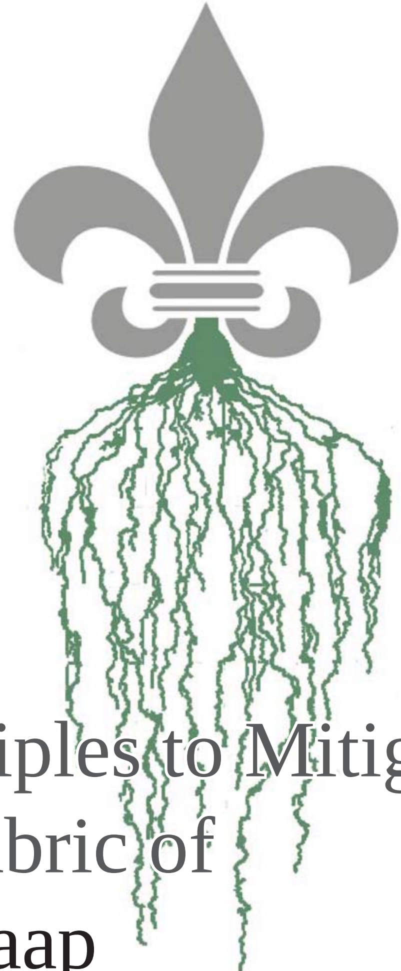

Deep Roots:

Applying Permaculture Principles to Mitigate Flooding within the Urban Fabric of New Orleans

by Andrew Schaap

DEEP ROOTS: APPLYING PERMACULTURE PRINCIPLES IN ORDER TO MITIGATE FLOODING WITHIN THE URBAN FABRIC OF NEW ORLEANS

by

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A REPORT

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Abstract

Urbanization has lead to environmental degradation in most of the world's great cities. With the degradation of natural systems comes a reliance on man-made and engineered systems to perform functions vital to cities such as water treatment, the filtering of pollutants, flood mitigation, temperature control, and erosion prevention; functions formerly performed by natural systems. Relying on man-made operations to perform essential services comes at a cost, both in terms of monetary costs and in the resources needed to construct and operate them.

New Orleans is a prime example of a city that has greatly altered the ecosystems that formerly existed on the site and has had to rely on human engineering for its survival. Instead of the mosaic of freshwater marshes, wooded swamps, wet meadows, and bottomland forests that once comprised New Orleans and allowed for the diffusion, evaporation, and infiltration of floodwater; present day New Orleans has had to rely on a system of levees and pumps to keep the City dry. These pumps and levees have allowed New Orleans to expand and prosper but failures in the flood control system have also lead to great disasters, Hurricane Katrina and the related flood in 2004 being the latest.

Implementing permaculture designs to New Orleans will buffer the City from the effects of hurricanes and flooding and decrease its reliance on city services. These permaculture designs recreate key elements of the natural systems that formerly existed in New Orleans and attempt to again create spaces in the City were stormwater can safely be detained without damaging property and that allow the stormwater to infiltrate into the soil. At the same time these permaculture designs would enhance the character and uniqueness that makes New Orleans one of the world's great cities.

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Abstract

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I would like to thank my wife Tara. Thank you for starting me on this adventure, thank you for all your support, and thank you for loving me.

Section One:

1

Introduction

Dilemma

Today's cities are becoming increasingly removed from the natural environments that formerly existed on the city sites. As the distance between cities and nature grows, citizens end up paying for services that natural systems formerly provided for free such as flood control, aquifer recharge, erosion protection, water treatment, and a reduction in the urban heat island effect. Perhaps the most interesting of these altered cities is New Orleans. New Orleans has been called an "inevitable and impossible city" referring both to its position as a port city connecting the Gulf of Mexico with the Mississippi River plain and due to the numerous natural hazards that continue to threaten the city's existence (Lewis, 1976). New Orleans has always depended on human engineering for its survival. An extensive system of levees and water pumps have allowed the city to exist and grow, but the degradation of its natural systems leaves the City increasingly susceptible to flooding damage.

Thesis

Implementing permaculture design principles in New Orleans will mitigate the threat of flooding in New Orleans and decrease the City's reliance on city services. These permaculture designs can improve the City's resistance to flooding while also creating activity centers for New Orleanians and enhancing the character that makes New Orleans one of the United State's most unique cities. Permaculture designs will also create secondary benefits to New Orleans' environment through an increase in the quantity and quality of wildlife habitat, the sequestration of carbon, a reduction of air and water pollution, and a decrease in the urban heat island effect.

Project Description

The Deep Roots Project focused on the process needed to gain an understanding of how permaculture principles can be used to mitigate the threat of flooding in New Orleans and benefit the lives of New Orleanians. In order to effectively apply permaculture principles, Deep Roots first looked at literature to get a general understanding of New Orleans history, New Orleans ecology, landscape urbanism, and flood mitigation. The literature review also focused on gaining an understanding of permaculture and its central principles. Deep Roots utilizes David Holmgren's twelve principles of permaculture design described in his book Permaculture: Principles and Pathways Beyond Sustainability (2002). These principles provide a checklist for what Holmgren describes as ethical and sustainable design and provide the Deep Roots Project with a set of guidelines to ensure that proposed designs remain consistent with permaculture ideals. The twelve permaculture principles described by Holmgren are defined in the Appendix A of this report and include:

- Apply Self-regulation and Accept Feedback
- Catch and Store Energy
- Creatively Use and Respond to Change
- Design from Patterns to Details
- Integrate Rather than Segregate
- Observe and Interact
- Obtain a Yield
- Produce No Waste
- Use and Value Diversity
- Use and Value Renewable Resources and Services
- Use Edges and Value the Marginal
- Use Small and Slow Solutions

In order to determine the sites within New Orleans that would best respond to permaculture design in a manner that mitigated flood hazard and produced additional benefits to local residents, a site inventory and analysis was performed. The sites determined to be appropriate for permaculture design in New Orleans fell into one of three different site types: flood-prone areas, commercials streets served by mass transit, and canal corridor residential sites. Further site analysis identified one specific site within each of the three site types for further analysis and conceptual design.

Program elements were generated from precedent studies, literature review, and site visits. Each site type had a specific set of program elements integrated in its conceptual designs based on the constraints of the site types and requirements of the program elements. A conceptual master plan based on permaculture design principles was generated for each site type. These designs were communicated through master plans, sections, and conceptual perspectives.

Site Location

The site for the Deep Roots project is the Metairie Canal – Canal Number Two Watershed in southeastern Louisiana and located in Orleans parish. The watershed includes most of the city of New Orleans and a small segment of Metairie, Louisiana. Figure 1.1 shows the location of the project location in Louisiana and Figure 1.2 on page eight shows the project location in relation to the Mississippi River, Lake Pontchartrain, and the city boundary of New Orleans.

The site was chosen because it is susceptible to a unique combination of natural hazards. These natural hazards coupled with the topography of the site, which includes a high proportion of land below sea level, leave the area especially susceptible to flooding. The natural environment of the Metairie Canal – Canal Number Two Watershed formerly included a mosaic of habitats including freshwater marsh, wooded swamp, wet meadow, and bottomland hardwood forest (Wicker, 1980).

Currently, the site and the surrounding area is home to over a million people and its cultural history, landmarks, and character make it one of the most unique cities in the United States (Colten, 2005). The interaction between the environment and the people who live within the site is what makes the Deep Roots project interesting. Using permaculture principles to recreate elements of the natural environment, Deep Roots seeks to recreate the functions of ecosystems in order to mitigate flooding while also creating spaces that provide recreational opportunities and increase the connectivity of surrounding residents.

Figure 1.1 Project Site in Louisiana

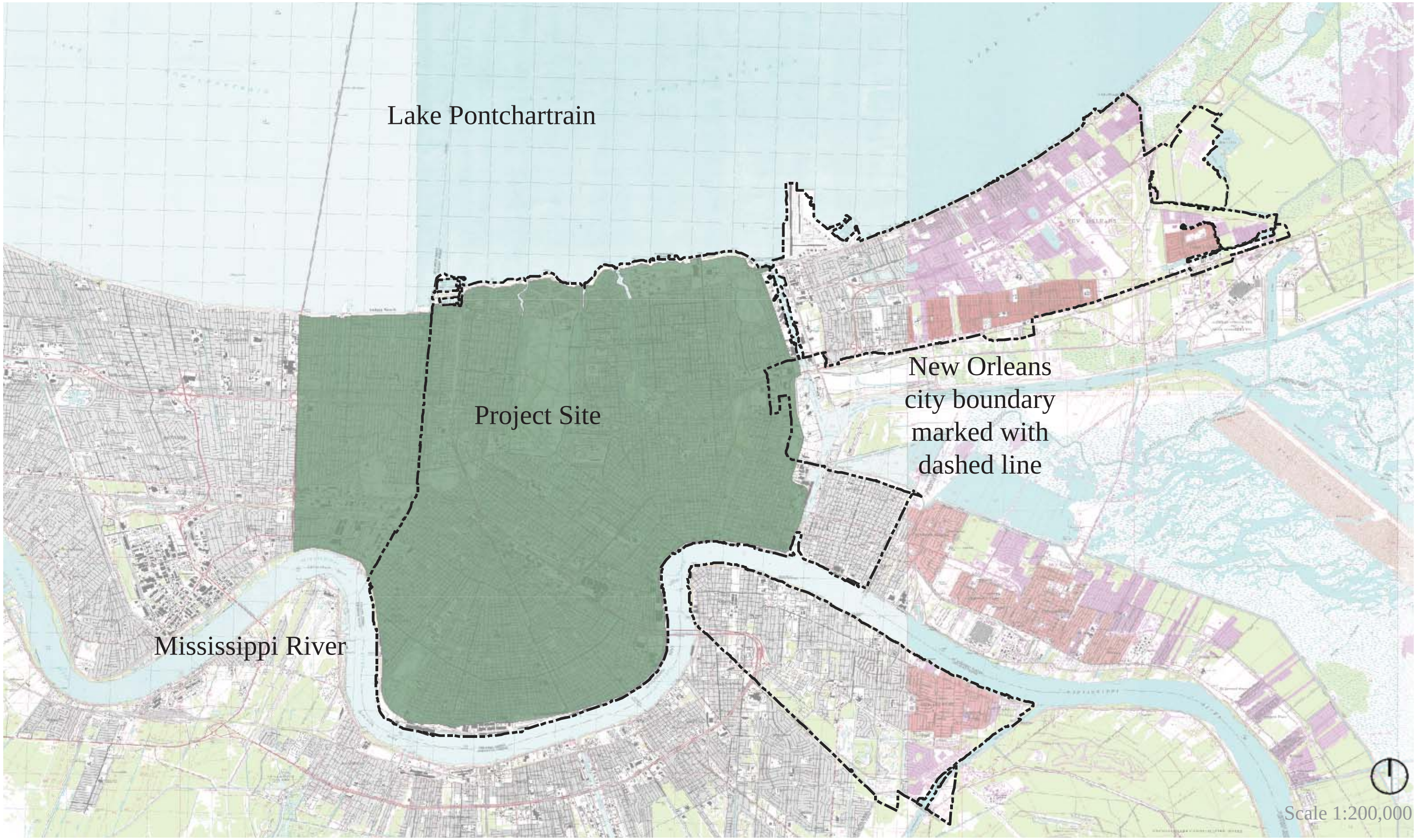


Figure 1.2 Project Site in New Orleans

Goal and Objectives

The overall goal of the Deep Roots Project is to recreate key functions of natural ecosystems utilizing permaculture principles in order to mitigate the threat of flooding within the project site while also ensuring that changes to the landscape create additional benefits for potential users and enhance the character of New Orleans. Looking closely at the overall goal it is possible to separate it into four objectives:

- Introduce designs that follow permaculture principles to help mitigate the threat of flooding in New Orleans.

- Create an interconnected flood mitigation system for the city that recreates key elements of the ecosystems that formerly exist on the site.

- Integrate Deep Roots designs within the urban fabric of New Orleans in areas that maximize their benefit to site users and the environment.

- Create designs that will enhance and reinforce the sense of place users experience within New Orleans.

Conclusions

There are a number of conclusions that can be drawn from Deep Roots and the steps taken to arrive at the final designs. The precedent studies uncovered numerous flood mitigation practices being used throughout the world, though most were limited in overall effectiveness because they fail to act as a comprehensive system. These precedent studies also revealed a number of solutions which could be combined to form a flood mitigation system that follows the principles of permaculture and can reduce the threat of flooding. The creation of this flood mitigation system can be done within New Orleans in a way that is both effective and provides additional benefits and activities for residents. Moreover, through the reintroduction of some of the natural processes to the City, New Orleans can gain a sense of uniqueness and residents can gain a better understanding of ecological systems. There are also a number of secondary benefits that are difficult to quantify but important to the local environment.

Section Two:

2

Literature Review

Introduction

The literature review for Deep Roots focused on five main subject areas: permaculture, landscape urbanism, urban flood mitigation, New Orleans development, and New Orleans ecology. Each of these areas of focus provided the Deep Roots Project with a base of information on work that has already been done. The five fields of study were chosen because each of them related to the goals of the Deep Roots Project. Knowledge gained in the literature review in each of these main subjects has been integrated into the inventory, analysis, programs, and designs of Deep Roots.

Permaculture

The field of permaculture provided the inspiration for Deep Roots and its guiding design principles. The most notable source of guiding principles was David Holmgren's <u>Permaculture: Principles & Pathways Beyond Sustainability</u> (2002). In this work Holmgren describes the twelve principles for ethical and sustainable design. Bill Mollison's (also a founder of permaculture) 1990 book, <u>Permaculture: A Practical Guide for a Sustainable Future</u>, parallels Holmgren's work; discussing the economic, environmental, and ethical advantages of permaculture design.

The focus of both Mollison and Holmgren's books are on the philosophy behind permaculture and its application. These books, and most other permaculture texts, propose design solutions for residential and agricultural settings that provide practitioners with food, clothing, fuels (biofuels), and comfortable shelter in a way that is significantly more self-sustaining and environmentally benign than conventional methods of agriculture, silviculture, and housing development.

Deep Roots employed the philosophy of permaculture but instead applied it to flood mitigation in an urban setting. The project used the following definition of permaculture adapted from Holmgren's <u>Permaculture: Principles & Pathways Beyond Sustainability</u> (2002): permaculture is a posivistic response to environmental crisis. Permaculture designs are consciously designed landscapes which mimic the patterns and relationships found in nature in order to, through the use of systems thinking and design principles, provide the organizing framework which creates a significantly more permanent culture.

Landscape Urbanism

Landscape urbanism was the next focus that pertained to the goals of the Deep Roots project. Broadly, landscape urbanism is the idea that the landscape rather than the built environment should be the organizing principle in the urban setting (Waldheim, 2006). The most relevant of the landscape urbanism readings was The Granite Garden by Anne Whiston Spirn (1984). This book focuses on the relationship between cities and nature, proposing that the environment within urban spaces has largely been ignored throughout history with the result being to "magnify problems that have plagued cities for centuries, such as floods and landslides, poisoned air and water" (Spirn, 1984, page xi). On the other hand, Spirn goes on to say that if these natural processes are acknowledged and harnessed they can be a great resource and help to shape urban spaces.

Flood Mitigation

The next group of readings in the literature review concerned flood mitigation. The most critical text was <u>Water in Environmental Planning</u> by Thomas Dunne and Luna Leopold (1978). This text provides a broad look at hydrology, focusing on the early recognition of problems with flood forecasting, water quality, and slope stability. According to the authors, the first aim of the text is to "make planners aware of some of the environmental constraints placed upon development by natural processes" (Dunne and Leopold, 1978). Dunne and Leopold go on to describe the amount of environmental damage that has occurred because planners were not present or because planners did not appreciate the interplay of processes that occurred within a site. The coastal aspect of flood hazard that New Orleans faces is not an aspect covered in <u>Water in Environmental Planning</u>. <u>The Human Ecology of Coastal Flood Hazard in Megalopolis</u> by Ian Burton (1969) looks at patterns of human development along coastal areas of the United States. It studies how various coastal populations deal with the threat of flooding using techniques including flood insurance, flood-proofing, large scale flood control methods, early warning systems, and land-use changes.

New Orleans Development

Clearly the planners and engineers responsible for the development and drainage plans for New Orleans were not big fans of Anne Whiston Spirn. Geographer Pierce Lewis has called New Orleans an “impossible but inevitable city” due to its strategic position as the gateway to the Mississippi River Valley and it precarious position with little solid ground and the serious threat of flooding (Lewis, 1976). Craig Colten has written two books, An Unnatural Metropolis: Wresting New Orleans from Nature (2005) and Transforming New Orleans and Its Environs (2000), both investigating the unique set of hazards that New Orleans is threatened by and the City’s responses to these threats. In these books Colten discusses the massively engineered water management system including levees, pumps, and canals that New Orleans has used to drain the City, keep river and lake waters at bay, and generally maintain the City’s viability. In the 1980’s New Orleans had eighty-nine drainage pumps with a combined capacity of 22.5 billion gallons per day which is equal to the flow of the Ohio River. Since then New Orleans has added drainage pumps and now has one hundred and forty-eight throughout the city (Colten, 2005).

Figure 2.1 shows the historical development pattern of New Orleans. The development of the City clearly followed the topography with the areas lowest in elevation such as the center of the City and land along Lake Pontchartrain being developed last. Figure 2.2 shows the system of canals employed by the City to help drain wetlands and allow for expansion of the City. An Unnatural Metropolis: Wresting New Orleans from Nature (2005) also looks at some of the catastrophic failures that were the result of some of these short-sighted responses and the magnitude of the threats that New Orleans faces.

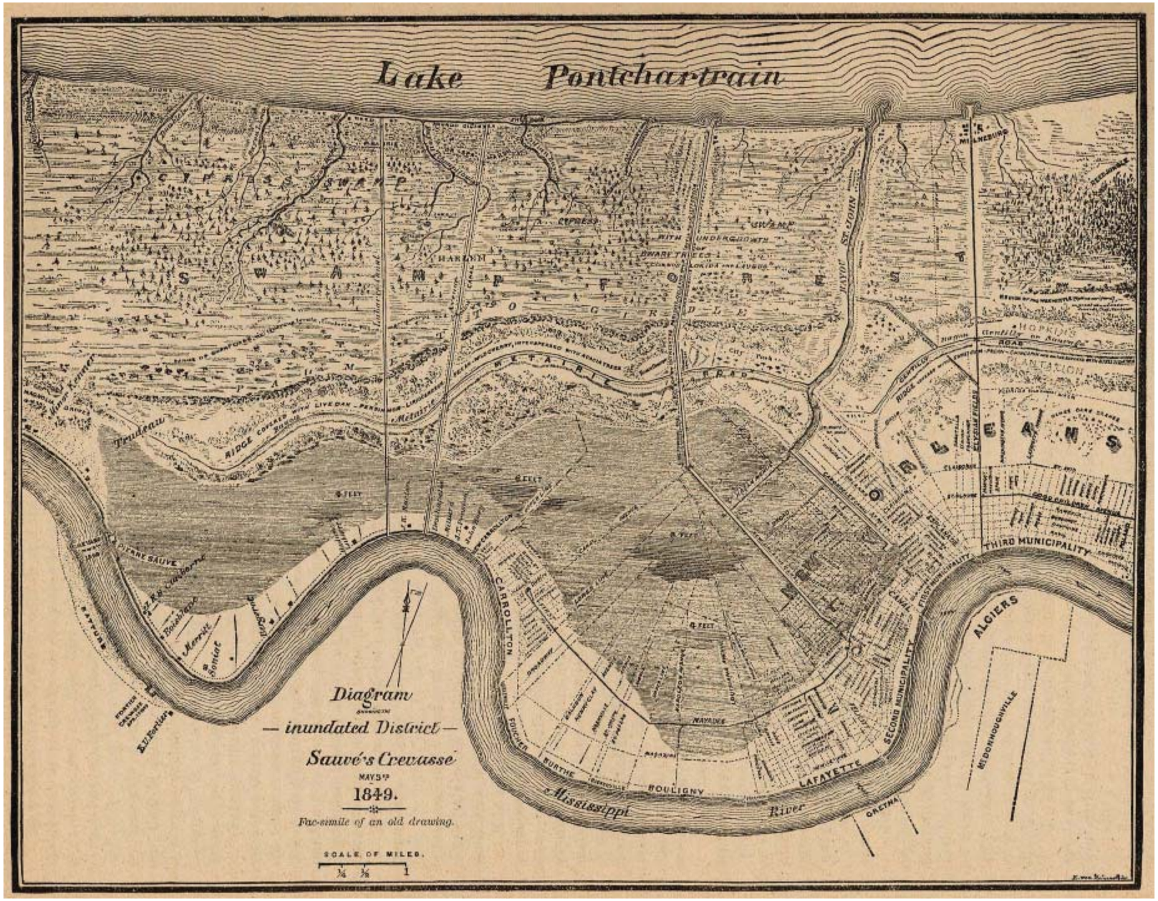


Figure 2.1 1849 Development Pattern of New Orleans

Figure 2.2 New Orleans Drainage Canals

New Orleans Ecology

Another key area of literature review was the ecology of New Orleans. These readings were useful in gaining an understanding of the ecosystems that existed in and around New Orleans prior to urbanization and also in understanding how these ecosystems functioned. The main resource on the ecosystems of Coastal Louisiana (which included New Orleans) was a 1980 study from the United States Fish and Wildlife Service titled <u>Mississippi Deltaic Plain Region Ecological Characterization: A Habitat Mapping Study</u> by Karen Wicker. This text illustrates the major ecosystems formerly found in New Orleans which include freshwater marsh, wooded swamp, wet meadow, and bottomland hardwood forest and also shows the species compositions and transitions between these habitat types (Wicker, 1980). Figures 2.3 and 2.4 provide examples bottomland hardwood forest and wooded swamp. The value in learning about these ecosystems is in knowing what is needed to restore these habitats and what functions they perform.

