DIVERSION INTO THE MAUREPAS SWAMP
DRAFT PROJECT DEVELOPMENT PLAN
Draft date: 6 January 2000

Introduction: The wetlands south of Lake Maurepas fall within the Amite/Blind Rivers mapping unit within Region 1 of the Louisiana coastal zone as defined in the Coast 2050 planning effort and restoration report. Both the Coast 2050 restoration planning effort and the Mississippi River Sediment, Nutrient, and Freshwater Redistribution (MRSNFR) study have identified this area as stressed and dying, and in need of restoration, with consideration of diversions as the recommended strategy. These recommendations were based on compilation, review, and consensus interpretation of existing studies and information, contribution of expertise of local researchers, and site-specific surveys. An important component of this Project Development Plan will be a more detailed and rigorous compilation and evaluation of existing information to thoroughly describe the problems and needs of this area.

<u>What We Know About Conditions in Maurepas Swamps</u>

The Amite/Blind Rivers mapping unit is predominantly cypress/tupelo swamp, including about 138,900 acres of swamp and 3,440 acres of fresh marsh as of 1990. The composition of major habitat types has been historically fairly consistent, as evidenced by data available for the period 1958 to 1988 when minimal change in overall habitat composition was observed.

The swamps south of Maurepas are dying. These swamps are composed of about 80% tupelo trees and 20% cypress trees. Ongoing research by Dr. Gary Shaffer of SLU indicate that most of the tupelo trees in the interior of the Maurepas swamps (i.e., except those along the ridges associated with bayous and canals) are exhibiting extreme stress, evidenced by breaking of their canopy tops. The cypress trees are not regenerating in most regions of the south Maurepas swamp. Over time, this lack of regeneration will lead to loss of this component of the swamp as older trees die off. Persistent swamp flooding and associated water stagnation may stress adult cypress and tupelo trees as well, and also impact other aspects of the swamp ecosystem, such as fisheries productivity. However, cypress and tupelo trees can withstand considerably deeper waters for longer durations, than herbaceous species. Also, over the past several decades, the substrate in southern Maurepas has become increasingly unconsolidated, almost certainly due to the demise of below-ground productivity. Therefore, it is expected that most of the dying swamp will succeed to open water.

Reflecting this situation, wetland loss rates for the Amite/Blind Rivers mapping unit for 1974-90 were estimated by USACE to be 0.83% per year for the swamps, and 0.02% per year for fresh marsh. Based on these rates, about 50% or 69,450 acres of swamp, and 1.2% or about 40 acres of fresh marsh will be lost in 60 years.

The Coast 2050 report lists subsidence, permanent flooding, and sediment and nutrient starvation as factors contributing to stress of the south Maurepas swamps. In response to this, it is the goal of a diversion project into the south Maurepas area to deliver sediment and nutrients as well as fresh water; stimulate productivity; and through a combination of these factors counteract subsidence and diminish the persistence of flooding. Since the construction of the Mississippi River flood control levees, the Maurepas swamps have been virtually cut off from any freshwater or sediment and nutrient input. Thus, the only soil building has come from organic production within the wetlands; and preliminary evaluations of Dr. John Day of LSU suggest that swamp productivity may be substantially depressed compared to normal conditions. Subsidence in this area is classified as intermediate, at about 1.1 to 2.0 feet/century. Minimal soil building in combination with moderately high subsidence has resulted in a net decrease in ground surface elevation. Dr. Shaffer has made some preliminary elevation measurements in the area of concern, and reports that ground surface elevation of much of the south Maurepas swamp may be lower than typical lake surface elevations, leading to a persistently flooded condition.

Occasional intrusion of saltwater is another factor that probably contributes to stress on the swamp forest. Several instances of intrusion of saltwater with salinities up to 5 ppt have been observed in the Maurepas swamps in the recent past, including two major events earlier this year. These intrusions are apparently associated with drought conditions combined with meteorological events that produce excessively high tides. Such salinity levels are damaging to freshwater swamps; tupelo trees are especially sensitive to salinity as low as 2 ppt.

