ENHANCING BENEFITS EVALUATION FOR WATER RESOURCES PROJECTS: TOWARDS A MORE COMPREHENSIVE APPROACH FOR NATURE-BASED SOLUTIONS

Consideration of Nature-Based Solutions in USACE Planning Studies

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PREFACE

To accelerate progress and delivery of new and enhanced infrastructure projects for navigation, flood risk management, water operations, and ecosystem restoration consistent with its Engineering With Nature® (EWN) initiative, the U.S. Army Corps of Engineers (USACE) has engaged in a collaborative effort with The Water Institute of the Gulf (the Institute) to conduct policy research for fully evaluating the benefits of EWN strategies and projects, to include Natural Infrastructure, Natural and Nature Based Features and other Nature-Based Solutions.

This document is the second in a series of reports produced as part of this collaborative effort. It is intended to outline the steps and processes taken to select six final case studies for analysis. The report includes: a) a description of the process taken to compile and inventory 150 planning studies, b) a summary of the methodology for evaluating, scoring, and ultimately selecting a subset of those planning studies, c) a description of how the planning studies were subsequently scored to determine the final six case studies, and d) a brief conclusion of this effort, along with descriptive fact sheets for 12 studies.

The six case studies selected (as described in this report) are reviewed and analyzed in a separate forthcoming report, *Case Study Analysis Results and Recommendations*.

Questions about this research can be directed to the writing lead, Eva Windhoffer (Eva Windhoffer (ewindhoffer@thewaterinstitute.org) or the project lead and Director of Planning and Policy Research at the Institute, Jordan Fischbach (jfischbach@thewaterinstitute.org).

EXECUTIVE SUMMARY

This document is the second in a series of reports produced as part of a collaborative effort with the U.S. Army Corps of Engineers (USACE) to accelerate progress and delivery of new and enhanced infrastructure projects consistent with its Engineering With Nature® initiative, including Natural Infrastructure, Natural and Nature Based Features, and other Nature-Based Solutions (NBS). This report describes the process used to inventory and ultimately identify a set of completed water resources planning studies that could be used to test a more comprehensive methodology to evaluate a more comprehensive set of benefits from NBS. A summary of the results of the scoring process, key analysis steps, and decisions that informed the selection of six planning studies for further case study analysis are described herein.

This collaborative research effort focuses on a specific portion of the USACE analysis process: the evaluation of proposed alternatives using Benefit-Cost Analysis (BCA) and other relevant metrics or criteria (i.e., related to planning objectives or site constraints). In this report, the study team developed an inventory of completed planning studies, gathered expert input on the suitability of these studies for further analysis, and identified a subset of planning studies that both included NBS in both plan formulation and evaluation and solicited interest in NBS from non-Federal sponsors. In addition, data availability, technical resources for the study area, and other key inputs that could support additional evaluation helped inform the selection of the case studies.

The initial inventory represented a convenience sample of recent USACE planning studies finalized between 2005–2020. The planning studies spanned mission areas of Coastal Storm Risk Management (CSRM), Flood Risk Management (FRM), Navigation (NAV), Environmental Restoration (ENR), and Water Supply. The initial screening process relied on input from Division and District Planning Chiefs and USACE Headquarters via a scoring process. The process to gather input from all levels of USACE served to provide different perspectives on the utilization of NBS alternatives and thus inform case study selection. Although the study team did not receive feedback from all Divisions and Districts, the broad knowledge and familiarity of the planning studies provided by Headquarters staff were adequate to fill in data and knowledge gaps.

The study team identified several preliminary findings from this inventory, scoring, and selection process:

- The number of studies conducted in any given year from 2005–2020, and the purpose of those studies, was influenced by major disaster events (e.g., hurricanes) and the passage of legislation by Congress (e.g., Water Resources Development Act bills).
- The formulation of NBS alternatives were influenced by the continued emphasis on National Economic Development (NED) benefits for project prioritization and selection.
- A majority (85%) of the planning studies scored by Division and District Planning Chiefs did consider NBS at some level; however, only half (53%) of the studies carried NBS alternatives through to the final array of alternatives.

- Of the planning studies that carried NBS through to the final array, 46% focused specifically on ENR, leaving only 29% of scored studies with other primary missions (or considered multi-mission) that formulated NBS alternatives and carried them through all phases of the analysis.

Overall, this effort was successful in selecting six studies that represent diversity across geographic regions, purposes, and various levels of complexity. The selected case studies include:

- Jacksonville Harbor, Mile Point, FL
- Southwest Coastal, LA
- South San Francisco Bay Shoreline, CA
- West Sacramento, CA
- South Platte River and Tributaries, Adams and Denver Counties, CO
- East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation, Atlantic Coast of NY

The diversity of these studies will help support a robust evaluation of different methodologies to evaluate economic, environmental, and social benefits and costs from projects including NBS.

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LIST OF ACRONYMS

Acronym	Term
BCA	Benefit-Cost Analysis
BCR	Benefit-Cost Ratio
CSRM	Coastal-Storm Risk Management
ENR	Environmental Restoration
ER	Environmental Restoration
EWN	Engineering With Nature®
FRM	Flood-Risk Management
HQ	Headquarters
LPP	Locally Preferred Plan
LRD	Great Lakes and Ohio River Division
MVD	Mississippi Valley Division
NAD	North Atlantic Division
NAV	Navigation
NBS	Nature-Based Solutions
NED	National Economic Development
NWD	Northwestern Division
OWPR	Office of Water Project Review
PAB	Planning Advisory Board
POD	Pacific Ocean Division
SAD	South Atlantic Division
SPD	South Pacific Division
SWD	Southwestern Division
USACE	U.S. Army Corps of Engineers
WRDA	Water Resources Development Act

1.0 INTRODUCTION

To accelerate progress and delivery of Nature-Based Solutions for application in navigation, flood risk management, water operations, and ecosystem restoration the U.S. Army Corps of Engineers (USACE), through its Engineering With Nature® (EWN) initiative, has engaged in a collaborative effort with The Water Institute of the Gulf (the study team) to conduct policy research for fully evaluating the benefits of Nature-Based Solutions (inclusive of Natural Infrastructure, Natural[1] and Nature Based Features (USACE, 2021) and related terms). Throughout this document, these techniques are referred to using the umbrella term "Nature-Based Solutions" (NBS).

This document is the second in a series of reports produced as part of this collaborative effort. This report describes the process used to inventory a set of completed water resources planning studies. These studies were scored by USACE subject matter experts based, in part, on the level of consideration of NBS included as a part of the plan formulation and evaluation process. A subset of six planning studies ("case studies") were ultimately identified through this process to be carried forward and used to evaluate other potential technical approaches for evaluating benefits from NBS. This report summarizes results of the scoring process and describes key steps and decisions that informed the final case study selection.

1.1 BACKGROUND

As detailed in the preceding report, *Evolution of Benefits Evaluation and Prioritization of Water Resources Projects*, the hypothesis of this policy research effort is that current USACE planning and evaluation policies and practices systematically overlook and undervalue NBS (Ehrenwerth et al., 2022). As a result, NBS features or alternatives are often excluded in early phases of planning studies or, if included in final planning study recommendations, may perform poorly in the current review structure using traditional economic and budgetary analysis methods.

The effort to develop an inventory of water resource planning studies and select a subset of relevant case studies, as detailed in this report, focused on a specific portion of the USACE analysis process: the evaluation of proposed alternatives using benefit-cost analysis (BCA) and other relevant metrics or criteria (i.e., related to planning objectives or site constraints). Due to time and resource constraints, this effort did not consider other key stages of the planning process, such as the early step of formulating plausible alternatives or considering the feasibility of different engineered approaches. Further, the inventory represents a convenience sample of recent USACE water resources projects that culminated in a

[1] "[N]atural features are created and evolve over time through the actions of physical, biological, geologic, and chemical processes operating in nature… [c]onversely, nature-based features are those that may mimic characteristics of natural features, but are created by human design, engineering, and construction to provide specific services such as coastal risk reduction" (Bridges et al., 2015).

signed Chief's Report[2] from the period 2005–2020 (hereafter referred to as "planning studies"), and the case study selection from this inventory focused on identifying planning studies that already included formulated NBS alternatives and had undergone some level of analysis.

The planning studies spanned the mission areas of Coastal Storm Risk Management (CSRM), Flood Risk Management (FRM), Navigation (NAV), Environmental Restoration (ENR), and Water Supply. This array of planning studies was then evaluated through several rounds of review and scoring with regard to the degree that studies were considered and carried forward to consider NBS alternatives. This evaluation was used to identify a subset of planning studies that included NBS in both plan formulation and evaluation and that solicited interest in NBS from non-Federal sponsors. Finally, a set of six case studies were selected for further analysis and evaluation with diversity across geographic areas, USACE mission areas (herein referred to as "planning study purpose"), planning study scale (in spatial or cost terms), community affected by the planning study, and potential factors limiting NBS alternatives selection.

1.2 ENGAGEMENT ACROSS USACE

A USACE Advisory Committee was formed to provide expertise and input during the course of the study. Advisory Committee members were selected by USACE Planning and Policy Division and USACE EWN to include different organizational perspectives, functional areas, expertise, and geographic distribution. The Advisory Committee members included District, Division, and Headquarters (HQ) personnel from Planning and Engineering organizations with experience and familiarity with USACE planning policies and NBS practices. The Division Planning Chiefs were engaged early in the study inventory process and supported the effort by scoring completed planning studies (as described in Section 3.2) and obtaining information from subject matter experts. On May 27, 2021, the study team hosted a kickoff meeting with the USACE Advisory Committee to introduce this effort, discuss future engagement, and arrive at a consensus on the planning study selection process.

The Advisory Committee was asked to support this effort in the following ways:

- Providing institutional knowledge and subject matter expertise
- Project liaison and coordination with other USACE elements
- Advising and counseling throughout the study effort.

To engage the Division Planning Chiefs, the study team briefed a smaller group, the Planning Advisory Board (PAB), on the study evaluation and selection process on June 09, 2021. The PAB is a standing USACE advisory group comprised of Division Planning Chiefs and senior HQ planners who advise the Chief of Planning and Policy. The PAB expressed support and interest in the development of a broader

[2] The Chief's Report is a detailed feasibility report including findings and recommendations of project alternatives and options that is sent to the Assistant Secretary of the Army for Civil Works for approval. For more information on this process, see the preceding report, "Evolution of Benefits Evaluation and Prioritization of Water Resources Projects", Section 2.2.

methodology for quantifying (monetizing and non-monetizing) benefits for NBS. Input provided by the PAB played a key role in the development of the evaluating and scoring used to evaluate the inventory of Planning Studies and to ultimately select the six studies for use as case studies in this policy research.

1.3 ORGANIZATION OF THIS REPORT

This document is the second in a series of reports produced as part of the effort, *Enhancing Benefits Evaluation for Water Resources Projects: Towards a More Comprehensive Approach for Nature-Based Solutions*. The organization of this report is outlined below and follows the steps that were taken to complete this effort:

- Section 2.0 outlines the process taken to compile the planning studies and provides summary descriptions of the resulting inventory of planning studies across USACE Divisions, planning study purposes, and dates.
- Section 3.0 summarizes the methodology for evaluating, scoring, and ultimately selecting a subset of planning studies for use as case studies.
- Section 4.0 outlines how the planning studies were subsequently screened through a series of steps to identify 12 planning studies final consideration and deliberation.
- Section 5.0 describes how the final portfolio of six planning studies were selected to be used as case studies.
- Section 6.0 provides a brief conclusion of this effort.
- Appendix A provides a complete list of 150 planning studies.
- Appendix B includes the fact sheets created for the 12 planning studies that are identified in Section 4.0

2.0 PLANNING STUDY INVENTORY

2.1 INVENTORY DEVELOPMENT

The study team initially developed an inventory of potential planning studies for evaluation by identifying all signed planning studies from the past 15 years, dating from approximately 2005 to 2020. Planning studies dating from 2005 were selected as the information and data pertaining to those planning studies would be more readily accessible for re-analysis, along with key USACE personnel and other stakeholders involved in the planning processes. The year 2005 also represents a landmark disaster year, with Hurricane Katrina in particular leading to significant attention to, and investments in, USACE CSRM planning studies (Interagency Performance Evaluation Taskforce, 2009; USACE, 2009a, 2011). As such, 2005 was selected as the starting year for identifying a modern inventory of USACE planning studies.

The planning studies recommend a project to Congress for authorization and include a brief description of the recommended project, formulation, and review process. The study team reviewed each planning study to assist in the identification of project purpose (FRM, ENR, CSRM, NAV or a combination thereof), geographic area, project complexity, and expected performance in terms of its economic contribution to National Economic Development (NED). Geographic area was defined by project area description as well as by USACE District and Division boundaries. Project complexity was assessed based on the financial scale of the project, and economic performance was based primarily on the project Benefit-Cost Ratio (BCR). Information collected from each planning study was summarized in tabular form and used to inform the initial screening of planning studies (see Table A-1). This table included the project name, the Division and District, the identified study authorization, the study purpose, the cost of the project, if the project deviated from the NED Procedures Manual (USACE Institute for Water Resources, 2009), and the project BCR.

2.2 INVENTORY SUMMARY AND DESCRIPTION

The resulting planning study inventory included 150 planning studies. Figure 1 shows the count of reports by Division and purpose across the 150 planning studies. The South Atlantic Division (SAD) and North Atlantic Division (NAD) had the highest number of planning studies, together totaling around 40% of the entire inventory. Within these two Divisions, CSRM, FRM, NAV, and ENR planning studies were represented. A large number of CSRM planning studies in SAD and NAD in this inventory were the result of a major coastal storms impacting the area between 2005 and 2020, specifically Hurricane Katrina (2005) in SAD and Hurricane Sandy (2012) in NAD (note that both of these large events impacted several USACE Divisions). Coastal storms in the Atlantic Coast and Gulf Coast regions also resulted in inland flooding associated with significant rainfall events.

It is expected that the majority of NAV planning studies resulted from a shift in the shipping industry towards the use of larger container vessels (USACE, 2015a). SAD, NAD, and the Southwestern Division (SWD) have numerous ports that were impacted by this change in shipping industry practices. Of the total 150 signed planning studies, there was only one Water Supply project (NWD). The majority of water supply changes occur as a result of the reallocation of existing water storage and typically do not require congressional authorization (Brougher & Carter, 2012). FRM planning studies were represented in all

Divisions, and ENR planning studies were represented in all Divisions with the exception of the Pacific Ocean Division (POD).

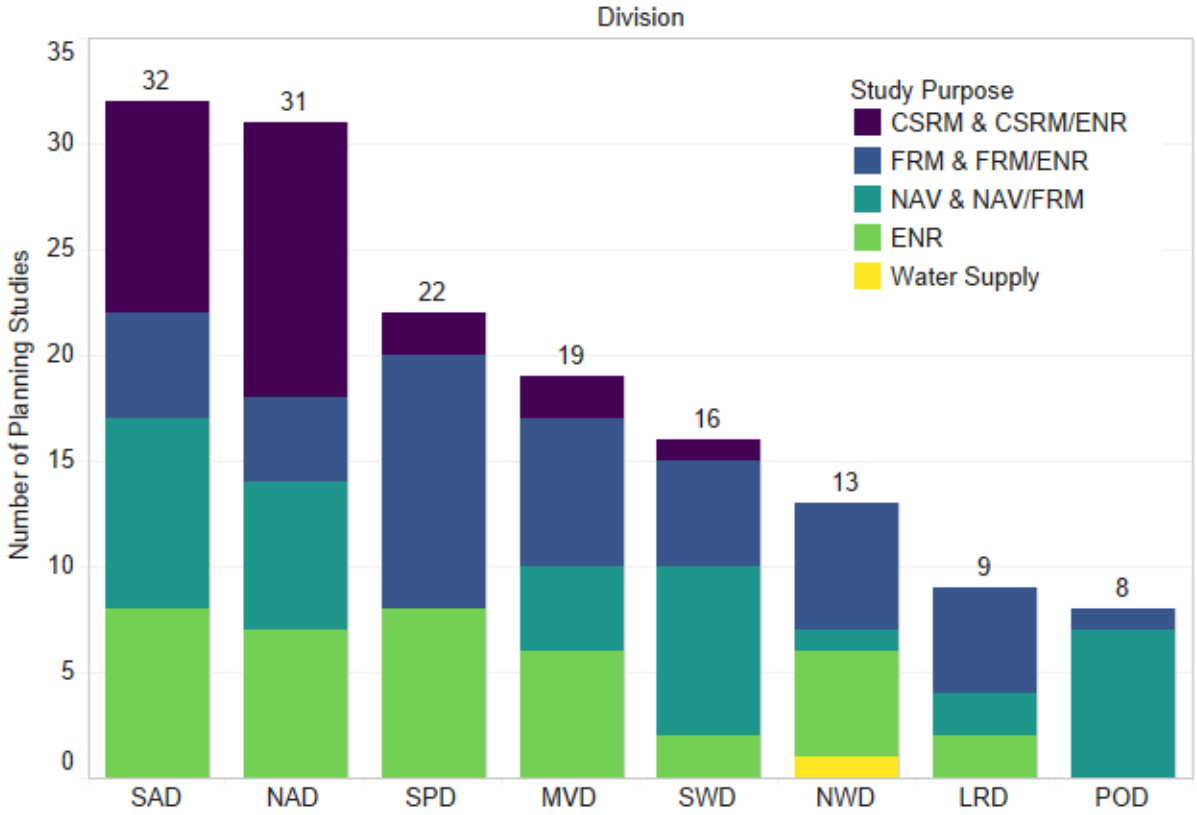

Figure 1. Planning Studies by Division and Purpose (Coastal Storm-Risk Management [CSRM], Environmental Restoration [ENR], Flood-Risk Management [FRM], Navigation [NAV], and Water Supply)

Figure 2 shows the count of planning studies over time by purpose. Close to 20% of the 150 planning studies were signed in 2020. In 2006, there was an influx of planning studies following hurricanes Katrina and Rita, over half of which were for FRM and CSRM. Most years included CSRM, FRM, NAV, and ENR planning studies, and the average number of planning studies per year increased after 2014 (from 7 to 12). The primary reason for this increase is that in years where a Water Resources Development Act (WRDA) bill is anticipated, there is increased emphasis on completing planning studies. Since 2014, a WRDA bill has been passed bi-annually whereas prior to 2014, the time between WRDA bills was routinely exceeding 4 to 5 years.

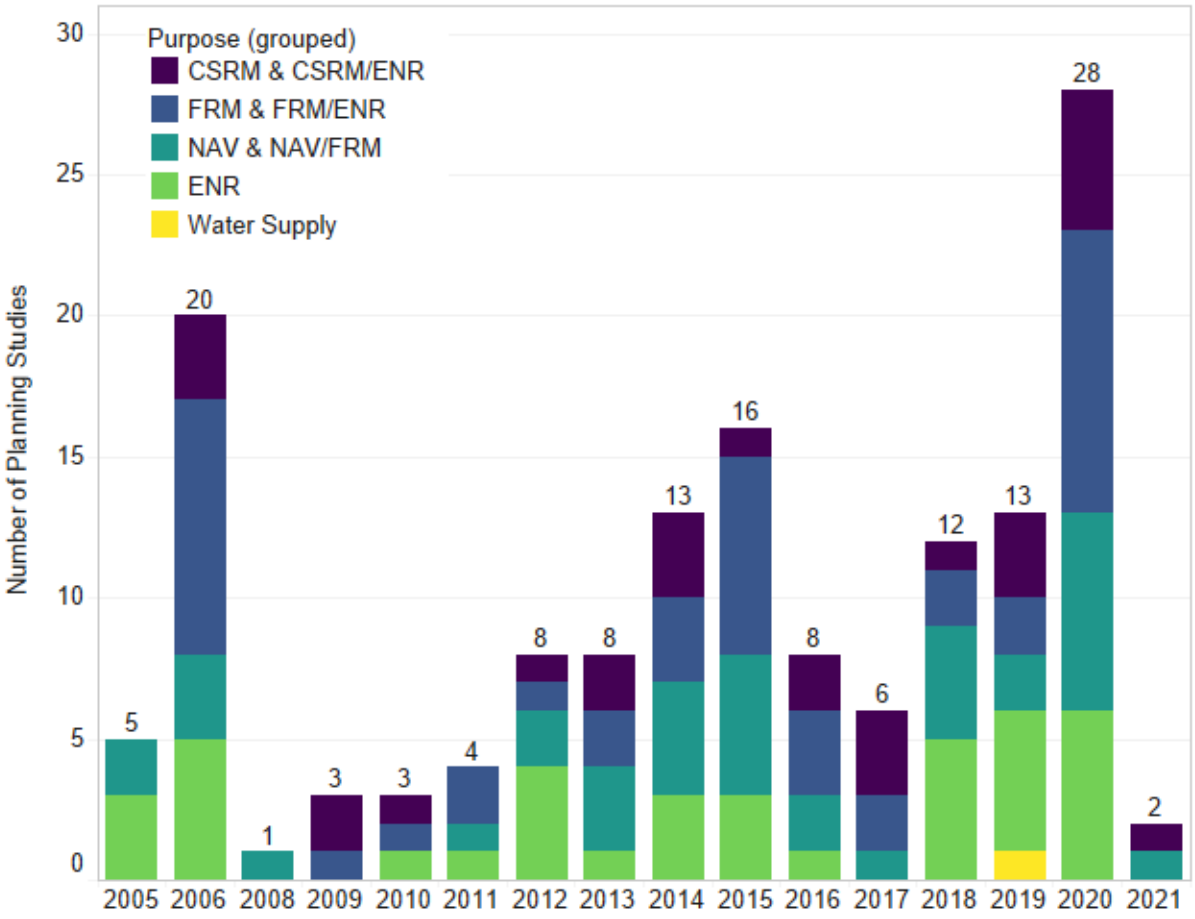

Figure 2. Planning Studies by Year and Purpose (Coastal Storm-Risk Management [CSRM], Environmental Restoration [ENR], Flood-Risk Management [FRM], Navigation [NAV], and Water Supply)

3.0 PLANNING STUDY EVALUATION, SCORING, AND SCREENING

3.1 PROCESS OVERVIEW

The objective of the selection process was to review the 150 completed planning studies, score those planning studies in regard to the degree to which NBS was considered, and ultimately identify six completed planning studies for use as case studies in this policy research. Figure 3 summarizes the scoring, screening and selection process and is detailed further beginning with Section 3.2 below.

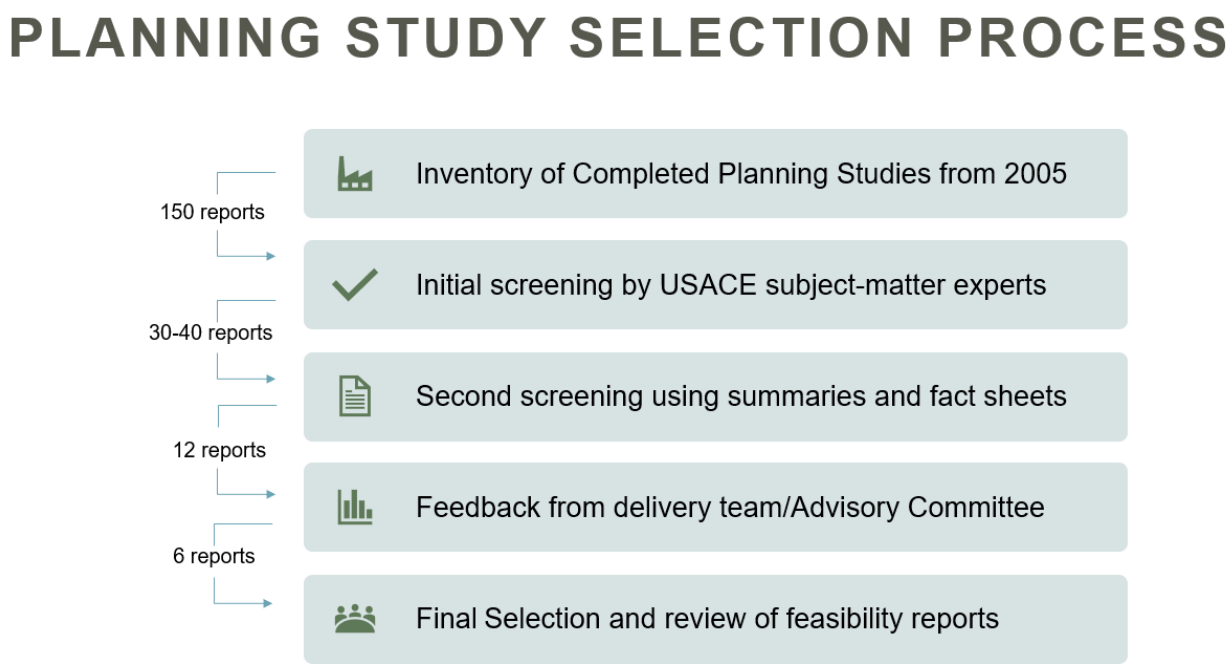

Figure 3. Overview of Study Selection Process

3.2 EVALUATION CRITERIA

The Division Planning Chiefs, in coordination with their District Planning Chiefs, were asked by the study team to review their respective planning studies using the data collected from the planning studies (Section 2.0). The Division and District Planning Chief's identified whether each project included NBS and provided an assessment of the level of consideration given to NBS during the formulation and evaluation process. This assessment was based on a scoring criterion from a scale of 1–5, as detailed in Table 1. The first question acted as a crosscheck for the level of NBS consideration, such that a "no" response would equate to a score of 1 and a "yes" response would equate to a score of 2–5.