Figure 2.3 Bottomland Hardwood Forest

Figure 2.4 Wooded Swamp at Bayou Sauvage Nation Wildlife Refuge

3

Section Three:

Precedent Studies

Introduction

Precedent studies provide a background of what cities around the globe have done in order to mitigate flooding problems. Elements of their flood mitigation systems that have proven effective, coincide with the goals of the Deep Roots Project, and follow the principles of permaculture design were considered for implementation in the final designs of Deep Roots. Each precedent study is presented in three sections: the first explains why the precedent study was chosen, the second describes what the particular city has done in order to mitigate flooding, and the third section discusses how the flood mitigation solutions used relate to Holmgren's twelve permaculture design principles and the overall project goals.

Five precedent studies were conducted to determine the effectiveness of the elements they used for flood control. The five precedents were Tulsa, Oklahoma; Guandu River, Taiwan; Portland, Oregon; Cheonggyecheon, Seoul, South Korea; and Houston, Texas. Each of these sites has a number of similarities to the project site though none can claim to face quite New Orleans' vast array of flooding hazards.

The precedent studies introduced a wide variety of solutions used to handle the numerous types of flooding hazards that various regions are subject to. Many of these solutions can be implemented or modified and implemented in the study area. A key to the analysis of the design solutions is to identify why they work in their specific cities and how they integrate with other flood control measures. In keeping with the Deep Roots Project's stated goals, these solutions help to provide further definition to the permaculture principles and help recognize how other cities are applying permaculture design principles even when it is not explicitly stated or even intended by designers. The intent of the precedent study is not to identify one 'magic bullet' solution to flooding but rather find a portfolio of solutions that can be applied to specific scenarios within the study area.

Tulsa, Oklahoma

Why Tulsa?

New Orleans faces a variety of environmental hazards that few cities in the world can match. Tulsa, Oklahoma is one of the very few cities that come close to matching New Orleans in the numbers of hazards that it faces and the damage that these hazards have waged on the City. Tulsa is subject to violent thunderstorms, tornados, and flooding from the Arkansas and Vedigris River Systems. During the 1970's and 1980's Tulsa led the nation in federally declared disasters. Tulsa was declared a federal disaster area nine times in a fifteen year period. Ten percent of the City is located in a flood plain. The flood of 1984 caused $180 million in damage and fourteen deaths. However, Tulsa, through improvements to its flood mitigation systems, has reduced losses from repeated flooding, enhanced quality of life by expanding open space recreational areas, and created a better environment by returning floodplains to wetlands and reclaiming wildlife habitat (Patton, 1993).

What Tulsa has Done

Tulsa has implemented a floodplain clearance program that has cleared 875 buildings from the floodplain since the 1970's. They did this by identifying properties within Tulsa that have experienced at least $1000 in damage twice within a ten year period. They have also created a stable funding mechanism for maintenance and management of flood mitigation measures. Residents pay $2.58 per month per house and businesses pay based on runoff from impervious areas. Funds from this program total $8 million dollars per year. To meet watershed-wide regulations, new developments must match stringent standards to ensure that they will not flood or aggravate flooding on other properties (Patton, 1993).

Tulsa has also implemented a public awareness program that includes annual mailings that tout flood insurance and preparedness planning. There are also sophisticated forecasting and alert systems in Tulsa warning residents of flooding and tornados. The city has master drainage plans for the entire city. The Army Corps of Engineers is completing a $143 million dollar Mingo Creek Project which involves twenty-three detention ponds and downstream channelization (Patton, 1993).

Tulsa has also incorporated recreation, open space, and nature preserves into many flood mitigation projects. For example soccer fields and other recreation activities are sited in detention basins which are dry except during floods. Also hiking and bike trails have been created along channel maintenance lanes and are being linked into a community-wide network (City of Tulsa, 2002).

The stormwater management system in Tulsa has been tested by a number of moderately large rainfalls and upstream water releases with few major problems. Tulsa has received top awards from the Association of State Floodplain Managers and the City's flood program received the nation's highest rating in the National Flood Insurance Program's community rating system, giving Tulsans the lowest flood insurance rates in the United States. Additionally, the Federal Emergency

Management Agency (FEMA) selected Tulsa for its Outstanding Public Service Award due to the city's "significant contributions and distinguished leadership" to the nation in floodplain management (City of Tulsa, 2002).

Analysis of what Tulsa has Done

Tulsa's flood program has proven effective in reducing flood damage and the creation of public amenities. One of the keys to Tulsa's system was the floodplain clearance program that removed houses in the floodplain that have had repeated flood damage claims. This is an example of the permaculture principle 'accepting feedback and applying self-regulation.' A floodplain clearance program could also be useful in New Orleans. It is important to recognize areas that repeatedly experience flood damage and take steps to remove infrastructure and property that is easily damaged. It is important to recognize and respond to feedback, which is flooding in this example, and recognize that these repeatedly flooded areas can be utilized in a manner much more useful to New Orleanians.

Tulsa also 'uses the edges and values the marginal.' This principle can be seen as the city applies regulations to all new developments in the watershed and attempts to restore upstream flood plains. The city is not just focusing on its core or the areas that experience the most flooding but is even looking at new developments on the edges of the watershed and floodplains upstream. This illustrates an understanding that what happens on the edges still has a major influence on what happens in more central areas of the watershed. This permaculture principle also applies to New Orleans, and this was the reason why Deep Roots identified the major watershed within New Orleans as the study area rather than the City boundary. It is important for New Orleans to recognize, as Tulsa has, that the focus has to be on the entire watershed where the stormwater is generated and not just on the areas that repeatedly flood.

The third success of the Tulsa flood mitigation program has been its use of the floodplain land. Instead of letting the floodplain land sit idle or serve simply as wildlife habitat, Tulsa has implemented program elements that take advantage of the available land in a way that does not compromise its value in flood control. The Tulsa program includes a series of trails and bike paths along its maintenance canals and as well as soccer and recreation field in dry detention basins. These features add value to Tulsa's flood mitigation program beyond flood control. It is an example of the permaculture principle of 'obtaining a yield.' To be able to convince the public that using space in New Orleans for flood mitigation is worthwhile, it is important that the spaces can benefit the everyday lives of residents rather than just providing disaster control.

Taipei, Taiwan

Why Taipei?

The Guandu Plain is the landform that contains the city of Taipei, Taiwan at the confluence of the Danshui and Keelong Rivers. The first generation of the city of Taipei depended on the natural resources provided by the rivers and the plain. Fishing and rice farming were the major activities of the community and both responded the natural fluctuations in water level (Casagrande, 2009). The second generation of the city was industrial. The rivers quickly became filled with industrial waste and sewage and the river repeatedly flooded, forcing the city to put up a floodwall system. This evolution of the city is similar to what has happened to New Orleans. New Orleans was founded as a portage between the Mississippi River and Lake Pontchartrain and has now grown to a city of over one million people (Colten, 2005). New Orleans, as with Taipei, has had to construct a extensive series of levees as the City extended from the ridges along the Mississippi River and Lake Pontchartrain and into the surrounding wetlands. To apply new ideas to these issues Sustainable Global Technologies (SGT) along with the United Nation's UN-HABITAT program has identified the Guandu Plain as an ideal location for a river urbanism UN-HABITAT location (Casagrande, 2009).

What Taipei has Done

The Taipei example is a proposed design. The proposed Guandu River is to be a man-made river created using water diverted from the highly polluted Keelong River. The river is intended to bring clean water to future residents by creating a five mile stretch of river with a biological filter that includes different layers of vegetation and filtering layers. The proposed new stretch of river will also features a recreational area and holiday village. The Guandu River plan for Taipei calls for the Taipei-Danshui Highway to be moved to an underground tunnel in order to create a larger unified ecological space. Urban farms and community gardens are to be encouraged in all areas of the urban environment and biomass production is encouraged along flood banks and in the Guandu Plain and are shown in the rendering in Figure 3.1. The built environment is based on the concept of free flooding. Built areas are elevated on ten meter high landfill islands using material from the river and highway tunnel constructions and housing is intended to be floating. The path of the newly created Guandu River is to be determined by river engineers and not by urban planners (Casagrande, 2009).

Analysis of what Taipei has Done

There are many ideas created for the ambitious Guandu River Plan that can be applied to the site in New Orleans though these ideas must be tempered because the project, unlike the other precedent studies, has not proven its effectiveness. Nevertheless, there are ideas here that adhere to Holmgren's principles of permaculture design and also seek to solve many of the same issues that New Orleans faces. The focus on urban farming and biomass for the sake of bioenergy clearly is an example of obtaining a yield, making sure the

Figure 3.1 Urban Farming

land used for flood control also reaps more immediate benefits to residents. Additionally, Guandu River also actively and creatively responds to change as shown by the elevated built area and floating housing as a response to flooding. Figure 3.2 includes people utilizing a floating walkway system used to connect various parts of the City. This is an example of not trying to battle the forces of nature to eliminate flooding, but rather building with flooding in mind.

The Guandu River project also uses and values renewable resources and services. The plan employs a biological filter of vegetation layers to clean polluted river water so that it requires less treatment and also so that it can be used for recreation. Another key to the design is that the path of the newly created river was designed by river engineers and not city planners. Also the urban planning is intended to respond to the hydrologic conditions and not the other way around (Casagrande, 2009). This clearly shows that the designers have the patience to 'observe and interact' and 'design from patterns to details;' letting the river function naturally and then designing the built environment around these natural functions. Using the material from the construction of the highway tunnel and river to create elevated islands is a creative way to 'produce no waste.'

Figure 3.2 River City Guandu

Portland, Oregon

Why Portland?

Portland is an urban area with a population roughly twice that of New Orleans and again a population density roughly twice as high as New Orleans' (American FactFinder, 2010). Portland has a major river running through the center of the city (the Willamette River) and issues involving the quality of runoff flowing into the river have been of major concern, much like in New Orleans. Among American cities Portland is considered to be one of the "greenest" and can serve as a model of how New Orleans can build and design initiatives that have been proven to work not just in a major urban area but a major urban area with similar concerns as to how to match new plans with the American culture.

What Portland has Done

One of Portland's many recent initiatives is the Grey to Green Initiative. This plan, which focuses on improving the health of the Willamette River, began in July of 2008 and Portland has committed to investing $50 million over a five year period. The stated goals of the project involve adding forty-three acres of ecoroofs to the city, planting 83,000 trees, restoring native vegetation and controlling the spread of invasive plants, replacing culverts that block fish passage, constructing 920 green street facilities (individual vegetated basins used to manage stormwater runoff from the street), and purchasing and protecting 419 acres of high priority natural areas within the watershed (City of Portland Bureau of Environmental Services, 2010).

The green street portion of the Grey to Green Initiative deals with the stormwater runoff from city streets. To alleviate the runoff Portland installed vegetated curb extensions, street planters with curb cuts, and infiltration basins that collect stormwater from streets and rooftops. Figures 3.3 and 3.4 provide examples of permeable detention basins collecting stormwater runoff from gutters and off city streets. These program elements reduce the amount of stormwater that reaches the sewer system, reduce the pollution and sediment that reach urban streams, provide wildlife habitat and neighborhood green spaces, and replenish groundwater supplies (City of Portland Bureau of Environmental Services, 2010).

Figure 3.3 Portland Gutter Detention Basin

Figure 3.4 Portland Permeable Street Planters

These street improvements from the Grey to Green Initiative have met with some success. The Portland Development Commission has built seven hundred of the nine hundred and twenty green street facilities it plans on building by the fifth year of the Initiative. These seven hundred green streets cumulatively manage an estimated 48 million gallons of stormwater runoff a year, sixty-two percent of which is located in the combined sewer area of Portland (City of Portland Bureau of Environmental Services, 2010).

Analysis of what Portland has Done

There was not one single component of the Grey to Green Initiative that on its own would greatly improve the condition of the Willamette River, but collectively they have had significant benefits with each acre of protected watershed, each newly planted tree, each green street, and each ecoroof playing a small role. The Initiative provided a number of potential program elements for the Deep Roots Project.

The Grey to Green Initiative is an excellent example of the principle of employing 'small and slow solutions.' Each small solution leads to decreases in the amount of stormwater that reaches the Willamette River and makes a small improvement to the quality of the water. The benefit of such a system is that it is not subject to massive failure such as New Orleans' levee and pump system. If a component of the levee system fails it leads to large scale flooding but if a component of Portland Grey to Green Initiative fails it has minor consequences.

These street improvements are potentially important to New Orleans. If New Orleans could remove or cleanse 48 million gallons of stormwater very close to the place it fell it would remove pressure on its antiquated water treatment system and also remove stormwater from the system before it began to fill the bowl that is New Orleans' topography (Colten, 2000). At the same time the green street facilities in Portland provide habitat for the City's wildlife and give the City a unique character. The same can be done in New Orleans; implementing these stormwater treatment elements along the streets of New Orleans can create a greater sense of place in the City as they clean and filter stormwater and provide habitat for wildlife species.

Seoul, South Korea

Why Seoul?

Cheonggyecheon is a six kilometer long recreational space in downtown Seoul, Korea that is centered on the Cheonggyecheon Creek. The Cheonggyecheon Creek, shown in Figure 3.5, was daylighted after being covered by concrete since 1958. The covering of the creek with an elevated highway was considered to be a triumph of industrialization and modernization for Seoul and also removed what had become an aesthetic detriment to the City as people threw trash and waste into the creek and shanty houses lined it following the Korean War (Stein, 2009). What Seoul has done is a useful case study for New Orleans as it is an impressive and successful ecological waterway restoration project done in the downtown area of a major world city.

What Seoul has Done

The Cheonggyecheon Creek restoration project cost roughly $384 million and is still far from a completely natural area. The water flows through seven miles of pipe in order to get to the open stretch of creek and when it gets there it is still contained by mostly concrete banks. That being said, most observers still view the project as a major urban ecosystem success. The number of fish species in Cheonggyecheon Creek increased from four to twenty-five, the number of bird species from six to thirty-six, and the number of insect species from fifteen to one-hundred and ninety-two (Stein, 2009). With the traffic removed along with the elevated highway, the

Figure 3.5 Cheonggyecheon Stream During the Day

small-particle air pollution also dropped from seventy-four micrograms per cubic meter to forty-eight and air temperatures in nearby areas are now often five degrees Fahrenheit cooler during the summer (Stein, 2009). In addition to the ecological advances, the Cheonggyecheon area is also visited by 90,000 pedestrians during the average day and has become a catalyst for the revitalization of downtown Seoul (Stein, 2009).

Analysis of what Cheonggyecheon has done

The Cheonggyecheon Creek restoration has been a major economic and environmental success for Seoul and a similar project in New Orleans can have similar results. The area is a perfect example of valuing and using diversity as shown by the number of different fish, bird, and insect species that have returned to the area. Louisiana contains twenty-five percent of the United States' wetlands, and over half of the wetlands have been loss to subsidence, wave erosion, saltwater intrusion, hurricanes and tropical storms, agricultural conversions, freshwater flow restrictions, and canal and levee construction (Coreil, 2004). Attempts to restore these wetlands, even in only partially natural forms in the urban environment, can provide additional habitat for fish, bird, insect, and even some mammal species from these disappearing habitats.

Cheonggyecheon Creek also shows a strong attempt to integrate rather than segregate, bringing 90,000 people per day to the river banks instead of separating the people from rivers like many cities such as New Orleans do. The popularity of Cheonggyecheon Creek can be seen in Figure 3.6. This is also a valuable idea for New Orleans. New Orleanians have long had a justifiably mixed relationship with the Mississippi River. Creating spaces where they can safely interact with or even observe waterways can provide a new class of urban attractions for the over 1 million people who live in New Orleans (Colten, 2004).

The project is also a fine example of using natural services. The creek cools the surrounding area during summer, a useful service in Seoul where the average August high is a humid eight-five degrees (Stein, 2009). These services would also be valuable for New Orleans, where the August high is ninety-one degrees (NOAA, 2010). Until a program is fully in place and long term trends can be observed it would be very difficult to accurately predict the exact benefits of recreating

Figure 3.6 Beginning of Cheonggyecheon Stream at Night

natural systems in New Orleans but there will likely be positive benefits such as the reduction in the heat island effect, carbon sequestration, improvements in air and water quality, and improved wildlife habitat in addition to flood control benefits.

Houston, Texas

Why Houston

Houston faces flooding threats similar to those faced by New Orleans. The urbanization within the Houston watersheds has altered the natural hydrologic system, resulting in greatly reduced permeability and storage capacity of the soil and in a quicker concentration of the water stored in the drainage channels of the City. The runoff from the city of Houston is diverted to a bayou system or to a number of reservoirs in the City. The entire Brays Bayou Federal Project will be completed in Houston around 2012. The plan will reduce flood elevations along the Brays Bayou by up to six and a half feet in a twenty-five year storm and four and a half feet in a one-hundred year storm. The plan also will bring the number of houses in the one-hundred year floodplain down from 30,000 to 1,700. The total cost of the project is projected to be $437 million and is expected to reduce flood damages by $98 million annually (Rice University, 2010).

What Houston has Done

Since the original City Plan for Houston in 1912, people have talked about making the City's bayous into linear parks, but it was not until the 1970's that the plans for the bayous began to take form. Greens Bayou Corridor Coalition has developed a strategic plan for the corridor, which sets aside a forty-five mile stretch of land as a natural refuge with hiking trails, water trails, parks, and open spaces. The strategic plan focuses on the acquisition of adjacent open space, conservation and landscaping to help communities preserve their local resources, the protection of river resources, the development of new trails, and the creation of new natural areas. A grant from the National Park Service will also provide technical assistance in linking existing trails and recreational facilities with new trail sections and parks (Roddy, 2009).

The 1.2 mile long Buffalo Bayou Promenade was a missing link in the development of the City's bayous, connecting Houston's downtown to the river park to the west under and through a confusing mess of freeways and bridges, adding twenty-three acres of parkland to Houston's inner city. The Buffalo Bayou Promenade, pictured in Figure 3.7, converted the area from a trash-soaked eyesore, intimidating to pedestrians and detrimental to flood control efforts, into 3,000 linear feet of urban park that provides a prominent gateway to downtown Houston celebrating both the natural and urban context of the site (ASLA, 2009).

Traditionally, development had turned its back to Houston's bayou system. The freeways that crisscross Buffalo Bayou, shown in Figure 3.8, block out sunlight and spill concentrated sheets of water off their sides during rain storms. The waters of the bayou also bring with them trash and silt that are constantly being deposited along the bank. Pedestrians who venture into this area of the bayou are more than thirty feet below the grade of surrounding streets, out of view and with few access points. Excessively steep banks are subjected to severe erosion. Invasive plantings were overgrown and created unsafe walking conditions for pedestrians. Recognizing these challenges, the design team employed a number of


Figure 3.7 Buffalo Bayou and Houston Skyline


Figure 3.8 Overhead View of Bayou Under Highways

site specific design solutions to make a successful pedestrian environment (ASLA, 2009).

Extensive re-grading of the site enabled the team to lay back slopes, helping to improve views into the park while also reducing the impact of erosion and improving flood water conveyance. A system of stairs and ramps connect provide safe, convenient and frequent access opportunities. LED lights incorporated into stairway railings wash the ground plane, offering an urban atmosphere that contrasts with the abundant green plantings along the bayou. Commissioned artwork, poetic interpretations of canoe frames, frame each park portal providing visitors a symbolic link between the city's arts district and its historic channel (ASLA, 2009).

The landscape architect balanced the stark, urban infrastructure with the bayou's sinuous forms. Exposed concrete, recycled crushed concrete, and galvanized steel were all employed for their durability, cost effectiveness, and contextual relevance. Special attention was paid to the design of railings, walls, walks, and signage so that they would be able to withstand degradation due to potential erosion and water borne debris. Recycled concrete cobble-lined swales were placed to absorb the destructive, high volume flows of water pouring from the surface of the freeways (ASLA, 2009).

