Louisiana Coastal Area (LCA) Program: Medium Diversion at White Ditch Project

Appendix K
Cost Effectiveness & Incremental Cost Analysis

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DRAFT

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1.0 PURPOSE

The purpose of this appendix is to describe the process by which alternatives for the White Ditch were developed, and compared. A Cost Effectiveness & Incremental Cost Analysis (CE/IC) was utilized.

2.0 DESCRIPTION OF ALTERNATIVE PLANS

Conceptual alternatives were integrated with the suitable locations for diversion structures to yield an array of alternatives that meet the goals and objectives of the project and are likely to restore the impaired deltaic processes. The alternatives are:

1. **White Ditch (WD) 1: No Action.** Over a 50-year period of analysis, if nothing were done, we would see significant losses of all marsh types throughout the project area. More major storms could accelerate this loss. As a result open water habitats would continue to grow allowing for further intrusion of saltwater into the marsh.
2. **White Ditch (WD) 2: Location 2 – 5,000 cfs.** This alternative involves construction of a structure capable of diverting up to 5,000 cfs. Additionally, once the preliminary freshwater and sediment supply benefits of the structure are determined, measures from the hydraulic distribution (H), sediment supply & distribution (S), and protection and sustainability (P) will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.
3. **White Ditch (WD) 3: Location 2 – 10,000 cfs.** This alternative involves construction of a structure capable of diverting up to 10,000 cfs. Additionally, once the preliminary freshwater and sediment supply benefits of the structure are determined, measures from the hydraulic distribution (H), sediment supply & distribution (S) and protection and sustainability (P) will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.
4. **White Ditch (WD) 4: Location 2 – 15,000 cfs.** This alternative involves construction of a structure capable of diverting up to 15,000 cfs. Additionally, once the preliminary freshwater and sediment supply benefits of the structure are determined, measures from the hydraulic distribution (H), sediment supply & distribution (S) and protection and sustainability (P) will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.
5. **White Ditch (WD) 5: Location 2 – 35,000 cfs.** This alternative involves construction of a structure capable of diverting up to 35,000 cfs. Additionally, once the preliminary freshwater and sediment supply benefits of the structure are determined, measures from the hydraulic distribution (H), sediment supply & distribution (S) and protection and sustainability (P) will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.
6. **White Ditch (WD) 6: Location 3 – 5,000 cfs.** This alternative involves construction of a structure capable of diverting up to 5,000 cfs. Additionally, once the preliminary freshwater and sediment supply benefits of the structure are determined, measures from the hydraulic distribution (H), sediment supply & distribution (S) and protection and

sustainability (P) will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.

7. **White Ditch (WD) 7: Location 3 – 10,000 cfs.** This alternative involves construction of a structure capable of diverting up to 10,000 cfs. Additionally, once the preliminary freshwater and sediment supply benefits of the structure are determined, measures from the hydraulic distribution (H), sediment supply & distribution (S) and protection and sustainability (P) will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.
8. **White Ditch (WD) 8: Location 3 – 15,000 cfs.** This alternative involves construction of a structure capable of diverting up to 15,000 cfs. Additionally, once the preliminary freshwater and sediment supply benefits of the structure are determined, measures from the hydraulic distribution (H), sediment supply & distribution (S) and protection and sustainability (P) will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.
9. **White Ditch (WD) 9: Location 3 – 35,000 cfs.** This alternative involves construction of a structure capable of diverting up to 35,000 cfs. Additionally, once the preliminary freshwater and sediment supply benefits of the structure are determined, measures from the hydraulic distribution (H), sediment supply & distribution (S) and protection and sustainability (P) will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.

2.1 Screening / Evaluation of Alternative Plans

The ERDC-SAND2 model was originally known as the Boustany Model. The Boustany Model was developed for evaluating the marsh creation potential. ERDC modified and refined the Boustany model to specifically measure the marsh creation potential of diversion structures. The modified version became known as the SAND model. The SAND was refined further and became the SAND2. The ERDC-SAND2 Model was the tool used by the MDWD team to predict changes in marsh acreages for all alternatives over a 50 year planning horizon. It is an ecohydraulic engineering model specifically designed to assess the effectiveness of potential diversion projects on restoration of land in the coastal marsh. The ERDC- SAND2 model is fundamentally based on three processes impacting marsh accretion:

1. Historical land loss rates are applied to account for marsh loss due to all negatively impacting system processes (e.g. sea level rise, compaction, subsidence, etc.) along with background processes existing prior to the diversion operation (e.g. marsh nutrient cycling, net tidal and groundwater inputs, etc.).
2. Inorganic benefits of flow diversion from the addition of sediment.
3. Organic benefits of flow diversion due to plant growth, mortality, and burial stimulated by addition of the limiting nutrient (nitrogen).

The model applies these processes to assess Future With Project and Future Without Project conditions for alternative comparison. Since the FWOP condition is without diversion, FWOP marsh acreage is a function of land loss only. The model processes these categories and projects acres of marsh within a specified project area. With some slight modifications, the model can also project acreages with accelerated sea level rise rates. Further information concerning the ERDC-SAND2 Model can be found in Appendix L.

The outputs (net and average annual acres) from the ERDC-SAND2 model become a key component of the WVA ecosystem model. Also, a defined operating plan had yet to be evaluated, so three such operating schemes were proposed to begin to characterize the potential range of benefits of various operating regimes for each diversion and the ability of each alternative to achieve the goals and objectives of the project. The Open Diversion reflects the upper threshold in terms of potential impacts. The other two regimes focus on maximizing sediment capture during the highest sediment load in the River based on available information. They are:

- Open Diversion Year Round
- A March 1–May 30 Maximum Pulse with no Maintenance Flow
- A March only pulse with a 1,000 cfs Monthly Maintenance Flow

Finally, the likelihood existed that these large diversion alternatives may have impacts beyond the immediate study area. Therefore the ERDC-SAND2 Model was run on the original study area as well as the entire Breton Sound Basin. The Institute for Water Resources (IWR) Planning Suite was used for the analysis.

Table 1 displays the costs and net acres of marsh created at the end of the 50-year period of analysis in order to compare alternatives that can achieve no net loss of marsh acres. The most cost effective alternatives and operating schemes that achieve a no net loss or desired future condition are highlighted in green. The desired future condition would be equivalent to the current marsh acres (2009) of 41,206. The Location 3 – 10,000 cfs alternative achieves this at the end of the period of analysis only for the year round open diversion operating regime. It does this more cost effectively than the same size diversion at Location 2. The Location 3 – 15,000 alternative achieves the desired future condition at the end of the period of analysis for the year round open diversion and the Mar/May Pulse. It does this more cost effectively than the same size diversion at Location 2. The Location 3 – 35,000 alternative achieves the desired future condition at the end of the period of analysis for all three operating regimes and more cost effectively than the same size diversion at Location 2. The 35,000 cfs diversion also achieves a no net loss of marsh within the expanded Breton Sound Basin if operated at full capacity year round.

It should be noted that the major difference in cost between Location 2 alternatives and Location 3 is the length of conveyance channels needed to move freshwater, nutrients and sediments. While Location 2 has an existing conveyance channel (White Ditch) Hydrologic and Hydraulic modeling indicated that it requires considerably more dredging and placement of material to make it effective at moving diversion flows to the majority of the study area. Location 3, while it does involve dredging of new conveyance channels, they are much shorter and more efficient at distributing diversion flows of freshwater, nutrients and sediments. A complete discussion of this can be found in the Engineering Appendix L.

Table 1. LCA: White Ditch Incremental Cost/Cost Effectiveness Step 1a

			Operating Regimes Gross/Net Acres (Original Study Area) Year 50			**Operating Regimes Gross/Net Acres (Expanded Study Area) Year 50**	
Alternative	Total First Cost*	Annualized Cost**	Original Project Area - Open Diversion	Original Project Area - Mar/May Pulse	Original Project Area - March Pulse + 1,000 CFS	Expanded Project Area Open Diversion	Expanded Project Area Mar/May Pulse
Location 2 - 5,000 CFS Box	$181,800,000	$9,013,128	35,241/-5,965	32,676/-8,530	34,484/-6,722	69,251	64,481
Location 2 - 10,000 CFS Box	$230,000,000	$11,402,748	43,448/2,242	38,071/-3,135	36,318/-4,888	80,924	70,298
Location 2 - 15,000 CFS Box	$398,600,000	$19,761,458	51,445/10,239	43,327/2,121	38,111/-3,095	92,668	76,099
Location 2 - 35,000 CFS Box	$493,400,000	$24,461,373	76,174/34,968	59,670/18,464	44,364/3,155	139,965	98,909
Location 3 - 5,000 CFS Box	$140,600,000	$6,970,549	35,241/-5,965	32,676/-8,530	34,484/-6,722	69,251	64,481
Location 3 - 10,000 CFS Box	$165,000,000	$8,180,232	**43,448/ 2,242**	38,071/-3,135	36,318/-4,888	80,924	70,298
Location 3 - 15,000 CFS Box	$229,400,000	$11,373,001	**51,445/10,239**	**43,327/2,121**	38,111/-3,095	92,668	76,099
Location 3 - 35,000 CFS Box	$334,800,000	$16,598,435	**76,174/34,968**	**59,670/18,464**	**44,364/3,155**	**139,965**	98,909

*Excludes Real Estate and O&MRRR

**FY 2010 Discount Rate 4 3/8%

Table 2. LCA: White Ditch Incremental Cost/Cost Effectiveness Step 1b

	Incremental Cost/Cost Effectiveness Analysis - Open Operation				**Incremental Cost/Cost Effectiveness Analysis Mar/May Pulse**			
Alternative	Open Diversion (Average Annual Acres)	Incremental Cost	Incremental Acres	Incremental Cost per Acre	Mar/May Pulse (Average Annual Acres)	Incremental Cost	Incremental Acres	Incremental Cost per Acre
Location 2 - 5,000 CFS Box	5,276		Non Cost		2,715		Non Cost	
Location 2 - 10,000 CFS Box	11,553		Effective		5,853		Effective	
Location 2 - 15,000 CFS Box	17,860		Plans		8,984		Plans	
Location 2 - 35,000 CFS Box	42,731				21,282			
Location 3 - 5,000 CFS Box	5,276	$6,970,549	5,276	$1,321	2,715	$6,970,549	2,715	$2,567
Location 3 - 10,000 CFS Box	11,553	$1,209,683	6,277	$193	5,853	$1,209,683	3,138	$385
Location 3 - 15,000 CFS Box	17,860	$10,163,318	11,583	$877	8,984	$10,163,318	5,846	$1,739
Location 3 - 35,000 CFS Box	42,731	$6,435,117	31,148	$207	21,282	$6,435,117	15,436	$417

*Excludes Real Estate and O&MRRR

**FY 2010 Discount Rate 4 3/8%

2.2 CE/IC Analysis

In order to refine the preliminary alternatives further a two-step Cost Effectiveness & Incremental Cost (CE/IC) Analysis was utilized. The first step used preliminary cost estimates developed for each action alternative and outputs from the ERDC SAND2 Model. Table 2 displays the CE/IC analysis of the action alternatives. Average Annual Acres of Marsh is compared against the annualized first cost of the action alternatives. Average Annual Acres of Marsh produced by each size of diversion structure is the same for each location. All of the alternatives at location 2 were not cost effective while the 5, 10 and 15 thousand cfs diversions at location 3 were found to be cost effective. The 35,000 cfs diversion was considered a best buy.

