ANNUAL REPORT

June 1, 2015 – September 30, 2016

Date: October 31, 2016

Agreement No.: P1496011 00 Grant Term: March 1, 2020

Project Title: Initiation of Thin-Layer Sediment Augmentation on the Pacific Coast

Grantee: U.S. Fish and Wildlife Service, San Diego NWRC

FISCAL REPORT

Fund Source	Amount Awarded	Amount Invoiced as of September 30, 2016	Total Amount Remaining
CDFW GGRF Grant Funds	$1,055,827	$232,834	$822,993
Cost Share	$1,306,048	$1,381,545*	<$75,497>
Agreement Totals	$2,361,875	$1,614,379	$747,496

* See itemized cost share expenditures presented in Attachment 1.

PROGRAM/TECHNICAL REPORT

Project Overview

Initiation of thin-layer sediment augmentation on the Pacific Coast is proposed for a 10-acre area of marsh plain located within the Seal Beach National Wildlife Refuge (NWR) (Attachments 2 and 3). The ultimate goal of this thin-layer sediment augmentation project is to ensure the long-term availability of coastal salt marsh habitat for carbon sequestration, as well as for the conservation of listed and sensitive species that are dependent on coastal salt marsh habitat for their existence. The existing conditions at the Seal Beach NWR present a unique opportunity to proactively develop and refine a sea-level rise adaptation strategy that if successful can then be implemented elsewhere over the next few decades. At the end of the project, a thin-layer sediment augmentation guidance document that describes this “proof-of-concept” project, including a description of the procedures and techniques employed to achieve sediment depths and minimize movement of sediment offsite (including the effectiveness of all tested procedures and lessons learned) and a discussion of the biological and physical monitoring results, will be produced and disseminated to facilitate future thin-layer sediment augmentation projects along the California coast. Project goals and initial results are already being shared with Federal, State, and local agency staff, land managers, and researchers through project team participation in webinars, seminars, workshops, and conferences.

Summary of Activities Performed from June 1, 2015 to September 30, 2016

The project team accomplished several significant milestones between June 2015 and September 30, 2016, including monitoring the pre-project site conditions at both the control site and the 10-acre augmentation site; placing a thin-layer of sediment over approximately 7.9 acres of the 10-acre site; and initiating post-augmentation monitoring of physical and biological conditions at the control and project site.

June 1 – September 30, 2015. During the first quarter, contracts were executed, monitoring protocols were developed, bids for the sediment augmentation process were requested and received, and pre-augmentation monitoring was initiated. A summary of accomplishments is provided below, with additional details provided in the quarterly report for this period.

- Agreement Number P1496011 00 between CDFW and USFWS was fully executed on June 30, 2015. With the CDFW agreement executed, the USFWS in turn executed Cooperative Agreements with the Southwest Wetlands Interpretive Association (SWIA) and Orange County Parks.

- Protocols for carbon work and pre- and post-sediment augmentation monitoring were completed. SWIA prepared contracts with the appropriate subcontractors for various monitoring tasks including carbon-related analysis, pre- and post-sediment augmentation monitoring, and eelgrass surveys. Some of these contracts are funded with the CDFW grant, while others are funded using a grant from the California Coastal Conservancy.

- USFWS purchased a boat using funding provided through a USFWS Cooperative Recovery Initiative (CRI) grant. The boat facilitates easy access to the project site for staff and researchers responsible for monitoring site conditions prior to, during, and after sediment augmentation.

- Orange County Parks completed 100% construction drawings for dredging and sediment augmentation and issued a request for bids for the Sunset/Huntington Harbour Maintenance Dredging and Waterline Installation on August 25, 2015. Bids were opened on September 23, 2015. Three bids were received, with Curtin Maritime Corp. the apparent lowest, responsive, responsible bidder.

- A coordination meeting was held involving Naval Weapons Station Seal Beach, Orange County Parks, and USFWS to discuss the logistics of access on the project site during sediment augmentation.

- Final CEQA/NEPA compliance documents and copies of required permits and approvals were provided to CDFW.

- USGS installed 21 deep rod surface elevation tables (SETs) (15 SETs in the sediment augmentation area and 6 SETs in the control area) during August 2015. In addition, USGS continued to analyze the sediment budget within the Seal Beach NWR using USFWS funding. Autonomous equipment deployed at two channels within Seal Beach NWR is continuously measuring turbidity and sediment flux in adjacent and adjoining channels.

- Using Coastal Conservancy funding, CSULB completed plant cover and biomass estimates within 0.25 m^2 quadrats for each plant species within 24 randomly generated plots in the augmentation area and 15 randomly generated plots in the control area. Measurements of pore water salinity, redox potential, and temperature were also made within the randomly selected plots. In the augmentation and control areas, 39 cores were collected to assess infaunal invertebrate community structure. The diversity and abundance of macroinvertebrates at the sites was also recorded.

- Monitoring of light-footed Ridgway's rail nesting activity was conducted throughout the 2015 breeding season, and twice monthly shorebird surveys were conducted.

- Field cameras were purchased with USFWS station funds to provide time lapse photographic documentation of changing site conditions over the course of the project.

- Project coordination included research team conference calls, meetings with the Navy to facilitate access to the project site, and discussions with Orange County Parks related to the bid package for placement of sediment on the project site.

October 1 – December 31, 2015. During this quarter, considerable effort was put into documenting existing conditions at both the project site and the control site. Other activities included coordination between Refuge staff and researchers and coordination among Refuge staff, the Navy, the County of Orange, and the sediment augmentation contractor. A summary of accomplishments is provided below, with additional details provided in the quarterly report.

- USFWS hired a term biologist (Rick Nye) for the Seal Beach NWR to assist in project monitoring and management during and after sediment augmentation. The funds for this position come from the USFWS CRI grant.

- On October 27, 2015, the Orange County Board of Supervisors awarded a contract to Curtin Maritime, Corp. for the Sunset/Huntington Harbour Maintenance Dredging and Waterline Installation project (which included the beneficial use of clean sediment onto the Refuge's sediment augmentation site).

- Marine Taxonomic Services, Ltd. (MTS) performed preconstruction sonar and SCUBA surveys to map eelgrass in the vicinity of the augmentation and control sites. MTS also verified that no *Caulerpa* was present within the study area and reference areas.

- To analyze sediment flux in the area, USGS maintained and downloaded data from two YSI 6600 EDS multiparameter sondes and one Nortek acoustic Doppler current profiler (ADCP) located in the tidal channels adjacent to the project site.

- To monitoring marsh plain surface elevations, USGS took measurements at all 25 surface elevation tables (SETs) on the Refuge (control site and augmentation site) twice during the quarter to establish pre-augmentation conditions. At each reading, sediment coverage, the result of natural tidal processes, was also assessed at existing feldspar plots and marker horizon depth was measured at fully covered plots.

- The locations of the various monitoring plots are presented in Attachment 4.

- To study sediment compaction and determine sediment thickness after augmentation, UCLA installed 24 new feldspar plots within the sediment augmentation area, each marked with PVC stakes at each corner. These plots are generally co-located (established approximately 3 meters away) from CSULB's plant/invertebrate plots. Another 14 feldspar plots were installed at the control site. These plots were also marked with PVC stakes at each corner and co-located with CSULB's plots.

- To study the effects of augmentation on tidal creek geomorphology, UCLA established 8 creek cross-sections at the sediment augmentation site and 4 at the control site. Each cross-section was marked by a PVC stake on each creek bank approximately 3 meters from the bank, and was surveyed for the initial cross-section data.

- Gas samples were collected at the project site from dark flux chambers in November and December. Researchers from Chapman University analyzed CO_2 and CH_4 in gas samples from all sampling events. The majority of these samples were highly linear (r^2>0.90) suggesting that the chambers worked well. Pore water samples were collected from the augmentation site on 6 December, 2015 coincident with gas samples. These have been analyzed for salinity and frozen for future chemical analyses.

- Plant parameters (e.g., total cover, species richness, height) and abiotic data were collected by CSULB on a quadrat basis within both the augmentation and control sites during November and December 2015. Plant physiology data was also collected on augmentation plots in December.

- Sediment coring was completed by UCLA in the augmentation site and control site for the purpose of assessing the current net sediment accretion rates and carbon accumulation rate. These cores were then stored at UCLA to be split for analysis in the next quarter. CSULB assisted in the collection of deep sediment cores.

- Fall 2015 invertebrate cores were collected from the augmentation, control, and threshold sites by CSULB during several field days throughout December 2015. Stable isotope samples were also collected on the augmentation and control sites during several field days throughout December 2015. In addition, fish, crab, and sediment samples were collected for food web analysis.