Because Buffalo Bayou is the principal drainage system for much of Houston, the waterway and its banks had to be treated with special care. By removing invasive monocultures and installing a large variety of native, flood-resistant riparian vegetation and trees, the wildlife habitat in the area was greatly improved. Groves of native trees were used to soften the stark urban infrastructure, buffer noise, mitigate the scale of the freeways, and create a shade canopy over the water which helps to cool the water and improve habitat conditions as illustrated in Figure 3.9. Areas under existing trees and freeway structures and along banks were planted with robust native plants to provide a lush, green groundcover that would resist erosion and be easily maintained. The gabion cages utilized over 14,000 tons of recycled crushed concrete. The open gabion cages also allow tree roots and riparian ground covers to form a natural edge while providing a porous foundation for the riparian community (ASLA, 2009).

Figure 3.9 Boating on Buffalo Bayou

The success of the park was in large part to be measured by its ability to function as a safe pedestrian environment at night. The primary trail lighting poles were placed at a relatively close spacing to offer pedestrians a strong visual rhythm along the trail and to give a clear indication of where path would lead through the maze of heavy infrastructure as shown in Figure 3.10. Lights were also used to carefully illuminate the dark urban corners under bridges and behind walls to alleviate safety concerns; if you light the places that feel dangerous and where someone might be lurking you don’t need to wash the whole site with light. This makes the trail environment feel safe, with a highly directed use of site lighting (ASLA, 2009).

Signage was designed to highlight the history of the waterway and the city of Houston as well as to assist wayfinding. The design celebrates historical infrastructure like the concrete foundations of Houston’s first civic center while educating pedestrians about flood-resistant native plants. Used by pedestrians, bikers, and boaters and enjoyed by drivers on overhead freeways, thousands of Houstonians are again becoming familiar with this once polluted waterway. In a region searching for more park space, the Promenade offers twenty-three acres of parkland to thousands of Houstonians in the heart of the city. The project also physically and visually augments several other downtown revitalization efforts focused on improving Houston’s quality of life (ASLA, 2009).

Figure 3.10 Lighting Under Interchange

Analysis of What Houston has Done

Houston, Texas provides a solid precedent that uses natural features in a way that allows them to continue to perform as drainage ways and provide additional to residents. The bayous in Houston are examples of two separate permaculture principles: 'actively respond to change' and 'integrate rather than segregate.' The bayous allow for fluctuating water levels, actively responding to change in their environment. Their natural edges with native plantings resist flood damage, emulate nature, and allow the spaces to function whether water levels are high or low. Though the natural waterways that flowed through New Orleans besides the Mississippi River have long been removed or diverted, the canals dug in New Orleans to drain the land cover the City much like Houston's bayous and could potentially serve a similar purpose (Colten, 2004).

The interconnected pedestrian and bicycle trail system, pictured in Figure 3.11, in Houston along the bayous is another feature valuable in its applicability to New Orleans. New Orleans is completely urbanized with little available open space. The land along the canals represents a way to increase walking and cycling in the City. These paths can provide a great way to provide safe open spaces connections to residents.

Figure 3.11 Cycling Along the Buffalo Bayou

Section Four:

4

Program Elements

Introduction

The potential program elements for the Deep Roots Project stem from precedent studies, site visits, and permaculture readings. The goal in selecting potential program elements was not to find one grand solution that solves all of New Orleans' problems but rather to utilize a variety of the solutions that have proven to be effective and that are being implemented around the world.

Potential program elements were analyzed to determine whether they match project goals. Each elements was chosen for its ability to further the goals of the Deep Roots Project. These goals include mitigating the threat of floods within New Orleans, creating benefits to local residents and visitors, and enhancing the character of the City. Potential program elements also had to be able to provide their advantages within the urban fabric of New Orleans and adhere to Holmgren's twelve permaculture principles (principles defined in Appendix A).

The potential program elements listed in this section all fulfill one or more of Holmgren's permaculture principles. Additionally, they are able to enhance the ability of the project site to handle flooding and stormwater. These elements may do so by buffering the City from storm surges, detaining water, creating areas that can handle fluctuating water levels, and by increasing the percentage of permeable surfaces allowing water to infiltrate into the soil.

Potential Program Elements

Trails are one program element that could be installed on a variety of different sites. The trails would connect various parts of the City and allow for urbanites to stroll through natural areas within the City. Walking and biking trails would include informative signage that would improve wayfinding, educate users on how natural processes benefit the City, and also provide information on the history of New Orleans. The trail system would also feature boardwalks and bridges in some areas to limit environmental damage and allow usage on consistently wet soils. Trails are common in most if the precedent studies used for the Deep Roots Project, specifically they are utilized in Houston's bayou system and along Tulsa's maintenance channels to connect various parts of the city to available parkland and to provide recreational opportunities. Trails in natural areas can provide access to wetlands where students from all education levels can study natural systems, native plants and animals, and hydrology (Coreil, 2004).

Stormwater can be cleansed within the project site in a manner that does not create human welfare issues. Constructed wetlands for water treatment, as shown in the example in Figure 4.1, have been employed in many regions of the United States and the world. One if the main functions of wetlands worldwide is to conserve and clean water. During floods and storms wetlands hold and slowly distribute water into aquifers and streams, maintaining the resources for human life and activity. Wetland plants absorb excessive amounts of nitrogen and phosphorus and also destroy the bacteria found in human and animal waste. Inorganic nutrients are converted into their organic forms and then settle into the layer of wetland sediment rather than continuing downstream. According to Paul Coreil of the Louisiana State University Agricultural Center, these services save communities thousands of dollars per acre per year and provide sediment-free water that can be efficiently treated for home and industrial use (Coreil, 2004).

Parks that recreate the mosaic of ecosystems that formerly existed in New Orleans can also be recreated within the Deep Roots study area. Wildlife habitat is enhanced when these native plant hierarchies are recreated in areas that were formerly residential neighborhoods, industrial parks, or commercial centers. Wetlands, wooded swamps, wet meadows, and bottomland forest are the primary habitats of a wide variety of mammals, fish, amphibians, insects, and a great number of migrating wildfowl including rare, threatened, and endangered species. With the disappearance of suitable habitats there is less area for migrating birds to find appropriate sites (Coreil, 2004). Replacing areas of the built environment with natural habitats can also greatly reduce the monetary cost of the damage caused by flood events. Tulsa has successfully removed buildings from surrounding floodplains through their floodplain clearance program which focused on removing properties with multiple flood-related insurance claims.

Figure 4.1 Example of a Constructed Wetland

Selective logging can also be done sustainably in forested areas of New Orleans. Selective logging can be undertaken within native ecosystems such as hardwood bottomland forest and wooded swamp. Permaculture literature advocates agroforestry as a way to obtain a yield from marginal areas. By removing less desirable trees (either economically or environmentally less desirable) for use as lumber or fuel, the stand of trees increases in value over time (Holmgren, 2002). Figure 4.2 on the following page shows lumber being harvested using horses or mules. Using animals rather than heavy equipment reduces impact on the forest and may also be necessary in New Orleans forests because wet soils may limit the use of heavy machinery. Safety procedures would be implemented logging in public areas to ensure that people would stay out of areas while the logging occurred.

Fishing is allowed in several of the wildlife refuges just outside of New Orleans and represents one way to make wildlife refuges beneficial to New Orleanians. Anglers in Louisiana spent $670 million for equipment and licenses plus trip-related purchases of gasoline, bait, food, and leases in


Figure 4.2 Example of Selective Logging Using Draft Animals


Figure 4.3 Fishing in Louisiana

2001 (Coreil, 2004). Anglers also create jobs for charter boat operators and guides as well as generating income for owners of hotels, marinas, camps, and equipment shops. Similar to selective logging, regulations on the number and size of fish taken can be used to control populations of certain species and increase the quality of the fishery (Coreil, 2004). Figure 4.3 shows a typical fishing scene in Louisiana.

Aquaculture is already practiced in the areas surrounding New Orleans, often in man-made floodable areas that support crayfish, catfish, and rice growing. Certain crops such as rice can be grown in areas subject to periodic flooding and can also provide local foods sources for New Orleans. These local foods can be made available to New Orleanians without expensive transport and provide a uniquely New Orleanian product. An example of the crayfish traps used for aquaculture around New Orleans are shown in Figure 4.4

Ball fields can be installed in highly, flood-prone areas as they require very little infrastructure. These ball fields can be used by the community when the water level is low and in times of high water they can provide extra areas for infiltration. Ball fields are a feature of detention basins in Tulsa, OK and would provide a way to bring people to these areas and spark additional use of other site amenities.

Every 2.8 miles of vegetated wetlands bordering a community can reduce a storm surge by about one foot (Coreil, 2004). The shorelines of Lake Pontchartrain and some areas along the Mississippi River, along with the majority of coastal Louisiana, were formerly lined with vegetated

Figure 4.4 Crayfish Aquaculture

wetlands (Wicker, 1980). By lining canals, rivers, and lakes with native wetland plantings New Orleans could once again benefit from these buffering effects on flooding and storm surges. The reintroduction of wetland species to the edge of waterways, replacing the mown grasses and concrete liners along many New Orleans waterways, would also improve the quality of wildlife habitat in the City.

Neighborhood parks are another program element that can be installed in locations throughout the Deep Roots project site. These parks would feature dining areas with picnic tables and areas of mowed grass. The intent is to provide areas where people who live in surrounding neighborhoods (especially in areas with small lots, apartments, or condos) can play with their children, picnic, or host small gatherings while also limiting the use of furniture or other amenities that are subject to damage during floods and maintaining a high percentage of permeable surfaces. These neighborhood parks would provide additional amenities for local residents mirroring those along Houston's Bayou system. Slightly larger pocket parks could even support crowds for parades and outdoor events.

Concrete access points for fishing and small boats are already present along the canals in New Orleans, as displayed in Figures 4.5 and 4.6, and can be enhanced to create easier access to the water. Boating in the canals can be excellent recreation and is also a good way for both residents and tourists to see the city from a different perspective. Connections to the water are important in a city like New Orleans where the levee

Figure 4.5 Canoes Along Canal

Figure 4.6 Concrete Steps Along Canal

system makes it difficult in many places see Lake Pontchartrain and the Mississippi River.

There are potential program elements that focus on removing stormwater from the streets, rooftops, and sidewalks in impermeable urban environments. These elements also focus on enhancing the aesthetic qualities of the area and maintaining the site's usability. Permeable bottomed planters built into sidewalks (as shown in Figure 4.7) and connected to downspouts allow rainwater to infiltrate into the soil rather than runoff and further tax New Orleans' water treatment system. These planters would also enhance outdoor dining and pedestrian experience by improving the sense of separation between the pedestrian environment and automobile traffic and provide a unique sense of place to the city of New Orleans through native plantings. Permeable planters are featured in Portland's Grey to Green Initiative.

Parking lot improvements are another potential program element for the Deep Roots Project. Additional improvements would include the use of permeable and high-abedo paving materials, bioswales, and an increased tree canopy. By implementing these improvements to surface parking lots throughout the City, New Orleans would decrease stormwater runoff, reduce air and water pollution, improve wildlife habitat, and decrease the urban heat island effect. These improvements have been made in many areas of Portland through their Grey to Green Initiative and can be done with minimal changes to the function of these parking lot.

Figure 4.7 Permeable Planter Showing Curb Cut

Green roofs (shown in Figure 4.8) are another potential program element to be considered for implementation in New Orleans. The greatest advantage of green roofs is that they replace impervious roofing material with plants and soils that absorb rain water. The roofs also reduce the urban heat island effect by reducing the radiation of heat off building roofs. The building with the green roof also benefits from lower heating costs due to increased insulation. Green roofs again were a portion of Portland's Grey to Green Initiative (City of Portland Bureau of Environmental Services, 2010).


Figure 4.8 Example of a Green Roof

Section Five:

Inventory and Analysis

Introduction

The role of inventory and analysis in the Deep Roots Project was to identify the sites within New Orleans that would best respond to the application of permaculture principles and maximize the benefit to New Orleanians. The inventory and analysis process for this project resulted in the selection of three specific site types appropriate for the application of a program that responded to the project goals. The three site types identified were large flood-prone spaces, commercial streets, and residential canal corridors.

The site inventory and analysis process began by classifying the land within the Metairie Canal – Canal Number Two Watershed into various site types. Site types were identified by using a decision tree. The decision tree for the Deep Roots Project is shown in Figure 5.1. The landscape features and demographic information used to identify the various site types include the fifty year flood hazard plain, land use codes, landmarks, parks, open space, and population density. The smallest land unit with demographic information and land use information available was census blocks. Therefore utilizing census blocks provided the greatest available detail for the site inventory. Information for New Orleans, whether it is flood hazard information, density, land use code, or specific features was based on these census blocks.

Three site types were identified for further analysis while others were determined to be unsuitable for the application of permaculture principles or unable to assist in the mitigation of flooding hazards within the site. Within each of the three site types one area was selected for conceptual design, these areas are known as highlighted sites.

The highlighted spaces were subject to further inventory and analysis. These three sites were also the subject of a site visit. During the site visit and during further inventory and analysis, specific parts of the sites were measured, circulation patterns were observed, site usage patterns were studied, specific building uses were noted, and other distinguishing site features were identified.

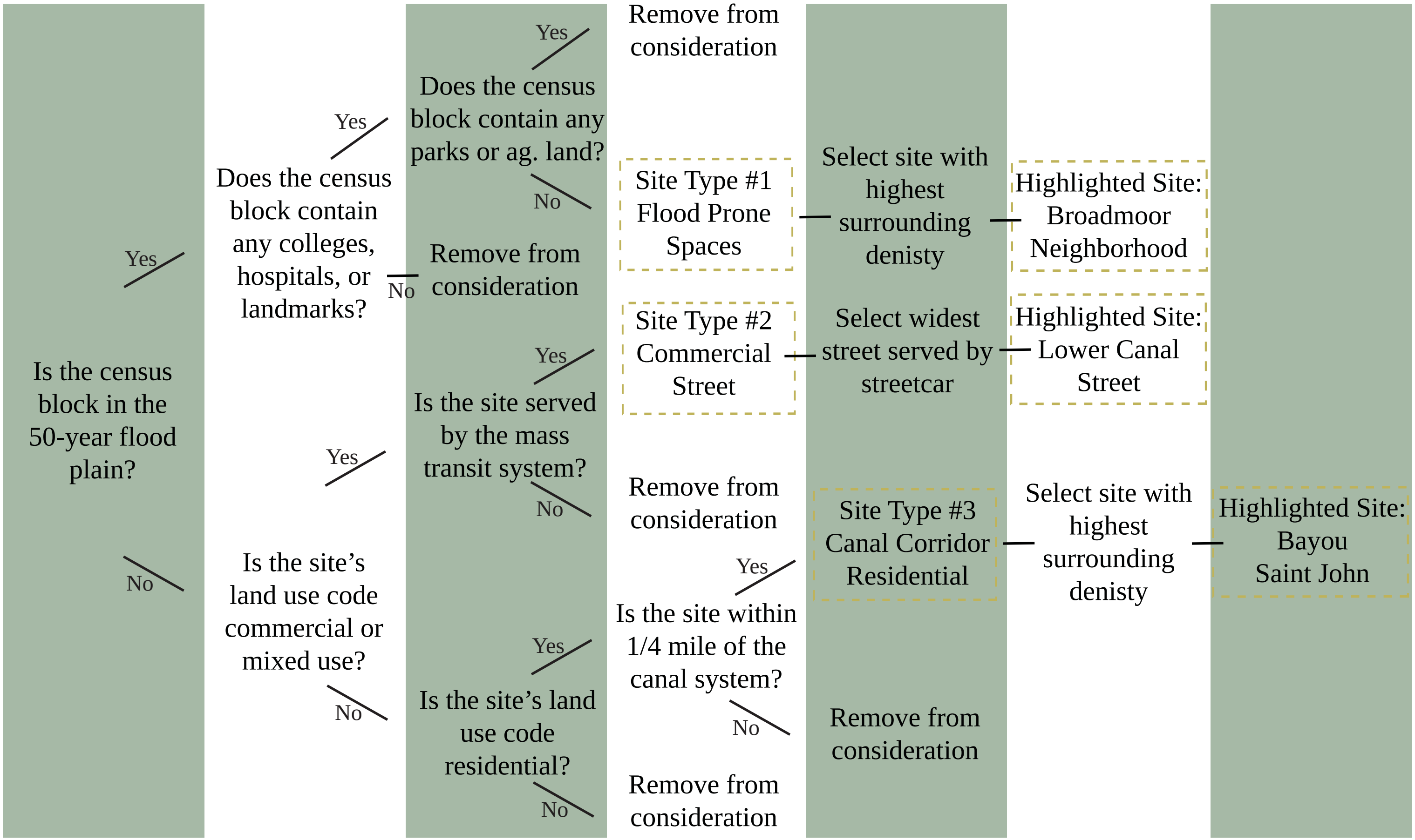


Figure 5.1 Decision Tree for Site Analysis Process

Flood Prone Spaces

The first step of the site analysis and inventory process was to identify areas of the project site within the fifty-year flood plain. The flood hazard map is closely related to the topography map shown in Figure 5.2. In the topography map it is possible to identify the areas of the city with the lowest elevation including the area in the center of the city (mainly located in the Broadmoor neighborhood) where large rain events often cause flooding (Colten, 2005). The map of the fifty-year flood plain is shown in Figure 5.3 on page forty-eight and comes from the Federal Emergency Management Agency (FEMA). The fifty year flood plain map is the shortest interval of flood map available from FEMA. Areas within the fifty-year flood hazard zone represent the areas of the Deep Roots project site that most threatened by repeated flooding. By identifying highly flood-prone areas the Deep Roots Project was able to recognize spaces unsuited for infrastructure and where flood remediation solutions could be effectively implemented.

Within the fifty-year flood plain sites that contained major institutions such as colleges, hospitals, and landmarks were eliminated from further consideration as these institutions are potentially icons of the city, requiring a large outlay of capital to build, and great effort and expense to relocate. The map of the major institutions including colleges, hospitals, and state recognized landmarks within New Orleans are shown in Figure 5.4 on page forty-nine.

Parks, open space, and agricultural land within the fifty-year flood plain were also eliminated from further consideration. Census blocks that contained these land use codes are shown in Figure 5.5 on page fifty. The large park in northern New Orleans is City Park; which is the sixth most visited urban park in the United States and houses a number of amenities such as the New Orleans Museum of Art, three eighteen-hole golf courses, two high school football fields, and the New Orleans Botanical Gardens (Wood, 2008). Parks, open space, and agricultural lands are eliminated from further consideration because they are already largely permeable and contain relatively little infrastructure when compared to the rest of New Orleans. The areas of the site that are in the 50-year flood plain but do not contain landmarks or parkland are shown in Figure 5.6 on page fifty-one. Major city streets are used to form consistent edges rather than jagged shapes in the identified flood prone spaces shown in Figure 5.6.

