State of California Department of Transportation

San Francisco – Oakland Bay Bridge
East Span Seismic Safety Project

EELGRASS HABITAT SURVEYS

FOR THE EMERYVILLE FLATS AND CLIPPER COVE, YERBA BUENA ISLAND (October 1999-2005, and 2007)

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TABLE OF CONTENTS

1.0 INTRODUCTION 1

1.1 PROGRAM OBJECTIVES 1
1.2 EELGRASS BACKGROUND 1
1.2.1 General 1
1.2.2 Functions and Values 2
1.2.3 San Francisco Bay Eelgrass Resources 2
1.2.4 Regulatory Framework for Eelgrass Conservation and Restoration 3
1.3 DESCRIPTION OF THE SURVEY AND CONSTRUCTION AREAS 3

2.0 SURVEY METHODS 4

2.1 SURVEY DATA INTERPRETATION AND EELGRASS MAPPING 6

3.0 RESULTS 6

3.1 EMERYVILLE FLATS AND CLIPPER COVE 6

4.0 DISCUSSION 6

4.1 EELGRASS HABITAT DYNAMICS 6
4.2 CAUSES FOR FLUCTUATIONS IN EELGRASS COVERAGE 14

5.0 REFERENCES 17

FIGURES

Figure 1. San Francisco-Oakland Bay Bridge East Span Survey Area Vicinity Map 5
Figure 2. Eelgrass Habitat Density Classification from Side-Scan Survey Records 7
Figure 3a. Eelgrass Distribution within the Emeryville Flats Survey and Construction Areas (September 2007) 8
Figure 3b. Eelgrass Distribution within the Clipper Cove Survey Area (September 2007) 9
Figure 4. Cumulative frequency of eelgrass coverage at Emeryville Flats from 1999 to 2007 12
Figure 5. Cumulative frequency of eelgrass coverage at Yerba Buena Island from 1999 to 2007 13
Figure 6. Eelgrass percent coverage within two depth ranges at Emeryville Flats 16

TABLES

Table 1. Eelgrass Bed Cover within East Span Project Survey Areas 11

APPENDICES

Appendix A. Cumulative Eelgrass Maps of Previous Surveys at Emeryville Flats, Clipper Cove, and Coast Guard Cove

1.0 INTRODUCTION

The California Department of Transportation (Caltrans) is replacing the East Span of the San Francisco – Oakland Bay Bridge (SFOBB) as part of seismic upgrades to improve bridge safety in the state. This project (East Span Project) has the potential to impact existing natural eelgrass (*Zostera marina* L.) communities both during and following construction. Caltrans contracted with Merkel and Associates (M&A) to determine the limits of eelgrass distribution within and near the East Span Project area.

1.1 PROGRAM OBJECTIVES

The main objectives of this study are to assess the eelgrass distribution within the East Span Project area, to evaluate the extent of project impacts, and to determine the appropriate mitigation measures. To complete these objectives, M&A has completed eelgrass surveys over the course of eight years. Surveys have been completed in October 1999, 2000, 2001, 2002, 2003, 2004, 2005 and late September 2007 to correspond to the peak extent of eelgrass coverage prior to entering into a winter dormancy and dieback period. Surveys were conducted within and near the construction work areas of the East Span Project at the Oakland Touchdown and Yerba Buena Island (YBI).

Other objectives are as follows:

1. To provide an estimate of the distribution, abundance, and density of eelgrass habitat within the vicinity of the proposed project and reference areas;

2. To evaluate annual eelgrass bed dynamics within the survey area and explore the natural fluctuations in eelgrass density and coverage observed between 1999 and 2007;

3. To aid in assessing impacts to eelgrass resources associated with project construction and provide a comparative analysis using pre- and post-construction survey data.

1.2 EELGRASS BACKGROUND

1.2.1 General

Eelgrass (*Zostera marina* L.) is a native marine vascular plant indigenous to the soft-bottom bays and estuaries of the Northern Hemisphere. The species ranges from Baja to northern Alaska along the West Coast of North America and is common in shallow bays and estuaries. Within the southern portion of its range, eelgrass growth is generally limited at the shoreward edge by desiccation stress at low tides. Throughout its range, eelgrass is generally limited along its deeper fringe by light limitation, expressed as the photo compensation depth (the depth at which photosynthesis is unable to meet the metabolic demands of the plant to sustain net growth). Eelgrass meadows occur within the shallow bay habitats and in the more saline brackish water interfaces of the San Francisco Bay estuary.

1.2.2 Functions and Values

Eelgrass plays a major role in nearshore coastal habitats. For example, eelgrass clarifies water through sediment trapping and substrate stabilization (Wyllie-Echeverria and Rutten 1989), cycles nutrients, and oxygenates water. Perhaps one of its most important functions is primary production through providing the base of a detrital-based food web and direct grazing by invertebrates, fish, and birds. Eelgrass provides habitat to an abundant and diverse array of invertebrates and fish, and also is considered to be an important resource for migratory birds. Studies in San Francisco Bay and other aquatic systems in California have demonstrated the abundance of fish and invertebrates within eelgrass beds (Hoffman 1986, Kitting 1994). Eelgrass is a nursery habitat for many commercially and recreationally important finfish and shellfish species including those that are resident within bays and estuaries, nearly all of the anadramous fish species found along the Pacific coast, and oceanic species which enter the estuaries to breed or spawn. Pacific herring regularly spawn on eelgrass leaves and salmonid fry and smelt often spend extensive amounts of time within eelgrass habitats prior to heading for the open ocean. Among other recreationally important species, striped bass and sturgeon both use eelgrass beds as habitat within San Francisco Bay. Eelgrass is also particularly important to waterfowl such as black brant that feed directly on the plants and a number of species that make a diet of both the eelgrass plants and the epiphytic growth that occurs on the leaf tissues (Ehrlich *et al*. 1988). Furthermore, eelgrass habitat supports a diverse community of marine species that are neither commercially nor recreationally critical and whose ecological roles are not well understood.