<u>What We Think We Know About Effects of Existing Conditions</u>

With minimal ability to drain and persistent flooding, the previously 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), and also sprout more readily from cut stumps (Johnson, 1978), conditions that may explain the current dominance of tupelo in the south Maurepas swamps. However, 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 and by herbivory, as well as by flooding (Conner et al., 1986).

An exception to the patterns of no regeneration in south Maurepas appears to be the area affected by sediments and nutrients delivered via the Amite River Diversion Canal, including the area immediately south of the Blind River between the confluence of the Blind and the diversion canal, and the mouth of the river where it discharges to the west end of the lake. Several cohorts of cypress seedlings have colonized and established in this area, demonstrating on a small scale the positive impacts that are expected from a proposed diversion of Mississippi River water into the southern Maurepas swamps.

The two saltwater intrusion events observed earlier this year caused 97% mortality of hundreds of cypress seedlings planted as part of some ongoing SELU research (Dr. Gary Shaffer) in the northwestern portion of Maurepas swamps. In a South Carolina swamp, Conner (1993) observed 66% mortality of trees after one year of exposure to 2 ppt salinity trapped in the swamp after Hurricane Hugo; another portion of the swamp exposed only to a pulse of salinity after the hurricane experienced 41% tree mortality. Salinity of 3 ppt can reduce growth of both cypress and tupelo saplings (Pezeshki, 1990); and when combined with flooding stress, growth reduction in cypress was substantial. In contrast, Myers et al. (1995) observed high survival of cypress in 3 ppt salinity if the trees were protected from grazing and overgrowth by vines. It appears possible that salinity can be a significant factor contributing to swamp deterioration if combined with other stressors (e.g., flooding, herbivory).

Herbivory by both tent caterpillars and nutria also appears to be a potentially important stressor in the south Maurepas swamps. Tupelo trees are susceptible to grazing by tent caterpillars, which can result in almost total defoliation in the spring; cypress trees apparently are not as susceptible. Caterpillar grazing can reduce production of litter by 13.5% (Conner and Day, 1976). Cypress and tupelo are both very susceptible to grazing by nutria, deer, and crawfish (Conner et al., 1986).

A question significant to the evaluation of this area is what happens if and when the swamp dies? From observations made during field visits to this area that were part of the MRSNFR study, it appears that many areas of interior swamp that have substantially opened and stressed or dying overstory vegetation also have bulltongue as understory vegetation. There are also some areas of stable fresh marsh within larger regions of swamp that can be identified as long-term features of the region. However, it is not clear that all or even most areas of dying swamp are converting to stable and healthy fresh marsh. Rather, it is expected that the vast majority of swamp in southern Maurepas will convert to open water. Factors contributing to this, as mentioned above, include the much greater tolerance of cypress and tupelo trees compared to herbaceous understory vegetation for deeper flooding of longer duration; and increasingly unconsolidated nature of the substrate in these swamps, almost certainly due to the demise of below-ground productivity.

The concept presented in the Coast 2050 Restoration Plan to initiate restoration of the upper Pontchartrain Basin swamps (including those south of Maurepas) is to divert Mississippi River water at appropriate locations, with outfall management.

<u>What Questions Need to be Answered in this Study of a South Maurepas Swamp Diversion?</u>

Development of more detailed study design was initiated with a technical scoping ("brainstorming") meeting convened on November 17th. Meeting objectives included discussion of extant knowledge of swamp conditions and their contributing factors; definition of the questions that really need to be answered to determine the need for and best characteristics of a diversion into the Maurepas swamps; and discussion of the best approaches to answering those questions.

The November 17th meeting ended without a formal list of questions and issues, but these matters were effectively addressed during the session. The following list of questions captures the essence of the technical inputs from the November 17th meeting. It is recognized that the various issues interact, and that there are elaborations that can be made regarding any issue. These notes highlight the big picture. Further review and feedback on this list is expected from prospective participating researchers, agency personnel, etc. In their refined state, this list will be used to drive study design and modeling scope.

I. What do we really need to know
   1. What will it take to achieve substantial regeneration (Cypress, Tupelo?)?
   2. Where are conditions conducive to achieving regeneration as a result of a diversion?
   3. How is productivity important to vertical accretion and habitat sustainability?
   4. What will it take to substantially improve productivity?
   5. Where are conditions conducive to improving productivity?
   6. What is the condition of the system in the absence of restoration?
   7. How does/can water move in the system?
   8. What conditions of water movement will best promote productivity and regeneration?
   9. How can these conditions of water movement best be achieved?

