



**DEPARTMENT OF THE ARMY**  
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WASHINGTON, D.C. 20310-2600

DAEN

SEP 16 2021

SUBJECT: Coastal Texas Protection and Restoration

THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress my report on coastal Texas protection and restoration which includes the coastal communities and shoreline of Texas. It is accompanied by the report of the Galveston District Commander. These reports are an interim response to a resolution from the Committee on Environment and Public Works dated June 23, 2004, entitled "Coastal Texas Protection and Restoration Study." The resolution provides for a study to "develop a comprehensive plan for severe erosion along coastal Texas for the purposes of shoreline erosion and coastal storm damages, providing for environmental restoration and protection, increasing natural sediment supply to coast, restoring and preserving marshes and wetlands, improving water quality, and other related purposes to the interrelated ecosystem along the coastal Texas area." Preconstruction engineering and design (PED) activities, if funded, would be continued under the authority provided by the resolution cited above.
2. The reporting officers recommend a systemwide risk management strategy for the coastline of Texas integrating structural and non-structural coastal storm damage risk reduction actions with ecosystem restoration actions to enhance the resiliency of coastal communities and the living shoreline from coastal storms. The recommended plan is hereinafter referred to as the Coastal Texas Resiliency Improvement Plan (CTRiP).
3. The location of potential improvements or other alternative plans were limited to areas within the Texas Coastal Zone Boundary. Texas has 367 miles of coastline within which 21 major river basins terminate. The Texas shoreline is characterized by seven barrier islands (Galveston, Follets, Matagorda, St. Joseph's (San José), Mustang, Padre, and Brazos), with 12 National Wildlife Refuges and 35 Coastal Barrier Resources Act (CBRA) Units (totaling 702,879 acres) under Department of Interior management. Bolivar Peninsula also acts like a barrier island due to its location along the Gulf shoreline. The CTRiP was developed using a comprehensive approach that resulted in robust multiple lines of defense to provide redundancy and resiliency against future storm and erosion damage.
4. The reporting officers recommend a combined National Economic Development (NED) Plan and National Ecosystem Restoration (NER) Federal Plan that includes coastal storm risk management (CSRm) and ecosystem restoration (ER) features functioning as a system to reduce the risk of coastal storm damages to natural and man-made infrastructure and to restore degraded coastal wetlands. Several ER

DAEN  
SUBJECT: Coastal Texas Protection and Restoration

features are expected to perform alongside features in the State's Coastal Resiliency Master Plan to fill in gaps for a resilient and comprehensive approach to risk reduction and restoration along the Texas Coast. The CTRiP was developed by region identifying elements to be cost-effective, technically sound, and environmentally and socially acceptable. The four regions were the Upper Texas Coast (Region 1) which includes Orange, Jefferson, Chambers, Harris, Galveston, and Brazoria Counties; the Mid to Upper Texas Coast (Region 2) which includes Matagorda, Jackson, Victoria, and Calhoun Counties; the Mid Texas Coast (Region 3) which includes Aransas, Refugio, San Patricio, Nueces, and Kleberg Counties; and the Lower Texas Coast (Region 4) which includes Kenedy, Willacy, and Cameron Counties.

5. The NED Plan consists of the following elements, with elevations subject to revision during the PED phase:

a. Galveston Bay Storm Surge Barrier System (Region 1). This system includes a Gulf line of defense which separates the Galveston Bay system from the Gulf of Mexico to reduce storm surge volumes entering the Bay system, and Bay defenses which enable the system to manage residual risk from Bay waters already in Galveston Bay.

i. Gulf Defenses. The Gulf defenses include three independent but connected features:

- The Bolivar Roads Gate System, across the entrance to the Houston Ship Channel, between Bolivar Peninsula and Galveston Island. The six primary features of the gate system include: a levee segment to tie into the dune system proposed on Bolivar Peninsula; a combi-wall, to connect the levee segment to the shallow water environmental gates; shallow water environmental gates, connecting the combi-wall to the vertical lift gates, facilitating normal tidal flow and circulation; vertical lift gates, located on either side of the proposed navigation sector gates, further facilitating normal tidal flow and circulation; navigable floating sector gates, accommodating both recreational and commercial navigation traffic within Bolivar Roads and the Houston-Galveston Navigation Channels entrance channel; and an Operations Center and Auxiliary Operations Center, to support day-to-day operation of the overall complex. The elevations of walls and gates were set at an elevation of 21.5 feet North American Vertical Datum of 1988 (NAVD88), based on total water levels which consists of still water level and wave overtopping for a one percent annual exceedance probability (AEP) under intermediate sea level rise conditions. The tie-in levee is designed to an elevation of 14 feet NAVD88 with a 1:3 vertical to horizontal (V:H) slope on the bayside and a 1V:6H slope on the Gulf side with stone protection. The levee height transitions to a final height of 21 feet NAVD88 at the start of the combi-wall;

- The West Galveston and Bolivar Peninsula Beach and Dune System. This is a natural and nature-based feature (NNBF) consisting of 43 miles of beach and dune segments on Bolivar Peninsula and West Galveston Island that work with the Bolivar Roads Gate System to form a continuous line of defense against Gulf of Mexico surge,

