

DISCOVERING THE BAYOU: SUCCESSIONAL RESTORATION  
OF BAYOU BIENVENUE

by

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A REPORT

submitted in partial fulfillment of the requirements for the degree

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## **Abstract**

All along the Gulf Coast, wetlands are disappearing due to saltwater intrusion from the draining of freshwater wetlands. Louisiana has about 40 percent of the coastal wetland in the lower 48 states but is currently losing approximately 24 square miles of wetlands a year (Louisiana Coastal 2009). Studies have shown that wetlands can help reduce the impact of a storm surge during a hurricane and have a cleansing ability from air to water. An increase in hurricane intensities due to climate change will likely result in bigger storm surges. Without wetlands to diffuse storm surges, disasters like Hurricane Katrina will recur.

Cities spend millions of dollars on treating wastewater and stormwater with facilities and chemicals. Wetlands can treat wastewater through different processes without using chemicals, thus reducing costs and increasing sustainability.

Bayou Bienvenue is a wetland located in New Orleans. This wetland was once a freshwater cypress swamp, but due to saltwater intrusion from the construction of Intracoastal Waterway and Mississippi River Gulf Outlet, has turned into a brackish lake. This wetland is separated from the Lower 9<sup>th</sup> Ward with a levee that creates a visual barrier which results in local residences not knowing that there is a former wetland behind the levee.

Bayou Bienvenue's Ecological Park's discovery center with educational programs about successional wetland landscapes will educate people about the importance of wetlands to New Orleans. The restored of the bayou will be a landscape that functions as infrastructure through the treatment of stormwater and wastewater. The bayou will aid in reducing storm surge impacts, provide wildlife habitat, become part of schools' curricula within the 9<sup>th</sup> Ward, stimulate the local economy and provide a community park for people to enjoy. Bayou Bienvenue's Ecological Park will help spur further wetland projects of this caliber in and around New Orleans

# Discovering the Bayou:

Successional Restoration of Bayou Bienvenue

Kristopher Kleinschmidt  
Kansas State University  
Masters Project & Report  
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## Abstract

All along the Gulf Coast, wetlands are disappearing due to saltwater intrusion from the draining of freshwater wetlands. Louisiana has about 40 percent of the coastal wetland in the lower 48 states but is currently losing approximately 24 square miles of wetlands a year (Louisiana Coastal 2009). Studies have shown that wetlands can help reduce the impact of a storm surge during a hurricane and have a cleansing ability from air to water. An increase in hurricane intensities due to climate change will likely result in bigger storm surges. Without wetlands to diffuse storm surges, disasters like Hurricane Katrina will recur.

Cities spend millions of dollars on treating wastewater and stormwater with facilities and chemicals. Wetlands can treat wastewater through different processes without using chemicals, thus reducing costs and increasing sustainability.

Bayou Bienvenue is a wetland located in New Orleans. This wetland was once a freshwater cypress swamp, but due to saltwater intrusion from the construction of Intracoastal Waterway and Mississippi River Gulf Outlet, has turned into a brackish lake. This wetland is separated from the Lower 9th Ward with a levee that creates a visual barrier which results in local residences not knowing that there is a former wetland behind the levee.

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aid in reducing storm surge impacts, provide wildlife habitat, become part of schools' curricula within the 9th Ward, stimulate the local economy and provide a community park for people to enjoy. Bayou Bienvenue's Ecological Park will help spur further wetland projects of this caliber in and around New Orleans.





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## Structure of Book

The report is structured as follows: dilemma and thesis, history of New Orleans and Lower 9th Ward, precedent studies, site inventory, program, landscape analysis, design, conclusion and appendices. This sequence allows presentation of the basic information required to understand the proposed design. The glossary is located in back of book.



“Should we remain in eroding marshes and continue centuries of tradition, or end our way of life and move inland so that aggressive coastal restoration may commence? Should we maintain all low-lying, far-flung neighborhoods and trust that levees will protect us? Or should we concede these areas to nature and build only on higher ground? Should we try to save everyone, at the risk of losing everyone? Or should we ask some to sacrifice everything so that others may maintain something? Shall we strive toward the probable survival of half the society, or the possible survival of the entire society? *Manuel Marquez’s dilemma: 1915*”



## Dilemma

All along the Gulf Coast wetlands are disappearing from saltwater intrusion due to the draining of the wetlands. Louisiana has approximately 40 percent of the coastal wetlands in the lower 48 states but is currently losing about 24 square miles of wetlands a year (Louisiana Coastal 2009). Figure 1.01 shows the land loss from 1932-2000 and the projected land loss till 2050. New Orleans was once completely surrounded by wetlands, but as New Orleans expanded the wetlands were drained and built upon. One wetland still remaining in New Orleans is Bayou Bienvenue. This bayou, just north of the Lower 9th Ward in New Orleans, used to be a freshwater cypress swamp and was a place full of wildlife and biodiversity. It was a place to go catch crayfish, fish and hunt. Now, due to building of the Mississippi River Gulf Outlet (MR-GO), a canal that connects the Gulf of Mexico to the Mississippi River, the bayou has turned into a brackish lake due to saltwater intrusion. Levees built along the Mississippi River to control flooding along with urbanization have prevented the addition of sediments into the area that would come with the flooding of the river. With the draining of wetlands, the lack of sediment accumulation and development on the land, subsidence is occurring. Subsidence is the lowering of the earth'. A wastewater treatment plant has been built in the bayou with a levee that separates the bayou and the Lower 9th Ward. This levee has completely blocked the view of the bayou and has resulted in some residents not knowing that there is a bayou behind the levee.

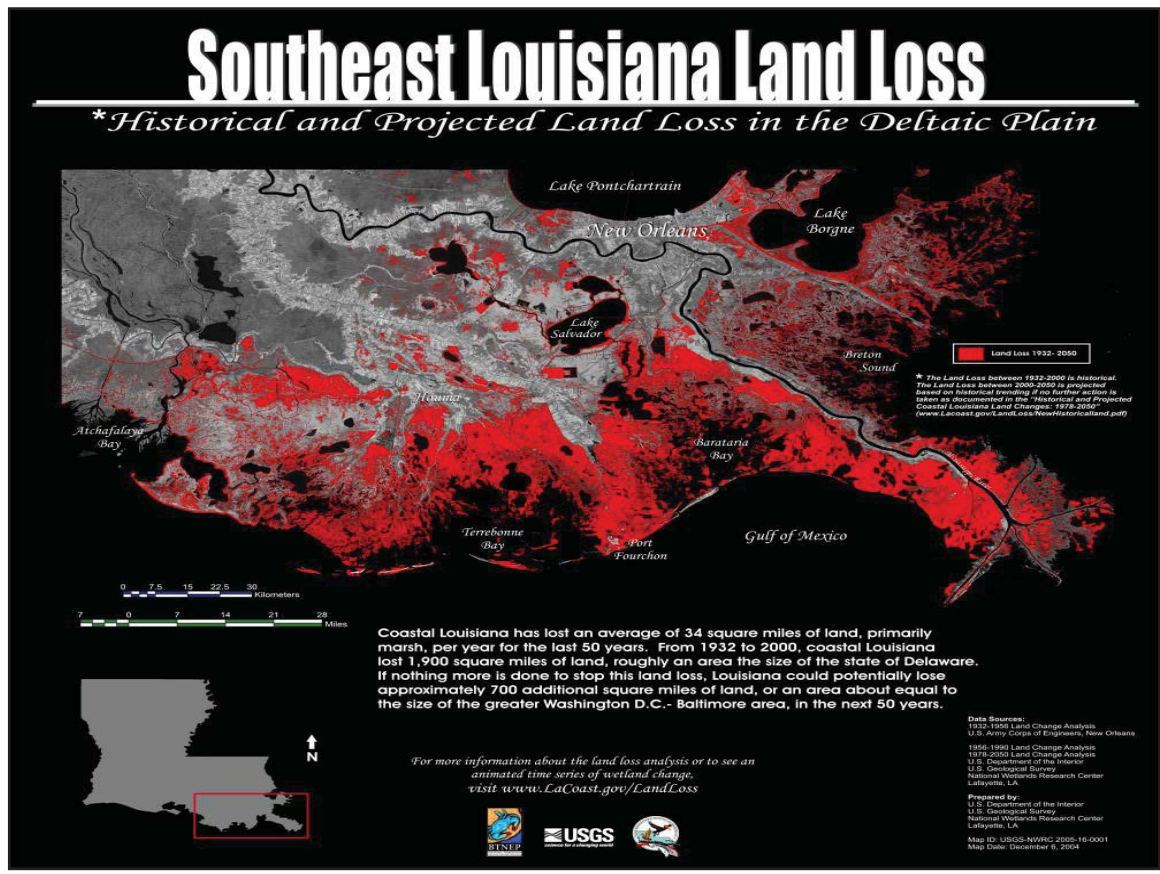


Figure 1.01 Land Loss (New Orleans Sewer and Water Board, 2008, 10)

## Thesis

Bayou Bienvenue's Ecological Park with a discovery center and educational programs about wetland ecosystems will enhance understanding of the significance of wetlands to the Lower 9th Ward and New Orleans for storm surge mitigation, the economy and the treatment of stormwater and wastewater as the bayou is reconstructed. This project could help spur further wetland projects of this caliber in and around New Orleans.

Figure 1.02 shows the current way to access the bayou and 1.03 shows the existing outlook.



Figure 1.02 Bayou Bienvenue (Photo by author)

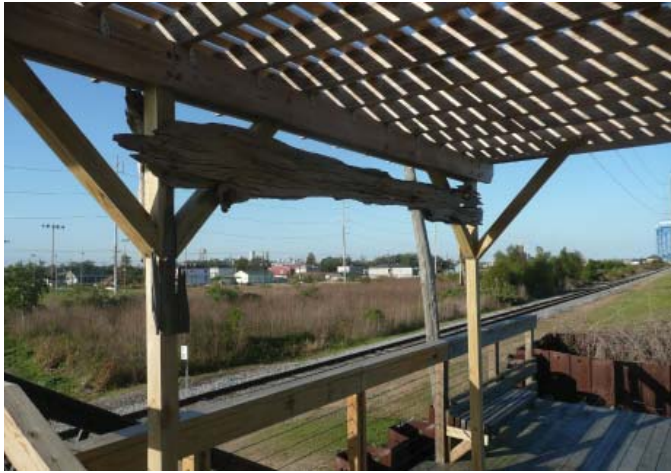


Figure 1.03 Existing Outlook (Photo by author)

## Personal Goals

- Further my knowledge of wetlands and their processes
- Further my knowledge of discovery centers
- Further my knowledge of the wastewater treatment processes
- Produce and manage a design project
- Continue to have dialogue with Make It Right Foundation

## Project Goals

- Restore the bayou back to a freshwater cypress swamp
- Educate the public about wetland functions
- Use the landscape as infrastructure
- Provide a community park for the Lower 9th Ward

## Design Philosophy

The design philosophy for this project revolves around three ideas: Wetlands, Community, and Education. Wetlands were chosen because New Orleans is a city that developed on wetlands and is surrounded by them. Community was chosen because New Orleans was devastated by a natural disaster. In the rebuilding process, community is a key to success. Education was chosen because the more people know, the better the society is. Each of these ideas is a circle that overlaps the others and where all three of the circles overlap is the site. Figure 1.04 shows design philosophy. The decisions that made by me about the design of the project will enhance the wetlands, community, and education of the public.

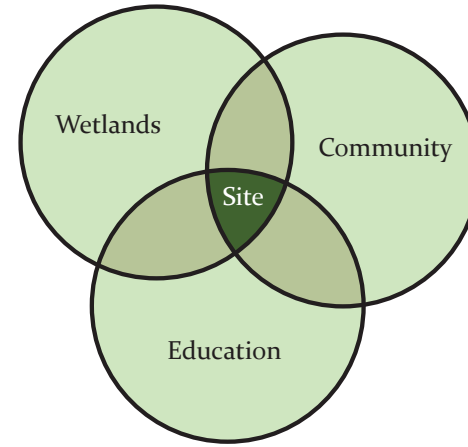


Figure 1.04 Philosophy (Produced by author)





“Mud, mud, mud...this is a floating city,  
floating below the surface of the water on a  
bed of mud...”

*Benjamin Henry Boneval Latrobe, 1819*



## History

Understanding the past will help to understand the present. This chapter begins by focusing on the history of the New Orleans area and the major events that have shaped the area. The next section focuses on New Orleans and the Lower 9th Ward. Current site conditions of Bayou Bienvenue are then discussed. The three sections focus on historical events that had an affect on wetlands around New Orleans.

## Natural History

The New Orleans area is heavily influenced by the Mississippi River which was formed after the last ice age. Glaciers melting in what are now known as the Missouri and Ohio River Basins converged at Cairo, Illinois. This confluence of melting water formed a river which grew in size as the glaciers continued to melt. This river is now known as the Mississippi River. The river carved the landscape by eroding away sediment on the banks. When the river hit the Gulf of Mexico, the sediment settled out extending the coastline to its current state. See Figure 2.01 for the Mississippi River's watershed. (Campanella 2008)

The soils around New Orleans were deposited 4,300 years ago by the settling of sediments as the river met the Gulf of Mexico and by continually deposited sediment from flooding of the Mississippi River until the present state. Figure 2.02 shows the expansion of the coastline over the thousands of years. As the water exceeds the banks of the river, heavier particles like sand settled out first and finer particles like clay settled out further away from the

river. This explains why the soils around New Orleans are mostly clay with the exception of the soils near the river. The height of the water table gets closer to the surface and there is more organic matter found in the soil the further away from the river you get. The reason is because wetlands used to exist in the area and wetlands contain high amounts of organic matter. Salinity levels are higher further away from the river because the flooding of the Mississippi dilutes the saltwater found in the groundwater. (Campanella 2008)

New Orleans' topography is tied to the Mississippi River. Higher elevation is located along the river and along a few ridges. Figure 2.03 shows the elevation of New Orleans. In general, the further away from the river, the lower the elevation is. This is in response to the flooding of the river and the deposition of sediment. By 1935 only 30% of New Orleans was below sea level and by 2000 50% of New Orleans was below sea level. The land that was already below sea level subsided even further due to denser development. Subsidence occurs from the draining of the wetlands and developing on the land. The excess weight from the development pushes down on the soil which used to be filled with water but is now filled with air resulting in soil compression. Today, the Mississippi River is higher than 95% of New Orleans. (Campanella 2008) Figure 2.04 is a map of subsidence that has occurred in New Orleans.



Figure 2.01 Mississippi River Watershed (Richard Campanella, 2008, inset)

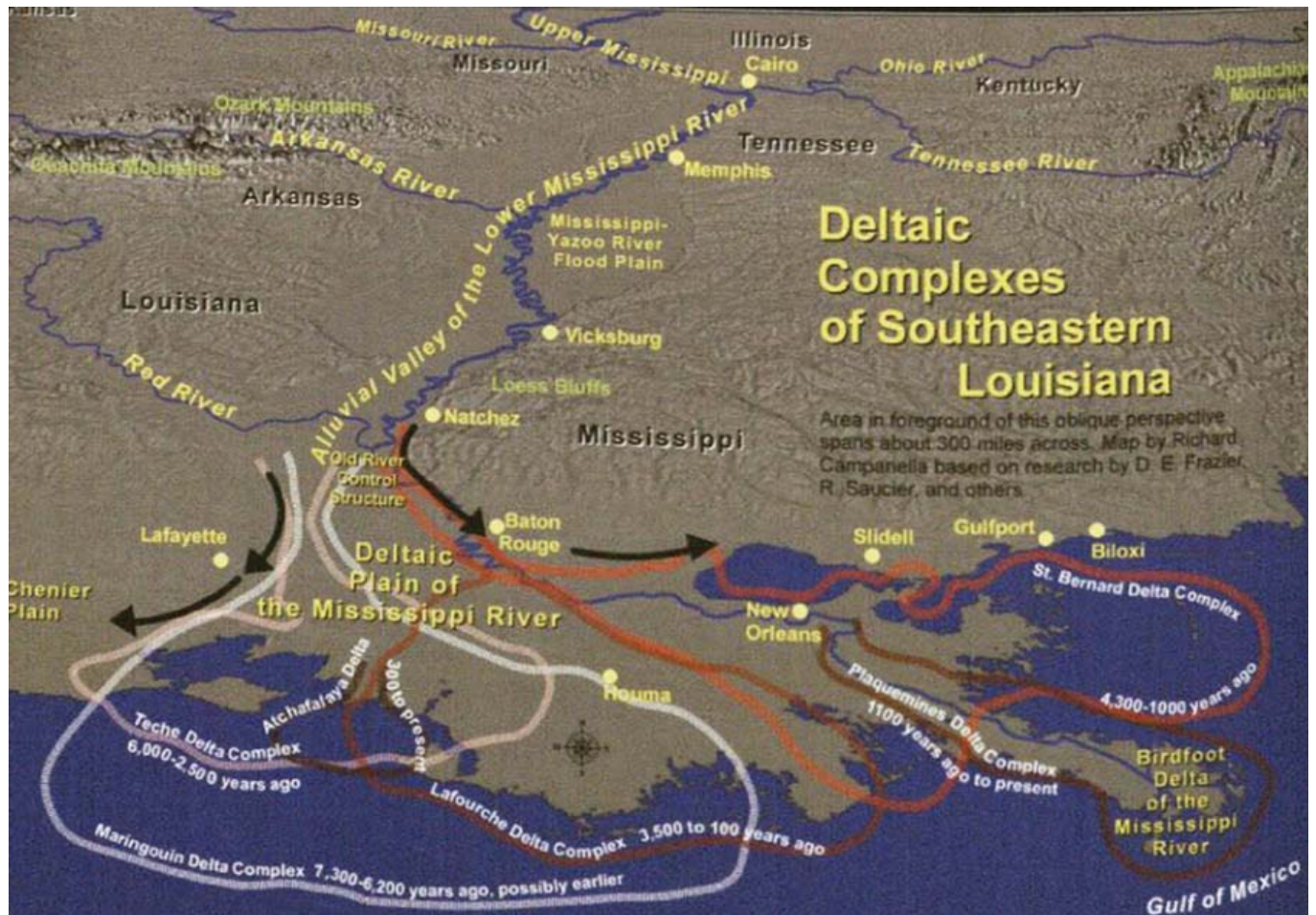


Figure 2.02 Delta Formation (Richard Campanella, 2008, inset)

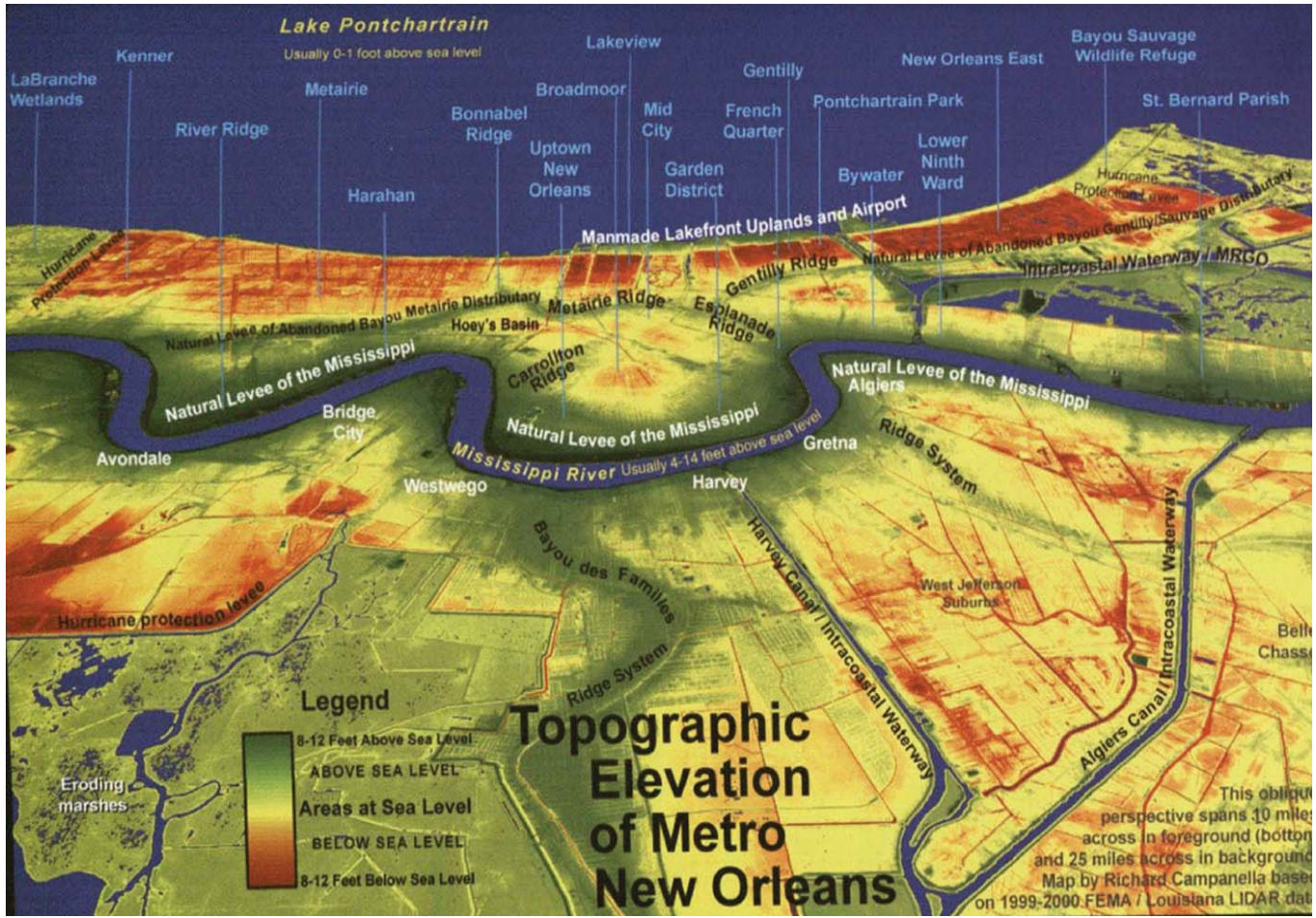


Figure 2.03 Elevation (Richard Campanella, 2008, inset)

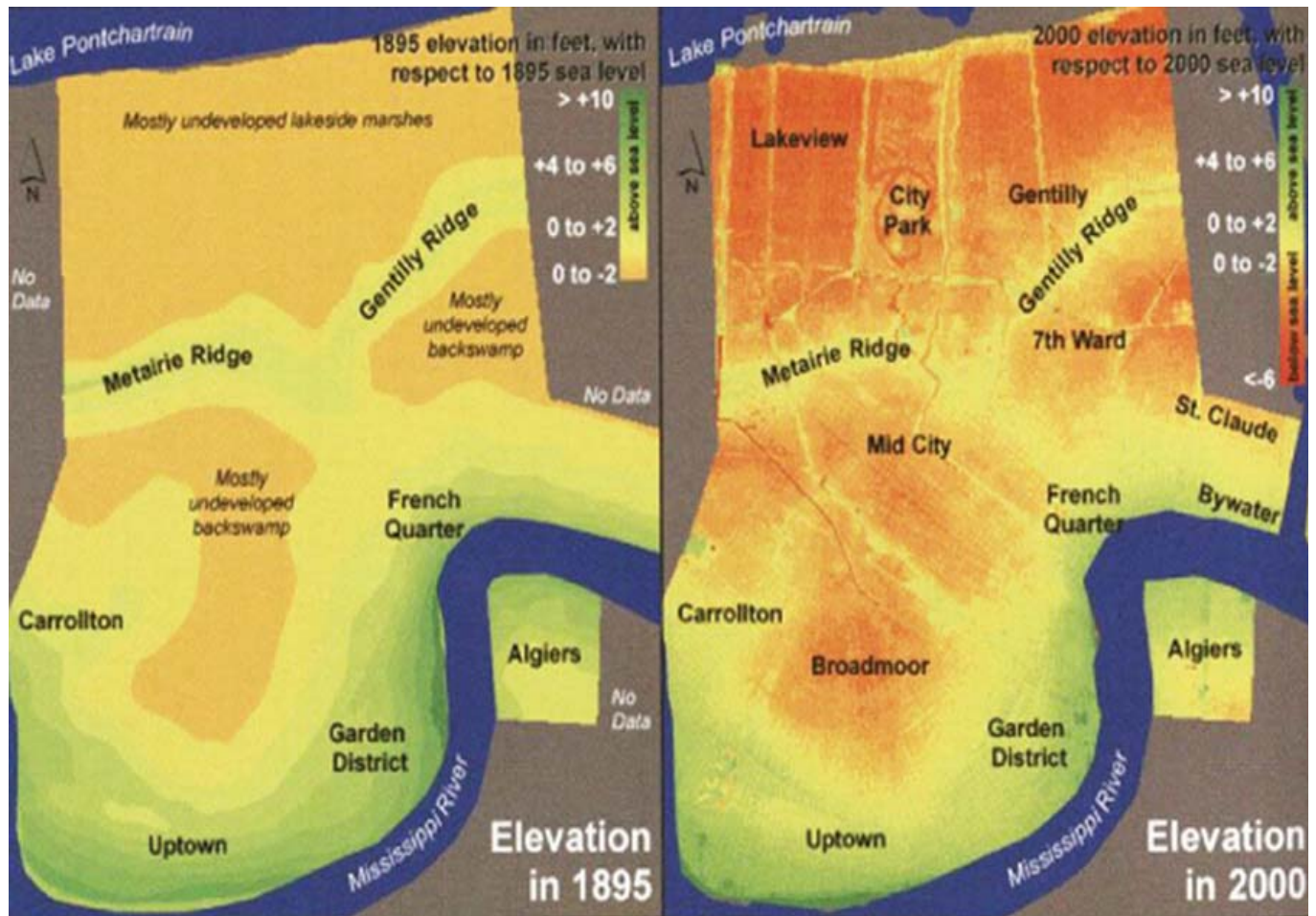


Figure 2.04 Subsidence (Richard Campanella, 2008, inset)

## New Orleans History

New Orleans was founded in 1717 by Bienville and Iberville (French explorers) for accessibility, control of the Mississippi River and Gulf of Mexico, riverine position, arability, natural resources, and lack of better alternatives in the area. Originally Bienville and the rest of the explorers had stopped at what would be New Orleans. They decided to forgo starting a settlement there due to all the wetlands and lack of high ground. The explorers went further up the Mississippi River to what is now Baton Rouge. This place had high ground and lacked all the wetlands, but Bienville decided to come back to New Orleans because they couldn't control the Gulf of Mexico that far up river. As a result, New Orleans was founded chiefly for military reasons and not for excess amounts of natural resources or high ground like other early settlements. (Campanella 2008) See Figure 2.05 for the exploration route by the French explorers.

