EPA/ROD/R04-94/178
1994

EPA Superfund
Record of Decision:

SANGAMO WESTON, INC./TWELVE-MILE CREEK/LAKE HARTWELL PCB CONTAMINATION
EPA ID: SCD003354412
OU 02
PICKENS, SC
06/28/1994

FINAL RECORD OF DECISION

for the

Sangamo Weston/Twelvemile Creek/Lake Hartwell
PCB Contamination Superfund Site - Operable Unit Two
Pickens, Pickens County, South Carolina

June 1994

Record of Decision Declaration

SITE NAME AND LOCATION

Sangamo Weston/Twelvemile Creek/Lake Hartwell PCB Contamination
Superfund Site - Operable Unit Two
Pickens, Pickens County, South Carolina

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the Sangamo Weston/Twelvemile Creek/Lake Hartwell PCB Contamination Superfund Site - Operable Unit Two ("Sangamo OU2") in Pickens County, South Carolina, which was chosen in accordance with CERCLA, as amended by SARA, and, to the extent practicable, the National Contingency Plan. This decision is based on the Administrative Record for the Site.

The State of South Carolina concurs with the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE REMEDY

This Operable Unit is the final action of two Operable Units for the Site. Operable Unit One addressed the land-based source areas which included the Sangamo Weston Plant and six satellite disposal areas. This action, Operable Unit Two, addresses the sediment, surface water, and biological migration pathways downstream from the source areas. This action addresses the primary PCB human exposure pathway by mitigating the consumption of PCB contaminated fish harvested from Lake Hartwell.

This major components of the selected remedy include:

- Continuation of the existing fish consumption advisory on Lake Hartwell;
- Public education program designed to increase awareness of advisory and methods to prepare/cook fish to reduce quantity of contaminants consumed;
- Continued monitoring of aquatic biota and sediment to support continuance and/or justify modifications to existing fish advisory; and
- Regulation of Twelvemile Creek Impoundments that will facilitate burial of contaminated sediment while mitigating adverse impacts to Lake Hartwell water quality.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. This remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. This remedy does not satisfy the preference for treatment as a principal element based upon the excessive costs associated with removal, treatment and disposal of approximately 4.7 million cubic yards of PCB contaminated sediment spread out over approximately 730 acres.

Because this remedy will result in hazardous substances remaining onsite above health-based levels, a review will be conducted no less often than every five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

_____ _____

John H. Hankinson, Jr. Date
Regional Administrator
EPA - Region IV

TABLE OF CONTENTS

SECTION PAGE

1.0 Site Name, Location, and Description.....1

2.0 Site History and Enforcement Activities.....1

3.0 Highlights of Community Participation.....6

4.0 Scope and Role of Response Action.....7

5.0 Summary of Site Characteristics.....8
5.1 Summary of Physical Characteristics.....8
5.1.1 Surface Features.....8
5.1.2 Surface Water Hydrology.....10
5.1.2.1 Surface Water Hydrology of Twelvemile Creek Watershed.....11
5.1.2.2 Surface Water Hydrology of Lake Hartwell.....13
5.1.3 Meteorology.....14
5.1.4 Demographics.....15
5.2 Sediment Investigation Summary.....16
5.2.1 Phase I Investigation.....17
5.2.2 Phase II Investigation.....18
5.2.3 Field Screening-Modified Spittler Method...18
5.2.4 Nature and Extent of Contamination.....19
5.2.5 Other Contaminants in Sediment.....24
5.2.6 Summary of Surface Water Investigations....28
5.3 Biological Investigation Summary.....28
5.3.1 Twelvemile Creek Watershed Investigations..29
5.3.2 Lake Hartwell Investigations.....33
5.3.3 Assessment of Resource Use.....38
5.4 Contaminant Fate and Transport.....40
5.4.1 Future Sedimentation.....40
5.4.2 Future Sediment and Water Quality Trends...43
5.4.3 Bioaccumulation and Future Fish Concentrations.....48
6.0 Summary of Site Risks.....50
6.1 Contaminants of Concern.....50
6.2 Exposure Assessment.....51
6.3 Toxicity Assessment.....52
6.3.1 Carcinogenic Toxicity of PCBs.....52
6.3.2 Noncarcinogenic Toxicity of PCBs.....53
6.4 Risk Characterization.....53
6.5 Monte Carlo.....54
6.6 Ecological Risk Assessment.....55
6.7 Uncertainty Assessment.....56
6.8 Summary.....56
7.0 Description of Alternatives.....66
7.1 Final Cleanup Goal for Sediment.....67
7.2 Final Cleanup Goal for Fish.....68
7.3 Remedial Alternatives.....70

8.0 Summary of the Comparative Analysis of Alternatives.....82
8.1 Overall Protection of Human Health and the Environmental.....82
8.2 Compliance with ARARs.....83
8.3 Long-Term Effectiveness and Permanence.....84
8.4 Reduction of Toxicity, Mobility, and Volume.....85
8.5 Short-Term Effectiveness.....86
8.6 Implementability.....88
8.7 Cost.....88
9.0 The Selected Remedy.....89
9.1 Continuation of Existing Health Advisory.....89
9.2 Public Education Program.....89
9.3 Aquatic Biota and Sediment Monitoring.....92
9.3.1 Aquatic Biota Monitoring.....92
9.3.2 Sediment Monitoring.....94
9.4 Regulation of Twelvemile Creek Impoundments.....94
9.5 Five-Year Reviews.....99
9.6 Cost Estimate.....99
10.0 Statutory Determinations.....100
10.1 Protection of Human Health and the Environment.....100
10.2 Compliance with ARARS.....101
10.3 Cost Effectiveness.....101
10.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable.....101
10.5 Preference for Treatment as a Principal Element.....102
11.0 Documentation of Significant Changes.....102

Appendix - Proposed Plan Fact Sheet

LIST OF TABLES

TABLE/TITLE PAGE

5-1 Monthly Mean Temperature and Precipitation for Clemson and Pickens, SC.....15

6-1 PCB Exposure Point Concentrations in Shallow Sediment.....57

6-2 Exposure Point Concentrations in Fish.....58

6-3 Exposure Parameters for Incidental Ingestion of and Dermal Contact with Sediment (Current/Future Use Scenario).....60

6-4 Exposure Parameters for Ingestion of Fish by Adult Recreational Fisherman (Current/Future Use Scenario).....61

6-5 Potential Direct Contact Risks Associated with PCBs in Sediment.....62

6-6 Potential Health Risks Associated with Ingestion of Fish..64

8-1 Time to Achieve Protectiveness.....87

9-1 Sediment Sample Locations in Twelvemile Creek Watershed and Arm of Lake Hartwell.....98

9-2 Cost Estimate for EPA's Selected Remedy.....100

LIST OF FIGURES

FIGURE/TITLE PAGE

1-1 Hartwell Lake and Watershed....2
1-2 Sangamo OU2 Study Area....3
2-1 Estimate of PCBs Received at the Sangamo Weston Plant....4
2-2 Estimate of PCBs Discharged Into Town Creek....5
5-1 Twelvemile Creek Drainage Basin....9
5-2 Twelvemile Creek Profile....12
5-3 PCB Distribution for Grab Samples....25
5-4 Vertical Distribution of Mean PCB Concentration per Transect Interval....26
5-5 Vertical Distribution of Maximum PCB Concentration per Transect Interval....27
5-6 Twelvemile Creek Drainage Sampling Locations....30
5-7 Lake Hartwell Fish Sampling Stations....34
5-8 PCB Concentrations in Largemouth Bass Fillets (1990-93)....36
5-9 PCB Concentrations in Channel Catfish (1990-93)....36
5-10 PCB Concentrations in Hybrid Bass Fillets (1990-93)....37
5-11 Simulated Bed Profile Twelvemile Creek Arm....41
5-12 Predicted Average Sediment Burial Rates....42
5-13 Initial WASP4 Surface Sediment PCB Concentrations....44
5-14 WASP4 Surface Sediment PCB Concentrations at 10 Years....45
5-15 WASP4 Surface Sediment PCB Concentrations at 20 Years....46
5-16 WASP4 Surface Sediment PCB Concentrations at 30 Years....47
5-17 Initial and Predicted Concentrations of Selected Biota....49
7-1 FGETS Modeling Results for Selected PCB-Cleanup Goals....69
7-2 Area to be Capped in Alternative 3A....74
7-3 Sediment Control Structure Location of Alternative 3B....76
7-4 Sediment Control Structure/Area to be Capped for Alternative 3C....78
7-5 Confined Disposal Facility for Alternative 4....80
9-1 Current Lake Hartwell Fish Advisory....90
9-2 Fish Sampling Stations in Lake Hartwell....93
9-3 Corbicula Basket Sampling Locations in Twelvemile Creek....95
9-4 Sediment Sampling Stations in Lake Hartwell....96
9-5 Sediment Sampling Stations in Twelvemile Creek....97

1.0 SITE NAME, LOCATION, AND DESCRIPTION

The Sangamo Weston/Twelvemile Creek/Lake Hartwell Polychlorinated Biphenyl (PCB) Contamination Site - Operable Unit Two (hereinafter referred to as "the Sangamo OU2 site") is located in Pickens County, South Carolina. The Sangamo OU2 Site comprises the sediment, surface water, and biological migration routes downstream from the Sangamo Weston Plant and satellite disposal areas that have site related PCB-contamination. The Sangamo Weston Plant and satellite disposal areas constitute Operable Unit one of the Site.

Lake Hartwell was constructed by the Savannah District U.S. Army Corps of Engineers (COE) between 1955 and 1963 by damming the Savannah, Seneca, and Tugaloo Rivers. Figure 1-1 provides an illustration of the 56,000 acre Hartwell Reservoir located on the Georgia-South Carolina border. The OU2 study area includes approximately 40 stream miles of Twelvemile Creek and its tributaries, the Twelvemile Creek Arm of Lake Hartwell, and portions of the Keowee and Seneca River Arms of Lake Hartwell down to the Route 37 (Rt. 37) bridge just south of Clemson, South Carolina. Figure 1-2 provides an illustration of the Sangamo OU2 study area. The primary focus of OU2 is centered on this area; however, samples were collected throughout Lake Hartwell during the OU2 investigations including that portion of the reservoir between Rt. 37 and Hartwell Dam.

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

Sangamo Weston, Inc., owned and operated a capacitor manufacturing plant in Pickens, South Carolina from 1955 to 1978, near the headwaters of Lake Hartwell. The plant manufactured several varieties of capacitors, including electrolytic, mica, and power factor capacitors as well as potentiometers. Schlumberger Industries, Inc. (SII) is the current owner of the plant site, as a result of a merger with Sangamo Weston in 1989.

The plant used several varieties of dielectric fluids in its manufacturing processes, including PCB-containing dielectric fluids. PCBs reportedly enhanced the performance and durability of the fluids. The PCBs used for this application were primarily Aroclors 1242, 1254, and 1016. Waste disposal practices from the Sangamo Plant included land-burial of off-specification capacitors and wastewater treatment sludges on the plant site and at the six satellite disposal areas. PCBs were also discharged with effluent directly into Town Creek, which is a tributary of Twelvemile Creek. Twelvemile Creek is a major tributary of Lake Hartwell. The use of PCBs was terminated by Sangamo Weston in 1977 prior to an EPA ban on PCB use in January 1978.

Estimates of the type and quantities of PCBs received, used, and discharged by Sangamo Weston were derived by reviewing Monsanto Corporation shipping records, Sangamo Weston records, interviews with Sangamo Weston employees, engineering and analytical reports completed by firms under contract to Sangamo Weston, and EPA documents. Figures 2-1 and 2-2 provide a graphical illustration of the PCBs received at the Sangamo Plant and an estimate of PCBs discharged to Town Creek, respectively.

<IMG SRC 0494178>
<IMG SRC 0494178A>
<IMG SRC 0494178B>

The average quantity of PCBs used by Sangamo Weston ranged from 700,000 to 2,000,000 lbs/yr from 1958 to 1977. Data indicate that an estimated 3 percent of the quantities received and used were discharged to Town Creek. This approach leads to an estimated cumulative discharge of PCBs into Town Creek of over 400,000 lbs through 1977.

Historical surficial and core sediment studies of the Twelvemile Creek watershed and Lake Hartwell were conducted by several entities including the South Carolina Department of Health and Environmental Control (SCDHEC), COE, EPA, RMT (for Schlumberger), and several Clemson graduate students. These studies were initiated in 1976 by SCDHEC and occurred intermittently through the mid to late 1980s. PCB concentrations in surficial sediments were highest from samples collected near the plant's discharge point on Town Creek and generally decreased with increasing distance downstream from the Sangamo Weston Plant Site. PCB concentrations in sediment core samples were highest in samples collected from the Twelvemile Creek Arm of Lake Hartwell. PCB concentrations generally increased to maximum at a depth of 10-30 cm.

In the mid-1970s, SCDHEC and EPA discovered that fish from certain areas of Lake Hartwell were contaminated with PCBs at levels above the U.S. Food and Drug Administration (FDA) safe tolerance

limit of 5 ppm (5 mg/kg). SCDHEC originally issued a health advisory in 1976 that warned the public against eating fish from the Seneca River Arm of Lake Hartwell north of State Highway 24 (Hwy 24) and Twelvemile Creek (Figure 1-1). FDA lowered the PCB tolerance level to 2 ppm (2 mg/kg) in 1984. As a result, SCDHEC modified the original health advisory in 1985 to state the following:

1) All fish taken from the Seneca River Arm of Lake Hartwell north of SC Hwy 24 and Twelvemile Creek should be released and not eaten;

2) All fish larger than three (3) lbs. taken from the remainder of Lake Hartwell should be released and not eaten; and

3) Fishing is not prohibited but SCDHEC advises that these fish not be eaten due to the presence of elevated levels of PCBs. Swimming, boating, and other related activities are not restricted by this advisory.

This advisory remains in effect, and signs warning against eating fish have been posted at the majority of the public boat launch and recreation areas in South Carolina since 1987.

SCDHEC has conducted studies in Lake Hartwell since 1976 to evaluate the levels of PCB contamination in fish. Their results indicate that PCB concentrations in non-migratory fish (i.e largemouth bass, catfish) collected within the Twelvemile Creek embayment remain above the FDA 2 mg/kg tolerance level with no apparent decrease over time. PCB concentrations in these non-migratory species generally decreased with increasing distance from the source area. However, migratory species (i.e. hybrid/striped bass) collected at all stations in the lake had elevated levels of PCBs which frequently exceeded the 2 mg/kg tolerance level. There was no apparent decrease in migratory fish tissue PCB concentrations over time.

In 1987, based upon the EPA Hazard Ranking System, SCDHEC monitoring programs, and accompanying concerns of citizens in the area, the Sangamo Site was proposed for inclusion on the National Priorities List (NPL). The Sangamo Site was finalized on the NPL in February 1990. As a result, EPA issued special notice to SII in April 1990 for performance of a Remedial Investigation and Feasibility Study (RI/FS). Since SII declined to conduct the RI/FS, EPA assumed the lead-role in performing the RI/FS at the Sangamo OU2 Site and formally initiated the process in September 1990. The RI/FS process for OU2 was divided into two separate studies, a Sediment Investigation and Biological Investigation, which were conducted concurrently. The Sediment Investigation was conducted by the Oak Ridge, TN office of Bechtel Environmental under the funding and direction of EPA. The Biological Investigation was conducted by the Savannah District of the U.S. Army COE, under funding and direction provided by EPA.

3.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

EPA held an OU2 RI Kick-Off Public Meeting at the Liberty (South Carolina) Senior High School Cafeteria on May 9, 1991 to present the approach for the Phase I Sediment RI and overall Biological Investigation strategy. On March 3, 1992, a public meeting was held at the Ramada Inn in Clemson, SC to discuss the Phase I Sediment Investigation results, planned approach for the focused Phase II Sediment Investigation, and provide an update on the Biological Investigations. The Final Remedial Investigation Reports (Sediment and Biological components) and a summary fact sheet were released to the public in May 1993. A public meeting was held on June 3, 1993 at the Ramada Inn in Clemson to present the findings from the completed investigations and the Baseline Risk Assessment.

The Draft Feasibility Study Report and a summary fact sheet were released to the public in February 1994 in an effort to facilitate greater public involvement in the remedy selection process at the Sangamo OU2 Site. On March 28, 1994, a public forum was held at the Strom Thurmond Institute on the Clemson University Campus to discuss the various remedial alternatives under consideration in the Draft FS Report.

The Final FS Report, Proposed Plan Fact Sheet, and all other site-specific documents EPA relied upon to develop the Proposed Plan were arranged in an Administrative Record and released to the public in April 1994. The Administrative Record was maintained and available for public review at the EPA Records Center in Region IV, and the following five information repositories: The Village Library in Pickens, SC; Pickens County Public Library in Easley, SC; R.M. Cooper Library at Clemson University, SC; Hart County Library in Hartwell, GA; and the Corps of Engineers Lake Hartwell Natural Resources Management Center near the Dam in Hartwell, GA.

Concurrent with the public release of the Proposed Plan, a notice of availability of the Administrative Record was published in the Greenville News and Anderson Independent on April 11, 1994; the Athens Daily, Easley Progress, Hartwell Sun, and Pickens Sentinel on April 13, 1994; and the Clemson Messenger Journal Tribune on April 16, 1994. A public comment period was held from April 11 through May 11, 1994. A Proposed Plan Public Meeting was held on April 19, 1994 at the Ramada Inn in Clemson, SC. At this meeting, representatives from EPA, the Savannah District COE, and SCDHEC discussed the site conditions, the remedial alternatives under consideration and presented the rationale behind the preferred alternative. During this meeting, a request for an extension to the public comment period was made. As a result, the public comment period was extended until June 10, 1994. The notice of this extended public comment period was published in the Greenville News on May 2, 1994.

A response to comments received during this 60-day public comment period is included in the Responsiveness Summary, which is attached to this Record of Decision (ROD) as Appendix B. This decision document presents the selected remedial action for the Sangamo OU2 Site in Pickens County, South Carolina, chosen in accordance with CERCLA, as amended by SARA, and in accordance with the National Contingency Plan. The decision for this Site is based on materials in the Administrative Record and comments received during the public comment period.

4.0 SCOPE AND ROLE OF RESPONSE ACTION

Due to the size and complexity of the Sangamo Site, and in order to simplify the investigation and response activities, EPA divided the Site into two discrete study areas known as Operable Units (OUs). Operable Unit One (OU1) consists of the land-based source areas, including the Sangamo Weston Plant Site and six satellite disposal areas in Pickens County used for the disposal of solid wastes containing PCBs (Figure 1-2). The six satellite disposal areas are located in rural areas within a 3-mile radius of Pickens and have the following designations: Breazeale, Cross Roads, Dodgens, John Trotter, Nix and Welborn. EPA selected the remedy for OU1 in a ROD signed on December 19, 1990. Under a Consent Decree negotiated with EPA, Schlumberger initiated remedial action at OU1 in November 1993. This included the excavation of waste and PCB contaminated soils from the six satellite disposal areas and transportation of the excavated materials to temporary storage facilities at the former Sangamo Plant Site. A treatment system will be built and tested at the plant at which time the contaminated material will be treated by means of low temperature thermal desorption. In addition, groundwater recovery and treatment systems will be installed at the plant site and at applicable satellite areas.

Operable Unit Two (OU2), the subject of this ROD, addresses the PCB-contamination in the sediments and aquatic biota of the study area (Figure 1-2). The exposures associated with ingestion of fish contaminated with PCBs from all fish sampling stations in Lake Hartwell exceeded EPA`s acceptable human health risk range. OU2 represents the final response action EPA expects to implement as part of its overall strategy in remediating the Sangamo Site. This response action addresses the principal threat posed at the Site which is ingestion of PCB-contaminated fish.

5.0 SUMMARY OF SITE CHARACTERISTICS

Due to the atypical size and complexity of the Sangamo OU2 Site, the Sediment and Biological Investigations generated an immense and extensive data base. In the interest of brevity, this information will not be reiterated in this ROD. This section presents a brief, comprehensive overview of the Sangamo OU2 Site characteristics as assessed during the Remedial Investigation. The reader is referred to the Final Remedial Investigation Report (May 1993), Volumes I and II and/or the Final Biological Investigation Report (February 1994) for a more detailed account of this subject matter.

5.1 SUMMARY OF PHYSICAL CHARACTERISTICS

This section presents information concerning the physical characteristics of the study area including its surface features, surface water hydrology, meteorology, and demographics.

5.1.1 Surface Features

The Sangamo OU2 study area generally consists of sloping to moderately steep uplands that are dissected by a well-developed drainage system. There are a number of small towns in the area in addition to the city of Clemson. Outside of the towns and the residential developments along the Hartwell lakeshore, the countryside is predominantly rural. Much of the undeveloped area is forested, but significant agricultural tracts can also be found.

The northern portion of the Twelvemile Creek watershed is in the foothills of the Blue Ridge Mountains, an area characterized by steep, heavily forested slopes and ridges. Twelvemile Creek originates near 1,920-ft-high Walnut Cove Mountain, in an isolated area approximately 7 miles north-northeast of Pickens, which includes first- and second-order streams with abundant riffles (Figure 5-1).

The relief is somewhat lower in the vicinity of Pickens and the OU1 source areas. In this portion of the watershed, Twelvemile Creek occurs as a meandering, relatively slow-moving, fourth-order stream with abundant pools, sand and gravel bars, and broad floodplains that in some reaches exceed 1,000 ft. However, approximately 1 mile south of Pickens, the stream valley narrows and the creek has a large number of sharp bends. In this area, Twelvemile Creek resembles a mountain stream with exposed rocks, swift-moving water, and abundant riffles that in some locations may be considered rapids. Floodplains are generally absent as the creek valley narrows to widths of only 100 to 200 ft., bounded by moderate to steep slopes that are generally covered with trees and other vegetation. Access to the creek is difficult and generally limited to the few bridges in the area. These conditions continue downstream (south) to the headwaters of Hartwell Lake, just upstream of the Maw Bridge (Hwy 337 Bridge).

<IMG SRC 0494178C>

The Twelvemile Creek Arm of Lake Hartwell is characterized by a narrow channel with steep, heavily vegetated shoreline with only limited access. The waters in the upper portion of this arm have been impounded and thus water velocities are greatly reduced. There is a sharp bend in the lake near the Madden Bridge, but otherwise the channel has a linear, northeast-southwest trend. The lake becomes progressively wider downstream, reflecting the widening of the former Twelvemile Creek floodplain, and the number and size of inlet coves increases. The lakeshore along the Twelvemile Creek Arm is generally undeveloped due to the relief and development restrictions imposed by the COE, which has classified much of the western shoreline and the major inlet coves on the eastern shoreline as a Protected Lakeshore Area. This designation does not necessarily prohibit all development, but has served to greatly limit the type and extent of development within this portion of the lake.

In the downstream direction, past the Keowee River confluence, into the Seneca River Arm and finally into Lake Hartwell proper, the shoreline typically becomes more gradually sloped and is more developed with less vegetative cover than the shoreline of the Twelvemile Creek Arm. Relief around the main portion of the lake is much lower, primarily due to the pool elevation, which becomes progressively closer to the hilltops toward the south.

Lake Hartwell was formed by the construction of Hartwell Dam across the Savannah River approximately 7 miles below the point where the Tugaloo and Seneca rivers converge to form the Savannah River. Construction of the dam began in 1955 and was completed in 1963. The dam is a concrete and earth structure that spans 18,000 ft across the Savannah River and rises 204 ft above the riverbed at its highest point. At normal pool level, Hartwell Lake extends for 49 miles up the Tugaloo River and 45 miles up the Seneca River and its tributaries (i.e., Twelvemile Creek and the Keowee River).

At a normal pool elevation of 660 ft. mean sea level (MSL), the lake has an area of 56,000 acres and large expanses of open water, particularly below the point where Twenty-six Mile Creek meets the Seneca River. Because of the relief and large number of coves, the lake has a shoreline of 962 miles. There are a number of large arms in the main portion of the lake. The major ones include the Tugaloo Arm, Twenty-six Mile Creek Arm, Coneross Creek Arm, and Eighteen Mile Creek arm.

5.1.2 Surface Water Hydrology

The Sangamo OU2 study area is defined by hydrologic features; therefore, the surface water hydrology is one of the most important physical characteristics of the study area. This section presents an overview of the hydrologic characteristics of the Twelvemile Creek watershed and Lake Hartwell, which are the principal hydrologic units in the study area.

5.1.2.1 Surface Water Hydrology of Twelvemile Creek Watershed

The Twelvemile Creek watershed has an area of 140-mi² and includes first-, second-, third- and fourth-order streams. The tributaries to Twelvemile Creek are predominantly first- and second-order streams. The major tributaries, Town Creek, Wolf Creek, Rices Creek, and Golden Creek, are third-order streams. Twelvemile Creek is a third order stream above the mouth of Town Creek; below this point, Twelvemile Creek is a fourth-order stream. Twelvemile Creek is the longest stream segment

in the watershed, which flows southward for approximately 24 miles until reaching the headwaters of Hartwell Lake. Within this 24-mile reach, approximately 80 tributaries flow into Twelvemile Creek.

