ENVIRONMENTAL APPENDIX D

GULF INTRACOASTAL WATERWAY
BRAZOS RIVER FLOODGATES AND COLORADO RIVER LOCKS, TEXAS

US Army Corps of Engineers ®

Texas Department of Transportation ®

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Acronyms and Abbreviations

Acronym or Abbreviation	Definition or Meaning
APE	Area of Potential Effect
BMP	Best management practice
BRFG	Brazos River Floodgates
CBRA	Coastal Barrier Resources Act
CBRS	Coastal Barrier Resources System
CFR	Code of Federal Regulations
CNRA	Coastal Natural Resource Area
CRL	Colorado River Locks
CWA	Clean Water Act
dB, dBA	Decibels, A-weighted decibels
DMMP	Dredged material management plan
DMPA	Dredged material placement area
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency (U.S.)
ESA	Endangered Species Act
FHCIP	Freeport Harbor Channel Improvement Project
FPPA	Farmland Protection Policy Act
FWOP	Future Without Project

Acronym or Abbreviation	Definition or Meaning
GARFO	Greater Atlantic Regional Fisheries Office
GHG	Greenhouse gas
GIWW	Gulf Intracoastal Waterway
HAPC	Habitat Areas of Particular Concern
HGB	Houston-Galveston-Brazoria
H&H	Hydrology & hydraulics
HTRW	Hazardous, toxic, and radioactive waste
IFR-EIS	Integrated Feasibility Report and Environmental Impact Statement
µPaRMS	Micro-Pascal root-mean square
m	Meters
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO_x	Nitrogen oxides
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
PCB	Polychlorinated biphenyls
PED	Pre-construction Engineering and Design
ppt	Parts per thousand
SIP	State Implementation Plan
TCEQ	Texas Commission on Environmental Quality
TCMP	Texas Coastal Management Plan
tpy	Tons per year
TxDOT	Texas Department of Transportation
U.S.	United States
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
VOC	Volatile organic compounds
WMA	Wildlife Management Area

1.0 INTRODUCTION

The United States Army Corps of Engineers (USACE), in cooperation with the Texas Department of Transportation (TxDOT) Maritime Division, is conducting a feasibility study to investigate improvements to the Gulf Intracoastal Waterway (GIWW), Brazos River Floodgates (BRFG) and Colorado River Locks (CRL) facilities that would reduce navigational difficulties, delays, and accidents occurring as tow operators transit the BRFG and CRL structures and across the Brazos and Colorado Rivers. As part of the Feasibility Study, the USACE has prepared an Integrated Feasibility Report and Environmental Impact Statement (IFR-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 report supplements the IFR-EIS by providing (1) additional information on environmental impacts of the alternatives considered during project development and (2) the resource-specific documents, agency coordination, and public involvement that are referenced as **Attachments D-1 through D-11** in the IFR-EIS. The IFR-EIS describes how the alternatives were developed and evaluated (see Chapters 3 and 4 of the IFR-EIS), and this report summarizes the alternatives and analyzes anticipated future without project (FWOP) conditions and environmental impacts of each Action Alternative. The impact discussions in this report rely on baseline environmental conditions in the study areas, which are described in Chapter 2 *Affected Environment* of the IFR-EIS and are not repeated in this document.

2.0 BACKGROUND

The GIWW is a shallow-draft navigation channel that extends from Brownsville, Texas, to the Okeechobee waterway at Fort Meyers, Florida. The authorized channel in the GIWW is 125 feet wide and is typically about 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 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 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 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.

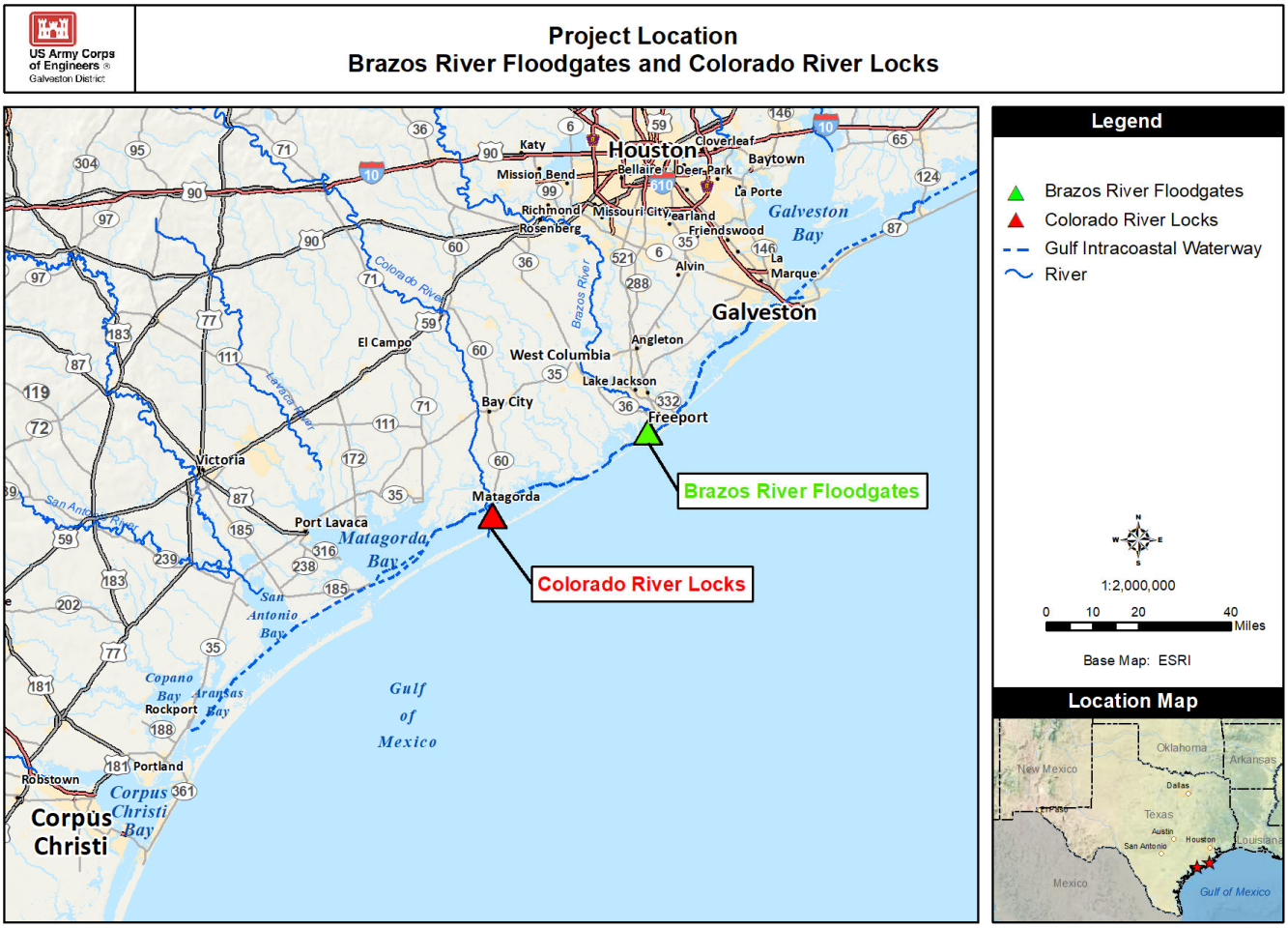

Figure 1 Project Location

3.0 SUMMARY OF ALTERNATIVES CONSIDERED AND RECOMMENDED PLAN

Early on in alternatives development, the project team identified several alternatives involving various measures to improve navigation through the BRFG and CRL. Through multiple screening efforts, the team narrowed the reasonable alternatives to five Action Alternatives at the BRFG, and three Action Alternatives at the CRL (**Table 1**). To minimize environmental impacts, the disturbance areas for the Action Alternatives were in and adjacent to the existing GIWW, BRFG, and CRL facilities. The project team further evaluated the alternatives through hydrology and hydraulics (H&H) modeling, economic analysis, and environmental analysis to identify a Tentatively Selected Plan (TSP or Recommended Plan). **Table 1** summarizes the alternatives presented in the February 2018 DIFR-EIS (Draft) that was made available for public review.

Table 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 presented in the February 2018 DIFR-EIS was BRFG Alternative 3a.1 and CRL Alternative 4b.1. Based on public and navigation industry input, both alternatives were refined after TSP selection.

The Recommended Plan that was presented to the public for review in the February 2018 DIFR-EIS included 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 consisted of (1) removing the existing floodgates, (2) constructing a new 125-foot-wide floodgate on the east side of the river (along the existing GIWW alignment and set back approximately 1,000 feet from the river), and constructing a minimum 125-foot-wide open channel (no floodgate) on the west side of the river crossing. At the CRL facility, the Recommended Plan consisted of the removal of the existing river-side sector gate structures and rehabilitation of the existing GIWW-side sector gate structures.

3.1 Refinement of the Recommended Plan

In consideration of public comments and further discussions with the navigation industry, the USACE and TxDOT refined the Recommended Plan at each facility. First, the GIWW alignment at both facilities was

shifted to the south of the existing alignment in order to maintain operation of the existing structures during construction. This refinement was made in response to concerns that the originally proposed temporary bypass channel, which would have remained open during the entire 1 to 2 years of anticipated construction, would result in excessive sedimentation and maintenance dredging costs in the GIWW and Freeport Channel during that period. Second, at the CRL facility, the Recommended Plan was refined to remove all four existing gate structures and construction a new 125-foot-wide gate on each side of the river. The following sections describe the refined plans at each facility.

3.1.1 Refined Plan at the BRFG

At the BRFG, the main features of the Recommended Plan are the removal of the existing gates on both sides of the river crossing, the construction of a 125-foot-wide open channel (no gate structure) on the west side of the river, and construction of a new 125-foot-wide sector gate structure on the east side of the river. The centerline of the GIWW through the BRFG area would be shifted 300 feet south of the existing centerline, allowing the existing floodgates to remain in operation until the new channel and west floodgate are completed. The open channel on the west side of the river will have a bottom width of 125 feet and bottom depth of -12 feet NAVD88. The new 125-foot-wide sector gate on the east side of the river will be set back approximately 1,300 feet from the existing gate structure, providing increased safety and efficient vessel operation through the crossing. Construction of the open channel and new sector gate at the BRFG will take approximately two years to complete, if adequate funding is provided. Assuming one contract, the general construction sequence will include the following:

- Dredge the new channel alignment on the west and east sides of the river, leaving a plug at the existing floodgates to maintain separation between the new channel and the river.
- Construct the new gate structure, guidewalls, and end cells on the east side of the river.
- Excavate the plugs at the river, and complete dredging of the new channel.
- Transfer navigation traffic to the new GIWW channel and gate structure.
- Decommission existing floodgates, demolish the southern gate leaf on both sides of the river, and build levee access to the new gate structure.
- Complete final site work, including grading, parking, and support buildings.

Anticipated pile-driving activities associated with the proposed BRFG plan are outlined in **Table 2**.

Table 2 Anticipated Pile-Driving for the BRFG Recommended Plan

Project Component	Pile Size	Pile Type	# of Piles	Hammer Type	Water Depth (meters)
Gate Structure Foundation	24”	Steel Pipe	246	Impact	< 5
Guidewalls	13”	Timber Piles	96	Impact	< 5
End Cells	18”	Steel Pipe	120	Impact	< 5
	20”	PS 31 Sheet Pile	930 LF	Impact	< 5
Needle Girder Storage	24”	Concrete	60	Impact	0 (on land)
Reservation Buildings	13”	Timber Piles	272	Impact	0 (on land)

3.1.2 Refined Plan at the CRL

At the CRL, the main features of the Recommended Plan are the decommissioning of all four existing gate structures and the construction of a new 125-foot-wide sector gate structure on the east and west sides of the river. The centerline of the GIWW through the CRL area would be shifted 260 feet south of the existing centerline, allowing the existing lock structures to remain in operation until the new channel and gates are completed. The new channel will have a bottom width of 125 feet and bottom depth of -12 feet NAVD88. Construction of the new CRL facility will take approximately two years to complete, if adequate funding is provided. Assuming one contract, the general construction sequence will include the following:

- Dredge the new channel alignment on the west and east sides of the river, leaving a plug to maintain separation between the new channel and the river.
- Construct the new gate structures, guidewalls, and end cells on each side of the river.
- Excavate the plugs at the river, and complete dredging of the new channel.
- Transfer navigation traffic to the new GIWW channel and gate structures.
- Decommission the existing lock facilities, demolish the southern gate leaf at each gate, and build levee access to the new gate structures.
- Complete final site work, including grading, parking, and support buildings.

The new CRL gate structures will be the same general dimensions as the new BRFG gate structure, so pile-driving activities are expected to be double the anticipated pile-driving at the BRFG (**Table 3**).

