Hammond Wetland Wastewater Assimilation <u>Use Attainability Analysis (UAA)</u>

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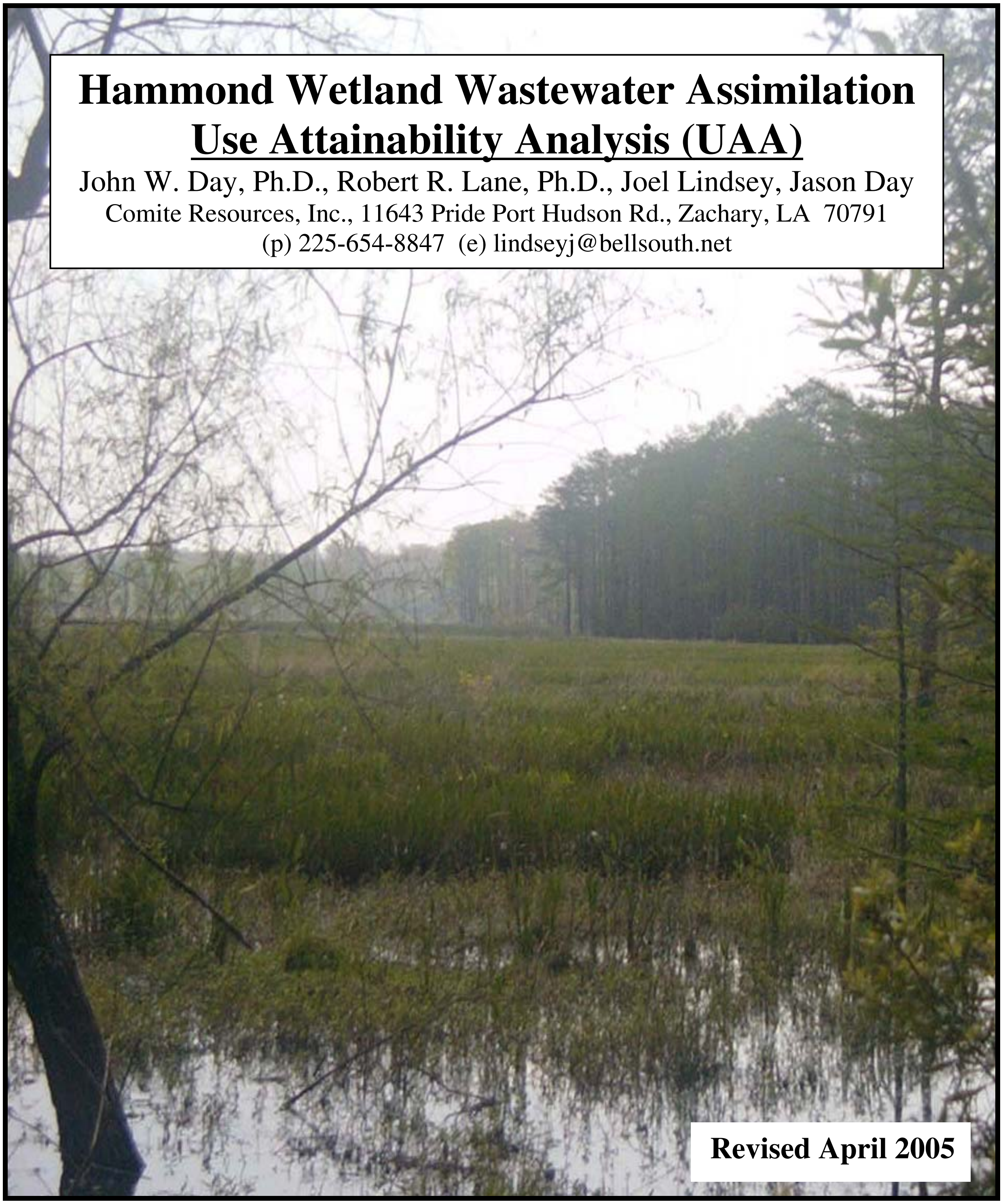

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FIGURES

Executive Summary

A Use Attainability Analysis (UAA) was begun March 2003 to determine the suitability of the South Slough wetlands and the Joyce Wildlife Management Area (JWMA) wetlands for the tertiary treatment of municipal wastewater. Hammond's wastewater treatment facilities will be the source of the wastewater, which have a combined volume of 4 million gallons per day (MGD), but is expected to increase up to 6.5 MGD in the foreseeable future. Flora communities in the South Slough wetlands are mostly cypress-tupelo-willow forested wetlands to the north of South Slough. Just south of the spoil bank along South Slough there is an area of freshwater marsh with mixed cattail and willow transitioning into Sagittaria dominated marsh. Much of the wetlands further south in the Joyce Wildlife Management Area are freshwater forested wetland which grade into fresh to brackish marshes.

This study includes water chemistry analysis, hydrology, sediment characterization, vegetation composition, and primary productivity analysis. There are two types of wetlands in the study area: forested swamps and emergent marshes, which required differing methods to determine plant composition and productivity. In forested swamps, 10 x 100m plots were established, all trees within the plots were tagged, and the diameter measured during the winters of 2004 and 2005. Six leaf litter collection boxes were installed at each plot, and leaf litter was collected periodically during the study. In addition, on-site measurements of pH, temperature, dissolved oxygen, salinity, and conductivity were also recorded at all sites when leaf litter was collected. In emergent marshes, end of season live (EOSL) biomass was collected in the end of September and used to measure net primary productivity. At all plots, water quality samples were taken quarterly and brought to the laboratory for nutrient and sediment analysis.

Nutrient loading rate analysis indicates that the South Slough wetlands and JWMA wetlands will assimilate 85 to 99% of nitrogen and phosphorus discharged from Hammond's wastewater treatment facilities. It is also expected that the productivity of the wetlands will be enhanced and that saltwater intrusion will be reduced. It is likely that there will be an increased area of cattails and willows, but that this will be limited to the South Slough wetlands. The overall results of the study indicate that the use of the

South Slough and JWMA wetlands for wastewater assimilation will be a long-term solution for treatment of effluent from the Hammond wastewater treatment facilities.

1.0 INTRODUCTION

The city of Hammond is evaluating the feasibility of discharging secondarily treated wastewater into the South Slough wetlands and the Joyce Wildlife Management Area (JWMA) wetlands to provide tertiary treatment to the wastewater prior to discharge to local water bodies. This Use Attainability Analysis (UAA) study was carried out to 1) determine the suitability of the South Slough wetlands and the JWMA wetlands for wastewater assimilation, and 2) evaluate the potential impacts of wastewater discharge to these wetlands. Environmental data were collected and analyzed for base line data on vegetation dynamics, water and soil chemistry, and hydrology. This data, along with data provided by the city of Hammond and from scientific literature sources, was used in this UAA.

This UAA on the feasibility of using the South Slough wetlands and JWMA wetlands for tertiary treatment of wastewater from the city of Hammond's wastewater treatment facility benefits from completed UAA's of similar systems at Thibodaux, Breaux Bridge, St. Bernard, Mandeville, Amelia, and Luling, Louisiana, as well as the scientific literature in general. Much of the experimental design presented in this document is based on the success of these past studies (see Day et al. 1999 and 2003 for details).

1.1 Description of area

The city of Hammond is funding an investigation of the feasibility of discharging secondarily treated effluent from the city's wastewater treatment facility into the South Slough and JWMA wetlands. The city of Hammond is located in eastern Louisiana in Tangipahoa Parish, 58 miles north of New Orleans, and 45 miles east of Baton Rouge (Figure 1). The South Slough wetlands are located approximately seven miles south-east of Hammond, and are bordered to the north by South Slough canal, to the west by Highway 51 and I-55, and to the east and south by the JWMA (Figure 2). The city of Hammond owns the South Slough wetlands, and proposes to construct a wastewater distribution system running east-west on the south side of the spoil bank along South Slough to disperse effluent evenly along the northern edge of the wetlands. Wastewater will be prevented from entering South Slough canal. The JWMA is south of the wetland discharge site and will be receiving water after passing through the South Slough wetlands. The JWMA is bordered to the north by uplands, to the west by Highway 51 and I-55, to the south by Pass Manchac, and to the east by Lake Pontchartrain and the Tangipahoa River. Vegetation patterns dominate hydrology in the JWMA, with very few drainage channels, forcing most water to flow overland.

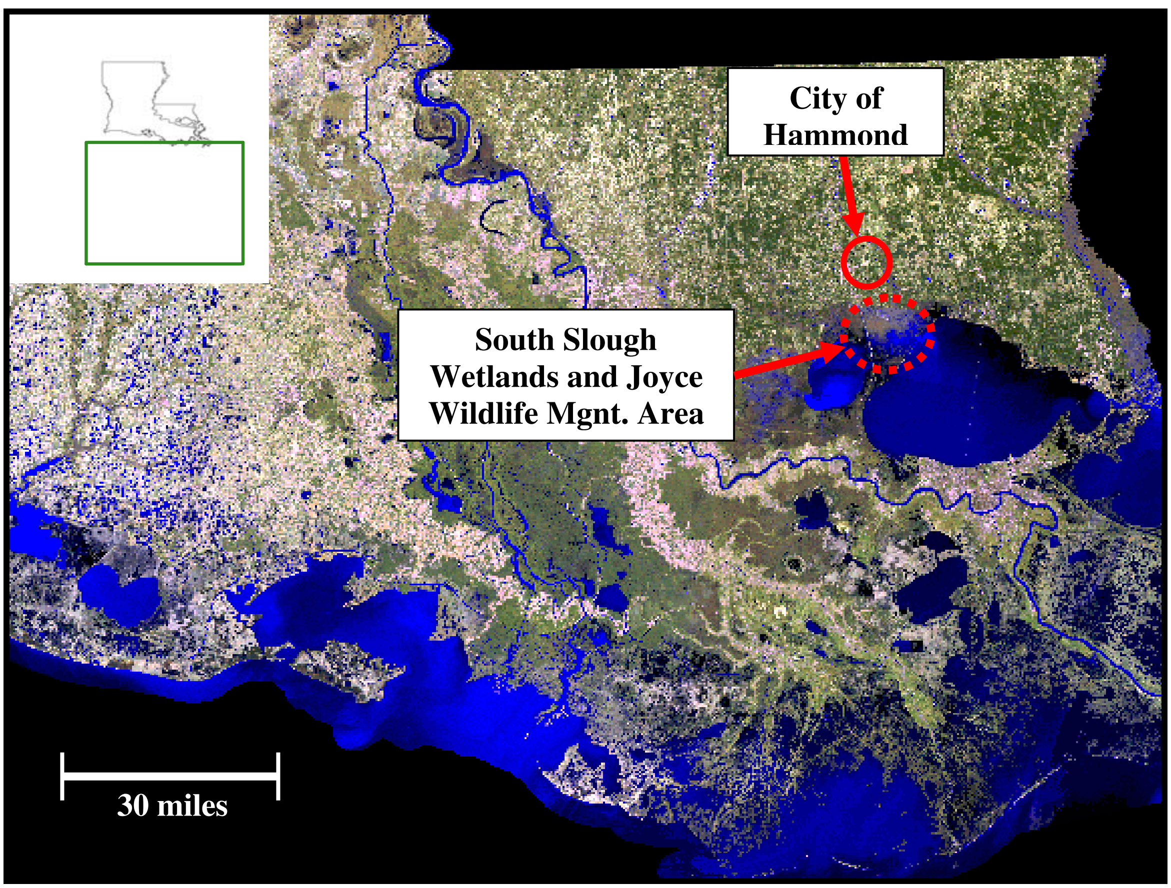

Figure 1 Location of the city of Hammond and the proposed wastewater assimilation wetlands.

The City of Hammond has two wastewater treatment facilities (Figure 3) with combined permitted flows of 4 million gallons per day (MGD). The north sewerage treatment facility is permitted for 1.5 MGD, and is located at 3001 Sun Lane in the northern region of Hammond. The northern facility discharges into Ponchatoula Creek, which drains into the Natalbany River and Tickfaw Rivers, and eventually into Lake Maurepas.

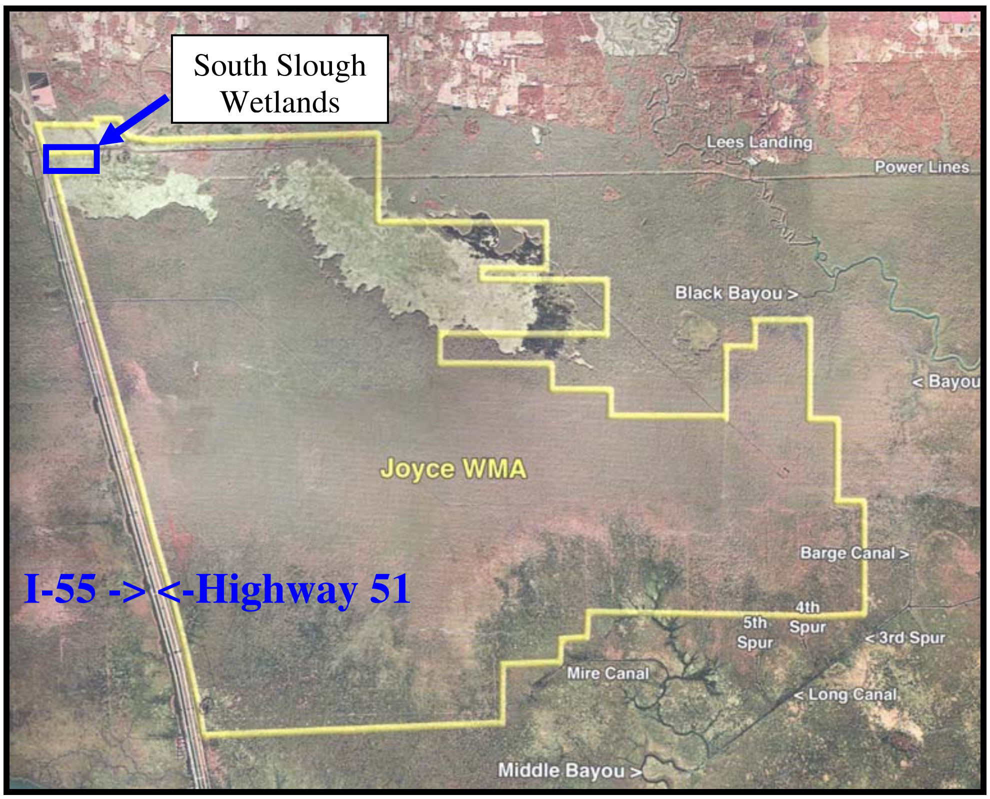

Figure 2 Location of South Slough wetlands and the Joyce wildlife management area (yellow line).

