COLORADO LAGOON RESTORATION: WHERE DREDGING AND MITIGATION BANKING MEET

Steve Cappellino[1], Shelly Anghera[2], Michael Whelan[3], Jack Malone[4], and Eric Lopez[5]

ABSTRACT

Colorado Lagoon is a small tidal lagoon located in Long Beach, California, that is connected to Alamitos Bay via an underground culvert. The lagoon is subject to a Total Maximum Daily Load (TMDL) regulation to meet water and sediment quality objectives as well as fish tissue consumption goals for human health. The Colorado Lagoon Restoration Program is designed to restore water and sediment quality while enhancing aquatic and shoreline habitats to provide valuable mitigation credits for other important City of Long Beach projects. During previous phases of the restoration, some contaminated sediments were removed via mechanical methods and disposed of off site and conduits for ongoing stormwater sources were closed. Sediment remediation activities removed the bulk of the contaminants of concern, but significant dredge residuals remained in the surficial zone where TMDL compliance standards apply. To achieve TMDL requirements, the current phase of the restoration effort included hydraulic dredging and filling to create elevated benches that will support improved habitat features, such as intertidal marsh and shallow subtidal eelgrass, and leave a sediment surface that meets water quality beneficial uses. Upland features were also transformed by adding walking trails, a bioswale to manage runoff from an adjacent golf course, landscaping to restore the ornamental vegetation to native coastal zone species, and public amenities. When complete, the final sediment surface is expected to be TMDL compliant. Future restoration efforts focus on opening a channel for a better hydrological connection between Colorado Lagoon and Alamitos Bay and eelgrass habitat restoration within Colorado Lagoon itself. The entire program will form a mitigation bank for the City of Long Beach, creating more than 25 acres of valuable coastal habitat.

Keywords: Dredging, beneficial uses, TMDL, eelgrass, mitigation banking, dredged material disposal, contaminated sediments.

INTRODUCTION

Colorado Lagoon is a Y-shaped tidal lagoon located in Long Beach, California, that is connected to Alamitos Bay via an underground culvert. The City of Long Beach (City) has been working with the Port of Long Beach (Port) to remediate and restore the lagoon for more than 10 years.

Colorado Lagoon was once part of the vast historic Los Cerritos Wetlands. In 1923, the low-lying tidelands of Alamitos Bay were dredged to form the lagoon and Marine Stadium. The 1932 Los Angeles Olympic Committee chose the lagoon for diving trials and Marine Stadium for rowing events. To prepare for these diving trials, the lagoon was separated from Marine Stadium by land filling along the current alignment of East Colorado Street and adding a short underground pipe culvert and tide gate to maintain adequate diving depth in the lagoon. In the late 1960s, the area between East Colorado Street and what is now the north end of Marine Stadium was filled and the existing underground box culvert was constructed, further separating the lagoon from Marine Stadium. This effort was completed to support the construction for the then proposed Pacific Coast Freeway. That freeway was never constructed, and this filled area is now known as Marina Vista Park, which supports various recreational and

[1] Principal Scientist, Anchor QEA, 27201 Puerta Real, Suite 350, Mission Viejo, CA 92691, USA, T: 949-347-2780, Email: scappellino@anchorqea.com

[2] Principal Scientist, Anchor QEA, 27201 Puerta Real, Suite 350, Mission Viejo, CA 92691, USA, T: 949-347-2780, Email: sanghera@anchorqea.com

[3] Senior Managing Engineer, Anchor QEA, 27201 Puerta Real, Suite 350, Mission Viejo, CA 92691, USA, T: 949-347-2780, Email: mwhelan@anchorqea.com

[4] Managing Scientist, Anchor QEA, 27201 Puerta Real, Suite 350, Mission Viejo, CA 92691, USA, T: 949-347-2780, Email: jmalone@anchorqea.com

[5] Project Management Officer, City of Long Beach, Public Works Engineering, 333 West Ocean Boulevard, Long Beach, CA 90802, USA, T: 562-570-5690, Email: Eric.Lopez@longbeach.gov

community events. A second road, Eliot Street, was added on the southern portion of the site, which further bounds the project area. Figures 1 and 2 show the project location and key site features.

