GREAT CHEBEAGUE ISLAND

MAINE

NAVIGATION IMPROVEMENT PROJECT

APPENDIX I

MITIGATION PLAN

This Page Intentionally Left Blank

Table of Contents

This Page Left Intentionally Blank for Duplication Purposes

1.0 INTRODUCTION

The U.S. Army Corps of Engineers (USACE), New England District is proposing improvement dredging in the vicinity of the Stone Wharf on Great Chebeague Island (Figure I-1). The proposed navigation improvements would create a new channel and turning basin at the Stone Wharf. The channel would extend from deep water in Casco Bay southeasterly ~1,600 feet to Great Chebeague Island public landing. The channel would be 100 feet wide and dredged to -10 feet deep mean lower low water (MLLW), with widening to 150 feet alongside the pier. An upper turning basin, 0.5 acre in size, between the channel and the boat/barge ramp would also be constructed by dredging to -8 feet MLLW to accommodate vessel maneuvering. Approximately 34,000 cubic yards of sediments would be dredged to create the channel and turning basin. The dredged material is comprised of primarily sand and silt, with some gravel at a few locations. The work will be performed by a private contractor, using a mechanical dredge and scows, under contract to the government. The dredge will remove the material from the harbor bottom and place the material in scows. The scows will be towed by tug to the Portland Disposal Site (PDS), where the material will be placed at designated locations within PDS.

The work will be accomplished over about a five to six-month period, between October 1 and April 1, of the year(s) in which funds become available. The Contractor will be allowed to dredge 24 hours per day, 7 days per week. Officials from the State of Maine and the Town of Chebeague have requested that this project then be maintained in perpetuity by USACE as a Federal Navigation Project (FNP).

2.0 PURPOSE

A Feasibility Report (FR) and an Environmental Assessment (EA) have been prepared for this project (USACE 2020). The FR and the EA have determined that impacts to eelgrass and intertidal areas are unavoidable. As such, this mitigation plan has been prepared to document the affected eelgrass and intertidal resources, discuss the avoidance and minimization procedures considered, document the quantification of impacts to eelgrass and intertidal areas, define mitigation alternatives, and make recommendations for compensatory mitigation.

3.0 EELGRASS AND INTERTIDAL IMPACT ASSESSMENT

3.1.1 Eelgrass Existing Conditions

The State of Maine Department of Marine Resources (MEDMR) periodically maps the eelgrass resources of the state. MEDMR eelgrass mapping data from the 1990s and the 2000s (Figure I-2) shows that the majority of the shallow subtidal waters surrounding Great Chebeague Island contain eelgrass beds (ME GIS, 2013).

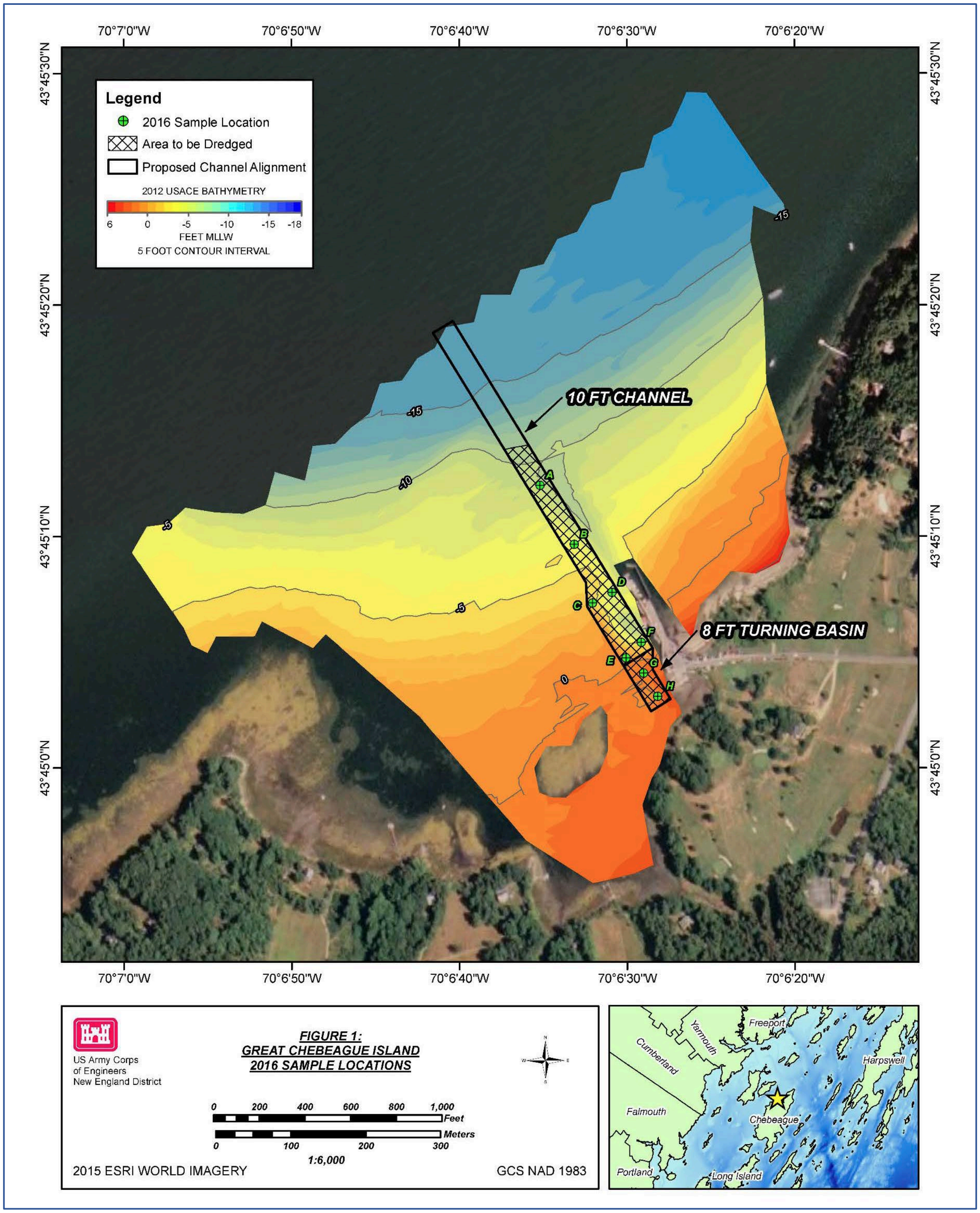

Figure I-1. Proposed Great Chebeague Island navigation improvement project.

Figure I-2. Distribution of eelgrass in the vicinity of Great Chebeague Island.

3.1.2 Future Project Conditions

The Detailed Project Report (DPR) for this project discusses the future conditions of the project area with and without the proposed action (see Section 6 of the DPR). In general, future conditions in the project area will be affected by regional and national changes in climate. Tide heights are predicted to increase by between 0.5 and 2.9 feet over the next 50 years and water temperatures are projected to rise over time.

Eelgrass in the western Atlantic Ocean ranges from the mid-Atlantic United States north to Canada and the Labrador Sea. Even though eelgrass prefers cooler waters compared to tropical seagrass species, the anticipated change in water temperatures within the proposed project area is not anticipated to impact the capability of the site to support eelgrass. Additionally, the change in tidal elevations within the project area (and mitigation site discussed below) are not anticipated to change the capacity of the site to support eelgrass. Assuming vessel drafts remain similar in the future, the need for dredging could reduce as water depth increases with sea level rise.