New Orleans during its first couple of years struggled to survive due to diseases like malaria and yellow fever and from the lack of people moving to the city. In 1722, a hurricane struck New Orleans destroying a majority of the city. This event allowed the city to start over and rebuild giving its current form of street layout found in the French Quarter. Originally the city did not have a plan for development but because of the hurricane, a comprehensive plan was drawn for New Orleans. The rebuilding of New Orleans also was a new way to market the city and draw people in. (Campanella 2008)

In 1788 Faubourg Ste. Marie became New Orleans's first suburb. From this point on New Orleans expanded outward first along the natural levees and ridges and then into the swamps surrounding the city. Figure 2.06 shows the different Fauburges in New Orleans while Figure 2.07 shows the growth of New Orleans. For the next century New Orleans kept growing and became a very important sea port to the United States as goods traveled in and out of the country as well as up and down the river. (Campanella 2008)

The first levees constructed in New Orleans were in 1722 along the Mississippi River to control flooding of the river. This was a way for the city to survive in its location and was the start of man trying to dominate nature. Levee construction continued up and down the length of the Mississippi. After the Great Flood of 1927 levees along the Mississippi River were raised, broadened, strengthened, and extended. Floodways, spillways, and runoff channels were constructed above and below the city to help prevent another disaster like in 1927. The Mississippi River is now a man controlled river with levees running on both sides of the river. New Orleans currently has 28 miles of levees and floodwalls and 73 floodgates along Mississippi River. There are 101 miles of levees and 107 floodgates along Lake Pontchartrain. (Campanella 2008)

New Orleans originally constructed canals as a way for transportation through the wetlands and as the city grew these canals came to help with the drainage system. The first canal constructed was the Chardonlet Canal in 1796 and from then on New Orleans built many canals. The next major canal constructed that greatly affected the city

was the Industrial Canal completed in 1923. This canal connects Lake Pontchartrain and the Mississippi River. The construction of the canal divided the 9th Ward into Upper 9th and Lower 9th Wards. The Lower 9th Ward was now separated from the rest of the city. The next major canal was the Mississippi River Gulf Outlet (MR-GO) completed in the 1960s. This canal connects the Intracoastal Waterway with the Gulf of Mexico giving a straight line for ships to navigate. This canal allows saltwater to flow into the wetlands and into the city. This canal plays an important role in modern New Orleans. (Campanella 2008)



Figure 2.05 French Explorers Route (Richard Campanella, 2008, inset)



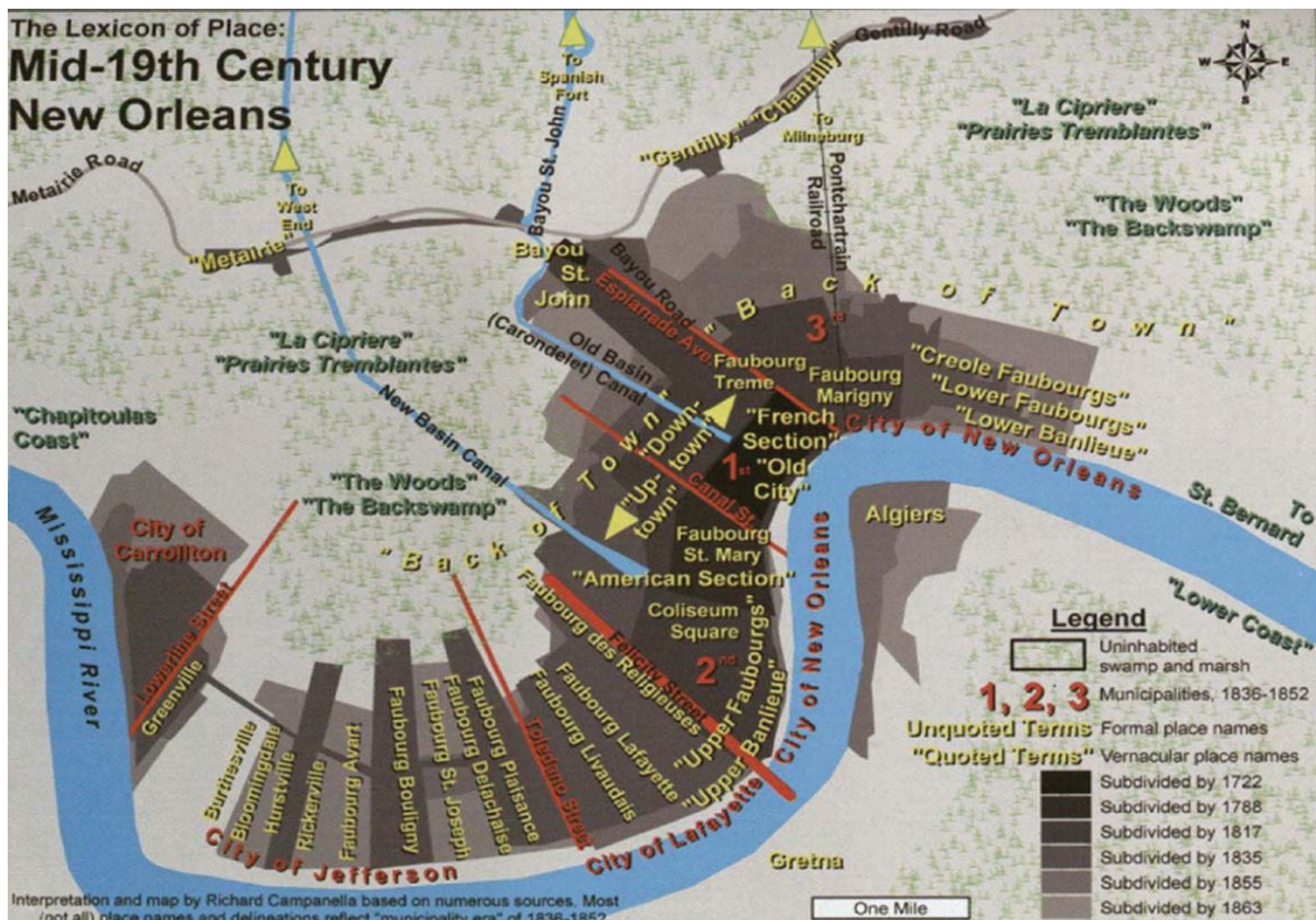


Figure 2.06 Faubourgs (Richard Campanella, 2008, inset)

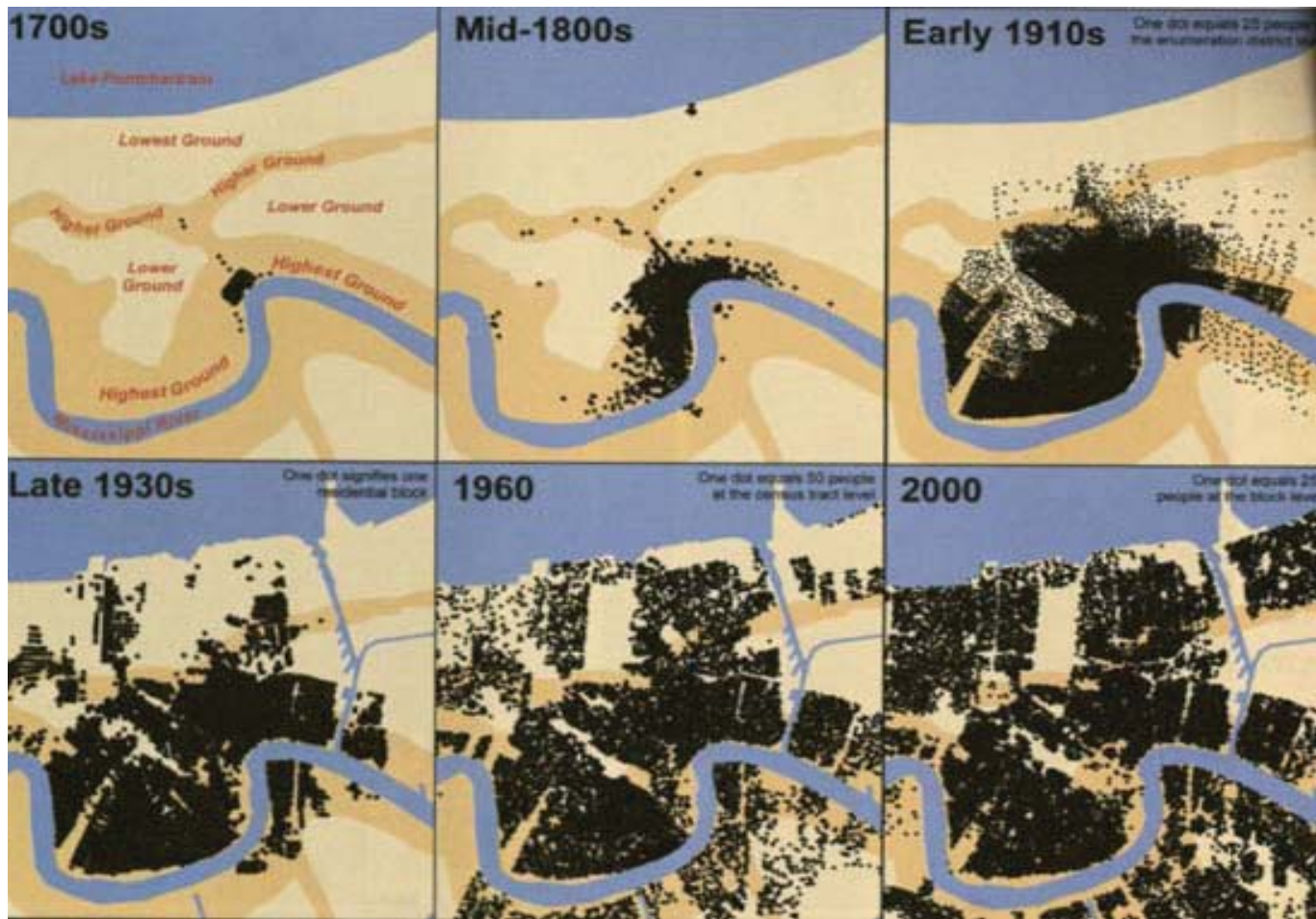


Figure 2.07 New Orleans' Growth (Richard Campanella, 2008, inset)

## History of Lower 9th Ward

Bienville and the explorers first came to what is now the Lower 9th Ward; it was covered with grasses and cypress trees. By 1730 the wetlands were drained and converted to plantations that grew tobacco, indigo, rice, grains, and vegetables. Lower 9th Ward remained rural and was one of the last areas of the city to develop. As the plantation owners sold their land for development, the streets were named after former owners. As New Orleans grew, the warehouses, slaughtering houses, and sewage treatment plant were located in the Lower 9th Ward. These items were located here because...

“these features and phenomena that people did not want to be located in the heart of the city, could not be located above the city because it would pollute the water source, but nevertheless had to be located within the city’s limits, often ended up in the city’s lowermost corner, first on the list for urban nuisances, last in line for amenities.” (Campanella 2008, 149)

Now the Lower 9th Ward is below sea level with some areas as much as eight feet below due to the draining of the wetlands and the results of subsidence. (Campanella 2008)

A military post called Jackson Barracks was located in Lower 9th Ward in 1835 because this is the first part of New Orleans ships would encounter traveling up the Mississippi River. This barracks would protect the city. This military post currently occupies the eastern part of the ward from the river to the bayou and holds the Louisiana National Guard. The barracks was the

first planned development in the Lower 9th Ward. (Campanella 2008)

There are several events that have shaped the Lower 9th Ward. Three of the events are hurricanes: the Great Storm of 1915, Hurricane Betsy and Hurricane Katrina. The Great Storm of 1915 had 135 mph winds which would make it a category 4 hurricane. This hurricane had a storm surge of one foot to eight feet high which resulted in a few levees being breached and only a small portion of the city flooding. The Lower 9th ward was one of those areas flooded while areas along the ridges and the Mississippi River were spared. (Campanella 2008)

Hurricane Betsy occurred in 1965 and was a strong category 2 almost a 3 with 110 mph winds. There was storm surge from six to eleven feet high that caused levee breaches in the eastern part of New Orleans. Lower 9th Ward saw major flooding of houses. Hurricane Betsy was the first hurricane to exploit the man-made Industrial Canal, Intracoastal Waterway and the under construction MR-GO. These canals caused the storm surge to be funneled and more destructive. (Campanella 2008)

On August 29, 2005, the worst disaster to ever come to the city and the US occurred. Hurricane Katrina struck the Gulf Coast with 125 mph winds making it a category 3 hurricane, but with storm surges that were from 10-30 feet high. This height makes the storm surge equivalent to a category 5 hurricane. Levees were breached throughout the city causing major flooding. In the Lower 9th Ward levees were breached along the Industrial Canal and along the non-federal levee separating the city from Bayou

Bienvenue. The Garden District and portions of Uptown were among the few areas in New Orleans that did not flood. See Figure 2.08 for flood depths in New Orleans. Hurricane Katrina fully exploited the man-made canals like Hurricane Betsy did in 1965. Currently the Lower 9th Ward as well as the rest of New Orleans are rebuilding their communities. (Campanella 2008)

Even though the three hurricanes were about the same in intensities, the hurricanes had varying effects. During 1915, New Orleans was located on high ground and had not yet expanded into the wetlands; however, in 2005 the city had encroached upon the diminishing wetlands in and around the city. The lack of wetlands and the development within those areas contributed to the different effects between the hurricanes.

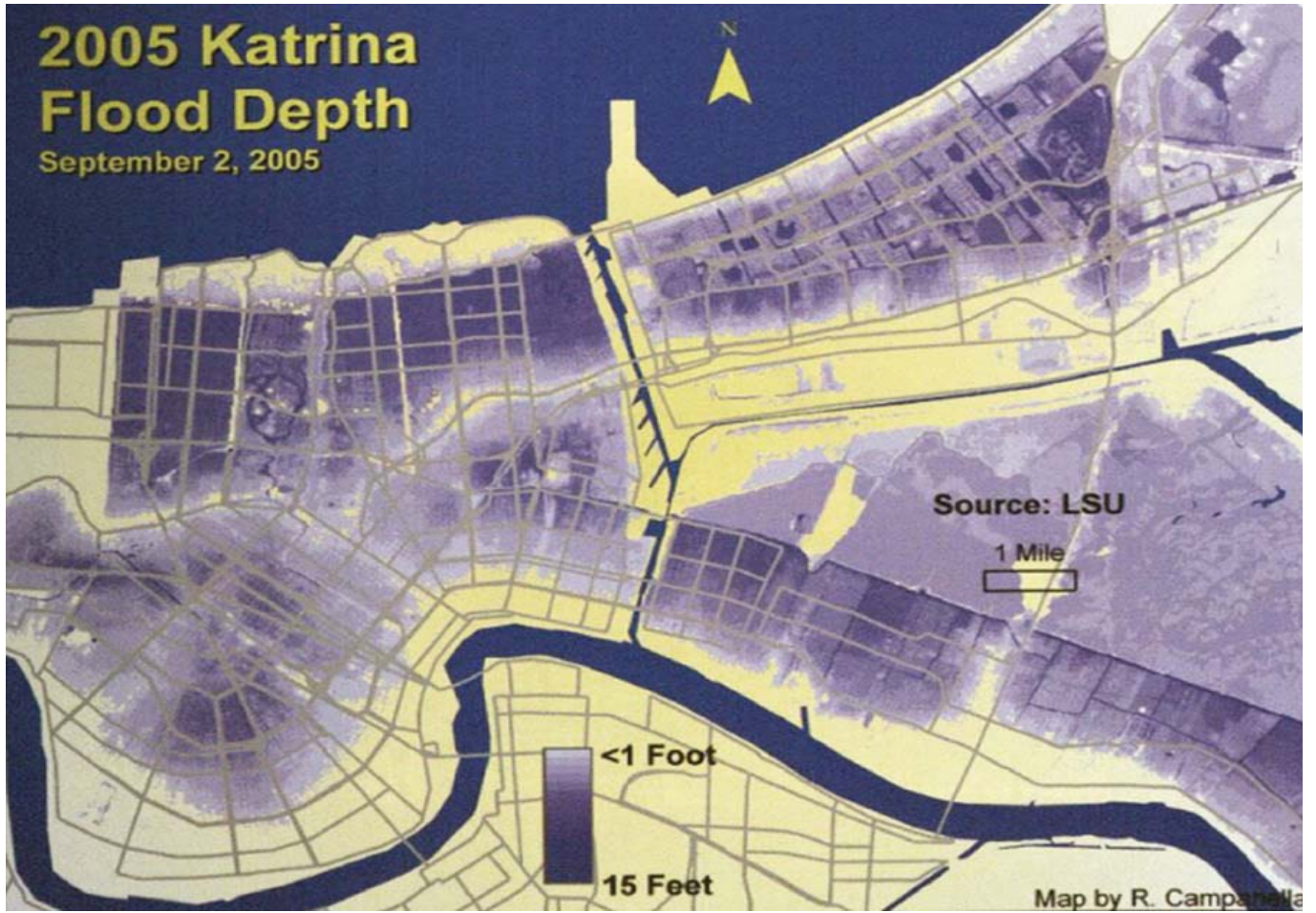


Figure 2.08 Flood Depth (Richard Campanella, 2008, inset)

## Site

The site for my Master's project is a 700 acre portion of Bayou Bienvenue marked in green in Figure 2.09 that lies within the city of New Orleans called the Wetland Triangle. Bayou Bienvenue is a wetland that covers 28 thousand acres between the city of New Orleans and the Gulf of Mexico. The Industrial Canal, Intracoastal Waterway, and Mississippi River Gulf Outlet (MR-GO) are all man-made structures built during the 20th century to help ships from Lake Pontchartrain and the Mississippi River have a direct route to the Gulf of Mexico. Due to construction of the MR-GO, saltwater has intruded into the wetlands damaging the cypress trees and turning the wetlands into salt marshes and/or brackish lakes. When Hurricane Katrina struck in 2005, the remaining cypress trees left in the bayou were killed. During the fall of 2009, the MRGO was beginning to be filled in with boulders to close the shipping channel to help start the process of restoring the wetlands in Bayou Bienvenue.

The Industrial Canal, Intracoastal Waterway and MR-GO surround the Wetland Triangle creating huge barriers. For a site aerial, see Figure 2.10. To the south of the bayou are the neighborhoods of the Lower 9th Ward with a levee that separates the residences from the bayou. This levee blocks the view of the bayou. Some residents were/ are not even aware that a bayou lay to the north of them until January of 2008 when students at the University of Colorado at Denver built an overlook to allow the community a chance to view the bayou. Running the length of the bayou on the south side is an active rail line and a 54" stormwater pipe that directs a majority

of the stormwater in the Lower 9th Ward towards the pumping station (New Orleans Planning Commission). The stormwater is then pumped into an out fall canal that eventually connects to the bayou. To the east of the bayou is Crescent Acres Landfill that collected non-hazardous waste. The landfill was closed and capped in 1993. In the southeast corner is the East Bank Sewage Treatment Plant, during Katrina the facility suffered damage and released sewage into the wetland. There is heavy truck traffic on Florida Avenue that runs along the levee to a metal recycling area to the northwest of the bayou.

Students of the University of Wisconsin with local organizations in the summer of 2009 put in floating islands of saltwater tolerant grasses to help start promoting the restoration of the bayou and get the local community involved. Figure 2.11 shows what the students installed in the bayou.



Figure 2.09 Context Map (Figure produced by author)



- Crescent Acres Landfill
- East Bank Sewage Treatment Plant
- Metal Recycling
- Pumping Station
- Outfall Canal
- Levee
- - - 54" Stormwater Pipe

Figure 2.10 Site (Figure produced by author)





Figure 2.11 Floating Islands (Photo by author)





“One day this city, rapidly increasing as it is in wealth and consequence, will be swept into the Gulf of Mexico, if the Mississippi happen to rise while the south-east wind raise the sea...”

*James Edward Alexander, 1832*

## Goals

The goal of precedent studies is to help refine the project. Studying other projects and seeing how wastewater was treated with wetlands or how discovery centers function help focus my Master's project towards a specific thesis. The program for my Master's project was derived from the precedent studies.

## Precedent Studies Process

The process for the precedent studies started out by creating three study areas: wetlands, wastewater process and discovery centers. Literature was synthesized on wetlands and wastewater treatment process. After getting an understanding of both, projects were selected for study. For wetland study, three projects were selected: Crowley Sewage Treatment Plant, Arcata Wastewater Marsh & Wildlife Sanctuary and Orlando Easterly Wetlands Reclamation Park. Three projects were selected for discovery center study which are James Clarkson Discovery Center, Lynches River County Park and Anita A. Gorman Conservation Discovery Center. All of the projects selected are described in Appendix B: Precedent Studies.

## Wetland Literature

Three books were employed to determine different types and characteristics of wetlands: *Creating Freshwater Wetlands* by Donald A. Hammer (1997), *Understanding Wetlands: Fen, Bog and Marsh and Algae* by S.M. Haslam (2003) and *Element Cycling in Wetlands* by Jan Vymazal

(1995). Each book had different ways to classify wetlands. After synthesizing the three books, similar classifications arose: bogs, fens, marshes and swamps. Bogs and fens are generally found north of the 40° N Latitude and New Orleans at 30° N Latitude rules out bogs and fens. Marshes can either be freshwater or saltwater and are dominated by herbaceous vegetation. Swamps can also be either freshwater or saltwater and dominated by woody vegetation. Both marshes and swamps can be inundated with water all year long or for long periods of time. Once an understanding of wetland types was achieved, the successional stages of a cypress swamp were determined because the Bayou Bienvenue is a brackish lake and one of the goals of this project was to restore bayou back to a freshwater cypress swamp. Knowing the different successional stages will help in the restoration process. The book *Cypress Swamp* by Katherine Carter Ewel and Howard T. Odum (1984) delineated different successional stages. The stages of succession for a cypress swamp are:

- Open water
- Marsh
- Palmetto/Pine or Myrtle or Buttonbush/Willow/Cypress
- Cypress/Hardwood, or Willow or Pond Apple/Pop Ash
- Cypress Swamp

The plant species listed in the different stages are the dominant plant species found in each stage.

## Wastewater Literature

Two books were used to understand the wastewater process: *Wetland Systems to Control Urban Runoff* by Miklas Scholz (2006) and *Wastewater Treatment and Technology* by Christopher Forster (2003). For the purpose

of this project, the general understanding of the process was all that was needed. The synthesized process is preliminary, primary /secondary treatment, and tertiary treatments. Preliminary treatment is the first phase of treatment where screening and grit removal occurs. This is the removal of debris and solids from the water. Primary/secondary treatment is sedimentation and the removal of BOD (biological oxygen demand). This can be done through trickling filters or through the active sludge process. Trickling filters are the older way while active sludge process is newer way that can handle more volume of wastewater. Tertiary treatment is the final phase where nutrients are removed and further cleansing occurs. The last part of the treatment process is sludge handling. This involves removing the sediment/sludge that has settled out during the sedimentation process and taking it to a landfill or composting it.

## Wetland Study Process

The wetland study had several criteria to be analyzed: the size of the wetlands studied, if the wetlands are a complement to a wastewater facility, how many gallons are treated, type of wetlands used to treat the wastewater, what wastewater processes techniques are used and other amenities on site. A table is setup to compare the projects within each group to show the commonalities among the projects. Table 3.01 shows the comparisons of the discovery centers.

Project	Location	Designer	Client	Date Designed	Size (acres)	Supplements Wastewater Facility	Treatment Types before wetlands	Gallons treated per day	Type of Wetlands	Plants (treating wastewater)	Type of Project
Arcata Wastewater March & Wildlife Sanctuary	Arcata, CA	Frank Klopp and Robert Gearhart	City of Arcata	1981	150	Yes	Primary	2-3 Million	Saltwater marsh	Bulrushes, cattails, duckweed	Restoration
Orlando Easterly Wetlands Reclamation & Park	Orlando, FL	Post, Buckley, Schuh & Jernigan	City of Orlando	1987	1,200	Yes	Primary & Secondary	20 Million	Freshwater marsh, hardwood swamp	Bulrushes, cattails, duckweed	Restoration
Crowley Sewage Treatment Plant	Crowley, LA	Mader-Miers Engineering and B.C. Wolverton	Town of Crowley	1992	178	No	Primary	2.5 Million	Freshwater marsh	Bulrushes, duckweed, torpedo grass	Constructed

Project	Location	Wastewater Process						Other Features	Notes	Reason For Selection	Items from project that will apply towards masters
		Screening	Sedimentation	Acitvated Sludge Process	Trickling Filters	Tertiary Treatment	Sludge Handling				
Arcata Wastewater March & Wildlife Sanctuary	Arcata, CA		x		x	x		Oxidation Pond Trails, fishing, picnicking, education, and wildlife habitat, fish hatchery	Public separated from	Treatment process and public	Multiple-uses (recreational, bird-watching, fish hatchery,
Orlando Easterly Wetlands Reclamation & Park	Orlando, FL					x		Trails (hiking & biking), education, wildlife habitat	Water is piped 7 miles away	Treatment process and public interaction	Multiple-uses (recreational, wastewater), treatment side & wildlife side
Crowley Sewage Treatment Plant	Crowley, LA		x		x	x		Oxidation Pond Wildlife habitat	Public not welcomed	Local plant palette and treatment process	Local plant palette and treatment process

Table 3.01 Wetlands (Produced by author)

## Discovery Center Process

Projects selected for discovery center study considered site location, size of site, building footprint and features, learning features offered, and other amenities on site. A table was developed to compare the projects within each group to show the commonalities among the projects.

Table 3.02 shows the comparisons of the discovery centers.

Project	Location	Designer	Client	Date Designed	Context	Size (acres)	Type of Landscapes	Type of Project	Age Group	Building Footprint	Building Features	Learning Features
James Clarkson Discovery Center	White Lake Township, MI	MSI	Huron-Clinton Metropolitan Authority	2006	Suburban	70	Tallgrass and shortgrass prairies, fens, marshes	Restoration	All Ages	20,000	classrooms, labs, 200 person event room, exhibit areas	Demonstration Garden Learning Programs Building Underwater viewing pond
Lynches River County Park	Coward, SC	Zinc Projects	Florence County	2008	Rural	676	Swamp, sand hills	Natural Park	Elementary-Middle	2,700	Small room, Big room, Porch; weather station, wildlife cam, tree canopy cam, historical data	Learning Programs Building
Anita B. Gorman Conservation Discovery Center	Kansas City, MO	BNIM	State of Missouri	2002	Urban	10	Wetlands, native gardens,	Urban park	All Ages	40,000	Auditorium, amphitheater, meeting rooms, labs, living machine	Learning Programs Building Aquarium

Project	Location	Learning Features				Jucational Program	Other Features	Notes	Reason For Selection	Items from project that will apply towards masters	
James Clarkson Discovery Center	White Lake Township, MI	Building	Underwater viewing pond	Playground	Council Rings	Labs	plants, animals, birds, insects	Playground, trails	Teaches kids/adults about the prairie and wetland processes, lets kids get dirty, part of a huge park system, teachers teach	Various landscapes, teaches the public about	Learning features, programs, tying various landscapes together, discovery center
Lynches River County Park	Coward, SC	Building		Playground	Education stations	Tree canopy walkway	plants, animals, birds, insects, cycles and weather	Baseball field, camping, playground, picnicking, canoe launch, trails, riverwalk	Teaches kids/adults about swamps and the natural environment, part of a county park, taught by expert	Discovery center located in a wetland	Learning features, programs, wetland location
Anita B. Gorman Conservation Discovery Center	Kansas City, MO	Building	Aquarium	Living Machines	Council Rings	Labs	plants, animals, birds, insects, water conservation,	Amphitheater, classrooms, bookstore/library, auditorium	Teaches kids/adults about wetlands, native landscapes, and about nature, taught by teachers	Discovery center in urban environment	Learning programs, discovery center building, Urban context

Table 3.02 Discovery Centers (Produced by author)



## Conclusion

The precedent study helped determine the type of wetlands that should be used to treat wastewater, how many gallons an acre can treat in a day, the wastewater process and helped determine the program for my Master's project. All three wetlands studied used marshes to treat the wastewater and were reconstructed wetlands. This tells me the marshes will need to take up the majority of Bayou Bienvenue. The plants used to treat the water were bulrushes, cattails and duckweed. For each wetland studied, the number of a gallons treated was divided by the size of the wetlands to get an idea of how many gallons an acre of wetlands can treat. To get a better idea, more wetlands were studied which include: New Hanover County, North Carolina, Jacques Marsh, Arizona, and a formula from Natural Systems International (National Systems Inc, 2009). The result was that about 15, 362 gallons could be treated per acre per day and can be seen in Table 3.03.

There are three steps to treating wastewater: preliminary, primary/secondary and tertiary treatments. Understanding the process allowed to see where wetlands could fit into the process of treating wastewater which is in tertiary treatment. East Bank Wastewater Treatment facility treats New Orleans' water through the secondary treatment which allows for tertiary treatment by the wetlands. Also, there is the possibility of the primary/secondary treatment at the wastewater facility to become a part of the wetlands since wetland can perform those treatment processes as well.

<b>Wetlands</b>	treated gallons
Aracata	13,333
Orlando	16,667
Crowley	14,045
New Hanover County	10,601
Jacques Marsh	15,748
NSI	21,780
	avg. 15,362

Table 3.03 Treated Acres of Water (Produced by author)

The discovery center precedent studies concluded with some program elements for my Master's project: discovery center building, council rings, labs, auditorium, bookstore, outlooks, trails, wetland types, stormwater management, wastewater treatment process and educational programs. The educational programs varied at each discovery center from native landscapes to various activities people can do in nature with one common theme, educating people on nature. A combination of the educational programs at the discovery centers studied will result in a rich learning experience for people visiting Bayou Bienvenue.



“All this land is a country of reeds and  
brambles and very tall grass”

*Pierre Le Moyne, sieur d'Iberville, 1699*

## Site Inventory Process

Site inventory was performed to identify factors that would affect the design of the Bayou Beivevue's Ecological Park (BBEP). The inventory started broad to determine influential factors that affect New Orleans. Then the focus narrowed to look at factors affecting BBEP. There are several factors affecting BBEP, but there are only a few factors that were the most influential towards the design of BBEP that are shown in this chapter as maps. The remaining inventory maps can be found in Appendix C.

## Social Factors

**Development Barriers-** There are barriers that will hamper development of BBEP which can be seen in Figure 4.01. One barrier is the restricted areas where the public is not allowed. I have labeled the restricted areas as: Never change and possible change. The 'never change' restricted areas are places where until the structure is removed, the restricted area will not be removed. The 'possible change' is a restricted area but could be changed in the future. There is a no development buffer area around the levee to keep the levee intact. There can be no structure mounted into the levee at all but a structure can straddle the levee. Another barrier is the street grid continuing into the bayou. The right-of-ways are owned by the city and the land within the blocks is owned by several people. Before construction, the city will have to purchase the land from the owners or the owners can donate the land to the city. Otherwise, the design of BBEP will be limited to just the right-of-ways owned by the city.



Figure 4.01 Development Barriers (Produced by author)

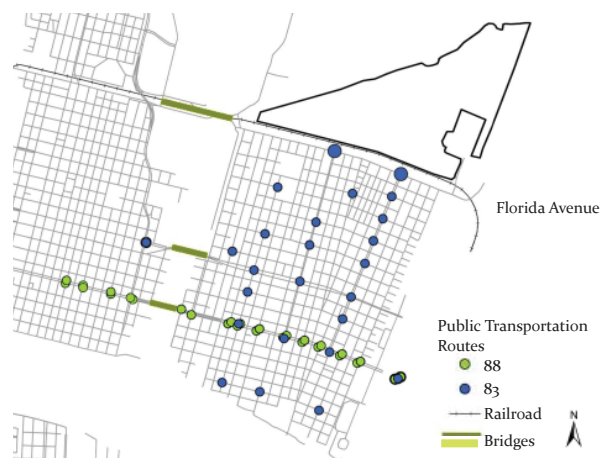


Figure 4.02 Public Transportation (Produced by author)



Figure 4.03 Educational Locations (Produced by author)

Transportation- There are only three bridges that connect the Lower 9th Ward with the rest of New Orleans. Route 88 is the only bus route that goes from the Lower 9th Ward into New Orleans while Route 83 is a shuttle van that travels throughout the Lower 9th Ward. There are two bus stops that are along Florida Avenue which would allow people access to the site. The location of the two transit stops will determine location of program elements of BBEP. Figure 4.02 shows the bus routes and stops.

