates

The 95th percentile predicted by the FISHRAND model was used to represent a reasonable 95 percent upper confidence limit (95% UCL) on the mean. Appendix B provides further details of the FISHRAND bioaccumulation model.

2.2 Ecological Effects Assessment

This subsection provides a brief overview of the general use and chemistry of DDT, and describes the Toxicity Reference Values (TRVs) for the selected ecological receptors. Appendix K provides the details of the method and its application for selecting TRVs for DDT, DDE and sum DDT for the species of concern in this assessment.

The TRVs are concentrations, doses, or body burdens associated with either Lowest Observed Adverse Effects Levels (LOAELs) or No Observed Adverse Effects Levels (NOAELs). The LOAELs are the lowest values at which adverse effects have been observed in either laboratory or field studies. The NOAELs represents the highest dose or body burden at which a specific effect was not observed.

Site-related doses that are below a NOAEL are not expected to result in adverse effects. Site-related doses that are above LOAELs may be more likely to result in an adverse effect than are site-related doses that exceed the NOAEL, but not the LOAEL.

2.2.1 General Use and Chemistry of DDT

The pesticide, DDT (dichlorodiphenyltrichlroethane), was an agricultural and disease control pesticide. It does not occur naturally. The United States banned the use of DDT and DDD in 1972 (except for public health emergencies) because of damage to wildlife and the potential harm to human health. Some countries still use DDT, mostly for malaria control. The breakdown product, DDE, has no commercial use.

DDT entered the soil as a direct application at agricultural sites or in waste disposal sites, or inadvertently during storage. DDT and its breakdown products can enter surface water either by direct spraying during insecticide use or indirectly by run-off from soil. DDT, DDD and DDE have strong binding affinity to organic carbon and tend to partition into organic sediments.

Technical grade DDT is a mixture of p,p'-DDT (85%), o,p'-DDT (15%), and trace amounts of o,o'-DDT, p,p'-DDD (p,p'-dichlorodiphenyldichlroethane), o,p'-DDD, p,p'-DDE (p,p'-dichlorodiphenyltrichlroethylene), and o,p'-DDE.

2.2.2 Toxicity Reference Values for Representative Receptors

This subsection provides the TRVs selected for assessment of the selected receptors. It is a brief discussion of each TRV. Appendix K provides the details of the selection method, a literature review for each TRV, and the rationale for each selected TRV. The TRVs for the selected receptors and the compounds to which they apply are:

Compound	Benthic Invertebrate	Fish		Mink		Mallard Duck		Osprey	
	(mg/kg wet wt.)	(mg/kg wet wt.)		(mg/kg-day)		(mg/kg-day)		(mg/kg-day)	
		NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Total DDT (DDT+DDD+DDE)	2.8	2.4	24	APPLY DDT TRV	APPLY DDT TRV	APPLY DDE TRV	APPLY DDE TRV	APPLY DDE TRV	APPLY DDE TRV
DDD	NA	NA	NA	NA	NA	NA	NA	NA	NA
DDT	NA	NA	NA	0.8	4.0	NA	NA	NA	NA
DDE	NA	NA	NA	NA	NA	0.06	0.6	0.11	1.1

NA = Not Analyzed
NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level

Invertebrate TRV

On the basis of laboratory toxicity studies (Appendix K), the sum DDT TRV for benthic invertebrates is a body burden of 2.8 mg/kg wet wt.

TRVs for Fish

Two studies on non-salmonid fishes, green sunfish and mosquito fish (Appendix K) report similar LOAELs of 24 and 26.5 mg sum DDT/kg, respectively, the lower of the two LOAELs is selected for development of a fish TRV for the present assessment. We applied LOAEL-to-NOAEL uncertainty factor to estimate a NOAEL of 2.4 mg sum DDT/kg.

On the basis of laboratory toxicity studies:

The sum DDT LOAEL TRV for non-salmonid fish is 24 mg/kg wet wt
The sum DDT NOAEL TRV for non-salmonid fish is 2.4 mg/kg wet wt.

TRVs for Mammals

This assessment uses a study that consists of repeated oral exposures over the lifetime of the animal, and that demonstrates reproductive effects to develop a TRV (Appendix K). The
LOAEL for reproductive effects is 4.0 mg/kg-day (50 mg/kg treatment) and the NOAEL is 0.8 mg/kg-day (10 mg/kg treatment).

On the basis of laboratory toxicity studies:

The DDT LOAEL TRV for mink is 4.0 mg/kg-day
The DDT NOAEL TRV for mink is 0.8 mg/kg-day

TRVs for Mallard Ducks

According to studies reviewed in Appendix K, p,p'-DDE is a more potent promoter of eggshell thinning than p,p'-DDT because of its specific effect on the synthesis of prostaglandin in the eggshell gland mucosa. Therefore, we used the DDE LOAEL and NOAELs as conservative TRVs in this assessment.

On the basis of laboratory toxicity studies:

The DDE LOAEL TRV for mallard duck is 0.60 mg/kg-day
The estimated DDE NOAEL TRV for mallard is 0.06 mg/kg-day

TRVs for Osprey

No study was identified that examined the toxicity of DDTs in the diet of ospreys, and one study investigated the effects of dietary uptake of DDE on birds in the same taxonomic order as the osprey, American kestrels (Appendix K).

On the basis of laboratory toxicity studies:

The DDE LOAEL TRV for osprey is 1.1 mg/kg-day
The DDE NOAEL TRV for osprey is 0.11 mg/kg-day

2.3 Risk Characterization

2.3.1 Overview

The risk characterization integrates the exposure assessment and effects assessment to estimate whether the predicted exposure to DDT, DDD and DDE are of sufficient magnitude to produce the effects associated with the selected toxicity factor.

The assessment integrates the exposure and effects information to characterize risks with respect to the stated assessment endpoints:

> Assessment Endpoint 1- Sustainability of warm water fish in the Big Sunflower River Basin; and,
>
> Assessment Endpoint 2 - Survival, growth, and reproduction of local populations of aquatic wildlife as represented by the osprey, mallard duck and mink in the Big Sunflower River Basin

Quotient method

The Quotient Method compares exposure concentrations to toxicologically effective concentrations as:

$$HQ = EPC/TF$$

where:

HQ	=	hazard quotient;
EPC	=	predicted dietary dose or body burden reflecting exposure in specific Items;
TF	=	the selected toxicity factor appropriate for the chemical and receptor (in this case NOAEL, LOAEL and effects concentrations).

Interpretation of Hazard Quotients

The HQs for the fish, osprey, mallard and mink are the ratios of estimated dietary doses or body burdens to corresponding NOAEL- and LOAEL- based TRVs. The HQs for the aquatic invertebrates are the ratios of the estimated body burdens to a corresponding effects concentration. We interpret these ratios to indicate:

> No potential risk if the NOAEL- and LOAEL-based Hazard Quotients (HQ) are less than 1;
>
> Potential risk if the NOAEL-based HQ is greater than 1 and the LOAEL-based HQ is equal to or greater than 1; and,
>
> A less certain potential risk if the NOAEL-based HQ is greater than 1, but the LOAEL-based HQ is less than 1.

There is no established relationship between the absolute magnitude of the HQ and the probability of potential risk. However, we based these interpretations on the HQ calculated with the annual average concentration or dose because populations encounter average exposures. We assign a qualitative opinion on the uncertainty in these interpretations based on the value of the HQ when calculated with the 95^{th} percentile concentration or dose.

2.3.2 Risk Summary

This subsection summarizes and compares the risks by assessment endpoint to the selected receptors within each Item and for the no dredging and dredging conditions.

2.3.2.1 Assessment Endpoint 1: Sustainability of warm water fish in the Big Sunflower River Basin

The analysis indicates that there is no potential risk to the fish community in Items 1,2,5,6, 7, and 10 based on the measurement endpoints, invertebrate body burdens and fish body burdens of DDT, DDD, and DDE under either the no dredging or dredging conditions.

In Item 8, there is potential for risk to the fish community based on the measurement endpoints, body burdens in invertebrates and body burdens in all fish species modeled. There is uncertainty in this opinion because the risk is predicted based on the body burdens in fish exceeding NOAELs but not LOAELs. The modeled dredging conditions in Item 8 neither ameliorate nor exacerbate this potential risk.

Estimated Risk to Aquatic Invertebrates under the No Dredging Condition

Table C.1 in Appendix C shows the HQs based on the annual average body burden of the sum of DDT, DDD, and DDE in aquatic invertebrates over a 40-year period. Table 2.1 summarizes these results.

Table C.2 in Appendix C shows the HQs based on the 95^{th} percentile body burden of the sum of DDT, DDD, and DDE in aquatic invertebrates over a 40-year period. Table 2.1 summarizes these results.

The results indicate:

	Effects Concentration Based HQ > 1
Average Exposure	Item 8, 10
95^{th} Percentile Exposure	Item 8, 10

This analysis suggests that:

There is no potential risk to aquatic invertebrates in Items 1, 2, 5, 6 and 7.

There is no potential risk to aquatic invertebrates in Item 10 because there are only two years when the HQ exceeds 1 under the annual average exposure. However, we have less confidence in this opinion because nearly all HQs exceed 1 under 95th percentile exposures.

There is potential risk to aquatic invertebrates in Item 8 because the HQs in Item 8 exceed 1 under average and 95th percentile exposures.

Estimated Risk to Aquatic Invertebrates under the Dredging Condition

Table C.3 in Appendix C shows the HQs based on the annual average body burden of the sum of DDT, DDD, and DDE in aquatic invertebrates over a 40-year period. Table 2.1 summarizes these results.

Table C.4 in Appendix C shows the HQs based on the 95th percentile body burden of the sum of DDT, DDD, and DDE in aquatic invertebrates over a 40-year period. Table 2.1 summarizes these results.

The results indicate:

	Effects Concentration Based HQ > 1
Average Exposure	Item 8
95th Percentile Exposure	Item 8, 10

This analysis suggests that:

There is no potential risk to aquatic invertebrates in Items 1, 2, 5, 6 and 7.

There is no potential risk to aquatic invertebrates in Item 10, but we have less confidence in this opinion because nearly all HQs exceed 1 under 95th percentile exposures.

There is potential risk to aquatic invertebrates in Item 8 because the HQs in Item 8 exceed 1 under average and 95th percentile exposures.

Risk Comparison between the No Dredging and Dredging Conditions for Aquatic Invertebrates

There is no difference in the risk to aquatic invertebrates between the two conditions. Note that after about 10 to 15 years, the risks tend to level off which probably represents the steady state risk under these conditions.

Estimated Risk to Mosquitofish under the No Dredging Condition

Table C.5 in Appendix C shows the HQs based on the annual average body burden of the sum of DDT, DDD, and DDE in mosquitofish over a 40-year period. Table 2.2 summarizes these results.

Table C.6 in Appendix C shows the HQs based on the 95th percentile body burden of the sum of DDT, DDD, and DDE in mosquitofish over a 40-year period. Table 2.2 summarizes these results.

The results indicate:

	NOAEL Based HQ > 1	LOAEL Based HQ ≥ 1
Average Exposure	Item 8	None
95th Percentile Exposure	Item 8	None

This analysis suggests that:

There is no potential risk to mosquitofish in Items 1, 2, 5, 6, 7 and 10.

There is a less certain potential risk to mosquitofish in Item 8.

Estimated Risk to Mosquitofish under the Dredging Condition

Table C.7 in Appendix C shows the HQs based on the annual average body burden of the sum of DDT, DDD, and DDE in mosquitofish over a 40-year period. Table 2.2 summarizes these results.

Table C.8 in Appendix C shows the HQs based on the 95th percentile body burden of the sum of DDT, DDD, and DDE in mosquitofish over a 40-year period. Table 2.2 summarizes these results.

The results indicate:

	NOAEL Based HQ > 1	LOAEL Based HQ ≥ 1
Average Exposure	Item 8	None
95th Percentile Exposure	Item 8	None

This analysis suggests that:

There is no potential risk to mosquitofish in Items 1, 2, 5, 6, 7 and 10.

There is a less certain potential risk to mosquitofish in Item 8.

Risk Comparison between the No Dredging and Dredging Conditions for Mosquitofish

There is no difference in the risk to mosquitofish between the two conditions. Note that after about 10 to 15 years, the risks tend to level off which probably represents the steady state risk under these conditions.

Estimated Risk to Buffalofish under the No Dredging Condition

Table C.9 in Appendix C shows the HQs based on the annual average body burden of the sum of DDT, DDD, and DDE in buffalofish over a 40-year period. Table 2.3 summarizes these results.

Table C.10 in Appendix C shows the HQs based on the 95th percentile body burden of the sum of DDT, DDD, and DDE in buffalofish over a 40-year period. Table 2.3 summarizes these results.

The results indicate:

	NOAEL Based HQ > 1	LOAEL Based HQ ≥ 1
Average Exposure	Item 8, 10	None
95th Percentile Exposure	Item 8, 10	Item 8

This analysis suggests that:

There is no potential risk to buffalofish in Items 1, 2, 5, 6, and 7.

There is no potential risk to buffalofish in Item 10, because the NOAEL-based HQs calculated using annual average exposures do not exceed 1 after the first 12 years. However, we have less confidence in this opinion because nearly all NOAEL-based HQs exceed 1 under 95th percentile exposures.

There is a less certain potential risk to buffalofish in Item 8. Note that there is only one year when the LOAEL-based HQ is equal to or exceeds 1 under 95th percentile exposures.

Estimated Risk to Buffalofish under the Dredging Condition

Table C.11 in Appendix C shows the HQs based on the annual average body burden of the sum of DDT, DDD, and DDE in buffalofish over a 40-year period. Table 2.3 summarizes these results.

Table C.12 in Appendix C shows the HQs based on the 95th percentile body burden of the sum of DDT, DDD, and DDE in buffalofish over a 40-year period. Table 2.3 summarizes these results.

The results indicate:

	NOAEL Based HQ > 1	LOAEL Based HQ ≥ 1
Average Exposure	Item 8	None
95th Percentile Exposure	Item 8, 10	Item 8

This analysis suggests that

There is no potential risk to buffalofish in Items 1, 2, 5, 6, and 7.

There is no potential risk to buffalofish in Item 10, but we have less confidence in this opinion because nearly all HQs (NOAEL-based) exceed 1 under 95th percentile exposures.

There is a less certain potential risk to buffalofish in Item 8. Note that there is only one year when the LOAEL-based HQ is equal to or exceeds 1 under the 95th percentile exposures

Risk Comparison between the No Dredging and Dredging Conditions for Buffalofish

There is no difference in the risk to buffalofish between the two conditions. Note that after about 10 to 15 years, the risks tend to level off which probably represents the steady state risk under these conditions.

Estimated Risk to Blue Catfish under the No Dredging Condition

Table C.13 in Appendix C shows the HQs based on the annual average body burden of the sum of DDT, DDD, and DDE in blue catfish over a 40-year period. Table 2.4 summarizes these results.

Table C.14 in Appendix C shows the HQs based on the 95th percentile body burden of the sum of DDT, DDD, and DDE in blue catfish over a 40-year period. Table 2.4 summarizes these results.

The results indicate:

	NOAEL Based HQ > 1	LOAEL Based HQ ≥ 1
Average Exposure	Item 8	None
95th Percentile Exposure	Item 8, 10	None

This analysis suggests that:

There is no potential risk to blue catfish in Items 1, 2, 5, 6, and 7.

There is no potential risk to blue catfish in Item 10, but we have less confidence in this opinion because nearly all of the NOAEL-based HQs exceed 1 under 95th percentile exposures.

There is a less certain potential risk to blue catfish in Item 8.

Estimated Risk to Blue Catfish under the Dredging Condition

Table C.15 in Appendix C shows the HQs based on the annual average body burden of the sum of DDT, DDD, and DDE in blue catfish over a 40-year period. Table 2.4 summarizes these results.

Table C.16 in Appendix C shows the HQs based on the 95th percentile body burden of the sum of DDT, DDD, and DDE in blue catfish over a 40-year period. Table 2.4 summarizes these results.

The results indicate:

	NOAEL Based HQ > 1	LOAEL Based HQ ≥ 1
Average Exposure	Item 8	None
95th Percentile Exposure	Item 8, 10	None

This analysis suggests that

There is no potential risk to blue catfish in Items 1, 2, 5, 6, and 7.

There is no potential risk to blue catfish in Item 10, but we have less confidence in this opinion because a subset of NOAEL-based HQs exceed 1 under 95th percentile exposures.

There is a less certain potential risk to blue catfish in Item 8.

Risk Comparison between the No Dredging and Dredging Conditions for Blue Catfish

There is no difference in the risk to blue catfish between the two conditions. Note that after about 10 to 15 years, the risks tend to level off which probably represents the steady state risk under these conditions.

Estimated Risk to Flathead Catfish under the No Dredging Condition

Table C.17 in Appendix C shows the HQs based on the annual average body burden of the sum of DDT, DDD, and DDE in flathead catfish over a 40-year period. Table 2.5 summarizes these results.

Table C.18 in Appendix C shows the HQs based on the 95th percentile body burden of the sum of DDT, DDD, and DDE in flathead catfish over a 40-year period. Table 2.5 summarizes these results.

The results indicate:

	NOAEL Based HQ > 1	LOAEL Based HQ ≥ 1
Average Exposure	Item 8	None
95th Percentile Exposure	Item 8, 10	None

This analysis suggests that:

There is no potential risk to flathead catfish in Items 1, 2, 5, 6, and 7.

There is no potential risk to flathead catfish in Item 10, but we have less confidence in this opinion because a subset of NOAEL-based HQs exceed 1 under 95th percentile exposures.

There is a less certain potential risk to flathead catfish in Item 8.

Estimated Risk to Flathead Catfish under the Dredging Condition

Table C.19 in Appendix C shows the HQs based on the annual average body burden of the sum of DDT, DDD, and DDE in flathead catfish over a 40-year period. Table 2.5 summarizes these results.

Table C.20 in Appendix C shows the HQs based on the 95th percentile body burden of the sum of DDT, DDD, and DDE in flathead catfish over a 40-year period. Table 2.5 summarizes these results.

The results indicate:

	NOAEL Based HQ > 1	LOAEL Based HQ ≥ 1
Average Exposure	Item 8	None
95th Percentile Exposure	Item 8	None

This analysis suggests that

> There is no potential risk to flathead catfish in Items 1, 2, 5, 6, 7 and 10.
>
> There is a less certain potential risk to flathead catfish in Item 8.

Risk Comparison between the No Dredging and Dredging Conditions for Flathead Catfish

There is no difference in the risk to flathead catfish between the two conditions. Note that after about 10 to 15 years, the risks tend to level off which probably represents the steady state risk under these conditions.

Estimated Risk to Shortnose Gar under the No Dredging Condition

Table C.21 in Appendix C shows the HQs based on the annual average body burden of the sum of DDT, DDD, and DDE in shortnose gar over a 40-year period. Table 2.6 summarizes these results.

Table C.22 in Appendix C shows the HQs based on the 95th percentile body burden of the sum of DDT, DDD, and DDE in shortnose gar over a 40-year period. Table 2.6 summarizes these results.

The results indicate:

	NOAEL Based HQ > 1	LOAEL Based HQ ≥ 1
Average Exposure	Item 8, 10	None
95th Percentile Exposure	Item 8, 10	None

This analysis suggests that:

> There is no potential risk to shortnose gar in Items 1, 2, 5, 6, and 7.
>
> There is no potential risk to shortnose gar in Item 10. We have less confidence in this opinion because eight NOAEL-based HQs exceed 1 under annual average exposures, while nearly all NOAEL-based HQs exceed 1 under 95th percentile exposures.
>
> There is a less certain potential risk to shortnose gar in Item 8.

Estimated Risk to Shortnose Gar under the Dredging Condition

Table C.23 in Appendix C shows the HQs based on the annual average body burden of the sum of DDT, DDD, and DDE in shortnose gar over a 40-year period. Table 2.6 summarizes these results.

Table C.24 in Appendix C shows the HQs based on the 95th percentile body burden of the sum of DDT, DDD, and DDE in shortnose gar over a 40-year period. Table 2.6 summarizes these results.

The results indicate:

	NOAEL Based HQ > 1	LOAEL Based HQ ≥ 1
Average Exposure	Item 8	None
95th Percentile Exposure	Item 8, 10	None

This analysis suggests that

There is no potential risk to shortnose gar in Items 1, 2, 5, 6, and 7.

There is no potential risk to shortnose gar in Item 10. We have less confidence in this opinion because nearly all NOAEL-based HQs exceed 1 under 95th percentile exposures.

There is a less certain potential risk to shortnose gar in Item 8.

Risk Comparison between the No Dredging and Dredging Conditions for Shortnose Gar

There is no difference in the risk to shortnose gar between the two conditions. Note that after about 10 to 15 years, the risks tend to level off which probably represents the steady state risk under these conditions.

2.3.2.2 Assessment Endpoint 2: Survival, growth, and reproduction of local populations of aquatic wildlife as represented by the osprey, mallard duck and mink in the Big Sunflower River Basin

The analysis indicates that there is potential risk to wildlife in Items 1, 7, 8, and 10 based on the measurement endpoint, doses of DDT, DDD, and DDE to osprey and in all Items based on the measurement endpoint, doses of DDT, DDD, and DDE to mallard duck.

The dredging conditions ameliorate this risk in Item 2 for the mallard duck.

Estimated Risk to Osprey under the No Dredging Condition

Tables E.1 and E.2 in Appendix E show the HQs based on the annual average dose of DDE to osprey and the annual average dose of the sum of DDT, DDD, and DDE to osprey for each item over a 40-year period. Tables 2.7 and 2.8 summarize these results.

Tables E.3 and E.4 in Appendix E show the HQs based on the 95th percentile dose of DDE to osprey and the 95th percentile dose of the sum of DDT, DDD, and DDE to osprey for each item over a 40-year period. Tables 2.7 and 2.8 summarize these results.

The results indicate:

	NOAEL Based HQ > 1		LOAEL Based HQ ≥ 1	
	DDE	Sum DDT, DDD, DDE	DDE	Sum DDT, DDD, DDE
Average Exposure	Item 8, 10	Item 1, 7, 8, 10	Item 8	Item 8
95th Percentile Exposure	Item 1, 7, 8, 10	Item 1, 5, 6, 7, 8, 10	Item 8	Item 8, 10

This analysis suggests that

There is no potential risk to osprey in Item 2.

There is no potential risk to osprey in Items 5 and 6, but we have less confidence in this opinion because the NOAEL-based HQs exceed 1 under 95th percentile exposures for all years.

There is a less certain potential risk to osprey in Items 1, 7, and 10. We have less confidence in this opinion for Item 10 because a subset of LOAEL-based HQs are equal to 1 under 95th percentile exposures to sum DDT.

There is potential risk to osprey in Item 8.

Estimated Risk to Osprey under the Dredging Condition

Tables E.5 and E.6 in Appendix E show the HQs based on the annual average dose of DDE to osprey and the annual average dose of the sum of DDT, DDD, and DDE to osprey for each item over a 40-year period. Tables 2.7 and 2.8 summarize these results.

Tables E.7 and E.8 in Appendix E show the HQs based on the 95th percentile dose of DDE to osprey and the 95th percentile dose of the sum of DDT, DDD, and DDE to osprey for each item over a 40-year period. Tables 2.7 and 2.8 summarize these results.

The results indicate:

	NOAEL Based HQ > 1		LOAEL Based HQ ≥ 1	
	DDE	Sum DDT, DDD, DDE	DDE	Sum DDT, DDD, DDE
Average Exposure	Item 8, 10	Item 1, 7, 8, 10	Item 8	Item 8
95^{th} Percentile Exposure	Item 7, 8, 10	Item 1, 5, 6, 7, 8, 10	Item 8	Item 8

This analysis suggests that

There is no potential risk to osprey in Item 2.

