SAN FRANCISCO WATERFRONT COASTAL FLOOD STUDY, CA

DRAFT APPENDIX K COMPENSATORY MITIGATION PLAN

JANUARY 2024

USACE TULSA DISTRICT | THE PORT OF SAN FRANCISCO

US Army Corps of Engineers

PORT OF SAN FRANCISCO

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Acronyms and Abbreviations

Acronym	Definition
BCDC	San Francisco Bay Conservation and Development Commission
CE/ICA	Cost-Effective, Incremental Cost Analysis
EWNG	Engineering with Nature Working Group
HEA	Habitat Equivalency Analysis
NFS	Non-federal sponsor (Port of San Francisco and City of San Francisco)
NMFS	National Marine Fisheries
RAWG	Resource Agency Working Group
SFWCFS	San Francisco Waterfront Coastal Flood Study, CA
TNBP	Total Net Benefit Plan
USFWS	U.S. Fish and Wildlife Service
Water Board	San Francisco Bay Regional Water Quality Control Board

K-1. Introduction

This document presents the compensatory mitigation plan for unavoidable habitat impacts associated with the San Francisco Waterfront Coastal Flood Study, CA (SFWCFS) project. This plan is only intended to address compensatory mitigation work and not the sequence of other activities performed during project planning to avoid, minimize, rectify, or reduce habitat impacts from each project alternative (see Engineer Regulation (ER) 1105-2-100, Section C-1(e)(8). A detailed discussion of the sequence actions are included in Appendix D-1-5 (Habitat Modeling), while more details can be found in the plan formulation appendix (Appendix A), the environmental supporting documents (Appendix D-1 and associated sub-appendices), and the 404(b)(1) analysis (Appendix D-4-1). These actions are incorporated into the mitigation objectives of this plan. The planning work performed to document those sequencing actions is complete and led the team to the need to develop a compensatory habitat mitigation plan for unavoidable impacts to fish and wildlife resources. This document details the work performed, including coordination, plan formulation, and environmental compliance, to develop the compensatory habitat mitigation plan.

It is important to note that this recommended mitigation plan will be further refined during the PED and it is fully anticipated that the mitigation site size, cost, and potentially even site location, if these sites are unavailable in 10 years when construction would begin, could be modified during subsequent planning phases. Therefore, the level of detail here is at a higher level than might be typically seen in other USACE mitigation plans. The intent of this plan is to provide a worst-case scenario cost-estimate, to confirm that sufficient mitigation exists in the area to offset the worst-case scenario losses, and document the most likely avenues for mitigation, monitoring and adaptive management.

1.1 Requirements

The authority and requirements for compensatory mitigation are founded in Federal laws and regulations. The legal foundation for mitigation for ecological resources includes the Clean Water Act, various Water Resources Development Acts, and other environmental laws. These laws are implemented and administered through rules, guidance, regulations, and policies issued by Executive Branch agencies.

The relevant laws and regulations specific to compensatory mitigation planning for Corps of Engineers civil works projects are listed in the References section of this document. The specific procedures followed to develop this compensatory habitat mitigation plan are found in ER 1105-2-100, Appendix C. Other forms of mitigation, such as plans for cultural resources conservation or induced flood damages, may also be required for a project. Those types of mitigation requirements are not directly related to fish and wildlife habitat impacts and are not covered in this plan.

Compensatory mitigation is the “restoration (re-establishment or rehabilitation), establishment, enhancement, and/or in certain circumstances preservation of aquatic resources for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved” (see 40 CFR 230.92). It is the policy of the Corps of Engineers civil works program, and in accordance with Section 906 of WRDA 1986, as amended, to demonstrate that impacts to all significant ecological resources, both terrestrial and aquatic, have been avoided and minimized to the extent practicable, and that any remaining unavoidable impacts have been compensated to the extent possible. Section 906(d) of WRDA 1986, as amended, requires functional assessments to be performed to define ecological impacts and to set mitigation requirements for impacted habitats. Corps of Engineers policy in ER 1105-2-100, paragraph C-3(d)(5), requires the use of a habitat-based methodology, supplemented with other appropriate information, to describe and evaluate the impacts of the alternative plans, and to identify the mitigation needs.

1.2 Coordination and Collaboration

Two interagency teams (Resource Agency Working Group [RAWG] and Engineering with Nature Working Group [EWNG]) met throughout the study and resource agencies contributed expertise and information to support the identification of significant resources, impacts, and avoidance, minimization and potential compensation (mitigation) measures. The RAWG includes more than 50 members from agencies including: San Francisco Bay Conservation and Development Commission (BCDC), California Department of Fish and Wildlife, City of San Francisco Planning Department, Environmental Protection Agency, National Park Service, National Marine Fisheries, Regional Water Quality Control Board, California State Lands Commission, USACE, US Fish and Wildlife, and Port of San Francisco. The EWNG was set up to identify where and which natural and nature-based features (NNBFs) should be considered within the study area and to help describe how NNBFs contribute to regional habitat goals and project benefits. The EWNG included 15 individuals from Federal, state, and local agencies, universities, non-governmental organizations, and private industry who have been identified as experts in the field of Engineering with Nature and ecological restoration.