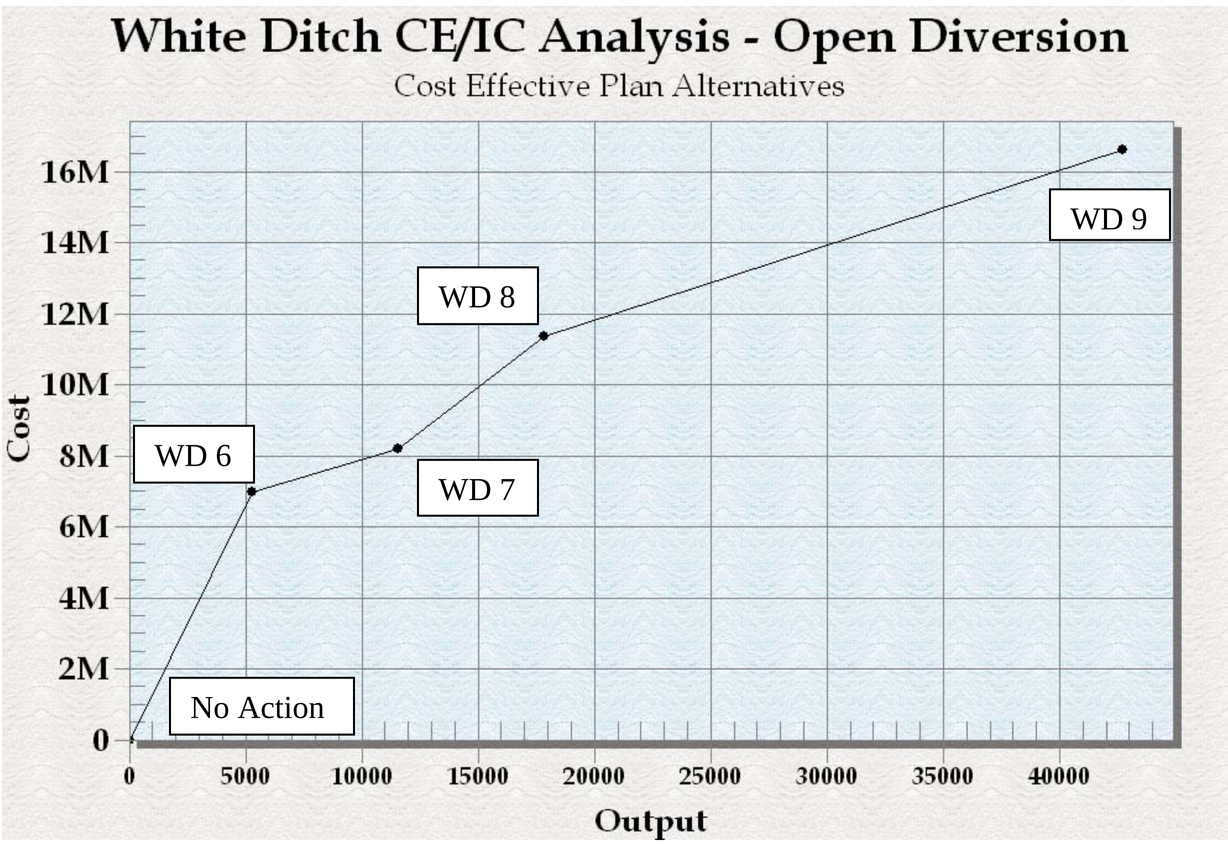

Figure 1. White Ditch CE/IC Analysis – Open Diversion

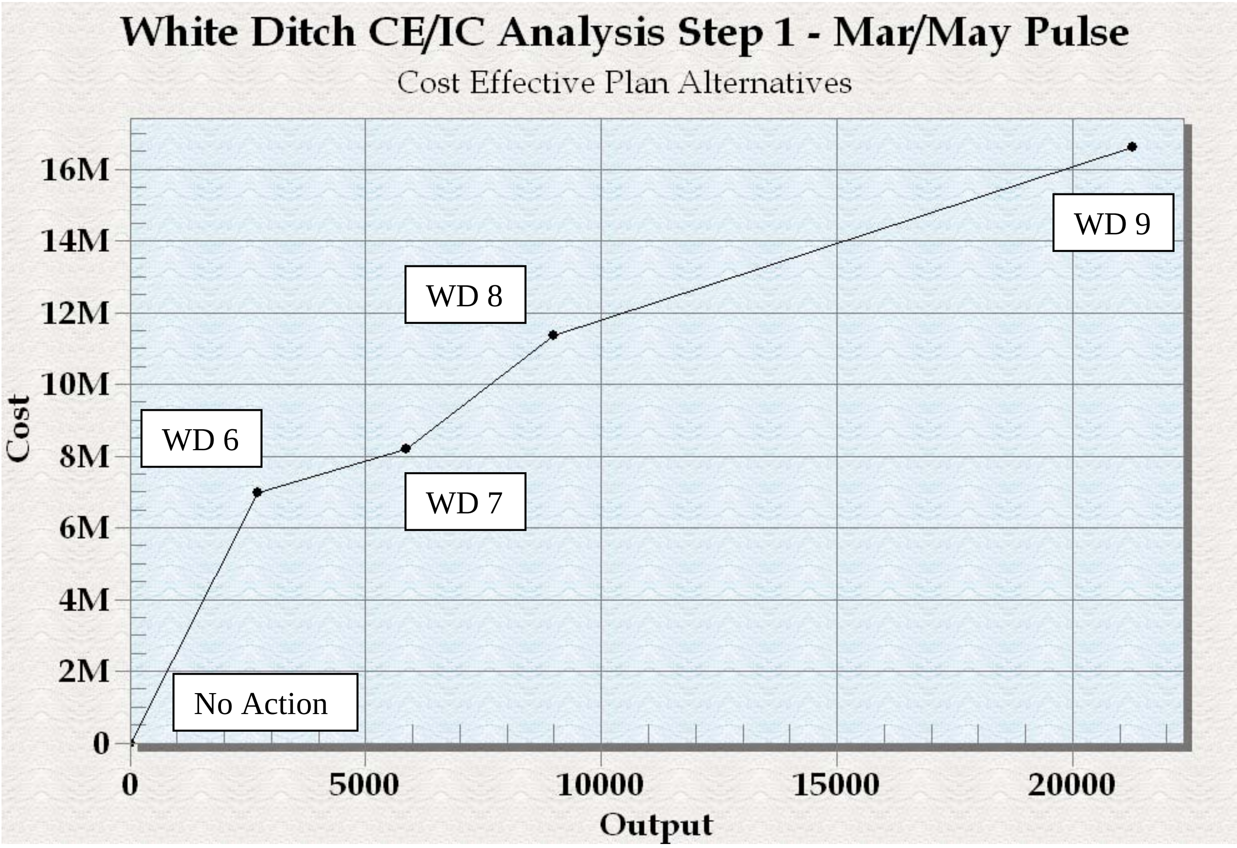

Figure 2. White Ditch CE/IC Analysis Step 1 – Mar/May Pulse

2.3 Alternative Plans not Carried for Further Analysis

Based on the above analysis it was determined that the following alternatives would not further evaluated:

- White Ditch (WD) 2: Location 2 – 5,000 cfs.
- White Ditch (WD) 3: Location 2 – 10,000 cfs.
- White Ditch (WD) 4: Location 2 – 15,000 cfs.
- White Ditch (WD) 5: Location 2 – 35,000 cfs.

3.0 FINAL ARRAY OF ALTERNATIVES

3.1 No Action (Future without Project Conditions)

No Action The future without project condition for White Ditch will continue to see declines in overall wetland acres of all types. The current altered deltaic process will result in the lack of freshwater, nutrients and sediments in the project are that are critical to sustain existing marsh and build additional areas. Overall the study area is expected to see an average loss of 274.5

acres of marsh per year. This land loss will, during the 50 year period of analysis, result in a further loss of 13,725 acres of marsh from the 2009 acreage of 41,206.

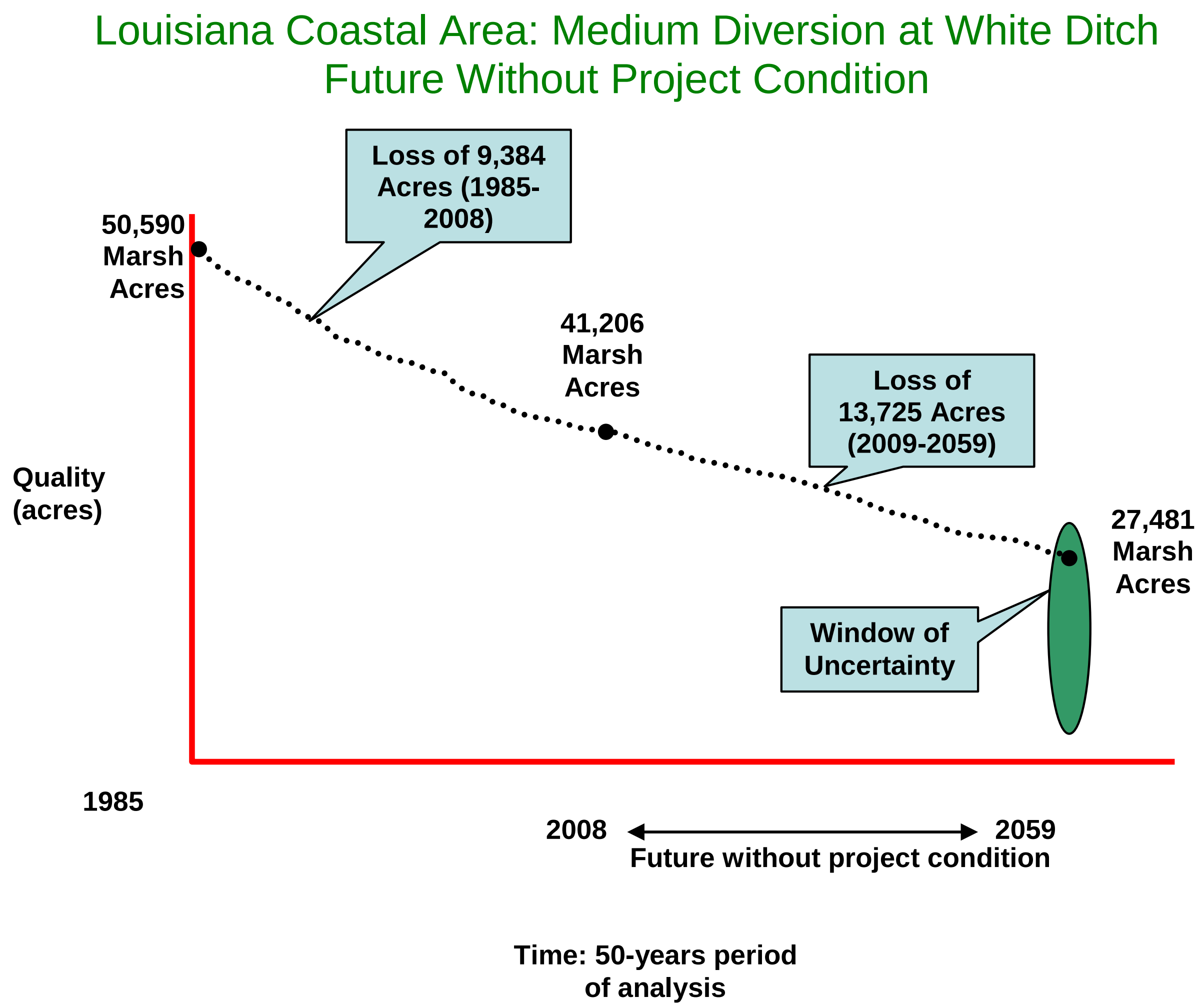

Figure 3. Louisiana Coastal Area: Medium Diversion at White Ditch – Future Without Project Condition

Waterbodies would grow larger and wave erosion would accelerate causing further land loss, making remaining marsh lands in the project area and the larger Breton Sound Basin more vulnerable to tropical storms. The Future Without Project Condition will likely see the existing marsh persist with minimal circulation of water, nutrients, and sediment. The sediment deficit has and would continue to result in both subsidence and a disruption of natural processes that promote productivity and diversity in the marsh ecosystem. Increases in relative sea level due to continued subsidence and sea level rise would continue to inundate plant communities, which would ultimately lead to substantial losses. The Study Area will likely see additional salt water intrusion and conversion of the remaining intermediate and brackish marsh to saline marsh types with the associated salt-tolerant or marine fauna.

The remaining marsh acreage of 27,481 does not account for any losses that may be incurred by moderate or high rates of sea level rise. The figure below depicts the impacts of both the moderate and high rates of sea level rise on the project area.

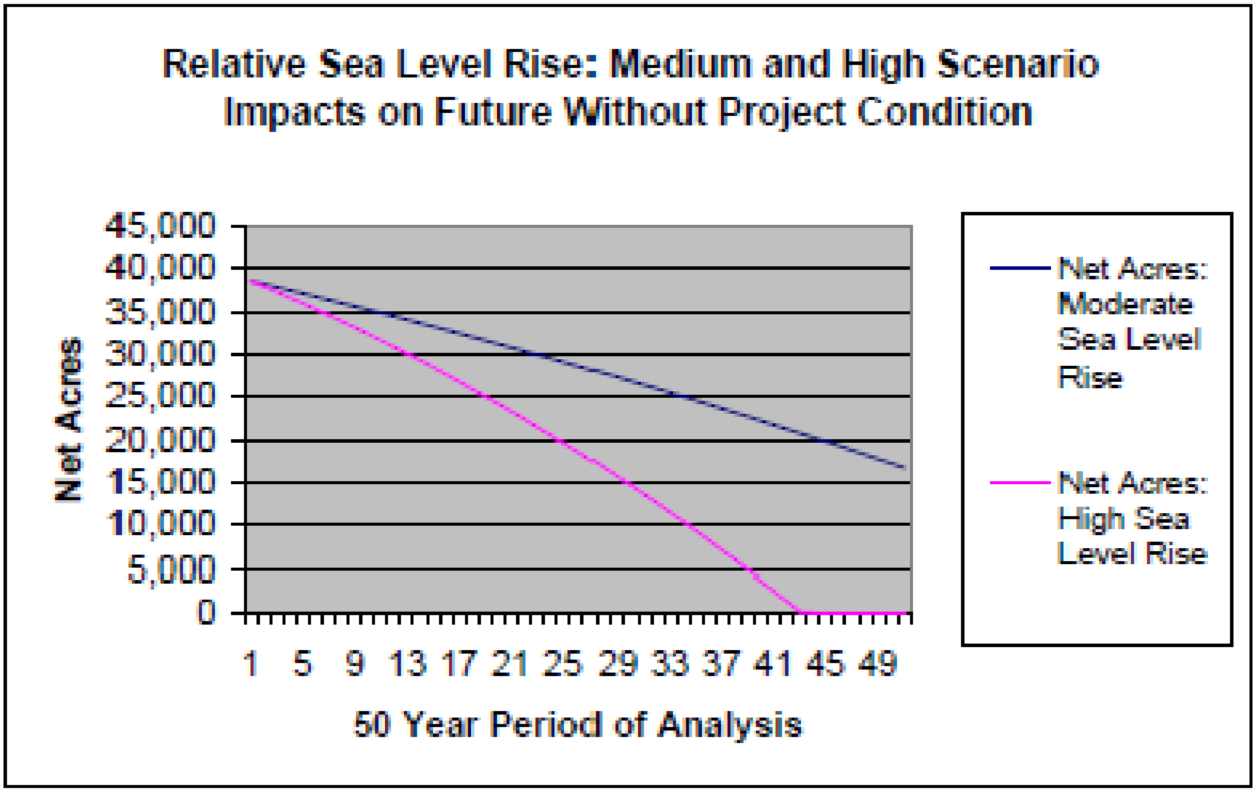

Figure 4. Relative Sea Level Rise: Medium and High Scenario Impacts on Future Without Project Condition

Marsh acres are the result of a variety of physical structure and functions within the larger ecosystem. Some of these components include soils and waterbottoms, sediment, subsidence, salinity, riparian vegetation, benthics and fishery resources. Summaries of the future without project condition for these resources are below with more details provided in Section 4.

