Tampa Bay Estuary Program

Master Plan for the Protection and Restoration of Freshwater Wetlands in the Tampa Bay Watershed, Florida

October 2014

Prepared For
The Tampa Bay Estuary Program

SCHEDA ECOLOGICAL ASSOCIATES

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EXECUTIVE SUMMARY

The Master Plan for the Protection and Restoration of Freshwater Wetlands in the Tampa Bay, Florida, Watershed is a guidance document for public and private agencies interested and involved with freshwater wetland restoration, protection and/or mitigation in the Tampa Bay region. The plan is a culmination of efforts to identify and quantify where freshwater wetlands existed historically (circa 1950s) and where they exist currently (2007) in order to understand the overall quantitative and spatial changes (losses, gains, and conversions) that have occurred.

Six basins comprising the Tampa Bay watershed were analyzed individually for acreages of freshwater wetlands, and types of freshwater wetlands, in the historic and current context. Results show that in each basin, herbaceous/non-forested wetlands had disproportionate losses on a percentage basis. According to the analysis, overall, approximately 33% of all wetlands within the study area have been lost during this time frame. In terms of structure, overall, non-forested wetlands have been disproportionately lost at 43%. Forested wetlands have also been lost throughout the Tampa Bay watershed however, relative to historic levels, not in a proportion as high as non-forested wetlands.

This information was used to establish quantitative restoration and protection targets for six categories of wetlands (listed below) within six basins of the Tampa Bay watershed. The targets were developed with an approach known as “Restore the Balance” which strives to restore habitats to similar ratios as they existed historically, so as to provide adequate diversity of habitats for the suite of fish and wildlife species that inhabit them. The approved targets by wetland category and basin are shown below. A delta of zero indicates that, for the specified basin and freshwater wetland type, disproportionate losses have not occurred and therefore the goal is to protect the current existing wetland area.

Overall, the watershed requires gains of both forested and non-forested wetland types in the sum of 18,703 acres in order to reach historic proportions. It is evident however, that the need for 17,088 acres of non-forested wetlands far outweighs the need for 1,615 acres of forested wetlands. As both structure types provide habitats for distinct wildlife species at different stages of life and provide differing levels and types of ecological services, it is of vital importance to restore proportional acreages. Extensive GIS analyses have shown that the presented targets are achievable within each basin.

Approved Restoration and Protection Targets by Wetland Category and Basin

Basin	Wetland Category		Target (ac)	Delta (ac)
Alafia River	Forested	Lacustrine	**1,254**	**871**
		Other	**1,544**	**0**
		Riverine	**21,743**	**0**
		Subtotal	**24,541**	**871**
	Non-Forested	Lacustrine	**1,856**	**603**
		Other	**3,945**	**0**
		Riverine	**7,573**	**1,595**
		Subtotal	**13,373**	**2,199**
Hillsborough River	Forested	Lacustrine	**2,592**	**553**
		Other	**11,504**	**0**
		Riverine	**54,430**	**0**
		Subtotal	**68,526**	**553**
	Non-Forested	Lacustrine	**3,340**	**202**
		Other	**9,536**	**0**
		Riverine	**15,884**	**1,209**
		Subtotal	**28,760**	**1,411**
Little Manatee River	Forested	Lacustrine	**173**	**0**
		Other	**866**	**0**
		Riverine	**12,951**	**0**
		Subtotal	**13,990**	**0**
	Non-Forested	Lacustrine	**632**	**567**
		Other	**2,917**	**1,685**
		Riverine	**7,307**	**2,991**
		Subtotal	**10,856**	**5,243**
Manatee River	Forested	Lacustrine	**305**	**137**
		Other	**1,251**	**0**
		Riverine	**15,692**	**0**
		Subtotal	**17,248**	**137**
	Non-Forested	Lacustrine	**448**	**278**
		Other	**3,920**	**1,644**
		Riverine	**10,773**	**1,745**
		Subtotal	**15,141**	**3,667**

Basin	Wetland Category		Target (ac)	Delta (ac)
Tampa Bay and Coastal Areas	Forested	Lacustrine	**3,721**	**0**
		Other	**3,883**	**0**
		Riverine	**17,432**	**0**
		Subtotal	**25,036**	**0**
	Non-Forested	Lacustrine	**1,239**	**357**
		Other	**3,444**	**1,095**
		Riverine	**7,160**	**2,948**
		Subtotal	**11,843**	**4,400**
Upper Coastal Areas	Forested	Lacustrine	**12**	**0**
		Other	**89**	**54**
		Riverine	**251**	**0**
		Subtotal	**352**	**54**
	Non-Forested	Lacustrine	**11**	**0**
		Other	**163**	**114**
		Riverine	**127**	**54**
		Subtotal	**302**	**168**

The Tampa Bay Estuary Program, with the cooperation and input of multiple agency partners, proposes that strategic compensatory mitigation be employed in order to achieve the outlined restoration targets.

This plan and the accompanying technical deliverables (mapping products, Geographic Information System layers, screening tools and supplemental products) can be used by an array of public and private entities for numerous beneficial wetland projects, such as prioritizing future restoration sites, identifying high quality wetlands for preservation, and siting future mitigation banks. The goals of this master plan will best be accomplished through a combination of publicly-funded restoration and privately-funded compensatory mitigation. In order to accomplish this through compensatory mitigation, regulatory permitting agencies at the federal, state, regional and local level have committed to utilizing the master plan recommendations and tools to identify and require mitigation of historic wetland conditions, when appropriate. Therefore, historically non-forested wetlands that may have transitioned to scrub/shrub systems, due to changes in hydrologic or fire regimes, would be mitigated as non-forested wetlands, helping to restore these historic conditions. Historic and current forested wetlands, or those that transitioned from herbaceous systems but are highly functioning currently, would continue to be mitigated as forested wetlands. Over time, it is anticipated that the targeted restoration and mitigation of non-forested wetlands will lead to measurable progress towards meeting the approved restoration and protection targets. The Tampa Bay Estuary Program and partners are committed to providing education for environmental professionals, guidance in utilizing the project deliverables, and periodic re-evaluation of this approach to ensure ecologically-beneficial freshwater wetland restoration and protection in the Tampa Bay, Florida, watershed.

1.0 INTRODUCTION

1.1 PROJECT HISTORY AND PREVIOUS STUDIES

This study represents the ongoing work of the Tampa Bay Estuary Program (TBEP) in determining the overall changes (net losses, gains and conversions) of freshwater wetland habitat types, along with proposed restoration strategies for freshwater wetlands, within the Tampa Bay Watershed. The historical perspective of these various efforts is summarized below.

1.1.1 Tampa Bay Habitat Master Plan

During the past two decades, scientists and managers within the Tampa Bay region have developed quantitative estuarine habitat restoration targets, as well as paradigms to guide habitat restoration and management, that have resulted in the recovery of thousands of acres of critical estuarine and upland habitats. Much of this work originated with the development of the Tampa Bay Habitat Master Plan and its recent Update. The TBEP began by examining the net losses of emergent tidal wetlands including mangrove forests, salt marshes and salt barrens within *Setting Priorities for Tampa Bay Habitat Protection and Restoration: Restoring the Balance* (Lewis and Robison, 1995). The study analyzed trends in emergent marine and estuarine wetland losses by comparing 1950 (baseline) with 1990 information, utilizing interpretation of aerial photography and land use classifications. The study determined that there have been disproportionate losses (a greater loss on a percentage basis) of certain habitat types within the Tampa Bay watershed, thus requiring additional protection and restoration of those habitats. It examined the importance of habitat ratios, or relative proportions of the different types of habitats, based on the assumption that a full suite of habitat types is essential to adequately support groups of organisms with similar habitat needs (guilds) and that a disproportionate loss of any habitat type may present a "bottleneck" for species that depend upon that habitat at some cycle of its life. Ultimately, the study recommended various protection and restoration strategies and goals to 'restore the balance' of estuarine habitat types within the watershed.

Elements of the "Restoring the Balance" document were subsequently incorporated into the original Comprehensive Conservation and Management Plan (CCMP) for Tampa Bay, entitled *Charting the Course* (TBEP 2006). The CCMP, which guides the overall protection and restoration of Tampa Bay, was formally adopted by the TBEP in 1996. It identified specific measurable goals for bay improvement in five areas: Water &

Sediment Quality, Bay Habitats, Fish & Wildlife, Dredging & Dredged Material Management, and Spill Prevention & Response. Within the Bay Habitats area, eight action items (BH-1 through BH-8) were identified to restore an optimum balance of seagrass, wetland and upland habitats for fish and wildlife, while protecting and enhancing existing habitats. The *Charting the Course* CCMP was subsequently updated in 2006, and this update included seven actions under the Bay Habitats Action Plan.

The original “Restoring the Balance” study was updated in 2010 by the TBEP as the Tampa Bay Estuary Program Habitat Master Plan Update (Robison 2010). The overall goal was to implement action BH-1, the stepwise strategy for implementing the Tampa Bay Master Plan for Habitat Protection and Restoration. The 2010 document developed updated habitat restoration and protection targets for estuarine habitats, following the “Restore the Balance” paradigm. This approach was recommended as recent updates to the bay-wide inventory of habitat demonstrated that some tidal wetland habitats continued to have disproportionate losses. In addition to establishing updated targets, the Habitat Master Plan Update recommended conducting a similar analysis for other critical habitat types, including freshwater wetlands. This high priority recommendation was adopted by the Tampa Bay scientific, management and elected community and served as the driver for this study.

1.1.2 Freshwater Wetlands Inventory in Hillsborough County

Following the above focus on restoring the balance within estuarine wetlands, ecologists at the Environmental Protection Commission of Hillsborough County (EPCHC) expanded this analysis to similarly study freshwater wetlands within Hillsborough County. This study compared three categories of freshwater wetland habitats (herbaceous, mixed hardwood, and cypress) present in pre-development and 1999 conditions (Stetler, R. et. al., 2003). The study concluded that within Hillsborough County, approximately 46% of freshwater wetlands had been lost, and that the greatest disproportionate loss was to cypress, estimated at 71%. This study provided valuable information regarding freshwater wetland impacts; however, it was limited to wetlands within Hillsborough County.

1.1.3 Development of a Coordinated Watershed Approach to Compensatory Mitigation in the Tampa Bay Watershed

The Development of a Coordinated Watershed Approach to Compensatory Mitigation in the Tampa Bay Watershed (Compensatory Mitigation) study was formulated to implement a high priority recommendation of the Tampa Bay Habitat Master Plan Update. The project proposal was submitted to and funded by a U.S. Environmental Protection Agency (EPA), Region IV Wetland Development Grant. The project goals were to: 1) develop watershed and basin-specific goals, targets and performance standards for freshwater wetland habitats; 2) direct wetland restoration and compensatory mitigation activities to identified priority sites within the Tampa Bay watershed; and 3) improve federal-state-local interagency coordination related to wetland resource regulation, restoration and management. The project directly addresses a recommendation from the Habitat Master Plan Update to establish a linkage between regulatory mitigation and publicly-funded habitat restoration. In addition, the project addresses the national and regional EPA priority area: *Improving the Effectiveness of Compensatory Mitigation: Support projects that incorporate a comprehensive watershed management approach for accomplishing wetland and aquatic resource protection/restoration goals by integrating multiple new or existing water quality program tools and/or authorities.*

The project was divided into two major phases. The first phase included the majority of the technical aspects, which were performed by a team of researchers from the University of South Florida (USF) and The Balmoral Group (Balmoral) (collectively referred to as the USF Team). The USF Team created the mapping products for both the historic and current conditions, completed wetland change analyses for the watershed, and developed a screening tool based on landscape development intensity and other factors. Those results are summarized below and were used to guide the second phase, which included wetland change analysis by basin, the development of protection and restoration targets; identification of high-priority areas for restoration or mitigation; and coordination with regulatory agencies. Those research tasks formed the basis of this initiative and are summarized within this freshwater wetland master plan.

1.1.4 USF Team Freshwater Wetland Change Analysis

The first phase of the compensatory mitigation study was completed by the USF Team. The study area, the Tampa Bay watershed, is shown in **Figure 1-1** and the final report

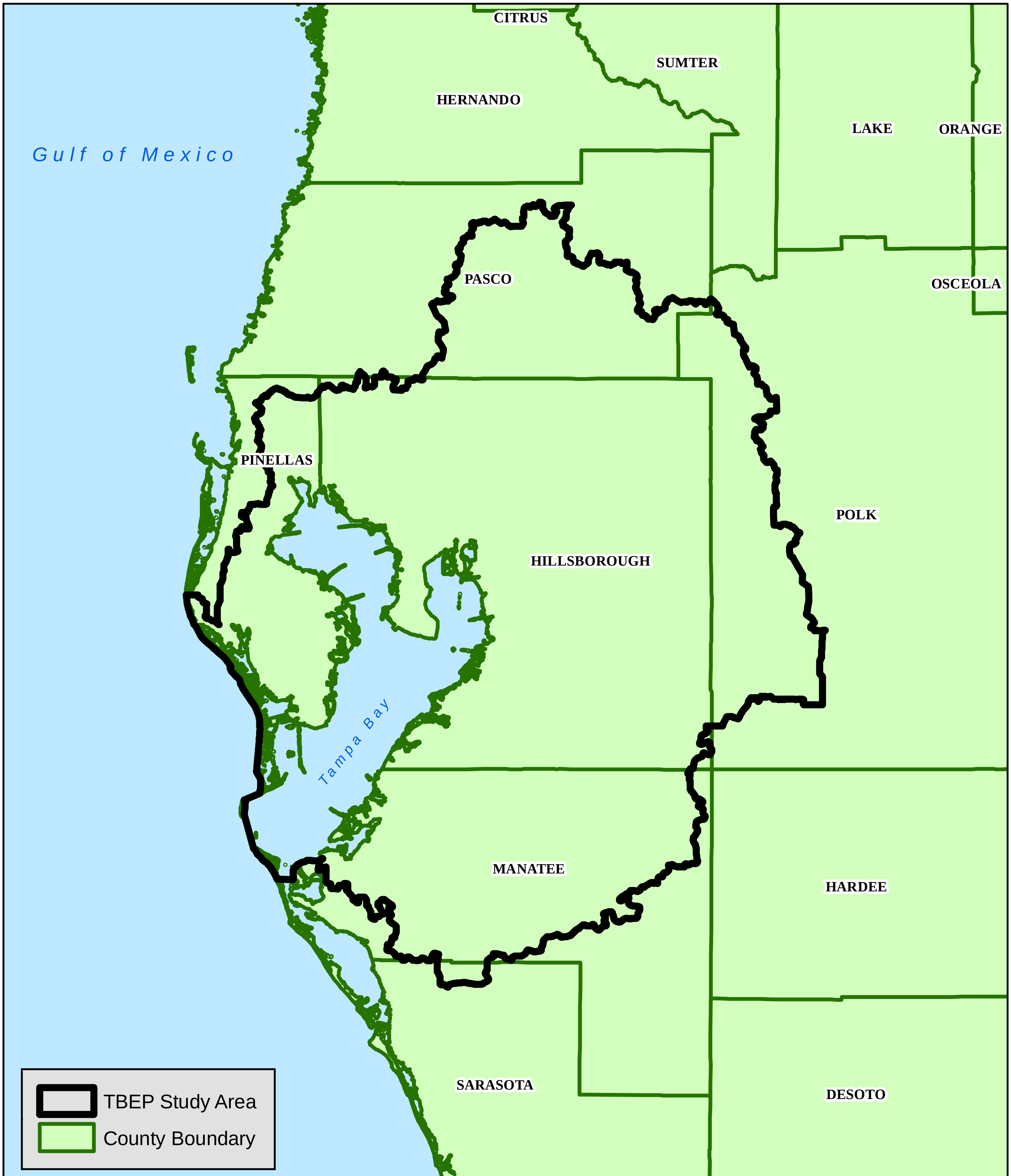

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Figure 1-1
Tampa Bay Watershed Boundary Map

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan

0 12 24 36 Miles

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Data Source:
- TBEP
- USF
Imagery Source:
- ESRI Base Map

Coordinate System:
NAD 1983 Florida
State Plane West

(Rains et al., 2012 and Rains et al., 2013) outlines the results of the following specific objectives:

- Geographic Information Systems (GIS) analysis and mapping of historical changes to freshwater wetland habitats comparing 1950 to 2007;
- Change analysis to identify changes in extent, structure, function and quality of wetlands;
- Conditional assessment to assess the state and condition of existing wetlands; and
- Development of a screening tool for use in prioritizing restoration, mitigation and preservation targets.

Historic and current wetlands mapped

1950 was chosen as the historic baseline for wetlands because adequate spatial datasets existed and because this time period was used as the benchmark for estuarine habitats in the previous "Restoring the Balance" study. While this period preceded extensive build-out in the watershed, development of large urban areas along the coastline, including the City of Tampa and much of Pinellas County, had already occurred and lead to losses in wetlands coverage prior to 1950s. The USF Team obtained data from various agencies and georeferenced unreferenced imagery using ArcMap toolsets. Wetland features were delineated using a 1990 Southwest Florida Water Management District (SWFWMD) land use/land cover (LULC) layer. Wetland structure and function were determined, if possible. The current wetland inventory was developed using 2007 LULC data from SWFWMD, excluding extractive (mining) land use.

Six wetland categories were assigned based on hydrologic association (lacustrine, riverine, other) and categories of structure (forested or non-forested). A crosswalk between structural classification, Florida Land Use Cover and Forms Classification System (FLUCCS) and National Wetlands Inventory (NWI) was also created. For the riverine category, this included wetlands that were within 100 meters of flowline features from the National Hydrography Database. Lacustrine wetlands were classified as those that fell within or touched the boundaries of a lake/pond (>20 acres in size) or fell within 30 meters of a previously classified lacustrine wetlands (Rains et al., 2012). If a wetland fit neither of these conditions, it was classified as "other." While more detailed FLUCCS data was available for the 2007 mapping product, this same level of wetland classification was not available for the 1950s products; therefore, all wetland classifications were aggregated to the six categories, based on structure and hydrologic association.

Wetland losses significant in some areas

Maps were created of 1950s and 2007 wetlands coverage. A wetland change analysis was used to describe structural changes to wetland boundaries and transformations in classification types between 1950s and 2007 within 32 sub-basins in the Tampa Bay watershed. This was conducted as an analysis of change to individual wetland boundaries and aggregate summary of changes within the watershed.

The study reported results by wetland type, basin, and by the watershed as a whole. Changes to wetland acreage varied by wetland type, as well as drainage basin. Based on hydrologic classification, the largest losses occurred with lacustrine, followed by riverine wetlands. The largest losses by drainage basin occurred in the eastern portions of the watershed that were less heavily developed during the baseline period. The study concluded that approximately 33% of freshwater wetlands have been lost watershed-wide, and the greatest disproportionate loss was to lacustrine wetlands, estimated at 49% watershed-wide. Both the area and percentage lost were higher for non-forested wetlands. The report and publication further examine the degree of freshwater wetland change by 32 sub-basins located within the Tampa Bay watershed

Screening tools will aid in target-setting

A suite of screening tools was developed to aid in the setting of protection and restoration targets and to direct future protection or restoration towards the most appropriate areas. These screening criteria can be applied to the GIS layers to examine specific locations or local priorities. For each of the criteria, a scale of 1 (best condition) to 5 (worst condition) was applied. Landscape development intensity (LDI) was used as a proxy for wetland condition. The correlation between LDI and field-verified assessment of surrounding land use from the Uniform Mitigation Assessment Methodology (UMAM) suggests good agreement (Brown and Vivas method). The utility of LDI scores as a function of wetland quality was verified through field visits to 37 wetland sites throughout the study area. Trained wetland scientists at the EPCHC compared LDI and field-assessed UMAM wetland functional scores. The validation showed that the LDI was strongly correlated with the UMAM and, therefore, was an appropriate proxy for wetland condition (Rains et al., 2012). The criteria include:

- Wetland loss (all types)
- Wetland loss (by type)
- Wetland condition (all types)
- Wetland condition (by type)
- Wetland hydrologic connectivity
- Future planned development

The screening criteria will be a useful tool, when used in concert with other mapping products and layers, by both public and private agencies. For example, protection of good condition wetlands may be a higher priority in less-developed areas, whereas targeted mitigation or restoration of moderate quality wetlands to provide ecosystem services such as nutrient attenuation may be more applicable in areas with significant losses (**Appendix A**). Application of the various screening criteria allows these specific searches to address local priorities.

1.2 GOALS AND OBJECTIVES

This study builds upon the results achieved within the USF Team project phases and had the following primary objectives:

- Aggregation and analysis of data by Environmental Resource Permit (ERP) basin boundaries;

- Establishment of restoration and protection targets for various freshwater wetland habitat types by basin;

- Development of screening tools to aid public and private agencies in identifying appropriate locations for freshwater wetland restoration or protection, based on soil types, existing land uses and nearby conservation areas; and

- Achieving consensus with the targets and overall restoration plan from local, state and federal regulatory agencies.

1.3 PROJECT ADVISORY GROUP

The Project Advisory Group consisted of members representing various cooperating agencies and entities throughout the Tampa Bay watershed project area. Routine presentations of the project information were made to members of this group throughout the project development process. Their valuable input, in the form of questions and comments regarding the information presented at each meeting and to written materials, provided the platform for modifying the information and decisions made during the project. Their role was integral to the overall success of the project.

Process guidance and support was provided by the EPCHC through field-verification of the landscape development index data for the USF Team, input on land use/land cover coding as it relates to the suitability of lands for restoration purposes, and providing monitoring information for mitigation sites within the county.

Regulatory perspectives were provided by members of the Project Advisory Group that had professional experience working within various regulatory agencies. Guidance related to the use of FLUCCS versus other land cover mapping approaches, non type-for-type mitigation, and use of other mitigation strategies was also provided. The project team also received input from a mitigation banker and modified regulatory recommendations to improve compatibility with mitigation banking protocols.

Coordination between all Project Advisory Group members resulted in other mutually beneficial outcomes that support the overall goals of the project, including:

- Development of a Low Impact Development (LID) stormwater manual for Pinellas County, highlighting the mutual habitat and water quality benefits of protecting and restoring urban freshwater wetlands (partial funding provided by TBEP) (**Appendix B**) ;and
- Acquisition of grant funding to expand the mapping and analysis of freshwater wetlands to include all of Manatee County (**Appendix C**).

1.4 BASIS OF PLAN

The following chapters outline the approach taken in developing this master plan for freshwater wetlands within the Tampa Bay watershed. First, the GIS datasets compiled and provided by the USF Team were analyzed using the ERP basin boundaries. This was done to address the overall regulatory objectives of the study by examining freshwater wetland changes within individual ERP basins. This was an attempt to "speak the same language" as the regulatory agencies, as wetlands impacted are typically mitigated for in the same basin as where impacts occurred. Next, restoration targets were developed and analyzed for each ERP basin (**Figure 1-2**). Strategies for achieving these goals were then developed and presented to regulatory agency personnel for input and consensus. This report documents this process and it is the hope of the TBEP that the master plan will be utilized and adopted, when appropriate, by regulatory agencies that govern compensatory mitigation decisions within the Tampa Bay watershed.

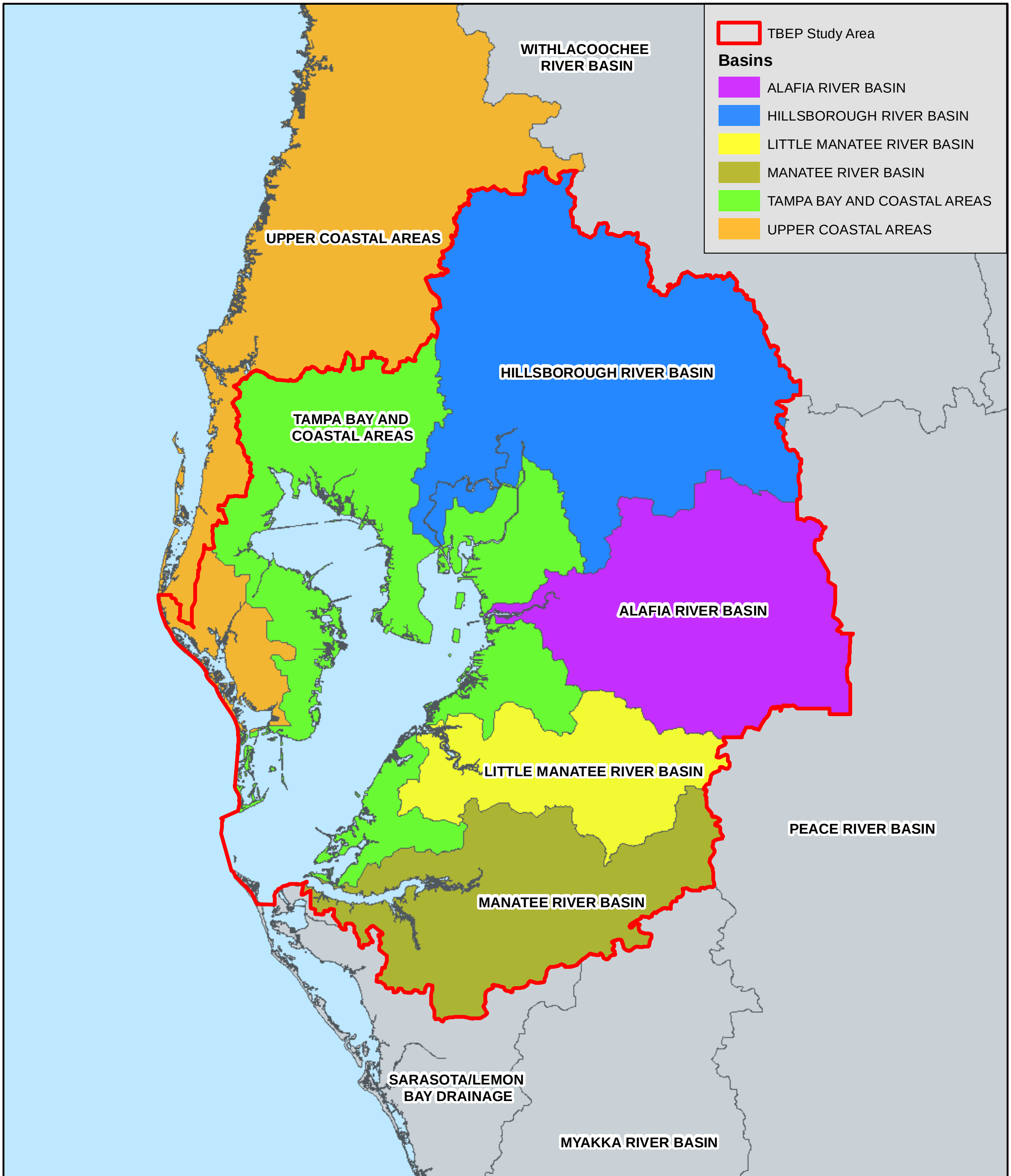

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Figure 1-2
ERP Drainage Basins within Study Area Map

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan

Feet
0 58,250 116,500 174,750

N

Data Source:
- TBEP
- USF
Imagery Source:
- ESRI Base Map

Coordinate System:
NAD 1983 Florida State Plane West

Date: 12/30/2013 Rev. Date: n/a PM: SSK GIS Analyst: GdA Map Document: TBEP_ERP_Basins_within_StudyArea_A_gda_20131230.mxd Project Number: 2470 PDF Document: TBEP_ERP_Basins_within_StudyArea_A_gda_20131230.pdf Plot Size: 8.5 x 11

2.0 FRESHWATER WETLAND GAINS AND LOSSES IN WATERSHEDS SURROUNDING TAMPA BAY

2.1 OVERALL TRENDS IN THE TAMPA BAY AREA

Change analysis for the entire watershed had been previously completed as part of the USF Team study and is revisited here to overview the entire watershed. **Table 2-1** below shows the change in wetlands from 1950 to 2007, aggregated for the entire watershed.

Table 2-1 Aggregate Wetland Change Analysis (adapted from Rains et al., 2012)

Wetland Type	1950 Wetland Area (ac)	2007 Wetland Area (ac)	Wetland Change 1950 - 2007 ac (%)
Lacustrine Forested	11,144.4	6,498.9	-4,645.6 (-42%)
Other Forested	24,068.0	19,076.5	-4,991.5 (-21%)
Riverine Forested	168,303.2	122,514.7	-45,788.6 (-27%)
Total all Forested Wetlands	**203,515.7**	**148,090.0**	**-55,425.7 (-27%)**
Lacustrine Non-Forested	12,355.3	5,510.4	-6,844.8 (-55%)
Other Non-Forested	27,922.9	19,397.7	-8,525.1 (-31%)
Riverine Non-Forested	70,350.8	38,326.0	-32,024.8 (-46%)
Total all Non-Forested wetlands	**110,628.9**	**63,234.2**	**-47,394.7 (-43%)**
Total Wetlands of All Types	**314,144.6**	**211,324.2**	**-102,820.4 (-33%)**

According to the analysis, approximately 33% of all wetlands have been lost during this time frame within the study area. In structure type, the non-forested wetlands have been disproportionately lost at 43%. The difference in losses between hydrologic classifications of wetlands is also shown: 33% for riverine, 49% for lacustrine, and 26% for other. Of the hydrologic classifications, lacustrine wetlands have been disproportionately lost.

This study expands upon the change analysis completed in the first phase. While the data remains the same, the project team has partitioned the data within the ERP basins to provide relevant information for regulatory agencies. The remaining discussion presents wetland losses and gains within the six ERP basins in the Tampa Bay watershed. The wetland change information within the six categories may be useful in determining the type of wetlands that could be restored within an individual ERP basin, based on acreage or proportional losses. Maps of overall wetland gains or losses by ERP basin are reported only as forested or non-forested category, rather than by the six categories. This is because impacts to freshwater wetlands, and subsequent compensatory mitigation requirements, are only classified as forested and non-forested categories by agencies that permit wetland impacts and mitigation.

2.2 ANALYSIS OF TOTAL LOSSES WITHIN EACH BASIN

2.2.1 Alafia River Basin

Within the Alafia River Basin, a total of 56% of the freshwater wetlands were estimated to be lost in the 57 years between 1950 and 2007 (**Table 2-2**). Of the total losses in this basin, 61% of the non-forested wetlands (17,622 acres) and 53% of the forested wetlands (26,821 acres) were estimated to be lost to various factors of drainage modification, development or other forms of land alteration.

Table 2-2 Changes in Freshwater Wetlands in the Alafia River Basin, by Wetland Function Classification

	1950	2007	Change Between 1950 & 2007
USF Team Classification	**Acres**	**Acres**	**Acres**
Forested/Lacustrine	3,216	382	**-2,834**
Forested/Other	3,961	1,544	**-2,417**
Forested/Riverine	43,314	21,743	**-21,571**
Forested Subtotal	50,491	23,670	**-26,821**
Non-Forested/Lacustrine	4,759	1,252	**-3,507**
Non-Forested/Other	4,613	3,945	**-668**
Non-Forested/Riverine	19,424	5,977	**-13,447**
Non-Forested Subtotal	28,796	11,175	**-17,622**
Total	**79,288**	**34,845**	**-44,443**

The forested wetland area loss was the greatest in the riverine category, equaling 21,571 acres and representing a 50% loss; however, the largest percentage loss within the forested habitats of the Alafia River Basin was 88% of the lacustrine wetlands or 2,834 acres. An additional 61% of the remaining forested undefined habitat category, a total of 2,417 acres, was also determined to be lost or converted to a non-wetland land form.

The non-forested wetland losses were estimated at 74% for the lacustrine and 69% of the riverine systems, while only 14% of the remaining category of non-forested wetland function, non-forested/other, was lost during this time period. **Figure 2-1** represents the change data graphically, incorporating total forested gains and losses and total non-forested gains and losses.

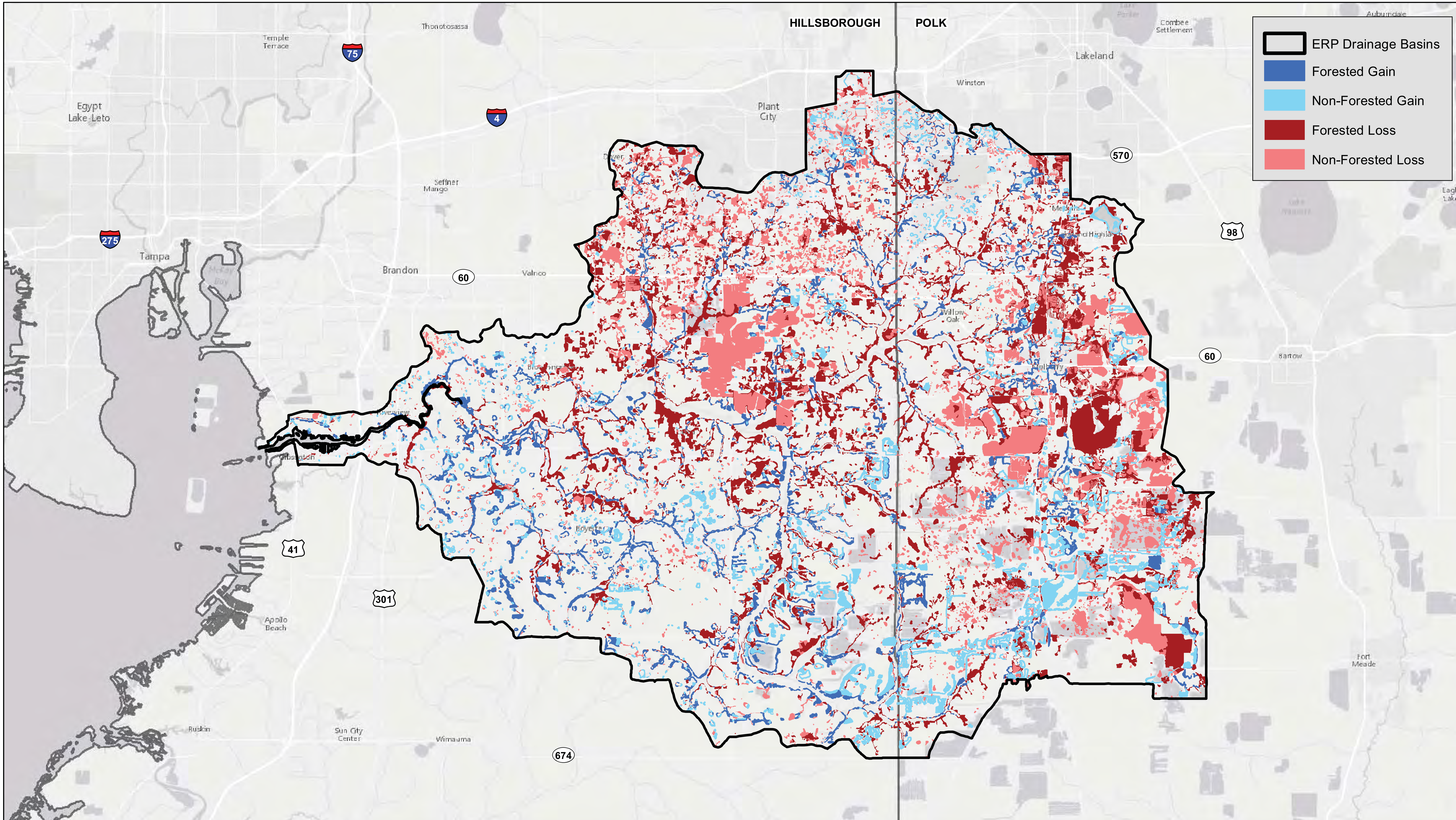

Figure 2-1
Changes in the Alafia River Basin; Wetland Gains and Losses by Habitat Type

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough and Polk Counties, Florida

0 3 6 9 Miles

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Data Source:
-TBEP
-USF
-Scheda
Imagery Source:
-ESRI Gray Canvas

Coordinate System:
NAD 1983 Florida
State Plane West

2.2.2 Hillsborough River Basin

A total of 32% of the wetland systems were lost in the Hillsborough River Basin during the study time period (**Table 2-3**). The percentage loss of wetlands was estimated to be 32% of the forested systems and 34% of the non-forested freshwater wetlands.

Table 2-3 Changes in Freshwater Wetlands in the Hillsborough River Basin, by Wetland Function Classification

	1950	2007	Change Between 1950 & 2007
USF Team Classification	**Acres**	**Acres**	**Acres**
Forested/Lacustrine	3,925	2,039	**-1,886**
Forested/Other	13,065	11,504	**-1,561**
Forested/Riverine	82,398	54,430	**-27,968**
Forested Subtotal	99,388	67,973	**-31,415**
Non-Forested/Lacustrine	5,057	3,138	**-1,919**
Non-Forested/Other	12,090	9,536	**-2,554**
Non-Forested/Riverine	24,046	14,676	**-9,370**
Non-Forested Subtotal	41,192	27,349	**-13,843**
Total	**140,580**	**95,322**	**-45,258**

The 31,415 acres of forested freshwater wetland loss was greater than the non-forested losses, in terms of total acreage, however, it was smaller in terms of percentage. It was dominated by the estimated loss of 27,968 acres, or 34%, of forested riverine systems in the basin. An additional 1,886 forested lacustrine acres, 48% of the basin total in 1950 were lost; representing a higher percentage of this forested category based on hydrologic association, but represented a much smaller area. Of the undefined forested wetland systems in the basin, 1,561 acres, equaling 12%, were also converted to a non-wetland land use category.

The estimated 34% loss of total non-forested wetland systems between 1950 and 2007 in this basin equals 13,843 acres. The non-forested wetland losses were also the greatest for both acreage and proportion in this basin in the riverine systems, equaling 9,370 acres or 39% of the 1950 coverage for this category, while the lacustrine and undefined non-forested categories lost 1,919 acres (38%) and 2,554 acres (21%), respectively. **Figure 2-2** represents the change data graphically.

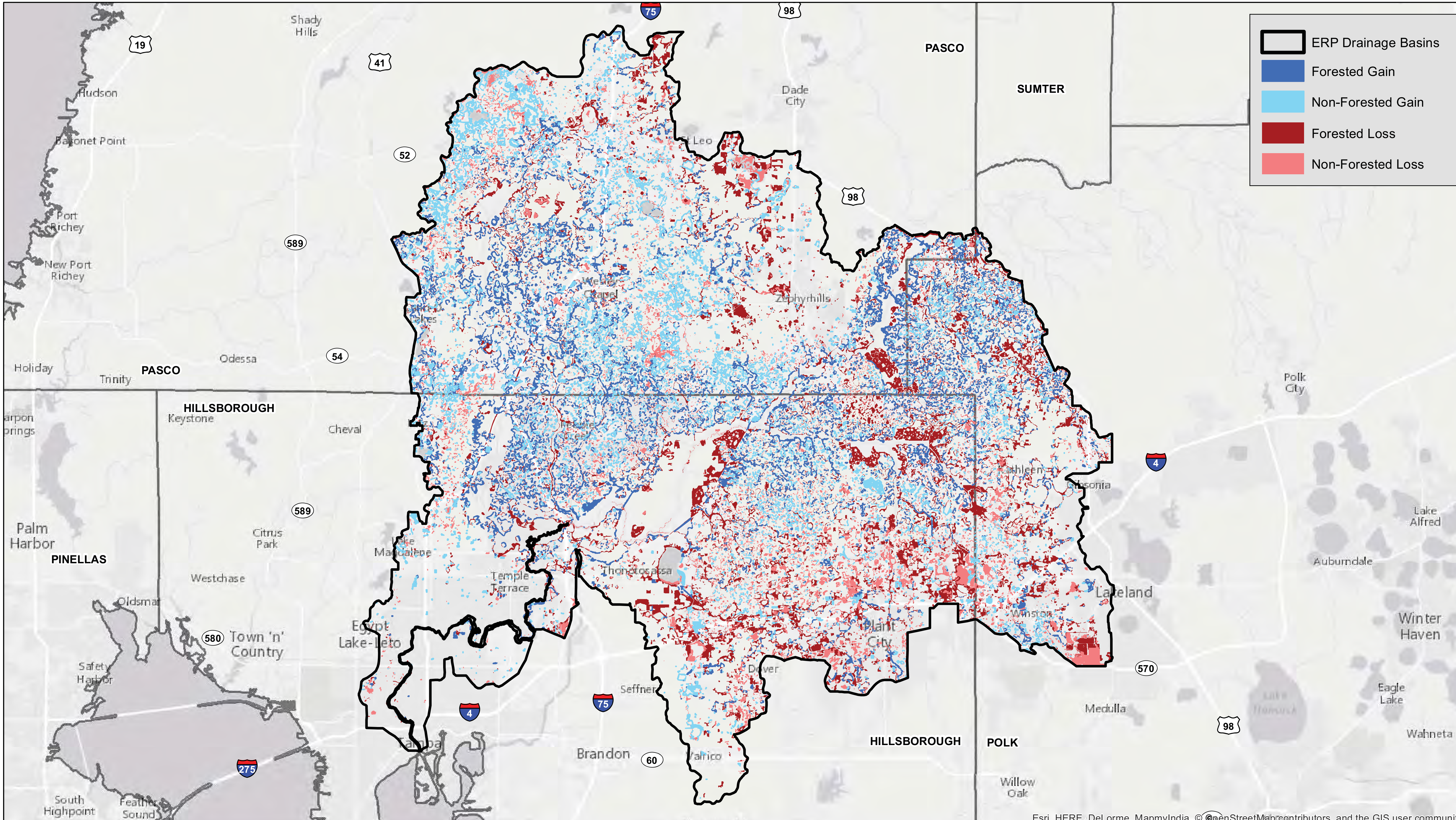

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Figure 2-2
Changes in the Hillsborough River Basin; Wetland Gains and Losses by Habitat Type

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough, Pasco and Polk Counties, Florida

0 4 8 12 Miles

N

Data Source:
-TBEP
-USF
-Scheda
Imagery Source:
-ESRI Gray Canvas

Coordinate System:
NAD 1983 Florida
State Plane West

2.2.3 Little Manatee River Basin

The analysis of the Little Manatee River Basin revealed an observed increase in the area of all three forested hydrologic categories (**Table 2-4**). The total basin wide loss of wetland was only 1%, or 203 acres. This total included a gain of 2,913 acres of forested habitat types and a loss of 3,116 acres of non-forested wetland habitats.

Table 2-4 Changes in Freshwater Wetlands in the Little Manatee River Basin, by Wetland Function Classification

	1950	2007	Change Between 1950 & 2007
USF Team Classification	**Acres**	**Acres**	**Acres**
Forested/Lacustrine	90	173	**83**
Forested/Other	696	866	**170**
Forested/Riverine	10,291	12,951	**2,660**
Forested Subtotal	11,077	13,990	**2,913**
Non-Forested/Lacustrine	508	65	**-443**
Non-Forested/Other	2,346	1,232	**-1,113**
Non-Forested/Riverine	5,875	4,316	**-1,559**
Non-Forested Subtotal	8,729	5,613	**-3,116**
Total	**19,805**	**19,602**	**-203**

Within the forested habitat categories, the greatest change was in the riverine systems for which an estimated 2,660 acres of wetlands were gained. Overall, an increase of 2,913 acres of forested wetlands was estimated over the 1950 acreage estimate. This represented an increase of 26% of this forested/riverine system type. An additional 93% increase equaling 83 acres for forested-lacustrine, and 24% increase equaling 170 acres for forested-undefined, were also estimated within this basin.

The non-forested systems in the 2007 reference data were estimated to have lost 36% of their coverage since the 1950 period. This equals a 3,116-acre loss. Within the three hydrologic categories of the non-forested wetlands, the losses equaled 1,559 acres (27%) of riverine, 1,113 acres (47%) of undefined, and 443 acres (87%) of lacustrine. The herbaceous acreage losses were greatest in the river-based systems; however, the percentage loss was much higher in the lake-based systems. **Figure 2-3** represents the change data graphically.

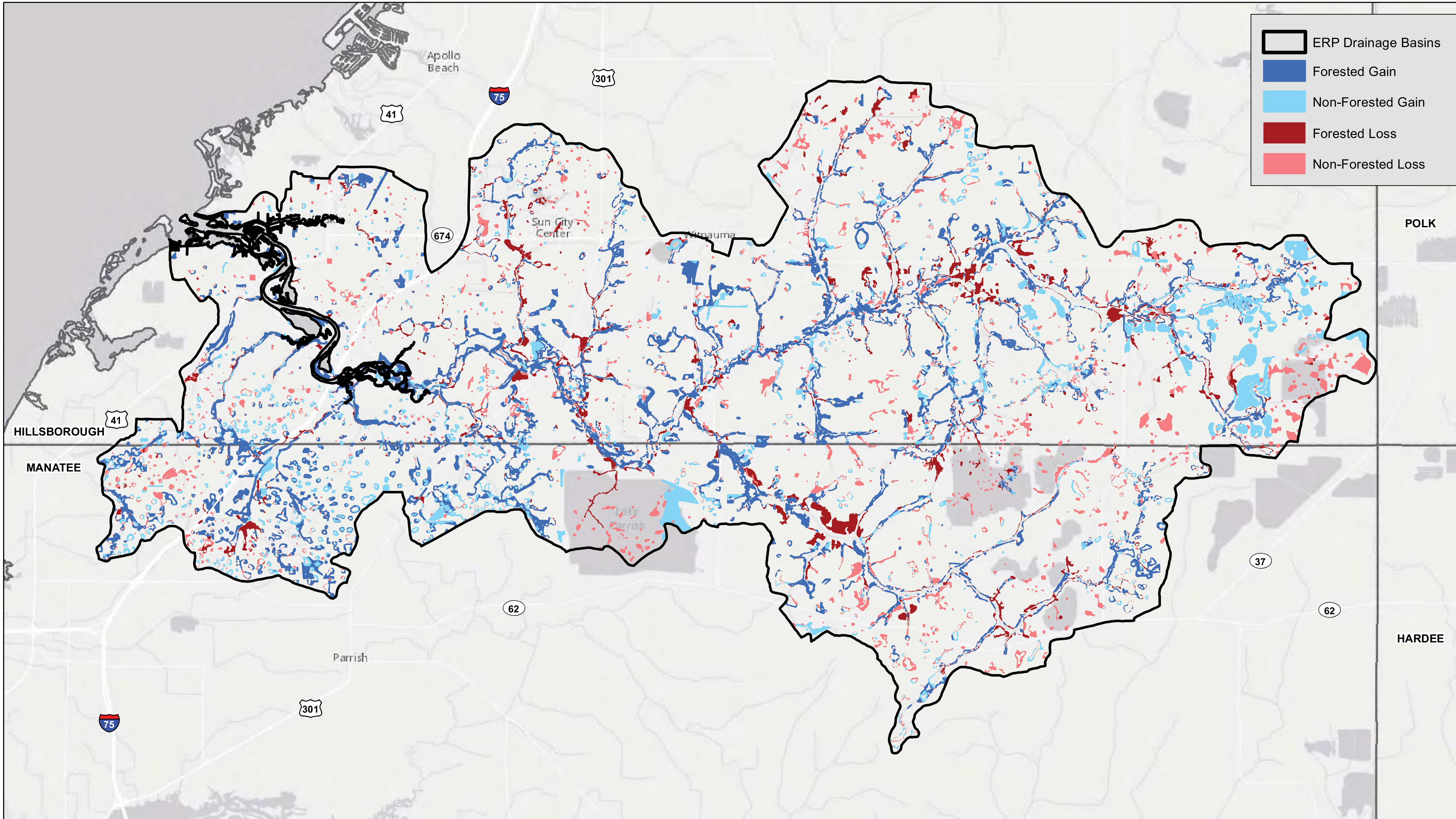

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Figure 2-3

Changes in the Little Manatee River Basin; Wetland Gains and Losses by Habitat Type

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough and Manatee Counties, Florida

0 2 4 6 Miles

N

Data Source:
-TBEP
-USF
-Scheda
Imagery Source:
-ESRI Gray Canvas

Coordinate System:
NAD 1983 Florida
State Plane West

2.2.4 Manatee River Basin

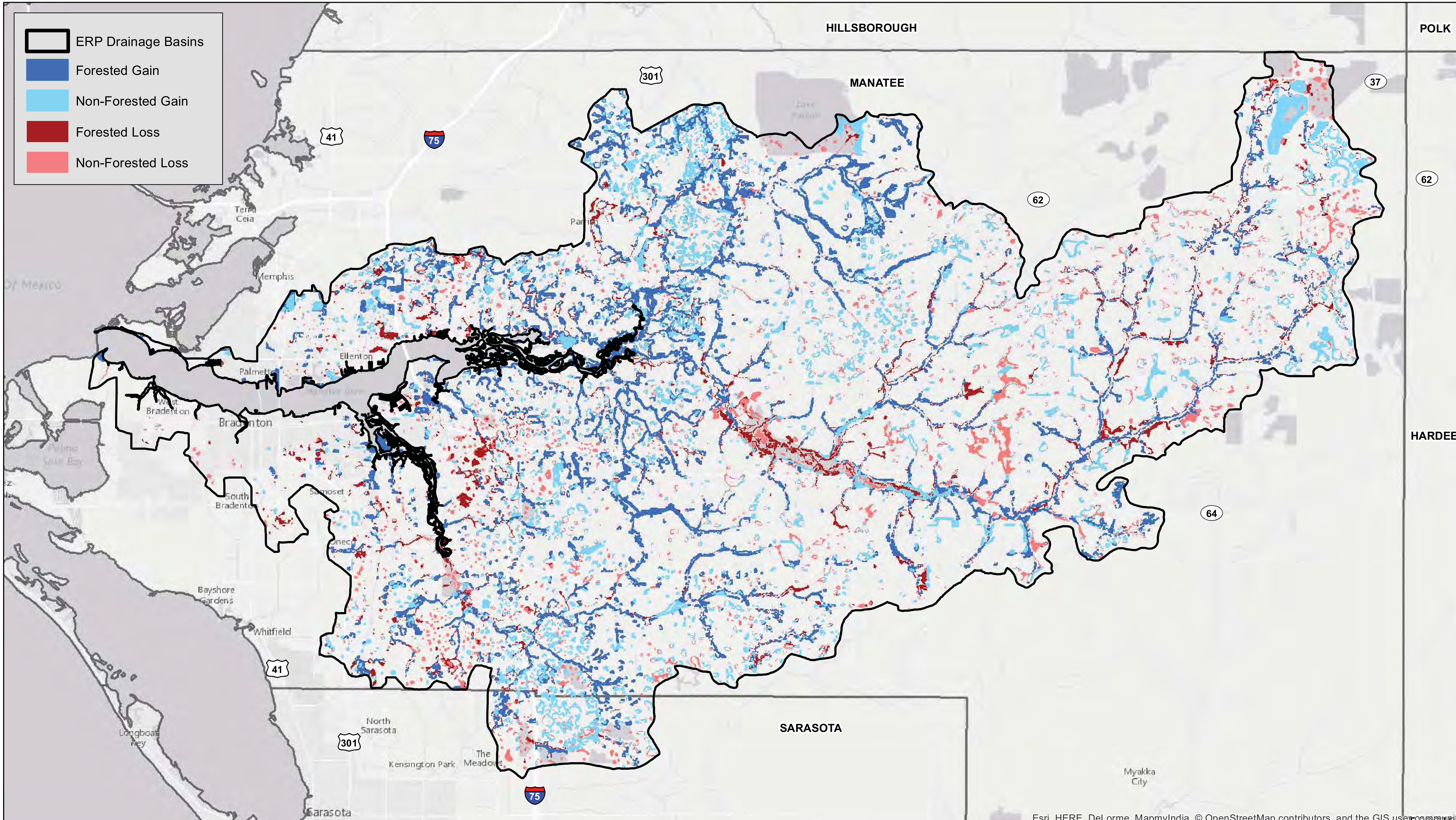
An increase in the acreage of the forested-riverine habitat type was also observed in the Manatee River Basin (**Table 2-5**). Overall, there was an 8% loss in all the wetland categories totaling 2,412 acres. This total included an increase of 2,506 acres of forested habitat types and a decrease of 4,918 acres of non-forested types.

Table 2-5 Changes in Freshwater Wetlands in the Manatee River Basin, by Wetland Function Classification

	1950	2007	Change Between 1950 & 2007
USF Team Classification	**Acres**	**Acres**	**Acres**
Forested/Lacustrine	330	168	**-162**
Forested/Other	1,355	1,251	**-103**
Forested/Riverine	12,921	15,692	**2,771**
Forested Subtotal	14,605	17,111	**2,506**
Non-Forested/Lacustrine	485	169	**-315**
Non-Forested/Other	4,244	2,276	**-1,968**
Non-Forested/Riverine	11,663	9,029	**-2,635**
Non-Forested Subtotal	16,392	11,474	**-4,918**
Total	**30,997**	**28,585**	**-2,412**

The forested wetland gain was solely due to an increase of 2,771 acres of riverine forested systems, offsetting a decrease of 162 and 103 acres of forested lacustrine and forested undefined habitats, respectively. Due to the differing sizes of the forested type acreages in the 1950 area estimates, this increase of forested riverine systems was 21%, while the decreases in forested/lacustrine and forested/other were 49% and 8%, respectively.

Within the non-forested wetland systems for the Manatee River Basin, the combined decrease of 4,918 acres, or 30%, included 2,635 acres of riverine (23%) and 1,968 acres of undefined (46%). While only 315 acres of non-forested lacustrine wetlands were lost, this represented 65% of the 1950 estimated amount for this wetland type. **Figure 2-4** represents the change data graphically.



SCHEDA ECOLOGICAL ASSOCIATES

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All data within this map are supplied as is, without warranty. This product has not been prepared for legal, engineering, or survey purposes. Users of this information should review or consult the primary data sources to ascertain the usability of the information.

Figure 2-4

Changes in the Manatee River Basin; Wetland Gains and Losses by Habitat Type

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Manatee and Sarasota Counties, Florida

0 2.5 5 7.5 Miles

N

Data Source:
-TBEP
-USF
-Scheda
Imagery Source:
-ESRI Gray Canvas

Coordinate System:
NAD 1983 Florida
State Plane West

2.2.5 Tampa Bay and Coastal Areas Basin

Changes in the freshwater wetlands within the boundaries of the Tampa Bay and Coastal Areas Basin totaled a decrease of 9,381 acres, which is 22% of the 1950 wetland estimates (**Table 2-6**). This represents a 49% decrease of the non-forested wetlands, but only an 8% decrease in forested wetlands.

Table 2-6 Changes in Freshwater Wetlands in the Tampa Bay and Coastal Areas Basin, by Wetland Function Classification

	1950	2007	Change Between 1950 & 2007
USF Team Classification	**Acres**	**Acres**	**Acres**
Forested/Lacustrine	3,567	3,721	**154**
Forested/Other	4,785	3,883	**-902**
Forested/Riverine	18,914	17,432	**-1,482**
Forested Subtotal	27,266	25,036	**-2,230**
Non-Forested/Lacustrine	1,527	882	**-645**
Non-Forested/Other	4,243	2,348	**-1,895**
Non-Forested/Riverine	8,824	4,213	**-4,611**
Non-Forested Subtotal	14,594	7,443	**-7,151**
Total	**41,860**	**32,479**	**-9,381**

The total 8% decrease in forested habitat types was more represented in acreage by the riverine systems, equaling 1,482 acres (8%), while the forested/other habitats lost a greater percentage at 902 acres (19%). The change analysis did indicate a 4% increase in forested lacustrine wetland coverage, with 154 acres gained since 1950.

The decrease in non-forested wetlands was relatively equal in percentage losses among the three habitat types; however the largest portion of this non-forested loss was in the riverine systems due to the greater overall 1950 acreage estimate for this wetland category. The non-forested/riverine systems lost 4,611 acres (52%). The non-forested/other habitat category lost 1,895 acres (45%). The non-forested/lacustrine wetlands lost 645 acres (42%). **Figure 2-5** represents the change data graphically.