3.2 Eelgrass Assessment Method

In July 2017, the USACE performed a hydroacoustic and video survey of the Great Chebeague Island project area to document eelgrass resources that may occur in the proposed project footprint. Figure 3 shows the result of the USACE eelgrass survey overlain on the proposed project footprint. The total amount of eelgrass within the proposed project footprint, which includes the width of the proposed channel and turning basin as well as the side slope (3:1 ratio) areas for each feature, is 47,195 square feet. (See Section 3.3 for details.)

2017 Eelgrass Assessment Survey

Staff from the NAE Environmental Branch conducted video and hydroacoustic surveys on 18 July of 2017. Work was carried out on a 17-foot Boston Whaler outfitted for shallow water survey operations. Positioning was achieved using a Hemisphere R330 Global Positioning System (GPS) receiving real time differential corrections. The system was interfaced with a computer running Hypack® for navigation and Biosonics Visual Acquisition software for real time visualization and recording of sonar data.

Forty-three survey transects were pre-planned in ESRI ArcGIS using a spacing of 50 feet in an orientation perpendicular to the proposed channel alignment. These transects were laid out to provide adequate coverage of the proposed dredge area in the vicinity of Submerged Aquatic Vegetation beds identified by the Maine Department of Marine Resources (MEDMR) through interpretation of 2013 orthophotography (available through the MEDMR website: http://www.maine.gov/dmr/rm/eelgrass). The planned survey transects for the project area are presented on Figure I-3.

Hydroacoustic data was collected using a BioSonics MX echosounder with a 204.8 kHz, 8.7° calibrated transducer operating at a 5Hz ping rate. The transducer was fixed to an adjustable boom mounted along the starboard side of the vessel. The face of the transducer was adjusted to be 16 inches below the water surface. The boat operator navigated all transects at a speed of approximately 3.5 knots (4.0 mph) while recording data. Adjacent transects were run in opposite directions to minimize non-recording time. Transect information including the number, filename, start and stop time, direction, and observations of bottom type and SAV were recorded in a field log during the survey. Sonar data was viewed in real time and recorded using Biosonics Visual Acquisition software. Waypoints were created throughout the survey to mark changes in bottom type and features of interest identified in real time to be later investigated during the video survey.

Video footage was collected at 25 stations corresponding to waypoints created during the acoustic survey. Video was collected using a Sea Viewer Sea-Drop 650 Underwater Video Camera and recorded to a portable DVR system outfitted with an LCD monitor for real time viewing. The camera was weighted with a 5lb downrigger weight and deployed off the starboard side of the vessel. The camera was allowed to remain on the bottom for approximately 5 to 10 seconds at each station, observing 5 to 10 linear feet of bottom with typical vessel drift. Depth and directional adjustments of the camera were made manually by USACE personnel positioned on deck. Real time observations of bottom type, macro algae, or eelgrass beds were recorded in the field notebook. Details on data processing of the hydroacoustic data and the video files are described in the Final July 2017 Predredge Survey for Submerged Aquatic Vegetation (Appendix D of the FR/EA for this project).

Analysis of the MEDMR eelgrass coverage for the project area from 1997-2013 suggests that a contiguous and fairly stable eelgrass bed has persisted in and along the western side of the proposed channel during that time period. Examination of the 2017 USACE survey data confirmed that the spatial extent of the existing SAV beds were consistent with historic coverage and that the primary species of SAV growing in the survey area is *Zostera marina*.

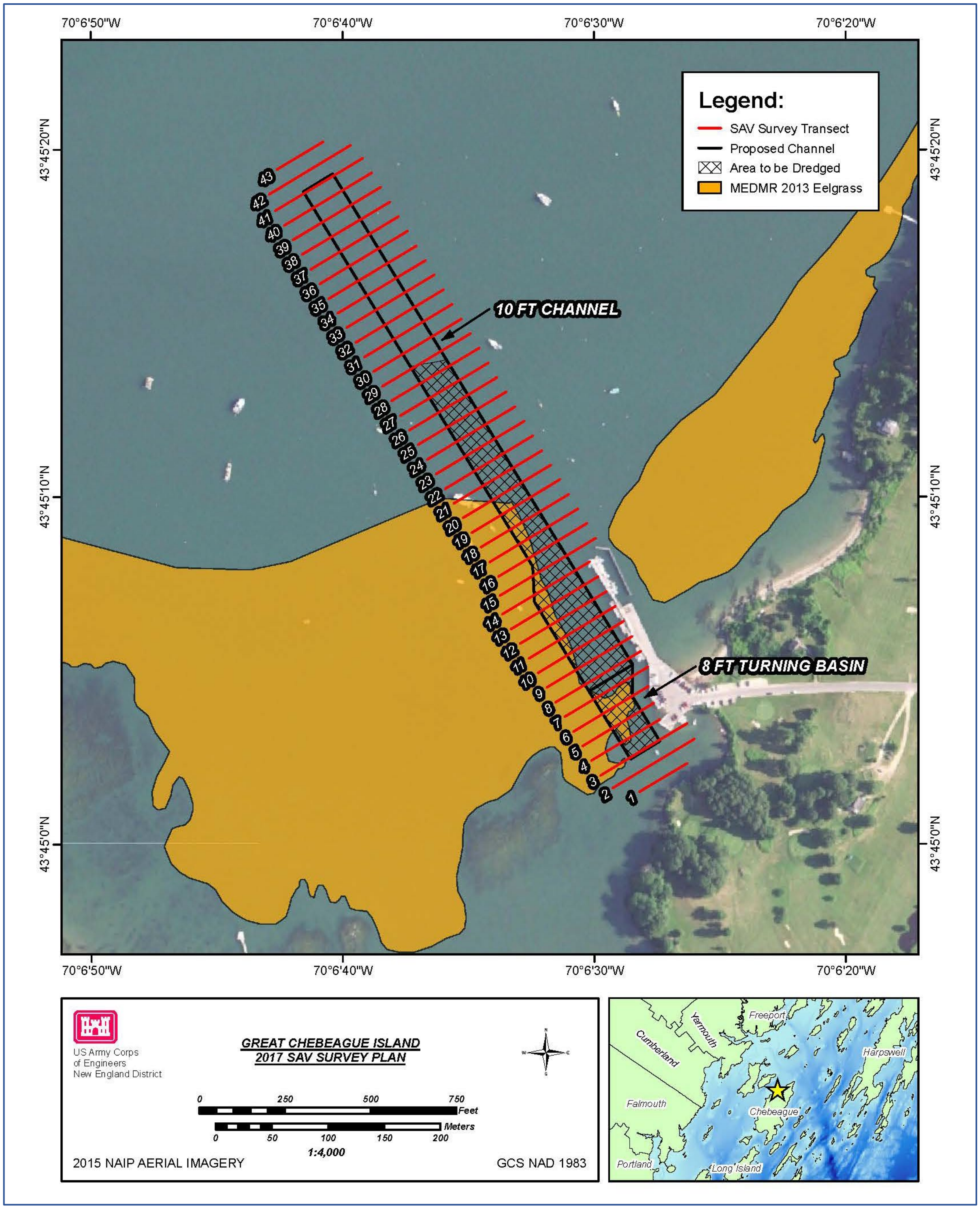

Figure I-3.

The eelgrass bed along the western side of the proposed project footprint was observed to begin at the top of the slope associated with the existing town channel and extend beyond the western survey boundary (Figure I-4). Bottom conditions in the outer portion of the proposed project area consisted of unvegetated fine sand and silt. The eastern portion of the channel adjacent to the town landing was documented as unvegetated fine sand and silt with a layer of leafy organic debris and eelgrass wrack at the surface. The area in the vicinity of the boat ramp along the southernmost portion of the town landing was found to be coarse substrate consisting of cobble, gravel, sand, and shell.

