DRAFT

ENVIRONMENTAL APPENDIX D

GULF INTRACOASTAL WATERWAY
BRAZOS RIVER FLOODGATES AND COLORADO RIVER LOCKS SYSTEMS FEASIBILITY STUDY

US Army Corps of Engineers ®

Texas Department of Transportation ®

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Acronyms and Abbreviations

Acronym or Abbreviation	Definition or Meaning
AAHU	Average Annual Habitat Units
APE	Area of Potential Effect
BG	block group
BGEPA	Bald and Golden Eagle Protection Act
BMP	best management practice
BRFG	Brazos River Floodgates
CAA	Clean Air Act
CAP	Climate Action Plan
CBRA	Coastal Barrier Resources Act
CBRS	Coastal Barrier Resources System
CCC	Coastal Coordination Council
CEPRA	Coastal Erosion Planning & Response Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO	carbon monoxide
CRL	Colorado River Locks
CT	census tract
CWA	Clean Water Act
dB, dBA	Decibels, A-weighted decibels
DHHS	Department of Health and Human Services
DMPA	dredged material placement area
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EO	Executive Order
EPA	Environmental Protection Agency (U.S.)
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration

Acronym or Abbreviation	Definition or Meaning
FIRM	Flood Insurance Rate Map
FMC	Fishery Management Council
FMP	Fishery Management Plan
FPPA	Farmland Protection Policy Act
FR	Feasibility Report
FTA	Federal Transit Authority
FWOP	Future Without Project
GHG	greenhouse gas
GIWW	Gulf Intracoastal Waterway
GLO	General Land Office (Texas)
GMFMC	Gulf of Mexico Fishery Management Council
GPM	gallons per minute
HAPC	Habitat Areas of Particular Concern
HEP	Habitat Evaluation Procedures
HGB	Houston-Galveston-Brazoria
HU	Habitat Units
H&H	hydrology & hydraulics
HRSR	historic resources survey report
HIS	habitat suitability index
HTRW	Hazardous, toxic, and radioactive waste
HUC	Hydrologic Unit Code
MAMP	Monitoring and Adaptive Management Plan
MBTA	Migratory Bird Treaty Act
MHHW	Mean Higher High Water
MHW	Mean High Water
MLLW	Mean Lowest Low Water
MLW	Mean Low Water
MMPA	Marine Mammal Protection Act
MSL	mean sea level
MTL	mean tide level
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NO_x	nitrogen oxides
NO_2	nitrogen dioxide
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NWR	National Wildlife Refuge
ODMDS	ocean dredged material disposal site
O&M	operations & maintenance

Acronym or Abbreviation	Definition or Meaning
OMMR&R	Operations, maintenance, repair, replacement, and rehabilitation
OSHA	Occupational Safety and Health Administration
O_2	oxygen
Pb	lead
PCB	polychlorinated biphenyls
PDT	Project Delivery Team
PED	Pre-construction, engineering, and design
PM_{10}, $PM_{2.5}$	particulate matter
Ppt	parts per thousand
RHA	Rivers and Harbors Act
RIBITS	Regulatory In-lieu Fee and Bank Information Tracking Information System
RRC	Railroad Commission (Texas)
RSLC	relative sea level change
SAL	State Antiquities Landmark
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SO_2	sulfur dioxide
TASA	Texas Archeological Sites Atlas
TCEQ	Texas Commission on Environmental Quality
TCMP	Texas Coastal Management Plan
THC	Texas Historical Commission
TIPPC	Texas Invasive Plant and Pest Control
TPWD	Texas Parks and Wildlife Department
TWDB	Texas Water Development Board
TxDOT	Texas Department of Transportation
TXNDD	Texas Natural Diversity Database
U.S.	United States
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
U.S.C.	United States Code
VOC	volatile organic compounds
WMA	Wildlife Management Area
WRDA	Water Resources Development Act
WWTP	wastewater treatment plant

1.0 INTRODUCTION

The United States Army Corps of Engineers (USACE), in cooperation with the Texas Department of Transportation (TxDOT) Maritime Division, is conducting the *Gulf Intracoastal Waterway (GIWW), Brazos River Floodgates and Colorado River Locks Systems Feasibility Study* to determine the feasibility of modifying the Brazos River Floodgates (BRFG) and Colorado River Locks (CRL) to reduce navigation impacts and costly waterborne traffic delays that are a result of aging infrastructure and inadequate channel dimensions. As part of the Feasibility Study, the USACE has prepared a Draft integrated Feasibility Report and Environmental Impact Statement (DIFR-EIS) in compliance with the National Environmental Policy Act (NEPA), USACE regulation ER-200-2, 33 Code of Federal Regulations (CFR) 230, the Flood Control Act of 1970 – Section 216, and other Federal, state, and local environmental policies and procedures.

This environmental report supplements and provides more detail to the environmental sections included in the DIFR-EIS. This report summarizes the alternatives considered and the Recommended Plan, describes baseline environmental conditions in the study areas, and analyzes anticipated future without project (FWOP) conditions and environmental consequences of each alternative considered. More detailed information on how the alternatives were developed is provided in the DIFR-EIS.

2.0 BACKGROUND

The GIWW is a 1,300-mile-long, shallow-draft, man-made protected waterway that connects ports along the Gulf of Mexico from St. Marks, Florida, to Brownsville, Texas. The authorized channel dimensions are 125 feet wide and 12 feet deep. The GIWW is an essential component of the transportation network of Texas and the nation, reducing congestion on highway and rail systems, thereby decreasing maintenance costs and extending the life of these transportation systems. Compared to truck or rail transport, the use of barges to transport goods produces fewer air emissions, is more fuel-efficient, and provides a safer mode of transportation. The GIWW is also used by the commercial fishing industry and for recreational activities such as fishing, skiing, sightseeing, and traveling long distances in the protected waterway (TxDOT 2016).

The BRFG and CRL are two lock-type structures on the GIWW located about 40 miles apart on the upper to mid-Texas coast, in Brazoria and Matagorda Counties, respectively (**Figure 2.1**). They were initially installed in the early 1940s to prevent heavy sediment loads in the Brazos and Colorado Rivers from entering the GIWW. The structures are over 60 years old and were installed at a time when most tug boats pulled barges behind them, rather than using the modern pushing method. At each facility, the gate openings are 75 feet wide, which is much narrower than the 125-foot-wide GIWW navigation channel. Although regulations restrict the width of tows to 55 feet, oversize tow permits are routinely granted for tows as wide as 108 feet, particularly along the upper Texas coast (TxDOT 2016). To move these wider tows through the BRFG and CRL, vessel operators must park the tows, break the barges apart, move them through the locks in smaller sets or individually, and reconnect the tows on the other side. This process, known as "tripping," is inefficient and causes delays that result in substantial costs to the towing industry each year (TxDOT 2013). In addition to the narrow gates, high flows in the Brazos and Colorado Rivers make navigation through the BRFG and CRL structures more difficult and result in temporary navigation restrictions and/or closures imposed by the USACE and U.S. Coast Guard. These restrictions and closures result in additional delays and economic impact to the towing industry.

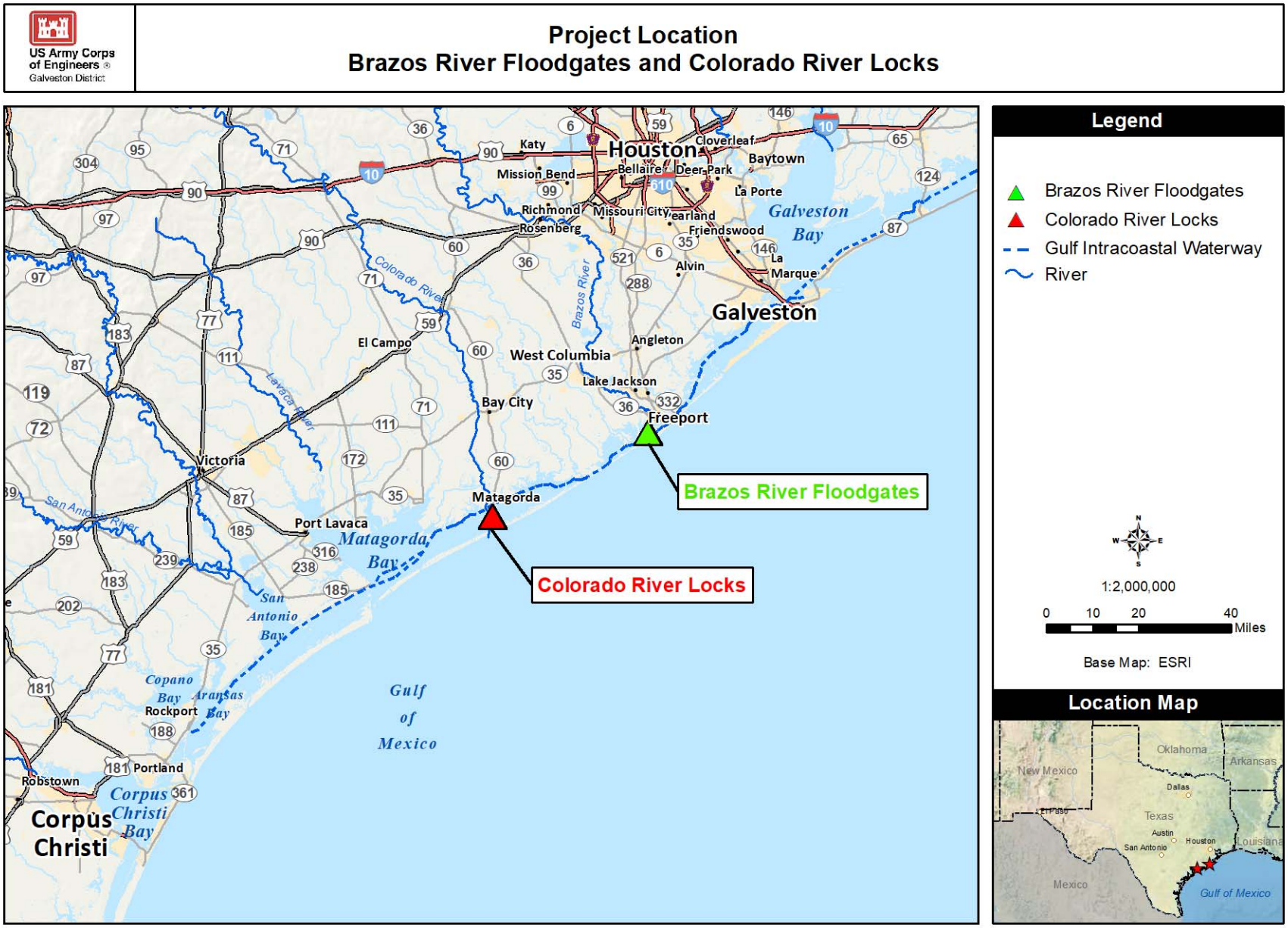

Figure 2.1 Project Location

3.0 SUMMARY OF ALTERNATIVES CONSIDERED AND RECOMMENDED PLAN

Chapter 3 of the DIFR-EIS describes the alternatives that were evaluated for the project, but the alternatives are also summarized here for reference. Early on in alternatives development, the USACE and TxDOT identified a number of alternatives that involved various measures to improve navigation through the BRFG and CRL facilities. Through multiple screening efforts, the USACE and TxDOT narrowed the reasonable alternatives to the No Action Alternative and five Action Alternatives at the BRFG facility, and the No Action Alternative and three Action Alternatives at the CRL facility. In an effort to minimize environmental impacts, the disturbance areas associated with the reasonable alternatives are located in and adjacent to the existing GIWW, BRFG, and CRL facilities. The USACE and TxDOT further evaluated these alternatives through hydrology and hydraulics (H&H) modeling, economic analysis, and environmental analysis to identify a Recommended Plan. **Table 3.1** lists the alternatives, provides a general overview of each alternative, and provides an estimated area that would be affected by the alternative.

Table 3.1 Summary of BRFG and CRL Alternatives Considered

Alternative	Alternative Overview	Estimated Acreage Affected	Recommended Plan?
BRFG Alternatives			
No Action	No improvements would be made to the BRFG facility. Normal maintenance activities would continue.	0	No
2a	Rehab Existing Facilities – Rehabilitate existing floodgates, guide walls, and other infrastructure; no major changes to overall footprint, orientation, operations, or bathymetry; H&H and salinity modeling and analysis assume conditions would be the same as existing.	0[1]	No
3a	Gate Relocation on Existing Alignment – Move floodgates farther from Brazos River along existing GIWW alignment; widen chamber wall opening from 75 feet to 125 feet wide.	83	No
3a.1	**Open Channel West/East Gate Relocation – Similar to Alternative 3a but only includes a new east floodgate; removes west floodgate, leaving an open channel on the west side of the river.**	**79**	**Yes[2]**
9a	Open Channel – Remove floodgates and excavate an open channel north of the existing GIWW alignment to straighten this section of the GIWW.	75	No
9b/c	New Alignment/Gates with Control Structures – Excavate new channel north of existing GIWW alignment and construct 125-foot-wide floodgates on the new channel. Alt. 9c includes a flow control structure at existing west gate location, while Alt. 9b does not.	87	No
CRL Alternatives			
No Action	No improvements would be made to the BRFG facility. Normal maintenance activities would continue.	0	No
2a	Rehab Existing Facilities – Rehabilitate existing locks, guide walls, and other infrastructure as needed; no major changes to overall footprint, guide wall orientation, gate operations, or bathymetry; H&H and salinity modeling/analysis assume conditions would be the same as existing.	0[1]	No
3b	Open Channel – Remove existing locks, creating an open channel through the intersection at the GIWW.	71	No
4b.1	**Removal of Riverside Gates – Remove riverside gates, converting the locks to floodgates.**	**71**	**Yes[2]**

[1] BRFG Alternative 2a and CRL Alternative 2a would rehabilitate the existing facilities within the existing footprints.
[2] The Recommended Plan is BRFG Alternative 3a.1 and CRL Alternative 4b.1.

The Recommended Plan includes implementing Alternative 3a.1 (Open Channel West/East Gate Relocation) at the BRFG facility and Alternative 4b.1 (Removal of Riverside Gates) at the CRL facility. At the BRFG facility, the Recommended Plan would remove the existing 75-foot-wide east and west floodgates, construct new 125-foot-wide floodgates on the east side of the Brazos River, and construct new wing walls and guide walls for the east floodgates. The new east floodgates would be on the existing GIWW alignment and set back from the Brazos River compared to the existing floodgates to provide a longer approach channel. The Recommended Plan would include an open channel west of the river; therefore, no new floodgates would be constructed west of the river. To allow navigation through the area during construction, a temporary bypass channel would be constructed on the south side of the existing channel. After construction, the bypass channel would be closed on the east side of the river. On the west side of the river, the bypass channel may serve as the permanent open channel, depending on final design of the Recommended Plan.

At the CRL, the Recommended Plan would remove the existing riverside (inner) gates east and west of the Colorado River and rehabilitate the existing GIWW-side (outer) 75-foot-wide gates. To allow navigation through the area during construction, a temporary bypass channel would be constructed on the south side of the existing channel. After construction, the bypass channel would be closed on both sides of the river.

Under the alternatives considered, materials that would be dredged during construction would be deposited into existing upland dredged material placement areas (DMPAs). Future maintenance materials dredged would also be placed primarily in upland DMPAs, although existing ocean dredged material disposal sites (ODMDS) may be used for maintenance dredging in the Freeport Channel since that is the current mode of disposal there. The USACE Galveston District is currently working on updating the dredged material management plan (DMMP) for the GIWW from High Island to the Brazos River, which includes the Freeport Channel, to allow disposal of future additional maintenance material at ODMDS.

4.0 AFFECTED ENVIRONMENT (ENVIRONMENTAL BASELINE)

4.1 General Environmental Setting of the Study Areas

4.1.1 Location

As described above, the BRFG and CRL are located about 40 miles apart on the upper to mid-Texas coast, in Brazoria and Matagorda Counties, respectively (**Figure 2.1**). For each facility, existing environmental conditions were evaluated within a study area that encompasses the maximum disturbance area for the reasonable alternatives. The BRFG study area encompasses roughly 600 acres and extends 1 mile east and west of the Brazos River crossing and up to 0.5 mile north and south of the river crossing (**Figure 4.1)**. The CRL study area encompasses roughly 400 acres and extends 1 mile east and west of the Colorado River crossing and up to 0.25 mile north and south of the river crossing (**Figure 4.2)**. Under the reasonable alternatives, all direct construction activities would occur within these study areas. Nearby resources were also identified and evaluated on a case-by-case basis depending on their potential to be indirectly affected by the project (e.g., salinity and sedimentation changes). In addition, the San Bernard River flows into the GIWW about 4 miles west of the BRFG, and the GIWW currently serves as the river's outlet through the west floodgate. As such, effects to the San Bernard River were assessed where possible.

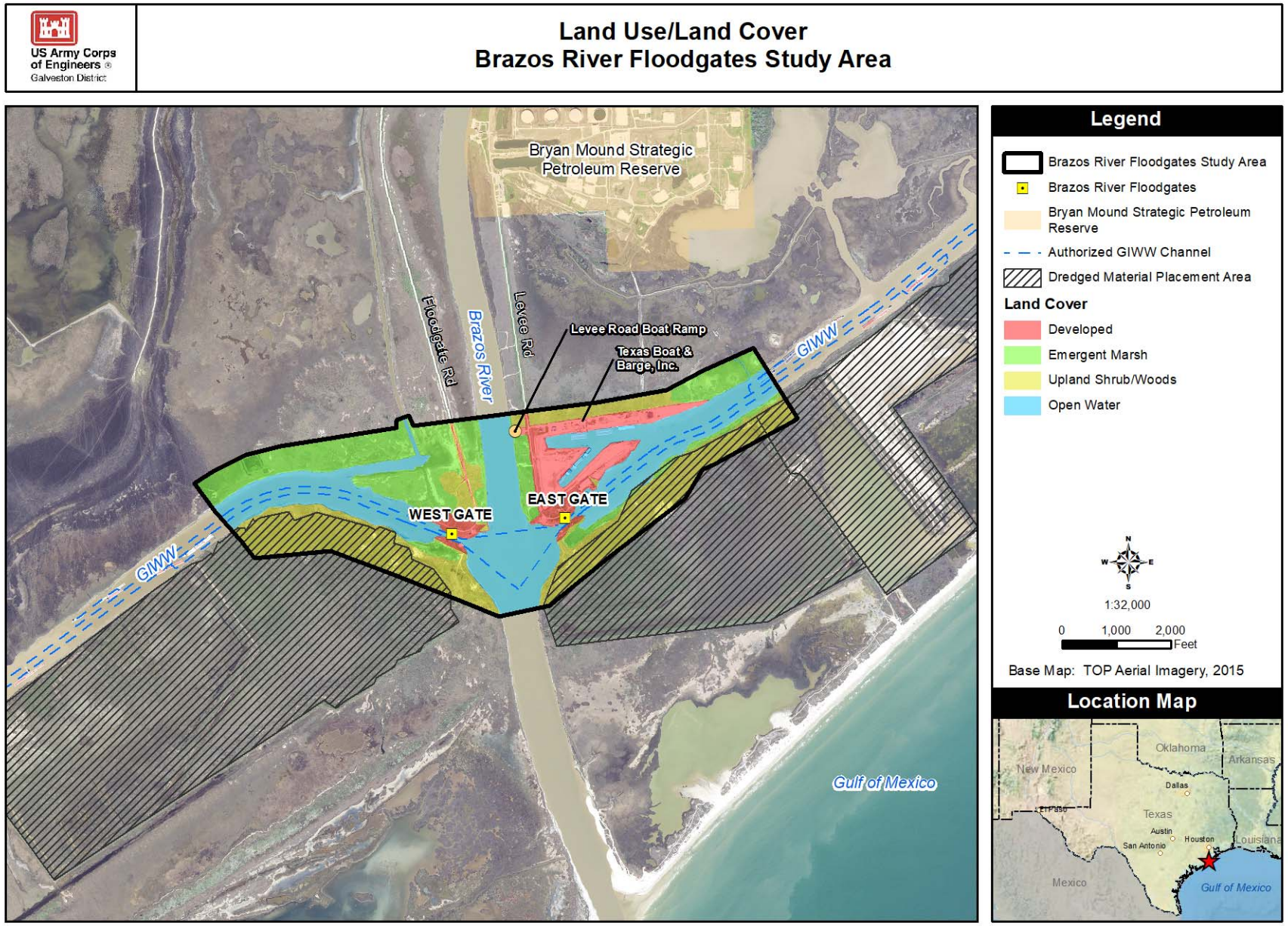

Figure 4.1 BRFG Study Area

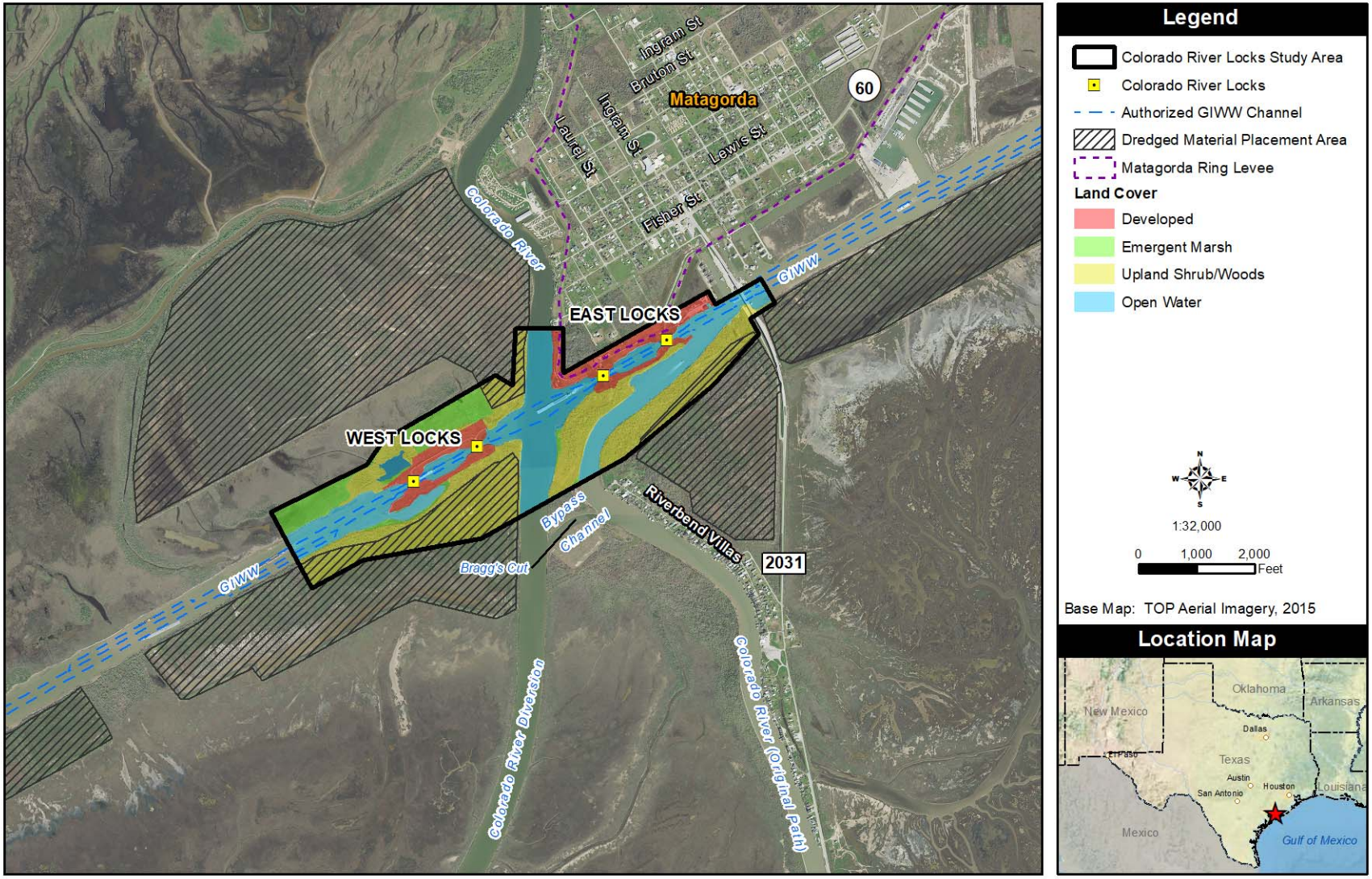

Figure 4.2 CRL Study Area

4.1.2 Geomorphic and Physiographic Setting

Brazoria and Matagorda Counties are within the West Gulf Coast subdivision of the Atlantic and Gulf Coastal Plains geomorphic province of the U.S. This region of Texas is underlain by rock and sediments that slope toward the Gulf of Mexico and date from the Pleistocene and Holocene epochs (Texas Water Development Board [TWDB] 1982, 1987). Surface geology in the BRFG and CRL study areas is of the late Pleistocene Beaumont Formation and younger deposits. The Beaumont Formation was deposited as a large alluvial plain, after which sea levels fell during a period of glacial advance. A period of erosion then followed, with incision of stream channels. At the end of the last glacial period, as sea levels rose again, the area was flooded and a series of estuaries and bays formed. As sea levels stabilized, barrier islands developed (Aronow 1981, 2002). Modern barrier islands along the Gulf coast are characterized by subparallel to parallel beach and foredune ridges that are closely spaced. In Brazoria County, the action of wind, hurricanes, or other natural processes destroyed the ridged pattern of the barrier islands (Aronow 1981). Ridged barrier islands and reefs persist in Matagorda County (USGS 1952, Hyde 2001).

4.1.3 Climate and Climate Change

The climate of the study areas is subhumid, with long, humid summers and short, warm winters. Annual rainfall in Brazoria and Matagorda Counties is about 52 and 48 inches, respectively, most of which falls from April through September (Crenwelge et al. 1981, Hyde 2001). The climate is influenced by the Gulf of Mexico, adjacent bays, and other major surface water features, cold fronts during the fall and winter, and tropical air masses during the spring and summer. The study areas experience both periodic droughts and flooding.

4.1.3.1 Storms and Hurricanes

The Texas coast periodically experiences tropical depressions, tropical storms, and hurricanes that cause property damage, environmental destruction, and even loss of human life. The main hurricane season is from July through September (Hyde 2001) and, historically, the frequency of hurricanes making landfall along any 50-mile segment of the Texas coast is one hurricane about every six years (Roth 2010). From 1900 through 2009, 44 hurricanes and 44 tropical storms made landfall on the Texas Coast, with Hurricane Ike (2008) and Hurricane Rita (2005) being the largest recent hurricanes during that period, totaling over $29 billion in damages (Roth 2010). The Galveston Hurricane of 1900, which resulted in an estimated 8,000 deaths, is considered the worst natural disaster in U.S. history in terms of human lives lost (Roth 2010).

Most recently, Hurricane Harvey (2017), the first Category 4 hurricane to make landfall on the Texas Coast since Hurricane Carla in 1961, affected the Texas Coast from Corpus Christi to Port Arthur, causing record rainfall and flooding, as well as property damage and loss of human life. Once final damages are estimated, Hurricane Harvey most likely be considered the most devastating hurricane in Texas history in terms of property damage. The storm surge from Harvey increased water and tide levels over most of the Texas Coast, with the highest storm tides observed at the Aransas National Wildlife Refuge (NWR) (60 miles southwest of the CRL), where the storm surge levels were more than 12 feet above ground level. Storm surge in Port Lavaca (39 miles west of the CRL) was also more than 10 feet and at least 6 feet in Port Aransas. Elsewhere across South Texas, storm tide levels were from near 3 feet to 6 feet above ground level

at Seadrift, Port O'Connor, Holiday Beach, Copano Bay, Port Aransas, and Bob Hall Pier (National Weather Service 2017). Instead of moving inland, Harvey stalled over South and Southeast Texas for days, producing catastrophic, deadly flash and river flooding. Southeast Texas bore the brunt of the heavy rainfall, with some areas receiving more than 40 inches of rain in less than 48 hours. Cedar Bayou in Houston (65 miles northeast of the BRFG) received a storm total of 51.88 inches of rainfall, which is a new North American record (National Weather Service 2017).

4.1.3.2 Climate Change

Federal guidance and direction regarding climate change evaluation is currently in flux. Several Executive Orders (EOs) have been issued in recent years that direct federal agencies to address climate change and greenhouse gas (GHG) emissions with emission reductions and preparedness planning and implementation. President Obama issued EO 13653, preparing the U.S. for the Impacts of Climate Change in 2013, which was rescinded by President Trump's EO 13783, Promoting Energy Independence and Economic Growth in 2017. EO 13693, Planning for Federal Sustainability in the Next Decade (2015) requires federal agencies to meet emission-reducing goals associated with energy use, water use, building design and utilization, Fleet vehicles, and procurement and acquisition decisions.

Federal agencies are required to consider GHG emissions and climate change in environmental assessment in accordance with NEPA. On August 1, 2016, the Council on Environmental Quality (CEQ) issued final guidance on the consideration of GHG emissions and climate change in NEPA review; however, EO 13783 directed the CEQ to rescind that guidance. At the same time, case law in the Ninth Circuit still requires climate change analysis: "The impact of greenhouse gas emissions on climate change is precisely the kind of cumulative impacts analysis that NEPA requires agencies to conduct" (Center for Biological Diversity v. National Highway Traffic Safety Administration, 538 F.3d 1172, 1217 [Ninth Circuit 2008]). Consistent with case law, an analysis of climate change impacts was conducted for the BRFG-CRL Feasibility Study.

During construction at the proposed BRFG and CRL facilities, GHG emissions will be from heavy construction equipment such as bulldozers, tugboats, barges, and other equipment powered by internal combustion engines. The USACE will estimate the emissions based on projected equipment needs and coordinate the anticipated emissions with the Texas Commission on Environmental Quality (TCEQ) and/or U.S. Environmental Protection Agency (EPA).

Two EOs, EO 13514 and EO 13693, as well as the President's Climate Action Plan (CAP) set forth requirements to be met by federal agencies. These requirements range from preparing general preparedness plans to meeting specific goals to conserve energy and reduce GHG emissions. In response to the EOs and CAP, the USACE prepared an Adaptation Plan, which is still in effect. The Adaptation Plan includes the following USACE policy statement:

> It is the policy of USACE to integrate climate change preparedness and resilience planning and actions in all activities for the purpose of enhancing the resilience of our built and natural water-resource infrastructure and the effectiveness of our military support mission, and to reduce the potential vulnerabilities of that infrastructure and those missions to the effects of climate change and variability.

Relative Sea Level Change

Based on U.S. Geological Survey (USGS) topographic maps, elevations in the BRFG and CRL study areas range from sea level to approximately 22 feet above mean sea level (USGS 1952, 1963, 1964). The tide gage with sea level trend information nearest to the Brazos and Colorado River systems, with over 40 years of record, is located at Freeport, TX (NOAA Gage 8772440). The NOAA MSL trend at this site (from 1954 to 2016) is equal to 4.35 mm/year with a 95 percent confidence interval of ± 1.12 mm/year. If the estimated historic eustatic rate equals that given for the modified NRC curves, the observed subsidence rate would be 2.65 mm/year (4.35 mm/year - 1.70 mm/year).

Subsidence

Subsidence is the sinking of the land surface over time due to natural processes and/or man-made causes, such as the withdrawal of groundwater, oil and gas, and/or mineral resources (Ratzlaff 1980, Neighbors 2003, Zilkoski et al. 2015). A 2013 NOAA report on estimating vertical land movement (subsidence) using long-term tide gage data estimates that the subsidence rate at the Freeport tide gage was -3.65 ± 0.41 mm/year between 1954 and 2006 (NOAA 2013). Subsidence in the Freeport vicinity has been attributed primarily to groundwater withdrawals for municipal and industrial use (Ratzlaff 1982). Localized subsidence attributable to subsurface sulfur mining over a salt dome has occurred in the Bryan Mound area, located less than 1 mile north of the BRFG study area. The elevation at Bryan Mound decreased from 23 feet in 1926, to 19 feet in 1980, to the current elevation of approximately 16 to 18 feet. Subsidence around the perimeter of Bryan Mound has resulted in the creation of Blue Lake to the north and Mud Pit (or "Mud Lake") to the southeast (Kirby and Lord 2015).

4.1.4 Tides, Currents, and River Stages

Tides, currents, and river stage/flows vary daily and seasonally, and continuously affect water levels in the BRFG and CRL study areas. Along the Texas Gulf coast, tides are considered *diurnal*, meaning that typically only a single high and low water level occur each tidal day (Hicks 2006). The mean tide range is the difference between mean high water (MHW) and mean low water (MLW). For perspective on the tidal ranges at the BRFG and CRL, **Table 4.2** summarizes the tide data from the National Oceanic and Atmospheric Administration (NOAA) tide gauge stations nearest to each facility (NOAA 2017a, 2017b). The mean tide range is 1.39 feet in the BRFG vicinity and 0.39 feet in the CRL vicinity. Based on data from the TCEQ, the tidally influenced reaches of the Brazos and Colorado Rivers extend 24 to 25 miles upstream from the Gulf of Mexico (TCEQ 2016a).

Table 4.1 Tide Levels in BRFG and CRL Study Areas

Tidal Datum	Elevations Relative to Mean Lower Low Water (MLLW), in Feet	
	BRFG Study Area[1]	CRL Study Area[2]
Mean Higher High Water (MHHW)	1.80	0.41
Mean Sea Level (MSL)	0.97	0.23
Mean Lower Low Water (MLLW)	0.00	0.00
Mean Tide Range[3]	*1.39*	*0.39*

[1] BRFG tide data is from NOAA tide gauge station 8772447 (Freeport, TX), which is located at the Freeport Channel entrance, approximately 5.8 miles northeast of the BRFG (NOAA 2017a).

[2] CRL tide data from NOAA tide gauge station 8773146 (Matagorda City, TX), which is located on the GIWW approximately 3.8 miles northeast of the CRL (NOAA 2017b).

[3] *Mean tide range* is the difference in height between MHW and MLW.

4.1.5 Land Use/Land Cover

Based on aerial photograph review and field reconnaissance, the BRFG and CRL study areas are largely undeveloped, with open water, emergent marsh, and upland shrub/woods being the major land cover types in both study areas (**Figures 4.1 and 4.2**). Some livestock grazing occurs within these areas. Commercial navigation is a major land use in both study areas, represented by the GIWW, BRFG and CRL facilities and access roads, and existing DMPAs along the GIWW. Developed areas in the BRFG study area include Texas Boat and Barge, Inc., which is a barge storage, cleaning, maintenance, and repair facility located adjacent to the east floodgate. Nearby, the Department of Energy's Bryan Mound Strategic Petroleum Reserve, which is one of two Federal strategic petroleum reserve sites in Texas, is located about 1 mile north of the east floodgate (**Figure 4.1**). At the CRL facility, residential areas lie just outside the study area to the northeast in the town of Matagorda and to the south along the east bank of the original Colorado River channel (**Figure 4.2**).

4.2 Soils and Waterbottoms

Soils are protected in some cases by laws and policies either directly (such as Prime and Unique Farmland soils regulated by the Farmland Protection Policy Act (FPPA) and the Council on Environmental Quality (CEQ) memorandum entitled *Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing the National Environmental Policy Act*), or indirectly (such as hydric soils that support wetlands, which are protected by the Clean Water Act (CWA) and *Executive Order 11990: Protection of Wetlands*). *Prime farmland* is defined as land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crop and that is available for these uses (USDA 2017a). *Hydric soil* is a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part and support hydrophytic vegetation (USDA 2017b).

Based on Natural Resources Conservation Service (NRCS) soil maps and data, the BRFG and CRL study areas contain a total of 12 different soil mapping units, along with areas mapped as "Water" (USDA 2017c) (**Table 4.3**; **Figures 4.3 and 4.4**). None of the soils in the BRFG study area are classified as Prime Farmland soils by the NRCS, but all are classified as hydric. Dredged material has been placed over native soils on the south side of the GIWW in the BRFG study area. Ijam clay is a hydric soil that formed from deposited dredged material (USDA 2017c, 2017d).

Table 4.2 Soils Mapped in the BRFG and CRL Study Areas

Soil Series	% Hydric	Prime Farmland[1]
BRFG Study Area		
Galveston fine sand, undulating	9	No
Ijam clay	100	No
Surfside clay, 0 to 1 percent slopes, occasionally flooded	100	No
Velasco clay, 0 to 1 percent slopes, frequently flooded	100	No
Veston fine sandy loam, 0 to 1 percent slopes, frequently flooded	100	No
CRL Study Area		
Asa silty clay loam, saline, occasionally flooded	0	No
Galveston fine sand, 0 to 3 percent slopes, occasionally flooded	9	No
Ijam clay, 1 to 3 percent slopes	90	No

Table 4.2 Soils Mapped in the BRFG and CRL Study Areas

Soil Series	% Hydric	Prime Farmland[1]
Norwood loam, 0 to 1 percent slopes, rarely flooded	1	Yes
Palacios loam, 0 to 1 percent slopes, rarely flooded	10	No
Placedo clay, 0 to 1 percent slopes, frequently flooded	98	No
Velasco clay, 0 to 1 percent slopes, frequently flooded	100	No

[1] Map unit meets the soil requirements for prime farmland except where the use is urban or built-up land.
Source: USDA 2017c

In the CRL study area, Norwood loam is classified as a Prime Farmland soil and occurs along the Colorado River banks. Portions of these areas have been disturbed by previous levee and road construction and dredged material placement. All the soils in the CRL study area, except for Asa silty clay loam, are classified as hydric soils or have hydric inclusions.

Waterbottoms in major waterways along the Texas Gulf coast, including the GIWW, Brazos and Colorado Rivers, and adjacent waters, generally consist of sand and mud, with scattered shell (TWDB 1982, 1987). Within the GIWW and Brazos and Colorado Rivers, the waterbottoms are periodically disturbed by natural processes and anthropogenic influences, including flooding, dredging, and barge traffic

4.3 River Sediment Resources

The Brazos River has the highest water and sediment load discharge of all Texas rivers, and the second highest sediment load discharge to the entire Gulf of Mexico, behind the Mississippi River (Milliman and Meade 1983, Carlin 2013). The Colorado River has lower sediment load discharges than the Brazos River but still carries large loads of sediment. In the early 1990s, the mouth of the Colorado River was moved from the Gulf of Mexico to West Matagorda Bay[1] in an effort to enhance seafood productivity of the bay, reduce flood damage potential along the lower Colorado River, and to reduce navigation hazards as well as channel maintenance costs (USACE 1981). Since the relocation, the river deposits sediments in West Matagorda Bay, creating shallow-water wetlands along the delta.