DAEN  
SUBJECT: Coastal Texas Protection and Restoration

preventing or reducing storm surge volumes that would enter the Bay system. The recommendation is a dual dune system, consisting of a 14 feet NAVD88 landward dune and a 12 feet NAVD88 Gulfward dune. The dune systems would be planted with grass species used along the Texas coast for dune construction. A typical 180 feet wide berm/beach is included. The West Galveston beach and dune system would start at the end of the existing Galveston seawall and continue westerly for 18 miles ending at San Luis Pass. The Bolivar Peninsula beach and dune system ties into the McFaddin National Wildlife Refuge Beach Ridge Restoration Project, which starts approximately two miles east of State Highway 87 and continues southwest for 25 miles to the end of Biscayne Beach Road, where the system will tie-into an earthen levee system associated with the east side of the Bolivar Roads Gate System. The dune systems will require 22.14 million cubic yards (mcy) of sand for initial beach and dune construction along Bolivar peninsula and 17.19 mcy of sand for initial beach and dune construction along West Galveston. Approximately 21.56 mcy will be needed for periodic nourishment every 6 years along Bolivar Peninsula and every 7 years on West Galveston, over a 50-year project life; and

- Improvements to the existing 10-mile seawall on Galveston Island to complete the continuous line of defense against Gulf surge. The recommendation is to increase the height of 7.7 miles of the existing seawall to reach a uniform level of protection of 21.0 feet NAVD88.

ii. Bay Defenses. The Bay defenses include four independent but connected features:

- The Galveston Ring Barrier System consists of a system of floodwalls and gates at an elevation of 14.0 feet NAVD88, pump stations, and levee sections, is proposed to address the residual risk that persists for the area because of wind driven storm surges from the Bay and provides flood risk management for approximately 15.8 square miles of the City of Galveston. The system includes ten miles of floodwall; a sector gate at Offatts Bayou; 34 gates at roadways; seven gates at rail crossings; dredging of Crash Boat Basin; 16 drainage structures; a 4,500 cubic feet per second (cfs) pump station at Offatts Bayou; a 50 cfs pump station for the 24 inch gas pipeline at the Galveston Causeway (I-45) as it enters Galveston Island; nonstructural measures in Channelview; offshore breakwaters; a 5,000 cfs pump station at 48th Street; a 1,500 cfs pump station at Pier 19; a 5,000 cfs pump station at University of Texas Medical Branch; and a 500 cfs pump station at Fort Point Road. The pumps are initially designed to handle 25-year rainfall with surge tail water boundary conditions of one percent AEP;

- The Clear Lake Gate System and Pump Station consists of a gated closure structure, associated barrier walls, and a pump station to address the residual risk that persists in the Clear Lake area. The floodwall and closure structure would start on the west side of State Highway 146, near NASA Road 1, and end on the south side of the outlet, near Marina Bay Drive west of State Highway 146. It will reduce surge

DAEN  
SUBJECT: Coastal Texas Protection and Restoration

volumes that push into neighborhoods around the critical industrial facilities that line Galveston Bay. It includes a 75 feet sector gate at Clear Lake with a sill elevation of -10 feet mean lower low water (MLLW) to match the authorized width and depth of the channel, 9,950 linear feet of floodwall; a 20,000 cfs pump station; and a secondary outlet. The elevation of the walls and gates are at an elevation of 17.0 ft (NAVD88);

- The Dickinson Bay Gate System and Pump Station consists of a gated closure structure, associated barrier walls, and a pump station to address the residual risk that persists for low-lying structures along Dickinson Bayou. The floodwall and closure structure would start on the west side of State Highway 146, near Avenue T, and end on the south side of the bayou, near Waterman's Harbor west of State Highway 146. The design includes a 100-foot sector gate with a sill elevation of -9 MLLW, to match the authorized depth of the channel, and a pump station with a design capacity of 19,500 cfs. The gate width is 40 feet wider than the authorized channel width of 60 feet to allow for additional flow area and conveyance. The elevation of the walls and gates are at an elevation of 18.0 feet NAVD88; and

- Nonstructural measures are proposed for the west side of Galveston Bay, north of the Texas City hurricane protection levees, to address the residual risk that persists for the area because of wind driven storm surges from the Bay. The nonstructural measures include elevation of 1,755 residential structures and floodproofing of 170 non-residential structures.

iii. The Galveston Bay Storm Surge Barrier System integrates with a NNBF for Bolivar Peninsula and the East Bay Gulf Intracoastal Waterway, which protects the shoreline from erosion and restores marshes and oyster reefs which enhance the resiliency of proposed adjacent CSRMs. This feature is discussed in more detail as part of the NER Federal Plan.

b. South Padre Island Beach Nourishment and Sediment Management which includes beach and dune nourishment to maintain a 120 feet wide beach and 12.5 feet NAVD88 dune along 2.9 miles of developed shorefront areas of South Padre Island, from approximately East Sunny Isle Drive and East Marisol Street to the beginning of Andy Bowie Park. Renourishment is proposed on a 10-year cycle for the authorized project life of 50 years. This feature will reduce risks from coastal storm surge to businesses, residents, and infrastructure, maintain nesting habitat for sea turtles and birds, and provide incidental recreation benefits to users of three reaches of the South Padre Island beach.

6. The NER Federal Plan works in concert with the proposed CSRMs features to provide redundant and resilient protection to and for Texas' coastal ecosystems and the communities nearby. These features fit into the multiple lines of defense strategy. The first line of defense is the barrier system, and the NER Federal Plan considered the ecological and geomorphic functions of barrier shorelines, islands, and headlands as well as barrier beach, dune, and back marsh. The second line of defense is the