Table 3 Anticipated Pile-Driving for the CRL Recommended Plan

Project Component	Pile Size	Pile Type	# of Piles	Hammer Type	Water Depth (meters)
West Gate Structure					
Gate Structure Foundation	24”	Steel Pipe	246	Impact	< 5
Guidewalls	13”	Timber Piles	96	Impact	< 5
End Cells	18”	Steel Pipe	120	Impact	< 5
	20”	PS 31 Sheet Pile	930 LF	Impact	< 5
East Gate Structure					
Gate Structure Foundation	24”	Steel Pipe	246	Impact	< 5
Guidewalls	13”	Timber Piles	96	Impact	< 5
End Cells	18”	Steel Pipe	120	Impact	< 5
	20”	PS 31 Sheet Pile	930 LF	Impact	< 5
Reservation Buildings	13”	Timber Piles	272	Impact	0 (on land)
Flow Separator	22”	PZ-22 Sheet Pile	500	Vibratory	< 5

3.1.3 Dredged Material Management

Dredged material resulting from construction of the Recommended Plan and subsequent maintenance would be placed within existing dredged material placement areas (DMPAs) until available capacity is exhausted, after which dredged material would be transported offshore to an existing ocean dredged material disposal site (ODMDS) that has been approved for Freeport Channel dredging. When that need arises, approval by the U.S. Environmental Protection Agency (EPA) would be required. Developing a full dredged material management plan (DMMP) to address disposal needs, either for future maintenance dredging associated with this project or for a larger GIWW segment that includes the BRFG and/or CRL,

could result in more cost-effective placement options, including beneficial uses for dredged material. 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.

4.0 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 5.0. 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.

As discussed earlier, Chapter 2 of the IFR-EIS describes baseline environmental conditions in the study areas, so that information is not repeated here. For reference, existing conditions were evaluated within a study area that encompasses the maximum disturbance area for the reasonable alternatives at each facility. At the BRFG, the study area encompasses roughly 600 acres and extends along the GIWW one mile east and west of the Brazos River crossing and up to 0.5 mile along the Brazos River, north and south of the GIWW crossing (**Figure 2**). At the CRL, the study area encompasses roughly 400 acres and extends along the GIWW one mile east and west of the Colorado River crossing and up to 0.25 mile along the Colorado River, north and south of the GIWW crossing (**Figure 3**). Under the reasonable alternatives, all construction activities and associated direct impacts would occur within these study areas. Outside of these study areas, nearby resources were identified and evaluated on a case-by-case basis depending on their potential to be indirectly affected by modifications to the BRFG and/or CRL facilities (e.g., effects of salinity and sedimentation changes at the San Bernard River and nearby piping plover critical habitat).

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.

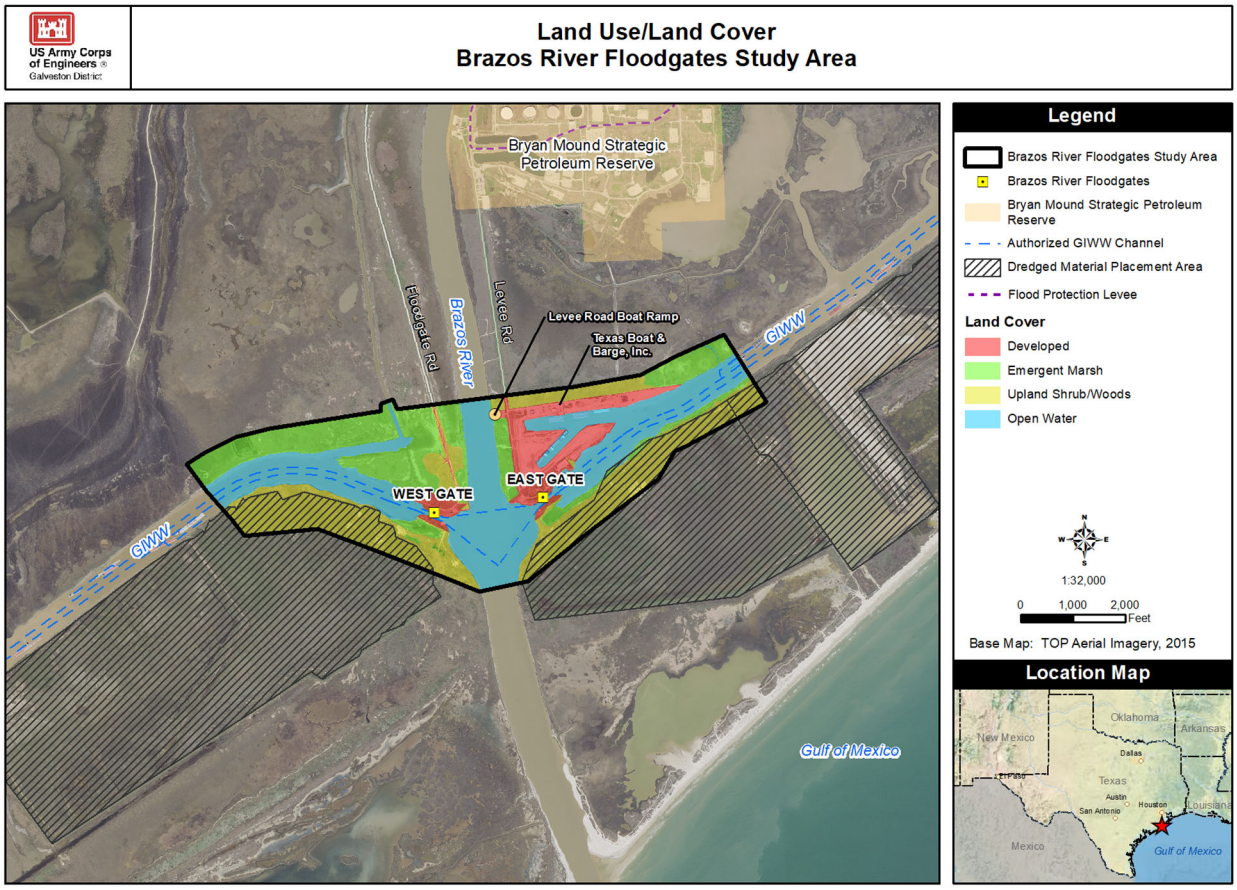

Figure 2 BRFG Study Area

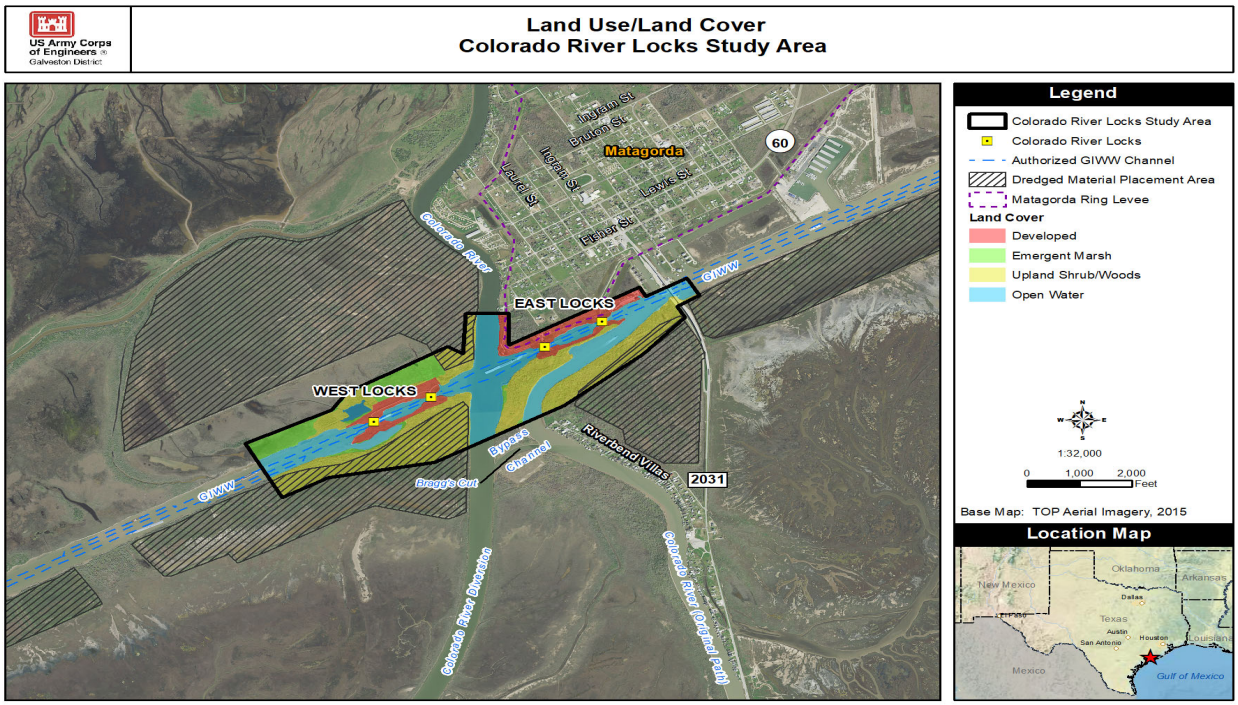

Figure 3 CRL Study Area

- 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 habitats are 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.

4.1 General Environmental Setting of the Study Areas

Under the FWOP Condition, there will be no changes to the overall location, physiography, or land use of the NEPA study areas resulting from the project. However, the Texas coast is a dynamic environment, and the study areas will continue to experience environmental factors that will change the landscape. Hurricanes and other storms will periodically affect the study areas, and projected sea level rises in the region range from about 1 foot to over 4 feet during the 50-year planning period (2030 and 2080), which would gradually inundate low-elevation areas. The projected sea level rise would generally cause a lower velocity in the rivers at the GIWW crossings, resulting in higher sedimentation in the GIWW and increased O&M costs.

Both study areas will likely remain undeveloped due to their low elevations, but development could occur on higher elevations along the rivers. 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. Wetlands could also be impacted if new DMPAs are established in the area to accommodate future maintenance dredging of the GIWW, although those impacts would likely be mitigated.

Under the FWOP Condition, the mouth of the San Bernard River (located about 4 miles west of the BRFG) is expected to naturally silt in and close after the 2017 Hurricane Harvey opening due to sediment transport and deposition from longshore currents in the Gulf. The San Bernard River outlet silted in and closed after previous dredging efforts to open the outlet, and as of September 2018, sand and silt were observed filling the mouth again after Hurricane Harvey (Friends of the San Bernard River 2018). This FWOP condition may change because a local study to re-open and maintain the San Bernard River outlet is ongoing and is included in a list of RESTORE Act projects.

4.2 Soils and Waterbottoms

Under the FWOP Condition, most soils in the study areas will remain in the current condition; however, lower elevation areas 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.

4.3 Sediment

Under the FWOP Condition, existing sediment load distribution downstream of the BRFG and CRL will continue, with most sediment in the Brazos River discharging into the Gulf of Mexico and most 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. Erosion along the Texas coast will continue, although studies like the Coastal Texas Study and 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.

4.4 Floodplains and Flood Control

Under the FWOP Condition, existing river flooding trends will continue, although flooding may increase as the project region and inland areas 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.

4.5 Water Resources

Under the FWOP Condition, no impacts to wetlands or other water resources would occur because of the project itself. Some wetland areas in the NEPA study areas may be converted gradually to open water habitats as sea levels rise and/or subsidence occurs. Wetlands could also be impacted if new DMPAs are established in the area to accommodate future maintenance dredging, although those impacts would likely be mitigated. Water use and supply would not be affected by the FWOP Condition, although sea level rise may increase salinities in the rivers during low-flow periods.

4.6 Water Quality

Under the FWOP Condition, periodic disturbance and suspension of sediments in the water column will continue because of O&M dredging operations, barge traffic, and flooding. As the BRFG and CRL facilities continue to age, and/or if barge traffic increases, the potential for accidents resulting in a contaminant spill may increase and may affect water quality. Continued implementation of pollutant protection programs by the EPA and Texas Commission on Environmental Quality (TCEQ) and use of best management practices (BMPs) will benefit water quality.

4.7 Salinity

Under the FWOP Condition, existing trends in salinity changes in the study areas would continue, with higher salinities occurring during low river flows and lower salinities occurring during high river flows. In the future, salinities in the study areas are expected to gradually increase due to anticipated sea level rises.

4.8 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 under the FWOP Condition. Wetlands and other habitats may also be lost or converted due to continued disposal of dredged material from the GIWW. Habitat losses could result in reduced habitat diversity, particularly for aquatic and semi-aquatic animals, waterfowl, and wading birds. Development in the NEPA study areas is expected to be minimal.

Large areas of wetlands and other native habitats in the BRFG and CRL regions will continue to be protected by the San Bernard National Wildlife Refuge (NWR), Justin Hurst Wildlife Management Area (WMA), and Mad Island WMA, and future wetland losses may be reduced by restoration and shoreline stabilization projects. Impacts to coastal habitats and resources would also be managed and mitigated to some extent by regulations such as the Clean Water Act (CWA), Endangered Species Act (ESA), Coastal Barrier Resources Act (CBRA), Coastal Zone Management Act, and Texas Coastal Management Program (TCMP), as well as by continued funding of programs to purchase, preserve, and manage coastal areas.

4.9 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.

4.10 Threatened and Endangered Species

Under the FWOP Condition, future losses of wetlands and beaches in the region due to sea level rises, erosion, subsidence, or other effects could impact wintering whooping cranes (*Grus americana*), piping plovers (*Charadrius melodus*), and red knots (*Calidris canutus rufa*), while future protection, restoration, and stabilization efforts in coastal habitats could benefit these species. Sea turtles may be affected by vessel traffic, industrial development, and dredging operations in the GIWW, although development in the NEPA study areas is expected to be minimal. Potential impacts of various activities would be managed by continued execution of the ESA, including development of conservation plans and measures.