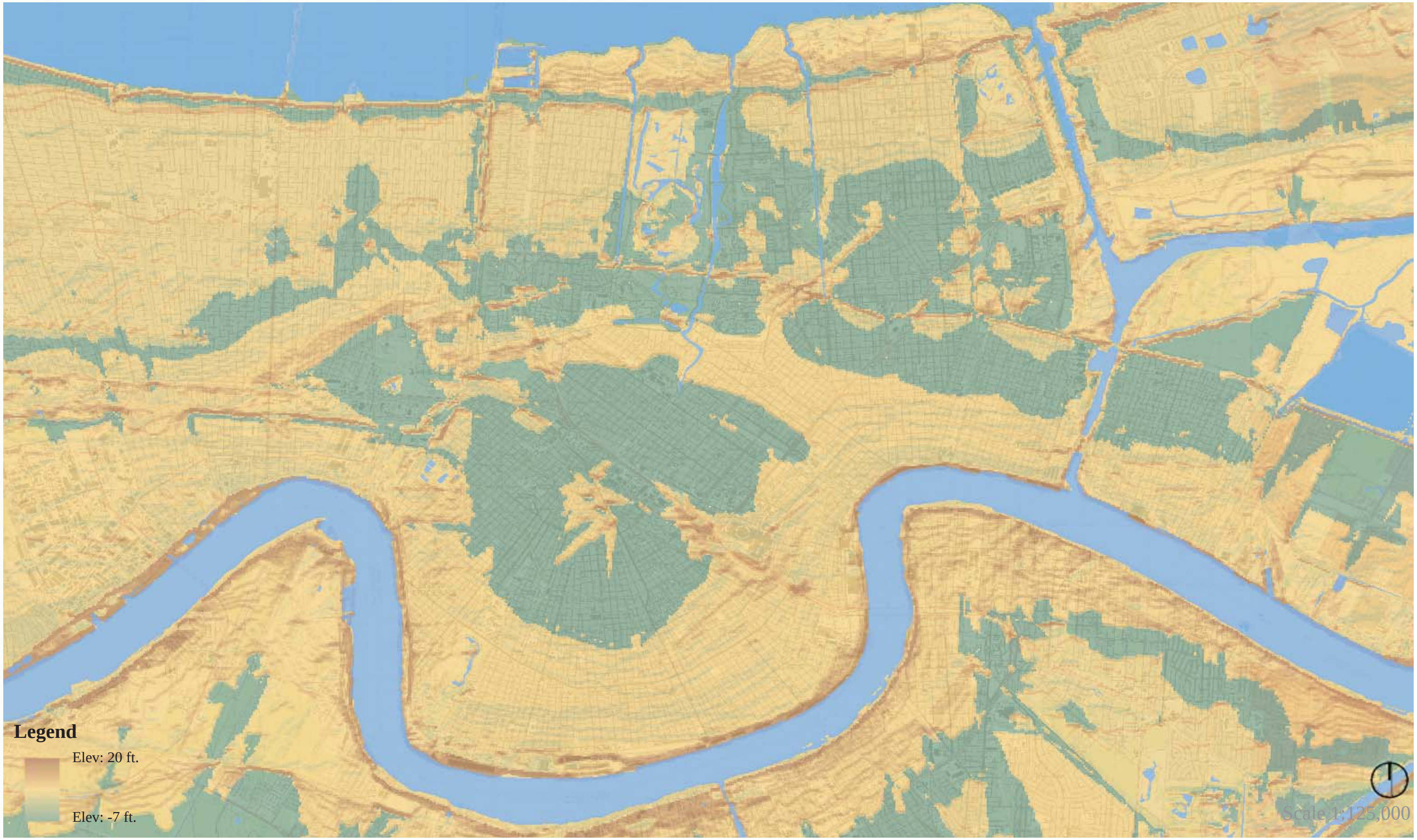


Figure 5.2 New Orleans Topography Map

Figure 5.3 50-year Flood Plain in Project Site

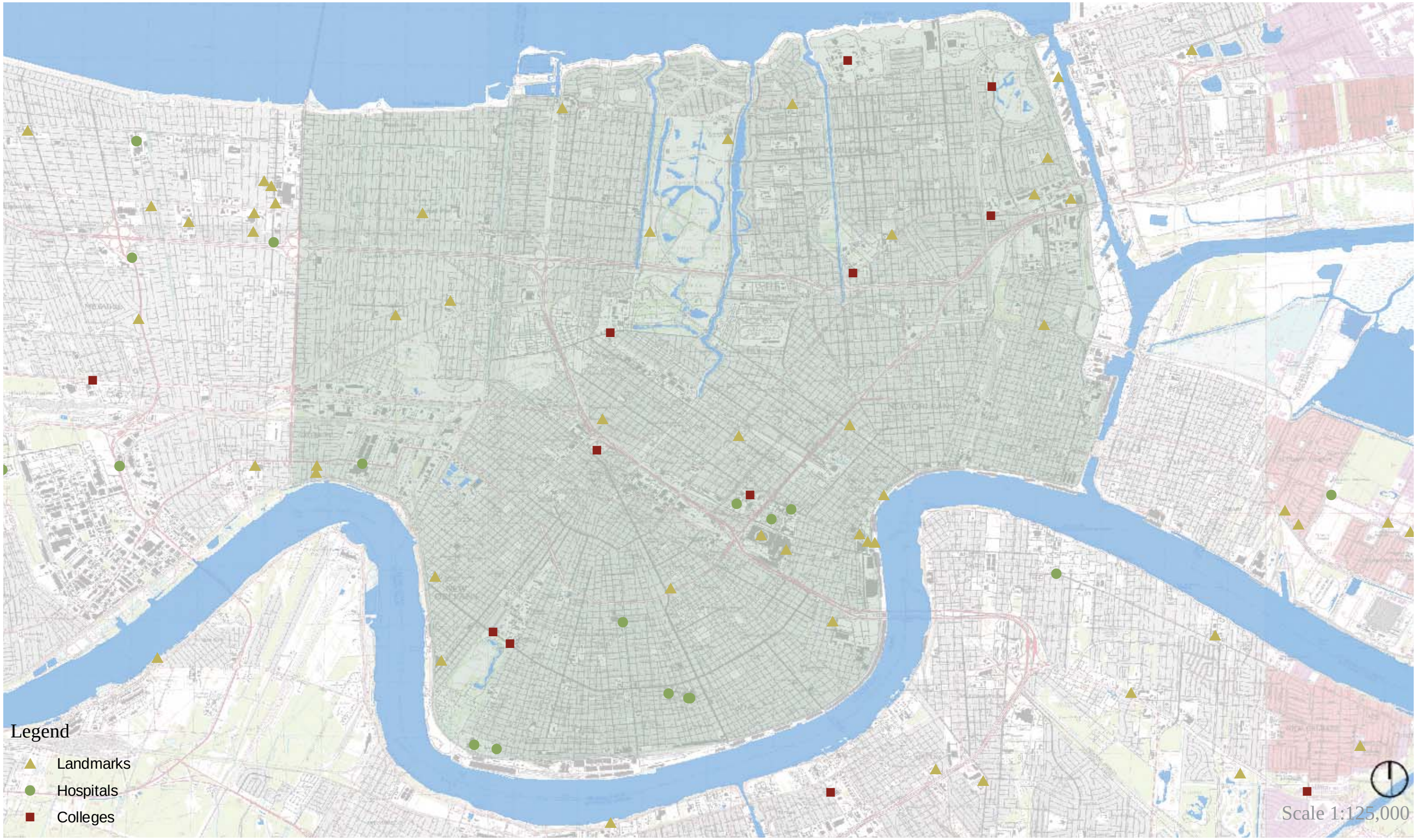


Figure 5.4 New Orleans Landmark Map

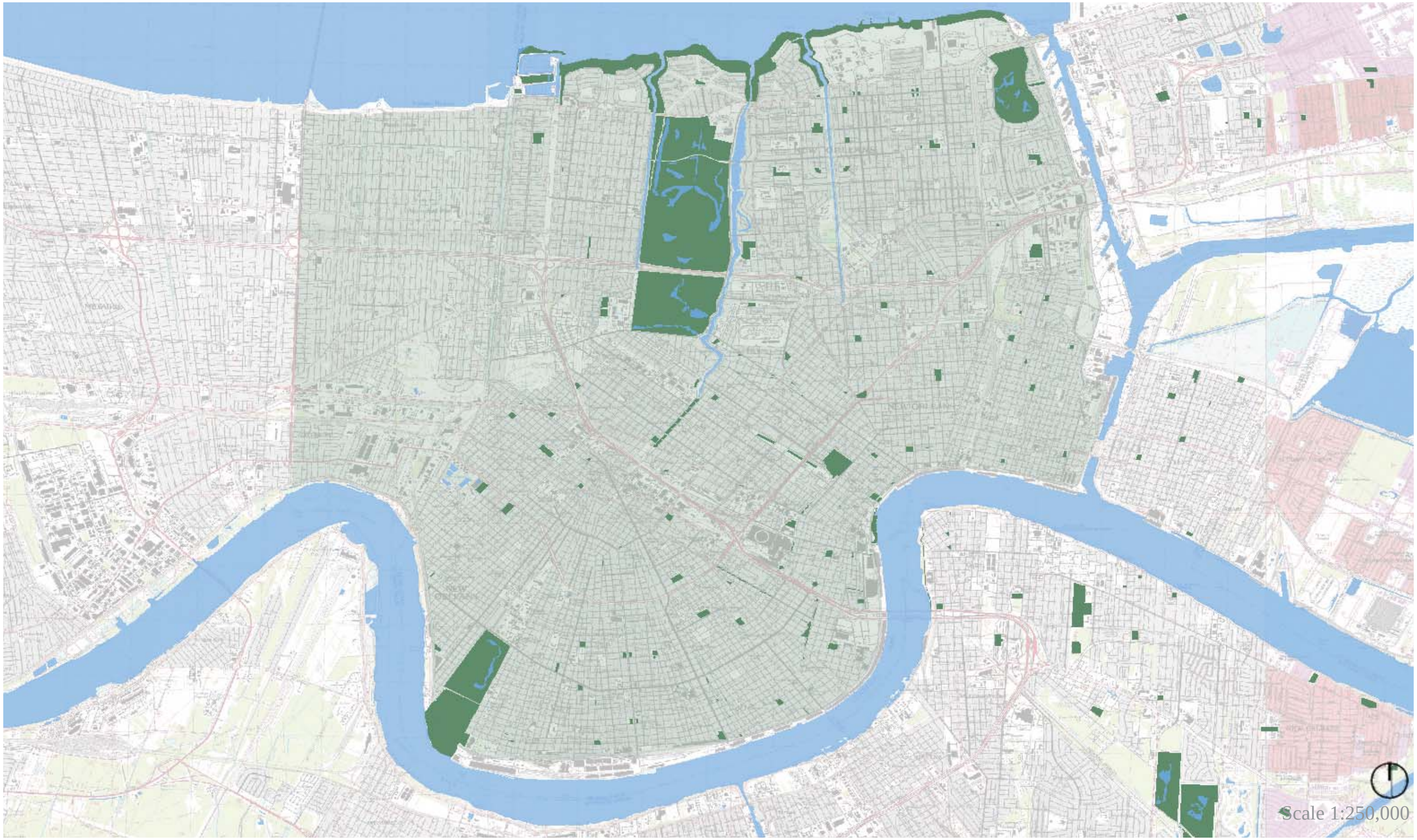


Figure 5.5 Parks and Agricultural Land in New Orleans

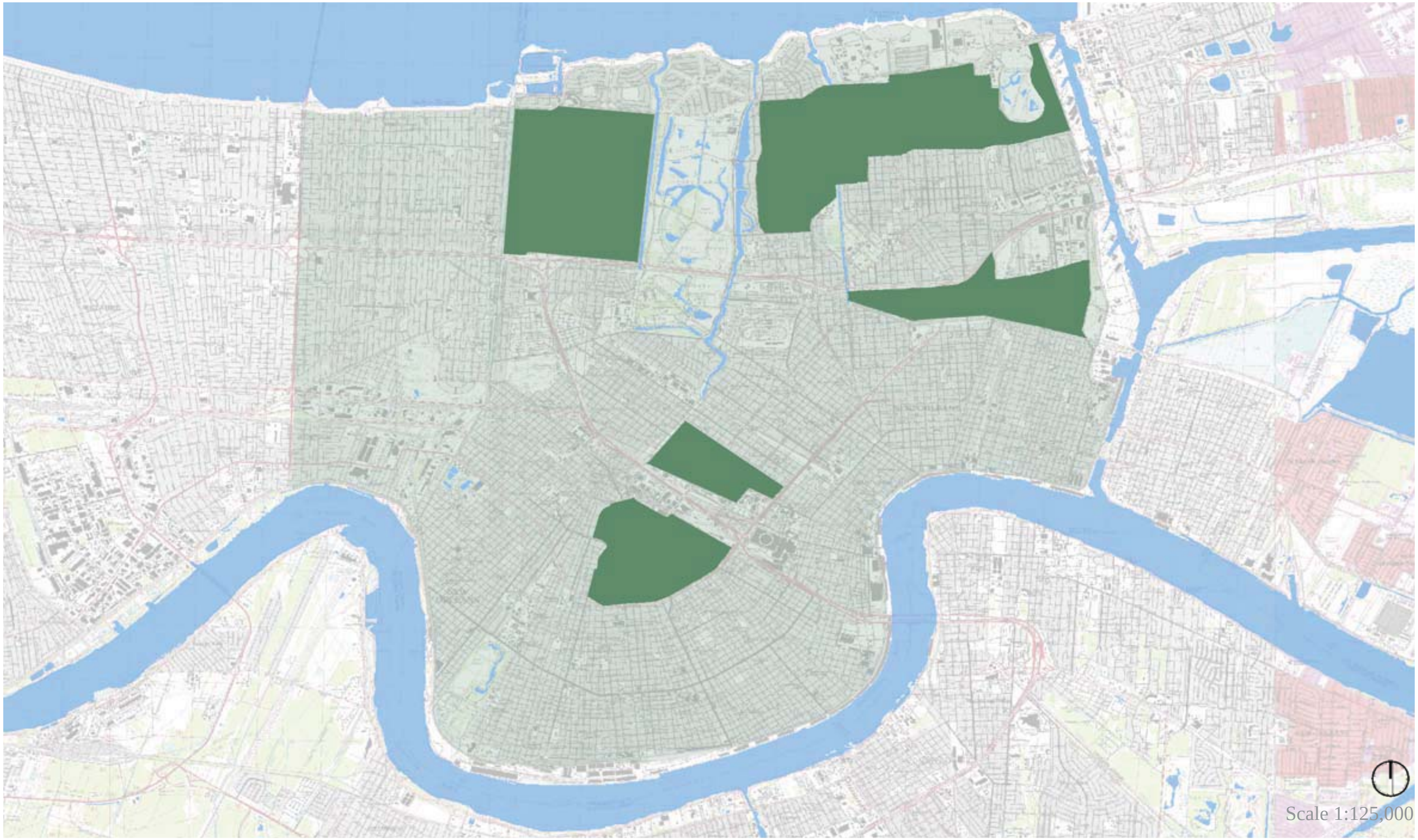


Figure 5.6 Selected Natural Areas Map

Canal Corridor Residential

Next the site analysis and inventory process focused on areas of the City that do not fall within fifty-year flood plain. These sites are not subject to the same flooding threat as areas within the flood plain but are still threatened. By increasing the permeability and natural plantings in areas outside of the fifty-year flood plain there is more area for water to infiltrate into the soil and less stormwater runoff to reach low spots in the topography.

Land use codes were used to identify the land uses of specific census blocks throughout the project site. The majority of New Orleans is composed of residential and commercial areas. Since these land uses comprise such a large area of the city; changes to these categories would have the greatest effect on the rest of the City. Residential sites, shown in Figure 5.7, are scattered throughout the site. If the census blocks had a land use code of residential they were considered for further inventory and analysis. Land use codes other than residential, commercial, and mixed-use were eliminated from consideration for the project.

Residential census blocks within one quarter mile of New Orleans' current canal system were subject to more analysis, those not along the canals were removed from further consideration. The canal system of New Orleans is a series of waterways that are linked to Lake Pontchartrain and the Mississippi River. The canals, shown in Figure 5.8 on page fifty-four are a useful asset for the City; they provide land that can link various parts of the City without having to secure private property and remove infrastructure. Additionally, the canals serve as a system of waterways which remove stormwater from dense residential areas and transport it to detention areas. The one quarter mile distance is used because it represents the distance most people are willing to walk to reach an amenity. Residential areas within one quarter mile of the canals are shown in Figure 5.9 on page fifty-five and represent a corridor along the City canals where improvements can be made to both benefit local residents and reduce the threat of flooding in the City.

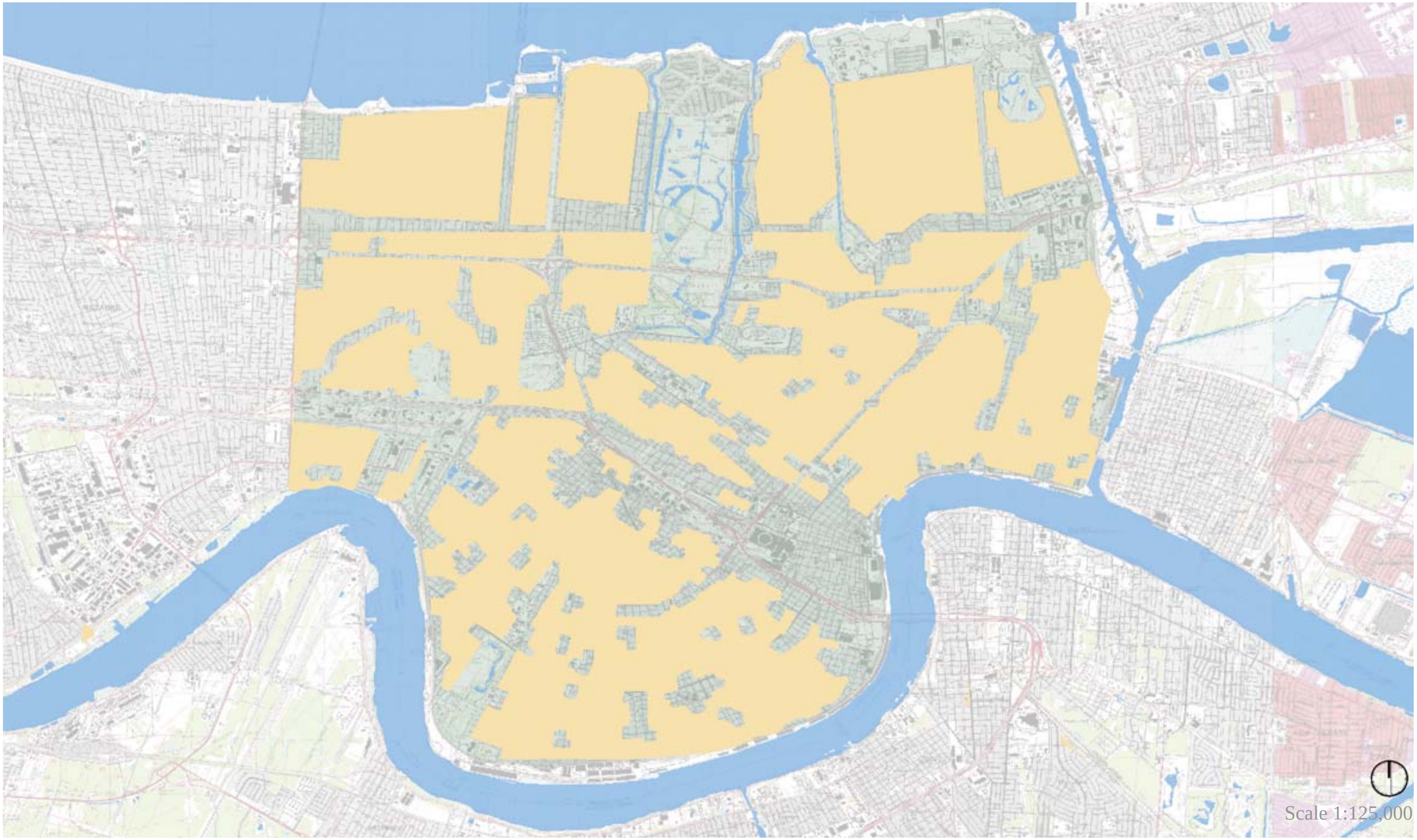


Figure 5.7 New Orleans Residential Areas Map

Figure 5.8 New Orleans Canal System

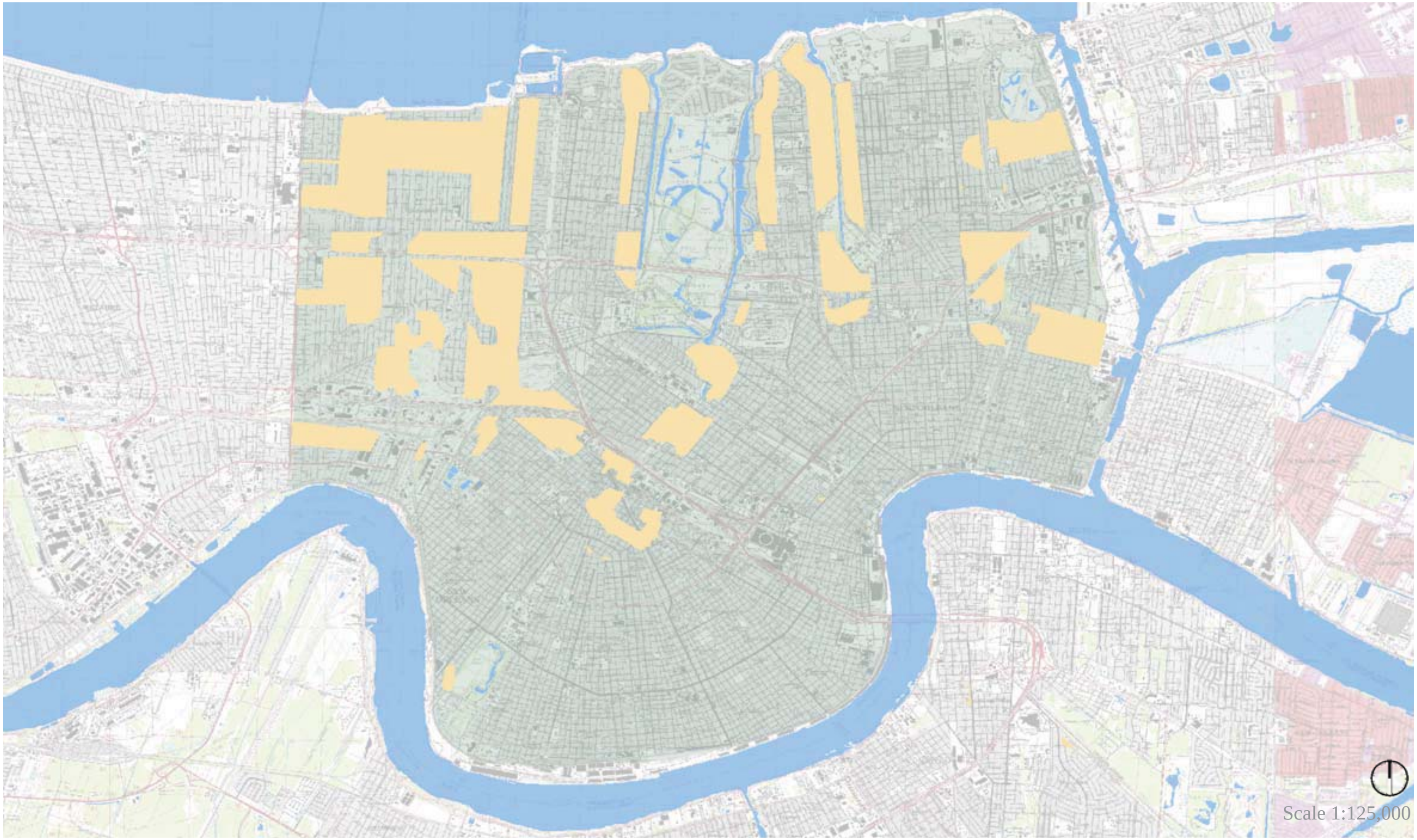


Figure 5.9 Residential Sites 1/4 Mile From Canals

Commercial Streets

The final focus of the site inventory and analysis process were census blocks with a land use code of commercial or mixed-use. Again the intent was to focus on commercial areas in the City that are popular and serve both New Orleans residents and tourists. Commercial sites, shown in Figure 5.10, are found throughout the City though there is a concentration of commercial sites in the French Quarter in the southeast corner of the New Orleans.