10. What conditions of seasonal hydrology will best promote productivity and regeneration?
11. How can these conditions of flooding and drainage best be achieved?
12. How will the optimum hydrologic regime impact private property?
13. How much effect will nutrients in diverted water have on productivity and regeneration?
14. How much of the nutrient load will be assimilated, and how much will reach the lakes?
15. What is the impact of exported nutrients on lake trophic status?
16. How much effect will sediment in diverted water have on productivity and regeneration?
17. What effect will diverted sediment have on lake turbidity and productivity?
18. How much effect will system freshening have on productivity and regeneration?
19. How will system freshening impact lake habitat condition?
20. Will a diversion have any benefits in reducing herbivory problems?
21. Are herbivory problems so severe that restoration is not viable?
22. What other water-quality effects result from diverting Mississippi River water?
23. Where are the best locations for diverting water?
24. What relocations and costs will be associated with a diversion?
25. What are the collective swamp habitat benefits of a diversion?
26. What are the collective non-swamp impacts of a diversion?

II. General nature of all the above questions

a. With respect to an issue, what locations, scales and timeframes are important?
b. For any issue, what is the current condition, and future with/without project?
b. For any issue, what are the controlling factors (e.g. what now determines salinity)?
c. For any issue, how does the system respond (e.g. how does salinity impact trees, fish)?
d. Does the issue require a model to assess existing/future conditions & if yes, what kind?
e. Are existing models adequate to address issues and if not, what is needed?
f. Are existing data adequate to answer questions and if not, what is needed?

Project Objectives: The objective of this restoration concept is to re-introduce river water with its sediments and nutrients to the swamps south of Lake Maurepas, in order to: counter subsidence through both introduction of river sediments and stimulation of organic production with river nutrients; increase health and productivity of the vegetation; restore the river connection and more natural hydrologic patterns of circulation and drainage; increase swamp regeneration; minimize stagnant water conditions; and improve fisheries habitat.

The objective of the study defined in this Project Development Plan (PDP) is to incorporate public input of knowledge, preferences and needs for the area, with data gathering and to evaluate and recommend a feasible plan for a diversion into the south Maurepas swamps. The study will include development and evaluation of alternatives, and will get direction from a steering committee that includes interested members of the public, academic, and agency communities.

Project Opportunities: Due to the net effects of existing flood protection and navigation projects, the substantial freshwater, sediment, and nutrient resources of the Mississippi River, which are the historic building blocks of coastal Louisiana, are for the most part guided around and away from coastal wetland and estuarine areas. The proximity of the south Maurepas swamps to the river represents a tremendous opportunity for useful redistribution of these resources, as recommended in the Coast 2050 plan.

Projects that represent variations of this restoration concept already have been under consideration as alternatives in the Mississippi River Sediment, Nutrient, and Freshwater Redistribution (MRSNFR) Study. The MRSNFR study has determined that a project in the south Maurepas area has sufficient potential to warrant further consideration. The development plan presented here would expand upon the analyses already performed.

A major concern of this study is flooding and impaired drainage that could be exacerbated by the diversion; such concerns would be addressed as an integral component of this study. The developed areas south of Lake Maurepas already experience flooding and drainage problems. This area has recently been evaluated by USACE for hurricane flood protection, and a levee alignment has been proposed. This Project Development effort presents an opportunity to coordinate the evaluation of flood control and drainage improvement measures with evaluations of hydrologic effects of various outfall management options and to maximize the benefits of outfall management features with respect to drainage and flood protection objectives. Through this project development process, the planning and implementation of inter-related hydrologic features could be integrated.