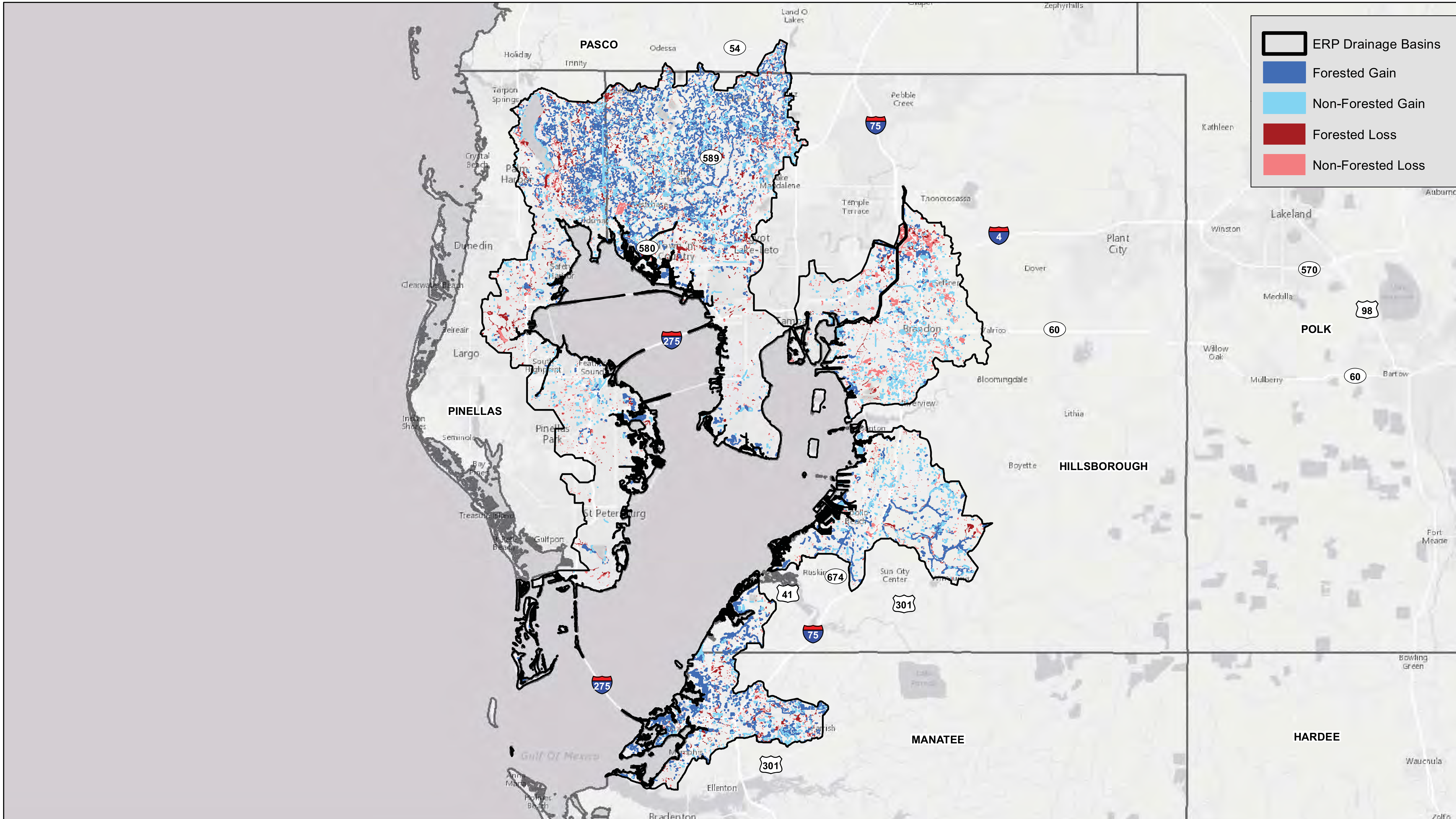

Figure 2-5

Changes in the Tampa Bay and Coastal Areas Basin; Wetland Gains and Losses by Habitat Type

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough, Manatee, Pasco, and Pinellas Counties, Florida

2.2.6 Upper Coastal Areas Basin

Analysis of the Upper Coastal Areas Basin was limited to the portion of the basin that is within the defined Tampa Bay watershed. Within this area, there was an overall estimated 65% loss of wetland habitat types equaling 808 acres within this basin, which is the smallest basin area investigated (**Table 2-7**). Of this, there was an 80% loss of non-forested types and a 46% loss of forested habitat types.

Table 2-7 Changes in Freshwater Wetlands in the Upper Coastal Areas Basin, by Wetland Function Classification

	1950	2007	Change Between 1950 & 2007
USF Team Classification	**Acres**	**Acres**	**Acres**
Forested/Lacustrine	27	12	**-16**
Forested/Other	208	35	**-172**
Forested/Riverine	321	251	**-69**
Forested Subtotal	555	298	**-257**
Non-Forested/Lacustrine	9	11	**2**
Non-Forested/Other	380	49	**-331**
Non-Forested/Riverine	296	74	**-222**
Non-Forested Subtotal	685	134	**-551**
Total	**1,240**	**432**	**-808**

The forested wetland losses were largest in the forested/other category, totaling 172 acres for an 83% loss. The riverine systems lost 69 acres over the study timeframe which equaled 22% of the 1950 estimated area. The forested/lacustrine changes were estimated at a decrease of 16 acres, representing 57% of the 1950 total coverage for this wetland category.

The non-forested wetland losses included a 222-acre riverine type loss, representing a 75% decrease, and a 331-acre undefined forested habitat loss, representing an 87% decrease. However, a minimal 2-acre addition in non-forested lacustrine area was detected, and this represents a 22% increase within this portion of the basin. **Figure 2-6** represents the change data graphically.

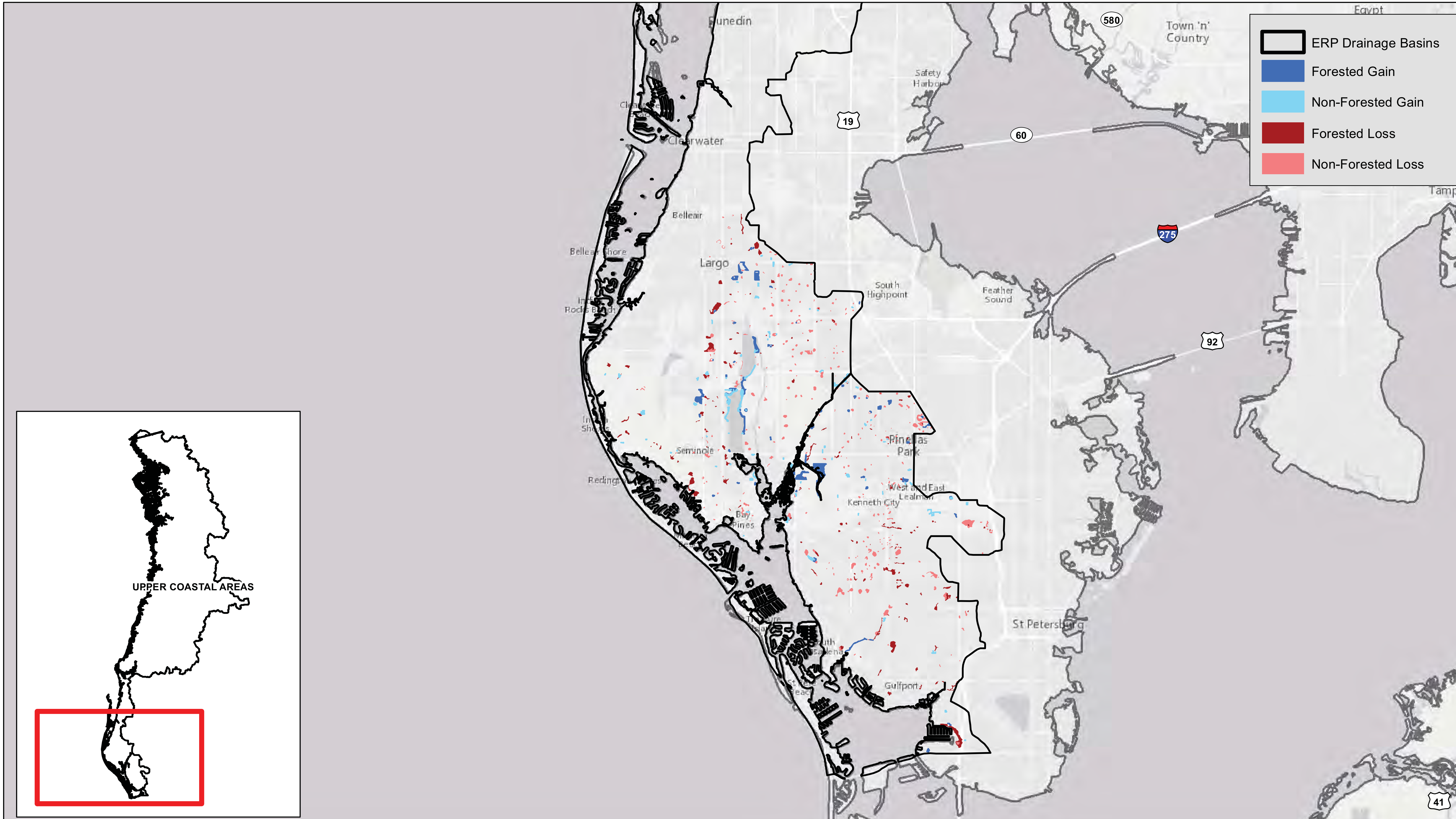

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Figure 2-6
Changes in the Upper Coastal Areas Basin; Wetland Gains and Losses by Habitat Type

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Pinellas County, Florida

0 2.5 5 7.5 Miles

N

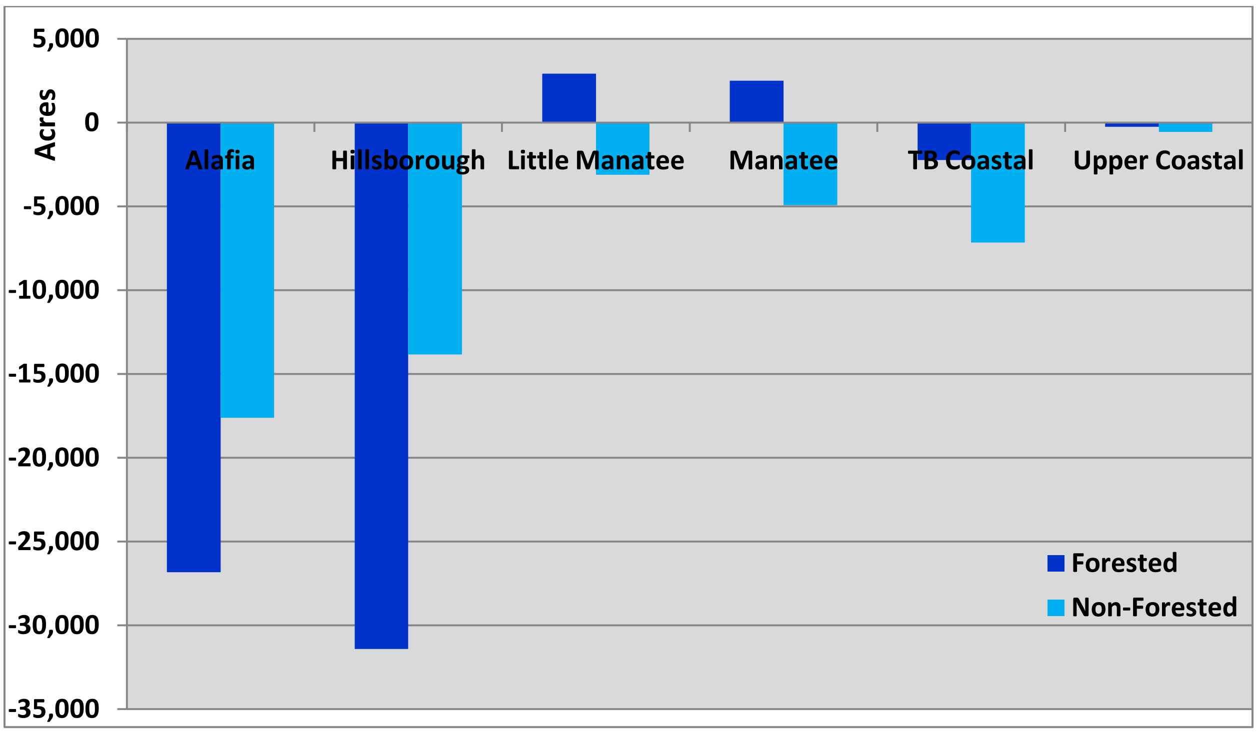
Data Source:
-TBEP
-USF
-Scheda
Imagery Source:
-ESRI Gray Canvas

Coordinate System:
NAD 1983 Florida
State Plane West

2.2.7 Comparison of Basins

Figure 2-7a shows the total acres of forested and non-forested freshwater wetlands lost/gained within each basin. For forested wetlands, the Alafia and Hillsborough River basins together lost approximately 58,235 acres, while all other basins combined represented a gain in forested wetlands. For non-forested wetlands, the Alafia and Hillsborough River basins together lost approximately 31,464 acres; all other basins combined lost 15,753 acres of non-forested wetlands. In the Alafia and Hillsborough River basins, more acres of forested wetlands were lost than non-forested wetlands; in all other basins, the data showed the opposite condition.

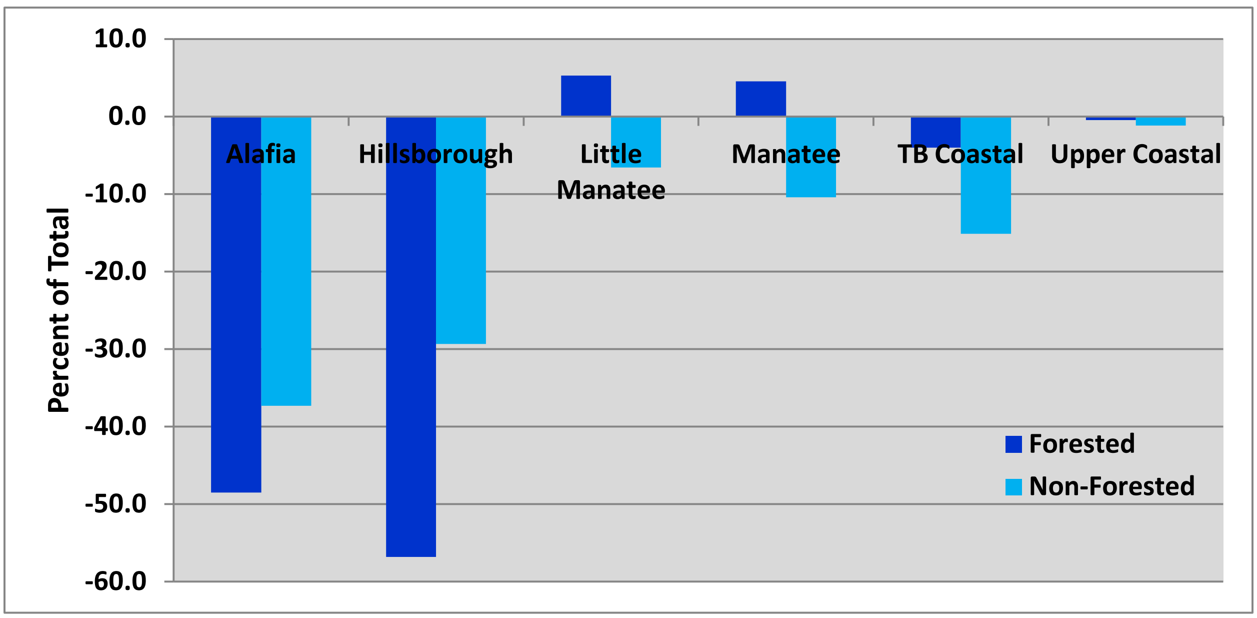
Figure 2-7a Acres of Wetland Lost/Gained Within Each Structure Type, by Basin



A graphical comparison of the relative percentages of wetlands lost within each basin is shown on the following page in **Figure 2-7b**. The greatest percent of forested wetlands lost during the study timeframe has been within the Alafia and Hillsborough River basins. The Little Manatee and Manatee River basins showed slight gains in forested wetlands. These gains were generally positioned along riverine wetlands within the basin. Many of these areas were examined more closely and appear accurate; however, in some cases, the gains appear to be an artifact of the mapping process. The gains were likely the result of "slivers" which can result when two delineations are overlain and don't exactly match up; although both represent the same wetland system, these minor differences in line work can produce false changes in coverage which are not actual changes in the habitat type. However in our opinion, these noted "slivers" did not account for large percentages of the noted changes between the time periods. For forested wetlands, the greatest losses also occurred within the Alafia and Hillsborough River basins. Notably, all basins experienced non-forested wetland losses.

These acres, represented as percentages, are shown within **Figure 2-7b** below.

Figure 2-7b Percent of Total Wetlands Lost/Gained Within Each Structure Type, by Basin



2.3 ANALYSIS OF ISOLATED WETLANDS

Wetland regulations, both historic and current, do not require mitigation of wetlands less than half-acre in size. This policy, along with the mapping limitations of some techniques, especially for establishing baseline conditions, suggests that losses to small (less than 0.5-acre) isolated wetlands may not be accurately characterized. These small wetlands were not mapped by the Soil Conservation Service (SCS; now known as the NRCS) as hydric soils. These same small wetlands are not mapped by FLUCCS or even the National Wetland Inventory (NWI) program, as they fall below their mapping protocols/thresholds. Because these small wetlands are very important for amphibians and wading birds, a preliminary analysis was conducted for each of the six basins within the study area to estimate the historic distribution and frequency of these isolated wetlands. The analysis utilized the historic aerial imagery (1938-1940) files that were collected and employed as part of the change analysis task of the "Development of a Coordinated Watershed Approach for Linking Compensatory Mitigation and Tampa Bay Habitat Restoration Goals" project of the Tampa Bay Estuary Program. This imagery was used to locate and delineate isolated freshwater wetlands that existed prior to the 1950s, which were not included in pre-existing historic wetlands datasets. The photography was provided through the Florida Center for Community Design and Research, University of South Florida. It is comprised of monochromatic, aerial imagery which was compiled for the Tampa Bay watershed ranging in date from 1938-1940.

Utilizing this imagery, an initial analysis of what scale provides the best resolution to identify isolated wetland/hydric soils signatures less than 0.5-acre in size was performed. From this analysis, it was determined that a 357-acre grid provided the best image resolution. Using this grid size, random sites were selected from areas which had no obvious anthropogenic impacts and contained less than 50% previously mapped wetland features. This stratified random approach was utilized within all the drainage basins to identify two 357-acre grids, or sample areas, which were then examined for obvious signs of these small hydric or wetland signature areas. These sample areas were then photo-interpreted to estimate the total number of isolated wetland signatures within the sample area that were visually estimated to be smaller than the 0.5-acre reference sample. Wetland signatures were conservatively evaluated and enumerated if the signature was clearly defined as wetland and was isolated from surrounding wetlands by an unmistakable upland signature. A wetland signature was included if it was estimated to be at least 50% located within the sample boundaries. The observations were totaled for each sample area and were used to estimate the range of isolated wetlands per sample area (**Table 2-8**). Results demonstrated that there were between one and 10 of these small (less than 0.5-acre) isolated wetlands within each sample area, which equates to a mean of 10 isolated wetlands per 1,000 acres.

This analysis demonstrates that these important wetland types (less than 0.5-acre isolated systems), all of which appeared to be non-forested in nature, have also been lost over time and may have been disproportionately lost within the Tampa Bay watershed.

Table 2-8 Sample Distribution of Isolated Wetlands Less Than 0.5-Acre in Size

Basin	Number Observed per Sample*	Density (#/1,000 ac)	Average Density (#/1,000 ac)
Alafia River	1	2.8	4.2
	2	5.6	
Hillsborough River	5	14.0	16.8
	7	19.6	
Little Manatee River	1	2.8	8.4
	5	14.0	
Manatee River	3	8.4	5.6
	1	2.8	
Tampa Bay and Coastal Areas	3	8.4	18.2
	10	28.0	
Upper Coastal Areas	2	5.6	7.0
	3	8.4	
	Range 1-10	**10.0**	

*sample area is 357 acres

3.0 DEVELOPMENT AND ANALYSIS OF RESTORATION TARGETS

3.1 OVERALL METHODOLOGY

3.1.1 Establishing the Targets

As discussed previously, the TBEP developed the 'Restore the Balance' approach for estuarine habitats in their study entitled *Setting Priorities for Tampa Bay Habitat Protection and Restoration: Restoring the Balance* (Technical Publication # 09-95, Lewis and Robison, 1996). This approach was re-evaluated and, ultimately continued in the Habit Master Plan Update, which included updated protection and restoration targets for estuarine habitats (Robison 2010). This document builds on that approach, and applies the same paradigm and resulting methodology for calculating targets to freshwater wetland habitats within the Tampa Bay watershed.

For the "Restoring the Balance" approach, faunal guilds were identified representing key estuarine-dependent species within the Tampa Bay watershed. This approach assumes that species in each of the guilds developed successful life history strategies during their evolution based on the optimal use of the various habitat types in their proportional quantities that existed prior to major anthropogenic impacts in Tampa Bay (e.g., circa 1950). However, as shown in Chapter 2 of this document, anthropogenic disturbances, and wetland mitigation strategies have resulted in habitat proportions that differ from the base condition. While it is not possible to restore or recover all lost or impacted habitats, this plan utilizes the same approach for developing targets for restoring the relative proportions of freshwater wetland habitat types focusing on those habitat types that have been disproportionately impacted. The underlying principle of the paradigm is that by restoring important freshwater habitats to their benchmark ratios, the habitat requirements of various wildlife species that utilize these habitats during their life cycles will be met.

The calculation of targets using the "restoring the balance" paradigm requires quantification of the areal extent and relative proportions (percentage of the total) of each habitat type for both the benchmark (circa 1950) and current (2007) time period.

For the optimal balance of habitat types under current conditions it is assumed that the ratio of the benchmark proportion and current acreage of the least impacted habitat type will be equivalent to the ratio of the benchmark proportion and restoration acreage of the habitat type of interest. In order to provide an example of this calculation, information related to the Alafia River Basin is provided on the following page.

Table 3-1 Example Calculation of Restoration Targets for Alafia River Basin

	Acres		Proportion of Totals	
USF Team Classification	**1950**	**2007**	**1950**	**2007**
Forested/Lacustrine	3,216	382	0.04	0.01
Forested/Other	3,961	1,544	0.05	0.04
Forested/Riverine	43,314	21,743	0.55	0.62
Forested Subtotal	50,491	23,670	0.64	0.68
Non-Forested/Lacustrine	4,759	1,252	0.06	0.04
Non-Forested/Other	4,613	3,945	0.06	0.11
Non-Forested/Riverine	19,424	5,977	0.24	0.17
Non-Forested Subtotal	28,796	11,175	0.36	0.32
Total	**79,288**	**34,845**	1.00	1.00

In this example, it is assumed that Forested/Other (highlighted orange) is the least impacted habitat type because the 2007 proportion of totals (0.04) is most similar to the 1950 proportion (0.05). Therefore, for this habitat type the protection and restoration target will remain the same as the 2007 acreage, or 1,544 acres. The calculation of the restoration target for Forested/Lacustrine, as shown below, is equivalent to the ratio of the benchmark proportion and restoration acreage of the habitat type of interest.

$$\frac{\text{Least Impacted Current Acres}}{\text{Least Impacted Benchmark Proportion}} = \frac{\text{Target Acres } (\mathbf{X})}{\text{Target Benchmark Proportion}}$$

OR

$$\frac{\text{(Forested/Other Acres) } 1{,}544}{\text{(Forested/Other Proportion) } 0.05} = \frac{\text{(Forested/Lacustrine Acres) } \mathbf{X}}{\text{(Forested/Lacustrine Proportion) } 0.04}$$

In solving for X, we obtain the "Restore the Balance" target for total Forested/Lacustrine acres in the Alafia River Basin of 1,254 acres. It should be noted that the proportions of totals shown in these tables are truncated. The actual values extend to four decimal places. In performing the calculations, the detailed acreages and proportions were retained and rounding occurred only with the result of the final calculation. Therefore, the actual targets may differ slightly from those calculated using a proportion rounded to the tenths place.

The target acreages signify the protection and restoration target. For this plan, it is the goal to preserve all of the existing (2007) acreage – this is the "protection target." If there is a deficit need to "Restore the Balance," the delta value is defined as the "restoration target" (i.e., the new acreage desired) and the "protection and restoration target" is the sum of the existing acreage and the restoration target. If either the acreage or proportion of a habitat type was higher in 2007 than in 1950, the 2007 acreage becomes the overall restoration and protection target.

Calculations were performed for each basin and for each freshwater wetland category within the Tampa Bay watershed and are presented and discussed in Section 3.2. The "Restoring the Balance" paradigm was applied to this project with general success. The few exceptions are a function of the calculation as it applies to the specifics of the basin; each exception is described within the appropriate basin discussion.

3.1.2 Analysis of the Targets

Various factors were considered once the targets were established in order to determine if the targets were reasonable and feasible. This exercise was completed using GIS analysis and is ultimately presented for each basin in graphical form. The factors considered are discussed below.

Land Use Suitability

Once the targets were established, it was recognized that they may not be feasible due to land development and changes in permanent land use conditions. In order to carry out this analysis, the land use/land cover classifications within the SWFWMD FLUCCS were evaluated for the wetland creation suitability. Using professional judgment, the team determined whether a wetland should or could be created, restored, or enhanced within each particular land cover classification. Accordingly, certain codes were eliminated from consideration, including all codes within the Transportation Series (8000), and most codes within the Urban and Built-Up Series (1000). Classifications within the Urban series that were allowed to remain include Reclaimed (1650), Recreational (1800), Golf Courses (1820) and Open Land (1900). After discerning the area that would remain suitable after eliminating these land cover codes, additional suitability factors were considered as described below.

Soils Suitability

Wetland restoration or creation often involves re-sculpting of the existing land forms to recreate the targeted wetland habitats. General criteria used to classify the suitability of mapped soil types for these activities depend on conditions in the soil descriptions that are conducive to wetland plant growth when the present land characteristics are changed. These proposed land form changes often must accommodate altered drainage patterns, or are proposed to provide wholesale habitat alterations to achieve the created targeted habitat. Characteristics that affect the soil type suitability for potential land alterations to attain wetland creation or restoration include:

- the depth and periodicity of the water table;
- drainage capability and depth of soil strata that affects drainage;
- possible existence of a subsurface confining layer or resistant material strata not conducive to plant growth or root penetration;
- excessive economic factors, such as too deep of excavation to reach wetland grade;
- excessive pre-existing land alterations that would preclude restoration, such as urban development or mining refuse settling ponds;
- excessive overburden placement; or
- household/commercial refuse landfill operations.

Finally, the soil types that are associated with a high percentage of existing wetland cover, open water, or beach communities were also excluded. The analysis of soil types within each county and their suitability for wetland mitigation is included within **Appendix D**.

Identification of other Factors that Could Affect Success

Public Conservation Lands – Following the analysis of land cover and soils suitability, resulting data was layered with public and conservation lands/easement records to date. In each basin, this analysis reveals that some of the remaining suitable areas are already in public ownership. This is important because each of these parcels may already have a management plan in place which dictates the restoration activities that will take place. Therefore, while these lands may initially be considered as viable options for wetland creation, there may be existing management constraints. Conversely, areas with suitable land use and soil types, located near existing public conservation lands, may be valuable for future protection or restoration by creating large conservation areas or for creating wildlife corridors, for example.

LDI Values – LDI values can also subsequently be considered. Even if an area passes the land use, soils and public lands factors, there may be higher LDI values in the area which correspond to higher intensity land uses that could negatively affect the quality of the wetland communities through potential for increased edge effects, changes in wetland hydrology (due to changes in amount of surface runoff received and/or altered connectivity to surrounding wetlands) or changes in increased pollutant loading within runoff to the wetlands. Existing LDI values were examined by the USF Team as a screening criteria layer and can be utilized to enhance the identification of appropriate areas for freshwater wetlands protection, restoration or mitigation.

3.2 SETTING TARGETS BY BASIN

This section presents the restoration targets that have been established for each basin, along with an analysis of the 'reasonableness' of the targets in terms of suitable land use/cover, soils and other relevant factors.

3.2.1 Alafia River Basin

Freshwater restoration calculations completed for the Alafia River Basin are shown in **Table 3-2**. In making these calculations, the Forested/Other proportion was considered to change the least from the benchmark year (1950) to the current year (2007), so its relevant information was used in the calculation. Its 2007 acreage becomes the target, or no net loss (the delta equals zero). The calculations show that in order to "restore the balance" additional acres are needed in three habitat classifications:

- Forested/Lacustrine: target is an increase in acres from 382 to 1,254, or a delta of 871 acres;
- Non-Forested/Lacustrine: target is an increase in acres from 1,252 to 1,856, or a delta of 603 acres; and
- Non-Forested/Riverine: target is an increase in acres from 5,977 to 7,573, or a delta of 1,595 acres.

Table 3-2 Alafia River Basin Freshwater Wetland Restoration Targets

	Acres		Proportion of Totals		Acres	Acres
USF Team Classification	**1950**	**2007**	**1950**	**2007**	**Target**	**Delta**
Forested/Lacustrine	3,216	382	0.04	0.01	**1,254**	**871**
Forested/Other	3,961	1,544	0.05	0.04	**1,544**	**0**
Forested/Riverine	43,314	21,743	0.55	0.62	**21,743**	**0**
Forested Subtotal	50,491	23,670	0.64	0.68	**24,541**	**871**
Non-Forested/Lacustrine	4,759	1,252	0.06	0.04	**1,856**	**603**
Non-Forested/Other	4,613	3,945	0.06	0.11	**3,945**	**0**
Non-Forested/Riverine	19,424	5,977	0.24	0.17	**7,573**	**1,595**
Non-Forested Subtotal	28,796	11,175	0.36	0.32	**13,373**	**2,199**
Total	**79,288**	**34,845**	1.00	1.00	**37,914**	**3,070**

For the last two habitat categories, Forested/Riverine and Non-Forested/Other, their proportions of the total have increased from 1950 to 2007, therefore, the calculation is not necessary, and their targets becomes the 2007 acreages, or no net loss.

The subtotal of the Forested habitat targets is 871 acres, and the subtotal of the Non-Forested habitats is 2,199 acres; this represents a combined target of 3,070 total acres of freshwater wetland protection and restoration for the Alafia River basin.

In the Alafia River Basin, the greatest decrease in proportion from 1950 to 2007 is within the Non-Forested Riverine category, and a possible reason for this is the extensive phosphate mining that has occurred in many areas adjacent to creeks and streams within the southeastern part of the basin. In order to better understand the basin and explore the factors that could affect the reasonableness of the targets, a series of maps were created to represent a stepwise consideration of these factors. The first map, shown in **Figure 3-1a**, considers land use suitability as described previously in this section. **Figure 3-1b** shows the analysis of soils suitability within the basin, with yellow indicating the most suitable soils. Within the Alafia River Basin, the suitable soil areas contain seven soil classification types that are mapped as containing at least 5% of the suitable area as defined by land use. The soil types omitted are either too xeric, considered to be a vast majority of wetland soils in the present condition, or otherwise excluded due to confining layers and/or other wetland creation limitations. The target soil types with at least 5% coverage are: Myakka (24.1%), Winder (19.9%), Smyrna (8.4%), Pomona (7.2%), St. Johns (6.6%) and Ona (5.3%).

When land use suitability is combined with soils suitability, it becomes evident how these factors could affect the potential success of reaching the targets in the future. In **Figure 3-1c**, all of the non-suitable land use and non-suitable soils areas are shaded gray, and only the areas represented as a color (yellow or blue) are potentially suitable for wetland creation, restoration, or enhancement. Finally, when we consider these potentially suitable areas in concert with public conservation and managed lands the resultant potentially suitable areas are shown in white on **Figure 3-1d**. The final area of potentially suitable lands that could be used to reach the stated targets totals 79,928 acres. If the publicly-owned or conservation lands layer is excluded due to differing land management strategies then this total declines to 60,292 acres of potentially suitable lands available for wetland creation, restoration or enhancement activities. This area could then be considered in concert with future planned LDI to determine those areas that may not achieve long-term mitigation success due to proximity to anticipated higher intensity land uses. LDI may also illustrate where either protection or restoration efforts may provide the most ecological benefit. For example, an area with a lower LDI may be an ideal candidate for wetland protection. An area with a higher LDI value may benefit from targeted restoration.

In summary, the availability of suitable acreage would support the achievement of the targets in this basin, however, the LDI will further influence land suitability in some locations. Achieving the recommended targets would benefit wildlife that depends on these ecosystems, especially when small isolated wetlands are included in the restoration or mitigation plan.

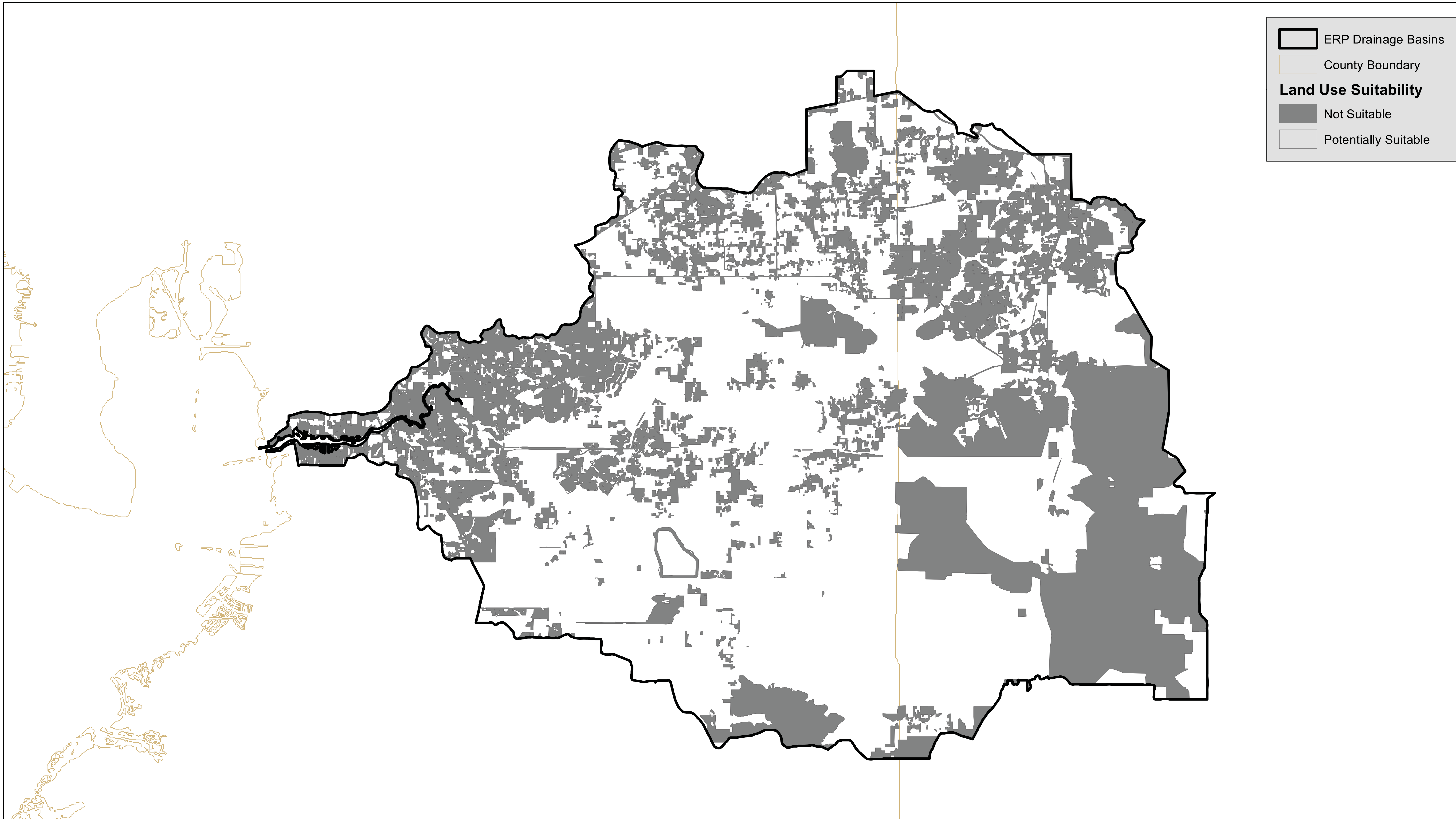


Figure 3-1a
Land Use Suitability within the Alafia River Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough and Polk Counties, Florida

0 3 6 9 Miles

N

Data Source:
-TBEP
-USF
-Scheda
-SWFWMD, 2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West

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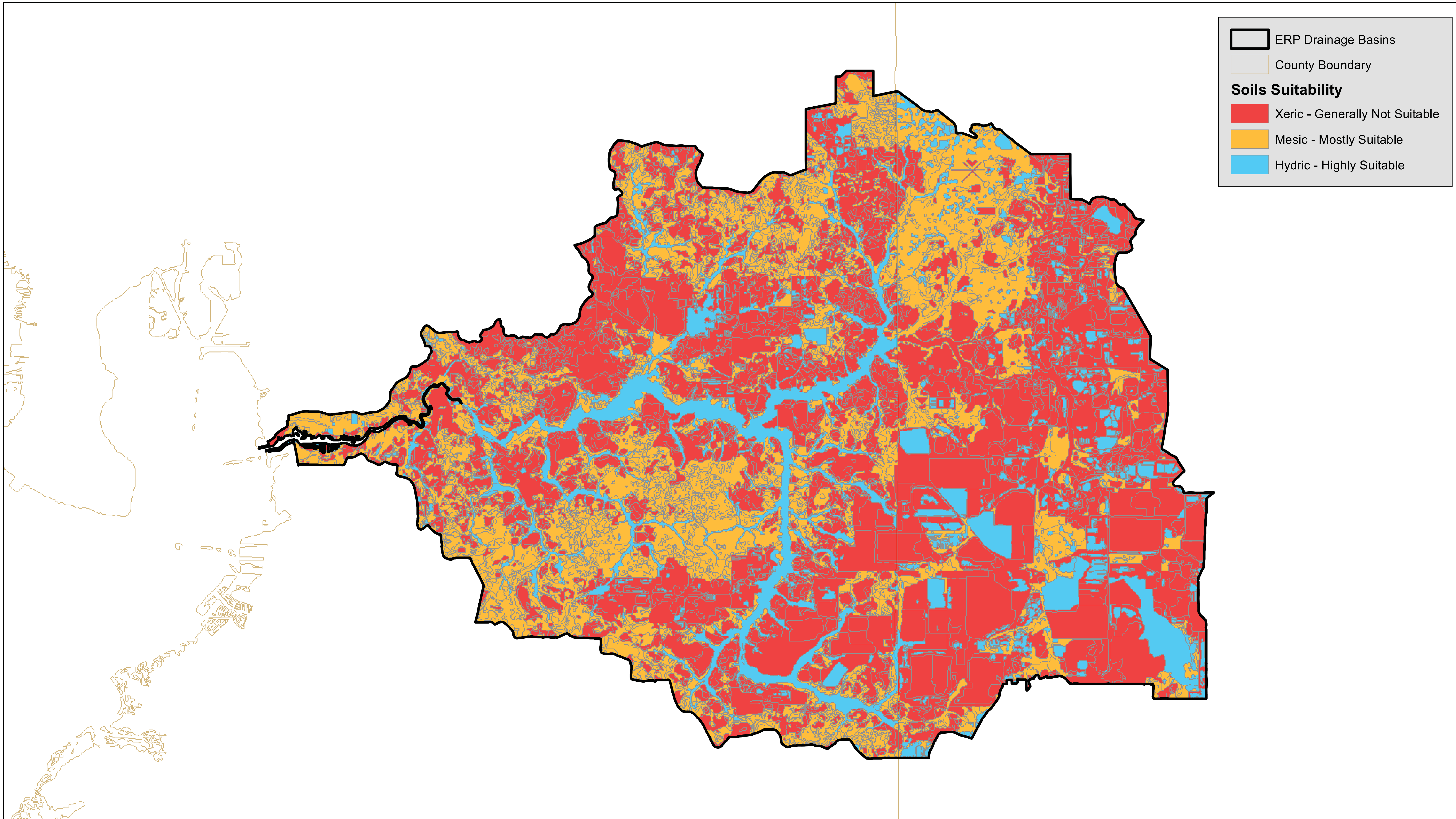

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Figure 3-1b
Soils Suitability within the Alafia River Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough and Polk Counties, Florida

0 3 6 9 Miles

N

Data Source:
-TBEP
-USF
-Scheda
-NRCS, 2009
Imagery Source:
-ESRI Gray Canvas

Coordinate System:
NAD 1983 Florida
State Plane West

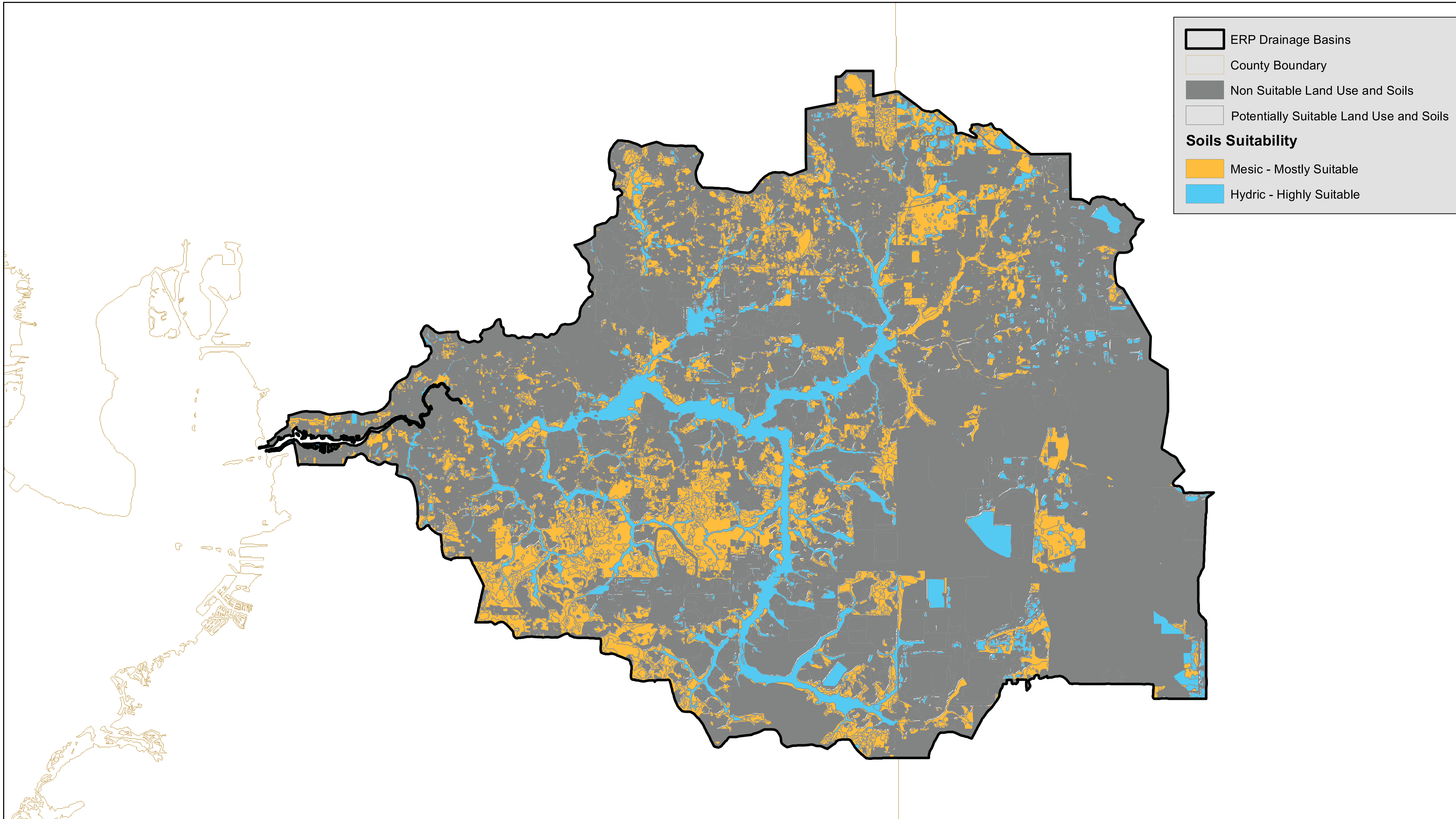

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Figure 3-1c
Combined Land Use and Soils Suitability within the Alafia River Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough and Polk Counties, Florida

0 3 6 9 Miles

N

Data Source:
-TBEP
-USF
-Scheda
-NRCS, 2009
-SWFWMD, 2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West

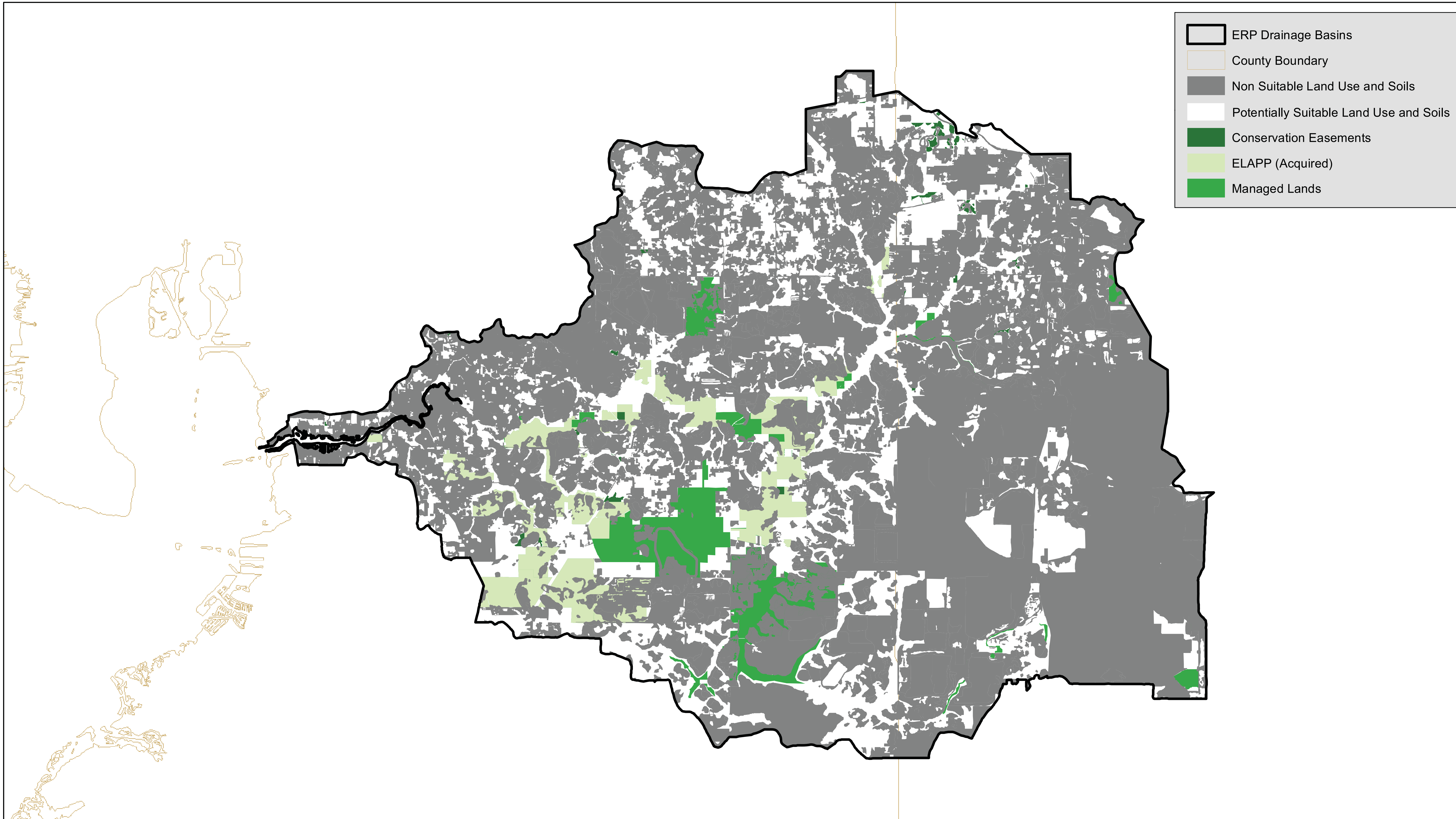

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Figure 3-1d
Conservation Areas and Combined Land Use/Soils Suitability within the Alafia River Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough and Polk Counties, Florida

Miles
0 3 6 9

N

Data Source:
-TBEP
-USF
-Scheda
-FNAI
-SWFWMD, 2009
-NRCS, 2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West

3.2.2 Hillsborough River Basin

Freshwater restoration calculations completed for the Hillsborough River Basin are shown in **Table 3-3**. In making these calculations, the Forested/Riverine proportion was considered to change the least from the benchmark year (1950) to the current year (2007), so its relevant information was used in the calculation. Its 2007 acreage becomes the target, or no net loss (the delta equals zero). The calculations show that in order to "restore the balance"; additional acres are needed in three habitat classifications:

- Forested/Lacustrine: target is an increase in acres from 2,039 to 2,592, or a delta of 553 acres;
- Non-Forested/Lacustrine: target is an increase in acres from 3,138 to 3,340, or a delta of 202 acres; and
- Non-Forested/Riverine: target is an increase in acres from 14,676 to 15,884, or a delta of 1,209 acres.

For the last two habitat categories, Forested/Other and Non-Forested/Other, their proportions of the total have increased from 1950 to 2007, therefore, the calculation is not necessary, and their 2007 acreages become the target, or no net loss (the delta equals zero).

Table 3-3 Hillsborough River Basin Freshwater Wetland Restoration Targets

	Acres		Proportion of Totals		Acres	Acres
USF Team Classification	**1950**	**2007**	**1950**	**2007**	**Target**	**Delta**
Forested/Lacustrine	3,925	2,039	0.03	0.02	**2,592**	**553**
Forested/Other	13,065	11,504	0.09	0.12	**11,504**	**0**
Forested/Riverine	82,398	54,430	0.59	0.57	**54,430**	**0**
Forested Subtotal	99,388	67,973	0.71	0.71	**68,526**	**553**
Non-Forested/Lacustrine	5,057	3,138	0.04	0.03	**3,340**	**202**
Non-Forested/Other	12,090	9,536	0.09	0.10	**9,536**	**0**
Non-Forested/Riverine	24,046	14,676	0.17	0.15	**15,884**	**1,209**
Non-Forested Subtotal	41,192	27,349	0.29	0.29	**28,760**	**1,411**
Total	**140,580**	**95,322**	1.00	1.00	**97,287**	**1,964**

The subtotal of the Forested habitat restoration targets is 553 acres, and the subtotal of the Non-Forested freshwater wetland habitats is 1,411 acres; this represents a combined target of 1,964 total acres of freshwater wetland protection and restoration for the Hillsborough River basin. The proportional acreages were similar for the three habitat classifications that require additional restorative acreage to achieve habitat balance. However, the delta value of 1,209 acres required to restore the balance for Non-Forested/Riverine systems was greatest, due to the greater baseline acreage.

The first map, shown in **Figure 3-2a**, considers land use suitability as described previously in Section 3. **Figure 3-2b** shows the analysis of soils suitability within the basin, with yellow indicating the most suitable soils. In **Figure 3-2c**, all of the non-suitable land use and non-suitable soils areas are shaded gray, and only the areas represented as a color (yellow or blue) are potentially suitable for wetland creation, restoration, or enhancement. **Figure 3-2d** shows the potential suitable areas when land use, soil suitability and potential conflicts with conservation/differing land management strategies are included. This represents an area of 163,051 acres potentially available to target for restorative work in the three target classifications to “restore the balance” of freshwater dependant habitats in the Hillsborough River Basin. Within these restorative suitable areas, four soil classifications are present in area that exceeds 5% of the total. These soil types are: Pomona (14.9%), Myakka (13.6%), Chobee (12.6%) and Bassinger (12.6%). Dominant impacts in this basin are likely attributable to mining activities and development/urbanization.