There is no potential risk to osprey in Item 5 and Item 6. A single NOAEL-based HQ exceedance for Item 6 and a subset of NOAEL-based HQ exceedances for Item 5 are recorded under 95^{th} percentile exposures.

There is a less certain potential risk to osprey in Items 1, 7, and 10.

There is potential risk to osprey in Item 8.

Risk Comparison between the No Dredging and Dredging Conditions for Osprey

There is no difference in the risk to osprey between the two conditions. Note that after about 10 to 15 years, the risks tend to level off which probably represents the steady state risk under these conditions.

Estimated Risk to the Mallard Duck under the No Dredging Condition

Tables E-9 and E-10 in Appendix E show the HQs based on the annual average dose of DDE to the mallard duck and the annual average dose of the sum of DDT, DDD, and DDE to the mallard duck for each item over a 40-year period. Tables 2.9 and 2.10 summarize these results.

Tables E-11 and E-12 in Appendix E show the HQs based on the 95^{th} percentile dose of DDE to the mallard duck and the 95^{th} percentile dose of the sum of DDT, DDD, and DDE to the mallard duck for each item over a 40-year period. Tables 2.9 and 2.10 summarize these results.

The results indicate:

	NOAEL Based HQ > 1		LOAEL Based HQ ≥ 1	
	DDE	Sum DDT, DDD, DDE	DDE	Sum DDT, DDD, DDE
Average Exposure	Item 1, 7, 8, 10	Item 1, 2, 5, 6, 7, 8, 10	Item 8	Item 8, 10
95th Percentile Exposure	Item 1, 2, 5, 6, 7, 8, 10	Item 1, 2, 5, 6, 7, 8, 10	Item 8, 10	Item 1, 8, 10

This analysis suggests that

There is a less certain potential risk to the mallard duck in Items 2, 5, 6 and 7.

There is a less certain potential risk to the mallard duck in Item 1. We have less confidence in this opinion because the LOAEL-based HQs are equal to 1 under 95th percentile exposures for nearly all years.

There is potential risk to the mallard duck in Items 8 and 10.

Estimated Risk to the Mallard Duck under the Dredging Condition

Tables E.13 and E.14 in Appendix E show the HQs based on the annual average dose of DDE to the mallard duck and the annual average dose of the sum of DDT, DDD, and DDE to the mallard duck for each item over a 40-year period. Tables 2.9 and 2.10 summarize these results.

Tables E.15 and E.16 in Appendix E show the HQs based on the 95th percentile dose of DDE to the mallard duck and the 95th percentile dose of the sum of DDT, DDD, and DDE to the mallard duck for each item over a 40-year period. Tables 2.9 and 2.10 summarize these results.

The results indicate:

	NOAEL Based HQ > 1		LOAEL Based HQ ≥ 1	
	DDE	Sum DDT, DDD, DDE	DDE	Sum DDT, DDD, DDE
Average Exposure	Item 7, 8, 10	Item 1, 5, 6, 7, 8, 10	Item 8	Item 8, 10
95th Percentile Exposure	Item 1, 5, 6, 7, 8, 10	Item 1, 2, 5, 6, 7, 8, 10	Item 8, 10	Item 1, 7, 8, 10

This analysis suggests that:

There is no potential risk to the mallard duck in Item 2, but we have less confidence in this opinion because nearly all NOAEL-based HQs exceed 1 under 95th percentile exposures.

There is a less certain potential risk to the mallard duck in Items 5, 6, and 7.

There is a less certain potential risk to the mallard duck in Item 1, but we have less confidence in this opinion because nearly all LOAEL-based HQs are equal to 1 under 95th percentile exposures.

There is potential risk to the mallard duck in Items 8 and 10.

Risk Comparison between the No Dredging and Dredging Conditions for the Mallard Duck

There is no difference in the risk to the mallard duck between the two conditions. Note that after about 10 to 15 years, the risks tend to level off which probably represents the steady state risk under these conditions.

Estimated Risk to the Mink under the No Dredging Condition

Tables E.17 and E.18 in Appendix E show the HQs based on the annual average dose of DDT to the mink and the annual average dose of the sum of DDT, DDD, and DDE to the mink for each item over a 40-year period. Tables 2.11 and 2.12 summarize these results.

Tables E.19 and E.20 in Appendix E show the HQs based on the 95th percentile dose of DDT to the mink and the 95th percentile dose of the sum of DDT, DDD, and DDE to the mink for each item over a 40-year period. Tables 2.11 and 2.12 summarize these results.

The results indicate:

	NOAEL Based HQ > 1		LOAEL Based HQ ≥ 1	
	DDT	Sum DDT, DDD, DDE	DDT	Sum DDT, DDD, DDE
Average Exposure	None	None	None	None
95th Percentile Exposure	None	Item 8	None	None

This analysis suggests that:

There is no potential risk to the mink in Items 1, 2, 5, 6, 7 and 10.

There is no potential risk to the mink in Item 8, but we have less confidence in this opinion because all NOAEL-based HQs for sum DDT exceed 1 under the 95th percentile exposures.

Estimated Risk to the Mink under the Dredging Condition

Tables E.21 and E.22 in Appendix E show the HQs based on the annual average dose of DDT to the mink and the annual average dose of the sum of DDT, DDD, and DDE to the mink for each item over a 40-year period. Tables 2.11 and 2.12 summarize these results.

Tables E.23 and E.24 in Appendix E show the HQs based on the 95th percentile dose of DDT to the mink and the 95th percentile dose of the sum of DDT, DDD, and DDE to the mink for each item over a 40-year period. Tables 2.11 and 2.12 summarize these results.
The results indicate:

	NOAEL Based HQ > 1		LOAEL Based HQ ≥ 1	
	DDT	Sum DDT, DDD, DDE	DDT	Sum DDT, DDD, DDE
Average Exposure	None	None	None	None
95th Percentile Exposure	None	Item 8	None	None

This analysis suggests that

There is no potential risk to the mink in Items 1, 2, 5, 6, 7 and 10.

There is no potential risk to the mink in Item 8, but we have less confidence in this opinion because all NOAEL-based HQs for sum DDT exceed 1 under the 95th percentile exposures.

Risk Comparison between the No Dredging and Dredging Conditions for the Mink

There is no difference in the risk to the mink between the two conditions. Note that after about 10 to 15 years, the risks tend to level off which probably represents the steady state risk under these conditions.

2.4 Uncertainty in the Ecological Risk Assessment

Vorhees et al. (1998) identify, describe and rank the various sources of uncertainty in ecological risk assessment as it applies to dredged material management. These include sources of uncertainty associated with characterization of the dredged material, development of the conceptual model, assessment and measurement endpoints, estimation of exposure point concentrations; and the selection of TRVs. Among these sources the elements that generally make the greatest contribution to uncertainty in the decision-making process include: the inputs to fate and transport models; the use of body burdens as TRVs; and extrapolations in TRVs to account for exposure periods.

Uncertainty in the Conceptual Models. Vorhees et al. (1998) indicate three sources of uncertainty associated with the conceptual model: characterization of the surrounding environment; identification of exposure pathways; and, selection of potential receptors.

This assessment provides a clear biological description of the surrounding environment, and the proposed activities based on the prior work (USACE, 1996). This readily available information provides confidence in our identification of exposure pathways and selection of receptors.

Uncertainty in the Assessment Endpoints. The assessment uses various measurement endpoints to reduce the uncertainty inherent in the evaluation of exposure in complex ecological systems. While it is impossible to evaluate the condition of every species and local population using the Sunflower River Basin, it is important to select species that: may use the river; are representative of larger feeding guilds; and have a high potential for exposure. The selected species are representative. They do not necessarily represent the most dominant species in the area, but they do occur within the study area and represent specific guilds.

Uncertainties in the Estimation of Exposure Point Concentrations. Appendices A and B discuss the various uncertainties associated with the estimates of DDT, DDD, and DDE in sediment, water, and biota. The models attempted to address this uncertainty by providing central tendency and upper bound estimates of exposure for use in comparison to TRVs.

The source of uncertainty that resonates throughout all subsequent estimates of exposure and risk is the adequacy of the underlying data that support the modeling. The existing sediment and water data are inadequate to provide confidence in the predictions to within an order of magnitude. This is an important source of uncertainty in the estimates of absolute risk, but less so for the risk comparison because the uncertainties apply equally to each condition.

There are additional uncertainties associated with operational assumptions that would affect the comparison. For example, the fate and transport models assumed that some proportion of contaminated sediments remain in place in each Item of work (Appendix A provides details). Changes in these assumptions would affect the differential risks between dredging and no dredging.

Appendix D describes how the food chain models accounted for uncertainties in the ecological exposure parameters (e.g. ingestion, body weight).

Uncertainties in the TRVs. There are various uncertainties associated with the selection of TRVs (Vorhees, 1998). These derive from the:

Uncertainties inherent in the experiments from which they are derived;

Extrapolations between species that are a necessary consequence of the limitation in the available data;

Uncertainties associated with timing of exposures;

Uncertainties associated with conversions between NOAELs and LOAELs.

We attempted to address this uncertainty by selecting TRVs that are likely to over-predict rather than under-predict risk by employing the selection procedures and applying the uncertainty factors detailed in Appendix K. Note that the appendix describes a method that leads to the selection of the most reasonably conservative TRV (i.e. tends to over-predict risk).
Specifically we:

Reviewed the toxicological literature widely (Appendix K) and chose TRVs based on sensitive species and studies that included a clear dose response to minimize experimental uncertainties in these studies;

Did not apply extrapolations to account for differences between species, but rather used studies based on the same species as the selected receptors or species from the same taxonomic family where possible;

Used studies that accounted for chronic exposures to address uncertainties associated with timing of exposures;

Used an uncertainty factor of ten to account for uncertainties associated with conversions between NOAELs and LOAELs, for studies where a NOAEL was unavailable.

3.0 HUMAN HEALTH EXPOSURE ASSESSMENT, TOXICITY ASSESSMENT AND RISK CHARACTERIZATION

3.1 Exposure Assessment

The human health exposure assessment:

Specifies and describes human receptors and exposure pathways;

Estimates exposure point concentrations; and,

Estimates average daily doses of COCs to humans.

It proceeds by developing exposure scenarios that describe:

Human activities which result in exposure to COCs;

The pathways and routes by which humans contact COCs;

The rate of contact (i.e. dose) of the COC by pathways and routes.

The exposure assessment estimates the magnitude of actual and potential human exposures, the frequency and duration of these exposures, and the pathways by which people are potentially exposed under these conditions. The assessment relies on measured and modeled concentrations. This subsection describes potentially complete exposure pathways at the Site, the approach used to calculate EPCs, and the exposure assumptions and models used to estimate daily COC intake.

The assessment employs two levels of exposure:

reasonable maximum exposure (RME) which uses exposure assumptions at the high end of exposure parameter distributions; and,

central tendency exposure (CTE) which uses average exposure assumptions.

The RME represents a potential exposure estimate that is unlikely to underestimate actual exposure. The CTE provides a more reasonable estimate of exposure to any given individual. In this risk assessment the number of years of exposure and fish ingestion rates are the key differences between the CTE and RME.

The exposure scenarios depend on site specific information and information from:

Exposure Factors Handbook (USEPA, 1997).

Child-Specific Exposure Factors Handbook (USEPA NCEA, 2000).

Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part A (USEPA, 1989).

Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment (USEPA, 2000).

Guidance for Assessing Chemical Contaminant Data for use in Fish Advisories. Volume II: Risk Assessment and Fish Consumption Limits (USEPA OST, 1994a).

Fish and Wild Game Consumption Patterns in the Delta Region of Mississippi (Frate, 2001).

Michigan sport anglers fish consumption survey (West et al., 1989).

Foods Commonly Eaten by Individuals (Pao et al., 1982).

The assessment does not predict risks to actual individuals who use the project area, but estimates potential risks based on types of behaviors and assumptions about those behaviors. Uncertainty in the exposure assessment arises from the lack of actual measurements of the population's exposure to DDT in the project area. We rely on assumptions about the population exposed including characteristics of the receptor group, the frequency and intensity of exposure, and the concentrations to which they may be exposed.

We have incorporated as much information that is specific to the Delta region of Mississippi as possible to minimize these uncertainties. Based on our assumptions, we calculated and compared the potential risks of no dredging to the potential risks associated with dredging.

Table 3.1 summarizes the exposure assumptions for each site-specific exposure scenario. The following subsections describe the assumptions used to estimate exposure. Tables H.1 through H.4 in Appendix H present the exposure estimates used in the risk calculations.

3.1.1 Receptors and exposure pathways

Exposure to DDT, DDE and DDD in the rivers of the project area may occur either through direct or indirect exposure pathways. Potential direct exposure pathways include dermal contact and ingestion of contaminated sediments or surface water. Indirect exposure pathways include ingestion of fish and aquatic species of wild game (e.g. ducks).

The assessment addresses only the fish ingestion pathway because other pathways through direct contact with sediment and surface water are less likely to occur and also unlikely to make a large proportional contribution to risk if they do occur.

3.1.1.1 Consideration of the Direct Pathways – Contact with Sediment and Surface Water

People in the Delta region of Mississippi engage in a variety of recreational activities associated with local oxbow lakes, rivers, tributaries and swamps, but the region specific information suggests that sediment and surface water exposures are limited. Frequency of swimming and other forms of recreation relate to accessibility and attractiveness of the area, availability of other swimming areas, and other factors that would encourage wading. However, based on discussions with people living in the Delta region (Table 1.1), the rivers in the project area are generally turbid and the presence of snakes and alligators discourages swimming and playing in and near the river. Hunters may wade while hunting, but they wear waders and other clothing that limit sediment and surface water contact. Boaters and anglers may also have limited contact with sediment and surface water when launching their boats or fishing from the banks of the river.

In addition to limited opportunities for exposure, the sediment and surface water pathways offer a low potential for risk. Surface water exposures are less likely to be significant than sediment exposures because the physical and chemical properties of DDT, DDE and DDD suggest that these compounds are likely to be present in sediment at higher concentrations than in the water. Therefore, we estimated the relative importance of the sediment pathway for human health risk with a screening calculation of risk from dermal exposure to sediment (Appendix F). Potential risk from this pathway is negligible (contributing less than 0.003%) relative to risk from fish ingestion pathways. Therefore, we did not evaluate sediment and surface water exposures from swimming, wading, hunting, boating and fishing in the quantitative risk assessment.

3.1.1.2 Consideration of the Indirect Pathway – Ingestion of Wild Game

Fishing and hunting wild game occur at the Site and are important potential sources of exposure to the COCs. We were not able to quantify the risk from ingestion of wild game from the Site because:

- data were not available for estimating the concentrations of DDT, DDE and DDD in any aquatic wild game tissue (e.g. duck, goose), and tissue concentrations for wild game could not be modeled with confidence; and

- the information available for estimating the consumption rate of wild game is very uncertain.

3.1.1.3 Consideration of the Indirect Pathway – Ingestion of Fish

We evaluated one scenario, an angler because:

Site-specific information from several sources (Table 1.1) indicate that fishing occurs in the Delta area; and,

The bioaccumulation of DDT in fish, birds, and other food items indicates that exposure will be greater for this pathway than for others.

Anglers fish to provide food for their families and as a recreational activity. They use cane poles, bobbers and live bait, and primarily fish from the river banks (D. Frate, personal communication 8-13-01). Fishing activities include casting, repairing and maintaining equipment, and cleaning the fish. Complete exposure pathways for the angler (see Figure 1.2) include:

Exposure through the food chain when an angler ingests fish tissue containing DDT, DDE or DDD from rivers in the project area; and,

Exposure through incidental dermal contact with contaminants in sediment while fishing.

We did not consider the direct dermal contact pathway as indicated in subsection 3.1.1.1.

We evaluated exposure to an angler, who consumes fish caught in the rivers in the project area for the first 15 or 45 years of his or her life (age 1 to 16 or 46), for no dredging and dredging conditions. We also evaluated a one-year, subchronic exposure to a young child (2 to 3 years old) who does not go fishing, but consumes the fish that his or her parents catch under no dredging and dredging conditions.

This subsection describes the variables for estimating the exposure and risk of the angler.

Exposure Duration

Exposure duration is the number of years that a person may be exposed to contaminated fish in the rivers in the project area. We based our estimates of exposure duration on residence times (i.e., the time between a person moving into a residence and the time the person moves out or dies, or the time since a person moved into their current residence).

US Census data available from counties in the project area do not provide site-specific residence times. USACE (1996) characterizes most people in the project area as rural populations with farmers as 8% of the total. We estimated residence time as the average of the farmer and rural residence times available from national data. In addition, Approximately 40% of the households surveyed reported that there were children under the age of 12 who consumed fish (Frate, 2001).

For chronic exposures, we assumed that:

> An angler between the ages of 1 and 46 may consume fish in rivers in the project area for either 45 (RME) or 15 (CTE) years;
>
> The person is one year old at the beginning of the no dredging or dredging scenario; and,
>
> The person consumes fish from rivers in the project area for either the first 15 years or the first 45 years of his or her life.

The first assumption provides a conservative estimate of chronic and carcinogenic risk, because people may begin consuming fish at an older age or may move into the area as adults. The values for exposure duration (45 and 15) are the average of the 95^{th} and 50^{th} percentile residence times for farmer and rural populations (Tables 15-164 and 15-163 respectively in USEPA, 1997).

For subchronic exposures, we assumed that the exposure duration is one year for a 2-3 year old child, because the expected duration of the dredging project for any Item is one year and the highest level of exposure may occur during the dredging period. The subchronic exposure duration for a small child provides a conservative estimate of risk to a sensitive receptor.

Averaging Time

Averaging time is the period of time over which a person's exposure is averaged. The averaging time selected depends on the type of toxic effect being assessed (USEPA, 1989). Exposure estimates for cancer risks use an expected lifetime as the averaging time, and estimates for non-cancer hazards use the exposure period.

In the present assessment, we used race and gender specific averaging times to estimate potential risk from cancer-causing chemicals. The length of an average lifetime varies by race and gender, thus using race and gender specific values provides better estimates of potential risk to the respective populations. For this risk assessment, local data indicate that African Americans comprise nearly 70 percent of the respondents in a health survey conducted in the Delta region (Appendix G, Frate, 2001) and approximately 59% of the population in the counties abutting the rivers in the project area (USACE, 1996). Thus, we were able to use race and gender specific estimates of an average lifetime for estimating potential cancer risk.

According to the US Census, the life expectancy for African Americans ranges from 64.7 years for males to 73.7 years for females. For Caucasians, life expectancy ranges from 73.0 years for males to 79.5 years for females (Table 8-1; USEPA, 1997).

To estimate non-cancer risk, we assumed that the averaging time is equal to the exposure duration for the chronic RME and CTE (45 years, or 16,425 days, and 15 years, or 5475 days, respectively) and 1 year (365 days) for subchronic exposure (USEPA, 1989).

Body Weight

Exposure is often expressed as a dose, or the mass of a substance contacted per unit body weight per unit time. The value for body weight is the average body weight over the exposure period, in this case, 15 and 45 years (USEPA, 1989). Therefore, we calculated weighted average body weights for the two exposure durations to estimate an angler's intake resulting from exposure to DDT, DDD and DDE in fish. The equations for calculating the body weights for the male and female anglers were:

$$BW_{age1-16} = \frac{BW_{age1} + BW_{age2} + ... + BW_{age16}}{15}$$

$$BW_{age1-46} = \frac{BW_{age1} + BW_{age2} + ... + BW_{age17} + (BW_{age18<25} * 7) + (BW_{age25<35} * 10) + (BW_{age35<45} * 10) + (BW_{age45<55} * 1)}{45}$$

Body weights vary by gender and race. However, gender and race specific body weight values are not available for children. The difference in body weights of adults across race is small compared to the difference across gender. Thus, we used the gender specific body weights calculated for the CTE and the RME.

For chronic exposures, the age adjusted body weight of the female angler between the ages of 1 and 16 is 31.1 kg and between the ages of 1 and 46 is 53.1 kg (USEPA, 1997). The age adjusted body weight of the male angler between the ages of 1 and 16 is 31.7 kg and between the ages of 1 and 46 is 62.3 kg (USEPA, 1997).

Subchronic risk is calculated for a 2-3 year old angler with a body weight of 13.0 kg for a female and 13.6 kg for a male child (USEPA, 1997).

Ingestion Rate

We assumed that anglers consume fish year-round under no dredging and dredging conditions. We assumed that the fish consumption rate applies to fish that the angler catches and eats from one of the rivers in the project area. The fish consumption rates used in this assessment are Delta specific (Appendix G, Frate, 2001). We assumed that the fish consumption patterns in the Big Sunflower area are the same as those in the areas covered by the survey.

Table 3.2 shows the average, the 95^{th} percentile and the range of yearly fish consumption rates. The average fish consumption rates were calculated based on the total population, which includes consumers and non-consumers of fish. However, 90% to 100% of individuals surveyed reported eating home-caught fish.

Table 3.2 Adult Yearly Consumption of Non-commercially Produced Fish

	Average (lbs.)	95th Percentile (lbs.)	Range (lbs.)
African American Males	46.4	114.0	5.6 – 185.6
African American Females	26.2	69.0	0 (1.5)* - 111.4
Caucasian Males	28.5	72.0	0 (1) - 99
Caucasian Females	13.7	36.0	0 (1) - 60.8
Total Population Average	30.8		0 (1) - 185.6

Source: Frate 2001 (See Appendix G)
* Values in parentheses include only those eating fish.

Frate (2001) also found that:

African Americans most commonly eat catfish and bream; and,

Caucasians more commonly eat bass and white perch;

Most people catch fish in lakes (oxbow lakes are common in this region), followed by rivers/streams and swamps/backwater areas.

We do not have site-specific consumption rates for children. Therefore, we adjusted adult ingestion rates to estimate child ingestion rates using two studies available from the literature (See Appendix H). Specifically, the gender and race specific chronic fish ingestion rates are weighted by assuming that:

children ages 1 through 10 consume approximately half the fish of an adult; and,

any individual 11 years of age and older consumes approximately the same amount of fish as the surveyed adult population.

These age-weighted ingestion rates are estimated as:

$$\text{Subchronic Fish IR}_{\text{2 to 3 year old}} = 0.5 * (\text{Site - Specific Adult IR})$$

$$\text{Chronic Fish IR}_{\text{1 to 16 years old}} = ((0.5 * (\text{Site - Specific Adult IR})) * 10) + ((\text{Site - Specific Adult IR}) * 5)$$

$$\text{Chronic Fish IR}_{1\text{ to }46\text{ years old}} = ((0.5 * (\text{Site - Specific Adult IR})) * 10) + ((\text{Site - Specific Adult IR}) * 35)$$

Assuming that anyone over 11 consumes similar amounts of fish as an adult may be an over-estimate of the actual ingestion rate. However, the data presented in Appendix H suggest that teenagers can consume as little as half an adult's serving or up to the same amount as an adult's serving.

Fish ingestion rates for the RME and CTE are calculated based on the gender and race specific ingestion rates for people in the Delta region (Appendix G). We used the average ingestion rates and the 95th%-tile ingestion rates to provide a best estimate (CTE) and an upper bound estimate (RME), respectively, of potential risk from fish ingestion. Gender and race specific fish ingestions rates were calculated for each of the three exposure durations for both the average and 95th%-tile ingestion rates in Table 3.3 (Frate, 2001).