Table 1. Scoring Criteria for Level of NBS Consideration

Rank	Scoring Criteria
1	NBS was not considered at all during formulation/evaluation
2	NBS was considered but not seriously
3	NBS was considered in formulation/evaluation but characterized as beneficial use, non-structural, other
4	NBS was considered in plan formulation/evaluation and but did not make final array
5	NBS was considered in plan formulation/evaluation and carried through to final array

In addition, the Division and District Planning Chiefs and USACE HQ Office of Water Project Review (OWPR) were asked to provide an assessment of the non-Federal sponsor's interest in formulating and implementing NBS. This assessment was likewise based on a scoring scale of 1–5, ranging from no non-Federal interest in formulating NBS alternatives to some willingness to implement NBS (Table 2).

Table 2. Scoring Criteria for Non-Federal Interest

	Scoring Criteria
1	Non-Federal interest indicated no interest to formulate NBS alternatives
2	Non-Federal interest indicated desire to formulate alternatives that included NBS elements
3	Non-Federal interest indicated desire to carry NBS alternatives to final array
4	Non-Federal interest indicated willingness to implement NBS a part of a Locally Preferred Plan (LPP)
5	Non- Federal Interest indicated willingness to implement NBS separately from the project

In addition to the Division and District Planning Chiefs, the OWPR from HQ was also independently asked to identify planning studies (based on their experience with the studies) that would present an opportunity to calculate benefits associated with NBS alternatives not otherwise captured in the original analysis. OWPR also used a 5-point scale to rate planning studies according to this criterion, but without additional guidance regarding the meaning of each scoring level.

4.0 SCREENING RESULTS

This section described the steps taken to identify six unique case studies for further analysis out of the 150 planning studies. Key steps included scoring conducted by USACE subject matter experts, additional research conducted by the study team, and iteration with the USACE Advisory Committee. In the process, the study team also gathered preliminary information regarding a) how often NBS have been considered in recent planning studies and b) of these studies, how many included NBS through to the final evaluation steps.

4.1 DIVISION AND DISTRICT SCORING RESULTS

The initial screening process used the data collected from the 150 planning studies as well as the project assessment from the Division and District Planning Chiefs and OWPR, as discussed in Section 3.2.

Out of the 150 planning studies identified in the inventory, the Division and District Planning Chiefs provided responses for 108 planning studies (Table 3). Forty-two planning studies were not scored due to insufficient information or familiarity with the planning studies in question, while three additional studies were not scored specifically for non-Federal interest.

Table 3. Count of Planning Studies by Level of NBS Consideration and Non-Federal Interest Score

	Non-Federal Interest Score						
Level of NBS Score	**1**	**2**	**3**	**4**	**5**	**Not Scored**	**Grand Total**
1	23						23
2	7	1			1		9
3	1	7			1		9
4		1	3	2	1	3	10
5		1	44	3	9		57
Not Scored						42	42
Grand Total	31	10	47	5	12	45	150

The scoring results show that comparatively few planning studies carried NBS forward throughout the entire evaluation process. 85 planning studies (79% of the 108 scored reports) considered NBS at some level, and of these 67 (62%) were formally considered during plan formulation and evaluation. This implies that NBS options were excluded in early phases in approximately 17% of planning studies considered.

Only 57 of 108 studies scored (53%) considered NBS during formulation and carried NBS alternatives through to the final array. Twenty-six of these 57 studies (46%) were specifically focused on the ENR mission where NBS alternatives would be the primary or sole focus, leaving only 31 studies with other primary missions (or considered multi-mission) that formulated NBS alternatives and carried them through all phases of the analysis. Although the analysis is limited by the number of studies not scored, the results nevertheless illustrate that NBS projects are often not considered or were excluded in early

phases of planning and evaluation. This finding is consistent with the present day barriers identified and discussed in Ehrenwerth et al. (2022).

For the purpose of identifying potential case studies, planning studies that scored 4–5 for their level of NBS consideration and 3–5 for non-Federal interest score were selected for further analysis. At these levels, the study team determined that NBS was a likely potential alternative and therefore provided suitable candidates for the final analysis (Figure 4).

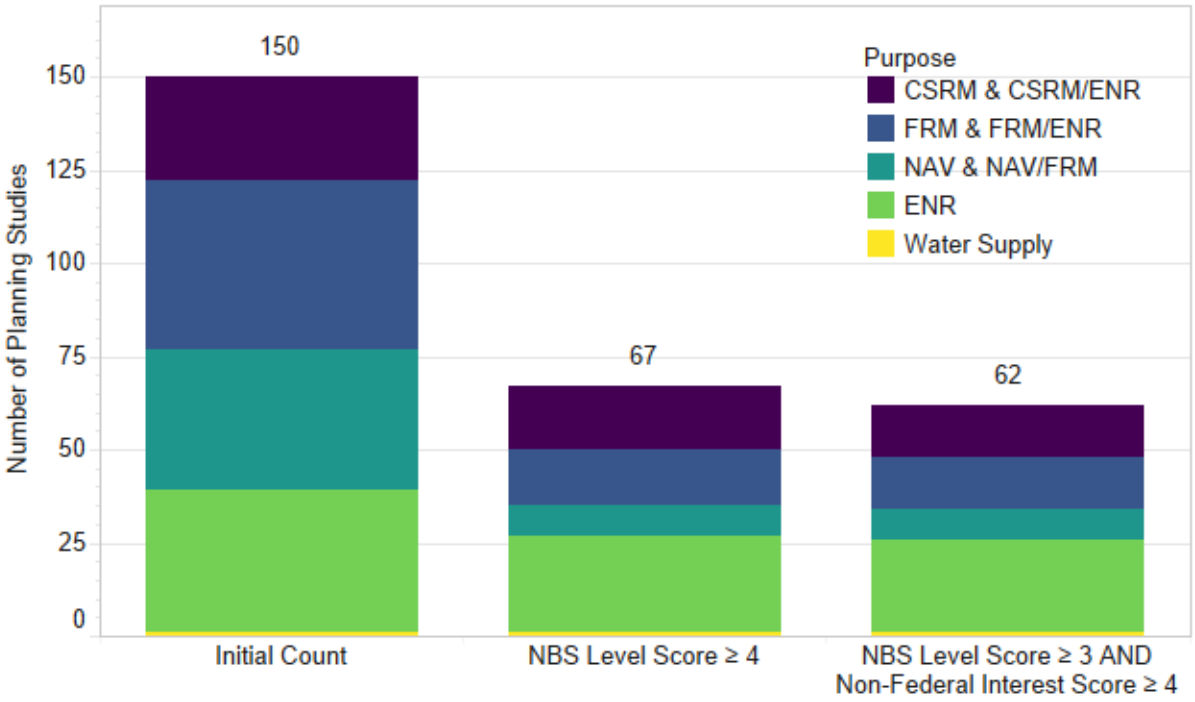

Figure 4. Planning Studies Meeting Selected NBS Scoring Thresholds (Coastal Storm-Risk Management [CSRM], Environmental Restoration [ENR], Flood-Risk Management [FRM], Navigation [NAV], and Water Supply)

4.2 OWPR SCORING RESULTS

The Division and District Planning Chiefs scoring process resulted in 62 planning studies for continued evaluation. This subset of planning studies, in addition to the 42 planning studies that Division and District Planning Chiefs did not score (due to insufficient information or lack of familiarity with the planning studies in question), were supplied to OWPR for additional input from a perspective largely independent from the prior round. OWPR scoring accounted not only for the level of NBS consideration, but also the suitability of different planning studies for case study re-analysis as part of this overall effort (e.g., availability of data; level of documentation for NBS evaluation or BCA analysis). At this next step, OWPR subject matter experts were able to score 70 of the 104 provided studies based on prior knowledge and familiarity. Results from this round of scoring are summarized by mission area in Figure 5.

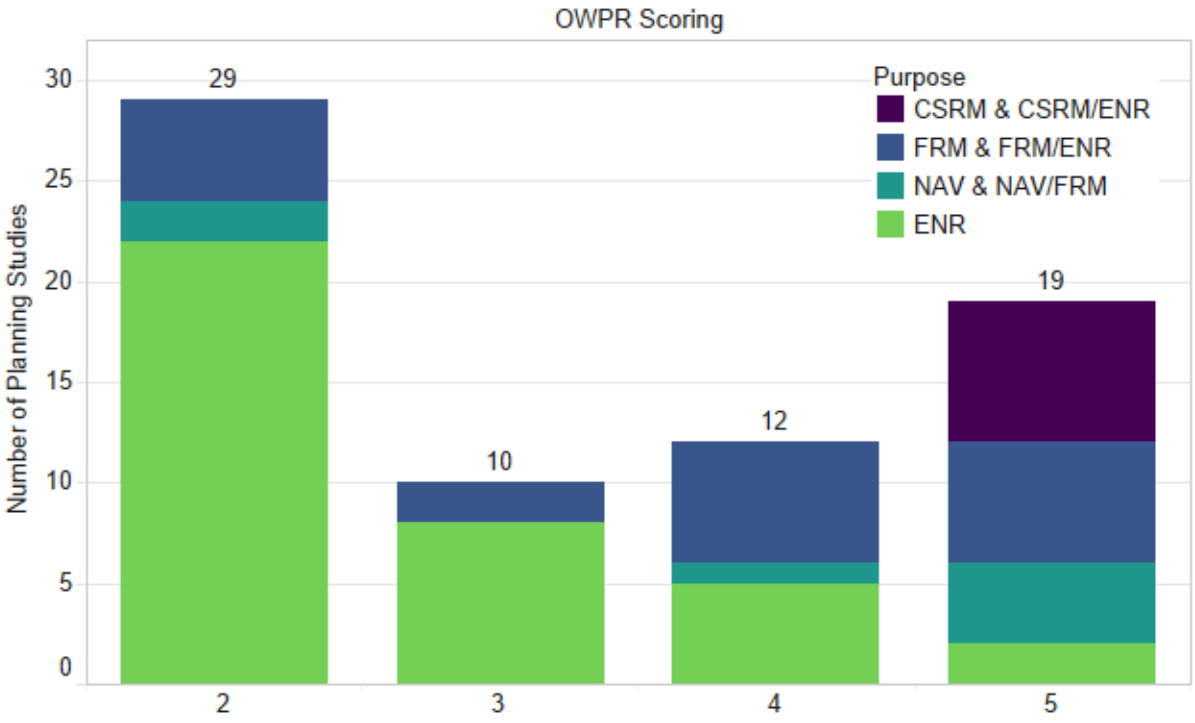

Figure 5. Count of Planning Studies by OWPR Score and Mission Area (Coastal Storm-Risk Management [CSRM], Environmental Restoration [ENR], Flood-Risk Management [FRM], Navigation [NAV], and Water Supply). Note that OWPR did not score any planning study a "1" on the 5-point suitability scale.

OWPR scored 31 of these studies as a "4" or "5" in terms of their suitability for retrospective NBS case study analysis. Twenty of the studies scored highly by OWPR also scored high on level of NBS consideration and non-Federal interest, while an additional 11 studies were scored highly by OWPR that either scored lower in the initial screening (3 studies) or were not previously scored (8 studies). Figure 6 shows a summary of the overlap between highly scored studies that emerged from Division and District scoring and OWPR scoring, respectively.

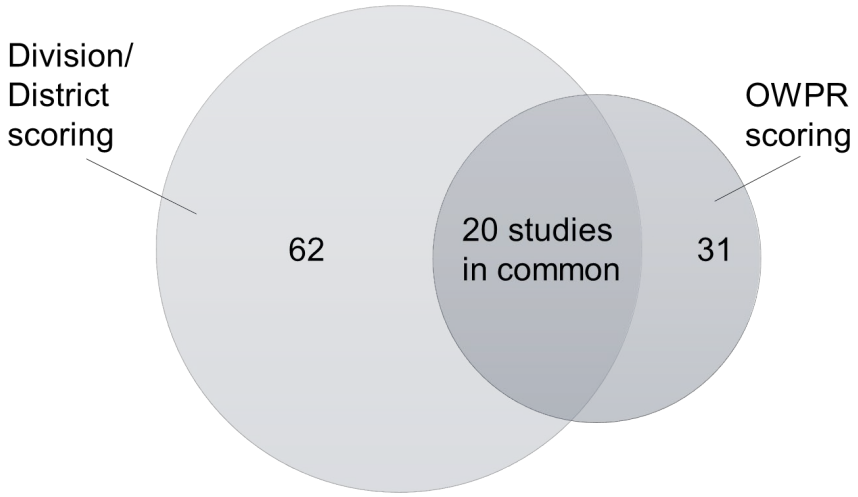

Figure 6. Venn Diagram Showing Overlap Between High-Scoring (High Suitability for NBS Case Study Analysis) Studies From Division and OWPR Screenings

The study team carried the 20 high scoring studies forward to the next stage of analysis, in addition to 8 studies that OWPR scored highly but were not evaluated by the Division and District Planning Chiefs. This led to a subset of 28 studies for further consideration. An overall summary of the filtering process to this point is summarized by mission area in Figure 7.

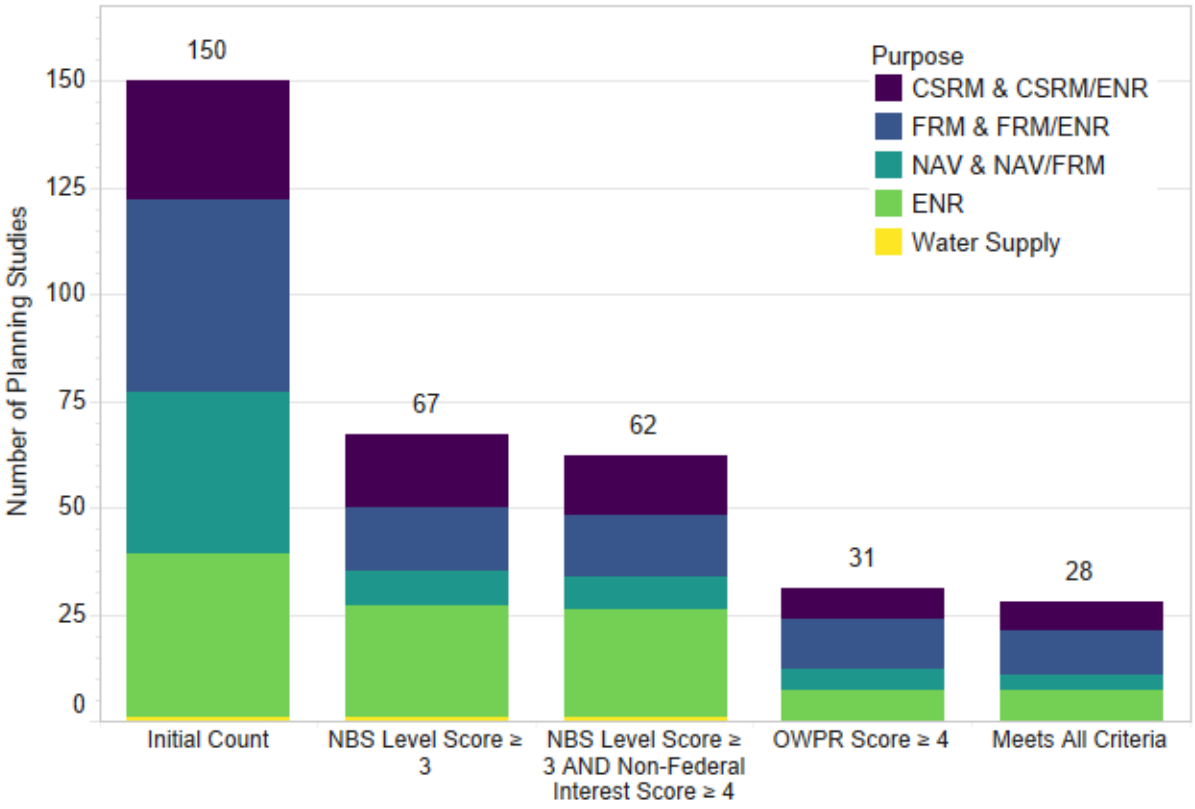

Figure 7. Bar Graph Summary of Initial Scoring and Screening Process

4.3 SECONDARY SCREENING AND SHORT LIST DEVELOPMENT

As a next step in the case study selection process (to select a diversified, representative set of case studies for the policy research), the study team conducted a secondary screening of the remaining 28 planning studies based on diversity of geographic location, business lines, scale and complexity, preliminary data availability, and alternative formulation information.

The aim of this study effort is to find planning studies with additional NBS benefit potential—typically within the FRM, CSRM, or NAV missions or across multiple planning goals—rather than to investigate

or reconsider the formulation process.[3] In addition, the study team wanted to consider planning studies that already went through a BCA process and would allow for re-analysis including additional monetized benefits and costs. Given these criteria, the study team determined that ENR-only planning studies were inconsistent with the goals of this effort because they use a different decision criterion—cost-effectiveness—which does not calculate monetized environmental or social benefits. Seven ENR-only studies were therefore removed from consideration at this stage, though consideration for ENR components could still be captured in several of the multipurpose planning studies. This left 21 planning studies for final screening and review.

To complete this screening, planning studies were grouped into one or a combination of CSRM, FRM, and NAV. Then, to ensure geographic diversity, location was considered for each planning study. If two planning studies within a group had similar locations, the planning study with a higher NBS score or the project that included more information was carried forward. This selection process resulted in a short list of 12 planning studies.

The 12 planning studies resulting from this screening are listed in Table 4. The results of this secondary screening process were presented to the Advisory Committee on November 11, 2021, to obtain additional input and finalize the secondary screening. Fact sheets were prepared for each of the 12 planning studies (Appendix B). These summaries were created using information from publicly available USACE project reports, including Feasibility Reports, General Reevaluation Reports, and Environmental Impact Statements.

[3] Project formulation is a phase of the planning process that considers alternative methods by which objectives and goals can be met within the constraints of the project.

Table 4. Final Array of 12 Planning Studies Identified as a Result of the Secondary Scoring

Planning Study Name	Purpose	Level of NBS Rating	Non-Federal Interest	OWPR Scoring	Division	District	Year	Cost (in billions)	BCR
East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation, Atlantic Coast of NY	CSRM	5	3	5	NAD	NAN	2019	$1.0	2.3
St. Johns County, FL	CSRM	5	3	5	SAD	SAJ	2017	$0.1	1.3
Mississippi Coastal Improvements, MS	CSRM/ ENR	-	-	5	SAD	SAM	2009	$1.0	
Southwest Coastal, LA	CSRM/ ENR	5	5	5	MVD	MVN	2016	$3.2	5.6
Truckee Meadows, NV	FRM	5	5	5	SPD	SPK	2014	$0.3	2.2
West Sacramento, CA	FRM	4	5	5	SPD	SPK	2016	$1.2	3.2
Westminster, East Garden Grove, CA	FRM	5	4	5	SPD	SPL	2020	$1.2	2.0
South Platte River and Tributaries, Adams and Denver Counties, CO	FRM/ENR	5	3	4	NWD	NWO	2019	$0.5	1.4
South San Francisco Bay Shoreline, CA	FRM/ENR	-	-	5	SPD	SPN	2015	$0.2	1.1
Brazos Island Harbor, TX	NAV	5	3	5	SWD	SWG	2014	$0.2	1.5
Jacksonville Harbor, Mile Point, FL	NAV	5	3	5	SAD	SAJ	2012	$0.0	1.4
Savannah Harbor Expansion, GA	NAV	-	-	4	SAD	SAS	2012	$0.7	5.5

Note: Blank cells indicate where the Division and District Planning Chiefs were not able to score a given study.

5.0 FINAL CASE STUDY SELECTION PROCESS

5.1 FINAL SELECTION

The study team presented the 12 case study options to the Advisory Committee on December 14, 2021, and recommended the final six studies that same week (Table 5). The final six studies were selected based on feedback and insight received from USACE as well as non-governmental stakeholders. Discussion about the selection of the final six planning study case studies with these organizations emphasized the importance of overall project interest, construction phase, complexity, and availability of project information.

Table 5. The Final Six Planning Studies Selected as Case Studies for the Policy Research

Project Name	Purpose	Level of NBS Rating	Non-Federal Interest	OWPR Scoring	Division	District	Year	Cost (in billions)	BCR
East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation, Atlantic Coast of NY	CSRM	5	3	5	NAD	NAN	2019	$1.0	2.3
Southwest Coastal, LA	CSRM/ENR	5	5	5	MVD	MVN	2016	$3.2	5.6
West Sacramento, CA	FRM	4	5	5	SPD	SPK	2016	$1.2	3.2
South Platte River and Tributaries, Adams and Denver Counties, CO	FRM/ENR	5	3	4	NWD	NWO	2019	$0.5	1.4
South San Francisco Bay Shoreline, CA	FRM/ENR	-	-	5	SPD	SPN	2015	$0.2	1.1
Jacksonville Harbor, Mile Point, FL	NAV	5	3	5	SAD	SAJ	2012	$0.0	1.4

There were several considerations that contributed to the selection of these final six case studies. Overall, more complex planning studies that had ample data were prioritized over planning studies with fewer elements and/or limited information. For instance, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation (NY; herein referred to as "Jamaica Bay") was selected as one of the final six case studies because it has a substantial NBS component. In addition, Jamaica Bay had considerable documentation from research developed after Hurricane Sandy. West Sacramento (CA) was selected in part because the project has consistent documentation regarding the BCR.

Both Southwest Coastal (LA) and South Platte River and Tributaries (CO; herein referred to as "South Platte") have multipurpose ENR included in their formulation which provided them with additional weighting. The selection of multipurpose ENR planning studies provided a means to consider ENR components in the case study analysis even though ENR-only planning studies were omitted.

Planning studies were also prioritized for case study analysis if they had unique features that were not represented in the other planning studies. For example, South San Francisco Bay Shoreline (CA) was

selected because it uniquely addresses tidal flooding and considers sea level rise scenarios. In addition to the reasons already noted, South Platte was selected due to the project being in a riverine system (with reservoirs) as well as in an urban area (with added community considerations). West Sacramento involves flood plain management, and Jacksonville Harbor (FL) was selected in part because it was the most complex NAV project and has been constructed. Jacksonville Harbor was also selected because it includes the beneficial use of dredged material to support NBS.

Finally, planning studies that received support from the USACE Division Planning Chiefs and OWPR as being suitable case studies were given consideration in selecting the final selection; these included South Platte, Southwest Coastal, and West Sacramento.

The six case studies represent a diverse array of planning studies with a variety of features. Figure 8 shows the geographic distribution of the six planning studies across the United States.

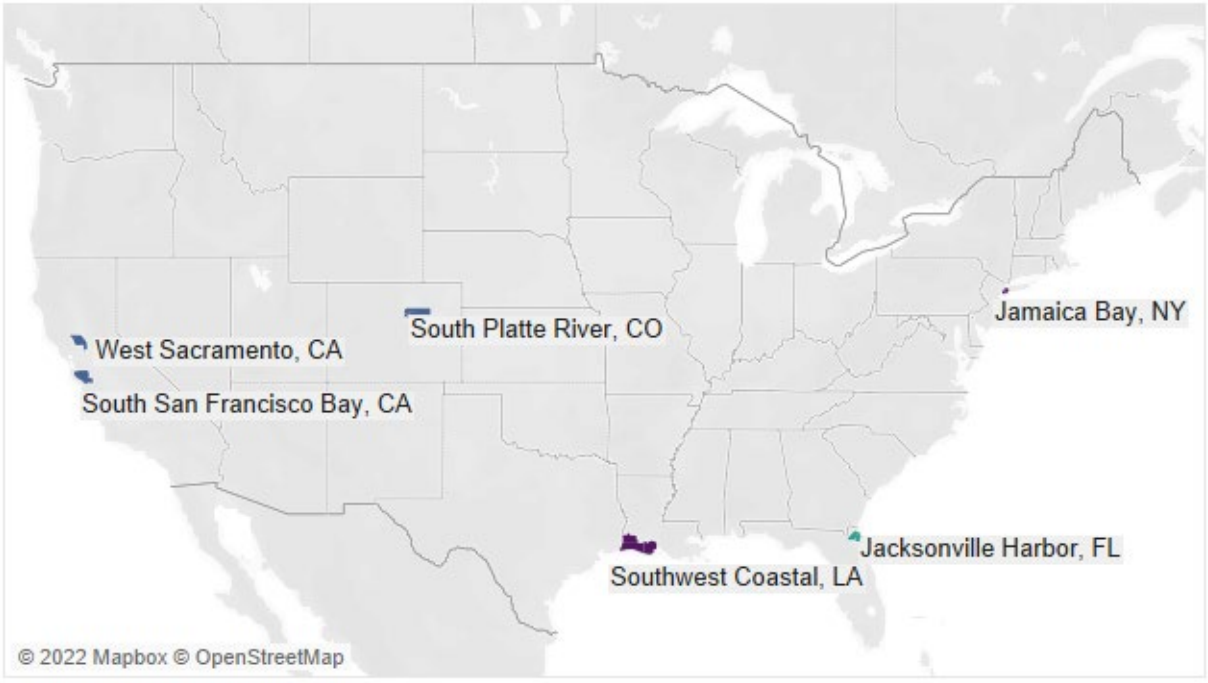

Figure 8. Locations of the Final Six Project Sites (Highlighted by County).

In the next step of this effort, each of these six case studies will undergo a detailed review and re-analysis that considers a wider set of economic, environmental, and social benefits that can be produced through NBS. Through this process, tangible, real-life examples will be provided to show how a more comprehensive evaluation of benefits of planning studies that include NBS features can be conducted in future USACE planning.

6.0 CONCLUSION

The process to gather input from all levels of USACE worked to provide different perspectives on the utilization of NBS alternatives and thus inform the project selection process. Although input was not received from all Division and District Planning Chiefs, the broad knowledge and familiarity of the planning studies at the HQ level were adequate to fill in the data gaps.