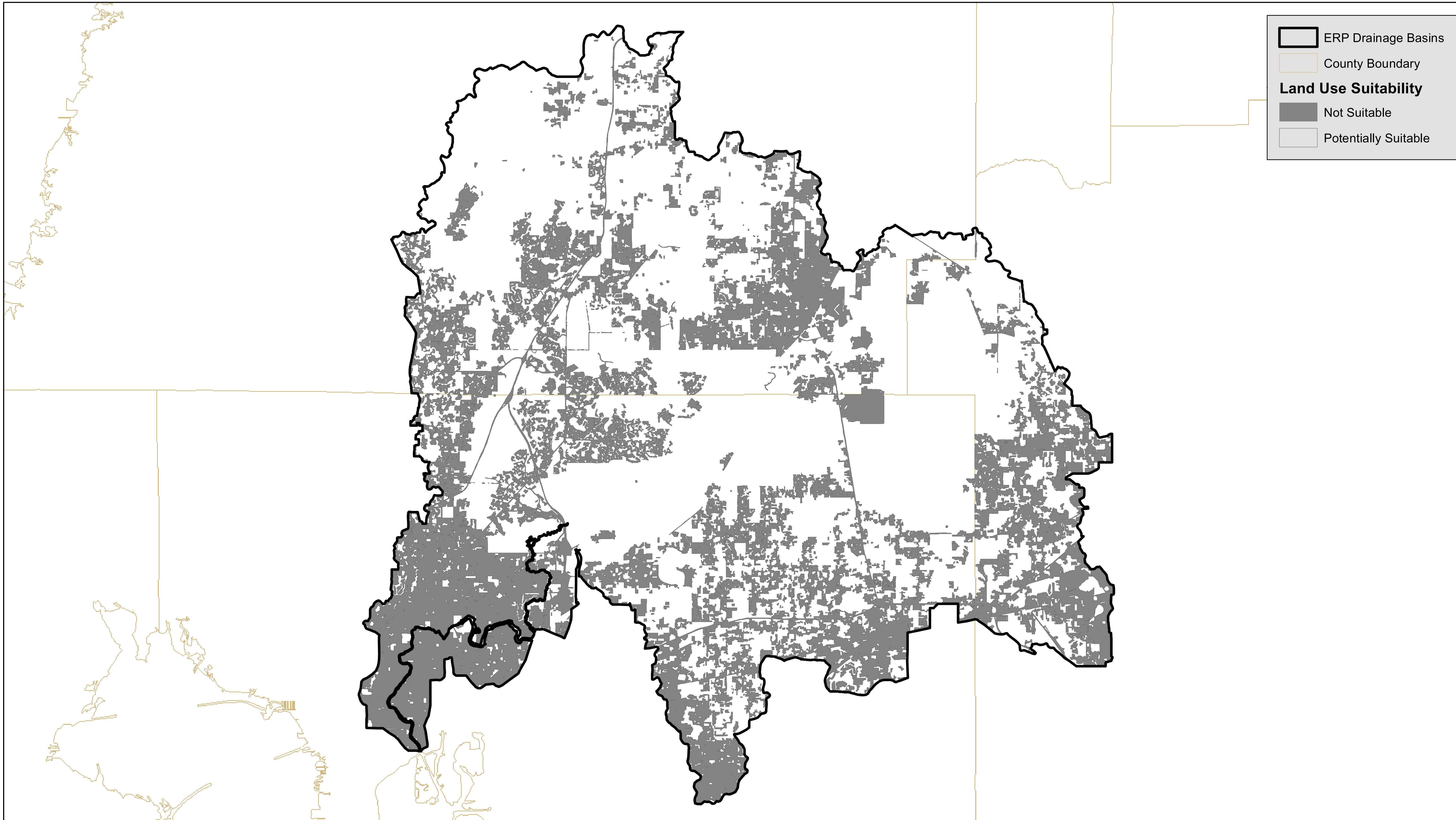

Figure 3-2a
Land Use Suitability within the Hillsborough River Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough, Pasco and Polk Counties, Florida

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Data Source:
-TBEP
-USF
-Scheda
-SWFWMD,2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West

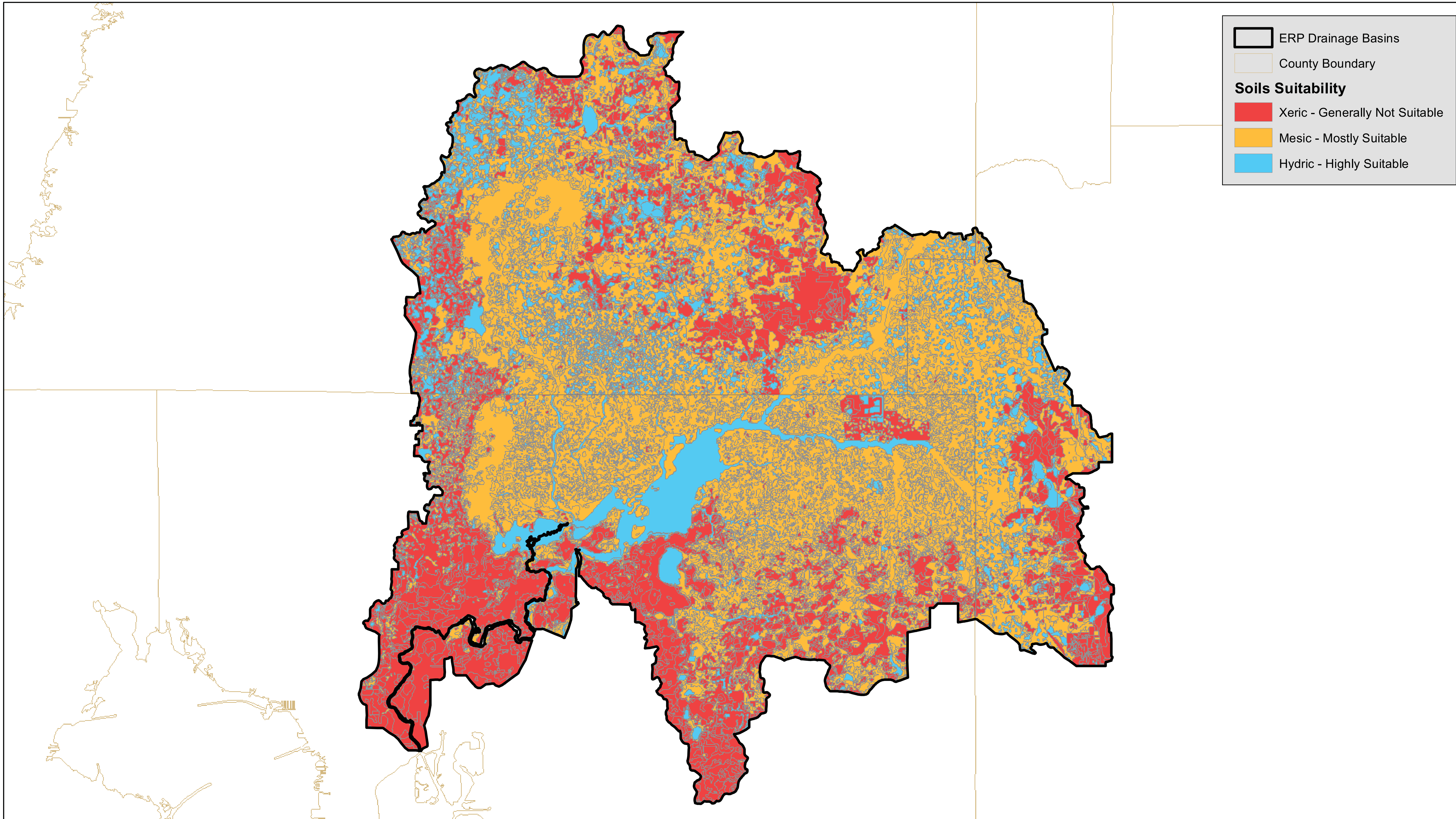

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Figure 3-2b
Soils Suitability within the Hillsborough River Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough, Pasco and Polk Counties, Florida

0 4 8 12 Miles

N

Data Source:
-TBEP
-USF
-Scheda
-NRCS,2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West

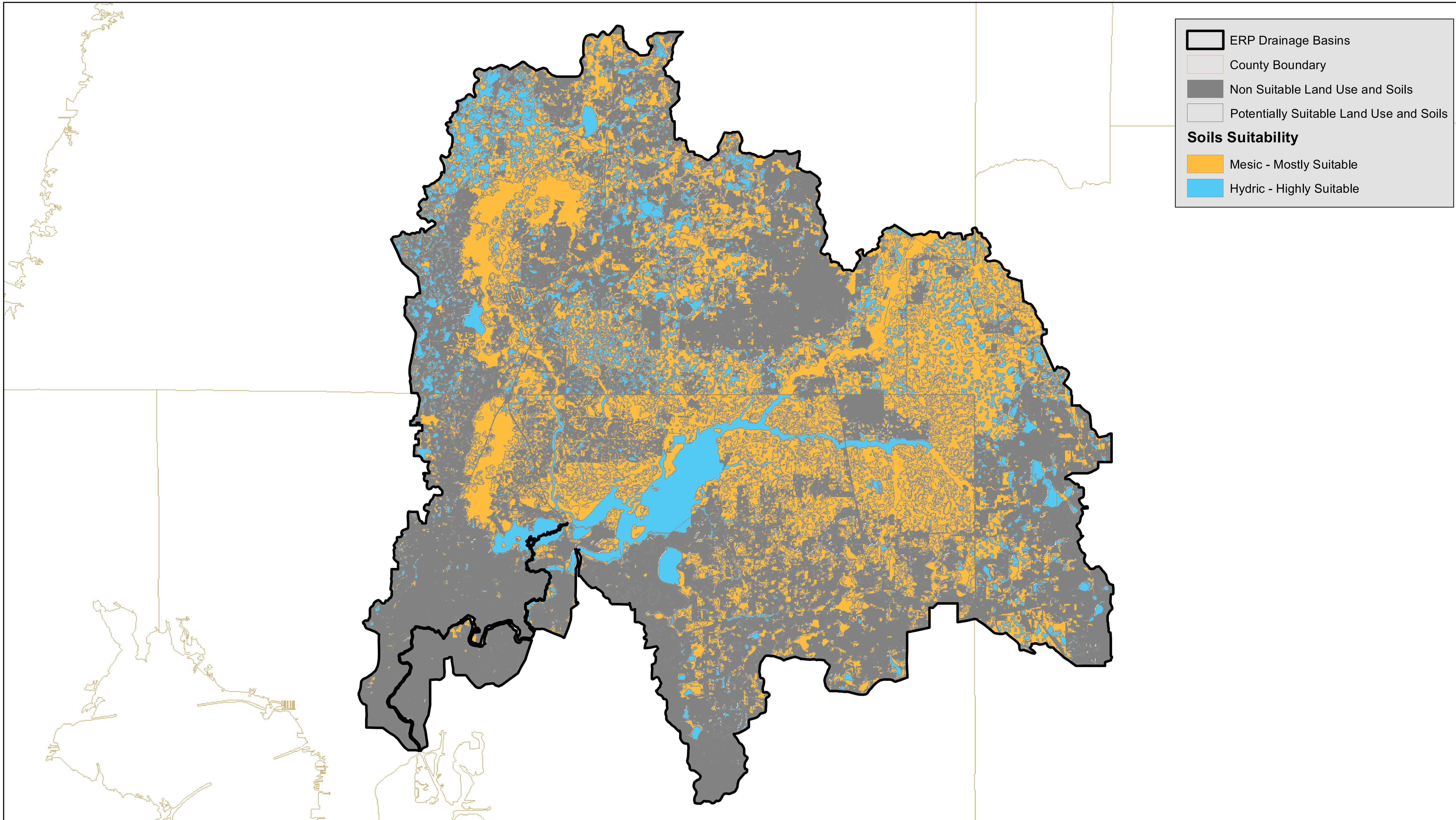

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Figure 3-2c

Combined Land Use and Soils Suitability within the Hillsborough River Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough, Pasco and Polk Counties, Florida

Miles
0 4 8 12

N

Data Source:
-TBEP
-USF
-Scheda
-NRCS, 2009
-SWFWMD, 2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West

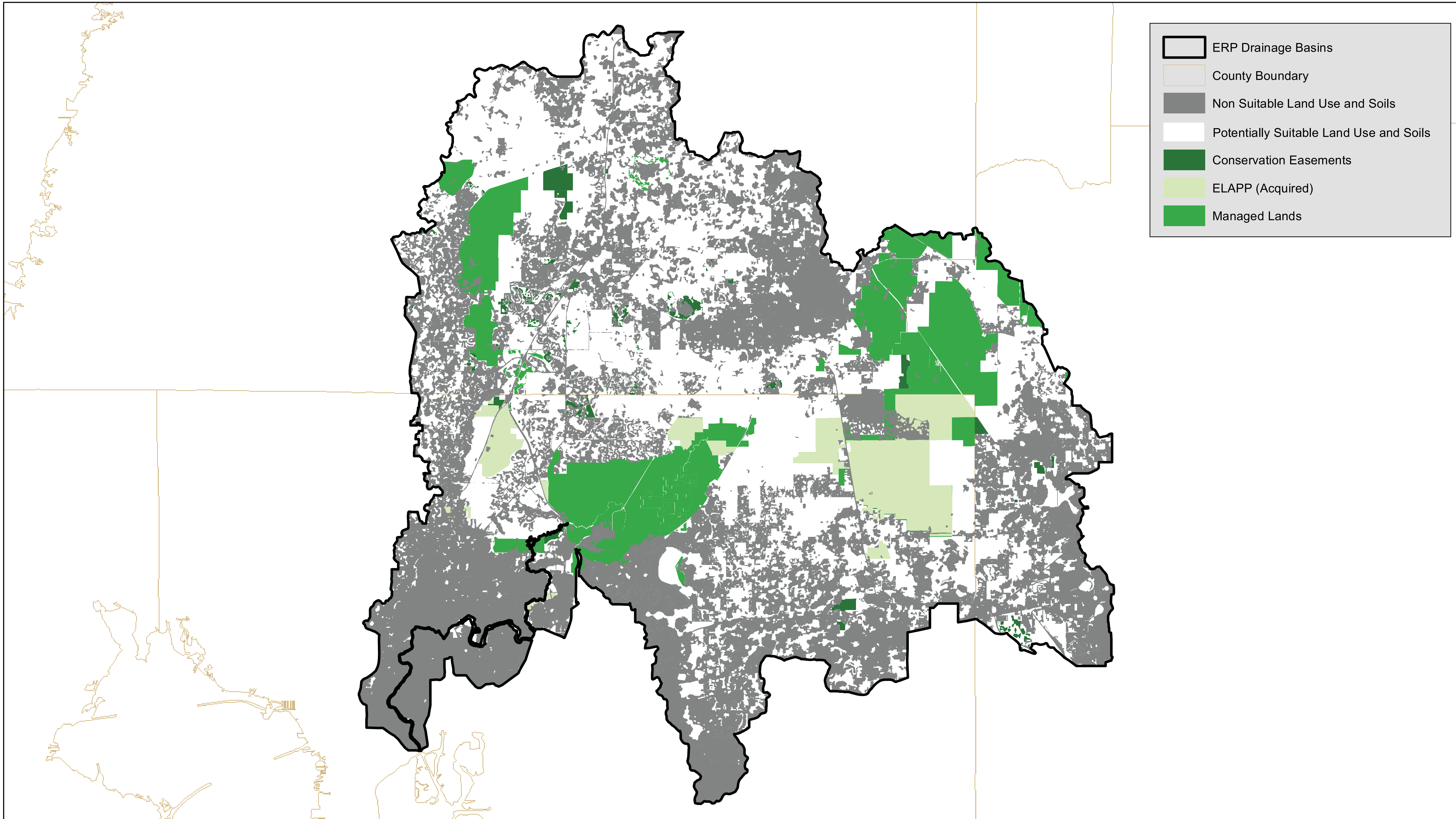

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Figure 3-2d
Conservation Areas and Combined Land Use/Soils Suitability within the Hillsborough River Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough, Pasco and Polk Counties, Florida

0 4 8 12 Miles

N

Data Source:
-TBEP
-USF
-Scheda
-FNAI
-SWFWMD, 2009
-NRCS, 2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West

3.2.3 Little Manatee River Basin

Freshwater restoration calculations completed for the Little Manatee River Basin are shown in **Table 3-4**. In making these calculations, the Forested/Other proportion was considered to change the least from the benchmark year (1950) to the current year (2007), so its relevant information was used in the calculation. Its 2007 acreage becomes the target, or no net loss (the delta equals zero). The calculations show that in order to "restore the balance" additional acres are needed in three habitat classifications:

- Non-Forested/Lacustrine: target is an increase in acres from 65 to 632, or a delta of 567 acres;
- Non-Forested/Other: target is an increase in acres from 1,232 to 2,917, or a delta of 1,685 acres; and
- Non-Forested/Riverine: target is an increase in acres from 4,316 to 7,307, or a delta of 2,991 acres.

Table 3-4 Little Manatee River Basin Freshwater Wetland Restoration Targets

	Acres		Proportion of Totals		Acres	Acres
USF Team Classification	**1950**	**2007**	**1950**	**2007**	**Target**	**Delta**
Forested/Lacustrine	90	173	0.00	0.01	**173**	**0**
Forested/Other	696	866	0.04	0.04	**866**	**0**
Forested/Riverine	10,291	12,951	0.52	0.66	**12,951**	**0**
Forested Subtotal	11,077	13,990	0.56	0.71	**13,990**	**0**
Non-Forested/Lacustrine	508	65	0.03	0.00	**632**	**567**
Non-Forested/Other	2,346	1,232	0.12	0.06	**2,917**	**1,685**
Non-Forested/Riverine	5,875	4,316	0.30	0.22	**7,307**	**2,991**
Non-Forested Subtotal	8,729	5,613	0.44	0.29	**10,856**	**5,243**
Total	**19,805**	**19,602**	1.00	1.00	**24,846**	**5,243**

For the last two habitat categories, Forested/Lacustrine and Forested/Riverine, their proportions of the total have increased from 1950 to 2007, therefore, the 2007 acreages become the protection targets, or no net loss.

The subtotal of the Forested habitat restoration target is 0 acres, and the subtotal of the Non-Forested habitats is 5,243 acres; this represents a combined restoration and protection target of 5,243 total acres for the Little Manatee River Basin. In this basin, the greatest decrease in habitat type, in both proportion and acreage from the 1950 estimate, occurred in the Non-Forested/Riverine habitat type. The calculations reveal a delta of 2,991 acres for this habitat type, making it the most in need of restorative acreage.

The calculations show a disproportionate loss for all three types of Non-Forested habitat, totaling 5,243 acres to achieve the target balance. The delta of zero for the Forested habitat types indicates that these systems did not sustain disproportional impacts and therefore the goal is to protect the existing acreage. To achieve this overall habitat balance, the same suitability factors were considered to determine the achievability of the targets. **Figure 3-3a**, considers land use suitability; **Figure 3-3b** shows the analysis of soils suitability within the basin, with yellow indicating the most suitable soils. In **Figure 3-3c**, all the non-suitable land use and non-suitable soils areas are shaded gray, and only the areas represented as a color (yellow or blue) are potentially suitable for wetland creation, restoration, or enhancement. To achieve this overall habitat balance, areas of potential restorative action are shown in **Figure 3-3d**, and total 72,857 acres. Within these suitable areas, there are four suitable soil classification types than consist of at least 5% in aerial coverage: Myakka (36.9%), Eaugallie (8.0%), St. John's (6.9%) and Winder (6.0%).

The observed increase in the different Forested type acreage may be attributed to pre-1950 logging practices and current reforestation, or more likely is due to anthropogenic enhancement of herbaceous wetland drainage patterns, resulting in the transformation of herbaceous systems to forested vegetative cover.

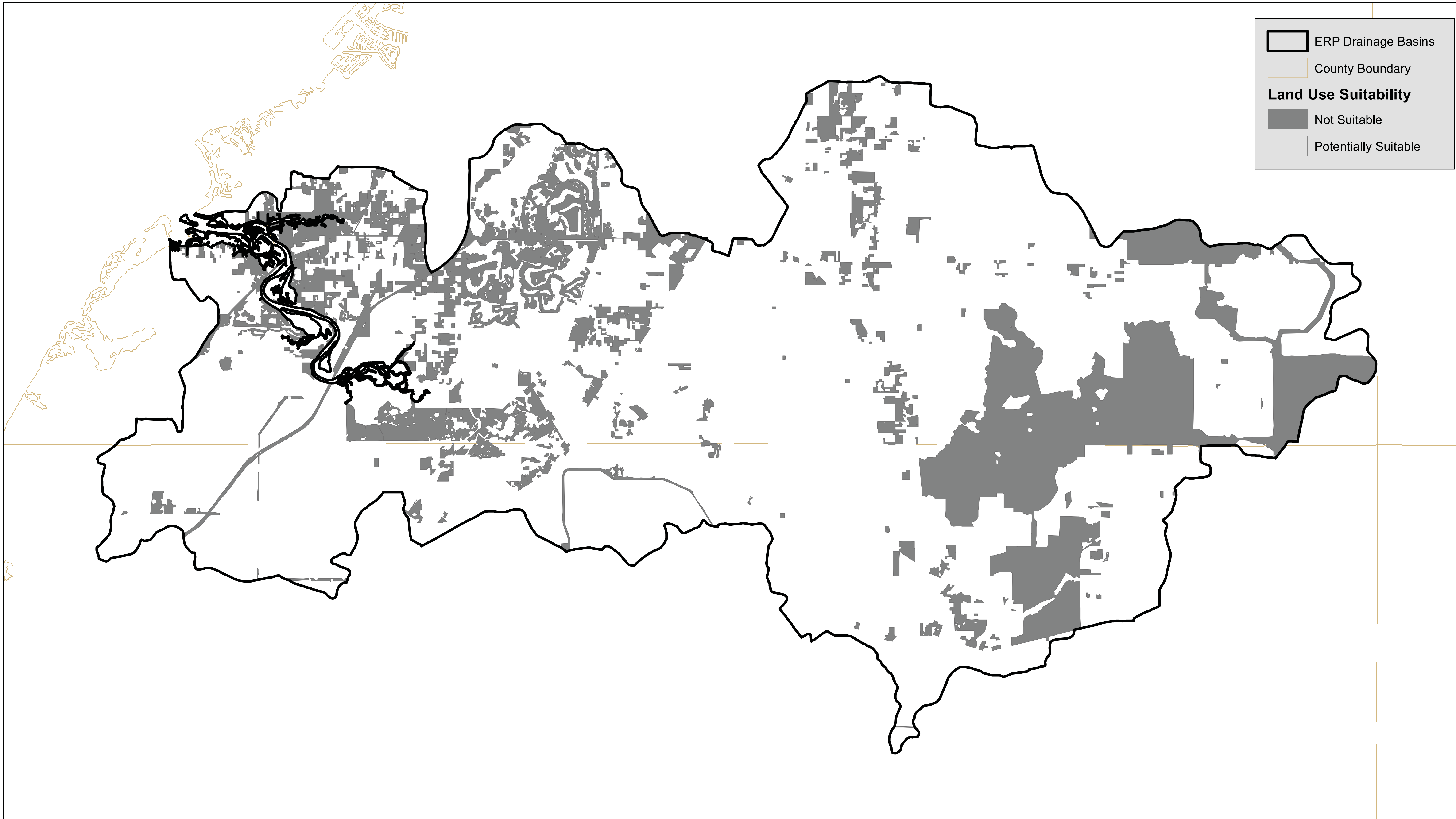

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Figure 3-3a
Land Use Suitability within the Little Manatee River Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough and Manatee Counties, Florida

Data Source:
-TBEP
-USF
-Scheda
-SWFWMD, 2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West

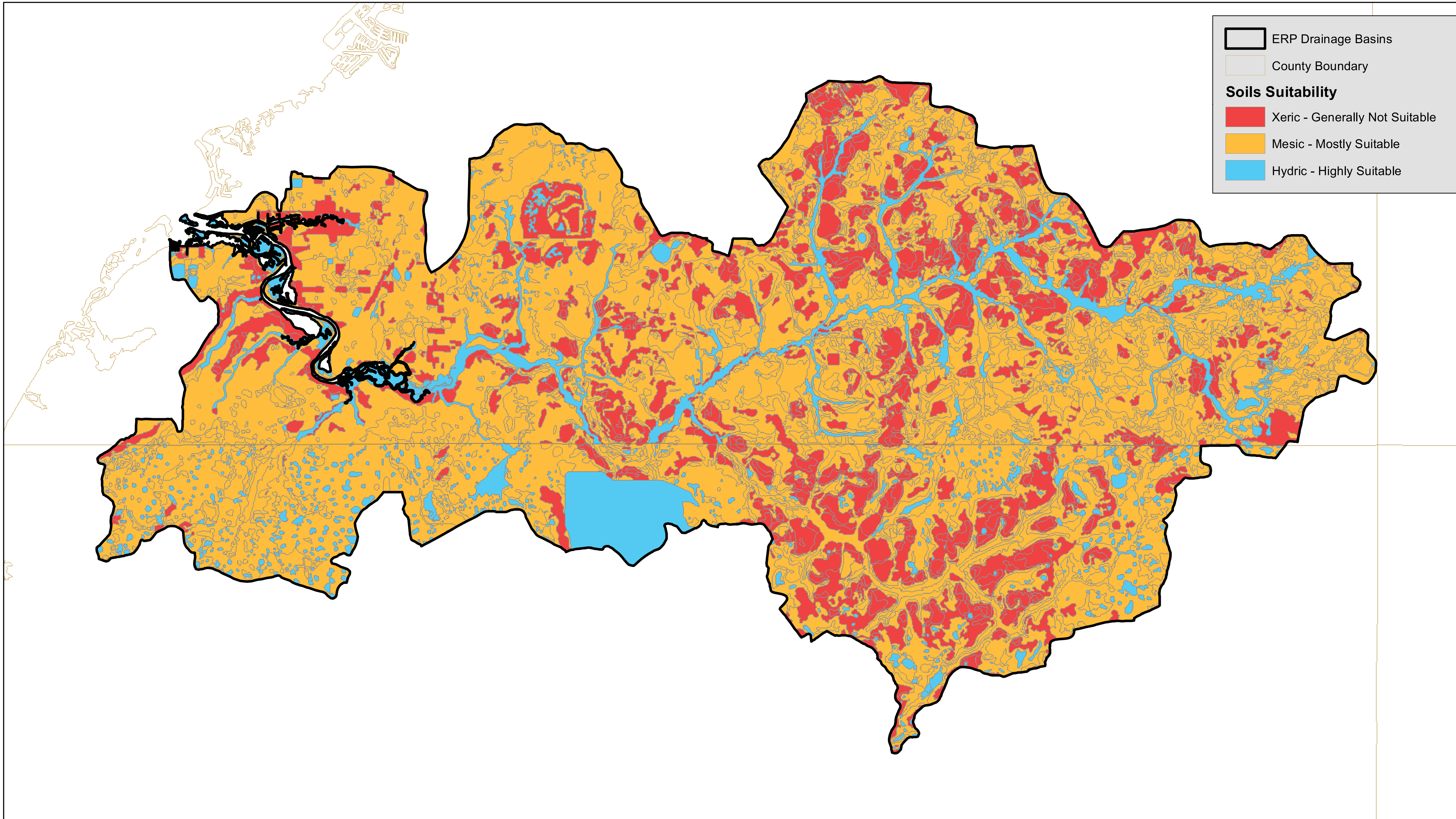

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Figure 3-3b
Soils Suitability within the Little Manatee River Basin

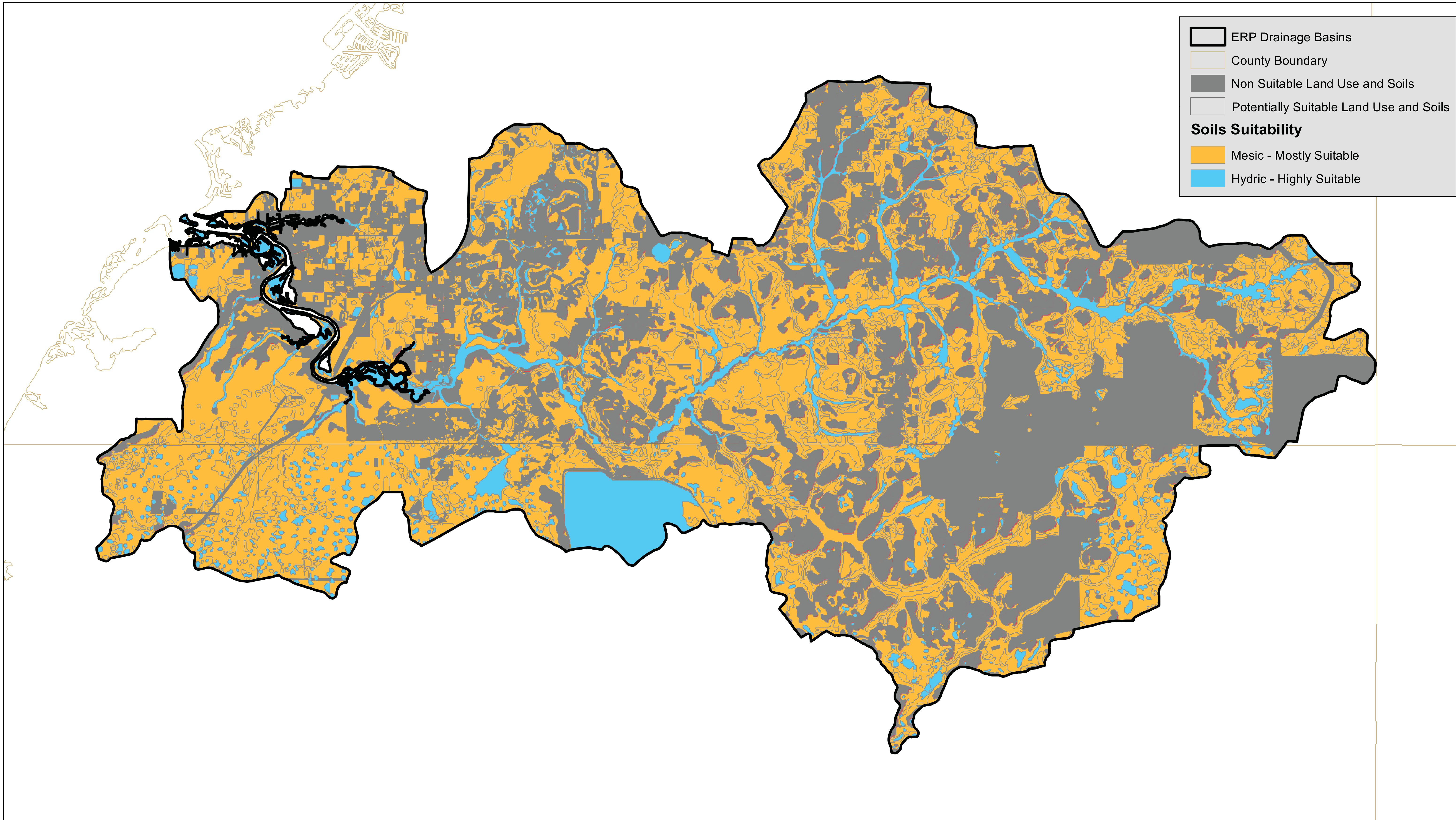
Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough and Manatee Counties, Florida

0 2 4 6 Miles

N

Data Source:
-TBEP
-USF
-Scheda
-NRCS, 2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West



Date: 06/02/2013 Rev. Date: 06/12/2013 PM: SSK GIS Analyst: GdA Map Document: TBEP_CombinedSuitability_Soils_Little_Manatee_River_B_gda_20130612.mxd Project Number: 2470 PDF Document: TBEP_CombinedSuitability_Soils_Little_Manatee_River_B_gda_20130612.pdf Plot Size: 11x17

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Figure 3-3c
Combined Land Use and Soils Suitability within the Little Manatee River Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough and Manatee Counties, Florida

0 2 4 6 Miles

N

Data Source:
-TBEP
-USF
-Scheda
-NRCS, 2009
-SWFWMD, 2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West

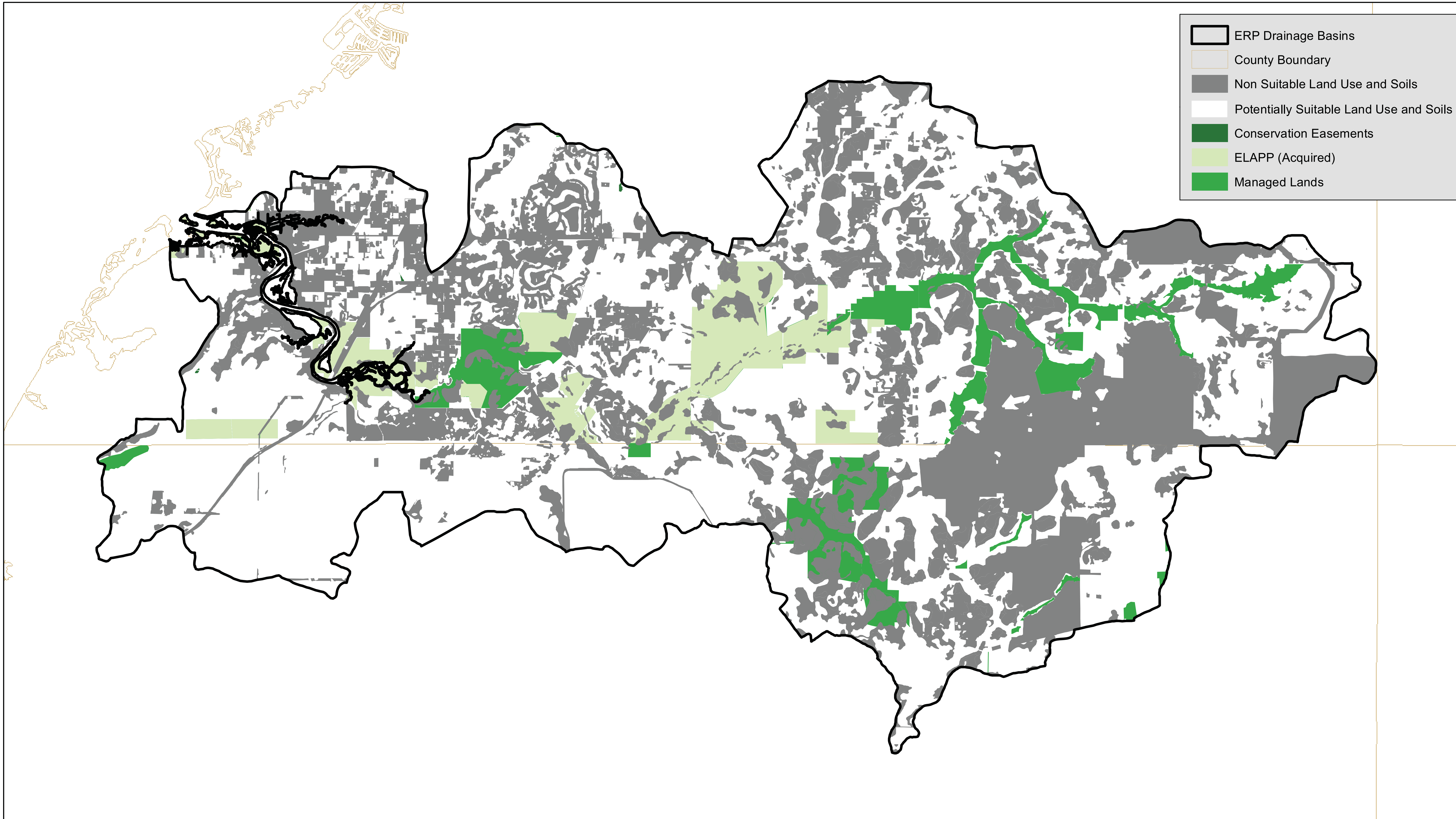

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Figure 3-3d

Conservation Areas and Combined Land Use/Soils Suitability within the Little Manatee River Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough and Manatee Counties, Florida

0 2 4 6 Miles

N

Data Source:
-TBEP
-USF
-Scheda
-FNAI
-SWFWMD, 2009
-NRCS, 2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West

3.2.4 Manatee River Basin

Freshwater restoration calculations completed for the Manatee River Basin are shown in **Table 3-5.** In making these calculations, the Forested/Other proportion was considered to change the least from the benchmark year (1950) to the current year (2007), so its relevant information was used in the calculation. Its 2007 acreage then becomes the target, or no net loss (the delta equals zero). The calculations show that in order to "restore the balance" additional acres are needed in four habitat classifications:

- Forested/Lacustrine: target is an increase in acres from 168 to 305, or a delta of 137 acres:
- Non-Forested/Lacustrine: target is an increase in acres from 169 to 448, or a delta of 278 acres;
- Non-Forested/Other: target is an increase in acres from 2,276 to 3,920, or a delta of 1,644 acres; and
- Non-Forested/Riverine: target is an increase in acres from 9,029 to 10,773, or a delta of 1,745 acres.

Table 3-5 Manatee River Basin Freshwater Wetland Restoration Targets

	Acres		Proportion of Totals		Acres	Acres
USF Team Classification	**1950**	**2007**	**1950**	**2007**	**Target**	**Delta**
Forested/Lacustrine	330	168	0.01	0.01	**305**	**137**
Forested/Other	1,355	1,251	0.04	0.04	**1,251**	**0**
Forested/Riverine	12,921	15,692	0.42	0.55	**15,692**	**0**
Forested Subtotal	14,605	17,111	0.47	0.60	**17,248**	**137**
Non-Forested/Lacustrine	485	169	0.02	0.01	**448**	**278**
Non-Forested/Other	4,244	2,276	0.14	0.08	**3,920**	**1,644**
Non-Forested/Riverine	11,663	9,029	0.38	0.32	**10,773**	**1,745**
Non-Forested Subtotal	16,392	11,474	0.53	0.40	**15,141**	**3,667**
Total	**30,997**	**28,585**	1.00	1.00	**32,389**	**3,804**

For the habitat category Forested/Riverine, its proportion of the total has increased from 1950 to 2007; therefore, the 2007 acreage becomes the protection target, or no net loss.

The subtotal of the Forested habitat targets is 137 acres, and the subtotal of the Non-Forested habitats is 3,667 acres; this represents a combined restoration and protection target of 3,804 total acres for the Manatee River Basin.

As in the Little Manatee River Basin, the Manatee River Basin experienced the greatest disproportional and total acreage losses in the Non-Forested habitat types. The losses in both Non-Forested/Other and Non-Forested/Riverine habitat were 6 percentage points from the 1950 estimates. The acreage deltas recommended for “restoring the balance” of these non-forested freshwater habitats are 1,644 and 1,745 acres, respectively. To determine the feasibility of achieving this overall habitat balance, the same suitability factors were considered. **Figure 3-4a**, considers land use suitability and **Figure 3-4b** shows the analysis of soils suitability within the basin, with yellow and blue indicating the most suitable soils. In **Figure 3-4c**, all the non-suitable land use and non-suitable soils areas are shaded gray, and only the areas represented as a color (yellow or blue) are potentially suitable for wetland creation, restoration, or enhancement. This potentially suitable acreage is shown in **Figure 3-4d** and totals 157,066 acres. Within this area there are seven suitable soil classification types that are present in at least 5% of the area. These soils are Myakka (26.1%), Eaugallie (15.8%), Waveland (14.1%), Floridana (6.2%), Delray (5.9%), Cassia (5.8%) and Felda (5.0%).

The calculated targets also show a relatively small target delta of 137 acres for the Forested/Lacustrine habitat type. However, there is a corresponding increase of habitat cover in the Forested/Riverine category. The reasons for the conversion or increase of this Forested/Riverine habitat may mirror the forested habitat increases observed in the Little Manatee River Basin, potentially due to drainage changes leading to a transformation of herbaceous (non-forested) to forested vegetative cover.

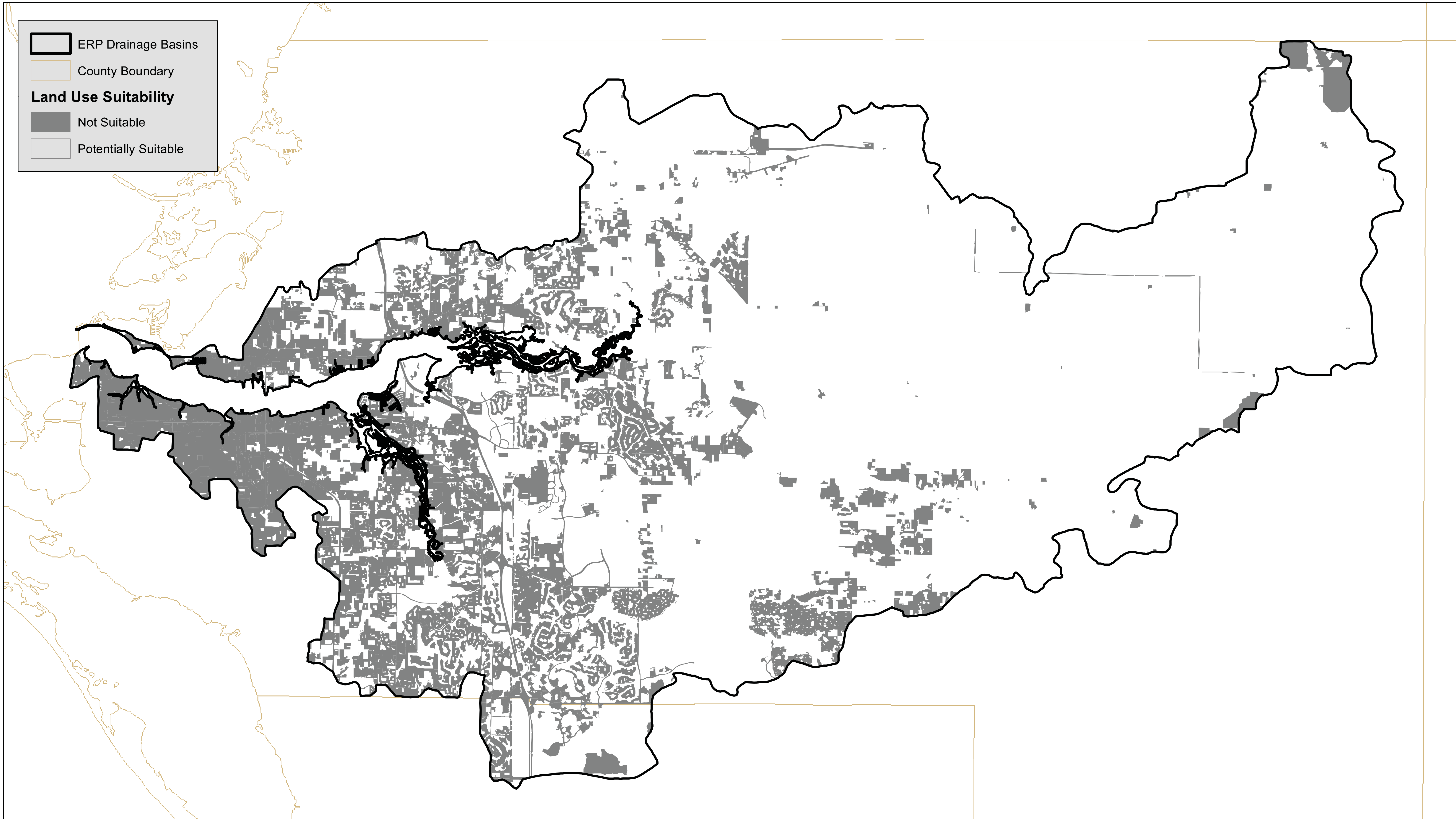

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Figure 3-4a
Land Use Suitability within the Manatee River Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Manatee and Sarasota Counties, Florida

Data Source:
-TBEP
-USF
-Scheda
-SWFWMD,2009
Imagery Source:
-None
Coordinate System:
NAD 1983 Florida
State Plane West

Date: 06/02/2013 Rev. Date: 06/11/2013 PM: SSK GIS Analyst: GdA Map Document: TBEP_LandUseSuitability_Manatee_River_blank_B_gda_20130611.mxd Project Number: 2470 PDF Document: TBEP_LandUseSuitability_Manatee_River_blank_B_gda_20130611.pdf Plot Size: 11x17

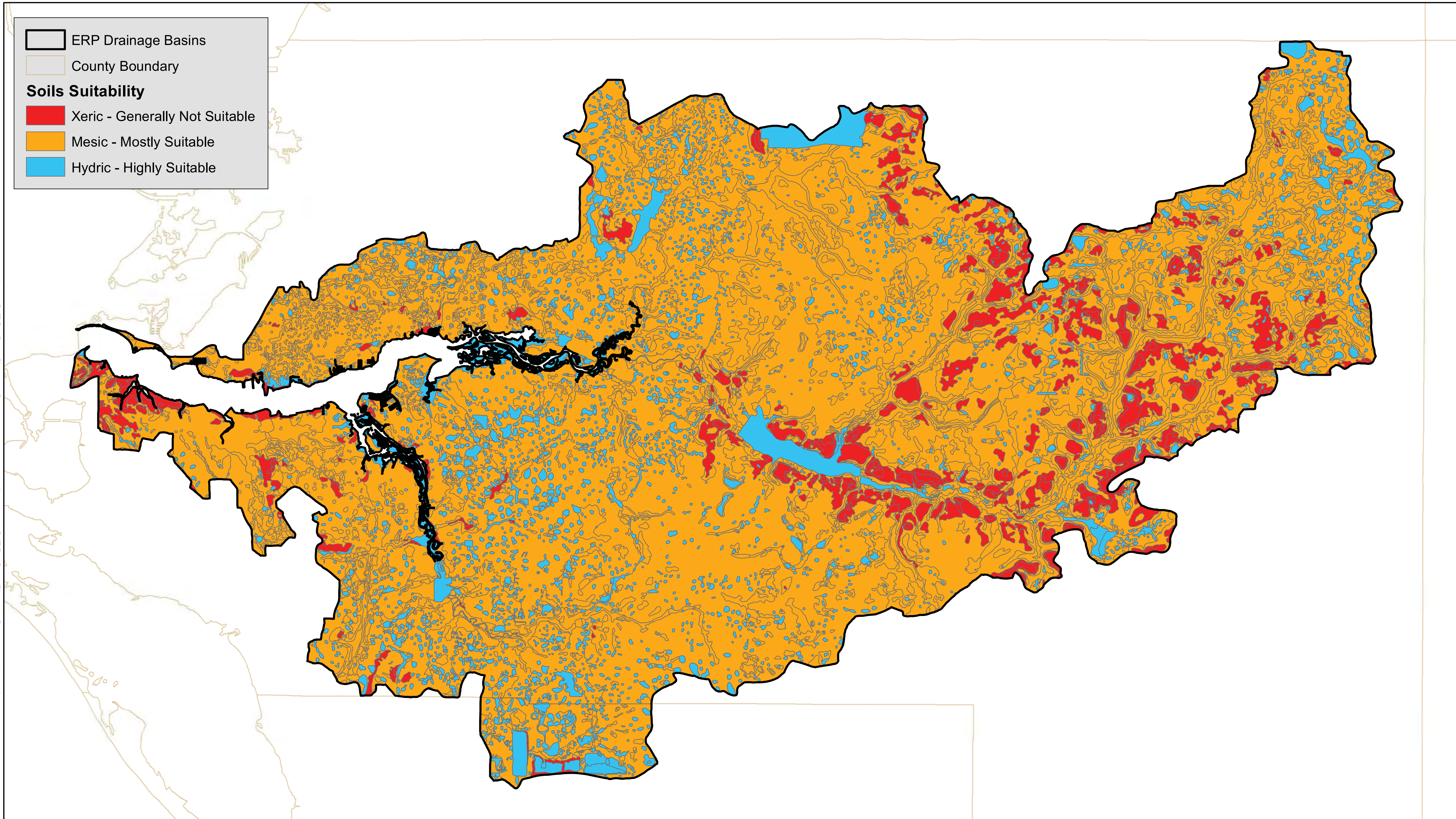

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Figure 3-4b
Soils Suitability within the Manatee River Basin

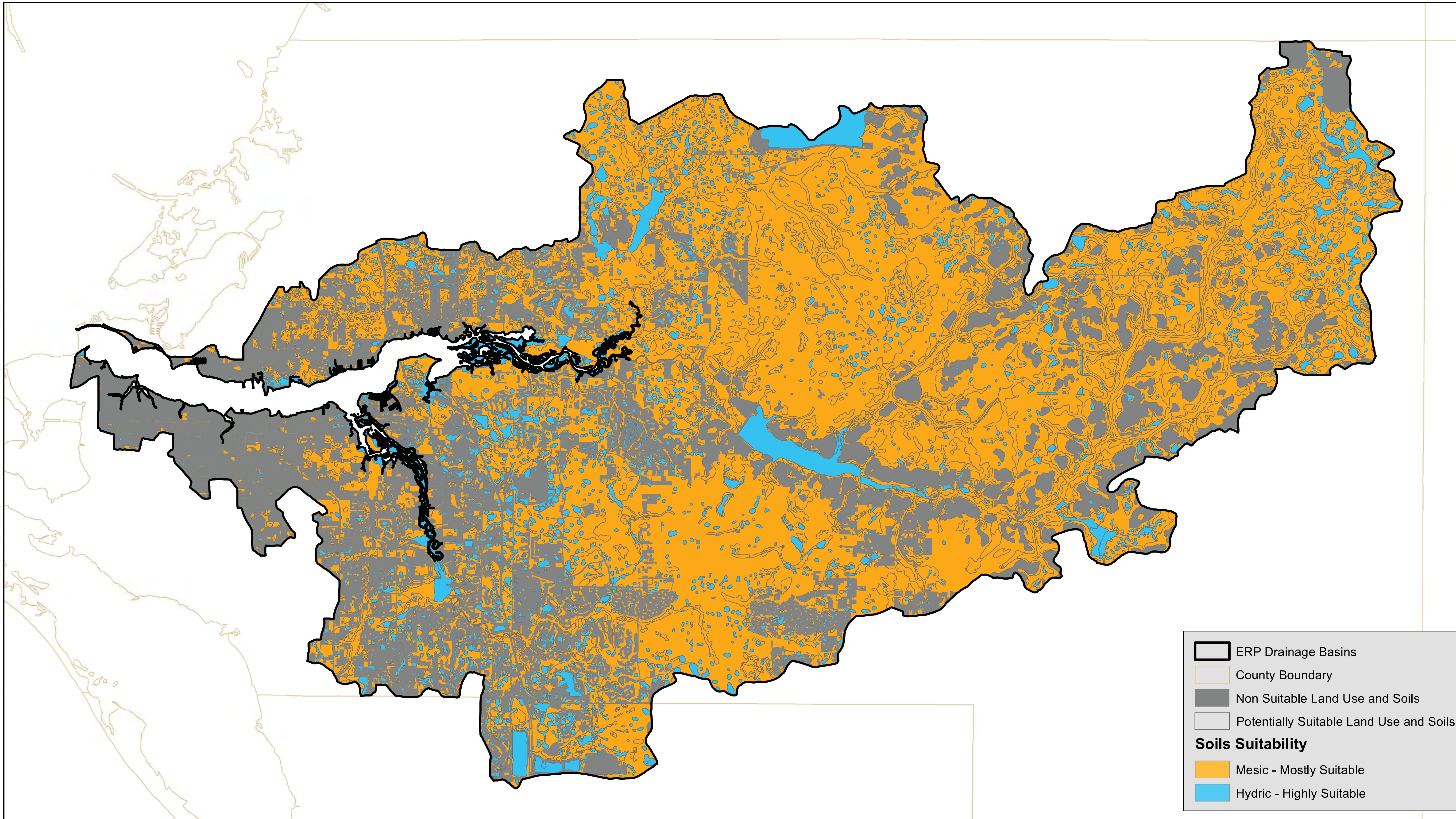
Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Manatee and Sarasota Counties, Florida

0 2.5 5 7.5 Miles

N

Data Source:
-TBEP
-USF
-Scheda
-NRCS,2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West



Date: 06/02/2013 Rev. Date: 06/12/2013 PM: SSK GIS Analyst: GdA Map Document: TBEP_CombinedSuitability_Soils_Manatee_River_B_gda_20130612.mxd Project Number: 2470 PDF Document: TBEP_CombinedSuitability_Soils_Manatee_River_B_gda_20130612.pdf Plot Size: 11x17

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Figure 3-4c

Combined Land Use and Soils Suitability within the Manatee River Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Manatee and Sarasota Counties, Florida

0 2.5 5 7.5 Miles

N

Data Source:
-TBEP
-USF
-Scheda
-NRCS, 2009
-SWFWMD, 2009
Imagery Source:
-None
Coordinate System:
NAD 1983 Florida State Plane West

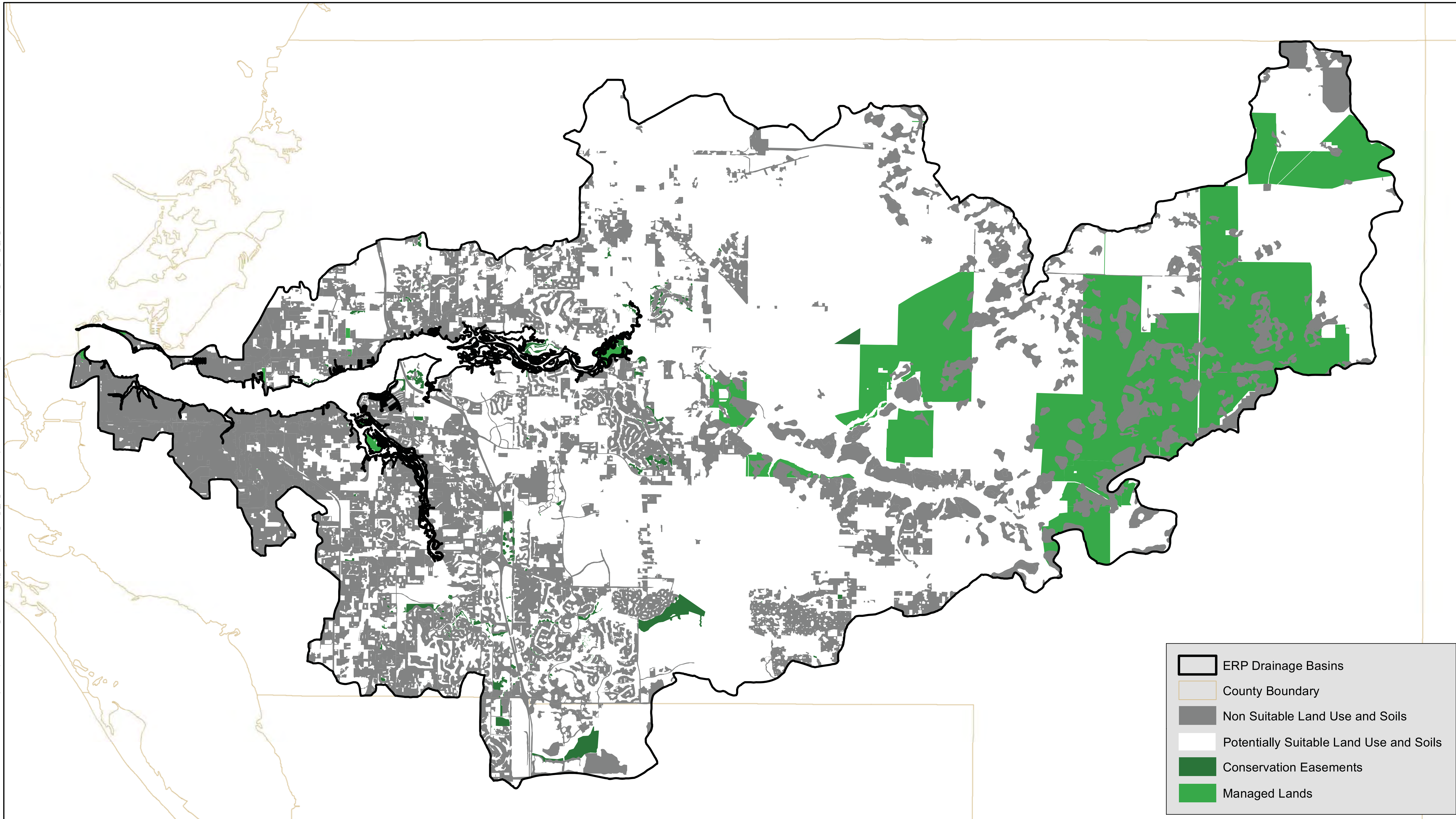

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Figure 3-4d
Conservation Areas and Combined Land Use/Soils Suitability within the Manatee River Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Manatee and Sarasota Counties, Florida

0 2.5 5 7.5 Miles

N

Data Source:
-TBEP
-USF
-Scheda
-FNAI
-SWFWMD, 2009
-NRCS, 2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West

3.2.5 Tampa Bay and Coastal Areas Basin

Freshwater restoration calculations completed for the Tampa Bay and Coastal Areas Basin are shown in **Table 3-6**. In making these calculations, the Forested/Other proportion was considered to change the least from the benchmark year (1950) to the current year (2007), so its relevant information was used in the calculation. Its 2007 acreage becomes the target, or no net loss (the delta equals zero). The calculations show that in order to "restore the balance" additional acres are needed in three habitat classifications:

- Non-Forested/Lacustrine: target is an increase in acres from 882 to 1,239, or a delta of 357 acres;
- Non-Forested/Other: target is an increase in acres from 2,348 to 3,444, or a delta of 1,095 acres; and
- Non-Forested/Riverine: target is an increase in acres from 4,213 to 7,160, or a delta of 2,948 acres.

Table 3-6 Tampa Bay and Coastal Areas Basin Freshwater Wetland Restoration Targets

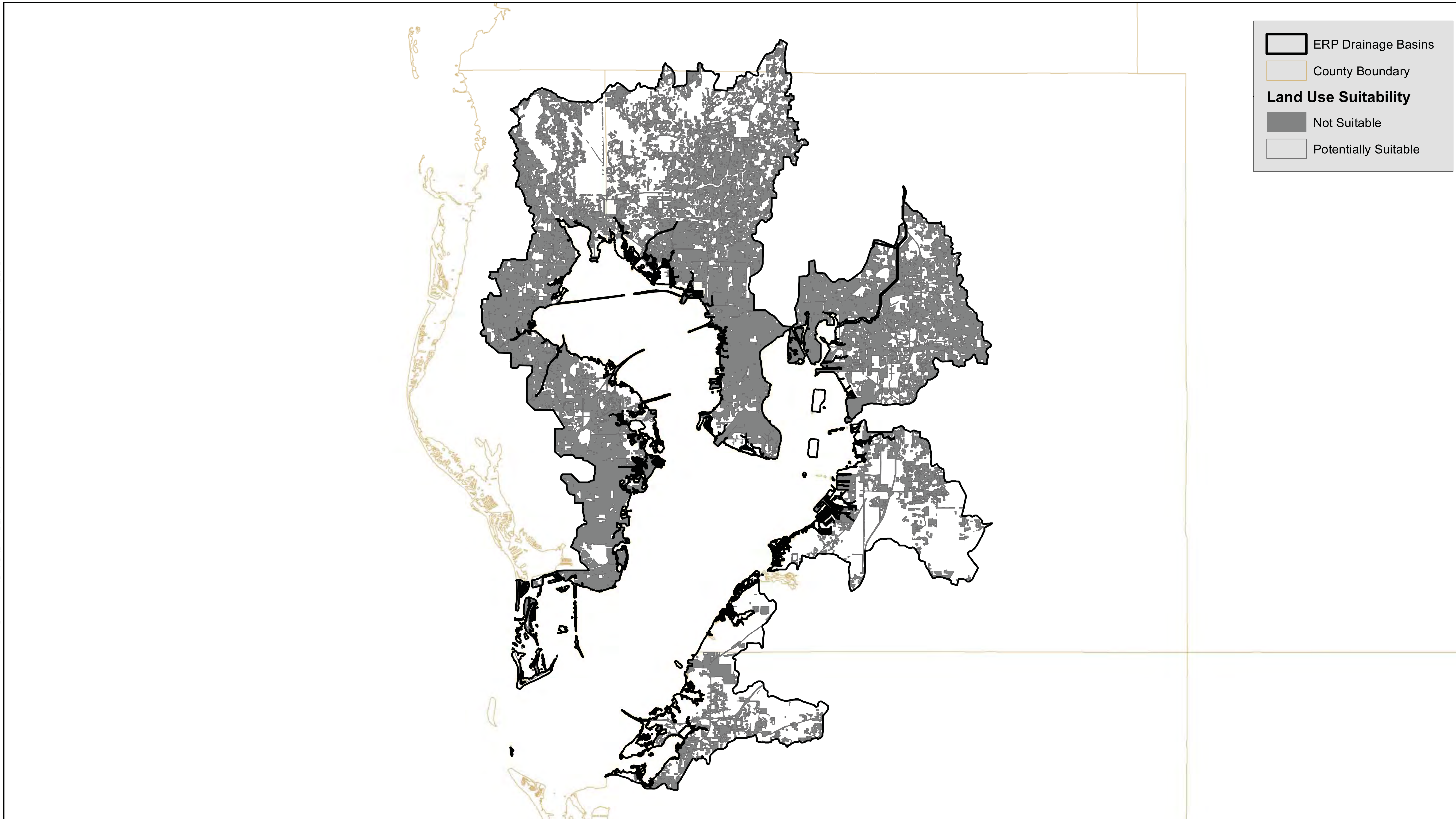
	Acres		Proportion of Totals		Acres	Acres
USF Team Classification	**1950**	**2007**	**1950**	**2007**	**Target**	**Delta**
Forested/Lacustrine	3,567	3,721	0.09	0.11	**3,721**	**0**
Forested/Other	4,785	3,883	0.11	0.12	**3,883**	**0**
Forested/Riverine	18,914	17,432	0.45	0.54	**17,432**	**0**
Forested Subtotal	27,266	25,036	0.65	0.77	**25,036**	**0**
Non-Forested/Lacustrine	1,527	882	0.04	0.03	**1,239**	**357**
Non-Forested/Other	4,243	2,348	0.10	0.07	**3,444**	**1,095**
Non-Forested/Riverine	8,824	4,213	0.21	0.13	**7,160**	**2,948**
Non-Forested Subtotal	14,594	7,443	0.35	0.23	**11,843**	**4,400**
Total	**41,860**	**32,479**	1.00	1.00	**36,879**	**4,400**

For the habitat categories Forested/Lacustrine and Forested/Riverine, their proportions of the total have increased from 1950 to 2007, therefore, the calculation is not necessary and their 2007 acreages become the protection targets, for no net loss.

The subtotal of the Forested habitat targets is 0 acres, and the subtotal of the Non-Forested habitats is 4,400 acres; this represents a combined target of 4,400 total acres of wetland mitigation, restoration or enhancement for the Tampa Bay and Coastal Areas Basin.

The Tampa Bay and Coastal Areas Basin is similar to previous basins analyses, and in particular, to the Little Manatee and Manatee River Basins. In each case, the non-forested habitats were disproportionately lost in comparison to the forested habitats. There was a calculated increase in the estimated acreage of Forested/Lacustrine and Forested/Riverine habitats. The largest loss from the baseline values was in the Non-Forested/Riverine systems, where the decrease was 8% and the area needed to "restore the balance" was calculated to be 2,948 acres.