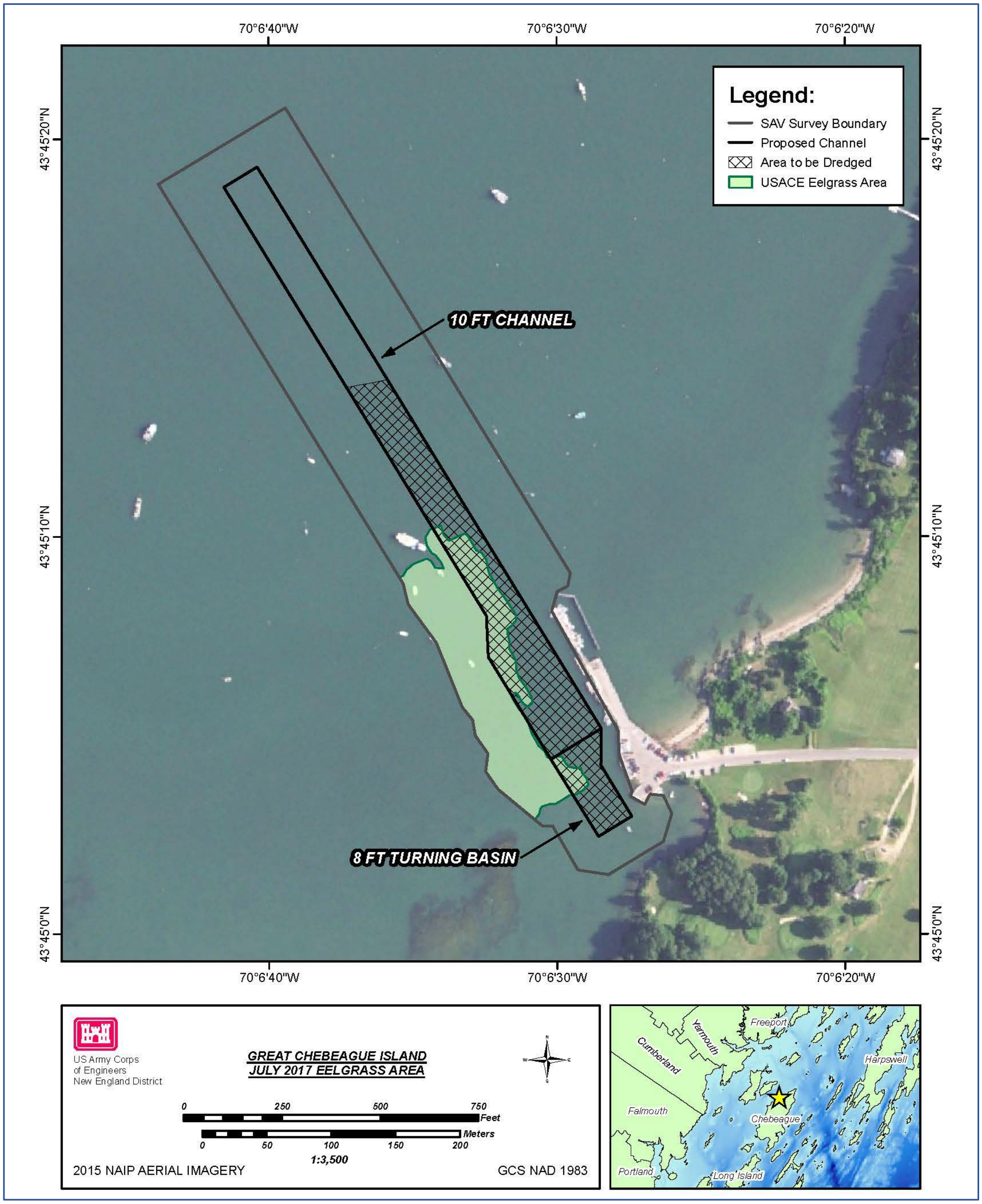

Figure I-4.

Future Pre-Construction and Post-Construction Assessments

USACE will perform a pre-construction eelgrass survey during the growing season (June-September) before the start of dredging operations. This survey will serve as the baseline condition for a final assessment of project impacts to eelgrass beds in the project area. A series of reference sites will be identified and surveyed during this effort in order to facilitate future assessments of natural variation within the system. These reference sites will be located outside of the dredging impact area but within the same system and should have depths similar to the target dredge depth in the channel and turning basin.

An identical post-construction eelgrass survey will be performed during the growing season following the completion of the dredging effort. Direct impacts to eelgrass in the project area will be quantified by comparing the spatial extent of eelgrass beds between the pre and post-construction surveys. The natural variation of eelgrass at the reference sites will be used to interpret project area impacts that cannot be directly attributed to dredging operations. The measured loss of eelgrass as a result of the dredging project will be used in final mitigation compensation as described in Section 5 below. USACE will provide the agencies with a full impact assessment report describing the pre and post-construction survey data and results of analysis.

3.3 Eelgrass Impact Estimations

Permanent Impacts

The area of eelgrass that will be impacted by the creation of a channel and turning basin in the project area was calculated by estimating eelgrass resources within the proposed navigation features. Additionally, a 3:1 slope around all features was evaluated and included in the overall impact estimate. The area of the 3:1 slope equates to a 30-foot perimeter extending around the 10-foot deep channel boundary and a 24-foot perimeter extending around the 8-foot deep turning basin. The eelgrass impact area within the channel and side slope footprint is 40,490 square feet and the area within the proposed turning basin and side slope is 6,705 square feet, totaling 47,195 square feet.

Areal impact are estimated based on direct dredging of the project footprint and the proposed side slopes. These estimates do not take sloughing of the dredge cut or other unforeseen physical impacts from dredging operations into account. Actual impacts may vary from the predictions in this document and the cost of any additional mitigation to compensate for these losses will be identified during monitoring and addressed through additional plantings. The cost of potential additional mitigation is covered by mitigation contingency funds.

Temporal Impacts

The permanent impacts described above will be mitigated for (see below). However, there will be a temporal lag in the development of the eelgrass resources at the mitigation site and as such there will be a temporary loss of full functions and values of the eelgrass resource. To compensate for the temporal loss of eelgrass during this period, an additional amount of eelgrass mitigation is being provided.

We estimated that the time the mitigation site will take to establish itself will be four years based on research conducted by Evans and Short (2005) within the same system within which the mitigation is planned. Details of the mitigation plan are discussed below. Our estimation of temporal loss of eelgrass was calculated by regressing the amount of eelgrass that would theoretically be present per year over the four year establishment period (Figure I-4a and Table I-1).