Several notable findings were revealed during this selection process. It is evident that the number of studies conducted in any given year from 2005–2020, and the purpose of those studies, was influenced by major disaster events (e.g., hurricanes) and the passage of legislation by Congress (e.g., Water Resources Development Act bills). In addition, the formulation of NBS alternatives were influenced by the continued emphasis on NED benefits for project prioritization and selection. It was also notable that although a majority (85%) of the planning studies scored by Division and District Planning Chiefs did consider NBS at some level, only half (53%) of the studies carried NBS alternatives through to the final array of alternatives. For this reason, it is noteworthy that during this effort, ENR-only planning studies were excluded, leaving only 29% of scored studies with other primary missions (or considered multi-mission) that formulated NBS alternatives and carried them through all phases of the analysis. This decision was based on ENR-only planning studies being formulated to meet specific habitat-based objectives, and thereby having limited data available for other economic, engineering, and social benefits.

Overall, this effort resulted in selecting six studies with diversity by geographic region, purpose, and level of complexity. It is anticipated that this diversity will allow for the development of a robust evaluation of planning and valuation methodologies.

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APPENDIX A. COMPLETED STUDY INVENTORY

Table A-1. The Array of 150 Planning Studies From 2005–2020 That Were Used to Inform the Initial Screening

ID	Project Name	Division	District	Study Authorization	Purpose	Cost $(000)	Recommended Plan included Deviation from NED/NER	BCR	Date of Report
1	Des Plaines River & Tributaries, IL & WI	LRD	LRC	Section 419 WRDA 1999	FRM/ENR	$307,087	N	1.7	06/08/15
2	South Fork of the South Branch of the Chicago River, Bubbly Creek, IL	LRD	LRC	Senate Committee Resolution July 20, 2005	ENR	$17,934	N	n/a	07/09/20
3	Hocking River Basin, Ohio Monday Creek Sub-basin	LRD	LRH	Committee Resolution March 7, 1996	ENR	$18,800	N	n/a	08/25/06
4	Licking River Basin, Cynthiana, KY	LRD	LRH	Committee Resolution Jan 21/1987	FRM	$17,460	N	3.1	10/24/06
5	Green and Barren Rivers Navigation Disposition, KY	LRD	LRL	Section 216 Flood Control Act 1970	NAV	$0	N	n/a	04/30/15
6	Louisville Metropolitan Flood Protection System Reconstruction, Jefferson and Bullitt Counties, KY	LRD	LRL	Section 216 Flood Control Act 1970	FRM	$188,087	N	11.0	10/27/20
7	Ohio River Shoreline, Paducah, KY	LRD	LRL	Section 5077 WRDA2007	FRM	$20,260	N	4.6	05/16/12
8	Mill Creek Watershed, Davidson County, TN	LRD	LRN	House Committee Resolution Dec. 7, 2005	FRM/ENR	$28,504	N	1.9	10/16/15
9	Upper Ohio Navigation Study, PA	LRD	LRP	House Committee Resolution March 11, 1982	NAV	$2,648,471	N	3.7	09/12/16
10	Bayou Sorrel Lock, LA	MVD	MVN	Senate Committee Resolution Sep. 29 1972	NAV/FRM	$88,500	N	19.2	01/03/05

ID	Project Name	Division	District	Study Authorization	Purpose	Cost $(000)	Recommended Plan included Deviation from NED/NER	BCR	Date of Report
11	Calcasieu Lock, LA	MVD	MVN	Senate Committee Resolution Oct. 12, 1972	NAV	$16,700	N	1.2	12/02/14
12	Louisiana Coastal Area (6 Projects), LA	MVD	MVN	Section 7006 e3 WRDA 2007	ENR	$1,627,000	N	n/a	12/30/10
13	Louisiana Coastal Area, Barataria Basin Barrier Shoreline, LA	MVD	MVN	Section 7006 c 1 c WRDA 2007	ENR	$495,000	N	n/a	06/22/12
14	Louisiana Coastal Area, LA, Ecosystem Restoration	MVD	MVN	Senate Committee Resolution Oct. 19, 1967	ENR	$112,300	N	n/a	01/31/05
15	Mississippi River Gulf Outlet (MRGO), St. Bernard Parish, LA, Deep Draft Deauthorization Study	MVD	MVN	Emergency Supplemental Appropriations Act 2006	NAV	$24,680	N	2.4	01/29/08
16	Morganza to the Gulf of Mexico, LA	MVD	MVN	Section 1001 24 A WRDA 2007	CSRM	$10,300,000	N	1.4	07/08/13
17	Port of Iberia, LA	MVD	MVN	Sec 431 WRDA 2000	NAV	$125,000	N	2.2 - 0.8	12/31/06
18	Southwest Coastal, LA	MVD	MVN	House Committee Resolution Dec 7, 2005	CSRM/ENR	$3,240,187	N	5.6	07/29/16
19	West Shore Lake Pontchartrain, LA	MVD	MVN	House Committee Resolution July 29, 1971	FRM	$718,090	N	2.9	06/12/15
20	Fargo-Moorhead Metro, MN & ND	MVD	MVP	Senate Committee Resolution Sept 1997	FRM	$1,924,300	Y	1.8	12/19/11
21	Marsh Lake, MN	MVD	MVP	House committee Resolution May 10, 1962	ENR	$10,400	N	n/a	12/30/11
22	Roseau River, Roseau, MN	MVD	MVP	Committee Resolution Sept 30, 1974	FRM	$25,100	Y	3.0	12/19/06

ID	Project Name	Division	District	Study Authorization	Purpose	Cost $(000)	Recommended Plan included Deviation from NED/NER	BCR	Date of Report
23	Souris River Basin, Bottineau, McHenry, Renville, and Ward Counties, ND	MVD	MVP	Section 209 Rivers and Harbor Act 1966	FRM	$87,323	N	1.1	04/16/19
24	Cedar River, Cedar Rapids, IA	MVD	MVR	House and Senate resolutions April 5 and May 23, 2006	FRM	$112,510	N	1.2	01/27/11
25	Des Moines and Raccoon Rivers, Des Moines, Iowa	MVD	MVR	Section 216 Flood Control Act 1970	FRM	$10,240	Y	2.7	03/28/06
26	The Great Lakes and Mississippi River Interbasin Study - Brandon Road, Will County, IL	MVD	MVR	Section 3061 (d) WRDA 2007	ENR	$830,784	N	n/a	05/23/19
27	St Louis Riverfront - Meramec River Basin Ecosystem Restoration Feasibility Study and Integrated Environmental Assessment, MO	MVD	MVS	Section 1202(b) WRDA 2018	ENR	$92,499	N	n/a	11/01/19
28	Wood River Levee System Reconstruction, Madison County, IL	MVD	MVS	Committee Resolution May 7,1997	FRM	$29,630	N	3.1	07/18/06
29	Anacostia Watershed Restoration, Prince George's County, MD	NAD	NAB	House Committee Resolution Sept 8 1988	ENR	$34,110	N	n/a	12/19/18

ID	Project Name	Division	District	Study Authorization	Purpose	Cost $(000)	Recommended Plan included Deviation from NED/NER	BCR	Date of Report
30	Poplar Island Environmental Restoration Project Expansion, Chesapeake Bay, Talbot County, MD	NAD	NAB	Sec 537 WRDA92	ENR	$256,100	N	n/a	03/31/06
31	Town of Bloomsburg, Columbia County, PA	NAD	NAB	Committee Resolution Sept 14, 1995	FRM	$43,302	N	1.4	01/25/06
32	Boston Harbor, MA	NAD	NAE	Senate Committee Resolution Sept 11, 1969	NAV	$310,980	Y	7.2	09/30/13
33	Fairfield and New Haven Counties, CT	NAD	NAE	House Committee Resolution April 29, 2010	CSRM	$133,141	N	2.2	01/19/21
34	New Haven Harbor, CT	NAD	NAE	Senate Committee Resolution July 31, 2007	NAV	$72,311	N	2.0	05/07/20
35	Pawcatuck River, RI	NAD	NAE	Senate Committee Resolution Sept 12 1969	CSRM	$77,320	Y	4.2	12/19/18
36	Portsmouth Harbor / Piscataqua River, Turning Basin, NH	NAD	NAE	Section 436 WRDA 2000	NAV	$20,770	N	3.1	02/08/15
37	Fire Island to Montauk Point Reformulation, NY (P.L. 113-2)	NAD	NAN	Disaster Relief Appropriations Act 2013	CSRM	$1,541,981	N	2.2	07/09/20
38	Hashamomuck Cove, NY	NAD	NAN	House Committee Resolution May 2007	CSRM	$12,549	N	1.1	12/09/19
39	Hudson Raritan Estuary, NJ, Liberty State Park	NAD	NAN	Committee Resolution April 15, 1999	ENR	$33,376	N	n/a	08/25/06
40	Hudson River Habitat Restoration, NY	NAD	NAN	Section 551 WRDA1996	ENR	$44,638	N	n/a	11/19/20

ID	Project Name	Division	District	Study Authorization	Purpose	Cost $(000)	Recommended Plan included Deviation from NED/NER	BCR	Date of Report
41	Hudson-Raritan Estuary Ecosystem Restoration, NY and NJ	NAD	NAN	Section 551 WRDA 1996	ENR	$408,184	N	n/a	05/26/20
42	Mamaroneck-Sheldrake Rivers, NY	NAD	NAN	Section 401 (a) WRDA 1986	FRM	$82,252	N	1.1	12/14/17
43	Montauk Point, New York	NAD	NAN	Committee Resolution May 15 1991	CSRM	$14,252	N	1.9	03/31/06
44	New York and New Jersey Harbor Anchorages, NY & NJ	NAD	NAN	Section 216 Flood Control Act 1970	NAV	$25,250	N	1.2	04/23/20
45	Peckman River Basin, NJ	NAD	NAN	House Committee Resolution June 21, 2000	FRM	$145,188	N	1.5	04/29/20
46	Rahway River Basin, NJ Coastal Storm Risk Management	NAD	NAN	House Committee Resolution March 24, 1998	CSRM	$71,929	N	2.4	06/09/20
47	Raritan Bay and Sandy Hook Bay, Highlands, NJ	NAD	NAN	House Committee Resolution Aug. 1, 1990	CSRM	$162,635	N	3.9	08/25/20
48	Raritan Bay and Sandy Hook Bay, Union Beach, NJ	NAD	NAN	Committee Resolution Aug 1, 1990	CSRM	$112,600	N	1.8	01/04/06
49	Westchester County Streams, Byram River Basin, Fairfield County, CT and Westchester County, NY	NAD	NAN	House Committee Resolution May 2007	FRM	$29,405	N	1.3	05/07/20
50	Atlantic Intracoastal Waterway, North Landing Bridge Replacement, VA	NAD	NAO	Section 216 Flood Control Act 1970	NAV	$98,494	N	2.8	08/25/20

ID	Project Name	Division	District	Study Authorization	Purpose	Cost $(000)	Recommended Plan included Deviation from NED/NER	BCR	Date of Report
51	Craney Island Eastward Expansion, Norfolk Harbor and Channels, Hampton Roads, VA	NAD	NAO	committee Resolution Sept 24 1997	NAV	$75,389	Y	4.4	10/24/06
52	Lynnhaven River Basin, VA	NAD	NAO	House Committee Resolution May 1998	ENR	$35,110	N	n/a	03/27/14
53	Norfolk Coastal, VA	NAD	NAO	Senate Committee Resolution July 25, 2012	CSRM	$1,361,810	N	3.2	02/05/19
54	Norfolk Harbor and Channels, VA	NAD	NAO	Section 216 Flood Control Act 1970	NAV	$271,822	N	5.3	06/29/18
55	Delaware Beneficial Use of Dredged Material for the Delaware River, DE	NAD	NAP	Senate Committee Resolution Oct. 26, 2005	CSRM/ENR	$331,930	N	1.7	03/06/20
56	Hereford Inlet to Cape May Inlet, NJ Shore Protection	NAD	NAP	Senate Committee Resolution Dec. 1987	CSRM	$104,030	N	2.3	01/23/15
57	New Jersey Beneficial Use of Dredged Material for the Delaware River, NJ	NAD	NAP	Senate Committee Resolution Oct. 26, 2005	CSRM/ENR	$288,560	N	1.4	04/08/20
58	Mid-Chesapeake Bay Island Ecosystem Restoration Project, Chesapeake Bay, MD	NAD	NAB	Senate Committee Resolution June 5, 1997	ENR	$1,908,850	N	n/a	02/05/18

ID	Project Name	Division	District	Study Authorization	Purpose	Cost $(000)	Recommended Plan included Deviation from NED/NER	BCR	Date of Report
59	East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation, Atlantic Coast of NY	NAD	NAN	House Committee Resolution Sept. 27, 1997	CSRM	$961,794	N	2.3	08/22/19
60	Argentine, East Bottoms, Fairfax-Jersey Creek, and North Kansas City Levee Units, Missouri River and Tributaries at Kansas Cities, MO and KS	NWD	NWK	Section 216 Flood Control Act 1970	FRM	$63,400	N	7.9	12/19/06
61	Grand River Basin Ecosystem Restoration, IA and MO	NWD	NWK	Senate House Resolution June 23, 2004	ENR	$121,347	N	n/a	11/18/20
62	Kansas Citys Levees, MO & KS - Phase 2	NWD	NWK	Section 216 Flood Control Act 1970	FRM	$318,517	N	3.4	01/27/15
63	Manhattan, KS	NWD	NWK	Section 216 Flood Control Act 1970	FRM	$23,754	N	3.5	04/30/15
64	Topeka, KS	NWD	NWK	Section 216 Flood Control Act 1970	FRM	$26,710	N	13.2	08/24/09
65	Upper Turkey Creek Basin, KS	NWD	NWK	House Committee Resolution Feb 16, 2000	FRM	$37,822	N	2.1	12/22/15
66	South Platte River and Tributaries, Adams and Denver Counties, CO	NWD	NWO	House Committee Resolution Sept. 24, 2008	FRM/ENR	$520,630	N	1.4	07/29/19
67	Lower Willamette River Environmental Dredging, OR	NWD	NWP	Senate Committee Resolution June 26, 2002	ENR	$29,774	N	n/a	12/14/15
68	Willamette River Basin Review, Reallocation Study, OR	NWD	NWP	House committee Resolution Sept. 8 1988	Water Supply	$62	N	n/a	12/18/19

ID	Project Name	Division	District	Study Authorization	Purpose	Cost $(000)	Recommended Plan included Deviation from NED/NER	BCR	Date of Report
69	Willamette River Floodplain Restoration, OR	NWD	NWP	Senate Committee Resolution Nov 15, 1961	ENR	$42,155	Y	n/a	01/07/14
70	Puget Sound Nearshore Ecosystem Restoration, WA	NWD	NWS	Section 209 River and Harbor Act 1962	ENR	$451,627	N	n/a	09/16/16
71	Seattle Harbor, WA	NWD	NWS	Section 216 Flood Control Act 1970	NAV	$332,373	Y	6.3	06/07/18
72	Skokomish River Basin, WA	NWD	NWS	Section 209 Flood Control Act 1962	ENR	$19,664	N	n/a	12/14/15
73	Craig Harbor, AK	POD	POA	House Committee Resolution Dec. 2, 1970	NAV	$32,317	N	1.2	03/16/16
74	Elim Subsistence Harbor, AK	POD	POA	Section 2006 WRDA 2007	NAV	$74,538	Y	0.3	03/12/21
75	Little Diomede Harbor, AK	POD	POA	House Committee Resolution Dec. 2, 1970	NAV	$28,960	N	0.2	08/10/15
76	Port Lions, Alaska	POD	POA	Committee Resolution Dec 2,1970	NAV	$9,300	N	1.4	06/14/06
77	Port of Nome Modifications, Nome, AK	POD	POA	Section 206 WRDA 2007	NAV	$490,919	N	n/a	05/29/20
78	St. George Harbor Improvement, St. George, AK	POD	POA	Section 4010 WRDA 2007	NAV	$159,838	Y	n/a	08/13/20
79	Unalaska (Dutch Harbor) Channels, AK	POD	POA	Section 204 Flood Control Act 1048	NAV	$34,937	N	1.9	02/07/20
80	Ala Wai Canal, Oahu, HI	POD	POH	Section 209 Flood Control Act 1962	FRM	$306,095	N	3.7	12/21/17
81	Charleston Harbor Post 45 Phase II, SC	SAD	SAC	Section 216 Flood Control Act 1970	NAV	$493,300	Y	3.9	09/08/15
82	Edisto Island, SC	SAD	SAC	Senate Committee Resolution April 22,1988	CSRM	$53,871	N	2.3	09/05/14

ID	Project Name	Division	District	Study Authorization	Purpose	Cost $(000)	Recommended Plan included Deviation from NED/NER	BCR	Date of Report
83	Pawleys Island, South Carolina	SAD	SAC	Committee Resolution April 22,1988	CSRM	$30,180	N	1.6	12/19/06
84	Canaveral Harbor, FL (Sec 203)	SAD	SAJ	Section 203 WRDA 1986	NAV	$41,070	N	2.0	02/25/13
85	CEPP Central Everglades, FL	SAD	SAJ	Section 601 b 1 WRDA 2000	ENR	$1,951,000	N	n/a	12/23/14
86	CERP - Loxahatchee River Watershed Restoration Plan, FL	SAD	SAJ	Section 601 (b)(1)	ENR	$740,760	N	n/a	04/08/20
87	CERP Biscayne Bay Coastal Wetlands, FL	SAD	SAJ	Section 601 WRDA 2000	ENR	$197,020	N	n/a	05/02/12
88	CERP Broward County Water Preserve Areas, FL	SAD	SAJ	Section 601 WRDA 2000	ENR	$896,140	N	n/a	05/21/12
89	CERP C-111 Spreader Canal Western, FL	SAD	SAJ	Section 601 WRDA 2000	ENR	$174,560	N	n/a	01/30/12
90	Comprehensive Everglades Restoration Plan, Central and Southern FL, Site 1 Impoundment Project, Palm Beach Cnty, FL	SAD	SAJ	Section 601 (b)(2)(C)(iii)	ENR	$80,840	N	n/a	12/19/06
91	Comprehensive Everglades Restoration Plan, Picayune Strand Restoration Project, Collier County, FL	SAD	SAJ	Section 309(1) WRDA 1992	ENR	$3,494,000	N	n/a	09/15/05
92	Flagler County, FL	SAD	SAJ	House Committee Resolution May 22,2002	CSRM/ENR	$44,962	N	1.9	12/23/14
93	Jacksonville Harbor, FL - Deepening	SAD	SAJ	House Committee Resolution Feb 5, 1992	NAV	$600,900	Y	2.7	04/16/14
94	Jacksonville Harbor, Mile Point, FL	SAD	SAJ	House Committee Resolution March 24,1998	NAV	$37,160	N	1.4	04/30/12

ID	Project Name	Division	District	Study Authorization	Purpose	Cost $(000)	Recommended Plan included Deviation from NED/NER	BCR	Date of Report
95	Lake Worth Inlet, Palm Beach Harbor, FL	SAD	SAJ	House Committee Resolution June 25, 1998	NAV	$88,531	N	2.0	04/16/14
96	Miami Harbor, Miami-Dade County, FL	SAD	SAJ	Committee Resolution Oct 29,1997	NAV	$161,980	Y	1.4	04/25/05
97	Port Everglades Harbor, FL	SAD	SAJ	House Committee Resolution May 9, 1996	NAV	$322,700	Y	2.9	06/25/15
98	Rio Culebrias at Aguadilla and Aguada, PR	SAD	SAJ	Section 204 Flood Control Act 1970	FRM	$25,034	N	1.5	08/17/20
99	Rio Guayanilla, Guayanilla, PR	SAD	SAJ	Section 722 WRDA 1986	FRM	$6,071	N	3.3	08/13/20
100	San Juan Harbor, PR	SAD	SAJ	House Committee Resolution Sept 20, 2006	NAV	$403,975	N	5.0	08/23/18
101	Savan Gut Phase II, St. Thomas, USVI	SAD	SAJ	Section 209 Flood Control Act 1966	FRM	$71,700	N	4.2	08/24/20
102	St. Johns County, FL	SAD	SAJ	House Committee Resolution June 21, 2000	CSRM	$78,417	N	1.3	08/08/17
103	St. Lucie County, FL	SAD	SAJ	House Committee Resolution April 11, 2000	CSRM	$53,296	N	2.3	12/15/17
104	Turpentine Run, St. Thomas, USVI	SAD	SAJ	Section 209 Flood Control Act 1966	FRM	$43,662	N	1.2	08/17/20
105	Walton County, FL	SAD	SAJ	Senate Committee Resolution July 25, 2002	CSRM	$171,650	Y	1.6	07/16/13
106	Mississippi Coastal Improvements, MS	SAD	SAM	DoD appropriations act 2006	CSRM/ENR	$1,010,080	N	n/a	09/15/09
107	Savannah Harbor Expansion, GA	SAD	SAS	Section 101 b 9 WRDA 1999	NAV	$706,000	N	5.5	08/17/12
108	Bogue Banks, Carteret County, NC	SAD	SAW	House Committee Resolution July 23, 1998	CSRM	$266,783	N	2.5	12/23/14

ID	Project Name	Division	District	Study Authorization	Purpose	Cost $(000)	Recommended Plan included Deviation from NED/NER	BCR	Date of Report
109	Neuse River Basin, NC	SAD	SAW	House Committee resolution April 15, 1966	ENR	$36,660	N	n/a	04/23/13
110	Princeville, NC	SAD	SAW	Section 216 Flood Control Act 1970	FRM	$21,540	N	0.5	02/23/16
111	Surf City & North Topsail Beach, NC	SAD	SAW	House committee resolution on Transportation and Infrastructure Feb 16, 2000	CSRM	$374,860	N	3.7	12/30/10
112	West Onslow Beach & New River Inlet (Topsail Beach), NC	SAD	SAW	Energy and Water appropriations act 2001	CSRM	$185,170	Y	3.0	09/28/09
113	Española Valley, NM	SPD	SPA	House Committee Resolution Dec 10 2009	ENR	$62,000	N	n/a	05/11/18
114	Middle Rio Grande Flood Protection, Bernalillo to Belen, NM at Albuquerque, NM	SPD	SPA	Section 401 WRDA 1986	FRM	$293,136	N	9.6	03/13/20
115	Rio Grande Sandia to Isleta, CO, NM, TX	SPD	SPA	Section 5056 WRDA 2007	ENR	$24,674	N	n/a	08/05/19
116	American River Watershed, Common Features, CA	SPD	SPK	Section 101 (a) (1) WRDA 1996	FRM	$1,565,750	Y	5.4	04/26/16
117	American River Watershed, Common Features, Natomas, CA	SPD	SPK	used construction authority Section 101 a 1 of WRDA 1996	FRM	$1,147,280	N	6.0	12/30/10
118	Delta Island and Levees, CA	SPD	SPK	House Committee Resolution May 8, 1964	ENR	$25,041	N	n/a	12/18/18
119	Encinitas-Solana Beach Shoreline, CA	SPD	SPL	House Committee Resolution April 22, 1999	CSRM	$167,454	Y	1.4	04/26/16

ID	Project Name	Division	District	Study Authorization	Purpose	Cost $(000)	Recommended Plan included Deviation from NED/NER	BCR	Date of Report
120	Lower San Joaquin River, CA	SPD	SPK	House Committee Resolution May 8, 1964	FRM	$1,070,309	N	7.0	07/31/18
121	Orestimba Creek, CA	SPD	SPK	House Committee Resolution May 8, 1964	FRM	$45,330	Y	1.4	09/25/13
122	Sutter Basin, CA	SPD	SPK	Section 209 Flood Control Act 1962	FRM	$688,930	Y	2.6	03/12/14
123	Truckee Meadows, NV	SPD	SPK	House Report associated with the EWDAA of 1996	FRM	$280,820	N	2.2	04/11/14
124	West Sacramento, CA	SPD	SPK	Section 101 (4) WRDA 1992	FRM	$1,190,528	N	3.2	04/26/16
125	Yuba River, CA	SPD	SPK	Senate Committee Resolution April 28, 2016	ENR	$97,219	N	n/a	06/20/19
126	Little Colorado River at Winslow, Navajo County, AZ	SPD	SPL	House Committee Resolution May 17, 1994	FRM	$79,093	N	2.7	12/14/18
127	Los Angeles River Ecosystem Restoration, CA	SPD	SPL	Senate committee Resolution June 25, 1969	ENR	$1,356,608	Y	n/a	12/18/15
128	Malibu Creek Ecosystem Restoration, Los Angeles and Ventura Counties, CA	SPD	SPL	House Committee Resolution Feb. 5, 1992	ENR	$264,999	Y	n/a	11/13/20
129	Salt River (Rio Salado Oeste), Phoenix, Maricopa County, AZ	SPD	SPL	Sec 6 Flood Control Act 1938	ENR	$164,950	N	n/a	12/19/06
130	Salt River (Va Shly'ay Akimel), Maricopa County, AZ	SPD	SPL	Section 6 Flood Control Act 1936	ENR	$138,970	N	n/a	01/03/05

ID	Project Name	Division	District	Study Authorization	Purpose	Cost $(000)	Recommended Plan included Deviation from NED/NER	BCR	Date of Report
131	San Clemente Shoreline, CA	SPD	SPL	Section 208 Flood Control Act 1965	CSRM	$99,080	N	1.4	04/15/12
132	Santa Cruz River, Paseo de las Iglesias, Pima County, AZ	SPD	SPL	Committee Resolution May 17, 1994	FRM/ENR	$92,100	N	n/a	03/28/06
133	Westminster, East Garden Grove, CA	SPD	SPL	House Committee Resolution May 8, 1964	FRM	$1,224,598	Y	2.0	07/09/20
134	South San Francisco Bay Shoreline, CA	SPD	SPN	House Committee Resolution July 24, 2002	FRM/ENR	$173,900	Y	1.1	12/18/15
135	May Branch, Fort Smith, AR	SWD	SWL	Committee Resolution March 11, 1982	FRM	$30,850	Y	1.1	12/19/06
136	Brazos Island Harbor, TX	SWD	SWG	House Committee Resolution May 5, 1966	NAV	$204,587	y	1.5	11/03/14
137	Guadalupe and San Antonio River Basins, Leon Creek, TX	SWD	SWF	House Committee Resolution March 11, 1998	FRM	$28,175	N	1.7	06/30/14
138	Lower Colorado River Basin Phase I, TX	SWD	SWF	Committee Resolution Aug 4, 1936	FRM/ENR	$110,730	N	1.5,1.7,2.7	12/31/06
139	Freeport Harbor, TX - Channel	SWD	SWG	Section 216 Flood Control Act 1970	NAV	$239,300	Y	1.9	01/07/13
140	Galveston Harbor Channel Extension, Houston-Galveston Navigation Channels, TX	SWD	SWG	Section 216 Flood Control Act 1970	NAV	$13,395	N	2.7	08/08/17

ID	Project Name	Division	District	Study Authorization	Purpose	Cost $(000)	Recommended Plan included Deviation from NED/NER	BCR	Date of Report
141	Gulf Intracoastal Waterway, Brazos River Floodgates and Colorado River Locks, Navigation Feasibility Study, TX	SWD	SWG	Section 216 Flood Control Act 1970	NAV	$409,777	N	3.3	10/23/19
142	Houston Ship Channel Expansion Channel Improvement Project, Harris, Chambers and Galveston Counties, TX	SWD	SWG	Section 216 Flood Control Act 1970	NAV	$876,848	Y	2.5	04/23/20
143	Jefferson County Ecosystem Restoration Feasibility Study, TX	SWD	SWG	House Committee Resolution Feb. 16, 2000	ENR	$62,252	N	n/a	09/12/19
144	Matagorda Ship Channel Improvement Project, Port Lavaca, TX	SWD	SWG	House Committee Resolution Dec. 31, 1970	NAV	$218,324	N	2.3	11/15/19
145	Sabine Neches Waterway, TX/LA	SWD	SWG	Senate Committee Resolution June 5, 1997	NAV	$1,114,040	Y	1.3	07/22/11
146	Sabine Pass to Galveston Bay, TX	SWD	SWG	House Committee Resolution June 23, 2004	CSRM	$29,757	N	4.7, 1.2, 8.4	12/07/17
147	The Resacas, In the Vicinity of the City of Brownsville, TX	SWD	SWG	House Committee Resolution Nov 10, 999	ENR	$202,500	N	n/a	09/06/18
148	Jordan Creek, Springfield, MO	SWD	SWL	Senate Committee Resolution May 11, 1962	FRM	$20,860	N	2.7	08/26/13
149	Three Rivers, AR	SWD	SWL	Section 216 Flood Control Act 1970	NAV	$180,295	N	4.4	09/06/18

ID	Project Name	Division	District	Study Authorization	Purpose	Cost $(000)	Recommended Plan included Deviation from NED/NER	BCR	Date of Report
150	Tulsa and West-Tulsa Levee Feasibility Study, Tulsa County, OK	SWD	SWT	Section 1202(a) WRDA 2016	FRM	$133,508	Y	0.0	04/23/20

APPENDIX B. FACT SHEETS

These fact sheet summaries were created using information from publicly available USACE project reports, including Feasibility Reports, General Reevaluation Reports, and Environmental Impact Statements.