Figures 3-5a through **3-5c** consider land use suitability combined with soils suitability within the basin. The final map in the series demonstrates potentially suitable areas for wetland mitigation, restoration and enhancement (**Figure 3-5d**), and available land area totals 90,699 acres, excluding conservation areas. There are four soil classification categories that are deemed suitable and are present in at least 5% of the suitable area: Myakka (25.1%), Bassinger (11.4%), Kesson (6.8%) and Malabar (6.7%).



Date: 06/02/2013 Rev. Date: 06/11/2013 PM: SSK GIS Analyst: GdA Map Document: TBEP_LandUseSuitability_Tampa_Bay_Coastal_B_gda_20130611.mxd Project Number: 2470 PDF Document: TBEP_LandUseSuitability_Tampa_Bay_Coastal_B_gda_20130611.pdf Plot Size: 11x17

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Figure 3-5a
Land Use Suitability within the Tampa Bay and Coastal Areas Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough, Manatee, Pasco, and Pinellas Counties, Florida

0 5.5 11 16.5 Miles

N

Data Source:
-TBEP
-USF
-Scheda
-SWFWMD, 2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West

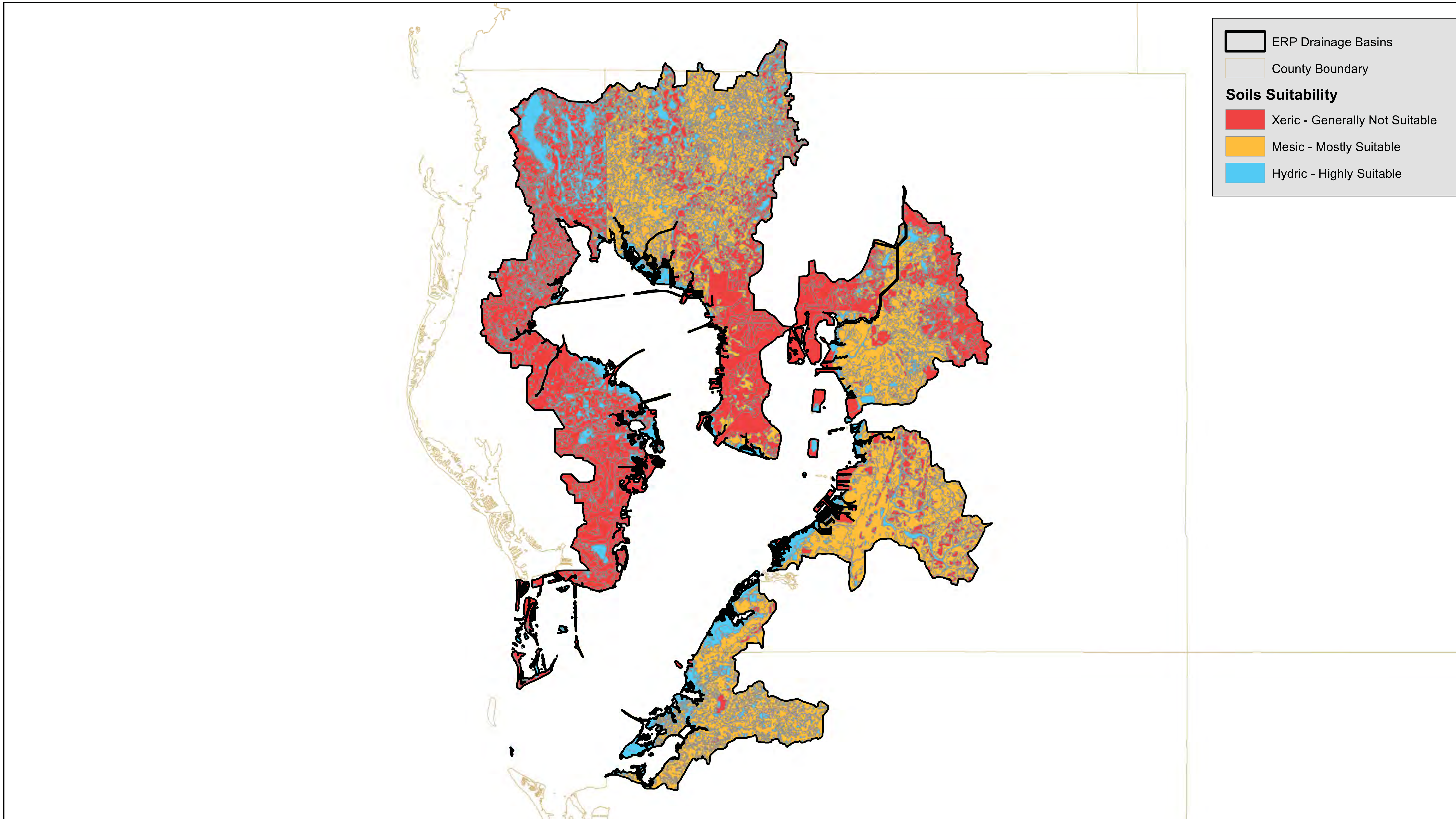

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Figure 3-5b

Soils Suitability within the Tampa Bay and Coastal Areas Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough, Manatee, Pasco, and Pinellas Counties, Florida

0 5.5 11 16.5 Miles

N

Data Source:
-TBEP
-USF
-Scheda
-NRCS, 2009
Imagery Source:
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Coordinate System:
NAD 1983 Florida
State Plane West

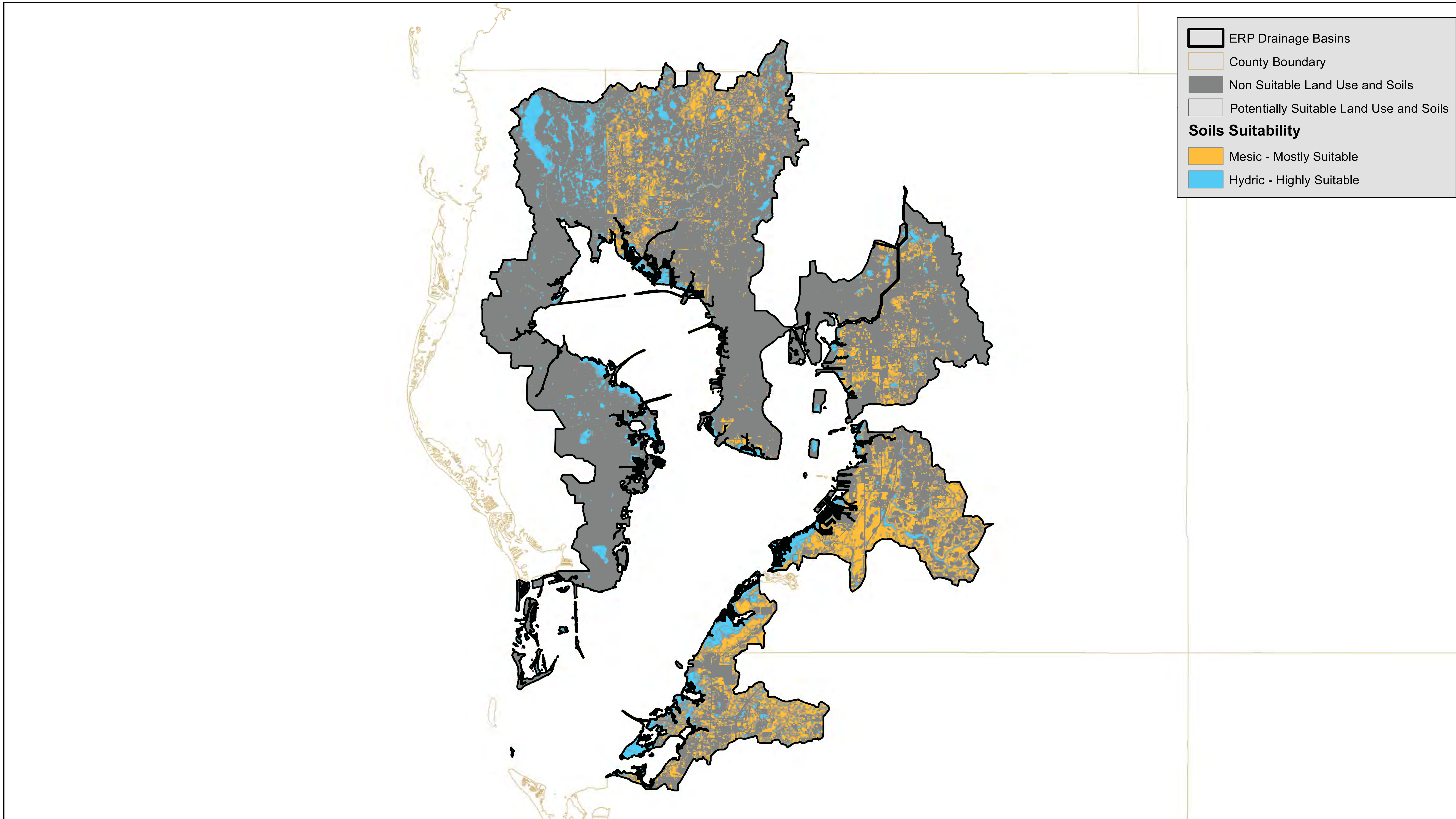

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Figure 3-5c
Combined Land Use and Soils Suitability within the Tampa Bay and Coastal Areas Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough, Manatee, Pasco, and Pinellas Counties, Florida

Miles: 0, 5.5, 11, 16.5

N

Data Source:
-TBEP
-USF
-Scheda
-NRCS, 2009
-SWFWMD, 2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West

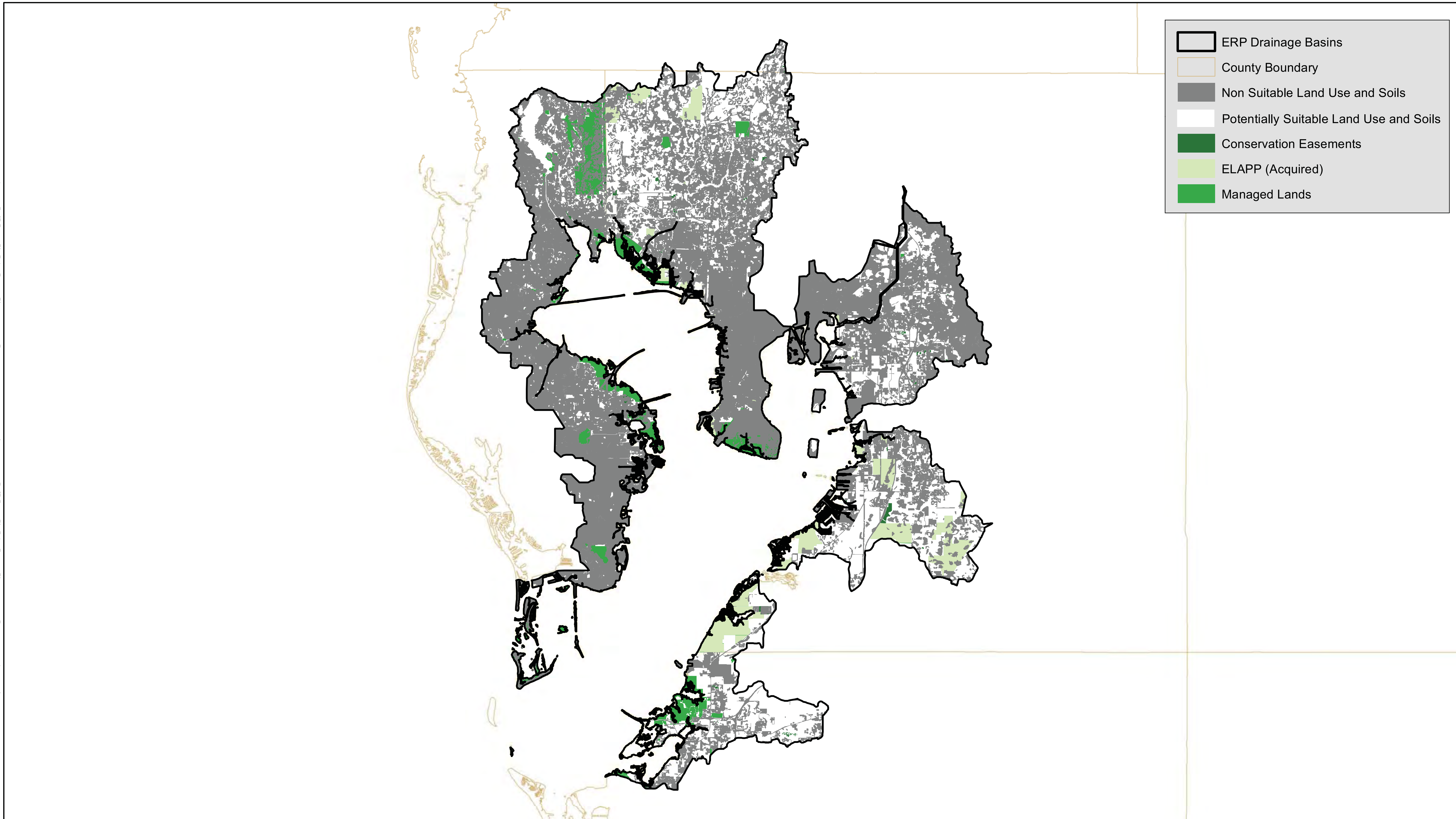

Figure 3-5d
Conservation Areas and Combined Land Use/Soils Suitability within the Tampa Bay and Coastal Areas Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Hillsborough, Manatee, Pasco, and Pinellas Counties, Florida

Data Source:
-TBEP
-USF
-Scheda
-FNAI
-SWFWMD, 2009
-NRCS, 2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West

3.2.6 Upper Coastal Areas Basin

Only a small portion (seven percent) of this basin is part of the Tampa Bay watershed, however, freshwater restoration calculations completed for this portion of the Upper Coastal Areas Basin are shown in **Table 3-7**. In making these calculations, the Forested/Lacustrine proportion was considered to change the least from the benchmark year (1950) to the current year (2007), so its relevant information was used in the calculation. Its target becomes the 2007 acreage, for no net loss (the delta equals zero). The calculations show that in order to "restore the balance," additional acres are needed in three habitat classifications:

- Forested/Other: target is an increase in acres from 35 to 89, or a delta of 54 acres;
- Non-Forested/Other: target is an increase in acres from 49 to 163, or a delta of 114 acres; and
- Non-Forested/Riverine: target is an increase in acres from 74 to 127, or a delta of 54 acres.

Table 3-7 Upper Coastal Areas Basin Freshwater Wetland Restoration Targets

	Acres		Proportion of Totals		Acres	Acres
USF Team Classification	**1950**	**2007**	**1950**	**2007**	**Target**	**Delta**
Forested/Lacustrine	27	12	0.02	0.03	**12**	**0**
Forested/Other	208	35	0.17	0.08	**89**	**54**
Forested/Riverine	321	251	0.26	0.58	**251**	**0**
Forested Subtotal	555	298	0.45	0.69	**352**	**54**
Non-Forested/Lacustrine	9	11	0.01	0.03	**11**	**0**
Non-Forested/Other	380	49	0.31	0.11	**163**	**114**
Non-Forested/Riverine	296	74	0.24	0.17	**127**	**54**
Non-Forested Subtotal	685	134	0.55	0.31	**302**	**168**
Total	**1,240**	**432**	1.00	1.00	**654**	**222**

For the last two habitat categories, Forested/Lacustrine and Non-Forested/Lacustrine, their proportions of the total have increased from 1950 to 2007, therefore, the calculation is not necessary, and the 2007 acreages become the protection target, for no net loss.

The subtotal of the Forested habitat targets is 54 acres, and the subtotal of the Non-Forested habitats is 168 acres; this represents a combined target of 222 total acres of freshwater wetland restoration recommended for the Upper Coastal Areas Basin.

The proportion of the entire Upper Coastal Areas Basin that is within the Tampa Bay watershed, and therefore part of this systems analysis, is an order of magnitude smaller than the other basins studied. This study area also resides within the mostly developed Pinellas County coastal limits, and therefore the wetlands can be expected to be impacted by this development, even prior to the baseline condition.

The total acreage recommended for "restoring the balance" of the freshwater wetland habitats is only 222 acres combined, for the three recommended targeted habitat types. **Figures 3-6a** through **3-6c** consider land use suitability combined with soils suitability within the basin. A cursory examination of **Figure 3-6d** reveals that there is limited area within the portion of the basin that has the potential for wetland habitat restorative action. The area within the portion of the Upper Coastal Areas Basin that is considered part of the Tampa Bay Watershed and has the required restorative potential is calculated to be 2,610 acres. Of these potential acres, two soil classification types are present in at least 5% of the areal extent: Kesson (16.8%) and Anclote (9.9%). To partially address the limited available land for freshwater wetland creation or restoration, a supplemental task was to develop a manual for incorporating Low Impact Development (LID) practices into stormwater management. The intent was to showcase innovative practices for managing stormwater in developed areas, such as the Upper Coastal Areas Basin, that can also be protective or beneficial to freshwater wetland habitats, as well as how protection or enhancement of wetlands can improve urban stormwater quality. This manual is currently under development and will be available through Pinellas County in 2015.

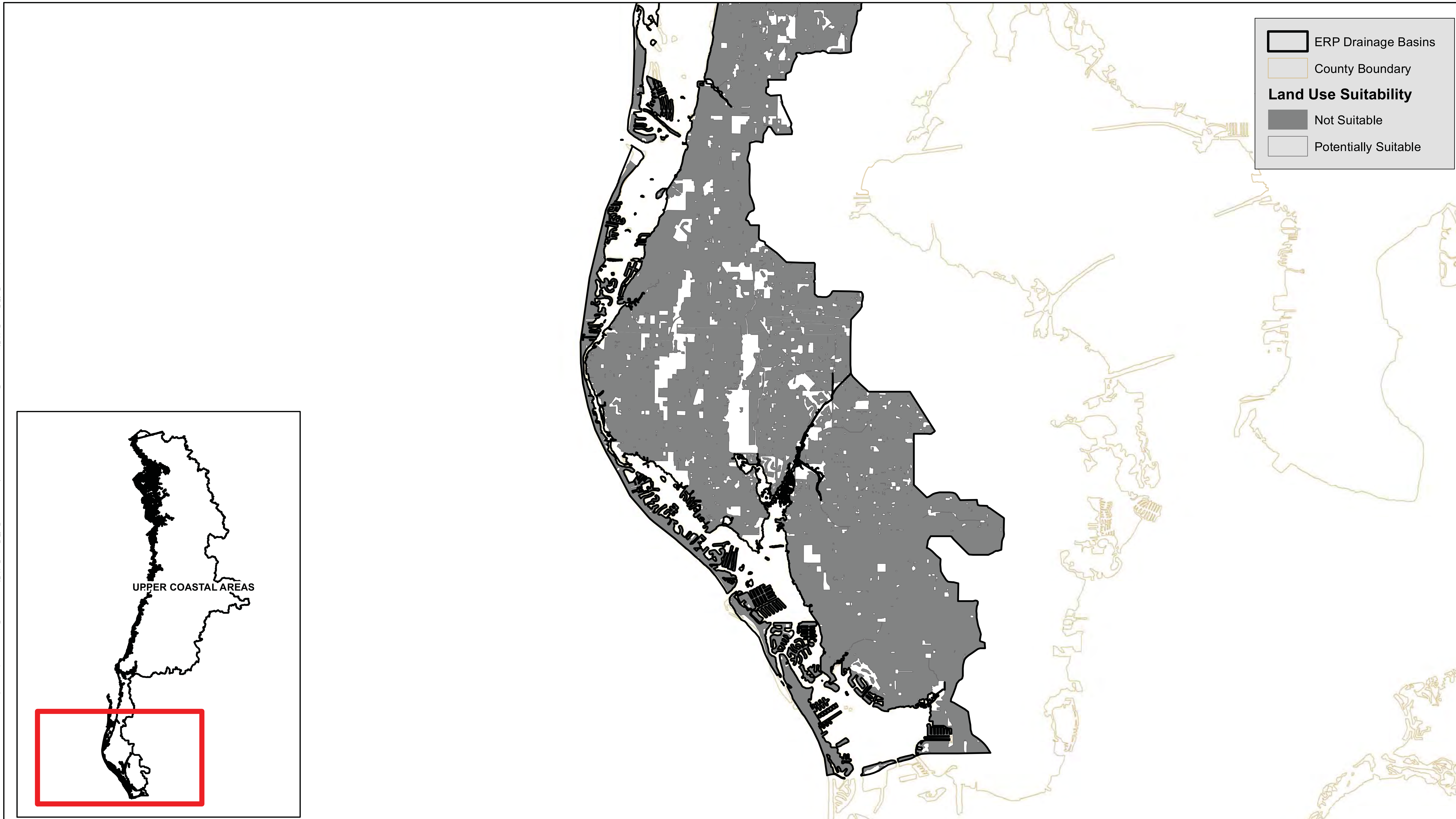

Figure 3-6a
Land Use Suitability within the Upper Coastal Areas Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Pinellas County, Florida

0 2.5 5 7.5 Miles

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N

Data Source:
-TBEP
-USF
-Scheda
-SWFWMD, 2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West

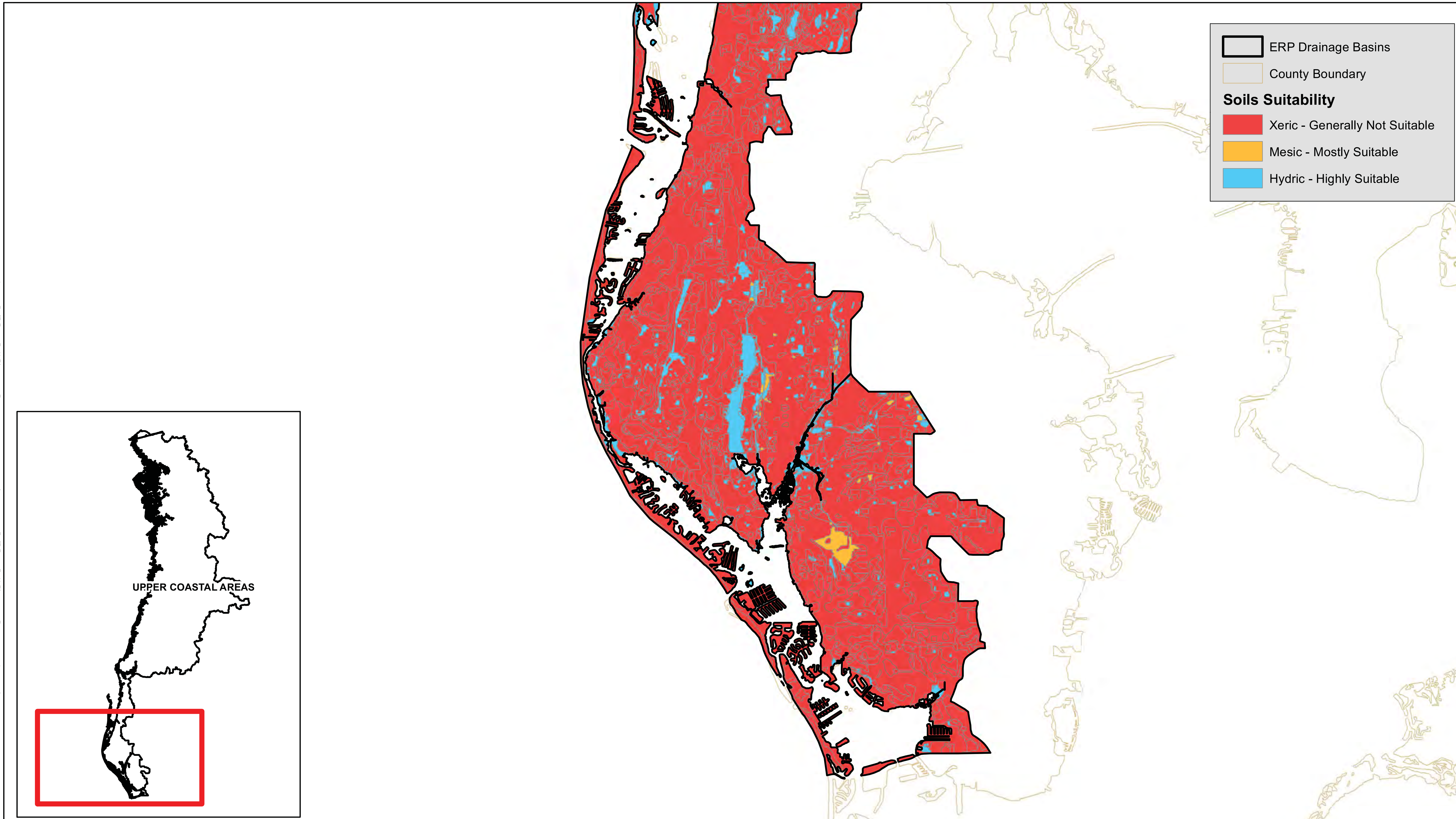

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Figure 3-6b
Soils Suitability within the Upper Coastal Areas Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Pinellas County, Florida

0 2.5 5 7.5 Miles

N

Data Source:
-TBEP
-USF
-Scheda
-NRCS, 2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West

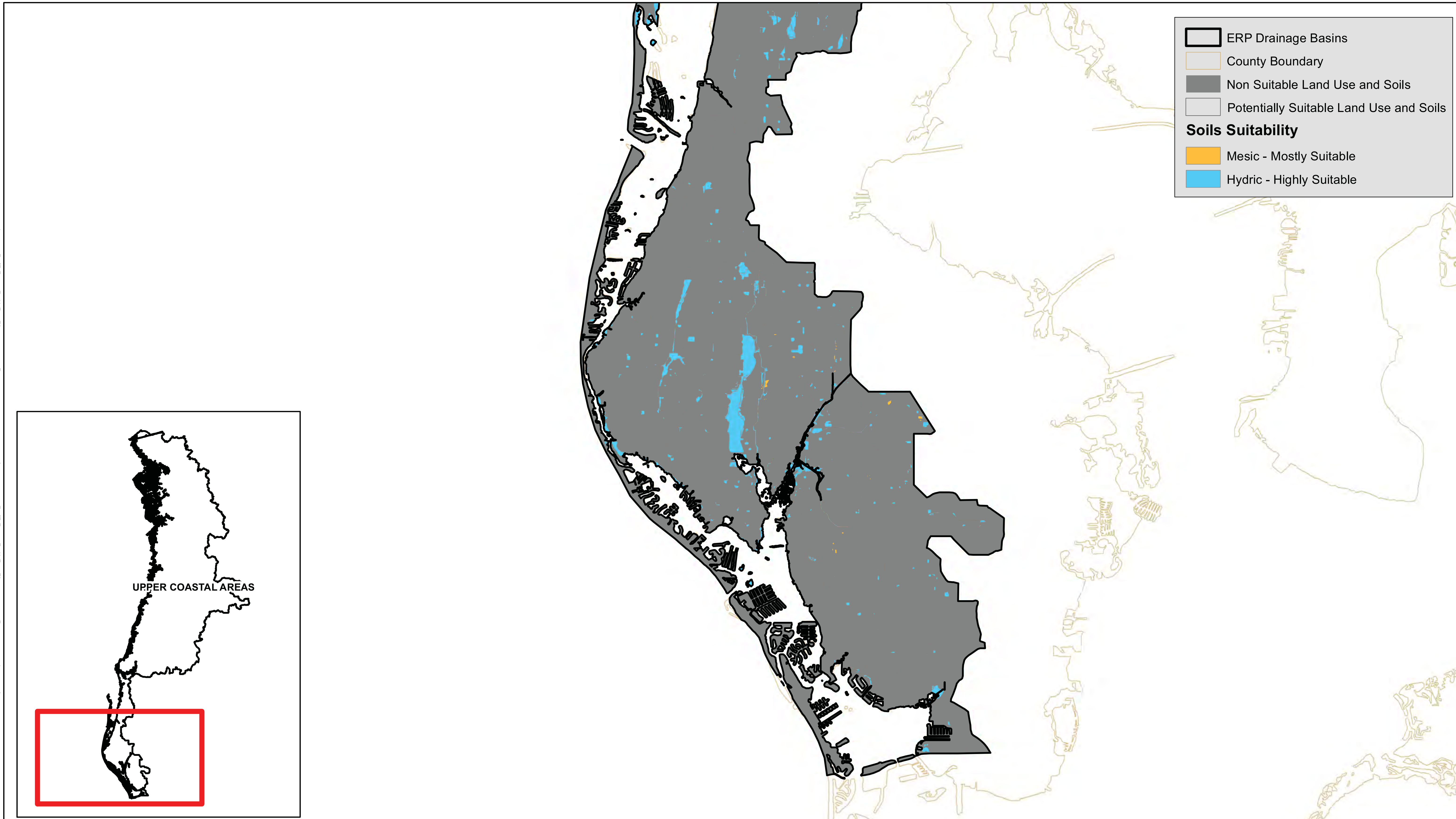

Figure 3-6c
Combined Land Use and Soils Suitability within the Upper Coastal Areas Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Pinellas County, Florida

0 2.5 5 7.5 Miles

N

Data Source:
-TBEP
-USF
-Scheda
-NRCS, 2009
-SWFWMD, 2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West

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Date: 06/02/2013 Rev. Date: 06/12/2013 PM: SSK GIS Analyst: GdA Map Document: TBEP_CombinedSuitability_Soils_Upper_Coastal_B_gda_20130612.mxd Project Number: 2470 PDF Document: TBEP_CombinedSuitability_Soils_Upper_Coastal_B_gda_20130612.pdf Plot Size: 11x17

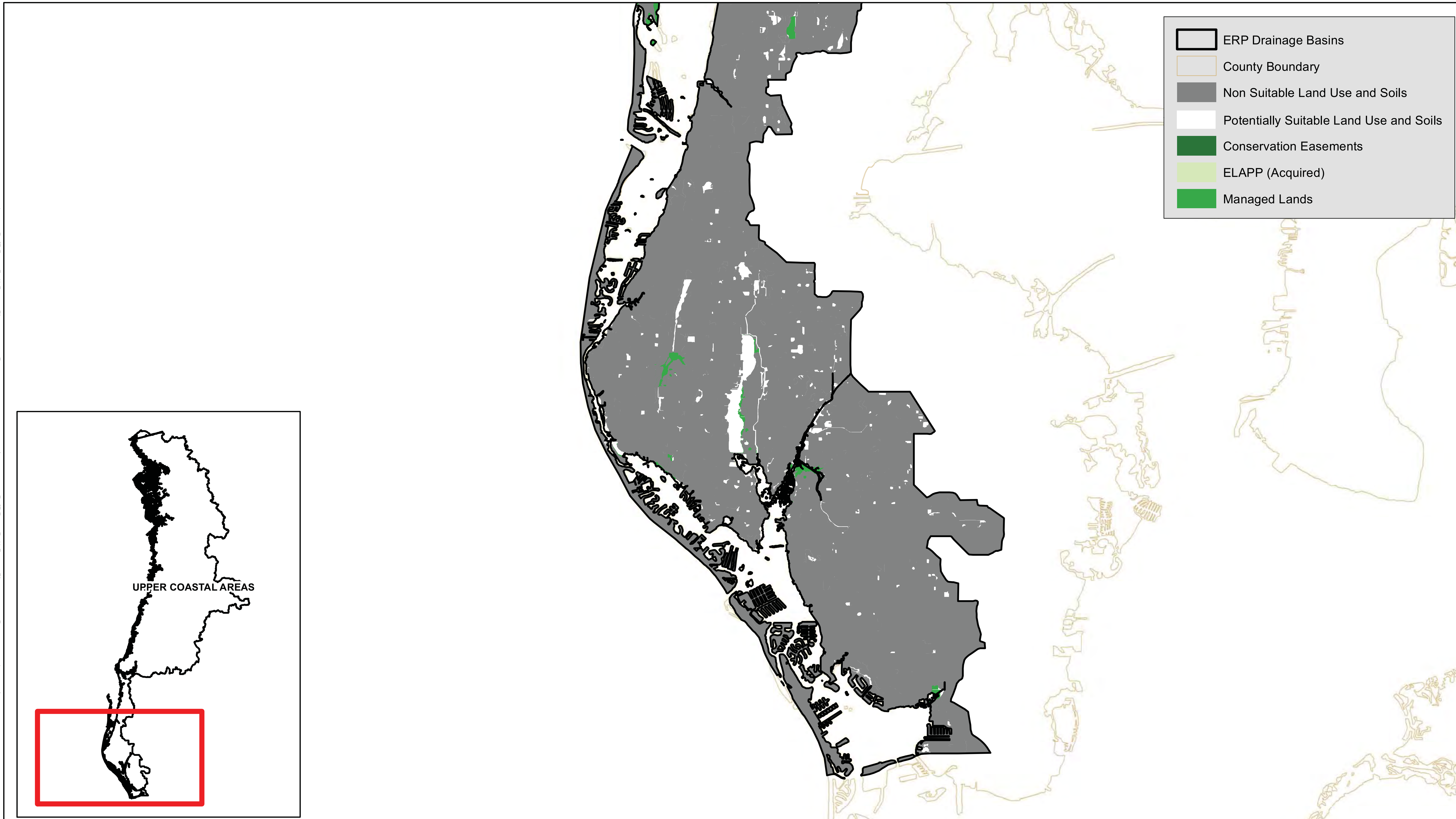

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Figure 3-6d
Conservation Areas and Combined Land Use/Soils Suitability within the Upper Coastal Areas Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan
Pinellas County, Florida

Miles: 0 2.5 5 7.5

N

Data Source:
-TBEP
-USF
-Scheda
-FNAI
-SWFWMD, 2009
-NRCS, 2009
Imagery Source:
-None

Coordinate System:
NAD 1983 Florida
State Plane West

3.3 ISOLATED WETLANDS

Exact disproportionate losses for isolated wetlands, less than 0.5-acre in size, are difficult to calculate because the mapping developed for year-to-year comparisons (e.g., FLUCCS maps) does not identify these smaller (<0.5 acre) wetlands. However, our review of the historic aerials revealed that there were numerous, less than 0.5 acre, isolated wetlands within the undeveloped areas for each basin. In addition, throughout decades of environmental regulatory protection for wetlands, there was no protection of these smaller wetland systems; therefore, there were no penalties for filling these systems. It is reasonable to assume that the smaller, more ephemeral marsh systems would have been easily and inexpensively filled to achieve a wide variety of agricultural and urban development goals within the watershed over the last 50 years. It is with this historical perspective that the study team determined that small isolated wetlands are likely to be disproportionately lost. These systems are critically important to certain life stages of amphibians as well as wading bird species, therefore, where they can be added to a restoration plan, their addition would facilitate the overall goals of this study.

3.4 SUMMARY AND RECOMMENDATIONS

Figure 3-7 summarizes the Forested and Non-Forested target totals by basin that have been adopted by the TBEP's Policy Board. The process by which these targets were developed was vetted and guided through several Project Advisory Group Meetings (described further in the next chapter). The approach and targets were presented to the TBEP Technical Advisory Committee (TAC) on July 30, 2013. The TAC recommended their approval by the TBEP Management and Policy Boards. The TBEP Policy Board, comprised of elected officials from the major jurisdictions surrounding Tampa Bay, formally approved the targets on August 23, 2013. At this point in the study, it was recommended that these targets be adopted, and the study team should begin discussion of methods to achieve these watershed goals with regulatory agencies.

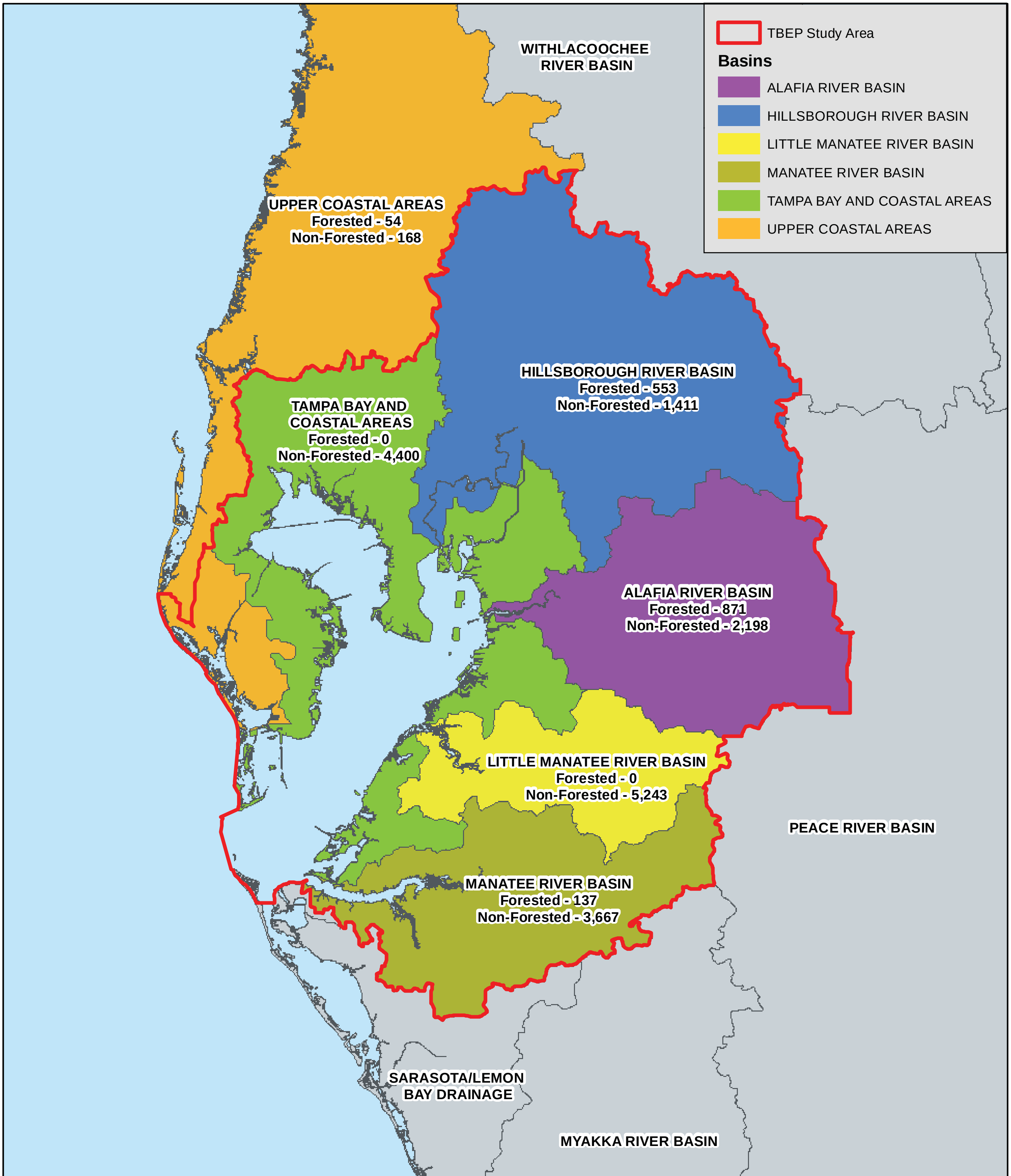

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Figure 3-7
Summary of Forested and Non-Forested Target Totals by Basin

Tampa Bay Estuary Program
Compensatory Mitigation Master Plan

0 58,250 116,500 174,750 Feet

N

Data Source:
- TBEP
- USF
Imagery Source:
- ESRI Base Map

Coordinate System:
NAD 1983 Florida
State Plane West

Date: 02/17/2014 Rev. Date: n/a PM: SSK GIS Analyst: GdA Map Document: TBEP_Forested_and_NonForested_Targets_A_gda_20140217.mxd Project Number: 2470 PDF Document: TBEP_Forested_and_NonForested_Targets_A_gda_20140217.pdf Plot Size: 8.5 x 11

4.0 ADDITIONAL RESEARCH TO SUPPORT COOPERATIVE FRESHWATER WETLAND MITIGATION STRATEGIES

The goal of the prior USF Team study and this study has been to determine if disproportional impacts have occurred to freshwater wetlands, and to develop a strategy that can be used to help prioritize what habitats to restore. The estuarine targets developed in *Setting Priorities for Tampa Bay Habitat Protection and Restoration: Restoring the Balance* (Lewis and Robison, 1995) and the *Tampa Bay Estuary Program Habitat Master Plan Update* (Robison, 2010) have been incorporated into local and regional habitat plans. Therefore it is feasible that the freshwater wetland analysis conducted for this study may similarly be incorporated into planning documents and strategies. Efforts to incorporate this information into regulations and policies will require the cooperation of public agencies and improved federal-state-local regulatory coordination with the overall goal of restoring a more historic balance of freshwater wetland types within the Tampa Bay watershed.

As stated previously, it would be unreasonable to restore or recover all lost or impacted wetlands to the baseline level of coverage. Therefore this document provides guidance for restoring the relative proportions of important freshwater wetland habitat types. The basin-specific target restoration goals presented above can be achieved by strategically evaluating the type of mitigation required for development projects which result in unavoidable wetland impacts. It is important to emphasize that this document endorses wetland mitigation only when impacts are truly unavoidable and the project team has engaged with regulatory agencies to develop strategies for the appropriate application of this information to mitigation, as discussed in detail later in this report.

4.1 DISPROPORTIONATE IMPACTS

The results of this study show the need for acreage gains of both forested and non-forested freshwater wetland systems in order to achieve historical proportions of freshwater wetlands. **Table 4-1** on the following page shows the total acreage requiring restoration throughout the Tampa Bay watershed (including all six ERP basins) broken down into the forested and non-forested freshwater wetland categories.

Table 4-1 Summary of Target Restoration Acreage Needed to Restore Balance (Forested and Non-Forested)

Basin	Forested Freshwater Wetlands (ac)	Non-Forested Freshwater Wetlands (ac)	Total
Alafia River	871	2,199	**3,070**
Hillsborough River	553	1,411	**1,964**
Little Manatee River	0	5,243	**5,243**
Manatee River	137	3,667	**3,804**
Tampa Bay and Coastal Areas	0	4,400	**4,400**
Upper Coastal Areas	54	168	**222**
Total	**1,615**	**17,088**	**18,703**

These data show that despite the watershed needing gains of both freshwater wetland types, the need for acres of non-forested wetlands far outweighs the need for acres of forested wetlands watershed-wide; 17,088 acres and 1,615 acres respectively. This is a reflection of disproportionately high rates of impacts to non-forested freshwater wetlands over the 57 year time-period analyzed.

Though there is no one reason why non-forested wetlands were impacted more than forested, there are a few factors which, combined, may have resulted in a system which favored the development of non-forested wetlands. Prior to the mid-1990s, regulations made it less expensive to impact non-forested systems as mitigation ratios for those impacts were lower. Mitigation areas for non-forested wetlands were also easier to design, construct, and maintain, and success criteria were relatively easy to achieve. Therefore there was economic incentive, in lower mitigation costs, to use designs that impacted less forested wetlands and more non-forested wetlands. Additionally, there are more physical difficulties associated with developing a forested wetland. For instance, preparing a forested wetland for development would involve bringing in machinery to clear heavy woody vegetation in mucky soils whereas many non-forested herbaceous wetlands are able to simply be filled.

There is variability between basins in terms of how much freshwater wetland restoration is required in order to return to historical proportions. Little Manatee River Basin requires the most total (5,243 acres) and Upper Coastal Areas Basin requires the least total (222 acres). What is consistent, however, is that all six ERP basins have had disproportionate impacts to non-forested freshwater wetlands and therefore future wetland creation and restoration efforts should focus on this habitat type. The following section explores the ecological background which supports a restored balance of freshwater wetland types within the Tampa Bay watershed.

4.2 ECOLOGICAL MOTIVATION

A potential approach to evaluating regional freshwater wetland status may only take into account the total coverage of freshwater wetlands. However, the finer balance of benefits provided by types of freshwater wetlands is lost with that perspective. The TBEP, however, considers it of vital importance to take into account the structure of those wetlands (i.e. forested versus herbaceous). This is a critical ecological distinction as the two freshwater wetland types provide habitats for distinct wildlife species at different stages of life and provide differing types and levels of ecosystem services.

The ecological benefit of restoring the historic proportions of wetland types is predicated on the notion that the habitat requirements of various wildlife species which inhabit those areas during their life cycle will be met. In addition, because restoring a more natural proportion of freshwater wetlands equates to the overall addition of wetland acres to the watershed, restoration would likely be accompanied by an increase in benefits provided by wetlands such as reduced run-off and improved water quality. The 2007 total freshwater wetland acres within the watershed was determined to be approximately 211,324 acres (**Table 2-1**). Therefore, the addition of the proposed target restoration, a total of 18,703 acres (**Table 4-1**) of freshwater wetlands (both forested and non-forested), represents an 8.85% increase in the overall area of freshwater wetlands. Such an increase would have measurable beneficial effects not only on mainland habitats but ultimately to the quality of Tampa Bay's estuarine ecosystem.

Researchers have expressed the importance of restoring herbaceous wetlands specifically over forested freshwater systems. Weisberg, Mortenson, and Dilts (2012) write: "We emphasize the importance of herbaceous wetlands as critical and often overlooked component of riparian ecosystems and the need for both passive and active restoration of fluvial marshes, sloughs, wet meadows, alkali meadows, off-channel ephemeral ponds, and other critical floodplain communities associated with herbaceous plant dominance." As presented by Hodgson in the Baywide Environmental Monitoring Report 2002-2005 "Even with strong state and local public support, local land acquisition programs have not kept pace with development, and critical wetlands and estuary habitats are being rapidly lost or functionally impaired. Clearly, the availability of suitable functioning foraging wetlands and estuarine habitats will remain of critical concern in an urbanizing region where wildlife competes with industrial, commercial, and residential construction for remaining open space."

Ten years ago, the TBEP recognized the importance of restoring estuarine habitat proportions. Since then, the actions taken by planning agencies have been successful in working towards that goal. This study provides the framework to continue the momentum and apply the same principles to another suite of habitats. The following section illustrates the need to restore the balance of freshwater wetlands, with emphasis on the ecological role of non-forested (herbaceous) wetlands.

4.2.1 Wildlife

Common insects in freshwater marsh detrital ecosystems are true flies including midges, mosquitoes, and crane flies. Nematodes and enchytraceids are important decomposers in the system. Macroinvertebrates serve as a critical food source for many species of wildlife. Crayfish, shrimp, and snails abound in submerged marshes where they are sheltered by aquatic plants such as naiad and water grass (Myers & Ewel, 1990). Deeper marshes are home to many fish species, including bass, northern pike and carp. Waterfowl and wading birds are distributed throughout the ecosystem along an elevation gradient, according to water adaptations. Dominant mammal species include herbivores such as muskrats, shrews and mice (University of Florida, 2014).

Up to 45% of birds, mammals, reptiles, amphibians, fish, and insects which inhabit wetlands are considered rare or endangered (University of Florida, 2014). The high rate of wetland loss has contributed to the endangered status of many species. Some species, such as the wood duck and muskrat, spend most of their life within wetlands, while others, such as peregrine falcon and deer, occasionally visit wetlands for food, water, or shelter (University of Florida, 2014).

While hardwood swamps are vitally important to the hydrology of Tampa Bay, most do not provide significant habitat for estuarine-dependent birds (Yates, Greening, & Morrison, 2011). However, freshwater wetlands located within the foraging areas of the bay's nesting wading bird populations do provide such habitat, and have been a key component of the Tampa Bay management effort (Lewis & Robison, 1996). Florida water birds that are particularly dependent on freshwater marsh habitat include the least bittern, American bittern, green-backed heron, white ibis, glossy ibis, limpkin, rails, marsh wren, common yellowthroat, red-winged blackbird, and boat-tailed grackle

(Myers & Ewel, 1990). Protected bird species which depend on non-forested wetlands include the federally-endangered wood stork which forages in freshwater marshes and the state-threatened Florida sandhill crane which nests in non-forested wetlands. Other wading birds often nest under the protection of the canopy in forested wetlands and forage in nearby marshes. Migratory birds traveling through Florida use freshwater marshes as locations to stop and rest, forage, and breed. The trend toward reducing the spatial distribution of palustrine wetlands and condensing them into stormwater ponds has been detrimental as birds use the natural patterns throughout the landscape as a cue for where to stop (Hodgson and Paul, 2009).

The bird species population statuses presented in the Baywide Environmental Monitoring Report (2002-2005) show that most coastal bird species' populations have declined in the past thirty years, particularly those that forage primarily in freshwater wetlands. Those species in decline include the roseate spoonbill, American oystercatcher, Caspian tern, royal tern and sandwich tern and others. The study cites that the number of snowy egrets, which feed freshwater invertebrates, frogs, and fish to their unfledged young, nesting at the Alafia Bank is declining probably due to wetland loss from development in Hillsborough County. Both the little blue heron and tricolored heron forage primarily in freshwater habitats and are vulnerable to continuing alteration of wetlands due to regional land development. White ibis are believed to have declined in Florida by about 80% since the 1940s, due to statewide loss of wetlands and wet pastures. Glossy ibis numbers have been declining generally over the last 20 years, and the overall population decline accelerated since 1994. Continuing urbanization and the loss of shallow, ephemerally flooded, pasture ponds and other freshwater wetlands in Hillsborough County due to development are the likely causes of this population decline in the Tampa Bay area. For each of these wading bird species the report suggests that regional planning should emphasize protection of isolated and inter-connected freshwater wetlands.

The ephemeral quality of some freshwater marshes provides dry season refugia which are crucial to the survival of many wading birds, reptiles, and amphibians. Studies have shown that during the nesting period, white ibis are dependent on access to freshwater wetland foraging areas with appropriate drying conditions, because osmoregulatory limitations make it difficult for their nestlings to develop on a diet composed entirely of saltwater prey (Bildstein, 1993). Wood storks depend on falling water conditions over a prolonged four-month nesting season (Myers & Ewel, 1990). In Florida, 28 amphibian species breed in ephemeral ponds either exclusively or opportunistically; this list of amphibians includes both common and rare frogs and salamanders (Means, 2014). At an ephemeral herbaceous emergent pond at the Ordway Swisher Biological Station in north central Florida, a total of 16 amphibian and 26 reptile species were captured during five years of sampling (Dodd, 1992). In mesic and wet flatlands natural communities in Florida, 28 species showed a higher relative abundance of herpetofauna in wet prairies (herbaceous) vs. hydric hammocks (forested) (Enge, 1997). As freshwater non-forested wetlands have been disproportionately impacted, the impacts to vulnerable amphibian species have likewise been disproportionately high.

4.2.2 Water Quality

It has been well-demonstrated that non-forested freshwater wetlands have the ability to remove pollutants from incoming water by filtering out pollutants and excessive nutrients. According to the Wetlands International Office (2003), in general, the most significant functions of emergent wetland plants in relation to water purification is the physical presence of plants. The plant structure provides extensive surface area for the attachment and growth of microbes. The physical components of the plants stabilize the surface of the beds, slow down the water flow thus assisting in sediment settling and trapping process and ultimately increasing water transparency. Marsh species which effectively take up nutrients have a large biomass both above and below the substrate. The matrix of entangled sub-surface plant tissues binds soil particles and creates a large surface area for taking up nutrients and ions. Hollow vessels in plant tissues enable oxygen to be transported from the leaves to the root zone and to the surrounding soil (Armstrong *et al.*, 1990; Brix and Schierup, 1990). This enables the active microbial aerobic decomposition process and the uptake of pollutants from the water system to take place (Wetlands International, 2003). As the Tampa Bay region is highly urbanized in areas and influenced by such factors as water pollution and impervious surfaces, the filtering of stormwater runoff performed by wetland plants is vital to the overall ecological functioning of the mainland and Tampa Bay.

4.2.3 Biodiversity and Ecosystem Services

The Tampa Bay watershed is in need of restored freshwater wetlands (primarily non-forested) in order to maintain an adequate diversity of habitats in the correct proportions to support a wide array of biodiversity. Regardless of the subject habitat, the value of diverse components to the ecosystem is important for many reasons as shown in excerpts from the study by Baumgärtner in 2002 on the following page.

“1. *Biodiversity may enhance ecosystem productivity.* In many instances, an increase in the level of biodiversity monotonically increases the mean absolute level at which certain ecosystem services, e.g., biomass production or nutrient retention, are provided. This effect decreases in magnitude with the level of biodiversity.

2. *Biodiversity may enhance ecosystem stability.* In many instances, an increase in the level of biodiversity monotonically decreases the temporal variability of the level at which these ecosystem services are provided under changing environmental conditions. This effect decreases in magnitude with the level of biodiversity.

Theory, both via simple ecological reasoning and via mathematical models, has led to the understanding that a diversity of species with different sensitivities to a suite of environmental conditions should lead to greater stability of ecosystem properties. The basic premise is that with increasing number of functionally different species, the probability increases that some of these species can react in a functionally differentiated manner to external disturbance of the system and changing environmental conditions. In addition, the probability increases that some species are functionally redundant, such that one species can take over the role of another species when the latter goes extinct. This is what ecologists refer to as the ‘insurance effect’ of biodiversity in carrying out ecological processes.”

Ecosystem services provided by freshwater wetlands include air pollution removal, shading, carbon sequestration, water purification, water attenuation, and nitrogen removal. These services are necessary for overall environmental quality and also provide direct tangible benefits to humans as part of the ecosystem as demonstrated in the United States Environmental Protection Agency estimations specific to Tampa Bay region. Data from freshwater wetlands in the Tampa Bay region suggest that herbaceous wetlands have a higher rate of denitrification and greater species richness than forested wetland types (EPA, 2013).

When promoting the complex process of restoring freshwater wetlands, the TBEP considers experiences of other researchers. It has been shown that restoration designed to mimic naturally-occurring habitat landscapes, when done correctly, can provide benefits to native fauna (Peterson and Turner 1994). Simenstad et al. (2000) stated that restoration should “be grounded on the historic landscape template that influenced evolution of anadromous species and meta-populations in that system.” Translation of this precept into effective actions, however, requires a careful evaluation of current ecological and social realities. Attempts to recreate or engineer an overly rigid conceptualization of “nature” can lead to disastrous failures in restoration (Palmer 2009); protection and restoration goals must seek a flexible and meaningful balance between nature and the realities of the present conditions that exist at a location (Cichetti and Greening, 2011).

Restoring the balance of freshwater wetlands within the Tampa Bay watershed will also aid in restoring a balanced and diverse regional ecosystem that best serves the needs of wildlife, improves water quality, and benefits the residents of the Tampa Bay region. In the following section, options to accomplish freshwater wetland (specifically non-forested) restoration are explored.

5.0 STRATEGIC COMPENSATORY MITIGATION

This study presents the opportunity for privately-funded mitigation to advance habitat restoration goals that have been vetted by the science and management community. The study was designed to fit the format of regulatory agencies (partitioned by ERP basins) in order to facilitate the application into compensatory mitigation requirements following the general rule that impacts to wetlands must be mitigated for in the same ERP basin.

The project team worked extensively with members of the regulatory community to vet this plan and develop innovative strategies for linking compensatory mitigation with overall freshwater wetland restoration and protection goals. The project team developed a conceptual approach that was presented to the agencies as an option for how compensatory mitigation could help to restore the balance of freshwater wetlands in the Tampa Bay watershed. Regulatory agencies provided input and questions to the project team throughout the course of a year and consulted with regional and statewide experts to develop an effective and feasible approach. Throughout this process, staff at the Florida Department of Environmental Protection (FDEP) suggested the approach of closely examining historical wetland type and mitigation requirements as a way to accomplish the goals of this plan. This approach was embraced by the other collaborating entities and will be developed further for implementation. This chapter presents the role of the regulatory agencies, coordination meetings with those agencies, initial options and the final approach for linking compensatory mitigation with the freshwater wetlands master plan.

5.1 REGULATORY PERSPECTIVES AND GUIDANCE FOR PLAN IMPLEMENTATION

The objectives of this plan are well supported in the literature from the standpoint of achieving and maintaining a balance of forested and non-forested systems for overall health of the watershed. These objectives can be achieved at local and regional levels through both freshwater restoration and mitigation projects. While many gains in freshwater wetland coverage will likely occur through publicly-funded restoration, it is the hope that progress towards meeting freshwater wetland protection and restoration targets can be realized through both publicly- and privately-funded restoration and mitigation. The project team realizes that a critical component to the success of this plan is support through regulatory permitting programs that require freshwater wetland mitigation areas to be designed and constructed to offset wetland impacts. Accordingly, coordination meetings were held with member agencies of the regulatory community to:

- review the information developed to date;
- explore the regulatory perspectives of the ‘restoring the balance’ concept for freshwater wetlands; and
- initiate thoughtful discussions about how the objectives of this study could be supported within the existing regulatory framework.

5.2 REGULATORY AGENCIES INVOLVED WITH FRESHWATER WETLAND MITIGATION IN THE TAMPA BAY REGION

Within the Tampa Bay, Florida region, freshwater wetland mitigation is governed by agencies at the federal, state, regional and county level. The following entities were involved with the process and provided feedback during coordination meetings and through written communication.

Environmental Protection Commission of Hillsborough County (EPCHC)

Wetland regulations for Hillsborough County are located within EPCHC Rules, Chapter 1-11. In addition, wetland setbacks from development are required in accordance with the County’s Land Development Code. Applicants must first demonstrate avoidance and minimization of wetland impacts before any mitigation plan is considered, however, once this requirement is satisfied, the county’s rule is flexible regarding non type-for-type mitigation.