The BRFG and CRL facilities were constructed on the GIWW to prevent excessive sedimentation in the navigation channel due to high sediment loads in the rivers. The USACE's primary objective for the BRFG and CRL continues to be minimizing sedimentation in the GIWW, as excessive sedimentation increases the need for maintenance dredging, which leads to increased maintenance costs and possible delays for commercial navigation. Even with the floodgates and locks, sediment does accumulate in the GIWW, resulting in the need for periodic maintenance dredging in the vicinity of the rivers. In addition, sediment from the Brazos River is transported west to the San Bernard River, and deposition of the sediment, along with low flows in the San Bernard River, contributes to the closing of the San Bernard River at the Gulf of Mexico.

[1] Note that the Colorado River currently drains to Matagorda Bay, which is often referred to as "West" Matagorda Bay to clearly differentiate it from East Matagorda Bay. Because both bays are referenced multiple times in this document, Matagorda Bay is referred to as West Matagorda Bay throughout the document.

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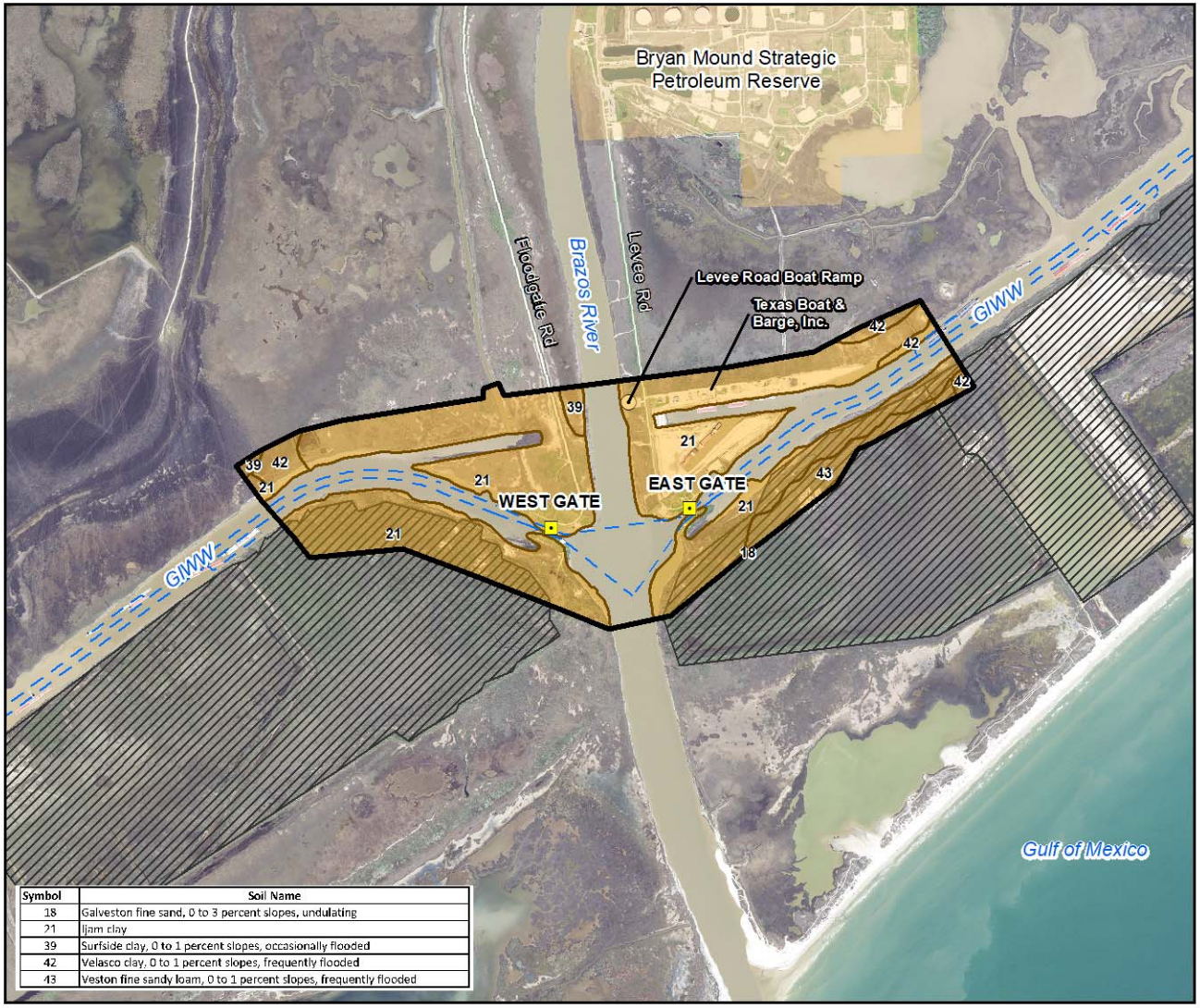
Galveston District

Soils, including Prime Farmland and Hydric Soils
Brazos River Floodgates Study Area



Symbol	Soil Name
18	Galveston fine sand, 0 to 3 percent slopes, undulating
21	Ijam clay
39	Surfside clay, 0 to 1 percent slopes, occasionally flooded
42	Velasco clay, 0 to 1 percent slopes, frequently flooded
43	Veston fine sandy loam, 0 to 1 percent slopes, frequently flooded

Legend

- Brazos River Floodgates Study Area
- Brazos River Floodgates
- Bryan Mound Strategic Petroleum Reserve
- Authorized GIWW Channel
- Dredged Material Placement Area
- Hydric Soils

No prime farmland soils are located within the Brazos River Floodgates Study Area

1:32,000

0 1,000 2,000 Feet

Data Source: U.S. Department of Agriculture, National Resources Conservation Service
Base Map: TOP Aerial Imagery, 2015

Location Map

Figure 4.3 Soils in the BRFG Study Area

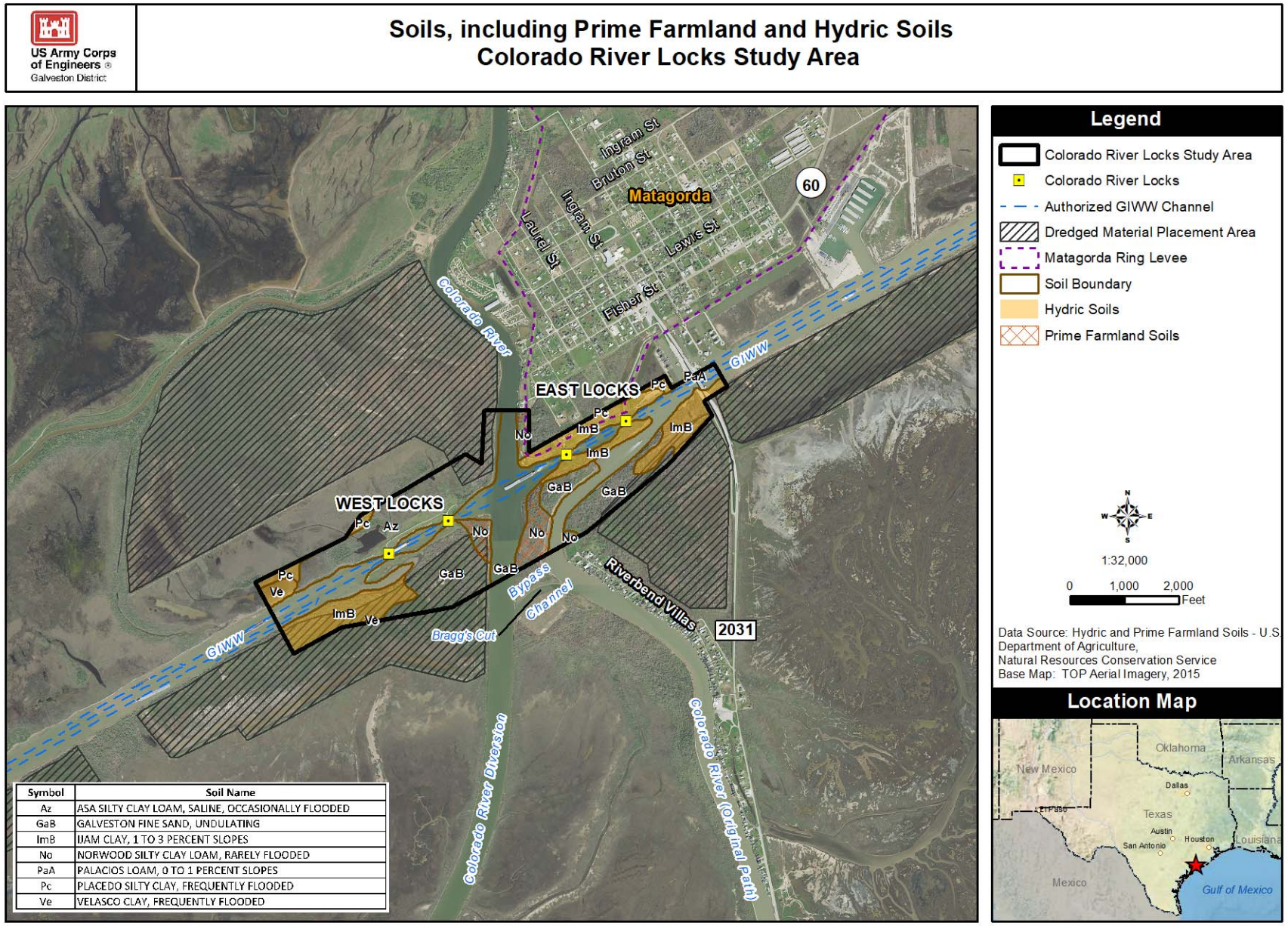


Figure 4.4 Soils in the CRL Study Area

4.3.1 Shoal Formation Concerns

At the BRFG, high sediment loads result in sediment deposits in the GIWW on the east and west sides of the river, creating shoals in areas where vessels pass. These shoals have caused periodic grounding of vessels, and dredging is required to remove the shoals. Shoaling has also occurred periodically at the CRL, particularly after major flooding events. Most recently, major flooding from Hurricane Harvey in August 2017 resulted in shoal formation near the west locks, making the GIWW impassable at this location.

4.3.2 Erosion

According to the Texas General Land Office's (GLO's) 2015 Coastal Erosion Planning & Response Act (CEPRA) Report, 84 percent of the Texas Gulf shoreline is retreating, averaging about 4 feet per year and resulting in 235 acres of lost land per year along the coastline, bays, estuaries, and navigation channels (GLO 2015). These land losses affect properties, extend saltwater intrusion, and affect wetlands and other habitats. Between the 1930s and 2012, the Gulf coastline extending from Quintana to Sargent Beach, which includes the BRFG study area, retreated an average of 9.5 feet per year. Land losses near the CRL study area were less than 5 feet per year during the same period (McKenna 2014, Paine et al. 2014, Bureau of Economic Geology 2016). Causes of coastal erosion include storm impacts, lack of sufficient sediment discharges, long-term sea level rises, and subsidence (McKenna 2014). In September 2008, 3 years after Hurricane Rita damaged the upper Texas coast, Hurricane Ike made landfall with a 5- to 10-foot storm surge in Brazoria County and 15- to 20-foot storm surge in Chambers and Galveston Counties to the north, causing major erosion along the coastline. Following Hurricane Ike, the State of Texas required local governments along the Gulf to develop erosion response plans, with the intent of minimizing future public expenditures for erosion and storm damages. Through these plans, various restoration and stabilization projects have helped maintain the shoreline position (McKenna 2014). Brazoria and Matagorda Counties have implemented multiple restoration and stabilization projects with the help of CEPRA funding.
Within the BRFG and CRL study areas, local shoreline erosion on the south end of the Brazos and Colorado River crossings of the GIWW are ongoing problems. Erosion also occurs along the GIWW banks where tows push into the banks while waiting for buoys to become available for tripping.

4.4 Floodplains and Flood Control

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) database, the majority of the BRFG and CRL study areas are within the 100-year floodplain (FEMA 2017) (**Figure 4.5**). Flooding events are primarily due to high river flows after heavy rains upstream of the Lower Brazos and Lower Colorado watersheds, although occasional hurricanes and tropical storms from the Gulf cause severe flooding.

Flood-protection levees have been constructed near the BRFG and CRL study areas to protect the nearby towns and cities. In the BRFG vicinity, the Velasco Drainage District operates and maintains a hurricane-flood protection system around Freeport and the surrounding area that includes 60 miles of levees, 14 pump stations, 34 gravity drainage structures, a navigation control tidal gate structure, and 72.5 miles of outfall ditches. The system's West End Pump Station, capable of pumping 450,000 gallons per minute (GPM), and Clute-Lake Jackson Pump Station, capable of pumping 1.95 million GPM, discharge into the Brazos River

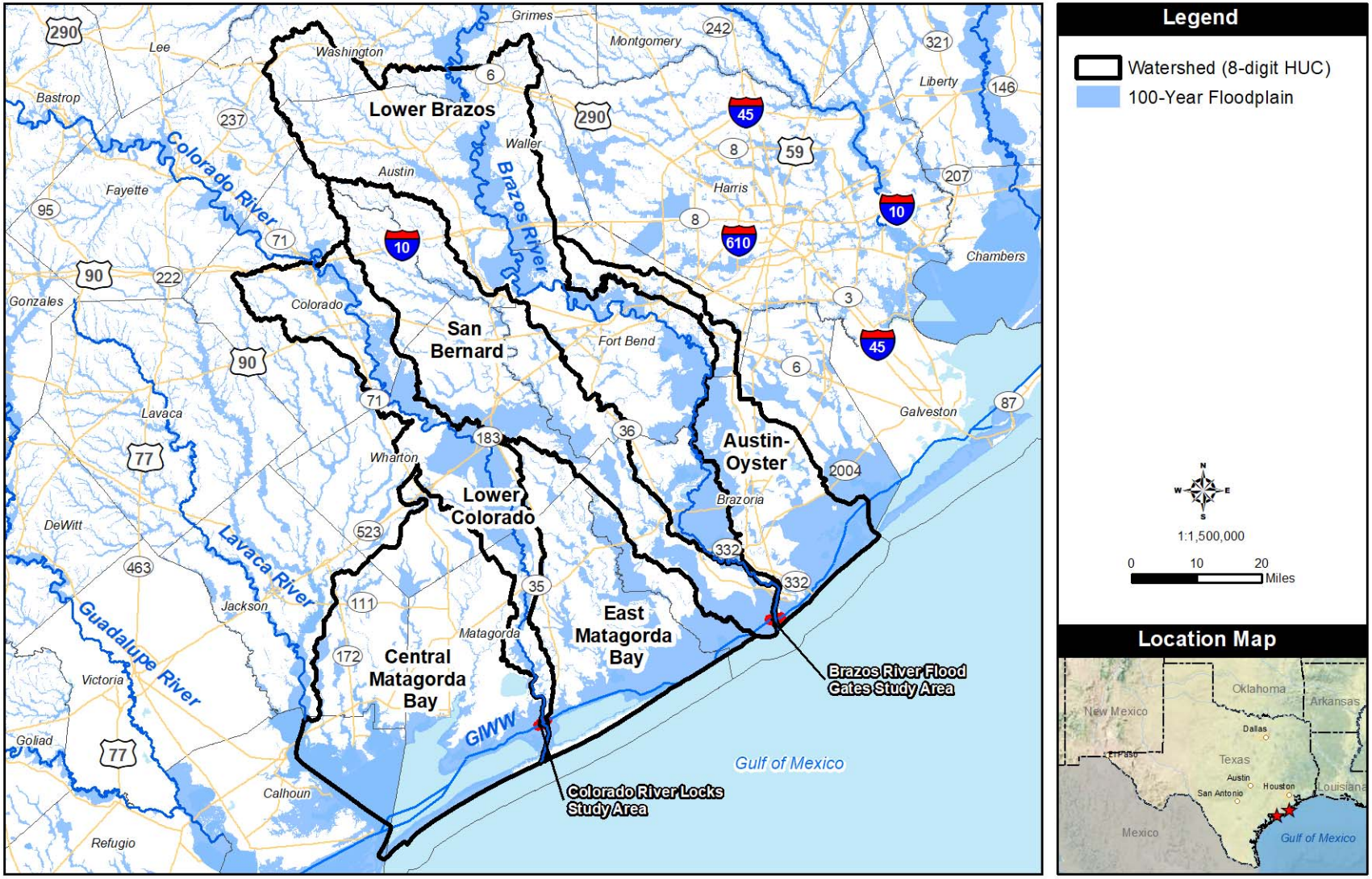


Figure 4.5 Watersheds and Floodplains

approximately 3.5 miles and 10.5 miles upstream of the BRFG, respectively. The nearest levee to the BRFG is on East Floodgate Road approximately 1.2 miles north of the East Floodgate (**Figure 4.6**). According to USACE (2005), the flood control levees around the Freeport area are expected to provide protection from a 100-year storm plus tide event.

In the CRL vicinity, the USACE has constructed over 40 miles of flood protection levees along the Colorado River in Matagorda County, including a 7-mile ring levee around the town of Matagorda that is designed to provide 100-year flood protection (Matagorda County Flood Mitigation Planning Committee 2010). The East Locks and associated facility are located on and adjacent to the Matagorda ring levee (**Figure 4.7**).

4.5 Water Resources

The BRFG study area includes portions of three sub-watersheds (**Figure 4.5**): (1) the Lower Brazos River watershed (Hydrologic Unit Code [HUC] 12070104) crosses the central part of the study area and includes the Brazos River and a narrow corridor on either side of the river; (2) the San Bernard watershed (HUC 12090401) covers the western part of the study area, west of the Lower Brazos; and (3) the Austin-Oyster watershed (HUC 12040205) covers the eastern part of the study area, east of the Lower Brazos (USGS 2017a, b). Based on aerial photography review and field reconnaissance, an estimated 60 percent of the BRFG study area contains water resources, including the GIWW, Brazos River, and adjacent marshes. The San Bernard River, Cedar Lakes, and various other sloughs, lakes, and marshes surround the study area. Hydrology in the BRFG area has been modified over the years by various activities such as excavation and maintenance of the GIWW and placement of dredged material; 1929 diversion of the Brazos River; 1943 construction of the BRFG; construction of levees, drainage ditches, pump stations, with a tidal gate structure for hurricane and flood protection; and natural migration and opening/closing of the San Bernard River.

The CRL study area also contains portions of three sub-watersheds (**Figure 4.5**): (1) the Central Matagorda Bay watershed (HUC 12100401) in the western half, (2) the Lower Colorado River watershed (HUC 12090302) in the eastern half, and (3) the East Matagorda Bay watershed (HUC 12090402) in the extreme eastern end (USGS 2017a, b). Based on aerial photography review and field reconnaissance, an estimated 44 percent of the CRL study area contains water resources, including the GIWW, Colorado River and Colorado River Diversion Channel, and adjacent marshes. West Matagorda Bay and East Matagorda Bay are to the southwest and east, respectively, and various other sloughs, lakes, and marshes occur in the surrounding low-elevation coastal plain. Hydrology in the CRL area has also been modified by activities such as excavation and maintenance of the GIWW and placement of dredged material; 1944 and 1951 construction of the CRL; levee construction for hurricane and flood protection; diversion of the Colorado River into West Matagorda Bay in the early 1990s; and 2012 excavation of Bragg's Cut between the Colorado River and Colorado River Diversion Channel.

The water resources in the BRFG and CRL study areas are considered waters of the U.S. subject to regulation under Section 404 of the Clean Water Act (CWA), and the GIWW, Brazos and Colorado Rivers, and other tidal waters are also navigable waters subject to regulation under Section 10 of the Rivers and Harbors Act (RHA). These statutes are administered by the USACE and regulate the discharge of dredged and fill material and other work in regulated waters.

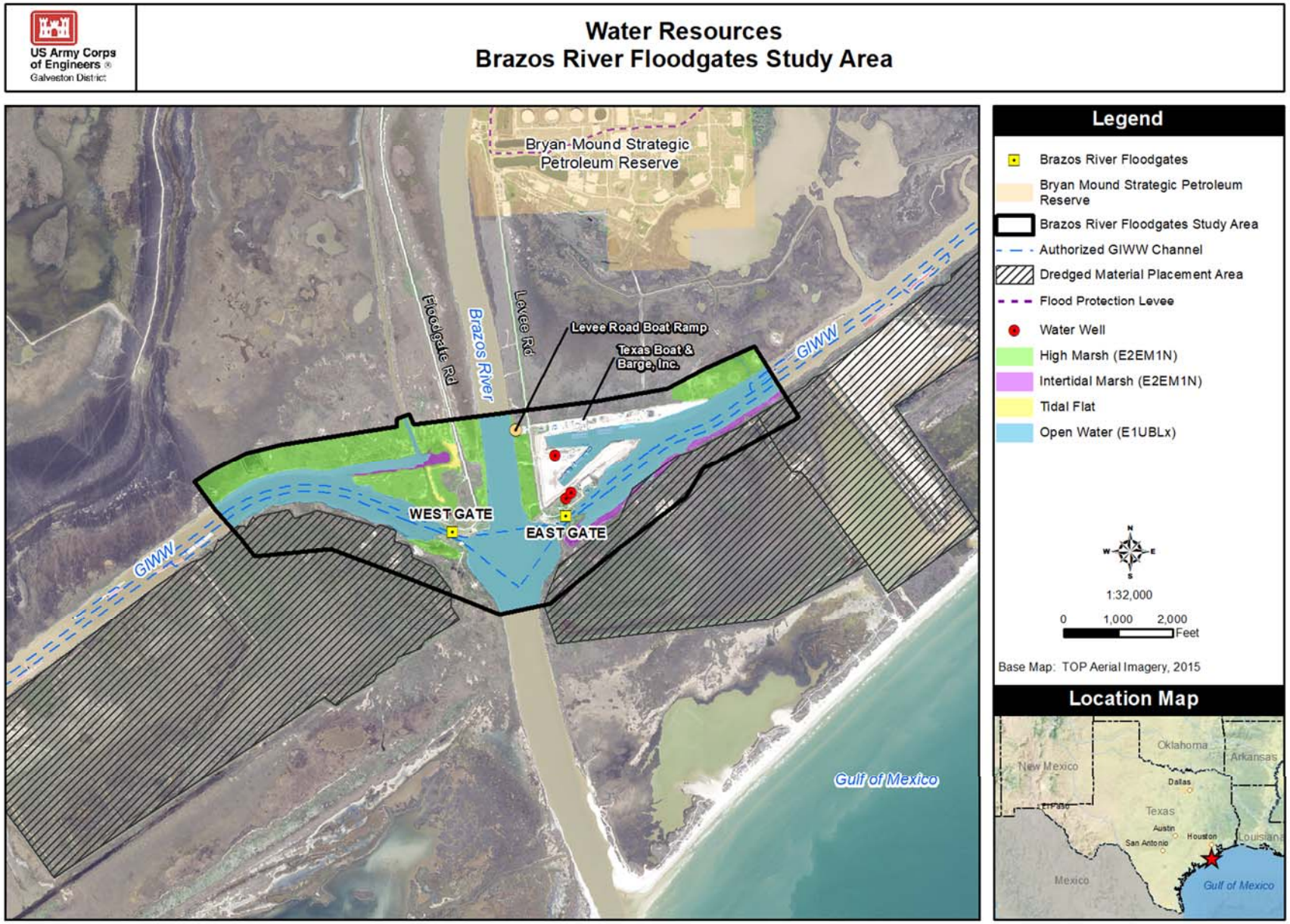


Figure 4.6 Water Resources in BRFG Study Area

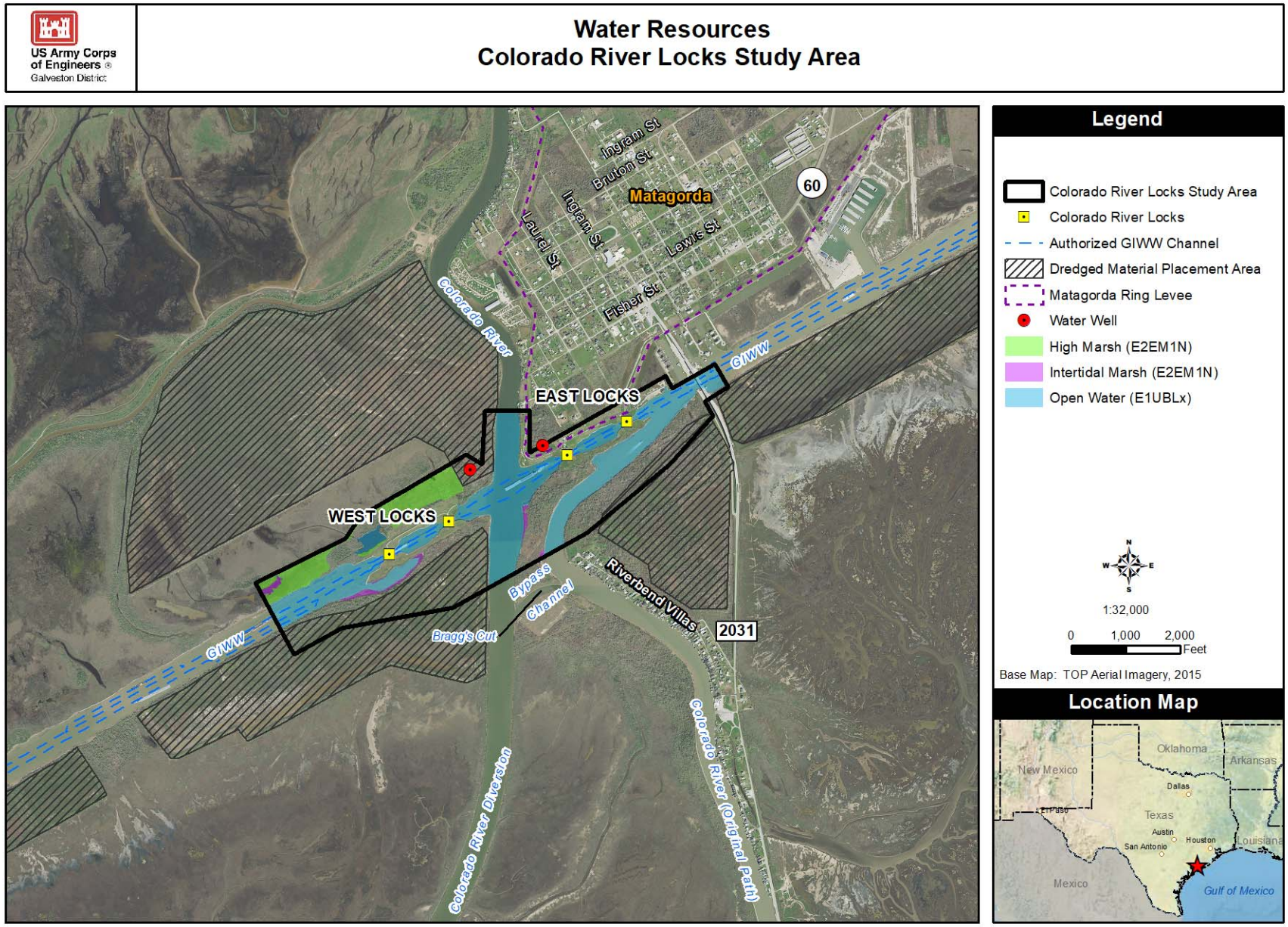


Figure 4.7 Water Resources in CRL Study Area

4.5.1 Water Supply and Use

4.5.1.1 Surface Water

The Brazos and Colorado Rivers are major water sources for irrigation, municipal water supply, manufacturing, electric power, livestock, and mining uses; there are over 40 water supply lakes/reservoirs in the Brazos River basin and over 30 water supply lakes/reservoirs in the Colorado River Basin (Lower Colorado Regional Water Planning Group 2015; Region H Regional Water Planning Group 2015; TWDB 2016a, 2016b, 2017b). However, there are no water supply lakes or reservoirs in or adjacent to the BRFG or CRL study areas.

Based on TCEQ data, there are water intake/diversion points off the Brazos River at the Bryan Mound Strategic Petroleum Reserve (1 mile north of the BRFG study area) and at the Dow Chemical Plant (over 6 miles north of the BRFG study area). The nearest intake/diversion point to the CRL study area is at the South Texas Electric Project generating station, located 8 miles to the north (TCEQ 2016b).

4.5.1.2 Groundwater

The BRFG and CRL study areas are underlain by the Gulf Coast Aquifer, a major aquifer system that parallels the Gulf of Mexico coastline from the Texas-Louisiana border to the Texas-Mexico border (George et al. 2011, TWDB 2017c). The thickness, water quality, and productivity of the aquifer varies across its range (George et al. 2011, TWDB 2017c). The Gulf Coast Aquifer is comprised of, from shallowest to deepest, the Chicot Aquifer, the Evangeline Aquifer, the Burkeville Confining Unit, and the Jasper Aquifer, with parts of the Catahoula Formation acting as the Catahoula Confining System (Coastal Plains Groundwater Conservation District 2014). The Gulf Coast Aquifer system is used for municipal, industrial, and irrigation purposes (TWDB 2017b, 2017c). The main source of groundwater in Brazoria County is the Chicot Aquifer (Brazoria County Groundwater Conservation District 2012). All registered wells in Matagorda County are in either the Chicot Aquifer or the Evangeline Aquifer (Coastal Plains Groundwater Conservation District 2014). Water level declines in the Gulf Coast Aquifer underlying Harris, Galveston, Fort Bend, Jasper, and Wharton Counties have historically led to land subsidence in some areas outside of the BRFG and CRL study areas (George et al. 2011, TWDB 2017c).

According to the TWDB Groundwater Database and the Submitted Driller's Report Database, there are four groundwater wells within the BRFG study area, and two groundwater wells located with the CRL study area (**Table 4.4**). All but one of the wells are part of the BRFG and CRL facilities. The other well is associated with the Texas Boat and Barge, Inc. facility located adjacent to the BRFG east floodgate.

Table 4.3 Groundwater Wells Located Within the BRFG and CRL Study Areas

State Well ID No. or Submitted Driller's Report No.	Well Owner	Aquifer Formation	Well Type	Purpose of Use
BRFG Study Area				
8105901	USACE	Chicot Aquifer, Upper	Withdrawal	Plugged or Destroyed
8105902	USACE	Chicot Aquifer, Upper	Withdrawal	Domestic
8105903	USACE #3	Chicot Aquifer, Upper	Withdrawal	Public Supply

Table 4.3 Groundwater Wells Located Within the BRFG and CRL Study Areas

State Well ID No. or Submitted Driller's Report No.	Well Owner	Aquifer Formation	Well Type	Purpose of Use
5586	Texas Boat and Barge	Not Identified	New Well	Domestic
CRL Study Area				
8117401	USACE	Chicot Aquifer	Withdrawal	Domestic
8117402	USACE	Chicot Aquifer	Withdrawal	Public Supply

Sources: TWDB 2017b

4.6 Water Quality

The Texas Integrated Report of Surface Water Quality is a requirement of the federal CWA Sections 305(b) and 303(d) and evaluates the quality of surface waters in Texas (TCEQ 2017a). Section 303(d) requires states to develop lists of impaired waters, which are waters where technology-based regulations and other required controls are not stringent enough to meet the state water quality standards. Based on a review of the Texas Integrated Report and 303(d) lists, there are no threatened or impaired surface waters in the BRFG or CRL study areas (TCEQ 2015). Within the BRFG study area, the Brazos River Tidal segment is designated as Segment 1201 and is in attainment for all water quality parameters. Within the CRL study area, the Colorado River Tidal segment is designated as Segment 1401 and is also in attainment for all water quality parameters. Near both study areas, the Gulf of Mexico is listed as threatened/impaired for mercury in edible tissue on the 2014 303(d) lists.

4.7 Salinity

Salinity in the bays, estuaries, and nearshore areas of the Gulf Coast of Texas is strongly influenced by the amount of freshwater inflow from surrounding streams and rivers. Salinity levels are typically reported in parts per thousand (ppt) and are categorized as follows: oligohaline (0.5-5 ppt), mesohaline (5-18 ppt), polyhaline (18-30 ppt), euhaline (30-40 ppt), and hyperhaline (>40 ppt). Salinity levels and fluctuations affect estuary characteristics such as nutrient cycling, benthic organism communities, and estuarine/wetland plant and animal communities, including juvenile fish and shellfish nursery stocks (Longley 1994).

Salinity in the BRFG and CRL study areas ranges widely depending on river stages/flows in the Brazos, San Bernard, and Colorado Rivers. The Brazos River discharges directly into the Gulf of Mexico, so the amount of freshwater flows in the river greatly influences salinity in the study area and surrounding areas. In the BRFG study area, site-specific salinity data measured from late 2012 through mid-2017 at the east floodgate showed monthly salinity levels ranging from less than 0.5 part per thousand (ppt) (essentially freshwater) to 33 ppt, which is near the average seawater concentration of 35 ppt. These salinities coincide with periods when high river flows reduce salinity, and low river flows allow tidal waters from the Gulf to extend upstream in the river.

Although there is no salinity gauge at the CRL, the USACE collected site specific data within the CRL study area between May and October 2001, and salinity ranged from 8 to 27 ppt during that period. Based on the CRL modeling results (see Engineering Appendix of the DIFR-EIS), existing average salinities in

the CRL study area range from 7 ppt in the GIWW-Colorado River intersection to 18 ppt in the original Colorado River channel. Average salinities in the Colorado River upstream and downstream of the study area are less than 1 ppt and 11 ppt, respectively. Existing salinities in West Matagorda Bay (outside the Colorado River delta) and East Matagorda Bay are 18 and 25 ppt, respectively. Most of the water in the Colorado River drains to West Matagorda Bay at the Colorado River delta, but when the CRL are open, some flow also enters the GIWW and reaches East Matagorda Bay and the Gulf through the original river channel. East Matagorda Bay is considered by some sources to be a lagoon with limited freshwater input, resulting in relatively high average salinities (Palmer et al. 2011, Montagna 2001).

4.8 Vegetation and Wildlife Habitats

The BRFG and CRL study areas are in the Mid-Coast Barrier Islands and Coastal Marshes portion of the Western Gulf Coastal Plain ecoregion, which stretches from Galveston Bay in the north to Corpus Christi Bay in the south (Griffith et al. 2007). This ecoregion is characterized as having salt marsh on the back side of barrier islands, with fresh or brackish marshes near river deltas. The region contains a matrix of wetland and upland habitats that support a variety of wildlife species.

Based on aerial photography review and field reconnaissance, six general vegetation communities/habitat types were observed within the BRFG and CRL study areas (**Figures 4.8 and 4.9**). **Table 4.5** lists the habitat types and the approximate percentage of each study area that contains the habitat. Descriptions of the habitat types follow the table.

Table 4.4 Estimated Habitat Types in the BRFG and CRL Study Areas

Habitat Type	Percentage of BRFG Study Area	Percentage of CRL Study Area
Open Water	36	35
Intertidal Marsh	2	1
High Marsh	21	8
Tidal Flat	0.5	0
Upland Shrub/Woods	30	43
Developed	11	13

Open Water

Open water is a major habitat type in both study areas and is present in the GIWW and Brazos and Colorado Rivers. The open water areas provide habitat for fish, shrimp, crabs, bottlenose dolphins (*Tursiops truncatus*), and other estuarine species. Most of the open water habitat experiences regular disturbances by barge tows and other vessels traveling through the GIWW, as well as periodic maintenance dredging.