The gradient of the Twelvemile Creek basin is represented by the longitudinal profile shown in Figure 5-2. The profile extends from the confluence of the Middle and North forks into Hartwell Lake as far as the Rt. 37 Bridge (the downstream limit of the study area in Hartwell Lake). From this figure, it can be seen that the total elevation drop from the confluence of the North and Middle forks to the headwaters of the lake is approximately 200 ft, which over a distance of 17 miles amounts to an average slope of 11.8 ft per mile.

The bulk of the stream flow is derived from runoff. Flow data for Twelvemile Creek indicate an average daily flow of 198 cubic feet per second (cfs), with historical daily flow ranging from 30 to 5360 cfs. Sediment in the creek is composed primarily of sand and has a generally low total organic carbon content (TOC), ranging from 0.1 to 3.6 percent. NPDES permit data indicate that Twelvemile Creek receives discharges from sewage treatment plants and a small number of industrial facilities. These discharges average 1 to 2 million gallons per day. During low flow periods, the permitted discharges may comprise 10-13 percent of the flow in the creek; during normal flows, the discharges comprise less than 2 percent of the flow and become negligible during high flow periods.

The three impoundments on the lower section of Twelvemile Creek are all of masonry construction. The lowermost impoundment (Woodside II) is the largest of the three, with an upper pool elevation of 722 ft MSL and a lower pool elevation of 684 ft MSL (difference of 38 ft). This impoundment was built in 1905. The middle impoundment (Woodside I) is located in the community of Cateechee and was rebuilt in 1937 after it failed in 1934. The middle impoundment has an upper pool elevation of 760 ft MSL and a lower pool elevation of 736 ft MSL (difference of 24 ft). Both the lower and middle impoundments were constructed by Norris Mills and are currently owned and operated by Consolidated Hydro of Greenville, South Carolina. These two impoundments were renovated in 1983-1985 and currently produce a combined 2.5 million kWh/yr. In 1984, up to 20 ft of sediments were flushed from the pools behind the lower and middle impoundments. In September 1993, an estimated 43,000 cubic yards of sediment were flushed from behind the lowermost impoundment. Currently, sediments are flushed from these pools approximately biannually.

<IMG SRC 0494178D>

The third, or uppermost, impoundment was built in 1926 and is the smallest of the three impoundments, with an upper pool elevation of 783 ft MSL and a lower pool elevation of 763 ft MSL (difference of 20 ft). This upper impoundment was formerly used for generation of hydroelectric power. The impoundment was purchased by the Easley-Central Water District in 1962 and is currently used as the intake point for the Easley-Central Water Plant. Sediments are flushed from behind the upper impoundment quarterly. Approximately 6 ft of sediments are flushed from behind the impoundment during each flushing event.

Surface water in the Twelvemile Creek basin is currently utilized for drinking water supply, fishing, and industrial uses. Twelvemile Creek is classified as a Class B stream according to South Carolina Regulations (Regulation 61-68, Water Classifications and Standards). Under the regulations, Class B waters are defined as being suitable for secondary-contact recreation (fishing, boating, wading) and drinking water supply (assuming conventional treatment methods are used) as well as both agricultural and industrial uses.

5.1.2.2 Surface Water Hydrology of Lake Hartwell

The surface water hydrology of the Hartwell Lake reservoir is different from that described for the Twelvemile Creek basin because it is an impoundment with a drainage basin 2,088 mi^2. Hartwell Lake is managed by the COE for flood control and electric power generation, both of which are affected by the storage capacity of the reservoir, which is 2,550,000 acre-feet of water (equivalent to 830 billion gallons). Since its construction, the reservoir has become one of the major recreational lakes in the Southeast. Current management practices therefore consider recreational benefits as well as flood control and power generation.

The COE maintains a pool elevation of 660 ft MSL during the recreation season (summer); in mid-October through mid-December the lake level is dropped 4 ft to a level of 656 ft MSL. The lake is drawn down in the fall in anticipation of the increased rainfall that the area usually receives during the winter and spring. The annual fluctuations in the lake commonly exceed 4 ft; peak elevations commonly occur

in April or May. The lowest recorded monthly average lake level of 643.3 ft MSL occurred in December 1981.

Water flows in the Lake Hartwell system were characterized by the inflow and outflow data provided by the COE. These data consist of 30 years of daily inflow and outflow data collected between 1962 and 1992. The average monthly inflow to the lake for the period 1962-1992 ranged from a low of 2,693 cfs in September to a high of 6,222 cfs in March. Average monthly outflow from Hartwell Dam in the same period ranged from a low of 3,034 cfs in September to a high of 5,190 cfs in April. On a yearly basis, the average monthly inflow to Hartwell Lake has been 4,090 cfs; outflow has been 3,997 cfs. Given the reported storage capacity of the reservoir (2,550,000 acre-feet or 830 billion gallons), the estimated hydraulic residence time in the lake is 25 days.

Lake Hartwell is Class A surface water (South Carolina regulations) suitable for primary contact recreation (swimming, waterskiing), secondary contact recreation (fishing, boating, wading), drinking water supply, and agricultural/industrial uses. The lake currently receives a significant level of point and non-point source discharges. NPDES-permitted discharges include industrial facilities, electric power generating stations, and various sewage treatment plants. The permitted industrial discharges include heavy metals, volatile organic compounds, cyanide, phenol, oil and grease, and textile dyes. Permitted discharges comprise only 18 million gallons per day (approximately 200 cfs). Since the reservoir continues to be a source of potable water for a number of communities, these discharges apparently have not had an appreciable impact on water quality in the lake.

5.1.3 Meteorology

Pickens County has a temperate climate characterized by mild winters and relatively abundant rainfall. The National Weather Service has two precipitation and temperature gauging stations in the Twelvemile Creek area, one at Pickens and the other at Clemson. Table 5-1 summarizes the monthly mean temperature and precipitation for these two locations.

Generally the mean monthly temperature is higher in the summer and winter months in Clemson while in the spring and fall it is higher in Pickens. The average monthly precipitation for the Pickens and Clemson stations ranges between 3.5 in. and 6.1 in. Annual precipitation in both Clemson and Pickens is more or less evenly distributed throughout the year. The average annual precipitation for Pickens from 1951-1992 was 56.04 in. The maximum and minimum annual rainfall events occurred 1964 and 1981, respectively, when 78.46 in. and 33.40 in. were recorded. In Clemson, the average annual precipitation from 1911-1992 was 53.23 in. The maximum and minimum annual rainfall events occurred in 1936 and 1925, respectively, when 73.36 and 34.31 in. of precipitation were recorded.

Free water surface evaporation data was obtained for the study area from the Evaporation Atlas for the Contiguous 48 United States (NOAA 1982). These data indicate that annual evaporation from Hartwell Lake should be in the range of 40 to 41 in. With annual precipitation in the area greater than 53 in., Hartwell Lake receives 12 to 13 in. of net precipitation per year.

TABLE 5-1
Monthly Mean Temperature and Precipitation for Clemson and Pickens, South Carolina1

Month	Clemson, SC[2]		Pickens, SC3	
	Temp. (°F)	Precipitation (inches)	Temp. (°F)	Precipitation (inches)
January	42.8	5.01	42.0	5.14
February	45.4	5.01	45.3	5.12
March	51.9	5.65	52.5	6.07
April	60.6	4.31	61.2	4.53
May	68.4	4.12	68.3	4.60
June	75.7	3.95	74.7	4.53
July	78.4	4.86	77.8	4.76
August	77.6	4.57	77.1	4.40
September	72.7	3.54	71.8	3.64
October	61.8	3.68	62.0	4.05
November	51.6	3.49	52.4	4.02
December	44.2	4.98	44.2	4.91

1 Data Source: National Climatic Data Center
2 Reporting Period 1911-1992
3 Reporting Period 1951-1992

5.1.4 Demographics

Demographics and land use in the Hartwell Lake area are variable, with small towns and rural residential development in the Twelvemile Creek watershed giving way to larger towns and more concentrated development in the areas surrounding Hartwell Lake. According to 1990 census data, approximately 356,000 people live in the six counties that border Hartwell Lake: Anderson, Pickens, and Oconee counties in South Carolina; and Hart, Franklin, and Stephens counties in Georgia. Of this total, an estimated 297,000 people live in the South Carolina counties; 93,894 live in Pickens County alone.

The major community in the upper portion of the Twelvemile Creek watershed is Pickens, which had an estimated population of 3,042 in 1990. Two communities are located along Twelvemile Creek: Cateechee (estimated 1990 population of 158) and Norris (estimated 1990 population of 884). The town of Clemson, with an estimated 1990 population of 11,096, is the only large community directly on the shoreline of the lake. Outside of the small towns and communities, the majority of the Twelvemile Creek watershed (and Pickens County in general) is undeveloped. Most of the acreage bordering Twelvemile Creek and its tributaries is either forested or cleared for agricultural purposes.

The entire Hartwell project, both land and water usage, is managed by the COE Savannah District. Hartwell Dam was constructed by the COE as part of a flood control and hydroelectric power project. In addition to these primary uses, Hartwell Lake has developed into one of the largest and most popular recreational lakes in the southeastern U.S. According to a 1989 COE survey, more than 15 million people visited the lake, making it one of the three most visited COE lakes in the nation. Data from a recreational area on Twelvemile Creek indicates that, out of a total of 301,000 visitors, 125,787 visits were made for fishing, 76,892 for boating, 30,310 for water skiing, and 28,139 for swimming.

Development along the shoreline of Lake Hartwell is at least partially controlled through the COE Lakeshore Management Plan (COE 1989). The COE controls 23,566 acres above the normal pool elevation of 660 ft MSL. The COE acreage in effect establishes a buffer zone of variable width around the entire shoreline. This buffer zone enables the COE to restrict access, development, and the types of activities permitted. These restrictions are effected through a system of permits and land use allocations as established in the Shoreline Management Plan. In order to administer the permit program, the shoreline of Hartwell Lake was allocated into four categories: Limited Development Areas, Public Recreation Areas, Protected Shoreline Areas, and Prohibited Access Areas.

Surface water supplies the bulk of potable water utilized by the residents of Pickens County and surrounding areas. Currently there are two active water intakes on Twelvemile Creek; these intakes provide potable water supply to the Pickens Water Plant and Easley-Central Water Plant. The Pickens Water Plant intake point is located near the confluence of the Middle and north Forks of Twelvemile Creek. Withdrawals from this intake enable the Pickens Plant to supply 2 to 2.5 mgd of potable water to approximately 4,000 residents in the Pickens area. The intake for the Easley-Central Water Plant is located in the uppermost of the three impoundments on Twelvemile Creek. According to the Easley-Central Water Plant, withdrawals from this intake supply an average of 1.2 mgd of potable water to approximately 1,100 residents in the plant's service area.

5.2 SEDIMENT INVESTIGATION SUMMARY

Field investigation activities for the sediment component of the Sangamo OU2 RI were conducted in two seasonal sampling events. The initial, Phase I event was conducted during July and August 1991. The objectives of Phase I were to verify extent-of-contamination data from previous investigations and further characterize the magnitude and distribution of PCB contamination in the Twelvemile Creek watershed and Hartwell Lake. Results of Phase I sampling were used to define a focused sampling program for the second, Phase II sampling event. Phase II was conducted during April and May 1992. The objective of Phase II was to address specific data gaps regarding the extent of PCB contamination in sediments of the upper Hartwell Lake reservoir (i.e., Seneca River, Keowee River, and Twelvemile Creek Arms) and the Twelvemile Creek watershed.

5.2.1 Phase I Investigation

Phase I field sampling encompassed an area extending some 50 miles, from the Sangamo Weston Plant site and the satellite disposal areas to the Hartwell Dam. A total of 480 samples, exclusive of quality assurance/quality control (QA/QC) samples, were collected during Phase I from Twelvemile Creek, its tributaries, and Hartwell Lake. Phase I samples included 88 surface water, 341 sediment core, and 51 sediment grab samples, at 50 locations throughout Lake Hartwell. An onsite field screening method, the Modified Spittler Method (See Section 5.2.3), and offsite Contract Laboratory Program (CLP) laboratories were used to analyze the samples.

A stainless steel ponar grab sampler was used for collecting the surface sediment sample. The depth of sample collected by the grab sampler was approximately 10 to 15 cm. A representative sample from this surface zone was important to adequately characterize the horizontal contamination in the biologically active zone and to determine the quality of sediment that was recently deposited. All 51 grab samples were analyzed by CLP laboratories. Four of these samples were selected for full-screen Target Compound List (TCL)/Target Analyte List (TCL) analyses. Offsite analyses were also conducted for grain size, TOC, and cation exchange capacity, all which are factors that affect the mobility of PCBs and other contaminants.

Sediment core samples were recovered to a maximum depth of 50 cm to characterize the vertical distribution of PCBs in the sediment. In shallow water areas, core samples were collected by driving a stainless steel core tube into the sediment by hand. In deep-water areas, a gravity corer with a stainless steel liner and core catcher was used to collect the subsurface sample. In both cases, sediment was extruded from the top of the core tube at 5-cm intervals and placed in jars marked according to the depth interval. All core samples were analyzed for total PCBs. Split samples were collected from 19 percent of the sediment cores analyzed onsite and sent for offsite PCB analyses at a CLP laboratory. This was done to determine the correlation between field and laboratory analytical results.

Surface water samples were collected at all 50 locations. A near-surface water sample was collected at all stations by dipping the mouth of the sample container just beneath the surface of the water. Where water depths exceeded 4 to 6 ft, a near-bottom sample was collected approximately 1 ft above the

sediment interface using a peristaltic pump and teflon tubing. All 88 water samples were analyzed for PCBs and TOC at offsite CLP laboratories. Samples from 4 stations received full scan TCL/TAL analyses. Selected surface water samples were also analyzed for the following water quality parameters: total dissolved solids (TDS), total suspended solids (TSS), chloride, flouride, sulfate, and nitrate-nitrite.

Given the large number of samples collected on the open water of Hartwell Lake, the technical impracticality of conducting an accurate location survey utilizing traditional survey methods, and the importance of precise sample locations in determining the nature and extent of contamination in OU2, sample location coordinates (latitude/longitude) were determined utilizing a hand-held Magellan Global Positioning System (GPS). GPS is a network of 24 satellites orbiting the earth at an altitude of 10,900 miles. The satellites and the hand-held receivers both generate a continuous code which allows the receiver to calculate how long it takes the signal to travel from the satellite, and then to extrapolate the satellites's distance. Once the hand-held receiver gets position information from three satellites, position coordinates are determined by triangulation.

5.2.2 Phase II Investigation

During the Phase II study, a more extensive sampling program was conducted in areas determined during the Phase I study to have the highest PCB concentrations. The Phase II field sampling effort focused on the Keowee River, Seneca River and Twelvemile Creek Arms of Hartwell Lake as well as Twelvemile Creek itself. Not including QA/QC samples, 744 samples consisting of 185 surface sediment, 550 sediment core, and 9 storm-event surface water samples were collected and analyzed by field screening and CLP analytical methods. Sample collection and location techniques were as described under Section 5.2.1.

Twenty transects with a maximum of five sediment coring stations per transect were established across the lake and creek bed. The sediment core stations along each transect were selected following a review of the bottom depth profile collected with a bathymetric profiler. Sediment grab samples were then collected between each transect location. Sediment was sampled from a total of 374 locations during the Phase II study. Composite surface water samples were collected from the following bridges, which cross Twelvemile Creek and the upper reaches of the Hartwell Lake reservoir: the Maw Bridge (Rt. 337), Madden Bridge (Rt. 15), Hwy 133 Bridge, Hwy 93 Bridge, and Rt. 37 Bridge. Samples were collected from these stations following two significant storm events to evaluate the potential for resuspension of PCBs into the water column.

5.2.3 Field Screening - Modified Spittler Method

Both phases of the Sediment Investigation utilized the Modified Spittler Method, a field screening analytical technique, to significantly reduce cost and turnaround time on analyses. Reduced turnaround time (approximately 24 hours) enabled sampling teams to identify locations where additional sampling was warranted and to evaluate data quality on a real time basis.

The Modified Spittler Method is an EPA-approved field screening technique for quantifying total PCB concentrations in a sediment/soil matrix. The technique employs a gas chromatogram (GC) with an electron capture detector (ECD), and has demonstrated reliability in the quantification of PCB concentrations in excess of 1 ppm (mg/kg). The primary difference in time and cost between the CLP procedure and Spittler Method is incurred in the extraction procedure. Using commonly available laboratory equipment, one analyst can extract 10 to 20 samples in less than 2 hours. The cost of GC/ECD analysis using the Spittler Method is between $50 and $100, compared to approximately $300 for conventional CLP analysis.

A total of 122 samples were analyzed for PCBs by both the modified Spittler and CLP methods during Phase I and II. A statistical comparison of the 67 Phase II samples analyzed by both CLP and Spittler was performed by the EPA Environmental Monitoring Systems Laboratory (EMSL) in Las Vegas, Nevada. Twenty-eight of these samples were reported as "non-detect" by both analytical methods. Of the remaining 39 samples, PCB concentrations reported by Spittler were greater than those reported by CLP for 35 samples, 3 samples analyzed by Spittler were less than the concentration reported by CLP, and 1 sample was not detected by Spittler, but was detected by CLP (i.e. false negative).

In general, PCBs results obtained by field screening were conservative. Ninety percent of the results were higher than those obtained by the CLP method, and only one false negative was reported. Only one result was an order of magnitude greater than the CLP laboratory result. Although correlation

coefficients were low, the data sets were generally in agreement when the factors affecting comparability are taken into consideration. The major reasons for poor statistical correlation in results were attributed to nonhomogeneity of the split samples and the differences in PCB quantitation.

Based upon this comparison, the Modified Spittler Method was found to detect PCBs as well as the CLP laboratory. It was concluded that the Spittler Method produces data of Data Quality objective (DQO) Level II/III when compared to DQO Level IV for CLP analyses. However, the level of data quality generated by this field screening technique allowed EPA to cost effectively determine the nature and extent of PCB contamination in a study area that encompassed approximately 40 stream miles and over 1,000 acres of open water.

5.2.4 Nature and Extent of PCB Contaminated Sediment

Previous investigations and the Sangamo OU2 RI have delineated in detail the distribution and magnitude of PCB contamination in sediment within the study area. Most of the contaminated sediment lies within the upper portion of Hartwell Lake, specifically the Twelvemile Creek Arm and Seneca River Arm opposite the city of Clemson. Within the Twelvemile Creek watershed, minor levels of PCB contamination have persisted in Town Creek near the Sangamo Weston plant site and in the impoundments associated with the 3 small dams on Twelvemile Creek. Within Hartwell Lake, localized accumulations of contaminated sediment have been detected as far downstream as the dam, with concentrations generally decreasing with increasing distance downstream from the Twelvemile Creek Arm. Concentrations have been decreasing since the mid-1980's, reflecting a decline in PCB input to the lake as well as the burial and/or dilution of previously deposited sediment through mixing with clean sediment.

A summary of the significant findings regarding PCB contamination in sediment for eight subsections of the study area is presented below. The sediment investigation results are also graphically illustrated on Figures 5-3, 5-4, 5-5 at the end of this section. Bridges and landmarks used in the description of the study area subsections can be found on these figures or Figure 5-1 and 1-2.

<u>Upper Twelvemile Creek Watershed</u> - This section includes segments of the principal tributaries of Twelvemile Creek that collect drainage or other discharges from the Sangamo Weston Plant Site and the six satellite disposal areas. This section also includes Hagood Reservoir and tributary reaches associated with the Midway Dump and Easley-Pickens Landfill. Sampling conducted for the RI and previous investigations supports the following conclusions:

- Sediment contamination in Twelvemile Creek was limited to isolated occurrences between the mouth of Town Creek and the upper (Easley-Central) impoundment; PCB concentrations were typically <1 mg/kg.

- PCB-contaminated sediments remain in Town Creek downstream of the Sangamo Weston outfall; RI data show concentrations as high as 6.5 mg/kg.

- The OU1 satellite disposal areas represent insignificant sources of PCB contamination based on the results of sediment sampling from locations downstream of these areas.

- Town Creek was confirmed as the only tributary contributing PCBs to Twelvemile Creek, further substantiating earlier conclusions that the Sangamo Weston Plant Site has been the principal source of PCB contamination released into the Twelvemile Creek watershed and Twelvemile Creek Arm of Hartwell Lake.

<u>Lower Twelvemile Creek Watershed</u> - This section includes the three small impoundments and the lower reach of Twelvemile Creek to the Lay Bridge (just south of the lowermost impoundment). Sampling in the impounded waters and in close proximity downstream of the 3 small dams in the lower reaches of Twelvemile Creek indicate low levels of PCB contamination have persisted and/or continue to accumulate in this area. Specific conclusions include the following:

- The upper impoundment had the lowest levels of PCB contamination among the 3 impoundments; concentrations were typically below detection limits or <0.5 mg/kg.

- The middle (Woodside I) impoundment had only low levels of PCB contamination (<1 mg/kg), most of which was detected in core intervals below 10 cm.

- More highly contaminated sediment has accumulated in the lower (Woodside II) impoundment; most samples had <1 mg/kg but concentrations ranged up to 6 mg/kg in core samples.

- All 3 of the impoundments are flushed on a periodic basis to remove sediment and the slightly contaminated sediment detected in these impoundments will eventually be released into the Twelvemile Creek Arm of Lake Hartwell.

Upper Twelvemile Creek Arm - This section begins at the Lay Bridge and extends south, in a downstream direction, to Madden Bridge (Route 15 Bridge). Historical and RI data indicate that potentially significant quantities of PCB-contaminated sediment have accumulated in the upper portion of the Twelvemile Creek Arm of Hartwell Lake, particularly in the open water section immediately above the Madden Bridge. Specific conclusions include:

- The most significant accumulations of PCB-contaminated sediment coincided with depositional areas for fine-grained materials; in the upper arm, these areas typically occurred in proximity to the shoreline or in coves.

- The uppermost portion of the arm, in the vicinity of Maw Bridge, has only minor levels of contamination (1-2 mg/kg) due to the higher water velocities and limited sedimentation.

- The open water area upstream of the Madden Bridge represents the principal site for deposition of contaminated sediment in the Twelvemile Creek arm; concentrations have ranged as high as 153 mg/kg in historical samples and to a maximum of 61 mg/kg in the RI samples.

- The magnitude of PCB contamination in the upper arm has declined significantly since the mid-1980's, reflecting the decreased input of PCBs to the lake and, in the open water area, burial of the more highly contaminated sediment through deposition of several feet of sediment with much lower levels of contamination. This burial is consistent with results from the HEC-6 sediment transport modeling discussed in Section 5.4.

- The vertical extent of contamination in the open water area was not defined. Given that the source of PCB contamination predated the impoundment of the creek and that releases continued for many years thereafter, contaminated sediment probably extends down to the original elevation of the land surface (and former channel).

Middle Twelvemile Creek Arm - This section begins at Madden Bridge and extends south to the Hwy 133 Bridge. A variable distribution of low to moderate levels of contamination was identified, with higher concentrations generally limited to depositional areas having finer-grained sediment. Specific conclusions include:

- Sediment PCB concentrations in the middle portion of the arm have varied over time, but since 1985 have consistently been greater than 1 mg/kg and in most cases greater than 3 mg/kg.

- RI data show surface sediments contaminated with 1-3 mg/kg of PCBs and slightly higher concentrations in deeper sediment from core samples.

- The more highly contaminated sediment was encountered in samples from depositional areas such as Moore Bend and the open water area upstream of the Highway 133 Bridge.

- PCB concentrations in samples collected from depositional areas show a downward trend since 1988, indicating decreased input of PCBs into the lake and that more highly contaminated sediments have either been buried, resuspended and transported away, or diluted through mixing with cleaner sediments.

- Alternating sequences of vertically increasing or decreasing contamination observed in the majority of sediment cores from the Twelvemile Creek arm complicate the interpretation of the vertical extent of contamination. This vertical extent was not defined in the middle segment of the arm.

Lower Twelvemile Creek Arm - This section begins at the Hwy 133 Bridge and extends south to the U.S. Hwy 123 Bridge adjacent to Clemson. The lower portion of the Twelvemile Creek arm has also been a depositional area for contaminated sediment, as evidenced by the widespread PCB contamination in this

area. A summary of the major findings include:

- RI data show PCB concentrations in surface sediments generally in the range of 1-2 mg/kg; higher concentrations were detected in core samples, with maximums in the 18-21 mg/kg range. Concentrations generally decreased with increasing distance downstream but localized accumulations of more highly contaminated material were identified.

- The vertical limits of contamination generally occurred in the upper 30-40 cm of sediment in most of the historical and RI sediment cores.

- The more highly contaminated sediment in the lower arm was usually detected in samples collected from within or in close proximity to the former submerged channel of Twelvemile Creek.

