Volume IV
APPENDIX K:
Benefit/Cost-Incremental Cost Analysis and WVA Report

Also included herein:

1) **WVA Report**
2) **Response to Comments on WVA Certification**

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As a result of the plan formulation and screening process presented in Section 3.0 of the main report, four alternatives, including the no action, were identified and each was assessed for ecosystem restoration benefits using the Wetland Value Assessment (WVA) to determine habitat values, The resulting habitat values along with preliminary engineering costs were used as inputs for the IWR Planning Suite to compare the alternatives in terms of outputs and costs as further described below.

Cost effectiveness and incremental cost analyses (CE/ICA) reveal information about good financial investments given the dollar costs and non-dollar outputs ("benefits") of alternative investment choices. The analyses are conducted in a series of steps that progressively identify alternatives that meet specified criteria and screen-out those that do not. US Army Corps of Engineer (USACE) Regulation 1105-2-100 requires cost effectiveness and incremental cost analyses to support recommendations for ecosystem restoration through implementation of the IWR Planning Suite (IWR). IWR takes user-defined solutions to planning problems and externally-generated estimates of each solution's effects and can formulate all possible combinations of those solutions, considering user-defined relationships between solutions. IWR will then identify which combinations are the best financial investments through cost effectiveness and incremental cost analyses. Each combination of solutions is an alternative plan and the use of IWR assists in identifying which plans are the best investments.

Cost effectiveness analysis begins with a comparison of the costs and outputs of alternative plans to identify the least cost plan for every possible level of output considered. The resulting least cost alternative plans are then compared to identify those that would produce greater levels of output at the same cost, or at a lesser cost, as other alternative plans. Alternative plans identified through this comparison are the cost effective alternative plans. Next, the cost effective alternative plans are compared to identify the most economically efficient alternative plans, that is, the "Best Buy" alternative plans that would produce the "biggest bang for the buck." Finally, the additional costs for the additional amounts of output ("incremental cost") produced by the Best Buy alternative plans are calculated. The results of all the calculations and comparisons of costs and outputs provide a basis for addressing the decision question "Is it worth it?" i.e., are the additional outputs worth the costs incurred to achieve them?

In practice, USACE ecosystem restoration studies typically measure the ecosystem benefits of alternative plans in terms of physical dimensions (number of acres of wetlands, for example), or population counts (number of wading birds, for example), or various habitat-based scores ("habitat units" based on the U.S. Fish & Wildlife Service's *Habitat Evaluation Procedures*, or "HEP", or Wetland Value Assessment "WVA" for example).

The performance measures evaluated and selected by the PDT for this project were habitat units (HUs). Habitat units are the metric that best integrate information regarding the quality and quantity of improved habitat for various representative species and/ or communities within the project benefit area.

Habitat unit (HU) output, or the performance of each of four alternative plans in the final array, was evaluated by the U.S. Fish & Wildlife Service based on the Wetland Value Assessment (WVA); the WVA methodology and resulting HU determinations are described in detail in **Section 3.5 of the main report**. The WVA is an accepted method used to determine HUs for restoration projects in coastal Louisiana. Preliminary detailed total costs were also developed for each of the final four alternatives and considered construction costs, engineering and design, supervision and administration, and real estate costs. Details for preliminary cost development are also presented in Section 3.5 of the main report and in Appendix L. Annualized costs were calculated, and a comparison of average annual cost to HU output for each of the four alternatives in the final array was conducted. Cost and HU output comparisons are summarized and illustrated in Figure K-1 below:

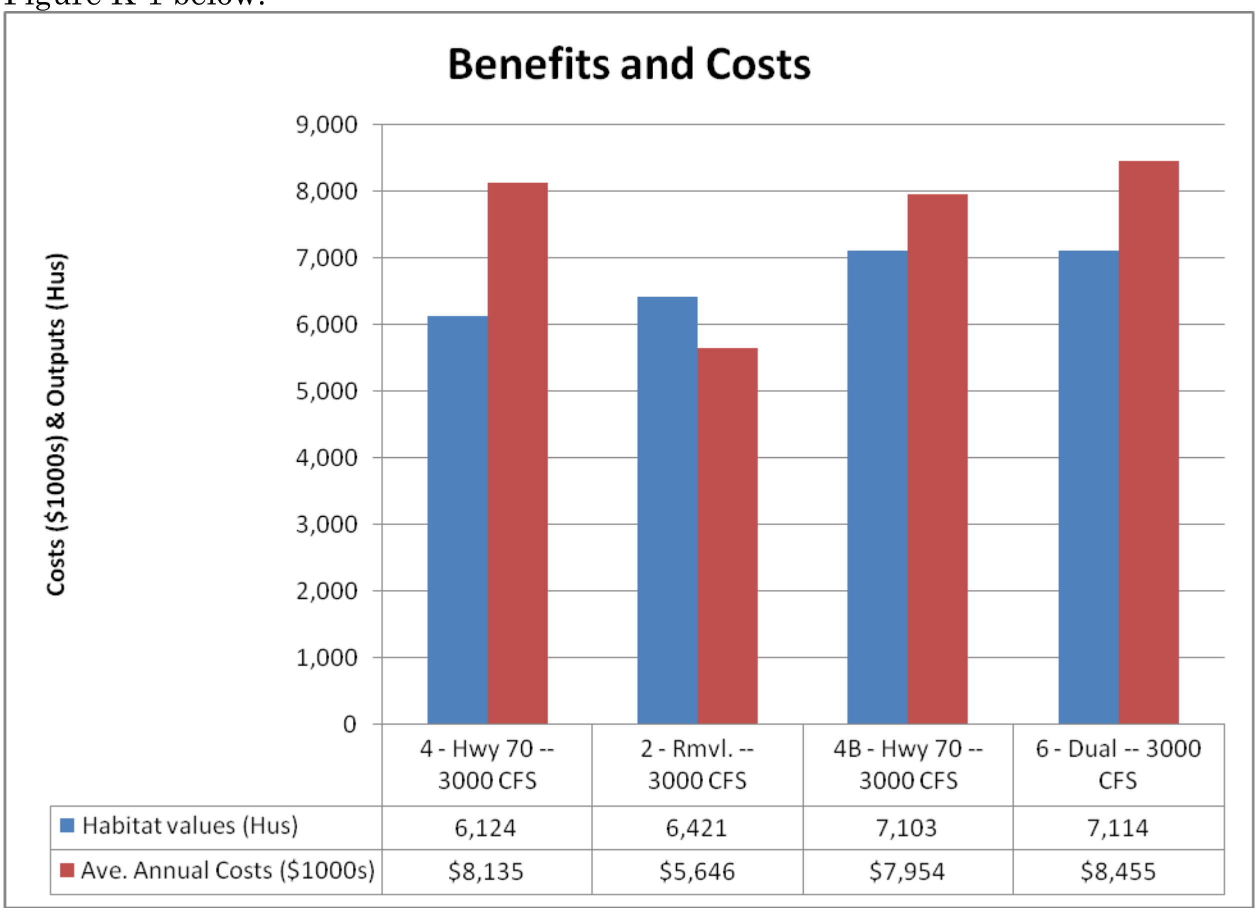


Figure K-1. Benefits and costs of the final array[1,2]

[1] All costs are in October 2009 prices

The cost-effectiveness of the alternatives is presented in table K-1 and figure K-2. The analysis indicates that Alternative 4 has lower benefits and higher costs than alternative 2 and is not a cost-effective solution. Therefore Alternative 4 will not be considered further. Alternates 2, 4B, and 6 are all cost-effective and are also best buy alternatives and will be considered further through an incremental cost analysis. However, it should be pointed out that Alternative 6 produces significant AAHUs at an extreme cost per habitat unit when compared to the other two alternatives. This is explained further in the following paragraphs.

	Alternative 4	**Alternative 2**	**Alternative 4B**	**Alternative 6**
	South Bridge, 3000 cfs	**Romeville, 3000 cfs**	**South Bridge (split flow)**	**Dual Diversion**
HUs	6124	6421	7103	7114
Cost ($1,000s)	$8,135	$5,646	$7,954	$8,455
Cost-effective	No	Yes	Yes	No
Best Buy	No	Yes	Yes	Yes

Table K-1. Cost-effectiveness analysis of the final array[3,4]

[2] First costs were annualized using a discount rate of 4-3/8% over a 50-year period
[3] All costs are in October 2009 prices
[4] First costs were annualized using a discount rate of 4-3/8% over a 50-year period

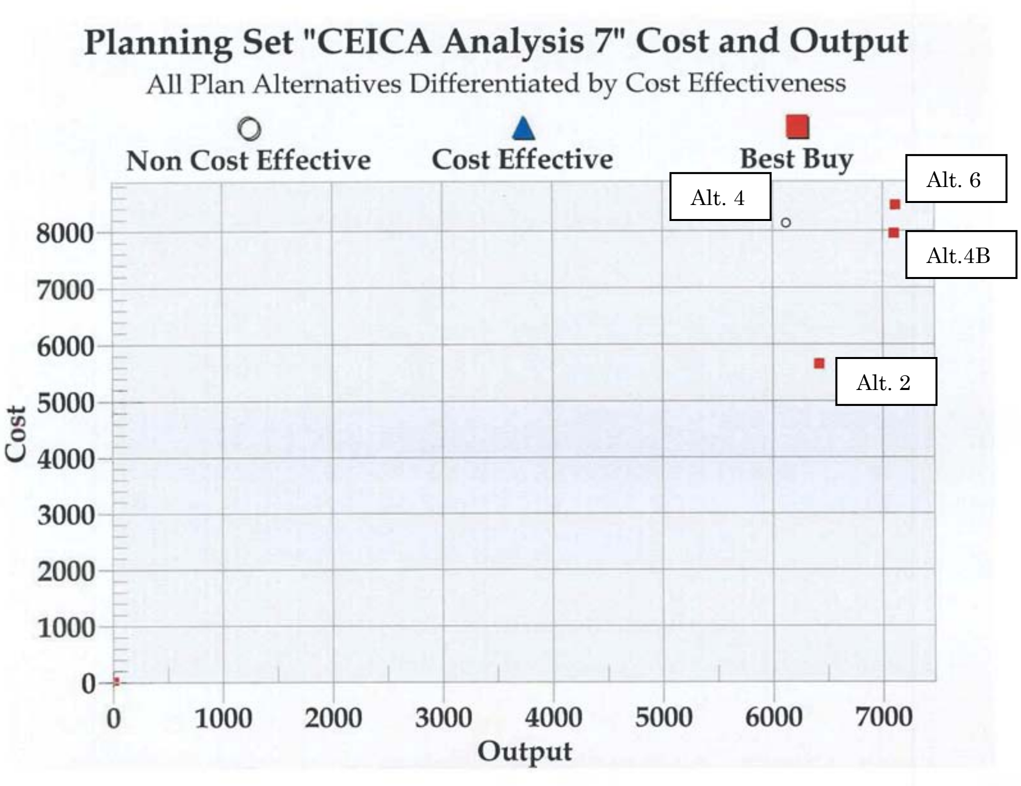


Figure K-2. Cost-effectiveness of analysis of the final array

Table K-2 and Figure K-3 below summarize the incremental analysis of the cost-effective alternative plans. Of the tree alternatives, Alternative 2 provides the lowest increase in average annual habitat units when compared to the future without-project condition. By delivering 3000 cfs of freshwater, sediments, and nutrients to the Southeast portion of the Maurepas Swamp drainage in the swamp would improve, there would be more dry periods to promote seed germination and sapling survival, and there would be a decrease in persistent inundation, short circuiting drainage patterns, and ponding and stagnation. Nutrients and sediment diverted and pulsed to the swamp will be more widely distributed in the swamp and that would result in increased nutrient assimilation and vegetative productivity as well as improved water quality in Blind River. Implementation of Alternative 2 would reverse the existing trend of swamp deterioration. The sediment diverted to the swamp and the increased productivity will increase accretion (soil building) and offset subsidence and sea level rise and reduce the decrease in the ground surface elevation in the swamp and reduce persistent inundation. Because of this strong contribution to the planning objectives, the $5,646,000 annual cost for Alternative 2 to produce 6421 average annual habitat units at a per unit cost of $880 is considered justified. The increment from Plan 2 to Plan 4b produces an additional 682 average annual habitat units at a cost of $2,309,000 or $3,384 per average annual habitat unit and the increment from Plan 4b to Plan 6 produces an additional 11 habitat units at a cost of $501,000 or $45,530 per average annual habitat unit. Alternative 2 provides over 90 percent of the benefits for about 67% of the cost of Alternative 6, the cost per AAHU is much lower for Alternative 2 that for the other two alternatives and the incremental cost per habitat unit in going from Alternative 2 to Alternative 4B and/or Alternative 6 is quite high. Due to the high incremental cost per habitat unit for the increments above Alternative 2 these increments are not considered to be justified. Alternative 2 is the alternative that reasonably maximizes ecosystem restoration benefits compared to costs and is designated as the National Ecosystem Restoration Plan.