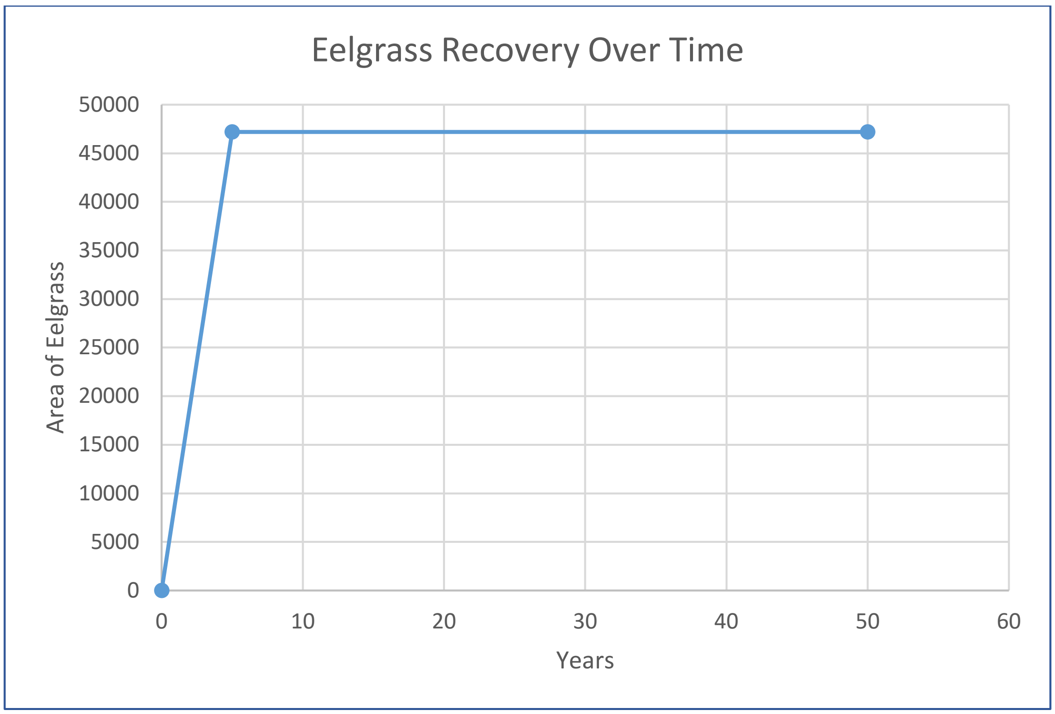

Figure I-4a. Areal extent of eelgrass at proposed mitigation site using a 4-year establishment period.

Table I-1. Estimation of eelgrass establishment at a mitigation site.

With action	Year Post Dredging (YPD)	Area of Eelgrass at YPD	Duration of Eelgrass at Area in the Previous Column	Area of Eelgrass at YPD Times No. of Years
1	0	-	1	-
2	1	9,439	1	9,439
3	2	18,878	1	18,878
4	3	28,317	1	28,317
5	4	37,756	1	37,756
6	5	47,195	45	2,123,775
		Average Annual Area		44,363 sf
		With Action minus Without Action		2,832 sf

Based upon predicted eelgrass establishment times, an additional 2,832 square feet of eelgrass mitigation is necessary to compensate for the time lag in the development of the mitigation site following planting. This value will be added into the overall mitigation needs for the proposed project.

3.4 Intertidal Existing Conditions

A bathymetric survey was performed by USACE in the proposed project area in 2017 and used during project formulation to aid in determining the appropriate locations of the navigation features being considered in the study (i.e., the channel and the turning basin). As noted above and in the DPR, all practicable configurations of the navigation features were explored to avoid and minimize impacts to ecological resources, specifically areas with eelgrass and intertidal areas. Figure I-5 shows the location of the proposed project overlain on the bathymetric survey data.

3.5 Intertidal Impact Estimations

The area of intertidal habitat that will be impacted by the creation of a turning basin in the project area was calculated by estimating the intertidal area in the footprint of the feature as well as within a 3:1 side slope. The area of the 3:1 slope equates to a 24-foot perimeter extending around the 8-foot deep turning basin. The intertidal area within the proposed turning basin footprint (including side slope) is 26,830 square feet.

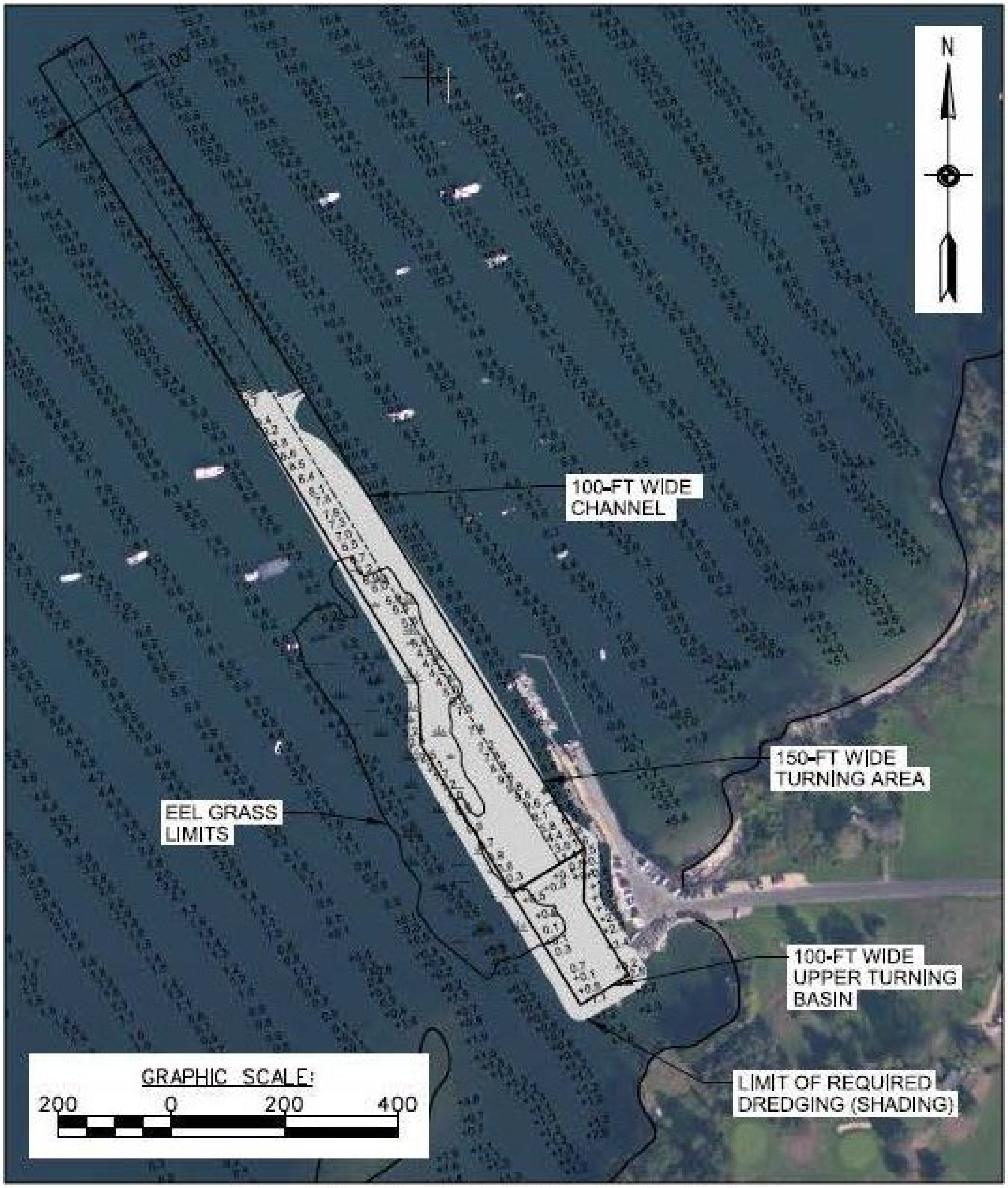

Figure I-5. Location of proposed turning basin and existing bathymetry.