- A decline in sediment PCB concentrations was observed at the mouth of Twelvemile Creek, reflecting the influence of the Keowee River arm, which has a much higher average flow than Twelvemile Creek.

- PCB concentrations in the shallow sediment (0-15 cm) of the lower arm have declined significantly, reflecting the decreased input of PCBs and/or that the more highly contaminated sediment detected in previous investigations is getting buried by or diluted through mixing with cleaner sediment.

- The persistence of relatively high levels in deeper sediment (down to 40 cm) supports conclusions based on the HEC-6 modeling that only limited amounts of sedimentation occur in the lower portion of the Twelvemile Creek arm.

Keowee Arm - The Keowee Arm is a branch of Lake Hartwell that meets the Twelvemile Creek Arm just north of Clemson. Historical data and the Phase I/Phase II sampling results from the Keowee River Arm indicate the following:

- RI data have shown generally low levels of contamination (<2 mg/kg) in the lower part of the Keowee arm, most likely related to hydrodynamic interactions with the Twelvemile Creek or Seneca River arms.

- Historical data included higher levels of contamination (6-7 mg/kg) in core samples collected from locations farther upstream in the Keowee arm, possibly indicating an additional PCB source in the upstream portion of the Keowee arm. This contamination is probably not related to the Twelvemile Creek source because of its occurrence several miles upstream in the Keowee arm and because flow in the Keowee is several times greater than flow in Twelvemile Creek. Data were insufficient to characterize the magnitude or determine the location of this source.

Seneca River Arm/Upper Section of Hartwell Lake - This section begins at the Hwy 123 Bridge and extends south to the Route (Rt) 37 Bridge. PCBs were detected throughout this area as concluded below:

- Surficial sediments had contamination in the range of 1-2 mg/kg everywhere except the excavated channel opposite the Clemson University diversion structures.

- Deeper contamination was encountered in the former Seneca River channel and the open water area just upstream from the Highway 37/Southern Railroad embankment. Deposition of more highly contaminated sediment near the Highway 37 embankment was attributed to the hydrodynamic influences associated with the constriction of the channel at this location.

- Residual PCB contamination likely exists in the former Seneca River channel located on the western edge of the Clemson University campus, behind the diversion structures.

- The vertical extent of contamination was defined and generally limited to depths of 20-40 cm. A good correlation between the depth of contamination in cores collected in 1988 and for the RI (in 1991-1992) indicate that only limited sedimentation has occurred in this portion of the lake during this 3 to 4-year period.

- Maximum PCB concentrations in sediment core samples declined from levels of 16 to 18 mg/kg in 1988 to concentrations of 5 to 11 mg/kg in 1991/1992; explanations for the decline, if predicted low sedimentation rates are accurate, include spatial variability in the distribution of contamination and continued mixing of the vertical sediment profile.

Lake Hartwell Proper - This section includes the remainder of Lake Hartwell, beginning at the Rt 37 Bridge and extending south to the Hartwell dam. Historical sampling in this area indicate that PCB contamination has migrated as far downstream as the Hartwell dam. This was not confirmed during the RI. The occurrence and magnitude of PCB contamination in Lake Hartwell declined significantly downstream of the confluence of the Seneca River Arm and Twenty-six Mile Creek, reflecting the input of significant quantities of uncontaminated sediment from Twenty-six Mile Creek and the various other tributaries. The majority of widespread contamination in the lower part of the lake was limited to concentrations below 1 mg/kg.

5.2.5 Other Contaminants in Sediment

A limited number of sediment grab and core samples were collected for full-screen TCL/TAL analyses. No significant contaminants other than PCBs were detected in these analyses. Specific conclusions include:

- No volatile organic contaminants were detected in any of the samples other than an estimated concentration of acetone (2200J µg/kg) in one duplicate sample.

- A number of semivolatile organic compounds were detected in one of the samples, mostly in low, estimate concentrations that were not indicative of significant contamination.

- Several unidentified semivolatile organic compounds were reported in sediments at 4 sampling stations, ranging in concentration from 2 mg/kg to 200 mg/kg. These compounds were most likely petroleum hydrocarbons related to urban run-off or boating discharges of fuel and oil.

- Several pesticide compounds (DDE, DDD, and DDT) were also detected, in low, estimated concentrations of 0.0024 to 0.053 mg/kg.

- Metals analyses did not identify any sediment with elevated concentrations of heavy metals; the following metals were not detected: antimony, arsenic, cadmium, mercury, selenium, and thorium.

<IMG SRC 0494178E>
<IMG SRC 0494178F>
<IMG SRC 0494178G>

5.2.6 Summary of Surface Water Investigations

Surface water quality investigations have focused on the presence of PCBs in waters downstream of the Sangamo Weston Plant Site, the OU1 offsite disposal areas, and/or the Midway dump and Easley-Pickens landfill. Relevant conclusions from these historical investigations and the RI studies include:

- The most frequent and highest levels of PCB contamination (1.7-20.3 µg/l) were detected in surface water samples collected from locations downstream of the Sangamo Weston outfall on Town Creek.

- PCBs were either not detected or present in concentrations <1 µg/l in surface water samples collected from drainage ditches and tributaries associated with the OU1 offsite disposal areas (Breazeale, Cross Roads, Dodgens, Trotter, and Welborn disposal areas). These areas are apparently not releasing appreciable levels of contamination to Twelvemile Creek or its tributaries.

- Based upon NPDES data, PCB concentrations in discharge from the Sangamo Weston wastewater treatment plant outfall on Town Creek during the mid-1970's averaged 13 µg/l and ranged as high as 235 µg/l; NPDES monitoring data from this outfall for 1992 reported PCB concentrations in the range 0.4 to 40.3 µg/l. This continued release of PCBs to Town Creek and the downstream portions of OU2 are expected to terminate once the OU1 remedial action at

the Sangamo Weston plant site has been completed.

- PCBs were not detected in any of the surface water samples collected for Phase I of the RI; detection limits for these unfiltered samples ranged from 1.2 to 1.3 µg/l.

- A limited number of these RI samples were also analyzed for full TCL analyses; no volatile organics, extractable organic compounds, pesticides or cyanide were detected, and inorganic (metals) concentrations were not indicative of contamination.

- PCBs were not detected in any of the storm event samples collected for Phase II of the RI; detection limits for these unfiltered samples ranged from 1.2 to 1.3 µg/l.

5.3 BIOLOGICAL INVESTIGATION SUMMARY

Field activities for the Biological Investigations were conducted by the COE in the Spring 1991, 1992, and 1993. The field activities were divided into two individual study areas; the Twelvemile Creek watershed and Lake Hartwell. The specific methods employed and results from these two investigations are summarized in the following sections.

The information gathered from the Biological Investigations conducted in the Twelvemile Creek watershed further support the conclusions made in the sediment component of the RI that: 1) the Sangamo Plant Site is the primary source of PCB contamination in Twelvemile Creek; and 2) the contribution of PCB contamination in the Twelvemile Creek watershed from the six satellite disposal areas is negligible. The aquatic biota in Twelvemile Creek appear to have suffered from the influence of man's activities. Although PCBs have likely contributed to these perturbations producing cumulative effects, other factors have no doubt had an additional impact on these animals at the population and community levels.

Fish in Lake Hartwell continue to be contaminated with PCBs often at levels that exceed the FDA safe tolerance limit of 2 mg/kg. PCBs appear to be the only pollutant of concern in Lake Hartwell fish. The highest concentrations of PCBs in fish are located in the Twelvemile Creek Arm. PCB concentrations in fish species that are generally non-migratory decrease both downstream and farther from the Twelvemile Creek Arm. Migratory fish species have PCB concentrations that are similar throughout the reservoir and are high enough to be a concern.

PCBs were detected at all levels of the food chain in both the Twelvemile Creek watershed and Lake Hartwell. Pathways for PCB uptake in aquatic biota of Lake Hartwell include ingestion through the food chain and contact, most likely through the gills. Exposure results from PCBs being adsorbed to sediments and transported down Twelvemile Creek into Lake Hartwell.

The health of fish in Lake Hartwell does not appear to be affected at the population level for fish that have PCB concentrations at the current levels (around 5 mg/kg). However, there is evidence that as concentrations increase to greater than 20 mg/kg fish health can be affected. Largemouth bass was the target species used during these investigations. The sensitivity or tolerance of other fish species to PCB contamination is not known.

5.3.1 Twelvemile Creek Watershed Investigations

Field investigations in the Twelvemile Creek watershed were conducted during Spring 1992 to: 1) determine the concentration of PCBs in one primary sport fish species and one bottom feeding species; 2) assess the condition of the fish community by determining the Index of Biotic Integrity (IBI); 3) assess the condition of the macroinvertebrate community by using Benthic Rapid Bioassessment techniques; 4) assess fish health of redbreast sunfish by using bioindicators and the Health Assessment Index (HAI); 5) assess composition and fate of harvest to determine public utilization by using a creel survey; and 6) determine on-going PCB contamination due to transport of drifting organic matter and bioaccumulation by a sediment dwelling, filter feeding organism, the freshwater clam (Corbicula fluminea).

<IMG SRC 0494178H>

Twelve sampling stations were established in Twelvemile Creek and three uncontaminated tributaries. These sample stations are shown in Figure 5-6. The length of each station was from 0.3 to 0.5 miles to encompass gross habitat types and ensure adequate sample size. Stations were permanently marked

with "Carsonite" markers located in the creek bank at the upper and lower boundaries. All 12 stations were not involved in each sub-element of the overall investigation (i.e. PCB tissue analysis, IBI, HAI).

Twenty fish were collected for PCB contaminant analysis from each of the stations in the Twelvemile Creek watershed and one tributary reference site. Redbreast sunfish (Lepomis auritus) were used as a sport fish species for assessment of human health and environmental risk. Redbreast sunfish were chosen based on abundance and likelihood of use by anglers. Ten redbreast were collected per site. Ten northern hogsauckers (Hypentelium nigricans) were collected per site to determine PCB concentrations in a bottom feeding species to assess environmental risk. Northern hogsuckers were selected based on abundance and tropic level. Largemouth bass and bluegill were substituted for redbreast sunfish at three stations.

Concentrations of PCBs in fish collected in the Twelvemile Creek watershed were highest in Town Creek and Twelve Mile Creek. Four of the 12 stations sampled had PCB values exceeding 2.0 mg/kg. Three of these stations (5, 8, and 12) were downstream from the Sangamo Plant Site. Station 4, the other station having high PCB values, was located just upstream from the confluence of Town Creek and Twelvemile Creek and was probably affected by fish migrating from both creeks. Stations upstream from station 4 could not be affected by migration due to a low head dam located at the upper boundary of station 4. Mean PCB concentrations ranged from a high of 12.5 mg/kg for northern hogsuckers in Town Creek to a low of 0.88 mg/kg in redbreast sunfish in Twelvemile Creek for stations downstream from the Sangamo Plant Site. The remaining stations located in tributary streams or upstream from the Sangamo Plant Site had lower PCB concentrations in fish than those located downgradient from the plant site.

Several non-diagnostic studies which employed a metric/index system were conducted to assess the health or condition of individuals, populations and/or communities in the Twelvemile Creek watershed. The benthic macroinvertebrate community of Twelvemile Creek watershed was evaluated using EPA's rapid bioassessment protocols. Samples were collected at a reference site and the remaining sites shown on Figure 5-6. Eight of the nine stations sampled in the Twelvemile Creek drainage were classified as moderately impaired. Station 11, located upstream of the Sangamo Plant site on Town Creek, was classified as non-impaired and had high values for taxa richness and exhibited an abundance of intolerant taxa. Sites immediately downstream of the Sangamo facility exhibited evidence of greater impairment than did upstream or tributary sites.

The Index of Biotic Integrity (IBI) was used to assess the general health of the fish community in the Twelvemile Creek watershed. The IBI index is based on a set of metrics determined from species composition and abundance for a fish community. These metrics focus on basic ecological characteristics of the fish fauna and have been used effectively in stream monitoring programs for the past decade. Nine stations in the Twelvemile Creek watershed and three reference sites were sampled. The IBI was effective for ranking the reference sites as expected based on no identifiable impacts at station 1 (IBI 40), known impacts of agricultural runoff at station 2 (IBI 30), and a known point source discharge at station 3 (IBI 12). Therefore, it appeared appropriate to use the IBI to assess the relative health of fish populations in the Twelvemile Creek watershed with confidence.

The IBI scores indicated that all stations sampled have been impaired to some degree. Most stations throughout the watershed were classified as either "fair" or "good" indicating moderate negative effects on the fish communities that could have resulted from habitat degradation from man's activities. Only the two reference stations 2 and 3 that were identified as having known impacts and station 5, located in Twelve Mile Creek downstream from Town Creek, were classified as "poor" or "very poor." The IBI classification at station 5 ("poor") and a comparison of relative health between sample stations and reference stations indicated that station 5 has been severely impacted. Both habitat degradation and water quality impacts including PCB contamination likely contributed to this adverse impact.

Both the macroinvertebrate and fish communities have been impaired throughout the Twelvemile Creek watershed. Assumably, these impairments have resulted from PCB discharges, habitat degradation, particularly siltation due to erosion from development, siviculture and agriculture, and poor water quality from both point and non-point discharges throughout the watershed.

The Health Assessment Index (HAI) was employed to assess the health of redbreast sunfish at selected stations in the Twelvemile Creek drainage and a reference site. HAI is an autopsy based index that uses divergence from the normal of various organs, tissues and blood parameters to evaluate fish health. The HAI scores for redbreast sunfish were variable throughout the watershed ranging from 39.3

to 62.7. Station 12 located in Town Creek immediately downstream from the Sangamo site had the lowest HAI score, 39.3, indicating healthy fish at this site.

It is not evident from evaluating the HAI scores that the health of redbreast sunfish has been effected by PCB contamination. HAI scores were variable throughout the drainage. However, scores in the range seen during this investigation were not considered high. It is likely that health problems that would manifest themselves to visual inspection through autopsy do not occur in fish contaminated at the lower PCB concentrations seen in redbreast sunfish in the Twelvemile Creek drainage.

Drift net samples were used to collect detritus (floating organic matter) in Town Creek downstream of the Sangamo site and in Twelvemile Creek at Lay Bridge. Additionally, cages of "clean" Corbicula fluminea (fresh water clams) were placed at these sites for 28 days to determine rates of bioaccumulation of PCBs by analyzing the muscle tissue. Drift net samples of coarse particulate matter collected from Town Creek, immediately downstream of the Sangamo Plant Site had detectable PCB concentrations ranging from 0.066 to 0.51 mg/kg. PCB concentrations in corbicula collected at this station ranged from 0.75 to 0.88 mg/kg. Corbicula collected from the station immediately downstream of the Lay Bridge had PCB concentrations that ranged from 0.45 to 0.57 mg/kg. From these results, it can be concluded, that even though PCBs have not been detected in water samples collected from the study area, transport of PCBs down Town Creek and Twelvemile Creek is occurring.

5.3.2 Lake Hartwell Investigations

Studies in Lake Hartwell were conducted during Spring 1991, 1992, and 1993 to: 1) determine the concentration of PCBs in primary sport and forage fish species; 2) assess fish health of largemouth bass using bioindicators and HAI; 3) determine PCB concentrations in seston and macroinvertebrates; and 4) assess composition and fate of harvest to determine public utilization using a creel survey.

Fish species selected for Lake Hartwell contaminant analysis included: 1) sport and/or commercial species, 2) fishes that seasonally occupy different habitats or exhibit seasonal migrations, and 3) primary forage species. Species selected for collection and analysis were: largemouth bass, hybrid bass, channel catfish, threadfin shad (Dorosoma petenense), gizzard shad (Dorosoma cepedianum), blueback herring (Alosa aestivalis), and bluegill (Lepomis macrochirus).

A total of 134, 144, and 144 fish were collected from six locations throughout Lake Hartwell during spring 1991, 1992, and 1993, respectively. These six stations are illustrated on Figure 5-7 and were selected to represent a gradient of PCB contamination in fish ranging from the most impacted (SV-107 in the Twelvemile Creek embayment) to a background location (SV-641) in the Tugaloo Arm. These fish were analyzed for PCB concentrations in standard U.S. FDA fillets with skin on, de-scaled with rib cage (except for catfish where the skin was removed). Additionally, the 60 largemouth bass collected in 1991 were analyzed for priority pollutants. Composite samples of forage fish, including bluegill, threadfin shad, gizzard shad, and blueback herring, were collected from SV-107 (highly impacted), SV-532 (intermediate zone), and SV-641 (background).

PCB concentrations in fish have historically been highest in the Twelvemile Creek Arm of Lake Hartwell (SV-107) and decrease in a downstream direction. This is expected since PCBs enter Lake Hartwell bound to sediments that are transported down Twelvemile Creek, as discussed in Section 5.2 of this ROD. Results of PCB analyses collected from 1990-1993 for largemouth bass, channel catfish, and hybrid bass are graphically illustrated on Figures 5-8, 5-9, and 5-10, respectively. These years were comparable since analyses were completed in the same manner. Although 4 years of data may be insufficient to justify meaningful trend analysis, PCB levels decreased significantly in largemouth bass at SV-107 (Figure 5-8). This trend was not significant at other stations. As in past samples, PCB levels in largemouth bass decreased in a downstream direction. PCB concentrations in channel catfish have also decreased at stations farther from the source in Twelvemile Creek (Figure 5-9). However, there has been little change in the PCB concentrations in channel catfish over the past 4 years

<IMG SRC 0494178I>

The distribution of PCB concentrations in hybrid bass throughout the lake remains a concern. Hybrid bass collected farther from the source in Twelvemile Creek have higher PCB concentrations than other species, often exceeding the FDA tolerance level of 2 mg/kg (Figure 5-10). This is thought to be a result of their migratory behavior and is also seen in the samples of walleye, another migratory species having high concentrations of PCBs (mean 3.48 mg/kg) from SV-642 at Hartwell Dam.

Contaminants other than PCBs were not identified at concentrations of concern nor were they widely distributed. A comparison of the priority pollutants to the established USFDA action levels showed that no chemical exceeded any of the safe tolerance standards except PCBs. Priority pollutants having no standards were compared to SCDHEC's fish tissue trend data base. Out of 60 largemouth bass there were 17 different compounds (mostly petroleum and organic solvents) that occurred only once in a single fish and several others that occurred only twice. There was no pattern of contamination and PCBs are considered the only contaminant of concern.

Forage fish species had mean PCB concentrations ranging from 3.00 mg/kg in threadfin shad to 12.43 mg/kg in gizzard shad at SV-107. PCB concentrations in forage fish decreased at stations farther from the Twelvemile Creek Arm. This supports the hypothesis that migratory species bioaccumulate PCBs while located in the upper Seneca River rather than through the food chain as forage species migrate out of the more heavily contaminated area.

The effects of PCB contamination on fish health and reproductive competence in Lake Hartwell were examined utilizing the HAI, biological indicator analyses, and age and growth analysis. Largemouth bass were the target fish species sampled. Comparisons of fish health using the HAI as the indicator were made among all six stations sampled in Lake Hartwell in 1992 and 1993. Differences in the HAI were seen between stations. Station SV-107 consistently had the highest HAI score for each year sampled. Station SV-106, the closest downstream station, also had high HAI scores. During 1992, these two stations exceeded 80 while stations farther from Twelvemile Creek ranged from 42 to 65. Fish from Twelvemile Creek (SV-107) and Martins Creek (SV-106) had the highest occurrence of fatty liver conditions. Accumulation of fat in the liver can be associated with exposure of fish to PCBs. The remaining stations had a greater percentage of normal livers with little occurrence of fatty livers. Although HAI scores only indicate the relative health of fish without indicating cause, decreases in the HAI scores with distance from the source was consistent with declines in PCB concentrations in fish at these stations.

<IMG SRC 0494178J>
<IMG SRC 0494178K>
<IMG SRC 0494178L>

Biomonitoring using biological indicators of fish health and reproductive competence was conducted at both Twelvemile Creek and Lake Hartwell study sites. The selected suite of bioindicators measured in this investigation included, among others, organ dysfunction, nutritional status, gonadal analyses, detoxification enzymes, and concentrations of reproductive steroids. The redbreast sunfish was the target species in the Twelvemile Creek watershed, while largemouth bass was the target species in Lake Hartwell. Bioindicator analyses conducted in Twelvemile Creek indicated that PCB contamination probably contributes, but is not the sole cause of impacts on fish health. There was evidence of biochemical and physiological differences between Lake Hartwell stations with largemouth bass collected from SV-107 exhibiting abnormal responses to several bioindicators. The most obvious physiological difference in largemouth bass between stations related to the functions of the liver. Additionally, age and growth analysis indicated that largemouth bass from SV-107 had a slower growth rate and were less plump having lower weights per unit of length.

Cages of clean corbicula were deployed for 28 days at two locations in the Twelvemile Creek Arm of Lake Hartwell to evaluate the uptake of PCBs by this filter feeding organism. The between the Maw (Hwy 337) and Madden (Hwy 15) Bridges and near the lower end of Twelvemile Creek Arm, just above the Keowee River confluence. PCBs were detected in corbicula muscle tissue at concentrations ranging from 0.48 mg/kg at the lower Twelvemile Creek Arm station to 0.56 mg/kg at the goose-neck bend station. Adult mayflies were also collected from the Twelvemile Creek Arm, just above the Hwy 133 Bridge and were found to have 2.6 mg/kg of PCBs.

5.3.3 Assessment of Resource Use

Public utilization of the fishery resources was assessed by creel surveys on Twelvemile Creek and Lake Hartwell. Twelvemile Creek was surveyed at major access points upstream to the confluence of the Middle Fork and North Fork. Lake Hartwell was divided into eight sampling areas that allowed analysis of angler use relative to PCB concentrations in fish within each area. Additionally, interviews provided data from which to evaluate the economic importance of the resource. The interviews also included questions to assess how fishermen used or consumed their harvest and fisherman awareness of the health advisory. These questions were the same for both the Lake Hartwell and the Twelvemile Creek creel survey.

Angler use of Twelvemile Creek appeared to be minimal. Only 21 interviews were obtained during this investigation. Some anglers were interviewed more than once indicating there may be a small localized group of anglers that frequent Twelvemile Creek. Most anglers interviewed were located at bridge crossings near the confluence of Twelvemile Creek and Lake Hartwell. They were encountered from March through August only. There was evidence of some fishing in more upstream areas from the presence of the types of trash that is customarily associated with bank fishermen. However, anglers were not encountered at these locations indicating low use.

Most anglers (66%) do consume fish caught in Twelvemile Creek. Channel catfish and sunfish made up most of the harvest. Consumption estimates for those anglers that indicated they ate fish were higher for Twelvemile Creek (37 g/day) than for Lake Hartwell (28 g/day). However, the total estimated harvest for Twelvemile Creek in 1992 was only 116.2 kg (256 lbs.).

Public utilization of the fishery resources in Lake Hartwell was also assessed by creel survey. A total of 415,839 fish were caught in 728,489 angler-hours of effort. A total of 239,726 (58%) were released, while 176,112 fish weighing 115,320 kg (253, 703 lbs.) were harvested. The top five species sought included largemouth bass, anything, striped bass, hybrid bass, and crappie. Largemouth bass and crappie comprised the largest percentage by number of fish harvested, while largemouth bass and hybrid bass comprised the largest percentage by weight.

The number of fish harvested was greatest in areas which comprised the Twelvemile Creek, Keowee River, and Seneca River Arms which encompass the most heavily contaminated portion of Lake Hartwell and much of the area under the most extreme advisory. Additionally, the Seneca River Arm area had the highest harvest by weight. By weight, 29% of the largemouth bass, 48% of the hybrid bass, and 66% of the striped bass harvested from Lake Hartwell came from the Seneca River Arm. Despite the advisory concerning fish consumption, anglers continue to harvest the largest portion of fish from Lake Hartwell from the areas most affected by PCB contamination.

Eighty-five percent of all anglers responding were aware of the fish consumption advisory. Sixteen percent had stopped eating fish because of the advisory. Sixty-seven percent of anglers interviewed indicated they ate fish from Lake Hartwell. The mean monthly per capita consumption for Lake Hartwell anglers that eat fish was estimated to be 0.85 kg (1.86 lbs). The mean monthly per capita consumption estimate for the Twelvemile Creek Arm, the most contaminated area, was 0.9 kg (2 lbs) near the lake average.

The health advisory on fish consumption appeared to influence consumptive habits of less than one-fourth of the anglers interviewed. Most anglers cited other reasons why they had stopped eating fish caught from Lake Hartwell. Most anglers indicated that they practiced catch-and-release, presumably for sport reasons. Some anglers indicated that a stronger advisory, a ban on fishing, seeing people get sick from eating fish and/or documentation of increased contamination would affect their fish consumption habits.

5.4 CONTAMINANT FATE AND TRANSPORT SUMMARY

An integral component of the Sangamo OU2 RI was to develop predictions regarding the continued deposition, migration, and accumulation of PCB contaminants in the sediment, water, and aquatic biota of Lake Hartwell. These predictions were accomplished through the use of specialized numerical-based models that considered the environmental processes and contaminant characteristics that control PCB migration and accumulation as well as the intermedia transfer and degradation of PCBs.