Table 3.3 Site-Specific Fish Ingestion Rates Accounting for Age, Gender, Race and Exposure Period

	CTE Average Ingestion Rates (kg/year)				RME 95%-tile Ingestion Rates (kg/year)			
Exposure Duration	**African American**		**Caucasian**		**African American**		**Caucasian**	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Subchronic	10.5	5.9	6.5	3.1	25.9	15.6	16.3	8.2
Chronic 1-16	13.3	7.5	8.2	3.9	---	---	---	---
Chronic 1-46	---[1]	---	---	---	45.4	27.5	28.7	14.3

Source: Frate 2001 (See Appendix G)
[1] Values not applicable

Oral absorption factor

We assumed that all of the DDT, DDE and DDD present in the food source is available for absorption in the gastrointestinal tract.

Fraction from Source

We assumed that all of the fish in the angler's diet comes from the rivers in the project area. Therefore, the fraction of fish ingested from the source is set to 1 in this assessment.

3.1.2 Estimate Exposure Point Concentrations (EPCs)

In this human health assessment, exposure point concentrations (EPCs) are concentrations of COCs in fish tissue. These are modeled concentrations, based on measured and modeled forage fish body burdens, sediment, and surface water concentrations (Appendix B). The fish modeling provides estimated concentrations, represented by distributions, of DDD, DDE and DDT in buffalofish, gar, blue catfish and flathead catfish for each year over a period of 46 years.

Selection of Items for Quantification of Risk

The fish tissue concentrations in Table 3.4 suggest that fish concentrations would not change significantly with dredging. Across the items, the average of the 50th percentile sum DDT tissue concentration ranges from the lowest in Item 2 (which is similar to Items 5, 6, 7 and 1), a mid-level concentration in Item 10, and a 10-fold higher concentration in Item 8. This order changes somewhat based on the maximum of the 95th percentile sum DDT. We ordered the Items based on the 50th percentile, as central estimates are more representative of the whole of the data.

Potential risks calculated from Items 2 and 8 represent the lower and upper boundaries, respectively, of the potential risks to people consuming fish from the BSRMP area. We selected Item 6 to assess the difference in risk between no dredging and dredging because it is an Item where fish tissue concentrations change between the two scenarios.

Calculating EPCs

Table H.5 summarizes the six separate duration-specific central and maximum estimates of exposure point concentrations for Items 2, 5, 6 and 8. Anglers in the area report eating buffalofish, catfish, gar, and other fish species. The ideally estimated EPC would derive from concentration data for all consumed species, weighted by species-specific consumption rates. However, we had fish concentration data only for buffalofish, blue catfish, flathead catfish, and gar, and we had no species-specific consumption rate data. Therefore, we assumed that anglers eat these four fish species in equal proportions to estimate EPCs.

Appendix B provides predicted fish tissue concentrations of DDD, DDE and DDT for the four fish species over 45 years. These are distributions of concentrations for each chemical for each year.

To evaluate the range of potential risks, we calculated the EPCs for the CTE using the first 15 years of the modeled concentration for the 50%tile and 95%tile of the concentration distributions, designated CTE50 and CTE95 respectively. We similarly calculated EPCs for the RME, using 45 years of the modeled concentration for the 50%tile and 95%tile of the concentration distributions, designated RME50 and RME95 respectively.

The subchronic hazards represent the highest one year of potential exposure. Thus, four separate duration-specific central and maximum estimates of exposure point concentrations are calculated. We used the maximum of the 50%tile over years 1-16 and years 1-46 for the CTE50 and RME50. The maximum of the 95%tile concentrations over years 1-16 and years 1-46 are the CTE95 and RME95, respectively.

The maximum concentration used to calculate an EPC is the single year with the maximum sum DDT across the four types of fish. After the maximum was identified, the concentrations of DDT, DDE and DDD associated with the maximum sum DDT were used as the individual EPCs for the risk calculations.

The chronic hazard and cancer risk estimates used four separate duration-specific central and maximum estimates of EPCs. Two of these are the same as those used to evaluate subchronic hazard. Central estimates of the EPCs were calculated using the average of the estimated 50^{th} percentile concentrations for DDT, DDE and DDD individually across all four fish over the first 15 years for the CTE50, and the first 45 years for the RME50. The CTE95 and RME 95 EPC values are the same as those used to evaluate subchronic hazard.

3.1.3 Estimating average daily doses

Average Daily Dose (ADD) combines the RME and CTE exposure assumptions with EPCs to estimate daily COC intakes for each exposure route and exposure point using the following general equations:

$$ADD_{(mg/kg-day)} = \frac{CPC_f \times IR \text{ x } ABS_{GI} \text{ x } FS \times ED}{BW \times AT}$$

CPC_f	=	Total contaminant concentration in fish (mg/kg)
IR	=	Total fish ingestion rate (kg/yr)
ABS_{GI}	=	Absorption of DDT in the gastrointestinal tract (unitless)
FS	=	Fraction from source (unitless)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (period over which exposure is averaged: days)

We calculated two ADDs for each exposure route, the ADD(year) and the ADD(life). The ADD(year) is used to evaluate non-carcinogenic effects. It represents the chemical dose during the exposure period and is calculated as the average daily dose over an appropriate averaging period.

The ADD(life) is used to evaluate carcinogenic effects. It represents the chemical dose averaged over a lifetime and is usually calculated as the average daily dose over a 70-year lifetime. As described in section 3.1, we used race and gender specific averaging times for this risk assessment.

Table 3.1 summarizes the rationale underlying the parameters used in this risk assessment. We calculated gender and race specific risks for twelve scenarios to explore the impact of the uncertainty in the exposure assumptions and in the choice of EPC.

All of the race and gender specific exposure parameter values used to calculate risk are presented in Tables H.1 through H.4 in Appendix H.

3.2 Dose-Response Assessment

The "dose-response relationship" is the relationship between the dose received and the incidence of an adverse effect. For carcinogens, it is expressed as a cancer slope factor (CSF) and is a measure of a carcinogen's potency through the oral route of exposure. For noncarcinogens, the toxicity benchmark, the Reference Dose (RfD), is based on the expectation that adverse effects are unlikely to occur if exposures are below a threshold of response.

This subsection:

Describes RfDs and CSFs for the COCs; and,

Provides surrogate toxicity values for COCs that lack such toxicity values.

Appendix J provides a toxicity profile for DDT, DDE and DDD.

3.2.1 Available Toxicity Information

Toxicity Assessments for COCs have two steps:

determining whether exposure to the compound results in observed toxic effects in animals or humans; and,

identifying the dose-response relationship.

Quantitative estimates of a compound's toxicity are either RfDs or CSFs, collectively referred to as toxicity values. The RfDs are average daily doses of compounds below which adverse non-cancer health effects are not expected to occur in sensitive humans. The CSFs are quantitative estimates of a compound's cancer potency. These toxicity values are selected from the following USEPA sources:

Integrated Risk Information System database (IRIS, http://www.epa.gov/iris);

National Center for Environmental Assessment (NCEA), Superfund Technical Support Center and on-line Toxicological Profiles (http://www.epa.gov/ncea); and, Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997).

The IRIS values are preferred in quantitative risk assessment because they receive the highest level of peer review. If IRIS toxicity values are not available, provisional values from NCEA are used, followed by values from HEAST.

Table 3.5 lists RfDs and CSFs for DDT, DDE and DDD that we used in our risk assessment. This table indicates the source of toxicity values, and assumptions made about the toxicity of COCs with no published toxicity values. DDE and DDD do not have RfDs or other published non-cancer toxicity values.

Table 3.5 Published Toxicity Values for DDT, DDE and DDD

Values from IRIS	DDT	DDE	DDD
RfD (mg/kg-day)	5E-4	Use DDT[1]	Use DDT
CSF $(mg/kg\text{-}day)^{-1}$	3.4E-1	3.4E-1	2.4E-1
Weight of Evidence	B2	B2	B2

[1]USEPA fish consumption guidance (USEPA, 2000) uses the DDT RfD as a surrogate RfD for DDE and DDD.

3.2.1.1 Evaluation of Non-cancer Health Effects Using RfDs

USEPA defines RfDs (mg/kg-day) as:

> estimates (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious non-cancer effects during a lifetime.

Interaction of Exposure Duration and Health Outcomes

The interaction of time scales of exposure with types of effects (acute, subchronic, and chronic) complicates the assessment of non-carcinogenic effects. Subchronic and chronic health effects are those that might occur following long-term exposures typically of concern at hazardous waste sites. USEPA defines subchronic exposures as those lasting up to seven years. Chronic exposures are those lasting more than seven years. Most available RfDs are applicable to the evaluation of chronic rather than subchronic exposures. Chronic RfDs are used to evaluate subchronic exposures when a subchronic value is not available from IRIS, NCEA, or HEAST. For DDT, HEAST (1997) uses the chronic value from IRIS as the subchronic value for DDT.

The chronic RfD for DDT on IRIS is derived from a subchronic study. This study was the most sensitive indicator of toxicity among the available studies. It was considered by USEPA to be appropriate for derivation of a chronic toxicity value, without the addition of an uncertainty factor to account for the less than chronic duration of the principal study.

This assessment used the chronic RfD for evaluating risk from subchronic exposure.

Derivation of RfDs

The RfD derivations start with the highest "No Observed Adverse Effect Level" (NOAEL), which is the dose or concentration at which there are no statistically or biologically significant increases in the frequency or severity of any effect between the exposed population and its appropriate control. Lowest observed adverse effect levels (LOAELs) are sometimes used when NOAELs are not available.

Uncertainty factors are applied to NOAELs to ensure that RfDs are sufficiently protective given uncertainties in the underlying toxicity database. Uncertainty factors (UF) are incorporated as divisors to the NOAEL associated with the critical effect (i.e. the first adverse effect, or its known precursor, that occurs as the dose rate increases). Standard uncertainty factors include:

10-fold factor for extrapolation from animals to humans;
10-fold factor for variability in the human population;
1 to 10-fold factor for use of a less-than-chronic study;
1 to 10-fold factor for extrapolation from a LOAEL to a NOAEL and,
3 to 10-fold factor for an incomplete database.

Application of these uncertainty factors results in RfDs between 3 and 10,000 times lower than the NOAEL. An additional divisor, or modifying factor (MF), between 0 and 10 can be used to account for scientific uncertainties of the study and database not explicitly treated with the standard uncertainty factors or to account for increased confidence in the available data. The default value for the MF is 1.

Interpretation of RfDs

Adverse effects are not likely at doses below RfDs. The level of concern for a particular COC does not increase linearly as the RfDs are approached or exceeded because these toxicity values are not equally accurate or precise, nor are they based on the same severity of toxic effects across chemicals. In fact, the slopes of dose-response curves in excess of RfDs can vary considerably among COCs. Therefore, comparing these toxicity values with exposure estimates at the Site provides an index of concern rather than a probability of an adverse effect occurring.

3.2.1.2 Evaluation of Cancer Risk Using CSFs

Carcinogenic potential is described by CSFs with units of $(mg/kg\text{-}day)^{-1}$. These values provide a quantitative estimate of the carcinogenic potency of chemicals to humans. According to USEPA Risk Assessment Guidelines (1986), human carcinogenic potential is classified through a weight-of-evidence classification scheme (A through E), which considers available test data, adequacy of studies, types of studies, and observed responses. Chemicals that give rise to cancer or gene mutations are generally classified as:

Group A: Human Carcinogen, sufficient human data;
Group B1: Probable Human Carcinogen, limited human data;
Group B2: Probable Human Carcinogen, sufficient evidence in animals and limited evidence or no evidence in humans;
Group C: Possible Human Carcinogen, limited evidence in animals and limited or no evidence in humans;
Group D: Not Classifiable as to Human Carcinogenicity, insufficient tests for carcinogenesis or mutagenesis are available; and
Group E: Evidence of Non-Carcinogenicity in Humans.

The weight-of-evidence classification for DDT, DDE and DDD is Group B2.

The CSF, as calculated in accordance with the USEPA 1986 guidelines, is usually the 95% statistical upper bound on the slope of the dose-response curve in the low-dose linear portion as estimated by the linearized multistage model (LMS). The larger the CSF, the more potent the carcinogenicity of the compound. In addition, CSFs are calculated assuming there are no threshold levels for carcinogenic effects and that the response increases linearly with dose at low levels, including dose levels encountered in the environment. CSF as calculated, is the upper bound on a risk estimate that could be as low as zero.

3.2.2 COCs with No Published Toxicity Values

RfD values for DDE and DDD are not available. Like many compounds, they can be toxic to humans but have an inadequate toxicity database to support the derivation of toxicity values or can have a database that has not been reviewed by USEPA. In this assessment, we assigned surrogate toxicity values wherever reasonable based on knowledge of the COC mechanism(s) of toxicity or structural similarity. This approach introduces uncertainty into the analysis but is judged to be more appropriate than ignoring these compounds.

Given the structural and mechanistic similarities between DDT, DDE and DDD it seems reasonable to use the RfD for DDT to evaluate the potential hazard from exposures to DDE and DDD as was done in the USEPA (2000) fish advisory guidance. We used the DDT RfD as a surrogate for the DDE and DDD RfDs to calculate the non-cancer hazard estimates for this risk assessment.

3.3 Risk Characterization

The purpose of the risk characterization is to estimate potential risks associated with contaminants at the site for each exposure scenario. The results of the dose-response assessment are combined with the results of the exposure assessment to derive quantitative estimates of risk and hazard.

3.3.1 Non-cancer Hazard Evaluation

Subchronic (1 year) and chronic (15 or 45 years) non-cancer hazards are estimated for each exposure scenario. We evaluate the potential for non-cancer health effects by calculating hazard quotients (HQs) and hazard indices (HIs). The HQ is the quotient of the average daily dose (ADD) for a given exposure pathway to the chemical- and route-specific (oral, dermal, or inhalation) reference dose (RfD).

$$HQ = ADDi/RfDi$$

Where:
ADDi = Average daily dose of contaminant (mg/kg-day)
RfD = Reference dose (mg/kg-day)

The hazard index (HI) is the sum of the hazard quotients for each pathway and then across all media.

$$HI_{pathway\text{-}specific} = \Sigma\ HQ$$

$$Total\ HI = \Sigma\ HI_{pathways}$$

The total and pathway-specific hazard indices are compared to a target hazard index of one. A hazard index greater than one may indicate the potential for adverse noncarcinogenic effects as a result of exposure to the contaminants from the site.

Table 3.6 summarizes the non-cancer hazard evaluation using IRIS RfDs. The inputs used to calculate the ADD and the EPC values for each gender and race specific exposure scenario are found in Tables H.1 through H.5, Appendix H.

3.3.2 Cancer Risk Evaluation

Cancer risk is calculated as:

$$Excess\ Lifetime\ Cancer\ Risk = LADDi * CSFi$$

Where:

LADDi = Lifetime average daily dose of contaminant (mg/kg-day)
CSFi = Chemical- and route-specific cancer slope factor of contaminant i $(mg/kg\text{-}day)^{-1}$

Cancer risks are summed across each pathway and then across all media, resulting in a total cancer risk.

$$\text{Cancer Risk}_{\text{pathway-specific}} = \Sigma \text{ Cancer Risk}_{\text{chemical-specific}}$$

$$\text{Total Cancer Risk} = \Sigma \text{ Cancer Risk}_{\text{pathways}}$$

The total and pathway-specific cancer risk estimates are compared to a target risk level. The US EPA and Mississippi DEQ target cancer risk is 10^{-4} to 10^{-6} while the target cancer risk in the Aquatic Risk Assessment Guidance developed for the USACE (Cura et al., 1998) is 10^{-5}. Cancer risk estimates above these ranges are considered unacceptable.

Table 3.6 summarizes the cancer risk estimates. The inputs used to calculate the LADD and the EPC values for each gender and race specific exposure scenario are found in Tables H.1 through H.5, Appendix H.

3.3.3 Risk Summary

Table 3.6 summarizes the results for the no dredging and dredging conditions including hazard and risk estimates for CTE and RME exposures for Items 2, 5, 6 and 8 using USEPA toxicity values. Risks were not quantified for Items 1, 7, and 10, as the EPC values, thus the risks, for these items fall in between Items 6 and 8. The results are presented by gender and race for the average EPC concentration, designated CTE50 and RME50, and for the 95th%tile concentrations, designated CTE95 and RME95. The USEPA and Mississippi DEQ range of acceptable cancer risks is 1E-4 to 1E-6. Nearly all risk estimates are greater than 1E-6. Therefore in this section we discuss in detail cancer risks that are greater than 1E-4 and non-cancer hazards that exceed the non-cancer benchmark of one.

Comparison of Risks - No Dredging and Dredging

The risk estimates for the no dredging and dredging condition are the essentially the same in Item 8. In Items 2, 5 and 6, estimated risks decline by a small amount after dredging. The declines in the EPC concentrations after dredging in Items 2, 5 and 6 are so small that only one of Item 2’s, four of Item 5’s and none of Item 6’s forty-eight risk estimates change from being just above the target hazard and risk levels under no dredging conditions, to being at the same level as the target hazard and risk under dredging conditions. The small changes in risk estimates result from predicted fish tissue concentrations.

Range of Potential Risk Estimates Across Items

We estimated cancer risk and non-cancer hazard for four Items that represent the range of sum DDT concentrations in the BSRMP. Because risk is a linear function of concentration, these four Items indicate possible lower, mid and upper bound risks in the BSRMP.

Estimated risks and non-cancer hazard associated with fish consumption increase with increased fish ingestion rates. Fish ingestion rates vary by race and gender. Caucasian females consume the least amount of fish. African American males consume the greatest amount of fish (Frate, 2001). Thus, risks are lowest for Caucasian females and highest for African American males.

Item 2

We evaluated the risks from Item 2 to provide an estimate of the lower bound on the potential risk of consuming fish from the BSRMP area, because Item 2 has the lowest estimated fish tissue concentrations. Risks from consuming fish from Item 2 are *above* benchmark levels,

> for subchronic hazard for all gender and race groups for all exposure estimates, except for Caucasian female CTE exposure estimates;
>
> for chronic hazard for African American males for CTE95 exposure estimates;
>
> for chronic hazard and cancer risk for African American males for RME50 exposure estimates; and,
>
> for chronic hazard and cancer risk for all gender and race groups for RME95 exposure estimates except for Caucasian females.

If dredging occurs, risks from consuming fish are the same as those estimated under the no dredging condition, except that chronic hazard estimate for the African American male RME50 changes from above benchmark level to being at the benchmark level.

Item 5

We evaluated the risks from Item 5 to characterize the location of the lower bound on the potential risk of consuming fish from the BSRMP area. Item 5 was selected because it has the next lowest estimated fish tissue concentrations based on sum DDT concentrations after Item 2. Risks from consuming fish from Item 5 are *above* benchmark levels,

> for subchronic hazard for all gender and race groups for all exposure estimates, except for Caucasian female CTE estimates;
>
> for chronic hazard for African American and Caucasian males for CTE95 exposure estimates;
>
> for chronic hazard and cancer risk for African American males and females for RME50 exposure estimates; and,
>
> for chronic hazard and cancer risk for all gender and race groups for RME95 exposure estimates, except Caucasian female cancer risk estimates.

If dredging occurs, risks from consuming fish are the same as those estimated under the no dredging condition, except that estimates from the following scenarios change from *above* benchmark levels to being *at* benchmark levels,

for chronic hazard for African American females RME50 and for Caucasian females RME95;

for cancer risk for African American females RME50.

Item 6

If no dredging occurs, risks from consuming fish are *above* benchmark levels under the following conditions,

for subchronic hazard for all gender and race groups for all exposure estimates, except for Caucasian female CTE estimates;

for chronic hazard for African American male CTE95 exposure estimates;

for chronic hazard and cancer risk for African American male RME50 exposure estimates; and,

for chronic hazard and cancer risk for all gender and race groups for RME95 exposure estimates, except for Caucasian female estimates.

If dredging occurs, the risks from consuming fish are the same as those estimated under the no dredging condition.

Item 8

Item 8 has significantly higher estimated fish tissue concentrations than all other Items. We calculated hazard and risk from Item 8 to provide an upper bound on the potential risk of consuming fish from the BSRMP area. The non-cancer and cancer risks from consuming fish from Item 8 are *above* benchmark levels, for all gender and race groups for all exposure estimates.

3.3.4 Risk Discussion

The results of this risk assessment indicate that risks to human health from fish ingestion are essentially equivalent with and without the dredging project.

However, there are risk and hazard estimates above the standard benchmark levels of 1 for the hazard index and 1E-4 for the carcinogenic risk from exposure to fish in all Items, except for CTE exposure in Items 2, 5 and 6. These results suggest that residents of this region may experience significant levels of risk for cancer and non-cancer health effects with or without the planned dredging activities.

The fish consumption advisory developed by Mississippi DEQ (6/26/01) limits fish consumption to 2 meals per month, which is equivalent to 12 lbs. of fish/year (assuming that each meal is 8 oz.) for rivers in the project area. This is just under the 13.6 lb. per year average adult Caucasian female ingestion rate found by Frate (2001). Non-cancer hazard and cancer risk calculated for Items 2, 5 and 6 for the Caucasian females are at or below the target risk levels. Subchronic hazard at the fish advisory levels is elevated when using RME EPCs (i.e. the maximum of the 50^{th} or 95^{th}%-tile). However, most people in the Delta area are consuming fish at higher ingestion rates than 12 lbs. per year even during the fish advisory.

We evaluated non-cancer hazard and cancer risk using a range of exposure assumptions and fish tissue concentrations to characterize the boundaries of the potential hazards and risks across the population consuming fish at the Site.

Subchronic hazards were estimated to make sure that we did not underestimate potential risks associated with short-term exposures (e.g., during a single year of dredging). We assessed the potential risk to a 2 to 3 year old child a sensitive receptor using fish tissue concentrations from the year with the highest fish concentration.

3.3.5 Uncertainty in Human Health Risk Characterization

Any risk characterization is subject to uncertainties since it combines the potential uncertainties in the data, exposure assumptions and toxicity estimates. Each of these areas has sources of uncertainty that may lead to overestimating or underestimating risk. Therefore, we characterized the range of potential values when data permitted. When data were not available, we applied conservative assumptions in keeping with USEPA default values.

The sections below describe sources of uncertainty for each area of the human health risk assessment and their potential for influencing the point estimates of potential hazards and risks presented in Table 3.6.

3.3.5.1 Data and Modeling Issues

Uncertainties in the environmental data and subsequent modeling are propagated through the exposure point concentrations used in the risk calculations. Thus, they contribute to the total uncertainty in the estimation of potential human health risks. Uncertainty arising from data and modeling issues is discussed in more detail in Section 2.4 and Appendix A and B.

3.3.5.2 Exposure Assumptions

Exposure Duration

Results of a health survey conducted in three counties of the Delta region of Mississippi show that fishing is a lifelong activity (Frate, Appendix G). We used two exposure durations (15 and 45 years for the central estimate and reasonable maximum estimate respectively) to account for the expected number of years a person consumes fish from an Item. These periods reflect the time a person resides in one residence. However, when people move, 67% move within 19 miles of their previous residence (Table 15-171, USEPA, 1997). Given the size of each item, it is possible that people may move to a new residence and still fish from the same location. Thus, the exposure durations used in this risk assessment could underestimate the number of years that a person may fish from the same Item.

We assume that chronic exposure to fish begins when a child is one year old. Assuming that exposures begin as a young child provides a conservative estimate of risk. Potential risks will be lower if people begin consuming fish at ages older than one.

Averaging time

We used gender and race specific averaging times from the US population. If life expectancy is lower in the project area, risks will be underestimated. Conversely, if life expectancy is higher in the project area than the US population, risk will be overestimated. The use of population specific averaging times should decrease uncertainty in the population averaging time as compared to using a default average value of 70 years for all populations considered. The magnitude of the uncertainty from this parameter is likely to be small relative to other parameters.

