US Army Corps
of Engineers ®
Memphis District

Lower Cache River, Arkansas
Section 1135 Project

Detailed Project Report

Finding of No Significant Impact &
Environmental Assessment

February 2011

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of Engineers ®
Memphis District

Lower Cache River, Arkansas

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Lower Cache River
Monroe County, Arkansas
Ecosystem Restoration

Executive Summary

In the early 1970's, the Corps of Engineers realigned the Cache River from the mouth of Bayou DeView to its confluence with the White River near Clarendon Arkansas. This channelization isolated portions of the historic Cache River because plugs were placed in the upstream openings of at least six meanders, thereby changing them from flowing river into standing backwater. This portion of the river lies partially within the Cache River National Wildlife Refuge, an internationally recognized wetland of importance, and a major portion of the Mississippi Flyway.

The purpose of this study is to determine the feasibility of restoring riverine conditions to isolated meanders located within the lower reach of the Cache River. The return of riverine flow to the historic meanders would restore aquatic habitat within the area. The scope of the study consists of analyzing alternatives to restore flows in up to six meanders cut off by the original flood control project.

Various alternatives were considered, and a recommended plan was determined. In compliance with federal policy, a national ecosystem restoration plan was identified that would restore all six cut-off meanders. However, due to funding issues, the recommended plan is a locally preferred plan that restores the upper three meanders.

The recommended plan is to degrade the earthen plugs and install closure structures across the channelized portion of the river downstream from each meander opening. Specifically, the recommended plan includes the removal of three earthen plugs at the opening of meanders 1, 2, and 3, installation of a closure weir across the channel immediately downstream of the meander openings, and the installation of a plug in a small cross-ditch connection between the channelized portion of the river and the middle of meander 3. These features will cause flow, especially during low-flow periods, to divert from the straight channelized section and return the flow to the meanders for

downstream conveyance. Further, the closure structures are sized so as to not impact the flood control afforded by the authorized project.

The recommended plan has fully funded estimated costs of $6,469,000 with a federal portion of $4,852,000 and a non-Federal portion of $1,617,000. These costs include costs for the project study, surveys, development of plans and specifications, easements, and construction. Operations, maintenance, repair, rehabilitation, and replacement (OMRR&R) is anticipated to include occasional repairs to the closure structures, removal of debris that may reduce flow into the meanders, inspection and flow monitoring, and is estimated to be $48,000 annual cost. The construction of the project is anticipated to take one construction season, and the construction will be done utilizing waterborne equipment. Because of this, construction will have to occur during the high-flow portion of the year which is typically December through May.

The potential non-federal sponsor is The Nature Conservancy. The study was initiated by the Corps following written requests from the Arkansas Game and Fish Commission and Ducks Unlimited on February 11, 2004. These parties maintained interest throughout the study process and continue to collaborate with The Nature Conservancy.

The public comment period for the environmental assessment for this project began on December 10, 2010, and closed on January 10, 2011. Comments were received from various federal, state, and local agencies and groups. There was no opposition expressed on this important project, and the project has strong local and state support.

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SECTION 1135 PROJECT
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INTRODUCTION

Background and Purpose of Report

The original flood control project (the Cache River Basin Project) authorized the Corps of Engineers to enlarge and realign 231 miles of the Cache River and adjacent Bayou DeView. Construction began in the lower Cache River in the early 1970's, but was stopped due to local opposition. However, the lower seven miles of the river was channelized before construction ended. This channelization isolated portions of the historic Cache River because plugs were placed in the upstream openings of at least six meanders, thereby changing them from flowing river into standing backwater. This degraded fish and mussel habitat in the river lies partially within a National Wildlife Refuge, an internationally recognized wetland of importance, and a major portion of the Mississippi Flyway.

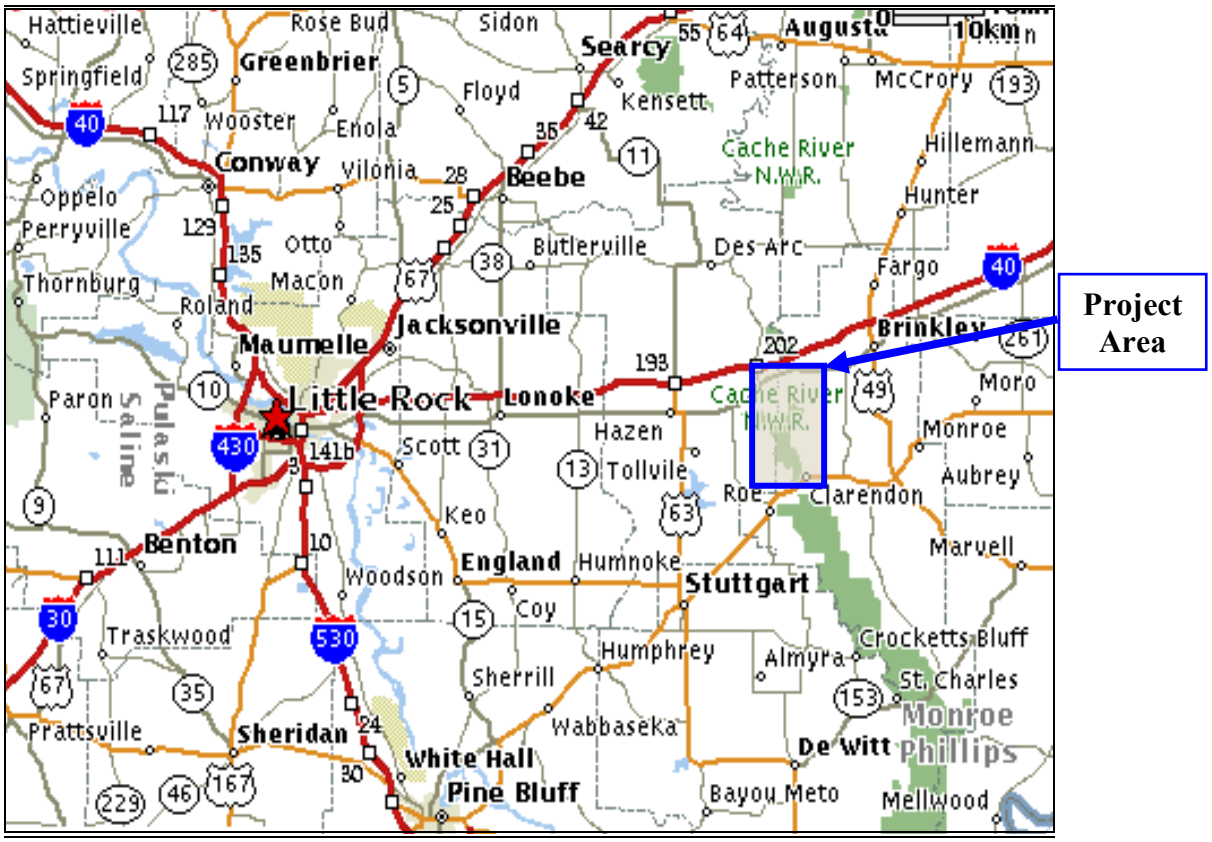
The purpose of this study is to determine the feasibility of restoring riverine conditions to isolated meanders located within the lower reach of the Cache River. Restoring flow to the historic meanders would improve fish and wildlife habitat within the area. The scope of the study consists of analyzing alternatives to restore flows in up to six meanders cut off by the original flood control project.

Project Location

The Cache River Basin is located in east central Arkansas and is a tributary of the White River, which lies to the south, and is bounded by the St. Francis River and the White and Black Rivers to the east and west, respectively. The basin has a maximum width of 18 miles and is approximately 143 miles in length. The total basin area is just over 2,000 square miles. The majority of the Cache River basin lies in the Delta region of Arkansas.

The proposed project encompasses a reach of the river located in Monroe County, Arkansas partially within the boundaries of the Cache River National Wildlife Refuge. Figure 1 represents the general vicinity of the Lower Cache River project. The reach of the Cache River in the study begins approximately 1.5 miles north of Clarendon, Arkansas and ends approximately 8.5 miles north of Clarendon. The project area includes several river meanders that were plugged during the Cache River Basin Project. That project diverted flow of the river into a straight channel dissecting the historic river configuration. Figure 2 depicts the location of the isolated meanders that are identified in this study. The meanders range in area from approximately 7 acres in meander 2 to approximately 32 acres in meander 3.

Figure 1: Location of proposed Cache River Ecosystem Restoration Project, located in Monroe County, Arkansas.



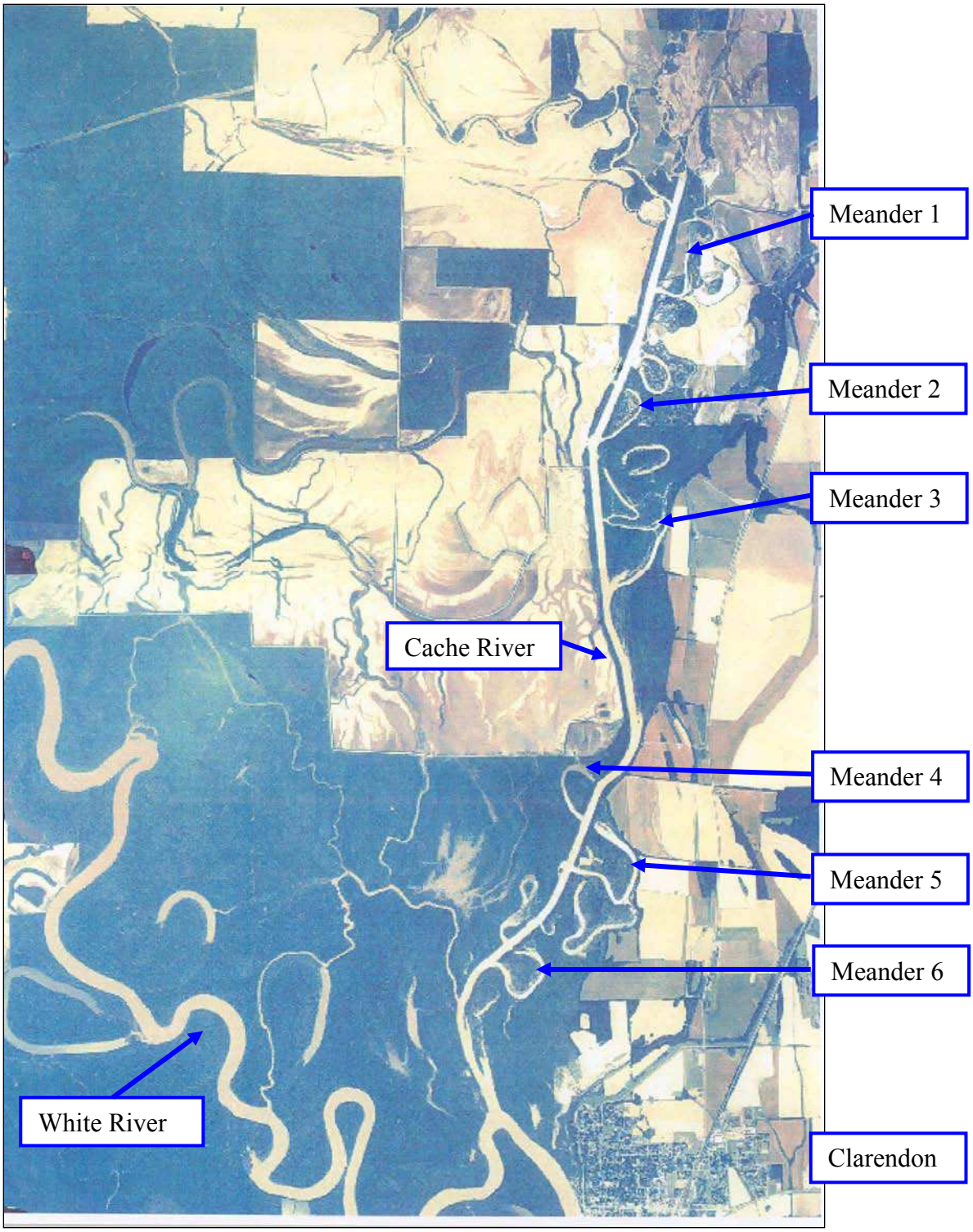


Figure 2: Location of partially isolated meanders initially identified for study in the lower Cache River, Monroe County Arkansas.

Project Authorization and Scope

The study is conducted under the authority of Section 1135 of the Water Resources Development Act of 1986, in response to a request from the Arkansas Game and Fish Commission (AGFC) and Ducks Unlimited (DU). In letters dated February 11, 2004, AGFC and DU requested the Corps of Engineers to conduct a study for an environmental restoration project on Cache River meanders upstream of Clarendon, Arkansas. The Nature Conservancy (TNC) requested to become a cost sharing partner by letter dated September 29, 2009. These letters are found in the Pertinent Correspondence Section of this report.

General Project Planning

Development of the Lower Cache detailed project report follows the Corps of Engineers' six-step planning process specified in Engineering Regulation (ER) 1105-2-100. This process identifies and responds to problems and opportunities associated with the Federal objective, as well as specified state and local concerns. The process provides a flexible, systematic, and rational framework to make determinations and decisions at each step. This allows the interested public and decision makers to be fully aware of the basic assumptions employed, the data and information analyzed, the areas of risk and uncertainty, and the significant implications of each alternative plan.

As part of identifying the Recommended Plan, a number of alternative plans are developed and compared with the "No Action" alternative, allowing for the ultimate identification of the National Ecosystem Restoration (NER) Plan. The NER plan reasonably maximizes ecosystem restoration benefits compared to costs, considering the cost effectiveness and incremental cost of implementing other restoration options. In addition to considering the system benefits and costs, it also considers information that cannot be quantified such as environmental significance and scarcity, socioeconomic impacts, and historic properties information.

The steps used in the plan formulation process are outlined as follows. In addition, a schematic of the plan formulation process is included in Figure 3.

1. Identify Problems and Opportunities. The specific problems and opportunities are identified, and the causes of the problems discussed and documented.

2. Inventory and Forecast Resource Conditions. This step characterizes and assesses existing conditions in the project area and forecasts the most probable without-project condition (or "no action alternative") over the period of analysis. The without-project condition is what the area and its uses are anticipated to be like over a 50-year period of analysis without any restoration implemented as a result of this study.

