EELGRASS MITIGATION AND MONITORING PROGRAM IN SUPPORT OF
THE FLAGSHIP SAN DIEGO HARBOR EXCURSIONS REDEVELOPMENT
PROJECT

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Merkel & Associates, Inc.
March 2011

INTRODUCTION
Flagship San Diego Harbor Excursions (SDHE) is currently implementing a project to improve their passenger receiving and vessel docking facilities (Project) in San Diego Bay. The Project area occurs between Broadway Pier and Navy Pier and within a lease limit that extends 180 feet from the seawall along shore (Figure 1).

The San Diego Port District (Port) has required SDHE to relocate its existing operations. As part of this Project, the existing gangway and dock between Broadway and Navy piers will be removed. The new facilities will consist of new floating docks and American’s with Disabilities Act compliant gangways (Figure 2). Additional Project details are provided in Padre Associates, Inc. (2011).

Eelgrass (Zostera marina) will be indirectly impacted during implementation of the Project. Eelgrass is a native marine vascular plant indigenous to the soft-bottom bays and estuaries of the Northern Hemisphere. It is a defining habitat-forming species for much of the shallow-subtidal elevations in southern California estuaries and shallow bays. Eelgrass plays many important roles in estuarine systems. It clarifies water through sediment trapping and stabilization (de Boer 2007). It also provides the benefits of nutrient transformation and water oxygenation (Yarbro and Carlson 2008). Eelgrass serves as a primary producer in detritus-based food webs (Thresher et al. 1992) and is further directly grazed upon by invertebrates, fish, and birds (Valentine and Heck 1999), thus contributing to eco-system health at multiple trophic levels. Additionally, it provides physical structure in the form of habitat to the community and supports epiphytic plants and animals, which are in turn grazed upon by other invertebrates, fish, and birds. Eelgrass is also a nursery area for many commercially and recreationally important finfish and shellfish (Heck et al. 2003), including both those that are resident within the bays and estuaries, as well as oceanic species that enter the estuaries to breed or spawn. Besides providing important habitat for fish, eelgrass and associated invertebrates provide important food resources, supporting migratory birds during critical life stages, including migratory periods.

On January 26 and 28, 2011, Dr. Robert Mooney, Mr. Jim Reeves, and Mr. Randy Storaasli from Merkel & Associates, completed a sidescan sonar and diver-based survey to determine baseline eelgrass cover and density within the Project area and to assess the sediment and bathymetric conditions of the site. The survey revealed 333 square feet (31 square meters) of eelgrass within the Project boundary (Figure 3). The eelgrass was supported on a narrow bench that extends from between 15 and 35 feet from the shoreline bulkhead wall. Water depths on the bench generally range from –4 to –12 feet MLLW before quickly dropping to approximately –32 feet MLLW.

Eelgrass on the bench area consisted of small and scattered patches along the entire length of the leasehold. The eelgrass depth distribution followed that of the bench itself ranging from –4 to –12
Project Vicinity Map
San Diego Harbor Excursions Redevelopment Project

M&A # 11-003-02

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Figure 1
Existing and Proposed Facilities
San Diego Harbor Excursions Redevelopment Project
(photograph represents existing conditions)

Figure 2

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Baseline Eelgrass Coverage
San Diego Harbor Excursions Redevelopment Project

M&A # 11-003-02

Lease Boundary
Eelgrass
Bathymetry (MLLW)

1ft contours
5 ft contours

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feet MLLW. The largest eelgrass patches were located towards Broadway Pier in shallower water. Smaller patches occurred elsewhere. Eelgrass had low turion (leaf shoot) densities (90.7±67.0 turions/m²) and appeared to be limited by sparse sediment accumulation and slope rather than being generally limited by more typical factors of light limitation and desiccation stress.

Most of the mapped eelgrass is expected to be indirectly impacted by shading from new Project features. However, expansion of eelgrass on the bench appears possible if greater sediment depth and distribution is developed. Thus, although the Project calls for greater bay coverage and increased shading from gangways, the current distribution of eelgrass is restricted by sediment depth. Some areas of the bench have no suitable sediment and are characterized by compact formational deposits. It is reasonable to expect that placement of suitable sediment in areas with minimal shading under the new layout will support eelgrass. Moreover, it is expected that eelgrass can be supported in an improved condition relative to what was observed during the baseline survey.

