WATERFOWL TECHNICAL APPENDIX
for the
YAZOO BACKWATER REFORMULATION PROJECT REPORT

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EXECUTIVE SUMMARY

The continued loss and degradation of waterfowl breeding and wintering habitat has resulted in a decrease in continental breeding populations. This loss of individuals and the continual loss of critical habitat has been identified as the major waterfowl management problem in North America. The primary purpose of this appendix is to quantify the impacts of proposed alternatives for the Yazoo Backwater Reformulation Project (YBRP) with and without the Big Sunflower River Maintenance Project (BSRMP) to wintering waterfowl in the study area.

The YBRP is expected to have impacts on waterfowl that winter in the study area because of changes in the duration and extent of backwater flooding. The Vicksburg District has developed data to allow quantification of potential impacts for each alternative under two different post-project scenarios. The first post-project scenario assumes that the Yazoo Backwater Project (U.S. Army Corps of Engineers-Vicksburg District 1977) will have no impact (hydrologic influence) on the BSRMP. The second post project scenario that was evaluated assumes that the YBRP is in place and has an influence on the BSRMP.

The methodology used to predict potential project on waterfowl impacts was developed by the USFWS and is based on using food as an index of wintering waterfowl carrying capacity (expressed in terms of the number of duck-use-days (DUD's)). Project impacts (in terms of increases and decreases of acres flooded) during the 120-day wintering period (from 1 November to 28 February) were quantified and used to compare available DUD's for each of the six proposed alternatives. Available DUD's were calculated for each alternative under two different scenarios. The first assumes only the YBRP work will be implemented and the second assumes both the YBRP and the BSRMP. Land use data were compiled for the study area and potential impacts were evaluated for two reaches (Little Sunflower Upper Sump (LSUS); and Steele Bayou Lower Sump (SBLS).

Analysis of land use data provided for the first post-project scenario (YBRP without the BSRMP) indicated a reduction in DUD's (-19,651.10) for Alternative 3 (under the "without reforestation" option). An increase in available DUD's was noted for Alternatives 2, 4, 5, 6, and 7, but a loss with Alternative 2B. Increases in DUD's for Alternatives 2, 4, 5, 6, and 7 were 195,476.10, 39,865.70, 75,807.1, 258,959.90, and 279,424.3, respectively. Alternative 2B results in a loss of 673,634.70 DUD's. Evaluation of the "with reforestation" option indicated a loss of DUD's for all of the alternatives evaluated. Loss of DUD's was greatest with Alternatives 2A and 2C (-516,987.50) and least under Alternative 7 (-328,552.30). Loss of DUD's under Alternatives 2, 4, 5, and 6 were –389,606.60, –493,877.50, -467,783.60, and –345,105.00, respectively.

Analysis of land use data for the second post-project scenario (YBRP with the BSRMP) indicated a reduction (-13,737.40 DUD's) in wintering waterfowl habitat for Alternative 3 (under the "without reforestation" option). DUD's available under

Alternatives 2, 4, 5, 6, and 7 were, 195,381.10, 40,910.90, 77,593.40, 260,158.60, and 275,526.50, respectively. DUD's available under the "with reforestation" option for the second post-project option ranged from –330,764.00 DUD's (Alternative 7) to –505,548.60 DUD's (Alternative 2a-c). Loss of DUD's available under Alternatives 2, 4, 5, and 6 were 380,108.40, 483,561.00, 456,881.10 and 333,086.10, respectively.

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INTRODUCTION

1. The purpose of this appendix is to identify the relative importance of the study area in terms of historic trends in wetlands and wintering waterfowl, to document existing wintering waterfowl carrying capacity in the study area, and to document project induced impacts compared to future without-project conditions using food as an index of carrying capacity (expressed in terms of DUD's). Quantifying food availability and consumption by waterfowl represents one facet of waterfowl biology and represents only 50 percent of waterfowl habitat requirements. The availability of winter water for other uses (i.e., loafing and pair bonding) are equally important, but more difficult to quantify.

HISTORICAL PERSPECTIVE OF WETLANDS AND WATERFOWL IN THE MISSISSIPPI ALLUVIAL VALLEY

Wetlands

2. Before settlement, the Mississippi Alluvial Valley (MAV) was an intricate maze of bottomland hardwood forests, swamps, and bayous, and historically, the largest forested wetland in North America (25 million acres) extending approximately from southeastern Missouri to southern Louisiana. The transformation of this vast forest into agriculture use was gradual, yet deliberate, with over 80 percent of the forest in this region cleared. Most of the MAV was subject to periodic flooding by the Mississippi River and its tributaries. Following the Flood Control Act of 1941, hydrologic relationships in the MAV were altered by federally funded water resource developments for flood control and agriculture (Reinecke et al. 1988). Despite these changes to the landscape and hydrology in the MAV, it remains a critical ecoregion for North American waterfowl and other wildlife (Kaminski 1999). Congress enacted a series of Swamplands Acts in the mid-1800's that deeded more than 20 million acres of swamplands to the states. With the proceeds from the sale of these lands being used for reclamation, wetlands were cleared, drained, and converted to agriculture use. Extensive settlement of the MAV occurred by 1900. As the result of devastating floods (1912, 1913, 1916, and 1927), Congress enacted the comprehensive flood protection program called the Mississippi River and Tributaries Project (MR&T). As a result of the construction of 1,500 miles of mainline levees along both banks of the Mississippi River under the MR&T Project, thousands of acres of bottomland hardwood forests were cleared for agricultural production. These lands were generally high in elevation for the Delta, well drained, and the most productive in the MAV. Today, these lands are primarily used for the production of cotton, with soybeans, rice, and wheat also important crops.

3. Following the completion of interior flood control projects, the period from 1950 through the 1970's saw the expansion of agriculture into the lower, wetter, flood prone land. During this time period, approximately 3.5 million acres of wooded wetlands were converted to agriculture production in the MAV (MacDonald et al. 1979). In western Mississippi, construction of the Mississippi River mainstem levee system and additional interior drainage improvements have reduced the acres flooded by the 2-year event by

approximately 88 percent (Galloway 1980). The futility of farming marginal, floodprone land was made evident during the devastating floods that occurred from 1973 through 1993. In response to concerns from environmental groups and in conjunction to agricultural interests, Congress enacted legislation to protect and restore wetlands (marginal, flood prone agricultural land brought into production during the period from 1950-1970): the 1985 Farm Bill, the Emergency Wetlands Protection Act of 1986, the Water Resources Development Act of 1986, the Agriculture Credit Act of 1987, the Conservation Reserve Program, the 1990 Farm Bill, the Food Security Act of 1992, the Wetlands Reserve Program (WRP), and the Federal Agriculture Improvement and Reform Act of 1996. For example, under the provisions of WRP, the federal government pays land owners fair market value for marginal cropland (farmed wetlands) and assists in replanting these areas in bottomland hardwood species. Today, the trend of Federal policy is decidedly toward (1) wetland restoration that will benefit waterfowl and other wildlife dependent on wetland habitat, and (2) sound floodplain management.

Waterfowl

4. Historically, the MAV served as a major wintering area for waterfowl. Waterfowl population numbers began to decline in the 1960's as the direct result of drought and loss of nesting habitat in the prairie pothole region of the North America (Table 1). The conversion of wintering areas in the MAV (bottomland hardwoods) to agricultural production also played a role in the decline. The net effect of wetland conversion and drainage has been that natural habitat is no longer sufficient to meet the needs of wintering waterfowl and other migratory birds. Clearing for grazing, timber harvesting, agriculture, and reservoir projects have all contributed to the decline of bottomland hardwoods in the region. Waste grain, rice, and soybeans are now the dominate food sources of waterfowl in the MAV. These crops are typically grown on frequently flooded cropland. Federal flood control and drainage programs have reduced the extent of these flooded areas, the result being that naturally flooded or ponded habitat is limited for a significant portion of the wintering period and areas that do flood are less extensive and more ephemeral.

5. Within North America, several species of waterfowl, including mallards, are showing signs of recovery approaching or exceeding the population levels recorded in the 1950's (Annual Breeding Duck Survey). Total duck abundance was 44.4 million birds, and increase of 14 percent over that of 1998, and 35 percent higher than the 1955-98 average. Mallard (*Anas platyrhynchos*) abundance was 11.3 million, an increase of 17 percent over 1998 and 53 percent greater than the long-term average. Blue-winged teal (*Anas discors*) abundance was 7.2 million, similar to 1998, but 66 percent greater than the long-term average. Northern pintail (*Anas acuta*; 3.1 million, +22 percent), green-winged teal (*Anas crecca*; 2.8 million, +36 percent), northern shoveler (*Anas clypeata*; 3.9 million, +22 percent), and American widgeon (*Anas americana*; 2.9 million, +4 percent) increased from 1998 estimates. American widgeon (+13 percent), greenwinged teal (+60 percent), and northern shoveler (+95 percent), and gadwall (*Anas strepera*; 3.2 million, +110 percent) were above their respective long-term averages. However, the northern

pintail (-30 percent) was below its long term average. While the annual breeding duck surveys are the most reliable estimates of waterfowl populations, population estimates are also available from extensive surveys of wintering ducks as well as waterfowl harvest data. The midwinter waterfowl survey for the Mississippi Flyway, conducted by the Service and the states, is an attempt to count the total number of ducks of each species (Table 2). Total duck abundance was 5.4 million birds, a decrease of 2 percent over that of 1998, but equal to the 1989-98 average. Mallard abundance was 2.4 million, an increase of 3 percent over 1998 and equal to the 1989-1998 average. Blue-winged teal abundance was 186,000 birds, an 8 percent decrease from 1998, but a 79 percent increase over the 1989-1998 average. Northern pintail (317,000, -16 percent), green-winged teal (618,000, +5 percent), northern shoveler (164,000, -45 percent), and American widgeon (244,000, +21 percent) compared to the 1998 estimates. American widgeon (-3 percent), green-winged teal (-14 percent), northern shoveler (-24 percent), and northern pintail (-37 percent) were below the 1989-1998 average, whereas gadwall (+27 percent) was above the long-term average. These population estimates are not considered reliable for measuring trends in abundance of most duck species because of the large area which must be surveyed, and the difficulty of counting birds, especially in wooded habitats, and the lack of a valid statistical sampling scheme.

6. Mid-winter waterfowl surveys provide useful, general information on wintering waterfowl population levels. However, comparing the statewide numbers from year to year does not account for extremes of temperature or above or below normal rainfall; factors known to influence the arrival and departure of wintering waterfowl. Therefore, these surveys tend to count fewer ducks than are actually present, but the amount of undercount is unknown and is likely variable from year-to-year.