- During November 2015, researchers took surface samples to characterize foraminfera and sediment conditions at various marsh elevations. A total of 20 surface samples were collected. High-resolution GPS data was collected on locations and elevations at the core collection sites. Pore water data was also collected at each site.

- Shorebird surveys continued during the October to December quarter. Monitoring of any light-footed Ridgway's rail activity on the augmentation site was conducted by USFWS.

- A new partner, the U.S. Army Corps of Engineers (USACOE) Research and Development Center, joined the team and provided funding and staffing for a pre-sediment augmentation RTK survey of the project site.

- Two field cameras were set up to capture changes at the augmentation site from pre-augmentation through the 5-year monitoring period.

- Noticing requirements, Navy approvals, and the holidays resulted in a delay in the start of the sediment augmentation process, as a result augmentation did not start during this quarter as had been anticipated. The contractor did however begin assembling the slurry pipeline.

- Monthly Sediment Augmentation Team conference calls ensured that all required research activities were being conducted as proposed.

January 1 – March 31, 2016. The majority of the work conducted during this quarter related to the sediment augmentation process. Weekly meetings involving the contractor, Orange County Parks staff, and Refuge staff were held throughout this quarter. A summary of accomplishments is provided below, with additional details provided in the quarterly report.

- The final dredge plan was submitted by the contractor to the USACOE for approval and a Sediment Placement Plan for the augmentation site was submitted to the Service and Orange County Parks.

- UCLA and the contractor installed grade stakes on a 10m x 10m grid with markings to depict the design height of the sediment following application.

- A sediment barrier, consisting of hay bales secured with wooden stakes, was installed around the perimeter of the augmentation site the first week in January. Rebar replaced wooden stakes after the first high tide displaced some of the hay bales.

- Scheduling delays associated with initiating the dredging project were apparent by early January. On January 15, 2016, the USFWS informed the USACOE, Santa Ana Regional Water Quality Control Board, California Coastal Conservancy, and NOAA of the potential need to extend the construction period into April. USACOE issued a revised Nationwide Permit verification letter on February 3, 2016.

- Initial sediment application on the site was conducted using an 8-inch dredge. The application process began the week of January 18, 2016 with the testing of sediment application nozzles within the designated test area. The first significant day of sediment application occurred on January 22, 2016.

- As augmentation moved forward, it became apparent that the ratio of silt to sand was much lower than anticipated by pre-project grain size analysis. The need for updated grain size analysis procedures when considering the use of dredge material for beneficial use was noted and will be addressed in the lessons learn document.

- As sediment slurry was applied to the site, scouring was observed under the hay bales, primarily in the vicinity of existing tidal channels. Straw waddles, sand bags, and geotextile fabric were used to minimize loss of sediment from the site. Reinforcement at these locations occurred throughout the application process. Where channels were not present, the hay bales provided a sufficient barrier.

- By the week of February 16, the contractor determined that more than the anticipated 13,500 CY of dredge material would be required to achieve 10 inches of sediment across the 10-acre site. Because of the fluid nature of the sediment slurry, which filled the site like water in a bathtub, applied sediment was deeper in the "ponds" and tidal creeks present within the site than on the slightly higher marsh plain.

- The 8-inch dredge experienced numerous breakdowns during the process, it was finally decided that a 12-inch dredge would be more efficient. When the dredge was replaced, additional nozzle testing was required.

- During the week of March 14, the three test plots were created with hay bales and the side walls were lined with geotextile sheets.

- By mid-March, it became clear that there would not be adequate sediment to cover the entire 10-acre site. As a result, the site boundaries were revised to eliminate portions of the site that did not include research plots.

- By March 31, application of sediment to the site was nearing completion.

- Photos and time lapse videos were taken throughout the application process, with some posted to the Refuge website.

- To minimize the potential for impacts to eelgrass beds located adjacent to the project site, Standard Operating Procedures for measuring and monitoring turbidity in adjacent tidal channels were prepared and followed. Measurements were routinely taken by Rick Nye, the Refuge's on-site monitor during sediment augmentation.

- During this quarter, USGS continued to analyze sediment flux and turbidity patterns in the tidal channel adjacent to the project site. The results of this analysis were provided in a written report on March 22, 2016.

- After developing and refining a gas chromatography method to analyze N_2O in samples collected from flux chambers in the field, it was determined that the net flux of N_2O was below detection limits at both the augmentation site and the control site for samples measured at the end of 2015.

- In response to concerns related to sediment grain size, the California Coastal Conservancy provided funding that enabled CSULB to conduct sediment grain size analysis of the material being applied to the site. Analysis results for the quarter indicated that the majority of the samples had between 85 – 95 percent sand with low silt and clay content (Attachment 5).

- All spring 2015 (pre-augmentation) invertebrate samples were sorted during this quarter and Dr. Whitcraft and her team were in the process of identifying the invertebrates to species.

- Five shorebird surveys were conducted.

- The project site was monitored for the presence of light-footed Ridgway's rails and adjacent waterways were monitored for the potential presence of sea turtles and marine mammals.

- Light-footed Ridgway's rails were observed on the project site on several occasions. Each time they were encouraged to move off the site prior to sediment application. The majority of the birds on the site were seabirds and shorebirds. An air horn was used to move these birds off the site prior to spreading sediment. However, once the spray of sediment was initiated, the birds returned to forage on invertebrates that had been carried to the site in the slurry. No birds were adversely affected.

April 1 – June 30, 2016. During this quarter, the sediment augmentation process was completed and initial post augmentation monitoring activities were initiated. A summary of accomplishments is provided below, with additional details provided in the quarterly report.

- The final day of the sediment application process was April 4, 2016.

- Turbidity levels in adjacent tidal channels were monitored throughout the augmentation process.

- The site was monitored during sediment application to ensure that no rails or other birds were impacted, and adjacent waterways were monitored for the potential presence of sea turtles and marine mammals. No adverse effects were observed.

- On the final day of sediment application, the contractor inadvertently allowed an excessive amount of sediment to accumulate in the southern portion of the site. This resulted in the placement of up to 20" of sediment over a portion of the site.

- A considerable amount of plastics and other marine debris were present at the final dredge site, resulting in the accumulation of debris on the augmentation surface. Between April 5 and April 8, the contractor removed a substantial amount of these plastics and other debris from the site. Clean up and demobilization was deemed complete on April 8, 2016.

- On April 7, USFWS staff measured the depth of the sediment applied to the site using the marked poles installed prior to augmentation to understand how the final sediment depths on the site met the initial specification of 10" of applied sediment $\pm$1". The sediment height throughout the site was closer to 10" $\pm$2".

- At completion, sediment was applied over approximately 7.87 acres of the 10-acre project site.

- On April 12, 2016, MTS performed the first of two SCUBA and side-scan sonar post-augmentation surveys of the eelgrass beds adjacent to the study area and within the reference area. The second set of surveys was conducted on May 6, 2016. The results of the sonar mapping showed minor declines in overall eelgrass cover within both the study and reference areas. Visual inspection of the sonar data showed one localized region near the augmentation site where eelgrass cover was absent relative to the pre-construction survey. The details of the survey results are provided in the survey report. A final report was provided on May 31, 2016, and a letter summarizing the results of the survey, along with a copy of the final survey report, was provided to NOAA on June 2, 2016. Adam Obaza from NOAA acknowledged receipt of the information on June 6, 2016.

Based on the results of the MTS post-augmentation eelgrass survey, we determined that it would be appropriate to conduct an elevation survey of the suspected eelgrass impact area, as well as a survey of a 200-foot band around the project site. This survey would provide a clearer understanding of the how the sub-tidal elevations may have changed around the perimeter of the site. This information was also considered important in our effort to fully address the lessons learned from the augmentation process. To conduct this survey, we requested that CDFW grant funds be reallocated from one subcategory to another to cover the cost for this work. The reallocation of funds was approved by CDFW on June 10, 2016.

- On April 13, 2016, Curtin Maritime Corp., Orange County Parks, Kim Garvey from Moffatt and Nichol, and Refuge staff met to discuss the lessons learned from the augmentation process. Later in 2016, Refuge staff will prepare a “lessons learned” document related to the sediment application process that will be made available to interested agencies and land managers.

- It was determined that aerial photography and photogrammetric mapping services would provide the best results for documenting the elevations of the site post augmentation. On April 18, 2016, with funding from the California Coastal Conservancy, GPSi conducted a photogrammetric surveying of the augmentation and control site (Attachment 6).

- Monitoring for light-footed Ridgway’s rail in the project vicinity included checks of rail rafts 117, 118, and 119. No activity was noted at Rafts 118 and 119, but at Raft 117 a nest with what appeared to be an incubating adult was observed. Researchers were instructed to avoid any activity in the vicinity of Raft 117.