3.1.1 Soils and Waterbottoms

No direct alteration of soils or substrate would occur under the No Action alternative and associated water management features. No conversion of prime or unique farmland would occur, and the No Action alternative would have no direct impact on these resources.

The indirect impacts of the No Action alternative, would be that the existing patterns of soil erosion and land loss would continue into the future. Organic soils in the project area would not be able to maintain their elevations due to subsidence, decreased plant productivity, wave erosion, and relative sea level rise. Net primary productivity within the project area would continue to decline and existing wetland vegetation would continue to diminish. The ongoing conversion of existing fragmented emergent wetlands to shallow open water would continue with associated indirect impacts on coastal vegetation, fish and wildlife resources, EFH, recreation, aesthetic, and socioeconomic resources. In the future, if no actions are taken to restore and protect marsh habitat within the project area, any prime and unique farmland that remains outside of the protection of existing Federal and non-Federal back levees would continue to be subject to further degradation and possible loss.

Cumulative impacts under the No Action alternative include continuing erosion and loss of marsh soils. Waterbodies would grow larger and wave erosion would accelerate causing further land loss, thus making remaining marsh lands in the project area and the larger Breton Sound Basin more vulnerable to tropical storms. In addition to land loss in coastal Louisiana, a large percentage of the Nation's wetlands would continue to disappear with accompanying impacts to wildlife, fisheries, coastal communities, and socioeconomic resources.

3.1.2 Sedimentation and Erosion

The No Action Alternative, i.e. not implementing a sediment and freshwater diversion in the White Ditch Study Area, would have a direct impact on sedimentation or erosion within the area between the Mississippi River and River aux Chenes through the continuation of existing degradation of marsh. The absence of a supply of fresh water, sediment, and nutrients combined with the ongoing pressures of wind and wave action, storm surges, and human activities has severely eroded marsh soils and reduced the ability of the project area to maintain a balance of emergent wetland and shallow water.

Indirect impacts of the No Action Alternative, not implementing the diversion, are the persistence of existing conditions. Consequences would include further degradation of the existing marsh from saltwater intrusion due to short circuited hydrologic processes present in the basin; as well as the continued lack of sediments, nutrients, and freshwater River aux Chenes and the Mississippi River. With the absences of these features, the marsh would not be able to sustain itself against subsidence and prolonged inundation from sea level rise. The No Action Alternative would cause the existing marsh to persist with minimal circulation of water, nutrients, and sediment. The sediment deficit has and would continue to result in both subsidence and a disruption of natural processes that promote productivity and diversity in the marsh ecosystem. Increases in relative sea level due to continued subsidence and sea level rise would continue to inundate plant communities, which would ultimately lead to substantial losses.

Cumulative impacts would be the synergistic effect of the No Action Alternative on other sedimentation and erosive forces with the added combination of similar wetland degradation and wetland loss impacts to sedimentation and erosion throughout coastal Louisiana, as well as the benefits and impacts of other state and Federal coastal restoration projects in the vicinity.

3.1.3 Subsidence

The Future Without Project Condition will likely see the existing marsh to persist with minimal circulation of water, nutrients, and sediment. The sediment deficit has and would continue to result in both subsidence and a disruption of natural processes that promote productivity and diversity in the marsh ecosystem. Increases in relative sea level due to continued subsidence and sea level rise would continue to inundate plant communities, which would ultimately lead to substantial losses.

3.1.4 Salinity

Under the No Action Alternative no direct impacts to salinity levels of the Mississippi River or the White Ditch project area would occur.

Indirect impacts of not implementing restoration features would result in the persistence of existing conditions for the Mississippi River and continued degradation of the White Ditch project area.

Cumulative impacts would be the synergistic effect of the No Action Alternative on salinity levels when considered in context with all past, present, and reasonably foreseeable acts of nature and/or the actions private entities, state government, and Federal government. The No Action Alternative would not contribute in a positive or negative manner to the cumulative effects on salinity.

3.1.5 Vegetation Resources

Direct impacts under the No Action Alternative, no construction of diversion structure or associated outfall management features would occur, and no BLH would be cleared or filled by construction activities. No opportunities for beneficial use of dredged material for construction features would occur. Existing BLH in the project footprint would continue to degrade and convert to intermediate marsh. No direct impacts to existing wetland vegetation resulting from construction of the proposed diversion and associated features would occur. No opportunities for beneficial reuse of marsh soil and substrate excavated for construction would be realized. No direct impacts to Submerged Aquatic Vegetation (SAV) would occur. Baseline SAV coverage was estimated at approximately 15% of open water areas in the vicinity of the proposed construction footprint (25% in the overall project area). Existing SAV in the project footprint would continue to degrade and die off as increased salinities enter the Study Area and marsh continues to decrease in acreage

Without implementation of the proposed diversion, no input of sediment, freshwater and nutrients to the project area would occur. This would result in indirect impacts including the continued erosion of marsh soils and continued fragmentation and conversion of BLH to intermediate and brackish marsh habitats. Both man-made and natural processes would contribute to the continued loss of vegetated habitats, including: continued erosion and subsidence, increased saltwater intrusion, and increased water velocities. Over the next 50 years, the remaining BLH species in the Study Area would experience continued subsidence, sea level rise, and salinity increases. The BLH would eventually diminish and convert to marsh. Over the next 50 years, approximately 13,750 acres of emergent marsh is projected to be lost, and it is likely that all remaining remnants of bottomland hardwood vegetation would disappear over the same period. Over the next 50 years, SAV is projected to be reduced from the estimated baseline of 25% of open water areas to approximately 15% as the area deteriorates.

Cumulative impacts would be the same effect of the No-Action alternative with land loss rates of approximately 274.5 acres per year throughout the 50-year project life. In addition, cumulative impacts would include the additive combination of coast wide BLH loss and degradation, as well as the benefits and impacts of other local, state, Federal, and private projects summarized in Section 1.5. The existing freshwater diversion at Caernarvon would freshen the surrounding waters, albeit to an unknown extent. In addition, the LCA Caernarvon Freshwater Diversion Modification (CFDM) project could potentially result in a selected plan having features that create and restore BLH ridges from the secondary use of channel dredging to redirect water flows. Some Section 10 and 404 permits have been issued by the CEMVN for maintenance dredging canals northeast of the WDWD project. Some dredged material placement areas from this dredging would likely reforest with BLH species.

Cumulative impacts on wetland vegetation would be the synergistic effect of implementing the No-Action Alternative with the additive combination of coast wide wetland loss and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity. The existing freshwater diversion at Caernarvon would freshen the surrounding waters, albeit to an unknown extent. Modification of the operation of the Caernarvon structure could result in a conversion of some intermediate marsh to fresh marsh in areas adjacent to the MDWD project area. However, such wetland conversion would probably have little effect on the species composition of the wetlands in the project area other than a slight shift towards less salt-tolerant species. The introduction of nutrients would likely increase the productivity of the nearby marshes, but any potential effects on productivity within the MDWD project area are unknown at this time.

Cumulative impacts would be the same effect of the No-Action alternative with the additive combination of coast wide SAV loss, as well as the benefits and impacts of other state, Federal, or private projects summarized in the FS/EIS. The proposed projects have borrow areas, channel dredging, and marsh restoration sites in and adjacent to Lake Lery that would impact SAV from dredging and filling. CFDM could result in a conversion of some intermediate marsh to fresh marsh in areas adjacent to the MDWD project area. The Duffy (1997) study showed that SAV abundance (Eurasian watermilfoil and coontail) has increased in the Breton Sound Basin in response to diversions. The introduction of nutrients would likely increase the productivity of the nearby SAV, but any potential effects on productivity within the MDWD project area are unknown at this time.

3.1.6 Benthics

The Future Without Project Condition will likely see marine (saltwater) influences continue to take hold and convert freshwater wetlands into intermediate, brackish, and saline marsh. As freshwater inputs continue to decline and allow marine influences to predominate over riverine influence, salinity levels rise, resulting in the conversion of low-lying vegetated areas to open water and the redistribution of marine sediment. These actions eventually lead to conditions that expedite interior marsh loss and the benthic community and benthic processes would shift from that of an estuarine community to a more open water marine community. Over the long term, without renewed inputs of fresh water, sediment, and nutrients to restore and maintain emergent marsh habitat, the project area is likely to convert from a predominately estuarine habitat to a predominately marine habitat. The benthic community which support the estuarine system processes would be adversely affected by the reduction and eventual loss of this habitat.

3.1.7 Essential Fish Habitat

The No Action alternative (no construction of river diversion structure or associated outfall management features) would have no direct impact on EFH.

Indirect impacts of not implementing wetland creation/nourishment and shoreline protection features would result in the persistence of existing conditions resulting in the conversion of categories of EFH, such as estuarine marsh and SAV, to marine water column and mud, sand, or shell substrates is expected to continue. Over time, the No Action alternative would result in the conversion of an estimated 13,724 acres of emergent marsh to open water. Substantial decreases in the quality of EFH in the project area would reduce the area's ability to support federally managed species.

Cumulative impacts would be the synergistic effect of the No-Action Alternative on EFH with the additive combination of similar EFH degradation and losses throughout coastal Louisiana, as well as the benefits and impacts of other state and Federal projects in the vicinity. Continued conversion of existing marsh to shallow open water habitats anticipated with the No Action alternative would contribute to declining quality of EFH, particularly nursery habitat for larval and juvenile fish and shrimp species.

3.2 Alternative 1 – 5,000 cfs diversion

Location 3 – 5,000 cfs. This alternative involves construction of a structure capable of diverting up to 5,000 cfs consisting of 3 15ft. x 15ft. box culverts. Additionally, 32 acres of ridge and terrace creation, 139 acres of marsh creation utilizing dredged material from an adjacent 153 acres of canal being reconfigured to convey freshwater, nutrient and sediments.