High Marsh

High marsh habitat is the dominant wetland habitat in the study areas, occurring at low elevations but only infrequently inundated by very high tides. Common plant species observed in this habitat include turtleweed (*Batis maritima*), saltgrass (*Distichlis spicata*), saltworts (*Salicornia* spp.), Gulf cordgrass (*Spartina spartinae*), marshhay cordgrass (*S. patens*), sea-oxeye daisy (*Borrichia frutescens*), seepweed (*Suaeda linearis*), and marsh-elder (*Iva frutescens*). Scattered threesquare (*Schoenoplectus pungens*), wolfberry

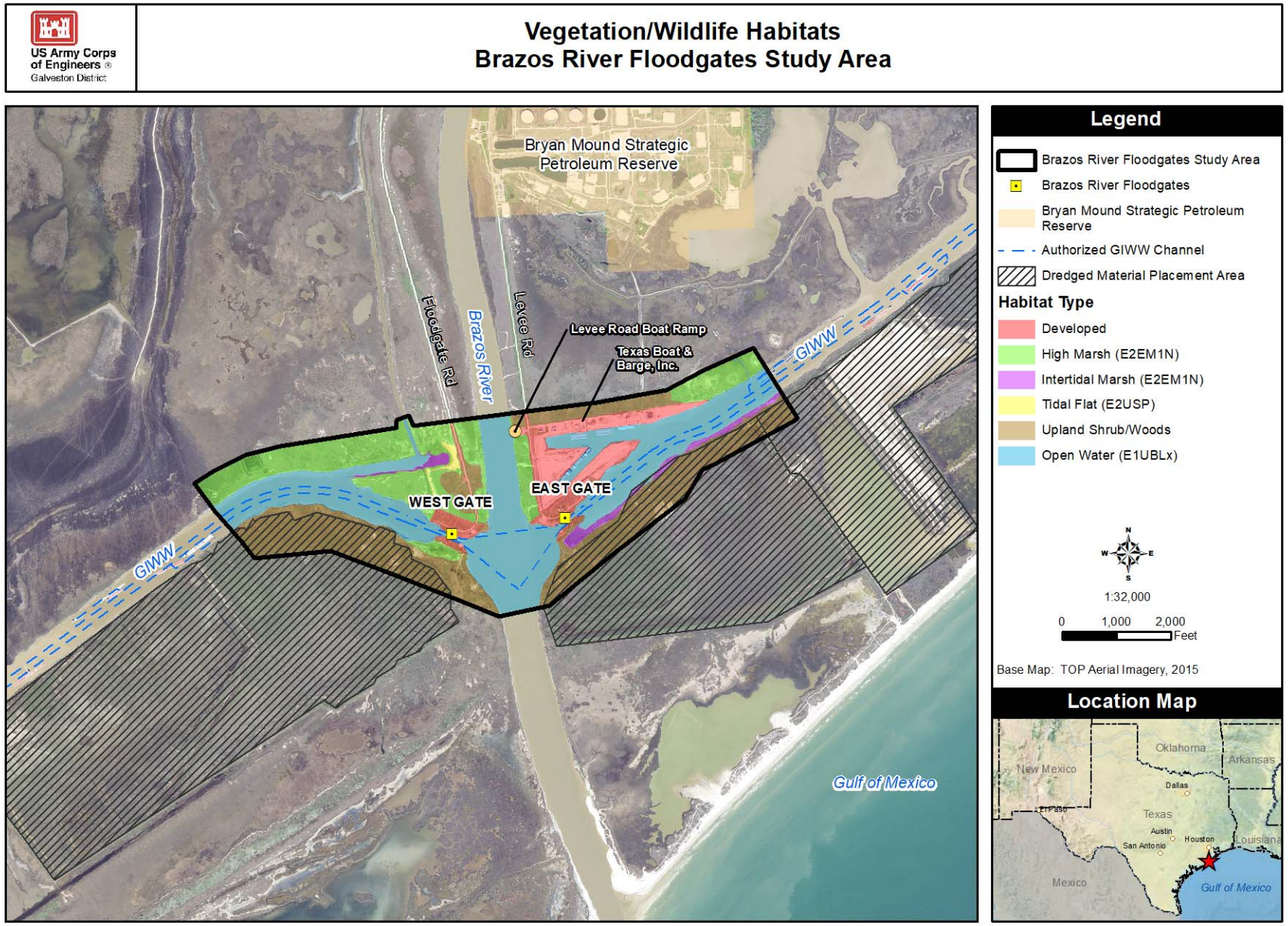


Figure 4.8 Vegetation/Wildlife Habitats in BRFG Study Area

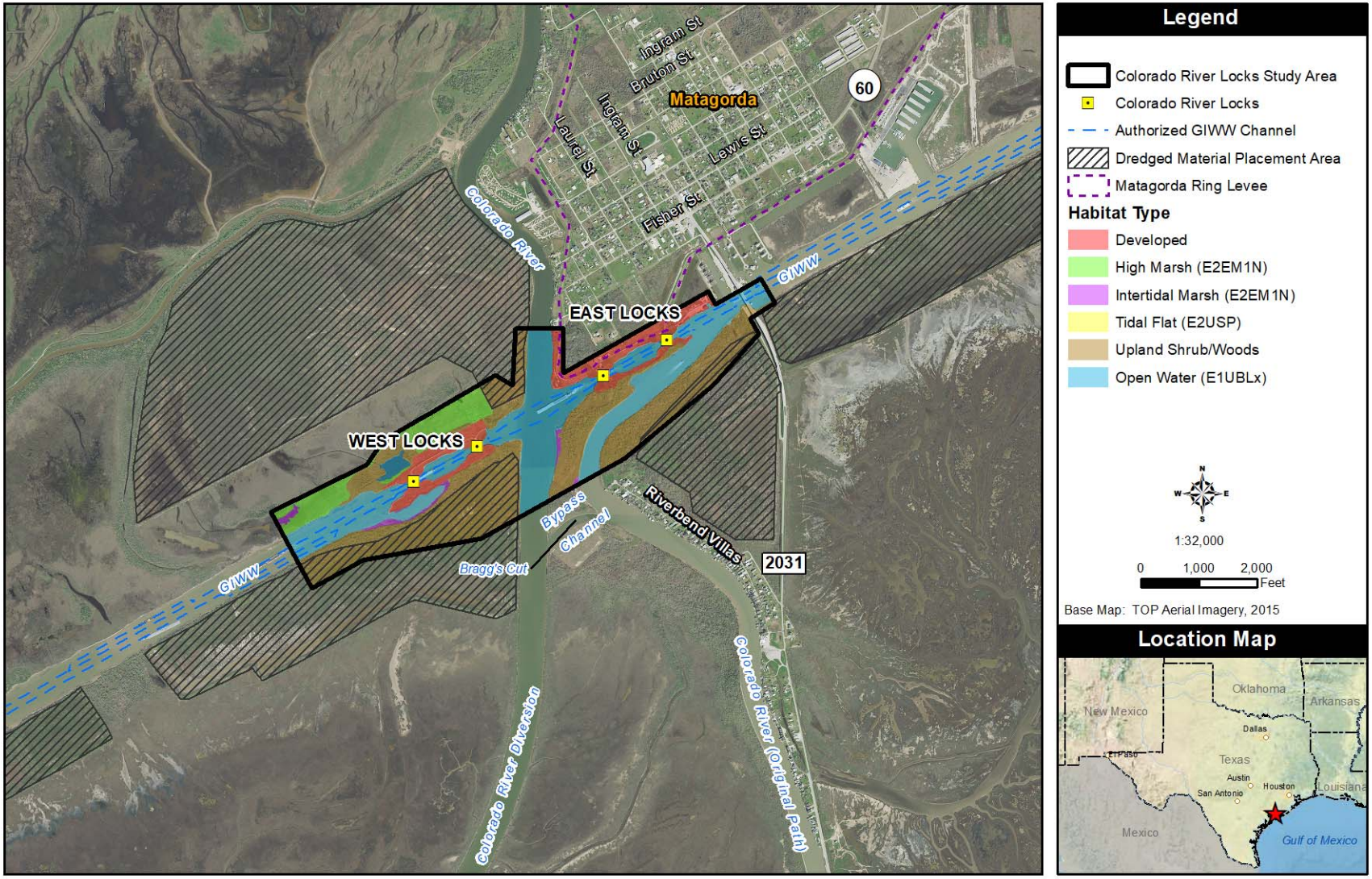


Figure 4.9 Vegetation/Wildlife Habitats in CRL Study Area

(*Lycium carolinianum*), saltcedar (*Tamarix ramosissima*), smooth cordgrass (*Spartina alterniflora*), and common reed (*Phragmites australis*) were also observed.

Intertidal Marsh

Within both study areas, there are relatively small patches of intertidal marsh, which are wetland areas that occur at elevations between the low and high tides (intertidal zone). These areas are dominated by smooth cordgrass (*Spartina alterniflora*), with species common to the high marsh habitat present along the edges.

Tidal Flat

One small area of unvegetated tidal flat is in the BRFG study area. This habitat is adjacent to an intertidal marsh and contained less than 5 percent plant cover (turtleweed, smooth cordgrass, saltwort, and saltgrass). Algal mats covered an estimated 50 percent of the flat during a February 2017 field investigation. The area also showed evidence of disturbance from cattle.

Upland Shrub/Woods

Higher elevations in the study areas, such as portions of the river banks and in DMPAs, support upland shrub/woods vegetation. Common plant species observed in this habitat include American elm (*Ulmus* americana), sugar hackberry (Celtis laevigata), honey mesquite (Prosopis glandulosa), Hercules'-club (Zanthoxylum clava-herculis), osage orange (Melia azedarach), roughleaf dogwood (Cornus drummondii), retama (Parkinsonia aculeata), elbowbush (Forestiera angustifolia), eastern baccharis (Baccharis halimifolia), saltcedar, Louisiana vetch (Vicia ludoviciana), rosettegrass (Dichanthelium sp.), catchweed (Galium sp.), crow-poison (Nothoscordum bivalve), hairyfruit chervil (Chaerophyllum tainturieri), giant ragweed (Ambrosia trifida), mustang grape (Vitis mustangensis), poison ivy (Toxicodendron radicans), southern dewberry (Rubus trivialis), Virginia creeper (Parthenocissus quinquefolia), and peppervine (Ampelopsis arborea).

Developed

Developed areas in the study areas include the floodgate and lock facilities and Texas Boat & Barge, Inc. (BRFG study area).

4.8.1 Habitat Evaluations

The mix of open water, wetland, and upland habitats provide the opportunity for the study areas to support a variety of aquatic and terrestrial wildlife species. An interagency biological team, including USACE, TxDOT, USFWS, NMFS, and TPWD, conducted field visits to evaluate habitats in the study areas. Through the field visits, the team determined that none of the upland or open water habitats are considered significant because most are associated with the GIWW or DMPAs and do not contain significant resources. The team conducted a habitat evaluation of the three wetland habitat types (high marsh, intertidal marsh, and tidal flat) in the study areas using Habitat Evaluation Procedures (HEP) methodology. HEP is a habitat-based assessment methodology developed by the USFWS to estimate habitat values for use in project planning and impact assessment (USFWS 1980). HEP requires the use of Habitat Suitability Index (HSI) models developed for wildlife indicator species that use the habitats. The HSI models evaluate structural habitat composition variables that are contained in optimum habitat, and these variables are measured in the field.

Modeled habitat conditions are expressed as a numeric function (HSI value) ranging from 0.0 to 1.0, where 0.0 represents no suitable habitat for an indicator species and 1.0 represents optimum conditions for the species. HSI values ranging from 0.01 to 0.24 are considered "poor" habitat, 0.25 to 0.49 are considered "below average" habitat, 0.50 to 0.69 are "average" habitat, 0.70 to 0.89 are "good" habitat, and 0.90 to 1.00 are considered "excellent" habitat. Habitat units (HU) are calculated by multiplying the HSI value for each habitat by the amount of acres of that specific habitat type present in the study area.

The interagency team met in February and March 2017 to (1) select wildlife indicator species that use each habitat in the BRFG and CRL study areas and (2) collect field data at representative locations within each habitat. The team selected seven wildlife indicator species for the wetland habitats: red drum, brown and white shrimp, and clapper rail for intertidal marsh; clapper rail, marsh wren, and mottled duck for high marsh; and least tern for tidal flats (**Table 4.6**). During the field visits, access to private properties in the study areas was limited, so data collection occurred on USACE property, in areas along the GIWW and Brazos and Colorado Rivers, and private properties where access was granted. Data were collected at six locations in wetland habitats in the BRFG study area and four locations in wetland habitats in the CRL study area (**Table 4.6**). Of the high marsh habitats sampled, the interagency team determined that only one site had the potential to be used by marsh wren and mottled duck.

Table 4.5 Wetland Habitats, Indicator Species, and HEP Data Sites for BRFG and CRL

Habitat Type	HEP Data Sites	Indicator Species					
		Red Drum	Brown/White Shrimp	Clapper Rail	Marsh Wren*	Mottled Duck*	Least Tern
BRFG							
High Marsh	1, 4, 5			x			
Intertidal Marsh	2, 6	x	x	x			
Tidal Flat	3						x
CRL							
High Marsh	1, 2, 3			x	x*	x*	
Intertidal Marsh	4	x	x	x			

* Marsh wren and mottled duck were evaluated only at one high marsh site in the CRL study area. During field investigations, the interagency team determined that the other high marsh habitats at BRFG and CRL were not suitable for these species.

Average HSI values and HUs for each habitat are summarized in **Table 4.7**. The habitats scored "average" to "excellent" with the exception of the high marsh habitat at CRL, which scored "poor". The limiting factor causing high marsh habitats in the CRL study area to score "poor" was the lack of tidally influenced waters adjacent to these habitats. The high marsh habitats in the CRL study area are mostly separated from the GIWW and Colorado River by upland habitats (see **Figure 4.9**).

Table 4.6 Average HSI Values and Habitat Units for Wetland Habitats in BRFG and CRL Study Areas

Habitat Type	Acreage	Indicator Species							HSI Average	Habitat Units
		Red Drum	Brown Shrimp	White Shrimp	Clapper Rail	Least Tern	Marsh Wren*	Mottled Duck*		
BRFG										
High Marsh	125.2				1.00				1.00	125.20
Intertidal Marsh	13.9	0.37	0.92	0.90	1.00				0.80	11.12
Tidal Flat	3.0					0.80			0.80	2.40
CRL										
High Marsh	32.0				0.15		0.85*	0.00*	0.25	8.0
Intertidal Marsh	4.5	0.45	0.97	0.91	0.98				0.83	3.74

* Marsh wren and mottled duck were evaluated only at one high marsh site in the CRL study area. During field investigations, the interagency team determined that the other high marsh habitats at BRFG and CRL were not suitable for these species.

4.8.2 Rare, Unique, and Imperiled Vegetation Communities/Wildlife Habitats

The vegetation communities/wildlife habitats present in the BRFG and CRL study areas are characteristic of the Texas Gulf coast, and, while they are important resources, none of the habitats are considered regionally rare, unique, or imperiled. Threatened and endangered plant and wildlife species that may occur in the study areas are discussed in the *Threatened and Endangered Species* section below.

4.8.3 Invasive Plant and Animal Species

Several invasive plant species occur in coastal Texas. In terrestrial areas, Chinese tallow (*Triadica sebifera*), Chinaberry (*Melia azedarach*), and Chinese privet (*Ligustrum sinense*) can become rapidly established in disturbed areas, including DMPAs (Texas Invasive Plant and Pest Council [TIPPC] 2017). Invasive aquatic plants include water hyacinth (*Eichhornia crassipes*) and common reed (*Phragmites australis*), both of which thrive in fresh to brackish water zones (USDA 2017e, Stutzenbaker 1999). Water hyacinth creates dense cover and root mats that block sunlight, reduce oxygen, and kill plants that provide food for fish and other aquatic life (TPWD 2017a). Common reed creates dense stands that choke out native wetland species. No large stands or concentrations of any of these plants were observed in the study areas during field reconnaissance, although scattered Chinese tallow and Chinaberry trees were observed in upland DMPAs at both sites.

Some invasive wildlife species common in the region include feral hogs (*Sus scrofa*), nutria (*Myocastor coypus*), and red imported fire ant (*Solenopsis invicta*). Feral hogs compete with wildlife and livestock and damage crops and habitats by uprooting vegetation and disturbing the soil. Nutria burrow into wetland soils and eat aquatic vegetation, which creates disturbed, unvegetated areas that erode and become open water. Fire ants damage electrical wiring and some crops, as well as prey on ground-nesting birds, eggs, and other wildlife (TPWD 2017a). Recently, Asian tiger shrimp (*Penaeus monodon*) have been recorded off the Texas Gulf coast and in some Texas bays, and the red lionfish (*Pterois volitans*) has been reported in Tres Palacios Bay, approximately 11 miles west-northwest of the CRL study area (TIPPC 2017). The habitats in the study areas are suitable for feral hogs, fire ants, and nutria, so they could occur there.

4.9 Protected/Managed Lands and Recreational Areas

The only public recreation facility in either study area is a public boat ramp that provides access to the Brazos River approximately 0.3 mile north of the GIWW crossing (**Figure 4.10**). Named the Levee Road Boat Ramp, it is owned and managed by Brazoria County (Atkins North America 2013). There are no other designated parks or recreation areas, national wildlife refuges, wildlife management areas, or other protected or managed lands within the BRFG or CRL study areas (**Figures 4.10 and 4.11**). Protected and managed lands and recreation areas that are near the study areas are listed in **Table 4.8**.

Table 4.7 Protected/Managed Lands and Recreational Areas near BRFG and CRL Study Areas

Property	Location from Study Area	Description
BRFG Study Area (Figure 4.10)		
Levee Road Boat Ramp	Within study area	Public boat ramp
Justin Hurst WMA	Less than 1 mile northwest of BRFG	Part of Central Coast Wetlands Ecosystem Project; develops/manages habitats for wildlife species with special emphasis on waterfowl
Bryan Beach State Recreation Area	Less than 1 mile south of BRFG study area	Public access for fishing in the Gulf of Mexico and the Brazos River, and for camping
Bryan Beach Park	1.5 mile east of study area	Public park maintained by City of Freeport
San Bernard NWR	3 miles west of study area	54,000-acre refuge that provides a habitat corridor for migrating and wintering birds
CRL Study Area (Figure 4.11)		
Mad Island WMA	1.5 miles west of study area	7,200 acres of fresh to brackish marsh with sparse brush and flat coastal prairie; preserve coastal wetland habitat for wintering waterfowl
Matagorda County Jetty Park	Matagorda Peninsula, 6 miles south of study area	Public park that is a popular birding location

Sources: TPWD 2017b, eBird 2017, The Go Travel Sites 2017

4.10 Threatened and Endangered Species

According to the USFWS' threatened and endangered species lists for Brazoria and Matagorda Counties (USFWS 2017a, 2017b, 2017c) and NMFS' threatened and endangered species list for the Texas portion of the Gulf of Mexico (NMFS 2017), 18 federally listed threatened or endangered species and four candidates for federal listing may occur in Brazoria and Matagorda Counties (**Table 4.9**). In addition, the USFWS has designated critical habitat for the wintering piping plover (*Charadrius melodus*) along the entire Texas Gulf, including in Brazoria and Matagorda Counties (USFWS 2009, 2017c) and near the study areas. There is no designated or proposed critical habitat for other species in or near the study areas.

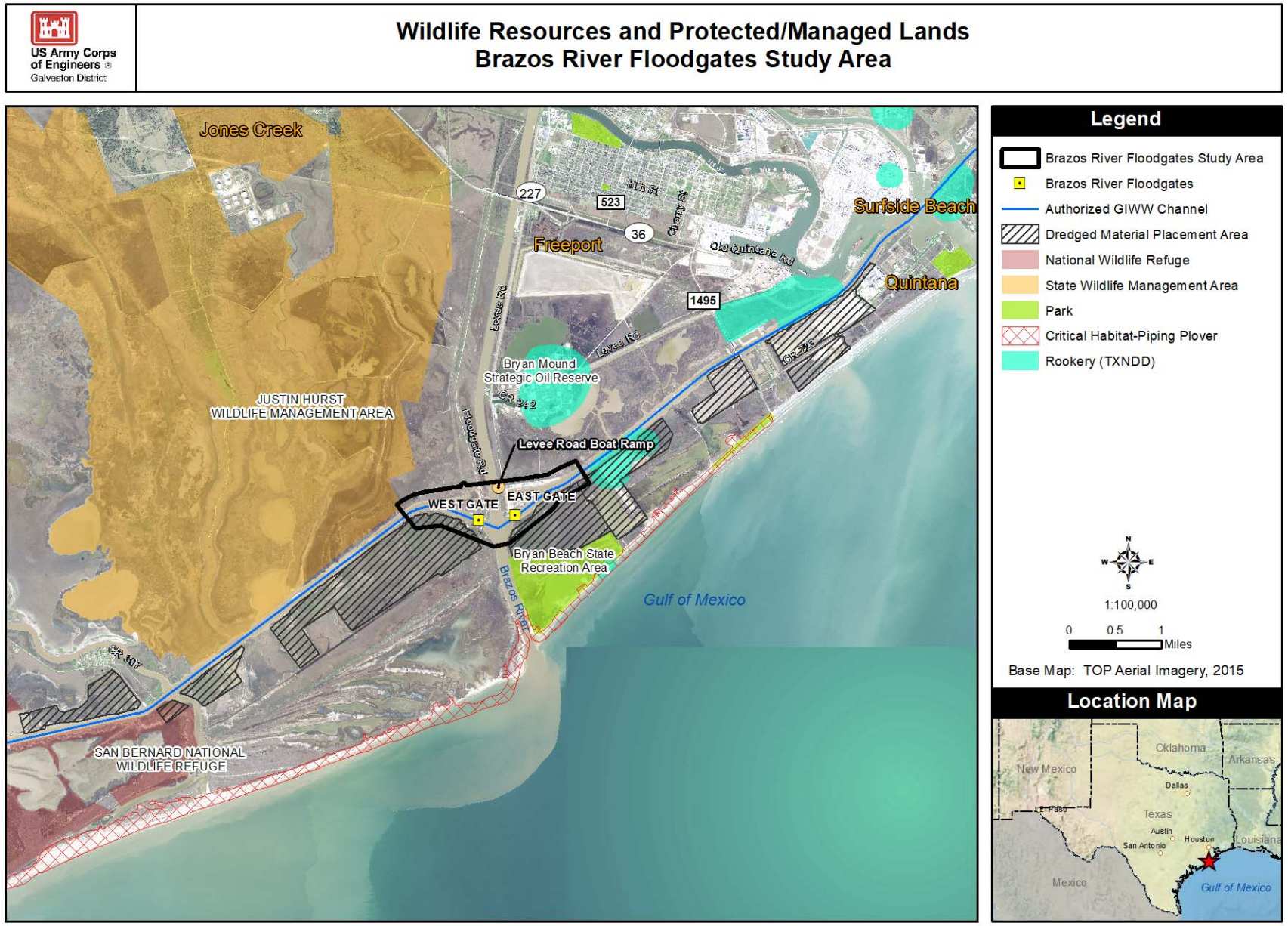


Figure 4.10 Wildlife Resources and Protected/Managed Lands in BRFG Study Area

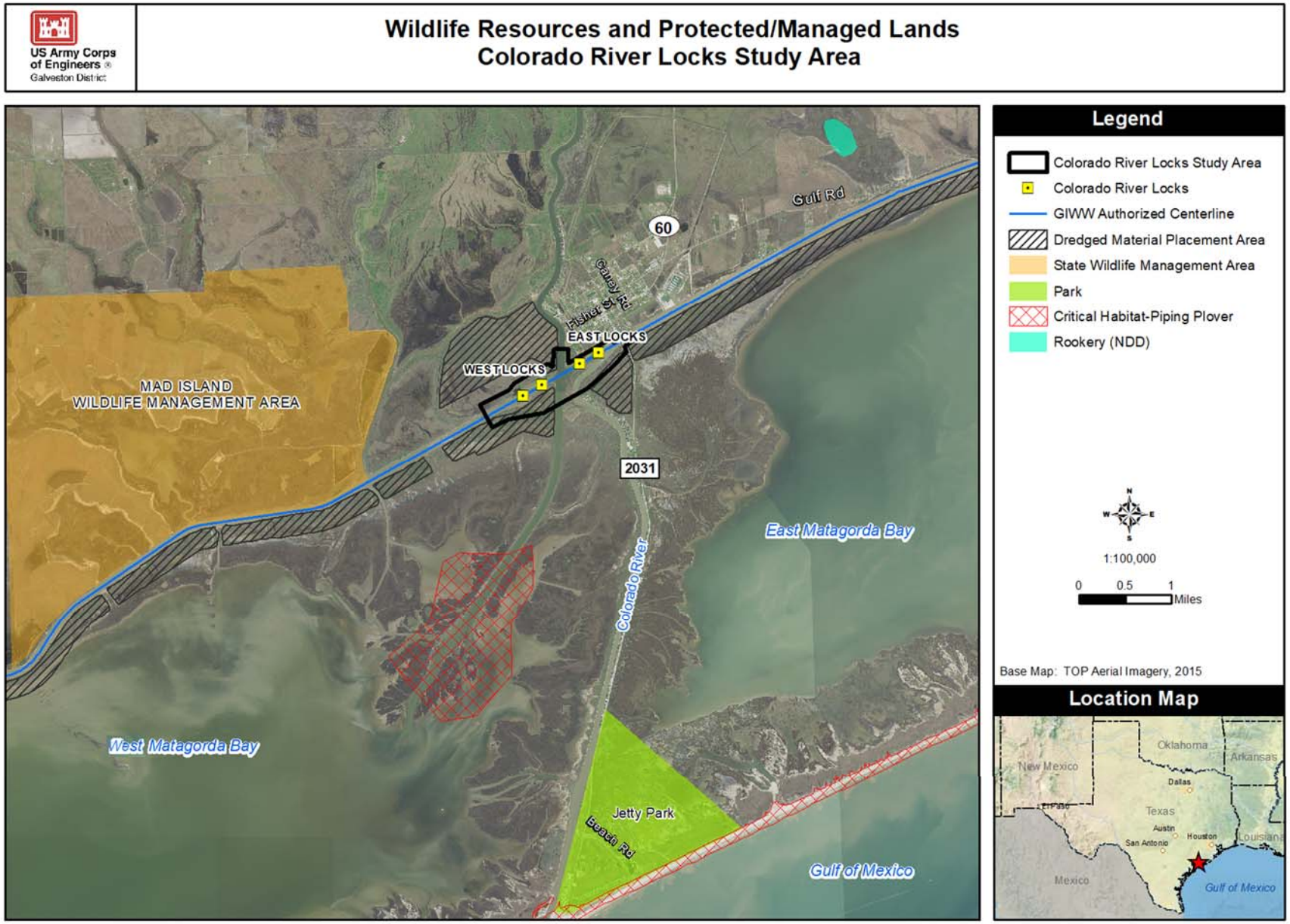


Figure 4.11 Wildlife Resources and Protected/Managed Lands in CRL Study Area

Table 4.8 Federally Listed and Candidate Species with Potential to Occur in Brazoria and Matagorda Counties, Texas

Listed Species		Listing Status	Jurisdiction	Potential to Occur in BRFG and CRL Study Areas?
Common Name	**Scientific Name**			
Birds				
Northern aplomado falcon	*Falco femoralis septentrionalis*	Endangered	USFWS	Yes
Piping plover	*Charadrius melodus*	Threatened	USFWS	Yes
Red knot	*Calidris canutus rufa*	Threatened	USFWS	Yes
Whooping crane	*Grus americana*	Endangered	USFWS	Yes
Mammals				
West Indian manatee	*Trichechus manatus*	Threatened	USFWS	Yes
Fin whale	*Balaenoptera physalus*	Endangered	NMFS	No
Humpback whale	*Megaptera novaeangliae*	Endangered	NMFS	No
Sei whale	*Balaenoptera borealis*	Endangered	NMFS	No
Sperm whale	*Physeter macrocephalus*	Endangered	NMFS	No
Reptiles				
Green sea turtle	*Chelonia mydas*	Threatened	NMFS	Yes
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered	USFWS; NMFS	Yes
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	USFWS; NMFS	Yes
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	USFWS; NMFS	No
Loggerhead sea turtle	*Caretta caretta*	Threatened	USFWS; NMFS	Yes
Mollusks				
Golden Orb	*Quadrula aurea*	Candidate	USFWS	No
Smooth pimpleback	*Quadrula houstonensis*	Candidate	USFWS	No
Texas fawnsfoot	*Truncilla macrodon*	Candidate	USFWS	No
Texas pimpleback	*Quadrula petrina*	Candidate	USFWS	No
Corals				
Boulder star coral	*Orbicella franksi*	Threatened	NMFS	No
Elkhorn coral	*Acropora palmata*	Threatened	NMFS	No
Lobed star coral	*Orbicella annularis*	Threatened	NMFS	No
Mountainous star coral	*Orbicella faveolata*	Threatened	NMFS	No

Sources: NMFS 2017; USFWS 2017a, b, c

Based on habitat assessments and recorded sightings, nine of the federally listed threatened/endangered species have the potential to occur in the BRFG and CRL study areas (**Table 4.9**). The following bullets summarize the potential for each species to occur in the study areas. More detailed information is provided in the Biological Assessment prepared for the project (**Attachment D-2**).

- Northern aplomado falcon (*Falco femoralis septentrionalis*) – A breeding population of northern aplomado falcons exists on Matagorda Island, located 32 miles southwest of the CRL study area. Individual sightings of the species have been recorded within 5 miles of the BRFG and CRL study areas, at San Bernard NWR and Mad Island Wildlife Management Area (WMA) (eBird 2017). The study areas contain open habitats that could be used by aplomado falcons, but no nesting falcons are expected based on the current known nesting range.

- Piping plover and red knot (*Calidris canutus rufa*) – The piping plover and red knot are migratory species that overwinter on the Texas coast and utilize barrier island beaches, exposed tidal flats,

washover passes, and mud flats. Designated critical habitat for the piping plover is present along the Gulf beach near both study areas, as well as in the Colorado River delta in West Matagorda Bay (USFWS 2017a, 2017b, 2017d) (**Figures 4.10 and 4.11**). Piping plovers and red knots have been recorded in the vicinity of both study areas (eBird 2017, Texas Natural Diversity Database [TXNDD] 2017).

- Whooping crane (*Grus americana*) – Whooping cranes also overwinter on the Texas coast, mostly in the area surrounding the Aransas NWR located about 30 miles southwest of the CRL study area. They utilize salt marshes and tidal flats on the mainland and barrier islands. Salt marsh habitat is present in both study areas, and whooping cranes have been recorded within 5 miles of both study areas at Justin Hurst WMA, San Bernard NWR, and Mad Island WMA (TXNDD 2017, eBird 2017).

- West Indian manatee (*Trichechus manatus*) – Manatee occurrences in Texas are extremely rare. The Texas Marine Mammal Standing Network has recovered fewer than 10 manatees along the Texas coast since 1980 (Houston Chronicle 2012). One historical manatee record is in the GIWW near Oyster Creek just north of Freeport. Historical records from Texas waters also include Cow Bayou, Sabine Lake, Copano Bay, the Bolivar Peninsula, and the mouth of the Rio Grande (Natural Science Research Laboratory 2017). In October 2012, live manatee sightings were recorded near Galveston and near Corpus Christi (Houston Chronicle 2012). A West Indian manatee could occur in the GIWW or rivers in the study areas; however, the likelihood of their occurrence is considered low due to their rare occurrence in Texas.

- Whales – Whales are generally restricted to offshore waters and are not expected to occur in the study areas.

- Sea turtles – The GIWW and Brazos and Colorado Rivers provide open water habitats that could be used by sea turtles. Four of the five sea turtle species are known to use Texas waters; the leatherback sea turtle (*Dermochelys coriacea*) is uncommon in Texas coastal waters and is not likely to occur in the study areas.

- Mollusks (mussels) – The mussel species that are candidates for federal listing are freshwater species and are not expected to occur in the tidal and brackish waters of the Brazos River, Colorado River, or other waters in the study areas due to salinity fluctuations.

- Corals – The listed corals are offshore species and do not occur in the study areas.

4.11 Other Protected Wildlife Species

In addition to species protected under the Endangered Species Act, other protected wildlife that may occur in the study areas include marine mammals, bald eagles, and general migratory birds. The following sections discuss the regulations protecting these species and their potential to occur in the study areas.

4.11.1 Marine Mammals

The Marine Mammal Protection Act (MMPA) was enacted in 1972 and prohibits the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas, as well as the importation of marine mammals and marine mammal products into the U.S. (NOAA 2017c). Take, as defined by the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal" (16 U.S.C. 1362). Although taking of marine mammals is prohibited, NMFS can issue incidental take authorizations for activities that may unintentionally take marine mammals, such as sonar and noise-producing activities (e.g., military sonar activities, oil/gas development, geophysical surveys, pile-driving, and demolition using explosives).

The only marine mammal species that is likely to occur in the BRFG and CRL study areas is the bottlenose dolphin (*Tursiops truncatus*), which are common throughout the Texas Gulf coast.

4.11.2 Bald and Golden Eagles

The Bald and Golden Eagle Protection Act (BGEPA) (16 U.S.C. §§ 668-668d) prohibits the take of bald and golden eagles unless pursuant to regulations. The BGEPA defines the take of an eagle to include a broad range of actions, including to pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb. Based on regulations found at 50 CFR 22.3, the term "disturb" means to "agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, (1) injury to an eagle, (2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior."

Golden eagles are not expected to occur in the study areas except for the possibility of migrating individuals passing through. Bald eagles, however, are well known to occur and nest near major water bodies in the Texas coastal region, including Brazoria and Matagorda Counties (Ortego 2016). Recent records show that the number of reported bald eagle nests in Brazoria and Matagorda Counties is 16 and 13, respectively; Harris County has the most reported nests of the coastal counties, with 23 nests (Ortego 2016).

Bald eagles may forage in the Brazos, San Bernard, and Colorado Rivers, GIWW, East and West Matagorda Bays, and other large water bodies in and near the study areas. No known bald eagle nests are in or adjacent to the study areas. Trees in the study area are generally too small to support bald eagle nests, and no nesting habitat for bald eagles is present in or adjacent to the study areas.

4.11.3 Migratory Birds

The Migratory Bird Treaty Act (MBTA) prohibits the taking, killing, possession, transportation, and export of migratory birds, their eggs, parts, and nests without a USFWS permit or other regulatory authorization. The MBTA protects most native bird species occurring in the wild in the U.S. except for gallinaceous birds (upland game birds such as turkeys and quail) that are not considered migratory. In addition, the MBTA does not protect some non-native species such as the house sparrow (*Passer domesticus*), European starling

(*Sturnus vulgaris*), rock pigeon (*Columba livia*), and any recently listed unprotected species in the Federal Register (70 FR 12710, March 15, 2005).

The habitats in the BRFG and CRL study areas are used by various migratory birds for nesting, foraging, loafing, and roosting. A number of rookeries that are used by colonial nesting birds are documented in the vicinity of the study areas (TXNDD 2017) (**Figures 4.10 and 4.11**). Species that have been documented nesting in the rookeries include cattle egret (*Bubulcus ibis*), great egret (*Ardea alba*), tricolored heron (*Egretta tricolor*), great blue heron (*Ardea herodias*), olivaceous cormorant (*Phalacrocorax brasilianus*), snowy egret (*Egretta thula*), roseate spoonbill (*Platalea ajaja*), least tern (*Sternula antillarum*), laughing gull (*Leucophaeus atricilla*), white ibis (*Eudocimus albus*), reddish egret (*Egretta rufescens*), forester's tern (*Sterna forsteri*), and black skimmer (*Rynchops niger*) (TXNDD 2017). The marsh and open water habitats in the study areas provide some foraging habitat for these species.

The Texas coast also provides important stopover habitats for migratory birds crossing the Gulf of Mexico during spring migration. Once they reach the coast, migrating birds sometimes "fallout" in large numbers to seek shelter and food. Fallouts of migratory birds have been recorded in and around the BRFG and CRL study areas, primarily in wooded habitats along the rivers and in DMPAs in the study areas (TXNDD 2017). These fallouts are mostly likely to occur in the spring.

4.12 Aquatic Resources

4.12.1 Plankton Resources

Plankton resources include any organism that is non-motile or too small or weak to swim actively against currents, and are composed of three groups: bacterioplankton, phytoplankton, and zooplankton (Knox 2001).

Plankton are vital to estuarine systems for various reasons. They are the base of the food web, serving as primary producers and providing major food and energy sources for larger organisms, including organisms that are important for commercial and recreational fishing. They serve a key role in nutrient cycling. Phytoplankton are responsible for 40 percent or more of all photosynthesis occurring on the earth and are therefore a major source of oxygen and organic matter (Day et al. 1989).

Phytoplankton include single-cell algae and are the major primary producers in estuaries, fixing carbon by photosynthesis and passing it through the food chain either directly to consumers or indirectly as detritus. In the open-bay bottoms of most Texas estuaries, the dominant phytoplankton assemblages include diatoms, dinoflagellates, green algae, and blue-green algae (Armstrong et al. 1987). In addition to their major beneficial roles, some phytoplankton species, such as the dinoflagellate *Karenia breve*, reproduce rapidly under high-nutrient or other favorable conditions. These "blooms" may result in toxic conditions such as red tide that kill finfish and shellfish and pose human health hazards.

Zooplankton are composed of a variety of faunal species and consist of two major groups: holoplankton, which spend their entire life cycle as plankton (e.g., copepods and amphipods) and meroplankton, which are animals that spend only part of their life cycles as plankton (e.g., eggs and larvae of fish, crabs, shrimp,

and other species). Some of the dominant zooplankton in Texas estuaries include the barnacle nauplii (larval stage), the copepod *Acartia tonsa*, and the dinoflagellate *Noctiluca scintillans* (Armstrong et al. 1987). Estuarine zooplankton communities appear to be sensitive to changes in the estuary, particularly changes in salinity. Freshwater inflows can enhance zooplankton production by bringing in freshwater zooplankton species and food sources; however, rapid freshwater inflows can decrease zooplankton populations by flushing out resident zooplankton.

4.12.2 Benthic Resources

Benthic organisms are invertebrates that live in and on bottom sediments of water bodies, including estuaries. They include sessile, burrowing, crawling, and swimming organisms such as annelid worms, clams and other mollusks, and various crabs and other crustaceans. They are divided into two main groups: epifauna, which live on the surface of the bottom substrate (e.g., oysters, crabs, and smaller crustaceans), and infauna, which burrow into the bottom substrate (e.g., some mollusks and polychaetes) (Green et al. 1992). Benthic communities are important in that they are directly or indirectly involved in most physical and chemical processes that occur in estuaries, and these processes determine various characteristics of the estuarine ecosystem, such as water turbidity or clarity, ecosystem productivity, oxygen levels, physical structure, and water filtration (Day et al. 1989). In addition, some members of the benthic community such as oysters, clams, and crabs, support commercial and recreational fisheries.

Although benthic organisms have limited mobility, benthic communities are not static and change with changes in habitat and water conditions. Studies have shown that benthic organism diversity, abundance, and biomass are generally highest in late winter to early spring, and increase with increasing salinity. Middle-bay areas and bays with less freshwater influence and higher salinities have higher benthic diversity, abundance, and biomass than river-influenced areas (Armstrong et al. 1987, Montagna et al. 2008, Palmer et al. 2011). The higher number of species in more saline areas is due to the increase in the presence of marine species (Palmer et al. 2011). Within river-dominated systems, the benthic species are dominated by polychaetes, with some oligochaetes and insect larvae. In more saline bays, benthic communities are dominated by various polychaetes, along with several species of nemertean, mollusks, and crustaceans (Armstrong et al. 1987).

4.13 Commercial and Recreational Fisheries

Fishery resources are managed by the Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-297). Fish, including finfish and shellfish, are vital components of estuarine and other aquatic habitats, they provide an important food source for people and wildlife, and they have both commercial and recreational value. The GIWW provides access to local bays for both commercial and recreational fishing. In 2014, the GIWW enabled commercial fishermen to catch an estimated 10.3 million pounds of shrimp, oysters, crabs, and finfish with a wholesale value of $30.4 million from Texas bays and estuaries (TxDOT 2016).

4.13.1 Finfish

Commercial fisheries for finfish are an important economic resource in Texas. According to NOAA's fishery statistics data (NOAA 2017d), in 2015 commercial fisheries in Texas harvested nearly 5 million pounds of finfish species with an estimated value of about $16.2 million. The most commonly harvested species were red snapper (*Lutjanus campechanus*), black drum (*Pogonias cromis*), and vermilion snapper (*Rhomboplites aurorubens*), which accounted for 75 to 80 percent of commercial catches by pound and value. In comparison to other Gulf states, Texas has the second highest catch rate for these three species after Louisiana.

According to the Marine Recreational Information Program, the most commonly recreational sport fish caught in Texas include spotted seatrout (*Cynoscion nebulosus*), sand seatrout (*Cynoscion arenarius*), red drum (*Sciaenops ocellatus*), Atlantic croaker (*Micropogonia undulatus*), black drum, southern flounder (*Paralichthys lethostigma*), sheepshead (*Archosargus probatocephalus*), red snapper, and mackerel (*Scomberomorus spp.*) (NOAA 2017e). Recreational catch, both the species caught and the number of fish caught, varies by season and annually, but the species listed are most commonly caught.

4.13.2 Shellfish (includes Shrimp, Crab, Oysters)

Commercial harvest of shellfish, including shrimp, crabs, and oysters, is also an important industry in Texas. In 2015, over 76 million pounds of shellfish were harvested from Texas waters, with an estimated value of nearly $162 million. These catches included an estimated 70.5 million pounds of shrimp ($148 million), 4.3 million pounds of blue crab ($5.5 million), and 1.6 million pounds of oysters ($8.4 million). an estimated commercial fisheries in Texas harvested nearly 5 million pounds of finfish species with an estimated value of about $16.2 million.

4.14 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-297), addresses the authorized responsibilities for the protection of Essential Fish Habitat (EFH) by the NMFS in association with regional Fishery Management Councils. The Act establishes eight regional Fishery Management Councils responsible for the protection of marine fisheries within their respective jurisdictions. Essential Fish Habitat is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." This definition extends to habitat specific to an individual species or group of species; whichever is appropriate, within each Fishery Management Plan (FMP). The Act also authorizes the designation of Habitat Areas of Particular Concern (HAPC) for marine fisheries. HAPCs are subsets of EFH that are rare, susceptible to human degradation, ecologically important, or located in an ecologically stressed area, and are therefore priorities for habitat conservation, management, and research (NMFS 2010, Mid-Atlantic FMC 2016).