Learning Facilities- Figure 4.03 shows the schools located near the Lower 9th Ward before Hurricane Katrina. The schools that are green are currently open and the ones that are yellow are being rebuilt. The schools that are blue are either closed, demolished, or the future for the school is unknown. There is one school that is open in the Lower 9th Ward and it has just started a wetland curriculum. This map helps to show where students are coming from to get to BBEP. There is one public library in the Lower 9th Ward located at the one school.

## Natural Factors

Dissolved Oxygen- Dissolved oxygen, a measure of oxygen in the water, is used as a tool to determine the water quality. Dissolved oxygen determines species distribution within an ecosystem. Water that has low dissolved oxygen is generally contaminated and requires special organism that can live in oxygen-deprived areas. The dissolved oxygen saturation limit at 30°C (86°F) is 7.54 mg/l and about half the site is saturated or supersaturated, a solution with more dissolved material than under normal conditions, with dissolved oxygen. This means that there

is plenty of oxygen for organism to survive in the water. (University of Wisconsin 2008, 56-57). There are two areas where the dissolved oxygen levels dip. Figure 4.04 shows the dissolved oxygen levels in BBEP. Dissolved oxygen levels will be important in locating crayfish habitat. Crayfish is an organism that used to live in the bayou and part of the restoration of the bayou includes bringing back the crayfish. Crayfish are also part of the culture and economy of New Orleans. Crayfish can tolerate dissolved oxygen levels as low as 3 ppm (Huner 1994).

**Salinity-** The salinity, a measure of dissolved salt concentrations in water, of the bayou makes it brackish. The salinity levels for freshwater are .5 parts per thousand (ppt) and below, brackish salinity levels are .5-35 ppt and saltwater salinity levels are 35 ppt and higher. The salinity levels within BBEP are 1.5-4.6 ppt which puts the water close to the freshwater salinity levels. (University of Wisconsin 2008, 55)The highest salinity levels are located in the northeast corner while the lowest salinity levels are in the southwest. Figure 4.05 shows the salinity levels in BBEP. Since saltwater intrusion killed the cypress swamp in BBEP, salinity will determine the wetland types and the crayfish habitats within BBEP. Crayfish can tolerate salinity levels up to 5 ppt (Huner 1994).

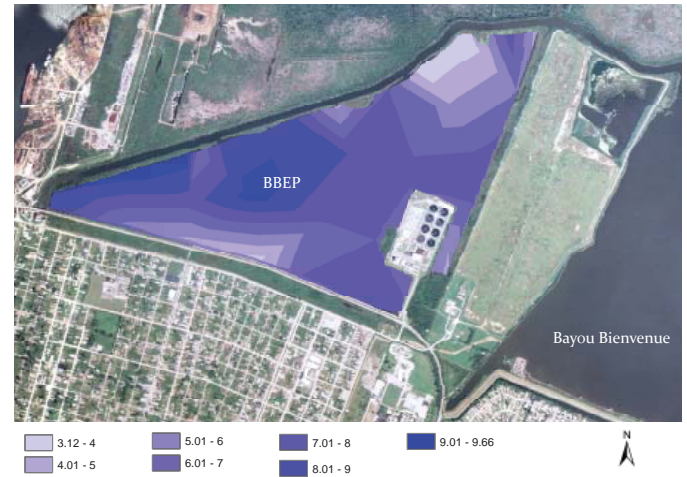


Figure 4.04 Dissolved Oxygen (Produced by author)

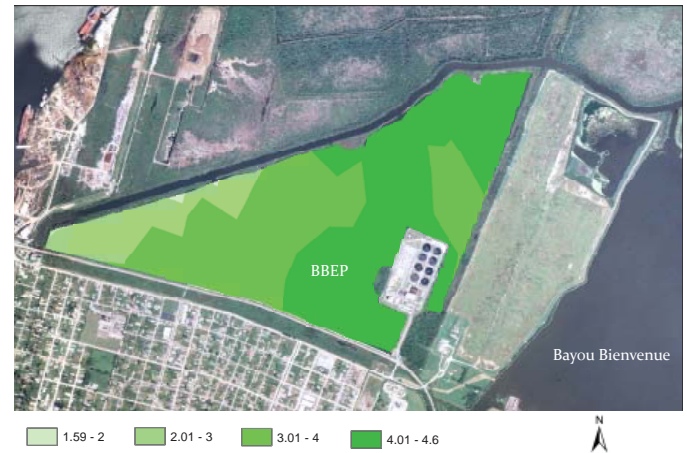


Figure 4.05 Salinity (Produced by author)

Monthly Precipitation				
Month	Avg.	Wettest	Driest	
January	5.87	19.28	0.19	
February	5.47	13.85	0.04	
March	5.24	19.09	0.24	
April	5.02	16.12	0.04	
May	4.62	21.18	0.02	
June	6.83	17.62	0.23	
July	6.2	13.15	1.38	
August	6.15	22.79	0.87	
September	5.55	18.98	0.24	
October	3.05	25.11	0	
November	5.09	19.81	0.18	
December	5.07	25.92	0.67	
Avg.	64.16	102.37	31.09	

Table 4.01 Precipitation (Produced by author)

Storm Intensities	
1 yr. 24 hr.	4.5
2 yr. 24 hr.	6
5 yr. 24 hr.	7.5
10 yr. 24 hr.	9
100 yr 24 hr.	13.5

Table 4.02 Storm Intensities (Produced by author)

Precipitation- New Orleans receives about 64 inches of rain annually. The wettest month is June at 6.83 inches and the driest month is October at 3.05 inches. New Orleans has received as much as 25 inches in one month and as little as no rain in a month. After each rain event, New Orleans must pump out the rain since the city is below sea level. See Table 4.01 for rainfall averages.

Stormwater- The storm intensities for New Orleans can be found in Table 4.02. Stormwater runoff quantities were inventoried to see if the bayou would be able to treat the water. The rational method was used to determine the stormwater runoff. New Orleans lots are graded so that water drains to the street where the water enters into the storm sewers. The Lower 9th Ward was divided based on the amount of impervious (not allowing water to pass through) area on a lot. The results can be found in table 4.03. BBEP will not be able to treat all of the stormwater coming from the Lower 9th Ward, but all of Bayou Bienvenue could treat a ten-year storm, a storm that appears once in ten years, leaving about 175,000,000 gallons of available water that can be treated. If wastewater from East Bank Sewage Treatment Plant is factored in, then there is only 53,000,000 gallons available for treatment by Bayou Bienvenue. This means that the parish south of New Orleans will not be able to use Bayou Bienvenue to treat their stormwater and wastewater along with New Orleans'.



**Pumping Station Facts**

	Area (square ft)	Gallons Per Day			
		Wettest Month June-6.83in	Intensity 2yr-6in	Intensity 5yr-7.5in	Intensity 10yr-9in
Roads	17,318,631	2,212,106	58,298,560	72,873,201	87,447,841
Open space	7,029,996	299,313	7,888,203	9,860,254	11,832,305
Impervious-100%	1,271,529	162,412	4,280,264	5,350,330	214,013
Impervious-95%	74,137	9,154	241,244	301,555	361,866
Impervious-90%	300,873	35,868	945,288	1,181,610	1,417,932
Impervious-85%	95,639	10,994	289,749	362,186	434,623
Impervious-80%	648,798	71,821	1,892,805	2,366,006	2,839,207
Impervious-75%	1,112,961	118,465	3,122,072	3,902,591	4,683,109
Impervious-70%	750,740	76,714	2,021,733	2,527,166	3,032,600
Impervious-65%	406,883	39,845	1,050,075	1,312,594	1,575,113
Impervious-60%	118,053	11,058	291,422	364,278	437,133
Impervious-50%	691,839	58,912	1,552,595	1,940,743	2,328,892
Impervious-40%	1,065,723	81,675	2,152,484	2,690,605	3,228,725
Impervious-30%	324,096	22,078	581,858	727,322	872,786
Impervious-25%	32,085	2,049	54,003	67,504	81,004
Impervious-20%	260,464	15,526	409,165	511,457	613,748
Residential Lot-65% Impervious	40,835,766	3,998,893	105,388,096	131,735,120	158,082,145
Construction Sites	2,774,761	157,520	4,151,331	5,189,163	6,226,996
<b>Total pumped gallons</b>	<b>75,112,974</b>	<b>7,384,404</b>	<b>194,610,947</b>	<b>243,263,684</b>	<b>285,710,038</b>
	BBEP	6,498,245 gallons it can treat			
	Bayou Bienvenue	460,868,410 gallons it can treat			

Table 4.03 Stormwater Runoff Quantities (Produced by author)





“This place has to be better than a place to  
go to the bathroom”

*Tim Duggan, 2009*

## Program Process

The programming of Bayou Bienvenue Ecological Park (BBEP) involved three steps. The first step was developing the program of BBEP which was derived from precedent study. The next step was to determine categories for each program element based on the principles of landscape ecology and the spatial requirements of each element. The last step determined the minimum requirements for each program element which include the minimum size, width, height clearance, slope percent or water depth. Also included in this step was determining the water holding capacity of BBEP in acre-feet. An acre-foot is the volume of water that covers one acre at a depth of one foot. Calculations can be found in Appendix C: Program.

## Site Program

The program for BBEP is broken down into three groups: site program, building program and educational program. Site programming is about enhancing the BBEP as a park that people would visit on a daily basis. Site program elements are: gathering spaces, pavilions, signage and wayfinding, bus stop improvements, outlooks, crayfish harvesting, fishing, farming, geo-caching, artwork, canoeing, a dog park, trails and open fields. Geo-caching is a treasure hunting game played with GPS devices. A dog park is included in the site program because currently there is no dog park for the dogs to roam and play freely in New Orleans. Crayfish harvesting and fishing are included in the site program because these are activities people used to perform when the bayou was healthy and are a part of New Orleans' culture. The criteria for each program element are listed in Figures 6.01-6.02 Program Tree and the source/reason for the element in Chapter Six: Landscape Analysis.

## Building Program

The discovery center at BBEP is programmed to enhance the learning experience about wetlands. The building program elements are: indoor labs, meeting rooms, classrooms, amphitheater, offices, restrooms, auditorium, bookstore, mechanical areas, balconies, rooftop garden/ observation deck for viewing the Lower 9th Ward and BBEP, and a sitting area. Part of BBEP is to allow students to collect organisms in the wetland and bring them back to the discovery center's labs for studying. An auditorium will play videos about wetlands and the bookstore will

sell information about wetlands. Educational programs located in the discovery center will include: water, carbon, phosphorus and nitrogen cycles and green infrastructure. These programs are focused at a city-scale to show the impacts of everyday activities of people on the wetlands surrounding New Orleans.

## Educational Program

Educational programming at BBEP is designed to enhance a person's educational experience about wetlands and their functions. The functions of wetlands are life support, hydrologic modification, water quality, erosion protection, aesthetics, geo-chemical storage and food. There will be educational sessions for various age groups. The educational program elements are wetland types stations, soil station, erosion station, flood mitigation station, oil rig station, composting station, stormwater station, wastewater station, outdoor labs and the discovery center building. The wetland type stations will include information on freshwater marshes, freshwater swamps, saltwater marshes and saltwater swamps. There will be a station and trail for each type of wetland. Each wetland station will cover the different plants, organisms and processes that occur in the wetland. The criteria for each educational program element are listed in Figures 6.02 Program Tree and the source/reason for the element in Chapter Six: Landscape Analysis. Other educational programming includes green infrastructure, geo-caching, photography, drawing and farming. These other educational programs are to enhance someone's experience while at the park.

## Program Categories

The site program and educational program at BBEP was divided into three groups: patch, corridor and matrix based upon landscape ecology principles. Patch, corridor and matrix are three of five principles in landscape ecology. These categories were chosen because these principles are used to understand a landscape and since I am designing a landscape, organizing the program into these principles will help in creating a landscape that functions well. The groups represent the spatial needs of the program and help with the design of the project. Patch is defined as an element that is a stop and requires the smallest amount of space. Corridor is defined as an element that has a start and end and is linear. Matrix is defined as an element that encompasses both stops and linear paths resulting in a network. Program elements that fall into the matrix category require the largest amount of space. Table 5.01 shows the program elements in the groups.

Program Elements	Patch	Corridor	Matrix
Gathering spaces	X		
Pavilions	X		
Signage and wayfinding			X
Bus stop improvements	X		
Outlooks	X		
Crayfish harvesting			X
Fishing			X
Farming	X		
Geo-caching			X
Artwork			X
Canoeing			X
Dog park	X		
Trails		X	X
Open fields	X		
Soil station	X		
Erosion station	X		
Flood mitigation station	X		
Oil rig station	X		
Composting station	X		
Stormwater station	X	X	
Wastewater station	X	X	
Outdoor labs	X		

Table 5.01 Program Categories (Produced by author)









## Definition

As landscape architects, we design landscapes for people and how they interact with their environment. To better understand a site, site analysis is performed. Site analysis focuses on the site and program while not always including the human experiences; therefore landscape analysis was chosen as a way to understand the landscape that surrounds Bayou Bienvenue's Ecological Park (BBEP) and what encompasses BBEP from the physical factors to the desired experiences. Site analysis reveals suitabilities and vulnerabilities for the site and program. Suitability refers to how well something is adapted for change and vulnerability refers how well something recovers from change. High suitability would be a site that requires very little changes to implement a program element while low suitability requires a lot of changes to the site. Low vulnerability would be a site that is able to recover back to towards it original condition from a site disturbance, such as implementing a program element, fairly fast while high vulnerability will require a much longer recovery time. BBEP's site vulnerability is low because the site is degraded and any changes to the site would be an improvement.

## Program Tree

BBEP's program suitability was determined by a tree diagram to help visualize the different criteria in determining the most suitable areas on the site for each program element of BBEP. For detail information on the program, reference Chapter Five: Program or figures 6.01, 6.02 on pages 55-58 for a list of the program elements in the tree diagram. The tree is structured with the program element on the left in black asking where the most suitable areas are. Next in the dark green is the answer to the question. Further along the tree diagram in light green are the ranked suitable criteria that meet the answer. On the far right in the brown is the source or reason for why those criteria were selected. A ranking system of one to nine was created to help with finding the suitable areas with nine the most suitable and one the least suitable. Each criteria was weighted because some criteria are more influential than others in finding the suitable area. The following figures show the most suitable areas for program elements. Only a select few elements are shown in this chapter (see Figures 6.03-6.09): these affected the layout of the design while the rest of the figures are shown in Appendix D: Landscape Analysis Maps.

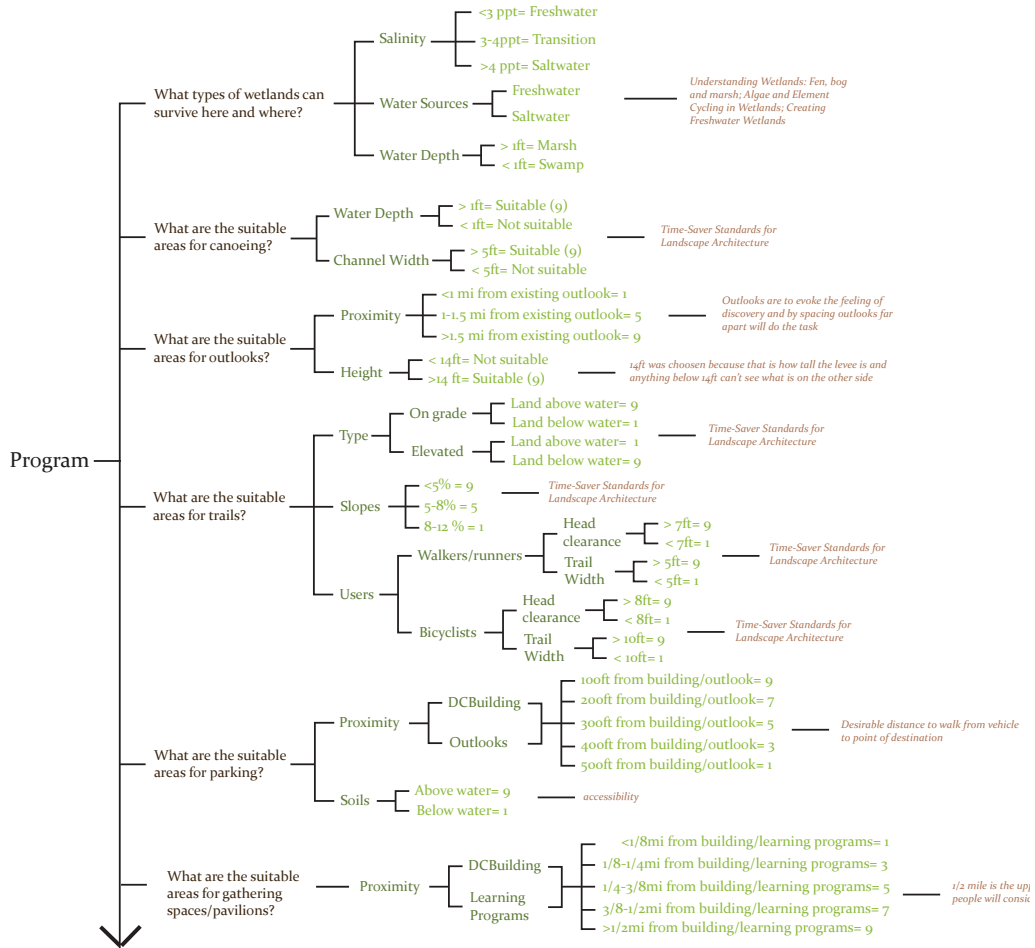


Figure 6.01A Program Tree (Produced by author)

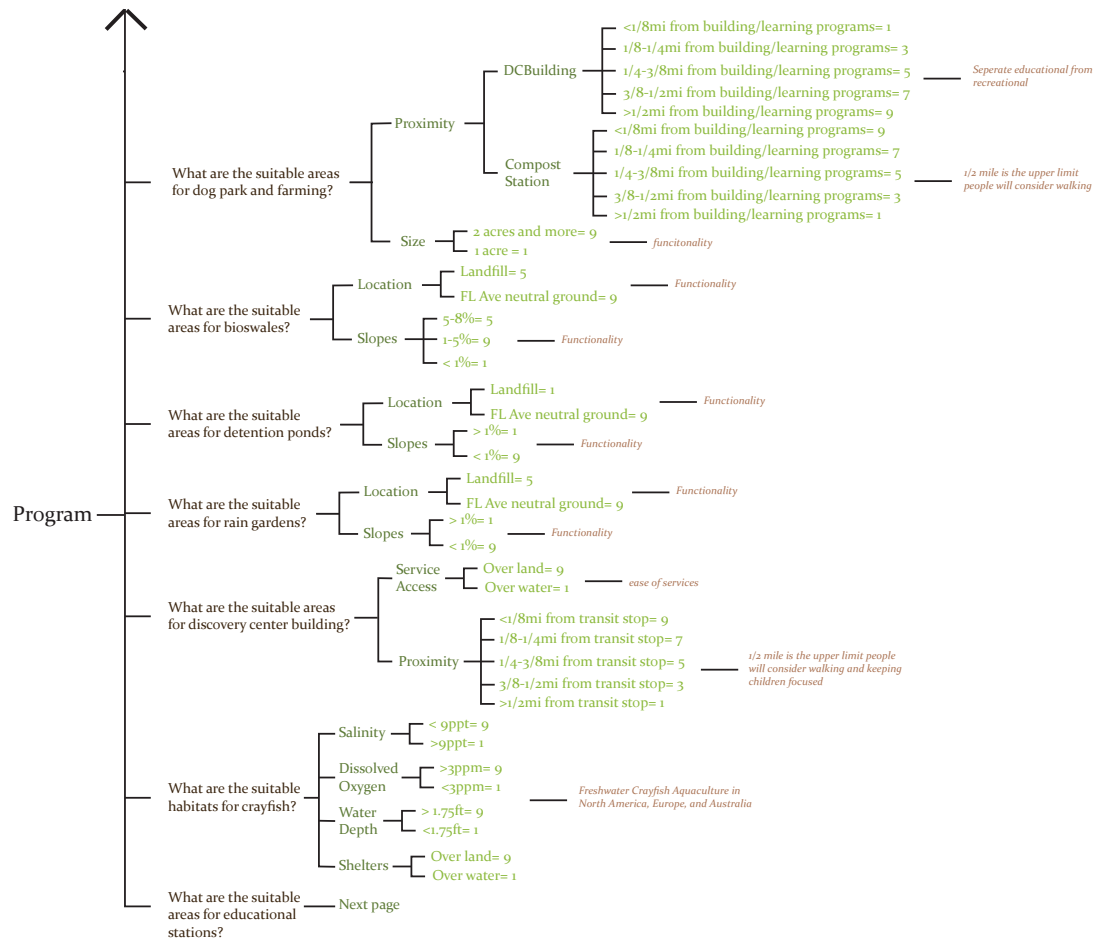


Figure 6.01B Program Tree (Produced by author)

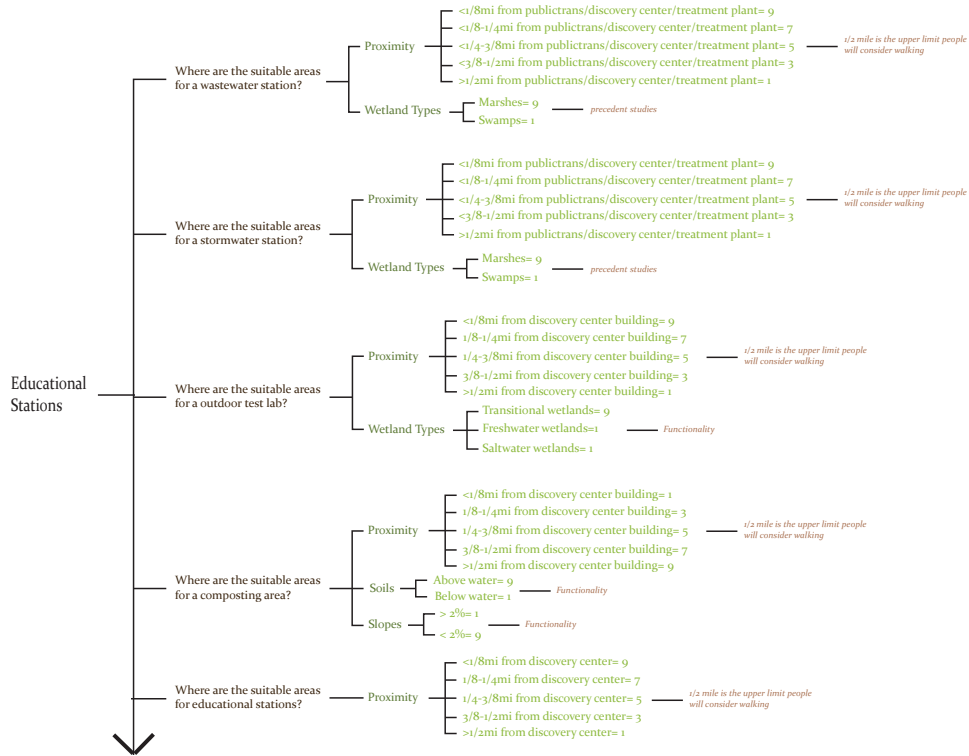


Figure 6.02A Educational Station Tree (Produced by author)

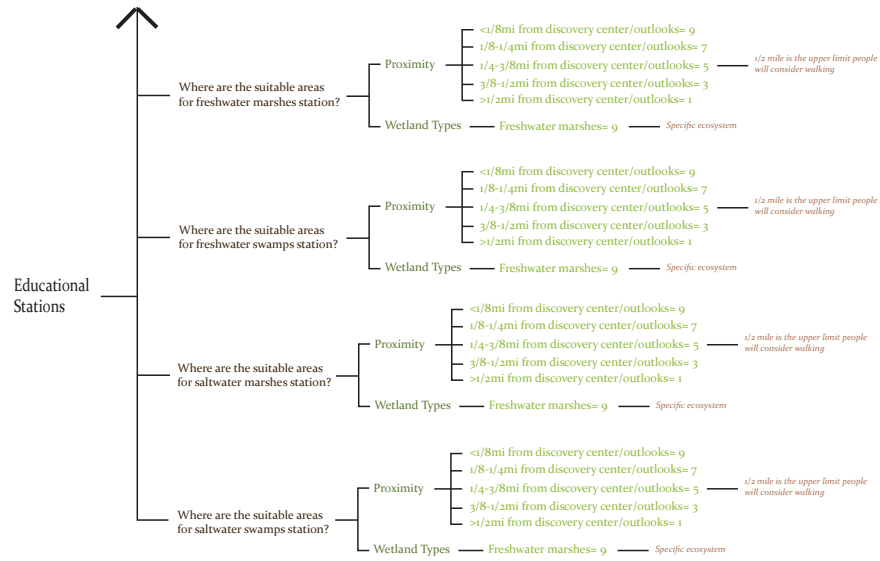


Figure 6.02B Educational Station Tree (Produced by author)





Figure 6.03 Building Suitability (Produced by author)



Figure 6.05 Dog Park Suitability (Produced by author)



Figure 6.04 Farm Suitability (Produced by author)

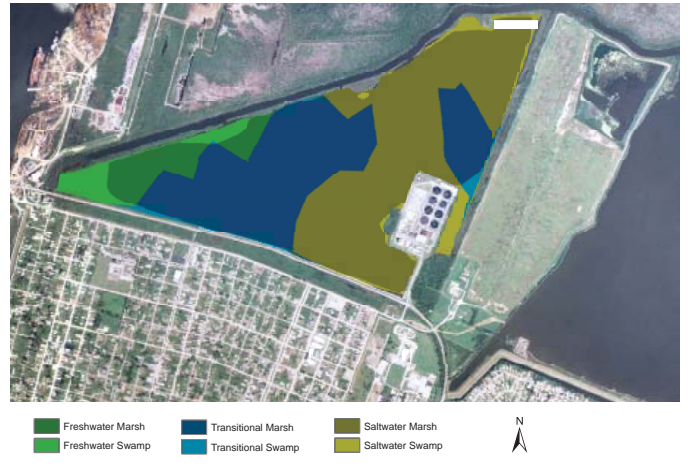


Figure 6.06 Wetland Types (Produced by author)



Figure 6.07 Compost Station Suitability (Produced by author)

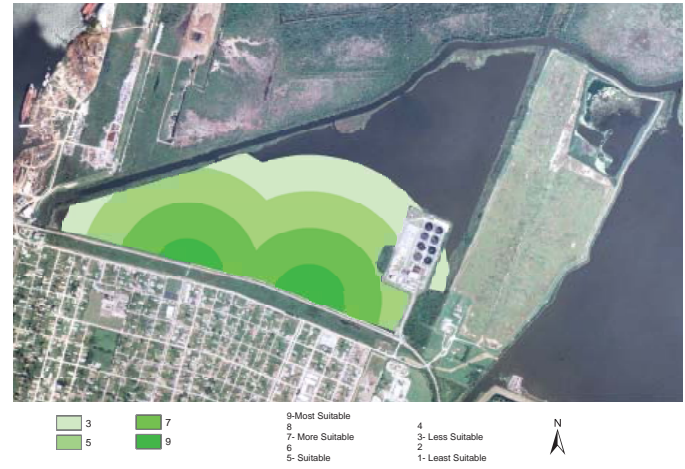


Figure 6.09 Educational Stations Suitabilities (Produced by author)

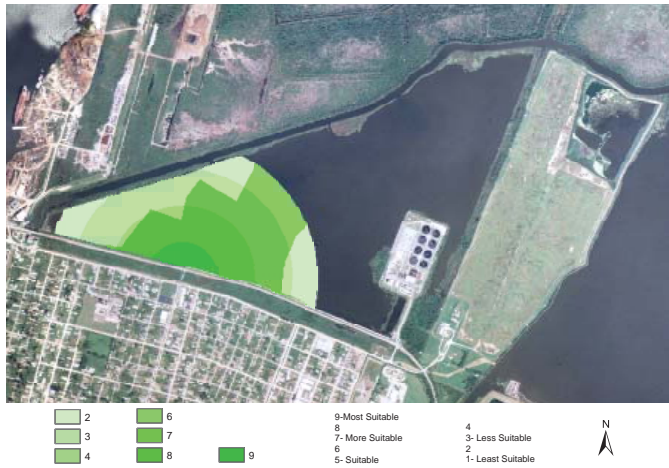


Figure 6.08 Outdoor Lab Suitability (Produced by author)

## Experience Tree

A part of landscape analysis is the inclusion of desired experiences which BBEP would provide, these were divided into two groups: educational and recreational. The educational experiences are discovery, inspiration and responsibility while the recreational experiences are hope, destruction and restoration. The educational experiences were chosen because those experiences follow the process of learning. People will discover a new concept/idea. Then some people will get inspired to learn more about that concept/idea. The last step in the learning process is taking responsibility. This can be done by spreading the word to donating money/time for work.

Destruction was chosen because Hurricane Katrina destroyed portions of New Orleans and Bayou Bienvenue has turned into a brackish lake. Hope was chosen because this is what New Orleans experiences as they rebuild their city and things start to turn better. Restoration was chosen because restoration is occurring at BBEP and people need to get restored to perform daily tasks.