Figure 1. General project location.

Figure 2. Key site features.

PROJECT OBJECTIVES

The Colorado Lagoon Restoration Program has two primary objectives: water and sediment quality improvements and habitat improvement. Secondary objectives include improving recreational benefits and developing a habitat mitigation bank to provide valuable mitigation credits for current and future City development projects. Overall project elements include dredging and capping to remove and isolate contaminated sediments, improving water quality by re-routing stormwater flows to bypass the lagoon, creating walking trails and recreational sports fields to enhance the recreational benefits, and contouring the shoreline to create habitat zones that can be planted with native salt marsh vegetation. The future phase of the program will be to remove the underground culvert and excavate an open-channel connection between the lagoon and ocean to restore unmuted tidal flow to the lagoon.

PROJECT SEQUENCING

The Colorado Lagoon Restoration Program, which began more than 10 years ago, is a multi-phased approach to improve water and sediment quality, enhance recreational benefits, and improve aesthetics to Colorado Lagoon and Marina Vista Park. The project was planned to be completed in three phases, starting with sediment management and stormwater improvements and finishing with habitat improvements.

First Phase

The first phase started in 2008 and included improving various storm drain (Termino Avenue drain construction, trash collectors, and low flow diverters), removing bulk sediment, restoring partial shoreline, and cleaning the culvert that connects Colorado Lagoon to Alamitos Bay to improve water flow. This phase was completed in 2012 and included the removal of more than 60,000 cubic yards of contaminated sediments, which were disposed of at the Port in a confined fill area that is now part of the Middle Harbor terminal. Because the focus of the current paper is on the linkage between dredging and the creation of a mitigation bank, this initial work is not discussed further.

Second Phase (Phase 2B)

The second phase, referred to as Phase 2B, included capping residual contamination in Colorado Lagoon; contouring additional portions of the shoreline to create native wetland and shallow subtidal habitats to support the development of a mitigation bank; and adding various upland features such as walking trails, a bioswale, and native landscaping to improve the aesthetic qualities of the site for the community. This phase was started in 2014 and was recently completed in April 2017.

Third Phase (Phase 2A)

The final phase of the program, referred to as Phase 2A, includes excavating an open channel through a portion of Marina Vista Park and Colorado Lagoon, constructing road crossings at Eliot and Colorado streets, re-locating utilities, leveling the elevation in Marina Vista Park, and enhancing on-site recreational activities. The open channel will replace the existing underground culvert between the lagoon and Marine Stadium and will provide increased tidal range and water circulation to better support intertidal and eelgrass habitat in order to create habitat mitigation banking for the City. The channel itself will also provide additional subtidal, intertidal, and buffer/transitional habitats and mitigation credits. Originally planned for construction before the lagoon restoration phase (2B), the schedule was reversed to allow for additional funding to be secured for the open-channel construction and to allow mitigation activities for an existing City project (Naples Island Seawall Replacement) to be advanced.

PROJECT HISTORY AND REGULATORY REQUIREMENTS

After decades of stormwater runoff and polluted waters, the City prepared a Restoration Master Plan for Colorado Lagoon in 2009, which focused on water and sediment quality, habitat, and recreation improvements. The Los Angeles Regional Water Quality Control Board (Water Board) adopted a TMDL for Colorado Lagoon in 2009 that established a regulatory driver for remediation. In response, the City developed an Implementation Plan that proposed dredging the lagoon and constructing the open channel as a mechanism for improving water quality in the lagoon. The idea of creating a mitigation bank was introduced during the development process to address existing City mitigation requirements and to help fund the program by providing additional mitigation opportunities to meet the mitigation needs of the City and Port's future capital and maintenance programs. These items are important in defining project need and goals and are discussed briefly below.