Florida Department of Environmental Protection (FDEP)

The FDEP is responsible for implementing the state regulations pertaining to wetlands and stormwater for certain types of projects: single family residences, utilities, ports and marinas. The wetland regulations can be found within Florida Administrative Code (FAC) Chapter 62-330.

Southwest Florida Water Management District (SWFWMD)

SWFWMD is responsible, through Memorandum of Agreement with FDEP, for implementing the state regulations pertaining to wetlands and stormwater for the remaining projects: public and private development and transportation.

U.S. Army Corps of Engineers (USACE)

The U.S. Army Corps of Engineers (USACE) is responsible for implementing the federal wetland regulations in accordance with Section 404 of the Clean Water Act. Requirements of the law are clear in that an avoidance and minimization analysis must be completed prior to authorization of wetland impacts. USACE's national prioritization policy is that unavoidable wetland impacts shall be first handled by approved wetland banks; however, in this region there are few approved banks. In addition, the USACE is slated to produce a Watershed Profile Analysis (WPA); which assess the watershed conditions and whether there are specific wetland needs in the region.

5.3 DRAFT APPROACH TO RESTORE THE BALANCE

The project team developed an initial, draft approach to address the disproportional impacts to non-forested wetlands within ERP basins in the Tampa Bay watershed. Since non-forested systems have been disproportionately impacted in each ERP basin within the Tampa Bay watershed, future mitigation of non-forested wetlands would occur as they currently do. The Restore the Balance approach applies to forested systems. The approach uses a hypothetical example of impacts to six acres of forested wetland losses equaling 3.0 units of functional loss. The traditional approach to mitigation would be to either create wetlands accounting for or to purchase 3.0 units of functional gain for forested wetlands. Using that type-for-type approach, there will always be uniform mitigation/restoration of both forested and non-forested systems which will perpetuate the unequal proportions currently present. The first proposed concept was to incorporate non type-for-type mitigation for projects which result in unavoidable impacts to wetlands, with a recommendation that future freshwater wetland mitigation prioritize non-forested wetland creation or restoration. Many potential ratio options could be used in order to enhance the creation of non-forested freshwater wetlands. Because the goal is to maintain existing wetland coverage (both forested and non-forested), an applicant would start by mitigating for the forested systems at a minimum of 1:1.

Following the mitigation to achieve no-net loss of forested wetlands, two alternatives were presented, each of which would include some restoration of non-forested systems without changing the overall functional gain. At a mitigation bank, credits could be purchased for 1.5 acres of functional gain for forested and 1.5 units of functional gain for non-forested. This reflects a simple equal splitting of functional gain between forested and non-forested. For mitigation outside of a bank, an option would be to ensure six acres of forested wetlands are restored in exchange for the six acres impacted. In this hypothetical example, the purchase of six acres of forested wetlands equaled 2.0 units of functional gain. The remaining 1.0 unit of functional gain required could then be split between forested (0.5 units) and non- forested (0.5 units)

Non-Bank – On or Off-site Option 1:

Impact:	6 acres forested	3.0 FL
Mitigate:	6 acres forested	1.5 FG
	X acres non-forested	1.5 FG

FL = Functional Loss FG = Functional Gain

Non-Bank – On or Off-site Option 2: (Addressing Risk Factor)

Impact:	6 acres forested	3.0 FL
Mitigate:	6 acres forested	2.0 FG
	1.5 acres forested	0.5 FG
	X acres non-forested	0.5 FG

Option 2 was preferred for non-bank scenarios, which provides 1:1 acreage for forested, plus the remainder being split 1:1 between forested and non-forested.

For banks, all agencies preferred utilizing a straight 50:50 purchase. For example, for a 6-acre forested impact with 3 units of FL, the bank purchase would be 1.5 units of FG of forested wetland and 1.5 units of FG of non-forested wetland.

Bank Scenario

Impact:	6 acres forested	3.0 FL
Mitigate:	forested	1.5 FG
	non-forested	FG

5.4 REGULATORY DECISION MATRIX

A regulatory decision matrix (**Figure 5-1**) was developed to capture methods of achieving the goal and provides a process for making related decisions consistent among the different agencies. This matrix was discussed during several meetings and conference calls with the permitting agencies.

Figure 5-1 Regulatory Decision Matrix

Note: This matrix should be used for unavoidable wetlands impacts only after avoidance and minimization requirements have been met.

Restore the Balance (RTB) is an approach that attempts to restore the historic proportion of freshwater wetlands within the Tampa Bay region. In each of the 6 Environmental Resource Program (ERP) Basins in Tampa Bay, non-forested/herbaceous wetlands have been disproportionately impacted; therefore, the RTB approach strives to regain the historic proportion of non-forested freshwater wetlands (see Table below).

1. Unavoidable Wetland Impacts Require Compensation?	Yes = #2	No = Permit w/o Mitigation
2. Are the Impacts to Rare or Unique Habitats?	Yes = Traditional Mitigation	No = #3
3. Does this Basin have Disproportionate Wetland Losses?	Yes = #4	No = Traditional UMAM
4. Mitigation Bank(s) within the ERP basin with appropriate credits?	Yes = #5	No = #8

5. <u>Mitigation Bank Option</u>
6. Traditional UMAM <u>OR</u>
7. Could RTB approach be allowed to assign Function Units as 50% type-for-type wetland mitigation: 50% disproportionate wetland type mitigation?

8. <u>Non-Mitigation Bank Option</u>
9. Traditional UMAM <u>OR</u>
10. Could RTB approach be allowed in mitigation plan to:
    a. Require minimum 1:1 mitigation (in acres) of impacted wetland type, and
    b. Allow remaining Functional Units to be assigned as 50% type-for-type wetland mitigation: 50% disproportionate wetland type mitigation?

Basin	Forested Freshwater Wetland Restoration Target (in acres)	Non-Forested Freshwater Wetland Restoration Target (in acres)	Total Freshwater Wetland Target (in acres)
Alafia River Basin	871	2,199	3,070
Hillsborough River Basin	553	1,411	1,964
Little Manatee River Basin	0	5,243	5,243
Manatee River Basin	137	3,667	3,804
Tampa Bay and Coastal Areas Basin	0	4,4400	4,4400
Upper Coastal Areas Basin	54	168	222

5.5 REGULATORY AGENCY COORDINATION MEETINGS

Several meetings were held in person and by phone in order to explore the opportunity for incorporating this plan's goals into the regional regulatory framework. In each case, an overview of the Freshwater Wetland Compensatory Mitigation Plan was given by the TBEP, with specific attention to the results of the freshwater wetland losses, especially disproportionate losses, and goals to address these impacts. A draft decision matrix, as demonstrated above, suggested how the decision process could be systematized for consistency was presented. Agency input was received and responses were provided to the TBEP study team. Hillsborough County is the only county within the Tampa Bay watershed that has adopted county-level wetland regulations, therefore, its overseeing agency, the EPCHC, was included in discussions, along with the federal, state and regional entities. Initial meetings with each agency were held in September and October 2013, and a multi-agency regulatory charette was held in December 2013. Follow-up meetings and conference calls were held throughout spring and summer 2014 to further refine concepts, develop requested literature reviews, and to vet the final proposed approach.

Regulatory Charette

A multi-agency charette was held to recap all previous discussions and to determine if all agency concerns could be addressed, and a consensus reached. The following specific and important topics were discussed and evaluated, and in general, agency concurrence/understanding was achieved.

The USACE noted that it is their national policy to mitigate through mitigation banks first and, if that is not possible, the applicant may undertake a watershed profile analysis. The USACE rule allows for the implementation of this plan and even supports this plan, but needs heavy justification (*USACE Watershed Profile Analysis)*.

All agencies agreed that 1 impacted acre must result in at least 1 acre of mitigation. It was suggested the standard UMAM scoring process should be used and the proportion of credits split at the end.

The FDEP expressed need for an accounting system to track these efforts.

The group agreed that the plan could be thought of as a ten-year pilot study, and that ten years would be a good check point. The EPCHC could track permit acres for the county under the pilot study. The TBEP also committed to analyzing the wetland trends within the Tampa Bay Study area on a five-year cycle.

From FDEP's perspective, there is enough flexibility in the state rule to allow for the plan with agency agreement on a ratio. It was suggested that additional discussion within FDEP should work toward aligning the approach as closely as possible with the USACE policies, for the ease of the applicant.

Finally, the group discussed the following two options for how the plan could be implemented. In these examples, a 6-acre forested wetland has a functional unit (FU) of three (3.0). All acreage and FUs are hypothetical and are used to illustrate the potential application of the "Restore the Balance" approach. Actual FU values would be determined through the regulatory permitting process between the applicant and appropriate regulatory agencies. These options are shown below.

Table 5-1 reflects a summary of these meetings and includes a discussion of topics of importance to each agency.

Key acronyms used:

ERP: Environmental Resource Permit

RTB: Restore the Balance

Table 5-1 Regulatory Agency Coordination Summary

Agency and Date	Discussion Items	Follow-Up, if Needed
EPCHC **9-11-13**	- (a) Overview of the Freshwater Wetland Compensatory Mitigation Plan, specifically the results of the freshwater wetland losses and goals to address these impacts. TBEP is interested in the prospect of whether the regulatory wetland permitting process can be used to regain these wetland systems (primarily non-forested) -(b) Draft Decision Matrix and Regulatory Flow chart that may be used when reviewing an applicant's request to work in/near wetlands within the study area -Applicants must first demonstrate avoidance and minimization before any mitigation plan is considered, once satisfied rule is flexible type for type -EPC decided to work on a decision matrix for their staff utilizing the draft version provided -UMAM calculations and differences in cost to mitigate herbaceous vs. forested wetlands -Suggested that TBEP present to Citizen's Environmental Advisory Committee as well as Mitigation Bank owners	-Send copy of finalized report to EPCHC -Participate in a design charette meeting to ensure all regulatory agencies are able to participate with the endeavor -Add this topic to upcoming Citizen's Environmental Advisory Committee meeting agenda -TBEP staff to make presentation to Florida Local Environmental Resource Agencies in October 2013
FDEP (SW District) **9-13-13**	-Reviewed same materials as (a) and (b) above -FDEP primarily issues ERP authorizations for single family homes, utilities and marinas -Rules need to be approved by FDEP in Tallahassee and coordination required with that representative -SWFWMD reps classifying disproportional wetland types as Significant Habitat -UMAM calculations and differences in cost to mitigate herbaceous vs. forested wetlands -Guidance policy could be a tool to implement RTB approach in Tampa Bay region, rather than a rule change	-Schedule presentation to FDEP (Tallahassee) -Participate in teleconference with EPC and SWFWMD to ensure participation
SWFWMD **9-13-13**	-Reviewed same materials as (a) and (b) above -Plan would be appropriate for Surface Water Improvement and Management Program and land management group - District rules require applicant first demonstrate avoidance and minimization, rule is flexible -UMAM calculations and differences in cost to mitigate herbaceous vs. forested wetlands	-Send copy of finalized report to SWFWMD -Participate in a design charette meeting to ensure all regulatory agencies are able to participate with the endeavor

Agency and Date	Discussion Items	Follow-Up, if Needed
USACE **10-24-13**	-Reviewed same materials as (a) and (b) above -Unavoidable wetland impacts first handled by approved mitigation banks, USACE slated to produce a Watershed Profile Analysis, TBEP wetland analysis to address objectives of USACE Watershed Profile Analysis and results could be adopted by USACE -Partners requested an updated Mitigation Map for this region be included in the TBEP report	-Copy of the Wetland Analysis Report graphics, USF Team Study Results, and the TBEP Restoring the Balance Report to be sent to the USACE -USACE will send a summary of available Mitigation Banks in the region and participate in a regulatory charette with representatives from other wetland agencies
Multi-Agency Regulatory Charette **12-9-13**	-Status and goals of the project reviewed -Overall freshwater targets for Tampa Bay region provided -TBEP proposes using mitigation to restore disproportionally impacted systems -Final step to develop master plan to implement goals -USACE policy to mitigate through mitigation banks first, if not possible, option to go through watershed profile analysis -Standard UMAM scoring process should be used -Accounting system needed to track these efforts -Non-Bank On or Off-site Option 1 and Option 2 were explored -Economic impact from the perspective of the applicant, recommended speaking to the Officer of General Council in Tallahassee	-Provided USF Team report, presentation, and GIS layers -Coordinate meeting with FDEP in Tallahassee -Agencies encouraged to mark up decision matrix as it applies to their agency -Discussion of potential start date after meeting in Tallahassee and with aid of a guidance memo
Multi-Agency Conference Call **2-4-14**	-Question from FDEP Tallahassee regarding how to deviate from the existing framework. -Discussion how the UMAM rule is not a barrier. The appropriateness examination allows agencies to look at watershed needs, rather than simply type-for-type mitigation. -USACE has a 12-step rule that looks at watershed needs. -FDEP did not see any "fatal flaws" in the proposed approach but would need to be applicant-driven. -Clarification that this approach would be used on a basin-by-basin case and project team is not recommending going out of basin. -Question about whether a formal guidance memo or	-Continue to refine the decision tree/ matrix as a tool for the agencies. -USF Team report and GIS layers provided to all agencies. -Provide draft chapters of the master plan, as available.

Agency and Date	Discussion Items	Follow-Up, if Needed
ctd. from previous	Memorandum of Understanding is required to document what will be done in the Tampa Bay watershed. -Suggest setting up goals for a proportion of credits towards out-of-kind, rather than acres.	
Multi-Agency Conference Call **3-24-2014**	-FDEP (Tallahassee) had some initial concerns about the data in regards to importance of herbaceous wetlands and drafted a list of questions to be discussed.	-A written response was sent back to FDEP on 7/2 - Another conference call has been scheduled for 8/12
Multi-Agency Conference Call **8-12-2014**	-Agreement from agencies that project team has done a good job of documenting wetland changes in the region -Discussion of why wetlands have changed, especially non-forested: changes to hydrologic and/or fire regimes -FDEP struggling with how to frame RTB approach so that it meshes with the existing ERP framework and is not inconsistent with other regions of the state. -Recommended Approach: more effectively utilize existing guidance in ERP Applicant's Handbook, Section 10.3.1.1 (incorporated in F.A.C. 62-330.010(4)) to examine historic community types and restore to that type if current condition is degraded (e.g., historically non-forested wetland that has transitioned, due to changes in hydrologic or fire regime, to a poorer quality scrub/shrub or even immature forested system). This could result in mitigation of more high-quality non-forested wetlands, while not losing any acreage or function of high-quality forested systems. -USACE has used Advanced Identification (AdId) through its mitigation options. This proposed approach is not in conflict with the ACOE 2008 Mitigation Plan. It may encourage entrepreneurial groups to establish mitigation banks with more herbaceous credits.	-Package GIS dataset with clear metadata and accompanying documentation -Provide data layers on FDEP server, Map Direct -Develop Operating Procedures Memo (OPM) for FDEP and SWFWMD staff that clarifies how this can be applied and fits within the existing rules -Outreach and training to permitting staff, regulatory agencies and consultants

5.6 SUMMARY OF AGENCY FEEDBACK/CONCERNS

EPCHC

The EPCHC refined the draft decision matrix provided by the TBEP study team to create a version that could be used in accordance with county regulations. In addition, the county suggested that the information be presented to both their Citizen's Environmental Advisory Committee (CEAC) and local mitigation bank representatives. The TBEP team made presentations at the Florida Local Environmental Resource Agencies (FLERA) conference in October of 2013 and to Hillsborough County's CEAC in November of 2013.

FDEP

Discussions with FDEP at the District level focused on how UMAM would still be used as part of the evaluation process, and that coordination with Tallahassee is needed to discuss if any rule changes would be required. In addition, FDEP requested that the TBEP team develop an 'ERP Guidance Memorandum' for the purpose of outlining the basis of the objective and the process for its consideration.

SWFWMD

Concerns stated by FDEP also apply to SWFWMD, as both agencies implement the same state regulations. SWFWMD representatives suggested that disproportionately-impacted habitat types could be classified as "significant habitat" regionally by the state to elevate protection levels and aid in achieving the goals within the plan.

USACE

The USACE suggested that if TBEP's wetland analysis could address the objectives of *USACE Watershed Profile Analysis*, then the results could be adopted by USACE.

Agencies discussed the proposed ratio approach and were generally supportive of the approach and matrix. All agency representatives agreed that this matrix should be used for unavoidable wetlands impacts only after avoidance and minimization requirements have been met. The matrix is easy to use, and provides the basis for moving forward with implementation of the plan, but it also does not mandate the use of this approach; applicants can also elect to use the standard existing mitigation options. However, FDEP express some concern that utilization of this approach for the Tampa Bay region only, while grounded in strong science and vetted by the local agencies, may be difficult since it is not consistent with statewide ERP rules. To address this concern, while still furthering the goals of this plan, FDEP staff suggested the approach presented below.

5.7 EXAMINATION OF HISTORIC WETLAND CONDITION FOR DETERMINING WETLAND MITIGATION REQUIREMENTS

Within the existing ERP framework, there is guidance, as part of Volume 1 of the Applicant's Handbook, related to examining the historic ecological community and hydrologic condition. Many non-forested wetland systems rely on periodic burning episodes to control the encroachment of non-fire-tolerant plants, such as shrubs, as well as non-native vegetation. Due to development within the watershed, natural fire patterns have been altered and prescribed burning as a management tool may be reduced due to the threat to nearby infrastructure. Changes to hydrology, resulting from developmental impacts, such as pumping groundwater and/or surface water or altering flow patterns, have also likely had detrimental effects to non-forested (as well as forested) wetlands. Therefore, some non-forested systems may transition to marginal-quality shrub/scrub systems due to the changes in hydrologic or fire regimes. Currently, in most cases, the existence of any canopy plants, such as shrubs, will categorize a wetland as a forested system. The mitigation of this historically non-forested wetland would then be mitigated as a forested wetland, leading to a continuation of disproportionate impacts to herbaceous systems. FDEP staff recommended a more thorough examination of historic ecological condition, utilizing the myriad tools developed in this project, to enable the regulatory agency staff to direct applicants to the most appropriate mitigation. In the case of fully functioning forested systems, these would continue to be mitigated as forested wetlands. However, degraded scrub/shrub wetlands that can be positively identified as historically non-forested, could be mitigated as non-forested.

- Section 10.3.1.1: In general, mitigation is best accomplished through creation, restoration, enhancement, or preservation of ecological communities similar to those being impacted. However, when the area proposed to be impacted is **degraded, compared to its historic condition**, mitigation is best accomplished through creation, restoration, enhancement or preservation of the **ecological community that was historically present**.

The advantage of this approach is that there will be no loss to mature, functioning forested wetlands and an opportunity to restore additional high-quality non-forested wetlands. An ERP guidance document further outlines this approach and is provided in **Appendix E.**

5.8 IMPLEMENTATION OF PREFERRED APPROACH

The consideration of historic ecological community type is already incorporated into existing ERP rules, therefore, no rule changes are necessary and this approach can be considered statewide, not just in the Tampa Bay region. Targeted outreach and training of permitting staff, through in-person meetings and the development of an Operating Procedure Memo (OPM) will further develop this concept. The tools developed in this project, especially the detailed GIS maps and screening criteria, will enable agency staff to accurately identify historic (1950s) wetland types and determine if field-verified degraded or transitional forested wetlands within the Tampa Bay region should be mitigated as non-forested wetlands. The suite of mapping products is available to any public or private entity and will be powerful tools for guiding future mitigation.

Outreach to environmental professionals and mitigation bankers will also be conducted to review the project objectives and findings, demonstrate the technical products available, and explore how to address disproportionate impacts through freshwater wetland mitigation. Public agencies involved in land protection and restoration will also benefit from the tools and can better develop restoration that addresses the needs of the watershed, basin and accompanying fish and wildlife species.

6.0 SUMMARY AND COMMITMENTS

This freshwater wetland study was modeled after the successful application of the "Restore the Balance" approach to restoration and protection of estuarine habitats within the Tampa Bay watershed. Analysis of various types of freshwater forested and non-forested wetlands within the six ERP basins that comprise the Tampa Bay watershed showed that in all instances non-forested freshwater wetlands have been impacted disproportionately as compared to forested wetlands. Non-forested freshwater wetlands hold tremendous value in the Tampa Bay region. They provide habitat for many species of wildlife and are necessary for various life stages of many wading birds, reptiles, amphibians, mammals, and fish. Non-forested systems also remove pollutants from water, provide ecosystem services such as carbon sequestration, denitrification, and water attenuation, and contribute to the biodiversity of the region.

The TBEP created restoration and protection acreage targets for each wetland type in each ERP basin that would re-establish the proportions of freshwater wetlands present in the 1950s. Each ERP basin requires the restoration of non-forested systems; four basins also require the restoration of forested systems though in a smaller relative amount. Through analysis of existing land uses it has been demonstrated that the targets are achievable within each ERP basin.

The TBEP proposes the goals be reached through a combination of publicly-funded restoration and strategic compensatory mitigation under which non-forested systems could be restored/created at a faster rate than they are currently. This tactic would be used for public and private development projects for which wetland impacts are unavoidable. Care would be taken to not lose any forested wetland acreage during prioritization of non-forested systems. Multiple ratios were considered as options to achieve this restoration. Ultimately, the preferred strategy is to utilize the myriad GIS and screening tools to identify historic wetland community type and recommend, when appropriate, that degraded or transitional forested wetlands be mitigated as non-forested wetlands if they were historically non-forested. This strategy will require extensive coordination of regulatory agencies such as the FDEP, USACE, EPCHC, and SWFWMD. Coordination has begun and these agencies have provided input to the TBEP and indicated that the flexibility exists within the system to apply this approach to incorporate beneficial strategic compensatory mitigation in the Tampa Bay region. More planning and coordination between the TBEP and the aforementioned regulatory agencies will be necessary. The representatives of those groups agreed that the initial effort of strategic mitigation could be regarded as a ten-year pilot study and the TBEP committed to analyzing the wetland trends within the study area on a five-year cycle. Finally, a regulatory decision matrix was developed as a guide as to when and how to apply strategic compensatory mitigation. Reaching the proposed target goals does appear to be achievable via strategic compensatory mitigation.

Commitments for future actions

The regulatory agency representatives have suggested a ten-year commitment, or pilot study, to determine the effectiveness of the proposed approach. During this time, the process can be modified to create added value for the permit applicant and the environment to create a winning option for the applicant in the regulatory arena. Agency staff has committed to developing appropriate guidance memos for permitting staff in assessing historic wetland type. The TBEP team has offered to assist regulatory staff in utilizing the project tools and deliverables, as well as communication project results and recommendations to environmental practitioners and mitigation bankers at conferences, environmental permitting training courses, and other appropriate venues. TBEP will share project results with wetland staff from EPA Region IV at the annual regional wetlands/section 401 workshop. In addition, TBEP has committed to assessing the progress against the targets every five years. Finally, TBEP will continue to provide guidance to and support the efforts of its regional partners to restore the balance of freshwater wetlands within the watershed and improve the overall quality of the region's natural environment.

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Appendix A

Prioritizing Habitat Restoration Goals in the Tampa Bay Watershed

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Submitted to
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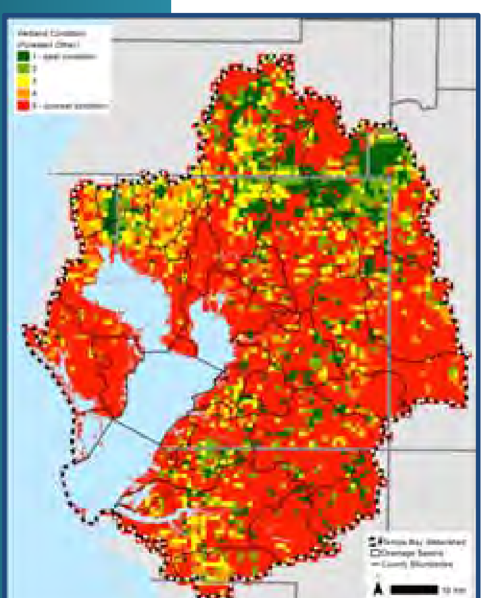

April 2012

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Introduction

Florida has a greater abundance of wetlands in terms of both total area and percentage of total land area than any other state in the 48 conterminous states (Hefner and Brown, 1984; Fretwell et al., 1996). However, nearly half of Florida's wetlands have been lost, with wetlands covering ~20 million ac or ~48% of the total land area in 1845 reduced to ~11 million ac or ~27% of the total land area by 1996 (Dahl, 2005). Historically, most wetland losses in Florida were to agriculture, as land was drained to be brought into agricultural production. In more recent years, however, the vast majority of wetland losses in Florida have been to urban development, which accounted for ~72% of wetland losses between 1985 and 1996 and ~61% of wetland losses between 1998 to 2004 (Dahl, 2005; Dahl, 2006). Recently, trends have changed nationally, with wetland area increasing in the conterminous states by an average of ~32,000 ac annually between 1998 and 2004 (Dahl, 2006). The net wetland gains are largely attributable to wetlands created, enhanced, or restored through regulatory and non-regulatory programs. However, many of these wetland gains have been made through structural and functional replacements, with many different types of natural wetlands having been replaced by created open-water ponds in urban settings, with an overall loss of some kinds of wetland functions (Dahl, 2006).

The Tampa Bay Estuary Program (TBEP) has applied considerable research and collective wisdom to develop the idea of "restoring the balance" of freshwater wetlands and habitat in the Tampa Bay watershed. The Tampa Bay Estuary Program Habitat Master Plan Update (PBS&J, 2010), building upon a previously published document entitled Setting Priorities for Tampa Bay Habitat Protection and Restoration: Restoring the Balance (Lewis Environmental Services, Inc., 1996) set forth specific goals. Goals included both shifting future efforts to restoration and protection of habitats in ratios that were historically present, and pursuing a unique federal-state-local-private partnership to provide the framework for the development of a coordinated approach to linking regulatory, resource management, and habitat restoration programs in the Tampa Bay watershed. This project was intended to provide the technical tools to assist in these related efforts. As outlined in the report, the project team was especially interested in structural versus functional criteria, and hydrologic connectivity.

This final report summarizes the ecological, hydrological, econometric and GIS analyses conducted during the project. The project achieved four specific objectives: (1) GIS analysis and mapping of historical changes to freshwater wetland habitats from 1950 to current conditions, (2) Change analysis to identify changes in extent, structure, function and quality of wetland habitats, (3) Conditional assessment to assess the state and condition of existing wetlands, and (4) Development of screening tools for use by local stakeholders in prioritizing restoration, mitigation, and preservation targets. Econometric modeling incorporating expectations of future land use patterns and relative values was incorporated to assess economic viability of various locations. An expected long-term outcome of the project will be for local stakeholders to identify the most desirable areas for future restoration to achieve habitat restoration and protection goals. Existing and planned compensatory mitigation will be included in this analysis, going forward.

Numerical results are presented throughout the report, providing quantifiable findings at the watershed and drainage basin scale. Overall, four broad project findings are significant. First, all types of wetlands have been impacted, but impacts vary widely from basis to basin and from County to County; no overall pattern or trend represents the watershed or a specific County. Secondly, given an objective of achieving habitat ratio goals, the relative scarcity of existing specific wetland function or condition at the drainage basin, County, or other sub-watershed scale must be viewed in historical context of the other wetland functions and conditions within the basin, and their vulnerability given economic pressures for land use change. The Screening Tool provided as a project deliverable allows for such consideration. Thirdly, conditional assessment showed that existing wetlands are distributed throughout the Tampa Bay Watershed, but are particularly concentrated near urban, suburban, and mining land use-land covers. Finally, the priorities of local stakeholders, which include regulators, policymakers, and local planners, are compatible with the screening tools provided, but incompatible with prescriptive targets for restoration, preservation or mitigation. Achievement of the project goals will occur only through commitments by stakeholders to utilize creativity and flexibility in adopting watershed-level principles to transactional activities.

Physiography

The Tampa Bay Watershed contains an extensive and diverse physical landscape, ranging from dense forested wetlands to open, barren lands. Other physiographic factors, such as climate and elevation, can have direct impacts on wetland physiological function and structure. This section examines the geographic and physical attributes of the Tampa Bay Watershed.

Geographic Extent and Hydrophysiography

The Tampa Bay Watershed is the 6,853 km2 terrestrial-estuarine watershed that drains to Tampa Bay on the Gulf of Mexico (Figure 1). It encompasses portions of six counties: Pinellas, Pasco, Hillsborough, Polk, Manatee, and Sarasota. Numerous rivers and artificial drainageways drain the Tampa Bay Watershed, with the Hillsborough River, Alafia River, Little Manatee River, and Manatee River being among the most prominent.

Figure 1. Map of the Tampa Bay Watershed Study Area.

Climate

The climate in the Tampa Bay Watershed is subtropical and humid (Southeast Regional Climate Center data for TAMPA WSCMO ARPT, FLORIDA 088788 for the period of 1933-2010). The mean annual temperature is 22.6 °C, ranging from a minimum monthly mean of 15.9 °C in January to a maximum monthly mean of 28.1 °C in August. The mean annual precipitation is 1203 mm, but intra-annual variability can be large, with annual totals ranging from a minimum of 680 mm in 1956 to a maximum of 1932 mm in 1959. Approximately 60% of the precipitation occurs during a four-month wet season from June-September, primarily during intense, localized thunderstorms, as well as occasional tropical storms and hurricanes. The remaining approximately 40% of the precipitation occurs during an eight-month dry season from October-May, primarily during winter frontal storms.

Geology

The Tampa Bay Watershed is underlain by a thick sequence of carbonate rocks covered by unconsolidated surficial sediments (Miller, 1997). The principal hydrogeologic units are, in descending order, the surficial aquifer, the intermediate confining unit, and the Upper Floridan aquifer (Figure 2).

The top of the surficial aquifer is contiguous with the land surface, and is comprised of complexly interbedded fine and coarse clastic sediments deposited during the Holocene (Sinclair, 1974; Miller, 1997). The thickness of the surficial aquifer varies, ranging from nearly absent in regional and local topographic lows, such as lowland river beds, to many tens of m in thickness in regional topographic highs, such as along the ridges. Water in the surficial aquifer is under unconfined, water-table conditions, and is contiguous with surface water in wetlands and streams.

The intermediate confining unit discontinuously overlies the Upper Floridan aquifer. This semiconfining layer consists primarily of undifferentiated deposits of the Hawthorn Group, a clay-rich sequence deposited during the Miocene, but also includes some post-Hawthorne group siliclastics from re-worked Hawthorne Group deposits and carbonate mud formed as residuum of the limestone in the Tampa Member of the Arcadia Formation (Sinclair, 1974; Knochenmus, 2006). The thickness of the intermediate confining unit varies, ranging from approximately 10 m in thickness in the south-east Tampa Bay Watershed to being absent in the north-west Tampa Bay Watershed (SWFWMD, 1996). Where the intermediate confining unit is present, it perches water in the surficial aquifer and confines water in the Upper Floridan aquifer, though vertical leakance can be high and water can flow up or down between the aquifers, depending upon the local hydraulic gradient (Stewart, 1968; Knochenmus, 2006).

The Upper Floridan aquifer underlies all of Florida and parts of South Carolina, Georgia, Alabama, and Mississippi (Miller, 1997). The Upper Floridan aquifer consists of multiple layers of continuous limestone and dolomite, ranging in age from Eocene to Miocene. Locally, the aquifer includes, in descending order, the Tampa Member of the Arcadia Formation, the Suwannee Limestone, the Ocala Limestone, and the

Avon Park Formation. The Upper Floridan aquifer is semiconfined throughout most of the Tampa Bay Watershed, being confined where the intermediate confining unit is present and unconfined where the intermediate confining unit is absent. Where the intermediate confining unit is absent, the surficial and Upper Floridan aquifers merge from a hydrogeologic standpoint and the Upper Floridan aquifer is said to outcrop at the surface. The Upper Floridan aquifer is an important water source for most residents in the Tampa Bay Watershed.

Land Cover

The total terrestrial area of the Tampa Bay Watershed is 5,908 km^2. The predominant land uses-land covers are urban development and agriculture, though wetlands, upland forests, rangeland, and water all total more than 200 km^2 each (Table 1; Figure 1). Though land uses-land covers are mixed throughout the watershed, urban development is particularly prominent in the lower watershed, while other land uses-land covers, especially agriculture, are particularly prominent in the headwaters.

Table 1. Land use-land cover in the Tampa Bay Watershed as based upon the 1000-Level of the Florida Land Use, Cover and Forms Classification System (Florida Department of Transportation, 1999).

Land Use-Land Cover	Total Area (km^2)	Percent Area (%)
URBAN AND BUILT-UP	2544	43%
AGRICULTURE	1324	22%
WETLANDS	903	15%
UPLAND FORESTS	458	8%
RANGELAND	253	4%
WATER	248	4%
TRANSPORTATION, COMMUNICATION AND UTILITIES	165	3%
BARREN LAND	13	<1%
SUM	**5908**	**100%**

Types of Freshwater Wetlands

In west-central Florida, freshwater wetlands are numerous, often small, and often surface-water isolated, at least during the dry season (Haag and Lee, 2010). This is particularly true in the northern Tampa Bay Watershed, where the surficial aquifer is irregularly pitted with karst depressions, which form due to irregular weathering of the underlying limestone, and are illustrated by localized sinkholes, some of which form small lakes or closed-basin depressional wetlands (Tihansky, 1999) (Figure 2). As is the case in all wetlands, hydrology is the primary control on the structure and function of wetlands in west-central Florida.

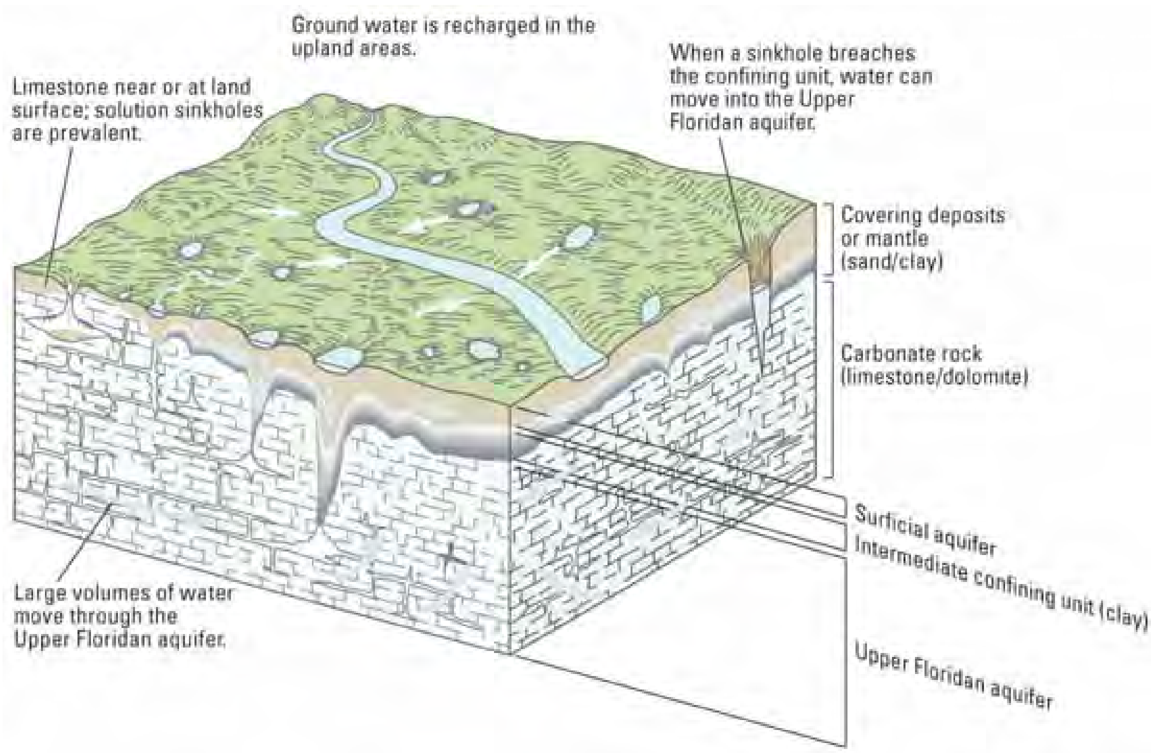

Figure 2. Diagram of Geology. Geologic setting, especially as regards the surface-water and ground-water interactions between wetlands and the surficial and Floridan aquifers. Reprinted with permission from (Haag and Lee, 2010).

Water levels in freshwater wetlands in west-central Florida are controlled by complex interactions between climate, geology, and water use. Where the intermediate confining unit is present and intact, wetland water levels are largely controlled by water levels in the surficial aquifer (Lee et al., 2009; Nilsson et al., In Review), which in turn are largely controlled by seasonal variations in precipitation and evapotranspiration. However, even under these conditions, some wetland water can be lost to groundwater recharge to the Upper Floridan aquifer (Lee et al., 2009). Where the intermediate confining unit is absent or perforated, such as where the Upper Floridan aquifer outcrops in the northern Tampa Bay Watershed, wetland water levels may be largely controlled by hydraulic heads in the Upper Floridan aquifer (Sinclair, 1974; Sinclair, 1977; SWFWMD, 1996), which in turn can be largely controlled by groundwater pumping, at least in close proximity to the wellfields. Therefore, the location of a given wetland relative to the intermediate confining unit is an important characteristic, and can determine whether wetland water levels are largely under local or regional control.

Geologic conditions being equal, water levels in freshwater wetlands in west-central Florida do not vary greatly. Wetland depressions tend to be shallow and surrounding land surfaces are typically relatively level, so water levels do not typically get deep, even during times of intense and long-duration precipitation (Haag et al., 2005; Lee et al., 2009; Nilsson et al., In Review). Furthermore, water levels in the surficial aquifer are typically near the land surface, so water levels do not typically draw down to great depths (Sinclair, 1974). Therefore, the overall possible range of variation in water levels is relatively small and does not always differ greatly between different wetland types (Nilsson et al., In Review).

More precise definitions are often needed to bound different types of wetlands and water bodies for the purposes of inventory, evaluation, and management. Cowardin et al. (1979) provides one such classification system, the Classification of Wetlands and Deepwater Habitats of the United States (Cowardin classification system). The Cowardin classification system is a hierarchical classification system, in which different types of wetlands are classified under one of five primary categories: marine systems, estuarine systems, riverine systems, lacustrine systems, and palustrine systems.

The Cowardin classification system is based upon structural features that can be readily observed from remote-sensing data, which allows the Cowardin classification system to satisfy the primary goal of providing the basis for tracking changes in the geographic extent of the nation's wetlands over time through the US Fish and Wildlife Services' (FWS) National Wetland Inventory. The emphasis on readily observable structural features also causes the Cowardin classification system to aggregate many wetlands and water bodies that are structurally similar but functionally distinct (i.e., wetlands and water bodies that look the same but function differently). This created the need for a separate but equal classification system based upon functional characteristics.

Brinson (1993) provides one such classification system, the hydrogeomorphic approach to wetland classification (HGM classification system). The HGM classification system is based on three characteristics related to how wetlands function: landscape position, water source, and hydrodynamics. The emphasis on functional characteristics allows the HGM classification system to satisfy the primary goal of aggregating wetlands that perform similar functions. The HGM classification system is an approach and not a strict, specifically defined, hierarchical classification system. Following up on Brinson (1993), Smith et al. (1995) suggested that wetlands can be divided into seven primary classes: estuarine, mineral-soil-flat, organic-soil-flat, slope, depressional, riverine, and lacustrine wetlands.

This report and the associated GIS geodatabase very generally follow the terminology proposed by Smith et al. (1995), retaining distinct categories for riverine and lacustrine wetlands but aggregating flat, slope, and depressional wetlands into a single category for simplicity. Estuarine wetlands were omitted, as they were not a focus of this study. The physical properties and characteristic functions of the wetland classes are more specifically described below.

Riverine wetlands occur on floodplains and riparian corridors in association with river channels (Figure 3). Dominant water sources are variable and depend upon specific local hydrologic conditions, and can include any combination of precipitation, channelized surface-water flow down the river channel, overbank and/or ground-water flow from the river channel, or ground-water discharge from the underlying aquifer. Perennial flows in the associated river channels are not requisite. Dominant outflows also are variable and depend upon specific local hydrologic conditions, and can include any combination of evapotranspiration, channelized surface-water flow down the river channel, overland and/or ground-water flow to the river channel, or ground-water recharge to the underlying aquifer. Hydrodynamics are dominated by downgradient, unidirectional flow, though lateral exchanges between the river channel and the riverine wetlands are common during floods. In the headwaters, riverine wetlands often intergrade with flat, depressional, and/or slope wetlands as the bed and bank of the channels disappear.

Figure 3. Headwater riverine wetland in the northern Tampa Bay Watershed.

Lacustrine wetlands occur on the margins of large open water bodies (Figure 4). Dominant water sources are variable, and can include any combination of precipitation, overland or channelized flow, or ground-water discharge. Dominant outflows also are variable, and can include any combination of evapotranspiration, overland or channelized flow, or ground-water recharge. Hydrodynamics are variable, with some depressional wetlands having lateral flow toward or away from the depression, depending upon local hydrologic conditions, and other depressional wetlands having lateral flow through the depression. Regardless, the predominant, readily observable hydrodynamics are vertical surface-water fluctuations, with surface-water stages rising when inflows exceed outflows and surface-water stages falling when outflows exceed inflows.

Figure 4. Lacustrine wetlands fringing a small lake in the eastern Tampa Bay Watershed.

Flat wetlands are located in level to nearly level landscapes, such as the expansive coastal plains located throughout peninsular Florida. Dominant water sources are precipitation. Outflows are vertical by evapotranspiration to the atmosphere and/or ground-water recharge to the water table. Hydrodynamics, to the extent that they occur, are characterized by vertical fluctuations, with water levels rising in response to precipitation and falling in response to evapotranspiration and/or ground-water recharge. The primary characteristic of flat wetlands is poor drainage. Precipitation falls, and cannot infiltrate very deeply due to the presence of a shallow water table and cannot runoff rapidly due to the low gradients and/or low-permeability surficial deposits. Therefore, precipitation accumulates at or near the surface, forming expansive, quiescent, flat wetlands. Extensive flat wetlands can occur by themselves, or can occur in close relation to other classes of wetlands. For example, depressional wetlands can be embedded within flat wetlands, and slope wetlands can form at the fringes of flat wetlands where higher gradients and/or higher-permeability surficial deposits occur.

Slope wetlands occur on gently to steeply sloping landscapes. Dominant water sources are variable, and can include any combination of precipitation, overland flow, shallow ground-water flow, and ground-water discharge to the land surface. Dominant outflows also are variable, and can include any combination of evapotranspiration, overland flow, and ground-water recharge. Channelized flow does not typically occur, though poorly defined swales and sloughs can occur locally. Hydrodynamics are dominated by downgradient, unidirectional flow. Slope wetlands can occur by themselves, but commonly occur in headwater settings, with channelized flows on the edges of slope wetlands forming the headwaters of downgradient riverine systems, as described below.

Depressional wetlands occur in topographic lows with closed-elevation contours (Figure 5). Depressional wetlands may have any combination of surface-water inlets and outlets or may be surface-water isolated. Dominant water sources are variable, and can include any combination of precipitation, overland or channelized flow, or ground-water discharge. Dominant outflows also are variable, and can include any combination of evapotranspiration, overland or channelized flow, or ground-water recharge. Hydrodynamics are variable, with some depressional wetlands having lateral flow toward or away from the depression, depending upon local hydrologic conditions, and other depressional wetlands having lateral flow through the depression. Regardless, the predominant, readily observable hydrodynamics are vertical surface-water fluctuations, with surface-water stages rising when inflows exceed outflows and surface-water stages falling when outflows exceed inflows. Depressional wetlands can occur by themselves, or can occur in close relation to other classes of wetlands. For example, depressional wetlands can be embedded within flat wetlands.

Figure 5. Depressional wetland in the northern Tampa Bay Watershed.

Methods

The first project objective included GIS analysis and mapping of historical changes to freshwater wetland habitats from 1950 to current conditions. This section sets forth the mapping methods applied to accomplish this objective.

Data Acquisition

Data acquisition included obtaining GIS raster and vector layers from multiple agencies and data providers. The contributors and data obtained included historical National Wetlands Inventory (NWI) data and drainage basin delineations from the US Geological Survey (USGS) and current (2007) and historical (1950) land use data from the Southwest Florida Water Management District (SWFWMD). Historic aerial photography, a key element in determining and verifying preexisting wetlands were provided by the University of Florida, the Florida Fish and Wildlife Research Institute and from multiple counties within the Tampa Bay estuary. Additional supporting data was also received from the Florida Geographic Data Library (FGDL), SWFWMD (e.g., shoreline and county boundaries), and TBEP (e.g., program boundaries).

The data acquisition phase also included preparing the data validation and change analysis plan for review and concurrence by the TBEP advisory committee (including crosswalk generation), generating wetland/habitat change maps and data to support later tasks and presentation materials and drafting a plan to prioritize efforts allocated to reviews of aerials, oblique imagery and field visits.

Mapping

Creation of historical wetland inventory

The historic baseline determined for this project was the early 1950s. This time period was chosen because it not only serves as a desirable snapshot of the natural wetlands condition for the area but because it also has a large amount of existing spatial datasets that depict these areas. This time period has also been used by TBEP and partners as the benchmark for estuarine habitats. Although Stetler et al. (2005) used historic soil survey data to provide estimates of wetland loss in Hillsborough County since the early 1900's, these estimates are unavailable for other areas of the watershed. While some wetlands were already lost (e.g., Pinellas County and Tampa) this period precedes the majority of development within the watershed (Cicchetti and Greening, 2011).

Two of the datasets which were used to recreate the representation of wetlands during this era are the 1950s National Wetlands Inventory habitat data (USGS, 1982) and the 1950 SWFWMD land use/land cover data (LULC) (SWFWMD, 2002a). These two existing datasets, combined, cover approximately 50 percent of the estuary (**Figure 6**) so a major portion of the GIS work involved in this project was to recreate the historic wetlands coverage for the missing portions of the estuary.

The creation of the historic wetlands inventory for these gaps was carried out in two phases:

1. Obtain historical aerial imagery from the 1950s for the missing areas, with an emphasis on finding imagery that has already been georeferenced.
2. Delineate wetland features using photointerpretation methods.

To conserve time and money, imagery that was already georeferenced, or defined in physical space, was preferred over imagery lacking a spatial reference. **Figure 6** shows the areas for which georeferenced imagery from the early 1950s was able to be obtained. Georeferenced imagery was available for approximately 50 percent of the area which needed to be recreated for the historical wetlands coverage.

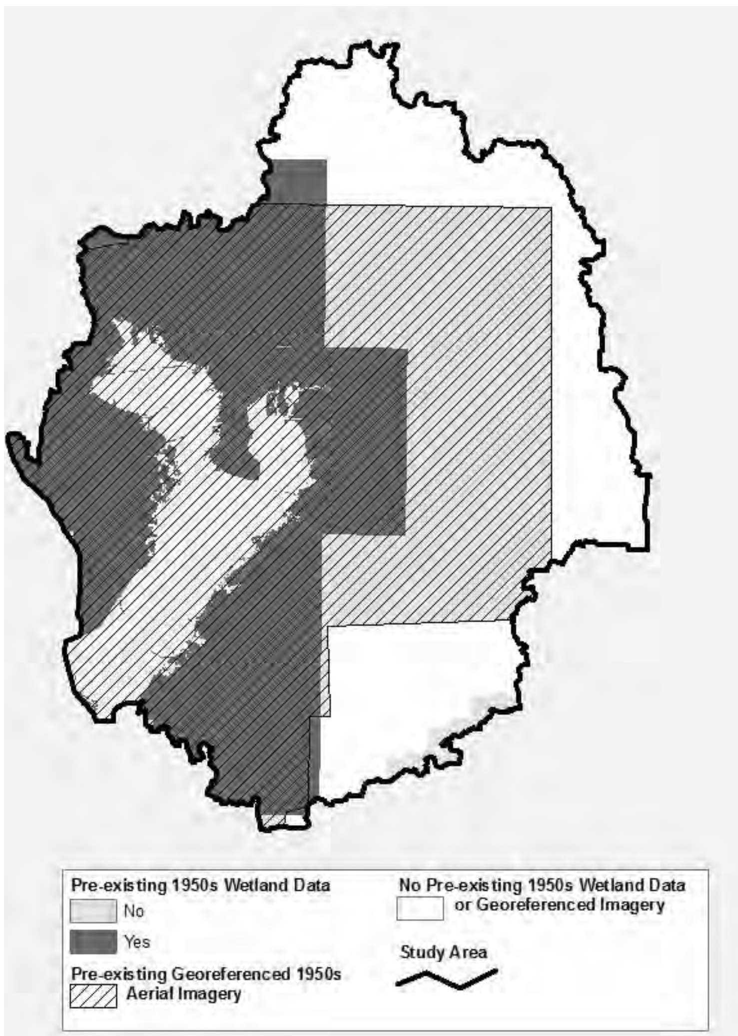

Figure 6. Availability of historical wetlands data and georeferenced historic aerial imagery

For the remaining areas for which georeferenced imagery could not be obtained, unreferenced images were requested from the University of Florida Map and Digital Imagery Library (http://www.uflib.ufl.edu/maps/Aerials/MAPNEWAERIAL.HTML). The methods used for georeferencing the historic aerial imagery followed the methodologies used by members of the project team for a project in which they georeferenced historic 1938 imagery for Hillsborough County (Hammond, 2005; Brooks et al., 2008).

The ArcMap georeferencing toolset was used to help spatially define these raw historic images. Supplemental raster datasets that were used for reference to help determine real-world feature coordinates include SWFWMD 2007 one-foot resolution true-color aerial imagery (SWFWMD, 2007a) and 1970 one-meter, monochromatic digital orthophotos (SWFWMD, 2003). Ancillary vector datasets, including roads and the National Hydrography Dataset, were also used for spatial reference when necessary. Each image was imported into ArcMap and registered against the other raster datasets. A minimum of six control points were created for each image, one distributed among each of the four corners, and the others being more centrally located. Given the time period for which the imagery represents, and the rural nature of the area at the time, locating well-defined control points in some of the imagery was quite difficult. In fact, in some of the images, the wetlands themselves were the only notable features (see Figure 7). Despite this limitation, all attempts were made to accurately reference the imagery and keep the accuracy within commonly accepted thresholds. In this case, the threshold was a Root Mean Square error of five meters or less, a value that is consistent with that used for similar historic georeferencing projects (Brooks et al., 2008).

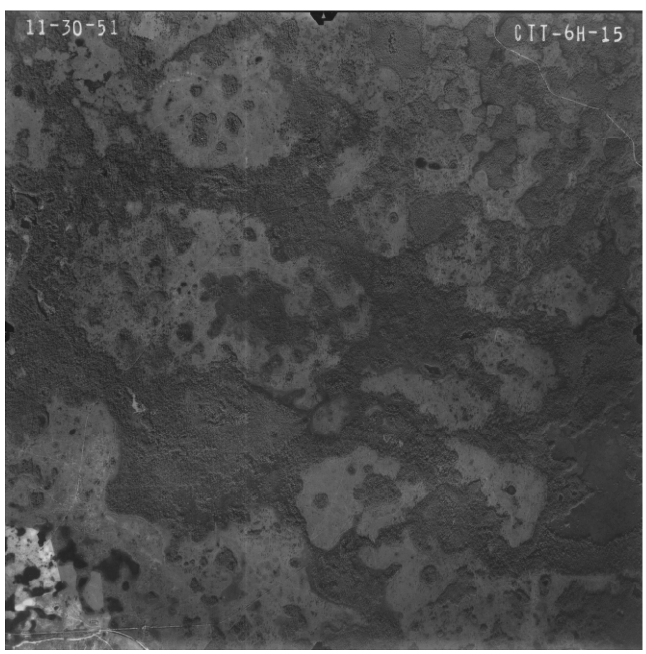

Figure 7. Ungeoreferenced historic imagery lacking well-defined control point features.

After the control points were added, a polynomial transformation method was applied to the raster to warp the image and determine the correct map coordinate for each raster cell. Given the relatively low variance in topography of the area, and the lack of abundant control features present on the historic imagery (which would be needed for higher order transformations), it was determined that a first order, or affine, transformation would provide a level of accuracy sufficient enough for the scope of this project. This transformation method allows raster datasets to be shifted, scaled and rotated, but not bent or curved like higher order transformations (ESRI, 2009). Once the quality control measures were met and USF staff was satisfied with the results of the georeferencing, the results for each raster were updated along with the image in a Mr. Sid (.sdw) world file.

Once completed, this set of georeferenced imagery was then used to photo-interpret historic wetland boundaries. The methodology selected by USF for this process was the same one used by SWFWMD for the creation of the historic 1950 land use/land cover being used in this study. In this process, land use/land cover delineations from a recent SWFWMD land use/land cover dataset were modified to conform to the boundaries recorded on historical imagery. Advantages of using this methodology include guaranteed edge-matching for unchanged portions of wetland polygons and the time savings generated by not having to digitize an entire wetland boundary, as adjustments were only made when necessary to replicate its 1950s extent. Another advantage of using this method is that wetland classifications already existed within the FLUCCS values for this data. While it was not automatically assumed that classifications remained constant over time, these classifications did provide a logical basis from which the true type was derived.

The SWFMWD 1990 land use/land cover (SWFWMD, 2002b) was the source layer for this process. A tabular query was performed on the layer to select and extract all features with a first-level FLUCCS value of either 5 or 6. These features were exported into a new personal geodatabase. This new feature class was then overlaid onto the 1950s historical imagery in ESRI's ArcMap. USF staff worked systematically through each image making changes to the existing linework and attributes when necessary, as defined by the feature boundary on the aerial photography. New features were created where appropriate to represent wetlands that have been completely exhausted over time (i.e., not present in the 1990 data). These were digitized at a scale of 1:5,000, using automated vertice generation every 20 meters. After a wetland feature was created, the wetland structure and wetland function were determined (if possible) and recorded in the appropriate attribute columns.

Quality control and review of the digitized wetlands were conducted weekly by GIS staff at The Balmoral Group. During each review, a random sample of newly digitized features were selected and reviewed to determine feature accuracy. An average accuracy rate of 90% was achieved for the entire digitizing effort. During this review process it was discovered that a handful of the features digitized were actually open water features and not true wetlands. A systematic method to locate and delete these features was developed in which centroids were created from the lake features of the 2007 LULC datasets. These points were spatially joined to any features they intersected within the historic wetlands layer. The area for the lake and the corresponding wetland feature were compared, and those features where the difference of the two was within +/- 50% of one another were targeted for manual inspection. All features meeting the above criteria were exported out and reviewed by Environmental Management staff of the Hillsborough County Environmental Protection Commission (EPC). Features interpreted to be open water by EPC were subsequently removed from the dataset.

Upon the completion of the delineation of historic wetland boundaries, these features were then appended to the dataset derived from the existing features contained within the 1950s NWI dataset and the 1950 SWFWMD land use/land cover wetlands. A specific attribute column was maintained to record from which process each feature was captured.

Creation of current wetland inventory

The most recent SWFWMD land use/land cover (LULC) data was used to create the current wetland inventory (SWFWMD, 2007b). The LULC data was first clipped to the extent of the Tampa Bay watershed. Next, queries were performed against the tabular data to select out all features where the first level FLUCCS code was either 5 (Water) or 6 (Wetlands). These features were then exported out to a new feature class and used as the most accurate representation of current day wetland delineations.

It was determined that polygon features from the original 2007 LULC that were recorded as "extractive" lands should also be reviewed for inclusion in this final wetlands layer. Mosaic, Inc. provided shapefiles representing existing and planned wetlands created in the post-mining landscape within southeast Hillsborough county and southwest Polk county. EPC staff familiar with the mining and reclamation process as well as many of the lands in question reviewed the data provided by Mosaic to ascertain which post-reclamation wetlands were created and functioning as wetlands as reflected in the 2007 aerial coverage provided by SWFWMD. These wetlands were then categorized as forested or nonforested, and as riverine, lacustrine (i.e., lakes 20 acres or greater) or as 'other'. Categorizations were based on the condition of the wetland as of 2007, but where information was available regarding the final design (i.e., target community), this information was included as well.

EPC staff then reviewed the extractive lands to ascertain if there were any additional wetlands that were not impacted by mining activity and should be included in the study. These wetlands were identified by comparison of historic and current aerial imagery, review of the USDA Soil Survey (via GIS layer), and by personal knowledge of some sites by staff. The boundaries were digitized at a scale sufficient to clearly identify the boundary (but no greater than 1:5000) and the polygons categorized as above. These features were then appended to the final 2007 wetlands dataset by USF Staff.

Classification

A step crucial to the success of this project was the determination of the distinct wetland types from both time periods and developing a classification system based on broad wetland categories that were congruous to both, and suitable for future change analysis. This was done by first assigning hydrologic association (i.e., lacustrine, riverine, other) based on National Hydrography Dataset flowpaths and waterbodies (USGS, 2008), and then by crosswalking, or generalizing and categorizing existing data classifications to aggregate categories of structure (i.e., forested and non-forested) to ensure equivalency of elements. The resulting six freshwater wetland categories are outlined in Table 2.