Highly visible sites commercial sites are important to the Deep Roots Project because the intent is to reach a large number of potential users so the ideas introduced by the Deep Roots can be spread. Many of the commercial streets in New Orleans are featured in tourist guide books including Canal Street, Magazine Street, St. Charles Street, as well as the streets in the French Quarter. Despite being major tourist destinations, streets such as Canal, St. Charles, and Magazine are also popular with New Orleanians (Wood, 2008).

Commercial streets that are served by New Orleans' mass transit system were selected because these areas would be highly accessible to all New Orleanians (even those without cars) and tourists. A map of New Orleans' transit system routes is illustrated in Figure 5.11 on page fifty-eight. The commercial areas that are within one block of a mass transit route are shown in Figure 5.12 on page fifty-nine. These commercial areas represent a street corridor where street improvements can be made to reduce stormwater runoff.

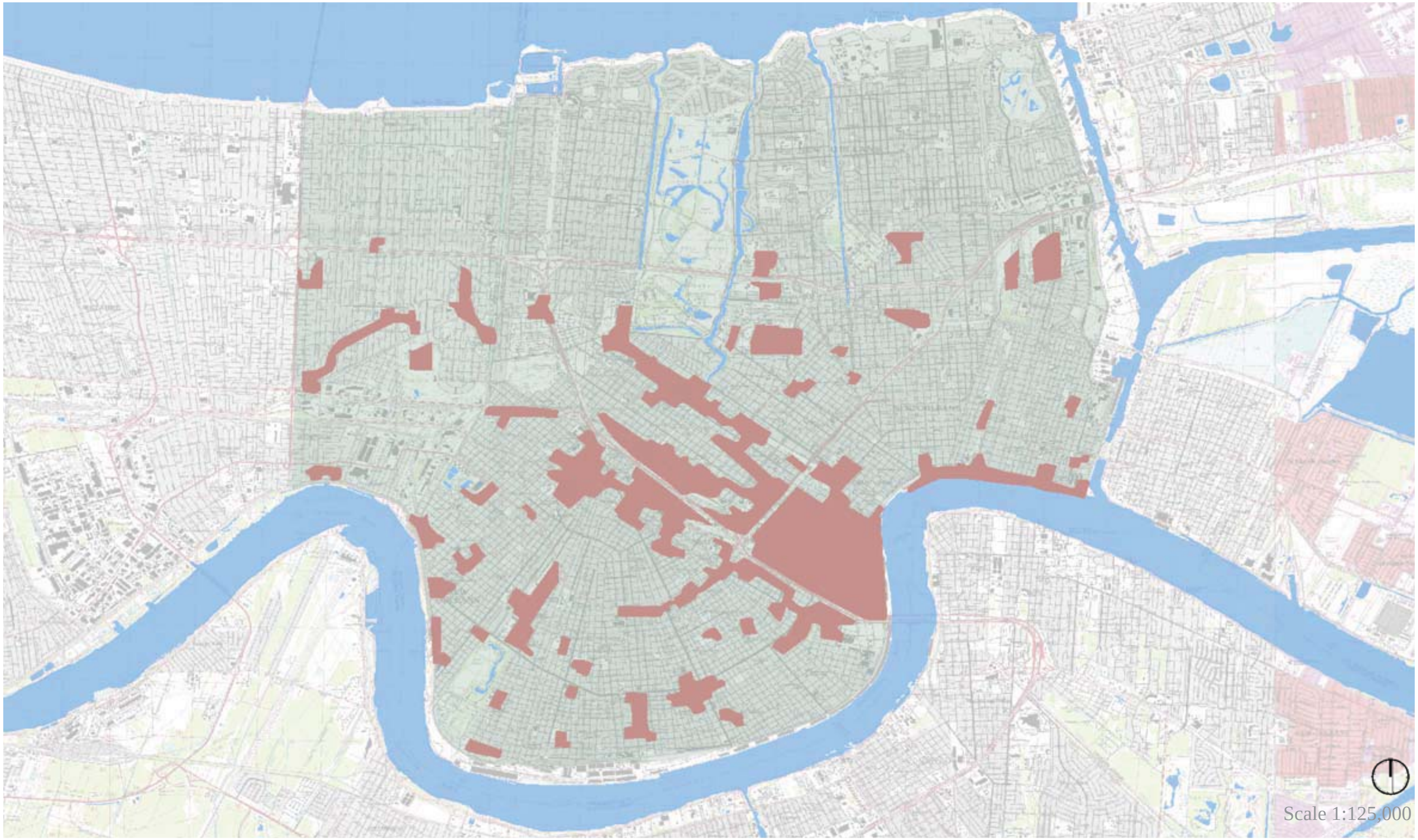


Figure 5.10 New Orleans Commercial Areas Map

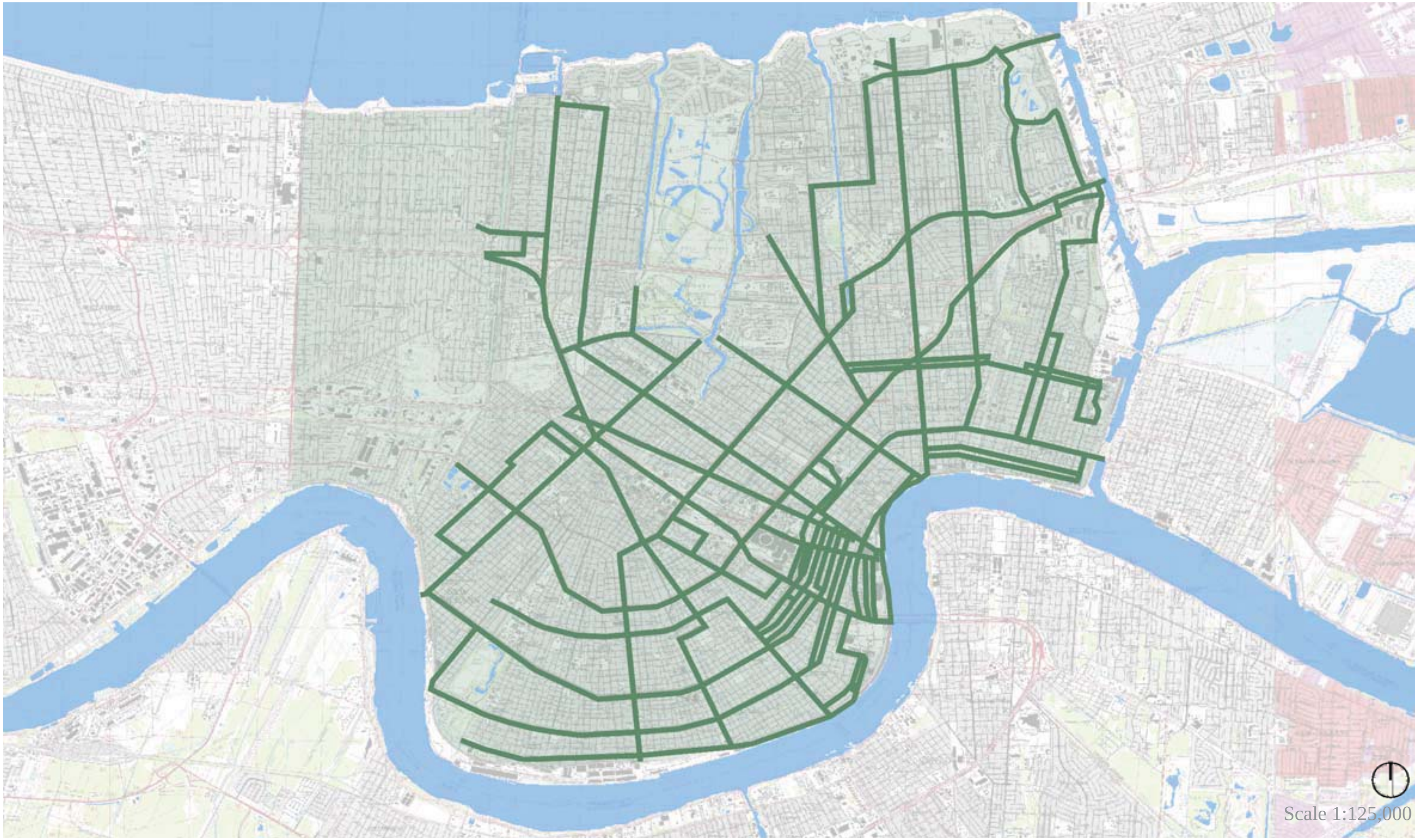


Figure 5.11 New Orleans Mass Transit System Route Map

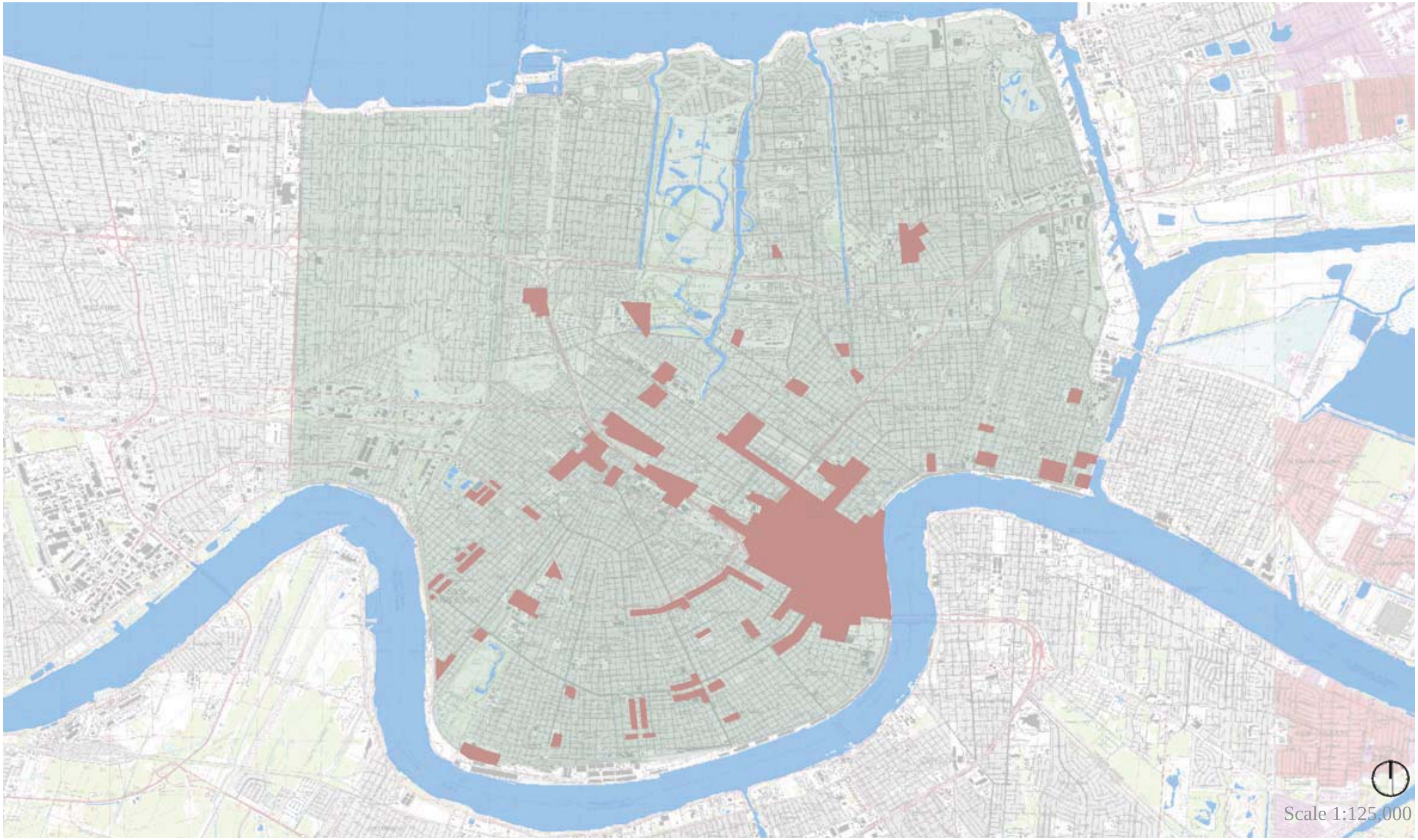


Figure 5.12 Commercial Areas Served by Mass Transit System

Highlighted Sites

The initial site inventory and analysis provided the Deep Roots Project with three site types: flood-prone spaces, canal corridor residential, and commercial streets. The next step was to identify specific sites within each of these three site types for further analysis and conceptual design. Areas within the three site types are considered to be suitable for the introduction of a permaculture-inspired design and the program elements discussed earlier in the Deep Roots Project. However, for the Deep Roots Project it is necessary to put the site types through an additional filter and determine the optimal areas for detailed design. In each case the emphasis, once it was been determined that the site was appropriate for flood mitigation techniques that follow Holmgren's twelve principles of permaculture design, was to select sites that would provide benefit to the greatest number of people and expose a large number of both residents and tourists to the concepts behind the Deep Roots Project.

The flood-prone area to highlight was chosen based on the surrounding density. The density map of New Orleans that was used to determine surrounding density is shown in Figure 5.13. The map shows the population per square mile of each of the census blocks within the project area. The flood-prone space with the greatest population density within one quarter mile was chosen in order to maximize the number of people who could easily reach the park. For the canal corridor residential areas, the site with the highest population density was again chosen to maximize the number of users who would benefit from site improvements along New Orleans' canals. The final highlighted site was chosen among the commercial street deemed suitable for permaculture design. To chose which commercial street to highlight the focus was on commercial streets served by New Orleans' streetcar system rather than just by the bus routes. The streetcar routes are shown in red in Figure 5.14 on page sixty-two. To decide between the multiple commercial streets served by the streetcar, the widest street was chosen. By choosing the widest street the Deep Roots designs were able to implement a full range of permaculture design solutions. The streets served by the New Orleans streetcar will allow residents and visitors see a wide variety of potential solutions and spread the ideas of the Deep Roots Project.

Figure 5.15, 5.16, and 5.17 on page sixty-three show the three highlighted sites selected from the three site types. The highlighted sites include the Broadmoor Neighborhood, Bayou Saint John, and Lower Canal Street. The three highlighted sites represent the areas of New Orleans that are not just suitable for permaculture design solutions that can reduce the flooding threat faced by the City but also maximize potential benefits to residents and increase the chance of Deep Roots ideas spreading.

Figure 5.13 Population Density Map for Project Site

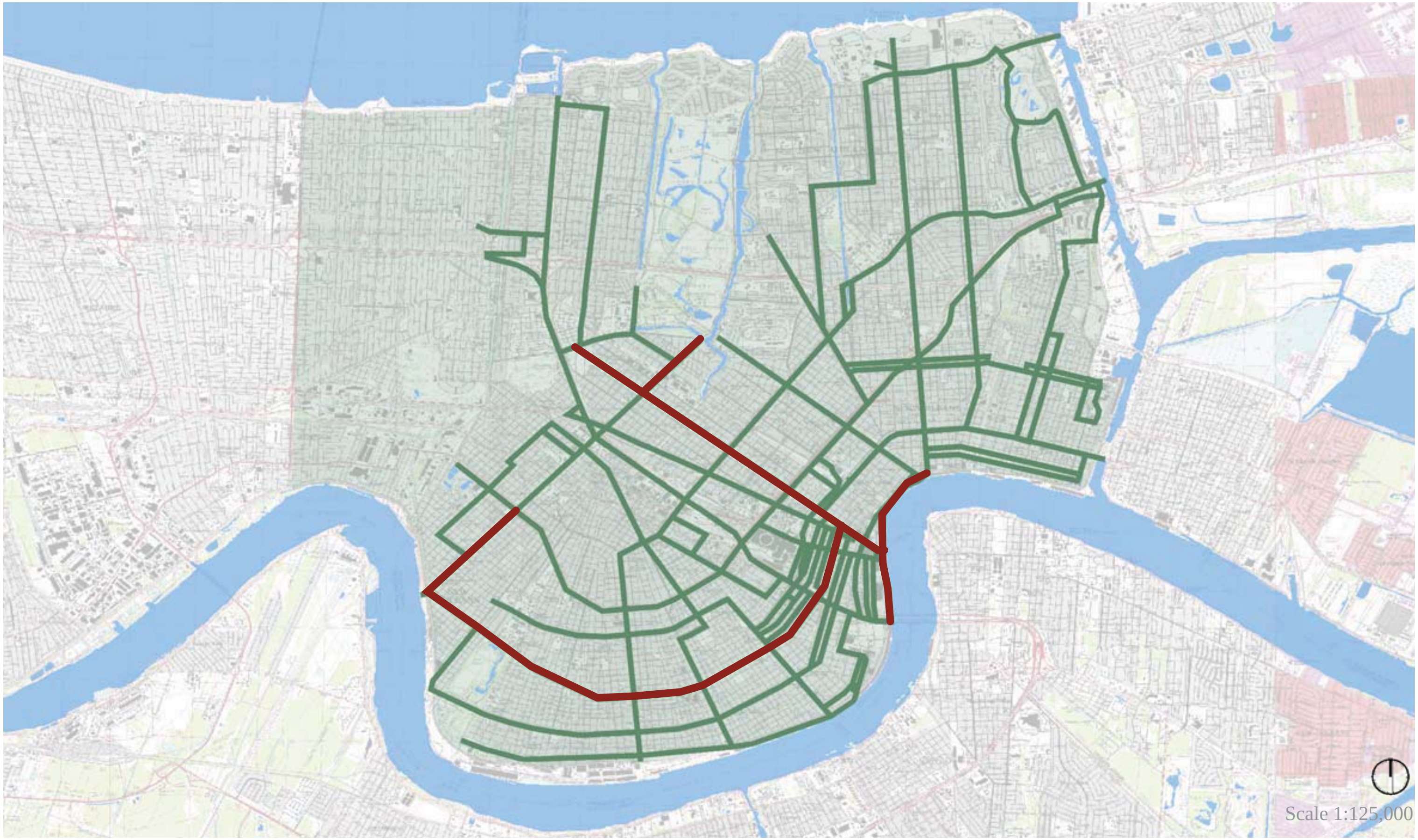


Figure 5.14 Mass Transit Route Map with Streetcar Routes in Red

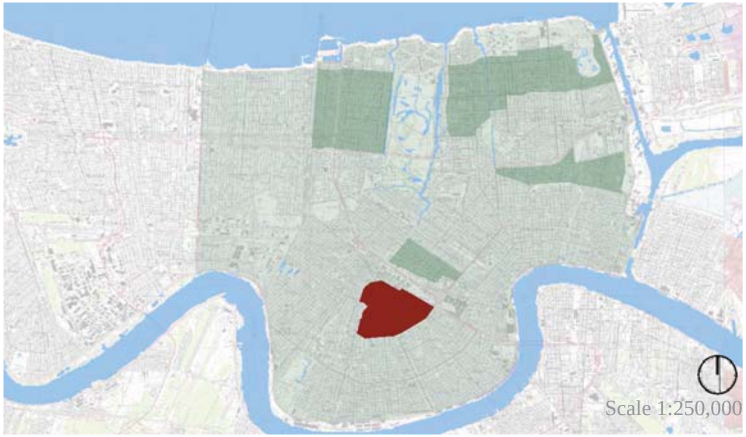


Figure 5.15 Highlighted Large Flood-Prone Site

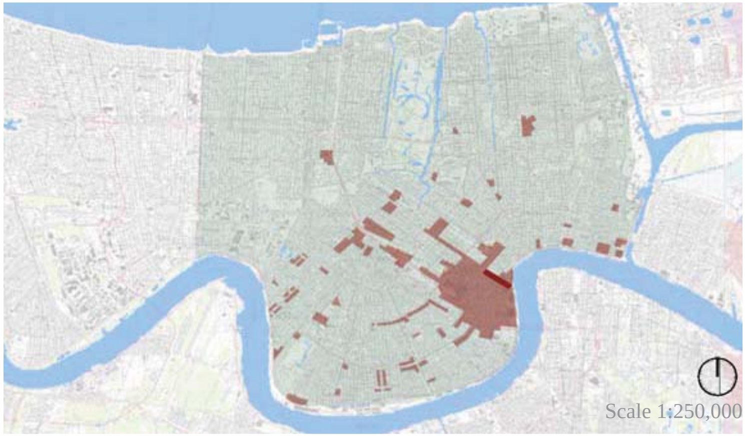


Figure 5.17 Highlighted Commercial Street Site

Figure 5.16 Highlighted Canal Adjacent Residential Site

The Broadmoor Neighborhood

The Broadmoor neighborhood occurs at the center of New Orleans in a low spot in the topography. The vast majority of this neighborhood is composed of single family houses. The houses are largely elevated as builders recognized the high flood threat in this neighborhood as shown in Figure 5.18. However elevated dwellings were not enough to avoid extensive damage during Hurricane Katrina in 2004. As shown in Figure 5.19, there are still large portions of this neighborhood that have not been rebuilt even in 2010. Despite the damage there has been an outspoken resistance to some City plans that called for not rebuilding the Broadmoor neighborhood as shown in the streetlight signs featured in Figure 5.20.