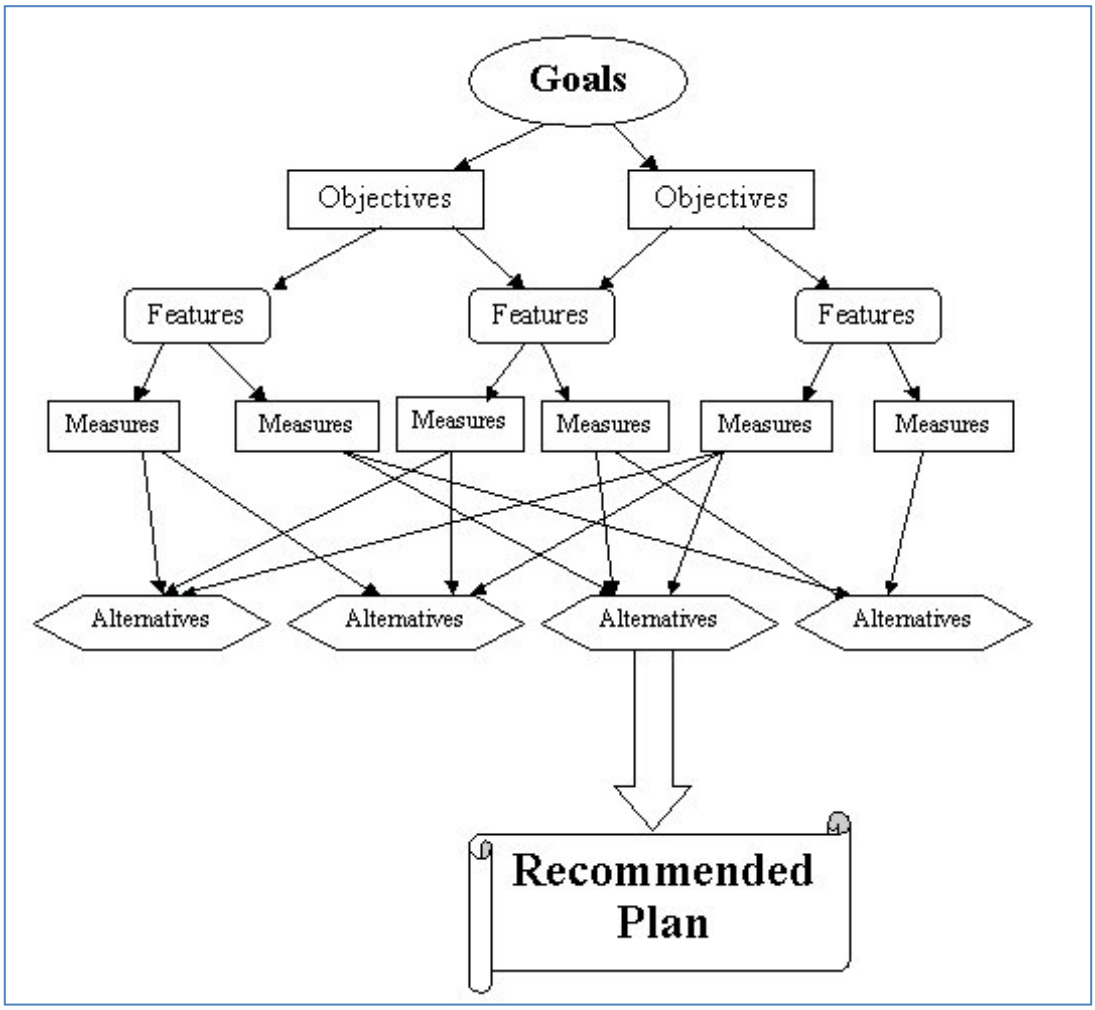
3. Formulate Alternative Plans. Potential features are proposed to meet the identified objectives. Specific design measures are developed for these features. These measures are combined into alternative plans in a systematic manner to ensure that reasonable alternatives are evaluated. Refer to Figure 3 for a schematic diagram of this process.

4. Evaluate Alternative Plans. The evaluation of each alternative consists of measuring or estimating the environmental benefits, costs, technical considerations, and social and economic effects of each plan, and determining the difference between the without- and with-project conditions. A key measure for evaluation of alternative plans is a cost-effectiveness and incremental cost analysis and evaluation of significance.

5. Compare Alternative Plans. Alternative plans are compared, focusing on the differences among the plans identified in the evaluation phase and public comment. As part of the evaluations, the "Best Buy" plans are identified—those plans that provide the greatest increase in benefits for the least increase in cost.

6. Select Alternative Plan. An alternative plan or the NER Plan is recommended. If a viable alternative is not identified, the selected plan will be the "No Action Alternative." In most cases, the NER plan would be selected from among the most cost effective plans. However, in the event the local sponsor prefers a different plan, such a plan may be selected with higher level approval. The NER Plan should be evaluated on acceptability, completeness, effectiveness, efficiency, and reasonableness of cost.

Figure 3: Schematic Diagram of Planning Process



The report is organized to follow the planning process except that the Problems and Opportunities are presented after the Inventory and Forecast of Conditions. This is so planning goals, objectives, and constraints are discussed in the report immediately prior to the formulation of alternatives. Regardless, the planning process does not necessarily follow the planning steps in exact sequence. The planning process is iterative. As such, as additional information was learned in subsequent steps, it was necessary to revisit and repeat portions of the previous step(s).

Previous Authorizations and Pertinent Federal Studies and Actions

Several studies and reports have been prepared that address the water resource needs in eastern Arkansas. Studies completed include the Cache River Basin Project; the Bayou Meto Basin, Arkansas, General Reevaluation Report; Grand Prairie, Arkansas Demonstration Project, General Reevaluation Report; and the White River Navigation to Batesville, Arkansas Feasibility Report.

The Cache River Basin Project authorized the Corps of Engineers to construct 231 miles of artificial channel for the purpose of flood control, including 140 miles of the Cache River, 76.9 miles of Bayou DeView, and 14.6 miles of an upper tributary. Many local landowners supported the project, but environmental groups opposed the project and construction was stopped in the late 1970s. The lower seven miles of the Cache River were already channelized, resulting in the loss of riverine habitat and natural hydrology.

The Bayou Meto Basin, Arkansas Project General Reevaluation was conducted in response to Congressional direction outlined in Section 363(a), Project Reauthorizations, of the Water Resources Development Act (WRDA) of 1996, Public Law 104-303. Congress reauthorized the original Grand Prairie Region and Bayou Meto Basin flood control project with a broadened scope of work as follows:

> "*Grand Prairie Region and Bayou Meto Basin, Arkansas.--The project for flood control, Grand Prairie Region and Bayou Meto Basin, Arkansas, authorized by section 204 of the Flood Control Act of 1950 (64 Stat. 174) and deauthorized pursuant to section 1001(b) of the Water Resources Development Act of 1986 (33 U.S.C. 579a(b)), is authorized to be carried out by the Secretary; except that the scope of the project includes ground water protection and conservation, agricultural water supply, and waterfowl management if the Secretary determines that the change in the scope of the project is technically sound, environmentally acceptable, and economic, as applicable."*

The general reevaluation was conducted to fully evaluate and determine the best plan of improvement for flood control, agricultural water supply, and waterfowl management. Because the area's primary crop is rice, farming and the associated local economy cannot exist without a dependable supply of water.

The project was approved by the Assistant Secretary of the Army (ASA) for Civil Works on September 24, 2007, and the Record of Decision was signed by MG Don T. Riley on November 13, 2007. The non-Federal sponsor is the Arkansas Natural Resources Commission.

The Grand Prairie Area Demonstration Project, General Reevaluation was conducted under the same authorization as the Bayou Meto Basin Project. The Grand Prairie portion of the Grand Prairie Region and Bayou Meto Basin, Arkansas, Project is primarily located in Arkansas and Prairie Counties with a small portion in Lonoke and Monroe Counties. This project provides ground water protection, agricultural water supply, and fish and wildlife restoration and enhancement. The General Reevaluation Report was approved by ASA, Civil Works, Joseph W. Westphal, on September 27, 1999. The Record of Decision was executed by MG Phillip R. Anderson on February 25, 2000. The PCA was approved by the ASA Civil Works on August 4, 2000. The non-Federal sponsors are the State of Arkansas and the White River Regional Irrigation Water Distribution District.

The White River Navigation to Batesville, Arkansas Feasibility Study was completed in May 1979. It was authorized by a resolution adopted May 25, 1967 by the Committee on Public Works of the United States Senate. The resolution reads as follows:

> "*Resolved by the Committee on Public Works of the United States Senate, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the report of the Chief of Engineers on the White River and Tributaries, Missouri and Arkansas, published as House Document Numbered 499, Eighty-third Congress, and other pertinent reports, with a view to determining whether any modifications of the recommendations contained therein are advisable at the present time, with particular reference to provision of a year-around, shallow-draft, navigable channel from Batesville, Arkansas, to the Mississippi River."*

The purpose of the study was to determine the feasibility of additional navigation improvements on the White River to Batesville, Arkansas; on the Little Red River to Judsonia, Arkansas; and on the Black River to Black Rock, Arkansas; and to identify the plan which serves the best interest of the public.

INVENTORY AND FORECAST OF RESOURCE CONDITIONS

Setting

Land Use and Vegetative Cover

Although the Cache River watershed has undergone significant conversion from forest to agriculture, it continues to have one of the largest remaining contiguous forested wetlands in the lower Mississippi River Valley (Kress et al. 1996). The conversion from forest to agriculture occurred primarily from the 1940's through the early 1970's and resulted in significant reductions in both total forested area (167,897 ha in 1935 to 60,749 ha in 1975) and forest core area (111,000 ha in 1935 vs. 21,508 ha in 1975). By 2000, less than 25% of the presettlement forest remained in the Cache River Basin, with areas in the northern Counties having less than 5% of the original BLH area (Heitmeyer, Oct. 2010). As Kress et al. (1996) notes, forest core is crucial habitat for species that require large blocks of forest such as migratory song birds.

In a study of vegetation in the Cache River floodplain, Smith (1996) noted that the species and distribution of vegetation was consistent with alluvial river floodplains found throughout the Coastal Plain. Trees in the river swamp forest, which is subject to nearly continuous flooding or saturation (Smith 1996) was co-dominated by water tupelo and bald cypress. The next higher zone of vegetation (where flooding or saturation occurs up to 50% of the year) had greater species richness, and was dominated by an overcup/water hickory assemblage (Smith 1996).

Agriculture is widespread in Monroe County and crops include rice, soybeans, and cotton. Farmed wetlands and lands in the Wetlands Reserve Program and Conservation Reserve Program are typical in the project area.

The Cache River National Wildlife Refuge provides some riparian buffer in this area, which has afforded a level of protection from riverside development. Significant levels of sediment enter and are transported by the Cache River. The sediment originates from headcutting and erosion in its tributaries and unstable reaches of the river itself. The sediment either moves downstream into the White River above Clarendon, Arkansas, or is deposited within choked reaches of the Cache River and its adjacent floodplain. Sediment that is deposited in the meanders significantly reduces the quality and quantity of available habitat for species adapted to riverine conditions.

Geology and Soils

The soil base along the Cache River north of the junction with the White River is dominated by three soil associations: Sharkey, Commerce, and Mahoon. Sharkey and Mahoon soils are found within an approximately 3.5-mile area north of the junction of the White and Cache Rivers. The soil association changes to Sharkey and Commerce soils beginning at the southern extent of Dobbs Landing, and for 3.5 miles

north to the end of the channelization of Cache River near the junction of Fish Lake Slough and Ingram Lake.

All three soil types within the proposed project area share several similar characteristics. They are located within poorly drained frequently flooded areas that are generally level, but also contain gently undulating swales and low ridges. Soil composition of Commerce and Mahoon soils is similar. They are composed of silty clay loam to fine sandy loam. Sharkey soils have a slightly more clay composition, and are silty clay loam to clay.

In most years, flooding occurs between December and June, which includes the normal planting seasons for many agricultural crops. The riverbank and adjacent lands are well suited to flood tolerant natural vegetation, including bottomland hardwood species which thrive in the wet soils and provide valuable habitat needs for a wide variety of wildlife species.

Climate and Hydrology

The climate of the area is generally moderate with long, hot summers and short, moderately cold winters. Monthly average temperatures range from approximately 39.2 degrees Fahrenheit in January to approximately 79.0 degrees Fahrenheit in July. Occasional periods of excessive summer heat and winter cold are common. The first and last killing frosts normally occur in mid-October and early April, respectively. The mean freeze-free period is about 200 days.

The average precipitation in January is 7.16 inches and in July it is 2.62 inches. The average annual rainfall for the area is approximately 49 inches based on the National Weather Service gage in Stuttgart, Arkansas. The months of March, April, and May have the highest average rainfall; July, August, September, and October have the lowest average monthly rainfall.

The project area is a typical deltaic stream region dominated by sinuous streams and rivers with bottomland hardwood swamps described in the Land Use and Vegetative Cover section previously. The White River, into which the Cache flows, significantly influences hydrology in the lower seven miles of the Cache. In fact, during White River flood events, flow in the lower seven miles can actually run upstream, which in part causes the significant amounts of sediment deposition in the meanders. The typical hydrograph in the project area is gradually increasing flooding during the late winter and early spring, with prolonged periods of flooding followed by a slow receding of floodwaters.

Existing Conditions of Resources

The following paragraphs present a description of existing conditions of resources within the Lower Cache River study area which a project may affect.

Wetlands

The project area lies within a Wetland of International Importance. The Cache-Lower White River site is number three in the United States on the Ramsar list. It is so designated because it is the longest continuous expanse of bottomland hardwoods (forested, periodically flooded wetlands) in the Lower Mississippi Valley. The area is internationally important for numerous species of wintering waterbirds, especially Canada geese. Up to 100 bald eagles also winter in the area. Channelization of the Cache River was intended to facilitate drainage of upstream agricultural lands and prevent flooding in communities far upstream of the Ramsar site. The small completed portion of the project did not affect flooding of the bottomland hardwoods and very little clearing occurred.

Fish and Wildlife

The Cache River system is part of the Mississippi Flyway. As recently as the 1980's, the Cache-Lower White River corridor contained 30-40% of all wintering mallards in Arkansas and over 10% of all wintering mallard habitat in the United States (Yaich 1990). However, from 2000 to 2009 the region has supported <20% and <5% of wintering mallards in Arkansas and the U.S., respectively. Habitat loss and altered hydrology that changes timing, depth and duration of winter floods is likely responsible for this decline (U.S. Department of the Interior 1984, Heitmeyer 2006, USFWS 2009). Concentrations of ducks and geese generally are associated with refuge/sanctuary areas on wildlife refuges and management areas. The project area is one such area and as such has become very important for waterfowl.

Qualitative mussel surveys conducted by Corps of Engineers personnel in 2007 indicated that the freshwater mussel populations within the isolated meanders were significantly reduced when compared to those found in both the channelized portion of the river and in comparison to the natural reaches upstream of the project area. Payne and Farr (2009) [Appendix C] suggest that factors related to the lack of flow, primarily silt accumulation, were significant negative impacts on the mussel communities. Siltation in the isolated meanders is unsuitable as a substrate for native freshwater mussel species.

Killgore and George (2009) [Appendix C] found that the meanders currently provide only marginal habitat for riverine species of fish, which is the guild that has been most impacted by the channelization of the lower seven miles of the river. Channelization has significantly reduced the amount of habitat available to those species that historically occurred in the lower reaches of the Cache River. Increased siltation in the meanders fills in spaces around the roots of the cypress trees and woody debris that juvenile fish need as refugia from predators.

Reports from local fishermen and commercial mussel shellers suggest that harvests of both fish and mussels were significantly reduced after the channelization project was completed.

Threatened and Endangered Species

Surveys conducted by Corps of Engineers personnel with the participation of the U.S. Fish and Wildlife Service (USFWS) in 2007 found no federally threatened or endangered freshwater mussel species present within the proposed project area. No other threatened or endangered species were observed during this or other site visits to the area. Coordination with the USFWS regarding final clearances for this project would occur prior to the initiation of project construction. This seven-mile stretch of river is within twelve miles of the location of the reported sightings of the ivory-billed woodpecker, and is in the contiguous forest block that is likely the last remaining habitat in Arkansas and possibly the nation for this species of critically endangered bird. The proposed restoration of the lower seven miles of the Cache River would have no significant impact to the ivory-billed woodpecker.

Cultural Resources

Portions of the Cache River project area were surveyed for cultural resources in 1975. Surveys were conducted within the areas of the present 1135 project area. No known sites are recorded within the potential area of project affect.

Socioeconomic Resources & Human Use

The economy in Monroe County, Arkansas, is predominantly related to agriculture; although only 11% of the county is directly employed in the farming industry, much of the retail trade is related to agriculture. Crops include rice, soybeans, and cotton. Some grazing of cattle also occurs in the project area. Outdoor activities, such as hunting and fishing, are also a source of area income, with significant opportunities for each afforded by the USFWS refuges (Cache and White River Nation Wildlife Refuges) in the immediate vicinity. The town of Clarendon, which is immediately south of the proposed project area, has a mean family income of $30,250, with approximately 61% of the residents owning homes.