Table 2. Six wetland classification types.

	Structure	**Hydrologic Association**
1	Forested	Riverine
2	Forested	Lacustrine
3	Forested	Other
4	Non-Forested	Riverine
5	Non-Forested	Lacustrine
6	Non-Forested	Other

The USGS National Hydrography Dataset (USGS, 2008) was used to determine wetland hydrologic association. Flowline features from the National Hydrography Database (NHD) were buffered to a distance of 100 meters (to correspond to U.S. Army Corps of Engineers standards. Wetlands within 100 meters of flowlines were classified as riverine. Because of the incomplete status of the NHD dataset, an iterative process was then used to classify remaining wetlands as riverine if they fell within 100 meters of the previously classified riverine wetlands. Remaining unclassified wetlands were then classified as lacustrine if they fell within or touched the boundaries of a lake/pond (NHD FTYPE=390) from the NHD waterbody feature data layer that was greater than 20 acres in size. Once again, an iterative process was used to then assign unclassified wetlands as lacustrine if they fell within 30 meters of the previously classified lacustrine wetlands. Finally, all unclassified wetlands were given the hydrologic association classification of other.

Assignment of hydrologic association for 1950s wetlands used a modified version of the NHD dataset that included an adjustment related to the flowpaths associated with ditching efforts. Current NHD data, as the only data source available within the scope and budget, does not perfectly represent 1950s conditions. Ditches and canals that have been created in the watershed since 1950 were included in the NHD data, but the use of these flowpaths would result in an inaccurate classification of 1950s wetlands. To address this, the NHD ditch/canal flowlines ("FType" = 336) were visually inspected against 1950s aerials. Viewing at a scale of 1:24000 in a grid cell of 5km x 5km, the operator determined whether or not to include/exclude the ditches within that grid for classification of 1950 wetland riverine status. Ditches were included if 50% or more of the ditches could be seen on the 1950s aerial. This resulted in a new NHD layer that was used to more accurately assign wetland hydrologic association to the 1950s wetlands.

Following the assignment of hydrologic association, detailed crosswalks were created to convert the historic National Wetlands Inventory (NWI) wetland classifications and the historic and current FLUCCS codes to the appropriate forest structure assignment: forested or non-forested. Table 3 provides a list of all FLUCCS and NWI codes and the structural classification to which wetlands were assigned.

Table 3. Crosswalk between FLUCCS, NWI and structural classification of forested/non-forested.

Structural Classification	FLUCCS Codes	NWI Codes
Forested	6100, 6110, 6130, 6150, 6160, 6200, 6210, 6230, 6240, 6300	P2FO, PF03, PFO1, PFO2, PFO3, PFO6, PSS1, PSS3, PSS5, PSS6
Non-Forested	6400, 6410, 6430, 6440, 6450, 6500	L1AB, L2EM, PAB2, PAB4, PAB5, PAB6, PAB7, PELC, PEM1, PEM3, PEM5, PEM6, PEMF, PEMS, PFLA, PFLC, PFLF, PLFL, R2AB

Wetland classification was conducted for 1950 data, and QC of wetland classification was conducted for both 1950 and 2007 data. Adjustments to classification were made for several items based on review of classification. First, tidal wetlands were removed from both datasets, as defined in Setting Priorities for Tampa Bay Habitat Protection and Restoration: Restoring the Balance (Lewis Environmental Services, Inc., 1996) and reiterated in the Tampa Bay Estuary Program Habitat Master Plan Update (PBS&J, 2010). For 1950s data, tidal wetlands were removed from the dataset as follows: as defined by the NWI as "E=Estuarine" and "M=Marine" and those recorded in the LULC data with FLUCCS 6120 (mangrove), 6420 (saltwater marsh) and 6600 (salt barrens). For the 2007 wetland dataset, polygons were removed based on these same three FLUCCS values.

Change Analysis

The wetland change analysis was used to describe the structural changes to wetland boundaries and transformations in classification types between 1950s and 2007 within each drainage sub-basin in the Tampa Bay Watershed. This analysis was conducted as two distinct procedures: analysis of change to individual wetland boundaries, and aggregate summary of changes within the watershed.

Change analysis of the individual wetland polygons

This method involved using geospatial processes to compare "from-to" changes between 1950s wetlands and 2007 wetlands. For example, wet prairies may have changed to hardwood forested wetlands; or wetlands may have changed to non-wetlands. This process was carried out by performing a spatial union between the final 1950 historical wetland inventory and the 2007 current wetland inventory. The resulting change dataset shows where changes to individual wetland polygons occurred. Increases and decreases in area of wetland polygons were then summarized for each drainage basin in the watershed.

Aggregate summary of changes

Due to the lower spatial accuracy and precision of the historic data, a direct one-to-one comparison of polygons may not meet accuracy requirements in all areas of the watershed. As a second dataset, we compared total area of each wetland category within each drainage basin and then compared the aggregate change. A determination was made to utilize the 32 drainage basins utilized in other TBEP projects for analysis.

At the scale of a drainage basin, the spatial inaccuracies and differences in precision were less problematic. The aggregate change analysis was used to validate the change analysis of individual wetlands and provide the minimum data required by the project to determine the amount of change within each drainage basin.

The change analysis determined that processing of digitized files included polygons below the minimum mapping unit of 0.5 acres both in 1950 and 2007 datasets. This skewed the minimum, maximum and average wetland size in each wetland classification category. To ensure consistency in all layers, wetland features with a total area less than 0.5 acres were selected out from both datasets and subsequently deleted.

Change Analysis was run with the final wetlands maps and Wetlands Gains/Losses were calculated at the watershed and drainage basin level. Changes were classified as Hydrological, Structural, or both, as well as to size in acreage by patch. Maps were generated reflecting the change analysis results.

Conditional Assessment

Another objective of the project was to assess existing conditions of remaining freshwater wetlands, including habitat quality and sustainability indicators. This was intended to be a conditional assessment, i.e., an assessment of the overall condition, or integrity, of the wetlands; this was not intended to be a functional assessment, i.e., an assessment of the functional capacity of the wetlands. The two are related in that wetlands in good condition tend to have high functional capacity. However, the two differ in important ways. In general, a conditional assessment only assesses the overall condition of a wetland, while a functional assessment first specifies the functions a particular type of wetland performs, then assesses the relative degree to which those functions are performed by that wetland (Fennessy et al., 2004; Fennessy et al., 2007). A conditional assessment was selected for this analysis for two reasons: (1) a conditional assessment score can best be used to rapidly screen between wetlands that can best benefit from preservation (e.g., those in good condition) and those that best can benefit from restoration (e.g., those in poor condition) and (2) a conditional assessment most easily serves the needs of the regulatory community charged with implementing federal, state, and local rules and regulations (Fennessey et al., 2004; Fennessy et al., 2007).

Several approaches were considered for the conditional assessment. The US Environmental Protection Agency (EPA) obligates state, local, and tribal resource and regulatory agencies use assessment methods to report on the condition of waters of the US, including wetlands, under their jurisdiction (EPA, 2002). Therefore, multiple approaches exist, many of which have been thoroughly reviewed (e.g., Fennessy et al., 2004; Fennessy et al., 2007). The bulk of the assessment tools developed to date are local in scale, being driven by the need to provide information for use in case-by-case, decision-making efforts. However, more recent efforts have focused on the development of assessment tools applicable at coarser scales, being driven in part by the desire to provide information for use in regional or national reporting and planning efforts (Brooks et al., 2004; Brown and Vivas, 2005; Reiss et al., 2010; Weller et al., 2007; Whigham et al., 2007; EPA, 2010).

Of the recent efforts focused on assessments at these coarser scales, the Landscape Development Index (LDI) has been calibrated and validated in Florida (Brown and Vivas, 2005; Reiss et al., 2010). The LDI is used as the conditional assessment tool for the purposes of this report. The LDI is based upon the idea that the condition of a landscape unit—a wetland, for example—is a function of the condition of the area immediately contributing to that landscape unit—a watershed, for example. The condition of the area immediately contributing to that landscape unit is taken as a function of the land use-land cover, specifically the amount of non-renewable energy required to create and sustain a given land use-land cover, with lower amounts of non-renewable energy necessary to create and sustain natural and range land uses-land covers and higher amounts of non-renewable energy necessary to create and sustain urban and industrial land uses-land covers. Therefore, low LDI values correspond to low-intensity land uses (e.g., freshwater marsh), while high LDI values correspond to high-intensity land uses (e.g., high-density residential).

Input data are land use-land cover data which, in this case, were readily available FLUCCS data. All FLUCCS polygons were assigned a non-renewable energy index value using a crosswalk developed from Reiss et al. (2010), and then rasterized to a 10 m X 10 m grid. Appendix A provides the full FLUCCS to LDI crosswalk used in the assessment. The LDI was then calculated two different ways: on a grid-cell basis for illustrative purposes and on a wetland basis for validation purposes. For illustrative purposes, the LDI was calculated for each grid cell by calculating the average LDI score for the 100 m buffer surrounding the grid cell, and the raster was then clipped to the wetland boundaries to illustrate condition for each wetland on a grid cell basis. For validation purposes, the LDI was calculated for each wetland by calculating the average LDI score for the 100 m buffer surrounding the wetland. For rivers, the wetland was defined as the 200 m reach upstream of any given point.

The LDI has been validated and shown to correlate with numerous conditional assessment and water quality metrics (Brown and Vivas, 2005; Reiss and Brown, 2007; Reiss et al. 2010). For this project, further validation was performed by comparing scores from the LDI and the Uniform Mitigation Assessment Method (UMAM) at 37 locations throughout the Tampa Bay Watershed, with UMAM scoring performed by EPC staff scientists. UMAM was selected as the basis for validation because Section 373.414(18), Florida Statutes, directs state agencies, in cooperation with federal, tribal, and local agencies, to use a uniform, state-wide method to determine the amount of mitigation required for regulatory permits. UMAM was developed in response to this statute (Chapter 62-345, F.A.C.). The quantitative portion of the UMAM assessment involves scoring the wetland for three indicators: location and landscape support (LL), water environment (WE), and community structure (CS). The final score for the wetland is then calculated as the sum of the scores for each indicator divided by 30, which yields a number between 0.0-1.0, with a 0.0 corresponding to a wetland in poor condition and a 1.0 corresponding to a wetland in good condition. The validation showed that the LDI was strongly correlated with the UMAM, especially with the LL and final scores (Figure 8 and Figure 9).

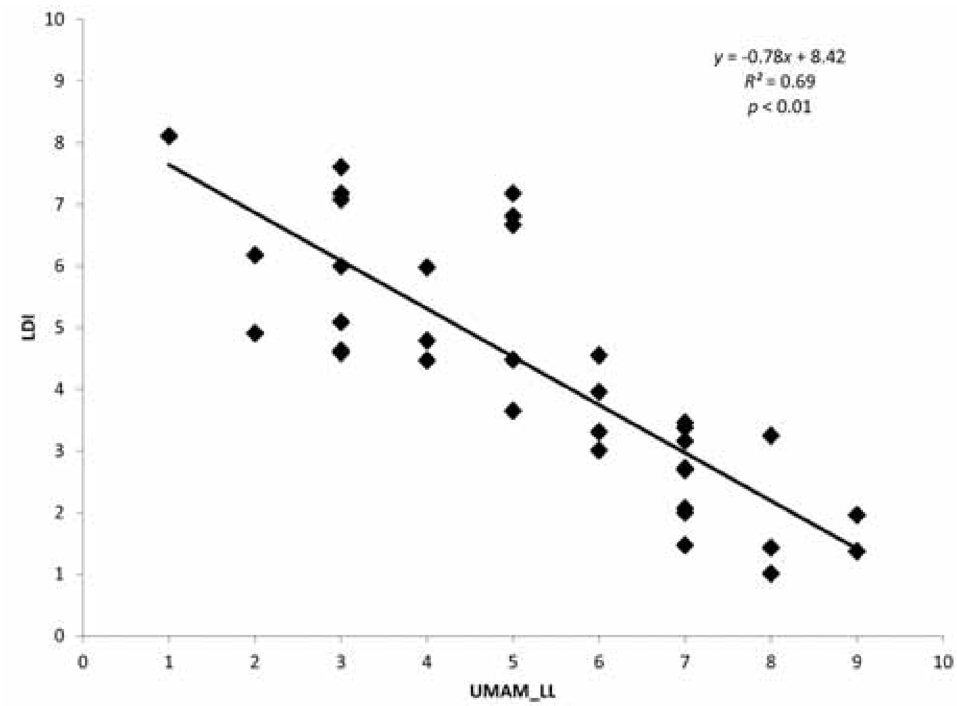

Figure 8. Regression of the LDI score v the UMAM landscape support score.

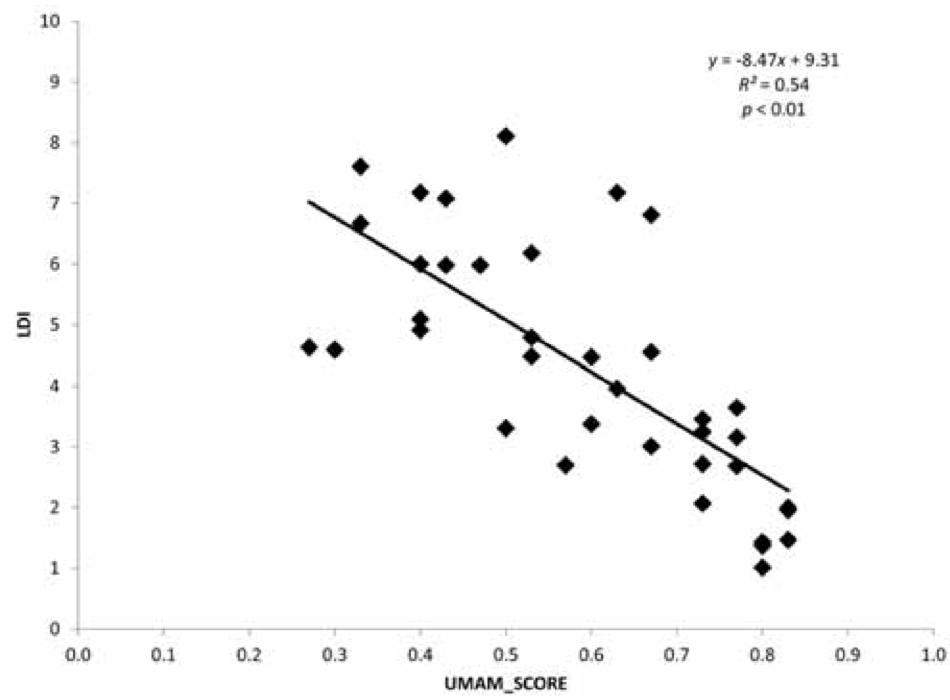

Figure 9. Regression of the LDI score v the UMAM final score.

Economic Analysis

The economic team worked closely with the GIS and wetland hydrology team to project future impacts to freshwater wetlands based on sound economic principles. For example, notwithstanding the need for habitat quality or connectivity, wetlands in areas with highest future land values are most likely to be lost, while mitigation banks are most likely to be located on land with the lowest land values (Milon, 2009). Research has found that, despite the varying functions or levels of ecosystem services provided by different mitigation banks in an area, the sole determinant of value tends to be underlying land value and its alternative (e.g., commercial/developed) uses (Milon, 2009). Investors in mitigation banks, therefore, have a market-based incentive to locate their wetland banking efforts on the "cheapest" land, regardless of whether it has high quality habitat or the potential for a highly functional wetland system. This is valuable information, since the issues of incentives and financial mechanisms to achieve watershed-specific performance will be driven by economics, not ecology. As a result, analysis of expected impacts, and of opportunities to influence those impacts, can begin with relatively simple fundamentals: expected future land use conditions.

Future economic development is uncertain, just as future wetland condition is uncertain. However, the intentions of municipal planning agencies are known and reflected in the Comprehensive Plans as changes to land uses. In Florida, each County files a Comprehensive Plan to outline its intended growth management plans, as well as how schools, roadways and infrastructure will be managed to support planned development. GIS files of the Comprehensive Plans (hereafter, "Comp Plans") were used to obtain future land use maps for each County and municipality in the study area. Land use types were slightly different for each local government, and were converted to like categories for comparison across the watershed, based as closely as possible to FLUCCS coding for consistency.

Comp plans change over time, and in the economic downturn experienced during the study period, dramatic changes in expectations of future development were occurring. As such, two scenarios were envisioned to facilitate discussion of prioritization processes: (1) a slow recovery, high gas/oil price scenario, and (2) a rapid recovery, low gas/oil price scenario. In the former, maps of monthly commuting costs were overlaid with current (existing) land use maps to identify areas where development and redevelopment were likely to occur with the most urgency; recognizing that commuting costs were likely to shift development closer to employment centers. In the latter, currently undeveloped areas with medium to high density future development were identified as prime candidates for conversion to residential development. In both cases, areas with current land use more than two levels of density below future land use were identified as priority areas for vulnerability to economic pressure for land use change. By overlaying these identified areas with the conditional assessment developed during the Mapping and Classification steps, it is possible to model various restoration, mitigation and preservation scenarios.

The wetland change analysis, conditional assessment and proximity to bay are all factors that could be used in setting priorities. The economic element enlightens the urgency in some cases. For example, a small area of forested riverine wetland may be a tiny portion of a drainage basin's overall wetland composition, but represent the vast majority of that type of wetland within the basin, and be situated directly in the path of land highly vulnerable to land use change under either scenario. If this type of wetland previously comprised a majority of the basin's wetland composition, important baseline requirements for restoring the hydrologic balance in the basin may hinge on the particular patch. Having this kind of information available to environmental planners as they assess mitigation requests can help, over time, to achieve the watershed goals. Without this information, planners are missing vital data.

Preliminary economic analysis approaches were demonstrated and discussed with the Technical Advisory Committee and with local planners, policymakers and environmental staff. Specific change analysis results for a representative drainage basin were provided to show the implications for restoration, vs. mitigation or preservation. Identification of the criteria most important to the stakeholders was discussed. The following parameters were suggested:

- Linkages to other public lands
- Linkages to water bodies
- Linkages to areas providing a high level of environmental services (based on EPA data)
- Linkage with watershed plans
- Potentially non-restorable due to restoration impediments, e.g., land use, soils

A goal of the planning workshops was preliminary discussion of target-setting processes. Individual land use decisions accumulate over time, and each land use change transaction can contribute to the overall objective of restoring habitat ratios. Long-term, targets are most likely to be achieved if documented processes allow local planners and environmental staff to incorporate project objectives into their transactional work on a daily basis. Discussions focused on how the change analysis information might be used to assess historical wetland composition, and how this might translate into local targets at the drainage basin level, and at political jurisdictional levels.

Existing policies for local governments were found to be largely compatible with the general conceptual plan of achieving targets. Policymakers felt targets could be achieved through documentation within Comprehensive Plan updates, or through reference to this TBEP Final report as a watershed plan. At the same time, there were varied reactions to the target-setting process discussions. In some areas, policymakers felt that no wetland loss was acceptable, even if a small, poorly functioning wetland patch was the only remaining wetland in an area. In other areas, policymakers felt that drainage-basin level targets created unfair competitive disadvantages for less developed municipalities. In these cases, targets below the watershed level were considered undesirable for economic development reasons.

Screening Tools

Screening criteria maps and data layers were developed to assist with the selection of wetlands for consideration as restoration targets. The screening criteria were purposefully designed to be flexible since the selection of individual sites is the responsibility of appropriate governmental agencies. Screening metrics were developed and maintained as separate map layers in order to allow an individual agency to choose and rank only those criteria that meet institutional mandates. The relative importance of each criteria is likely a temporal moving target that must be adjusted periodically to account for urban expansion patterns and availability of appropriate wetlands that can be managed to achieve the maximum level of watershed services and functions.

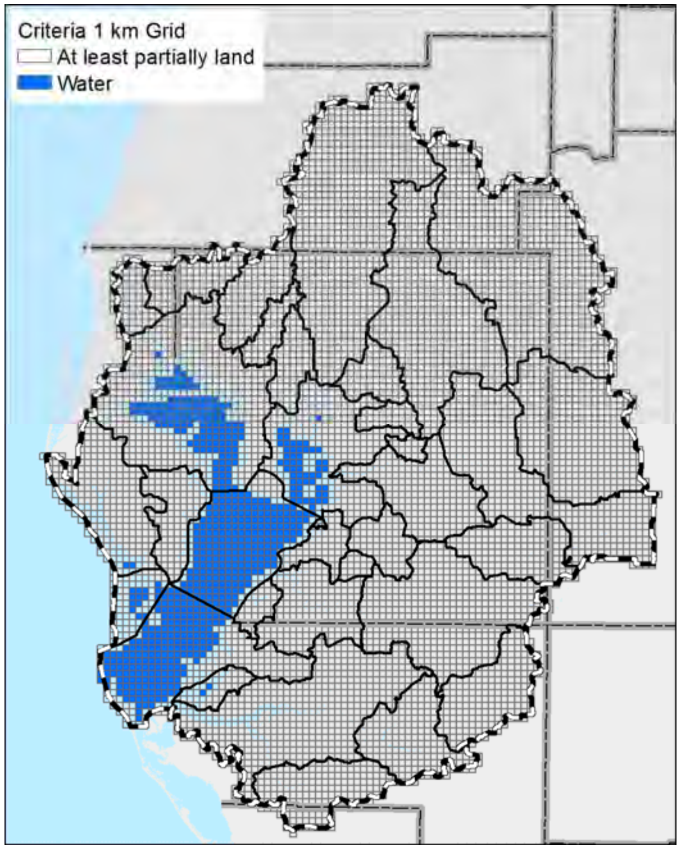

Figure 10. Map showing 1 km Screening Grid.

The screening tool was calculated using a 1 km grid for the Tampa Bay Watershed (Figure 10). Each grid cell was given a "priority" ranking for each of the criteria stated below. The meaning of the priority value generally remain the same for each criteria: one indicates the "best" condition and higher values indicate progressively "poorer" conditions. The ArcGIS 10 "Fishnet" tool was used to create a 1 km polygon grid for the extent of the Tampa Bay Watershed (referred to below as "screening grid"). All screening criteria were calculated separately and added as individual value fields to the screening grid. Grid cells located entirely within Tampa Bay, as defined by the SWFWMD map layer of detailed coastlines (SWFWMD County Boundaries), were labeled as water and assigned null values for each screening criteria.

The following sections describe each of the screening criteria. The descriptions briefly describe the reason why the criteria are recommended, the methods used to develop each criteria as a screening grid, and the meaning of the rankings defined within each criteria. Although most methods are briefly described, the Wetland Condition section contains a detailed step by step process description and is meant to illustrate the detailed steps used to create all criteria maps.

Wetland Loss

Special attention should be paid, not only to those sites whose restoration could have the greatest impact to reverse overall wetland loss within the watershed, but also to areas that have undergone the greatest loss of wetlands historically. For example, future development scenarios could be considered in order to predict where replacement of lost wetlands would have the greatest positive benefit into the future for watershed management.

The 1km screening grid cells were categorized according to the relative extent of area-weighted wetland loss on a scale of 1-5. The 1950-2007 Wetland Change map layer was used to define wetland loss. A value of 1 (i.e., "best") was assigned to all grid cells where there has been no net change in wetlands or where there has been a gain in wetlands. Grid cells where wetlands were not found in both 1950 and 2007 were assigned a null value. All grid cells where wetland change was negative were ranked on a scale of 2-5 according to their quantile distribution of all grid cell values within the watershed. Grid cells with the least wetland loss (i.e., lowest quantile) were given a value of 2 to indicate that these areas were worse than areas of no change, but better than areas of greater change.

Wetland Loss by Type

It is sometimes important to consider where the loss of specific types of wetlands had occurred. Whereas the criteria for total wetland loss would conceal areas where wetlands had undergone change in classification type (e.g., from a forested to a non-forested wetland), wetland loss by type would show these areas. Following the same methods described in the preceding section, wetland loss was also calculated separately for each of the six wetland classification types.

Area-weighted wetland loss on a scale of 1-5 was calculated for each of the six types of wetlands in the 1950-2007 Wetland Change map layer, based on the change in area of the 1950 wetlands. The example of forested riverine wetlands will be used here to illustrate the method. Consider wetlands listed as forested riverine wetlands in 1950. A value of 1 was assigned to all grid cells where there was no loss in forested riverine wetlands or where there was a gain in forested riverine wetlands. Grid cells where forested riverine wetlands were not found in both 1950 and 2007 were assigned a null value. Grid cells where forested riverine wetland change was negative (i.e., loss) were ranked on a scale of 2-5 according to their quantile distribution of all grid cell values within the watershed. The same process was repeated for each of the six wetland types. It is important to note that a change from one classification type (e.g., forested riverine) to another classification (e.g., non-forested riverine), such as what would occur as a result of deforestation, would be listed as a loss of the individual wetland for that classification type and result in a worse criteria score.

Wetland Area

The distribution of remaining wetland area is an important consideration by itself and in conjunction with other screening criteria (e.g., combined with wetland condition). The proportion of each 1 km grid cell covered by 2007 wetlands is provided as the wetland area criteria.

In order to determine the total area of wetlands within each grid cell, the 1 km grid cell GIS layer first was used to divide (i.e., ArcGIS 10 Identify tool) wetland polygons from the 2007 Wetlands data layer. The identify tool split the wetland polygons along grid cell boundaries, and then all wetland polygons within a single grid cell were labeled with the unique identifier of that cell. The resulting data table was used to calculate total surface area (in km^2) of all wetland within each grid cell, and then divided by 1 km^2 to determine the proportion of each grid cell occupied by wetlands of any type. A value of 1-5 is assigned to each grid cell based on the quartile distribution of wetland area in all grids. Grids in the upper 20% of wetland area (i.e., the "best") are assigned a value of 1, while grids with the least, lowest 20% of wetland area are assigned a value of 5.

Wetland Condition

While conservation of wetland structure should be a goal, maximization of wetland functions and services should be the ultimate goal of any management or restoration effort. Elevation of function and process in the decision process recognizes the reality of wetlands within urbanizing landscapes, namely that multiple wetland types (structures) can perform the same vital functions and processes considered critical for landscape and downstream management.

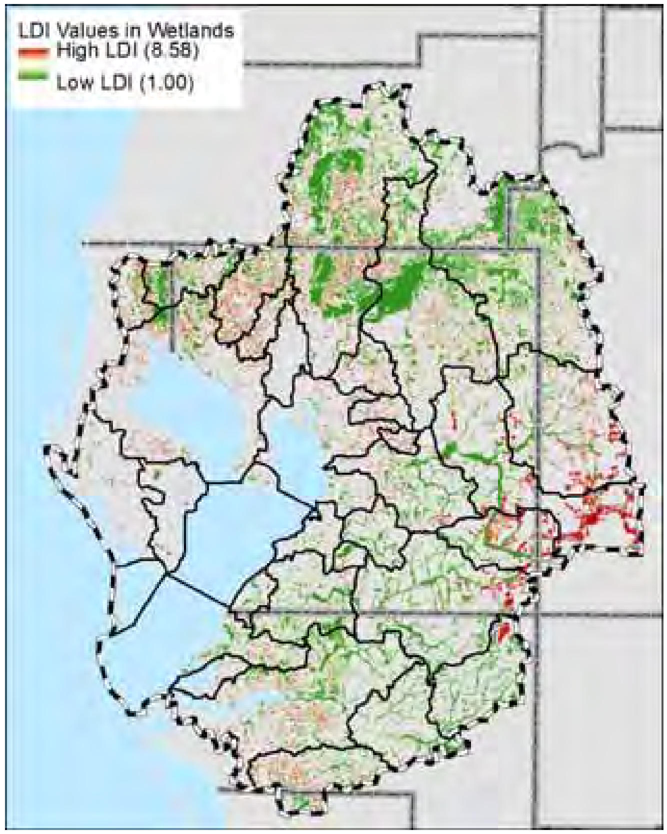

Figure 11. Map of LDI values within wetlands. Higher LDI values imply more impacted wetlands.

Conditional assessment, using the Landscape Development Intensity index (LDI) was used as a proxy for wetland function; low LDI indicates a minimally impacted wetland, while high LDI indicates a highly impacted wetland. Refer to the Condition Assessment methods section for a full description of all wetland condition methods. Using the ArcGIS 10 raster clipping tool, boundaries of existing 2007 wetlands were used to extract LDI values in the 10 meter raster grid that were located within wetlands. Figure 11 shows a map of LDI values, generated from the conditional assessment phase of the project. Note the difficulty in interpreting the map for the purpose of prioritization at the watershed scale. Our approach to developing a watershed scale screening criteria was to generalize the LDI values at the scale of the 1 km screening grid.

Several steps were necessary to convert LDI information at the wetland scale into screening criteria at the watershed scale. The first step in this process was to calculate the mean LDI values within each of the 1 km screen grid cells. Using the ArcGIS 10 Spatial Analyst Statistics Table tool, mean LDI values within wetlands were then calculated for each 1km grid cell. The screen grid (Figure 10) was used to define the zones (i.e., one zone was a grid cell) and the Wetland Condition LDI map layer was used as the input to calculate mean LDI value per zone.

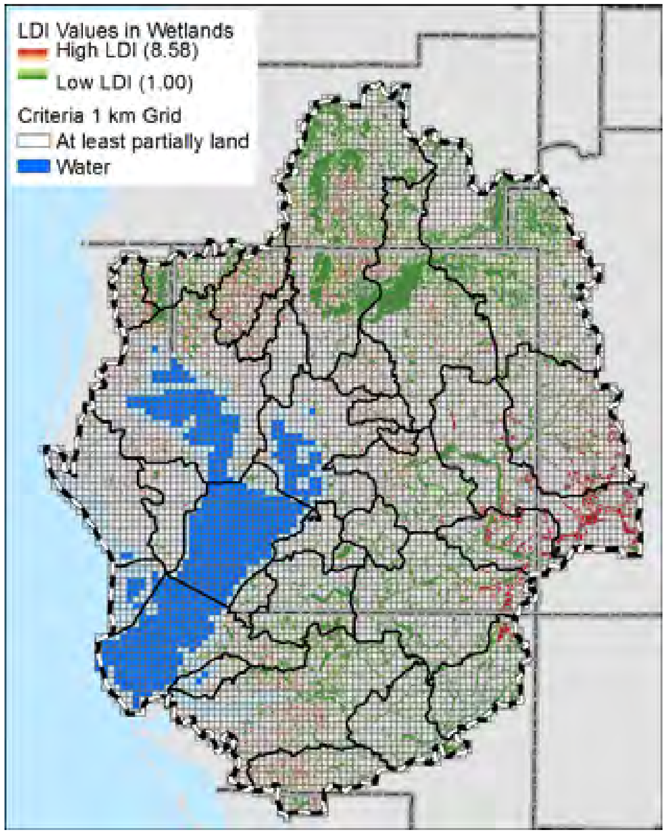

Figure 12. LDI values overlaid by 1 km screening grid. Higher LDI values imply more impacted wetlands.

The result of the mean LDI calculations was a range of mean values ranging from 1 to 8.58 (i.e., LDI value), in addition to numerous null (i.e., empty) values for cell locations were wetlands did not exist. In order to convert these values into screening criteria that was comparable with other criteria, the condition of remaining wetlands was categorized on a scale of 1-5, with 1 being the "best" condition and 4 being the “poorest” condition for grid cells with wetlands. Grid cells with no wetlands (i.e., null/empty values) that were not located within the Bay waters were assigned a value of 5 to indicate that areas lacking wetlands were worse than areas with wetlands. Grid cellswith existing wetlands were assigned the category 1-4 according to the quantile distribution of mean LDI values. Grid cells with the lowest, or best, mean LDI value were assigned a value of 1 and grid cells with the worst LDI values were assigned a value of 4. Figure 13 shows the distribution of all valid (i.e., not null) mean LDI values within grid cells of the Tampa Bay Watershed. A quantile binning technique was used in order to establish a rank that included equal numbers of grid cells within each rank. The break value section of the figure illustrates that 25% of the grid cells representing the “best” condition had a mean LDI value of less than or equal to 1.69, while the “poorest” condition (aside from having no wetlands) was represented by grid cells with a mean LDI greater than 3.66. Rankings 1-4 used the break values shown in the Figure 13.

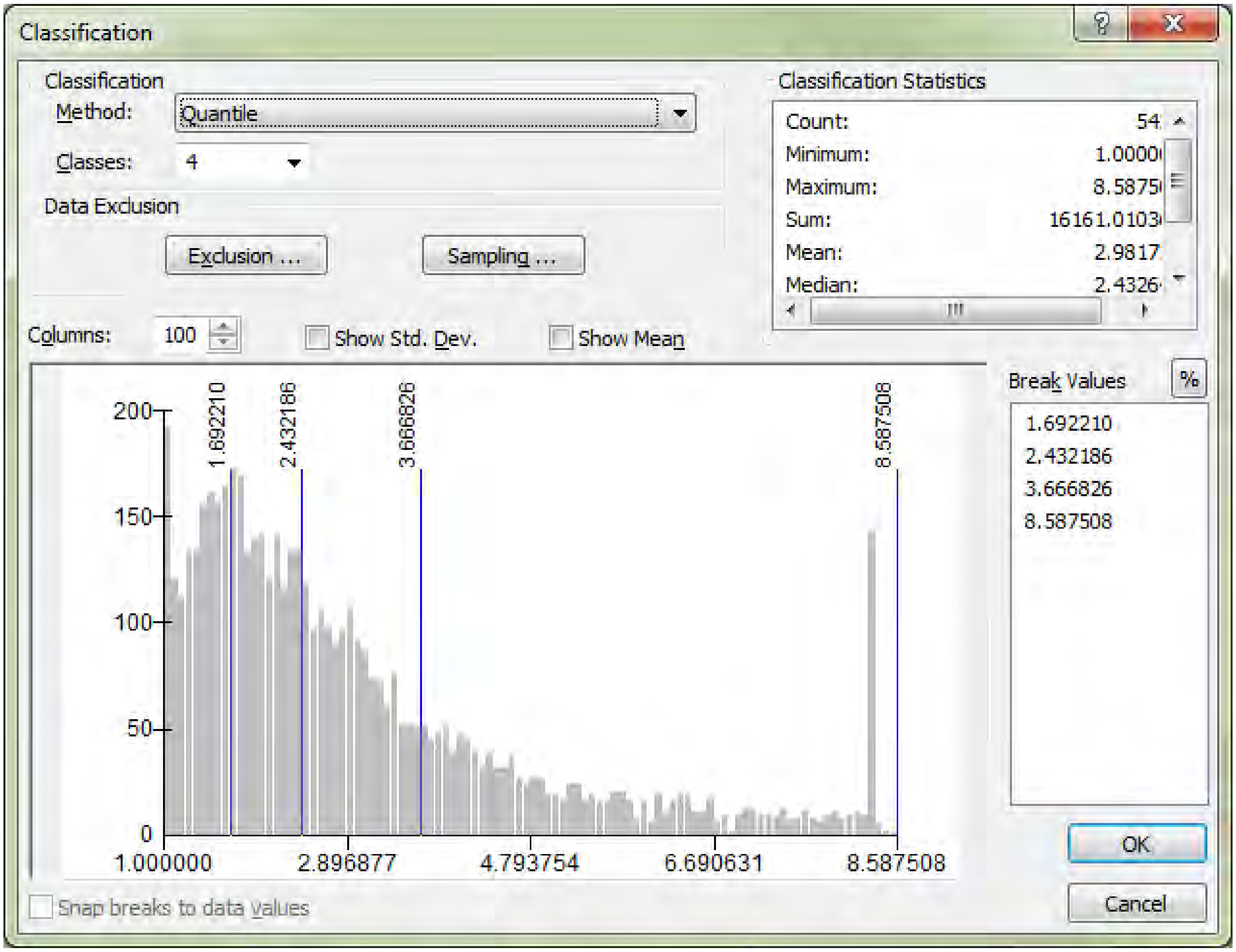

Figure 13. Illustration of binning technique of mean LDI distribution. Higher LDI values imply more impacted wetlands.

The methods described above represent the same basic process used for all screening criteria. In summary: 1) raw data at the wetland scale were summarized for each 1 km grid cell; 2) if necessary, null/empty values were assigned the lowest ranking (or highest, depending on the criteria); 3) summarized values were placed into a quantile distribution (note that other criteria use quartile); and finally 4) remaining ranks were set based on quantile distribution.

Wetland Condition by Type

The condition of specific types of classified wetlands can also be important criteria to consider. Following methods similar to those used for all wetlands, condition of remaining wetlands was also calculated separately for each of the six classified wetland types.

Separate wetland boundary polygon layers were created for each of the six types from the existing 2007 wetlands, such that each layer contained only one type (e.g., forested riverine). Each of the six polygon layers was used to extract LDI values in the 10 meter raster grid that were located within wetlands of that type. Mean LDI values within wetlands of that type were then calculated for each 1km grid cell and ranked according to the quantile distribution specific to that wetland classification type. Six additional screening criteria were thus created, one for each wetland type following the same ranking method used for combined wetlands.

Wetland Hydrological Connectivity

The hydrologic connectivity of remaining wetlands is an important consideration because wetlands with a more direct hydrologic connection to Tampa Bay may have a greater influence on Bay water quality. Existence of riverine wetlands in 2007 was used to develop a binary score to indicate wetland connectivity. Grids with riverine wetlands were scored as 1 and grids without riverine wetlands were scored as 0.

The data table from the wetland area calculations contained a unique identifier for each 1 km grid cell, and records of all wetland polygons located within each cell. The wetland classification type data value was retained and used to determine hydrologic connectivity. Grid cells that contained a riverine polygon were selected and assigned a value of 1 (i.e., riverine wetlands present). All remaining grid cells (i.e., lacking riverine wetland polygons) were then assigned a value of 0, except water grid cells which were assigned a null value.

Wetland Mitigation Opportunity / Planned Development Impact

Planned or future land use acquired from the various planning agencies (see methods) was consolidated into a single polygon map layer. Future land use categories were converted to Landscape Development Intensity (LDI) using the same lookup table that was utilized to convert FLUCCS level 1 land use land cover classifications into LDI. Planned land use derived LDI values were converted from a polygon layer to a raster dataset using the same 15 meter cell size that was used for wetland condition calculations. Using the ArcGIS 10 Spatial Analyst Statistics Table tool, mean planned LDI values were calculated for each 1km grid cell. A value of 1-5 is assigned to each grid cell based on the quartile distribution of mean planned LDI in all grids. Grids in the lowest 20% of planned LDI (i.e., the "best") are assigned a value of 1, while grids with the highest 20% of planned LDI were assigned a value of 5.

Results and Discussion

Geographic Extent of Wetlands, 1950 and 2007

Total surface area of wetlands of all types in the Tampa Bay Watershed in 1950 was 1,271 square kilometers, or 314,170 acres (see Table 4). The majority, 76%, of all wetland area was classified as riverine, while slightly more than 7% was lacustrine and 16% was classified as other wetlands. In 1950, nearly 65% of all wetlands were classified as forested.

Table 4. Wetland surface area in 1950 summarized by type.

Wetland Type	1950 Wetland Area (km^2)	% of All Wetland Types
Riverine Forested	681.1	53.6%
Riverine Non-Forested	284.7	22.4%
Total Riverine Wetlands	**965.8**	**76.0%**
Lacustrine Forested	45.1	3.5%
Lacustrine Non-Forested	50.0	3.9%
Total Lacustrine Wetlands	**95.1**	**7.5%**
Other Forested	97.4	7.7%
Other Non-Forested	113.0	8.9%
Total Other Wetlands	**210.4**	**16.5%**
Total all Forested Wetlands	**823.7**	**64.8%**
Total all Non-Forested Wetlands	**447.7**	**35.2%**
Total Wetlands of All Types	**1,271.4**	**100.0%**

The geographic extent of wetland coverage in 1950 within the Tampa Bay Watershed is shown in Figure 14. Although a detailed description of the geographic extent is beyond the scope of this report, there are a few important points to make regarding this distribution. The map shows that by 1950, wetlands are largely absent within the large urban areas of the City of Tampa and St. Petersburg. The urban core in both of these cities had experienced the bulk of their growth prior to World War II. Determining pre-settlement wetland coverage would require going back in time to the early 1800s. Reconstructing pre-settlement wetland area and distribution may be a valuable exercise for future research.

In 1950, wetlands were abundant within the northern and northeastern areas of the watershed. Large wetland systems were associated with basins around the Hillsborough River in the north and the Alafia River in the east. Smaller riverine wetland systems are evident throughout the eastern and southern areas of the watershed. High densities of smaller wetlands cover large areas of the eastern and northeastern watershed, as well as the south portion of the watershed.

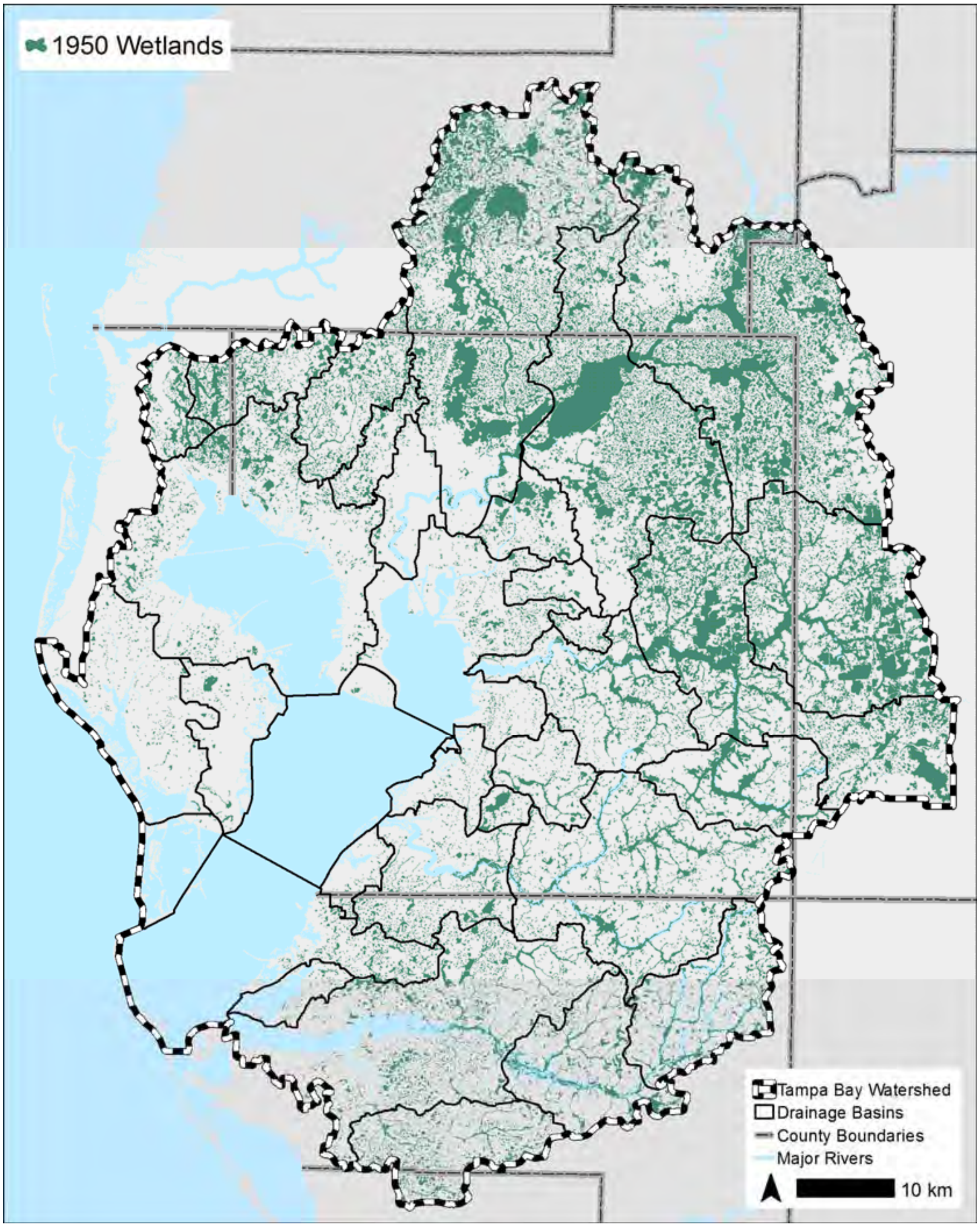

Figure 14. Geographic Extent of Wetlands, 1950.

Total surface area of wetlands of all types in the Tampa Bay Watershed in 2007 was 855 km^2, or 211,325 acres (see Table 5). Slightly over 76% of all wetland area was classified as riverine, while nearly 6% was lacustrine and 18% was classified as other wetlands. In 2007, nearly 70% of all wetlands were classified as forested.

Table 5. Wetland surface area in 2007 summarized by type.

Wetland Type	2007 Wetland Area (km^2)	% of All Wetland Types
Riverine Forested	495.8	58.0%
Riverine Non-Forested	155.1	18.1%
Total Riverine Wetlands	650.9	**76.1%**
Lacustrine Forested	26.3	3.1%
Lacustrine Non-Forested	22.3	2.6%
Total Lacustrine Wetlands	48.6	**5.7%**
Other Forested	77.2	9.0%
Other Non-Forested	78.5	9.2%
Total Other Wetlands	155.7	**18.2%**
Total all Forested Wetlands	599.3	**70.1%**
Total all Non-Forested Wetlands	255.9	**29.9%**
Total Wetlands of All Types	855.2	**100.0%**

The geographic extent of wetland within the Tampa Bay Watershed in 2007 is shown in Figure 15. Existing wetlands classified from 2007 data sources show a distribution comprised of generally much smaller wetland systems than those evident on the 1950 map (Figure 14). Large wetland systems are associated with basins around the Hillsborough River and to a lesser extent around the Alafia River in the east. Smaller riverine wetland systems remain throughout the eastern and southern areas of the watershed. The density of smaller wetlands appears to be fairly evenly distributed throughout northern and southern areas of the watershed.

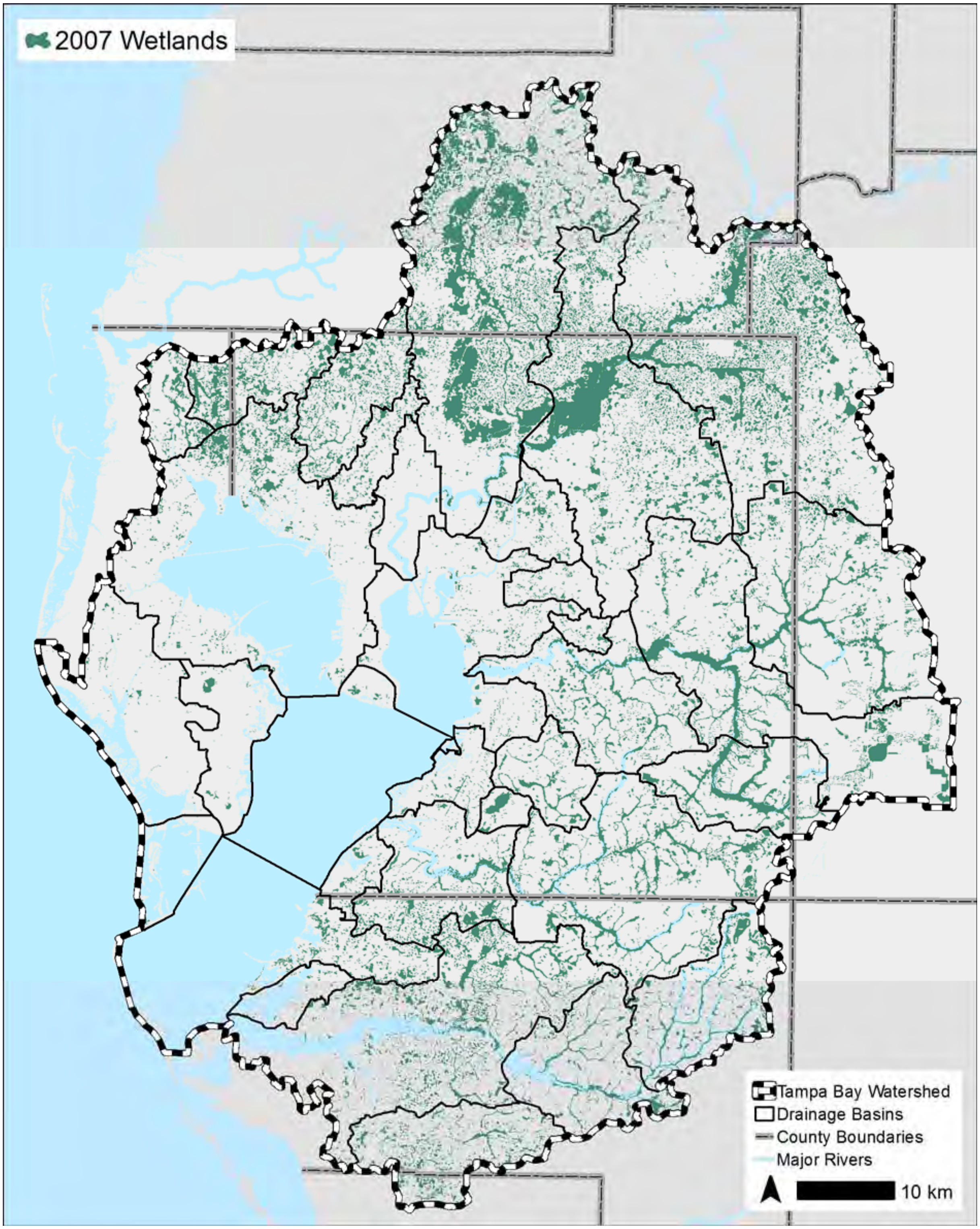

Figure 15. Geographic Extent of Wetlands, 2007.

Wetland Change, 1950-2007

Total freshwater wetland surface area decreased by over 416 km^2 between 1950 and 2007 within the Tampa Bay Watershed (Table 6). The change is a 33% reduction in total wetland area. The largest loss, by far, to surface area occurred to riverine wetlands (314.9 km^2). Lacustrine wetlands exhibited the largest loss as a percentage of surface area that existed in 1950; nearly 50% of the 1950 lacustrine wetland area had been lost by 2007. While loss to total wetland area was slightly greater for forested (224.4 km^2) compared to non-forested (191.8 km^2), the percentage change was actually much larger for non-forested (43% compared to 27% for forested). Within the riverine classification, forested wetland area loss was greater (185.3 km^2) compared to non-forested (129.6 km^2) even though the percentage lost was higher for non-forested. In the lacustrine and other wetland categories, both the area lost and percentage lost were higher for non-forested.

Table 6. Wetland Change, 1950-2007: Total area and percent change.

Wetland Type	1950 Wetland Area (km^2)	2007 Wetland Area (km^2)	Wetland Change 1950 – 2007 km^2 (%)
Riverine Forested	681.1	495.8	-185.3 (-27%)
Riverine Non-Forested	284.7	155.1	-129.6 (-46%)
Total Riverine Wetlands	**965.8**	**650.9**	**-314.9 (-33%)**
Lacustrine Forested	45.1	26.3	-18.8 (-42%)
Lacustrine Non-Forested	50	22.3	-27.7 (-55%)
Total Lacustrine Wetlands	**95.1**	**48.6**	**-46.5 (-49%)**
Other Forested	97.4	77.2	-20.2 (-21%)
Other Non-Forested	113	78.5	-34.5 (-31%)
Total Other Wetlands	**210.4**	**155.7**	**-54.7 (-26%)**
Total all Forested Wetlands	**823.7**	**599.3**	**-224.4 (-27%)**
Total all Non-Forested Wetlands	**447.7**	**255.9**	**-191.8 (-43%)**
Total Wetlands of All Types	**1,271.4**	**855.2**	**-416.2 (-33%)**

In addition to examining wetland area changes at the aggregate of the entire Tampa Bay Watershed, this study also compared changes at the scale of individual wetlands. Figure 16 illustrates the general geographic distribution of four types of change that occurred with individual wetlands 1950-2007. “No change” is indicated when neither the wetland boundaries nor the type of wetland changed. “Wetland gain” occurred in areas of wetland expansion or wetland creation. “Change in type” means that an area remained a wetland, but that the type of wetland (e.g., riverine forested) in 2007 was different than the type of wetland that was present in 1950. Finally, “wetland loss” shows the areas where wetlands were present in 1950 but no longer existed in 2007. The small map in Figure 16 is provided to show major patterns of change. In order to examine large scale local changes, consult the complete spatial database of map layers provided with this report.

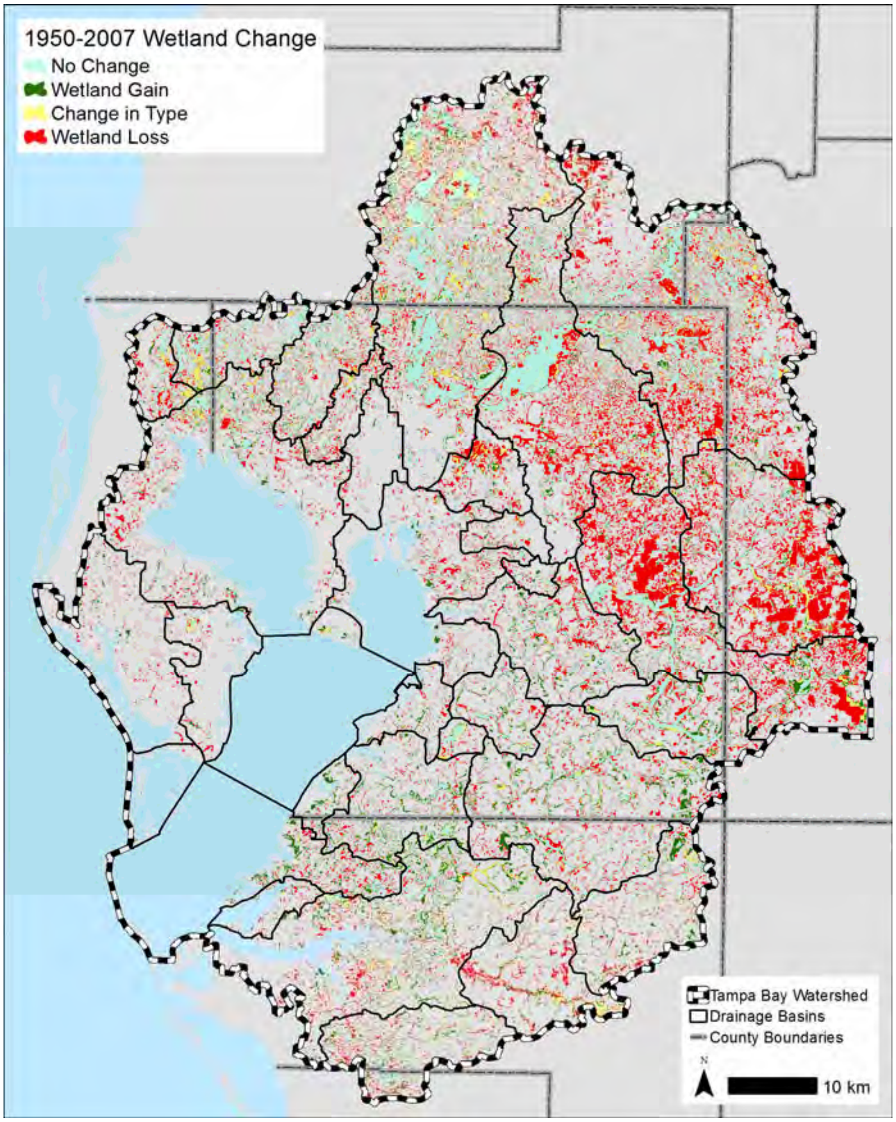

Figure 16. Wetland Change, 1950-2007.

Several patterns of wetland change are evident from the map of wetland area change shown in Figure 16. The eastern portion of the watershed is marked by loss of very large wetland systems and numerous other wetland areas. These areas of the watershed have been impacted by phosphate mining activities, large scale agriculture and suburban expansion. In addition to wetland loss, change in wetland type and some gain is also visible in the eastern areas of the watershed. Mine reclamation activities may be responsible for some of these patterns.

Change in wetland classification type is defined as a change in classified structural or hydrologic connectivity for all or a portion of individual wetlands between 1950 and 2007. Change to type is visible as small patches distributed throughout the watershed. The northernmost drainage basin is dotted with numerous areas where the type of wetland changed. Wetlands in these areas may have undergone a structural change between non-forested and forested. The growth of trees on former agricultural or timber lands is one example. To understand the magnitude of classification type changes within the watershed, Table 7 shows the types of changes that were found when comparing differences between 1950 and 2007 boundaries or individual wetlands. Changes to the structure and hydrological connectivity of wetlands was 15.2% of all changes that occurred at the scale of individual wetlands; a total of 146.5 km^2. Change from non-forested to forested, or vice versa, represent the greatest proportion of all types of change, excluding loss and gain.

Table 7. Type of change at the scale of individual wetlands.