The experience tree is structured with the experiences on the left in brown. Next in the light green is a question that asks what kind of characteristics give that experience. Following along the tree diagram in the dark green are the answers to the questions. On the far right in the brown are the ranked criteria for the answers. A ranking system was created to help with finding the suitable areas that uses the numbers one to nine with nine the most suitable and one the least suitable. Each criteria was weighted because some criteria are more influential in giving an

experience than others. Since the site is underwater and the landscape will have to be created, the experience tree is going to be used as an evaluation of the design and can be found on pages 62-64

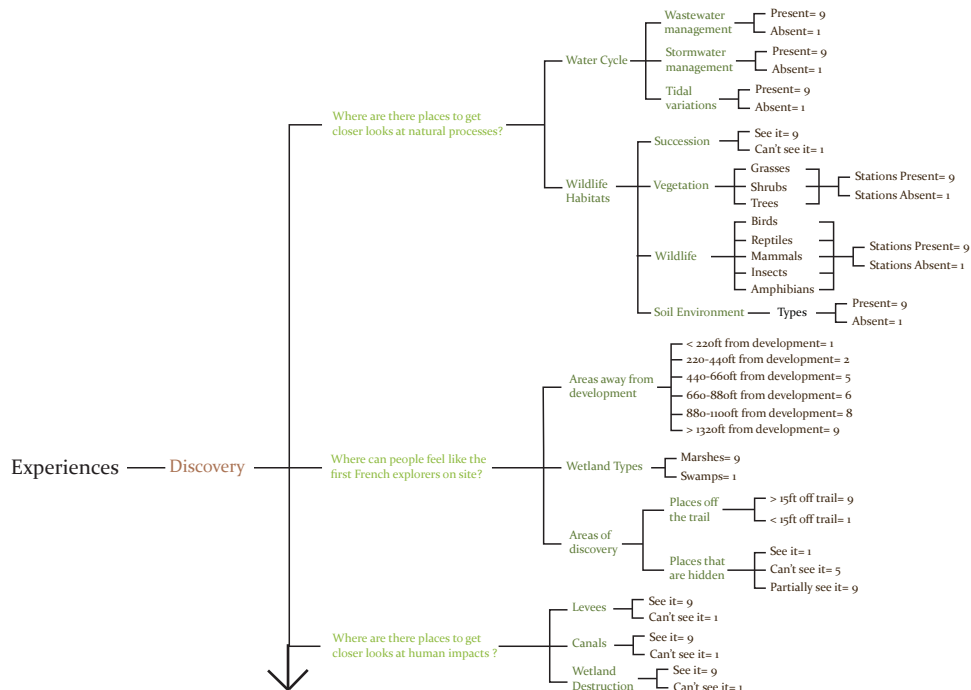


Figure 6.10A Experience Tree (Produced by author)

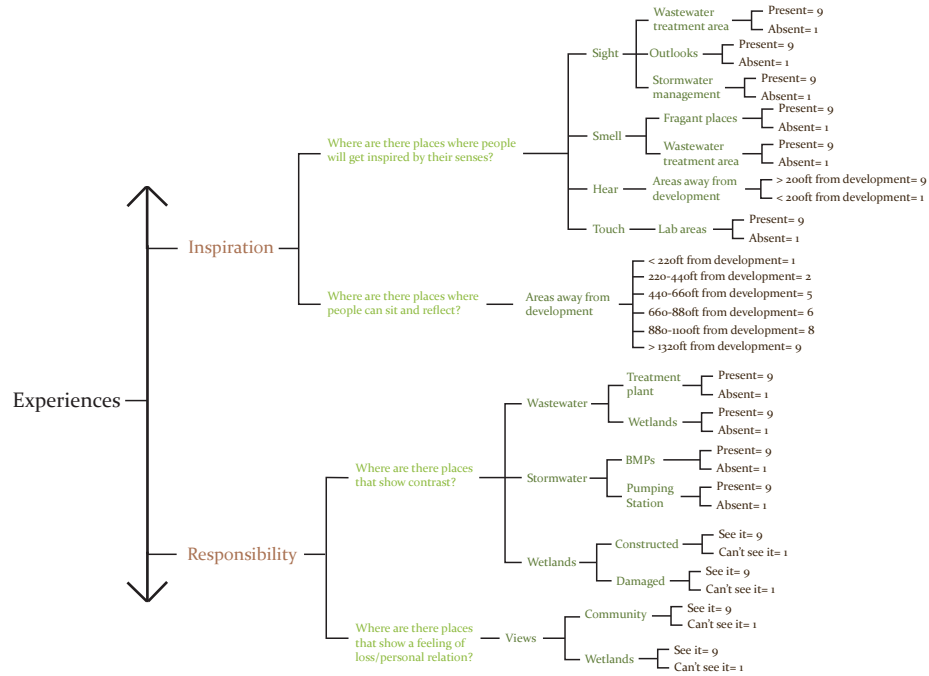


Figure 6.10B Experience Tree (Produced by author)

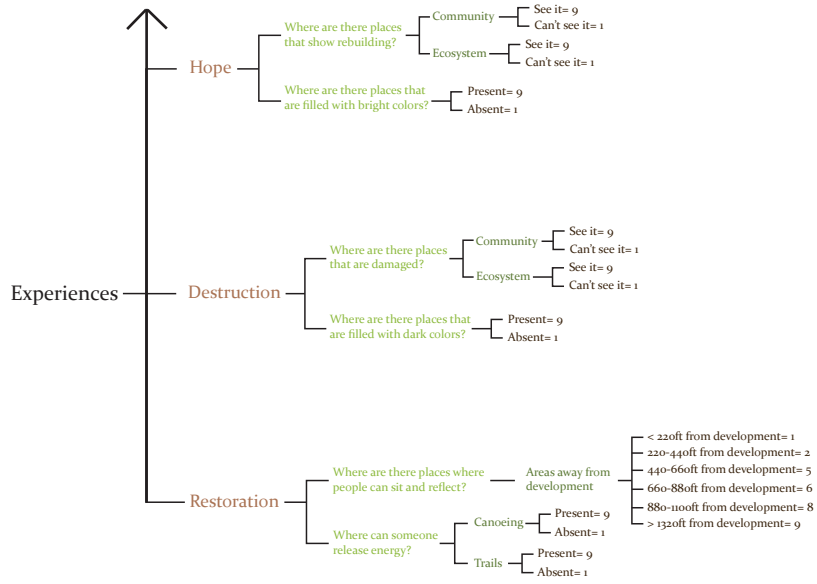


Figure 6.10C Experience Tree (Produced by author)

## Conclusion

After performing the landscape analysis, there were certain areas in BBEP that are suitable for multiple program elements including the areas around the bus stops, pumping station and the wastewater treatment facility. An area that was not suitable in BBEP for the program elements was the northeast corner of the site due to its far distance from the entrance. The mapping of the suitable areas for the program elements helped with determining the design of BBEP. Appendix D contains my Landscape Analysis maps.







“Will I be able to retell the story of the  
sponge?”

*Eric Bernard, 2009*

## Concept

There were three concepts that shaped the design philosophy of Bayou Bienvenue's Ecological Park (BBEP). The design philosophy for the project focused upon wetlands, community and education. The decisions made about the project's design were to enhance all three parts of the philosophy. The goals of the project were to rehabilitate the bayou, educate people, use landscape as infrastructure and create park space. The goals for BBEP were derived from the design philosophy and so by adhering to the design philosophy, the goals will be met. The conclusions from site inventory and landscape analysis were important in the decision making process for BBEP.

The concept of BBEP is successional wetland landscapes that express the feelings of discovery, inspiration, responsibility, hope, destruction and restoration.

# Bayou Bienvenue's Ecological Park through users' eyes

## The student

Today is the day your class goes to Bayou Bienvenue's Ecological Park (BBEP) and as a class you walk down Caffin Avenue until it intersects Florida Avenue. At the intersection, is the **Discovery Center** emerging out of the landscape. At the Discovery Center you learn about the cycles that affect the ecosystems and how you personally affect the cycles. From the Discovery Center, you venture into the wetlands stopping at the outlook on top of the levee. From here you can see the whole site and off in the distance there is a tower appearing out of the wetlands. Your group stops at a pavilion on its way to the tower to learn about freshwater marshes. This pavilion is one of five **educational stations**. At this pavilion you learn about the different plants and organisms that make the freshwater marsh their home. Some of the birds you have seen in the canals throughout the city live in this ecosystem. After leaving the pavilion, you cross over a bridge where water is flowing underneath it from one wetland cell to another. The sign tells you that it is a **weir**. The next stop after the weir is Taxodium Tower that looks like an oil rig platform but is an **observation tower**. Stepping on to the platform, you notice that the floor is made of plexiglass and that you can see the underwater environment of a wetland. At the tower you learn about the flood mitigation that wetlands provide against storm surges. Now it's time to leave for the day and you head back to school. On the way back to school you are thinking about the flood mitigation station and how the

storm surge had dissipated so much by traveling through the wetlands causing little damage to the model city. You realize that the model city was a representation of any city along the coast like New Orleans and make the connection that wetlands can really help your city when the next hurricane/tropical storm hits the area. Later that night at dinner, you tell your parents about the field trip to BBEP and the lesson that you learned about wetlands.

## The business person

It has been a long day at work and you decided to stop by Bayou Bienvenue's Ecological Park (BBEP). You get off the bus at the intersection of Tupelo Street and Florida Avenue next to the **dog park**. Seeing all the dogs running around started to bring a smile to your face. At the outlook on the levee, you see a landscape that changes from grasses to trees and is peaceful besides the barking of the dogs playing behind you. After walking the main trail for a little bit, you see a trail that branches off to the left and take the trail. You notice an immediate difference in the visual **character** of the trail. The main trail was open and above the wetlands while this trail was more closed and immersed in the wetlands. You are now a part of nature. The trail changes from crushed, compacted gravel travel to a boardwalk that is only a foot above the water. Off the boardwalk is a trail leading to a small sitting area that you discovered. You venture off the trail and head into the sitting area. While sitting there, all you can hear are the blades of grasses blowing in the wind and the faintest sound of water moving through the landscape. Off in the distance are birds chirping away. After sitting for a couple minutes, the long day at work has left your mind and you can only think of the beauty of nature. You continue on

the trail that led you through the site. You notice that the plants around you were changing. There are now more varieties and it is not just grasses anymore. Flowers are appearing among the grasses as well as shrubs. You cross the main trail and move into what looks like a forest growing out of the water. The signage tells you that it is a **cypress swamp**. Around a bend, there is sculpture that is immersed in the trees. The sign for the sculpture tells you that it contains pieces of oil rigs that were destroyed in hurricanes and are one of many scattered throughout BBEP. On the way back to the bus stop, you run into a family of three generations who are bicycling along the trail. This gives you an idea for this weekend with your family. You get on the bus and go home.

## Illustrative Plan

The symbolic part of the design was in the layout of the berms, this pattern was based on a pattern oil companies left in the wetlands along the gulf coast of the United States. The pattern left behind by the oil companies was chosen because the pattern was used to exploit nature for a resource while causing disturbances through the creation of canals. These canals would set the path for the degradation of the wetlands. Now this same pattern will be used to help restore a wetland by creating land in the form of berms instead of the exploiting the wetlands. The berms in section view will vary in shape and consist of the classic C shape, the mountain point and the tilted berm. These figures are found on pages 73-75.



Figure 7.01 Illustrative Plan (Produced by author)

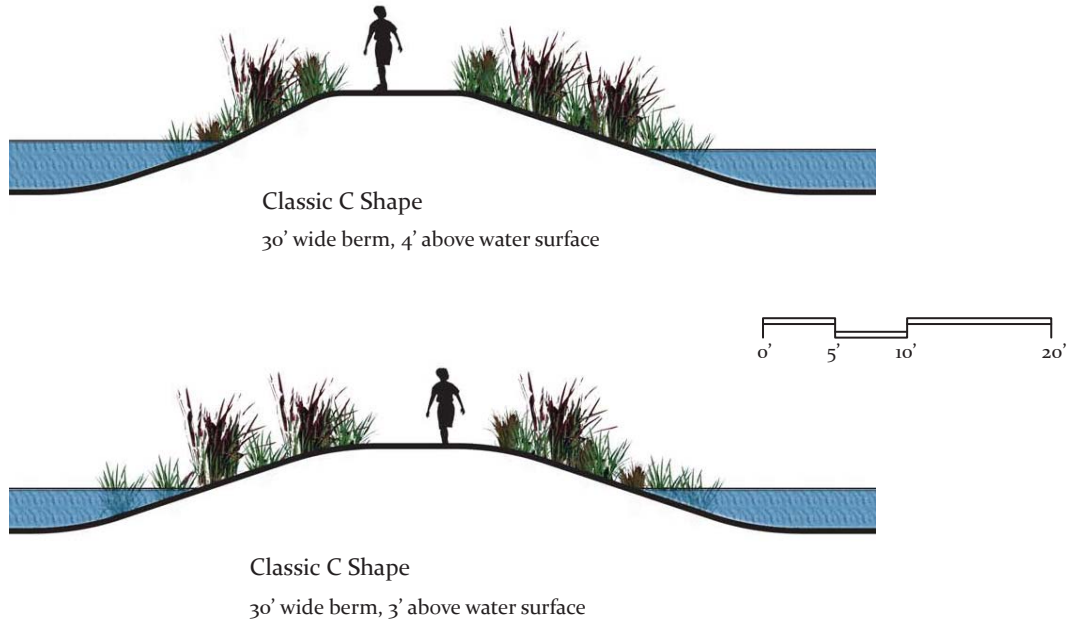


Figure 7.02A Berm Shapes (Produced by author)

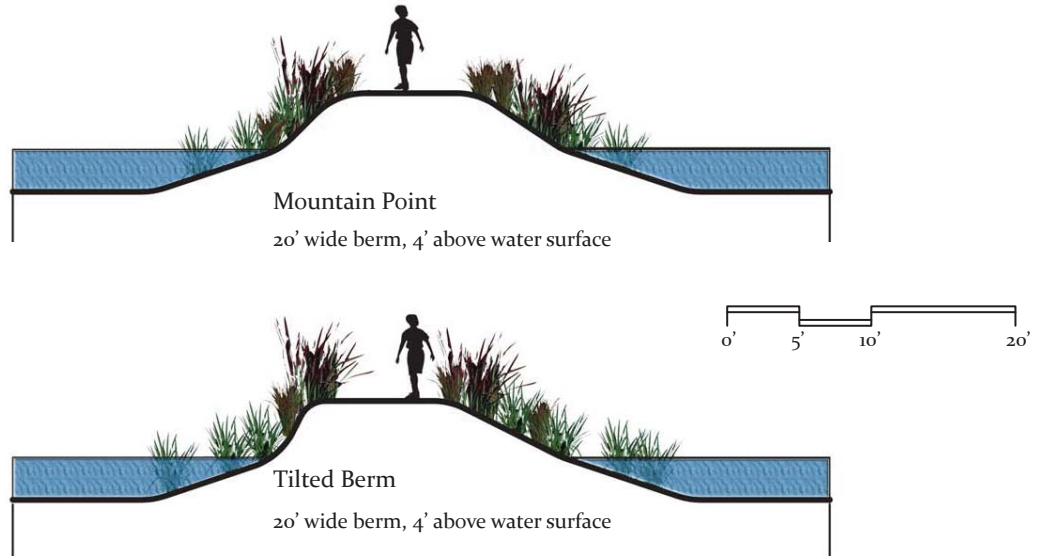


Figure 7.02B Berm Shapes (Produced by author)



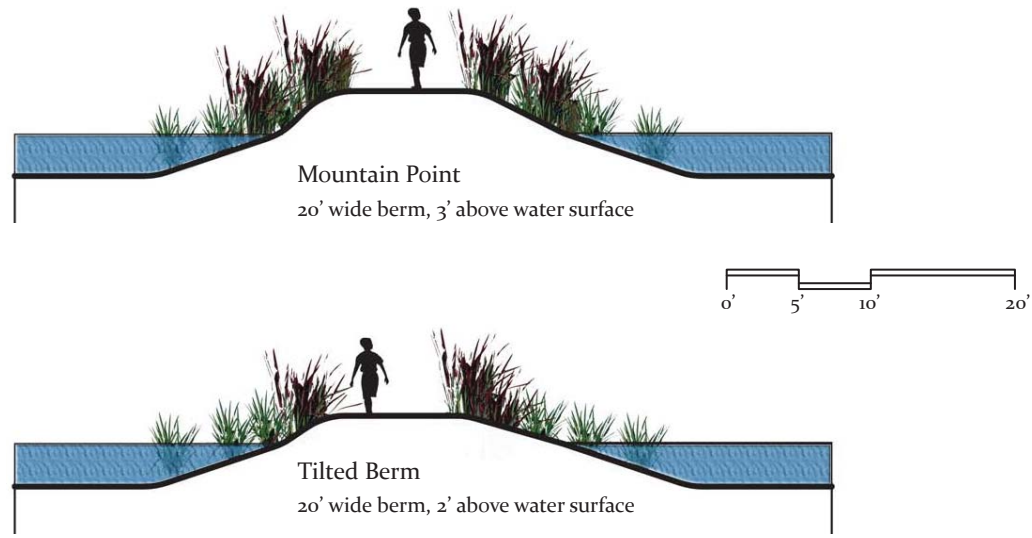


Figure 7.02C Berm Shapes (Produced by author)

## Character

The character of the site is based on successional landscapes of a saltwater marsh, saltwater swamp, freshwater marsh and freshwater cypress swamp. Each landscape has its own successional stages. BBEP is divided into four major wetland cells so that BBEP will be able to treat wastewater and stormwater. Figures 7.03-.05 are sections taking across BBEP and Figure 7.06 shows the location and direction of the sections. These sections have a vertical exaggeration to show what little elevation change there is at BBEP. Figure 7.07 shows the layout of the cells. The cells follow the wetland types that exist at BBEP. Cell one is a freshwater swamp/marsh, cell two is a transitional marsh and cell three and four are saltwater marshes/swamps.

Cells three and four have a landscape that consists of a few varieties of grasses due to the salinity levels. There is only a single layer of plants across all of cells three and four. Single layer of plants means that there is one uniform height across the landscape. Cells three and four have a feeling of openness since there are no vertical obstacles like trees blocking the sky. There are only grasses that can get as tall as a person. Walking along the berms a person is above the grasses and sees across the site. Walking along the boardwalks a person is among the grasses and only sees the grasses around them and the sky above them. Figures 7.08-.09 show what cells three and four look like. Figure 7.08 is cell three after the completion of the wetland cell and Figure 7.09 is the cell a few years later.

Cell two has the same feel as cells three and four except that there are more varieties of grasses because the salinity level is lower. There are forbs and flowers that appear among the grasses adding color to the landscape. Cell one has a landscape that has the highest species diversity. There are varieties of trees, shrubs, forbs, flowers and grasses located within cell one giving multiple layers to the landscape.

Cell one has a feeling of closeness due to the tree canopy. Figures 7.10-.11 show what cell one looks like. Figure 7.10 is the cell after the completion and Figure 7.11 is the cell a few years later. Over time, cell one will succeed to a freshwater swamp while cells two, three and four will be a combination of freshwater marshes and swamps. Overall, the site will go from a landscape with one layer of plants, low species diversity and small in height to a landscape with multiple layers of plants, high species diversity and varying in height.

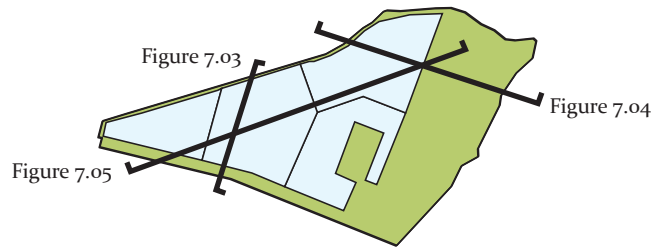


Figure 7.06 Section Locator

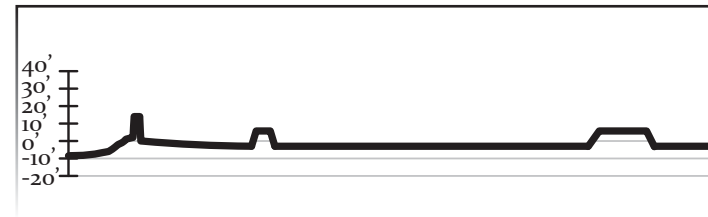


Figure 7.03 Transitional Section (Produced by author)



Figure 7.04 Landfill Section (Produced by author)



Figure 7.05 Longitudinal Section (Produced by author)

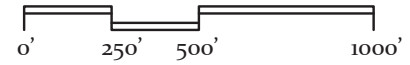
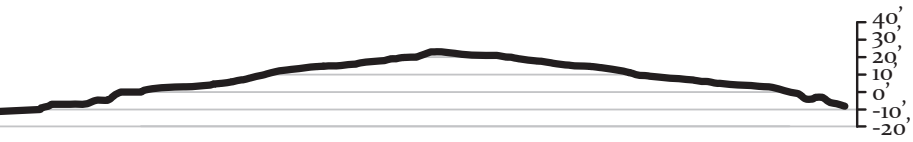
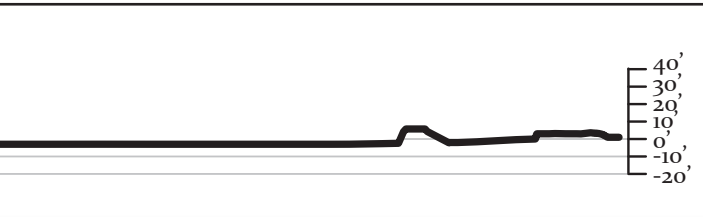




Figure 7.07 Wetland Cells (Produced by author)



Figure 7.o8 Saltwater Marsh initially (Produced by author)



Figure 7.09 Saltwater Marsh filled-in (Produced by author)



Figure 7.10 Freshwater Marsh/Swamp initially (Produced by author)





Figure 7.11 Freshwater Marsh/Swamp filled-in (Produced by Author)

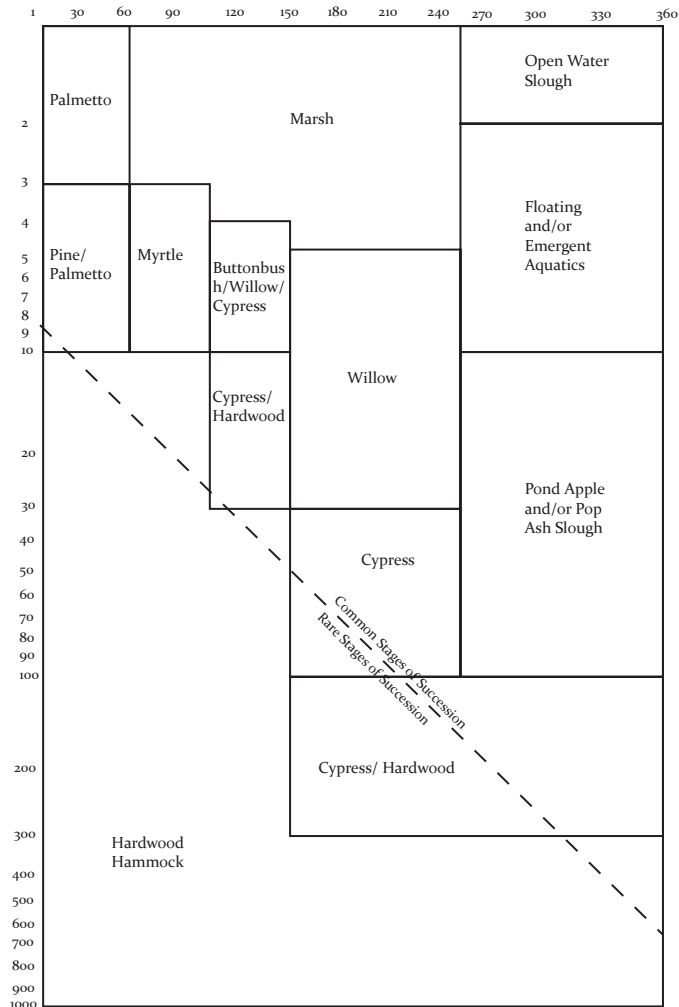


Figure 7.12 Wetland Succession (Ewel and Odum, 1984, 302)

## Successional Landscapes

The first stage of succession from an open body of water is the saltwater marsh due to the high salinity levels. The saltwater marsh is a landscape that will have the fewest variety of plant species. The next stage is the freshwater marshes which will be more species rich than the saltwater marsh. Both types of marshes will be low in height and have one layer of plants which means that there is one uniform height across the landscape. The next stage in the succession is the transition from marsh to swamp and the type of landscape all depends on what plant species get established first. The different landscapes are a myrtle swamp, buttonbush/willow/cypress swamp or willow swamp and each has a different character. The buttonbush/willow/cypress swamp will have more silver in color due to the buttonbush while the willow and myrtle swamp will be greener. All three swamps will be multi-layered and be taller than the marshes. The next stage is a cypress/hardwood swamp or cypress swamp which will be multi-layered and be the tallest. The cypress/hardwood swamp will have more variety in tree species and in the fall will have color than the cypress swamp. Figure 7.12 and 7.13 show the different successional stages of a freshwater cypress swamp

### Successional Wetland Landscapes: Bayou Bienvenue's Ecological Park



Figure 7.13 Successional Wetlands at BBEP (Produced by author)

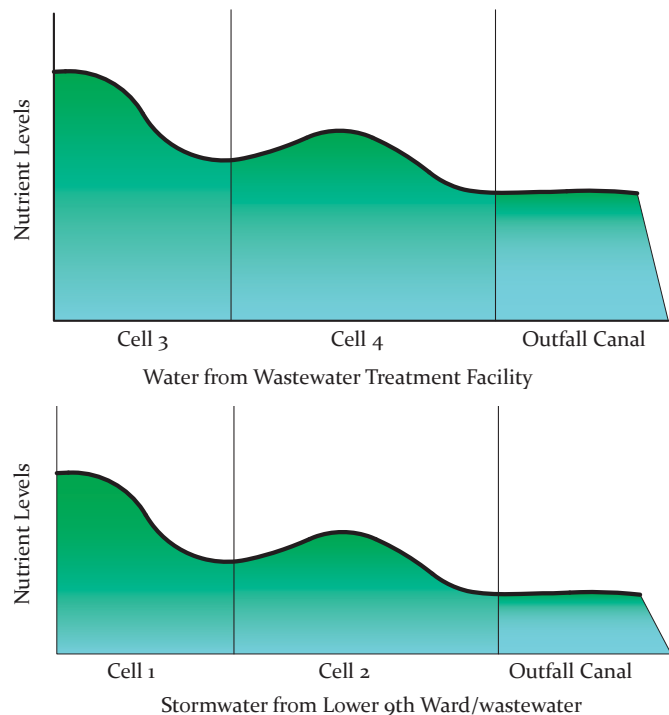


Figure 7.14 Nutrient Flow Levels (Produced by author)

## Water Flow through the Wetland Cells

There are four points where the influent, incoming water, enters the site, one in each cell. Influent coming into each cell is thought to spread from the pipe in a ring pattern expanding outward. As the water moves through the cells, the wetlands will treat the water and remove excess nutrients. Figure 7.14 shows the nutrient flow levels as the water moves through BBEP. The berms are positioned within each wetland cell to slow down the water's velocity so the sediment in the water will settle out causing the berms to expand. Figure 7.15 shows the flow patterns within the wetland cells. Ideally a team of experts would have helped realize the conceptual placement of the berms I have designed.

Wetland cell one flows into cell two while cell three flows into cell four. Wetland cells two and four are the discharge points for BBEP into the outfall canal. Wetland cell one can treat 962,784 gallons per day of stormwater, cell two can treat 2,124,781 gallons per day of wastewater, cell three can treat 1,446,830 gallons per day of wastewater and cell four can treat 1,967,209 gallons per day of wastewater. Overall the whole site will be able to treat 962,784 gallons of stormwater per day and 5,538,820 gallons of wastewater per day.

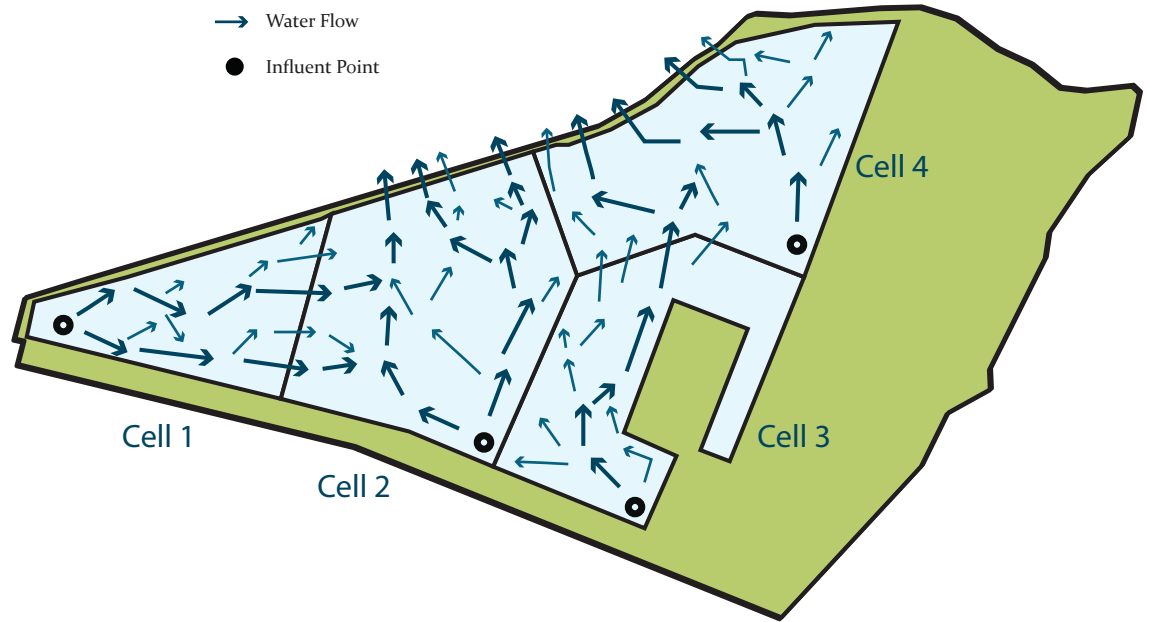


Figure 7.15 Water Flow (Produced by author)

## Educational Stations

The educational stations about the different wetland ecosystems will educate people about the plants, organisms and cycles that occur in each wetland ecosystem. The stormwater and wastewater station is located at the effluent point for wetland cell two. At this station, the process of treating the water through wetlands will be explained as well as the wastewater treatment process. The flood mitigation station will have a model about the impacts of storm surge on communities by showing the storm surge moving through marshes, swamps and open waters. The oil rig station will discuss the history of the oil industry in Louisiana, the impacts to wetlands and what the industry is doing to restore wetlands. The soil station will have a model showing the different types of soils in New Orleans for people to touch and a model showing how poor soils and good soils affect plants. The erosion station will have a model where people can change the different land cover types and slopes to see how they affect erosion. A wayfinding device for locating the educational stations is all stations will have a green roof. The different educational stations can be seen in Figure 7.16.