Figure 5.19 Lack of Rebuilding in Broadmoor Neighborhood

Figure 5.18 Elevated Home in Broadmoor Neighborhood

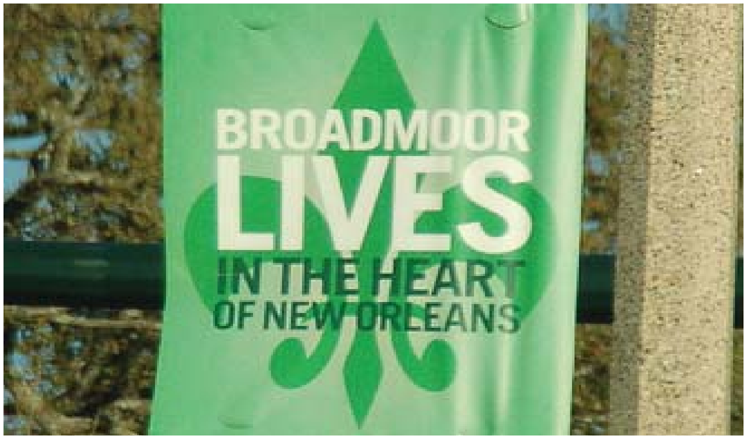


Figure 5.20 Streetlight Pole Banner for Broadmoor Neighborhood

Bayou Saint John

Bayou Saint John is a residential neighborhood in New Orleans that surrounds a small stretch of a canal by the same name. The Bayou Saint John canal is shown in Figure 5.21. The canal is actually one of the only canals in New Orleans that is based on a natural waterway (Colten, 2005). Bayou Saint John used to extend further south into the center of New Orleans and still drains naturally into Lake Pontchartrain (Colten, 2005). The canal in this neighborhood has mowed grass banks that vary in width from about sixty feet to just under twenty feet; the width of the canal is about two hundred and fifty feet at its widest and is also quite variable. The sides of the canal are lined with concrete.

The neighborhood is composed of single family homes and a few scattered small businesses as displayed in Figure 5.22. The houses along the canal are set on small lots and face the canal. The properties are separated from the greenspace by two lane streets. The greenspace has little sense of separation from the street and lacks any site lighting. There are no constructed paths but the majority of the greenspaces show worn areas in the grass (shown in Figure 5.21). These worn areas are evidence that the space is use as a pathway by residents. The only other sign of use is the concrete steps in the grass that lead down to the waters edge; in some areas these concrete steps had kayaks tied to them.

Figure 5.21 Mowed Banks Between Canal and Street.

Figure 5.22 Single Family Homes Along Bayou Saint John

Lower Canal Street

Canal Street is the main shopping street of New Orleans and forms the southwestern border of the famous French Quarter, New Orleans' oldest neighborhood (Colten, 2005). The street is popular with both tourists and New Orleanians. Canal Street is served by New Orleans' streetcar system, shown in Figure 5.23, which runs in the center median of Canal Street. With two streetcar tracks in the center, wide sidewalks (shown in Figure 5.24), street parking, and two to three lanes of traffic, Canal Street is the widest street in New Orleans at one hundred and seventy feet across. Canal Street is exceptionally wide because there were originally plans to build a canal down the center of the street (Colten, 2005).

The street is lined with palm trees both along the sidewalk and in the median giving the street an upscale tropical feel. The street is a major shopping area and also contains hotels and some notable landmarks. Landmarks in the lower nine blocks of the Street include Spanish Plaza, Harrah's Casino, the Shops of Canal Place, Audubon Aquarium of the Americas, the Ferry to Algiers, Woldenberg Riverfront Park, and the Audubon Insectarium (Wood, 2008).

Figure 5.23 Streetcar Tracks on Canal Street

Figure 5.24 Canal Street Sidewalk

6 Section Six:

Project Designs

Broadmoor Park

Broadmoor Park was created in a space that formerly housed the Broadmoor neighborhood of New Orleans, shown in Figure 6.1. This neighborhood is located at a low spot within New Orleans' topography and has recently received significant property damage from both the flooding following hurricane Katrina and the flood of 1995. Broadmoor Park, and other spaces like it, provide a large urban open space where a number of productive activities can take place while also removing housing and businesses from an area that repeatedly suffer flood-related damages. The large spaces allow for an area where water levels can fluctuate naturally and slowly infiltrate the soil without damaging infrastructure and property. The major streets running through the park were maintained to prevent traffic problems. Elevated roadways and culverts were used to maintain water levels between various areas of Broadmoor Park.

A trail system provides an opportunity for local residents to go cycling, hiking, or a running. Figure 6.2 provides a conceptual perspective highlighting some of the activities that occur within the park and along the trails. Areas of these trails feature bridges and boardwalks so that the trails can be used even when water levels are high and wet soils would make earthen paths impassable. Signage along the trail system informs people of the function of the site and provides information on the restored ecosystems.

Along these trails users can see the four different ecosystems that formerly existed in New Orleans: freshwater marsh, wooded swamp, wet meadow, and bottomland hardwood forest. These restored ecosystems provide an opportuni-

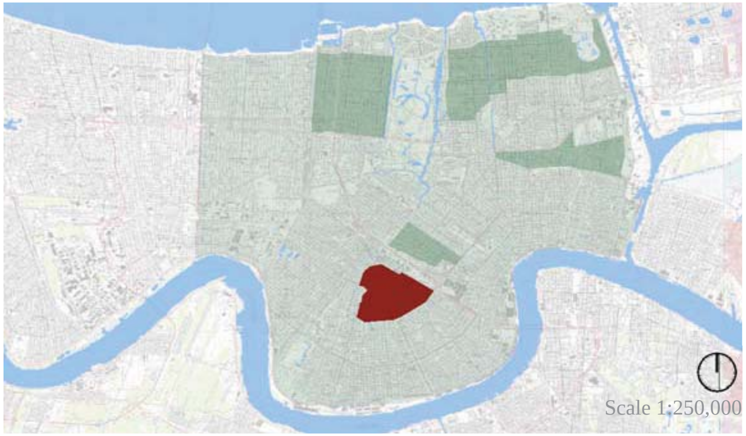


Figure 6.1 Highlighted Flood Prone Space

ty for learning for students from elementary school to college. The mosaic of ecosystems is also important to many native species of plants and animals. Of particular note are the many migrating waterfowl that visit the New Orleans area each year. These waterfowl provide an opportunity for birdwatchers.

Fishing areas used to be one of the main features of the site where the Broadmoor neighborhood now exists. The lowest spots, where water would be found throughout the year can again provide this activity and provide an opportunity for the over 1 million people who live near the study area (Colten, 2004). Fishing is a popular activity in several of the natural reserves located outside of the City. By bringing fishing back to the Broadmoor area, the pastime is even more convenient and accessible to New Orleanians. To accommodate fishing

Figure 6.2 Conceptual Perspective of Broadmoor Park

there are piers and boat landings installed in areas of the park that tend to have consistent water levels.

For those who tend to be unsuccessful in fishing, aquaculture provides another opportunity to enjoy fish caught within New Orleans. Aquaculture and agriculture work well in unison in the area surrounding New Orleans; there are many fields where there is a rotation between crayfish, catfish, and rice depending on the season. The production of the new Broadmoor Park will not be enough to feed a large portion of New Orleanians but does provide a pilot program of producing local food within the city that does not need to be transported from surrounding areas. Several buildings within the park house equipment needed for the aquaculture and agricultural production.

Water treatment is another natural processes that wetlands formerly provided and that a recreated wetland can still provide. Water to be treated enters into the lowest areas of Broadmoor Park. The lowest areas are located in the northern section of the park where two different canal enter the park. Stormwater from these canals flow through three separate water treatment pools. As the water passes through the system of pools, the freshwater marsh plants continue to remove sediment and pollutants. This water is available to the City and since the natural system has already removed most of the sediment and pollutants treatment costs are greatly reduced.

Selective logging would be allowed in certain areas of the park. The removal of a small number of trees can be done without conflicting with other activities and would provide an income that can go toward park maintenance. Additionally, through the cutting of invasive and non-native species, selective logging can serve to improve the habitat quality of the park while also generating income.

Ball fields are the final element included in the Broadmoor Park design and both are located in areas adjacent to especially populated residential areas. These ball fields provide useful open space for the local residents who live at a high density with little available yard space. These parks allow children and adults to enjoy soccer, football, baseball, and softball. Additionally, the ball fields represent a way to get people into the park initially and once in the park they can explore other park amenities. During times of high water the two ball fields can serve as additional permeable areas where floodwater can infiltrate into the soil. The overall master plan for Broadmoor Park is shown in Figure 6.3.

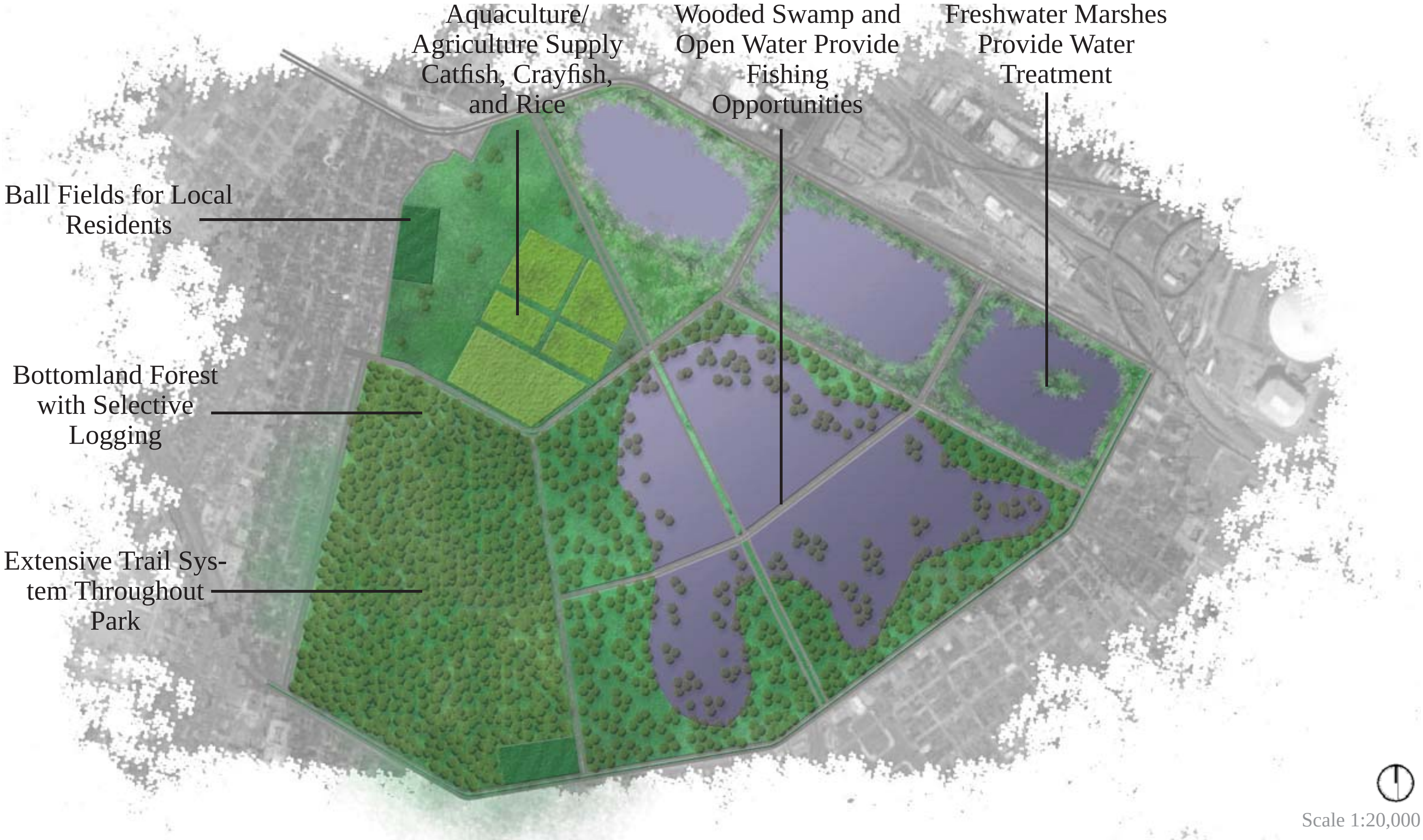


Figure 6.3 Master Plan of Broadmoor Park

Bayou Saint John

The role of the canal adjacent residential sites such as Bayou Saint John is as a linkage; connecting users to other parts of the City through a pedestrian and bicycle trail system. The canal system also transports stormwater runoff from these residential communities and commercial streets to large flood prone parks that have the capacity to store the water as it slowly infiltrates the soil. Sites such as the Bayou Saint John are also intended to improve the site for residents. The location of Bayou Saint John is shown in red in Figure 6.4.

The water's edge features native freshwater marsh plantings able to handle fluctuating water levels, an important element to wetland function. These native plantings that line the canals also provide valuable habitat for birds, fish, mammals, and amphibians. Native plantings along the canals can successfully act as a buffer against fluctuating water levels and hurricane-related storm surges.

The rest of the greenspace lining the canal features mown grass. The mown grass areas feature very little infrastructure so that during times of high water there is minimal property damage and the mown areas can provide additional areas to detain floodwater and allow for infiltration. Residents of Saint John Bayou, who have very little yard space, can use the space along the canal to allow their children play outside, play catch, read, or enjoy an outdoor meal. Picnic tables and installed grills are included to help residents enjoy these outdoor spaces without a large outlay for expensive features that could be damaged during high water.

Figure 6.4 Highlighted Canal Adjacent Residential Site

The Deep Roots design for Bayou Saint John provides a pedestrian and cycling trail that is connected to a city-wide pedestrian and cycling trail system along all of New Orleans' canals. There paths feature site lighting to ensure that the trail system is safe for users. To enhance the comfort and safety of the trails, they also feature benches, drinking fountains, and signage. The signs improve wayfinding along the trails, inform users on the ecological functions of the canal system, and also discuss the history of the city. Street trees were also added along the street to improve the sense of separation from automobile traffic, a quality that the site lacked prior to design implementation. Figure 6.5 is a conceptual perspective showing potential ways that users can utilize the new canal adjacent trail system.

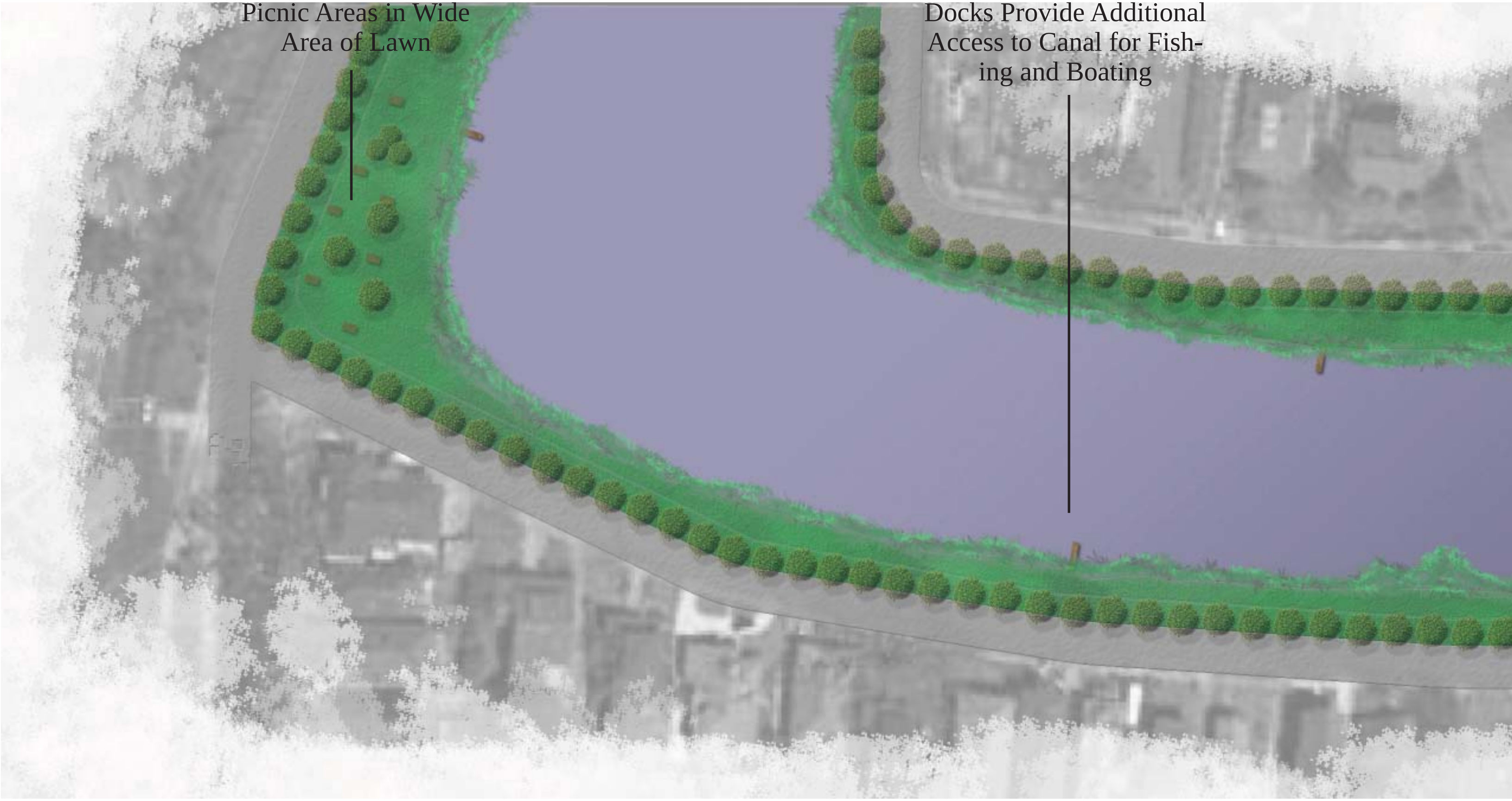
Figure 6.5 Conceptual Perspective of Saint John Bayou

Concrete steps down to the water's edge and small kayaks were already located along the canals during the site visit. In the Deep Roots design these concrete steps are expanded with actual docks and ramps for easier access to the water's edge for both fishing and boating. The Bayou Saint John Canal is up to two-hundred and fifty feet across at its widest and provides a great opportunity for canoeing and kayaking, especially if the water quality is improved. Figure 6.6 shows a section of the canal corridor along Bayou Saint John. The canals provide an opportunity to both residents and visitors to see the city of New Orleans from a different perspective. Just like the pedestrian and cycling trail system, boating in the canals provides linkages to the rest of the City and also an opportunity for exercise for residents.

The removal of the concrete liners along the canals and the planting of native wetland species also positively impacts the quality of fishing in the canals. Like Broadmoor Park, the canals in New Orleans and specifically Bayou Saint John provide an opportunity to bring fishing back into the city limits. Residents along the canals can step right outside their doors and walk a block and spend some time fishing. Docks would help to make fishing accessible to as many people as possible along the canals. Figure 6.7 on pages seventy-eight and seventy-nine shows a conceptual master plan for Bayou Saint John.