1.2.3 San Francisco Bay Eelgrass Resources

The San Francisco estuary is the second largest estuary in the nation and the largest estuary on the Pacific coast, consisting of approximately 291,840 acres (118,000 hectares) of water surface at high tide. In the late 1920s, eelgrass was reported as an abundant species along the shores of San Francisco Bay (Setchell 1929). More recently, a 1987 National Marine Fisheries Service (NOAA Fisheries) survey of the Bay revealed only 316 acres (128 hectares) (0.1% total Bay bottom coverage) of eelgrass throughout the Bay with much of the existing habitat exhibiting conditions of environmental stress (Wyllie-Echeverria and Rutten 1989, Wyllie-Echeverria 1990). In comparison, the percent coverage of eelgrass in other bay and estuary systems such as San Diego Bay (11.4%), Mission Bay (55%), Humboldt Bay (approximately 20%), Tomales Bay (13%), and Coos Bay (approximately 5%) is much higher than San Francisco Bay. Nutrient and sediment loading in the runoff from the metropolitan area as well as dredging and filling appear to have taken their toll on eelgrass resources of San Francisco Bay. However recent work indicates that conditions may not be as bleak as once thought. In 2003, 2,618 acres (1,060 hectares) of eelgrass was mapped during the Baywide Eelgrass Inventory (Caltrans and NOAA Fisheries 2004). These data suggest that either a significant expansion of eelgrass habitat has occurred since 1987 or that improved survey techniques have identified more eelgrass than was detectable using prior techniques. However, the occurrence of eelgrass within San Francisco Bay is still as much as two orders of magnitude lower than that found in other large bays and estuaries along the Pacific coast.

1.2.4 Regulatory Framework for Eelgrass Conservation and Restoration

Eelgrass, as a vegetated shallow water habitat, is protected under the Clean Water Act, 1972 (as amended), section 404(b)(1), "Guidelines for Specification of Disposal Sites for Dredged or Fill Material", subpart E, "Potential Impacts on Special Aquatic Sites". This area includes sanctuaries and refuges, wetlands, mudflats, vegetated shallows, coral reefs, riffle, and pool complexes.

1.3 DESCRIPTION OF THE SURVEY AND CONSTRUCTION AREAS

The area in the vicinity of the East Span Project, extending from the eastern touchdown of the SFOBB to YBI, was assessed for eelgrass coverage in 1999. Based on the water depths that are potentially suited to support eelgrass beds, Emeryville Flats, north of the eastern touchdown of the SFOBB, and Clipper Cove at YBI, were selected as areas for focused eelgrass surveys (Figure 1). Construction areas were designated at Emeryville Flats and Clipper Cove as those areas that were within the area of potential effect of construction. Surrounding the construction areas were larger survey areas. The survey areas were used to provide baseline data for the natural fluctuations of eelgrass beds within the vicinity of the construction areas.

The Emeryville Flats survey area consisted of the Emeryville Flats near Radio Beach, located north of the existing bridge at the Oakland Touchdown. In the 1999 survey the Oakland Outer Harbor Flat, a deeper location to the south of the Oakland Touchdown, was also surveyed. The Emeryville Flats survey area is 64.8 acres (26.2 hectares) and the construction area within it is 6.7 acres (2.7 hectares). Surveys at this site have been completed from 1999 through 2005, and 2007.

In 2007, a construction area turbidity curtain was erected adjacent to the Oakland Touchdown area at the Emeryville Flats. This turbidity curtain blocked survey access to portions of the construction area. This altered the Emeryville Flats survey area during the 2007 survey year to a 59.2-acre (23.9-hectare) survey area bounded by the turbidity curtain to the southwest. While surveys were not conducted south of the turbidity curtain, eelgrass was observed in this area and was plotted with an approximate boundary of the visually detected eelgrass. This eelgrass was not quantified in the 2007 survey since it could not be precisely mapped.

The YBI survey area consisted of Clipper Cove, adjacent to the northern shore of YBI to the north of the existing bridge and Coast Guard Cove located to the south of the YBI touchdown near the U.S. Coast Guard station. Clipper Cove was surveyed in October 1999 through 2005 and again in 2007. Coast Guard Cove was surveyed in the 1999 baseline and again in 2004 and 2005. The 2004-2005 surveys of Clipper Cove were initiated due to a change in construction strategy involving the South-South Detour section of the project.

The Clipper Cove survey area is 27.1 acres (11.0 hectares) and the approved construction area within it is 6.2 acres (2.5 hectares). This area was proposed for a temporary trestle and marine access. Since prior surveys, the need for Clipper Cove construction work has been re-evaluated, and the contractor is proposing a different construction work area located to the east of the existing approved work area. This newly proposed work area is located outside of all of the Clipper Cove eelgrass beds.

The Coast Guard Cove survey area is 8.5 acres (3.4 hectares) and the approved construction area within it is 2.5 acres (1.0 hectare). The construction area within Coast Guard Cove was designated for future temporary trestle use and marine access. Impacts to eelgrass beds resulting from the trestle use are expected to be temporary with subsequent trestle removal and repair of site damage. This was discussed at the March 2003 Interagency Biological Mitigation Work Group meeting wherein resource agencies agreed that if eelgrass restoration efforts associated with the project were successful elsewhere the minor area of temporary impacts from a Coast Guard Cove marine trestle would not require additional mitigation.

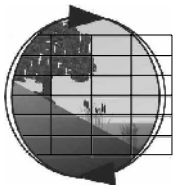
The survey areas include a variety of exposures to wind, waves and currents, and are characterized by variable sediment conditions. The harshest wind and wave environment is found on the Emeryville Flats. Clipper Cove, a more sheltered environment, is only subject to short-fetch, infrequent easterly waves. There is substantially greater wave-generated re-suspension of bottom sediments at Emeryville Flats than in the more protected waters of Clipper Cove. As a result, higher turbidity occurs at the Emeryville Flats than at Clipper Cove. Sediments at the survey sites range from sand along the shallow shoals of Emeryville Flats to finer silty-sands within Clipper Cove. The eelgrass survey areas range from shallow intertidal elevations (deeper than + 1.6 feet [+0.5 meter] Mean Lower Low Water [MLLW]) to shallow subtidal depths (shallower than -9.8 feet [-3.0 meter] MLLW).

2.0 SURVEY METHODS

A combination of acoustic (side-scan sonar) and diver surveys were used to map the eelgrass beds and to assess bed density and turion densities within individual eelgrass patches. These methods have been used in the seven previous annual surveys at these areas and have been used in eelgrass surveys of Richmond Harbor (SAIC and Merkel & Associates 1997a; Merkel & Associates 1999a), the Baldwin Ship Channel (SAIC and Merkel & Associates 1997b), along the Richmond – San Rafael Bridge (Merkel & Associates 1997), the Oakland Middle Harbor Shoal (Merkel 1999b), and the Baywide Eelgrass Inventory (Caltrans and NOAA Fisheries 2004). Because of the sparse occurrence of eelgrass found during the East Span Project eelgrass surveys, mapping techniques and areal coverage determination made use of a mix of analytical techniques (SAIC and Merkel & Associates 1997a and 1997b, Merkel 1988 and 1992, U.S. Navy SWDIV 1994).