- With a few exceptions, post-augmentation research began on June 1, 2016.

July 1 – September 30, 2016. During this quarter, post-augmentation monitoring continued and where data was available, the results of initial pre- and post-augmentation monitoring have been compiled into annual reports by various researchers. Post-augmentation monitoring was somewhat limited by the extent of unconsolidated sediment on the site and the current lack of vegetation in the augmentation site. Monitoring activities for this period are described below. This discussion serves as the quarterly report for the period July 1 – September 30, 2016.

- Monitoring to collect data related to abiotic factors (e.g., temperature, porewater salinity, redox), plant parameters, and invertebrate parameters was conducted on the control site, while monitoring on the augmentation site was limited to abiotic factors and invertebrate parameters, as no vegetation was present on the site during this monitoring period.

- Colonization trays have been set out on the site to study invertebrate succession and re-colonization. The intent is to assess whether sediment type (sand versus silt and clay) and elevation (control area versus augmented site) have an effect on the invertebrates that recolonize the dredged sediment at the Seal Beach NWR.

- Analysis of below-ground biomass in the long cores taken by UCLA was completed during this quarter.

- UCLA consulted with various researchers to determine the most effective method for obtaining core samples within the feldspar plots. The ability to collect solid cores using a narrow corer was impacted due to the percentage of sand in the applied sediment. The decision was made to use a Russian corer for sampling sediment in the feldspar plots.

- Post-augmentation sampling events to measure greenhouse gas fluxes were conducted by Chapman University at both the control site and the augmentation site.

- UCLA continues to process long cores from the site for Loss-on-Ignition (LOI) and magnetic susceptibility before selecting horizons for dating. Completion of this work has been delayed due to high demands for the USC dating facility. To address this issue, another lab has been identified that can run the 137Cs dates. Project completion, including the final report, is now expected by March 2017.

- USGS has drafted a report describing the results of the pre and post elevation surveys conducting for the project, as well as assessing the elevation change at the control site and the augmentation site. This report is currently in review and will be provided with the next quarterly report.

- USGS continues to collect data related to sediment flux.

- Based on the results of the post-augmentation eelgrass survey that indicated changes to the presence of eelgrass in the vicinity of the augmentation site, MTS was contracted to conduct a bathymetry survey of the subtidal areas around the project site. The survey was performed on July 1, 2016, with a 210 kHz, survey-grade echosounder. Data were collected by navigating a series of tracklines across the survey area. The depth data were combined with the previously collected eelgrass data to determine the proportionate distribution of eelgrass within each of the depth classes present within the survey area. With this information, we hope to better understand where and to what extent elevations surrounding the project site may have changed as a result of sediment augmentation, and how the current elevations could influence the recovery and spread of eelgrass in the project vicinity. A final report with the findings of this survey is nearing completion.

Project Coordination

- Conference calls are conducted six to eight times per year to keep connected with the project team, including funders and researchers. Additional coordination occurs as needed.

- Researchers provide quarterly updates to Refuge staff describing activities completed and preliminary results during the period.

- Check in procedures have been developed to ensure researcher safety while out at the project site.

Project Outreach/Information Dissemination

A webpage (https://www.fws.gov/refuge/seal_beach/what_we_do/ resource_ management/ Sediment_Pilot_Project.html) for the project is maintained on the Seal Beach NWR website. Information about the sediment augmentation project is posted and progress on the project is updated as necessary.

Quarterly reports prepared for CDFW are also posted, and photos and links to time lapse photography are provided. The page also acknowledges our funding partners.

Many members of the project team have participated in presentations, seminars, conferences, and webinars. A number of these public outreach efforts are listed below.

- Kirk Gilligan, Refuge Manager for the Seal Beach NWR, gave a presentation about the project at the San Diego Management and Monitoring Program's symposium on Climate-Smart Conservation Case Studies in the Southern California Coast held on September 23, 2015.

- Several team members, including Kirk Gilligan, Vicki Touchstone, and Evyan (Borgnis) Sloane participated in a conference call on October 30, 2015 with others across the State interested or involved in thin-layer sediment augmentation.

- Kirk Gilligan gave a presentation to about 30 people at the 2015 Climate Summit, held on November 2 and 3, 2015, in Sacramento, California. The focus of the summit was "Bridging the gap—from science to management action in climate adaptation."

- At the Coastal and Estuarine Research Federation 2015 Conference, held in Portland, Oregon on 8-12 November 2015, our Coastal Conservancy partner Evyan (Borgnis) Sloane presented a poster about the sediment augmentation project.

- Karen Thorne (USGS) gave a talk at the American Geophysical Union (AGU) meeting in December 2015 in San Francisco regarding the benefit of researchers working with managers and used our project as a positive example.

- Kirk gave a project presentation on March 3, 2016 in San Francisco at the USACE office. The presentation/webinar was attended or watched by a wide range of interests, from consultants and land managers, to regulatory staff, and interested members of the public.

- Kirk presented the project to the Carlsbad Ecological Services office of the USFWS on April 4, 2016.

- Dr. Rich Ambrose, UCLA, present a talk on the sediment augmentation project, titled "Managing sea level rise in coastal wetlands: testing thin layer sediment augmentation as an adaptation strategy" at the US-Iran Wetland Symposium in Irvine, CA, sponsored by the National Academy of Sciences.

- Dr. Jason Keller, Chapman University, also gave a presentation about the project at the US-Iran Symposium on Wetlands.

- Dr. Keller also addressed the project at a public lecture on blue carbon at the Aquarium of the Pacific in Long Beach, CA.

- Dr. Christine Whitcraft and Kaelin McAtee, M.S. student and researcher on the project, from CSU Long Beach each presented a poster using data from the project at the California Estuarine Research Society Forum held April 29-30th 2016 at California State University, Long Beach.

- Evyan (Borgnis) Sloane presented the project goals and objectives at a poster session on May 17, 2016 at the 4th Ocean Climate Summit: Resilience through Climate-Smart Conservation held in San Francisco.

- In June, 2016, Kim Garvey, Moffatt & Nichol, and Susan Brodeur, Orange County Parks, gave a presentation in New Orleans at the Ports'16 Conference about the Huntington Harbour dredging project and associated re-use benefits of our thin-layer sediment augmentation project.

- Kirk Gilligan and Rick Nye participated in a three part webinar "Coastal Salt Marsh Response to Sea Level Rise" hosted by the USACOE on July 28, Aug. 18, and Sept. 20. The webinar content is available at http://cw-environment.usace.army.mil/ exchange.cfm?Option= ArchiveSchedule &CoP=Env. The Sep. 20 webinar had 61 participants (32 repeats) representing 31 entities.

Status of Ongoing Research

UCLA (SEDIMENT CORING): Researchers at UCLA under the direction of Dr. Glen MacDonald are assessing the pre-augmentation net sediment accretion rates and average carbon accumulation rate (CAR) at Seal Beach NWR and evaluating the long-term storage and temporal scale of carbon storage. To date, all cores have been collected, cataloged, and described. Cores are varying depths were taken from both the control site and the augmentation site. In addition, samples were taken in another location within the marsh to study foraminifera transfer function. The location and depth of each core sample is presented in Table 1.

Table 1
Cores Taken, GPS Locations in Decimal Degrees, and Depths

	Core #	Site Location	Latitude (dd)	Longitude (dd)	Depth (cm)
1	SB15-06	Control	33.73495	-118.0837	100
2	SB15-07	Control	33.73535	-118.0827333	200
3	SB15-08	Control	33.73475	-118.0831333	100
4	SB15-09	Control	33.7359167	-118.0822667	200
5	SB15-10	Control	33.7355667	-118.0824	200
6	SB15-11	Control	33.7351833	-118.0826667	181
7	SB15-12	Augmentation	33.73684	-118.07822	100*
8	SB15-13	Augmentation	33.73707	-118.07771	100*
9	SB15-14	Augmentation	33.73672	-118.0776	100*
10	SB15-15	Augmentation	33.73621	-118.07757	100*
11	SB15-16	Augmentation	33.73655	-118.07844	100*
12	SB15-17	Augmentation	33.73607	-118.07807	100*
13	SB15-18	Augmentation	33.73624	-118.0787	100*
14	SB15-19	Augmentation	33.7359	-118.0785833	100*
15	SB15-20	Augmentation	33.73545	-118.0785333	238
16	SB15-21	Augmentation	33.7356	-118.07954	210
17	SB15-22	Augmentation	33.73623	-118.0796	100
18	SB15-23	Augmentation	33.73609	-118.07856	100

To date, magnetic susceptibility analysis has been conducted to 100 cm depth on all cores. The cores were halved with one half stored for analysis at UCLA facilities and the other sent to CSULB for below ground biomass analysis. The below biomass analysis has been completed and the results are currently being documented.