TMDL Compliance Requirements

The Water Board adopted Resolution No. R09-005 on October 1, 2009, incorporating a TMDL for organochloride (OC) pesticides, polychlorinated biphenyls (PCBs), sediment toxicity, polycyclic aromatic hydrocarbons (PAHs), and metals in Colorado Lagoon. A schedule for development of TMDLs in the Los Angeles Region was established in a Consent Decree (Heal the Bay Inc. et al. v. Browner C 98-4825 SBA) approved on March 22, 1999. The Consent Decree combined waterbody pollutant combinations in the Los Angeles Region into 92 TMDL analytical units. In accordance with the Consent Decree, Colorado Lagoon OC pesticides, PCBs, sediment toxicity, PAHs, and metals TMDL addresses the impairments in Colorado Lagoon associated with DDT, PCBs, chlordane, dieldrin, PAHs, metals (lead and zinc), and sediment toxicity (RWQCB 2009). Initial phases of the Colorado Lagoon Restoration Program were designed to remove and cap sediments to comply with the TMDL. The final open-channel phase was identified as a critical next step in improving water quality and preventing sediments from being re-contaminated.

Existing City Mitigation Requirements

The Naples Island Seawall in Long Beach prompted the City's near-term need for habitat mitigation. The project requires extensive repairs and installation of new seawall sections, which impact submerged soft-bottom areas and eelgrass. Phase 1 of the seawall project entails installing a new steel sheetpile seawall on the water side of the existing vertical concrete seawalls along both sides of Rivo Alto Canal (1,915 linear feet), new guardrails, landscape beds, sidewalks, and an improved drainage system as well as relocating street lighting along the canal. The new seawall extends 18 inches beyond the existing seawall into the adjacent channel, resulting in the fill of 1,727 square feet of submerged soft-bottom habitat (CCC 2013). To mitigate for this loss, the City agreed to set aside a portion of the newly created shallow soft-bottom habitat in the lagoon, which would be planted with eelgrass and monitored for achievement of performance criteria. Including a contingency, approximately 4,350 square feet (0.1 acre) of eelgrass will be planted in the lagoon to satisfy eelgrass mitigation requirements for Phase 1 of the Naples Island Seawall Replacement Project. Eelgrass impacts associated with future phases of the that project would be quantified prior to construction and mitigated with credits from the Colorado Lagoon mitigation bank.

Future City Mitigation Bank Requirements

A primary goal of the Colorado Lagoon Restoration Program is to restore the ecological functions and values of the lagoon by improving and creating subtidal and intertidal habitat. These improvements provide the optimum habitat for additional mitigation opportunities within the lagoon and the open channel in order to meet not only the mitigation needs of the Naples Island Seawall Replacement Project but also the City's future capital and maintenance programs (i.e., dredging, dock or wharf construction, and seawall improvements) within Alamitos Bay and the Port. The current habitat development plan for the open-channel portion of the project is detailed in Figure 3, with proposed acreages for each habitat type noted. Figure 4 shows the same open-channel features in a pair of cross-sectional views. Target acreages were developed as part of the mitigation bank establishment negotiations with the Interagency Review Team (IRT) and were used to guide the shape and contours of the proposed open-channel design. The combined habitat features (as built for the lagoon and proposed for the open channel) are depicted in Figure 5 and summarized in Table 1. These credits represent the latest estimates proposed to the IRT.

Table 1
Colorado Lagoon and Open-channel Habitat Credit Summary

Waters of the United States Credit Type (USACE/CCC)	Waters of the United States Essential Fish Habitat Credit Type (NMFS)	California Coastal Zone Credit Type (CCC)	Maximum Possible Credits/Acre Points (USACE/USEPA/ NMFS)	Maximum Possible Credits/Acre Points (CCC)
Subtidal/Intertidal	Subtidal/Intertidal	Subtidal/Intertidal	11.00	11.20
Supratidal	No Credits	Supratidal	4.77	5.12
Eelgrass	Eelgrass	Eelgrass	9.80	9.80
		Total	**25.57**	**26.12**

Notes:
CCC: California Coastal Commission
NMFS: National Marine Fisheries Service
USACE: U.S. Army Corps of Engineers
USEPA: U.S. Environmental Protection Agency