Project Work Activities

Task I. Project Scoping and Coordination

A. Public Meetings and Outreach

A series of public meetings will be held, as needed, to get input for definition of issues and concerns regarding both existing conditions and the prospective restoration concept. The first such meeting was held in Garyville on August 24th. Other smaller meetings have been held seeking early input from elected officials, engineers and planners in St. John the Baptist and St. James Parishes and with the Amite/Blind River Commission. The Governor's Office, Louisiana Department of Natural Resources (LDNR), the Corps of Engineers, the Federal Emergency Management Agency (FEMA), the Lake Pontchartrain Foundation, the Coalition to Restore Coastal Louisiana, and Dr. Gary Shaffer of Southeastern Louisiana University (SELU) have assisted EPA in various of these meetings. After formation of the steering committee (see Task I.B), substantial public involvement and input will be promoted through the committee. A method will be developed to keep the public appraised of progress and direction of the Project Development activities, such as mailings or e-mail announcements.

B. Steering Committee

A steering committee will be established that will include representatives of the main study participants, agencies, local government, conservation organizations, industry, and the public. This committee will jointly review ongoing study results, provide direction to future study elements, and make recommendations to the lead agency regarding project features and other decisions. Their participation will continue throughout implementation of this Project Development Plan.

C. Problem Identification

Existing conditions of the south Maurepas swamps and the prospective No Action alternative will be described, to define the problems facing this region which this restoration concept must try to address. Both existing information and results of initial field studies will be used to accomplish this task. Problem definition was initiated at the technical scoping meeting convened on November 17th. When field studies and modeling of existing conditions are largely completed toward the end of this study, any revisions needed to the description of existing conditions and of the No Action alternative will be made. Specific forecast of no-action conditions for target years that can be used in the WVA evaluation of benefits (i.e., for 5, 10, 15, and 20 years into the future) will be included.

D. Maps and Photos

Appropriate maps and aerial photos will be acquired. These will be used in the preliminary siting task and design of needed field studies, and also to develop project base maps. Project base maps would be developed in digital (i.e., electronic) format.

E. Permit Analysis

Federal, State, and local permits that will be required to construct and operate a diversion project in south Maurepas will be identified, and a critical path chart will be developed that indicates when specific permitting actions must be initiated.

F. Project Management

Conduct and management of this study and associated decision making will be a joint effort coordinated among the CWPPRA Task Force agencies, reflecting a close partnership among the study sponsoring agencies that include USACE, the Louisiana Governor's Office, LDNR, FEMA and EPA; and will closely involve public and local government and interest groups represented on the Steering Committee. Day-to-day management of the various study components must, by needs, be coordinated through one point of contact, with information and study outputs then disseminated to all members of the managing partnership. This point of contact will be EPA and EPA's contractor. Through EPA's contractor, expert assistance, including Dr. Gary Shaffer, an SLU researcher and expert on the Manchac/Maurepas swamps, will be available to assist with strategy evaluation.

Task II. Preliminary Siting

Extensive discussion was undertaken at the technical scoping meeting about the range of practical siting options for a Maurepas diversion. These were based primarily on real estate, relocation, and cost information developed for sites in the MRSNFR study; evaluations of another potential site conducted as part of a recent Bonnet Carre study; and other extant information and input provided by participants. It is clear that there are limited possibilities, including:

- A diversion into the upper (i.e., headwaters of) Blind River, via one or more (relatively small) diversions in the vicinity of Convent, and/or a diversion at Romeville; or

- A diversion into Hope Canal.

The need, defined in the MRSNFR study, for extensive relocations at the Reserve Relief Canal site, including relocation of many residences, was considered a fatal flaw, that essentially eliminates this site from further consideration.

As a result, preliminary siting will focus on the possibilities listed in the bullets above. All existing information pertinent to site feasibility will be summarized in a form (e.g., a matrix) that facilitates site evaluation and comparison. Preliminary efforts to contact major land owners will also be initiated, to determine probable site availability and relocation requirements. The objective of this task is to select a preferred diversion location, if possible, or a preferred location with one or two alternatives if more than one location remains viable after review of information and landowner contacts.

The selected site(s) would become the focus of subsequent field sampling and modeling evaluations. Over the course of the study, results of field studies, hydrologic and ecological modeling will be used to evaluate how much water, nutrients and sediment is needed and can be assimilated by the wetlands from those locations; how flooding and drainage problems can be accommodated through outfall management planning or other project features at those locations, and what the limit on size of diversion would be at the preferred location(s) with regard to management of flooding, drainage, and other hydrologic concerns.