In estuarine environments, EFH is defined as "all estuarine waters and substrates (mud, sand, shell, rock, and associated biological communities), including the sub-tidal vegetation (seagrasses and algae) and adjacent inter-tidal vegetation (marshes and mangroves)" (GMFMC 2004). The estuary habitats (open water, high marsh and intertidal marsh, and tidal flats) in the BRFG and CRL study areas have been

identified as EFH for red drum (*Sciaenops ocellatus*), shrimp, coastal migratory pelagics, 43 species of reef fish, and several shark species: blacknose shark (*Carcharhinus acronotus*), blacktip shark (*Carcharhinus limbatus*), bonnethead shark (*Sphyrna tiburo*), bull shark (*Carcharhinus leucas*), great hammerhead shark (*Sphyrna mokarran*), lemon shark (*Negaprion brevirostris*), scalloped hammerhead shark (*Sphyrna lewini*), and spinner shark (*Carcharhinus brevipinna*) (NMFS 2015).

Although the study areas contain EFH for the above-mentioned species, the study areas are partially developed with navigation-related and commercial facilities and do not provide high-quality EFH. Additionally, marine water column and marine non-vegetated bottoms occur in abundance in the region and are, therefore, not unique to the area. No HAPCs are located in the study areas. More detailed information on EFH in the study areas is provided in the EFH Assessment Report that has been prepared for the project (**Attachment D-3**).

4.15 Coastal Barrier Resources and Coastal Natural Resources

The Coastal Barrier Resources Act (CBRA) was enacted in 1982 to discourage development in certain coastal areas that are vulnerable to hurricane damage and are host to valuable natural resources. The CBRA designated certain undeveloped coastal areas ineligible for most new federal expenditures and financial assistance. The coastal barrier resources system (CBRS) is delineated and maintained by the U.S. Department of the Interior through USFWS (USFWS 2017e).

There are two CBRA-designated areas near the study areas: Brazos River Complex T05/T05P and Matagorda Peninsula Unit T07/T07P (**Figure 4.12**) (CBRS 2017). At the BRFG, Unit T05 has 4,766 acres and Unit T05P has 2,759 acres. Unit T05 is designated as an Otherwise Protected Area, which includes undeveloped coastal barriers within the boundaries of lands reserved as wildlife refuges, parks, or for other conservation purposes. At the CRL, Unit T07 encompasses approximately 32,036 acres and Unit T07P has approximately 43,715 acres (CBRS 2017).

Exceptions to the Federal expenditure restrictions include maintenance of constructed improvement(s) to existing Federal navigation channels and related structures including the disposal of dredged material related to maintenance and construction. Thus, the proposed alternatives being evaluated for the BRFG-CRL Feasibility Study are exempt from the prohibitions identified in the CBRA.

The Texas Coastal Management Program (TCMP) was designed to protect coastal natural resources. The study areas are located within the coastal zone and, as such, the USACE has evaluated impacts of the project to coastal natural resources. Information on impacts to coastal natural resources and consistency with TCMP policies is provided in the Coastal Consistency Determination that has been prepared for the project (**Attachment D-4**). The Coastal Coordination Council (CCC) will also review the project for consistency with the TCMP. All project planning has made efforts to avoid and otherwise minimize the cumulative adverse effects to coastal natural resource areas relating to the BRFG and CRL alternatives.

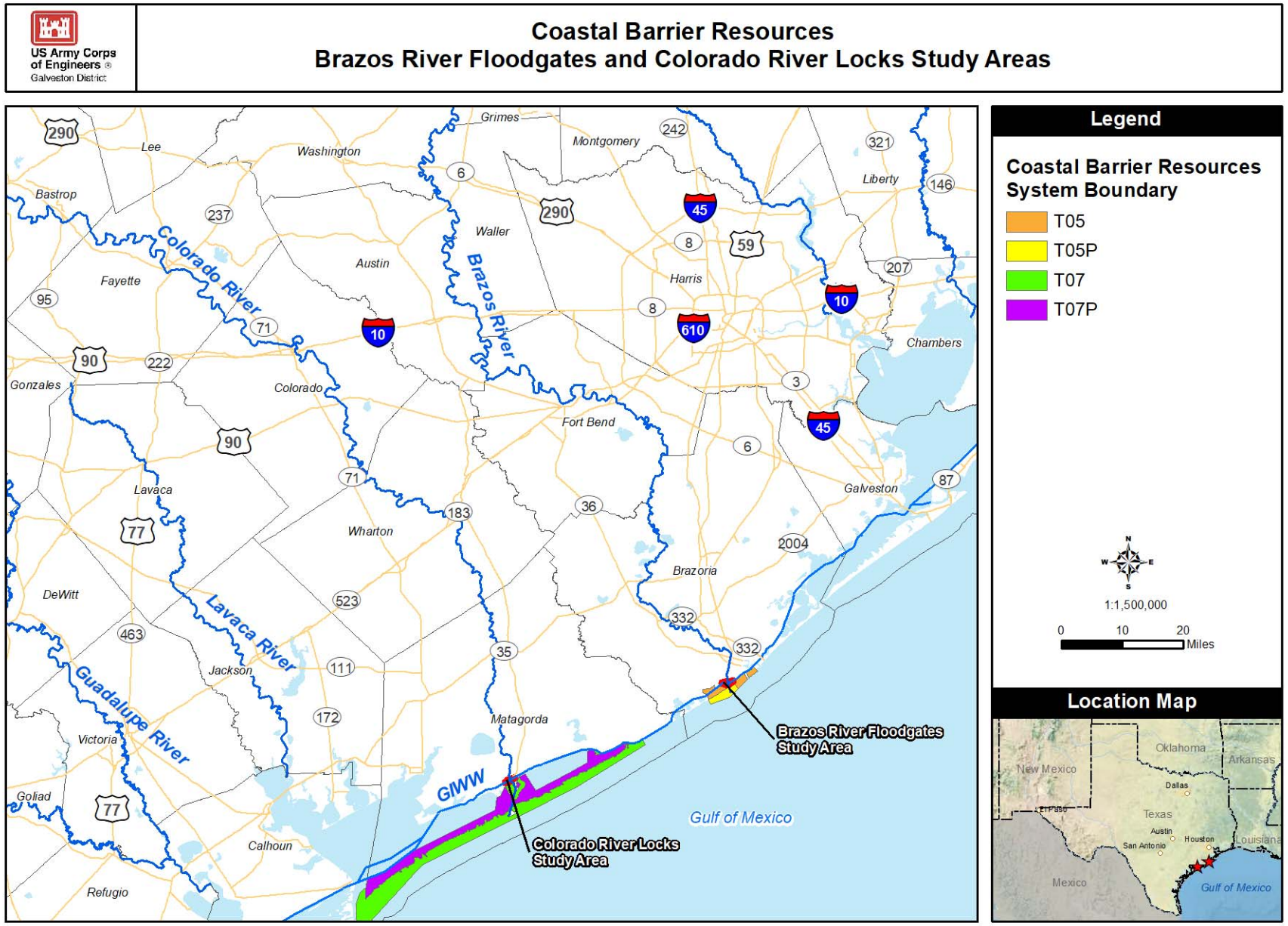


Figure 4.12 Coastal Barrier Resources in the BRFG and CRL Study Areas

4.16 Historic and Cultural Resources

Cultural resources (archeological and historic resources) are protected by a number of laws and regulations, primarily the National Historic Preservation Act (NHPA) and, on lands owned by the State of Texas or political subdivisions of the State, the Antiquities Code of Texas. The following discusses existing conditions regarding archeological resources and non-archeological historic resources within the BRFG and CRL study areas.

4.16.1 Archeological Resources

An archeological background review was conducted for the areas around the BRFG and CRL. Examination of the online files and maps at the Texas Historical Commission's (THC) restricted-access online Texas Archeological Sites Atlas (TASA) were searched for previously recorded archeological sites, sites listed on the National Register of Historic Places (NRHP), historical markers, and State Antiquities Landmarks (SALs). Additional records affiliated with the National Park Service, the THC's Online Historical Sites Atlas, and the Texas Archeological Research Laboratory were also consulted.

The files and maps on the TASA show that portions of the BRFG study area and surrounding area have been subject to previous archeological survey by the Department of Energy in 1991; the USACE in 1987, 1991, 1992, and 1998; Prewitt & Associates in 1999; and PBS&J in 2008 and 2009. Based on the TASA, there are no previously recorded archeological sites within the BRFG study area, and the nearest recorded archeological site is in the Bryan Beach State Recreation Area, approximately 0.5 mile south of the BRFG study area. Site 41BO110 was recorded in 1978 as a historic site with ceramics and brick and is listed as a State SAL. It was not found during subsequent investigations in 1998, suggesting it has either been destroyed, buried, or the location was mapped erroneously.

In the CRL vicinity, the TASA shows that several archeological surveys were conducted between 1973 and 1980. There are no previously recorded archeological sites in the CRL study area, and the nearest recorded site is Site 41MG128, which is a historic wooden home built in 1833 that is located 0.2 mile north of the study area. Two shipwrecks and one NRHP-listed cemetery, the Matagorda Cemetery, are also located in the general vicinity but well outside the CRL study area.

Much of the BRFG and CRL study areas have been extensively disturbed by previous excavation of the GIWW, diversion of the Brazos and Colorado Rivers, construction of the BRFG and CRL facilities, and construction of roads, levees, and DMPAs. Therefore, the potential for encountering intact archeological sites is considered relatively low and limited to few undisturbed areas.

4.16.2 Non-archeological Historic Resources

Non-archeological historic resources include buildings, structures, objects, and historic districts located above ground. In accordance with Section 106 of the NHPA and its associated regulations (36 CFR 800), the USACE established Areas of Potential Effect (APE) at BRFG and CRL for non-archeological historic resources in cooperation with the Texas State Historic Preservation Office (SHPO). Due to the insular nature of the study areas, the APE at each facility was established as 500 feet from the study area boundary.

Per 36 CFR 800.4, non-archeological historic resource studies were completed to determine if historic-age resources within the APEs are eligible for or listed in the NRHP and may be affected by project alternatives.

A review of the THC's Texas Historic Sites Atlas revealed that there are no non-archeological historic resources listed in the NRHP within the BRFG and CRL APEs. In July and August 2017, a survey was conducted to determine if any non-archeological historic resources within the APEs were NRHP-eligible. A survey cutoff date of 1975 was established based on an estimated date of construction of 2020. Although National Park Service (NPS) guidelines state that a property must generally be at least 50 years old to be NRHP eligible, an additional five years was subtracted to account for delays in project planning or funding. The identified pre-1975 historic resources in the study areas are also referred to as "historic-age" resources.

As documented in the September 2017 historic resources survey report (HRSR) titled *Non-Archeological Historic Resources Survey Report for the Gulf Intracoastal Waterway Brazos River Floodgates and Colorado River Locks Systems Feasibility Study, Brazoria and Matagorda Counties, Texas*, a total of 25 historic-age resources within the APEs at BRFG and CRL were identified, inventoried, and evaluated for their NRHP eligibility per NPS criteria. Within the APE of the BRFG, 10 historic-age resources were identified and inventoried, which included the floodgates and other USACE-owned resources within the BRFG facility (e.g., control houses, power houses, pump house, boat house). Based on evaluations documented in the HRSR, none of the historic-age resources within the BRFG APE met the NPS criteria for NRHP eligibility.

Within the APE of the CRL, 15 historic-age resources identified and inventories; 11 of the resources were associated with the CRL facility and four of the resources were located outside the CRL facility. As outlined in the HRSR, none of the historic-age resources within the CRL APE met the NPS criteria for NRHP eligibility.

4.17 Air Quality

4.17.1.1 National Ambient Air Quality Standards

The Clean Air Act (CAA) of 1970, as amended in 1977 and 1990, regulates air emissions from stationary and mobile sources. The CAA requires the EPA to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment (40 CFR 50). The CAA establishes two types of NAAQS: primary and secondary. Primary standards define levels of air quality that the EPA judges necessary, with an adequate margin of safely, to protect the public health, particularly to "sensitive" populations such as children, elderly, and asthmatics. Secondary define levels of air quality that the EPA deems necessary to protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings (40 CFR 50).

The EPA has established NAAQS for six principal pollutants, called "criteria" air pollutants: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ground-level ozone (O_3), particulate pollution or particulate matter (PM_{10} and $PM_{2.5}$), and sulfur dioxide (SO_2) (EPA 2017a). The CAA requires the EPA to monitor ambient air quality and assign a designation to each area based on its compliance with the NAAQS. Based on their NAAQS compliance level, the EPA designates areas as either:

- Attainment – area currently meets the NAAQS;
- Maintenance – area currently meets the NAAQS, but has previously been out of compliance;
- Non-attainment – area currently does not meet the NAAQS; or
- Unclassified – area that cannot be classified based on available data.

Ozone nonattainment areas are further classified as extreme, severe, serious, moderate, and marginal depending on the severity of NAAQS exceedance (EPA 2017b).

Under the CAA, if an area is designated as nonattainment, then state and local governments must develop a State Implementation Plan (SIP), which is a comprehensive plan for an area to meet federal air quality guidelines. The TCEQ has developed a SIP, with EPA's approval, that describes how Texas will comply with the CAA and how the compliance will be monitored (TCEQ 2017b).

The BRFG study area is located within the Houston-Galveston-Brazoria (HGB) Intrastate Air Quality Control Region, which is in attainment for all criteria pollutants except ozone (EPA 2017c, TCEQ 2017b). The HGB Ozone Nonattainment Area was classified as "severe" by the EPA in October 2008 under the 1997 eight-hour ozone NAAQS. As of July 2012, the EPA designated the HGB area as "marginal" for the 2008 ozone NAAQS based on major improvements in air quality for the area. In December 2016, the HGB area was reclassified as "moderate" ozone nonattainment for the 2008 ozone NAAQS, with an attainment deadline of July 2018 (81 FR 90207).

The CRL area is located in Matagorda County, which is in attainment for all criteria pollutants.

4.17.1.2 Conformity of Federal Actions

As required by the CAA, the EPA has established rules to ensure that Federal actions conform to the appropriate SIP. The General Conformity Rule applies to all Federal actions within NAAQS nonattainment areas, except for Federal Highway Administration (FHWA)/Federal Transit Authority (FTA) actions, which are subject to the Transportation Conformity Rule.

The CAA prohibits Federal undertakings (including funding, permitting, constructing, or licensing) that do not comply with the applicable SIP. The General Conformity requirement ensures that Federal agencies consult with State and local air quality managers and allows State agencies to include expected emissions into the appropriate SIP.

Since the BRFG study area is in the HGB moderate ozone nonattainment area, the USACE will evaluate projected pollutant emissions from construction and, if needed, maintenance activities. If the projected emissions exceed 100 tons per year (tpy) of either nitrogen oxides (NOx) or volatile organic compounds (VOCs), a General Conformity Determination will be required (TCEQ 2017c). Since the CRL study area is in an area that is in attainment for all criteria pollutants, no emissions analysis or conformity determination will be needed there.

4.18 Noise

The magnitude of noise is generally described by its sound pressure. The range of sound pressure varies greatly, and sound is generally measured on a logarithmic scale, measured in decibels (dB). Environmental measurements of sound are usually made on the A-weighted scale, as this is the frequency range detected by humans; this frequency is expressed as dBA. Common sound/noise levels that an individual may encounter, and the human response, are listed in **Table 4.10**. Included are noise levels of tugs and some common equipment that may be used for construction or maintenance in the BRFG and CRL study areas.

Table 4.9 Sound Levels and Human Response

Common Sound[1]	dBA	Human Response
Rocket launching pad (no ear protection)	180	Irreversible hearing loss
Carrier deck jet operation Air raid siren	140	Painfully loud
Thunderclap Shotgun blast	130	
Jet takeoff (200 feet) Auto horn (3 feet)	120	Uncomfortably loud; Maximum vocal effort
Pile driver Rock concert (20 feet)	110	Extremely loud
Garbage truck Firecrackers	100	Very loud
Heavy truck (50 feet) City traffic **Tug boat** (50 feet)[2] **High Solids Pump** (3 feet)[2]	90	Very annoying Hearing damage (8 hours)
Alarm clock (2 feet) Hair dryer **Excavator Clamshell Dredge** (50 feet)[2]	80	Annoying
Noisy restaurant Freeway traffic Business office **Work Boat** (50 feet)[2]	70	Telephone use difficult
Air conditioning unit Conversational speech	60	Intrusive
Light auto traffic (100 feet)	50	Quiet
Living room Bedroom Quiet office	40	
Library Soft whisper (15 feet)	30	Very quiet
Broadcast recording studio	20	
Whisper Light rainfall	10	Just audible
	0	Threshold of hearing

[1] Occupational Safety and Health Administration (OSHA) 2017
[2] Epsilon Associates, Inc. 2006

Noise generators are limited in the study areas, with tugs and other vessels being a primary source of noise. Operations at the floodgate/lock facilities and Texas Boat and Barge would also generate noise. Tug operators sometimes have to moor the tows along the bank while waiting to transit the BRFG or CRL. Normally, tugs leave their generators running and often leave their main engines running while waiting to transit, contributing to the overall noise environment. There are no sensitive receptors in the study areas, and limited residential or recreational (e.g., the Bryan Beach Recreation Area) near the study areas.

4.19 Oil, Gas, and Minerals

Oil, gas, and mineral resources vary between the BRFG and CRL study areas. Near the BRFG, the Bryan Mound Strategic Petroleum Reserve is the closest major energy and mineral resource; it is located about 1 mile north of the East Floodgate (**Figure 4.1**). The site stores 245 million barrels of crude oil, or one-third of the nation's oil reserves, in a subterranean salt dome held by the Strategic Petroleum Reserve for use in national emergencies. It has 20 underground chambers and is connected to port facilities at Freeport. A number of other major facilities occur in the BRFG vicinity, including Dow Chemical, Freeport Liquefied Natural Gas, and facilities around the Port of Freeport and the GIWW.

There are no oil or gas pipelines in the BRFG study area (Texas Railroad Commission [RRC] 2017). There are four known oil wells in the study area. However, three locations are considered dry holes, and drilling was cancelled or abandoned at the fourth locations. There are no oil wells, pipelines, or other oil, gas, or mineral resources in the CRL study area (RRC 2017).

The GIWW is a critical facility for the transportation of oil and gas commodities.

4.20 Hazardous, Toxic, and Radioactive Waste

The USACE identified potential hazardous, toxic, and radioactive waste (HTRW) issues that may affect the BRFG and CRL areas. The survey included 2-mile and 4-mile search radii. The results of the efforts are summarized here and documented in a report titled *Hazardous Toxic Radioactive Waste (HTRW) Survey for Gulf Intracoastal Waterway Brazos River Floodgates & Colorado River Lock Feasibility Study* (USACE 2017a).

4.20.1 Potential HTRW Impacts from Construction of the Structures

The BRFG and CRL were built in 1943 and 1944, respectively, when industrial marine facilities were coated in lead paint. Depending on the repairs and rehabilitation projects done at the facilities, there may still be lead paint on the structures.

4.20.2 Potential HTRW Impacts from Nearby Facilities

Two possible HTRW sites were identified within 2 miles of the BRFG facility: Texas Boat & Barge, Inc., located adjacent to the east floodgate, and Bryan Mound Strategic Petroleum Reserve, located about 1 mile to the north of the BRFG. Beyond 2 miles, there are a number of industrial and chemical facilities in and around the Freeport-Lake Jackson area.

Two possible HTRW sites were also identified within 2 miles of the CRL facility: Matagorda wastewater treatment plant (WWTP), located east of the CRL, and Beach Road Municipal Utility District WWTP, located about 2 miles south of the CRL facility. According to database information, both of these facilities hold discharge permits that include polychlorinated biphenyls (PCBs) and heavy metals such as lead, nickel, zinc, cadmium, arsenic, mercury, and molybdenum. In addition to the two WWTPs, the South Texas Electric Project discharges into the Colorado River about 4 miles upstream of the CRL facility.

The EPA has records of two water quality testing locations near the CRL facility. Testing results from these locations indicate relatively high metals, microbes, and pesticides (USACE 2017a).

In August 2017, Hurricane Harvey made landfall on the Texas Gulf coast, and flooding and power outages contributed to a high potential for chemical releases and other contamination from industrial operations, particularly upstream of the BRFG facility where large chemical and petrochemical plants occur.

4.21 Socioeconomic and Human Resources

4.21.1 Population and Housing

The BRFG and CRL study areas are largely undeveloped, and there are no communities, residences, or other community-related facilities within either study area. Therefore, there are no populations that reside within the study areas, and no housing options are available within the study area boundaries.

The nearest residential areas to the BRFG study area are associated with the city of Freeport, approximately 2 to 3 miles east and north of the study area, and along the San Bernard River approximately 3.5 miles west of the study area. Freeport, with a population of just over 12,000, was estimated to have approximately 4,700 housing units (according to the 2010 U.S. Census) with approximately 54 percent of the housing units owner-occupied. Median gross rent of housing units available in the city of Freeport is approximately $613 (U.S. Census Bureau 2017a).

In the CRL vicinity, residential communities associated with the town of Matagorda and along the east bank of the Colorado River are present immediately north and south of the study area. Matagorda is a small fishing and tourist township with a population of less than 500 people. Lodging for visitors to the area includes motels, bed and breakfasts, and lodges, as well as condo and beach house rentals.

4.21.2 Infrastructure

Infrastructure within the BRFG study area includes the access roads, utilities, and buildings associated with the floodgate operations, and infrastructure associated with the Texas Boat and Barge, Inc. barge storage, cleaning, maintenance, and repair facility. Along the south side of the GIWW are DMPAs and associated containment levees.

Infrastructure within the CRL study area includes the access road, utilities, and buildings associated with the lock operations. The Matagorda ring flood-protection levee is adjacent to the east lock, and the town of

Matagorda is within the levee to the northeast of the study area. FM 2031 crosses the GIWW over a high bridge approximately 0.2 mile east of the east lock.

4.21.3 Employment and Income

Most of the infrastructure located in the BRFG study area support the floodgate operations. Since the BRFG are owned and operated by the USACE, employment and income within the study area is dominated by government sector jobs associated with the maintenance, operation, and oversight of the BRFG. Texas Boat and Barge, Inc. is a commercial barge cleaning, maintenance, and repair facility and has been operating for approximately 26 years. Texas Barge & Boat is estimated to generate $8.2 million in annual revenues and employs approximately 60 people at this single location (Buzzfile 2017).

The BRFG are located near the cities of Freeport and Lake Jackson, an area with a large petrochemical industry. Lake Jackson is home to Dow Chemical, one of North America's largest petrochemical complexes, and the number one employer for the Freeport area. According to the City of Freeport business development website, other major employers in the Freeport area include contractor labor, Texas Department of Criminal Justice, Brazosport ISD, and other large petrochemical companies. Based on median household income data from the 2011-2015 U.S. Census American Community Survey, the median household income for areas surrounding the BRFG study area is above the U.S. Department of Health and Human Services (DHHS) 2017 threshold for low-income populations (U.S. Census Bureau 2017b, DHHS 2017).

Within the CRL study area, virtually all the infrastructure supports the lock operations, thus employment and income within the study area is dominated by government sector jobs associated with the maintenance, operation, and oversight of the CRL. According to the Matagorda County Economic Development Corporation, the top industry in Matagorda County is educational services and health care and social services, other major industries include manufacturing, agricultural, and the seafood and fishing industry. Based on median household income data from the 2011-2015 U.S. Census American Community Survey, the median household income for areas surrounding the CRL study area is above the DHHS 2017 threshold for low-income populations.

4.21.4 Environmental Justice

Executive Order (EO) 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," signed by the president on February 11, 1994, directs Federal agencies to take the appropriate and necessary steps to identify and address disproportionately high and adverse effects of Federal projects on the health of the environment of minority and low-income populations to the greatest extent practicable and permitted by law. The EO requires that minority and low-income populations not receive disproportionately high adverse human health or environmental impacts, and requires that representatives of any low-income or minority populations that could be affected by the proposed project be involved in the community participation and public involvement process.

In compliance with EO 12898, data was collected from the 2010 U.S. Census and the 2011-2015 U.S. Census American Community Survey at the state, county, census tract (CT), block group (BG), and block

level (when available). A review of U.S. Census Bureau data on population, race, ethnicity, income, and English proficiency was conducted to determine the potential for persons from minority populations and low-income populations to reside within the study area (U.S. Census Bureau 2017a, b, c).

Brazos River Floodgates

There are no residences located within the BRFG study area; therefore, there are no environmental justice populations living in the study area. The study area is located within a larger BG (BG 2) which is part of an even larger CT (CT 6644). CT 6644-BG 2 encompasses approximately 16,113 acres and has a total population of approximately 1,375. Based on the 2010 U.S. Census, CT 6644-BG 2 is composed of 657 Hispanic or Latino persons (approximately 48 percent of the population), which is lower than the CT (CT 6644) at 58 percent. However, based on review of aerial photography, the closest residence to the BRFG study area is over 2 miles to the northeast.

Colorado River Locks

No residences are located within the CRL study area, so no environmental justice populations live within the study area. The study area is located within three larger BGs which are part of two larger CTs 7305.01 and CT 7306. CT 7305.01-BG 1, CT 7305.01-BG 4, and CT 7306-BG 1 encompass a combined total of approximately 241,059 acres with a total population of approximately 2,869. Based on the 2010U.S. Census, all three BGs are composed primarily of non-Hispanic or Latino persons with a majority of residents identifying as White. The percentage of Hispanic or Latino populations within each BG is less than 31 percent, which is lower than the Matagorda County average (approximately 38 percent). Although no residences are located within the CRL study area, the city of Matagorda is located adjacent to the study area, with some residences located immediately north and south of the study area.

5.0 FUTURE WITHOUT PROJECT CONDITIONS (ENVIRONMENTAL CONSEQUENCES OF NO-ACTION ALTERNATIVE)

This section discusses the anticipated future conditions in the study areas if no improvements were made to the BRFG and CRL facilities (i.e., the FWOP Condition or environmental consequences of the No Action Alternative). The environmental consequences of the Action Alternatives, including the Recommended Plan, at both sites are described in Section 6.0. Identification of the expected FWOP Condition is the first step in evaluating potential impacts of each Action Alternative because the FWOP Condition serves as a baseline to evaluate the impacts of the Action Alternatives. The FWOP Condition discussed in this section considers the following assumptions (USACE 2016):

- Operation of the existing floodgates/locks will continue as currently, and the floodgates/locks would be repaired and maintained as needed.

- Outdated floodgate/lock mechanical features will continue to deteriorate, which will increase operations and maintenance (O&M) costs and have an adverse impact to navigation.

- Existing large scour areas adjacent to the guide walls, gravity walls, and within the channel could cause undermining and failure of the structures, resulting in a stoppage of navigation.

- Shipping delays (economic impacts) will continue, and likely increase, due to operation shutdown/ structure failure.

- Continued risk to safety of navigation industry crews and recreational boaters is expected.

- Flooding is expected to increase due to climate change, sea level rise, and subsidence, which will result in more frequent flooding with longer periods of high water.

- Potential erosion impacts may occur upstream if high water delays shipping containers/barges, resulting in increased wakes along banks (causing erosion).

- Continued bank erosion will increase sediment loads in the rivers and degrade habitat along the river banks.

- Overall, fish and wildlife habitat is expected to remain similar to current conditions; however, barges may continue to experience accidents, thus increasing the potential that contaminants may leak and impact habitat and aquatic resources. In addition, projected sea level rises due to climate change are expected to inundate wetlands and other wildlife habitats.

5.1 General Environmental Setting of the Study Areas

Under the FWOP Condition, there will be no changes to the overall location, physiography, or land use resulting from the project. However, the Texas Gulf coast is a dynamic environment, and the study areas will continue to be exposed to environmental factors that will change the landscape. Hurricanes and other storms will periodically affect both of the study areas, and projected sea level rises in the study areas resulting from climate change range from roughly 1 foot to as much 4.1 feet between 2030 and 2080, which will gradually inundate low-elevation areas.

- Low – Use the historic rate of local mean sea level change as the "low" rate. The guidance further states that historic rates of sea level change are best determined by local tide records (preferably with at least a 40-year data record).

- Intermediate – Estimate the "intermediate" rate of local mean sea level change using the modified NRC Curve I. It is corrected for the local rate of vertical land movement.

- High – Estimate the "high" rate of local mean sea level change using the modified NRC Curve III. It is corrected for the local rate of vertical land movement.

The FR/EIS provides a detailed discussion of anticipated RSLC. **Table 4.1** summarizes predicted future rates of RSLC for 20-year, 50-year, and 100-year periods of analysis.

Table 5.1 Predicted Future Rates of RSLC for 20-year, 50-year, and 100-year Periods of Analysis

Period of Analysis	Tide Gage	Measured Relative Sea Level Rise Rate (NOAA 2013)	Low (feet)	Intermediate (feet)	High (feet)
20-year (2030 - 2050)	Freeport, TX	4.35 mm/year	0.83	1.13	2.07
50-year (2030 - 2080)	Freeport, TX	4.35 mm/year	1.26	1.94	4.13
100-year (2030 – 2130)	Freeport, TX	4.35 mm/year	1.97	3.66	9.03

Both of the study areas are expected to remain largely undeveloped due to their low elevations; however, development could occur in topographically high points along the rivers based on potential increases in shipping on the GIWW. Local wildlife refuges/management areas could expand their boundaries to incorporate more of the surrounding coastal wetland habitats. Some wetland areas may gradually disappear either by inundation due to erosion and sea level rises, or by filling by continued disposal of maintenance dredged material from the GIWW and other navigation channels.

Under the alternatives considered, materials that would be dredged during construction would be deposited into existing upland DMPAs. Future maintenance materials dredged would also be placed primarily in upland DMPAs, although existing ODMDS may be used for maintenance dredging in the Freeport Channel since that is the current mode of disposal there. The USACE Galveston District is currently working on updating the DMMP for the GIWW from High Island to the Brazos River, which includes the Freeport Channel, to allow disposal of future additional maintenance material at ODMDS.

Under the FWOP Condition, the San Bernard River is expected to continue to flow through the GIWW and the west floodgate and out to the Gulf of Mexico through the Brazos River. This condition may change, as future re-opening of the San Bernard outlet is being evaluated and is included in a list of RESTORE Act projects. Previous outlet dredging for the San Bernard River within the last decade has silted in due to low flow.

5.2 Soils and Waterbottoms

Under the FWOP Condition, most of the soils in the study areas will remain in the current condition; however, areas at lower elevations may be gradually inundated and converted to waterbottoms due to future erosion and a combination of sea level rises and subsidence. Some soils may also be altered by deposition of dredged material from maintenance operations. Any effects to prime farmland soils would be minor, as the BRFG study area does not contain prime farmland soils, and the CRL study area contains a small amount of prime farmland soils. Furthermore, the study areas have not been farmed and would not be farmed in the future.

Maintenance dredging of the GIWW to maintain the authorized depth will continue, periodically disturbing the bottom sediments. Historically, the reach of the GIWW from Freeport Harbor to Matagorda Bay has been dredged every 24 months (USACE 2012). Waterbottoms will also continue to be affected by barge traffic, flooding/scouring, and sediment deposition from the Brazos and Colorado Rivers.

5.3 River Sediment Resources

Under the FWOP Condition, erosion along the Texas Gulf coast will continue, although projects such as beach nourishment, marsh construction and restoration, and shoreline protection have and will continue to have a positive impact on maintaining shorelines. Continued protection of undeveloped coastal barrier areas will also help curb erosion.

Existing sediment load distribution downstream of the BRFG and CRL will continue, with the majority of sediment in the Brazos River discharging into the Gulf of Mexico and the majority of sediment in the Colorado River discharging into West Matagorda Bay. The BRFG and CRL facilities will continue to be operated to prevent excessive sedimentation in the GIWW, and the existing schedule for maintenance dredging near the BRFG and CRL is expected to continue.

5.4 Floodplains and Flood Control

Under the FWOP Condition, existing river flooding trends will continue, although flooding may increase as the project region and areas further inland in the major watersheds (such as Brazos, San Bernard, and Colorado Rivers) are developed and impervious cover increases, resulting in more runoff during storms. In addition, flooding may increase due to projected climate change, sea level rises, and subsidence in the region. The Velasco Drainage District and Matagorda hurricane/flood protection systems may also need to expand in the future to accommodate development, resulting in more water being pumped outside the levee system during and after storm events.

5.5 Water Resources

Under the FWOP Condition, no impacts to wetlands or other waters will occur because of the project itself. Some wetland areas in the study areas may be converted gradually to open water habitats as sea levels rise; disposal of maintenance dredged material may also convert wetland areas to uplands. Water use and supply will not be affected by the FWOP Condition, although sea level rise may increase salinities further upstream in the rivers during low-flow periods.

5.6 Water Quality

Under the FWOP Condition, continued implementation of pollutant protection programs by the EPA and TCEQ and use of best management practices will benefit water quality. Periodic disturbance of sediments and suspension of sediments in the water column will continue because of maintenance dredging operations, barge traffic, and flooding. However, as the BRFG and CRL facilities continue to age, and/or if waterborne vessel traffic on the GIWW increases, the potential for accidents resulting in a contaminant spill may increase and may affect water quality.

Continued sedimentation in the GIWW will result in the need for regular maintenance dredging and dredged material disposal. River flooding trends will also continue and may change as inland areas within the major watersheds (such as Brazos, San Bernard, and Colorado Rivers) are developed and impervious cover increases, resulting in more stormwater runoff.

5.7 Salinity

Under the FWOP Condition, the project would not affect salinities in or near the study areas. Salinities are projected to increase due to anticipated sea level rises; however, in the study areas, freshwater inflows from the Brazos, San Bernard, and Colorado Rivers should help minimize the effects of salinity rises, except during low-flow periods.

5.8 Vegetation and Wildlife Habitats

Due to their low-lying position and proximity to the Gulf of Mexico, wetlands and other habitats in the BRFG and CRL areas are susceptible to being lost to rising sea levels resulting from climate change under the FWOP Condition. Wetlands and other habitats will also be lost to development and continued disposal of dredged material from the GIWW. Habitat losses would result in reduced habitat diversity, particularly for aquatic and semi-aquatic animals, waterfowl, and wading birds.

Large wetland areas in the BRFG and CRL regions will continue to be protected by the San Bernard NWR, Justin Hurst WMA, and Mad Island WMA, and future wetland losses may be reduced by restoration and shoreline stabilization projects and possible use of dredged material for those projects. Impacts to coastal habitats and resources would also be managed and mitigated to some extent by regulations such as the CWA, ESA, CBRA, Coastal Zone Management Act, and TCMP, as well as by continued funding of programs to purchase, preserve, and manage coastal areas.

5.9 Protected/Managed Lands and Recreational Areas

Under the FWOP Condition, the Levee Road Boat Ramp, located in the BRFG study area, is expected to continue to be open to the public and maintained by Brazoria County. The San Bernard NWR, Justin Hurst WMA, Mad Island WMA, and other parks and recreation areas near the BRFG and CRL study areas will continue to operate.

5.10 Threatened and Endangered Species

Under the FWOP Condition, future losses of wetlands and beaches in the region due to sea level rises or other effects could have an impact on wintering whooping cranes, piping plovers, and red knots, while future restoration and stabilization efforts in coastal habitats could, in contrast, benefit these species. Sea turtles may be affected by increased vessel traffic, industrial development, and dredging operations in the GIWW and other waterways. Potential impacts of various activities would be managed by continued execution of the ESA, including development of conservation plans and measures.

5.11 Other Protected Wildlife Species

Under the FWOP Condition, overall habitat conditions in the study areas are expected to be similar to existing conditions, although sea level rises would increase open water areas and decrease wetland areas, which could affect some wildlife species. Bottlenose dolphins may be affected by increased vessel traffic, industrial development, and dredging operations in the GIWW and other waterways. Natural changes to

vegetation/wildlife habitats would alter use of the habitats by migratory birds, but overall the study areas are expected to remain largely undeveloped and existing wildlife refuges/management areas are expected to continue protecting valuable coastal habitats for migratory birds.

5.12 Aquatic Resources

Under the FWOP Condition, plankton and benthic resources will continue to be temporarily impacted by activities such as maintenance dredging. Maintenance dredging will affect benthic communities, primarily through removal; however, benthic organisms, particularly the infauna, are expected to re-colonize the dredged area within a relatively short period of time, perhaps as little as 18 months (Texas Water Resources Institute 1995).

5.13 Commercial and Recreational Fisheries

Under the FWOP Condition, expected land and wetland losses from erosion and sea level rise would result in the loss of important habitat for estuarine and marine fishery species. Erosion and sea level rise are expected to increase open water habitat but decrease wetland habitat that provides nursery grounds for important fishery species. As open water replaces marshes, fishery production is expected to decrease.

5.14 Essential Fish Habitat

Under the FWOP Condition, erosion could lead to existing shallow waters deepening, causing salinity gradients to be less estuarine. In addition, sea level rises are projected to result in marsh losses, which provide important nursery habitats. As loss of land and nursery habitat continues, it can be anticipated that there would be a reduction in fishery production.

5.15 Coastal Barrier Resources and Coastal Natural Resources

Under the FWOP Condition, development within the Texas coastal zone is expected to continue at current rates and would continue to affect coastal barriers and natural resources. Impacts to coastal resources would be managed to some extent by regulations such as the CBRA, Coastal Zone Management Act, TCMP, and CWA, as well as by continued allocation of funding to purchase, preserve, and manage coastal areas through Federal, state, and non-governmental resource agencies.

5.16 Historic and Cultural Resources

Under the FWOP Condition, the BRFG and CRL facilities will continue to be operated and maintained as they have been for the last several decades. It is anticipated that the USACE will continue to repair steel members within the sector gates, replace portions of the timber guide walls, maintain the USACE support buildings, and maintenance dredge the GIWW as needed. Since there are no NRHP-listed or NRHP-eligible non-archeological historic resources within the BRFG and CRL APEs, none of these activities would affect any non-archeological historic resources under Section 106 of the NHPA.

Cultural resources may be impacted by continued shoreline erosion and by development. For projects where Federal and/or State land, funding, or permitting are involved, impacts to cultural resources would be addressed by avoidance, minimization, or mitigation.

5.17 Air Quality

Future population growth within the Brazos, Colorado, and/or San Bernard River watersheds and within the HGB ozone nonattainment area will result in the potential for more contaminants to affect air quality under the FWOP Condition. Maintenance dredging in the GIWW will also continue to result in emissions, although it is expected that emissions would be minor. Continued implementation of pollutant protection programs by the EPA and TCEQ and use of best management practices will benefit air quality.