Radiocarbon (^{14}C) dating was conducted at the UC Irvine Keck Radiocarbon Lab. A total of 11 samples were dated, including 9 plant microfossils and 2 marine shells from a single hash layer. Macrofossils from between 9 and 171 cm in depth returned calibrated dates from 713 and 1502 years before present (BP). The result is in a robust age-depth relationship for all dates obtained. Table 2 provides age-depth data for all of the samples. An average of long term accretion rates from ^{14}C dates at Seal Beach NWR is 1.19 $\pm$ 0.03 mm yr^{-1}.

Table 2
Calibrated ^{14}C Results

UCIAMS #	Core	Depth (cm)	Sample Type	Age (YBP)	±
168426	SB15-09	110	shell - Unkn. clam	931	27
168427	SB15-10	171	shell - Unkn. snail	1329	27
168441	SB15-11	110	plant- *Sarcocornia*	956	25
168442	SB15-14	104	plant - *Spartina*	876	31
168443	SB15-14	107	plant - *Sarcocornia*	943	17
168444	SB15-16	91	plant - *Sarcocornia*	875	35
168445	SB15-18	97	plant - *Spartina*/mixed	713	25
168446	SB15-19	102	plant - mixed	957	25
168447	SB15-20	166	plant - *Sarcocornia*	1502	126
168448	SB15-23	169	plant - *Sarcocornia*	1259	33
168449	SB15-23	169	plant - *Sarcocornia*	1308	30

Horizon dates have not yet been completed in part because of the time it has taken to preprocess the cores for LOI and magnetic susceptibility, as well as the back-up at the USC dating facility where the upper 137Cs dates can be obtained. Another lab has been identified to run the 137Cs dates that will allow the process to proceed more expeditiously.

CHAPMAN UNIVERSITY (GREENHOUSE GAS FLUX): Sampling to measure seasonal emissions of CO_2, CH_4, and N_2O and associated abiotic parameters (i.e., water level, porewater salinity, sulfate and nitrate) in the three dominant plant communities at Seal Beach NWR, including the project site pre- and post- augmentation, is being conducted by Dr. Jason Keller. Sampling periods include prior to sediment augmentation and in Years 1, 2 and 3 following augmentation. The objective is to compare greenhouse gas fluxes from the sediment augmentation project at Seal Beach NWR pre- and post-augmentation and greenhouse gas fluxes post-augmentation to a natural salt marsh within the Refuge (the control site).

Sampling to measure greenhouse gas fluxes was conducted at the control site and augmentation site prior to augmentation, and post-augmentation sampling events were conducted in Spring 2016 at both the control site and the augmentation site. Additional measurements are needed before any final conclusions can be made.

UCLA (CHANGES IN MARSH PLAIN POST-AUGMENTATION): Under the direction of Dr. Richard Ambrose, researches will measure thickness and bulk density of added sediment in the augmented area over time. Additionally, the morphology of existing tidal creeks will be assessed to determine whether sediment augmentation alters their characteristics, and if so, how this varies over time.

Sediment thickness will be sampled at multiple locations distributed across the project area. These locations have been coordinated with other sampling aspects, particularly the invertebrate and vegetation sampling, to provide the most integrated view of the ecosystem response to sediment augmentation. Two types of sampling stations have been established on the marsh plain: (1) consolidated stations including feldspar plots, sediment stakes and bulk density sampling locations, and (2) sediment stake stations.

Changes in tidal creek morphology will be assessed using two methods: (1) aerial photography, and (2) creek cross-section surveys. Aerial photography includes the entire sediment augmentation site and control site, so there are no specific sampling locations. Tidal creek cross-sections were taken prior to sediment augmentation at representative creeks in the sediment augmentation area and the control area.

Following the completion of augmentation, researchers began measuring the thickness of added sediment in the augmented area and will continue to do this for five years in an effort to better understand the effectiveness of sediment augmentation as an adaptation measure in addressing sea level rise. Changes in bulk density of the added sediment will also be measured, and the morphology of tidal creeks within the augmentation site will be assessed to determine whether sediment augmentation alters their characteristics, and if so, how this varies over time.

Since the completion of sediment augmentation on April 4, 2016, 24 new feldspar plots have been established in the augmentation area adjacent to the original plots that are now buried by the sediment. The plots will allow researchers to quantify any sediment accretion on the site following augmentation. In addition, 14 feldspar plots in the control area were measured for thickness of sediment over the feldspar layer that was applied prior to augmentation.

A total of 23 bulk density samples were collected in the sediment augmentation area next to each feldspar plot. Two new PCV stakes were added to delineate the area for taking bulk density measurements to ensure that the sample area is not disturbed. The distance from the top of the stakes of the old feldspar plot to the sediment surface was measured.

Tidal creek cross-sections were surveyed, 4 in the control site and 8 in the sediment augmentation site. The distance from the top of the stakes to sediment surface was measured. Sediment stakes inside the sediment augmentation site were measured from the top of the stake to the sediment surface, and all feldspar and sediment stakes were permanently labeled using an engraving tool and sharpie. Sediment thickness, bulk density measurements, and tidal creek measurements will be taken at 2, 6, 12, 24, 36, 48, and 60 months after sediment addition.

The feldspar plots will be sampled by removing a small portion of the sediment above the feldspar marker horizon and measuring the distance from the top of the feldspar layer to the top of the sediment core. Originally, a liquid nitrogen corer was to be used for sampling the feldspar plots, but due to the amount of sand in the sediment, this sampling method will not result in the extraction of solid cores. Instead, a Russian corer will be used to extract the plugs of sediment for measurement.

CSU LONG BEACH (PLANT AND INVERTEBRATE STUDIES): To evaluate the health and function of the augmentation site prior to and for five year following augmentation, Dr. Christine Whitcraft (CSULB) and her students are monitoring the diversity, abundance, and distribution of the plant and invertebrate communities and associated abiotic parameters (temperature, porewater salinity, redox) of the control and augmentation sites both pre- and post-augmentation. Plant community sampling locations are co-located with the invertebrate sampling locations, and these locations were selected in collaboration with USGS and UCLA so that the sampling locations overlap with placement of sediment monitoring stakes.

These researchers will also assess the ability of plants and sediment to store carbon by collecting data on the photosynthetic rate of plants, C:N ratios of plants, plant traits (e.g. leaf area) and isotope ratios in sediment.

Pre-augmentation sampling and the first spring sampling post-augmentation have been completed. Sampling will continue twice annually for five years post augmentation. The LiCor, used to collect photosynthetic measurements, has been calibrated and will be used once vegetation is present on the augmentation site.

Funding from the California Coastal Conservancy was also provided to conduct sediment grain size analysis for the dredge material that was applied to the site. Based on this work, it was established that the sediment dredged from the adjacent waterway contained substantially more sands than the initial sediment characterization report had indicated.

Laboratory analysis involving invertebrate sorting is ongoing. All pre-augmentation spring invertebrate samples (top 2 cm) have been sorted and the process of identifying the invertebrates to species is underway. Spring 2015 (pre-augmentation) samples indicate that the invertebrate community is largely made up of oligochaetes, specifically Tubificidae and Enchytraeidea. Insect and insect larvae, mainly Dolichopodidae and Ceratopigonidae, amphipods and polychaetes are also found at all sample sites. Pond-dominated habitats tend to have the lowest overall abundance of invertebrates, except for experiment pond 1T, which has an unusually large number of oligochaetes. Species richness was highest in Batis-dominated habitats and lowest in pond-dominated habitats.

The “Annual Report: Thin-Layer Sediment Application Pilot Project at Seal Beach National Wildlife Refuge, *Abiotic Parameters, Plant and Invertebrate Communities* 2016” compares the monitoring results in Spring 2015 (pre-augmentation) with initial results from monitoring conducted in Spring 2016 (post-augmentation) for abiotic factors (e.g., temperature, porewater salinity, redox), plant parameters, and invertebrate parameters. The results indicate few changes in abiotic factors, plant parameters, and invertebrate parameters in the control site from pre-augmentation to post-augmentation. As was expected, there was a significant decrease in the percent cover, abundance, and species richness of plants in the project site post-augmentation as compared to pre-augmentation due to the placement of sediment across the site. Plant recruitment or rhizomatous extension from the edges is expected in Fall 2016. There was also a significant decrease in abundance and species richness of invertebrates in the project site post-augmentation as compared to pre-augmentation.