7. Waterfowl harvests have fluctuated since records have been kept, being lowest during the early 1960's when waterfowl populations, potential hunters, and days afield were low. In most years, harvests have tracked the fluctuation of these factors, especially waterfowl populations. In recent years, nationwide harvests of the heavily hunted mallard and of total ducks remained relatively constant, while hunter numbers declined and hunter success increased. It appears that fewer hunters have been increasingly successful at harvesting ducks. In the Mississippi Flyway, 2.75 million mallards were harvested in 1998, or 52.6 percent of the total mallard harvest in the United States, followed by 1 million gadwall (56.5 percent of the total harvest), 1 million greenwinged teal (43.4 percent of the total harvest), and 838,000 wood ducks (58.6 percent of the total harvest). Within Mississippi, mallards also comprised the majority of the ducks harvested (55.1 percent), followed by gadwall (15.8 percent), green-winged teal (8.3 percent), and wood duck (5.6 percent) (U.S. Fish and Wildlife Service 1999b). Hunters afield in Mississippi totaled 23,041 in 1998 (10 percent more than 1997) and total hunter days equaled 257,530 days (9 percent less than 1997). Total duck harvest in Mississippi in 1998 was 414,300 ducks or 15.7 ducks per adult hunter.

TABLE 1. BREEDING DUCK POPULATION ESTIMATES (in thousands)[1] .

Years	Mallard	Gadwall	American Widgeon	Green-winged Teal	Northern Shoveler	Northern Pintail	Blue-winged Teal
1955-60	9,386	651	3,195	1,584	1,556	8,543	4,909
1961-65	6,062	928	2,310	1,228	1,368	3,514	3,601
1966-70	7,805	1,641	2,702	1,652	2,105	5,177	4,138
1971-75	8,284	1,544	2,973	1,873	2,026	5,968	4,617
1976-80	7,800	1,457	3,012	1,851	1,910	4,891	4,695
1981-85	5,915	1,483	2,616	1,612	1,934	3,240	3,645
1986-90	5,932	1,443	2,002	1,860	1,789	2,334	3,584
1991	5,444	1,584	2,254	1,558	1,716	1,803	3,764
1992	5,976	2,033	2,208	1,773	1,954	2,098	4,333
1993	5,708	1,755	2,053	1,694	2,046	2,053	3,193
1994	6,980	2,318	2,382	2,108	2,912	2,972	4,616
1995	8,269	2,836	2,614	2,301	2,855	2,758	5,140
1996	7,941	2,984	2,272	2,500	3,449	2,736	6,407
1997	9,940	3,897	3,118	2,507	4,120	3,558	6,124
1998	9,640	3,742	2,857	2,087	3,183	2,520	6,398
1999	11,257	3,235	2,983	2,834	3,892	3,060	7,212

[1] U.S. Fish and Wildlife Service 1999a

TABLE 2. MIDWINTER WATERFOWL SURVEYS, MISSISSIPPI (in thousands) [1].

Years	Mallard	Gadwall	American Widgeon	Green-winged Teal	Northern Shoveler	Northern Pintail
1971-1975	343	4	11	5	2	22
1976-1980	272	8	11	11	2	14
1981-1985	184	15	12	4	10	8
1986-1990	133	11	8	6	23	7
1991	144	22	6	12	6	25
1992	126	14	7	16	4	15
1993	191	27	9	18	10	8
1994	174	43	15	27	9	23
1995	146	21	9	33	6	7
1996	127	11	7	36	6	10
1997	126	22	5	17	8	5
1998	98	39	4	30	4	3
1999	107	16	1	12	1	4

[1] Gamble 1999

WINTERING WATERFOWL BIOLOGICAL CHARACTERISTICS

8. The loss and degradation of waterfowl habitat has been identified as the major waterfowl management problem in North America (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1986). Wintering waterfowl habitat requirements can be broken down into three components: habitat availability, utilization, and suitability in meeting social behavioral requirements. Waterfowl populations and recruitment in the MAV are a direct function of these three components.

Habitat Availability

9. Relationships exist among availability of wetland habitat and food during winter and waterfowl physiological, behavioral, and population responses (Kaminski 1999). Hydrology and resulting wetland habitat and intrinsic resources are critical proximate factors related to waterfowl use of alluvial environments like the Lower Mississippi Delta (Fredrickson and Heitmeyer 1988). Additionally, current and cross-seasonal physiological status, survival, and reproductive performance of waterfowl have been linked to winter habitat and food resources (Table 3).

10. Studies of wild mallards and wood ducks have revealed that landscape-scale flooding and dry conditions during winter influence distribution and abundance of these and likely other species of 13 waterfowl and wetland birds (Kaminski 1999). Widespread winter flooding in the MAV resulted in regional increases in mallards (Nichols et al. 1983), and below-average precipitation during spring and summer in southeastern United States caused wood ducks to disperse to more southerly latitudes during fall and winter where wetland availability apparently was greater (Hepp and Hines 1991). Additionally, increased wetland availability during winter presumably enhances foraging opportunities and food availability for mallards and other waterfowl (Wright 1961, Delnicki and Reinecke 1986, Reinecke et al 1988, Wehrle et al 1995), which in turn have been related to increased body weights in mallards (Delnicke and Reinecke 1986), earlier prebasic molt and acquisition of basic (breeding) plumage in female mallards (Heitmeyer 1987, Richardson and Kaminski 1992), and increased mallard survival (Reinecke et al. 1987) and reproductive rates (Heitmeyer and Fredrickson 1981, Kaminski and Gluesing 1987). The results of recent research on mallards and wood ducks showed that winter wetland availability is linked to current and cross-seasonal life-cycle events of mallards and wood ducks, and possibly other waterfowl using alluvial environments like the Delta (Kaminski 1999). Managed and unmanaged wintering waterfowl habitats are present in the MAV. Managed habitats, using structural measures and vegetation manipulation, are primarily found on federal and state lands, and represent the core wintering habitat during dry (below normal rainfall) years. Since 1988, Ducks Unlimited, the U.S. Fish and Wildlife Service's Private Lands Program, and the Mississippi Partners Program (comprised of the U.S. Fish and Wildlife Service, Delta Wildlife Foundation, and Mississippi Department of Wildlife, Fisheries and Parks) have provided assistance to hundreds of private land owners to manage 59,677 acres as winter waterfowl habitat (30,767 acres under the

TABLE 3. POTENTIAL GENERIC BENEFITS TO MALLARDS AND WOOD DUCKS FROM FAVORABLE WINTER WATER (HABITAT) AND FEEDING CONDITIONS IN THE MISSISSIPPI ALLUVIAL VALLEY OR UNDER CAPTIVE CONDITIONS (adapted from Reinecke et al. 1988).

POTENTIAL BENEFIT	REFERENCE
Improved foraging	
Natural foods (e.g., seeds, invertebrates)	Wright (1961), Wehrle et al. (1995)
Agricultural seeds (rice)	Reinecke et al. (1988)
Improved physiological condition	
Increased body weight	Delnicki and Reinecke (1986), Demarest et al. (1997)
Earlier prebasic molt in females	Heitmeyer (1987), Richardson and Kaminski (1992), Barras (1993)
Increased pair formation	Demarest et al. (1997), Vrtiska (1995)
Changes in distribution and habitat use	
Response to local/regional flooding	Reinecke (unpubl. data), Hepp and Hines (1991)
Regional increase in winter population	Nichols et al (1983)
Increased survival and reproductive performance	
Survival	Reinecke et al. (1987), Demarest et al. (1997), Vrtiska (1995)
Reproductive performance	Heitmeyer and Fredrickson (1981), Kaminski and Gluesing (1987), Dubovsky and Kaminski (1994) and Vrtiska (1995)

Private Lands Program, 16,676 by Ducks Unlimited, and 12,234 acres by the Mississippi Partners Program). Unmanaged winter habitat provides important foraging habitat to wintering waterfowl during years of normal or above normal rainfall. These periods of above normal rainfall show increases in available foraging habitat from 900 percent in Mississippi to 1,200 percent in Arkansas (Reinecke et al. 1988). The increased availability of wintering habitat also effects the distribution of wintering waterfowl in the MAV. Proportionately more waterfowl have been found to winter in the MAV during periods of above normal rainfall and cold winters (Nichols et al. 1983, Reinecke et al. 1987). This unmanaged and flood susceptible habitat, which is so important to wintering waterfowl, has long been subject to federal flood control drainage projects in the MAV.

Habitat Utilization

11. Waterfowl are mobile and opportunistic, and their feeding habits have changed over time, presumably in response to the large-scale conversion of native wooded wetlands to small grain agricultural crops. The principal foods of mallards generally include agricultural grains; seeds and tubers of native plants; acorns; and invertebrates such as isopods, snails, and fingernail clams (Reinecke et al. 1987). Heitmeyer (1985) and Combs (1987) found that pin oak (*Quercus palustris*) and cherrybark oak (*Quercus falcata* var. *pagodaefolia*) acorns dominate the mallard diet during years of good mast production and favorable water conditions in southeastern Missouri. Nuttall oak (*Quercus nuttalli*) fills the same ecological niche in the southern Mississippi Delta as pin oak in Missouri. In the early fall, mallards concentrate on shallowly flooded openings in bottomland forests. Shortly after arrival, mallards complete prealternate (breeding plumage) molt and consume aquatic insects and moist soil seeds. Following molt, mallards begin courtship and by early January, 90 percent of the birds are paired (Bellrose 1980). During pairing, mallards forage intensively in flooded forests or agricultural fields, where they consume acorns and cereal grains. After pairing, mallards readily use shallowly flooded forests and continue to consume acorns, but increase consumption of macroinvertebrates (Fredrickson and Batema 1992). Wood ducks and hooded mergansers (*Lophodytes cucculatus*) use overcup oak, cypress/tupelo forest types and scrub/shrub habitats during fall courtship and pairing (Bellrose 1980). Both species breed in Mississippi and nest in natural tree cavities or artificial nest boxes. After pairing, wintering habitat includes the deeper areas of lowland hardwoods, cypress/tupelo, overcup oak, and scrub/shrub habitats. Wright (1961) and Delnicki and Reinecke (1986) demonstrated the importance to waterfowl of large areas of flooded rice and soybean fields. Seeds and tubers of grasses, sedges, and other moist soil plants are also important components of the diet (Wright 1961, Wills 1970, Heitmeyer 1985, Delnicki and Reinecke 1986, Combs 1987). Invertebrates generally provide less than 10 percent of the diet in agricultural (Delnicki and Reinecke 1986) and moist soil (McKenzie 1987) habitats, but may be more important in forested wetlands (Heitmeyer 1985). Although the nutrition of wintering waterfowl is not well understood, it is, however, increasingly clear that nutrition affects dietary energy and protein intake, and that meeting these dietary requirements is positively related to winters with normal or above normal rainfall. Studies conducted in Mississippi during the wet winter of 1982-83 show increased mallard body weights while the dry winter of

1980-1981 show decreased mallard body weights (Delnicke and Reinecke 1986). Similar results in Missouri indicated that mallard body weights increased when water conditions and mast production were favorable, or when rainfall was sufficient to flood low lying cropland (Heitmeyer 1985, Combs 1987). The condition in which waterfowl return to the breeding grounds has been shown to have a major impact on their breeding success and survival (Bellrose 1980, Reinecke et al. 1989). In recent years, research has focused on relative waterfowl utilization and associated food availability in natural and agricultural foraging habitat. Utilization of agricultural fields differs among crops (Nelms and Twedt 1996). Herbaceous native vegetation is used to a greater extent than any agricultural crops. Bottomland hardwoods are utilized for foraging to a certain extent and roosting, loafing, and pair formation to a large extent (Reinecke et al. 1989). (Caloric values, seed consumption, and seed decomposition rates of available waterfowl foraging habitat form the basis for determining project impacts and are discussed in detail in the Impact Assessment Methodology section of this appendix.)