The cooperating and participating agencies are listed below. An early interagency coordination meeting was held to comply with the provisions of the Water Resources Reform and Development Act of 2014 Section 1001. The meeting afforded agencies an opportunity to learn about the project and to provide initial input into the study.

- **Cooperating Agencies**: Environmental Protection Agency Region 9 (Formally Accepted), Federal Emergency Management Agency Region IX (Planning and Implementation Branch), National Marine Fisheries Service (Formally Accepted), National Park Service, US Fish and Wildlife Service

- **Participating Agency:** California Department of Fish and Wildlife, California Regional Water Quality Control Board, California State Lands Commission, San Francisco Bay Conservation and Development Commission, and San Francisco Planning Department

The views of each of the resource agencies were considered in the development of the draft plan and this draft compensatory mitigation plan. However, due to the nature and timing of the identification of the Tentatively Selected Plan (TSP), for which the compensatory mitigation plan must be developed, this conceptual plan has not been thoroughly reviewed by the interagency team. Extensive coordination will continue between draft report release and the final report to ensure that the mitigation plan is satisfactory to all. Additionally, these organizations will be offered an opportunity to continue to play a role in the finalization of the mitigation plan and design and implementation phases of the mitigation work when the project is authorized and funded.

K-2. Ecological Resources

The SFWCFS is in the San Francisco Bay watershed. From a habitat standpoint the area is characterized as the largest estuary on the west coast. The Bay Area is home to over 7 million people and is one of the densest urban areas in the nation.

Historically, San Francisco Bay had about 300 square miles of tidal marsh with 6,000 miles of channels and 12 square miles of shallow pan. Until the 1850's, the Bay was navigable as far south as San Jose. Following the 1850's Gold Rush, large amounts of sediment from upstream erosion and hydraulic mining flowed into the Bay, and surrounding tidal wetlands were diked for salt production, hay-fields, or filled in, reducing the Bay's size by as much as one-third.

The Bay is home to over 500 species of fish and wildlife, 20 of which are threatened or endangered with extinction. The Bay and its surrounding water systems play host to millions of migratory birds every year as they cross the Pacific flyway.

2.1 Sources of Information

The PDT, RAWG, and EWNG investigated the habitat resources found in the project area. The teams collected information from existing data sources and conducted site visits, when possible. No site-specific surveys were completed during the feasibility phase, but will be completed during PED to confirm the presence/absence, quantity, and quality of existing habitat at the adversely impacted and restoration sites when the designs are more fully developed. Sources of habitat data include information from resource agencies, published reports, agency records, and site visits. Table 1 describes how the most used data sources were used in developing the mitigation plan.

Table 1. Data Sources

Year	Source of Information	Information	Use in Mitigation Planning
2023	San Francisco Estuary Institute (SFEI)	California Aquatic Resources Inventory (CARI)	Habitat Mapping
2023	Google	Google Earth Imagery	Habitat Mapping, Identification of Potential Mitigation Sites
2023	EPA	Compensatory Mitigation in Estuarine and Marine Habitats	Mitigation Measure Identification
2021, 2022, 2023	PDT	Site Visits	Inventory site conditions
2022	San Francisco Estuary Partnership	San Francisco Estuary Blueprint	Mitigation Measure Identification
2015	Goals Project	Bayland Ecosystem Goals Project	Mitigation Measure Identification
2010	Werme et al. (SFEI)	Removal of Creosote-Treated Pilings and Structures from San Francisco Bay	Mitigation Measure Identification, Designs, Considerations, and Cost Estimates
2010	Werme et al. (SFEI)	SF Bay Creosote Pilings GIS Data	Mitigation Measure Identification
2010		San Francisco Bay Subtidal Habitat Goals Report, Conservation Planning for the Submerged Areas of the Bay	
Various	Port of San Francisco	Cost Estimates for Pier and Pile Removal Projects	Cost Estimates

2.2 Identification of Habitats and Impacts

The project area includes seven habitat types including: subtidal, beach, artificial rocky intertidal, pond and associated vegetation, tidal flat and marsh panne, tidal marsh, and eelgrass. Only subtidal habitat is expected to have unavoidable adverse impacts as a result of implementing the Independent Measures, while implementation of the total net benefits plan (TNBP), alone, would have no unavoidable adverse impacts.

Implementation of the Independent Measures would result in a total net loss of 8.0 acres of subtidal habitat (see Appendix D-1-5). The impact is the result of fill material being placed within the open water column to allow for construction of the Independent Measures 2a and 2B. Subtidal habitats are submerged areas beneath the San Francisco Bay water surface to the Bay bottom and include mud, shell, sand, rocks, artificial structures, shellfish beds, macroalgal beds, and the water column above the bay bottom (Cosentino-Manning et al. 2010). Soft substrate comprises the majority of the bay's bottom (approximately 90%) and ranges between soft mud with high silt and clay content and areas of coarser sand.

