Big Sunflower River Watershed (Quiver River), Mississippi Draft Feasibility Report with Integrated Environmental Assessment

YMD

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Executive Summary

The Quiver River lies the Yazoo Basin in the Delta region of northwestern Mississippi. The Tallahatchie and Yalobusha Rivers join to form the Yazoo River and the Big Sunflower River enters downstream of this confluence. The Quiver River is a tributary of the Big Sunflower River.

The Quiver River is typical of streams in the Lower Mississippi River Alluvial Valley. Agriculture, irrigation, and flood risk management projects have degraded aquatic habitat. Past channelization and reduced instream flows in the Quiver River limit the amount of physical habitat present and cause decreased dissolved oxygen levels and higher water temperatures. Most streams within the Yazoo Basin have limited riparian vegetation, high nutrient concentrations, limited in-stream cover, low dissolved oxygen, high water temperatures, high turbidity, reduced habitat complexity, and low aquatic species richness and diversity. There are opportunities to restore a more historic flow regime, reestablish BLH riparian corridors, reduce sedimentation, lower nutrient concentrations, lower summer and fall water temperatures, and increase dissolved oxygen.

The Tentatively Selected Plan would build a pumping station on the Tallahatchie River approximately 2 miles north of Sharkey, MS. The station would have the capacity to pump 400 cfs from the Tallahatchie River. A 1,500 foot long channel would be excavated (63,000 cubic yards) to connect the pump station to Cassidy Bayou. Water would flow from Cassidy Bayou into Swan Lake. Water would flow from Swan Lake to Black Bayou, then to Sandy Bayou and then Parks Bayou, and finally into the Quiver River approximately 2.5 miles northeast of Brooks, MS.

The pumping station would be operated to ensure 100 cfs is maintained in the Quiver River. Water transfers to meet the project flow are most likely in September and October, but some may also be needed in August and November. Irrigation season generally extends from May to August and water can be withdrawn from the system as long as the 100 cfs project flow is maintained. Operation of the pump is not likely from December through April when the extra water is not needed for irrigation or ecological flows.

The Tentatively Selected Plan will address the three principal stressors on aquatic communities in the Quiver River and the transfer channels (Cassidy, Black, Sandy and Parks Bayous and Swan Lake). It will ensure a more natural stream flow and will improve water quality during late summer and autumn.

The Tentatively Selected Plan would supply enough water to irrigate approximately 36,855 acres split equally among rice, soybeans, and corn. All of these acres are currently irrigated with groundwater. It is anticipated that groundwater would no longer be used to irrigate these acres.

The estimated cost to construct the Tentatively Selected Plan is $20,236,141 and the annual operation cost is estimated to be $93,000.

The project would not have any significant adverse impacts on threatened or endangered species, water quality, air quality, historic resources, or the human environment.

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I. INTRODUCTION

The Quiver River lies the Yazoo Basin in the Delta region of northwestern Mississippi. The Tallahatchie and Yalobusha Rivers join to form the Yazoo River and the Big Sunflower River enters downstream of this confluence. The Quiver River is a tributary of the Big Sunflower River.

Historically, the Quiver River was a low gradient, meandering river with riparian corridors, instream cover and enough year-round flow to provide habitat for a variety of mussel and fish species. Water withdrawals, primarily for irrigation, now limit stream flow in the late summer and early fall and have degraded aquatic habitat quality and quantity. Loss of instream cover and riparian vegetation also impact habitat quality. Twenty-four mussel species are found in the river now, but over 40 native species exist in the Yazoo Basin and may have at one time been present in the Quiver River. Likewise for fish species, 43 species now occur in the Quiver River, but more than 80 may have been present in the past.

Loss of riparian vegetation, especially bottomland hardwoods, has degraded the aquatic habitat. Between 1950 and 1976, approximately one-third of the lower Mississippi alluvial valley's bottomland hardwood (BLH) forests were cleared for agriculture. By the 1980's less than 20% of the original forested wetlands remained (Klimas 1988, Stanturf et al. 2000, Gardiner et al. 2005, King et al. 2006). These bottomland swamps also provided water storage that supported stream flow in the Quiver River during the fall. Groundwater provided base flow in some of the Quiver tributaries (Speer et al. 1964). Water withdrawals for irrigation deplete water in the Quiver River and the alluvial aquifer. Depletion of the alluvial aquifer degrades habitat quality. A lack of reliable, affordable water for irrigation threatens the agricultural economy in the area.

Study Area

The headwaters of the Quiver River lie in west-central Tallahatchie County. It meanders more than 60 miles south through Tallahatchie and Leflore Counties before its confluence with the Big Sunflower River just north of U.S. Highway 82 in Sunflower County.

The Quiver River (Figure 1) is part of the Yazoo River Basin in the Mississippi Delta. Sardis, Arkabutla, Grenada, and Enid Lakes are all located in the Yazoo Basin and provide flood risk reduction. The Tallahatchie River flows from the hills of eastern and central Mississippi into the Delta region. As indicated in the Study Area map (Figure 2), downstream of Sardis Lake, the Tallahatchie flows through Panola, Quitman, and Tallahatchie Counties. North of Greenwood, MS, the Tallahatchie River converges with the Yalobusha River to form the Yazoo River. The Yazoo River downstream of the project area is authorized for a depth of 9 feet for navigation from the mouth of the river in Vicksburg, MS to Greenwood, MS. Clearing and snagging maintains the navigation channel to Yazoo City, MS.

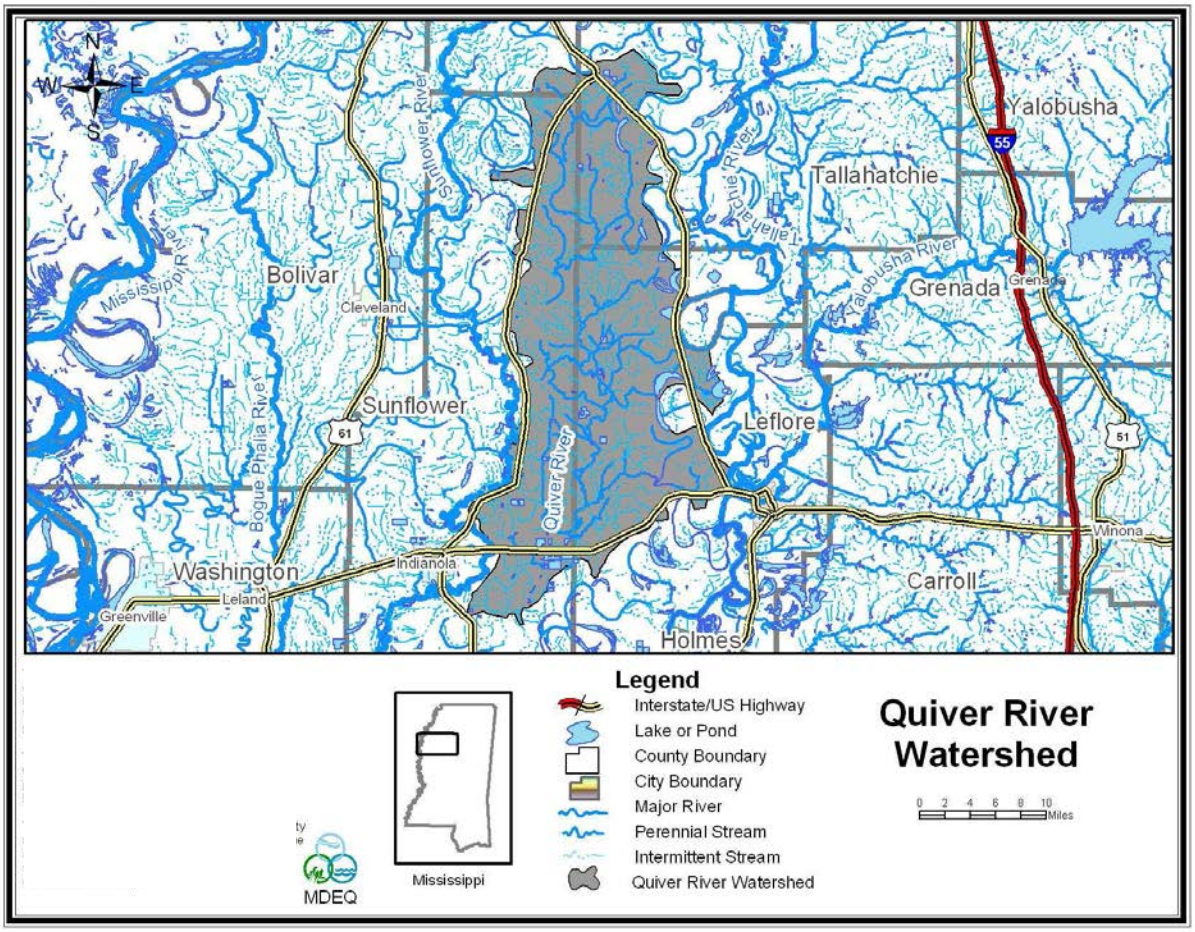

Figure 1. Map of the Quiver River Watershed

Study Scope

The study investigates potential aquatic habitat restoration of the Quiver River and considers compatible opportunities to provide agricultural water supply.

Authority

This study is being conducted in response to a Senate Resolution adopted 29 June 1973 by the Committee on Public Works of the US Senate. It reads as follows:
"*Resolved by the Committee on Public Works of the United States Senate, That the Chief of Engineers. U.S. Army, is hereby requested to review the report on the Mississippi River and Tributaries Project contained in House Document No. 308, 88th Congress, 2nd Session, and other reports with a view to determining whether any modifications of the recommendations contained therein are advisable at the present time with reference to providing a plan for the development, utilization and conservation of water related land resources of the Yazoo Basin, including the backwater areas of the Mississippi and Yazoo Rivers. Such study should include appropriate considerations of the needs for flood protection, wise use of flood plain lands, bank stabilization, navigation facilities, regional water supply and waste water management facilities systems, general recreation facilities, enhancement and control of water quality, enhancement and conservation of fish and wildlife and other measures for the protection and enhancement of the environment.*"

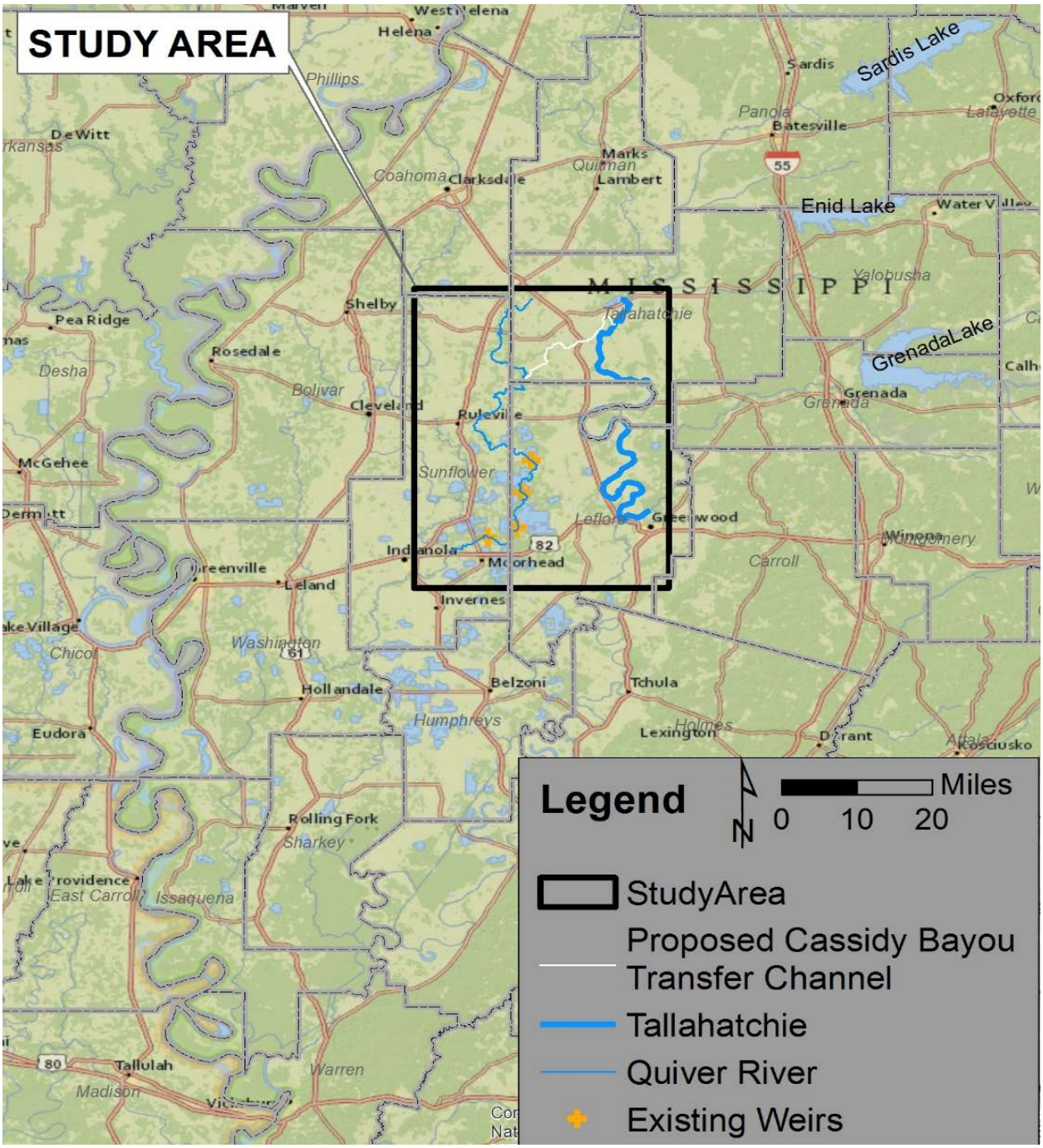

Figure 2. Map of the Study Area with features described later in the report.