This comprehensive modeling effort focused on changes to an approximate 10 mile reach of the Twelvemile Creek Arm of Lake Hartwell over a 30-year period and consisted of: 1) future sediment transport/deposition using the HEC-6 computer model, "Scour and Deposition in Rivers and Reservoirs, Version 4.0", which was developed by the Hydrologic Engineering Center of the COE; 2) future PCB fate and transport using the "Water Quality Analysis Simulation Program (WASP-4), Version 4.0" developed and supported by EPA; and 3) future aquatic bioaccumulation modeling using the "Food and Gill Exchange of Toxic Substances (FGETS), Version 3.0" developed by EPA. The results of these modeling efforts are summarized below.

5.4.1 Future Sedimentation

The objective of sediment transport simulation was to determine rates at which presently contaminated sediments would be buried by relatively clean sediments from tributary drainages over the next 30

years. This simulation assumes that the historic hydrologic flow regime and sediments loading to the system remains unchanged. An overview of sedimentation regimes within the Twelvemile Creek Arm and upper Seneca Arm is summarized below. Figure 5-11 provides a bed profile of the Twelvemile Creek Arm. Figure 5-12 provides an illustration of the average sediment burial rates as predicted by the HEC-6 model.

The model identified three distinct sediment transport regimes. The first regime extends from just below the Woodside II impoundment (Transect T19) to a point approximately 2,400 ft upstream of the Maw Bridge (Transect T16). This reach is upstream of the backwater influence of the Hartwell impoundment (normal pool elevation of 660 ft MSL) and, therefore, behaves as a river. Energy gradients, bottom shear stresses, and turbulence intensities are relatively large in this reach; sediment transport potential is therefore high and sediments of all sizes, sand included, are carried by the flow aa suspended sediment. The HEC-6 results predict excess sediment transport potential, resulting in a small amount of scour along this reach.

The second regime extends from upstream of the Maw Bridge to just above the Hwy 133 bridge; this reach represents a zone of transition from a high energy fluid environment (river) to a low energy environment (lake). As the transition from river to lake occurs, energy gradients, bottom shear stresses, and turbulence levels all decrease, resulting in high rates of sediment deposition (1.43 to 13.12 cm/yr) as all of the sand and most of the silt coming into the reservoir are deposited (clays remain as suspended sediment and continue downstream). The model predicted a 30-year accumulation of nearly 10 ft of sediment in some areas. Sedimentation in this area results in the formation of a delta that advances into the impoundment over time, moving the headwater location further into the impoundment as well (See Figure 5-11). With a continuous supply of sediment from the watershed, this delta eventually will advance below Madden Bridge.

<IMG SRC 0494178M>
<IMG SRC 0494178N>

The third regime extends from upstream of the Hwy 133 bridge to the Hwy 37 bridge, which marks the downstream extent of the system modeled. Hydraulically, this portion of the system behaves as an impoundment with low-energy gradients and turbulence levels. This quiescent environment favors sediment deposition; however, only small deposition depths and burial rates are predicted because most of the sand and silt load is deposited upstream, and only slow-settling, clay-sized particles are available for deposition downstream. Most of the clay entering this reach is deposited, resulting in predicted deposition depths ranging from 0 to 54 cm and average burial rates of 0 to 1.8 cm/yr.

5.4.2 Future Sediment and Water Quality Trends

Future PCB fate and transport in the Twelvemile Creek/Hartwell Lake system was modeled using the WASP4 code developed by EPA. The modeling was conducted to predict the fate and transport of PCBs in the Twelvemile Creek/Hartwell Lake system over the next 30 years. This work was conducted to assist in the extrapolation of PCB data collected in the present investigation to future conditions. An overview and results of the water quality modeling study are summarized below. Figures 5-13, 5-14, 5-15, and 5-16 provide predicted PCB concentrations in surface sediment initially, at 10 years, 20 years, and 30 years, respectively.

Results from the WASP4 simulations reflect a relatively complex cycling of PCBs through the system. Initially, PCB concentrations are relatively high in upstream surface and bottom sediment segments. Over time, clean sediment from the upstream tributary is deposited over the contaminated sediments, which results in burial and dilution of the contaminated sediments. Because sediment resuspension and deposition can occur simultaneously, some contaminated sediments from upstream segments is resuspended in the water column, where advection and dispersion transport them further into the impoundment. These contaminated sediments are then redeposited. Because suspended sediment concentrations decrease with increasing distance into the impoundment, the rate at which redeposited sediments are buried is much smaller than at points upstream where they originated.

<IMG SRC 0494178O>
<IMG SRC 0494178P>
<IMG SRC 0494178Q>
<IMG SRC 0494178R>

The net result of these transport processes is (1) a significant reduction in PCB concentrations in the surface and bed sediments in the upper and middle portions of the system, and (2) an increase in PCB concentrations in surface and bed sediments near the lower end of the system. Surface and bottom sediments upstream of the Hwy 133 bridge, which had initial PCB concentrations ranging from 1,600 to 10,000 µg/L, are predicted to decrease to near zero levels within the first 5 years. This reduction in concentration is due to burial by clean sediments derived from upstream reaches along with removal by sediment resuspension.

In the middle reach of the system between the Hwy 133 bridge and the Hwy 93 bridge, PCB concentrations also decrease over time for the same reason but at a much slower rate. Initially, concentrations in this middle reach ranged between 1,800 and 23,000 µg/L. The range is reduced to 400 to 8,000 µg/L after 5 years, 50 to 2,800 µg/L after 10 years, and 0 to 40 µg/L after 30 years. Surface and bottom sediments lying between the Hwy 93 bridge and the Hwy 37 bridge show PCB concentrations increase over time. Initially, concentrations in these segments ranged between 400 and 1,400 µg/L; after 30 years, concentrations in these segments are predicted to range up to 8,800 µg/L. This predicted concentration increase is attributed to hydrodynamic influences associated with the Hwy 37 embankment.

5.4.3 Bioaccumulation and Future Fish Concentrations

Aquatic bioaccumulation modeling was conducted to predict future PCB levels in the fish of the Twelvemile Creek/Hartwell Lake system using the FGETS model. This work was conducted to assess: (1) how PCB levels in fish would change over the next 30 years if the contaminated sediments were left unmanaged, and (2) how long it would take for levels to drop below the current FDA tolerance level of 2 mg/kg in several species. The results of the aquatic bioaccumulation modeling study are summarized below. Figure 5-17 provides a graphical summary of this effort.

FGETS is a time-dependent model that predicts whole-body fish residues at specified points in time. The outputs of the model are averaged residues for each year of the fish's life. FGETS can predict chemical uptake by fish through two principal pathways: (1) directly from water via respiration, and (2) through consumption of contaminated food and sediments. For hydrophobic organic chemicals, such as PCBs, the second pathway is known to be the more significant one.

Application of the FGETS model requires the construction of a conceptual model, which includes selection of a representative food web. Three species of fish were chosen to be included in the representative food web, based on the species present in Hartwell Lake, the availability of data for calibration, and the potential for human exposure. Largemouth bass was selected as the top predator for the food web model, since it is the most frequently harvested species and currently has the highest PCB residues for game (harvest) fish. Gizzard shad and bluegill sunfish were identified as the two most important forage fish for Hartwell Lake largemouth bass. Plankton and benthos composed the lower levels of the food web. Plankton and benthos were assumed to be in chemical equilibrium with the dissolved-phase PCB concentrations of the water column and particulate-phase PCB concentrations of the surficial sediments, respectively, as predicted by the WASP4 water quality model.

<IMG SRC 0494178S>

Actual modeling consisted of a long-term simulation to predict future PCB fish tissue concentrations over the next 30 years. Results show PCB concentrations in all components of the aquatic bioaccumulation model decreased over the 30-year simulation period (Figure 5-17). PCB concentrations in plankton and benthos, assumed to be in chemical equilibrium with the water column and surface sediments, showed a rapid rate of decline consistent with the WASP4 predictions. In response to decreasing water column and surface sediment PCB levels, concentrations in fish declined as well. Mean concentrations in largemouth bass fillets (10.75 mg/kg initially) declined to 5.16 mg/kg by year 5 and fell to 1.74 mg/kg and below the 2.0 mg/kg FDA tolerance level by year 10 (year 2003).

Although the mean largemouth bass concentration fell below the FDA limit by year 10, a longer period of time is required for concentrations in older age classes to fall below the FDA limit. PCB concentrations in 10-year-old fish, representing the highest age class and largest fish in the model, required 12 years (year 2005) to fall below the 2.0 mg/kg FDA limit. By year 30, mean concentrations in largemouth bass fillets are expected to be very low, with a mean value of 0.025 mg/kg predicted.

6.0 SUMMARY OF SITE RISKS

CERCLA directs EPA to protect human health and the environment from current and potential exposure to hazardous substances at the Sangamo OU2 Site. The Baseline Risk Assessment provides the basis for taking action and indicates contaminants and the exposure pathways that need to be addressed by the Remedial Action. It serves as an indication of what risks the Site poses if no action were taken. A Baseline Risk Assessment was conducted to evaluate the potential current and future human health and ecological impacts associated with exposure to PCBs in sediment and fish. This section of the ROD contains a summary of the results of the Baseline Risk Assessment conducted for this Site. Tables utilized and referenced in this discussion are included at the end of this Section to facilitate the readability of this Section.

6.1 CONTAMINANTS OF CONCERN

The Baseline Risk Assessment focused only on PCBs as the chemical of potential concern. As described in Section 5.0, full-screen analyses were conducted on a limited number of sediment and fish tissue (biological) samples. These analyses did not detect appreciable quantities of volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, and/or inorganics (metals).

The human health exposure pathways that were quantitatively evaluated under this Baseline Risk Assessment were as follows:

1) Ingestion and dermal absorption of PCBs in shallow sediment by a child and an adult at:

- The upper section of Twelvemile Creek Arm,
- The upper Twelvemile Creek Watershed,
- The Hagood Reservoir, and
- Immediately downgradient of the Sangamo Plant Site.

2) Ingestion of PCB-contaminated fish by a recreational fisherman.

Sediment data were divided into two overall categories in order to best define exposure. These included sediment sample locations which were 2.1 m (7 ft) or less below the water surface, and sediment sample locations which were between 2.1 m and 3 m (7-10 ft) below the water surface. As discussed previously, the lake level fluctuates an average of 4 ft, hence exposing additional sediment. The lower interval was developed to evaluate this potential exposure. Table 6-1 summarizes the information used to calculate sediment exposure point concentrations at the four locations. Sediment data is from the Phase I and Phase II Sediment Investigation.

The risks posed by the ingestion of PCB-contaminated fish were evaluated at all six Lake Hartwell fish sampling locations (SV-107, SV-106, SV-532, SV-535, SV-642, SV-641). These locations are depicted on Figure 5-7 in Section 5.3 of this ROD. In addition, risks posed by the ingestion of fish caught in the Twelvemile Creek watershed, tributaries of the watershed, and a background location were quantified. Risks were evaluated separately by fish species and also for all species combined to account for both individuals who may eat one specie exclusively and individuals who consume all types of fish. Table 6-2 summarizes the information used to calculate fish tissue exposure point concentrations at these locations. Fish tissue data are from the 1991 and 1992 Biological Investigations prepared in accordance with standard FDA fillet method (i.e. fillet including rib cage and belly flap with skin on/scales off - except catfish where skin is removed).

6.2 EXPOSURE ASSESSMENT

For purposes of this Baseline Risk Assessment, it was assumed that in the future the Twelvemile Creek/Lake Hartwell system will continue to exist in its present state. All exposure pathways that are complete under the current land-use conditions were also assumed to be potentially complete under the future land-use scenario. The exposure pathways that were quantitatively evaluated under the current/future use scenarios are described in Section 6.1 of this ROD.

EPA employed a reasonable maximum exposure (RME) approach to estimate the potential exposures and associated risks at the Sangamo OU2 Site. The RME is the highest exposure that is reasonably expected to occur at the Site. The intent of the RME is to estimate a conservative exposure case that is still within the range of possible exposures. The calculation of risk posed by exposures to PCBs requires the combination of exposure point concentrations with assumptions regarding frequency, duration, and

magnitude of receptor contact. RME exposure point concentrations for sediment and fish tissue are listed in Tables 6-1 and 6-2, respectively. The RME exposure parameter assumptions for sediment and fish that were used to characterize risk posed by PCBs are listed in Tables 6-3 and 6-4, respectively. The exposure parameters for ingestion of fish were derived from results the site-specific recreational angler survey discussed in Section 5.3.

6.3 TOXICITY ASSESSMENT

For risk assessment purposes, individual chemicals are separated into two categories of chemical toxicity depending on whether they exhibit principally carcinogenic (cancer-causing) or noncarcinogenic effects. The carcinogenic and noncarcinogenic toxicity of PCBs are discussed below.

6.3.1 Carcinogenic Toxicity of PCBs

EPA assigns weight of evidence classifications to potential carcinogens. Under this system, chemicals are classified as follows:

Group A - Human Carcinogen: Sufficient evidence from human epidemiological studies to support a causal association between a chemical and cancer.

Group B1- Probable Human Carcinogen: Limited evidence from human epidemiological studies of carcinogenicity to humans.

Group B2- Probable Human Carcinogen: Sufficient evidence of carcinogenicity to animals.

Group C - Possible Human Carcinogen: Limited evidence of carcinogenicity in animals and an absence of data on humans.

Group D - Not Classified: Inadequate evidence of carcinogenicity in animals.

Group E - No Evidence of Carcinogenicity to Humans

PCBs are classified as a Class B2 carcinogen, which indicates that there is sufficient evidence from tests on animals to link exposure of PCBs with carcinogenic effects.

Slope factors (SFs) have been developed by EPA for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic contaminants. SFs, which are expressed in units of (mg/kg-day)-1 or risk per milligram per kilogram of dose, are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to provide an upper bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper-bound" reflects the conservative estimate of the risks calculated from the SF. Use of this approach makes underestimation of the actual cancer risk highly unlikely. Slope factors are derived from the results of human epidemiological studies or chronic animal bioassay data to which mathematical extrapolation from high to low dose and from animal to human dose has been applied, as well as statistics to account for uncertainty (e.g. to account for the use of animal data to predict effects on humans). A SF of 7.7 (mg/kg-day)-1 for the PCB Aroclor 1260 was obtained from the Integrated Risk Information System (IRIS) for use in this Baseline Risk Assessment.

6.3.2 Noncarcinogenic Toxicity of PCBs

Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to the contaminants exhibiting noncarcinogenic effects. RfDs, which are expressed in units of mg/kg-day, are estimates of daily exposure levels for humans, including sensitive populations, that are likely to be without risk of adverse effect. Estimated intakes of contaminants from environmental media can be compared to the RfD. RfDs are derived from human epidemiological and animal studies to which uncertainty factors have been applied. A chronic RfD of 7 X 10-5 mg/kg-day for the PCB Aroclor 1016 was used in this Baseline Risk Assessment. This daily exposure estimate has been documented in studies conducted on monkeys to produce reproductive effects (reduced birth weights).

6.4 RISK CHARACTERIZATION

For carcinogens, risks are estimated as the incremental probability of an individual developing cancer over a life-time as a result of exposure to the contaminants of concern, in this case PCBs. Excess life-time cancer risk is calculated from the following equation:

$$Risk = CDI \times SF$$

where:

Risk = a unitless probability (i.e. 2 x 10-5) of an individual developing cancer.
CDI = chronic daily intake averaged over 70 years (mg/kg-day).
SF = slope factor, expressed as (mg/kg-day)-1.

These risks are probabilities that are generally expressed in scientific notation (i.e. 1 x 10-6). An excess lifetime cancer risk of 1 x 10-6 indicates that, as a reasonable maximum estimate, an individual has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure to a carcinogen over a 70 year lifetime under the site-specific exposure conditions for the site. EPA's generally acceptable risk range is 1 x 10-4 to 1 x 10-6.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period with a reference dose derived for a similar exposure period. The ratio of exposure to toxicity is called a Hazard Quotient (HQ). An HQ<1 indicates that an individual's dose of a single contaminant is less than the RfD, and that the toxic noncarcinogenic effects from that chemical are unlikely. The Hazard Index (HI) is generated by adding the HQs for all chemicals of concern that affect the same target organ within a medium or across all media to which a given population may reasonably be exposed. An HI<1 indicates that, based on the sum of all HQs from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. The HQ is calculated as follows:

$$\text{Non-cancer HQ} = CDI/RfD$$

where:

CDI = chronic daily intake
RfD = reference dose

CDI and RfD are expressed in the same units (mg/kg-day) and represent the same exposure period.

The carcinogenic and noncarcinogenic risks associated with direct contact with or incidental ingestion of PCB contaminated sediment and ingestion of PCB-contaminated fish are summarized in Tables 6-5 and 6-6, respectively. Adverse human health risks resulting from direct contact or incidental ingestion with the sediment are unlikely to occur, however, sediments are a continuing source of contamination in the aquatic biota of the study area. Exposures associated with the ingestion of fish caught from all sampling stations resulted in unacceptable risks ranging from 10-2 to 10-4. The highest cancer risk of 4 x 10-2 was calculated for anglers exclusively consuming largemouth bass from the Twelvemile Creek watershed. The highest cancer risk for ingestion of all species combined, 1 x 10-2, was calculated for the Twelvemile Creek Arm. The lake-wide risk associated with ingestion of all species combined was 5 x 10-3.

6.5 MONTE CARLO

The human health risks presented under Section 6.4 are referred to as the deterministic risks. That is, the resultant risk is a single value for a single set of specific exposure parameters. A refined approach to risk assessment can be achieved by taking into account the probability distributions of possible values for each of the exposure parameters rather than relying on discrete parameter values. Such an approach was taken in the Sangamo OU2 risk assessment through Monte Carlo analysis. The advantage of this approach is that it furnishes more information of the variability of the full range of potential risks that may occur.

The fish ingestion pathway was chosen for Monte Carlo analysis evaluation because this pathway is associated with the highest potential risks. The potential cancer risk associated with exposure to PCBs was evaluated for ingestion of bass (largemouth and hybrids) lake-wide and for ingestion of bass (largemouth and hybrids) caught in the area associated with the highest PCB concentrations (i.e.

SV-107). The mode of the risk distribution is of most interest when interpreting the final distribution of risks since it represents the most frequently occurring risk. The most frequently occurring risk in the distribution, or mode, was estimated to be 2 x 10-4 and 3 x 10-4 for ingestion of lake-wide bass and bass at SV-107, respectively. The results of the Monte Carlo analysis indicated that the 1 x 10^{-2} risk associated with the ingestion of bass from location SV-107 represented the 95th percentile of high end of the overall risk distribution, while the 5 x 10-3 risk associated with ingestion of lake-wide bass corresponded to the 90-95th percentile of the overall risk distribution.

6.6 ECOLOGICAL RISK ASSESSMENT

An ecological risk assessment was conducted to evaluate the impact PCBs may be having on aquatic receptors (plant, invertebrates, and fish) and terrestrial receptors (birds and mammals) of the Sangamo OU2 study area. The Biological Investigations clearly document PCB contamination at all levels of the aquatic food web. However, although PCBs appear to be impacting the fish and macroinvertebrate communities in Twelvemile Creek, habitat degradation from man's influence is likely causing additional adverse impacts.

A 1990 investigation conducted independently of these RI studies provided evidence that fish health and populations can be affected as concentrations in fish increase to an average of 20 mg/kg and greater. Results from the bioindicator analyses support the contention that individual largemouth bass may be impacted at SV-107 and SV-106, areas closest to the Sangamo Plant Site. However, at the present level of PCB concentrations in fish tissue (approximately 5 mg/kg), the data from the Biological Investigations do not support a conclusion that significant impacts to the overall health and the population/community levels to Lake Hartwell fish are occurring.

Ecological exposures to surface water were not directly evaluated in the ecological assessment because PCBs were not detected in surface water at detection limits ranging from 1.2-1.3 µg/L during the RI. Aquatic plants are not likely to suffer adverse impacts from PCB concentrations just below the detection limit. Aquatic invertebrates that are intimately associated with sediments (primarily benthic organisms) may be adversely impacted in the study area based on a comparison of PCB concentrations in sediment to EPA's interim sediment quality criteria for aquatic organisms. Reliable population estimates for avian species (eastern phoebe, green-backed heron, belted kingfisher, osprey) and mammals (mink, otter) that would feed in the study area were not obtainable. Therefore, the certainty of the extent of any population impacts caused by PCBs in the study area is unknown. However, population effects on these terrestrial species is not likely.

6.7 UNCERTAINTY ASSESSMENT

In any risk assessment, there is some degree of uncertainty associated with the estimates of human and ecological risks. The primary sources of uncertainty included environmental sampling, exposure parameter estimation and toxicological data. Typically, these uncertainties are compensated for by employing conservative assumptions. Consequently, the qualitative and quantitative risk estimates for Sangamo OU2 should not be construed as absolute estimates of risk, but rather as conditional estimates based on a number of assumptions regarding exposure and toxicity.

6.8 SUMMARY

The primary human health exposure pathway of concern at the Sangamo OU2 Site is the ingestion of fish contaminated with PCBs. Exposures associated with ingestion of fish caught from all sampling locations resulted in unacceptable carcinogenic risks ranging from 10-2 to 104 and HQs greater than 1. As discussed under Section 5.4 (Contaminant Fate and Transport) of this ROD, PCB concentrations in sediment are predicted to decrease over time. The impact of decreasing sediment concentrations on overall risk was evaluated for the ingestion of largemouth bass at SV-107. The output from the food-chain bioaccumulation model (FGETS Section 5.4.3) was utilized in this analysis. It was found that the total modeled risk over a 30-year time frame (2 x 10-3) was not substantially different from the calculated deterministic RME risk of 1 x 10-2. This was largely because risk over this time period is dominated by the very high risks calculated for the first eight years of exposure. In actuality, a period of approximately 22 years appears to be required for one-year risks to drop to the 10^{-2} risk level. It would require more than 22 years for the entire 30-year risks to decline to < 10-6. With respect to noncancer risks, a period of approximately 20 years appears to be required for the HQ to drop below one. After the next 20-30 years, long-term risk associated with the consumption of fish harvested from Lake Hartwell should be substantially lower.

Actual or threatened releases of hazardous substances for the Sangamo OU2 Site, if not addressed by implementing the response action in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

TABLE 6-1
PCB Exposure Point Concentrations in Shallow Sediment

Area/ Interval	PCB Concentration (mg/kg)			
	Meana	95% UCL of Meanb	Maximum Detected Concentration	RME Exposure Point Concentration°
Upper 12 Mile Creek Arm				
Beneath 0-2.1 m of Lake Water	0.91	1.65	7.54	1.65
Beneath 0-3 m of Lake Water	1.51	2.93	7.88	2.93
Upper 12 Mile Creek Watershed				
Beneath 0-2.1 m of Lake Water	0.45	0.70	0.76	0.70
Beneath 0-3 m of Lake Water	0.45	0.72	0.91	0.72
Hagood Reservoir				
Beneath 0-2.1 m of Lake Water	0.29	0.36	0.33	0.33
Beneath 0-3 m of Lake Water	0.28	0.33	0.33	0.33
Downgradient of Sangamo Plant				
Beneath 0-2.1 m of Creek Water	1.51	---	3.52	3.52

a) Arithmetic mean concentration (including one-half detection limit for non-detects).

b) Value represents 95th percent Upper Confidence Limit (UCL) on the arithmetic mean.

c) RMB=Reasonable Maximum Exposure; value listed is the lower value of the 95th percent UCL on the arithmetic mean and the maximum detected concentration.