4.0 MITIGATION PLANNING OBJECTIVE

The mitigation effort proposed will compensate for the permanent loss of 47,195 square feet of eelgrass habitat in an area near Stone Wharf on Great Chebeague Island, the temporal loss of eelgrass habitat functions (estimated to equate to 2,837 square feet) and the conversion of 26,830 square feet of intertidal habitat to subtidal habitat. The proposed area of eelgrass habitat impact, along with other unvegetated subtidal areas, will be maintained in perpetuity as a Federal Navigation Project (FNP) and will be subject to future maintenance dredging. The maintenance dredging cycle is anticipated to be every 10-20 years. The compensatory mitigation proposed within this study will exempt future maintenance dredging efforts in the authorized FNP footprint from the need for mitigation under the Magnuson-Stevens Fisheries Conservation Act.

5.0 MITIGATION STRATEGIES

The proposed project will impact approximately 47,195 sq. ft. of eelgrass and 26,830 square feet of intertidal habitat. In accordance with mitigation regulation 33 CFR Parts 325 and 332, USACE evaluated several alternative measures for mitigation, based on what is practicable and capable of compensating for the aquatic resource functions that will be lost as a result of the project. The alternatives considered are listed below.

5.1 Eelgrass Compensatory Mitigation Alternatives

5.1.1 On-Site, In-kind, Whole Plant Transplanting Mitigation

A practicable on-site, full scale whole plant transplanting, in-kind mitigation alternative was explored. USACE examined whole-plant eelgrass transplanting within the channel and side slopes of the proposed project following construction. However, this option was found to be unfavorable due to the projected maintenance dredging cycle of the project. Additionally, any eelgrass that does recolonize the FNP will be subject to frequent prop wash from the ferry that services the island, particularly in the turning basin, and will not likely survive as the maneuvering of large vessels such as a ferry within a channel and turning basin has a significant impact to the bottom as opposed to vessels transiting through a navigation channel. Assuming a 10 year maintenance cycle and four year development period for eelgrass to fully colonize the channel, planting would have to occur every ten years to provide about six years of benefits (10 year dredging interval minus 4 year recovery period). This alternative would require replanting every ten years and clearly would not be cost effective relative to other mitigation alternatives. USACE also looked into other potential areas for whole plant transplanting efforts in the vicinity of Great Chebeague Island; however, no viable locations were identified.

5.1.2 On-Site, In-kind, Low Impact Moorings

The majority of recreational boat moorings in New England are constructed of a large block or mushroom style weight that anchors the mooring and a heavy chain and line that adds additional weight and drag and secures a vessel to the mooring block while allowing the vessel to move in with changing tidal heights, winds, and current directions. In traditional moorings within eelgrass beds, the mooring block itself causes a loss of eelgrass due to its large surface area and can cause scour resulting from bottom shear stress. The chain, which is designed to drag on the substrate, often wears a circular pattern into the eelgrass bed as the boat swings 360 degrees around the mooring because of tides, winds, and currents. Low impact moorings can reduce eelgrass impacts by reducing the "scar" area produced by traditional moorings within eelgrass beds. Low impact moorings use an alternative anchoring mechanism (e.g., helical screw anchor) and a taut wire system (e.g., bungee or rubber) to replace the traditional mooring and chain system thereby reducing the areal impact of the block and eliminating the scars caused by the moving chain. The USACE investigated the current conditions in the project area and identified several anchorage areas surrounding Great Chebeague Island that could serve as candidate sites for replacing traditional moorings with low impact moorings.

The Town of Great Chebeague Island maintains a database of moorings in the waters surrounding the island. As of May 2020, 414 total moorings were present (Figure 5). According to the Great Chebeague Island Harbormaster, all of the moorings are traditional block and chain moorings. The GIS data layer of moorings was overlain on the most recent GIS layer of eelgrass resources in Casco Bay to determine how may moorings were located within eelgrass habitat (Figure I-6). A total of 216 moorings were located within eelgrass habitat. To calculate an estimate as to the amount of eelgrass habitat that could potentially be restored per mooring, USACE assumed that an average chain length of 8 feet would produce a scour circle of 201 square feet. Assuming 216 moorings and 201 square feet of eelgrass habitat restored per mooring, the USACE estimates that approximately 43,416 square feet of eelgrass could be restored with this alternative.

This alternative is considered possible; however, there are several factors that could hinder the practicability of its implementation. First and foremost is the fact that the moorings in the waters of Great Chebeague Island and the surrounding islands are entirely privately owned. As the Town currently has no requirements to use low impact moorings, the implementation of this alternative would require mooring owners to voluntarily replace and maintain moorings. The Town could conceivably require the replacement of all the moorings by the owners with low impact moorings upon re-permitting, however this would require the Town to pass a bylaw requiring the replacement. This process could take several years to implement and would not achieve the required mitigation within a reasonable timeframe that would account for the loss of eelgrass habitat from the proposed project. There are also substantial maintenance requirements that would have to be enforced to ensure permanent eelgrass restoration. This would require a substantial monitoring effort. For these reasons, this alternative is not practicable and was not carried through for further analysis.