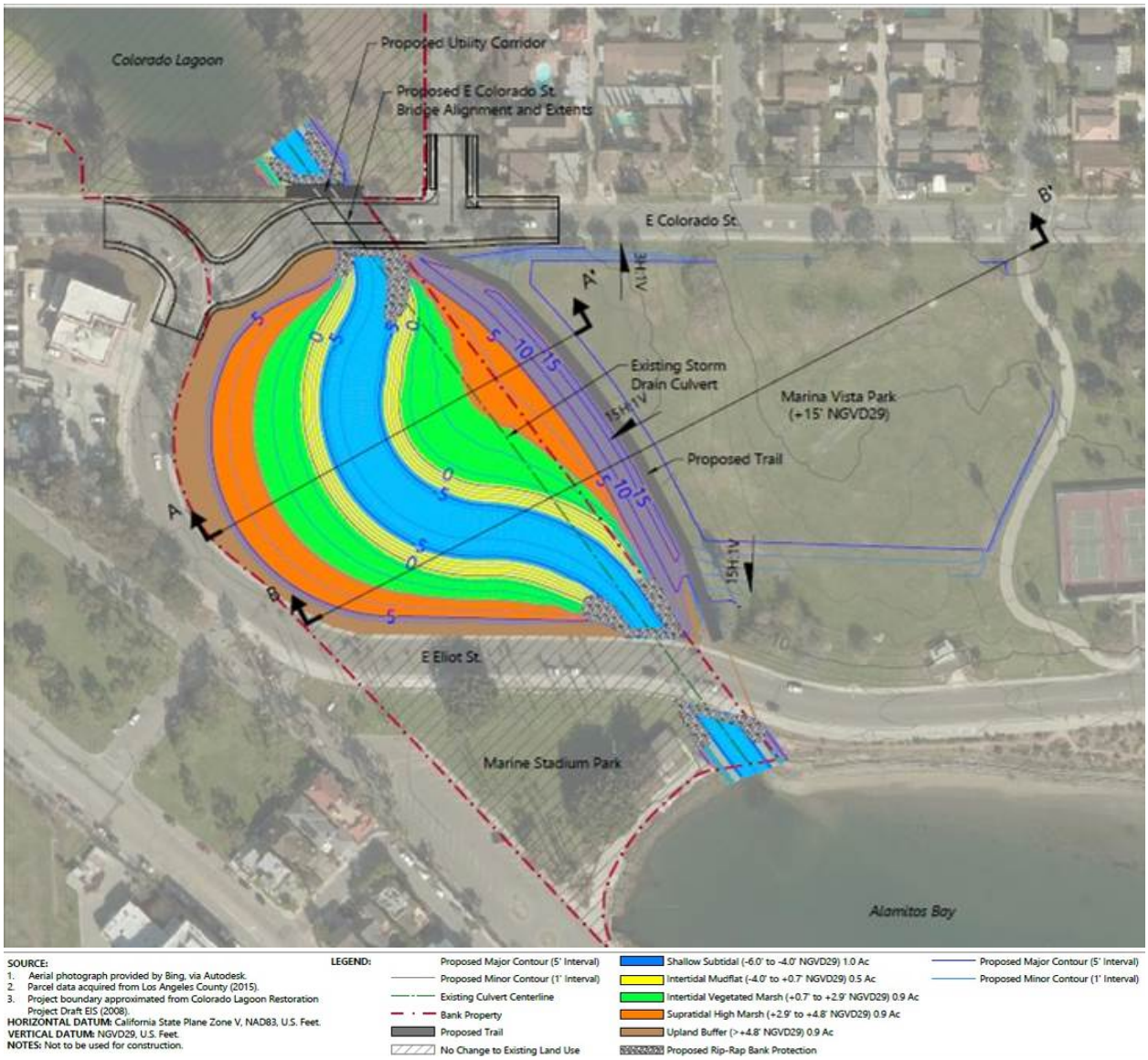

Figure 3. Habitat features for the open channel.