DAEN

SUBJECT: Coastal Texas Protection and Restoration

estuarine bay system, and the NER Federal Plan considered ecological and geomorphic functions of bay shorelines and estuarine marsh, bird rookery islands, oyster reefs, and seagrass beds. The third line of defense is the bayhead deltas and the NER Federal Plan considered ecological and geomorphic functions of bayhead deltaic features and associated habitats including adjacent bird rookery islands, reefs, subaquatic vegetation, and marsh. The NER Federal Plan includes:

a. Bolivar Peninsula and West Bay Gulf Intracoastal Waterway (GIWW) Shoreline and Island Protection (Region 1). This NNBF includes construction of 40.4 miles of rock breakwater at a crest height of 7 feet NAVD88 that will reduce erosion of unprotected segments of shoreline along the GIWW on Bolivar Peninsula and along the north shore of West Bay. Sediment from dredging the GIWW and the Bolivar Roads Gate System construction will be used to recreate 326 acres of island surface that once protected approximately 5 miles of the GIWW and the mainland in West Galveston Bay. The addition of 18 acres of oyster cultch will act as a natural breakwater to restore protection to the island on the bayside and provide critical habitat. A total of 1,295.4 average habitat units (AAHU) would be created;

b. Follets Island Gulf Beach and Dune Restoration (Region 1). This element includes restoration of the existing beach and dune complex on 10.1 miles of Gulf shoreline on Follets Island in Brazoria County. The dune would have a crest elevation of 9 feet NAVD88 and a width of 12 feet. The nourished beach width would be approximately 400 feet. This element would create habitat and protect beaches and dunes from breaches and erosion caused by storm surge and exacerbated by relative sea level rise. This element would also provide incidental risk reduction for State Highway 257, which is the only evacuation route for this area. Construction of the beach and dunes on Follets Island will also protect Bastrop, Christmas, and Drum Bays, and the Brazoria National Wildlife Refuge. A total of 240.1 AAHU would be created;

c. Bastrop Bay, Oyster Lake, West Bay, and GIWW Shoreline Protection (Region 1). This element involves 43.2 miles of rock breakwater at a crest height of 7 feet NAVD88 and 551 acres of marsh nourishment. The construction of the rock breakwaters will reduce erosion along critical shoreline on the western side of West Galveston Bay and Cowtrap Lakes, and for about 40 miles of GIWW in Brazoria County. The element will protect critical reaches in Oyster Lake from breaching into West Bay by adding about 3,700 feet of oyster cultch to encourage the creation of oyster reef. Sediment from the GIWW will be used for marsh restoration and nourishment. A total of 1,297.5 AAHU would be created.

d. East Matagorda Bay Shoreline Protection (Region 1). This element consists of rock breakwater at a crest height of 7 feet NAVD88 to reduce erosion at 12.4 miles of unprotected segments of the GIWW shoreline and associated marsh along the Big Boggy National Wildlife Refuge shoreline and eastward to the end of East Matagorda Bay. Sediment from the GIWW or Placement Area 8 would also be used to restore a 96-acre island that once protected 3.5 miles of shoreline directly in front the of Big Boggy

DAEN  
SUBJECT: Coastal Texas Protection and Restoration

National Wildlife Refuge. Oyster cultch will be placed on the bayside of the island to act as a natural breakwater to restore protection to the island. In addition to the 96 acres of island restoration, the element also provides 236.5 acres of wetland and marsh restoration and 3.7 miles of oyster reef creation. A total of 481.5 AAHU would be created;

e. Keller Bay Restoration (Region 2). This element consists of the construction of 3.8 miles of rock breakwaters at a crest height of 7 feet NAVD88 and 2.3 miles of oyster reef creation through the placement of reef balls along 2.3 miles of Sand Point in Lavaca Bay to reduce erosion along approximately five miles of Matagorda Bay shoreline adjacent to Keller Bay and to aid in the protection of submerged aquatic vegetation that occurs within Keller Bay. The element would prevent Matagorda Bay from breaching into Keller Bay, with subsequent loss of intertidal marsh, submerged aquatic vegetation beds, and oyster reef in Keller Bay. A total of 240.1 AAHU would be created;

f. Powderhorn Shoreline Protection and Wetland Restoration (Region 2). This element consists of the construction of 5.0 miles of rock breakwaters at a crest height of 7 feet NAVD88 and creation of 529 acres of wetlands to restore marshes and reduce erosion along approximately 6.5 miles of Matagorda Bay shoreline fronting portions of the community of Indianola, Powderhorn Lake estuary, and Texas Parks and Wildlife Department's Powderhorn Ranch. A total of 18.4 AAHU would be created;

g. Redfish Bay Protection and Enhancement (Region 3). This element includes the construction of 7.4 miles of rock breakwater at a crest height of 7 feet NAVD88, 391.4 acres of island restoration, and 1.4 miles of oyster reef creation within the Redfish Bay island complex. The element provides for the restoration of the Dagger, Ransom, and Stedman Island complex in Redfish Bay and would protect and expand the remaining submerged aquatic vegetation within Redfish Bay. A total of 3,500.5 AAHU would be created;

h. Port Mansfield Channel, Island Rookery, and Hydrologic Restoration (Region 4). This element will restore hydrologic connectivity and provide beach nourishment, island restoration, sediment management, and shoreline protection and restoration utilizing breakwaters. A total of 13,936.6 AAHU would be created. The element consists of:

i. Restoration and maintenance of the hydrologic connection between Brazos Santiago Pass and the Port Mansfield Channel by one-time dredging 6.9 miles of the Port Mansfield Ship Channel, providing 112,864.1 acres of hydrologic restoration in the Lower Laguna Madre;

ii. 9.5 miles of beach nourishment along the Gulf shoreline north of the Port Mansfield Channel using the beach quality sand from the above-described dredging; and

DAEN

SUBJECT: Coastal Texas Protection and Restoration

iii. Protection and restoration of Mansfield Island with the construction of a 0.7-mile rock breakwater and placement of sediment from the Port Mansfield Channel to create 27.8 acres of island surface at an elevation of 7.5 feet NAVD88.