Each fact sheet contains information about the project background and goals, as well as plan formulation details, consideration of NBS, and the outcome of the Chief's Report. Figures are presented in each sheet that depict project location, the alternative plan formulation process, and project milestones. A table is presented at the end of each summary that highlights the consideration of NBS and other relevant/available information.

Some limitations were encountered in the development of these summaries, primarily due to limitations in information or data availability. These limitations were due in part to how far along the project was in terms of development, and the level of detail provided for each project alternative throughout the formulation and screening processes.

The fact sheets for the final 12 case studies are presented within this appendix.

B.1 EAST ROCKAWAY INLET TO ROCKAWAY INLET & JAMAICA BAY, NY

Purpose	CSRM
Division	NAD
District	NAN

Project Goals: Reduce vulnerability, future flood risk, and economic costs of large-scale flood and storm events, as well as support long-term sustainability of the coastal ecosystem, improve community resiliency, and enhance natural storm surge barriers.

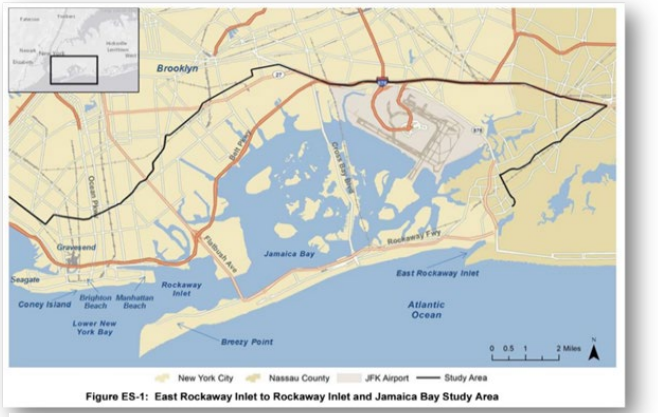

Figure B-1. East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Study Area.

Background: After Hurricane Sandy made landfall on the Atlantic Coast of New York in 2012, the area containing East Rockaway Inlet to Rockaway Inlet and Jamaica Bay experienced some of the storm's most devastating impacts, with over 1,000 structures damaged or destroyed (USACE, 2016a). In addition to significant storm surge damage, low-lying northern and central neighborhoods surrounding Jamaica Bay faced disproportionate devastation from flood waters, including disrupted transit service as a result of damage to subway infrastructure, widespread school closures, and the destruction of habitat for coastal waterbirds. The project area's low-lying elevation, dense population, and extensive development place it at particularly high risk for storm surge inundation because heavy urbanization has degraded coastal ecosystems and processes that historically provided a buffer against tidal flooding.

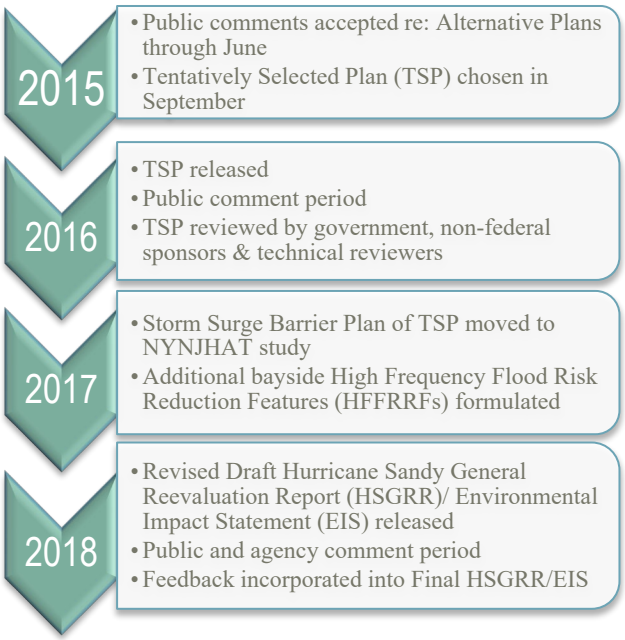

Figure B-2. East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Project Milestones.

Plan Formulation: The Project Delivery Team (PDT) worked in consultation with the non-federal sponsor (the New York State Department of Environmental Conservation [NYSDEC]), the City of New York, and state and local agencies, among others, to form alternative plans for two separate planning reaches (Figure B-3). The Atlantic Ocean Shorefront Planning Reach centered around mitigating inundation, erosion, wave attack, and overtopping along the Rockaway Peninsula, while the Jamaica Bay

Planning Reach addressed the storm surges that systematize in the bay after entering through Rockaway Inlet and overtopping the Rockaway Peninsula and Coney Island.

Consideration of Nature-Based Solutions: The PDT established a goal of incorporating Natural and Nature-Based Features (NNBFs) at the outset of the project and several NNBFs became crucial elements of the Final Recommended Plan (RP). Upon screening for cost effectiveness and feasibility, the PDT determined that including beach restoration and renourishment to enhance the Atlantic Ocean Shorefront Planning Reach's structural components would together provide the lowest annualized costs of the project's 50-year lifespan and provide recreational co-benefits (USACE, 2016a).

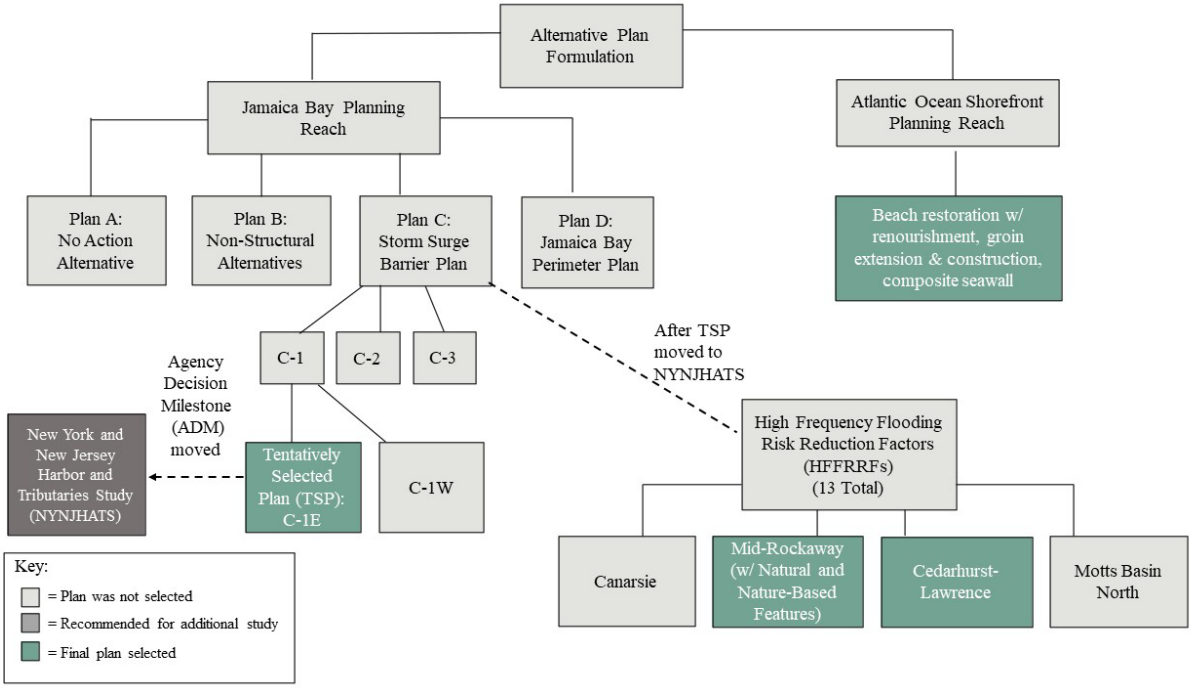

Figure B-3. East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Alternative Plan Formulations to Arrive at Final Recommended Plans

After the Jamaica Bay Planning Reach Storm Surge Barrier Plan moved to the New York and New Jersey Harbor and Tributaries (NYNJHAT) study, the PDT utilized NNBFs to identify location-appropriate, stand-alone High Frequency Flooding Risk Reduction Features (HFFRRFs), that could be designed to both operate with an eventual barrier and function independently. The study team ultimately found that NNBFs could enable "co-location with the flood risk reduction features in order to take advantage of their capacity to improve the function and resilience of the structural features" (USACE, 2016a). The Final Report notes that the NNBFs are crucial for controlling erosion and are self-mitigating.

Table B-1. Consideration of Nature-Based Solutions for East Rockaway Inlet to Rockaway Inlet and Jamaica Bay. Grey Shading Indicates That a Measure was Carried Forward Through This Stage; White Shading Indicates That the Measure was Eliminated at or Before This Stage.

Planning Reach	Preliminary NNBF Alternatives	Project Phase		
		Prelim. HFFRRF Screening (w/BCR)	Final HFFRRF Screening (w/BCR)	Final Recommended Plan (w/BCR)
Jamaica Bay Planning Reach	Mid-Rockaway Arverne Site 1	1.8	1.4	1.1
	Mid-Rockaway Arverne Site 2	1.8	1.4	1.1
	Mid-Rockaway Arverne Site 3	1.8	1.4	1.1
	Mid-Rockaway Edgemere Area	1.8	1.4	1.1
	Norton Basin	<1		
	Bayswater	<1		
	Motts Basin North (NNBF component)	1.8*	*	*
	Motts Basin South	<1		
Atlantic Ocean Shorefront PR	Atlantic Shorefront of Rockaway Peninsula (from Beach 9th St to Beach 149th St)			2.6

**Note: The PDT screened the Motts Basin North (MBN) HFFRRF in Phase 2 (BCR 1.3), but the NNBF component was eliminated in the preliminary screening, as the existing mudflat would be adversely impacted by conversion to intertidal marsh. The MBN HFFRRF was removed from the final plan due to a rise in construction costs & BCR dropping to .80.*

Outcome of Chief's Report: The Chief's Report was signed August 22, 2019, and subsequently transmitted to the Assistant Secretary for the Army for Civil Works (ASACW) for review and final approval. A Tentatively Selected Plan (TSP) for the NYNJHAT study was anticipated in spring 2021, but delivery of that study has been delayed due to funding concerns. A TSP is expected in July 2022, with a Draft Feasibility Report and Environmental Impact Statement to follow in summer, along with public review. The Chief's Report is currently approved for release in summer 2024.

B.2 MISSISSIPPI COASTAL IMPROVEMENTS PROGRAM, MS (MSCIP)

Purpose	CSRM/ENR
Division	SAD
District	SAM

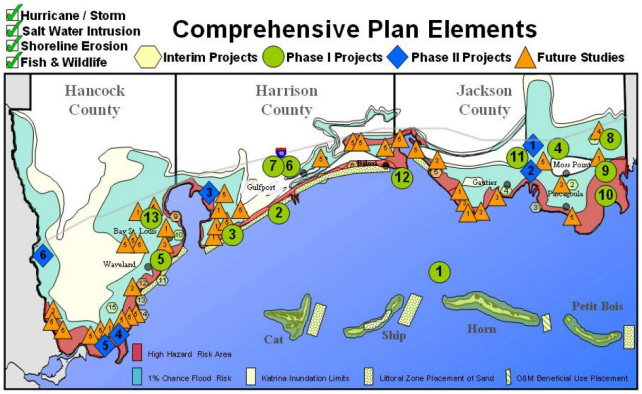

Figure B-4. MsCIP Study Area and Comprehensive Plan Elements.

Project Goals: Reduce loss of life and damages caused by hurricane and storm surge, restore fish and wildlife habitat, manage seasonal salinities to optimize oyster growth conditions, reduce erosion to barrier islands, mainland and interior bay shorelines, and create opportunities for collaboration with local, state, and federal agencies to facilitate implementation (USACE, 2009a).

Background: After Hurricane Katrina caused severe impacts to the Gulf region, Congress directed USACE to conduct hurricane and storm damage reduction analyses to inform design for improvements in the coastal area of Mississippi. The request from Congress also directed USACE to include measures for the prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes in their analyses (USACE, 2009b).

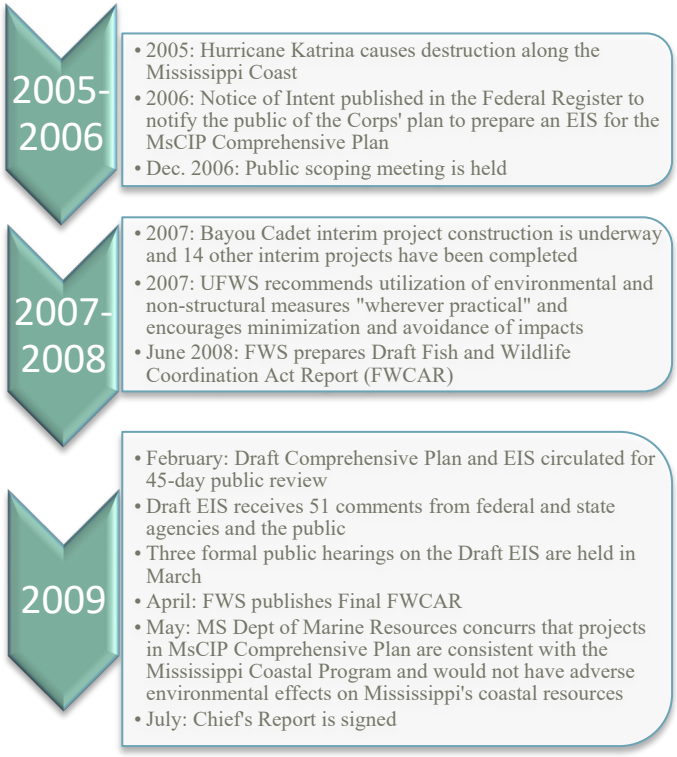

Figure B-5. MsCIP Project Milestones.

Plan Formulation: After public input and data collection, the SAM District created initial measures to address the project's CSRM and ENR (Environmental Restoration) objectives, and then screened and combined the measures to formulate alternative plans (Figure B-6). USACE reformulated these plans to increase effectiveness, and then plans were selected to undergo Public/Agency Reviews (USACE, 2009c). The plans were then compared for cost effectiveness and risk using a risk informed decision framework (RIDF; Mobile District, 2009). Finally, the District evaluated each alternative for its environmental and economic benefits, social impacts, and risk using the same RIDF. Projects were also separated into different categories: Interim projects, Phase I projects (immediate

implementation) Phase II projects (future implementation) and Future Studies (pilot studies that would determine larger-scale future projects).

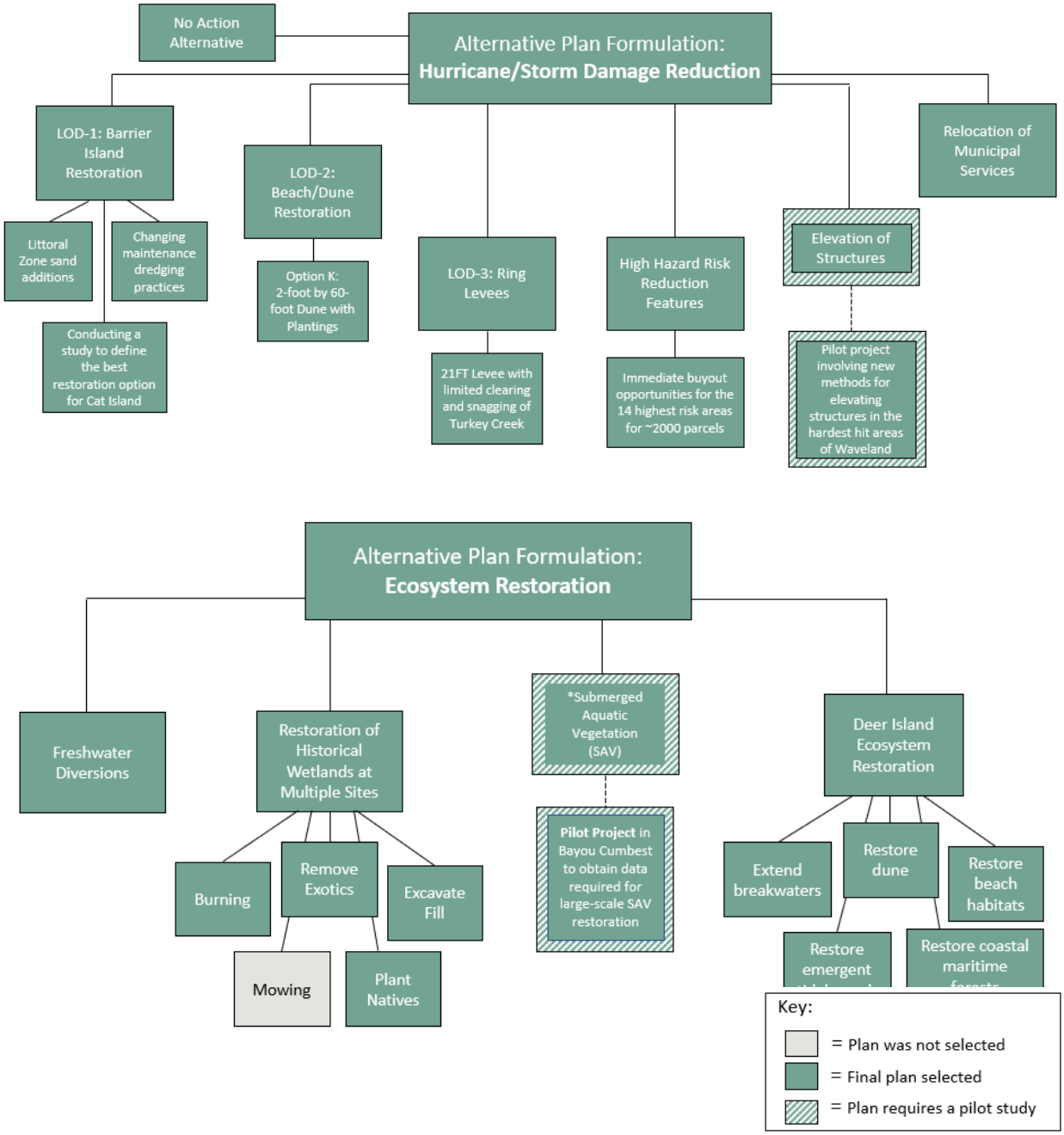

Figure B-6. MsCIP Alternative Plan Formulations to Arrive at Final Recommended Plans for Hurricane and Storm Surge Reduction (top); Alternative Plan Formulations to Arrive at Final Recommended Plans for Ecosystem Restoration (bottom).

Table B-2. Consideration of Nature-Based Solutions for MsCIP. Grey Shading Indicates That a Measure was Carried Forward Through This Stage, White Shading Indicates That the Measure was Eliminated at or Before This Stage.

Type of Measure	Project Phase			
	Initial Measures	Formulated Alternatives	Final Alternatives	Final Comprehensive Plans
Storm Damage Reduction	Acquisition of Structures			
	Zoning and Building Code Modification			
	Floodplain Management			
Saltwater Intrusion	Re-regulation of reservoirs			
	Diversion of freshwater sources into critical need areas			
Erosion Reduction	Placement of additional sand, shell materials, construction debris, rubble, stone, and/or geo-textiles			
	Supply of additional sand to littoral zone/island sediment budget			
	Reduction of sand-robbing activities in the near-shore or barrier island zones			
Ecosystem Restoration and Fish and Wildlife Preservation	Acquiring and restoring currently undeveloped lands			
	Restoring previously degraded wetlands			
	Removal of sediment and/or debris choking streams and estuaries			
	Re-grading to historic conditions and topography			
	Preserving habitats to reduce fragmentation			
	Removal of invasive species			
	Removal of dead vegetation, deadfalls, and other vegetation that interferes with natural functions			
	Planting of native species in areas in which those species were killed by the hurricanes			
	Filling of drainage channels that interfere with natural hydrologic functions			
	Submerged aquatic vegetation (SAV) Restoration			

Consideration of Nature-based Solutions: The District formulated NBS to address storm damage reduction, saltwater intrusion, erosion reduction, and ecosystem restoration (Table B-2). Of the 18 initial measures, 11 were included in the final comprehensive plans. The Corps eliminated seven of the initial measures that were determined to be cost prohibitive. To evaluate ecosystem restoration measures, the Project Delivery Team (PDT) used Hydrogeomorphic (HGM), Freshwater Health Index (FHI), and Spatial Decision Support System (SDSS) models. Saltwater intrusion reduction methods involved analyzing freshwater diversion methods using a Water Quality Model (WQM). Throughout the study, the District evaluated measures using the following metrics: scientific verifiability, cost-effectiveness, communicability, ability to be changed by human intervention, credibility, scalability, relevance, sensitivity, transparency, and minimal redundancy.

Outcome of Chief's Report: The Chief's Report was signed in July 2009, and construction for Forest Heights Levee Elevation and Deer Island Restoration began in June 2014. Completed projects to date include Barrier Island Restoration (all phases completed in May 2020), Cat Island Restoration and West Ship Island Restoration (completed December 2017). Projects currently under construction include the Forest Heights Levee Elevation and Deer Island Restoration. As of January 2021, nine projects and several studies remained unfunded.

B.3 SOUTHWEST COASTAL, LA

Purpose	CSRM/ENR
Division	MVD
District	MVN

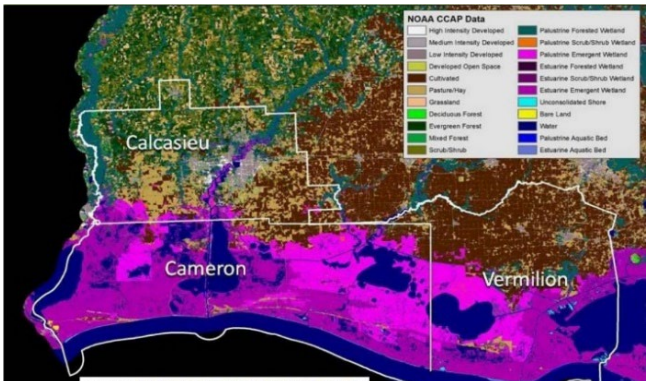

Figure B-7. Southwest Coastal, LA Study Area

Project Goals: Reduce the risk of damages and losses from hurricane storm surge flooding through the restoration of landscapes that serve as protective barriers and wildlife habitat and stabilize canal banks to decrease shoreline erosion and protect adjacent wetlands. Additional objectives include managing tidal flows to improve drainage and prevent increases in marsh salinity, as well as increasing wetland productivity in marshes to maintain function.