Prior Reports, Projects, and Ongoing Programs

1928 – Flood Control Act of 1928 authorized four flood control reservoirs in the hill country of western Mississippi as part of the Yazoo Headwater Project. The four reservoirs are: Arkabutla (completed 1943), Sardis (1940), Grenada (1954), and Enid (1952). These lakes all drain to the Tallahatchie River. Releases from these flood control reservoirs provide year round flow to the Tallahatchie River. In addition to flood risk management, these reservoirs are used for recreation. Lake Enid is authorized to provide water supply.

1955 – Big Sunflower, Little Sunflower, Hushpuckena, and Quiver Rivers, and their Tributaries, and Deer Creek, Steele Bayou, and Bogue Phalia, Mississippi, General Design Memorandum No. 1. This report proposed a system of channel improvements along the area's rivers and tributaries.

1959 – Annex M to the Mississippi River and Tributaries, Comprehensive Review Report, Big Sunflower River Basin. This report recommended that the scope of the existing authorized project for the Big Sunflower Basin be increased to provide greater channel capacity on Steele Bayou and its tributaries.

1962 – Big Sunflower, Little Sunflower, Hushpuckena, and Quiver Rivers, and their tributaries and Deer Creek, Steele Bayou, and Bogue Phalia, Mississippi, Supplement A (GDM No. 1). This report recommended modifications to project streams as proposed in GDM No. 1.

1963 - Supplement B (to GDM No.1), prompted by local interest, this report modified GDM No.1 to add channel improvement to a reach of the Quiver River.

1967 – Channel Improvement Project, Quiver River above Parchman, Yazoo River Basin, Mississippi. Comprised 5.18 miles of clearing and snagging to a width of 110 feet, one channel cutoff, 118 feet in length with a bottom width of 25 feet and side slopes of 1 on 3; and enlargement of 0.74 mile of channel by excavation of 3 feet of material from the bottom and one side of the channel.

1995 - Flood Control, Mississippi River and Tributaries, Big Sunflower River Maintenance Project, Yazoo Basin, Mississippi - sediment removal and vegetation control measures on all or parts of the Big Sunflower River, Big Sunflower Bend way, Little Sunflower River, Bogue Phalia, Bogue Phalia Cutoff, Holly Bluff Cutoff, and Dowling Bayou south of Highway 82 to their confluence with the Yazoo River to reduce headwater flooding impacts.

Ongoing – Mississippi River Basin Healthy Watersheds Initiative (MRBI). Through the MRBI, NRCS and partners work with producers and landowners to implement voluntary conservation practices that improve water quality, restore wetlands, enhance wildlife habitat and sustain agricultural profitability in the Mississippi River basin. Both the Big Sunflower and the Upper Yazoo basins are identified as Focus Area Watersheds. In this program, NRCS offers agricultural producers in priority watersheds the opportunity for voluntary technical and financial assistance.

Ongoing – Delta Task Force and the Yazoo-Mississippi Delta Joint Water Management District. Mississippi Governor's Executive Order No. 1341 – The Governor of the State of Mississippi established the Governor's Delta Sustainable Water Resources Task Force on 26 August 2014 to address the unsustainable decline of groundwater levels in the Mississippi River Alluvial Aquifer, the principal water supply for agriculture in the Mississippi Delta. This task force is led by the Executive Director

of the Mississippi Department of Environmental Quality (MDEQ) and includes representatives from the Delta Council, Delta F.A.R.M., Mississippi Farm Bureau, the Mississippi Soil and Water Conservation Commission, the Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture, the Vicksburg District of the U.S. Army Corps of Engineers (USACE), and the Yazoo-Mississippi Delta Joint Water Management District (YMD). The Task Force is charged to work together to promote conservation measures, irrigation management practices and plans for the implementation of new Delta surface water and groundwater supplies; to advise MDEQ on policies related to Delta water resources; and to prepare and promote the implementation of strategies and plans developed though the Task Force to ensure the future sustainability of water resources in the Delta.

The 2014 Mississippi Ground Water Quality Assessment states:

> ***"Developing and Implementing Conjunctive Water Management Strategies***
> *The future of the Mississippi Delta's economic and environmental viability depends on abundant, accessible water of sufficient quality. Water needs in the region are broad and include personal consumption, irrigation, aquaculture, fisheries and aquatic habitat, wetland function, wildlife, and waste water assimilation. Over 17,000 permitted irrigation wells screened in the shallow Mississippi River Valley Alluvial Aquifer (MRVA) are used for irrigation and aquaculture and pump approximately 1.5 billion gallons of groundwater each day. However, this pumpage demand has exceeded the recharge to the MRVA resulting in continuing overbalances of groundwater withdrawals versus aquifer recharge, and notable water-level declines in the aquifer. Because of increased yields and profitability that irrigation provides over dry land farming, the level of water withdrawal permit applications continues to increase which further complicates this issue. Fortunately, these challenges are in a region that experiences historically around 53-55 inches of rainfall each year, is adjacent to the 1-1.5 MM cubic feet/second flow of the Mississippi River, and is downstream from four adjacent major flood control reservoirs. So, although the challenges are significant, opportunities exist for the development of conjunctive water management options and alternative surface water supplies. Conjunctive water management is the foundation for sustainable Delta water resources. In its simplest context, conjunctive water management is managing the coordinated use of surface and groundwater to satisfy desired water needs such that the total benefits exceed the sum of the benefits that would result from independent management of each water resource."*

II. PROBLEMS AND OPPORTUNITIES

The Quiver River is typical of streams in the Lower Mississippi River Alluvial Valley. Agriculture, irrigation, and flood risk management projects have degraded aquatic habitat. Past channelization and reduced instream flows in the Quiver River limit the amount of physical habitat present and cause decreased dissolved oxygen levels and higher water temperatures. Most streams within the Yazoo Basin have limited riparian vegetation, high nutrient concentrations, limited in-stream cover, low dissolved oxygen, high water temperatures, high turbidity, reduced habitat complexity, and low aquatic species richness and diversity. There are opportunities to restore a more historic flow regime, reestablish BLH riparian corridors, reduce sedimentation, lower nutrient concentrations, lower summer and fall water temperatures, and increase dissolved oxygen.

Figure 3. Quiver River in early fall showing low flow

PROBLEMS

Aquatic Habitat

Flows in the Quiver River, during the late summer and early fall, are lower than historic levels. Parts of the Quiver River are nearly dry in October and the fish and mussel habitat is poor. Bottomland hardwood forests and their associated water storage capacity have been lost. Low water levels in the

alluvial aquifer reduce the amount of water available to provide base flow to the small tributaries of the Quiver River. Loss of hydrologic connectivity (i.e. flowing water) within the system reduces the sustainability of fish and mussel populations. This interrupts dynamic biologic processes and the structure and function of the aquatic ecosystem and surrounding floodplain. Sedimentation from surrounding land use and lack of stable substrate for aquatic species contributes to the Quiver River ecosystem degradation. Three tributaries to the Quiver (Wild Bill, Bear, and Pecan Bayous) are Mississippi listed Section 303(d) Impaired Water Bodies due to organic enrichments (nutrients) and low dissolved oxygen (MDEQ 2008a, MDEQ 2008b, MDEQ 2008c). The specific problems include:

- Death of mussels from periodic streambed drying.
- Tolerant fish and mussel species dominate aquatic habitats
- Poor habitat reduces potential for protected aquatic species to recolonize the Quiver River
- Reduced littoral habitat and cover for young fish survival and rearing
- Groundwater depletion limits the aquifer's contribution to stream flow
- Low dissolved oxygen and increased water temperatures
- Reduced connectivity to tributaries in the larger watershed
- Lack of shade increases water temperatures in Quiver River
- Reduced input from vegetation limits food availability in the Quiver River
- Reduced habitat complexity and aquatic ecosystem structure
- BLH forest fragmentation
- Reduced migratory waterfowl feeding and refuge habitat in the Mississippi Flyway

Regional Water Supply

The Quiver River drains the region of the Mississippi Delta that has experienced the most groundwater depletion over the last few decades. Water use from the alluvial aquifer exceeds natural recharge by an estimated 300,000 acre feet per year. Groundwater users must drill deeper and spend more money to pump water from increasingly greater depths. Well maintenance costs are increasing because water from deeper wells has a higher mineral content and increases screen fouling.

OPPORTUNITIES

Aquatic Habitat

Restoring the natural flow regime in the Quiver River would directly benefit fish and mussels, and may allow some species to recolonize the area. Forested buffers would benefit the aquatic environment and a variety of mammals, birds, amphibians, and reptiles. There are specific opportunities to:

- Increase flow and wetted perimeter
- Increase littoral habitat for young fish rearing and survival
- Provide flow to sustain freshwater mussels
- Increase aquatic species richness and diversity

- Reconnect the Quiver River to its tributaries, the Big Sunflower River and the Lower Mississippi River System for riverine fish species
- Restore year round flow in the Quiver River
- Improve aquatic refugia habitat
- Improve spawning habitat
- Increase forested riparian zone.
- Increased bank stability
- Increase input from surrounding vegetation and food availability
- Improve aquatic structural complexity
- Reconnect isolated BLH tracts
- Increase biodiversity of aquatic and terrestrial resources
- Reconnect isolated BLH tracts for neo-tropical migratory birds
- Implement features noted in the North American Waterfowl Management Plan with the joint venture agencies
- Reduce nitrate concentrations
- Decrease water temperature
- Increase dissolved oxygen

Regional Water Supply

Mississippi produces 72% of the nation's farm raised catfish. Leflore and Sunflower Counties account for 22% of Mississippi's aquaculture acreage. There are opportunities to:

- Provide a supplemental, resilient, and reliable agricultural water source
- Reduce dependency on the alluvial aquifer
- Reduce irrigation costs
- Decrease well and pump maintenance needs

PLANNING GOALS AND OBJECTIVES

Goal

To restore the degraded aquatic and riparian ecological processes in the Quiver River, Cassidy, Black, Parks and Sandy Bayous, and Swan Lake; provide a more reliable water source for agriculture and aquaculture; and improve the reliability of the alluvial aquifer to be a long-term source for regional water supply.

Objectives

1. Restore fish and mussel habitat in the Quiver River.
   Required data: Output of Delta Minnow Model
2. Increase average wetted perimeter in the Quiver River connector channels
   Required data: Wetted perimeter in connector channels – Parks, Sandy, and Black Bayous.
3. Restore bottomland hardwood habitat in the floodplain.
   Required data: Acres of Bottomland hardwood restored.

4. Improve the economic efficiency of water supply for agriculture.
   Required data: The net average annual benefits.

Planning Constraints

1. Do not impact authorized navigation in adjacent streams.
2. Do not reduce benefits from existing flood risk management or other projects.

Public Scoping

A public scoping meeting for this study was conducted on 24 October 2012. Attendees included state and federal agency staff and landowners. Concerns raised included: navigation on the Yazoo River, soil erosion, streambank stability, irrigation, water quality, turbidity, nutrients, buffer strips, and ecotourism. A copy of the comments received are included in Appendix A.

III. EXISTING AND FUTURE CONDITIONS

EXISTING CONDITIONS [Affected Environment]

Physical

The study area is located in the Delta region of the Yazoo River Basin in northwestern Mississippi. The Delta is the flat, lowland area in the alluvial valley of the Mississippi River bordered by the loess bluffs to the east and the Mississippi River to the west. This is a highly productive agricultural region known for its cotton, corn, soybeans, rice, and catfish. Streams in this region are slow moving, and experience substantial variation in river stage. The area also contains an extensive system of oxbow lakes. Nearly all of the streams have been altered for flood control. These alterations were initiated in the early 1900's and work continues today. Channel modifications include clearing, cleanout, enlargement, straightening, and weir construction.

Cultivated crops cover over 70% of the land. Catfish farms are common. The riparian areas along the Quiver River, Tallahatchie River, and associated ditches and tributaries are generally less than 100 feet wide. There are some larger tracts of woody wetlands around oxbow lakes, abandoned channels, and in the NRCS's Wetlands Reserve Program.

Long, hot summers, comparatively short, mild winters, and abundant rainfall characterize the region's climate. The average annual temperature is approximately 63 degrees Fahrenheit with average monthly temperatures ranging from 82° in July and August to 41° in January. The average annual precipitation is approximately 55 inches with monthly averages ranging from approximately 3 inches in August to 6 inches in May. Precipitation as snowfall generally occurs about once a year, and is usually light. The frost-free growing season is approximately 7 months.

The project area is located within the Mississippi Alluvial Valley. Glacial melt waters carried large amounts of water, silt, sand, and gravel from the country's interior down to the Gulf Coast. The alluvial valley ranges in width from 30 to 90 miles. Holocene meander belts of the Mississippi River traverse the project area from north to south. Abandoned channels, point bar deposits, and some backswamp deposits are the major landforms within the immediate vicinity of the project area (Saucier 1994). Elevations in the project area range between 100 and 130 feet above sea level. The dominant soils in the project area are Alligator and Dundee soils with slopes of less than 3 percent (SSURGO 2014).

The Quiver River originates in west-central Tallahatchie County and meanders more than 60 miles through Tallahatchie and Leflore Counties before its confluence with the Big Sunflower River near Indianola in Sunflower County. The Quiver River is a slow-flowing stream and river stages vary approximately 15 feet annually. The river is turbid during flood flows, and dissolved oxygen is low when the river becomes stagnant in late summer and early fall. Four low-water weirs are located in the southern portions of the project area within the channel of the Quiver River. The weirs were built in the early 1960s to retain a minimum level of water in the stream during low water periods in late summer and early fall. Figure 3 (page 6) showed the Quiver River during low flow. Figure 4 shows the Quiver River during early spring and Figure 5 is the annual hydrograph for the Quiver River. Appendix B provides more detail on the hydrologic and hydraulic conditions.