Side-scan methodology with an integrated differential global positioning system (dGPS) was utilized to determine eelgrass areal coverage. Data were collected using a side-scan sonar operating at 600 kilohertz (kHz) scanning out 66 feet (20 meters) on both the starboard and port channels, creating a 130-foot (40-meter) swath. The surveys were conducted by running transects that were spaced approximately 125 feet (38 meters) apart in order to ensure overlap between transects. The side-scan was positioned approximately 3.3 feet (1 meter) below the water surface. SCUBA divers measured turion densities at Emeryville Flats within identified eelgrass patches. Turion density was measured by counting all of the turions within 1/16-square-meter quadrats (n = 30).

The 2007 annual eelgrass surveys, including diver turion counts, at the East Span Project survey area were conducted on September 20, 2007.



N
W E
S

1" = 1000'

San Francisco-Oakland Bay Bridge East Span
Survey Area Vicinity Map
(Source: USGS 7.5' Oakland West, CA Quadrangle)

Figure 1

2.1 SURVEY DATA INTERPRETATION AND EELGRASS MAPPING

Defining the edges of the eelgrass beds is critical to determining the total eelgrass coverage in the survey area. For the purpose of this survey, a given eelgrass bed included many clustered eelgrass patches and the edges were determined by locating the greatest extent of the eelgrass patches within the survey area. Within the boundaries of the bed, eelgrass was subdivided into four categories of percent coverage, 0%, 5%-20%, 20%-40%, and greater than 40% cover (Figure 2). Percent coverage for the purposes of this report is defined as the percentage of area occupied by eelgrass shoots within a given eelgrass patch. A minimum coverage of 5% was used for mapping purposes and to define aggregations of eelgrass plants that constitute a bed. Individual plants were considered to be the boundaries of the bed in instances where individual plants were too far apart to constitute 5% plant cover.

Following completion of the surveys, sonar traces were downloaded, processed, and geographically registered using ArcView Version 3.2a and eelgrass habitat was digitized as a theme over an AutoCAD basemap provided by PB. All maps were generated based on California State Plane Zone 3 (NAD 83).

3.0 RESULTS

3.1 EMERYVILLE FLATS AND CLIPPER COVE

During the 2007 survey, 14.2 acres (5.7 hectares) of eelgrass were mapped within the entire survey area of the Emeryville Flats. From this total, 0.7 acres (0.3 hectare) were mapped in the construction area (Figure 3a). A dense core of eelgrass surrounded by less dense fringes categorized the eelgrass bed at Emeryville Flats. Within the survey area 37% of the eelgrass was in the > 40% coverage category. The eelgrass in the construction area was less dense than the survey area as a whole; in the construction area 14% of the eelgrass was in the > 40% coverage category.

At Clipper Cove, 0.6 acre (0.2 hectare) of eelgrass was mapped in the survey area. From this total 0.3 acre (0.1 hectare) of this was mapped within the construction area (Figure 3b). The eelgrass coverage at this location ranged from 20% to greater than 40%.

4.0 DISCUSSION

4.1 EELGRASS HABITAT DYNAMICS

For environmentally stressed areas, the size, shape, and density of eelgrass beds can be highly variable. Under optimal growing conditions, extrinsic environmental influences may not result in recognizable effects on eelgrass distribution or abundance. In marginal environments, however, minor changes in the extrinsic environment may result in a substantial expansion or decline in eelgrass because additive stress can create unfavorable growth conditions. The Emeryville Flats and Clipper Cove are considered marginal environments, when compared to other eelgrass ecosystems on the Pacific coast, due to high turbidity that results in low light conditions. Therefore, these sites can be subject to significant variability in eelgrass coverage as a result of minor environmental flux. The changes in eelgrass coverage observed throughout the eight years of surveys have raised the question as to what the “normal” condition is for these beds and how such noticeable changes could occur between years.