Social Behavior

12. During winter, courtship and pair formation dominate the social behavior of dabbling ducks. Most of the study area is agricultural land, replacing forested wetlands as the primary foraging habitat. The forested wetlands and normally associated shrub swamps, beaver ponds, riparian habitat, and other deep water habitat are used as resting or roosting areas and provide isolation from human disturbance, protection from predators, and a location for courtship and other social activities where pairs are visually isolated. Whereas much of the foraging and nutritional requirements can be met by flooded agricultural lands, a variety of habitats is needed to satisfy the total biological requirements of wintering waterfowl, because members of the population may differ in their habitat needs at any particular time (Reinecke et al. 1987). Examples include the likelihood of juvenile or unpaired mallards feeding in agricultural lands and adults and pairs seeking the isolation of shrub swamps to avoid harassment from courting parties (Heitmeyer 1985).

Methodology

13. In this section, the term wintering waterfowl includes primarily puddle ducks consisting of the mallard, northern pintail, American wigeon, gadwall, green-winged teal, northern shoveler, and blue-winged teal. Prior YBRP waterfowl appendices incorporated a methodology that used available food (energy) as an index of the carrying capacity of winter foraging habitat for dabbling ducks in the MAV. This methodology was developed in 1992 by Mr. Robert Barkley (U.S. Fish and Wildlife Service, Vicksburg Field Office) and Dr. Kenneth J. Reinecke (United States Geological Survey, Mississippi Valley Research Field Station). This method was used on several Corps flood control projects to quantify the impact of altering hydrology on traditional waterfowl wintering areas and for designing appropriate mitigation measures (U.S. Army Corps of Engineers 1991, 1993). This method has also been used by the Lower Mississippi Valley Joint Venture in setting habitat management goals for wintering waterfowl habitat in the MAV (Loesch et al. 1994). The Vicksburg District of the Corps of Engineers prepared a GIS data base tailored to identify the acres of available foraging habitat under existing conditions and future conditions (with and without the project). For a determination of existing and future carrying capacities (based on the implementation of an alternative), land use was broken down into available foraging habitats having food value to wintering waterfowl, these included: fallow fields, rice fields, soybean fields, bottomland hardwood forested wetlands, and reforested areas.

14. To determine carrying capacity in terms of numbers of duck-use-days (DUD's), data requirements include land use, hydrology, and available food during the 120 day (November 1 to February 28) waterfowl wintering period. The data were specific to those habitats and food resources that were available and used by foraging waterfowl.
The amount of food available on a unit area was determined by Reinecke et al. (1989) and McAbee (1994). Small grain crop residues, moist soil native weed seeds, acorns, and invertebrates in forest stands with more than 25 percent red oaks represent the available winter waterfowl food. For this waterfowl appendix the methodology was further refined to include information on seed deterioration rates and seed abundance, invertebrate abundance, as well as depth and duration of flooding (Nelms 1996). Waterfowl foraging habitat, regardless of food value, is only of use to wintering waterfowl if available. Food availability is dependent on extent, duration, and depth of flooding. Waterfowl use relatively shallow water areas, eighteen inches or less, for feeding. Through the use of extensive hydrological data (1943-1997), the Corps estimated seasonal acres flooded eighteen inches or less for the wintering season. The land use data provided for the study area were specific to those acres inundated and represent only potential available foraging habitat. By including the factors described above, the present methodology is more representative of winter waterfowl foraging habitat. The index of carrying capacity for wintering waterfowl foraging habitat is expressed in duck-use-days (DUD's) per acre which represents the capacity of the available forage per acre that meets the energy requirements of one duck for one day. The information requirements to estimate DUD's are: (1) current land use, including crop type, (2) extent, duration, and depth of flooding, (3) amount of winter food present by land use, (4) energy of food items, (5) deterioration rates of food items,

(6) energy requirements of waterfowl, and (7) estimated density of waterfowl. The equation for this is as follows:

$$DUD/Acre = (Food\ X\ Energy) / (Duck\ Energy\ needs)$$

15. The equation used to estimate DUD's was further refined by factoring in the amount of seed deterioration that occurs over time because seed deterioration has a significant impact on DUD's. Deterioration rates were estimated from experimental data using the best fitting regression model (Nelms and Twedt 1996). Daily seed consumption estimates were also incorporated into the equation to preclude overestimating the influence of seed deterioration because foods consumed by ducks are not subject to deterioration. Since DUD's are a function of the weight of the food available and food is easily converted to calories, calculations are in terms of the weight of food. The equation for food available to ducks on a given day when seed consumption and deterioration are taken into account is:

$$Food_j = Food_0 - \sum (Food_{consumed\ i} + Food_{deteriorated\ i})$$

where:

$$Food_{consumed} = \frac{Mean\ Duck\ Density\ x\ Kcal\ consumed/duck/day}{Kcal/kg\ of\ food}$$

and

$$Food_{deteriorated} = Food\ x\ Deterioration\ rate\ x\ Days_i$$

where i and j are days.

16. Duck-use-days per acre, adjusted for deterioration, is calculated by multiplying the number of days times the projected density of ducks. By converting to DUD's, units are comparable across habitats which facilitates both mitigation efforts and management decisions. This is particularly useful when the loss of one habitat must be mitigated with another habitat type due to practical constraints or the need to meet multiple ecosystem management goals. DUD's provide an objective index of the relative value of different habitats for dabbling ducks as winter foraging habitats. To facilitate calculation, food item densities, deterioration rates, and energy values were aggregated within a given habitat type. Weighted averages based on weights of food items were used to calculate the aggregate values. Aggregate values are representative of any generic unit of food in the habitat of interest (Table 4).

17. Once aggregate values were calculated, the density of ducks feeding in the habitats of interest is projected so that daily consumption can be estimated. An overall average of

systematic observations of waterfowl in flooded moist soil, rice, and soybean fields in the MAV was used to estimate duck density. The estimated diurnal density of ducks in

TABLE 4. FOOD DENSITIES AND METABOLIZABLE ENERGY CONTENT OF WATERFOWL FOODS IN THE MISSISSIPPI ALLUVIAL VALLEY [1].

Foraging Habitat	Acorns kg/ha (Kcal/kg)	Grain kg/ha (Kcal/kg)	Weeds kg/ha (Kcal/kg)	Invertebrates Kg/ha (Kcal/kg)
Moist Soil			450 (2,500)	0.69 (2,500)
Corn		250 (3,670)		
Milo		200 (3,500)	25 (2,500)	
Rice		166 [1,2] (2,933)	32 [1,2] (2,500)	3.96 [2] (2,500)
Soybean		86 [1,2] (1,871)	54 [2] (2,500)	0.44 [2] (2,500)
30% Red Oaks	27 (3,500)		22.5 (2,500)	13.7 (2,500)
50% Red Oaks	44 (3,500)		22.5 (2,500)	13.7 (2,500)
70% Red Oaks	62 (3,500)		22.5 (2,500)	13.7 (2,500)
90% Red Oaks	80 (3,500)		22.5 (2,500)	13.7 (2,500)

1 All information from Reinecke et al. (1989) unless indicated otherwise
2 McAbee (1994)

flooded rice, soybean, and moist soil fields in the MAV from data collected by McAbee (1994) and Dr. Dan Twedt (U.S. Geological Survey) and Mr. Curtis Nelms (U.S. Fish and Wildlife Service, Vicksburg) (unpublished data) is 10.1 ducks/ha. No empirical estimates of waterfowl density in flooded bottomland hardwoods (BLH) in the MAV are known to exist, so estimates from croplands and moist soil are also used for BLH. Little information is available on nocturnal feeding densities of waterfowl, although this has been shown to be an important phenomenon (Paulus 1980, Reinecke unpublished data). To adjust for nocturnal foraging, the estimate of diurnal density is doubled to 20.2 ducks/ha. The role of the projected density and subsequent consumption

estimates is to dampen the effects of seed deterioration on food availability. If the average daily consumption estimates were not included in the model then the influence of seed deterioration would be overestimated because foods consumed by ducks are no longer subject to deterioration. From these calculations, DUD's/ha and Days to Exhaustion (DTE) were generated (Table 5). Reasonable estimates were generated for the number of days of flooding until exhaustion of food resources occurred at an average duck density. This density is assumed to be the point where declining foraging efficiency causes ducks to abandon a field. Reinecke et al. (1989) found this threshold foraging efficiency to be 50 kg/ha. The estimated Days To Exhaustion (DTE) of food resources is useful for determining the impact of the length of flooding on habitat values. DTE allows the inclusion of data on flood duration and is useful in determining the impacts of flood control projects on wintering waterfowl foraging habitat. For example, if under existing conditions a moist soil area floods for 126 days during the waterfowl season, it can support 1,037 ducks per acre per day, and this food resource will be exhausted in 126 days. If a flood control project reduces the duration of flooding, then food availability will also be reduced (i.e., loss of DUD's).

TABLE 5. DUCK-USE-DAYS (PER HECTARE AND ACRE) AND DAYS TO EXHAUSTION OF WINTER FOOD RESOURCES FOR FLOODED MOIST SOIL, RICE, SOYBEAN, AND BOTTOMLAND HARDWOOD FORESTS [1].

Habitat	Duck-use-days/ha	Duck-use-days/ac	Days to Exhaustion
Moist Soil	2,563	1,037	126
Rice	1,434	580	71
Soybean	626	253	31
30% Red Oaks	141	57[2]	7
50% Red Oaks	303	123	15
70% Red Oaks	485	196 (237[3])	24
90% Red Oaks	667	270	33

1 - Nelms and Twedt 1996
2 - 30% red oaks (57 DUD's/acre) is used in this appendix to represent carrying capacity of existing BLH, and in the calculation of existing conditions.
3 - 70% red oaks is used in this appendix as an average seedling survival rate. Forty-one DUD were added due to the presence of moist soil (fallow field) habitat during the first five years after planting. The 237 DUD/acre is used as the carrying capacity of reforested cleared land in the calculation of future with and without –project conditions, and to determine mitigation acres.