Ingestion Rate

Using fish consumption data from a recent survey of populations in the Delta region (Frate, 2001) decreased the uncertainty in human population fish consumption rates in comparison to using national average data. In addition, these data permit us to calculate fish consumption rates that incorporate variability across populations by race and gender. This permits better representation of the risks to the populations of concern for this project. One caveat is that this study was conducted in three Delta counties adjacent to the counties in the Big Sunflower River Basin (Figure 3.1). Thus, we must assume that populations in adjacent counties have similar fish consumption habits. The increase in uncertainty contributed from this assumption is expected to be outweighed by the decrease in uncertainty afforded by the region specific information provided by the survey.

Fish Tissue Exposure Concentrations

Differential consumption of various parts of the fish, such as muscle, head, roe, skin, and tail, and food preparation methods will contribute to the accuracy of the fish consumption risk estimates and uncertainty in those estimates. According to an investigation of consumption patterns in the Delta Region of Mississippi, almost all respondents reported eating the meat (muscle) of the fish and a high proportion (60% to 70%) of African-Americans reported eating the skin and tail of the fish. A few African-American respondents (6% to 10%) also reported eating the fish head and roe (eggs). DDD, DDE and DDT accumulate in the fatty portion of fish tissue. Thus, consumption of parts of fish other than muscle is likely to increase exposure to DDT. Potential risk may be underestimated in this risk assessment for populations consuming parts of fish in addition to muscle because fish tissue concentrations represent only muscle.

For all respondents, frying is the most common method of cooking fish, followed by baking and grilling. Therefore, the concentrations of these compounds in fish tissue may be reduced in the cooking process if the compounds transfer to the cooking oil. However, according to the fish consumption study conducted in the Delta region, over three-quarters of the people responding to this survey reported that they cook other food items (e.g., hushpuppies) in the grease used to fry the fish (Appendix G). Thus, foods cooked in the oil after the fish could absorb DDT, DDE and DDD from the oil and serve as a source of exposure.

Removing the skin from the fish fillet (trimming) can also reduce exposure to contaminants in the lipid. However, up to 70% of African-American and up to 35% of Caucasian respondents (male and female) reported eating the skin of the fish. In addition, the fish samples used to estimate fish tissue concentrations of DDT, DDE and DDD for this risk assessment were trimmed before these compounds were measured. Thus, the measured concentrations of COCs may underestimate the exposure concentrations. Therefore, we do not estimate loss of DDD, DDE and DDT due to trimming or cooking in this assessment.

3.3.5.3 Dose-Response

Major sources of uncertainty concerning the toxicity assessment include the extrapolation from high doses in animals to low doses in humans for non-carcinogens and carcinogens, and conservative assumptions built into derivation of RfDs and CSFs. An additional source of uncertainty is the use of chronic RfDs due to the absence of subchronic RfDs. The level of conservative introduced by these uncertainties is unknown.

Uncertainty Due to Missing Toxicity Values

DDE and DDD do not have RfDs on IRIS. Thus for this risk assessment we used the DDT RfD as a surrogate RfD for DDE and DDD. This introduces uncertainty in the non-cancer hazard estimates that may under or over estimate hazard to an unknown extent.

Studies summarized in the ATSDR 2000 Draft Toxicity Profile suggest that the toxicity of DDE and DDD is lower than that of DDT. Thus, using the DDT RfD appears to provide a conservative estimate of hazard. Because DDE concentrations are greater than DDT concentrations in fish tissue and because DDE may be less toxic than DDT, we derived toxicity values for DDE and DDD using the information summarized in ATSDR (2000) and USEPA derivation methods (Barnes and Dourson, 1988). This allows us to evaluate the contribution of the uncertainty in the DDE and DDD potency estimates to the potential non-cancer hazard. The toxicity values presented in Table 3.7 provide for screening level evaluation of possible non-cancer hazard, but please note that these values have not received the extensive review and consideration that is typical for USEPA derived RfDs and should not be interpreted as such.

A detailed description of the derivation is presented in Appendix I.

Table 3.7 Non-Cancer Toxicity Values for DDT, DDE and DDD

Source of Non-Cancer Value	**DDT (mg/kg-day)**	**DDE (mg/kg-day)**	**DDD (mg/kg-day)**
IRIS	5E-4	Use DDT	Use DDT
MCA (Screening Level)	Use IRIS	3E-3	9E-3

The sensitivity analysis calculates the non-cancer hazard for all exposure scenarios using the no dredge EPCs from Items 5 and 8, and the DDT RfD and MCA derived toxicity values as surrogate RfDs for DDE and DDD.

The results of the sensitivity analysis in Table 3.8 show reduced non-cancer hazards when calculated with MCA derived toxicity values as surrogates for DDE and DDD. The magnitude of the decrease in non-cancer hazard suggests that the missing toxicity values for DDE and DDD contribute substantial uncertainty to the hazard estimates.

4.0 REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Draft Toxicological Profile for DDT, DDE, and DDD. U.S. Department of Health and Human Services, Atlanta, GA.

Arkansas' Game Fish – Blue Catfish. Arkansas Game and Fish Commission. 2001. http://www.agfc.com/fishing/gamefish/blue_catfish.html

Barnes, D.G., and M.L. Dourson. 1988. Reference Dose (RfD): Description and Use in Health Risk Assessments. Regulatory Toxicology and Pharmacology, 8:471-486.

Clarke, J.U. and McFarland, VA. 1991. "Assessing bioaccumulation in aquatic organisms exposed to contaminated sediments." Miscellaneous Paper D-91-2. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Cura, J.J., W. Heiger-Bernays, T.S. Bridges, and D.W. Moore. 1998. Ecological and Human Health Risk Assessment Guidance for Aquatic Environments. Dredging Operations and Environmental Research Program. Technical Report DOER-4.

Frate, D.A. 2001. Fish and Wild Game Consumption Patterns in the Delta Region of Mississippi. University of Mississippi Medical Center, Department of Preventive Medicine. Jackson, MS.

i-Bird.com. 2001. Abundant, common and uncommon birds: Yazoo National Wildlife Refuge Complex, Mississippi. 2001. http://www.i-bird.com/Location/MSYazoo.htm

Johnson, D. August 24, 2001. Personal communication with Katherine von Stackelberg of Menzie-Cura & Associates transmitting results of regression analysis to estimate DDE concentrations in fish obtained from Items 1 and 4.

Missouri Department of Conservation. 2001. Endangered Species Guidesheet: Pondberry. http://www.conservation.state.mo.us/nathis/endangered/endanger/pondberr/index.htm

MS delta, 2001. http://www.ymd.org/PDF/Executive_Summary.PDF

Natureserve. 2001. http://www.natureserve.org

Pao, E. M., K. H. Fleming, P. M. Guenther, S.J. Mickle. 1982. Foods commonly eaten by individuals: Amount per day and per eating occasion. Home Economics Research Report Number 44. U.S. Department of Agriculture, Hyattsville, MD.

Peddicord, R.K., Chase, T., Dillon, T., McGrath, J., Munns, W.R., van de Gucthe, K., and van der Schalie, W. 1997. "Workgroup summary report on navigational dredging." Ecological Risk Assessment of Contaminated Sediments. Ingersoll, C.G., Dillon, T. and G.R. Biddinger, ed. SETAC Publication, Pensacola, FL.

Persaud, D., R. Jaagumagi, and A. Hayton. 1993. "Guidelines for the protection and management of aquatic sediment quality in Ontario." Ontario Ministry of the Environment, Department of Water Resources, Toronto.

Sample, B.E., Opresko, D.M., and Suter, G.W. II. 1996. "Toxicological benchmarks for wildlife: 1996 revision," ES/ER/TM-86-R3.

Sigal, L.L., and Suter, G.W. II. 1989. "Potential effects of chemical agents on terrestrial resources," Environmental Professionals, 11, 376-384.

Stephan, C.E. 1993. "Derivation of proposed human health and wildlife bioaccumulation factors for the Great Lakes Initiative," USEPA, Office of Research and Development, Environmental Research Laboratory, Duluth, MN.

Suter, G.W. II, Barnthouse, L.W., Bartell, S. M., Mill, T., Mackey, D., and Paterson, S. 1993. Ecological risk assessment. Lewis Publishers, Chelsea, MI.

Texas Parks & Wildlife: Species Account. 2001. http://www.tpwd.state.tx.us/fish/infish/species/sbf/sbf.htm

Thomann, R.V. 1989. "Bioaccumulation model of organic chemical distribution in aquatic food chains," Environ. Sci. Technol., 23, 699-707.

U. S. Army Corps of Engineers. 2001. http://www.mvk.usace.army.mil/Offices/pp/Projects/Big_Sunflower_Maint/index.htm

U.S. Army Corps of Engineers (USACE). 1996. Final Supplement No. 2 to the Final Environmental Impact Statement. Flood Control, Mississippi River and Tributaries, Yazoo Basin, Mississippi. Big Sunflower River Maintenance Project. Volume I, II, and III.

U. S. Army Corps of Engineers. (USACE). 1995. "Environmental effects of dredging, the automated dredging and disposal alternatives management system (ADDAMS)," Technical Notes EEDP-06-12, Vicksburg, MS.

U.S. Environmental Protecton Agency. (USEPA). 2000a. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment Interim Guidance). Office of Emergency and Remedial Response, Washington, DC.

U. S. Environmental Protection Agency. (USEPA). 2000b. Guidance for Assessing Chemical Contaminant Data for Use in fish Advisories. Volume 2. Risk Assessment and Fish Consumption Limits, Third Edition. Office of Water, Washington, DC. EPA 823-B-00-008.

U. S. Environmental Protection Agency. (USEPA). 2000c. Child-Specific Exposure Factors Handbook. NCEA-W-0853. Office of Research and Development, Washington, DC.

U. S. Environmental Protection Agency. (USEPA). 1999a. "National recommended water quality criteria," EPA/822-Z-99-001. Office of Water, Washington, DC.

U. S. Environmental Protection Agency. (USEPA). 1999b. *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual* Supplemental Guidance *Dermal Risk Assessment, Interim Guidance.* EPA/540/R-99/005. Office of Emergency and Remedial Response, Washington, D.C. PB99-963312.

U. S. Environmental Protection Agency. (USEPA). 1998. "Guidelines for Ecological Risk Assessment. Federal Register, May 14, 1998," 63(93), 26845-26924.

U. S. Environmental Protection Agency. (USEPA). 1997a. "Ecological risk assessment guidance for superfund: Process for designing and conducting ecological risk assessments (interim final). Environmental Response Team, Edison, NJ.

U. S. Environmental Protection Agency. (USEPA). 1997b. "Health effects assessment summary tables (HEAST). EPA/540/R-94/020. Office of solid waste and emergency response.

U. S. Environmental Protection Agency. (USEPA). 1997c. Integrated risk information system database (IRIS).

U. S. Environmental Protection Agency. (USEPA). 1997d. "Exposure Factors Handbook Volume I, General Factors." EPA/600/P-95/002Fa. Washington, DC.

U. S. Environmental Protection Agency. (USEPA). 1997e. "Exposure Factors Handbook Volume II, Food Ingestion Factors." EPA/600/P-95/002Fb Washington, DC.

U. S. Environmental Protection Agency. (USEPA). 1997f. "Exposure Factors Handbook Volume III Activity Factors." EPA/600/P-95/002Fc. Washington, DC.

U. S. Environmental Protection Agency. (USEPA). 1996a. "Estimating Contaminant Losses from Components of Remediation Alternatives for Contaminated Sediments," EPA/905-R96-001. Great Lakes National Program Office, Assessment and Remediation of Contaminated Sediments (ARCS) Program.

U. S. Environmental Protection Agency. (USEPA). 1996c. “Proposed guidelines for ecological risk assessment,” EPA/630/R-95/002b, USEPA Risk Assessment Forum.

U. S. Environmental Protection Agency. (USEPA). 1995. “Exposure factors handbook, review draft,” Office of Research and Development. EPA/600/P-95/002A. Washington, DC.

U. S. Environmental Protection Agency. (USEPA). 1994. “Guidance for the data quality objectives process,” EPA/600R-96/055, USEPA Office of Research and Development, Washington, DC.

U. S. Environmental Protection Agency. (USEPA). 1993. “Wildlife exposure factors handbook, volume 1,” EPA/600/R-93/187a. Office of Research and Development, Washington, D.C.

U. S. Environmental Protection Agency. (USEPA). 1992a. “Framework for ecological risk assessment,” Risk Assessment Forum. EPA/630/R-92/001, Washington, DC.

U. S. Environmental Protection Agency. (USEPA). 1992b. “Consumption surveys for fish and shellfish: A review and analysis of survey methods,” USEPA, Office of Water. EPA/822/R-92-80. Washington, DC.

U. S. Environmental Protection Agency. (USEPA). 1992c. “Final guidelines for exposure assessment,” Federal Register, 57(104).

U. S. Environmental Protection Agency. (USEPA). 1992d. “Supplemental guidance to RAGS: Calculating the concentration term. Office of Emergency and Remedial Response. EPA/9285.7-081, Washington, DC.

U. S. Environmental Protection Agency. (USEPA). 1991a. “Methodology for estimating population exposures from the consumption of chemically contaminated fish,” prepared by Tetra Tech, Inc., Fairfax, VA., for the Offices of Policy, Planning and Evaluation, and Research and Development, EPA/600/9-91/017, Washington, DC.

U. S. Environmental Protection Agency. (USEPA). 1991b. “Human health evaluation manual, supplemental guidance: Standard default exposure factors,” EPA OSWER Directive 9285.6-03, Washington, DC.

U. S. Environmental Protection Agency. (USEPA). 1991c. “Risk assessment guidance for superfund: Volume I - Human health evaluation manual (Part C, risk evaluation of remedial alternatives),” PB92-963334. Washington, DC.

U. S. Environmental Protection Agency. (USEPA). 1989a. “Risk assessment guidance for Superfund: Volume I - Human health evaluation manual (Part A),” Office of Emergency and Remedial Response, EPA/540/1-89/002, Washington, DC.

U. S. Environmental Protection Agency. (USEPA). 1989b. "Assessing Human health risks from chemically contaminated fish and shellfish," Offices of Marine and Estuarine Protection and Water Regulations and Standards, Washington, DC.

U. S. Environmental Protection Agency. (USEPA). 1989c. "Exposure factors handbook," EPA/600/8-89/043. Washington, DC.

U. S. Environmental Protection Agency. (USEPA). 1989d. "Risk assessment guidance for superfund (RAGS): Volume II - Environmental manual, interim final," Washington, DC.

U.S. Environmental Protection Agency. (USEPA). 1986a. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response. EPA/540/1-86/060. (OSWER Directive 9285.4-1).

U. S. Environmental Protection Agency. (USEPA). 1986b. Guidelines for Carcinogenic Risk Assessment. Federal Register, Volume 51, No. 185. September 24, 1986.

U. S. Environmental Protection Agency and United States Army Corps of Engineers. 1998. "Evaluation of dredged material proposed for inland disposal: Testing manual," Washington, DC.

U.S. Fish and Wildlife Service. 2001. Species Accounts: Pondberry. U.S. Fish and Wildlife Service, Division of Endangered Species. http://endangered.fws.gov/i/q/saq3o.html

USDA Forest Service. 2001. Biological Data and Habitat Requirements. USDA Forest Service. http://www.fs.fed.us/database/feis/animals/index.html

USGS, 2001. http://ms.water.usgs.gov/ms_proj/ eric/yazoo.html

Vorhees, D.J., Kane Driscoll, S.B., von Stackelberg, K, and Bridges, T.S. 1998. Improving Dredged Material Management Decisions with Uncertainty Analysis. Technical Report DOER-3. December 1998.

West, P.C., J. M.Fly, R. Marans, and F. Larkin. 1989. Michigan Sport Anglers Fish Consumption Survey. Published as Natural Resource Sociology Research Lab Technical Report #1. University of Michigan, Ann Arbor, MI.

TABLES

Table 1.1 Sources of information for developing conceptual model and exposure scenarios

Organization/ Agency Name	Contact person	Contact information	REMARKS
Yazoo National Wildlife Refuge/ U.S. Fish & Wildlife Service	David Linden, Biologist for Yazoo National Wildlife Refuge (NWR) Complex	662-839-2638	The Yazoo NWR Complex is made up of five National Wildlife Refuges in the Delta region of Mississippi: Yazoo, Panther Swamp, Hillside, Morgan Brake and Matthews Break. Spoke with him about local hunting practices.
Mississippi State University, Department of Wildlife & Fisheries	Don Jackson	662-325-7493 Djackson@cfr. msstate.edu	Spoke to him about home ranges and microhabitat uses for fish species. He also provided information and contact names regarding human exposure pathways in the Delta region.
Mississippi State University, Department of Wildlife & Fisheries	Dr. Richard Kaminski	662-325-2623 Rkaminski@cfr.msstate.edu	Reviewed his papers on the extent of illegal hunting in the Mississippi Flyway. He suggested contacting US FWS Harvest Survey Office for duck harvest statistics.
Brigham Young University, Department of Sociology	Dr. Ralph Brown	801-378-3242 rbb44@email.byu.edu	When at Mississippi State University, did work on subsistence activity in the Delta region. Reviewed one of his papers on this subject.
University of Mississippi Medical Center, Department of Preventive Medicine	Dr. Dennis Frate	601-984-1935 dfrate@prevmed. umsmed.edu	Worked with him to design survey questions for fish and wildlife game consumption study in the Delta region of Mississippi. Called him several times regarding local fishing practices.
Mississippi Department of Wildlife, Fisheries & Parks	Representative	Contact Mahannah Wildlife Office	Associated with Mahannah Wildlife Area as well.

Organization/ Agency Name	**Contact person**	**Contact information**	**REMARKS**
US FWS, Division of Migratory Bird Management, Harvest Survey	Dr. Paul Padding	301-497-5982	Spoke to him about number of ducks bagged per hunter and number of hunting trips per season for Mississippi hunters.
US Army Corps of Engineers, Vicksburg District	Dave Johnson	Dave.R.Johnson@mvk02.usace.army.mil, (601) 631-7221	Technical contact at District for data etc.
US Army Corps of Engineers, WES	Paul Schroeder	Paul.R.Schroeder@erdc.usace.army.mil	WES fate and transport modeler
US Army Corps of Engineers, WES	Gui Lotufo	Guilherme.R.Lotufo@erdc.usace.army.mil, (601) 634-4103	Eco effects assessment, TRV development

Table 1.2 Data Summary Table
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

Item (and Species, if applicable)	Number of Samples (#)	% Detects (%)	Minimum (ug/kg)	Maximum (ug/kg)	Average (ug/kg)	Standard Deviation (ug/kg)
		<<<< ------------ DDD -------------->>>>				
Item 1	8	100%	4.1	75.0	23.8	24.5
Item 2	5	100%	20.0	35.0	28.8	7.3
Item 5	3	67%	15.0	70.0	46.3	28.3
Item 6	4	100%	2.6	21.0	10.1	7.8
Item 7	2	100%	27.0	31.0	29.0	2.8
Item 8	3	100%	29.0	140.0	103.0	64.1
Item 10	1	100%	6.5	6.5	6.5	NA
		<<<< ------------ WATER -------------->>>>				
	(#)	(%)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Item 1	8	0%	0.006	0.075	0.032	0.023
Item 2	5	0%	0.021	0.023	0.022	0.001
Item 5	3	0%	0.011	0.030	0.020	0.013
Item 6	4	0%	0.017	0.038	0.027	0.009
Item 7	2	100%	0.180	0.190	0.185	0.007
Item 8	3	100%	0.180	0.250	0.203	0.040
Item 10	1	100%	0.012	0.012	0.012	NA
		<<<< ------------ FISH -------------->>>>				
	(#)	(%)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Item 1 Buffalofish	14	100%	0.04	1.61	0.50	0.47
Item 1 Blue catfish	5	100%	0.05	0.79	0.27	0.30
Item 1 Gar	5	100%	0.29	0.46	0.36	0.07
Item 4 Buffalofish	1	100%	0.91	0.91	0.91	NA
Item 4 Blue catfish	4	100%	0.05	0.25	0.14	0.09
Item 4 Gar	3	100%	0.29	3.76	1.45	2.00
Item 5 Buffalofish	13	100%	0.04	1.61	0.41	0.47
Item 5 Gar	2	100%	0.38	0.46	0.42	0.06
Item 6 Buffalofish	11	100%	0.05	2.91	0.94	1.05
Item 6 Flathead catfish	5	100%	0.11	0.58	0.37	0.20
Item 6 Gar	5	100%	0.45	2.80	1.61	1.18
Item 7 Flathead catfish	3	100%	0.03	0.41	0.17	0.21
Item 8 Flathead catfish	1	100%	0.36	0.36	0.36	NA
Item 10 Buffalofish	5	100%	0.05	0.74	0.47	0.32
Item 10 Flathead catfish	3	100%	0.11	0.25	0.16	0.08
Item 10 Gar	4	100%	0.44	3.13	1.74	1.10

Table 1.2 Data Summary Table
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

Item (and Species, if applicable)	Number of Samples (#)	% Detects (%)	Minimum (ug/kg)	Maximum (ug/kg)	Average (ug/kg)	Standard Deviation (ug/kg)
		<<<< ------------ DDE -------------->>>>				
Item 1	8	100%	2.9	52.0	20.6	17.3
Item 2	5	100%	31.0	57.0	43.0	10.4
Item 5	3	67%	2.6	58.0	27.9	28.0
Item 6	4	100%	2.5	25.0	10.0	10.2
Item 7	2	100%	42.0	48.0	45.0	4.2
Item 8	3	100%	80.0	360.0	246.7	147.4
Item 10	1	100%	7.0	7.0	7.0	NA
		<<<< ------------ WATER -------------->>>>				
	(#)	(%)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Item 1	8	100%	0.008	0.018	0.013	0.004
Item 2	5	100%	0.015	0.018	0.017	0.002
Item 5	3	100%	0.007	0.008	0.008	0.001
Item 6	4	100%	0.008	0.028	0.013	0.010
Item 7	2	100%	0.260	0.270	0.265	0.007
Item 8	3	100%	0.250	0.390	0.300	0.078
Item 10	1	100%	0.008	0.008	0.008	NA
		<<<< ------------ FISH -------------->>>>				
	(#)	(%)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Item 1 Buffalofish	14	0%	0.22	4.31	1.14	1.19
Item 1 Blue catfish	5	0%	0.38	1.55	0.72	0.48
Item 1 Gar	5	0%	1.32	1.62	1.44	0.12
Item 4 Buffalofish	1	0%	1.39	1.39	1.39	NA
Item 4 Blue catfish	4	0%	0.38	0.70	0.52	0.14
Item 4 Gar	3	0%	1.32	1.47	1.38	0.08
Item 5 Buffalofish	13	100%	0.22	4.31	1.12	1.24
Item 5 Gar	2	100%	1.47	1.62	1.55	0.10
Item 6 Buffalofish	11	100%	0.36	7.83	2.80	2.86
Item 6 Flathead catfish	5	100%	0.29	1.09	0.81	0.33
Item 6 Gar	5	100%	0.79	7.35	4.31	3.32
Item 7 Flathead catfish	3	100%	0.08	0.79	0.34	0.39
Item 8 Flathead catfish	1	100%	1.24	1.24	1.24	NA
Item 10 Buffalofish	5	100%	0.36	1.49	1.03	0.43
Item 10 Flathead catfish	3	100%	0.29	1.12	0.59	0.46
Item 10 Gar	4	100%	1.72	5.25	3.78	1.64

Table 1.2 Data Summary Table
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