Type of Change	**Area (km^2)**	**% of all Change**
Structural Change	73.1	7.5%
Hydrologic Change	58.5	6.0%
Change to both Structure and Hydrology	14.9	1.5%
Total Change in Structure or Hydrology	**146.5**	**15.2%**
Wetland Loss	**622.7**	**63.8%**
Wetland Gain	**206.7**	**21.2%**
Total Individual Wetland Change	**975.9**	**100%**

Gains to the areas of individual wetlands (i.e., wetland gain), shown spatially in Figure 16 and as total area in Table 7, was recorded when the boundaries of an individual wetland were larger in 2007 than in 1950 or when a wetland recorded in 2007 had not been visible in 1950. Green areas of Figure 16 are visible throughout much of the watershed. There are at least several major explanations for these wetland gains. Construction of water management infrastructure can include the creation of retention and detention ponds and associated wetland areas. Construction activities can change the surface hydrology within localized areas, thus turning formerly dry areas into wet areas, and vice versa. Restoration and reclamation activities on mining lands have led to the creation of many wetlands, as evidenced by the large areas of gain in the easternmost portions of the county (see Figure 16).

Photointerpretation error is also a possible explanation for the large total area of wetland gain, as well as other types of change. Classification of 1950 and 2007 wetlands was done using photointerpretation techniques. Although photointerpretation is arguably the best available method for reconstructing historic land cover, differences in results have been shown to be highly dependent on both the interpreter and the quality of the imagery. Small differences in the digitized boundary of a wetland can result in wetland change that is recorded as a gain (or loss). In other cases, the wetland area may not have changed, but a small spatial shift can result in gain that is equal to the loss. The minimum mapping unit of 0.2 hectare (½ acre) can result in small patches of wetland left undetected in one or both of the datasets, and the total impact of the differences at the watershed scale may be somewhat large. Independent validation testing demonstrated a 90.1% accuracy of the digitized 1950s wetlands. According to the SWFWMD, the source of the 2007 land use land cover data used for wetland classification, accuracy testing results are not reported but is likely to be 80-90% (SWFWMD, 2008). Individual wetland change was not the primary focus of this study, and therefore a detailed accuracy testing of individual wetland changes was not attempted. Caution should be exercised when interpreting the results at the scale of the individual wetland shown in Figure 16 and in Table 7.

Aggregate net change at larger geographic extents is a much more valid way of interpreting the change analysis results.

Wetland change aggregated by drainage basin ranged from a net loss of 90.3 km^2 to a net gain of 4.8 km^2 (Table 8). Percent change in wetland area by basin is shown geographically in Figure 17. Total area and percent change is listed in Table 8 and sorted in descending order by the total area of wetland loss. As shown in Figure 17, basins with the largest (top two quartile groups) percentage loss in wetland area between 1950 and 2007 are located in the southeast portion of the watershed associated with the Manatee and Alafia Rivers (especially basins 204-2 and 02300500), coastal areas on the east side of Tampa Bay near Cockroach Bay (basin 206-E) and Bullfrog Creek (basin 206-3E and 2300700), northeast basins associated with the Hillsborough River and Itchepackesassa Creek (basins 02303330 and 02303000), and the coastal areas on the north and west sides of Old Tampa Bay (basin 206-1).

An examination of total area of wetland change (i.e., in contrast to percent change) by basin shows a somewhat different result. Table 8 includes two columns to compare the difference between total area versus percentage change: rank order by km^2 change and rank order by % change. Only two of the basins ranked in the top five in terms of percentage change were also in the top five in terms of total area change. Basins associated with the Manatee River (basins 02299950 and 02300500) were near the top rank in terms of both total area lost and total percentage loss. Several basins that lost a substantial surface area of wetlands between 1950 and 2007 are not in the top rank in terms of percentage wetland lost. Basins associated with the Hillsborough River (e.g., 02303330 and 02303000) ranked moderately high in terms of both area and percentage loss. In contrast, Alafia River basins (02301000, 02301500 and 02301300) were not in the upper two quartiles in terms of percentage loss, but were in the highest quartile in terms of total surface area of wetland loss.

Extreme care must be exercised when using wetland change statistics within the environmental management and policy arena. For example, from the perspective of the total magnitude loss of ecosystem services derived from wetlands (e.g., water quality treatment), the total area lost in many basins might be a primary concern. However, when viewed from a habitat change perspective, a greater percentage loss to wetlands may result in substantial change to ecosystem dynamics and associated widespread consequences to ecosystem function. Interpretation of the results of the change analysis therefore depends on the specific goals of the agency.

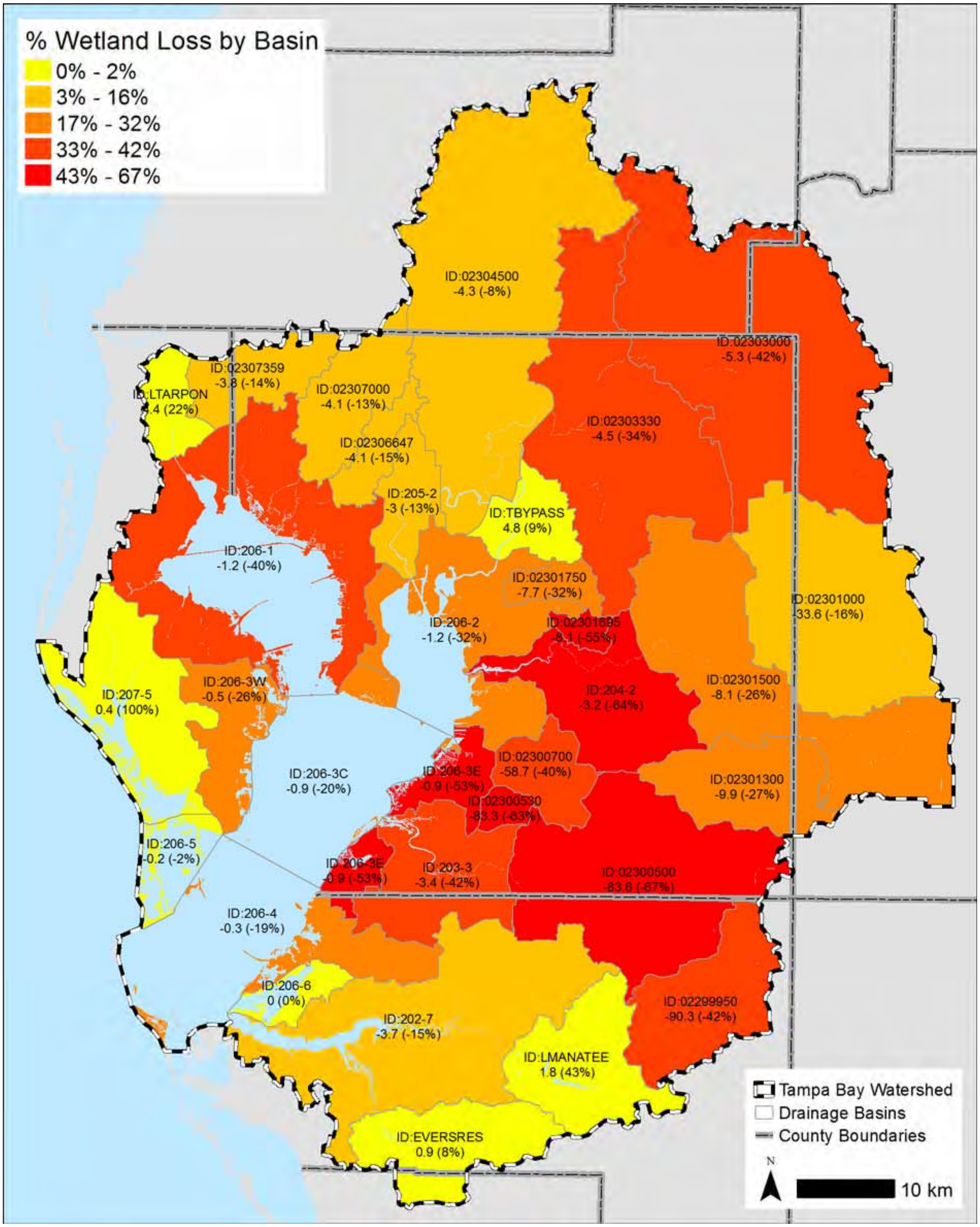

Figure 17. Wetland loss by drainage basin, 1950-2007. Categories are defined by quartile groups.

Table 8. Wetland Change, 1950-2007: Total area and percent change by drainage basin.

Drainage Basin ID	1950 Wetland Area (km^2)	2007 Wetland Area (km^2)	Change 1950 – 2007 km^2 (%)	Rank order by km^2 change	Rank order by % change
02299950	215.5	125.2	-90.3 (-42%)	1	6
02300500	124.9	41.3	-83.6 (-67%)	2	1
02300530	132.4	49.1	-83.3 (-63%)	3	3
02300700	147.4	88.7	-58.7 (-40%)	4	9
02301000	204.7	171.1	-33.6 (-16%)	5	19
02301300	36.5	26.6	-9.9 (-27%)	6	14
02301500	30.6	22.5	-8.1 (-26%)	8	4
02301695	14.7	6.6	-8.1 (-55%)	7	15
02301750	24.2	16.5	-7.7 (-32%)	9	12
02303000	12.6	7.3	-5.3 (-42%)	10	7
02303330	13.1	8.6	-4.5 (-34%)	11	11
02304500	55.8	51.5	-4.3 (-8%)	12	25
02306647	26.6	22.5	-4.1 (-15%)	13	20
02307000	31.1	27	-4.1 (-13%)	14	23
02307359	27.7	23.9	-3.8 (-14%)	15	22
202-7	25.4	21.7	-3.7 (-15%)	16	21
203-3	8.1	4.7	-3.4 (-42%)	17	8
204-2	5	1.8	-3.2 (-64%)	18	2
205-2	23	20	-3 (-13%)	19	24
206-1	3	1.8	-1.2 (-40%)	20	10
206-2	3.8	2.6	-1.2 (-32%)	21	13
206-3C	4.4	3.5	-0.9 (-20%)	23	5
206-3E	1.7	0.8	-0.9 (-53%)	22	17
206-3W	1.9	1.4	-0.5 (-26%)	24	16
206-4	1.6	1.3	-0.3 (-19%)	25	18
206-5	8.2	8	-0.2 (-2%)	26	26
206-6	0.1	0.1	0 (0%)	27	27
207-5	0.4	0.8	0.4 (100%)	28	32
EVERSRES	10.8	11.7	0.9 (8%)	29	28
LMANATEE	4.2	6	1.8 (43%)	30	31
LTARPON	20.4	24.8	4.4 (22%)	31	30
TBYPASS	51.4	56.2	4.8 (9%)	32	29
Total Wetland Area	**1271.4**	**855.4**	**-416 (-33%)**		

Screening Tools

Screening criteria maps and data are summarized in this section of the report. The maps are primarily for illustrative purposes. The reader is encouraged to utilize the screening criteria GIS data layer directly for the purpose of analysis or prioritization. Appendix B provides a demonstration of the use of the Wetland Screening Criteria. The demonstration is meant to serve as an example of how the criteria might be used to address basic prioritization questions.

Table 9 provides a summary of the grid data used to develop the screening criteria. The wetland loss 1-5 scale screening criteria was developed from the "change" data listed in the table. The term change is used here to recognize that the raw data represent both an increase (positive values) and a loss (negative values) of wetlands within each 1 km^2 grid. As shown in the table, 1950-2007 wetland loss of all wetland types averaged 0.07 km^2 within 1 km^2 grid cell, or 7% loss. Each 1 km^2 grid cell contains an average of 0.13 km^2, or 13% wetland coverage by area. Wetland condition of all types within each 1 km^2 grid cell is equal to a 2.98 average LDI value. Future "planned LDI" based on future land use will result in a worsening of wetland condition as indicated by a 5.78 average LDI value. Finally, wetland connectivity screening criteria data indicates that 71% of all 1 km^2 grid cells contain a riverine wetland (of any size).

Table 9. Summary statistics of raw grid data used to develop screening criteria.

Screening Criteria	Units	Mean	Std. Dev	Min	Max
Change (All Types)	change in km2 within 1 km2 grid	-0.07	0.14	-1.00	0.67
Change (Forested Lacustrine)	change in km2 within 1 km2 grid	-0.02	0.08	-0.47	0.69
Change (Forested Other)	change in km2 within 1 km2 grid	-0.01	0.04	-0.36	0.56
Change (Forested Riverine)	change in km2 within 1 km2 grid	-0.04	0.12	-1.00	0.48
Change (Non-Forested Lacustrine)	change in km2 within 1 km2 grid	-0.02	0.08	-0.72	0.51
Change (Non-Forested Other)	change in km2 within 1 km2 grid	-0.01	0.03	-0.24	0.57
Change (Non-Forested Riverine)	change in km2 within 1 km2 grid	-0.03	0.10	-1.00	0.80
Wetland Area Remaining	area remaining within 1 km2 grid	0.13	0.16	0.00	1.00
Condition (All Types)	wetlands LDI within 1 km2 grid	2.98	1.79	1.00	8.59
Condition (Forested Lacustrine)	wetlands LDI within 1 km2 grid	2.94	1.38	1.00	8.32
Condition (Forested Other)	wetlands LDI within 1 km2 grid	3.20	1.58	1.00	8.32
Condition (Forested Riverine)	wetlands LDI within 1 km2 grid	2.35	1.27	1.00	8.32
Condition (Non-Forested Lacustrine)	wetlands LDI within 1 km2 grid	3.63	2.25	1.00	8.32
Condition (Non-Forested Other)	wetlands LDI within 1 km2 grid	3.92	1.98	1.00	8.59
Condition (Non-Forested Riverine)	wetlands LDI within 1 km2 grid	3.07	1.85	1.00	8.42
Planned LDI	future LU LDI within 1 km2 grid	5.78	2.33	1.00	8.66
Wetland Connectivity	presence of rivers (Yes/No)	0.71	0.45	0	1

Table 10 provides the cutoff values used to calculate each 1-5 criteria score. For example, a score of 1 for change/loss of all types of wetlands was assigned to each 1 km^2 grid cell with raw data values greater than or equal to 0. A change/loss score of 1 was assigned for all raw data values less than 0 and greater than or equal to -0.024. Bin values for change criteria and wetland area remaining should be interpreted as follows: score 1 is assigned when values meet the criteria shown in Bin 1; score 2 when values are less than Bin 1 and greater than or equal to Bin 2; score 3 when values < Bin 2 and >=Bin 3; score 4 when values < Bin 3 and >=Bin 4; score 5 when values < Bin 4. Condition and planned LDI score are calculated similarly except that all values for progressive scores are greater than, rather than less than, the preceding score. For example, condition score 2 for all types is assigned for values >=Bin 1 and < Bin 2. Note that wetland connectivity is not shown in the table because it is a binary indicator based on presence (i.e., 1) or absence (i.e., 0) of rivers.

Table 10. Raw data cutoff values used for each 1-5 wetland criteria score. Bin 1 indicates the values used for criteria score 1, Bin 5 indicates the cutoff used for criteria score 5.

Screening Criteria	Bin 1	Bin 2	Bin 3	Bin 4	Bin 5
Change (All Types)	>=0	-0.024	-0.066	-0.150	-1.000
Change (Forested Lacustrine)	>=0	-0.008	-0.024	-0.061	-0.471
Change (Forested Other)	>=0	-0.005	-0.013	-0.029	-0.357
Change (Forested Riverine)	>=0	-0.016	-0.047	-0.123	-0.995
Change (Non-Forested Lacustrine)	>=0	-0.007	-0.022	-0.060	-0.724
Change (Non-Forested Other)	>=0	-0.004	-0.012	-0.026	-0.241
Change (Non-Forested Riverine)	>=0	-0.009	-0.027	-0.067	-1.000
Wetland Area Remaining	>=0.21	0.10	0.03	0.00	0
Condition (All Types)	<1.69	2.43	3.67	8.59	NULL
Condition (Forested Lacustrine)	<1.96	2.78	3.59	8.32	NULL
Condition (Forested Other)	<1.98	2.87	4.21	8.32	NULL
Condition (Forested Riverine)	<1.44	2.00	2.87	8.32	NULL
Condition (Non-Forested Lacustrine)	<1.93	2.88	4.76	8.32	NULL
Condition (Non-Forested Other)	<2.36	3.43	5.24	8.59	NULL
Condition (Non-Forested Riverine)	<1.74	2.51	3.74	8.42	NULL
Planned LDI	<3.83	6.80	7.47	8.33	8.66

Wetland Loss

Screening criteria for loss of all types of wetlands is shown in Figure 18. As shown in the map, the eastern portion of the study area contains the 1 km^2 grid cells with the greatest amount of loss, or poorest condition. Southeastern areas of the study area contain 1 km^2 grid cells with the lowest amount of loss and/or gain, or best condition. Other areas of the study area are highly variable in terms of loss.

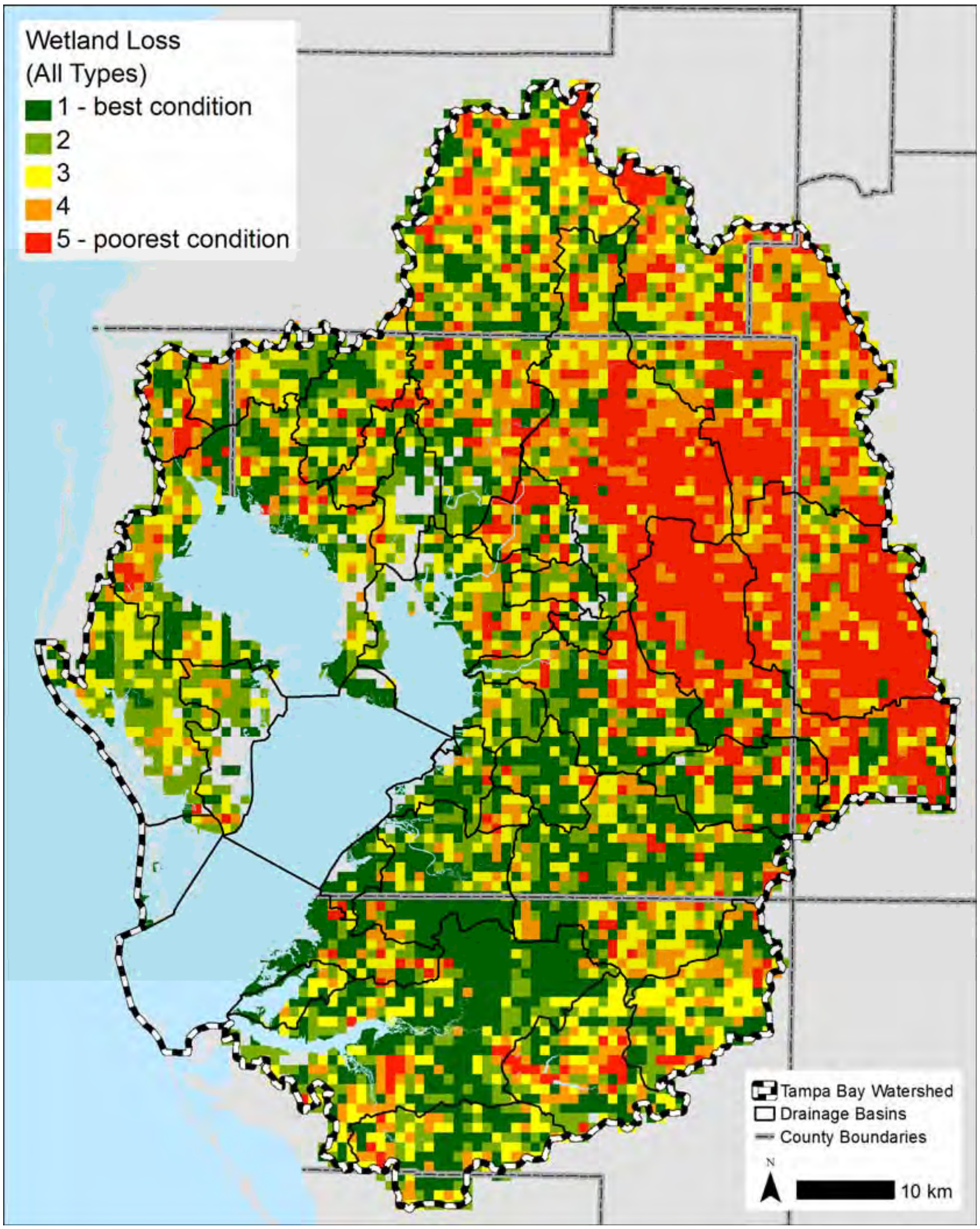

Figure 18. Screening Tool: Loss of All Wetlands.

Wetland Loss by Type

Screening criteria for loss of specific types of wetlands is shown in Figure 19 through Figure 24. The patterns of loss shown within the 1 km^2 grid cells on these maps are highly variable. In general, the eastern and northeastern portion of the study area suffered a large amount of loss of all wetland types. Other patterns vary by type of wetland.

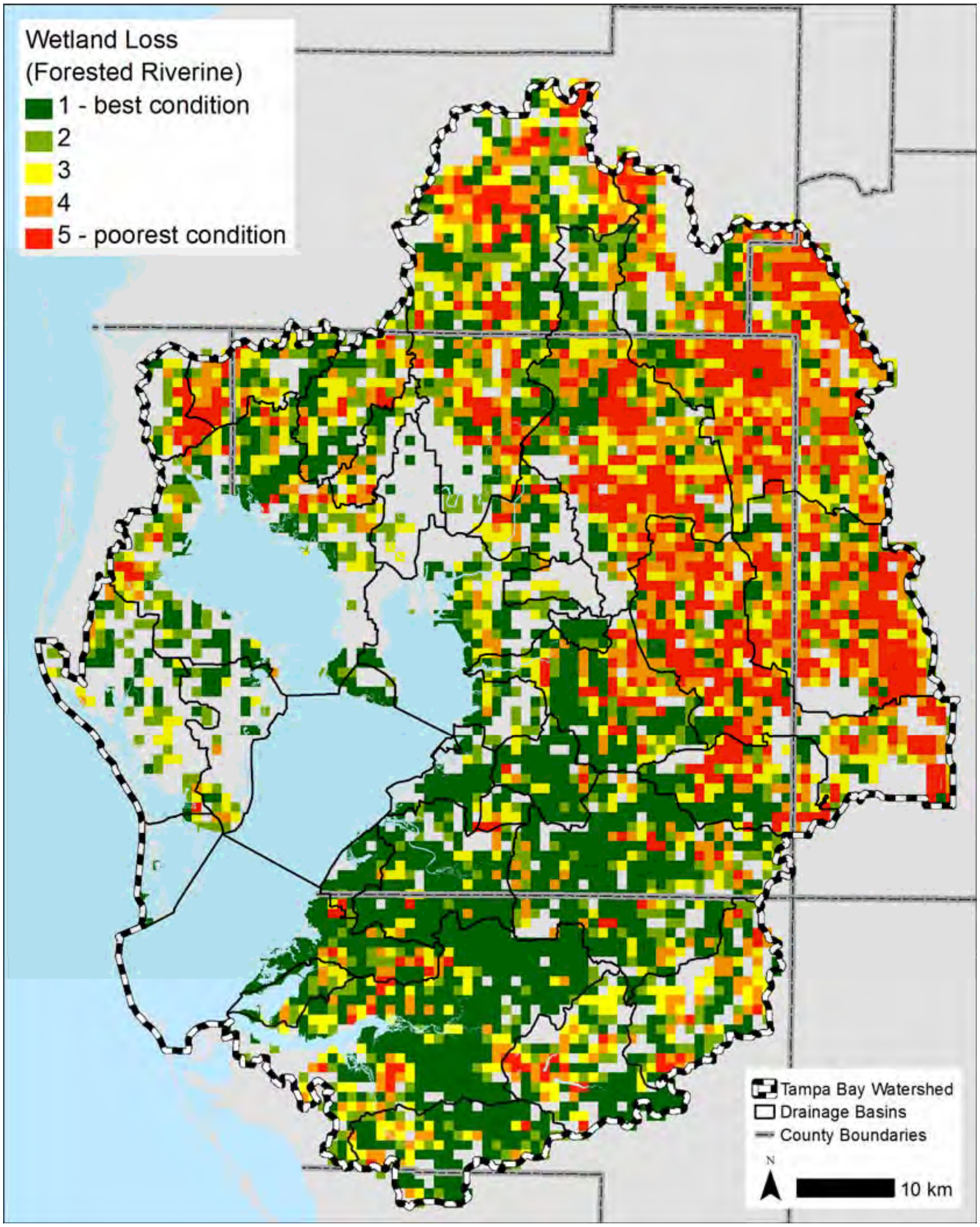

Figure 19. Screening Tool: Loss of Forested Riverine Wetlands.

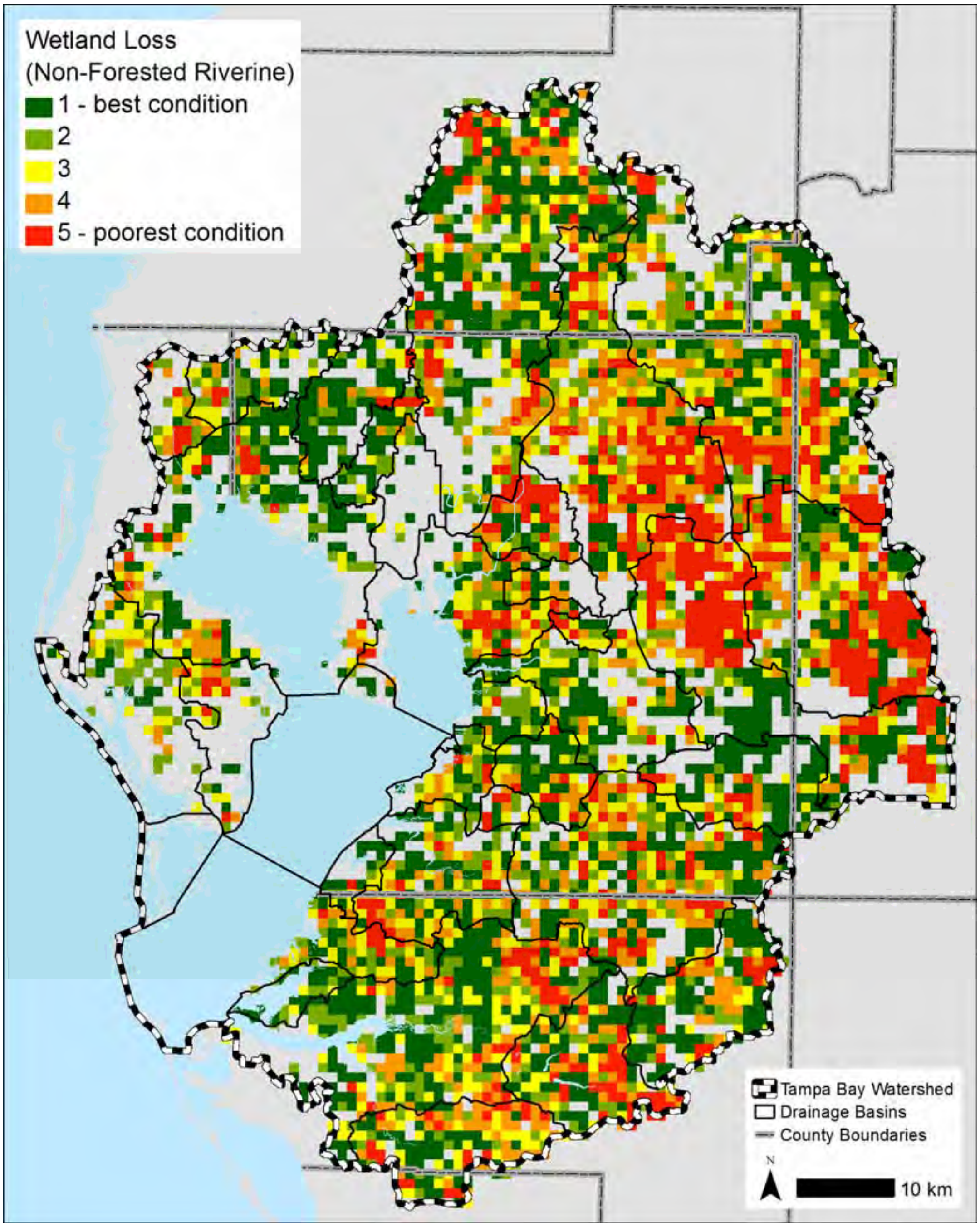

Figure 20. Screening Tool: Loss of Non-Forested Riverine Wetlands.

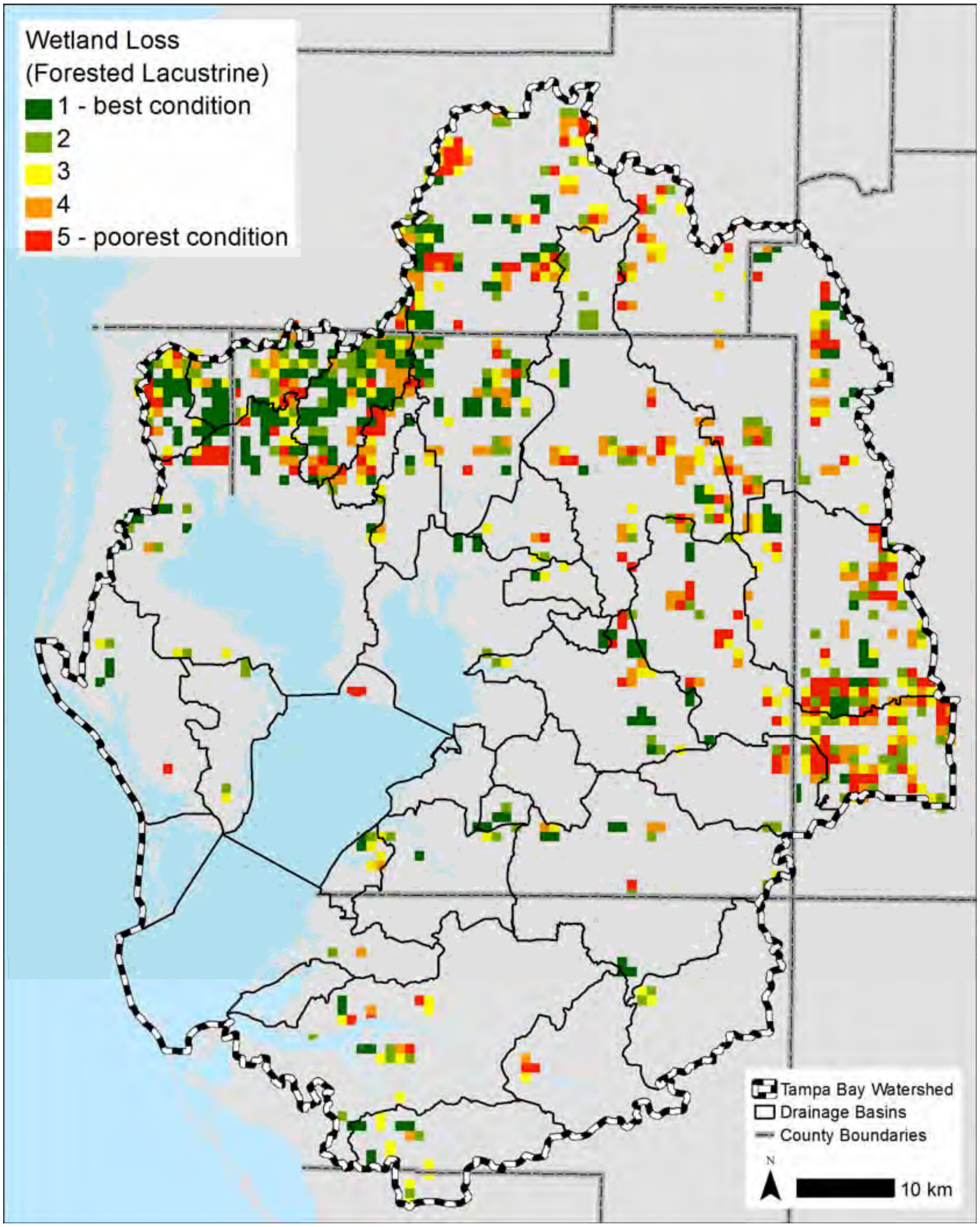

Figure 21. Screening Tool: Loss of Forested Lacustrine Wetlands.

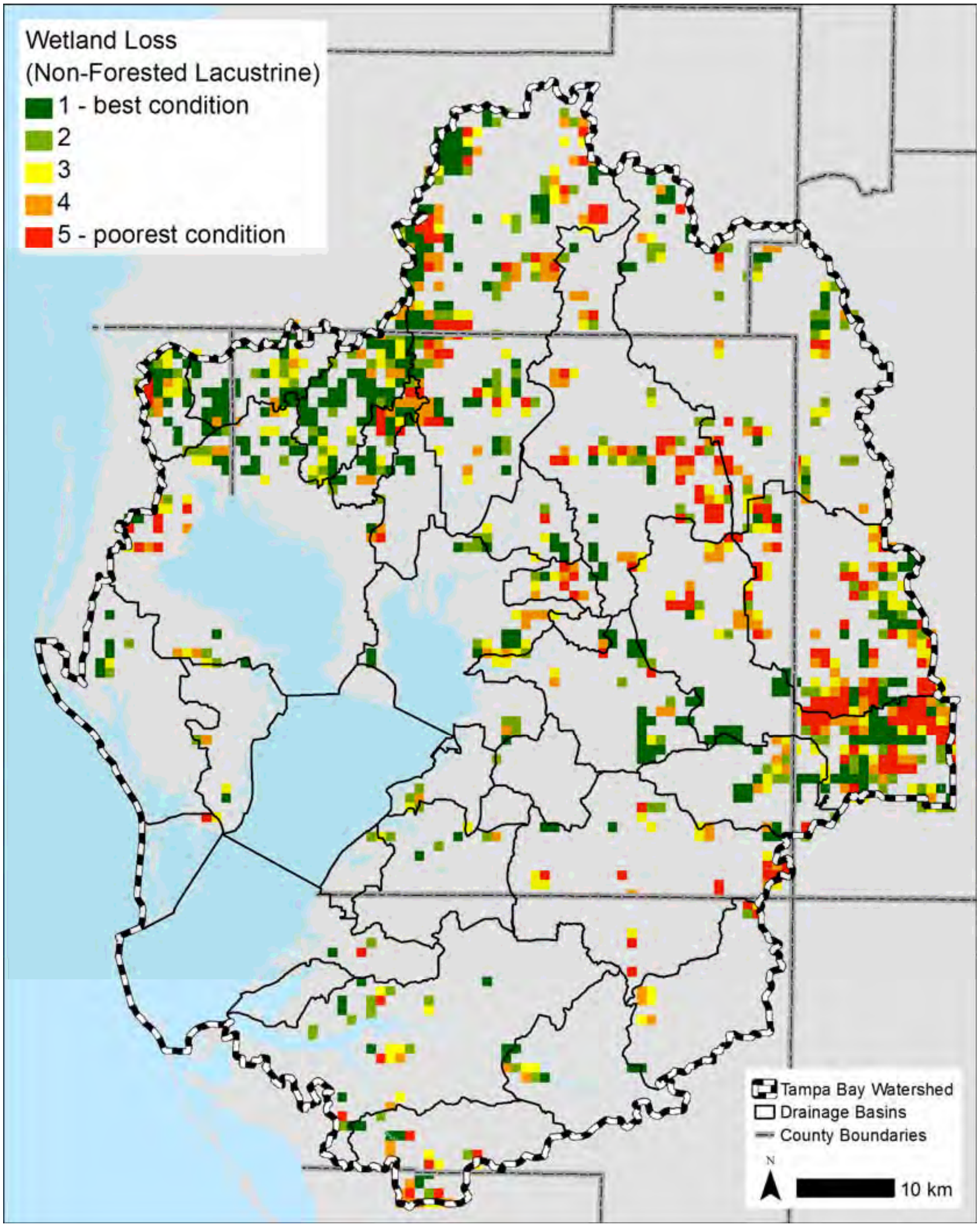

Figure 22. Screening Tool: Loss of Non-Forested Lacustrine Wetlands.

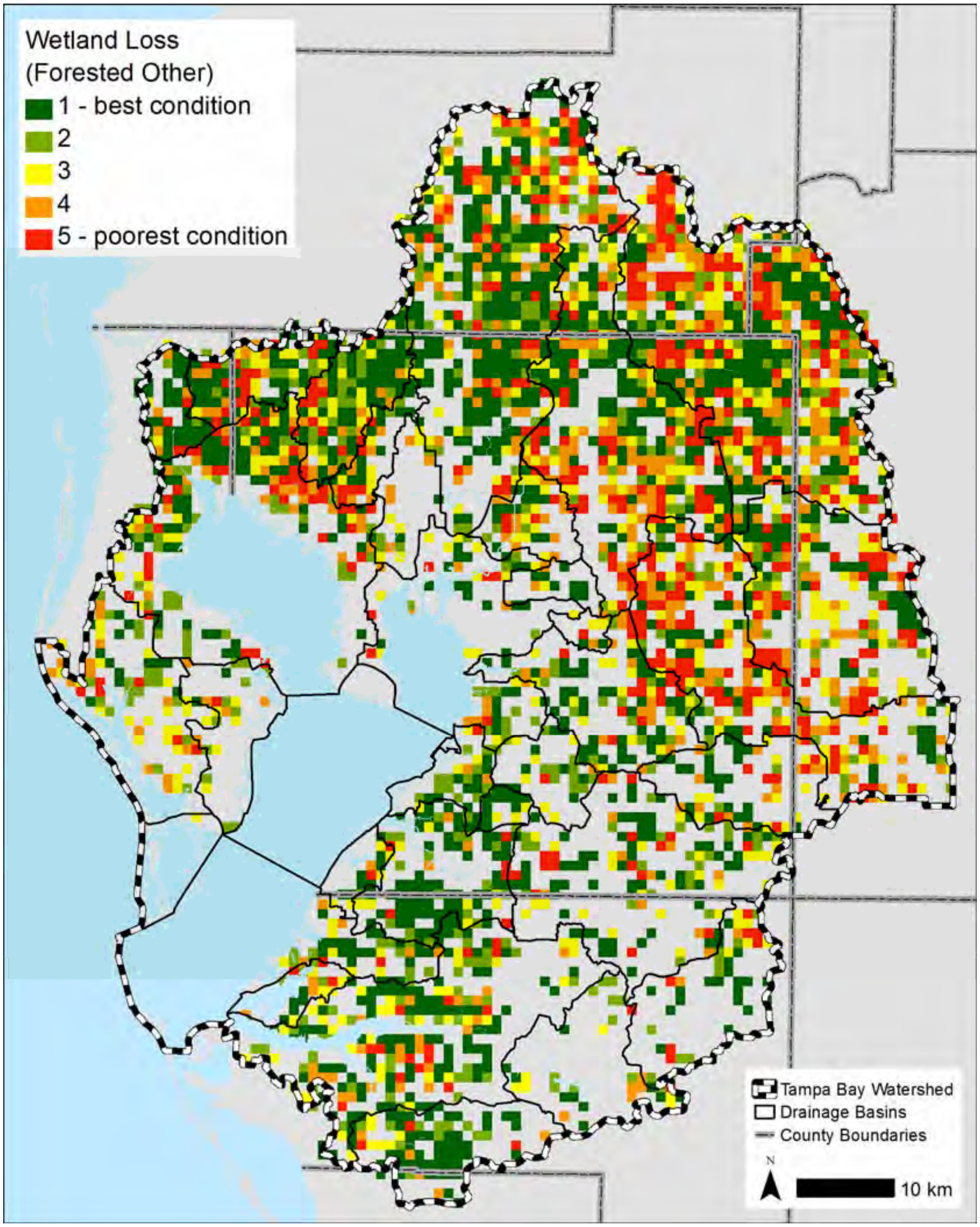

Figure 23. Screening Tool: Loss of Forested Other Wetlands.

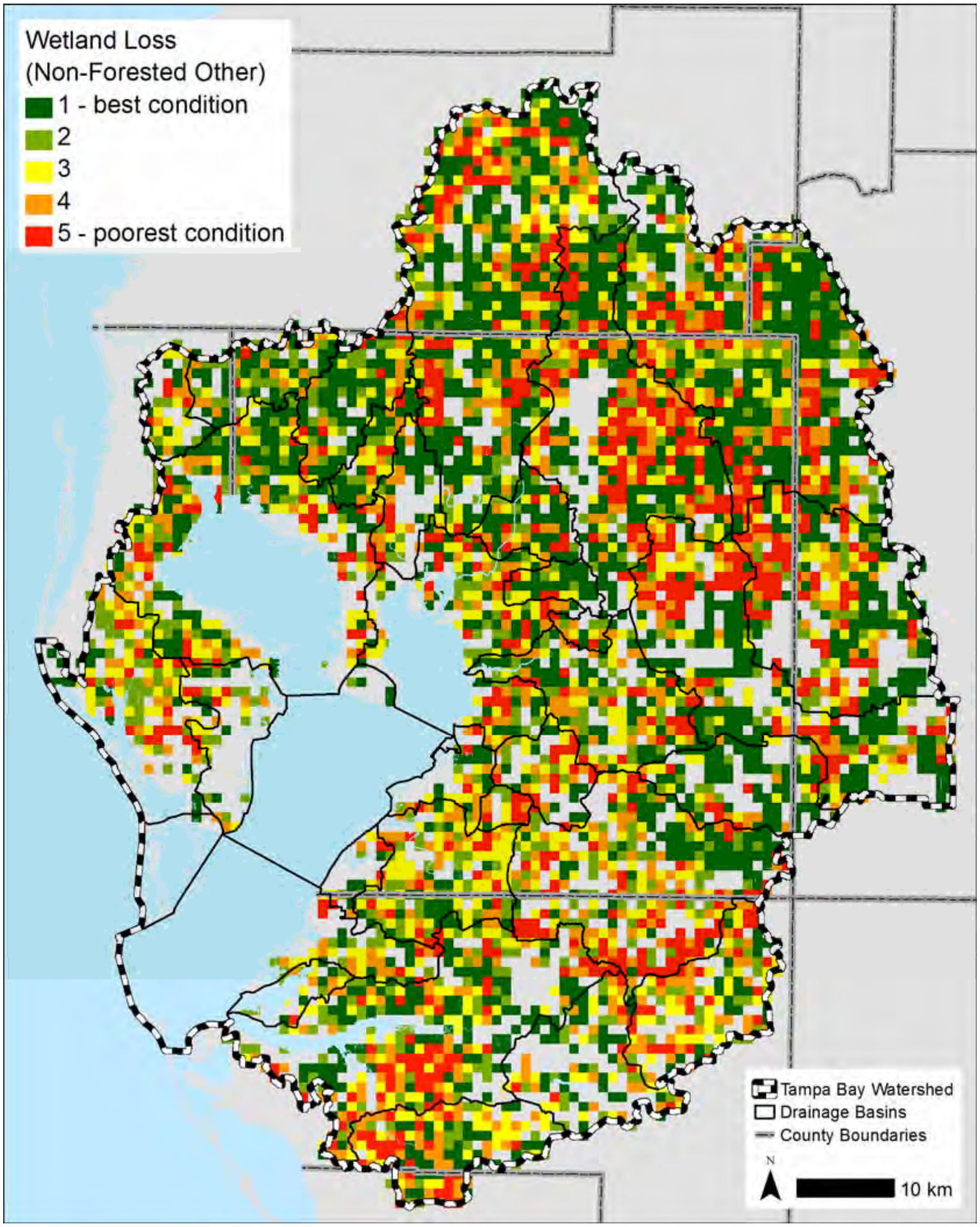

Figure 24. Screening Tool: Loss of Non-Forested Other Wetlands.

Wetland Area

Wetland area remaining screening criteria is shown in Figure 25. As shown on the map, the areas of St. Petersburg and Tampa are in the poorest condition because they have no remaining wetlands within many 1 km^2 grid cells. The best condition, or largest area of wetlands remaining, is in the northeast portion of the study area, near the Hillsborough River.

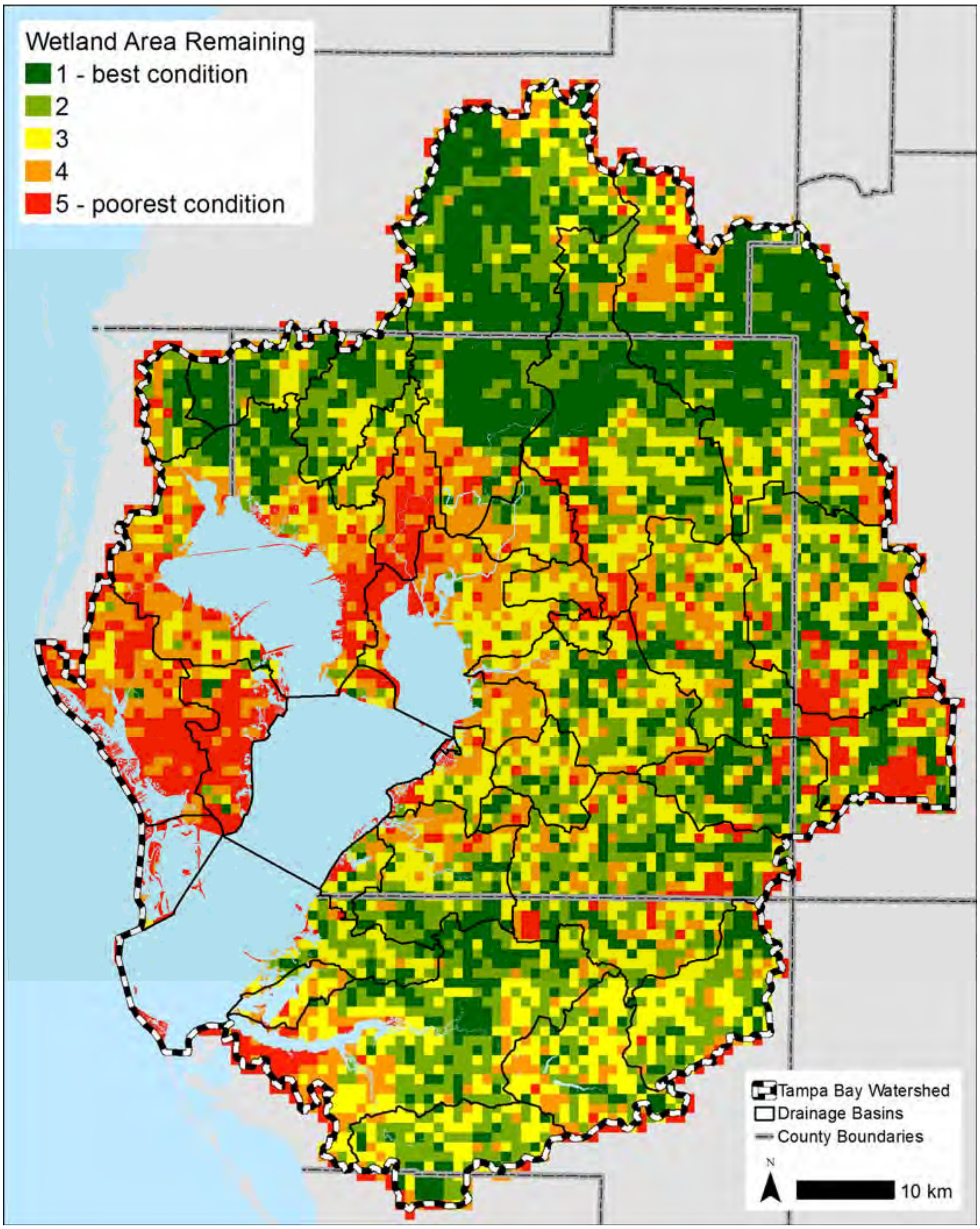

Figure 25. Screening Tool: Wetland Area.

Wetland Condition

Wetland condition for all types of wetlands is shown in Figure 26. Values 1-4 are used to indicate the condition in areas that had wetlands. Areas without wetlands are considered to be the poorest condition and therefore assigned a value of 5. Large areas of wetlands in the best condition are located in the southern, northern and northeastern portions of the study area. Wetland condition is worst in many areas of the urban areas of Tampa and St. Petersburg, as well as in the mined areas in the east.

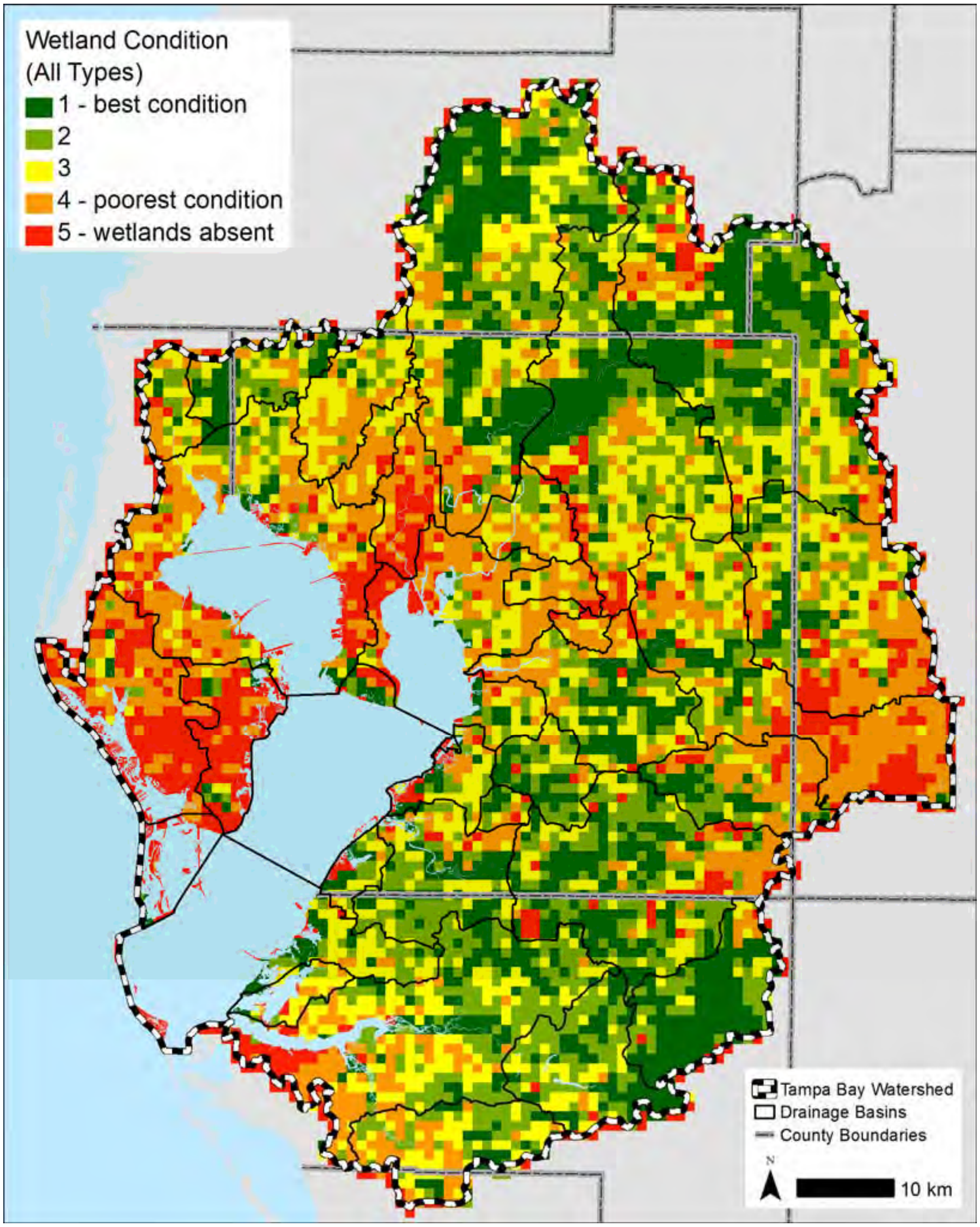

Figure 26. Screening Tool: Condition of All Wetlands.

Wetland Condition by Type

Wetland condition for each individual type of wetlands is shown in Figure 27 through Figure 32. Although the pattern of best and worst condition for each type of wetland is generally similar to the map of all types of wetlands (Figure 26), many 1 km^2 grid cells throughout the study area lack forested riverine wetlands (i.e., 5).

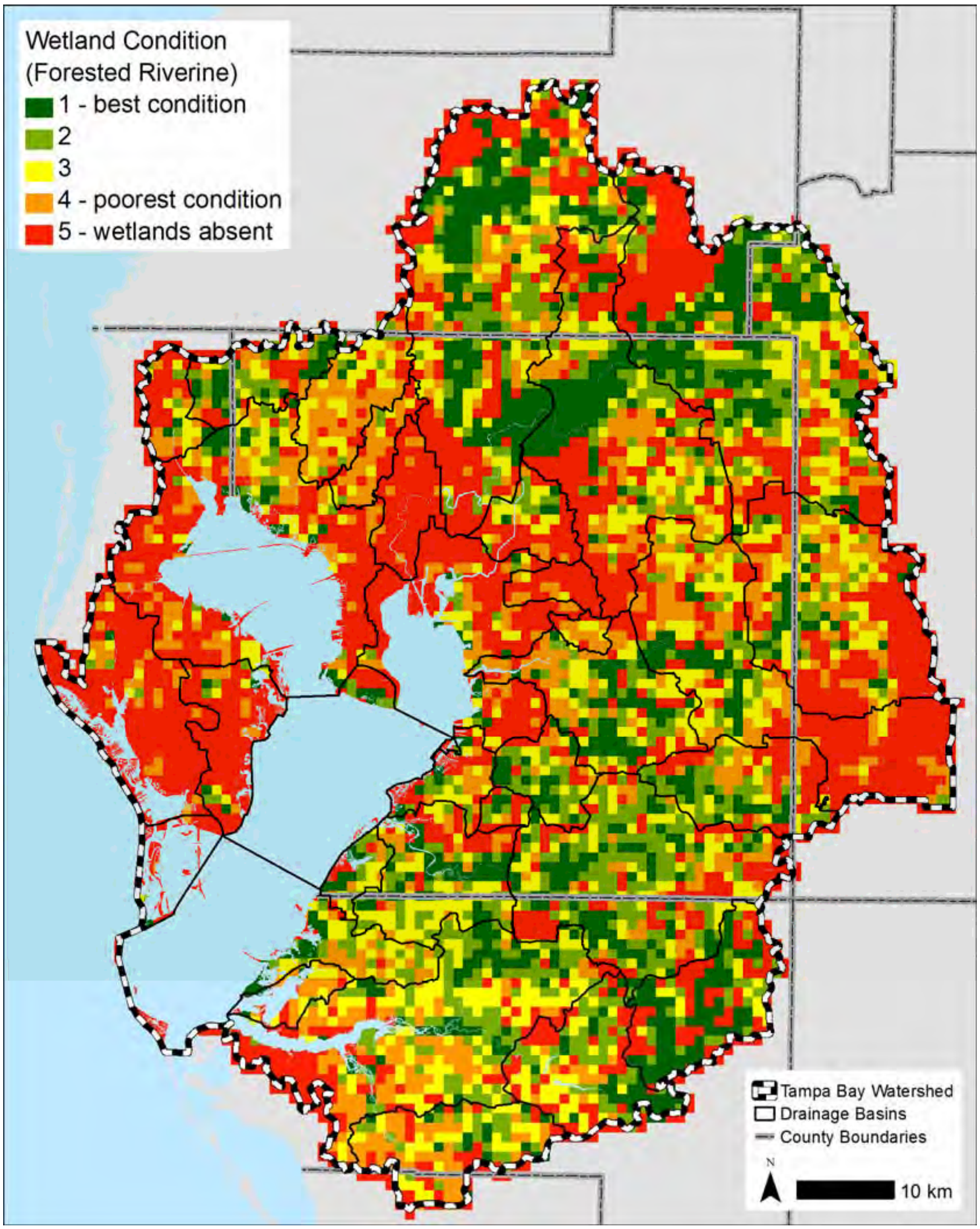

Figure 27. Screening Tool: Condition of Forested Riverine Wetlands.