18. Forty-one DUD's were added due to the presence of moist soil (fallow field) habitat during the first five years after planting. The 237 DUD's/acre is used as the carrying capacity of reforested cleared land in the calculation of future with and without-project conditions, and to determine mitigation acres.

Results

Hydrologic and Reforestation Impacts – YBRP Without BSRMP

19. Potential hydrologic impacts were determined using the methodology described above. DUD's per acre were calculated for each alternative within each of the two reaches. Analysis of baseline conditions (Alternative 1) indicated that a total of 1,849,731.30 DUD's are currently available within both reaches (Table 7). Of these, 621,681.50 DUD's are available in fallow fields, 45,182.00 DUD's are available in rice fields, 272,101.50 DUD's are available in soybeans, 547,513.50 DUD's are available in bottomland hardwoods (BLH), and 363,252.80 are available in reforested lands.

A total of 2,045,217.40 DUD's would be available with Alternative 2 (without the reforestation of cleared lands). This represents 696,967.70 DUD's in fallow fields, 48,082.00 DUD's in rice fields, 299,931.50 DUD's in soybeans fields, 606,126.60 DUD's in BLH stands, and 394,109.60 DUD's in reforested lands (Table 8). A total of 1,460,134.7 DUD's would be available under Alternative 2 if cleared lands were reforested.

Table 7. Duck use days available for Alternative 1 (baseline conditions) (Yazoo Backwater Pump Project Without BSRMP).

Land Use	Percent Land Use By Reach		Little Sunflower Upper Sump (11,450 ac)	Steele Bayou Lower Sump (4,748 ac)	Total Acres Impacted	DUD/acre	Total DUD
	LSUS	SBLS					
Fallow Field	3.49	4.21	399.61	199.89	599.50	1037	621,681.50
Rice	0.61	0.17	69.85	8.07	77.92	580	45,182.00
Soybeans	6.98	5.82	799.21	276.33	1,075.54	253	272,101.50
Crop Subtotal	**11.08**	**10.20**	**1,268.66**	**484.30**	**1,752.96**	NA	**938,965.00**
BLH	60.69	55.95	6,949.01	2,656.51	9,605.51	57	547,513.50
Reforested [1]	14.02	7.77	1,605.29	368.92	1,974.21	184	363,252.80
Forested Subtotal	**74.71**	**63.72**	**8,554.30**	**3,025.43**	**11,579.72**	**NA**	**910,766.30**
Other Subtotal [2]	**15.9**	**23.3**	**1,627.04**	**1,238.27**	**NA**	**NA**	**NA**
Total	**100.0**	**100.0**	**11,450.00**	**4,748.00**	**13,332.70**	**NA**	**1,849,731.30**

NOTE: LSUS = Little Sunflower Upper Sump reach, SBLS = Steele Bayou Lower Sump reach.

[1] **- Herbaceous -** recently reforested lands within the 2-year floodplain with trees averaging 10 years old when project begins.
[2] **- Other** - includes land use categories not regularly used by wintering waterfowl

Table 8. Hydrologic and Reforestation Impacts - duck use days available for Alternative 2 (Yazoo Backwater Reformulation Project Without BSRMP).

Land Use	Percent Land Use By Reach		Little Sunflower Upper Sump (11,896 ac)	Steele Bayou Lower Sump (6,102 ac)	Total Acres Impacted	DUD/acre	DUD Available Without Reforestation	DUD Available With Reforestation	
	LSUS	SBLS					Total DUD	DUD lost after cleared lands are reforested [1]	Net DUD Avaiable [2]
Fallow Field	3.49	4.21	415.2	256.9	672.1	1037	696,967.7		
Rice	0.61	0.17	72.6	10.4	82.9	580	48,082.0		
Soybeans	6.98	5.82	830.3	355.1	1,185.5	253	299,931.5		
Crop Subtotal	**11.08**	**10.20**	**1318.1**	**622.4**	**1,940.5**	NA	**1,044,981.2**	**1,044,981.2**	
BLH	60.69	55.95	7219.7	3414.1	10,633.8	57	606,126.6		
Reforested [3]	14.02	7.77	1667.8	474.1	2,141.9	184	394,109.6		
Forested Subtotal	**74.71**	**63.72**	**8887.5**	**3888.2**	**12,775.7**	**NA**	**1,000,236.2**		**1,460,134.7**
Other [4] Subtotal	**14.2**	**26.1**	**1,690.4**	**1,591.4**	**NA**	**NA**	**NA**		
Total	**100.0**	**100.0**	**11,896**	**6,102**	**14,716.20**	**NA**	**2,045,217.4**		**1,460,134.7**

[1] - The reforestation feature of this plan will eliminate the DUD's provided by cleared lands used by waterfowl.

[2] - The reforestation feature of this plan will reduce the loss of DUD's that were provided by cleared lands used by waterfowl because reforested lands will provide 237 DUD per acre.

[3] - Reforested - recently reforested lands within the 2-year floodplain with trees averaging 10 years old when project begins.

[4] - includes land use categories not regularly used by wintering waterfowl

20. Analysis of land use data provided for Alternative 3 indicated that a total of 1,832,256.29 DUD's would be available under the first option. This represents 616,683.16 DUD's in fallow fields, 44,590.40 DUD's in rice fields, 269,452.59 DUD's in soybeans fields, 542,406.30 DUD's in BLH stands, and 359,123.84 DUD's in reforested lands (Table 9).

21. Analysis of land use data provided from Alternative 4 indicated that a total of 1,891,773.00 DUD's would be available under the first option. This represents 636,552.08 DUD's in fallow fields, 46,069.40 DUD's in rice fields, 278,221.57 DUD's in soybeans fields, 560,013.60 DUD's in BLH stands, and 370,916.40 DUD's in reforested lands (Table 10). A total of 1,355,863.80 DUD's would be available under Alternative 4 if cleared lands were reforested.

22. Analysis of land use data provided from Alternative 5 indicated that a total of 1,927,714.40 DUD's would be available under the first option. This included 648,125.00 DUD's in fallow fields, 47,049.60 DUD's in rice fields, 283,557.34 DUD's in soybeans, 570,610.47 DUD's in BLH stands, and 378,372.08 DUD's in reforested lands (Table 11). A total of 1,381,957.70 DUD's would be available if cleared lands are reforested.

23. Analysis of land use data provided from Alternative 6 indicated that a total of 2,110,867.22 DUD's would be available under the first option. This included 721,109.06 DUD's in fallow fields, 47,925.40 DUD's in rice fields, 309,649.23 DUD's in soybean fields, 626,132.46 DUD's in BLH stands, and 406,051.20 DUD's in reforested lands (Table 12). A total of 1,506,636.30 DUD's would be available if cleared lands are reforested.

24. Analysis of land use data provided from Alternative 7 indicated that a total of 2,131,331.6 DUD's would be available under the first option. Calculation of available DUD's under the no reforestation option of Alternative 7 totaled 2,131,331.6. This included 726,947.37 DUD's in fallow fields, 50,001.80 DUD's in rice fields, 312,490.42 DUD's in soybean fields, 631,699.08 DUD's in BLH stands, and 410,193.04 DUD's in reforested lands. A total of 1,521,189.00 DUD's would be available if cleared lands are reforested (Table 13).

Table 9. Hydrologic and Reforestation Impacts - duck use days available for Alternative 3 (Yazoo Backwater Reformulation Project Without BSRMP).

Land Use	Percent Land Use By Reach		Little Sunflower Upper Sump (11,271 ac)	Steele Bayou Lower Sump (4,782 ac)	Total Acres Impacted	DUD/acre	DUD Available Without Reforestation	DUD Available With Reforestation	
	LSUS	SBLS					Total DUD	DUD lost after cleared lands are reforested [1]	Net DUD Avaiable [2]
Fallow Field	3.49	4.21	393.36	201.32	594.68	1,037	616,683.16		
Rice	0.61	0.17	68.75	8.13	76.88	580	44,590.40		
Soybeans	6.98	5.82	786.72	278.31	1,065.03	253	269,452.59		
Crop Subtotal	**11.08**	**10.20**	**1,248.83**	**487.76**	**1,736.59**	NA	**930,726.15**	**NA**	**930,726.15**
BLH	60.69	55.95	6,840.37	2,675.53	9,515.90	57	542,406.30		
Reforested [3]	14.02	7.77	1,580.19	371.56	1,951.76	184	359,123.84		
Forested Subtotal	**74.71**	**63.72**	**8,420.56**	**3,047.09**	**11,467.65**	**NA**	**901,530.14**		**901,530.14**
Other [4] Subtotal	**14.2**	**26.1**	**1,601.6**	**1,247.1**	**NA**	**NA**	**NA**		
Total	**100.0**	**100.0**	**11,271**	**4,782**	**13,204.24**	**NA**	**1,832,256.29**		**1,832,256.29**

[1] - The reforestation feature of this plan will eliminate the DUD's provided by cleared lands used by waterfowl.

[2] - The reforestation feature of this plan will reduce the loss of DUD's that were provided by cleared lands used by waterfowl because reforested lands will provide 237 DUD per acre.

[3] - Reforested - recently reforested lands within the 2-year floodplain with trees averaging 10 years old when project begins.

[4] - includes land use categories not regularly used by wintering waterfowl

Table 10. Hydrologic and Reforestation Impacts - duck use days available for Alternative 4 (Yazoo Backwater Reformulation Project Without BSRMP).

Land Use	Percent Land Use By Reach		Little Sunflower Upper Sump (11,650 ac)	Steele Bayou Lower Sump (4,923 ac)	Total Acres Impacted	DUD/ acre	DUD Available Without Reforestation	DUD Available With Reforestation	
	LSUS	SBLS					Total DUD	DUD lost after cleared lands are reforested [1]	Net DUD Avaiable [2]
Fallow Field	3.49	4.21	406.59	207.26	613.84	1,037	636,552.08		
Rice	0.61	0.17	71.07	8.37	79.43	580	46,069.40		
Soybeans	6.98	5.82	813.17	286.52	1,099.69	253	278,221.57		
Crop Subtotal	**11.08**	**10.20**	**1,290.82**	**502.15**	**1,792.97**	NA	**960,843.05**	**960,843.05**	
BLH	60.69	55.95	7,070.39	2,754.42	9,824.80	57	560,013.60		
Reforested [3]	14.02	7.77	1,633.33	382.52	2,015.85	184	370,916.40		
Forested Subtotal	**74.71**	**63.72**	**8,703.72**	**3,136.94**	**11,840.65**	**NA**	**930,930.00**		**1,355,863.80**
Other [4] Subtotal	**14.2**	**26.1**	**1,655.5**	**1,283.9**	**NA**	**NA**	**NA**		
Total	**100.0**	**100.0**	**11,650**	**4,923**	**13,633.62**	**NA**	**1,891,773.0**		**1,355,863.80**

[1] - The reforestation feature of this plan will eliminate the DUD's provided by cleared lands used by waterfowl.

