YAZOO BACKWATER AREA REFORMULATION
MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY (MDEQ)
SECTION 401 CERTIFICATION REQUIREMENTS

ATTACHMENT 1 TO APPENDIX 2

YAZOO BACKWATER AREA REFORMULATION
MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY (MDEQ)
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QUESTION 1 - FEASIBLE ALTERNATIVES TO THE ACTIVITY

RESPONSE

1. The U.S. Army Corps of Engineers (USACE), Vicksburg District, considered a full range of alternative plans for the Yazoo Backwater Area Reformulation. The list of alternatives went through several iterations and included input from public involvement workshops. Altogether, four arrays of alternatives were considered between 1995 and 2000. During this period, consideration was given to 72 alternative plans, including 5 pump capacities; conservation easements and reforestation at 3 elevations (85.0, 90.0, and 100.3 feet, National Geodetic Vertical Datum (NGVD); flow management below 80.0 and 85.0 feet, NGVD; and construction of ring levees to protect individual communities. The final array of alternatives, selected by a Consensus Committee, includes variations of the following: (a) a pump station to provide flood damage reduction benefits above the pump station operation elevation; (b) conservation easements from willing sellers with reestablishment of forest on open land below the pump operation elevation to prevent existing flood damages by converting the land to a use more compatible to frequent flooding; (c) conservation easements from willing sellers to preserve forest land below the pump station operation elevation; (d) modified operation of the Steele Bayou structure to maintain higher water levels; and (e) compensatory mitigation for unavoidable environmental impacts.

2. The final list of alternatives evaluated for the Yazoo Backwater Area Reformulation is presented in detail in Volume 1 - Main Report, Supplement No. 1 to the 1982 Yazoo Area Pump Project Final Supplemental Environment Impact Statement (FSEIS). The final array of alternatives are described in the section "Final Array of Alternatives (2007 Final Report)." The final list of alternatives includes: (a) a no-action plan (Plan 1); (b) four nonstructural plans that would not utilize a pump station at the Steele Bayou structure for flood damage reduction (Plans 2, 2A, 2B, and 2C); (c) a structural plan that utilizes a pump station at the Steele Bayou structure for flood damage reduction, but does not include reforestation features (Plan 3); and (d) four combination plans that combine various pump station (structural) and reforestation/conservation measures (nonstructural) scenarios (Plans 4, 5, 6, and 7). Alternative 2C is based on the plan proposed by Dr. Leonard Shabman and Ms. Laura Zepp for the Environmental Protection Agency (EPA). Alternative 7 is based on the plan proposed by the U.S. Fish and Wildlife Service (FWS).

3. Other measures included in some of the alternatives would change the operation of the Steele Bayou structure to increase the low-flow water depth. In addition, for the alternatives with reforestation features up to 10 percent of a property could be in wildlife management

conservation measures other than reforestation. Conservation measures are practices implemented and maintained solely for wildlife management purposes. Conservation measures include, but are not necessarily limited to, (a) water management impoundments for waterfowl, wading birds, or other wildlife purposes; (b) food plots; (c) permanent openings maintained in early successional stages; (d) access trails, roads, and firebreaks; or (e) facilities and buildings necessary for property management (constructed above the 100-year flood plain elevation). While the Vicksburg District will provide the pipe for the waterfowl impoundments, landowners would be responsible for the cost of implementing and maintaining the waterfowl impoundments and any other conservations practices. Landowners also would be responsible for maintaining ditches used for agricultural operations on remaining portions of their properties or for agricultural operations on other properties dependent on those ditches. The Vicksburg District will have the right to enforce the terms of the registered easements. Should monitoring indicate a violation of the terms of the easement, the Vicksburg District will take necessary action to regain voluntary compliance with the terms of the agreement or use legal actions, if necessary.

4. In accordance with Federal regulations for water resource planning, evaluations were conducted to develop alternative flood protection plans that would provide a balance between economic development and environmental enhancement for water resource improvements in the Yazoo Backwater study area. The purpose of these evaluations was to determine the best plan overall in terms of flood damage reduction, National Economic Development (NED), and environmental quality (EQ). The NED plan is the optimum plan economically (i.e., the plan that produces the greatest excess benefits over costs or net benefits); and the EQ plan protects the quality of the environmental resources (i.e., fish and wildlife habitat, water quality, steam flow, cultural resources, and /or wetlands) in water resource planning. A detailed description describing selection of the NED, EQ, and the recommended plan is provided in the Main Report and in the Economics Appendix (Appendix 7).

5. As outlined in Engineer Regulation (ER) 1105-2-100, the criteria to evaluate alternative plans include all significant resources, outputs and plan effects, contributions to the Federal and study planning objectives, compliance with environmental protection requirements, the Principles and Guidelines for evaluation (completeness, effectiveness, efficiency, and acceptability), and any other criteria deemed significant by participating stakeholders. These criteria were used in the screening process to select the recommended plan. Each of the environmental resource analyses (wetlands, terrestrial, waterfowl, and aquatics) and the water quality analysis assumed that the maximum acres identified in each alternative plan would be reforested. For the economic and mitigation determinations, each of the environmental resources was reduced by 10 percent to account for the inclusion of 10 percent of the easement lands into the voluntary conservation measures.

6. According to Federal guidelines, any plan with a benefit-cost ratio (BCR) greater than or equal to 1, when compared to existing conditions, is economically justified and therefore feasible under USACE guidelines. Table 1 shows the BCR of the Yazoo Backwater Project (YBWP) final alternatives. The no-action alternative (Plan 1) was evaluated but was not considered viable

because it does not achieve a balanced solution to flood control needs and environmental opportunities in the study area. Flood damages to residences, agricultural lands, and infrastructure would continue impacting the city and county governments and the social well-being of local residents. In addition, the opportunity to achieve environmental benefits would be forgone with no-action. Only Plans 3, 4, 5, and 6 had a BCR greater than 1 and were determined to be economically justified under Federal guidelines. Plan 3 does not balance the flood damage reduction needs and environmental opportunities in the study area, as well as Plans 4 through 6, and was removed from further analysis. Plan 4, with the highest BCR, was determined to be the NED plan.

TABLE 1
SUMMARY OF BENEFITS TO
COST RATIO OF ALTERANTIVE PLANS
YAZOO BACKWATER AREA REFORMULATION a/

BCR	Alternative Plans								
	2	2A	2B	2C	3	4	5	6	7
Including Employment	0.61	0.80	0.88	0.74	1.3	1.6	1.5	1.3	0.94
Excluding Employment	0.61	0.80	0.82	0.73	1.3	1.6	1.4	1.2	0.89

NOTE: Benefits and costs are annualized at the current Federal interest rate of 5-1/8 percent and a 50-year project economic life (2005 cost data, 2005 land use).

a/ From Table 7-78, Economics Appendix, Appendix 7.

7. In addition to economic considerations, USACE must consider environmental sustainability in its selection of feasible alternatives. According to ER 1165-2-28 (30 April 1980), the EQ plan "must enhance, preserve, or restore the environment of the study area." The USACE utilizes four resource categories (wetland, terrestrial, waterfowl, and aquatics) to determine environmental benefits. The data developed in the analysis of these categories were used to calculate the incremental EQ benefits. Table 2 summarizes net environmental gains and losses in resource units based upon each plan's combined structural and nonstructural features. Gains and losses for each component feature (i.e., construction, hydrologic, and reforestation) will be discussed in the response to Question 2 - Mitigation. Of the plans identified as economically justifiable (Plans 3, 4, 5, and 6), Plans 5 and 6 have the greatest overall environmental gains.

TABLE 2
RESOURCE UNITS
ENVIRONMENTAL GAINS AND LOSSES
YAZOO BACKWATER AREA REFORMULATION a/ b/

Plan	Terrestrial		Waterfowl		Wetlands		Aquatic c/			
							Spawning e/		Rearing	
	(AAHU)	% Base	(DUD) d/	% Base	(FCU)	% Base	(AAHU)	% Base	(AAHU)	% Base
1f/	699,592		1,849,741		885,296		19,337		89,414	
2	174,658	25.0	2,785,122	150.6	418,291	47.2	16,684	86.3	28,322	31.6
2A	114,286	16.3	1,567,899	84.8	273,704	30.9	10,917	56.5	17,582	19.7
2B	23,273	3.3	-582,837	-31.5	21,168	2.4	-5,227	-27.0	-29,156	-32.6
2C	160,618	23.0	2,394,549	129.4	384,666	43.4	15,343	78.8	24,710	27.6
3	-113	0.0	-19,651	-1.1	-44,230	-5.0	-7,818	-40.3	-14,693	-16.4
4	52,355	7.5	489,408	26.5	96,712	10.9	913	4.7	-820	-1.0
5	78,188	11.2	977,406	52.8	172,525	19.5	5,850	30.3	7,201	8.0
6	114,534	16.4	1,754,222	94.8	264,164	29.8	10,889	56.3	16,642	18.6
7	174,906	25.0	2,846,517	153.9	414,102	46.8	18,010	93.1	28,243	31.6

a/ Taken from Table 18, Main Report.
b/ Data represent changes to resources based upon reforestation of 90 percent of the targeted acres for each plan.
c/ Aquatics was determined to be the controlling resource based upon the number of acres required to achieve no net loss of resource (mitigation) (Appendix 1).
d/ Includes 5 percent of perpetual easements in waterfowl foraging habitat.
e/ Aquatic-spawning was determined to be the controlling aquatic resource based on number of available acres (Appendix 11).
f/ Plan 1 represents the baseline conditions in each category.

8. A modified incremental environmental analysis was conducted to determine the most cost-effective plan from an environmental benefit perspective (Appendix 7, Section 8 and Main Report, section "Incremental Environmental Analysis"). This "modified" analysis was used to demonstrate why deviating from the NED plan was warranted and in the best interest of the Nation in regard to implementing water resource improvements in the Yazoo Backwater study area. Results of the modified incremental analysis are presented in Tables 3 and 4. Habitat units (HU) for each environmental resource were analyzed individually and then compared with incremental benefits from the entire array of outputs. Because Drs. Killgore and Hoover (Appendix 11) identified spawning habitat as the controlling aquatics habitat type, the modified incremental analysis used impacts to spawning HUs to determine the incremental costs to aquatics habitat. For this reason, impacts to aquatic rearing habitat are not discussed in any detail in this Section 401 Certification document.

TABLE 3
AVERAGE ANNUAL NONSTRUCTURAL COSTS BY HABITAT TYPE
AND BY SELECTED PLAN
YAZOO BACKWATER AREA REFORMULATION a/

Habitat Type	Environmental Benefits by Plan								
	Plan 4			Plan 5			Plan 6		
	Annual Costs b/ c/ ($000)	Units d/	Cost Per Unit ($)	Annual Costs b/ c/ ($000)	Units d/	Cost Per Unit ($)	Annual Costs b/ c/ ($000)	Units d/	Cost Per Unit ($)
Wetlands (FCU)	966	96,712	9.99	3,345	172,525	19.39	6,343	264,164	24.01
Terrestrial (AAHU)	966	52,355	18.45	3,345	78,188	42.78	6,343	114,534	55.38
Waterfowl (DUD)	966	489,408	1.97	3,345	977,406	3.42	6,343	1,754,222	3.62
Spawning Aquatics (AAHU)	966	913	1,058.05	3,345	5,850	571.79	6,343	10,889	582.51

a/ Table 20, Main Report.
b/ Values presented in 2006 dollars, including all costs associated with the construction and operation of these plans, and annualized at the current Federal interest rate of 5-1/8 percent over a 50-year economic project life.
c/ Annual costs for the nonstructural component are shown in Table 14, Main Report, and include the cost of land and reforestation, which applies to all environmental resource categories.
d/ Units were reduced from those shown in Table 16, Main Report, to account for those needed to compensate for construction of the structural feature. This table only reflects those units attributable to the nonstructural feature.

TABLE 4
AVERAGE ANNUAL NONSTRUCTURAL INCREMENTAL COSTS
ABOVE THE NED PLAN
BY HABITAT TYPE AND BY SELECTED PLAN
YAZOO BACKWATER AREA REFORMULATION a/

Habitat Type	Environmental Benefits by Plan								
	Plan 4 b/			Plan 5 c/			Plan 6 d/		
	Annual Costs e/ f/ ($000)	Units	Cost Per Unit ($)	Annual Costs e/ f/ ($000)	Units	Cost Per Unit ($)	Annual Costs e/ f/ ($000)	Units	Cost Per Unit ($)
Wetlands (FCU)	0	0	0	2,379	75,813	31.38	2,998	91,639	32.72
Terrestrial (AAHU)	0	0	0	2,379	25,833	92.09	2,998	36,346	82.49
Waterfowl (DUD)	0	0	0	2,379	487,998	4.88	2,998	776,816	3.86
Spawning Aquatics (AAHU)	0	0	0	2,379	4,937	481.87	2,998	5,039	594.96

a/ Table 21, Main Report.
b/ Plan 4 is the NED plan.
c/ Plan 5 is compared to Plan 4.
d/ Plan 6 is compared to Plan 5.
e/ Values presented in 2006 dollars, including all costs associated with the construction and operation of these plans, and annualized at the current Federal interest rate of 5-1/8 percent over a 50-year economic project life.
f/ Annual costs for the nonstructural component are shown in Table 14, Main Report, and include the cost of land and reforestation, which applies to all environmental resource categories.

9. Table 3 displays the average annual cost for the nonstructural features for Plans 4, 5, and 6. These are the three plans in the final array identified to be within the closest proximity to the NED plan and to exhibit the "least" total average annual costs. For these plans, the average annual costs of the nonstructural features ranged from a low of $966,000 with Plan 4 to a high of $6,343,000 with Plan 6. Outputs for the four habitat types were evaluated individually to determine the cost per HU for each habitat type and each plan. For example, with Plan 4, the average cost per average annual habitat unit (AAHU) for aquatics was determined to be $1,058.05 ($966,000 ÷ 913 AAHUs). This same process was utilized to determine the average cost per unit by habitat type for all three plans. Plan 5 was determined to produce more aquatics habitat units at a lower cost per unit ($571.79 per HU), which was identified as the controlling resource during mitigation determinations since it required the most acres to achieve no net loss.

10. Table 4 provides the results of the incremental cost analysis, which illustrates the cost per HU increase between plans and substantiates the deviation from Plan 4 to Plan 5. The average annual nonstructural cost for Plan 5 increased by $2,379,000 over Plan 4's average annual cost (i.e., $3,345,000 for Plan 5 less $966,000 for Plan 4 (Table 3)). Likewise, the average annual cost for the nonstructural features of Plan 6 increased by $2,998,000 (i.e., $6,343,000 for Plan 6 less $3,345,000 for Plan 5 (Table 3)). The incremental analysis shows that Plan 5 produces 4,937 additional aquatics-spawning AAHUs than Plan 4 at an incremental cost of $481.87 per unit. At the same time, the incremental analysis shows that Plan 6 would add an additional 5,039 spawning AAHUs at a cost of $594.96 per unit. Implementation of Plan 5 reduces the incremental cost of aquatics-spawning and thus, was the deciding factor in deviating from Plan 4 to Plan 5. Plan 6 was removed from the array because the incremental costs per HU for Plan 6 aquatics were higher per unit than the incremental costs per HU for Plan 5 aquatics.