USGS (SEDIMENT FLUX PATTERNS AND SETS): USGS maintains two YSI EXO2 multi-parameter sondes (ysi) to monitor turbidity and a Nortek aquadopp current profiler (ADCP) to monitor inundation and flow velocities within tidal channels located in proximity to the augmentation site. Data is periodically upload to calculate sediment fluxes using Matlab 2014a. In addition, USGS installed and obtains data from 21 deep rod surface elevation tables (SETs) (15 SETs in the sediment

augmentation area and 6 SETs in the control area). The data from this monitoring equipment is used to: 1) detect changes in turbidity in the eelgrass bed adjacent to the project site due to effects of construction and sediment application, 2) detect changes in turbidity and sediment fluxes at the deep channel site due to effects of construction and sediment application, and 3) assess changes in elevation, including accretion and shallow subsidence, before, during, and immediately after construction at the sediment augmentation site. Results related to elevation changes at the augmentation site are compared with results at a control site.

An annual report, "Annual Report: Thin-Layer Sediment Application Pilot Project at Seal Beach National Wildlife Refuge, *Sediment flux and turbidity patterns, Surface Elevation Table (SET) monitoring,* August 17, 2016," is nearing completion that will present the results of this monitoring from pre-augmentation to several months post augmentation. During the monitoring period, augmentation activities such as, sediment spraying, construction activities, and boat traffic did not show any long-term effects on sediment fluxes measured near the mouth of Seal Beach wetlands in the deep channel. However, elevated suspended sediment concentrations (SSC) were measured in the eelgrass monitoring site. Sediment flux calculations showed that net export of suspended sediment occurred throughout the sampling time at the deep water site. Sediment budget was consistent across deployment periods. In the deep channel site, time-series of water level, depth-averaged water speed, SSC, and flux per unit area of the creek cross-section were calculated for six months between November 11, 2014 and April 16, 2016. Interestingly, the mean SSC increased, sediment export decreased, and the SSC during flood tides was greater than SSC during ebb tides. The small decrease in sediment export was potentially caused by weather events on March 6-7, 2016, which contributed to sediment import.

Across all monitoring periods and sensors, mean turbidity was greatest in the eelgrass site during the March 4 - April 16, 2016 monitoring period. Since overall SSC remained low in the deep channel sensor, increases in turbidity in the eelgrass site are presumably related to sediment from the marsh surface flowing out of creeks through openings in the geotextile fabric, sandbag, and hay bale barriers used to dam the mouth of creeks. Elevation change and accretion rates measured by SETs varied within and between the augmentation and control study site during the monitoring period. Average elevation change for the augmentation study area between pre and post augmentation was +23.4 cm (9.21 inches) with a Range of 18.34-32.04 cm (7.22 – 12.61 inches) at the SET sampling locations.

Bird Surveys and Light-footed Ridgway's Rail Monitoring: Bird surveys to assess species diversity and abundance on the augmentation site are ongoing. These surveys are conducted twice monthly, generally during a high tide and a low tide. Prior to augmentation, species diversity on the project site never exceeded seven species and total abundance ranged from 0 birds to 53 birds (with a total of seven species identified). In the months following augmentation, species diversity remained low; generally one to two species were observed. On July 1, a total of five species were observed on the site. Of the species observed on the site, black-bellied plovers were observed in the highest numbers, with 55 observed on August 24 and 60 observed on August 26.

Rail monitoring is conducted as part of a refuge-wide rail monitoring survey. Annual monitoring reports are prepared following the end of the rail nesting season. A high tide count is conducted prior to nesting and again after the nesting season in fall or early winter. Nesting data is obtained through monthly visits to the nesting rafts.

Additional avian visits to the site were noted by the biological monitor. Gulls and a variety of shorebirds came to forage on invertebrates transported from the dredge site and sprayed onto the augmentation site. Following the completion of the augmentation process, western snowy plovers were observed roosting and foraging on the site on multiple occasions. One least tern nest was established on the area where excessive sediment was applied to the site; however the nest was lost during a high tide. Adult and fledgling least terns were often observed roosting on the site during the summer breeding season.

Percentage of Task Completed as of September 30, 2016

Task 1 – Project Management and Administration		20%
Task 2 – Sediment Augmentation		100%
Task 3 – Project Monitoring (overall)		29**%**
1) Carbon Storage/Sequestration Benefits	55%	
2) Plant and Invertebrate Monitoring	10%	
3) Pacific Cordgrass Analysis	10%	
4) Site Elevations	25%	
5) Sediment Analysis (compaction, movement, bulk density)	25%	
6) Turbidity Levels	35%	
7) Bird monitoring	22%	
8) Eelgrass	50%	
Task 4 – Engineering Design/Environmental Documentation (overall)		100%
1) Engineering Plans for Sediment Augmentation Site		100%
2) Environmental Documentation*		100%
*CEQA/NEPA has been completed by SCC/USFWS		
Task 5 – Public Participation/Presentations (overall)		45%
1) Oral/Poster Presentations	65%	
2) Workshops and/or Webinars	25%	
Overall Project		**70.6%**

Deliverables Completed for Each Task

Task 1 – Project Management and Administration

1) Quarterly Progress Report	5 reports (This annual report also serves as the July 1 – September 30, 2016 quarterly report.)
2) Monthly Invoices	11monthly invoice
3) Subcontractor Selection	Orange County Parks & SWIA selected
4) Data Management	preliminary data for monitoring locations
5) Acknowledgement of Credit	ongoing

Task 2 – Sediment Augmentation

1)	Sediment Application	completed
2)	Adaptive Management	on going
3)	Reporting Results/Lessons Learned	in process

Task 3 – Project Monitoring

1)	Carbon Storage/Sequestration Benefits	pre-augmentation site monitoring completed/core data processing underway
2)	Plant and Invertebrate Monitoring	pre-augmentation work completed/post augmentation work underway
3)	Pacific Cordgrass Analysis	pre-augmentation work completed
4)	Site Elevations	pre-augmentation RTK survey; post-augmentation photogrammetry; SET data downloads; monitoring of feldspar plots underway
5)	Sediment Analysis	initial core samples retrieved/data processing nearing completion; grain size analysis of new sediment in progress; more coring planned
6)	Turbidity Levels	monitoring ongoing; annual report completed
7)	Bird Monitoring	pre-augmentation work completed/post augmentation work underway
8)	Eelgrass	pre-augmentation and post- augmentation surveys completed

Task 4 – Engineering Design/Environmental Documentation

1)	Engineering Plans for Augmentation Site	100% engineering plans completed
2)	Environmental Documentation* *for USFWS and Coastal Conservancy	CEQA/NEPA documents final; ND recorded

Task 5 – Public Participation/Presentations

1)	Oral/Poster Presentations	Presentations ongoing
2)	Workshops and/or Webinars	Participated in USACOE webinar

Problems/Delays Proposed Resolution

Sediment Augmentation - We were not able to fully achieve our sediment augmentation site acreage or uniform coverage objectives; however, this is not expected to impact our overall objective of demonstrating that thin-layer sediment augmentation is a useful tool in addressing impacts to low marsh habitat due to subsidence and sea level rise. In addition, the documentation of these results will assist in the design of future thin-layer sediment augmentation projects. Unexpected outcomes of the sediment augmentation process included: 1) achieving sediment coverage over at total of 7.87 acres rather than 10 acres as originally proposed; 2) achieving a less uniform coverage of sediment than anticipated (overall coverage was closer to 10” ±2”, rather than 10” ±1”); and 3) the sediment delivered to the site contained a

much greater percentage of sand than the grain size analysis conducted for the dredge sites had implied. Additionally, due to contractor error, a portion of the site received up to 20" of sediment, rather than the 10" identified in the contract. All of these outcomes will be addressed in a forthcoming lesson learned document.

The planned coverage of 10" over 10 acres could not be achieved because the sediment was applied as a slurry, which caused the sediment to distribute across the site like water in a bathtub. As the material in the slurry settled, lower areas (e.g., shallow ponds, tidal channels, and other low spots) filled to greater depths than the surrounding slightly higher marshplain. In addition, a portion of the underlying marsh was compacting under the weight of the added sediment. More sediment was therefore required per acre than we had originally assumed. To address this issue, we reduced the boundaries of the augmentation site in a manner that eliminated the larger tidal channels within the site, but still included all but one feldspar plot and one vegetation monitoring plot.

The effects of the variability in sediment thickness will be determined as post-augmentation monitoring continues. Because the research plots for studying sediment depth and elevation were collocated with plant and invertebrate monitoring sites, the differences in sediment depth access the site are not expected to significantly influence study results.

To better understand the sand to silt ratio of the sediments delivered to the site, we identified additional funding that enabled us to conduct grain size analysis of the dredge material that was applied to various portions of the site. This information will be helpful in understanding the timeframes for and species diversity associated with plant reestablishment and invertebrate recolonization.