[2] - The reforestation feature of this plan will reduce the loss of DUD's that were provided by cleared lands used by waterfowl because reforested lands will provide 237 DUD per acre.

[3] - Reforested - recently reforested lands within the 2-year floodplain with trees averaging 10 years old when project begins.

[4] - includes land use categories not regularly used by wintering waterfowl

Table 11. Hydrologic and Reforestation Impacts - duck use days available for Alternative 5 (Yazoo Backwater Reformulation Project Without BSRMP).

Land Use	Percent Land Use By Reach		Little Sunflower Upper Sump (11,913 ac)	Steele Bayou Lower Sump (4,970 ac)	Total Acres Impacted	DUD/acre	Total DUD Available Without Reforestation	DUD Available With Reforestation	
	LSUS	SBLS					Total DUD	DUD lost after cleared lands are reforested [1]	Net DUD Avaiable [2]
Fallow Field	3.49	4.21	415.76	209.24	625.00	1037	648,125.00		
Rice	0.61	0.17	72.67	8.45	81.12	580	47,049.60		
Soybeans	6.98	5.82	831.53	289.25	1,120.78	253	283,557.34		
Crop Subtotal	**11.08**	**10.20**	**1,319.96**	**506.94**	**1,826.90**	NA	**978,731.94**	**978,731.94**	
BLH	60.69	55.95	7,230.00	2,780.72	10,010.71	57	570,610.47		
Reforested [3]	14.02	7.77	1,670.20	386.17	2,056.37	184	378,372.08		
Forested Subtotal	**74.71**	**63.72**	**8,900.20**	**3,166.88**	**12,067.09**	**NA**	**948,982.55**		**1,381,957.70**
Other [4] Subtotal	**14.2**	**26.1**	**1,692.8**	**1,296.2**	**NA**	**NA**	**NA**		
Total	**100.0**	**100.0**	**11,913**	**4,970**	**13,893.99**	**NA**	**1,927,714.40**		**1,381,957.70**

[1] - The reforestation feature of this plan will eliminate the DUD's provided by cleared lands used by waterfowl.

[2] - The reforestation feature of this plan will reduce the loss of DUD's that were provided by cleared lands used by waterfowl because reforested lands will provide 237 DUD per acre.

[3] - Reforested - recently reforested lands within the 2-year floodplain with trees averaging 10 years old when project begins.

[4] - includes land use categories not regularly used by wintering waterfowl

Table 12. Hydrologic and Reforestation impacts - duck use days available for Alternative 6 (Yazoo Backwater Pump Project Without BSRMP).

Land Use	Percent Land Use By Reach		Little Sunflower Upper Sump (12,184 ac)	Steele Bayou Lower Sump (6,417 ac)	Total Acres Impacted	DUD/acre	DUD Available Without Reforestation	DUD Available with Reforestation	
	LSUS	SBLS					Total DUD	DUD Lost After Cleared Lands are Reforested [1]	Net DUD Available [2]
Fallow Field	3.49	4.21	425.22	270.16	695.38	1037	721,109.06		
Rice	0.61	0.17	71.72	10.91	82.63	580	47,925.40		
Soybeans	6.98	5.82	850.44	373.47	1,223.91	253	309,649.23		
Crop Subtotal	**11.08**	**10.20**	**1,347.38**	**654.53**	**2,001.91**	NA	**1,078,683.69**	**1,078,683.60**	
BLH	60.69	55.95	7,394.47	3,590.31	10,984.78	57	626,132.46		
Reforested [3]	14.02	7.77	1,708.20	498.60	2,206.80	184	406,051.20		
Forested Subtotal	**74.71**	**63.72**	**9,102.67**	**4,088.91**	**13,191.58**	**NA**	**1,032,183.66**		**1,506,636.30**
Other Subtotal [4]	**15.9**	**23.3**	**1,734.00**	**1,673.60**	**NA**	**NA**	**NA**		
Total	**100.0**	**100.0**	**12,184.00**	**6,417.00**	**NA**	**NA**	**2,110,867.22**		**1,506,636.30**

NOTE: LSUS = Little Sunflower Upper Sump reach, SBLS = Steele Bayou Lower Sump reach.

[1] - The reforestation feature of this plan will eliminate the DUD's provided by cleared lands used by waterfowl.

[2] - The reforestation feature of this plan will reduce the loss of DUD's that were provided by cleared lands used by waterfowl because reforested lands will provide 237 DUD per acre.

[3] - Reforested - recently reforested lands within the 2-year floodplain with trees averaging 10 years old when project begins.

[4] - includes land use categories not regularly used by wintering waterfowl

Table 13. Hydrologic and Reforestation impacts - DUD's available for Alternative 7 (Yazoo Backwater Pump Project Without BSRMP).

Land Use	Percent Land Use By Reach		Little Sunflower Upper Sump (12,344 ac)	Steele Bayou Lower Sump (6,418 ac)	Total Acres Impacted	DUD/acre	DUD Available Without Reforestation	DUD Available with Reforestation	
	LSUS	SBLS					Total DUD	DUD Lost After Cleared Lands are Reforested [1]	Net DUD Available [2]
Fallow Field	3.49	4.21	430.81	270.20	701.01	1037	726,947.37		
Rice	0.61	0.17	75.30	10.91	86.21	580	50,001.80		
Soybeans	6.98	5.82	861.61	373.53	1,235.14	253	312,490.42		
Crop Subtotal	**11.08**	**10.20**	**1,367.72**	**654.64**	**2,022.36**	NA	**1,089,439.59**	**1,089,439.50**	
BLH	60.69	55.95	7,491.57	3,590.87	11,082.44	57	631,699.08		
Reforested [3]	14.02	7.77	1,730.63	498.68	2,229.31	184	410,193.04		
Forested Subtotal	**74.71**	**63.72**	**9,222.20**	**4,089.55**	**13,311.75**	**NA**	**1,041,892.10**		**1,521,189.00**
Other Subtotal [4]	**15.9**	**23.3**	**1,754.10**	**1,673.80**	**NA**	**NA**	**NA**		
Total	**100.0**	**100.0**	**12,344.00**	**6,418.00**	**15,334.11**	**NA**	**2,131,331.60**		**1,521,189.00**

NOTE: LSUS = Little Sunflower Upper Sump reach, SBLS = Steele Bayou Lower Sump reach.

[1] - The reforestation feature of this plan will eliminate the DUD's provided by cleared lands used by waterfowl.

[2] - The reforestation feature of this plan will reduce the loss of DUD's that were provided by cleared lands used by waterfowl because reforested lands will provide 237 DUD per acre.

[3] - Reforested - recently reforested lands within the 2-year floodplain with trees averaging 10 years old when project begins.

[4] - includes land use categories not regularly used by wintering waterfowl

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25. The analysis of baseline conditions for Alternative 1 indicated that a total of 1,820,073.80 DUD's are currently available within both reaches (Table 14). Of these, 610,585.60 DUD's are available in fallow fields, 44,138.00 DUD's are available in rice fields, 266,712.60 DUD's are available in soybeans, 543,278.40 DUD's are available in BLH stands, and 355,359.20 are available in reforested lands.

26. The analysis of baseline conditions for Alternative 2 indicated that a total of 2,015,454.90 DUD's are currently available within both reaches. This represents 685,768.10 DUD's in fallow fields, 47,038.0 DUD's in rice fields, 294,466.70 DUD's in soybeans fields, 602,039.70 DUD's in BLH stands, and 386,142.40 DUD's in reforested lands (Table 15). A total 1,439,965.40 DUD's would be available under Alternative 2 if cleared lands were reforested.

27. The analysis of baseline conditions for Alternative 3 indicated that a total of 1,808,502.50 DUD's are currently available within both reaches. This represents 607,453.86 DUD's in fallow fields, 43,691.40 DUD's in rice fields, 269,949.19 DUD's in soybeans, 539,864.10 DUD's in BLH stands, and 352,544.00 DUD's in reforested lands (Table 16).

28. The analysis of baseline conditions for Alternative 4 indicated that a total of 1,863,150.70 DUD's are currently available within both reaches. This represented 625,767.28 DUD's in fallow fields, 45,019.60 DUD's in rice fields, 272,959.17 DUD's in soybeans, 556,175.79 DUD's in BLH stands, and 363,228.88 DUD's in reforested lands (Table 17). A total of 1,336,512.8 DUD's would be available under Alternative 4 if cleared lands were reforested.

29. The analysis of baseline conditions for Alternative 5 indicated that a total of 1,899,833.2 DUD's are currently available within both reaches. This included 637,526.86 DUD's in fallow fields, 46,011.40 DUD's in rice fields, 278,383.49 DUD's in soybean fields, 567,098.13 DUD's in BLH stands, and 370,813.36 DUD's in reforested lands (Table 18). A total of 1,363,193.70 DUD's would be available under Alternative 5 if cleared lands were reforested.

30. The analysis of baseline conditions for Alternative 6 indicated that a total of 2,082,398.40 DUD's are currently available within both reaches. This represented 709,816.13 DUD's in fallow fields, 48,331.40 DUD's in rice fields, 304,141.42 DUD's in soybeans, 622,106.55 DUD's in BLH stands, and 398,003.04 DUD's in reforested lands (Table 19). A total of 1,486,987.70 DUD's would be available under Alternative 6 if cleared lands were reforested.

31. The analysis of baseline conditions for Alternative 7 indicated that a total of 2,097,766.30 DUD's are currently available within both reaches. This represents 714,524.11 DUD's in fallow fields, 48,789.60 DUD's in rice fields, 306,433.60 DUD's in soybeans, 626,674.53 DUD's in BLH stands, and 401,344.48 DUD's in reforested lands. A total of 1,498,309.80 DUD's would be available with Alternative 7 if cleared lands are reforested (Table 20).

Table 14. Hydrologic Impacts - duck use days available for Alternative 1 (baseline conditions) (Yazoo Backwater Reformulation Project With BSRMP).