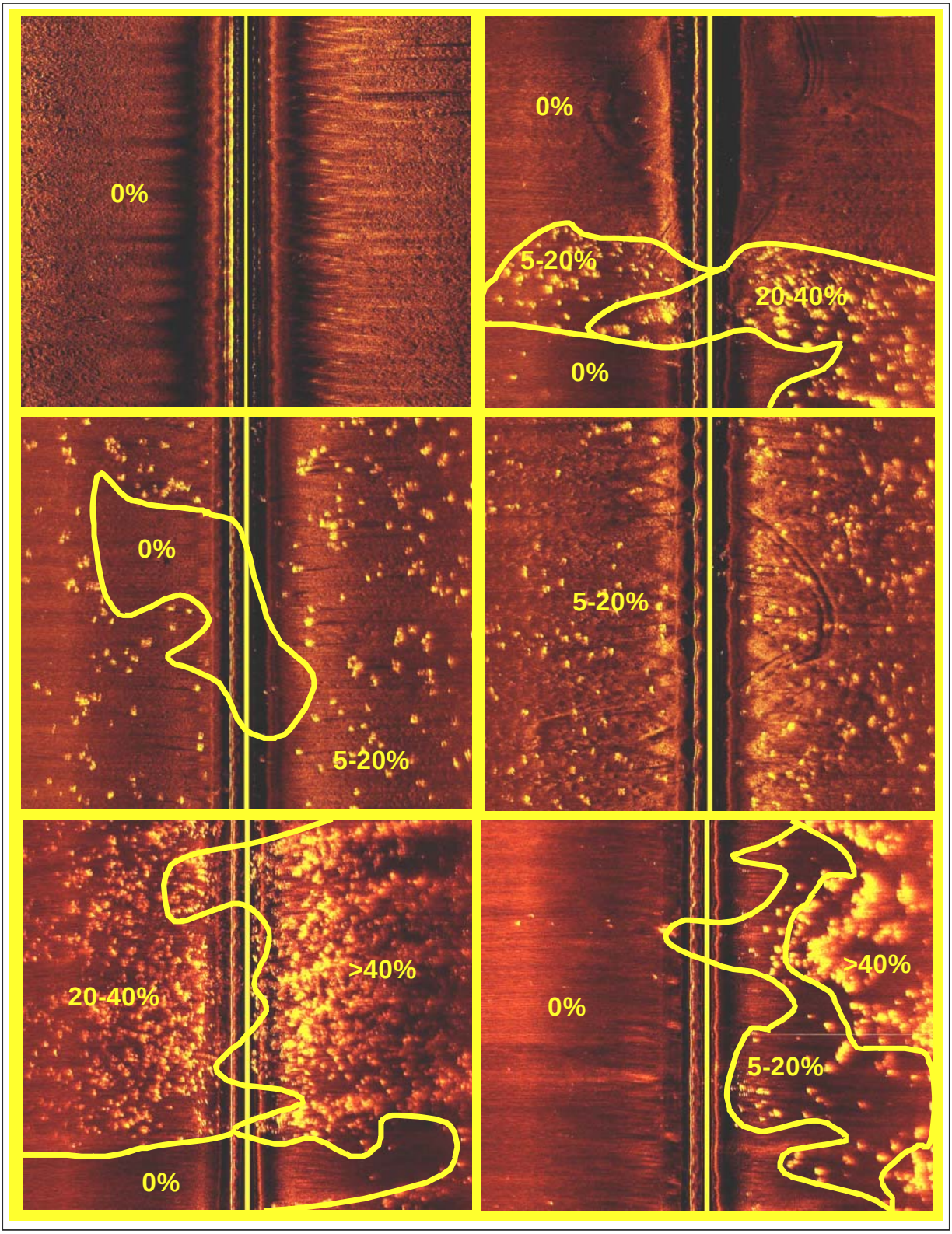
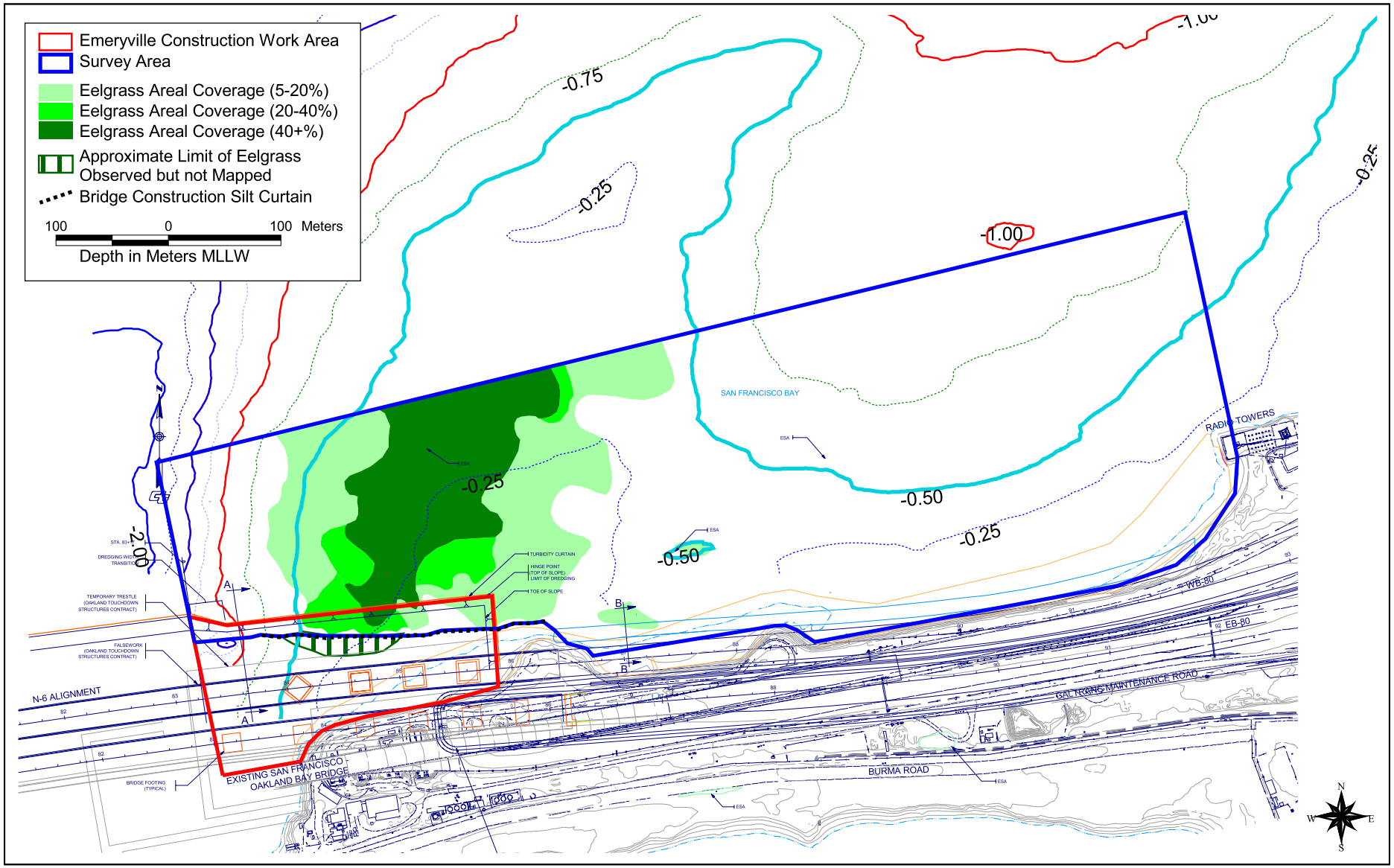
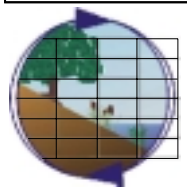