Changes in Eelgrass Distribution Pre- and Post-Augmentation – The post-augmentation survey indicated changes in eelgrass cover in both the control site and the project site survey areas when compared to the pre-augmentation survey, as described in the final report provided with the April through June 2016 quarterly report. Visual inspection of the sonar data showed one localized region near the augmentation site where eelgrass cover was absent relative to the pre-construction survey. This site is located generally along the southeastern edge of the augmentation site. With an approved reallocation of grant funds from one subcategory to another, MTS was contracted to conduct a bathymetry survey of the subtidal areas around the project site. With this data, we hope to better understand of the reasons for the loss of eelgrass in this area. The survey was conducted in July 2016. Preliminary results indicate that elevations have changed in the area where the absence of eelgrass was noted. The extent of change and the effect this change could have on eelgrass reestablishment in this area is currently under review. A final report is currently being completed, and additional eelgrass surveys will be conducted in 2017 and 2018.

14 C Dating of Long Cores – Completion of the analysis and final report related to sediment core dating has been delayed and will not be completed until March 31, 2017. This delay, which will not result in any increase in cost, is the result of additional time needed to preprocess the cores for LOI and magnetic susceptibility before selecting horizons for dating, as well as a significant back-up at the USC dating facility that was to be used for the upper 137Cs dates. UCLA has now identified another lab to run the 137Cs dates, so completion of the dating can now proceed to meet the March report completion date.

Project Benefits and Results

Thin-Layer Sediment Augmentation. Although it is too early in the project to fully address project benefits and results, we have already learned quite a bit about the sediment augmentation process and can suggest changes to the process that will benefit future projects. Some of this information has already

been addressed at various workshops and seminars, as described above. During the next quarter, we will prepare a "lessons learned" document related to the initial augmentation process that will detail what appeared to work and what changes could be made to the project design to improve initial outcomes. This information will benefit those land managers contemplating the initiation of this process elsewhere on the Pacific Coast. The data being collected to better understand carbon sequestration rates at this site will also provide information benefits.

2. Greenhouse Gas Assessment. The estimated carbon sequestration benefit from the USFWS Seal Beach NWR thin-layer sediment augmentation project is presented in the following table.

Grantee	Project (Abbrev. Title)	Project Acreage	Project Life as defined in proposal	Carbon Sequestered as Reported in the Application	Conversion Process to Arrive at Reported GHG sequestration value	Value to Report on Project Report (MT CO2-e)
U.S. Fish and Wildlife Service	Seal Beach NWR Sediment Augmentation	10 acres	n/a	Carbon storage estimate of 250 Mg C ha^{-1} of tidal marsh (i.e., 917.5 Mg CO2 ha-1) represents avoided emissions - associated with halting loss of tidal marsh at the SBNWR	250 MT C ha-1 * 3.67 = 917.5 MT CO2 ha-1 917.5 MT CO2 ha-1 * (1 ha/2.471 ac) = 371.3 MT CO2 ac-1 371.3 MT CO_2 ac-1 * 10 ac = 3,713.1 MT CO2	3,713

Assessment of the pre-augmentation net sediment accretion rates and CAR at Seal Beach NWR and evaluation of the long-term storage and temporal scale of carbon storage were initiated in November 2015. A total of 16 cores were taken from the augmentation site, the control site, and another site in the marsh. At each core location intended for high-resolution carbon analysis, a GPS point was taken and vegetation of the surrounding area was described. Using a Russian Auger, each core was extracted in meter long sections, until either intertidal or marine sediments were reached (determined by visual description of sediment, lack of tidal marsh macrofossils, or presence of marine shells) or collection was no longer physically possible (usually caused by an impenetrable basal layer or sheer stress). Meter sections were extruded in-field, described, and wrapped for transport back to UCLA where they were stored at 4°C.

In addition, 20 sites along a transect were GPS located to cm-level accuracy for elevation. Pore-water salinity was sampled using a small tube inserted into the marsh and removed at the end of collecting. Finally, a core of 10cm diameter and 1cm depth were collected to sample live and dead assemblages (differentiated by the addition of Rose Bengal dye added after sampling) of foraminifera.

All cores have been cataloged and described. Magnetic susceptibility analysis was conducted to 100cm depth on the 16 long cores. Cores were halved, with one half stored for analysis at UCLA facilities and the other sent to USCLB for belowground biomass analysis. In February 2016, radiocarbon (14C) dating was conducted at the UC Irvine Keck Radiocarbon Lab. A total of 11 samples were dated, including 9 plant macrofossils and 2 marine shells from a single hash layer. Macrofossils from between 91 – 171 cm depth return calibrated dates from 713 to 1502 years BP. This results in a robust age-depth relationship for all dates obtained. An average of long term accretion rates calculated from 14C dates at Seal Beach is 1.19 ± 0.03 mm yr-1, which is typical for accretion rates obtained from 14C.

Chronological control using radiocesium (137Cs) and radiolead (210Pb) will be conducted in the next quarter, and once chronologies have been established, loss-on-ignition (LOI) analysis will be completed to determine carbon content. Work on the Forminifera analysis project is nearing completion. A final report of all findings will be provided in March 2017.

Summarize Benefits to Disadvantaged Communities (if applicable)

Not applicable to this project.

List of Proposed Activities and Tasks for 2017

Task 1 – Project Management and Administration
Refuge staff will continue to coordinate individually and through conference calls with researchers and other team members. Invoices and quarterly reports will be prepared. A "lessons learned" document will be prepared to address the sediment augmentation process. Annual monitoring reports due in spring 2017 will be reviewed and prepared for submittal to CDFW.

Task 2 – Sediment Augmentation
This task is now complete.

Task 3 – Project Monitoring
Post-augmentation monitoring will continue and expand as the augmentation site begins to revegetate.

USFWS staff will continue to work with the researchers to ensure that no impacts to listed or sensitive species occur during post-augmentation monitoring.

Annual monitoring reports will be prepared.

Monthly bird surveys and annual monitoring of the light-footed Ridgway's rail will continue.

Dr. MacDonald and his team at UCLA will complete core sample analyses and determine carbon content. Work on forminifera analysis will be completed.

Dr. Ambrose and his team at UCLA will obtain and analyze core samples from feldspar plots to measure the thickness of sediment over the feldspar. Laboratory analyses of bulk density, grain size, and carbon content (LOI) will also be conducted on core samples taken from the site.

Dr. Whitcraft and her staff will continue to conduct post-augmentation sampling and analysis related to plant and invertebrate diversity and abundance, plant photosynthesis, and biomass. Additional research will be conducted in an effort to determine the origin of plants and invertebrates that appear/colonize on the augmentation site (e.g., growing from existing plants/invertebrates and/or new recruits).

USGS will continue collecting data from the YSIs and SETs.

Dr. Keller from Chapman University will be collecting samples and analyzing porewater ions (e.g., chloride, sulfate), as well as completing post-augmentation gas flux measurements at the augmentation site and control site.

An eelgrass survey and report will be conducted to evaluate eelgrass conditions one year post augmentation.

Time lapse videos will be continually updated and posted to the Refuge website.

Task 4 – Engineering Design/Environmental Documentation
This task has been completed.

Task 5 – Public Participation/Presentations
We will continue to update the project webpage, and participate in conferences and webinars as opportunities arise.

Once the "lessons learned" documentation is completed for the sediment augmentation process and we have some initial post-augmentation monitoring results, we will begin sharing and distributing this information.

Description of Amendments and Modifications to Grant

We made a minor modification to the existing grant by redirecting $4,950 of unallocated research funds to additional eelgrass survey work. The reallocation of funds was approved by CDFW on June 10, 2016. The eelgrass elevation survey has been completed and the final report will be issued in November.