Item (and Species, if applicable)	Number of Samples (#)	% Detects (%)	Minimum (ug/kg)	Maximum (ug/kg)	Average (ug/kg)	Standard Deviation (ug/kg)
		<<<< ------------ DDT -------------->>>>				
Item 1	8	100%	1.4	30.0	10.6	10.3
Item 2	5	100%	1.2	22.0	10.9	7.6
Item 5	3	100%	7.6	19.0	12.5	5.9
Item 6	4	100%	2.3	9.6	4.6	3.4
Item 7	2	100%	6.2	9.6	7.9	2.4
Item 8	3	100%	6.8	50.0	23.6	23.1
Item 10	1	100%	1.8	1.8	1.8	NA
		<<<< ------------ WATER -------------->>>>				
	(#)	(%)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Item 1	8	100%	0.017	0.032	0.027	0.005
Item 2	5	100%	0.023	0.034	0.029	0.008
Item 5	3	100%	0.022	0.031	0.027	0.006
Item 6	4	100%	0.011	0.029	0.023	0.009
Item 7	2	100%	0.036	0.061	0.049	0.018
Item 8	3	100%	0.007	0.390	0.151	0.209
Item 10	1	100%	0.024	0.024	0.024	NA
		<<<< ------------ FISH -------------->>>>				
	(#)	(%)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Item 1 Buffalofish	14	100%	0.01	0.86	0.20	0.24
Item 1 Blue catfish	5	100%	0.00	0.20	0.06	0.08
Item 1 Gar	5	100%	0.05	0.11	0.09	0.03
Item 4 Buffalofish	1	100%	0.50	0.50	0.50	NA
Item 4 Blue catfish	4	100%	0.00	0.04	0.02	0.02
Item 4 Gar	3	100%	0.05	0.11	0.08	0.03
Item 5 Buffalofish	13	100%	0.01	0.86	0.18	0.23
Item 5 Gar	2	100%	0.07	0.11	0.09	0.03
Item 6 Buffalofish	11	100%	0.04	1.65	0.75	0.71
Item 6 Flathead catfish	5	100%	0.05	0.21	0.13	0.08
Item 6 Gar	5	100%	0.17	0.98	0.57	0.41
Item 7 Flathead catfish	3	100%	0.01	0.08	0.05	0.05
Item 8 Flathead catfish	1	100%	0.09	0.09	0.09	NA
Item 10 Buffalofish	5	100%	0.04	0.47	0.29	0.19
Item 10 Flathead catfish	3	100%	0.05	0.10	0.07	0.03
Item 10 Gar	4	100%	0.33	0.99	0.66	0.28

Table 1.3 Measured Surface Water Concentrations
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

River	Station	Sample Date	Item	DDD ug/L	Estimated Total DDD ug/L	DDE ug/L	Estimated Total DDE ug/L	DDT ug/L	EstimatedTotal DDT ug/L
Big Sunflower	BS-7	28-Jan-93	1	-0.110	**0.029**	0.018	**0.018**	0.028	**0.028**
Big Sunflower	BS-12	28-Jan-93	1	-0.110	**0.022**	0.008	**0.008**	0.029	**0.029**
Big Sunflower	BS-18	28-Jan-93	1	-0.110	**0.024**	0.009	**0.009**	0.032	**0.032**
Big Sunflower	BS-19	28-Jan-93	1	-0.110	**0.033**	0.015	**0.015**	0.028	**0.028**
Big Sunflower	BS-24	28-Jan-93	1	-0.110	**0.075**	0.014	**0.014**	0.028	**0.028**
Big Sunflower	BS-33	28-Jan-93	1	-0.110	**0.006**	0.015	**0.015**	0.017	**0.017**
Little Sunflower	LS-12	28-Jan-93	2	-0.110	**0.023**	0.015	**0.015**	0.023	**0.023**
Little Sunflower	LS-17	11-Feb-93	2	-0.110	**0.021**	0.018	**0.018**	0.034	**0.034**
Big Sunflower	BS-45	28-Jan-93	5	-0.110	**0.030**	0.007	**0.007**	0.031	**0.031**
Big Sunflower	BS-50	28-Jan-93	5	-0.110	**0.011**	0.008	**0.008**	0.022	**0.022**
Big Sunflower	BS-55	28-Jan-93	6	-0.110	**0.029**	0.008	**0.008**	0.027	**0.027**
Big Sunflower	BS-60	28-Jan-93	6	-0.110	**0.038**	0.009	**0.009**	0.029	**0.029**
Big Sunflower	BS-65	28-Jan-93	6	-0.110	**0.017**	0.009	**0.009**	0.027	**0.027**
Big Sunflower	BS-70	28-Jan-93	6	-0.110	**0.024**	0.028	**0.028**	-0.120	**0.011**
Bogue Phalia	BP-0	28-Jan-93	7	0.190	**0.190**	0.270	**0.270**	0.000	**0.036**
Bogue Phalia	BP-6	16-Jun-93	7	0.180	**0.180**	0.260	**0.260**	0.000	**0.061**
Bogue Phalia	BP-12	16-Jun-93	8	0.180	**0.180**	0.260	**0.260**	0.000	**0.007**
Bogue Phalia	BP-18	16-Jun-93	8	0.180	**0.180**	0.250	**0.250**	-0.120	**0.055**
Bogue Phalia	BP-11	16-Jun-93	8	0.250	**0.250**	0.390	**0.390**	0.390	**0.390**
Big Sunflower	BS-75	28-Jan-93	10	-0.110	**0.012**	0.008	**0.008**	0.024	**0.024**

"-" indicates concentration reported as a non-detect
Rationale for DDD estimated concentrations presented in Appendix A.

Table 1.4 Measured Sediment Concentrations
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

River	Station	Sample Date	Item	DDD (mg/kg)	DDE (mg/kg)	DDT (mg/kg)	TOC	%FINES
Big Sunflower	BS-7	28-Jan-93	1	46.00	52.00	20.00	14349	1.4349
Big Sunflower	BS-12	28-Jan-93	1	11.00	9.60	8.80	9088	0.9088
Big Sunflower	BS-18	28-Jan-93	1	22.00	32.00	4.90	10288	1.0288
Big Sunflower	BS-19	28-Jan-93	1	11.00	13.00	1.40	6025	0.6025
Big Sunflower	BS-24	28-Jan-93	1	75.00	12.00	30.00	9282	0.9282
Big Sunflower	BS-33	28-Jan-93	1	10.00	36.00	15.00	4079	0.4079
Big Sunflower	RM 7	21-Aug-95	1	11	7	2.5	2568	0.2568
Big Sunflower	RM 12	21-Aug-95	1	4.1	2.9	2.3	1191	0.1191
Little Sunflower	LS-8	28-Jan-93	2	35	44	13	18496	1.8496
Little Sunflower	LS-12	28-Jan-93	2	35	48	9.5	15575	1.5575
Little Sunflower	LS-17	11-Feb-93	2	32	57	22	14538	1.4538
Little Sunflower	RM 8	21-Aug-95	2	22	31	8.7	8727	0.8727
Little Sunflower	RM 12	21-Aug-95	2	20	35	1.2	10604	1.0604
Big Sunflower	BS-39	28-Jan-93	5	-140.00	-5.10	7.60	15500	1.55
Big Sunflower	BS-45	29-Jan-93	5	54	58	11	13389	1.3389
Big Sunflower	BS-50	29-Jan-93	5	15	23	19	11644	1.1644
Big Sunflower	BS-55	29-Jan-93	6	8.2	6.2	3.6	4462	0.4462
Big Sunflower	BS-60	29-Jan-93	6	8.5	6.1	2.3	2524	0.2524
Big Sunflower	BS-65	29-Jan-93	6	2.6	2.5	2.8	2285	0.2285
Big Sunflower	BS-70	29-Jan-93	6	21	25	9.6	13495	1.3495
Big Sunflower	BP-0	16-Jun-93	6	31	48	6.2	.	
Bogue Phalia	BP-12	16-Jun-93	8	140	300	6.8	.	87.40
Bogue Phalia	BP-18	16-Jun-93	8	29	80	14	.	54.60
Bogue Phalia	BP-11	16-Jun-93	8	140	360	50	.	87.00
Big Sunflower	BS-80	29-Jan-93	10	6.5	7	1.8	2279	0.2279

"-" indicates concentration reported as a non-detect

Table 1.5 Measured Fish Concentrations
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

Species	SampleDate	Item	SampleType	Length	Length Units	Weight (Lbs)	Percent Lipid	DDD (mg/kg)	DDE (mg/kg)	DDT (mg/kg)
Bigmouth Buffalo	19-Oct-93	1	FISHTIS	530	mm	4.8841	0.4	0.205	0.945	0.307
Bigmouth Buffalo	19-Oct-93	1	FISHTIS	524	mm	4.7515	1	0.112	0.333	0.066
Bigmouth Buffalo	19-Oct-93	1	FISHTIS	403	mm	2.1879	1.1	0.376	0.333	0.066
Bigmouth Buffalo	19-Oct-93	1	FISHTIS	518	mm	5.2598	2	0.181	0.556	0.154
Bigmouth Buffalo	19-Oct-93	1	FISHTIS	427	mm	8.7737	0.4	0.038	0.218	0.021
Smallmouth Buffalo	19-Oct-93	1	FISHTIS	340	mm	1.326	0.9	0.053	0.23	0.012
Smallmouth Buffalo	19-Oct-93	1	FISHTIS	465	mm	2.8288	0.4	0.83	0.30846	0.011
Smallmouth Buffalo	19-Oct-93	1	FISHTIS	571	mm	6.7626	7.8	0.998	2.706	0.276
Smallmouth Buffalo	19-Oct-93	1	FISHTIS	400	mm	2.1216	1.2	0.173	0.544	0.149
Smallmouth Buffalo	19-Oct-93	1	FISHTIS	451	mm	2.7625	6	1.61	4.309	0.859
Smallmouth Buffalo	19-Oct-93	1	FISHTIS	491	mm	3.1382	1.7	0.737	2.022	0.259
Smallmouth Buffalo	19-Oct-93	1	FISHTIS	380	mm	1.8122	0.2	0.128	0.426	0.041
Smallmouth Buffalo	19-Oct-93	1	FISHTIS	396	mm	2.1216	4.8	0.597	1.655	0.088
SmallmouthBuffalo	19-Oct-93	1	Fillet	460	mm	3	1.5	0.912	1.388	0.495
Blue Catfish	19-Oct-93	1	FISHTIS	625	mm	6.0112	3.4	0.788	1.548	0.198
BlueCatfish	19-Oct-93	1	Fillet	512	mm	2.13	2.8	0.05	0.376	0.0015
BlueCatfish	19-Oct-93	1	Fillet	435	mm	1.31	0.4	0.16	0.551	0.031
BlueCatfish	19-Oct-93	1	Fillet	426	mm	1.56	0.4	0.09	0.44	0.007
BlueCatfish	19-Oct-93	1	Fillet	430	mm	1.38	1	0.252	0.697	0.042
Gar	19-Oct-93	1	Fillet	502	mm	1.25	1.9	0.301	1.338	0.054
Gar	19-Oct-93	1	Fillet	630	mm	2.94	3.2	0.291	1.32	0.085
Gar	19-Oct-93	1	Fillet	505	mm	1.38	1.8	0.376	1.474064	0.112
Shortnose Gar	19-Oct-93	1	FISHTIS	605	mm	2.2542	3.8	0.376	1.474	0.069
Shortnose Gar	19-Oct-93	1	FISHTIS	603	mm	2.0111	7.8	0.455	1.617	0.113
Blue Catfish	19-Oct-93	4	FISHTIS	435	mm	1.326	0.4	0.16	0.551	0.031
Blue Catfish	19-Oct-93	4	FISHTIS	426	mm	1.5691	0.4	0.09	0.449	0.007
Blue Catfish	19-Oct-93	4	FISHTIS	512	mm	2.1216	2.8	0.05	0.376	0.0015
Blue Catfish	19-Oct-93	4	FISHTIS	430	mm	1.3702	1	0.252	0.697	0.042
Shortnose Gar	19-Oct-93	4	FISHTIS	505	mm	1.3702	1.8	3.76	1.474064	0.112
Shortnose Gar	19-Oct-93	4	FISHTIS	502	mm	1.2597	1.9	0.301	1.338	0.054
Shortnose Gar	19-Oct-93	4	FISHTIS	630	mm	3.0719	3.2	0.291	1.32	0.085
Smallmouth Buffalo	19-Oct-93	4	FISHTIS	460	mm	3.0056	1.5	0.912	1.388	0.495
BigmouthBuffalo	19-Oct-93	5	Fillet	403	mm	2.19	1.1	0.376	0.333	0.066

Table 1.5 Measured Fish Concentrations
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

Species	SampleDate	Item	SampleType	Length	Length Units	Weight (Lbs)	Percent Lipid	DDD (mg/kg)	DDE (mg/kg)	DDT (mg/kg)
BigmouthBuffalo	19-Oct-93	5	Fillet	518	mm	5.25	2	0.181	0.556	0.154
BigmouthBuffalo	19-Oct-93	5	Fillet	530	mm	4.88	0.4	0.205	0.945	0.307
BigmouthBuffalo	19-Oct-93	5	Fillet	524	mm	4.75	1	0.112	0.333	0.066
BigmouthBuffalo	19-Oct-93	5	Fillet	427	mm	2.56	0.4	0.038	0.218	0.021
SmallmouthBuffalo	19-Oct-93	5	Fillet	571	mm	6.75	7.8	0.998	2.706	0.276
SmallmouthBuffalo	19-Oct-93	5	Fillet	340	mm	1.31	0.9	0.053	0.23	0.012
SmallmouthBuffalo	19-Oct-93	5	Fillet	491	mm	3.12	1.7	0.737	2.022	0.259
SmallmouthBuffalo	19-Oct-93	5	Fillet	396	mm	2.13	4.8	0.597	1.655	0.088
SmallmouthBuffalo	19-Oct-93	5	Fillet	380	mm	2.81	0.2	0.128	0.426	0.041
SmallmouthBuffalo	19-Oct-93	5	Fillet	400	mm	2.13	1.2	0.173	0.544	0.149
SmallmouthBuffalo	19-Oct-93	5	Fillet	451	mm	2.75	6	1.61	4.309	0.859
SmallmouthBuffalo	19-Oct-93	5	Fillet	465	mm	2.81	0.4	0.083	0.30846	0.011
BigmouthBuffalo	1-Jun-00	5	Flesh	18.1102368	inches	3.939594356				
BigmouthBuffalo	1-Jun-00	5	Flesh	21.181103	inches	6.060405644				
Blu Catfish	1-Jun-00	5	Flesh	22.2834653	inches	4.309964727				
BlueCatfish	19-Oct-93	5	Fillet	625	mm	6	3.4	0.788	1.548	0.198
BlueCatfish	4-Sep-97	5	Whole	19	inches	2	2.2	0.78	2.7	0.31
BlueCatfish	1-Jun-00	5	Flesh	24.8031504	inches	6.529982363				
BlueCatfish	4-Sep-97	5	Fillet	27	inches	6.75	7.8	1.8	2.9	0.63
BlueCatfish	4-Sep-97	5	Whole	20	inches	3.25	3.9	0.86	2.2	0.32
BlueCatfish	4-Sep-97	5	Whole	21	inches	3.375	14.2	5.3	7.3	2.1
BlueCatfish	4-Sep-97	5	Whole	17	inches	1.5				
BlueCatfish	4-Sep-97	5	Whole	20	inches	3	11.6	1.4	1.8	0.71
BlueCatfish	4-Sep-97	5	Fillet	21	inches	2.75	0.42	0.08	0.22	0.02
BlueCatfish	4-Sep-97	5	Whole	21	inches	2.75	2.2	0.54	1.4	0.21
BlueCatfish	4-Sep-97	5	Whole	20	inches	2.75	1.9	0.36	0.55	0.16
BlueCatfish	4-Sep-97	5	Whole	19	inches	2.875	11.6	2.6	5	0.75
BlueCatfish	4-Sep-97	5	Whole	19	inches	2	7.2	1.2	1.4	0.45
BlueCatfish	4-Sep-97	5	Fillet	17	inches	1.5	1.5	0.23	0.8	0.08
BlueCatfish	4-Sep-97	5	Whole	18	inches	2	7.3	1.3	2.4	0.53
BlueCatfish	4-Sep-97	5	Whole	17	inches	1.75	7.1	0.88	1.2	0.26
BlueCatfish	4-Sep-97	5	Whole	24	inches	4.75	7.7	1.3	2	0.52
BlueCatfish	4-Sep-97	5	Whole	27	inches	6.75	11	3.1	4.6	1.1

Table 1.5 Measured Fish Concentrations
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

Species	SampleDate	Item	SampleType	Length	Length Units	Weight (Lbs)	Percent Lipid	DDD (mg/kg)	DDE (mg/kg)	DDT (mg/kg)
CommonCarp	1-Jun-00	5	Flesh	16.732284	inches	2.46031746				
Gar	19-Oct-93	5	Fillet	603	mm	22	7.8	0.455	1.617	0.113
Gar	19-Oct-93	5	Fillet	605	mm	2.25	3.8	0.376	1.474	0.069
GizzardShad	1-Jun-00	5	Flesh	14.4488194	inches	1.199294533				
ShortnoseGar	1-Jun-00	5	Flesh	20.6299219	inches	1.060405644				
SmallmouthBuffalo	1-Jun-00	5	Flesh	15.4724414	inches	2.100970018				
SmallmouthBuffalo	1-Jun-00	5	Flesh	15.1574808	inches	2.096560847				
Bigmouth Buffalo	12-Oct-94	6	FISHTIS	591	mm	8.12	1.7	1.22	4.37	1.65
Bigmouth Buffalo	12-Oct-94	6	FISHTIS	601	mm	10	2.7	0.2	0.48	0.16
Bigmouth Buffalo	12-Oct-94	6	FISHTIS	579	mm	7.9	0.3	0.29	1.17	0.29
Bigmouth Buffalo	18-Sep-94	6	FISHTIS	629	mm	9.8	3.3	0.6	1.05	0.4
BigmouthBuffalo	12-Oct-94	6	Fillet	601	mm	10	2.7	0.2	0.48	0.16
BigmouthBuffalo	12-Oct-94	6	Fillet	591	mm	8.12	1.7	1.22	4.37	1.65
BigmouthBuffalo	12-Oct-94	6	Fillet	579	mm	7.9	0.3	0.29	1.17	0.29
Smallmouth Buffalo	2-Nov-94	6	FISHTIS	510	mm	4.8	5.2	2.91	7.83	1.63
Smallmouth Buffalo	18-Sep-94	6	FISHTIS	458	mm	3.4	0.3	0.048	0.36	0.039
Smallmouth Buffalo	18-Sep-94	6	FISHTIS	460	mm	3.4	1.2	0.44	1.72	0.33
SmallmouthBuffalo	2-Nov-94	6	Fillet	510	mm	4.8	5.2	2.91	7.83	1.63
Flathead Catfish	14-Sep-94	6	FISHTIS	669	mm	6.5	0.2	0.11	0.29	0.053
Flathead Catfish	19-Sep-94	6	FISHTIS	720	mm	8.6	0.5	0.3	0.79	0.082
Flathead Catfish	19-Sep-94	6	FISHTIS	700	mm	11	0.5	0.58	1.09	0.21
FlatheadCatfish	19-Sep-94	6	Fillet	720	mm	8.6	0.5	0.3	0.79	0.082
FlatheadCatfish	19-Sep-94	6	Fillet	700	mm	11	0.5	0.58	1.09	0.21
Gar	12-Oct-94	6	Fillet	760	mm	3.4	3.1	2.8	7.35	0.98
Gar	12-Oct-94	6	Fillet	698	mm	2.8	5	0.45	0.79	0.17
Shortnose Gar	12-Oct-94	6	FISHTIS	698	mm	2.8	5	0.45	0.79	0.17
Shortnose Gar	12-Oct-94	6	FISHTIS	760	mm	3.4	3.1	2.8	7.35	0.98
Shortnose Gar	18-Sep-94	6	FISHTIS	640	mm	1.9	3.3	1.57	5.25	0.56
Paddlefish	2-Nov-94	6	FISHTIS	1260	mm	8.9	5.4	0.29	0.52	0.055
Paddlefish	2-Nov-94	6	FISHTIS	1410	mm	20.1	6.2	1.39	2.28	0.29
Paddlefish	2-Nov-94	6	FISHTIS	1240	mm	17.2	11.6	0.92	1.57	0.17
Paddlefish	2-Nov-94	6	FISHTIS	1276	mm	18.11	6	0.75	1.28	0.15
PaddleFish	2-Nov-94	6	Fillet	1260	mm	8.9	5.4	0.29	0.52	0.055

Table 1.5 Measured Fish Concentrations
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

Species	SampleDate	Item	SampleType	Length	Length Units	Weight (Lbs)	Percent Lipid	DDD (mg/kg)	DDE (mg/kg)	DDT (mg/kg)
Paddlefish	2-Nov-94	6	FISHTIS	1287	mm	18	5.7	0.84	1.23	0.3
PaddleFish	2-Nov-94	6	Fillet	1240	mm	17.2	11.6	0.92	1.57	0.17
PaddleFish	2-Nov-94	6	Fillet	1276	mm	18.11	6	0.75	1.28	0.15
PaddleFish	2-Nov-94	6	Fillet	1287	mm	18	5.7	0.84	1.23	0.3
PaddleFish	2-Nov-94	6	Fillet	1410	mm	20.1	6.2	1.39	2.28	0.29
FlatheadCatfish	10-Dec-93	7	Fillet				3.04	0.41	0.79	0.08
FlatheadCatfish	10-Dec-93	7	Whole				0.5	0.07	0.15	0.01
FlatheadCatfish	10-Dec-93	7	Fillet				0.55	0.03	0.08	
Bass	10-Dec-93	8	Fillet				0.03	0.03	0.09	0.01
FlatheadCatfish	10-Dec-93	8	Fillet				8.07	0.36	1.24	0.09
Carp	22-Aug-95	9	Whole					0.85	5	0.087
Carp	22-Aug-95	9	Whole					0.68	5.1	0.52
Bigmouth Buffalo	10-Sep-94	10	FISHTIS	570	mm	6.14	3.7	0.73	1.31	0.47
BigmouthBuffalo	18-Sep-94	10	Fillet	629	mm	9.8	3.3	0.6	1.05	0.4
Smallmouth Buffalo	16-Sep-94	10	FISHTIS	408	mm	2.4	1	0.22	0.95	0.14
Smallmouth Buffalo	16-Sep-94	10	FISHTIS	400	mm	1.4	2.8	0.74	1.49	0.39
SmallmouthBuffalo	18-Sep-94	10	Fillet	458	mm	3.4	0.3	0.048	0.36	0.039
Flathead Catfish	16-Sep-94	10	FISHTIS	641	mm	5.12	0.5	0.13	0.37	0.051
Flathead Catfish	19-Sep-94	10	FISHTIS	703	mm	7.5	0.4	0.25	1.12	0.098
FlatheadCatfish	14-Sep-94	10	Fillet	669	mm	6.5	0.2	0.11	0.29	0.053
Gar	18-Sep-94	10	Fillet	640	mm	1.9	3.3	1.57	5.25	0.56
Gar	18-Sep-94	10	Fillet	460	mm	3.4	1.2	0.44	1.72	0.33
Shortnose Gar	18-Sep-94	10	FISHTIS	840	mm	6.4	6.3	1.8	3.19	0.76
Shortnose Gar	18-Sep-94	10	FISHTIS	800	mm	4.12	6.7	3.13	4.94	0.99

Table 2.1. Body Burden Comparison Summary
Aquatic Invertebrates
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