4.11 Other Protected Wildlife Species

Under the FWOP Condition, overall habitat conditions in the NEPA 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 (*Tursiops truncatus*) may be affected by

increased vessel traffic, industrial development, and dredging operations in the GIWW and other waterways, but this is expected to be a minor impact because vessel traffic and dredging operations are existing conditions, and development in the NEPA study areas is expected to be minimal.

Natural changes to vegetation/wildlife habitats would alter use of the habitats by migratory birds and other wildlife, but overall the NEPA study areas are expected to remain largely undeveloped and existing NWRs and WMAs would continue protecting coastal habitats.

4.12 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 known to re-colonize dredged areas within 18 months (Texas Water Resources Institute 1995).

4.13 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.

4.14 Essential Fish Habitat

Under the FWOP Condition, no impacts to essential fish habitat (EFH) would occur because of the project. Existing EFH in the study areas would continue to be affected by normal coastal process, and as sea levels rise, marshes may be converted to open water, which would reduce nursery habitat. Projected sea level rises would also generally result in lower river velocity at the GIWW crossings, resulting in higher sedimentation and need for additional DMPAs that could affect EFH. Existing NWRs and WMAs in the BRFG and CRL region would continue to protect large areas of coastal marshes, and future wetland losses may be reduced by restoration and shoreline stabilization projects.

4.15 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 coastal natural resource areas (CNRAs). 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 agencies. Development in the NEPA study areas is expected to be minimal under the FWOP Condition.

4.16 Historic and Cultural Resources

Under the FWOP Condition, the USACE would continue to operate and maintain the BRFG and CRL facilities as they have for the last several decades. The USACE would continue to repair steel members

within the sector gates, replace portions of the timber guidewalls, maintain the USACE support buildings, and dredge the GIWW as needed. These activities are not expected to affect archeological sites, and since the USACE determined that the BRFG and CRL facilities themselves are not eligible for listing on the National Register of Historic Places (NRHP) (see Chapter 2 of the IFR-EIS), the activities would not affect non-archeological historic resources protected by Section 106 of the National Historic Preservation Act (NHPA). If archeological sites are present near the project sites, they may be impacted by shoreline erosion and development. For projects where Federal and/or State land, funding, or permitting are involved, impacts would be addressed by avoidance, minimization, or mitigation in compliance with applicable regulations.

4.17 Air Quality

Under the FWOP Condition, future population growth within the Brazos, Colorado, and/or San Bernard River watersheds and within the Houston-Galveston-Brazoria (HGB) ozone nonattainment area will result in the potential for more contaminant emissions to affect air quality. Maintenance dredging in the GIWW will also continue to result in emissions, although these emissions are expected to be minor. Continued implementation of pollutant protection programs by the EPA and TCEQ, as well as use of BMPs, would benefit air quality. The EPA and TCEQ will continue to monitor air quality in the HGB area and re-evaluate air quality attainment status according to current standards and procedures that are incorporated in the TCEQ's State Implementation Plan (SIP) to manage emissions. Based on current population trends in the CRL region, significant air quality concerns are not expected in the near future.

4.18 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. This could periodically and temporarily increase noise levels at residences near the CRL, but the effects would likely be minor because residences to the north of the CRL are located behind a levee, and residences to the south of the CRL are buffered by trees.

4.19 Oil, Gas, and Minerals

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

4.20 Hazardous, Toxic, and Radioactive Waste

Under the FWOP Condition, Hazardous, Toxic, and Radioactive Waste (HTRW) concerns are expected be similar to existing concerns: The existing structures and buildings at the BRFG and CRL may contain lead paint and asbestos, and sediments in the GIWW and Brazos and Colorado Rivers may contain contaminants from permitted discharges or inadvertent releases from nearby facilities and heavy flooding during Hurricane Harvey. As the BRFG and CRL facilities continue to age, and/or if barge traffic on the GIWW increases, the potential for accidents resulting in a contaminant spill may increase.

4.21 Socioeconomic and Human Resources

Populations in both NEPA 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 NWRs and WMAs 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 NEPA study area will not be altered.

5.0 ENVIRONMENTAL CONSEQUENCES OF ACTION ALTERNATIVES

This section discusses potential environmental impacts associated with the various Action Alternatives considered for the BRFG and CRL sites. The information used to determine environmental consequences of the Action Alternatives is derived from baseline environmental conditions in the study areas (see Chapter 2 of the IFR-EIS), initial descriptions and draft engineering drawings of the alternatives, field reconnaissance and desktop analysis, and engineering reports (see Engineering Appendix A of the IFR-EIS). 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). In addition, the rehabilitation alternatives would not meet the purpose and need and objectives of the project. No additional discussion of environmental consequences of these two Action Alternatives are provided here.

Environmental impacts of the other Action Alternatives are discussed together and/or separately below, depending on the individual resource and similarity of anticipated impacts among alternatives. These discussions are intended to provide a general comparison of the Action Alternatives and are not intended to provide complete discussions of impacts resulting from the Recommended Plan. More detailed discussions of environmental consequences, including indirect and cumulative impacts, associated with the Recommended Plan are provided as needed in Chapter 5 of the IFR-EIS and in the resource-specific documents found in **Attachments D-1 through D-11** of this environmental report. Chapter 6 of the IFR-EIS discusses compliance of the Recommended Plan with applicable laws and regulations.

For reference, the current Action Alternatives for each site include:

BRFG

- Alternative 2a: Rehab Existing Facilities – impacts are generally the same as FWOP Condition
- Alternative 3a: Gate Relocation on Existing Alignment
- Refined Alternative 3a.1 (Recommended Plan): Open Channel West/East Gate Relocation
- 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 are generally the same as the FWOP Condition
- Alternative 3b: Open Channel
- Refined Alternative 4b.1 (Recommended Plan): Remove Existing Gates and Construct 125' Gates

5.1 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. As discussed in Engineering Appendix A of the IFR-EIS, sea level change and other climate changes could affect the performance of the Recommended Plan and other alternatives. Therefore, the PDT evaluated the potential impacts of climate and RSLC on river velocity and sedimentation. Modeling showed that changes in river velocity appear to be uniform across all alternatives at each site, and sedimentation rates are not highly sensitive to sea level rise. Higher Gulf water levels are expected to result in slower velocities at the river crossings and increased channel depths, which would improve navigability. Based on the hydraulic analyses, the overall effects of RSLC on the Recommended Plan are relatively minor. Further discussion of the impact of RSLC is provided in Engineering Appendix A of the IFR-EIS.

Studies of precipitation and streamflow trends generally show mild increases in annual precipitation and streamflow in the Texas coastal region over the past century. Increased river discharges in the BRFG and CRL study areas are likely to increase sedimentation, although the amount of increase due to climate change is assumed to be small relative to the uncertainty in the modeled sedimentation volumes. Further discussion of the impact of precipitation changes is provided in Engineering Appendix A of the IFR-EIS.

:Like the FWOP Condition, existing land uses in the study areas would continue, and the study areas are expected to remain undeveloped under the Action Alternatives. Changes to the general environmental setting specific to each Action Alternative are discussed below.

BRFG Alternative 3a: This alternative would directly impact an estimated 83 acres, primarily due to excavation of a temporary bypass channel to allow navigation through the area during construction. The impacted areas would occur largely in and adjacent to the existing GIWW and DMPAs and would not change the general environmental setting of the area.

BRFG Refined Alternative 3a.1 (Recommended Plan): This alternative would directly impact an estimated 125 acres, most of which would be temporary impacts to open water during construction. The Refined Alternative 3a.1 is expected to impact a larger footprint than estimated prior to refinement because the permanent GIWW realignment extends dredging limits compared to the earlier temporary bypass channel. The resulting land alteration would not change the general setting. 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 directly impact approximately 75 acres; however, the site's overall setting would not change and would be consistent with the other Action Alternatives. One commercial facility (Texas Boat & Barge, Inc.) and one recreational boat ramp (Levee Road Boat Ramp) would be removed by this alternative. Since Alternative 9a would remove result in an open channel, it would provide an open connection between the Brazos River and the GIWW, as well as allow increased drainage of San Bernard River flows to the Brazos River; however, these effects would not be expected to change the overall location, physiography, or climate of the NEPA study areas.

BRFG Alternative 9b/c: This alternative is like Alternative 9a and would directly impact approximately 87 acres. Like Alternative 9a, it would remove the Texas Boat & Barge, Inc. commercial facility and Levee Road Boat Ramp, but it would not change the overall setting of the area.

CRL Alternative 3b: This alternative would directly impact an estimated 71 acres, primarily due to excavation of a temporary bypass channel to allow navigation through the area during construction. The general setting would be like the FWOP Condition, although operations associated with the CRL would no longer be needed. Without the locks in place, some 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 Refined Alternative 4b.1 (Recommended Plan): This alternative would directly impact an estimated 86 acres of land, most of which would be temporary impacts to open water during construction. The Refined Alternative 3a.1 is expected to impact a larger footprint than this prior to refinement because the permanent GIWW realignment extends dredging limits compared to the initially proposed temporary bypass channel. However, the general setting of the area would remain similar to the FWOP Condition.

5.2 Soils and Waterbottoms

The Farmland Protection Policy Act (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" (U.S. Department of Agriculture 2017). 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, and the Action Alternatives may have minor effects on prime farmland soils there. However, no farming has occurred in the study area in the past, and none is expected to occur in the future.

BRFG Alternative 3a: Under Alternative 3a, hydric soils would be removed to relocate the structures and construct a 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 an existing ODMDS that is currently used for Freeport Channel dredging may be used for this alternative. 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 Refined Alternative 3a.1 (Recommended Plan): Impacts to soils and waterbottoms would be similar to Alternative 3a, although the refined plan calls for a permanent realignment of the GIWW, which will permanently convert some areas to open water.

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 Natural Resources Conservation Service (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 Refined 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 the proposed GIWW realignment would impact approximately 4.3 acres of NRCS-designated prime farmland soils, the NRCS has determined that the project would not have a negative impact on productive agricultural lands and is exempt from provisions of the FPPA (**Attachment D-10**). 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.

5.3 Sediment

To assess potential changes in sedimentation patterns and volumes in the GIWW resulting from the Action Alternatives, the project team conducted sedimentation analyses for the BRFG and CRL sites. Descriptions and results of the sedimentation analyses are provided in Engineering Appendix A of the IFR-EIS. At the BRFG, the analysis evaluated existing and projected sedimentation within six zones, as shown on **Figure 4**. **Table 4** summarizes the existing and projected sedimentation volumes for each alternative.

Figure 4 Sediment Deposition Zones Near the BRFG

Table 4 Average Annual Deposition Simulations for Existing and Alternative Scenarios based on Simulation Results at BRFG (Presented as volume in cubic yards and % change)

BRFG Alternative	West GIWW	Brazos Basin	East GIWW	Freeport Channel	Brazos Delta	Freeport Offshore	Total in Zones Requiring Maintenance
Existing/2a	554,769	48,000	890,769	295,385	44,382,462	208,726	1,788,923
3a	493,846 (-11%)	59,077 23%	902,769 1%	316,615 7%	44,332,615 0%	190,864 (-8%)	1,772,307 (-0.1%)
3a.1 (Recommended Plan)	653,130 18%	58,332 22%	902,653 1%	326,420 11%	44,000,887 (-1%)	196,239 (-6%)	1,940,535 8%
9a	781,846 41%	92,308 92%	1,079,077 21%	978,462 231%	42,026,769 (-5%)	854,614 309%	2,931,693 64%
9b	780,923 41%	96,923 102%	1,044,000 17%	550,154 86%	43,232,308 (-3%)	396,989 90%	2,472,000 38%
9c	781,846 41%	107,077 123%	1,044,000 17%	550,154 86%	43,218,462 (-3%)	395,887 90%	2,483,077 39%

As shown in **Table 4**, all the BRFG Action Alternatives would increase overall sedimentation in zones requiring maintenance except Alternatives 2a and 3a. Increased sediment in the GIWW would require higher O&M dredging costs, which was considered in the economic analysis of the alternatives. Potential environmental impacts of the sedimentation changes could include habitat impacts due to raising of bottom elevations, reducing sediment reaching the Brazos Delta and nearby beaches, and future DMPA requirements that may impact habitats. Based on the projected sedimentation changes, potential impacts from BRFG Alternatives 9a, 9b, and 9c would be larger than impacts from Alternatives 3a and 3a.1. As

discussed in Chapter 5 of the IFR-EIS, anticipated impacts to habitats resulting from increased sediment deposition under the Recommended Plan (Refined Alternative 3a.1) are not expected to be significant.

At the CRL, sedimentation was projected for the zones shown on **Figure 5**. **Table 5** summarizes the existing and projected sedimentation volumes within those zones for each alternative. As shown in **Table 5**, CRL Alternative 3b, which entails removing the locks and maintaining an open channel, would significantly affect sediment deposition, including increased sediment deposition in the GIWW. This would result in increased O&M dredging costs and disposal needs and could impact habitats in areas where major sediment changes would occur. In contrast, projected changes in sediment volumes resulting from the Recommended Plan at the CRL (Alternative 4b.1) are relatively minor, ranging from less than 1,000 cubic yards to about 6,000 cubic yards annually depending on zone, and are not expected to result in significant impacts.