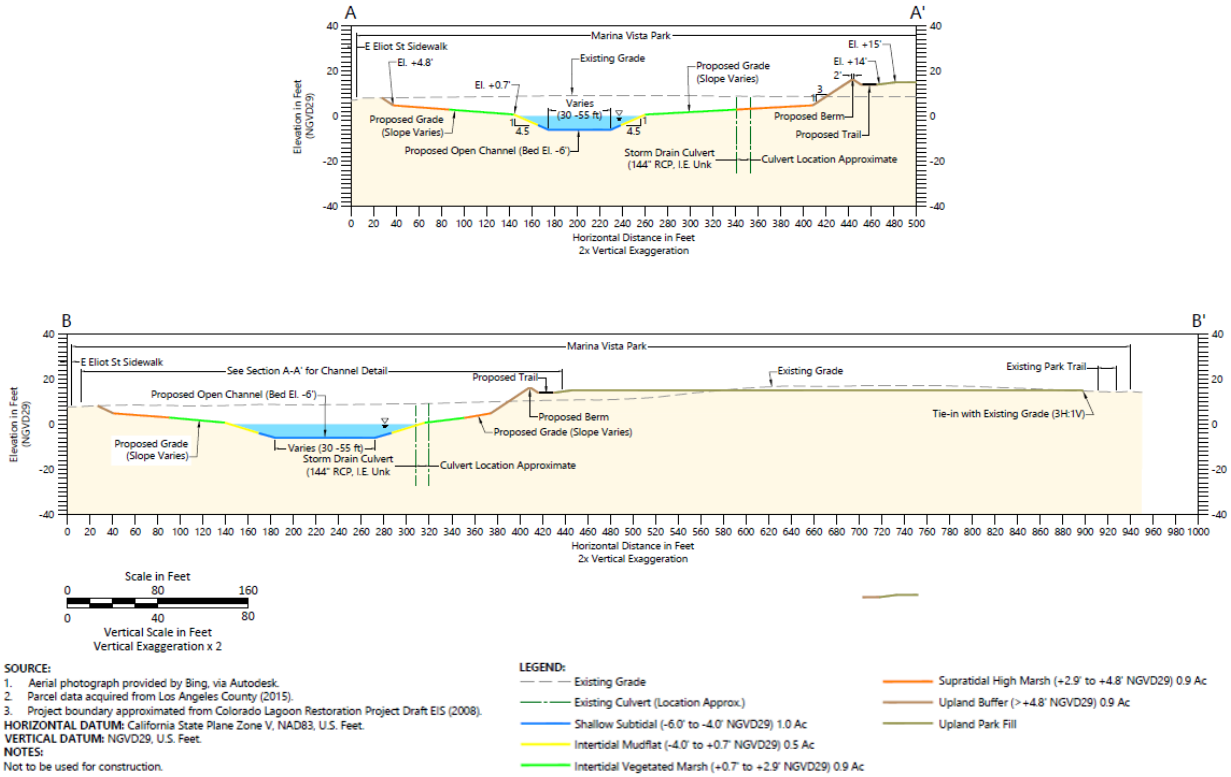

Figure 4. Cross section of open channel.

