INTRODUCTION

This Integrated Final Feasibility Report and Environmental Impact Statement (Integrated Final Report & EIS) is the result of considering and incorporating responses to the public and policy comments on the Southwest Coastal Louisiana Integrated Draft Feasibility Report and Programmatic Environmental Impact Statement released on December 13, 2013 and the Revised Integrated Draft Feasibility Report and Environmental Impact Statement released on March 20, 2015. This Integrated Final Report & EIS documents revisions to the detailed feasibility design, analysis and impacts analyses of the Recommended Plan on significant resources. Revisions from the Revised Integrated Draft Feasibility Report and Environmental Impact Statement include changing the programmatic NED plan to a detailed and constructible nonstructural flood risk reduction plan and further development of a detailed and constructible ecosystem restoration plan.

Purpose of Action and Scope (*NEPA Required)

The low elevation and proximity of the Study Area to the Gulf of Mexico puts the unique environment and cultural heritage of southwest coastal Louisiana communities at risk of damages from hurricane storm surge and coastal erosion. Land subsidence and rising sea level are expected to increase the potential for coastal flooding, shore erosion, saltwater intrusion, and loss of wetlands and chenier habitats into the future. Through separate authorizations, Congress authorized the investigation of alternatives to: (1) provide hurricane protection and storm damage risk reduction, and (2) significantly restore the natural ecosystem including the Chenier Plain in Calcasieu, Cameron, and Vermilion parishes in Louisiana. The intent is to develop potential solutions to address these water resource problems. Both the Nonstructural National Economic Development (NED) hurricane storm damage risk reduction measures and the National Ecosystem Restoration (NER) measures have been developed to a feasibility-level of design and are recommended for construction.

Federal Objectives

The Federal objective of water and related land resources planning is to provide the greatest net contribution to the NED consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. The ecosystem restoration objective is to contribute to the NER by restoring degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition.

1.0 PROJECT SETTING

This chapter describes the historic and existing conditions of the affected environment and forecasts the future without-project conditions (FWOP) (No Action Alternative) which provide the basis for plan formulation. More detailed information concerning historic and existing conditions for a number of the important resources discussed in Chapter 1 is provided in Appendix A.

1.1 Affected Environment (*NEPA Required)

Study Area

The study area (Figure 1-1) is located in southwest Louisiana and includes all of Calcasieu, Cameron, and Vermilion parishes encompassing approximately 4,700 square miles. Cameron Parish is located in the southwest corner of Louisiana. The southern boundary of the parish is the Gulf of Mexico. Eighty-two percent of Cameron Parish is coastal marshes. Geographically, it is one of the largest parishes in Louisiana. The parish is chiefly rural and the largest communities are Cameron and Hackberry. Cameron is located along LA-82, while Hackberry is located along LA-27. Other smaller communities include Creole, Johnsons Bayou, and Holly Beach. Calcasieu Parish is located due north of Cameron Parish. The city of Lake Charles is the parish seat, which is the largest urban area in the study area. Only a small portion of the parish is located in the coastal zone. Vermilion Parish is located due east of Cameron Parish. The southern boundary of the parish is the Gulf of Mexico. Large expanses of Vermilion Parish are open water (lakes, bays, and streams). Approximately 50 percent of the land is coastal marshes. The parish is chiefly rural and the town of Abbeville is the parish seat as well as the largest urban area in the parish. Other communities include Delcambre, Kaplan, and Gueydan, which are all located along LA-14 in the northern part of the study area. Pecan Island and Forked Island are smaller communities, both located along LA-82 in lower Vermilion Parish. Located along LA-333, Intracoastal

City supports the area's oil and shrimp industries and is the nearest access to Vermilion Bay and the Gulf of Mexico in this region.

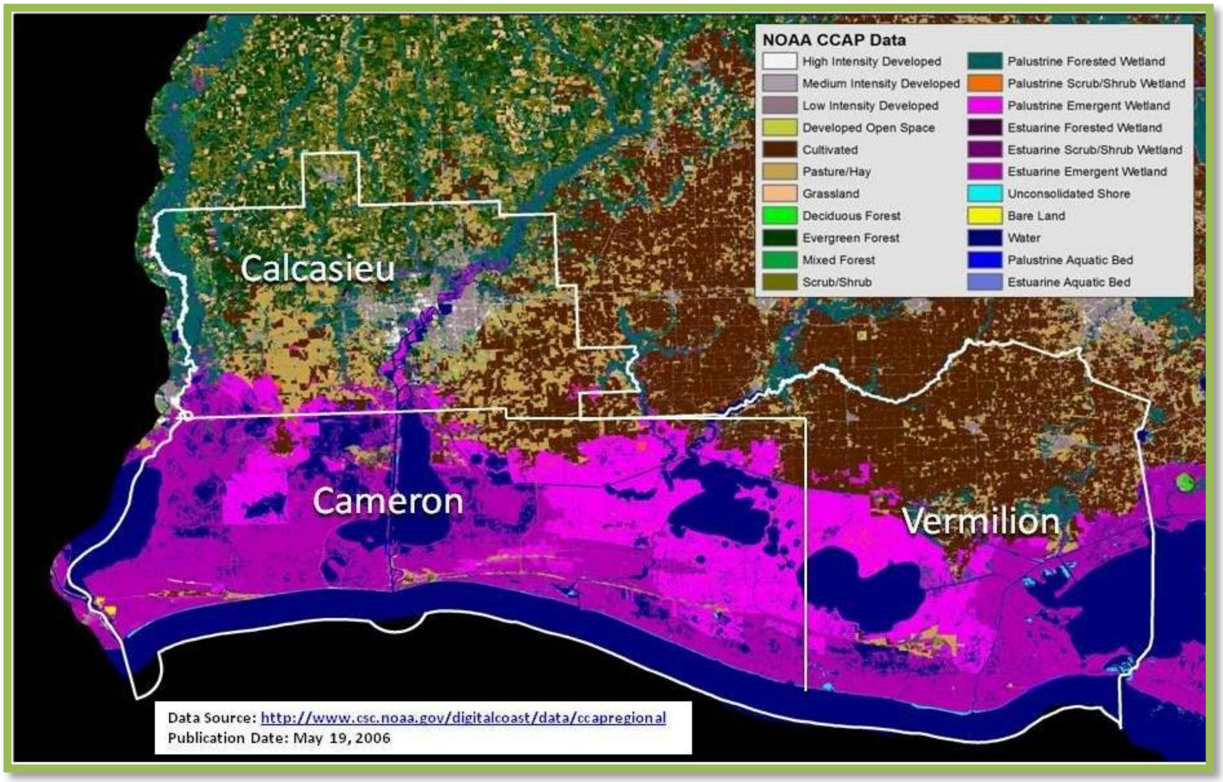

Figure 1-1: Study area map.

Geomorphic and Physiographic Setting

The area is characterized by extensive coastal marshland interrupted by forests atop relict chenier ridges and natural ridges. The cheniers are unique geological features that are critical components of the ecology. Cheniers and natural ridges were formed over thousands of years by the deltaic processes of the Mississippi River and other streams. The chenier ridges run laterally to the modern shoreline and rise above the surrounding marshes by as little as a few inches or as much as 10 feet (Byrne et al. 1959). These ridges can range from 100 to 1,500 feet wide with some ridges extending along the coast for a distance of up to 30 miles. Cheniers were created during the Pleistocene epoch by river sediments being pushed westward by shoreline currents in the Gulf of Mexico (Gould and McFarlan 1959). Natural ridges were formed by the repeated overbank flood sedimentation of rivers in southeast Louisiana (Fisk 1944). Principally, the rivers involved in creating these natural levees are past distributaries of the Mississippi River.

The main physiographic zones of the Chenier Plain include the Gulf Coast Marsh, Gulf Coast Prairies, and Forested Terraced Uplands. The Gulf Coast Marsh is at or near sea level and borders the Gulf of Mexico and most of the large lakes are in this area. The Gulf Coast Prairie extends from the central part of Vermilion and Cameron Parishes into the southern part of Calcasieu Parish; while the Forested Uplands, which occur at or near 25-foot elevation, are located in the northern part of Vermilion and Calcasieu Parishes. Louisiana's coastal prairies, once encompassing an estimated 2.5 million acres in the southwest portion of the state, now are considered critically imperiled with less than 600 acres remaining. The relationship between the forested cheniers and the surrounding aquatic ecosystem is inextricably linked. Cheniers provide valuable habitat for wetland-dwelling animal species in the form of cover, food, and nesting. Additionally, cheniers offer a protective element to nearby wetlands by reducing wave energies and diverting water flow that can come ashore from tropical events. These remnant beachheads, although elevated, offer a unique and important habitat that is currently in a degraded form. Land cover classifications from the Louisiana Coastal Area (LCA) habitat dataset for calendar year 2000, the most recent data set available from the U.S. Geological Survey (USGS), are presented in Table 1-1. The 2000 LCA habitat data composition does not cover the portion of the study area north of the coastal zone (USGS 2013). See Appendix A, for more detailed information concerning the study area.

Table 1-1: Year 2000 area habitat classification.

Habitat Class	Acres	Percent of Project Area
Water	286,086	9.79%
Water - Fresh Zone	73,262	2.51%
Water - Intermediate Zone	84,736	2.90%
Water - Brackish Zone	49,896	1.71%
Water - Saline Zone	5,309	0.18%
Water - Swamp Zone	0	0.00%
Fresh Marsh	336,406	11.51%
Intermediate Marsh	310,577	10.62%
Brackish Marsh	177,369	6.07%
Saline Marsh	35,518	1.22%
Non-wetlands	15,651	0.54%
Wetland Forest	16,208	0.55%
Upland Forest	7,709	0.26%
Swamp	0	0.00%
Wetland Shrub/Scrub	17,076	0.58%
Upland Shrub/Scrub	10,745	0.37%
Agriculture/Pasture	67,842	2.32%
Developed	7,211	0.25%
Barren	9	0.00%
*Out of Analysis	1,421,582	48.63%
Total Acres	2,923,194	

*Out of analysis—this area, primarily north of the Coastal Zone, was not included in the original data set from which the data is derived.
(source: USGS Map ID USGS-NWRC 2014-11-0001 Map Date: October 18, 2013.)

Climate

The climate is subtropical marine with long humid summers and short moderate winters. The average temperatures range from 59 to 78°F; with August being the warmest and December the coolest. Average annual rainfall is 57 inches; with June the wettest and April the driest month (Source: http://www.srh.noaa.gov/lch/?n=KLCH, accessed December 14, 2015). During the summer, prevailing southerly winds produce conditions favorable for afternoon thundershowers. In the colder seasons, the area is subjected to frontal movements that produce squalls and sudden temperature drops. River fogs are prevalent in the winter and spring when the temperature of the major water bodies is somewhat colder than the air temperature. Since 1865 a total of 16 hurricanes have made landfall within 65 nautical miles of Lake Charles (source:http://csc.noaa.gov/hurricanes/#app=6078&7239-selectedIndex=0&3722-selectedIndex=0, accessed December 14, 2015).

1.2 Human Environment

Communities include the cities of Lake Charles and Sulphur; the towns of Vinton and Iowa in Calcasieu Parish; the towns of Cameron, Grand Lake, Hackberry, and Grand Chenier in Cameron Parish; and the city of Abbeville, the towns of Erath, Kaplan, and Pecan Island in Vermilion Parish; and the town of Delcambre in Vermilion and Iberia parishes. These parishes have historically suffered extensive damage from hurricanes and tropical storms due to insufficient hurricane storm surge damage risk reduction features. The impact of preparing for, mitigating, and recovering from these damages has placed a significant physical and emotional burden on both individuals and communities. Most recently, Hurricanes Rita (2005) and Ike (2008) caused significant damage to homes and businesses. In this section, socioeconomic and other social effects (OSE) data for Calcasieu, Cameron, and Vermilion Parishes provide a context from which to evaluate potential effects of the proposed action.

1.2.1 Population and Housing

Table 1-2 shows the population trend in the three-parish area from 1970 to 2012. Population increases between 2000 and 2010 reflect similar growth patterns state-wide over this period. Population in the three-parish area in 2012 was 259,918, although there was a decline of population, due in large part to impacts from tropical storms and hurricanes, in Cameron Parish from 2000 to 2012. It is probable that recovery requirements and updated FEMA base flood delineation following this series of storms had a more pronounced effect on redevelopment in predominantly coastal Cameron Parish. Significant elevation requirements in order to achieve FEMA compliance likely resulted in a northward population shift. Such a shift would be consistent with the observed population trend in Calcasieu Parish.

Table 1-2: Population in the study area.

Parish	1970	1980	1990	2000	2010	2012
Calcasieu	145,415	167,223	168,134	183,577	192,768	194,493
Cameron	8,194	9,336	9,260	9,991	6,839	6,702
Vermilion	43,071	28,458	50,055	54,014	57,999	58,723
Total	**196,680**	**205,017**	**227,449**	**247,582**	**257,606**	**259,918**

Sources: U. S. Census, 2010 and U.S. Census Abstract, 2013

The trend in household formation, shown in Table 1-3, parallels the growth in population. Most households are located in the metropolitan areas which include: Lake Charles in Calcasieu Parish; Cameron (which serves as the seat of government in Cameron Parish); and Abbeville located in Vermilion Parish.

Table 1-3: Households (in thousands) in the study area.

Parish	1970	1980	1990	2000	2010	2012
Calcasieu	42.1	56.8	60.4	68.6	70.6	72.2
Cameron	2.3	3.0	3.1	3.6	2.5	2.4
Vermilion	12.8	16.3	17.7	19.9	21.1	21.6
Total	**57.2**	**76.1**	**81.3**	**92.1**	**94.2**	**96.2**

Sources: U. S. Census, 2010 and U.S. Census Abstract, 2013

According to the Federal Emergency Management Agency (FEMA 2013), flood claims from all sources for the three-parish area between 1978 and 2012 totaled $420,900,000 (Table 1-4). (NOTE: FEMA flood claims occur due to a property experiencing inundation regardless of the source of flooding; however, in the study area, the majority of the flooding experienced derives from a combination of storm surge and heavy rainfall associated with tropical events. The subject study is limited to addressing the risk of damages from flooding derived from hurricane storm surge and does not address flooding associated with rainfall events, even those associated with a hurricane or tropical storm event.)

Table 1-4: Summary of flood claims data for the period 1978 to 2012.

Parish	Claims	Total Nominal Dollar Amount (in millions)	Average Amount per claim
Calcasieu	4,008	$132.0	$32,930
Cameron	3,061	$173.5	$56,679
Vermilion	3,218	$115.4	$35,860
Total	**10,287**	**$420.9**	**$41,823**

Note: Dollar amounts reflect the amount paid out at time of claim

1.2.2 Employment, Business, and Industrial Activity

Economic growth is highly dependent upon the major employment sectors. With the exception of the cities of Lake Charles, Sulphur, Abbeville, and Delcambre, the study area is sparsely populated. The area is rich in natural resources and industrial infrastructure. The economy of the coastal communities is centered on fishing, shrimping, and offshore oil services. The agricultural land located 30 to 40 miles inland is used for rice, sugar cane, and livestock production. The northern-most portion is heavily forested and supports a substantial timber industry. Lake Charles, which is the population center of the region, is the home of large oil refineries, petro-chemical plants, a deep-water port, McNeese State University, and casinos along the lakefront.

Table 1-5 shows the growth of non-farm employment over the last four decades. The leading employment sectors are education, healthcare, petroleum production, and petrochemical refining. Other significant employment sectors include education, manufacturing, accommodations and social services, and retail trade. Employment growth was steady from 1970 to 2012 for Calcasieu and Vermilion parishes, although employment in Cameron parish declined since 2000, and is reflected in the population estimates previously described. See Appendix A for more detailed information concerning non-farm employment by industry for each parish.

Table 1-5: Non-farm employment in the study area (in thousands).

Parish	1970	1980	1990	2000	2010	2012
Calcasieu	41.1	67.0	69.0	84.6	87.9	93.3
Cameron	2.8	4.4	4.1	3.9	2.6	2.7
Vermilion	9.4	16.6	13.3	14.7	15.5	16.9
Total	53.3	88.0	86.4	103.2	106.0	112.9

Source: Moody's 2013

1.2.3 Public Facilities and Services

Public facilities and services have historically grown to meet population demands. The area includes a mixture of community centers, schools, hospitals, airports, colleges, and fire protection. The Port of Lake Charles is a key center for international trade, and is among the top 15 busiest ports in the nation. A total of 603 public and quasi-public buildings were specifically inventoried in 2012.

1.2.4 Transportation

The transportation infrastructure includes major roads, highways, railroads, and navigable waterways that have developed historically to meet the needs of the public. Interstate 10 (I-10), an east-west bi-coastal thoroughfare that connects Houston and Baton Rouge, crosses the northern part of the area and is a primary route for hurricane evacuation and post-storm emergency response. US-165, another evacuation and emergency response route, is located north of I-10. Most of I-10 is either at or just below the 100-year floodplain. Other major highways include US-13 and US-26, which run north-south and intersect I-10 in the northeastern portion of the parishes. LA 82 is an east-west state highway that serves as a vital route for the area's fishing, oil and gas, and seafood industries as well as hurricane evacuation. Like portions of LA 82, LA 27 is part of the Creole Nature Trail, also known as Louisiana's Outback, and the Gulf Beach Highway. Portions of LA 27 and LA 82 run east-west along the Gulf shoreline between Holly Beach and Cameron, LA. Other modes of transportation include water transport along the Gulf Intracoastal Waterway (GIWW) and the Sabine and Calcasieu Rivers, all of which accommodate ocean-going vessel and barge traffic. See Appendix A for more detailed information concerning navigation projects including: the GIWW, the Sabine-Neches Waterway and Sabine Pass Ship Channel, the Calcasieu River and Pass, the Mermentau River, the Freshwater Bayou and Freshwater Bayou Lock, and the Bayou Teche and Vermillion River. See Appendix A for information concerning the operations and maintenance dredging of navigation channels.