Subtidal habitat in the San Francisco Bay is recognized as significant across institutional, public, and technical perspectives. Significance assessments assist teams in understanding the ecosystem impacts of the project and the linkages of the resources to other parts of the system or watershed. The following supports that subtidal habitat is considered significant in the study area:

- **Institutional, Technical and Public Criteria:** As mentioned in Section 2.0, up to one-third of the historic bay has been filled in, so resource agencies and the public recognize the value in maintaining what open water is present and discourages bay fill unless for the purpose of restoring habitat.
- **Institutional Criteria:** Subtidal habitat is regulated under the Coastal Zone Management Act and Clean Water Act and has been identified as a critical resource for Endangered Species Act and Magnuson-Stevens Fishery Management Act protected and managed species.
- **Technical Criteria:** Subtidal habitats provide diverse structure and function as an important habitat in the bay for various wildlife including fish (protected and managed herring and salmon), shellfish, invertebrates, marine mammals, and birds (diving ducks, shorebirds) that forage, rest, refuge, migrate through, and reproduce in the subtidal areas (Cosentino-Manning et al. 2010). The most common large mobile benthic invertebrate organisms in the Bay include blackspotted shrimp (*Crangon nigromaculata*), the bay shrimp (*C. franciscorum*), Dungeness crab (*Metacarcinus magister*), and the slender rock crab (*Cancer gracilis*). All these mobile invertebrates provide an important food source for carnivorous fishes, marine mammals, and birds in San Francisco Bay's food web.

2.3 Significant Net Losses

Based upon the type of habitat in the project area it was determined that the Habitat Equivalency Analysis (HEA) would be an appropriate tool to assess the project's impacts on fish and wildlife habitat and other ecological resources. Other models were considered such as Habitat Evaluation Procedures and THERM; however, none of these were sensitive to the potential changes at the impact or restoration site that would demonstrate a mitigation need or the value of the potential mitigation measures. HEA is a method developed by the National Oceanographic and Atmospheric Administration (NOAA) to scale compensation for habitat damage resulting from oil spills and other damage-related impacts (NOAA 1997). HEA is currently only approved on a project-by-project basis. Single-use model certification is being sought from the Ecosystem Restoration Center of Expertise (Eco-PCX).

HEA focuses on complete, in-kind replacement of services lost between the time of impact and when the restored or created habitat becomes fully functional. HEA accomplishes this by incorporating the concept of discounting from economic theory (i.e. services for future years have a lower value on benefits because they take longer to accrue). Model outputs are in a discounted-service-acre-year (DSAY). A complete description along with the model parameters and assumptions have been documented in Appendix D-1-5 (Habitat Modeling).

For purposes of this phase of feasibility, the worst-case scenario of implementation was assumed and included construction and long-term operation of the TNBP measures and construction of the independent measures where long-term adverse impacts are expected and no EWN benefits are realized. Additional coordination with the resource agencies will occur after the draft IFR-EIS is released to the public to better understand what is an appropriate assumption for the quantity of tidal marsh and intertidal habitat that would be restored/created and how that could contribute to project benefits that would offset the impacts of bay fill as part of the total project design. As a result, only the bay fill impacts to subtidal habitats were modeled.

The HEA results indicate that for 1.0 acre of bay fill a total of 500,000 DSAY are lost (Table 2), which totals 4,500,000 DSAY lost for the 9.0 acres of bay fill associated with implementing the Independent Measures at 2A and 2B.

The TNBP also includes 1.0 acre of pier removal as one of the project features that need to be accounted for when determining the mitigation need since this is a subtidal long-term benefit associated with the project. HEA was used to calculate the benefit of pier removal and it was determined that 1.0 acre of pier removal results in a gain of 499,999 DSAY of subtidal habitat (Table 2). As a result, the total mitigation need for the project is 4,000,001 DSAY (i.e. 4,500,000 DSAY [bay fill, permanent loss] – 499,999 DSAY [pier removal, permanent gain] = 4,000,001 DSAY mitigation need).

Table 2. Summary of HEA Results for the Total Project

Measure	Acres Impacted	DSAY/ac	Total DSAY
Bay Fill (loss)	-9.0	-500,000	-4,500,000
Pier Removal (gain)	+1.0	499,999	+499,999
Total Mitigation Need	**-8.0**	**--**	**-4,000,001**

K-3. Mitigation Planning

The project includes mitigation sequencing actions employed during the development and refinement of details for each alternative plan. These sequencing actions include steps to avoid, minimize, rectify, and reduce/eliminate habitat impacts for each alternative. These actions are part of the overall mitigation plan for the project. The need for compensatory mitigation is driven by the remaining unavoidable impacts to significant ecological resources.

3.1 Mitigation Planning Objective

The goal of this mitigation plan is to fully compensate for the unavoidable impacts to subtidal habitats that would occur with project implementation. The objectives of the mitigation plan are defined by the results of the HEA. HEA was also used to estimate potential project impacts and potential outputs of mitigation measures. The objective of this mitigation plan is:

- Compensate for the loss of 8.0 acres of subtidal habitat (4,000,001 DSAY) along the San Francisco Waterfront in San Francisco Bay.