Item Number	Dredge Type	Aquatic Invertebrates			
		Annual Average		95th Percentile	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	0.4	0.3	1	0.8
Item 2	Hydraulic	0.2	0.1	0.3	0.2
Item 5	Hydraulic	0.2	0.1	0.5	0.4
Item 6	Hydraulic	0.2	0.2	0.6	0.4
Item 7	Dragline	0.3	0.1	0.8	0.4
Item 8	Dragline	6	4	18	13
Item 10	Hydraulic	2	0.2	3	0.5
Dredging Scenario					
Item 1	Hydraulic	0.3	0.3	0.9	0.8
Item 2	Hydraulic	0.1	0.001	0.2	0.004
Item 5	Hydraulic	0.2	0.1	0.4	0.2
Item 6	Hydraulic	0.2	0.1	0.4	0.3
Item 7	Dragline	0.3	0.1	0.9	0.5
Item 8	Dragline	6	4	18	13
Item 10	Hydraulic	1	0.03	2	0.1

Table 2.2. Body Burden Comparison Summary
Mosquitofish
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

Item Number	Dredge Type	Mosquitofish (Annual Average Body Burden)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	0.3	0.2	0.03	0.02
Item 2	Hydraulic	0.1	0.1	0.01	0.01
Item 5	Hydraulic	0.2	0.1	0.02	0.01
Item 6	Hydraulic	0.2	0.1	0.02	0.01
Item 7	Dragline	0.3	0.1	0.03	0.01
Item 8	Dragline	3	2	0.3	0.2
Item 10	Hydraulic	1	0.4	0.1	0.04
Dredging Scenario					
Item 1	Hydraulic	0.2	0.2	0.02	0.02
Item 2	Hydraulic	0.1	0.04	0.01	0.004
Item 5	Hydraulic	0.2	0.1	0.02	0.01
Item 6	Hydraulic	0.2	0.1	0.02	0.01
Item 7	Dragline	0.3	0.1	0.03	0.01
Item 8	Dragline	3	2	0.3	0.2
Item 10	Hydraulic	0.8	0.2	0.08	0.02

Item Number	Dredge Type	Mosquitofish (95th Percentile Body Burden)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	0.4	0.3	0.04	0.03
Item 2	Hydraulic	0.2	0.1	0.02	0.01
Item 5	Hydraulic	0.3	0.2	0.03	0.02
Item 6	Hydraulic	0.3	0.2	0.03	0.02
Item 7	Dragline	0.4	0.2	0.04	0.02
Item 8	Dragline	6	4	0.6	0.4
Item 10	Hydraulic	1	0.6	0.1	0.06
Dredging Scenario					
Item 1	Hydraulic	0.3	0.3	0.03	0.03
Item 2	Hydraulic	0.2	0.1	0.02	0.01
Item 5	Hydraulic	0.3	0.1	0.03	0.01
Item 6	Hydraulic	0.3	0.2	0.03	0.02
Item 7	Dragline	0.4	0.2	0.04	0.02
Item 8	Dragline	6	4	0.6	0.4
Item 10	Hydraulic	1	0.2	0.1	0.02

Table 2.3. Body Burden Comparison Summary
Buffalofish
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

Item Number	Dredge Type	Buffalofish (Annual Average Body Burden)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	0.5	0.3	0.05	0.03
Item 2	Hydraulic	0.2	0.1	0.02	0.01
Item 5	Hydraulic	0.3	0.2	0.03	0.02
Item 6	Hydraulic	0.3	0.2	0.03	0.02
Item 7	Dragline	0.3	0.2	0.03	0.02
Item 8	Dragline	5	5	0.5	0.5
Item 10	Hydraulic	2	0.4	0.2	0.04
Dredging Scenario					
Item 1	Hydraulic	0.4	0.3	0.04	0.03
Item 2	Hydraulic	0.2	0.02	0.02	0.002
Item 5	Hydraulic	0.2	0.1	0.02	0.01
Item 6	Hydraulic	0.2	0.1	0.02	0.01
Item 7	Dragline	0.4	0.2	0.04	0.02
Item 8	Dragline	5	5	0.5	0.5
Item 10	Hydraulic	1	0.1	0.1	0.01

Item Number	Dredge Type	Buffalofish (95th Percentile Body Burden)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	0.9	0.6	0.09	0.06
Item 2	Hydraulic	0.3	0.2	0.03	0.02
Item 5	Hydraulic	0.4	0.3	0.04	0.03
Item 6	Hydraulic	0.4	0.3	0.04	0.03
Item 7	Dragline	0.6	0.3	0.06	0.03
Item 8	Dragline	11	8	1	0.8
Item 10	Hydraulic	3	0.5	0.3	0.05
Dredging Scenario					
Item 1	Hydraulic	0.6	0.6	0.06	0.06
Item 2	Hydraulic	0.2	0.02	0.02	0.002
Item 5	Hydraulic	0.4	0.1	0.04	0.01
Item 6	Hydraulic	0.3	0.2	0.03	0.02
Item 7	Dragline	0.7	0.3	0.07	0.03
Item 8	Dragline	11	8	1	0.8
Item 10	Hydraulic	2	0.1	0.2	0.01

Table 2.4. Body Burden Comparison Summary
Blue Catfish
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

Item Number	Dredge Type	Blue Catfish (Annual Average Body Burden)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	0.4	0.3	0.04	0.03
Item 2	Hydraulic	0.2	0.1	0.02	0.01
Item 5	Hydraulic	0.2	0.2	0.02	0.02
Item 6	Hydraulic	0.2	0.2	0.02	0.02
Item 7	Dragline	0.3	0.2	0.03	0.02
Item 8	Dragline	4	4	0.4	0.4
Item 10	Hydraulic	1	0.5	0.1	0.05
Dredging Scenario					
Item 1	Hydraulic	0.3	0.3	0.03	0.03
Item 2	Hydraulic	0.2	0.1	0.02	0.01
Item 5	Hydraulic	0.2	0.1	0.02	0.01
Item 6	Hydraulic	0.2	0.1	0.02	0.01
Item 7	Dragline	0.3	0.2	0.03	0.02
Item 8	Dragline	4	4	0.4	0.4
Item 10	Hydraulic	1	0.2	0.1	0.02

Item Number	Dredge Type	Blue Catfish (95th Percentile Body Burden)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	0.6	0.4	0.06	0.04
Item 2	Hydraulic	0.2	0.2	0.02	0.02
Item 5	Hydraulic	0.3	0.3	0.03	0.03
Item 6	Hydraulic	0.3	0.3	0.03	0.03
Item 7	Dragline	0.5	0.3	0.05	0.03
Item 8	Dragline	8	6	0.8	0.6
Item 10	Hydraulic	2	0.6	0.2	0.06
Dredging Scenario					
Item 1	Hydraulic	0.4	0.4	0.04	0.04
Item 2	Hydraulic	0.2	0.1	0.02	0.01
Item 5	Hydraulic	0.3	0.2	0.03	0.02
Item 6	Hydraulic	0.3	0.2	0.03	0.02
Item 7	Dragline	0.5	0.3	0.05	0.03
Item 8	Dragline	8	6	0.8	0.6
Item 10	Hydraulic	2	0.3	0.2	0.03

Table 2.5. Body Burden Comparison Summary
Flathead Catfish
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

Item Number	Dredge Type	Flathead Catfish (Annual Average Body Burden)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	0.4	0.3	0.04	0.03
Item 2	Hydraulic	0.2	0.1	0.02	0.01
Item 5	Hydraulic	0.2	0.2	0.02	0.02
Item 6	Hydraulic	0.2	0.2	0.02	0.02
Item 7	Dragline	0.3	0.2	0.03	0.02
Item 8	Dragline	4	3	0.4	0.3
Item 10	Hydraulic	1	0.5	0.1	0.05
Dredging Scenario					
Item 1	Hydraulic	0.3	0.2	0.03	0.02
Item 2	Hydraulic	0.2	0.1	0.02	0.01
Item 5	Hydraulic	0.2	0.1	0.02	0.01
Item 6	Hydraulic	0.2	0.1	0.02	0.01
Item 7	Dragline	0.3	0.2	0.03	0.02
Item 8	Dragline	4	3	0.4	0.3
Item 10	Hydraulic	1	0.3	0.1	0.03

Item Number	Dredge Type	Flathead Catfish (95th Percentile Body Burden)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	0.5	0.4	0.05	0.04
Item 2	Hydraulic	0.2	0.2	0.02	0.02
Item 5	Hydraulic	0.3	0.3	0.03	0.03
Item 6	Hydraulic	0.3	0.2	0.03	0.02
Item 7	Dragline	0.5	0.2	0.05	0.02
Item 8	Dragline	6	5	0.6	0.5
Item 10	Hydraulic	2	0.7	0.2	0.07
Dredging Scenario					
Item 1	Hydraulic	0.4	0.3	0.04	0.03
Item 2	Hydraulic	0.2	0.1	0.02	0.01
Item 5	Hydraulic	0.3	0.2	0.03	0.02
Item 6	Hydraulic	0.3	0.2	0.03	0.02
Item 7	Dragline	0.5	0.2	0.05	0.02
Item 8	Dragline	6	5	0.6	0.5
Item 10	Hydraulic	1	0.5	0.1	0.05

Table 2.6. Body Burden Comparison Summary
Shortnose Gar
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

Item Number	Dredge Type	Gar (Annual Average Body Burden)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	0.5	0.3	0.05	0.03
Item 2	Hydraulic	0.3	0.2	0.03	0.02
Item 5	Hydraulic	0.3	0.3	0.03	0.03
Item 6	Hydraulic	0.4	0.3	0.04	0.03
Item 7	Dragline	0.5	0.2	0.05	0.02
Item 8	Dragline	5	4	0.5	0.4
Item 10	Hydraulic	2	0.9	0.2	0.09
Dredging Scenario					
Item 1	Hydraulic	0.4	0.3	0.04	0.03
Item 2	Hydraulic	0.3	0.1	0.03	0.01
Item 5	Hydraulic	0.3	0.2	0.03	0.02
Item 6	Hydraulic	0.4	0.2	0.04	0.02
Item 7	Dragline	0.5	0.2	0.05	0.02
Item 8	Dragline	5	4	0.5	0.4
Item 10	Hydraulic	1	0.5	0.1	0.05

Item Number	Dredge Type	Gar (95th Percentile Body Burden)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	0.6	0.4	0.06	0.04
Item 2	Hydraulic	0.3	0.2	0.03	0.02
Item 5	Hydraulic	0.4	0.3	0.04	0.03
Item 6	Hydraulic	0.4	0.3	0.04	0.03
Item 7	Dragline	0.5	0.3	0.05	0.03
Item 8	Dragline	7	5	0.7	0.5
Item 10	Hydraulic	2	1	0.2	0.1
Dredging Scenario					
Item 1	Hydraulic	0.5	0.4	0.05	0.04
Item 2	Hydraulic	0.3	0.1	0.03	0.01
Item 5	Hydraulic	0.4	0.2	0.04	0.02
Item 6	Hydraulic	0.4	0.2	0.04	0.02
Item 7	Dragline	0.5	0.3	0.05	0.03
Item 8	Dragline	7	5	0.7	0.5
Item 10	Hydraulic	2	0.6	0.2	0.06

Table 2.7. Food Chain Model Risk Summary
Osprey
Annual Average
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

Item Number	Dredge Type	Osprey (Total DDT)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	3	2	0.3	0.2
Item 2	Hydraulic	0.9	0.6	0.09	0.06
Item 5	Hydraulic	1	0.9	0.1	0.09
Item 6	Hydraulic	1	1	0.1	0.1
Item 7	Dragline	2	0.9	0.2	0.1
Item 8	Dragline	24	21	2	2
Item 10	Hydraulic	9	2	0.9	0.2
Dredging Scenario					
Item 1	Hydraulic	2	1	0.2	0.1
Item 2	Hydraulic	0.8	0.07	0.08	0.007
Item 5	Hydraulic	1	0.3	0.1	0.03
Item 6	Hydraulic	1	0.6	0.1	0.06
Item 7	Dragline	2	0.9	0.2	0.1
Item 8	Dragline	23	21	2	2
Item 10	Hydraulic	6	0.3	0.6	0.03

Item Number	Dredge Type	Osprey (DDE)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	1	0.6	0.1	0.06
Item 2	Hydraulic	0.4	0.3	0.04	0.03
Item 5	Hydraulic	0.8	0.5	0.1	0.05
Item 6	Hydraulic	0.5	0.3	0.1	0.03
Item 7	Dragline	0.8	0.5	0.1	0.05
Item 8	Dragline	14	12	1	1
Item 10	Hydraulic	4	0.6	0.4	0.1
Dredging Scenario					
Item 1	Hydraulic	0.8	0.6	0.08	0.06
Item 2	Hydraulic	0.4	0.004	0.04	0.0004
Item 5	Hydraulic	0.6	0.2	0.06	0.02
Item 6	Hydraulic	0.4	0.3	0.04	0.03
Item 7	Dragline	1	0.5	0.1	0.05
Item 8	Dragline	13	12	1	1
Item 10	Hydraulic	3	0.1	0.3	0.01

Table 2.8. Food Chain Model Risk Summary
Osprey
95th Percentile
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

Item Number	Dredge Type	Osprey (Total DDT)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	4	3	0.4	0.3
Item 2	Hydraulic	1	0.9	0.1	0.1
Item 5	Hydraulic	2	2	0.2	0.2
Item 6	Hydraulic	2	2	0.2	0.2
Item 7	Dragline	3	2	0.3	0.2
Item 8	Dragline	52	39	5	4
Item 10	Hydraulic	12	2	1	0.2
Dredging Scenario					
Item 1	Hydraulic	3	3	0.3	0.3
Item 2	Hydraulic	1	0.1	0.1	0.01
Item 5	Hydraulic	2	0.6	0.2	0.1
Item 6	Hydraulic	2	0.9	0.2	0.09
Item 7	Dragline	3	2	0.3	0.2
Item 8	Dragline	52	39	5	4
Item 10	Hydraulic	9	0.6	0.9	0.06

Item Number	Dredge Type	Osprey (DDE)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	2	0.9	0.2	0.1
Item 2	Hydraulic	0.6	0.4	0.1	0.04
Item 5	Hydraulic	1	0.8	0.1	0.1
Item 6	Hydraulic	0.7	0.5	0.1	0.05
Item 7	Dragline	2	0.9	0.2	0.1
Item 8	Dragline	26	19	3	2
Item 10	Hydraulic	5	0.9	0.5	0.1
Dredging Scenario					
Item 1	Hydraulic	1	0.8	0.1	0.08
Item 2	Hydraulic	0.5	0.01	0.05	0.001
Item 5	Hydraulic	1	0.5	0.1	0.05
Item 6	Hydraulic	0.6	0.4	0.06	0.04
Item 7	Dragline	2	0.9	0.2	0.1
Item 8	Dragline	26	19	3	2
Item 10	Hydraulic	4	0.2	0.4	0.02

Table 2.9. Food Chain Model Risk Summary
Mallard Duck
Annual Average
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

Item Number	Dredge Type	Mallard (Total DDT)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	5	3	0.5	0.3
Item 2	Hydraulic	2	1	0.2	0.1
Item 5	Hydraulic	2	2	0.2	0.2
Item 6	Hydraulic	2	2	0.2	0.2
Item 7	Dragline	3	2	0.3	0.2
Item 8	Dragline	62	41	6	4
Item 10	Hydraulic	16	2	2	0.2
Dredging Scenario					
Item 1	Hydraulic	3	3	0.3	0.3
Item 2	Hydraulic	1	0.01	0.1	0.001
Item 5	Hydraulic	2	0.6	0.2	0.1
Item 6	Hydraulic	2	1	0.2	0.1
Item 7	Dragline	3	2	0.3	0.2
Item 8	Dragline	62	41	6	4
Item 10	Hydraulic	12	0.3	1	0.03

Item Number	Dredge Type	Mallard (DDE)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	2	1	0.2	0.1
Item 2	Hydraulic	0.9	0.6	0.1	0.06
Item 5	Hydraulic	1	0.8	0.1	0.1
Item 6	Hydraulic	0.9	0.6	0.1	0.1
Item 7	Dragline	2	0.9	0.2	0.1
Item 8	Dragline	35	21	4	2
Item 10	Hydraulic	6	1	0.6	0.1
Dredging Scenario					
Item 1	Hydraulic	1	1	0.1	0.1
Item 2	Hydraulic	0.7	0.003	0.1	0.0003
Item 5	Hydraulic	1	0.5	0.1	0.1
Item 6	Hydraulic	0.7	0.5	0.1	0.1
Item 7	Dragline	2	0.9	0.2	0.1
Item 8	Dragline	35	21	4	2
Item 10	Hydraulic	5	0.2	0.5	0.02

Table 2.10. Food Chain Model Risk Summary
Mallard Duck
95th Percentile
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

Item Number	Dredge Type	Mallard (Total DDT)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	15	9	1	0.9
Item 2	Hydraulic	3	2	0.3	0.2
Item 5	Hydraulic	5	4	0.5	0.4
Item 6	Hydraulic	6	5	0.6	0.5
Item 7	Dragline	9	5	0.9	0.5
Item 8	Dragline	195	136	19	14
Item 10	Hydraulic	35	5	3	0.5
Dredging Scenario					
Item 1	Hydraulic	10	9	1	0.9
Item 2	Hydraulic	3	0.04	0.3	0.004
Item 5	Hydraulic	4	2	0.4	0.2
Item 6	Hydraulic	5	3	0.5	0.3
Item 7	Dragline	10	5	1	0.5
Item 8	Dragline	195	138	19	14
Item 10	Hydraulic	26	0.9	3	0.09

Item Number	Dredge Type	Mallard (DDE)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	6	3	0.6	0.3
Item 2	Hydraulic	2	1	0.2	0.1
Item 5	Hydraulic	3	2	0.3	0.2
Item 6	Hydraulic	3	2	0.3	0.2
Item 7	Dragline	5	3	0.5	0.3
Item 8	Dragline	108	70	11	7
Item 10	Hydraulic	14	2	1	0.2
Dredging Scenario					
Item 1	Hydraulic	4	3	0.4	0.3
Item 2	Hydraulic	1	0.01	0.1	0.001
Item 5	Hydraulic	3	2	0.3	0.2
Item 6	Hydraulic	2	2	0.2	0.2
Item 7	Dragline	6	3	0.6	0.3
Item 8	Dragline	108	70	11	7
Item 10	Hydraulic	11	0.7	1	0.1

Table 2.11. Food Chain Model Risk Summary
American Mink
Annual Average
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

Item Number	Dredge Type	Mink (Total DDT)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	0.1	0.09	0.03	0.02
Item 2	Hydraulic	0.06	0.04	0.01	0.009
Item 5	Hydraulic	0.08	0.06	0.02	0.01
Item 6	Hydraulic	0.1	0.06	0.02	0.01
Item 7	Dragline	0.1	0.06	0.02	0.01
Item 8	Dragline	1	1	0.3	0.2
Item 10	Hydraulic	0.5	0.2	0.09	0.03
Dredging Scenario					
Item 1	Hydraulic	0.1	0.08	0.02	0.02
Item 2	Hydraulic	0.06	0.01	0.01	0.003
Item 5	Hydraulic	0.08	0.03	0.02	0.01
Item 6	Hydraulic	0.1	0.05	0.02	0.01
Item 7	Dragline	0.1	0.1	0.02	0.01
Item 8	Dragline	1	1	0.3	0.2
Item 10	Hydraulic	0.4	0.1	0.07	0.01

Item Number	Dredge Type	Mink (DDT)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	0.03	0.02	0.01	0.005
Item 2	Hydraulic	0.02	0.02	0.005	0.003
Item 5	Hydraulic	0.02	0.01	0.004	0.003
Item 6	Hydraulic	0.03	0.02	0.01	0.004
Item 7	Dragline	0.03	0.02	0.01	0.003
Item 8	Dragline	0.3	0.1	0.05	0.03
Item 10	Hydraulic	0.1	0.07	0.03	0.01
Dredging Scenario					
Item 1	Hydraulic	0.03	0.02	0.01	0.004
Item 2	Hydraulic	0.02	0.01	0.005	0.002
Item 5	Hydraulic	0.02	0.01	0.004	0.002
Item 6	Hydraulic	0.03	0.02	0.01	0.003
Item 7	Dragline	0.03	0.02	0.01	0.003
Item 8	Dragline	0.3	0.1	0.05	0.03
Item 10	Hydraulic	0.1	0.03	0.02	0.01

Table 2.12. Food Chain Model Risk Summary
American Mink
95th Percentile
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

Item Number	Dredge Type	Mink (Total DDT)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	0.3	0.2	0.05	0.04
Item 2	Hydraulic	0.09	0.06	0.02	0.01
Item 5	Hydraulic	0.1	0.1	0.03	0.02
Item 6	Hydraulic	0.1	0.1	0.03	0.02
Item 7	Dragline	0.2	0.1	0.04	0.02
Item 8	Dragline	4	3	0.7	0.5
Item 10	Hydraulic	0.8	0.2	0.2	0.05
Dredging Scenario					
Item 1	Hydraulic	0.2	0.2	0.04	0.03
Item 2	Hydraulic	0.09	0.02	0.02	0.003
Item 5	Hydraulic	0.1	0.1	0.03	0.01
Item 6	Hydraulic	0.1	0.1	0.03	0.02
Item 7	Dragline	0.2	0.1	0.04	0.02
Item 8	Dragline	4	3	0.7	0.5
Item 10	Hydraulic	0.6	0.1	0.1	0.02

Item Number	Dredge Type	Mink (DDT)			
		NOAEL		LOAEL	
		Max HQ	Min HQ	Max HQ	Min HQ
No Dredging Scenario					
Item 1	Hydraulic	0.1	0.05	0.01	0.01
Item 2	Hydraulic	0.03	0.02	0.01	0.004
Item 5	Hydraulic	0.03	0.02	0.01	0.003
Item 6	Hydraulic	0.05	0.03	0.01	0.01
Item 7	Dragline	0.04	0.02	0.01	0.004
Item 8	Dragline	0.7	0.4	0.1	0.08
Item 10	Hydraulic	0.2	0.1	0.05	0.02
Dredging Scenario					
Item 1	Hydraulic	0.05	0.04	0.01	0.01
Item 2	Hydraulic	0.03	0.01	0.01	0.002
Item 5	Hydraulic	0.03	0.01	0.01	0.002
Item 6	Hydraulic	0.05	0.02	0.01	0.005
Item 7	Dragline	0.04	0.02	0.01	0.004
Item 8	Dragline	0.7	0.4	0.1	0.1
Item 10	Hydraulic	0.2	0.04	0.03	0.01

Table 3.1 Description of Exposure Assumptions
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

		CTE 50	CTE 95	RME 50	RME 95
Exposure Duration (year)		15	15	45	45
Averaging Time (year)	**subchronic**	1	1	1	1
	chronic	15	15	45	45
	cancer	average lifetime - gender/race specific	average lifetime - gender/race specific	average lifetime - gender/race specific	average lifetime - gender/race specific
Body Weight (kg)		average over 1-16 years	average over 1-16 years	average over 1-46 years	average over 1-46 years
Ingestion Rate (kg/year)		1-10 yrs at half avg adult rate; 11-16 yrs at avg adult rate	1-10 yrs at half avg adult rate; 11-16 yrs at avg adult rate	1-10 yrs at half 95th%tile adult rate; 11-46 yrs at 95th %tile adult rate	1-10 yrs at half 95th%tile adult rate; 11-46 yrs at 95th %tile adult rate
EPC (mg/kg)	**subchronic**	max 50th%tile over 1-16 yrs	max 95th%tile over 1-16 yrs	max 50th%tile over 1-46 yrs	max 95th%tile over 1-46 yrs
	chronic	avg 50th%tile over 1-16 yrs	max 95th%tile over 1-16 yrs	avg 50th%tile over 1-46 yrs	max 95th%tile over 1-46 yrs
	cancer	avg 50th%tile over 1-16 yrs	max 95th%tile over 1-16 yrs	avg 50th%tile over 1-46 yrs	max 95th%tile over 1-46 yrs

Table 3.4 Item-Specific Fish Exposure Concentrations Under No Dredging and Dredging Conditions
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

	No Dredging - Fish				***Dredging - Fish***			
	DDD (mg/kg wet wt)	**DDE (mg/kg wet wt)**	**DDT (mg/kg wet wt)**	**sumDDT (mg/kg wet wt)**	**DDD (mg/kg wet wt)**	**DDE (mg/kg wet wt)**	**DDT (mg/kg wet wt)**	**sumDDT (mg/kg wet wt)**
Item 1								
Average [1]	0.25	0.37	0.19	0.8	0.23	0.33	0.18	0.74
95%tile [2]	0.77	0.79	0.66	2.2	0.49	0.57	0.44	1.5
Item 2								
Average [1]	0.082	0.16	0.13	0.38	0.074	0.13	0.12	0.33
95%tile [2]	0.19	0.22	0.36	0.76	0.19	0.22	0.36	0.76
Item 5								
Average [1]	0.13	0.32	0.11	0.56	0.12	0.26	0.097	0.48
95%tile [2]	0.26	0.68	0.084	1	0.32	0.44	0.12	0.89
Item 6								
Average [1]	0.12	0.17	0.23	0.51	0.11	0.16	0.15	0.42
95%tile [2]	0.24	0.24	0.52	1	0.24	0.24	0.52	1
Item 7								
Average [1]	0.13	0.26	0.12	0.51	0.12	0.27	0.12	0.52
95%tile [2]	0.47	0.82	0.2	1.5	0.43	0.97	0.15	1.6
Item 8								
Average [1]	2.3	6	1.2	9.5	2.3	5.9	1.2	9.4
95%tile [2]	6.4	14	7.3	27	6.4	14	7.3	27
Item 10								
Average [1]	0.72	1.5	0.9	3.1	0.63	1.3	0.78	2.7
95%tile [2]	1.8	2.4	2.2	6.4	1.3	2.1	1.5	4.8

[1] Average concentration is the average of DDD, DDE, and DDT concentrations across all fish over 45 years.
[2] The 95th %tile concentration was selected based on the maximum sum of DDD, DDE, and DDT 95th percentiles in any one year over the 45 year modeling period.