This task must be initiated early in the first study year. An additional outcome of this task would be a work plan, based on the site(s) that remain viable, for subsequent real estate research (see Task III.B, below).

Task III. Data Gathering

A. Existing Information

One immediate priority identified in the November 17th technical scoping meeting was to articulate clearly the factors responsible for healthy local swamps, versus deteriorating ones. This will include gathering of existing information on hydrology and geomorphology, water quality, vegetation, and other habitat characteristics. Specific input will be requested from the Amite/Blind River Commission, the Maurepas Society, the Lake Pontchartrain Basin Foundation, and engineers and planners from parish government and municipalities in St. John the Baptist and St. James Parishes. Documented evidence of past effects from other construction events that may have bearing on this effort, such as construction of I-10 that involved extensive water and sand pumping in the swamp, will be investigated. Anecdotal evidence suggests that land building occurred in some past construction events. This information will support definition of existing conditions and the No Action alternative (see Task 1C above), and will also help identify information gaps that must be filled by focused field studies.

B. Preliminary Real Estate Research

Preliminary real estate research will be conducted during the first year of study, following from result of the preliminary siting efforts, as described above. Specific activities will, of course, be based on the outcome of preliminary siting, but might include: review of existing Tobin ownership maps; review of plats and maps for pipeline, power line, and other utility locations; and field surveys. Real estate considerations will be incorporated into the site selection process, to minimize, as possible, subsequent difficulties with acquisition of land rights, flowage easements, and other rights-of-way. In the long term, a risk-assessment approach could be used, which might include elements such as the following: projected cost of title work; preliminary appraisal of values for purchases and/or easements; information about landowner willingness to sell property or easement; possible existing surface uses of the alternative sites; and estimates of time and cost to finalize documents, etc. Other siting consideration might include (but are not limited to):

- location of conveyance channels along tract boundaries rather than in the middle of a tract to preserve existing uses and increase the likelihood of the owner selling only the needed portion;
- avoidance of existing pipelines for both the conveyance channel and in the outfall area if scour is a possibility;
- avoidance of flooding of private property.

The results of real estate research also will provide the basis for estimating real estate costs associated with each potential site, and for estimating the probability of successfully acquiring needed land-rights and of implementing a diversion at each possible location.

C. Field Sampling

An outcome of the technical scoping meeting was to focus the study questions, which are framed above at least in draft. Another priority activity proposed based on outcome of the technical scoping meeting is to clearly articulate what is presently known about the factors responsible for healthy local swamps, versus deteriorating swamps. The focused study questions plus a clear articulation of existing knowledge will be used to define a detailed field study design; participating researchers are at present providing input to this end. Rationale developed to date that identifies specific study elements needed to address study questions is summarized below.

Studies

The need for swamp field studies focuses on three objectives.

I. Understanding the nutrient assimilation capacity of the south Maurepas swamp, in order to estimate size of a prospective diversion with regard to loading limits to protect adjacent lake water quality and prevent algal blooms.

II. Developing a basis for differentiating influences and responses over a gradient of least to greatest apparent stress, in order to associate swamp conditions with causal factors, especially riverine influences.

III. Supporting analysis of baseline biological conditions in the swamps, to provide input to biological/ecological models, and to support predictions of conditions in the future without a restoration project, in order to define benefits that would be gained from a diversion.

Three major compartments of the swamp plant community would be affected by a freshwater diversion: (1) floodwater variables (chemistry, suspended sediments, hydroperiod, and phytoplankton productivity); (2) soil edaphic variables (interstitial nutrients and salinity, redox status, bulk density, and organic matter content); and (3) the overstory and understory plant community variables (species composition, primary productivity, and reproduction). Efforts to address the above objectives should rely on assessing changes in these main compartments of the ecosystem.

1. Floodwater variables. To adequately size the diversion, preliminary data need to be collected on nutrient loading and assimilation rates under present conditions. Nitrate/nitrite, ammonia, total nitrogen, phosphate, total phosphorus, and silicate are the most important ones

to monitor both in the swamp system and in adjoining water bodies. Salinity in flood waters also affects nutrient assimilation. At a minimum, water samples should be collected every two months. These data will be instrumental in influencing decisions concerning outfall management.