## Trails

There are two major types of trails found in BBEP: recreational and educational. The recreational trails are located throughout the site giving people the option to bike, run or walk. The educational trails are located in the center of the site that creates a loop between the two entrances with trails that branch off the main loop allowing people the opportunity to explore the different wetland types in BBEP. The educational trail is located on the wetland cell berm divider. There are freshwater marsh, freshwater swamp, saltwater swamp and saltwater marsh trails. The saltwater swamp and marsh trails over time will phase out and become freshwater marsh and swamp trails as BBEP succeeds to a freshwater marsh and swamp. Figure 7.16 shows the different trail types in BBEP.

There are two different ways trails exist at BBEP: elevated or on grade. On grade trails are located on the berms while the elevated trails connect on berm to another or to allow the water to flow underneath. The elevated trails are boardwalks that are one foot above the water surface. The on grade trails are crushed gravel and the trails height above the water surface vary according to the different successional wetland landscapes. The berms in the saltwater marshes are one to two feet above water surface, freshwater marshes berms are three above and the freshwater swamp berms are four feet above. The different trail types can be seen in Figure 7.17.

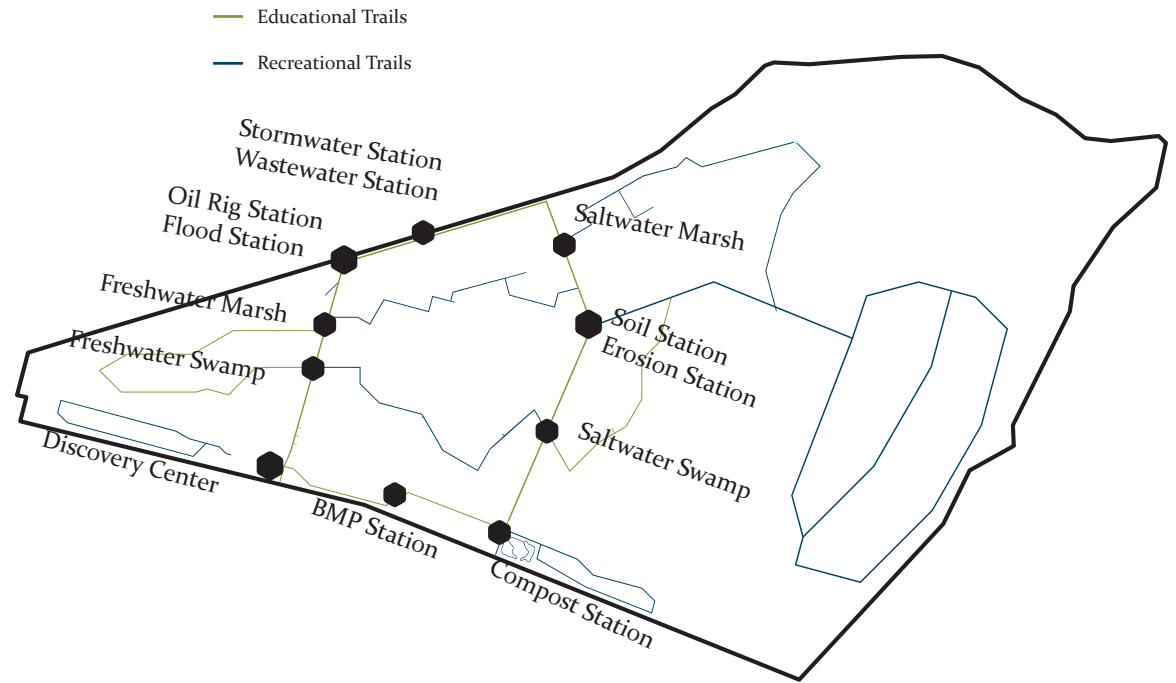


Figure 7.16 Trail and Educational Diagram (Produced by author)

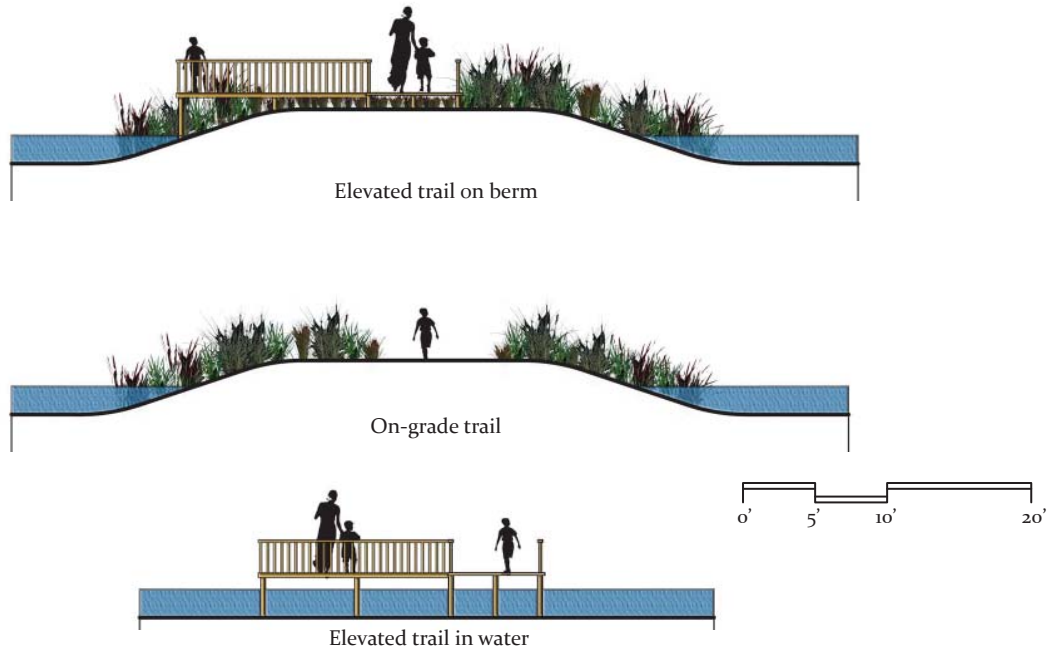


Figure 7.17 Trail Types (Produced by author)



## Discovery Center

The discovery center is the place where you gather all the information about the ecological park. At the discovery center, people will learn about the different cycles that occur in ecosystems like the carbon, nitrogen, phosphorus and water cycles. There will be education on the green infrastructure implemented on and around the building. The green infrastructure will include rain gardens, green roofs, bioswales, pervious paving and detention ponds. The discovery center will have a pond that features the different wetland types and outdoor classrooms. The discovery center building will be elevated eight feet and a portion of the building will hang over the pond. The building's character is of an oil rig platform. An observation deck will be on top of the building for viewing the Lower 9th Ward and Bayou Bienvenue's Ecological Park. The observation deck will be part of a green roof and rooftop plaza. Since I am a landscape architect, the design of the discovery center will be done by an architect. The plan for the placement of discovery center and its surroundings are in Figure 7.18 and the program list is in Table 7.01. Figure 7.19 shows the character of what the discovery center will look like.

## Discovery Center

### Program and Character

- Indoor labs ~ 16,000 sq. ft
- Classrooms/meeting rooms ~ 2,700 sq. ft
- Amphitheater ~ 1,000 sq. ft
- Educational programs ~ 8,000 sq. ft
- Offices ~ 500 sq. ft
- Bookstore ~ 1,000 sq. ft
- Restrooms ~ 1,300 sq. ft
- Mechanical ~ 8,000 sq. ft
- Total area ~ 40,000 sq. ft
- 8 ft above ground
- Balcony along south and east facades
- Rooftop garden/observation deck on roof
- Entrances on west and east sides

### Educational Programs:

- Water cycle
- Carbon Dioxide cycle
- Phosphorus cycle
- Nitrogen cycle
- Green infrastructure implemented on building

Table 7.01 Discovery Center Program (Produced by author)



Figure 7.18 Discovery Center Plan (Produced by author)



Figure 7.19 Discovery Center Character (Produced by author, Building Green, Preston)

## Observation Towers



Figure 7.20 Tower Character

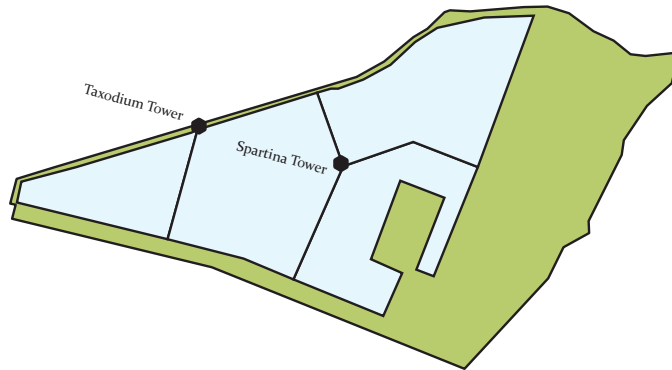


Figure 7.21 Tower Locations (Produced by author)

There are two observation towers located within the site: Taxodium Tower and Spartina Tower. The names of the towers come from the genus of two plant species that are in wetlands: Taxodium (cypress tree) in the swamp and Spartina (cordgrass) in the marsh. Both the towers represent oil rig platforms (see Figure 7.20). Taxodium Tower is located just north of the discovery center while Spartina Tower is located north of the dog park. Refer to Figure 7.21 for the locations of the two towers. People will have to walk across a boardwalk to get to either tower. Each tower has periscopes so people can get a view from a much higher elevation and see off into the distance just like observation scopes. Taxodium Tower was chosen as a name because the tower is tall and slender just like the cypress tree. The tower has the flood mitigation station and oil rig station located there. The base floor will be made of plexiglass so people will be able to see underwater environment of wetlands. Figure 7.22 and 7.23 shows what Taxodium Tower looks like right after completion and a few years later respectfully. Spartina Tower was chosen as a name because the tower is shorter and there is a pavilion attached. The tower has the soil station and erosion station. Spartina Tower has a pavilion attached to the observation tower with a green roof on top of it. The pavilion allows for large gatherings and picnicking opportunities. Both towers have a light on top to represent the flame on an oil rig and can be seen in Figure 7.24.



Figure 7.22 Taxodium Tower-initially (Produced by author)



Figure 7.23 Taxodium Tower-filled-in (Produced by author)



Figure 7.24 Taxodium Tower at Night (Produced by author)

## Farming

BBEP will be a place that generates food for New Orleans. There is a community farm located between Discovery Center and compost station (see Figure 7.01). This community farm is available to anyone living in the Lower 9th Ward who wants to grow fruits and vegetables. The community farm can expand along Florida Avenue or occupy parts of the landfill if needed. There are also other areas available for food production in BBEP. The berms could be planted with blueberries (wetland plant) or other fruits. Another area is in the water where fish and crayfish could be harvested and sold to the local farmers market.

## Weirs

Weirs are placed on the main wetland cell divider berms to allow water to flow from one wetland cell to another cell. The weirs are designed to look man-made just like how the layout of the berms is man-made. Water from a wetland cell will flow into a channel. This channel will extrude past the berm into the other wetland cell at an elevation above the water surface to create a waterfall. This waterfall will cause the water surface to break which will prevent mosquito eggs from hatching. With the weirs designed this way and with the water moving, mosquitoes should not be as much of a problem. The following two figures show the character of the weirs in section.





Figure 7.25 Wier Elevation (Produced by author)

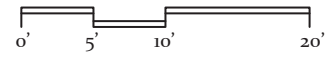


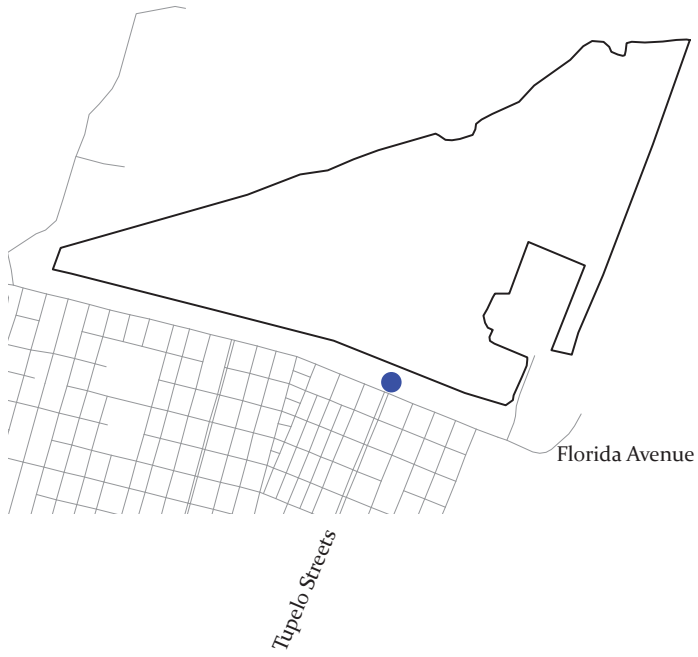
Figure 7.26 Wier Section (Produced by author)

## Dog Park

A dog park will be located at the intersection of Tupelo Street and Florida Avenue (see Figure 7.27). A dog park is included in BBEP because this dog park is one of the first dog parks in New Orleans. Currently, dogs are allowed in New Orleans's parks, but the dogs must be on leashes. This dog park will allow the dogs to roam around freely. The inclusion of the dog park helps with creating a community park for the Lower 9th Ward. There are two sides for the dog park: a small dogs' area and a large dogs' area. Each side has a double gate entry, obstacle course, open field, wooded area, wetlands and a lake that allows the dogs to get wet. There are balls and Frisbees available for loaning out during the stay at the dog park. Restrooms, pavilions and benches are provided for the human companions. The dog park will follow the concept of successional landscapes from a maintained grass field to a wooded natural area. Figure 7.28 shows the plan of the dog park and 7.29 is a perspective of the park.

## Composting Station

The composting station is located at the intersection of Tupelo Street and Florida Avenue. A composting station is needed to store the dredge from the wetlands and the sludge from the wastewater treatment plant. Composting this dredge and sludge will turn a non-usable soil (due to high concentrations of bacteria, dissolved metals and plant debris) into a very productive soil that is available to the public. Composting breaks down the plant debris into small particles and cleans the soil of bacteria and dissolved metals through decomposers. This station will educate people on what can be composted and the steps for composting. The station will provide local jobs and help stimulate the local economy by selling the compost. The composting station will take the dredge from the wetland cells and the sludge from the wastewater treatment plant. Once the Bayou Bienvenue's Ecological Park has been constructed, the excess compost will be used for the restoration of the remaining 28,000 acres of Bayou Bienvenue. The plan for the composting station can be seen in Figure 7.28.



7.27 Dog Park Location (Produced by author)



7.28 Dog Park Plan (Produced by author)

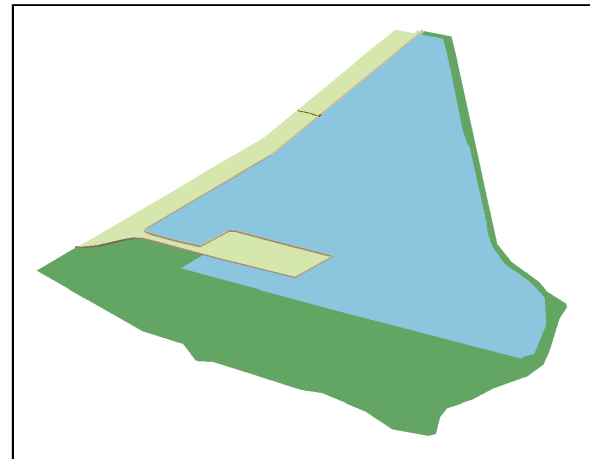


Figure 7.29 Dog Park Perspective (Produced by author)

## Phasing

Bayou Bienvenue's Ecological Park will be constructed in 23 phases that will take 23 years. The reason for 23 years is that dredging the wetland cells typically occur at 20-25 years and since there are three wetland cells that will be dredged (wetland cells 2, 3, 4) a 21 year cycle was chosen. Refer back to Figure 7.07 for the numbering of wetland cells. The construction of BBEP is phased so that wetlands cells two, three and four take seven years each to complete for a total of 21 years because each wetland cell starts construction once the previous wetland cell has been completed with the exception of wetland cell one and two. This means once wetland cell four is completed, wetland cell two is ready to be dredged. Once cell two has been dredged, cell three will be dredged seven years later and cell four will be dredged seven years after cell three. This will create a cycle where a cell gets dredge every seven years. Each wetland cell is dredged completely leaving only the berms which allow plants on the berms to continue succession. Dredging in wetland cell one will never occur. This will allow cell one to succeed completely and become a cypress swamp while the other wetland cells will have cypress swamps on the berms and marshes everywhere else in the cell. The dredging of the Mississippi River and canals in New Orleans will supply the soil for the berms. The first year of construction is preparing BBEP for the treatment of wastewater and stormwater by raising the berm along outfall canal so water will not come into BBEP from the outfall canal and the start of wetland cell one with berm extending north. Infrastructure will be installed to allow portions of stormwater from pumping station into wetland cell one. Phase 2 will divide BBEP

into three wetland cells. The pipe transporting portions of wastewater from treatment plant into bayou will be installed during phase 2. Phase 9 will put in the last major berm that will divide BBEP into four wetland cells and the influent pipe for that wetland cell three is installed. Phase 16 will install the influent pipe for wetland cell four and this means the site will function at full capacity on treating the wetlands. Other important phases for BBEP are phase four with the Discovery center, phase six with the dog park and composting station, phase nine with the installation of Taxodium Tower, outdoor labs, stormwater/wastewater station, saltwater marsh, saltwater swamp, freshwater marsh and freshwater swamp stations, and phase 16 with Spartina Tower. Table 7.02 shows all the phases and the major construction completion. The following figures show the major phases in the construction of BBEP. Figures 7.37-7.48 are perspective views from Taxodium Tower. Double click on figure below for phasing animation.



Phases	Major Completions
1	BBEP preparation and Cell 1 infrastructure installed
2	Cell 2 infrastructure installed
3	
4	Discovery center built
5	Cell 1 completed
6	
7	Dog Park and compost station completed
8	
9	Cell 2, Taxodium Tower, outdoor labs, stormwater/wastewater station, saltwater marsh and swamp, freshwater marsh and swamps completed, Cell 3 infrastructure installed
10	
11	
12	
13	
14	
15	
16	Phase 3 and Spartina Tower completed, Cell 4 infrastructure installed
17	
18	
19	
20	
21	
22	
23	Phase 4 and site completed

Table 7.02 Phasing (Produced by author)

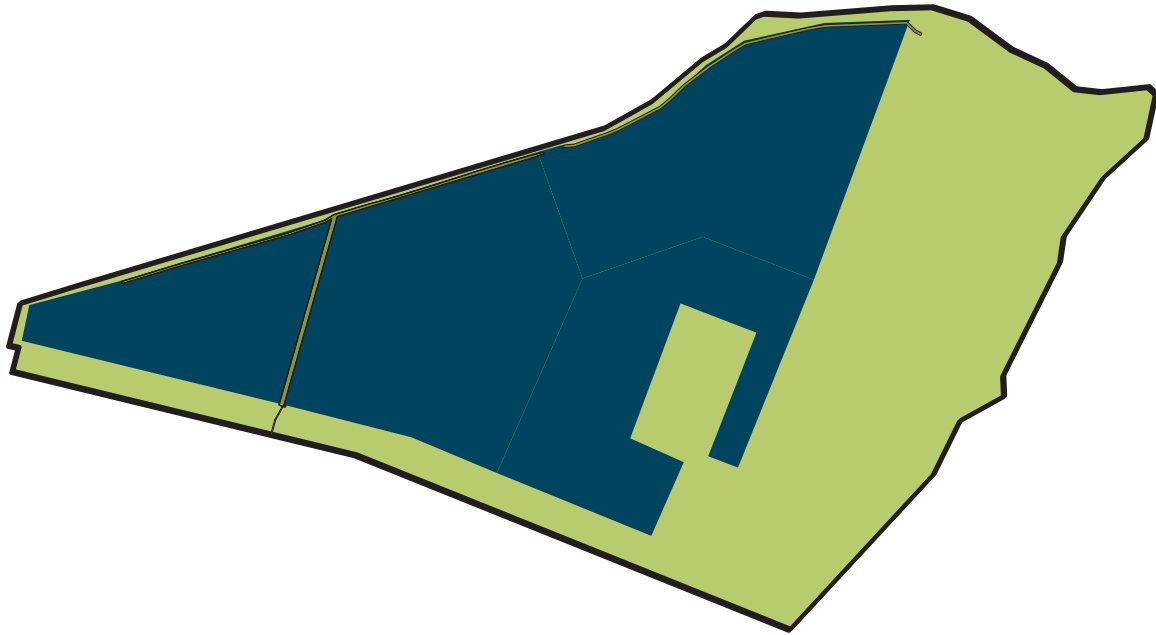


Figure 7.30 Phase 1 (Produced by author)



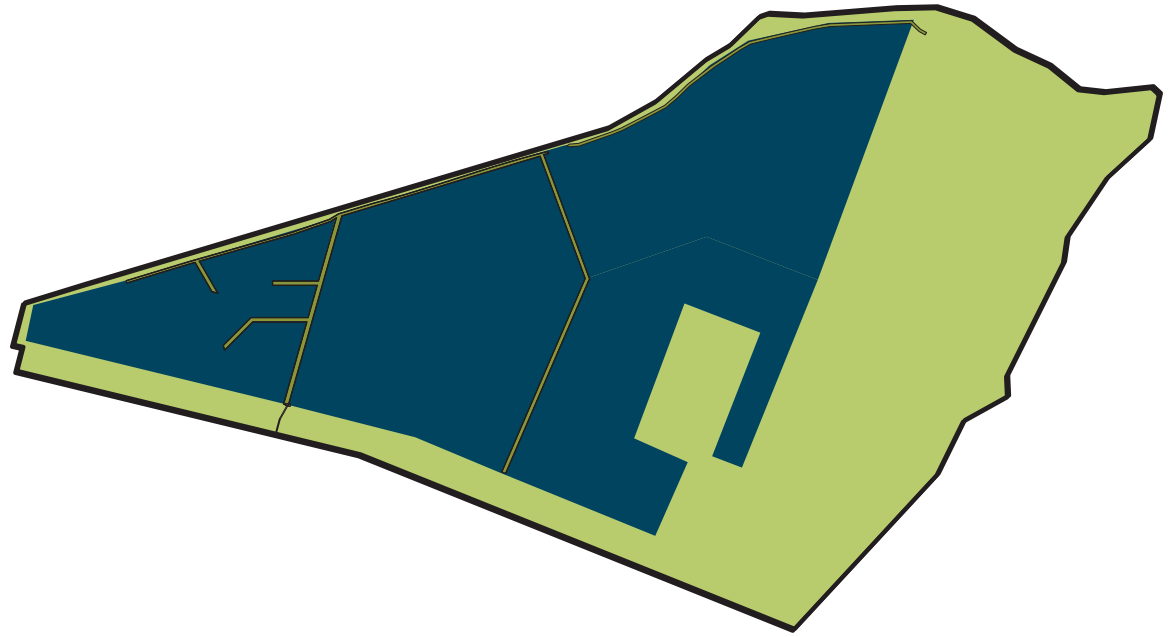


Figure 7.31 Phase 2 (Produced by author)

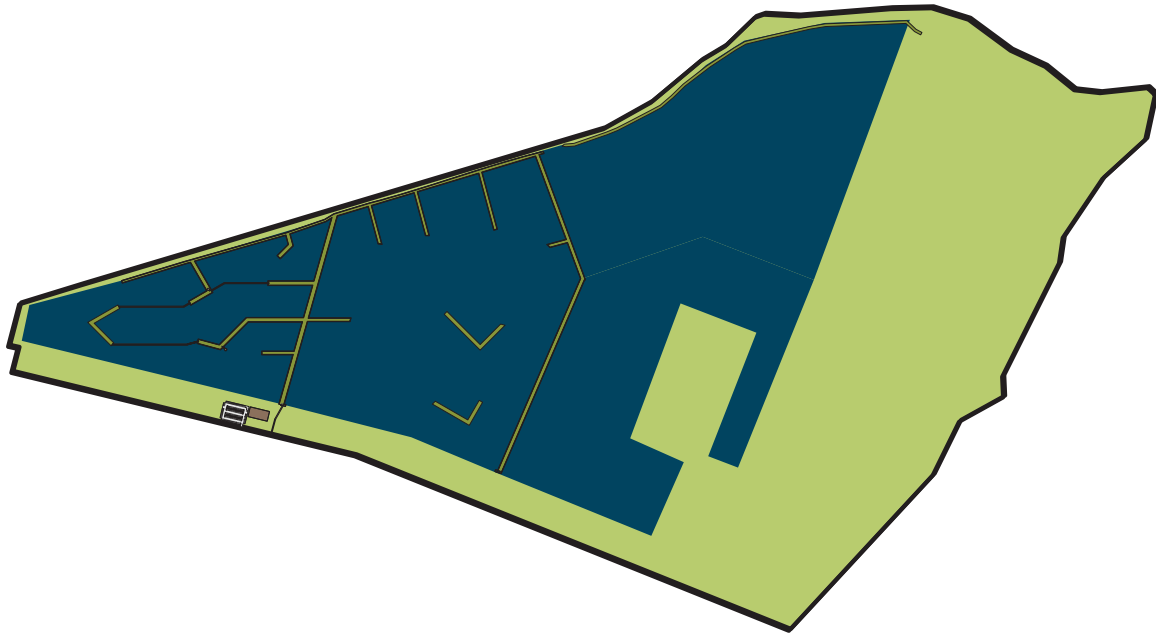


Figure 7.32 Phase 4 (Produced by author)

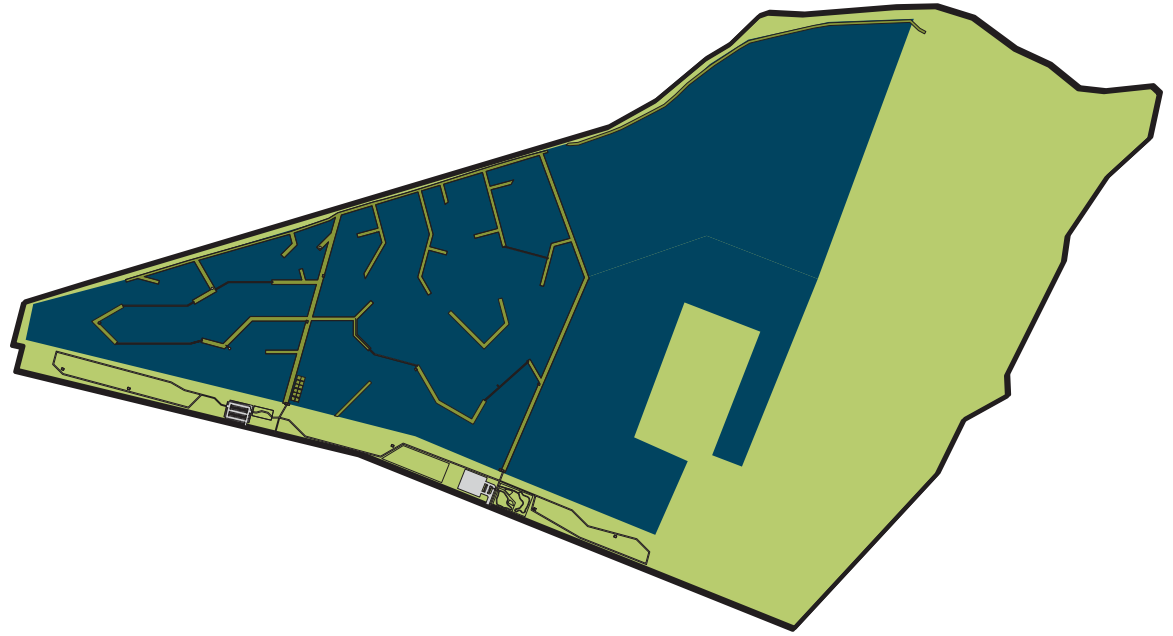


Figure 7.33 Phase 7 (Produced by author)