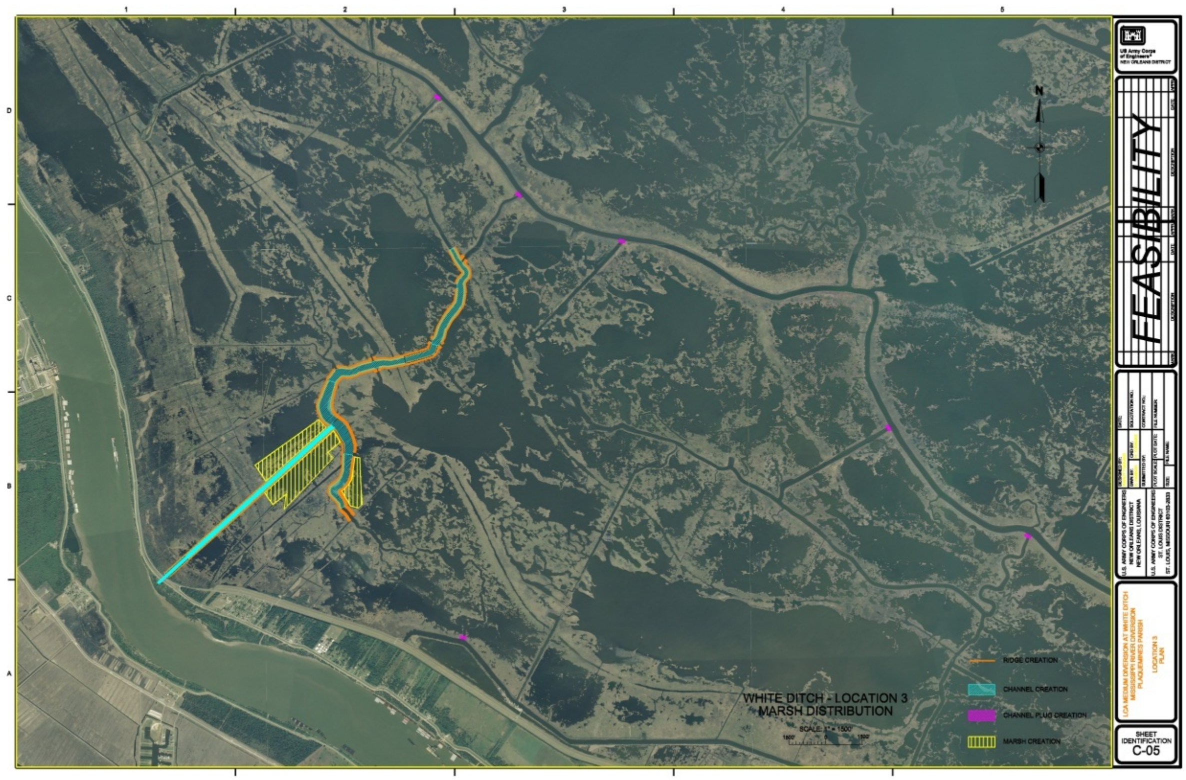

Figure 5. Alternative 1 Location 3

3.3 Alternative 2 – 10,000 cfs Max Diversion

Location 3 – 10,000 cfs. This alternative involves construction of a structure capable of diverting up to 10,000 cfs consisting of 3 15ft. x 15ft. box culverts. Additionally, 32 acres of ridge and terrace creation, 176 acres of marsh creation utilizing dredged material from an adjacent 167 acres of canal being reconfigured to convey freshwater, nutrient and sediments.

Figure 6. Alternative 2 Location 3

3.4 Alternative 3 – 15,000 cfs Max Diversion

Location 3 – 15,000 cfs. This alternative involves construction of a structure capable of diverting up to 15,000 cfs consisting of 10 15ft. x 15ft. box culverts. Additionally, 32 acres of ridge and terrace creation, 235 acres of marsh creation utilizing dredged material from an adjacent 182 acres of canal being reconfigured to convey freshwater, nutrient and sediments.

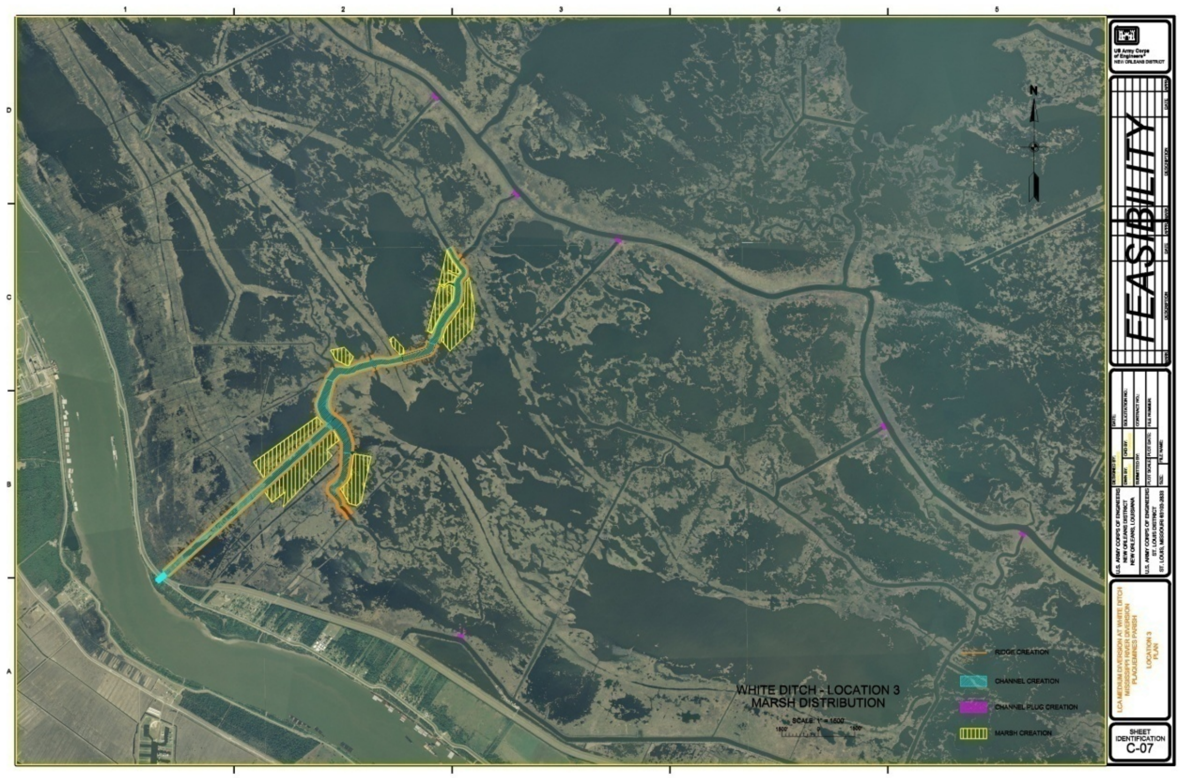

Figure 7. Alternative 3 Location 3

3.5 Alternative 4 – 35,000 cfs Max Diversion (TSP)

Location 3 – 35,000 cfs. This alternative involves construction of a structure capable of diverting up to 35,000 cfs consisting of 10 15ft. x 15ft. box culverts. Additionally, 31 acres of ridge and terrace creation, 385 acres of marsh creation utilizing dredged material from an adjacent 223 acres of canal being reconfigured to convey freshwater, nutrient and sediments.

Figure 8. Alternative 4 Location 3

4.0 COMPARISON OF ALTERNATIVE PLANS

This section describes the alternative plans and the process used to determine the potential costs, habitat benefits, incremental cost/cost effectiveness, and other factors leading to a recommended plan.

4.1 Incremental Cost/Cost Effectiveness Analysis Process.

Cost effectiveness analysis was used to determine what project features should be built, based on habitat benefits (outputs) that meet the goals and objectives of the project and at the same time are the most cost effective. The Corps has incorporated cost effectiveness analysis into its planning process for all ecosystem restoration planning efforts. A cost effectiveness analysis is conducted to ensure that least cost alternatives are identified for various levels of output. After the cost effectiveness of the alternatives has been established, incremental cost analysis is conducted to reveal and evaluate changes in cost for increasing levels of environmental output.

Cost effectiveness and incremental analysis is a three step procedure: (1) calculate the environmental outputs of each alternative; (2) determine a cost estimate for each alternative; (3) combine the alternatives to evaluate the best overall project alternative based on habitat benefits and cost. While cost and environmental outputs are necessary factors, other factors such as the ability to construct, schedule, likelihood to achieve projected results, unmeasurable environmental benefits, ancillary benefits etc., are very important in deciding on the preferred alternative.

Environmental outputs were calculated as Average Annual Habitat Units (AAHUs). The annualized costs were calculated by applying a 4-3/8% annual interest rate to the construction costs over the 50-year period of analysis. What is described below is the second step of the process introduced in Section 1.1.1 above.

4.2 Wetland Value Assessment (WVA)

The Wetland Value Assessment (WVA) methodology is a quantitative habitat-based assessment methodology developed for use in determining wetland benefits of project proposals submitted for funding under the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA). The WVA quantifies changes in fish and wildlife habitat quality and quantity that are expected to result from a proposed wetland restoration project. The results of the WVA, measured in Average Annual Habitat Units (AAHUs), can be combined with cost data to provide a measure of the effectiveness of a proposed project in terms of annualized cost per AAHU gained. In addition, the WVA methodology provides an estimate of the number of acres benefited or enhanced by the project and the net acres of habitat protected/restored. See Appendix B for a complete description of the WVA and its application to this project.

The WVA was developed by the Environmental Work Group (EnvWG) assembled under the Planning and Evaluation Subcommittee of the CWPPRA Technical Committee; the EnvWG includes members from each agency represented on the CWPPRA Task Force and members of the Academic Assistance Subcommittee. The WVA was designed to be applied, to the greatest extent possible, using only existing or readily obtainable data.

The WVA has been developed strictly for use in determining the wetland benefits of proposed CWPPRA projects; it is not intended to provide a detailed, comprehensive methodology for establishing baseline conditions within a project area. Some aspects of the WVA have been defined by policy and/or functional considerations of the CWPPRA; therefore, user-specific modifications may be necessary if the WVA is used for other purposes.

The WVA is a modification of the Habitat Evaluation Procedures (HEP) developed by the U.S. Fish and Wildlife Service (U.S. Fish and Wildlife Service 1980). HEP is widely used by the Fish and Wildlife Service and other Federal and State agencies in evaluating the impacts of development projects on fish and wildlife resources. A notable difference exists between the two methodologies, however, in that HEP generally uses a species-oriented approach, whereas the WVA utilizes a community approach.

The WVA has been developed for application to several habitat types along the Louisiana coast and community models have been developed for fresh marsh, intermediate marsh, brackish marsh, saline marsh, fresh swamp, barrier islands, and barrier headlands (Attachments 1-4). A WVA Procedural Manual has also been prepared by the EnvWG to provide guidance to project planners in the use of the various community models. Two other habitat assessment models for bottomland hardwoods and coastal chenier/ridge habitat were developed outside of the CWPPRA arena and are periodically used by the EnvWG.

Habitat types impacted by construction of the MDWD outfall management features (channel enlargement, marsh creation, and ridge creation) are intermediate marsh and open water in the intermediate salinity zone. Habitat types impacted by operation of the MDWD are intermediate, brackish, and saline marsh, and open water in the intermediate, brackish, and saline zones. Project implementation will create two habitat types found historically but not currently present in the impacted area – fresh marsh and ridge. Consequently, the WVA assessment for MDWD utilized community models for fresh/intermediate marsh, brackish marsh, saline marsh, and coastal chenier/ridge habitat.

4.2.1 WVA Concept

The WVA operates under the assumption that optimal conditions for fish and wildlife habitat within a given coastal wetland habitat type can be characterized, and that existing or predicted conditions can be compared to that optimum to provide an index of habitat quality. Habitat quality is estimated or expressed through the use of community models developed specifically for each habitat type. Each model consists of 1) a list of variables that are considered important in characterizing fish and wildlife habitat, 2) a Suitability Index graph for each variable, which defines the assumed relationship between habitat quality (Suitability Index) and different variable values, and 3) a mathematical formula that combines the Suitability Index for each variable into a single value for habitat quality; that single value is referred to as the Habitat Suitability Index, or HSI. The output of each model (the HSI) is assumed to have a linear relationship with the suitability of a coastal wetland system in providing fish and wildlife habitat.

The WVA models have been developed for determining the suitability of Louisiana coastal wetlands in providing resting, foraging, breeding, and nursery habitat to a diverse assemblage of fish and wildlife species. The models have been designed to function at a community level and therefore attempt to define an optimum combination of habitat conditions for common fish and wildlife species utilizing a given habitat type. Earlier attempts to capture other wetland functions and values such as storm-surge protection, flood water storage, water quality functions, and nutrient import/export were abandoned due to the difficulty in defining unified model relationships and meaningful model outputs for such a variety of wetland benefits. However, the ability of a Louisiana coastal wetland to provide those functions and values may be generally assumed to be positively correlated with fish and wildlife habitat quality as predicted through the WVA.

4.2.2 Community Model Variable Selection

Habitat variables considered appropriate for describing habitat quality in each wetland type were selected according to the following criteria:

- The condition described by the variable had to be important in characterizing fish and wildlife habitat quality in the wetland type under consideration;

- Values had to be easily estimated and predicted based on existing or readily obtainable data (e.g., aerial photography, habitat classification data, water quality monitoring stations, interviews with knowledgeable individuals, etc.); and
- The variable had to be sensitive to the types of changes expected to be brought about by typical wetland restoration projects proposed under the CWPPRA.
- The marsh community models used in the WVA assessment for the MDWD (fresh/intermediate, brackish, and saline) all utilize the same habitat variables. These are: 1) percent of wetland (marsh) covered by emergent vegetation; 2) percent of open water covered by submerged and floating-leaved aquatic vegetation; 3) Marsh edge and interspersion with open water; 4) percent of open water less than or equal to 1.5 feet deep in relation to marsh surface; 5) salinity; and 6) aquatic organism access.

4.2.3 Suitability Index Graphs

A suitability index graph is a graphical representation of how fish and wildlife habitat quality or "suitability" of a given habitat type is predicted to change as values of the given variable change, and allows the model user to numerically describe, through a Suitability Index, the habitat quality of a wetland area for any variable value. Each Suitability Index ranges from 0.1 to 1.0, with 1.0 representing the optimal condition for the variable in question. Suitability Index (SI) graphs were constructed for each variable. While the three marsh community models used for the MDWD utilize the same six variables, the suitability graphs for each variable differ according to the marsh community type (fresh/intermediate, brackish, or saline).