7. The CTRiP would have some adverse impacts to the environment and mitigation is required. A mitigation plan is included in the recommendation to replace the lost functions and values of impacted areas through restoration or enhancement activities that increase and/or improve the habitat functions and services within a mitigation site. Mitigation will be required for 1,577.6 acres of direct and indirect impacts to wetlands and oyster reefs. Over 1,378 acres of habitat will be created or restored to offset the direct and indirect impacts of the proposed plan. With feature refinement for the CTRiP expected to continue in the PED phase, the final size and location of the mitigation measures (width, length etc.) may change. However, due to the conservative nature of engineering and economic assumptions used in the development of the CTRiP, it is anticipated that design refinements of the proposed structures will result in equal or lesser environmental impacts than currently estimated. The first cost for mitigation for CSR features is \$114,451,000. In addition, adaptive management and monitoring activities included in the mitigation plan would address ecological and other uncertainties that could prevent successful implementation of mitigation project measures. As part of the development of supplemental National Environmental Policy Act (NEPA) documents, the U.S. Army Corps of Engineers (USACE) will coordinate with resource agencies and others to identify any maintenance windows, gate closure notification procedures, or other mitigating strategies that could help avoid and minimize environmental and navigation impacts. Public review and comment periods will be part of supplemental NEPA compliance efforts.

8. The CEQ's "Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act" (40 CFR 1500 – 1508) and USACE regulations at 33 CFR 230.13 allow NEPA studies for large and complex projects, such as the CTRiP, to be carried out in a multi-stage or tiered process. This tiered approach involves the preparation of a comprehensive plan-level NEPA document, in this instance the Final Environmental Impact Statement (FEIS) accompanying the reporting officers' report, that makes broad level decisions while considering the full range of potential effects to both the human and natural environments of the entire plan. This "Tier One" EIS presents the information considered in selecting the recommended plan from among the range of reasonable alternatives identified for providing comprehensive coastal storm risk management and ecosystem restoration within the study area and identifies data gaps and plans to supplement the data needed to better understand the direct, indirect, and cumulative effects of the recommended plan. The Tier One measures will be refined during PED to improve project performance and minimize environmental and social impacts. The scope of these refinements may include modifications to the following systems as described in the FEIS and may include: previously authorized USACE projects (e.g., Houston Ship Channel, Galveston Island seawall, Clear Creek flood risk management) in the proposed project footprint; sediment sources and disposal sites identified in reporting officers' report; and other modifications as

DAEN  
SUBJECT: Coastal Texas Protection and Restoration

described in engineering appendices to achieve the performance of the CTRiP. Once refinements are made and additional information are gathered during the PED phase, USACE will update the impact assessments and prepare additional NEPA documents (either an EIS or Environmental Assessment) that supplement the Tier One EIS. The updated assessments will disclose site-specific impacts associated with the proposed solution and identify avoidance, minimization, and compensatory mitigation efforts to lessen adverse effects. In addition, the updated documents will undergo formal public review periods and resource agency coordination prior to construction. Within the reporting officers FEIS, measures have either been denoted as "Actionable Measures" or "Tier One Measures," as defined below:

a. The CTRIP includes six actionable measures that currently have enough design and impact detail to complete the environmental review. They include:

- i. Bolivar Peninsula and West Bay GIWW Shoreline and Island Protection;
- ii. West Bay and Brazoria GIWW Shoreline Protection;
- iii. East Matagorda Bay Shoreline Protection;
- iv. Keller Bay Restoration;
- v. Powderhorn Shoreline Protection and Wetland Restoration; and
- vi. Redfish Bay Protection and Enhancement.

b. Tier One Measures included in the CTRIP that will require Tier Two environmental review include:

- i. Bolivar Roads Gate System
- ii. Bolivar and West Galveston Beach and Dune System
- iii. Galveston Ring Barrier System
- iv. Galveston Seawall Improvements
- v. Nonstructural Improvements
- vi. Clear Lake Gate System and Pump Station
- vii. Dickinson Bay Gate System and Pump Station
- viii. South Padre Island Beach Nourishment and Sediment Management
- ix. Follets Island Gulf and Beach Dune Restoration
- x. Port Mansfield Channel, Island Rookery, and Hydrologic Restoration

9. Coastal Barrier Resources Act (CBRA) Compliance. Coastal Barrier Resources System (CBRS) designated units are in a few proposed project areas of the CTRiP. The USACE, Galveston District consulted with the U.S. Fish and Wildlife Service (USFWS) to ensure that the recommended plan complies with CBRA policies. On 21 October 2020, USFWS responded to a USACE request for consultation under CBRA indicating that the project is located within a System Unit and meets General Exception 16 U.S.C. §3505(a)(2) (maintenance or construction of improvements of existing federal navigation channels), and specific exceptions 16 U.S.C. §3505(a)(6)(A) (projects for the study, management, protection, and enhancement of fish and wildlife resources and habitats) and 16 U.S.C. §3505(a)(6)(G) (nonstructural projects for shoreline stabilization) of the



DAEN  
SUBJECT: Coastal Texas Protection and Restoration

CBRA. USFWS recognizes that it is not the intention of the project to promote development and that development is limited by the inability of property owners to receive federally backed insurance or construct in areas protected by the CWA. The USFWS response, dated 10 October 2020, recommends that USACE and the non-federal sponsor consider acquiring conservation easements or other development restrictions over lands located in CBRS units that may benefit from the implementation of measures included in the CTRiP. Based on the information and analysis in USACE's original consultation documentation, 14 August 2020, USACE has determined that acquisition of conservation easements or other development restrictions is not necessary for Bolivar Peninsula and West Bay GIWW Shoreline and Island Protection; West Bay and Brazoria GIWW Shoreline Protection; and Port Mansfield Channel, Island Rookery, and Hydrologic Restoration. During the preparation of supplemental NEPA documentation for Follets Island Gulf Beach and Dune Restoration and the Bolivar Peninsula Beach and Dune System, USACE will reassess whether acquisition of conservation easements or other development restrictions over lands north of State Highway 257 or on the Bolivar Peninsula, respectively, is necessary to implement the measures. If USACE determines that development restrictions are required, the non-Federal sponsor will be responsible for all acquisition costs to acquire the development restrictions at 100 percent non-federal expense. The costs will not be included in the authorized project cost nor will the costs be shared with the Federal Government. Alternatively, if the non-federal sponsor elects not to acquire the development restrictions, the non-federal sponsor will be responsible for all costs allocated to the portion of the measures located within the CBRA zones.