Land Use	Percent Land Use By Reach		Little Sunflower Upper Sump (11,144 ac)	Steele Bayou Lower Sump (4,748 ac)	Total Acres Impacted	DUD/acre	Total DUD
	LSUS	SBLS					
Fallow Field	3.49	4.21	388.9	199.9	588.8	1037	610,585.6
Rice	0.61	0.17	68.0	8.1	76.1	580	44,138.0
Soybeans	6.98	5.82	777.9	276.3	1,054.2	253	266,712.6
Crop Subtotal	**11.08**	**10.20**	**1,234.8**	**484.3**	**1,719.1**	**NA**	**921,436.2**
BLH	61.69	55.95	6874.7	2656.5	9,531.2	57	543,278.4
Reforested [1]	14.02	7.77	1562.4	368.9	1,931.3	184	355,359.2
Forested Subtotal	**75.7**	**63.7**	**8,437.1**	**3,025.4**	**11,462.5**	**NA**	**898,637.6**
Other [2] Subtotal	**13.2**	**26.1**	**1,472.1**	**1,238.3**	**NA**	**NA**	**NA**
Total	**100.0**	**100.0**	**11,144**	**4,748**	**NA**	**NA**	**1,820,073.8**

NOTE: LSUS = Little Sunflower Upper Sump reach, SBLS = Steele Bayou Lower Sump reach.

[1] - Reforested - recently reforested lands within the 2-year floodplain with trees averaging 10 years old when project begins.

[2] - includes land use categories not regularly used by wintering waterfowl

Table 15. Hydrologic and Reforestation Impacts - duck use days available for Alternative 2 (Yazoo Backwater Reformulation Project With BSRMP).

Land Use	Percent Land Use By Reach		Little Sunflower Upper Sump (11,587 ac)	Steele Bayou Lower Sump (6,102 ac)	Total Acres Impacted	DUD/acre	DUD Available without Reforestation	DUD Available With Reforestation	
	LSUS	SBLS					Total DUD	DUD lost after cleared lands are reforested [1]	Net DUD Avaiable [2]
Fallow Field	3.49	4.21	404.4	256.9	661.3	1,037	685,768.1		
Rice	0.61	0.17	70.7	10.4	81.1	580	47,038.0		
Soybeans	6.98	5.82	808.8	355.1	1,163.9	253	294,466.7		
Crop Subtotal	**11.08**	**10.20**	**1,283.8**	**622.4**	**1,906.3**	NA	**1,027,272.8**	**1,027,272.8**	
BLH	61.69	55.95	7,148.0	3,414.1	10,562.1	57	602,039.7		
Reforested [3]	14.02	7.77	1,624.5	474.1	2,098.6	184	386,142.4		
Forested Subtotal	**75.7**	**63.7**	**8,772.5**	**3,888.2**	**12,660.7**	**NA**	**988,182.1**		**1,439,965.4**
Other [4] Subtotal	**13.2**	**26.1**	**1,530.6**	**1,591.4**	**NA**	**NA**	**NA**		
Total	**100.0**	**100.0**	**11,587.0**	**6,102.0**	**NA**	**NA**	**2,015,454.9**		**1,439,965.4**

NOTE: LSUS = Little Sunflower Upper Sump reach, SBLS = Steele Bayou Lower Sump reach.

[1] - The reforestation feature of this plan will eliminate the DUD's provided by cleared lands used by waterfowl.

[2] - The reforestation feature of this plan will reduce the loss of DUD's that were provided by cleared lands used by waterfowl because reforested lands will provide 237 DUD per acre.

[3] - Reforested - recently reforested lands within the 2-year floodplain with trees averaging 10 years old when project begins.

[4] - includes land use categories not regularly used by wintering waterfowl

Table 16. Hydrologic and Reforestation Impacts - duck use days available for Alternative 3 (Yazoo Backwater Reformulation Project With BSRMP).

Land Use	Percent Land Use By Reach		Little Sunflower Upper Sump (11,016 ac)	Steele Bayou Lower Sump (4,782 ac)	Total Acres Impacted	DUD/acre	DUD Available without Reforestation	DUD Available With Reforestation	
	LSUS	SBLS					Total DUD	DUD lost after cleared lands are reforested [1]	Net DUD Avaiable [2]
Fallow Field	3.49	4.21	384.46	201.32	585.78	1,037	607,453.86		
Rice	0.61	0.17	67.20	8.13	75.33	580	43,691.40		
Soybeans	6.98	5.82	768.92	278.31	1,047.23	253	264,949.19		
Crop Subtotal	**11.08**	**10.20**	**1,220.57**	**487.76**	**1,708.34**	NA	**916,094.45**	**NA**	**916,094.45**
BLH	61.69	55.95	6,795.77	2,675.53	9,471.30	57	539,864.10		
Reforested [3]	14.02	7.77	1,544.44	371.56	1,916.00	184	352,544.00		
Forested Subtotal	**75.71**	**63.72**	**8,340.21**	**3,047.09**	**11,387.30**	**NA**	**892,408.10**		**892,408.10**
Other [4] Subtotal	**13.2**	**26.1**	**1,455.2**	**1,247.1**	**NA**	**NA**	**NA**		
Total	**100.0**	**100.0**	**11,016**	**4,782**	**NA**	**NA**	**1,808,502.50**		**1,808,502.50**

NOTE: LSUS = Little Sunflower Upper Sump reach, SBLS = Steele Bayou Lower Sump reach.

[1] - The reforestation feature of this plan will eliminate the DUD's provided by cleared lands used by waterfowl.

[2] - The reforestation feature of this plan will reduce the loss of DUD's that were provided by cleared lands used by waterfowl because reforested lands will provide 237 DUD per acre.

[3] - Reforested - recently reforested lands within the 2-year floodplain with trees averaging 10 years old when project begins.

[4] - includes land use categories not regularly used by wintering waterfowl

Table 17. Hydrologic and Reforestation Impacts - duck use days available for Alternative 4 (Yazoo Backwater Reformulation Project With BSR

Land Use	Percent Land Use By Reach		Little Sunflower Upper Sump (11,352 ac)	Steele Bayou Lower Sump (4,923 ac)	Total Acres Impacted	DUD/acre	DUD Available without Reforestation	DUD Available With Reforestation	
	LSUS	SBLS					Total DUD	DUD lost after cleared lands are reforested [1]	Net DUD Avaiable [2]
Fallow Field	3.49	4.21	396.18	207.26	603.44	1,037	625,767.28		
Rice	0.61	0.17	69.25	8.37	77.62	580	45,019.60		
Soybeans	6.98	5.82	792.37	286.52	1,078.89	253	272,959.17		
Crop Subtotal	**11.08**	**10.20**	**1,257.80**	**502.15**	**1,759.95**	NA	**943,746.05**	**943,746.05**	
BLH	61.69	55.95	7,003.05	2,754.42	9,757.47	57	556,175.79		
Reforested [3]	14.02	7.77	1,591.55	382.52	1,974.07	184	363,228.88		
Forested Subtotal	**75.71**	**63.72**	**8,594.60**	**3,136.94**	**11,731.54**	**NA**	**919,404.67**		**1,336,512.8**
Other [4] Subtotal	**13.2**	**26.1**	**1,499.6**	**1,283.9**	**NA**	**NA**	**NA**		
Total	**100.0**	**100.0**	**11,352**	**4,923**	**NA**	**NA**	**1,863,150.7**		**1,336,512.8**

NOTE: LSUS = Little Sunflower Upper Sump reach, SBLS = Steele Bayou Lower Sump reach.

[1] - The reforestation feature of this plan will eliminate the DUD's provided by cleared lands used by waterfowl.

[2] - The reforestation feature of this plan will reduce the loss of DUD's that were provided by cleared lands used by waterfowl because reforested lands will provide 237 DUD per acre.

[3] - Reforested - recently reforested lands within the 2-year floodplain with trees averaging 10 years old when project begins.

[4] - includes land use categories not regularly used by wintering waterfowl

Table 18. Hydrologic and Reforestation Impacts - duck use days available for Alternative 5 (Yazoo Backwater Reformulation Project With BSRMP).

Land Use	Percent Land Use By Reach		Little Sunflower Upper Sump (11,620 ac)	Steele Bayou Lower Sump (4,970 ac)	Total Acres Impacted	DUD/acre	DUD Available without Reforestation	DUD Available With Reforestation	
	LSUS	SBLS					Total DUD	DUD lost after cleared lands are reforested [1]	Net DUD Avaiable [2]
Fallow Field	3.49	4.21	405.54	209.24	614.78	1,037	637,526.86		
Rice	0.61	0.17	70.88	8.45	79.33	580	46,011.40		
Soybeans	6.98	5.82	811.08	289.25	1,100.33	253	278,383.49		
Crop Subtotal	**11.08**	**10.20**	**1,287.50**	**506.94**	**1,794.44**	NA	**961,921.75**	**961,921.75**	
BLH	61.69	55.95	7,168.38	2,780.72	9,949.09	57	567,098.13		
Reforested [3]	14.02	7.77	1,629.12	386.17	2,015.29	184	370,813.36		
Forested Subtotal	**75.71**	**63.72**	**8,797.50**	**3,166.88**	**11,964.38**	**NA**	**937,911.49**		**1,363,193.70**
Other [4] Subtotal	**13.2**	**26.1**	**1,535.0**	**1,296.2**	**NA**	**NA**	**NA**		
Total	**100.0**	**100.0**	**11,620**	**4,970**	**NA**	**NA**	**1,899,833.20**		**1,363,193.70**

NOTE: LSUS = Little Sunflower Upper Sump reach, SBLS = Steele Bayou Lower Sump reach.

[1] - The reforestation feature of this plan will eliminate the DUD's provided by cleared lands used by waterfowl.

[2] - The reforestation feature of this plan will reduce the loss of DUD's that were provided by cleared lands used by waterfowl because reforested lands will provide 237 DUD per acre.

[3] - Reforested - recently reforested lands within the 2-year floodplain with trees averaging 10 years old when project begins.

[4] - includes land use categories not regularly used by wintering waterfowl

Table 19. Hydrologic and Reforestation Impacts - duck use days available for Alternative 6 (Yazoo Backwater Reformulation Project With BSRMP).