Attachments

1. Table of Cost Share Expenditures
2. Location Map
3. Aerial Photograph of the Project Site
4. Locations of Research Plots within the Augmentation and Control Sites
5. Graphic Depiction of Grain Size Analysis of Applied Sediment across the Site
6. Post-Augmentation Elevation Map using Photogrammetric Mapping
7. Assorted Site Photos (time lapse photo video provided under separate cover)

Attachment 1
Itemized Cost Share Items and Activities

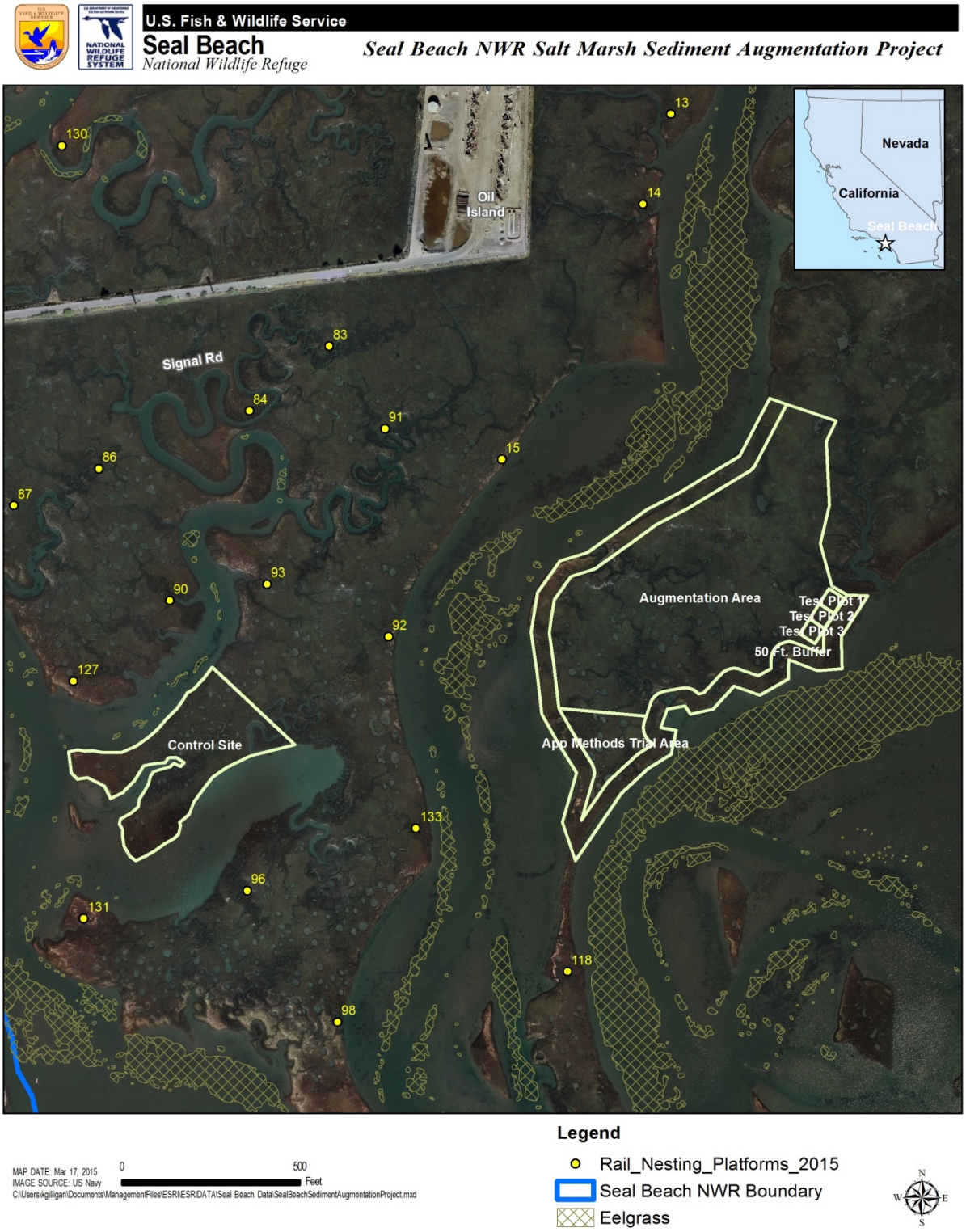
Cost Share (June 1, 2015 to September 30, 2016)		
Activity or Item[1]	Funding Source	Expenditure
June 1 – September 30, 2015		
Purchase boat to access site	USFWS CRI Grant	$2,425
Pre-augmentation monitoring	California State Coastal Conservancy	$55,387
RTK elevation survey	US Army Corps of Engineers	$50,252
USFWS staff time[2]	USFWS CRI Grant	$30,560
	Subtotal	$138,624
January 1 – March 31, 2016		
Pre-augmentation monitoring	California State Coastal Conservancy	$15,438
	Subtotal	$15,438
April 1 – June 30, 2016		
Sediment augmentation	USFWS CRI Grant	$350,000
Sediment augmentation[3]	Orange County Parks	$670,500
USFWS staff time[2]	USFWS CRI Grant and Station Funds	$38,525
Post-augmentation monitoring	California State Coastal Conservancy	$47,120
	Subtotal	$1,106,145
July 1 – September 2016		
Post-augmentation monitoring	California State Coastal Conservancy	$52,831
USFWS staff time[2]	USFWS CRI Grant	$68,507
	Subtotal	$121,338
	Total Cost Share to Date	**$1,381,545**

[1] Costs associated with bird surveys and light-footed Ridgway's rail monitoring are not included.

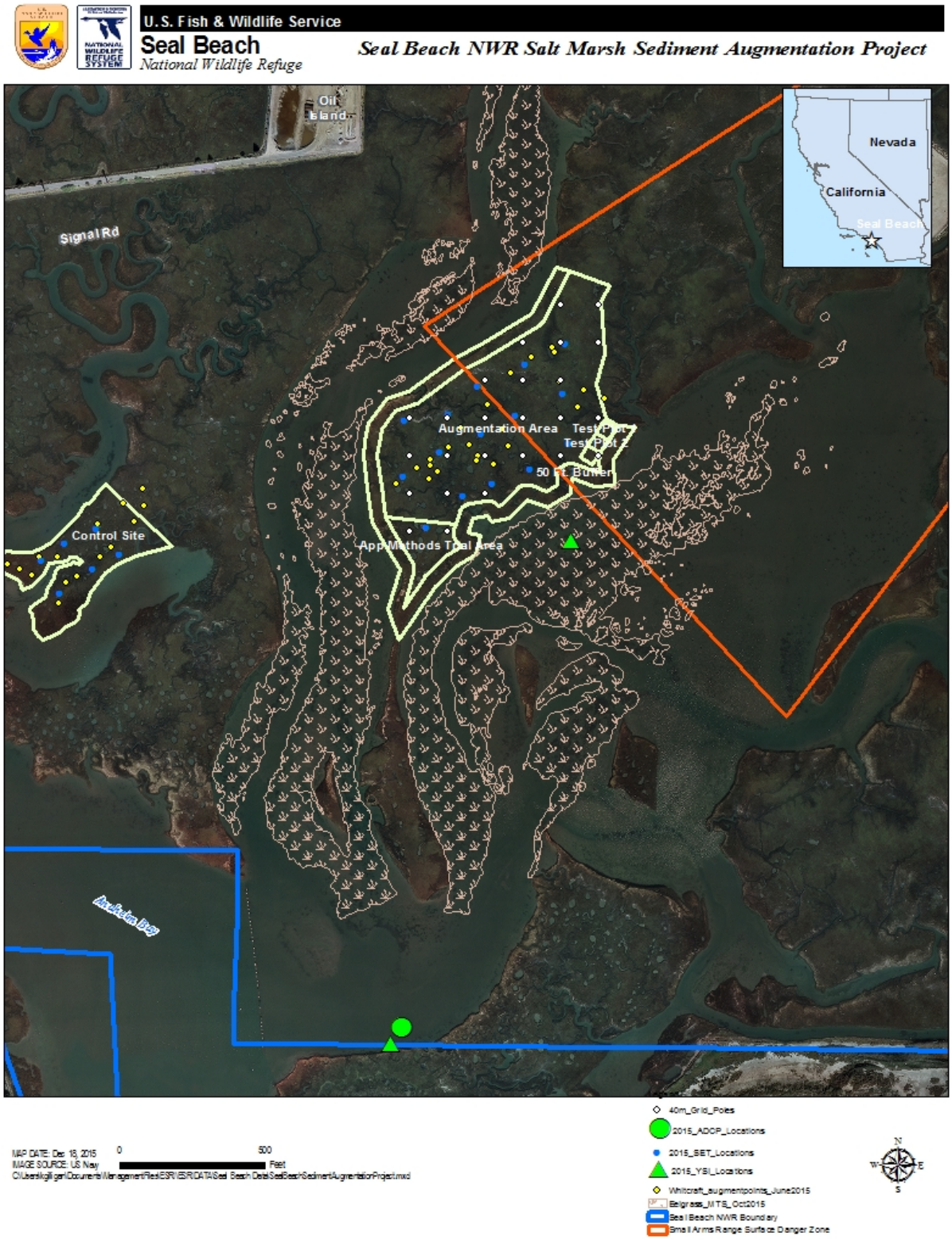
[2] This does not include staff time accounted for on monthly invoices.

[3] The bids for sediment augmentation came is much higher than estimated by the project engineer, therefore, some of the cost for sediment augmentation was covered by the Orange County Parks.