Figure 4. Quiver River during spring high flow

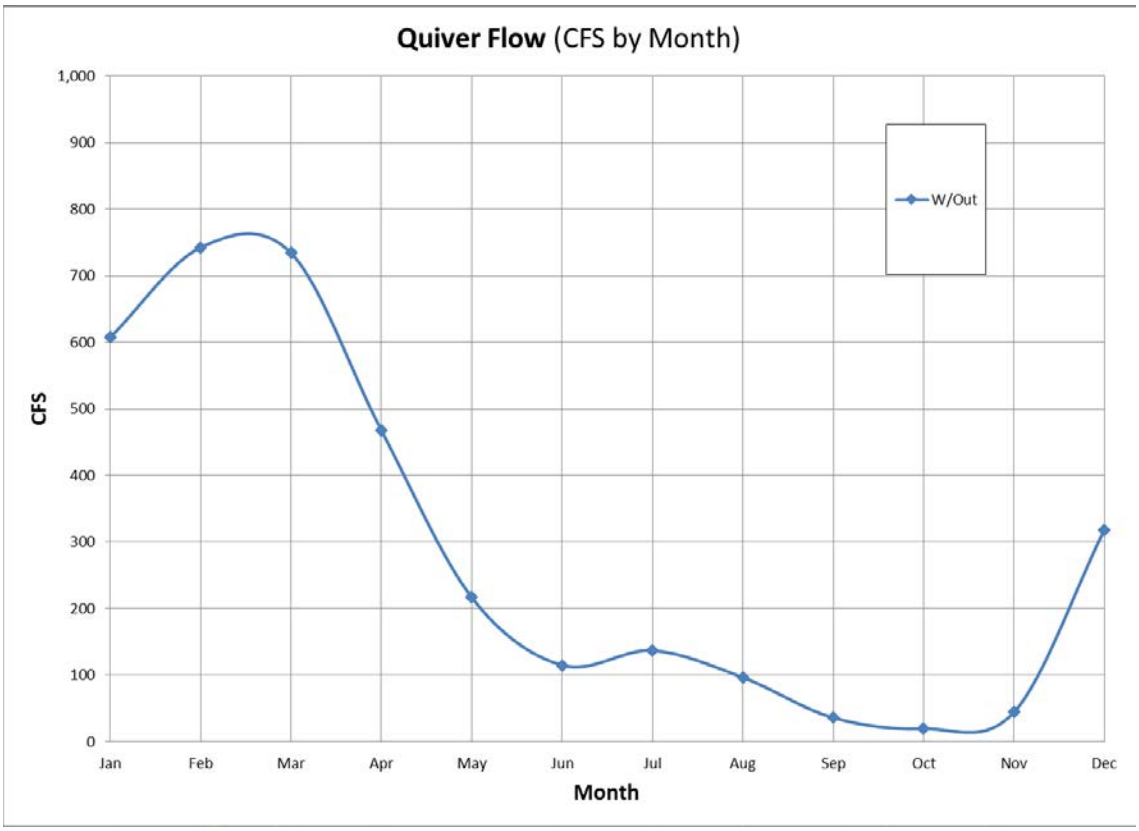

Figure 5. Quiver River Hydrograph (without project)

The Tallahatchie River originates in western Tippah County and flows west and then south for approximately 230 miles into Leflore County. North of Greenwood, Mississippi, the Tallahatchie River converges with the Yalobusha River to form the Yazoo River. In its course, the Tallahatchie River flows from the hills of eastern and central Mississippi into the Delta region of the state. Three USACE flood control reservoirs, Arkabutla, Sardis, and Enid, drain to the Tallahatchie River. Water levels on the Tallahatchie can fluctuate more than 20 feet annually with high stages typically occurring in late winter and early spring and low stages in late summer and early autumn. Discharge in the Tallahatchie River rarely drops below 1,000 cfs. The reservoirs regulate some of the flow in the Tallahatchie River. Outflows from the reservoirs are limited during the normal flood season (December to May) and regulated during the beginning of the low water season (June to September) in order to empty the flood control storage. This emptying of the flood control storage maintains flows during the typical low water season. The reservoir releases reduce summer water temperatures and lower turbidity. Figure 6 shows the Tallahatchie River annual hydrograph.

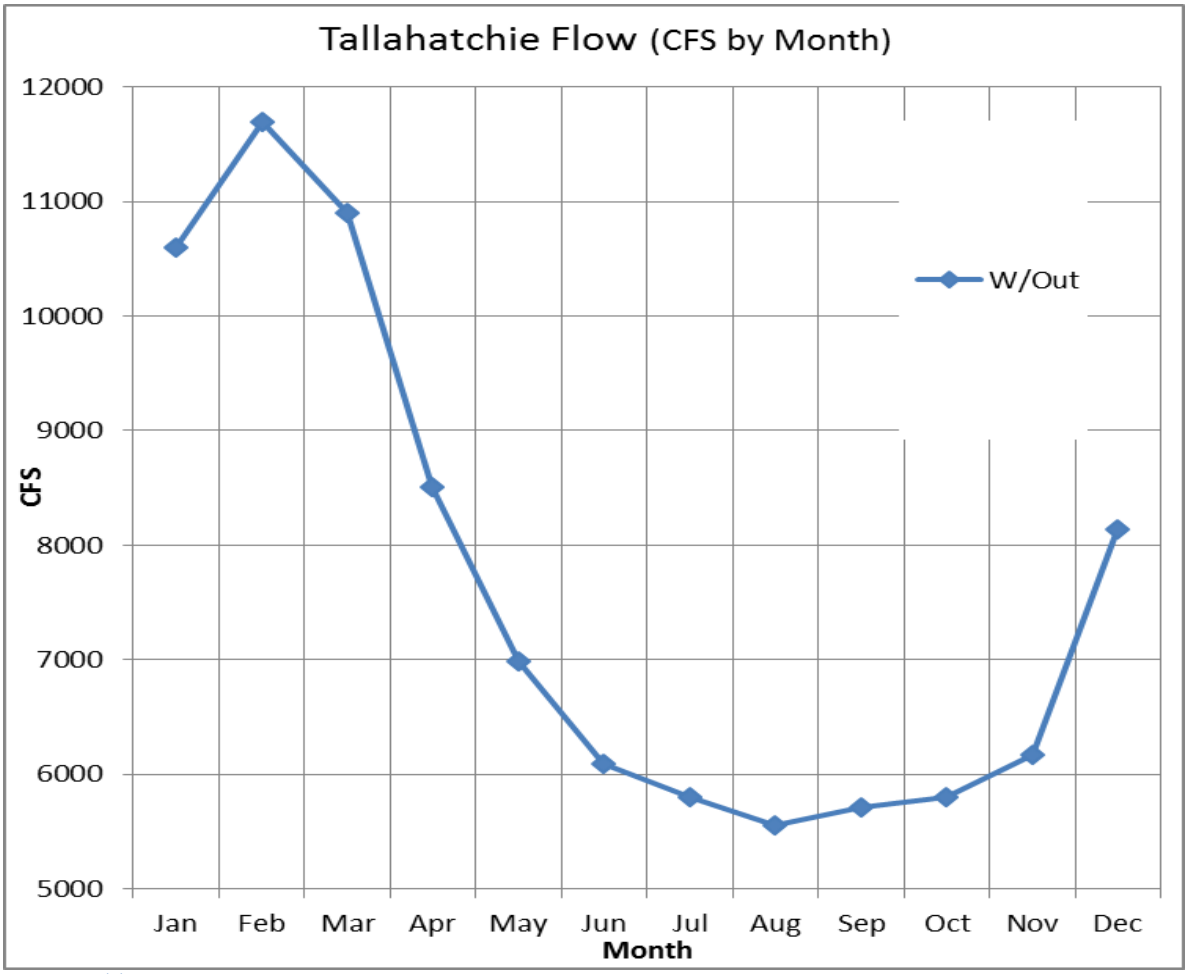

Figure 6. Tallahatchie River Hydrograph (without project)

The delta is the flat, lowland area of the Mississippi River alluvial valley. There is little vertical relief between the watersheds. The streams, ditches, and rivers in the region are connected, when the Tallahatchie River exceeds its banks and flow crosses into the Quiver River and other adjacent

watersheds. Fish and mussels from the Tallahatchie have access into the Quiver River, but the habitat in the Quiver does not support the same aquatic communities as that in the Tallahatchie.

Aquatic Resources and Fisheries

Past hydrologic modifications have reduced aquatic habitat quality, species diversity, and water quality throughout the project area. Littoral zones of the project area streams typically have soft, unconsolidated substrates, and instream cover is sparsely distributed. Emergent vegetation, primarily alligator weed, provides the only substantial instream cover but coverage is usually less than 10% of littoral area. There are sections of the Quiver River which have no surface flow for short, intermittent periods throughout the year. In Sandy and Parks Bayou there is almost no flow in the summer and no wetted stream perimeter to maintain macroinvertebrates and vegetation. Black Bayou is a large ditch with little habitat value. Three principal stressors on aquatic communities in the Quiver River are apparent: increased sedimentation (from ditch erosion and instream accretion of soft, unconsolidated soil particles), reduced stream flow and consequent poor water quality during late summer and autumn, and loss of a forested riparian corridor.

The Quiver River flows into the Big Sunflower which is a tributary of the Yazoo River. There are no significant barriers to fish movement in the system so all of the aquatic species occurring anywhere within the Yazoo or any of its tributaries have access to the Quiver River. At high water, the headwaters of the Yazoo Basin streams are also connected which further facilitates fish movement within the Basin. There are 83 species of fish in the Yazoo River and they all have access to the Quiver, but only 43 species are found there (Appendix C). Minnows and sunfishes dominate the fisheries in the Quiver River and tolerant fish species are most common. They are adapted to low dissolved oxygen and high pulses of suspended solids; they do not require clean, firm substrates for spawning; and they have the ability to live in shallow, slack water pools for extended periods.

The Delta Stream Minnow Model was used to quantify the quality of the fish habitat in the Quiver River. This model was developed at the Engineer Research and Development Center to evaluate habitat quality in low gradient, warmwater streams in the Mississippi River Alluvial Plain Level III ecoregion. Research has shown that the percentage of native minnows is well correlated to changes in velocity and is a good indicator of the habitat conditions. Most minnows are positively rheophilic and will respond to changes in water velocity. These minnows are also the host species for several mussel species. The relationship of habitat suitability to velocity is shown in the following equation:

$$HSI = Velocity_{ft/s} (0.37) + 0.22$$

This model was applied to the October median flows in the Quiver River. October has the lowest median flows and the poorest habitat conditions in the Quiver (see Figure 5). The October median flows range from approximately 4 to 14 cfs in the Quiver River. The model found an average HSI of 0.27 in the Quiver River in October. The total surface acres at October median flow is 374.95. The total Habitat Units available are 94.27. [The model was calculated across 114 cross sections in the Quiver River which varied in the acres. The average HSI shown here is the average of the HSI values, but each value represents a slightly different acreage. Appendix C contains the complete model results.]

The most common mussel species are also tolerant of poor habitat. The threeridge (*Amblema plicata*), and bankclimber (*Plectomerus dombeyanus*) mussels comprise 85% of the population in the Quiver (Miller and Payne 1997a, Miller and Payne 1997b, Miller and Payne 2004). During the summer and autumn, the Quiver River has shallow water with little or no surface flow. Low flow stresses mussels (Figure 7).

Although tolerant mussels dominate in the area, there are low densities of more sensitive species. The state endangered pyramid pigtoe (*Pleurobema rubrum*) is present within the Quiver, and the federally endangered sheepnose (*Plethobasus cyphyus*) and federally threatened rabbitsfoot (*Quadrula cylindrica cylindrica*) are present within the Sunflower River near the confluence with the Quiver River. Overall, there are 44 species of freshwater mussels in the Yazoo Basin with 28 species identified from the Quiver River (Appendix C). Miller and Payne (1997a, 2004) noted a lack of juvenile mussels in the study area and few small mussel shells indicating that recent recruitment is low or sporadic.

Figure 7. Quiver River Mussels at Low Water

Terrestrial and Wildlife Resources

The majority of the project area is agricultural and has little value for wildlife with the exception of flooded fields in winter for waterfowl. There are forested riparian areas, some larger scattered bottomland hardwood and cypress tupelo forests associated with oxbows and abandoned stream channels, and private lands enrolled in the NRCS Wetland Reserve Program (WRP). Approximately 16 percent of the project area is forested (USDA 2014). Native species in the riparian and forested areas include raccoon, mink, bobcat, coyote, deer, wild turkey, muskrat, river otter, beaver, turtles, snakes, frogs, toads, hawks, vultures, Mississippi kite, herons, egrets, bald eagles, kingfishers, songbirds, and woodpeckers.

Wetlands

The majority of the forested lands are streamside wetlands (USDA 2014). Most of these wetlands are bottomland hardwoods, e.g., willow oak, Nutall oak, overcup oak, bitter pecan, red maple, sweetgum, green ash. Riverine backwater flooding supports bald cypress and water tupelo swamps

in stream-connected depressions (Klimas et al. 2011). There are also restored wetlands in various stages of succession scattered throughout the project area.

Threatened and Endangered Species

Federally listed species within the study area include pondberry (*Lindera melissifolia*), sheepnose mussel (*Plethobasus cyphyus*), and rabbitsfoot mussel (*Quadrula cylindrica cylindrica*). Pondberry is a low growing, deciduous shrub approximately 1.5 to 6.5 feet in height that grows in clumps in shaded areas of mature bottomland hardwood forests. There are two known colonies of pondberry within Sunflower County located in small wooded patches along an agricultural drainage ditch outside of the project area (USFWS 2014). The endangered sheepnose mussel and threatened rabbitsfoot mussel are known to occur in the Big Sunflower River upstream of the Quiver River confluence. The sheepnose mussel is primarily found in larger rivers in shallow shoal habitats with moderate to swift currents over coarse sand and gravel. The rabbitsfoot mussel is typically found in medium-sized streams and some larger rivers in shallow areas along the bank and adjacent runs and shoals where water velocity is reduced. Within the Big Sunflower River, both species were found in gravelly shoals (Miller and Payne 2004). Both of these mussel species are tachytictic, or summer breeders (Parmalee and Bogan 1998). Potential fish hosts for these mussel species include rheophilic shiners, chubs, and minnows (Fobian 2007, Guenther et al. 2009, Wolf et al. 2012).