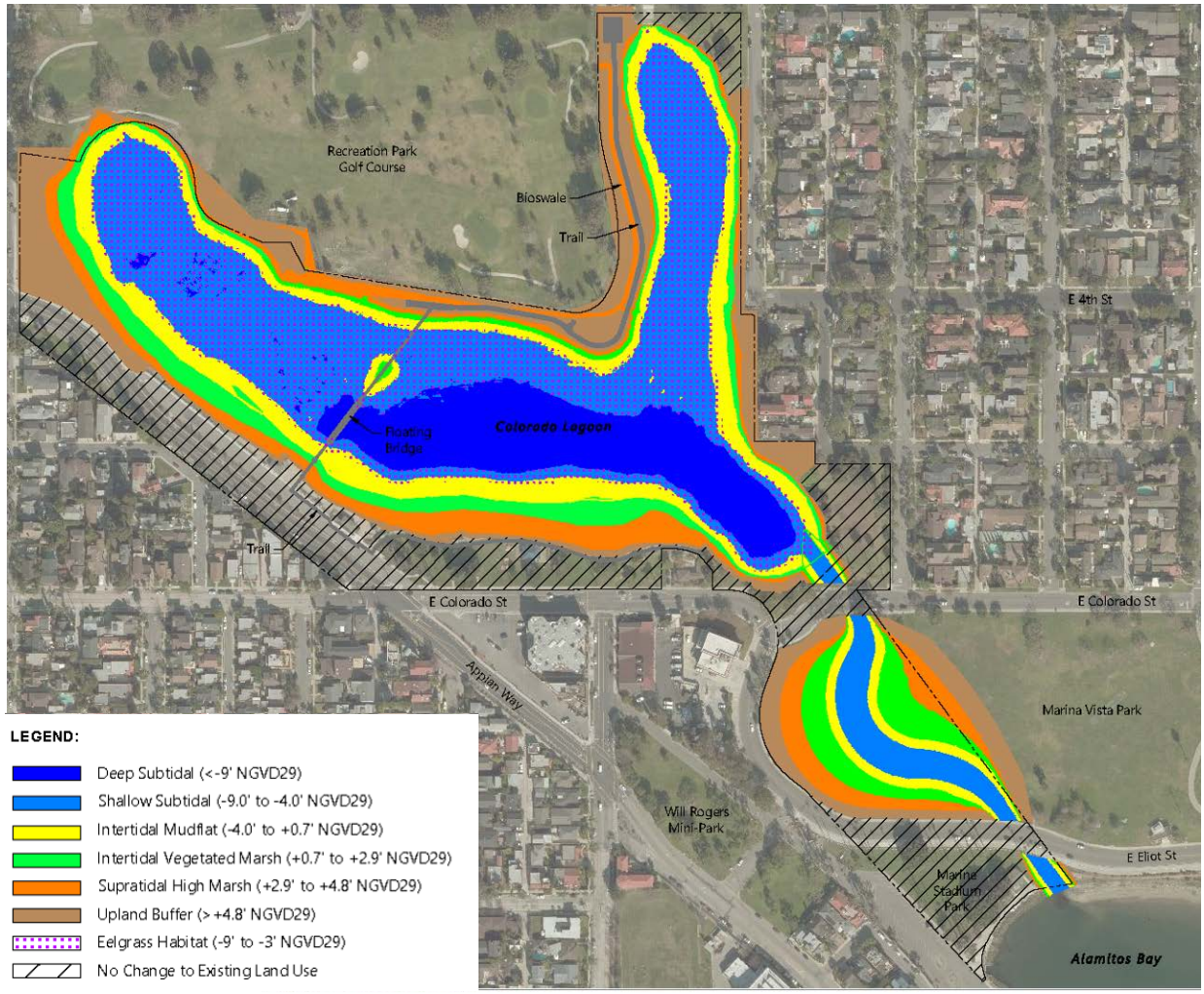

Figure 5. Combined habitat features for channel and lagoon.

DESIGN AND CONSTRUCTION OVERVIEW

Lagoon Remediation/Restoration (Phase 2B)

Phase 2B of the Colorado Lagoon Restoration Program began with engineering design in 2014. Project elements included hydraulic dredging and covering of lagoon sediments, excavating the shoreline and contouring to form intertidal and shallow subtidal habitat zones, planting intertidal and marsh vegetation, creating bioswales and walking trails, and extending the length of an existing pedestrian bridge across the lagoon. Several pre-design studies (e.g., soil coring in the lagoon and along the shoreline for chemistry and geotechnical characteristics) were conducted to reduce uncertainty with site conditions, and surface water flow path modeling was conducted to assist in designing the bioswale. Chemical characterization results showed that the entire surface of the lagoon was contaminated, per the numerical limits of the TMDL (RWQCB 2009), and that materials underlying the entire shoreline were clean and suitable for use as cover material.

Construction began in September 2016, with Los Angeles Engineering as the prime contractor responsible for the upland portion of the site and Dixon Marine Services as the subcontractor responsible for the dredging and covering portion of the project. Hydraulic dredging was conducted using a 10-inch cutter suction dredge (Figure 6) constructed by DSC Dredges, and material was pumped to placement areas using a spill barge and diffuser. Because the entire submerged surface of the lagoon was contaminated and required either removal or covering, the dredge design included three main steps. The first step was to use some of the shoreline cut material to create two underwater berms that separated the lagoon's western and northern arms from its deeper central area. The second

step was to hydraulically dredge the impacted sediments[6] from the central lagoon and pump the material behind the berm in the western arm, ensuring that the material did not migrate back into the central lagoon. Isolation was achieved by using layers of silt curtains to contain the material and monitoring bathymetry daily to watch for mud waves or material migration. The third step was to use the clean shoreline cut material to cap both the western and northern arms, leaving each lagoon area with a clean sediment surface. The amount of material placement in the western and northern arms was also designed to increase the surface elevation to a depth that would support eelgrass development for the mitigation bank. All shoreline cuts were executed in a manner that provided beneficial habitat zones and benches that also created improved ecological functions. Figure 7 shows a cut and fill diagram for the lagoon dredging where warm (red and orange) colors represent cuts and cool (blue and green) colors represent fill areas.