11. The Vicksburg District's analysis identified Plan 5 as the plan that maximizes both economic and environmental resource benefits to the YBWP Area. For these reasons, Plan 5 was selected as the recommended plan. Plan 5 will provide flood reduction benefits through both structural and nonstructural measures and includes an operational measure to provide environmental benefits. Plan 5 measures include:

a. Nonstructural. Acquisition and reforestation/conservation measures on up to 55,600 (b) acres of agricultural lands through perpetual easements from willing sellers only. Approximately 42,800 acres of cleared land are potentially available below elevation 87.0 feet, NGVD (1-year flood plain at the Steele Bayou structure), and the remaining acreage needed to reach up to the 55,600 acres would be acquired between elevation 87.0 and 91.0 feet, NGVD (2-year flood plain at the Steele Bayou structure). Up to 10 percent of an acquired property could be in conservation measures other than reforestation. Conservation measures are practices implemented and maintained solely for wildlife management purposes. Conservation measures include, but are not necessarily limited to: (1) water management impoundments for waterfowl, wading birds, or other wildlife purposes; (2) food plots; (3) permanent openings maintained in early successional stages; (4) access trails, roads, and firebreaks; or (5) facilities and buildings necessary for property management (constructed above the 100-year flood plain elevation). While the Vicksburg District will provide the pipe for the

waterfowl impoundment, landowners would be responsible for the cost of implementing and maintaining the waterfowl impoundment and any other conservation practices. Landowners also would be responsible for maintaining ditches used for agricultural operations on remaining portions of their properties or for agricultural operations on other properties dependent on those ditches.

b. Structural. A 14,000-cfs pump station with a year-round pumping elevation of 87.0 feet, NGVD.

c. Operational. Operation of the Steele Bayou structure to maintain water elevations between 70.0 and 73.0 feet, NGVD, during low-water periods. No additional real estate is required for this feature.

[NOTE: Blocking Out. The reforestation/conservation features easement acquisition limits for the Yazoo Backwater Reformulation Study were established based upon flood frequency stage elevations. However, based upon sound real estate practices and guidance as found in USACE real estate regulations, blocking out will be utilized to address such items as access, the extent of severance damages, and avoidance of an uneconomic remainder. The blocking out will result in the acquisition of some lands outside a given flood event or elevation. The Vicksburg District Real Estate Division has vast experience in the acquisition of lands based upon elevation and typically uses a blocking factor of 30 percent. This figure was utilized for calculating the acreage to be acquired for the reforestation/conservation features easement in connection with the Yazoo Backwater Reformulation Study. The symbol "(b)" indicates a blocked acreage in the alternative descriptions listed above. Acreages are rounded to the nearest 100 acres and are based on 2005 land use.

Slope. In the description of the alternative, the elevation at the Steele Bayou structure was referenced regarding the acquisition of perpetual/flowage easements. These references do not imply an absolute elevation, but imply an elevation that rises as you move upstream from the structure. The rate of the rise or the slope of the surface can be found in Appendix 6 (Engineering), and it is based upon a hydrologic event, such as the 1-year frequency flood. The use of the elevation at the Steele Bayou structure establishes a standard point of reference for comparison of the alternatives.]

12. The Vicksburg District will acquire perpetual easements on lands for a period of 14 years after the Record of Decision (ROD) is signed. This period includes 4 years of construction and 10 years following construction. The additional 10 years would allow sufficient time for the community to cycle through postproject flood experiences, as well as two Farm Bill

Amendments that might affect landowner decisions. Land use analysis shows that approximately 42,800 acres of cleared land are potentially available below 87.0 feet, NGVD (1-year flood plain). The remaining acreage needed to reach the target of 55,600 acres would be acquired between 87.0 and 91.0 feet, NGVD (2-year with-project flood plain), which contains approximately 56,400 acres of cleared lands. The Vicksburg District believes landowners will be willing to enroll portions of their lands in the postproject 2-year flood plain because the pump station does not remove all crop damages to these lands. Depending on the landside and riverside stages at the Steele Bayou structure, the pump station may not operate during a 2-year or greater flood event. There is still potential annual loss for landowners on with-project 2-year frequency lands. According to the U.S. Department of Agriculture (USDA) – Farm Services Agency (FSA), Farm Bill policy caps Natural Resources Conservation Service (NRCS) Wetland Reserve Program (WRP) at 10 percent of the county total cropland acreage. The NRCS Conservation Reserve Program (CRP) caps at 25 percent of the total county cropland acreage; however, WRP acreage is included in the 25 percent. The ceiling for WRP enrollment in Sharkey and Issaquena Counties has been reached, according to the FSA National website. Since CRP enrollments are not perpetual and are subject to revision with each Farm Bill, enrollment in this program should not impact long-term land use. County governments have expressed reservations on raising these ceilings due to the impact on their tax revenue because reforestation under these programs results in a significant reduction in property taxes for the counties. Based on local action to date and upon recent congressional actions, future expansion of these programs is unlikely. For these reasons and because of the reforestation trend already begun in the Yazoo Backwater study area, the Vicksburg District believes the 55,600 acres are attainable.

13. Of the targeted 55,600 acres, the Vicksburg District guarantees acquisition and reforestation of a minimum of 15,029 acres prior to pump station operation. The guaranteed minimum reforestation will provide 100 percent compensation for all environmental impacts including: (a) the current YBWP; (b) past construction at the Yazoo Backwater pump station site in 1986; and (c) the remaining mitigation owed for construction of the Yazoo Backwater levee. The first 4,367 acres acquired will be credited to compensatory mitigation required for past construction at the pump station site and the Yazoo Backwater levee. The next 3,858 acres will achieve a no net loss of wetland functional value. The remaining 6,804 acres obtained to achieve the minimum threshold of reforestation will result in a no net loss in aquatic resource value. Therefore, a minimum of 15,029 acres must be acquired prior to pump station operation. The minimum guaranteed acreage will produce a no net loss of aquatic-spawning value and provide a 2.1 percent increase in terrestrial value, a 1.4 percent increase in waterfowl value, and a 2.4 percent increase in wetland value. The remaining acres of reforestation/conservation measures will provide additional environment resource benefits to the study area.

14. Should the Vicksburg District be unsuccessful in securing enough perpetual conservation easements to cover the minimum threshold requirements for pump station operation, compensatory mitigation for the previous work on the inlet and outlet channel, losses from the timing of the mitigation for the Yazoo Backwater levee, and unforested areas within Lake George Wildlife Management Area, then the difference between the amount of perpetual conservation easements acquired and the minimum threshold will be purchased in fee title from willing sellers. This purchase in fee would first be evaluated in the Yazoo-Mississippi Delta, but if sufficient agricultural lands were not available, the Vicksburg District would look elsewhere in the Mississippi Alluvial Valley. Fee title acquisition will follow the same selection criteria as easement acquisition (i.e., target the 1-year flood plain with some acquisition above the 1-year flood plain due to real estate blocking requirements). These lands would be reforested and turned over to a state or Federal agency to manage.

QUESTION 2 - MITIGATION

RESPONSE

15. Mitigation for the Yazoo Backwater Area Reformulation is discussed in Appendix 1 – Mitigation, found in Volume 1, Supplement No. 1 to the 1982 Yazoo Area Pump Project FSEIS.

16. The goal of the Yazoo Backwater reformulation was to develop a project that would provide an appropriate balance between environmental sustainability and flood damage reduction. To achieve this goal, the Vicksburg District initiated the process of avoiding, minimizing, and compensating adverse environmental effects early in the planning process. This approach is consistent with the 7 February 1990 Memorandum of Agreement (MOA) between EPA and the Department of the Army concerning the determination of mitigation under the Clean Water Act Section 404(b)(1) guidelines. Section III.B states ". . . such mitigation should provide, at a minimum, one for one functional replacement (i.e., no net loss of values) . . . ." This philosophy was integral to the development of a balanced recommended plan for the YBWP and is consistent with Regulatory Guidance Letter No. 02-2. Sections 2a, 2c, and 2d address a watershed-based approach; mitigation to replace functional losses to aquatic resources (including wetlands); and functional assessment, replacement, and accounting.

17. In keeping with the intent of the MOA, the Yazoo Backwater environmental mitigation analyses utilized changes in the functional value of each environmental resource rather than relying only on changes in the number of acres affected by features of each alternative evaluated. Wetland, aquatic, terrestrial, and waterfowl resources have long been identified as significant environmental resources to projects within the Vicksburg District's boundaries. As such, tools have been developed to assist evaluations of project impacts to each of these significant resources. Teams of professional biologists from USACE; EPA; FWS; and the Mississippi Department of Wildlife, Fisheries and Parks have developed methodologies to identify and quantify project impacts to each of these environmental resources. Each impact analysis uses methodologies that account for both the quantity of habitat (acres) and the quality of the habitat being provided to the resource. Combining both aspects has been demonstrated to provide a better assessment of the true value of environmental resources. For example, 1 acre of mature bottom-land hardwoods provides greater wetland functional value than 1 acre of a 10-year-old restored stand of bottom-land hardwoods.

18. Environmental effects to each resource were determined for the proposed YBWP alternatives. Gains and/or losses to the environment included hydrologic (operating the pump station), reforestation, and construction effects, as well as unmitigated past losses that have prorated over time (i.e., construction at the Yazoo Backwater pump station site in 1986 and reformulation of mitigation owed for the Yazoo Backwater levee). Table 5 is a summary of these resource changes for the final array of alternatives. Table 6 is a summary of the corresponding acreage impacts for the final array of alternatives. The net effects of each plan are presented as structural effects (hydrologic and construction impacts) and nonstructural effects (reforestation). This allowed the calculation of a minimum threshold of reforestation to achieve no net loss (mitigation).

19. Table 7 summarizes the net environmental effects for the YBWP alternatives. The avoid-and-minimize and nonstructural flood damage reduction features (reforestation and waterfowl foraging areas) reduced or offset all adverse effects on all plans except Plans 2B and 3, which require additional mitigation exclusive of any nonstructural environmental gain. Plan 3 contained no nonstructural flood damage reduction feature to offset environmental losses. Plan 2B is considered a nonstructural plan although it includes ring levees, a pump station, structures, and acquisition of lands below the 2-year flood plain. The recommended plan (Plan 5) will require a minimum number of mitigation threshold acres to offset the impacts from construction and operation of the pump station and to achieve no net loss of resource value (Table 8). Once the minimum threshold acres are acquired, the additional acres of reforestation/conservation measures would provide a 19.5 percent increase in wetland function, an 11.2 percent increase in terrestrial resource value, a 52.8 percent increase in waterfowl foraging value, and a 30.3 percent increase in aquatic spawning value.

20. The minimum threshold analysis is used to determine the minimum number of reforested acres required under the nonstructural feature to ensure that no net loss of resource value is achieved prior to initiation of pump station operation (Table 8). The minimum threshold analysis is based upon the recommended plan's structural impacts. For the recommended plan, the wetland and aquatic-spawning resources showed structural HU losses and will require a minimum threshold of reforestation before no net loss of resource (mitigation) is achieved. Converted into acres, the -1,607 aquatic-spawning AAHUs are equivalent to 10,662 acres, while the -14,428 wetland FCUs are equivalent to 3,858 acres. A minimum threshold of 10,662 acres of reforestation is required to ensure no net loss of spawning habitat value. Because aquatic spawning is the resource that requires the most acres of reforestation to achieve no net loss, it was the resource identified as the controlling resource. Acquisition and reforestation of 10,662 acres would produce a net gain in wetland functional value by adding an additional 6,804 acres of reforested bottom-land hardwood wetlands above the 3,858 acres required to achieve no net loss of wetland functional value.

TABLE 5
ENVIRONMENTAL GAINS AND LOSSES
FINAL ARRAY OF PLANS
YAZOO BACKWATER AREA REFORMULATION a/
(2005 LAND USE)

Alternative	Terrestrial (AAHU)			Wetland (FCU)		
	Structural Effect		Nonstructural Effect	Structural Effect		Nonstructural Effect
	Construction	Hydrologic	Reforestation b/	Construction	Hydrologic	Reforestation b/
1	0	0	0	0	0	0
2	0	0	174,658	0	0	418,291
2A	0	0	114,286	0	0	273,704
2B	-9,892	-3,901	37,066	-16,732	-50,869	88,769
2C	0	0	160,618	0	0	384,666
3	-113	0	0	-240	-43,990	0
4	-113	239	52,229	-240	-28,132	125,084
5	-113	239	78,062	-240	-14,188	186,953
6	-113	361	114,286	-240	-9,300	273,704
7	-113	361	174,658	-240	-3,949	418,291

Alternative	Waterfowl (DUD)				Aquatic Spawning (AAHU)		
	Structural Effect		Nonstructural Effect		Structural Effect		Nonstructural Effect
	Construction	Hydrologic	Reforestation b/	Foraging c/	Construction	Hydrologic	Reforestation b/
1	0	0	0	0	0	0	0
2	0	195,476	-526,574	3,116,220	0	0	16,684
2A	0	0	-471,171	2,039,070	0	0	10,917
2B	-290,768	-673,635	-279,754	661,320	-1,904	-6,864	3,541
2C	0	0	-471,171	2,865,720	0	0	15,343
3	-2,166	-17,485	0	0	-27	-7,791	0
4	-2,166	42,032	-482,318	931,860	-27	-4,049	4,989
5	-2,166	77,973	-491,181	1,392,780	-27	-1,580	7,457
6	-2,166	261,126	-543,808	2,039,070	-27	-1	10,917
7	-2,166	281,591	-549,128	3,116,220	-27	1,353	16,684

NOTE: Construction effects are those that result from the actual construction site; hydrologic effects are those that result from operation of the structural features; reforestation effects are those that result form reforesting agricultural lands; and foraging effects are those that result form installation of water control structures.

+ indicates a gain in environmental resources
- indicates a loss in environmental resources

a/ Table 16, Main Report.
b/ Ninety percent of the reforestation acreage was used to estimate habitat value because up to 10 percent of the nonstructural feature could be used for other conservation purposes.
c/ Assumes 5 percent of the easement lands could be used for waterfowl foraging habitat.

TABLE 6
ACRES AFFECTED BY PLAN
FINAL ARRAY OF PLANS
YAZOO BACKWATER AREA REFORMULATION a/
(2005 LAND USE)

Alternative	Terrestrial			Wetland		
	Structural Effect		Nonstructural Effect	Structural Effect		Nonstructural Effect
	Construction	Hydrologic	Reforestation	Construction	Hydrologic	Reforestation
1	0	0	0	0	0	0
2	0	0	124,400	0	0	124,400
2A	0	0	81,400	0	0	81,400
2B	-3,156	-11,985 b/	26,400	-3,156	92,104	26,400
2C	0	0	114,400	0	0	114,400
3	-38	0	0	-38	118,486	0
4	-38	430 c/	37,200	-38	101,629	37,200
5	-38	430 c/	55,600	-38	66,945	55,600
6	-38	1,460 b/	81,400	-38	48,066	81,400
7	-38	1,460 b/	124,400	-38	28,408	124,400

Alternative	Waterfowl				Aquatic Spawning		
	Structural Effect		Nonstructural Effect		Structural Effect		Nonstructural Effect
	Construction	Hydrologic	Reforestation d/	Foraging e/	Construction	Hydrologic f/	Reforestation f/
1	0	0	0	0	0	0	0
2	0	1,384	1,940	6,220	0	0	40,299
2A	0	0	1,753	4,070	0	0	26,370
2B	-3,156	-4,766	1,106	1,320	-3,156	-14,347	8,552
2C	0	0	1,753	5,720	0	0	37,060
3	-38	-128	0	0	-38	-16,285	0
4	-38	301	1,793	1,860	-38	-8,463	12,051
5	-38	561	1,827	2,780	-38	-3,303	18,012
6	-38	1,861	2,001	4,070	-38	-2	26,370
7	-38	2,001	2,022	6,220	-38	2,828	40,299

NOTE: Construction effects are those losses that result from the actual construction site; hydrologic effects are those that result from operation of the structural features; reforestation effects are those that result form reforesting agricultural lands; and foraging effects are those that result form installation of water control structures.

+ indicates a gain in environmental resources
- indicates a loss in environmental resources

a/ Table 17, Main Report.
b/ Combined wood duck and mink acres.
c/ Wood duck acres only.
d/ Represents only that portion of total number of acres reforested that contribute to waterfowl resources.
e/ Waterfowl foraging acres based on 5 percent easement lands.
f/ Average flooded acres.