TABLE 6-2
Exposure Point Concentrations in Fish

Species	PCB Concentrations (mg/kg) Mean	95% UCL of Mean	Maximum Detected Concentration	RME Exposure Point Concentration
		SV-107		
Largemouth Bass	6.8	8.5	19.7	8.5
Hybrid Bass	1.4	2.0	2.3	2.0
Largemouth Bass and Hybrid Bass	5.7	7.9	19.7	7.9
Channel Catfish	5.6	7.8	8.3	7.8
All Species Combined	5.4	7.0	19.7	7.0
		SV-106		
Largemouth Bass	3.3	3.8	9.2	3.8
Hybrid Bass	4.7	8.0	9.7	8.0
Channel Catfish	2.5	3.9	4.0	3.9
All Species Combined	3.6	4.3	9.7	4.3
		SV-532		
Largemouth Bass	1.7	3.8	3.5	3.5
Hybrid Bass	3.9	5.9	9.6	5.9
Channel Catfish	1.7	4.4	3.5	3.5
All Species Combined	2.5	4.0	9.6	4.0
		SV-535		
Largemouth Bass	0.80	1.3	1.7	1.3
Hybrid Bass	1.8	3.3	3.9	3.3
Channel Catfish	0.60	0.82	0.90	0.82
All Species Combined	1.2	1.7	3.9	1.7
		SV-642		
Largemouth Bass	0.56	0.98	1.1	0.98
Hybrid Bass	2.3	3.7	7.0	3.7
Channel Catfish	0.71	2.6	2.8	2.6
All Species Combined	1.3	2.1	7.0	2.1

TABLE 6-2
Exposure Point Concentrations in Fish

Species	PCB Concentrations (mg/kg) Mean	95% UCL of Mean	Maximum Detected Concentration	RME Exposure Point Concentration
SV-641 (Lake Background)				
Largemouth Bass	0.22	0.3	1.2	0.3
Hybrid Bass	2.0	2.8	9.3	2.8
Channel Catfish	0.41	1.4	0.8	0.8
All Species Combined	0.74	1.1	9.3	1.1
All Areas of Lake Hartwell + 12 Mile Creek				
All Species Combined	3.0	3.9	19.7	3.9
Largemouth Bass and Hybrid Bass	3.2	4.2	19.7	4.2
12 Mile Creek Watershed				
Largemouth Bass	4.0	25	13.9	13.9
Redbreast Sunfish	1.7	2.2	7.1	2.2
Tributaries of Watershed				
Redbreast Sunfish	0.74	0.2	1.2	0.2
Watershed Background	ND	ND	ND	ND

TABLE 6-3
Exposure Parameters for Incidental Ingestion of and Dermal Contact with Sediment (Current/Future Use Conditions)

Parameters	Reasonable Maximum Exposure Case	
	Child	Adult
Age Period (years)	4-12	>18
Exposure Frequency (days/year)a	105	75
Exposure Duration (years)	8	30b
Soil Ingestion Rate (mg/day)c	138	100
Skin Surface Area Available for Contact (cm)2	700d	1,230d
Sediment to Skin Adherence Factor (mg/cm2)e	1.0	1.0
Dermal Absorption Fraction (PCBs)f	0.01	0.01
Body Weight (kg)g	27	70
Averaging Time (years)		
Carcinogenich	70	70
Noncarcinogenic	8	30

a) For children, assumes that children will swim 7 days/week from Memorial Day to Labor Day (15 weeks) for a total of 105 exposure events/yr. For adults, assumes that adults will swim 5 days/week for same 15 weeks for a total of 75 exposure events/yr.
b) Based upon national upper-bound time at one residence (USEPA 1991a, 1989a).
c) Value for children is a weighted-average ingestion rate, assuming 4, 5, and 6 year olds ingest sediment at a rate of 200 mg/day and older children ingest sediment at 100 mg/day (USEPA 1989a, 1991a). Value for adults is the standard default value recommended by USEPA (1991a, 1989a)
d) Surface area based on 50th percentile values from USEPA (1985) for feet. Values for child and adult are the time-weighted averages.
e) Based on USEPA Region IV guidance (USEPA 1992b).
f) Based on USEPA Region IV guidance (USEPA 1992b).
g) Value for 4-12 year old child is the time-weighted average based on data provided by USEPA (1989b). Value for adult is the standard default value recommended by USEPA (1991a).
h) Based on USEPA (1991a, 1989a) standard assumption for lifetime.

TABLE 6-4
Exposure Parameters for Ingestion of Fish by Adult Recreational Fisherman (Current/Future Use Conditions)

Parameters	Reasonable Maximum Exposure Value
Fish Ingestion Rate (grams/meal)a	357
Exposure Duration (years)b	30
Exposure Frequency by Sampling Location (meals per year)c	
Twelvemile Creek Watershed	60
SV-107	30.6
SV-106	27.6
SV-532	20.6
SV-535	22.5
SV-642	37
SV-641 (Lake Background)	22.7
Lake-Wide Average	27.6
Body Weightd	70
Averaging Time (years)	
Carcinogenice	70
Noncarcinogenic	30

a) Based on the arithmetic mean of fish ingestion rates reported for 52 anglers surveyed at Twelvemile Creek on Lake Hartwell.
b) Value is based on the national upper-bound time at one residence (USEPA 1991a, 1989a).
c) Values based on January to December 1992 data obtained from Lake Hartwell Recreational Angler Survey. These values are the arithmetic mean exposure frequency in meals/month, multiplied by 12 months/year reported for a total of 677 anglers surveyed at Twelvemile Creek/Lake Hartwell. Final report of survey stated that some anglers were interviewed more than once, indicating that the survey results may include fishing habits of subsistence fisherman as well as recreational fisherman.
d) Standard default value provided by USEPA (1991a, 1989a).
e) Based on USEPA (1991a, 1989a) standard assumption for lifetime.

TABLE 6-5
Potential Direct Contact Risks Associated with PCB in Sediment

Exposure Pathway	Upper Bound Excess Lifetime Cancer Risk	HQ for Noncar-cinogenic Effectsa
INCIDENTAL INGESTION OF SEDIMENT		
Upper Twelvemile Creek Arm		
Child (4-12 years)	2 x 10-6	<1 (0.03)
Adult	3 x 10-6	<1 (0.01)
Upper Twelvemile Creek Watershed		
Child (4-12 years)	9 x 10-7	<1 (0.01)
Adult	7 x 10-7	<1 (0.003)
Immediately Downgradient of Sangamo Plant Site		
Child (4-12 years)	5 x 10-6	<1 (0.06)
Adult	3 x 10-6	<1 (0.02)
Hagood Reservoir		
Child (4-12 years)	4 x 10-7	<1 (0.006)
Adult	3 x 10-7	<1 (0.001)
DERMAL ABSORPTION FROM SEDIMENT		
Upper Twelvemile Creek Arm		
Child (4-12 years)	1 x 10-7	<1 (0.002)
Adult	4 x 10-7	<1 (0.001)
Upper Twelvemile Creek Watershed		
Child (4-12 years)	5 x 10-8	<1 (0.0007)
Adult	9 x 10-8	<1 (0.0004)
Immediately Downgradient of Sangamo Plant Site		
Child (4-12 years)	2 x 10-7	<1 (0.004)
Adult	5 x 10-7	<1 (0.002)
Hagood Reservoir		
Child (4-12 years)	2 x 10-8	<1 (0.0003)
Adult	4 x 10-8	<1 (0.0002)

TABLE 6-5
Potential Direct Contact Risks Associated with PCBs in Sediment

Exposure Pathway	Upper Bound Excess Lifetime Cancer Risk	HQ for Noncar-cinogenic Effectsa
DIRECT CONTACT WITH SEDIMENT (TOTAL)		
Upper Twelvemile Creek Arm		
Child (4-12 years)	2 x 10-6	<1 (0
Adult	3 x 10-6	<1 (0
Upper Twelvemile Creek Watershed		
Child (4-12 years)	1 x 10-6	<1 (0
Adult	8 x 10-7	<1 (0
Immediately Downgradient of Sangamo Plant Site		
Child (4-12 years)	5 x 10-6	<1 (0
Adult	4 x 10-6	<1 (0
Hagood Reservoir		
Child (4-12 years)	4 x 10-7	<1 (0.
Adult	3 x 10-7	<1 (O.

a) Hazard Quotient >1 indicates exposure to PCBs may result in adverse health effects. Actual value listed in ().

TABLE 6-6
Potential Health Risks Associated with the Ingestion of Fish

Location/Species	Upper Bound Excess Lifetime Cancer Risk	HQ for Noncar-cinogenic Effectsa
SV-107		
Largemouth Bass	1 x 10-2	>1 (50)
Hybrid Bass	3 x 10-3	>1 (10)
Largemouth Bass and Hybrid Bass	1 x 10-2	>1 (50)
Channel Catfish	1 x 10-2	>1 (50)
All Species Combined	1 x 10-2	>1 (50)
SV-106		
Largemouth Bass	5 x 10-3	>1 (20)
Hybrid Bass	1 x 10-2	>1 (40)
Channel Catfish	5 x 10-3	>1 (20)
All Species Combined	5 x 10-3	>1 (20)
SV-532		
Largemouth Bass	3 x 10-3	>1 (10)
Hybrid Bass	6 x 10-3	>1 (20)
Channel Catfish	3 x 10-3	>1 (10)
All Species Combined	4 x 10-3	>1 (20)
SV-535		
Largemouth Bass	1 x 10-3	>1 (6)
Hybrid Bass	3 x 10-3	>1 (10)
Channel Catfish	9 x 10-4	>1 (4)
All Species Combined	2 x 10-3	>1 (8)
SV-642		
Largemouth Bass	2 x 10-3	>1 (7)
Hybrid Bass	6 x 10-3	>1 (30)
Channel Catfish	4 x 10-3	>1 (20)
All Species Combined	4 x 10-3	>1 (20)
SV-641 (Lake Background)		
Largemouth Bass	3 x 10-4	>1 (1)
Hybrid Bass	3 x 1O-3	>1 (10)
Channel Catfish	8 x 10-4	>1 (4)
All Species Combined	1 x 10-3	>1 (5)
All Areas of Lake Hartwell + 12 Mile Creek		
All Species Combined	5 x 10-3	>1 (20)
Largemouth Bass and Hybrid Bass	5 x 10-3	>1 (20)
Twelvemile Creek Watershed		
Largemouth Bass	4 x 10-2	>1 (200)
Redbreast Sunfish	6 x 10-3	>1 (30)
Tributaries of Watershed		
Redbreast Sunfish	6 x 10-4	>1 (20)
Watershed Background	ND	ND

a) Hazard Quotient >1 indicates exposure to PCBs may result in adverse health effects. Actual value listed in ().

7.0 DESCRIPTION OF ALTERNATIVES

Based upon the findings of the RI and associated Baseline Risk Assessment (human health/ecological), EPA developed remedial action objectives to support the identification, development and screening of remedial alternatives. These remedial action objectives were:

- Mitigate continued migration of PCB-contaminated sediments into Lake Hartwell by eliminating releases of PCBs into Twelvemile Creek.
- Control or eliminate the downstream migration of PCB-contaminated sediment within the Twelvemile Creek Arm of Hartwell Lake.
- Limit, to the extent feasible, the transfer of PCB contaminants from sediment to biota.
- Prevent or minimize exposure to fish with PCB contamination above target risk (or FDA) levels.

Protection of human health is considered the primary driver for developing and evaluating remedial action alternatives. Thorough development and evaluation of feasible remedial alternatives for the Sangamo OU2 Site required the derivation of cleanup goals for the media of concern: sediment and fish. Cleanup goals were not developed for surface water since PCBs were not detected in any sample collected during the RI above the detection limits of 1.2 to 1.3 µg/l. Cleanup goals for sediment and fish were also necessary to identify areas to be addressed by the range of remedial alternatives that were evaluated in detail. The Final Cleanup Goals for sediment and fish, and the supporting rationale are presented in Sections 7.1 and 7.2, respectively.

The contaminants of concern for the Sangamo OU2 Site are total PCBs. No Aroclor- or congener-specific distinctions are factored into the evaluation of remedial action alternatives. Discharges from the Sangamo Weston Plant into Town Creek included a variety of PCBs consisting predominantly of Aroclors 1242, 1254, and 1016. Analytical data for the RI included both Aroclor-specific concentrations (from offsite CLP analyses) and concentrations of total PCBs (from onsite field screening analyses). However, all of the results, findings and conclusions in the RI were discussed in terms of total PCBs. The reasons for this approach are as follows:

- A majority of the health-based and environmental criteria for PCBs are stated in terms of total PCBs (i.e., FDA tolerance level).
- EPA uses a carcinogenic slope factor for PCBs that is based on Aroclor 1260; this provides a conservative indicator of potential health effects for all PCB mixtures.
- Evaluation of contamination in terms of total PCBs was cost-effective; it permitted collection of a large number of samples and the use of field screening (Modified Spittler Method) for sediment analyses.

7.1 FINAL CLEANUP GOAL FOR SEDIMENT

Potential cleanup goals for PCB-contaminated sediment at the Sangamo OU2 Site were determined through an evaluation of available criteria and accepted techniques for calculating cleanup goals in sediment. This approach generated a range of potentially viable cleanup concentrations for the Sangamo OU2 sediment based on the following sources:

- Existing (published) criteria for PCBs in sediment, typically derived from either geographic-based, background PCB concentrations or biological effects observed or predicted in aquatic organisms.
- Precedents from other NPL sites where EPA has identified protective sediment cleanup goals for PCBs that have been finalized in RODs.
- Site-specific cleanup goals calculated using EPA's equilibrium partitioning approach based on contaminant partitioning between sediment and sediment pore water, based on protection of aquatic life.

From this evaluation, three representative sediment cleanup goals (1 mg/kg, 0.4 mg/kg and 0.05 mg/kg) were selected for further analysis. The analysis consisted of an evaluation of the long-term impacts of potential sediment cleanup goals on PCB concentrations in fish, and ultimately human health via ingestion of contaminated fish, given that the ingestion of fish is the principal exposure pathway of concern at the site. This evaluation was conducted utilizing the FGETS bioaccumulation model discussed in Section 5.4.3 of this ROD. The rationale for selecting these values is presented below.

- 1 mg/kg - The most frequently selected sediment cleanup goal for PCBs at NPL sites based on a review of the EPA's ROD database. A concentration of 1 mg/kg also represents a reasonable lower limit considering technical feasibility and cost.

- 0.4 mg/kg - The mean value for the site-specific sediment quality criteria calculated using the EPA's equilibrium partitioning approach; also equal to the Effects Range-Median criteria based on an evaluation of published criteria associated with biological effects on aquatic life as reported by the National Oceanic and Atmospheric Administration (NOAA).

- 0.05 mg/kg - Equal to the Effects Range-Low from NOAA based on an evaluation of published criteria associated with biological effects on aquatic life; also representative of the more commonly reported background-based sediment criteria for PCBs.

The time required for 2-8 year old largemouth bass in the Twelvemile Creek Arm of Lake Hartwell to achieve 2 mg/kg for the range of selected sediment cleanup goals are compared to the baseline condition in Figure 7-1. As shown in this figure, fish PCB concentrations decline at about the same rate regardless of the sediment cleanup goal. Therefore, a final sediment cleanup goal of 1 mg/kg was selected based on technical feasibility rather than performance or risk-based considerations. This concentration identified the entire Twelvemile Creek Arm, extending from the headwaters of the lake downstream to the confluence with the Keowee Arm, as an area to be addressed. This area covers approximately 730 acres with a total estimated volume of 4,722,000 cubic yards (yd3) of contaminated sediment.

7.2 FINAL CLEANUP GOAL FOR FISH

Fish ingestion was identified as the primary exposure pathway of concern at the Sangamo OU2 Site. Potential remediation goals include the FDA tolerance level of 2 mg/kg for PCBs in the edible portions of fish, and risk-based levels that consider the fish ingestion exposure pathway. Both of these options are described below.

The FDA criterion was identified as a contaminant-specific Applicable or Relevant and Appropriate Requirement (ARAR). In addition, the existing health advisory for Hartwell rake is based on the continuing presence of PCBs in fish in concentrations greater than 2 mg/kg. Selection of risk-based cleanup goals for fish were considered by determining the concentration levels in largemouth bass that would result in acceptable risk to anglers (through ingestion of the fish) based on EPA's target risk range of 1 x 10-4 to 1 x 10-6. The acceptable concentrations were estimated using the same methodology used for the baseline human health risk assessment and for determining risk levels for the sediment cleanup goals. A fish tissue concentration of 0.036 mg/kg is associated with a 10-4 risk, 0.0036 mg/kg with a 10-5 risk, and so on.

Using EPA's deterministic, reasonable maximum exposure (RME) approach and site-specific exposure parameters, the 30-year carcinogenic risk associated with the FDA criterion of 2 mg/kg results in an estimated risk of 6 x 10-3. This is well above the upper end of EPA's target risk threshold of 1 x 10-4. It is important to note that EPA considers the RME assumptions to be conservative, since they represent upper confidence limits for a given range of values for a particular risk input parameter or variable. It is also important to note that consumption of fish from Lake Hartwell (or other sources) is a strictly voluntary activity.

Use of the risk-based concentrations for fish remediation goals (i.e., 0.036 mg/kg) was determined to be technically impracticable at SV-107 for several reasons. Fish bioaccumulate PCBs from both the water column and food chain; thus, PCB concentrations in sediment and surface water would likely have to be reduced to levels in the ranges of parts per billion (0.001 mg/kg) or parts per trillion (0.001 µg/L) to achieve risk-based levels in fish. Reducing surface water and sediment concentrations to these levels is beyond the capability of proven treatment technologies, particularly when the scale of the site is taken into consideration. Moreover, as shown in the FGETS modeling, PCB cycling among fish, plankton, benthos, sediment, and surface water greatly complicates the removal of PCBs from a

biological system once the contaminants have been introduced. Even if concentrations in sediment and surface water could be reduced to levels commensurate with the risk-based fish concentrations, it would be many years before the fish concentrations actually declined to acceptable levels.

<IMG SRC 0494178T>

Given the existence of an ARAR for PCB concentrations in fish, the technical impracticability of establishing risk-based cleanup goals, and the classification of fish consumption as a voluntary exposure, the FDA tolerance level of 2 mg/kg was selected as the Final Cleanup Goal for Lake Hartwell fish.

7.3 REMEDIAL ALTERNATIVES

Response actions that were identified and passed the screening of technologies and process options were assembled into a range of remedial alternatives that included no action, institutional controls, containment, collection, removal/disposal, and removal/treatment/disposal. These eight remedial alternatives were evaluated in detail in the Final March 1994 Feasibility Study Report. A summary description of these alternatives follows. The reader should refer to Final FS Report for a more detailed account of this subject matter.

All alternative cost estimates are expressed in 1993 dollars and are based upon conceptual engineering and design. Capital cost consists of direct (construction) and indirect (non-construction) costs incurred in the first year of operation. Operation and Maintenance (O&M) cost refers to long-term post-construction items necessary to ensure continued effectiveness of a remedial action. Total present worth cost represents that sum of money, if invested in the base year and disbursed as needed, would be sufficient to cover all costs of a remedy over its planned life.

ALTERNATIVE 1 - NO ACTION

As required by CERCLA, a no further action alternative was evaluated to serve as the basis for comparison with other active cleanup alternatives. Under this no-action alternative, no further remedial actions for the contaminated sediments or fish at the site would be conducted. The no-action alternative would not affect the existing health advisory issued by SCDHEC, who would be expected to continue the advisory until PCB concentrations in fish tissue decline to levels below 2 mg/kg (FDA tolerance level). The advisory currently warns against the consumption of fish from the Seneca River Arm of Hartwell Lake above the Hwy 24 bridge and fish larger than 3 lb throughout the entire lake. The advisory would be modified if warranted by future trends regarding PCB levels in fish. Maintenance of the fish advisory is assumed to entail the periodic replacement of existing signs that advise against fish consumption.

As discussed in Section 5.4.3 of this ROD, the mean largemouth bass PCB concentration is predicted to fall below the FDA limit by year 10. However, a longer period of time is required for concentrations in higher age classes to fall below the FDA limit. PCB concentrations in 10-year-old fish, representing the highest age class and largest fish in the model, required 12 years, or the year 2005, to fall below the 2.0 mg/kg FDA limit. For these reasons, it was assumed that the fish consumption health advisory would remain in effect for 12 years.

The no-action alternative would also entail periodic reviews of site conditions to ensure that the alternative remained protective of human health and the environment. These reviews would be conducted at least every 5 years as required by CERCLA.

Capital Cost = $7,000
Total O&M Cost = $123,000
Total Present Worth Cost = $130,000

ALTERNATIVE 2A - INSTITUTIONAL CONTROLS

This alternative is a limited action alternative that relies on a series of institutional controls to prevent or minimize ingestion of contaminated fish tissue, which was identified as the primary exposure pathway of concern for the Site. Generally, these institutional controls consist of the following components:

- Continuance of the Existing Fish Advisory

- Public Education Program - A program would be initiated to inform the public on available methods for reducing the intake of PCBs through fish consumption. Specific preparation, handling, and cooking techniques can reduce the quantity of contamination consumed. Information of this type would be disseminated to the public through a series of local public meetings and distribution of an informational pamphlet.

- Fish and Sediment Monitoring - In addition to maintaining the current fish advisory, annual monitoring of PCB levels in fish and sediment of Twelvemile Creek and Lake Hartwell would be conducted. Results from this monitoring program would be utilized to support modifications to the fish advisory and to monitor concentrations of PCBs in sediment and fish over time. Results of this program would be made available to the public.

- Regulation of Twelvemile Creek Impoundments - A routine schedule would be developed for flushing of sediment accumulated behind the 3 small impoundments located on Twelvemile Creek. Periodic flushing (most recently in September 1993) of a large load of sediment over a short period of time has been documented to have an adverse impact on the water quality and aquatic biota of the upper portion of the Twelvemile Creek Arm. These adverse impacts are attributed to elevated levels of suspended sediment and not PCBs. A routine flushing schedule would minimize impacts to the ecosystem while enhancing burial of more contaminated sediments with cleaner sediments from the Twelvemile Creek drainage.

Capital Cost = $366,000
Total O&M Cost = $2,842,000
Total Present Worth Cost = $3,208,000

ALTERNATIVE 2B - FISHERIES ISOLATION

Alternative 2B is a more aggressive approach consisting of management of the fisheries resource within the lake to minimize ingestion of PCB-contaminated fish. The primary control measure includes construction of a barrier, or fish fence, to prevent the movement of migratory fish (i.e. striped bass, hybrid bass, and walleye) into or out of the most contaminated portions of the reservoir. These migratory species represent approximately 50% of the fish harvested by weight from Lake Hartwell.

Placement of the barrier in the vicinity of the Hwy 37 Bridge, just south of Clemson, would result in isolation of the Twelvemile Creek, Keowee River, and upper Seneca River Arms, which represent less than 10 percent of the total area of Hartwell Lake. Isolation of these upstream areas is expected to result in an accelerated decline in migratory fish PCB concentrations in the downstream portions of the reservoir (i.e., the remaining 90+ percent of the lake). Reduction of fish PCB levels would allow for rescinding of the existing health advisories in these areas, returning the majority of lake areas to normal use. This approach is consistent with the COE's Best Management Practices for Hartwell Lake, designed to achieve the maximum beneficial uses for the reservoir, which include fish and wildlife management and recreational use.

The fish isolation barrier would be designed/constructed to meet the following performance standards:

- Minimize safety hazards for boaters and other users of the lake (i.e. waterskiers);

- Maximize effectiveness to prevent passage of migratory game fish through the barrier;

- Allow boats to pass unimpeded to minimize disruptions of boating traffic on the lake (i.e. no gate);

- Construct a semi-permanent structure that could be removed once PCB levels decline to health-based levels;

- Incorporate value engineering principles to minimize cost for design and construction;

- Minimize operations and maintenance requirements and costs;

- Design and installation of fish fence will not impede normal lake usage.

This alternative would require an approximate 6 month pre-design (treatability type) phase to develop a detailed design in accordance with the above performance standards. If pre-design studies are successful, full scale construction/installation of this remedy could be accomplished in approximately 1 year. PCBs would continue to accumulate in the fish upstream of the fish fence, therefore, fish are predicted to decline to protective levels (the 2.0 mg/kg FDA tolerance level) in approximately 12 years. By isolating the impacted upstream areas, PCB concentrations in migratory fish from the remaining 90+ percent of the lake are predicted to decline to the 2 mg/kg level in approximately 3-4 years.

Lake use restrictions, such as no-wake zones and warning signs would be implemented to prevent damage to the fence and for boating safety. Alternative 2B also includes the institutional controls described for Alternative 2A.

Capital Cost = $1,232,000
Total O&M Cost = $3,012,000
Total Present Worth Cost = $4,244,00O

ALTERNATIVE 3A - CAPPING

Alternative 3A involves the isolation of PCB-contaminated sediments by placing an 18 inch clean sediment cap over the areas with the highest contamination. The cap would be constructed using fine sand (minimum particle size 0.25 mm) to eliminate the further downstream migration of contaminated sediment and the transfer of PCBs from sediment to aquatic biota. The cap would extend 7 miles from just upstream of the Maw Bridge (Rt. 337) to the confluence with the Keowee River, just upstream of Hwy 123. The cap would cover an area of 730 acres and would require approximately 1,800,000 yd3 of sand to construct the cap. Figure 7-2 provides an illustration of the area to capped under this alternative.

The cap thickness was designed to minimize the impacts associated with bioturbation and sediment burrowing biota (i.e. mayfly). Based upon sediment transport modeling for a cap with a minimum particle size of 0.25 mm, no significant erosion of cap material was observed in areas below the Madden Bridge. However in areas above the Madden Bridge (i.e., the "goose-neck" bend area), the model results showed erosion for all grain sizes tested (i.e., 10, 2, and 0.25 mm). These results indicate that maintenance of the cap would be difficult in the headwaters. Placement of the cap would be accomplished using a hydraulic barge unloader equipped with a sand spreader. The barge and sand spreader would likely be supplied with sand through a slurry pipeline between the barge and the shore or by a separate hopper barge. A local sand source has been identified near the community of Liberty, South Carolina. The cost estimate assumes that the sand would be transported by truck to the staging area, converted to a slurry using lake water, and pumped out to the sand spreader barge.