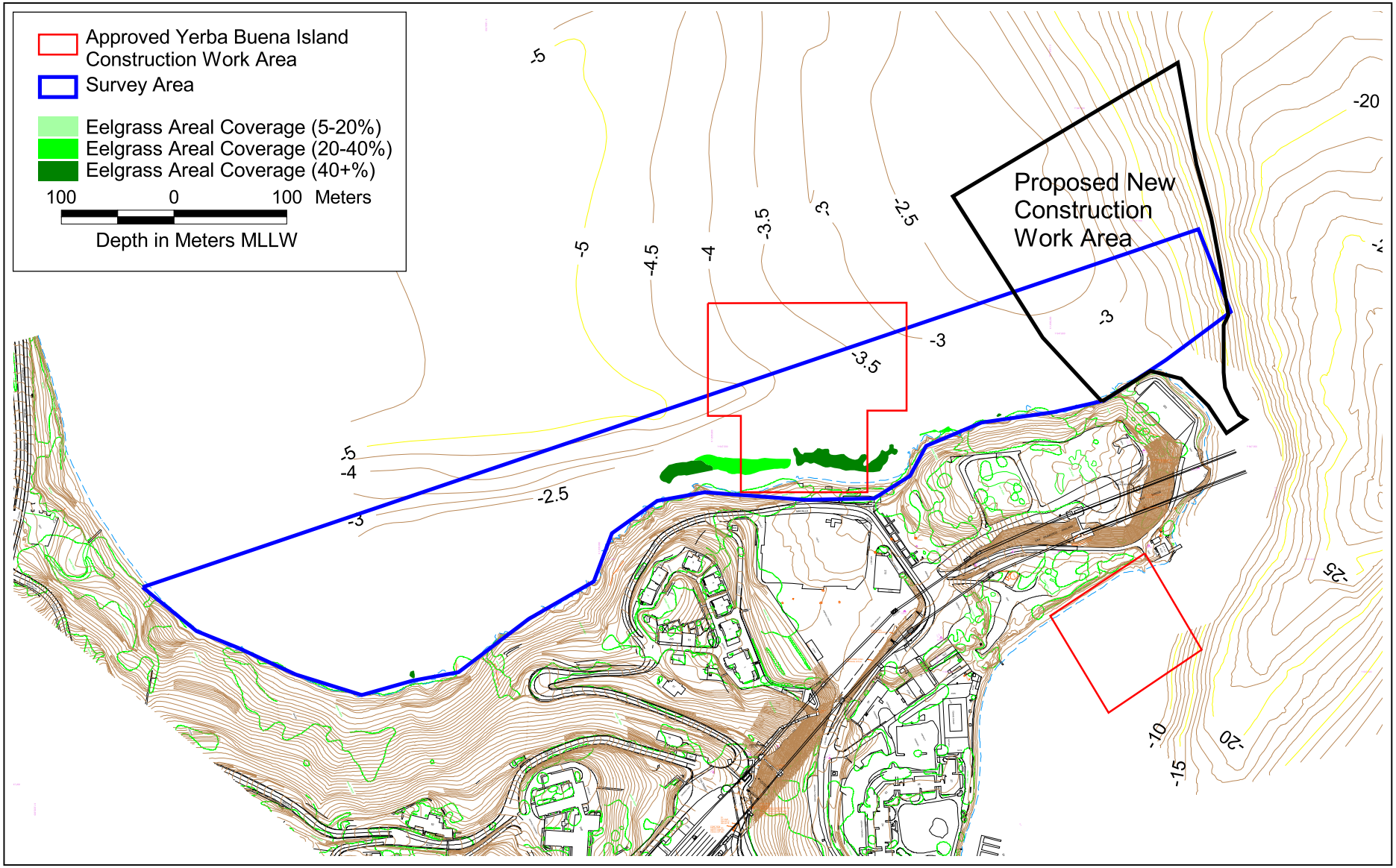
Figure 2. Eelgrass Habitat Density Classification from Side-Scan Survey Records

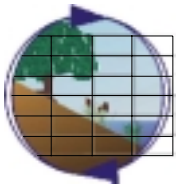




Eelgrass Distribution within the Emeryville Flats Survey and Construction Areas (2007)

Figure 3a





Eelgrass Distribution within the Yerba Buena Island, Clipper Cove Survey Area (2007)

Figure 3b

Substantial changes in eelgrass coverage have been observed within the East Span Project survey areas since the monitoring program began in 1999 (Table 1 & Appendix A). The general trend that has been observed is increased coverage from 1999 to 2001 and decreased coverage from 2001 to 2005. The 2007 survey records a 2.4 acres (0.9 hectare) increase in total eelgrass coverage at Emeryville Flats from the last survey in 2005, representing an 20% increase (Table 1). However, eelgrass density has decreased since 2005 at the Emeryville Flats. In 2005 the coverage of eelgrass in the >40% coverage category was about 47% of the total coverage and in the 2007 survey it was about 37%. During the same period, the 5 – 20% coverage category increased from 38% to 52% of the total coverage.

Within the Emeryville Flats construction area a decrease in eelgrass was observed. Eelgrass coverage dropped from 1.7 acres (0.7 hectares) in 2005 to 0.7 acres (0.3 hectare) in 2007, representing a 59% decrease. This change corresponds to a decrease in coverage within the 5-20% and >40% coverage categories and an increase in eelgrass coverage within the 20-40% coverage category. From 2005 to 2007 eelgrass coverage in the 5-20% category dropped by 77% from 1.3 (0.5 hectare) to 0.3 acre (0.1 hectare), and coverage in the >40% category was reduced by 75% from 0.4 acre (0.2 hectare) to 0.1 acre (<0.1 hectare). Eelgrass coverage increased in the 20-40% category from zero to 0.3 acre (0.1 hectare) from 2005 to 2007.

At Clipper Cove, total eelgrass coverage increased substantially from 0.2 acre (0.1 hectare) to 0.6 acre (0.2 hectare), representing a 300% increase. From 2005 to 2007 eelgrass coverage within the 5-20% category dropped from 0.2 acre (0.1 hectare) to zero while eelgrass coverage within the 20-40% category increased from zero to 0.2 acre (0.1 hectare). Between 2005 and 2007 the largest change in eelgrass coverage occurred within the >40% category with an increase from <0.1 acre to 0.4 acre (0.2 hectare). A corresponding increase was also observed in the adjacent area that was previously delineated for the approved construction access area, where total eelgrass coverage increased from 0.1 acre (<0.1 hectare) in 2005 to 0.3 acre (0.1 hectare) in 2007. No eelgrass coverage is found within the surveyed portions of the proposed construction work area and due to water depth, no eelgrass is expected within the areas that were not surveyed in the present investigations.