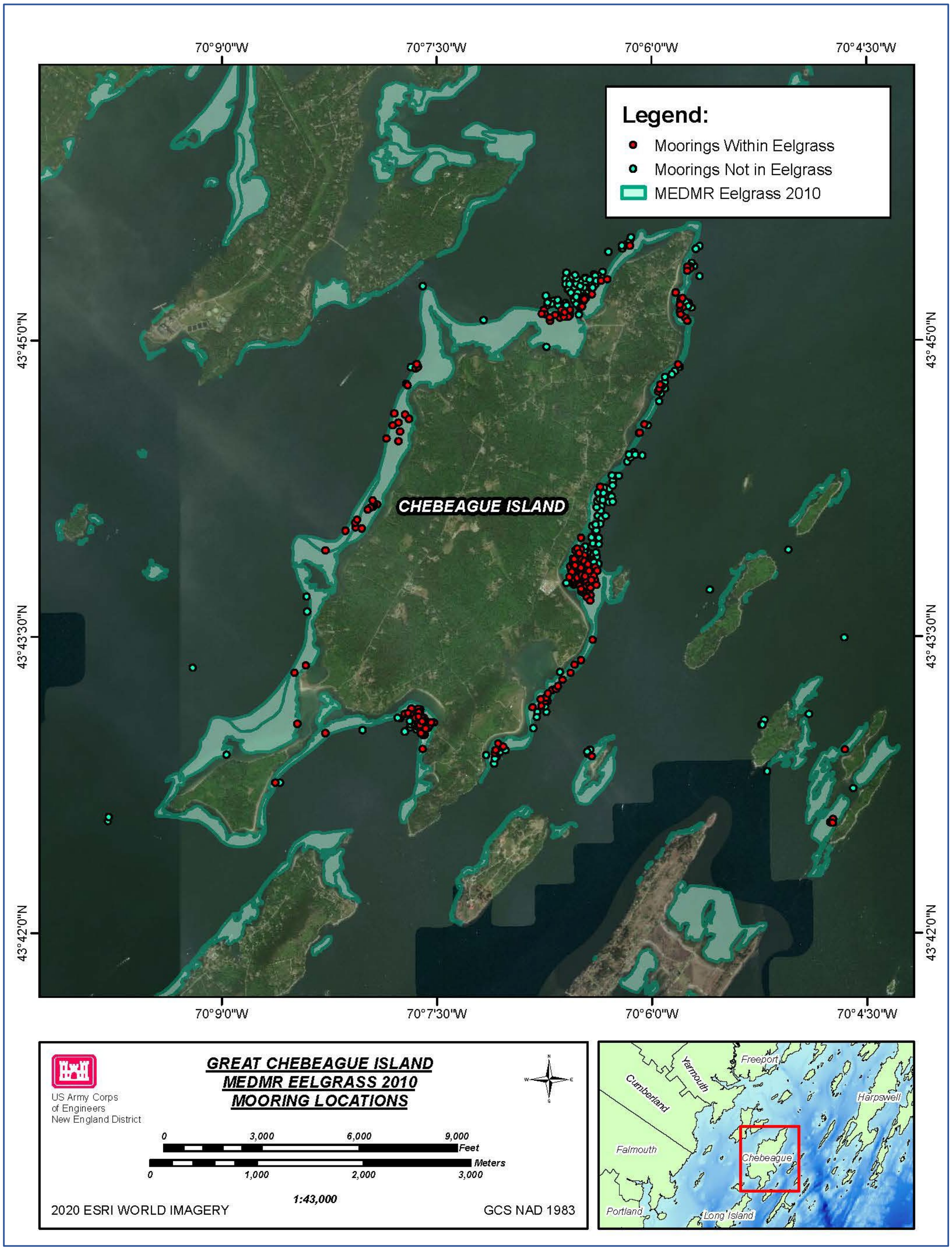

Figure I-6. Mooring locations surrounding Great Chebeague Island. Mooring noted with a red symbol are within mapped eelgrass beds. Moorings noted with a green symbol are not within mapped eelgrass beds.

5.1.3 Off-Site, In-kind, Whole Plant Transplanting

As noted in Section 5.1.1, attempts were made to find in-kind restoration alternatives adjacent to the project area. However, as evident in Figures 2 and 6, eelgrass is abundant along most of the Great Chebeague Island shoreline. As such, attempts were made to identify off-site restoration areas within Casco Bay and within the southern Maine geographic region.

Inquiries to the State of Maine's Department of Marine Resources, Department of Environmental Protection and Maine Coastal Program, the National Marine Fisheries Service, and the US Environmental Protection Agency were made in an attempt to find a site. Additionally, a study of eelgrass recovery and potential restoration opportunities in Great Bay estuary was reviewed (Burdick et al., 2019).

One site located in Kittery, Maine was identified as a potential in-kind off site mitigation alternative. The Fishing Island site, located in Pepperrell Cove on the Kittery, Maine side of Portsmouth Harbor, was a 15-acre eelgrass flat that was denuded of eelgrass in 2003 by overwintering Canada geese (Rivers and Short 2007). In their application of the preliminary transplant suitability index model (PTSI), an eelgrass restoration site selection model, to Great Bay (Figure I-7), Burdick et al. (2019) found and recommended the Fishing Island site as a priority site for eelgrass restoration. They noted that geese no longer visit the site, and with reestablishment of the bottom contours, eelgrass could be transplanted here.

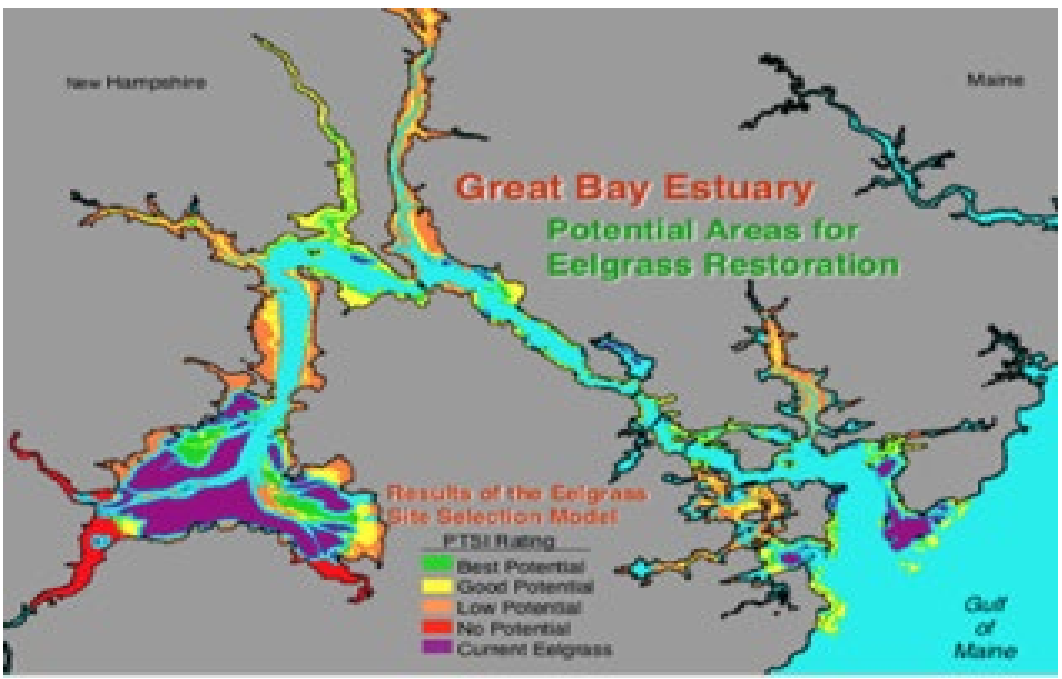

Figure I-7. Preliminary Transplant Suitability Index model for Great Bay Estuary (from Burdick et al., 2019).

Historic distribution of eelgrass resources in the vicinity of Fishing Island are shown in Figure I-8. Approximately 20 acres of habitat are available for restoration. This alternative is viable and practicable as mitigation for the impacts associated with the proposed project.