The South Sewage Treatment Plant is permitted for 2.5 MGD, and is located at 1801 Mooney Ave. in the southern region of Hammond. The southern facility discharges into Arnold's Creek, which drains into Ponchatoula Creek and joins effluent from the northern treatment facility. The current maximum allowable concentrations for effluent discharged from the treatment facilities is 10 mg/l for Biochemical Oxygen Demand (BOD_5) and 15 mg/l for Total Suspended Solids (TSS). Hammond has a sewer use ordinance (NO. 01-2822, Article5, Section 35-53) that limits or prohibits the discharge of excessive conventional pollutants (BOD, TSS, and pH) or toxic substances to the sewer from local industries, commercial users, and private residences.

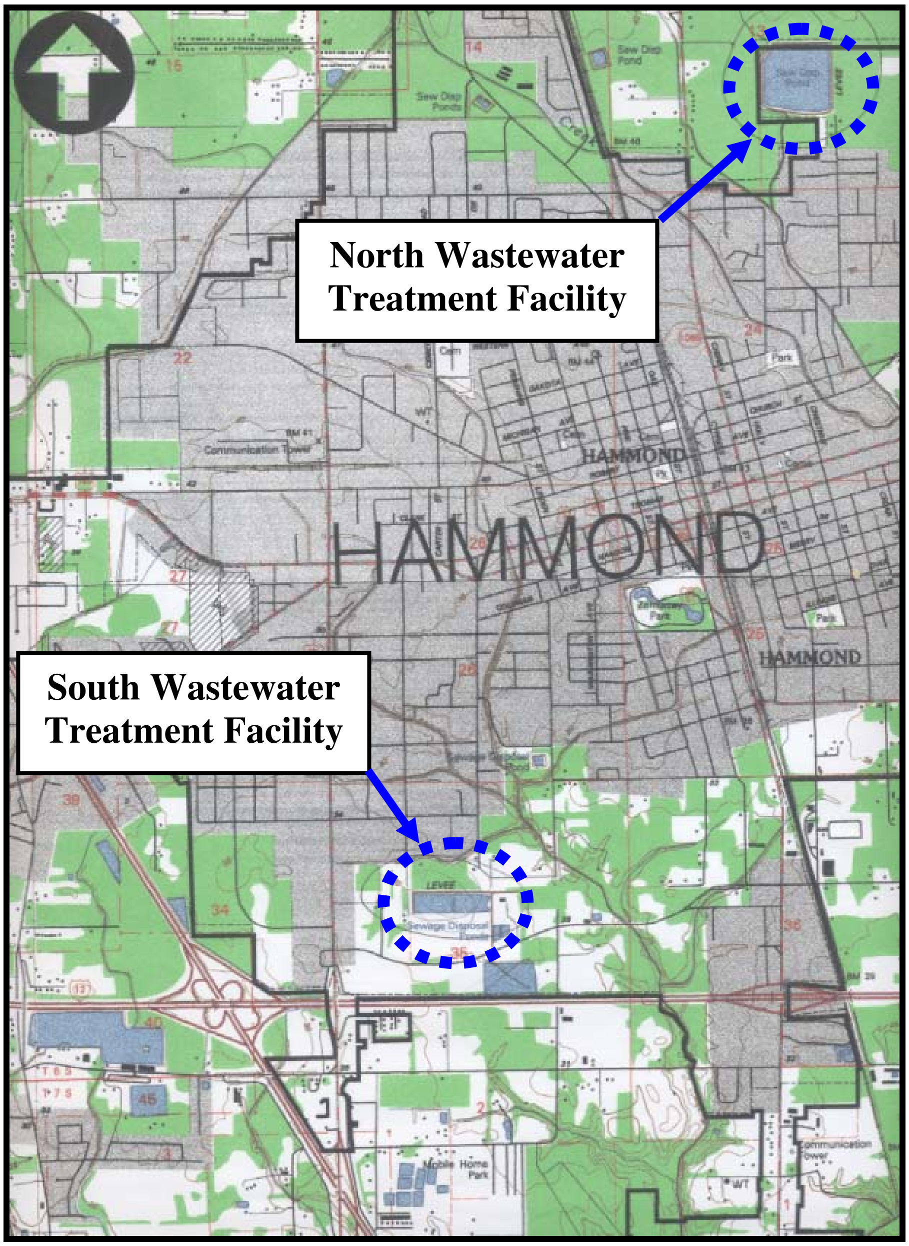

Figure 3. Location of Hammond's wastewater treatment facilities.

1.2 Wetland assimilation of treated domestic wastewater

Wetlands have been used to treat wastewater for centuries, but only in the past several decades has the response to such use been scientifically analyzed in a comprehensive way (Richardson & Davis 1987). The ability of wetlands to perform certain water purification functions has been well established for natural watersheds (Conner et al. 1989; Kadlec and Alvord 1989; Kemp et al. 1985; Khalid et al. 1981 a &b; Knight et al. 1987; Nichols 1983; Richardson & Davis 1987; Richardson & Nichols 1985; U.S. EPA 1987, Kadlec and Knight 1996, Faulkner and Richardson). Studies in the southeastern United States have shown that wetlands chemically, physically, and biologically remove pollutants, sediments and nutrients from water flowing through them (Wharton 1970; Shih and Hallett 1974; Kitchens et al. 1975; Boyt 1976; Nessel 1978; Yarbro 1979; Nessel and Bayley 1984; Yarbro et al. 1982; Tuschall et al. 1981; Kuenzler 1987). Nitrogen, in particular, undergoes numerous chemical transformations in the wetland environment (Figure 4). Some questions remain as to the ability of wetlands to serve as long-term storage nutrient reservoirs, but there are cypress systems in Florida that continue to remove major amounts of sewage nutrients even after 20-45 years (Boyt et al. 1977; Ewel & Bayley 1978; Lemlich & Ewel 1984; Nessel & Bayley 1984). Recently, Hesse et al. (1998) showed that cypress trees at the Breaux Bridge wastewater treatment wetlands, which have received wastewater effluent for 50 years, had a higher growth rate than nearby trees not receiving effluent.

From an ecological perspective, interest in wetlands to assimilate effluent is based on a belief that the free energies of the natural system are both capable of and efficient at driving the cycle of production, use, degradation, and reuse (Odum 1978). The basic principle underlying wetland wastewater assimilation is that the rate of application must balance the rate of decay or immobilization. The primary mechanisms by which this balance is achieved are physical settling and filtration, chemical precipitation and adsorption, and biological metabolic processes resulting in eventual burial, storage in vegetation, and denitrification (Patrick 1990; Kadlec & Alvord 1989; Conner et al. 1989). Effluent discharge generally introduces nutrients as a combination of inorganic (NO_3, NH_4, PO_4) and organic forms. Nitrogen and phosphorus from wastewater can be removed by short-term processes such as plant uptake, long-term processes such as peat and sediment accumulation, and permanently by denitrification (Hemond and Benoit 1988). Wetlands with long water residence times are best suited for BOD reduction and bacteria dieback. Many pathogenic microorganisms in sewage effluent cannot survive for long periods outside of their host organisms, and root excretions from some wetland plants can kill pathogenic bacteria (Hemond and Benoit 1988). Protozoa present in shallow waters actively feed on bacteria. The presence of vegetation can also improve the BOD purifying capacity of a wetland by trapping particulate organic matter and providing sites of attachment for decomposing bacteria.

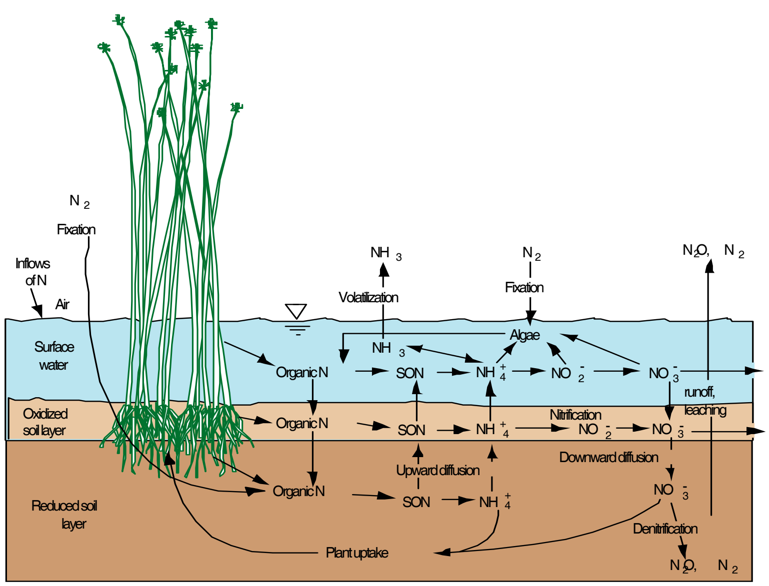

Figure 4. Chemical transformations of nitrogen in wetlands.

The purpose of the Louisiana Water Control Law and Federal Clean Water Act is to protect or enhance the quality of public water, including wetlands. Three components of the water quality standards adopted by Louisiana and approved by the EPA are: 1) beneficial water uses such as propagation of fish and wildlife, 2) criteria to protect these beneficial uses, and 3) an antidegradation policy which limits the lowering of water quality. In Louisiana, discharging treated effluent into wetlands can allow for the potential enhancement and restoration of the functional attributes associated with wetlands such as groundwater re-charge, flood control, and biological productivity (Kadlec and Knight 1996; Rybczyk et al. 1996; Day et al. 1999, 2004). Specifically, most coastal wetlands have been hydrologically altered, and are isolated from the alluvial systems responsible for their creation (Boesch 1994; Day et al. 2000). This makes these wetlands especially vulnerable to the high rates of relative sea level rise (RSLR: subsidence plus eustatic sea level rise) associated with deltaic systems (Penland 1988) and to predicted increases in eustatic sea level rise (Gornitz 1995; IPCC 2001).

Wetlands have been shown to persist in the face of RSLR when vertical accretion equals or exceeds the rate of subsidence (Baumann et al. 1984; Delaune et al. 1983; Stevenson et al. 1986). In the past, seasonal overbank flooding of the Mississippi River deposited large amounts of sediments into the interdistributary wetlands of the delta plain. Not only did these floods provide an allochthonous source of mineral sediments, which contributed directly to vertical accretion, but also the nutrients associated with these sediments also promoted vertical accretion through increased autochthonous organic matter production and deposition, and the formation of soil through increased root growth. This sediment and nutrient source has been eliminated since the 1930's with the completion of levees along the entire course of the lower Mississippi, resulting in vertical accretion deficits (RSLR > accretion) throughout the coastal region. Rybczyk et al. (2002) reported that effluent application at Thibodaux, LA, increased accretion rates by a factor of three.

Contributing further to the problem of vertical accretion deficits, many wetlands in the deltaic region have been hydrologically isolated from surrounding marshes, swamps and bayous due to an exponential increase in the construction of canals and spoil banks during the past century (Turner and Cordes 1987). In addition to impeding drainage and, in many cases, physically impounding wetlands, these spoil banks also prevent the overland flow of sediments and nutrients into coastal wetlands, creating essentially ombrotrophic systems from what were naturally eutrophic or mesotrophic.

The total acreage of swamp forest in the Louisiana coastal zone has decreased by 50% from 1956 to 1990 (Barras et al. 1994). Furthermore, it has been predicted that increased rates of eustatic sea level rise and associated increase in salinity could eliminate most of the remaining forested wetlands (Delaune et al. 1987). In the wetland forests of southeastern Louisiana, Conner and Day (1988) estimated vertical accretion deficits ranging from 2.5 to 10.8 mm/yr, which leads directly to increased flooding duration, frequency and intensity. Productivity decreases observed in these wetlands may be attributed to either the direct physio-chemical effects of flooding (i.e. anoxia or toxicity due to the reduced species of S and Fe), flood related nutrient limitations (i.e. denitrification or the inhibition of mineralization), nutrient limitations due to a reduction in allocthonous nutrient supplies, lack of regeneration, or most likely, a combination of these factors (Mitsch and Gosselink 1986).

Recent efforts to restore and enhance wetlands in the subsiding delta region have focused on attempts to decrease vertical accretion deficits by either physically adding sediments to wetlands or by installing sediment trapping mechanisms (i.e. sediment fences), thus increasing elevation and relieving the physio-chemical flooding stress (Boesch et al 1994; Day et al. 1992, 1999, 2004). Breaux and Day (1994) proposed an alternate restoration strategy by hypothesizing that adding nutrient rich secondarily treated wastewater to hydrologically isolated and subsiding wetlands could promote vertical accretion through increased organic matter production and deposition. Their work, and other studies, have shown that treated wastewater does stimulate productivity and accretion in wetlands (Odum et al. 1975; Mudroch and Copobianco 1979; Bayley et al. 1985; Turner et al. 1976; Knight 1992; Craft and Richardson 1993; Hesse et al. 1998; Rybczyk 1997; Rybczyk et al. 2003).

The introduction of treated municipal wastewater into the highly perturbed coastal wetlands of Louisiana is a major step towards their ecological restoration. The nutrient component of wastewater effluent increases wetland plant productivity (Hesse et al. 1998; Rybczyk 1996), which helps offset regional subsidence by increasing organic matter deposition on the wetland surface. The freshwater component of effluent provides a buffer for saltwater intrusion events, especially during periods of drought, which are predicted to increase in frequency in the future due to global climate change (IPCC 2001). These ecological benefits to wetlands will be in addition to providing the city of Hammond with an economical means to meet more stringent water quality standards in the future.

2.0 PLANNING

2.1 Land use

2.1.1 Existing Land Use

The South Slough and JWMA wetlands are used as habitat for wetland wildlife and for hunting. The city of Hammond owns the South Slough wetlands. The JWMA wetlands are publicly owned, and are managed by Louisiana Department of Wildlife and Fisheries.