Table 5 Average Annual Deposition Simulations at the CRL based on 2016 Simulation Regression Analysis (Presented as volume in cubic yards and % change)

Area of Interest	Existing (No Action)	Alt. 3b (Open Channel)	Alt. 4b.1 (Recommended Plan)
GIWW East	88,921	476,787 (436%)	83,387 (-6%)
GIWW West	212,956	834,907 (292%)	206,952 (-3%)
Bypass Channel	70,519	171,101 (143%)	72,813 (3%)
Intersection	11,789	30,017 (155%)	14,695 (25%)
Delta 1	2,432,825	2,206,549 (-9%)	2,523,478 (4%)
Delta 2	651,095	791,945 (22%)	648,468 (-0.4%)
Delta 3	1,450,778	765,962 (-47%)	1,453,523 (0.2%)
Offshore	360,739	799,477 (122%)	359,459 (-0.4%)

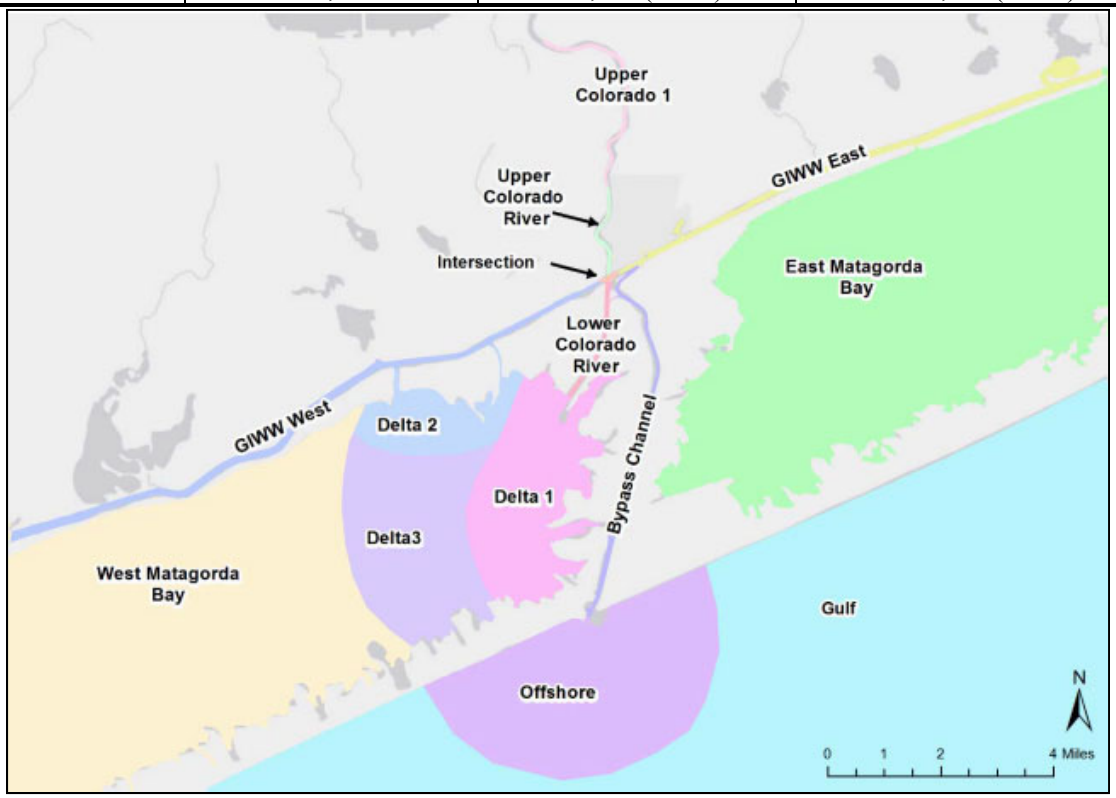

Figure 5 Zones for Sedimentation Analysis Near the CRL

5.4 Floodplains and Flood Control

Overall, no major impacts to floodplains or flood control from the Action Alternatives were identified during alternatives evaluation. During development and evaluation of the various measures and alternatives for the project, a major consideration was avoidance of existing flood-protection levees and structures. As with the FWOP Condition, flooding in the BRFG and CRL vicinities would continue to occur after storms upstream and, less frequently, during tropical storms and hurricanes, and future flooding in the region may be exacerbated by projected climate change, sea level rises, and subsidence.

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. Existing levees and flood control structures would not be altered by this alternative.

BRFG Refined Alternative 3a.1 (Recommended Plan): Compared to the FWOP Condition, the Recommended Plan is not expected to have significant effects on flooding or flood protection in the BRFG area. The removal of the west floodgate would allow for free exchange between the Brazos River and the West GIWW; however, analysis of water levels under this alternative indicated that low water levels in the West GIWW would be reduced, while high water levels would be slightly increased, with the absolute peak water level showing a minor increase of 0.3 to 0.4 feet (3.5 to 5 inches) (see Engineering Appendix A of the IFR-EIS). Comparing the increase to GIWW bank elevations, the minor increase in peak water level is not expected to increase overtopping of the GIWW banks; thus, the Recommended Plan is not expected to increase flooding of adjacent land areas.

Similarly, the project team evaluated anticipated water levels near the communities of Rivers End and Sanders Road on the San Bernard River (see Engineering Appendix A of the IFR-EIS). Compared to the FWOP Condition, the Recommended Plan at BRFG is expected to reduce water surface elevations at the two communities during low tides, likely because the proposed open channel would allow increased drainage of San Bernard River flows to the Brazos River. During other conditions, water levels at the communities are expected to be similar to the FWOP Condition.

BRFG Alternative 9a: Under this alternative, impacts to floodplains and flood control in the study areas are expected to be similar to Alternative 3a.1. Since this alternative would also provide an open connection between the west GIWW and the Brazos River, it is expected to result in minor increases in peak water levels but is not expected to increase overtopping of the GIWW banks or adversely affect flooding conditions at communities on the San Bernard River.

BRFG Alternative 9b/c: Under these alternatives, impacts to floodplains and flood control are expected to be similar to Alternatives 3a.1 and 9a.

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 impact existing flood control levees/structures. The lower water level may be considered favorable in comparison to the FWOP Condition, particularly during flooding conditions.

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. This alternative is expected to have minimal to impact on floodplains or existing flood control levees/structures.

5.5 Water Resources

For each Action Alternative, the acreages of wetland and other special aquatic sites (e.g., tidal flats) that would be removed are discussed below and summarized in **Table 6**. Under all alternatives, mitigation would be provided to offset wetland losses, and the project would be designed and constructed in compliance with CWA Section 404(b)(1) (**Attachment D-1**). In addition to estimated wetland losses, all Action Alternatives are expected to affect open water areas throughout the work areas; however, most of the open water impacts would consist of temporary construction impacts (e.g., barge access, pile driving, dredging, and turbidity). Overall, all Action Alternatives would result in similar to higher acreages of open water in the study areas compared to the FWOP Condition. Regardless of the selected alternative, other wetland areas in the study areas may be converted gradually to open water habitats over time as sea levels rise, similar to the FWOP Condition. Since existing DMPAs and ODMDS would be used, none of the Action Alternatives are expected to impact wetlands due to dredged material placement, although the need for placement areas would be highest for those alternatives with the greatest increases in sediment deposition in the GIWW (e.g., Alternatives 9a, 9b, and 9c). None of the Action Alternatives affect local water supply or water use.

Table 6 Estimated Impacts to Wetlands and Other Special Aquatic Sites (acres)

Alternative	High Marsh	Intertidal Marsh	Tidal Flat	Total
BRFG Action Alternatives				
No Action/Alt.2a	0	0	0	**0**
3a	3.8	2.3	0	**6.1**
3a.1 (Refined – Recommended Plan)[1]	2.4	11.4	0	**13.8**[1]
9a	25.2	3.2	2.1	**30.5**
9b/c	24.9	2.6	1.0	**28.5**
CRL Action Alternatives				
No Action/Alt.2a	0	0	0	**0**
3b	0	0.7	0	**0.7**
4b.1 (Refined – Recommended Plan)	0	0.7	0	**0.7**

BRFG Refined Alternative 3a.1 is expected to impact a larger footprint than the initial plan because the proposed GIWW realignment extends the dredging limits compared to the previously proposed temporary bypass channel.

BRFG Alternative 3a: This alternative would remove approximately 6.1 acres of wetlands, primarily due to excavation of a temporary bypass channel to maintain navigation through the area during construction. Mitigation of wetland impacts would likely be accomplished through on-site creation of high marsh and intertidal marsh in the temporary bypass channel after construction is completed.

BRFG Refined Alternative 3a.1 (Recommended Plan): Under the refined Alternative 3a.1, the proposed GIWW realignment and other construction would remove approximately 13.8 acres of wetlands. The Refined Alternative 3a.1 would impact more wetlands than the initial plan because the extended dredging limits of the GIWW realignment in the East GIWW impacts intertidal marsh along a longer segment of the GIWW shoreline. Mitigation of wetland impacts would consist of on-site, in-kind mitigation consisting of

creation of appropriate amounts of high marsh and intertidal marsh within the study area. A mitigation plan is provided in **Attachment D-8**.

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, which would require mitigation.

CRL Refined 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. A mitigation plan for this impact is provided in **Attachment D-8**.

5.6 Water Quality

Under all the Action Alternatives, water-based construction activities such as barge access, pile driving, and dredging would disturb soils and sediments, resulting in suspended sediments and increased turbidity in the GIWW and Brazos and Colorado Rivers. During land-based construction activities adjacent to the GIWW at both facilities, runoff from exposed earth could also contribute to temporary increases in suspended sediment and turbidity in adjacent water. The increase in turbidity would be temporary and is expected to return to existing conditions after construction activities are completed. In addition, BMPs such as silt fences would be used 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. Under all Action Alternatives, sediment sampling would be conducted prior to dredging to characterize any contaminants present. If contaminated, the material would be handled and disposed of in accordance with applicable local, state, and federal permits, statutes, and regulations.

As under the FWOP Condition, periodic disturbance of sediments and suspension of sediments in the water column would continue because of maintenance dredging operations, barge traffic, and flooding. None of the Action Alternatives are expected to result in a violation of water quality standards.

BRFG Alternative 3a: Under this alternative, minor and temporary water quality impacts are expected to occur as outlined above.

BRFG Refined Alternative 3a.1 (Recommended Plan): Under this alternative, minor and temporary water quality impacts are expected to occur as outlined above.

BRFG Alternative 9a: Compared to Alternatives 3a and 3a.1, temporary turbidity increases under this alternative would be more frequent because more maintenance dredging would be required for the open channel. This alternative also 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 similar to Alternative 9a.

CRL Alternative 3b: The increased frequency of maintenance dredging under this alternative would result in increased temporary turbidity compared to the FWOP Condition and Alternative 4b.1.

CRL Refined Alternative 4b.1 (Recommended Plan): Under this alternative, minor and temporary water quality impacts are expected to occur as outlined above.

5.7 Salinity

To assess potential changes in salinity resulting from the Action Alternatives, the project team modeled existing and projected salinity conditions for four zones shown on **Figure 4**. Descriptions of the modeling and results are provided in Engineering Appendix A of the IFR-EIS. **Tables 7 and 8** summarize the projected average salinities, in parts per thousand (ppt) for each zone under low and high freshwater flows, respectively. Note that the model was calibrated using salinity data collected during the 13-month period spanning March 2015-March 2016, which was a relatively wet period when the Brazos River exhibited multiple high flow events and had greater flows throughout the period relative to periods with less rainfall.

Table 7 Mean Salinity (and change from existing) (ppt) at the BRFG, October-December (High Freshwater Flow)

BRFG Alternative	West GIWW	Brazos Basin	East GIWW	Freeport Channel
Existing	5.7	1.7	5.0	15.0
3a	6.1 (0.4)	2.2 (0.5)	3.9 (-1.1)	14.6 (-0.4)
3a.1 (Recommended Plan)	3.9 (-1.8)	2.1 (0.4)	5.2 (0.3)	15.2 (0.2)
9a	3.7 (-2.0)	2.3 (0.6)	3.9 (-1.1)	9.7 (-5.3)
9b	4.2 (-1.5)	1.9 (0.2)	3.7 (-1.3)	12.8 (-2.2)
9c	4.2 (-1.5)	2.1 (0.4)	3.6 (-1.4)	12.7 (-2.3)

Table 8 Mean Salinity (and change from existing) (ppt) at the BRFG, June-August (Low Freshwater Flow)

BRFG Alternative	West GIWW	Brazos Basin	East GIWW	Freeport Channel
Existing	3.1	0.4	3.8	15.0
3a	3.0 (-0.1)	0.6 (0.2)	2.5 (-1.2)	14.6 (-0.4)
3a.1 (Recommended Plan)	0.9 (-2.2)	0.2 (-0.2)	2.6 (-1.2)	15.1 (-0.1)
9a	1.5 (-1.6)	0.2 (-0.2)	0.3 (-3.5)	9.9 (-5.3)
9b	2.3 (-0.8)	0.4 (0.0)	1.7 (-2.1)	12.1 (-2.9)
9c	2.2 (-0.9)	0.5 (0.1)	1.7 (-2.1)	12.1 (-2.9)

Based on the modeling, the greatest salinity changes that are expected from the Action Alternatives are within the West GIWW, East GIWW, and Freeport Channel, where there would be general decreases in salinity. The average projected decrease in the West GIWW is 1.8 ppt during low freshwater flows and 2.2 ppt during high freshwater flows. Because modeled existing salinities were already low, the projected changes represent a relatively high percent decrease. As noted above, the salinity model was calibrated using data collected during a relatively wet period spanning 13 months. During drier periods, overall salinities would be higher than those identified in **Tables 7 and 8**, particularly for the West GIWW and East GIWW. Under all Action Alternatives, salinities in and near the study areas are expected to be within the broad range of an estuarine system, with lowest salinities occurring during temporary high flows in the Brazos and/or San Bernard Rivers, gradually recovering as river flows reduce. Based on this assessment, salinity changes resulting from the Action Alternatives at the BRFG are not expected to have a significant effect on estuarine habitats or wildlife in or near the study area.