The proposed project is located in a relatively rural portion of central Arkansas. The town of Clarendon, which is the closest municipality to the proposed project, had a population of 1,960 people in 2000. The remainder of the project area is extremely rural, with low population densities. Duck hunters use the area in the fall/winter during high water. Recreational fishing was more common prior to channelization. There are a few landowners with frontage on the meanders, but they are unable to launch boats or float the river except during high water. Some canoeists do access the river from the White River downstream, but it is not a highly used area.

Hazardous, Toxic, and Radioactive Waste

No hazardous, toxic, or radioactive wastes are known to occur in the project area.

Future Without Project Conditions

If this project is not constructed, meander restoration is unlikely to occur. Other entities are not likely to restore flow to the meanders from the channelized portion of the lower Cache River without federal assistance. Therefore, there would likely be no improvement in fish and wildlife populations; hydrology would continue to be impaired in the meanders, resulting in further sediment accumulation.

Without restoration, the meanders would continue to degrade over time and fish and wildlife habitat would be lost. The potential for a successful restoration will decline as time goes on and the system degrades further. Mussels will have an especially hard time re-colonizing the area and reestablishing an endemic species assemblage. The meanders currently provide 22 Habitat Units (HUs) for fish, but based on conventional wisdom and observed trend, continued sedimentation would degrade it to zero over 50 years. Currently the area provides approximately 3,272 HUs for mussels, but over time the situation will continue to deteriorate and all mussel habitat is likely to be lost within 50 years in all except Meander 3. More than half of Meander 3 still has some connection to the river and although the habitat would continue to decline, approximately 581 HUs would remain after 50 years (assuming 50% loss).

The decline in physical habitat for fish and mussels is predictable, but other factors may also cause mussel populations to decline. Mussel propagation is directly linked to mussel specific host fish species; certain mussels will only use certain fish for propagation. If those species are riverine, and if the lentic environment within those meanders would inhibit those host fish species from access there could be further loss of mussel populations. This loss is not quantifiable given the state of the science regarding mussels and their fish hosts.

The bottomland hardwood wetlands are healthy and still have a natural hydrologic flooding regime. Other projects in the area are developed, monitored and managed with the protection of this wetland site in mind. The wetland is expected to maintain its quality and quantity over time. Waterfowl habitat in the area should likewise remain stable.

IDENTIFICATION OF PROBLEMS AND OPPORTUNITIES

Problems

- Channelization of the Cache River altered the natural hydrology of the system.
- The fish and mussel habitat in the meanders has been lost or severely reduced.
- Habitat degradation within the meanders is ongoing and eventually all will be lost.

Opportunities

- Natural hydrology can be restored to some of the historic meanders in the Cache River.
- Fish and mussel habitat within the meanders can be restored.

The primary problem identified within the study area is the loss of natural hydrology, river function, and riverine fish and wildlife habitat. Formerly, lentic habitat existed mainly in overbank pockets that became inundated during high-water events. Since the flood control project was constructed, all the meanders (the former river channel) lost riverine or lotic habitat which is considered by most a more valuable ecosystem. These meanders are now lentic habitats except when overbank flooding in the channelized portion of the Cache River can reach the meanders from the upstream end. Otherwise, the meanders only receive backwater that enters from the downstream end. This backwater habitat can become stagnant and provides much less value compared to the historic riverine characteristics. Artificial habitats such as this have less diversity and in many cases exotic or non-endemic species invade and thrive, such as nuisance carp. Native species are often displaced.

The riverine fish and freshwater mussel communities have been negatively impacted by the channelization project. Restoration of these meanders, while maintaining the authorized flood control project, would benefit not only the natural environment, but also area residents, who have indicated that the fishery in the lower seven miles of the Cache River has degraded since the channelization project occurred.

Researchers at the Corps of Engineers' Engineering Research and Development Center (ERDC) evaluated the potential benefits of the proposed project on riverine fish species and on the freshwater mussel communities known to inhabit the Cache River Basin. The results from both studies can be found in Appendix C of this report. Both studies initially analyzed the habitat units that would be gained from restoring flow to the six meanders as originally proposed. As would be expected, both riverine fishes and freshwater mussels would benefit significantly from restoration of flow into the meanders. As the study progressed, it became necessary to analyze the benefits that would be derived from restoration of individual meanders, and further analysis was undertaken to determine relative benefits from each meander.

Planning Goals and Objectives

The goals of this ecosystem restoration project are tied directly to the Corps of Engineer's programmatic goal in the ecosystem restoration program. Corps policy focuses efforts on aquatic and wetland ecosystem restoration. The Corps' ecosystem restoration objective is to restore degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition.

Restored ecosystems should mimic, as closely as possible, conditions which would occur in the area in the absence of human changes to the landscape and hydrology. Indicators of success would include the presence of a large variety of native plants and animals, the ability of the area to sustain larger numbers of certain indicator species or more biologically desirable species, and the ability of the restored area to continue to function and produce the desired outputs with a minimum of continuing human intervention. Those restoration opportunities that are associated with wetlands, riparian and other floodplain and aquatic systems are most appropriate for Corps involvement.

The goal of the project in the most general terms to be consistent with the Corps programmatic ecosystem restoration goal is to restore the selected historic river meanders and enhance the lower Cache River Basin ecosystem. The project would return portions of seven miles of the lower Cache River to more natural hydrologic conditions, allowing a return to natural hydrology within the river and its adjacent wetlands.

The specific goals of this project are to:

- Increase the potential of the lower Cache River system to support riverine biologic functions and processes that historically existed

- Restore/Reestablish Natural Geomorphology/Hydrology in the historic river channel (i.e., meanders)

Objectives to reach the goals of the study are objectives necessary to support and increase the quality and amount of habitat for riverine species that existed prior to channelization. The species selected for measurement are fish and mussels. These species indicate a healthy riverine ecosystem in a deltaic setting. Further, an objective is to identify economically efficient alternatives that would restore riverine habitat to the selected meanders in the lower seven miles of the Cache River, without disrupting the functioning of the authorized flood control project. Figure 4 provides the planning Goals and Objectives.

Figure 4: Project Goals, Objectives, and Measures*

Goal	Objective	Management Measure
Increase the potential of the lower Cache River system to support riverine biologic functions and processes that historically existed Restore/Reestablish Natural Hydrology in the historic river channel (i.e., meanders)	1. Return flow to the meanders 2. Return flow in sufficient quantities to support mussel populations 3. Create conditions to enhance native fish habitat 4. Re-establish a geomorphically stable channel in the historic river 5. Minimize disturbance during construction within the existing meanders	• Removal of plugs at upstream end of a meander/Reestablish channel into Meander • Installation of culvert(s) to allow flow from channelized portion of the Cache River into meander(s) • Construct closure in channelize portion of the Cache River to divert flow into meanders o Organic Material (trees, brush, etc) o Timber Pile Wall o Geotubes o Stone weir • Fill channelized section of Cache River between upstream inlet and downstream outlet of meander(s)

* Management Measures are discussed below in the Potential Management Measures section

Planning Constraints and Considerations

The planning constraints and considerations used during the study process included other authorized purposes, environmental sensitivity, economic efficiency, and technical soundness. In addition, compliance with various regulations, circulars and policies that govern water resources studies was sought.

1. The project may not induce flooding

The existing authorized and partially constructed Cache River Basin Project provided protection from flood damage. No alternative contemplated under this Section 1135 study may negatively impact this authorized project. The Cache River/ Bayou DeView Improvement District has operation and maintenance responsibility for the flood control project. They support the project.

2. The project must comply with all environmental laws and policies

These include but are not limited to: the National Environmental Policy Act, Endangered Species Act, Fish and Wildlife Coordination Act, Clean Water Act, National Historic Preservation Act, Clean Air Act and Corps of Engineers Engineer Regulations and Circulars and applicable State and local laws.

3. The project should minimize damages to other landowners which must be addressed or compensated

The Cache River National Wildlife Refuge is adjacent to the proposed project. The Cache River/ Bayou DeView Improvement District holds rights of way and/ or easements along the channelized portion of the river. Several private landowners are adjacent to the channel and the meanders.

4. The project area must be accessible and the selected plan must be constructable

This is not a constraint, but this is a consideration that effects project planning, and in part can provide screening rational for measures and/or alternatives. Land-based access to the project area is problematic. Water borne access to the area can occur, but is highly dependent on river stage and limited to when barge borne material and equipment can access the project area from downstream in the White River. Airborne access to the project area is not a consideration from a practicality perspective for anything other than inspections.

Potential Management Measures

In order to accomplish the outlined objectives, management measures were proposed. Measures are considered the building blocks of alternatives. Alternatives consist of one or more measures. Due to the limited scope of this project, all measures deal directly with improvement of hydrology. Professional judgment by the Corps of Engineers and the project stakeholders such as Arkansas Game and Fish Commission, Ducks Unlimited, U. S. Fish and Wildlife Service, and the Nature Conservancy was used to develop concepts to affect the project area hydrology. Measures that go beyond causing an effect to the hydrology are considered beyond the scope of this project and the non-Federal Sponsor and stakeholders prefer a natural system response. However, meander hydrology cannot be restored without the implementation of this project.

Potential Measures

- Removal of plugs at upstream end of a meander/reestablish channel into meander
- Installation of culvert(s) to allow flow from channelized portion of the Cache River into meander(s)
- Construct closure in channelized portion of the Cache River to divert flow into meanders
    - Organic Material (trees, brush, etc)
    - Timber Pile Wall
    - Geotubes
    - Stone weir
- Fill channelized section of Cache River between upstream inlet and downstream outlet of meander(s)

Of these measures, all were considered in the formulation of alternatives plans except for closures constructed out of geotubes, organic debris material, and timber piles. As discussed in the Hydraulics and Hydrology Appendix D, Page D2-9, these measures were removed from further consideration due to limitations. The U.S. Fish and Wildlife Service and Arkansas Game and Fish requested consideration for the geotubes, but there is not a sufficient quantity of sand in the project area to fill the tubes. The use of timber structures would not achieve the level of flow control necessary because of their porous structure. Also, the installation of a timber pile structure would require more time to install. Installation time is limited to when waterborne equipment can access the project area, and there would not be time to install the timber piles. Closures constructed by rock weirs can be installed much faster than sheet pile installation.

FORMULATION OF ALTERNATIVE PLANS

Plan formulation is conducted in accordance the U. S. Army Corps of Engineers regulations, policies and guidelines which require that all reasonable alternatives for addressing the problems and opportunities of the study area be investigated and clearly identified in terms of economics, impacts on the environment, and technical soundness. Each alternative is formulated with completeness, effectiveness, efficiency, and acceptability. Completeness is the extent to which alternatives are investigated to include all necessary information relative to the project's formulation. Effectiveness is the extent to which the alternatives alleviate the specified problems and achieve the specified opportunities. Efficiency is the extent to which the alternatives are the most cost-effective means of alleviating the specified problems and realizing the specified opportunities. Acceptability is the ability of the alternatives to comply with existing rules, regulations, and policies and to be accepted by state and local entities.

In addition to the No Federal Action Alternative, four structural alternative measures were evaluated to address the water resources problems and opportunities of the study area. These alternatives are measures or combinations of measures described above. The alternatives evaluated provided the basis for selecting the plan that meets the planning goals and objectives. The No Federal Action Alternative would result in no improvements to meander habitat. The four structural alternatives are listed below.

Alternative 1 – Earthen plug removal with no closure placement

This alternative involved meander restoration at six locations in the lower 7 miles of the river. It consisted of removing the earthen closure plugs at the upstream ends of the remnant channels and did not include any structures within the canal to divert flow to the meanders. Plate 4 of Appendix D, Hydrology and Hydraulics (page D2-24), shows the channel alignment for Alternative 1. This alternative did not achieve a sufficient level of flow in the restored meanders to maintain the channel. Geomorphology relationships indicate that the channel forming discharge is required to maintain proper sediment movement through a channel. This alternative failed to provide the level of flow needed to meet this requirement.

Alternative 2 – Earthen plug removal with closure placement

This alternative was originally formulated for all six meanders. Later when costs became concern, two additional variations were considered. Together, these are Alternatives 2a, 2b, and 2c. See Appendix D, Plates 7 (page D2-27) and 15 (page D2-35) for the channel alignments for Alternatives 2a and 2b, respectively. See "Refinement of Formulated Alternatives" at Page 30 for details. This alternative approach in all three of its variations included the measures of:

- Removal of plugs at upstream end of a meander/reestablish channel into meander, and

- Construct closures in canal portion of the Cache River to divert flow into meanders using rock weir(s)

Meander 3 has a unique feature compared to the other meanders. About half way down the meander, a cross-channel ditch connects the channelized portion of the river to Meander 3. This cross-channel ditch requires two closures adjacent to Meander 3 to affect the desired hydrologic change. The upstream closure would be located immediately downstream of the plug removal (top of meander) while the second closure would be immediately downstream of the cross-channel connecting ditch.

Alternative 3 – Meander Restoration by Plug Removal and Filling of the Channelized Reach

Alternative 3 involved meander restoration at the six locations by removing the earthen closures at the upstream ends of the remnant channels and filling the canal adjacent to the restored meanders. Plate 10 of Appendix D, Hydrology and Hydraulics (page D2-30), shows the channel alignment and fill locations for Alternative 3. The fill elevations used for this alternative were the same as the closure crest elevations developed for Alternative 2.

Because vegetation would begin to develop across the filled canal section during summer low flow months, the Manning's roughness coefficient was increased to consider the long-term effects on water surface profiles. Water surface profiles that include the effects of vegetation growth on the fill over the project life are shown on Plates 13 and 14 of Appendix D, Hydrology and Hydraulics (page D2-33 and 34) for the canal and meander, respectively. The Manning's n value used following construction was 0.03 for the canal with 0.035 for the restored meanders. A higher Manning's n of 0.045 was used in the canal to account for increased vegetation growth on the fill expected over the project life. Although the projected vegetation growth on the fill had minimal effect on computed water surface profiles at the Authorized Project discharge, this alternative has the most likely negative impact to the Authorized Flood Control Project.

Alternative 4 – Culvert Installation through Earthen Plugs with Closure Placement

This alternative consisted of restoring flow to meander channels by placing a culvert through the earthen closures at the upstream ends of the remnant channels and closures across the channelized portion of the river to divert the flow. Because the construction of culverts through the embankment would require a large amount of disturbance of the area, there was no foreseeable advantage of this option over removing the embankment. An additional consideration was the fact that culvert structures would require continual maintenance to remove debris.

EVALUATION OF ALTERNATIVE PLANS

Screening of Alternatives

The evaluation of the effects of each alternative consists of assessment and appraisal. Assessment is the process of measuring or estimating the effects of an alternative plan. The difference between without plan and with plan conditions for each category of effects is determined during the assessment process. The results of the evaluation are discussed in the following paragraphs.

After completion of the formulation of the alternative plans and estimation of the challenges and benefits of each plan, initial screening of all alternatives was performed by evaluating various criteria including the acceptability, completeness, efficiency, partnership context, and effectiveness in meeting stated objectives. Table 1 presents the results of this screening. Table 2 presents other comparisons for the system of accounts required by the Principals and Guidelines except for the National Economic Development (NED) account.