2.1.2 Basin Land Use Change

Historically, river spring flood events inundated both riparian and coastal wetlands in the Lake Pontchartrain basin, introducing substantial amounts of nutrients and sediments to these wetland communities. Under natural conditions, much of this water moved as sheet-flow through these wetlands, providing ideal conditions for nutrient and sediment retention. As human population and development increased in the region, nutrient concentrations in upland runoff also increased. The impact of these raised nutrient levels on local water quality was increased by the channelization of distributaries and wetlands for flood control, transportation, and oil and gas activities. This channelization often completely drained or bypassed surrounding wetlands, shunting nutrient rich water directly to major distributaries. South Slough and the canal along I-55 is an example of this. Thus, as urbanization and agriculture increased, the amount of upland runoff passing through wetlands decreased. This has led to a number of ecological changes in the Lake Pontchartrain basin, including eutrophication of basin waters, increased occurrence of saltwater intrusion events, reduced wetland productivity, and decreased wetland surface elevation (Day et al. 1982). Urbanization is likely to dominate land-use in the region for the foreseeable future, and habitat and water quality conditions are expected to worsen if no action is taken.

2.1.3 Future Land Use

The population of Hammond was 18,170 in the year 2000, and has a projected population of 18,990 by the year 2005 and 19,850 by the year 2010. The South Slough and JWMA wetlands have recognized value for flood storage, wildlife habitat, and water quality improvement, making their alteration or development unlikely. There are currently no known plans for development of this area and public ownership of most of the area ensures that this will not occur.

2.1.4 Wetland Ownership/Availability

The city of Hammond owns the South Slough wetlands. The Joyce Wildlife Management Area is publicly owned, and is managed by the Louisiana Department of Wildlife and Fisheries (LWF). The City of Hammond and the LWF have signed a Memorandum of Understanding (MOU), outlining the use of the wetlands for wastewater assimilation.

2.1.5 Accessibility

The South Slough wetlands are easily accessible by way of South Slough, the northern boundary canal that runs east-west and intersects with Hwy. 51. There is a spoil bank along the southern side of South Slough. The spoil bank prevents most water exchange between South Slough and the wetlands to the south and provides upland access to the South Slough wetlands. Access to the interior of the Joyce Wildlife Management Area can only be accomplished by airboat, since there are no roads or navigable bayous or other streams, but the southern portion of the management area (including the Out study site) is accessible by boat via North Pass and Middle Bayou (Figure 2). There is a public boat launch at the North Pass Bridge along Highway 51.

2.1.6 Distance to Wetland

The city of Hammond's southern and northern wastewater treatment facilities are located 6.2 and 8.1 miles, respectively, from the South Slough wetlands.

2.1.7 Current Wastewater Characteristics

Of the 37 estuaries in the Gulf of Mexico area, the Lake Pontchartrain Basin is characterized as having one of the highest levels of eutrophic conditions. In the next 3-5 years, it is expected that Louisiana Department of Environmental Quality (LDEQ) will lower the allowable concentrations for nitrogen and phosphorus, and water quality standards will become more stringent, exemplifying the need for water quality alternatives such as the one described in this report. The effluent currently discharged from Hammond's wastewater treatment facilities will not meet these more stringent standards.

2.1.8 Demographic profile of surrounding area (3 miles)

The three-mile area around the South Slough wetlands is 88.52% land (almost all wetlands) and 11.48% water (US Census). South Slough, an east-west canal, delineates the northern boundary of the treatment wetlands, and is 6.2 miles from Hammond's southern wastewater treatment facility. There are no housing units in the three-mile area.

2.2 Pollutant Assessment

2.2.1 Wastewater Flow Projections

The ability of wetlands to remove nutrients from inflowing water is primarily dependent on the nutrient concentration and volume of water discharged, and the area of wetlands available to receive the discharge. Nutrient uptake is also influenced by temperature and the hydrology of the specific wetland site. For example, when flow becomes channelized in a wetland it decreases the physical interface and time of interaction between the effluent and the surrounding landscape, resulting in greatly lowered nutrient removal efficiency for the system.

Nutrient input into a wetland is normally expressed as a loading rate that integrates the nutrient concentration and volume of the inflow, and the area of the receiving wetland. Loading rate is generally expressed as the amount of nutrient introduced per unit area of wetland per unit time; normally as g N or P per m^2/yr.

Nutrient removal is inversely related to loading rate. Richardson and Nichols (1985) reviewed a number of wetland wastewater treatment systems and found a clear relationship between loading rate and nutrient removal efficiency (Figure 5). Nutrient removal efficiency is the percentage of nutrients removed from the overlying water column and retained within the wetland ecosystem or released into the atmosphere. The relationship between nutrient removal efficiency and loading rate is not linear, with very efficient nutrient removal at low loading rates, and rapidly decreasing removal efficiency as loading rates rise (Figure 5). Mitsch et al. (2001) found a similar loading-uptake relationship for wetland in the upper Mississippi basin.

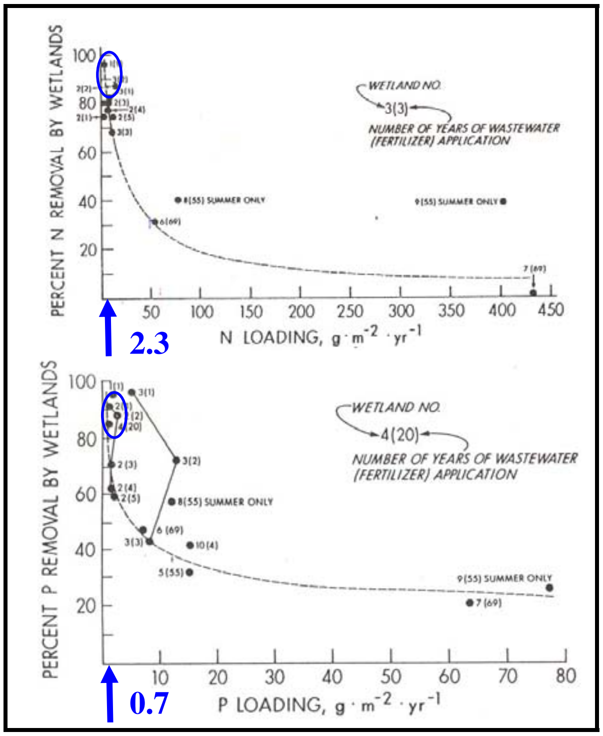

Figure 5. Nitrogen and phosphorus removal efficiency as a function of loading rate in various wastewater assimilation wetlands (taken from Richardson & Nichols, 1985). Blue lines indicate predicted loading to the South Slough and Joyce Wildlife Management Area

The curves of Richardson and Nichols (1985) are for wetland sewage treatment systems located in many different parts of the United States. There are a number of studies from Louisiana where loading rates and nutrient removal efficiencies have been reported. Breaux and Day (1994) provided estimates of loading rate and removal efficiencies for forested wetlands near Thibodaux and Breaux Bridge where secondarily treated sewage was being discharged. Day et al. (2004) showed that this relationship was generally true for all treatment wetlands in Louisiana. Nutrient uptake has also been reported in coastal wetlands receiving Mississippi River water from the Caernarvon freshwater diversion (Lane et al. 1999). We used the loading and removal rates reported in the studies cited above to estimate water quality improvement associated with different alternatives suggested for the Hammond wastewater treatment facilities.

Initially, in order to estimate nutrient removal, the concentrations of total nitrogen (TN) and total phosphorus (TP) and the area of wetlands is needed. TN and TP values were not available for the city of Hammond, so average values for secondarily treated wastewater (10 mg/l TN and 3 mg/l TP) were used (Richardson and Nichols 1985). These values are somewhat high compared to average Louisiana wastewater concentrations, thus, our calculations of nutrient retention are conservative. The current discharge from Hammond's wastewater treatment facilities is approximately 4 MGD (million gallons per day), but we used 6.8 MGD to account for expected rises in discharge volume. Loading rate calculations were based on the wetland area available in the South Slough and the JWMA wetlands (conservatively estimated to be 10,000 acres). The curves of Richardson and Nichols were used to estimate N and P retention (Figure 5).

Calculations indicate that the proposed wastewater assimilation at the South Slough and JWMA wetlands will have nutrient loading rates of 2.3 g N/m^2/yr and 0.7 g P/m^2/yr (Table 1). These nutrient-loading rates are within the lower range for existing wastewater assimilation wetlands in Louisiana (Day et al. 2004). Based on these loading rate estimates, retention rates should range 90-99% for N and 85-95% for P (Figure 5, Table 1). Actual loading is likely to be lower, and actual nutrient retention will likely be higher, since we used above average TN and TP concentration values.

Table 1. Quantity of effluent discharged from Hammond's wastewater treatment facilities (MGD: million gallons per day), nutrient concentration and loading, wetland area available for wastewater assimilation, and nutrient loading rate and predicted percent reduction.

		Nitrogen	Phosphorus
Discharge (MGD)	6.8		
Discharge (m^3/day)	25,700		
Discharge (m^3/year)	9.4×10^6		
Nutrient Conc. (mg/L)		10	3
Nutrient Loading (kg)		94,000	28,200
Wetland Area (acre)	10,000		
Wetland Area (ha)	4050		
Wetland Area (m^2)	40.5×10^6		
Loading Rate (g N/m^2/yr)		2.3	0.7
Predicted Reduction (%)		90-99	85-95

2.2.2 Other Point and Nonpoint Pollution Sources

While there is no known point source pollution other than the proposed treated wastewater, the South Slough and JWMA wetlands receive some water from the Tangipahoa River during high river stage and Lake Maurepas during prolonged southern wind events. The wetland site is hydrologically controlled by rainfall and by inputs from the Tangipahoa River and Lake Maurepas.

2.2.3 The effect of pH on Pond Cypress

There has been some concern that the pH of municipal wastewaters may adversely affect the Pond Cypress (*Taxodium distichum var. nutans*) communities in and around the JWMA. Pond cypress live in slightly acidic soils and water with pH ranges from 5.5 to 6.7 (Monk and Brown. 1965). The Department of Wildlife and Fisheries consider pond cypress a critically endangered natural community in Louisiana.

In December of 2003 and then in March of 2004, a survey of pH measurements was conducted to determine the pH values of the JWMA and surrounding waters. Readings ranged from pH 5.4 to 6.7 in the proposed discharge area along South Slough and in the marsh directly south of South Slough. Along the eastern side of the JWMA values ranged from pH 5.62 to 6.76. Along the southern boundary values were 6.73 to 7.04. On the eastern boundary values were pH 6.25 to 6.53. In all, 25 pH measurements were made.

Measurements made in the wastewater treatment wetlands at Thibodaux and Breaux Bridge, which have been using wetlands for wastewater treatment for 15 and 50 years, respectively, showed significant drops in pH within 50 m of discharge. For example, Breaux Bridge discharged wastewater with a pH of 7.7, and within 30 m pH was 6.8. We therefore believe the introduction of municipal wastewater into the JWMA wetlands will not negatively affect Pond Cypress growth or survival.

2.3 Cultural Resources

2.3.1 Archaeological Resources

In a letter dated June 6, 2003, the Louisiana State Historic Preservation Officer, Laurel Wyscoft, stated no known archaeological sites will be affected by Hammond's wetland wastewater assimilation project (see Appendix).

2.3.2 Historical resources

In a letter dated June 6, 2003, the Louisiana State Historic Preservation Officer, Laurel Wyscoft, stated no known historic properties will be affected by Hammond's wetland wastewater assimilation project (see Appendix).

2.3.3 Natural resources estimation/use

The major natural resource values and land use for the South Slough wetlands are for habitat and flood storage. Timber species in the area are flood-tolerant (Hook 1984) and might be considered insensitive to sewage loading (Kuenzler 1987). From other studies in the southeastern United States, we can expect that the biomass, productivity and leaf area index of under story plants will increase (Ewel 1984; Nessel and Bayley 1984; Hesse et al. 1998), or not be significantly affected (Straub 1984).

2.3.4 Recreation

Hunting and fishing occurs in the forested wetlands surrounding the project area, as well as in the Joyce Wildlife Management Area. These activities will be restricted in the South Slough wetlands, but they should not be impacted in the JWMA.

2.3.5 Protected species occurrence

There has been concern that the addition of secondarily treated wastewater might negatively affect flora and fauna in the JWMA (see Appendix for complete list of species). The bird species of concern are the Bald Eagle (*Haliaeetus leucocephalus*) and bird colony species such as: Little Blue Heron (*Florida caerulea*), Great Egret (*Casmerodius albus*) and Snowy Egret (*Egretta thula*). According to Louisiana Natural Heritage Program (LNHP) there is one active Bald Eagle nest within a mile of the proposed discharge area, but this nest is on the west side of I-55. Work in the discharge area is far enough away to not disturb the eagles. In the one year of site visits to the area, no eagles have been observed in the northern part of the JWMA and no nests have been observed along South Slough. We have observed eagles several times along Pass Manchac. If any Bald Eagles are sighted in the work area, they will be reported to Ines Maxit of the LNHP.

Wading bird rookeries can move from year to year and it would be plausible that rookeries could become established in the area of discharge. However, in the one year of site visits to the proposed area of discharge, no rookery activity has been sighted near South Slough or the spoil bank adjacent to the future discharge area. The South Slough area is heavily used by fishermen and trappers. In other wastewater assimilation wetlands, such as at Thibodaux, wading birds feed regularly in the treatment swamps and flocks have notably grown larger. The addition of wastewater will increase wetland productivity, thus likely improving habitat for wading birds. In any case, all wading bird activity will be reported to the LNHP zoologist Chris Reid.

There are several plant species that are of concern. These are Hemlock water-parsnip (*Sium suave*), Sarvis Holly (*Ilex amelanchier*) and Floating-Heart (*Nymphoides cordata*). The last reported sightings of these plants were in the 1930’s, with exception of Holly, that was found in 1986. If there are sightings of these species, they will be reported to Chris Reid for advice on the best way to protect them.

Freshwater marshes in Louisiana and the JWMA are already threatened by sea level rise and saltwater intrusion. Climate change will likely make these problems worse. Thus, the addition of nutrient rich freshwater will benefit the wetland in terms of increased productivity and preventing salt-water intrusion. All flora and fauna will be monitored before and during treatment, and if any problems do arise, the proper persons or agencies will be contacted.

2.4 Institutional

2.4.1 Permitting Feasibility

The Louisiana Department of Environmental Quality (LDEQ) has issued five sanitary wastewater discharge permits for municipal wetland wastewater assimilation projects: Thibodaux, 1992, Breaux Bridge, 1998, Amelia, 2002, St Bernard, 2003 and Mandeville, 2003. For more information see Chapter 3 River and Stream Water Quality Assessment, 2000 305(b) Part III: Surface Water Assessment, Louisiana Department of Environmental Quality.

2.4.2 Funding sources

The project budget is currently $6.8 million, which includes $4.0 million on hand from City of Hammond's Sewer Revenue bond funds; $435,600 from an EPA STAG grant; $1.0 million from a Louisiana CDBG; and $1.4 million from City of Hammond Capital Improvements appropriation.