At the CRL, the open channel alternative (Alternative 3b) would affect salinities more than the Recommended Plan (Refined Alternative 4b.1), which would maintain a floodgate on each side of the Colorado River. Like the BRFG alternatives, though, the CRL Action Alternatives would not be expected to affect salinities to a level that would adversely impact estuarine habitats.

5.8 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 9**. **Figures 6 through 11** 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 9 Impacts to Vegetation and Wildlife Habitats (acres)

Alternative	Developed	High Marsh	Intertidal Marsh	Tidal Flat	Upland Shrub/ Woods	Open Water[1]	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)[2]	3.1	2.4	11.4	0	14.0	94.4	**125.3**
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)[2]	12.1	0	0.7	0	11.4	61.0	**85.8**

[1] Most of the reported impacts to open water are temporary construction impacts (e.g., barge access, pile driving, turbidity, dredging). None of the Action Alternatives are expected to result in a net loss of open water habitat.
[2] BRFG Refined Alternative 3a.1 and CRL Refined Alternative 4b.1 would impact a larger footprint than initial plans because the proposed GIWW realignments extend dredging limits compared to the previously proposed temporary bypass channels.

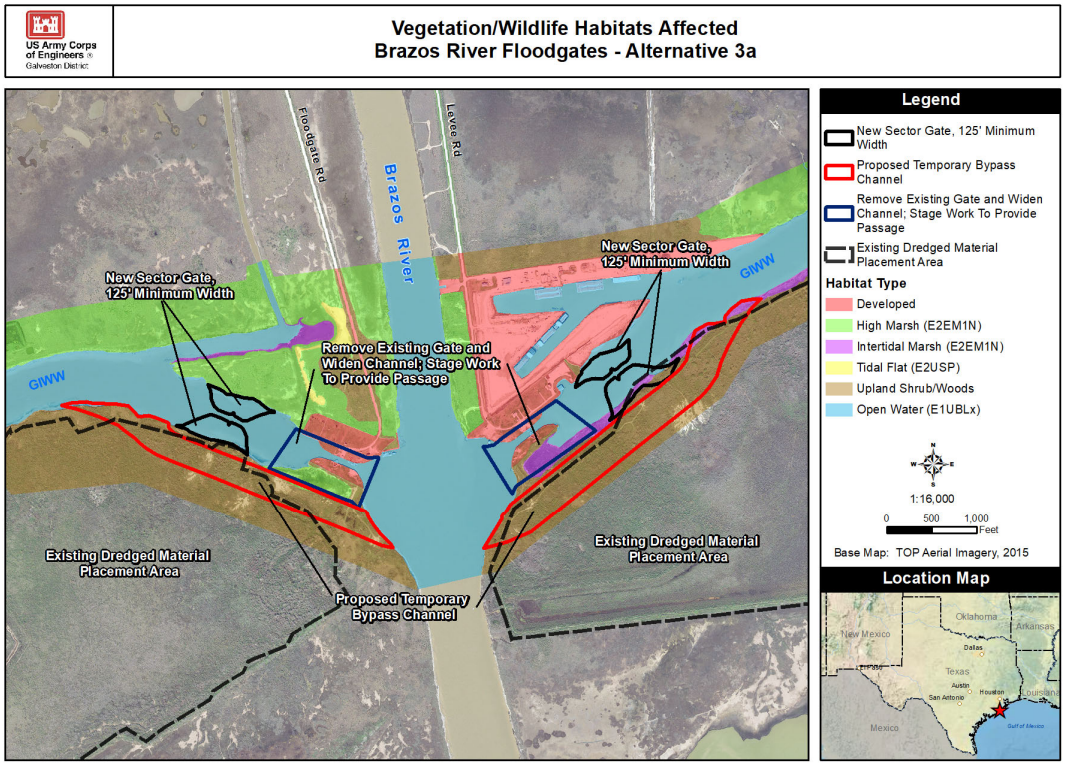

Figure 6 Vegetation/Wildlife Habitats Affected by BRFG Alternative 3a

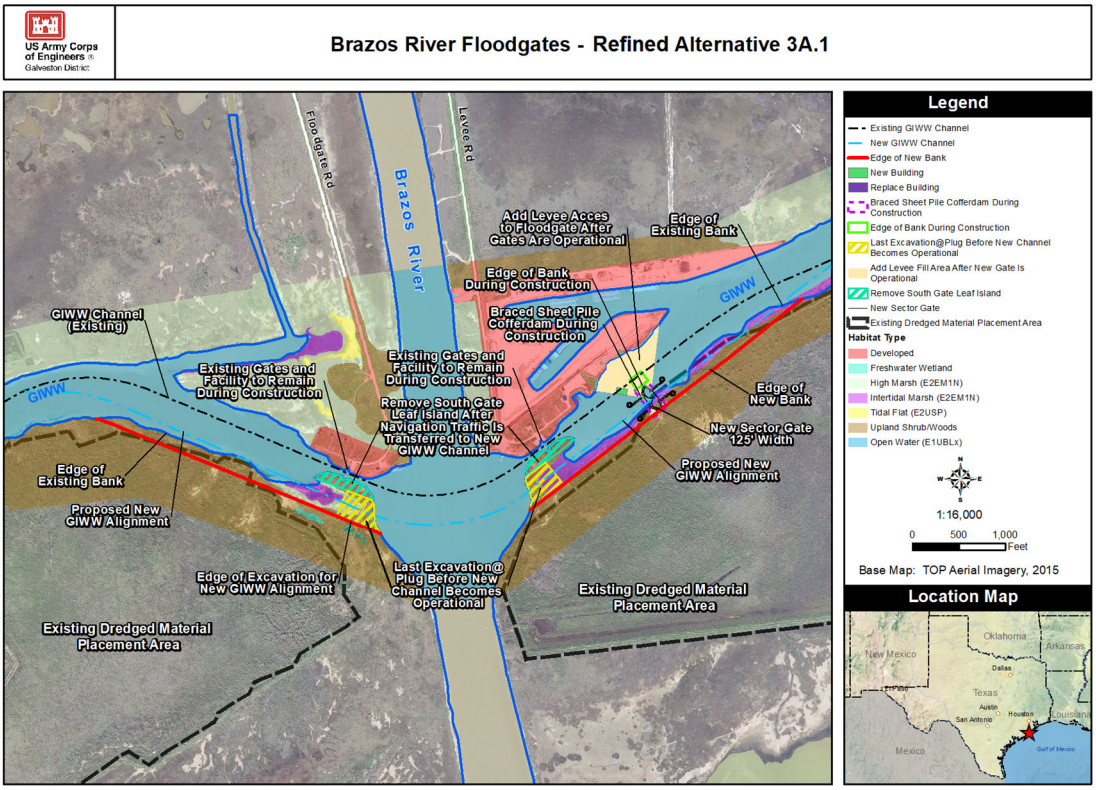

Figure 7 Vegetation/Habitats Affected by BRFG Refined Alternative 3a.1 (Recommended Plan)