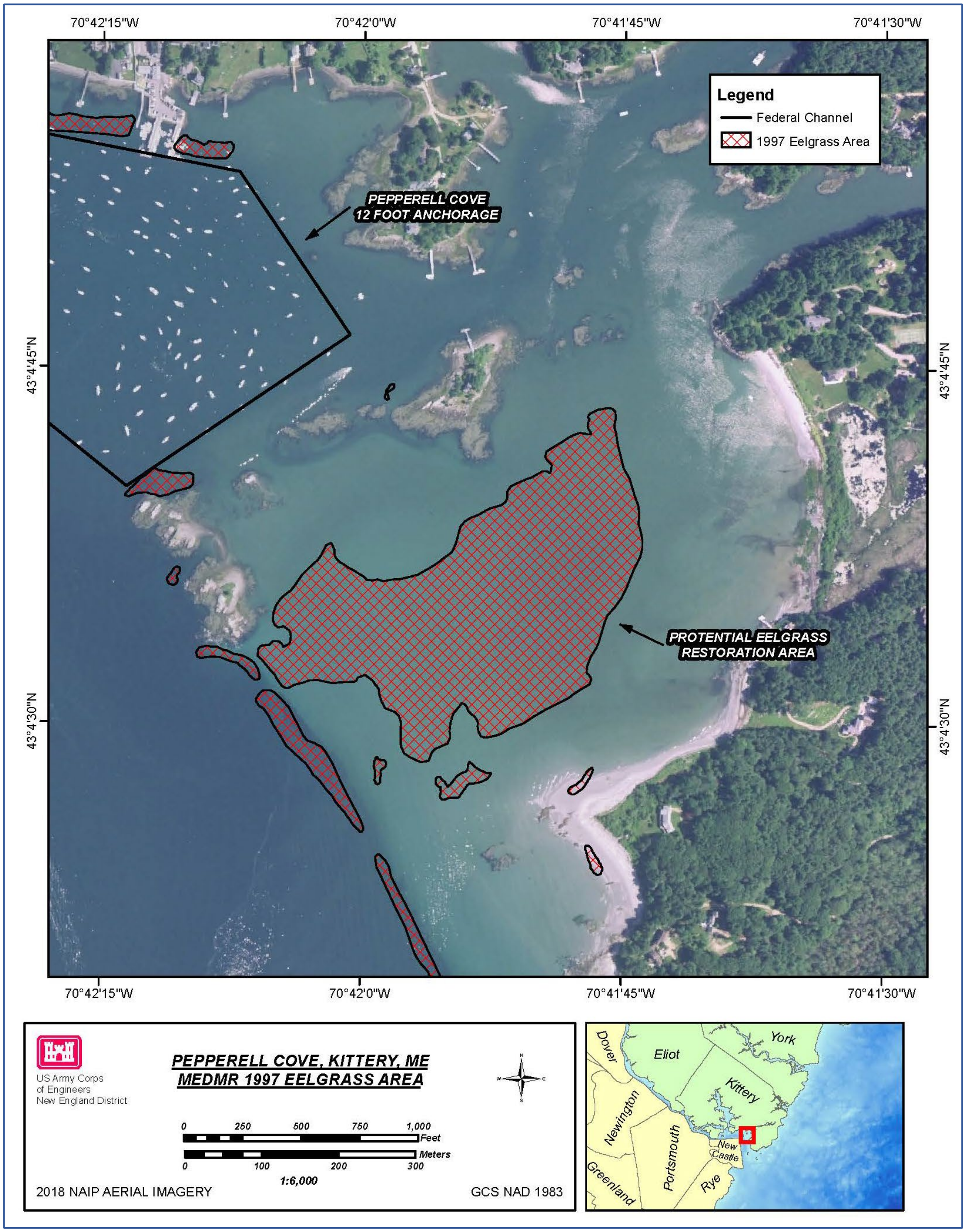

Figure I-8. Historic distribution of eelgrass in the vicinity of Fishing Island Kittery, Maine shown in hatched shading. Eelgrass restoration area proposed as mitigation indicated by arrow.

5.2 Intertidal Compensatory Mitigation Alternatives

5.2.1 On-Site, In-kind, Intertidal Creation Mitigation

Finding a practicable on-site, in-kind intertidal habitat mitigation alternative was explored. The USACE examined shallow subtidal areas surrounding Great Chebeague Island to determine if any sites would be candidates to receive dredged material to create intertidal habitat. However, no options were found favorable due to the extensive presence of eelgrass resources surrounding the island.

5.2.2 Off-Site, Out-of-kind, Eelgrass Mitigation

As no practicable on-site intertidal mitigation alternatives were available, we have chosen to include the square footage of impact to intertidal areas (26,830 square feet) as an addition to the proposed eelgrass mitigation effort described above in Section 5.1.2.

5.3 Out-of-kind Mitigation Alternatives

Mitigation guidance (33 CFR Parts 325 and 332) indicates a strong preference for in-kind mitigation, but allows for out-of-kind mitigation where there are no practicable in-kind mitigation options are available. USACE considered several out-of-kind mitigation alternatives for the proposed project. Alternatives included the Maine In Lieu Fee Program and several out of kind mitigation alternatives in the vicinity of the proposed project area such as land preservation and other ecosystem restoration projects. There are no in-kind In Lieu Fee mitigation options for eelgrass mitigation in Maine. As in-kind mitigation options are available for the eelgrass impacts, the out-of-kind alternatives were not fully developed for eelgrass compensation. However, as no practicable alternatives for intertidal mitigation were found, the mitigation for the intertidal impacts is being added to the mitigation effort for the eelgrass impacts. Applying the guidance in 33 CFR Parts 325 and 332, USACE considered whether it was appropriate to apply a mitigation ratio for the out of kind mitigation. Factors to consider in this case include the differences between the functions lost at the impact site and the functions to be produced by the compensatory mitigation project, and the distance between the affected aquatic resource and the compensation site. The quantity of out-of-kind mitigation would be based on a functional assessment of loses and gains between the two habitat types if a model existed to estimate the appropriate compensation and tradeoff. A model with that capability does not exist for intertidal mudflats and eelgrass. Vegetated shallows and intertidal mud flats are both Special Aquatic Sites under the Clean Water Act, Section 404(b)(1) guidelines. Given a relatively higher value of eelgrass compared to mud flat and the only application of ratios would be related to the difference in functions and distance from the impact site with a goal of achieving a negligible overall project impact, USACE proposes a 1.2:1 mitigation ratio.

6.0 PROPOSED MITIGATION

The USACE intends to use whole plant transplanting at the Fishing Island site (as described in Section 5.1.3) as mitigation for resources that will be impacted by the proposed project. A total of 76,857 square feet (1.7 acres) of eelgrass habitat will be created to mitigate for the 47,195 square feet of permanent eelgrass loss, 2,832 square feet of temporal eelgrass function loss, and 26,830 square feet of intertidal area that will be converted to subtidal habitat, and a 0.2 mitigation ratio for the out-of-kind mitigation (5,366 square feet). The estimated cost of the mitigation effort and subsequent monitoring efforts would be approximately $322,000 ($176,000 per acre) for the 76,857 square feet of eelgrass mitigation. A full cost-effectiveness/ incremental mitigation analysis is not necessary for this project because there is only one practicable mitigation alternative available. The range of mitigation alternatives to be considered would simply be increments of the same plan with a straight-line relationship for additional cost per area. The cost of $176,000 per acre for mitigation is considered reasonable. This proposal will provide full mitigation for impacts. Any changes to the area of mitigation would only change the cost in a direct linear relations ship.

7.0 MITIGATION IMPLEMENTATION

The following sections present the general implementation procedures for the proposed mitigation effort. A detailed harvesting/planting plan and monitoring plan will be developed during the engineering design phase of the effort.

7.1 Harvesting and Planting

Harvesting of Adult Plants

The adult plants to be used in the mitigation area will be harvested from a site upstream of the mitigation area in the Piscataqua River. The harvest site is within an eelgrass bed that will be disturbed by USACE's Portsmouth Harbor Navigation Improvement Project.

Adult eelgrass shoots will be collected by SCUBA divers and transported by boat to on-shore processing stations. Diver collection will insure that whole plants (leaves, roots, and rhizomes) will be collected and that damage to the uprooted plants will be minimal. The shoots will be bundled into groups of 50 for planting purposes. The plants will be held in totes filled with seawater which will be at ambient temperatures until transplanting. The time limitation between harvesting and planting will be no more than 72 hours.

Transplanting

Transplanting of the eelgrass in the mitigation area will be done by use of the TERFS™ method (Short et al. 1999). The TERFS™ method involves attaching 50 eelgrass shoots in pairs (i.e. 25 planting units) to a weighted rubber-coated wire frame with biodegradable paper twine. TERFS are prepared on shore and then placed on the seafloor by wading into the water and placing the TERFS in the sediment. The TERFS are placed on the bottom so the eelgrass roots are in contact with the sediment and the eelgrass leaf blades extend into the water column. Four bricks attached to the frame provide weight to press the eelgrass roots into the top centimeter of sediment. The bricks also ensure the TERFS will remain on the bottom where they are placed. The frame protects the fragile shoots from being uprooted by burrowing animals such as green crabs. The TERFS, with the eelgrass shoots attached, are left on the sediment surface at the transplanting site for 3-5 weeks, enough time for the plants to root into the sediment. The frames will be removed when the plants have rooted securely into the sediment.

7.2 Monitoring

Monitoring of the transplanted eelgrass will occur at the mitigation site immediately (within one month) following the initial planting effort. Subsequent monitoring at the mitigation site and reference site will be performed each summer for ten years following transplanting.