10. Based on October 2021 price levels, the estimated project first cost is \$28,873,131,000, which includes the cost of initial construction of \$27,742,351,000 and periodic nourishments at a total cost of \$1,130,780,000. The federal share of project first costs is \$17,978,202,000 and the non-federal share is \$10,894,929,000. The measures for Bastrop Bay, Oyster Lake, West Bay, and GIWW Shoreline Protection and for East Matagorda Bay Shoreline Protection are located on or benefit USFWS National Wildlife Refuge lands and were included in the CTRiP in collaboration with the USFWS. The portion of the initial construction cost attributable to these elements is \$403,097,000 and will be borne by the Department of Interior. A description of the costs and benefits of the CTRiP are as follows:

a. The estimated project first cost for the NED Plan at October 2021 price levels, is \$26,200,398,000, which includes the cost of initial construction of \$25,069,618,000 and periodic nourishments at a total cost of \$1,130,780,000. Based on a 2.50 percent discount rate and a 50-year period of analysis, the total average annual costs of the NED Plan are estimated to be \$1,209,904,000, including operation, maintenance, repair, replacement, and rehabilitation (OMRR&R), and the equivalent average annual benefits are estimated to be \$2,309,894,000 with net average annual benefits of \$1,098,955,000 and a benefit-to-cost ratio (BCR) of approximately 1.9 to 1. The incremental costs and benefits of the NED Plan are:

DAEN

SUBJECT: Coastal Texas Protection and Restoration

i. Galveston Bay Storm Surge Barrier System. The estimated project first cost of this element of the CTRiP at October 2021 price levels, is \$26,128,041,000. Total cost for periodic renourishment of the Bolivar Peninsula beach and dune system is \$710,086,000, and the total cost for periodic renourishment of the West Galveston beach and dune system is \$378,135,000. The first cost for mitigation is \$102,690,000 for the Bolivar Road Gate System; \$1,100,500 for the Clear Lake Surge gate; \$2,500,500 for the Dickinson Bay Surge Gate; and \$8,160,000 for the Galveston Ring Barrier System. LERRD costs for the Galveston Bay Storm Surge Barrier System are \$964,985,000. Based on a 2.50 percent discount rate and a 50-year period of analysis, the total average annual costs of this element are estimated to be \$1,208,000,000, including OMRR&R. This element would reduce average annual coastal storm damages by about 54 percent and would leave average total equivalent annual residual damages estimated at \$1,796,000,000. The equivalent average annual benefits for this element are estimated to be \$2,306,000,000 with net average annual benefits of \$1,097,000,000 which results in a benefit-to-cost ratio (BCR) of approximately 1.9 to 1.

ii. South Padre Island Beach Nourishment and Sediment Management. The estimated project first cost of this element of the CTRiP at October 2021 price levels, is \$29,798,000. The total cost for periodic renourishment is \$42,560,000. LERRD costs are estimated to be \$18,328,000. Based on a 2.50 percent discount rate and a 50-year period of analysis, the total average annual costs of this element are estimated to be \$1,904,000. The equivalent average annual benefits for this element prior to inclusion of recreation benefits are estimated to be \$1,294,000 with net average annual benefits of -\$610,000, which results in a BCR of approximately 0.7 to 1. With the inclusion of \$2,565,000 in recreation benefits, the total benefits are estimated to be \$3,894,000 with net average annual benefits of \$1,955,000, which results in a BCR of approximately 2.0 to 1.

b. The estimated project first cost for the NER Federal Plan at October 2021 price levels, is \$2,269,636,600. Based on a 2.50 percent discount rate and a 50-year period of analysis, the total average annual costs of the NER Federal Plan are estimated to be \$102,032,000. Elements of the NER Federal Plan were formulated to be resilient for the life of the project. Annual costs for OMRR&R will be further developed during PED as features in the NER Federal Plan are refined. A total of about 21,010 AAHU would be created. The NER Federal Plan incorporates post-construction monitoring and adaptive management for a period of 10 years to ensure project performance. The LERRD cost for NER Federal Plan is estimated to be \$1,089,400. The incremental costs and benefits of the NER Federal Plan are:

i. Bolivar Peninsula and West Bay Gulf Intracoastal Waterway (GIWW) Shoreline and Island Protection. The project first cost for this element is estimated to be \$935,303,000 at October 2021 price levels. Based on a 2.50 percent discount rate and a 50-year period of analysis, the total average annual costs of this element are estimated to be \$36,001,000. A total of 1,295.4 AAHU would be created;

DAEN  
SUBJECT: Coastal Texas Protection and Restoration

ii. Follets Island Gulf Beach and Dune Restoration. The project first cost for this element is estimated to be \$59,013,000 at October 2021 price levels. Based on a 2.50 percent discount rate and a 50-year period of analysis, the total average annual costs of this element are estimated to be \$2,362,000. A total of 240.1 AAHU would be created;

iii. Bastrop Bay, Oyster Lake, West Bay, and GIWW Shoreline Protection. The project first cost for this element is estimated to be \$802,705,000 at October 2021 price levels. Of this, \$393,812,000 is attributed to measures that are located within or would benefit National Wildlife Refuge lands. Based on a 2.50 percent discount rate and a 50-year period of analysis, the total average annual costs of this element are estimated to be \$30,894,000. A total of 1,297.5 AAHU would be created.