<IMG SRC 0494178U>

Placement of the cap, including design, procurement, and construction, would require approximately 2 years. Once the contaminated sediments were isolated beneath the cap, further transfer to biota would be significantly reduced, and PCB concentrations in the fish in Twelvemile Creek Arm would decline at an accelerated rate. A period of 3 to 4 years after cap placement would be required for the mean concentration of PCBs in largemouth bass filets to fall below the FDA limit of 2.0 mg/kg. As part of cap O&M, detailed hydrographic surveys would need to be conducted periodically to assess the integrity and overall performance of the clean sediment cap. These surveys would focus on the upstream segment of the cap in the area where sediment deposition and scour processes are most active.

Alternative 3A also consists of lake usage restrictions to minimize erosion of the cap once it is placed and other institutional controls described under Alternative 2A.

Capital Cost = $48,296,000
Total O&M Cost = $2,843,000
Total Present Worth Cost = $51,139,000

ALTERNATIVE 3B - SEDIMENT CONTROL STRUCTURE

Alternative 3B involves the construction of a 1,600 ft. fixed-crest weir near the mouth of the Twelvemile Creek Arm. The weir would maintain a constant pool elevation of 660 ft MSL in the Twelvemile Creek Arm, minimizing the scour/erosion and resuspension of contaminated sediment in the

headwaters and thereby reducing the downstream migration of PCB-contaminated sediment into Hartwell Lake. The constant pool elevation may also enhance the burial of these contaminated sediments in the upstream reaches. In addition, the weir would greatly reduce the migration of fish into and out of Twelvemile Creek Arm. The location of the sediment control structure is shown on Figure 7-3.

The weir, or sediment control structure, would be an effective barrier to the downstream movement of suspended bed-load sediments, which are transported just above the sediment-water interface. The weir would allow water to flow from the Twelvemile Creek Arm to Hartwell Lake but would otherwise be an effective physical barrier between the two water bodies. The sediment control structure would not allow the passage of boats or other watercraft, and lakeshore property owners in the Twelvemile Creek Arm would not have direct boating access to or from Hartwell Lake. Monthly pool elevation data and the reservoir operating rule curve were used to select the crest elevation for the weir. Based on the pool elevation data, it is estimated that the pool elevation for Lake Hartwell is above 660 ft MSL approximately 23 percent of the time. The sediment control structure would be constructed of concrete by utilizing proven cofferdam techniques.

<IMG SRC 0494178V>

Implementation of Alternative 3B, including design and construction of the weir and establishment of institutional controls, would require approximately 2 years. Within the newly impounded Twelvemile Creek Lake, contaminated sediments would not be isolated from the biota and future contaminant trends in the fish would be as described under the Alternatives 1 and 2A. The time to achieve protectiveness in the main body of Lake Hartwell (i.e., the approximate 90+ percent of the total lake area downstream of the sediment control structure) was assumed to be comparable to that predicted for Alternative 2B (fish fence), given that both the weir and fish fence would greatly limit the movement of fish into and out of the area with the most highly contaminated sediment. Using this approach, the FDA Tolerance Level in migratory fish downstream of the sediment control structure would be attained in an estimated 3 to 4 years after construction of the weir was completed.

To ensure public safety, watercraft would be restricted from the immediate vicinity of the sediment control structure. Fishing restrictions in the isolated area, as well as institutional controls under Alternative 2A, would be implemented to limit consumption of contaminated fish until protective levels were achieved.

Capital Cost = $51,226,000
Total O&M Cost = $2,365,000
Total Present-Worth Cost = $53,591,000

ALTERNATIVE 3C - OPTIMAL CAPPING/SEDIMENT CONTROL STRUCTURE

Value engineering techniques were used to combine elements of Alternatives 3A and 3B to achieve similar results with significantly lower costs and reduced impact to lakeshore residents and property owners. Figure 7-4 provides a conceptual approach to this alternative.

The sediment control structure for Alternative 3C consists of a fixed-crest weir similar in design to the structure proposed in Alternative 3B. The proposed location for the weir under Alternative 3C is approximately 1,000 ft upstream of the Hwy 133 bridge. Placement of the structure at this location would isolate the areas having the highest levels of PCB contamination in the sediment while at the same time effectively isolating a smaller portion of the Twelvemile Creek Arm from the main lake. Moving the weir upstream also allows for its placement at a relatively narrow constriction of the channel, resulting in a much smaller weir (length-wise) and construction cost. The weir would also maintain an upper pool elevation of 660 ft, minimizing scour and resuspension of contaminated sediment in the headwaters of the Twelvemile Creek Arm. This action would minimize the migration of contaminated sediment into the lower portion of the Twelvemile Creek Arm and Hartwell Lake. The weir is also expected to reduce the movement of fish into and out of the areas of highest sediment PCB contamination.

<IMG SRC 0494178W>

The area downstream of the sediment control structure to the mouth of the Twelvemile Creek Arm would be capped under this alternative using the same performance criteria (e.g., prevent burrowing into underlying sediment), conceptual design parameters (e.g., 18-in. thick, sand-silt mixture), and construction methods (i.e., hydraulic sand spreader barge) as described for the Alternative 3A. The

area for capping consists of approximately 285 acres and would require approximately 700,000 yd3 of material to construct. Cap integrity below the weir would be maintained using riprap and other reinforcing materials to prevent scour from flow over the top of the weir.

Construction of the sediment control structure and placement of the cap would require a period of 2 to 3 years. Upstream of the weir, contaminated sediments are not isolated from the biota and thus PCB concentration in fish would continue to exceed the FDA limit of 2.0 mg/kg for the an estimated 12 years. Downstream of the weir in the Twelvemile Creek Arm, cap placement would accelerate the reduction of PCB levels in fish to protective levels because contaminated sediments have been isolated, limiting further transfer of PCBs to biota. An estimated period of 3 to 4 years (after cap placement) is required for PCB concentrations to fall below the FDA limit of 2.0 mg/kg in the capped area as well as in the main body of Hartwell Lake. Institutional controls under Alternative 2A and fishing restrictions upstream of the sediment control structure would be implemented until protective levels in the fish were achieved.

Capital Cost = $31,684,000
Total O&M Cost = $2,365,000
Total Present Worth Cost = $34,049,000

ALTERNATIVE 4 - CONFINED DISPOSAL FACILITY

Alternative 4 involves a much more rigorous remediation approach than any of the alternatives discussed above. This alternative involves removal by hydraulic dredging of contaminated sediment from the Twelvemile Creek Arm with PCB concentrations greater than 1 mg/kg followed by disposal of the dredged material in a Confined Disposal Facility (CDF). The conceptual approach to this alternative is shown in Figure 7-5.

Implementation of Alternative 4 would be a complex undertaking controlled through scheduling and rigid conformance to procedural requirements needed to minimize environmental impacts. The following discussion provides an overview of the remedial construction activities associated with Alternative 4:

- Excavate channel - Rerouting the Twelvemile Creek Arm would begin immediately south of the high-tension powerline crossing and would proceed due south for a distance of approximately 1,600 ft. where it would reconnect with the original lake channel. The rerouted channel would be approximately 50 ft. wide at the base with a maximum excavation depth for the channel at approximately 55 ft. Material excavated during the channeling operation would be used for construction associated with the CDF. Rerouting the channel in this area would only isolate one shoreline residence on the goose-neck bend.

- Construct Confined Disposal Facility - The COE commonly uses CDFs for disposal of dredged sediments. The goose-neck bend area between Maw and Madden Bridges was selected as the optimum location for the following reasons: 1) this area has most highly contaminated sediments avoiding the need to dredge approximately 1.3 million yd3 of material; 2) approximately 113 acres is available providing sufficient capacity for disposal of 5 million yd3 of material; and 3) minimal impacts on existing residents would occur.

- Dredge and pump dredged sediment into CDF - Sediments from entire Twelvemile Creek Arm with PCB concentrations >1 mg/kg would be removed via hydraulic dredging and transported to CDF via pipeline. Sediment would settle out in CDF, while water was returned to the lake.

- Compact/grade pediment to promote runoff followed by placement of soil cap over CDF.

<IMG SRC 0494178X>

Additional detailed information regarding dredging techniques, dredged material characteristics, and design of the CDF would be required prior to implementation of Alternative 4. Implementation of the dredging alternative is expected to require a period of 3 to 4 years (including treatability testing, design, procurement and construction). Once sediments with greater than 1 mg/kg of PCBs have been removed from the lake, the FGETS model predicts that the mean PCB concentration in largemouth bass fillets would fall below the FDA limit of 2.0 mg/kg in 5 to 6 years. Institutional controls would be used to limit consumption of contaminated fish until protective levels were achieved.

Capital Cost = $43,422,000
Total O&M Cost = $3,487,000
Total Present Worth Cost = $46,9O9,000

ALTERNATIVE 5 - STABILIZATION

Alternative 5 is a very complex and costly alternative that involves removal of contaminated sediments with PCB concentrations greater than 1 ppm via a combination of shallow water excavation and hydraulic dredging. Contaminated sediments in the middle and lower portions of Twelvemile Creek Arm would be dredged while the upper portion is dewatered and excavated. The dredged/excavated sediments would be treated by stabilization with cement and placed in a CDF as described under Alternative 4. Fish and other biota in the upstream segment would be collected and destroyed as part of the dewatering operations. This alternative was evaluated in an attempt to satisfy the preference for treatment as a principal element for selected remedial alternatives at NPL sites.

Implementation of Alternative 5 would likely trigger a substantial number of ARARs, the most significant being the Clean Water Act and South Carolina Water Classification Standards. Based on a volume estimate of 4,722,000 yd3 for excavation and dredging, expected stabilization production rates, and the rate at which the confined disposal facility can be filled, implementation of Alternative 5 would entail a duration of 4 to 5 years. Once the contaminated sediment has been removed, fish PCB concentrations downstream of the Madden Bridge would decline at an accelerated rate, achieving the FDA tolerance level in approximately 5 to 6 years. The time to achieve protectiveness for this alternative therefore is 9 to 11 years.

Capital Cost = $581,957,000
Total O&M Cost = $3,486,000
Total Present Worth Cost = $585,443,000

8.0 SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

This section documents the comparative analysis conducted to evaluate the relative performance of each alternative in relation to each of the evaluation criteria. The purpose is to identify and clearly understand the advantages and disadvantages of each remedial alternative described in Section 7.0 of this ROD. As stated in NCP [40 CFR 300.430 (f)], the evaluation criterion are arranged in a hierarchal manner that is then used to select a remedy for the site based on the following categories:

Threshold Criteria:
- Overall Protection of Human Health and the Environment
- Compliance with ARARs

Primary Balancing Criteria:
- Long-term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume
- Short-term Effectiveness
- Implementability
- Cost

Modifying Criteria:
- State Acceptance
- Community Acceptance

The Threshold criteria must be met before an alternative is eligible for selection as a preferred alternative in the Proposed Plan and ultimate selection in the ROD. The five Primary Balancing Criteria provide the basis for determining which alternative provides the best balance of trade-offs among all others considered. The State of South Carolina has reviewed this ROD and concurs with EPA's selected remedy described in Section 9.0. The State of South Carolina concurrence letter is attached as Appendix A to this ROD. Community Acceptance is addressed in the Responsiveness Summary attached as Appendix B to this ROD. The following discussion addresses the Threshold and Primary Balancing Criteria.

8.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

Complexities related to the cycling of PCBs in the biota of Lake Hartwell cause residual risk levels to remain above 1 x 10-4 regardless of which remedial action alternative is implemented. A reduction in sediment PCB concentrations does not result in an immediate reduction in PCB concentrations in fish. High PCB concentrations in fish during the initial years of the 30-year exposure duration result in average risk estimates exceeding acceptable levels. Therefore, all of the alternatives rely on institutional controls to minimize exposures to PCB-contaminated fish tissue (limiting these exposures was identified as one of the primary remedial action objectives). These controls include public education and continuation of the current fishing advisory.

The most protective alternatives are those that rely principally on engineering rather than institutional controls to reduce or eliminate exposures, given the uncertainty regarding the performance/reliability of the institutional controls. The removal/disposal and removal/treatment/disposal actions under Alternatives 4 and 5, respectively, provide the highest level of protectiveness, as the contaminated material is removed from the lake and isolated in an engineered disposal facility. Alternative 2B entails construction of a fish fence to be designed and constructed so as to maximize effectiveness while minimizing operations and maintenance; however, additional, pre-design studies would be needed to develop the actual design for the structure. Alternatives 3A and 3C involve capping actions that should permanently isolate the contaminated sediment in all or a major portion of the Twelvemile Creek Arm. The capping would be highly protective of human health and the environment; its reliance on long-term monitoring and maintenance to assure cap integrity is a disadvantage but does not compromise the overall protectiveness or long-term effectiveness of the action.

8.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Section 121 (d) of CERCLA requires that remedial actions at NPL sites at least attain legally applicable or relevant and appropriate federal and state requirements, standards, criteria and limitations which are collectively referred to as "ARARs", unless such ARARs are waived under CERCLA section 121 (d) (4). Applicable requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address hazardous substances found at the site ("contaminant-specific ARARs), the remedial action to be implemented at the site ("action-specific ARARs"), the location of the site ("location-specific ARARs"), or other circumstances at the site. Relevant and appropriate requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law which, while not applicable to the hazardous substances found at the site, the remedial action itself, the site location or other circumstances at the site, nevertheless address problems or situations sufficiently similar to those encountered at the site that their use is well-suited to the site.

All of the alternatives rely on natural fate and transport processes to reduce PCB concentrations in Lake Hartwell fish to the FDA tolerance level of 2 mg/kg. Several alternatives include actions designed to speed up the rate at which these natural processes act (i.e. by capping or removing contaminated sediment). No contaminant-specific ARARs for PCBs in sediment were identified, which led to the identification of To-Be-Considered (TBC) criteria and the selection of a sediment cleanup goal of 1 mg/kg based on an evaluation of these criteria. Alternatives 3A (Capping), 4 (Confined Disposal Facility) and 5 (Stabilization) would best achieve the TBC criteria for sediment. The sediment control structures (Alternatives 3B and 3C) are expected to impact PCB concentrations in the sediment, but not to the same extent as capping or removal.

Alternatives 4 and 5 would trigger the largest number of and most complex action- and location-specific ARARs, including the Clean Water Act dredge-and-fill requirements, South Carolina requirements for surface water discharges, and, if PCB concentrations in dredged/excavated sediments exceed 50 ppm TSCA requirements for handling/storage/treatment/disposal. The alternatives could be designed and implemented to attain compliance with these requirements. Capping activities under alternatives 3A and 3C would also trigger Clean Water Act and South Carolina requirements related to surface water discharges; compliance with these requirements would be factored into the design and implementation. Action-specific ARARs were not identified for the institutional controls under any alternative or for construction of the fish fence under Alternative 2B.

8.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Long-term effectiveness and permanence refers to the expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time. The criterion

includes the consideration of residual risk and the adequacy and reliability of controls.

Contaminant transport and bioaccumulation modeling conducted during the RI showed that Lake Hartwell is a dynamic system in which PCB concentrations in sediment and biota are gradually declining in response to natural fate and transport processes such as burial by clean sediment, resuspension and desorption followed by flushing out of the reservoir, and other processes. The modeling results indicate that PCB levels in the sediment will decline below the 1 mg/kg cleanup goal in 5 to 10 years (depending on location within Twelvemile Creek Arm) and that PCB concentrations in fish will decline to the FDA tolerance level in 12 years. If the modeling predictions are accurate, even Alternative 1 (No Action) would eventually result in a permanent solution for the site in approximately 12 years, given that consumption of contaminated fish was the primary exposure pathway of concern.

Alternatives 2 to 5 rely on institutional controls to prevent exposure to contaminated fish; the performance and reliability of these controls is dependent on site-specific factors and therefore difficult to predict. In the context of technology performance and reliability, the fish fence (Alternative 2B) has not been proven for the same scale of application proposed for Sangamo OU2. Capping (Alternatives 3A and 3C) is a proven technology but is dependent on an extensive program of monitoring and maintenance to ensure cap integrity and long-term effectiveness. Capping of only the downstream portion of the Twelvemile Creek Arm under Alternative 3C would result in a cap that was easier to maintain, and therefore, it should have a higher degree of long-term effectiveness. Sediment control structures (Alternatives 3B/3C) are also widely used and are less dependent on maintenance.

Although dredging and confined disposal facilities are widely recognized as reliable technologies, further technology evaluation, in the form of pilot-scale treatability studies, would be needed to obtain design and operating data essential to minimize environmental impacts. Similarly, stabilization treatability studies under Alternative 5 would require further technology evaluation to determine material handling and process requirements (e.g., optimum stabilization mixture). Treatability studies are also needed to determine effluent treatment requirements for the dewatering fluids from the confined disposal facility or material handling/stockpiling areas.

8.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies for the remedy. None of the alternatives has an effect on the toxicity of the contaminants, expect Alternative 5 which involves treatment by stabilization. Alternative 5 would accomplish the most significant reduction in the mobility of PCBs through a stabilization treatment process, followed by disposal in a confined disposal facility. Contaminant mobility would also be reduced through disposal in a CDF, with no treatment, in Alternative 4.

The capping alternatives (Alternatives 3A and 3C) also accomplish a reduction in contaminant mobility, but the effect is contingent upon proper maintenance of the cap. Reductions in contaminant mobility are expected with the sediment control structures (Alternatives 3B and 3C), primarily through maintaining pool elevation, thereby decreasing scour/erosion in the headwaters. The capping, sediment control structures and fish fence alternatives also reduce PCB transfer to migratory fish by isolating the contaminated sediment (through capping) or restricting the migration of fish into and out of the areas with the highest sediment contamination (through the fence or weirs). The net result is a reduction in the level of PCB contamination in lake-wide migratory fish.

8.5 SHORT-TERM EFFECTIVENESS

Short-term effectiveness refers to the period of time needed to complete the remedy and any adverse impacts on human health and the environment that may be posed during the construction and implementation of the remedy.

Implementation of Alternatives 1 (No-Action) and 2A (Institutional Controls) would have the least impact on the community, workers, and the environment; Alternative 2B has only a slightly greater impact. Alternatives 3A/3B/3C have greater impacts on the local community due to construction of sediment control structures and excessive truck traffic associated with the transportation of capping material. The greatest impacts (and least short-term effectiveness) are associated with the more aggressive alternatives that entail dredging, re-channeling, and construction of the CDF (Alternatives 4/5).

Table 8-1 summarizes the estimated schedule for each alternative, presenting the time required to implement, time required for fish PCB concentrations to decline to protective levels (FDA tolerance level), and total time for alternative to achieve protectiveness. Because the most highly contaminated sediment is concentrated in a relatively small, upstream portion of the lake that represents less than 10 percent of the reservoir area, separate estimates are shown for the time to attain FDA levels and time to achieve protectiveness in both this upstream portion (i.e., the Twelvemile Creek/Seneca River Arm) and in the main body of Hartwell Lake. The impact on a given alternative with regard to protective levels throughout the lake is an important consideration given the significant resource potential of the reservoir. It is important to note that the time required for implementation includes design, procurement, and construction but does not consider the time between issuance of the Proposed Plan/signing of the ROD and initiation of the Remedial Design.

The table shows that isolation or removal of the most highly contaminated sediment, through fisheries isolation, capping, sediment control structures, or dredging often has a much greater effect on PCB levels in downstream areas than within the Twelvemile Creek Arm. This response is mostly due to the impact of limiting or preventing the movement of migratory fish into and out of the areas with the more highly contaminated sediment (lake-wide, non-migratory fish have exceeded the FDA levels on an infrequent and isolated basis while migratory fish have typically had PCB levels higher than 2 mg/kg). Accelerated declines in PCB levels would be expected for alternatives involving capping or removal; otherwise, PCB reductions would be accomplished only through natural fate and transport processes conditions.

The most favorable alternatives with regard to the estimated time to achieve protectiveness would be Alternatives 2B and 3A; fisheries isolation (Alternative 2B) is more quickly implemented and therefore leads to a slightly faster reduction in PCB levels in the main body of Hartwell Lake but the capping alternative would have a much greater effect in the Twelvemile Creek/Seneca River Arm. If more than 1 to 2 years elapse between the signing of the ROD and the initiation of the Remedial Design, the dredging alternatives (Alternatives 4/5) will not achieve protectiveness appreciably faster than that obtained under baseline (no-action) conditions.

Table 8-1
Estimated Time to Achieve Protectiveness

ALT. NO.	DESCRIPTION	TIME TO IMPLEMENT(1) (yrs)	TIME FOR FISH TO ATTAIN FDA LEVEL (yrs): TWELEMILE CREEK/SENECA RIVER(2) ARM	TIME FOR FISH TO ATTAIN FDA LEVEL (yrs): MAIN BODY OF HARTWELL LAKE(3)	TIME TO A PROTECTIVENESS(4) (yrs): R MAIN BODY OF HARTWELL LAKE
2	No action	0	12	12	
2A	Institutional	0.5	12	12	
2B	Fisher Isolation	1	12	3-4	
3A	Capping	2	3-4	3-4	
3B	Sediment Control Structure	2	12	12	
3C	Optimal Capping/Sediment Control Structure	2-3	3-4 (downstream) 12 (upstream	3-4	
4	Confined Disposal Facility	3-4	5-6	5-6	
5	Stabilization	4-5	5-6	5-6	

NOTE: (1) Includes time needed for pre-design studies, procurement, and constr between Proposed Plan/Record of Decision and initiation of Remedial Design.

(2) Twelvemile Creek Arm only; FGETS modeling results indicate that fish mg/kg) in approximately 12 years under baseline conditions; none of the alternatives will extend the period required for this to period to achieve protectiveness of greater than 12 yrs).

(3) Downgradient of the Twelvemile Creek Arm (i.e., main body of Hartwel decline more rapidly for actions involving isolating, capping or removal of contaminated sediment (Alternatives 2B, 3A-C, 4 and 5). It was a comparable to that observed in the Twelvemile Creek Arm for Alternatives involving capping (3-4 yrs) or removal of the sediment verify this estimated.

(4) Duration only; based on estimated time to implement remedy and durat to decline to FDA level, based on the FGETS modeling results presented in Section 3.3 and assumptions regarding migratory

8.6 IMPLEMENTABILITY

Alternatives 1 and 2A would be the most readily implementable; the main activity associated with the institutional controls under Alternative 2A (and other alternatives) involves planning and coordination with COE, SCDHEC, and other agencies. Alternative 2B (Fish Fence) would be somewhat more complex to implement, primarily due to the predesign testing to assess the suitability of various designs.

Alternatives 3A, 3B, and 3C represent an intermediate range of implementability. Capping and weirs have been successfully constructed at a wide variety of sites and conditions at Hartwell Lake and should not present any unusual difficulties. The reduced scale of the area to be capped and size of weir for Alternative 3C would simplify both design and construction activities associated with these individual components. A limitation to Alternative 3A and, to a lesser extent, 3C, concerns the availability and transportation logistics of as much as 1.8 million yd3 of capping material. From a technical and engineering perspective, construction of the fixed crest weirs for Alternatives 3B and 3C should be much more implementable than capping due to the likelihood of encountering problems with the capping materials.

The most difficult alternatives to implement, in terms of both technical and administrative feasibility, would be Alternatives 4 and 5; both involve dredging, which is a widely used technology, but they would still require considerable predesign testing and evaluation to optimize operations and minimize environmental impacts. Construction of the confined disposal facility in what is currently a large body of open water and rechanneling the Twelvemile Creek Arm through a forested ridge would also present a number of technical challenges, while not insurmountable, the challenges do make implementation of Alternatives 4 and 5 considerably more complex than the other remedial alternatives. These alternatives would also have the greatest administrative requirements due to the need to fulfill permit-related requirements related to Clean Water Act dredge-and-fill permits, South Carolina NPDES permits, and possibly other permitted activities.

8.7 COST

Costs for each alternative were provided under Section 7.3 of this ROD. Alternative 5 is the most expensive alternative to implement, and is considered cost prohibitive. The more aggressive alternatives (Alternatives 3A/3B/3C/4) that involve engineering controls to satisfy the remedial action objectives have total present worth costs that generally range from $30-50 million. Alternative 2B achieves protectiveness in the main body of Lake Hartwell in a shorter amount of time than the other more aggressive and passive (Alternatives 1/2A) alternatives for only an additional $1 million over the cost of Alternative 2A (estimated present worth cost of $3,208,000). The No-Action alternative is the least expensive.

9.0 THE SELECTED REMEDY

This section of the ROD discusses EPA's selected remedy in detail for the Sangamo OU2 Site. EPA has selected Alternative 2A - Institutional Controls to address the contaminated sediments and fish at the Site. The selected remedial alternative for the Sangamo OU2 Site consists of the following components: 1) continuation of existing fish advisory; 2) public education program; 3) future sediment and aquatic biota monitoring; and 4) regulation of the Twelvemile Creek Impoundments. These primary components are discussed below.