	Alt. 2 – Romeville	**Alt. 4B 0 South Bridge (Split flows)**	**Alt. 6 – Dual Diversion**
AAHUs	6,421	7,103	7,114
AA Cost ($1,000s)	$5,646	$7,954	$8,455
			Yes
Δ AAHU	6,421	682	11
Δ AACost ($1000s)	$5,646	$2,309	$501
Δ AA Cost/AAHUs ($1000s)	$0.88	$3.39	$45.53

Table K-2. Incremental cost analysis of the final array[5,6]

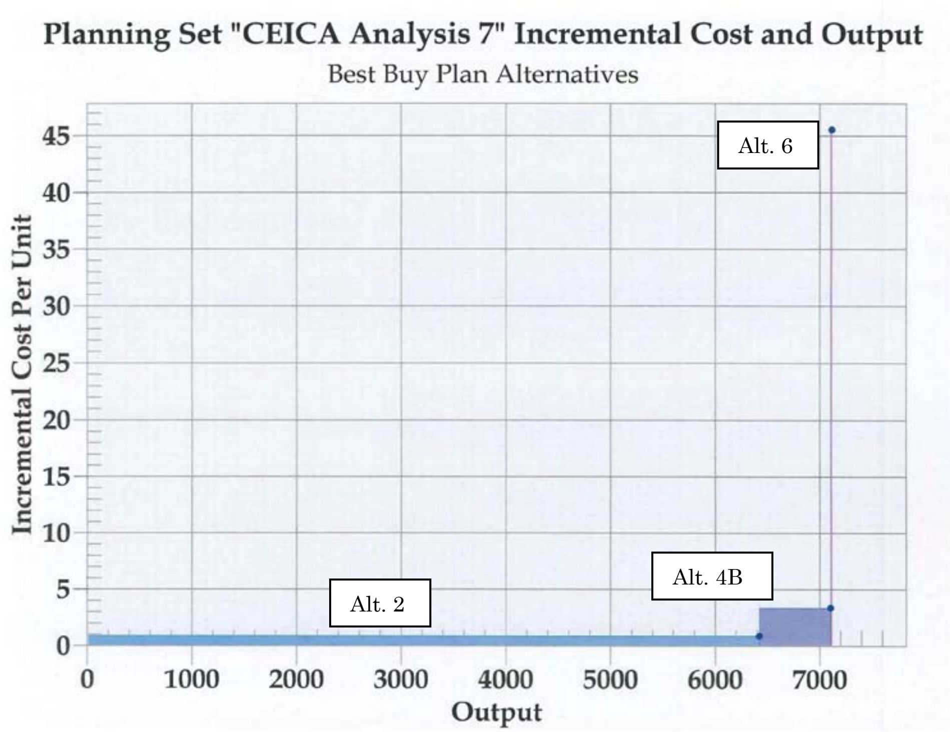


Figure K-3. Incremental cost analysis of the final array[7,8]

[5] All costs are in October 2009 prices
[6] First costs were annualized using a discount rate of 4-3/8% over a 50-year period

It should also be noted that benefits in addition to creating HUs include improved recreational value. The existing recreation benefits within the project area were estimated using the Unit Day Value (UDV) method, employed in compliance with the USACE Economics Guidance Memorandum, 09-03.

The natural and built resources of the project site were analyzed and assigned points based on five criteria:

- Recreation Experience: Based on the number of activities available at the site and whether they are unique to the site;
- Availability of Opportunity: Based on how many other areas for fishing and hunting are within 30 minutes, 45 minutes, 1 hour and 2 hours travel time of the study site;
- Carrying Capacity: Based on a rating of the facilities on site: minimum, basic, adequate, optimum and ultimate;
- Accessibility: Based on a rating of the accessibility to the site and within the site: limited; fair and good; and
- Environmental: Based on aesthetic factors such as geology, topography, water and vegetation, air pollution, water pollution, poor climate, and adjacent views.

This same method was used to determine UDVs for each of the four alternatives.

The following table demonstrates the guidelines for assigning points within the UDV method.

Guidelines for assigning points within the Unit Day Value Method.

Criteria	**Judgment Factors**				
Recreation experience Total Points: 30	Two general activities	Several general activities	Several general activities; one high quality value activity	Several general activities; more than one high quality high activity	Numerous high quality value activities; some general activities
Point Value: 13	0-4	5-10	11-16	17-23	24-30
Availability of opportunity Total Points 18	Several within one hour travel time; a few within 30 minutes travel time	Several within one hour travel time; none within 30 minutes travel time	One or two within one hour travel time; none within 45 minutes travel time	None within one hour travel time	None within 2 hour travel time

[7] All costs are in October 2009 prices
[8] First costs were annualized using a discount rate of 4-3/8% over a 50-year period

Point Value: 6	0-3	4-6	7-10	11-14	15-18
Carrying capacity Total Points 14	Minimum facility for development for public health and safety	Basic facility to conduct activity(ies)	Adequate facilities to conduct without deterioration of the resource of activity experience	Optimum facilities to conduct activity at site potential	Ultimate facilities to achieve intent of selected alternative
Point Value: 8	0-2	3-5	6-8	9-11	12-14
Accessibility Total Points: 18	Limited access by any means to site or within site	Fair access, poor quality roads to site; limited access within site	Fair access, fair road to site; fair access, good roads within site	Good access to good roads to site; fair access, good roads within site	Good access, high standard road to site; good access within site
Point Value: 11	0-3	4-6	7-10	11-14	15-18
Environmental Total Points: 20	Low aesthetic factors that significantly lower quality	Average aesthetic quality; factors exist that lower quality to minor degree	Above average aesthetic quality; any limiting factors can be reasonably justified	High aesthetic quality; no factors exist that lower quality	Outstanding aesthetic quality; no factors exist that lower quality
Point Value: 8	0-2	3-6	7-10	11-15	16-20

The dollar values determined for the project area was based on the unit day values (UDVs) calculated for each alternative; the UDVs were the same for Alternative 2 and Alternative 4, both of which were assigned a UDV value of 37. The dollar values calculated for Alternative 6 and Alternative 4B were also the same, with an assigned UDV value of 41. The associated annual dollar revenues based on UDVs were $35,129 for Alternatives 2 and 4A, and $36,406 for Alternatives 6 and 4B. While these UDVs can be subjective based on limited available user data, it can be said that a positive increase in opportunities for recreation would be provided with the primary recreation activities that include fishing, hunting, boating, and bird watching. These are wildlife-dependent recreation activities that would at the very least be maintained with either of the alternatives and with respective increase in HUs. Without implementation of one of these alternatives, swamp degradation would eventually impact recreational use adversely. In summary, recreational benefits are realized with each of the alternatives; however, the recreational benefits were not used to discriminate between alternatives as were HUs. For additional detailed information on recreational use and UDV evaluation, refer to Section 5.15 in the main report.

Wetland Value Assessment Project Information Sheet
Comparing Final Array of Alternatives

September 8, 2010

Prepared for:
U.S. Army Corps of Engineers
and
Louisiana Department of Natural Resources

Prepared by
U.S. Fish and Wildlife Service

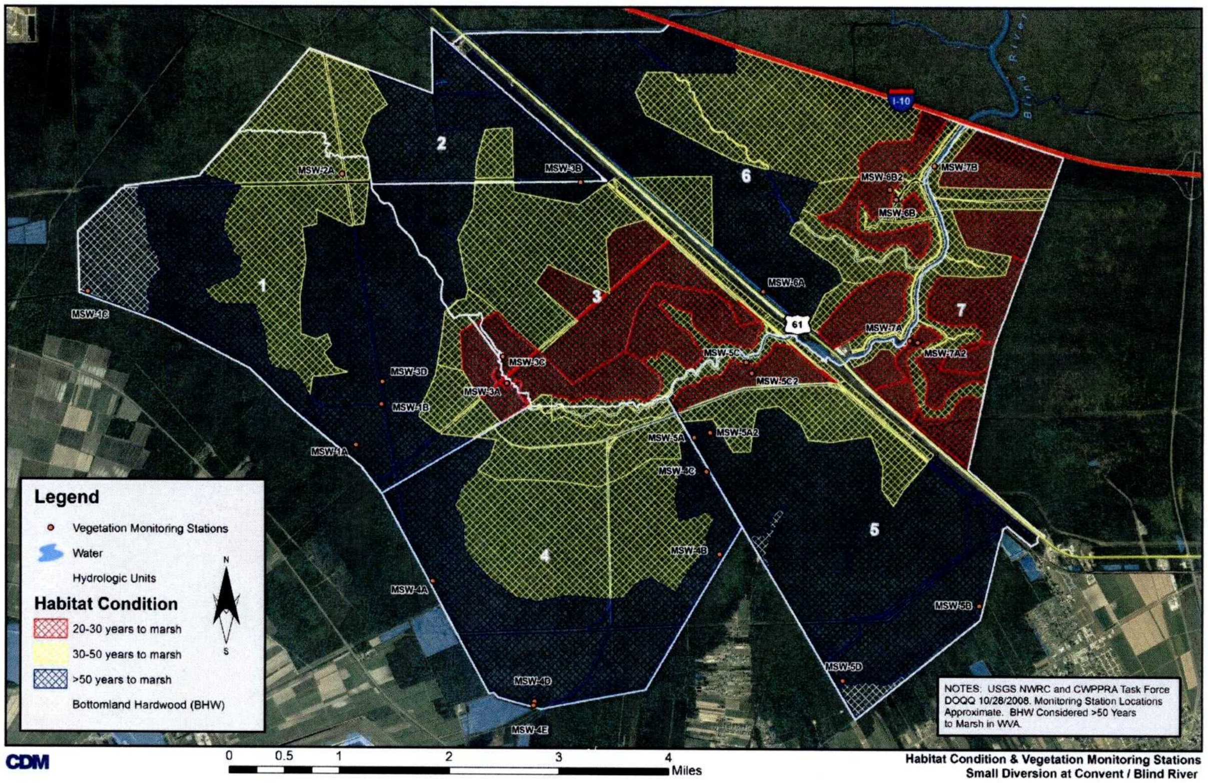
Project Name: Louisiana Coastal Area – Small Freshwater Diversion at Convent/Blind River

Project Type(s): Freshwater diversion and hydrologic restoration within swamp habitat

Project Area: The project area is within the Maurepas Swamp west of Lake Pontchartrain and predominantly within St. James Parish with a small portion of the northern extent in Ascension Parish, LA (LCA Sub-province 1). The U.S. Interstate 10 corridor defines the northern boundary with the remaining project boundary being defined by several parish drainage canals. The cities and towns that flank the Mississippi River extend further to the southeast, south, and southwest of the project area. The Maurepas swamp is one of the largest remaining tracts of coastal fresh water swamp in Louisiana. Including Lake Maurepas, the Maurepas Swamp area comprises an area that totals approximately 232,928 acres, most of which is swamp with some isolated areas of bottomland hardwood forest and fresh marsh. The Blind River flows from St. James Parish, through Ascension and Saint John the Baptist Parishes, and then discharges into Lake Maurepas. Much of the project area is situated within the Louisiana Department of Wildlife and Fisheries, Maurepas Swamp Wildlife Management Area.

For planning and hydrologic modeling purposes, the project area was divided into three benefit areas (i.e., benefit area 1, 2, and 3) and within those benefit areas are several sub-basins. Benefit areas and sub-basins are defined by topographic high areas (e.g., spoil banks, relict railroad grade, road embankments) or channels, natural or artificial (e.g., rivers, canals, channels, intermittent tributaries) that would serve to impede or intercept hydrologic flows. The area south and southwest of Blind River is defined as benefit area 1 (i.e., 100 sub-basin series). The area north of Blind River and west of U.S. Highway 61 is benefit area 2 (i.e., 200 sub-basin series), and the area north of Blind River and east of U.S. Highway 61 is benefit area 3 (i.e., 300 sub-basin series). For the purposes of the Wetland Value Assessment (WVA) the sub-basins are grouped into hydrologic units (Figure 1), or units that are considered to be under the same hydrological influences.

Figure 1. Hydrologic Units and Habitat Condition Classes for the Convent/Blind River Freshwater Diversion.



Problem: Since the construction of the Mississippi River flood control levees, the Maurepas Swamps have been virtually cut off from any freshwater, sediment, or nutrient input. Thus, the only soil building has come from organic production within the wetlands. Preliminary evaluations suggest that productivity in the stressed Maurepas Swamps may be substantially depressed compared to normal conditions. With minimal soil building and moderately high subsidence, there has been a net lowering of ground surface elevation, leading to a doubling in flood frequency over the last four decades (Thomson 2000), so that now the swamps are either permanently or semi-permanently flooded. With minimal ability to drain and persistent flooding, the typical seasonal drying of the swamp does not usually occur. Cypress and tupelo trees are able to grow in flooded conditions. Apparently, tupelo trees are more competitive in permanently flooded conditions (Conner et al. 1981, Dicke and Tolliver 1990), a condition that may explain the recent dominance of tupelo in the south Maurepas swamps and the project area. However, a high mortality of tupelo trees also has occurred in the last few years within the Maurepas study area possibly as a result of salinity spikes. Neither cypress nor tupelo seeds can germinate when flooded. Seeds of both species remain viable when submerged in water and can germinate readily when floodwaters recede (Kozlowski 1984). The potential for re-establishment seems to be hindered by the relatively low numbers of viable seeds observed in swamp seed banks, as well as by flooding (Conner et al. 1986). Storm surge and accompanying episodic saltwater intrusion has also exacerbated degradation resulting in lack of tree regeneration and substrate accretion.

It is expected that without restoration, the factors and processes that are contributing to stress and deterioration of the south Maurepas Swamps will continue and result in loss of the swamp, with succession to open water (Shaffer et al. 2001). The Coast 2050 Report estimated wetland loss rates for the Amite/Blind Rivers mapping unit for 1974-90 to be 0.80 percent per year for swamp and fresh marsh habitat combined. Based on these rates, approximately 50 percent of swamp and 1.2 percent of fresh marsh will be converted to open water within 60 years. Nearly 69,500 acres of swamp (50% of the 1990 total) and 40 acres of marsh are projected to be lost by 2050 (LCWCRTF 1999).

U.S. Army Corps of Engineers guidance requires project performance to be assessed using three sea level change scenarios, a low estimate, an intermediate estimate, and a high estimate. Using the rate of 9.20 mm/yr, a starting year of 2011, and a 50-year project life, a sea-level rise of 1.5 feet is projected for the year 2061 (Table 1). A historic rate considered to be representative of the project area is calculated using the West End at Lake Pontchartrain gauge (85625). The rate of 9.20 mm/yr is considered to include both the eustatic and local subsidence contributions to the estimated total sea-level rise.

In order to estimate the local subsidence rate for the project area, the global eustatic rate (1.7 mm/yr) is subtracted from the local sea level rate or:

Local subsidence rate = 9.20 mm/yr – 1.7 mm/yr = 7.50 mm/yr.

Table 1. Summary of total sea level rise (i.e., considers subsidence) for each scenario.