iv. East Matagorda Bay Shoreline Protection. The project first cost for this element is estimated to be \$281,678,000 at October 2021 price levels. Of this, \$9,284,900 is attributed to measures that are located within or would benefit National Wildlife Refuge lands. Based on a 2.50 percent discount rate and a 50-year period of analysis, the total average annual costs of this element are estimated to be \$10,570,000. A total of 481.5 AAHU would be created;

v. Keller Bay Restoration. The project first cost for this element is estimated to be \$76,815,000 at October 2021 price levels. Based on a 2.50 percent discount rate and a 50-year period of analysis, the total average annual costs of this element are estimated to be \$2,883,000. A total of 240.1 AAHU would be created;

vi. Powderhorn Shoreline Protection and Wetland Restoration. The project first cost for this element is estimated to be \$107,222,000 at October 2021 price levels. Based on a 2.50 percent discount rate and a 50-year period of analysis, the total average annual costs of this element are estimated to be \$4,028,000. A total of 18.4 AAHU would be created;

vii. Redfish Bay Protection and Enhancement. The project first cost for this element is estimated to be \$344,084,000 at October 2021 price levels. Based on a 2.50 percent discount rate and a 50-year period of analysis, the total average annual costs of this element are estimated to be \$12,912,000. A total of 3,500.5 AAHU would be created; and

viii. Port Mansfield Channel, Island Rookery, and Hydrologic Restoration. The project first cost for this element is estimated to be \$65,914,000 at October 2021 price levels. Based on a 2.50 percent discount rate and a 50-year period of analysis, the total average annual costs of this element are estimated to be \$2,382,000. A total of 13,936.6 AAHU would be created.

11. The costs for construction will be shared in accordance with the cost sharing provisions of Section 103 of the Water Resources Development Act (WRDA) of 1986,

DAEN  
SUBJECT: Coastal Texas Protection and Restoration

as amended (33 U.S.C. §2213) and Section 221 of Public Law 91-611, the Flood Control Act of 1970, as amended (42 U.S.C. §1962d-5), as follows:

a. The costs for the initial construction of coastal storm risk management and ecosystem restoration features, minus those that are located on or benefit USFWS National Wildlife Refuge lands, are generally shared at a rate of 65% federal and 35% non-federal for the initial construction. The federal share of the costs for the initial construction of coastal storm risk management and ecosystem restoration features is \$17,978,202,000 and the non-federal share is estimated at \$10,894,929,000 which includes the costs of land, easements, rights-of-way, relocations, and dredged or excavated material disposal areas (LERRD). LERRD costs are estimated at about \$1,089,392,000. The non-federal sponsor will receive credit for the costs of LERRD toward the non-federal share. The value of LERRD that exceeds the 35 percent non-federal statutory cost share would be reimbursable to the non-federal sponsor. The non-federal share also includes the cost for the Bolivar Peninsula Tie-in Levee Section of the CTRiP, which is located within a CBRA zone and will be non-federally funded. The federal share of costs includes \$403,097,000 for Department of Interior implementation of elements that are located on or benefit USFWS National Wildlife Refuge lands.

b. The costs for periodic nourishment for coastal storm risk management measures will be shared at a rate of 50 percent federal and 50 percent non-federal. The federal and non-federal shares of periodic nourishment are estimated to be \$565,390,000 each.

c. The non-federal sponsor would be responsible for the OMRR&R of the project after construction, except for project features located on or benefiting USFWS National Wildlife Refuge lands. The non-federal sponsor's average annual OMRR&R cost is currently estimated at \$131,000,000.

12. Various entities within the State of Texas, including the General Land Office (GLO) and the Gulf Coast Protection District (GCPD), will be the non-federal sponsors fulfilling the requirements of the items of local cooperation for construction including providing all LERRD's with support from local entities, for future phases of the CTRiP. Accordingly, local entities such as counties, cities, levee improvement districts, drainage districts, municipal utility districts, or other special taxing entities may elect to, or be created to, support the State of Texas and USACE in the implementation of this project. Most critically, this includes the GCPD, created in the 2021 Texas legislative session including Harris, Galveston, Orange, Jefferson, and Chambers Counties, who is anticipated to serve as the non-federal sponsor for the upper Texas coast CSRM elements. In addition, a portion of the CTRiP, the Bolivar Peninsula Tie-in Levee Section, is located within a CBRS unit (CBRA zone) and is not permitted by one of the Act's exceptions. Consequently, the non-federal sponsor will be responsible for the full cost of this feature, a total of \$96,884,000. Since this feature is required for the system to operate, the costs are still included in the overall authorized cost; however, the costs have been excluded from the estimate of project costs shared with the Federal

DAEN

SUBJECT: Coastal Texas Protection and Restoration

Government. Two additional features of the CTRiP, the Bolivar Peninsula beach and dune system and the Follets Island gulf beach and dune restoration, are located within CBRA zones also. Additional analysis is required during PED to address USFWS recommendations regarding the acquisition of development restrictions for these features.