Alternative 1 is eliminated from further analysis. Hydraulically, this alternative fails to provide the necessary level of flow to induce a channel forming condition, and therefore would fail to meet, with any level of certainty, any of the project objectives. As discussed in the Alternative Description in the Formulation of Alternative section above, geomorphology relationships indicate that the channel forming discharge is required to maintain proper sediment movement through a channel. This alternative failed to provide the level of flow needed to meet this requirement. This alternative has little likelihood of effecting any sustainable change. Because of these factors, this alternative is unacceptable.

Alternative 2 is carried further to detailed analysis. Alternative 2 involves earthen plug removal to allow both upstream and downstream reconnection to river flows, as well as the installation of a closure adjacent to each meander to direct flows into the upstream end of each meander. Hydrologic analyses determined the closure crest elevations that would divert the maximum amount of flow up to the bankfull capacity in the historic channels without increasing water surface elevations above the authorized project water surface profile. These respective elevations at each meander would force flows into the meander at the critical channel forming flow that would create a sustainable meander flow path and closely mimic historic natural conditions.

Alternative 3 is eliminated from further analysis. Hydraulically, this alternative provides the necessary level of flow to induce a channel forming condition, and therefore would meet the project objectives 'Return flow to the meanders' and 'Re-establish a geomorphically stable channel in the historic river.' However, alternative 3 could negatively impact the authorized flood control project, from which the Bayou DeView/Cache River Improvement District derives benefits.

Alternative 4 is eliminated from further analysis. Because the construction of culverts through the embankment will require a large amount of disturbance of the area,

there was no foreseeable advantage of this option over removing the embankment. An additional consideration was the fact that culvert structures would require continual maintenance to remove debris. The sponsor has a negative view of the minor and routine maintenance requirement of this alternative.

Table 1 Initial Alternative Screening against Project Objectives

Description	NO ACTION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4
A. PLAN DESCRIPTION	No change in study area	Open meanders w/o closure structures	Open meanders place closure in channel	Open meanders fill in straightened channel	Place culverts through plugs place closure in channel.
B. SIGNIFICANT IMPACTS	No significant Impacts	No significant impacts	Restoration of flow to six meanders, restoring riverine conditions.	Restoration of flow to six meanders and potential negative flooding impacts	Temporary restoration of flow to six meanders but then return to baseline conditions with significant maintenance expenditures.
C. ACCEPTABILITY	N/A	Minimal acceptability, but public would be disappointed by poor performance	Fully Meets	Does not meet due to flood control risk and potential high maintenance keeping filled channel maintained	Does not meet due to high maintenance requirement
D. COMPLETENESS	Fails to meet- accomplishes one project objective	Partially Meets – does not divert sufficient water to sustain project	Fully Meets	Fully Meets	Partially Meets – Does not divert enough water to accomplish objectives
E. EFFICIENCY	Efficient w/ no expenditure but only accomplishes 1 objective	Partially Meets – does not divert sufficient water to sustain project	Fully Meets	Fails to meet – Most expensive alternative	Partially Meets – does not divert sufficient water to sustain project
F. STAKEHOLDERS VIEW	Fails	Acceptable, but simply fails to meet expectation	Acceptable, but preference would be for material other than rock, NFS* concerned with project price	Mixed – Bayou DeView Improvement District views alternative unfavorably while NFS* more likely to accept – (except for maintenance liability)	Acceptable, but simply fails to meet expectation and NFS concerned about high maintenance

* NFS – Non-Federal Sponsor

TABLE 1 (Continued)

Initial Alternative Screening against Project Objectives

Description	NO ACTION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4
F. EFFECTIVENESS -OBJECTIVES	*Alternatives compared relative to each other in general likelihood for success*				
Return flow to the meanders	No success	Limited Success –little diversion during low flows	Most Successful	Most Successful	Limited success does not divert sufficient water to sustain project
Return flow in sufficient quantities to support mussel populations	No success	No Success – low flows would inhibit mussel habitat	Most Successful	Most Successful	No Success – low flows would inhibit mussel habitat
Create conditions to enhance native fish habitat	No success	Limited Success –riverine fish habitat during higher flows – not during summer	Most Successful	Successful, but less than Alternative 2 which also provides some habitat in main channel in vicinity of closures	Limited Success – riverine fish habitat during higher flows – not during summer
Re-establish a geomorphically stable channel in the historic river	No success	Limited Success –little diversion does not meet critical channel forming flows	Successful	Most Successful – but possibly at risk of flood control project	Limited Success – little diversion does not meet critical channel forming flows
Minimize disturbance during construction within the existing meanders	Successful	Limited Success –construction of plug removal will disturb meander	Limited Success – construction of plug removal will disturb meander *	Limited Success – construction of plug removal will disturb meander	Limited Success – construction of plug removal will disturb meander

* The LPP that is discussed later does introduce some additional disturbance within the meander 3 during construction

Table 2 Other Considerations – Three Accounts
(National Ecosystem Restoration, Regional Economic Development, Other Social Effects)

ACCOUNT	NO ACTION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4
National Ecosystem Restoration (NER)*					
Aquatic Resources	No change expected.	No significant improvements in meander habitat.	Significant improvement in riverine habitat in six meanders. Recolonization of mussels and riverine fish species in meanders expected.	Significant improvement in riverine habitat in meanders. Change from aquatic to terrestrial habitat in straightened channel area. Recolonization of mussels and riverine fish species in meanders expected.	Short term improvement in meander habitat then return to close to existing conditions.
Air Quality	No change expected.	Short term reduction in air quality. No significant impacts.	Short term reduction in air quality. No significant impacts.	Short term reduction, although of longer duration than other plans. No significant impacts.	Short term reduction in air quality. No significant impacts.
Water Quality	No change expected.	Short term reduction in water quality. No significant impacts.	Short term reduction. No significant impacts.	Short term reduction, although of longer duration than other plans. No significant impacts.	Short term reduction. No significant impacts.
Wooded Land	No change expected.	Minor impacts to wooded lands during construction.	Minor impacts to wooded lands during construction.	Increase in wooded lands over time as channelized portion naturally reforests.	Minor impacts to wooded lands during construction.
Wetlands	No change expected.	Minor impacts to wetlands during construction.	Minor impacts to wetlands during construction	Increase in bottomland hardwoods over time as channelized portion naturally reforests.	Minor impacts to wetlands during construction
Regional Economic Development*					
Employment	No Effect	Temporary increase in construction employment.	Temporary increase in construction employment.	Temporary increase in construction employment.	Temporary increase in construction employment.

Other Social Effects*					
a. Noise	No Effect	Temporary increase during construction.	Temporary increase during construction.	Temporary increase during construction.	Temporary increase during construction.
b. Aesthetics	No Effect	Reduced temporarily during construction.	Reduced temporarily during construction.	Reduced temporarily during construction.	Reduced temporarily during construction.

* *There is no anticipated difference in agricultural lands, cultural resources, income, regional growth, local government finance, health, safety, security of life, public facilities and services, displacement of people, community cohesion, community growth, and emergency preparedness from any of these alternatives or the no action alternative.*

Refinement/Optimization of Alternative 2

Technical

Several different closure designs were analyzed for alternative 2 to determine the appropriate configuration to route flow into the meander channels, withstand flood events, and be economically efficient while still achieving the objectives. This array of designs included differing crown widths (10 and 20 foot crown widths); differing upstream (1:6 or 1:1.5) and downstream weir slopes (1:20, 1:6, or 1:1.5); embedded riprap thicknesses (4, 6, and 8 foot), and closures keyed into the substrate or without key. An engineering analysis was performed to derive an efficient and effective design.

Hydrologic analysis determined that the downstream-most closure needed to be built in such a manner as to be able to withstand current velocities from both normal flow conditions as well as "reverse" flows (i.e. flow running upstream in the Cache River during White River flooding events). Closures upstream of the lowermost closure did not require that level of protection and thus two designs were determined necessary.

The lowermost closure would need to be keyed in with an embedded riprap thickness of 6 feet; a crown width of 20 feet; slopes of 1V:6H upstream and downstream, with a 50 foot downstream apron. This closure, which would be 8 feet in height, would require approximately 20,350 cubic yards of R2200 rock and a two part filter consisting of 675 cubic yards of R90 rock and crushed limestone.

The closures upstream of the largest weir would not need to be keyed in and would have embedded riprap thicknesses of 6 feet; a crown width of 20 feet; and slopes of 1V:1.5H upstream and downstream, with a 50 foot downstream apron. These closures would also be 8 feet in height, and would require approximately 8,300 cubic yards of

R2200 rock and a two part filter consisting of 675 cubic yards of R90 rock and crushed limestone.

Optimization

The initially evaluated Alternative 2a was described in the Formulation of Alternative Plans section above (page 24) and is further described below. Incremental cost analyses were conducted to determine the NER Plan and inform the sponsor relative to smaller plans that may have been within their financial capability.

Three options, based on Alternative 2, were analyzed. The options had differing numbers of meanders identified for restoration. The smallest option, Alternative 2c consisted of restoring flow to meanders 1, 2, and 3 and would require four closures (meander 3 would require two closures due to a cross-channel ditch that connects the channelized reach to the middle portion of the meander), and the removal of three plugs. The next larger option, Alternative 2b, would consist of restoration of four meanders (1, 3, 5, and 6) and would require five closures and the removal of four plugs. The choice to eliminate Meanders 2 and 4 in Alternative 2b is based upon a lesser amount of restorable habitat for those two weirs with respect to the construction cost for those two meanders. Alternative 2(a), would consist of restoration of all six meanders, and would require seven closures and the removal of six earthen plugs. In each case, the lowermost closure would be the larger, keyed structure described above in the Technical section, and the upstream closures would have the smaller configuration.

Incremental cost analysis was conducted on each option and included the cost per Average Annual Habitat Unit (AAHU) gained for both fish and freshwater mussel. The results of the incremental cost analyses are presented in the Comparisons of Alternative Plans section below.

These refined alternatives are described as follows:

Alternative 2a - *This alternative consisted of meander restoration at the same six locations as Alternative 1, but included constructing closures across the channelized section just downstream of the openings to divert flow back to the meanders. Plate 7 of Appendix D, Hydrology and Hydraulics (page D2-27), shows the channel alignment, plug removals, and weir locations for Alternative 2a.*

Alternative 2b - *This alternative consisted of meander restoration of only meanders 1, 3, 5, and 6 but in the same manner as Alternative 2a. Plate 15 of Appendix D, Hydrology and Hydraulics (page D2-35), shows the channel alignment, rock weir locations, and plug removal locations for Alternative 2b. With this alternative, while infrequent maintenance may be performed by temporarily degrading the downstream closure weirs in order to barge replenishment stone to upstream closure weirs as needed, any future construction of weirs for the omitted meanders - Meanders 2 and 4 - would be problematic.*

This is due to the quantity of stone needed with the window for access to deliver the stone to the closure locations.

Alternative 2c - *This alternative consisted of meander restoration of only meanders 1, 2, and 3 but in the same manner as Alternative 2a. There is no specific plate in Appendix D that presents this alternative 2 variation.*

All of these alternatives included two channel closures associated with Meander #3. An additional scenario was considered that was smaller than Alternative 2c and included the restoration of meanders 1 and 3. This additional scenario had identical engineering parameters for the closure structures as Alternative 2c. The fully funded cost for this scenario was $7.598 mil and it would restore 7,963 habitat units, for an efficiency of $39.69 per habitat unit.

Ecosystem Outputs of Alternatives

A study conducted on the effects of channelization on fish populations and productivity (Mauney and Harp 1979) reported that species richness, total fish biomass, and mean weight of game fishes were significantly higher in non-channelized reaches when compared to the channelized portion of the Cache River. Christian (1995) conducted surveys of mussel beds in the Cache River and reported that mussel populations and species richness were significantly lower in the channelized portion of the Cache than in the non-channelized upstream reaches (portions farther upstream than the flood control project reached). For example, up to 20 different freshwater mussel species were collected upstream of the channelized reach, with densities of up to 37.6 individuals per square meter. Contrasting that, the largest bed encountered in the channelized reach had a mean density of 11.2 individuals per square meter and contained only seven species.

Based upon the background information provided above, and the views and interests of the Corps and project stakeholders, ecosystem outputs were considered and calculated for fish and mussels in terms of habitat. Through the formulation process with involvement of project stakeholders and the sponsor, the alternative 2 scenarios described above – (Alternatives 2a, 2b, and 2c) were considered and the ecosystem outputs for each evaluated. The Engineering Research and Development Center, Environmental Laboratory (ERDC-EL), performed the analyses to determine the existing habitat and potential benefits from project implementation based on these two resources. The outputs are provided the Comparison of Alternative Plans section. The two studies are Lower Cache River Basin Restoration: Benefits to Fish and Aquatic Habitat (Killgore and George, 2009) and A Model to Evaluate Mussel Habitat Improvement by Restoring Connectivity to Isolated Meanders of the Lower Cache River, Arkansas (Payne and Farr, 2009). These reports may be found in Appendix C.

As previously noted, an assessment of the benefits of the proposed restoration project to riverine fishes within the project area was developed (Killgore and George, 2009). The analysis considered habitat in the channelized portion as well as in the

meanders. These numbers were refined to only include the ecosystem restoration benefits of the meander restoration. The analyses indicated that significant benefits to fish species would be derived from implementation of the project. The calculated habitat units (HUs) assume that the transition in habitat type occurs within one year of project completion and that the HUs are maintained throughout the life of the project. Therefore, the HUs are average annual habitat units (AAHUs) (Kilgore 2010 pers comm).

The assessment of habitat gained for freshwater mussels previously noted (Payne and Farr, 2009) considered habitat in the channelized portion as well as in the meanders. These numbers were refined to only include the ecosystem restoration benefits of the meander restoration. The restoration of flows to the meanders would generate a significant increase in habitat available to mussels (see Table 4, Payne and Farr). These HUs are AAHUs as explained above. However, the populations of mussels may take years to reestablish even after the habitat is reestablished.

The existing condition, future without project condition, and future with project condition for Alternative 2a, 2b, and 2c were calculated. These results are provided in Appendix C, and are summarized in the Comparisons of Alternative Plans section below within Table 4.

Real Estate Considerations of Alternatives

The potential non-Federal project sponsor is The Nature Conservancy (TNC). Other involved parties are Arkansas Game and Fish Commission (AGFC) and Ducks Unlimited. None of these currently identified stakeholders own any of the lands needed for the project. Over half of the project lands within the 7-mile long project area are presently owned by the Federal government. These lands are located within the Cache River National Wildlife Refuge and are being managed by the U.S. Fish and Wildlife Service. However, three meanders are not adjacent to the Wildlife Refuge. The Federal government channelized and constructed the existing Cache River flood control project in partnership with the Cache River/Bayou DeView Improvement District as the non-Federal sponsor. There is an existing standard Channel Improvement Easement that was used for the flood control project which extends about 200 feet from the bank channel. Under an Assurance of Local Cooperation, the Corps has the rights to use the existing Channel Improvement Easement right-of-way, and can construct part of the restoration project using these rights. However, the restoration project will need to acquire additional land from the Cache River/Bayou DeView Improvement District that extends about 100 feet beyond the original flood control project right-of-way. The restoration project would need a Channel Improvement Easement, depending on the Alternative 2 variant recommended, on from 20 to 60 acres of land. Access to the sites will be from the river and no additional access will be required. No utility or facility relocations are required. There are no known Public Law 91-646 relocations necessary for the project. No person, farm, or business will be displaced as a result of the project. TNC, DU and AGFC are working in cooperation with both the Cache River National Wildlife Refuge (USFWS), and the Cache River/Bayou DeView Improvement District who are the majority landowners of the project right-of-way.

Relocations

The tentatively recommended plan will not require relocation or alteration of any existing utilities found within the project area.