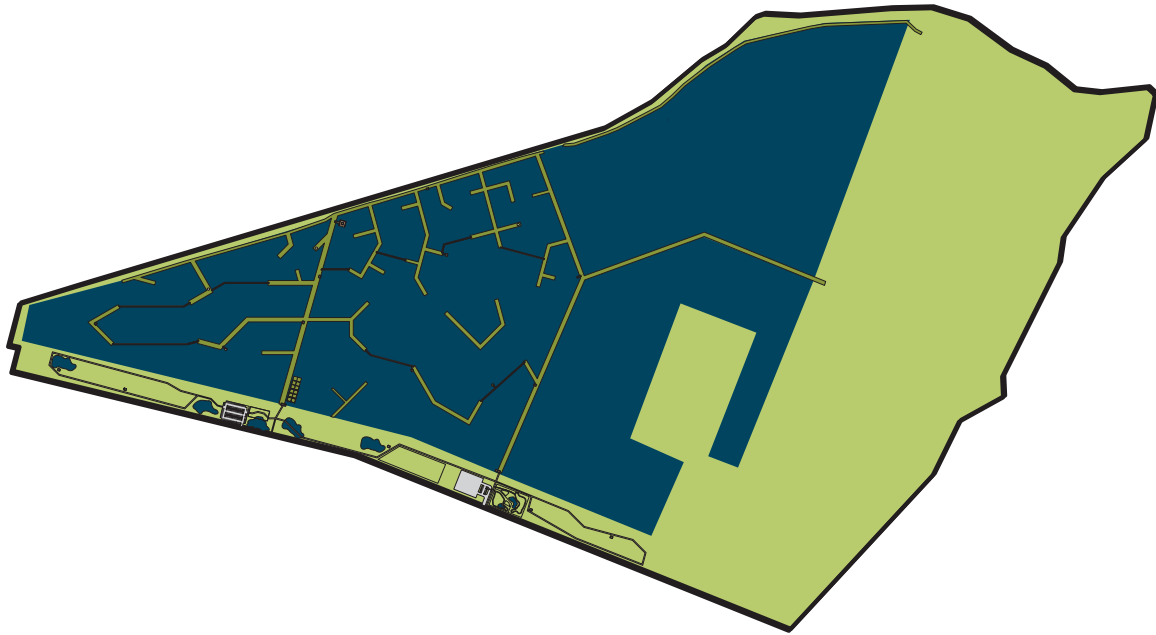


Figure 7.34 Phase 9 (Produced by author)



Figure 7.35 Phase 16 (Produced by author)

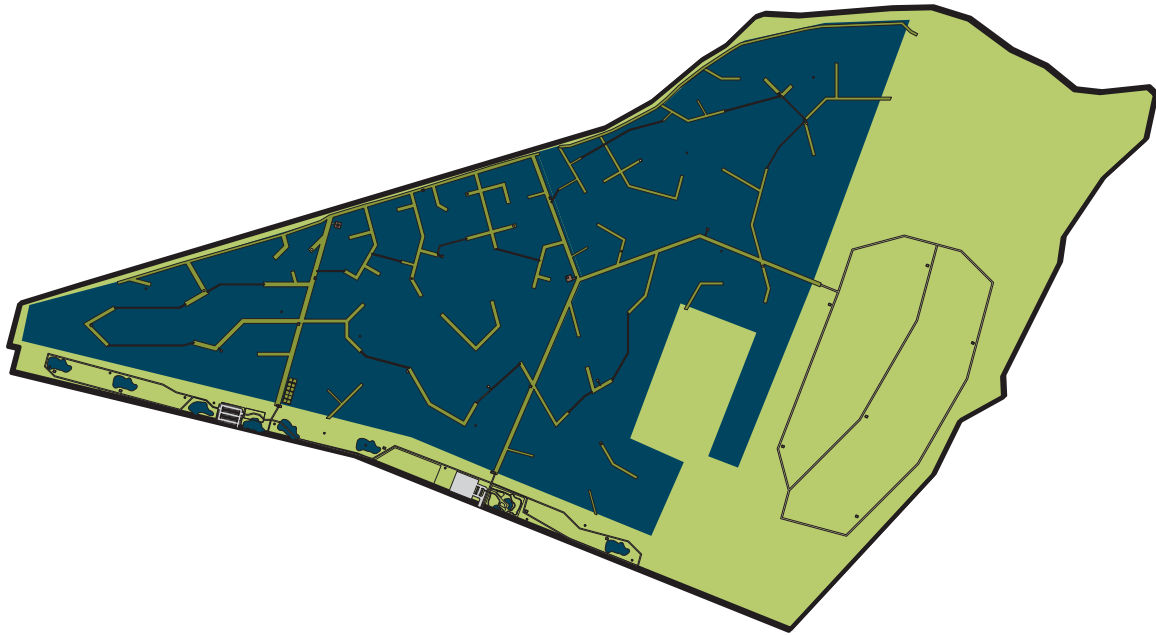


Figure 7.36 Phase 23 (Produced by author)

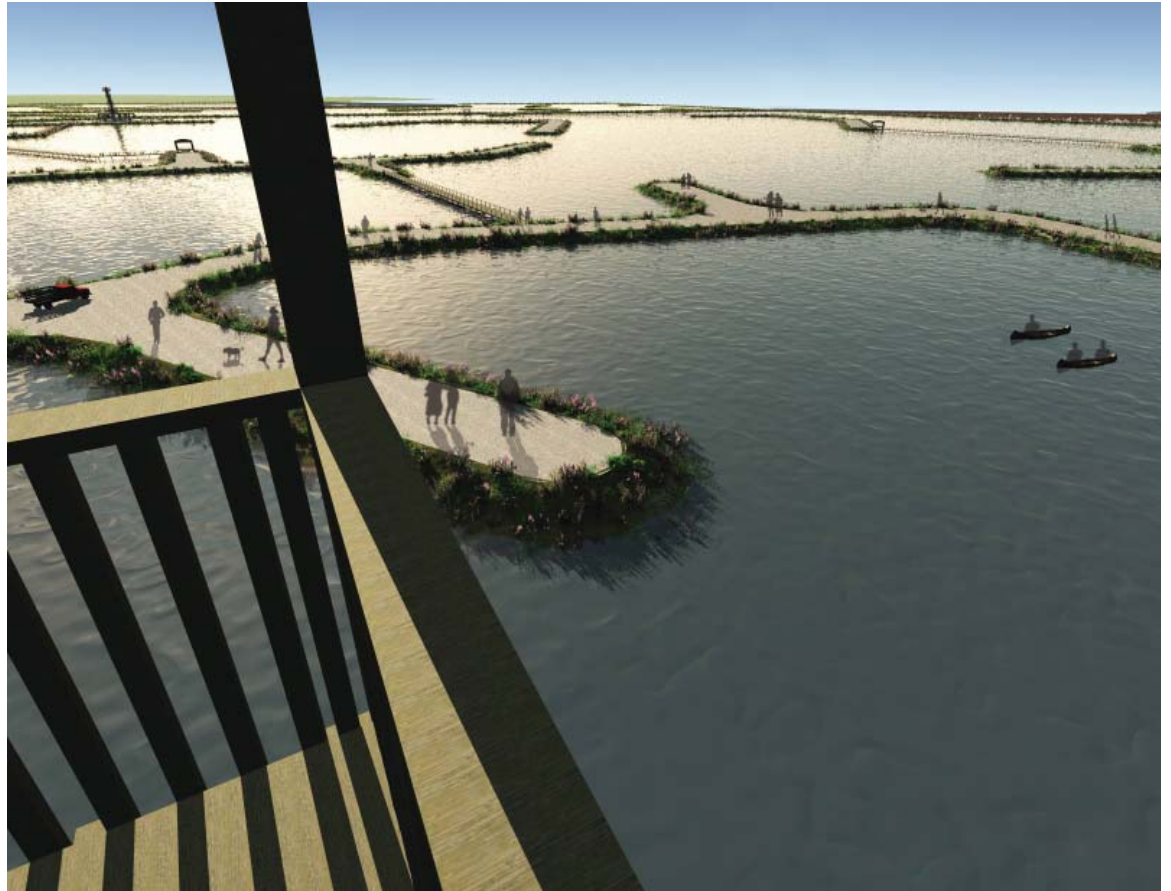


Figure 7.37 Southeast view successional stage 1 (Produced by author)

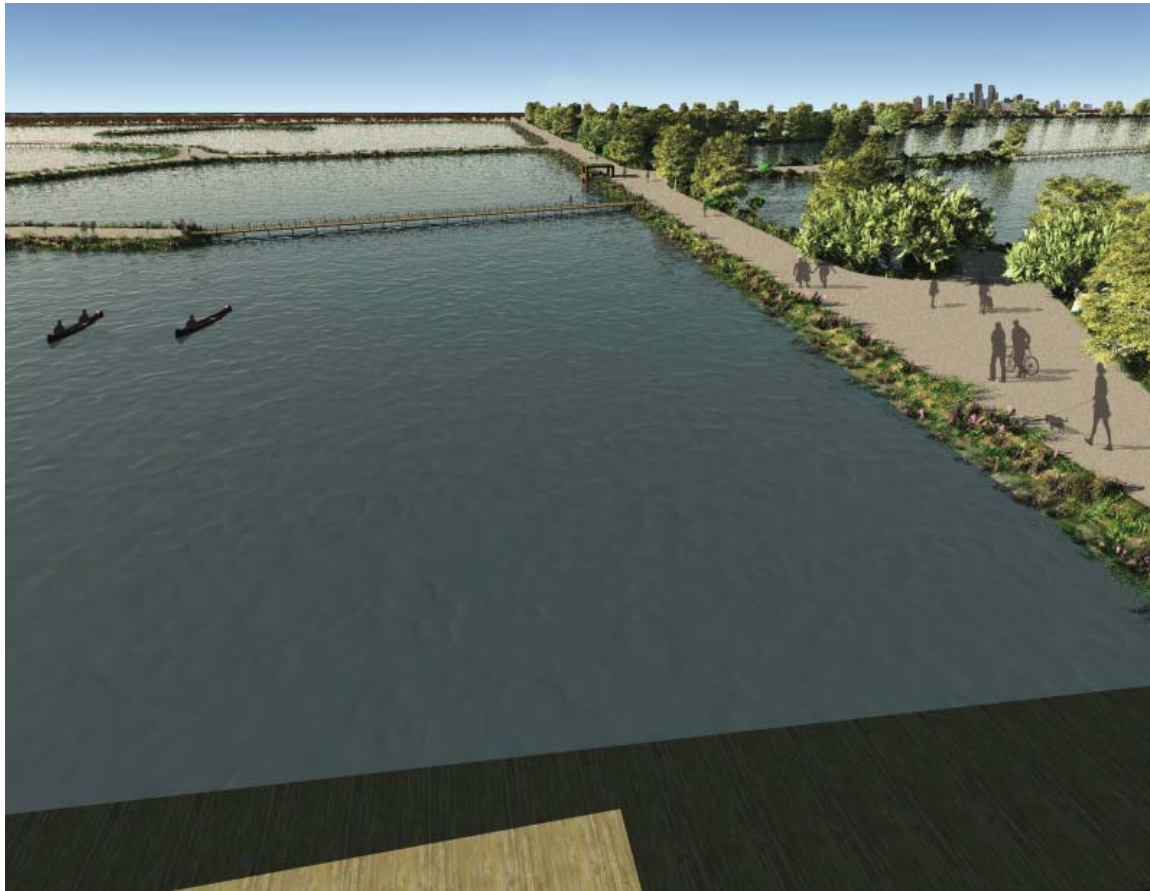


Figure 7.38 Southwest view successional stage 1 (Produced by author)



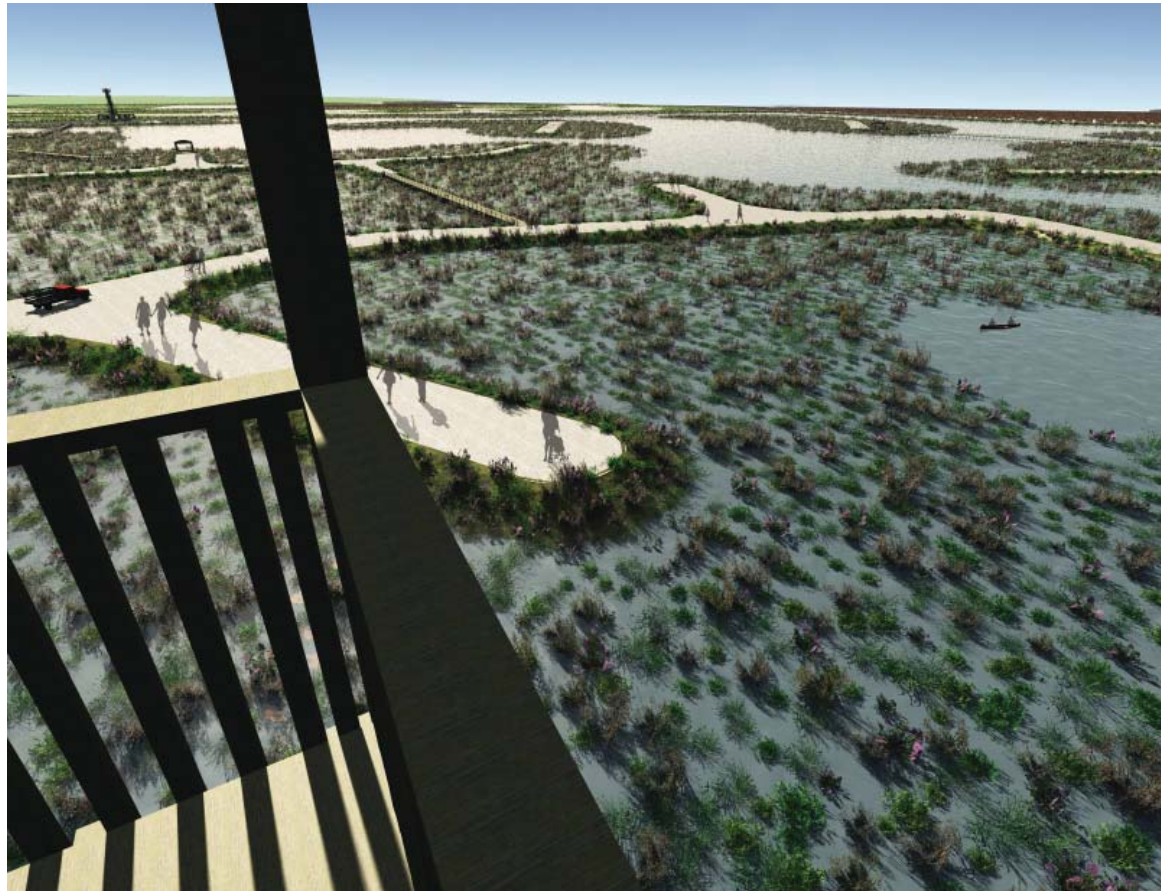


Figure 7.39 Southeast view successional stage 2 (Produced by author)



Figure 7.40 Southwest view successional stage 2 (Produced by author)

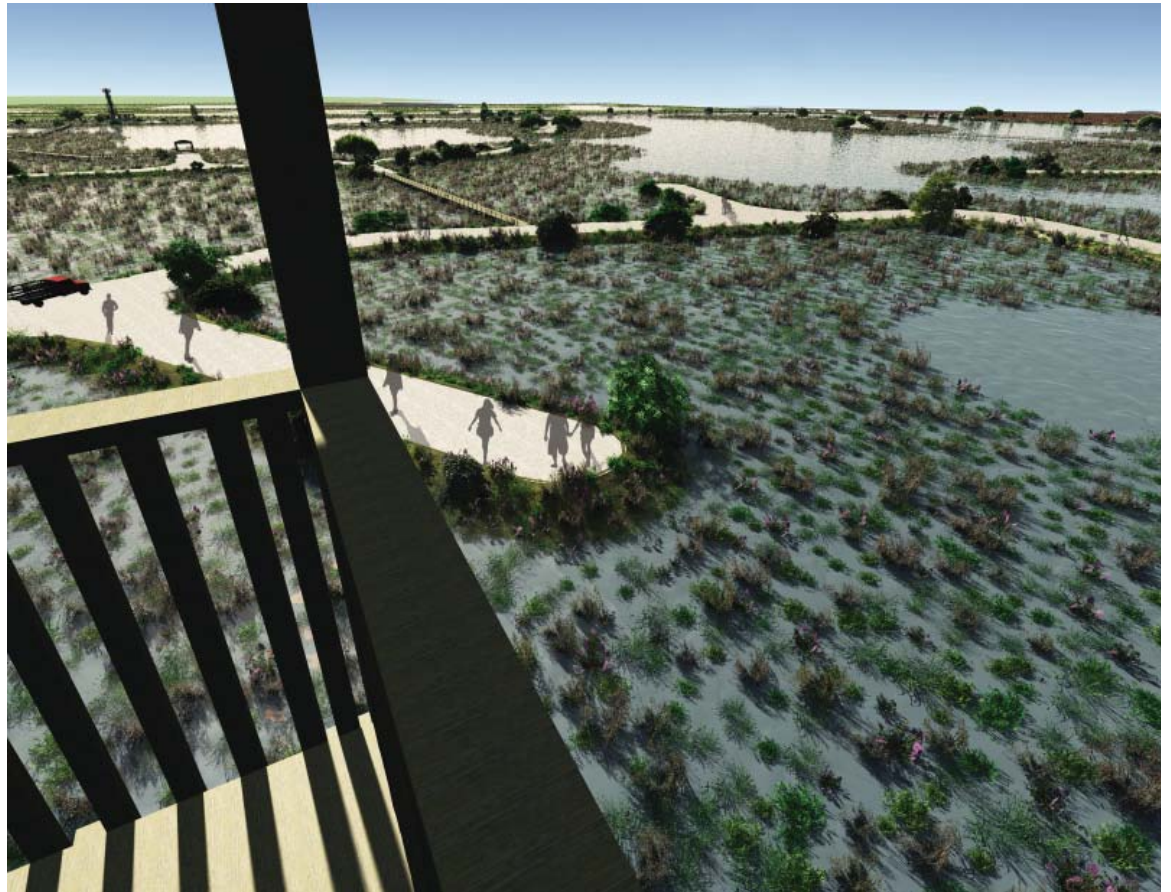


Figure 7.41 Southeast view successional stage 3 (Produced by author)

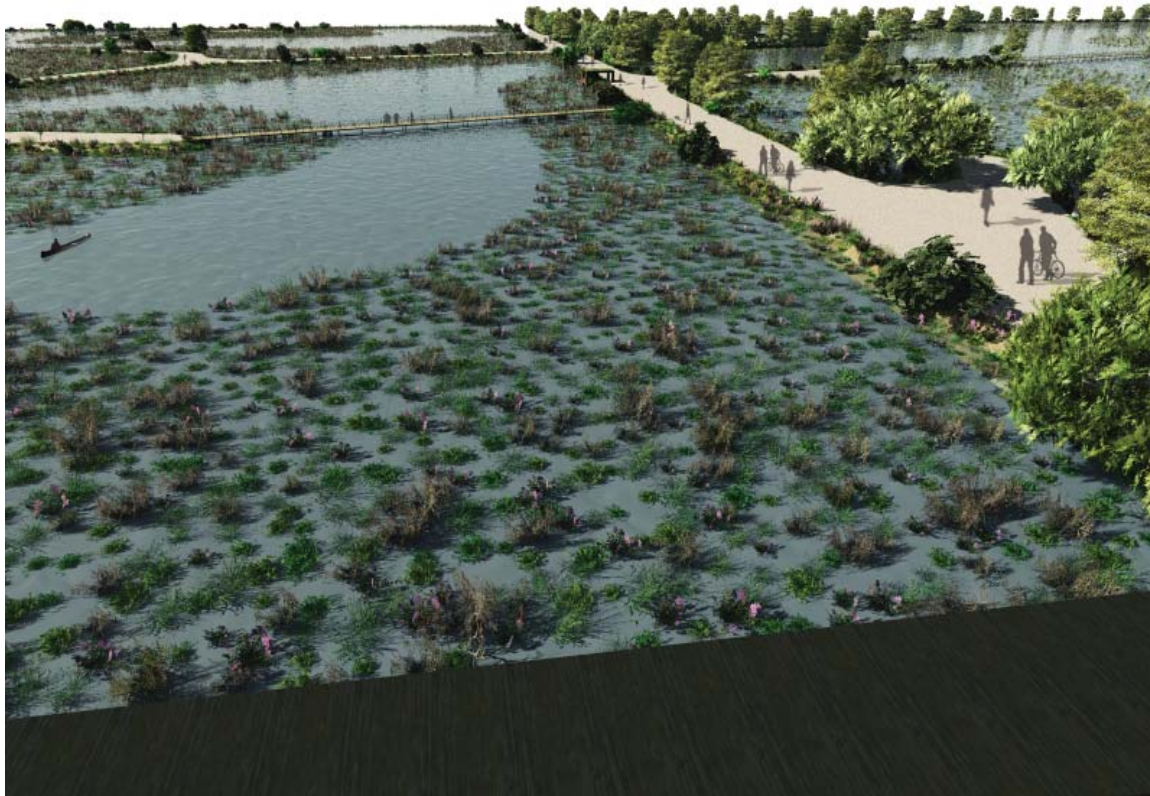


Figure 7.42 Southwest view successional stage 3 (Produced by author)

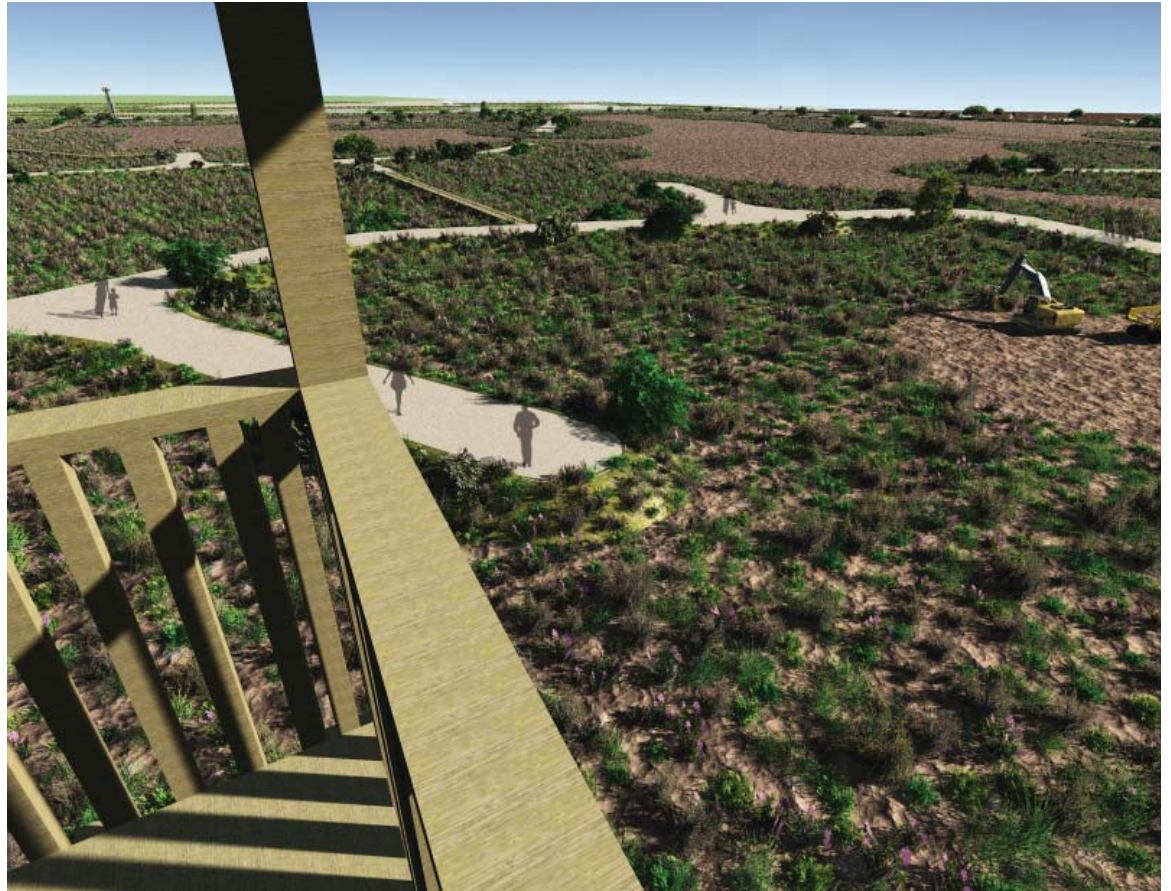


Figure 7.43 Southeast view successional stage 4 (Produced by author)



Figure 7.44 Southwest view successional stage 4 (Produced by author)

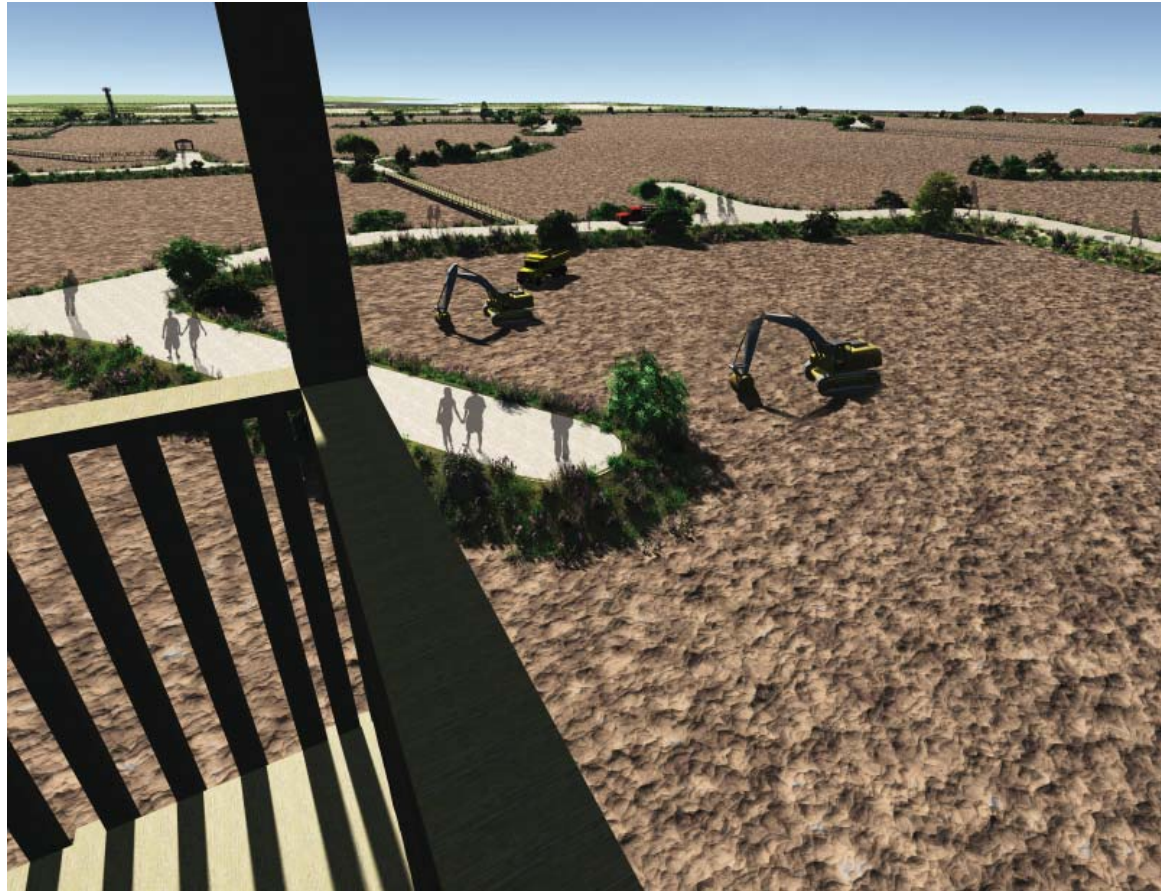


Figure 7.45 Southeast view successional stage 5 (Produced by author)



Figure 7.46 Southwest view successional stage 5 (Produced by author)



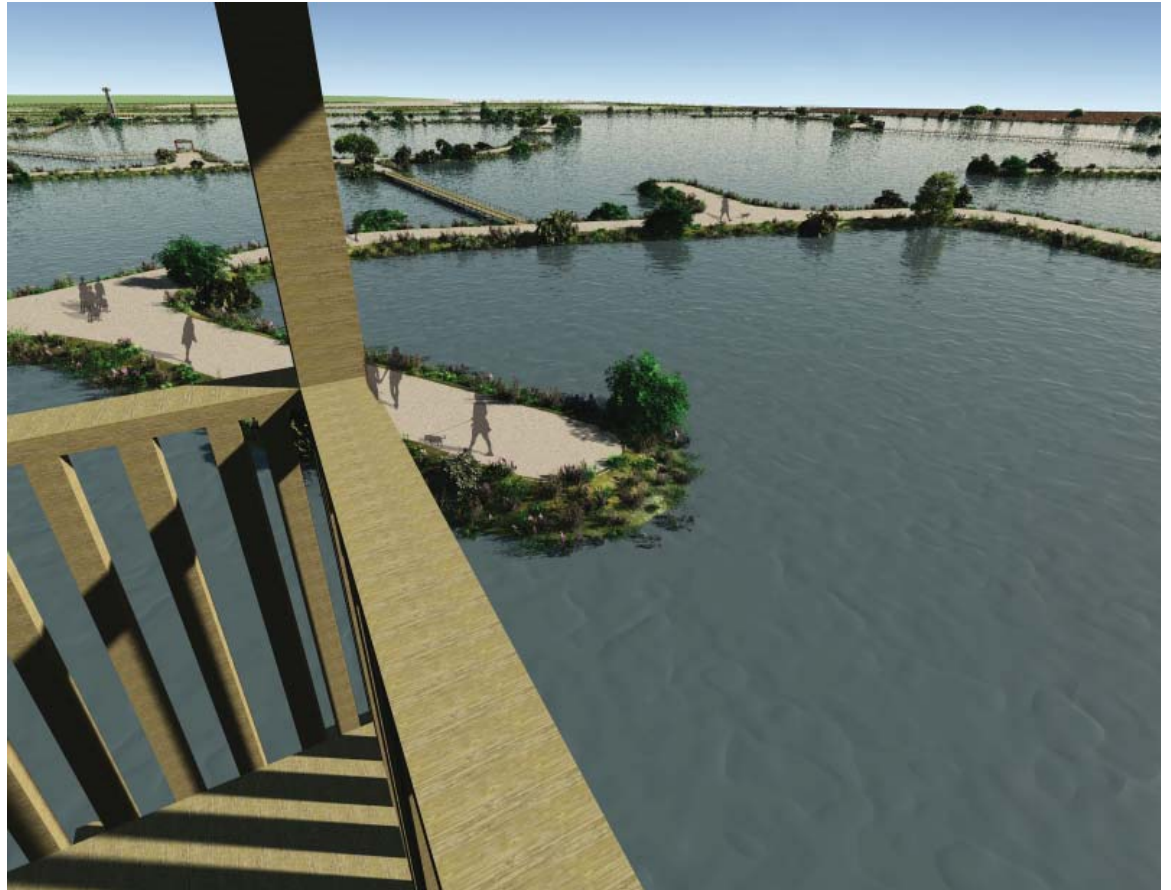


Figure 7.47 Southeast view successional stage 6 (Produced by author)



Figure 7.48 Southwest view successional stage 6 (Produced by author)



“Resolved to establish, thirty leagues up the river, a burg which should be called New Orleans...”