13. The performance of the CTRiP varies between regions and system elements. The recommendation builds redundancy into the system for Gulf Storm Surge Barrier and Galveston Bay Defense System – the NED Plan to address the variability in storm tracks. The action of layering of critical components or functions of a system with the intent of increasing the reliability of the system, either in the form of backup features, or to improve actual system performance, equates to varying levels of risk reduction across the system. The Hurricane and Storm Damage Risk Reduction System design guidelines (USACE 2012) criteria established the basis of design and were applied to determine the crest elevations for the most critical components of the recommended features. The criteria used for design of the systems and crest elevations was based on an overtopping limit state with an AEP of one percent. This was consistent with the present USACE practice and other recent Region 1 projects. The flood risk reduction potential for the CTRiP is based on damages that would be prevented considering relative sea level change (RSLC), wave set-up, and run-up under average still-water levels, and that some of the project features will remain in service much longer than the economic period of analyses (50-year) planning horizon. Consequently, an adaptation strategy was developed for up to 100 years, consistent with Engineering Regulations 1110-2-8159 and 1100-2-8162. The engineering and conceptual design conducted during this study support the project alignment, type of structure and top of system elevation; but do not finalize design criteria or detail project features. Further investigation, engineering, and design analysis will be needed in future phases. The features were developed to incorporate uncertainty by including redundancy and robustness, so they are adaptable to future conditions including RSLC. For the CSRM features the equivalent average annual benefits are estimated to range from nearly \$1,809,000,000 under the low SLC scenario, to \$2,306,000,000 under the intermediate SLC scenario, and to \$3,823,000,000 under the high SLC scenario. Corresponding annual net benefits for the recommended plan range from approximately \$601,000,000 to \$2,615,000,000 with BCRs ranging from 1.50 to 3.16 depending on future sea level change. The lowest-cost comprehensive ER plan is recommended.

14. The CTRiP is designed to function as a system with multiple lines of defense using nature-based features as well as engineered features to reduce the risk of coastal storm damages to natural and man-made infrastructure and to restore degraded coastal ecosystems through a comprehensive approach along the Texas coastline. Many of the features are independent of each other but to achieve the overall effect of a resilient coastline are dependent on each other for execution. Due to the size of the efforts, uncertainty in funding, and varied timelines for future NEPA compliance, the reporting officers offered different prioritization strategies for the resilient coastline strategy with a focus on the first line of defense when feasible. Supplemental NEPA would be

completed for all the CSRSM measures before physical construction is initiated. The GLO and other entities have institutionalized a collaborative adaptive systems strategy that will incorporate the CTRiP into the regions with the primary goal of reducing risks to life safety and reduction of storm damages. During PED, updates to implementation strategies may be evaluated because of additional engineering and environmental analyses to confirm that the CTRiP and the implementation strategies are technically sound, environmentally, and socially acceptable, and economically justified.

15. In accordance with USACE Sea Level Change guidance, Engineer Regulation 1100-2-8162, the study evaluated potential impacts due to sea level change in its plan formulation and engineering of the CTRiP. Three levels of RSLC were considered for the without-project and with-project conditions for both the ER and CSRSM elements of the recommendation. The lowest-cost comprehensive ER plan is recommended, however, should RSLC be greater than the rate assumed in the report, it is recommended that adaptations be considered in a future study to consider outyear renourishment for ER features as these areas become affected by RSLC impacts over time. The CTRiP is intended to prevent damages to structures, content and critical infrastructure from coastal storm surge and waves. It should be noted, however, that reducing the risk of loss of life during major storm events can only be achieved by adhering to existing procedures for evacuation of residents and visitors well before expected hurricane landfall, thus removing people from harm's way. This study recommends continuation of the assessment of the evacuation policy both with and without the project. Key uncertainties are:

a. In recognition of the uncertainty presented by sea level rise, adaptation capacity has been incorporated into the final feasibility-level design to maximize the system's overall usefulness over the life of the project. The adaptability will allow for limited overtopping of wave and minor still water overtopping that would then be mitigated using interior drainage features or height increases to the floodwall if required. In addition, the reporting officers initially considered "managed retreat" as an overall long-term strategy, however it was determined not to be a practicable and standalone solution. A standalone managed retreat scenario, whereby development retreats inland away from coastal risks, rather than addressing storm surge, inundation, and erosion through structural alternatives, is a significant challenge along the Texas coastline. In coastal areas, where residents and business are tied to the coastal landscape, there is historical evidence to show residents don't fully retreat from the coast, but rather retreat vertically, using methods such as home raising or rebuilding at a higher elevation. Rather than completely removing the managed retreat options, the reporting officers determined that a managed retreat option could work in combination with a structural system to manage residual risk and address changes in future conditions. Accordingly, managed retreat, through an expanded use of home raising or rebuilding at a higher elevation, could be considered as a future adaptation to help the region continue to adapt to changing risks.

DAEN

SUBJECT: Coastal Texas Protection and Restoration

b. Uncertainty in the modeling approach includes some potential induced flooding. However, a more robust modeling approach is needed in PED to quantify actual induced flooding associated with the CTRiP. As needed during the design phase, and prior to finalizing supplemental NEPA and construction, a parcel level analysis of flood benefits and potential inducement will be completed for each modeled storm scenario. Induced flooding and potential mitigation options at every parcel indicating inducement will be conducted. Then each scenario will be compared to identify the minimum impacts that capture the greatest flood risk reduction benefit. Finally, additional public outreach will be conducted to communicate the results of that refinement.

16. In accordance with USACE policy on review of decision documents, all technical, engineering, and scientific work underwent an open, dynamic, and rigorous review process. The comprehensive review process included district quality control review, agency technical review, independent external peer review (IEPR), public review, and a headquarters policy and legal review to confirm the planning analyses, alternative design and safety, and the quality of decisions. The IEPR was completed by Battelle Memorial Institute. A total of nineteen comments were documented and concurrence was reached on all comments. Washington level review indicates that the plan recommended by the reporting officers complies with all essential elements of the 1983 U.S. Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Land Related Resources Implementation Studies, as well as other administrative and legislative policies and guidelines. The views of interested parties, including federal, state, and local agencies, were considered and all comments from the above referenced reviews have been addressed and incorporated into the final report documents where appropriate.