2.4.3 Existing/Future Wetland Uses

The use of the South Slough and JWMA wetlands is expected to remain largely the same. The habitat of the wetlands should be enhanced, and the floodwater storage capacity should be maintained.

3.0 GEOMORPHOLOGY

3.1 Wetland Identification

3.1.1 Wetland Classification

The wetland classifications of the study area include palustrine forested, palustrine scrub-shrub, palustrine emergent, and estuarine emergent (Cowardin et al. 1979). Flora communities in the South Slough wetlands are mostly cypress-tupelo-willow forested wetlands to the north of South Slough, transitioning south of the slough into cattail-Sagittaria dominated marsh. After being processed by the South Slough wetlands, effluent will flow into the Joyce Wildlife Management Area. This area is characterized by freshwater forested wetlands and fresh to brackish marshes dominated by spartina sp., with minor species consisting of bulltongue, maidencane, alligatorweed, cattail, common rush, pickerelweed, swamp smartweed, and swamp knotweed.

It is noteworthy that the wetlands immediately south of the spoil bank bordering South Slough are dominated by cattail and willow. This likely reflects periodic inflow of high nutrient waters from South Slough. It is expected that the cattails and willow will expand in the freshwater marsh of the South Slough wetlands, but there should be no composition changes in freshwater marshes further south and east in the JWMA wetlands.

3.1.2 Wetland Boundaries and Delineation

The South Slough wetlands are bordered to the north by South Slough canal, to the west by the Canada National Railroad, US Highway 51 and I-55, and to the south by a power line crossing (Figure 2). There is no hydrological southern boundary and wetlands continue into the Joyce Wildlife Management Area (JWMA). The JWMA is bordered to the north by the uplands and the South Slough wetlands, to the west by the Canada National Railroad, US Highway 51 and I-55, to the south by Pass Manchac, and to east by Lake Pontchartrain and private wetlands west of the Tangipahoa River. The entire area is classified as wetland.

3.2 Relationship to Watershed

3.2.1 Watershed Morphometry

The South Slough wetlands and the JWMA are located in the Lake Pontchartrain Basin in southeastern Louisiana. The Lake Pontchartrain Basin consists of the tributaries and distributaries of Lake Pontchartrain, a large estuarine coastal lagoon-like lake. The basin is bounded to the north by the Mississippi state line, on the west and south by the east bank Mississippi River levee, on the east by the Pearl River Basin and on the southeast by Breton and Chandeleur Sounds. This basin includes Lake Borgne, Chandeleur Sound and the Chandeleur Islands. These coastal waters are characterized as shallow with low tidal energy, long retention times, and increasing nutrient inputs. The northern part of the basin consists of wooded uplands, both pine and hardwood forests, a significant portion of which has been developed. The southern portions of the basin consist of cypress-tupelo swamps and lowlands and brackish and saline marshes. The marshes of the southeastern part of the basin constitute some of the most rapidly eroding areas along the Louisiana coast. Elevations in this basin range from minus five feet in New Orleans, to just at or above sea level at the study wetlands (Figure 6), and to over two hundred feet near the Mississippi border.

3.2.2 Wetland Morphometry

The South Slough wetlands are located approximately seven miles southeast of Hammond, and are bordered to the north by South Slough canal, to the west by Highway 51 and I-55, and to the east and south by the Joyce Wildlife Management Area (Figure 2). The Joyce Wildlife Management Area is south of the wetland discharge site and will be receiving water after passing through the South Slough wetlands. Wetland topography is relatively flat, and lies within the water level variations of nearby lakes and the Tangipahoa River. Vegetation patterns dominate overland flow in most areas, with very few drainage bayous, forcing most water to flow overland.

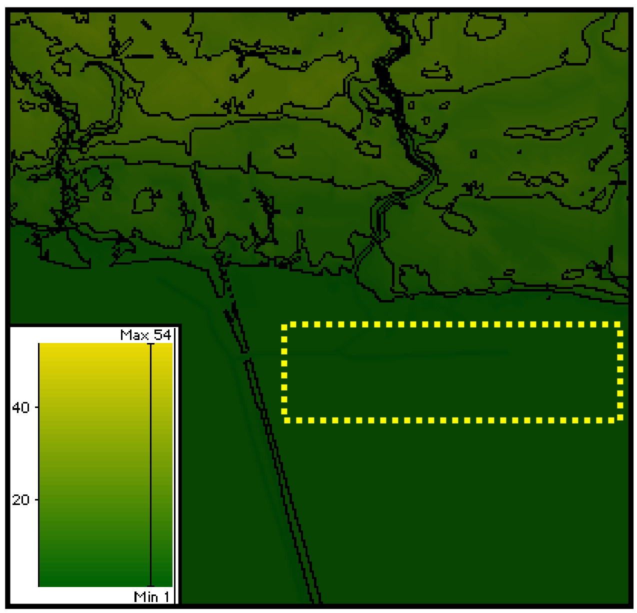

Figure 6. Elevation of South Slough wetlands (located in box; elevations shown in feet).

3.3 Soils

3.3.1 Type

The dominant soil in this wetland site is Kenner muck (KE, Figure 7). This soil is described as very poorly drained, organic and very fluid. The surface layer is very dark grayish brown, slightly acid, very fluid muck about 12 inches thick. The next layer is gray, slightly acid, very fluid clay about 1 inch thick underlain by a layer of black, slightly acid, very fluid muck to a depth of about 17 inches. Below that layer to a depth of about 49 inches is dark gray, neutral, very fluid clay. The next layer to a depth of 84 inches is black, neutral, very fluid muck.

This Kenner soil is ponded or flooded by several inches of fresh water most of the year. The high water table is generally at or above the surface, but during periods of sustained north winds and low gulf tides, it is as much as 6 inches below the surface. Subsidence is very high in these soils (>1.0cm/yr; Penland and Ramsey 1988).

This soil provides habitat for crawfish, swamp rabbits, white tail deer, alligator, and furbearers, such as mink, nutria, otter, and raccoon. The natural vegetation is mainly freshwater forested wetlands, bulltongue, maidencane, alligatorweed, cattail, common rush, pickerelweed, and swamp smartweed, and swamp knotweed.

Figure 7. Soil delineation for the South Slough wetlands (located in box).

3.4 Geology

Recharge potential maps of Louisiana aquifers (U.S. Geological Survey) indicate that the wetland is located within a zone of no recharge potential. Thus, there is no danger of aquifer contamination.

3.4.1 Subsidence

There is a high relative sea level rise along the Louisiana coast that is caused mostly by regional subsidence. This, combined with vertical accretion of the wetland surface, means that a significant portion of the material deposited on the surface of the wetland will be buried and permanently lost from the system. This represents a pathway of permanent loss that is not available for non-subsiding wetlands. Penland and Ramsey (1990) estimated a relative sea-level rise of approximately 1.0 cm/yr in the Louisiana delta plain. Therefore, the potential sink for nutrients via burial is large. Wetlands in the northern part of the wetland area that includes the South Slough wetlands likely have a lower subsidence rate because the depth to the Pleistocene is shallow.

4.0 HYDROLOGY and METEOROLOGY

4.1 Water Budget

To prepare a water budget, monthly precipitation and mean temperature values were obtained from the National Climate Data Center for the meteorological station in Hammond, Louisiana (station Hammond 5E) from 1983- 2003. Using this data, evapotranspiration (PET) was calculated using Thornwaite's equation. The maximum possible sunshine hours used in the calculation of PET were determined from the Normals value for the New Orleans station. Due to the lack of available data, PET was not calculated during 2001. In addition, the 20-year monthly average of precipitation and PET from 1983-2003 were calculated. Data from 2001 was not included in the 20-year average. The water budget can be used to demonstrate the variability of climate during a year in the area and to show the impacts of additional water loading. The components of the water budget are discussed below.

4.1.1 Precipitation

Monthly precipitation at Hammond was highly variable over the 21-year time span from 1983- 2003 (Figure 7). Precipitation ranged from 0.6 to 49.4 cm in May 2003 and September 1998, respectively. The long-term 20-year average of precipitation showed the majority of rain occurred during the spring and late summer. On average, the greatest amount of precipitation occurred in July (16.0 cm). The least amount of precipitation fell in May (10.4 cm).

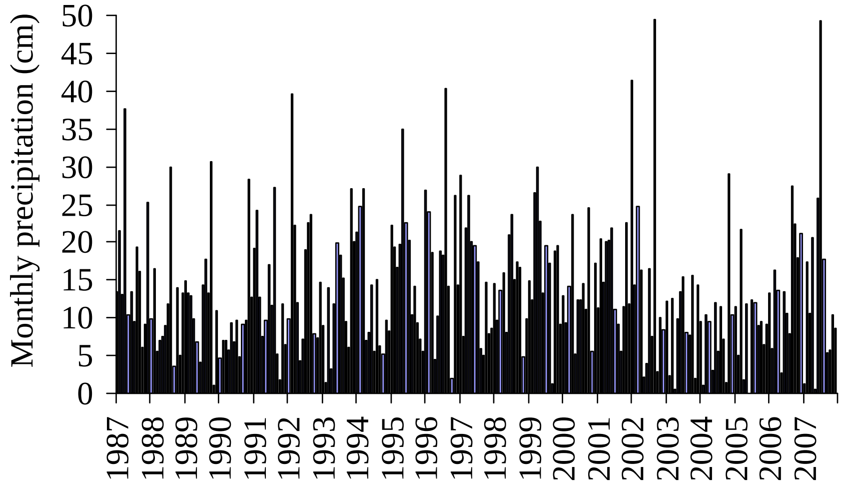

Figure 8. Monthly precipitation at Hammond, Louisiana, obtained from the National Climate Data Center.

4.1.2 Evapotranspiration

Potential evapotranspiration (PET) showed a typical trend of higher values during the warmer months with longer days and lower values during the winter months with shorter days and lower temperatures (Figure 9). PET ranged from 0.5 to 19.8 cm, with the lowest PET occurring during January and December, 1.6 and 1.9 cm respectively, and the maximum during July (17.0cm).

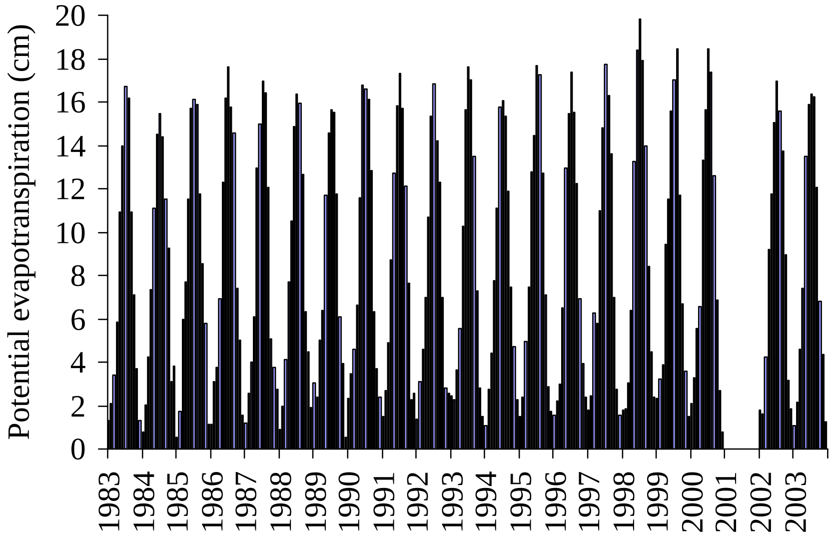

Figure 8. Potential evapotranspiration at Hammond, Louisiana.

4.1.3 Groundwater Interactions

Little is known about groundwater interactions of the site, but in general, there is little lateral groundwater movement in the fine-grained sediments of south Louisiana coastal wetlands. The low conductivity of clays (10.6 mm/sec; Terzaghi and Peck 1968), coupled with the lack of any significant topographic gradient, indicates that horizontal and vertical groundwater velocities are more likely dominated by surface water pressure (head) and density (salinity) gradients rather than gravity or soil permeability. Moreover, the study area is not in a recharge area for any major underlying aquifer, so little or no loss of surface water to groundwater recharge is expected.

4.1.4 Water Surplus/Deficit

Seasonal and annual variations of rainfall give rise to variability in water surplus/deficit (P-PE). Although rainfall is normally greatest during the warm weather months, high evapotranspiration rates during these months often lead to a net water deficit. Rainfall is generally lower during cold weather months, but net water surpluses are observed due to low evapotranspiration rates.

In this study, the average precipitation exceeded average PET during all months except May-August, resulting in a surplus of precipitation in comparison with PET during the majority of the year, but a deficit during the summer months of May- August (Figure 10). This water deficit during the summer months combined with southerly winds leads to conditions favoring saltwater intrusion during major storm events. The introduction of the freshwater effluent from Hammond will create a freshwater buffer that will reduce the potential for such salinity intrusion problems.

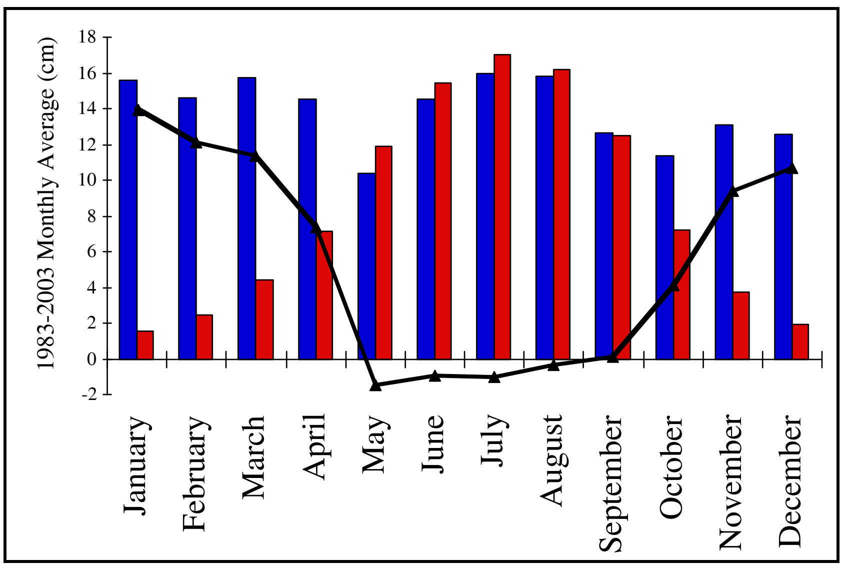

Figure 9. Average rainfall (blue), potential evapotranspiration (red) and net surplus/deficit (line).