Rail and aviation facilities are spread throughout. During Hurricanes Rita and Ike, portions of I-10 were inundated by a combination of storm surge and rainfall. This interfered with emergency service access and prevented local and regional residents from returning to their primary residences and businesses. This delay in repopulation results in additional emergency costs, due to the longer time periods required for sheltering residents until the area was made safe to return.

1.2.5 Community and Regional Growth (Income)

Community and regional growth primarily track population and employment trends that were described in the preceding sections. Table 1-6 shows per capita growth in income since 1990.

Table 1-6: Nominal per capita income in the study area.

Parish	1990	2000	2010	2012
Calcasieu	$15,511	$23,034	$29,021	$34,577
Cameron	$13,001	$18,433	$20,739	$33,784
Vermilion	$12,343	$19,130	$23,091	$29,873

Note: Dollar amounts reflect the income in associated year prices

1.2.6 Tax Revenue and Property Values

Historically, damages from storm surge events have adversely impacted business and industrial activity, agricultural activity, and local employment and income, which then led to commensurate negative impacts to property values and the tax base upon which government revenues rely. As in other developed communities, the presence of high risk of damages from hurricane storm surge has reduced property values since the cost of repairing those damages [whether directly by property owners or through claims made through the National Flood Insurance Program (NFIP) for which annual premiums are charged] increases the long-term cost of property ownership. Measurement of this loss is problematic since the market price of properties captures an extensive array of factors such that the contribution of hurricane storm surge risk to changes in market value cannot be directly ascertained. As described in detail in the Economics Appendix, structure characteristics for 46,860 residential and 4,997 non-residential structures were collected to assist in evaluating the impacts of hurricane storm surge risk under existing and future conditions. As this data reflects, currently, the median depreciated replacement value of housing units is $115,684 (in 2012 price prices).

1.2.7 Community Cohesion

Community cohesion is based on the characteristics that keep the members of the group together long enough to establish meaningful interactions, common institutions, and agreed upon ways of behavior. These characteristics include race, education, income, ethnicity, religion, language, and mutual economic and social benefits. The area is comprised of communities with a long history and long-established public and social institutions including places of worship, schools, and community associations. In 2005 with Hurricane Rita, and again in 2008 with Hurricane Ike, communities in Calcasieu, Cameron, and Vermilion Parishes were inundated by storm surge. Due to the absence of hurricane storm surge risk reduction measures, and the resulting direct impacts to existing structures, local populations were forced to evacuate and/or relocate for significant time periods, thereby significantly disrupting temporarily, and in some instances, permanently, community cohesion throughout the study area.

1.2.8 Other Social Effects (OSE)

In accordance with the USACE Institute for Water Resources (IWR) handbook in Applying Other Social Effects in Alternatives Analysis (USACE, 2013) seven social factors that describe the social fabric of a community were identified. The social factors identified and described in Table 1-7 are based on conventional psychological Human Needs Theory and Abraham Maslow's Hierarchy of Needs (USACE 2013). These social factors are also covered in the socioeconomic sections of the report. Additional detailed information is included in the Other Social Effects section of Appendix A.

Table 1-7: Social Factors

Social Factor	Description
Health and Safety	Refers to perceptions of personal and group safety and freedom from risks
Economic Vitality	Refers to the personal and group definitions of quality of life, which is influenced by the local economy's ability to provide a good standard of living
Social Connectedness	Refers to a community's social networks within which individuals interact; these networks provide significant meaning and structure to life
Identity	Refers to a community member's sense of self as a member of a group, in that they have a sense of definition and grounding
Social Vulnerability and Resiliency	Refers to the probability of a community being damaged or negatively affected by hazards, and its ability to recover from a traumatic event
Participation	Refers to the ability of community members to interact with others to influence social outcomes
Leisure and Recreation	Refers to the amount of personal leisure time available and whether community members are able to spend it in preferred recreational pursuits

Socioeconomic data for Calcasieu, Cameron, and Vermilion Parishes are presented in order to provide a context from which to evaluate the potential social impacts of the proposed project. A more detailed explanation of socioeconomic characteristics is available in Sections 1.2.1, 1.2.2, 1.2.5 and 1.2.9. The Social Profile of Communities provides a baseline profile of existing and future without project conditions for the social communities in the study area. Data for the social profile were obtained from a variety of sources including 2010 U.S. Census records, the 2007-2011 U.S. Census Bureau's American Community Survey (ACS) estimates, ESRI data, public meetings, interviews with local representatives, and aerial photography. The baseline characteristics are considered the existing and future-without project conditions.

The Hazards and Vulnerability Research Institute at the University of South Carolina created an index that compares the social vulnerability of U.S. counties/parishes to environmental hazards. The variables included in the index are based on previous research which has found that certain characteristics (e.g., poverty, racial/ethnic composition, educational attainment, and proportion over the age of 65) contribute to a community's vulnerability when exposed to hazards. According to the Institute for Water Resources Other Social Effects handbook (USACE 2008), the Social Vulnerability Index (SoVI®) is a valuable tool that can be used in the planning process to identify areas that are socially vulnerable and whose residents may be less able to withstand adverse impacts from hazards. The SoVI® was computed as a comparative measure of social vulnerability for all counties/parishes in the U.S., with higher scores indicating more social vulnerability than lower scores. Calcasieu Parish has a SoVI® 2006-10 score of -1.21 (0.28 national percentile), Cameron Parish has a SoVI® 2006-10 score of -3.59 (.08 national percentile), and Vermilion Parish has a SoVI® 2006-10 score of -0.04 (0.49 national percentile). Based on these scores, Calcasieu Parish is rated as more socially vulnerable than roughly 72 percent of counties/parishes in the U.S.; Cameron Parish is rated as more socially vulnerable than about 92 percent of counties/parishes in the U.S.; and Vermilion Parish is rated as more socially vulnerable than roughly 51 percent of counties/parishes in the U.S. By comparison, Orleans Parish, notorious for its enduring levels of high poverty, has a SoVI® 2005-09 score of -0.92 making it more socially vulnerable than 33 percent of counties/parishes in the nation. Hence, Cameron Parish is by far the most socially vulnerable to hurricane storm surge damage consequences in the study area followed by Calcasieu Parish and Vermilion Parish is the least socially vulnerable in the area. However, all three parishes are ranked as being more socially vulnerable to hurricane storm surge damage consequences than Orleans Parish.

1.2.9 Environmental Justice

The Environmental Justice (EJ) study area contains all Census Tracts and Census block groups located within Calcasieu, Cameron, and Vermilion parishes.

Table 1-8 shows the racial characteristics of the three parishes according to the 2010 U.S. Census. Overall, minority residents make up 29% of the population in Calcasieu, 4% of the population in Cameron and 20% of the population in Vermilion Parishes. According to the 2010 U.S. Census data, there are 42 block groups in Calcasieu Parish and 8 block groups in Vermilion Parish where 50 percent or more of the population identify themselves as part of a minority group. There are no block groups in Cameron Parish where more than one percent identify themselves as part of a minority group (Figure 1-2).

Table 1-8: Racial characteristics.

Parish	White	African American*	American Indian/Alaska Native*	Asian*	Hawaiian/Pacific Islander*	Total	Percent Minority**
Calcasieu	136,514	47,782	898	2,073	93	192,768	29%
Cameron	6,546	119	36	6	0	6,839	4%
Vermilion	46,922	8,286	209	1,160	5	57,999	20%

* 2010 Census / ** 2007 – 2011 Census

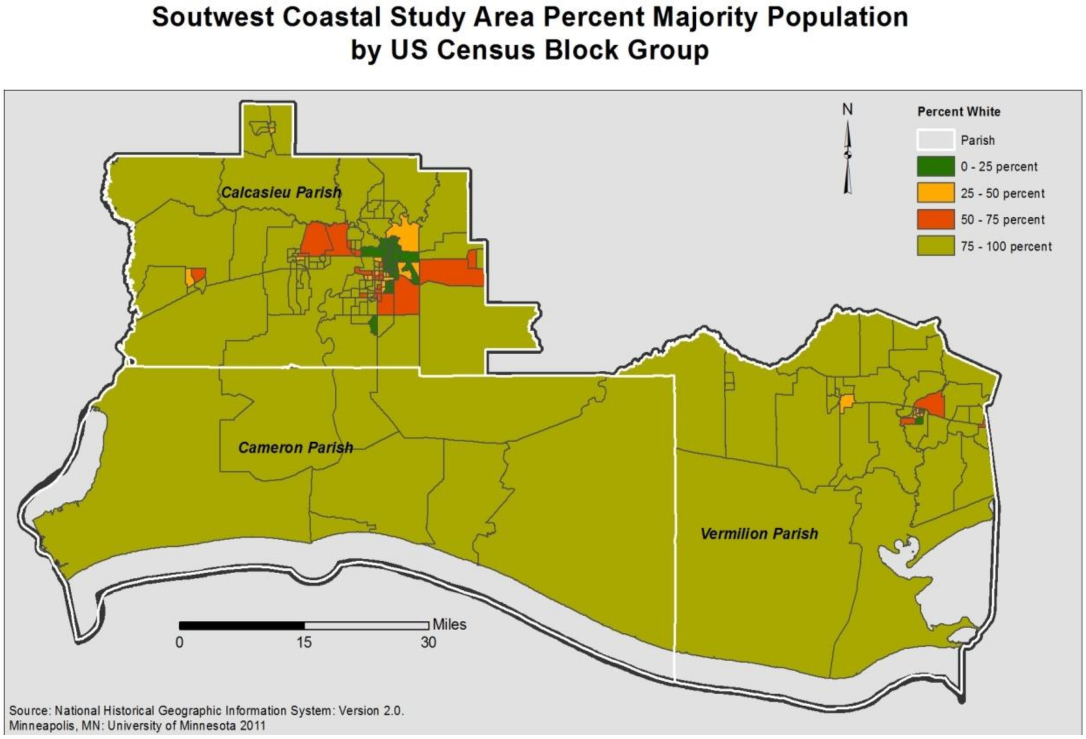

Figure 1-2: Racial majority by block group.

High poverty rates negatively impact the social welfare of residents and undermine the community's ability to provide assistance to residents in times of need. The 2007-2011 American Community Survey (ACS) data indicate that 9 percent of households in Calcasieu Parish, 5 percent in Cameron Parish, and 10 percent in Vermilion Parish fell below the poverty line (Figure 1-3). The 2007-2011 Census ACS data indicate that there are:

- 17 poverty areas and 2 extreme poverty areas (block groups) in Calcasieu Parish
- 0 poverty areas or extreme poverty areas (block groups) in Cameron Parish
- 7 poverty areas and 1 extreme poverty areas (block groups) in Vermilion Parish

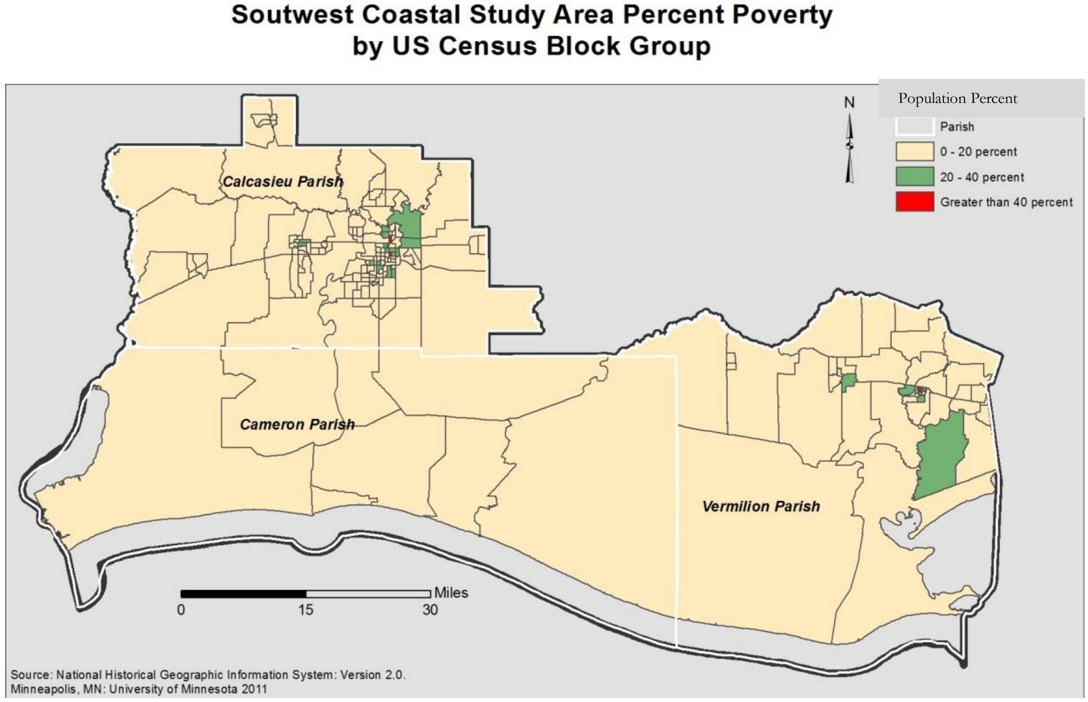

Figure 1-3: Percent population below poverty line by block group.

1.3 Water Environment (Hydrology and Hydraulics)

The two major hydrologic basins in the Chenier Plain are the Mermentau Basin and the Calcasieu-Sabine Basin (LCA, 2004). The Teche-Vermilion Basin is another significant hydrologic basin in the study area. The general location and major features/water bodies in each basin are described below. Figure 1-4 identifies major hydrologic features. For the most part, areas below the GIWW are within the coastal zone.

Calcasieu-Sabine Basin - The Calcasieu-Sabine Basin lies in the western portion of the Chenier Plain in Cameron and Calcasieu Parishes. It is bounded to the east by LA-27, to the south by the Gulf of Mexico, and to the west by the Sabine River and Sabine Lake. The Basin is a shallow coastal wetland system with freshwater input at the north end, a north-south flow through Calcasieu and Sabine Lakes, and some east west water movement through the GIWW and interior marsh canals (e.g., North Starks and South Starks canals on the Sabine National Wildlife Refuge). The dominant hydrologic features of the basin are the Calcasieu and Sabine Lakes, which are directly influenced by the Calcasieu, Sabine, and Neches Rivers. Navigation channels include the Sabine-Neches Waterway, and the Calcasieu River and Pass. Water control structures in the area include the Calcasieu Locks. Managed wetlands, which utilize natural and manmade features to regulate water level and quality, and marsh productivity, are a significant feature of the Calcasieu-Sabine Basin (LADNR 2002). The Calcasieu drainage basin north of the point where the Sabine River crosses the GIWW is 3,235 square miles. The Sabine drainage basin has a drainage area of 9,760 square miles. The headwaters start in northeastern Texas and the river runs about 150 miles before it meets the Louisiana-Texas state line, then runs to the Gulf. The Toledo Bend Reservoir and Sabine Lake are the major hydrologic features of the Sabine Basin.

The GIWW from the Sabine River to the Calcasieu River is a 125 feet (ft.) wide x 12 ft. deep. Construction of the GIWW significantly altered regional hydrology by connecting the two major ship channels. Prior to the construction of the GIWW, the Calcasieu and Sabine estuaries were mostly distinct and were more influenced by the Calcasieu and Sabine rivers, respectively. The Gum Cove Ridge once separated the Sabine Basin from the Calcasieu Basin, with little water exchange between the basins. Removing the mouth bars and deepening the Calcasieu Ship Channel (CSC) and the Sabine-Neches channels, as well as the GIWW and interior canals bisecting the Gum Cove Ridge, made the region hydrologically indistinct, which caused water flow and salinity patterns of one basin to profoundly affect those patterns of the other basin. In addition to combining the two basins, the GIWW severed hydrologic connections (e.g., bayous and sheet flow) between the northern and southern portions of these basins, and channelized these freshwater flows directly to the Gulf of Mexico, thereby partially bypassing the southern marshes.

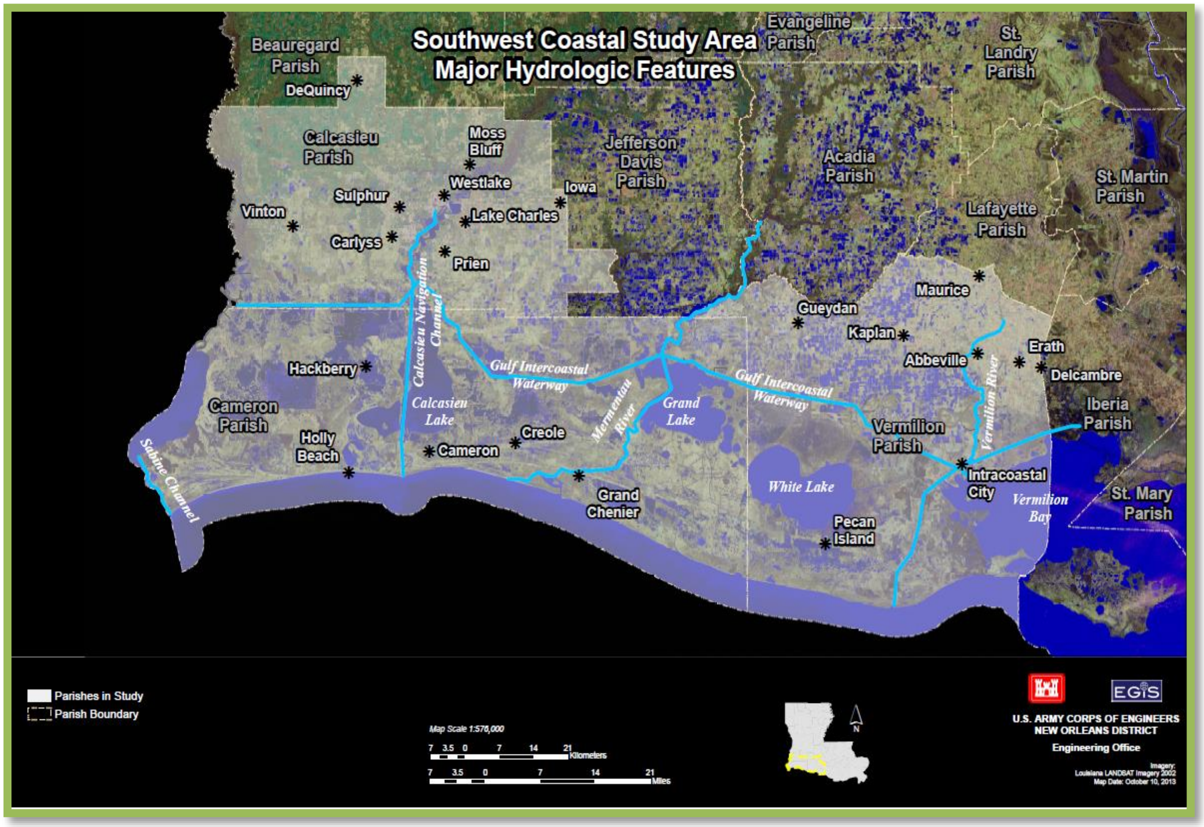

Figure 1-4: Major hydrologic features.