4.2.4 Habitat Suitability Index Formula

The final step in model development was to construct a mathematical formula that combines all Suitability Indices into a single Habitat Suitability Index value. Because the Suitability Indices range from 0.1 to 1.0, the HSI also ranges from 0.1 to 1.0, and is a numerical representation of the overall or "composite" habitat quality of the particular wetland area being evaluated. The HSI formula defines the aggregation of Suitability Indices in a manner unique to each wetland type depending on how the formula is constructed.

Within an HSI formula, any Suitability Index can be weighted by various means to increase the power or "importance" of that variable relative to the other variables in determining the HSI. Additionally, two or more variables can be grouped together into subgroups to further isolate variables for weighting.

4.2.5 Benefit Assessment

The net benefits of a proposed project are estimated by predicting future habitat conditions under two scenarios: future without-project and future with-project. Specifically, predictions are made as to how the model variables will change through time under the two scenarios. Through that process, HSIs are established for baseline (pre-project) conditions and for future without- and future with-project scenarios for selected "target years" throughout the expected life of the project. Those HSIs are then multiplied by the project area acreage at each target year to arrive at Habitat Units (HUs). Habitat Units represent a numerical combination of quality (HSI) and quantity (acres) existing at any given point in time. The HUs resulting from the future without- and future with-project scenarios are annualized, averaged over the project life, to determine Average Annual Habitat Units (AAHUs). The "benefit" of a project can be quantified by comparing AAHUs between the future without- and future with-project scenarios. The difference in AAHUs between the two scenarios represents the net benefit attributable to the project in terms of habitat quantity and quality. The starting point for the WVA 50 year period of analysis was assumed to be 2015 based upon the current schedule to complete Plans & Specifications and Construction. This 2015 date differs slightly from the 2009 used in the previous iterations of the planning process. While the starting point of the analysis has changes between steps (2015 compared to 2009) the entire final array of alternatives was evaluated on equal terms and therefore the comparison of alternatives and their respective benefits is valid.

The WVA assessment for the MDWD utilized habitat and land-water data generated by USGS for the project area, aerial photography, monitoring and hydrodynamic modeling data (for salinity) and also used field survey data collected for WVAs recently conducted for other, smaller CWPPRA projects within and adjacent to the MDWD project area. Separate WVA analyses were conducted for each marsh type and each diversion size alternative, and for each outfall management feature type. Target year 0 (TY0) was assumed to be 2015. The WVA analyses conducted for the future-without-project (FWOP) condition used two target years – 1 (TY1) and 50 (TY50) to assess changes in the project area over the 50-year planning horizon. Analyses of the future-with-project (FWP) condition also used TY1 and TY50, but added a target year 5 (TY5) within the 50-year planning horizon. TY5 was used in the FWP analyses because review of hydrodynamic modeling outputs projecting salinities indicated that a portion of the intermediate marsh area would transition to fresh marsh within a few years following the start of project operation. More detailed information concerning data sources, variable assumptions, anticipated habitat changes, and performance of the diversion alternatives over time is presented in an appendix to the USFWS Coordination Act Report at Appendix B.

4.2.5 MDWD Summary

Following the multiple operating regimes analyzed as part of Step 1 described previously, an optimal operating regime was established based on the best available supplies of freshwater, nutrients and sediments while avoiding the negative impacts of open diversions on the public, oyster and alligator resources. A March/April Open Pulse with a 1,000 cfs maintenance flow the rest of the year would achieve these ends. The WVA for the MDWD project is summarized below:

Table 3. Direct Footprint Acreage Impacts

	Ridge Creation	Marsh Creation	Channel Enlargement
Alternative 1: Location 3 – 5,000 cfs Diversion	32	139	153
Alternative 2: Location 3 – 10,000 cfs Diversion	32	176	167
Alternative 3: Location 3 – 15,000 cfs Diversion	32	235	182
Alternative 4: Location 3 – 35,000 cfs Diversion	31	385	223

Table 4a: WVA Benefits Summary

Benefits Summary				
Outfall Management Features				
Feature	**5,000 cfs**	**10,000 cfs**	**15,000 cfs**	**35,000 cfs**
Marsh Creation	54.59	72.52	92.19	155.20
Channel Enlargement	-15.99	-19.08	-21.89	-31.25
Ridge Footprint	-11.33	-11.33	-11.33	-11.37
Ridge Creation	28.24	28.24	28.24	27.36
Net AAHUs	**55.51**	**70.35**	**87.21**	**139.94**
Diversion Benefits				
Marsh Type	**5,000 cfs**	**10,000 cfs**	**15,000 cfs**	**35,000 cfs**
Fresh/Intermediate	3,505.05	3,862.13	5,650.28	8,802.11
Brackish	1,359.93	1,655.31	1,656.16	3,965.54
Saline	276.26	347.78	347.97	447.42
Net AAHUs	**5,141.24**	**5,86522**	**7,65441**	**13,215.07**
Total Net AAHUs	**5,196.75**	**5,935.57**	**7,741.62**	**13,355.01**

Table 5b. Acreage Summary

MDWD Final Array of Alternatives		
	WVA AAHU's March/Aprl Open + 1,000 cfs Maintenance Flow Year 0 = 2015	Gross/Net Acres March/Aprl Open + 1,000 cfs Maintenance Flow Year 0 = 2015 No Net Loss Acres = 39,587
Location 3 – 5,000 cfs	5,197	35,638 / -3,949
Location 3 – 10,000 cfs	5,936	40,419 / 562
Location 3 – 15,000 cfs	7,742	45,046 / 5,459
Location 3 – 35,000 cfs	13,555	59,902 /20,315

4.3 Cost Estimates for Habitat Improvement Measures.

Cost estimates were developed to conduct the cost effectiveness and incremental cost analysis of the various alternative plans. Items included in the first cost construction estimated are mobilization, dredging, placement, demobilization, contingency, Engineering and Design during Construction (EDC), Supervision & Administration (S&A), Real Estate and Operations and Maintenance. Table 3.12 summarizes the costs associated with each alternative plan. Following selection of the TSP, the design will be refined and a feasibility level cost estimate prepared in MCACES. Therefore, the cost of the recommended plan may differ from the numbers used during IC/CE analysis. Further details can be found in the Engineering and Cost Appendices.

Table 6. LCA: White Ditch Cost Estimates

Alternative	Total First Cost*	Annualized O&MRRR	Annualized First Cost**	**Total Annualized Cost**
Location 3 - 5,000 CFS Box	$152,900,000	$781,804	$7,580,348	$8,362,152
Location 3 - 10,000 CFS Box	$174,200,000	$871,463	$8,636,342	$9,507,805
Location 3 - 15,000 CFS Box	$241,700,000	$1,131,044	$11,982,801	$13,113,845
Location 3 - 35,000 CFS Box	$329,300,000	$1,467,836	$16,325,760	$17,793,596

*Includes Real Estate

**FY 2010 Discount Rate 4 3/8%

4.4 Results of the Incremental Cost/Cost Effectiveness Analysis

The analyses showed that alternative plans 1, 2, 3, and 4 are cost effective. Aside from the No Action alternative, Alternative 4 exhibited the lowest cost per Unit of all alternatives, $1,332 per AAHU. Alternative 3 exhibited the highest cost per Unit at $1,694 per AAHU.

Table 7. White Ditch Incremental Cost/Cost Effectiveness Step 2

Alternative	Total Annualized Cost	WVA AAHU	Average Cost per AAHU
Location 3 - 5,000 CFS Box	$8,362,152	5,197	$1,609
Location 3 - 10,000 CFS Box	$9,507,805	5,936	$1,602
Location 3 - 15,000 CFS Box	$13,113,845	7,742	$1,694
Location 3 - 35,000 CFS Box	$17,793,596	13,355	$1,332
*Includes Real Estate			
**FY 2010 Discount Rate 4 3/8%			

Overall, alternative 4 was considered a best buy plan. However, as the plans are linear in benefits and costs, a CE/IC analysis was conducted on all of the alternatives. These plans provide the greatest increase in benefits for the least increase in cost.

The No Action Alternative (FWOP) is cost effective, however provides no improvement in habitat quality resulting in steep declines in marsh. Alternative plan 1 provides 5,197 AAHUs over and above the No Action Alternative (FWOP) at an annualized incremental cost of $8,362,152 (tables 3.11 and 3.12). Alternative plan 2 provides 739 additional AAHUs, at an annualized incremental cost of $1,145,653. Alternative plan 3 provides 1,806 additional AAHUs, at an annualized incremental cost of $3,606,040. Alternative Plan 4 provides 5,613 additional AAHUs at an annualized incremental cost of $4,679,752. Alternative 4 has the lowest incremental cost per AAHU of $834.

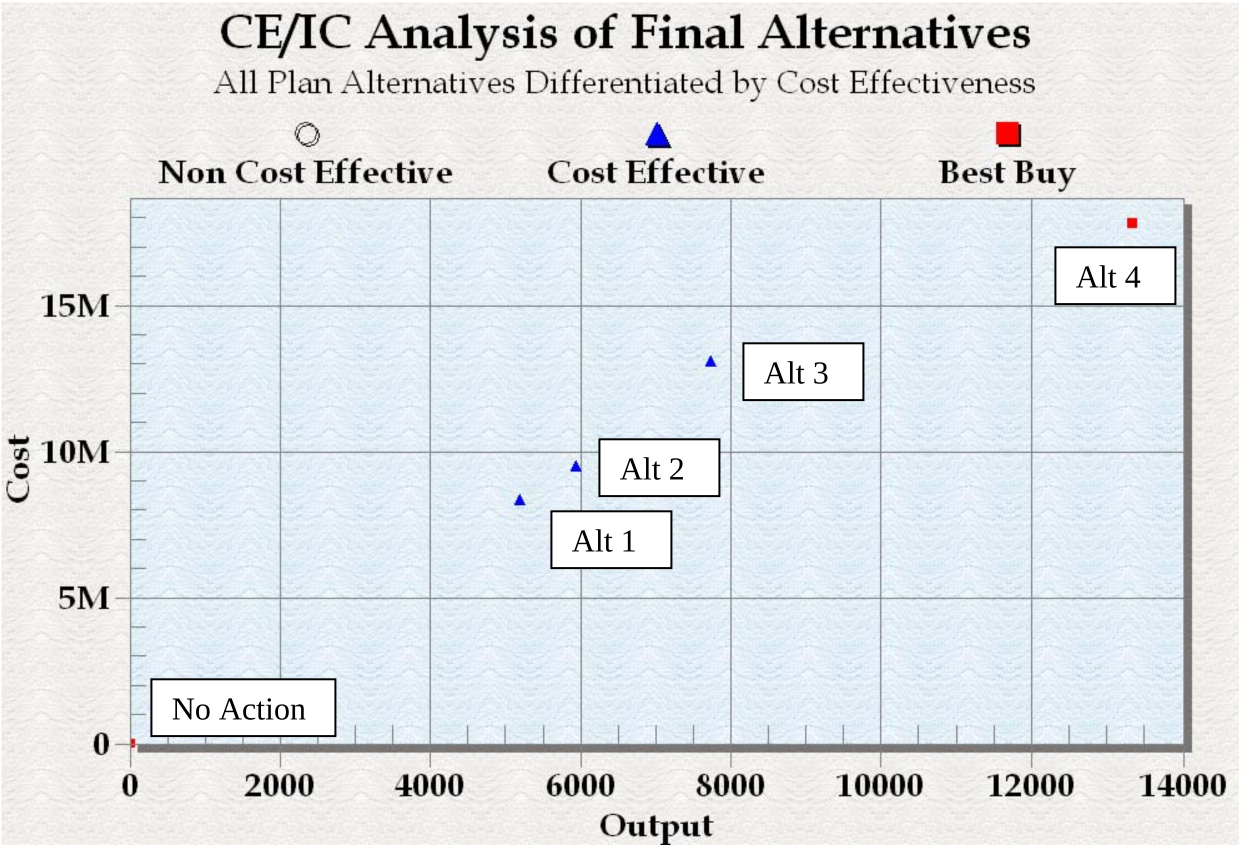

Figure 9. CE/IC Analysis of Final Alternatives

Table 8. White Ditch Incremental Cost/Cost Effectiveness Step 2

Alternative	Total Annualized Cost	WVA AAHU	Incremental Cost/Cost Effectiveness Analysis of Cost Effective Plans: Incremental Cost	Incremental AAHU	Incremental Cost per AAHU
Location 3 - 5,000 CFS Box	$8,362,152	5,197	$8,362,152	5,197	$1,609
Location 3 - 10,000 CFS Box	$9,507,805	5,936	$1,145,653	739	$1,550
Location 3 - 15,000 CFS Box	$13,113,845	7,742	$3,606,040	1,806	$1,997
Location 3 - 35,000 CFS Box	$17,793,596	13,355	$4,679,752	5,613	$834