Land Use	Percent Land Use By Reach		Little Sunflower Upper Sump (11,872 ac)	Steele Bayou Lower Sump (6,417 ac)	Total Acres Impacted	DUD/acre	DUD Available without Reforestation	DUD Available With Reforestation	
	LSUS	SBLS					Total DUD	DUD lost after cleared lands are reforested [1]	Net DUD Avaiable [2]
Fallow Field	3.49	4.21	414.33	270.16	684.49	1,037	709,816.13		
Rice	0.61	0.17	72.42	10.91	83.33	580	48,331.40		
Soybeans	6.98	5.82	828.67	373.47	1,202.14	253	304,141.42		
Crop Subtotal	**11.08**	**10.20**	**1,315.42**	**654.53**	**1,969.95**	NA	**1,062,288.90**	**1,032,288.9**	
BLH	61.69	55.95	7,323.84	3,590.31	10,914.15	57	622,106.55		
Reforested [3]	14.02	7.77	1,664.45	498.60	2,163.06	184	398,003.04		
Forested Subtotal	**75.71**	**63.72**	**8,988.29**	**4,088.91**	**13,077.20**	**NA**	**1,020,109.50**		**1,486,987.70**
Other [4] Subtotal	**13.2**	**26.1**	**1,697.3**	**1,673.6**	**NA**	**NA**	**NA**		
Total	**100.0**	**100.0**	**12,001**	**6,417**	**NA**	**NA**	**2,082,398.40**		**1,486,987.70**

NOTE: LSUS = Little Sunflower Upper Sump reach, SBLS = Steele Bayou Lower Sump reach.

[1] - The reforestation feature of this plan will eliminate the DUD's provided by cleared lands used by waterfowl.

[2] - The reforestation feature of this plan will reduce the loss of DUD's that were provided by cleared lands used by waterfowl because reforested lands will provide 237 DUD per acre.

[3] - Reforested - recently reforested lands within the 2-year floodplain with trees averaging 10 years old when project begins.

[4] - includes land use categories not regularly used by wintering waterfowl

Table 20. Hydrologic and Reforestation Impacts - duck use days available for Alternative 7 (Yazoo Backwater Reformulation Project With BSRMP).

Land Use	Percent Land Use By Reach		Little Sunflower Upper Sump (12,001 ac)	Steele Bayou Lower Sump (6,418 ac)	Total Acres Impacted	DUD/acre	DUD Available without Reforestation	DUD Available With Reforestation	
	LSUS	SBLS					Total DUD	DUD lost after cleared lands are reforested [1]	Net DUD Avaiable [2]
Fallow Field	3.49	4.21	418.83	270.20	689.03	1,037	714,524.11		
Rice	0.61	0.17	73.21	10.91	84.12	580	48,789.60		
Soybeans	6.98	5.82	837.67	373.53	1,211.20	253	306,433.60		
Crop Subtotal	**11.08**	**10.20**	**1,329.71**	**654.64**	**1,984.35**	NA	**1,069,747.30**	**1,069,747.30**	
BLH	61.69	55.95	7,403.42	3,590.87	10,994.29	57	626,674.53		
Reforested [3]	14.02	7.77	1,682.54	498.68	2,181.22	184	401,344.48		
Forested Subtotal	**75.71**	**63.72**	**9,085.96**	**4,089.55**	**13,175.51**	**NA**	**1,028,019.00**		**1,489,309.80**
Other [4] Subtotal	**13.2**	**26.1**	**1,585.3**	**1,673.8**	**NA**	**NA**	**NA**		
Total	**100.0**	**100.0**	**12,001**	**6,418**	**NA**	**NA**	**2,097,766.3**		**1,489,309.80**

NOTE: LSUS = Little Sunflower Upper Sump reach, SBLS = Steele Bayou Lower Sump reach.

[1] - The reforestation feature of this plan will eliminate the DUD's provided by cleared lands used by waterfowl.

[2] - The reforestation feature of this plan will reduce the loss of DUD's that were provided by cleared lands used by waterfowl because reforested lands will provide 237 DUD per acre.

[3] - Reforested - recently reforested lands within the 2-year floodplain with trees averaging 10 years old when project begins.

[4] - includes land use categories not regularly used by wintering waterfowl

Hydrologic Impacts – Non-structural Alternatives

32. Potential post-project impacts of three non-structural alternatives (2A, 2B, and 2C) were also evaluated for each hydrologic condition (YBRP without BSRMP and YBRP with BSRMP).

Alternatives 2A & 2C

33. Analysis of data provided for the first non-structural alternative (YBRP without BSRMP) indicated that a total of 1,856,276.90 DUD's would be available in both reaches (Table 21). Of these, 621,681.50 DUD's are available in fallow fields, 45,182.00 DUD's are available in rice fields, 272,111.62 DUD's are available in soybeans, 554,040.00 DUD's are available in bottomland hardwoods (BLH), and 363,252.80 are available in reforested lands. Part of this condition calls for the reforestation of 1,753 acres of frequently flooded land (within the 2-year floodplain). Reforesting 1,753 acres of frequently flooded floodplain lands will provide an additional 415,461.00 DUD's (Table 23).

34. Analysis of data provided for the second non-structural alternative (YBRP with BSRMP) indicated that a total of 1,840,779.80 DUD's are currently available within both reaches (Table 22). Of these, 610,585.60 DUD's are available in fallow fields, 64,844.0 DUD's are available in rice fields, 266,712.6 DUD's are available in soybeans, 543,278.40 DUD's are available in BLH stands, and 355,359.20 are available in reforested lands. Part of this scenario calls for the reforestation of 1,754.8 acres of frequently flooded land (within the 2-year floodplain). Reforesting 1,754.5 acres of frequently flooded floodplain lands will provide an additional 415,887.60 DUD's (Table 23).

Alternative 2b

35. Analysis of landuse data provided for Alternative 2b (YBRP without the BSRMP) indicate that a total of 1,176,106.0 DUD's would be available in both reaches (Table 24). Of these, 361,394.5 DUD's are available in fallow fields, 35,322.0 DUD's are available in rice fields, 176,341.0 DUD's are available in soybean fields, 345,448.5 DUD's are available in bottomland hardwoods, and 257,600.0 DUD's are available in reforested lands. A total of 573,057.5 DUD's will be lost if cleared lands are reforested and a net gain of 865,265.3 DUD's will be realized with reforestation.

36. Analysis of data provided for the second non-structural alternative (YBRP with BSRMP) indicated that a total of 1,153,049.3 DUD's are currently available within both reaches (Table 25). Of these, 354,342.9 DUD's are available in fallow fields, 34,626.0 DUD's are available in rice fields, 172,874.9 DUD's are available in soybeans, 338,665.5 DUD's are available in BLH stands, and 252,540.0 DUD's are available in reforested lands. A total of 561,843.8 DUD's will be lost if cleared lands are reforested and a net gain of 848,279.4 DUD's will be realized after cleared lands are reforested.

Table 21. Hydrologic Impacts - duck use days available for Alternative 2a and 2c(Yazoo Backwater Reformulation Project Without BSRMP).

Land Use	Percent Land Use By Reach		Little Sunflower Upper Sump (11,450 ac)	Steele Bayou Lower Sump (4,748 ac)	Total Acres Impacted	DUD/acre	DUD Available Without Reforestation	DUD Available With Reforestation	Net DUD's Available
	LSUS	SBLS					Total DUD	DUD Lost After Cleared Lands Are Reforested	
Fallow Field	3.49	4.21	399.6	199.9	599.5	1037	621,681.50		
Rice	0.61	0.17	69.8	8.1	77.9	580	45,182.00		
Soybeans	6.98	5.82	799.21	276.33	1075.54	253	272,111.62		
Crop Subtotal	**11.08**	**10.20**	**1268.7**	**484.3**	**1,753.0**	NA	**938,975.12**	**938,975.12**	
BLH	61.69	55.95	7063.5	2656.5	9,720.0	57	554,040.00		
Reforested [1]	14.02	7.77	1605.3	368.9	1,974.2	184	363,252.80		
Forested Subtotal	**75.71**	**63.72**	**8668.8**	**3025.4**	**11,694.2**	**NA**	**917,292.80**		**1,332,753.80**
Other [2] Subtotal	**15.9**	**23.3**	**1,512.5**	**1,238.3**	**NA**	**NA**	**NA**		
Total	**100.0**	**100.0**	**11,450**	**4,748**	**NA**	**NA**	**1,856,276.90**		**1,332,753.80**

NOTE: LSUS = Little Sunflower Upper Sump reach, SBLS = Steele Bayou Lower Sump reach.

[1] - "**Reforested**" - recently reforested lands within the 2-year floodplain with trees averaging 10 years old when project begins.
[2] - "**Othe**r" includes land use categories not regularly used by wintering waterfowl

Table 22. Hydrologic Impacts - duck use days available for Alternative 2a and 2C (Yazoo Backwater Reformulation Project With BSRMP).

Land Use	Percent Land Use By Reach		Little Sunflower Upper Sump (11,144 ac)	Steele Bayou Lower Sump (4,748 ac)	Total Acres Impacted	DUD/acre	DUD Available Without Reforestation	DUD Available With Reforestation	
	LSUS	SBLS					Total DUD	DUD's Lost After Cleared Lands Are Reforested	Net DUD's Available
Fallow Field	3.49	4.21	388.9	199.9	588.8	1037	610,585.6		
Rice	0.61	0.17	68.0	8.1	111.8	580	64,844.0		
Soybeans	6.98	5.82	777.9	276.3	1,054.2	253	266,712.6		
Crop Subtotal	**11.08**	**10.20**	**1,234.8**	**484.3**	**1,754.8**	**NA**	**942,142.2**	**942,155.36**	
BLH	61.69	55.95	6874.7	2656.5	9,531.2	57	543,278.4		
Reforested [1]	14.02	7.77	1562.4	368.9	1,931.3	184	355,359.2		
Forested Subtotal	**75.7**	**63.7**	**8437.1**	**3025.4**	**11,462.5**	**NA**	**898,637.6**		**1,314,525.20**
Other [2] Subtotal	**13.2**	**26.1**	**1,472.1**	**1,238.3**	**NA**	**NA**	**NA**		
Total	**100.0**	**100.0**	**11,144**	**4,748**	**13,217.35**	**NA**	**1,840,779.8**		**1,314,525.20**

NOTE: LSUS = Little Sunflower Upper Sump reach, SBLS = Steele Bayou Lower Sump reach.

[1] - "**Reforested**" - recently reforested lands within the 2-year floodplain with trees averaging 10 years old when project begins.

[2] - "**Othe**r" includes land use categories not regularly used by wintering waterfowl

Table 23. Alternatives 2A, 2B, and 2C (nonstructural), DUD's produced by reforesting frequently flooded areas within the 2-year floodplain.

Alternative	Total Acreage to be Reforested	DUD Available (per acre) in BLH Stands With Mast Producing Species [1]	DUD Produced by Reforesting Areas Within the 2-year Floodplane
Alternatives 2a & 2c			
YBRP with BSRMP	1,754.8	237	415,887.6
YBRP Without BSRMP	1,753.0	237	415,461.0
Alternative 2b			
YBRP with BSRMP	1,084.7	237	257,073.9
YBRP Without BSRMP	1,106.4	237	262,216.8

Table 24. Hydrologic and Reforestation impacts - duck use days available for Alternative 2b (Yazoo Backwater Pump Project Without BSRMP).