9.1 CONTINUATION OF EXISTING FISH ADVISORY

The existing fish advisory on Lake Hartwell shall remain in effect. Signs warning against consuming fish have been posted at the majority of the public boat launch and recreation areas since 1987. Figure 9-1 provides an illustration of the posted advisory. The advisory is currently maintained by SCDHEC, and SCDHEC will remain responsible for management, supervision, and administration of the fish consumption advisory in the future. The advisory will be modified if warranted by future trends regarding PCB concentrations in fish. Modifications shall be fully supported and justified by the annual monitoring program discussed in Section 9.3 of this ROD.

Maintaining the fish advisory will likely entail the posting and replacement of signs describing the advisory at access points along the shoreline. For purposes of enhancing the effectiveness of the advisory, additional signs may be posted. Additional activities designed to increase public awareness of the existing fish consumption advisory are discussed in Section 9.2 of this ROD.

As discussed in the Section 5.4.3, FGETS bioaccumulation food-chain modeling, the mean PCB concentration in 2-8 year old largemouth bass is predicted to fall below the FDA limit by year 10. However, a longer period of time is required for concentrations in higher age classes to fall below the FDA limit. PCB concentrations in 10-year-old fish, representing the highest age class and largest fish in the model, required 12 years to fall below the 2.0 mg/kg FDA limit. For these reasons, it was assumed that the fish consumption health advisory would remain in effect for a minimum of 12 years, or the year 2005.

9.2 PUBLIC EDUCATION PROGRAM

Proper preparation of contaminated fish can reduce the quantity of contamination consumed. Contaminants (PCBs) are generally stored in fatty tissue (i.e., belly flap, strip along the backbone and lateral line, and skin). By removing these areas when cleaning the fish, individuals can substantially reduce their intake of PCBs. Broiling, baking, and grilling fish also provides additional risk reduction. Many states, including Georgia, provide fish preparation suggestions to the public in pamphlets and other publications on state fishing regulations; South Carolina currently does not.

EPA shall develop a pamphlet that outlines methods, including those described above, for reducing the intake of contaminants through fish consumption. This pamphlet will be distributed to the general public and to frequent Lake Hartwell resource users. The most effective method of distribution to the general public is to provide the pamphlet to everyone who purchases a fishing license. Thus, all establishments that sell fishing licenses in the Hartwell Lake area will be supplied with the pamphlets, as will marinas and selected retail establishments (i.e., convenience stores) in the area. In addition to the pamphlets, advertisements will be placed periodically in newspapers from all of the counties surrounding the lake. The advertisements will reiterate the potential risks associated with consumption of PCB-contaminated fish from Lake Hartwell.

Printed information regarding the fish advisory will also be supplemented with periodic public meetings hosted by EPA, SCDHEC, and the COE. Public meetings will begin the first year following signing of the ROD and will be held at a minimum of 5-year intervals. The public meetings will serve to update the general population on PCB concentration trends in sediment and fish as well as the latest estimates of PCB-related risks resulting from consumption of contaminated fish. Analytical results from the annual monitoring program described in Section 9.3 and the five-year reviews, as required by CERCLA, will be disseminated to those attending these meetings, local citizens, and frequent lake users. The meetings would also provide a forum for public input into the decision-making process regarding continued institutional controls for the lake. The proposed locations for these meetings include:

- Anderson, S.C.
- Cateechee/Norris S.C.
- Clemson, S.C.
- Hartwell, Ga.
- Seneca, S.C.

Figure 9-1
Current Lake Hartwell Fish Advisory

ATTENTION

FISH CONSUMPTION ADVISORY-LAKE HARTWELL
S.C. DEPARTMENT OF HEALTH AND
ENVIRONMENTAL CONTROL (SCDHEC)

- ALL FISH TAKEN FROM THE SENECA RIVER ARM OF LAKE HARTWELL NORTH OF SC HIGHWAY 24 AND 12 MILE CREEK SHOULD BE RELEASED AND NOT EATEN.

- ALL FISH LARGER THAN THREE (3) POUNDS TAKEN FROM THE REMAINDER OF LAKE HARTWELL SHOULD BE RELEASED AND NOT EATEN.

- FISHING IS NOT PROHIBITED BUT SCDHEC ADVISES THAT THESE FISH NOT BE EATEN DUE TO THE PRESENCE OF ELEVATED LEVELS OF POLYCHLORINATED BIPHENYLS (PCBs). SWIM MING, BOATING, AND OTHER WATER RELATED ACTIVITIES ARE NOT RESTRICTED BY THIS ADVISORY.

FOR ADDITIONAL INFORMATION,
CONTACT SCDHEC AT:

COLUMBIA	GREENVILLE	ANDERSON
734-5300	242-9850	225-3731

The above public education program represents a baseline approach. EPA, COE, and SCDHEC will periodically evaluate the overall approach and effectiveness of this program by soliciting public comment and input from Lake Hartwell resource users. Creel surveys, similar to those conducted as part of the Biological Investigation, may also be utilized as a mechanism to obtain information from anglers on Lake Hartwell. The public education program is expected to evolve while attempting to identify the most productive method(s) for reaching the targeted audience. EPA, in close consultation with SCDHEC and the COE shall modify the public education program as required.

9.3 AQUATIC BIOTA AND SEDIMENT MONITORING

This section describes the program of annual monitoring of PCB levels in the fish, corbicula, and sediment of Lake Hartwell and the Twelvemile Creek watershed.

9.3.1 AQUATIC BIOTA MONITORING

In the interest of consistency and to support trend analysis, fish samples will be collected from the same 6 Lake Hartwell stations that have been utilized historically by SCDHEC and also during the Biological Investigation. These stations are shown on Figure 9-2 and are generally described as follows:

- SV-107 Twelvemile Creek Arm of Lake Hartwell in the vicinity of County Road 37; Pickens County, SC.
- SV-106 Seneca River Arm of Lake Hartwell in the vicinity of Martin Creek; Anderson County, SC.
- SV-532 Seneca River Arm of Lake Hartwell in the vicinity of Eighteen Mile Creek; Anderson County, SC.
- SV-535 Andersonville Island area of Lake Hartwell near the confluence of the Tugaloo and Seneca Rivers; Anderson County, SC.
- SV-641 Tugaloo River Arm of Lake Hartwell in the vicinity of Interstate I-85; Oconee County, SC.
- SV-642 Open water area of Lake Hartwell in the vicinity of Hartwell Dam; Anderson County, SC.

Fish samples shall be collected annually in the spring using gill nets and/or electrofishing techniques. Hybrid bass (weight class 3.0-5.0 lbs.), largemouth bass (weight class 1.5-3.0 lbs.) and channel catfish (weight class 2.0-4.0 lbs.) will be collected from the above 6 stations in Lake Hartwell. In past sampling events, 10 hybrid bass, 10 largemouth bass, and 4 catfish were collected at each station to calculate a representative mean. The adequacy of these respective numbers in determining a representative mean concentration in fish tissue is currently under review by SCDHEC. In any event, sampling conducted pursuant to this ROD will at a minimum include 10 hybrid bass, 10 largemouth bass, and 4 catfish. Game fish shall be prepared in accordance with the standard US FDA fillet method i.e., fillet including rib cage and belly flap with skin on and scales off - except for catfish where skin is removed.). All fish shall be analyzed for the PCB component of EPA’s Target Compound List (TCL).

Forage fish, consisting of gizzard shad/blueback herring, threadfin shad and bluegill, shall be collected at stations SV-107, SV-532, and SV-641. Forage fish will be collected concurrently with game fish sampling discussed above using electrofishing techniques. Samples will consist of whole body composite samples for each species. All forage fish samples shall be analyzed for PCBs. Data generated from the forage fish collection and analyses shall be utilized to support future food-chain modeling activities.

<IMG SRC 0494178Y>

In addition to fish sampling in Lake Hartwell, corbicula (fresh water clams) baskets will be placed at 6 locations in Twelvemile Creek for 28 days each in the spring of each year to determine current PCB loading into the Twelvemile Creek system. The sampling locations for corbicula baskets are shown on Figure 9-3. Corbicula baskets will be deployed concurrent with the fish sampling activities described

above. After 28 days, baskets shall be recovered and analyzed for PCBs.

9.3.2 SEDIMENT MONITORING

Sediment monitoring locations are shown in Figures 9-4 and 9-5. Sediment samples shall be collected annually from 15 locations in Hartwell Lake and 5 locations in the watershed. Sediments will be collected using a ponar dredge. Stations SD-001 through SD-005 in the Twelvemile Creek watershed will be discrete samples. For the remaining 15 locations in Lake Hartwell, a transect shall be established at each station and 5 grab samples will be collected along the transect. These 5 samples shall be composited to provide a mean concentration of PCBs in surface sediments from a given transect. Sample and transect locations shall be established with sufficient accuracy to enable collection of future samples from same locations. Details of the sediment sample locations in Twelvemile Creek and Lake Hartwell are presented in Table 9-1.

All sediment and aquatic biota monitoring shall continue under the direction of EPA. Data from the annual monitoring will allow EPA, SCDHEC and COE to continue ongoing efforts to evaluate contamination trends in the sediment and biota. These trends will be used to support decisions to modify the advisory, in response to PCB concentration trends in the fish. Annual monitoring results shall be summarized and disseminated to the public in support of the public education program described under Section 9.2. For purposes of the cost estimate described in Section 9.6, it was assumed that this annual monitoring program will continue for a minimum of 15 years from signature of the ROD.

9.4 REGULATION OF TWELVEMILE CREEK IMPOUNDMENTS

The Federal Energy Regulatory Commission (FERC) regulates hydroelectric facilities in the U.S. Currently, the middle and lower impoundments on Twelvemile Creek, Woodside I and II, respectively, are non-licensed hydroelectric impoundments based on the date of construction and navigability of Twelvemile Creek. These impoundments effectively trap a large portion of the sediment load from Twelvemile Creek, and as a result, are flushed periodically to remove sediment and to restore storage capacity within the impoundments. Historically, these trapped sediments have contained high levels of PCBs. However, the RI and subsequent sampling in response to a recent flushing event (September 1993) have shown that more recent sediment accumulating behind the small dams has relatively low levels of PCB contamination (1 to 3 mg/kg). These low concentrations confirm that PCB-contaminated sediments continue to flow down Twelvemile Creek into Hartwell Lake, but the magnitude of this contaminant flux is small.

Although flushing of these impoundments is not currently contributing appreciable quantities of PCB contamination to the Twelvemile Creek Arm of the lake, the release of the equivalent of a half-year's sediment load (or more) during a short time period (typically less than 1 week) has been documented to have potentially significant adverse effects on water quality in the upper portion of the Twelvemile Creek Arm. The influx of sediment in the most recent flushing event (September 1993) was observed to result in a notable fish kill in Twelvemile Creek below the impoundments and in the upper portion of the Twelvemile Creek Arm. This was attributed to elevated levels of suspended sediments and not PCBs. Similar and possibly more damaging effects to benthic organisms within the upper portion of the reservoir are also likely to occur.

The frequency at which these impoundments are flushed is based primarily on an operations schedule established by the owner/operator rather than hydraulic or other technical constraints. To minimize the negative impacts on water quality, and to facilitate burial of relatively more contaminated sediments downstream, EPA's selected remedy shall include the development of a routine schedule for sluicing of all three impoundments (i.e., Woodside I and II, and Easley-Central Water District). Quarterly flushing of these impoundments is thought to be adequate to minimize the negative impacts.

<IMG SRC 0494178Z>
<IMG SRC 04941781>
<IMG SRC 04941782>

TABLE 9-1
Sediment Sample Locations in Twelvemile Creek Watershed and Arm of Lake Hartwell

Station ID	Location
SD-001	Town Creek downstream of Sangamo Weston outfall - same location as corbicula basket 2
SD-002	Twelvemile Creek upstream of Wolf Creek confluence - same location as corbicula basket 3
SD-003	Wolf Creek downstream of Breazeale site - same location as corbicula basket 4
SD-004	Twelvemile Creek at Easley-Central impoundment - same location as corbicula basket 5
SD-005	Twelvemile Creek at Lay Bridge
SD 006	Maw Bridge
SD-007 - 009	Between Maw and Madden Bridges
SD 010	Madden Bridge
SD-011	Between Madden and Hwy 133 Bridges
SD-012	Hwy 133 Bridge
SD-013	Mouth of Twelvemile Creek Arm
SD-014	Between US 123 and Hwy 93 Bridges
SD-015	Hwy 37 Bridge
SD-106	SV-106 fish sampling station
SD-532	SV-532 fish sampling station
SD-535	SV-535 fish sampling station
SD-641	SV-641 fish sampling station
SD-642	SV-642 fish sampling station

Preliminary discussions with Consolidated Hydro, Inc., owners/operators of Woodside I and II, have indicated a willingness to comply with this requirement. It is estimated that approximately $200,000 in capital improvements to the gating mechanisms are necessary to fulfill the objectives of this component of EPA's selected remedy. Compliance with the routine schedule shall be monitored by SCDHEC. In addition, water quality and sediment monitoring will be conducted on downstream areas during the sluicing events to facilitate modification of the schedule as needed.

9.5 FIVE YEAR REVIEWS

As required by CERCLA, 5-year reviews will be conducted to ensure that the alternative remains protective of human health and the environment. The results of the annual monitoring studies shall be incorporated into the 5-year reviews. The 5-year reviews shall continue at intervals no less often than 5 years following signature of this ROD until protectiveness has been achieved.

9.6 COST ESTIMATE

Table 9-2 provides a cost breakdown, by component, of Alternative 2A - Institutional Controls. The estimated total present worth cost for EPA's selected remedy is $3,208,000, which includes $366,000 of capital costs.

TABLE 9-2
Cost Estimate for EPA's Selected Remedy, Alternative 2A-Institutional Controls

Remedy Component/ Cost Item		Capital Cost ($)	O&M Cost ($/yr.)	O&M Cost ($5/yrs.)	Present Worth Cost ($)
Fish Advisory		$4,000	$1,000		$12,000
Public Education			$33,000	$25,000	$314,000
Biota & Sediment Monitoring			$132,000		$1,202,000
Twelvemile Creek Impoundments		$200, 000			$200,000
5-Year Reviews				$28,000	$60,000
Subtotal		$204,000	$166,000	$53,000	$1,788,000
Engineering	10%	$20,000	$17,000	$5,000	$179,000
Procurement	5%	$10,000	$8,000	$3,000	$89,000
Construction Management	15%	$31,000	$25,000	$8,000	$268,000
Subtotal		$265,000	$216,000	$69,000	$2,324,000
Indirects/Profit		$40,000	$32,000	$10,000	$349, 000
Subtotal		$305,000	$248,000	$79,000	$2,673,000
Contingency	20%	$61,000	$50,000	$16,000	$535,000
TOTAL		$366,000	$298,000	$95,000	$3,208,000

10.0 STATUTORY DETERMINATIONS

This section of the ROD describes how EPA's selected remedy, Alternative 2A - Institutional Controls, meets the statutory requirements as delineated in Section 121 of CERCLA.

10.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The extent to which EPA' selected remedy is protective of human health and the environment is directly dependent upon the effectiveness of the institutional controls that are the principal components of this response action. The reliability of the institutional controls in limiting exposure is difficult to predict due to the significance of site-specific demographic factors governing the likely response of the public to the advisory and other component of this remedy that are designed to limit exposures. Risks posed by the primary exposure pathway, ingestion of PCB contaminated fish, are declining due to natural fate and transport processes, primarily the burial of contaminated sediment. Baseline

modeling activities predict that PCB concentrations in largemouth bass fillets would decline to the FDA tolerance limit in approximately 12 years (year 2005).

Effective implementation of the institutional controls described in Section 9.0 of this ROD would limit exposures until PCB contamination dropped to these protective levels. Therefore, this alternative is considered to be adequately protective of human health and the environment.

10.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The only applicable requirement identified for the selected remedy is the contaminant-specific ARAR governing PCB concentrations is fish. Continuation of the existing fish advisory in conjunction with the aggressive public education program addresses the FDA requirement governing consumption of PCB contaminated fish.

No sediment-related, contaminant-specific ARARs were identified. TBC and health-based criteria for sediment were identified in the discussions of ARARs and sediment cleanup goals. Alternative 2A does not attain the TBC or health-based levels directly, but these levels would be attained through natural sedimentation processes in the reservoir. Depending on the area of the Twelvemile Creek Arm, the selected TBC sediment cleanup goal of 1 mg/kg will be attained in a period of 5-10 years.

10.3 COST EFFECTIVENESS

EPA believes this remedy will minimize risks posed to human health and the environment at an estimated cost of $3,208,000. Complexities related to the cycling of PCBs in the aquatic biota of Lake Hartwell cause residual risk levels to remain above acceptable levels regardless of which remedial alternative is implemented. The most effective means to limit exposure to PCB-contaminated fish is by the effective implementation of the primary components of EPA's selected remedy, Alternative 2A - Institutional Controls. Therefore, in terms of risk-reduction for money spent, Alternative 2A is the most cost-effective remedial alternative that was evaluated in detail by EPA.

10.4 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE

EPA has determined and the State of South Carolina has concurred with EPA's determination that the selected remedy represents the maximum extent to which permanent solutions can be utilized in a practicable manner for Operable Unit Two of the Sangamo Site. Engineering controls and treatment technologies did not offer a significant advantage in terms of overall risk reduction for the cost. EPA and the State have determined that the selection of Alternative 2A - Institutional Controls, provides the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element and community acceptance. The selected remedy addresses the primary risk associated with Sangamo OU2, the ingestion of PCB contaminated fish, by the most effective means practicable.

10.5 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

EPA's selected remedy does not satisfy the preference for treatment as a principal element due to the excessive costs (>$500 million) associated with removal, treatment and disposal of approximately 4.7 million cubic yards of PCB contaminated sediment spread out over approximately 730 acres. Moreover, alternatives that involved aggressive engineering controls to contain, remove, and dispose of PCB contaminated sediment ranged from $30-$50 million without offering a significant advantage in terms of overall risk reduction.

11.0 DOCUMENTATION OF SIGNIFICANT CHANGES

Pursuant to the requirements of Section 117(b) of CERCLA, this section of the ROD documents and discusses the reasons for significant changes made to the selected remedy from the time the Proposed Plan was released to the public to the final selection of the remedy in this ROD. For reference, the Proposed Plan is attached to this ROD as Appendix C. Specific written and/or oral comments received during the formal 60-day public comment period held from April 11 through June 10, 1994 are discussed in the Responsiveness Summary (Appendix B).

EPA's preferred alternative, as delineated in the Proposed Plan, was Alternative 2B - Fisheries Isolation. In addition to the Institutional Controls under Alternative 2A, Alternative 2B also

involved the construction of a fishery isolation barrier ("fish fencer") to prohibit the movement of migratory fish into or out of the area of Lake Hartwell with the highest PCB concentrations in sediment. Placement of the fish fence near the Hwy 37 Bridge, just south of Clemson on the Seneca River Arm, would result in isolation of less than 10 percent of the total area of Lake Hartwell. Isolation of these upstream areas was expected to result in accelerated declines in PCB concentrations in migratory fish in the downstream portions of Lake Hartwell (i.e. the remaining 90+ percent of the lake).

The reasons supporting EPA's preference for Alternative 2B were simply: 1) Migratory species represent approximately 50% of the fish harvested by weight from Lake Hartwell. Accelerated reductions of PCB concentrations in these fish, for the majority of Lake Hartwell, would achieve a higher degree of protection by eliminating, or at the very least, minimizing exposures to this group of migratory fish; 2) Reduction in fish PCB levels would allow for rescinding of the existing fish advisories in the areas downstream of the fish fence, in an accelerated time frame, thus returning the majority of Lake Hartwell to its highest beneficial use; 3) The incremental cost to implement Alternative 2B was only approximately $1 million over that of Alternative 2A.

Moderate, yet unwavering public opposition was expressed to EPA's preferred alternative at the Proposed Plan public meeting held in Clemson, SC on April 19, 1994. This and subsequent comments received during the public comment period suggest that the general consensus supports Alternative 2A and/or no-further action. In summary, the reasons supporting public opposition to Alternative 2B were essentially two-fold. First, the public does not believe EPA is capable of designing, constructing and installing a safe fishery isolation barrier that would meet the specified performance standards (See Section 7.3) at the estimated cost. Secondly, given the fact that Institutional Controls provide the most reliable mechanism for reducing exposures to PCB contaminated fish, the incremental cost for constructing a fish fence is not justified.

EPA has given serious consideration to the concerns that were voiced by the public. In response to these concerns, EPA, in close consultation with SCDHEC and the Savannah District Corps of Engineers, has selected Alternative 2A - Institutional Controls as the Final remedial alternative for the Sangamo OU2 Site.

Appendix

Proposed Plan Fact Sheet <text is truncated on right side of page>

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

SUPERFUND PROPOSED PLAN FACT SHEET

SANGAMO WESTON/TWELVE MILE CREEK/LAKE HARTWELL PCB CONTAMINATION SUPERFUND SITE-OPERABLE UNIT TWO

Pickens County, South Carolina

A number of terms specific to the Superfund process (printed in bold print end of this publication.

INTRODUCTION

The Region IV office of the United States Environmental Protection Agency has developed this Proposed Plan Fact Sheet for the Sangamo Weston/Twelvemile Creek/Lake Hartwell Polychlorinated Biphenyl (PCB) Contamination Superfund Site - Operable Unit Two ("Sangamo OU2 Site") in Pickens County, South Carolina. This Proposed Plan is issued to present the alternatives that EPA has considered to address PCB contamination in the sedinment and aquatic biota of the Sangamo OU2 Site. More specifically, the purpose of this Proposed Plan is to:

! Identify the preferred alternative for remedial action at the Site and explain the rationale for that preference;

! Describe the other remedial options considered in detail in the Final Feasibility Study Report;

! Solicit public review of and comment on all of the alternatives described; and

! Provide information on how the public can be involved in the remedy selection process at the Sangamo OU2 Site.

PROPOSED P
MEE
for
SANGAMO-
SUPERFUND
Tuesday,
7:
RAMAD
U.S. 76
Clemson,

EPA, in consulta
Distact of the U
Engineers (COE)
Department of He
Control (SCDHEC)
remedy for the S
public comment p
information subm
been reviewed an
encouraged to su
alternatives, an
supports these a
Remedial Project
of this publicat
presented in a R
could differ fro
depending upon n
EPA receives dur
comment period.

EPA is issuing this Proposed Plan as part of its public participation responsibilities under Section 117(a) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, more commonly known as Superfund). This fact sheet summarizes information that can be found in greater detail in the Remedial Investigation/Feasibility Study (RI/FS) Reports and other site-related documents contained in the Administrative Record, located at the established information repositories. The reader is referred to the

of the sediments,
biota from the San
Town Creek through
well into the Twel
Hartwell. During
was discovered tha
of Late Hartwell c
exceeded the recom
by the U.S. Food a
(U.S. FDA). Subse
a fish consumption
issued in 1976 and
SCDHEC in 1985 as

information repositories listed at the end of this publication for a more detailed account of this subject matter.

SITE BACKGROUND

From l955 to 1987, Sangamo Weston, Inc. owned and operated a capacitor eaten. manufacturing plant in Pickens, South Carolina, near the headwaters of Lake Hartwell. In its manufacturing processes, Sangamo used several varieties of dielectric fluids which contained PCBs. Waste disposal practices from the Sangamo Plant included land burial of off-specification capacitors and wastewater treatment sludges on the plant site and at six satellite disposal areas. PCBs were discharged with untreated effluent directly into Town Creek, which is a tributary of Twelvemile Creek. Twelvemile Creek is a major tributary of Lake Hartwell. It is estimated that over 400,000 lbs. of PCBs were released into the Twelvemile Creek system until the use of PCBs were discontinued prior to an EPA ban in January 1978. Schlumberger Industries, Inc. (SII) is the current owner of the plant site, as a result of a merger with Sangamo Weston in December 1989.

Historical sampling events conducted by SCDHEC, COE, and EPA documented the presence of widespread PCB contamination

to reduce human ex
states: 1) All fi
River Arm of Lake
Highway 24 and Twe
be released and no
larger than 3 lbs.
Lake Hartwell shou
eaten. This advis
warning signs agai
posted at the majo
launch and recreat

In 1987, based upo
Ranking System, SC
programs and accom
citizens in the ar
proposed for inclu
Priorities List (N
was finalized on t
A Remedial Investi
separate sediment
components, was th
nature and extent
the Sangamo OU2 st
study area extends
Weston Plant's dis
Creek, through the
watershed, and fin
of Lake Hartwell.
this publication p
illustration of La
surrounding area.
focused descriptio

Field sampling and analysis for the sediment component of the OU2 RI was performed in July and August 1991 (Phase I) and April and May 1992 (Phase II). The sediment investigation included the collection and analysis of over 1,100 sediment cores and grab samples to adequately characterize the horizontal and vertical distribution of PCB contamination in the sediments of the study area. The sediment investigation determined that most of the PCB-contaminated sediment lies within the upper portion of Lake Hartwell, specifically the Twelvemile Creek Arm. PCB concentrations of surficial sediments (i.e. grab samples) were typically less than 5 parts per million (ppm), but higher concentrations up to 61 ppm were detected in the deeper sediments (i.e. core samples). Figure 3 illustrates average sediment PCB concentrations for an approximate 10 mile reach extending from Maw Bridge(Rt. 337)to the Rt 37 Bridge at the southernmost boundary of the focused OU2 study area.