17. I concur in the findings, conclusions, and recommendations of the reporting officers. Accordingly, I recommend that the plan to reduce the risks of tropical storm surge impacts and to restore degraded coastal ecosystems on the Texas Coast be authorized in accordance with the reporting officers' recommended plan at an estimated project first cost of \$28,873,131,000 with such modifications as in the discretion of the Chief of Engineers may be advisable. My recommendation is subject to cost sharing, financing, and other applicable requirements of federal and state laws and policies, including Section 103 of WRDA 1986, as amended (33 U.S.C. §2213). The non-federal sponsor would provide the non-federal share of project costs and all lands, easements, and rights of way, including those necessary for the borrowing of material and the disposal of dredged or excavated material, and would perform or assure the performance of all relocations, including utility relocations. This recommendation is subject to the non-federal sponsor agreeing in a binding written agreement to comply with all applicable federal laws and policies and to perform the following required items of local cooperation:

a. Provide 35 percent of construction costs of the project allocated by the Government to ER, 35 percent of construction costs for initial construction of the project and 50 percent of construction costs for periodic nourishment allocated by the

DAEN

SUBJECT: Coastal Texas Protection and Restoration

Government to CSRMs, 100 percent of construction costs for initial construction and periodic nourishment allocated by the Government to beach improvements with exclusively private benefits, 100 percent of construction costs for ER and for CSRMs initial construction and periodic nourishment allocated by the Government to improvements and other work located within the Coastal Barrier Resources System that the Government has determined are ineligible for federal financial participation, and 100 percent of construction costs for CSRMs initial construction and periodic nourishment allocated by the Government to the prevention of losses of undeveloped private lands, as further specified below:

- i. Provide, during design, 35 percent of design costs in accordance with the terms of design agreement entered into prior to commencement of design work for the project.
  - ii. Provide all real property interests, including placement area improvements, and perform all relocations determined by the Government to be required for the project.
  - iii. Provide, during construction, any additional contribution necessary to make its total contribution equal to at least 35 percent of construction costs for ER and for CSRMs initial construction and 50 percent of construction costs for CSRMs periodic nourishment.
- b. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) that might reduce the ecosystem restoration outputs of the ER components of the project or the level of coastal storm risk reduction afforded by the CSRMs components of the project, hinder operation and maintenance of the project, or interfere with the project's proper function.
  - c. Not use project or lands, easements, and rights-of-way required for the project as a wetlands bank or mitigation credit for any other project.
  - d. Following the end of the authorized period of federal participation in periodic nourishment for the CSRMs components of the project, or any extension thereof authorized under Section 156 of the Water Resources Development Act of 1976, as amended, 42 U.S.C. §1962d-5f, perform periodic nourishment of the Bolivar Peninsula beach and dune system at 100 percent non-federal expense.
  - e. At least annually and after storm events, at no cost to the Government, perform surveillance of the CSRMs components of the project to determine losses of material and provide results of such surveillance to the Government.
  - f. For shores, other than federal shores, protected using federal funds, ensure the continued public use of such shores compatible with the authorized purpose of the project.



DAEN  
SUBJECT: Coastal Texas Protection and Restoration

g. Provide and maintain necessary access roads, parking areas, and other associated public use facilities, open and available to all on equal terms.

h. Operate, maintain, repair, rehabilitate, and replace the project or functional portion thereof at no cost to the Government, in a manner compatible with the project's authorized purposes and in accordance with applicable federal laws and regulations and any specific directions prescribed by the Government.

i. Give the Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-federal sponsor owns or controls for access to the project to inspect the project, and, if necessary, to undertake work necessary to the proper functioning of the project for its authorized purpose.

j. Hold and save the Government free from all damages arising from design, construction, operation, maintenance, repair, rehabilitation, and replacement of the project, except for damages due to the fault or negligence of the Government or its contractors.

k. Perform, or ensure performance of, any investigations for hazardous, toxic, and radioactive wastes (HTRW) that are determined necessary to identify the existence and extent of any HTRW regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. §9601-9675, and any other applicable law, that may exist in, on, or under real property interests that the federal government determines to be necessary for construction, operation and maintenance of the project;

l. Assume, as between the Government and the non-federal sponsor, complete performance and financial responsibility for all necessary cleanup and response actions and costs of any HTRW regulated under applicable law that are located in, on, or under real property interests required for construction, operation, maintenance, repair, rehabilitation, or replacement of the project;

m. Agree, as between the Government and the non-federal sponsor, that the non-federal sponsor shall be considered the owner and operator of the project for the purpose of CERCLA liability or other applicable law, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause HTRW liability to arise under applicable law.

n. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, 42 U.S.C. §4630 and §4655, and the Uniform Regulations contained in 49 CFR Part 24, in acquiring real property interests necessary for construction, operation, and maintenance of the project including those necessary for relocations, and placement area improvements; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

DAEN

SUBJECT: Coastal Texas Protection and Restoration

18. The recommendation contained herein reflects the information available at this time and current departmental policies governing formulation of individual projects. It does not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program or the perspective of higher review levels within the Executive Branch. Consequently, the recommendation may be modified before it is transmitted to the Congress as a proposal for authorization and implementation funding. However, prior to transmittal to Congress, the Governor of Texas, the non-federal sponsor, interested federal agencies, and other parties will be advised of any significant modifications and will be afforded an opportunity to comment further.

A handwritten signature in black ink, appearing to read "S.A. Spellmon". The signature is fluid and cursive, with the first name "S.A." and the last name "Spellmon" clearly distinguishable.

SCOTT A. SPELLMON  
Lieutenant General, USA  
Chief of Engineers