4.1.5 Measurement of Water Flux on the Western Boundary of the Joyce Wildlife Management Area

An issue of concern is whether water flows out of JWMA by way of the culverts and bridges along the western border, thereby bypassing much of the available wetlands. At some times of year, there are considerable flows from the JWMA to the west, and some people familiar with the area consider that the dominant flow in the northern part of the JWMA to be from east to west. In order to determine the importance of this potential short circuit, we carried out a number of measurements of flow through the culverts and bridges under the service road on the east side of I-55.

Between North Pass and Sough Slough, there are 15 culverts or bridges under the road. We measured water level, and current direction and velocity 11 times from March 30 to May 22, 2004 (Table 2). During the study period, there were no strong flows measured either into or out of the JWMA, even when there had been heavy rains. The only exception was the final flow measurement when lake levels were low. For example, the measurements on May 12 occurred after heavy rains of between 5 and 10 inches the prior two days and the flow at South Slough was strongly to the west at 33 cm/sec. However, where there was flow under road (openings 9, 10, 11, 12, and 13), the flow was east into the marsh. On May 22, following additional heavy rains and when the lake levels were low, there was strong flow out of the JWMA to the west. These data indicate that the most important factor controlling flow along the western boundary is the water level in Lake Maurepas. There is a canal along I-55 connecting the lake to the culverts. Since water level fluctuations are much greater in the lake than in the wetland, lake water levels will primarily control flow.

Table 2. Water flux through culverts and bridges on the western edge of the JWMA (+= flow into the JWMA, -= flow out of the JWMA (cm/sec)). Bridge #1 is located near North Pass, and #15 is located near South Slough. The Wildlife and Fisheries boardwalk (and the Mid Site) is located between #14 and #15. No data is given for bridges 2, 3, 6, 7, 14 and 15 because flow was measured to be zero.

Bridges	**3/30/04**	**4/1/04**	**4/5/04**	**4/7/04**	**4/12/04**	**4/13/04**	**4/25/04**	**4/26/04**	**4/26/04**	**5/12/04**	**5/22/04**
1	0	0	0	0	-1	0	-2.7	0	0	0	41.6
4	0	-2.4	0	0	-5.8	0	0	1.6	-10	0	15.3
5	0	0	0	3.5	-5.5	0	0	4	-5.7	0	136.3
8	-1	0	0	0	0	0	0	0	0	0	37.0
9	0	0	0	0	0	0	0	3.3	0	3.7	19.8
10	0	0	0	0	0	0	-3.2	5	0	16	28.8
11	0	0	0	0	0	0	0	3.7	-12.5	3.2	32.5
12	0	0	0	0	0	0	0	4.1	-4.7	4.3	19.0
13	-3	0	0	0	0	0	0	3	0	4.3	31.3
16	0	-8	0	0	-8.3	-22	0	-16.6	-12.5	-33.3	119.0

It is likely that water flow out of the JWMA to the west occurs mainly in the winter when low lake levels are generally lowest, although the final measurements show that this can occur at times of year other than winter. High Tangipahoa River levels with east winds could also contribute to a westerly flow of water through the area. We conclude that water flow through the western boundary of the JWMA is not a dominant path of water movement for most of the year. The hydrological modeling discussed in the next section will contribute to answering this question. If water flow to the west is discovered to be a major pathway at certain times, then a low weir can be constructed at the first, and perhaps the second opening in the western boundary south of South Slough to prevent discharge of water out of the JWMA.

4.1.6 Relative Contribution of Sources – Hydrological Modeling

Hydrologic inputs to the wetland study area include precipitation, daily tides, upland runoff and the Tangipahoa River during high river stage. In order to understand and predict the behavior of such a complex system a TABS-MD computer hydrologic model was developed. The TABS-MD model, an extremely reliable engineering model, has been used extensively in the university research environment (Barrett 1996; Freeman 1992; Roig 1994). Barrett (1996) used the TABS-MD model for wetland design. Freeman (1992) conducted a review of the model behavior in shallow water, and Roig (1994) used this tool for marsh and wetland modeling.

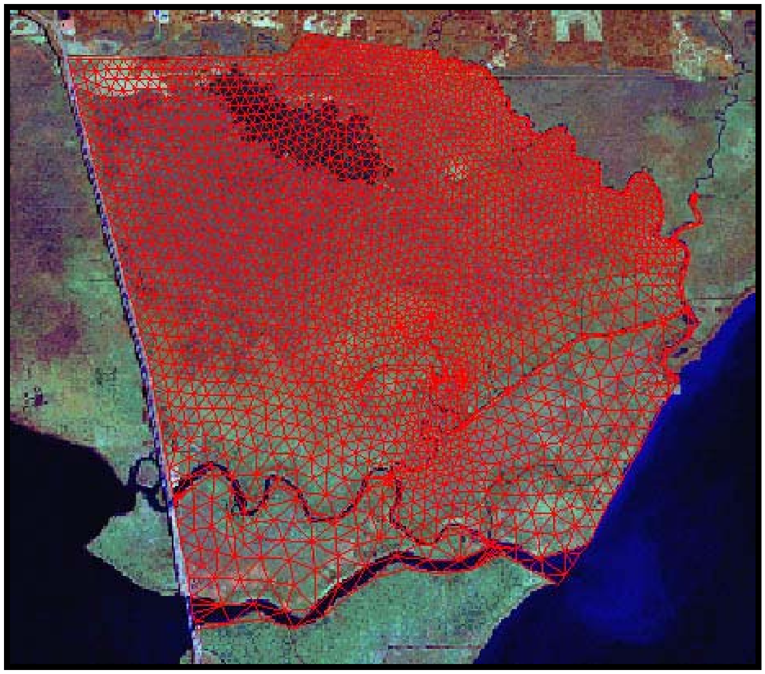

Figure 10. The finite element mesh of the study area used in the TABS-MD hydrologic model.

Two modules (GFGEN, RMA2) of the TABS-MD are used in this study. The module GFGEN was used to create the finite element mesh of the study area (Figure 11); the module RMA2 simulated hydrodynamic conditions of the study area. The RMA2 program is a two-dimensional depth-averaged finite element hydrodynamic model that is two-dimensional in the horizontal plane. Like all vertically averaged schemes, it is not recommended where vortices, vibrations or vertical accelerations are of primary interest (Donnell et al. 2000). Vertically stratified flows are similarly beyond the capability of this model (Donnell et al. 2000). The TABS-MD model assumes the fluid is vertically well mixed with a hydrostatic pressure distribution; vertical acceleration is assumed negligible.

A 6.5 MGD diversion run of one-month duration was made to examine the change of water surface elevation and velocity profile compared to a no discharge scenario. Based on surveyed and observed data, the topography of the receiving swamp was created and the ranges in elevation were found to be roughly 1.0 ft. A constant tide elevation of 1.0 ft was used as the boundary conditions.

Model results suggested that water levels would be raised by less than 2 cm under the designed discharge scenario and that flows were at steady state in less than one month. Change in flow velocity due to the diversion was found to be 0.2 cm/sec. Flow directions are mostly southeastern while some circulation toward the west was observed near the discharged point (Figure 12). For this reason, it is recommended that culverts 14 through 16 be hydrologically restricted by weirs, flap-gates or total closure.

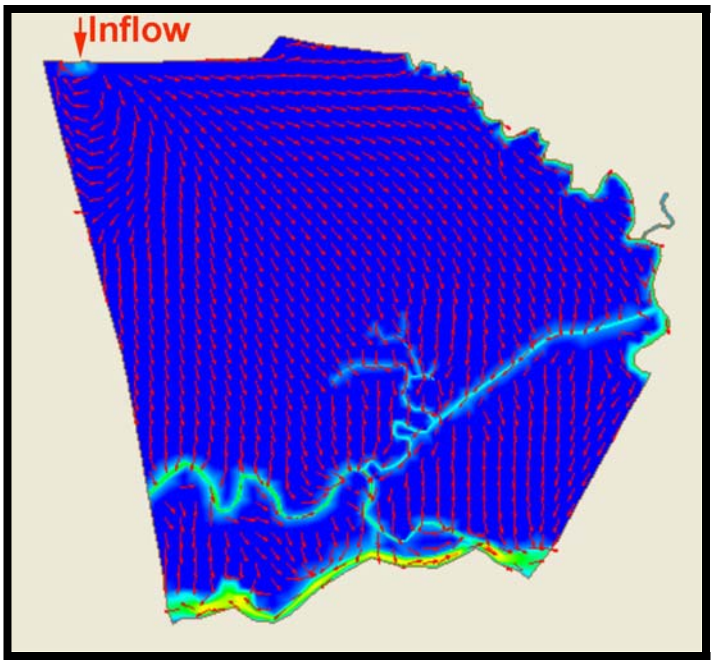

Figure 11. Water flow vectors at steady state resulting from TABS-MD hydrologic model.

5.0 METHODS

5.1 Sampling Design

The city of Hammond will be discharging secondarily treated sewage effluent from the city's two treatment facilities along the northern edge of the South Slough wetlands using a wastewater distribution system to disperse effluent evenly and promote overland flow (Figure 13). In order to effectively monitor the effect of this discharge on the floral and faunal components in the receiving wetlands, several study locations were identified and delineated. The region surrounding the future location of the wastewater distribution system was designated as the Treatment Site. The region where effluent will pass out of the Joyce Wildlife Management Area into Middle Bayou was designated as the Out Site. A study site was also established in the forested wetlands south of the treatment site, designated as Mid Site. Two control sites, one forested and one marsh, were also established in hydrologically isolated but ecologically similar wetlands located nearby (Figure 13). The forested wetland control site, referred to as Forested Control in this document, is located just west of Black Bayou. The marsh control site, referred to as Marsh Control in this document, is located near the southwestern corner of the JWMA (Figure 13). Together, the sites described above will be referred to as the Study Sites in this document.

Results of other wetlands assimilation sites in Louisiana indicate that benthic community sampling is highly variable and not particularly relevant or useful for wetland monitoring and assessment (Day et al. 1993, 1997, 2004). Therefore, benthos will not be included as part of the sampling design for this UAA. Instead, monitoring of the vegetative community of the South Slough and JWMA wetlands will be used to provide the required technical data for protecting wetland uses as required under the Clean Water Act.

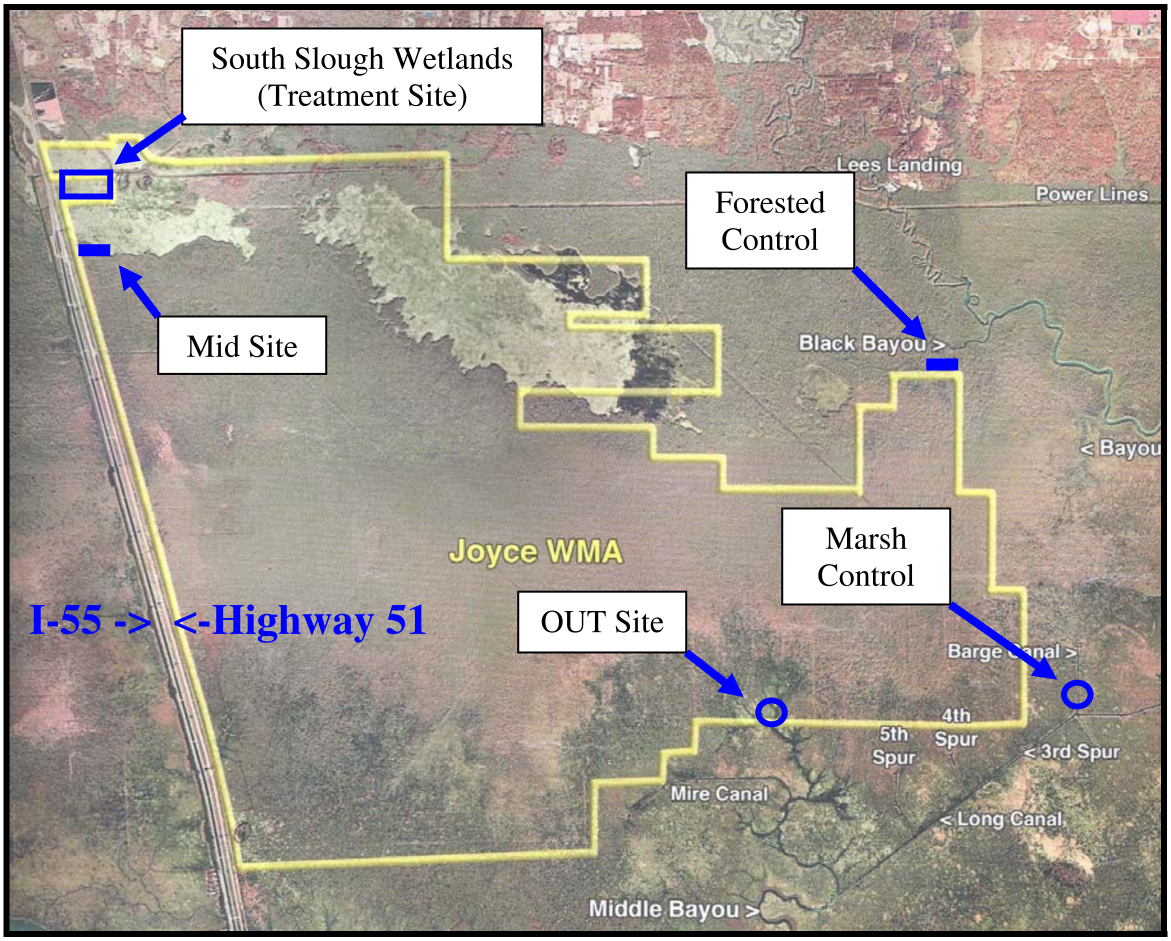

Figure 12. Location of South Slough wetlands, the Joyce wildlife management area (yellow line), and study sites established for this UAA.

5.2 Water Level

Measurements of daily water level were taken in the Treatment, Out and Swamp Control sites using automatic water level recorders produced by Remote Data Systems, Inc. These recorders have internal data loggers that were programmed to record water level once a day at 8 am. The data were downloaded onto a Palm Pilot series i705 and later uploaded to a PC computer. The data were calibrated using staff gage readings taken in the respective plots. The data were referenced to the ground so that positive values indicate flooding and negative values indicate subsurface water level. The water level recorders were deployed on June 13, 2003, at the Out Site, July 25, 2003, at the Swamp

Control Site, and April 27, 2004, at the Treatment Site. The late deployment at the treatment site reflected the fact that there was some uncertainty about the exact location of the treatment area until spring of 2004.