*Company of the West Ledger, 1717*

## Project Conclusion

The goals for Bayou Bienvenue's Ecological Park (BBEP) were: rehabilitate the bayou, educate people about wetlands, use landscape as infrastructure and provide a community park for the Lower 9th Ward. The goal of rehabilitating the bayou was achieved through the reconstruction of the successional wetlands in the bayou. These different wetlands help the bayou begin the process of succession towards a cypress swamp. The goal of educating people about wetlands was met with implementation of a discovery center with educational stations explaining the processes and functions of wetlands. Using the landscape as infrastructure was met by treating significant portions of stormwater and wastewater. Providing a community park for the Lower 9th Ward was accomplished by providing a park that could be used on a daily basis and ties into the community. People can ride their bikes, run or walk along the trails, have family gatherings at the various pavilions located throughout BBEP and let their dogs roam around and play with other dogs at the dog park.

## Experience Evaluation

One way of evaluating the design of BBEP was through the experience tree diagram which describes the different ways of expressing the six desired experiences: discovery, inspiration, responsibility, hope, destruction and restoration, on site. BBEP offers various ways for discovery to be expressed. One way is through the educational stations teaching people new terms and concepts about wetlands that they never knew. Another way is being able to feel like the French explorer and explore BBEP by various ways: biking, hiking and canoeing. Inspiration can be experienced at BBEP through the interactive educational stations and at the various outlooks as people look over the site. Responsibility can be experienced by having a direct relation with an item. So by showing how certain items directly affect a person, they will take responsibility towards that item whether it is trying to prevent losing it to changing your lifestyle so it does not affect others. The flood mitigation station is an area that responsibility can be felt as the station shows how wetlands protect the residence of New Orleans by mitigating storm surge. Hope and destruction can be experienced through education as people learn new ideas and learn the old ways. Hope can also be experienced through the restoration of the bayou and through learning new ideas and concepts about wetlands. Destruction can be experienced through the dredging of the bayou and teaching people the old way of development in wetlands (oil rig platforms). Restoration can be experienced through someone coming to the site and letting themselves get away from the chaos of life or through the literal process of restoring the bayou.

## Further Study

Due to the limit of time, there are areas that need further study ranging from detail design to more research. There are two areas in BBEP that could have more detail design: the landfill and the open space between the levee and Florida Avenue (refer to Figure 7.01 in Chapter Seven). The design of BBEP only has the placement of trails and pavilions in the two areas. Due to time constraints, only the ideas of each educational station and the discovery center were thought out. The actual design of each educational station and discovery center will be the next step of the design. Another area would be to find more information about the stormwater pipe along Florida Avenue. Decisions could have been made about the potential of daylighting the pipe or treating the stormwater through detention ponds and wetlands if information was provided about the invert elevations of the pipes and the volume of water flowing through the pipe. Further research on wetlands could also be performed. Only a general understanding of wetlands was accomplished. Understanding the different processes and how they work in BBEP could have possibly led to a design that reflected those processes. Being able to understand how the sedimentation and water flow within BBEP could have allowed for an exact placement of berms instead of an assumption of what would happen. Understanding the life cycle of dredging and whether it will be cost effective would be another area for further study. Another item to study is to look at a model of patch dredging within each wetland cell instead of dredging the whole cell and see how that will effect character of the site.

## Personal Conclusion

For my personal goals of Master's project, I would have to say I accomplished the goals. I furthered my knowledge of wetlands and now know the different types of wetlands and the characteristics of those. I have learned the many values of wetlands from the economic benefits to the cleansing power. I now know the process for treating wastewater from the time it enters a treatment facility until it leaves and returns to nature. I have a better grasp of discovery centers and how they function as well as the wide potential discovery centers have in a community. For producing a design project, I could have done a better job with leaving more time to focus on the design instead of working on the technical parts of the project. In the end, I produced a project that is a design project that will function properly and be able to portray information at the many educational stations.



## Parks in New Orleans

BBEP will have impacts on the city of New Orleans. One of the impacts is providing an ecological park within city's limits. Currently, people of New Orleans will have to travel thirteen mile southwest of the city to Jean Lafitte Natural Park or seventeen miles east to Bayou Sauvage from downtown New Orleans to visit a park like BBEP. Another impact will be the education provided to the residents of New Orleans on wetlands and how important they are to the city. This could lead to further restoration projects of wetlands around New Orleans. BBEP's will have an impact on the city by providing another city-wide park. City-wide parks are defined as a park that has at least 100 acres. Currently there are two other city-wide parks: City Park located near the center of the city and Audubon Park located in the western part of the city. BBEP will provide a park on the eastern part of the city and will create a triangle of city-wide parks in New Orleans setting up a network of for future parks linking New Orleans together. See Table 8.01 for comparison among the existing city parks and BBEP.

BBEP will affect the Lower 9th Ward dramatically by providing one of the first community/city-wide parks in the Lower 9th Ward. Currently there are only a few pocket and neighborhood parks scattered throughout the Lower 9th Ward. Pocket parks are defined as parks taking up a lot or two while neighborhood parks take up about a block in size. BBEP would also be an attractive amenity compared to the wastewater treatment facility and warehouses found in the Lower 9th Ward. This park could give a new aesthetic to the Lower 9th Ward. BBEP also will

provide jobs for the community and help stimulate the economy.

Activities	Audubon Park	City Park	BBEP
Golf Course	X	X	
Baseball fields	X	X	
Soccer fields	X	X	
Basketball courts	X	X	
Tennis courts	X	X	
Football fields	X	X	
Art museum		X	
Arboretum		X	Information about plants in each wetland landscape
Outdoor train rid		X	
Boating		X	
Trails	X	X	X
Dog park		Proposed	X
Zoo	X		
Riverwalk	X		
Discovery Center			X
Geo-caching			X
Fishing			X
Compost station			X
Educational stations			X
Character	Huge live oak trees and maintained landscapes	Huge live oak trees and maintained landscapes	Successional wetland landscapes with a natural look
Size	340 acres	1300 acres	700 acres

Table 8.01 Park Comparison (Produced by author)

## Landscape Architecture

BBEP will have an impact on the field of landscape architecture several ways. The impacts are using landscapes as infrastructure, stormwater and wastewater treatment of city scale, temporality, restoration and education. BBEP is a project that uses the landscape as infrastructure by using wetlands to treat stormwater and wastewater while still being a park for the community to use. The idea of a park treating stormwater and wastewater is not a new idea, but what makes this project a little different is the large scale treatment of water. The project is treating millions of gallons of water a day. BBEP could be used as a study for other projects treating neighborhood/ city-wide stormwater and wastewater. The temporality of BBEP makes this project unique due to the always changing landscape. Most parks allow the plants to grow and the landscapes to evolve, but BBEP also dredges the wetlands. The dredging causes the landscape to basically start over from a newly planted landscape every time and evolve. This constant disturbance of dredging will have an impact on the whole ecosystem. Studying BBEP can give a better understanding on how ecosystems adapt to disturbances. BBEP is a wetland restoration project. BBEP took a damaged ecosystem and restored the ecosystem so it can function. What is a little different about this restoration project is that BBEP is not solely a restoration project; BBEP includes how humans will interact and be a part of nature. Also, BBEP could be the catalyst for other wetland projects along the gulf coast. BBEP affects landscape architecture by using the landscape to educate people. The lack of education has led to poor decision making which have led to disasters

that have been detrimental to communities around the world. BBEP will educate people about wetlands and the importance of wetlands to storm surge mitigation efforts. Having better educated people will lead to better decision making.

## References

ASLA. "General Design Honor Award: James Clarkson Discovery Center." ASLA 2008 Professional Awards. <http://www.asla.org/awards/2008/08winners/338.html> (accessed December 2, 2009).

BNIM. "Anita B. Gorman Conservation Discovery Center." BNIM. <http://www.bnim.com/fmi/xsl/portfolio/index.xsl?token.pnum=97002&-token.pid=pr11-2&-token.cat=cat-11> (accessed December 3, 2009).

Building Green. "William J. Clinton Presidential Center." Building Green. <http://www.buildinggreen.com/hpb/overview.cfm?projectid=431> (accessed March 25, 2010).

Campanella, Richard. *Bienville's Dilemma*. Lafayette, LA: Center for Louisiana Studies. 2008.

Campbell, Craig S., Ogden, Michael H. *Constructed Wetlands in the Sustainable Landscape*. New York: John Wiley & Sons, Inc., 1999.

City of Arcata. "Arcata Marsh & Wildlife Sanctuary." City of Arcata. [http://www.cityofarcata.org/index.php?option=com\\_content&task=view&id=20&Itemid=47](http://www.cityofarcata.org/index.php?option=com_content&task=view&id=20&Itemid=47) (accessed December 2, 2009).

DogPark. "Starting a Dog Park." DogPark. <http://www.dogpark.com/Starting-A-Dog-Park.html> (accessed March 12, 2010).

Dyer, Jon C., Jackson, Kathe. "Orlando, FL-Wetland

Treatment Systems: A Case History- The Orlando Easterly Wetlands Reclamation Project." EPA Office of Water. <http://www.epa.gov/owow/wetlands/pdf/Orlando.pdf> (accessed December 2, 2009).

East, Charles Jr. "Innovative Wastewater Treatment." Louisiana Environmentalist. <http://www.leeric.lsu.edu/le/covers/lead073.htm> (accessed December 2, 2009).

Ewel, Katherine Carter, Odum, Howard T. *Cypress Swamps*. Gainesville: University Presses of Florida, 1984.

Ford, Phyllis M. *Principles and Practices of Outdoor/ Environmental Education*. New York: John Wiley & Sons, Inc., 1981.

Forster, Christopher. *Wastewater Treatment and Technology*. London: Thomas Telford Ltd. 2003.

Greater New Orleans Community Data Center. "The New Orleans Index Tracking the Recovery of New Orleans and the Metro Area." Metropolitan Policy Program. <https://gnocdc.s3.amazonaws.com/NOLAIndex/ESNOLAIndex.pdf> (accessed December 3, 2009).

Groundspeak. "Geo-caching." Groundspeak. [Http://www.geocaching.com](http://www.geocaching.com) (accessed April 12, 2010).

Hammer, Donald A. *Creating Freshwater Wetlands*. Boca Raton, FL: CRC Press LLC, 1997.

Harris, Charles W., Dines, Nicholas T. *Time-Saver Standards for Landscape Architecture*. New York: McGraw-Hill Publishing Company, 1998.

Haslam, S.M. *Understanding Wetlands: Fen, Bog and Marsh*. New York: Taylor & Francis, Inc., 2003.

Humboldt State University. "Arcata's Wastewater Treatment Plant & The Arcata Marsh and Wildlife Sanctuary." Humboldt State University. <http://www3.humboldt.edu/engineering/sites/www3.humboldt.edu/engineering/marsh/index.htm> (accessed December 2, 2009).

Huner, Jay V. *Freshwater Crayfish Aquaculture in North America, Europe, and Australia*. New York: Food Products Press. 1994.

"Kansas City's Urban Conservation Campus." <http://mdc.mo.gov/areas/kcmetro/discovery/> (accessed December 3, 2009).

Kent, Donald M. *Applied Wetlands Science and Technology*. Boca Raton, FL: CRC Press LLC. 2001.

Knudson, Douglas M., Cable, Ted T., Beck, Larry. *Interpretation of Cultural and Natural Resources*. State College, PA: Venture Publishing, Inc. 2003.

Louisiana Coastal. "A Lifeline of Sand Restoration Turns Back the Clock for Louisiana's Barrier Islands." USGC National Wetlands Research Center. <http://www.lacoast.gov/> (accessed December 2, 2009).

Lyle, John Tillman. *Regenerative Design for Sustainable Development*. New York: John Wiley & Sons, Inc., 1994.

Lynches River County Park. "Lynches River County Park." Heritage Digital. <http://www.lynchesriverpark.com/> (accessed December 2, 2009).

MSI. "James Clarkson Environmental Discovery Center." MSI. <http://msidesign.com/index.php/james-clarkson/> (accessed December 2, 2009).

Natural Systems International. "Constructed Wetlands." Natural Systems International. <http://www.natsys-inc.com/resources/about-constructed-wetlands/> (accessed December 3, 2009).

National Hurricane Center. Saffir-Simpson Hurricane Scale. [http://www.nhc.noaa.gov/HAW2/english/basics/saffir\\_simpson.shtml](http://www.nhc.noaa.gov/HAW2/english/basics/saffir_simpson.shtml) (accessed March 12, 2010).

New Hanover County. "Pilot Constructed Wetlands Project." New Hanover County. <http://www.nhcgov.com/AgnAndDpt/ENVM/Pages/Wetlands.aspx> (accessed December 3, 2009).

New Orleans Planning Commission. "Documents and Resources." City of New Orleans. <http://www.nolamasterplan.org/documentsandresources.asp> (accessed December 3, 2009).

Preston Koerner. "Green Building." Jetson Green. [http://www.jetsongreen.com/green\\_building/page/3/](http://www.jetsongreen.com/green_building/page/3/) (accessed March 25, 2010).

Scholz, Miklas. *Wetland Systems to Control Urban Runoff*. Amsterdam: Elsevier. 2006.

SmithGroup. "Indian Springs Metropolitan Authority, James Clarkson Environmental Discovery Center." *Architectural Record*. <http://archrecord.construction.com/projects/bts/archives/Civic/10Indian-Springs/default.asp> (accessed December 2, 2009).

Southeast Louisiana National Wildlife Refuges. "Bayou Sauvage National Wildlife Refuge." U.S. Fish & Wildlife Service. <http://www.fws.gov/bayousauvage/> (accessed December 3, 2009).

University of Wisconsin-Madison. *Wetland Restoration and Community-Based Development Bayou Bienvenue, Lower Ninth Ward, New Orleans*. Madison: University of Wisconsin. 2008

Vymazal, Jan. *Algae and Element Cycling in Wetlands*. Boca Raton, FL: CRC Press LLC. 1995.

Zinc Projects. "Lynches River county Park Opens Environmental Discovery Center." Zinc Projects. <http://www.zincprojects.com/press-article.cfm?ArticleID=36> (accessed December 2, 2009).





## Appendices

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## Appendix A: Literature

### Literature Map

The literature map is divided into four groups: Wetlands, Wastewater/Stormwater, Education and New Orleans. These four areas are derived from the project's philosophy: community, education and wetlands with the addition of wastewater/stormwater. The four groups are connected to each other and influence one another. Each group has keywords that relate to the topic of the group. Projects that are used in the precedent studies are listed in smaller print. Text/projects are positioned according how relevant it is to the keywords and the groups. Text that is near the center of a group contains information specific to the topic of the group while text on the outskirts contain information that is related to the other three groups. Figure A.01 shows the literature map.

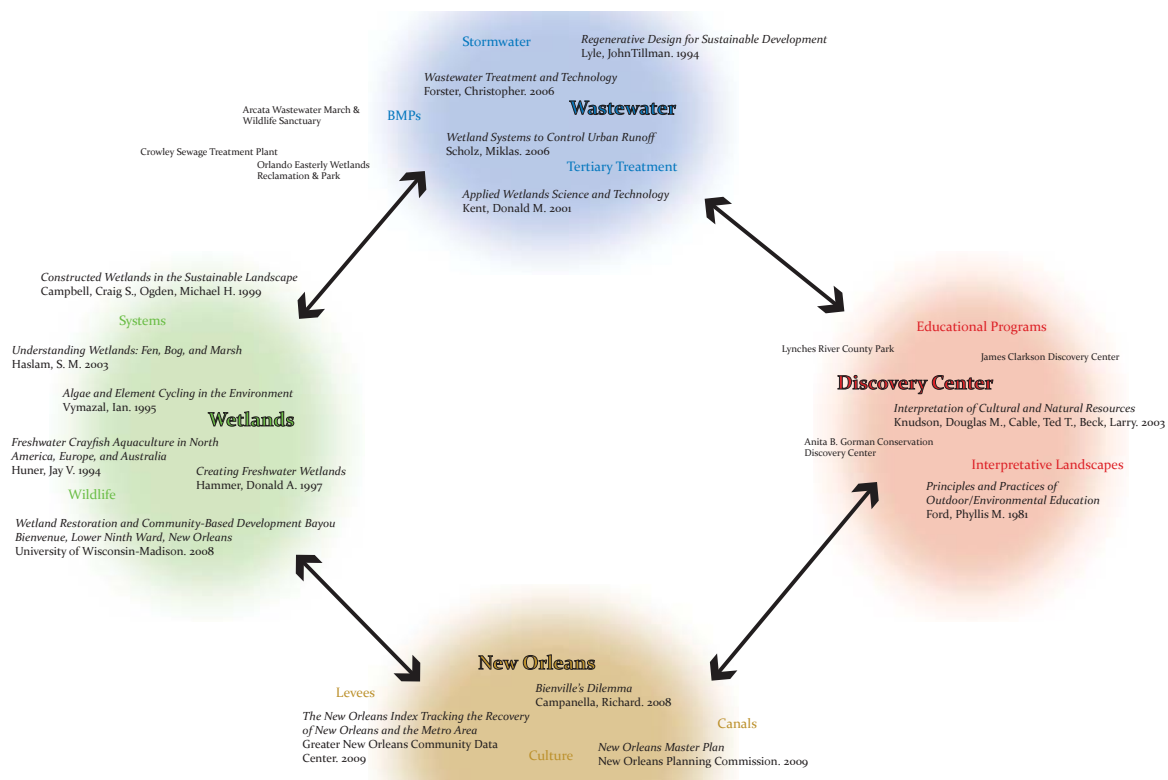


Figure A.01 Literature Map (Produced by author)

## Annotated Bibliography

Campanella, Richard. *Bienville's Dilemma*. Lafayette, LA: Center for Louisiana Studies. 2008.

*Bienville's Dilemma* explains the history of New Orleans from when it was founded to after Hurricane Katrina. There is a detailed timeline of the major events that have shaped and made the city the way it is today. The book is broken down into the formation of the landscape, settling the landscape, manipulating the landscape, humanizing the landscape, devastating the landscape and restoring the landscape.

Campbell, Craig S., Ogden, Michael H. *Constructed Wetlands in the Sustainable Landscape*. New York: John Wiley & Sons, Inc., 1999.

*Constructed Wetlands in the Sustainable Landscape* discusses the functions and values of wetlands. The functions listed are groundwater recharge/discharge, floodwater alterations, sediment stabilization, sediment/toxicant retention, nutrient removal/transformation, production export, aquatic and wildlife diversity/abundance. The values discussed were recreation, uniqueness/heritage values, and aesthetics. The book talks the importance of wildlife and how people prefer to have wildlife around even in the urban environment. It explains that with constructed wetlands comes wildlife and that you need to plan on that. That there should be an idea of what wildlife to expect and what wildlife you want. The design of the wetlands should include the habitats of the wildlife wanted on the site. The book ends with several case studies of wetlands ranging in sizes from very small to thousands of acres.

Ewel, Katherine Carter, Odum, Howard T. *Cypress Swamps*. Gainesville: University Presses of Florida, 1984. *Cypress Swamps* discusses the different vegetation types within an existing cypress swamp located in southwest Florida and the successional stages. The different vegetation types are pinelands, hardwood hammocks, cypress swamps, prairies, marshes and ponds. Pinelands are composed of pines for the overstory. The understory varies depending on how wet the site is. If the site is drier than palmettos make up the understory and if it is wet, then grasses and forbs will make up the understory. Wax myrtles and other shrubs make up the mid story. Cabbage palm can be found throughout the pinelands. Pinelands are generally found in elevated site and only get inundated for less than two months. Hardwood hammocks consist of mostly hardwoods like laurel, water and live oaks, red maple, pop ash, willow and swamp bay. Hardwood hammocks are not as species rich as pinelands due to the thick overstory. There are three types of cypress swamps: large strands of cypress, cypress domes, and dwarf cypress trees. Large strands of cypress trees exist in shallow waters and have a subcanopy of hardwoods. Cypress domes are isolated cypress trees that have small cypress trees on the periphery and taller cypress trees in the center giving it a dome shape. Dwarf cypress trees occur in drier areas and have grasses and sedges as the understory. Prairies consist of grasses and sedges that only get inundated for about 50 days of the year. Marshes consist of grasses, forbs and sedges that stay inundated for about 250 days of the year. Ponds are usually one meter deep and full of floating plants. Starting with the primary stage and working up to the climax community for a cypress swamp are: pond; marsh; pine/palmetto, myrtle, buttonbush/willow/cypress; willow, cypress/hardwood; pond apple/pop ash,

cypress; and cypress swamp.

Ford, Phyllis M. *Principles and Practices of Outdoor/Environmental Education*. New York: John Wiley & Sons, Inc., 1981.

*Principles and Practices of Outdoor/Environmental Education* discusses the teaching progression a person much goes through to become familiar with the environment and to understand the environment. There are seven levels: are art forms, analogies, sensory awareness, ecological principles, problem-solving processes, decision-making procedures and esthetics: a philosophy for survival. The first three levels get a person familiar with the outdoors and being comfortable so learning can take place. Ecological principles are the ideas that you want your visit to learn. The next three levels are taking the ideas learned and applying them with the top level having a stewardship for all human and natural resources.

Forster, Christopher. *Wastewater Treatment and Technology*. London: Thomas Telford Ltd. 2003. *Wastewater Treatment and Technology* discusses the wastewater treatment process at sewage treatment facilities. The wastewater treatment process begins with screening and grit removal. Here all the debris and large items are removed from the water. Next, the water moves into trickling filters or activated sludge process. Here this is where sludge settles out and other sediments. After the settling out process, wastewater's excess nutrients are removed by algae and bacteria. Further treatment of wastewater is done in wetlands to remove more nutrients and solids. This step is called tertiary treatment. The sludge that settles out in the trickling filters/activated

sludge process gets collected and then can be used as fertilizer for farmland or be composted into soil.

Hammer, Donald A. *Creating Freshwater Wetlands*. Boca Raton, FL: CRC Press LLC, 1997.

*Creating Freshwater Wetlands* talks about the different classifications of wetlands like swamps, bogs, marshes, and fens. Swamps are wetlands dominated by woody plants and trees while marshes are dominated by herbaceous plants. Bogs are dominated by acidic-tolerant mosses and have acidic waters. Fens are dominated by sedges and have water that is more neutral. Wetland values can be broken down into six major categories: Life support, Hydrologic modification, Water quality, Erosion protection, Open space and aesthetics, and Geo-chemical storage.

Haslam, S.M. *Understanding Wetlands: Fen, Bog and Marsh*. New York: Taylor & Francis, Inc., 2003.

*Understanding Wetlands: Fen, Bog and Marsh* talks about the value of wetlands from a hydrological, landscape, chemical and biochemical, biotic, and societal points. The hydrological values are water supply, flood storage/dispersal, long-term water storage, bank stabilization, and aquifer recharge/discharge. The landscape values are landscape diversity, maintaining topographical variation, and reduce noise pollution. The chemical and biochemical values are nutrient source and sink, water purification, air quality improvement, accumulation of organic matter. The biotic values are habitat, organic matter, fuel, and biological integrity. The societal values are aesthetics, education, art, recreation, and heritage. Later on it explains wetland functions and the different types of processes going on within a wetland. Wetlands

are broken down into seven classifications: bogs, fens, marshes, reedswamps, grasslands, and woodlands. Bogs and fens need northern climates to sustain them. Bogs are more acidic than fens. Bogs contain mostly mosses while fens contain sedges. Marshes are generally located in flood plains and along the coast. The dominate vegetation in marshes are herbaceous plants. Marshes can be freshwater or saltwater. Reedswamps are like bogs but instead of invading land, reedswamps invade water and are mostly reeds. Grasslands are wetlands that have starter to dry up but are still wet. Grasslands are dominated by grasses. Woodlands are wetlands that have woody vegetation as the dominate plant species.

Huner, Jay V. *Freshwater Crayfish Aquaculture in North America, Europe, and Australia*. New York: Food Products Press. 1994.

*Freshwater Crayfish Aquaculture in North America, Europe, and Australia* discusses a crayfish's habitat and life. Crayfish lay eggs in burrows and once hatch takes three months to mature. Takes one year for crayfish to mature and reproduce. Crayfish need waters that are low in salinity, have dissolved oxygen levels above 3 ppm and have water that is neutral to slightly alkaline. Crayfish eat living plants and animals. June through October is when crayfish are harvested and the other months allow crayfish to repopulate.

Kent, Donald M. *Applied Wetlands Science and Technology*. Boca Raton, FL: CRC Press LLC. 2001.

*Applied Wetlands Science and Technology* discusses the different treatment types for wetlands. There are three types: Free water surface, subsurface flow, and hybrid treatment wetlands. The book goes into the removal

process by physical, biological, or chemical ways. It talks about design considerations and the construction of wetlands for wastewater treatment. Later on it talks about the different ways to manage the wetlands from grazing, burning, dredging, and water-level manipulation.

Knudson, Douglas M., Cable, Ted T., Beck, Larry. *Interpretation of Cultural and Natural Resources*. State College, PA: Venture Publishing, Inc. 2003.

*Interpretation of Cultural and Natural Resources* discusses the history of interpretation in parks and the different ways of interpreting/learning. The definition of interpretation is an educational activity which aims to reveal meanings and relationships through the use of original objects, by firsthand experience and by illustrative media, rather than simply to communicate factual information (Knudson 2003, 4). Interpretation has several benefits like educational, recreational, inspirational and benefits to the society. The different learning theories for people are cognitive development, social cognition, bloom's taxonomy, and moral development. There are different types of learners from actual-spontaneous to conceptual-global learners

Lyle, John Tillman. *Regenerative Design for Sustainable Development*. New York: John Wiley & Sons, Inc., 1994.

*Regenerative Design for Sustainable Development* explains how the concept of waste can be a resource. Taking waste from a process and using it in a way that is more sustainable and safer towards the planet is what he challenges us. One just example of using waste as a resource is taking wastewater from a treatment plant and using nature to clean the water instead of man-made devices in the treatment building. He uses several projects

across the US as case studies proving his point.

Scholz, Miklas. *Wetland Systems to Control Urban Runoff*. Amsterdam: Elsevier. 2006.

*Wetland Systems to Control Urban Runoff* discusses the treatment process for wastewater. Wastewater goes through three phases: Preliminary Process, Primary Treatment, and Biological Treatment. The Preliminary treatment is the screening and grit removal. Primary treatment involves the activated sludge process where sludge settles out of the water. Biological treatment removes the nutrients and more solids. Here algae, bacteria, and plants are used to treat the water. The sludge that settles out gets gathered up and can be used as fertilizer for farmland or be composted into soils.

University of Wisconsin-Madison. *Wetland Restoration and Community-Based Development Bayou Bienvenue, Lower Ninth Ward, New Orleans*. Madison: University of Wisconsin. 2008

*Wetland Restoration and Community-Based Development Bayou Bienvenue, Lower Ninth Ward, New Orleans* talks about the history of the bayou and Lower 9th Ward, the general ecology of cypress swamps, cypress swamp restoration, wastewater assimilation, the environmental characteristics of the bayou, and the connection the bayou and the Lower 9th Ward had. This book laid down a process for restoring the bayou at a general level. The book orients the reader to understand the history and complex nature of the bayou.

Vymazal, Jan. *Algae and Element Cycling in Wetlands*. Boca Raton, FL: CRC Press LLC. 1995.  
*Algae and Element Cycling in Wetlands* talks about the

different classifications of wetlands. There are more classifications in this book compared to others. The list includes bogs, marshes, swamps, fens, shallow lakes, floodplain, and pocosin. Bogs are acidic and dominated by mosses. Fens are meadow-like covered with sedges and are less acidic and more nutrient rich than bogs. Marshes are dominated by herbaceous plants and can be either freshwater or saltwater. Swamps are dominated by woody vegetation. There was not just one definition for each classification but several from various sources resulting in a common definition.