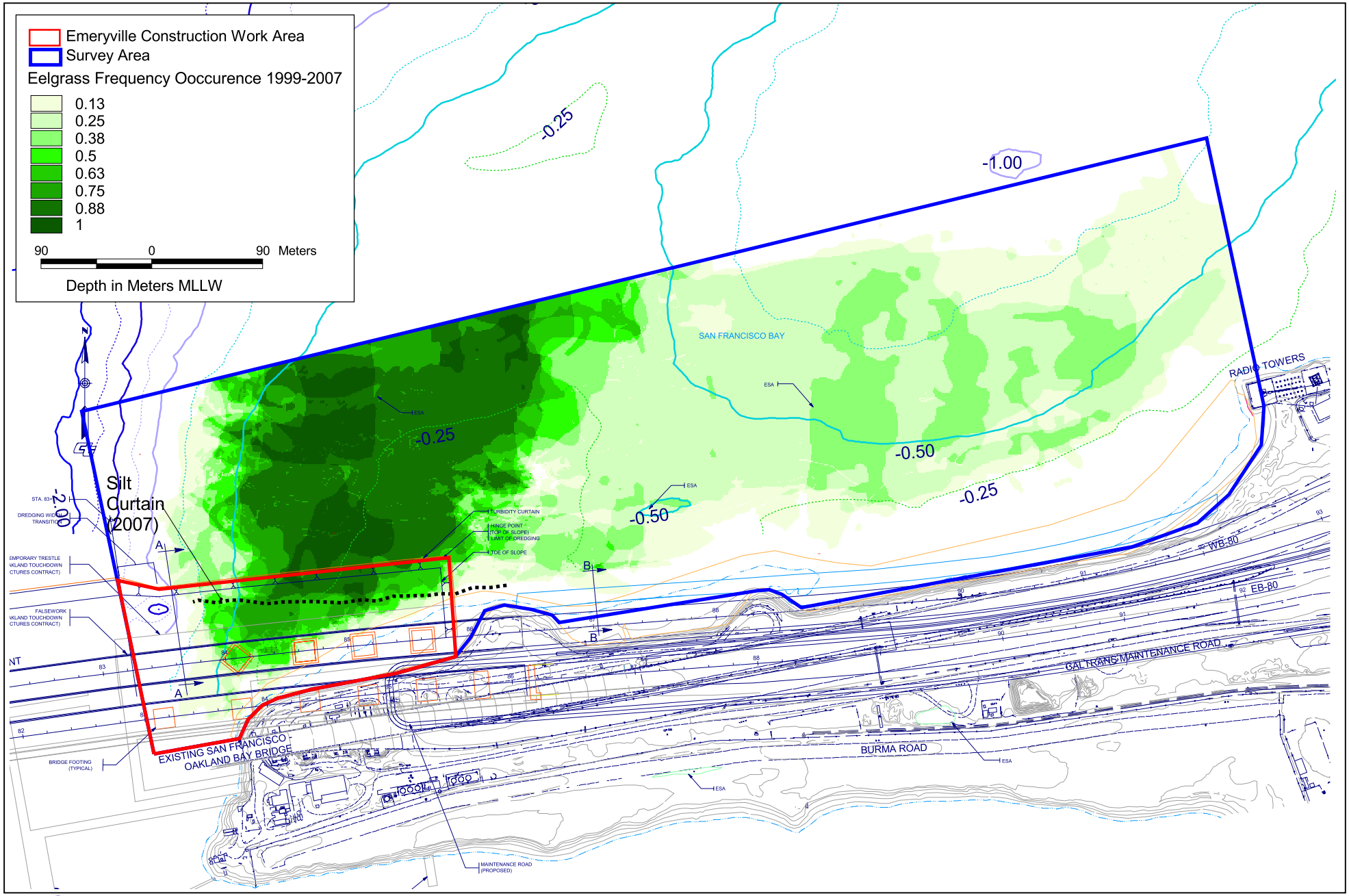
Throughout the eight annual surveys, the largest, most stable area of eelgrass at the Emeryville Flats occurred on the sandy shoal area near the Oakland Touchdown of the SFOBB (Figure 4). This stable core of the eelgrass bed is surrounded by less stable areas fringing on the upper and lower edge of the bed and towards Radio Point Beach. Eelgrass within Clipper Cove was even less stable from year to year (Figure 5).

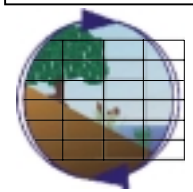
Eight years of survey data indicate that fluctuations in eelgrass coverage have occurred on the deeper edges of eelgrass growth, in the more light-limited environments, and in many areas eelgrass has been absent for the past several years. Alternatively, the shallow upper edges of the eelgrass bed at Emeryville Flats (–1.5 foot (-0.5 meter) to 0 foot (0 meter) MLLW) became more developed from 2000 to 2004. In these shallow areas, eelgrass beds grew from sparsely scattered plants to dense beds. From 2005 to 2007 these beds have thinned back to a patchy distribution pattern.

Table 1. Eelgrass Bed Cover within East Span Project Survey Areas

SURVEY AREA	5-20%	20-40%	>40%	Total
	Eelgrass coverage in acres (hectares)*			
Emeryville Flats Survey Area				
1999	15.8 (6.4)	0.5 (0.2)	0.7 (0.3)	17.0 (6.9)
2000	18.8 (7.6)	14.1 (5.7)	2.0 (0.8)	34.9 (14.1)
2001	16.8 (6.8)	16.8 (6.8)	1.8 (0.7)	35.4 (14.3)
2002	3.4 (1.4)	2.2 (0.9)	9.3 (3.8)	14.9 (6.0)
2003	2.1 (0.8)	4.3 (1.7)	3.6 (1.5)	10.0 (4.0)
2004	2.3 (0.9)	0.7 (0.3)	9.8 (4.0)	12.8 (5.2)
2005	4.5 (1.8)	1.7 (0.7)	5.6 (2.3)	11.8 (4.8)
2007	7.4 (3.0)	1.6 (0.6)	5.2 (2.1)	14.2 (5.7)
Mean	**8.9 (3.6)**	**5.2 (2.1)**	**4.7 (1.9)**	**18.9 (7.6)**
Emeryville Flats Construction Area				
1999	0.4 (0.1)	0.4 (0.2)	0.0 (0.0)	0.8 (0.3)
2000	1.5 (0.6)	1.5 (0.6)	0.2 (0.1)	3.0 (1.2)
2001	1.1 (0.5)	0.7 (0.3)	0.4 (0.2)	2.2 (0.9)
2002	0.6 (0.2)	0.6 (0.3)	0.5 (0.2)	1.7 (0.7)
2003	0	1.4 (0.6)	0	1.4 (0.6)
2004	1.1 (0.5)	0.2 (0.1)	1.5 (0.6)	2.8 (1.1)
2005	1.3 (0.5)	0	0.4 (0.2)	1.7 (0.7)
2007	0.3 (0.1)	0.3 (0.1)	0.1 (<0.1)	0.7 (0.3)
Mean	**0.8 (0.3)**	**0.6 (0.3)**	**0.4 (0.2)**	**1.8 (0.7)**
Yerba Buena Survey Area				
1999	0	1.2 (0.5)	0	1.2 (0.5)
2000	1.2 (0.5)	0.7 (0.3)	0	1.9 (0.8)
2001	0.1 (< 0.1)	0.2 (0.1)	0.1 (< 0.1)	0.4 (0.2)
2002	0.1 (< 0.1)	0.1 (< 0.1)	0	0.2 (0.1)
2003	0.3 (0.1)	0.2 (0.1)	0	0.5 (0.2)
2004	0	0.9 (0.4)	0	0.9 (0.4)
2005	0.2 (0.1)	0	<0.1(< 0.1)	0.2 (0.1)
2007	0	0.2 (0.1)	0.4 (0.2)	0.6 (0.2)
Mean	**0.2 (0.1)**	**0.4 (0.2)**	**0.1 (<0.1)**	**0.7 (0.3)**
Yerba Buena Construction Area				
1999	0	0.2 (0.1)	0	0.2 (0.1)
2000	0.5 (0.2)	0.2 (0.1)	0	0.7 (0.3)
2001	0	0.1 (< 0.1)	0	0.1 (< 0.1)
2002	0.1 (< 0.1)	0.1 (< 0.1)	0	0.1 (< 0.1)
2003	0.2 (0.1)	0.2 (0.1)	0	0.4 (0.2)
2004	0	<0.1(< 0.1)	0	<0.1(< 0.1)
2005	0.1 (< 0.1)	0	<0.1(< 0.1)	0.1(< 0.1)
2007	0	0.1 (<0.1)	0.2 (0.1)	0.3 (0.1)
Mean	**0.1 (<0.1)**	**0.1(<0.1)**	**<0.1(< 0.1)**	**0.2 (0.1)**