<u>Mermentau Basin</u> - The Mermentau Basin lies in the eastern portion of the Chenier Plain in Cameron and Vermilion Parishes. The Mermentau River Basin can be divided into three sub-basins: Upland, Lakes, and Chenier. The Upland Sub-basin covers an area of 3,683 square miles of predominantly agricultural land. The Lakes Sub-basin is delineated by the Freshwater Bayou Canal on the east, the limit of the coastal zone on the north, LA-27 on the west, and LA-82 on the south. LA-82 runs atop and between the Grand Chenier-Pecan Island ridge complex. The Chenier Sub-basin lies south of this ridge complex. The dominant hydrologic features of the Mermentau basin are the Grand and White Lakes and the Mermentau River. Navigation channels include the Mermentau Ship Channel. Various water control structures include the Freshwater Bayou Canal Lock, the Schooner Bayou Canal Structure, and the Catfish Point Control Structure.

Before human-induced hydrologic alterations from navigation channels in the early 1900s, the natural drainage in the Mermentau Basin was dominantly north-south through the Mermentau River, Freshwater Bayou, Bayou Lacassine, and Rollover Bayou. The eastern portion of the basin also drained in an easterly direction through Belle Isle and Schooner bayous. In addition, sheet flow over the marsh occurred between Grand Chenier and Pecan Island ridges, as well as to the west into the Calcasieu/Sabine Basin. Human activities related to wildlife management, navigation improvement, flood control, agriculture, and petrochemical exploitation have dramatically altered the hydrology of the Mermentau Basin. The net effect of these alterations is that drainage through the Lakes Sub-basin is now predominantly east-west and hydrologically isolated from the Chenier Sub-basin. The Lakes Sub-basin now functions more as a freshwater reservoir and less as a low-salinity estuary, its natural form (Gunter and Shell 1958; Morton 1973).

Teche/Vermilion Basin - The Teche/Vermilion Basin extends from Point Chevreuil to Freshwater Bayou Canal and includes East and West Cote Blanche Bays, Vermilion Bay, and the surrounding marshes. Navigation features include the Freshwater Bayou Canal Navigational Channel and the Leland Bowman Lock. The Basin has a drainage area of 3,040 square miles (LCA 2004). Only the western extent of this hydrologic basin lies within the authorized Southwest Coastal study area.

1.3.1 Water Stage Duration and Frequency

Normal astronomical tides are diurnal (one high tide and one low tide per day) and can have a spring range of as much as 2 ft. The mean tidal range is approximately 1.28 ft. at Calcasieu Pass and 1.48 ft. at Freshwater Canal. Amplitudes are influenced by tides, but are generally controlled by meteorological events. South winds drive water into the marshes.

1.3.2 Relative Sea Level Rise

In coastal Louisiana, relative sea level rise (RSLR) is the term applied to the difference between the change in eustatic (global) sea level and the change in land elevation. According to Intergovernmental Panel on Climate Change (IPCC 2007), the global mean sea level rose at an average rate of about 1.7 mm/yr during the 20th Century. Recent climate research has documented global warming during the 20th Century, and has predicted either continued or accelerated global warming for the 21st Century and possibly beyond (IPCC 2007).

Land elevation change can be positive (accreting) or negative (subsiding). Land elevations decrease due to natural causes, such as compaction and consolidation of Holocene deposits and faulting, and human influences such as sub-surface fluid extraction and drainage for agriculture, flood protection, and development. Forced drainage of wetlands results in lowering of the water table resulting in accelerated compaction and oxidation of organic material. Areas under forced drainage can be found throughout coastal Louisiana and the study area. Land elevations increase as a result of sediment accretion (riverine and littoral sources) and organic deposition from vegetation. Vertical accretion in most of the area, however, is insufficient to offset subsidence, causing an overall decrease in land elevations. The combination of subsidence and eustatic sea level rise is likely to cause the landward movement of marine conditions into estuaries, coastal wetlands, and fringing uplands (Day and Templet, 1989; Reid and Trexler 1992).

Subsidence Rates - Subsidence rates vary considerably across coastal Louisiana. A coast wide system for quantifying and predicting subsidence on a regional scale has not yet been established. Therefore, subsidence rates are estimated using a combination of benchmark leveling, tide gauge measurements, and radiometric dating of buried marsh horizons. The subsidence rate for most of the study area is considered low, at 0 to 1 ft/century; however, the subsidence rates in the Mermentau Basin for Hackberry Ridge, Big Lake, Cameron-Creole, Brown Lake, Hog Island Gully, and Mud Lake watersheds, all located within the study area, are considered intermediate, at 1.1 – 2 ft per century. Perry Ridge in the Calcasieu/Sabine Basin and Locust Island and Little Prairie in the Mermentau Basin are considered stable (Coast 2050, 2009).

Accretion Rates - Net accretion varies significantly on a local level and over time. Average measurements of accretion across the Louisiana coastal region indicate that current accretion rates are 0.7 to 0.8 cm per year (ERDC/EL TN-10-5). Since there is currently a lack of evidence to support applying a habitat specific accretion rate, a long-term accretion estimate of 0.7 cm per year captures the central tendency of all herbaceous marsh data that have been reviewed for this analysis.

1.3.3 Storm Surge

While the study area has periodically experienced localized flooding from excessive rainfall events, the primary cause of the flooding events has been the storm surges from hurricanes and tropical storms. During the past eight years, the area has been greatly impacted by storm surges associated with four Category 2 or higher hurricanes (Lili, Rita, Gustav, and Ike), which inundated structures and resulted in billions of dollars in damages to southwest coastal Louisiana. Hurricane storm surge also causes significant permanent damage to wetlands. Hurricane surge has formed ponds in stable, contiguous marsh areas and expanded existing, small ponds, as well as removed material in degrading marshes (Barras, 2009). Fresh and intermediate marshes appear to be more susceptible to surge impacts, as observed in Barras (2006).

1.3.4 Storms of Record

Hurricane Audrey (June 25 - 29, 1957) ranks as the 7th deadliest hurricane to strike the United States and was the deadliest natural disaster in the history of southwest Louisiana in modern record-keeping with at least 500 deaths (source: http://www.srh.noaa.gov/lch/?n=audrey; accessed January 7, 2016).

Hurricane Lili (September 23 - October 3, 2002) was originally a Category 4 hurricane and first made landfall near Marsh Island in Iberia Parish with maximum sustained winds of 92 mph. Highest recorded rainfall amount was about 9 inches in some parts of Louisiana. The highest storm surge was over 11 feet in St. Mary Parish (source: https://coast.noaa.gov/hes/docs/postStorm/Lili_%20final.pdf; accessed December 15, 2015).

Hurricane Rita (September 24 - 26, 2005) Hurricane Rita, reaching its peak intensity southeast of the mouth of the Mississippi River as a Category 5, first made landfall just west of Johnson's Bayou and east of Sabine Pass at the Texas-Louisiana border as a Category 3 hurricane. Sensors recorded storm-surge water levels over 14 ft above NAVD 88 at Constance Beach (LC11), Creole (LA12), and Grand Chenier (LA11), La., about 20 miles, 48 miles, and 54 miles, respectively, east of Sabine Pass, Texas. In general, storm-surge water levels increased eastward from the Sabine River into southwest Louisiana. The magnitude of the storm surge was greatest near the coast and decreased inland through the approximate latitude of I-10, about 35 miles inland from the coast (source: http://pubs.usgs.gov/circ/1306/pdf/c1306_ch7_j.pdf; accessed December 15, 2015).

Hurricane Gustav (August 25 - September 4, 2008) Gustav made landfall near Cocodrie, Louisiana on September 1, 2008 as a strong category 2 (based on 110 mph sustained winds) and continued to move northwest, spreading hurricane force wind gusts across portions of Southeast and South Central Louisiana (http://www.srh.noaa.gov/lix/?n=gustavsummary; accessed January 26, 2016). Due to the storm making landfall east of the study area, storm surge values were only 4-5 feet across St. Mary, Iberia, and Vermilion parishes (http://www.srh.noaa.gov/images/lch/tropical/HPW1-SUN.pdf; accessed January 26, 2016).

Hurricane Ike (September 1-14, 2008) first made landfall near Galveston, Texas on September 13, 2008 as a Category 2 hurricane with maximum sustained winds of 110 mph (http://www.srh.noaa.gov/hgx/?n=projects_ike08; accessed December 15, 2015). Ike was a large hurricane with tropical-storm-force and hurricane-force winds associated at the time of its landfall extending approximately 275 miles and 120 miles from the storm center, respectively. In Louisiana, estimated wind speeds ranged from 80 mph near the Texas-Louisiana border to 50 mph in Vermilion Parish. Storm surge caused flooding in Cameron, Vermilion, and many parishes to the east, with over 9 foot stillwater levels estimated for Lake Charles (http://www.fema.gov/media-library-data/20130726-1648-20490-1790/757_ch1_final.pdf; accessed December 15, 2015).

1.3.5 Flow and Water Levels

The marsh area of southwest Louisiana extends northward and slightly beyond the GIWW. Rainfall runoff drains from the higher elevations in the north and is trapped in the marsh area to the south due to chenier ridges that parallel the coast. The natural drainage pattern prior to the construction of the GIWW was for rainfall in the basin to drain through the Mermentau River and empty into the Gulf of Mexico. However, some of that flow is now redistributed to the east and west along the GIWW. The Calcasieu Lock, Catfish Point Control Structure, Leland Bowman Lock, and Schooner Bayou Lock were created to allow for navigation and salinity control.

Land stewardship through hydrologic management and shoreline protection are the mainstays of coastal restoration in the Calcasieu-Sabine basin. Water control structures are operated both passively and actively. Virtually all hydrologic management focuses on controlling salinity and minimizing tidal fluctuations by constructing and operating levees, weirs, and a variety of gated structures. A 1990 inventory of such water control structures identified 174 individual structures in the interior and along the perimeter of the basin (LADNR 2002; Marcantel 1996).

The Cameron-Creole Watershed Project covers approximately 176 square miles in Cameron Parish. The area is bounded by the GIWW on the north; Calcasieu Lake and Calcasieu Pass on the west; LA-27, Little Chenier Ridge, and Creole Canal on the east; and the Gulf of Mexico and Mermentau River on the south. To counter this conversion of marsh to open water, the Cameron-Creole Watershed Project was initiated cooperatively by the Soil Conservation Service (now Natural Resource Conservation Service [NRCS]), Gulf Coast Soil and Water Conservation District, Cameron Parish Police Jury, Cameron Parish Gravity Drainage Districts 3 and 4, the Miami Corporation, and the United State Fish and Wildlife Service (USFWS), Sabine National Wildlife Refuge. The water control structures began operation in 1989 (LADNR 2002).

1.3.6 Water Quality and Salinity

Water quality is influenced by chenier plain elevations, surface water budget, land cover and use, chenier plain geomorphologic processes, and regional weather. The study area occupies most of the Louisiana chenier plain, and consists of low relief topography to the north and estuary to the south, with increasing estuary salinity southward. The area includes the Calcasieu and Mermentau River basins; the former is connected to the Gulf of Mexico via the Calcasieu ship channel, while the latter is maintained as freshwater environ via several water control structures (Rosen and Xu 2011). The area has experienced hydromodification via the construction of water control structures, canals, and embankments (Demcheck et al. 2004). Chemical transformations occurring in the estuary can be biologically mediated by estuary wetlands (Mitsch and Gosselink 2000); a diversity of wetland types exist within the study area which are affected by chenier plain geomorphology and anthropogenic factors (Visser et al. 2000). Weather patterns can affect marine influence, flow direction, water level, and wetlands biogeochemistry (Gosselink 1984). Timing and amount of precipitation can also affect water quality (Demcheck et al. 2004).

Demcheck et al. (2004), Garrison (1997), Waldon (1996), Skrobialowski et al. (2004), Demcheck and Skrobialowski (2003), Macdonald et al. (2011), Rosen and Xu (2011), and Steyer et al. (2008) provide detailed descriptions of water quality and salinity in the study area. In general, water quality concerns are related to urbanization in the parts of the area where hurricane storm surge risk reduction measures are proposed, oil and gas activities and saltwater intrusion in the Calcasieu River basin, and agriculture in the Mermentau River basin.

The Sabine River is the dominant influence across most of the basin in moderating gulf salinity and tidal fluctuations. Observations by USFWS personnel reveal that strong and prolonged south and southeast winds result in large volumes of Gulf of Mexico water being pushed into Calcasieu and Sabine lakes, which causes the water level in the marshes to rise (Paille 1996). A similar effect on marsh water level has been observed during periods of low barometric pressure in the region (LADNR 2002; Paille 1996).

The primary saltwater barrier in the Calcasieu Basin is the Calcasieu Lock, located approximately two miles east of the CSC. This sector-gated lock, which opened in 1950, was designed to prevent saltwater intrusion into the Mermentau Basin, and is operated primarily for navigation.

Louisiana Water Quality Inventory: Historical (1998-2012) Clean Water Act (CWA) Section 305(b) assessments of study area sub-segments were evaluated. For each sub-segment, an average designated use support value was calculated (0=always impaired, 1=unimpaired; see the unabridged report for methodology and details). Long-term average support values reveal that impairments are most common in the uppermost sub-segments in the study area in the Calcasieu and Teche-Vermilion watersheds. The most commonly suspected causes of impairment included in the 305(b) assessments were low dissolved oxygen, elevated total suspended solids, mercury, elevated turbidity, nitrate/nitrite, carbofuran, and total phosphorus, while the most commonly suspected sources of impairment were unknown sources, agriculture, natural sources, atmospheric deposition, flow alteration, urban runoff, and on-site treatment systems.

In the 305(b) assessment for 2012, the frequently cited suspected causes of impairment included fecal coliform, low dissolved oxygen, turbidity, mercury, total suspended solids, and carbofuran, while most frequently cited suspected sources of impairment included unknown sources, agriculture, natural sources, on-site treatment systems, atmospheric deposition, and drought-related impacts (LDEQ 2013).

1.4 Natural Environment

1.4.1 Sedimentation and Erosion

The study area is divided by the Sabine, Calcasieu, Mermentau, and Vermilion rivers which flow in a north-south direction. These rivers have been highly altered by the placement of locks and dams, dredged channels, manmade outlets to the Gulf, and bisected by the GIWW. These alterations influence the movement of sediment throughout the area. The rivers and interior lakes which they enter (Sabine, Calcasieu, and Grand) act as sediment sinks. Overbank deposition into adjacent marshes is minimal in these low flow rivers. Sediments in the interior lakes can be re-suspended and deposited in adjacent marshes during storm events and cold front passages. Extensive hydrologic alterations within the area (levees, channels, roads, locks, control structures, etc.) influence sediment movement throughout. Sediments in the rivers that make it to the coast are deposited at the mouths and generally move westward nourishing the beaches and marshes.

A significant source of sediment is the Atchafalaya River (McBride et al. 2007). Sediment travels westward from Atchafalaya Bay and the GIWW and enters the area through tidal exchange at the Gulf and from flooding during storm events. A large percentage of Atchafalaya River sediments are deposited along the Gulf shoreline in the vicinity of Freshwater Bayou as mudflats while coarser sediments continue westward along the shoreline.

The shorelines of most channels, lakes, and the Gulf are experiencing erosion with erosion rates generally highest where the shorelines protrude into the lakes, focusing wave and current action For example, White Lake average shoreline erosion rate of 15 feet per year (USACE 2006); southwest Grand Lake shoreline erosion rate of approximately 11 feet per year to 32 feet per year (source: https://lacoast.gov/reports/PPL/24/REGION4FSpwptsUPDATED.pdf; accessed January 6, 2016; and Sabine Lake about 10 feet per year (personal communication Darryl Clark, USFWS, January 6, 2016). The Louisiana coast has approximately 350 miles of sandy shoreline along its barrier islands and gulf beaches; however, there are about 30,000 miles of land-water interface along bays, lakes, canals, and streams. Most of these shores consist of muddy shorelines and bank lines, and virtually all are eroding. In many instances, rims of firmer soil around lakes and bays, and natural levees along streams have eroded away leaving highly organic marsh soils directly exposed to open water wave action. Examples include Redfish Point, Grassy Point, Umbrella Point, Short Point, and Commissary Point. High rates of Gulf shoreline erosion occur from the vicinity of Rollover Bayou, west to the Mermentau River. Accelerated shoreline loss occurs where erosion has caused Gulf, lake, and channel shorelines to intersect interior water bodies.