5.3 Water Quality

Water quality was measured at all study sites. Dissolved oxygen, water temperature, conductivity and salinity were measured *in situ* using a Yellow Springs Instrument Co. meter. Discrete water samples were taken 5 to 10 cm below the water surface with effort taken not to stir bottom sediments or include any film that may be present on water surface. The samples were immediately stored at 4˚C, on ice, for preservation. The samples were transported to Comite Resources analytical laboratories, and within 24 hours filtered and subsampled. Samples analyzed for nitrate+nitrite were filtered in the laboratory using 0.45 um Whatman GF/F glass fiber filters, and unfiltered samples were subsampled into 125 ml bottles. Both filtered and unfiltered samples were frozen until analysis. The samples were analyzed for nitrate+nitrite (NO_3+NO_2-N), total Kjeldahl nitrogen (TKN), and total phosphorus (TP) by American Analytical and Technical Services, Inc., Baton Rouge, LA, using EPA methods 353.2, 351.2, and 365.1. Total nitrogen (TN) was calculated by adding NO_2+NO_3-N and TKN values.

5.3.1 Quality Assurance/Quality Control

Quality Assurance/Quality Control procedures were complied with throughout the project period. A log of all samples received in-house, the type of analysis performed and the QC performed was maintained by document control. The following procedures were followed to insure QA/QC compliance.

5.3.2 Laboratory Blanks

Laboratory, or method blanks consisted of deionized water used for the dilution, glassware cleaning, or any other function utilized in the analytical procedure being performed. The blank was treated exactly as the samples, being of the same volume and carried through the same procedures as the lot of samples analyzed. Laboratory blanks allowed for the detection of interference arising from contaminated glassware, reagents, solvents, or other materials utilized in sample processing and analysis. Blanks were analyzed at a minimum of one per analytical batch in the sample lot.

5.3.3 Field Blanks

Field blanks consisted of laboratory-deionized water placed in a sample container that accompanied sample bottles and the resulting samples through collection, shipment and storage of the samples. As with laboratory blanks, field blanks were carried through the same analytical procedures as the samples analyzed. Field blanks allowed for the detection of contamination arising during sample collection, shipment or storage.

5.3.4 Matrix Spikes/Matrix Spike Duplicates

Matrix spikes and matrix spike duplicates were analyzed at a minimum of 1 in 20 or every two weeks, whichever came first. Matrix spikes and spike duplicates were utilized to the precision of the complete analytical procedure and in some instances were also utilized to assess sample collection procedures. In addition, spike recoveries were examined to determine the effects of the sample matrix on compound recovery during extraction and analysis.

5.3.5 Reference Standards

Reference standards were analyzed as appropriate to assess analyst and laboratory proficiency.

5.3.6 Equations Used to Assess Data Precision, Accuracy and Precision

Precision is defined as the reproducibility of multiple data points that have been generated for a particular method under identical condition. For duplicate samples, precision is expressed as the relative percent difference (RPD) where: RPD = (X1-X2)/X (l00), and Xl and X2 are the sample and duplicate values, respectively.

Accuracy is a measure of the closeness between an experimentally determined value and the actual value, the latter of which is determined by the analyst using sample spikes, surrogates, or reference standards. Accuracy is expressed in percent recovery, %R = Observed value/Actual Value x 100.

5.4 Vegetation

5.4.1 Tree Productivity

Two 10 x 100 m quadrates, divided into three 10 x 33.3 m subplots, were established at the Mid and Forested Control sites. Two 0.25 m^2 leaf litter boxes, with screened bottoms and approximately 10 cm wide sides, were placed randomly in each subplot. Leaves and other materials collected in the boxes were gathered periodically starting September 30, 2003. We use the term 'leaf litter' in reference to all non-woody litter including flowers, fruits, and seeds that typically account for < 10% of the non-woody litterfall total (Megonigal and Day 1988). Large stems and sticks were removed from the litter, and the cleaned litter was dried to constant mass at 65 degrees Celsius and weighed.

The diameter (dbh) of all trees were measured above and below (≈5 cm) an identification tag during the winters of 2004 and 2005. For woody growth, measurements are taken in the winter dormant period. This method allowed measurements to be taken a safe distance from the tag's nail, which often caused a small localized swell. Diameter was measured above the butt swell on large cypress trees. We assumed that the contribution of wood from stems <10 cm dbh and herbs was a relatively small fraction of aboveground net primary production (Phillips 1981; Megonigal et al. 1997).

Tree species composition analysis was carried out using equations 1-3 (modified from Barbour et al. 1987). Basal area is defined as the trunk cross-sectional area of a given species in cm^2/m^2.

Relative density = (individuals of a species) / (total individuals of all species) (1)

Relative dominance = (tot. basal area of a sp.) / (tot. basal area of all sp.) (2)

Importance = Relative density + Relative dominance (3)

Stem production was estimated from annual changes in wood biomass calculated using allometric equations based on stem diameter at breast height (dbh, ≈1.3 m) as the independent variable (Table 3). Aboveground net primary production (NPP) was calculated as the sum of leaf litter and wood protection. Woody litter was not included because we assumed that all wood production was accounted for by the allometric equations that were based on measurements of whole-plant wood biomass.

The following steps are used to calculate aboveground net primary production:

- Estimate biomass (kg) from dbh (cm) for each year measured (Table 3).
- Sum biomass per study site and divide by area (m^2) of study site. This calculates the Biomass per unit area (kg/m^2) for each year and study site.
- Subtract Yr1 biomass (kg/m^2) from Yr2 biomass, and multiply by 1000. This calculates Net Primary Productivity (NPP) ($g/m^2/yr$).

Table 3. Regression equations used to convert diameter at breast height (DBH) measurements

Species	Biomass	f(D)	DBH Range	Reference
Fraxinus spp.	Biomass(kg)	= ((2.669*((DBHcm*0.394)^2)^1.16332))*0.454	>10 cm	Megonigal et al. '97
Taxodium distichum	Biomass(kg)	= 10^(-.97+2.34*LOG10(DBHcm))	>10 cm	Megonigal et al. '97
Nyssa aquatica	Biomass(kg)	= 10^(-.919+2.291*LOG10(DBHcm))	>10 cm	Megonigal et al. '97
Acer rubrum	Biomass(kg)	= ((2.39959*((DBHcm*0.394)^2)^1.2003))*0.454	10-28 cm	Megonigal et al. '97
Quercus nigra	Biomass(kg)	= ((3.15067*((DBHcm*0.394)^2)^1.21955))*0.45	10-28 cm	Megonigal et al. '97
	Biomass(kg)	= ((5.99898*((DBHcm*0.394)^2)^1.08527))*0.45	>28 cm	Megonigal et al. '97
Salix spp.	Biomass(kg)	= 10^((-1.5+2.78*LOG10(DBHcm)))	n.a.	Scott et al. 1985
Other Species	Biomass(kg)	= ((2.54671*((DBHcm*0.394)^2)^1.20138))*0.45	10-28 cm	Megonigal et al. '97
	Biomass(kg)	= ((1.80526*((DBHcm*0.394)^2)^1.27313))*0.45	>28	Megonigal et al. '97
All species <10cm)	Biomass(kg)	= ((2.50008*((DBHcm*0.394)^2)^1.19572))*0.45	<10cm	Phillips 1981

5.4.2 Marsh Productivity

At each non-forested marsh study site, end of season live (EOSL) biomass was measured using five randomly placed 0.06 m^2 quadrats. Clip plot samples were collected during the last two weeks of September 2004, 10-20 m from the bayou edge in an area of relatively homogenous herbaceous vegetation. Vegetation within the quadrat was cut as close to the marsh surface as possible, stored in labeled paper bags, brought back to the laboratory, and refrigerated until processing. Live material was separated from dead, and dried at 60°C to a constant weight. All data are presented as live dry weight per square meter basis (g dry wt m^{-2}), and is representative of aboveground net primary productivity (NPP).

5.5 Soil Characterization

Bulk density cores were taken from the study sites using a 10 cm long 2.5 cm diameter 120 cm^3 syringe with the top cut off. This allowed the application of suction as the core was taken, greatly reducing compaction. The sample was sliced into 2 cm sections, dried at 100 degrees Celsius for 24 hours, and weighed. Bulk density was calculated in g/cm^3 units.

6.0 RESULTS

6.1 Water Level

Water levels fluctuated greatly during the study period, but generally were at or above surface level at all sites (Figure 14). Water levels at the Treatment site, which were recorded from May to December 2004, ranged from just at the surface during August to a spike of 112 cm at the end of September (Figure 14). Water levels at the Out site, which were recorded from June 2003 to December 2004, fluctuated between –26 cm to 112 cm, with several large pulses of water recorded in July 2003, and April, June and September of 2004. Water levels at the Forested Control site ranged from –10 to 125 cm, following much the same pattern as the Out site. The high degree of correlation between the Forested Control and Out site (Figure 14) suggests a hydrologic connection between the two sites, with the Tangipahoa River, large storm events and southern winds being the primary forcing functions on water levels in the region.

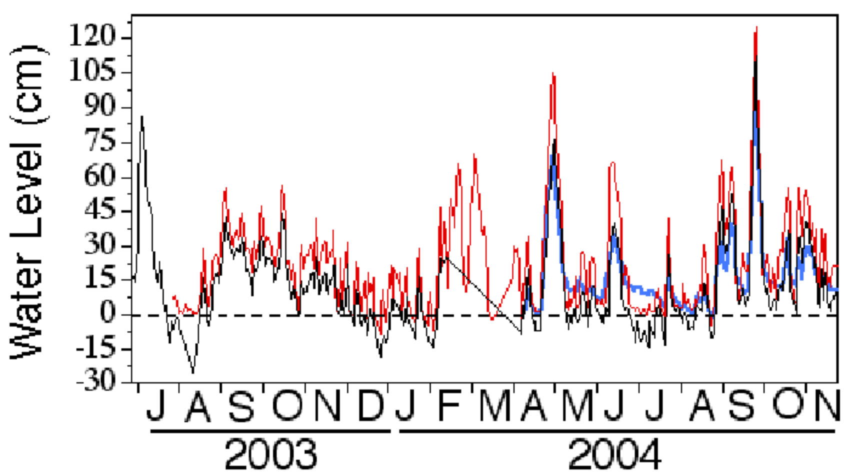

Figure 13. Water levels at the Treatment (blue), Out (black) and Forested Control (red) study sites

6.2 Vegetation composition and productivity

The Mid site was numerically dominated by Cypress (*Taxodium distichum*, n=160), and Tupelo (*Nyssa aquatica*, n=40), followed by Wax Myrtle (*Myrica cerifera*, n=31), Red Maple (*Acer rubrum*, n=8), Water Oak (*Quarcus nigra,* n=2), and Buttonbush (*Cephalanthus occidentalis*, n=1; Table 4). Cypress had the highest basal area, Relative Density and Relative Dominance, followed by Tupelo and Wax Myrtle. The sum of these indicators, as given by the Importance Value, shows that Cypress was by far the most important species in the Mid site, followed by Tupelo and Wax Myrtle (Table 4).

Table 4. Tree species, number of individuals per plot, Basal Area, Relative Density, Relative Dominance and Importance Values.

Site	Species	Number of Trees	Basal Area (cm^2/m^2)	Relative Density	Relative Dominance	Importance Value
MID	Buttonbush	1	0.02	0.4%	0.0%	0.00
MID	Cypress	160	39.58	66.1%	80.1%	1.46
MID	Red Maple	8	0.78	3.3%	1.6%	0.05
MID	Tupelo	40	8.34	16.5%	16.9%	0.33
MID	Water Oak	2	0.06	0.8%	0.1%	0.01
MID	Wax Myrtle	31	0.61	12.8%	1.2%	0.14
F-CON	Buttonbush	10	0.16	5.3%	0.7%	0.06
F-CON	Cypress	61	10.10	32.6%	44.2%	0.77
F-CON	Red Maple	11	0.27	5.8%	1.1%	0.07
F-CON	Tupelo	98	12.10	52.4%	52.9%	1.05
F-CON	Wax Myrtle	7	0.23	3.7%	1.0%	0.05

The Forested Control site was numerically dominated by Tupelo (n=98) and Cypress (n=61), followed by Red Maple (n=11), Buttonbush (n=10), and Wax Myrtle (n=7; Table 4). Tupelo had the highest basal area, Relative Density and Relative Dominance, followed by Cypress. The Importance Value indicates that Tupelo and Cypress were the most important species in the Forested Control site (Table 4)

Leaf litter showed a general trend of highest production during the fall and winter, and greatly decreased production during spring and summer (Table 5). Ephemeral NPP was higher at the Mid site (781.5 $g/m^2/yr$) than the Forested Control site (578.6 $g/m^2/yr$; Table 5).

Table 5. Leaf litter data extrapolated to ephemeral net primary production (NPP ±1 standard error).

Date	MID (g/m^2)	F-CON (g/m^2)
9/30/03	emptied	emptied
11/7/2003	206.5±21.0	228.5±36.7
12/8/2003	306.9±17.1	126.7±1.9
1/26/2004	121.7±5.6	107.4±1.0
6/10/04	40.1±5.1	6.9±1.9
8/16/04	19.4±2.7	18.2±5.8
9/25/04	86.8±10.5	90.9±18.3
Ephemeral NPP ($g/m^2/yr$)	781.5	578.6

Like ephemeral NPP, perennial NPP was higher at the Mid site (509.4±31.6 $g/m^2/yr$) than the Forested Control site (245.4±29.2 $g/m^2/yr$; Table 6). The sum of Perennial and Ephemeral NPP indicates total above ground net primary productivity (NPP_t). Above ground NPP_t was 1290.9 $g/m^2/yr$ at the Mid site and 824.0 $g/m^2/yr$ at the Forested Control site (Table 6).

Table 6. Perennial (dbh), ephemeral (leaves) and total (p+e) net primary productivity (NPP).

Plot	$NPP_{perennial}$ ($g/m^2/yr$)	$NPP_{ephemeral}$ ($g/m^2/yr$)	NPP_{total} ($g/m^2/yr$)
MID	509.4±31.6	781.5	1290.9
F-CON	245.4±29.2	578.6	824.0

Total above ground net primary productivity (NPP_t) at the non-forested marsh study sites was measured directly by end of season live (EOSL) biomass dry weight. These areas are dominated by spartina sp., with minor species consisting of bulltongue, maidencane, alligatorweed, cattail, common rush, pickerelweed, swamp smartweed, and swamp knotweed. The Treatment and Out sites had similar NPP_t values, 1410.2±214.9 and 1399.8±215.1 g/m^2/yr (Table 7), respectively, and were comparable to the Mid site NPP_t. The Marsh Control site had the lowest NPP_t (759.9±125.3) of this study, but was similar to the Forested Control site NPP_t.