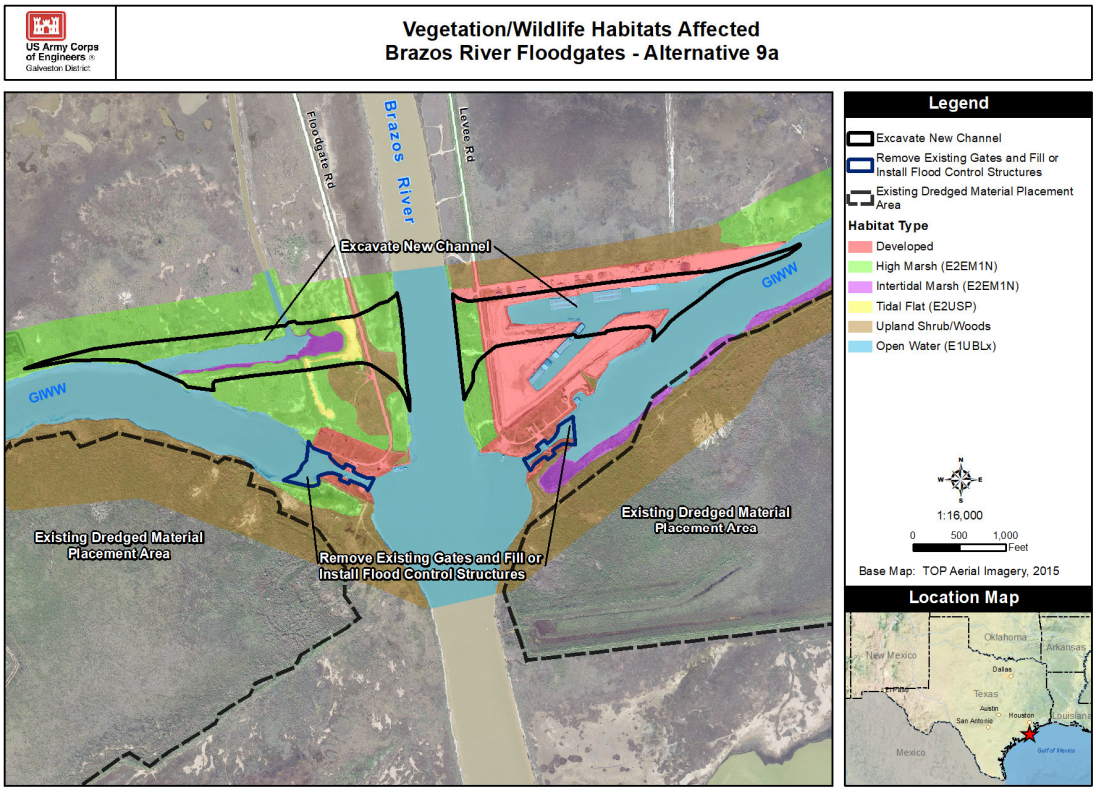

Figure 8 Vegetation/Wildlife Habitats Affected by BRFG Alternative 9a

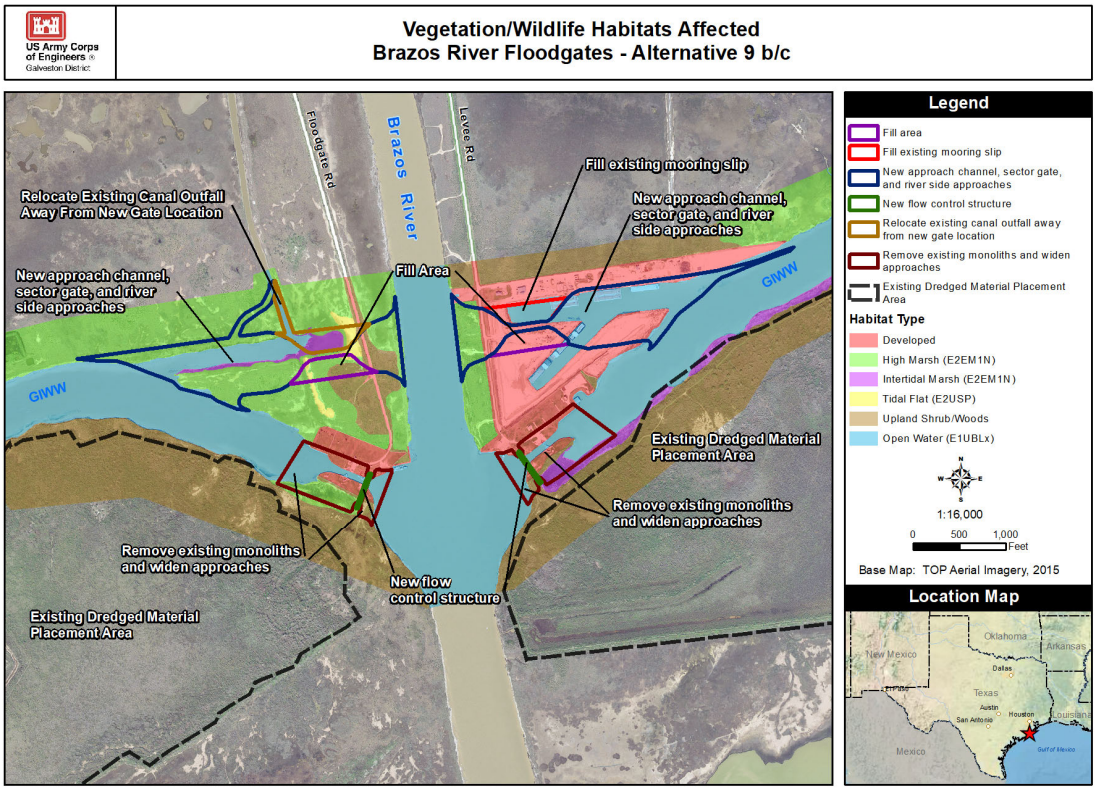

Figure 9 Vegetation/Wildlife Habitats Affected by BRFG Alternative 9b/c

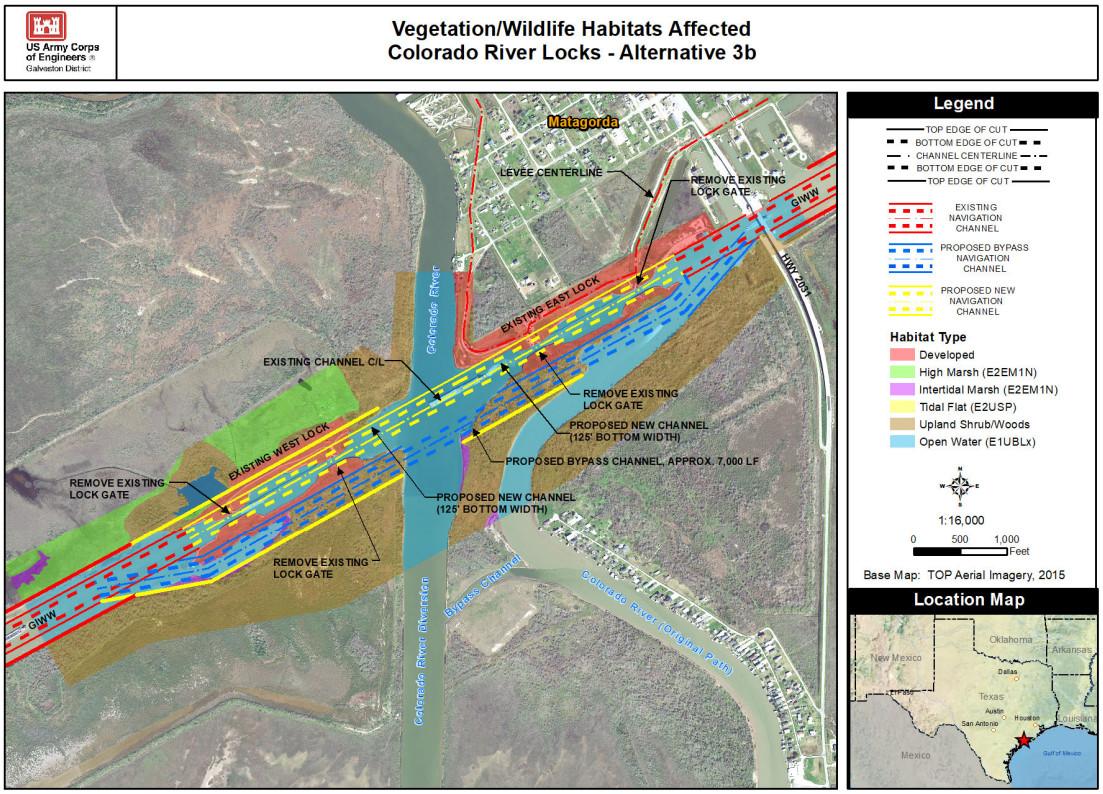

Figure 10 Vegetation/Wildlife Habitats Affected by CRL Alternative 3b

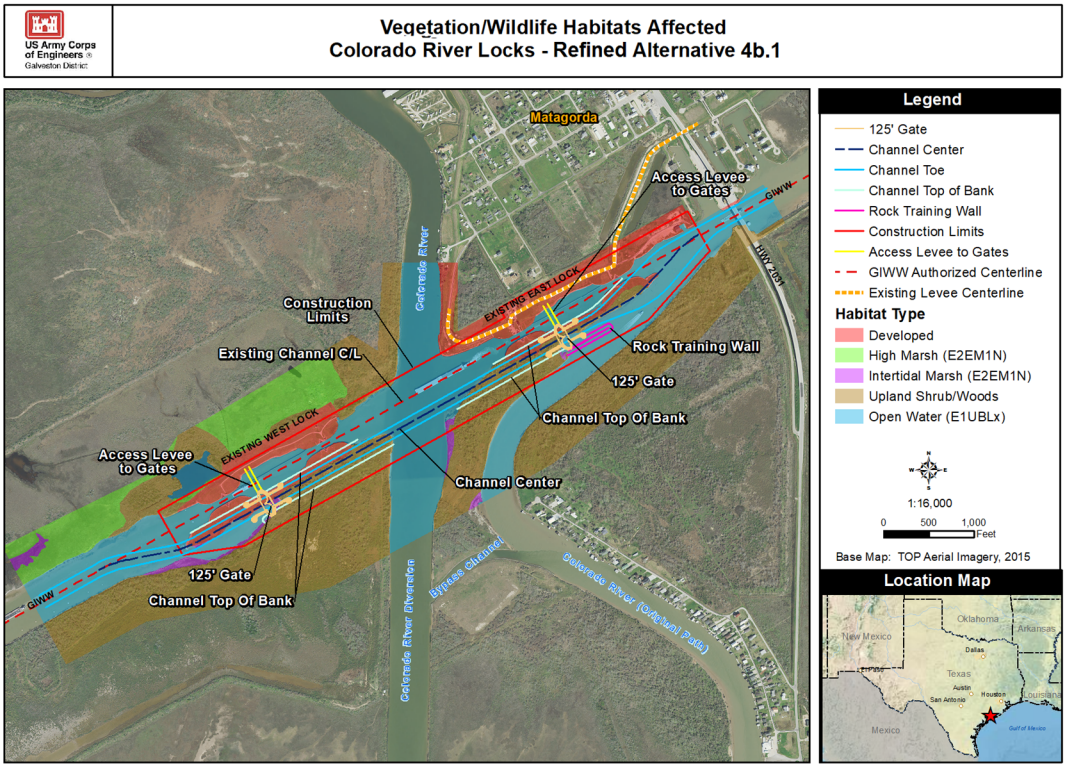

Figure 11 Vegetation/Habitats Affected by CRL Refined Alternative 4b.1 (Recommended Plan)

While some vegetation/wildlife habitats would be lost due to construction of most Action Alternatives, none of the vegetation communities are considered regionally rare, unique, or imperiled. Based on current USACE guidance and procedures, the USACE would propose mitigation only for the wetland habitats that would be impacted by the alternatives. Although the open water resources in the study areas are significant for multiple reasons (see Chapter 2 of the IFR-EIS), they are not limited resources in the region, and the Action Alternatives would not result in a net loss of open water habitats. Although the impacted upland shrub/woods habitats in the study areas provide foraging, roosting, and nesting opportunities for migratory birds protected under the Migratory Bird Treaty Act, they are not unique in this respect. In addition, the wooded habitats in the study areas consist of relatively young (<50 years) woody growth, do not constitute bottomland hardwoods or other significant woodland habitat, and contain both common and non-native shrub and tree species. Similar habitats are also common in the region. As a result, the impacted upland shrub/woods habitats are not considered significant ecological resources in the study areas.

5.9 Protected/Managed Lands and Recreational Areas

None of the BRFG or CRL Action Alternatives would impact designated parks, recreation areas, national wildlife refuges, WMAs, or other protected or managed lands. 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 removed by BRFG Alternatives 9 and 9b/c; it would not be directly impacted by Alternative 3a or Refined Alternative 3a.1 (the Recommended Plan). With any of Action Alternatives, noise during construction may make areas near the facilities temporarily less attractive to use, particularly the Levee Road Boat Ramp.

5.10 Threatened and Endangered Species

Table 10 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). In general, all Action Alternatives are expected to have similar effect determinations because they would impact similar habitats and require similar construction methods. However, the Recommended Plan and other Action Alternatives (e.g., BRFG Alternative 3a) that would construct new gate structures, guidewalls, and other components requiring major pile driving would have a higher potential to impact sea turtles due to underwater noise from pile driving than alternatives that would result in an open channel with no gate structures (e.g., BRFG Alternatives 9a and 9b/c and CRL Alternative 3b). Potential impacts to sea turtles from pile driving are discussed below and would be minimized using various to reduce sound exposure.

Table 10 Anticipated Effects of Recommended Plan on Threatened and Endangered Species

Listed Species		Listing Status[1]	Jurisdiction	Potential in Study Areas?	Effect Determination[2,3]
Common Name	**Scientific Name**				
Birds					
Northern aplomado falcon	*Falco femoralis septentrionalis*	E	USFWS	Yes	No Effect
Piping plover	*Charadrius melodus*	T	USFWS	Yes	MANLAA; No CH Modification
Red knot	*Calidris canutus rufa*	T	USFWS	Yes	MANLAA

Table 10 Anticipated Effects of Recommended Plan on Threatened and Endangered Species

Listed Species		Listing Status[1]	Jurisdiction	Potential in Study Areas?	Effect Determination[2,3]
Common Name	**Scientific Name**				
Whooping crane	*Grus americana*	E	USFWS	Yes	MANLAA
Mammals					
West Indian manatee	*Trichechus manatus*	T	USFWS	Yes	No Effect
Fin whale	*Balaenoptera physalus*	E	NMFS	No	No Effect
Humpback whale	*Megaptera novaeangliae*	E	NMFS	No	No Effect
Sei whale	*Balaenoptera borealis*	E	NMFS	No	No Effect
Sperm whale	*Physeter macrocephalus*	E	NMFS	No	No Effect
Reptiles					
Green sea turtle	*Chelonia mydas*	T	NMFS	Yes	MANLAA
Hawksbill sea turtle	*Eretmochelys imbricata*	E	USFWS; NMFS	Yes	MANLAA
Kemp's ridley sea turtle	*Lepidochelys kempii*	E	USFWS; NMFS	Yes	MANLAA
Leatherback sea turtle	*Dermochelys coriacea*	E	USFWS; NMFS	No	No Effect
Loggerhead sea turtle	*Caretta caretta*	T	USFWS; NMFS	Yes	MANLAA
Mollusks					
Golden Orb	*Quadrula aurea*	C	USFWS	No	No Effect
Smooth pimpleback	*Quadrula houstonensis*	C	USFWS	No	No Effect
Texas fawnsfoot	*Truncilla macrodon*	C	USFWS	No	No Effect
Texas pimpleback	*Quadrula petrina*	C	USFWS	No	No Effect
Corals					
Boulder star coral	*Orbicella franksi*	T	NMFS	No	No Effect
Elkhorn coral	*Acropora palmata*	T	NMFS	No	No Effect
Lobed star coral	*Orbicella annularis*	T	NMFS	No	No Effect
Mountainous star coral	*Orbicella faveolata*	T	NMFS	No	No Effect

[1] Listing status: E = Endangered, T = Threatened, C = Candidate for listing
[2] The Recommended Plan is BRFG Alternative 3a.1 and CRL Alternative 4b.1.
[3] MANLAA = May affect, not likely to adversely affect; CH = Critical habitat
Sources: National Marine Fisheries Service (NMFS) 2017; U.S. Fish and Wildlife Service (USFWS) 2017a, b, c

As identified in **Table 10**, the Recommended Plan is expected to have *no effect* on most of the listed species because they are not likely to occur 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 seven species: piping plover, red knot, whooping crane, green sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, and loggerhead sea turtle. Discussions of the effect determinations for the Recommended Plan are provided by species below. More information on impacts of the Recommended Plan on threatened and endangered species is provided in the Biological Assessment (**Attachment D-2**). The Recommended Plan (and any alternative) would be constructed in compliance with the ESA and in consultation with U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS).

Northern Aplomado Falcon

Open habitats in the study areas are limited to coastal marshes that could be used by foraging aplomado falcons, but are not their preferred habitats. No nesting sites have been documented in the study areas, and no nesting falcons are expected based on the current known nesting range and lack of suitable nesting habitat. This species is no more likely to occur in the study areas than in other similar habitats in the region. Therefore, the Recommended Plan is expected to have ***no effect*** on northern aplomado falcons.

Piping Plover and Red Knot

The Recommended Plan would not result in a direct loss of piping plover and red knot habitat at the BRFG or CRL. Designated critical habitat for the wintering piping plover, which may also be used by wintering red knots, is present along the Gulf beach near both study areas, as well as in the Colorado River delta (Delta 1) in West Matagorda Bay (see Chapter 2 of the IFR-DEIS). As discussed earlier, the Recommended Plan is projected to reduce the volume of sediment reaching the Brazos Delta, which would reduce available sediment that can be transported westward and deposited on nearby beaches. However, this impact is not expected to adversely modify critical habitat along the beaches, or otherwise impact the piping plover or red knot, because the projected sediment reduction accounts for less than 1% of the total sediment that reaches the delta, and over 44 million cubic yards would still reach the delta annually.

At the CRL, the Recommended Plan is expected to result in over 90,000 cubic yards of additional sediment deposition at Delta 1 annually, which will facilitate continued growth of the delta, associated wetlands, and piping plover and red knot habitat. As with the BRFG, the Recommended Plan at the CRL is not expected to destroy or adversely modify critical habitat.