Water level in the swamp affects soil biogeochemistry, including redox and dissolved oxygen status, and can be diagnostic of altered hydrologic conditions. Stagnant water conditions are often an outcome of altered hydrology and persistent flooding.

2. Soil variables. Primary productivity not only responds to the soil environment, but also influences it through below-ground productivity and litter fall. A diversion would be expected to contribute to swamp vertical accretion through increases in biomass production and mineral sediment input. Accurate knowledge of net accretion or subsidence and the processes that influence it are paramount to our understanding of "future with" versus "future without" project scenarios.

3. Plant community variables. Large (perhaps five-fold) increases in swamp primary productivity are expected to occur with a freshwater diversion into the south Maurepas swamps. Over the past several decades, the substrate in southern Maurepas has become increasingly unconsolidated, almost certainly due to the demise of below-ground productivity. If this trend continues (i.e., "future without project"), it is likely that the vast majority of swamp in southern Maurepas will convert to open water.

Primary productivity is an integrated response of the plants to their environments (both positive and negative factors) and therefore provides the single best measure of "future with" versus "future without" project comparisons. It is also a potentially critical input variable to the proposed (future) ecological modeling. In association with productivity, cover value estimates provide information on changes in diversity and open water distribution.

Variables

Based on this information, nine categories of measurements have been identified that respond to study objectives and should be measured as part of this study.

a. Water column nutrients (nitrate/nitrite, ammonia, total nitrogen, phosphate, total phosphorus, and silicate), sampled bimonthly, in the swamp and adjoining water bodies.

b. Water salinities, using a portable field meter.

c. Primary productivity of overstory (woody) vegetation, using litterfall traps and tree-band collars.

d. Primary productivity of understory (herbaceous) vegetation, based on bimonthly clip plots.

e. Cover-value estimates by species, for diversity.

f. Soil biogeochemistry (interstitial nutrients and salinity, redox, sulfides, organic matter and bulk density)

g. Accretion and subsidence, based on Sediment Elevation Tables (SETs)

h. Water levels, using in-place gages.

i. Flow velocities, measured with a portable flow meter during each field effort.

Addressing the first objective of nutrient assimilation requires the water column nutrient measurements, including water column samples from the river, the swamps, major canals and/or bayous, and the lake; as well as the interstitial nutrients. Overstory and understory productivity also is needed, because plants affect natural assimilation directly through uptake; indirectly through production of rhizomes that are sites for microbial development; and indirectly through enhanced substrate stability. Salinity is needed because it may hamper nutrient assimilation due to sulfides and other biogeochemical factors. Water level data is needed because it affects soil biogeochemistry, particularly redox, which affects assimilation.

Evaluation of the second objective, comparing better and worse areas of swamp, requires inputs from all nine categories of measurements proposed. The variables being measured represent either potential controlling factors (e.g., water level, salinity, soil conditions, accretion) or characteristics that integrate ecosystem response to environmental factors (e.g., productivity, diversity). To the extent that the area of swamp influenced by the Amite diversion canal differs from the more stressed areas of south Maurepas swamp, the resulting data may support contrasts of responses along a gradient of stresses, and thus association of conditions with causal factors.

With the possible exception of the nutrient measurements, all variables will contribute to evaluation of the third objective, to predict future conditions without the project. For example, factors including productivity, elevation, and accretion are input variables to an ecological model (Rybzcyk et al., 1998) that projects net wetland surface elevation into the future. To the extent that other variables can be compared along a stress gradient, they can be used to predict future changes in swamp conditions.

Preliminary Design

Preliminary recommendations for a sampling design that would address the objectives, support sampling of the recommended parameters, supply appropriate inputs for the models, and be consistent with long-term monitoring, include the following.

- Establishment of twenty (20) sampling sites for evaluation of overstory and understory primary productivity and cover variables; and soil variables.

- Establishment of 10 Soil Elevation Table (SET) sites, with two (2) stations per site, for evaluation of subsidence and accretion.

- Establishment of ten (10) water-level gauges sites tied to benchmark.

- Measurements of water levels at twenty (20) sites tied to benchmark during ebb and flood high water events.