Background: The study area encompasses 4,700 square miles and three parishes (Cameron, Calcasieu, and Vermilion) in southwestern Louisiana. The area's compounding factors of proximity to the Gulf of Mexico, low elevation, sea level rise and subsidence make it increasingly vulnerable to coastal flooding, shoreline erosion, saltwater intrusion, and loss of wetlands and chenier habitats into the future. Historically, these parishes have suffered extensive damage from hurricanes and tropical storms, most recently from hurricanes Laura and Delta in 2020. This study, completed in 2016, specifically addresses the impacts of prior hurricanes: Audrey (1957), Lili (2002), Rita (2005), Gustav (2008) and Ike (2008; USACE, 2016b).

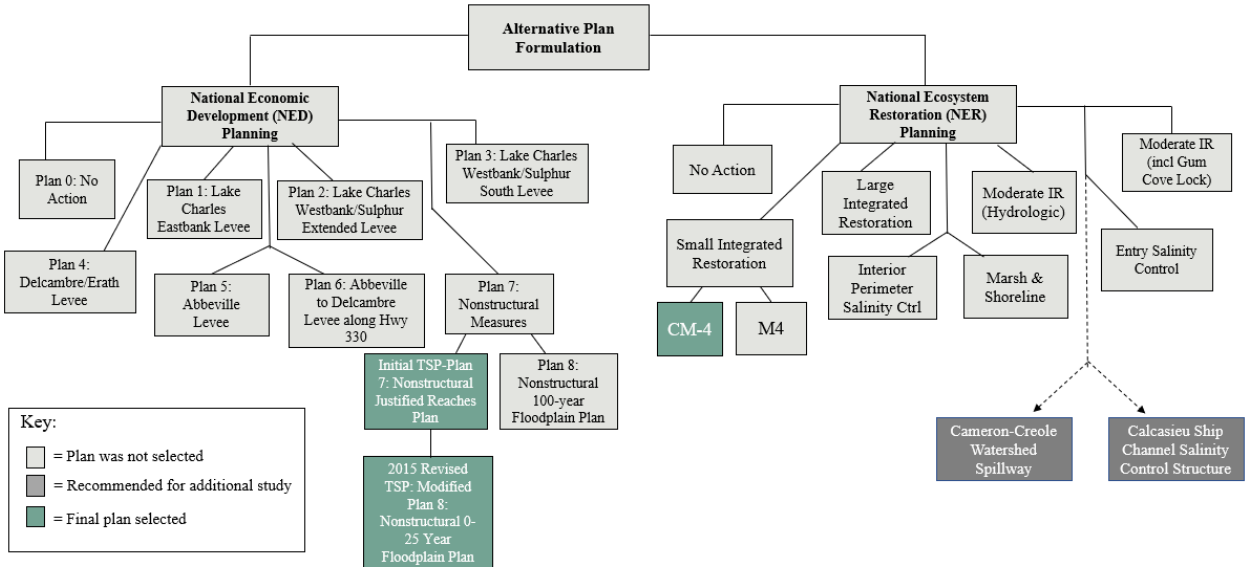

Figure B-8. Southwest Coastal, LA Alternative Plan Formulation to Arrive at Final Recommended Plans.

Plan Formulation: The PDT evaluated roughly 300 concepts to arrive at the initial array of National Economic Development (NED) Alternative Plans (Figure B-8). Of these, 15 Hurricane and Storm Damage Risk Reduction (HSDRR) alternatives consisting of an armored 12-ft levee along the Gulf Intracoastal Waterway (GIWW), highway armoring, levee alignments, and nonstructural (NS) measures were screened for further analysis. Every structural solution failed to meet the decision criteria, leading to the proposal of NS solutions in the TSP. Two NS plans (Plans 7 and 8) made the Final Array of Alternatives, with Plan 7 (NS Justified Reaches Plan) selected as the initial TSP. However, controversy arose during the 2013–2014 public comment period, which led to the development of a new NED TSP (a modified version of Plan 8) in 2015. The National Ecosystem Restoration Recommended Plan (NER RP) focuses on stabilizing wetlands and consists of 49 ecosystem restoration features (including chenier reforestation, marsh restoration and shoreline protection features) recommended for construction. In addition to addressing land loss and ecosystem degradation, the selected NER RP (Plan CM-4 Small Integrated Restoration (SIR), offers a comprehensive ecosystem restoration plan that is both least-cost and cost-effective.

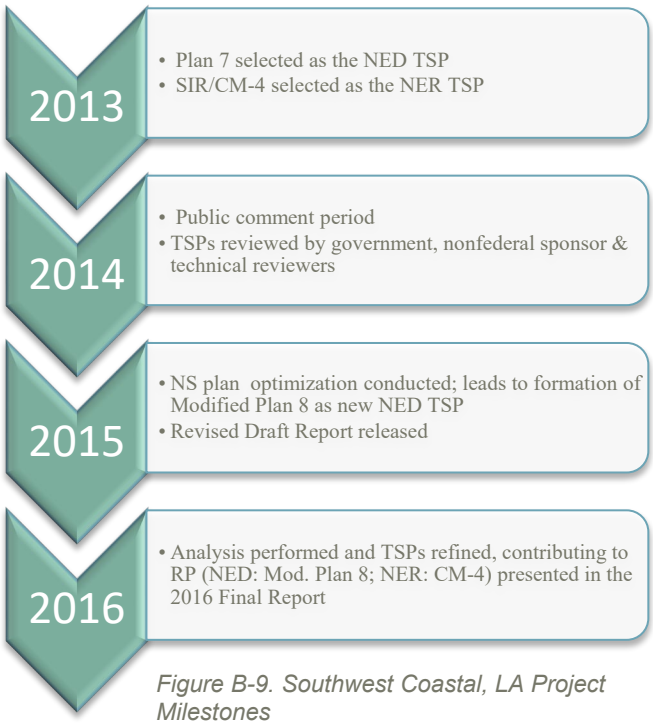

Figure B-9. Southwest Coastal, LA Project Milestones

Consideration of Nature-Based Solutions: The NER RP prioritized NNBFs from the outset (Table B-3). The study team analyzed NNBFs for engineering and economic feasibility, maximum benefits provided over the 50-year analysis period (2025–2075), and their capacity to meet the project's objectives. The process for selecting the NER TSP consisted of several rounds of screening and plan iterations before arriving at the final combination of measures that most effectively offered net environmental benefits that contribute to regional and coastal ecosystem functions. Considering the difficulty in quantifying benefits for such a wide array of NNBFs, Cost Effectiveness and Incremental Cost Analysis (CE/ICA) was utilized to best inform environmental investment decisions. Ultimately, the Comprehensive Small Integrated Restoration Plan (CM-4) was determined to be the most suited, cost-effective, and economically justified option to achieve project goals.

Outcome of Chief's Report: The Chief's Report was signed in July 2016 and transmitted to the Secretary for the Army for review and Congressional approval. The project first cost for the NER Plan is $2.19 billion and the NED Plan is $906 million based on a 3.125 percent discount rate. As of October 2020, Federal Construction funds have not yet been received from Congress to begin implementation. The President's Budget for federal FY 2022 (October 2021–September 2022) is the next available opportunity for funding (CPRA, 2020).

Table B-3. Consideration of Nature-Based Solutions for Southwest Coastal, LA. Grey Shading Indicates That a Measure Was Carried Forward Through This Stage, White Shading Indicates That the Measure was Eliminated at or Before This Stage.

Measure Type/ Objective	Project Phase				
	NER/NNBF Alternatives identified (from 1st screening of over 200 features)	Initial Array screening (by measure type)	Alternative Plan Evaluation	Focused Array (screened by location & strategy)	Final Array; NER TSP (CM-4)
Marsh Restoration	(3a1-3, 3c, 3d) Marsh creation and terracing NW of Calcasieu Lake and E Calcasieu Lake. Beneficial use of dredged material from Calcasieu Ship Channel.	Screened for first cost, total acres, effectiveness (net acres), efficiency ($/acre)	3a1, 3c move fwd	3a1 & 3c1 move fwd	
	(47a, c) Marsh creation at South Grand Chenier				
	(47f, h) Marsh creation at South Pecan Island				
	(124a-d) Marsh creation at Mud Lake			124c, d move fwd	
	(127c) Marsh creation at East Pecan Island (Eastern portion)			127c3 moves fwd	
	(135a) Marsh creation at Sweet Lake				
	(306a, b) Restore marsh at Marsh Island and Rainey Marsh		306a moves fwd	306a1	
Shoreline Protection/ Stabilization	(5a, 6b) Gulf Shoreline Protection - Holly Beach & Rockefeller Refuge Reaches	Shoreline Protection/ Stabilization			
	(12a-d) Shoreline protection at Grand, Sweet, and Willow Lakes (Cameron)				
	(16a, b) Freshwater Bayou Bank Protection/Stabilization, Belle Isle to Lock		16b moves fwd	16b	
	(26) Fortify spoil banks of GIWW				
	(49a, b) Stabilize Calcasieu Lake Shoreline				
	(99a) Gulfshore protection from Freshwater Bayou to Southwest Pass				
	(113a, b) Stabilize shoreline of Vermilion, East and West Cote Blanche Bays (via Rock Dike)		113b2 moves fwd		
Hydrologic & Salinity Control Structures	Salinity control structures at Alkali Ditch (17a), Hwy 82 (21a-c), Calcasieu Pass & Ship Channel (7), Crab Gully (17b), Black Lake Bayou (17c) & Sabine Pass (48)	Benefits (measuring <500 acres = screened out)	17a-c work as a unit; 7*, 48* preclude need for 17a-c, 407 & 74a; 21a-c excluded		
	(13) Freshwater introduction/retention structure or sill on Little Pecan Bayou				
	(74a-c) Cameron Spillway structures at East Calcasieu Lake		74a moves fwd	74a	Recommended for Additional Study
	(304a, 304b) Southwest Pass Sills				
	(407) Structure on GIWW at Gum Cove Ridge				
	(507, 508) Abbeville reef restoration/ creation				
	(602) Changes to Cameron-Creole Watershed Control Structure				
	(603) Control structure at Tom's Bayou				
Chenier reforestation	(416) Grand Chenier ridges (restore ridges & upland forests on prominent ridges	Implementability & Sustainability			
	(509a-e) Restore/sustain Chenier ridges and upland forests on prominent ridges in Vermilion Parish		509 c&d move forward		
	(510a, b, d) Chenier Ridges in Cameron Parish (restore/sustain ridges and upland forests on prominent ridges)				
Oyster Reef Pres.	(604) Preservation of Sabine Historic Oyster Reefs	Benefits & other funding sources			

B.4 ST. JOHN'S COUNTY, FL

Purpose	CSRM
Division	SAD
District	SAJ

Project Goals: The project was developed to formulate a plan that would address CSRM and maintain environmental habitat and recreation for three reaches within St John's County, Florida (USACE, 2017).

Background: The St. John's County Shoreline is extremely vulnerable to structural damages from erosion and storm surge caused by coastal storm events. Vilano Beach and Summer Haven were selected as project reaches as the areas were deemed "critically eroded" by the state of Florida. Between 2004 and 2008, Florida identified South Ponte Vedra Beach as critically eroded and it was added as a second reach (Figure B-10). The Vilano Beach study reach was expanded in order to study this portion of the shoreline as a "contiguous system."

Figure B-10. St. John's County, FL Project Map.

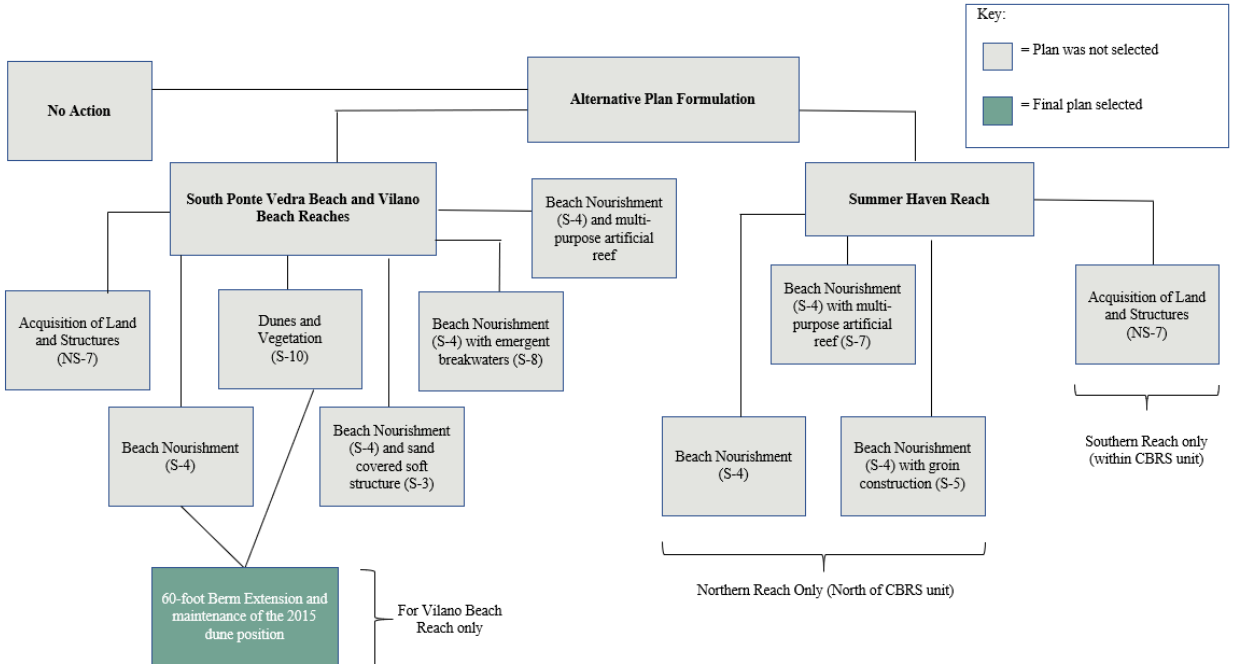

Figure B-11. St John's County, FL Alternative Plan Formulation to Arrive at Final Recommended Plans.

Plan Formulation: The study began in 2005 with an initial screening of 34 measures (seven structural and 10 nonstructural for each of the two reaches). Measures that reached the Alternative Plan Formulation phase in 2015 are represented in Figure B-11. USACE dropped the Summer Haven Reach during the Alternatives Milestone Meeting due to a reduced number of structures, infrastructure relocation, and the work that had already been done by the non-federal sponsor. The secondary screening with ROM costs identified the following alternatives for further development and modeling: Dunes and vegetation, beach nourishment, and Acquisition of land and structures in Vilano Beach only. Structure and land Acquisition costs were not justified, and the other two alternatives were further analyzed through Beach-fx modeling to assemble an alternative with the greatest net benefits. This turned out to be Alternative 6, which had a benefit-cost ratio (BCR) of 1.3 and included a 60-ft berm extension along with maintenance of the 2015 dune position.

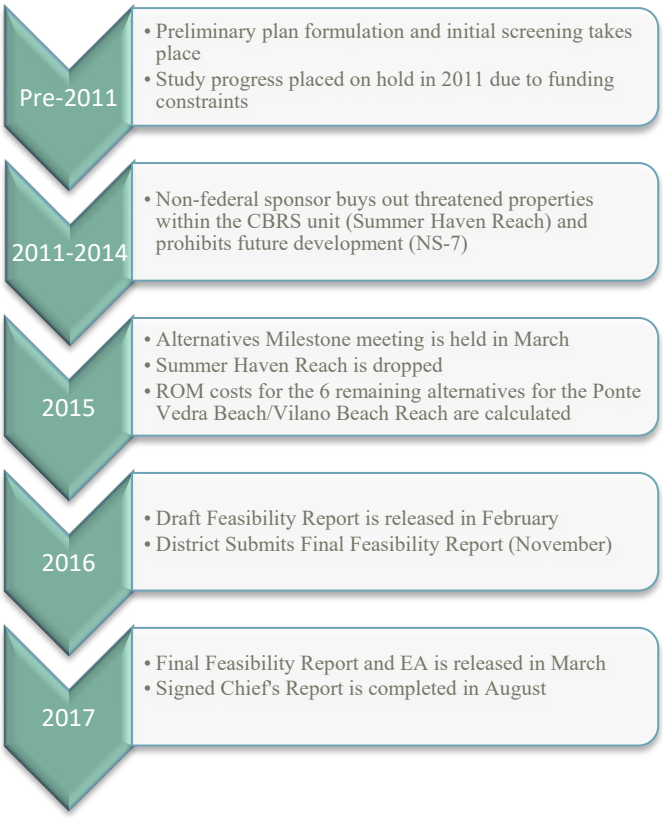

Figure B-12. St John's County, FL Project Milestones.

Consideration of Nature-based Solutions: Of the initial CSRM measures proposed for further screening, 10 were considered NNBFs, and 5 of them were retained as preliminary measures (Table B-4). Four-fifths of the preliminary NNBFs passed the initial screening. After the Summer Haven Reach was dropped from the study, three NNBFs were carried forward to the Secondary Screening, where Rough Order of Magnitude (ROM) costs were calculated (Table B-4). These included a Beach Nourishment measure, a Dunes and Vegetation measure, and an Acquisition of Land and Structures measure. After the BCRs were calculated through Beach-fx modeling, the Land/Structure Acquisition measure was dropped (the BCR was 0.45), and both the Beach Nourishment measure and Dunes and Vegetation measure were retained. These two measures were run through a Beach-fx model to formulate 13 different alternatives, which were essentially different variations of the beach nourishment and dunes/vegetation measures. Finally, after project reaches were adjusted, BCRs were calculated again to determine the Final Recommended Plan (Alternative 6).

Table B-4. Consideration of Nature-Based Solutions for St John's County, FL. Grey Shading Indicates That a Measure was Carried Forward Through This Stage, White Shading Indicates That the Measure was Eliminated at or Before This Stage.

Planning Reach	Project Phase							Discount Rate: 3.125%
	Preliminary NNBF Alternatives (Pre-2011 Formulation)	Initial Screening (pre-2011)	Secondary Screening	13 Alternatives Formulated	Final NNBF Alternatives	Beach-fx Modeling & BCR Calculation	Reach Adjustment with BCA	Recommended Plan (Includes Rec Benefits)
South Ponte Vedra Beach and Vilano Beach	S-4: Beach Nourishment		1.3		**Alternative 4:** (S-4 and S-10)	1.23	1.2	
	S-10: Dunes & Vegetation		1.3		**Alternative 6:** (S-4 and S-10)	1.29	1.25	1.3
	NS-7: Acquisition of Land and Structures		0.45					
	S-7: Submerged Artificial Multi-purpose Reefs							
	S-3: Sand-covered soft structure							
Summer Haven Reach	S-4: Beach Nourishment		Summer Haven Reach excluded from further study due to limited potential for justification					
	S-6: Submerged Artificial Reefs							
	S-7: Submerged Artificial Multi-purpose Reefs							
	S-10: Dunes & Vegetation							
	NS-7: Acquisition of Land and Structures							

Outcome of Chief's Report: The Final Recommended Plan in the Chief's Report includes beach and dune nourishment within the South Ponte Vedra and Vilano Beach Reach. The plan calls for a 60-foot equilibrated berm extension along 2.6 miles of shoreline and a dune feature that matches the 2015 dune position, which involves tapers that require sand placement along three miles of shoreline. The plan also includes planting of native vegetation on existing dune areas that will be disturbed by construction. According to St. John's County, the construction, de-mobilization, and dune planting for this project has been completed.

B.5 SOUTH PLATTE RIVER AND TRIBUTARIES, ADAMS AND DENVER COUNTIES, CO

Purpose	ERM/ENR
Division	NWD
District	NWO

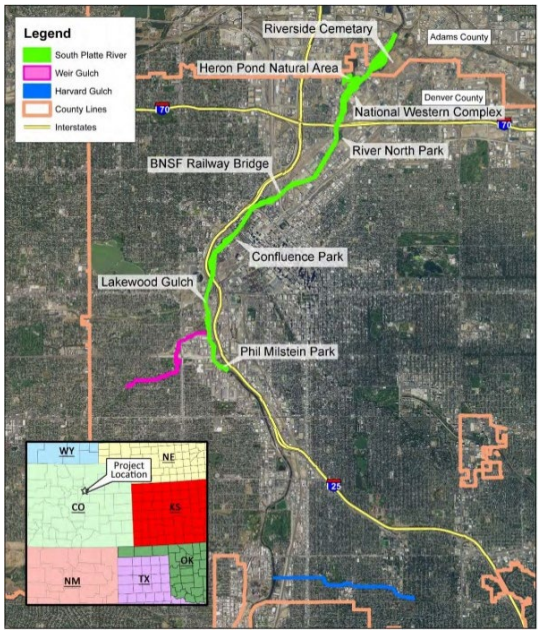

Figure B-14. South Platte River and Tributaries Study Area.

Project Goals: Restore riparian, wetland, and in-channel habitat for migratory birds and native plant, animal, and aquatic species, as well as reduce flood risk and damages, and improve public recreation opportunities and accessibility in the South Platte River and Harvard and Weir Gulches.

Background: The study area encompasses a 6.5 mile stretch of the South Platte River and the Harvard and Weir Gulch Watersheds in Denver and Adams Counties, Colorado. The South Platte River and tributaries are "nationally significant ecosystems providing critical habitat linkages between the Rocky Mountains and Great Plains river systems"(USACE, 2018) but have been severely impacted by river alteration and urbanization. Riparian habitats and wetlands are critically important features along the South Platte River, as they represent roughly two percent of Colorado land area, but are used by 80 percent of wildlife species. Restoration of these corridors would provide higher

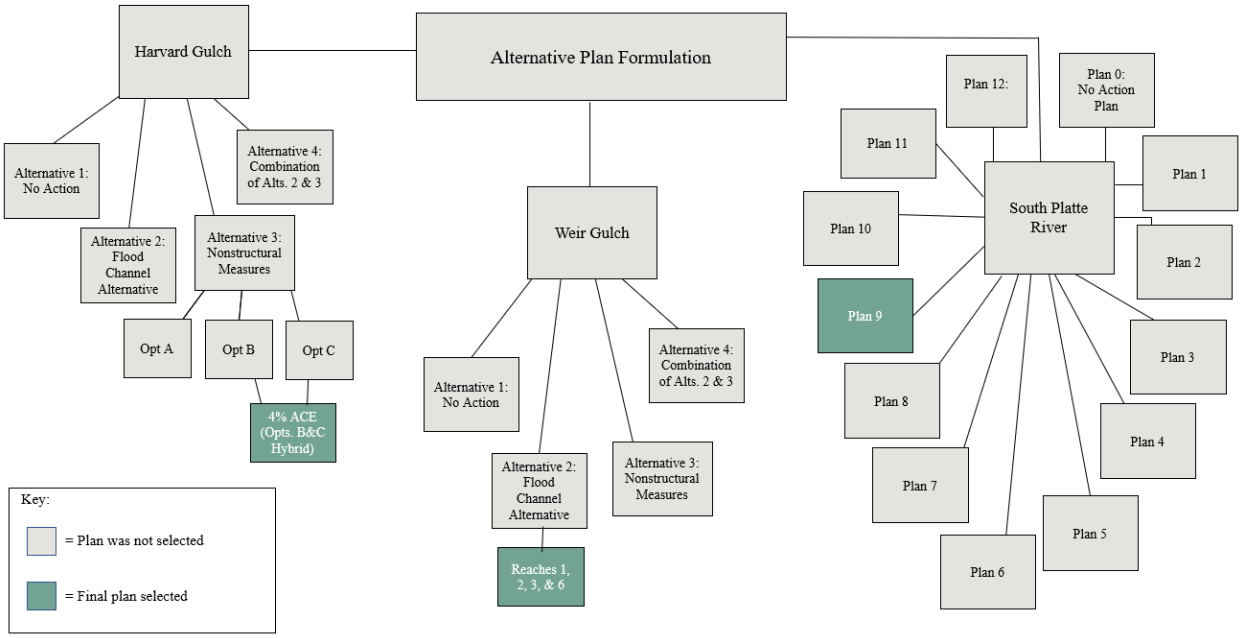

Figure B-13. South Platte River and Tributaries Alternative Plan Formulation to Arrive at Final Recommended Plan

functioning habitat for the species that depend on them but would also address flood risk and safety issues posed by extensive development in the floodplain that disallows their functional capacity.

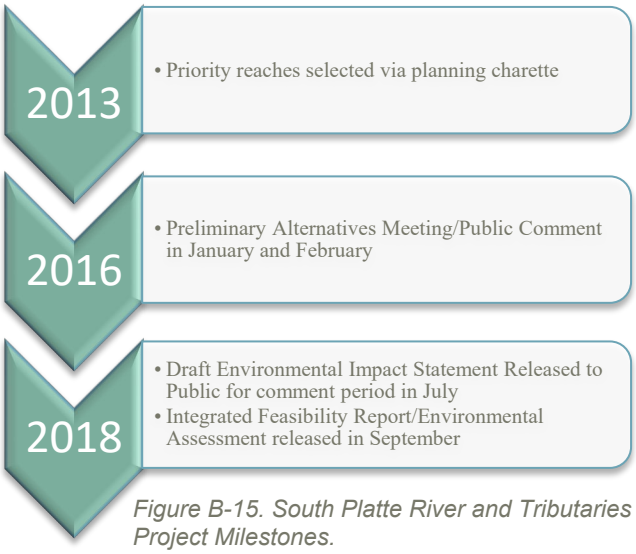

Figure B-15. South Platte River and Tributaries Project Milestones.