***English-metric converted values may differ due to rounding.**

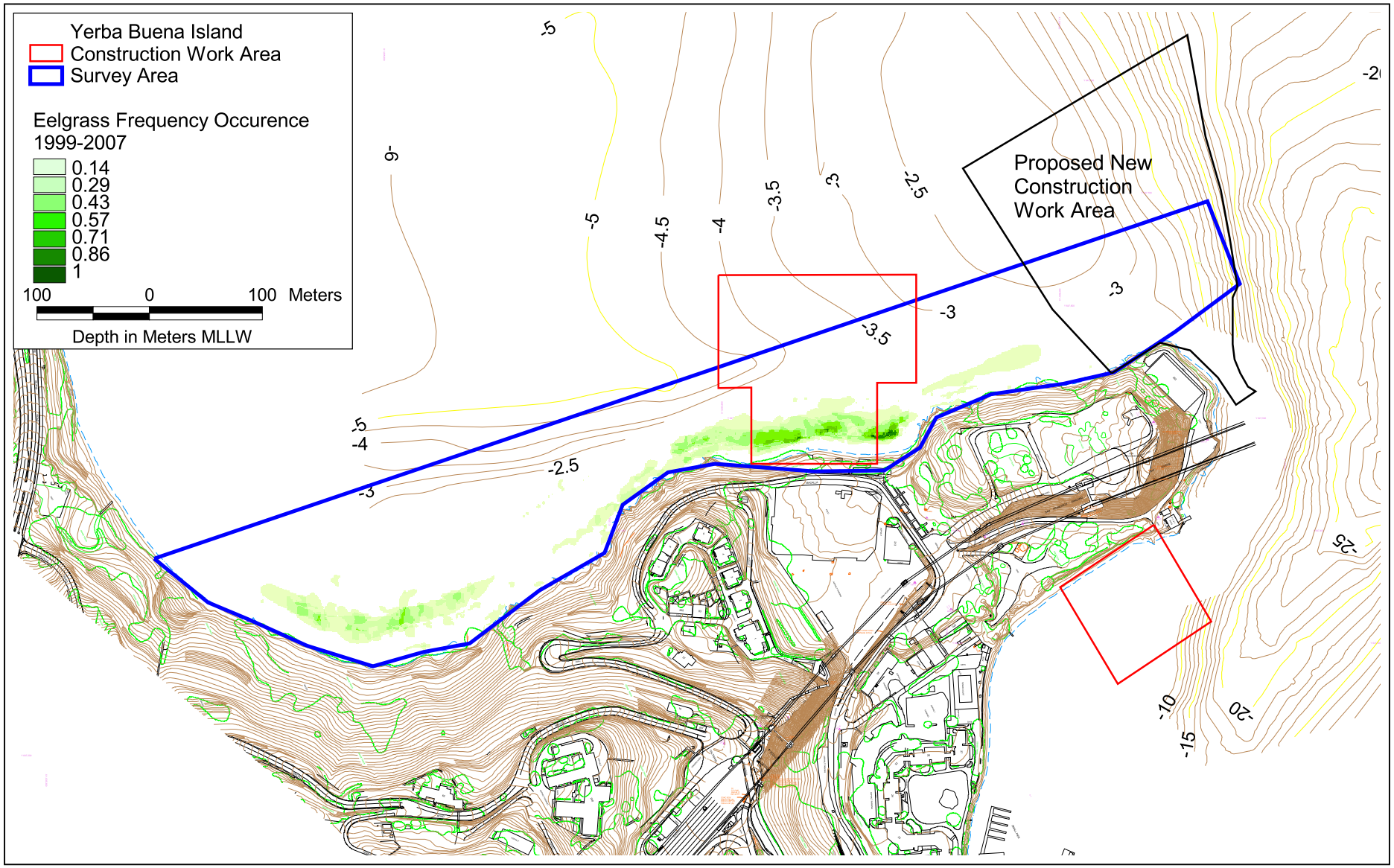


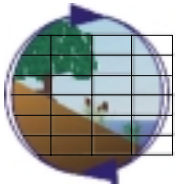


Cumulative Frequency of Eelgrass at Emeryville Flats from 1999 to 2007

Merkel & Associates, Inc.

Figure 4





Cumulative Frequency of Eelgrass Coverage at Yerba Buena Island (1999-2007)

Figure 5

The narrow depth range of eelgrass within the survey areas compounds the stressful growing conditions resulting from high turbidity. For example, at Emeryville Flats in October 1999 the entire extent of the mapped eelgrass beds occurred within a range of depths less than 3.3 feet (1.0 meter). Between 1999 and 2000, a large increase in eelgrass coverage was observed and most of the gain in coverage took place at the lower depth limit. Thus, eelgrass had a wider distribution in October 2000 and 2001, extending across depth ranges in excess of 5.6 feet (1.7 meters) and 4.9 feet (1.5 meters), respectively. During the declines in eelgrass coverage observed at Emeryville Flats in 2002 and 2003, the depth range decreased to 3.3 feet (1.0 meters) and 1.6 feet (0.5 meters), respectively, and the declines in eelgrass coverage were observed on the deep edges of the bed. A slight increase in eelgrass density observed from 2005 to 2007 at the Emeryville Flats was observed on the eastern edge of the bed. The fluctuations observed in eelgrass coverage at Emeryville Flats between 1999 and 2007 are typical for marginal environments with very flat bathymetry (Merkel 1992).

4.2 CAUSES FOR FLUCTUATIONS IN EELGRASS COVERAGE

The environmental changes that have allowed expansion and contraction of eelgrass coverage within the survey areas are largely unknown, but the following discussions on eelgrass dynamics may provide a better understanding of these changes. The mechanisms creating such variability could be natural annual variations, episodic environmental events, or human-induced environmental changes.