Immediate Field Activities

At the meeting, some components of field activities were identified as deserving immediate action.

- LIDAR overflights of portions of the Louisiana coast are being conducted for FEMA under the auspices of the Oil Spill Coordination Office. The output will be relative accurate and detailed elevation contours. A synoptic field survey to coincide with the scheduled LIDAR overflight of the study area would provide detailed elevation data at minimal relative cost, and allow absolute values of all water level and bathymetry data collected as part of this study to be corrected to a single datum consistent with the LIDAR elevation data. More detailed and accurate elevation and bathymetry data are essential for both the prospective hydrologic and ecological models. However, recent interactions with the company doing the overflights (3001, Inc.) indicate a change in original schedule, such that the overflight for the study area will occur in April of 2000 (rather than in January or February, as originally anticipated).

- Some aspects of swamp biogeochemistry, nutrient flux, primary productivity and accretion are considered essential to understanding what a diversion would accomplish in south Maurepas, and what its impacts would be. Because most of these measurements require sampling over a full growing season, delay of associated field efforts past the beginning of the upcoming growing season would effectively delay all field studies for another full year. Details of this swamp sampling are described above.

Lidar Field Sampling. It is anticipated that the scheduled Lidar overflight of the south Maurepas swamp area would span a 1 to 2 day period in April. This will miss the optimal period for such flights, during maximum leaf-off and low water conditions. Apparently, no further flights will take place until 3001 replaces its existing equipment with new LIDAR hardware installed in a new airplane, actions expected to take place in February to early March (plus time for testing).

An array of water level gauges will be in place and operational by the time the LIDAR overflight takes place. It will be desirable to be able to rectify water level, bathymetry, and possibly other elevation measurements taken in the Maurepas study area with LIDAR elevation outputs. LIDAR technicians at 3001 recommend a conventional approach to surveying the gauges to existing benchmarks. LIDAR also uses a series of GPS ground stations placed at benchmarks no further than about 35 km apart; resulting information is used to correlate LIDAR returns with surveyed ground elevations. The LIDAR technicians feel that surveying gauges to proximal benchmarks will be adequate to correlate LIDAR elevations with any other bathymetric and/or elevation surveys conducted.

During the LIDAR overflights, field crews would be deployed in the study area as needed to take synoptic measurements of water levels from any staff gauges deployed; data from recording gauges would also be obtained. The water level gauges will be linked to the LIDAR outputs through the synoptic water level measurements.

Immediate Swamp Field Sampling. To ensure that data collection can proceed at the beginning of the next growing season, 10 field sites (half of the total of 20 sites proposed for the full study) would be implemented over the Christmas break. At least 2 of the 10 sites will be located in the area of swamp directly affected by the Amite diversion canal, representing an area of swamp that appears somewhat less stressed that other regions of south Maurepas, presumably due to the associated inputs of freshwater, nutrients and sediments. Productivity, cover, and soil biogeochemistry would be measured at each of the 10 locations; nutrients will also be measured at 10 locations, although sampling locations for nutrients and vegetation do not necessary have to completely coincide. SETs would be duplicated at each site. Water level gages would be installed at 5 of the sites.

Task IV. Hydrologic Modeling

It is clear from the technical scoping meeting, as well as inputs from the Engineering and Environmental Workgroups, that hydrologic modeling is needed to address essential questions in this study. Hydrologic capacity of the receiving area; where water goes, and how diverted water, affects existing water levels have been identified as questions that should be answered to help guide selection of an optimal diversion size.

Final selection of a hydrologic model has not been accomplished, although substantial progress has been made in formulating the essential questions that must be answered (see above). The technical scoping group agreed that immediate selection of models was not essential. Instead, the priority activity identified was to summarize information on existing models in a manner that will help determine those models that already can or could easily be adapted to answer questions specific to this study site.

Specific modeling tasks will depend on which models are selected. For example, if a hydrologic model (e.g., TABS) that already exists for the Maurepas/Pontchartrain area would be selected, only minimal model development might be needed, while site-specific calibration may be required. A detailed modeling scope of study will be prepared after models are selected. General subtasks are summarized below.