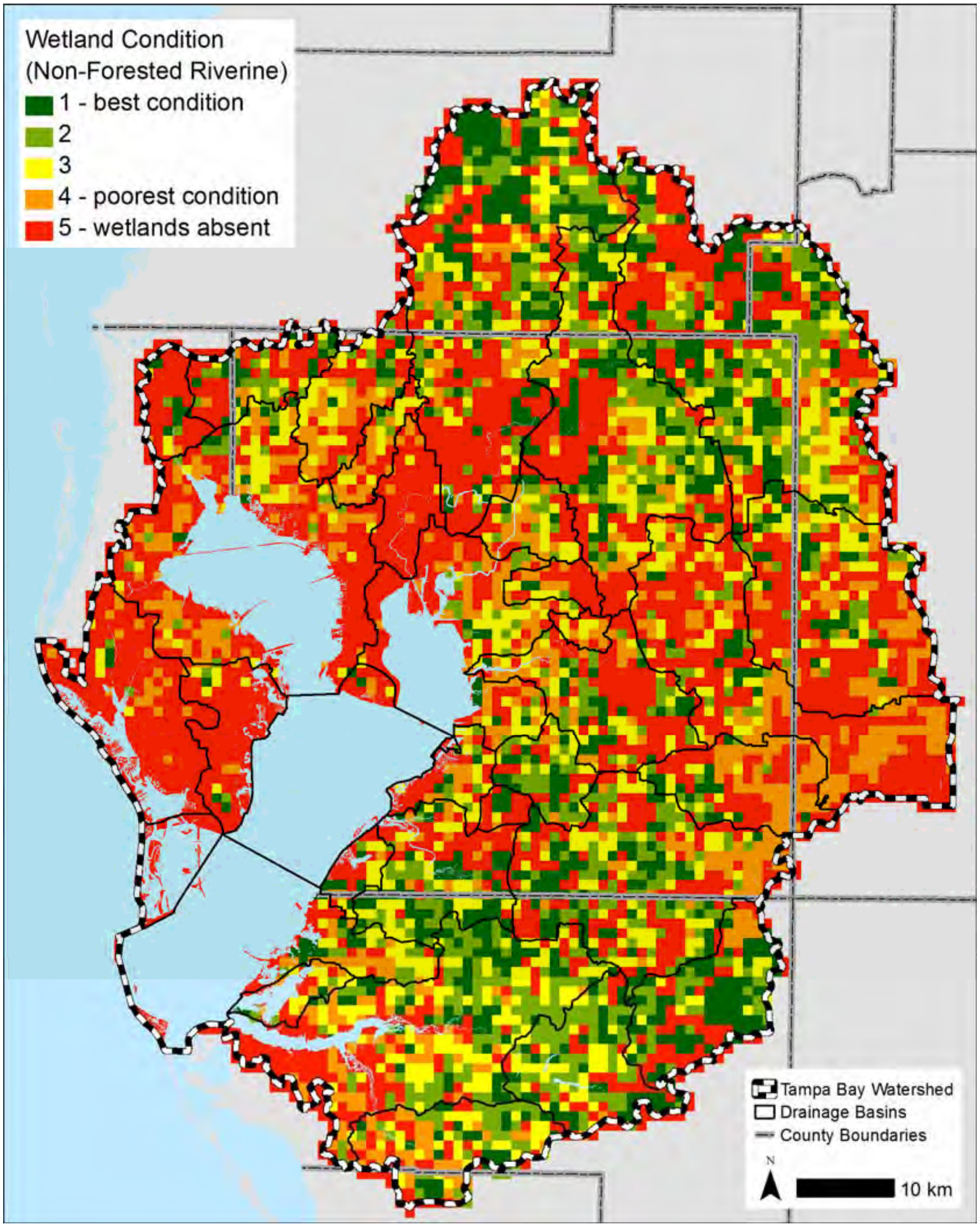

Figure 28. Screening Tool: Condition of Non-Forested Riverine Wetlands.

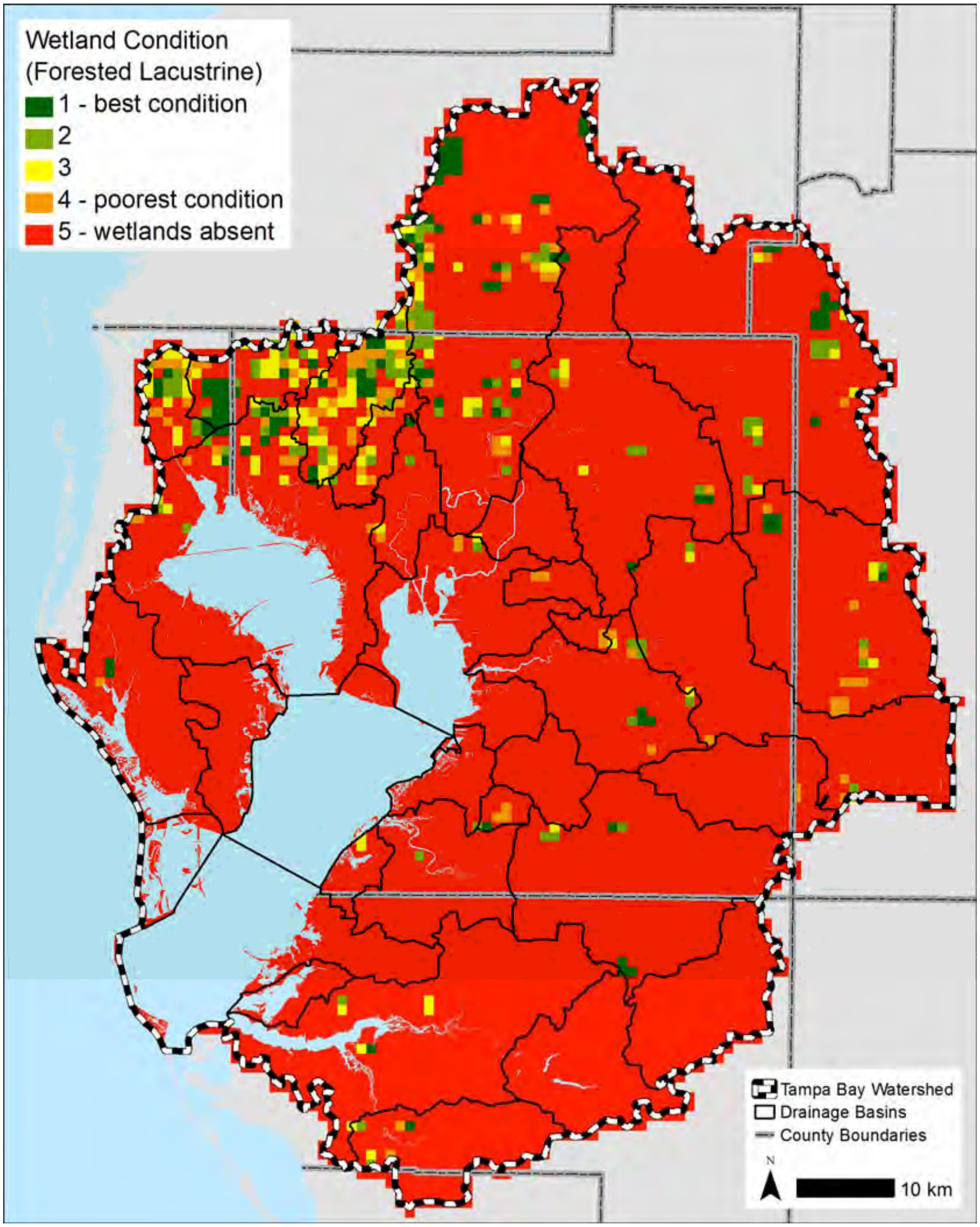

Figure 29. Screening Tool: Condition of Forested Lacustrine Wetlands.

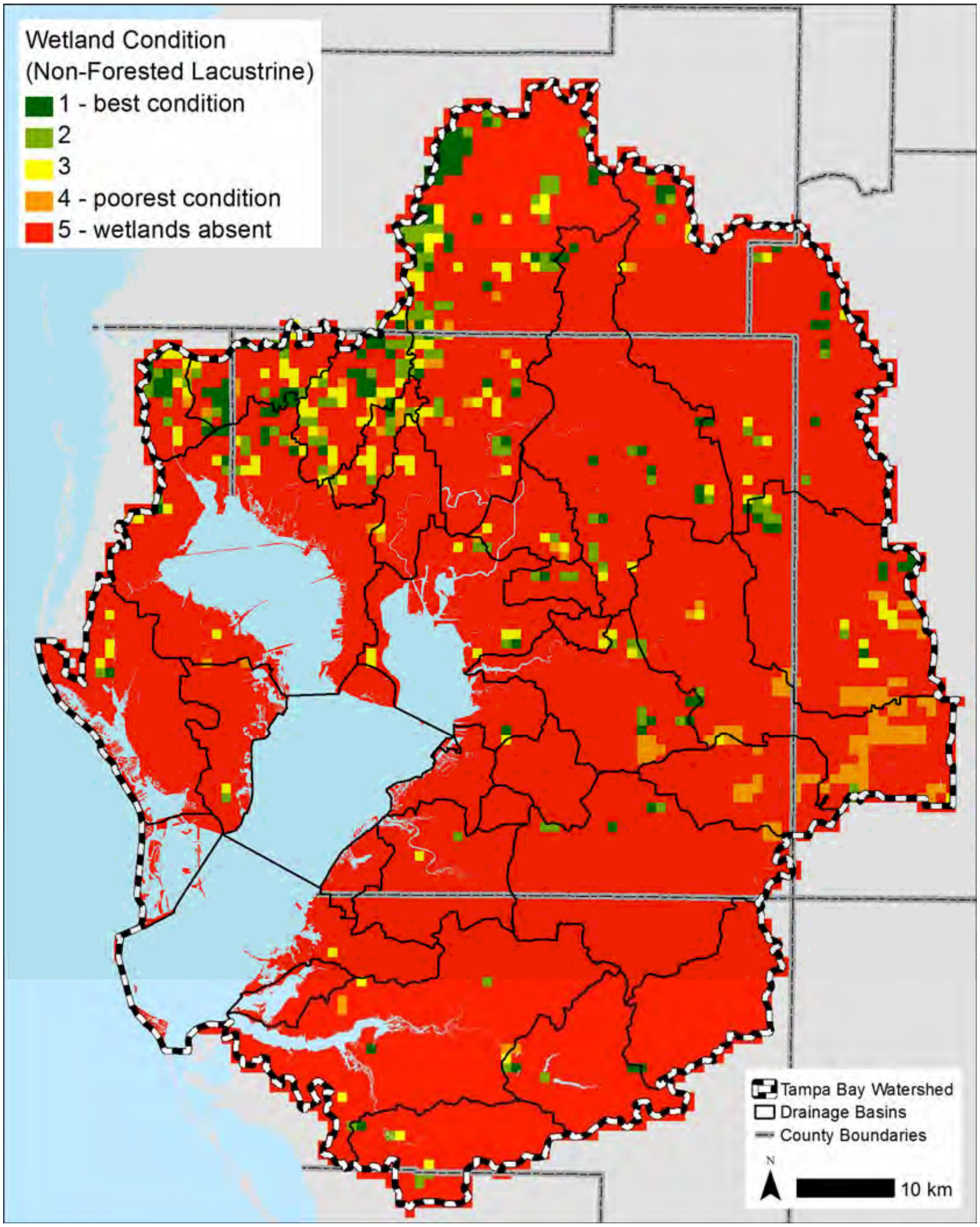

Figure 30. Screening Tool: Condition of Non-Forested Lacustrine Wetlands.

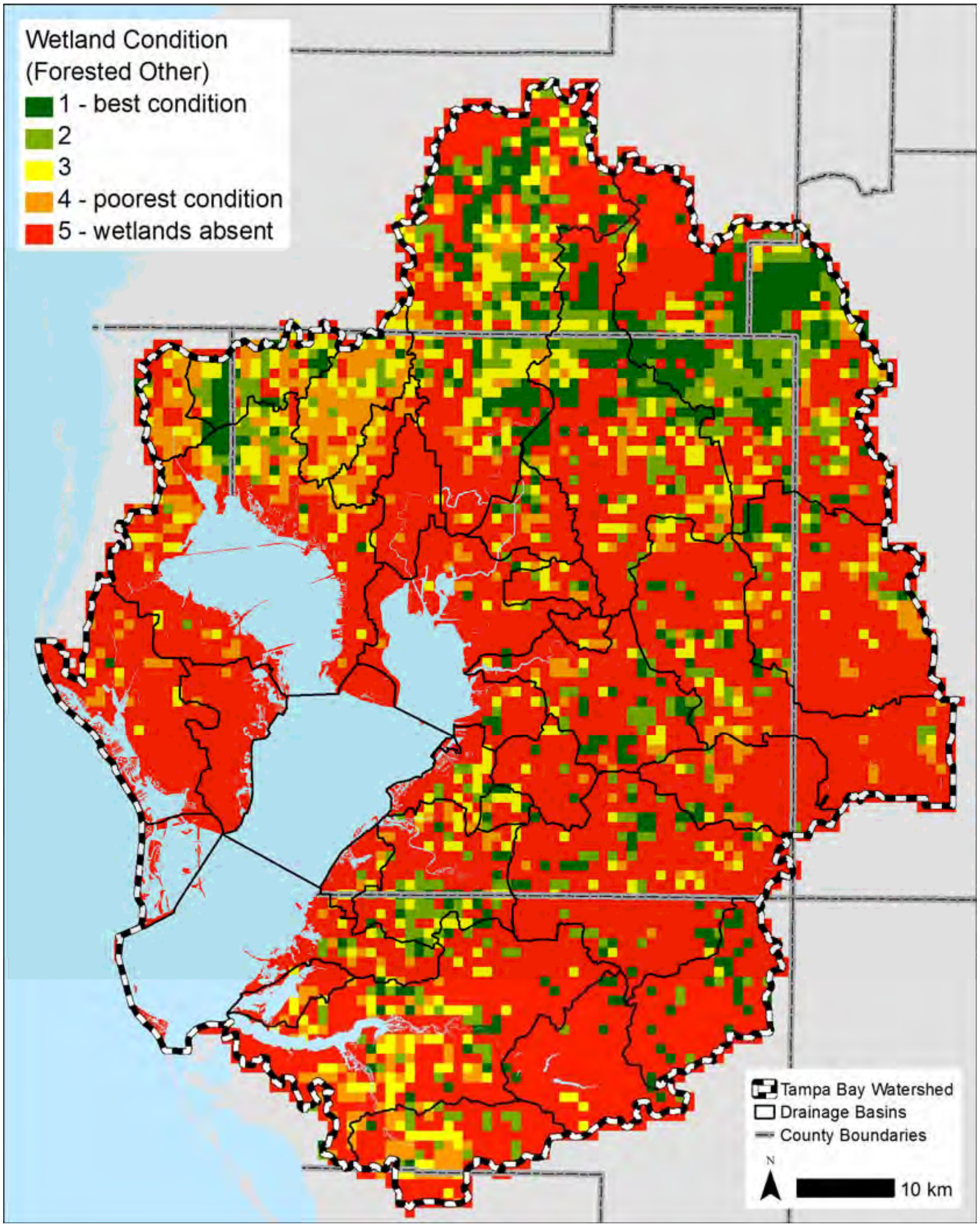

Figure 31. Screening Tool: Condition of Forested Other Wetlands.

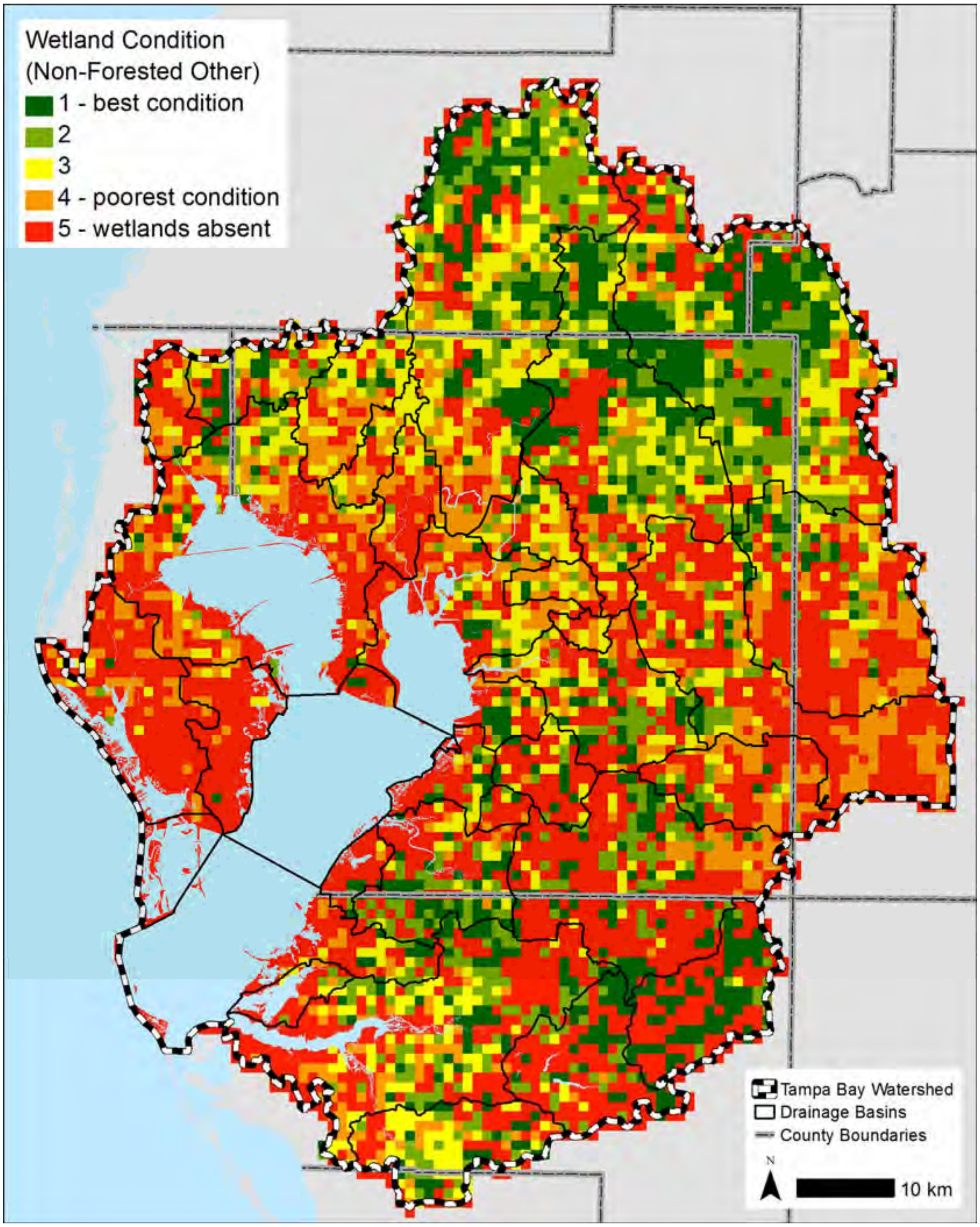

Figure 32. Screening Tool: Condition of Non-Forested Other Wetlands.

Wetland Hydrologic Connectivity

Figure 33 shows the screening criteria for hydrologic connectivity. The map shows 1 km^2 grid cells with riverine wetlands present (i.e., 1) and absent (i.e., 0). As a result of the large networks of creeks, streams and rivers in the study area, many of the grid cells have at least one riverine wetland.

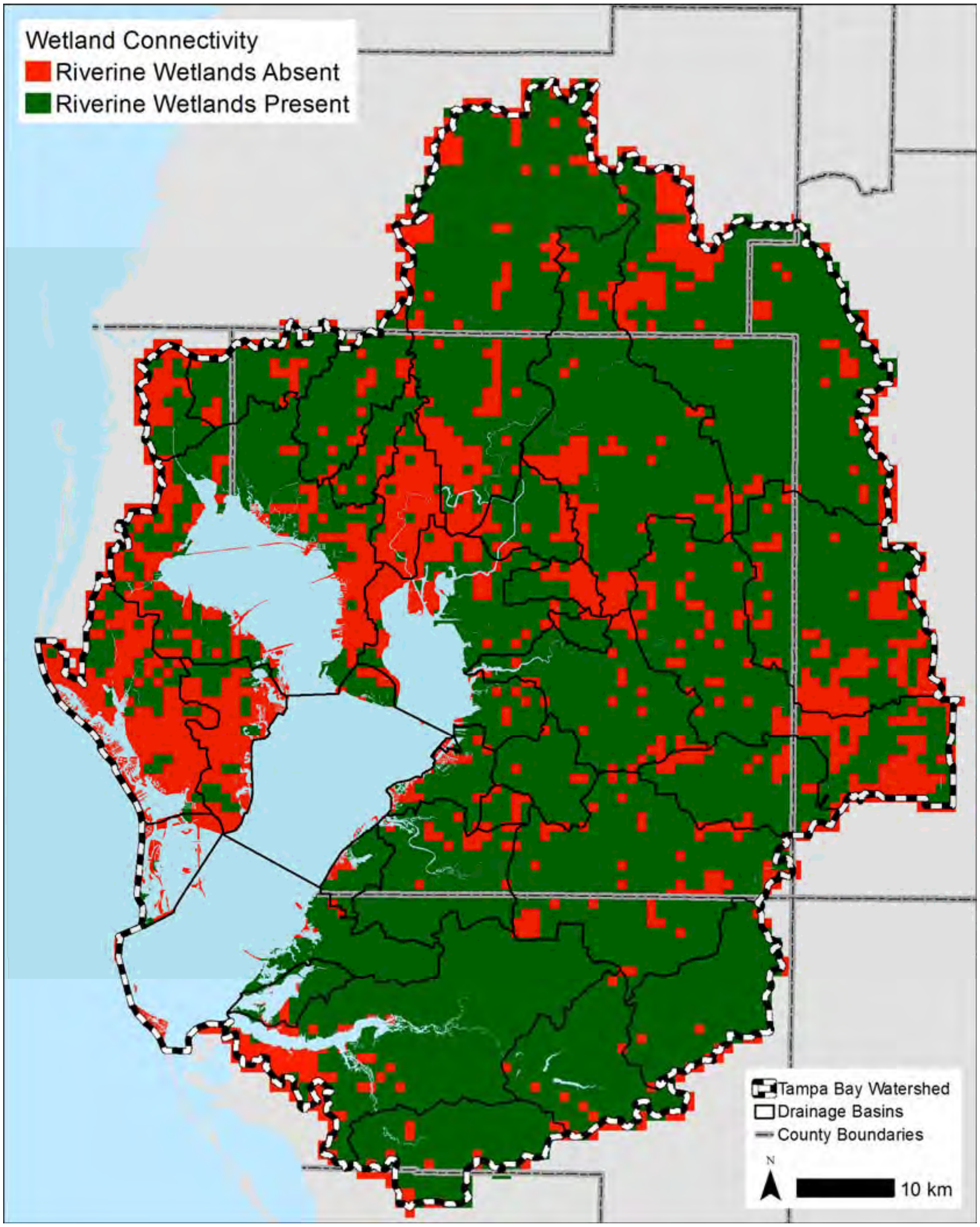

Figure 33. Screening Tool: Connectivity of All Wetlands.

Wetland Mitigation Opportunity / Planned Development Impact

Figure 34 shows the map of best and worst conditions as indicated by the future planned development (i.e., Planned LDI). Because the scores are based on the distribution of LDI values specific to the planned LDI data layer, the best and worst condition may differ greatly from the existing wetland condition maps of Figure 26 through Figure 32.

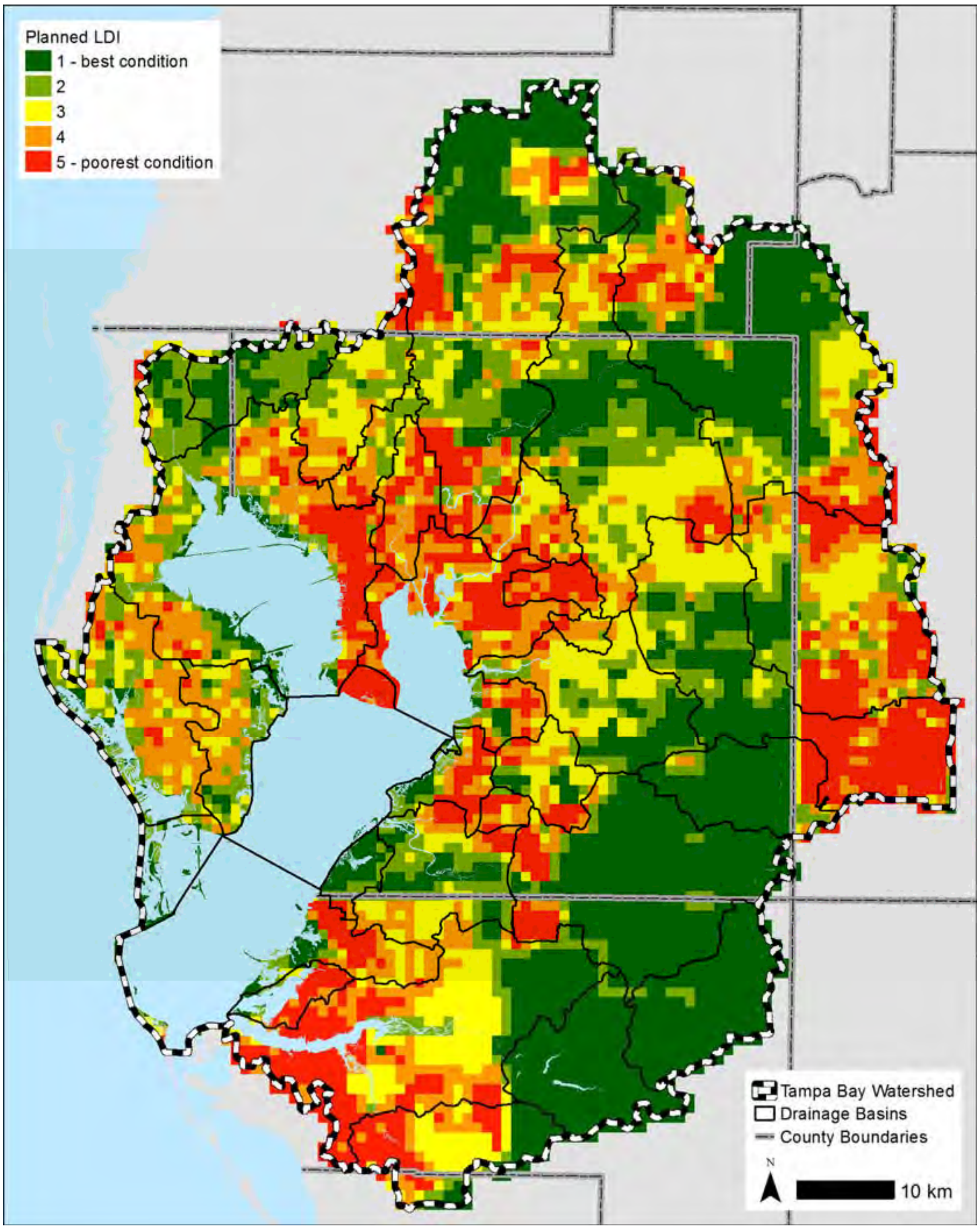

Figure 34. Screening tool: Planned Development Impact (LDI).

Conclusions

The overall objectives of this project were threefold: (1) assess the current status of wetlands within the Tampa Bay Watershed and provide a historical perspective on the losses and gains in wetlands since 1950, (2) establish criteria for addressing which wetlands should be considered for restoration and what the restoration goal should be and (3) suggest tools that management and/or permitting agencies might use to rank wetlands within their jurisdictions for restoration. Such an approach was designed to add complexity, and in a sense uncertainty, progressively to the overall questions leading to increased importance of agencies in the ultimate decision process.

The criteria for wetland loss/gain since 1950 were physical and biological structure, with emphasis on wetland size classes, wetland types, total numbers of systems lost and position within the wateshed. While in line with similar surveys of wetland loss internationally, this strictly structural approach does not provide information on how wetlands have changed in function within the watershed over time. In addition, the role of wetlands created as part of development or mitigation cannot be distinguished from that of “natural” systems in general or such systems that have been hydrologically isolated within the landscape or connected to major development.

Criteria for identifying wetlands to be considered for restoration utilized both structural and functional criteria. Initially, structural elements were considered, including rareness of the wetland type being considered and historical loss of total wetlands by sub-basin within the Tampa Bay watershed. The conditional assessment provided increased complexity to the evaluation, but was an important step toward determining which wetlands were candidates for preservation (e.g., those with low LDI scores) or restoration (e.g., those with moderate to high LDI scores). Similarly, the economic analysis provided increased complexity to the evaluation, but was an important step toward determining locations where preservation or restoration efforts might best be prioritized, given planned development impacts. Connectivity is seen as a secondary criteria that may be of particular interest if one is interested in federal regulatory jurisdiction under the Clean Water Act following the Supreme Court decisions of *SWANCC v US* (2001) and *Rapanos v US* (2006) or in the water quality effects of freshwater wetlands in the Tampa Bay Watershed on Tampa Bay. In this regard, the focus is on hydrological connectivity, because flowing water is a primary mechanism by which mass, energy, and organisms move across landscapes, and because the flow of water is so central to both the federal regulatory context and the water quality in Tampa Bay. To this end, the assessment of hydrologic connectivity was based mainly on surface connectivity with the stream/river network of the watershed, although groundwater connectivity and associated interaction with the stream network was presumed to be related directly to distance from the network as well. Reasoning for this approach was that the closer the wetland to the stream network leading to Tampa Bay, the greater the influence of that wetland ultimately on nutrient loading to the bay. Throughout the analysis, it was recognized that land use was an importance factor determining the watershed function of wetlands, especially related to the extent of impervious surfaces, that had to be considered along with connectivity as a wetland selection criterion.

Selection of the ultimate restoration goal for an individual rests with the agency initiating the process, but it is suggested that, with the exception of extremely rare wetland types, restoration goals should emphasize functional rather than structural criteria. It will be nearly impossible to establish and maintain the structural integrity of a "natural" wetland within a highly urbanized landscape. As hydrology determines the success of both plant and animal species residing in a wetland, linking "protected" wetlands with the urban landscape via storm water runoff can result in hydroperiods and water levels not conducive to characteristic species. In addition, urban development presents an insurmountable physical barrier to biotic exchange with other wetlands and eliminates upland habitats needed for the successful life cycle of many amphibians. If true restoration – i.e., restoration to a pre-development state – is not possible, then mitigation goals should focus on functional criteria, seeking to best restore functional capacity to the Tampa Bay Watershed by carefully taking advantage of the preservation and restoration opportunities that remain available now and will likely remain available in the future. Obvious examples include management of storm water and sequestering of associated nutrients to lessen impacts downstream to Tampa Bay. To this end, the tools provided herein can assist in these decisions, by providing information on what types of wetlands have been lost or impacted in what locations, and what types of opportunities remain now and will likely remain in the not-too-distant future.

A number of criteria were selected from which final decisions for ranking wetlands for restoration can be performed. While a system was proposed to determine the relative importance of individual criteria, it was clearly recognized that only the agency in charge of final selection of wetlands for restoration would be able both to assess and rank the relative importance of individual criteria during the process of wetland evaluation. It must be emphasized that each wetland should be regarded as an individual case; therefore, the criteria and their relative ranking should be applied on a case by case basin.

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Appendix A: FLUCCS to LDI crosswalk used for conditional assessment

The table below provides the full crosswalk between FLUCCS codes contained within the 2007 SWFWMD LULC dataset and the LDI value assigned as an indicator of wetland condition.

Table 11. FLUCCS to LDI Crosswalk.

FLUCCS	FLUCCS Description	LDI
1100	RESIDENTIAL LOW DENSITY < 2 DWELLING UNITS	6.9
1200	RESIDENTIAL MED DENSITY 2->5 DWELLING UNIT	7.47
1300	RESIDENTIAL HIGH DENSITY	8.66
1400	COMMERCIAL AND SERVICES	8.59
1500	INDUSTRIAL	8.32
1600	EXTRACTIVE	8.32
1650	RECLAIMED LAND	8.32
1700	INSTITUTIONAL	8.07
1800	RECREATIONAL	4.38
1820	GOLF COURSES	6.92
1900	OPEN LAND	1.83
2100	CROPLAND AND PASTURELAND	3.41
2140	ROW CROPS	4.54
2200	TREE CROPS	3.68
2300	FEEDING OPERATIONS	7
2400	NURSERIES AND VINEYARDS	3.68
2500	SPECIALTY FARMS	7
2550	TROPICAL FISH FARMS	7
2600	OTHER OPEN LANDS <RURAL>	2.02
3100	HERBACEOUS	2.02
3200	SHRUB AND BRUSHLAND	2.02
3300	MIXED RANGELAND	2.02
4100	UPLAND CONIFEROUS FOREST	1
4110	PINE FLATWOODS	1
4120	LONGLEAF PINE - XERIC OAK	1
4200	UPLAND HARDWOOD FORESTS - PART 1	1
4340	HARDWOOD CONIFER MIXED	1
4400	TREE PLANTATIONS	1.58
5100	STREAMS AND WATERWAYS	1
5200	LAKES	1
5300	RESERVOIRS	4.38
5400	BAYS AND ESTUARIES	1
5720	GULF OF MEXICO	1
6100	WETLAND HARDWOOD FORESTS	1
6110	BAY SWAMPS	1
6120	MANGROVE SWAMPS	1
6150	STREAM AND LAKE SWAMPS (BOTTOMLAND)	1
6200	WETLAND CONIFEROUS FORESTS	1
6210	CYPRESS	1
6300	WETLAND FORESTED MIXED	1
6400	VEGETATED NON-FORESTED WETLANDS	1

FLUCCS	FLUCCS Description	LDI
6410	FRESHWATER MARSHES	1
6420	SALTWATER MARSHES	1
6430	WET PRAIRIES	1
6440	EMERGENT AQUATIC VEGETATION	1
6520	SHORELINES	1
6530	INTERMITTENT PONDS	1
6600	SALT FLATS	1
6600	SALT FLATS	1
7100	BEACHES OTHER THAN SWIMMING BEACHES	1
7200	SAND OTHER THAN BEACHES	1
7400	DISTURBED LAND	4.375
8100	TRANSPORTATION	8.045
8200	COMMUNICATIONS	8.32
8300	UTILITIES	8.32

Appendix B: Overview of Screening Criteria Usage

This section provides a demonstration of the use of the Wetland Screening Criteria. The demonstration is meant to serve as an example of how the criteria might be used to address basic prioritization questions. The brief instructions outlined here are written for the level of expertise of a user of geographic information systems applications, but the terminology may be specific to the ESRI ArcGIS 10 suite of applications.

Screening Criteria Project Goal: Locate potential areas for wetland restoration efforts in areas of the watershed that lost a lot of wetlands between 1950-2007, and where restoration may make a substantial contribution to wetland-based water quality treatment, but in areas that will be less impacted by future planned development.

The Wetland Screening Criteria dataset (GIS data layer name: Wetland_Screening_Criteria contains 17 separate criteria: Wetland Condition, Wetland Condition by Type of wetland (6 criteria), Wetland Loss, Wetland Loss by Type (6 criteria), Wetland Area, Wetland Hydrological Connectivity, and Wetland Mitigation Opportunity / Planned Development Impact. The GIS data layer is structured as a polygon grid with an attribute table that contains separate columns for each criterion. Record selection (i.e. selecting grid cells) based on attributes is one of the easiest GIS methods to locate potential areas that meet the project goal.

The following steps illustrate this example:

1. In this example, the screening goal might be to find wetlands that are currently in poor condition (i.e. Wetland Condition) where restoration will be beneficial. Using the attribute selection tool of the GIS application, we might select grid cells with wetland condition ranked as 4 or 5 (on a scale of 1=best condition and 5=worst condition).
2. A second goal might be to focus on portions of the watershed that lost a relatively large amount of wetland area, such that providing restored wetlands to the area might make a relatively large improvement to the water quality treatment capacity of the sub-basin. Using the “remove from selection” attribute selection tool of the GIS application, we would select grid cells where wetland loss was not the worst (select wetland loss = 4 or 5). The result after the remove from selection query would be grid cells with wetlands of condition 4 or 5 where the grid cell lost substantial amounts of wetland between 1950-2007.
3. Finally, we want to invest in restoration in areas where the land is not planned for extensive land use densification. Although one might argue with this strategy, the example suggests that we would not want to invest in restoration where future surrounding impacts would negatively impact the wetland. In this case, we wish to only consider grid cells where Planned LDI is the best condition (i.e. a score of 1 or 2). Using the “remove from selection” query, we would select Planned LDI values of worse than 1 or 2 (i.e., greater than 2).

The final result would meet the three goals of our analysis. Figure 35 provides a map of the grid cells remaining after the three-step selection process illustrated by the example. The Target Areas are shown as the selected grid cells that met all three criteria.

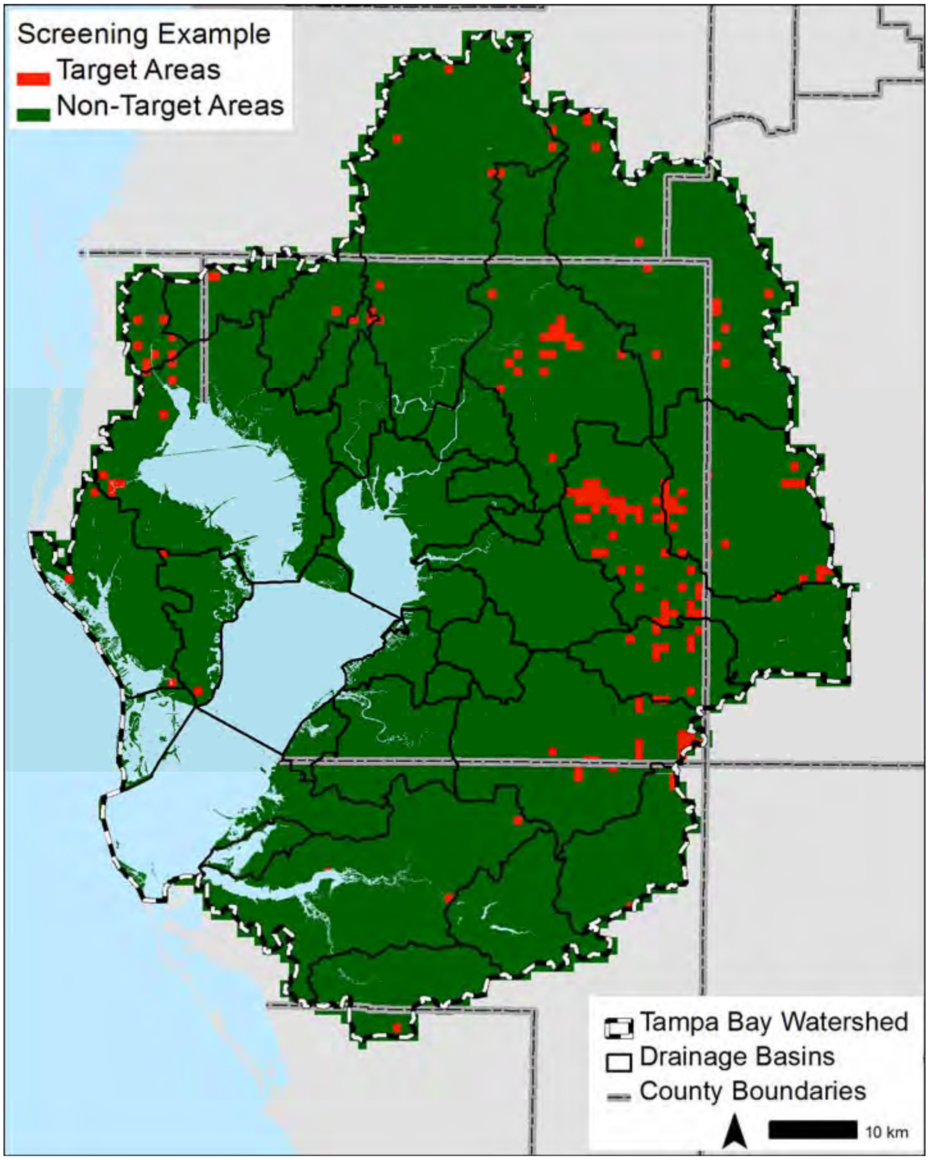

Figure 35. Target areas selected following screening criteria example.

Appendix B

Low Impact Land Development Strategies and Stormwater Regulations Designed to Support Improvements in Water Quality and Enhancement of Wetland Habitats in the Urbanized Pinellas County Environment

Appendix B

Low Impact Land Development Strategies and Stormwater Regulations Designed to Support Improvements in Water Quality and Enhancement of Wetland Habitats in the Urbanized Pinellas County Environment

Appendix: Pinellas County Stormwater Management Manual

This product will be available in August 2015 through Pinellas County Website (www.pinellascounty.org) and the Tampa Bay Estuary Program Technical Website (www.tbeptech.org)

The purpose of this supplemental task was to support development of a stormwater management manual for Pinellas County to address water quality improvement and habitat preservation/restoration goals. Grant funds through this project partially funded development of the manual.

Project Rationale: Pinellas County is an urban coastal county, located on a small peninsula between Tampa Bay and the Gulf of Mexico, where the land development emphasis has shifted from “greenfield” development to urban infill and redevelopment, as essentially, the County is built-out today. Much of the County had experienced its first wave of development by the 1970s, well before stormwater and habitat/wetland management regulations and protections were in place. The Pinellas County Comprehensive Plan, and regulatory mandates require new approaches to the traditional development strategy, and place an emphasis on each redevelopment project contributing incrementally to improvement of the County’s environmental condition. With the inception of the Clean Water Act, the creation of a Master Drainage Plan, and adoption of the County’s Comprehensive Plan in 1989, Pinellas County initiated a more integrated approach to flood control, water quality and habitat management. With a major update to the Comprehensive Plan in 2008, the policy commitment to protecting and improving the ecological function, balance and connectivity of the County’s marine, estuarine and upland environment was reinforced, as was the commitment to partner with the Tampa Bay Estuary Program to address common management and habitat restoration goals for the Tampa Bay watershed.

The impact of both the Municipal National Pollutant Discharge Elimination System (NPDES) permit requirements and the number of impaired water bodies with Total Maximum Daily Loads (TMDLs) within Pinellas County create an even greater need to reduce stormwater pollutant loads and improve water quality, wetland, and habitat conditions. Additionally, the County recognizes that non-conventional stormwater management practices are essential to encourage and support quality redevelopment, which is critical to sustaining the local economy. The County’s current Municipal NPDES permit require that jurisdictions revisit their land development codes to ensure they promote “low impact development” to effectively support water quality improvement goals, which Pinellas County is currently doing. Additionally, the Pinellas County Comprehensive Plan has been amended to propose a more holistic approach to resource management and integrated/synergistic review of stormwater, flood control, wetland, and habitat protection and enhancement considerations. In a built-out landscape, each redevelopment project therefore provides an opportunity to incrementally contribute to meeting those goals while growing a sustainable economy supported by a quality community.

Manual Content: The Pinellas County Stormwater Management Manual functions as a "tool box" of nonstructural and structural stormwater best management practices (BMPs) that can be applied to a variety of redevelopment and development opportunities to satisfy regulatory standards and reduce stormwater pollutant loadings discharged from the site. The manual will address stormwater quantity, as well as quality, making it a comprehensive stormwater management manual. This will help to improve the ecological value of the individual site and contribute to an overall benefit for the county's water resources and natural environment.

The manual provides technical guidance and design specifications for stormwater management practices, especially stormwater best management practices (BMPs) used to treat stormwater, in compliance with applicable Pinellas County codes designed to prevent discharges that cause or contribute to violations of State water quality standards.

The manual will contain the following chapters:

1. Introduction;
2. Evaluating and Master Planning a Site;
3. Stormwater Quality Permitting Requirements;
4. Stormwater Quantity/Flood Control Requirements;
5. Catalog of Stormwater Best Management Practices; and
6. Case Studies.

Appendix C

Freshwater Wetland Gains and Losses in Manatee County

Appendix C

Freshwater Wetland Gains and Losses in Manatee County

Appendix: Supplemental Manatee County Wetland Change 1950s to 2007

(Data can be obtained by contacting staff at TBEP, lcross@tbep.org or sherwood@tbep.org)

The purpose of this supplemental task was to develop additional spatial datasets for the geographic extent of Manatee County following the same protocols used for the *Prioritizing Habitat Restoration Goals in the Tampa Bay Watershed* (Wetland) project. Staff and students at the Florida Center for Community Design and Research at the University of South Florida (University) conducted several tasks necessary in order to develop the following datasets for Manatee County: georeferenced 1950s aerial imagery; 1950s wetland layer; 2007 wetland layer; 1950-2007 wetland change data layer; Landscape Development Index; wetland criteria screening tool data layer; and map graphics for all of the 17 criteria figures, wetland change figure, and wetland condition figure. All protocols followed those described in the QAPP and final Wetland project report. All data layers and figures were developed to include the total area of the Tampa Bay Watershed plus the area of Manatee County (with a ½ section buffer around the County). Data layers were delivered as ArcGIS 10 geodatabases in the same projection as the original project (i.e., NAD1983 HARN UTM Zone 17N).

Task 1: Acquire and georeference 1950s aerial imagery
The University acquired all available 1950s aerial images (i.e., 1948-1958 depending on availability) to cover the extent of Manatee County plus a border or one-half PLSS Section. The total images required were approximately 194 ungeoreferenced aerials. Images were organized, cropped and georeferenced. Aerial images covered the extent of the coastal areas, including barrier islands where available, even though the wetlands only included freshwater wetlands following the original project.

Deliverable: 1950s Georeferenced aerials (individual images, no metadata)

Task 2: Digitize 1950s Wetlands
The University developed a polygon dataset of 1950s wetlands using a combination of existing 1950s National Wetland Inventory data, existing data from the original Wetland project, and new data digitized from the 1950s aerial image dataset developed in Task 1. The 1950s NWI data was available for much of the coastal area. Approximately 297 PLSS Sections were digitized using the aerial imagery. The six wetland types were assigned, including: riverine forested, riverine non-forested, lacustrine forested, lacustrine non-forested, other/isolated forested and other/isolated non-forested. Quality assurance and quality control followed the original Wetland project. Following the original Wetland project, only freshwater wetlands were included.

Deliverable: 1950s 6-type Wetland layer with metadata

Task 3: Convert 2007 LULC and Conduct Change Analysis
The University acquired and extracted 2007 SWFWMD Land Use Land Cover data for the development the 2007 wetlands data layer. The University followed the same procedures as the original Wetland project, using the same lookup table, to convert FLUCCS codes in the LULC data to the six freshwater wetland types. In the few areas of Manatee County classified as "extractive" within the 2007 LULC data, the University extracted wetlands from 2008 or 2009 LULC data when the 2007 aerial images show wetlands were present. Quality assurance and quality control followed the original Wetland project.

The University also conducted a change analysis following methods used for the original Wetland project. The 1950s wetlands data was overlain with 2007 wetlands in order to calculate the type of change.

Deliverables: 2007 6-type Wetland layer with metadata
1950-2007 Wetland Change layer with metadata

Task 4: Wetland Condition and Screening Criteria

The final task was the development of wetland screening criteria data, including the creation of some intermediary datasets. The University developed the Landscape Development Intensity (LDI) index raster data layer following the same procedures used for the original Wetland project. The LDI data layer l served as a proxy for the condition of 2007 wetlands, based on the ground sampling efforts from the original project. The University also extended the wetland screening criteria 1 kilometer grid data layer developed as part of the original project to cover Manatee County. The data layer included screening criteria scores and raw number values for the same criteria used in the original project, including: Wetland Loss, Wetland Loss by Type (times six types), Wetland Area, Wetland Condition, Wetland Condition by Type (times six types), Wetland Hydrological Connectivity, Wetland Mitigation Opportunity / Planned Development Impact. In addition, the University created several of the same figures as shown in the original final report to include Manatee County, including twenty figures: 14, 15, 16, and 18-34 (refer to the document *Prioritizing Habitat Restoration Goals in the Tampa Bay Watershed*).

Deliverables: Screening Criteria data layer with metadata
LDI Raster Data with metadata
Twenty figures in 300 dpi Tiff format

Appendix D

Analysis of Soils Suitability for Wetland Mitigation

Appendix D

Analysis of Soils Suitability for Wetland Mitigation

PASCO COUNTY		
High Ridge/well drained	**Soils groups targeted for mitigation potential**	**Wetland soil groups**
6- Tavares sand, 0 - 5% slope	1- Wachula fine sand, 0 - 5% slope	8- Sellers mucky loamy fine sand
7- Sparr fine sand, 0 - 5% slope	2- Pomona fine sand	16- Zephyr muck
11- Adamsville fine sand	3- Pineda fine sand	23- Basinger fine sand, depressional
12- Astatula fine sand, 0 - 5% slope	4- Felda fine sand	29- Lacoochee complex
13- Chandler fine sand, 0-5% slope	5- Myakka fine sand	30- Okeelanta-Terra Ceia association
14- Chandler fine sand, 5 - 8% slope	9- Ona fine sand	47- Weekiwachee muck
15- Tavares-Urban land complex, 0 - 5% slope	10- Vero fine sand	52- Samsula muck
18- Electra Variant fine sand, 0 - 5% slope	17- Immokalee fine sand	55- Homosassa mucky fine sandy loam
19- Paola fine sand, 0 - 8% slope	20- Aripeka fine sand	58- Tomoka muck
24- Quartzipsamments, shaped, 0 - 5% slope **(filled/developed)**	21- Smyrna fine sand	60- Palmetto-Zephyr-Sellers complex **(mostly wetland)**
26- Narcoossee fine sand	22- Basinger fine sand	61- Pompano fine sand (**mostly wetland**)
28- Pits	27- Anclote fine sand	63- Delray mucky fine sand
31- Udalfic Arents-Urban land complex	34- Pompano fine sand	76- Bessie muck
32- Lake fine sand, 0 - 5% slope	35- EauGallie fine sand	
36- Candler-Urban land complex, 0 - 8% slope	39- Chobee soils, frequently flooded	
37- Paola-Urban land complex, 0 - 8% slope	40- Paisley fine sand	
38- Urban land **(75% structure coverage)**	43- Arrendondo fine sand, 0 - 5% slopes	
41- Pits-Dumps complex	44- Arrendondo fine sand, 5 - 8% slopes	
42- Pomello fine sand, 0 - 5% slopes	46- Cassia fine sand, 0 - 5% slope	
45- Kendrick fine sand, 0 - 5% slope	49- Blichton fine sand, 0 - 2% slope	
48- Lochloosa fine sand, 0 - 5% slope	50- Blichton fine sand, 2 - 5% slope	
53- Sparr fine sand, 5 - 8% slope	51- Blichton fine sand, 5 - 8% slope	
59- Newnan fine sand, 0 - 5% slope	54- Flemington Variant fine sand, 2 - 5% slope	
62- Kendrick fine sand, 5 - 8% slope	56- EauGallie-Urban land complex	
64- Nobleton fine sand, 0 - 5% slope	57- Vero Variant fine sand	
65- Gainesville loamy fine sand, 0 - 5% slope	67- Kanapaha fine sand, 0 - 5% slope	
66- Micanopy fine sand, 2 - 5% slope	70- Placid fine sand	
68- Lake fine sand, 5 - 8% slope	71- Anclote-Tavares-Pomello association, flooded	
69- Millhopper fine sand, 0 - 5% slope		
72- Orlando fine sand, 0 - 5% slope		
73- Zolfo fine sand		
74- Candler Variant fine sand, 0 - 5% slope		
75- Beaches		

Appendix E

ERP Regulatory Guidance Memorandum

Appendix E

ERP Regulatory Guidance Memorandum

ERP Guidance Document:
Acceptance of Non-type-for-type Mitigation to Restore the Balance of Freshwater Wetlands in Tampa Bay Watersheds

The Master Plan for the Protection and Restoration of Freshwater Wetlands in the Tampa Bay Watershed, Florida has been developed over the past three years as a cooperative project involving the Tampa Bay Estuary Program, the U.S. Environmental Protection Agency, the University of South Florida and numerous agencies, local governments and other stakeholders in the Tampa Bay area. The Plan identifies freshwater wetland losses that have occurred in the Tampa Bay area since 1950 and establishes a goal of restoring the balance of freshwater wetlands by using both publicly-funded restoration and privately-funded mitigation to increase the acreage of disproportionately impacted systems in this region. The Plan will be made accessible online in the future.

The Plan quantifies acreages and relative proportions of freshwater wetland types in 1950 compared to the 2007/2008 time period. It identifies a disproportionate loss of non-forested freshwater wetlands in all of the basins surrounding Tampa Bay. The results vary by basin and specific restoration acreage targets for each basin are identified in *Figure 1.*

	Forested Freshwater Wetland Restoration Target (in acres)	Non-Forested Freshwater Wetland Restoration Target (in acres)	Total Freshwater Wetland Target (in acres)
Alafia River Basin	871	2,199	3,070
Hillsborough River Basin	553	1,411	1,964
Little Manatee River Basin	0	5,243	5,243
Manatee River Basin	137	3,667	3,804
Tampa Bay and Coastal Areas Basin	0	4,4400	4,4400
Upper Coastal Areas Basin	54	168	222

Figure 1: Adopted restoration targets for freshwater wetlands in Tampa Bay, by ERP basin.

Mitigation is seen as a partial means to achieve the goals of the Plan[1] by facilitating the restoration/creation of disproportionately impacted wetland types. Achieving this goal, however, requires flexibility in implementing permitting requirements, specifically the acceptance of non-type-for-type mitigation when this is consistent with ERP criteria.

In determining whether it is appropriate to accept non-type-for-type mitigation, one must determine whether reasonable assurance has been provided that the Environmental Conditions for Issuance listed in Section 10.1.1 of Volume 1 of the Applicant's Handbook (AH1) are met. While applicants must provide reasonable assurance that all Conditions for Issuance are met, there is one in particular that most closely addresses the issue of type-for-type mitigation. This Condition for Issuance, listed in Rule 330.301(1)(d), F.A.C. states that "A regulated activity will not adversely impact the value of functions provided to fish and wildlife and listed species by wetlands and other surface waters." Note that this Condition for Issuance prohibits adverse impacts to the ***value of functions*** but does not prohibit adverse impacts to specific functions. Thus, when consistent with other ERP criteria, it is possible to "trade" functions and accept non-type-for-type mitigation so long as the value of the replacement functions is at least equal to the value of the lost functions.

One consideration in determining the appropriateness of non-type-for-type mitigation is found in Section 10.2.2 of AH1. This section requires reasonable assurances that a regulated activity will not impact the values of wetland and other surface water functions so as to cause adverse impacts to:

(a) The abundance and diversity of fish, wildlife, listed species, and the bald eagle (*Halieaeetus leucocephalus*), which is protected under the Bald and Golden Eagle Protection Act, 16 U.S.C. 668-668d (April 30, 2004); a copy of the Act is in Appendix F; and

(b) The habitat of fish, wildlife, and listed species.

Accepting type-for-type mitigation is the generally accepted method of meeting Section 10.2.2. In some cases, however, the abundance and diversity of fish and wildlife can be improved by directing mitigation efforts toward the replacement of habitats that are under-represented in the regional ecosystem compared to historic proportions. This is likely the case in many of the basins surrounding Tampa Bay where the disproportionate loss of non-forested freshwater wetlands is well-documented.

[1] In any case, mitigation should be considered only when the applicant has complied with the requirements of sections 10.2.1 through 10.2.1.3, above, regarding practicable modifications to reduce or eliminate adverse impacts.

One example where this concept might be implemented is when the acreage of mitigation required to offset a proposed impact to forested wetlands exceeds the acreage of the proposed impact. In this case, the abundance and diversity of fish and wildlife may be improved if the acreage of forested wetlands impacted is replaced by an equivalent acreage of forested wetlands and then non-forested wetlands are accepted to fulfill any additional mitigation requirements. This example is illustrated below:

> *Assume proposed impacts to 1 acre of forested wetlands given a UMAM score of 0.7 (i.e., Functional Loss = 0.7).*
>
> *Assume 1 acre of forested wetlands creation or restoration provides 0.43 units of Functional Gain (i.e., RFG = 0.38).*
>
> *Assume 1 acre of non-forested wetlands creation or restoration provides 0.63 units of Functional Gain (i.e., RFG = 0.56).*
>
> *The proposed Functional Loss of 0.7 could be offset by a combination of forested and non-forested creation/restoration as follows:*
>
> > *1 acre of forested wetlands creation/restoration (FG = 0.38)*
> >
> > *Plus*
> >
> > *0.57 acres of non-forested wetlands creation/restoration (FG = 0.32)*

The Applicant's Handbook provides additional guidance regarding the acceptance of non-type-for-type mitigation. Section 10.3.1.1, AH1, establishes the general premise that "In general, mitigation is best accomplished through creation, restoration, enhancement, or preservation of ecological communities similar to those being impacted." This section also recognizes that type-for-type mitigation is not a requirement, however, and states that "Mitigation involving other ecological communities is acceptable if impacts are offset and the applicant demonstrates that greater improvement in ecological value will result."

Two exceptions are specifically identified in Section 10.3.1.1, A.H. where non type-for-type mitigation is desirable:

1. The first exception addresses instances "when the area proposed to be impacted is degraded compared to its historic ecological community and hydrologic condition." In these cases the rule states that "mitigation is best accomplished through creation, restoration, enhancement or preservation of the ecological community that was historically present."
2. The second exception addresses instances when the area proposed to be impacted consists of "wetlands or other surface waters that have been altered from

their native community type." In these instances, "the historic community type at that location shall be used as a reference, unless the alteration has been of such a degree and extent that a different native community type is now present and self-sustaining."

Both of these exceptions have applicability to mitigation within the watersheds of Tampa Bay. In many cases, wetlands in the Tampa Bay region have been degraded by altered hydrology and altered fire regimes. Often, these wetlands were non-forested in their historic condition but have been colonized by trees and shrubs able to exploit these altered conditions. It may be useful to refer to historic aerial photographs to determine the historic character of wetlands in this area proposed to be impacted.

In summary, applicants may propose, and evaluators may accept, non-type-for-type mitigation when Conditions for Issuance are met and the proposed mitigation is consistent with the criteria in the Applicant's Handbook as described above. For projects located in the basins surrounding Tampa Bay, proposed mitigation that results in an increase in the proportion of non-forested wetlands should be considered to restore the balance of freshwater wetlands in these ecosystems.

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