Project year	Scenario 1, Low Rate (feet)	Scenario 2, Intermediate Rate (feet)	Scenario 3, High Rate (feet)
2011	0.0	0.0	0.0
2016	0.2	0.2	0.2
2021	0.3	0.3	0.5
2026	0.5	0.5	0.8
2031	0.6	0.7	1.1
2036	0.8	0.9	1.4
2041	0.9	1.1	1.7
2046	1.1	1.3	2.0
2051	1.2	1.5	2.4
2056	1.4	1.7	2.8
2061	1.5	1.9	3.2

The estimate for the local subsidence rate is used in conjunction with estimates for the eustatic rates using NRC curves I and III to determine the intermediate and high projections of sea level rise for the project area. The following formula is used to estimate the total rise in eustatic sea level for the project life for the intermediate and high rate scenarios of sea level rise:

$$E(t_2) - E(t_1) = 0.0017(t_2 - t_1) + b(t_2^2 - t_1^2)$$

where:

b is the acceleration factor related to NRC curves I and III or 2.36E-5 and 1.005E-4 respectively,
t_1 is the time in years between the project's construction date and 1986,
and
t_2 is the time between a future date at which one wants an estimate for sea-level rise and 1986.

These eustatic estimates are added to the local subsidence estimate to get the total sea-level rise for the intermediate and high rate scenarios. For the purposes of hydrologic modeling for this project the intermediate rate was used.

Project Goal: Reverse the trend of degradation in the southeast portion of the Maurepas Swamp, so as to contribute toward achieving and sustaining a coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana and thus contribute to the well-being of the Nation.

Objectives:

1. Promote water distribution in the swamp which, in turn, will increase freshwater throughput and nutrient input thereby increasing swamp productivity and wetland assimilation.
2. Facilitate swamp building: by increasing swamp productivity and sediment input by up to 1000 g/sq meter per year to decrease the annual subsidence rate (or accretion deficit).
3. Establish hydroperiod fluctuation in the swamp to improve bald cypress and tupelo productivity and seed germination and survival. This is proposed by decreasing flood duration for high flood events within the swamp, increasing the length of dry periods in the swamp, and increasing the number of cypress and tupelo saplings per acre from existing conditions.
4. Improve fish and wildlife habitat in the swamp and in Blind River by increasing sediment and nutrient input, freshwater flow, and dry periods which will contribute to an increase in swamp productivity. This will result in a diversity of stand structure components (tree species composition and a combination of herbaceous, midstory and overstory vegetation), thus improving fish and wildlife habitat needs. Direct project related benefits fish and wildlife resources (i.e., swamp habitat) are quantified by acreage and habitat quality using the Wetland Value Assessment, and are defined by average annual habitat units or AAHUs.

Alternatives:

No Action Alternative (Future without Project Conditions)
Alternative - 2 – 3,000 cfs Diversion at Romeville (Gated Culvert System)
Alternative - 4 – 3,000 cfs Diversion at South Bridge (Gated Culvert System)
Alternative - 4B – 3,000 cfs Diversion at South Bridge with split flows (Gated Culvert System)
Alternative - 6 – Two 1,500 cfs (3,000 cfs combined) Diversions at Romeville and South Bridge (Siphons)

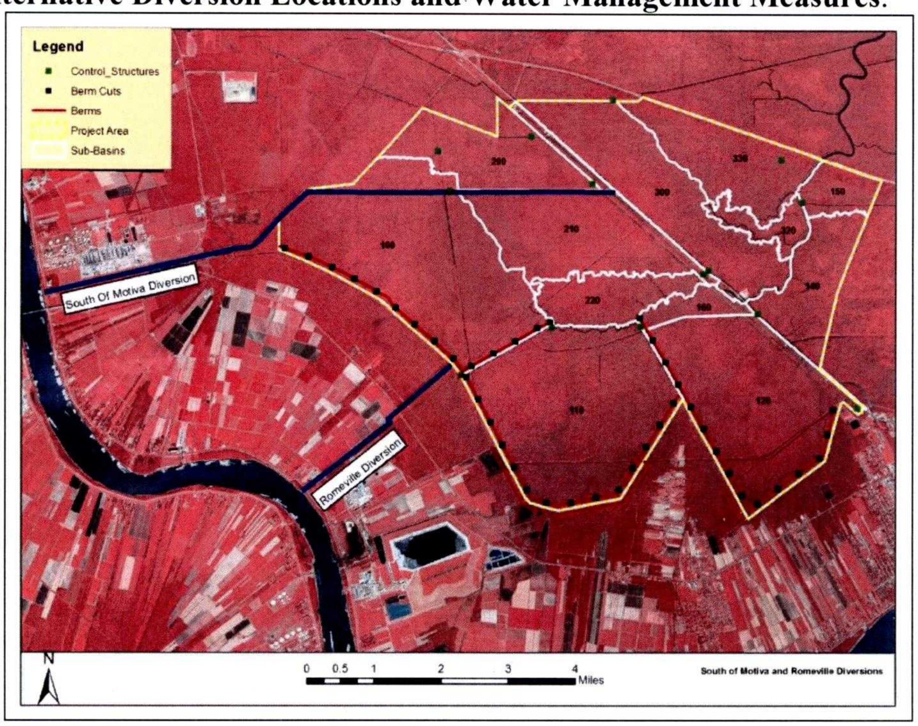
Alternative 2 – 3,000 cfs Diversion at Romeville
This alternative adds a gated culvert system and transfer canal along the Romeville alignment, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp and adds 3 new culverts under U.S. Highway 61.

Alternative 4 – 3,000 cfs Diversion at South Bridge
This alternative adds a gated culvert system and transfer canal along the "Cox" alignment located south of the U.S. Highway 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp and adds 3 new culverts under U.S. Highway 61.

Alternative 4B – 3,000 Split Diversion at South Bridge
This alternative adds a gated culvert system and transfer canal along the "Cox" alignment located south of the U.S. Highway 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to six control structures at strategic locations in the swamp, and adds 3 new culverts under U.S. Highway 61. This alternative includes a modification to the distribution of the diversion provided by Alternative 4 by sending 1,500 cfs to the south through the St. James Parish Canal in order to achieve a similar distribution to Alternative 6.

Alternative 6 – 3,000 cfs Dual Diversion at Romeville and South Bridge
This alternative adds a gated culvert system- and a transfer canal- along the Romeville alignment and a gated culvert system- and transfer canals along the "Cox" alignment located south of the U.S. Highway 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp and adds 3 new culverts under U.S. Highway 61.

Figure 2. Alternative Diversion Locations and Water Management Measures.



HEC-RAS and HEC-HMS Modeling

The Hydrologic Engineering Centers - River Analysis System (HEC-RAS) is designed to perform one-dimensional hydraulic calculations for a full network of natural and constructed channels to determine hydrologic flow simulation, sediment transport, and water quality analysis. The HEC - Hydrologic Modeling System (HEC-HMS) is designed to simulate the precipitation-runoff processes of dendritic watershed systems. It is designed to be applicable in a wide range of geographic areas for solving the widest possible range of problems including large river basin water supply and flood hydrology, and small urban or natural watershed runoff. Hydrographs produced by the program are used directly or in conjunction with other software for studies of water availability, urban drainage, flow forecasting, future urbanization impact, flood damage reduction, floodplain regulation, and systems operation.

Preliminary HEC-RAS and HMS modeling has been conducted by the contractor, CDM. The HEC-RAS was simulated over an average year, 2003 being the representative average water year. HEC-HMS used a 15-year simulation period from 1989-2004. One of the major constraints with directing freshwater into the study area is the efficiency of the Blind River to remove water from the system greatly reducing the exchange and widespread distribution of water throughout the system. A diversion directed to the southern portion of the project area and within benefit area 1 has limited influence on the other benefit areas because Blind River acts as a hydrologic barrier, and vice versa.

Modeling for this project, as well as the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) River Reintroduction into Maurepas Swamp Project (PO-29) has revealed that the Maurepas Swamps are often lower in elevation than Lake Maurepas. This results in swamp water levels and dry-out periods being dependent on the water levels in Lake Maurepas, and essentially, flooding is semi-permanent with low to very low water exchange and throughput (EPA 2001).

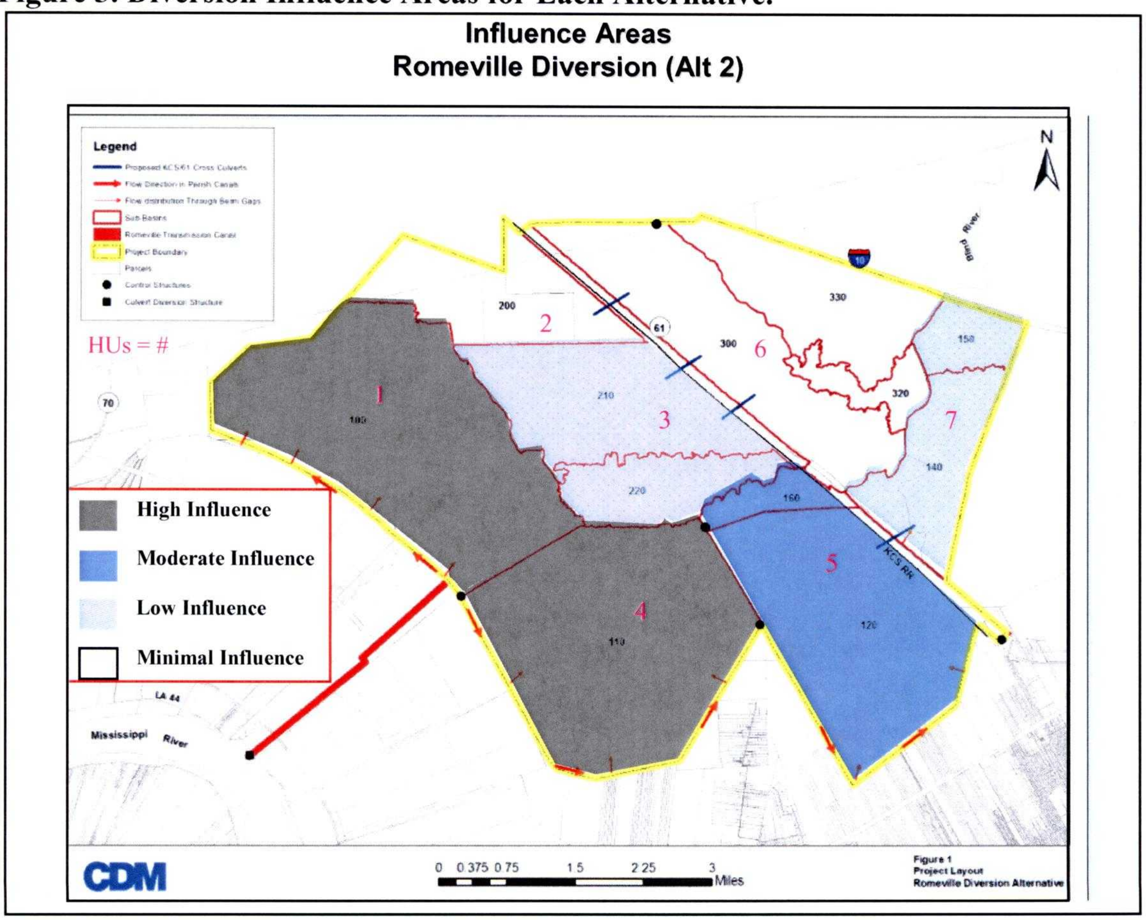
Investigations into diversion capacity determined that changes related to swamp productivity within the system require a minimum diversion flow of 1,000 cubic feet per second (cfs), and 1,500 cfs is required to prevent backflow from Lake Maurepas into the Blind River and swamps. Modeling results also indicate that hydrologic benefits within the system (described by modeling reports as average water depth, water depth exceedence, frequency above Lake Maurepas, and average annual freshwater inflow) either stabilize or do not see incremental benefits as a diversion flow magnitude exceeds 3,000 cfs. Another constraint affecting diversion operations is the availability of water from the Mississippi River. To meet design flow rates Mississippi River water elevations need to be at a minimum of 11 feet; the Mississippi River is at or above that elevation 60 % of the year. It was determined that a 3,000 cfs diversion would be required to provide enough water when available to offset unavailability during low flow periods in the Mississippi River.

Table 2. Diversion Influence for Each Alternative by Habitat Condition Class (construction impacts considered).

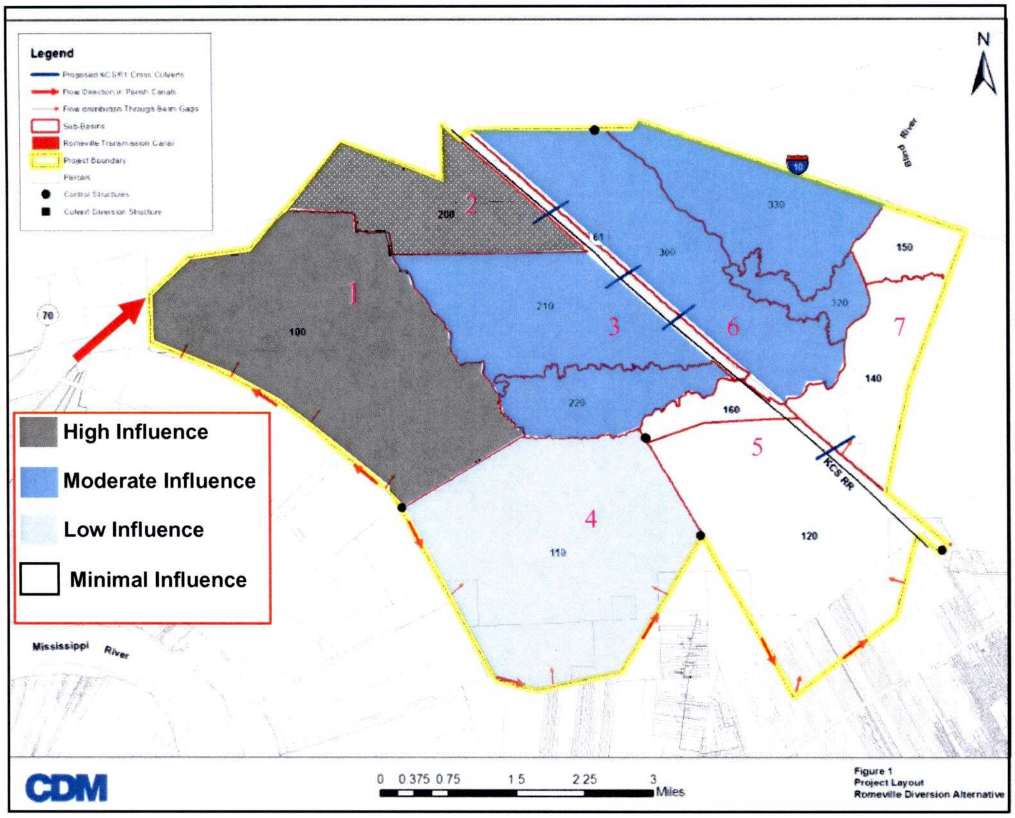
	Degree of Diversion Influence	20-30 Years to Marsh[1]		30-50 Years to Marsh		>50 Years to Marsh	
		HUs[2]	acres	HUs	acres	HUs	acres
Alternative 2 (Romeville)	High	1,4	169	1,4	3364	1,4	4555
	Moderate	5	204	5	604	5	2607
	Low	3,7	2397	3,7	1669	3	469
	No /Minimal	2,6	525	2,6	2297	2,6	2509
Alternative 4 (Hwy 70 Bridge)	High	1,2	169	1,2	1827	1,2	3550
	Moderate	6,3	1837	6,3	2972	6,3	2070
	Low	4	0	4	2013	4	1799
	No /Minimal	5,7	1289	5,7	1073	5	2607
Alternative 6 (Total Div)	High	1,2,4	169	1,2,4	3848	1,2,4	5361
	Moderate	3,5,6	2041	3,5,6	3579	3,5,6	4691
	Low	7	1085	7	469	--	0
	No /Minimal	--	0	--	0	--	0