Table 3.6 Human Health Risk Summary Table[1]
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

	No Dredging				Dredging			
	CTE 50[2]	CTE 95	RME 50	RME 95	CTE 50	CTE 95	RME 50	RME 95
ITEM 2								
African American Male								
Subchronic Hazard Quotient	**3**	**3**	**7**	**8**	**3**	**3**	**7**	**8**
Chronic Hazard Quotient	1	**2**	**2**	**3**	0.7	**2**	1	**3**
Cancer Risk	4E-05	7E-05	**2E-04**	**3E-04**	3E-05	7E-05	1E-04	**3E-04**
African American Female								
Subchronic Hazard Quotient	**2**	**2**	**4**	**5**	**2**	**2**	**4**	**5**
Chronic Hazard Quotient	0.6	1	1	**2**	0.4	1	0.9	**2**
Cancer Risk	2E-05	3E-05	1E-04	**2E-04**	1E-05	3E-05	9E-05	**2E-04**
Caucasian Male								
Subchronic Hazard Quotient	**2**	**2**	**4**	**5**	**2**	**2**	**4**	**5**
Chronic Hazard Quotient	0.6	1	0.9	**2**	0.4	1	0.8	**2**
Cancer Risk	2E-05	4E-05	9E-05	**2E-04**	1E-05	4E-05	8E-05	**2E-04**
Caucasian Female								
Subchronic Hazard Quotient	0.9	1	**2**	**3**	0.9	1	**2**	**3**
Chronic Hazard Quotient	0.3	0.6	0.6	1	0.2	0.6	0.5	1
Cancer Risk	9E-06	2E-05	5E-05	1E-04	6E-06	2E-05	4E-05	1E-04
ITEM 5								
African American Male								
Subchronic Hazard Quotient	**3**	**4**	**9**	**10**	**3**	**4**	**9**	**9**
Chronic Hazard Quotient	1	**2**	**2**	**4**	1	**2**	**2**	**4**
Cancer Risk	5E-05	9E-05	**2E-04**	**5E-04**	4E-05	7E-05	**2E-04**	**4E-04**
African American Female								
Subchronic Hazard Quotient	**2**	**3**	**5**	**7**	**2**	**2**	**5**	**6**
Chronic Hazard Quotient	0.8	1	**2**	**3**	0.6	1	1	**3**
Cancer Risk	3E-05	5E-05	**2E-04**	**3E-04**	2E-05	4E-05	1E-04	**2E-04**
Caucasian Male								
Subchronic Hazard Quotient	**2**	**3**	**5**	**7**	**2**	**2**	**5**	**6**
Chronic Hazard Quotient	0.9	**2**	1	**3**	0.6	1	1	**2**
Cancer Risk	3E-05	5E-05	1E-04	**3E-04**	2E-05	4E-05	1E-04	**2E-04**
Caucasian Female								
Subchronic Hazard Quotient	1	1	**3**	**4**	1	1	**3**	**3**
Chronic Hazard Quotient	0.4	0.7	0.8	**2**	0.3	0.6	0.7	1
Cancer Risk	1E-05	2E-05	8E-05	1E-04	9E-06	2E-05	6E-05	1E-04
ITEM 6								
African American Male								
Subchronic Hazard Quotient	**4**	**4**	**9**	**10**	**4**	**4**	**9**	**10**
Chronic Hazard Quotient	1	**2**	**2**	**4**	1	**2**	**2**	**4**
Cancer Risk	5E-05	9E-05	**2E-04**	**4E-04**	4E-05	9E-05	**2E-04**	**4E-04**
African American Female								
Subchronic Hazard Quotient	**2**	**2**	**6**	**7**	**2**	**2**	**6**	**7**
Chronic Hazard Quotient	0.7	1	1	**3**	0.6	1	1	**3**
Cancer Risk	2E-05	4E-05	1E-04	**3E-04**	2E-05	4E-05	1E-04	**3E-04**
Caucasian Male								
Subchronic Hazard Quotient	**2**	**3**	**6**	**7**	**2**	**3**	**6**	**7**
Chronic Hazard Quotient	0.8	1	1	**3**	0.6	1	1	**3**
Cancer Risk	3E-05	5E-05	1E-04	**2E-04**	2E-05	5E-05	1E-04	**2E-04**
Caucasian Female								
Subchronic Hazard Quotient	1	1	**3**	**3**	1	1	**3**	**3**
Chronic Hazard Quotient	0.4	0.7	0.8	1	0.3	0.7	0.6	1
Cancer Risk	1E-05	2E-05	7E-05	1E-04	9E-06	2E-05	6E-05	1E-04
ITEM 8								
African American Male								
Subchronic Hazard Quotient	**50**	**100**	**100**	**300**	**50**	**100**	**100**	**300**
Chronic Hazard Quotient	**20**	**70**	**40**	**100**	**20**	**70**	**40**	**100**
Cancer Risk	**9E-04**	**2E-03**	**4E-03**	**1E-02**	**8E-04**	**2E-03**	**4E-03**	**1E-02**
African American Female								
Subchronic Hazard Quotient	**30**	**70**	**80**	**200**	**30**	**70**	**80**	**200**
Chronic Hazard Quotient	**10**	**40**	**30**	**80**	**10**	**40**	**30**	**80**
Cancer Risk	**4E-04**	**1E-03**	**3E-03**	**8E-03**	**4E-04**	**1E-03**	**3E-03**	**8E-03**
Caucasian Male								
Subchronic Hazard Quotient	**30**	**70**	**80**	**200**	**30**	**70**	**80**	**200**
Chronic Hazard Quotient	**10**	**40**	**20**	**70**	**10**	**40**	**20**	**70**
Cancer Risk	**5E-04**	**1E-03**	**2E-03**	**7E-03**	**5E-04**	**1E-03**	**2E-03**	**7E-03**
Caucasian Female								
Subchronic Hazard Quotient	**20**	**40**	**40**	**100**	**20**	**40**	**40**	**100**
Chronic Hazard Quotient	**7**	**20**	**10**	**40**	**7**	**20**	**10**	**40**
Cancer Risk	**2E-04**	**6E-04**	**1E-03**	**4E-03**	**2E-04**	**6E-04**	**1E-03**	**4E-03**

[1]Hazard Quotients and Risk Estimates calculated using default USEPA IRIS toxicity values in Table 3.5
[2]CTE 50, CTE 95, RME 50, RME 95 denote the combination of the CTE and RME exposure assumptions with the 50th%tile or 95th%tile EPC value. Table 3.1 provides a full description of the exposure scenarios.

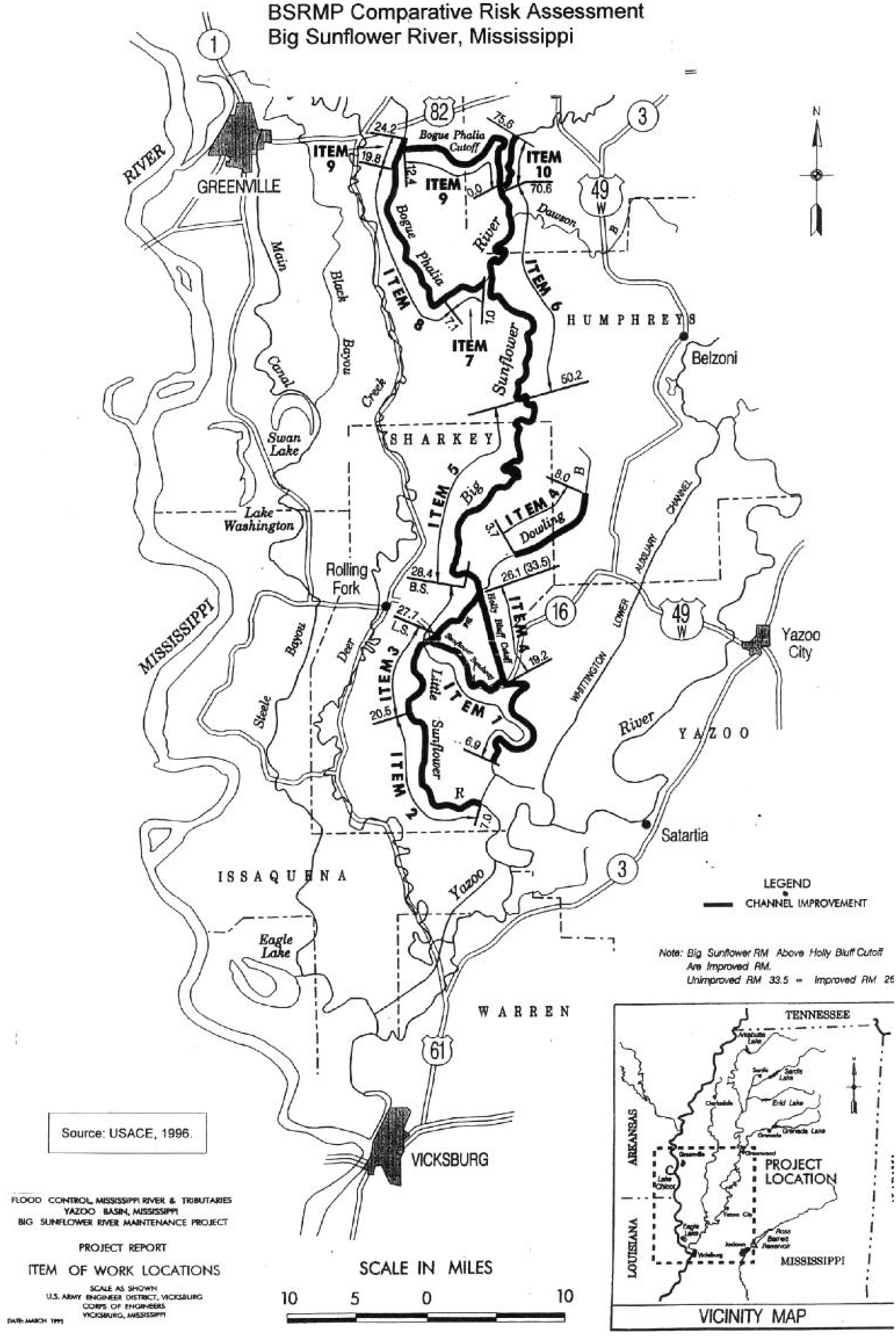
Table 3.8 Comparison of Non Cancer Hazards Using Default and MCA-Derived Toxicity Values[1] - No Dredging Conditions
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

	Using Default Toxicity Values				Using MCA-Derived Toxicity Values			
	CTE 50[2]	CTE 95	RME 50	RME 95	CTE 50	CTE 95	RME 50	RME 95
ITEM 5								
African American Male								
Subchronic Hazard Quotient	**3**	**4**	**9**	**10**	1	0.9	**4**	**2**
Chronic Hazard Quotient	1	**2**	**2**	**4**	0.4	0.5	0.7	0.9
African American Female								
Subchronic Hazard Quotient	**2**	**3**	**5**	**7**	0.9	0.5	**2**	1
Chronic Hazard Quotient	0.8	1	**2**	**3**	0.2	0.3	0.5	0.6
Caucasian Male								
Subchronic Hazard Quotient	**2**	**3**	**5**	**7**	0.9	0.6	**2**	1
Chronic Hazard Quotient	0.9	**2**	1	**3**	0.2	0.3	0.4	0.5
Caucasian Female								
Subchronic Hazard Quotient	1	1	**3**	**4**	0.5	0.3	1	0.7
Chronic Hazard Quotient	0.4	0.7	0.8	**2**	0.1	0.2	0.3	0.3
ITEM 8								
African American Male								
Subchronic Hazard Quotient	**50**	**100**	**100**	**300**	**10**	**40**	**30**	**100**
Chronic Hazard Quotient	**20**	**70**	**40**	**100**	**6**	**20**	**9**	**40**
African American Female								
Subchronic Hazard Quotient	**30**	**70**	**80**	**200**	**8**	**20**	**20**	**70**
Chronic Hazard Quotient	**10**	**40**	**30**	**80**	**3**	**10**	**7**	**30**
Caucasian Male								
Subchronic Hazard Quotient	**30**	**70**	**80**	**200**	**8**	**30**	**20**	**70**
Chronic Hazard Quotient	**10**	**40**	**20**	**70**	**4**	**10**	**6**	**30**
Caucasian Female								
Subchronic Hazard Quotient	**20**	**40**	**40**	**100**	**4**	**10**	**10**	**30**
Chronic Hazard Quotient	**7**	**20**	**10**	**40**	**2**	**7**	**3**	**10**

[1]Default and MCA derived surrogate values for DDE and DDD are in Table 3.7.
[2]CTE 50, CTE 95, RME 50, RME 95 denote the combination of the CTE and RME exposure assumptions with the 50th%tile or 95th%tile EPC value. Table 3.1 provides a full description of the exposure scenarios.

FIGURES

Figure 1.1 Item Location Overview
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi



Source: USACE, 1996.

Figure 1.2 Human Health Conceptual Model
BSRMPComparative Risk Assessment
Big Sunflower River, Mississippi

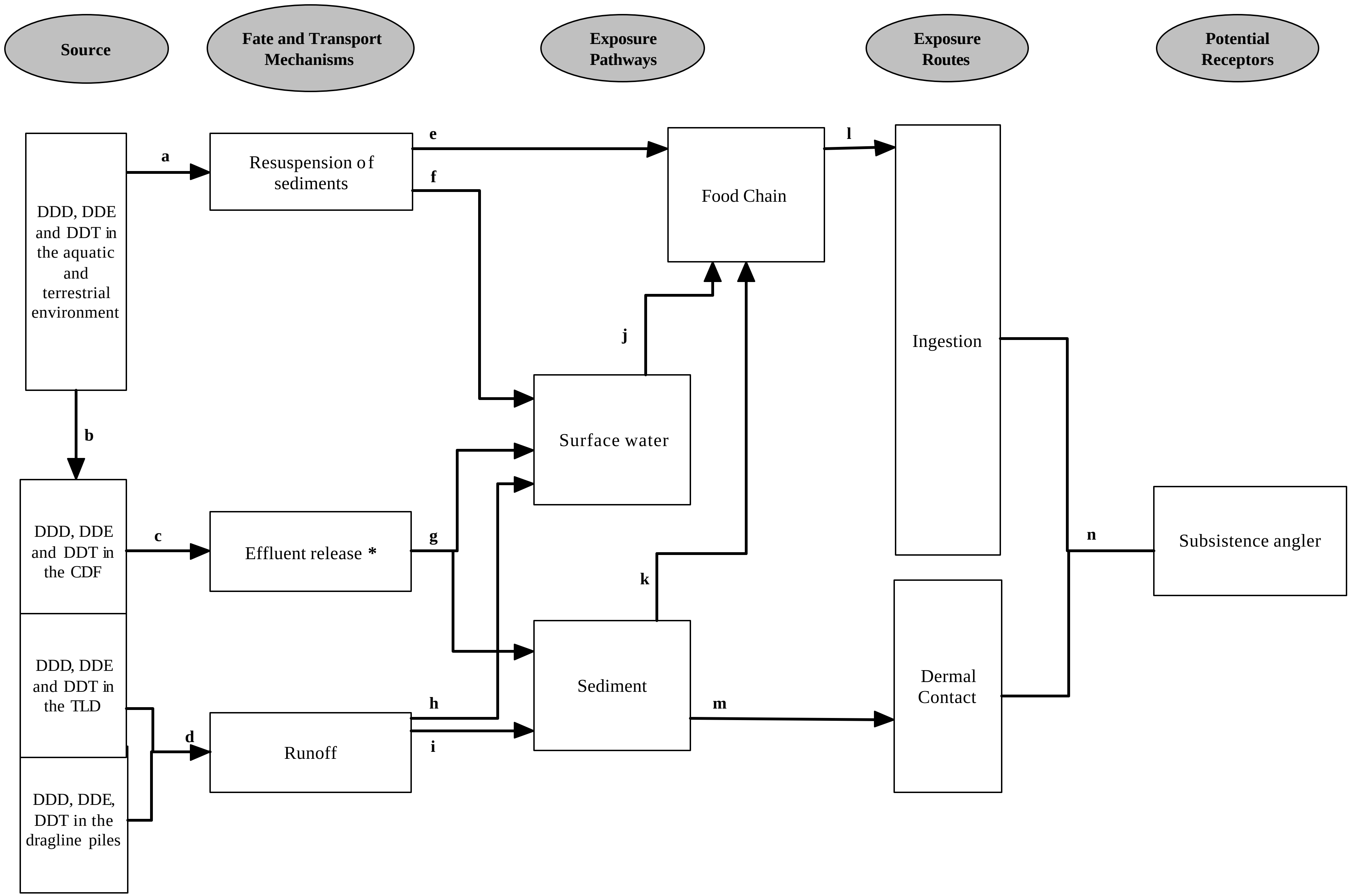


Figure notes:

***** Effluent release applies to the after dredging scenario only.

The following are descriptions of how humans may come into contact with contaminants in the Big Sunflower River Maintenance Project area.

a Hydraulic or dragline dredging in the project area can stir up sediment so that it becomes suspended in the overlying surface water.

b Sediment that has been dredged will be disposed of in a CDF, TLD facility or dragline pile.

c Sediment disposed of in a CDF will contain some water. The water will be released from the CDF in the form of effluent.

d Although dredged material is assumed to be confined in a TLD facility or dragline pile, we assume that the sediments will need to be dewatered. Therefore, some runoff may occur.

e Animals living in the rivers in the project area may be exposed to DDD, DDE and DDT sorbed to resuspended sediments resulting from dredging activity in the area. See Figure 1.3 for a detailed explanation of how these animals may be exposed to contaminants sorbed to resuspended sediments.

f The result of resuspension of sediments from dredging is that an increased amount of sediment particles with DDD, DDE and DDT sorbed to them will be present in the water column.

g Effluent from the CDFs will be discharged into the river near the disposal facility. DDD, DDE and DDT may be present in the water itself or may be sorbed to fine particles suspended in the effluent.

h Water from dredged sediment disposed of in TLD facilities or dragline piles may enter the river via overland runoff.

i Sediments from the dragline piles may be eroded or sediment may be carried in overland runoff from dragline piles and TLD facilities. It is assumed that this sediment will be deposited in the river bed adjacent to each disposal facility.

j Animals living in the rivers in the project area may be exposed to DDD, DDE and DDT in surface water. Some of these animals may be consumed by humans. See Figure 1.3 for a detailed explanation of how these animals may be exposed to contaminants in surface water.

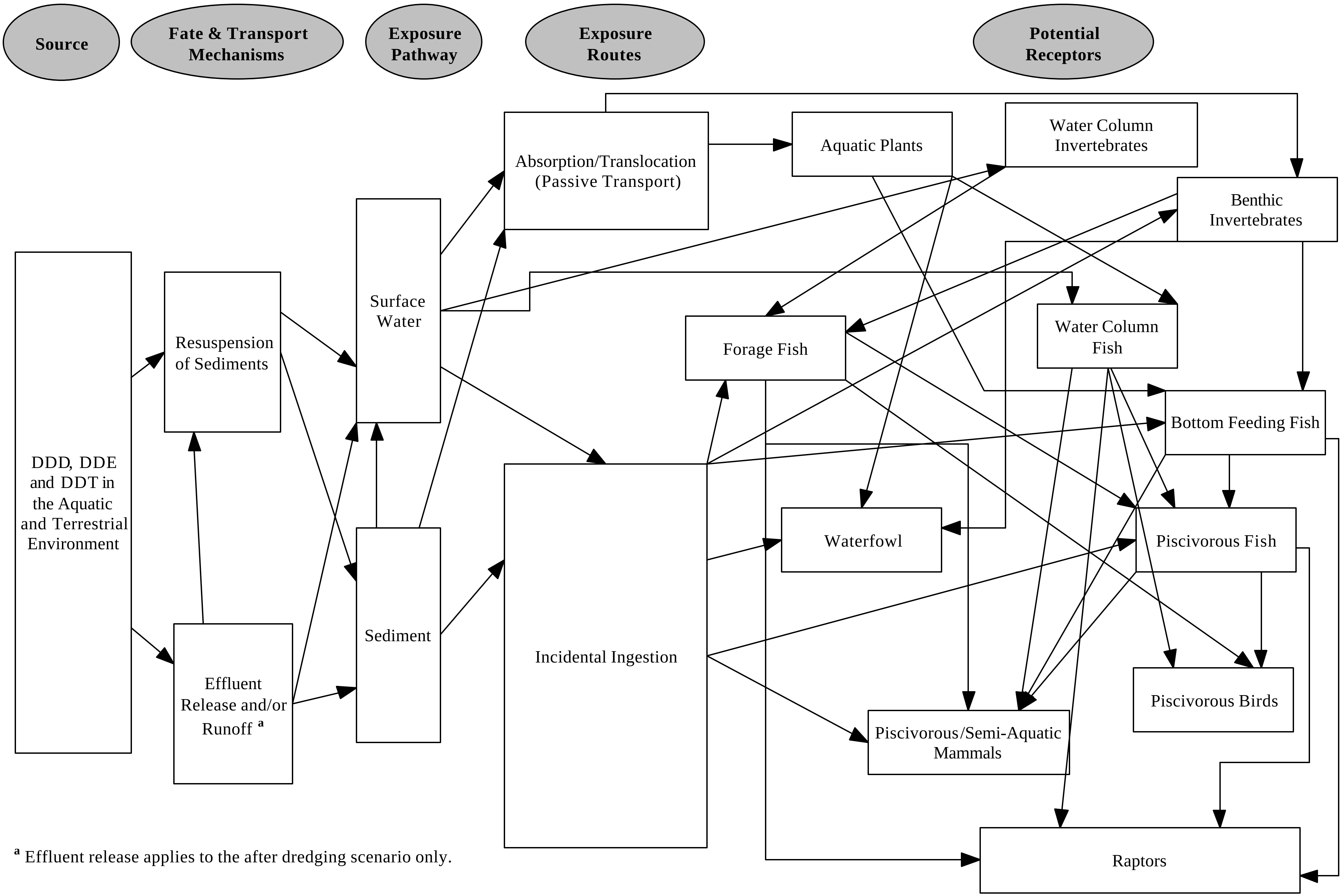
k Animals living in the rivers in the project area may be exposed to DDD, DDE and DDT in sediment. Some of these animals may be consumed by humans. See Figure 1.3 for a detailed explanation of how these animals may be exposed to contaminants in sediment.

l Humans may be exposed to DDD, DDE and DDT through consumption of fish from the project area.

m Humans may be directly exposed to DDD, DDE and DDT in sediments via dermal contact while engaged in recreational activities at rivers in the project area.

n A person may fish in the rivers in the project area in order to provide food for his or her family (subsistence fishing). We assume that this person may be exposed to DDD, DDE and DDT via dermal contact with sediment and ingestion of fish.