Socio-economic Resources

The study area lies in Leflore, Sunflower, and Tallahatchie Counties, Mississippi. These counties are all rural. Within the project area, more than 70 percent of the land is in agriculture.

The population of Leflore County in 2013 was estimated at 31,607 with an estimated 2.2 percent decrease from 2010. The median household income of Leflore County was $24,480 from 2009 to 2013. The largest employers by industry in Leflore County in 2013 were manufacturing (22%), retail trade (17%), and healthcare (12%). No other industry accounted for greater than 10 percent of the annual average employment.

The population of Sunflower County in 2013 was estimated at 27,997 with an estimated 4.9 percent decrease from 2010. The median household income was $26,619 from 2009 to 2013. The largest employers by industry in 2013 were transportation and warehousing (19%), retail trade (17%), healthcare (15%), and agriculture forestry, fishing, and hunting (12%). No other industry accounted for greater than 10 percent of the annual average employment.

The population of Tallahatchie County in 2013 was estimated at 15,081 with an estimated 1.9 percent decrease from 2010. The median household income was $29,853 from 2009 to 2013. The largest employers by industry in 2013 were retail trade (30%), agriculture forestry, fishing, and hunting (19%), and transportation and warehousing (12%). No other industry accounted for greater than 10 percent of the annual average employment. Appendix D includes more information on the socio-economic conditions in the area.

Water Quality

The study area has had hydrologic modifications such as clearing, snagging, channel enlargements, drainage ditches/alterations, weirs, diversions, and water withdrawals/irrigation. Low water, excessive sedimentation, and the accumulation of historically used organo-chlorine pesticides such as DDT are also common in the project area streams. In 2001, a fish consumption advisory was issued for all lakes, rivers, bayous, and sloughs in the Delta region of Mississippi due to DDT and toxaphene contamination, and although a few waterbodies have been removed from the advisory since that time none are located in the project area (MDEQ 2014a). This advisory recommends people limit their consumption of carp, gar, buffalo and large catfish (over 22 inches) to no more than two meals per month. The Tallahatchie River, Quiver River, and proposed transfer channel alignment are not identified on the 2014 303(d) list of impaired waters for the state of Mississippi; however, two Quiver River tributaries - Pecan Bayou and Turkey Bayou - in the vicinity of the project area are listed for organic enrichment/low dissolved oxygen (MDEQ 2014b). The Quiver River was listed on the 2006 303(d) list for sediment, organic enrichment/low dissolved oxygen, nutrients (primarily from nonpoint sources), and total nitrogen and total phosphorous. Total Maximum Daily Loads (TMDL) were developed in 2008 for all of these (MDEQ 2008a, 2008b, 2008c). Concentrations of nitrogen and phosphorus typically peak in the spring when agricultural fertilizers are applied and runoff occurs from bare, tilled soil (Shields et al. 2008).

Water Supply

The Quiver River has experienced the most severe groundwater level declines in the Delta over the past several decades as agricultural irrigation has increased to improve agricultural productivity. Water use from the Mississippi River Alluvial Aquifer (alluvial aquifer) exceeds natural recharge by an estimated 300,000 acre feet per year. Catfish farming is a significant industry in the region and relies on groundwater; the mineral content of surface water makes it less desirable for intensive fish farming. Row crop farmers also withdraw surface water from rivers and streams, including the Quiver. Agricultural surface water withdrawals from the Quiver and Big Sunflower Rivers reduce flow and compromise aquatic habitat.

Tailwater recovery and on-farm surface water impoundments are capturing some of the runoff from agricultural fields and reusing it for irrigation. These conservation practices do reduce the need to use groundwater and surface water for irrigation, but they also limit the amount of water that returns to the streams. The MRBI encourages use of such conservation practices. These conservation measures alone are not be sufficient to supply the water needed for agriculture and aquifer levels continue to decline in the region. Aquifer depletion and surface water withdrawals both degrade fish habitat.

FUTURE WITHOUT PROJECT CONDITIONS

Water use (groundwater and surface water) for irrigation purposes is expected to continue. The water level in the alluvial aquifer will continue to decline. Energy costs to pump groundwater will increase. The flow in the Quiver River will likely decrease. If the water supply declines too much, or the cost of pumping from the aquifer increases, there may be a change to crops that require less water. These crops would not be as valuable and agricultural benefits would decline. This could have impacts to both the regional and national economies.

Climate change may increase the frequency and duration of extreme weather events, such as floods or droughts. More frequent droughts would likely exacerbate the water supply, stream flow and groundwater issues.

Groundwater withdrawals will continue to exceed recharge capacity. It is possible that the cost of pumping water for irrigation would eventually make it economically unviable, but surface water withdrawals would not stop and the aquifer would not likely recover within the next 50 years.

There will be no foreseeable change in high water conditions in the study area. During high water, the Tallahatchie River will continue to exceed its banks and flow into the Quiver River and other adjacent streams.

Aquatic Resources and Fisheries

Aquatic habitat will continue to degrade as water withdrawals continue. Vegetation in the channel may increase as flows decline. Declining flow volume will decrease velocity and the habitat units available will decrease. Calculating habitat units for the Future Without Project (FWOP) would require making assumptions about the locations and amounts of future water withdrawals. For the purposes of the analysis of impacts, this calculation will not be done and the future without project habitat units will be assumed to be the same as the existing condition – 94.27 habitat units. Mussel populations will decline and more species will likely be lost from the Quiver. Declining flows will stress mussels more than fish because fish can move to other areas as water levels fall.

Terrestrial and Wildlife Resources

The majority of the project area is agricultural. If irrigation water becomes less available, less productive farm land may be converted to drier crops, pasture or may be allowed to lie fallow. More land may be enrolled in USDA conservation programs. The habitat for some species of wildlife could improve slightly if less land is farmed. Winter flooding for waterfowl hunting is likely to continue unchanged.

Wetlands

The only remaining wetlands known to occur in the area are the riparian forests. These are likely to remain. The lower flows in the late summer and fall may shift the species mix in some areas, but the spring high flows will provide the hydrology to sustain them.

Threatened and Endangered Species

Mussel habitat quality will continue to degrade and there will be less habitat available for rabbitsfoot and sheepnose. Pondberry would not likely establish within the project area.

Socio-economic Resources

The population would continue to decrease. There will be fewer jobs in the agricultural sector. Mechanization and farming practices changes are driving this trend throughout the region.

Water Quality

Nutrient levels peak in the spring and these are not likely to change. Lower flows in the late summer and fall will drive dissolved oxygen levels down. These flows will likely have no effect on sedimentation or scouring within the channel. Changes in agricultural practices could shift the use of fertilizers, but the change would not have a significant effect on water quality.

Water Supply

Water supply (groundwater and surface water) needs for irrigation are expected to continue. The water level in the alluvial aquifer will continue to decline and the energy costs to pump groundwater will increase. The amount of surface water available in the Quiver River will likely decrease. If the water supply declines too much, there may be a change to crops that require less water, more pasture, and/or more fallow lands. The drier crops would be less valuable. This could have negative impacts to both the regional and national economies. Catfish production would also decrease causing a significant economic impact in the region.

IV. FORMULATE ALTERNATIVE PLANS

The planning objectives must be directly related to the problems and opportunities identified for the study and will be used for the formulation and evaluation of plans. Historical data defined specific characteristics of the Quiver River and targets for habitat restoration. The strategy of the plan formulation is to address the low flow in the Quiver River, especially during the most impacted period of the year that is the fall fish young-of-year rearing period.

Modeling of the flow using the Tennant Methodology (discussed below) establishes the targeted flow to achieve and sustain ecological benefits. Measures are considered that will achieve some or all of these objectives in some quantifiable manner, and these are combined into alternative plans. The ability and costs of these plans to achieve the objectives are analyzed and use for screening and comparison purposes.

Management Measures

Measure 1. End alluvial aquifer use.

Measure 2. Transfer water from adjacent surface water source.

Measure 3. Modify Existing Weirs. This measure would modify the four existing weirs to allow for fish passage and increased water transfer down the channel during low flow periods.

Measure 4**.** Reconnection of historic oxbows and channels.

Measure 5. New Bayou Weirs. Placement of weirs at the downstream end of bayous to retain water within the bayous year round.

Measure 6. Riparian Forests. Establish riparian forests on stream banks.

Screening of Measures

Measure 1: This measure was screened and will not be carried forward into alternative formulation. It would cause increased use of Quiver River surface flow which would impact aquatic habitat. Catfish farming relies on groundwater. Complete elimination of aquifer use is not consistent with the state's statutory requirement for conjunctive use of surface water and groundwater and therefore is not a practical option.

Measure 2: This measure is retained for further analyses.

Measure 3: The measure was screened out and will not be carried forward into alternative formulation. The existing weirs are sheet metal and stone with a concrete cap. Modification of the weirs would require complete removal. It would also affect the function of the existing weirs and violate the second constraint.

Measures 4 and 5: Theses measures were screened out and will not be carried forward into alternative formulation. Survey data showed the Quiver River was too incised for these measures to provide benefits. Water would not enter into these oxbows and bayous from the Quiver River

without significantly altering them or the Quiver River. Increased water retention in these areas could also induce flooding.
Measure 6: This measure is retained for further analyses. It provides increases to water quality and aquatic fauna refugia habitat. It has relatively low implementation costs.

Formulation Strategy

Measures 2 and 6 were carried forward for alternative formulation.

Measure 2 had to be refined to determine transfer routes and possible quantities. The only adjacent surface water source that would provide a reliable summer and fall capacity is the Tallahatchie River. A series of connector channels would transfer water from the Tallahatchie River to the Quiver River - Cassidy Bayou, Swan Lake, Black Bayou, Parks Bayou, and Sandy Bayou. A newly constructed transfer ditch could be built, but using the existing channels will provide more benefits and be more cost efficient. Figure 8 shows the approximate route of water transfer from the Tallahatchie to the Quiver River.

Several factors impact the quantity of water that can be transferred from the Tallahatchie to the Quiver. First, water withdrawals cannot impact navigation in the Yazoo River. Second, water withdrawals cannot degrade habitat in the Tallahatchie. And third, water input into the Quiver River cannot induce flooding. Preliminary hydraulic analysis shows the Quiver River has the capacity to add 400 cfs during the irrigation season. This was set as the upper limit for the analysis. Habitat analysis using the Revised Tennant Method and the Tennessee Method indicate the historic low flow in the Quiver River was 60 – 100 cfs. The project flow for alternative formulation was set at 100 cfs. More detail is provided in the Appendix B.

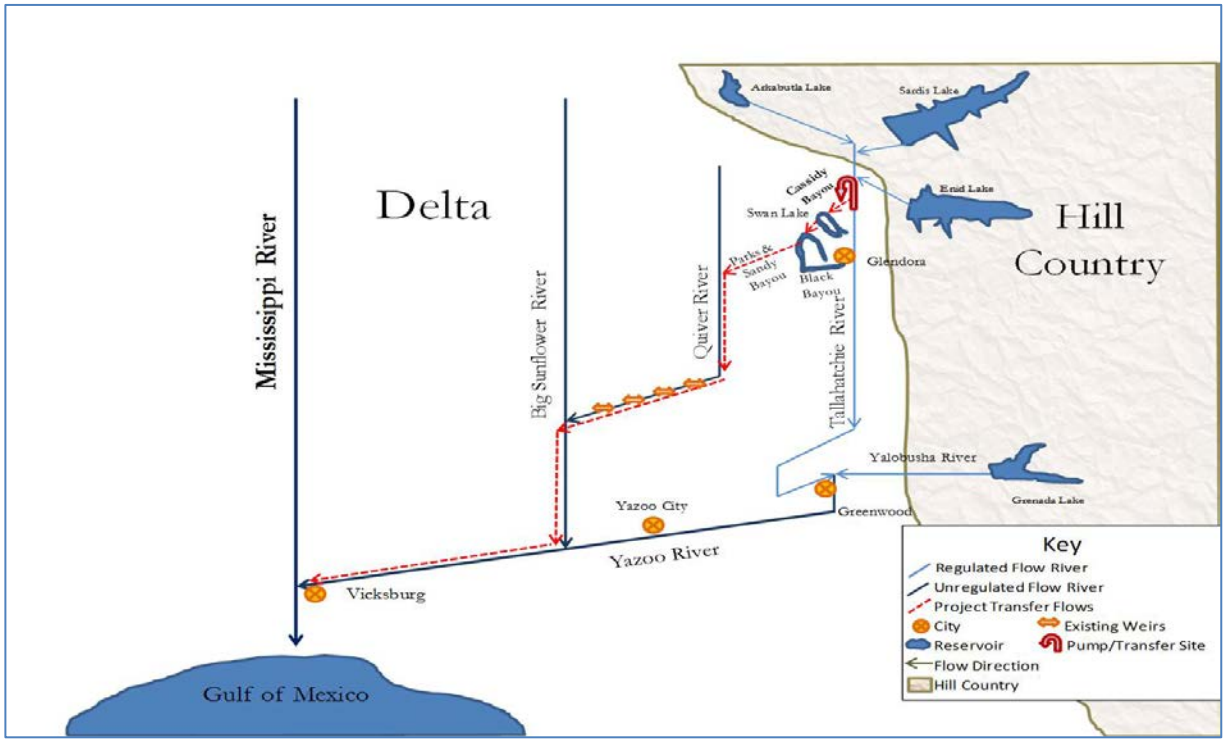

Figure 8. Transfer Conveyance from Tallahatchie River to the Quiver River (not to scale).