**PROJECT MITIGATION REQUIREMENTS**

Much of the 333 square feet (31 square meters) of eelgrass present at the Project site will be lost because the Project involves increasing the dock footprint and installing an additional gangway over shallow water. This will cause significant shading impacts to the eelgrass. For the purposes of mitigation planning, all eelgrass is assumed to be lost. However, it is anticipated that some eelgrass will ultimately survive within areas with lower levels of shading.

Due to the ecological importance of eelgrass, impacts are required to be mitigated under the Southern California Eelgrass Mitigation Policy (SCEMP). The SCEMP, a policy developed by National Marine Fisheries Service, U.S. Fish and Wildlife Service, and the California Department of Fish and Game, offers specific guidelines for appropriate responses and mitigation measures for activities that threaten eelgrass vegetated habitats (NMFS 1991, as amended). The policy requires that any losses to eelgrass be restored at a ratio of 1.2:1. In other words, for every square meter of eelgrass impacted, 1.2 square meters of eelgrass habitat must be established. Moreover, the policy suggests that mitigation planners should increase the planting area 20-30% to ensure successful establishment of the mitigation goal.

Assuming a total loss of eelgrass occurs due to the Project, the mitigation requirement for eelgrass resources is the successful establishment of 400 square feet (37 square meters) of replacement eelgrass. SDHE intends to mitigate for this loss and provide mitigation for losses to open water habitat through an integrated mitigation concept that will be implemented within the Project boundary.

**INTEGRATED FISHERIES / EELGRASS MITIGATION CONCEPT**

In addition to the 400 square foot eelgrass mitigation requirement, the United States Fish and Wildlife Service is requiring 1,700 square feet of seafloor fisheries enhancement to mitigate for increased bay cover associated with the Project. This mitigation requirement is discussed in the Project’s essential fish habitat assessment (Padre Associates 2011) and is part of the United States Army Corps of Engineers permit.
SDHE intends to mitigate for both bay coverage and eelgrass impacts with a single on-site mitigation plan. The concept includes artificial reef structures and two eelgrass-planting areas to meet the mitigation goals (Figure 4). In some cases the artificial reef structures stand on their own and in others they help to support eelgrass-planting areas that require fill.

The primary eelgrass planting area takes advantage of the southern portion of the leasehold. This area is unobstructed by docks and associated structures and is exposed to nearly full sun from the south. Unfortunately, this area occurs over some of the deepest depths along the shoreline bench and has minimal amounts of suitable sediment to support eelgrass. In this southern planting site, stacks of clay (or similar) pipe will be used as a retaining structure for sand fill (refer to Figure 5 for component details). The stacked pipe would be placed at approximately -10 feet MLLW at the bayward end of the fill footprint. From there it would turn eastward at the north and south extents of the fill area and end at approximately -5 feet MLLW. The outer sides of the stacked pipe structure would be drilled with holes to enhance its value as artificial reef. Inside the retaining structure, sand fill (composed of clean washed river sand) would be used to provide a suitable planting substrate and to bring the bottom contour up to a more desirable elevation for eelgrass growth. The top of the retaining structure would range from -2 feet MLLW near the headwall to -7 feet MLLW along the bayward boundary. Within this structure the sand fill would come to -7.5 feet MLLW at the bayward boundary and rise to -4 feet MLLW near the middle of the fill site. From there it would continue at -4 feet MLLW to the headwall. Approximate 125 cubic yards of material would be required to fill this southern eelgrass fill site. Clean washed sand is to be used so that it is free of fines and thus not a potential carrier of contaminants. A similar source sand was used to construct the Le Meridien.