5.18 Noise

Under the FWOP Condition, noise patterns in the BRFG and CRL vicinities would follow current trends, but increases in vessel traffic at the BRFG and CRL along the GIWW may increase noise levels in the areas, particularly during river flood-stage when the BRFG and CRL are closed or under restriction. Increased noise levels may affect residences at the CRL because of their proximity (within 0.25 mile); however, increased noise levels are expected to be periodic and temporary.

5.19 Oil, Gas, and Minerals

Under the FWOP Condition, the Bryan Mound Strategic Petroleum Reserve and other existing oil and gas facilities in the study areas are expected to continue operations as at present. Any additional oil wells that would be drilled in the study area would not be impacted by the No Action Alternative.

5.20 Hazardous, Toxic, and Radioactive Waste

Under the FWOP Condition, HTRW concerns are expected be similar to existing concerns. Lead paint would continue to be a potential concern at the BRFG and CRL facilities themselves, and contamination from permitted discharges or inadvertent releases from nearby facilities would continue to be a possibility.

5.21 Socioeconomic and Human Resources

Populations in both study areas have been stable over the past decade, so rapid increases in growth and expansion are not expected under the FWOP Condition. Some expansion at ports and increased shipping on the GIWW may occur to support future growth and commerce in other portions of Texas. In addition, residential or industrial development may occur along the Brazos, Colorado, and San Bernard Rivers or other high points in the area. Likewise, existing wildlife refuges/management areas may expand to incorporate more coastal wetland habitats. Distribution of minority and low-income populations in the BRFG and CRL areas is expected to follow current trends. The existing aesthetics of the study area will not be altered.

6.0 ENVIRONMENTAL CONSEQUENCES OF ACTION ALTERNATIVES

This section discusses the environmental consequences of the reasonable Action Alternatives for the BRFG and CRL sites, as required under NEPA. The information used to determine environmental consequences of the Action Alternatives is derived from initial descriptions and draft engineering drawings of the alternatives, field reconnaissance and desktop analysis, and engineering reports such as the "Brazos River Floodgates Hydraulic Engineering Appendix" (TxDOT 2017a) and the "Hydrodynamic Evaluation of Proposed Navigation Improvements at the Colorado River Intersection with the Gulf Intra-Coastal Waterway" (USACE 2017b).

The anticipated environmental consequences of each Action Alternative, including the Recommended Plan, are provided below. Exceptions include BRFG Alternative 2a and CRL Alternative 2A, both of which entail rehabilitating the existing gates, guide walls, and other infrastructure within the existing footprint. These alternatives would result in minor, if any, changes to the overall footprint, orientation, operations, or bathymetry. Therefore, H&H modeling, sedimentation, salinity, and other conditions were assumed to be the same as the FWOP Condition (No Action Alternative), and no additional discussion of environmental consequences of these two Action Alternatives are provided here.

For the Action Alternatives that are discussed below, environmental consequences to a particular resource may be the same among alternatives; however, in this report the alternatives are listed and discussed separately for each resource, noting where the consequences are expected to be the same as other alternatives. Those alternatives that have similar impacts may be discussed together in the DIFR-EIS. For reference, the Action Alternatives considered for each site include:

- BRFG
  - Alternative 2a: Rehab Existing Facilities – impacts assumed to be same as the FWOP Condition
  - Alternative 3a: Gate Relocation on Existing Alignment
  - Alternative 3a.1: Open Channel West/East Gate Relocation (existing alignment)
  - Alternative 9: Open Channel (new alignment to the north to straighten this section of the GIWW)
  - Alternative 9b/c: New Alignment/Gates with Control Structures
- CRL
  - Alternative 2a: Rehab Existing Facilities – impacts assumed to be same as the FWOP Condition
  - Alternative 3b: Open Channel
  - Alternative 4b.1: Removal of Riverside Gates

6.1 General Environmental Setting of the Project Area

None of the Action Alternatives would affect the overall location, physiography, or climate of the study areas; however, the study areas would continue to be exposed to environmental factors that will affect the area, including hurricanes, climate change and projected sea level rises, local subsidence, and periodic disposal of dredged material from maintenance dredging. These effects are expected to be similar to the FWOP Condition, or No Action Alternative. Other changes to the general environmental setting are discussed below for each Action Alternative.

BRFG Alternative 3a: This alternative would impact an estimated 83 acres of land, primarily due to excavation of a temporary bypass channel to maintain navigation through the area during construction. The land alteration would not change the general setting. Consistent with the FWOP Condition, the area is expected to remain undeveloped due to the low elevation of the area, and portions of the study area may be gradually inundated due to projected sea level rises. Existing land uses in the study area would remain.

BRFG Alternative 3a.1 (Recommended Plan): This alternative would impact an estimated 73 acres of land, primarily due to excavation of a temporary bypass channel to maintain navigation through the area during construction. The land alternation would not change the general setting. Consistent with the FWOP Condition, the area is expected to remain undeveloped due to the low elevation of the area, and portions of the study area may be gradually inundated due to projected rises in sea level. Existing land uses in the study area would remain. Without the west floodgate in place, this alternative would allow increased drainage of San Bernard River flows to the Brazos River, but that is not expected to change the overall location, physiography, or climate of the NEPA study areas.

BRFG Alternative 9a: This alternative would impact approximately 75 acres of land; however, the general setting would not change and would be consistent with the FWOP Condition. One commercial facility, Texas Boat & Barge, Inc. would be removed by this alternative. Since Alternative 9a would remove floodgates, it would allow increased drainage of San Bernard River flows to the Brazos River; however, that is not expected to change the overall location, physiography, or climate of the NEPA study areas.

BRFG Alternative 9b/c: This alternative would impact approximately 87 acres of land; however, the general setting would not change and would be consistent with the FWOP Condition. One commercial facility, Texas Boat & Barge, Inc. would be removed by this alternative.

CRL Alternative 3b: This alternative would impact an estimated 71 acres of land, primarily due to excavation of a temporary bypass channel to maintain navigation through the area during construction. The general setting would remain the same as the FWOP Condition, and low-elevation portions of the study area may be gradually inundated due to projected rises in sea level. Without the locks in place, sediment from the Colorado River would be diverted into the GIWW, which would reduce the amount of sediment that reaches the delta in West Matagorda Bay. Over time, this may slow development of the delta and affect resources in the bay.

CRL Alternative 4b.1 (Recommended Plan): This alternative would impact an estimated 71 acres of land, primarily due to excavation of a temporary bypass channel to maintain navigation through the area during construction. The general setting would remain the same as the FWOP Condition.

6.2 Soils and Waterbottoms

The FPPA was enacted "to minimize the impact Federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses" and to "assure that federal programs are administered to be compatible with state, local units of government, and private programs and policies to protect farmland" (USDA 2017f).

Projects considered exempt under the FPPA include projects that do not intend to use land that qualifies as prime farmland or farmland of state and local importance. No prime farmland soils or farmlands of state and local importance are present in the BRFG study area, so none of the BRFG alternatives would affect prime farmlands. Therefore, the BRFG portion of the project is not subject to provisions of the FPPA.

Small areas of prime farmland soils occur in the CRL study area. A Farmland Conservation Impact Rating (Form AD-1006) will be completed for the Recommended Plan and submitted to NRCS for review. The anticipated conversion of prime farmland in the CRL study area is not expected to cause adverse effects, and the project will comply with the FPPA.

BRFG Alternative 3a: Under Alternative 3a, hydric soils would be removed to relocate the structures and construct the temporary bypass channel. Soils that remain in place would be subject to inundation and conversion to waterbottoms due to erosion and the combined effects of sea level rise and subsidence. Soils removed for the construction of this alternative would be placed in existing DMPAs, which would alter the soil structure at those areas. Future maintenance materials dredged would also be placed in upland DMPAs, although existing ODMDs may be used for maintenance dredging in the Freeport Channel since that is the current mode of disposal there. Offshore disposal would temporarily affect waterbottoms in the ODMDS. Waterbottoms would be affected by barge traffic, flooding/scouring, and sediment deposition as under the FWOP Condition.

BRFG Alternative 3a.1 (Recommended Plan): Impacts to soils and waterbottoms would be similar to Alternative 3a.

BRFG Alternative 9a: Impacts to soils and waterbottoms would be similar to Alternative 3a.

BRFG Alternative 9b/c: Impacts to soils and waterbottoms would be similar to Alternative 3a.

CRL Alternative 3b: A temporary bypass channel needed to construct this alternative would impact an estimated 4.3 acres of NRCS-designated prime farmland soils. Projected increases in velocities in the Colorado River channel and in the GIWW during floods may lead to soils being eroded at a faster rate than under the FWOP Condition. Soils that remain in place would be subject to inundation and conversion to waterbottoms due to erosion and the combined effects of sea level rise and subsidence. Soils removed for this alternative would be placed in existing DMPAs and ODMDS, which would alter the soil structure and bottom habitats at those areas. Waterbottoms would continue to be affected by barge traffic and flooding/scouring similar to the FWOP Condition.

CRL Alternative 4b.1 (Recommended Plan): Under this alternative, soil and waterbottom conditions in the CRL study area would be similar to the FWOP Condition, although a temporary bypass channel needed to construct this alternative would impact approximately 4.3 acres of NRCS-designated prime farmland soils. Soils that remain in place would be subject to inundation and conversion to waterbottoms due to erosion and the combined effects of sea level rise and subsidence. Soils removed for this alternative would be placed in existing DMPAs and ODMDS, which would alter the soil structure and bottom habitats at those areas. Waterbottoms would be affected by barge traffic, flooding/scouring, and sediment deposition as under the FWOP Condition.

6.3 River Sediment Resources

BRFG Alternative 3a: Under this alternative, there is an overall small projected change in sedimentation that would require maintenance dredging, with a small decrease in sedimentation to the GIWW west of the BRFG and a small increase to the GIWW east of the BRFG. Project increases in sedimentation would occur in the Brazos Basin (23%), East GIWW (1%), and Freeport Channel (7%). Maintenance dredging would prevent or reduce the shoaling that would occur under natural sediment deposition processes, as under the FWOP Condition.

BRFG Alternative 3a.1 (Recommended Plan): Under this alternative, a net 8 percent increase in sedimentation requiring maintenance is projected. Areas where increased sedimentation is expected include the West GIWW (18%), Brazos Basin (22%), East GIWW (15%), and Freeport Channel (11%). Portions of the increased sediment in the west GIWW may be transported to the San Bernard outlet at the Gulf of Mexico, which combined with low flow in the San Bernard, may contribute to silting in of the river's outlet and adjacent areas. The San Bernard River outlet to the Gulf of Mexico is currently closed, and silting in has occurred after dredging the outlet. With implementation of the Recommended Plan, silting is expected to be similar to existing conditions, and habitat development/conversion over time is expected to occur naturally. Although some areas adjacent to the outlet may silt in over time and convert to upland coastal prairie habitat, this is expected to have no more than a minor effect on the overall ecology of the area.

BRFG Alternative 9a: The GIWW alignment would be altered, and there would be an open channel without any floodgates. Modeling indicates this Action Alternative would have the largest effects on sedimentation to the GIWW both west and east of the BRFG, and the increased sedimentation would require a substantial increase in maintenance dredging in the study area, with a projected 231 percent of increased sedimentation in the Freeport Harbor and Channel to the east. The additional sediment load would cause shoaling, which in turn would reduce navigational passages, increasing overall transportation costs. Maintenance dredging would prevent or reduce the shoaling that would occur under natural sediment deposition processes, as under the FWOP Condition, although more maintenance dredging would be needed compared to the FWOP Condition. This alternative would also increase sediment in the west GIWW by an estimated 41%, which is more than twice that of the Recommended Plan (Alternative 3a.1, and may result in additional sedimentation at the San Bernard River outlet.

BRFG Alternative 9b/c: The GIWW alignment would be altered, there would be 125-foot-wide floodgates installed on new alignment, and a flood control structure may be installed at the existing west gate location. Under this alternative, there would be an increase in sedimentation, but not to the same magnitude as Alternative 9a. More sediment would be deposited in the Brazos River between the floodgates, and less sediment would be deposited in the GIWW both west and east of the BRFG than for Alternative 9a. Overall, less maintenance dredging would be required for this alternative than for Alternative 9a. Maintenance dredging would prevent or reduce the shoaling that would occur under natural sediment deposition processes, as under the FWOP Condition.

CRL Alternative 3b: Removing the locks and maintaining an open channel at the CRL would increase the existing sediment budget in the GIWW. Sedimentation rates might increase by approximately 436 percent

in the East GIWW and increase by approximately 292 percent in the West GIWW. This deposition would require additional significant maintenance dredging. This alternative would substantially reduce the amount of sediment that reaches the delta in West Matagorda Bay. Maintenance dredging would prevent or reduce the shoaling that would occur under natural sediment deposition processes, as under the FWOP Condition.

CRL Alternative 4b.1 (Recommended Plan): Under this alternative, modeling indicates that sedimentation trends in the GIWW, Colorado River, West Matagorda Bay, and other areas would be similar to the FWOP Condition.

6.4 Floodplains and Flood Control

BRFG Alternative 3a: Under this alternative, flooding and flood control conditions in the BRFG study area are expected to be similar to the FWOP Condition. Flooding in the area would continue to occur after storms upstream, causing localized flooding, and to a lesser extent, flooding from tropical storms and hurricanes would occur. Existing levees and flood control structures would not be altered by this alternative.

BRFG Alternative 3a.1 (Recommended Plan): Impacts to floodplains and flood control would be similar to Alternative 3a and the FWOP Condition. With an open channel connection (no floodgates) to the Brazos River from the west, the low water levels in the west GIWW are raised while high water levels are slightly reduced. The peak water level under this alternative is slightly increased by 0.3 to 0.4 foot. Comparing this slight increase to bank elevations along the GIWW, the minor increase in peak water level is not expected to increase overtopping of the GIWW banks (see "Hydraulic Engineering Appendix, Brazos River Floodgates" in Appendix A of the DIFR-EIS).

An additional concern was that the open connection between the west GIWW and the Brazos River could cause elevated water levels in communities along the San Bernard River. However, compared to the FWOP Condition, Alternative 3a.1 is expected to reduce water surface elevations at the communities, likely because the proposed open channel would allow increased drainage of San Bernard flows (see Appendix A of the DIFR-EIS).

BRFG Alternative 9a: Impacts to floodplains and flood control in the study areas would be similar to Alternative 3a and the FWOP Condition. Since this alternative would also provide an open connection between the west GIWW and the Brazos River, water level trends in the west GIWW and San Bernard River are expected to be the same as under Alternative 3a.1: peak water level increased by 0.3 to 0.4 foot in the west GIWW, which is not expected to increase overtopping of the GIWW banks, and reduced water surface elevations at communities along the San Bernard River likely due to increased drainage to the Brazos River.

BRFG Alternative 9b/c: Impacts to floodplains and flood control would be similar to Alternative 3a and the FWOP Condition.

CRL Alternative 3b: If the locks are removed, water levels in the Colorado River channel during high-flow events would be lower compared to existing and FWOP conditions. This reduction in water level is not expected to have a substantial effect on floodplains or cause additional impacts to existing flood control

structures. The lower water level may be considered favorable in comparison to the FWOP Condition, particularly during flooding conditions. This alternative would not affect flood control levees/structures.

CRL Alternative 4b.1 (Recommended Plan): Under this alternative, flooding conditions and flood protection in the CRL study area are expected to be similar to the FWOP Condition. Flooding in the area would continue to occur after storms upstream, causing localized flooding, and to a lesser extent, flooding from tropical storms and hurricanes would occur. Existing levees and flood control structures would not be altered by this alternative.

6.5 Water Resources

For each action alternative, the acreage of wetland and other special aquatic sites (e.g., tidal flats) that would be removed by the alternative are provided below and summarized in **Table 6.1**. Under all Action Alternatives, other wetland areas in the area may be converted gradually to open water habitats over time as sea levels rise, but this impact is similar to the FWOP Condition. Since existing DMPAs and ODMDS would be used, none of the alternatives are expected to impact wetlands due to dredged material placement. There would be no change to water supply or water use under any of the alternatives.

Table 6.1 Estimated Impacts to Wetlands and Other Special Aquatic Sites (acres)

Alternative	High Marsh	Intertidal Marsh	Tidal Flat	Total
BRFG Action Alternatives				
2a	0	0	0	**0**
3a	3.8	2.3	0	**6.1**
3a.1 (Recommended Plan)	3.7	2.3	0	**6.0**
9a	25.2	3.2	2.1	**30.5**
9b/c	24.9	2.6	1.0	**28.5**
CRL Action Alternatives				
2a	0	0	0	**0**
3b	0	0.7	0	**0.7**
4b.1 (Recommended Plan)	0	0.7	0	**0.7**

BRFG Alternative 3a: This alternative is expected to remove approximately 6.1 acres of wetlands, primarily due to excavation of a temporary bypass channel to maintain navigation through the area during construction.

BRFG Alternative 3a.1 (Recommended Plan): Under this alternative, impacts to wetlands would be similar to Alternative 3a, with approximately 6.0 acres of wetlands being removed, primarily due to excavation of a temporary bypass channel.

BRFG Alternative 9a: Under this alternative, excavation of a new open channel would remove an estimated 30.5 acres of wetlands consisting mostly of high salt marsh. Due to higher impacts, this alternative would require higher amounts of mitigation than Alternatives 3a and 3a.1.

BRFG Alternative 9b/c: Impacts to wetlands, as well as mitigation needs, would be similar to Alternative 9a, with an estimated 28.5 acres of wetland habitats (mostly high salt marsh) being impacted by the new channel and floodgates.

CRL Alternative 3b: This alternative would result in minor changes to the physical and hydrological characteristics of the Colorado River and GIWW including the conversion of adjacent uplands into open water during construction of a temporary bypass channel. An estimated 0.7 acre of intertidal marsh would be impacted by the temporary bypass channel.

CRL Alternative 4b.1 (Recommended Plan): This alternative would also require construction of a temporary bypass channel, which would impact an estimated 0.7 acre of intertidal marsh.

The Recommended Plan (BRFG Alternative 3a.1 and CRL Alternative 4b.1) will impact an estimated total of 6.7 acres of wetland habitats due primarily to the excavation of temporary bypass channels at each facility. Additional information on impacts to waters of the U.S. resulting from the Recommended Plan is provided in the 404(b)(1) analysis that has been prepared for the project (**Attachment D-1**). In compliance with EO 11990 on Protection of Wetlands, the Recommended Plan at each facility minimizes impacts to wetlands compared to other alternatives that meet the project's purpose and need. The USACE will provide mitigation for the impacted wetland habitats, and a preliminary mitigation plan is provided in Section 8.0 of this document. During future detailed design of the proposed improvements, the USACE will consider best management practices (BMPs) and other options for further reducing impacts to wetlands.

6.6 Water Quality

All of the alternatives would incorporate BMPs such as silt fences to reduce suspended solids from overland runoff. Similarly, turbidity screens or silt collection curtains around construction equipment would reduce the amount of sediment entrained in the water. As under the FWOP Condition, periodic disturbance of sediments and suspension of sediments in the water column would continue as a result of maintenance dredging operations, barge traffic, and flooding. None of the alternatives are expected to result in a violation of water quality standards.

BRFG Alternative 3a: Water-based construction activities would increase turbidity in the GIWW and Brazos River as a result of maintenance dredging. During land-based construction activities adjacent to the GIWW, runoff from exposed earth would result in localized, temporary increases in suspended sediment in adjacent water. The increase in turbidity is temporary and local, and water quality is expected to return to existing conditions after dredging and construction activities are completed.

BMPs would be used to reduce suspended solids from land runoff, including installation of silt fences. Similarly, turbidity screens or silt collection curtains around construction equipment would reduce the amount of sediment entrained in the water. As under the FWOP Condition, periodic disturbance of sediments and suspension of sediments in the water column would continue as a result of maintenance dredging operations, barge traffic, and flooding.

BRFG Alternative 3a.1 (Recommended Plan): Water quality impacts from this alternative, including turbidity increases from dredging activities, would be similar to Alternative 3a.

BRFG Alternative 9a: Temporary turbidity increases from this alternative would be more frequent due to the need for more maintenance dredging that would be needed if no gates were present. In addition, compared to Alternatives 3a and 3a.1, this alternative has a higher potential to affect water quality due to potential HTRW concerns associated with Texas Boat & Barge, Inc., which would be removed by this alternative.

BRFG Alternative 9b/c: Temporary turbidity impacts under this alternative would be similar to Alternative 3a; however, this alternative has a higher potential to affect water quality due to the removal of Texas Boat & Barge, Inc., which has HTRW concerns.

CRL Alternative 3b: The increased frequency of maintenance dredging under this alternative would result in increased temporary turbidity compared to the FWOP Condition.

CRL Alternative 4b.1 (Recommended Plan): Under this alternative, there would be an increase in turbidity that would occur at dredging locations during construction and maintenance dredging. Impacts from maintenance dredging are expected to be similar to the FWOP Condition.

6.7 Salinity

In general, during high flows in the Brazos and Colorado Rivers, salinities in the study areas would decrease due to higher influx of freshwater. Salinities would gradually increase as river levels and freshwater inflow decrease to normal flows and low flows. Modifying the BRFG and CRL facilities has the potential to change salinity in the study areas, the Brazos and Colorado Rivers upstream and downstream of the rivers, and nearby waters such as Cedar Lakes at BRFG and East and West Matagorda Bays at CRL. Salinity modeling at BRFG indicates the alternatives would alter average salinities by a decrease of up to 6 percent to and an increase of as much as 16 percent (see Engineering Appendix A of the DIFR-EIS). However, under the existing and FWOP conditions, the area experiences large fluctuations in salinities, from near freshwater (0 ppt) to near seawater (35 ppt), and overall, projected average salinities under the various alternatives are expected to follow this trend.

BRFG Alternative 3a: Hydraulic modeling predicted that during typically low-flow months (June through August), salinity would remain approximately the same as under the FWOP Condition.

BRFG Alternative 3a.1 (Recommended Plan): Changes to salinity under this alternative would be similar to Alternative 3a and the FWOP Condition.

BRFG Alternative 9a: Under this alternative, hydraulic modeling projects that the mean salinity throughout the study area would be reduced due to the absence of floodgates, which leads to a greater exchange between the Brazos River and the GIWW; however, there would not be a substantial reduction in salinity compared to the FWOP Condition.

BRFG Alternative 9b/c: Under this alternative, salinity changes would be similar to Alternative 9a, with only minor changes in salinity.

CRL Alternative 3b: Under this alternative, the average salinity decreases slightly in West Matagorda Bay and increases in East Matagorda Bay. However, freshwater inflows from the Colorado River would be expected to limit salinity increases to periods of low river flows. This alternative is not anticipated to result in a substantial change in salinity compared to the FWOP Condition.

CRL Alternative 4b.1 (Recommended Plan): Salinity conditions in the study area under this alternative are expected to be similar to the FWOP Condition.

6.8 Vegetation and Wildlife Habitats

For each action alternative, the acreages of vegetation/wildlife habitats that are present within the anticipated disturbance footprint are provided below and summarized in **Table 6.2**. **Figures 6.1** through **6.6** show the footprints of the alternatives in relation to habitats. Under all Action Alternatives, other habitats in the area may be converted gradually to open water habitats over time as sea levels rise, but this impact is similar to the FWOP Condition. Since existing DMPAs and ODMDS would be used, none of the alternatives are expected to impact new vegetation/wildlife habitats due to dredged material placement.

Table 6.2 Impacts to Vegetation and Wildlife Habitats (acres)

Alternative	Developed	High Marsh	Intertidal Marsh	Tidal Flat	Upland Shrub/ Woods	Open Water	Total
BRFG Action Alternatives							
2a	0	0	0	0	0	0	**0**
3a	6.1	3.8	2.3	0	49.7	21.4	**83.3**
3a.1 (Recommended Plan)	6.1	3.7	2.3	0	45.1	21.4	**78.6**
9a	12.9	25.2	3.2	2.1	2.7	29.1	**75.2**
9b/c	17.7	24.9	2.6	1.0	4.4	36.0	**86.6**
CRL Action Alternatives							
2a	0	0	0	0	0	0	**0**
3b	10.8	0	0.7	0	14.7	45.2	**71.4**
4b.1 (Recommended Plan)	10.8	0	0.7	0	14.7	45.2	**71.4**

While some vegetation/wildlife habitats would be lost due to construction of most alternatives, none of the vegetation communities are considered regionally rare, unique, or imperiled. BMPs will be used during construction activities to prevent the establishment and spread of invasive plant species.

With the exception of the two rehabilitation alternatives (which do not meet the purpose and need of the project), the Recommended Plan (BRFG Alternative 3a.1 and CRL Alternative 4b.1) have the lowest impacts to wetland habitats compared to other alternatives. Impacted wetland habitats in the temporary bypass channels would be restored and/or mitigated, resulting in no net loss due to any of the Action Alternatives. A preliminary mitigation plan for wetland habitats is provided in Section 8.0.

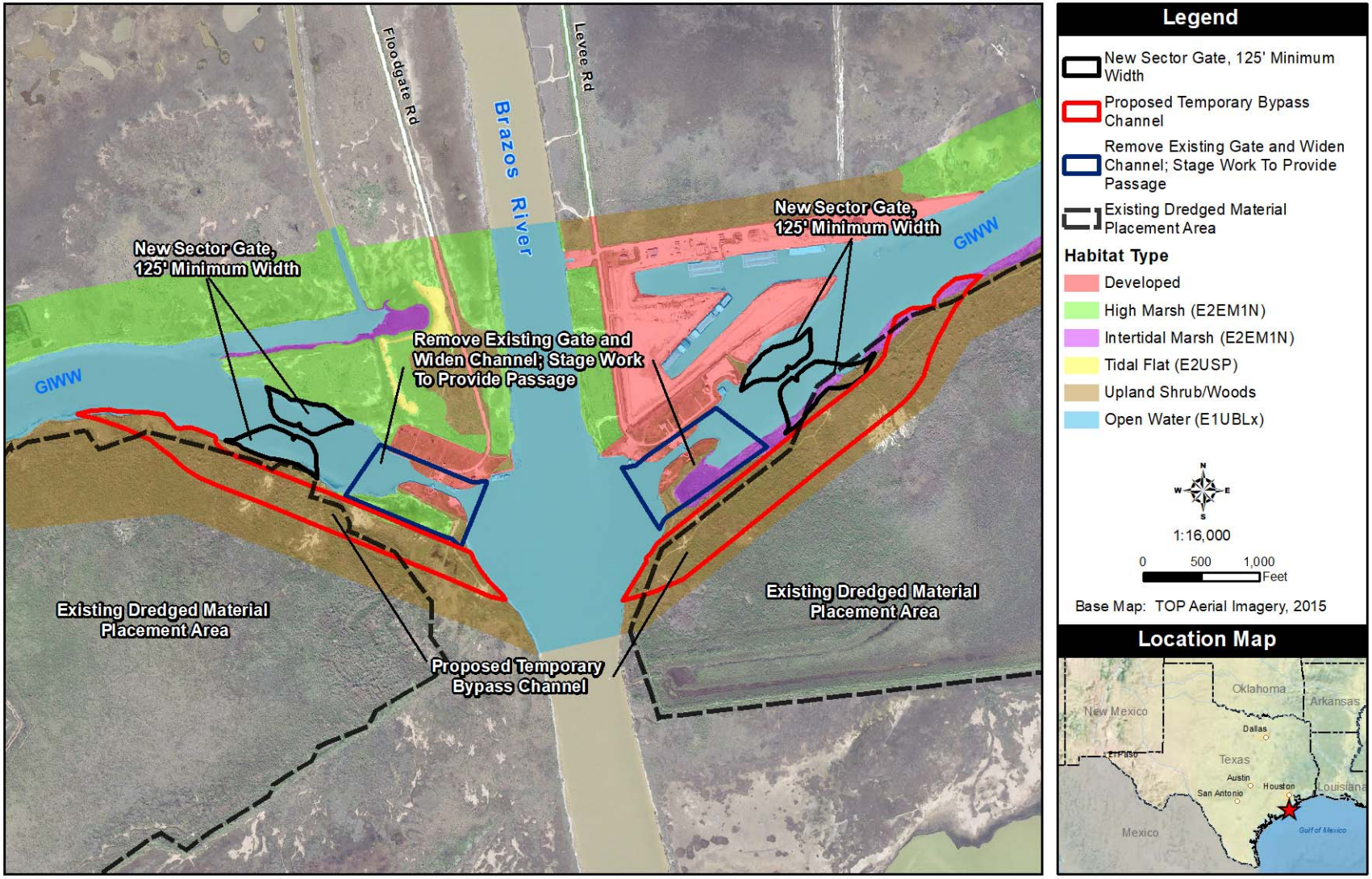


Figure 6.1 Vegetation/Wildlife Habitats Affected by BRFG Alternative 3a

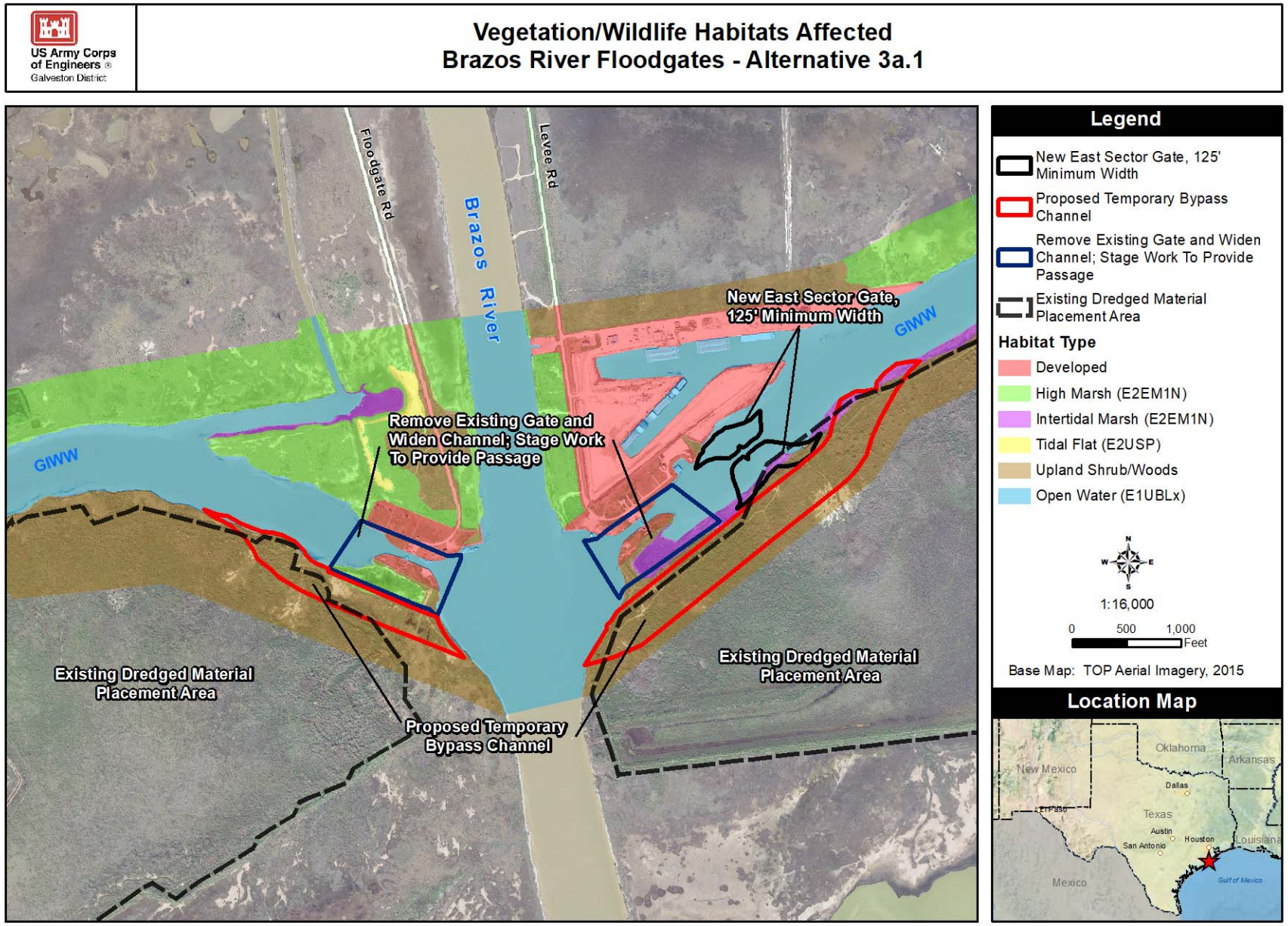


Figure 6.2 Vegetation/Wildlife Habitats Affected by BRFG Alternative 3a.1 (Recommended Plan)