Construction activities at both facilities will temporarily elevate noise levels; however, this is not expected to contribute to any permanent noise disturbances for piping plovers or red knots. There are no preferred habitats immediately adjacent to the proposed work areas. Overall, the Recommended Plan may have minor but discountable effects on the piping plover and red knot; therefore, the project ***may affect, but is not likely to adversely affect*** these species. The Recommended Plan is not expected to destroy or adversely modify designated critical habitat.

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. The Recommended Plan would impact salt marshes (foraging habitat), but impacts are considered low compared to the availability of salt marshes in the region, and the impacted marshes will be replaced in-kind through the project's mitigation plan. Since most whooping crane wintering occurs well south of the NEPA study areas, direct effects on the whooping crane due to habitat loss are not anticipated. Construction activities will create temporary, short-term increases in noise levels. However, whooping cranes prefer to forage away from human disturbance and would, therefore, not be likely to occur in the study areas during typical operations and maintenance of the existing facilities, nor are they expected to be present during construction activities or maintenance dredging activities. Overall, the project ***may effect, but is not likely to adversely affect*** 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, the likelihood of their occurrence in the in the NEPA study areas is considered low, and the Recommended Plan is expected to have ***no effect*** on the West Indian manatee.

Whales

Whales are generally restricted to deeper offshore waters and are not expected to occur in the NEPA study areas. Therefore, the Recommended Plan is expected to have ***no effect*** on the listed whale species.

Sea turtles

Potential impacts to sea turtles were evaluated in terms of habitat loss, dredging and turbidity, and noise and vibration. Anticipated impacts are summarized here and detailed in the Biological Assessment (**Attachment D-2**). The study areas do not contain preferred foraging habitat for sea turtles, occurrence of sea turtles in the study areas would be temporary, and measures could be implemented as needed to avoid impacting sea turtles during pile driving activities; therefore, the project ***may affect, but is not likely to adversely affect*** green, hawksbill, Kemp's ridley, and loggerhead sea turtles. The project is expected to have ***no effect*** on leatherback sea turtles because they are uncommon in Texas coastal waters and not likely to occur in the study areas.

Habitat Loss

The Recommended Plan is not expected to result in habitat loss for any sea turtle species. The open water habitats in the study areas are largely associated with the GIWW and river crossings and do not provide notable preferred foraging habitats for sea turtles. Furthermore, the Recommended Plan would result in a net increase of open water habitat.

Dredging and Turbidity

Dredging for the project would be completed using mechanical dredges and cutterhead suction dredges, and sea turtles are not known to be vulnerable to entrainment in these dredge types (NMFS 2003). As a result, adverse effects on sea turtles from dredging are discountable.

Although turbidity increases are expected during in-water activities such as dredging and pile driving, turbidity is not expected to affect sea turtle foraging habitat, as none is in the study areas. Since sea turtles breathe air, they are not particularly susceptible to increased turbidity. Based on the temporary and localized nature of turbidity increases, lack of foraging habitat in the study areas, and anticipated infrequency of sea turtles entering the construction area, effects of turbidity on sea turtles are discountable.

Noise and Vibration

The Recommended Plan would result in a temporary increase in vessel traffic during construction due to the addition of construction-related vessels. However, vessel traffic noise is not known to cause mortality or potential mortal injury to sea turtles (Popper et al. 2014). Likewise, noise from dredging equipment during construction is not expected to adversely affect sea turtles.

Noise from proposed pile driving at both sites has the potential to adversely affect sea turtles by injury and behavioral effects. Therefore, the project team estimated noise pressure levels resulting from proposed pile driving by using a model developed by NMFS' Greater Atlantic Regional Fisheries Office (GARFO) as an in-house tool for assessing potential effects on federally listed species from underwater sound produced during pile driving (NMFS 2016). For sea turtles, the GARFO model considers behavioral and physiological thresholds of 166 and 180 decibels (dB) re 1 micro-Pascal root-mean square (µPaRMS), respectively, and predicts the distance to those effects thresholds from pile driving activities, depending on pile type and size, hammer type, and water depth.

Table 11 provides estimated worst-case sound levels resulting from pile driving that may occur at the BRFG and CRL under the Recommended Plan. *Note that in some cases, actual sound levels should be*

lower because the "proxy" used in GARFO involved larger pile sizes than is proposed. As seen in **Table 11**, the estimated noise levels for all proposed pile types except guidewall timber piles exceed the injury threshold for sea turtles; this injury noise level would occur up to 30-40 meters from the pile driving. However, measures can be implemented as needed to avoid impacting sea turtles if they occur in the GIWW during construction. Measures may include:

- Implement a "soft start" for up to 20 minutes to allow sea turtles to leave the project vicinity before sound pressure increases above injury thresholds. Once noise levels reach the 166 dB RMS behavioral threshold, sea turtles are expected to leave the area and not re-enter.
- Install piles within dewatered cofferdams, providing a 5-10 dB reduction in noise levels.
- Use a vibratory hammer or cushioned impact hammer to reduce noise levels. As is seen in **Table 12**, the GARFO model estimates that noise levels would be below injury thresholds for all anticipated pile driving if a vibratory hammer is used.

Table 11 Estimated Distances to Sea Turtle Injury and Behavioral Thresholds from Pile Driving

Project Component	Pile Size and Type	Hammer Type	Distance (m) to 180 dB RMS (injury)	Distance (m) to 166 dB RMS (behavior)
Gate Structure Foundation	24" Steel Pipe	Impact	40.0	86.7
Guidewalls	12-14" Timber	Cushioned Impact	NA	18.0
End Cells	20" Steel Pipe[1]	Impact	33.3	80.0
	24" AZ Steel Sheet[2]	Impact	30.0	58.0
Needle Girder Storage	24" Concrete	Impact	NA (on land)	NA (on land)
Reservation Buildings	12-14" Timber	Impact	NA (on land)	NA (on land)
Flow Separator	24" AZ Steel Sheet[2]	Vibratory	NA	NA

[1] 20" steel pipe used as proxy; actual pile size proposed for the end cells is 18".
[2] 24" AZ steel sheet used as proxy; actual sheet pile proposed for the end cells is 20" PS-31 sheet pile.

Table 12 Estimated Distances to Sea Turtle Injury/Behavioral Thresholds from Pile Driving – *Vibratory Hammer*

Project Component	Pile Size and Type	Hammer Type	Distance (m) to 180 dB RMS (injury)	Distance (m) to 166 dB RMS (behavior)
Gate Structure Foundation	24" Steel Pipe	Vibratory	NA	53.3
Guidewalls	12-14" Timber	Vibratory	NA	NA
End Cells	20" Steel Pipe[1]	Vibratory	NA	46.7
	24" AZ Steel Sheet[2]	Vibratory	NA	NA
Needle Girder Storage	24" Concrete	Vibratory	NA (on land)	NA (on land)
Reservation Buildings	12-14" Timber	Vibratory	NA (on land)	NA (on land)
Flow Separator	24" AZ Steel Sheet[2]	Vibratory	NA	NA

[1] 20" steel pipe used as proxy; actual pile size proposed for the end cells is 18".
[2] 24" AZ steel sheet used as proxy; actual sheet pile proposed for the end cells is 20" PS-31 sheet pile.

Through informal consultation, NMFS identified additional measures that would minimize impacts to sea turtles, which include:

- Using wood cushion blocks as needed for pile driving with impact hammer to maximize attenuation of underwater noise.
- Adhering to NMFS' *Sea Turtle and Smalltooth Sawfish Construction Conditions*
- Conducting in-water work during daylight hours only

A list of additional measures to minimize impacts to other fish and wildlife resources is provided in the USFWS CAR (**Attachment D-9**).

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 NEPA study areas due to salinity fluctuations. Therefore, the Recommended Plan would have no effect on the candidate mussel species.

Corals
The listed corals are offshore species and do not occur in the NEPA study areas. Therefore, the Recommended Plan would have no effect on corals.

5.11 Other Protected Wildlife Species

The Recommended Plan and other Action Alternatives could adversely affect marine mammals (bottlenose dolphins) and migratory birds. However, under any alternative, BMPs would be incorporated into project design and construction plans to minimize impacts on dolphins, migratory birds, and other wildlife species. The following paragraphs discuss the potential effects of the Recommended Plan and associated BMPs for marine mammals, eagles, and migratory birds.

Marine Mammals
Construction of the Recommended Plan would temporarily disturb open water habitats, fill some open water areas to construct the new floodgates, and create open water areas by excavating the new GIWW alignment. Overall, the Recommended Plan and the other Action Alternatives would result in a net increase of open water habitat. Bottlenose dolphins may experience increased noise from construction vessels and increased turbidity from in-water dredging, pile driving, and other work, but these impacts are not expected to significantly affect dolphins. No blasting or sonar is anticipated during construction.

Underwater noise from pile driving can result in injury and harassment of dolphins if they are in the study area during construction. Therefore, the Recommended Plan and other Action Alternatives (e.g., BRFG Alternative 3a) that would construct new gate structures, guidewalls, and other components requiring major pile driving would have a higher potential to impact dolphins due to underwater noise from pile driving than alternatives that would result in an open channel with no gate structures (e.g., BRFG Alternatives 9a and 9b/c and CRL Alternative 3b). To estimate noise pressure levels from proposed pile-driving for the Recommended Plan, the USACE used the same NMFS GARFO model (NMFS 2016) used to assess noise impacts on sea turtles. For cetaceans, the model considers behavioral thresholds of 160 dB re 1 µPaRMS

for impulsive noises (1.e., pile driving using impact hammers) and 120 db µPaRMS for non-pulse noises (i.e., pile driving using vibratory hammers). **Table 13** provides estimated distances to cetacean behavioral thresholds resulting from pile driving that may occur at the BRFG and CRL under the Recommended Plan. *Note that in some cases, actual sound levels should be lower because the "proxy" used in GARFO involved larger pile size than is proposed.* The estimated noise levels for all proposed pile types exceed the cetacean behavioral thresholds; the distance to the behavior thresholds range from 30 to 107 meters (98 to 351 feet).

Table 13 Estimated Distances to Cetacean Behavioral Thresholds from Pile Driving

Project Component	Pile Size/Type	Hammer Type	Distance (m) to 160 dB RMS (behavior for impulsive noise)	Distance (m) to 120 dB RMS (behavior for non-pulse noise)
Gate Structure Foundation	24" Steel Pipe	Impact	106.7	86.7
Guidewalls	12-14" Timber	Cushioned Impact	30.0	18.0
End Cells	20" Steel Pipe[1]	Impact	100.0	80.0
	24" AZ Steel Sheet[2]	Impact	70.0	58.0
Needle Girder Storage	24" Concrete	Impact	NA (on land)	NA (on land)
Reservation Buildings	12-14" Timber	Impact	NA (on land)	NA (on land)
Flow Separator	24" AZ Steel Sheet[2]	Vibratory	NA	90.0

[1] 20" steel pipe used as proxy; actual pile size proposed for the end cells is 18".
[2] 24" AZ steel sheet used as proxy; actual sheet pile proposed for the end cells is 20" PS-31 sheet pile.

Although estimated noise levels exceed behavioral thresholds for cetaceans and may result in harassment of bottlenose dolphins if they come within the distances outlined in **Table 13**, dolphins are expected to avoid the areas during construction. The Marine Mammal Protection Act Report in **Attachment D-3** provides additional information regarding potential impacts to bottlenose dolphins. If needed, and in final consultation with NMFS, appropriate measures will be incorporated to minimize effects of pile driving on dolphins. Also if needed based on final consultation with NMFS, the USACE will obtain an incidental harassment authorization prior to commencement of pile driving. With the implementation of BMPs, the Recommended Plan is not expected to result in significant adverse effects to marine mammals.

Bald and Golden Eagles

Golden eagles are not expected to occur in the NEPA 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 NEPA study areas, but no bald eagle nests are in or adjacent to the NEPA study areas (Texas Natural Diversity Database 2017). An on-site habitat assessment was conducted in each study area and determined that trees in the study areas are too small to support bald eagle nests. Therefore, no nesting habitat for bald eagles is present in or adjacent to the facilities, and the Recommended Plan other Action Alternatives are not expected to affect bald or golden eagles. Prior to construction, the habitats in and adjacent to the impact area will be reassessed for the potential for bald eagle nests, and a nest survey will be conducted if needed.

Migratory Birds

The Recommended Plan and other Action Alternatives would remove wetland and upland habitats that could be used by migratory birds for various activities including nesting, foraging, loafing, and roosting.

Any alternative would be designed to minimize impacts to migratory birds by minimizing habitat removal and incorporating BMPs, if needed, to avoid removing active nests. Clearing of vegetation would also be completed outside of the nesting season (March 1 to August 31), if possible. If vegetation clearing is required during nesting season, nest surveys will be completed prior to ground disturbance.

During construction, noise from pile driving and other construction activities could affect bird use of nearby habitats and may result in temporary avoidance of habitats. However, given the mobile nature of birds, abundance of habitats in the region, and temporary nature of the construction, this impact is not expected to be significant. BMPs that are incorporated to reduce noise levels and potential impacts to sea turtles and marine mammals in consultation with the USFWS and NMFS would reduce impacts on wildlife.