TABLE 7
ENVIRONMENTAL GAINS AND LOSSES – ALL RESOURCES
FINAL ARRAY OF PLANS
YAZOO BACKWATER AREA REFORMULATION a/ b/

Plan	Terrestrial (AAHUs)	Waterfowl (DUDs)	Wetlands (FCUs)	Aquatic (AAHUs) Spawning
1	0	0	0	0
2	174,658 (25.0)	2,785,122 (150.6)	418,291 (47.2)	16,684 (86.3)
2A	114,286 (16.3)	1,567,899 (84.8)	273,704 (30.9)	10,917 (56.5)
2B	23,273 (3.3)	-582,837 (-31.5)	21,168 (2.4)	-5,227 (-27.0)
2C	160,618 (23.0)	2,394,549 (129.4)	384,666 (43.4)	15,343 (78.8)
3	-113 (0)	-19,651 (-1.1)	-44,230 (-5.0)	-7,818 (-40.3)
4	52,355 (7.5)	489,408 (26.5)	96,712 (10.9)	913 (4.7)
5	78,188 (11.2)	977,406 (52.8)	172,525 (19.5)	5,850 (30.3)
6	114,534 (16.4)	1,754,222 (94.8)	264,164 (29.8)	10,889 (56.3)
7	174,906 (25.0)	2,846,517 (153.9)	414,102 (46.8)	18,010 (93.1)

a/ From Table 1-28, Mitigation Appendix.
b/ Data for resources are based on reforestation of 90 percent of the targeted acres for each plan.

TABLE 8
MITIGATION/MINIMUM THRESHOLD REFORESATION REQUIREMENTS
RECOMMENDED PLAN
YAZOO BACKWATER AREA REFORMULATION a/

Effect	Terrestrial		Waterfowl		Wetlands		Aquatic Spawning	
	AAHUs	Threshold Acres	DUDs	Threshold Acres b/	FCUs	Threshold Acres	AAHUs	Threshold Acres
Baseline	699,529	-	1,849,741	-	885,296	-	19,337	-
Structural								
Construction	-133	72	-2,166	4	-240	64	-27	59
Hydrologic	239	0	77,973	0	-14,188	3,794	-1,580	10,603
Total Structural	126	72	75,807	4	-14,428	3,858	-1,607	10,662
Nonstructural								
Reforestation	78,062	0	-491,181	980	186,953	0	7,457	0
Foraging	N/A	N/A	1,392,780	0	N/A	N/A	N/A	N/A
Total Nonstructural	78,062	0	901,599	980	186,953	0	7,457	0
TOTAL	78,188	72	977,406	984	172,525	3,858	5,850	10,662

a/ From Table 1-34, Mitigation Appendix.
b/ Acres of waterfowl impoundments.

21. Table 9 summarizes the minimum acreages required for compensatory mitigation of past construction and to achieve a no net loss of resource value. In addition to acreage required for no net loss of resource value for YBWP, there is a mitigation requirement of 4,367 acres of reforestation owed for past construction activities on the Yazoo Backwater levee at the Lake George Wildlife Management Area and for clearing at the Yazoo Backwater pump station construction site in 1986. The total mitigation requirement for Plan 5 and past construction becomes 15,029 acres.

TABLE 9
MITIGATION REFORESTATION ACREAGE TO ACHIEVE NO NET LOSS
YAZOO BACKWATER AREA REFORMULATION a/

Item	Acreage
Nonstructural Reforestation Required - Recommended Plan	
Pump Structure – Changes in Hydrology	10,603
Pump Structure – Loss of 38 acres of woodlands at construction site	59
Subtotal	10,662
Compensatory Mitigation Required – Past Construction	
Pump Structure (original 215.2 acres of clearing in 1986 prorated for time lag)	519
Lake George Mitigation Area (prorated for time lag and unplanted areas)	3,848
Subtotal	4,367
Total Acreage to Be Acquired (needed to achieve no net loss)	15,029

a/ Table 1-35, Mitigation Appendix.

22. Under the recommended plan, the Vicksburg District has committed to the purchase of perpetual easements on up to 55,600 acres of agricultural lands on or about elevation 87.0 feet, NGVD. Acquisition of easements and reforestation/conservation measures will be accomplished concurrently with project design and construction. Purchase will begin as soon as the ROD is signed, funding becomes available, and the Real Estate documentation can be completed. The first perpetual easements acquired will be used to mitigate for past construction at the pump station site and the Yazoo Backwater levee. After the first 4,367 acres of mitigation are acquired to compensate for past construction, all future lands will be assigned to the YBWP recommended plan. The next 3,858 acres acquired will achieve a no net loss of wetland functional value. The remaining 6,804 acres required to achieve the minimum threshold of reforestation to achieve a no net loss in aquatic resource value will be acquired prior to pump station operation. If the nonstructural reforestation component of the recommended plan does not achieve this minimum threshold through perpetual easements, any remaining acres would be acquired in fee title and would be managed by a Federal or state resource agency. The remainder of the 55,600 acres of perpetual easements will be solicited through the first 10 years of pump station operation. Including the construction period, the Vicksburg District will solicit perpetual easements and reforest agricultural land for 14 years after the ROD is signed. This topic is discussed in more detail in the response to Question 1.

23. The Vicksburg District is committed to successful reforestation programs. All reforested areas are monitored to ensure adequate survival. In addition, USACE scientists at the U.S. Army Engineer Research and Development Center (ERDC) began monitoring wetland functional value for mitigation reforestation in the Yazoo Basin in 2000. Reports of ERDC's findings are presented as Attachment 1 to the Mitigation Appendix. Functional value monitoring utilizes the same hydrogeomorphic (HGM) methodology that was used for impact assessment. Functional recovery is estimated using field data and assumptions pertaining to the value of reforestation on the recovery of wetland function, which are listed in the Wetland Appendix. Properties selected for monitoring are rotated every year and are currently on a 5-year sampling cycle. The existing properties currently being monitored are similar to the lands that will be reforested for the YBWP. Once reforested, a portion of the YBWP lands will be incorporated into the ERDC sampling cycle. Preliminary monitoring data since 2001 indicate that functional recovery is occurring as projected on reforested lands in the Yazoo Basin. The Vicksburg District does not plan to conduct HGM evaluations to determine if reductions are occurring in areas receiving flood protection.

24. For the YBWP, the Vicksburg District will monitor to be assured that any water control structure furnished to the landowner is installed. Tree survival will be monitored visually by the Vicksburg District to ensure success in the early years; however, after successful establishment, monitoring of both the reforestation and water control structures will primarily be conducted by remote sensing techniques with visual onsite inspections, if warranted. Planting of the perpetual easement lands, as well as the purchase of water control structures, will be accomplished as rapidly as funding, manpower, seedlings, and structures are available, but should be complete within 24 months of acquisition of the perpetual easements.

25. Pursuant to Section 7 of the Endangered Species Act, a Biological Assessment (BA) for the endangered plant pondberry and the threatened Louisiana black bear was sent to FWS on 5 December 2005 (Appendix 14). The BA determined that the project was not likely to adversely affect either species. The FWS did not concur with the determination that the project was not likely to adversely affect pondberry. The Vicksburg District requested initiation of Section 7 formal consultation with FWS to ensure the project did not jeopardize the continued existence of pondberry. The FWS initiated Section 7 formal consultation for pondberry on 18 January 2006. The FWS provided its pondberry BO 2 July 2007. The formal consultation enabled the Vicksburg District and FWS to examine possible impacts on pondberry in greater detail. Looking at the same data, each agency drew different conclusions about the role of backwater flooding on pondberry. Despite these differences, FWS concluded the project would not jeopardize the continued existence of the endangered plant pondberry.

26. To help conserve and recover the pondberry, the Vicksburg District has significant ongoing or planned activities designed to address data and recovery tasks contained in the FWS 1993 Pondberry Recovery Plan. In 2003, the Vicksburg District and USDA Forest Service entered into a 7-year, $5 million interagency agreement to conduct extensive research on pondberry's biological and ecological requirements. In addition, in 2007, the Vicksburg District and FWS signed an MOA to establish two new pondberry populations in the study area and conduct additional field experiments evaluation the effects of flooding, stand thinning, competition, and pathogens.

QUESTION 3 - INITIAL AND SECONDARY IMPACTS ON ALL EXISTING AND ALL CLASSIFIED USES OF THE WATERS OF THE STATE

RESPONSE

27. All waters of the state are classified for uses consistent with the goals of the Clean Water Act. According to Mississippi's 2004 Section 305(b) report, most of the streams in the YBWP Area are classified as Fish and Wildlife streams. Classified uses for most of the waters within the YBWP Area are for aquatic life support and fish consumption. Many of the flowing streams are also used for secondary contact recreational uses, such as wading, fishing, and boating. The water quality criteria associated with each of these classified uses are found in the "State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters" (Mississippi Department of Environmental Quality (MDEQ), 2002). Many of these waters were determined to not be supporting their designated use, and many have been determined to be impaired when evaluated against existing water quality standards. Irrigation is a nonclassified, but current, use for some of the project area waters. Completion of the YBWP will not cause significant impacts to existing and classified uses of waters of the state. The following discussion will show that the nonstructural reforestation feature will benefit water quality within the study area.

28. Impacts to water quality for the recommended plan (Plan 5) may result from: (a) deforestation and earth movement at the construction site, (b) operation of the Yazoo Backwater pump station, (c) changes in hydrology that reduce flood elevations above the 1-year flood plain, (d) reforestation, and (e) increases in the minimum water surface elevation behind the Steele Bayou structure each year. For simplicity, the net impact of the combination of reduced flood duration and reforestation will be discussed as a unit. The impacts of each of these project features, as they apply to existing and classified uses of study area waters, will be discussed in greater detail below. For the water quality analysis, estimates of reforestation benefits were calculated on reforestation of the maximum number of acres targeted within each project alternative.

AQUATIC LIFE SUPPORT (CLASSIFIED USE)

29. Construction impacts on the aquatic life support designated use of adjacent water bodies have been fully analyzed in the Water Quality Appendix (Appendix 16). Construction at the Yazoo Backwater pump station site and completion of the inlet and outlet channels would cause temporary increases in turbidity. Construction activities associated with the pump station will conform to the MDEQ Stormwater Construction General Permit. During construction, erosion at the pump station site will be minimized by temporary and permanent stormwater prevention measures. Existing levees and dikes will also protect surrounding water bodies. The partially completed inlet and outlet channels will be unwatered to allow use of land-based equipment during construction. The unfinished connections to the Yazoo River and Steele Bayou will

remain in place until most of the construction is complete. Localized turbidity plumes could occur when the inlet and outlet channel connections are completed and during periodic maintenance dredging within these channels. During these periods the inlet and outlet channels will be slack water environments, which should minimize turbidity increases in the adjacent water bodies. Temporary increases in turbidity could cause fish to temporally move out of the immediate vicinity. Temporary increases in turbidity could also decrease light penetration affecting phytoplankton primary productivity and reduce dissolved oxygen (DO) concentrations. Any effects to turbidity or DO should be short term, however, and concentrations should return to ambient conditions once these operations are completed.

30. Possible impacts to fish during pump station operation are discussed in Appendix 11, the Aquatics Appendix. Given the distribution of fish species in Steele Bayou, only a small percentage of the regionally available fish are likely to be in the waters above the structure in the periods of flooding when the pump station will be operating. There is no particular fishery habitat need that would concentrate fish in the waters above the pump station during flood stages. However, during pump station operation, there is the possibility that fish and other aquatic organisms could become trapped and move through the intake structure (entrainment) where they could potentially be harmed or killed from pump impellers and excessive hydraulic forces. There is also the possibility that organisms, including adult fish, could become trapped against the screening devices associated with pump intakes (impingement). The Vicksburg District acknowledges that entrainment may occur during operation of the pumps, but does not anticipate significant impacts to fish populations in the study area for the reasons stated below. Impingement against the trash rack is also a possibility, but with a 6-inch wire mesh most fish will either go through the rack into the pump or avoid the intake. Therefore, no significant adverse impacts are anticipated for impingement.

31. The type and operation of the pump station indicates that entrainment will not be a major impact. The pump station will draw water near the bottom of the inlet channel, which is approximately 27 feet in total depth. Smaller, more entrainable fish are usually found in the mid- to upper-water column where food and oxygen are more plentiful. At the trash rack, the intake velocities will be approximately 3 feet per second. Velocities in the inlet channel will decrease rapidly to less than 2 feet per second. Approximately 500 feet from the trash rack, velocities will decrease by 24 percent and 800 feet from the trash rack, they will have decreased by 32 percent. Most adult fish, including minnows, have burst speeds of 3 feet per second or greater that can be maintained for at least 30 seconds (Beamish, 1978). In addition, most fish avoid moving backwards in a current (at the point of entrainment) and will exhibit burst swimming speeds to move out of the intake area, if necessary.

32. Most juvenile and larval species are found in the fringing flood plain upstream of the Steele Bayou structure and should not be affected. For juvenile and larval fish that occur near the bottom of the forebay, entrainment is possible because of their weaker swimming ability. Based on previous sampling behind the Steele Bayou structure, gizzard shad will be the primary species most susceptible to entrainment because they are abundant and their eggs and larvae are pelagic.

33. Entrained organisms can be subjected to rapid changes in shear stress, pressure, acceleration, and turbulence. However, most studies of fish entrainment through powerplant turbines concluded that overall mortality is less than 5 percent (Cada, 1990). Conversely, greater than 75 percent mortality has been reported for some fish species entrained through towboat propellers (Killgore, et al., 2001). Eggs, on the other hand, appear to be resistant to entrainment mortality, and larvae are only susceptible at small, developmental sizes. Considering that the pump impellers will be approximately 20 feet in diameter and the rotations per minute (rpm) will be relatively slow (120 to 130 rpm), physical forces such as shear stress, acceleration/ deceleration, and turbulence will be lower than those created by smaller and faster propellers/impellers associated with intakes of towboats. Slower moving propellers also have a reduced probability of striking or injuring a fish passing through. The outlet velocities will be approximately 12 feet per second, but flows will quickly subside to around 3 feet per second in the stilling basin immediately below the pump outfall. Those fish that move through the pump unharmed will travel into the stilling basin, through a connecting channel approximately 0.5 mile long, and into the Yazoo River. Given these reasons, it is assumed that entrainment mortality will be low and, if fish are impacted, gizzard shad will be the most susceptible species. Since gizzard shad are ubiquitous throughout the lower Mississippi Valley (Ross, 2002), no impacts to their population integrity are anticipated.

34. Operation of the Yazoo Backwater pump station to reduce flood extent and duration could impact the amount of wetland acres available for fish spawning and rearing. In their 2007 report on the effects of the YBWP on fish habitat (Appendix 11), Killgore and Hoover identified the number of spawning acres as the controlling resource in determining species richness in YBWP Area waters because there is less spawning habitat than there is rearing habitat in the study area. Fish spawning acres were defined as the number of acres flooded at least 1 foot in depth for at least 8 days. The 1-foot depth was considered necessary for adults to move into the flood plain. Eight days of flooding are important for egg incubation since eggs can be stranded and desiccated if water levels drop before hatching. Eight days of flooding was also a conservative estimate that allowed sufficient time for adult fish to move into the flood plain and construct nests, for eggs to hatch, and for fry to leave the nest.

35. In contrast to spawning, rearing fish do not have specific hydraulic requirements other than a preference for slack-water or swift-water conditions, depending on the species. Larval fish can exploit a variety of depths, and most species along the shoreline tend to move with fluctuating water levels without stranding or injury (Adams, et. al., 1999). Preproject studies showed that larval fish abundance was related to the presence of vegetation, shade, and structure. The highest concentrations of larval fish were found in the fringing flood plain and in oxbow lakes contiguous with the river. Overall, permanent flood plain water bodies provided better habitat value for rearing fish than did cleared land. Additionally, Habitat Suitability Index scores showed flooded bottom-land hardwoods, contiguous oxbow lakes, and tributary mouths had the

best flood plain habitats for spawning and rearing. In their report, Killgore and Hoover showed plans that included reforestation resulted in a net gain in AAHUs for spawning and rearing of fish. The highest gains were for combination plans that included conservation easements and reforestation. Plan 5 has no impact on the size of the 1-year flood plain. It is the same size with or without the project. Reforestation/conservation measures proposed in Plan 5 will increase AAHUs for spawning by 30.3 percent and increase AAHUs for rearing by 8.0 percent.