1.4.2 Soils, Water Bottoms, and Prime and Unique Farmlands

Both hydric and non-hydric soils are found throughout. The area consists generally of forested terrace uplands and Gulf Coast Prairies in the northern portions and Gulf Coast Marsh habitats in the southernmost portions. Predominant soils are described in Appendix A. The major water bottoms throughout include: Lake Charles, Prien Lake, Sabine Lake, Calcasieu Lake, Grand Lake, White Lake, and Vermilion Bay. There are numerous smaller lakes such as Sweet Lake, Mud Lake, Black Lake, Big Constance Lake, and Lake Misere. Rivers include the Calcasieu, Sabine, Mermentau, and Vermillion Rivers. A listing of the water bottoms is described in Appendix A.

Prime and Unique Farmlands: Prime farmlands are present and make up approximately 941,196 acres, or 34.3 percent of the soils; breakdown by parish is as follows: Calcasieu Parish is 479,426 acres, or 51 percent; Cameron Parish is 106,008 acres, or 11 percent; Vermilion Parish is 355,761 acres, or 38 percent. The majority of the Gulf Coast Marshes consists of wetland type soils and shorelines that are prone to frequent flooding and not suitable for agricultural use. Prime farmland is more predominant inland, and outside, of the Gulf Coast Marsh physiographic area. Prime farmland can also be found on natural ridge tops and cheniers (Hackberry loamy fine sand). Prime farmland soils are best suited for producing food, feed, forage, fiber, and oilseed crops, and possess qualities that are favorable for crop production using only acceptable farming methods (NRCS Soil Survey of Calcasieu Parish, dated June 1988). Several soil types exist that meet those qualities and are identified as prime farmlands (see Appendix A). Urban areas, like Lake Charles and Abbeville, as well as industrial areas have excluded some prime farmlands from agricultural use.

1.4.3 Gulf Coastal Shorelines

Gulf coastal shorelines, located along the northern rim of the Gulf of Mexico, provide essential and critical shelter, nesting, feeding, roosting, cover, nursery, and other habitats and life requirements for fish and wildlife. They function as the boundary between marine and estuarine ecosystems and provide protection to the estuarine wetlands, bays, and other inland habitats. Coastal shorelines, as well as other coastal landscape features such as shoals, coastal marshes, and forested wetlands, can provide a significant and potentially sustainable buffer from wind wave action and storm surge generated by tropical storms and hurricanes. Rapid deterioration of the barrier coast is resulting in a transformation of low-energy, semi-protected bays into high-energy, open marine environments (Stone et al. 2005). Numerical modeling by Stone et al. (2005) demonstrated that physical loss of the barrier system and marsh results in a considerable increase in modeled storm surge levels and wave heights. Geomorphic features such as coastal shorelines and barrier islands, as well as coastal marsh and other wetland land masses can block or channelize flows (Working Group for Post-Hurricane Planning for the Louisiana Coast 2006). The area's coastal shorelines are experiencing some of the highest land loss rates in the Nation, due to both natural and man-made factors (USACE 2004).

Barrier beach and surf, dune, supratidal and intertidal wetlands, and swale habitats have undergone substantial loss due to oil and gas activities (e.g., pipeline construction), construction of navigation channels and jetties, subsidence, sea-level rise, and marine and wind-induced erosion. For example, the average long-term erosion rate at Rockefeller Wildlife Refuge was estimated to be 30.9 ft/yr (Connor et al. 2004). Recent estimates of Gulf shoreline recession rates by Kindinger et al (2013) vary from -4.4 feet per year near Hackberry Beach, +8.7 feet per year at Ocean View Beach, -36.1 feet per year at Mermentau Beach and -52.4 feet per year at Rockefeller Wildlife Refuge. (Kindinger et al. 2013). The 9-mile stretch of the Gulf shoreline, starting on the western side of the Calcasieu Ship Channel's gulf outlet and proceeding to approximately two miles west of Holly Beach is presently eroding at a rate of 5 to 30 feet per year and is threatening coastal highways LA 82/27 (source: http://coastal.la.gov/project/cameron-parish-shoreline-protection/; accessed January 6, 2016).

1.4.4 Vegetation Resources

The area consists of open water ponds and lakes, cheniers, Gulf shorelines, and freshwater, intermediate, brackish, and saline marsh. Table 1-9 compares habitat types pre- and post- Hurricane Rita.

Table 1-9: Habitat types by basin in acres.

Habitat Type	Calcasieu/Sabine Basin		Mermentau Basin		Teche/Vermilion Basin	
	2004	2005	2004	2005	2004	2005
Forested Wetlands	0.00	0.00	0.00	0.00	46,080	46,080
Other Land	46,080	45,4400	51,840	38,400	21,760	20,480
Freshwater Marsh	96,000	89,600	281,601	230,401	33,280	32,640
Intermediate Marsh	177,520	163,200	119,680	103,040	122,880	122,600
Brackish Marsh	81,280	78,720	60,800	55,680	82,560	80,640
Saline Marsh	8,960	8,960	26,240	25,600	5,120	5,120
Water	184,961	202,881	202,241	289,281	348,162	353,281
Totals	588,803	588,803	742,403	742,403	659,843	659,843

Gulf Coast Prairie and Forested Terraced Uplands vegetation includes:

- Swamp, found in low-lying areas typically adjacent to waterways, is dominated by cypress and tupelo-gum.
- Riverine habitats along stream and river bottoms and bottomland forests are comprised of water tupelo, willow, sycamore, cottonwoods, green ash, pecan, elm, cherrybark oak, white oak; these are often

interspersed with Chinese tallow. Depending upon the locations, riverine habitats grade into higher elevated and better drained areas comprised of oak-pine forests.

- Oak-pine forest types dominate the better drained areas especially surrounding Lake Charles and Sulfur and include longleaf pine, loblolly pine, slash pine, sweetgum, elm, southern red oak, water oak, black gum and Chinese tallow.
- Pasture and rangelands with mixtures of perennial grasses and legumes (e.g., bermundagrass, Pensacola bahiagrass, tall fescue, and white clover) comprise the majority of the outlying areas surrounding Abbeville, Erath, and Delcambre.

Gulf Coast Marsh consists of back barrier vegetated areas; cheniers; freshwater, intermediate, brackish, and saline marsh; interspersed with bayous, lakes, ponds and other waters some of which may include submerged aquatic vegetation (SAVs). Vegetation typically follows the salinity gradient (O'Neil 1949; Chabreck et al. 1972; Gosselink et al. 1979; Visser et al. 2000).

- Gulf shorelines vegetation includes sea-beach orach, sea rocket, pigweed, beach tea, salt grass, seaside heliotrope, common and sea purslane, marsh-hay cordgrass, and coastal dropseed (LCA 2004, Gosselink et al. 1979).
- Cheniers are live oak-hackberry forests with live oak and hackberry the dominant tree canopy species with other typical species including swamp red maple, toothache tree, green ash, and American elm. Although this forest type is the typical habitat, some areas may be scrub thicket or grasslands (source: http://dnr.louisiana.gov/assets/docs/coastal/227-009-001NG-Chenier-Rpt-DNR.pdf; accessed December 14, 2015; LADNR 2009).
- Marsh types: Visser et al. (2000), expanding on previous studies by Penfound and Hathaway (1938) and Chabreck (1970), classified freshwater marsh in the Chenier Plain as a combination of maidencane and bulltongue arrowhead; intermediate marsh as sawgrass, saltmeadow cordgrass, and California bulrush; brackish marsh as saltmeadow cordgrass, chairmaker's bulrush, and sturdy bulrush; and saline marsh as smooth cordgrass, needlegrass rush, and saltgrass.
- Submerged Aquatic Vegetation (SAV): wild celery, duckweed, pickerelweed, sago pondweed, southern naiad.

Invasive plants include water hyacinth, alligatorweed, hydrilla, common salvinia, giant salvinia, Chinese tallow, Chinese privet, Cogon grass, Johnsongrass, Japanese privet, Japanese honeysuckle, common ragweed, rescuegrass, sticky Chickweek, purple nutsedge, mimosa tree (personal communication Cindy Steyer, NRCS on September 20, 2013). These invasive species compete with native flora for resources such as nutrients and light, community structure and composition, and ecosystem processes. Water hyacinth, common salvinia, giant salvinia, and hydrilla all limit the amount of light penetrating the water column which effects plankton biomass production. Alligatorweed, Chinese tallow and Chinese privet are of minimal wildlife value and can proliferate until nearly monocultural stands exist, limiting food available for wildlife.

***Land Loss* –** The processes of wetland loss can result from the gradual decline of marsh vegetation due to inundation and saltwater intrusion, as well as from storm surge events; both of which can eventually lead to complete loss of marsh vegetation. As marsh vegetation is lost, underlying soils are more susceptible to erosion and are typically lost as well, leading to deeper water and precluding marsh regeneration. Significant accretion of sediments is then required in order for marsh habitat to reestablish. Perhaps the most serious and complex problem in the study area is the rate of land and habitat loss. The Louisiana coastal plain contains one of the largest expanses of coastal wetlands in the contiguous United States and accounts for 90 percent of the total coastal marsh loss in the nation (USACE 2004). Couvillion et al. (2011) analyses show coastal Louisiana has undergone a net change in land area of about -1,883 square miles from 1932 to 2010. Trend analyses from 1985 to 2010 show a wetland loss rate of about 16.57 square miles per year. Table 1-10 displays land area changes in chenier plain basins from 1932-2010 (Couvillion et al. 2011).

Table 1-10: Land area changes in chenier plain basins between 1932 – 2010 (Couvillion et al. 2011)

Date	Calcasieu/Sabine Basin (square miles)	Mermentau Basin (square miles)	Teche/Vermilion Basin (square miles)	Coastwide (square miles)
1932	824.99	958.27	548.94	7,545.92
2010	611.42	803.09	471.57	5,662.71
Change	-213.57	-155.18	-73.37	-1883.21

The effects of recent hurricanes have accelerated marsh loss. Table 1-11 includes estimates of wetland loss attributed to the major hurricanes of 2004 to 2008 in the Chenier Plain and throughout coastal Louisiana. More recently, Palaseanu-Lovejoy et al. (2013) estimated wetland loss in the Hackberry area located in the southwestern part of the chenier plain that was impacted by Hurricane Rita (2005) and Ike (2008). Persistent land loss in the Hackberry area due to Hurricane Rita was approximately 5.8% and increased by an additional 7.9% due to Hurricane Ike. It is expected that the chenier plain has sustained more persistent land loss with intermediate and brackish marshes experiencing the most land loss, while saline marshes were less impacted and fresh marshes showed evidence of vegetation seasonality change and regrowth, which concealed the hurricane impacts.

Table 1-11: Wetland loss estimates in acres (km²) following hurricanes Katrina and Rita (2005) and Gustav and Ike (2008) by geographic province (Barras 2009).

Period	Storms	Chenier Plain	Marginal Delta Plain	Delta Plain	Coastal Louisiana
2004-2006	Katrina + Rita	-72,154 (-292)	-642 (-2.6)	-56,834 (-230)	-129,730 (-525)
2006-2008	Gustav + Ike	-34,347 (-139)	-14,579 (-59)	-30,641 (-124)	-79,815 (-323)
2004-2008	All storms	-106,750 (-431)	-15,320 (-62)	-87,475 (-354)	-209,545 (-848)

1.4.5 Rare, Unique, and Imperiled Vegetative Communities

The following rare, unique, and imperiled communities, documented by the Louisiana Natural Heritage Program (LNHP), are important in that they contribute to the diversity and stability of the coastal ecosystem. Table 1-12 displays information from the LNHP database identifying rare, unique or imperiled vegetative communities. See Appendix A for more detailed information concerning this important resource.

Table 1-12: LNHP rare, unique, or imperiled vegetative communities.

Vegetative Communities	Basins or Parish
Submergent Vascular Vegetation (Marine & Estuarine)	Waters of northern Gulf of Mexico, Vermilion-Teche, Mermentau, Calcasieu and Sabine
Salt Marsh	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Brackish Marsh	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Intermediate Marsh	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Coastal Prairie	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Flatwoods Ponds	Calcasieu Parish
Western Hillside Seepage Bogs	Calcasieu and Sabine
Scrub/Shrub Swamp	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Cypress Swamp	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Bottomland Hardwood Forest	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Batture	Vermilion-Teche
Live Oak Natural Levee Forest	Vermilion-Teche
Bayhead Swamp/Forested Seep	Calcasieu Parish

Table 1-12: LNHP rare, unique, or imperiled vegetative communities.

Vegetative Communities	Basins or Parish
Pine Flatwoods	Calcasieu Parish
Western Longleaf Pine Savannah	Calcasieu Parish
Small Stream Forest	Calcasieu Parish
Coastal Dune Grassland	Mermentau, Calcasieu, Sabine
Coastal Dune Shrub Thicket	Mermentau, Calcasieu, Sabine
Coastal Live Oak-Hackberry Forest	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Western Upland Longleaf Pine Forest	Calcasieu Parish
Western Xeric Sandhill Woodland	Calcasieu Parish
(source: http://www.wlf.louisiana.gov/wildlife/louisiana-natural-heritage-program; accessed December 14, 2015)	

1.4.6 Wildlife Resources

Coastal and especially estuarine wildlife is taxonomically diverse with distributions shaped by landforms, climate, salinity, tides, vegetation, other animals and human activities (Day et al. 1989). Appendix A shows the status, functions of interest, trends, and projections from 1985 through 2050 for avifauna, furbearers, game mammals, and reptiles as adapted from the Coast 2050 report by the Louisiana Coastal Wetlands Conservation and Restoration Task Force (LCWCRTF) and the Wetlands Conservation and Restoration Authority (WCRA 1999). Area estuarine wetlands, cheniers, and barrier habitats have historically provided many different species of birds and other wildlife with shelter, nesting, feeding, roosting, cover, nursery, and other life requirements. These habitats provide neotropical migrants with essential staging and stopover habitat (after Stoffer and Zoller 2004, Zoller 2004). Cheniers attract thousands of trans-Gulf migrant birds during their peak migratory months of April to May and August through October. The majority of these birds fly to and from parts of Mexico, and the cheniers offer the birds an important stop-over on their migration. Millions of ducks and geese use the area from September through February. Over 300 species of birds have been recorded in the area, making this region a popular destination for visiting birders, wildlife photographers, and hunters. However, climate and seasonal availability of resources affect the ways estuaries are used by birds and other wildlife (Day et al. 1989). Vegetated habitats within urban and suburban areas, such as bottomland hardwood (BLH) and swamp habitats along streams, lakes, and other waterways, provide critical breeding bird habitats (Wakeley and Roberts 1996).

Among the several sources documenting Louisiana birds, Lowery (1974) and the U.S. Forest Service (source: http://www.fs.fed.us/land/pubs/ecoregions/ch21.html accessed December 14, 2015) indicate the area supports shorebirds (e.g., piping plover, sandpipers, gulls, stilts, skimmers, and oystercatchers), ducks and geese (e.g., mottled duck, mallard, fulvous tree-duck, pintail, teal, wood duck, scaup, mergansers, and Canada goose); herons, egrets, ibis and cormorants; hawks and owls (e.g., bald eagle, osprey, and barred owl); belted kingfisher; woodpeckers and sapsuckers; marsh birds (e.g., rails and gallinules); and various songbirds (e.g., wrens, flycatchers, swallows, warblers, and vireos). Waterfowl, seabirds, coots, and rail populations are stable within the Calcasieu-Sabine and Mermentau basins [see Appendix A (LCWCRTF & WCRA 1999)].

The bald eagle and brown pelican have increased in populations resulting in de-listing as endangered species. Colonial nesting waterbird rookeries (e.g., herons, egrets, ibis, night-herons, and roseate spoonbills) are found throughout and generally show stable or increasing populations [see Appendix A (LCWCRTF & WCRA 1999)]. Habitat loss and fragmentation is among the most pervasive threats to the conservation of biological diversity (Rosenberg et al. 1997). Area BLH, swamp, and other riverine habitats provide travel corridors for birds and other wildlife connecting populations which have been effected by habitat loss and fragmentation. The greatest threat to birds throughout not only the area, but the entire North American continent, is habitat loss (American Bird Conservancy 2009).

Most estuarine mammals show distributions or behaviors that are related to salinity patterns (Day et al. 1989). Large herbivores and carnivores include manatee, coyote, red wolf, ringtail, and river otter; smaller herbivores include swamp rabbit, fulvous harvest mouse, eastern wood rat, and nutria (source: http://www.fs.fed.us/land/pubs/ecoregions/ch21.html accessed December 14, 2015). Populations of furbearers (nutria, muskrat, mink, otter, and raccoon) and game mammals (rabbits, squirrels, and white-tailed deer) have been stable or increasing [see Appendix A (LCWCRTF & WCRA 1999)]. Prior to the introduction of nutria to Louisiana in 1930s (USGS 2000, Baroch et al. 2002), no invasive wildlife species were known to be present. A substantial population increase of nutria is attributed to the decline in the price of pelts in 1989 (USGS 2000, Baroch et al. 2002). Areas of extensive nutria damage, or "eat outs," alter the composition and habitat type of wetland communities (USGS, 2000). Aerial surveys estimated 80,000 acres of marsh in the State of Louisiana were damaged by nutria (Keddy et al. 2007).

Common species of amphibians and reptiles include the Gulf coast salt marsh snake, Gulf coast toad, pig frog, American alligator, diamondback terrapin, Mediterranean gecko, and Texas horned lizard (source: http://www.fs.fed.us/land/pubs/ecoregions/ch21.html accessed December 15, 2015). The LADNR (2009) observed the following reptiles within the cheniers: the American alligator; turtles (e.g., musk turtle, pond slider, and red-eared slider); snakes (e.g., plain-bellied water snake, banded water snake). Various lizards, and skinks (LADNR 2009). Little is known about amphibian or reptile populations with the exception of the American alligator whose population continues to remain stable. (Source: http://www.wlf.louisiana.gov/general-alligator-information; accessed December 15, 2015). Since 1972, over 700,000 wild alligators have been harvested, over 5.2 million alligator eggs have been collected, and over 2.7 million farm raised alligators have been sold, bringing in an estimated $495,000,000 to the state of Louisiana (LDWF, 2006). According to LDWF scientists, the alligator population dropped significantly between 2008 and 2009. In 2008, more than 43,000 alligator nests were found, while in 2009 only 24,500 nests were found, a 43 percent statewide decrease. This drop in alligator nests is probably the result of saltwater intrusion during Hurricanes Gustav and Ike. A similar trend occurred after Hurricanes Katrina and Rita, with alligator nests decreasing between the 2005 and 2006 surveys. However, the number of nests found increased significantly by 2007.