[1]Habitat Classes as defined under Habitat Assessment Method [2]Hydrologic Units (see Figure 1)

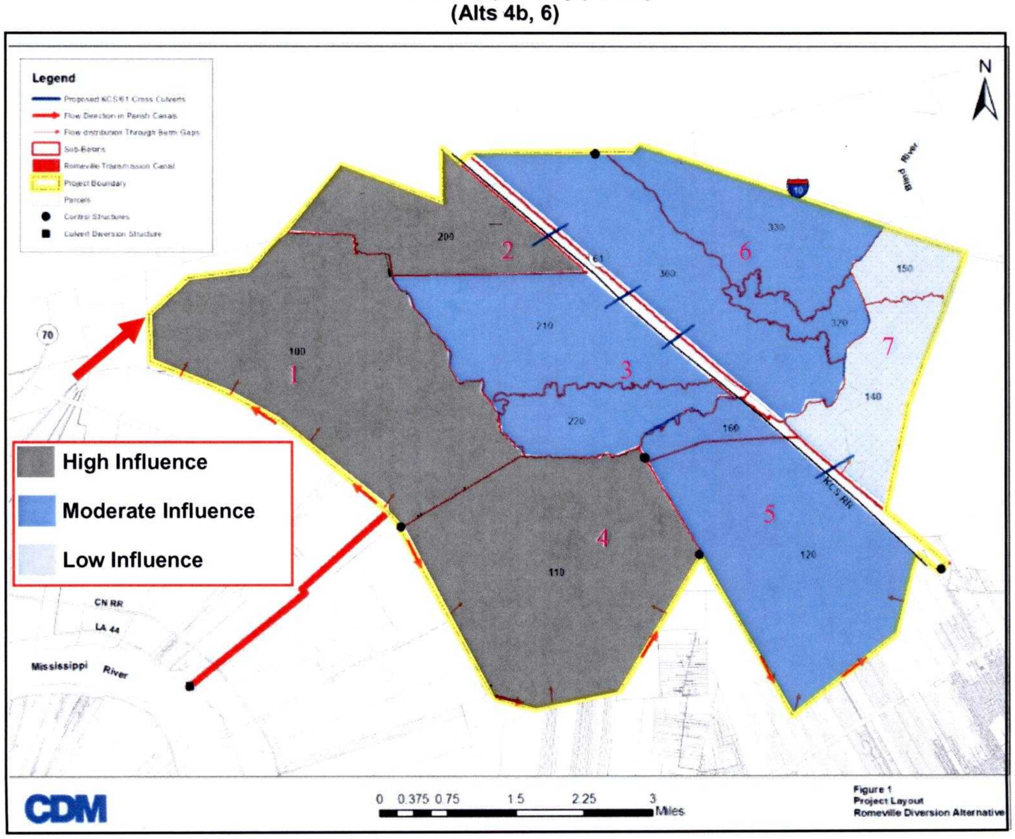
Figure 3. Diversion Influence Areas for Each Alternative.



Influence Areas
Sunshine Bridge Diversion (Alt 4)
(Original – No split southward)



Influence Areas
2 Diversions (or entry points)
(Alts 4b, 6)



Habitat Assessment Method

The procedure for evaluating project benefits on swamp habitats, the WVA swamp model, uses a series of variables that are intended to capture the most important conditions and functional values of a swamp. Values for these variables are derived for existing conditions and are estimated for conditions projected into the future if no restoration efforts are applied (i.e., future-without-project), and for conditions projected into the future if the proposed diversion project is implemented (i.e., future-with-project), providing an index of quality or habitat suitability of the swamp for the given time period. The habitat suitability index (HSI) is combined with the acres of swamp to get a number that is referred to as "habitat units". Expected project benefits are estimated as the difference in habitat units between the future-with-project (FWP) and future-without project (FWOP). To allow comparison of WVA benefits to costs for overall project evaluation, total benefits are averaged over a 50-year period, with the result reported as Average Annual Habitat Units (AAHUs).

Existing and Future without Project Conditions

To characterize existing conditions CDM established 28 vegetation monitoring stations throughout and adjacent to the project area during four separate field trips from March through September of 2009. A trend apparent to Shaffer et al. (2003) in the Maurepas swamp was increasing habitat degradation with proximity to Lake Maurepas. Therefore, two vegetation stations were positioned outside of the project area, closer to Lake Maurepas, to reference and track the progression of more degraded habitat conditions and to suggest potential future conditions for the project area under the no-action alternative. Data was collected on hydrology, wildlife, vegetation, community structure, composition, and health (per WVA methodology) at all vegetation monitoring stations. Soils data were also recorded at most monitoring stations.

On October 7, 2009, the team met with Dr. Gary Shaffer [Southeastern Louisiana University, (SELU)] and Bernard Wood (Research Assistant, SELU) to inspect the project area and compare habitat quality and swamp degradation to other areas of the Maurepas swamp that they are currently studying. Based on observations made during that field trip, data collected during previous field trips, knowledge of the habitat condition of the entire Maurepas swamp by Dr. Shaffer and Mr. Wood, and aerial photography, a habitat condition class map was then developed to categorize the different areas of swamp habitat (levels of degradation) according to classifications used by Dr. Shaffer at other areas within the Maurepas swamp (Figure 1). The intersection of diversion influence and habitat condition class defines the different areas that would require a separate WVA for each alternative (32 WVAs, not including WVAs for construction related impacts).

Three levels of habitat condition class were defined within the project area: 20-30 years-to-marsh, 30-50 years-to-marsh, and greater than 50-years-to-marsh. Data obtain from representative vegetation monitoring stations were then summarized according to each habitat class to get a representative value for each habitat class for the WVA. Because we can not accurately determine when these swamps will convert to marsh or open water, these habitat condition classifications are meant to define the level or rate of degradation and not necessarily the target years that the habitats will be removed from the habitat assessment or converted to marsh habitat.

Variable V_1 – Stand Structure (Table 3)

Most swamp tree species do not produce hard mast; consequently, wildlife foods predominantly consist of soft mast, other edible seeds, invertebrates, and vegetation. Because most swamp tree species produce some soft mast or other edible seeds, the actual tree species composition is not usually a limiting factor. More limiting is the presence of stand structure to provide resting, foraging, breeding, nesting, and nursery habitat and the medium for invertebrate production. This medium can exist as herbaceous vegetation, scrub-shrub/midstory cover, or overstory canopy and preferably as a combination of all three. This variable assigns the lowest suitability to sites with a limited amount of all three stand structure components, the highest suitability to sites with a significant amount of all three stand structure components, and mid-range suitability to various combinations when one or two stand structure components are present.

Conversion of forested wetlands to open water or marsh within the project area has not been observed during field investigations. Minimal windthrow of canopy trees was observed; however, light to moderate crown damage and windthrow of midstory trees was evident and likely occurred from recent hurricanes and tropical storm events. Similar damage was observed throughout Maurepas swamp, with data suggesting that midstory windthrow was inversely related to canopy density (Effler et al. 2007, Shaffer personal communication per DEIS). Decreasing canopy is also indicative of stress due to prolonged inundation and/or stagnant water conditions. Decreased vigor may increase susceptibility of trees to tropical storm damage.

Plant diversity in baldcypress-tupelo swamps is typically low due to low light penetration into the understory and the extended hydroperiod, which limit the establishment and survival of understory vegetation. Baldcypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*) are common codominant canopy species in this habitat, with swamp red maple (*Acer rubrum var. drummondii*) predominant and green ash (*Fraxinus pennsylvanica*) codominant, in the midstory and understory strata. Common herbaceous species include arrow arum (*Peltandra virginica*), pennywort (*Hydrocotyle* spp.), smartweed (*Polygonum punctatum*), and lizard's tail (*Saururus cernuus*). Salvinia (*Salvinia* spp.), a non-native invasive aquatic fern, is prolific in many areas. Savanna panicum (*Phanopyrum gymnocarpon),* thought to be an indicator of flow and nutrients, was also observed in the higher quality swamps. A complete list of species and existing habitat conditions at each vegetation monitoring station is provided in CDM's October 2, 2009, "Existing Environmental Condition of Project Area" Memorandum.

<u>Stand Structure for 20-30 Years-to-Marsh</u>

Existing –The 20-30 years-to-marsh habitat class is characterized by having 23 percent canopy cover, 33 percent midstory cover, and 80 percent herbaceous or ground cover (Class 1). Of the overstory canopy cover, 81 percent is tupelo and other species, and the remaining 18 percent is cypress, with some monitoring sites being comprised of 100 percent tupelo. While basal area averages 113.85 ft^2/ac (moderately dense), one monitoring site has a basal area of 34.52 ft^2/ac

which is considered open, and one site is 64.43 ft^2/ac which is considered to be moderately open. One aspect of stand structure that is not reflected in the data is crown damage or loss of tree tops. While this is localized within the project area it is expected to be a common characteristic in the future as conditions deteriorate which is evident in other areas of Maurepas swamp. Crown damage also contributes to the low canopy cover phenomenon in an area were basal area is moderately dense, which consequently results in a high herbaceous cover. Water tolerance by tupelo has allowed the swamp stand structure to be dominated by tupelo in those areas experiencing prolonged flooding. Coupled with occasional salinity spikes, some tupelo dominated areas are experiencing either canopy top-off or complete canopy die off.

FWOP – Conditions are expected to continue to degrade as lack of nutrients, accretion, and freshwater, and an increase in sea level rise, subsidence, episodic salt water intrusion, and storm events all take a toll on the swamp. As a result of these deteriorating conditions, tree mortality, will continue resulting in lower tree density. The canopy will continue to thin, and canopy cover will persist below 33 percent (Table 3).

FWP – Depending on the location of this habitat class within the influence of the diversion, the 20-30 years to marsh is expected to see some benefits as a result of increased sediments, nutrients, and/or freshwater. Increased throughput is also expected to provide benefits as a result of berm cuts and other in-swamp management measures. Consequently, canopy, midstory and herbaceous cover is projected to increase through time. According to FWP modeling of "existing conditions with berm cuts", the project area is expected to be constantly inundated with an average annual water depth throughout the project area of 1.01 feet by target year 20 and 1.75 feet by target year 50. Additional flows from a 3,000 cfs diversion would only increase flood duration. Flood duration was estimated based on hydrologic modeling data presented for "berm cuts without diversions" scenario assuming that the diversion would be operated to mimic the natural historic Mississippi River overbank flooding cycle and would allow for the longest period of drying. With the diversion average, annual water depths are predicted to be in some areas as high as 3.71 feet (Alternative 6, hydrologic sub-basin series 200) and 5.82 feet (Alternative 4, hydrologic sub-basin series 200) during operation of the diversion. Therefore, the stand structure class was reduced at target year 50 (Table 3) to reflect prolonged inundation and a reduced herbaceous and midstory component.

Areas not affected by the diversion should see some benefits of increased hydrologic flow/throughput as a result of the in-swamp management measures. However, these benefits are short term as total sea level rise contributes to these areas returning to a persistent flooding regime by target year 20. It is projected that those areas of 20-30 years-to-marsh habitat class within areas not influenced by the diversion will not have enough time and benefits to regenerate and maintain a healthy forested stand, and, therefore, returns to a Class 1 by target year 30.

Table 3. Future-with and Future-without Project Stand Structure Conditions.