Field sampling and analysis for the biological component of the OU2 RI was conducted in the Spring of 1991 and 1992.

Arm and decrea
downstream, si
sediment conta
species (i.e.
concentrations
entire reservo
frequently exc
level. PCB co
bass and hybri
stations, year
Figures 5 and

SCOPE OF THE P

The Sangamo Si
Units. Operab
the land-based
the Sangamo We
satellite disp
mile radius of
Industries, un
initiated clea
November 1993.
consist of exc
contaminated s
disposal areas
excavated mate
facilities at

Largemouth bass, catfish, and hybrid bass were collected and analyzed from 6 stations in Lake Hartwell. These stations are illustrated on Figure 4. The biological investigation determined that fish in the Twelvemile Creek drainage and Lake Hartwell are contaminated with PCBs, often at levels that exceed FDA's safe tolerance level of 2 ppm. Furthermore, caged fresh water clams and forage fish (small, young fish) accumulated PCBs over a relatively short period of time which confirmed the presence of food chain and respiratory transport mechanisms. PCB concentrations in sedentary fish (i.e. largemouth bass, catfish) are highest in the Twelvemile Creek

The excavated storage facili treatment syst site, at which materials will temperature th

This publicati to present the for Operable U addresses the migration rout land-based sou final response implement as p remediating th

SUMMARY OF SITE RISKS

CERCLA directs EPA to protect human health and the environment from current and potential exposure to hazardous substances at the Site. A Baseline Risk Assessment was conducted to evaluate the potential current and future human health and ecological impacts associated with exposure to PCBs in sediment and fish. The human exposure pathways which were quantitatively evaluated under current and future land-use conditions included: 1) Ingestion and dermal absorption of PCBs in the shallow sediment by a child and an adult; and 2) Ingestion of PCB-contaminated fish by a recreational fisherman. PCBs were not detected in the surface water during the RI and therefore this medium was not evaluated in the risk assessment.

EPA evaluated PCBs according to their potential to produce either cancer and/or noncancer health effects. The carcinogenic risk range EPA has set for Superfund cleanups to be protective of human health is 1 X 10-4 to 1 X 10-6. For example, a cancer risk of 1 X 10-6 indicates that an individual has a 1 in 1,000,000 (or 1 in 10,000 for 1 X 10-4) incremental chance of developing cancer as a result of site-related exposure to a carcinogen over a 70 year lifetime under the specific exposure conditions at the Site. EPA generally uses the cumulative benchmark risk level of 1 X 10-4 for all exposures relating to a particular medium to trigger action for that medium. Noncancer exposure estimates were developed using EPA reference doses to calculate a Hazard Quotient (HQ). A HQ greater than 1 indicates that PCBs are present at concentrations that could produce harmful effects.

Human Risk

The risks associated fish were calculated stations in Twelvemil Hartwell (Figure 4). separately by fish sp species combined to a individuals who may e exclusively and indiv types of fish. Expos ingestion of fish cau stations resulted in ranging from 10-2 to than 1. The highest was calculated for an consuming largemouth Twelvemile Creek wate cancer risk for inges combined, 1 X 10-2, w Twelvemile Creek Arm. associated with inges combined was 5 X 10-3 health risks resultin incidental ingestion unlikely to occur, ho continuing source of aquatic biota of the

Ecological Risk

An ecological risk as to evaluate the impac on the aquatic recept The biological invest document PCB contamin the aquatic food web. PCBs appear to be imp macroinvertebrate com Twelvemile Creek, hab man's influence is li adverse impacts at th community levels. Th Lake Hartwell does no

at the population level for fish that have PCB concentrations around 5 ppm. However, there is evidence that as concentrations increase to greater than 20 ppm, fish health can be effected.

Based upon the results of the Baseline Risk Assessment, it was concluded that actual or threatened releases of hazardous substances from this Site, if not addressed by the preferred alternative or one of the other active measures considered, may present a current or potential imminent and/or substantial endangerment to public health, welfare, or the environment.

SUMMARY OF ALTERNATIVES

Thorough development and evaluation of feasible remedial alternatives for the Sangamo OU2 Site required the derivation of cleanup goals for the media of concern: sediment and fish. Cleanup goals were not developed for surface water since PCBs were not detected in any sample collected during the RI above the detection limits of 1.2 to 1.3 ppb. Cleanup goals were also necessary to identify areas to be addressed by EPA's preferred alternative. The final cleanup goals are discussed below.

Final Sediment Cleanup Goal -
Concentration of 1 ppm was selected based upon technical feasibility. Remediation goal of 1 ppm identified the entire Twelvemile Creek Arm, extending from the headwaters of the lake downstream to the confluence with the Keowee Arm, as an area to be remediated. This area covers approximately 730 acres with a total estimated volume of 4,722,000 cubic yards of contaminated sediment.

would be conducted. The existing fishing advisory would continue and 5-year reviews would be conducted to assess sediment/fish PCB concentrations and associated risks to human health and the environment.

Due to the complex, dynamic nature of the Lake Hartwell system, significant changes in the nature and extent of contamination are expected over time even under the no-action scenario. A comprehensive modeling effort consisting of sediment transport, water quality and contaminant transport, and food-chain bioaccumulation was conducted during the RI to predict the future fate and transport of PCBs in sediments and aquatic biota of the study area. The predicted results of this modeling exercise are important considerations when evaluating the no-action alternative. For this reason, the predicted

Final Fish Cleanup Go
safe tolerance level
based upon technical
carcinogenic risk-bas
evaluated by determin
levels in largemouth
in acceptable risk to
ingestion of fish. U
assessment methods, a
concentration of 0.03
with a 10-4 risk. Th
goal of 0.036 ppm was
technically impractab

In a similar fact she
and in the Final FS R
the range of remedial
under consideration f
alternatives are brie
All alternative cost
in 1993 dollars and a
conceptual engineerin
cost consists of dire
indirect (non-constru
the first year of ope
maintenance (O&M) cos
postconstruction item
continued effectivene
Total present worth c
of money, if invested
disbursed as needed,
cover all costs of a
life.

Alternative 1: No Ac

As required by CERCLA
alternative was evalu
basis for comparison
cleanup alternatives.
no further remedial a
contaminated sediment

Sediment Quality Tre

The objective of sed
was to predict the f
in the surface and b
Twelvemile Creek/Lake Ha
over the next 30 yea
sediments upstream o
are predicted to dec
within 5 years. Sed
133 Bridge and the H
predicted to fall be
goal in approximatel
bottom sediments lyi
Bridge and the Hwy 3
to increase and rema
cleanup goal after 3
increase is attribut
finer, clay sized pa
constriction of the

results of the baseline modeling activities are summarized below.

Future Sedimentation

The objective of sediment modeling was to determine the rates at which presently contaminated sediments would be buried by relatively clean sediments from tributary drainages over the next 30 years. Average sediment burial rates for the 30 year simulation are presented in Figure 7. Substantial rates of sediment deposition are predicted from Maw Bridge (Rt. 337) to just above the Hwy 133 Bridge. All of the sand and most of the silt coming into the reservoir from the Twelvemile Creek drainage are deposited in this reach with a predicted 30-year accumulation of nearly 10 feet of sediment in some areas. This deposition pattern is favorable since PCB concentrations have historically been higher in sediments from this portion of the study area.

embankment.

Bioaccumulation and Fish Concentrations

Aquatic bioaccumulat conducted to assess fish would change over t the contaminated sedimen unmanaged, and 2) H for levels to drop be goal. A representa developed to evalua into fish via respi contaminated food. Larg selected as the top p shad/bluegill sunfish plankton and bentho levels of the food PCB concentrations for t web are presented in bioaccumulation mod concentrations to d food web during the 30-y

PCB concentrations in older largemouth bass are predicted to fall below the 2 ppm cleanup goal by 2005.

Capital Cost = $7,000
Total O&M Cost = $123,000
Total Present Worth Cost = $130.000

Alternative 2A: Institutional Controls

This alternative is a limited action alternative that relies on a series of institutional controls to prevent or minimize ingestion of contaminated fish tissue, which was identified as the primary exposure pathway of concern for the Site. Generally, these institutional controls consist of the following:

- Public Education Program - A program would be initiated to inform the public on available methods for reducing the intake of PCBs through fish consumption. Specific preparation, handling, and cooking techniques can reduce the quantity of contamination consumed. Information of this type would be disseminated to the public through a series of local public meetings and distribution of an informational pamphlet.

- Fish and Sediment Monitoring - In addition to maintaining the current fish advisory, annual monitoring of PCB levels in fish and sediment of Twelvemile Creek and Lake Hartwell would be conducted. Results from this monitoring program would be utilized to support modifications

- Regulation of Impoundments - be developed f accumlated beh impoundments l Creek. Period September 1993 sediment over been documente impact on the biota of the u Twelvemile Cre impacts are at suspended sedi routine flushi impacts to the burial of more with cleaner s Twelvemile Cre

Capital Cost = $
Total O&M Cost =
Total Present Wo

Alternative 2B:

Alternative 2B i approach consist fisheries resour minimize ingesti fish. The prima construction of prevent the move striped bass, hy or out of the m the reservoir. represent approx harvested by wei

to the fish advisory and to monitor concentrations of PCBs in sediment and fish over time. Results of this program would be made available to the public.

- Minimize safety hazards for boaters and other users of the lake (i.e. waterskiers);

- Maximize effectiveness to prevent passage of migratory game fish through the barrier;

- Allow boats to pass unimpeded to minimize disruptions of boating traffic on the lake (i.e. no gate);

- Construct a semi-permanent structure that could be removed once PCB levels decline to health-based levels;

- Incorporate value engineering principles to minimize cost for design and construction; and

- Minimize operations and maintenance requirements and costs.

Lake use restrictions, such as no-wake zones and warning signs would be implemented to prevent damage to the fence and for boating safety. Alternative 2B also includes the institutional controls described for Alternative 2A.

Capital Cost = $1,232,000
Total O&M Cost = $3,012,000
Total Present Worth Cost = $4,244,000

Alternative 3A: Capping

Under this alternative, an 18 inch clean sediment cap would be placed over the entire Twelvemile Creek Arm to eliminate the further downstream migration of contaminated sediment and the transfer of PCBs from sediment to aquatic biota. The cap would extend from just upstream of the Maw Bridge (Rt. 337) to the confluence with the Keowee River, just upstream of Hwy

The fish isolati
the vicinity of
designed/constru
performance sta

123. The cap would
acres and would req
1,800,000 yd3 of sa
Alternative 3A also
restrictions to min
once it is placed a
controls described

Capital Cost = $48,
Total O&M Cost = $2
Total Present Worth

Alternative 3B: Se
Structure

Alternative 3B woul
a 1,600 ft. long fi
of the Twelvemile C
the confluence with
Construction of the
structure would phy
Twelvemile Creek Ar
of Lake Hartwell re
downstream migratio
sediment and moveme
areas with highest
Fishing restriction
well as institution
Alternative 2A, wou
limit consumption o
protective levels w

Capital Cost = $51,
Total O&M Cost = $2
Total Present Worth

Alternative 3C: Op
Sediment Control St

Alternative 3C util
techniques to optim
capped and location
The weir would be c
upstream location n

resulting in the physical isolation of a much smaller area than Alternative 3B. A similar clean sediment cap as described under Alternative 3A would be placed below the weir and extend downstream to the mouth of the Twelvemile Creek Arm. The area to be capped under this alternative is approximately 285 acres. Institutional controls under Alternative 2A and fishing restrictions for the isolated area would be implemented until protective levels in the fish were achieved.

concentrations gr
combination of sh
hydraulic dredgin
in the middle and
Twelvemile Creek
while the upper p
excavated. The d
would be treated
cement and placed
under Alternative
the upstream segm
and destroyed as
operations. Inst

Capital Cost = $31,684,000
Total O&M Cost = $2,365,000
Total Present Worth Cost = $34,049,000

Alternative 4: Confined Disposal Facility

Alternative 4 involves a much more rigorous remediation approach than any of the alternatives discussed above. Under this alternative, contaminated sediments from the Twelvemile Creek Arm with PCB concentrations greater than 1 ppm would be removed by hydraulic dredging. All dredged sediments would be placed in a near-shore confined disposal facility (CDF) located in the "goose neck" bend area between the Maw (Rt. 337) and Madden (Rt. 15) Bridges. Twelvemile Creek would then be diverted around the CDF via a physically rerouted channel. institutional control would be used to limit consumption of contaminated fish until protective levels were achieved.

Capital Cost = $43,422,000
Total O&M Cost = $3,487,000
Total Present Worth Cost = $46,909,000

Alternative 5: Stabilization

Alternative 5 is a very complex and costly alternative that involves removal of contaminated sediments with PCB

used to limit con
fish until protec

Capital Cost = $5
Total O&M Cost =
Total Present Wor

EVALUATION OF ALT

EPA has established
comparing the adv
eath alternative
alternatives disc
against one anoth
specified in the
40 CFR 300.430(e)
evaluation criter

1) Overall Prote
and the Envir
2) Compliance wi
Relevant and
(ARARs)
3) Long-term Eff
Permanence
4) Reduction of
Volume
5) Short-term Ef
6) Implementabil
7) Cost
8) State Accepta
9) Community Acc

The first two criteria are referred to as threshold criteria and must be met for an alternative to be eligible for selection. The next five criteria are referred to as balancing criteria and are used to weigh major trade-offs among alternatives. The final two criteria, state and community acceptance, are referred to as modifying criteria and are addressed during the proposed Plan comment period. The following discussion briefly evaluates the relative performance of each alternative to the evaluation criteria.

Overall Protection of Human Health and the Environment - It is important to note that complexities related to cycling of PCBs in the biota of Lake Hartwell cause the residual risk levels to remain above EPA's threshold of 1 X 10-4 regardless of which remedial alternative is implemented. A reduction in sediment PCB concentrations does not result in an immediate reduction in PCB concentrations in fish. High PCB concentrations in fish during the initial years of the 30-year exposure duration result in average risk estimates exceeding acceptable levels. Therefore, the most effective measures to minimize exposures to PCB-contaminated fish tissue are institutional

protectiveness, a
is removed from t
engineered dispos

Compliance with A
assesses the over
Federal/State req
alternatives rely
processes to redu
Lake Hartwell fis
level of 2 ppm.
capping and isola
2B/3A/3B/3C) achi
quicker in the ma
Alternatives 3A,
the cleanup goal
However, Alternat
trigger a large n
requirements asso
dredging, and dis

Long-term Effecti
With the exceptio
Alternative, all
institutional con
contaminated fish
reliability of th
site-specific fac
predict. The fis

controls (i.e. public education, continuation of fish advisory).

However, the most protective alternatives rely principally on engineering rather than institutional controls to reduce or eliminate exposures, gives the uncertainty regarding the performance/reliability of institutional controls. Alternatives 3A and 3C involve capping actions that would permanently isolate the contaminated sediment in all or a major portion of the Twelvemile Creek Arm. The more aggressive alternatives 4 and 5 provide an even higher level of

Reduction of Toxicity. Mobility, or Volume - Alternative 5 would accomplish the most significant reduction in the mobility of PCBs through a stabilization treatment process followed by disposal in CDF. The capping alternatives (Alternatives 3A/3C) also accomplish a reduction in contaminant mobility, but the effect is contingent upon proper maintenance of the cap. The sediment control structures (Alternatives 3B/3C) and fish fence (Alternative 2B) would be the most effective in limiting contaminant mobility related to the migration of fish into and out of the areas with the highest sediment contamination.

Short-term Effectiveness - Implementation of Alternatives 1 (No-Action) and 2A (Institutiona1 Controls) would have the least impact on the community, workers, and the environment; Alternative 2B has only a slighly greater impact. Alternatives 3A/3B/3C have greater impacts on the local community due to construction of sediment control structures and excessive truck traffic associated with transportation of capping material. The greatest impacts (and least short-term effectiveness) are the more aggressive alternatives that entail dredging, re-channeling and construction of the CDF (Alternatives 4/5).

Table 1 at the end of this publication summarizes the estimated schedule for each alternative, presenting the time required to implement, time required for fish PCB concentrations to decline to the FDA safe tolerance level, and total time to achieve protectiveness. This information is presented for the focused Sangamo OU2 study area (Twelvemile Creek/Seneca River Arm) as well as the main portion of Lake Hartwell The table shows that most of the alternatives rely on natural fate and transport processes

be evaluated after the public comment period and will be described in the Record of Decision for the Site.

would require pre
to demonstrate ef
application at Sa
(Alternatives 3A/
but is dependent
monitoring and ma
integrity and lon
Sediment control
widely used and a
maintenance. Fur
and treatability
prior to implamen
and 5 to obtain d
the dredging, CDF

within the r
protective l
Twelvemile C
alternatives
control stru
protectivene
years. Alte
achieves pro
Lake Hartwel
lake area) i
5 years) tha
costly alter

Implementabi
would be the
Alternatives
close coordi
and other ag
administrati
with these a
manageable.
to implement
and technica
Alternatives

Cost - Costs
provided und
section of t

State Accept
Carolina is
Plan. The S
Alternative
should be se
final select
the public c
State will r
selection of

Community Ac
this Propose
is to encour
the remedy s
acceptance o

maximum exten
remedy does n
treatment as a princ

EPA'S PREFERRED ALTERNATIVE

In summary, based upon the information available at this time, EPA is proposing Alternative 2B - Fisheries Isolation, which also includes those activities described under Alternative 2A. Placement of the fish fence in the vicinity of the Hwy 37 Bridge would result in isolation of the Twelvemile Creeks Keowee River and upper Seneca River Arms, which represent less than 10 percent of the total area of Lake Hartwell Isolation of these upstream areas is expected to result in an accelerated decline in migratory fish PCB concentrations in the downstream portions of the reservoir (i.e. the remaining 90+ percent of the lake). Migratory species represent approximate 50% of the fish harvested by weight from Lake Hartwell Reduction of fish PCB levels would allow for rescinding of the existing fish advisories in these areas, returning the majority of lake areas to normal use. This approach is consistent in the COE's Best Management Practices for Lake Hartwell, designed to achieve the maximum beneficial uses for the reservoir, which include fish and wildlife management and recreational use.

Alternative 2B - Fisheries Isolation represents the best balance among the criteria used to evaluate the other alternatives. Alternative 2B is believed to be protective of human health and the environment, would attain ARARs, would be cost effective and would utilize permanent solutions and resource technologies to the

excessive costs. Ba
received from the pu
comment
period, EPA, in clos
COE and SCDHEC, may
preferred alt
remedial alte
Proposed Plan

COMMUNITY PAR

Concurrent wi
Plan, EPA has
comment perio
through May 1
written and o
Plan and all
located in th
below. All c
should be dir
Remedial Proj
OU2 Site, at
number listed
EPA will exte
by 30 additio
public meetin
1994 to prese
the RI/FS Rep
rationale beh
Alternative 2B
meeting will
located at th
Hwy 123 in Cl
Representativ
Corps of Engi
Department of
Control will
questions the
future activi

GLOSSARY

Administrative Record - A file which contains all information used by the EPA to make its decision on the selection of a response action under CERCLA. This file is required to be available for public review and a copy is to be established at or near the site, usually at the information repository. A duplicate file is maintained in a central location such as a regional EPA and/or state office.

Baseline Risk Assessment - An assessment which provides an evaluation of the potential risk to human health and the environment in the absence of remedial action.

Comprehensive Environmental Response,

Parts Per B
Units
of contamin
in 1
million oun
PCB's are m
pool, the w

Polychlorinated Biphenyls
family of
organic compounds used since
1926 in electric
transformer
lubricants,
carbo
compo
proce
environment because they do no
break down.
PCBs are st

Compensation and Liability Act (CERCLA)-
A federal law passed in 1980 and modified in 1986 by the Superfund Amendments and Reauthorization Act (SARA). The Act created a trust fund, known as Superfund to investigate and clean up abandoned or uncontrolled hazardous waste sites.

Hazard Ranking System - A scoring system used by EPA to evaluate relative risks to public health and the environment. A score is calculated based on actual or potential release of hazardous substances through all media present (i.e. the air, soils, surface water, sediments, groundwater). If a site scores above 28.5, the site is proposed for inclusion of the National Priorities List.

Information Repository - Materials on Superfund and a specific site located conveniently for local residents.

Macroinvertebrates - Small animals lacking backbones found in sediments of water bodies.

National Contingency Plan - The Federal regulation that guides the Superfund program.

National Priorities List (NPL) - EPA's list of uncontrolled or abandoned hazardous wastes sites eligible for long-term cleanup under the Superfund Remedial Program.

FOR MORE INFORMATION CONTACT:

Remedial Project Managers
Operable Unit Two - Craig Zeller
Operable Unit One - Bernie Hayes

Community Relations Coordinator
Cynthia Peurifoy
AT
U S. Environmental Protection Agency - Region IV
North Superfund Remedial Branch
345 Courtland Street, N.E., Atlanta, GA 30365
1-(800) 435-9233, or (404) 347-7791

****

C. Michael Alexander
Savannah District Fishes Biologist
U.S. Army Corps of Engineers
Richard B. Russell Lake
4144 Russell Dam Drive
Elberton, GA 30635
(706) 283-8731

****

Richard Haynes, District Engineer
South Carolina Department of Health & Environmental Control
2600 Bull Street, Columbia, South Carolina 29201
(803) 734-5487

animals through the biaccumulation process. EPA banne are not although acute PCBs Remed Two d toget conta site- Recor expla Natio choos possi Super (SARA Octob

INFORMATION REPOSITORIES

The Administrative Record for the Sangamo Site is available for review a

The Village Library
Main Street
Pickens, SC 29671
(803) 859-9679

Pickens Coun
Easley Branc
110 West Fir
Easley, SC 2
(803) 859-96

R. M. Cooper Library
Clemson University
Clemson, SC 29634-3001
(803) 656-5174

Hart County
Benson Stree
Hartwell, GA
(706) 376-46

U S. Army Corps of Engineers
Lake Hartwell Natural Resources Management Center
Hartwell, Georgia
(706)376-4788

<IMG SRC 04941783>
<IMG SRC 04941784>
<IMG SRC 04941785>
<IMG SRC 04941786>
<IMG SRC 04941787>
<IMG SRC 04941788>
<IMG SRC 04941789>

Table 1
Estimated Time Required to Achieve Protectiveness
Sangamo OU-2 FS

ALT. NO.	DESCRIPTION	TIME TO IMPLEMENT(1) (yrs)	TIME FOR FISH TO ATTAIN FDA LEVEL PROTECTIVENESS(4) (yrs) TWELVEMILE CREEK/SENECA RIVER(2) ARM	MAIN BODY OF HARTWELL LAKE(3)
1	No action	0	12	12
2A	Institutional Control	0.5	12	12
2B	Fisheries Isolation	1	12	3-4
3A	Capping	2	3-4	3-4
3B	Sediment Control Structure	2	12	3-4
3C	Optimal Capping/Sediment Control Structure	2-3	3-4 (downstream) 12 (upstream)	3-4
4	Confined Disposal Facility	3-4	5-6	5-6
5	Stabilization	4-5	5-6	5-6

NOTE: (1) Includes time needed for pre-design studies, design, procure include time between Proposed Plan/Record of Decision Initiation of Remedial Design.

(2) Twelvemile Creek Arm only; FGETS modeling results indicate t level (2 mg/kg) in approximately 12 years under baseline conditions; none of the alternatives will extend the period required for this period to achieve protectiveness of greater than 12 yrs).

(3) Downgradient of the Twelvemile Creek Arm (i.e., main body of decline more rapidly for actions involving isolation, capping or removal of contaminated sediment (Alternatives 2B, 3A-C, 4 and 5). It comparable to that observed in the Twelvemile Creek Arm for Alternatives involving capping (3-4 yrs) or removal of the sediment (5-6 estimate.

(4) Duration only; based on estimated time to implement remedy a levels to decline to FDA level, based on the FGETS modeling results presented in Section 3.3 and assumptions regarding migratory

USE THIS SPACE TO WRITE YOUR COMMENTS

Your input on the Proposed Plan for the Sangamo Superfund Site - OU2 i
helping EPA select a final remedy for the site. You may use the spac
your comment, then fold and mail. A response to your comment will be

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

REQUEST TO BE PLACED ON THE SANGAMO WESTON, INC./TWELVE MILE CREEK/LAKE
HARTWELL SITE MAILING LIST

If you would like to be placed on the mailing list for the Sangamo Sit
this form and return to: Cynthia Peurifoy, Community Relations Coordi
IV, North Superfund Remedial Branch, 345 Courtland Street, Atlanta, Ge
call 1-800-435-9233.

NAME:_____

ADDRESS:_____

_____

TELEPHONE:_____

AFFILIATION:_____