1.4.7 Aquatic and Fisheries Resources

The area contains a variety of aquatic habitats, including rivers, bayous, canals, lakes, ponds, shallow open water areas, the Gulf of Mexico, and estuarine marsh and embayments. Salinity and habitat structure (SAV, marsh, tidal creeks, deep water, oyster reefs, and benthic substrate) are the primary drivers that affect the distribution of fish and macrocrustaceans throughout the area with three general types: freshwater resident, estuarine resident, and transient marine species. Freshwater species, some of which may tolerate low salinities, generally live in the freshwater portions of the more interior and northern-most regions of the area. Resident species are generally smaller and do not commonly migrate very far. Marine transient species spend a portion of their life cycle in the estuary, generally spawning offshore or in high-salinity bays, and use coastal marshes as nursery areas (Herke 1971, 1995). Species typically found in freshwater areas include: spotted gar, bowfin, largemouth bass, channel catfish, crappie, and gizzard shad. Estuarine-dependent species typically include red and black drum, spotted seatrout, Gulf menhaden, and southern flounder. Typical marine species include king and Spanish mackerel, and cobia.

Plankton communities serve several important roles in coastal waters. Bacterioplankton are primarily decomposers; phytoplankton are the primary producers of the water column, and form the base of the estuarine food web; zooplankton provide the trophic link between the phytoplankton and the intermediate level consumers such as aquatic invertebrates, larval fish, and smaller forage fish species (Day et al. 1989; Thompson and Forman 1987). Biological factors such as predation by nekton and ctenophores, duration of the larval stages of meroplankton, and changes in the aquatic environment brought by the zooplankton populations themselves are important biological factors in the regulation of zooplankton densities (Bouchard and Turner 1976; Conner and Day 1987). Bouchard and Turner (1976) found that salinity largely influenced the distribution of zooplankton. Gillespie (1978) found spring zooplankton peaks were related to temperature. Conner and Day (1987) identified the following factors affecting zooplankton populations: tidal flushing, inflow of freshwater carrying organic detritus, river discharge, water depth, tidal changes, turbidity, and dissolved oxygen.

Gosselink et al. (1979) provide an extensive overview of benthic resources in the area. The bottom estuarine substrate or benthic zone regulates or modifies most physical, chemical, geological, and biological processes throughout the entire estuarine system via what is called a benthic effect (Day et al. 1989). Benthic communities do not have a static structure; rather, they provide a residence for many sessile, burrowing, crawling, and even swimming organisms. Benthic animals are directly or indirectly involved in most physical and chemical processes that occur in estuaries and trophic relationships that occur in aquatic ecosystems (Day et al. 1989). Oysters and mussels from the epibenthic community provide commercial and recreational fisheries and create oyster reef habitats used by many marine and estuarine organisms. A discussion on estuarine benthic organisms and primary consumer groups is in Appendix A. A major link in the aquatic food web between plants and predators is formed by the conversion of plant material (formed in primary production) by benthic detritivores and herbivores to animal tissue (Cole 1975). The salt marsh is a major producer of detritus for both the salt marsh system and the adjacent estuary (Mitsch and Gosselink 2000). In some cases, exported marsh detritus is more important than the phytoplankton based production to the estuary. Detritus export and the sheltering marsh edges make salt marshes important nursery areas for many commercially important fish and shellfish.

Gulf of Mexico nearshore benthic habitats have been more thoroughly studied for longer periods of time, and hence our understanding of status and trends in these areas is greater. Within the Gulf of Mexico four benthic habitats have protracted temporal and synoptic data: oyster reefs, seagrasses, mangroves, and coastal wetlands (NOAA 2013). Mangroves are found only in southeastern Louisiana. Although wigeon grass is common along coastal Louisiana, true seagrass meadows, containing turtle grass, manatee grass, shoal grass and star grass currently occur only east of the Mississippi River near the Chandeleur Islands (source: http://pubs.usgs.gov/sir/2006/5287/pdf/StatewideSummaryforLouisiana.pdf; accessed January 6, 2016). Coastal wetland benthics in the area as referenced above are described in Gosselink et al. (1979), Mitsch and Gosselink (2000), and Day et al. (1989). The American oyster is discussed below.

The American oyster is a keystone estuarine species and has been identified as an ecosystem engineer (Dame 1996). Oyster reefs provide major structural components of estuaries and support more animal life than any other portion of the sea bottom (Bahr and Lanier 1981; Meyer and Townsend 2000; Nelson et al. 2004; Tolley and Volety 2005; Tolley et al. 2005; Boudreaux et al. 2006). The total number and densities of fish, invertebrate and algal species greatly increase in areas containing oyster reefs (Bahr & Lanier 1981). More than 300 marine invertebrate species may occupy an oyster reef at one time (Wells 1961). In addition to increasing species richness, the three-dimensional structure of the reef provides other services such as stabilizing and buffering shorelines from high wave energy (Smithsonian 2001). Because oysters are sessile and pump water through their bodies, they are recognized as good ecosystem monitors. Changes in ecosystem health can be noted over time scales varying from hours to years. Because oysters are continually submersed in environmental conditions, they actively contribute to water quality assessments (Smithsonian 2001). In addition, the chemistry of their shell can provide information on global changes in the environment (Surge et al. 2003). Accordingly, oysters have been used as monitors and indicators of stress in marine ecosystems.

Figure 1-5 shows the location of the oyster reefs Sabine Lake. Calcasieu Lake has been designated by the LDWF as a Public Oyster Tonging Area. More information on oysters including locations of oyster reefs in other areas can be found at the Louisiana Department of Wildlife and fisheries website (source: http://www.wlf.louisiana.gov/fishing/oyster-program; accessed December 14, 2015). The Louisiana portion of Sabine Lake has approximately 34,067 water bottom acres. This area was cleared by the Louisiana Department of Health and Hospitals (LDHH) in March of 2011 for harvesting, but LDWF has not opened a season on this area at this time.

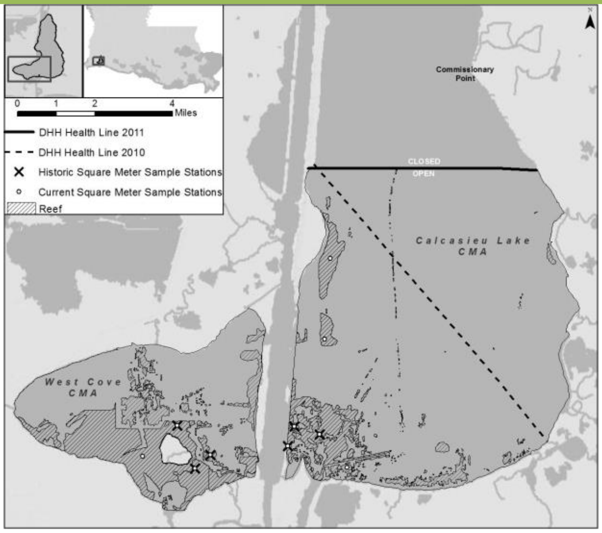

Figure 1-7: The 2011 oyster square meter sampling stations and results within the Calcasieu Lake Public Oyster Area (source: http://www.wlf.louisiana.gov/sites/default/files/pdf/document/37757-stock-assessments/2011_oyster_stock_assessment.pdf; accessed December 16, 2015)

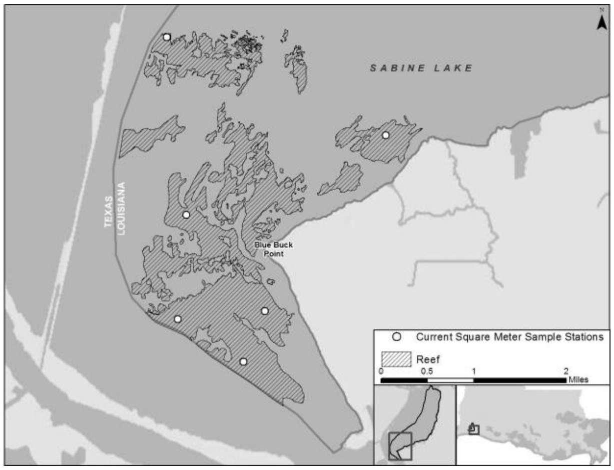

Figure 1-8. Oyster habitat (reef) coverage within the Sabine Lake Public Oyster Area (source: http://www.wlf.louisiana.gov/sites/default/files/pdf/document/37757-stock-assessments/2011_oyster_stock_assessment.pdf; accessed December 16, 2015).

Salinity and submerged vegetation affect the distribution of fish and macrocrustaceans throughout the area with three general types: freshwater, resident, and transient marine species. Freshwater species, some of which may tolerate low salinities, generally live in the freshwater portions of the more interior and northern-most regions of the area. Resident species are generally smaller and do not commonly migrate very far. Marine transient species spend a portion of their life cycle in the estuary, generally spawning offshore or in high-salinity bays, and use coastal marshes as nursery areas (Herke 1971, 1995). See Appendix A for more detailed information concerning fisheries resources including a description of species typically found in freshwater areas.

1.4.8 Essential Fish Habitat (EFH)

Figures displaying EFH for coastal migratory pelagics (king mackerel, Spanish mackerel, and cobia); shrimp (brown, white and pink shrimp); red drum; and stone crab, respectively within the area are provided in Appendix A. Table 1-13 list the EFH for life stages of species.

Table 1-13: EFH life stages in the area (personal communication, NMFS August 29, 2015)

EFH Requirements for Species Managed by the Gulf of Mexico Fishery Management Council: Ecoregion 4, Mississippi River Delta (South Pass) to Freeport, TX.			
Species	**Life Stage**	**System[1]**	**EFH**
Brown shrimp	juvenile	E	<18m; SAV, sand/shell/soft bottom, emergent marsh, oyster reef
White shrimp	larvae/postlarvae	M/E	<82m; pelagi, soft bottom, emergent marsh
	juvenile	E	<30m; soft bottom, emergent marsh
Red drum	larvae/postlarvae	E	all estuaries planktonic, SAV, sand/shell/soft bottom, emergent marsh
	juvenile	M/E	GOM, <5m Vermilion Bay & E; all estuaries SAV, sand/shell/soft/hard bottom, emergent marsh
	adults	M/E	GOM 1-46 m Vermilion Bay & E; SAV, sand/shell/soft/hard bottom, emergent marsh
Lane snapper	larvae	E/M	4-132 m; reefs, SAV
	juvenile	E/M	<20; SAV, mangrove, reefs, sand/shell/soft bottom
	adults	E/M	4-132 m; shoal banks
King mackerel	juvenile	M	<9m; pelagic
Vermilion snapper	juvenile	M	1-25 m; hard bottom
Grey snapper	adult	E/M	0180 m; emergent marsh, soft bottom, hard bottom, sand shell, shoal banks
Cobia	adult/juvenile	M	1-300 m; pelagic
Greater amberjack	adult/juvenile	M	1-360 m; pelagic, drift algae
Atlantic sharpnose shark	neonate/juvenile/adult	M	All nearshore and offshore waters Freeport, TX, to mouth of the Mississippi River
Scalloped hammerhead	neonate	M	All nearshore waters to 30 fathoms; Galveston Bay, Vermilion Bay to West Bay, TX
Bull shark	neonate	M	Estuarine and nearshore waters Freeport to mouth of Sabine River; nearshore waters off west Cameron Parish.
[1]E=Estuarine, M=marine			

1.4.9 Threatened/Endangered Species and Other Protected Species of Concern

There are 10 threatened or endangered species (T&E), and one candidate species known or believed to occur in the area (see Table 1-14) as well as critical wintering habitat for the piping plover and Sargassum critical habitat for loggerhead sea turtles. There are no threatened or endangered plants (personal communication with Ms. Brigette Firmin USFWS, September 20, 2013). A detailed description of T&E species and critical habitats is presented in the supplemental information found in Appendix A and in Appendix A, Annex K.

Table 1-14: Federally listed and candidate species within the area.

Species	Calcasieu Parish	Cameron Parish	Vermilion Parish
*Sprague's pipit (*Anthus spragueii*)	Candidate	Candidate	Candidate
Red-cockaded woodpecker (*Picoides borealis*)	Endangered	NA	NA
Piping plover (*Charadrius melodus*)	NA	Threatened Critical habitat	Threatened Critical habitat
Red knot (*Calidris canutus*)	NA	Threatened	Threatened

Species	Calcasieu Parish	Cameron Parish	Vermilion Parish
**Whooping crane (*Grus americana*)	NA	NA	Threatened
West Indian manatee (*Trichechus manatus*)	NA	Endangered	Endangered
Gulf sturgeon (*Acipenser oxyrinchus desotoi*)	NA	Threatened	Threatened
Green sea turtle (*Chelonia mydas*)	NA	Threatened	Threatened
Kemp's (Atlantic) ridley sea turtle (*Lepidochelys kempi*)	NA	Endangered	Endangered
Leatherback sea turtle (*Dermochelys coriacea*)	NA	Endangered	Endangered
Hawksbill sea turtle (*Eretmochelys imbricata*)	NA	Endangered	Endangered
Loggerhead sea turtle (*Caretta caretta*)	NA	Endangered Critical habitat	Endangered Critical habitat

**Listed as a candidate species until a listing proposal can be prepared by USFWS*
***Designated non-essential experimental population*

Piping plovers winter in Louisiana but do not nest on the coast. Critical wintering habitat encompasses 24,950 acres along 342.5 miles of shoreline, which is most of the coast of Louisiana. Piping plovers arrive from their northern breeding grounds as early as late July and may be present in designated critical wintering habitat for 8 to 10 months of the year. See Appendix A and Annex K for a depiction of piping plover critical habitat in the Project area.

Loggerhead Critical Habitat (*Sargassum* habitat) exists in the southernmost (offshore) portion of the study area. This critical habitat expands the entire length of the project (west to east) with the closest points ranging from approximately four to nine miles offshore. See Appendix A and Annex K, Figure 4-3 for a depiction of Loggerhead sea turtle critical habitat in the Project area.

1.4.10 Cultural and Historic Resources

The cultural history of coastal southwest Louisiana is a very rich one, going back some 10,000 years or more. The general chronological sequence can be summarized as follows: Paleoindian (11,500 - 6,000 B.C.), Archaic (6,000 - 1,500 B.C.), Poverty Point (1,500 - 500 B.C.), Tchula (500 B.C. - A.D. 1), Marksville (A.D. 1 - 400), Baytown (A.D. 400 - 700), Coles Creek (A.D. 700 - 1200), and Mississippian (A.D. 1200 - 1700). The historic period begins at approximately A.D. 1700, and historic perspectives include the Attakapa Indians, first European settlement in Attakapa country, the Acadian migration, the Louisiana Purchase with the western boundary of the United States in dispute until 1819, the Civil War, postbellum period, and the early 20th century.

The study area is located within the Marginal Plain and the Pleistocene Prairie Terrace. Archaeological sites in the southernmost portion of the study area postdate the formation of the Marginal Plain (or Chenier Plain) at the end of the Pleistocene Epoch. Four NRHP listed historic districts, thirty-six NRHP listed standing structures, and seventeen NRHP eligible archeological sites are located within the study area.

An area of potential effects (APE) will be determined for each structure participating in the nonstructural flood risk reduction plan, after which cultural and historic resources, including the preliminarily eligible structures and any additional resources located within the APE, will be identified and assessed for significance and NRHP eligibility. Structures preliminarily eligible for the NED nonstructural flood risk reduction plan are located within the boundaries of two local historic districts as designated by the City of Lake Charles, the Downtown Development District of the Charlestown Cultural District and the Margaret Place Historic District.

An APE will be determined for each of the ecosystem restoration measures recommended for construction, the scope of which would include related project activities. Cultural and historic resources will be identified and assessed for significance and NRHP eligibility. A cultural resources assessment was completed for the ecosystem restoration measures, and it is estimated that less than 15% of the proposed footprint for the measures has been investigated. Thirty-seven archaeological sites have been recorded in the vicinity of proposed measures. The previously recorded sites include: El Nuevo Constante Shipwreck, which has been determined to be eligible for listing in the NRHP; two prehistoric sites that are potentially eligible for listing in the NRHP; and eight sites, three of which date to the 20th century, that have been determined not eligible for listing in the NRHP. The remaining 26 have not been assessed for eligibility. Seven cemeteries have also been identified in the vicinity of proposed measures. Seventy-two standing structures inventoried in the Louisiana Historic Standing Structures Survey are located in the vicinity of the measures. One is potentially eligible for listing in the NRHP, sixty are not likely to be eligible for listing in the NRHP, and 11 are of undetermined eligibility.

The above information is detailed in the report titled Cultural Resources Assessment and Research Design for the Southwest Coastal Louisiana Project, Calcasieu, Cameron, and Vermilion Parishes, Louisiana on file with the Louisiana Division of Archaeology (Wells and Hill 2016). The USACE has elected to fulfill its obligations under Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, through the execution and implementation of two Programmatic Agreements as provided for in 36 CFR Part 800.14(b) (see Appendix A, Annex F).