A. Model Selection and Review

To evaluate and select the most appropriate model for this project, a matrix will be developed to show which existing models could easily answer project questions. Information on status of the model, whether it has been adapted to the study area or larger region, input data required, level of complexity, etc. will also be incorporated in the decision matrix.

B. Initiate Development of Hydrologic Model for Study Area

The extent of this task required will depend on the models selected and whether they have already been applied to the study area. Existing and field survey information on project area characteristics will be used, as needed, to develop the selected hydrologic model for this study site. It is anticipated that use of more detailed and accurate elevation data, which will be acquired through cooperation with and existing LIDAR survey of portions of coastal Louisiana including the study area, will greatly improve the accuracy of the models selected for application.

C. Simulation of Existing Conditions

Current hydrologic information obtained in Tasks III A & C will be incorporated, as appropriate, in the hydrologic models. Existing hydrologic conditions will be simulated, including water level elevations, flow volumes and velocities, patterns of drainage (including the movement of water across I-10, Airline Highway, LA 641, etc.), and circumstances under which flooding occurs. It is anticipated that ecological modeling will be used to simulate existing levels of productivity, accretion and subsidence, and that these will be compared to results of field studies, as a baseline for simulation of potential future conditions with a diversion. Nutrient flux will be evaluated, either through model simulation or through direct analysis. Other characteristics that may be simulated include tree growth, regeneration, and mortality.

D. Simulation of Diversion Options

The hydrologic model will be used to simulate the effects of different quantities of diverted water on water levels, flows and velocities, drainage, and flooding. It will also be used to evaluate the effects of different actions that could be used to optimize the distribution of diverted water, and to minimize or mitigate drainage or flooding problems. Such actions could include addition and/or enlargement of culverts under highways and railroads, or other outfall management options. Any other project features being considered, such as culverts or spoil bank gaps in the Amite Diversion Canal, will also be evaluated. It would also include simulation of operations during storm conditions, to help define potential emergency response operations that would be needed to minimize storm-related flooding and drainage problems.

Task V. Project Evaluation, Preliminary Design and Costs

A. Evaluation of Alternatives

Results of the various components of the study will be integrated and reviewed to develop and recommend the best project alternative in terms of location and size. Volume diverted will consider, among other factors, the maximum volume that is within the assimilation capacity of the swamp and provides significant benefits to productivity, soil accretion, and other swamp functions, balanced against hydrologic limitations of the project area imposed by drainage, flooding, and other factors. Location will consider factors such as minimization of impacts to cultural, historical, and environmental resources, protection of existing infrastructure, real estate, and land-rights issues as well as maximization of wetland benefits.

B. Preliminary Design

The recommendation on best location and size of the diversion will be used with other site-specific information to recommend a preliminary, conceptual design of major project features. This level of design is minimal, intended only to provide a basis for preliminary cost estimation, to support initial cost-benefit evaluations for the CWPPRA process of selecting projects to move forward to PED. It is not intended to be a level of engineering and design that would lead to development of plans and specifications. This level of engineering and design would occur subsequent to this study in the PED phase, should the recommended project be selected for implementation.

C. Cost Estimates

Preliminary estimates of project costs, including construction, contingencies, engineering and design, environmental compliance, supervision and administration, supervision and inspection, real estate and permitting, operation and maintenance, and monitoring costs, will be made, to support initial cost-benefit evaluations for the CWPPRA process of selecting projects to move forward to PED.

D. Benefits Analysis

A description of expected project benefits will be based on interpretation of the combined results of analysis of existing and field study results, and of hydrologic modeling. To the extent that this project could evolve into a multi-use plan, if various drainage and/or flood control features are integrated into the plan, such drainage, flood control or other benefits would also be described.

Formal analysis of project benefits for purposes of CWPPRA cost-benefit analysis will be estimated through a Wetland Value Assessment conducted through standard CWPPRA channels. Results of field sampling and hydrologic and ecological modeling will provide substantial input for evaluation of WVA variables. Experience in applying the swamp model used to estimate benefits in the WVA shows it generally takes about 50 years for large benefits to be reflected in the model variables.

Task VI. Report

A report will be produced that summarizes results of all components of this Project Development Plan, including clear definition of the preferred project alternative.