FWOP

Habitat Condition Class	TY0					TY1	TY20				TY30				TY50			
		%O	%M	%H	Class	Class	%O	%M	%H	Class	%O	%M	%H	Class	%O	%M	%H	Class
20-30 yrs. to marsh		23	33	80	**1**	**1**	<33			**1**	<33			**1**	<33			**1**
30-50 yrs. to marsh		38	39	51	**5**	**5**	33<50	<33	<33	**2**	33<50	<33	<33	**2**	<33			**1**
>50 yrs. to marsh		64	46	22	**4**	**4**	50<75	>33	<33	**4**	50<75	>33	<33	**4**	33<50	<33	<33	**2**

FWP

Habitat Condition Class	Level of Influence	TY0				TY1				TY20				TY30				TY50			
		%O	%M	%H	Class	%O	%M	%H	Class	%O	%M	%H	Class	%O	%M	%H	Class	%O	%M	%H	Class
20-30 yrs. to marsh	High Influence	23	33	80	**1**	23	33	80	**1**	33<50	>33	>33	**5**	33<50	>33	>33	**5**	50<75	>33	<33	**4**
	Moderate Influence	23	33	80	**1**	23	33	80	**1**	33<50	>33	>33	**5**	33<50	>33	>33	**5**	50<75	>33	<33	**4**
	Low Influence	23	33	80	**1**	23	33	80	**1**	33<50	>33	>33	**5**	33<50	>33	>33	**5**	33<50	>33	<33	**3**
	No Influence**	23	33	80	**1**	23	33	80	**1**	33<50	>33	>33	**5**	<33			**1**	<33			**1**
30-50 yrs. to marsh	High Influence	38	39	51	**5**	38	39	51	**5**	33<50	>33	>33	**5**	≥50	>33	>33	**6**	≥50	>33	<33	**4**
	Moderate Influence	38	39	51	**5**	38	39	51	**5**	33<50	>33	>33	**5**	≥50	>33	>33	**6**	≥50	>33	<33	**4**
	Low Influence	38	39	51	**5**	38	39	51	**5**	33<50	>33	>33	**5**	33<50	>33	>33	**5**	33<50	>33	<33	**3**
	No Influence**	38	39	51	**5**	38	39	51	**5**	33<50	>33	>33	**5**	33<50	>33	>33	**5**	33<50	>33	<33	**3**
>50 yrs. to marsh	High Influence	64	46	22	**4**	64	46	>33	**6**	≥50	>33	>33	**6**	50<75	>33	<33	**4**	50<75	>33	<33	**4**
	Moderate Influence	64	46	22	**4**	64	46	>33	**6**	≥50	>33	>33	**6**	50<75	>33	<33	**4**	50<75	>33	<33	**4**
	Low Influence	64	46	22	**4**	64	46	>33	**6**	≥50	>33	>33	**6**	50<75	>33	<33	**4**	50<75	>33	<33	**4**
	No Influence**	64	46	22	**4**	64	46	>33	**6**	≥50	>33	>33	**6**	50<75	>33	<33	**4**	50<75	>33	<33	**4**

Stand Structure for 30-50 Years-to-Marsh

Existing – The 30-50 years-to-marsh habitat class is characterized by having 38 percent canopy cover, 39 percent midstory cover, and 51 percent herbaceous or ground cover (Class 5). Of the overstory canopy cover, 85 percent is tupelo and other species and the remaining 15 percent is cypress. Similar to the 20-30 years-to-marsh habitat class, several of the monitoring vegetation sites were 100 percent tupelo. Basal area varied from 133.42 ft^2/ac to 320.79 ft^2/ac, or moderately dense to dense; however, light penetration appears to be suitable enough to support a midstory and herbaceous cover component.

FWOP – Conditions are expected to continue to degrade as lack of nutrients, accretion, and freshwater, and an increase in sea level rise, subsidence, episodic salt water intrusion, and storm events all take a toll on the swamp. As a result of these deteriorating conditions, tree mortality, especially to tupelo, will continue resulting in lower tree density. The canopy will continue to thin, and canopy cover is predicted to drop below 33 percent by target year 50.

FWP – High to moderate influenced areas are predicted to see benefits as a result of increased sediments, nutrients, and/or freshwater. Increased throughput is also expected to provide benefits as a result of berm cuts and other in-swamp management measures. Consequently, canopy, midstory and herbaceous cover is projected to increase through time. As noted above, flood duration is expected to increase as total sea level rise increases, resulting in an eventual decrease in herbaceous cover by target year 50.

Areas that are not affected (no influence areas) or are minimally affected (low influence areas) by the diversion see no increase in stand structure, but rather maintain the existing stand structure until target year 50. Consistent with the previously mentioned hydrologic conditions, stand structure is reduced at target year 50 as a result of a reduced herbaceous component.

Stand Structure for Greater than 50 Years-to-Marsh

Existing – The greater than 50 years-to-marsh habitat class is characterized by having 64 percent canopy cover, 46 percent midstory, and 22 percent herbaceous or ground cover. Of the overstory canopy cover, 44 percent is tupelo and other species and 56 percent is cypress. While the percentage indicates an even distribution, the individual monitoring vegetation sites were dominated by either one or the other species. Basal area and percent canopy cover is considered optimal, or dense, with an average basal area of 256.09 ft^2/ac. The midstory is also considered suitable; however, herbaceous cover is less than optimal likely due to lack of light penetration and nutrients.

FWOP – In comparison to other areas of the Maurepas swamp, this habitat class is considerably healthier and is expected to maintain a Class 4 stand structure through much of the FWOP life. By target year 50 conditions will begin to deteriorate and the canopy begins to thin.

FWP – This habitat class is expected to see benefits as a result of increased sediments, nutrients, and freshwater from the diversion, and due to increased throughput as a result of in-swamp management measures. Consequently, an increase in herbaceous cover is expected within the short term for all areas of influence. However, as canopy closure becomes even more prevalent and as flood duration is expected to increase as total sea level rise increases, a decrease in herbaceous cover by target year 30 is predicted.

Variable V_2 – Stand Maturity (Table 8)

The suitability graph for this variable assumes that snags, cavities, downed treetops, and invertebrate production are present in suitable amounts when the average diameter-at-breast height (DBH) of canopy-dominant and canopy-codominant trees is above 16 inches for baldcypress and above 12 inches for tupelogum and other species. Therefore, stands with those characteristics are considered optimal for this variable (SI = 1.0).

Another important component of this variable is stand density, measured in terms of basal area. A scenario sometimes encountered in mature swamp ecosystems is an overstory consisting of a very few, widely-scattered, mature baldcypress. If stand density was not considered, but only average DBH, then those stands would receive a high SI for this variable without providing many of the important habitat components of a mature swamp ecosystem, specifically an adequate number of trees for nesting, foraging, and other habitat functions. Therefore, the SI for this variable is dependent on average DBH and basal area which is used as a measure of stand density.

Existing Conditions

Seven vegetation monitoring stations were identified that were representative of the 20-30 years-to-marsh class. Basal area averaged 113.85 ft^2/acre. The average DBH measured 11.21 inches for cypress and 13.08 inches for tupelo and other canopy co-dominant species. Even though this is the most degraded habitat, class basal area is still considered to be moderate.

Six vegetation monitoring stations were identified that were representative of the 30-50 years-to-marsh class. Basal area averaged 222.73 ft^2/acre. The average DBH measured 14.71 inches for cypress and 14.20 inches for tupelo and other canopy co-dominant species.

Nine vegetation monitoring stations were identified that were representative of the greater-than 50 years-to-marsh class. Basal area averaged 256.09 ft^2/acre. The average DBH measured 15.76 inches for cypress and 13.97 inches for tupelo and other canopy co-dominant species.

FWOP

Numerous bald cypress and tupelo growth rates have been documented in deep water swamp habitats and are summarized by Visser and Sasser (1995). For FWOP conditions we assumed mean annual growth rates documented by Dr. Shaffer (unpublished) (Table 4) for target years 1-20. These assumptions are similar to what was used for the LCA, Amite River Diversion Channel Modification project. Since subsidence, total sea level rise and associated stresses are expected to continue mean annual growth rates were reduced for target years 20-50.

Increase in basal area was estimated by species and habitat condition class by calculating and projecting the increase in basal area using the predicted growth rates and tree mortality. Percent composition of canopy trees in the FWOP was estimated based on best professional judgment of expected mortality of tupelo among the habitat condition classes taking into consideration

Table 4. Cypress and Tupelo Annual Growth Rates FWOP

	Cypress (inches)	Tupelo et al (inches)
TY 0-20		
20-30 yrs to marsh	0.11	0.08
30-50 yrs to marsh	0.15	0.1
>50 yrs to marsh	0.15	0.1
TY 20-50		
20-30 yrs to marsh	*0.064	**0.073
30-50 yrs to marsh	*0.064	0.08
>50 yrs to marsh	*0.064	0.08

*Visser and Sasser (1995) ** Day (1985) from Visser and Sasser (1995)

assumptions made for the CWPPRA River Reintroduction into Maurepas Swamp Project. The CWPPRA River Reintroduction into Maurepas Swamp Project estimated that 50% of tupelo would die over the 20 year FWOP life, but that actual mortality of cypress would be minimal. Because habitat conditions within the Convent/Blind River project area are more favorable and are not at the same stage of degradation we assumed a reduced tupelo mortality rate for the first 20 years and for higher quality habitat condition classes (Table 5). Because tupelo is more flood tolerant highly degraded areas have become dominated by tupelo. Those areas have also experienced continued degradation as a result of seasonal salinity spikes and are seeing increased tupelo mortality and reduced vigor. In order to be conservative only tupelo mortality was assumed when determining FWOP mortality and projected project benefits because lower quality habitats were dominated by tupelo.

Table 5. Tupelo Mortality FWOP

	TY 20	*TY 50
20-30 yrs to marsh	50%	50%
30-50 yrs to marsh	25%	50%
>50 yrs to marsh	25%	25%

*percent mortality is of the TY 0 (existing) stand

Table 6. Tupelo Mortality FWP

	TY 1	TY 20	TY 50	Total Mortality
High Influence				
20-30 yrs to marsh	0%	0%	5%*	5%
30-50 yrs to marsh	0%	0%	5%*	5%
> 50 yrs to marsh	0%	0%	0%	0%
Moderate Influence				
20-30 yrs to marsh	0%	0%	10%*	10%
30-50 yrs to marsh	0%	0%	10%*	10%
> 50 yrs to marsh	0%	0%	0%	0%
Low Influence				
20-30 yrs to marsh	0%	0%	20%*	20%
30-50 yrs to marsh	0%	0%	20%*	20%
> 50 yrs to marsh	0%	0%	10%*	10%
No Direct Influence				
20-30 yrs to marsh	0%	40%*	40%*	80%
30-50 yrs to marsh	0%	10%*	40%*	50%
> 50 yrs to marsh	0%	10%*	20%*	30%

*% of existing stand @ TY0

ble 8. Future-with and Future-without Project Stand Maturity Conditions.

Future Without Project:

Habitat Condition Class	Level of Influence	Species Group	AVERAGE DIAMETER (inches) TY1	TY20	TY30	TY50	% Contribution by Number of Individuals TY1	TY20	TY30	TY50	BASAL AREA (ft^2/ac) TY1	TY20	TY30	TY50
20-30 yrs. to marsh	FWOP	baldcypress	11.87	13.96	14.60	15.88	10.42	18.87	18.87	100.00	122.35	82.98	90.81	18.42
		tupelo et al.	13.56	15.08	15.81	0.00	89.58	81.13	81.13	0.00				
30-50 yrs. to marsh	FWOP	baldcypress	15.61	18.46	19.10	20.38	17.57	22.13	22.13	46.02	241.96	247.88	269.12	157.24
		tupelo et al.	14.80	16.70	17.50	19.10	82.43	77.87	77.87	53.98				
		baldcypress	16.66	19.51	20.15	21.43	41.51	48.62	48.62	58.67	280.03	320.24	345.15	338.32
>50 years to marsh	FWOP	tupelo et al.	14.57	16.47	16.47	18.87	58.49	51.38	51.38	41.33				

Future With Project:

Habitat Condition Class	Level of Influence	Species Group	AVERAGE DIAMETER (inches) TY1	TY20	TY30	TY50	% Contribution by Number of Individuals TY1	TY20	TY30	TY50	BASAL AREA (ft^2/ac) TY1	TY20	TY30	TY50
20-30 yrs. to marsh	High Influence	baldcypress	11.98	16.16	17.25	18.91	10.42	10.42	10.42	10.91	123.80	185.60	213.14	247.37
		tupelo et al.	13.64	16.68	17.92	19.82	89.58	89.58	89.58	89.09				
	Moderate Influence	baldcypress	11.95	15.50	16.33	17.61	10.42	10.42	10.42	11.44	123.37	174.97	195.25	208.04
		tupelo et al.	13.62	16.20	17.15	18.61	89.58	89.58	89.58	88.56				
	Low Influence	baldcypress	11.91	14.62	15.26	16.54	10.42	10.42	10.42	12.69	122.79	161.30	176.18	170.34
		tupelo et al.	13.59	15.56	16.29	17.75	89.58	89.58	89.58	87.31				
	No Influence**	baldcypress	11.87	13.96	14.60	15.88	10.42	16.23	16.23	36.76	122.35	96.67	105.81	54.07
		tupelo et al.	13.56	15.08	15.81	17.27	89.58	83.77	83.77	63.24				
30-50 yrs. to marsh	High Influence	baldcypress	15.56	21.26	22.35	24.01	17.57	17.57	17.57	18.32	241.69	383.85	435.66	500.91
		tupelo et al.	14.80	18.60	19.96	22.04	82.43	82.43	82.43	81.68				
	Moderate Influence	baldcypress	15.52	20.36	21.19	22.47	17.57	17.57	17.57	19.15	240.70	359.05	397.06	423.01
		tupelo et al.	14.77	18.00	19.04	20.64	82.43	82.43	82.43	80.85				
	Low Influence	baldcypress	15.46	19.16	19.80	21.08	17.57	17.57	17.57	21.04	239.40	327.36	355.08	348.08
		tupelo et al.	14.73	17.20	18.00	19.60	82.43	82.43	82.43	78.96				
	No Influence**	baldcypress	15.41	18.26	18.90	20.18	17.57	19.15	19.15	29.89	238.42	280.58	305.05	232.82
		tupelo et al.	14.70	16.60	17.40	19.00	82.43	80.85	80.85	70.11				
>50 yrs. to marsh	High Influence	baldcypress	16.81	22.51	23.60	25.27	41.51	41.51	41.51	41.51	275.69	454.73	510.25	601.75
		tupelo et al.	14.67	18.47	19.83	21.91	58.49	58.49	58.49	58.49				
	Moderate Influence	baldcypress	16.77	21.61	22.45	23.73	41.51	41.51	41.51	41.51	274.46	423.36	464.05	530.56
		tupelo et al.	14.64	17.87	18.91	20.51	58.49	58.49	58.49	58.49				
	Low Influence	baldcypress	16.71	20.41	21.05	22.33	41.51	41.51	41.51	44.09	272.83	383.33	412.97	450.44
		tupelo et al.	14.60	17.07	17.87	19.47	58.49	58.49	58.49	55.91				
	No Influence**	baldcypress	16.66	19.51	20.15	21.43	41.51	44.09	44.09	50.34	271.61	336.31	363.08	372.21
		tupelo et al.	14.57	16.47	17.27	18.87	58.49	55.91	55.91	49.66				

**NO INFLUENCE GROWTH RATES SET AS FWOP.

FWP

The proposed diversion is expected to substantially stimulate productivity, and so stimulate growth of the cypress and tupelo (as well as other species). The amount of stimulation is assumed to be related to level of influence of the diversion. Depending on the alternative diversion location certain hydrologic units will receive different levels of influence. Those areas within the high influence area will receive freshwater, nutrients, and sediments; so it is assumed those hydrologic units will see the greatest increase in growth. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (EPA 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing levels of productivity in Maurepas are ½ to ¼ of average values (EPA 2001). Southeast Louisiana University study sites within the Maurepas swamp that receive non-point source runoff (i.e., containing nutrients and sediment) have documented an average 1 centimeter of diameter increase per year. When sewage effluent is involved some study sites average 1.5 cm of growth per year close to such a source (Bernard Wood, personal communication). As a very conservative projection, a 2-fold increase in growth rate (i.e., 200% of growth rates listed in Table 4) was applied to the high influence areas for the first 19 years to capture the anticipated stimulation of growth from the diversion. Reduced growth rates were assumed as the level of influence decreased and as the area returned to a more semi-permanent flooding regime (Table 7). DBH and basal area in the FWP were estimated as for FWOP, by applying the increased growth rates and mortality rates.