36. Wetland functions and wetland FCUs were described by Smith and Lin (2007) in the Yazoo Backwater HGM assessment. The Yazoo Backwater HGM analysis evaluated losses of wetland functional capacity from clearing an additional 38 acres at the construction site and from project induced changes in hydrology and offset these losses with the gains in wetland functional capacity from reforestation. Wetland FCUs describe the condition of the eight individual wetland functions identified in the Yazoo Backwater wetland analysis. Three of these functions relate directly to water quality (Appendix 16, "Wetland Functions Related to Removal of Sediments, Nutrients, and Pesticides within the Yazoo Backwater Study Area"). These are the export of organic carbon, the physical removal of elements and compounds (sediment, phosphorus, and pesticides), and the biological removal of elements and compounds (nitrogen). The reforestation feature has the potential to increase the amount of organic carbon that is delivered to study area waters during flooding each spring. Export of organic carbon is an important function of wetlands contiguous with rivers and streams in the study area. Dissolved and particulate organic carbon is an important first-order energy source for the aquatic system. Organic carbon provides food sources for microbes and macroinvertebrates, which in turn provide food sources for other aquatic organisms in area streams. Using the Yazoo Backwater HGM assessment under Plan 5 and assuming that all targeted acres were reforested, the average annual export of organic carbon wetland function would be increased by 9 percent above current base conditions during spring floods (Table 10). The natural, slow release of organic carbon by wetland ecosystems is a benefit to aquatic organisms. However, heavy releases of unprocessed organic carbon (i.e., BOD) during high rainfall runoff events can be detrimental to DO concentrations at any time of the year. This is also a natural, but infrequent, process that has been observed in YBWP Area water bodies. Following these events, conditions have been observed to return to normal once the organic load has been processed or discharged from the system and normal oxygenation processes become reestablished.

TABLE 10
REFORESTATION IMPACTS BASED UPON HGM
WETLAND ANALYSIS AND STORMWATER RUNOFF ANALYSIS
YAZOO BACKWATER AREA REFORMULATION a/ b/

Reforestation for Plan 5 (Recommended Plan)	Sediment	Pesticides	Nutrients	Organic Enrichment
	%	%	%	%
Impact of HGM Wetland Functional Analysis	+ 4	+ 4	+ 7	+ 9
Impact of Stormwater Runoff Analysis	+ 11	+ 2	+ 9	-
Total Impact	+ 15	+ 6	+ 16	+ 9

a/ From Table 16-36, Water Quality Appendix
b/ Assumes 100 percent of targeted lands are reforested.

37. The other water quality wetland functions addressed in Appendix 16 were the physical and biological removal of elements and compounds, which are defined as the ability of the wetland to permanently remove or temporarily immobilize nutrients, metals, and other elements and compounds that are imported to the wetland via flooding. The physical removal of elements and compounds function addresses those elements and compounds that are primarily removed by the physical process of settling. This includes phosphorus and other elements and compounds adsorbed to soil particles such as metals and legacy pesticides. The biological removal of elements and compounds function addresses compounds such as nitrogen and pesticides that can be removed by biological processes such as microbial degradation or uptake by plants. Using the individual water quality wetland FCU analysis, the reforestation proposed in Plan 5 would increase the removal of sediment in wetlands by 4 percent, increase the removal of nutrients by 7 percent, and increase the removal of pesticides such as DDT by 4 percent (Table 10). These data show that reforestation would have the effect of improving water quality and thereby improving aquatic life support.

38. Reforestation of agricultural land also benefits water quality by stabilizing soil and reducing erosion. Reduced erosion from agricultural fields decreases the amount of sediment, nutrients (fertilizers), and pesticides associated with nonpoint source runoff from agricultural fields. Yuan and others (2002) used a simulation tool, the Annualized Agricultural Non-Point Source pollutant loading model (AnnAGGNPS 2.1) to evaluate watershed responses to agricultural management practices. The model was used to assess the impact of several best management practices (BMP) combinations on sediment yield from the Deep Hollow Lake Watershed in the Mississippi Delta. Model results showed significant reductions in sediment yield when a conventionally tilled field was restored to all forest. In a comparison of field data collected between 1980 and 1989, the U.S. Geological Survey (USGS) (Smith, et al., 1993) showed a 60 to

70 percent reduction in nutrient and sediment yield from agricultural fields converted to forest lands. More recently, scientists at the University of Missouri reported the results of modeling to estimate water quality, air quality, and soil carbon benefits from the NRCS CRP (NRCS, 2007). Across all assessed soil types, the amount of soil moving off the field in runoff was 99 percent lower for CRP conservation cover than for crop production that might otherwise occur. Model outputs showed that some of the largest per acre reductions were found in the Mississippi River alluvial flood plain that includes Mississippi, Arkansas, and Louisiana. These data suggest that reforestation would have the effect of improving water quality and thereby improving aquatic life support.

39. Effects of the proposed YBWP reforestation on erosion control (stormwater runoff) were calculated for each alternative plan (Appendix 16, "Reduction and Improved Quality of Stormwater Runoff"). Reductions in sediment, legacy pesticide, and nutrient yield were estimated for each alternative plan using the number of acres available for reforestation within the 2-year flood plain. Estimates for nitrogen reduction were based upon the number of acres planted in cotton, corn, and soybeans (2005 land use) and the corresponding export coefficients for each crop. Estimates for the legacy pesticides and phosphorus were based upon sediment yield values reported in the Big Sunflower River total maximum daily load (TMDL) document (MDEQ, 2003a). Since the Vicksburg District does not believe the flood protection provided by the YBWP will alter current land use such that additional acres of existing forest land will be cleared (Mitigation Appendix), no increases in stormwater runoff were predicted for these protected lands. The stormwater runoff analysis predicted that the reforestation proposed in Plan 5 would decrease sediment yield by 11 percent, decrease legacy pesticide yield by 2 percent, and decrease nutrient (nitrogen and phosphorus) yield by 9 percent (Table 10). Results from the stormwater runoff analysis were combined with results from the HGM analysis to address project impacts to TMDL and impaired water bodies. Table 10 summarizes the expected changes to water quality based upon the analysis of the HGM wetland functions for each alternative plan and upon analysis of sediment yield reductions from the stormwater runoff. The table also includes an estimate of the total impacts. Overall, reforestation would decrease sediment in study area waters by 15 percent, decrease legacy pesticides by 6 percent, decrease nutrients by 16 percent, and increase the export of organic carbon by 9 percent.

40. The recommended plan proposes changing the operation of the Steele Bayou structure during low-flow conditions to raise the minimum water levels from between 68.5 and 70.0 feet, NGVD, to between 70.0 and 73.0 feet, NGVD. Increased water depth would benefit the study area fishery. Increased water depth will provide reliable minimum water levels in small tributaries to lower Steele Bayou and the lower Big Sunflower River. This should improve macroinvertebrate and fish habitat. The Vicksburg District's monitoring data show that DO concentrations in waters upstream of the Steele Bayou structure are maintained by phytoplankton primary productivity during the late summer between July and October when DO concentrations are considered most critical for aquatic life support. The EPA also noted DO supersaturation in

some YBWP Area streams during a 2006 monitoring study in the Yazoo Basin. The EPA attributed the condition to high levels of algal productivity (EPA, 2007). Because of the reliance on primary productivity, however, it is likely that these waters can become intermittently stratified with reduced DO concentrations during extended periods of dense cloud cover. This is an existing condition within the study area and will not change because of the proposed changes in operation of the Steele Bayou structure.

41. Dr. James L. Martin at Mississippi State University (MSU) utilized the EPA water quality model (Water Quality Analysis Simulation Program (WASP)) to develop the organic enrichment/low DO TMDL of the Big Sunflower River for MDEQ. Dr. Martin utilized the same model to predict project impacts from increasing the water surface elevation at the Steele Bayou structure during the summer when DO concentrations are considered most critical for aquatic life support. Dr. Martin extended the model downstream to the Steele Bayou structure and analyzed low-flow conditions with and without the 3 feet of additional water depth proposed for Plan 5. The model was calibrated with project-specific data collected over a 2-year period. A typical model output is presented in Figure 1. In the model output, phytoplankton primary productivity maintained average water column DO concentrations above the MDEQ DO criterion of 5.0 milligrams per liter (mg/L) for all model reaches. These model results suggest that the operational feature to increase the minimum water surface elevation will not have a detrimental impact on DO concentrations in the lower study area. If water quality is found to be impaired by increasing the water surface elevation during low-flow periods, the Vicksburg District can resume preproject operation of the Steele Bayou structure.

FISH CONSUMPTION (CLASSIFIED USE)

42. Currently, the Mississippi Delta is under a fish consumption advisory for DDT and toxaphene. This advisory limits the consumption of fish meals that can be eaten each month based on the length and species of fish. The lower advisory limit for DDT is 1.0 milligram per kilogram (mg/kg), while the lower limit for toxaphene is 0.4 mg/kg.

43. Legacy pesticides such as DDT and toxaphene were used for pest control on agricultural crops between the 1940s and 1980s. DDT was banned in the United States in 1973 while toxaphene was banned from most uses in 1982 and from all uses in 1990. In 2006, however, the World Health Organization recommended the use of DDT for residual spraying inside homes to control malaria. These pesticides adhere to clay and organic matter. When contaminated soil washes into adjacent streams, it becomes deposited in areas that do not maintain enough velocity to keep sediment suspended and flushed out of the stream. Any project feature that reduces the amount of contaminated soil entering the aquatic system could potentially reduce DDT and toxaphene concentrations in fish tissue. As was mentioned previously, reforestation would stabilize previously tilled soil and reduced erosion. Past studies by NRCS and USGS showed

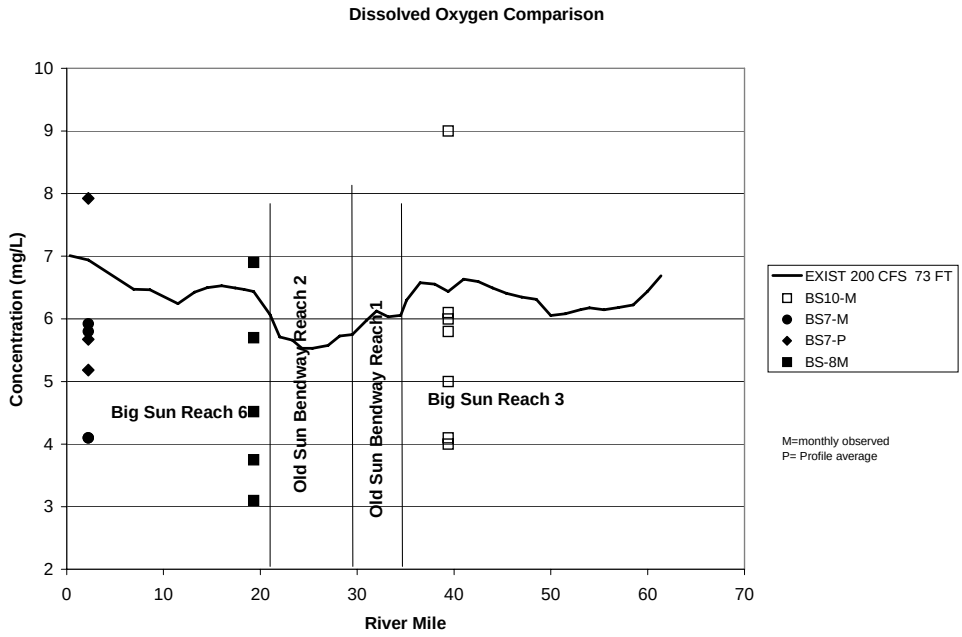

Figure 1. WASP Model output for the lower Big Sunflower River using a downstream elevation of 73 ft, NGVD, at the Steele Bayou structure.

significant reductions in sediment yield from agricultural fields converted to forest lands. These reductions in erosion and sediment yield can be directly related to reductions in pesticide yield from fields with historic applications of DDT and toxaphene. Estimates by the Vicksburg District for decreases in sediment yield are presented in Table 10. For the recommended plan, legacy pesticide yield would be reduced by 2 percent. In addition, reforestation of frequently flooded fields will increase the wetland function that processes these pesticides. The physical removal of elements and compounds wetland function for Plan 5 would increase the removal of pesticides such as DDT and toxaphene from floodwaters by up to 4 percent. These calculations show that reforestation could decrease legacy pesticides in the study area sediments by up to 6 percent. As a result, the nonstructural reforestation feature of the recommended plan should have the positive effect of lowering future pesticide concentrations in fish tissue.

44. The site selected for the Yazoo Backwater pump station was never used for agricultural purposes and has not received applications of DDT or toxaphene. Construction activities at the pump station site will not release soil containing these pesticides into the aquatic system. The YBWP does not have an extensive dredging component. The only dredging included in the YBWP is periodic maintenance dredging for the inlet and outlet channels. The Engineering Summary (Appendix 6) predicts that occasional maintenance dredging may be necessary, depending on hydrologic conditions and rates of sediment buildup. This material will be deposited in upland disposal sites located on the pump station site. Effects of maintenance dredging in the inlet and outlet channels will be localized and short term and should not affect the fish tissue consumption advisory for DDT and toxaphene.

RECREATION (EXISTING USE)

45. Although recreation is not a classified use for most of the flowing waters in the YBWP Area, these streams are used year-round for fishing and boating. The state lists fecal coliform bacteria, dissolved solids, and specific conductance as the water quality parameters that directly impact waters used for recreation (MDEQ, 2002). The YBWP recommended plan will not have any impact on dissolved solids or specific conductance in project area water bodies. However, it is possible that increased wildlife or waterfowl habitat may result in localized increases in fecal coliform. Similar localized increases in fecal coliform could be expected from any project that increases wildlife and waterfowl habitat within the YBWP area flood plain. While the YBWP does not have features that are intended to directly improve water recreation in the project area, the operational feature that increases the minimum water surface elevation behind the Steele Bayou structure should have the secondary impact of improving fishing and boating opportunities in the lower Steele Bayou and Big Sunflower River. At the pump-start elevation, 87.0 feet, NGVD, floodwaters will be out-of-bank in study area streams, leaving adequate depth for recreational activities. Improvements to water quality provided by the reforestation feature could also be beneficial to recreational water sports.

IRRIGATION (EXISTING USE)

46. The YBWP does not have a feature to provide surface water for irrigation. Most of the project's features are in effect in the spring when rainfall is usually adequate and irrigation is not needed. The feature to increase the minimum surface water elevation behind the Steele Bayou structure will make additional summer water depths available up to river mile (RM) 30 on Steele Bayou and up to approximately RM 60 on the Big Sunflower River; however, this feature is not intended to provide surface water for irrigation. In fact, with-project demand for irrigation water should go down as agricultural land in the Steele Bayou and Little Sunflower River ponding areas are reforested and removed from production. Use of surface water by adjacent landowners is governed by laws of the state (Mississippi Commission on Environmental Quality, Regulation LW-2, Surface-Water and Ground-Water Use and Protection). Currently, the lower Yazoo Backwater study area has sufficient supplies of ground water, such that additional surface water availability should not change local irrigation practices (personal communication, Dr. Dean Pennington, YMD, Stoneville, Mississippi). If surface waters were to be utilized for irrigation, their withdrawal would not change aquatics-spawning benefits. Aquatic spawning was identified as the controlling habitat type since it required the most acres of reforestation to achieve no net loss. Aquatic spawning benefits are calculated during the spring floods when irrigation water is not needed.

QUESTION 4 - DEGREE OF COMPLIANCE OF THE PROPOSED ACTIVITY WITH THE STATE OF MISSISSIPPI WATER QUALITY CRITERIA FOR INTRASTATE, INTERSTATE, AND COASTAL WATERS

RESPONSE

47. The State of Mississippi's water quality antidegradation policy protects and enhances water quality within the state. The state's water quality standards are meant to ensure that water quality will not be degraded below (or above) the base levels set forth for the protection of the beneficial uses of each water body.