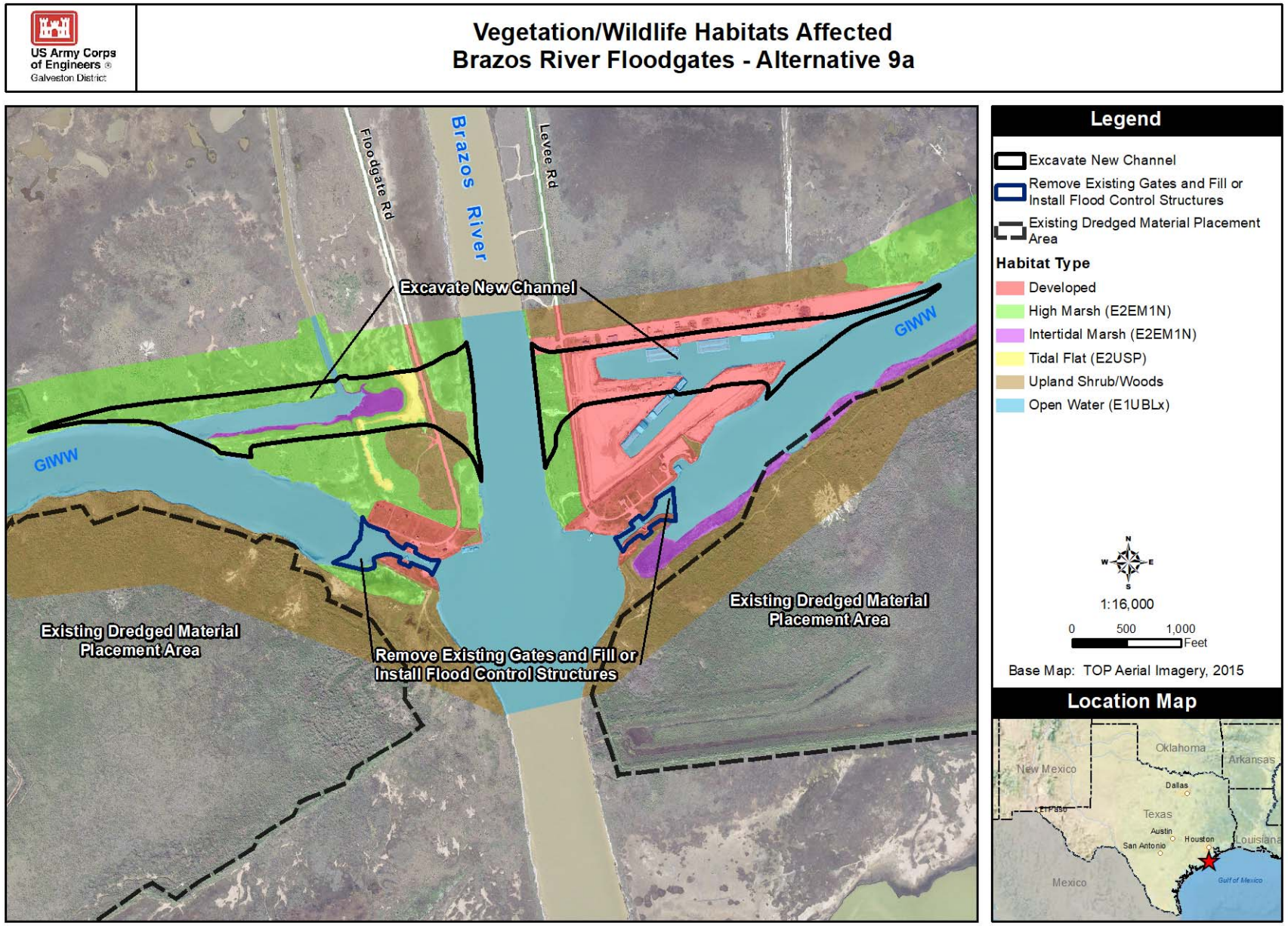


Figure 6.3 Vegetation/Wildlife Habitats Affected by BRFG Alternative 9a

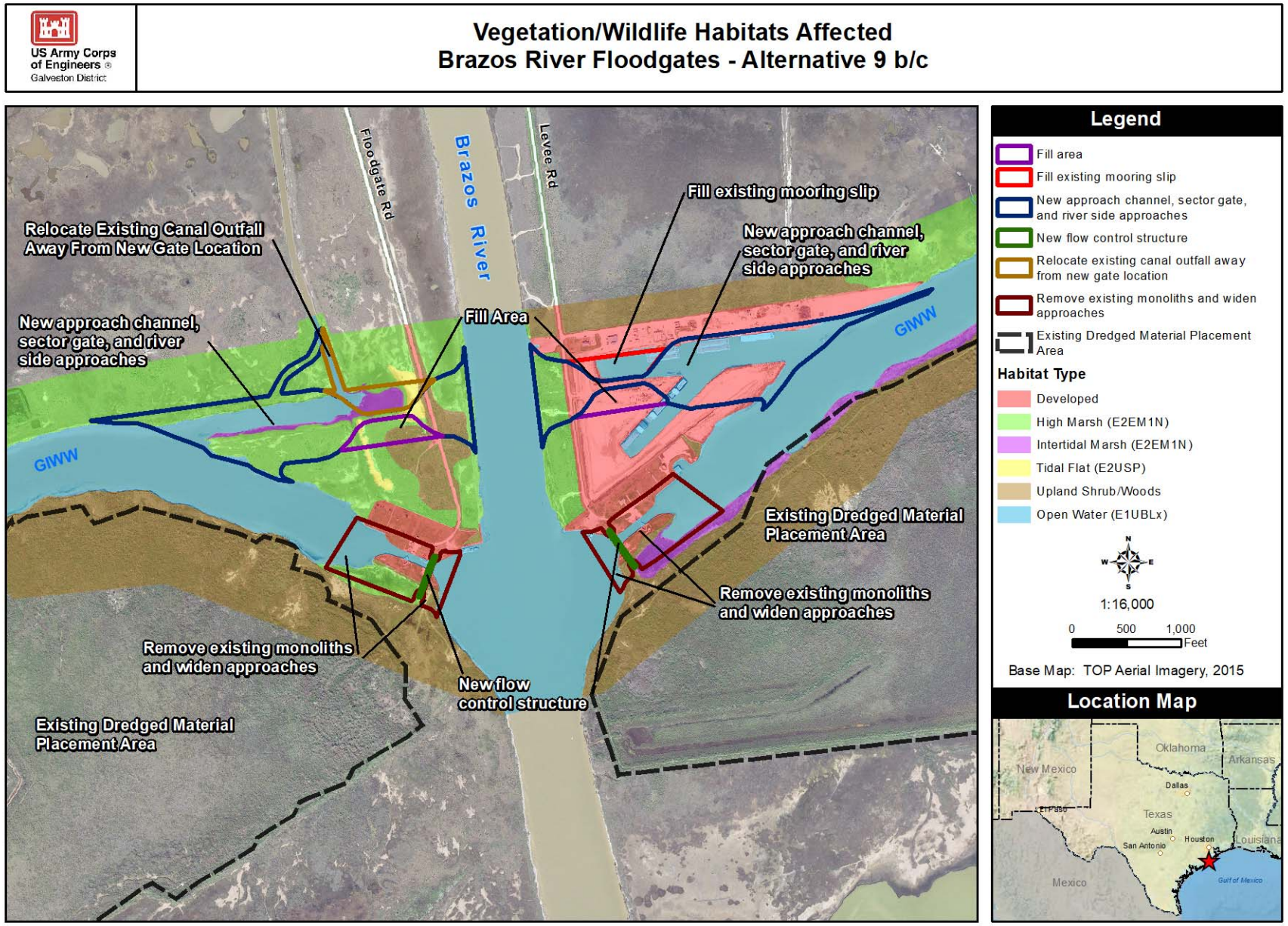


Figure 6.4 Vegetation/Wildlife Habitats Affected by BRFG Alternative 9b/c

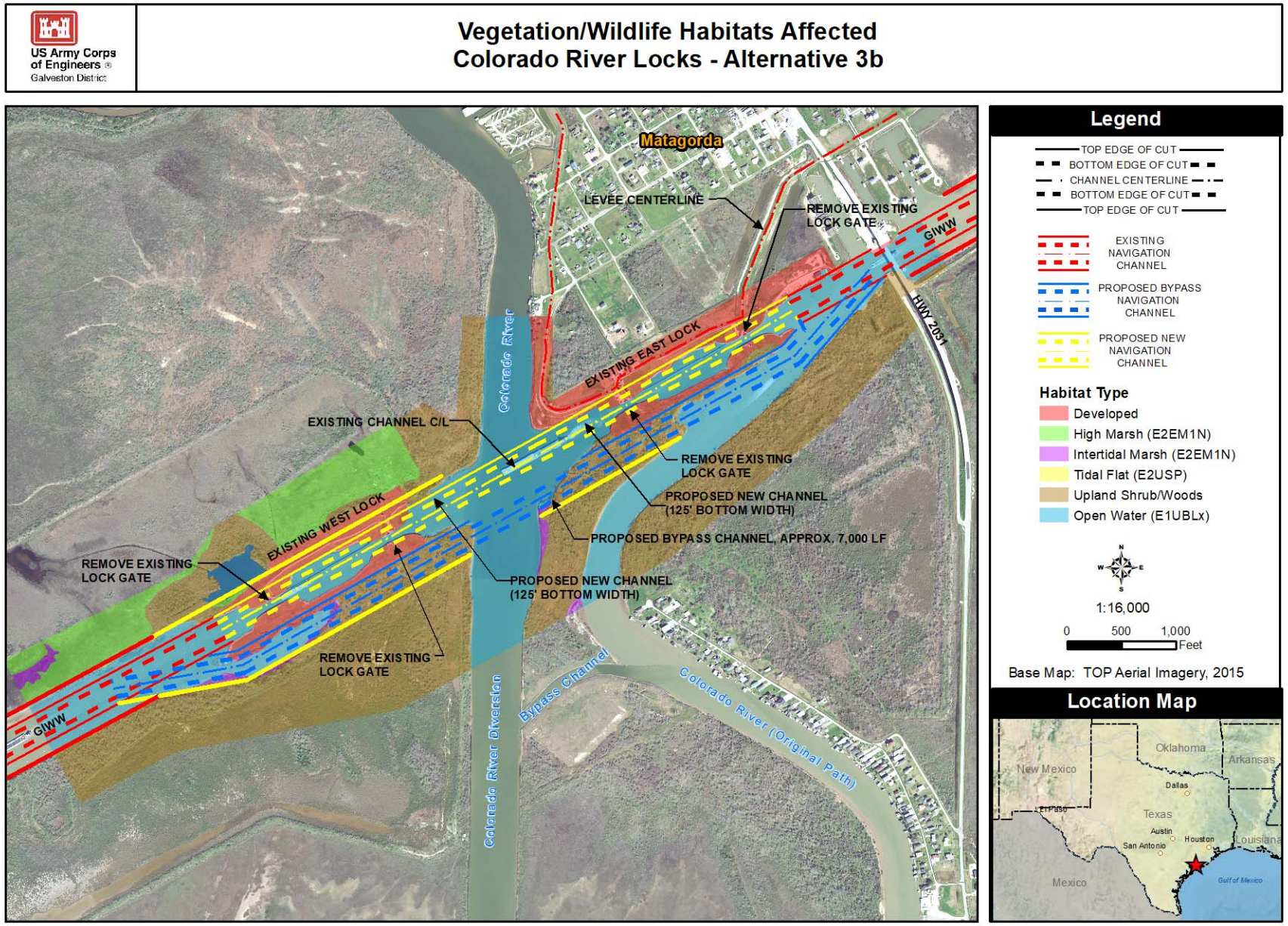


Figure 6.5 Vegetation/Wildlife Habitats Affected by CRL Alternative 3b

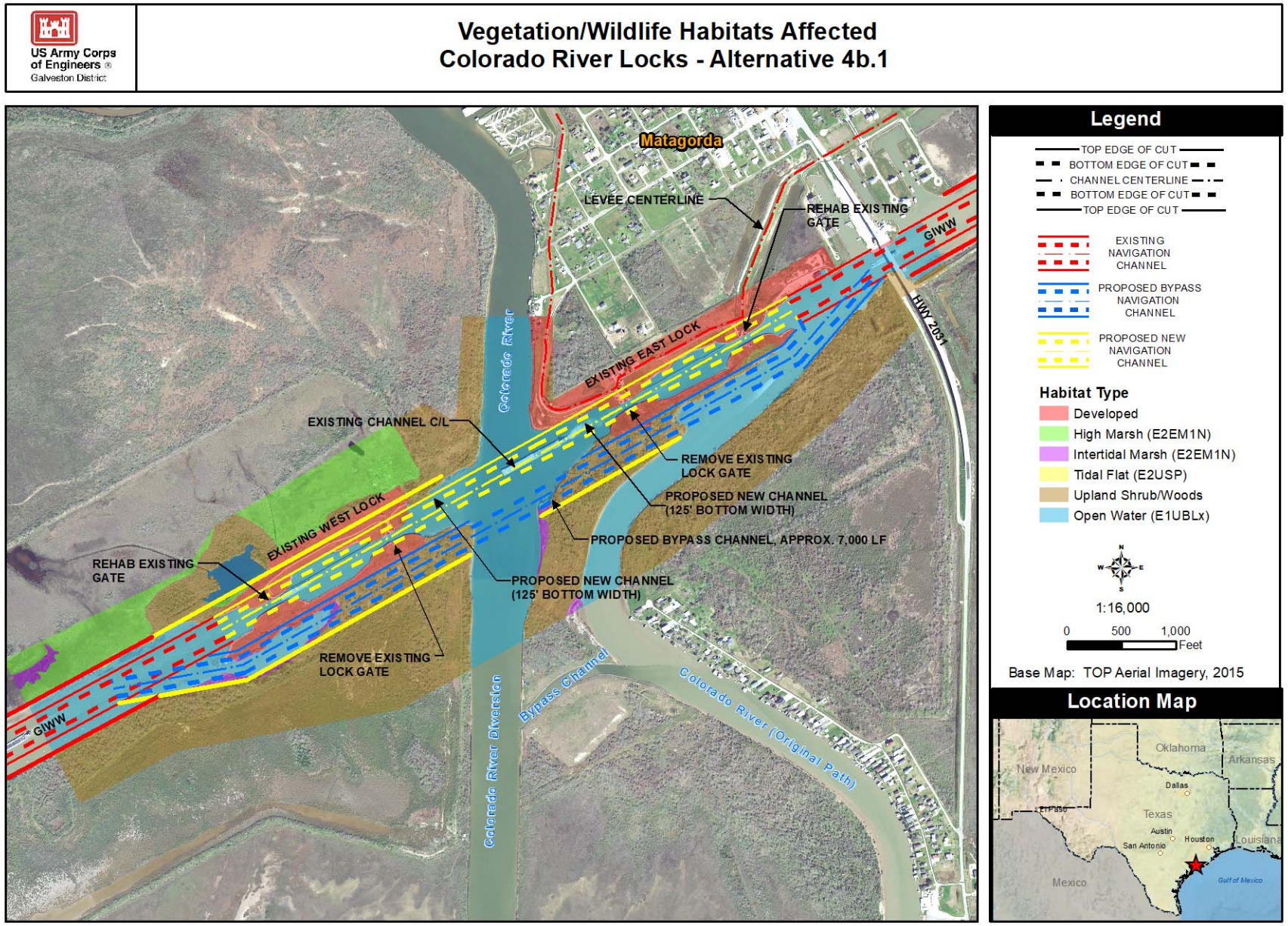


Figure 6.6 Vegetation/Wildlife Habitats Affected by CRL Alternative 4b.1 (Recommended Plan)

6.9 Protected/Managed Lands and Recreational Areas

None of the Action Alternatives would impact designated parks, recreation areas, national wildlife refuges, wildlife management areas, or other protected or managed lands, as none are in the study areas. The Levee Road Boat Ramp, which is a public boat ramp owned and managed by Brazoria County and located on the Brazos River approximately 0.3 mile north of the GIWW crossing, would be impacted by some of the BRFG alternatives, as outlined below.

BRFG Alternative 3a: The Levee Road Boat Ramp would not be impacted by this alternative.

BRFG Alternative 3a.1 (Recommended Plan): The Levee Road Boat Ramp would not be impacted by this alternative.

BRFG Alternative 9a: The Levee Road Boat Ramp would be removed by this alternative. Relocation of the ramp would need to be discussed with Brazoria County.

BRFG Alternative 9b/c: The Levee Road Boat Ramp would be removed by this alternative. Relocation of the ramp would need to be discussed with Brazoria County.

CRL Alternative 3b: Under this alternative, no changes to Mad Island WMA, Jetty Park, Big Boggy NWR, or other protected lands or recreational areas near the study area are expected to occur. There would be no change in impacts compared to the FWOP Condition.

CRL Alternative 4b.1 (Recommended Plan): Like Alternative 3b, this alternative is not expected to impact protected lands or recreational areas.

6.10 Threatened and Endangered Species

Table 6.3 identifies the federally listed threatened and endangered species that may occur in Brazoria and Matagorda Counties and provides the anticipated effect determination for the Recommended Plan (BRFG Alternative 3a.1 and CRL Alternative 4b.1). The Recommended Plan is expected to have *no effect* on most of the listed species because those species have low potential of occurring in the study areas and/or proposed improvements could be constructed in a way that would avoid impact. The Recommended Plan *may affect, but is not likely to adversely affect* the following six species:

- piping plover
- red knot
- green sea turtle
- hawksbill sea turtle
- Kemp's ridley sea turtle
- loggerhead sea turtle

Table 6.3 Anticipated Effects of Project on Threatened and Endangered Species

Listed Species		Listing Status	Jurisdiction	Potential to Occur in Study Areas?	Recommended Plan Effect Determination[1]
Common Name	**Scientific Name**				
Birds					
Northern aplomado falcon	*Falco femoralis septentrionalis*	Endangered	USFWS	Yes	No Effect
Piping plover	*Charadrius melodus*	Threatened	USFWS	Yes	May Affect, Not Likely to Adversely Affect
Red knot	*Calidris canutus rufa*	Threatened	USFWS	Yes	May Affect, Not Likely to Adversely Affect
Whooping crane	*Grus americana*	Endangered	USFWS	Yes	No Effect
Mammals					
West Indian manatee	*Trichechus manatus*	Threatened	USFWS	Yes	No Effect
Fin whale	*Balaenoptera physalus*	Endangered	NMFS	No	No Effect
Humpback whale	*Megaptera novaeangliae*	Endangered	NMFS	No	No Effect
Sei whale	*Balaenoptera borealis*	Endangered	NMFS	No	No Effect
Sperm whale	*Physeter macrocephalus*	Endangered	NMFS	No	No Effect
Reptiles					
Green sea turtle	*Chelonia mydas*	Threatened	NMFS	Yes	May Affect, Not Likely to Adversely Affect
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered	USFWS; NMFS	Yes	May Affect, Not Likely to Adversely Affect
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	USFWS; NMFS	Yes	May Affect, Not Likely to Adversely Affect
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	USFWS; NMFS	No	No Effect
Loggerhead sea turtle	*Caretta caretta*	Threatened	USFWS; NMFS	Yes	May Affect, Not Likely to Adversely Affect
Mollusks					
Golden Orb	*Quadrula aurea*	Candidate	USFWS	No	No Effect
Smooth pimpleback	*Quadrula houstonensis*	Candidate	USFWS	No	No Effect
Texas fawnsfoot	*Truncilla macrodon*	Candidate	USFWS	No	No Effect
Texas pimpleback	*Quadrula petrina*	Candidate	USFWS	No	No Effect
Corals					
Boulder star coral	*Orbicella franksi*	Threatened	NMFS	No	No Effect
Elkhorn coral	*Acropora palmata*	Threatened	NMFS	No	No Effect
Lobed star coral	*Orbicella annularis*	Threatened	NMFS	No	No Effect
Mountainous star coral	*Orbicella faveolata*	Threatened	NMFS	No	No Effect

[1] The Recommended Plan is BRFG Alternative 3a.1 and CRL Alternative 4b.1.
Sources: NMFS 2017; USFWS 2017a, b, c

Discussions of the effect determinations are provided by species below. More detailed information on impacts to threatened and endangered species resulting from the Recommended Plan is provided in the Biological Assessment prepared for the project (**Attachment D-2**).

- Northern aplomado falcon – The nearest population of northern aplomado falcon, which includes approximately 14 territorial pairs, is over 30 miles south of the CRL study area along the length of Matagorda Island and adjacent San Jose Island. Individual sightings have been recorded within 5 miles

of the study areas, and the study areas contain open habitats that could be used by aplomado falcons. None of the Action Alternatives would remove preferred habitat, and none have the potential to affect aplomado falcon nesting; therefore, the Recommended Plan and other Action Alternatives are expected to have *no effect* on the northern aplomado falcon.

- Piping plover and red knot – The piping plover and red knot are migratory species that overwinter on the Texas coast and utilize barrier island beaches, exposed tidal flats, washover passes, and mud flats. Although no substantial habitat is located within the study areas, designated critical habitat for the piping plover is present along the Gulf beach near both study areas, as well as in the Colorado River delta in West Matagorda Bay. The Action Alternatives, including the Recommended Plan, could affect sediment budget to those areas; however, this change is not expected to modify the critical habitat or adversely affect the species. As a result, the Recommended Plan and other Action Alternatives *may affect, but are not likely to adversely affect* piping plovers and red knots.

- Whooping crane – Whooping cranes also overwinter on the Texas coast, mostly in the area surrounding the Aransas NWR located about 30 miles southwest of the CRL study area. They have been recorded within 5 miles of both study areas and could utilize salt marsh habitat in the study areas. The Action Alternatives will have varying levels of impacts to salt marshes, all of which are considered low compared to the availability of salt marshes in the region. Since most whooping crane wintering occurs well south of the study areas, the Recommended Plan and other Action Alternatives are expected to have *no effect* on whooping cranes.

- West Indian manatee – Texas is the extreme western edge of the West Indian manatee's current distribution, and occurrences in Texas are occasional to rare. Thus, it is unlikely that this species will occur in the study areas and be exposed to construction activities. As a result, the Recommended Plan and other Action Alternatives are expected to have *no effect* on the West Indian manatee.

- Whales – Whales are generally restricted to offshore waters and are not expected to occur in the study areas. Therefore, the Recommended Plan and other Action Alternatives are expected to have *no effect* on the listed whale species.

- Sea turtles – Green, hawksbill, Kemp's ridley, loggerhead, and leatherback sea turtles are known to occur off the Texas coast, although leatherback sea turtles are uncommon in Texas coastal waters and are not expected to occur in the study areas. The GIWW and Brazos and Colorado Rivers provide open water habitats that could be used by sea turtles. However, it is anticipated that hopper dredges would not be used for this project, thereby avoiding the potential of killing sea turtles. Activities in the GIWW and river channels could have some minor effect on sea turtles; therefore, the Recommended Plan and other Action Alternatives *may affect, but are not likely to adversely affect* green, hawksbill, Kemp's ridley, and loggerhead sea turtles and would have *no effect* on leatherback sea turtles.

- Mollusks (mussels) – The mussel species that are candidates for federal listing are freshwater species and are not expected to occur in the tidal and brackish waters of the Brazos River, Colorado River, or

other waters in the study areas due to salinity fluctuations. Therefore, the Recommended Plan and other Action Alternatives would have *no effect* on the candidate mussel species.

- Corals – The listed corals are offshore species and do not occur in the study areas. Therefore, the Recommended Plan and other Action Alternatives would have *no effect* on corals.

6.11 Other Protected Wildlife Species

Marine Mammals – Bottlenose dolphins are common on the Texas coast and are known to occur in the BRFG and CRL study areas. The proposed construction activities associated with the Recommended Plan and other Action Alternatives are not expected to include blasting or SONAR. However, pile driving of sheet pile or other structures for the proposed new guide walls at the BRFG has the potential to impact bottlenose dolphins. The Recommended Plan would minimize activities that could affect dolphins, incorporate BMPs to minimize impacts, and adhere to the MMPA. The USACE will consult with NMFS on the potential effects and obtain an Incidental Take Authorization prior to conducting activities such as pile driving that may affect dolphins.

Bald and Golden Eagles – Golden eagles are not expected to occur in the study areas except for the possibility of migrating individuals passing through the area. Bald eagles may forage in the Brazos, San Bernard, and Colorado Rivers, GIWW, East and West Matagorda Bays, and other large water bodies in and near the study areas, but no bald eagle nests are in or adjacent to the study areas. Therefore, the Recommended Plan and other Action Alternatives are not expected to adversely affect bald or golden eagles.

Migratory Birds – The Recommended Plan and other Action Alternatives will remove wetland and upland habitats that could be used by migratory birds for various activities including nesting, foraging, loafing, and roosting. The Recommended Plan would minimize impacts to migratory birds by minimizing habitat removal and incorporating BMPs, if needed, to avoid removing active nests.

6.12 Aquatic Resources

BRFG Alternative 3a: Construction of this alternative would result in temporary disruption of benthic habitats within the channel, and impacts associated with maintenance dredging would continue. Dredging operations would alter benthic habitats through evacuation of bay bottom and dredged material placement in ODMDS, if used (Montagna et al. 1998). The impact to benthic organisms is likely to be confined to the immediate vicinity of the area dredged (Newell et al. 1998), and recovery of benthic macroinvertebrates following burial is typically rapid (recovering within months rather than years) (Van Der Wal et al. 2011, Wilber et al. 2006, Wilber and Clarke 2001). Benthic communities that may be present in the submerged sediment on the edge of the current channel would be destroyed, but they would rapidly recolonize. Overall, changes to benthic communities are expected to be minor, localized, and similar to the FWOP Condition, which also includes bottom disturbances from maintenance dredging and barge traffic. No substantial changes to zooplankton species are anticipated, as the alternatives would result in only slight changes in salinity.

BRFG Alternative 3a.1 (Recommended Plan): Impacts to benthic and plankton resources would be similar to Alternative 3a.

BRFG Alternative 9a: Impacts to benthic and plankton resources would be similar to Alternative 3a.

BRFG Alternative 9b/c: Impacts to benthic and plankton resources would be similar to Alternative 3a.

CRL Alternative 3b: Impacts to benthic and zooplankton resources from construction at the CRL facility would be similar to the anticipated impacts for the BRFG alternatives: temporary disruption of benthic communities that are expected to recover quickly after the disturbance is removed. Overall, changes to benthic communities are expected to be minor, localized, and similar to the FWOP Condition, which also includes bottom disturbances from maintenance dredging and barge traffic. No substantial changes to zooplankton species are anticipated, as the alternatives would result in only slight changes in salinity.

CRL Alternative 4b.1 (Recommended Plan): Impacts to benthic resources would be similar to Alternative 3b.

6.13 Commercial and Recreational Fisheries

BRFG Alternative 3a: This alternative is not expected to have a substantial effect on commercial or recreational fisheries or fishery species. Temporary, localized disturbances and turbidity increases would affect fishery habitats and juvenile fish in the immediate vicinity of the construction, but there are large amounts of habitat in the surrounding area that support fisheries. Wetland losses from the alternative (approximately 6.1 acres) would be mitigated, and only slight changes in salinity are expected. The GIWW would remain open during construction via a bypass channel, so area waterbodies would remain accessible for recreational and commercial fishing.

BRFG Alternative 3a.1 (Recommended Plan): Impacts to fisheries would be similar to Alternative 3a and would impact approximately 6.0 acres of wetland habitats

BRFG Alternative 9a: Impacts to fisheries would be similar to Alternative 3a, although this alternative would affect more wetland habitats (approximately 30.5 acres).

BRFG Alternative 9b/c: Impacts to fisheries would be similar to Alternative 3a, although this alternative would affect more wetland habitats (approximately 28.5 acres).

CRL Alternative 3b: Like the BRFG alternatives, this CRL alternative is not expected to have a substantial effect on commercial or recreational fisheries or fishery species. Wetland habitat loss would be minor (approximately 0.7 acre) and would be mitigated. Other habitat disturbances would be temporary, and only slight changes in salinity are expected. The GIWW would remain open during construction via a bypass channel, so area waterbodies would remain accessible for recreational and commercial fishing.

CRL Alternative 4b.1 (Recommended Plan): Impacts to fisheries would be similar to Alternative 3b.

6.14 Essential Fish Habitat

The study areas contain EFH for various species but are already partially developed with navigation-related structures and do not provide high-quality EFH. Additionally, marine water column and marine non-vegetated bottoms occur in abundance in the surrounding areas and are, therefore, not a unique resource. No HAPCs are located in the study areas. The USACE will provide mitigation for tidal wetland habitats that serve as EFH. Coordination with NMFS is ongoing, and the EFH Assessment Report that has been prepared for the Recommended Plan (**Attachment D-3**) will be submitted to the NMFS for review.

BRFG Alternative 3a: Under this alternative, water column turbidity would increase during and immediately after construction activities, and displacement of water column food sources for finfish would be expected; however, recovery is expected to be rapid after construction activities are complete. During maintenance dredging activities, mobile finfish are expected to move away from the equipment; therefore, impacts would be considered short-term and not dissimilar to the FWOP Condition.

BRFG Alternative 3a.1 (Recommended Plan): Impacts to EFH would be similar to Alternative 3a.

BRFG Alternative 9a: Impacts to EFH would be similar to Alternative 3a, although this alternative would affect more wetland habitats.

BRFG Alternative 9b/c: The impacts would be similar to Alternative 3a, although this alternative would affect more wetland habitats.

CRL Alternative 3b: The impacts would be similar to BRFG Alternative 3a, although fewer wetland losses would occur.

CRL Alternative 4b.1 (Recommended Plan): The impacts would be similar to BRFG Alternative 3a, although fewer wetland losses would occur. Wetland impacts under this alternative would be the same as CRL Alternative 3b.

6.15 Coastal Barrier Resources and Coastal Natural Resource Areas

The Recommended Plan and other Action Alternatives would affect coastal barrier resources and coastal natural resource areas; however, they would not substantially change the overall coastal environment. Improvements to the GIWW, BRFG, and CRL facilities are consistent with the CBRA because under Section 6, a Federal expenditure is allowable within CBRS when funds are used to maintain or construct improvements to existing federal navigation channels, such as the GIWW (16 USC 305(a)(2)). The GIWW was authorized long before the CBRA was enacted in 1982 and the CBRS units in the study areas were designated. In addition, consistent with the CBRA, the project is not expected to change development rates or patterns or induce growth on barrier islands. Compliance with the CBRA will be coordinated with the USFWS.

The Recommended Plan and other Action Alternatives would affect coastal natural resource areas protected by the TCMP, including coastal barriers, shore areas, wetlands, and special hazard areas (floodplains). The

primary difference among the alternatives is the amount of coastal wetlands that would be removed. Under all alternatives, commensurate mitigation would be provided for wetland losses. The USACE has determined that the Recommended Plan complies with the TCMP and will be conducted in a manner consistent with all rules and regulations of the program. The USACE will coordinate the Consistency Determination provided in **Attachment D-4** with the GLO, and the results of consultation will be provided in the final report.

6.16 Historic and Cultural Resources

Much of the BRFG and CRL project areas have been extensively disturbed by previous excavation of the GIWW, diversion of the Brazos and Colorado Rivers, construction of the BRFG and CRL facilities, and construction of roads, levees, and DMPAs. Therefore, the potential for encountering intact archeological sites is considered relatively low for any of the action alternatives.

A non-archeological historic resources survey was conducted in the APE for the BRFG and CRL facilities. Ten historic-age resources were inventoried in the BRFG APE and 15 historic-age resources were inventoried in the CRL APE. Most of the resources consisted of the floodgates, locks, and other USACE-owned resources within the BRFG and CRL facilities (e.g., control houses, power houses, pump house, boat house). None of the historic-age resources met the NPS criteria for NRHP eligibility. As a result, none of the action alternatives would affect historic resources.

6.17 Air Quality

Under the Recommended Plan and other Action Alternatives, air emissions would be from construction equipment associated with the project (dredging equipment, land-based construction equipment), and from personal vehicles for workers traveling to the project sites. Air emissions from the equipment will emit air pollutants and GHG. The air emissions from new construction would not occur at the same time as maintenance dredging. Air emissions are generally dispersed with distance and time, and a relatively slight increase in emissions during construction would correspond to a slight increase in ambient air quality concentrations for that air contaminant.

The Recommended Plan and other Action Alternatives are expected to have similar effects on air quality, although alternatives that require greater dredging volumes, longer construction durations, and longer or more frequent maintenance cycles would result in higher overall emissions. The CRL facility is located in an attainment area, so no specific emissions determination is needed for the Recommended Plan at CRL. Since the BRFG facility is located in the HGB ozone moderate nonattainment area, calculations of projected pollutant emissions from construction are required in order to determine if they exceed the General Conformity de minimis threshold, which is 100 tpy for the ozone precursors NOx and VOCs (2008 8-hour standard). If projected emissions for either of these pollutants exceed 100 tpy, then a General Conformity Determination is required.

At the time this draft report was prepared, the BRFG Recommended Plan was not developed with enough detail to accurately estimate pollutant emissions. However, a qualitative estimate of potential emissions was made by comparing the BRFG Recommended Plan to the USACE Galveston District's ongoing

reevaluation of the Freeport Harbor Channel Improvement Project, as described in the report titled *Draft Integrated General Reevaluation Report and Environmental Assessment* (USACE 2017). Construction of the additional features addressed in the Freeport Harbor Channel re-evaluation was expected to be completed in 1 calendar year and projected to result in 115.31 tpy of NOx emissions and 2.61 tpy of VOC emissions, thereby requiring a General Conformity Determination for the NOx emissions. Of the projected NOx emissions, 106.83 tpy (93% of total) was from dredging and sheet pile placement, 8.07 tpy (7% of total) was from land side dredged material placement, and 0.42 (<1% of total) was from employee commuter vehicles. The project involved 1,946,801 cubic yards dredging quantity, 4,300 feet of sheet pile installation, and 1-year construction duration.

In comparison, the BRFG Recommended Alternative involves an estimated 1,770,900 cubic yards dredging quantity, 1,140 feet of sheet pile installation, and 2-year construction duration. Based on these estimates, the emissions of NOx and VOCs may be similar to the Freeport Channel Harbor re-evaluation estimates, but would be spread over a 2-year construction period instead of a 1-year period. Based on this qualitative analysis, NOx emissions from the BRFG Recommended Plan are not expected to exceed the 100 tpy de minimis threshold and is exempt from a General Conformity Determination. Once the Recommended Plan has been further refined after the ADM, emissions can be calculated and coordinated with the TCEQ and EPA to verify that emissions are below de minimis and a conformity determination is not needed.

6.18 Noise

BRFG Alternative 3a: Noise sensitive receptors would be limited to recreational users of nearby parks such as San Bernard NWR, Justin Hurst WMA, Bryan Beach State Recreation Area, Bryan Beach Park, Quintana Beach County Park, Surfside Beach, or Brazoria NWR. No permanent noise sources would be installed as part of this alternative. Construction activities would create short-term noise level increases similar to increases during maintenance dredging currently occurring in the project area. Therefore, this alternative would have no adverse noise impacts. The noise generated by the existing maintenance dredging regime would continue as under the FWOP.

BRFG Alternative 3a.1 (Recommended Plan): Noise impacts would be similar to Alternative 3a.

BRFG Alternative 9a: Noise impacts would be similar to Alternative 3a.

BRFG Alternative 9b/c: Noise impacts would be similar to Alternative 3a.

CRL Alternative 3b: Noise sensitive receptors would be limited to recreational users of nearby parks such as Mad Island WMA, Jetty Park, or Big Boggy NWR, as well as residences located near the CRL study area. Construction activities would create short-term noise level increases similar to increases during maintenance dredging currently occurring in the project area. Therefore, this alternative would have no adverse noise impacts. The noise generated by the existing maintenance dredging regime would continue as under the FWOP.

CRL Alternative 4b.1 (Recommended Plan): Noise impacts would be similar to Alternative 3b.

6.19 Oil, Gas, and Minerals

BRFG Alternative 3a: This alternative would not affect existing, or induce new, oil and gas wells or pipelines in the BRFG vicinity. It would also not affect the Bryan Mound Strategic Petroleum Reserve. This alternative would be similar to the FWOP Condition in terms of oil, gas, and mineral resources.

BRFG Alternative 3a.1 (Recommended Plan): Impacts to oil, gas, and mineral resources would be similar to Alternative 3a.

BRFG Alternative 9a: Impacts to oil, gas, and mineral resources would be similar to Alternative 3a.

BRFG Alternative 9b/c: Impacts to oil, gas, and mineral resources would be similar to Alternative 3a.

CRL Alternative 3b: This alternative would not affect existing, or induce new, oil and gas wells or pipelines in the CRL vicinity. This alternative would be similar to the FWOP Condition in terms of oil, gas, and mineral resources.

CRL Alternative 4b.1 (Recommended Plan): Impacts to oil, gas, and mineral resources would be similar to Alternative 3b.

6.20 Hazardous, Toxic, and Radioactive Waste

The BRFG and CRL were built in 1943 and 1944, respectively, when industrial marine facilities were coated in lead paint. Depending on the repairs and rehabilitation projects done at the facilities, there may still be lead paint on the structures. Other than the potential for lead paint, another HTRW concern in the immediate vicinity of the projects is Texas Boat & Barge, Inc., which is a barge cleaning and repair facility located adjacent to the east BRFG floodgate.

Sediment deposits around the BRFG may contain HTRW from upstream chemical and petroleum manufacturing and processing facilities including Superfund sites. The EPA has characterized the GIWW in the vicinity of the study area as having high sediment contaminants. High flooding in the area in 2017 may have caused contaminated surface soil from upstream petroleum refineries, chemical plants and plastic manufacturing facilities to erode into the river, depositing in the sediments. At a minimum, sediment samples to characterize the contaminants present will be required for alternatives that result in disturbance of the riverbed. Potential contaminants from upstream operations include, but are not limited to, polychlorinated biphenyls [PCBs], heavy metals such as lead, nickel, mercury, zinc, cadmium, chromium, and arsenic, and organic compounds that include known carcinogens. Depending on the sediment sample results, there may be additional costs for disposal, treatment, or additional health and safety requirements during construction.

Sediment deposits near the CRL may also contain HTRW material. EPA records of water quality testing near the CRL indicate fairly high metal, microbiology, and pesticide results. While there are not currently many industrial facilities visible upstream, there are several industrial wastewater discharge points that have

had known past releases of hazardous materials. Depending on the sediment sample results, there may be additional costs for disposal, treatment, or additional health and safety requirements during construction.

BRFG Alternative 3a: Under this alternative, removal of the existing floodgates would require testing for lead paint and handling if present. Sediment sampling may be required to characterize the contaminants present; depending on the sediment sample results, there may be additional costs for disposal, treatment, or additional health and safety requirements during construction.

BRFG Alternative 3a.1 (Recommended Plan): HTRW concerns would be similar to Alternative 3a.

BRFG Alternative 9a: Under this alternative, removal of the existing gates would require testing for lead paint and handling if present. Sediment sampling may be required to characterize the contaminants present; depending on the sediment sample results, there may be additional costs for disposal, treatment, or additional health and safety requirements during construction. Also, additional HTRW investigations would be needed to determine if there are contamination issues in the Texas Boat & Barge facility.

BRFG Alternative 9b/c: HTRW concerns would be similar to Alternative 9a.

CRL Alternative 3b: Under this alternative, removal of the existing lock gates would require testing for lead paint and handling if present. Sediment sampling may be required to characterize the contaminants present; depending on the sediment sample results, there may be additional costs for disposal, treatment, or additional health and safety requirements during construction.

CRL Alternative 4b.1 (Recommended Plan): HTRW concerns under the Recommended Plan would be similar to Alternative 3b.

6.21 Socioeconomic and Human Resources

BRFG Alternative 3a: This alternative would not impact minority or low-income populations in the BRFG vicinity. The duration of the construction would be relatively short, and therefore, it is not expected that workers will temporarily relocate to the project area; however, some expansion at ports and increased shipping on the GIWW may occur to support future growth and commerce leading to residential or industrial development along the Brazos or San Bernard Rivers. This alternative would allow for transit through the GIWW throughout construction, and would provide a long-term economic benefit to the shipping industry by making it more efficient to travel through the BRFG area. This alternative may be considered beneficial compared to the FWOP Condition.

BRFG Alternative 3a.1 (Recommended Plan): Socioeconomic and human resource impacts would be similar to Alternative 3a.

BRFG Alternative 9a: Overall, socioeconomic and human resource impacts would be similar to Alternative 3a. This alternative would require relocation of one business, Texas Boat & Barge, Inc., which may temporarily affect the business and its employees.

BRFG Alternative 9b/c: Socioeconomic and human resource impacts would be similar to Alternative 9a.

CRL Alternative 3b: This alternative would not impact minority or low-income populations in the CRL vicinity. The duration of the construction would be relatively short, and therefore, it is not expected that workers will temporarily relocate to the project area; however, some expansion at nearby ports and increased shipping on the GIWW may occur to support future growth and commerce. This alternative would allow for transit through the GIWW throughout construction, and would provide a long-term economic benefit to the shipping industry by making it more efficient to travel through the CRL area. This alternative may be considered beneficial compared to the FWOP Condition.

CRL Alternative 4b.1 (Recommended Plan): Socioeconomic and human resource impacts would be similar to Alternative 3b.

6.22 Indirect Impacts of Recommended Plan

This section describes the anticipated indirect impacts associated with the Recommended Plan (BRFG Alternative 3a.1 and CRL Alternative 4b.1). Indirect impacts are those impacts that are expected to be caused by the Recommended Plan, but "are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems." (40 CFR Section 1508.8). Indirect impacts are also known as secondary or induced impacts.

Overall, the Recommended Plan is expected to benefit the regional and national economy by improving navigation through the BRFG and CRL facilities, reducing navigation delays at the facilities, and reducing the risk of accidents at the facilities. The Recommended Plan would be constructed largely within the existing GIWW and BRFG/CRL facilities, and no induced growth is expected as a result of the Recommended Plan. Overall, the Recommended Plan is not expected to have major indirect effects.

Potential indirect effects of the Recommended Plan include the following:

- Changes in salinity – Major changes in salinity could result in long-term effects to habitats and wildlife communities. However, the Recommended Plan is not expected to result in major salinity changes. Minor salinity changes resulting from the Recommended Plan are expected to have commensurate small effects on wetlands, vegetation, and wildlife communities.

- Changes in sediment budget – Major changes in sediment budget and increased sedimentation in navigation channels could adversely affect navigation and result in large increases in maintenance dredging requirements. Changes in sediment budget could have long-term effects on beach habitats, the Colorado River delta development, piping plover critical habitat, and wetland habitats. At the CRL, the Recommended Plan would result in sedimentation trends that are similar to the FWOP Condition. At the BRFG, the Recommended Plan would increase sedimentation up to 22 percent in the Brazos Basin and up to 18 percent in the GIWW; however, maintenance dredging would prevent or reduce shoaling and provide for continued navigation through these areas. The Recommended Plan is expected to result in a 1-percent reduction in sediment reaching the Brazos

delta, which is expected to result in no more than minor effect on beach habitat, including piping plover critical habitat.

- Additional Maintenance Dredging – Increased maintenance dredging requirements could result in multiple indirect effects, including impacts from establishment of new DMPAs or ODMDS, increases in noise and air emissions, and disruptions to the water column and benthic communities. Under the Recommended Plan, maintenance dredging requirements at the CRL are expected to be similar to the FWOP Condition. At the BRFG, the Recommended Plan is projected to result in an 8-percent increase in sedimentation in zones that require maintenance (e.g., the GIWW, Brazos Basin, and Freeport Channel). The increased maintenance dredging needs would result in increases in noise, air emissions, and disturbances of the water column and benthic communities; however, these impacts are expected to be temporary and short-term. Based on current engineering analysis, no additional DMPAs or ODMDS are anticipated for the Recommended Plan.

- Changes at San Bernard River – The proposed open channel on the west side of the BRFG is expected to have indirect effects on the San Bernard River in that it will allow increased drainage of San Bernard flows, thereby reducing water surface elevations along the river. The open channel would also increase the amount of sediment that enters the west GIWW and may be transported to the San Bernard outlet at the Gulf of Mexico. Both of these factors may contribute to silting in of the river's outlet and adjacent areas. The San Bernard River outlet to the Gulf of Mexico is currently closed, and silting in has occurred after dredging the outlet. With implementation of the Recommended Plan, silting is expected to be similar to existing conditions, and habitat development/conversion over time is expected to occur naturally. Although some areas adjacent to the outlet may silt in over time and convert to upland coastal prairie habitat, this is expected to have no more than a minor effect on the overall ecology of the area. Future projects may re-open the outlet, and future re-opening of the outlet is being evaluated and is included in a current list of RESTORE Act projects.

6.23 Cumulative Impacts

The CEQ defines cumulative impacts as those impacts "which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or persons undertake such actions." Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Impacts include both direct and indirect effects.