Once dredging, covering, and shoreline contouring activities were completed, the project shifted to the development of the upland amenities, which included decomposed granite walking trails, footbridges, bioswales, irrigation, and native vegetation. Figures 8, 9 and 10 show a series of before and after photographs of the shoreline contouring and upland planting.

Figure 6. 10-inch cutter suction dredge excavating shoreline at Colorado Lagoon.

[6] The dredge design was initially determined to be a 4- to 6-foot cut based on pre-dredge sampling but later included an additional 2-foot cut over some areas until a clean surface was achieved.

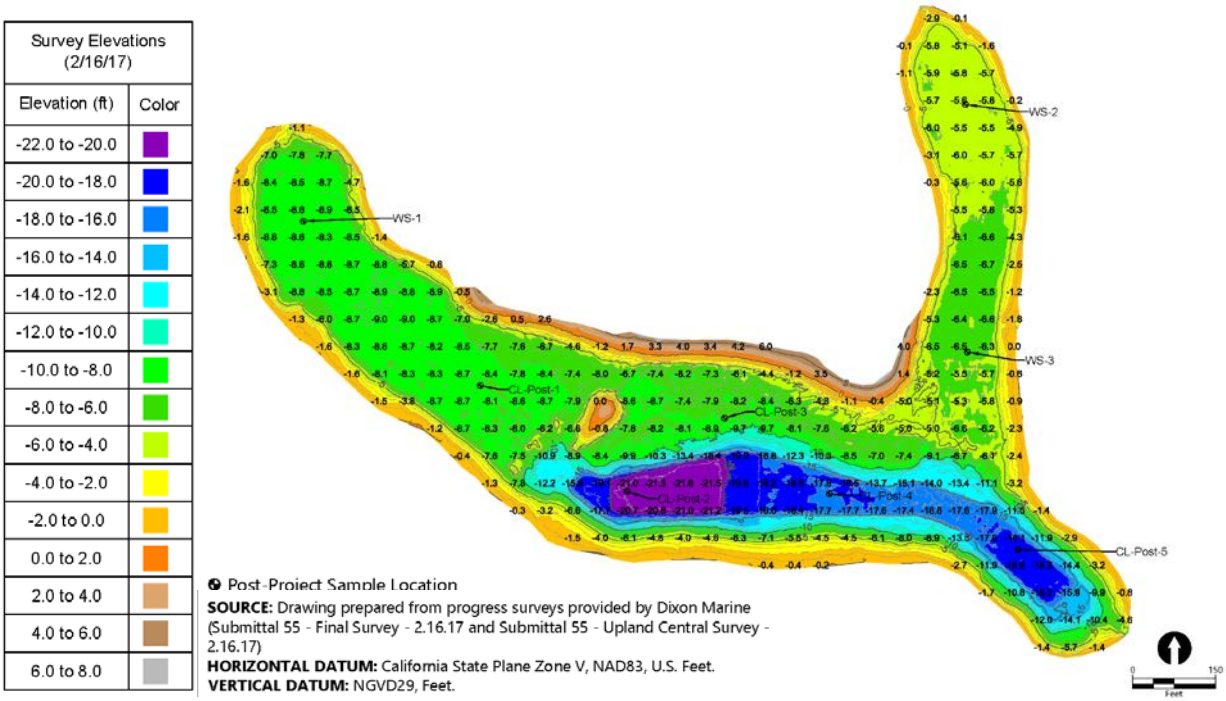

Figure 7. Lagoon dredge and fill final bathymetry.

Figure 8. Before and after 1.

Figure 9. Before and after 2.