Cost of Alternative Plans

Due to the relatively low diversity of type of costs, the cost for the procurement, transportation, and placement of the stone for the closure structures is the predominant cost. Real Estate Costs are for easements alone and average 1.2% of the overall costs for these alternatives. There is no relocation cost as there is no infrastructure in the project area. Overall project costs are a significant concern because of the non-federal sponsor's ability to share the costs.

Cost estimates were calculated for each plug removal and closure structure. The costs for each alternative are presented in Appendix F. The construction costs were then amortized over the period of analysis to compute an annualized cost for each alternative for comparison to annualized benefits. At the time of this analysis, the fiscal year annual interest rate was 4 1/8 percent. Average costs were calculated by applying this rate to the construction costs over the 50-year period of analysis. Table 3 shows the annualized costs for each alternative. Costs shown do not include planning costs.

Table 3 Average Annual Cost Summary

For Each Option of Alternative 2

(November 2010 Price Level @ 4 1/8% Interest Rate)

Alternative Option	Total Estimated First Cost	Average Annual Cost	OMRR&R Average Annual Costs	Average Annual Monitoring Cost	Average Annual Cost
2a	$13,054,000	$634,000	$6,000	$3,000	$643,000
2b	$9,868,000	$479,000	$6,000	$3,000	$488,000
2c	$8,271,000	$393,000	$6,000	$3,000	$402,000
No Action	N/A	N/A	N/A	N/A	N/A

COMPARISON OF ALTERNATIVE PLANS

Once the three Alternative 2 scenarios were determined, the costs and benefits for each were calculated, and a cost effectiveness and incremental cost analysis (CE/ICA) procedure performed. The initial alternative considered was the no action alternative. Then, each Alternative 2 scenario from the smallest increment to the largest was considered.

The complete results of the incremental cost analysis are provided in Appendix H. The following tables summarize the results. Table 4 indicates the alternatives and habitat gains by restoration of each set of meanders. Table 5 indicates the annualized cost and benefits, and whether the alternative was cost effective. Figures # and # demonstrate this information graphically. The results of the incremental Cost analysis follow:

Table 4 Mussel and Fish Habitat Benefits*

Alternative	Meanders	Mussel AAHUs	Riverine Fish AAHUs	Total Average Annual Habitat Units
No Action	none	54	0	54
2c	1, 2, 3	7,961	56	8,017
2b	1, 3, 5, 6	12,470	91	12,561
2a	1, 2, 3, 4, 5, 6	16,143	111	16,254

* A description of how AAHUs were determined is provided in the third and fourth paragraphs of the Ecosystem Outputs of Alternatives section above (pages 32 and 33).

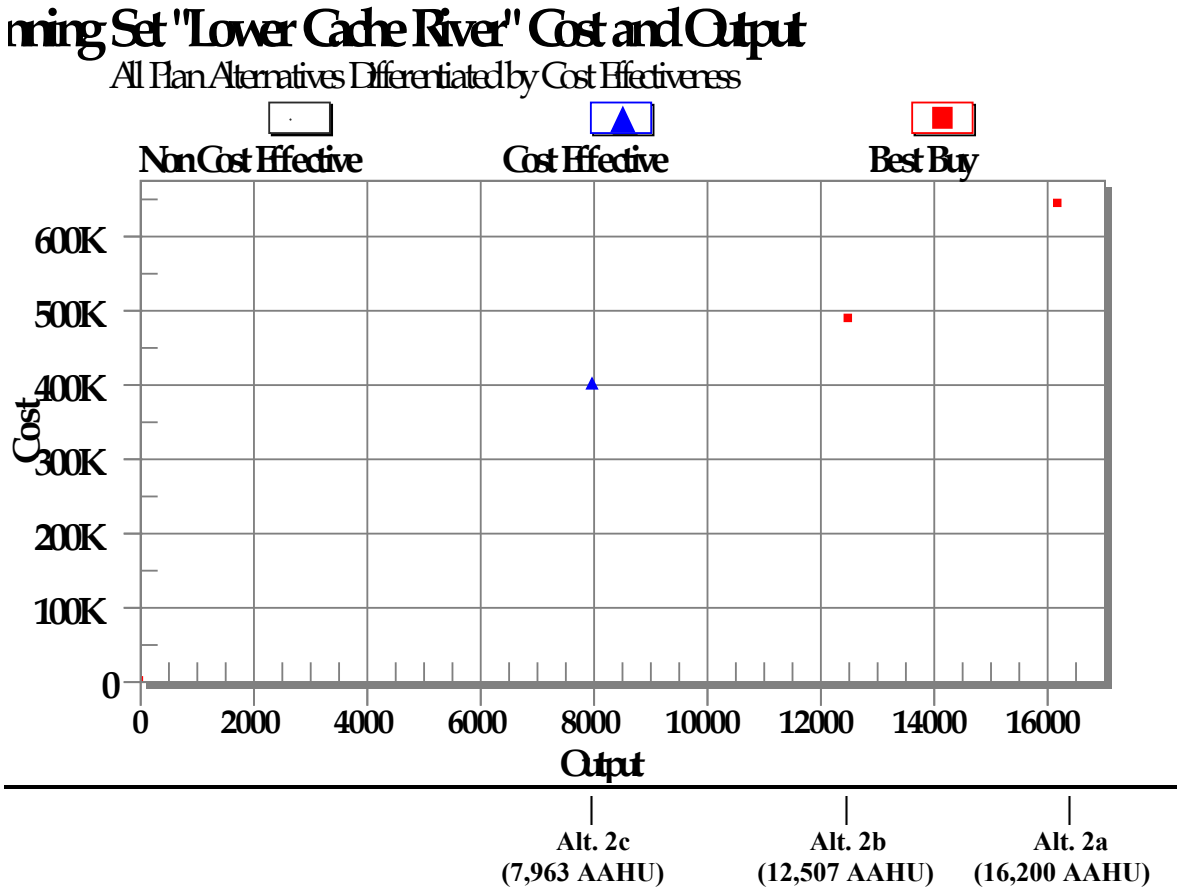
Table 5 Annualized Cost, Habitat Units and Cost Effectiveness

Name	Annual Cost	Net* Output	Cost Effective
No Action Plan	0	0	-
Alt. 2c - Meanders 1, 2, & 3	$402,000	7,963	Yes**
Alt. 2b - Meanders 1, 3, 5, & 6	$488,000	12,507	Best Buy
Alt. 2a - Meanders 1, 2, 3, 4, 5, & 6	$643,000	16,200	Best Buy

* Net Habitat Units minus future without project conditions

** Alternative 2c is an incrementally justified alternative and therefore cost effective, however it is not optimal as a best buy plan in accordance with the IWR methodology for Cost Effectiveness and Incremental Cost Analysis.

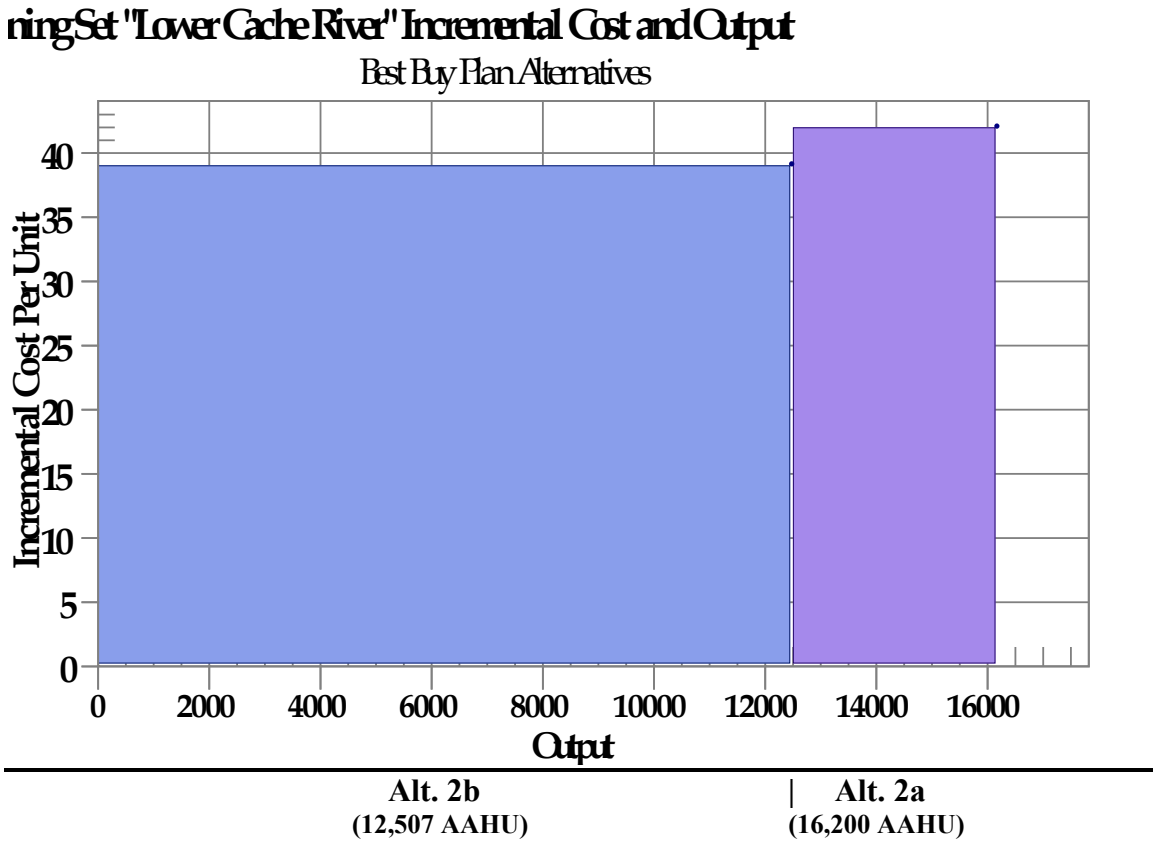
Figure 5: Cost and Output Graph



DATA & RESULTS

Name	Average Annual Cost	Average Annual Output (HU)	Cost Effective
No Action Plan	0	0	-
Alt. 2a - Meanders 1, 2, 3, 4, 5, & 6	$643,000	16,200	Best Buy
Alt. 2b - Meanders 1, 3, 5, & 6	$488,000	12,507	Best Buy
Alt.2c - Meanders 1, 2, & 3	$402,000	7,963	Yes

Figure 6: Cost and Output Graph



Identification of the National Ecosystem Restoration Plan

The identified national ecosystem restoration (NER) plan is the ecosystem restoration plan of the desired scale that maximizes the monetary and non-monetary beneficial effects/outputs (AAHU) as compared to the monetary and nonmonetary costs. The (CE/ICA) cost analyses do not provide a discrete decision criterion for plan selection, however, the incremental cost analysis does provide for the explicit comparison of the relevant changes in costs and outputs on which such decisions may be based. Decision makers must decide whether the additional gain in environmental benefit is worth the additional cost.

Based on the results of the CE/ICA presented in Table 6, it was determined that Alternative 2a (Meanders 1-6) results in the greatest outputs for very little additional cost. Since it restores the maximum environmental benefits at the optimal cost and was considered to be the NER Plan for restoring the ecosystem. However, because of a constraint of funds, the NER Plan is not implementable.

Table 6 Incremental Cost of Best Buy Plan Combinations

(November 2010 Price Level @ 4 1/8% Interest Rate)

Col. 1 Alternative	Col. 2 Project Construction First Cost	Col. 3 Average Annual Cost	Col. 4 Change in Incremental Cost	Col. 5 Total Habitat Units	Col. 6 Net Restored Habitat Units	Col. 7 Change in Incremental Restored HU	Col. 8 Average Cost/HU (Col.3/Col.6)	Col. 9 Incremental Cost/ HU (Col.4/Col.7)
No Action	N/A	N/A	0	54	0	0	N/A	N/A
Alt. 2b	$9,868,000	$488,000	$488,000	12,561	12,507	12,507	$39.02	$39.02
Alt. 2a	$13,054,000	$643,000	$155,000	16,254	16,200	3,693	$39.69	$41.97

Table 6 shows that Alternative 2b, with an incremental cost of $39.02 per habitat unit, results in restoring a total of 12,507 average annual habitat units, has the lowest incremental cost, and is the first "Best Buy" plan beyond No Action. Alternative 2a is the most cost-effective plan that maximizes ecosystem restoration benefits as compared to costs**.** Alternative 2a, however, results in the most cost effective plan that maximizes ecosystem restoration benefits as compared to costs. Although it does not result in the least costly plan per HU, it does provide the maximum amount of environmental benefits (16,200 HUs), which is 30 percent more in outputs than the next smaller plan.

LOCALLY PREFERRED PLAN (LPP)_DEVELOPMENT AND DESCRIPTION

Prior to November 2010, all considered alternatives exceeded the potential sponsor(s)'s ability to fund. The nature of the project presents opportunities to scale the project downward. This scale could be from the restoration of a single meander to the restoration of all meanders that were impacted by the authorized flood control project. In November 2010, TNC stated a willingness to be the non-federal sponsor if a project that restored three or four meanders could be implemented in a manner within the organization's ability to cost share. Therefore, in addition to other alternatives the study includes a smaller locally preferred plan that is implementable to the non-federal sponsor.

Because of sponsor funding constraints, the Corps of Engineers was requested to analyze a project smaller than the NER plan and perform a value engineering assessment to further optimize the project cost for the smallest alternative previously investigated (Alternative 2c). The request is provided in Appendix B.

Identifying an LPP

The Corps study team considered possible ways to reduce project costs while achieving the environmental restoration objectives. The only way identified was to pursue construction under an approach where the Corps would partner to do initial construction for 3 closures, 3 plug removals, and an additional plug within the cross-ditch in meander 3. Only one closure would be installed adjacent to Meander 3; the uppermost weir would be eliminated. The closure that would be installed for Meander 3 would be across the canal portion of the Cache River immediately downstream of the cross-ditch. The added plug in the cross-ditch in the middle of Meander 3 would keep flows in the meander that enter at the upstream meander opening.

Regarding the hydraulic performance of this approach; with addition of a plug in the cross-ditch and limited bank armor within meander 3, hydraulic calculations show that a degree of flow control can be achieved to divert flow into meander 3. Without the upstream closure included in the Alternative 2 variants, water levels at the upper end of meander 3 would be between 0 and 0.4 ft lower than with the closure for within-bank discharges (flows). For conditions where the closures are submerged, there would be virtually no perceptible difference in water levels. A lowering of 0.4 feet at the entrance to the restored meander 3 would affect the amount of flow diverted to the meander for a small percentage of flows. Except for seepage through the closure weir, all discharges up to the crest of closure would be diverted into meander 3. For the increment of flow between this level and 0.4 feet higher there would be a proportionate flow split between the meander and the canal. With the upstream closure at meander 3 in place, as in the case of the NER plan, this full increment of flow would divert to the meander. For conditions where discharge exceeded the level required to overtop the upstream closure, there would be no perceptible difference in flow distribution. The need for the upstream

closure at the top of the meander that is not included in the LPP will be monitored and reassessed by the sponsor as the canal and meander channels respond to the new flow regime.

To further reduce project costs, the study team next evaluated project performance with closures at a lower elevation than considered in the Alternative 2 variations. Closure crest elevations were decreased by 2 feet to elevations as shown in Table LPP-1 in the Hydraulic portion of Appendix K.