Initial Array of Alternative Plans

Alternative 1 is the No Action Alternative. Under this alternative, USACE would take no action to restore the ecosystem in the Quiver River or provide any additional water for agriculture. Other agencies would continue to manage resources in and around the Quiver River. USDA would continue to enroll willing landowners in conservation programs and MDEQ would continue to manage water quality and TMDLs.

Alternative 2 would transfer 100 cfs of water from the Tallahatchie River to the Quiver River. It would also plant trees on approximately 100 acres. At the request of Yazoo Management District, MDEQ provided assurances that the 100 cfs project flow would remain in the stream.

Alternative 3 would transfer 200 cfs of water from the Tallahatchie River to the Quiver River. It would also plant trees on approximately 100 acres. At the request of Yazoo Management District, MDEQ provided assurances that the 100 cfs project flow would remain in the stream.

Alternative 4 would transfer 300 cfs of water from the Tallahatchie River to the Quiver River. It would also plant trees on approximately 100 acres. At the request of Yazoo Management District, MDEQ provided assurances that the 100 cfs project flow would remain in the stream.

Alternative 5 would transfer 400 cfs of water from the Tallahatchie River to the Quiver River. It would also plant trees on approximately 100 acres. At the request of Yazoo Management District, MDEQ provided assurances that the 100 cfs project flow would remain in the stream.

Final Array of Alternative Plans

Alternatives 2 – 5 all include the same project flow of 100 cfs and would have similar benefits for the environment, although the larger alternatives would increase wetted perimeter in the transfer channels. The larger alternatives would have benefits for water supply and aquifer protection so all of the alternatives from the initial array were retained.

Alternative 1 – No Action: Under this alternative, USACE would take no action to restore the ecosystem in the Quiver River or provide any additional water for agriculture. A variety of non-structural actions from other agencies will continue.

USDA agencies would work with landowners to implement projects that would benefit habitat in the area and provide some aquifer protection.

The Farm Service Agency (FSA) manages the Farmable Wetlands Program. The Farmable Wetlands Program (FWP) is designed to restore previously farmed wetlands and wetland buffer to improve both vegetation and water flow. FWP is a voluntary program to restore up to one million acres of farmable wetlands and associated buffers. Participants must agree to restore the wetlands, establish plant cover, and to not use enrolled land for commercial purposes. By restoring farmable wetlands, FWP improves groundwater quality, helps trap and break down pollutants, prevents soil erosion, reduces downstream flood damage, and provides habitat for water birds and other wildlife.

FSA administers the Conservation Reserve Program (CRP). In exchange for a yearly rental payment, farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality. The long-term goal of the program is to re-establish valuable land cover to help improve water quality, prevent soil erosion, and reduce loss of wildlife habitat.

The Natural Resources Conservation Service (NRCS) administers the Agricultural Conservation Easement Program (ACEP). Agricultural Land Easements prevent conversion of productive working lands to non-agricultural uses and protect the long-term viability of the nation's food supply. Agricultural land easements provide additional public benefits, including environmental quality, historic preservation, wildlife habitat and protection of open space. Wetland Reserve Easements provide habitat for fish and wildlife, including threatened and endangered species, filter sediments and chemicals to improve water quality, reduce flooding, recharge groundwater, protect biological diversity and provide opportunities for educational, scientific and limited recreational activities.

NRCS also manages the Healthy Forests Reserve Program (HFRP). Land enrolled in HFRP easements must restore, enhance or measurably increase the recovery of threatened or endangered species, improve biological diversity or increase carbon storage.

Alternative 2 – 100 cfs: This alternative would build a pumping station on the Tallahatchie River approximately 2 miles north of Sharkey, MS. The station would have the capacity to pump 100 cfs from the Tallahatchie River. A 1,500 foot long channel would be excavated (63,000 cubic yards) to connect the pump station to Cassidy Bayou. Water would flow from Cassidy Bayou into Swan Lake. Water would flow from Swan Lake to Black Bayou, then to Sandy Bayou and then Parks Bayou, and finally into the Quiver River approximately 2.5 miles northeast of Brooks, MS. This alternative will require new weirs in Cassidy and Black Bayou so that water can reach the required water surface elevation without flowing back into the Tallahatchie. At Black Bayou 2.4 acres will be cleared to construct the weir and 1.3 acres will be cleared at the Cassidy Bayou site.

In Parks and Sandy Bayous, some channel blockages and sediment deposits will have to be removed to allow 100 cfs to pass. This will include up to 13,905 ft and 45,000 cubic yards of channel work.

Bottomland hardwoods will be replanted on any area cleared for construction and along the streambanks in areas where conservation easements are acquired; a maximum of 100 acres of tree planting is anticipated.

The pumping station would be operated to ensure 100 cfs is maintained in the Quiver River. Water transfers to meet the project flow are most likely in September and October, but some may also be needed in August and November. During October, nearly all of the 100 cfs will be needed to maintain the project flow. Irrigation season generally extends from May to August and water can be withdrawn from the system as long as the 100 cfs project flow is maintained. Operation of the pump is not likely from December through April when the extra water is not needed for irrigation or ecological flows. It is assumed the pump cannot be regulated to deliver less than 100 cfs.

All of the programs described for Alternative 1 would be available.

The estimated cost of this alternative is $11,634,653 (in 2016 dollars).

Alternative 3 – 200 cfs: This alternative is essentially the same as Alternative 2, however the pump station would have two 100 cfs pumps so that it can deliver 200 cfs for irrigation and ecological purposes, but only 100 cfs when needed to maintain the project flow.

At Black Bayou 2.4 acres will be cleared to construct the weir and 1.5 acres will be cleared at the Cassidy Bayou site.

In Parks and Sandy Bayous, some channel blockages and sediment deposits will have to be removed to allow 200 cfs to pass. This will include up to 22,700 ft and 114,100 cubic yards of channel work.

Bottomland hardwoods will be replanted on any area cleared for construction and along the streambanks in areas where conservation easements are acquired; a maximum of 100 acres of tree planting is anticipated.

All of the programs described for Alternative 1 would be available.

The estimated cost of this alternative is $15,829,056 (in 2016 dollars).

Alternative 4 – 300 cfs: This alternative is essentially the same as Alternative 2, however the pump station would have one 100 cfs pump, and one 200 cfs pump so that it can deliver 300 cfs for irrigation and ecological purposes, but only 100 cfs when needed to maintain the project flow.

At Black Bayou 2.5 acres will be cleared to construct the weir and 1.7 acres will be cleared at the Cassidy Bayou site.

In Parks and Sandy Bayous, some channel blockages and sediment deposits will have to be removed to allow 300 cfs to pass. This will include up to 38,600 ft and 191,700 cubic yards of channel work.

Bottomland hardwoods will be replanted on any area cleared for construction and along the streambanks in areas where conservation easements are acquired; a maximum of 100 acres of tree planting is anticipated.

All of the programs described for Alternative 1 would be available.

The estimated cost of this alternative is $17,577,719 (in 2016 dollars).

Alternative 5 – 400 cfs: This alternative is essentially the same as Alternative 2, however the pump station would have two 100 cfs pumps and one 200 cfs pump so that it can deliver 400 cfs for irrigation and ecological purposes, but only 100 cfs when needed to maintain the project flow.

At Black Bayou 2.6 acres will be cleared to construct the weir and 1.8 acres will be cleared at the Cassidy Bayou site.

In Parks and Sandy Bayous, some channel blockages and sediment deposits will have to be removed to allow 400 cfs to pass. This will include up to 41,700 ft and 249,200 cubic yards of channel work.

Bottomland hardwoods will be replanted on any area cleared for construction and along the streambanks in areas where conservation easements are acquired; a maximum of 100 acres of tree planting is anticipated.

All of the programs described for Alternative 1 would be available.

The estimated cost of this alternative is $20,236,141 (in 2016 dollars).

V. EVALUATE ALTERNATIVES

Alternative 1 – No Action. The impacts of this alternative were described in the Future Without Project Conditions Section.

Alternative 2 – 100 cfs.

Aquatic Resources and Fisheries

This alternative will address the three principal stressors on aquatic communities in the Quiver River and the transfer channels (Cassidy, Black, Sandy and Parks Bayous and Swan Lake). It will ensure a more natural stream flow and will improve water quality during late summer and autumn. The 100 acres of bottomland hardwood reforestation and the USDA programs restore habitat on the streambank, shade the streams, increase allocthonous input, and improve overall habitat conditions. The USDA programs also have the potential to reduce sedimentation.

The Delta Stream Minnow Model was applied to the October median flows in the Quiver River. The October median flows for this alternative range from approximately 104 to 114 cfs in the Quiver River. This flow would closely approximate the historic October flow in the Quiver River. The model found an average HSI of 0.41 in the Quiver River in October. The total surface acreage at October median flow is 467.05. The total Habitat Units available are 180.83 for a net increase of 86.56 over Alternative 1. As the habitat improves, some of the fish and mussel species in the Yazoo River are likely to move into the Quiver.

All of the fish and mussel species in the Tallahatchie River already have access to the Quiver River through the Yazoo and Big Sunflower Rivers and during headwater flooding. No new species will be introduced into the Quiver River. As the habitat in the Quiver River improves, more species are likely to colonize this area from elsewhere in the Basin. The required weirs on Black and Cassidy Bayous would not create barriers to fish passage or otherwise impact habitat.

Terrestrial and Wildlife Resources

Winter flooding for waterfowl will be the same. Improved fish and mussel populations will benefit a variety of animals that eat fish and mussels such as great blue herons, mink, and raccoon. Construction noise and activity will disturb wildlife and drive them from the area temporarily. Animals will return to the area post-construction. Some trees will be cleared to facilitate construction, but the areas will be replanted.

Wetlands

The weir sites on Black and Cassidy Bayous lie on the edge of the water. Construction will be managed to avoid impacts to these waterbodies. No other wetlands are known to occur in the areas proposed for construction. If wetlands are discovered, they will be avoided. Some of the transfer channels like Parks and Sandy Bayous were historic wetlands but are now dry most of the year. Restoring flow through these may restore some wetland functions. Wetted perimeter in Parks and Sandy Bayous would increase 10 - 50%. This alternative would replant approximately 100 acres of

high quality bottomland hardwoods along streambanks. These trees would benefit songbirds, squirrels and other species.

Threatened and Endangered Species

Mussel habitat quality will improve as indicated above and there will be more habitat available for rabbitsfoot and sheepnose mussel. Pondberry is not likely to recolonize the area. Coordination with U.S. Fish and Wildlife Service will confirm the determinations regarding impacts to listed species.

Socio-economic Resources

There will likely be a continued population decrease. Supplying some water for irrigation will improve productivity on farms, but would not significantly affect employment, because other factors are driving the decreases.

Water Quality

Water quality in the Tallahatchie and Quiver Rivers are similar so there would be no direct impact on water quality. Increased flows in the late summer and fall will raise dissolved oxygen levels and benefit fish and mussels. Although this alternative will increase flows from May to November, the flows will still be less than the spring high flows and will not increase sedimentation or scouring within the channel. There will be some short term disturbance in the connector channels during construction, but the channels will be dry at that time. Excavated material will be spread on adjacent agricultural fields.

Water Supply

This alternative would supply enough water to irrigate approximately 9,214 acres split equally among rice, soybeans, and corn. All of these acres are currently irrigated with groundwater. It is anticipated that groundwater would no longer be used to irrigate these acres.

Alternative 3 – 200 cfs.

Aquatic Resources and Fisheries

The effects of this alternative will be similar to that for Alternative 2. Although more water will be diverted into the system for irrigation, these higher diversions will occur during early to mid-summer, and not during the low flow season. The total Habitat Units available are 180.83, net increase of 86.56, same as Alternative 2 because the October flows are the same for both alternatives. As the habitat improves, some of the fish and mussel species in the Yazoo River are likely to move into the Quiver.

Terrestrial and Wildlife Resources

Winter flooding for waterfowl will be the same. Improved fish and mussel populations will benefit a variety of animals that eat fish and mussels such as great blue herons, mink, and raccoon. Construction noise and activity will disturb wildlife and drive them from the area temporarily.

Animals will return to the area post-construction. Some trees will be cleared to facilitate construction, but the areas will be replanted.

Wetlands

Similar impacts to Alternative 2. Wetted perimeter in Parks and Sandy Bayous would increase 20 - 100%. This alternative would replant approximately 100 acres of high quality bottomland hardwoods along streambanks. These trees would benefit songbirds, squirrels and other species.

Threatened and Endangered Species

Mussel habitat quality will improve as indicated above and there will be more habitat available for rabbitsfoot and sheepnose mussel. Pondberry is not likely to recolonize the area. Coordination with U.S. Fish and Wildlife Service will confirm the determinations regarding impacts to listed species.

Socio-economic Resources

There will likely be a continued population decrease. Supplying 200 cfs for irrigation will improve productivity on farms more than supplying 100 cfs, but it would not significantly affect employment.

Water Quality

The effects on water quality for this alternative will be similar to those described for Alternative 2.

Water Supply

This alternative would supply enough water to irrigate approximately 18,427 acres split equally among rice, soybeans, and corn. All of these acres are currently irrigated with groundwater. It is anticipated that groundwater would no longer be used to irrigate these acres

Alternative 4 – 300 cfs.

Aquatic Resources and Fisheries

The effects of this alternative will be similar to that for Alternative 2. Although more water will be diverted into the system for irrigation, these higher diversions will occur during early to mid-summer, and not during the low flow season. The total Habitat Units available are 180.83, net increase of 86.56, same as Alternative 2 because the October flows are the same for both alternatives. As the habitat improves, some of the fish and mussel species in the Yazoo River are likely to move into the Quiver.

Terrestrial and Wildlife Resources

Winter flooding for waterfowl will be the same. Improved fish and mussel populations will benefit a variety of animals that eat fish and mussels such as great blue herons, mink, and raccoon. Construction noise and activity will disturb wildlife and drive them from the area temporarily.