Figure 1.3 Ecological Conceptual Model
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi



[a] Effluent release applies to the after dredging scenario only.

Figure 1.4 Ecological Conceptual Model - Piscivores
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

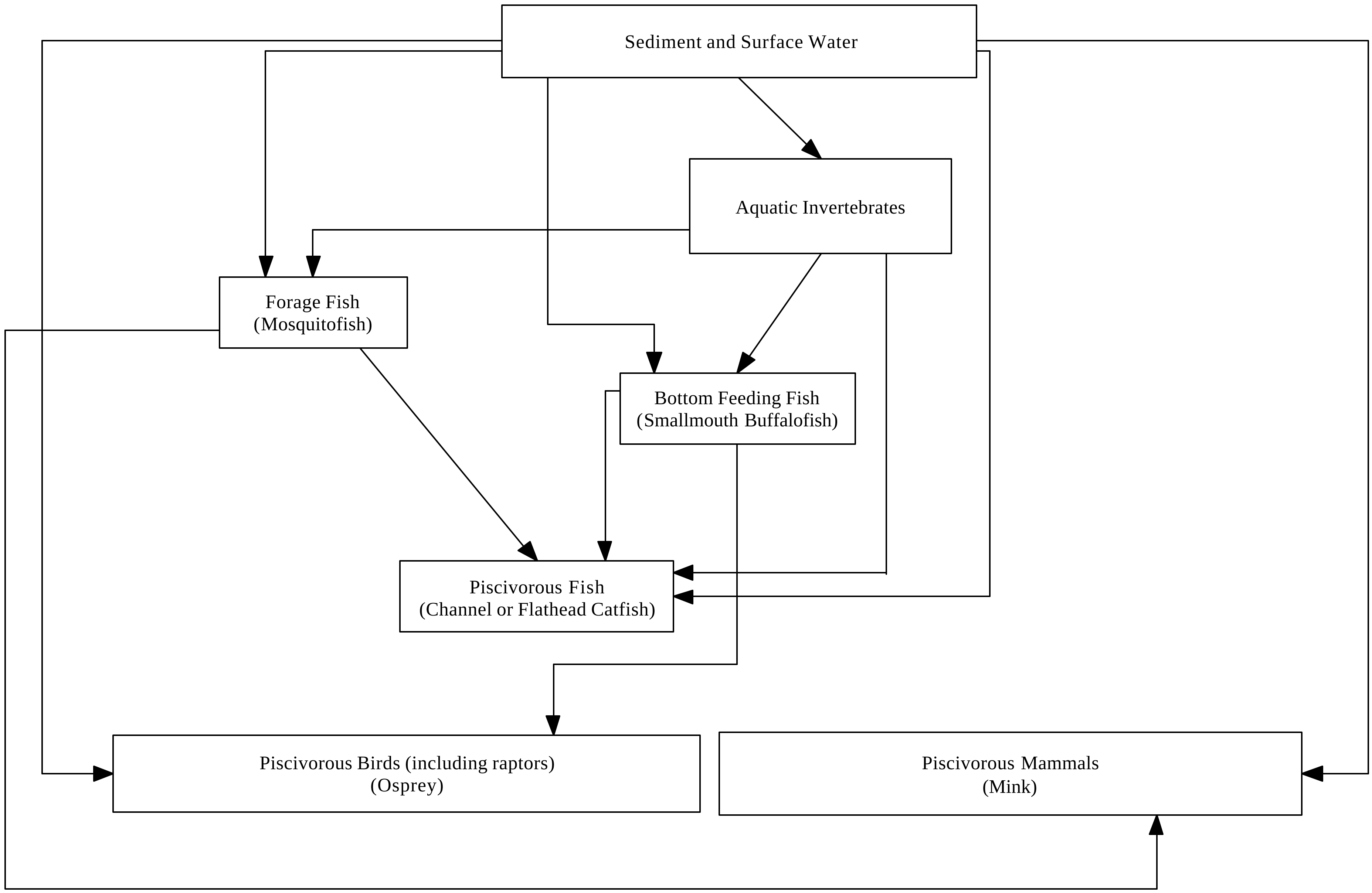


Figure 1.5 Ecological Conceptual Model - Waterfowl
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

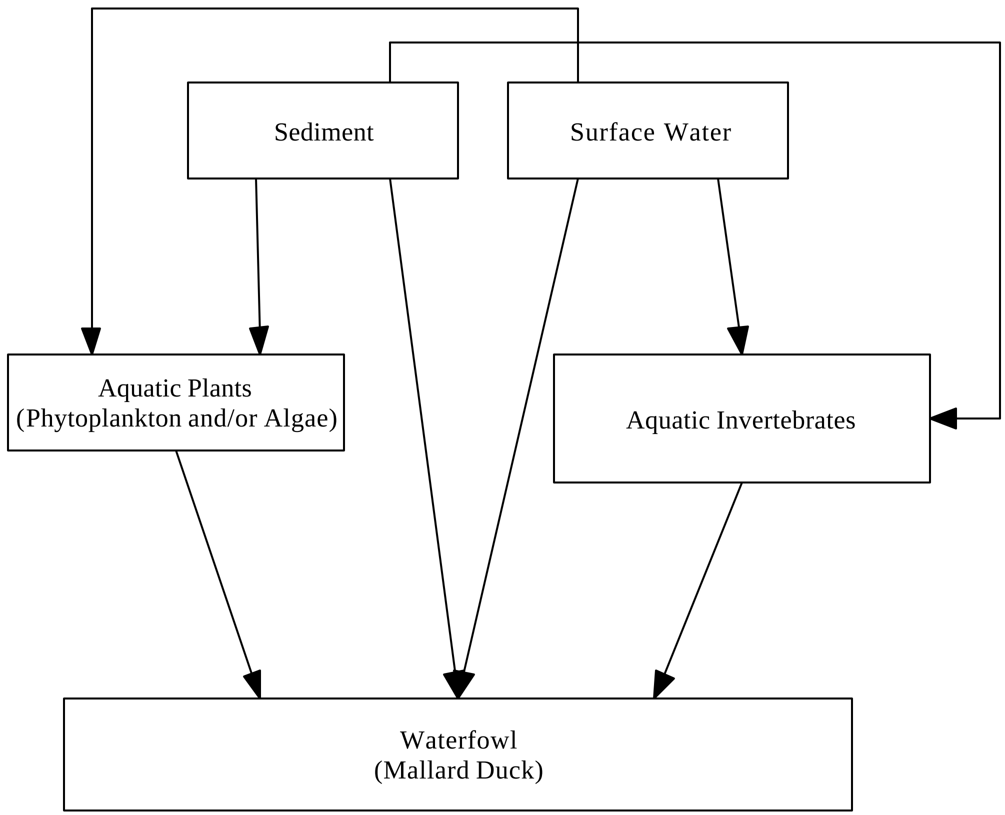


Figure 1.6 Sampling Locations, Items 1-4
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

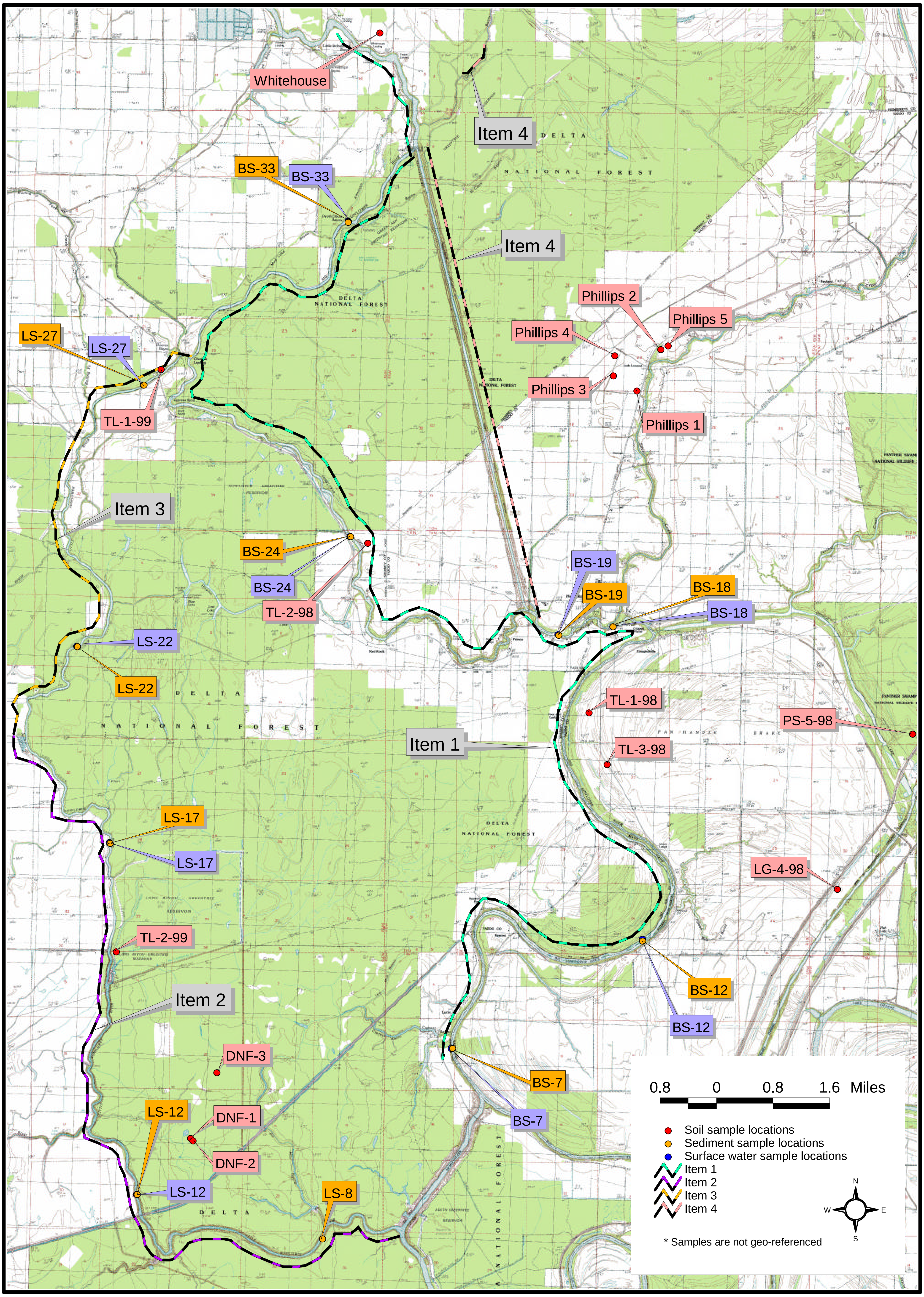


Figure 1.7 Sampling Locations, Item 5
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

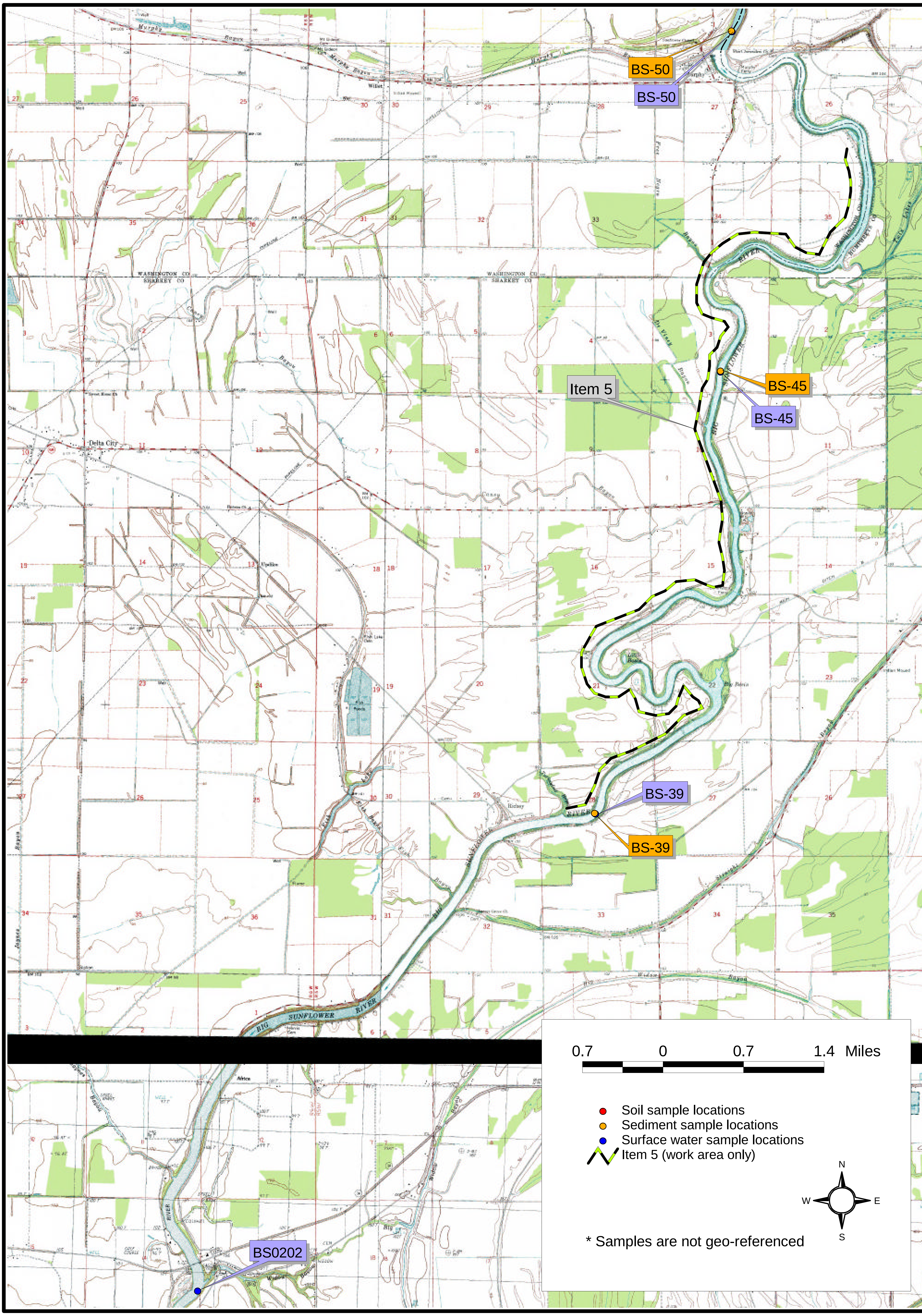


Figure 1.8 Sampling Locations, Item 6
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

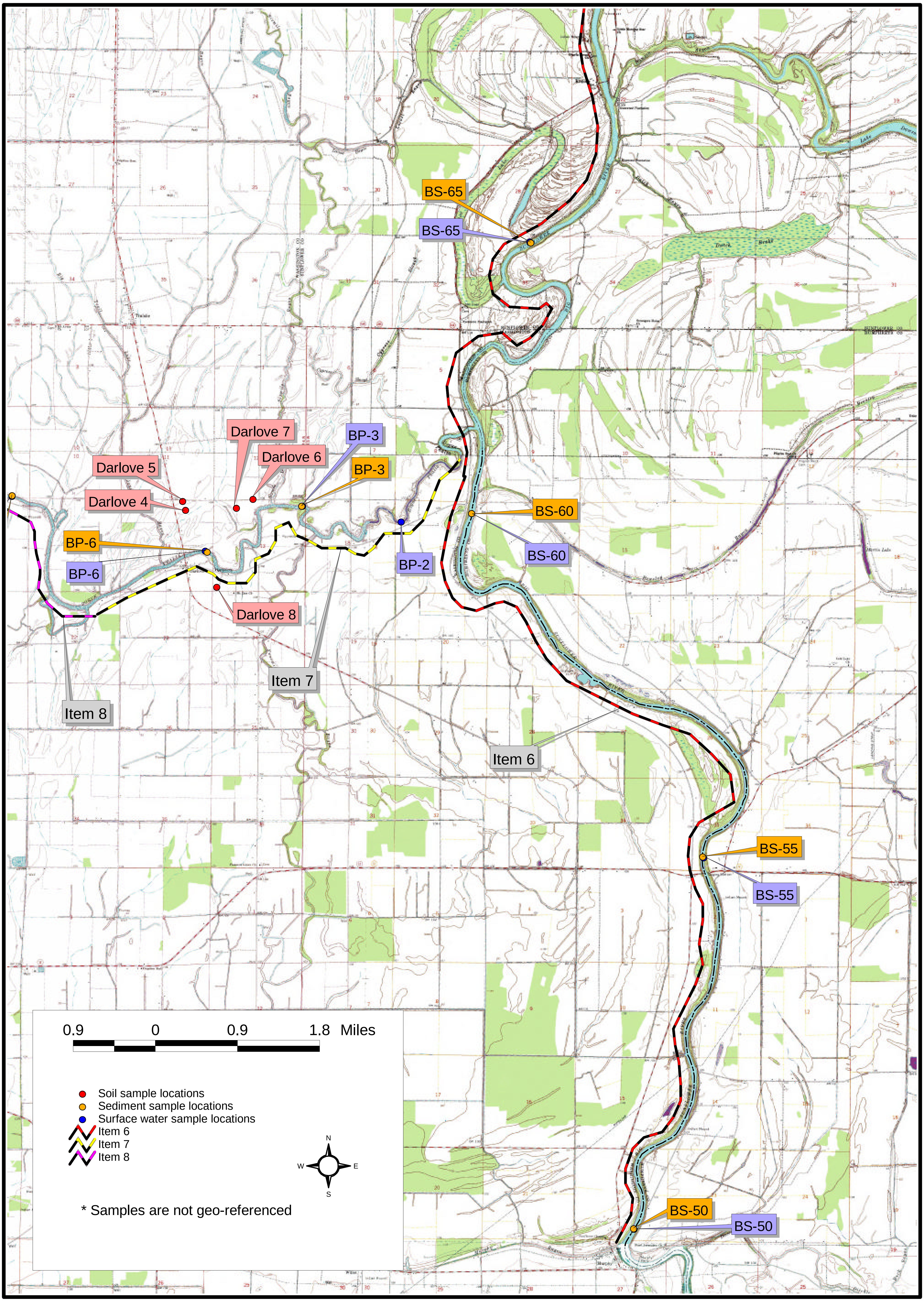


Figure 1.9 Sampling Locations, Items 6-10
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi

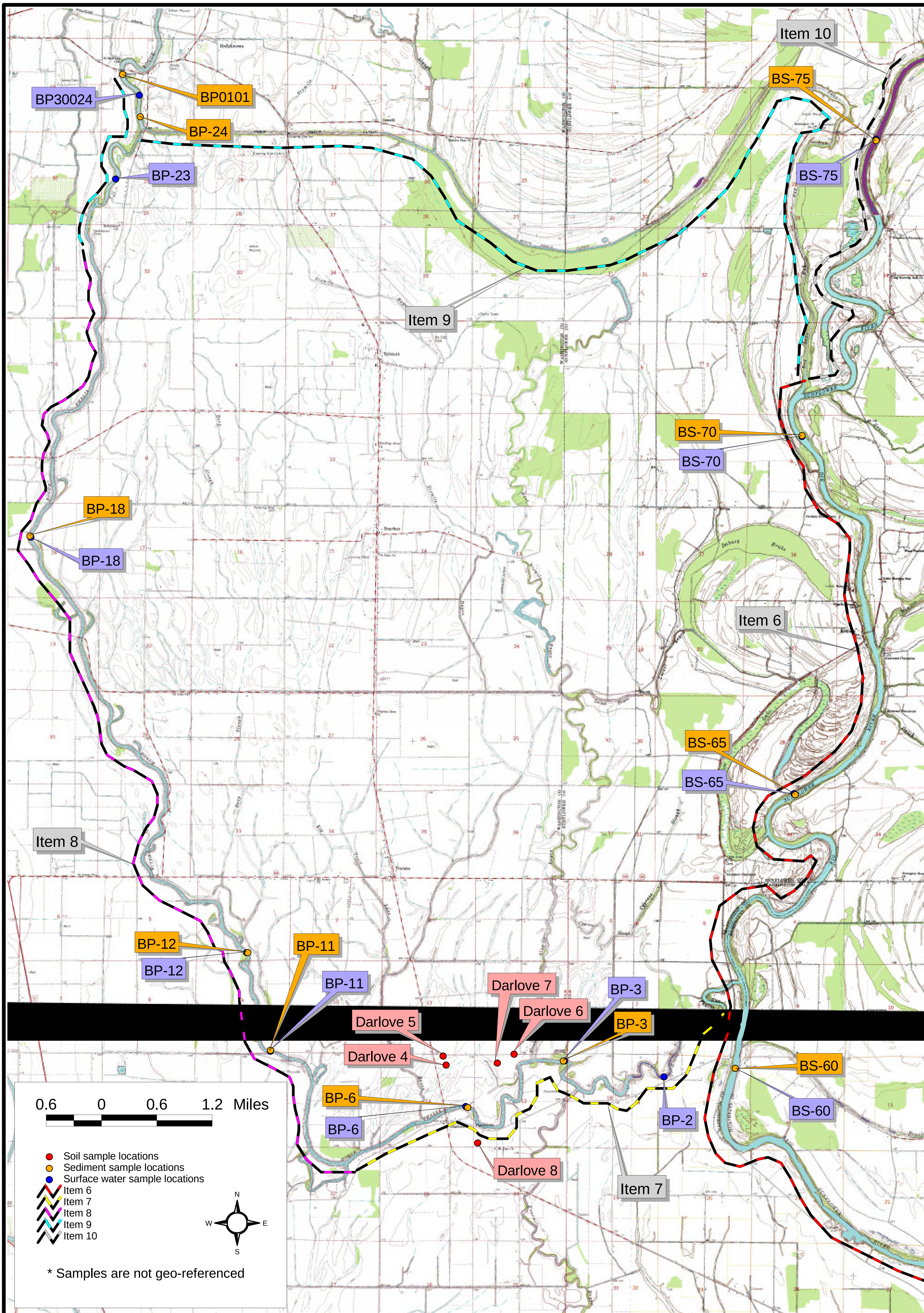


Figure 3.1. Summary of Counties Included in Fish Consumption Survey and Big Sunflower River Assessment
BSRMP Comparative Risk Assessment
Big Sunflower River, Mississippi