1.4.11 Aesthetics and Visual Resources

Based on available aerial photography, the visual conditions have changed significantly over the past 20 years due to the growth of urban development and the loss or conversion of swamps into marsh, or open water areas. Comparisons between the 1992 and 2010 photography show that the same public thoroughfares that are in place today were in place then; however, the scenery has changed from natural to a developed state with residential, commercial, and industrial development dominating US-90, I-10, and the state and parish roads surrounding Sulphur and Lake Charles. The areas in Cameron and Vermillion Parish are still relatively rural, giving the viewer near unobstructed views of a native landscape that has remained aesthetically pleasing. Primary view sheds then, as they are today, were best taken from the local road system. There is one identified Scenic Stream, the Calcasieu River, located in the northeastern corner of Calcasieu Parish. The portion of Calcasieu River that qualifies as scenic stretches from the northeastern corner of Calcasieu Parish northeast into Allen Parish (approximately 34 miles). The Calcasieu River flows through a relatively uniform type of mixed pine-hardwood forest of uneven ages on low, rolling, well drained hills. Much of the timberland is grazed by cattle which tend to lower its value for wildlife. The best habitat can be found immediately adjacent to the stream where the area exhibits high habitat diversity.

Access to the area is in abundance with highways and byways crisscrossing the region along with local streets and neighborhoods in the more developed portions. Scenic Byways include the Creole Nature Trail; which traverses State and Parish Highways 82, 27, 384, 385, and 397. This Scenic Byway is both state and federally designated and also has an "All American Road" status, making it significant in culture, history, recreation, archeology, aesthetics, and tourism. Other Scenic Byways include the Zydeco Cajun Prairie Scenic Byway, located just north of Lafayette and the Jean Lafitte Scenic Byway, located just south of Lafayette. Both of these byways carry a state designation only, but are no less significant in their importance to the region in terms of tourism, scenic vistas, recreation, and the local economy. See Appendix A for additional detail concerning aesthetic and visual resources.

1.4.12 Recreation Resources

Recreational features and opportunities vary throughout the coastal zone, habitat, and culture playing significant roles in the diversity of activities. From the games and competitions of Native Americans, to the influence of diverse immigrant cultures, traditional recreation in Louisiana has been a product of its people. Nearly 10,000 years ago, people began living off the ample resources of Louisiana. The means by which Louisiana's early residents lived, hunting and fishing for food, utilizing high ground for camps, and building vessels for transportation, shaped what is now recognized as traditional recreation in southern Louisiana.

State parks within the *Gulf Coast Prairie and Forested Terraced Uplands* physiographic regions include Palmetto Island and Sam Houston Jones parks. Eight boat launches are located within these regions. Access into the

Wildlife Management Areas (WMAs) and refuges is generally by car or boat. Consumptive recreation includes hunting, fishing for freshwater and saltwater species, and trapping alligators and nutria. Non-consumptive recreation includes bird watching, sightseeing, boating, and environmental education/interpretation. Many of the parks offer hiking/biking trails, camping, and picnic shelters. Federal parks within or adjacent to the *Gulf Coast Marsh* physiographic region provide access to high quality recreational resources. From east to west, the region includes national wildlife refuges (NWR), Louisiana state wildlife refuges (WR) and a state wetland conservation area, including: Cameron Prairie NWR, Lacassine NWR, and the 130,544-acre Sabine NWR; nearly 450,000 people visited the NWRs in 2012. The Louisiana 76,000-acre Rockefeller WR and the 71,544-acre White Lake Wetlands Conservation Area. Outside, but adjacent to the region, is Shell Keys NWR, and Louisiana Marsh Island WR, and Cypremort State Park.

In addition to the high quality recreational fishing and hunting in the parks in the Gulf Coast Marsh region, several lakes and inland marshes offer opportunities for hunting and catching both freshwater and saltwater species. Grand, White, and Calcasieu Lakes, and Vermillion Bay are prime fishing spots for recreational species such as redfish and speckled trout as well as flounder and brown and white shrimp. White Lake is a remote open lake and can only be accessed by the Schooner Bayou Canal, the old Intracoastal Canal north of Pecan Island or via the Superior Canal west of Pecan Island. The Calcasieu Lake area offers 10 of the 35 public or private boat launches in the area.

Bird watching is also an important recreational resource. A global initiative of BirdLife International, implemented by Audubon and local partners in the United States, the Important Bird Areas Program (IBAs) is an effort to identify and conserve areas that are vital to birds and other biodiversity. In the NER area, Audubon lists the entire Chenier Plain as a globally IBA (source: http://netapp.audubon.org/iba, accessed December 14, 2015). Many of the IBAs recognized are located within state or federally operated areas. Federal parks within the Chenier Plain that are globally IBAs include Lacassine NWR, Cameron Prairie NWR, and Sabine NWR. Also in the area is the Baton Rouge Audubon Society 40-acre Peveto Woods Sanctuary located along the Louisiana coast in Cameron Parish. The Peveto Woods Sanctuary site is the most heavily birded locale in Louisiana and was the first chenier sanctuary for migratory birds established in Louisiana. Each spring and fall, Peveto Woods hosts most migratory songbirds native to eastern North America (source: http://www.braudubon.org/peveto-woods-sanctuary.php, accessed December 14, 2015). The State of Louisiana owns and operates the White Lakes Conservation Area, Rockefeller WR, and the State Wildlife Refuge (SWR), all located in the Chenier Plain and all globally IBAs as is the Audubon/Paul J. Rainey Wildlife Sanctuary to the west and the Marsh Island Wildlife Refuge to the east. Finally, Palmetto Island State Park is an IBA just north of the SWR.

Designated within Gulf Marsh region is the Creole Nature Trail National Scenic Byway, a 105- mile driving and walking tour touching four state and NWRs and a bird sanctuary. Finally, public and private boat launches are located throughout the entire region.

1.4.13 Noise

Noise, or unwanted sound, may be objectionable in terms of the nuisance, health, or well-being effects it may have upon humans and the human environment, as well as upon animals and ecological systems (Kryter 1994). Generally, noise is a localized phenomenon. There are many different noise sources throughout the area including commercial and recreational boats, and other recreational vehicles; automobiles and trucks, and all-terrain vehicles; aircraft; machinery and motors; and industry-related noise.

1.5 Need for Action

The processes of sea level rise, subsidence, saltwater intrusion, and erosion of wetlands in southwest coastal Louisiana have caused significant adverse impacts, including increased rates of wetland loss and ecosystem degradation. The loss of wetland and marsh habitat also exacerbates the potential for damages to property and infrastructure caused by hurricane storm surge. As hurricanes make landfall, surge from the Gulf of Mexico is pushed further inland since eroded marshes and wetlands that have converted to open water cannot as effectively prevent the surge from encroaching. As surge comes ashore, the potential for damages and potential loss of life is increased. Without action, damages from storm surge are expected to increase. Without action, this highly productive coastal ecosystem, composed of diverse habitats and wildlife, is not sustainable. Infrastructure constructed for access into and across the wetlands has modified the hydrology of the coastal zone, thus facilitating and accelerating saltwater intrusion and fragmentation, and conversion of wetlands to open water. Hurricane surge has formed ponds in stable, contiguous marsh areas and expanded existing, small ponds, as well as removed material in degrading marshes (Barras, 2009). Fresh and intermediate marshes appear to be more susceptible to surge impacts, as observed in Barras (2006).

A wetland morphology model developed by Couvillion et al. (2013) and coupled with other predictive models suggests that under a "future-without-action" condition, coastal Louisiana is at risk of losing between 523,369 acres and 115,571 acres of land over the next 50 years. Soil organic carbon storage (to a depth of 1 m) could decrease by between 108 and 250 million metric tons, a loss of 12% to 30% of the total coastwide soil organic carbon. Couvillion et al. (2013) findings suggest that despite the efficacy of restoration projects in mitigating losses in certain areas, net loss of wetlands in coastal Louisiana is likely to continue. Model results also suggest certain areas may eventually be lost regardless of proposed restoration investment, and, as such, other techniques and strategies of adaptation may have to be utilized in these areas.

Land loss and ecosystem degradation threaten the continued productivity of the area's ecosystems, the economic viability of its industries, and the safety of its residents. The following valuable social and economic resources are at risk:

- Residential and non-residential structures, warehouses, and industrial facilities
- Commercial harvest of fishery resources
- Critical infrastructure such as roads and utilities
- Rice, crawfish, and cattle farming
- Recreational saltwater and freshwater fisheries
- Ecotourism
- Oil and gas production
- Petrochemical industries
- Strategic petroleum reserve storage sites
- The buffering effect intact marshes and cheniers provide against storm surge
- Navigation corridors and port facilities for commerce and national defense, and
- Actual and intangible value of land passed down through generations.

During the NEPA scoping process, stakeholders noted the following problems related to saltwater intrusion:

- As the CSC widens and deepens, salinity levels increase after hurricane storm surge events and farmers have greater difficulty operating their rice farms.
- In the 2006 growing season, farmers were unable to plant because of high salinity levels caused by Hurricane Rita which overtopped local levees built in the 1940s or early 1950s.
- As a result of salinity encroachment in Calcasieu Lake, the Sabine Refuge now contains large open water areas.
- Saltwater intrusion is occurring in the Calcasieu and Mermentau Basins and is in turn negatively impacting the seafood industry. Ship channels in the Calcasieu and Sabine Rivers are allowing saltwater movement into the upper estuaries.

From 2002 through 2013, the area has been greatly impacted by hurricane storm surges associated with three Category 2 or higher hurricanes (Lili, Rita, and Ike) which inundated structures and resulted in billions of dollars in damages to southwest coastal Louisiana. Hurricane surge also causes significant damage to wetlands. The breakup of marshes surrounding the towns and communities is allowing hurricane storm surge and associated inundation to more directly impact habitable areas. As a consequence, a smaller hurricane is able to inflict significant surge-related flooding damages to residential and non-residential structures. As the coastal ecosystem continues to fragment, these losses are expected to increase, thus placing larger populations at risk.

Problems
The people, economy, unique environment, and cultural heritage of southwest Louisiana are at risk due to hurricane storm surge flooding and wave impacts. The area's low elevation, proximity to the Gulf of Mexico, land subsidence, and rising sea level, are expected to exacerbate flooding from hurricane events, shoreline erosion, saltwater intrusion, and loss of wetland and chenier habitats in the future. System-wide problems and opportunities were used to identify and define more geographically specific problems and opportunities.

Problems include the following:

- Flooding from tidal surge and waves associated with hurricanes.
- Increased submergence and inundation of wetlands, resulting in wetland loss.
- Erosion of channel banks and shorelines, resulting in wetland loss.
- Deforestation and mining of chenier ridges.

1.5.1 Significance of Loss of Southwest Coastal Louisiana's "Working Coast"

The first settlers were Native Americans who were present throughout the delta and chenier building processes. These human communities, both prehistoric and modern, have depended on the coastal environment in complex ways. This has always been a working coast. The way of life in coastal Louisiana has evolved over the past 300 years and forms an intricate and vital part of the world's social and natural ecosystems (Gramling and Hagleman 2005). The area is uniquely suited to its current use of sheltering the infrastructure of the navigation, oil and gas, and seafood industries of the region. The 2012 State Master Plan and Coastal Protection and Restoration Authority Board describe the majority of the coast as privately owned. Close working relationships with private landowners are essential, not only for their support, but to gain from their knowledge about private coastal lands (source: http://coastal.la.gov/a-common-vision/master-plan/principles/ accessed December 14, 2015).

- The loss of marsh and wetlands threatens the productivity of the region's coastal ecosystem, the economic viability of industries, and the safety of residents, a marine-resource based economy defined by the interactions of numerous stakeholders engaged in consumptive and non-consumptive uses of coastal resources.
- Southwest Louisiana's "Working Coast" is unique in its scope and scale, with extensive infrastructure needs to serve the navigation, oil and gas, and commercial and recreational fishing industries, which must be balanced and must exist in harmony with each other.
- The loss of marsh and wetlands would threaten nationally significant economic, historical, and cultural and historic resources and have significant negative impacts on the navigation, oil and gas, and seafood industries, and the residents that service these industries.
- The implementation and OMRR&R of the NER RP should be designed so that the users of the resources of the "working coast", may continue use of the resources, including use of the surface, but only to the extent that such uses are practicable and economically justified without impinging upon the purpose, objectives, and sustainability of the features of the NER RP. Impacts of the NER RP on the "working coast" will be more fully addressed in Chapter 3. Chapter 4, and the Real Estate Plan (Appendix E) will address the manner and extent to which the present "working coast" usages of the resources in Southwest Louisiana will be able to continue when the NER features of the RP are implemented.

Navigation

- Wetlands provide protection to several Federal navigation projects, including the GIWW, the Calcasieu River and Pass (providing access to the Ports of Lake Charles and Cameron), Sabine Pass (providing access to Port Arthur, Texas), and Freshwater Bayou (providing access to the Port of Iberia). With the loss of wetlands, the sustainability of the Federal navigation system in the region becomes less reliable and more expensive.

- The Port of Lake Charles is a deepwater seaport, on the U.S. Gulf Coast. The Port is currently the 13th-busiest seaport in the U.S.
- The loss of wetlands would expose Federal navigation channels, and the ports to which they provide access, to increased erosion/shoaling, especially during extreme weather events, and may force the relocation or abandonment of certain channels and port facilities that currently serve the transportation and oil and gas industry requirements of the region and nation.

Oil and Gas (O&G) Infrastructure

- Regional ports serve the area's vast network of offshore oil and gas facilities, including production facilities and an extensive network of pipelines that provide the U.S. with needed energy resources. The area is also home to three of the 11 liquefied natural gas import/export terminals in the U.S.
- The O&G industry encompasses production (active and passive), distribution of products from offshore/near shore sources throughout North America (via vast unseen pipeline distribution network), support service industry, and rig fabrication and service vessel building.
- The area provides O&G to both domestic and international markets through strategically laid pipelines. Even brief interruptions in service have significant impacts to the supply and pricing of gasoline and natural gas throughout the U.S.
- Erosion of wetlands could result in the displacement/damage of the region's strategic O&G industry infrastructure, especially the extensive near-shore pipeline network, resulting in disruption of service and increased repair and maintenance cost. Potential damage to the pipeline network could increase the risk of unintended releases of petroleum products and the resulting ecosystem damage.

Seafood

- Southwest Louisiana has large commercial and recreational fishing industries that are dependent on the region's wetlands.
- The fisheries industry encompasses commercial fishing harvesting, distribution, and processing, fisheries support industry, boat building, and recreation fishing/hunting support (marinas, fishing charter/guide services, camps, bait/tackle shops).

Social

- Developments in the coastal zone are primarily smaller communities that support resource extraction and harvests in the agricultural, energy, and fishing industries.
- While human populations in and near the wetland areas are low, Southwest Coastal Louisiana is a hub of activity supporting the numerous ports, waterways, oil and gas fields, rich fishing grounds, and other elements of a working coast.
- The impact of the loss of wetlands will be felt far beyond the industries directly impacted, with residents that serve these industries, especially the offshore oil and gas industry, being forced to abandon their communities and move further inland.

1.6 Opportunities

Opportunities to address, in part or entirely, the problems include:

- Incorporate structural and nonstructural hurricane and storm surge risk reduction measures solutions to reduce the risk of damages and prevent loss of community cohesion (examples of how this can be accomplished include construction of levees, pump stations, interior drainage, elevating structures, or flood proofing).
- Improve internal system hydrology to restore wetlands (examples of how this can be accomplished include measures such as gates, weirs, or marsh restoration).
- Manage salinity levels to maintain fresh and intermediate marsh (examples of how this can be accomplished include water control structures or modifying hydrology).
- Reduce bank and shoreline erosion (examples of how this can be accomplished include rock armoring or breakwaters).

- Prevent loss of significant cultural and historic resources (examples of how this can be accomplished include levees, marsh restoration, or elevating structures).

1.7 Authorities

The study has both NED and NER components. This stems from two separate authorizations. The NED feature was authorized for the Southwest Coastal Louisiana Feasibility Study by language from the River and Harbor Act of 1962 and from a 2005 House of Representatives Resolution adopted following the impact of Hurricane Rita respectively, as follows:

> *"Surveys of the coastal areas of the United States and its possessions, including the shores of the Great Lakes, in the interest of beach erosion control, hurricane protection and related purposes: Provided, 'That surveys of particular areas shall be authorized by appropriate resolutions of either the Committee on Public Works of the United States Senate or the Committee on Public Works of the House of Representatives."*
>
> And,
>
> *"Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, that, in accordance with Section 110 of the River and Harbor Act of 1962, the Secretary of the Army is requested to survey the coast of Louisiana in Cameron, Calcasieu, and Vermilion Parishes with particular reference to the advisability of providing hurricane protection and storm damage reduction and related purposes to include the feasibility of constructing an armored 12-foot levee along the Gulf Intracoastal Waterway."* (December 7, 2005 – Committee on Transportation and Infrastructure, U.S. House of Representatives, Resolution Docket 2747, Southwest Coastal Louisiana).

Investigation of the NER purpose was recommended in the 2005 Chief's Report for the LCA Ecosystem Restoration Program. The Chenier Plain Freshwater and Sediment Management and Allocation Reassessment Study was one of six large-scale restoration concepts that were purported to have the ability to "significantly restore environmental conditions that existed prior to large-scale alteration of the natural ecosystem" upon construction. The LCA program was authorized in Title VII of the Water Resources Development Act (WRDA) of 2007.