The mitigation site and a reference site (noted above) will be evaluated in the summer following planting to assess shoot count. This initial assessment is to document any initial loss of planted material and to obtain a baseline data set for the reference bed. Shoot count will be assessed in 100 randomly selected ¼ m^2 quadrats within the mitigation site. Random quadrats will be chosen by creating a GIS grid corresponding to the dimensions of the mitigation site. Monitoring personnel will count the number of live eelgrass shoots within each of the selected grids. Mean shoot counts will be compared to the initial planting shoot density to assess whether loss of plants has occurred. Shoot counts will also be assessed in 25 randomly selected ¼ m^2 quadrats within the reference site for comparative purposes. In addition to shoots counts, percent macroalgae cover, percent epiphyte coverage on eelgrass, and numbers and species of crabs present will be measured.

Shoot counts will be measured annually for ten years subsequent to the initial plantings. A total of 50, ¼ m_2 quadrats will be randomly selected each year for shoot count sampling in the mitigation area. Monitoring will occur in the late summer months. Each year, mean shoot count at the mitigation area will be compared to shoot counts at a reference bed in the harbor to evaluate success. Evaluations will be compared using the methodology described in Short et al. (2000). Biomass and canopy height will also be evaluated at the mitigation site and reference site. Sampling will occur using the "minimum impact sampling method" described by Evans and Short (2005) at 25 randomly selected locations in the mitigation site. The sampling locations will be chosen such that each originates from a different planting grid. At each of the sampling locations, shoot count will be measured in a ¼ m_2 quadrat. The minimum impact method involves selecting 10 shoots from each location for biomass measurements. The 10 selected shoots will be collected, dried at 60_o C for 48 hours and weighed to the nearest tenth of a gram. The mean weight of ten shoots at each location will be multiplied by the corresponding number of shoots to obtain a number representing biomass/m_2. The average biomass in the mitigation site will be represented by a mean of the biomass calculated for each of the 25 sampling locations. This will be used to evaluate success in relation to the average biomass at the reference location. The shoots collected for biomass will also be used to evaluate canopy height of the eelgrass using the methods described in Evans and Short (2005). Within each sample canopy height will be calculated as 80% of the maximum leaf/sheath lengths by excluding the two tallest leaves and averaging the remaining eight leaf/sheath lengths. The canopy height calculated for each of the 25 quadrats will be averaged and this value will be used to evaluate success in relationship to canopy height at the reference locations.

Biomass, canopy height, and shoot density of eelgrass will also be measured at a reference site to facilitate comparison of the characteristics of the restored area to a natural eel grass bed. Shoot density will be measured in 50 randomly selected plots and biomass and canopy height will be measured in 25 random locations. Sampling at the reference site will occur in accordance with the methods described above.

The dimensions of each planted grid will also be measured during each annual sampling event subsequent to the initial year of transplanting. These measurements will allow an assessment of whether or not the areas planted with eelgrass are increasing beyond the planted grids.

Success Criteria

The total number of surviving plots and failed plots will be monitored. To assess the relative success of the eelgrass mitigation area(s), biomass, canopy height, and shoot density of eelgrass at the mitigation site(s) will be compared to a reference site each year. The shoot count, biomass, and canopy height data will be analyzed in accordance with the methodologies described in Short et al. (2000). These methodologies involve development of a success criteria (SC) based on characteristics of a natural, reference eelgrass bed, and a success ratio (SR) based on a comparison of characteristics at a restored eelgrass bed and a reference eelgrass beds.

According to Short et al (2000), the success criterion is calculated as SC = 100((µref-SD ref) µref, where µref is the mean of the data collected at the reference site and SD ref is the standard deviation of the data collected at the reference site. The success ratio is calculated as SR = 100 (µref/µres), where µres is the mean of the data collected at the restored site and µref is the mean of the data collected at the reference site. If the SR for a given parameter is greater than or equal to the SC for that parameter, then the restoration is considered successful for that parameter. This methodology will be applied to each of the three parameters being evaluated. Annual progress toward the success goal for each parameter will be assessed using an incremental progress target of 50% of the goal by year one, 75% of the goal by year two, and 100% of the goal by year three. Thus, the effectiveness of the mitigation effort will be evaluated by assessing progress toward the final success target by the end of the monitoring program, without the need to reach the success criteria in one year.

Although the data will be quantitatively compared, the determination of whether the particular year's eelgrass survival and growth has been successful will also include a qualitative assessment, based on evident data trends. In addition, the dimensions of each planting grid will be graphically compared to the previous year (S) data to help assess whether there is a trend toward expansion of the mitigation area, which would indicate that the mitigation is on a trajectory toward success.

Adaptive Management

Adaptive management will be implemented if specific eelgrass restoration standards are not met or if actual conditions diverge sufficiently far from the intended conditions to threaten the achievement of overall project goals. The adaptive management program will consider the data generated from the monitoring of the site success criteria noted above. Further refinement of the adaptive management procedures will be completed by the USACE and its sponsors during the Pre-Construction Engineering and Design phase of the project.

8.0 REFERENCES

Burdick, D., K. Edwardson, T. Gregory, K. Matso, T. Mattera, C. Peter, F. Short, and D. Torio. 2019. Draft Whitepaper A Case for Restoration and Recovery of *Zostera marina* L. in the Great Bay Estuary. Convened and edited by Melissa Paly November 13, 2019. 22 pp.

Fonseca, M. S., W. J. Kenworthy, and G. W. Thayer. 1998. Guidelines for the conservation and restoration of seagrasses in the United States and adjacent waters. NOAA Coastal Ocean Program Decision Analysis Series No. 12 NOAA Coastal Ocean Office, Silver Springs, MD. 222 pp.

Maine DEP. 2020, In Lieu Fee Compensation Program Guidance. https://www.maine.gov/dep/land/nrpa/ILF_and_NRCP/ILF/fs-in-lieu-fee.pdf

Maine GIS. 2013. Maine eelgrass GIS data layer. https://www.maine.gov/geolib/catalog.html

Musson, Noel. The Musson Group 2015. Consideration for Moorings; a preliminary guide to mooring systems, mooring choices and mooring selection. Prepared for the Maine Coastal Program. Department of Agriculture, Conservation & Forestry, 93 State House Station, Augusta, Maine 04333.

Rivers, D., and F.T. Short. 2007. Effect of Grazing by Canada Geese Branta canadensis on an Intertidal Eelgrass Zostera marina Meadow. Marine Ecological Progress Series 333: 271-279.

Swan, B.M. 2012. Eelgrass and Moorings. Maine Department of Marine Resources. Marine Resources Laboratory, P.O. Box 8, 194 McKown Pt. Rd., W. Boothbay, Maine 04575-008

Short, f., B. S. Kopp, J. Gaeckle, and H. Tamaki. 1999. Seagrass Ecology and Estuarine Mitigation: A low-cost method for eelgrass restoration. https://doi.org/10.2331/fishsci.68.sup2_1759

Urban Harbors Institute, University of Massachusetts Boston, "Conservation Mooring Study" (2013). Urban Harbors Institute Publications. Paper 41. http://scholarworks.umb.edu/uhi_pubs/41

U.S. Army Corps of Engineers (USACE). 2020. Draft Environmental Assessment for Great Chebeague Island Navigation Improvement Project. US Army Corps of Engineers, Concord, MA.

USFWS. 1980. Habitat Evaluation Procedures (HEP) ESM 102. Division of Ecological Services, U.S. Fish and Wildlife Service, Department of Interior, Washington, D.C.