Cumulative effects can result from a wide range of activities including the addition of materials to the affected environment, repeated removal of materials from the affected environment, and repeated environmental changes over large areas and long periods. Cumulative impacts may also occur when individual disturbances are clustered, creating conditions where effects of one episode have not dispersed before the next occurs (timing) or are so close that their effects overlap (distance). In assessing cumulative impacts, consideration is given to the following:

- the degree to which the proposed action affects public health or safety;
- unique characteristics (physical, biological, and socioeconomic factors) of the geographic area;
- the degree to which effects on the quality of the human environment may be highly controversial;
- the degree to which possible effects on the human environment are highly uncertain or involve unique or unknown risks; and
- whether the action is related to other actions with individually insignificant, but cumulatively significant, impacts on the environment.

6.23.1 Assessment Method

The cumulative impacts analysis followed similar methods as recent analyses conducted by the USACE for Freeport Channel improvements, addressing impacts for a set of criteria and comparing other past, present, and reasonably foreseeable projects in the general vicinity of the BRFG and CRL areas to the Recommended Plan. For the purposes of this analysis, cumulative impacts were assessed within an area that included the BRFG and CRL study areas and surrounding areas generally bounded by West Matagorda Bay to the west, Freeport Channel and Harbor to the east, the Gulf of Mexico to the south, and north to the limits of Federal navigation channels in the Colorado, San Bernard, and Old Brazos Rivers.

6.23.2 Evaluation Criteria

Evaluation criteria that were considered included key resources that the Recommended Plan would impact and that are discussed in NEPA documents and project reports. These include the following attributes:

- Biological/Ecological Environment – the Recommended Plan will affect the following key biological resources:
  - Wetlands
  - Threatened and Endangered Species
  - Essential Fish Habitat
- Physical/Chemical Environment – the Recommended Plan will affect the following physical/chemical elements:
  - Water Quality
  - Air Quality
- Human Environment – the Recommended Plan will affect the following human environment resources:
  - Socioeconomic and Human Resources

6.23.3 Individual Project Evaluation

Table 6.4 lists the past, present, and reasonably foreseeable projects/activities that were identified in the general study area based on previous reports and available planning documents. The projects were compared to the BRFG and CRL Recommended Plan Alternatives presented in this report.

Table 6.4 Past, Present, and Reasonably Foreseeable Future Actions within the Study Area

Project/Activity	Approximate Location
Past or Present Projects/Activities	
Freeport Harbor Jetties	Freeport
Brazos River Diversion Channel	Freeport
Freeport Harbor Channel 45-foot Project	Freeport
GIWW Maintenance	GIWW in Brazoria and Matagorda Counties
Freeport Hurricane Flood Protection Levees	Freeport
Bryan Mound Strategic Petroleum Reserve	East side of Brazos River about 1 mile north of BRFG
CenterPoint Energy 69-kV electric transmission line	Freeport and vicinity
Petrocom Fiber Optic Network	Brazoria County
Freeport Area Industrial Complex(es)	Freeport and vicinity
Freeport Harbor Channel Outer Bar and Jetty Channels Widening (Widening Project)	Freeport
Freeport LNG Phase I	Quintana Island
Velasco Terminal	Freeport
Tenaris Bay City Pipe Mill	Bay City
Schulman's Movie Bowl and Grille	Bay City
Henderson Fabrication Expansion	Bay City
Reasonably Foreseeable Future Projects/Activities	
BP Exploration Gulf of Mexico Fiber Optic Network	Brazoria County
Freeport LNG Phase II	Brazoria County
Port Freeport Modifications	Freeport
Freeport Harbor Channel Improvement Project	Freeport
Parcel 14 Developments	Freeport
OXEA Chemicals Bay City Plant Expansion	Bay City
STP Nuclear Operating Company Expansion	Approx. 9 miles northwest of CRL
Chocolate Bayou Wind Project	Brazoria County
Peyton Creek Wind Farm	Matagorda County
Various Roadway Improvement Projects	Various

Sources: Brazoria County 2016; Caswell 2016; Matagorda County Economic Development Corporation (EDC) 2016; Reddell 2017; TxDOT 2017b, 2017c; USACE 2012

6.23.4 Resource Impact Evaluation

Biological/ecological, physical/chemical, and human resource impacts were evaluated based on individual project reviews. Acreages and rankings for the past, present, and reasonably foreseeable projects, compared to qualitative and quantitative impacts of the BRFG-CRL Recommended Plan, are presented in **Table 6.5**. Impacts for the BRFG-CRL Recommended Plan considered in this cumulative analysis are summarized in the analysis table. Direct impacts to specific habitats that could be quantified (e.g., acreages) from existing project documents were considered. Where relevant information is not quantifiable, impacts were evaluated qualitatively. Cumulative impact conclusions follow the project descriptions and summary table. **Table 6.5** includes those projects that had some impact information available. Although not included in **Table 6.5**, other projects were considered in the cumulative impacts analysis.

Table 6.5 Comparison of Environmental Impacts of Past, Present, and Reasonably Foreseeable Future Projects/Activities and BRFG-CRL Recommended Plan

Past and Present Projects/Activities						
Resource	**Existing SH-45**	**GIWW**	**Bryan Mound SPR**	**CenterPoint Energy Transmission Line (Route 4)**	**Freeport LNG Phase I**	**Freeport Channel Widening**
Wetlands	NA ("some water filled low areas and ponds")	Dredge: NO Disposal: 4,464 ac	20 acres impacted (brackish marsh and creek/river)	8 acres impacted	68 acres impacted	NO
Threatened or Endangered Species	NA	NO	NO	NO	NO	May affect, not likely to adversely affect, piping plover, 2 injury or mortality sea turtle takes, 32 noninjurious sea turtle takes allowed per NMFS BO
EFH	NA	NA	NA	NA	NI	NA
Water Quality	NO	Dredge turbidity: NO Disposal turbidity: NO Dredge pollutants: NA Disposal pollutants: NO	Possible toxic releases and increase in groundwater salinity: NA	NO	Groundwater: NI Surface water: NO	Groundwater: NO Surface water: NO
Air Quality	Odors	Dredge: NO Disposal: NI	Hydrocarbon emissions periodically exceed stds: NA	NA	NO	NO_X exceedances; coordinating regarding compliance with SIP is ongoing
Historic and Cultural Resources	Historic USCG building relocation	Dredge: NO Disposal: NA	NA	NO	NO	NO
Socioeconomic and Human Resources	NA	NA	NA	NA	NA	NO

Reasonably Foreseeable Future Projects/Activities and BRFG-CRL Recommended Plan						
Resource	**BP Fiber Optic Network**	**Freeport LNG Phase II**	**Freeport Harbor Channel Improvement**	**Port Freeport Modifications (Berth 7)**	**BRFG Recommended Plan (Alternative 3a.1)**	**CRL Recommended Plan (Alternative 4b.1)**
Wetlands	NO	NI	39 acres impacted	2 acres impacted	Removal of approximately 6.0 acres of wetlands, primarily due to excavation of a temporary bypass channel.	Removal of approximately 0.7 acre of wetlands, due to excavation of a temporary bypass channel.
Threatened or Endangered Species	NO	NO	Likely to affect sea turtles during dredging; may affect, not likely to adversely affect piping plover	NA	Project may affect, but is not likely to adversely affect, the piping plover, red knot, and four sea turtle species. The project would have no effect on other threatened or endangered species.	Project may affect, but is not likely to adversely affect, the piping plover and red knot. The project would have no effect on other threatened or endangered species.
EFH	NO	NI	NO	NA	Impacts to EFH during construction and maintenance dredging expected to be minor, short-term, and similar to the FWOP Condition.	Impacts to EFH during construction and maintenance dredging expected to be minor, short-term, and similar to the FWOP Condition.
Water Quality	NO	Groundwater: NI Surface water: NO	Groundwater: NO Surface water: NO	NA	Increase in turbidity during construction and maintenance dredging.	Increase in turbidity during construction and maintenance dredging.
Air Quality	NO	NO	NOx exceedances	NA	Air emissions from construction equipment and maintenance dredging, but no large impact on air quality. Anticipated emissions are expected to be consistent with allowable emissions for the non-attainment area.	Air emissions from construction equipment and maintenance dredging, but no large impact on air quality.
Historic and Cultural Resources	NI: 3 anomalies, buffered to avoid	NO	NI: 3 anomalies will require diving, and additional investigation of site 41BO226 in PA 9 will be needed	NA	Potential for encountering intact archeological sites is considered relatively low. No effects to historic resources.	Potential for encountering intact archeological sites is considered relatively low. No effects to historic resources.
Socioeconomic and Human Resources	NA	NA	NO	NA	Long-term economic benefit to the shipping industry. May be considered beneficial compared to the FWOP Condition.	Long-term economic benefit to the shipping industry. May be considered beneficial compared to the FWOP Condition.

Impacts in this table are derived from publicly available project impact documents. These impacts are presented as they were in the documents, at the time of the document production. Note: Acreages have been rounded to nearest whole number.
"NO" = No adverse effect from project; limited in duration or extent such that the resource is not adversely affected, according to project document(s). "NI" = Impact mitigated by compensatory or protective measures, as stated in project document(s). "NA" = No impact information is available for the resource in project document.

6.23.5 Past or Present Projects/Activities

Freeport Harbor Jetties

The Freeport Harbor Jetties were originally constructed in the early to mid-1880s, and repaired and strengthened by the USACE in 1908. Currently, the jetties extend on the north and south sides of the channel. The North Jetty was relocated north of its original location as part of 45-foot channel improvements. The South Jetty was also rehabilitated concurrent with the North Jetty improvements. Sand moving southwest along the beach at Surfside is carried out along the North Jetty and deposited in the channel, where it is regularly removed and deposited in ODMDS. No quantifiable environmental impacts from this project could be located for inclusion in **Table 6.5** as it was constructed in the distant past.

Brazos River Diversion Channel

Due to excessive siltation problems at Freeport, the Brazos River was diverted in 1929, through the location of the current BRFG facility. Today, the Brazos River still outfalls into the Gulf of Mexico through the diversion channel, and the old Brazos River channel is developed and serves as the Freeport Channel and Harbor. No quantifiable environmental impacts from the diversion project are available for inclusion in **Table 6.5** as it was constructed in the distant past.

Freeport Harbor Channel Deepening 45-Foot Project (Past and Current Condition)

The 45-foot Freeport Harbor Channel project was constructed in 1978. The Freeport Harbor Channel Jetty and Outer Bar channels are currently maintained by the USACE to a depth of -47 feet MLT at a width of 400 feet. These existing channels are approximately 6.3 miles long. Ongoing routine maintenance requires the removal of material per maintenance cycle for placement in the ODMDS at a roughly 10-month interval. Maintenance impacts are included in **Table 6.5**.

GIWW Maintenance Activities

As discussed above, the GIWW is routinely dredged to maintain the navigation channel. In 1975, approval was provided for maintenance dredging. The current authorized maintenance dimensions of the GIWW are 12 feet by 125 feet, maintained using a hydraulic pipeline dredge. Dredged material from the GIWW in the vicinity of the project area is placed in DMPAs designated for GIWW maintenance dredging. In **Table 6.5**, potential impacts for the GIWW segment(s) within the study area have been generally estimated from the 1975 EIS, although the maintenance segments are not exactly correlated to study area boundaries.

Freeport Hurricane Flood Protection Levees

Galveston District led studies in 1958 for hurricane-flood protection projects at Freeport and Port Arthur. Both areas had local levee systems at the time, challenged by Hurricane Carla; the newer Federal projects were designed to improve and augment existing protection. At Freeport, approximately 42 square miles (including areas of Freeport, Velasco, Lake Jackson, Clute, Lake Barbara, and Oyster Creek) were protected by approximately 56 miles of levees, wave barriers, floodwalls, drainage structures, pumping plants, and a vertical-lift tide gate with a navigation opening. In 1982, approximately 43 miles of the existing levee system and 2 miles of new levee were constructed, with two pumping stations. The Freeport Harbor levee system is projected to be able to protect the city and port from a 200-year hurricane; therefore, it is not likely that any additional construction would be required for the levee system. No documentation could be

located about the construction impacts of the Freeport Hurricane Flood Protection Levee system, either from the 1970s or 1980s. Because previous project impact information was not readily available and no new construction is anticipated, the Freeport Hurricane Flood Protection Levees are not included **Table 6.5**.

Bryan Mound Strategic Petroleum Reserve

The Bryan Mound Strategic Petroleum Preserve occupies 500 acres on the east side of the Brazos River about 1 mile north of the BRFG facility. The site has a total authorized storage capacity of approximately 232 million barrels. The site was operational by 1979 and was expanded under two supplemental NEPA documents. A Finding of No Significant Impact was issued in 1993 on a brine pipeline replacement. A new commercial potable water line was permitted by USACE, and the installation was completed in 1985.

Bryan Mound Strategic Petroleum Preserve operations have contributed to three documented large brine spills: two spills totaled 606,000 barrels at Bryan Mound and West Hackberry in 1985; one 825,000-barrel spill at Bryan Mound in 1989; and one 74,000-barrel spill at Bryan Mound in 1990. The 1989 brine spill removed vegetation in a limited area and resulted in subacute toxicity over a wider area; eventual recovery was achieved over time in some areas through natural flushing and succession, but revegetation and/or drainage enhancement was required to restore completely any poorly drained areas. Construction and operational impacts from Bryan Mound are included to the extent available in **Table 6.5**.

CenterPoint Energy, Inc.

Construction and operation of the Freeport LNG Project required that new, dedicated electrical service be brought to the LNG Terminal site. Freeport LNG requested CenterPoint Energy to provide a new 69-kV electric transmission line from an existing CenterPoint Energy substation to the Freeport LNG substation, located near the storage and vaporization facility on Quintana Island. An Environmental Assessment (EA) was approved in March 2006. Construction on the facility ended in June 2007. Impacts from this transmission line are included in **Table 6.5**.

Petrocom Fiber Optic Network

Petrocom, a Gulf cellular and microwave communications provider, created a fiber optic ring in a rough oval, starting in Texas from Freeport north to Houston, crossing into Louisiana to New Orleans and south to Fourchon, then offshore south and westward to return to Freeport. Cable installation began in June 1999. No environmental impacts from this project could be located for inclusion in **Table 6.5**.

Freeport Area Industrial Developments

The Freeport area and surrounding communities within the study area support a wide variety of private industrial uses. These industrial developments include various private companies, such as BASF, Dow, Cyanco, INEOS and Shin-Etsu. Operations, materials storage and transport, and discharges are generally regulated under EPA and TCEQ guidelines and requirements. As construction and operational impact information is not uniformly available on all of these sites, impacts from industrial facilities within the project area are not included in **Table 6.5**.

Freeport Harbor Channel Widening Project (Widening Project)

The Brazos River Harbor Navigation District (BRHND) of Brazoria County, Texas (now Port Freeport) applied to USACE, Galveston District, for a CWA Clean Air Act Section 404 permit and Rivers and

Harbors Act Section 10 permit for dredge and fill activities related to the widening of portions of the Freeport Harbor Channel on April 14, 2005. Activities subject to the jurisdiction of USACE would include dredging in navigable waters to widen portions of the Jetty Channel and all of the Outer Bar Channel, and placement of fill in waters of the U.S. Based on the Section 10/404 permit application submitted by Port Freeport to USACE in April 2005, USACE determined that the permitting action for the proposed dredge and fill activities constitutes a major Federal action. Impacts to resources are included in **Table 6.5**.

Freeport LNG Phase I

Freeport LNG Development, LP was permitted to construct the new Freeport LNG Import Terminal Project on Quintana Island, Brazoria County, Texas, providing infrastructure to shippers at the Stratton Ridge Meter Station. This first phase of the Freeport LNG Project was completed in April 2008 and is currently operational. Potential impacts associated with this first phase are included in **Table 6.5**.

Velasco Terminal

The Velasco Terminal is one of the larger port improvements in the last 40 years. Although it is planned to total 2,400 linear feet of berth, Phase I has completed 800 feet of berth thus far. The terminal would handle containerized and break-bulk cargo, with 90 acres of developable land with 22 acres of a general cargo area. No environmental impacts from this project could be located for inclusion in **Table 6.5**.

Tenaris Bay City

Construction began in August 2013 on this $1.8 billion seamless steel pipe mill that is capable of producing 600,000 tons of pipe per year on an 1,800-acre site east of Bay City on Hwy 35 (Matagorda County EDC 2016). This project will create 600 new direct manufacturing jobs with an average salary of $66,000. During the first six years of operation, the facility's projected economic impact in Matagorda County shall be more than $19 billion. The pipe mill was unveiled in December 2017 (Tenaris 2017). No environmental impacts from this project could be located for inclusion in **Table 6.5**.

Schulman's Movie Bowl and Grille

Waco-based Schulman Amusement, together with the City of Bay City, broke ground on a 54,000 sq. ft. entertainment center in June 2016. The center was scheduled to open in summary 2017 and features 12 bowling lanes, eight movie screens, an arcade, and a full-service restaurant (Matagorda County EDC 2016). No environmental impacts from this project could be located for inclusion in **Table 6.5**.

Henderson Fabrication Expansion

This metal fabrication company, founded in Bay City in the late 1980s, doubled its operation with a $1+ million expansion, adding 10 new employees, partly due to a contract they secured with Tenaris Bay City. Construction was completed in 2016 (Matagorda County EDC 2016). No environmental impacts from this project could be located for inclusion in **Table 6.5**.

6.23.6 Reasonably Foreseeable Future Projects/Activities

BP Fiber Optic Cable Network

BP Exploration and Production, Inc. has proposed installation of a 725-mile fiber optic cable network extending across the Gulf from Pascagoula, Mississippi, to Freeport, Texas. The proposed network will

provide offshore oil and gas facilities in the Gulf with updated telecommunications service. Onshore construction in Freeport has been designed to avoid all wetland impacts. This location is on Quintana Beach.

The proposed fiber optic cable network project is subject to Section 404(b)(1) evaluation, Texas Coastal Zone consistency certification, and Section 401 water quality certification from TCEQ. To avoid potential impacts to three previously identified potential cultural resource sites (anomalies), construction will not occur within a 164-foot radius avoidance zone around each anomaly. Preliminary indications are that no known threatened or endangered species or their critical habitat will be affected by the proposed project, and no substantial adverse impacts to EFH or federally managed Gulf fisheries are anticipated. An EA and Statement of Findings was issued August 16, 2007. This project is included in **Table 6.5**.

Freeport Harbor Channel Improvement Project

The USACE and Port Freeport plans to deepen the Freeport Harbor Channel from approximately 45 feet to approximately 55 feet. The project proposes to deepen and selectively widen the Freeport Harbor Channel and associated turning basins. This project is included in **Table 6.5**.

Freeport LNG Phase II

In July 2005, Freeport LNG Development, LP submitted environmental documentation to FERC to increase the diameter of the previously authorized 9.6-mile send-out pipeline from 36 inches to 42 inches. As a result, the LNG terminal would also require expansion. The environmental effects for the LNG terminal expansion are presented in an EA approved in 2006. A FEIS was approved in June 2014 to modify its previously approved Phase II facilities discussed in the 2006 EA, as well as, authorization to export up to 13.2 million tons of LNG per year from its proposed Liquefaction Plant and associated facilities in Brazoria County. Impacts associated with Phase II for the Freeport LNG development are presented in **Table 6.5**.

Port Freeport Modifications

Several projects were identified by Port Freeport as reasonably foreseeable in the Freeport area. Some of these projects include: Dock 5 Expansion; Cool Storage Facility; Construction of Berth 7; and BASF Polycaprolactam Facility. Because many of these projects are still in the planning stages, there is little information available regarding their potential impacts, therefore impacts are not included in **Table 6.5**.

Parcel 14 Developments (Warehouse and Rail Multimodal Facility)

Parcel 14 is an environmentally mitigated tract immediately south of SH 36. The location would be developed as a multimodal facility with on-site warehousing and rail access. With a grade separation at FM 1495 and SH 36, connectivity with other port parcels is contiguous, with non-port traffic separated from port traffic. Preliminary studies are proposed in the near future, but at this time no information regarding the environmental impacts are available, thus not included in **Table 6.5**.

OXEA Chemicals Bay City Plant Expansion

OXEA, a chemical manufacturer, began construction of a new world-scale propanol unit at its production site in Bay City in 2017; the unit is expected to come on stream in 2018 (BusinessWire 2017). This expansion project will create 19 new full-time, permanent jobs and will be an initial investment of $90 million with a total maximum investment of $250 million (Matagorda County EDC 2016). No environmental impacts from this project could be located for inclusion in **Table 6.5**.

STP Nuclear Operating Company Expansion

This electric generating company and Matagorda County's largest employer was granted license to build two new units in late 2015. Expansion plans are ongoing (Matagorda County EDC 2016). No environmental impacts from this project could be located for inclusion in **Table 6.5**.

Chocolate Bayou Wind Generation Project

The Chocolate Bayou Wind Generation Project is a proposed wind energy project to be located in Brazoria County (Cassell 2016). The project would include 65 wind turbines with a total net rating of 149.5 megawatts (MW). There is no firm commercial operation target date for the project. No environmental impacts from this project could be located for inclusion in **Table 6.5**.

Peyton Creek Wind Farm

The Peyton Creek Wind Farm is a proposed wind energy project to be located in southern Matagorda County (Reddell 2017). The project would include between 44 and 75 wind turbines on 12,000 to 15,000 leased acres south of Bay City that are currently used primarily for cattle and grazing. Construction of the project is expected to start in late 2018 and take 10 to 14 months. Up to 300 workers would be hired during construction; an estimated 10 full-time technical and mechanical jobs would be created by the project. No environmental impacts from this project could be located for inclusion in **Table 6.5**.

Various Roadway Improvement Projects

Several roadway improvement projects are planned for the area (Brazoria County 2016, TxDOT 2017a, 2017b, USACE 2012). However, because many of these projects are still in the planning stages, minimal information is available regarding their potential impacts; since no environmental impacts for these projects could be located, they are not included in **Table 6.5**.

Re-opening of San Bernard River Outlet

Brazoria County, as local sponsor, is proposing to re-open the San Bernard outlet to the Gulf of Mexico. The project is included in Texas' current Multi-year Implementation Plan for RESTORE Act funding. This project is considered a restoration project intended to restore the outlet and associated habitats.

6.23.7 Cumulative Impacts Discussion

This section provides a discussion of the potential cumulative impacts of the past, present, and reasonably foreseeable projects, combined with the BRFG and CRL Recommended Plan Alternatives. Each of the seven evaluation criteria are addressed.

Biological/Ecological Environment

Wetlands

The Recommended Plan would impact approximately 6.0 acres of wetlands at BRFG and 0.7 acre of wetlands at CRL. Most of these impacts would occur in the temporary bypass channels, and the USACE would provide mitigation for the impacted wetlands. Additional wetland habitat impacts over time are related to the Bryan Mound Strategic Petroleum Preserve, CenterPoint Energy electric transmission line,

45-foot Freeport Channel project, Freeport LNG, and Port Freeport modifications. From the 1950s to 2002, the Brazos Delta and surrounding area have shown a significant estuarine marsh loss trend. Losses can be attributed to erosion at the mouth of the diverted Brazos River, conversion to uplands due to early placement of dredged materials (e.g., the GIWW), agricultural land conversion, and residential and industrial development. Similar losses have occurred at the Colorado River and in Matagorda Bay and East Matagorda Bay. The BRFG and CRL projects, and the other projects identified in this analysis, are subject to Section 404 of the CWA and would therefore be required to avoid, minimize, and mitigate impacts to wetlands. As a result, no significant cumulative impacts to wetlands are anticipated as a result of the BRFG-CRL project.

Threatened and Endangered Species

None of the proposed projects included in this analysis are expected to adversely affect federally protected species, with the exception of some dredging activities associated with some of the projects that may affect sea turtles. Coordination with NMFS is required for these projects to avoid or minimize potential impacts to sea turtles during dredging operations; specific protective measures are engaged to prevent adverse impacts to the extent practicable. Any unavoidable impacts will be to individuals, within thresholds established by NMFS; therefore, the overall potential cumulative impacts are not expected to adversely impact sustainable populations. Furthermore, the BRFG-CRL project is not expected to have a significant contribution to impacts to these species.

Essential Fish Habitat

In general, placement of dredged material into open-water areas may affect food sources, increase turbidity, and release contaminants in EFH. Several projects compared in this analysis use ODMDS in construction and/or maintenance, potentially affecting EFH, albeit temporarily. Recovery of some benthic organisms would likely occur relatively quickly, although the assemblage in the dredged material might differ from the assemblage that existed prior to construction. Impacts to EFH from turbidity associated with ocean placement are not significant. If the material to be dredged is not contaminated, there would be no contamination issues with respect to EFH. Placement of dredged material associated with the projects included in this analysis would occur over time and would be subject to USACE and EPA permitting; therefore, it is reasonable to expect that dredged material placed into open-water sites would not contain contaminants. No significant cumulative impacts to EFH are anticipated.

Physical/Chemical Environment

Water Quality

For those projects that include dredging activities, dredging and placement operations are expected to temporarily degrade water quality in the project vicinity through increased turbidity and the release of nutrients from the sediment. No projects reviewed showed concerns with sediment contamination. Dredging and placement at proposed DMPAs and ODMDS may increase suspended solids, release contaminants and bound nutrients, and deplete oxygen. This impact is temporary and, except for turbidity, insignificant. If temporary degradation occurs, the study area should rapidly return to ambient conditions

upon completion of dredging. Although ship traffic in the study area may increase over time and due to some projects, this increase is expected to be offset by efficiency increases derived from those proposed.

Groundwater impacts may occur in two of the projects considered in this analysis; however, no groundwater impacts are foreseeable or expected from implementation of the BRFG-CRL Recommended Plan. With implementation of BMPs and other permitting requirements, no significant cumulative impacts to surface water quality or groundwater quality are expected.

Air Quality

Objectionable odors (e.g., hydrogen sulfide) may result from the dredging of maintenance sediments containing high concentrations of organic matter in those reviewed projects requiring dredging or digging into aquatic sediments. Current maintenance dredging activities (such as GIWW and Freeport Harbor Channel) and proposed projects that include dredging activities for construction would emit NO_X, CO, particulates, sulfur dioxides, and hydrocarbons. Part of the study area occurs within the HGB nonattainment area for ozone; therefore, all applicable projects in the study area with the potential to affect air quality must coordinate with TCEQ in regards to the SIP. This coordination should ensure compliance with the SIP, and thus the NAAQS, resulting in no significant cumulative impact to air quality.

The cause of global climate change is generally accepted to be the increased production of GHG emissions worldwide. Unlike criteria pollutant impacts, which are local and regional, climate change impacts occur at a global level. In addition, the relatively long lifespan and persistence of GHGs require that climate change be considered a cumulative and global impact. It is unlikely that an increase in global temperature or sea level could be directly attributed to the emissions resulting from a single project or combination of a few local projects. Rather, it is more appropriate to conclude that the GHG emissions associated with the BRFG-CRL Recommended Plan Alternatives, as well as the other projects considered herein, would combine with emissions across the U.S. and the globe to cumulatively contribute to global climate change.

Human Environment

Socioeconomic and Human Resources

The EO on Environmental Justice was instituted in 1994; therefore, several of the projects evaluated in the cumulative impacts analysis did not include this as a criterion. The BRFG-CRL project is expected to have an overall economic benefit, and many of the other projects discussed are also intended to provide economic benefits. Projects that are considered Federal actions are required to follow the EO on Environmental Justice. Therefore, no cumulative impacts to Environmental Justice communities are expected.

6.23.8 Conclusions

Cumulative impacts due to past, existing, and reasonably foreseeable future projects, along with the proposed BRFG-CRL improvements, are not expected to have significant adverse effects in the study area. Most of the resources considered in this analysis are not affected by any or are affected by very few of the projects, in minor (small areas, mitigated) and/or temporary (short-term, recoverable with conditions) ways:

threatened or endangered species, EFH, water quality, and air quality. Impacts associated with the BRFG-CRL project would be offset by mitigation measures.

7.0 APPLICABLE LAWS AND ENVIRONMENTAL REGULATIONS

Table 7.1 presents the status of compliance with environmental laws and regulations for the proposed action. The subsequent paragraphs discuss the laws and regulations.

Table 7.1 Relationship of Recommended Plan to Environmental Protection Statutes and Other Environmental Requirements

Policies	Compliance of Recommended Plan
Public Laws	
Clean Air Act, 1977, as amended	In Progress
Clean Water Act, 1972, as amended	In Progress
Coastal Zone Management Act, 1972, as amended	In Progress
Endangered Species Act, 1973, as amended	In Progress
Farmland Protection Policy Act	In Progress
Fish and Wildlife Coordination Act, 1958, as amended	In Progress
Magnuson-Stevens Fishery Conservation and Management Act	In Progress
Migratory Bird Treaty Act, 1918, as amended	Compliant
National Historic Preservation Act, 1966, as amended	In Progress
Coastal Barrier Resources Act of 1982, as amended	In Progress
Executive Orders	
Protection and Enhancement of Environmental Quality (EO 11514)	Compliant
Consultation with Indian Tribes (EO 13175)	In Progress
Environmental Justice (EO 12898)	Compliant
Floodplain Management (EO 11988)	Compliant
Protection of Wetlands (EO 11990)	Compliant
Invasive Species (EO 13112)	Compliant
Migratory Birds (EO 13186)	Compliant
Protection of Children (EO 13045)	Compliant

7.1 Federal laws

7.1.1 Clean Air Act of 1970 (Air Quality)

The CAA sets goals and standards for the quality and purity of air. It requires the EPA to set NAAQS for certain pollutants considered harmful to public health and the environment and requires federal agencies to act in conformity with an applicable SIP. The BRFG study area is located within the HGB Intrastate Air Quality Control Region, which is in attainment for all criteria pollutants except ozone (EPA 2017c, TCEQ 2017b). The HGB Ozone Nonattainment Area was classified as "severe" by the EPA in October 2008 under the 1997 eight-hour ozone NAAQS. As of July 2012, the EPA designated the HGB area as "marginal" for the 2008 ozone NAAQS based on major improvements in air quality for the area. In December 2016, the HGB area was reclassified as "moderate" ozone nonattainment for the 2008 ozone NAAQS, with an

attainment deadline of July 2018 (81 FR 90207). The CRL area is located in Matagorda County, which is in attainment for all criteria pollutants.

Since the BRFG facility is located in the HGB ozone moderate nonattainment area, calculations of projected pollutant emissions from construction are required in order to determine if they exceed the General Conformity de minimis threshold, which is 100 tpy for the ozone precursors NOx and VOCs (2008 8-hour standard), and require a General Conformity Determination. At the time this draft report was prepared, the BRFG Recommended Plan was not developed with enough detail to accurately estimate pollutant emissions. However, a qualitative estimate of potential emissions was made by comparing the BRFG Recommended Plan to the USACE Galveston District's ongoing reevaluation of the Freeport Harbor Channel Improvement Project (USACE 2017). That construction project, which involved 1,946,801 cubic yards of dredging, 4,300 feet of sheet pile installation, and 1-year construction duration, was projected to result in 115.31 tpy of NOx emissions and 2.61 tpy of VOC emissions. Of the projected NOx emissions, 106.83 tpy (93% of total) was from dredging and sheet pile placement, 8.07 tpy (7% of total) was from land side dredged material placement, and 0.42 (<1% of total) was from employee commuter vehicles.

In comparison, the BRFG Recommended Alternative involves an estimated 1,770,900 cubic yards dredging quantity, 1,140 feet of sheet pile installation, and 2-year construction duration. Based on these estimates, the emissions of NOx and VOCs may be similar to the Freeport Channel Harbor re-evaluation estimates, but would occur over a 2-year construction period instead of a 1-year period. Based on this qualitative analysis, NOx emissions from the BRFG Recommended Plan are not expected to exceed the 100 tpy de minimis threshold and is exempt from a General Conformity Determination. Once the Recommended Plan has been further refined after the ADM, emissions will be calculated and coordinated with the TCEQ and EPA to verify that emissions are below de minimis and a conformity determination is not needed.

7.1.2 Clean Water Act of 1972 – Section 401 (Water Quality)

The CWA sets and maintains goals and standards for water quality and purity. Section 401 requires a Water Quality Certification from the TCEQ that a proposed project does not violate established effluent limitations and water quality standards. The Recommended Plan will incorporate BMPs such as silt fences to reduce suspended solids from land runoff, as well as turbidity screens or silt collection curtains as needed around construction equipment to reduce the amount of sediment entrained in the water. The USACE will coordinate the Section 404(b)(1) evaluation provided in **Attachment D-1** with the TCEQ to obtain Section 401 Water Quality Certification, and will include the water quality certification in the final report.

7.1.3 Clean Water Act of 1972 – Section 404(b)(1) (Disposal Sites for Dredged or Fill Material)

The USACE administers regulations under Section 404(b)(1) of the CWA, which establishes a program to regulate the discharge of dredged and fill material into waters of the U.S. Potential project-induced impacts subject to these regulations were evaluated during feasibility level design, and a draft 404(b)(1) is included in **Attachment D-1**. Compared to other alternatives that meet the project's purpose and need, the Recommended Plan at the BRFG and CRL facilities minimizes impacts to wetlands and other water resources; as such, the Recommended Plan is the least environmentally damaging practicable alternative.

The USACE has prepared a mitigation plan to offset wetland impacts, which is described in Section 8.0. A Section 404 Public Notice will be prepared and distributed for public and agency review, and a final 404(b)(1) evaluation will be included in the final report.

7.1.4 Coastal Zone Management Act of 1972 (Coastal Zone Development)

The Coastal Zone Management Act establishes a partnership structure allowing states and the Federal government to work together for the protection of U.S. coastal zones from environmentally harmful over-development. Potential project-induced impacts were evaluated during feasibility level design and are described in a Consistency Determination that is included in **Attachment D-4**. The USACE has determined that the Recommended Plan complies with the Texas Coastal Management Program and will be conducted in a manner consistent with all rules and regulations of the program. The USACE will coordinate the Consistency Determination with the GLO, and the results of consultation will be provided in the final report.

7.1.5 Endangered Species Act of 1973 (Threatened and Endangered Species)

The ESA is designed to protect and recover threatened and endangered species of fish, wildlife, and plants. The Galveston District is coordinating with the USFWS and NMFS to ensure the protection of those listed species under their respective jurisdictions. The USFWS has previously identified several threatened and endangered species that are either known to or may possibly occur in the project area: piping plover, red knot, and sea turtles. No plants were identified as being threatened or endangered in the project area. Based on review of existing data and initial informal consultation with the USFWS, the Galveston District finds that implementation of the Recommended Plan may affect, but would not likely adversely affect, any listed species or their critical habitat. During further project design and in consultation with USFWS and NMFS, the USACE will refine construction methods and incorporate BMPs to minimize impacts and ensure that the project will not adversely affect any T&E species. The USACE has prepared a Biological Assessment, which is included in **Attachment D-2** and will be submitted to the USFWS and NMFS for review. The results of USFWS and NMFS consultation will be provided in the final report.

7.1.6 Fish and Wildlife Coordination Act of 1934 (Fish & Wildlife)

The FWCA provides authority for USFWS involvement in evaluating impacts to fish and wildlife from proposed water resource development projects. It requires that fish and wildlife resources receive the same consideration as other project features. It requires Federal agencies that construct, license or permit water resource development projects to first consult with the USFWS, NMFS, and state resource agencies regarding the impacts on fish and wildlife resources and measures to mitigate these impacts. Section 2(b) requires the USFWS to produce a Coordination Act Report (CAR) that details existing fish and wildlife resources in the project area, potential impacts due to the proposed project and recommendations for the project. The USACE has coordinated with the USFWS, as well as NMFS and TPWD, regarding habitat and other fish and wildlife resources. The primary concern brought forth during meetings with the agencies was to minimize impacts to wetlands. A draft CAR will be submitted by the USFWS and include the USFWS positions and recommendations.

7.1.7 Magnuson-Stevens Fishery Conservation and Management Act of 1976 and The Magnuson-Stevens Act Reauthorization of 2006 (Essential Fish Habitat)

The Magnuson-Stevens Act and its reauthorization govern marine fisheries management in the U.S. Specific categories of EFH occurring in the project area include estuarine emergent wetlands, estuarine water column and estuarine mud substrate (bottom). These habitats provide EFH to three Federally-managed estuarine/marine species that are commonly to abundantly found in the project area: brown shrimp, white shrimp, and red drum. Waterbodies and wetlands provide nursery and foraging habitats for a variety of fish species, some of which may serve as prey for other fish species designated as EFH species (e.g., mackerel, snapper, and grouper) and highly migratory fishes (e.g., billfish and sharks). The Galveston District has assessed the effects of the project on EFH and determined that the Recommended Plan would have short-term, localized, and minor adverse effects on EFH for shrimp and red drum because of substrate disturbances and loss of prey during construction and maintenance dredging. The Recommended Plan includes mitigation for EFH habitats, thus is not expected to result in permanent adverse effects to EFH. The USACE will coordinate the EFH assessment prepared for the project (**Attachment D-3**) with NMFS and include the results of coordination in the final report.

7.1.8 Marine Mammal Protection Act of 1972 (Marine Mammals)

The MMPA protects whales, dolphins, sea lions, seals, manatees, and other species of marine mammals. Whales, sea lions, and seals do not occur in the study areas. Dolphins are known to occur in the study areas. Manatees may rarely be found in the study areas. The proposed construction at the BRFG facility is expected to entail pile driving of new sheet pile to install the proposed east floodgate, which may adversely affect bottlenose dolphins. The Recommended Plan would minimize activities that could affect dolphins, incorporate BMPs to minimize impacts, conduct training, and adhere to the MMPA. The USACE will consult with NMFS on the potential effects and secure an Incidental Take Authorization prior to conducting activities such as pile driving that may affect dolphins.

7.1.9 Migratory Bird Treaty Act of 1918 and Migratory Bird Conservation Act of 1929 (Migratory Birds)

The MBTA and the Migratory Bird Conservation Act protect migratory birds and their habitat. The marsh, tidal flats, and uplands woods within the study areas provide habitat for migratory birds. The BRFG/CRL will be monitored for nesting and feeding migratory birds and activities would be temporally be modified to avoid take of migratory birds. Clearing of vegetation will be completed outside of the nesting season (March 1 to August 31), if possible. If clearing of vegetation is required during nesting season, nest surveys will be completed prior to ground disturbance. The USFWS has previously indicated that areas near the project area may support colonial-nesting water birds (e.g., herons, egrets, ibis, night-herons, anhingas, and roseate spoonbills). The Galveston District would conduct preconstruction surveys for colonial nesting birds, and if colonies are found, would adjust the timing of construction activities so that impacts to the nesting birds are avoided.