These reductions in the number and height of closures do create an impact to the project design. After an engineering evaluation, it was determined that the primary impact from these reductions will be manifested as risk that operations, maintenance, repair, rehabilitation, and replacement (OMRR&R) costs will be higher. The increases in OMRR&R costs (i.e., $6,000 for average annual OMRR&R costs for the NER Plan versus $45,000 for average annual OMRR&R costs for the LPP with three meanders) are included in the analyses for the LPP and have been presented to the potential local sponsor. The potential local sponsor has stated intent to partner with another interested party, possibly the Arkansas Game and Fish Commission, for the performance of OMRR&R. In correspondence and with knowledge of this likely increase in annual costs, the local sponsor has requested the Corps of Engineers pursue construction of three closures and three plug removals for Meanders 1, 2, and 3 and one additional plug within the cross-ditch in Meander 3, including the re-engineered design to further reduce costs, as the LPP plan.

Formulation of LPP Scenarios

While the sponsor requested in correspondence a locally preferred plan to restore meanders one, two, and three, which is provided in Appendix B, the Federal water resources planning approach as established in the "Economic and Environmental Principals for Water and Related Land Resources Implementation Studies" (February 3/March 10, 1983) (P&G) requires the formulation of alternatives. The formulation must be conducted in a systematic manner. Various scenarios based upon identical engineering parameters described in the previous section were developed and analyzed.

This provides a framework where decision makers can consider the requested locally preferred plan, and verify if there is a scenario that is a cost effective Federal investment that the sponsor may prefer. Each measure and scale was combined with the cost and output of each part being summed. As a result, each combination had an associated total cost and total output. Each possible combination was considered a Scenario/plan. These combinations are as follows:

No Action plan: No Federal action would be undertaken to restore the degraded conditions in the project area with the No Action plan.

LPP-1 (M 1 & 2): This scenario includes the removal of channel plugs in 2 meanders (1 & 2), and the building of 2 low water weirs in the main channel.

LPP-1 (M 1 & 3): This scenario includes the removal of channel plugs in 2

meanders (1 & 3), and the building of 3 low water weirs in the main channel, and adding 1 rock plug in meander 3. (Note: Meander 2 cannot be opened in the future after building weirs at meander 3.)

LPP (M 1, 2 & 3): This scenario includes the removal of channel plugs in 3 meanders (1, 2 & 3), and the building of 4 low water weirs in the main channel, and adding 1 rock plug in meander 3. This is the plan that the sponsor requested in correspondence in November 2010.

LPP-1 (M 1, 2, 3 & 4): This scenario includes the removal of channel plugs in 4 meanders (1, 2, 3 & 4), and the building of 5 low water weirs in the main channel, and adding 1 rock plug in meander 3.

Cost Effectiveness Analysis for LPP Scenarios

A cost effective analysis was performed for the LPP Scenarios to determine if no other plan provided the same level of output for less cost and if no other plan provided more output for the same or less cost. Table 7 presents the results of these analyses. This identifies the least-cost or best solution plan for a given amount (or range) of outputs. All four LPP Scenarios/plans were identified as being "cost effective" plans.

Table 7 Average Annual Total Project Cost for the LPP Scenario & Cost Per Habitat Unit

(November 2010 Price Level @ 4 1/8% Interest Rate)

Col. 1 Scenario (Meanders)	Col. 2 Project Construction First Cost	Col. 3 Average Annual Cost 1/	Col. 4 Annual OMRR&R Cost 2/	Col. 5 Average Annual Monitoring 3/	Col. 6 Average Annual Total Cost (Col. 3+4+5	Col. 7 Average Annual Net Restored Habitat Units	Col. 8 Average Annual Cost Per Habitat Unit (Col. 6÷7)
No Action	N/A	N/A	N/A	N/A	N/A	N/A	N/A
LPP-1 (M1&2)	$3,794,000	$180,000	$30,000	$3,000	$213,000	4,446	$47.91
LPP-1 (M1&3)	$4,289,000	$204,000	$30,000	$3,000	$237,000	6,240	$37.98
LPP (M1,2,3)	**$5,574,000**	**$265,000**	**$45,000**	**$3,000**	**$313,000**	**7,963**	**$39.31**
LPP+1 (M1,2,3,4)	$6,902,000	$335,000	$60,000	$3,000	$398,000	9,933	$40.07
NER 4/ Alt. 2a (M1,2,3,4,5&6)	$13,054,000	$634,000	$6,000	$3,000	$643,000	16,200	$39.69

1/ Project construction will take place over a 1-year period for LPP-1 & LPP, and a 2-year period for LPP+1. Average annual cost includes Interest During Construction (IDC). Common reference period is end of year.

2/ OMRR&R costs are for inspection, weir maintenance, and minor repairs at the 10 year intervals after construction.

3/ Performance monitoring of the project site will take place after construction.

4/ The NER plan is not actually comparable to the LPP scenarios, because of the smaller weir design, however, the NER is shown at the bottom of this table for informational purposes only.

The LPP Scenarios provided relatively similar outputs with lower construction costs when decreasing the number of meanders that were being unplugged. Figure 7 shows that LPP-1 (M1&2) and LPP (M1,2,3) are cost effective plans, whereas LPP-1 (M1&3) and LPP+1 (M1,2,3,4) are cost effective plans and also determined to be "Best Buy" plans. The following additional observations are provided for LPP-1 (M1&3), LPP+1 (M1,2,3,4), and LPP (M1,2,3):

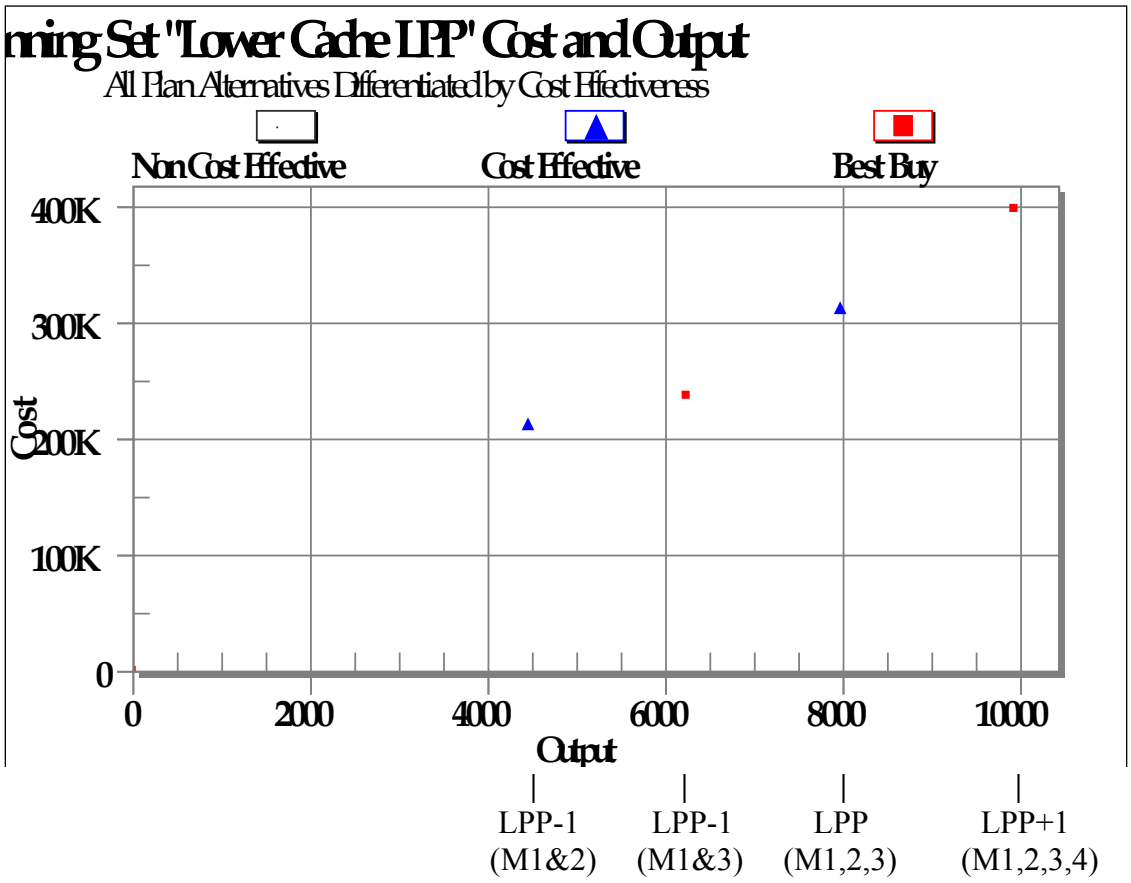
a. Although the LLP-1 (M1&3) is the first Best Buy plan, with an average cost of $37.98 per habitat unit, it is not exactly comparable to the other LPP plans in that by building weirs at meanders 1 and 3, this eliminates the possibility of opening meander 2 in the future which none of the other scenarios do. Therefore, the net benefits for meander 2 would be lost. This is an acceptable plan and can be chosen by the decision makers if they decide to eliminate opening meander 2.

b. LPP+1 (M1,2,3,4) is the second Best Buy plan, however, the project costs to build this alternative is much higher (over $1.3 million) than the sponsor's financial capability to participate.

c. LPP (M1,2,3) is a cost effective plan with an average cost of $39.31 per habitat unit. Net benefits for unplugging only 3 of the 6 meanders are 7,963 average annual habitat units (AAHU). By unplugging the first 3 meanders located at the top of the Lower Cache River (Meanders 1, 2, and 3) as the first project design, the lower 3 meanders (Meanders 4, 5, and 6) could still be unplugged at a later date. This means that the potential restoration of habitat units from the lower 3 meanders could still be realized in the future. This is an acceptable plan and can be chosen by the decision makers.

d. LPP-1 (M1&2) is a cost effective plan with an average cost of $47.91 per habitat unit. However, it is not as cost effective any other scenario. This is an acceptable plan and can be chosen by the decision makers.

Figure 7: LPP Scenarios Indicated by Cost Effectiveness



SELECTION OF RECOMMENDED PLAN

The planning process leads to the identification of alternative plans that are in the Federal interest and could reasonably be implemented jointly by the Federal Government and the non-Federal sponsor. The non-Federal Sponsor has reviewed the information presented above for the various LPP-1 and LPP+1 scenarios, and prefers the LPP (M1,2,3). The LPP (M1,2,3) is recommended for implementation and is hereinafter refer to as the LPP or the Recommended Plan. It is a cost effective, smaller increment of the NER Plan which is within the local sponsor's capability to participate in the project. The LPP provides the greatest restoration benefits for the funds that are available and would not preclude construction of the NER Plan in the future.

Description of the LPP

The LPP consists of restoring flow to Meanders 1, 2, and 3. The location of these meanders is shown on Figure 8.

Closure weirs would be placed at three locations in the channelized section of the seven mile reach, including immediately below the reopened meanders 1 and 2 and immediately below a cross-channel ditch from the channelized river into meander 3.

An additional closure weir would be installed in the cross-channel ditch in Meander 3. This is shown in Figure 9. This additional closure is required on meander 3 because the restoration of current within the meander would likely cause the flow to run through the cross-channel ditch, thereby isolating a significant portion of meander 3 from flow, and losing the benefits that are possible in Meander 3. Analysis determined that the length of stream bank at risk for being cut through (i.e. too close to the channelized river) was too long for bank protection to be a viable option. Therefore the additional closure weirs would ensure that flows would not be able to bypass the upper portion of meander 3.

All closure weirs would be constructed as described in the evaluation of alternatives section of this report. Fast growing vegetation, such as willows would be planted at the bank tie-in locations of the closures to help stabilize the disturbed areas and minimize the risk for structure flanking.

Final designs would be confirmed during the "Design and Implementation" phase after surveys have been completed.

Total first cost of the LPP is $5,574,000 at current (November 2010) price levels. Real estate cost is estimated to be $68,000 or 1.2% of the total. The bulk of the cost is for constructing the weirs and removing the plugs, which is estimated to be $4,735,000 or 84.9% of the total. The remaining $771,000 (13.9%) is for engineering & design, and supervision & administration. Only actual project construction costs were included in the total project first cost calculations for the Cost Effectiveness Analysis. Study costs are

sunk costs and were not included as part of the total project costs for this analysis. However, the sponsor's cost share of the study costs will be recouped after execution of the Project Partnership Agreement for the project.

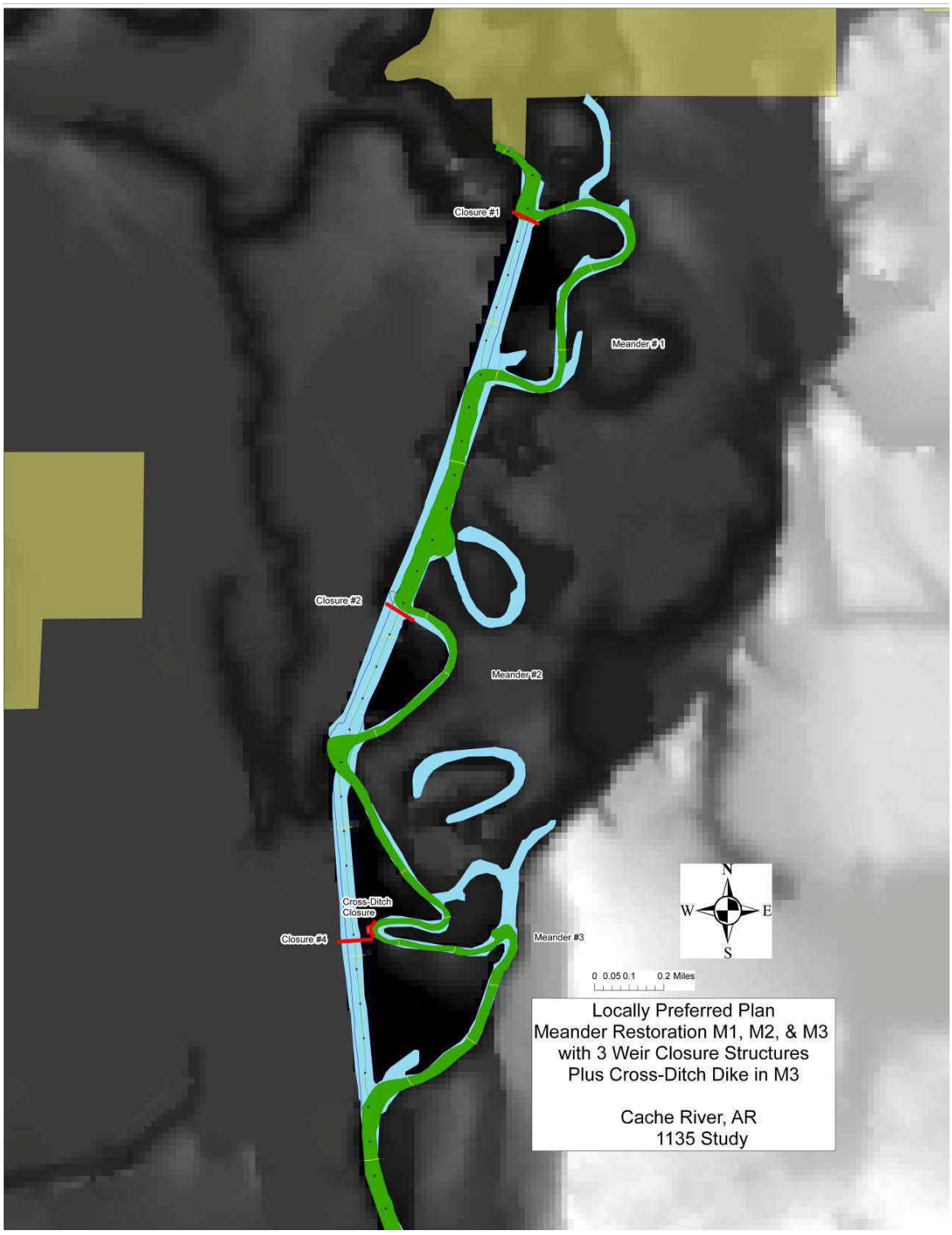


Figure 8: Locally Preferred Plan

Annualized cost for the investment is estimated to be average annual investment of $265,000 due to the first costs for construction. Total annual OMRR&R costs are estimated at $45,000 for the LPP Alternative. OMRR&R costs are for inspection, weir maintenance, and major repairs at 10 year intervals. Performance monitoring and inspection of the project site will take place during the 1st, 3rd, 5th, and 10th year after construction. The average annual equivalent costs are estimated at $3,000 for the LPP Alternative. The LPP is estimated to produce net benefits of 7,963 average annual habitat units at an average total cost of $313,000, for an average cost of $39.31 per habitat unit. The LPP is a cost-effective plan that maximizes ecosystem restoration benefits in three meanders as compared to costs, and is within the sponsor's capability to cost share.