*Includes Real Estate
**Discount Rate 4 3/8%

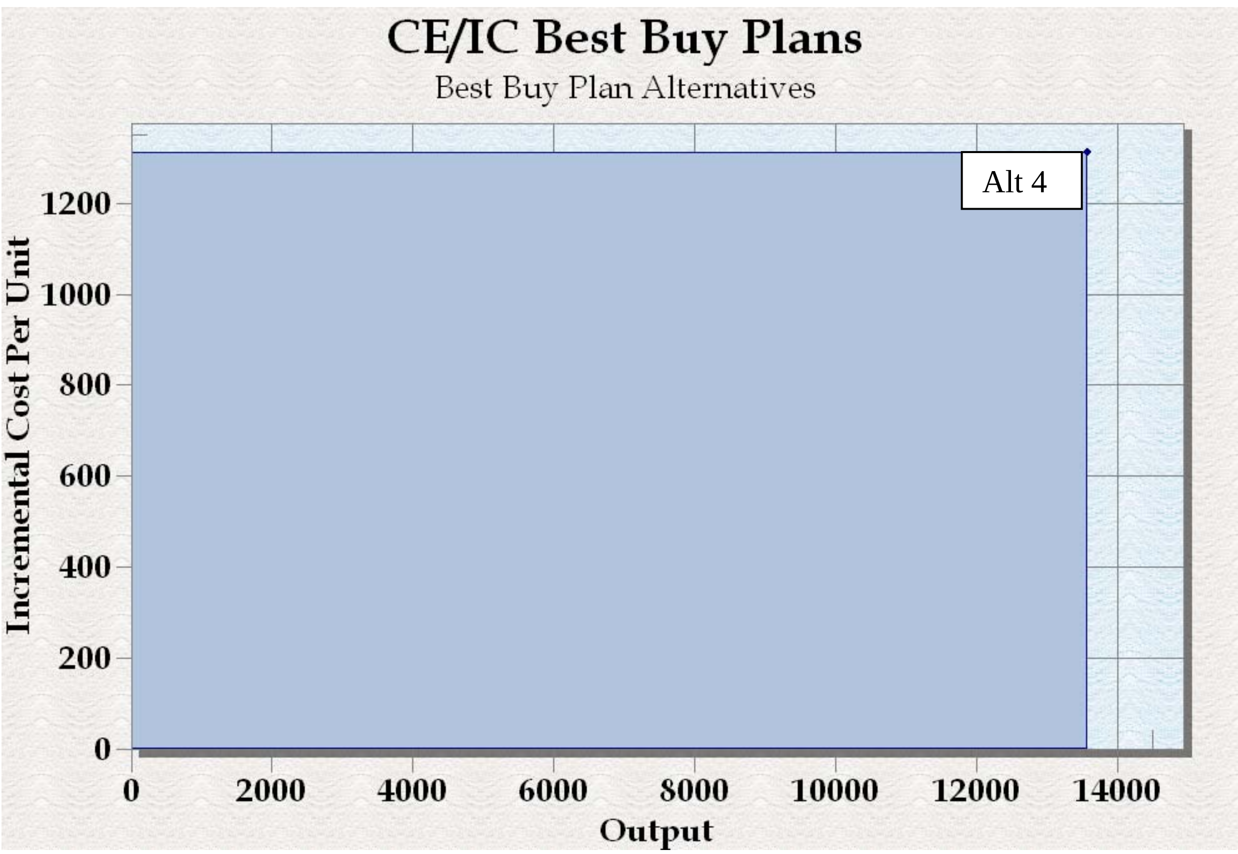

Figure 10. CE/IC Best Buy Plans

4.5 Other Factors

As part of the process to determine whether additional increments of ecosystem investment are worth the cost, other factors were considered.

4.5.1 Recreational Benefits

The primary purpose of the White Ditch Study is to determine a cost effective ecosystem restoration plan, however there are potential ancillary benefits to recreation. Recreation benefits are not being claimed to justify the project but are useful in discerning among the final alternatives. A complete analysis can be found in the Recreation Benefits Analysis Annex to Appendix K.

Given that the study area has 90,109 unit days per year and that each unit day is valued at $8.99, the total annual monetary value of the recreational resource that would be affected by the White Ditch project is $810,256. Given that the likelihood at success with fishing will increase and that environmental factors will improve over time if the proposed project is implemented, the total annual monetary value of the recreational resource will increase in the future compared to the annual monetary value of the recreational resource should the proposed project not be implemented.

To better understand the economic impact of the proposed project on recreation, the analysis considered effects over a 50-year period. The analysis uses the Federal discount rate for 2009 of 4 3/8%. The following table summarizes the potential net present value of recreational resources for each alternative.

Table 9. Net Increase in Recreation Benefits

	Without Project	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Net Present Value of Benefits over 50 years	$0	$1,206,000	$1,278,000	$1,421,000	$853,000
Annualized Benefits	$0	$57,284	$60,704	$67,496	$40,517

4.5.2 Desired Future Condition

The desired future established early on in the study was to achieve a no net loss of marsh acres at the end of the 50-year period of analysis. While it was desirable to maximize the acres of marsh, it was uncertain if that was possible given the various physical and operational constraints. The outputs of the ERDC SAND model are one of the key components in the WVA. Based on the ERDC SAND results, Alternative 4 provided the most net acres at the end of period of analysis. In fact it is probable, based on the modeling, that the study area could see a return to historic marsh acreages. Finally, the IC/CE analysis of the final array of alternatives utilized WVA benefits based in part on an operation regime of Open Diversion during March-April with a 1,000 cfs maintenance flow the remainder of the year. As can be seen in the Figure below, under a variety of operating regimes, Alternative 4 is the most capable at achieving no net loss. Alternative 3 has the potential to achieve no net loss but there is no room for error. This uncertainty was viewed by the PDT and stakeholders as unacceptable.

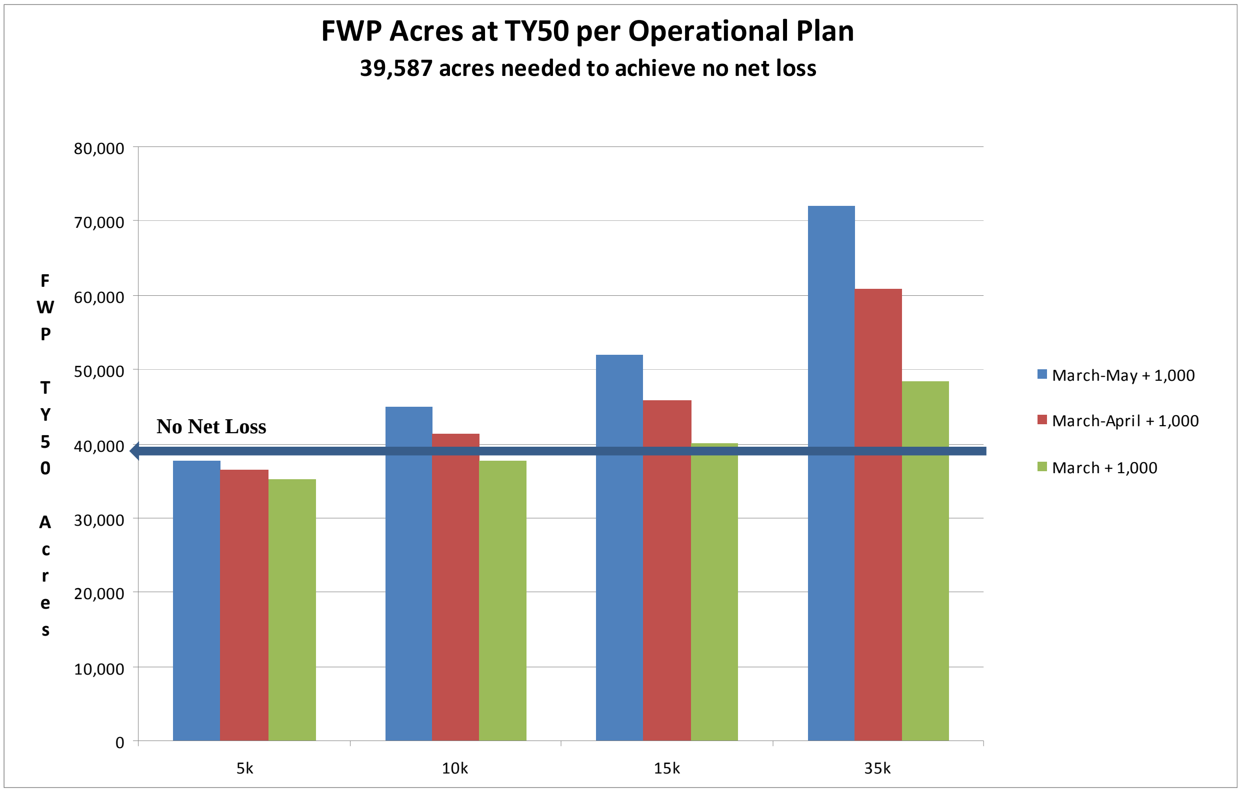

Figure 11. FWP Acres at TY50 per Operational Plan

4.5.3 Relative Sea Level Rise

An analysis of the high sea level rise scenario was conducted utilizing the ERDC-SAND2 model. The model was used to determine whether a net loss or gain of marsh acreage would occur assuming a high sea level rise scenario. Alternative 4 was the most effective at countering the effects of high sea level rise. Alternative 4 could maintain marsh acreage out to approximately year 20 of the analysis which was then quickly followed by a sharp decline and eventual collapse of the marsh and near total conversion to open water. This result was based on the March/April Pulse plus a 1,000 cfs maintenance flow the rest of the year. Table 9 and Table 10 display these details. It should be noted however, that in the event high sea level rise becomes a reality, Alternative 4 alone has the capability (assuming an open diversion) to divert large enough quantities of freshwater, nutrients and sediments to overcome high sea level rise. Longer term pulses of freshwater may result in large scale habitat switching to predominately freshwater types. Further, long term freshwater pulses can saturate marsh vegetation and soils such that they are less resilient to storm surge from seasonal events resulting in marsh displacement and conversion to open water. There is strong public feeling that the prolonged operation of Caernarvon prior to Katrina contributed to the severe loss of marsh. While not publicly acceptable at present (due to the anticipated negative consequences of over-freshening the basin), if the collapse of the marsh within the study areas was imminent, then having the ability to respond accordingly with a year round open diversion would be critical.

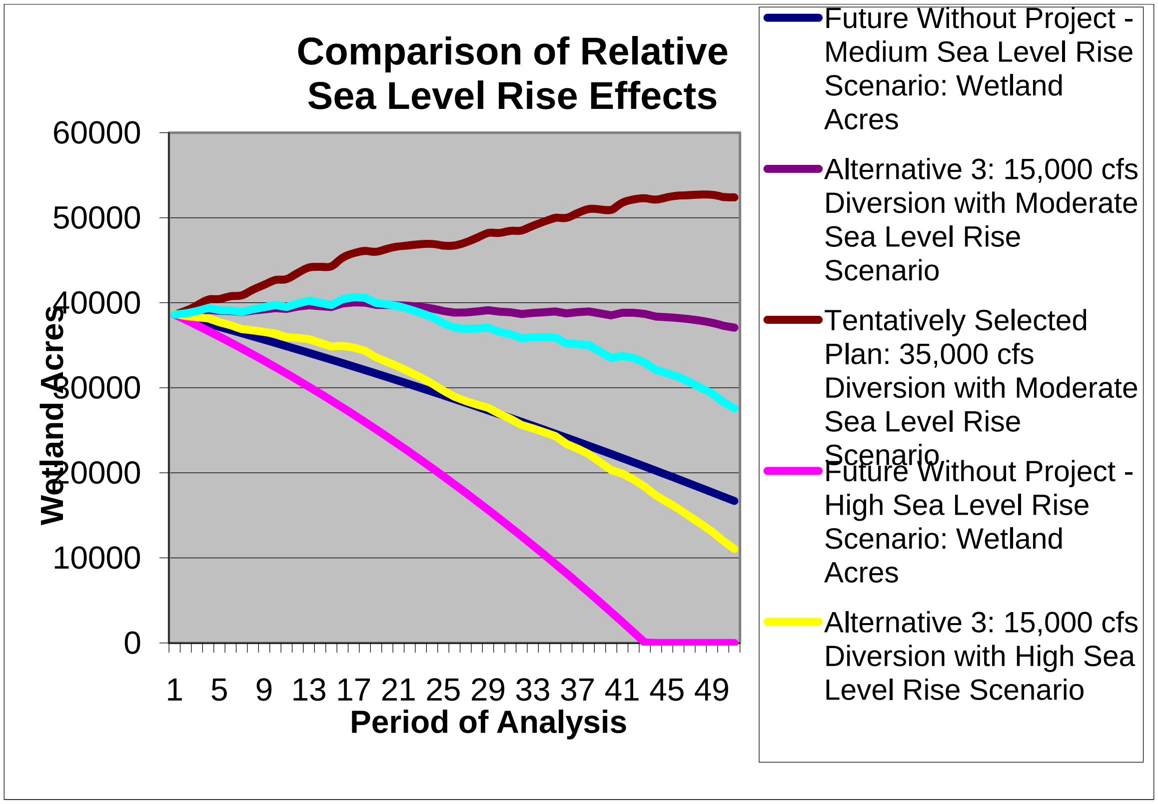

Figure 12. Comparison of Relative Sea Level Rise Effects

Table 10. ERDC-SAND2 Model Calculations of Acreages for the MDWD Project Area under Historical Sea Level Rise Rates