Figure 10. Before and after 3.

Construction was anticipated to take 4 months to complete but instead required 8 months due to extreme winter weather, which caused almost 6 weeks of rain delays as well as several unplanned repairs to other site features (such as replacing most of the original bridge structure due to termite damage, excavating and repairing a broken stormwater drain pipe that was flooding the project area, and addressing several erosional areas caused by heavy flooding[7]). Final lagoon dredging volumes totaled approximately 51,000 cubic yards. Total construction costs, including upland park features, totaled approximately $3 million.

Open Channel Excavation (Phase 2A)

The last phase of the Colorado Lagoon Restoration Program includes removing the buried culvert and creating the open-channel connection to the ocean. Project elements for this phase include demolishing the existing culvert, excavating the open channel to create natural tidal exchange and habitat features that will add to the mitigation bank, constructing bridges at two road crossings, relocating 12 utilities that currently cross the channel location, and developing recreational facilities within the remainder of Marina Vista Park. Phase 2A is currently in the preliminary design phase, with construction expected in 2019. Figure 13 shows key project features.

[7] During construction of the project, Long Beach experienced extreme flooding events that set records for daily rainfall totals (4 inches in 1 day and 7.5 inches in a 3-day period)

Figure 13. Open channel site features.

Prior to initiating design activities, a series of field investigations were conducted to accomplish the following objectives:

- Standard and aerial surveying of the site to develop detailed topographical maps
- Soil coring program throughout the site to evaluate the chemical and geotechnical properties of the material planned for excavation
- Ground penetrating radar and pot holing to locate and evaluate all utilities within the project area
- Sewer lift study to evaluate the potential for using a sewer siphon instead of a lift station to meet the changes in project road grades
- Residential view shed analysis to determine potential site impacts to adjacent residences
- Hydrodynamic modeling of the proposed channel configuration and size to ensure that full, unmuted, tidal conditions will be established and that excessive erosion within the channel does not occur

The results of initial field investigations were used to develop a preliminary conceptual design and cost estimate for the project, which was necessary for planning purposes and finalizing the mitigation Bank Enabling Instrument with the agencies. Figure 13 shows the planned cut and fill areas for the open channel and adjacent park, and Figure 14 shows an artist's rendering of the project area once completed.

Figure 14. Artist rendering of open channel.

The existing park space is largely unusable for sporting events because of the uneven slopes and layout of the fields. Phase 2A will improve this condition by reusing a portion of the excavated material from the open channel to raise the elevation and level the remaining park space to make it more valuable for organized sporting events. Improved landscaping and new grass fields will also be included in the final design, as will native coastal vegetation along the open-channel banks.

CONCLUSIONS

The Colorado Lagoon Restoration Program is a unique blend of remediation and mitigation using a variety of construction techniques that range from hydraulic dredging and covering to upland excavation using traditional earth moving equipment. The initial goals for the program were to improve sediment and water quality to meet regulatory requirements. As project plans were developed, the City seized the opportunity to pursue a multi-faceted project that would also enhance the ecosystem through restoration. The project evolved into the creation of a marine mitigation bank, one of the first of its kind in the region, to offset restoration costs and provide additional benefits to the City and Port. After 10 years of progress, the program is entering the final and most complex phase, where an open-channel connection between the lagoon and the ocean will be restored. This last phase is expected to enter construction within the next 2 years and take approximately 2 years to complete. When finished, the Colorado Lagoon mitigation bank is expected to provide almost 26 acres of habitat credits to help offset impacts from future capital and maintenance projects.

REFERENCES

RWQCB (Los Angeles Regional Water Quality Control Board), 2009. Amendment to the Water Quality Control Plan for the Los Angeles Region to incorporate a Total Maximum Daily Load (TMDL) for organochlorine (OC) pesticides, PCBs, sediment toxicity, PAHs, and metals for Colorado Lagoon. Los Angeles Regional Water Quality Control Board Resolution No. R-09-005. October 1, 2009.

CCC (California Coastal Commission), 2013. Coastal Development Permit for Naples Island Seawall Improvement Project. Permit 5-11-085. City of Long Beach (applicant). Filed on July 30, 2013.

CITATION

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