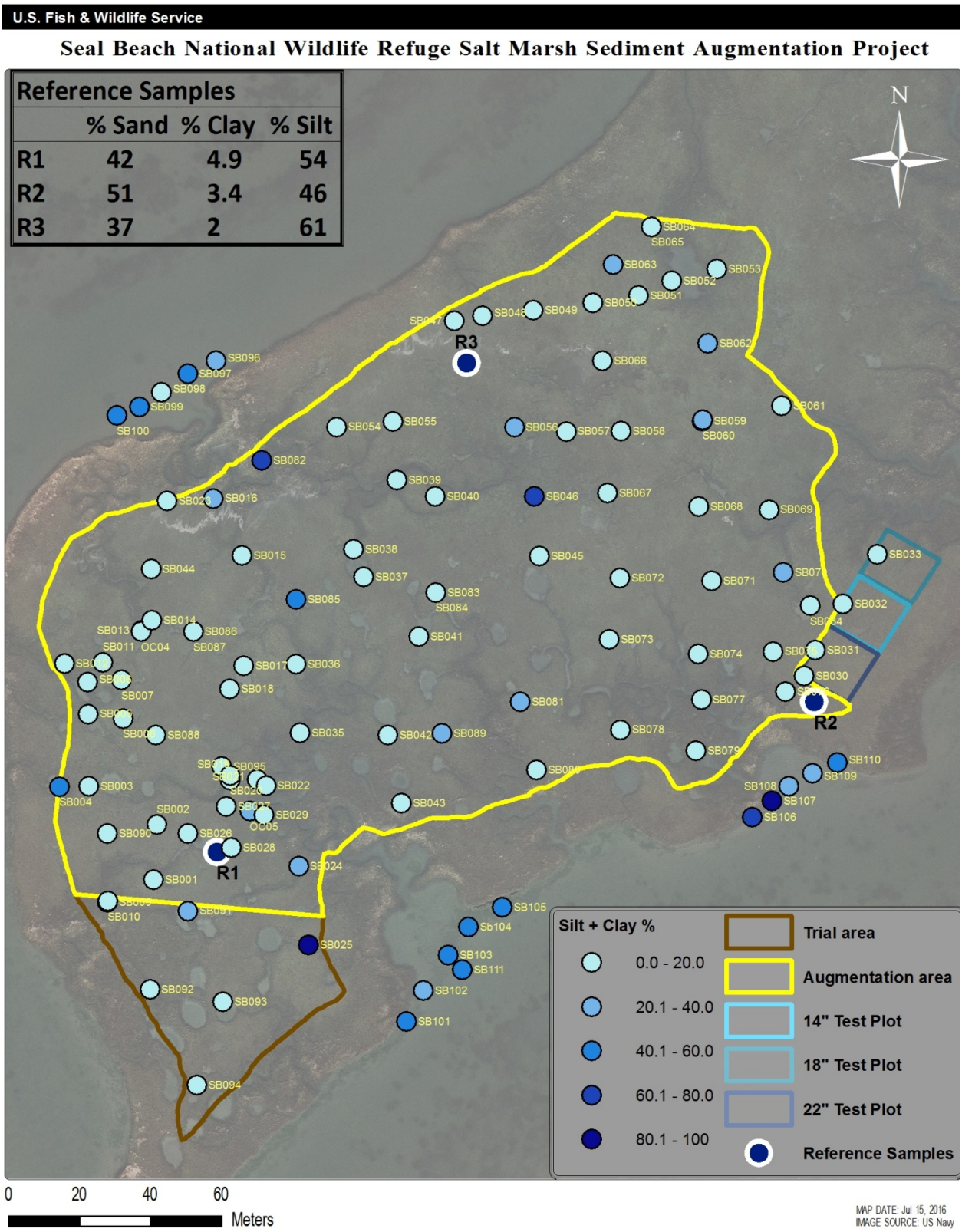
Attachment 2. Location Map - Seal Beach NWR Initiation of Thin-Layer Sediment Augmentation on the Pacific Coast Sediment Augmentation Site



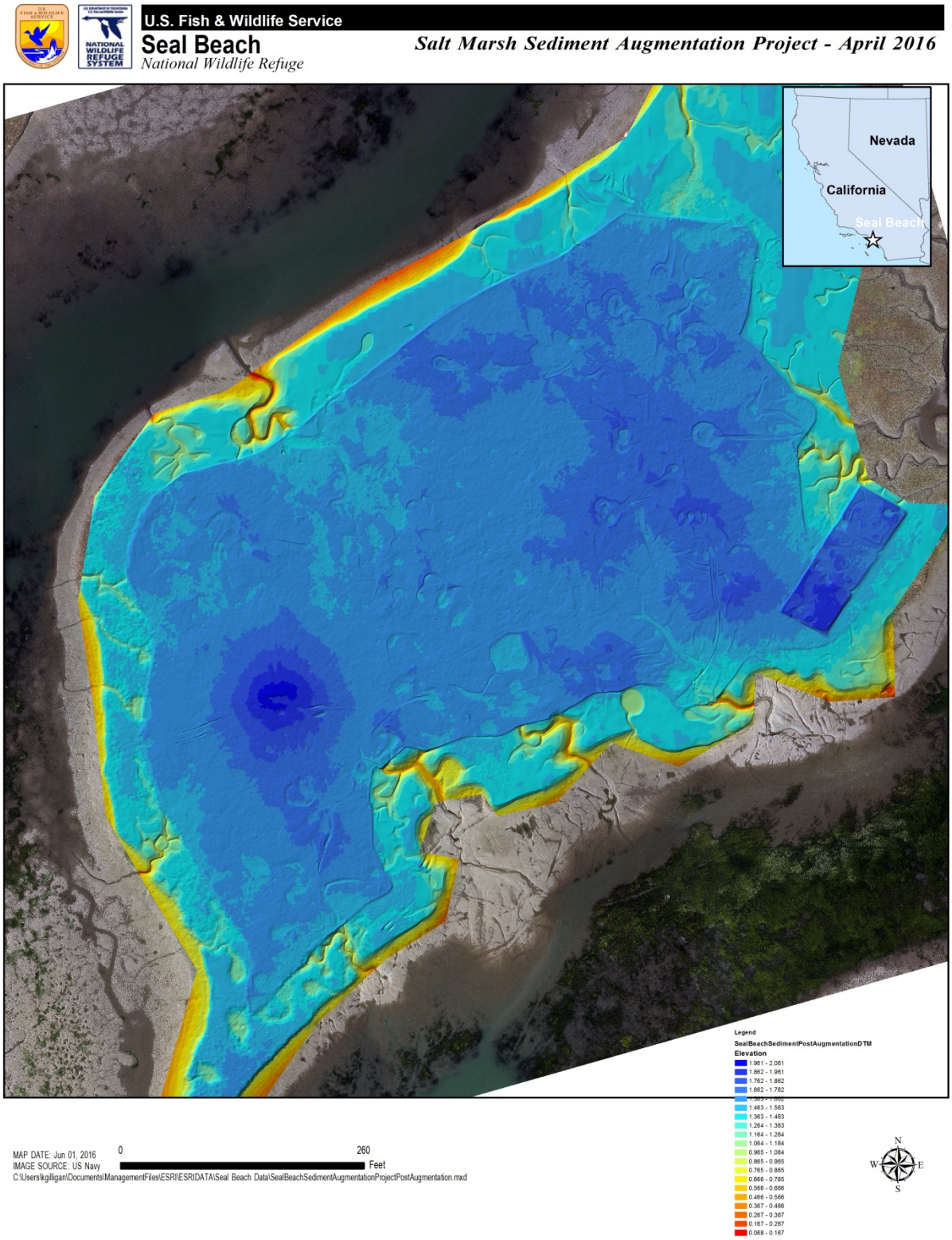
Attachment 3. Aerial Photo - Seal Beach NWR Initiation of Thin-Layer Sediment Augmentation on the Pacific Coast Augmentation Site and Control Site



Attachment 4. Locations of Research Plots within the Augmentation and Control Sites



Attachment 5. Depiction of Grain Size Analysis of Applied Sediment across the Site



Attachment 6. Post-Augmentation Elevation Map of the Augmentation Site using Photogrammetric Mapping

Attachment 7 – Assorted Site Photos

Augmentation Site prior to Sediment Augmentation; from top left to bottom: marsh plain at low tide; installation of a research plot in the marsh; and marsh plain at high tide.

Attachment 7 – Assorted Site Photos

Photographs of the Augmentation Process – From top left to bottom right: First day of augmentation; augmented portion of the marsh; hay bales used to retain sediment within the site; and post-augmentation view of a low spot in the marsh reforming.

Attachment 7 – Assorted Site Photos

Panoramic view of the site following completion of sediment augmentation.