Plan Formulation: The Corps selected Plan 9 as the National Ecosystem Restoration Recommended Plan (NER RP) for achieving all planning objectives and offering a significant amount of habitat restoration benefits at a high level of cost effectiveness in the South Platte River (Figure B-13). Despite initially identifying Option A of the nonstructural alternatives as the optimal plan for Harvard Gulch, the study team determined that formulating plans around community groups and geographical boundaries such as floodplains was worth further consideration. The team selected a hybridized version of Options B & C (developed based on the 2% and 4% ACE floodplains, respectively) as the RP. The team selected the structural plan for Reaches 1, 2, 3, and 6 as the NED Plan for Weir Gulch for providing the highest net benefits.

Consideration of Nature-Based Solutions: Considering the project's focus on ecosystem restoration, the study team placed NNBFs at the center of the South Platte alternative plan formulation and integrated these features into the Harvard and Weir Gulch plans where possible (see Table B-5). To meet the project goal of restoring aquatic habitat, the NNBFs selected emphasized modifying existing infrastructure to reconnect the river corridor and adding features such as wetland benches and jetties to support new wetland formation and improve habitat. Other NNBFs considered in the alternative plan development phase were the removal and replacement of non-native and invasive species with native vegetation.

Outcome of Chief's Report: The Chief's Report, signed July 29, 2019, recommends the combined NER/NED plan, which, at a 2.875% federal discount rate and a 50-year period of analysis, arrives at an estimated $520.6 million project cost based on 2019 price levels. The plan will connect approximately 450 acres of wetland, riparian and aquatic habitat and provide $2.36 million annual net benefits. On December 2, 2021, the Mayor of Denver announced the Memorandum of Understanding (MOU) to unite project stakeholders and inform the public of this investment to restore local waterways, manage flood risk, and create new jobs.

Table B-5. Consideration of Nature-Based Solutions for South Platte River and Tributaries. Grey Shading Indicates That a Measure was Carried Forward Through This Stage, White Shading Indicates That the Measure was Eliminated at or Before This Stage.

Project Area	Type of Measure	Project Phase				
		Initial Measures	Initial Screening	Final Array of Sub-Alternatives	Alternative Plans	NER Plan
South Platte River	Ecosystem Restoration	Regrade to address bank erosion and stability				
		Regrade to widen river and connect existing wetland and riparian area to river corridor				
		Modification of large storm outfall to support new wetlands channel				
		Riprap invert and submerged banks of the channel to accommodate deep thalweg				
		Vegetate existing sand bar to increase wetland area				
		Regrade existing benches to create wetlands				
		Restore wetlands				
		Add wetland benches to improve aquatic habitat				
		Create wetland features at storm outfalls				
		Add cobble bars to improve aquatic habitat				
		Add jetties to improve aquatic habitat				
		Replace existing drops with pool-riffle-run complexes				
		Stabilize eroded and steep banks				
		“Lay back” the banks to reduce the slope				
		Relocate sanitary sewers to widen riverbank				
		Relocate sewer in Reach 1 and widen to the river to the existing canal				
		Remove invasive species and plant native vegetation				
		Relocate Burlington Canal				
		Relocate the Burlington Ditch point of diversion				
		Purchase water rights in order to maintain low flow in river				
		Set back the Globeville levee to widen riverbanks				
		Relocate existing Globeville Landing Park Pedestrian Bridge				
		Relocate Ringsby Ct. to behind Taxi Development				
		Lower Arkins Promenade				
		Replace Confluence Park Diversion with Flashboard Gates				
		Construct conventional sluicing gate at Confluence Park				
		Relocate trolley tracks to widen riverbanks				
		Reconstruct Lakewood Gulch drop to provide riffles				
		Widen the river at Xcel Properties between RTD and 13th Ave				
		Reconstruct the RTD drop to provide riffles				
	Rec.	Extend/Connect Trails				
		Construct focused access points to river				
						NED Plan
Harvard Gulch	Ecosystem Restoration	Wetland benching				Recommended Plan for Harvard Gulch involved floodproofing
		Wetland and riparian plantings				
		Noxious plant replacement				
	Rec.	Extend/Connect Trails				
Weir Gulch	Ecosystem Restoration	Wetland benching				
		Wetland and riparian plantings				
		Create backwater/oxbow wetland for flood overflow				
	Rec.	Extend/Connect Trails				

B.6 TRUCKEE MEADOWS, NV

Purpose	ERM
Division	SPD
District	SPK

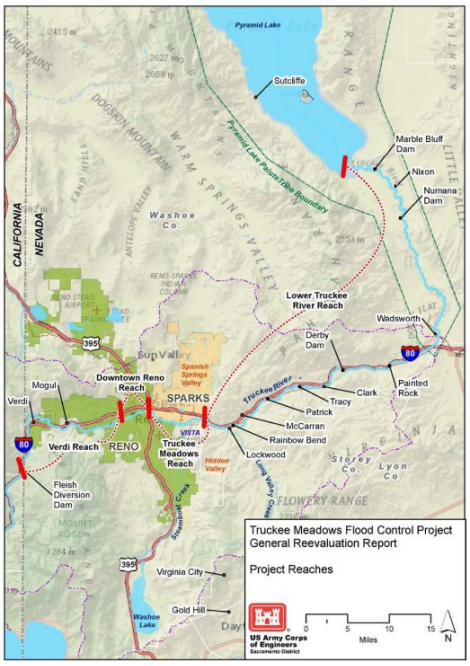

Figure B-17. Truckee Meadows Project Reaches.

Project Goals: Reduce flood damages to populated areas, provide access and recreation to the public, avoid and minimize effects to riparian and aquatic habitats, comply with planning and environmental policy, and complement other federal, state, and local plans and projects for Truckee Meadows River area.

Background: The Truckee Meadows area has historically been prone to flooding due to its proximity to the Truckee River (Figure B-16). Flooding poses a threat to public safety through floodwater exposure and accidents during evacuation and flood fighting. Life safety concerns are limited, but present. Additionally, the Truckee River has experienced loss of riparian and related floodplain habitats, loss of aquatic habitats, channel instability, and the obstruction of spawning fish passage due to artificial barriers.

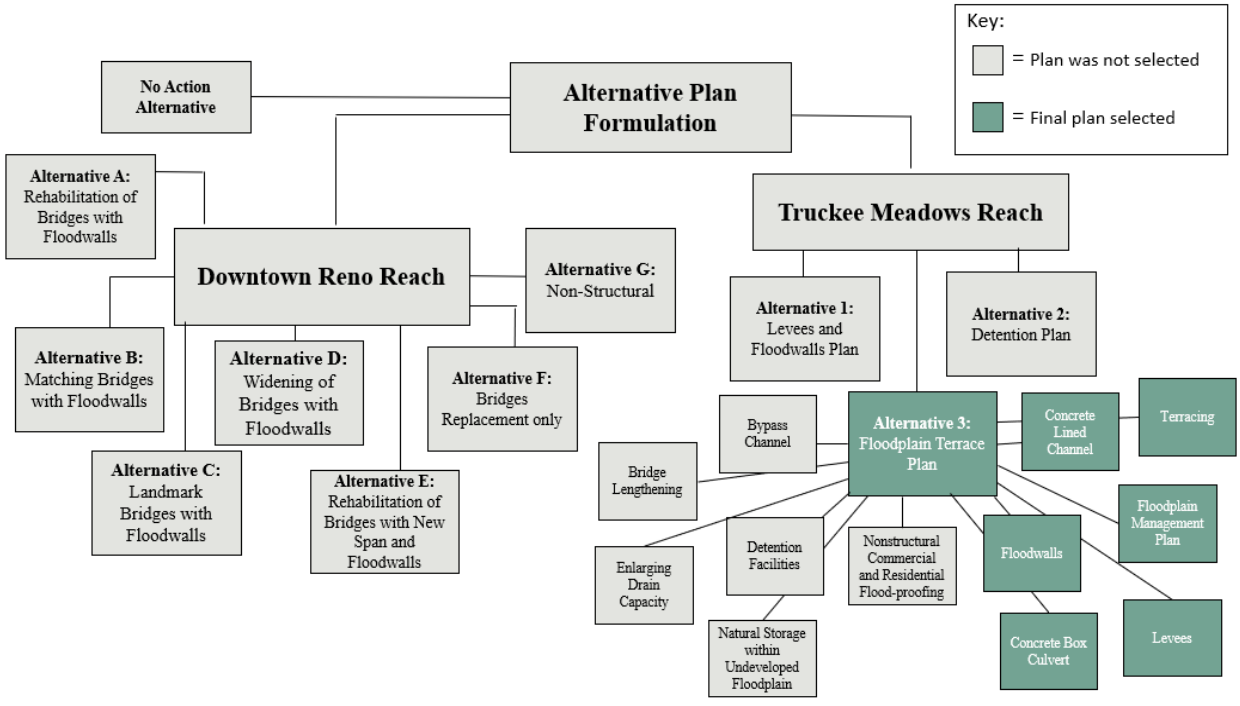

Figure B-16. Truckee Meadows Alternative Plan Formulation to Arrive at Final Recommended Plan

Plan Formulation & Consideration of Nature-based Solutions: In the early stages of the study, USACE determined that the Downtown Reno reach and the Truckee Meadows/Lower Truckee combined reaches were "separable elements" and had separable costs and benefits due to the physical separation and hydrological independence of the floodplains developed for the study area. 28 Natural and Nature Based Features (NNBFs) were considered, and 17 were retained for further analysis after being screened for effectiveness and efficiency. The 17 retained measures were then combined to formulate 10 alternatives (seven for the Downtown Reno Reach and three for the Truckee Meadows Reach; (USACE, 2013).

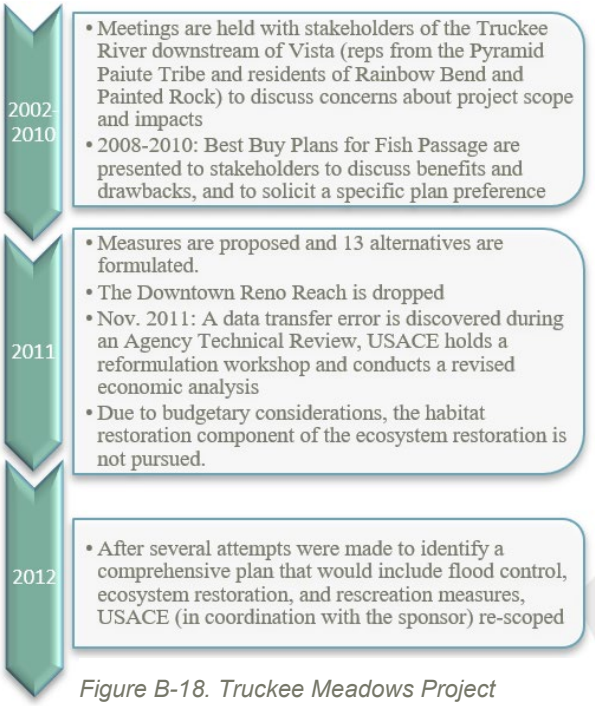

Figure B-18. Truckee Meadows Project Milestones.

Downtown Reno Reach:
The District retained five NNBFs within the Downtown Reno Reach alternative plans including channelization, floodplain management plans, channel widening, small scale floodplain evacuation plans, and non-structural commercial and residential flood-proofing. After the preliminary screening in 2011, the Corps dropped all seven Downtown Reno Reach Alternatives (including accompanying NNBFs) from further analysis due to negative net benefits.

Truckee Meadows Reach
The District retained five NNBFs within the three Alternatives formulated for the Truckee Meadows Reach. These NNBFs included a bypass channel at McCarran Blvd, a floodplain management plan, terracing upstream of Steamboat confluence, terracing downstream of Steamboat confluence, and Non-structural Commercial & Residential Flood-proofing. During the preliminary screening (Figure B-17), the three alternatives were scored by the Corps according to net NED benefits. Alt. 1 scored intermediate, Alt. 2 scored lowest, and Alt. 3 scored highest. During this stage, the Non-structural Commercial & Residential Flood-proofing features were removed from consideration as they were not incrementally justifiable At a Reformulation Workshop in 2011, a modeling data transfer error was discovered. Adjustments to the hydraulic and economic models affected all alternatives consistently, so the previous scoring of alternatives beginning with the 2nd scoring plan did not change (Alt. 3 became the optimal plan and Alternatives 1 and 2 were not re-evaluated because of the model adjustments). After the BCR was calculated for Alt. 3 and the plan was selected as the Reformulated Plan, the habitat restoration component of the project was dropped due to budgetary considerations. In 2012, USACE, the admin, and the sponsor decide to refocus the plan selection on the primary project purpose of FRM to expedite completion. The 2012 GRR noted that federal interest in a plan for fish passage restoration was established but was not recommended for implementation by USACE.

Outcome of Chief's Report: The project's design and construction status are unknown at the time of writing.

Table B-6. Consideration of Nature-Based Solutions for Truckee Meadows. Grey Shading Indicates That a Measure was Carried Forward Through This Stage, White Shading Indicates That the Measure was Eliminated at or Before This Stage.

Type of Measure	Purpose	Project Phase									Discount Rate: 3.5%
		Measures Considered	Effectiveness & Efficiency Screening	Combination of Measures into Alternatives	Planning Reach	Preliminary NNBF Alternatives		Preliminary Screening (Score)	2011 Reformulation Workshop	Reformulated Plan	Recommended Plan
Structural	Increase Channel Flow Capacity	Channelization Keystone Ave to Arlington Ave		Combination of Measures into Alternatives	Downtown Reno	Alternatives A-G	Channelization between Arlington and Virginia Street	All 7 Downtown Reno Reach Alternatives dropped due to negative net benefits (2011)	N/A		
		Channelization Arlington Ave to Virginia Street									
		Channel Widening Sierra St to Lake St					Floodplain Management Plan				
		Widening on the South Bank									
		Downtown Buyout					Channel widening from Sierra to Lake				
		Channelization at Glendale Park Area									
		Terracing Upstream of Steamboat Confluence									
		Terracing Downstream of Steamboat Confluence					Small Scale Floodplain Evacuation				
		Channel Widening (to channel bottom)									
		Channel Deepening at Vista Reefs									
	Reduce Flow Constrictions at Bridges	Bypass Channel at McCarran Boulevard					Non-structural Commercial & Residential Flood-proofing				

Non-Structural	Ecosystem Restoration (Fish Passage)	Eliminate Irrigation Diversions		Truckee Meadows	Alternative 1	Bypass Channel at McCarran Blvd	*Intermediate*	Data Transfer Error identified Alternative 3d as the optimal plan, and Alternatives 1 and 2 were not re-evaluated due to model adjustments	N/A	
		Alter Irrigation Diversions				Floodplain Management Plan				
		Combine Diversion Structures			Alternative 2	Bypass Channel at McCarran Blvd	*Lowest*			
		Modify Existing Fish Ladders				Floodplain Management Plan				
		Install Bypass Channel			Alternative 3	Terracing upstream of Steamboat confluence	*Highest*		**2.1**	**2.2 (1.2 for OMB)**
		Install Fish Ladder				Terracing downstream of Steamboat confluence				
		Replace Diversion Structure with Pump Diversion				Floodplain Management Plan				
		Install Fish Screen				Bypass Channel at McCarran Blvd			Habitat restoration component is dropped due to budgetary considerations	
	FRM	Flood Insurance				Non-structural Commercial & Residential Flood-proofing	Dropped from consideration (not incrementally justified)			
		Early Flood Warning System								
		Flood-proofing								
		Large Scale Floodplain Evacuation								
		Small Scale Floodplain Evacuation								
		Dedication of Developed Floodplain to Natural Storage								
		Dedication of Undeveloped Floodplain to Natural Storage								
		Floodplain Management Plan								

**BCR not available for Alternatives 1 and 2. System of accounts comparison provides a relative scoring (low, intermediate, and high) based on Net NED Benefits*

***In 2012, the USACE and the Administration, in coordination with the sponsor, decided to refocus plan selection on the primary project purpose of flood risk management to expedite completion of the study consistent with Administration and sponsor priorities (Reference: Commander, USACE South Pacific Division memorandum dated 6 July 2012, subject: Truckee Meadows Project General Reevaluation Report, NV). Federal interest in a plan for the restoration of fish passage has been established, but that plan is not being recommended for implementation by the USACE at this time.*

B.7 SOUTH SAN FRANCISCO BAY SHORELINE, CA

Purpose	ERM/ENR
Division	SPD
District	SPN

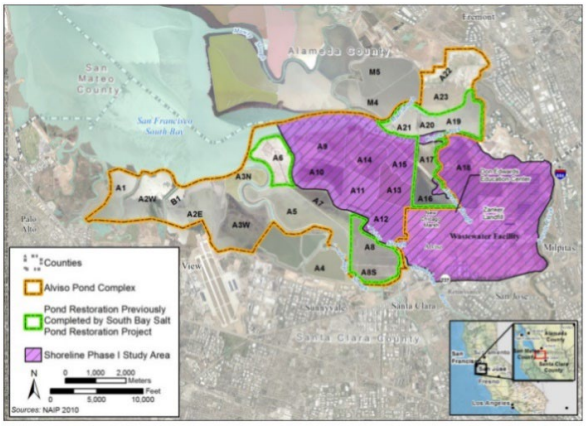

Figure B-19. Map of Shoreline Phase I Study Area and Completed Pond Restoration.

Project Goals: Reduce risks to public health, safety, and the environment associated with tidal flooding, reduce risk of economic damage, restore ecological function and habitat quantity, quality, and connectivity for native plant and animal species, and improve public access, education, and recreation.

Background: In addition to the former salt production ponds, "the Shoreline Phase I Study Area includes a mix of tidal, diked marsh, and upland habitats as well as residential, industrial, and commercial structures" (USACE, 2015b). The area is prone to tidal flooding due to its low-lying terrain, which is protected by non-engineered dikes (Figure B-19). Flood risk in the area continues to increase due to sea level change. Additionally, the presence of former salt harvesting ponds along the southern portion of San Francisco Bay has led to habitat loss within most of the area's tidal salt marsh (USACE, 2015b)

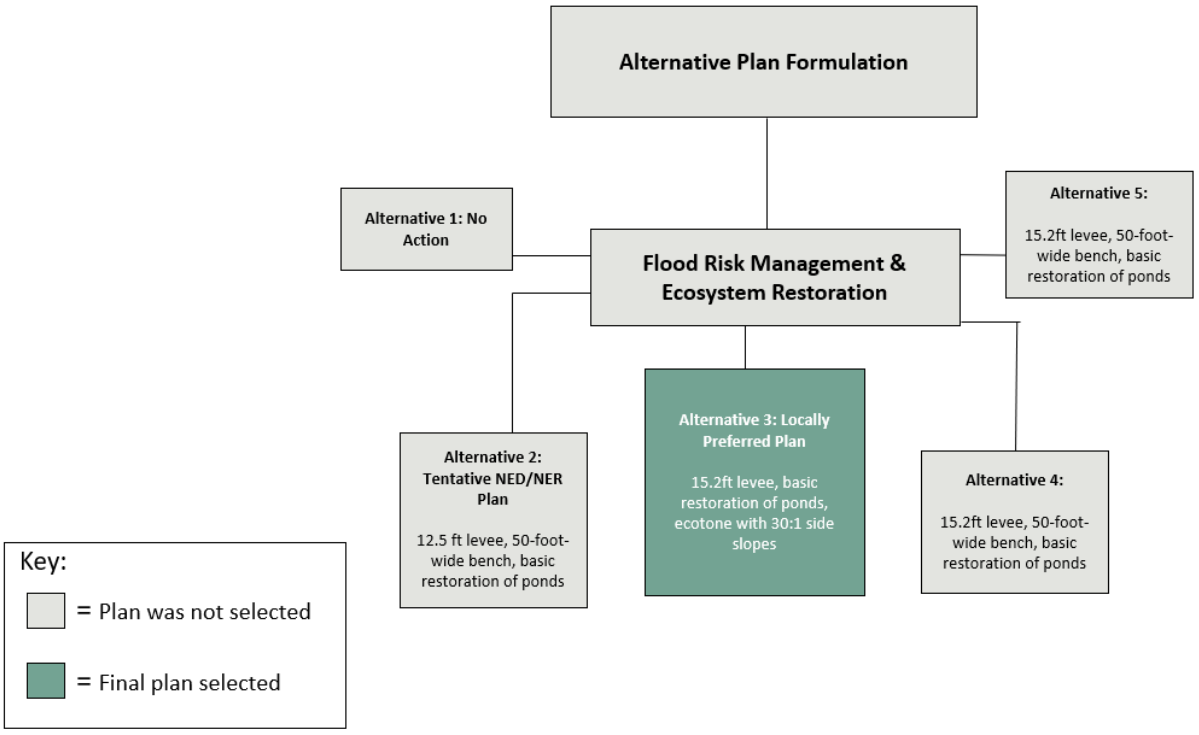

Figure B-20. South San Francisco Bay Shoreline, CA Alternative Plan Formulation to Arrive at Final Recommended Plan

Plan Formulation: The District formulated Preliminary Alternatives for both flood risk management and tidal marsh restoration. After an initial screening, the final array of alternatives was formulated to include a tide gate, a levee, pond increments and basic restoration, bench or ecotone features, and recreation features (Figure B-20). After a screening of the final array of alternatives, the Corps advanced a Locally Preferred Plan (Alternative 3) and a NED/NER plan (Alternative 2) for further analysis. The Corps ultimately selected the Locally Preferred Plan as the RP (see Alternative 3 in Figure B-20). The key differences between the two plans were the levee heights and the fact that Alternative 3 included ecotone instead of a bench to provide transitional habitat for species.

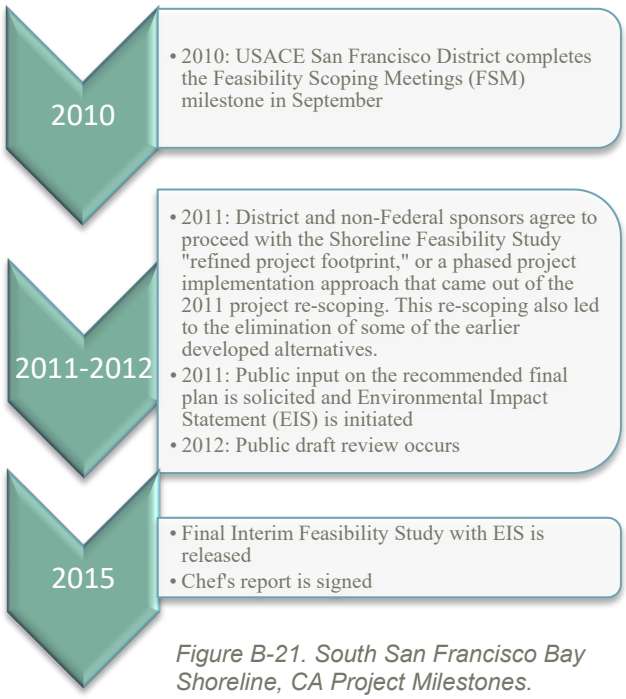

Figure B-21. South San Francisco Bay Shoreline, CA Project Milestones.

Consideration of Nature-based Solutions: Twenty-eight Nature-Based Solutions were formulated as initial measures. USACE eliminated barrier islands during the preliminary screening as they would not restore ecological function, quality, or connectivity, and were considered a short-term solution (see Table B-7). Barrier islands also did not reduce risk for modeled future tidal flooding scenarios. The District also eliminated rehabilitation of existing pond dike infrastructure as they did not demonstrate reduction in risk of future levee overtopping and didn't allow for tidal restoration. In addition, there were many cost constraints. The biosolid relocation measure was eliminated due to ongoing work by the City of San Jose. The nesting islands measure was eliminated because a study was being conducted at the time. After the final screening, the Corps eliminated the NED/NER plan because of its high residual flood risk. The RP (in this case the Locally Preferred Plan) included phased breaching of existing pond dikes to restore tidal marsh habitat, and the addition of ecotone to a new levee that would be built.

Outcome of Chief's Report: In FY2021, the Corps updated the overall project cost estimate, and additional efforts were made to secure sufficient funding for all project components. In August 2021, Reaches 1–3 were funded and design work for Reach 4/5 continued. Additionally, construction is still ongoing for Reaches 1–3.

Table B-7. Consideration of Nature-Based Solutions for San Francisco Bay Shoreline, CA. Grey Shading Indicates That a Measure was Carried Forward Through This Stage, White Shading Indicates That the Measure was Eliminated at or Before This Stage.