Animals will return to the area post-construction. Some trees will be cleared to facilitate construction, but the areas will be replanted.

Wetlands

Similar impacts to Alternative 2. Wetted perimeter in Parks and Sandy Bayous would increase 30 - 150%. This alternative would replant approximately 100 acres of high quality bottomland hardwoods along streambanks. These trees would benefit songbirds, squirrels and other species.

Threatened and Endangered Species

Mussel habitat quality will improve as indicated above and there will be more habitat available for rabbitsfoot and sheepnose mussel. Pondberry is not likely to recolonize the area without intervention. Coordination with U.S. Fish and Wildlife Service will confirm the determinations regarding impacts to listed species.

Socio-economic Resources

There will likely be a continued population decrease. Supplying 300 cfs for irrigation will improve productivity on farms more than supplying 100-200 cfs, but it would not significantly affect employment.

Water Quality

The effects on water quality for this alternative will be similar to those described for Alternative 2.

Water Supply

This alternative would supply enough water to irrigate approximately 27,641 acres split equally among rice, soybeans, and corn. All of these acres are currently irrigated with groundwater. It is anticipated that groundwater would no longer be used to irrigate these acres

Alternative 5 – 400 cfs.

Aquatic Resources and Fisheries

The effects of this alternative will be similar to that for Alternative 2. Although more water will be diverted into the system for irrigation, these higher diversions will occur during early to mid-summer, and not during the low flow season. The total Habitat Units available are 180.83, net increase of 86.56, same as Alternative 2 because the October flows are the same for both alternatives. As the habitat improves, some of the fish and mussel species in the Yazoo River are likely to move into the Quiver.

Terrestrial and Wildlife Resources

Winter flooding for waterfowl will be the same. Improved fish and mussel populations will benefit a variety of animals that eat fish and mussels such as great blue herons, mink, and raccoon.

Construction noise and activity will disturb wildlife and drive them from the area temporarily. Animals will return to the area post-construction. Some trees will be cleared to facilitate construction, but the areas will be replanted.

Wetlands

Similar impacts to Alternative 2. Wetted perimeter in Parks and Sandy Bayous would increase 40 - 200%. This alternative would replant approximately 100 acres of high quality bottomland hardwoods along streambanks. These trees would benefit songbirds, squirrels and other species.

Threatened and Endangered Species

Mussel habitat quality will improve as indicated above and there will be more habitat available for rabbitsfoot and sheepnose mussel. Pondberry is not likely to recolonize the area. Coordination with U.S. Fish and Wildlife Service will confirm the determinations regarding impacts to listed species.

Socio-economic Resources

There will likely be a continued population decrease. Supplying 400 cfs for irrigation will provide the biggest improvement in productivity, but it would not significantly affect employment.

Water Quality

The effects on water quality for this alternative will be similar to those described for Alternative 2.

Water Supply

This alternative would supply enough water to irrigate approximately 36,855 acres split equally among rice, soybeans, and corn. All of these acres are currently irrigated with groundwater. It is anticipated that groundwater would no longer be used to irrigate these acres

VII. COMPARE ALTERNATIVE PLANS

Several different sets of criteria were used to compare the alternative plans. The first two are from the 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G). The last table compares other pertinent information for the alternatives.

Table 1. Summary of Alternatives relative to the Planning Objectives

Alternatives	Costs	AAHU increase Objective 1	Wetted Perimeter Increase Objective 2	Bottomland Hardwood Acres Objective 3	NED Excess Annual Benefits Objective 4
1 – No Action	$0	0	0	0	0
2 – 100 cfs	$11,634,653	86.56	10 – 50 %	100	$151,000
3 – 200 cfs	$15,829,056	86.56	20 – 100%	100	$137,000
4 – 300 cfs	$17,577,719	86.56	30 – 150%	100	$225,000
5 – 400 cfs	$20,236,141	86.56	40 – 200%	100	$275,000

Table 2. Qualitative Assessment of the Four Principles and Guideline Criteria (for both the federal ecosystem mission and local water supply)

Alternatives	Completeness	Effectiveness	Efficiency	Acceptability
1 – No Action	This alternative provides no benefits.	This alternative will not alleviate any problems or achieve any opportunities	Although this alternative has no cost, habitat conditions will decline. It is not efficient.	There are no obstacles to implementing this plan, but it provides no solution to the identified problems.
2 – 100 cfs	This alternative is complete. All benefits can be achieved without further actions.	All four action alternatives would effectively solve the habitat problems. This alternative would provide some benefits for water supply, but would not solve the problem as much as other plans.	This plan is the most efficient for NER benefits.	This alternative is implementable. It will provide resolution for the ecosystem problems and will alleviate some of the identified water supply problems.
3 – 200 cfs	This alternative is complete. All benefits can be achieved without further actions.	All four action alternatives would effectively solve the habitat problems. This alternative is the third most effective in resolving water supply problems.	This plan is the second most efficient for NER benefits.	This alternative is implementable. It will provide the same amount of resolution for the ecosystem problems and will provide more resolution of the identified water supply problems than Alternative 1 or 2.
4 – 300 cfs	This alternative is complete. All benefits can be achieved without further actions.	All four action alternatives would effectively solve the habitat problems. This alternative is the second most effective in resolving water supply problems.	This plan is the third most efficient for NER benefits.	This alternative is implementable. It will provide the same amount of resolution for the ecosystem problems and will provide more resolution of the identified water supply problems than Alternative 1, 2 or 3.
5 – 400 cfs	This alternative is complete. All benefits can be achieved without further actions.	All four action alternatives would effectively solve the habitat problems. This alternative would provide the most resolution for the water supply problem.	This alternative is the least efficient for NER benefits among the four action alternatives.	This alternative is implementable. It will provide the same amount of resolution for the ecosystem problems and will provide the most resolution of the identified water supply problems.

Table 3. System of Accounts Alternative Comparison

Alternatives	NED	EQ	RED	OSE
1 – No Action	This alternative provides no benefits.	This alternative will not alleviate any problems or achieve any opportunities	No impact.	No impact
2 – 100 cfs	The net excess average annual benefits of this alternative are $151,000.	This alternative will provide EQ benefits.	This alternative would have the least RED benefits during construction because it is the smallest of the action alternatives. Some RED benefits may derive for the operation, maintenance and monitoring of the pump station, and they would be similar for all alternatives.	All of the construction is in rural areas. There are no anticipated effects on noise, air quality, community cohesion or any other factor significant to OSE.
3 – 200 cfs	The net excess average annual benefits of this alternative are $137,000.	Same benefits as Alt 2.	This alternative would have the second least RED benefits. Slightly more operation, maintenance and monitoring RED benefits.	All of the construction is in rural areas. There are no anticipated effects on noise, air quality, community cohesion or any other factor significant to OSE.
4 – 300 cfs	The net excess average annual benefits of this alternative are $225,000.	Same benefits as Alt 2.	This alternative would have the second most RED benefits during construction. Slightly more operation, maintenance and monitoring RED benefits.	All of the construction is in rural areas. There are no anticipated effects on noise, air quality, community cohesion or any other factor significant to OSE.
5 – 400 cfs	The net excess average annual benefits of this alternative are $275,000.	Same benefits as Alt 2.	This alternative would have the most RED benefits. Slightly more operation, maintenance and monitoring RED benefits.	All of the construction is in rural areas. There are no anticipated effects on noise, air quality, community cohesion or any other factor significant to OSE.

VIII. TENTATIVELY SELECTED PLAN

PLAN SELECTION

The National Ecosystem Restoration (NER) Plan is Alternative 2. It is the most efficient plan and delivers the most ecosystem benefits for the cost.

The non-Federal Sponsor prefers Alternative 5 and is prepared to pay the difference between the NER plan and Alternative 5. Therefore, the Tentatively Selected Plan (TSP) is the locally preferred plan (LPP) - Alternative 5, which is a multipurpose Ecosystem Restoration and Water Supply plan. The TSP maximizes water supply benefits compared to costs. Provides the same level of ecosystem benefits as the NER plan, and is consistent with the Federal objectives. This alternative allows the non-Federal sponsor to provide a reliable water source for irrigation and reduce aquifer depletion.

The Assistant Secretary of the Army for Civil Works approved a waiver to allow the LPP on 23 June 2016. That approval stated in part:

> The LPP includes all the measures of the NER plan, but would include an enlarged diversion structure from the Tallahatchie River and a modification to the Sandy Bayou and Parks Bayou to allow for the capability to provide up to 400 cfs of water for agricultural water supply purposes. The additional withdrawals for agriculture irrigation would typically occur from May through August of any given year. The priority for the withdrawal of the 100 cfs flow of water is to support the ecosystem restoration. Additional withdrawals for agricultural purposes would not impair the proposed restored flows for the Quiver River nor the existing flows of the Tallahatchie. By allowing the withdrawals of surface flows for agricultural purposes, there would be fewer withdrawals from the aquifer, thereby supporting a continued stabilization of the aquifer and potential capacity for increased recharge.

ECOSYSTEM SIGNIFICANCE

Streams are important as spawning and nursery habitats, seasonal feeding areas, refuges from predators and competitors, shelter from extreme weather, and travel corridors. The Mississippi Department of Environmental Quality considers the ecosystem of the Quiver River to be significant and has committed to regulate the extraction of surface water out of the Quiver River for the purpose of ecosystem restoration. Institutional, technical, and public importance factors as described in ER 1105-2-100 are:

Institutional Importance

The TSP would improve conditions for these listed species:
Endangered Species Act
- Sheepnose mussel (*Plethobasus cyphyus*) [endangered]
- Rabbitsfoot mussel (*Quadrula cylindrica*) [threatened]

Mississippi State Heritage Program
- Pyramid pigtoe mussel (*Pleurobema rubrum*)
- Mucket mussel (*Actinonias ligamentina*)
- Spike mussel (*Elliptio dillata*

Technical Importance

Greater than 80% of bottomland hardwood forest wetlands in the Mississippi Alluvial Valley have been lost to deforestation which is positively correlated with regional losses of biodiversity and degradation of downstream water quality. These loss percentages are thought to be similar to the losses within the Quiver River.

The needs within the watershed for conservation practices and partnerships that improve water quality, restore riparian forests, enhance wildlife habitat, while sustaining agriculture productivity is becoming an increasingly high priority. The Quiver River is located within the Big Sunflower River Watershed, which NRCS specifically identified as a focus area of the Mississippi River Basin Healthy Watersheds Initiative (MRBI)(Figure 9). The Natural Resources Conservation Service (NRCS) works through the MRBI to work with producers to conserve America's natural resources while ensuring economic viability of cropland. The MRBI is part of a commitment of $100 million over four years to address critical water quality concerns in priority watersheds while boosting rural economies.
http://www.nrcs.usda.gov/Internet/FSE_MEDIA/nrcseprd336528.jpg.

The study area is located entirely within the Mississippi River Basin which is one of eight critical conservation areas (CCAs) designated by the Secretary of Agriculture as priority regions across the country. Identified resource concern priorities are water quality degradation, inefficient use of irrigation water, and inadequate habitat for fish and wildlife. The Regional Conservation Partnership Program is being implemented by NRCS to focus conservation efforts within this high priority CCA.

Yazoo-Mississippi Delta Joint Water Management District (YMD) Groundwater reports 1990 – present

YMD and USGS studies show a 21.5 ft decline in the water surface of the aquifer since 1990. This is a strong indicator of the increasing scarcity of the groundwater resource.

The decline of the aquifer decreases the base flow in some tributaries of the Quiver River. The decreased flow limits fish habitat and decreases biodiversity and in-stream connectivity.

The diversity of the Quiver River is far below that of other streams in the larger watershed that benefit from water releases upstream. The Tallahatchie River adjacent to the Quiver River receives additional flow from the USACE owned and operated Sardis Reservoir, which is one of four USACE reservoirs in Mississippi.

Perennial streams and smaller rivers, which provide a significant portion of the flow to higher order rivers like the Yazoo and Mississippi Rivers, have been reduced to intermittent streams in the Mississippi River delta. These former perennial streams and rivers provided the nursery areas and important habitat for many terrestrial, avian, and aquatic species.