Other factors may influence planning objectives and the development of strategies, measures, and alternative plans. These may even play a role in plan selection depending on specific project circumstances and opportunities. Some of these factors are based on legal requirements and policies and others are derived from scientific or technical standards. For example, acquisition of lands or interests in lands for mitigation must be acquired before construction of the project commences or concurrently with acquisition of lands and interests in lands for other project purposes; and the physical construction of the mitigation work is required to be carried out before or concurrently with project construction (see Section 906(a) of WRDA 1986, as amended). This introduces an implementation time factor to consider later in plan evaluation and selection. Another example, from a scientific perspective, larger contiguous land tracts may offer better habitat value for fish and wildlife compared to dispersed smaller areas. This may influence site selection and land considerations for a mitigation project.

3.2 Land Considerations

Most of the subtidal habitats along the waterfront are publicly owned by the Port of San Francisco (Port) and/or the City of San Francisco (City) as granted under the Burton Act. Most of the piers and adjacent lands are also owned by the Port and/or City, with a few exceptions of private parcels along the 7.5-mile waterfront. Since the Port and City are the primary landowners and the NFS, finding mitigation options without real estate challenges should not be an issue. Additionally, focusing on mitigation on their lands will reduce the overall costs and provide long-term protections to the site.

3.3 Mitigation Strategies

Planning strategies are different means employed to develop an alternative plan or plans to achieve a project goal. The use of one or more strategies helps teams focus on an approach to developing a plan. For mitigation planning work, strategies may range from the purchase of mitigation bank credits to the construction of a project or projects to achieve the objectives and compensate for unavoidable habitat impacts. Strategies may also involve different approaches to site selection such as the use of public lands or identifying contiguous sites to enhance wildlife corridors or expand wildlife populations. In addition, Section 2036(c) of WRDA 2007, as amended, requires the Corps of Engineers to consider mitigation banks and in-lieu fee programs where appropriate. Consideration of these options as mitigation strategies may be helpful when available. The strategies considered for planning this mitigation project are described below.

- **Purchase of mitigation bank credits.** Mitigation banks sell credits for mitigation work performed at an approved site. The banks are approved and legally bound through banking instruments that hold the operators to certain standards of performance and reporting. The use of mitigation banks for a project may offer advantages to the government and non-federal sponsor (NFS) by reducing performance risk and eliminating project specific requirements for operations and maintenance work and the development of monitoring and adaptive management plans.
- **Purchase of in-lieu fee program credits.** In-lieu fee programs are established by state or local natural resource management agencies and approved by the Corps of Engineers and U.S. Environmental Protection Agency to accept funds for future mitigation work. The programs are approved to implement either specific or general wetland or other aquatic resource development projects. Programs must meet the requirements that apply to an offsite mitigation effort and provide adequate assurances of success and timely implementation. A formal agreement between the program sponsor and the agencies, like a banking instrument, defines the conditions under which the use of the program is considered appropriate. Using an in-lieu-fee program for a project's mitigation needs may offer advantages to the government and NFS by reducing performance risk and

eliminating project specific requirements for operations and maintenance work and the development of monitoring and adaptive management plans.

- **Construction of a mitigation project.** The government and NFS may choose to construct a mitigation project. This construction strategy offers some potential advantages in tailoring a project to specific needs or locations. In addition, the partners may bring special expertise to the project gained from previous work on similar projects in the area.
- **Non-structural mitigation methods.** Various non-structural approaches may be available for accomplishing mitigation objectives. These approaches generally do not involve major construction work and therefore potentially reduce some associated environmental impacts. These actions may include land preservation, invasive species control, environmental flows, or other management actions that produce ecosystem benefits. As a strategy reducing environmental impacts may be more appropriate and complimentary in sensitive or protected areas. Non-structural mitigation may be combined with all other mitigation strategies to guide formulation of alternative plans.
- **Partnership opportunities.** Many organizations have goals that align with Corps of Engineers mitigation planning needs, the Environmental Operating Principles, or other missions. Opportunities may exist to collaborate to plan a project that meets the goals of the mitigation plan and the watershed goals of one or more partners. This strategy offers an opportunity to benefit from the strengths of organizations outside of government and may leverage existing information or offer unique local insight. There may be opportunities to perform habitat mitigation work on lands managed by partners.

3.4 Identify Measures

Management measures are actions or activities that work towards accomplishing planning objectives. Each measure is linked to one or more stressors or drivers in the conceptual ecological model. A measure may stand alone as a single activity that serves as an alternative plan. Two or more individual measures may be combined to form an alternative plan.