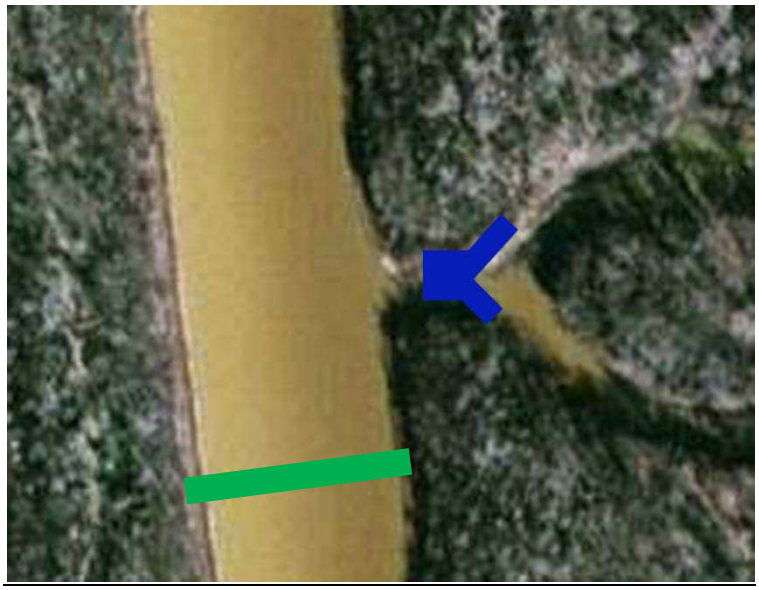


Figure 9: Cross-Ditch at Meander #3 showing proposed plug (Blue) with bank protection. Approximate location of Closure is shown in Green.

Costs and Cost Apportionment of the Recommended Plan

Tables 8 provide the first costs, annual costs, and annual benefits for the recommended plan. Table 9 provides the fully funded cost over the construction period and Table 10 presents the Federal and Non-Federal cost apportionment based on the first costs.

Table 8 Recommended Plan HU Benefits and Cost Summary
(November 2010 Price Levels)

Account	First Cost
01 Lands and Damages	$ 68,000
02 Relocations	$0
06 Fish and Wildlife Facilities	$4,735,000
30 Engineering and Design	$1,323,000
31 Construction Management	$343,000
Total First Cost	$6,469,000
Average Annual Cost	$265,000
Average Annual OMRR&R Cost	$45,000
Average Annual Performance Monitoring Cost	$3,000
Total Average Annual Cost *	$313,000
Average Annual Habitat Units	7,963

** Includes first cost, OMRR&R, and Performance monitoring costs at 4 1/8% and a 50-year period of analysis.

Table 9 Recommended Plan Fully Funded Cost Summary

	Budget Year Effective Price Level Oct 11*	Fully Funded Cost Estimate**			
Account		FY11	FY12	FY13	Total Cost
01 Lands and Damages	$68,000	$ 48,000	$20,000		$ 68,000
02 Relocations					$0
06 Fish and Wildlife Facilities	$4,811,000			$4,891,000	$4,891,000
30 Engineering and Design***	$1,323,000	$995,000	$278,000	$50,000	$1,323,000
31 Construction Management***	$343,000			$343,000	$343,000
Total Cost	$6,545,000	$1,043,000	$298,000	$5,284,000	$6,625,000

* The Budget EC year is 2012 (Per EM 1110-2-1304 Rev. 30 Sep 2010, composite index rate is 1.6% from FY11 to FY12).

** The fully funded cost estimate year for the construction contract is assumed to be FY13, but this assumes a lengthy PPA negotiation period (Per EM 1110-2-1304 Rev. 30 Sep 2010, composite index rate is 3.3% from FY11 to FY13).

*** The hired labor costs are held constant due to this legislation: Section 147 of the Continuing Appropriations Act, 2011 (Pub. L. 111-242), as amended by section 1(a) of the Continuing Appropriations and Surface Transportation Extensions Act, 2011 (Pub. L. 111-322).

Table 10 Cost Apportionment First Cost Federal and Non-Federal

Accounts:	Description	Cost	Contingency	Sub Total	Total
01 Real Estate	Lands and Damages	$68,000	0%	$68,000	$68,000
02 Relocations	*Relocations*	$0	0%	0	$0
06 Fish and Wildlife	*Plug Removals (3)*	$181,000	26%	$229,000	$4,735,000
	Large Weir	$1,553,000	27%	$1,977,000	
	Small Weirs (2)	$1,652,000	27%	$2,103,000	
	Rock Plug (Meander 3)	$335,000	27%	$426,000	
30 PED	*Feasibility Study*	$895,000	0%	$895,000	$1,323,000
	E&D for Fish and Wildlife	$372,000	15%	$428,000	
31 Construction Mngmt		$298,000	15%	$343,000	$343,000
	Total	$5,354,000	21%	**$6,469,000**	**$6,469,000**
			Total Federal Costs		**$4,852,000**
			Total Non-Federal Costs		**$1,617,000**
			LERRDS		$68,000
			In-Kind Work		$952,000
			Cash		$597,000

SUMMARY OF EFFECTS

Authorized Flood Project

Of all the alternatives consider in this study, the one with the highest likelihood of negatively affecting the authorized flood project is Alternative 3, which is the removal of the upstream meander plugs and the backfilling of the canal adjacent to the meanders. For clarity, the level that each canal reach would be filled is related to the meander bankfull elevations, and not the top bank of the canal reach. There will still be a canal that will pass flow during any except the lowest flow conditions. Description details of this alternative are most clearly described in Appendix D, particularly on page D2-4 and the hydraulic effects on pages D2-5 and the top of D2-6. In summary, even considering increased roughness due to vegetation growth, this alternative had minimal effect on computed water surface profiles at the Authorized Project discharge. This may be observed in Appendix D when comparing the authorized project flowlines on Plate 3 to the without vegetation and with extensive vegetation project flowlines on Plates 11 and 13.

Wetlands

This area does lie within a Ramsar listed wetland of International Importance, but the values for which the area was listed are not likely to be directly affected either positively or negatively. Indirectly, returning a portion of the river to a more natural condition will be perceived as positive for the significance of the wetland complex if only as an aesthetic improvement.

Fish and Wildlife

Habitat changes throughout the system have decreased the quality and quantity of available waterfowl habitat. This project lies in an area of intact waterfowl habitat so it will have no impact either positive or negative.

There is a total of 111 acres in the six meanders. The current habitat value for fish of these is 0.2 Habitat Units (HUs) per acre on a 0 to 1 scale for a total of 22 HUs. Restoration of the meanders will increase the value of the habitat to 1 HU per acre for a total of 111 fishery HUs. This increase in habitat quality will occur immediately upon completion of the project. Fish population changes will take place more slowly. Pioneering species will re-enter the system very quickly, but other species may take several years to repopulate the area. The proximity of the White River to the lower meanders will speed the process. Eventually, a more native species assemblage is expected to take over the restored meanders. It may become valuable as a nursery area for the White River.

The total length of the meanders is 26,905 feet. At present the value of this habitat for mussels ranges from 0.1 to 0.2 HUs per foot (on a 0 to 1 scale) for a total of 3272 HUs. Restoration of the meanders will increase the habitat value to 0.6 per foot for

a total of 16,143 mussel HUs. It will take years for the mussels to re-establish an endemic species assemblage; longer than it will take for fish. Mussels are slower to reproduce and depend on fish to move them into new habitat. Many species do still occur in the meanders, the White River and the channelized section, so, the probability of successful re-establishment is very high.

Threatened and Endangered Species

No threatened or endangered species are known to occur near the project. Coordination with the U.S. Fish and Wildlife Service is ongoing. The closure sites in the channels will be inventoried for mussels prior to construction. Any significant population of mussels (endangered or otherwise) will be relocated if found.

Cumulative Impacts

The proposed project would result in the restoration of riverine hydrology to three meanders in the lower seven miles of the Cache River, which is expected to increase the habitat available to riverine species of fish and improve habitat quality and quantity for freshwater mussels.

Other meander restorations are possible within the Cache River system. Meander restoration has also been discussed as a potential solution for flooding around Grubbs, Arkansas, over 100 miles upstream. Success in restoring meanders in the lower portion of the Cache River could encourage other such projects. Although the current restoration is small-scale in comparison to the amount of alteration in the system, it could lead to more widespread restoration efforts which would have a cumulative positive effect on the system for fish, mussels, waterfowl and other species.

Cultural Resources

The proposed project poses no danger to the one site in the area as it is well away from the plug areas. As excavated materials will be removed by floating equipment and placed on existing spoil piles there is no possibility of affecting a cultural resource. The present project as proposed will not affect any cultural resource. Correspondence was mailed to the State Historic Preservation Officer dated December 12, 2010 and to the Tribal Historic Preservation Officers of federally recognized consulting Tribes dated December 27, 2010 to notify these groups of the project and the likelihood the proposed project would cause any impacts to cultural resources. Copies of these letters are provided in Appendix J. A response from the State Historic Preservation Office was received on January 18, 2011 is included.

Socioeconomic Resources and Human Use

Human use in the area is limited to duck hunters, fishermen and a few scattered homeowners. The quality of the recreational fishery will increase in the area. Landowners along the meanders will be able to access the river directly most of the year. Canoeists and other recreational users will also have more access and aesthetics will improve. The large rock closures in the constructed channels will be underwater when those areas are navigable.

Increased recreational fishing and boating access may provide a slight economic boost to a few local businesses; primarily those selling bait and tackle. No change in agricultural income, home prices, etc is anticipated as a result of the project.

Probable Adverse Environmental Impacts Which Cannot Be Avoided

The Environmental Assessment found that there were no significant negative environmental impacts. The proposed project would have a positive impact on fish and mussel habitat.

Compliance with Environmental Quality Statutes

The relationships of the recommended plan to the requirements of environmental laws, executive orders, and other policies are presented below:

Federal Policies and Acts	Compliance Status
Archeological Resources Protection Act of 1979	1
Bald Eagle Act	1
Clean Air Act Amendments of 1977	1
Clean Water Act of 1977, as amended	1
Endangered Species Act of 1973, as amended	2
Farmland Protection Policy Act of 1984	1
Fish and Wildlife Coordination Act of 1958	1
Flood Control Act of 1946, as amended	1
Food Security Act of 1985	1
National Environmental Policy Act of 1969	1
National Historic Preservation Act of 1966, as amended	2
River and Harbor and Flood Control Act of 1970	1
Water Resources Development Act of 1986	1
Water Resources Planning Act of 1965	1
Executive Orders	

Floodplain Management (E.O. 11988)	1
Protection, Enhancement of the Cultural Environment (E.O. 11593)	1
Protection of Wetlands (E.O. 11990)	1
Other Federal Policies	
Prime and Unique Farmlands	1
Water Resources Council, Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies	1

1/ Full compliance with the policy and related regulations has been accomplished.
2/ Partial compliance with the policy and related regulations has been accomplished, but ongoing coordination will be necessary.

Relationship of the Proposed Activity to Other Planning Efforts

The project lies within the area being studied under the White River Basin Comprehensive Study. This study is authorized under Section 729 of the Water Resources Development Act of 1986. This comprehensive study includes sediment analyses in the upper portion of the Cache Basin, and vegetation, wetlands and hydrology in the Lower White River in addition to many other analyses.

Locally Preferred Plan

Impacts and benefits of the LPP will be similar in nature, but smaller in scope to those of the NER plan. The differences between the two plans are notable only in the benefits to fish and mussels.

The LPP will restore 56 acres of fisheries habitat in the meanders for a total of 56 HUs. The LPP will restore 13,268 linear feet of mussel habitat in the meanders for a total of 7,963 HUs. Additionally, since the meanders closest to the White River are not being restored, it may take longer for some species of fish and mussels to re-colonize the meanders. The probability of successful re-colonization remains high.

OPERATIONS, MAINTENANCE, REPAIR, REHABILITATION, AND REPLACEMENT

OMRR&R is a non-federal responsibility and will consist of an annual average cost of approximately $45,000 for the recommended plan (LPP). OMRR&R costs are for inspection of structures to ensure the river doesn't cut around the closures, closure weir maintenance, minor repairs, and major repairs using existing rock to reshape after a major event or at a 10 year interval as needed. As noted in the OMRR&R spreadsheet for the LPP included in Appendix K, the large downstream weir adjacent to Meander 3 will be accessible by barge to bring in rock during high water when needed. The two upstream weirs will be accessible by temporarily notching the large weir and bringing in rock during high water. Costs for this effort are reflected in the OMRR&R cost. OMRR&R will also include keeping the openings of the meanders free of debris that would inhibit flow into the meanders and prevent project benefits from being realized.

Inspection must be done through physical inspection and observation, with documentation of results. In addition to observing that flow is progressing through the restored meanders, the performance and condition of physical construction items must be verified. This includes verifying the inlet conditions of each meander where the earthen plugs would have been removed during construction. These meander openings must be free flowing and not obstructed by debris. Blockage by debris or through beaver activity must be eliminated or minimized so as to not impede flow. The physical condition of the closure weirs must also be inspected. If the weirs are not properly functioning to divert low-flows, the weirs must be repaired. Such repairs may include replenishment of stone.

PERFORMANCE MONITORING AND ADAPTIVE MANAGEMENT

The specific objectives of the project are:

1. Return flow to the meanders
2. Return flow in sufficient quantities to support mussel populations
3. Create conditions to enhance native fish habitat
4. Re-establish a geomorphically stable channel in the historic river
5. Minimize disturbance during construction within the existing meanders

The primary physical driver to accomplishing the above objectives is the return of historic flow to the meanders. If the project fails to restore riverine hydrology, then objectives 2, 3, and 4 cannot be accomplished.

The success of the project will be measured by the return of flow to the meanders during low-flow periods such as mid-summer. It is during these periods that the limited flows are needed in the meanders to restore historic hydrology. Since the flow varies year to year and during the year, no absolute minimum flow is appropriate as a success metric. The success shall be a measure of available flow that is diverted into the meanders. This shall be accomplished by a comparison of measured flows in the channelized reach to the flow in each of the three meanders. To establish the flow in the existing channelized reach, a measurement benchmark for a transect will be established 100 feet upstream from the entrance to meander 1. This shall serve as the control for the in-stream flow. To establish the flow in each of the three restored meanders, flows will be measured within 100 feet downstream of the mouth of the meander.