Historic RSLR	Gross Acres of Marsh					
Project Life Years	0	10	20	30	40	50
No Action Alternative (FWOP)	38,700	36,000	33,300	30,500	27,800	25,000
5,000 cfs Diversion Alternative	38,700	38,300	37,800	37,000	36,600	35,600
10,000 cfs Diversion Alternative	38,700	39,300	39,900	39,900	40,700	40,400
15,000 cfs Diversion Alternative	38,700	40,300	41,900	42,700	44,600	45,000
35,000 cfs Diversion Alternative	38,700	43,800	48,800	52,200	57,300	59,900

*** The total project area for the Medium Diversion at White Ditch is 98,000 acres

Table 11. ERDC-SAND2 Model Calculations of Acreages for the MDWD Project Area under the Intermediate and High Sea Level Rise Rates

Intermediate RSLR	Gross Acres of Marsh					
Project Life Years	0	10	20	30	40	50
No Action Alternative (FWOP)	38,700	34,900	30,900	26,500	21,800	16,900
35,000 cfs Diversion Alternative	38,700	42,800	46,600	48,500	51,800	52,400
High RSLR	Gross Acres of Marsh					
Project Life Years	0	10	20	30	40	50
No Action Alternative (FWOP)	38,700	31,500	23,700	14,000	2,900	0
35,000 cfs Diversion Alternative	38,700	39,500	39,600	36,300	33,800	27,600

*** The total project area for the Medium Diversion at White Ditch is 98,000 acres

4.5.4 Breton Sound Benefits

During the initial ERDC SAND evaluation of alternatives in Step 2, it was determined that Alternative 4 has the capability to create marsh in the larger Breton Sound basin through nutrient transfer. The modification of the Caernarvon Diversion is currently being evaluated in an effort to address the design deficiency in capturing sediment. It may be possible, with further analysis, to claim benefits to the Caernarvon project area as a result of implementing Alternative 4. This may lead to cost savings for the Caernarvon project.

4.5.5 Adaptive Management

Alternative 4 provides the most robust capability for adapting to future risk and uncertainty. As discussed above, Alternative 4 provides the most flexible management of operations to respond to sea level rise. The difference between alternatives 3 and 4 is the outfall canals, ridges and flow constrictions that are responsible for distributing flows at 15,000 and 35,000 cfs respectively. Just as sea level rise represents uncertainty at one end of the spectrum, it is also possible that the sea level rise will not be any more pronounced than historic levels. Also, as the science of operating large diversion structures is refined throughout the period of analysis, it is possible maximize environmental outputs with smaller diversions. Finally, it is expected that as the project is actually operated and benefits are achieved, it will be of value for the federal, state and local partnership to revisit the goals and objectives associated with the project area. If the project is proving to be very successful at creating marsh it may no longer necessary to maintain a 35,000 cfs diversion capability. To achieve this, O&M could be reduced resulting in outfall canals, ridges and flow constrictions necessary to support a decreased diversion flow.

4.5.6 Acceptability, Completeness, Effectiveness, and Efficiency.

Alternative 4 meets the four evaluation criteria of the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. Special consideration is also given to these criteria within the larger context of the LCA Report (2004). The four criteria are acceptability, completeness, effectiveness, and efficiency.

Acceptability

The plan is acceptable to Federal, state, tribal, local entities, and the public. It is compatible with existing laws, regulations, and policies.

Completeness

The plan is complete. Realization of the plan does not depend on implementation of actions outside the plan.

Effectiveness

The plan is effective. It addresses all the project objectives. It improves marsh habitat by restoring deltaic process related to freshwater, nutrient and sediments. It does this by introducing the quantities of freshwater, nutrients and sediments required (objectives) to achieve no net loss of marsh during the period of analysis.

Efficiency

The plan is efficient. It is a cost-effective solution to the stated problems and objectives. No other plan produces the same level of output more cost effectively. The plan is cost effective and provides the greatest increase in benefits for the least increase in costs.

4.5.7 Recommendation of the Tentatively Selected Plan.

The interagency team recommends Alternative Plan 4 as the tentatively selected plan. This alternative best meets the study objectives. It would result in restoration of deltaic processes within the project area. In cooperation with the USFWS, NOAA, and the State of Louisiana the Corps has planned and would design a project that serves the needs of the nation.

ANNEX 1
Incidental Recreation Benefits

Introduction and Methodology

This report summarizes the potential incidental recreational benefits of the White Ditch Diversion project, which is the development of a freshwater diversion from the Mississippi River into marshland. The White Ditch Study Area is between the River aux Chenes and the Mississippi River in Plaquemines Parish, Louisiana.

The methodology for estimating the potential incidental recreational benefits of the White Ditch diversion is described by the USACE in publication number ER 1105-2-100, Planning - Planning Guidance Notebook. ER 1105-2-100 authorizes the use of three separate procedures to estimate recreation benefits. These are the travel cost method, the contingent valuation method, and the unit day value method. The first two require a variety of data that are not readily available for the White Ditch Project; therefore, the unit day value (UDV) method has been utilized. A model using the UDV method was developed to estimate the value of recreational benefits in the Study Area for the with- and without-project condition.

Annually, USACE publishes unit day values for both specialized recreation and general recreation. For this project, the general recreation unit day values for general recreation published in Economic Guidance Memorandum Number 10-03 (EGM 10-03) are used. The term “general recreation” refers to an area that provides access to a variety of recreational activities, is widely used, and provides supportive facilities, such as marinas.

Estimating Recreational Use Based Upon State of Louisiana Data

The Louisiana Statewide Comprehensive Outdoor Recreation Plan (SCORP) is published every five years by the Office of State Parks within the Louisiana Department of Culture, Recreation and Tourism. The SCORP is based upon in field and telephone surveys and is used to prioritize the funding of recreation facilities within the state and is prepared to comply with National Park Service guidelines. The 2003-2008 SCORP contains more detailed information, and more regional information than the 2009-2013 SCORP, so both were consulted for this analysis.

The 2003-2008 SCORP explains how facility use standards were developed. The 2003-2008 SCORP facility use standard is based upon a turnover of 20 boats per boat ramp daily, with three persons per boat. Hunting facility use is based upon a turnover of one hunter for every 25 acres per day. The 2009-2013 SCORP states that fishing and hunting are both declining recreational activities, with fishing declining 20% since the last SCORP.

The percentage of the population participating in saltwater fishing by boat based upon either SCORP differs significantly from that indicated by licensing, which is managed by the Louisiana Department of Wildlife and Fisheries (LADWF). The LADWF requires a saltwater endorsement to a fishing license when fishing south of Interstate 10. For this analysis, the midpoint between the two figures

(SCORP estimate and LADWF licensed population) is used to estimate the annual use of the study area for recreational fishing.

For each parish, the number of activity days for fishing in a boat was estimated based upon parish population in the latest Census estimate, the percentage of the population that participate in fishing from a boat provided in the SCORP, and the number of people in the parish with a fishing license and saltwater endorsement provided by LADWF. This number was multiplied by the average number of activity days for fishing in a boat per person in the region, which is provided in the SCORP, to estimate annual activity days by parish residents. The proportion of activity days for fishing from a boat was allocated to the study area for each parish. This figure was allocated 60% to weekends and 40% to weekdays. The result is that the number of weekday visitors annually in this area is estimated at 54,101; the number of weekend visitors annually is estimated at 36,063. The weekend visitation rate was compared with the study area capacity. The capacity of this study area is driven primarily by the availability of boat launches and parking for boat trailers. After reviewing the capacity of the two baot launches in the study area and the water access from outside the study area, a judgement was made that capacity constraints did not impact weekend visitation. Thus, the total number of visitors using this area for a day or the number of unit days is 90,164 annually.

A portion of the activity days for each parish were also allocated to the neighboring area to the northeast. This is the recreational area closest to the White Ditch Study Area and the area most likely to be used as an alternative, such as during the pulse period. The allocation of activity days to the two areas listed, Study Area and Adjacent Area, are less than 100%, because parish residents will spend some activity days in totally different regions. The White Ditch Study Area is in Plaquemines Parish, where the majority of the population lives on the west bank of the Mississippi River. A large portion of this population is unlikely to travel across the Mississippi River to the White Ditch Study Area or the adjacent area.

During the pulse period a portion of the activity days that would have been spent in the White Ditch Study Area might be spent in the adjacent area to the northeast, for the alternatives of 10,000 cfs (Alternative 2) or greater. The assumption is made that 10% of the activity days will be shifted from the Study Area to the adjacent area at Year 5 for Alternatives 2 and 3 and 20% for Alternative 4. At Year 10 the assumption is made that Alternatives 2 and 3 would have benefitted the study area enough to increase annual activity days to the original amount, despite the dislocation during the pulse period. Alternative 4 has a high diversion rate of 35,000 cfs during the pulse period, and this rate would significantly reduce visitation through the entire planning period. In comparison to the Caernarvon and Davis Pond Diversion Projects, the flow with Alternative 4 would be much higher, and, according to focus group members, recreational fishing would be greatly impacted for an extended period during and after the pulse period.

These shifts in user days, between the study area and the adjacent area are shown in the two tables below.

Recreation Resource Year 5

July 1, 2017	Without Project	Alternative 1	Alternative 2	Alternative 3	Alternative 4
White Ditch Study Area					
Unit Day Value (2010 value)	$8.38	$8.73	$8.90	$9.08	$9.30
Number of Unit Days	90,164	90,164	81,148	81,148	72,131
Total Annual Monetary Value	$755,213	$786,951	$722,538	$736,820	$670,820
Total Benefit / Loss with Project	n/a	$31,738	-$32,675	-$18,393	-$84,393
Outside of Study Area					
Unit Day Value (2010 value)	$8.38	$8.38	$8.38	$8.38	$8.38
Number of Unit Days	167,106	167,106	176,122	176,122	185,138
Total Annual Monetary Value	$1,399,676	$1,399,676	$1,475,197	$1,475,197	$1,550,718
Total Benefit / Loss with Project	n/a	$0	$75,521	$75,521	$151,043
Net Monetary Benefit / Loss	n/a	$31,738	$42,846	$57,128	$66,649
Total Number of Unit Days - Both Areas	257,269	257,269	257,269	257,269	257,269

Recreation Resource Year 10

July 1, 2022	Without Project	Alternative 1	Alternative 2	Alternative 3	Alternative 4
White Ditch Study Area					
Unit Day Value (2010 value)	$8.38	$8.82	$8.99	$9.12	$9.34
Number of Unit Days	90,164	90,164	90,164	90,164	81,148
Total Annual Monetary Value	$755,213	$794,885	$810,754	$822,656	$758,243
Total Benefit / Loss with Project	n/a	$39,672	$55,541	$67,443	$3,030
Outside of Study Area					
Unit Day Value (2010 value)	$8.38	$8.38	$8.38	$8.38	$8.38
Number of Unit Days	167,106	167,106	167,106	167,106	176,122
Total Annual Monetary Value	$1,399,676	$1,399,676	$1,399,676	$1,399,676	$1,475,197
Total Benefit / Loss with Project	n/a	$0	$0	$0	$75,521
Net Monetary Benefit / Loss	n/a	$39,672	$55,541	$67,443	$78,551
Total Number of Unit Days - Both Areas	257,269	257,269	257,269	257,269	257,269

There are three general activities in the study area. One activity, recreational fishing, is of high value. Recreational fishing is almost exclusively from boats, as there are no piers and bank fishing is difficult. The only other recreational activities are duck hunting, which has a short, 60 day season, and wildlife watching. The focus group attendees stated that most duck hunting was outside the White Ditch Study Area, in the Mississippi River Gulf Outlet area. The model was used to estimate the number of unit value days for duck hunting and wildlife watching. Based upon the estimates, as shown in the table below, the number of user days for these activities was approximately 6% of the number for recreational fishing. Therefore separate unit day values were not estimated for these activities and recreational benefits were not included for these activities.