Measures were identified based on resource agency feedback and were further developed and guided by the goals established in several conservation and management plans developed by various partnerships and coordination efforts in San Francisco Bay (see Table 1). Within these plans, the common restoration goals applicable to habitats along the waterfront and that align with the mitigation objective include:

- Improve biodiversity, resilience, and water quality
- Limit disturbances to soft substrates and discourage the use of bay fill
- Remove artificial structures that have negative impacts on soft bottom habitat function, contribute to water quality degradation and that provide minimal habitat benefit
- Remove marine debris from intertidal or subtidal areas

- Minimize the impacts of aquatic invasive species on native subtidal habitats

Most of these plans focus on restoration actions in habitats that would not meet the mitigation objective, such as tidal marsh restoration. Other restoration actions include measures that may be considered out-of-kind mitigation such: preserving remaining natural habitats (e.g. eelgrass and oyster beds and soft bottoms); protecting areas for future expansion, restoration or creation of natural habitats; restoration of natural habitats; or improving water quality for discharges directly into the Bay. While each of these would provide an overall benefit to subtidal habitat, other measures are available that would meet the restoration goals stated above. If for some reason sufficient in-kind measures cannot be found when the mitigation plan is finalized, consideration of these out-of-kind mitigation measures should be considered in coordination with the resource agencies.

A total of 10 measures were identified as meeting the planning objective; however, of these only two were carried forward as potential mitigation measures that could be implemented to offset the impacts to subtidal habitat. The measures and the rationale for carrying forward or eliminating from further is documented in Table 3.

The two measures were further assessed to determine the potential to combine it with other measures to form alternative plans. Both measures can stand alone as if a measure can stand alone as a plan or be combined together to form another plan. Neither of these measures have any restrictions that would prevent its combination with another measure.

The measures were then combined into an array of alternative plans aligned with the mitigation planning strategies. A no action alternative is included as a basis for comparison as well as meeting the requirements of the National Environmental Policy Act.

- **No Action Alternative.** Under this scenario no mitigation work would be performed, and the structure, functions and values of project impacted habitats would be permanently lost. The alternative is retained for purposes of a baseline comparison against other action alternatives.
- **Alternative 1.** Remove 15 acres of abandoned and derelict piles from the San Francisco waterfront between Aquatic Park and Heron's Head. The Warme et al. Creosote Piling Geodatabase identifies at least 8.5 acres (2,549,992 DSAY). Additional pier removal options will need to be investigated during PED to implement this alternative.
- **Alternative 2.** Remove 8 acres of abandoned, derelict, or unnecessary piers from the San Francisco waterfront between Aquatic Park and Heron's Head. The Waterfront Plan and Design & Access Element includes policies for removal of a portion of the Pier 23 shed and Pier 64. These options equate to about 3.5 acres of pier removal (1,749,997 DSAY). Other piers identified in the Waterfront Plan have already been completed. Other options along the waterfront or outside the study area will need to be investigated during PED to implement this alternative.

- **Alternative 3.** Combination of pile and pier removal. Some locations offer the opportunity for removal of pier and pile from the same location, while a combination of pier and pile removal may be necessary in order to mitigate within the study area. By combining the identified locations in Alternative 1 and Alternative 2 a total of 4,299,988 DSAY would be completed, leaving an excess and options for identifying priority areas or if the pile polygons, in particular, are smaller than mapped.

Table 3. Potential Mitigation Measures

Measure	Description	Carried Forward	Rationale
Mitigation Bank Credits	Purchase mitigation credits from an approved mitigation bank.	No	No approved mitigation banks currently exist in the primary, secondary, or tertiary service area that provide open water or subtidal habitat credits.
In-Lieu Fee Credits	Purchase ILF credits from an approved bank.	No	No approved ILF credits are available in the primary, secondary, or tertiary service area that provide open water or subtidal habitat credits.
Restoration-Pile Removal	Remove abandoned and derelict piles from the waterfront, with a primary focus on known locations with creosote piles.	Yes	These measures meet the objective of restoring subtidal habitat by: • Reducing shading of the bottom and water column • Reducing restrictions to flow and sediment movement • Restoring, re-creating, or realigning intertidal mudflats, sand flats, rock, shellfish, and macroalgal beds, and soft bottoms • Reducing toxic effects of creosote and other contaminants
Restoration-Pier Removal	Remove abandoned, derelict, or unused piers and overwater structures to include removal of all decking, pilings, and other materials associated with the structure.	Yes	
Restoration-Restore Shoreline	Remove shoreline fill in abandoned or unused areas.	No	As of now, there does not appear to be any areas that would be suitable to restore the shoreline along the 7.5-mile waterfront or in other adjacent areas. However, as conditions changes over the next decade, this measure should be reconsidered during PED. *Note: If the 4A independent measure is included in the final designs, that feature may meet this criteria and should be accounted for in the total project impacts to determine if a mitigation need still exists.