Just north of the southern eelgrass fill area an additional, smaller fill area is proposed. This area, located between the two proposed gangways would be filled slightly to enhance the site’s ability to support eelgrass (Figure 4). The site would not be filled to the same extent as the southern area and there would be no significant structure holding back the fill sand. The area near the headwall would be filled to -4 feet MLLW with approximately 20 cubic yards of sand. The fill would be allowed to naturally slope to approximately -6 feet MLLW, the approximate depth where the fill site meets the adjacent artificial reef placement area. This eelgrass fill area would be approximately 390 square feet (36 square meters). The proposed project eelgrass mitigation area totals 1,165 square feet (108 square meters) across both planting areas.

In addition to the perforated stacked pipe reef used to retain the southern eelgrass planting area, a larger artificial reef placement area is proposed throughout the northern portions of the shallow, near-shore bench. This primary reef placement area is intended to offset the area of over-water coverage of the dock plan relative to the existing dock. The plan calls for the placement of 600 individual 2-foot a-jacks units placed in bundles. The a-jacks bundles would consist of groups of either 5 or 10 individual a-jacks structures. The layout depicted in Figures 4 and 5 consist of 30 and 60 of the large and small reef units, respectively. The distribution of the artificial reef units across the area depicted in Figure 3 would produce an artificial reef area of 1,710 square feet with approximately 50% of bottom cover by reef structures.
Three-dimensional oblique view of the proposed artificial reef placement area (bottom). Insets represent generalized arrangement of 2 foot a-jacks used to form the artificial reef units as groups of 5 a-jacks (right inset) and 10 a-jacks (left inset). The stacked pipe used to support the 775 square foot eelgrass fill area depicted in Figure two is shown in cross section (top right) and lateral view (top left).
EELGRASS MITIGATION CREDITS
With the creation and planting of the 1,165 square feet (108 square meters) of eelgrass, the Project’s eelgrass sites may produce an excess of up to 765 square feet (71 square meters) of eelgrass. This maximum number could increase if Project impacts are lower than assumed. This number can also decrease if additional eelgrass is identified during the Project’s pre-construction eelgrass survey. SDHE’s principal application of this surplus of eelgrass is to buffer against any shortfalls in order to ensure success of the mitigation needs for the project. In the event a surplus of eelgrass mitigation is generated, SDHE proposes that the additional eelgrass habitat be reserved as credits in an eelgrass mitigation bank or available for transferred for future in-water construction projects.

The Southern California Eelgrass Mitigation Policy states:

“Any mitigation transplant success that, after five years, exceeds the mitigation requirements may be considered as credit in a “mitigation bank”. Establishment of any “mitigation bank” and use of any credits accrued from such a bank must be with the approval of the resource agencies and be consistent with the provisions stated in this Policy. Monitoring of any approved mitigation bank shall be conducted on an annual basis until all credits are exhausted.”

EELGRASS DONOR SITES
Eelgrass for transplantation to the Project mitigation site will be salvaged from patches within the Project area. Salvaged eelgrass will come from patches that will be heavily shaded or growing in areas that will be covered by mitigation measures. The eelgrass currently on site is of low density and quality and will therefore provide only a small fraction of the required donor material. The balance of the required eelgrass will be harvested from nearby donor beds. The targeted eelgrass donor beds will be those beds adjacent to the San Diego Coast Guard facility located at 2710 North Harbor Drive, San Diego, CA (Figure 6). Harvesting efforts will be dispersed to minimize impacts to the harvest area.

To prevent adverse impacts to the donor beds, no more than 10% of the eelgrass within any localized donor area will be harvested; this will allow the beds to recover quickly. These donor beds have been selected based on a number of factors:

1) Proximity to the transplant receiver site, which favors both logistic convenience and selection of appropriate plant materials for the area;
2) Similarity in biological and physical characteristics to the receiver site;
3) Suitability of donor site size and eelgrass density to provide necessary transplant materials;
4) Recovery potential for the donor site; and,
5) Accessibility of the donor site and diver safety.

Shoreline staging and work areas will be situated adjacent to the Project restoration site.

TIMING OF THE MITIGATION WORK
The timing of mitigation is associated with the Project timing. The Project is scheduled to begin in September 2011. Construction is expected to take 4 months. The physical mitigation measures will
Proposed Eelgrass Donor Sites
San Diego Harbor Excursions Redevelopment Project

Figure 6
be installed after pile driving but prior to dock and gangway installation. Eelgrass planting will occur during the growth season. Dependent upon Project timing this may mean waiting until March 2012 to perform the transplant.