White Ditch Study Area - Potential Visiting Population

Parish of Residence

Potential Recreational Users	Plaquemines	St. Bernard	Orleans	Jefferson	Total
Potential Visitors to Study Area Annually - Fishing	15,237	9,633	14,418	50,876	90,164
Potential Visitors to Adjacent Area Annually - Fishing	7,618	28,899	28,837	101,752	167,106
Potential Visitors to Study Area Annually - Duck Hunting	33	28	9	94	164
Potential Visitors to Adjacent Area Annually - Duck Hunting	66	56	17	188	327
Potential Visitors to Study Area Annually - Nature Study	1,155	1,024	1,693	2,368	6,241
Potential Visitors to Adjacent Area Annually - Nature Study	578	1,024	8,467	11,842	21,911
Potential Visitors to Study Area Annually - Total	16,425	10,685	16,121	53,338	96,569
Potential Visitors to Adjacent Area Annually - Total	8,262	29,979	37,321	113,781	189,343

The time in transit for the recreational fishers using the study area would change with the alternatives, based upon the species sought. During the pulse, saltwater species are expected to migrate away from the diversion towards open water. The drive time to boat launches would remain the same, but the time in transit by boat to fishing spots would increase for those seeking saltwater species. Within the White Ditch Study Area the additional transit time would not be significant. An additional 10 minutes of transit time by boat each way is not significant compared with the total preparation and transit time needed to spend the day fishing. Therefore the unit day value is not changed based upon transit time or "steaming time." However, some fishers will go to another area, outside the study area, rather than fish in more open water, which has more choppy conditions

Estimate of Unit Day Value

The study area is assumed to be stable in the without-project condition, meaning the unit day values for recreation remain constant.. The net changes in unit day values are determined by comparing the future condition with the current condition. The estimates of annual use are combined with unit day values to estimate annual recreation benefits. Unit day values were estimated using the most recent values available in EGM 10-03.

The Unit Day Value method involves assigning points in each of five categories or criteria. The five criteria are:

- Recreation Experience, the number of high quality recreational activities possible in the area;
- Availability of Opportunity, the availability of similar opportunities nearby;
- Carrying Capacity, the degree to which an area provides services to support recreation;
- Accessibility, the degree to which the area is readily accessible; and
- Environmental Quality, the aesthetic qualities of the area including water and vegetation, air and water quality, scenery, and climate.

Points were assigned for each of these five criteria. The determination of points for each criterion is described below. Two of the five criteria are impacted by the project.

Recreation Experience: A maximum of 30 points may be assigned for this criterion. Point values to be assigned are described in the table below.

Availability of Opportunity					
Description	Several similar opportunities within one hour and a few within 30 min travel time	Several similar opportunities within one hour but none within 30 min travel time	One or two within one hour travel time but none within 45 min	No similar opportunities within one hour travel time	No similar opportunities within two hour travel time
Range of Points	0–3	4–6	7–10	11–14	15–18

For this analysis, 16 points are assigned because there are three activities; wildlife watching, fishing and hunting, and because fishing in this area is, according to Focus Group participants, some of the best in the country. None of the alternatives affect the points assigned for this criterion.

Availability of Opportunity and Likelihood of Fishing Success: A maximum of 18 points may be assigned for this criterion. Point values to be assigned are described in the table below. Availability of Opportunity is equated with likelihood of success at fishing and hunting, as stated in Table 2 of EGM 10-03. During the annual pulse period and for a short period afterwards, likelihood of fishing success will diminish. During the other months, the likelihood of fishing success would not be

Recreation Experience					
Description	Two general activities available	Several general activities available	Several general activities available with one high quality	Several general activities available, more than one high quality	Numerous high quality activities available
Range of Points	0–4	5–10	11–16	17–23	24–30

impacted. The diversion is intended to improve the marsh and wildlife, so the long term impact on recreation should be beneficial. When the beneficial impacts to wildlife become apparent after ten years the likelihood of fishing and hunting success will increase.

For the White Ditch Study Area, the net increase in average annual habitat units and marsh acres are considered when estimating the improved likelihood of success at fishing and hunting. Other factors could be considered dependent upon data availability. The model does not use a direct correlation between these factors and the likelihood of fishing success but is dependent upon a subjective interpretation of the data.

Thus, 10 points are assigned for the without-project condition and additional points are assigned for each of the alternative's subsequent years based upon the environmental outputs of the project. The outputs of the ecosystem restoration, Average Annual Habitat Units (AAHUs) and marsh acres, are used in assigning points for this criteria. Increasing AAHUs and marsh acres indicate increased likelihood of fishing success and increased esthetics. The correlation of these outputs to improvements in recreational fishing has been determined through previous research but the direct conversion of AAHUs and marsh acres to points is subjective. The model is consistent, in that more of these outputs result in more points. Within coastal Louisiana, different projects have different outputs, and sometimes these projects are adjacent to each other. For that reason the unit day values for the MRGO Ecosystem Restoration project are considered when determining the point assignment for the White Ditch Project.

The points assigned for Availability of Opportunity/Likelihood of Fishing Success are shown in the table below. Based upon increases in AAHUs and input from the focus group, each alternative is expected to increase the likelihood of fishing success significantly. Alternative 4 results in the highest number of points, 16 out of 18, compared to the other alternatives.

White Ditch Study Area General Recreation Points - Year 5

Criteria	Without Project	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Recreation Experience (Number of Activities)	16	16	16	16	16
Availability of Opportunity *	10	11	12	13	16
Carrying Capacity	5	5	5	5	5
Accessibility	10	10	10	10	10
Environmental (Esthetic Quality) *	11	14	15	16	18
Total Points	**52**	**56**	**58**	**60**	**65**
Unit Day Value	**$8.38**	**$8.73**	**$8.90**	**$9.08**	**$9.30**
Variable - Availability of Opportunity					
Likelihood of Fishing Success (Net Change from Base)	0	1	2	3	6
Additional (Net Change) Marsh AAHUs	0	< 5457	< 6095	< 7921	< 13575
Marsh Creation (Acres)	0	< 55	< 70	< 91	< 163

Carrying Capacity: A maximum of 14 points may be assigned for this criterion. Point values to be assigned are described in the following table:

Carrying Capacity					
Description	Minimum facility development for public health and safety	Basic facilities to conduct activity	Adequate facilities to conduct activity	Optimum facilities to conduct activity	Ultimate facilities to conduct activity
Range of Points	0 - 2	3 - 5	6 - 8	9 - 11	12 - 14

For this analysis, 5 points are assigned because facilities to support recreation in this area are currently adequate. However, should the proposed White Ditch project and resulting changes in salinity levels reduce the amount of fishers utilizing existing marinas and causing them to go out of business, there may be negative impacts to recreational fishing because there will be fewer services available in the area. Since these closures are considered unlikely, the assumption is made that the marinas will remain in business and recreational users will be able to obtain the services they need.

Accessibility: A maximum of 18 points may be assigned for this criterion. Point values to be assigned are described in the following table:

Accessibility					
Description	Limited Access by any means to site	Fair access to site; limited access within site	Fair access to site; fair access within site	Good access to site; fair access within site	Good access to site; good access within site
Range of Points	0 - 3	4 - 6	7 - 10	11 - 14	15 - 18

For this analysis, 10 points are assigned because the study area has one highway providing access to the two boat launches within the site. None of the alternatives will affect this criterion.

Environmental: A maximum of 20 points may be assigned for this criterion. Point values to be assigned are described in the following table:

Environmental					
Description	Low aesthetic factors	Average aesthetic factors	Above average esthetic factors	High aesthetic factors	Outstanding aesthetic factors
Range of Points	0–2	3–6	7–10	11–15	16–20

For this analysis, 11 points are assigned because while the area is considered to be very beautiful, the proposed project will affect some aesthetic factors during the pulse period and for several weeks afterward. In particular, increased turbidity may affect water quality and decreased salinity will kill some existing vegetation during the pulse period. However, because vegetation that can tolerate changing salinity levels will eventually be established in the area, the aesthetic quality of the area will recover. Thus over time, the number of points that can be assigned for this criterion will increase. The table below shows that increase at Year 10 of the project.

Study Area
General Recreation Points - Year 10

Criteria	Without Project	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Recreation Experience (Number of Activities)	16	16	16	16	16
Availability of Opportunity *	10	12	13	14	17
Carrying Capacity	5	5	5	5	5
Accessibility	10	10	10	10	10
Environmental (Esthetic Quality) *	11	14	15	16	18
Total Points	**52**	**57**	**59**	**61**	**66**
Unit Day Value	**$8.38**	**$8.80**	**$8.99**	**$9.12**	**$9.34**
Variable - (Environmental - Esthetic Quality)					
Esthetic Quality (Net Change from Base)	0	3	4	5	7
Additional (Net Change) Marsh AAHUs	0	< 5457	< 6095	< 7921	< 13575
Marsh Creation (Acres)	0	< 55	< 70	< 91	< 163

Recreational Benefits

EGM 10-03 provides a table showing how to relate points assigned using the five criteria to dollar values. Since this project is evaluated to have a total of 52 points under the without-project condition, using linear interpolation and the values provided by EGM 10-03 for either 50 or 60 points, we assign a dollar value of $8.38 as the general recreation unit day value. Unit day value increases through year 50 for each alternative, based upon the evaluation points criteria discussed above to $8.90 for Alternative 1, $9.08 for Alternative 2, $9.17 for Alternative 3 and $9.34 for Alternative 4 (TSP).

The annualized benefits are based upon changes in both the number of unit days and the unit day value, occurring over a fifty period. Both of these figures were input into the model at the time of project completion, as well as five years, ten years, twenty years, and fifty years after project completion. The benefits for every year during the fifty year planning period were based on the outputs of the model for these years, with equal incremental changes between these years. The net present value (NPV) of the annual benefits is calculated and the NPV is annualized.

Given that the area has 90,164 unit days per year and that each unit day is valued at $8.38, the total annual monetary value of the recreational resource that would be affected by the White Ditch project is $755,213. Given that the likelihood at success with fishing will increase and that environmental factors will improve over time if the proposed project is implemented, the total annual monetary value of the recreational resource will increase in the future compared to the annual monetary value of the recreational resource should the proposed project not be implemented. A combination of an increase in unit day value and user-days for the with-project condition results in an increase in net benefits for each alternative. A combination of an increase in unit day value and total user-days for Alternatives 1-3 results in increased recreational benefits. Alternatives 1 through 3 are expected to increase user days by 9,000 in the study area by year 50, whereas annual visitation will not increase for Alternative 4 because of users shifting out of the study area during the pulse period. This annual decrease results from adverse conditions during the pulse period and for several weeks after. The number of unit value days and the value of those days at Year 50 are shown in the next table

The following table shows the net present value and total annualized benefits for each alternative, both inside the study are and outside the study area. There is a net positive benefit outside the study area from the displaced users during the pulse period.

Recreation Resource Year 50

July 1, 2062	Without Project	Alternative 1	Alternative 2	Alternative 3	Alternative 4
White Ditch Study Area					
Unit Day Value (2010 value)	$8.38	$8.90	$9.08	$9.17	$9.34
Number of Unit Days	90,164	99,180	99,180	99,180	90,164
Total Annual Monetary Value	$755,213	$883,102	$900,557	$909,285	$842,492
Total Benefit / Loss with Project	n/a	$127,889	$145,344	$154,072	$87,279
Outside of Study Area					
Unit Day Value (2010 value)	$8.38	$8.38	$8.38	$8.38	$8.38
Number of Unit Days	167,106	167,106	167,106	167,106	167,106
Total Annual Monetary Value	$1,399,676	$1,399,676	$1,399,676	$1,399,676	$1,399,676
Total Benefit / Loss with Project	n/a	$0	$0	$0	$0
Net Monetary Benefit / Loss	n/a	$127,889	$145,344	$154,072	$87,279
Total Number of Unit Days - Both Areas	257,269	266,286	266,286	266,286	257,269

Total Recreation Resource Annualized Benefits

	Without Project	Alternative 1	Alternative 2	Alternative 3	Alternative 4
White Ditch Study Area					
Total Net Present Value (NPV) all 50 years	15,345,000	16,815,000	16,795,000	16,983,000	15,831,000
Total Annualized Rec Benefits - 50 years	728,873	798,697	797,747	806,677	751,958
Net Present Value Increase / Decrease		1,470,000	1,450,000	1,638,000	486,000
Annualized Benefits Increase / Decrease		69,824	68,874	77,803	23,085
Outside of Study Area					
Total Net Present Value (NPV) all 50 years	28,344,000	28,344,000	28,637,000	28,637,000	29,262,000
Total Annualized Rec Benefits - 50 years	1,346,314	1,346,314	1,360,231	1,360,231	1,389,918
Net Present Value Increase / Decrease		0	293,000	293,000	918,000
Annualized Benefits Increase / Decrease		0	13,917	13,917	43,604

To better understand the economic impact of the proposed project on recreation, the analysis considered effects over a 50-year period. The analysis uses the Federal discount rate for 2009 of 0.04625. The following table summarizes the potential net present value of recreational resources for each alternative.

Net Increase in Recreation Benefits

	Without Project	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
Net Present Value of Benefits over 50 years	$0	1,470,000	1,743,000	1,931,000	1,404,000
Annualized Benefits	$0	69,824	82,791	91,721	66,689

Alternative 3 has the highest benefits. Unit day values increase more for Alternative 3 than for Alternatives 1 and 2 and it has a higher number of unit days than Alternative 4. Alternative 4 has the highest unit day value for each year modeled because it has the highest level of environmental outputs . However, the high water flow for Alternative 4 is expected to cause the greatest reduction in visitation. To summarize, Alternative 3 has the highest benefits based upon the combination of both unit day values and annual visitation.

References

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