48. Construction of the YBWP is not expected to cause long-term adverse changes in the existing water quality within the study area. Only temporary, short-term impacts to water quality are anticipated as a direct result of project construction. These impacts include temporary increases in suspended solids and increases in turbidity levels that would occur during construction operations. During the 4 years of construction, the site will be isolated from Steele Bayou and the Yazoo River by levees and dikes. Stormwater management practices will provide additional protection from short-term turbidity increases adjacent to the construction site. The inlet and outlet channels will be unwatered and completed using land-based equipment. The most likely periods for increased turbidity would be during unwatering, connection of the inlet and outlet channels to Steele Bayou and the Yazoo River, and during periodic maintenance dredging. When the connection between the inlet and outlet channels and Steele Bayou and the Yazoo River is completed, the water will likely flow into the inlet and outlet channels, thus reducing turbidity entering Steele Bayou and the Yazoo River. During dredging activities, the Vicksburg District or its contractor monitors turbidity concentrations upstream and downstream of dredging to ensure that turbidity concentrations at the edge of the 750-foot downstream mixing zone do not exceed the 50 nephelometric turbidity units (NTU) above background concentration (measured upstream of the dredge) as prescribed in Section II of the State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters document (MDEQ, 2002). Typically, maintenance dredging would occur during slack water conditions in the inlet and outlet channels, which should minimize the amount of turbidity entering adjacent water bodies.

49. Because there will not be any extensive dredging associated with the project in the study area and reforestation should reduce erosion, there should not be any increases in sediment, metals, or pesticides concentrations within study area waters. As was discussed in the response to Question 3, reforestation should stabilize soil, reduce sediment yield, and increase the wetland uptake of nutrients, sediment, and pesticides from floodwaters.

50. One concern with the project due to changes in flood duration has been whether there will still be adequate removal of suspended sediment and other compounds from floodwaters. The Vicksburg District evaluated suspended sediment removal from three out-of-bank backwater floods between 2001 and 2003 (Appendix 16). The data, collected from sites located in duration

zones flooded between 14 and 20 days, showed that 60 percent or more of the suspended sediment in the initial floodwater was removed in as little as 17 days of flooding. Although some currently flooded forest acres will be lost as flood durations change, the reforestation of currently farmed land will provide additional benefits that have taken these losses into account and will offset them, as was described for the HGM analysis discussed in the response to Question 3. An analysis of postproject duration zones shows that there are currently 20,501 flooded acres that are flooded between 14 and 20 days. Under Plan 5, 88 percent of these existing forested wetland acres will be retained and continue providing the physical settling of elements and compounds wetland function at current efficiencies (60 percent or greater). The HGM wetland functional analysis has shown that adding up to 55,600 acres of forests will provide a 4 percent net increase in sediment removal over existing conditions. For this reason, the Vicksburg District believes there will be sufficient out-of-bank flooding to provide a level of suspended solids removal at least as great as existing conditions. In addition to increasing sediment removal, the wetland HGM analysis shows a 4 percent increase in pesticide removal and a 7 percent increase in nutrient removal (Table 10). Sustained improvement in wetland functions will have long-term benefits to the water quality within the Yazoo Backwater study area.

51. The stormwater runoff analysis discussed in Question 3 showed that sediment yield would be reduced by 11 percent if 55,600 acres of agricultural land are converted to forests. For the recommended plan, however, 26,277 acres may lose their Federal wetland status due to changes in the hydrologic regime. The Vicksburg District believes that current land use will not change (Mitigation Appendix). Postproject, forested acres will remain forested and agricultural acres should remain in agriculture or be converted to forests. Postproject, existing agricultural land that is not reforested will continue to export sediment and other agricultural chemicals into study area water bodies at current rates. Reforested lands would produce reductions in stormwater runoff yields. The stormwater runoff analysis showed that sediment yield would be reduced by 11 percent, pesticide yield would be reduced by 2 percent, and nutrient yield would be reduced by 9 percent (Table 10).

52. Total reductions for combined benefits of the stormwater runoff analysis and the HGM analysis are also presented in Table 10. The level of reforestation recommended in Plan 5 would reduce sediment by 15 percent, reduce pesticides by 6 percent, reduce nutrients by 16 percent, and increase the export of organic carbon by 9 percent. On average, water quality would improve by approximately 12 percent above existing/base conditions if 55,600 acres were reforested. Once the 15,029 acres that are guaranteed before the pump station can begin operation are reforested, the benefit (1 percent) will offset any water quality impacts from construction and operation of the Yazoo Backwater pump station.

53. The analysis of water quality impacts from reforestation was done without knowledge of the exact location of the reforestation other than reforestation will target the cleared lands in the 1- and 2-year flood plains. For impaired waters and TMDL waters, the precise location of the reforestation could be important. To reduce impairment, the reforestation needs to be at the source of the impairment for erosion control or downstream or downgradient of the impairment in order to fully utilize wetland function as described by HGM wetland functional model. Maps identifying cleared land remaining in the Yazoo Backwater study area show that the majority of cleared land in the 1-year flood plain is located in the ponding areas above the Steele Bayou structure and the Little Sunflower River structure. Floodwaters ponding in these two areas would receive maximum benefits from increases in wetland functional value. In addition, the agricultural land surrounding the 1- and 2-year flood frequency cleared lands are upgradient such that runoff from higher elevation agricultural land often passes through 2- and 1-year land before entering streams. This type of filtering through progressive layers of reforested wetlands maximizes YBWP reforestation benefits to water quality.

54. Temporary increases in turbidity caused by completing the connection between the inlet and outlet channels and Steele Bayou and the Yazoo River could cause temporary decreases in DO concentrations due to short-term decreases in light penetration and phytoplankton productivity. These effects should last only until the construction activities are completed, after which DO concentrations should return to seasonal norms.

55. There has also been concern that raising the minimum summer pool depth behind the Steele Bayou structure could impact seasonal DO levels. The water quality analysis showed that during the summer low-flow period between July and October, DO concentrations were at their highest due to decreases in turbidity and increases in phytoplankton primary productivity. To better understand the impact of increasing the water depth in the Steele Bayou pool, the Vicksburg District contracted with Dr. James L. Martin at MSU to expand the EPA WASP model used for development of the Big Sunflower River organic enrichment/low DO TMDL. The revised model (discussed briefly in the response to Question 3) evaluated the Big Sunflower/Little Sunflower River system from Lock and Dam 1 to the Steele Bayou structure. The model used data collected within the study area to predict the impacts to late summer DO concentrations from increasing water depth in the lower Big Sunflower River during low-flow conditions. The model analyzed existing conditions in the lower Big Sunflower River under current and proposed operating scenarios. It also analyzed the cumulative effects of completing the Big Sunflower Maintenance Project with and without increases in summer water levels behind the Steele Bayou structure. Results of the model analysis suggest there is no clear relationship between the proposed increases in pool elevation and variations in DO concentrations. This is largely due to the input from phytoplankton primary productivity. None of the reaches modeled predicted daily average DO concentrations below the MDEQ criterion of 5.0 mg/L. Figure 1 shows an example of the model's output prediction for the Big Sunflower River at Steele Bayou structure elevation 73.0 feet, NGVD. Model predictions indicate that late summer DO concentrations should not be affected by the proposed changes in operation of the Steele Bayou structure. The model report is Attachment 2 to Appendix 16.

QUESTION 5 - DEGREE OF PHYSICAL, CHEMICAL, AND BIOLOGICAL IMPACTS ON WATERS OF THE STATE

RESPONSE

56. The physical, chemical, and biological impacts on waters of the state due to the YBWP have been examined in detail. The following is a discussion of expected impacts. Physical impacts include changes in hydrology and flood duration, increasing the minimum water surface elevation behind the Steele Bayou structure, water temperature, and light availability. Chemical impacts include changes in the loading and processing rates of nutrients, oxygen-consuming materials, and toxicants such as pesticides. Biological impacts are those impacts directly affecting aquatic species as a result of construction and operation of the Yazoo Backwater pump station (hydrology and flood duration), reforestation, and increasing the minimum water surface elevation behind the Steele Bayou structure.

PHYSICAL IMPACTS

57. Physical impacts include changes to hydrology and flood duration, increased number of reforested wetland acres, water temperature, light availability, and stratification.

58. Construction of the pump station and completion of the inlet and outlet channels would change hydrology by providing an alternate route for floodwaters to exit the Yazoo Backwater study area when the Steele Bayou gates are closed because of high stages on the Mississippi River. The same water would be discharged from the Yazoo Backwater study area into the Yazoo River; only the timing would be changed.

59. The Yazoo Backwater pump station would only be in operation an average of 31 days each year and would have the effect of reducing the peak flood elevation during those times when gravity outflow through the existing Steele Bayou structure is not possible. Operation of the pump station will change the water surface elevation of floods greater than the 1-year frequency flood. Flood elevations of the 1-year flood will remain the same, 87.0 feet, NGVD. At the Steele Bayou structure, Plan 5, for example, would reduce the 2-year flood from 91.0 to 87.8 feet, NGVD, and reduce the flood volume by 38.6 percent (Table 11). Plan 5 would reduce the 100-year flood from 100.3 to 95.7 feet, NGVD, and reduce the flood volume by 42.6 percent. Both are significant volume reductions for a backwater flood. Changes in duration could alter the duration of up to 66,945 acres of wetlands to some extent and potentially cause the loss of 26,277 acres of wetlands currently inundated 14 days or more (Federal definition of wetland). The analysis that determined impacts to these wetland acres was worst case. Impacts from these physical changes are minimized by virtue of conservative assumptions, by mitigation, and by reforestation. These predicted impacts to wetland hydrology were based on the assumption that

backwater flooding is the only source of water to sustain wetlands. The analysis assumes that the 51 inches of annual precipitation do not play an important role in sustaining wetlands in the Yazoo Backwater study area. Because precipitation does likely play an important role in sustaining wetlands, this analysis may be overstating the impact of the YBWP on loss of wetland resources.

60. Reforestation of up to 55,600 acres of agricultural land would fully compensate for the YBWP losses of wetland function. The HGM analysis for Plan 5 shows the losses in FCU due to additional clearing at the pump station site (- 240 FCU) and changes in wetland hydrology (-14,188 FCU) (Table 8). A portion of the benefits of reforestation (14,428 FCU) will mitigate for the structural (construction and hydrologic) losses; the remaining reforestation FCU will produce a net gain in wetland FCU. Overall, reforestation/conservation measures on 55,600 acres would increase the net wetland FCU by 19.5 percent. Reforestation/conservation measures on the minimum 15,029 acres guaranteed before pump station operation will begin would increase the net wetland FCU by 2.4 percent.

61. These changes to flood extent and duration would be slow and gradual. The data in Table 11 show that if the pump station were the sole means of evacuating floodwater, it would take 25.2 days to reduce the water surface elevation at the Steele Bayou structure from 91.0 to 87.0 feet, NGVD. This amounts to an average daily change in the water surface elevation of 0.16 foot. It would take just over 6 days to lower the water surface elevation 1 foot. The data presented in Table 11 show that lowering water surface elevations during floods greater than the 2-year frequency would result in smaller average daily changes in the water surface elevation at the Steele Bayou structure. The actual change in the water surface elevation will be greatest near the pump station and less in the headwaters.

TABLE 11
INCREMENTAL CHANGES TO WATER SURFACE
ELEVATIONS AT THE STEELE BAYOU STRUCTURE
RECOMMENDED PLAN
YAZOO BACKWATER AREA REFORMULATION a/

Flood Frequency	Preproject Water Surface Elevation (feet, NGVD)	Postproject Reduction in Water Surface Elevation (feet)	Postproject Reduction in Surface Area (%)	Postproject Reduction in Volume (%)	Average Change in Water Surface Elevation per Day (feet)	Days of Pumping to Lower Flood to 87 feet	Days of Pumping to Lower Flood to Next Level
1-Year	87.0	0.0	0.0	0.0	N/A	N/A	N/A
2-Year	91.0	3.2	31.1	38.6	0.16	25.2	25.2
5-Year	94.6	5.0	30.3	46.5	0.11	58.3	33.1
10-Year	96.3	5.1	31.6	47.9	0.07	82.7	24.4
25-Year	98.0	5.0	28.4	47.0	0.06	110.5	27.8
50-Year	99.2	4.8	27.3	45.4	0.06	129.0	18.6
100-Year	100.3	4.6	25.0	42.6	0.07	145.3	16.3

a/ From Table 6-17, Engineering Appendix.

62. After startup, construction at the Yazoo Backwater pump station site will take approximately 4 years to complete. While care will be taken to reduce the amount of sediment entering adjacent water bodies during construction, there is the possibility that concentrations of suspended sediment or turbidity could temporarily increase in the immediate vicinity of the construction site. Higher turbidity levels can lead to increased water temperature as the suspended material adsorbs and holds energy in sunlight rather than transmitting it into the water. Turbidity reduces the depth of the photic zone and can reduce photosynthesis and the amount of DO, a key component of aquatic life and water quality. Any increases in turbidity, water temperature, and decreased light availability as a result of construction should be temporary and should return to normal seasonal levels once construction is complete and any disturbed areas become revegetated. The greatest opportunity for turbidity and suspended sediment related impacts would be during completion of the connections of the inlet and outlet channels to Steele Bayou and the Yazoo River.

63. With Plan 5, floodwaters behind the Steele Bayou structure and the pump station would still benefit from the physical reduction in turbidity and suspended solids due to settling. This topic was discussed in the response to Question 3. Changes in duration due to operation of the Yazoo Backwater pump station should not reduce the amount of suspended sediment/turbidity physically removed from out-of-bank floodwaters. An evaluation of 3 years of data collected during backwater flooding in reforested WRP forests has shown that more than 60 percent of the suspended sediment is removed from floodwater in as little as 17 days. An analysis of pre- and postproject duration zones shows that 88 percent of existing forested acres flooded between 14 and 20 days (7.5 percent duration) will be receive the same level of flooding after implementation of Plan 5. In addition, the HGM wetland analysis shows that reforestation would enhance the removal of suspended solids as the reforested acres of frequently flooded mitigation land fill in with trees and undergrowth. The HGM analysis shows that the physical removal of element and compounds wetland function would increase by 4 percent (Table 10). Therefore, physical settling efficiencies during out-of-bank flooding should not be affected.

64. The recommended plan will increase the minimum water surface elevation behind the Steele Bayou structure. This could increase water depth and increase the streambank wetted surface area approximately 60 RM up the Big Sunflower River and approximately 30 RMs up Steele Bayou. Increased water surface area along streambanks will expand foraging and rearing opportunities for many species of fish. The littoral area will become more structurally diverse, and streams will have greater connectivity with the riparian zone (personal communication, August 3, 2006, Dr. Jack Killgore, ERDC, Vicksburg, Mississippi). Increasing the water depth during the summer could also provide some relief from the thermal heating that has been observed in some streams during the summer.

65. Reported occurrences of stratification immediately upstream of the Steele Bayou structure have led to concerns that increasing the minimum water surface elevation behind the Steele Bayou structure would exacerbate these existing conditions during low-flow periods and result in low DO regions near the bottom of the channel where stratification may form a barrier against mixing with the more oxygen-rich zone near the surface. The Vicksburg District acknowledges that it is likely that the Steele Bayou pool becomes intermittently stratified immediately upstream of the structure. During flood conditions, the Steele Bayou gates are closed when the Yazoo River stage reaches 75 feet and rising. Prolonged periods without flow could initiate stratification immediately upstream of the Steele Bayou structure. During the summer, however, when DO concentrations are considered more critical to aquatic life, the gates are not closed for extended periods. Currently, the gates are opened and closed to maintain water surface elevations between 68.5 and 70.0 feet, NGVD, with a minimum flow nearly always being released. Mathematical equations to predict stratification potential can be used to calculate the minimum flows through the lower connecting channel and lower Steele Bayou. For the proposed 73-foot, NGVD, water surface elevation, the lower connecting channel would become stratified when discharge is less than 60 cfs, and lower Steele Bayou would become stratified when discharge is less than 25 cfs. Low-flow conditions measured in 1988 show that the minimum flow through the Steele Bayou structure was between 80 and 100 cfs. For these reasons, the Vicksburg District does not believe the proposed increase in minimum water surface elevation will increase the potential for stratification behind the Steele Bayou structure.