Land Use	Percent Land Use By Reach		Little Sunflower Upper Sump (7,328 ac)	Steele Bayou Lower Sump (2,658 ac)	Total Acres Impacted	DUD/acre	DUD Available Without Reforestation	DUD Available with Reforestation	
	LSUS	SBLS					Total DUD	DUD Lost After Cleared Lands are Reforested [1]	Net DUD Available [2]
Fallow Field	3.49	4.21	255.7	92.8	348.5	1037	361,394.5		
Rice	0.61	0.17	44.7	16.2	60.9	580	35,322.0		
Soybeans	6.98	5.82	511.5	185.5	697.0	253	176,341.0		
Crop Subtotal	**11.08**	**10.20**	**811.9**	**294.5**	**1,106.4**	NA	**573,057.5**	**573,057.5**	
BLH	60.69	55.95	4,447.4	1,613.1	6,060.5	57	345,448.5		
Reforested [3]	14.02	7.77	1,027.4	372.6	1,400.0	184	257,600.0		
Forested Subtotal	**74.71**	**63.72**	**5,474.80**	**1,985.70**	**7,460.50**	**NA**	**603,048.5**		**865,265.3**
Other Subtotal [4]	**15.9**	**23.3**	**1,041.30**	**377.80**	**NA**	**NA**	**NA**		
Total	**100.0**	**100.0**	**7,328.00**	**2,658.00**	**8,566.90**	**NA**	**1,176,106.0**		**865,265.3**

NOTE: LSUS = Little Sunflower Upper Sump reach, SBLS = Steele Bayou Lower Sump reach.

[1] - The reforestation feature of this plan will eliminate DUD's provided by cleared lands.

[2] - The reforestation feature of this plan will reduce the loss of DUD's that were provided by cleared lands because each acre of reforested land will provide 237 DUD's.

[3] **- Reforested -** recently reforested lands within the 2-year floodplain with trees averaging 10 years old when project begins.

[4] - "**Other**" includes land use categories not regularly used by wintering waterfowl

Table 25. Hydrologic and Reforestation impacts - duck use days available for Alternative 2b (Yazoo Backwater Pump Project With BSRMP).

Land Use	Percent Land Use By Reach		Little Sunflower Upper Sump (7,132 ac)	Steele Bayou Lower Sump (2,658 ac)	Total Acres Impacted	DUD/acre	DUD Available Without Reforestation	DUD Available with Reforestation	
	LSUS	SBLS					Total DUD	DUD Lost After Cleared Lands are Reforested [1]	Net DUD Available [2]
Fallow Field	3.49	4.21	248.9	92.8	341.7	1037	354,342.90		
Rice	0.61	0.17	43.5	16.2	59.7	580	34,626.00		
Soybeans	6.98	5.82	497.8	185.5	683.3	253	172,874.90		
Crop Subtotal	**11.08**	**10.20**	**790.2**	**294.5**	**1,084.7**	NA	**561,843.80**	**561,843.80**	
BLH	60.69	55.95	4,328.4	1,613.1	5,941.5	57	338,665.50		
Reforested [3]	14.02	7.77	999.9	372.6	1,372.5	184	252,540.00		
Forested Subtotal	**74.71**	**63.72**	**5,328.3**	**1,985.7**	**7,314.0**	**NA**	**591,205.50**		**848,279.40**
Other Subtotal [4]	**15.9**	**23.3**	**1,013.5**	**377.8**	**NA**	**NA**	**NA**		
Total	**100.0**	**100.0**	**7,132.0**	**2,658.0**	**8,398.7**	**NA**	**1,153,049.30**		**848,279.40**

NOTE: LSUS = Little Sunflower Upper Sump reach, SBLS = Steele Bayou Lower Sump reach.

[1] - The reforestation feature of this plan will eliminate DUD's provided by cleared lands.

[2] - The reforestation feature of this plan will reduce the loss of DUD's that were provided by cleared lands because each acre of reforested land will provide 237 DUD's.

[3] **- Reforested -** recently reforested lands within the 2-year floodplain with trees averaging 10 years old when project begins.

[4] - "**Other**" includes land use categories not regularly used by wintering waterfowl

Changes in DUD's for Each Alternative Compared to Baseline Conditions (YBRP without BSRMP)

Without Reforestation

37. The only alternative that resulted in a net loss of DUD's under the "without reforestation" option was alternative 3 (-19,651.1 DUD's) (Table 26). Alternatives 2, 4, 5, 6, and 7 produced increases in available DUD's ranging from 39,865.7 (Alternative 4) to 279,424.3 (Alternative 7). Change in DUD's for Alternatives 2, 5, and 6 were 195,476.1, 75,807.1, and 258,959.92, respectively.

With Reforestation

38. Each of the alternatives under the "with reforestation" option produced a loss of DUD's when compared to baseline conditions. Loss of DUD's ranged from –328,552.3 (Alternative 7) to –984,476.0 (Alternative 2b) (Table 26). Loss of DUD's for Alternatives 2, 4, 5, and 6 were -389,606.6, -389,606.60, -467,783.6, and –343,105.0, respectively.

Table 26. Changes (gains or losses) in DUD's for each Alternative Compared To Baseline Conditions (YBRP without BSRMP)

Alternative	Available DUD's *			
	Without Reforestation	Changes in DUD's Compared to Baseline Conditions	With Reforestation	Changes in DUD's Compared to Baseline Conditions
Alternative 1 (Baseline)	1,849,741.30	NA	NA	NA
Alternative 2	2,045,217.40	195,476.10	1,460,134.70	-389,606.60
Alternatives 2a & 2c	NA	NA	1,332,753.80	-516,987.50
Alternative 2b	1,176,106.60	-673,634.70	865,265.30	-984,467.00
Alternative 3	1,830,090.29	-19,651.10	NA	NA
Alternative 4	1,889,607.00	39,865.70	1,355,863.80	-513,877.5
Alternative 5	1,925,548.40	75,807.10	1,381,957.70	-467,783.6
Alternative 6	2,108,701.22	258,959.90	1,506,636.30	-343,105.0
Alternative 7	2,129,165.60	279,424.30	1,521,189.00	-328,552.3

*** - Takes into account a loss of 2,166 DUD's resulting from the loss of 38 acres of wetlands/BLH (at the proposed pump station site for Plans 3-7).**

Changes in DUD's for Each Alternative Compared to Baseline Conditions (YBRP with BSRMP)

Without Reforestation

39. The only alternatives that resulted in a net loss of DUD's under the "without reforestation" option was Alternative 3 (-13,737.40) and Alternative 2b (-667,024.5) (Table 27). Alternatives 2, 4, 5, 6, and 7 produced increases in available DUD's ranging from 77,593.40 (Alternative 5) to 40,910.00 (Alternative 4). Change in DUD's for Alternatives 2, 6, and 7 were 195,381.10, 260,158.60, and 275,526.50 respectively.

With Reforestation

40. All of the alternatives evaluated under the "with reforestation" option resulted in a net loss of DUD's (Table 27). Losses ranged from 330,764.00 DUD's (Alternative 7) to 971,794.40 DUD's for Alternative 2b. Loss of DUD's under Alternatives 2, 4, 5, and 6 were 380,108.40, 483,561.00, 456,880.10, and 333,086.10, respectively.

Potential Mitigation Requirements for Loss of Bottomland Hardwood Stands

41. Although reforestation results in a net loss of foraging value per acre, reforestation is the USFWS preferred mitigation measure because reforestation addresses all wintering waterfowl habitat requirements. BLH forests provide food, courtship sites, shelter, protection from predators, cover in extreme weather, roosting sites, and isolation from disturbance. Reforestation also represents an ecosystem level approach and would provide a stable, low maintenance, highly reliable mitigation feature. While mitigation rates are difficult to determine, earlier research by USFWS scientists has suggested that losses of winter waterfowl habitat in the study area be compensated for at different rates depending on land use (i.e., moist soil, rice, soybeans, and BLH). Consistent with the reforestation mitigation approach, reforestation of BLH, which generates 237 DUD's per acre, can compensate for impacts to waterfowl Recommended acreage for potential mitigation efforts are provided in Tables 28 & 29.

Table 27. Changes (gains or losses) in DUD's for each Alternative Compared To Baseline Conditions (YBRP with BSRMP)

Alternative	Available DUD's *			
	Without Reforestation	Changes in DUD's Compared to Baseline Conditions	With Reforestation	Changes in DUD's Compared to Baseline Conditions
Alternative 1 (Baseline)	1,820,073.80	NA	NA	NA
Alternative 2	2,015,454.90	195,381.10	1,439,965.40	-380,108.40
Alternatives 2a & 2c	NA	NA	1,314,525.20	-505,548.60
Alternative 2b	1,153,049.30	-667,024.50	848,279.40	-971,794.4
Alternative 3	1,806,336.40	-13,737.40	NA	NA
Alternative 4	1,860,984.70	40,910.90	1,336,512.80	-483,561.00
Alternative 5	1,897,667.20	77,593.40	1,363,193.70	-456,880.10
Alternative 6	2,080,232.40	260,158.60	1,486,987.70	-333,086.10
Alternative 7	2,095,600.30	275,526.50	1,489,309.80	-330,764.00

* **- Takes into account a loss of 2,166 DUD's resulting from the loss of 38 acres of wetlands/BLH (at the proposed pump station site for Plans 3-7).**

Table 28. Alternatives that result in a loss of duck-use-days (DUD's) and potential mitigation Requirements (YBRP without BSRMP).

Alternative	With Reforestation		
	Net Loss in DUD's For Each Alternative	Conversion Factor	Acres Required For Mitigation
Alternative 1 (Baseline)	NA	NA	NA
Aternative 2	389,606.60	237	1,643.90
Aternative 2a & 2c	516,987.50	237	2,181.38
Aternative 2b	984,476.00	237	4,163.00
Aternative 3	19,651.10	237	82.92
Aternative 4	513,877.50	237	2,168.25
Aternative 5	467,783.60	237	1,973.77
Aternative 6	343,105.00	237	1,447.70
Aternative 7	328,552.30	237	1,386.29

Table 29. Alternatives that result in a loss of duck use days (DUD) and potential mitigation requirements (YBRP with BSRMP).

Alternative	With Reforestation		
	Net Loss in DUD's For Each Alternative	Conversion Factor	Acres Required for Mitigation
Alternative 1 (Baseline)	NA	NA	NA
Alternative 2	380,108.40	237	1,603.83
Alternatives 2a & 2c	505,548.60	237	2,133.11
Alternative 2b	971,794.40	237	4,100.39
Alternative 3	13,737.40	237	57.96
Alternative 4	483,561.00	237	2,040.34
Alternative 5	456,880.10	237	1,927.76
Alternative 6	333,086.10	237	1,405.42
Alternative 7	330,764.00	237	1,395.62

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