5.12 Aquatic Resources

The Action Alternatives are expected to have similar impacts on benthic habitats and zooplankton, although maintenance dredging would likely result in more frequent habitat disturbances for those alternatives that substantially increase sedimentation compared to the FWOP Condition. Construction of any of the Action Alternatives would result in temporary disruption of benthic habitats in the GIWW and other dredged areas, 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 disturbed area (Newell et al. 1998), and recovery of benthic macroinvertebrates following disturbance 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 present in submerged sediments on the edge of the current channel would be destroyed, but benthic communities have been documented to recolonize within 18 months (Texas Water Resources Institute 1995). Overall, changes to benthic communities resulting from construction of the Action Alternatives, including the Recommended Plan, are expected to be minor and localized and are not expected to be significant.

After construction, effects of maintenance dredging are expected to be similar to the FWOP Condition, although dredging would likely be required more frequently for Action Alternatives that substantially increase sedimentation compared to the FWOP Condition. None of the Action Alternatives are expected to have a significant impact on zooplankton.

5.13 Commercial and Recreational Fisheries

None of the Action Alternatives are expected to have a substantial effect on commercial or recreational fisheries or fishery species. Underwater noise and vibration from pile driving associated with construction has been documented to cause hearing loss, behavioral changes, physiological effects, and even death in fish (Buehler et al. 2015), but pile driving is expected to affect a relatively small area at any one time and is not expected to result in significant impacts to fish communities. 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 resulting from the any alternative would be mitigated, and projected salinities would still support estuarine habitats and biotic communities. Under any of the Action Alternatives, the GIWW would remain

open during construction, either by a temporary bypass channel or GIWW realignment, so area waterbodies would remain accessible for recreational and commercial fishing.

5.14 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 Habitat Areas of Particular Concern (HAPCs) are in the study areas. All Action Alternatives that meet the project's purpose and need would remove tidal wetlands that provide EFH (see **Table 6** above), but the USACE would provide mitigation for those losses in coordination with NMFS. All Action Alternatives would affect open water areas and bottom sediments, but most of those impacts would consist of temporary temporary construction impacts (e.g., barge access, pile driving, dredging, and turbidity). Overall, all Action Alternatives would result in similar to higher acreages of open water in the study areas. None of the alternatives are expected to have long-term or significant impacts on EFH or managed species. The EFH Assessment Report in **Attachment D-4** provides additional information on anticipated impacts of the Recommended Plan on EFH and managed species.

5.15 Coastal Barrier Resources and Coastal Natural Resource Areas

The Recommended Plan and other Action Alternatives would affect coastal barrier resources and CNRAs; however, they would not substantially change the overall coastal environment. None of the Action Alternatives are expected to change development rates or patterns or induce growth on barrier islands, so development trends in coastal areas are expected to be similar to the FWOP Condition.

Coastal Barrier Resource System (CBRS) units are near but not within the CRL study area; therefore, none of the work associated with the Action Alternatives at the CRL would occur within CBRS units or affect the CBRS. At the BRFG, all Action Alternatives would result in some work that would affect CBRS Units T05 and T05P. The stated purpose of the CBRA is to "minimize the loss of human life, wasteful expenditure of Federal revenues, and the damage to fish, wildlife, and other natural resources associated with the coastal barriers....by restricting future Federal expenditures and financial assistance which have the effect of encouraging development of coastal barriers…." (16 U.S.C. § 3501(b)). The CBRA prohibits government expenditures on new projects within certain identified CBRS units unless they fit certain exceptions found within 16 U.S.C. §3505. The CBRA provides that the general prohibition on federal expenditures affecting the system include the construction of structures in CBRA units (§3504(a)(3)).

A navigation exception at 16 U.S.C. 3505(a)(2) provides an exception for "the maintenance or construction of improvements of existing Federal navigation channels (including the Intracoastal Waterway) and related structures (such as jetties), including the disposal of dredge materials related to such maintenance or construction." Based on the definition in Section 6(b) of the statute, the exception applies only to maintenance or construction of improvements of existing Federal navigation channels and to maintenance or construction of improvements of existing related structures such as jetties. Existing channels are those authorized before the designation of the coastal barrier resource units that the authorized channels may traverse or impact.

Federal agencies are required to consult with the USFWS on the applicability of CBRA exceptions and for written comment on planned expenditures for an action excepted under CBRA, 16 U.S.C. §3505(a). Compliance rests with the Federal officer responsible for making the funds available for the action. The USACE has determined that the GIWW is an existing channel subject to the Navigation Exception and USFWS provided a letter of concurrence with the USACE's determination (**Appendix D-10**).

The Recommended Plan and all other Action Alternatives would affect CNRAs protected by the TCMP, including coastal barriers, shore areas, wetlands, and special hazard areas (floodplains). Commensurate mitigation would be provided for wetland losses. The USACE has determined that the Recommended Plan complies with the TCMP and would be conducted in a manner consistent with all rules and regulations of the program. **Attachment D** provides a TCMP Consistency Determination for the Recommended Plan.

5.16 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. The disturbance areas associated with the Recommended Plan and other Action Alternatives are largely within previously disturbed areas in and adjacent to the GIWW 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 Area of Potential Effects (APE) for the BRFG and CRL facilities (see Historic Resources Survey Report in **Attachment D-6**). 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 National Park Service (NPS) criteria for NRHP eligibility (see Chapter 2 in the IFR-EIS). On January 23, 2019, the Texas State Historic Preservation Office concurred with the USACE's determination that none of the non-archeological historic properties in the APE are eligible for listing on the NRHP (see consultation letter in **Attachment D-10**). As a result, none of the Action Alternatives would adversely affect non-archeological historic resources.

5.17 Air Quality

Under the Recommended Plan and other Action Alternatives, air emissions would be from construction equipment associated with the project (e.g., dredging equipment, pile-driving equipment, support boats, and land-based construction equipment), and from personal vehicles for workers traveling to the project sites. The equipment will emit air pollutants and greenhouse gases (GHGs). Air emissions from new construction would not occur at the same time as O&M 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 in an attainment area for all National Ambient Air Quality Standards (NAAQS), so no specific emissions determination is needed for Recommended Plan or other alternatives at the CRL. Since the BRFG facility is in the HGB ozone moderate nonattainment area, calculations of projected pollutant emissions from construction are required to determine if they exceed the General Conformity de minimis threshold, which is 100 tons per year (tpy) for the ozone precursors NO_x and VOCs (2008 8-hour standard). If projected emissions for either pollutant exceed 100 tpy, then a General Conformity Determination is required.

When this report was prepared, the Recommended Plan design, construction plan (including equipment needs), and schedule were not developed with enough detail to accurately estimate pollutant emissions at the BRFG. However, a qualitative estimate of emissions was made by comparing the Recommended Plan to the USACE Galveston District's reevaluation of the nearby Freeport Harbor Channel Improvement Project (FHCIP, USACE 2017). Construction of the additional features addressed in the FHCIP re-evaluation was expected to be completed in one calendar year and projected to result in 115.31 tpy of NO_x emissions and 2.61 tpy of VOC emissions, thereby requiring a General Conformity Determination for the NO_x emissions. Of the projected NO_x 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 over 8 months, and a 1-year construction duration.

Construction of the Recommended Plan at the BRFG is expected to use similar equipment as the FHCIP, including marine equipment (hydraulic cutterhead dredge, crane with pile driver, support equipment such as tugboats, spill barge, and crew boats) and land-based equipment (off-road construction equipment and on-road vehicles). Comparing estimated dredging and pile quantities and construction schedule to the FHCIP, the BRFG Recommended Plan involves:

- 1,022,000 cubic yards dredging quantity (52% of FHCIP)
- 930 feet of sheet pile and 794 other piles of various types/sizes (7 months of pile driving)
- 2-year construction duration

Based on these quantities, the emissions of NO_x and VOCs may be similar to less than the FHCIP re-evaluation estimates, but the BRFG emissions would be spread over a 2-year construction period instead of a 1-year period. This qualitative analysis indicates that NO_x emissions from the Recommended Plan would not exceed 100 tpy at the BRFG and would not require a General Conformity Determination. Therefore, the Recommended Plan would not have a significant adverse effect on air quality.

During the Pre-construction Engineering and Design (PED) phase, the project design, construction plans, and schedule will be completed, and the USACE will calculate emissions and coordinate them with the TCEQ and EPA to verify that they are below de minimis and do not require a Conformity Determination. If calculated emissions exceed de minimis thresholds, the USACE would conduct and coordinate a General Conformity Determination pursuant to the Clean Air Act, Section 176(c)(1), to document that emissions would be in conformity with the SIP for the HGB ozone nonattainment area.

5.18 Noise

None of the Action Alternatives would not result in new permanent noise sources. However, elevated noise levels would occur near both study areas during construction. Noise from most construction activities is expected to be minor and not expected to extend beyond the study areas such that they would affect residences or other noise-sensitive receptors. However, noise from pile driving could extend farther; therefore, the Recommended Plan and other Action Alternatives (e.g., BRFG Alternative 3a) that would construct new gate structures, guidewalls, and other components requiring major pile driving would have a higher potential to impact noise-sensitive receptors than alternatives that would result in an open channel with no gate structures (e.g., BRFG Alternatives 9a and 9b/c and CRL Alternative 3b). Depending on methods and equipment used, pile driving can produce noise levels as high as 110 dBA up to 20 feet from the source, which is considered extremely loud and can cause hearing damage if exposed for a long enough period without protection. Sound levels decrease approximately 6 dBA for every doubling of distance from the source. At this rate, a noise level of 110 dBA would require 2,560 feet (0.5 mile) to be at or below 70 dBA, assuming there are no physical features that abate the noise within this distance.

At the BRFG, the nearest residences are approximately 2.5 miles to the east, so noise from pile driving or other construction activities at the BRFG is not expected to adversely affect residences. Construction noise could affect workers at the adjacent Texas Boat & Barge, Inc. facility, so coordination of construction activities with that business would be conducted as needed. Construction noise could affect users of Justin Hurst WMA and Levee Road Boat Ramp, but any effects are expected to be minor and temporary due to their distance from the anticipated pile driving area and temporary use of those recreational facilities.

At the CRL, a number of residences are within 0.5 mile of the east lock, with the closest being about 600 feet from the east gate proposed under the Recommended Plan. Therefore, they could experience elevated noise levels from pile driving. Noise levels to the north of the CRL would be mitigated to some extent by the Matagorda ring levee, which is roughly 20 feet high, and residences to the south of the CRL would be buffered by trees and DMPAs. As such, noise impacts are not expected to be significant, but monitoring should be considered during PED and project implementation.

5.19 Oil, Gas, and Minerals

Neither the Recommended Plan nor other Action Alternatives are expected to affect existing, or induce new, oil and gas wells or pipelines in the BRFG or CRL vicinity. Likewise, none of the BRFG alternatives would affect the Bryan Mound Strategic Petroleum Reserve. All Action Alternatives would be similar to the FWOP Condition in terms of oil, gas, and mineral resources.

5.20 Hazardous, Toxic, and Radioactive Waste

A feasibility-level HTRW evaluation found no sites that had recognized environmental conditions (RECs) (**Attachment D-7**). The BRFG and CRL were built in 1943 and 1944, respectively, when industrial marine facilities were coated in lead paint and buildings were constructed using asbestos-containing materials. Depending on the repairs and rehabilitation projects done at the facilities, lead paint and asbestos may still be present. Other than the potential for lead paint and asbestos, 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. Hurricane Harvey, which affected the Gulf coast and the project sites in August-September 2017, increased the potential for encountering contaminated sediment from flooded cleanup sites or industrial facilities.

Under the Recommended Plan and all other Action Alternatives, testing for lead paint and asbestos would be conducted at the BRFG and CRL during the PED phase, prior to removal of existing gate structures and buildings. If lead paint or asbestos is found, removal of structures would be conducted using appropriate handling procedures, and the materials would be disposed of at an approved facility. Sediment sampling at both facilities would also be conducted during the PED phase, prior to construction, to characterize any contaminants present. If contaminated, the material would be disposed of in accordance with applicable local, state, and federal permits, statutes, and regulations.

In addition to the above concerns, Alternatives 9a and 9b/c would affect Texas Boat & Barge, Inc. Therefore, other soil testing may be needed in upland areas of the site under those alternatives. Any contaminated materials would be disposed of in accordance with applicable local, state, and federal permits, statutes, and regulations.

5.21 Socioeconomic and Human Resources

The Recommended Plan and other Action Alternatives are not expected to impact minority or low-income populations. The duration of the construction would be relatively short (two years at each facility), and therefore, it is not expected that workers would temporarily relocate to the project areas; 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 in the general area, similar to the FWOP Condition. Any alternative would be constructed to 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 and CRL areas. Although the Recommended Plan and other Action Alternatives would result in higher maintenance dredging costs due to increased sedimentation, these costs have been accounted for the economic analysis of the alternatives, and the Recommended Plan and other alternatives would have overall economic benefits compared to the No Action Alternative.

5.22 Indirect and Cumulative Impacts

Indirect and cumulative impacts of the Recommended Plan are addressed in Chapter 5 the FR-EIS.

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ATTACHMENTS