Table 7. Net primary productivity (NPP ±1 standard error) at the non-forested marsh study site sites as measured by end of season live (EOSL) biomass.

Plot	NPP_{total} (g/m^2/yr)
TMT	1410.2±214.9
OUT	1399.8±215.1
M-CON	759.9±125.3

6.3 Water chemistry

Water quality data was collected in July and November of 2003, and February and April of 2004. Nitrate concentrations were below detection levels (<0.02 mg/L) at all study sites except the Marsh Control site that had levels just at the detection limit (Table 8). Ammonium levels were relatively low at all study sites ranging from below detection levels (<0.01 mg/L) to 0.13 mg/L. The Forested Control site had much higher silicate concentrations than the other study sites during the 2003 sampling times, but not during 2004 (Table 8). Total phosphorus concentrations were relatively homogenous during the July 2003 sampling effort, ranging from 0.13-0.17 mg/L, were elevated at the Treatment and Control sites during the November 2003, ranging from 1.23-2.07 mg/L, but decreased dramatically for the 2004 sampling periods (Table 8). Total nitrogen concentrations ranged from 0.43-1.19 mg/L, but were generally below 0.6 mg/L (Table 8). These data indicate that the area is characterized by low nutrient concentrations.

Addition of nutrients should stimulate productivity in these wetlands.

Dissolved oxygen (D.O.) in July 2003 was highest at the Marsh Control (33.4%, 2.26 mg/L), followed by the Out Site (18.6%, 1.15 mg/L), Forested Control (13.1%, 1.01 mg/L), Mid Site (10.6%, 0.84 mg/L), and lastly by the Treatment Site with very low DO concentrations of 3.8%, 0.26 mg/L. This general trend was evident during the subsequent sampling efforts. Such low oxygen levels are common for wetlands. Salinity was below 1 PSU at all sites (Table 9). PH ranged from 5.43-6.66 (Table 9).

Table 8. Nutrient at the South Slough and Joyce Wildlife Management wetlands

Date & Location	NO_3 (mg/L)	NH_4 (mg/L)	SiO_4 (mg/L)	TP (mg/L)	TN (mg/L)
7/10/03 Treatment	bd	0.07	3.51	0.13	0.48
7/10/03 Mid Site	bd	bd	2.65	0.17	0.55
7/10/03 Out Site	bd	0.05	0.53	0.16	0.46
7/10/03 Forested Control	bd	0.13	24.07	0.17	0.51
7/10/03 Marsh Control	bd	0.01	2.11	0.16	0.44
11/7/03 Treatment	bd	0.01	5.43	1.23	0.51
11/7/03 Mid Site	bd	0.02	5.83	0.12	0.52
11/7/03 Out Site	bd	0.04	2.20	0.13	0.82
11/7/03 Forested Control	bd	0.01	10.50	2.07	0.35
11/7/03 Marsh Control	0.02	0.01	3.59	1.25	0.95
2/19/04 Treatment	bd	bd	0.66	0.03	0.56
2/19/04 Mid Site	bd	bd	0.30	0.03	0.43
2/19/04 Out Site	bd	bd	0.36	0.05	0.54
2/19/04 Forested Control	bd	0.04	0.30	0.05	0.44
2/19/04 Marsh Control	0.04	0.03	0.28	0.04	0.04
4/23/04 Out Site	bd	bd	0.41	0.11	1.19
4/23/04 Forested Control	bd	0.01	0.10	0.11	0.49
4/23/04 Marsh Control	0.10	0.07	1.68	0.10	0.59

Table 9. Dissolved oxygen (% and mg/L), conductivity (µs), temperature (˚C), salinity (PSU) and pH (n.a.= not available due to lack of water).

Site / Date	**7/10/03**	**11/7/03**	**12/8/03**	**1/26/04**	**4/2/04**
Treatment					
D.O. %	3.8	9	n.a.	n.a.	n.a.
mg/L	0.26	0.83	n.a.	n.a.	n.a.
Conductivity	66.7	886	n.a.	n.a.	n.a.
Temperature	29.2	21.3	17.3	n.a.	n.a.
Salinity	0	0.5	0.4	n.a.	n.a.
pH	na	n.a.	5.43	n.a.	n.a.
MID					
D.O. %	10.6	n.a.	8.5	10.2	5.3
mg/L	0.84	n.a.	0.89	0.99	0.51
Conductivity	46.2	n.a.	714	379	269
Temperature	26.6	n.a.	12.6	15.4	16.2
Salinity	0	n.a.	0.5	0.2	0.2
pH	n.a.	n.a.	5.62	5.65	5.6
OUT					
D.O. %	18.6	33.3	44.7	22.6	32.7
mg/L	1.15	2.88	4.86	2.5	2.81
Conductivity	54.2	1370	642	642	833
Temperature	30.4	21.1	10.5	16	22.3
Salinity	0	0.7	0.4	0.4	0.4
pH	n.a.	n.a.	6.66	5.97	5.82
Forested Control					
D.O. %	13.1	38.8	42.5	44	59.8
mg/L	1.01	3.5	4.74	4.37	5.99
Conductivity	43.5	157.1	342.8	335.5	310.5
Temperature	27.1	20.9	10.6	14.9	22.6
Salinity	0	0.1	0.2	0.2	0.2
pH	n.a.	n.a.	6.1	5.77	5.94
Marsh Control					
D.O. %	33.4	n.a.	n.a.	n.a.	62.7
mg/L	2.26	n.a.	n.a.	n.a.	5.14
Conductivity	66.1	n.a.	n.a.	n.a.	1427
Temperature	30.2	n.a.	n.a.	n.a.	24.4
Salinity	0	n.a.	n.a.	n.a.	0.7
pH	n.a.	n.a.	6.24	n.a.	5.92

6.4 Characterization of the sediment

The Treatment site had the highest bulk density of all the study sites, ranging from 0.27-0.34 g/cm^3 (Table 10). The rest of the study sites had relatively low and homogenous bulk density, ranging from 0.06 to 0.17 g/cm^3 (Table 10).

Table 10. Bulk density of soils at study sites.

	Bulk Density (g/cm^3)	
Site	Rep 1	Rep 2
Treatment	0.27	0.34
Mid Site	0.10	0.06
Out Site	0.09	0.12
Forested Control	0.17	0.17
Marsh Control	0.16	0.15

6.5 Discussion

Nitrate concentrations in the JWMA and Control plots ranged from below level of detection to just at the detection limit (<0.02 mg/L), and ammonium levels were relatively low ranging from below detection levels (<0.01 mg/L) to 0.13 mg/L (Table 8). These low concentrations are very similar to other wetlands along the Louisiana coastal zone that are not receiving riverine water, and are indicative of possible inorganic nitrogen deficiency (Lane et al. 2003). Total nitrogen concentrations, however, were as high as 2.07 mg-N L^{-1}. These high total nitrogen and low inorganic nitrogen concentrations indicate that nitrogen is predominately in organic forms, such as humic substances, tannins, and vegetation, which are not available for assimilation by phytoplankton.

Calculations of nitrogen loading to the JWMA wetlands, and estimates of the efficiency of these wetlands to remove N, indicate that 95% of the nitrogen introduced with Hammond's wastewater effluent will be removed. Nitrogen is removed from the water column by four major processes: 1) uptake by plants; 2) immobilization by microorganisms into microbial cells during decomposition of plant material low in N; 3) sorption of NH_4 onto the organic matter and the clay cation exchange complex; and 4) most importantly, mineralization-nitrification-denitrification reactions (Lindau et al. 1994). Denitrification has been found to be a significant pathway for the loss of nitrogen from wetlands (Boynton et al. 1995; Nowicki et al. 1997; Lund et al. 2000; Reilly et al. 2000; Brock 2001).

Rates of denitrification are greater under conditions of fluctuating redox potential (flooding and draining cycles) than where the redox is continuously high or continuously low, and is an important mechanism for the oxidation of ammonia to nitrate and subsequent denitrification (Smith et al. 1983). Frequent changes from anaerobic to aerobic conditions have been shown to cause oxidation of some of the ammonium nitrogen to nitrate during the aerobic phase followed by reduction of the ammonium to nitrogen gas during the anaerobic phase (Patrick and Delaune 1977). The alternate flooding and draining of the JWMA wetlands due to tides and frontal passages ensure that introduced wastewater will have substantial contact with the marsh.

Calculations of phosphorus loading and wetland removal efficiency indicate that 90% of the phosphorus input into the JWMA wetlands will be removed. The major mechanism for removal of phosphorus from the water column is plant uptake, microbial assimilation and soil fixation (Patrick 1992). Soluble inorganic phosphate is readily immobilized in soils by adsorption and precipitation reactions with aluminum (Al), Iron (Fe), calcium (Ca), and clay materials (Nichols, 1983). Similar to nitrogen, the fixation of phosphorus is more extensive and less reversible under alternating flooding-draining than under either continuously flooded or continuously moist soil conditions (Patrick 1992). Alternate flooding and drying increases the amount of phosphorus in the ferric phosphate and reluctant-soluble occluded fractions at the expense of the soluble and aluminum phosphate fractions.

Phosphate is usually buffered in wetland systems, with the constituent taken up when concentrations are high and released when they are low (Patrick and Khalid 1974; Patrick 1992). The most important factors in determining phosphorus fixation and release in wetlands soils are the kinds and amounts of clay, the quantities of iron, aluminum, calcium and magnesium compounds, the oxidation-reduction status of the soil as determined by microbial activity under low oxygen conditions, and the soil pH (Patrick 1992).

In forested wetlands, hydrology is the most important factor influencing primary productivity (Conner 1994). Aboveground biomass and primary productivity values for cypress/tupelo forests are among the highest reported for forest ecosystems, due largely to the effects of fluctuating water levels and nutrient inflows (Conner and Day 1994). Alterations in natural hydrologic patterns leading to increased flooding or drainage can cause decreased growth rates or even death of the forest. Since the turn of the century, repeated logging of alluvial forest that were once dominated by cypress has likely shifted the composition toward water tupelo because of its prolific coppicing from stumps (Conner and Day 1976). This is likely a factor at the Forested Control site, where Tupelo was a dominant species (Table 4).

Litterfall at the Mid and Forested Control sites was 781.5 and 578.6 $g/m^2/yr$, respectively. This is comparable to 642.8 $g/m^2/yr$ measured in a North Carolina coastal plan alluvial forest by Brinson et al. (1980), but higher than the 328.3 to 417.4 $g/m^2/yr$ measured in the Lac des Allemands swamp, Louisiana, by Conner and Day (1976). Net primary productivity at the Mid and Forested Control sites was 1290.9 and 824.0 $g/m^2/yr$, respectively (Table 6). This is comparable to NPP found at the Lac des Allemands swamp of 886.7 $g/m^2/yr$ for a permanently flooded area and 1779.9 $g/m^2/yr$ for a crawfish farm (Conner and Day 1976).

Total above ground net primary productivity (NPP_t) at the non-forested marsh sites in this study was measured directly by end of season live (EOSL) biomass dry weight. End of season live biomass in Louisiana has been reported to range from 639 to 1056 $g/m^2/yr$ (Turner 1976). EOSL biomass in this study is comparable, with values ranging from 759 to 1410 $g/m^2/yr$ (Table 7).

7.0 CONCLUSIONS

These results provide a baseline of vegetation, sediment, and water data reflecting the current status of the treatment and control plots at the South Slough and JWMA wetlands. These results indicate that the South Slough and JWMA wetlands are excellent candidates for assimilation of secondarily treated municipal wastewater. The relatively low loading rates and long residence times of wastewater effluent in the wetlands will lead to high assimilation rates of nutrients. It is likely that the added nutrients will lead to increased productivity in the receiving wetlands, as has been observed in other sites, that will help offset regional subsidence. There will likely be expansion of cattails and willows in the northern part of the South Slough wetlands. Hydrodynamic modeling suggest that culverts 14 through 16 may need to be hydrologically restricted by weirs, flap-gates or total closure. Hydrology should be monitored after discharge begins, and if there is significant flow of water through culverts to the west, one or a combination of hydrologic modifications will have to be put into effect. It is recommended that the city of Hammond implement the proposed wetland assimilation project outlined in this UAA as a long-term solution for municipal wastewater treatment.

In summary, the proposed wetland wastewater assimilation project provides both economic and environmental benefits to the citizens of Hammond. Use of the South Slough and JWMA wetlands for wastewater assimilation will lead to economic savings, improved water quality and enhanced habitat for fish and wildlife. Citizens will also benefit aesthetically from having a healthy natural ecosystem near the city for recreation purposes, as well as for storm buffering capacity to help protect the population from flooding. As management of the wetland ecosystem improves its health and functioning, it contributes to the improvement of the larger Lake Pontchartrain estuary bringing with it the benefits of such things as clean water, improved fisheries, and better swimming conditions.

7.1 Uses, criteria and regulatory issues

This report presents data necessary for the discharge of treated wastewater into wetlands in the vicinity of Hammond, Louisiana. The following gives the wetland subsegment designation and description and appropriate criteria and implementation procedures.

The South Slough Wetlands & The Joyce Wildlife Management Area.

Located 1.4 miles south of the City of Pontchatoula, Louisiana, and directly east of I-55, extending to Pass Manchac to the south and the Tangipahoa River to the east.

Designated Uses - Naturally Dystrophic Waters
B – Secondary Contact Recreation
C - Fish and Wildlife Propagation

The following Criteria are applicable:

- No more than 20% reduction in the total above-ground wetland productivity as measured by litterfall and stem growth data due to effluent addition.

7.1.1 Background and Basis for Criteria Implementation and Assessment

Above ground primary productivity is a key measurement of overall ecosystem health in the wetlands of south Louisiana (Conner 1994; Day et al. 2004). Primary productivity is dependent on a number of factors, including hydrology, nutrient availability and past management practices (Conner 1994; Conner and Day 1976, 1988a and b; Ewel & Odum 1984). Hydrology will not be influenced to a significant degree in the receiving wetlands by this project, with exception of the areas immediately surrounding the discharge locations. The underlying ecological model is that the addition of secondarily-treated nutrient rich municipal wastewater to south Louisiana wetlands will promote vertical accretion through increased organic matter production and deposition, counteracting the effects of hydrological isolation and subsidence. Rybczyk et al. (2002) reported that municipal effluent application at Thibodaux, LA, increased soil accretion rates by a factor of three and Hesse et al. (1998) showed that cypress trees at the Breaux Bridge wastewater assimilation wetlands, which have received wastewater effluent for 50 years, had a higher growth rate than nearby trees not receiving effluent.