Scale 1” = 70’

Figure 6.6 Section of Saint John Bayou Canal Corridor


Picnic Areas in Wide Area of Lawn
Docks Provide Additional Access to Canal for Fishing and Boating

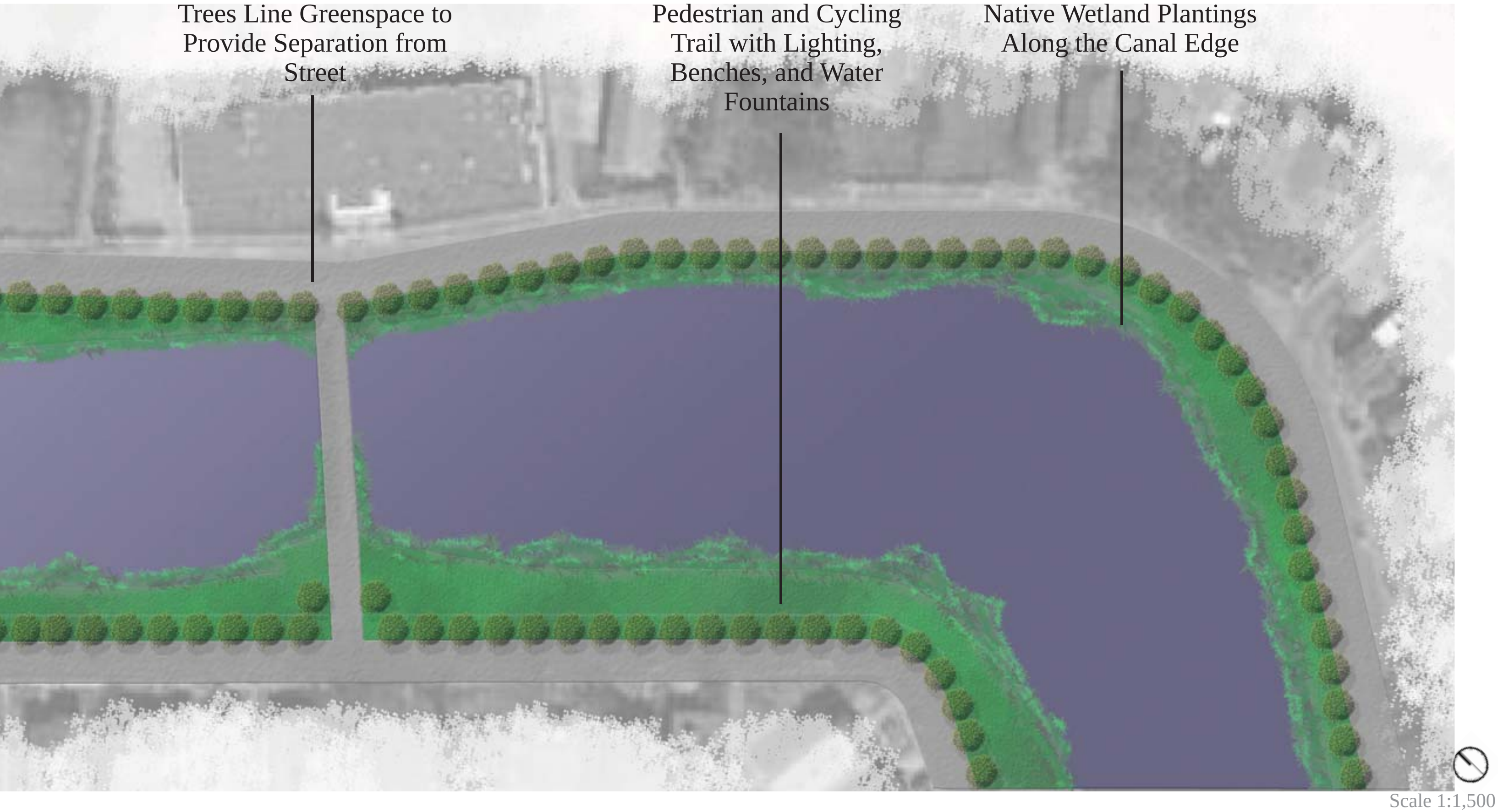


Figure 6.7 Master Plan of Bayou Saint John

Lower Canal Street

Canal Street provides a space highly visible to both residents and visitors while also increasing filtration rates so stormwater from this site does not lead to flooding in other areas of the City. The lower nine blocks of Canal Street feature a number of elements that make the area more permeable, preventing stormwater that falls on the site from entering New Orleans' antiquated water treatment system and rather creating spaces that allow it to infiltrate into the soil. Along with the stormwater management, the designs also make the streetscape more pleasant and uniquely New Orleanian for both residents and tourists. The lower nine blocks of Canal Street is one of the major commercial centers and most visible areas of the City. As such, there is a great potential to introduce stormwater solutions along Canal Street to inspire other commercial streets in New Orleans to adopt similar programs. The location of Lower Canal Street is shown in Figure 6.8.

There are a number of program elements that are introduced in the design for lower Canal Street. The conceptual perspective illustrated in Figure 6.9 shows some of the activities and some of the excitement found along Canal Street. Probably the key element to the master plan for lower Canal Street is the permeable bottomed planters along the sidewalks and in the medians along the street. These planters feature curb cuts that allow stormwater from the street to enter into permeable planters were the water is temporarily detained until it can infiltrate into the soil. The planters also feature curb cuts that allow excess water to return to the street and enter the next in a chain of permeable planters. The intent of the permeable planters is to eliminate or at least reduce the amount of stormwater

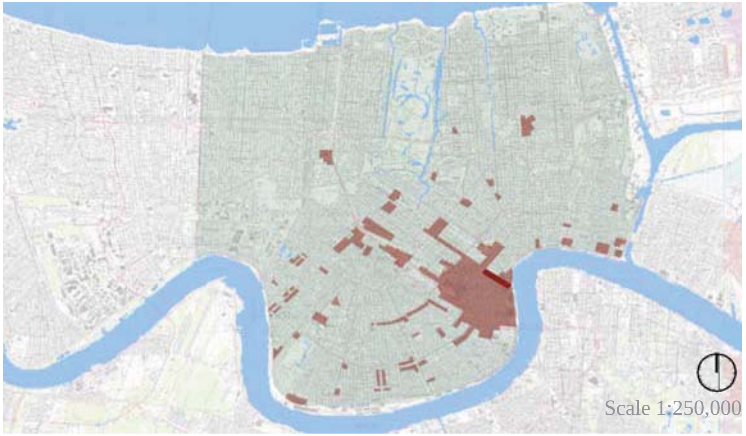


Figure 6.8 Highlighted Commercial Street Site

entering New Orleans' water treatment system from commercial streets.

These planters also serve to increase the sense of separation between the sidewalk and automobile traffic. This separation creates a more pleasant experience for people on the sidewalk. The permeable planters are planted with native plants suited to indeterminate water levels. These plants include bald cypress trees. The bald cypress tree is the state tree of Louisiana and the trees replace the palms that currently line Canal Street. The presence of the bald cypress serve as a symbol of the return of natural ecosystems to the heart of New Orleans and give lower Canal Street a very unique appearance.

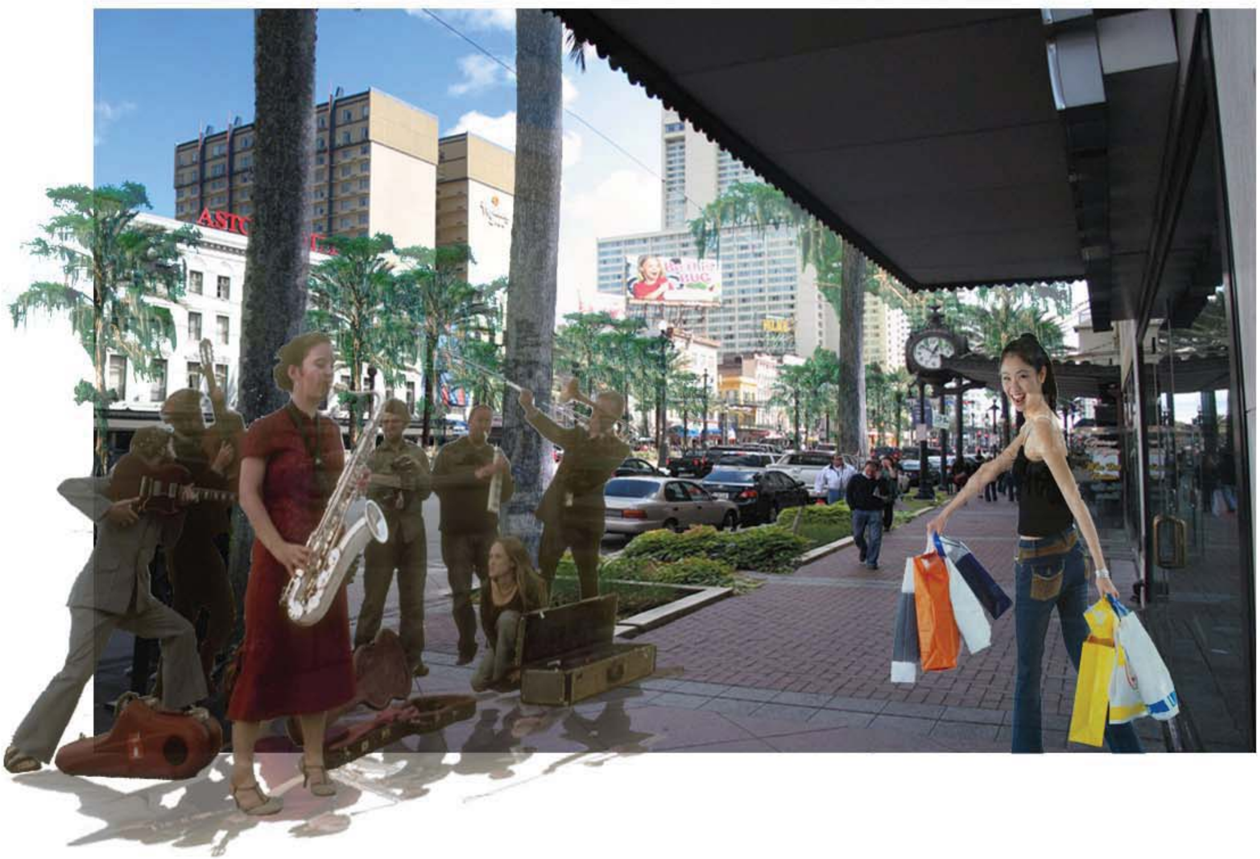


Figure 6.9 Conceptual Perspective of Canal Street

Detention basins attached to downspouts serve a similar function to the permeable planters lining the streets and medians. These basins collect water that falls on the City rooftops. The detention basins are also linked to the permeable planters through narrow channels cut into the sidewalk so that any excess water can overflow into the higher capacity system rather than cause flooding issues on the sidewalk.

The master plan also features a green roof atop the Audubon Insectarium. The green roof would be able to soak up rainwater instead of allowing it to runoff like conventional roofs. The Audubon Insectarium (which shares the building with the U.S. Customs House) was selected because it is a imposing stone building that likely has the ability to handle the additional load created by the green roof planting material. The building is also located in the busiest area of Canal Street, the lower three blocks. Additionally, the Audubon Insectarium is surrounded by the Sheraton, Marriot, and Wyndham hotels, three of the tallest buildings in New Orleans, which allow for views down to the green roof.

The final program element to be implemented in the lower nine blocks is low impact parking lot. This parking lot, located next to the Wyndham Hotel and the One Canal Place Shops features high-albedo paving, permeable concrete, bio-swales, and a high percentage of canopy cover. These feature do not limit the lot significantly in the number of stalls that it can offer but does serve to greatly reduce the stormwater runoff from the lot, remove pollutants from the air and storm-water, and reduce the urban heat island effect. A section of the lower Canal Street corridor is shown in Figure 6.10 and the overall master plan is shown in Figure 6.11 on page eighty-three.

Scale 1” = 40’

Figure 6.10 Section of Lower Canal Street

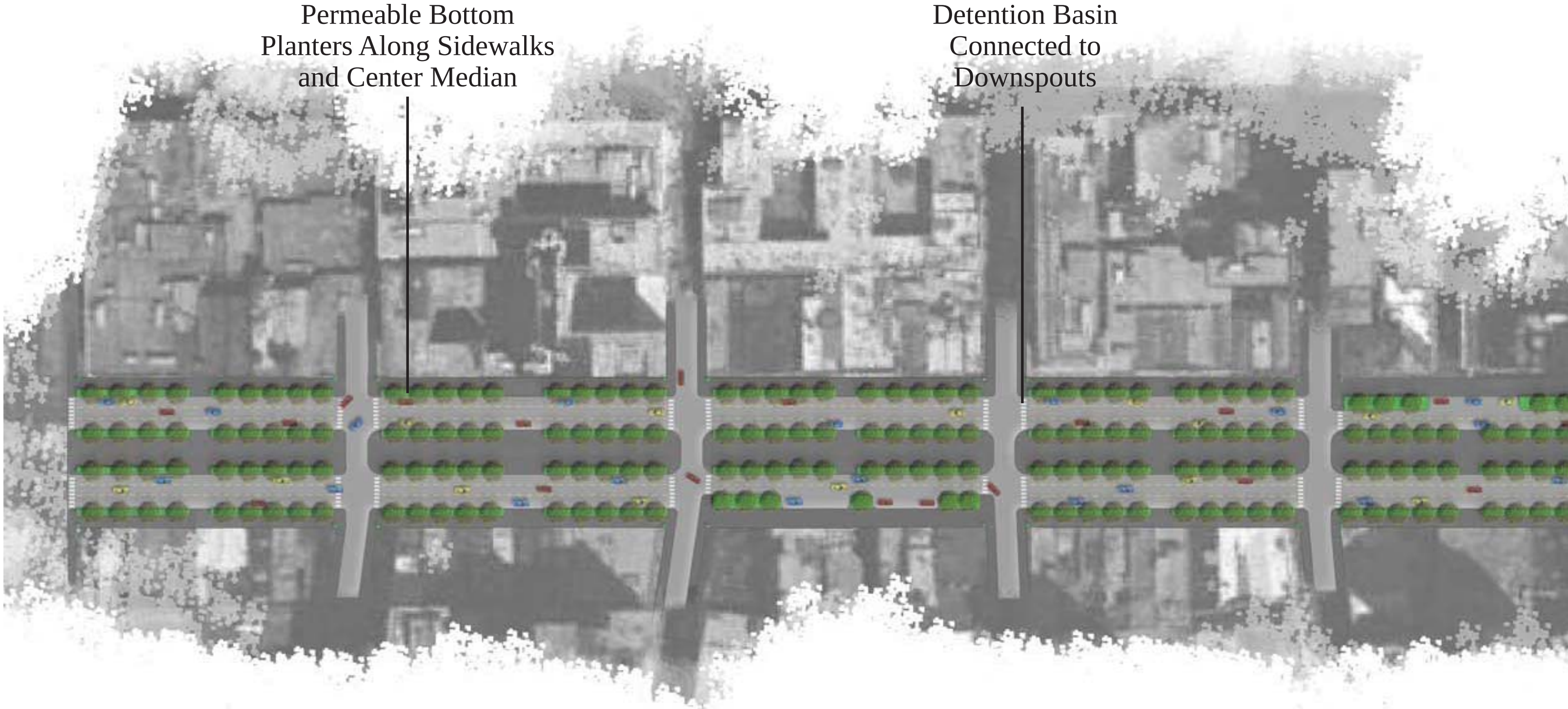

Permeable Bottom
Planters Along Sidewalks
and Center Median
Detention Basin
Connected to
Downspouts

Figure 6.11 Master Plan of Canal Street

7

Section Seven:

Conclusion

Conclusion

Cities around the world have long underestimated the value of the services provided by surrounding ecosystems. One of these key ecosystem services is flood mitigation. As the ecosystems around New Orleans deteriorated and receded due to urbanization and sprawl, the City became increasing damaged by large flood events. The Deep Roots project presents a process for selecting sites within the Metairie Canal – Canal Number Two Watershed to be used to for permaculture designs. The proposed designs introduce elements, which by reintroducing the functions of the wetland ecosystems, provide flood mitigation in New Orleans as well as additional services and activities for New Orleanians.

The Deep Roots Project can serve as a starting point for further investigation into the application of permaculture design to mitigate flooding in New Orleans and cities beyond. The designs act as an inspiration as to what permaculture design can provide. Further research into permaculture design and its applicability to flood mitigation is a source of potential societal benefit and landscape architecture can have a central role in adapting this field of study to the urban environment.

The influence of permaculture on the Deep Roots designs and the designs' adherence to the twelve permaculture principles introduced by David Holmgren is seen in the creation of a linked system of small flood control solutions. There are numerous flood mitigation practices being used throughout the world that are limited in effectiveness because they fail to act as a comprehensive system. By recreating key elements from natural systems there is inherent flexibility in the system; with each part contributing to the overall goals. Deep Roots intends to allow floodwater to slowly infiltrate back into the soils as they did naturally before New Orleans existed rather than be collected and pumped to surrounding water bodies.

The creation of a flood mitigation system can be done within New Orleans in a way that is both effective and provides additional benefits and activities for residents. Both in times of flooding and during normal water levels, there are features that make the project valuable to New Orleanians not just for flood mitigation but also as urban parks, greenways, and green streets useful for recreation and the enhancement of daily lives.

The designs of the Deep Root Project call for the creation of over fifty-three miles of natural wetland plantings along New Orleans' canals. The canal system of New Orleans and the residential neighborhoods that line them are shown in Figure 7.1. Coreil, in his 2004 text titled Functions and Values of the Louisiana Coast, states that every 2.8 miles of vegetated wetlands can reduce storm surge by up to one foot (Coreil, 2004). It is unclear the exact benefit in terms of storm surge buffering that the narrow wetlands that line the canal would have, but without question fifty-three additional miles of vegetated wetlands would absorb a significant portion of the energy from a storm surge entering the City.

Figure 7.1 Canal System with Residential Neighborhoods

The large flood-prone parks proposed for the site total over 5,300 acres; over seventeen percent of the site's total of 30,201 acres. The large flood-prone parks for the Deep Roots Project are shown in Figure 7.2. A wetland that is equal to only fifteen percent of the acreage in a watershed can reduce flood peaks by as much as sixty percent (Coreil, 2004). These large flood prone parks are not natural wetlands, featuring areas for aquaculture, agriculture, ballfields, and pedestrian paths, but they do comprise a significant portion of the Deep Roots Project site and would again greatly mitigate flood peaks in New Orleans.

The Deep Roots designs would also greatly enhance the overall permeability of New Orleans. Deep Roots' designs for the large flood prone parks call for nearly one hundred percent permeability. A sample of blocks taken from the neighborhoods replaced by the large flood prone parks show that the existing neighborhoods are comprised of roughly sixty-two percent impervious surfaces (roofs, sidewalks, streets, and driveways) and thirty-eight percent permeable surfaces (lawns, undeveloped spaces, and planting beds). The sample blocks from the flood-prone spaces are shown in the appendix of this report. Overall, changes to these large flood prone create an additional 3,280 acres of permeable surfaces within the Deep Roots Project site.

The Deep Roots plan also leads to thirty-six linear miles of improved commercial streets. The commercial streets that are suitable for the proposed street improvements are shown in Figure 7.3 on page seventy-two. Existing commercial streets within the project site vary greatly in the percentage of permeable surfaces and in width. Most streets in New Orleans are comprised of less than one percent permeable surfaces; mostly just the small areas around trees are unpaved. However, there are some streets in the City with unpaved medians that consist of up to thirty-three percent permeable surfaces. On average, the streets in the project area are comprised of 7.5 percent permeable surfaces. The Deep Roots designs create street corridors that is over thirteen percent permeable. These designs call for the improvement of two hundred and eighty-eight acres of street and sidewalk space, creating an additional twenty acres of permeable surfaces in the Deep Roots project site. The impact of permeable surfaces along commercial streets are heightened by gutters and curb cuts that direct stormwater from streets and rooftops to permeable planters and detention basins. These permeable surfaces collect and detain the stormwater that falls on the impervious services and allows for its slow infiltration into the soil.