Table 7. Percent Increase in DBH growth rate based on Level of Diversion Influence (50 yr project life) FWP

	TY 1	TY 20	TY 30
High Influence Area	200%	170%	130%
Moderate Influence Area	170%	130%	100%
Low-Direct Influence Area	130%	100%	100%

Areas not affected by the diversion may still experience benefits as a result of the berm cuts and in-swamp management modifications. Tupelo mortality was assumed based on flood duration and existing stand health. Flood duration was estimated based on hydrologic modeling data presented for "berm cuts without diversions" scenario assuming that the diversion would be operated to mimic the natural historic Mississippi River overbank flooding cycle and would allow for the longest possible dry out period in some years.

Variable V_3 _ Water Regime (Table 9)

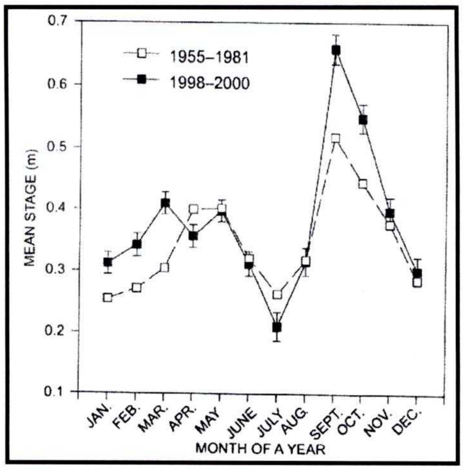
The optimal water regime is assumed to be seasonally flooded with abundant and consistent riverine/tidal input and water flow-through (SI=1.0). Seasonal flooding with periodic drying cycles is assumed to contribute to increased nutrient cycling (primarily through oxidation and decomposition of accumulated detritus), increased vertical structure complexity (due to growth of other plants on the swamp floor), and increased recruitment of dominant overstory trees. In addition, abundant and consistent input and water flow-through is optimal, because under that regime the full functions and values of a swamp in providing fish and wildlife habitat are assumed to be maximized. Temporary flooding is also assumed to be desirable. Habitat suitability is assumed to decrease as water exchange between the swamp and adjacent systems is reduced. The combination of permanently flooded conditions and no water exchange (e.g., an impounded swamp where the only water input is through rainfall and the only water loss is through evapotranspiration and ground seepage) is assumed to be the least desirable (SI=0.1). Those conditions can produce poor water quality during warm weather, reducing fish use and crawfish production (WVA Procedure Manual).

Existing

Hydrologic modeling for this project, as well as hydrologic investigations for the CWPPRA River Reintroduction into Maurepas Swamp project, has revealed that the Maurepas swamp floor elevations [i.e., 1.12 feet NAVD per the CWPPRA, Coastwide Reference Monitoring System (CRMS) station 5167] are often lower than Lake Maurepas bottom elevations. This results in swamp water levels and dry-out periods being dependent on the water levels in Lake Maurepas, and essentially, flooding is semi-permanent with low to very low water exchange and throughput. The observed doubling of flood durations from 1955 to present at Pass Manchac (Thomson et al. 2002) coupled with swamp elevations lower than lake elevations suggests that the duration of inundation within the project area has drastically increased over the last fifty years. Moreover, flood durations within the project area swamps are influenced by adjacent urban storm water runoff of areas to the northwest (i.e., Baton Rouge and surrounding cities) and the hydrologic impoundments caused by major transportation corridors. Adjacent urban storm water drainage projects force storm water runoff via large drainage canals into the Blind River. These storm waters bypass the floodwater storage capabilities of adjacent forested wetlands and increase the water levels in Blind River resulting in back water flooding conditions upstream of the waterways confluence. Being that the project area is located at the headwaters of the Blind River and is impounded by several major hydrologic barriers [i.e., U.S. Interstate 10, U.S. Highway 61, and Kansas City Southern Railroad (KCSRR)]; flood waters within the project area are the last to recede from the basin. It is appears that within hydrologic unit 3 interior elevations are low enough to allow ponding of water for longer periods of time, and is, therefore, considered permanently flooded with low water exchange.

Lunar tidal fluxes in Maurepas swamp average 30 cm but are typically overwhelmed by meteorological tidal fluxes. Wind is also a significant forcing agent for water level in Maurepas swamp and may exhibit daily and seasonal variability. During the summer and early fall, storms and prevailing winds from the southeast raise water levels in the swamp as they push Gulf water into the system. Conversely, during the winter months, continental fronts with prevailing winds from the northeast often lower water levels in the swamp as they push water out of the system and towards the Gulf. Fluctuations in water level are generally expected to be similar throughout Maurepas swamp, acknowledging slight variability associated with landscape position and elevation. Within any given year, water stage is characterized by a bimodal hydrograph (Figure 4). Water level rises in the spring, then falls to its lowest level during the summer, rises to its highest level in the fall, and again falls to low levels in the winter (Thomson 2000, Keddy et al. 2007). The intensity of peaks and troughs is typically associated with those meteorological events.

Figure 4. Intra-annual variability of montly mean stage comparing the periods 1955-1981 (historical) and 1998-2000 (drought period). The duration of flooding (percentage of the year that the marshes by Schleider's Ditch flood) more than doubled over the period of record for the USACE tide gage (from Thomson 2000, referenced in Keddy 2007)



Water exchange between the project area swamps and adjacent swamps is reduced to what the Blind River and other small tributaries can exchange across the embankments of the three transportation corridors (i.e., U.S. Interstate 10, U.S. Highway 61, and KCSRR). These embankments act as hydrologic barriers and reduce flow-through across the project area swamp. Within the project area interior drainage and hydrologic exchange has been altered by the construction of drainage canals and associated berms, pipeline and transmission line rights-of-way, and remnant logging infrastructure (i.e., roads, pull boat ditches, and temporary railroad track embankments). Historically, seasonal overbank flooding over the natural Mississippi River levees facilitated hydrologic exchange and freshwater input on average every three to five years. Today the only additional freshwater input is through rainwater runoff, and even those contributions can by-pass the wetland system through the many storm water drainage canals that direct floodwaters directly into Blind River and Lake Maurepas. The project area swamp habitat has been altered and disrupted to a point that adequate water exchange does not exist, and is considered to have low water exchange.

FWOP

Future without project conditions flood durations are expected to worsen as sea level rise and subsidence continues and storm water control projects continue to force storm water into an already flooded system. It is assumed that the entire project area swamp habitat will become permanently flooded and continue to have low flow exchange.

Table 9. Summary for Average Annual Water Depth (ft)

No Sea Level Rise (existing conditions)

Alternatives	Scenario/Sub-basin	HU1 100	HU2 200	HU3 210, 220	HU4 110	HU5 120, 160	HU6 300, 320, 330	HU7 140, 150	Total Project Site Average
	Existing Conditions	1.90	1.73	1.83	2.09	1.34	1.53	1.61	1.72
	Existing Conditions; With Berm Cuts	0.78	0.74	0.69	0.82	0.55	0.58	0.65	0.69
2	Romeville Diversion	2.13	0.74	1.30	2.18	0.55	0.59	0.66	1.16
4	South of Highway 70 Bridge Diversion	1.79	3.40	1.62	0.85	0.54	0.59	0.65	1.35
6	Total Diversion	1.82	2.08	1.47	1.54	0.55	0.59	0.65	1.24

20-year Sea Level Rise

Alternatives	Scenario/Sub-basin	HU1 100	HU2 200	HU3 210, 220	HU4 110	HU5 120, 160	HU6 300, 320, 330	HU7 140, 150	Total Project Site Average
	Existing Conditions	1.92	1.76	1.84	2.11	1.37	1.56	1.65	1.75
	Existing Conditions; With Berm Cuts	1.10	1.08	0.99	1.20	0.81	0.89	1.02	1.01
2	Romeville Diversion	2.75	1.08	2.03	2.93	0.82	0.90	1.02	1.65
4	South of Highway 70 Bridge	2.42	4.66	2.46	1.27	0.81	0.89	1.02	1.93
6	Total Diversion	2.44	2.84	2.30	2.13	0.81	0.90	1.02	1.78

30-year Sea Level Rise

Alternatives	Scenario/Sub-basin	100	200	210, 220	110	120, 160	300, 320, 330	140, 150	Total Project Site Average
	Existing Conditions	1.95	1.82	1.87	2.14	1.42	1.61	1.71	1.79
	Existing Conditions; With Berm Cuts	1.29	1.30	1.17	1.42	0.98	1.08	1.26	1.21
2	Romeville Diversion	2.99	1.30	2.38	3.21	0.99	1.12	1.27	1.89
4	South of Highway 70 Bridge	2.77	5.13	2.91	1.54	0.98	1.09	1.26	2.24
6	Total Diversion	2.76	3.16	2.70	2.45	0.99	1.10	1.27	2.06

50-year Sea Level Rise

Alternatives	Scenario/Sub-basin	100	200	210, 220	110	120, 160	300, 320, 330	140, 150	Total Project Site Average
	Existing Conditions;	2.15	2.07	2.04	2.33	1.64	1.83	2.02	2.01
	Existing Conditions; With Berm Cuts	1.83	1.88	1.68	1.96	1.48	1.58	1.86	1.75
2	Romeville Diversion	3.49	1.88	3.06	3.73	1.51	1.68	1.88	2.46
4	South of Highway 70 Bridge	3.52	5.82	3.83	2.16	1.48	1.60	1.85	2.90
6	Total Diversion	3.42	3.71	3.47	3.16	1.51	1.69	1.88	2.69

FWP

Depending on the location of the hydrologic unit within the watershed in relation to the diversion outfall it was assumed that certain hydrologic units would receive different levels of influence (i.e., high, moderate, low, or no influence). However, all HUs see increased benefits in the form of dry-out frequency as a result of the berm cuts assuming the diversion would be operated to maximize dry-out frequency. At this time an operational plan has not been developed. In target year 1 (defined as "existing conditions with berm cuts" in Table 9), without a diversion water depths are lower than existing conditions throughout all hydrologic units for all alternatives, and below swamp floor elevations in most hydrologic units (Table 9).

Hydrologic data indicates that by TY 20 water levels within all areas are at or above swamp floor elevations. Within areas of high influence sediment accretion is expected and should keep up with total sea level rise. Nutrient input into areas moderately influenced would facilitate increased growth rates contributing to above ground biomass. While this has been taken into consideration, accretions rates have not been predicted or analyzed at this time. As displayed in Table 10, FWP water regime was evaluated by each hydrologic unit for each alternative and grouped according to level of influence by the diversion.

Table 10. Future With Project Water Regime Conditions.

	TY0		TY1		TY20		TY30		TY50	
	duration-exchange	**SI**	**duration-exchange**	**SI**	**duration-exchange**	**SI**	**duration-exchange**	**SI**	**duration-exchange**	**SI**
Alternative 2										
high influence	semiperm-low	0.45	seasonal-high	1.00	semipermanent-high	0.75	semiperm-high	0.75	semiperm-high	0.75
moderate	semiperm-low	0.45	seasonal-high	1.00	semipermanent-high	0.75	semiperm-high	0.75	semiperm-high	0.75
low	semiperm/perm-low	0.40	seasonal-moderate	0.85	semiperm-moderate	0.65	perm/semiperm-moderate	0.55	perm/semiperm-moderate	0.55
no influence	semiperm-low	0.45	seasonal-low	0.70	semiperm-low	0.45	semiperm-low	0.45	semiperm-low	0.45
Alternative 4										
high influence	semiperm-low	0.45	seasonal-high	1.00	semiperm-high	0.75	semiperm-high	0.75	semiperm-high	0.75
moderate	semiperm/perm-low	0.40	seasonal-high	1.00	semiperm-high	0.75	semiperm/perm-high	0.70	semiperm/perm-high	0.70
low	semiperm/-low	0.45	seasonal-moderate	0.85	semiperm-moderate	0.65	semiperm-moderate	0.65	semiperm-moderate	0.65
no influence	perm-low	0.30	seasonal-low	0.70	semiperm-low	0.45	perm-low	0.30	perm-low	0.30
Alternative 6										
high influence	semiperm-low	0.45	seasonal-high	1.00	semiperm-high	0.75	semiperm-high	0.75	semiperm-high	0.75
moderate	semiperm/perm-low	0.40	seasonal-high	1.00	semiperm-high	0.75	semiperm/perm-high	0.70	semiperm/perm-high	0.70
low	permanent-low	0.30	semiperm-moderate	0.65	semiperm-moderate	0.65	permanent-moderate	0.45	permanent-moderate	0.45
no influence	-	-	-	-	-	-	-	-	-	-

Variable V_4 - Mean high salinity during the growing season.

Swamps can tolerate increased salinities; however increased salinity spikes coupled with prolonged flooding has been shown to be detrimental to those forested swamps. Baldcypress is able to tolerate higher salinities compared to other swamp species such as tupelogum and many herbaceous species which are salinity-sensitive. Salinity recorded at Pass Manchac during the 1999-2000 drought spiked at 8 parts-per-thousand (ppt) and averaged around 5 ppt until heavy rains in July 2000 ended the drought (Keddy et al. 2007). For the Swamp WVA optimal conditions for salinity are assumed when mean high salinities during the growing season are equal to or less than 1.0 ppt. Habitat suitability is assumed to decrease rapidly at mean high salinities in excess of 1.0 ppt.