Type of Measure	Project Phase				Discount Rate: 3.375%
	Alternatives Development (2011–2012)	Preliminary Screening	Final Array of Alternatives	Locally Preferred Plan	Recommended Plan (with BCR, High SLR)
Flood Risk Management	Rehabilitate existing pond dike infrastructure				
	Increase erosion protection for existing pond dikes				
	Protect sites containing potentially hazardous materials				
	Phased Breaching of Existing Pond Dikes to restore tidal marsh habitat			**Alternative 3**	**Ranges from 4.2-9.6**
	Construct new levee (Ecotone)				
	Construct barrier islands				
	Increase tidal marsh footprint to attenuate tidal flooding				
	Increase downstream conveyance through tidal marsh restoration				
Ecosystem Restoration	Use on-site material and natural sedimentation processes to fill in low areas of ponds			**NED/NER Plan**	**Plan Elimination Justification:** Higher residual flood risk, no additional transitional habitat for 2 ponds to accelerate evolution of the marsh habitat necessary to immediately benefit special-status species (**BCR was 10.62**)
	Bench Refugia				
	Import fill or dredge material for habitat restoration actions				
	Nonstructural Measures: Relocating critical utilities, emergency education for the public, establishing evacuation and flood-response plans, managing disease vectors (e.g., mosquitos), and establishing a local flood warning system			**Alternative 2**	
	Manage sediment accretion areas to maintain or create marshes and trap additional material				
	Eliminate or relocate biosolids lagoons at the Wastewater Facility and convert to additional marsh area				
	Restrict public access				
	Control and remove nonnative predator species				
	Enhance native species populations				
	Enhance food supply productivity				
	Improve habitat connectivity				
	Establish mosaic of tidal marsh habitat				
	Establish species-specific tidal marsh habitat and features				
	Incorporate nesting islands for native birds in proposed designs				
	Remove and/or relocate undesirable nonnative species				
	Prevent or deter entry of additional undesirable nonnative species				
	Remove perching areas used by undesirable nonnative species				
	Control food sources used by undesirable nonnative species				
	Increase public awareness and restrict human activity				
	Purchase land or easements				

B.8 WESTMINSTER, EAST GARDEN GROVE, CA

Purpose	ERM
Division	SPD
District	SPL

Project Goals: Identify sustainable flood risk management solutions to reduce flooding caused by overtopping of local channel systems and contain the 1% ACE storm event throughout the study area. Additional objectives include reducing the risk of flood damages to structures, infrastructure, and life-safety, as well as promoting compatible recreation (USACE, 2020).

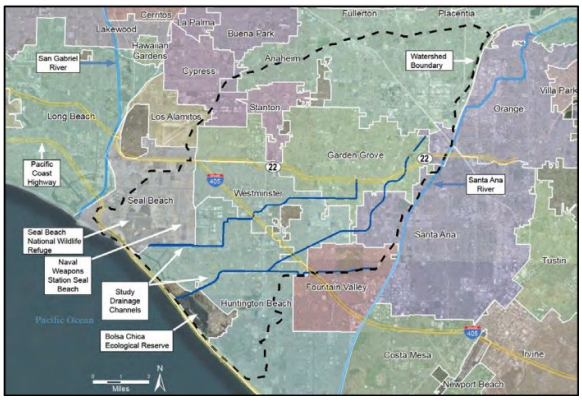

Figure B-22. Westminster and East Garden Grove Study Area.

Background: The Westminster watershed lies on a flat coastal plain and covers approximately 87 square miles in western Orange County, CA, 25 miles southeast of Los Angeles. Historically, the study area was largely agricultural, but since the 1950s, heavy urbanization has increased its impermeability and with it, the potential for flood related damages associated with the overtopping of local channel systems during high intensity, short duration rainfall events. Originally built in the 1950s and '60s to contain the 25-year event, these undersized conveyance channels, combined with increased runoff, result in flood risk to residents, roadways, and the spread of contaminants to sensitive ecosystems.

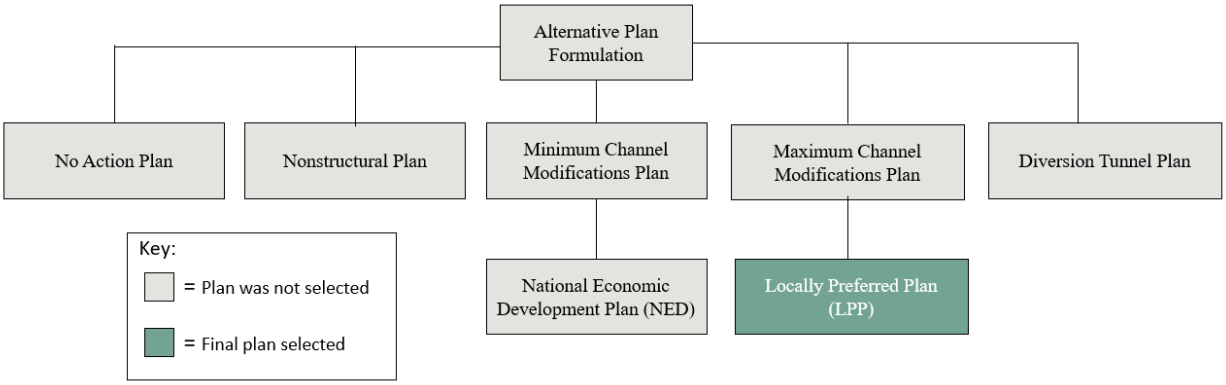

Figure B-23. Westminster, East Garden Grove, CA Alternative Plan Formulation to Arrive at Final Recommended Plan.

Plan Formulation: The PDT initially grouped measures into nonstructural, in-channel, upstream, and downstream categories for screening. The study area's high land values and lack of available real estate in a highly dense, urban environment swiftly eliminated several measures. Completion of the first round of screening produced a shift in focus to improving channel and downstream conveyance, as well as increasing channel capacity, leading to the identification of six alternative plans (Figure B-23). Of these

plans, the PDT selected the No Action, Minimum, and Maximum Channel Modifications Plans for additional screening. After developing cost information for each measure and channel reach and completing an incremental analysis, the team selected the Minimum Channel Modifications Plan as the NED Plan (USACE, 2020). However, the non-federal sponsor identified the Maximum Channel Modifications Plan as the optimal plan for achieving its goal of containing the 1% ACE and selected it as the Locally Preferred Plan (LPP). An LPP requires the NFS to provide 100 percent of the increased cost difference from the identified NED Plan and must earn approval from the ASACW to become the RP. The ASACW approved the LPP as the RP in October 2019.

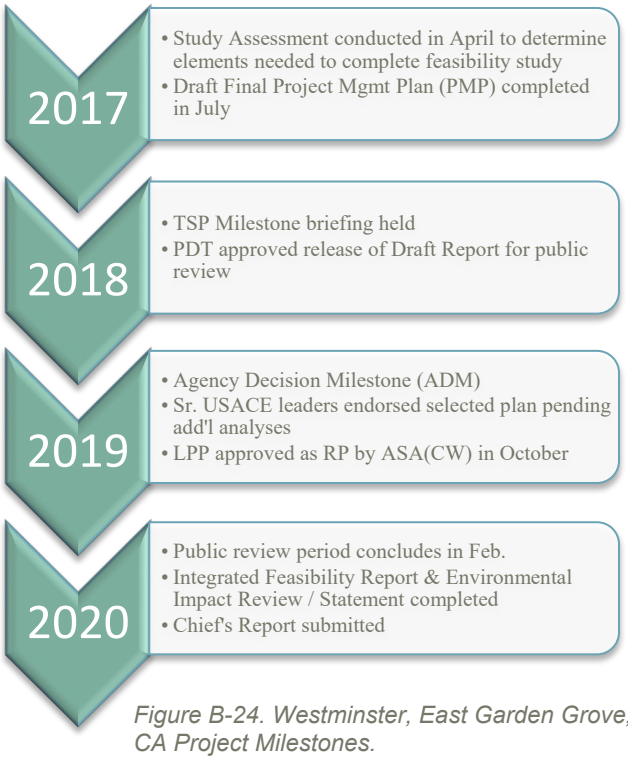

Figure B-24. Westminster, East Garden Grove, CA Project Milestones.

Consideration of Nature-Based Solutions: The Westminster watershed is highly urbanized, and there are few sensitive natural resources remaining that would be impacted by the project. Therefore, rather than identifying NNBFs to complement or replace existing levees and floodwalls, environmental consideration focused on mitigating direct and indirect impacts to existing estuarine wetland, eelgrass and special status wildlife predominantly located in the Bolsa Chica Ecological Reserve (BCER). The BCER is owned by the CA State Lands Commission and was used for oil extraction in recent decades before a restoration project, completed in 2006, removed oil wells, reconnected the reserve with the Pacific Ocean, and constructed nesting areas for migratory birds. The lower segment of one channel bisects BCER and drains into the Outer Bolsa Bay (OBB), and therefore, the study team conducted a robust environmental assessment—including effects to biological resources, air and water quality, public health, social/environmental justice, recreation, etc.—to minimize impacts to the area's sensitive ecosystem (Table B-8).

Table B-8. Consideration of Nature-Based Solutions for Westminster, East Garden Grove, CA. Grey Shading Indicates That a Measure was Carried Forward Through This Stage, White Shading Indicates That the Measure was Eliminated at or Before This Stage. FDRR= Flood Damage Risk Reduction, UM = Upstream Modifications, DM = Downstream Modifications, NS = Nonstructural.

NNBFs Considered	Type of FDRR measures	Reason(s) Screened Out
Santa Ana River (SAR) Diversion	UM	Difference in channel inverts (C05 to SAR) create drainage issues requiring additional intervention. Diversion to SAR creates potential for damages in separate watershed High-cost, low benefit
Storage/Retention Basins	UM	Excessive amount of excavation and difficulty of disposing of spoil material. High groundwater elevation would require constant pumping. Mile Square Park (potential basin site) one of very few recreational open space areas - significant adverse impacts
Intentional Breaching of the Levee on C05 Adjacent to the Muted Tidal Pocket	DM	Breaching the levee would alter the balance of fresh and saltwater entering the system, likely altering the established habitat and requiring mitigation Area provides limited storage capacity
Dredging in Outer Bolsa Bay (OBB)	DM	NFS has no rights to dredge OBB - would require an agreement between Orange County Public Works and the State Land Commission Habitat concerns – would convert OBB to open water, impacting protected and endangered species and introducing invasive species Severely impact public access to the reserve
Construction of New Ocean Outlet	DM	High levels of uncertainty regarding surrounding effectiveness and maintenance costs.
Razing/Removal of Structures	NS	Removal of structures infeasible because dense development and high real estate values make these measures too expensive to implement on such a large scale (~44,000 structures within the 0.2% ACE floodplain in the study area).
Removal of Impediments to Flow	NS	Not excluded and could be implemented on a priority-basis, increasing maintenance investments in locations that are known to require greater capacity during flood events

Outcome of Chief's Report: The Chief's Report was submitted to the Secretary of the Army for transmission to Congress on July 9, 2020. The total average annual equivalent (AAEQ) costs of the project including Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) are estimated at $58.2 million and based on a 2.75% discount rate. The RP is estimated to produce over $116.2 million in AAEQ benefits and addresses the project goal of managing flood risk, as it reduces the annual probability of flooding from over 50 percent in the highest risk areas to <1 percent and expected annual damages by over 99 percent.

B.9 WEST SACRAMENTO, CA

Purpose	ERM
Division	SPD
District	SPK

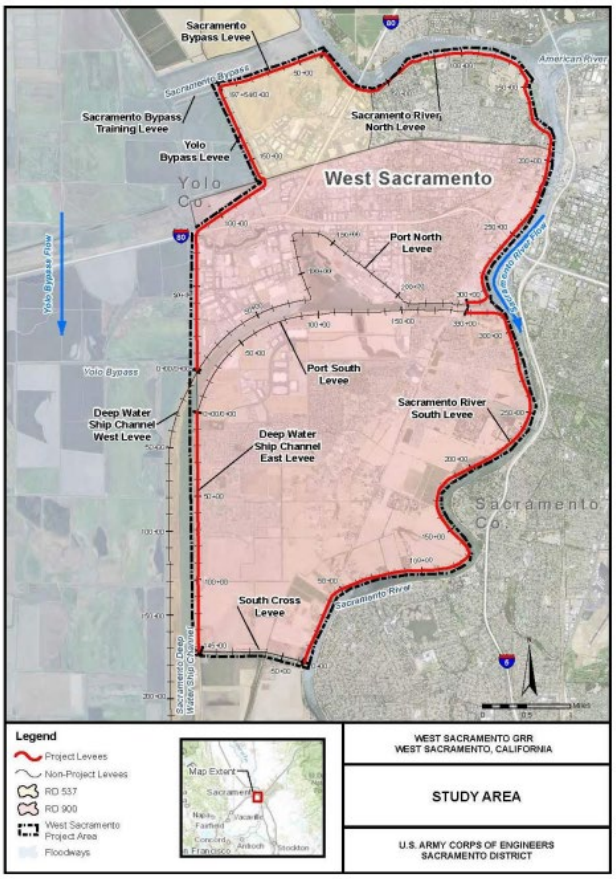

Figure B-25. West Sacramento Study Area.

Project Goals: Reduce flood risk and impacts to critical infrastructure, encourage wise use of the floodplain (strengthen floodplain management plan), and increase public awareness of residual flood risk.

Background: West Sacramento is subject to high flood risk because it is located within the Sacramento River floodplain between the American and Sacramento rivers and is adjacent to the Yolo Bypass (see Figure B-25). This area is prone to flood hazards because it contains large watersheds with high runoff potential and outdated levees that experience seepage, instability, and erosion (USACE, 2016c).

Plan Formulation: An initial evaluation of the 38 measures formulated for this study was conducted by the District, and measures were assessed based on how well they met the project objectives. The measures were dropped or retained using the metrics shown in Table B-9. The retained measures were combined to construct a series of preliminary alternatives (Figure B-26). Thirteen alternatives were developed, and the District conducted a preliminary to calculate the BCR of each. After the BCRs were identified for each alternative, the District determined that Alternatives 1, 3, and 5 contained the greatest annual net benefits. A final screening by the District to identify the NED plan determined that Alternative 5 would be the RP and authorized for implementation

Table B-9. Screening Criteria and Metrics for Proposed Measures.

Impacts to waterside vegetation	Number of acres affected by measure
Effect on Critical Habitat for a Listed Species	Number of acres of critical habitat affected by measure
Number of Required Residential Relocations	Number of residential parcels
Amount/Cost of Real Estate	Preliminary real estate appraisal
Effectiveness	Does the measure respond to one or more objectives?
Efficiency	Cost effectiveness
Expected Reduction in Annual Flood Damages	Economic benefits
Life Safety Metric	How well measure would reduce flood risk (qualitative, measured in residual risk)

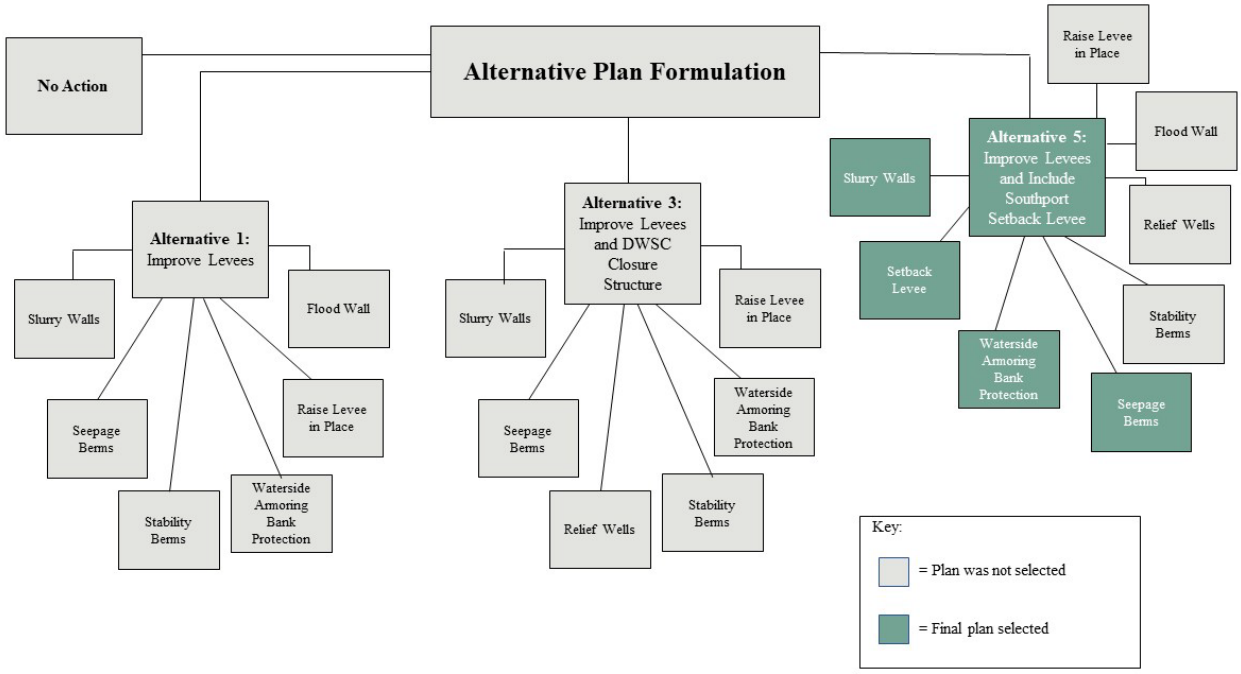

Figure B-26. West Sacramento, CA Alternative Plan Formulation to Arrive at Final Recommended Plans.

Consideration of Nature-Based Solutions: Bank protection measures were formulated to address erosion and were carried through to the NED plan based on the BCRs calculated throughout the formulation process (Figure B-26). Non-structural measures were screened out early in the formulation process because they did not meet the project criteria and was unable to stand alone as an alternative.

Outcome of Chief's Report: The 2014 GRR report has been approved by Corps headquarters and is now eligible for congressional appropriations to begin the engineering, design, and construction process.

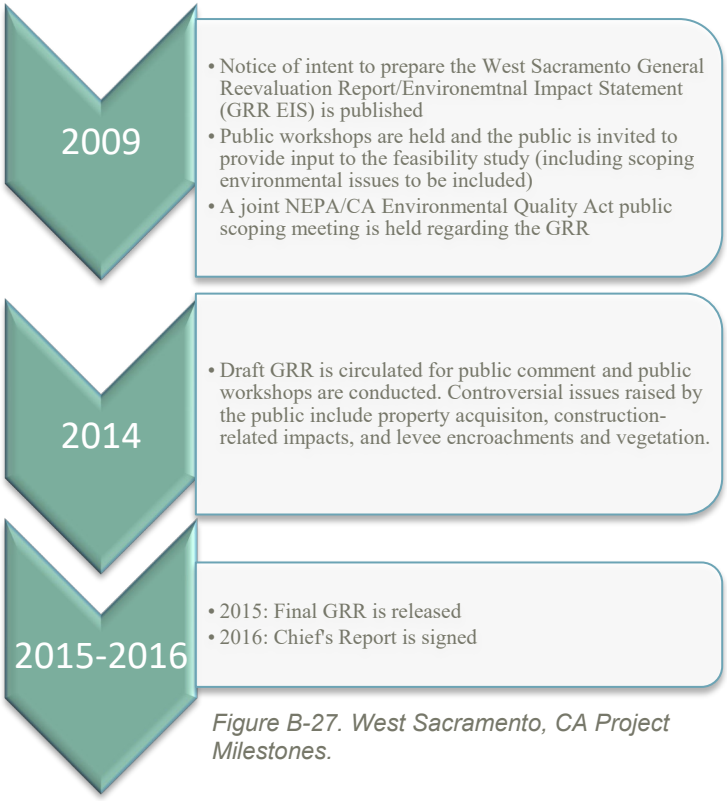

Figure B-27. West Sacramento, CA Project Milestones.

Table B-10. Consideration of Nature-Based Solutions for West Sacramento, CA. Grey Shading Indicates That a Measure was Carried Forward Through This Stage, White Shading Indicates That the Measure was Eliminated at or Before This Stage.

Objectives Addressed	Initial Formulation of NNBFs	Combination of Measures into Alternatives	Preliminary NNBF Alternatives		Preliminary Screening	Final Alternatives	NED Plan	Final BCR
Reducing Levee Seepage and Underseepage & Addressing Erosion through Bank Protection	Seepage Berms Removal of Ditches Adjacent to Levees Waterside Armoring of Levee Slopes Launchable Rock Trench BioEngineering Armoring of Slopes		**Alternative 0.5A:** North Basin Plan	seepage berms waterside armoring bank protection	3.2			
			Alternative 0.5B: South Basin Plan	seepage berms stability berms waterside armoring bank protection	1.2			
			Alternative 0.5C: Mid-Cross Levee	seepage berms waterside armoring bank protection	1.8			
			Alternative 0.5D: West Sacramento Basin	seepage berms stability berms waterside armoring bank protection	0.8			
			Alternative 1: Improve Levees	seepage berms stability berms waterside armoring bank protection	2.5	2.4		
			Alternative 2: Improve Levees and Sacramento Weir and Bypass Widening	seepage berms stability berms waterside armoring bank protection	2.2			
			Alternative 3: Improve Levees and DVSC Closure Structure	seepage berms stability berms waterside armoring bank protection	2.1	2.0		
			Alternative 4: Improve Levees, Sacramento Weir and Bypass Widening Alternative, and DWSC Closure Structure	seepage berms stability berms waterside armoring bank protection	1.8			
			Alternative 5: Improve Levees and Include Southport Setback Levee	seepage berms stability berms waterside armoring bank protection	2.9	2.6	2.6	3.2
			Alternative 6: Street Diversion Structure Improvement Measures	seepage berms stability berms waterside armoring bank protection	1.7			
			Alternative 7: Auburn Dam Levee Improvement	seepage berms stability berms waterside armoring bank protection	0.8			
			Alternative 8: Maximum Levee Improvement Plan	seepage berms stability berms waterside armoring bank protection	0.5			
Non-Structural Measures	Permanent Relocation Raising Structures in place Flood Proofing of Existing Structures Floodplain Management Providing Floodplain Information to Regulatory Agencies Annual Publication of Residual Risk Improve Flood Warning System Improve Emergency Evacuation Plans Add Evacuation Routes Secure Hazardous Material Tanks		**Alternative 9:** Non-Structural Alternative	Floodplain Management Providing Floodplain Information to Regulatory Agencies Annual Publication of Residual Risks Improvements to Flood Warning System Improve Emergency Evacuation Plans Add Evacuation Routes Secure Hazardous Material Tanks	Alternative 9 was excluded from further study because it did not meet the completeness, effectiveness, or acceptability criteria (it was unable to stand alone, did not meet the project's planning objectives, and lacked implementability).			

B.10 BRAZOS ISLAND HARBOR, TX

Purpose	NAV
Division	SWD
District	SWG

Project Goals: Increase navigational efficiency of the Brownsville Ship Channel (BSC) to better accommodate cargo vessels and offshore rigs during the 50-year period of analysis (2021–2071), while minimizing impacts to cultural resources as well as threatened and endangered species and their habitats.

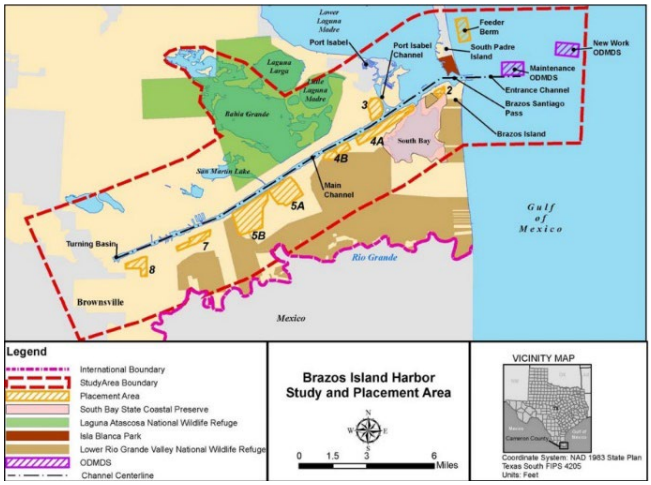

Figure B-28. Brazos Island Harbor Study Area.

Background: The study area encompasses 103,250 acres of the Lower Rio Grande Valley (LRGV) of TX and includes the BSC, a deep-draft navigation channel located along the Gulf coast near the U.S. border with Mexico. Channel improvements are needed to "reduce operating costs of deep-draft vessels using the channel to import and export both liquid and dry bulk commodities, and to reduce restrictions on the transit of large oil drilling rigs" (USACE, 2014b). These improvements have the potential to boost economic activity in the area, as they would allow transit of oil drilling rigs, larger deep-draft vessels, and new rigs constructed on the channel. In addition, the improvements would enable vessels that currently use the BSC to load more fully.