> *"SEC. 7003. LOUISIANA COASTAL AREA.*
> *(a) IN GENERAL. The Secretary may carry out a program for ecosystem restoration, Louisiana Coastal Area, Louisiana, substantially in accordance with the report of the Chief of Engineers, dated January 31, 2005."*

Additional guidance is identified in Section 5007 of WRDA of 2007: Expedited Completion of Reports and Construction for Certain Projects. Guidance provided by the Director of Civil Works on December 19, 2008 states that "*the coastal restoration components proposed as part of the LCA Chenier Plain study will be evaluated as part of the Southwest Coastal Louisiana feasibility study.*"

1.8 Future Without Project Conditions (No Action Alternative)

The second step in the Civil Works Planning process is to develop an inventory of the critical resources (physical, demographic, economic, social, natural etc.) relevant to the problems and opportunities under consideration in the planning area. Then a forecast of the inventory's condition at the future date of the period of analysis (2075) is performed. Those changes in conditions are determined by the impact of all on-going actions, manmade or natural, upon the resources if no alternatives are implemented as part of this evaluation. Section 1.1 described the existing conditions of the affected environment; this section forecasts and reflects the future conditions expected during the 50-year period of analysis if no action is taken. NEPA requires an analysis of the environmental effects from taking no action. The No Action Alternative is the future condition without action and is considered the "future without project" (FWOP) conditions. However, under the future without project conditions that alternative of taking no action is not without impacts from preexisting on-going forces that affect the study area. Therefore, to be consistent with NEPA the following sections reflect the "impacts of taking no action", which for purposes of alternative analysis are compared with the effects of implementing the proposed action alternatives. The difference between the impacts of taking an action and the no-action provides the basis from which alternative plans are evaluated. This analysis provides a benchmark, enabling decision makers to compare the magnitude of environmental effects of implementing an action alternative.

This section presents the future without project conditions for implementing the No Action Alternative. For aesthetic visual resources and noise there would be no direct, indirect, or cumulative impacts resulting from taking no action. As such, these resources are not discussed further.

1.8.1 Human Environment

1.8.1.1 Population and Housing

Changes in population, households, and housing are expected to follow the growth in employment within the area. Recent trend analysis (Moody's Analytics 2008) indicates an increase of 15,000 residents and approximately 5,600 residential structures projected for the area which would impact estimates of employment, as described in the next section. Generally, the overall population is projected to increase. However, the Cameron Parish population is projected to continue its trend of decreasing since 2000 (Table 1-15). It is probable that refined building requirements and updated FEMA base flood delineation following the series of storms between 2000 and 2010 produced a more permanent effect on development in predominantly coastal Cameron Parish. Significant elevation requirements in order to achieve FEMA compliance likely place a significant constraint on future development.

Table 1-15: Projected parish population (in thousands).

Parish	Population		
	2020	2030	2080
Calcasieu	195.0	200	236.7
Cameron	6.6	6.6	3.9
Vermillion	59.9	63	76.8
Total	261.4	269.6	317.4

A single or multiple catastrophic hurricane storm surge event could result in significant damage to economic assets including primarily residential, commercial, and industrial structures. Additionally, property owners could potentially incur higher insurance premiums offered by the NFIP should Flood Insurance Rate Maps (FIRMs) be updated to reflect an increase in risk over time due to RSLR. The Biggert-Waters Flood Insurance Reform Act of 2012 puts in place a process to adjust flood insurance rates for primary residencies to be consistent with flood risk. Under the new legislation, rates for these properties will increase by 25% per year until premiums meet the full actuarial cost, attempting to move the NFIP toward risk-based pricing. The law also phases out subsidies for vacation and second homes, as well as businesses, severe repetitive loss properties, or substantially improved/damaged properties. Properties not currently insured by the NFIP or any lapsed policy also would be subject to full actuarial rates. The subsequent Homeowner Flood Insurance Affordability Act (HFIAA) of 2014 sets aside the immediate implementation of the Biggert-Waters Act provisions for currently insured property owners and also lengthens the period over which insurance rates would ultimately be adjusted. However, all properties covered by the Biggert-Waters Act will be subject to the appropriate conditions of the act, as amended by the HFIAA, upon a change in ownership. Since a significant portion of the study area lies within a Federal Emergency Management Agency (FEMA) designated floodplain these statutory provisions have potential significant ramifications with regard to the relative value, and affordability, of the housing stock in the area, as well as the long-term individual wealth of the population.

FWOP conditions include an increased potential for flood damage to economic assets due to relative sea level rise. As a consequence of this increased flood risk, property owners and the NFIP (if insured) over time would together incur increased costs to repair flood-damaged property. Additional costs to implement appropriate risk reduction measures to address potential increased flood risk from sea level rise would also be incurred. Such actions could include the migration (or displacement) of affected populations from areas exposed to high flood risk to areas with relatively lower flood risk. Migration out of the area could also result from the temporary or permanent relocation of businesses and employment opportunities.

1.8.1.2 Employment, Business, and Industrial Activity (including Agriculture)

FWOP conditions would include a higher potential for temporary interruption or permanent displacement of employment, business, and industrial activity as businesses temporarily or permanently relocate to areas with less hurricane storm surge damage risk. Growth in employment, business and industrial activity is expected to follow national economic trends to the extent that economic growth is dependent upon macroeconomic variables such as inflation, interest rates, and the business cycle. However, employment in this region is also partially dependent on the petroleum exploration, production, and refining industries, which do not necessarily correlate with national economic trends. Employment trends (Moody's Analytics 2008) suggests growth from 2012 to 2038 with an additional 6,880 jobs projected by the year 2038 (Table 1-16). Cameron Parish, employment is expected to stabilize at 2012 levels (Moody's Analytics 2008).

Table 1-16: Projected non-farm employment (in thousands).

Parish	2012	2020	2030	2038
Calcasieu	91.89	96.5	95.5	95.4
Cameron	2.69	2.8	2.7	2.7
Vermilion	16.54	17.7	18.4	19.9
Total	111.12	116.9	116.5	118.0
Source: Moody's Analytics				

One or more series of catastrophic hurricane storm surge events in the future could result in significant disruption to business and industrial activity that could adversely affect employment and population. Such catastrophic events causing significant damage to non-residential, commercial, and industrial structures would likely increase over time as a result of multiple factors such as RSLR and climate change (source: http://www.climatehotmap.org/global-warming-effects/economy.html accessed December 14, 2015). Additionally, business owners in these communities could potentially incur higher flood insurance premiums should the FIRMs be updated to reflect an increase in flood risk over time.

1.8.1.3 Public Facilities and Services

FWOP conditions would include a greater potential for permanent displacement of public facilities and services due to hurricane storm surge events. Public facilities and services are expected to grow with the needs of the population and would follow population growth trends. In addition to the existing 603 public and quasi-public buildings, an additional 193 such facilities are projected by 2080. These projected facilities are expected to be placed at elevations above the 100-year floodplain. Over time, all facilities would be more susceptible to damages resulting from future hurricane storm surge events as RSLR occurs. The increased risk of damage to public facilities and the resulting temporary or potentially permanent relocation of these facilities would have a negative impact on services which would no longer be available either temporarily or permanently.

1.8.1.4 Transportation

Transportation infrastructure would be more susceptible to damages resulting from hurricane storm surge events due to expected RSLR. There would also be reduced access to infrastructure due to hurricane storm surge. For example, LA 82 in Cameron Parish is being eroded by Gulf waves (source: http://www.coast2050.gov/reports/Chap6.pdf; accessed January 7, 2016). A 5-mile-long segment of Louisiana Highway 27 almost totally blocks drainage from the western portion of the Lakes Subbasin of the Mermentau Basin into adjacent wetlands of the Calcasieu/Sabine Basin. Similarly, along the southern boundary of the Lakes Subbasin, LA 82 blocks drainage across 17 miles of marsh. The Freshwater Bayou navigation channel has altered the historic drainage pattern in the eastern portion of the Lakes Subbasin. These numerous blockages of drainage outlets significantly increase ponding in the subbasin (source: https://lacoast.gov/new/About/Basin_data/me/Default.aspx; accessed January 7, 2016).

1.8.1.5 Community and Regional Growth

Income growth and associated community and regional growth are expected to follow trends in national income, local employment, household formation, and the demand for public facilities and services. There would also be a higher potential for unstable or disrupted community and regional growth due to increasing risk of damage from storm surge events.

1.8.1.6 Tax Revenues and Property Values

FWOP conditions would include lower tax revenues as property values decline due to higher risk of damage from hurricane storm surge events over time. The real estate market cycle is the primary factor in establishing existing and future property values at any point in time. However, over the period of analysis (50 years) changes in property values would be primarily reflective of the growth in income. As risk of damage grows over time due to higher hurricane storm surge events as a feature of RSLR, the effects of the higher risk of damage from hurricane storm surge would continue to suppress real estate market values for residential and non-residential properties. As in other coastal regions, higher risk of damage from hurricane storm surge would manifest itself in higher premiums for flood insurance under the NFIP: higher premiums are expected to increase the cost of property ownership and result in correspondingly lower market values. In extreme cases, such premiums are expected to rise to such high levels that the cost of flood insurance would become prohibitively expensive to some property owners. As a result, some properties would not be marketable and their values could be reduced to an extremely low level. To the extent that government assessments of these properties accurately reflect the diminished fair market values, the tax base could be reduced and property tax revenues could decline.

Some property owners would choose to reduce higher expected future risk of damage from hurricane storm surge through activities to mitigate or reduce the potential for those damages to occur. These activities would primarily include, but are not limited to, structure elevation, flood-proofing of commercial structures, and relocation to less risky portions of the study area. Each of these mitigation efforts require substantial financial resources to implement, whether these costs are borne by the property owner or are supplemented, in whole or in part, by public assistance.

1.8.1.7 Community Cohesion

The area would become more susceptible to damage caused by hurricane storm surge events that are projected to increase over the period of analysis. The increased risk of damage from hurricane storm surge to residential and non-residential structures and the resulting temporary and/or permanent relocation of populations would negatively affect the community cohesion in many communities. Additionally there would be a greater potential for reducing community cohesion if the civic infrastructure continues to be damaged as a result of hurricane storm surge events. Community cohesion may also be reduced if residents and businesses relocate to lower-risk areas.

1.8.1.8 Other Social Effects (OSE)

The area's social vulnerability is expected to increase over time if subsidence and sea level rise continue to increase, and the population increases as it is projected to do. The absolute number of socially vulnerable people (e.g., low-income, minority, less-educated, and over the age of 65) at risk for damage from hurricane storm surge events will increase. This, in turn, may lead to an increased burden placed on local, state, and Federal agencies to ensure that the most socially vulnerable populations have access to resources before, during, and after hurricane storm surge events.

1.8.2 Water Environment

1.8.2.1 Relative Sea Level Rise

Sea level rise (SLR) conditions were simulated by incorporating the predicted subsidence levels into the initial water elevation parameter to capture the combined effects of subsidence and local SLR into a single RSLR value. For the 2025 and 2075 hydrologic simulations, RSLR values specific to each gage were added to the 2013 initial water surface elevations (WSE) to calculate the initial WSE appropriate for each year and SLR rate. SLR and RSLR data are shown in Figure 1-6 and listed in Table 1-17. Four gages were used for the entire RSLR analysis (Calcasieu Lock West, Catfish Point, Schooner Bayou, and Leland Bowman Lock East), however only the gage closest to the main area with potential benefits is shown here as an example.

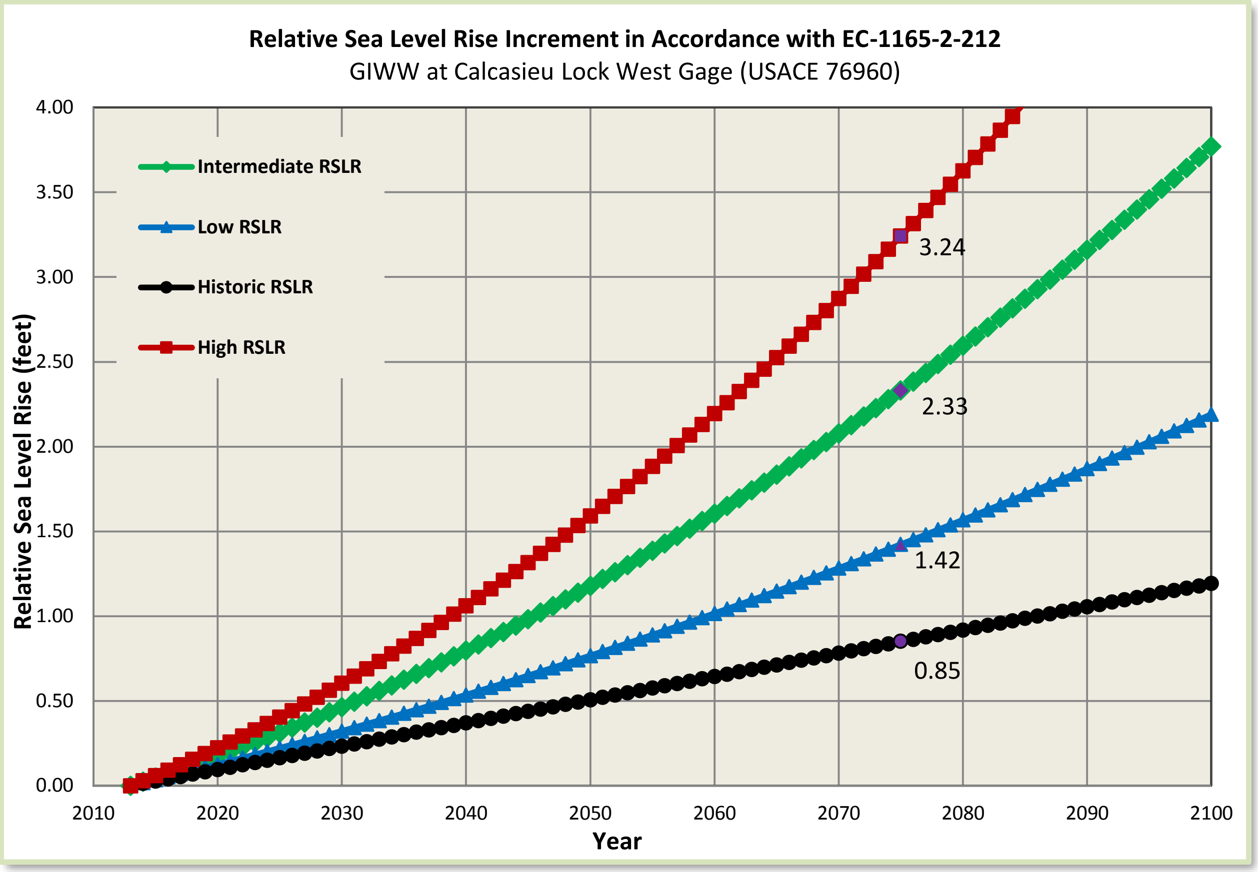

Figure 1-6: Relative sea level rise in the study area.
Historic RSLR rate is based hind cast of the local gauge data

Table 1-17: Predicted RSLR rise rates for the gage on the GIWW west of Calcasieu Lock.

Year and SLR Scenario	Calcasieu West RSLR increment (in feet)	Calcasieu West gage elevations (NAVD88 feet)
2025 Low SLR	0.125	0.222
2025 Intermediate SLR	0.216	0.313
2025 High SLR	0.307	0.405
2075 Low SLR	0.919	1.424
2075 Intermediate SLR	1.827	2.331
2075 High SLR	2.736	3.241

1.8.2.2 Hydrology and Hydraulics

Using the "intermediate" rate of RSLR as a plan formulation assumption is a technique to consider the impacts RSLR could have on the study area both in consideration of NED damages as well as NER ecosystem effects. The intermediate rate was chosen because it offers a balance between potentially unlikely scenarios (i.e. the current trend of RSLR continuing indefinitely and the high rate that could be disastrous for the study area). In the immediate area of Lake Charles, 100-year [1% Annual Chance Exceedance (ACE)] frequency event water levels are estimated to rise between 0.47 ft and 1.19 ft between 2013 and 2075 (see data shown in tables in the Engineering Report - Southwest Coastal Louisiana Explanation of FWOP Results at Appendix B.) In the surrounding marsh areas for all parishes, water levels are estimated to rise between 1.30 ft and 7.40 ft. For the areas along I-10 such as Welsh, Jennings, and Crowley that are far away from any water source connected to the Gulf of Mexico, there is no estimated rise in water surface elevations. This analysis is based upon the intermediate rate of relative sea level rise. Adding marsh accretion raises water levels slightly in the marsh areas, while not impacting any NED areas. More information about the potential effects of RSLR can be found in Appendix O.

1.8.2.3 Flow and Water Levels

Under the FWOP condition there would be the continuation of the existing water flow and water level trends. As existing marsh fragments and is eventually converted to open water, the rainfall runoff from the north and the increasing RSLR would result in the area converting to greater expanses of fragmented marsh and open water. As sea levels rise, existing locks and control structures used for salinity control would be closed on a more frequent basis over time until they would be closed all the time to prevent saltwater intrusion. Natural drainage pattern flow paths would remain unchanged; however, as sea levels rise, drainage times would increase.

1.8.2.4 Water Quality and Salinity

There would be no direct impacts from implementing the No Action Alternative. Indirect impacts would include the continuation of existing water quality trends as described in Section 1.3.6. Without implementing an action alternative there would be an increased risk of damages resulting from flooding of structures within the study area, with drainage of floodwaters containing elevated nutrients, metals, and organics into water bodies connected to the Calcasieu, Mermentau, and Tech-Vermillion river basins. Into the future the area would be affected by existing and proposed restoration measures, chenier geomorphologic processes, development (in particular, oil and gas development in the Calcasieu River basin and agriculture in the Mermentau River basin), and climate patterns (Mousavi et al., 2011).

1.8.3 Natural Environment

1.8.3.1 Sedimentation and Erosion

FWOP conditions would include persistence of current sedimentation and erosion patterns. Existing hydrologic alterations would continue to affect water levels and salinities and continue influencing land loss at similar or increased rates. RSLR would expose additional shoreline areas to erosive forces into the foreseeable future. Couvillion et al. (2013) predict coastal Louisiana is potentially at risk of losing between 2,118 and 4,677 km^2 of land over the next 50 years. This would be a potential loss of between 14.6% and 32.3% of the remaining coastal wetlands in the state over the next 50 years (exclude Atchafalaya Basin). The uncertainty range for wetland change projections represents anywhere from a 32.2% reduction to a 49.6% increase in the average wetland loss rates experienced from 1932–2010 (Couvillion et al., 2011). These results suggest that a net wetland loss in coastal Louisiana over the next 50 years would likely occur regardless of uncertainties in parameters that influence coastal wetland loss.