## Appendix B: Site Inventory Maps

Figure B.01 Wetlands- Bayou Bienvenue is part of an extensive network of wetlands around New Orleans. There are a wide range of wetlands ranging from freshwater ponds to estuarine wetlands. Wetlands surrounding Bayou Bienvenue will provide information on plant palette, wildlife species and the general characteristic of wetlands.

Figure B.02 Watershed- The watershed for the Bayou Bienvenue is unique because there are specific point sources where water enters the site. New Orleans has an extensive network of levees which forms bowls that requiring pumping water out creating point sources. Water enters the watershed through pumping stations, sewage treatment plants or the floodgates. The floodgates are where water enter and leaves the site depending on the tide located along the Mississippi River Gulf Outlet. The watershed will help determine the wetland types by the location of water sources with the type of water being discharged. Figure B.02 shows the watershed for Bayou Bienvenue.

Figure B.03 Levees- Bayou Bienvenue is surrounded by levees acting as a barrier for people to interact with the bayou. The levee running along the southern edge is a corten steel levee that is not crossable except in one location. Earthen mounds at least allow people to walk up and down the levees. Earthen mound levees can be a part of greenways while concrete/steel levees are obstacles. Levees will be useful in the design of project as barriers to overcome.

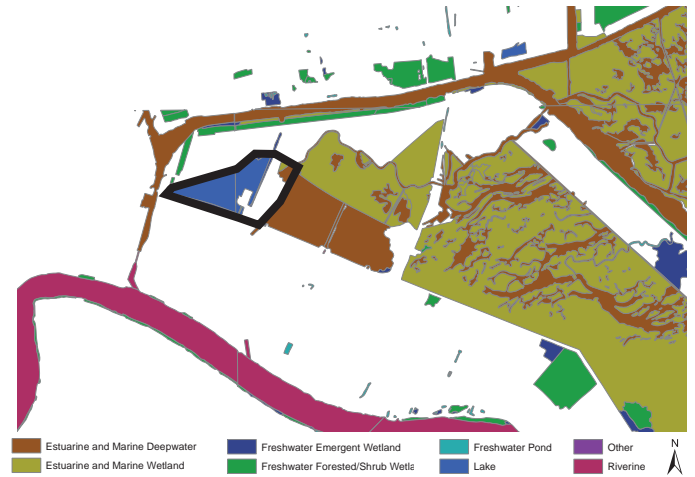


Figure B.01 Wetlands (Produced by author)



Figure B.02 Watershed (Produced by author)



Figure B.03 Levees (Produced by author)

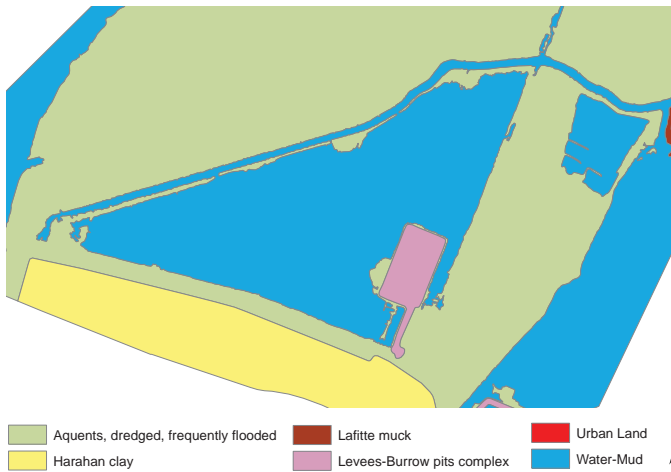


Figure B.04 Soil Types (Produced by author)

Figure B.04 Soils-The soils around Bayou Bienvenue are rich in clay. Lafitte muck is a soil type that makes up a majority of the soil above water in the remaining 28,000 acres of Bayou Bienvenue. Most of Bayou Bienvenue is label as water. For this project the soils for the site are label as water-mud. This means that the soils have characteristics of the Lafitte muck but are under water. Soils along with elevation will help determine location the building and parking areas.

Figure B.05 Land Use- Bayou Bienvenue is zoned as a natural area with residential areas to the south and industrial areas west and east of the site. This means the site could serve as a place for breaks for the employees at the industrial areas and as family time for the residents. This land use is deceptive in that the area appears to be developed but after Hurricane Katrina the structures in the Lower 9th Ward were demolished. The area is vacant with weeds growing on the lots but the community is rebuilding.

Figure B.06 Slope- Bayou Bienvenue has slopes under five percent except near the levees and the landfill. The landfill has slopes that are under 12 percent making it ADA accessible while around the levees the slopes can get up to 300 percent. Slope will determine the suitable areas for stormwater management.

Figure B.07 Elevation- To create a surface for Bayou Bienvenue required some manipulation. The national elevation dataset (NED) was taken a few weeks after Hurricane Katrina when New Orleans was still flooded. This hampered the data so that the lowest elevation was



1.5 feet above sea level and New Orleans goes below sea level. To fix this Make It Right Foundation supplied a CAD drawing with contours. The contours are only in Orleans Parish and the site goes into St. Bernard Parish. That is why there is a distinct line south of the site. The highest elevation in the area is the landfill while the lowest spot is the Lower 9th Ward. Bathymetry data for the bayou was supplied by the University of Wisconsin at Madison. This helped to create a surface for the bottom of the bayou. Elevation will play a role in wetland delineation, outlook locating, finding crayfish habitat and locating buildings.



Figure B.05 Land Use (Produced by author)

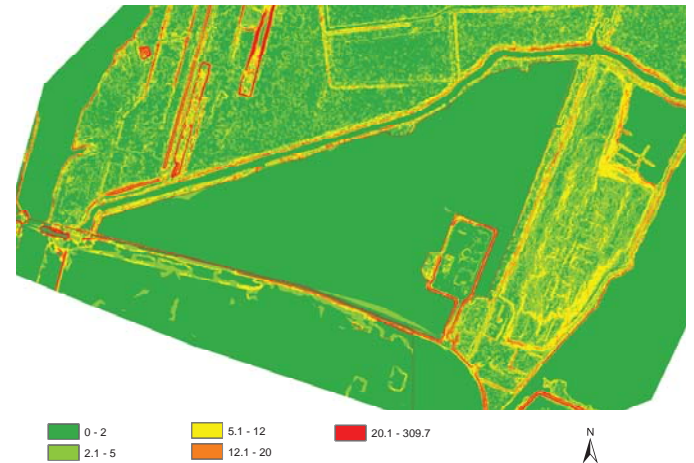


Figure B.06 Slope Percentage (Produced by author)

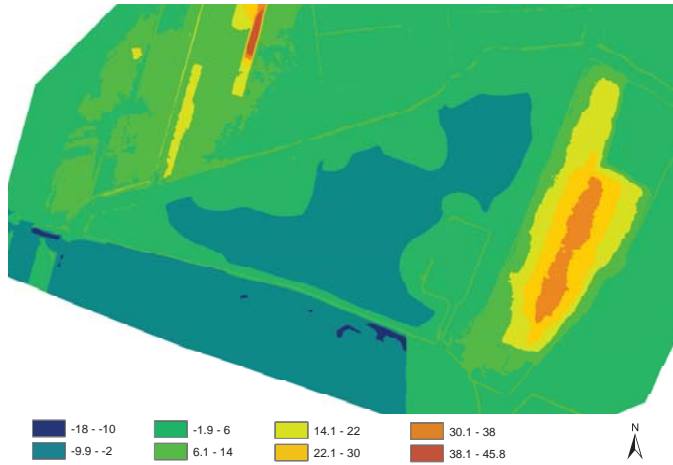


Figure B.07 Elevation (Produced by author)

## Appendix C: Program

### Water Holding Capacity

The Figures C.01-04 show BBEP's water holding capacity at various acre-feet. Figure C. 01 is showing 122 million gallons of water (equivalent of water treated at sewage treatment plant) at a depth of two feet. Figure C.02 is 122 million gallons at 1.5 feet deep and Figure C.03 is at one foot. Figure C.04 shows how much water half of BBEP can treat at a depth of one foot.

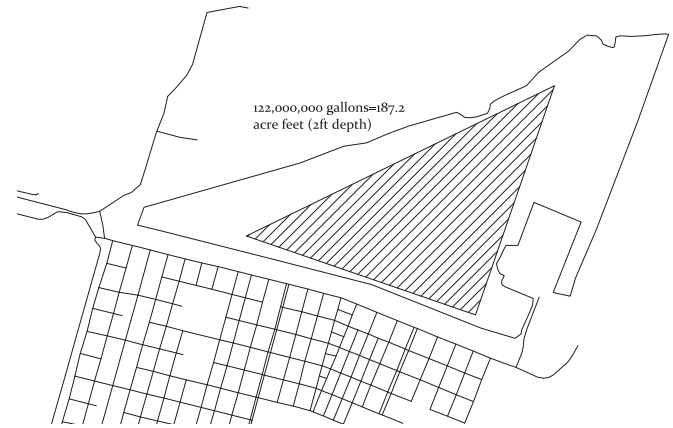


Figure C.01 Water Capacity- 2 feet (Produced by author)

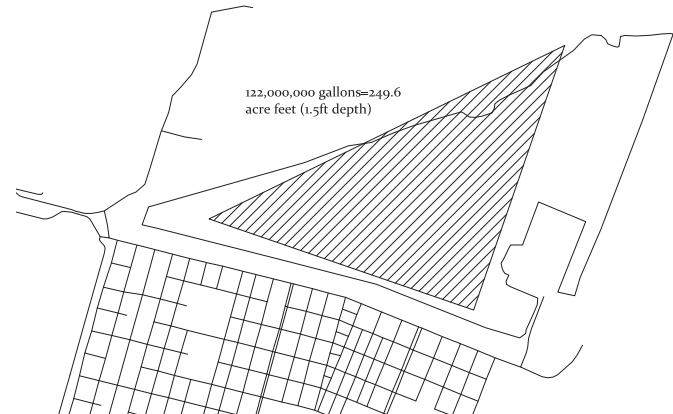


Figure C.02 Water Capacity- 1.5 feet (Produced by author)

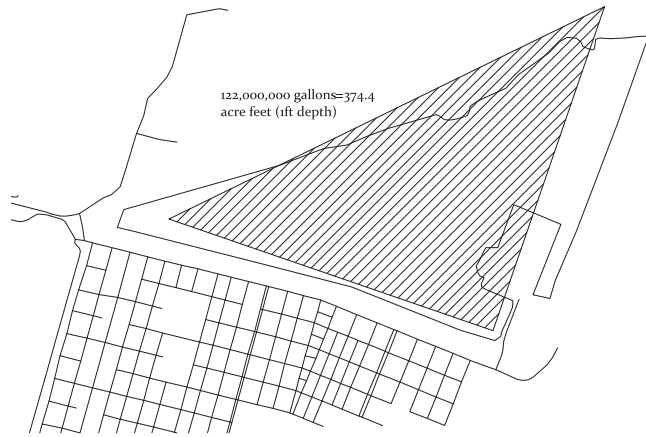


Figure C.03 Water Capacity- 1 foot (Produced by author)



Figure C.04 BBEP Water Capacities (Produced by author)

## Minimum Spatial Requirements

Some of the program elements have minimum spatial requirements. Two of the program elements, crayfish and canoeing, have water depth minimums. Crayfish will encompass the whole site once Bayou Bienvenue’s Ecological Park (BBEP) is completed. Crayfish require a habitat with water depths of about 1.5 feet that allow 1.5 feet in free board (Huner 1994). Canoeing will be allowed in all four wetland cells and need at least a five foot wide clearing with water depth greater than two feet. Trails on site will need to be a minimum of five wide for pedestrians or bicycles, but will need a minimum of twelve feet for pedestrian and bike path. Both trail types need to have a height clearance of eight feet. (Harris 1998) Detention pond sizes will vary but need to fit within a 200 foot wide piece of land. Bioswale need to have a minimum slope of one percent to function. Rain garden will also vary in size but will be about less than 400 square feet. Pavilions and gathering space will have an area from 200 to 900 square feet depending on number of people desired at the pavilion or gathering space. The dog park will need to be at least one acre of land to allow dogs to play. (DogPark)

## Appendix D: Landscape Analysis Maps

The following maps show the most suitable areas within Bayou Bienvenue's Ecological Park for various program elements. A ranking system of one to nine was created to help with finding the suitable areas with nine being the most suitable and one being the least suitable. To see the decision making process to determine the suitable areas, refer back to Chapter Six: Landscape Analysis Figures 6.01, 6.02, and 6.10.



Figure D.01 Rain Garden Suitability (Produced by author)



Figure D.02 Detention Pond Suitability (Produced by author)

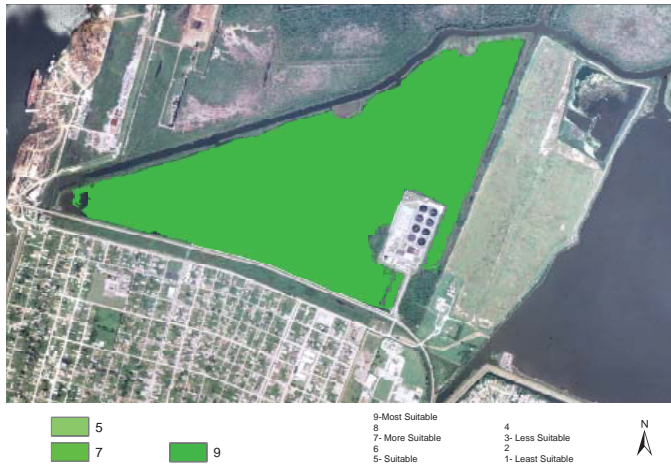


Figure D.03 Elevated Trails Suitability (Produced by author)



Figure D.05 Canoeing Suitability (Produced by author)



Figure D.04 On-grade Trails Suitability (Produced by author)



Figure D.06 Pavilion/Gathering Space Suitability (Produced by author)

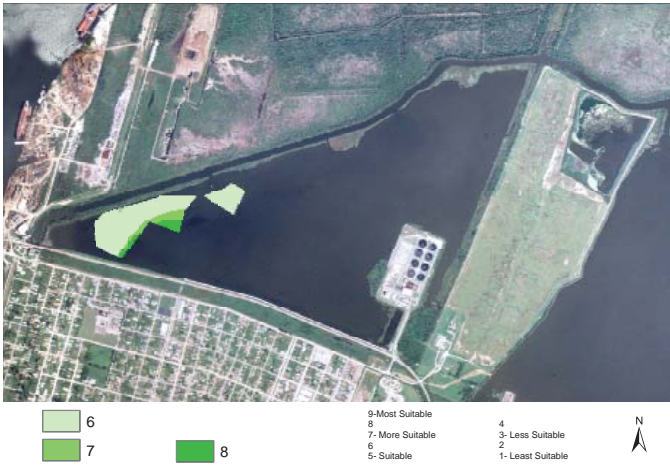


Figure D.07 Freshwater Marsh Station Suitability (Produced by author)



Figure D.09 Saltwater Marsh Station Suitability (Produced by author)



Figure D.8 Freshwater Swamp Station Suitability (Produced by author)



Figure D.10 Saltwater Swamp Station Suitability (Produced by author)

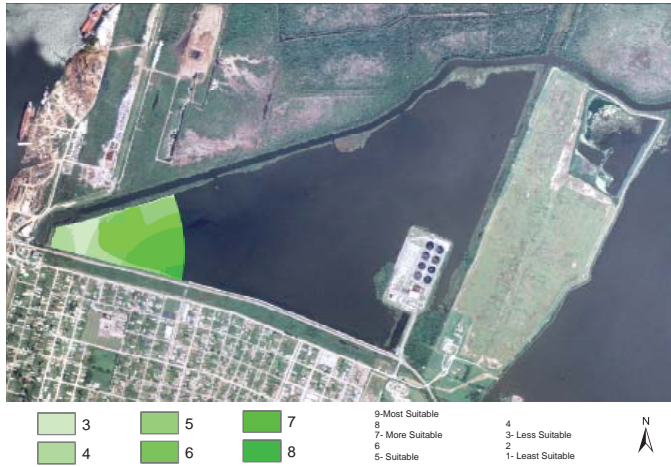


Figure D.13 Stormwater Station Suitability (Produced by author)



Figure D.14 Wastewater Station Suitability (Produced by author)



## Appendix E: Plant & Animal Lists

The following figures are plant and animal lists from other wetlands. Figure E.01 shows the various plants that can grow in freshwater marshes or swamps. This list is not specific to a certain location in the world. The plants listed are native to New Orleans. Plants that are highlighted in green are salt tolerant. The lists are broken up by depth of water plants can tolerate. Figure E.02 is a plant list from a wetland located in Orlando, FL known as Orlando Easterly Wetland Reclamation Park. The plants appearing in this list can survive in Bayou Bienvenue's Ecological Park because Orlando and New Orleans are in the same plant zone. Figure E.03 is a list of animal species that live in Bayou Sauvage, marsh wetland ecosystem located east of BBEP in New Orleans, and the animal species listed can be expected in BBEP.

### Wetland Plants

Scientific Name	Common Name	Scientific Name	Common Name
<b>Transitional-seasonally flooded</b>			
Hymenocallis spp.	Spider Lily	Taxodium distichum	Bald Cypress
Polygonum lapathifolium	Pale Smartweed	Salix nigra	Black Willow
Iris fulva	Red Iris	Carya aquatica	Water Hickory
Osmunda cinnamomea	Cinnamon Fern	Planera aquatica	Water Elm
Osmunda regalis	Royal Fern	Nyssa aquatica	Water Tupelo
Spartina pectinata	Cordgrass	Foresteria acuminata	Swamp Privet
Panicum virgatum	Switchgrass	<b>Fraxinus pennsylvanica</b>	<b>Green Ash</b>
Asclepias incarnata	Swamp Milkweed	Quercus nuttallii	Nuttall's Oak
<b>Distichlis spicata</b>	<b>Saltgrass</b>	Quercus lyrata	Overcup Oak
Hibiscus moscheutos	Swamp Rose Mallow	Ilex decidua	Deciduous Holly
Hibiscus militaris	Halbeard-leaved R. Mallow	<b>Cephalanthus occidentalis</b>	<b>Buttonbush</b>
<b>Shallow- seasonally flooded to permanently flooded to 15 cm</b>			
Juncus effusus	Soft Rush	Carys illinoensis	Pecan
Iris virginicus	Blue Iris	Campsis radicans	Trumpet Vine
Iris pseudacorus	Yellow Iris	Diospyros virginiana	Persimmon
<b>Panicum agrostoides</b>	<b>Panic Grass</b>	<b>Flooding for one growing season</b>	
Scirpus cyperinus	Woolgrass	Vaccinium uliginosum	Blueberry
Habenaria spp.	Swamp Orchids	Populus heterophylla	Swamp Cottonwood
Thelypteris palustris	Marsh Fern	magnolia virginiana	Sweetbay
Sarracenia spp.	Pitcherplant	<b>Rhus glabra</b>	<b>Smooth Sumac</b>
Justicia americana	Water Willow	Populus deltoides	Cottonwood
Polygonum pensylvanicum	Pennsylvania Smartweed	<b>Quercus imbricaria</b>	<b>Shingle Oak</b>
<b>Mid Depths- 15-50cm water depths</b>			
Polygonum amphibium	Water Smartweed	Diospyros virginiana	Persimmon
<b>Cladium jamaicense</b>	<b>Sawgrass</b>	<b>Fraxinus americana</b>	<b>White Ash</b>
Zizania aquatica	Wild Rice	Acer rubrum	Red Maple
Typha latifolia	Wide-leaved Cattail	Celtis laevigata	Sugarberry
Typha angustifolia	Narrow-leaved Cattail	<b>Flooding for less than 30 days</b>	
<b>Blirraginus australis</b>	<b>Giant Reed</b>	Tilia americana	Basswood
Scirpus validus	Bulrush	<b>Carpinus caroliniana</b>	<b>Ironwood</b>
Nasturtium officinale	Watercress	Acer negundo	Box Elder
<b>Deep- 50-100cm water depths</b>			
Ranunculus flabellaris	Yellow Water Buttercup	Vitis riparia	Wild Grape
Utricularia spp.	Bladderwort	Parthenocissus quinquefolia	Virginia Creeper
Nymphaea odorata	Fragrant White Lily	Quercus phellos	Willow Oak
Nelumbo lutea	Water Lotus	Quercus nigra	Water Oak
Nymphoides aquatica	Water Heart	Quercus falcata	Spanish Oak
<b>Floating</b>			
Azolla spp.	Water Fern	<b>Quercus macrocarpa</b>	<b>Bur Oak</b>
Wolffia spp.	Watermeal	Platanus occidentalis	Sycamore
		Betula nigra	River Birch
		Ilex opaca	American Holly
		Crataegus mollis	Hawthorn
		<b>Acer saccharinum</b>	<b>Silver Maple</b>
		Ulmus americana	American Elm
		<b>Flooding for less than 5 days</b>	
		Acer saccharum	Sugar Maple
		Carya ovata	Shagbark Hickory
		<b>Carya cordiformis</b>	<b>Bitternut Hickory</b>
		<b>Carya laciniosa</b>	<b>Shellbark Hickory</b>
		Cornus florida	Flowerin Dogwood
		<b>Juglans nigra</b>	<b>Black Walnut</b>
		Prunus serotina	Black Cherry
		Quercus velutina	Black Oak
		Quercus alba	White Oak
		Quercus rubra	Red Oak

Figure E.01 Wetland Plants (Produced by author)

Orlando Easterly Wetlands Reclamation  
Project Species Planted

<b>Red Maple</b> ( <i>Acer rubrum</i> )	
<b>Water hyssop</b> ( <i>Bacopa caroliniana</i> )	
<b>Canna</b> ( <i>Canna flaccida</i> )	
<b>Sawgrass</b> ( <i>Cladium jamaicense</i> )	
<b>Spikerush</b> ( <i>Eleocharis cellulosa</i> )	
<b>Pop ash</b> ( <i>Fraxinus caroliniana</i> )	
<b>Dahoon Holly</b> ( <i>Ilex cassine</i> )	
<b>Blue flag</b> ( <i>Iris hexagona</i> )	<b>Pondweed</b> ( <i>Potamogeton illinoensis</i> )
<b>Soft rush</b> ( <i>Juncus effusus</i> )	<b>Swamp laurel oak</b> ( <i>Quercus laurifolia</i> )
<b>Sweet gum</b> ( <i>Liquidambar styraciflua</i> )	<b>Arrowhead</b> ( <i>Sagittaria graminea</i> )
<b>Sweet bay</b> ( <i>Magnolia virginica</i> )	<b>Arrowhead</b> ( <i>Sagittaria lancifolia</i> )
<b>Stone wort</b> ( <i>Nitella</i> sp.)	<b>Three-square bulrush</b> ( <i>Scripus americanus</i> )
<b>Cow lily</b> ( <i>Nuphar luteum</i> )	<b>Giant bulrush</b> ( <i>S. Californicus</i> )
<b>Water lily</b> ( <i>Nymphaea odorata</i> )	<b>Soft stem bulrush</b> ( <i>S. Validus</i> )
<b>Black gum</b> ( <i>Nyssa sylvatica</i> )	<b>Pond cypress</b> ( <i>Taxodium ascendens</i> )
<b>Maidencane</b> ( <i>Panicum hemitomon</i> )	<b>Thalia</b> ( <i>Thanlis geniculata</i> )
<b>Knot grass</b> ( <i>Paspalum distichum</i> )	<b>Cattail</b> ( <i>Typha domingensis</i> )
<b>Smartweed</b> ( <i>Polygonum punctatum</i> )	<b>Cattail</b> ( <i>T. latifolia</i> )
<b>Pickerelweed</b> ( <i>Pontederia cordata</i> )	<b>Tapegrass</b> ( <i>Vallisneria americana</i> )

Figure E.02 Orlando's Wetland Plant List (Produced by author)

## Bayou Sauvage Refuge Biota

Species of concern and/or significance for management purposes occurring Bayou Sauvage National Wildlife Refuge are listed below. For a complete list of birds found on the refuge, contact refuge headquarters for a bird list.

<u>Common Name</u>	<u>Scientific Name</u>
<b>Birds</b>	
Bald Eagle	<i>Haliaeetus leucocephalus</i>
Eastern Brown Pelican	<i>Pelecanus occidentalis carolinensis</i>
Wood Duck	<i>Aix sponsa</i>
Mottled Duck	<i>Anas fulvigula</i>
Blue-winged Teal	<i>Anas discors</i>
Northern Pintail	<i>Anas acuta</i>
Black-bellied Whistling Duck	<i>Dendrocygna autumnalis</i>
King Rail	<i>Rallus elegans</i>
Clapper Rail	<i>Rallus longirostris</i>
Purple Gallinule	<i>Porphyrio porphyrio</i>
Common Moorhen	<i>Porphyrio martinica</i>
Great Blue Heron	<i>Ardea herodias</i>
Great Egret	<i>Ardea alba</i>
Green Heron	<i>Butorides virescens</i>
Louisiana or Tricolored Heron	<i>Egretta tricolor</i>
Black-necked Stilt	<i>Himantopus mexicanus</i>
Least Bittern	<i>Ixobrychus exilis</i>
Sora Rail	<i>Ortygometra carolinus</i>
Virginia Rail	<i>Rallus virginianus</i>
Little Blue Heron	<i>Egretta caerulea</i>
White Ibis	<i>Eudocimus albus</i>
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>
Acadian Flycatcher	<i>Empidonax virescens</i>
Prothonotary Warbler	<i>Protonotaria citrea</i>
Glossy Ibis	<i>Plegadis falcinellus</i>
White-faced Ibis	<i>Plegadis chihii</i>
Common Yellowthroat	<i>Geothlypis trichas</i>
<b>Mammals</b>	
Nutria	<i>Myocastor coypus</i>
Feral Hogs	<i>Sus scrofa</i>
<b>Reptiles and Amphibians</b>	
American Alligator	<i>Alligator mississippiensis</i>
Alligator Snapping Turtle	<i>Macrochelys temminckii</i>
Canebrake Rattlesnake	<i>Crotalus horridus</i>
Gulf Coast Box Turtle	<i>Terrapene carolina major</i>
<b>Fish and Shellfish</b>	
Alligator Gar	<i>Atractosteus spatula</i>
Largemouth Bass	<i>Micropterus salmoides</i>
Bream sp.	<i>Lepomis</i> spp.
Crawfish sp.	<i>Procambarus</i> spp.
Blue Crab	<i>Callinectes sapidus</i>

Figure E.03 Animal List (Produced by author)

## Glossary

Acre-foot- the volume of water that would cover one acre at a depth of one foot (Webster Dictionary).

Activated sludge process- consists of an aeration tank and settling tank (Forster 2003, 67).

Army Corps of Engineers- civilians and soldiers delivering engineering services to customers worldwide (US Army Corps of Engineers).

Bayou- a creek, secondary watercourse, or minor river that is tributary to another body of water (Webster Dictionary).

BOD- Biological Oxygen Demand is a process to determine the uptake of oxygen by micro-organisms (Scholz 2006, 16).

Bogs- form primarily in deeper glaciated depressions, are acidic, low-nutrient water and dominated by mosses (Hammer 1997, 16).

Crayfish- a freshwater crustacean that is closely related to lobsters, crabs, and shrimp (Huner 1994, 1).

Dissolved Oxygen- a measure of oxygen in the water (University of Wisconsin-Madison 2008, 56).

Fauburg- the French term for an inner suburb (Campanella 2008, 289).

Fen- has water closer to neutral and are dominated by

sedges (Hammer 1997, 16).

Geo-caching- high tech treasure hunting game played with GPS devices (Groundspeak)

Hurricane Katrina- a category 3 hurricane with a storm surge of a category 5 hurricane that hit Louisiana on August 29, 2005 that damaged and flooded the New Orleans and other coastal cities near Louisiana (Campanella 2008, 331).

Marshes- wetlands dominated by herbaceous vegetation, moderately or nonpeat forming, mainly meso- to Eutrophic, and sometimes saline (Vymazal 1995, 163). Marshes are dominated by herbaceous plants (Hammer 1997, 13).

Oxidation pond- a pond that allow for sedimentation and are filled with algae to recharge the oxygen levels (Humboldt State University).

Preliminary treatment- the first phase of wastewater treatment process and consists of screening and grit removal. (Scholz 2006, 13)

Primary treatment- the settling out of solids. (Scholz 2006, 13)

Saffir Simpson Hurricane Scale- Hurricane rating system. Tropical storm: <75 mph, Category 1: 75-95 mph, Category 2: 96-110 mph, Category 3: 111-130 mph, Category 4: 131-155 mph and Category 5: 156> mph (National Hurricane Center)

Salinity- a measure of dissolved salt concentrations in water (University of Wisconsin-Madison 2008, 55).

Secondary treatment- the removal of BOD and some nutrients. (Scholz 2006, 13)

Subsidence- lowering of the earth's crust. (Columbia Encyclopedia 2008)

Swamps- contain a variety of woody plants and water-tolerant trees (Hammer 1997, 13). Swamps are meso- to Eutrophic systems, with or without peat, and with woody shrubs or trees as dominant vegetation (Vymazal 1995, 164).

Tertiary treatment- the final phase of wastewater treatment process where nutrients are removed through plants (Scholz 2006, 13).

Trickling filter- a bed of coarse porous media on which a biological film or slime grows that help remove BOD (Scholz 2006, 85).

Wards- are political-geographical unit for dividing the city (Campanella 2008, 288).