**TRANSLANT METHODS**

**TRANSLANT UNITS**
The proposed mitigation program will utilize anchored bare-root transplant units. Bare-root transplants are the preferred means of transplanting eelgrass in most situations, and anchored bare-root units are the primary planting units used in large-scale restoration projects at the current time. The survival of such planting units has been shown to be quite high when properly prepared (Fonseca *et al.* 1982; Merkel 1987, 1990a). Similarly, bare-root units have shown an ability to rapidly expand and colonize bare substrate (Merkel 1990b). In addition to offering high unit survival and rapid expansion rates, bare-root units can be prepared with limited damage to the donor bed. Unlike plug extractions, bare-root units can be prepared using materials collected without substantial sediment disturbance.

**BIODEGRADABLE ANCHORS**
The anchors used in this program will be biodegradable and pliable anchors such as those described in Merkel (1987) and used in eelgrass restoration projects throughout Mission Bay, San Diego Bay, and Agua Hedionda and Batiquitos Lagoons. The anchors consist of a cotton collar and a pliable paper anchor, which is planted parallel to, and approximately 4-6 inches below, the sediment surface.

**PLANTING UNIT SIZE**
For bare-root transplant units, Merkel (1990a) determined that differential survivability and unit performance exists between units of differing sizes (*i.e.*, differing numbers of rhizomes in planting unit bundles). Studies conducted in Sail Bay, Mission Bay in 1990 determined that the optimal transplant unit was comprised of 8-12 healthy turions/unit (Merkel 1990a). While the point of optimization is likely to differ among areas and environments, this size range has been used successfully in a number of transplant programs in southern California and has met with high unit success. Each transplant unit for the project work will consist of 8-12 turions. It is critical that anchor collars be sized appropriately such that rhizomes are held firmly, yet not substantially damaged by the collar.

**PLANTING UNIT SPACING**
Planting unit spacing is typically determined by balancing the rate of bed establishment with the cost of the transplant project. In some instances, rapid bed establishment is required to minimize potential storm damage or scouring of unconsolidated rhizome mats. In other cases, rapid recovery rates are desirable to meet bed establishment milestone objectives. Taking into account the rate of eelgrass growth during similar mitigation projects in the Port, a planting unit spacing of one meter on center will be used.

**PLANT COLLECTION**
Bare-root material will be collected from the donor beds by hand picking rhizomes out of the surface sediment layers and loosely filling a mesh bag with collected material. During eelgrass collection, care will be taken to work the rhizomes free as opposed to ripping the plants free of the
sediment. This will preserve as much root material as possible. Divers will move systematically through an area and collect no more than 10% of the plant material. Collected eelgrass will consist of no less than three healthy internodal segments with well-developed root initiates and vigorous shoots. More intact rhizome segments and roots are preferred for use in the planting unit bundles. Collected material will be held in a flow-through seawater source until it is processed into planting units. No material will be stored for over 8 hours from harvesting to unit preparation. Once units are prepared, they will be stored in open water for no longer than 24 hours prior to transplantation.

Prior to commencing work, a letter of permission to harvest and transplant will be obtained from the California Department of Fish and Game (CDFG).

PLANTING EELGRASS UNITS
The plant materials will be planted by excavating a hole in the sediments with a small trowel or by hand. The anchor will be planted parallel to the sediment surface and approximately 4 inches below the sediment surface. The root/rhizome bundle will be planted approximately 2 inches below the sediment surface. During planting, spot checks of the plantings will be made to ensure proper planting depth and firmness of the anchoring system.