Success shall be determined by comparing the channelized flow benchmark to the flow in each of the three meanders. Within the first three years prior to the weirs becoming significantly silted in, the performance metric shall be the diversion of 70% of the control flow into each meander. From year four through year ten, the success metric shall increase to 80% - 90% of the control flow diverted into the meanders. Further detail shall be determined by the project hydrologist, project delivery team, and the Sponsor during the development of the plans and specifications for this project. This is also when the location of the control benchmark will be established. These parameters and requirements shall be included in the project OMRR&R plan, along with the flow determination methodology which shall be in accordance with accepted standards. The sponsor assumes responsibility for all project monitoring activities which are currently estimated to be $3,000 for the recommended plan.

The simplicity of the project limits the need for and usefulness of adaptive management. The project contains no operational features. Small adjustment to weir height would be done as maintenance. Likewise, any minor adjustments to the meanders openings will be done as maintenance.

RISK AND UNCERTAINTY

Potential risks associated with the construction of the recommended plan were evaluated and included induced flooding, loss of life or financial damage should the project fail, and the inability of the local sponsors to cost share the project.

A significant amount of time and effort was invested in the analyses of river hydrology, including the affects of flooding and the influence of the White River. These analyses were used to plan and design the project. Closures were designed at a height which was sufficient to move water into the restored meanders, but would still allow flood waters to overtop them, thus not impacting the authorized flood control project or its functioning. This design will ensure that no additional flooding is likely to occur as a result of project implementation.

The hydrologic analyses also ensure that the risk of failure of the project design would be acceptable, since the closures weirs were designed to withstand foreseeable events. However, the risk of failure does exist regardless of the design of the closure weirs. There is an elevated risk of higher maintenance on the closure weirs since the structures were downsized, and this risk is manifested in increased OMRR&R costs. In any event, the failure of any structure, however unlikely, would not increase the risk of loss of life or property, since the proposed project area is sparsely inhabited and little real property is within the river banks.

CONSTRUCTION METHOD

Construction of the Recommended Plan would consist of work on three meanders (1, 2, and 3). This would involve constructing three closure weirs in the channelized section of the Cache River, removing three plugs in the upstream entrances to the meanders, and installation of one rock plug in the cross-channel ditch at Meander 3. The closure weirs would work to divert water into the meanders during normal flow periods and would not impede conveyance during flood events.

The earthen material in the upstream end of each meander would be removed via equipment transported up the river on waterborne platforms. The equipment would be moved on shore for the plug removal activity and the earthen material removed would be placed on the bank of the channelized section of the river. Some clearing of existing vegetation would be required for the construction activity and placement of the resultant excavated material. No bank protection would be required at the newly reopened locations, as the natural riverine processes would ensure proper adjustments to the openings.

Because construction of this project is only feasible using waterborne equipment due to the large quantities of riprap required for the closures and the intent to create as little terrestrial disturbance as possible, river stage analysis was conducted to determine the most likely period for adequate water levels to move barges up the river. The greatest probability for adequate river stages was determined to be the six month period between December and May. Additionally, the order of work must be for the restoration of the upstream most meander first, then the next one downstream second, and so forth. This is due to limited waterborne access following closure weir construction.

FUNDING AND CONSTRUCTION SCHEDULE

A detailed layout of the construction schedule and associated funding stream will be developed following the execution of the PPA. During a project briefing in December 2010 with The Nature Conservancy and Corps personnel, an outline of the general process necessary from the negotiation of the PPA, through the Design and Implementation stage, up to the construction contract award was presented to sponsor representatives. This outline is provided as follows:

Process Following Report Approval

*The following is intended to identify the **major** process steps that it takes to get a project through the survey and design process, prepare plans and specifications, advertise, and award a construction contract. For this project, some step durations are based on professional judgment. This outline should only be used for process familiarization, and is not intended to replace detailed schedule development that will occur upon the execution of the PPA agreement.*

- *Negotiate the Project Partnership Agreement – Duration 180 days*

After PPA Signing:

- *Prepare for Surveying and initiate field work during low water – Duration 45 days*
- *Develop Plans and Specs – Duration 60-75 days*
- *Perform Biddability/Constructability/Environmental Review (BCOE) – Duration 21 days*
- *Contracting Prepares for Advertisement – Duration 21 days*
- *Contract Advertised - Duration 30 days*
- *Process Award – duration 15 days*
- *Preconstruction submittals – duration 30 days*
- *Construction begins depending on water stage*

This process example should not be used in any manner other than a general outline with typical durations per step. As with any Federal Project, availability of funds, Federal or non-Federal, would affect the schedule. Further, details of the PPA will set the exact commitments of either party.

The schedule for construction forecasted by the engineering members of the study team anticipates that given an average construction season, field work for construction should occur within one construction season. This is based on the time available during the high water season on average compared to the amount of stone that must be transported per barge to the construction site and placed. The construction season could begin as early as November and extend through May during a year with early high water. Regardless, one construction season or one year has been used as the basis of much of the estimated costs for the tentatively Recommended Plan - the Locally Preferred Plan. A construction schedule is provided in Appendix K in the Cost Engineering documentation.

PLAN IMPLEMENTATION

Institutional Requirements: Section 1135 project costs are cost shared with non-federal sponsors paying a percentage of the total project cost. The non-federal cost share consists of all lands, easements, rights-of-way, relocations, and dredged material disposal areas (LERRDS) required for project construction and maintenance of the project, work for in-kind crediting and any additional cash requirement to bring the non-federal share up to the required percent of total project cost. Costs of Section 1135 studies are initially federally funded and are cost shared with project sponsors during construction of the project. Provisions of the Section 1135 program do allow for the non-Federal sponsor to perform work for in-kind crediting against the non-Federal cost share up to 80% of the non-Federal cost share total amount. The potential non-Federal sponsor in this project intends to provide services or material that will contribute to their in-kind credit.

The Model Section 1135 PPA will be used and the local sponsor would review a draft PPA and must accept the terms of the PPA prior to project implementation. Any deviations to the model would be approved by appropriate authority.

DIVISION OF PLAN RESPONSIBILITIES

The Lower Cache River, Arkansas, Section 1135 project has a potential sponsor, The Nature Conservancy, and several participating stakeholders who include the Arkansas Game and Fish Commission and Ducks Unlimited. This section describes the non-Federal sponsor responsibilities in conjunction with the Federal government to implement the tentatively Selected Plan. It is The Nature Conservancy's intent to partner with these other stakeholder groups to share some of the non-Federal responsibilities. Any third party agreements made by The Nature Conservancy will undergo review by the Government prior to Government approval of the PPA. The model PPA package will be submitted as a separate documentation to this report. The non-Federal local cooperation requirements are as follows:

(1) Provide 25 percent of the project costs for environmental restoration as further specified below:

(a) Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations determined by the Government to be necessary for the construction, operation, and maintenance of the project;

(b) Provide or pay to the Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged or excavated material disposal areas required for the construction, operation, and maintenance of the project; and

(c) Provide work for in-kind crediting as discussed in the Cost Sharing section following this section, and as defined in the PPA.

(d) Provide, during construction, any additional funds as necessary to make its total contribution equal to 25 percent of the project costs, including the costs of the study.

(2) For so long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project, at no cost to the Government, in accordance with applicable Federal and State laws and any specific directions prescribed by the Government.

(3) Give the Government a right to enter, at reasonable times and in a reasonable manner, upon land which the local sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

(4) Assume responsibility for operating, maintaining, repairing, rehabilitating, and replacing (OMRR&R) the project or completed functional portions of the project without cost to the Government, in a manner compatible with the project's authorized purpose and in accordance with applicable Federal and State laws and specific

directions prescribed by the Government in the OMRR&R manual and any subsequent amendments thereto.

(5) Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

(6) Hold and save the Government free from all damages arising from the construction or operation and maintenance of the Project and any Project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors. The phrase "operation and maintenance" includes repair, replacement, and rehabilitation.

(7) Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as would properly reflect total project costs.

(8) Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements or rights-of-way necessary for the construction, operation, and maintenance of the project; except that the non-Federal sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude without prior specific written direction by the Government.

(9) Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Government determines necessary for the construction, operation, or maintenance of the project.

(10) To the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that would not cause liability to arise under CERCLA.

(11) Prevent future encroachments on project lands, easements, and rights-of-way which might interfere with the proper functioning of the project.

(12) Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public law 91-646, as amended by title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR part 24, in acquiring lands, easements, and rights-of-way, and performing relocations

for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

(13) Comply with all applicable Federal and State laws and regulations, including Section 601 of the Civil Rights Act of 1964, Public Law 88-352, and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army".

(14) Provide 25 percent of that portion of total cultural resource preservation mitigation and data recovery costs attributable to environmental restoration that are in excess of one percent of the total amount authorized to be appropriated for environmental restoration.

(15) Do not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

COST-SHARING REQUIREMENTS

The cost sharing requirements for a Section 1135, Project Modifications for Improvements of the Environment, requires that the non-Federal sponsor be responsible for 25% of the total project costs during the design and implementation period, including recovering costs of the feasibility study. In accordance with the terms of the PPA, the non-Federal sponsor must provide all lands, easements, rights-of-way, and dredged material disposal areas (LERRDs) required for the project. Due to the cost of the tentatively selected plan, the Federal/non-Federal cost sharing of this project would be 75% Federal/25% non-Federal per the estimated project costs. OMRR&R is a 100% non-Federal responsibility. Table 10 depicts the fully funded cost sharing requirements necessary for implementation.

Provisions of the Section 1135 program do allow for the non-Federal sponsor to perform work for in-kind crediting against the non-Federal cost share up to 80% of the non-Federal cost share total amount. The potential non-Federal sponsor in this project intends to provide services or material that will contribute to their in-kind credit. The actual items and estimated costs for the in-kind work that is possible in this project and that the non-Federal sponsor wants to pursue will be determined during the negotiation of the Project Partnership Agreement (PPA) between the Government and the potential non-Federal Sponsor.

During discussions with the potential non-Federal sponsor, the following items have been identified as potential work for in-kind credit: Provision of stone materials, including R2200, R90, and filter material stone, the planting of trees along the bank protection for each of the three closure weirs, performance of pre-construction quantity surveys, and development of plans and specifications. These items have been reviewed by Corps Contracting, Construction Management, and Project Management persons, and deemed to be implementable in conjunction with a construction contract to actually perform all the construction including constructing closure weirs, removing meander plugs, and installing a rock plug in the middle of Meander 3. Table 10 reflects the estimated costs for the potential in-kind items. The effects to the cost estimate based upon supplied rock material have been estimate and incorporated. However, specific details and commitments to provide in-kind material to the project, or plant trees in support of the project, will be finalized in the PPA.

VIEWS OF NON-FEDERAL INTERESTS

It is the desire of the potential non-Federal sponsor, The Nature Conservancy, and important project stakeholders, AGFC and DU, to restore geomorphology, hydrology, and associated riverine habitats that once existed in the meanders of the lower seven miles of the Cache River, without negatively impacting the authorized flood control project. Letters of support are found in Pertinent Correspondence. Previously, both AGFC and DU were potential project non-federal sponsors. The State Historic Preservation Officer has provided correspondence stating no concerns with the project. Additionally, communications received by the Corps through The Nature Conservancy and during the 30 day public comment period for the draft Environmental Assessment indicate that the project has very strong local support.

FINANCIAL CAPABILITY

The AGFC was one the local sponsors during the earlier stages of the study development. Due to the affects of the recession on the economy of the state of Arkansas, the AGFC has deferred becoming a sponsor for this project until such time as the economy improves. In November 2010 during a meeting with Corps Officials, The Nature Conservancy committed to the project. The Nature Conservancy, or any other project sponsor, will be required to commit to financial support of the project in the PPA; and this commitment must be verified prior to the execution of the PPA.

CONCLUSIONS

The Nature Conservancy, AGFC, and DU staff members participated fully in the study process. Representatives of resource agencies that have responsibility for various aspects of the natural environment in Arkansas and members of the Cache River/Bayou DeView Improvement District were briefed on the proposed project during the planning process. Resource agencies and other organizations included the U. S. Fish and Wildlife Service, and Environmental Protection Agency. These agencies also provided information and recommendations. Letters of support are found in Pertinent Correspondence. A legal review by the Memphis District Office of Counsel would be conducted prior to finalization of the PPA. A Public Notice was distributed to the public and state and federal agencies to notify them of the availability of the draft environmental assessment and draft finding of no significant impact on 10 December 2010. This detailed project report was made publicly available for review on 27 December 2010.

Based on the detailed analyses for the potential of restoration of riverine habitat in the lower seven miles of the Cache River in Monroe County, Arkansas, the plan described herein as the tentatively recommended plan, which is the locally preferred plan, is environmentally justified for construction under Section 1135 of the Water Resources Development Act of 1986. The Recommended Plan (Locally Preferred Plan) has a total project cost (first cost plus study cost) of $6,469,000, and a fully funded cost of $6,625,000 through the anticipated construction year (2013). The average annual cost of the total project, including operations and maintenance, is $313,000 based on a 50-year period of analysis and a 4 1/8 percent interest rate. Benefits expected include the restoration of 7,963 AAHUs for riverine fishes and freshwater mussels. It is expected that over time the quality of recreational fishing in the river would return to levels approaching those reported prior to the flood control project.

RECOMMENDATIONS

Lower Cache River, Monroe County, Arkansas
Section 1135 Ecosystem Restoration Project

As District Engineer, I have considered the environmental, social, and economic effects; the engineering feasibility; and the comments from the other Federal and state resource agencies, the Cache River Bayou DeView Improvement District, and the public and have determined that the Recommended Plan presented in this report is in the overall public interest and is technically sound, environmentally acceptable, and economically feasible and cost effective.

The Locally Preferred Plan is the Recommended Plan. The plan for ecosystem restoration on the Lower Cache River near Clarendon Arkansas is to restore historic riverine flows to three meanders. Riverine flows were stopped into these three meanders as a result of channelization that occurred in the lower seven miles of the Cache River in the 1970's. Riverine flow shall be restored under the Recommended Plan by the removal of the upstream earthen plug in each of the three uppermost meanders. Further, closure structures consisting of weir or dike type structures shall be installed in the channelized portion of the lower Cache downstream from each meander opening. These closures shall be constructed to divert low-flows into the meanders, but still allow flood-flows to pass and therefore cause no impact to the authorized flood risk management project. Additionally, a rock plug will be installed in a small cross-over ditch between the channelized portion and meander 3 immediately upstream of the closure structure for meander three to increase the performance of the project.

The total estimated fully funded cost of the Recommended Plan is $6,625,000. The first costs in November 2010 price levels is estimated at $6,469,000 a federal portion of $4,852,000 and a non-Federal portion of $1,617,000. The estimated annualized operations, maintenance, repair, rehabilitation, and replacement costs are $45,000 and the annualized performance inspection costs is estimated to be $3,000. The Recommended Plan has a cost per habitat efficiency of $39.31 per average annual habitat unit compared to the National Ecosystem Restoration Plan which has a cost per habitat unit efficiency of $39.69 per average annual habitat unit.

The recommendation contained herein reflects the information available at this time and current Federal water resources planning policies. It does not reflect program and budgeting priorities inherent in the formulation of national civil works construction program not the perspective of higher review levels within the executive branch. Consequently, the recommendation may be modified prior to construction. However, prior to the execution of the Project Partnership Agreement, interested Federal Agencies, the State of Arkansas, the non-Federal Sponsor, and other interested parties will be advised of any modifications and will be afforded the opportunity to comment further.

_____ _____

Date

Vernie L. Reichling
Colonel, US Army Corps of Engineers
Commander
Memphis District

LOWER CACHE RIVER, ARKANSAS PROJECT
CONTINUING AUTHORITIES PROGRAM
SECTION 1135, FISH AND WILDLIFE RESTORATION

APPENDICES