CHEMICAL IMPACTS

66. Chemical impacts include loading and processing rates for nutrient, toxicants (pesticides), and oxygen consuming materials.

67. The recommended plan (Plan 5) does not have features that would cause adverse chemical impacts to waters of the State of Mississippi. Currently, the inlet and outlet channels are not connected to Steele Bayou and the Yazoo River. Therefore, it is unlikely that sediments containing legacy organochlorine pesticides such as DDT are deposited within these channels. Once the channel connections are completed, however, the sediments that accumulate in these channels could contain concentrations of pesticides similar to concentrations found upstream of the pump station site. Sediment pesticide concentrations were discussed in Appendix 16 in the section “Sediment Organochlorine Pesticides Data.” Maximum concentrations of the sum of DDT, DDE, and DDD (∑DDT) were 0.391 mg/kg for the Steele Bayou Basin and 0.305 mg/kg for the Big Sunflower River Basin. Both concentrations are below the EPA probable effects concentration (PEC) of 0.572 mg/kg for ∑DDT in sediment. The PEC is the concentration above which harmful biological effects to aquatic organisms are likely to be observed. Pesticide concentrations in the sediment that will accumulate in the inlet and outlet channels are likely to be lower than basin averages because of proposed reforestation upstream of the pump station.

Current plans call for sediments removed from the inlet channel during periodic maintenance dredging to be disposed of in borrow areas within the pump station site. Any chemicals associated with these sediments will be permanently removed from study area waters.

68. Implementation of Plan 5 should not increase nutrient or pesticide loading rates. Although cropping patterns are expected to change from year to year over the life of the project, total land in agriculture production is expected to remain relatively constant (Main Report, Socioeconomic section). Once the Yazoo Backwater pump station is in operation, it is unlikely that there would be any increases in the acreage planted or permanent conversions to alternate crops. In addition, the Vicksburg District does not believe that additional acres of existing forest land will be cleared for agricultural production (Mitigation Appendix). It is likely that lands protected by the Yazoo Backwater pump station will either continue under existing cropping patterns or be reforested; thus, nutrient and pesticide loading rates should not increase. Studies show that reforestation will reduce erosion and sediment yield from reforested agricultural lands. Reduced erosion from agricultural fields reduces the amount of nutrients (fertilizers) and pesticides associated with nonpoint source runoff from agricultural fields. Reports prepared by USGS and NRCS estimate significant reductions in sediment yield when conventionally tilled agricultural fields are reforested (Smith, et al., 1993; Yuan, et al., 2002; and NRCS, 2007). Reduction in sediment yield translates into reduction of materials attached to sediments such as phosphorus, pesticides, and metals. The 2007 NRCS report estimated that overall nitrogen and phosphorus losses from agricultural fields would be reduced by 95 and 86 percent, respectively, for CRP conservation cover compared to the without-CRP scenario. The stormwater runoff analysis for the Yazoo Backwater study area is described in Appendix 16, "Reduction and Improved Quality of Stormwater Runoff" and was discussed in the response to Question 3. The stormwater runoff analysis showed that reforestation of up to 55,600 acres would reduce sediment yield by 11 percent, reduce pesticide yield by 2 percent, and reduce nutrient yield by 9 percent (Table 10). For the reasons discussed at the beginning of this paragraph, the analysis did not include increases in stormwater runoff yield from fields protected by operation of the pump station, but assumed these yields to be part of the project base conditions. Actual reductions in stormwater runoff yield will be location specific. However, most of the agricultural lands available in the 1- and 2-year flood plains lie in the lower and upper ponding areas above the Steele Bayou structure and Little Sunflower River structure. Floodwaters ponding in these two areas would receive maximum benefits from reforestation because they flood the most frequently. Cleared land above the 1- and 2-year flood frequency are upgradient, such that runoff from higher elevation agricultural land often passes through 2- and 1-year land before entering streams. This type of filtering through progressive layers of reforested wetlands maximizes the YBWP reforestation benefits to water quality.

69. Changes in hydrology due to implementation of Plan 5 are not expected to cause agricultural intensification such that there is a marked increase in the use of fertilizers or pesticides. The major change in farming due to changes in hydrology from operation of the Yazoo Backwater pump station will likely be earlier planting of soybeans in areas better protected from flooding. Early planting of soybeans would reduce the amount of fungicide required to control Asian Soybean Rust because crops would mature before late-season infestations could develop. Because soybeans are not routinely fertilized, there should be no increases in nutrient runoff from early soybeans. Farming practices in the Delta (MSU, 2005) show that phosphorus is typically applied in the fall, and nitrogen is typically applied in March through May. These dates coincide with seasonal increases in surface water nutrient concentrations observed in study area streams. This pattern should not change, but surface water concentrations could be reduced with implementation of the nonstructural reforestation feature as discussed in the preceding paragraph. Reforested low-lying cropland would become stabilized with reduced sediment yield. It would gradually develop wetland functions that would remove some of the sediments and nutrients passing through it.

70. Since 1995, the trend in the Mississippi Delta has been toward the use of genetically engineered seed such as Roundup Ready corn and soybean seed and Roundup Ready Bt cotton seed. This transition to genetically engineered seed enables farmers to move away from conventional tillage and utilize conservation tillage and no-till planting practices, which should further reduce erosion during the spring rainy season. Reduced erosion decreases the amount of suspended sediment entering adjacent streams and could reduce the concentration of legacy organochlorine pesticides entering the aquatic environment. The transition to genetically engineered seed has also resulted in a significant shift in the quantities and types of chemicals needed for successful crop production (personal communication, March 8, 2006, Dr. Robert Williams, MSU, Starkville, Mississippi). In fact, according to EPA pesticide market estimates (Aspelin, 1997; Aspelin and Grube, 1999; Donaldson, et al., 2002; and Kiely, et al., 2004), total agricultural pesticide use in the United States remained fairly constant between 1982 and 2001; however, the annual volume of insecticides and fungicides used may have decreased. The use of Bt cotton seed has significantly reduced the amount of insecticides used in cotton production. No-till planting practices and the use of genetically engineered seed could increase the use of current-use herbicides such as glyphosate. Glyphosate is a broad spectrum systemic herbicide that is generally not mobile in soil. It is estimated that only 2 percent of the applied chemical is lost to runoff (Kamrin, 1997).

71. Another wetland function identified in the HGM analysis was the wetland's ability to export organic carbon to provide downstream energy sources for the aquatic ecosystem. This wetland function increases in efficiency as forests mature and increases in quantity as the number of forested acres in the flood zone increases. Organic carbon is critical for the health of a water body. It provides the energy source that fuels the lower levels of the food chain. However, assimilation of high organic carbon loads released during the late spring or summer could place

DO stress on the system. The incremental HGM analysis of wetland functions showed that export of organic carbon should increase by 9 percent under the recommended plan. Organic carbon is usually released from wetlands during the spring, not later in the summer, low-flow period when DO concentrations are considered more critical to aquatic life support. However, heavy releases of unprocessed organic carbon (i.e., BOD) during high rainfall runoff events can be detrimental to DO concentrations at any time of the year. This is also a natural, but infrequent, process that has been observed in YBWP Area water bodies. Following these events, conditions have been observed to return to normal once the organic load has been processed or discharged from the system and normal oxygenation processes become reestablished. The organic carbon loading in many of these heavy BOD loading events has been traced back to agricultural fields. Reforestation could mediate the effect of these heavy BOD loading events.

BIOLOGICAL IMPACTS

72. Biological impacts include loss of habitat and functional value from construction or changes in hydrology during pump operation, improved habitat and functional value in reforested areas, and improved aquatic habitat from increased minimum water depth behind the Steele Bayou structure.

73. Construction at the Yazoo Backwater pump station site will take approximately 4 years to complete after startup. The inlet and outlet channels constructed in 1987 were never connected to Steele Bayou or the Yazoo River. These two channels, approximately 34.5 acres of open water, will be temporarily unwatered (drained) to complete construction. Once completed and connected to the river system, the inlet channel will provide 30.8 acres of permanent open water behind the Steele Bayou structure. The outlet channel will provide up to 19.2 acres of additional open water that fluctuate with the water level of the Yazoo River. Project construction will permanently convert approximately 5.6 acres of open water at the construction site to other uses. This includes up to 0.9 acre of Cypress Lake, located adjacent to Highway 465. The remaining 4.7 acres of open water are in low areas left by construction in 1987. These shallow ponds are seasonal and are sustained by precipitation. Some of the construction activities at the pump station site would have permanent, unavoidable impacts to aquatic biota. Deposition of fill material at the pump station site would permanently impact any macroinvertebrates or benthic organisms inhabiting the 5.6 acres of open water. Draining the unfinished inlet and outlet channels would temporarily (4 years) destroy any aquatic habitat that has developed in these channels since 1987. However, once completed, these channels would develop additional habitat within the lower basin. Periodic maintenance dredging in these channels would impact benthos. However, free-floating or swimming organisms should move away until conditions return to normal. The temporary reduction in light penetration as a result of construction activities could

affect phytoplankton populations immediately adjacent to the construction site. These effects would be minimized by use of BMPs for stormwater pollution prevention. Impacts will be greatest during completion and maintenance of the inlet and outlet channels when the channels are connected to the river system. Temporary increases in turbidity should not have significant impacts on fish populations. Fish are generally highly mobile and would avoid or escape any areas of high turbidity.

74. The flood plains adjacent to the Steele Bayou structure provide spawning and rearing habitat for Delta fish. Any periodic increases in turbidity during the spawning period adjacent to the pump station site should not have any significant impacts on spawning. While operation of the Yazoo Backwater pump station would reduce the extent of flooding and shorten flood durations in some parts of the study area, the nonstructural reforestation feature would offset these loses in resource function. Drs. Killgore and Hoover (Appendix 11) identified spawning habitat as the controlling aquatic resource in the Yazoo Backwater study area and based impacts to aquatic resources on spawning acreages. Overall, the YBWP will increase AAHUs for spawning by 30.3 percent. Reforesting the guaranteed 15,029 acres of agricultural land will ensure there is no net loss of aquatic spawning resources.

75. Although fish inhabiting the YBWP Area are highly mobile, it is possible that fish and other aquatic organisms could become entrained or impinged during pump station operation. This topic was discussed in detail in the response to Question 3. There is no particular fishery habitat need that would concentrate fish in the waters above the pump station during flood stages. Given the distribution of fish species in Steele Bayou, only a small percentage of the regionally available fish are likely to be in the waters above the structure in the periods of flooding when the pump station will be operating. The type and operation of the pump station indicates that impingement against the trash rack will not be a major factor. Most fish will either go through the trash rack into the pumps or avoid the intake. The pumps will draw water near the bottom of the inlet channel, which is approximately 27 feet in total depth. Smaller, more entrainable fish are usually found in the mid- to upper-water column where food and oxygen are more plentiful. Pump intake velocities in the inlet channel are estimated to be less than 2 feet per second, while velocities at the trash rack are estimated to be approximately 3 feet per second. Most adult fish, including minnows, have bursts speeds of 3 feet per second or greater that can be maintained for at least 30 seconds (Beamish, 1978). In addition, most fish will avoid moving backwards in current (at the point of entrainment) and will exhibit burst swimming speeds to move out of the intake area, if necessary. For juvenile and larval fish that occur near the bottom of the forebay, entrainment is possible because of their weaker swimming ability. Based on previous sampling behind the Steele Bayou structure, gizzard shad will be the primary species most susceptible to entrainment because they are abundant and pelagic. Since gizzard shad are ubiquitous throughout the lower Mississippi Valley (Ross, 2002), no impacts to their population integrity are anticipated.

76. Modifying the operation of the Steele Bayou structure to increase water surface elevation by 3 feet during low-flow periods will provide reliable aquatic habitat in small streams that are tributary to lower Steele Bayou and Little Sunflower River, thus providing improved habitat for small fish and invertebrates. Increasing the water depth would have the effect of increasing the wetted surface along the channel banks to provide increased foraging and rearing opportunities for many species of wetland and riverine fish (personal communication, August 3, 2006, Dr. Jack Killgore, ERDC, Vicksburg, Mississippi). Increased surface area, depth, and volume would improve phytoplankton primary productivity and could provide a DO reservoir to buffer against sediment oxygen demand. Vicksburg District monitoring data show that DO concentrations are typically lowest in early summer in May and June, not during the summer between July and October when DO concentrations are considered more critical for aquatic organisms. During the summer, phytoplankton primary productivity is an important source of DO to project area water bodies. Modeling studies by MSU indicate that late summer DO concentrations should not be affected by increasing the water surface elevation (Figure 1).

77. In addition to improving aquatic spawning habitat functional value by 30.3 percent, the recommended plan will also increase net functional value for other environmental resources (Table 7). Terrestrial habitat functional value would increase by 11.2 percent. Foraging acres for waterfowl would increase the DUD functional value by 52.8 percent, and wetland functional value would increase by 19.5 percent. Each of these environmental resource analyses included the loss of resource value due to construction at the pump station site and changes in hydrology once the pump station is placed into operation. While the Vicksburg District is committed to acquiring 55,600 acres, an analysis of resource value improvement for the 15,029 acres that will be acquired before the pump station begins operation shows that once these acres are acquired and reforested there will be a net increase over base conditions for three of the four resources. This minimum reforestation will produce a no net loss of aquatic value and provide a 2.1 percent increase in terrestrial value, a 1.4 percent increase in waterfowl value, and a 2.4 percent increase in wetland value.

78. Changes in hydrology from implementation of Plan 5 could cause the loss of up to 26,277 acres of wetlands currently inundated 14 days or more. The analysis that determined impacts to these wetland acres was conservative (i.e., worst case) because the estimate of wetlands in the study area assumed that only backwater flooding provided hydrology, rather than any of the 51 inches of annual rainfall or other headwater sources of hydrology that can maintain wetland conditions. Although the project affects 66,950 acres of wetlands, it will only reduce the net wetland functional capacity by 1.6 percent. In addition, these hydrologic changes will be dispersed over a large geographic area. Table 9 shows that pump station operation would actually produce small, gradual changes in water surface elevation at the Steele Bayou structure. Water surface elevation changes at the upstream gages are also expected to be small and gradual. With project, the worst case scenario is a 2.4 percent increase in wetland functional value with the minimum reforestation of 15,029 acres.

79. With regard to the potential impacts to the endangered plant, pondberry, formal consultation with FWS was completed with issuance of the BO on 2 July 2007. While FWS and the Vicksburg District do not agree on the role of backwater flooding on pondberry, FWS concluded that the project will not jeopardize the continued existence of the endangered plant pondberry. The Vicksburg District and FWS signed an MOA to conduct additional field studies and establish two new pondberry populations in the YBWP Area.

QUESTION 6 - THE EFFECT ON CIRCULATION PATTERNS AND WATER MOVEMENT ON WATERS OF THE STATE

RESPONSE

80. Project effects to circulation patterns and water movement are discussed in the Engineering Appendix (Appendix 6). Construction of inlet and outlet channels will provide an additional connection between Steele Bayou and the Yazoo River. This will allow pooled water to bypass the Steele Bayou structure and be pumped across the Yazoo Backwater levee when the Steele Bayou gates are closed, providing movement of floodwaters during a period when normally there would be no movement. This would result in changes in circulation patterns. As floodwaters are removed from the lower basin, additional water will move in from upstream to keep the system in equilibrium. The same volume of water will be moved downstream. Only the residence time will be affected.