Measure	Description	Carried Forward	Rationale
Restoration-Trash and debris removal	Remove trash and debris (e.g. abandoned boats, fishing gear) from the open water areas along the waterfront.	No	This would require a reoccurring program to be set up in perpetuity and would not be a permanent improvement to water quality due to the recurring nature of trash input. There would be uncertainty whether the measure would fully compensate for the loss in perpetuity.
Restoration-Increase diversity	Addition of living seawalls or texture to existing artificial structures and incorporating troughs into deepwater habitats	No	Small scale efforts have been completed and shown success; however, the long-term benefits are still assumed. Additionally, there are significant challenges in quantifying how much each of these measures could offset one acre of subtidal habitat loss. These are acknowledged as extremely valuable tools for increasing diversity; however, for purposes of mitigation there is risk and uncertainty in knowing that the impact has been sufficiently offset and will provide benefits in perpetuity. This measure should be reconsidered in PED when many of the pilot projects have been completed. *Note: Living seawalls are an independent measure for consideration and if they are included, the feature may meet this criteria and may need to be accounted for in the total project impacts to determine mitigation need. Further discussion with resource agencies is necessary before considering.

Measure	Description	Carried Forward	Rationale
Restoration-Invasive Species Removal	Remove at least two invasive species from the waterfront	No	The potential for eradication or reduction to acceptable levels may or may not occur within a reasonable time frame (for example, no longer than 10 years). There is also no guarantee whether the proposed methods for treatment are going to work or whether there is reasonable assurance that no identifiable vector will re-introduce the species proposed for control or eradication making this an extremely difficult task and introduces significant uncertainty whether the measure would fully compensate for the loss in perpetuity.
Preservation – Open Water	Permanently protect areas of open water in or near ecologically important habitat through the implementation of appropriate legal and physical mechanisms.	No	Areas that could meet this purpose are found on publicly owned lands and actions which could affect habitat is regulated under various Federal and State laws. The State, City, and Port have implemented several actions to minimize impacts that is also contributing to existing habitat protection.
Preservation – Future Uses	Protect submerged land as it may become available to incorporate transition zones into restoration designs.	No	This measure would be dependent on other activities that would not be associated with the mitigation action. Additionally, the considerations for Open Water preservation are also applicable here.

3.5 Cost of Mitigation Plan Increments

3.5.1 Cost of Mitigation Plan and Increments

Cost estimates were prepared for each alternative. The team used various information sources to estimate the costs of the alternatives. Available information included records of recent mitigation bank credit and in-lieu fee program credit sales and details from recently completed nearby ecosystem projects. The study team also considered other cost factors such as site access, fuel and equipment, and the disposal of materials. Table 4 displays the costs and outputs for each alternative plan.

For pier removal, the cost was assumed to be $80/square foot or $3,484,800/acre and includes removal and disposal of all decking, piles, and other structural materials. For pile removal, a number of factors can influence the cost including pile material, disposal needs (e.g. creosote material may need special handling and disposal compared to concrete), spacing/quantity of piles in the location. Cost estimates can range from $1,000 to $6,000 per pile or anywhere from $200,000 to $6,000,000 per acre. For purposes of this analysis, the median price of $3,100,000/acre was used.

Table 4. Estimated Cost of Alternative Plans

Alternative	Acres	Cost	Output (DSAY)
No Action	0	$0	0
Alternative 1	15	$46,500,000	4,000,001
Alternative 2	8	$27,878,400	4,000,001
Alternative 3	Assumes 3.5 ac of pier removal and 7.5 acres pile removal.	$35,446,800	4,000,001

3.5.2 Incremental Costs

Cost effectiveness analysis is conducted on alternative compensatory mitigation plans to ensure the least cost alternative is identified for each level of output. Subsequently, incremental cost analysis is done on the cost-effective plans to reveal changes in costs as output levels increase and allow for an assessment of whether the increase in output is worth the additional cost. Determination of the final compensatory mitigation plan will utilize these results to identify and describe the least cost plan.

The outputs of different mitigation alternatives may be similar. Each alternative plan should be appropriately scaled to meet or closely meet the mitigation planning objective

based upon unavoidable ecological impacts generally expressed in habitat units. Some variations in alternative plan outputs and costs may be expected because of differences in site conditions or other factors at various project locations under consideration.

IWR Planning Suite software is used to analyze and compare plans. The software uses information about the mitigation measures and alternative plans including combinability and exclusions, costs, and outputs. The team establishes the parameters and enters cost estimates and plan outputs into the software. The resulting information is used to evaluate alternatives and identify a suite of cost-effective solutions or plans. Figure 1 displays the results of the cost effectiveness evaluation for all the alternative plans. Figure 2 shows only the cost-effective plans and Table 5 displays the incremental cost analysis of best buy plans.

Based on the information available, the least cost alternative plan – Alternative 2 - that provides full mitigation of losses specified in the planning objectives is identified and displayed. There are no other plans that provide the same amount of benefits at a lower cost.