For the CWPPRA River Reintroduction into Maurepas Swamp project the lowest existing salinities documented were 1.53 ppt for the "Hope" station group (EPA 2001). The Convent/Blind River Diversion project area is located further inland from the "Hope" station group and is landward of several hydrologic barriers (i.e., I-10, US 61, KCSRR), thereby being protecting from the higher salinity waters coming from the Gulf. Because of these barriers it is likely salinity levels remain relatively consistent throughout the project area and do not fluctuate within the project area. While salinity spikes still affect the project area through the hydrologic connectivity of Blind River and other small tributaries, those salinity spikes are not representative of typical salinities and are not represented in this variable. For 2008, average salinities during the growing season recorded at CRMS stations (0065 and 5167) located west of U.S. Hwy 61 were measured at 0.25 ppt. The highest salinity measured during the growing season was 0.33 ppt. Salinities have been collected periodically in Blind River at US Hwy 61 by LDEQ (LA040403), and average annual salinities taken from 1981 to 1998 were 0.95 ppt. Average salinities recorded during the growing season at that station range from 0.15 ppt in 1996 to 0.70 ppt in 1995. However, those values were only obtained from the months of April, June, August, and October. For two CRMS stations located west of U.S. Hwy 61 and in the project area average salinities in the growing season were measured at 0.35 ppt (CRMS0039) and 0.53 ppt (CRMS5167), slightly higher than the interior sites.

According to the data available for the entire project area it appears that mean high salinity during the growing season is less than 1.0 ppt. Should coastal restoration and protection projects (e.g., MRGO Ecosystem Restoration Project and features of the Federal Hurricane and Storm Damage Risk Reduction System) proposed for the Lake Pontchartrain Basin not be implemented, it is highly likely that the project area will continue to see slight increases in average salinities and a greater frequency in salinity spikes. This is evident from the salinity trends observed in the forested swamps to the east and closer to Lake Maurepas. However, average high salinities during the growing season are not expected to exceed 1.0 ppt over the project life. The suitability index for salinities 1.0 ppt or less is 1.0.

It is assumed that the project area can be subdivided into two salinity regions. Areas east of U.S. Hwy 61 and south of Interstate 10 experience slightly higher salinity levels as a result of being closer to the lake. Areas further inland and west of U.S. Hwy 61 are slightly fresher due to the hydrologic barriers impeding the salinity gradient and the contribution of freshwater run-off from the adjacent upland areas.

Existing conditions for areas east of U.S. Hwy 61 are estimated based on the CRMS data for 0065 and 5167. Salinities were consistent throughout the 2008 growing season so mean high salinities were not calculated. Because of freshwater runoff and the hydrologic barriers, average mean high salinities are not expected to increase; however, salinity will still be a detrimental factor to swamp sustainability in the form of seasonal and drought induced salinity spikes. Average high salinities during the growing season are not expected to exceed 1.0 ppt over the 50-year future without project life.

Existing conditions for areas west of U.S. Hwy 61 are estimated using data from the two CRMS stations (0039 and 5167) within the area. It is likely that in the 50-year future without project life the area will experience a slight increase in salinities, but will still be within the optimal range. Project area salinities are greatly influenced by adjacent storm water and agricultural freshwater runoff, and hydrologic barriers prevent high saline waters from entering the swamps. Salinity will still be a detrimental factor to swamp sustainability in the form of seasonal and drought induced salinity spikes.

Modeling conducted for the closure of the MRGO at Bayou La Loutre showed that salinities would decrease within the adjacent marshes and associated waterways on the order of 1.0 to 3.0 ppt as a result of that closure (Draft IER 11 Tier 2 Pontchartrain 2009). Higher saline waters that commonly entered through the MRGO into the southern end of Lake Pontchartrain have been cut off as a result of that closure and the Lake Borgne surge barrier currently being constructed.

Summary/Results
According to initial results from the hydrologic modeling, benefits are achieved through gapping spoil banks and modifying other hydrologic barriers to allow the redistribution of hydrologic flow throughout the swamp system. Because in-swamp management is a feature of all three alternatives, all three alternatives see considerable WVA benefits in the first 20 years as a result of those features; therefore, the difference in AAHUs between alternatives is minimized. The analysis then becomes a comparison of diversion influence areas. Based on preliminary hydrologic modeling results which at this stage of the study has focused on transfer of flow between benefit areas, the Romeville diversion alternative (Alternative 2) directly influences a larger area (i.e., HUs 1 and 4) compared to Alternative 4, the South of Hwy 70 Bridge diversion alternative (i.e., HUs 1 and 2). The "Total diversion" alternative (i.e., Alternative 6 and 4b) consequently has the highest benefits because sediments, nutrients, and freshwater are influencing a larger receiving area. Another observation in the analysis is that basal area throughout most of the project area is considered to be within the optimal range (i.e., >161 sq. ft./ac) to support wildlife habitat. The WVA, therefore, does not show a distinction (or change in suitability indices) between habitat classes and between FWP and FWOP for this variable. Because of these factors, alternative evaluations have placed an emphasis on stand structure and water regime. The project area is semi-permanently flooded and future-with-project modeling projections indicates that the flooding regime within most of the project area will return to pre-project conditions by target year 20 as a result of total sea level rise. However, hydrologic flow will be improved and will provide additional benefits by increasing forest stand vigor, accretion, water quality and back flow prevention.

Data Gaps and Additional Information Needs for Analyzing Benefits of the Tentatively Selected Plan (TSP)

Because of the expedited schedule, limited data was available at the time of this analysis. Therefore, the intent of this habitat analysis is to provide a comparison of alternative benefit areas and potential direct impacts associated with project construction to support the selection of a TSP. To fully evaluate the benefits of the TSP the following additional information and actions will be required:

- Additional results of hydrologic modeling efforts that better identify/quantify influence areas and how water (sediment and nutrients) moves through the system and within each hydrologic unit.
- Water levels and swamp floor elevations need to be determined on a refined scale and incorporated into the hydrologic modeling.
- Salinity predictions need to be re-evaluated and changes, if necessary, be undertaken.
- Diversion operations need to be developed by alternative and incorporated into the hydrologic modeling.
- Accretion rates need to be determined and incorporated into the hydrologic modeling (e.g., flood durations and depths should decrease). Benefits cannot be fully addressed without including this in the analysis.

IMPACTS

For each alternative, impacts to swamp habitat are associated with the transmission channel from the Mississippi River to the outfall area (benefit area) and with transmission canal construction and modification within the outfall area (Tables 11 & 12). For FWP all habitat suitability index (HSI) values are 0.0 to reflect the removal of forested habitat as a result of the proposed alternative.

Table 11. Forested Wetland Impacts (Acres)

	Alternative 2 Romeville 3000cfs	**Alternative 4** Southbridge 3000cfs	**Alternative 4B** Southbridge 3000 cfs split flows	**Alternative 6** Romeville 1500 cfs Soutbridge 1500 cfs
Diversion Channel	53	107	107	160
Northern Transmission Canal	-	163	126	126
Widening of St James Canal	-	-	72	-
Total	**53**	**270**	**305**	**286**

Impacts associated with the transmission channel were quantified using the highest quality habitat (i.e., greater than 50 years-to-marsh) variable assumptions from the WVA assessing benefits. Field data was not obtained along the proposed transmission channels due to limited time associated with the expedited schedule; therefore, variable assumptions were made to give advantage to the forested resources being impacted (e.g., stand structure and maturity were assumed to have the highest suitability index value). Forested areas closer to, and associated with, the natural levee of the Mississippi River are at higher elevations, and prolonged inundation is not expected. Therefore, for areas where water regime is currently classified as seasonal or temporary, stand structure class is expected to increase through the 50-year project life. Water regime was determined using classifications by National Wetlands Inventory 1988. Forested habitat at higher elevations along the natural levee of the Mississippi River is not expected to experience marked salinity influences through the project life. See WVA worksheets for the discrete variable assumptions.

The proposed northern transmission canal (i.e., Alternatives 4A, 4B, and 6) traverses through the "benefit area" and the associated acreage was previously included in the habitat analyses evaluating benefits. Those analyses were revised, and the associated acres impacted were subtracted from the respective analysis by habitat condition class. The associated impacts were then evaluated using the same variable assumptions from those previous habitat analyses assessing benefits for FWOP. Again, for FWP, all habitat suitability index (HSI) values are 0.0 to reflect the removal of forested habitat as a result of the proposed project.

Alternative 4B would include expanding the St. James Parish Canal and constructing channel berms to achieve a head differential sufficient to move diverted water to the southern portion of the project area. While additional indirect impacts would be associated with impounding areas of swamp by constructing these berms, only direct impacts to wetlands were evaluated. Much of this area was already classified in the habitat condition class and the same variable assumptions for FWOP were used. Again, for FWP all habitat suitability index (HSI) values are 0.0 to reflect the removal of forested habitat as a result of the proposed project.

Figure 5. Forested Impacts Associated with the Romeville Diversion Channel (Alts. 2 & 6)

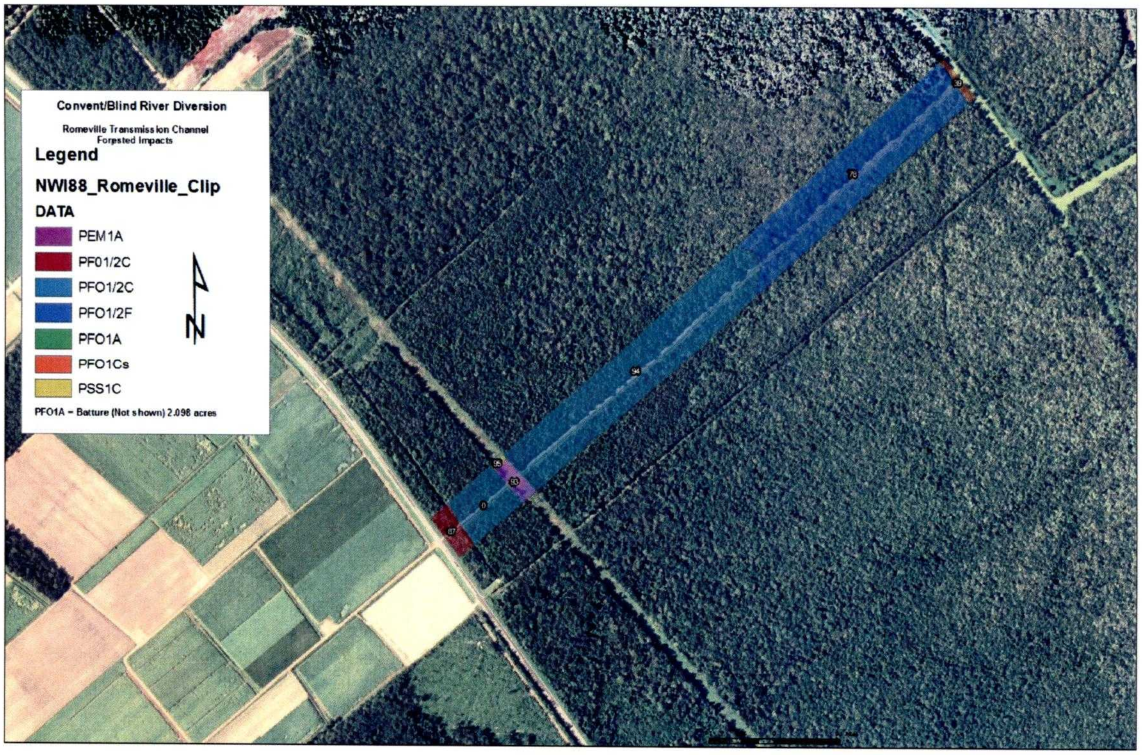


Figure 6. Forested Impacts Associated with the South Bridge Transmission Channel (Alternative 4A and 6)

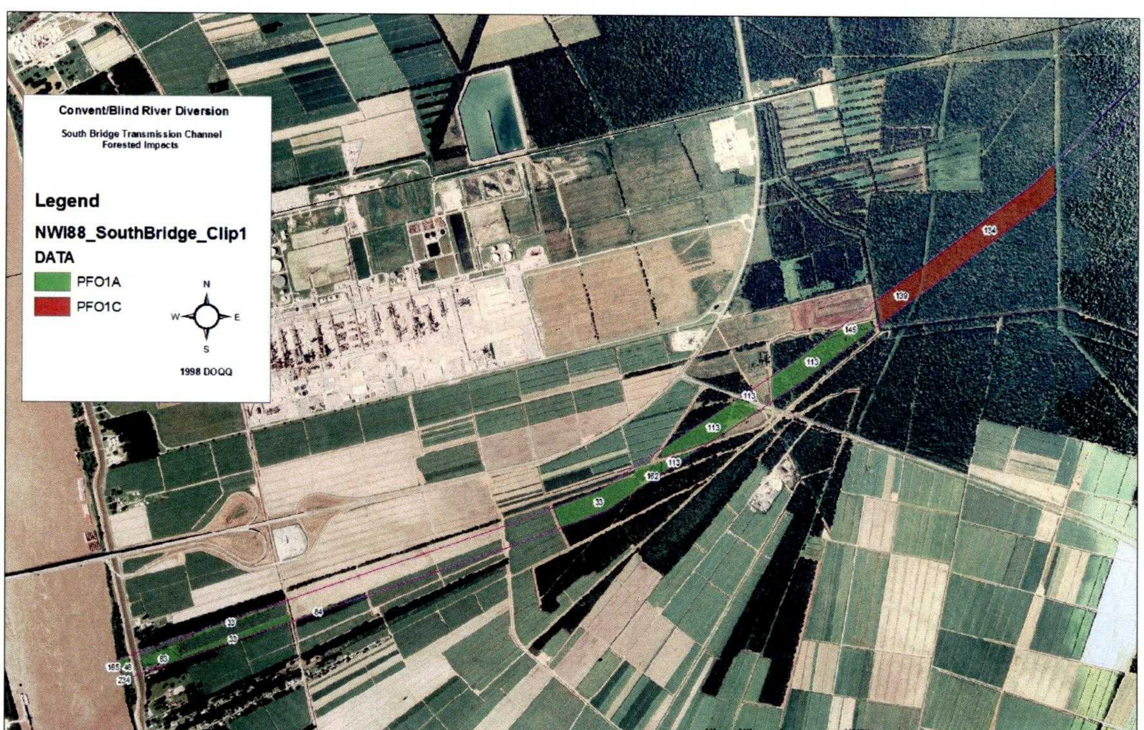


Figure 7. Forested Impacts Associated with the Outfall Canal (Alternatives 4A, 4B, & 6).