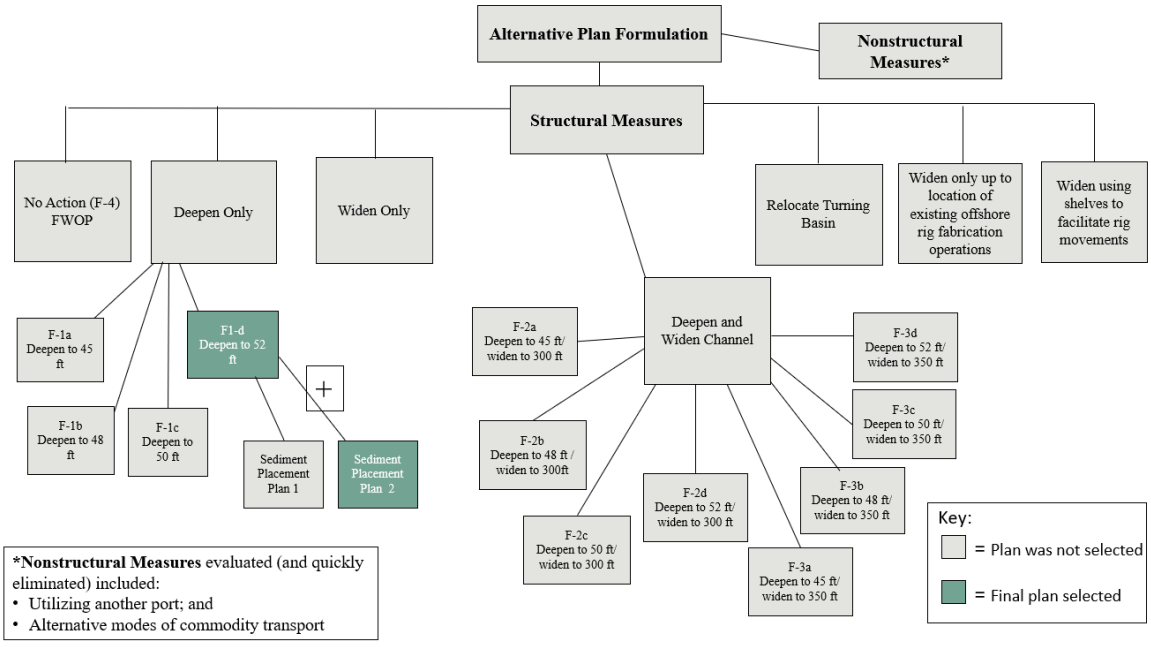

Figure B-29. Brazos Island Harbor, TX Alternative Plan Formulation to Arrive at Final Recommended Plans

Plan Formulation: In consultation with the Brownsville Navigation District (the project's non-federal sponsor), the Galveston District evaluated both nonstructural and structural measures to identify the initial array of alternatives (Figure B-30). Nonstructural options (i.e., using another port and alternative modes of transport) quickly fell out of consideration. Management measures identified for screening included isolated and combined versions of channel deepening and widening, as well as relocating the turn basin to a new location closer to the channel entrance. Qualitative analysis on the initial array swiftly ruled out options that did not meet the project's objectives. Remaining measures were screened for economic benefits and costs. As a result, the District arrived at the remaining three deepening-only and combination alternatives (deepening w/ 200-ft widening). The team then added a 52-ft deepening alternative to this Final Array to evaluate against the tentatively selected 50-ft deepening measure to determine if it was, in fact, the NED. The 52-ft deepening alternative proved to have the greatest benefit-to-cost ratio (BCR) net excess benefits and sponsor preference and was therefore selected as the RP. However, because the District did not evaluate alternatives deeper than 52 feet, it was not identified as the NED Plan (USACE, 2014b).

Figure B-30. Brazos Island Harbor Project Milestones.

Consideration of Nature-Based Solutions: The BIH project's primary focus was navigation improvement to an existing deep-draft channel, so options for incorporating NNBFs to the project design were limited. However, the District must have a sediment management plan for dredging projects, so after selecting the RP, the team considered beneficial uses for the large amounts of dredged sediment it anticipated from deepening the channel. The team initially identified 10 project areas for potential distribution and disposal, including two existing Ocean Dredged Material Disposal Sites (ODMDSs) and one nearshore Feeder Berm, the latter of which could be used to supplement the eroding South Padre Island shoreline with beach quality sand and increase habitat for threatened and endangered species. Of these options, the team preferred the Feeder Berm option because it is the most environmentally preferable and least-cost plan.

Outcome of Chief's Report: The Chief's Report was submitted to the Secretary of the Army for transmission to Congress on November 3, 2014. Average annual benefits for BIH improvements are estimated at $20.6 million and costs at $13.9 million based on October 2014 price levels and the federal discount rate of 3.375% (USACE, 2014a). Congressional approval of the project occurred in 2016. In May 2021, the Galveston District issued a permit to begin dredging BIH and placing sediment for beneficial uses at South Padre Island.

Table B-11. Consideration of Nature-Based Solutions.for Brazos Island Harbor, TX. Grey Shading Indicates That a Measure was Carried Forward Through This Stage, White Shading Indicates That the Measure was Eliminated at or Before This Stage.

Type of Measure	Project Phase				
	Alternatives Development	**Environmental Evaluation Criteria**	**Alternative Deepening Plans**	**BCA**	**RP**
Structural	**No Action (F-4)** Future w/o Project	Construction Air Quality Vegetation/SAV Terrestrial Wildlife Habitat Wetlands Aquatic Habitat Essential Fish Habitat Threatened & Endangered Species Water & Sediment Quality Hazardous, Toxic, & Radioactive Waste Energy & Mineral Resources Environmental Justice Environmental & Safety Risks to Children			
	F-1 Plans Channel Deepening Alternatives		45 ft Depth Plan	1.97	
			48 ft Depth Plan	2.13	
			50 ft Depth Plan	1.96	
			52 ft Depth Plan		1.88
	F-2 Plans Channel Deepening and Widening to 300ft Alternatives		45 ft Depth Plan	1.34	
			48 ft Depth Plan	1.19	
			50 ft Depth Plan	1.29	
			52 ft Depth Plan	1.25	
	F-3 Plans Channel Deepening and Widening to 350ft Alternatives		45 ft Depth Plan	0.64	
			48 ft Depth Plan	0.79	
			50 ft Depth Plan	0.82	
			52 ft Depth Plan	0.84	
Sediment Placement	**Dredged Sediment Alternative Placement Plans**				
	Type of Sediment Likely to be Dredged	**Beneficial Uses**	**Screening Results**		**In RP?**
	Clay sediments	Marsh restoration; dike construction	No marshes nearby in need of clay		
	Sand and silt	Beach nourishment; reduce shoreline erosion	Beach-quality sand placed on South Padre Island for restoration		Yes

B.11 JACKSONVILLE HARBOR, MILE POINT, FL

Purpose	NAV
Division	SAD
District	SAJ

Project Goals: Investigate and recommend solutions to water resources issues at Mile Point, including reducing crosscurrent effects to the shoreline, and explore options to remove navigation restrictions for vessels transiting Jacksonville Harbor (USACE, 2012a).

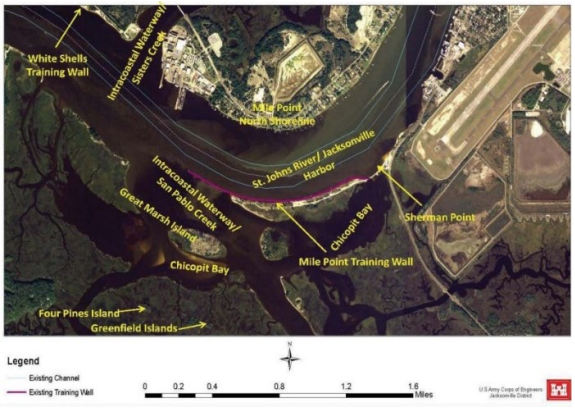

Figure B-31. Jacksonville Harbor Study Area.

Background: Jacksonville Harbor's Mile Point shoreline is located west of the Atlantic Ocean along the St. Johns River between river miles four and five. The Intracoastal Waterway (IWW) and St. Johns River converge within Mile Point, producing crosscurrents that are difficult to navigate during ebb tide, such that the St. Johns Bar Pilots enacted restrictions for vessels transiting during this time. Additionally, the north bank of the river has experienced significant erosion and multiple sections of the Mile Point training wall are submerged. These dangerous conditions produced over 500 casualties between 1982 and 2004. As a result, a plan to address concerns at Mile Point was warranted for both safety and economic reasons.

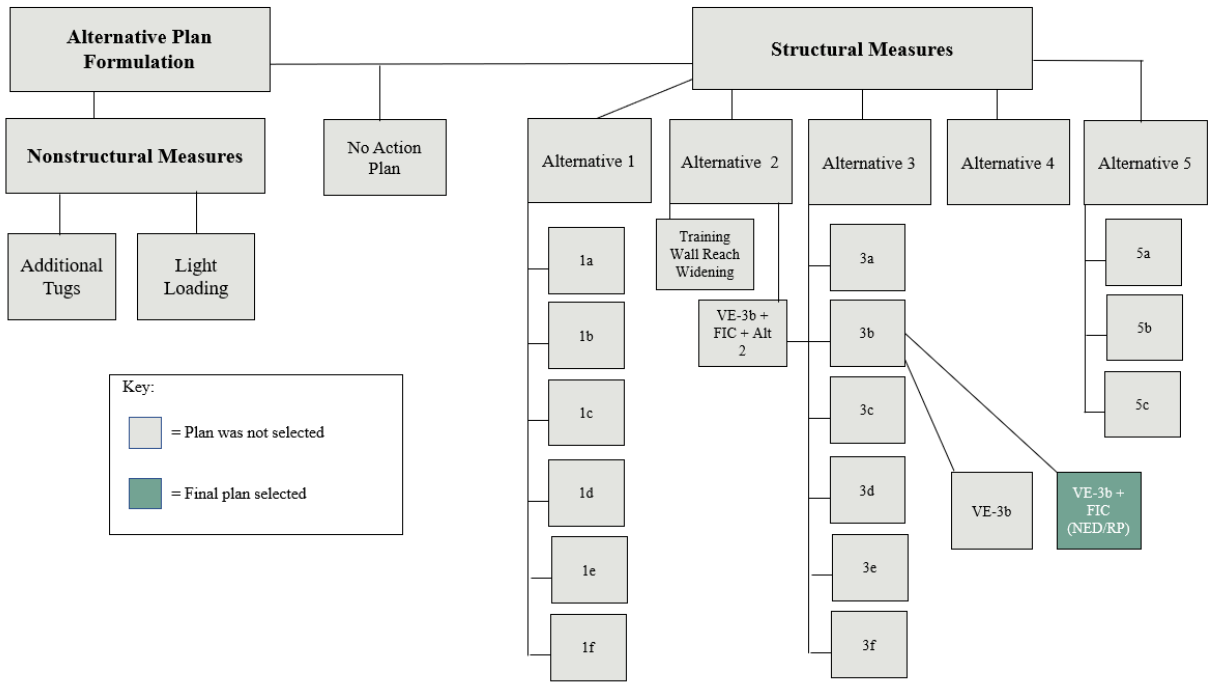

Figure B-32. Jacksonville Harbor Alternative Plan Formulations to Arrive at Final Recommended Plan.

Plan Formulation: The initial measures formulated for this study included additional tugs, light loading, structural erosion protection measures (bulkhead, groins, or beach fill), crosscurrent reduction measures (submerged weir, training wall, a diversion/bypass channel, and reconfiguration of an existing training wall (Figure B-33). Together with the St. Johns Bar Pilots and local homeowners, the study team formed five alternative plans to address erosion on the Mile Point shoreline and reduce ebb tide navigation restrictions. Four of these plans did not significantly impact crosscurrents and were eliminated. The remaining plan, Alternative 3B, produced favorable results and was further refined to include "beneficial use of dredged material by creating a salt marsh mitigation area that restores wetlands lost on Great Marsh Island as a result of erosion" (USACE, 2012a). The inclusion of the marsh island restoration would support navigation improvement and potentially reduce shoreline erosion along Mile Point. Great Marsh Island restoration also includes incidental environmental benefits by offsetting the 8.15 acres that would be impacted by relocation. For these reasons, this refined alternative was ultimately included in the RP.

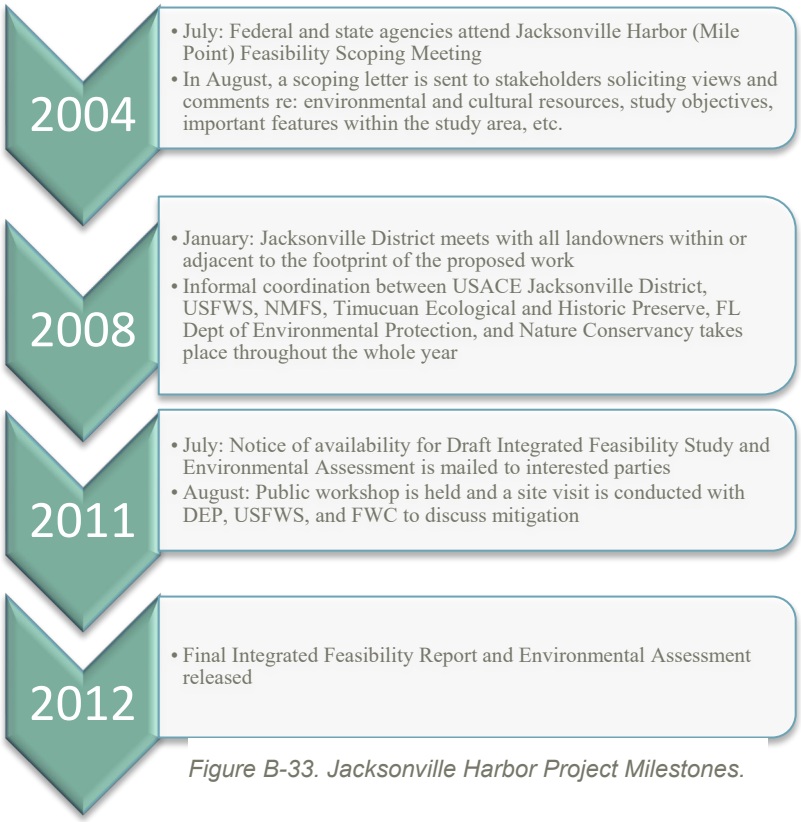

Figure B-33. Jacksonville Harbor Project Milestones.

Consideration of Nature-based Solutions: Restoration of Great Marsh Island was introduced after the Alternative Plans were evaluated (see Table B-12). After a Value Engineering (VE) study, Alternative 3B (relocation of the Mile Point Training wall) was refined to incorporate the creation of a beneficial-use, salt marsh mitigation area (up to 53 acres) that would use dredged material and restore wetlands lost from natural habitat erosion on Great Marsh Island (GMI) due to crosscurrents. A Flow Improvement Channel (FIC) in Chicopit Bay was also proposed as a vital counterpart to the GMI restoration to prevent water quality issues that would arise from the inability to flush out non-source pollution if the island's breakthrough were closed off. The FIC would also restore the historical channel which had silted in from GMI's erosion. Both GMI restoration and the Chicopit Bay FIC were included in the RP.

Table B-12. Consideration of Nature-Based Solutions for Jacksonville Harbor. Grey Shading Indicates That a Measure was Carried Forward Through This Stage, White Shading Indicates That the Measure was Eliminated at or Before This Stage.

Planning Reach	Mitigation Plan Restoration Alternatives	Project Phase		
		Total Project Acreage	Quantified Habitat Units (HUs)	Incremental Cost (Millions)/HUs
Recommended Plan (Alternative VE-3B)	Alternative 1: 1:1 Mitigation + 8.15 acres of planting	8.15	4.89	$ 0.0047
	Alternative 2: Required Mitigation + 18.84 acres of planting	18.2	10.92	$ 0.0049
	Alternative 3: Optimal Restoration + 18.84 acres of planting	45	16.28	$ 0.0055
	Alternative 4: Optimal Restoration + 45 acres of planting	45	27	$ 0.0047
	Alternative 5: Expanded Restoration + 18.84 acres of planting	53	17.88	$ 0.0056
	Alternative 6: Expanded Restoration + 45 acres of planting	53	28.6	$ 0.0048
	Alternative 7: Expanded Restoration + 53 acres of planting	53	31.8	$ 0.0047
	Natural Resource Mitigation Plan			
	Construction of tidal creeks within the restored marsh; sprigging of the 53 acres of marsh with commercially grown salt marsh species; training walls constructed with material known to support oysters; and placement of oyster shell within a newly constructed tidal channel to provide hard substrate for live oyster colonization			

Outcome of Chief's Report:

On April 30, 2012, the Chief's Report submitted the NED Plan, Alternative VE-3B + FIC, as the RP. The report recommended relocating and reconfiguring the existing Mile Point training wall, as well as restoring the breakthrough in GMI using excavated material from project construction (USACE, 2012a). The GMI restoration was designed to create up to 53 acres of salt marsh, exceeding the 18.84 acres required to mitigate 8.15 acres of marsh lost due to reconfiguration of the training wall. The report also recommended construction of the FIC to mitigate water quality issues arising from closing off the recently formed channel that flushes Chicopit Bay. The RP's BCR was 1.4, with a project first cost estimated at $36 million (Office of Management and Budget, 2012). The average annual costs were estimated at $1.7 million based on a 4 percent discount rate at October 2011 price levels.

Congress authorized the Mile Point project through Section 7002(1) of the Water Resources Reform and Development Act of 2014 and USACE entered into a project partnership agreement with the Jacksonville Port Authority, the project's nonfederal sponsor, in January 2015 (USACE, 2015c). Construction began in November 2015 ("Jacksonville Harbor Begins Mile Point Project Ahead of Port Deepening," 2015), and was completed in 2017.

B.12 SAVANNAH HARBOR EXPANSION, GA

Purpose	NAV
Division	SAD
District	SAS

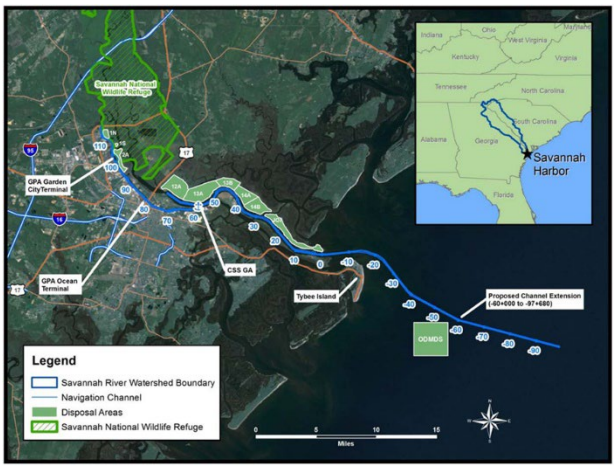

Figure B-34. Savannah Harbor Expansion Project Map.

Project Goals: Reduce congestion in the river channel, accommodate recent and anticipated future growth in containerized cargo and container ship traffic, improve efficiency of operations for container ships within the Savannah Harbor Navigation Project, allow larger and more efficient container ships to use the Port, and address adverse impacts through environmental and cultural resource mitigation actions (USACE, 2012b).

Background: Savannah Harbor contains one of the largest container ports in the nation yet had an extremely shallow controlling depth for a major port (see Figure B-34). This navigation improvement project aimed to reduce future transportation costs, improve international trade efficiency, and improve cargo vessel operations to accommodate larger container ships.

Plan Formulation: The District initially identified two alternative plans (the No Action alternative and a series of Channel Deepening Alternatives). The five channel deepening alternatives were screened out based on the BCR and NER-related impacts evaluated using the system of accounts framework (Figure B-35). The District further prioritized and screened alternatives based on contributions to NED. Along with the selection of the NED Plan (the 47 ft depth plan), the Corps also formulated a Natural Resource Mitigation Plan to mitigate a variety of expected adverse impacts to tidal wetlands, dissolved oxygen levels, endangered fish species, chloride levels, and cultural resources. The Natural Resource Mitigation Plan included a combination of structural and nonstructural alternatives, including flow re-routing features, wetland acquisition, marsh restoration, an oxygen injection system, a fish bypass channel, a striped bass stocking program, a raw water impoundment, and the availability of additional adaptive management features if needed (including moving the tidegate sills, construction of a boat

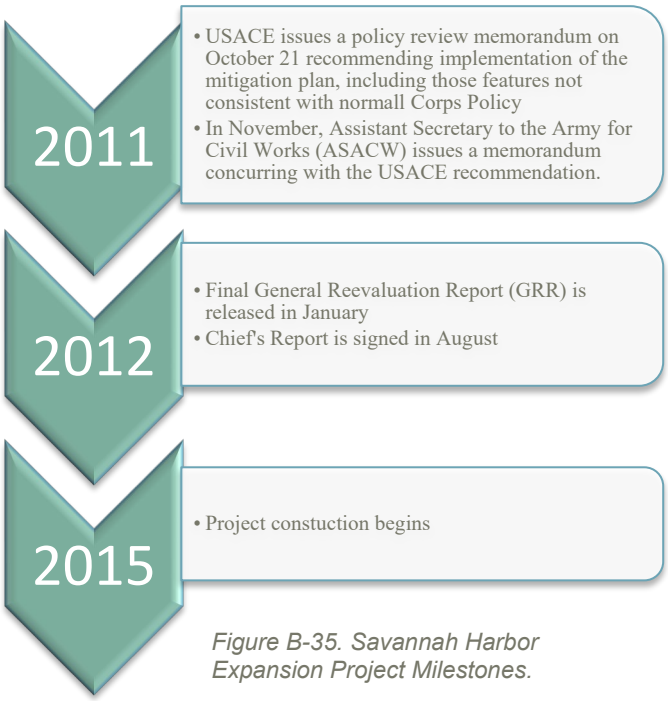

Figure B-35. Savannah Harbor Expansion Project Milestones.

ramp, removal and curation of the CSS Georgia, modifying diversion structures and more wetland acquisition (USACE, 2012d).

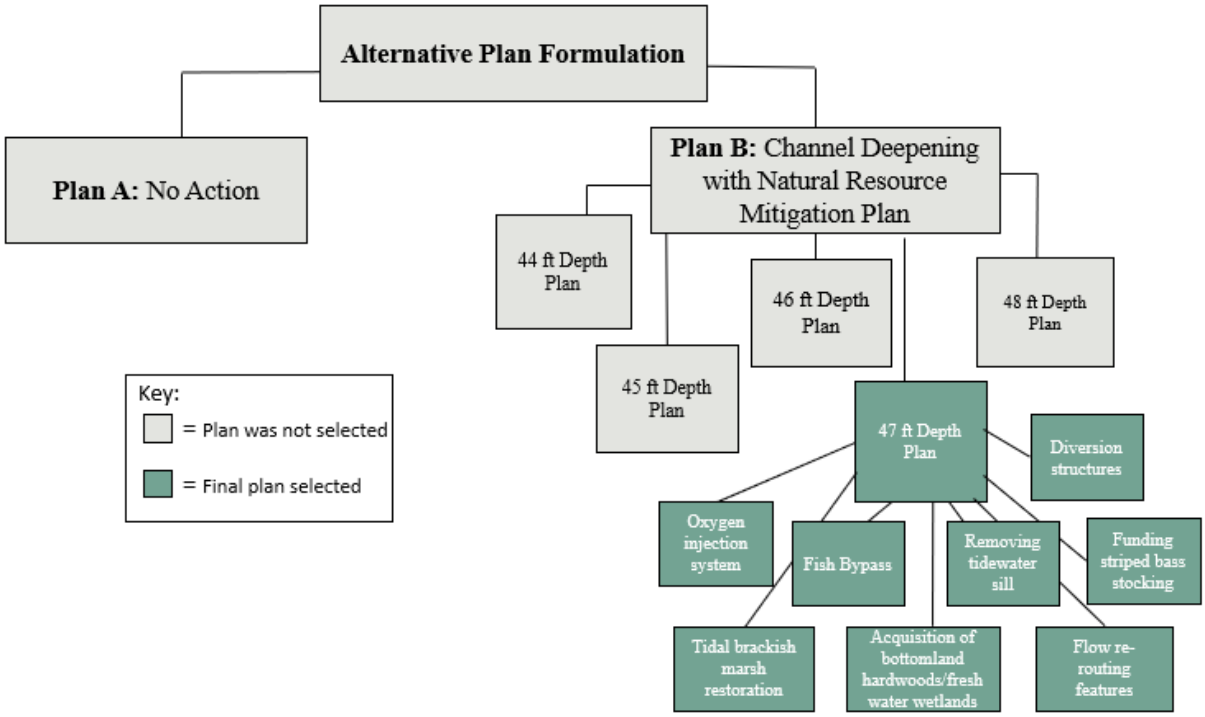

Figure B-36. Savannah Harbor Expansion Alternative Plan Formulation to Arrive at Final Recommended Plans.

Consideration of Nature-based Solutions: The structural alternatives formulated for this project included an NER consideration that was carried through to the tentatively selected NED plan (marsh restoration and wetland acquisition). These measures were carried through and became part of the TSP. This project also included many natural resource mitigation measures to account for project impact (Table B-13; USACE, 2012c).

Outcome of Chief's Report: The Chief's Report included the construction of a 47-foot depth alternative plan which involved extending and widening bends on the entrance channel, constructing two meeting areas, Since the signing of the Chief's Report, the following project features have been 100% completed: Outer Harbor Dredging, Dissolved Oxygen Injection System, Raw Water Storage Impoundment, First Dike Raising, Sediment Basin Tidegate Removal, Freshwater Wetlands Acquisition, and McCoy's Cut Area Work. The CSS Georgia Recovery & Conservation feature is 95 percent complete, and the Inner Harbor Dredging is 88 percent complete. Marsh Restoration began in August 2021, and the fish passage feature is still in the design phase

Table B-13. Consideration of Nature-Based Solutions for the Savannah Harbor Expansion. Grey Shading Indicates That a Measure was Carried Forward Through This Stage, White Shading Indicates That the Measure was Eliminated at or Before This Stage.

Type of Measure	Project Phase				Discount Rate: 4.125%
	Alternatives Development	NER Considerations	Alternative Deepening Plans	BCA	Tentatively Selected NED Plan
Structural	**Plan A:** No Action	N/A			
	Plan B: Channel Deepening Alternatives	Tidal Marsh Bottomland Hardwoods Fisheries Endangered Species (striped bass, southern founder, American shad, sturgeon, sea turtles)	44 ft Depth Plan	3.4	
			45 ft Depth Plan	4.3	
			46 ft Depth Plan	4.6	
			47 ft Depth Plan	4.5	5.5
			48 ft Depth Plan	4.2	
Structural	Natural Resource Mitigation Plan				
	Oxygen injection system Fish bypass channel to compensate for habitat impacts Removing the tidegate sill, enlarging a diversion structure, adding diversion structure (as needed)				
Nonstructural	Funding striped bass stocking Flow re-routing features to reduce salinity impacts to tidal freshwater and brackish wetlands Acquisition of bottomland hardwoods/freshwater wetlands Restoration of 28.75 acres of tidal brackish marsh Acquisition of another 10% of freshwater wetland acreage to compensate for wetland impacts as needed Wetlands (223 acres) to compensate for salinity increases to tidal freshwater wetlands) as needed				

US Army Corps of Engineers

THE WATER INSTITUTE OF THE GULF