Beside flood mitigation and stormwater management there are a number of additional benefits that would coincide with the implementation of the Deep Roots designs and their adoption throughout the City. These difficult to quantify services include improvements in water and air quality through the filtering of pollutants, the expansion and enhancement of wildlife habitat, increased carbon sequestration, and aquifer recharge. Improvements are created by utilizing native plantings and by increasing the permeability, tree canopy, and the density of plantings in New Orleans. Though it would be misleading to predict actual numbers, such as the additional species that would be found in New Orleans or the exact temperature

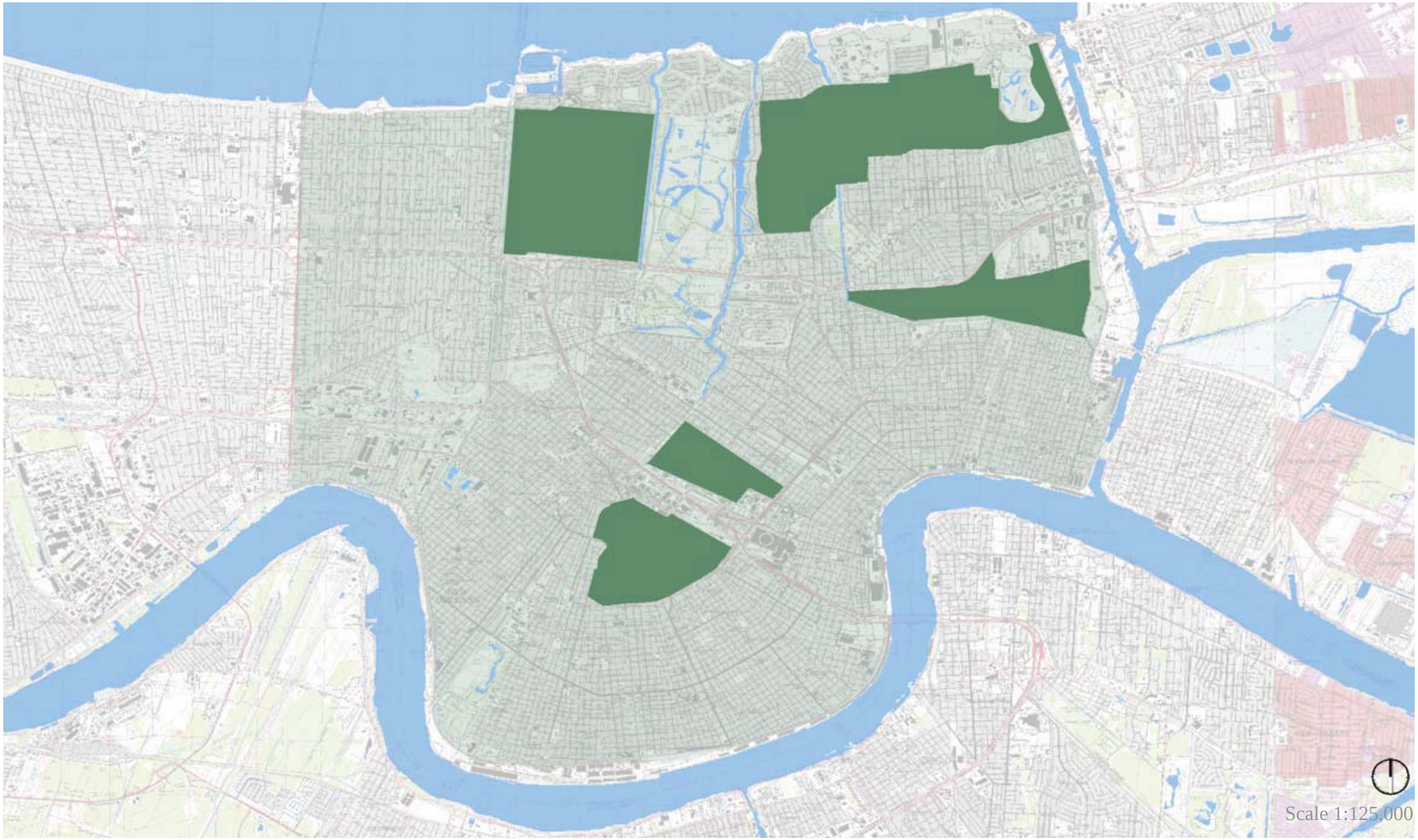


Figure 7.2 Large Flood-Prone Parks

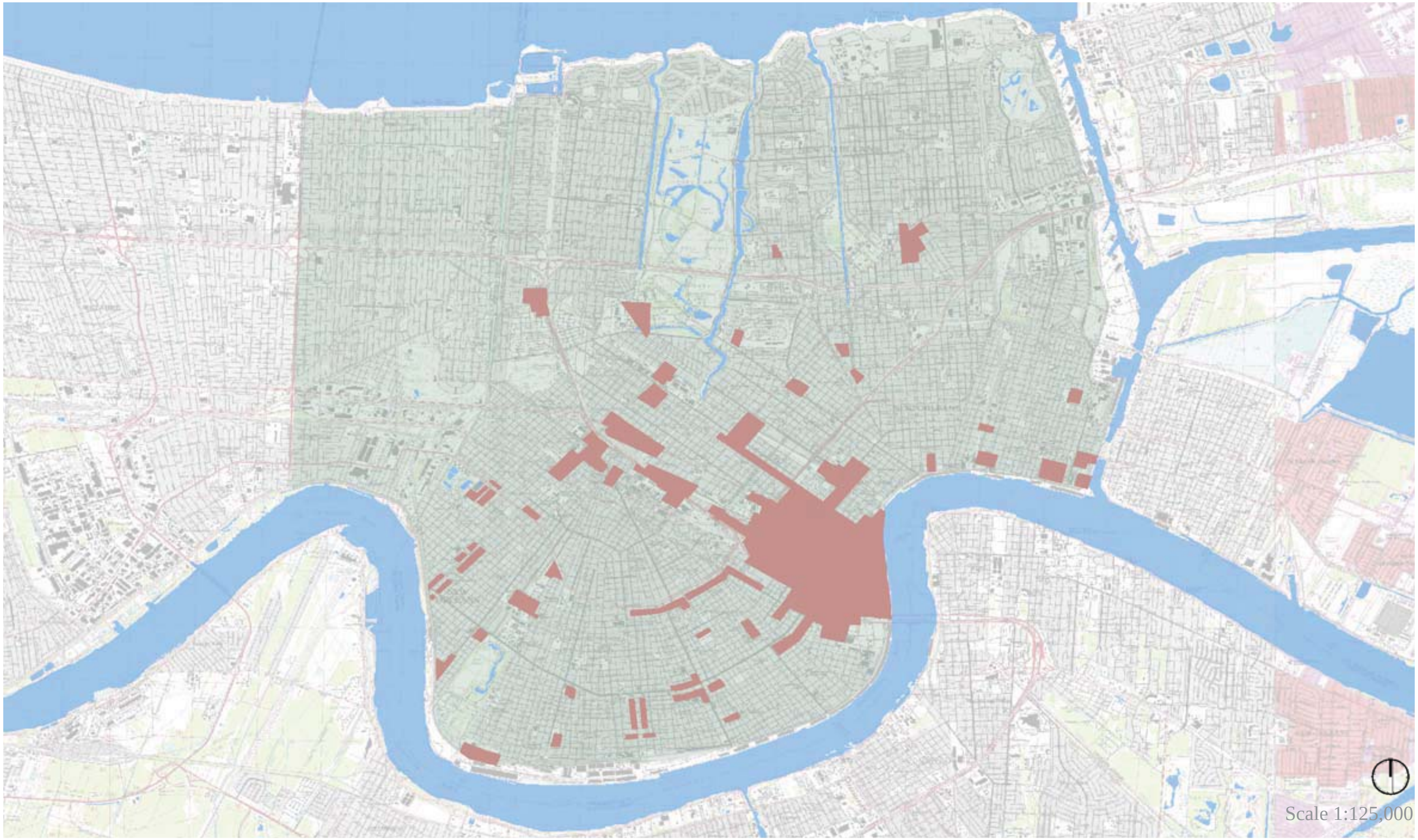


Figure 7.3 Commercial Streets Suitable for Improvements

difference through the reduction of the heat island effect, these services would provide significant benefit to the City.

A sixty-two percent decrease in paved surfaces and rooftops within the large flood prone parks and a 5.5 percent decrease in paved surfaces on commercial streets, coupled with an increased tree canopy cover along commercial streets, in the large flood prone parks, and along residential canals would also create a reduction in the urban heat island effect. In total, the Deep Roots Project alters 6,400 acres between its canal corridors, commercial streetscapes, and large flood prone parks. Within these spaces there is an emphasis on native plantings replacing lawns, buildings, and pavement. These improvements enhance wildlife habitat throughout the 6,400 acres.

The Deep Roots Project also adds to the list of ammenities available to residents. The large flood prone parks provide opportunities for fishing within the New Orleans city limit and its over one million people. The parks also provide New Orleanians with walking trails and ballfields. Additionally, through aquaculture and selective logging, residents can obtain crayfish, catfish, lumber, and rice raised within New Orleans City limits.

Residents also benefit from the fifty-three new miles of pedestrian and cycling trails. These trails would greatly enhance the cycling opportunities throughout the City and create the first interconnected system of bicycle trails in New Orleans (New Orleans Metro Bicycle Coalition, 2010). The spaces along the canals also provide an open space for local residents to enjoy outdoor dining, kayaking, leisurly walks, and play with their children.

The Deep Roots Project creates a distinct sense of place for people in New Orleans. New Orleans is one of the most unique cities in the United States but like other cities there is a trend toward homogenization. Implementing the Deep Roots plans would create features based on natural systems and native plantings. The sight of Bald Cypress and native grasses in pervious planters replacing the palm trees along Canal Street, central parks providing an opportunity for people to recreate and explore a mosaic of ecosystems in the heart of the City, and a system of canals providing a green network of trails throughout New Orleans can help create, along with New Orleans' history and landmarks, a lasting memory of the City.

Beyond New Orleans, the Deep Roots Project can potentially alter the interactions between mankind and nature. Cities like New Orleans have grown and prospered despite nature, not because of it. Permaculture provides an opportunity to alter this relationship. Through the application of permaculture principles, Deep Roots seeks to provide an example of how cities can allow nature into their urban fabric in a way that is beneficial to both residents and to nature. Natural ecosystems have found a way to balance imputs and outputs in a way that no city ever has. Allowing and encouraging natural systems to once again function in urban spaces can help cities to reduce waste, mitigate natural hazards, curb pollution, efficiently use resources, and generally be more pleasant and interesting places for people to live.

Section Eight:

8

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Appendix A:

Glossary of Terms

Glossary of Terms

Hydrologically Significant: Sites are considered to be hydrologically significant if they are found within the 50-year flood hazard zone. These sites have a two percent (2%) chance of flooding each year.

Permaculture: Permaculture is a “posivistic” response to environmental crisis. Permaculture designs are “consciously designed landscape which mimic the patterns and relationships found in nature in order to, through the use of systems thinking and design principles that provide the organizing framework, create a significantly more permanent (sustainable) culture (Holmgren, 2002).”

Posivistic: Focusing on solutions that involve what concerned parties can do in order to solve a problem rather than what they need to stop doing.

Observe and Interact: Refers to designs that illustrate that the designers carefully mimicked the processes that occur in nature. From these designs and patterns found in the natural world the simplest solution is usually the best.

Catch and Store Energy: This principle refers to capturing usable sources of energy such as solar energy, wind energy, biomass, and water that can be used either on-site or off-site at a later time

Obtain a Yield: Obtain a yield is a principle that proposes that all sites produce a useful product whether it is a food crop, biomass, timber, or other natural products.

Apply Self-Regulation and Accept Feedback: The application of self-regulation and acceptance of feedback is a simple recognition that a final design is not final. After a design is implemented it must be evaluated and regulated and then this feedback needs to be used to improve the current or future designs.

Use and Value Renewable Resources and Services: This principle is at the very core of this project. The principle insists that designers make the best of what renewable resources can offer and ensures that the use of the renewable resource is within the renewable limits of the resource (Holmgren, 2002).

Produce No Waste: This is the simplest of the permaculture design resources to understand. This principle involves reusing and reducing the resources used while allowing nature to utilize the resources that people cannot.

Design from Patterns to Details: This design principle is similar to observing and interacting. To design from patterns to details means to design first for functionality based on natural patterns and secondly for aesthetics.

Integrate Rather Than Segregate: There are two sub-principles that are implicit within the idea of integrating rather than segregating. The first of these is that each element performs many functions. The second sub-principle is that each important function is supported by many elements (Holmgren, 2002).

Use Small and Slow Solutions: This is a two part principle. The slow aspect of the principles follows the idea that slow solutions reject new ideas that may or may not be well-thought out and favor taking the time to ensure that designs are well-thought out before construction begins. Small solutions are favored because small designs are easier to apply and maintain, are labor intensive rather than capital and energy intensive, and can make more efficient use of local resources and markets (Holmgren, 2002).

Use and Value Diversity: This is another easy to understand permaculture principle. This principle challenges designers to create spaces that have a high degree of density in every sense of the word. The simplest place to apply this is to plants. Permaculture designs should utilize plants with a diversity of structure, a diversity of age, and a genetic diversity. Often yield and diversity conflict and permaculture favors a compromise between the two design influences.

Use Edges and Value the Marginal: This principle recognizes the edges of both natural and cultivated landscapes are dynamic, diverse, and productive and thus are important to consider in any design.

Creatively Use and Respond to Change: Again there are two parts of this principle. Number one is designing in a way that makes use of change in a useful way and secondly creatively responding and adapting to large-scale change that is beyond the control of the designer.

River Urbanism: River Urbanism is a form of Landscape Urbanism with the river nature as the dominating voice of urban development. The theory views cities and settlements as river-based growing organisms (Casagrande, 2009).

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Appendix B:

Calculations

Commercial Street Calculations

The calculations for commercial streets were based on two basic street widths found among the streets in New Orleans served by New Orleans' mass transit system. The width of the streets is based on the width from building front to building front, including traffic lanes, medians, sidewalks, and street parking. Figure 10.1 shows the two basic widths of the commercial streets selected in the Deep Roots Project. The red lines show the wider streets, which are between one hundred and thirty feet and one hundred and fifty feet wide. The green lines represent narrower streets which vary between forty and one hundred feet from building face to building face.

In total their are over thirty-six miles of commercial streets selected by the Deep Roots Project. Of these thirty-six miles of street, fourteen miles were comprised of the wider streets and twenty-two miles were comprised of the narrower streets. Based on an average width of one hundred and forty feet for the wider streets and of seventy feet for the narrow streets we get a rough estimate of four hundred and twenty-four acres of streetscape impacted by the Deep Roots Project.

Taking a sample of the commercial streets identified by the project, it was determined that the majority of them contain less than one percent permeable surfaces. These surfaces are mainly the small areas around street trees. However, some of the wider street contained medians that are unpaved. Measurements taken on sample streets show that these streets can be up to thirty-three percent permeable surface. Based on the samples the overall average for the commercial streets selected in the project contain 7.5 percent permeable surfaces.

The Deep Roots Project design for Lower Canal Street corridor contains over thirteen percent permeable surfaces. These permeable surfaces include the detention basins connected to building gutters and permeable planters in the sidewalk and along the median. The figures do not contain the permeable percentage using the low impact parking lots because these improvements do not occur within the street corridor between building faces.

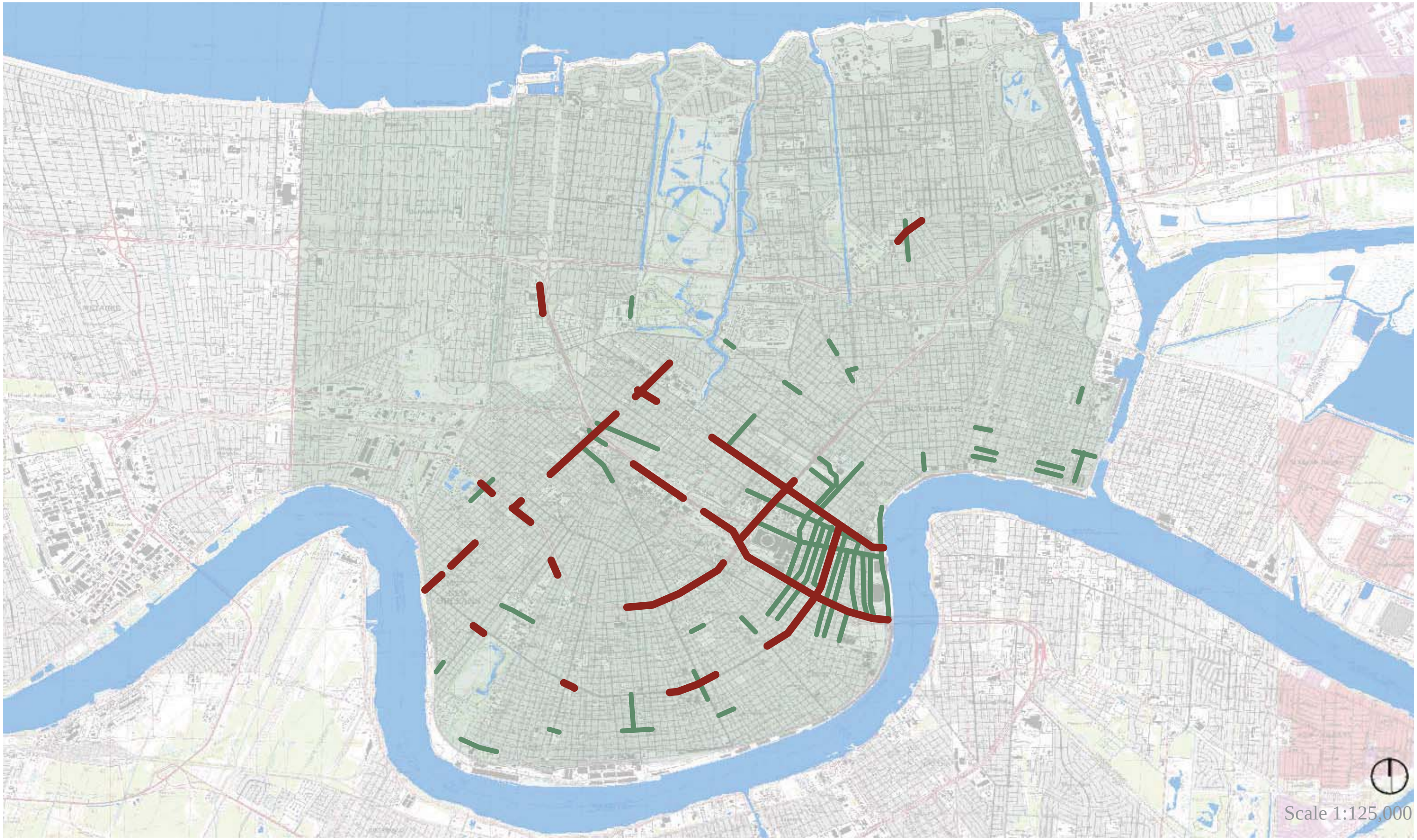

Figure 10.1 Street Width Map

Sample Blocks

Sample blocks were selected from the neighborhoods in New Orleans being replaced by large flood-prone parks. The sample blocks were used to make calculations to estimate the existing permeability of blocks before the Deep Roots designs were implemented. To calculate permeability the areas of the rooftops including outbuildings, sidewalks, roadways, driveways, paved patios, planting beds, and lawns were all measured. The rooftops, sidewalks, roadways, driveways, and patios were all considered to be impervious surfaces and were totaled. The planting beds and lawns were classified as permeable and were also totaled. These totals were compared to the total area of the sample block to determine the percentage of permeable and impervious surfaces.

The sample block were chosen by the author to match the general qualities of the neighborhood. Blocks with unusual feature such as schools or other non-residential buildings were not chosen. The area of the four sample blocks and the permeable and impervious areas were totalled and used to generate a rough estimate of the overall permeability of the existing neighborhoods to use for comparisons with proposed Deep Roots designs. In order to ensure that streets were not counted twice, only the streets on the south and east side of the sample blocks were measured.


Figure 10.2 Sample Block from Broadmoor Neighborhood

Total Area:

111,780 square feet

Total Area of impervious surfaces including rooftops, streets, sidewalks, driveways, patios:

67,340 square feet

Total area of permeable surfaces including lawns and planting beds:

44,440 square feet

Percentage of impervious surfaces:

60%

Percentage of permeable surfaces:

40%

Total Area:

139,624 square foot

Total Area of impervious surfaces including rooftops, streets, sidewalks, driveways, patios:

66,540 square feet

Total area of permeable surfaces including lawns and planting beds:

73,084 square feet

Percentage of impervious surfaces:

48%

Percentage of permeable surfaces:

52%

Figure 10.3 Sample Block from Gentilly Terrace Neighborhood

Figure 10.4 Sample Block from Lakeview Neighborhood

Total Area:

224,785 square feet

Total Area of impervious surfaces including rooftops, streets, sidewalks, driveways, patios:

134,871 square feet

Total area of permeable surfaces including lawns and planting beds:

89,914 square feet

Percentage of impervious surfaces:

60%

Percentage of permeable surfaces:

40%

Figure 10.5 Sample Block from Tulane/Gravier Neighborhood

Total Area:

132,554 square feet

Total Area of impervious surfaces including rooftops, streets, sidewalks, driveways, patios:

111,469 square feet

Total area of permeable surfaces including lawns and planting beds:

21,085 square feet

Percentage of impervious surfaces:

84%

Percentage of permeable surfaces:

16%

Figure 10.6 Sample Block from St. Roch Neighborhood

Total Area:

139,978 square feet

Total Area of impervious surfaces including rooftops, streets, sidewalks, driveways, patios:

83,987 square feet

Total area of permeable surfaces including lawns and planting beds:

55,991 square feet

Percentage of impervious surfaces:

60%

Percentage of permeable surfaces:

40%