81. Operation of the Yazoo Backwater pump station would change the water surface elevation of floods greater than the 1-year frequency flood, thus reducing the aerial extent and the duration of floods greater than the 1-year flood. At the Steele Bayou structure, Plan 5, for example, would reduce the 2-year flood from 91.0 to 87.8 feet, NGVD, and reduce the flood volume by 38.6 percent (Table 11). Plan 5 would reduce the 100-year flood from 100.3 to 95.7 feet, NGVD, and reduce the flood volume by 42.6 percent (Table 11). Both are significant volume reductions for a backwater flood. Based upon the 55-year period of record (1943-1997) used for the hydraulic analysis, the average annual pumping period had the pump station been in place would have been 31 days. During the period of record, however, 27 years would have pumped less than 20 days, and 13 years would not have needed to pump at all. The data presented in Table 11 also show that during pump operation, the change in water surface elevation would be slow and gradual. If the pump station were the sole means of evacuating the floodwater, it would take 25.2 days to reduce the water surface elevations at the Steele Bayou structure from 91 to 87 feet, NGVD, (the difference between a 1- and 2-year frequency flood). This amounts to an average daily change in the water surface elevation of 0.16 foot. It would take just over 6 days to lower the water surface elevation 1 foot. The data presented in Table 11 show that lowering water surface elevations during floods greater than the 2-year frequency would result in smaller average daily changes in the water surface elevation at the Steele Bayou structure. The actual change in water surface elevation would be greatest near the pump station and less in the headwaters. As a result, movement of floodwater through the upper reaches of the study area should be gradual allowing sufficient time for sediment and nutrient processing as the out of bank floodwater moves through forested wetlands. At the same time, reforestation of historic agricultural fields in the 1-year flood plain would reduce the sediment and pesticide yield entering floodwaters.

82. The Engineering Appendix (Appendix 6) discusses impacts from pump operation on the Mississippi River and lower Yazoo River. In the 1982 and subsequent design analyses, the impact of a large pump station (25,000 cfs) on the Mississippi River was evaluated using the Mississippi Basin Model, which was calibrated to 1973 conditions. Flood hydrographs for the 1973 and 1975 floods were introduced, and stage hydrographs were recorded at stations on the Lower Yazoo and Mississippi Rivers including preproject (no backwater levees), existing (levees and floodgates only), and the then recommended 25,000-cfs pump station. The model predicted a maximum increase of approximately 0.4 foot in riverside stages with the 25,000-cfs station in continuous operation. With the recommended 14,000-cfs pump station, the increase would be much smaller than 0.4 foot. From the routing results and rating curves, it is estimated that the maximum increase in peak riverside stages would be approximately 0.25 foot at the initial startup elevation of 87.0 feet, NGVD. At 87.0 feet, NGVD, the water levels are below major damage levels for developed areas downstream of the pump station along the Yazoo and Mississippi Rivers. Once the Mississippi River water levels rise to overflow the Yazoo River banks, the impacts from the pump discharge into the Yazoo River will be minimal. For example, at the pump start elevation of 87.0 feet, NGVD, on the riverside of the pump station and with a comparable stage of 40.77 feet, NGVD, on the Mississippi River at the Vicksburg gage (gage zero = 46.23 feet, NGVD) the flow is approximately 1.1 million cfs. The maximum discharge of 14,000 cfs from the pump station is approximately 1 percent of the total flow in the Mississippi River at the pump start elevation of 87.0 feet, NGVD.

83. The recommended plan will not have an impact on the Yazoo River for river stages below 87.0 feet, NGVD. The navigation depth under low-flow conditions would not be impacted. The pump station outlet channel was designed to minimize crosscurrents in the Yazoo River navigation channel when the pump station would be in operation (ERDC, 1990). During pump station operation, the maximum velocity in the auxiliary channel connecting Steele Bayou and the Little Sunflower River would be less than 4 feet per second. During pump operation, the maximum velocity in the outlet channel would be 1 to 2 feet per second.

84. Increasing the minimum water surface elevation behind the Steele Bayou structure should not have a significant effect on hydrology. Current operational procedures at the Steele Bayou structure were discussed in the response to Question 5 – Physical Impacts. The Steele Bayou gates are only closed for extended periods during flood events. During low-flow conditions, the gates are opened and closed to maintain water surface elevations within the operational range. This practice allows the system to maintain a minimum flow and prevents extended periods of stagnation that could result in stratification during the late summer. Implementation of the proposed changes to the operation of the Steele Bayou structure will only affect the operational range, not the management practice.

QUESTION 7 - DEGREE OF ALTERATION ON THE AQUATIC ECOSYSTEM

RESPONSE

85. Implementation of the recommended plan will provide significant benefits to the Yazoo Backwater study area aquatic ecosystem. The nonstructural reforestation and operational features will increase aquatic habitat, improve habitat value for aquatics and waterfowl, and improve wetland functional value.

86. The construction site for the proposed Yazoo Backwater pump station covers approximately 215.2 acres, excluding the existing levee, cofferdam, and Highway 465. All impacts of clearing the site in 1986 have been included in the mitigation analysis (Appendix 1). The Vicksburg District has identified additional impacts that were incorporated into the 2007 environmental analyses. Construction of the backwater pump station will result in the permanent conversion of up to 38 acres of forested wetlands and 5.6 acres of open water to other uses. This includes 0.9 acre of Cypress Lake, which is located adjacent to Highway 465. The remaining 4.7 acres of open water are in low areas left by construction in 1987. These shallow ponds are seasonal and sustained by precipitation. The inlet and outlet channels were constructed in 1987, but were never connected to Steele Bayou or the Yazoo River. These two channels, 34.5 acres of open water, will be temporarily unwatered to complete construction. Deposition of fill material at the pump station site would permanently impact any macroinvertebrates or benthic organisms inhabiting the 5.6 acres of open water. Unwatering the unfinished inlet and outlet channels would temporarily destroy any aquatic habitat that has developed in these channels since 1987. However, once completed, these channels would develop additional habitat within the lower basin. The completed inlet channel will provide 30.8 acres of permanent open water behind the Yazoo Backwater pump station. The outlet channel will provide up to 19.2 acres of additional open water that fluctuate with the water level of the Yazoo River. The newly connected channels will be lentic in nature during most of the year. When the pump station is in operation, intake velocities within the inlet channel will be less than 2 feet per second. Outlet velocities will be approximately 12 feet per second, but flows should quickly subside to around 3 feet per second in the stilling basin. The possibility of entrainment of young and juvenile fish was discussed in the responses to Questions 3 and 5.

87. Currently during the summer months, the Steele Bayou structure is operated to maintain minimum water surface elevations between 68.5 and 70.0 feet, NGVD. Monitoring data show that DO concentrations are at their lowest in the late spring after extended flooding. During the summer months, phytoplankton primary productivity maintains adequate DO concentrations in the pool behind the Steele Bayou structure. On 22 July 2005, DO concentrations immediately upstream of the Steele Bayou structure were greater than 10 mg/L (Figure 2). Current seasonal cycles are not expected to change with implementation of the YBWP. During low water, it is likely the inlet channel to the pump station will also exhibit this same type of phytoplankton primary productivity.

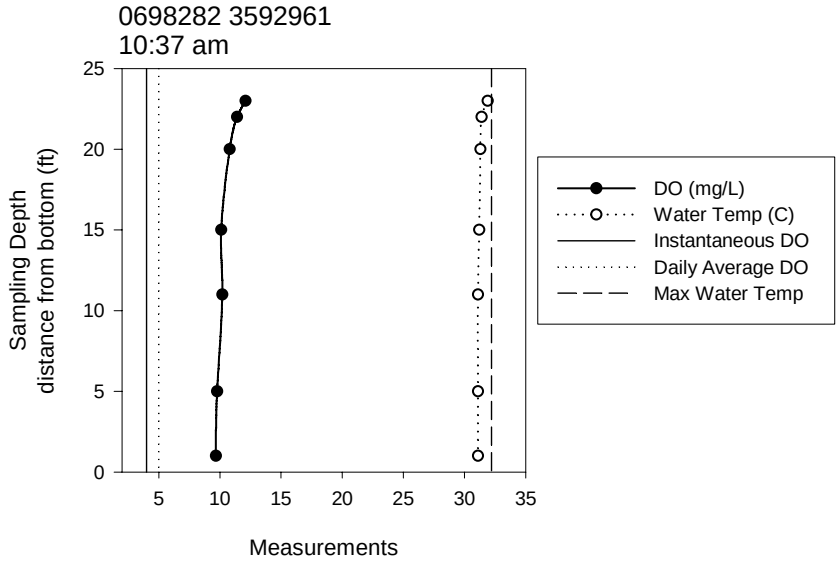

Figure 2. Dissolved oxygen and temperature profiles upstream of the Steele Bayou structure on 22 July 2005.

88. Changes in hydrology from operating the Yazoo Backwater pump station would result in a loss of 14,188 wetland FCUs; however, the nonstructural reforestation feature would add up to 55,600 acres of new forests primarily in the 1-year flood plain and would add 207,726 FCUs. Reforestation/conservation measures would increase net wetland FCUs by 19.5 percent. Plan 5 would also increase the aquatic-spawning habitat resource value by 30.3 percent and the waterfowl habitat resource value by 52.8 percent. While operation of the Yazoo Backwater pump station would affect 66,945 acres of wetlands in the Yazoo Backwater study area, permanent and managed water bodies in the Delta National Forest (DNF) would not be affected. These areas begin flooding above 85.0 feet, NGVD, 2 feet below the proposed pump start elevation of 87.0 feet, NGVD.

89. Question 5 – Physical Impacts discussed the potential loss of 26,277 acres of Federal wetlands currently inundated 14 days or more due to changes in hydrology. The analysis that determined impacts to these wetland acres was worst case. Impacts from these physical changes are minimized by virtue of conservative assumptions (not all of the estimated loss may happen since the wetlands can be sustained by precipitation instead of backwater flooding), by mitigation (no net loss of functional value), and by reforestation (net gain in functional value). Although the project affects 66,945 acres of wetlands, it will only reduce the net wetland functional capacity by 1.6 percent. These hydrologic changes are dispersed over a large geographic area. With project, the worst case scenario is a 2.4 percent increase in wetland functional value with the minimum reforestation of 15,029 acres. Table 11 shows that operation of the pump station would actually produce small, gradual changes in water surface elevation at the Steele Bayou structure. Water surface elevation changes at the upstream gages are also expected to be small and gradual.

90. With regard to the potential impacts to the endangered plant pondberry, formal consultation with FWS was completed with issuance of the BO on 2 July 2007. The FWS BO states that the project will not jeopardize the continued existence of the pondberry. In addition, the Vicksburg District and FWS have signed an MOA to conduct additional field studies and establish two new pondberry populations in the Yazoo Backwater study area.

91. The proposed 3-foot increase in minimum water surface elevation behind the Steele Bayou structure when the project is implemented would provide additional water depth, additional surface area, and additional acres of wetted perimeter for aquatic habitat. Increased depth will provide reliable water in small streams that are tributary to lower Steele Bayou and the Little Sunflower River and would provide improved habitat for small fish and invertebrates. Increasing the wetted surface along channel banks would provide increased foraging and rearing opportunities for many species of wetland and riverine fish. Increased surface area, depth, and volume would improve phytoplankton primary productivity and could provide a reservoir to buffer against sediment oxygen demand and the wide swings in afternoon thermal heating that occur in the summer. The abundance of gizzard shad (Appendix 11) suggests that the fishery derives a good portion of its food base from algae. Any increase in riparian forested wetlands would help provide shade and structure and help diversify the food base and invertebrate population.

QUESTION 8 - DEGREE OF CONSISTENCY WITH APPROVED
WATER QUALITY MANAGEMENT PLANS
ADOPTED BY THE COMMISSION

RESPONSE

92. The Vicksburg District is unaware of any existing approved water quality management plans for the YBWP Area. The Vicksburg District is assisting with development of the Steele Bayou and Big Sunflower water quality implementation plans currently being developed by the state and will comply with findings once the plans are approved.

93. Many of the water bodies in the YBWP Area have TMDLs in place. Many others are listed as impaired and are scheduled to have TMDLs developed by December 2007. The Vicksburg District is committed to improving water quality within its boundaries and design of construction projects within the District is consistent with this philosophy.

94. The YBWP Area consists of three major basins--Steele Bayou, Deer Creek, and the Big Sunflower River. For the analysis of impaired water bodies, the study area was defined as the extent of the 100-year flood. As of April 2007, only four finalized TMDLs apply to the Yazoo Backwater study area (MDEQ, 2007). Applicable TMDLs are listed in Table 12 and include organic enrichment, nutrients, and sediment for the Big Sunflower River; biological impairment by toxicity or unknown pollutants for Wade, Howlett, and Cypress Bayous; fecal coliform for the Yazoo River; and legacy pesticides DDT and toxaphene in the Yazoo River Basin. Project impacts to Yazoo Backwater study area water bodies are discussed in detail in Appendix 16. Impacts due to Plan 5 are summarized here.

TABLE 12
TMDLs WITHIN THE YAZOO BACKWATER STUDY AREA
YAZOO BACKWATER AREA REFORMULATION a/

Basin	TMDL	Completed
Big Sunflower River	TMDL for Organic Enrichment, Nutrients, and Sediment for the Big Sunflower River - Sunflower, Coahoma, Washington, Humphreys, and Sharkey Counties, Mississippi	2003
	TMDLs for Biological Impairments by Toxicity or Unknown Pollutants – Wade, Howlett, and Cypress Bayous	2003
Yazoo River	Fecal Coliform TMDL for the Yazoo River – Carroll, Holmes, Leflore, and Warren Counties	2003
	TMDLs for Legacy Pesticides DDT and Toxaphene in the Yazoo River Basin	2005

a/ Table 16-33, Water Quality Appendix.

95. Effects of the proposed YBWP reforestation on erosion control (stormwater runoff) were calculated for each alternative plan (Appendix 16, "Reduction and Improved Quality of Stormwater Runoff"). Reductions in sediment, legacy pesticide, and nutrient yield can each be linked with specific water quality impairments. Load reductions for each of these parameters were estimated for each alternative plan using the number of acres available for reforestation within the 2-year flood plain. Estimates for nitrogen reduction were based upon the number of acres planted in cotton, corn, and soybeans (2005 land use) and the corresponding export coefficients for each crop. Estimates for the legacy pesticides and phosphorus were based upon sediment yield values reported in the Big Sunflower River TMDL document (MDEQ, 2003a). Since the Vicksburg District does not believe the flood protection provided by the YBWP will alter current land use such that additional acres of existing forest land will be cleared (Mitigation Appendix), no increases in stormwater runoff were predicted for these protected lands. The stormwater runoff analysis predicted that the reforestation proposed in Plan 5 would decrease sediment yield by 11 percent, decrease legacy pesticide yield by 2 percent, and decrease nutrient (nitrogen and phosphorus) yield by 9 percent (Table 10).

96. The water quality HGM wetland analysis was another important tool for addressing project benefits to impaired waters in the Yazoo Backwater study area. The HGM analysis addresses the net functional value of the wetlands within the 1-year flood plain that will be affected by changes in hydrology and by reforestation. The three wetland functions that relate directly to water quality are the physical removal of elements and compounds, the biological removal of elements and compounds, and export of organic carbon. The physical removal of elements and compounds addresses the ability of a wetland to remove materials that will physically settle from floodwaters passing through them. The physical removal of elements and compounds addresses removal of suspended sediment and material attached to them such as total phosphorus, metals, and organochlorine pesticides. The biological removal of elements and compounds addresses the ability of a wetland to process materials that are microbially degraded. These include nitrogen and some of the current-use pesticides. The export of organic carbon function addresses the wetland's ability to deliver dissolved organic carbon into adjacent streams as a first order energy source for the aquatic ecosystem. Analysis of these three wetland functions was used to predict net benefits from implementation of Plan 5. Reforestation for Plan 5 would increase the wetland functions that remove sediment and pesticides by 4 percent and nutrients by 7 percent. Reforestation would also increase the export of organic carbon by 9 percent (Table 10).

97. Reforestation of up to 55,600 acres of cropland primarily in the 1-year flood plain will provide a significant benefit to waters impaired by sediment and pesticides through reductions in stormwater runoff from agricultural land and through increases in wetland functional value as newly planted forests mature. The combined analyses predict a 15 percent reduction in sediment and a 6 percent reduction in pesticides (Table 10). In addition, reforestation will reduce applications of current-use pesticides as the croplands are converted to new forests.

98. Reforestation will result in a 16 percent increase in the Yazoo Backwater study area's ability to retain and process nutrients (Table 10). Studies by the Vicksburg District and MSU (2005) do not predict any increases in nutrient delivery into study area streams as a result of implementation of Plan 5.