Figure 1. Chart of Alternative Plans

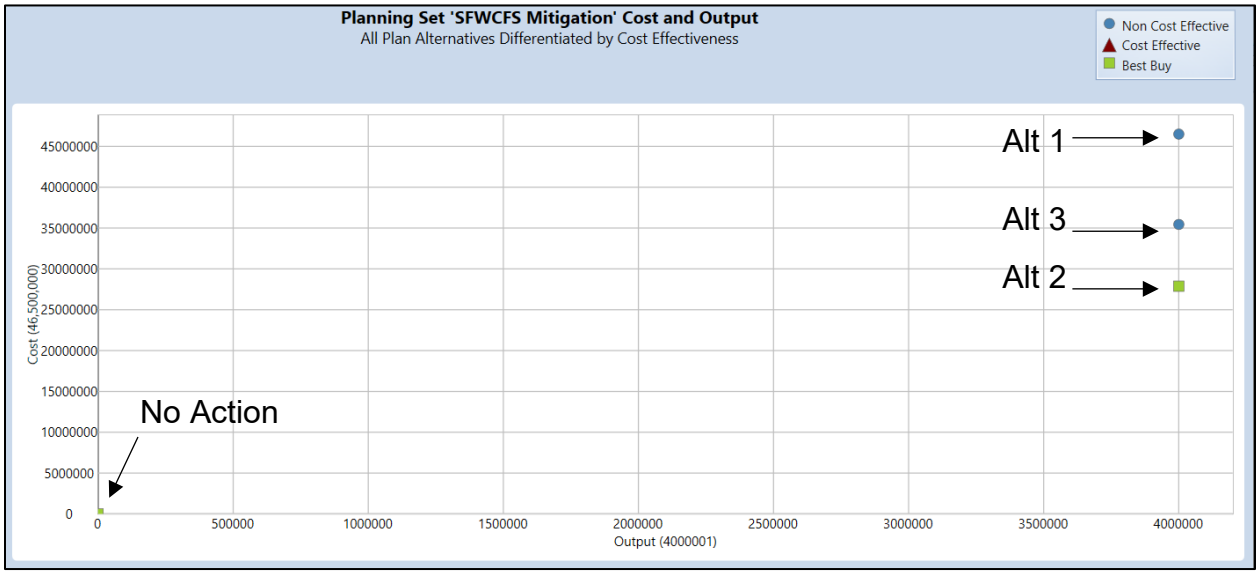

Figure 2. Cost-Effective Alternative Plans

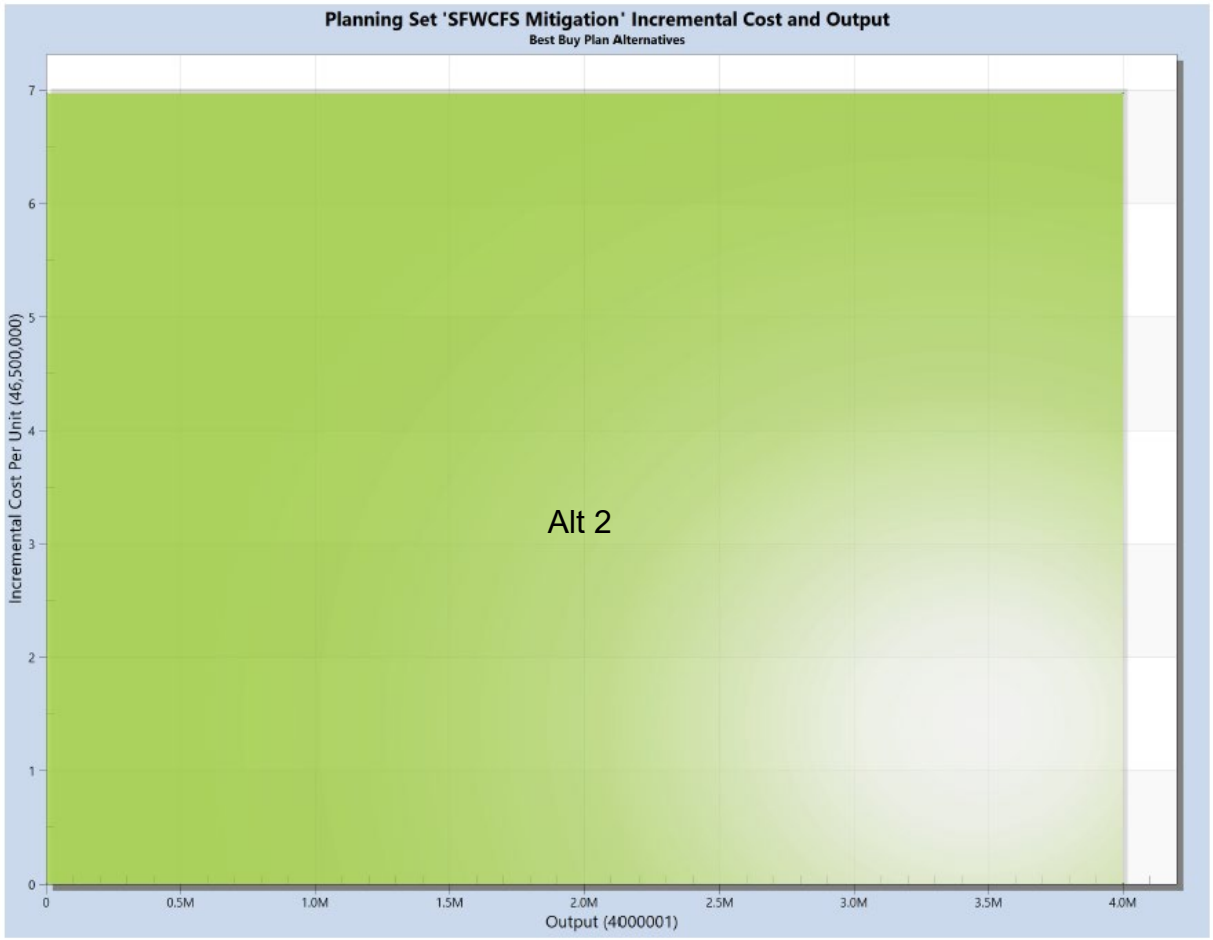

Table 5. Incremental Costs and Benefits of Alternatives

Alternative	Output	Cost ($)	Average Cost	Incremental Cost	Incremental Output	Incremental Cost per Output
No Action	0	0	0.000	0	0	0.000
Alt 1	4,000,001	46,500,000	11.625	46,500,000	4,000,001	11.625
Alt 2	4,000,001	27,878,400	6.970	-18,621,600	0.000	0.000
Alt 3	4,000,001	35,446,800	8.862	7,568,400	0.000	0.000

3.6 Plan Considerations

As briefly mentioned in Section 3.5.1, there is significant uncertainty in the cost of pier removal as a number of factors can influence the cost of the action. Additionally, there is a lot of effort throughout the Bay to remove old piers and piles through grants, funding

for water quality improvements, special interest working group efforts, and as a form of mitigation for other projects. As a result, the number of piles and piers needing removal goes down every year. Since this project would not have a finalized mitigation plan in at least 5-7 years, the costs and incremental analysis is considered valid based on the information today but will need to be re-run during PED to ensure that the alternatives have not changed that would result in a new cost effective or best-buy plan being identified.

During PED, if Alternative 1 or 2 are selected, additional sites will need to be identified within or outside the immediate project area in order to obtain enough acreage of removal and outset the DSAY losses. If sites are selected outside of the study area, consideration should be given to finding locations as close as possible to the area of impact; however, real estate challenges could be presented, particularly if needing to obtain ownership or perform condemnation at a site under another city or county's ownership. Needing to acquire real estate would increase the overall cost of the action and would also contribute to a potentially different array of best buy or cost-effective plans.

Specifically for piles, during PED each individual site will need to be reviewed and, if possible, a standard set to ensure that one acre of restoration will provide sufficient habitat improvement. For example, a site with greater spacing in piers will have a higher starting service life than is assumed and modeled for this study thus requiring more restoration than original assumed. One possible metric for standardization would be to measure the cubic yards of piles being removed and determine an acceptable cubic yardage of material that would equate to one acre of service life at 75%. For piers, the presence of decking is what defines the service life and thus the acreage of decking would contribute to that acreage of habitat once removed.