MONITORING PROGRAM
PRE-TRANSPLANT ASSESSMENT SURVEY
The created mitigation site will be inspected by the Project marine biologist for planting suitability prior to transplantation. Following the final site contouring, a stabilization period will be allowed, during which time sediment monitoring stakes will be planted throughout the site to determine whether sediments shift excessively, or if they are stable enough for planting. Sediment stakes will be marked with a line and positioned so that the circumscribed line on the sediment stake is just visible above the bottom sediments. Site stability will be determined by both a review of divers' observations, and a review of sediment monitoring efforts, with careful attention given to slopes and elevated surfaces. For a spring season transplant project with no anticipation of additional winter storms, erosion rates of 0.5 mm/day are considered acceptable for eelgrass planting.

POST-PLANTING MONITORING
Upon completion of the planting effort, a monitoring program will be initiated and will continue for a 60-month (5-year) period as required by the SCEMP. Aerial extent and density of the transplanted eelgrass and control sites will be monitored using either sidescan sonar or diver transects across the planting sites. Randomly placed quadrats will be surveyed via SCUBA to determine eelgrass turion density.

The monitoring program will be conducted at intervals of 0, 6, 12, 24, 36, 48, and 60-months post-transplant. When monitoring dates fall outside of the normal eelgrass growing season, dates will be shifted to coincide with the growing season to ensure that valuable information on growth and survival is collected. For each monitoring, a summary report will be prepared and submitted to the resource and regulatory agencies within 30 days of completion of the monitoring survey.

CONTROL SITE MONITORING
An eelgrass monitoring control site will be established nearby to the Project site. The site shall be selected with the following factors under consideration:
1) Proximity to the mitigation site;
2) Similarity in biological characteristics to the restoration; and,
3) Merkel & Associates has monitored nearby sites for previous transplant programs. If appropriate a previously surveyed site will be chosen to increase the robustness of the data record.

**MONITORING REPORTS**

Monitoring reports will include information from previous monitoring intervals, including numerical comparisons and graphical presentations of changing bed configurations. The monitoring report will include an analysis of any declines or expansions in eelgrass coverage based on physical conditions of the site, as well as any other significant observations. Each report will include an analysis of the mitigation site relative to mitigation milestones. Reports will include the two-page summary report required under the latest revision of the SCEMP. Finally, the monitoring report will provide a prognosis for the future of the eelgrass bed and will identify the timing for the next monitoring period.

**MITIGATION SUCCESS CRITERIA**

Mitigation will be deemed successful when it has met the success criteria outlined in the SCEMP. Criteria for determination of transplant success will be based upon a comparison of vegetation coverage (area) and density (turions per square meter) between the control area and the mitigation site. Extent of vegetation cover is defined as the area where eelgrass is present and where gaps in coverage are less than 1 meter between individual turion clusters. Density of shoots is identified as the number of turions per meter, as measured from representative areas within the control or transplanted beds. Key success criteria are as follows:

A) A minimum of 70 percent areal coverage and 30 percent density should be achieved after the first year.
B) A minimum of 85 percent areal coverage and 70 percent density should be achieved after the second year.
C) A minimum of 100 percent areal coverage and 85 percent density should be achieved for the third, fourth, and fifth years.

Areas that do not meet the above success criteria will be re-vegetated, and monitored for another five-year period, until the final goal is achieved. Should replanting of the areas at the project site fail to meet the success criteria, an alternative mitigation site will be selected to meet the mitigation requirements.

Should the control area experience a decline in eelgrass cover or density for reasons outside the control of the Project applicant, the applicant will not be held responsible for similar declines in the mitigation area.

Monitoring reports will be submitted to SDHE for submission to appropriate state and federal agencies.
MITIGATION SITE RESPONSIBILITY
The eelgrass beds impacted at the Project site are within navigable waters of the United States and controlled under the authority of the Port of San Diego. The Port leases the shore-side and water area of the Project area to the operator. As such, the Port is responsible for designation and authorization of land and water uses within the leaseholds, including protection of mitigation site constructed within Port waters. At this site, the Port would authorize the proposed project including the use of the area for mitigation purposes. Any future disturbance of this mitigation area would require subsequent Port authorization and Corps permitting. As a result, the mitigation sites are protected under the lease and federal regulation until such time as the lease is revoked or otherwise transferred. Termination of the lease would either cause the removal of the structures resulting in impact, allowing for recovery of function, or would result in a transfer of protection obligations to a new party.

REFERENCES