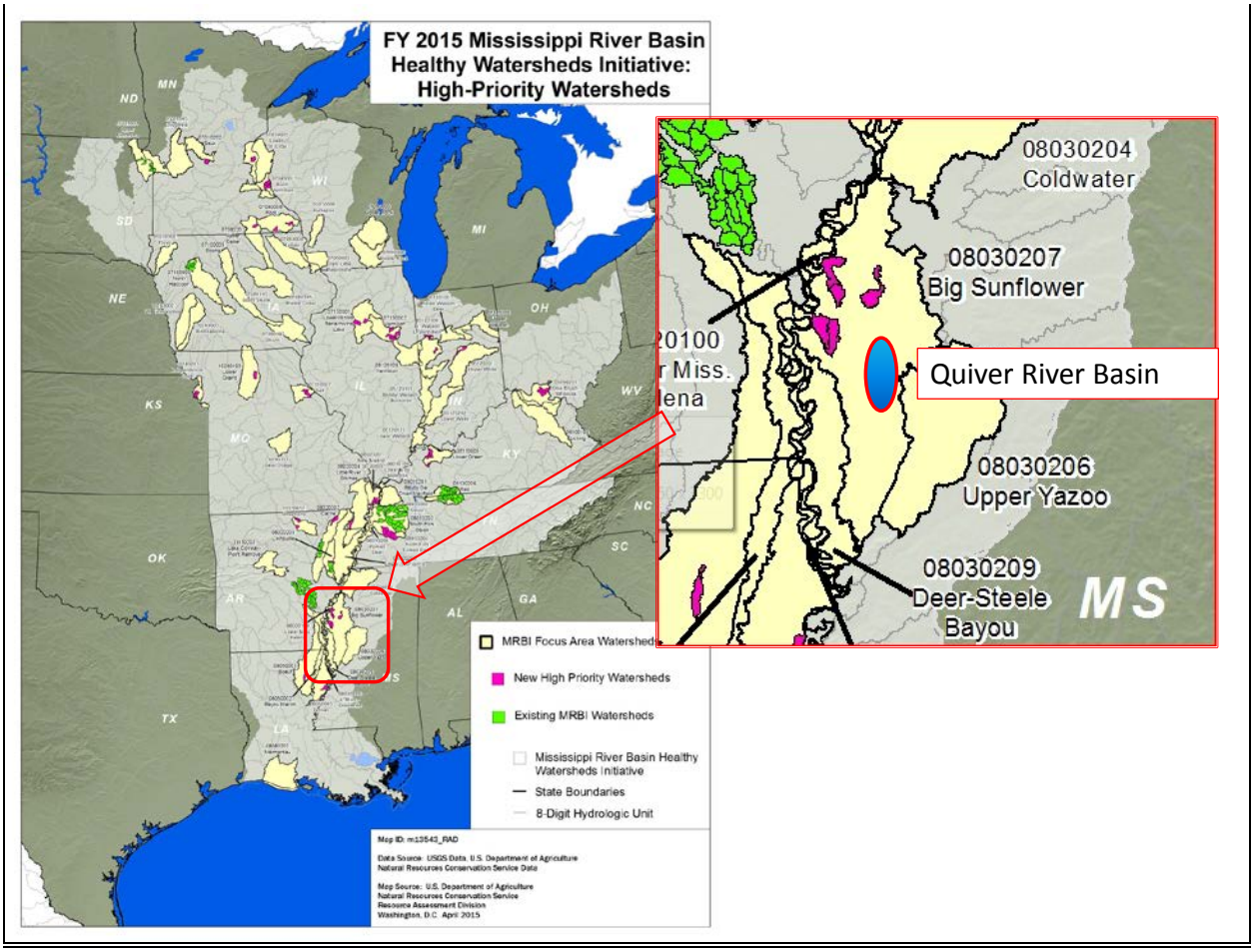

Figure 9. NRCS Mississippi River Basin Initiative Focal Areas - Big Sunflower

Public Importance

The American Fisheries Society vulnerable species list in the Yazoo River Basin (larger encompassing watershed) include the American eel, paddle fish and blue sucker. These rheophilic species (prefers to live in fast moving water) likely used the Quiver River during portions of their life cycle when it experienced perennial flows, and this potential would return if flow in the Quiver River was restored. Restoring the presence of rheophilic species in the Quiver would result in increased aquatic species richness and diversity and aid to increased biodiversity in the larger system. The interagency Neo-tropical Migratory Bird Conservation Program, known as Partners in Flight (PIF), have identified bottomland hardwood forests throughout the southeast as a habitat of regional concern from the impacts of its loss and high fragmentation to breeding birds. The Department of Defense participates in this effort (http://www.dodpif.org) with representatives from all branches of the Services. The Corps of Engineer's representative is from the Engineering Research and Development Center in Vicksburg, Mississippi. The key components to DoD PIF's work are its partnerships at local, state, regional, national, and international levels, as well as its leadership in implementing ecosystem-based bird conservation planning, installation, and regional Integrated Management Plans (INRMPs), the DoD Coordinated Bird Monitoring Plan, North

American Bird Conservation Initiative (NABCI) projects, management of DoD's Important Bird Areas Program, and the Bird/Animal Aircraft Strike Hazard (BASH) Program.

Implementation Plan

Real Estate

Real estate interests will be acquired for access, the pump station, new disposal sites, channel weir locations, construction areas, and planting areas. All property is agricultural land.
The following will be acquired in the Cassidy Bayou area (5 owners):
Perpetual Road Easement for access to site (5.77 acres)
Perpetual Channel Easement (includes Channel, Weir & Disposal Areas) (54.25 acres)
Fee excluding minerals (Proposed Pump Site) (11.73 acres)

The following will be acquired in the Black Bayou area (2 owners):
Perpetual Road Easement for access to site (4.02 acres)
Perpetual Channel Improvement Easement (includes Area for Weir) (22.70 acres)
Quiver River excavation will be on private water bottoms and a channel easement will be acquired, as well as a temporary work area easement for the disposal of the excavated materials. The location of these excavation and disposal areas has not been identified yet. The project will reforest riparian stream banks with native bottom land hardwood species within 25 feet of both bank tops at several locations within Tallahatchie and Leflore Counties. Possible areas of reforestation are Cassidy Bayou, Fish Lake Outlet, Black Bayou, Sandy Bayou, Parks Bayou, Quiver River and Big Sunflower River. Actual locations have not been identified at this time. The District proposes the acquisition of a Bank Protection and Reforestation Easement. This subject will be addressed further in final REP.

Construction Method

The construction of the channel cross overs is based on a dragline excavating from the top bank and casting the material into a spoil bank running parallel to the channel. The material in the spoil bank is to be spread and shaped by dozers. The construction of the weirs consist of stone with a sheet pile cut-off. It is assumed that the water would be diverted around or through the site so that the construct can be in the dry. The sheet piling is to be driven by pile driving equipment (crane, pile hammer, and etc.). A hydraulic excavator and front-end loader is to place the stone for each weir.

In general the pumping station consist of a concrete substructure supported on H-piles, a metal building superstructure housing electric pumps, misc. equipment and materials associated with pumps, and a riprap channel protection. It is assumed that a dewatering system (well points) is required. Dozers and an hydraulic excavator would be used to clear and grub the site. The hydraulic excavator with the assistance of a dozer is to excavate the channel and the site for the structure. The H-piles are to be driven by pile driving equipment (crane, pile hammer, and etc.). A crane is to be used to place the concrete, construct the metal building, and to install the pumps. A hydraulic excavator, dozer, front-end loader, rollers are used to place fill/backfill for the structure. The hydraulic excavator and front-end loader would place the riprap and filter stone for the riprap channel protection.

More detail regarding access and construction methods will be developed during the preparation of plans and specifications for the project.

Funding And Construction Schedule

A detailed funding and construction schedule cannot be developed until Congress provides construction authority and appropriations for the project. Below is a generic schedule which will be further refined after detailed plans and specifications are developed.

- Receive Congressional Authority and Appropriation
- Negotiate the Project Partnership Agreement – Duration 100 days
- Prepare for Surveying and initiate field work – Duration 45 days
- Develop Plans and Specs – Duration 255 days
- Perform Biddability/Constructability/Environmental/Sustainability Review (BCOES) – Duration 30 days
- Contracting Prepares for Advertisement – Duration 30 days
- Contract Advertised - Duration 30 days
- Process Award – Duration 15 days
- Preconstruction submittals – Duration 30 days
- Construction begins when conditions allow
- Construction will take 3 years to complete

Operations, Maintenance, Repair, Rehabilitation, and Replacement

The project flow of 100 cfs will be measured at the downstream most weir in the Quiver River. If the flow is below 100 cfs, the pumps must be engaged to reach 100 cfs and/or water withdrawals in the system must stop.

Cost-Sharing Requirements

For the TSP, the cost of the NER (100 cfs) plan will be cost shared at a 65% Federal and 35% non-Federal sponsor. Per ER 1105-2-100, Chapter 3.b.3, the non-Federal sponsor must pay all cost allocated to water supply purposes. Therefore, any cost above the 100 cfs pump (NER) will be 100% funded by the non-Federal sponsor. Detailed cost information can be found in Appendix E.

Table 4. Cost Apportionment for the NER and LPP Plans in 2016 dollars

Item	NER Plan – Alternative 2*	LPP – Alternative 5 (TSP)
Lands and Damages	$502,750	$502,750
Channels and Canals	$3,642,662	$5,495,491
Pumping Plant	$4,812,223	$9,513.076
PED	$2,028,044	$3,579,411
Construction Management	$648,974	$1,145,412
Interest During Construction	$517,000	$895,000
Total	**$12,151,653**	**$21,131,140**

*The Federal Cost Share limit is 65% of the NER Plan.

Table 5. Cost Apportionment for the LPP in 2016 dollars

Item	Federal Cost	Non-Federal Cost	Total
Construction (not including interest during construction)	$7,562,524*	$12,673,617	$20,236,141
Feasibility Study	$675,000	$675,000	$1,350,000
Monitoring and Adaptive Management	$97,500	$52,500	$150,000
Total	$8,335,024	$13,401,117	$21,736,141
Annual OMRR&R		$93,000	$93,000

*This is 65% of $11,634,653 – the NER construction cost without interest during construction.

Table 6. Sponsor Responsibility for the LPP in 2016 dollars

Item	Cost
LERRDS	$502,750
Feasibility Study	$675,000
Monitoring and Adaptive Management	$52,500
Cash	$12,170,867
Annual OMRR&R	$93,000

Monitoring and Adaptive Management

The project is designed to benefit fish and mussels. Baseline fish and mussels surveys will be done prior to beginning pump operation. Mussel surveys will be done in years 0, 3, and 5 and fish monitoring in years 0, 2 and 4. The Year 0 monitoring will include habitat and substrate surveys to establish the monitoring locations. After year 5, the results will be examined to determine if mussels have recolonized in the Quiver River and if the appropriate fish hosts are present. Monitoring will cease if results for both are positive. If either fish or mussels do not respond, adaptive management may be necessary. If fish species do not show a positive response, the system will be examined for potential barriers or other limiting factors. If fish respond but mussels do not, mussels could be relocated from within the Quiver/Big Sunflower system. Monitoring will continue after adaptive management actions.

The Year 0 mussel and fish surveys are estimated at $18,000, and the subsequent surveys will be $12,000 each. The initial fish survey will be $15,000 and subsequent surveys will be $10,000 each. The total cost of monitoring will be between $77,000 and $120,000. Relocating mussels would cost around $20,000. A total of $150,000 is estimated for monitoring and adaptive management.

Federal Responsibilities for the Selected Plan

The Federal government (USACE) will be responsible for PED and construction of the project in accordance with the applicable provisions of Public Law 99-662 (WRDA of 1986), as amended. The Government (USACE), subject to Congressional authorization, the availability of funds, and the execution of a binding agreement with the NFS in accordance with Section 221 of the Flood Control Act of 1970, as amended, and using those funds provided by the NFS, shall expeditiously construct the Project, applying those procedures usually applied to Federal projects, pursuant to Federal laws, regulations, and policies.

Non-Federal Responsibilities for the Selected Plan

Provide 35 percent of the costs for the NER plan and 100% of the costs for the difference between the NER plan and the LPP:

> Provide the non-Federal share of design costs allocated by the Government to ecosystem restoration in accordance with the terms of a design agreement entered into prior to commencement of design work for ecosystem restoration features of the project;
>
> Provide, during the first year of construction, any additional funds necessary to pay the full non- Federal share of design costs allocated by the Government to ecosystem restoration;
>
> Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the ecosystem restoration features of the project;
>
> Provide, during construction, any additional funds necessary to make its total contribution equal to 35 percent of total ecosystem restoration costs.

Do not use funds provided by a Federal agency under any other Federal program, to satisfy, in whole or in part, the non-Federal share of the cost of the project unless the Federal agency that provides the funds determines that the funds are authorized to be used to carry out the project;

Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such

detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d- 5), and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213), 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;

Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army" and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 - 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c et seq.);

Perform, or ensure performance of, 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), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;

Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA.

Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the ecosystem restoration features, hinder operation and maintenance of the project, or interfere with the project's proper function.

Do not use project or lands, easements, and rights-of-way required for the project as a wetlands bank or mitigation credit for any other project.

Risk and Uncertainty

Several uncertainties will be addressed during the development of feasibility level designs for the project.

1. Channel capacity of Quiver River and transfer channels will be verified during feasibility level design. The existing surveys date to 1980 and there is potential for changed conditions that may require modification to the NER plan and/or the LPP.

2. The height and status of existing weirs in the system will be verified during feasibility level design and could require some adjustments in the anticipated channel work in the connector channels.

3. The locations of bottomland hardwood reforestation are not known. All of the alternatives propose 100 acres, but is dependent on willing land owners. The habitat value will be higher if the replanting connects or creates larger contiguous blocks of forest

Environmental Disclosures

Environmental Operating Principles

Operating Principal #3 – Create mutually supporting economic and environmentally sustainable solutions. Quiver River is a severely degraded ecosystem that due to low flow or no flow conditions nearly every year provides poor aquatic habitat. A relatively simple project to lift water and let it gravity flow into the watershed from an adjacent river with year round flow (due to reservoir management) can significantly increase aquatic habitat. Additionally, for some additional cost, reliable agricultural production and food security can be increased.

Operating Principal #5 – Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs. A relatively simple project provides surface water as a resource for a degraded system with only life cycle management needed for the pumping facilities. Since this is not a flood risk management project, and once the lift is initiated from the Tallahatchie the remaining flow is gravity based, there will be little to no long term channel maintenance expected. The risk of poor performance is minimal.

Floodplain Management

Executive Order 11988, Floodplain Management (signed 24 May 1977), requires Federal agencies to recognize the significant values of floodplains and to consider the public benefits that would be realized from restoring and preserving floodplains. The Executive Order has an objective of the avoidance, to the extent possible, of long and short-term adverse impacts associated with the occupancy and modification of the base floodplain and the avoidance of direct and indirect support of development in the base floodplain wherever there is a practical alternative. Under this Order the Corps of Engineers is required to provide leadership and take action to:

a. Avoid development in the base floodplain unless it is the only practical alternative;
b. Reduce the hazard and risk associated with floods;
c. Minimize the impact of floods on human safety, health, and welfare; and
d. Restore and preserve the natural and beneficial values of the base floodplain.