Table 1-18: Net land area change (km^2) projections by basins in the study area (source: Couvillion et al. 2013)

Basin	Land Area 2010 (km^2)	Land Area 2060 (km^2)	Net change 2010-2060 (km^2)
Calcasieu/Sabine	1495.0	1348.5	-146.5
Mermentau	1914,1	1706.0	-208.5
Teche/Vermilion	1239.4	1172.4	-67.0
Total Louisiana Coast	16,793.8	14693.0	-2100.8

1.8.3.2 Soils, Water Bottoms, and Prime and Unique Farmlands

The FWOP conditions would be the continuation of existing conditions with coastal shoreline recession, subsidence and land loss continuing at similar or increasing rates of change with concomitant increase in shallow open waterbottoms. As RSLR increases and areas become inundated by salt water, prime farmlands could be lost. As human populations and development increase, prime farmlands could be converted to suburban, urban, and industrial uses and areas available for agricultural use would decrease. Gulf shoreline recession rates, varying between +8 ft to -52.9 ft per year, would result in Gulf shoreline rollover onto interior marshes, the loss of cheniers throughout the study area due to subsidence, and change in land use patterns from forested areas to agriculture and grazing pasture. Soils identified as prime farmlands on chenier ridge tops would also be susceptible to flooding events and subsidence and could be lost as RSLR increases.

1.8.3.3 Gulf Coastal Shorelines

The FWOP conditions would be the continuation of existing conditions with coastal shoreline recession, subsidence and land loss continuing at similar or increasing rates of change. For example, from 1984 to 2010 the Rockefeller WR shoreline change rate was -43.4 acres per year or 0.056% per year; and Freshwater Bayou/North Pecan Island change rate was -111 acres per year or -0.308% (Appendix A, Annex W), Hypertemporal Subunit Change Rate and Map). The loss of these coastal shorelines would adversely affect the extraordinary scenic, scientific, recreational, natural, historical, archeological, cultural, and economic importance of the coastal shorelines. The continued loss of coastal shorelines would result in the reduction and eventual loss of the natural protective storm buffering. Without the protective buffer provided by the coastal shorelines, interior estuarine wetlands would be at an increased risk to severe damage from hurricane storm events. Continued shoreline recession, subsidence and land loss resulting in the movement of unstable sediments would undermine man-made structures, especially the extensive oil and gas pipelines and related structures in this "working coastline."

1.8.3.4 Vegetation Resources

The FWOP conditions would be the continuation of existing conditions and factors driving trajectories of ecological change to area vegetation zones. Without an extensive ecosystem restoration plan, marsh habitat may continue to be restored through other restoration projects and programs such as those authorized for construction through the CWPPRA, the Coastal Impact Assistance Program (CIAP), and LCA, but not on a large and broad enough scale to completely restore natural processes and features vital to the long-term sustainability of the watershed. (Note, however, that the CWPPRA project authority, absent Congressional amendment, will end in 2019. However, recent approval for the trust fund that funds projects has been approved for an additional five years (personal communication, Brad Inman USACE CWPPRA Lead Manager, January 28, 2016). Additionally, funding approved for construction of CWPPRA projects may be reduced in the intervening years before the expiration of the CWPPRA authorization as the Task Force addresses funding requirements to OMRR&R constructed CWPPRA projects for the remainder of their project life. Finally, some LCA projects, such as the LCA BUDMAT project authority is presently subject to a Federal cost cap; therefore, unless that project authority is amended, construction of future LCA BUDMAT projects will be limited by the existing cap on Federal expenditure.) Without action, the coastal vegetated resources would continue to decline, including bankline erosion and sloughing of the shoreline, and continued fragmentation and conversion of existing brackish and saline marsh to shallow open water habitats. Both human-induced impacts and natural processes would contribute to the continued loss of vegetated habitats, including continued shoreline erosion and subsidence, increased saltwater intrusion, increased water velocities, and increased herbivory. Table 1-19 displays the predicted acreage loss of different wetland types in southwest coastal Louisiana by the year 2050. Net marsh loss by 2050 is expected to be 97,505 acres (Coast 2050 Report, 1999).

Table 1-19: Predicted acreage loss of different wetland types in study area (Coast 2050 Report 1999).

SOUTHWEST COASTAL LOUISIANA	Fresh Marsh lost by 2050 (acres)	Intermediate Marsh lost by 2050 (acres)	Brackish Marsh lost by 2050 (acres)	Saline Marsh lost by 2050 (acres)	Net Marsh loss by 2050 (acres)
Mermentau Basin	34,885	9,080	14,620	525	59,110
Calcasieu/Sabine Basin	2,640	11,555	23,770	430	38,395
Totals	37,525	20,635	38,390	955	97,505

Gulf Coast Prairie and Forested Terraced Uplands:

- Some unknown extent of existing riverine BLH and associated swamp habitats would be converted to more efficient water conveyance channels as human populations and development increase.
- Some unknown extent of existing pasture and rangelands would be converted to rural, suburban and urban human habitats, generally in the order presented, as human populations and development increase.

Gulf Coast Marshes

- Habitat switching would occur due to increasing sea level rise, subsidence, shoreline erosion and other land loss drivers.
- Gulf shoreline recession rates, varying between +8 ft to -52.9 ft per year, would result in Gulf shoreline rollover onto interior marshes thereby converting these existing habitats to barrier shorelines.
- Chenier ridge habitat has been lost throughout the southwest coastal area due to subsidence and change in land use patterns from forested areas to agriculture and grazing pasture. Other anthropogenic activities have affected the extent of chenier habitat such as sand mining though much of this activity has decreased significantly. The open areas on the chenier ridges would continue to be maintained as agricultural or pasture land hence native or invasive scrub shrub habitat would be limited.
- Inland ponds and lakes shoreline loss rates, varying between 3.6 ft and 9.3 ft, would result in conversion of existing salt, brackish, and intermediate/fresh marsh to shallow open water habitats.
- Habitat switching of interior marsh could result from saline intolerant dominant species to species that can tolerate higher salinities.
- SAVs could become lost due to erosive forces and increased sedimentation due to land loss.

1.8.3.5 Rare, Unique, and Imperiled Vegetative Communities

Existing conditions and trends of land loss are expected to continue resulting over time in the loss of these valuable vegetative communities. For example, without action, saltwater intrusion and drainage problems would continue, resulting in the conversion of freshwater marsh to intermediate and brackish marsh and eventual open water.

1.8.3.6 Wildlife Resources

Existing conditions and changes caused by ecosystem drivers would persist. RSLR, human encroachment and development, and other factors would result in loss of existing wildlife estuarine, chenier, riverine, and oak-pine forest habitats. Increases in RSLR would increase saltwater intrusion and exacerbate ongoing conversion of estuarine wetlands to shallow open water. As habitat loss continues, migratory Neotropical avian species would have less suitable stopover habitat forcing them to fly further to suitable habitat. Flying longer distances to find suitable stopover habitat could result in an increase in mortality resulting in a corresponding reduction in overall species diversity and abundance. Most mammalian, amphibian, and reptilian species would migrate to more suitable habitats. Subject to the above described limitations of the CWPPRA and LCA programs, wildlife would benefit from restoration activities implemented by other programs such as CIAP, CWPPRA, LCA and the beneficial use of dredged material; however these activities are not enough to keep up with the current trends in habitat loss and RSLR.

1.8.3.7 Aquatic and Fisheries Resources

Existing conditions and associated changes due to ecosystem drivers, as described in Section 1.4.7, would persist into the future. Increases in RSLR would increase saltwater intrusion and exacerbate ongoing conversion of estuarine wetlands to shallow open water and loss of existing estuarine fish habitats. Increases in RSLR could exacerbate ongoing conversion of existing aquatic organism distributions from an estuarine-dependent to more marine-dependent distribution. As habitat loss continues, there would be a corresponding reduction in overall species diversity and abundance as well as loss of estuarine nursery, foraging, refugia, and other estuarine aquatic habitats. Subject to the above described limitations of the CWPPRA and LCA programs, aquatic and fisheries would benefit from restoration activities implemented by other programs such as CIAP, CWPPRA, beneficial use of dredged material; however these activities are not enough to keep up with the current trends in habitat loss and RSLR.

1.8.3.8 Essential Fish Habitat (EFH)

Existing trends and continued shoreline erosion, subsidence, and land loss, as described in Section 1.4.8 and Appendix A, Annex W would continue to convert existing estuarine EFH to marine and open water EFH types resulting in the loss of existing estuarine EFH but an increase in the open water and marine EFH.

1.8.3.9 Threatened/Endangered Species and Other Protected or Species of Concern

Land loss would directly reduce the availability of habitat for threatened and endangered species. Sprague's pipit populations could decline due to habitat conversion to seeded pasture, hayfield, and cropland, as well as overgrazing by livestock. Moreover, management favoring intensive cattle grazing and reduced fire frequency may lead to the degradation of remaining suitable grassland tracts over much of their range. Without proper fire intervals, shrubs and excessive vegetation litter may reduce habitat quality; in addition, grasslands may eventually succeed to shrubland or savannah (source: http://www.fws.gov/mountain-prairie/species/birds/spraguespipit/SpraguesJS2010r4.pdf; accessed December 17, 2015). Red-cockaded woodpeckers require open pinelands and savannahs with large old pines for nesting and roosting habitat. Foremost among the limiting factors for the red-cockaded woodpecker is suitable nesting habitat and lack of cavity trees, habitat fragmentation, and degradation of foraging habitat through fire suppression. Continued and extensive coastal land loss would continue to reduce the availability of transitional estuarine marsh and chenier forest habitats for use by threatened and endangered species. Piping plover would lose access to some forage and roosting habitat as it shifts to shallow open water. As interior marshes are lost, shoreline retreat rates increase. The coastal habitat utilized by sea turtles would continue to be impacted from this accelerated shoreline retreat rate. The continued erosion of the Gulf coast shoreline would result in additional salt water intrusion into the interior wetlands area resulting in additional marsh loss. Conversely, the recently delisted brown pelicans would gain access to more shallow water foraging areas, resulting from the shoreline retreat. Indirect effects would be the continued reduction of piping plover critical wintering habitat due to coastal erosion. Without action there would be the continued degradation and loss of emergent wetland habitats used by many different fish and wildlife species for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements. The loss and deterioration of transitional wetland habitats over time could continue to indirectly affect, to an undetermined degree, all listed species that may potentially utilize the area including: Gulf sturgeon, piping plovers, red knots, green sea turtles, Kemp's Ridley sea turtles, loggerhead sea turtles, hawksbill sea turtles, leatherback sea turtles, and the West Indian manatee. The recovery of some sensitive/delisted species such as brown pelican, bald eagle, and colonial nesting birds could be indirectly impacted if habitat loss goes unabated.

1.8.3.10 Cultural and Historic Resources

Impacts to cultural and historic resources in southwest Louisiana have resulted from both natural processes, such as erosion and reworking of archaeological deposits, and human activities, such as land development, dredging, agriculture, and vandalism. Coastal environments are dynamic, and impacts to cultural and historic resources in the area would continue as a result of both natural processes and anthropogenic modifications of the landscape.

1.8.3.11 Recreation Resources

Recreational resources in the Louisiana coastal zone that would be most affected are those related to loss of wetlands/marshes and habitat diversity. Many recreational activities are based on aquatic resources and directly related to the habitat and species in an area.

Gulf Coast Prairie and Forested Terraced Uplands: Indirectly, recreational infrastructure would remain vulnerable to surges. Another major consequence of hurricane storm surge is land loss and the possible loss of facilities and infrastructure that support or are supported by recreational activities. Land loss can result in the loss of park land, boat launches, parking areas, access roads, as well as marinas and supply shops. In general, without continued comprehensive ecosystem restoration efforts across the study area, further degradation of area marshes would continue and its associated negative effects on recreational activities will increase. Additionally, saltwater intrusion and predicted RSLR will continue to cause land loss. As existing freshwater wetland/marsh areas convert to saltwater marsh, then to open water, the recreational opportunities will change accordingly.

Gulf Coast Marshes: Indirectly, the continued loss of wetlands/marshes and habitat diversity affects recreational opportunities. Storm surge and saltwater could influence freshwater forests and habitats and could reduce recreational resources (e.g., fishing, hunting, bird watching, and other). In general, further degradation of area marshes would continue and its associated negative effects on recreation activities would increase. As existing freshwater wetland/marsh areas convert to saltwater marsh, then to open water, the recreational opportunities would change accordingly. For example, freshwater fishing opportunities may be expected to become saltwater opportunities. If the expected peak and then decline of fishery production occurs in these open waters, then the associated marine-fishery recreational opportunities would also decline. As populations of migratory birds and other animals dependent on marsh and swamp decrease, again associated recreational opportunities, such as hunting and wildlife viewing, would decrease. There may be an economic loss felt by marinas and other shops, which may be two-fold. One is losing the actual facility or access to the facility, the other is change in opportunities. Habitat change and resulting changing recreation opportunities (i.e., fresh to marine) may, for example, severely impact a marina specializing in services to particular types of recreation (i.e., loss of freshwater opportunities).

1.8.3.12 Noise

There would be no direct, indirect, or cumulative effects to noise.

1.9 Cumulative Impacts for Future Without Project Conditions (No Action Alternative)

Cumulative impacts would be the incremental direct and indirect effects of not taking action to address hurricane storm surge damage risk reduction or ecosystem restoration on the human, water and natural environment resources, in addition to the direct and indirect impacts of other past, present and reasonably foreseeable future actions (40 CFR § 1508.7) on these important resources. In the FWOP conditions, the following human, water and natural environmental important resources would continue to be at risk.

Human Environment

- An estimated population increase of 225,000 and 15,000 residential structures in the study area in the year 2075 would remain at risk of hurricane storm surge damage;
- Employment of 106,000 workers in the three-parish area in the year 2010; 1,580 non-residential structures in the study area by 2075; 808,414 acres of agricultural land within the three-parish area in 2009; projected 603 public and quasi-public buildings, and an additional 193 such facilities projected by 2080 would remain at risk of hurricane storm surge damage;
- Transportation infrastructure would be more susceptible to damages resulting from hurricane storm surge events due to expected RSLR and loss of coastal wetlands;
- Infrastructure would remain at risk and continue to experience reduced access due to hurricane storm surge damage and loss of coastal wetlands;
- Community and regional growth would remain at risk of continued hurricane storm surge damage;
- Tax revenues and property values would remain at risk due to continued hurricane storm surge damage and continued erosion, fragmentation and eventual loss of coastal wetlands;
- Expected higher flood insurance premiums would be expected to increase the cost of property ownership and result in correspondingly lower market values;
- Continued or increased risk of damage to residential and non-residential structures resulting in temporary and/or permanent relocation of populations would negatively affect the community cohesion in many communities;
- Continued temporary displacement of minority and/or low-income populations because residents within the area would remain vulnerable to flooding from hurricane storm surge and may be forced to relocate to areas with risk reduction measures in place;

- Continued higher risks of damage from hurricane storm surge would manifest itself in higher premiums for flood insurance under the NFIP;
- Continued shoreline recession, subsidence, and land loss would result in the movement of unstable sediments and would undermine man-made structures, especially the extensive oil and gas pipelines and related structures in this "working coastline."

Water Environment

- Existing hydrologic alterations would continue to impact water levels and salinities and continue influencing land loss at similar or increased rates;
- As sea levels rise, natural drainage pattern flow paths would remain unchanged but drainage times would increase;
- Continued salt water intrusion and inundation during hurricane storm surge events;
- Continued erosion by wave and current action resulting in continued shoreline erosion of most channels, lakes, and the Gulf.

Natural Environment

- Degradation, fragmentation and continued loss of soil resources, especially coastal wetlands would continue into the FWOP condition. The LCA Study (USACE, 2004) estimated coastal Louisiana would continue to lose land at a rate of approximately 6,600 acres per year over the next 50 years. It is estimated that an additional net loss of 328,000 acres may occur by 2050, which is almost 10 percent of Louisiana's remaining coastal wetlands. More recently, Couvillion et al (2013) estimated that between 2010-2060 coastal Louisiana would show a net change of -519,119 acres with the Calcasieu/Sabine basin showing a net change of -36,201 acres, Mermentau basin a net change of -51,521 acres and the Teche/Vermilion basin with a net change of -16,556 acres. However, wetland soil losses would be offset to some extent by restoration projects implemented through other programs;
- Continued increases in RSLR could increase saltwater intrusion and exacerbate ongoing conversion of existing estuarine wetlands to shallow open water;
- Impacts to cultural and historic resources in coastal Louisiana would continue as a result of both natural processes and cultural modifications of the landscape;
- Recreational infrastructure and consumptive recreational opportunities would remain vulnerable to damage from hurricane storm surges;
- Continued conversion of existing vegetated wetlands used as foraging, nesting, and over-wintering habitat to open water habitats;
- Reduction in overall species diversity and abundance as well as loss of estuarine nursery, foraging, refugia, and other estuarine aquatic habitats;
- Continued bankline erosion with sloughing, fragmentation and continued degradation of shorelines;
- Continued encroachment of salinity into fresher areas of brackish and freshwaters;
- Continued habitat switching by organisms due to continued fragmentation, degradation and loss of transitional estuarine habitats due to increasing RSLR, subsidence, shoreline erosion, and other land loss drivers; and
- Loss of existing transitional estuarine and chenier habitats would further stress species that are dependent on these habitats for all or a part of their life cycle.

The future without project risks to the important resources in the human, water and natural environment could be offset, to some undetermined degree, by other hurricane storm damage risk reduction projects and ecosystem restoration efforts. The Future Without Conditions are the same as described in Chapter 3, Section 3.4, *Reasonably Foreseeable Actions* subsections.