7.1.10 National Historic Preservation Act of 1966 (Cultural and Historic Resources)

In compliance with Section 106 of the NHPA and 36 CFR §800, Federal agencies are required to identify and consider the potential effects that their undertakings might have on significant historic properties, districts, sites, buildings, structures, or objects that are included in or eligible for inclusion in the NRHP. Additionally, a Federal agency shall consult with any federally-recognized tribe that attaches religious and cultural significance to such properties. Agencies shall afford the SHPO and tribes a reasonable opportunity to comment before decisions are made.

Although several archeological surveys have been conducted in the BRFG and CRL study areas, no previously recorded archeological sites are within the study areas. The nearest recorded sites are 0.5 mile from the BRFG and 0.2 mile from the CRL. Much of the BRFG/CRL study areas have been previously disturbed by previous excavations of the GIWW, diversion of the Brazos and Colorado Rivers, and construction of the BRFG and CRL. Therefore potential for discovering cultural or archeological resources is low.

The BRFG and CRL facilities are historic-age resources (e.g., more than 50 years old) but were determined to be not eligible for listing in the National Register. No National Register-eligible resources have been identified in the Area of Potential Effect for the project, and the Recommended Plan is not expected to adversely affect cultural resources. The USACE is coordinating this determination with the SHPO, and the results of consultation will be included in the final report.

7.1.11 Coastal Barrier Resources Act of 1982 (Coastal Barriers)

The CBRA was enacted in 1982 to discourage development in certain coastal areas that are vulnerable to hurricane damage and are host to valuable natural resources. The CBRA designated certain undeveloped coastal areas ineligible for most new Federal expenditures and financial assistance. The recommended plan would affect designated coastal barrier resources but, consistent with the CBRA, is not expected to change development rates or patterns or induce growth on barrier islands. The recommended plan is consistent with CBRA because under Section 6 a Federal expenditure is allowable within CBRS when funds are used to maintain or construct improvements to existing federal navigation channels, such as the GIWW (16 USC 305(a)(2)). The GIWW was authorized long before the CBRA was enacted in 1982 and the CBRS units in the study areas were designated. The USACE will coordinate with the USFWS regarding the CBRA, and the results of this coordination will be provided in the final report.

7.2 Executive Orders

7.2.1 Executive Order 11514, Protection and Enhancement of Environmental Quality

EO 11514 directs Federal agencies to "initiate measures needed to direct their policies, plans and programs so as to meet national environmental goals." The Recommended Plan was developed considering environmental impacts and minimizes environmental impacts compared to other alternatives that meet the project purpose and need. Impacts to sensitive habitats (wetlands) as a result of the recommended plan will be mitigated. The Recommended Plan complies with EO 11514.

7.2.2 Executive Order 13175 - Consultation and Coordination with Indian Tribal Governments (Tribal Interests)

In partial fulfillment of EO 13175, in addition to NEPA and NHPA Section 106, consultation will be initiated with the following Federally-recognized Tribes: Alabama-Coushatta Tribe of Texas, Comanche Nation of Oklahoma, Kiowa Tribe of Oklahoma, Tonkawa Tribe of Oklahoma, Caddo Nation of Oklahoma, Coushatta Tribe of Louisiana. Correspondence will be included in the final report.

7.2.3 Executive Order 11988, Floodplain Management

EO 11988 directs agencies to avoid development in floodplains to the maximum extent feasible. All alternatives considered, including alternatives eliminated from detailed consideration in DIFR-EIS would be located at existing facilities within the base floodplain. No non-floodplain alternatives exist. The recommended plan is not expected to alter base flood elevations and complies EO 11988.

7.2.4 Executive Order 11990, Protection of Wetlands

EO 11990 directs Federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the destruction or modification of wetlands, and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative. Of the alternatives that meet the purpose and need of the project, the Recommended Plan minimizes impacts to wetlands. Impacts to wetlands were minimized by designing the recommended plan to remain on the existing GIWW alignment. Mitigation planning was integrated into the feasibility study by considering, individually and collectively, each of the CWA mitigation actions of avoiding, minimizing, reducing, and rectifying potential adverse impacts to wetlands to the extent practicable. The Recommended Plan would involve compensatory mitigation for wetland impacts and complies with EO 11990.

7.2.5 Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

EO 12898 requires agencies to make achieving environmental justice (EJ) part of their missions by identifying and addressing disproportionately high and adverse human health or environmental effects of programs, policies and activities on minority populations and low-income populations. The BRFG and CRL are located outside of city limits and no population centers or residences are located within the study area. The proposed action complies with EO 12898.

7.2.6 Executive Order 13112, Invasive Species

EO 13112 directs Federal agencies to prevent the introduction of invasive species; provide for their control; and minimize the economic, ecological and human health impacts that invasive species cause. The Recommended Plan is consistent with EO 13112 to the extent practicable and permitted by law. Efforts will be made to ensure that invasive species do not spread by cleaning earth moving equipment before soil disturbance activities and planting native species for the restoration of BRFG/CRL project lands and mitigation areas.

7.2.7 Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds

EO 13186 directs Federal agencies to take actions to further implement the MBTA. The Recommended Plan has been evaluated for potential effects on migratory birds, with emphasis on species of concern. The BRFG/CRL will be monitored for nesting and feeding migratory birds and activities would be temporally modified if needed to avoid take of migratory birds.

7.2.8 Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks, as amended by EO 13229 and EO 13296.

These EOs require each Federal agency to ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks. No disproportionate environmental health risks or safety risks to children, as defined in EO 13045, are expected from implementation of the Recommended Plan.

8.0 MITIGATION ANALYSIS

The CEQ and NEPA guidelines state that damages to fish and wildlife resources should be prevented to the extent practicable through planning, design, and incorporating mitigation measures. For USACE projects, mitigation plans should be the most efficient and least costly measures appropriate to reduce fish and wildlife resource losses. If project lands cannot fulfill mitigation requirements, then separable public lands adjacent to project lands, to the extent possible, should be considered for acquisition. Subsection 906(a) of the Water Resource Development Act (WRDA) of 1986 requires that the USACE maintain the power of eminent domain, which is the right to take private property for public use. The intent is to maintain the integrity and viability of significant natural resources and their contributions to local or regional ecosystems by applying sound ecosystem management techniques.

The ultimate goal of the USACE Mitigation Policy is to avoid significant areas, such as wetlands and critical habitat (Resource Category 1); avoid or replace in-kind, such as Riparian Bottomland Hardwoods (Resource Category 2 Areas); minimize impacts while providing no net loss of habitat for areas such as upland hardwoods (Resource Category 3 areas); and minimize impacts and habitat loss for areas such as successional grassland/old field or active pasture lands (Resource Category 4 areas). Generally, these goals can be accomplished by avoiding negative impacts, restoring impacted areas, compensating for impacts by creating or improving habitats at a different location, or through a combination of these measures. The areas determined to have the greatest potential for mitigation projects yielding the greatest habitat value increase include riparian bottomland hardwoods and wetlands.

As described in the Existing Conditions and Environmental Consequences sections, none of the upland or open water habitats impacted by the Recommended Plan at BRFG and CRL are considered significant because most are associated with the GIWW or DMPAs and do not contain significant resources. Therefore, mitigation is not required or proposed for upland or open water habitats. Wetland impacts would occur at each facility, including an estimated 3.7 acres of high marsh and 2.3 acres of tidal marsh at BRFG and 0.7 acre of intertidal marsh at CRL. The following sections describe proposed mitigation for wetland impacts.

8.1 Wetland Mitigation

The USACE PDT evaluated wetland mitigation options to develop a mitigation plan to offset the projected wetland habitat losses that would result from the Recommended Plan. To ensure that the mitigation plan would adequately compensate for wetland losses, the USACE compared average annual benefits of the mitigation project, in terms of Average Annual Habitat Units (AAHU) determined through the IWR Planning Suite annualizer, to the AAHUs under the FWOP Condition. The AAHUs provided by the mitigation project were calculated and compared to the FWOP Condition in the following stepwise process:

1. Baseline HSIs for the existing wetland habitats within the study areas were calculated through on-site surveys conducted by an interagency biological team in February and March 2017. Average HSIs for each habitat type were calculated by averaging the HSIs across wildlife indicator species and representative data-collection points. Habitat units (HU) provided by each habitat type were then calculated by multiplying the average HSI for the habitat type by the number of acres of the habitat type that are present in the study area.

2. For the FWOP Condition (No Action Alternative), HUs were calculated over a 50-year analysis period and annualized using the annualizer in the IWR Planning Suite to determine AAHUs.

3. Similarly, AAHUs under the Future With Project Condition (Recommended Plan) were calculated, considering the areas of wetland habitats removed by the Recommended Plan.

4. To predict future habitat values *with* the implementation of mitigation, the interagency team met to predict future habitat values for each wildlife indicator species and habitat. From this effort, future HSIs were calculated for each habitat type, and HUs were calculated over the 50-year analysis period and annualized using the annualizer in the IWR Planning Suite to determine AAHUs for the mitigation scenarios.

The following discusses the analysis conducted in each step and the results.

8.1.1 Step 1: Baseline HSIs for Existing Wetland Habitats

From Step 1 above, **Table 8.1** summarizes existing wetland habitats in terms of acres and HUs. A detailed discussion of the habitat evaluations conducted is provided in the Existing Conditions section of this report.

Table 8.1 Average HSI Values and Habitat Units for Existing Wetland Habitats in the BRFG and CRL Study Areas

Habitat Type	Acreage	HSI Average	Habitat Units
BRFG			
High Marsh	125.2	1.00	125.20
Intertidal Marsh	13.9	0.80	11.12
Tidal Flat	3.0	0.80	2.40
CRL			
High Marsh	32.0	0.25	8.00
Intertidal Marsh	4.5	0.83	3.74

8.1.2 Step 2: FWOP Condition AAHUs

Through Step 2 above, AAHUs were calculated for each wetland habitat type under the FWOP Condition, or "No Action" Alternative. Under the FWOP Condition, no improvements would be made to the BRFG or CRL facilities, although the USACE will continue to perform normal O&M activities and natural ecological processes will continue to occur in the study areas. For the FWOP analysis, existing wetland habitats were assumed to maintain, and not degrade, over the 50-year analysis period. Although climate change, sea level rises, and periodic major storm events may affect wetland habitats over the analysis period, these effects are expected to be similar under the FWOP Condition and the Future With Project Condition. Based on this assumption, the HUs were calculated for the FWOP Condition over the 50-year analysis period and annualized using the annualizer in the IWR Planning Suite to determine AAHUs. The following summarizes the results for each habitat in the BRFG study area and CRL study area, respectively.

BRFG – Wetland Habitat Calculations under the FWOP Condition

Wetland habitats within the BRFG study area include 125.2 acres of high marsh (21 percent of the study area), 13.9 acres of intertidal marsh (2 percent of the study area), and 3.0 acres of tidal flats (0.5 percent of the study area). **Tables 8.2 through 8.4** provide, for each of these wetland habitat types, the AAHUs over the 50-year period of analysis, as well as the calculations of the size and quality of each wetland habitat type in the study area for 1-, 5-, 10-, 25-, and 50-year without-project conditions.

Table 8.2 BRFG FWOP Condition: *High Marsh* Habitat Calculation of HUs and AAHUs

	Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
High Marsh	HSI	1.00	1.00	1.00	1.00	1.00	1.00		
	Acres	125.2	125.2	125.2	125.2	125.2	125.2		
	Target Year HU	125.20	125.20	125.20	125.20	125.20	125.20		
	Interval HU		125.20	500.80	626.00	1878.00	3130.00	6260.00	125.20

Table 8.3 BRFG FWOP Condition: *Intertidal Marsh* Habitat Calculation of HUs and AAHUs

	Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
Intertidal Marsh	HSI	0.80	0.80	0.80	0.80	0.80	0.80		
	Acres	13.9	13.9	13.9	13.9	13.9	13.9		
	Target Year HU	11.12	11.12	11.12	11.12	11.12	11.12		
	Interval HU		11.12	44.48	55.60	166.80	278.00	556.00	11.12

Table 8.4 BRFG FWOP Condition: *Tidal Flat* Habitat Calculation of HUs and AAHUs

	Target Year	0	1	5	10	25	50	Cumulative HU	AAHU
	Interval (years)	0	1	4	5	15	25		
Tidal Flat	HSI	0.80	0.80	0.80	0.80	0.80	0.80		
	Acres	3.0	3.0	3.0	3.0	3.0	3.0		
	Target Year HU	2.40	2.40	2.40	2.40	2.40	2.40		
	Interval HU		2.40	9.60	12.00	36.00	60.00	120.00	2.40

CRL – Wetland Habitat Calculations under the FWOP Condition

Wetland habitats within the CRL study area include 32.0 acres of high marsh (8 percent of the study area) and 4.5 acres of intertidal marsh (1 percent of the study area). **Tables 8.5 and 8.6** provide, for each wetland habitat type, the AAHUs over the 50-year period of analysis, as well as calculations of the size and quality of each wetland habitat type in the study area for 1-, 5-, 10-, 25-, and 50-year without-project conditions.

Table 8.5 CRL FWOP Condition: *High Marsh* Habitat Calculation of HUs and AAHUs

	Target Year	0	1	5	10	25	50	Cumulative HU	AAHU
	Interval (years)	0	1	4	5	15	25		
High Marsh	HSI	0.25	0.25	0.25	0.25	0.25	0.25		
	Acres	32.0	32.0	32.0	32.0	32.0	32.0		
	Target Year HU	8.00	8.00	8.00	8.00	8.00	8.00		
	Interval HU		8.00	32.00	40.00	120.00	200.00	400.00	8.00

Table 8.6 CRL FWOP Condition: *Intertidal Marsh* Habitat Calculation of HUs and AAHUs

	Target Year	0	1	5	10	25	50	Cumulative HU	AAHU
	Interval (years)	0	1	4	5	15	25		
Intertidal Marsh	HSI	0.83	0.83	0.83	0.83	0.83	0.83		
	Acres	4.5	4.5	4.5	4.5	4.5	4.5		
	Target Year HU	3.74	3.74	3.74	3.74	3.74	3.74		
	Interval HU		3.74	14.96	18.70	56.10	93.50	187.00	3.74

Summary of Habitat Calculations under the FWOP Condition

Based on the above FWOP analysis, **Table 8.7** summarizes the anticipated acres of wetland habitat types and associated AAHUs in the BRFG and CRL study areas under the FWOP Condition.

Table 8.7 Summary of Acres and AAHUs under the FWOP Condition

Habitat Type	Existing Acres	Existing AAHUs
BRFG		
High Marsh	125.2	125.20
Intertidal Marsh	13.9	11.12
Tidal Flat	3.0	2.40

Table 8.7 Summary of Acres and AAHUs under the FWOP Condition

Habitat Type	Existing Acres	Existing AAHUs
CRL		
High Marsh	32.0	8.00
Intertidal Marsh	4.5	3.74

8.1.3 Step 3: Future With Project AAHUs

Through Step 3, AAHUs were calculated for each wetland habitat type under the Future With Project Condition, e.g., implementing the Recommended Plan. The Recommended Plan includes implementing Alternative 3a.1 (Open Channel West/East Gate Relocation) at the BRFG facility and Alternative 4b.1 (Removal of Riverside Gates) at the CRL facility. At the BRFG facility, the Recommended Plan would remove the existing 75-foot-wide east and west floodgates, construct new 125-foot-wide floodgates on the east side of the Brazos River, and construct new wing walls and guide walls for the east floodgates. The new east floodgates would be on the existing GIWW alignment and set back from the Brazos River compared to the existing floodgates to provide a longer approach channel. The Recommended Plan would include an open channel west of the river; therefore, no new floodgates would be constructed west of the river. To allow navigation through the area during construction, a temporary bypass channel would be constructed on the south side of the existing channel.

At the CRL, the Recommended Plan would remove the existing riverside (inner) gates east and west of the Colorado River and rehabilitate the existing GIWW-side (outer) 75-foot-wide gates. To allow navigation through the area during construction, a temporary bypass channel would be constructed on the south side of the existing channel.

Table 8.8 summarizes the anticipated wetland habitat changes in the study areas under the Recommended Plan. Overall, approximately 6.0 acres of wetland habitat would be lost at the BRFG and 0.7 acre of wetland habitat would be lost at the CRL. For each study area, HUs were calculated for the Future With Project Condition over the 50-year analysis period and annualized using the annualizer in the IWR Planning Suite to determine AAHUs. The following summarizes the results.

Table 8.8 Summary of Wetland Habitat Changes Under Recommended Plan

Habitat Type	Existing Area (acres)	Future With Project Conditions in Study Areas under the Recommended Plan (acres)	Change in Habitat under Recommended Plan (acres)
BRFG			
High Marsh	125.2	121.5	-3.7
Intertidal Marsh	13.9	11.6	-2.3
Tidal Flat	3.0	3.0	0
CRL			
High Marsh	32.0	32.0	0
Intertidal Marsh	4.5	3.8	-0.7

BRFG – Wetland Habitat Calculations for Future With Project Condition (Recommended Plan)

The Recommended Plan would result in the loss of 3.7 acres of high marsh and 2.3 acres of intertidal marsh at the BRFG; no impacts to tidal flats would occur. **Tables 8.9 through 8.11** provide, for each wetland type in the study area, the AAHUs over the 50-year period of analysis, as well as the calculations of the size and quality of each wetland habitat type in the study area for 1-, 5-, 10-, 25-, and 50-year with project conditions.

Table 8.9 BRFG Future With Project Condition: *High Marsh* Calculation of HUs and AAHUs

	Target Year	0	1	5	10	25	50		
	Interval (years)	0	1	4	5	15	25	Cumulative HU	AAHU
High Marsh	HSI	1.00	1.00	1.00	1.00	1.00	1.00		
	Acres	121.5	121.5	121.5	121.5	121.5	121.5		
	Target Year HU	121.50	121.50	121.50	121.50	121.50	121.50		
	Interval HU		121.50	486.00	607.50	1822.50	3037.50	6075.00	121.50

Table 8.10 BRFG Future With Project Condition: *Intertidal Marsh* Calculation of HUs and AAHUs

	Target Year	0	1	5	10	25	50		
	Interval (years)	0	1	4	5	15	25	Cumulative HU	AAHU
Intertidal Marsh	HSI	0.80	0.80	0.80	0.80	0.80	0.80		
	Acres	11.6	11.6	11.6	11.6	11.6	11.6		
	Target Year HU	9.28	9.28	9.28	9.28	9.28	9.28		
	Interval HU		9.28	37.12	46.40	139.2	232.00	464.00	9.28

Table 8.11 BRFG Future With Project Condition: *Tidal Flat* Calculation of HUs and AAHUs

	Target Year	0	1	5	10	25	50		
	Interval (years)	0	1	4	5	15	25	Cumulative HU	AAHU
Tidal Flat	HSI	0.80	0.80	0.80	0.80	0.80	0.80		
	Acres	3.0	3.0	3.0	3.0	3.0	3.0		
	Target Year HU	2.40	2.40	2.40	2.40	2.40	2.40		
	Interval HU		2.40	9.60	12.00	36.00	60.00	120.00	2.40

CRL – Wetland Habitat Calculations for Future With Project Condition (Recommended Plan)

The Recommended Plan would result in the loss of 0.7 acre of intertidal marsh at the CRL; no impacts to high marsh would occur. **Tables 8.12 and 8.13** provide, for each wetland habitat type in the study area, the AAHUs over the 50-year period of analysis, as well as the calculations of the size and quality of each wetland habitat type in the study area for 1-, 5-, 10-, 25-, and 50-year with project conditions.

Table 8.12 CRL Future With Project Conditions: *High Marsh* Habitat Calculation of HUs and AAHUs

	Target Year	0	1	5	10	25	50	Cumulative HU	AAHU
	Interval (years)	0	1	4	5	15	25		
High Marsh	HSI	0.25	0.25	0.25	0.25	0.25	0.25		
	Acres	32.0	32.0	32.0	32.0	32.0	32.0		
	Target Year HU	8.00	8.00	8.00	8.00	8.00	8.00		
	Interval HU		8.00	32.00	40.00	120.00	200.00	400.00	8.00

Table 8.13 CRL Future With Project Conditions: *Intertidal Marsh* Habitat Calculation of HUs and AAHUs

	Target Year	0	1	5	10	25	50	Cumulative HU	AAHU
	Interval (years)	0	1	4	5	15	25		
Intertidal Marsh	HSI	0.83	0.83	0.83	0.83	0.83	0.83		
	Acres	3.8	3.8	3.8	3.8	3.8	3.8		
	Target Year HU	3.15	3.15	3.15	3.15	3.15	3.15		
	Interval HU		3.15	12.60	15.75	47.25	78.75	157.50	3.15

Summary of Wetland Habitat Calculations for Future With Project Condition (Recommended Plan)

In summary, the Recommended Plan will remove about 6.0 acres of wetland habitats at the BRFG site and 0.7 acre at the CRL site. As a result, the project will reduce AAHUs in the study areas compared to existing and FWOP conditions. **Tables 8.14** summarizes the anticipated habitat changes within each study area.

Table 8.14 Comparison of Acres and AAHUs under FWOP Condition and Future With Project Condition (50-year period of analysis)

Habitat Type	Existing/FWOP Acres	Existing/FWOP AAHUs	Future with Project Acres	Future with Project AAHUs	Net Acres	Net AAHUs
BRFG						
High Marsh	125.2	125.20	121.5	121.50	-3.7	-3.70
Intertidal Marsh	13.9	11.12	11.6	9.28	-2.3	-1.84
Tidal Flat	3.0	2.40	3.0	2.40	0	0
CRL						
High Marsh	32.0	8.00	32.0	8.00	0	0
Intertidal Marsh	4.5	3.74	3.8	3.15	-0.7	-0.59

8.1.4 Step 4: Future AAHUs with Mitigation

In Step 4, future habitat values with the implementation of mitigation were projected to ensure that a mitigation plan would adequately compensate for wetland losses. To predict future habitat values of a potential mitigation site, the interagency team met to discuss the anticipated progression of a created wetland in terms of the habitat variables in the HSI models for the wildlife indicator species for each of the

wetland habitats that would be impacted by the Recommended Plan and thus created by a mitigation plan: high marsh and intertidal marsh. These data were input into the HSI models and future HSIs were calculated for each created habitat type at each project site (BRFG and CRL). The HSIs were annualized over the 50-year analysis period using the annualizer in the IWR Planning Suite.

BRFG – Habitat Calculations for Created High Marsh

High marsh habitat created in the BRFG study area is expected to result in an average annual HSI (AAHSI) of 0.98 over the 50-year period of analysis. Based on this AAHSI value, 3.78 acres of created high marsh would be needed to provide sufficient HUs to compensate for the 3.7 acres of high marsh loss due to the Recommended Plan. **Table 8.15** shows the anticipated HSI values at a BRFG high marsh mitigation site over the 50-year life of the project and provides a calculation of the mitigation needs.

Table 8.15 BRFG On-site Mitigation: Projected Conditions for High Marsh Creation

Target Year	**0**	**1**	**5**	**10**	**25**	**50**		
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**	**Cumulative HSI**	**AAHSI**
HSI	0.00	0.79	1.00	1.00	1.00	1.00		
Interval HSI		0.40	3.58	5.00	15.00	25.00	48.98	0.98
Mitigation Needs:	AAHU = 3.70							
	AAHSI = 0.98							
	Acres Needed for Mitigation = AAHU / AAHSI = 3.70/0.98 = **3.78 acres**							

BRFG – Habitat Calculations for Created Intertidal Marsh

Intertidal marsh habitat created in the BRFG study area is expected to result in an AAHSI of 0.82 over the 50-year period of analysis. Based on this AAHSI value, 2.24 acres of created intertidal marsh would be needed to provide sufficient HUs to compensate for the 2.3 acres of intertidal marsh loss due to the Recommended Plan. **Table 8.16** shows the anticipated HSI values at a BRFG intertidal marsh mitigation site over the 50-year life of the project and provides a calculation of the mitigation needs.

Table 8.16 BRFG On-site Mitigation: Projected Conditions for Intertidal Marsh Creation

Target Year	**0**	**1**	**5**	**10**	**25**	**50**		
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**	**Cumulative HSI**	**AAHSI**
HSI	0.05	0.63	0.84	0.84	0.84	0.84		
Interval HSI		0.34	2.94	4.20	12.60	21.00	41.08	0.82
Mitigation Needs:	AAHU = 1.84							
	AAHSI = 0.82							
	Acres Needed for Mitigation = AAHU / AAHSI = 1.84/0.82 = **2.24 acres**							

CRL – Habitat Calculations for Intertidal Marsh Creation

Intertidal marsh habitat created in the CRL study area is expected to result in an AAHSI of 0.80 over the 50-year period of analysis. Based on this AAHSI value, 0.74 acre of created intertidal marsh would be needed to provide sufficient HUs to compensate for the 0.7 acre of intertidal marsh loss due to the

Recommended Plan. **Table 8.17** shows the anticipated HSI values at a CRL intertidal marsh mitigation site over the 50-year life of the project and provides a calculation of the mitigation needs.

Table 8.17 CRL Mitigation Site: Projected Conditions for Intertidal Marsh Mitigation

Target Year	0	1	5	10	25	50	Cumulative HSI	AAHSI
Interval (years)	0	1	4	5	15	25		
HSI	0.05	0.46	0.70	0.75	0.87	0.87		
Interval HSI		0.26	2.32	3.63	12.15	21.75	40.11	0.80
Mitigation Needs:	AAHU = 0.59							
	AAHSI = 0.80							
	Acres Needed for Mitigation = AAHU / AAHSI = 0.59/0.80 = **0.74 acre**							

Summary of Habitat Calculations for Created Wetland Habitats and Resulting Mitigation Needs

Based on predicted habitat values of created high marsh and intertidal marsh in the study areas, 6.76 acres of marsh creation is needed to sufficiently offset the 6.7 acres of marsh habitats that would be impacted by the Recommended Plan. The 6.76 acres of created marsh would provide an estimated 6.13 AAHUs, which would replace the AAHUs that would be lost as a result of the project (**Table 8.18**).

Table 8.18 Wetland Habitats Impacted by the Recommended Plan and Mitigation Needs

Habitat Type	Average Baseline HSI (Annualized)	Acres Lost	AAHUs Lost	Projected Mitigation HSI (Annualized)	AAHU Needed	Acres Needed
BRFG						
High Marsh	1.00	3.7	3.70	0.98	3.70	**3.78**
Intertidal Marsh	0.80	2.3	1.84	0.82	1.84	**2.24**
CRL						
Intertidal Marsh	0.83	0.7	0.58	0.80	0.58	**0.74**
Total for Both Project Sites	**--**	***6.7***	***6.12***	**--**	***6.12***	***6.76***

8.1.5 Mitigation Alternatives Screening

The USACE considered three alternatives for meeting the identified mitigation needs, two of which had three different planting options/scales. The mitigation alternatives considered included:

1. Purchase mitigation bank credits
2. Establish wetlands off-site with the following planting scales:
    - Plugs purchased
    - Plugs collected on site
    - Seeded pots of marsh vegetation
3. Establish wetlands on-site with the following planting scales
    - Plugs purchased
    - Plugs collected on site
    - Seeded pots of marsh vegetation

The mitigation alternatives were screened based on high-level constraints and comparisons. Purchasing mitigation bank credits was screened out because, based on the USACE's Regulatory In-lieu Fee and Bank Information Tracking Information System (RIBITS) website (USACE 2017c), the BRFG and CRL project sites are not within the service area of any active or pending mitigation bank or in lieu fee program that has tidal marsh credits. Therefore, wetland mitigation cannot be accomplished through mitigation bank or in lieu fee program credits. In addition, a sensitivity analysis was conducted, and mitigation bank costs are expected to be an order of magnitude more costly than the on-site mitigation alternative.

Establishing wetlands off-site was also screened out because the projected benefits would be the same as establishing wetlands on site, but the off-site mitigation alternative would result in the addition of real estate costs.

Based on the initial screening, one mitigation alternative was evaluated in further detail: establish wetlands on-site with three planting scales. As noted above, the three planting scales include (1) plugs purchased, (2) plugs collected on site, and (3) seeded pots of marsh vegetation. Leaving the created wetlands to vegetate on their own was not considered because interagency coordination indicated that, if left unplanted, the mitigation areas would establish vegetation very slowly, with a projected 10 percent coverage in 5 years compared to an expected 75 to 100 percent coverage if planted. The analysis of the on-site mitigation alternative assumes that the three planting scales would produce the same habitat benefits (AAHUs); however, the planting scales would affect mitigation cost. As a result, the on-site mitigation options were evaluated using cost effective/incremental cost analysis using the IWR Planning Suite (version 1.0.11). **Table 8.19** provides the preliminary cost estimates for each planting scale.

Table 8.19 Preliminary Cost Estimates for On-site Planting at Three Scales

Planting Scale	Cost per Plug	# Plugs/ Acre	Plug Cost/ Acre	Planting Cost/ Acre	OMRRR Cost/ Acre[1]	Total Cost/ Acre[2]	Total Mitigation Cost[3]	Average Annual Cost/Acre
Plugs purchased	$3.00	12,575	$37,725	$20,000	$2,500	$60,225	$407,121	$2,685
Plugs on-site	$1.00	12,575	$12,575	$20,000	$2,500	$35,075	$237,107	$1,676
Seeded nursery	$10.00	12,575	$125,750	$20,000	$2,500	$148,250	$1,002,170	$6,215

[1] OMRR&R = Operations, Maintenance, Repair, Replacement, and Rehabilitation. Because the mitigation sites should be self-sustaining after the success criteria are met, OMRR&R costs should be minimal.
[2] Note that these costs assume that site prep would be done through the dredged material placement.
[3] Total mitigation cost is based on a total mitigation acreage of 6.76 acres.

Collecting plugs on-site was identified as the Best Buy mitigation plan, as it incurs the lowest average annual cost per acre. An uncaptured ancillary benefit of the on-site plug option is that it promotes the establishment of other native marsh species in addition to the target species because other species or their seeds may be included in the collected plugs.

8.1.6 Mitigation Site Location and Implementation

As determined through the above analyses, the Recommended Plan would require a total 6.76 acres of wetland habitat creation, in the form of high marsh and intertidal marsh, between the BRFG and CRL sites. This includes 6.02 acres at the BRFG site and 0.74 acre at the CRL site. Establishing 6.76 acres of wetland

habitats at these locations, as described above, would produce 6.13 AAHUs to offset the 6.12 AAHUs that would be lost as a result of the Recommended Plan.

Considering multiple mitigation alternatives, the USACE determined that creating wetland habitats on the project site would be the most cost-effective mitigation solution. Under the Recommended Plan, anticipated wetland impacts at both the BRFG and CRL are due to construction of temporary bypass channels to maintain navigation through the areas during construction. After construction is completed, the bypass channels may provide areas for backfilling and creating wetland habitats. Of the planting options evaluated for on-site wetland creation, collecting plugs on-site to plant within the mitigation areas was determined to be the Best Buy mitigation plan.

Based on the mitigation analysis, the USACE proposes to create 6.02 acres of wetland habitat at the BRFG site (3.78 acres of high marsh and 2.24 acres of intertidal marsh) and 0.74 acre of wetland habitat (intertidal marsh) at the CRL site. At the BRFG facility, the preliminary mitigation location is within the temporary bypass channel on the east side of the Brazos River or along the existing GIWW channel west of the river. At the CRL facility, the preliminary mitigation is within the temporary bypass channel on the west side of the Colorado River. Although the proposed mitigation is planned to be constructed within the temporary bypass or original channels, the exact locations, extents, and design of the mitigation areas at each facility will be determined during the pre-construction, engineering, and design (PED) phase of the project, when further engineering details for the Recommended Plan at each project site are available.

Within the mitigation areas, the area will be filled and/or contoured to target elevations, which will be determined based on the existing elevations of impacted and/or nearby marshes. The elevations will take into account anticipated settling of fill material. In addition, the mitigation areas will be designed to minimize the potential for erosion from vessel wakes, currents in the GIWW, and flooding from the rivers. After the fill material has settled to the target elevation, areas where intertidal marsh will be established will be planted with smooth cordgrass at a minimum of 3-foot centers. Areas where high marsh will be established will be planted at a minimum of 3-foot centers, with herbaceous species found in nearby high marsh habitats, such as turtleweed, saltgrass, saltworts, Gulf cordgrass, marshhay cordgrass, sea-oxeye daisy, and seepweed. A nearby source marsh or marshes will be identified from which to collect the vegetation plugs. The use of collected plugs would facilitate the transplanting of various native plants or seeds that may be present in the plugs. The USACE will coordinate with TPWD and other agencies as needed to establish transplant methodology and obtain transplant permits.

The total estimated cost for the proposed 6.76 acres of marsh creation is $237,108 (**Table 8.20**). In addition to construction costs, the preliminary mitigation cost includes estimated Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) costs that may be needed for the success of the mitigation efforts. Because the mitigation sites should be self-sustaining after the success criteria are met, OMRR&R costs should be minimal, and a preliminary cost of $2,500 per year over the 50-year analysis period was estimated. The proposed mitigation plan would provide sufficient habitat units to meet mitigation requirements and compensate for the anticipated habitat loss due to the Recommended Plan at the BRFG and CRL facilities. Further development of the Recommended Plan and mitigation plan will determine final costs associated with wetland mitigation efforts.

Table 8.20 Preliminary Cost Estimates for Wetland Mitigation

Habitat Type	Acres Created	AAHUs Gained	Cost per acre	Total Cost
BRFG				
High Marsh	3.78	3.70	$35,075	$132,584
Intertidal Marsh	2.24	1.84	$35,075	$78,568
CRL				
Intertidal Marsh	0.74	0.58	$35,075	$25,956
TOTALS	**6.76**	**6.12**	**$35,075**	**$237,108**

8.1.7 Monitoring and Adaptive Management

The WRDA of 2007, Section 2039 states, "Monitoring includes the systematic collection and analysis of data that provides information useful for assessing project performance, determining whether ecological success has been achieved, or whether adaptive management may be needed to attain project benefits." This section discusses the preliminary feasibility-level monitoring and adaptive management strategies for the anticipated wetland mitigation efforts at the BRFG and CRL facilities. The primary intent of this preliminary Monitoring and Adaptive Management Plan (MAMP) is to identify monitoring and adaptive management actions appropriate for the project's mitigation goals and objectives. The MAMP, including costs, is based on currently available data and information developed during plan formulation of the mitigation plan. Uncertainties remain regarding the project design and construction details, extents of the mitigation areas and associated features, monitoring elements, and adaptive management opportunities. During the PED phase of the project, the PDT will develop a more detailed MAMP that will address uncertainties, provide a detailed cost breakdown, and further assess the establishment and success of the mitigation features proposed in the mitigation plan.

Authority and Purpose

Mitigation plans must include a strategy for monitoring the success of the mitigation [Section 2039, WRDA 2007]: "Monitoring includes the systematic collection and analysis of data that provides information useful for assessing project performance, determining whether ecological success has been achieved, or whether adaptive management may be needed to attain project benefits." Section 2039 also directs that a Contingency Plan (Adaptive Management Plan) be developed for all ecological mitigation projects.

Implementation

Pre-construction, during construction, and post-construction monitoring shall be conducted by utilizing a MAMP Team consisting of representatives of the USACE, TxDOT, and contracted personnel. Monitoring will focus on evaluating mitigation success and guiding adaptive management actions by determining if the project has met Performance Standards. Monitoring will be carried out until the project has been determined to be successful (performance standards have been met), as required by Section 2039 of WRDA 2007. Monitoring objectives are summarized in **Table 8.21** and discussed below.

Table 8.21 Monitoring Criteria, Performance Standards, and Adaptive Management Strategies

Measurement	Performance Standard	Adaptive Management Measures
Herbaceous Plant Cover	70 percent cover by target marsh species	Replanting and/or re-contouring as needed Changing species composition Collecting plugs from different locations
Non-native Vegetation	< 10 percent cover by non-native or invasive species	Mechanical removal Local herbicide application Replanting as needed
Water Depth	Target water depth for specific habitat	Re-contouring as needed
Erosion Control	Minimal erosion observed	Install breakwaters or other controls Re-contouring as needed

The mitigation areas will be assessed prior to construction, then monitored initially at 6 months after construction and initial planting is completed. Afterward, the mitigation areas will be monitored annually for up to 3 years or until the mitigation success criteria are achieved. The mitigation areas will be considered successful when:

1) herbaceous cover of target plant species is at least 70 percent;
2) cover of non-native or invasive plant species is less than 10 percent; and
3) target water depths are present.

After any monitoring period, if it is determined that the mitigation areas are not progressing as planned, adaptive management actions outlined in **Table 8.21** will be implemented as appropriate.

Reporting

After each monitoring period, a report will be prepared and submitted to the USFWS, NMFS, TPWD, and other interested parties. Permanent locations for photographic documentation will be established to provide a visual record of habitat development over time. The photograph locations will be identified in the pre-construction monitoring report. Photographs taken at each location will be included in monitoring reports.

Monitoring and Adaptive Management Costs

Costs to be incurred during PED and construction phases include drafting of the detailed MAMP. Cost calculations for post-construction monitoring are displayed as a 3-year (maximum) total. If ecological success is determined earlier (prior to 3 years post-construction), then the monitoring program will cease and costs will decrease accordingly.

It is intended that monitoring conducted for the wetland mitigation will utilize centralized data management, data analysis, and reporting functions associated at the USACE Fort Worth District office. All data collection activities will follow consistent and standardized processes established in the detailed MAMP. Cost estimates include monitoring equipment, photograph point establishment, data collection, quality assurance/quality control, data analysis, assessment, and reporting for the proposed monitoring elements (**Table 8.22**). The current total estimate for implementing the MAMP is $66,000. Unless otherwise noted, costs will begin at the onset of the PED phase and will be budgeted as construction costs. With the addition of these MAMP costs to the anticipated constriction and OMRR&R costs, the total cost to construct, maintain, and monitor the proposed mitigation is $303,108.

Table 8.22 Preliminary Cost Estimates for Implementation of the Monitoring and Adaptive Management Plan (MAMP)

Category	Activities	PED Set-up & Data Acquisition	1-year Post-construction	2-year Post-construction	3-year Post-construction	Total
Monitoring: Planning and Management	Monitoring workgroup, drafting detailed monitoring plan, working with PDT on performance measures	$4,000	$1,000	$1,000	$1,000	$7,000
Monitoring: Data Collection	Vegetation	$6,000	$6,000	$6,000	$6,000	$24,000
Data Analysis	Assess monitoring data and performance standards	$2,000	$2,000	$2,000	$2,000	$8,000
Adaptive Management Program	Detailed Adaptive Management Plan and Program Establishment	$10,000	--	--	--	$10,000
	Management of Adaptive Management Program	--	$4,000	$4,000	$4,000	$12,000
Database Management	Database development, management, maintenance	$2,000	$1,000	$1,000	$1,000	$5,000
Total MAMP Costs		**$24,000**	**$14,000**	**$14,000**	**$14,000**	**$66,000**
Total Construction and OMRRR Cost						**$237,108**
TOTAL MITIGATION COST						***$303,108***

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