Hazardous, Toxic, And Radioactive Waste (HTRW)

The local sponsor shall be responsible for ensuring that the development and execution of Federal, state, and/or locally required HTRW response actions are accomplished at 100 percent non-project cost, and no cost sharing credit will be given for the cost of response actions. If an HTRW problem is discovered during the PED phase, all work on that portion of the project shall be delayed until the local sponsor, EPA, state and local authorities, as appropriate, are consulted and the extent of the problem is defined. Measures to avoid the HTRW site can then be considered, if necessary, or possible required design changes can be accomplished after the problem and response have been determined (ER 1165-2-132)

In the case of HTRW identification, changes to the project schedule, cost estimate and NEPA documentation must be considered. Should the discovered HTRW site result in significant impacts for the recommended project, preparation of a reformulation document and/or a post-authorization change report may be required. The local sponsor will be responsible for planning and accomplishing any HTRW response measures, and will not receive credit for the costs incurred. This does not limit any rights the sponsor may have to recover such costs from PRP or responsible third parties or to work through state agencies to compel cleanup by PRP or responsible third parties prior to sponsor's acquisition of land.

A search of EPA databases on superfund sites (CERCLIS), toxic release inventory (TRI), hazardous waste sites (RCRA), Brownfields facilities (ACRES), facilities regulated for toxic substances (TSCA), facilities regulated for radiation and radioactivity (RADInfo), and water discharge permits (PCS) revealed that no releases or spills occurred within the proposed work limits. A search of MDEQ databases for underground storage tanks also revealed no tanks within the proposed work limits. If any HTRW is encountered during construction activities, the proper handling and disposal of these materials would be coordinated with the Mississippi Department of Environmental Quality (MDEQ) and USEPA.

State and Federal Holdings

There are no state or federal holdings within the project area.

Cultural Resources

A search of the Mississippi Historic Resources Inventory Database (2011) for recorded archaeological sites and previous surveys within one (1) mile of the proposed project areas did not reveal any recorded sites within the footprint of any of the proposed project features. However, several archaeological sites have been recorded within the one mile search area. Twenty-three sites were identified within one mile of the Black Bayou Weir project area, including 22 National Register of Historic Places (NRHP) ineligible, and one NRHP unevaluated site. Twenty seven (27) archaeological sites were identified within one mile of the proposed Cassidy Bayou Weir and Pump

Station, including 23 NRHP ineligible sites, three NRHP eligible, and one NRHP listed Mississippian mound and associated artifact scatter. Along with the archaeological sites, the MDAH database indicated six cultural resource surveys have been performed within one mile of this proposed project area. Three (3) archaeological sites were identified within one mile of the proposed Cassidy Transfer Cut at area 1, including two NRHP unevaluated sites, and one site listed as NRHP eligible. Finally, 10 archaeological sites were identified within one mile of the proposed Cassidy Transfer Cut at area 2, including six NRHP ineligible sites and four NRHP eligible. The MDAH database also indicates one archaeological survey within one mile of the proposed project area.

Elements of this project are still in design stages, but the area of proposed effect (APE) will be contained within the boundaries of the currently defined Rights-of-Entry (ROE) areas, and in close proximity to the project locations. When firm design plans that include the final APEs are finalized these will be supplied to the State Historic Preservation Officer (SHPO) and the Tribal Historic Preservation Officers (THPO) with vested interests in the culture resources in these areas. Since the ROE areas, and in turn future APEs, have not been previously surveyed for cultural resources, pursuant to 36 CFR 800, approximately 100% of the APEs will be Phase I surveyed for cultural resources prior to construction. The results of these surveys will be presented to the SHPO and THPOs during consultation. Should cultural resources be encountered during surveys, the U.S. Army Corps of Engineers, following consultation with the SHPO and THPOs, will first seek to avoid sites. If avoidance is not possible, coordination will be initiated with the Advisory Council on Historic Preservation, SHPO, and THPOs to develop appropriate testing and mitigation procedures.

Recreation Resources

The state of Mississippi recently conducted surveys of residents and an associated report of recreational needs (MDWFP 2014). The top five recreational activities that Mississippi residents participate in include fishing on a bank or pier, fishing on a boat, camping, jogging/running/walking for exercise, and events/festivals. The top five activities that Mississippi residents stated they would like to participate in include hiking and trails, canoeing/kayaking/rafting/tubing, water parks/splash pool/sprayground, camping, and archery. The proposed project would take some water from the Tallahatchie River and move it to the Quiver River. This would slightly improve recreational fishing opportunities in the Quiver River, but is not likely to have any significant effect on fishing in the Tallahatchie.

Prime & Unique Farmlands

The majority (>70 percent) of the lands in the project area are in agriculture. Dominant crops include soybeans (~41 percent), corn (~12 percent), rice (~5 percent), and cotton (~4 percent) in the vicinity of the project area (USDA 2014). Aquaculture becomes more prevalent along the downstream reaches of the Quiver River accounting for approximately 1 percent of the project area. The majority of agricultural lands immediately adjacent to the Tallahatchie River, proposed transfer channel, and Quiver River are considered prime farmland with the exception of those adjacent lands of the Quiver River in Leflore County (SSURGO 2014).

The project will not convert any prime farmland to other uses.

Environmental Justice

The Department of Defense's Strategy on Environmental Justice of 1995, directs Federal agencies to identify and address any disproportionately high adverse human health or environmental effects of Federal actions to minority and/or low-income populations. Minority populations are those persons who identify themselves as Black, Hispanic, Asian American, American Indian/Alaskan Native, and Pacific Islander. A minority population exists where the percentage of minorities in an affected area either exceeds 50 percent or is meaningfully greater than in the general population.

In Leflore County, the civilian labor force unemployment rate was 10.6 percent from November 2013 to December 2014. The amount of the population living below the poverty level in 2013 was 41.1 percent. The population of Leflore County in 2013 consisted of: 72.6 percent Black or African American, 24.1 percent white persons not Hispanic, 2.5 percent persons of Hispanic or Latino origin, 0.7 percent Asian, 0.4 percent American Indian and Alaska Native, less than 0.1 percent was Native Hawaiian and Other Pacific Islander, and 0.7 percent persons reporting two or more races.

In Sunflower County, the civilian labor force unemployment rate was 12.3 percent from November 2013 to December 2014. The amount of the population living below the poverty level in 2013 was 45.0 percent. The population of Sunflower County in 2013 consisted of: 72.8 percent Black or African American, 25.2 percent white persons not Hispanic, 1.5 percent persons of Hispanic or Latino origin, 0.4 percent Asian, 0.3 percent American Indian and Alaska Native, less than 0.1 percent was Native Hawaiian and Other Pacific Islander, and 0.6 percent persons reporting two or more races.

In Tallahatchie County, the civilian labor force unemployment rate was 9.6 percent from November 2013 to December 2014. The amount of the population living below the poverty level in 2013 was 38.4 percent. The population of Sunflower County in 2013 consisted of: 56.5 percent Black or African American, 36.2 percent white persons not Hispanic, 6.0 percent persons of Hispanic or Latino origin, 0.9 percent Asian, 0.3 percent American Indian and Alaska Native, 0.1 percent was Native Hawaiian and Other Pacific Islander, and 1.0 percent persons reporting two or more races.

The minority populations of the counties encompassing the project area are greater than 50 percent and are meaningfully greater than the general population. No residential, commercial, or industrial areas exist within or adjacent to the proposed project area. Impacts associated with construction activities of the pump station, weirs, and associated channel work would be temporary and have no disproportionate effects to environmental justice communities. Additionally, the project would not result in any loss of flood risk reduction from existing flood risk management projects in the area.

Navigation

The Tallahatchie River receives discharges from three of the four flood control reservoirs in Mississippi. Due to these releases the summer and fall flow in the Tallahatchie River is an order of magnitude higher than it was prior to the construction of the reservoirs. All of the streams connected to the reservoirs are greatly enhanced by the operation of the reservoirs. The following hydrograph from a gage near Glendora, which is downstream of the proposed transfer point, shows that the withdrawals for ecosystem restoration and water supply is less than 10% of the Tallahatchie flow downstream of the transfer point and would not affect navigation downstream.

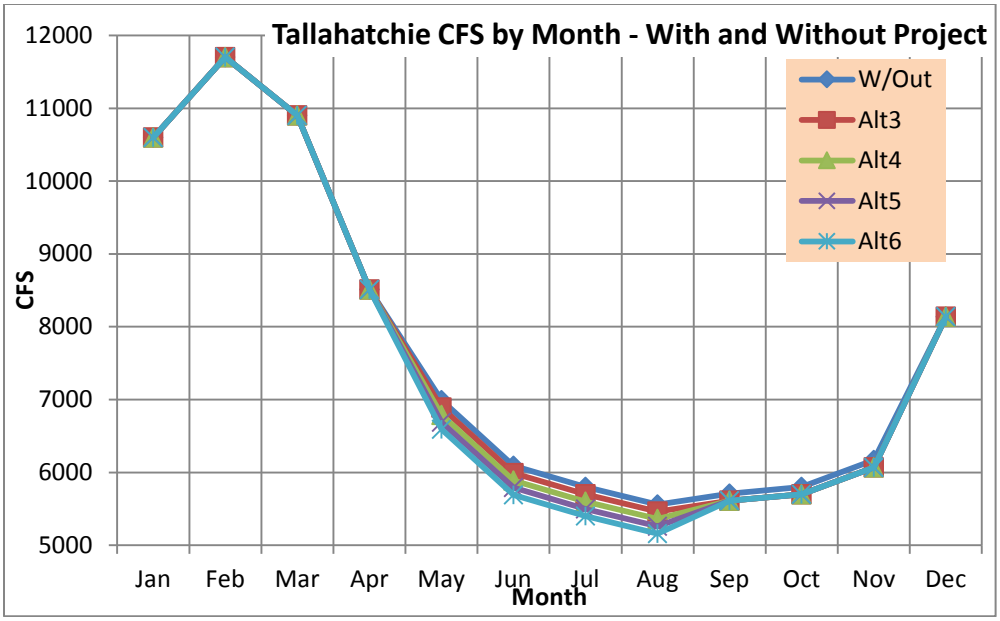

Figure 10. Tallahatchie stages by alternative (Alt 3= 100cfs, Alt 4 =200cfs, Alt 5=300cfs, Alt 6=400cfs)

Air Quality

Leflore, Sunflower, and Tallahatchie counties, Mississippi are all presently classified as "in attainment" with the state's air quality requirements. Project construction would require heavy equipment and there would be some mobile, temporary sources of emissions. These would not violate air quality standards. The planned pump station will be electric powered and will have no on-site emissions.

Noise

There will be an increase in noise during construction, but the construction areas are rural and near developed agricultural areas. The temporary increase in noise will not have significant impacts on the human environment and is not likely to disturb wildlife. The pumps are electric-powered and will be audible when operating, but only at close range.

Water Quality

A draft 404(b)1 Water Quality Analysis is included in Appendix F. At this time, the impacts to water quality are expected to be minor and short term. More detailed analysis will be done during the development of feasibility level designs and plans and specifications. The Vicksburg District will obtain Water Quality Certification from the State of Mississippi prior to construction. If the LPP would induce any unavoidable impacts, they would be mitigated in accordance with the Clean Water Act and state laws.

VIEWS OF THE NON-FEDERAL SPONSOR

The Non-Federal Sponsor supports the TSP, the Locally Preferred Plan, and provided a letter to the Vicksburg District on 21 September 2015 affirming their support. The letter also confirms their understanding that they will be responsible for all incremental costs over and above the costs associated with the 100 cfs National Ecosystem Restoration Plan, including any additional design, real estate, construction, operational, or maintenance costs.

CUMULATIVE EFFECTS

Quiver River lies within the Big Sunflower watershed. The Big Sunflower River is a tributary of the Yazoo River which flows into the Mississippi River. The Quiver River watershed is 515 square miles. Land use is predominately agriculture.

The section "Prior Reports, Existing Water Projects, and Ongoing Programs" of this report describes all of the specific past and present activities that may accumulate with the proposed project. The entire area has undergone significant alterations to maximize agricultural production and efficiency. Terrestrial wildlife habitat is limited, but conditions are stable. Aquatic habitat is degraded and is trending down in most of the region. Agricultural water supply and groundwater depletion are growing concerns throughout the Mississippi Delta and in the entire Mississippi Embayment region which includes Mississippi, Arkansas, Tennessee and other surrounding states.

The proposed Quiver River project would restore fish and mussels habitat and increase sustainability of those resources in the region. There are no other reasonably foreseeable projects in the area which would accumulative with this proposed project to either improve or further degrade habitat.

There are two large water supply projects under construction in Arkansas. These types of projects are likely to continue as groundwater depletion is reducing the economic efficiency of agriculture in the region and degrading stream habitat quality.

COORDINATION

The project delivery team had multiple meetings with representatives from the U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, the Mississippi Department of Wildlife Fish and Parks, and Mississippi Department of Environmental Quality. These agencies raised issues regarding operations and maintenance of the system, ecosystem effects, impacts to the Tallahatchie, water quality, groundwater, and endangered species. These issues drove plan formulation, analysis and plan selection. As indicated elsewhere in the report, further analysis during the feasibility design phase and plans and specifications will be necessary to resolve all concerns.

Relationship of Plan To Environmental Laws And Regulations

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	2
Bald Eagle Act	1
Clean Air Act Amendments of 1977	1
Clean Water Act of 1977, as amended	2
Endangered Species Act of 1973, as amended	2
Farmland Protection Policy Act of 1984	1
Fish and Wildlife Coordination Act of 1958	2
Flood Control Act of 1946, as amended	1
Food Security Act of 1985	1
National Environmental Policy Act of 1969	2
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	2
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. Coordination is ongoing.

IX. CONCLUSION

This office has assessed the environmental impacts of the proposed action and has determined that the tentatively selected plan is expected to benefit aquatic species and provide water supply benefits. It would have no significant negative impacts upon vegetation, fish, wildlife, cultural resources, or the human environment. Restoration of the Quiver River would benefit the natural environment and would help protect the agricultural economy in the area. A draft Finding of No Significant Impact is included in Appendix G.

Following public and technical review, more detailed construction plans will be developed and analyzed. All appropriate site specific surveys and coordination for water quality certification, cultural resources, HTRW, and federally listed species will be completed prior to construction.

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