At each forested study site a 10 x 100 m quadrate was established to measure forest productivity. Productivity of a forested wetland is defined as the sum of stem growth (perennial productivity) and leaf and fruit fall (ephemeral productivity). Perennial productivity was calculated using diameter at breast height (dbh) measurements of all trees with dbh greater than 3.2 cm. Measurements of dbh were taken annually during winter when trees are dormant, and biomass calculated using allometric equations based on dbh. Ephemeral productivity was measured using 0.25 m^2 leaf litter boxes, with screened bottoms and approximately 10 cm wide sides. Six boxes were placed randomly in each study site. Leaves and other materials that collected in the boxes were gathered bimonthly, separated into leaves and woody material, dried to a constant weight, and weighed. Aboveground net primary productivity (NPP) was calculated as the sum of ephemeral and perennial productivity, and presented as live dry weight per square meter basis (g dry wt m^{-2}).

At each non-forested marsh study site, end of season live (EOSL) biomass was measured using five randomly placed 0.06 m^2 quadrats. Clip plot samples were collected during the last two weeks of September 2004, 10-20 m from the bayou edge in an area of relatively homogenous herbaceous vegetation. Vegetation within the quadrat was cut as close to the marsh surface as possible, stored in labeled paper bags, brought back to the laboratory, and refrigerated until processing. Live material was separated from dead, and dried at 60°C to a constant weight. All data are presented as live dry weight per square meter basis (g dry wt m^{-2}), and is representative of aboveground net primary productivity (NPP) for the area.

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APPENDIX

Table A1. List of species of concern, the last year the named species was observed, the location of the observation, and comments.

SPECIES	LASTOBS	LAT./LONG	COMMENTS
BALD EAGLE	2004	302428N 902708W	This nest is not in the immediate project area, however, it is within one mile. The nest was active this year (2004) with the adults producing 2 chicks. If bald eagles are sighted in the project area, please report sightings to LNHP (225) 765-2820 Ines Maxit.
FRESHWATER MARSH	2003	302317N 902155W	High quality marsh in immediate project area. Monitor the marsh for any impacts associated with the project and coordinate with Patti Faulkner (225) 765-2975.
POND CYPRESS-SWAMP BLACKGUM SWAMP	2003	302346N 902534W	High quality pondcypress-swamp blackgum swamp; this is considered an imperiled natural community in LA and this specific occurrence is the only protected location of this natural community type in the state. Monitor the swamp for any impacts associated with the project and coordinate with Patti Faulkner (225) 765-2975.
WATERBIRD NESTING COLONY	4/25/90	302300N 902400W	Rookeries can move from year to year and no current information is available on the status of this rookery. No activity is permitted within 300 meters around rookeries during the breeding season which is generally March 15-July 15. If work takes place during the breeding season, the project area should be checked for rookery activity. If you have any questions please call LNHP Zoologist Ines Maxit at 225-765-2820.
WATERBIRD NESTING COLONY	6/17/98	302256N 902423W	Rookeries can move from year to year and no current information is available on the status of this rookery. No activity is permitted within 300 meters around rookeries during the breeding season which is generally March 15-July 15. If work takes place during the breeding season, the project area should be checked for rookery activity. If you have any questions please call LNHP Zoologist Ines Maxit at 225-765-2820.
WATERBIRD NESTING COLONY	6/14/99	302256N 902230W	Rookeries can move from year to year and no current information is available on the status of this rookery. No activity is permitted within 300 meters around rookeries during the breeding season which is generally March 15-July 15. If work takes place during the breeding season, the project area should be checked for rookery activity. If you have any questions please call LNHP Zoologist Ines Maxit at 225-765-2820.
SPECIES	LASTOBS	LAT./LONG	COMMENTS

WATERBIRD NESTING COLONY	6/17/98	302334N 902650W	Rookeries can move from year to year and no current information is available on the status of this rookery. No activity is permitted within 300 meters around rookeries during the breeding season which is generally March 15-July 15. If work takes place during the breeding season, the project area should be checked for rookery activity. If you have any questions please call LNHP Zoologist Ines Maxit at 225-765-2820.
HEMLOCK WATER-PARSNIP	6/19/36	302406N 902544W	This plant species could occur anywhere within 1 1/2 miles of this location. Contact Chris Reid (225) 765-2828 for further info or to report sighting.
SARVIS HOLLY	1986	302335N 902517W	This plant identified at this specific location. Contact Chris Reid (225) 765-2828 for further info or to report sighting.
FLOATING-HEART	7/23/38	302420N 902626W	This plant could be located anywhere within the project area. Contact Chris Reid (225) 765-2828 for further info or to report sighting.

LA NATURAL HERITAGE REPORTING FORM

Mail completed form to:
Louisiana Natural Heritage Program
LA Department of Wildlife & Fisheries
P.O. Box 98000
Baton Rouge, LA 70898
(225) 765-2821

FOR OFFICE USE ONLY
QUADCODE & NAME: ___________________________________
Date received: ________________________________(yyyy-mm-dd)
ELCODE: ____
EOR completed by: _________(initials) _____________________(date)

We Need Your Help. If you have any information on the location of a rare animal, rare plant or natural ecological community, please complete this form and mail it to us. Thank you!

Species name (scientific & common): ____

Natural community type (if known or reporting only a natural community location): ____

Date(s) species located: ____

Parish name:____________________________ Nearest Town: ________________________________

Township/Range/Section: ____________ Latitude/Longitude: ______________________________

*Directions to the site (as detailed as possible): ____
____
____
____
____
____

Habitat Description (plant communities, associated vegetation, topography, surrounding land use):
____
____
____
____
____
____

Data on species

Number of individuals observed: ______________

Life Stages Present:

For Plants: vegetative ___, in bud ___, flower ___, fruit ___, seedling ___, dormant ___

For Animals: eggs ___, larvae ___, immature ___, adult female ___, adult male ___, adult – sex unknown ___

Other descriptive data on the observation:
____
____
____
____
____
____

Photograph taken? _____ (If yes, please include a copy for positive identification verification.)

Identification (How was the species identification made? Name identification field guides used or experts consulted. Describe any identification problems):
____
____
____
____
____
______

Landowner's name, address, & phone if known:
____
____
____
____

Ownership comments:
____
____
______

Disturbance or threats to population:
____
____
____
____

Observer's Name, address, & phone:
____
____
____
____

- PLEASE ATTACH A LOCATION MAP TO THIS FORM (USGS quadrangle map preferred).

John Dardis

CITY OF HAMMOND

Date: 6-6-03

No known archaeological sites or historic properties will be affected by this undertaking. This effect determination could change should new information come to our attention.

Laurel Wyckoff, [signature]

State Historic Preservation Officer

Mayson H. Foster
Mayor

May 21, 2003

Rachel Watson

~~Gerri Hobdy,~~ Laurel Wyckoff
State Historic Preservation Officer (225) 342-8160
State Office of Cultural Development
P O Box 44247
Baton Rouge, LA 70804-4247

RE: HAMMOND, LA. SEWAGE TREATMENT PROJECT

Dear Mr. Hobdy:

The City of Hammond, Louisiana proposed sewerage upgrade and improvement plan calls for closing its two operational sewerage treatment plants located in the City of Hammond and building one consolidated treatment plant south of the City of Ponchatoula, just east of Interstate 55. Sewage would be pumped by force main to this new treatment plant site via a 48" pipe installed either along the I-12 and I-55 Service Road or along the Canadian National railroad right of way (a final decision on that route has not been determined pending proposed permitting and costs). The waste would then be partially treated through construction of a new 3 cell aerated lagoon with ultraviolet disinfection on a 40 acre site to be purchased south of the City of Ponchatoula oxidation pond (we have been talking to officials in Ponchatoula about joining together with Hammond in this project and using only one pond site, but there is no final commitment from Ponchatoula on that issue). The existing swamp that is located south of the proposed treatment plant would then treat the wastewater further. The City would construct an effluent lift station to pump from the lagoon/UV system to the new wetlands distribution system that will disperse treated and disinfected wastewater into the Joyce Wildlife Management Refuge. The attached map and aerial should give you a good indicator of the location of these activities.

The concept behind the City's sewerage treatment proposal is to use the existing swamps as a tertiary water purifier, to spread the discharge out over a large area (not one point discharge), and to help build the health of the swamp through sediment deposit. The proposed oxidation pond **search area is shown in red** on the attached large USGS quad map as being below the 5-foot contour line and in a wet soils area. The **lines shown in yellow** on the attached large map are proposed locations of sewerage lines. The discharge line would be built south of the South Slough (east-west bayou) There will be no displacement of businesses or homes as a result of this project. There are no air discharges related to the project. The plant site and all sewerage lines will be maintained by the City of Hammond. The City has contracted with the environmental firm, Comite

Council: Curtis Wilson - District 1 • Tony Licciardi - District 2 • Willie G. Jackson - District 3 • Kathy Montecino - District 4 • Nicky Muscarello - District 5
P. O. Box 2788 • Hammond, LA 70404-2788 • (985) 542-3400 • Fax (985) 542-3619 • www.Hammond.org

State of Louisiana

James H. Jenkins, Jr.
Secretary

Department of Wildlife & Fisheries
Post Office Box 98000
Baton Rouge, LA 70898-9000
(225) 765-2800

M.J. "Mike" Foster, Jr.
Governor

Name	Mr. Joel L. Lindsey
Company	Comite Resources, Inc.
Street Address	11643 Pride Port Hudson Rd.
City, State, Zip	Zachary, LA 70791
Project	City of Hammond Wetland Wastewater Assimilation Project
Date	November 7, 2002
Invoice Number	02110701

Personnel of the Habitat Section of the Fur and Refuge Division have reviewed the preliminary data for the captioned project. Our database indicated your project area to be in the Louisiana Department of Wildlife and Fisheries Joyce Wildlife Management Area (WMA). Contact the District Supervisor John Mullins at 225-765-2360 to coordinate all activity.

Our database indicated the following observations to occur in your project area:
-An historical 1936 observation of hemlock water-parsnip (Sium suave). While no legal protection is afforded this species, it does hold a state rank of S2 and is considered imperiled in Louisiana. This is an extremely old record and no current information is available.

-A 1986 observation of sarvis holly (Ilex amelanchier). While no legal protection is afforded this species, it does hold a state rank of S2 and is considered imperiled in Louisiana.

-A 1999 observation of a freshwater marsh natural community. This natural community type is considered imperiled in Louisiana.

-A 2000 observation of a pond cypress-swamp blackgum swamp. This natural community type is considered critically imperiled in Louisiana.

-1990, 1998, and 1999 observations of waterbird nesting colonies. Rookeries can move from year to year and no current information is available.

Our database indicated the following observations in the surrounding area of your project:
-1998 observations of waterbird nesting colonies. Rookeries can move from year to year and no current information is available.

-A 1987 observation of an old growth cypress swamp natural community.

- A 1990 observation of sarvis holly (Ilex amelanchier). While no legal protection is afforded this species, it does hold a state rank of S2 and is considered imperiled in Louisiana.

- A 2002 observation of an active bald eagle nest. The bald eagle (Haliaeetus leucocephalus) is provided a threatened status on the federal species list and an endangered status on the state species list. Human activities, both short-term and long-term, and alteration of habitat may affect the reproductive success of nesting eagles. In the Southeast, the nesting period of most eagle pairs will fall between October 1 and May 15. Disturbance during this critical period may lead to nest abandonment, cracked and chilled eggs, and exposure of small young to the elements. Human activity (including aircraft operation) near a nest late in the nesting cycle may cause flightless birds to jump from the nest tree. We recommend that there be no activity within a 1,500-foot radius (457meters) from the nest tree at any time (nesting area). A buffer zone should be arranged to be contiguous to feeding area and provide protected access between nests and the food source; it should be approximately circular and with a minimum boundary of 1 mile (1,609 meters) from the nest tree. In general, no major activities should occur during the nesting period. Even intermittent use or activities of short duration are likely to provide such a disturbance (ex. Logging, seismographic activities w/explosives, mining, low level aircraft operations). Acceptable minor activities within this buffer zone include hiking, bird watching, camping, and recreational off-road vehicle use.

Other Recommendations Regarding the Bald Eagle:
-Existing nests are often rebuilt and occupied after years of inactivity and, therefore, cannot be removed or destroyed even though they have been seemingly abandoned. Non-nest trees within the nesting area should also be protected until the nest tree is destroyed by the elements.
-Eliminate the use of toxic chemicals in the watersheds of lakes and rivers where eagles feed.
-Discourage the construction of buildings along shorelines where eagles feed.
-There must be no clear-cut and high-grade logging along the shore line of feeding waters. This will prevent the removal of large trees preferred by eagles for hunting, roosting, and loafing perches.
-If possible, prevent or reduce shoreline erosion to protect roost or perch trees.
-Within the nesting area, no large trees should be removed. Within the buffer zone, a minimum of three to five large trees should be saved for potential roost and perch trees. Characteristically, these should be the largest trees in the timber stand which provide safety from any threat from the ground. Trees with open crowns and stout lateral limbs are preferable.

In reviewing our database, no other rare, threatened, or endangered species or critical habitats were found within the area of the captioned project that lies in Louisiana. No state or federal parks, wildlife refuges, or scenic streams are known at the specified site within Louisiana's boundaries.

The Louisiana Natural Heritage Program has compiled data on rare, endangered, or otherwise significant plant and animal species, plant communities, and other natural features throughout the state of Louisiana. Heritage reports summarize the existing information known at the time of the request regarding the location in question. The quantity and quality of data collected by the LNHP are dependent on the research and observations of many individuals. In most cases, this information is not the result of comprehensive or site-specific field surveys; many natural areas in Louisiana have not been surveyed.

This report does not address the occurrence of wetlands at the site in question. Heritage reports should not be considered final statements on the biological elements or areas being considered, nor should they be substituted for on-site surveys required for environmental assessments. The Louisiana Natural Heritage Program requires that this office be acknowledged in all reports as the source of all data provided here. If you have any questions or need additional information, please call Louisiana Natural Heritage Program Data Manger Jill Kelly at (225) 765-2643.

Sincerely,

Gary Lester

Gary Lester, Coordinator
Natural Heritage Program

cc: John Mullins