99. Plan 5 would increase the export of organic carbon from wetlands into adjacent streams by 9 percent. However, much of this material would be introduced during the spring floods rather than in the late summer when impact to the aquatic system might be more critical to aquatic life support. The project would not introduce additional BOD loading (including organic material or nutrients) during the late summer, low-flow period between July and October and should not affect the DO. Increasing the minimum low-flow water surface elevation behind the Steele Bayou structure from 70.0 to 73.0 feet, NGVD, could reduce reaeration downstream of the Holly Bluff weir (crest elevation 73.0 feet, NGVD). However, during the late summer, the bulk of the flow moves through the Sunflower River Big Bend rather than over the weir. Results of the water quality WASP model to predict with-project DO concentrations were discussed in the responses to Questions 3 and 4. An example of model results was presented in Figure 1. Model predictions indicate that operational changes proposed in the YBWP should not impact DO concentrations upstream of the Steele Bayou structure.

100. Several small bayous are listed as impaired by toxicity or unknown pollutants. During backwater flooding, these bayous serve as distributaries for floodwater from major streams. Many of these bayous also have low-water weirs to retain water during the summer months. Suspended sediments containing nutrients and pesticides move into these bayous during flooding, and the material that remains when floodwaters recede may be sources of unknown toxicity. Completion of the YBWP could reduce the amount of floodwater entering the bayous, shorten the duration of the flooding in the bayous, and reduce the amount of materials in the floodwaters.

101. The Yazoo River (the receiving water for the Yazoo Backwater pump station) is the only study area water body impaired by fecal coliform/pathogens. The YBWP would have no effect on this impairment.

QUESTION 9 - STORMWATER MANAGEMENT

RESPONSE

102. Construction activities associated with the pump station will conform to MDEQ Stormwater Construction General Permit. A stormwater pollution prevention plan (SWPPP) will be developed during final engineering design according to USACE guidance (USACE, 1997). Both temporary and permanent stormwater management practices and controls will be incorporated into SWPPP to manage stormwater discharges from the study area as outlined in the "Mississippi Stormwater Pollution Prevention Plan (SWPPP) Guidance Manual for Construction Activities" (MDEQ, 2005) and the "Planning and Design Manual for the Control of Erosion, Sediment, and Stormwater" (NRCS, 1994). Continued maintenance and inspection of the stormwater management controls will be conducted throughout construction to ensure compliance with the general permit.

QUESTION 10 - COMPLIANCE HISTORY OF THE APPLICANT

RESPONSE

103. The Vicksburg District is committed to complying with regulations and laws of the State of Mississippi. The Vicksburg District complies with stormwater prevention measures on all of its projects, monitors and complies with mixing zone turbidity regulations during dredging activities, and mitigates for losses in resource functional value that incur as a result of project construction.

104. As discussed in the response to Question 9, all Vicksburg District construction activities conform to the MDEQ Stormwater Construction General Permit. The Vicksburg District will develop an SWPPP, which becomes part of each contract. The contractor is responsible for ensuring construction activities are incompliance with the General Permit. The Vicksburg District knows of no stormwater pollution compliance issues.

105. As discussed in the response to Question 4, the Vicksburg District monitors turbidity related to dredging activities as required in Section II of the "State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters." The Vicksburg District knows of no compliance issues related to its dredging activities.

106. The Vicksburg District is committed to fulfilling all of its authorized mitigation requirements. Lands acquired for mitigation by the Vicksburg District are from willing sellers and are generally frequently flooded agricultural lands, which are then reforested. Once these tracts have achieved a suitable stand of bottom-land hardwood forests, they are turned over to another state or Federal agency for management. The Vicksburg District has been criticized about mitigation timing in relation to flood control projects. The issue is not whether the Vicksburg District has completed mitigation requirements, but rather is mitigation concurrent with project construction. The Vicksburg District has been timely in meeting its mitigation requirements for past projects. In addition, the lands purchased to meet mitigation requirements are acquired concurrent with project construction. To date, the Vicksburg District has purchased 102,550 acres of mitigation lands, which is 32,165 acres above the District's required minimum mitigation of 70,385 acres. The August 2006 status of the Vicksburg District's mitigation is shown in Table 13. Project mitigation is discussed more thoroughly in the Mitigation Appendix under the section "Project Mitigation."

TABLE 13
VICKSBURG DISTRICT MITIGATION EFFORTS AUGUST 2006 a/

Project	Acreage Planned for Acquisition	Acreage Acquired b/	Acreage Remaining c/	Total Percent Acquired to Date (%)	Percent Concurrent with Construction (%)
Upper Steele Bayou	5,250	5,569	(319)	103	110
Upper Yazoo Projects	17,000	10,919	6,081	64	99
Yalobusha and Tallahatchie River Channel Maintenance	1,380	1,380	0	100	100
Big Sunflower River Channel Maintenance	1,912	287 d/	1,625	15	1,510
Yazoo Backwater Levee	8,400	8,773	(373)	104	104
Mississippi River Levees	5,200	2,140	3,060	41	98
Aloha-Rigolette Area	964	964	0	100	100
Delta Headwaters Project-Abiaca/Coldwater	1,290	811	479	63	101
Red River Waterway	14,000	7,063	6,937	50 e/	56
Red River Below Denison Dam	189	57	132	30	97
Tensas-Cocodrie Pump station	6,400	6,400	0	100	100
Sicily Island Area Levee	3,000	3,000	0	100	100
Below Red River	3,100	3,100	0	100	100
Bushley Bayou	1,400	1,400	0	100	100
Red River Waterway Below RM 104	900	900	0	100	100
Total	70,385	52,763	18,314	75	92

a/ Table 1-42, Mitigation Appendix.
b/ To date, the Vicksburg District has purchased 102,550 acres of mitigation lands, which is 32,165 acres above the required minimum.
c/ Surplus acreage in parentheses is not included in the total.
d/ Project is on hold pending completion of new Supplemental EIS. Only one item was constructed with 38 acres of mitigation owed.
e/ Requires congressional action to authorize acquisition of cleared lands. Currently, only purchase of forested lands is authorized.

107. As of August 2006, the Vicksburg District has acquired 75 percent of the property that has been authorized for acquisition to fulfill its mitigation requirements. The Vicksburg District has adopted the policy of acquiring mitigation land to keep concurrent with actual project construction. Using this measure, authorized mitigation obligations within the Vicksburg District are 92 percent concurrent with actual project construction. The Red River Waterway is the only project with its mitigation less than 97 percent below project construction levels. Congressional restrictions on location and type of land eligible for mitigation have prevented fulfilling mitigation obligations for the Red River Waterway project. Currently, the Vicksburg District is only authorized to purchase forested land within certain parishes to mitigate for this project. However, Congressional authorization is being sought to acquire and reforest agricultural land in order to fulfill this mitigation requirement.

108. As of August 2006, the Vicksburg District has planted approximately 6,044,780 trees. Since January 1991, the District has reforested approximately 27,000 acres of land acquired by easement and fee title.

QUESTION 11 - ANY OTHER FACTORS DEEMED TO BE NECESSARY BY MDEQ TO PROTECT WATER QUALITY

RESPONSE

109. It is MDEQ's policy "to deny certification when any of a list of eight determinations are made unless the Department is assured that appropriate measures will be taken to eliminate unreasonable degradation and irreparable harm to waters of the State." In this response, the Vicksburg District addresses each of these eight factors with respect to impacts from the YBWP.

a. The proposed activity permanently alters the aquatic ecosystem such that water quality criteria are violated and/or it no longer supports its existing or classified uses.

Response. All impacts of clearing the pump station site in 1986 have been included in the mitigation analysis (Appendix 1). Impacts from conversion of the 5.6 acres of water and 38 acres of forested wetlands are accounted for in the appropriate environmental analyses. Effects to water quality and existing or classified uses were discussed in detail in the response to Question 3. The Vicksburg District water quality analysis of the YBWP shows that the reforestation and operational features of the recommended plan should improve overall water quality in the study area. Although completion of the YBWP will convert 5.6 acres of open water at the pump station construction site to other uses, completion of the inlet channel will create 30.8 acres of permanent open water that will provide lentic habitat for most of the year. The HGM wetland functional analysis and the stormwater runoff analysis (Table 10) show that reforestation of up to 55,600 acres of cropland primarily in the 1-year flood plain could reduce water quality impairments related to existing TMDLs within the study area. Suspended sediment concentrations would be reduced by 15 percent, legacy pesticides in sediment would be reduced by 6 percent, and nutrient concentrations would be reduced by 16 percent. The HGM analysis shows that while some wetland function may be unavoidably lost, there will be a net increase of 19.5 percent from reforestation/conservation measures on up to 55,600 acres of cropland primarily within the 1-year flood plain. Increased minimum water surface elevations behind the Steele Bayou structure will not worsen DO concentrations or impair fish habitat during the summer critical season. While there could be some localized increases in fecal coliform bacteria if populations of wildlife and waterfowl increase in the perpetual easement lands, these same increases would occur with any sizable reforestation program within the 1-year flood plain.

b. There is a feasible alternative to the activity which reduces adverse consequences on water quality and classified or existing uses of waters of the state.

Response. Feasible alternatives to the YBWP were discussed in the response to Question 1. The Vicksburg District evaluated nine alternatives (Main Report and FSEIS) for the YBWP. The Vicksburg District considered each alternative, but focused on the alternatives that met Federal NED and EQ criteria. Plan 4 was determined to be the NED plan; however,

Plan 5 showed the most environmental benefits for the least added cost and was selected as the EQ plan. The recommended plan, Plan 5, was selected because it accomplishes the flood control objective and maximizes both economic and environmental resource benefits to the Yazoo Backwater study area. Plan 5 is also supported by the local sponsor. The water quality analysis presented in Appendix 16 does not show significant adverse consequences to water quality or to classified and existing uses of waters of the state. Impacts to water quality and existing or classified uses were discussed in detail in the response to Question 3.

c. The proposed activity adversely impacts waters containing state or Federally recognized threatened or endangered species.

Response. Twelve species on the State of Mississippi's threatened and endangered species list are known to be in the YBWP Area. Assessments on the recommended plan's effects to these species determined that there should not be any significant impacts to the pyramid pigtoe, pallid sturgeon, Louisiana black bear, mucket, southern redbelly dace, and interior least tern. The reforestation feature of Plan 5 would benefit the wood stork, Florida panther, peregrine falcon, bald eagle, and bewick's wren. There are 19 species on the State of Louisiana's threatened and endangered species list in Madison Parish, Louisiana. Because portions of the project area lying within Madison Parish only comprise 0.37 percent of the 100-year Yazoo Backwater flood plain, this area is only affected by infrequent flood events. Hence, no adverse impacts should occur to any of the listed species in Louisiana.

The FWS identified the endangered plant pondberry and the threatened Louisiana black bear as species that may occur in the study area. Pursuant to Section 7 of the Endangered Species Act, a final BA for these species was sent to FWS on 5 December 2005 (Appendix 14). The BA determined that the project was not likely to adversely affect either species. The FWS did not concur with the determination that the project was not likely to adversely affect pondberry. The FWS also indicated they wanted additional informal consultation on the Louisiana black bear prior to determining whether the project was likely to adversely affect the Louisiana black bear. Although the BA concluded that the project was not likely to adversely affect pondberry, the Vicksburg District did request initiation of Section 7 formal consultation to ensure the project did not jeopardize the continued existence of pondberry. The FWS initiated Section 7 formal consultation for pondberry on 18 January 2006.

After additional informal consultation, FWS concurred with the Vicksburg District's determination that the project was not likely to adversely affect the Louisiana black bear (letter of 10 August 2006). The FWS provided its pondberry BO 2 July 2007. The formal consultation enabled the Vicksburg District and FWS to examine possible impacts on pondberry in greater detail. Looking at the same data, each agency drew different conclusions about the role of backwater flooding on pondberry. Despite these differences, FWS concluded the project would not jeopardize the continued existence of the endangered plant pondberry.

To help conserve and recover the pondberry, the Vicksburg District has significant ongoing or planned activities designed to address data and recovery tasks contained in the FWS

1993 Pondberry Recovery Plan. In 2003, the Vicksburg District and the USDA Forest Service entered into a 7-year, $5 million interagency agreement to conduct extensive research on pondberry's biological and ecological requirements. In addition, in 2007, the Vicksburg District and FWS signed an MOA to establish two new pondberry populations in the study area and conduct additional field experiments evaluation the effects of flooding, stand thinning, competition, and pathogens.

d. The proposed activity adversely impacts a special or unique aquatic habitat, such as National or State Wild and Scenic Rivers and/or State Outstanding Resource Waters.

Response. The YBWP Area does not contain any wild and scenic rivers or outstanding resource waters. The DNF is a unique habitat in that it is identified by the National Forest Service as the only bottom-land hardwood ecosystem in the National Forest System. Permanent and managed water bodies in DNF would not be affected by the YBWP. The Big Sunflower and Little Sunflower Rivers both contain populations of freshwater mussels. Operation of the Yazoo Backwater pump station will not impact these mussel populations. The reforestation feature could reduce sediment loading in some areas, thus possibly improving mussel habitat.

e. The proposed activity in conjunction with other activities may result in adverse cumulative impacts.

Response. In accordance with NEPA regulations, the Vicksburg District performed cumulative impact analysis of the YBWP when added to other past, present, and reasonably foreseeable future actions. Results of the cumulative impact analysis are presented in the FSEIS. Table 14 summarizes results of the cumulative analysis with regard to each category. Overall, the YBWP was determined to provide "low beneficial effects" to each of the resource categories.

TABLE 14
POTENTIAL CUULATIVE EFFECTS
RECOMMENDED PLAN
YAZOO BACKWATER AREA REFORMULATION a/

Potential Impact Area	Pump Construction	Operation	Reforestation	Past Actions	Other Present Actions	Future Actions	Cumulative Impact
Terrestrial	*	*	+++	***	*	*	+
Waterfowl	*	*	+++	***/+++	+	*	+
Wetlands	*	**	+++	***	+	*	+
Aquatic	*	**	+++	***	+	*	+
Water Quality	*	[]	++	**	+	[]	+
Threatened & Endangered Species	[]	*	++	***	+	[]	+
Compensatory Mitigation				+	+	+	+

KEY: * low adverse effect; ** moderate adverse effect; *** high adverse affect; [] no effect; + low beneficial effect; ++ moderate beneficial effect; +++ high beneficial effect.
a/ Table SEIS-61

f. Nonpoint source/stormwater management practices necessary to protect water quality have not been proposed.

Response. Construction activities associated with the pump station will conform to the MDEQ Stormwater Construction General Permit. An SWPPP will be developed during final engineering design according to USACE guidance (USACE, 1997). Both temporary and permanent stormwater management practices and controls will be incorporated into the SWPPP to manage stormwater discharges from the project area as outlined in the "Mississippi Stormwater Pollution Prevention Plan (SWPPP) Guidance Manual for Construction Activities" (MDEQ, 2005). Continued maintenance and inspection of the stormwater management controls will be conducted throughout construction to ensure compliance with the general permit.

g. Denial of wastewater permits and/or approvals by the state with regard to the proposed activities.

Response. A stormwater permit will be required prior to start of construction at the Yazoo Backwater pump station site. The Vicksburg District does not anticipate any problems obtaining the stormwater permit. During construction, the Vicksburg District may also require a permit for the dewatering wells, depending upon the size of the well. The Vicksburg District does not anticipate any problems obtaining this permit. The Vicksburg District does not anticipate the need for any other permits for the YBWP.

h. The proposed activity results in significant environmental impacts which may adversely impact water quality.

Response. The YBWP will not result in significant environmental impacts that could adversely affect water quality. While the YBWP will permanently convert 38 wetland acres and 5.6 open water acres at the pump station site to other uses, reforestation will produce net increases in the sediment and nutrient removal functionality as the newly forested wetlands become established. Reforestation of currently farmed land will stabilize the soil and reduce erosion and sediment yield. Monitoring and modeling studies of DO in the lower study area show that increasing the minimum water surface elevation behind the Steele Bayou structure during the summer critical season should not worsen DO concentrations during the summer critical season.

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