None of these alternatives should require long-term operation or maintenance, which is a significant savings over some other potential measures that were initially identified, if those are being reconsidered.

K-4. Plan Selection

Based on the information available today and if the project was being implemented in the immediate future, Alternative 2 would be the recommended mitigation plan. However, there are several factors that must be taken into account that cannot rule out any of the other alternatives at this time. It must be acknowledged that this is a draft or conceptual mitigation plan and is expected to be revisited during the next phases of feasibility and during PED as designs are refined.

4.1 Implementation Risks

A suite of foreseeable implementation risk factors across each phase of implementation (Pre-Construction Engineering and Design, Construction, and Operations) have been

identified (Table 5). These factors are based upon experience from similar projects and the consideration of regional risks generally associated with design and construction work in wet environments. Each risk was assessed and assigned a significance level. Potential risk management measures were identified and will be considered should the need arise during implementation or adaptive management.

Table 6. Implementation Risks

Pre-Construction, Engineering, Design Phase (PED)			
Risk Factor	Risk Potential	Risk Rating	Risk Management Measures
Decrease in Habitat Impacts	Moderate	High	Incorporate avoidance, minimization, and NNBF into the designs
Increase in Total Project Habitat Benefits	High	Moderate	Revise habitat modeling and recalculate mitigation need
Sites no longer available (completed by others)	Moderate	High	• Complete mitigation efforts as soon as practicable • Coordinate with resource agencies, USACE regulatory, and special interest groups in the Bay to identify other sites.
Costs Change	High	High	Consider alternative mitigation sites or methods to construction.
Construction			
Construction Management	Moderate	Varies	Monitor use of BMPs during construction work. Confirm construction as-built requirements are met. Document all pre- and post-construction at site.
Long-Term Operation			
none			Once construction is complete, no long-term O&M is necessary.

4.2 Additional Mitigation Requirements

There may be requirements for compliance with statutes where another Federal agency has decision-making authority. These may include additional specific compensation for ecological impacts to special status fish and wildlife species or other resources. These additional requirements may be necessary to comply with laws such as the Endangered Species Act, the Magnuson – Stevens Fishery Conservation and Management Act, or other Federal laws. If the agencies identify any additional mitigation requirements to obtain project approval, the details of the need will be added here for the final IFR-EIS or during PED.

K-5. References

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