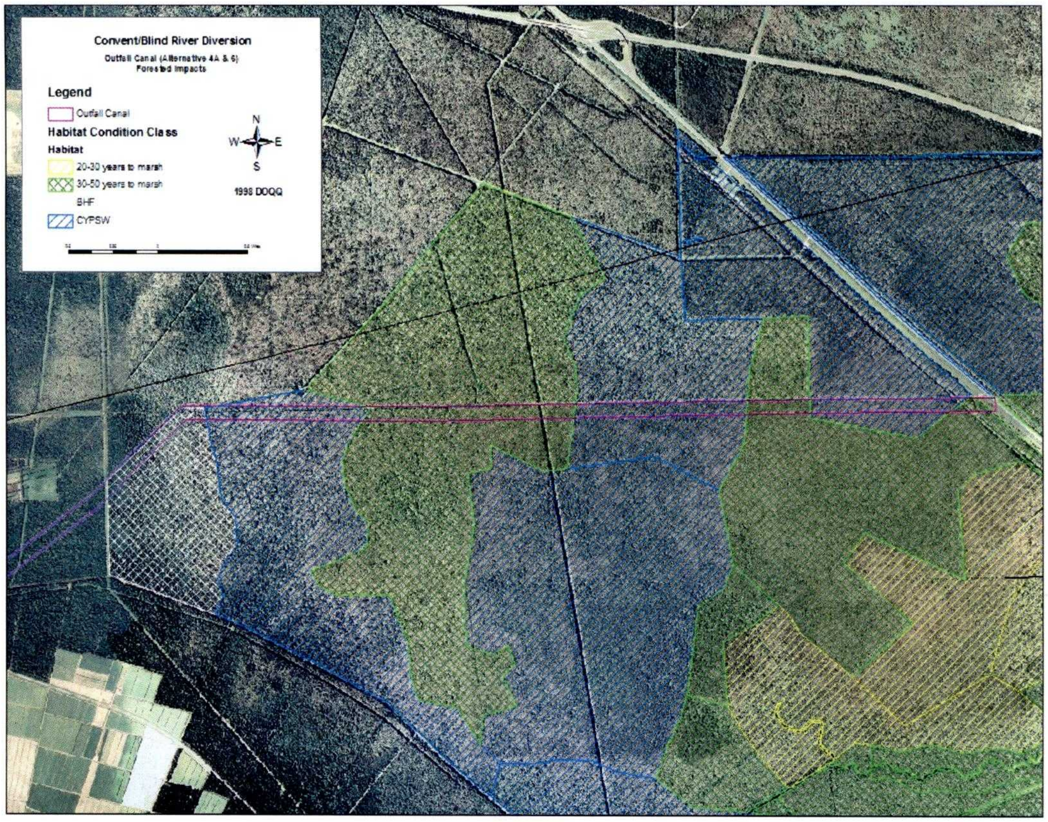


Figure 8. Forested Impacts Associated with Widening St. James Parish Canal (Alt. 4B)

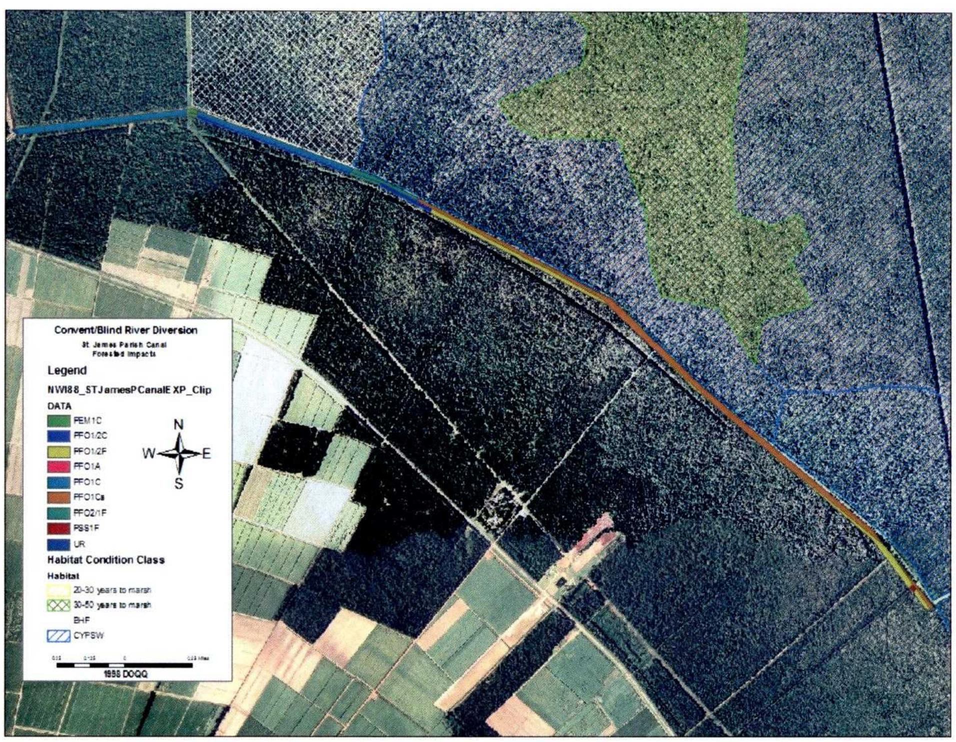


Table 12. Summary of Total Acres Benefited and Impacted.

	Acres			
Benefits	Alternative 2	Alternative 4A	Alternative 6,	4B
High IA, 20-30 years to marsh	169	169	169	169
High IA, 30-50 years to marsh	3364	1827	3848	3848
High IA, >50 years to marsh	4555	3550	5361	5361
Moderate IA, 20-30 years to marsh	204	1837	2041	2041
Moderate IA, 30-50 years to marsh	604	2972	3579	3579
Moderate IA, >50 years to marsh	2607	2070	4691	4691
Low IA, 20-30 years to marsh	2397	0	1085	1085
Low IA, 30-50 years to marsh	1669	2013	469	469
Low IA, >50 years to marsh	469	1799	0	0
No IA, 20-30 years to marsh	525	1289	0	0
No IA, 30-50 years to marsh	2297	1073	0	0
No IA, >50 years to marsh	2509	2607	0	0
Benefits Total	21,369	21,206	21,243	21,243
Impacts				
Outfall Area				
High IA, 30-50 years to marsh	0	36	28	28
High IA, >50 years to marsh	0	52	40	40
Moderate IA, 30-50 years to marsh	0	13	10	10
Moderate IA, >50 years to marsh	0	62	48	48
Transmission Channel				
FWetlands, Seasonally Flooded	31	39	70	39
FWetlands, Temporarily Flooded	2	69	71	69
FWetlands, Semipermanent Flooded	20	0	20	0
St. James Parish Canal Modificaitons				
FWetlands, Seasonally Flooded	0	0	0	22
FWetlands, Semipermanent Flooded	0	0	0	50
Impacts Total	53	271	287	306
Combined Total Acres	21,422	21,477	21,530	21,549

Table 13. Summary of Total AAHUs.

	Average Annual Habitat Units (AAHUs)			
Benefits	Alternative 2	Alternative 4A	Alternative 6,	4B
High IA, 20-30 years to marsh	77	77	77	77
High IA, 30-50 years to marsh	1350	733	1545	1545
High IA, >50 years to marsh	1293	1014	1532	1532
Moderate IA, 20-30 years to marsh	93	828	919	919
Moderate IA, 30-50 years to marsh	243	1182	1423	1423
Moderate IA, >50 years to marsh	745	585	1325	1325
Low IA, 20-30 years to marsh	935	0	354	354
Low IA, 30-50 years to marsh	527	663	137	137
Low IA, >50 years to marsh	110	447	0	0
No IA, 20-30 years to marsh	72	163	0	0
No IA, 30-50 years to marsh	585	237	0	0
No IA, >50 years to marsh	431	373	0	0
Benefits Total	**6,462**	**6,302**	**7,313**	**7,313**
Impacts				
Outfall Area				
High IA, 30-50 years to marsh	0	-17.07	-13.28	-13.28
High IA, >50 years to marsh	0	-30.19	-23.22	-23.22
Moderate IA, 30-50 years to marsh	0	-6.09	-4.69	-4.69
Moderate IA, >50 years to marsh	0	-35.69	-27.63	-27.63
Transmission Channel				
FWetlands, Seasonally Flooded	-25.87	-32.55	-58.43	-32.55
FWetlands, Temporarily Flooded	-1.67	-56.33	-57.96	-56.33
FWetlands, Semipermanent Flooded	-13.50	0	-13.5	0
St. James Parish Canal Modificaitons				
FWetlands, Seasonally Flooded	0	0	0	-18.36
FWetlands, Semipermanent Flooded	0	0	0	-33.76
Impacts Total	-41.04	-177.92	-198.71	-209.82
Combined Total AAHUS	**6,421**	**6,124**	**7,114**	**7,103**

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CONVENT/BLIND RIVER DIVERSION PROJECT
WVA MODEL JUSTIFICATION

1. Starting the SI curves for all variables at 0.1 is problematic because even habitat with no ecological value appears to have some ecological value.

The WVA swamp model has only two graphs. One of them, V2 - Stand Maturity, has a zero intercept. The other, Salinity, does not. However, McKay and Fischenich (1) did a sensitivity analysis on the Barataria Barrier Shoreline WVA. Their study showed that the application of the zero slope intercept instead of 0.1 as in the model did not affect the relative rankings of any of the alternatives. The same is likely to be true for the Convent/Blind River diversion project.

3. The number of target years should be increased to improve the predictive ability of the models given that changes are often non-linear.

For the Convent/Blind River diversion project, different alternatives were analyzed using target years depending upon various assumptions such as the health of the vegetation relative to similar vegetation in the Swamp outside of the project area as reflected in the habitat classification map (20-30 years to marsh, 30-50 years to marsh, and >50 years to mash). The target years used for the Convent/Blind River diversion project were TY0, TY1, TY20, TY30, and TY 50.

For the WVA Certification additional text has been provided in the Procedural Manual to guide users on the selection of target years. A Table has been added summarizing, by project type, the use of specific target years to reflect aspects of project evolution. Suggestions have been made for ensuring the justification for the selection of Target years is added to the Project Information Sheet.

4. In the spreadsheet for the marsh model, open water and emergent marsh AAHUs are incorrectly combined and should be added rather than taking the arithmetic mean.

The marsh models were not used in the Convent/Blind River diversion project.

6. Sea level is an important driver and relative sea level rise and climate change should be included in the models.

For the Convent/Blind River diversion project relative sea level and subsidence were accounted for in the land loss rates calculated for each project area. Data in the literature indicated that the rate of accretion will offset sea level rise and subsidence. The hydrologic modeling that was used to evaluate WVA metrics for the Convent/Blind River used the intermediate rate of sea level rise.

For WVA Certification, a new section ‘Climate Change’ has been added to the Procedural Manual to provide guidance on how to consider sea-level rise and other climate change effects in the evaluation. Suggestions have been made to document in the Project Information Sheet how these factors are considered in the evaluation.

10. **For some model variables, policy decisions appear to supersede the biology of the relationships for developing the Suitability Index (SI) curves.**

This comment referred to a problem that the reviewers had with the marsh models. The marsh models were not used in the Convent/Blind River diversion project.

11. **The spreadsheets for the models as created are likely to lead to errors in maintenance and use.**

The USFWS Habitat Evaluation Team (HET) member for the Convent/Blind River diversion project is experienced in the use of WVA spreadsheets. To ensure that "% cover" and "class", as well as other spreadsheet numbers were entered correctly the spreadsheet entries have been and will be reviewed by several members of the HET (e.g., agency representatives).

For WVA Certification, the spreadsheets have been corrected as Battelle suggested correction of calculation errors, improvement of the spreadsheet user interface, to decrease the likelihood of user errors.

12. **Several inaccuracies were identified in the model spreadsheets that should be corrected.**

As explained above, the USFWS HET member is experienced in the use of WVA spreadsheets and the HET reviewed all spreadsheets, According to model developers, the spreadsheet works correctly for the Swamp WVA V2.

For WVA Certification, the spreadsheets have been corrected as suggested by Battelle to correct calculation and specification errors.

15. **The WVA method should be expanded to handle risk and uncertainty in areas exposed to episodic events**.

Risk and uncertainty are already incorporated into the WVA model used for the Convent/Blind River diversion project. Risk and uncertainty are also addressed in Section 3.10 of the Integrated Feasibility Study and Environmental Impact Statement and include hydrologic, environmental, and construction and economic uncertainties.

For WVA Certification, suggestions have been made to add a section to the Project Information Sheet to describe how risk and uncertainty are considered in the evaluation.
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16. **The WVA method should be updated, taking into account new GIS data, LIDAR, and other new data sources as well model formats/presentation (visualization tools, HGM).**

The WVA model used for the Convent/Blind River diversion project included use of the most recent imagery and land loss data available from the USGS as well as the most appropriate historic imagery to determine land loss and habitat conversion. The habitat classification map was developed by scientists with the most knowledge about the condition of wetlands in Maurepas Swamp in conjunction with the most recent available imagery from the USGS.

For WVA Certification, the Procedural Manual has been updated to reflect current use and to provide appropriate guidance on available data sources.

18. The use of the geometric mean may be more appropriate than the arithmetic mean to derive some HSIs. Provide scientific basis for the decision.

The WVA Swamp Model used for the Convent/Blind River diversion project uses a geometric mean to derive HSI's.

Literature Cited

1. McCay, S. K. and Fisschenich, C. J. 2009. Sensitivity Analysis of the Barataria Basin Barrier Shoreline Wetland Value Assessment (WVA) Model[1] Prepared for the USACE

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