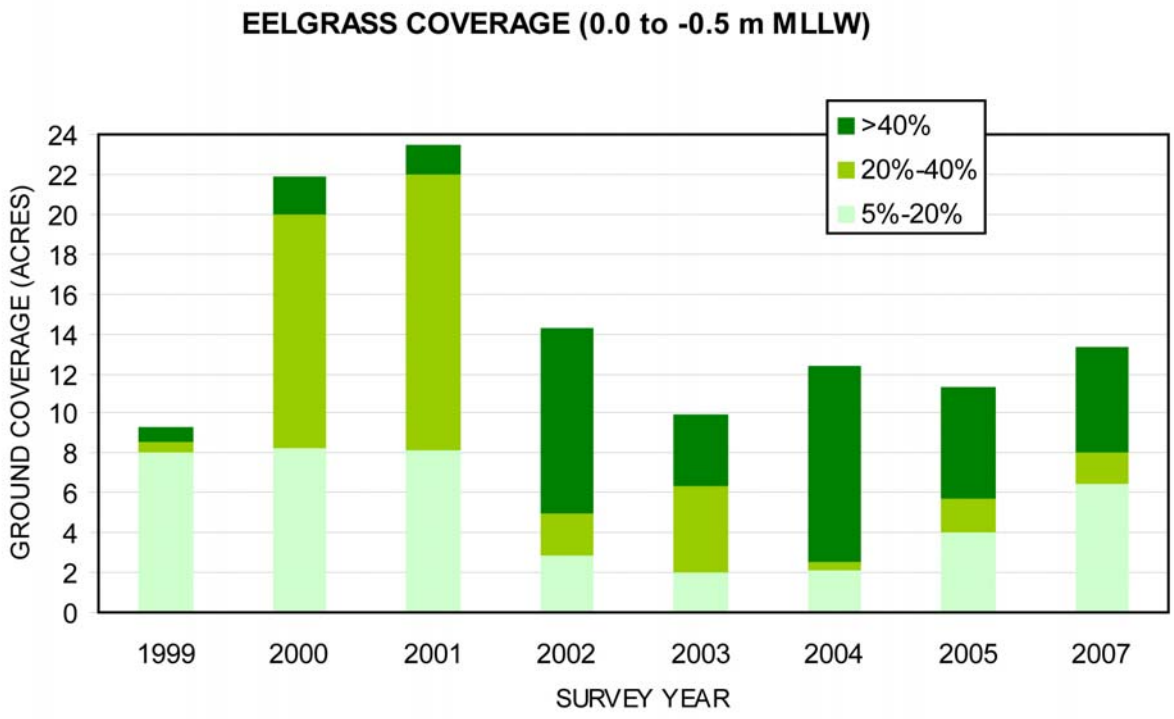
Declines in eelgrass coverage at the Emeryville Flats that occurred between 2001 and 2003 may have been related to the elevated turbidity in the eastern region of the survey area during the placement of the fill for the approach to the new East Span. During this work, problems with the original turbidity control measures resulted in the need to change the work program substantially to accomplish the required construction and bring the construction area into compliance with turbidity limits. However, work on the fill for the approach has been completed for over two years and only a small recovery in eelgrass coverage has been observed. In addition, work in the Oakland Touchdown area has been ongoing for the past two years, which could be affecting eelgrass density on the nearby shoal. While the construction for the fill approach offers a plausible explanation regarding the 58% decline at Emeryville Flats during the concurrent time period, no similar explanation can be used for the 75% decline in eelgrass at Clipper Cove during 2001.

Previous annual eelgrass reports for the East Span Project have suggested that the El Niño Southern Oscillation (ENSO) may have depressed the eelgrass coverage in 1999 and that the expansion observed in 2000 and 2001 was a return to normal conditions. However, if the ENSO conditions were the only reason for the trends in eelgrass bed expansion and contraction, a continued persistence of eelgrass in expansion areas at both Clipper Cove and Emeryville during 2002 and 2003 would have been expected. Because the coverage of eelgrass within the Emeryville Flats survey area has been less than 15.0 acres (6.0 hectares) since 2002, it appears that the large spike in coverage that was observed in 2000 and 2001 was atypical for this site. The additive stress of both construction-associated effects and episodic ENSO-related effects may have influenced the annual variation in eelgrass coverage observed over the past eight years. While the post-ENSO recovery of eelgrass beds would be expected to result in the continued expansion and increased density of eelgrass beds in stable and suitable habitats, construction-associated impacts might have accounted for variability and delayed recovery of eelgrass in marginal eelgrass habitats. However, the continued absence of eelgrass within areas east of the shoal, long after the conclusion of in-water work associated with the bridge approach geofill contract, would tend to suggest that observed prolonged declines have little to do with construction effects and may be more likely associated with anomalous expanded conditions in 2000-2001 and a rebound to more normal eelgrass distribution patterns.

Fluctuations in eelgrass coverage could also be a result of seasonal differences. The decline in eelgrass coverage from 2001 to 2003 that was observed at Emeryville Flats was also apparent at several sites throughout the Bay during the Baywide Eelgrass Inventory (Caltrans and NOAA Fisheries 2004). The baywide surveys were conducted from June to October 2003 and, by re-surveying certain eelgrass beds throughout the survey, it became evident that some of these beds were dense during the spring and were either sparse or non-existent by fall. One possible explanation for these observations is that the peak of eelgrass abundance, which is typically observed in early fall in southern California, is dynamic in San Francisco Bay. While October may have been the annual peak in abundance during 2000 and 2001, the peak could have occurred earlier in the other survey years, giving the appearance that eelgrass coverage had declined in these years. However, because the annual surveys for the East Span Project have always been conducted in fall, the survey timing should not be adjusted.

Despite the fluctuations observed in eelgrass bed coverage, the percent coverage of eelgrass during all survey years was fairly typical for the central east shore of San Francisco Bay. Several studies completed between 1996 and 1998 from Point Richmond to Richmond Harbor demonstrated eelgrass coverage from less than 5% to 25% (SAIC and Merkel & Associates 1997a, SAIC and Merkel & Associates 1997b, Merkel & Associates 1999a). The greatest portion of these eelgrass beds fell at or below 5% vegetative cover during both 1996 and 1998. Shallower and more sheltered areas supported eelgrass beds with percent coverage ranging from 10% to 20%. In October 1999, the eelgrass coverage on Middle Harbor Shoal was 12% for this small bed (Merkel & Associates 1999b). During the Baywide Eelgrass Inventory, the majority of eelgrass between the Richmond-San Rafael Bridge and Bayfarm Island fell within the 20-40% category (Caltrans and NOAA Fisheries 2004).

The observations made at the East Span Project survey areas underscore the difficulty in evaluating the dynamics of eelgrass within San Francisco Bay. However, the continued monitoring of these survey areas has provided a baseline for eelgrass coverage and density. By characterizing the areas surrounding the construction impact areas, the average condition of the eelgrass beds within the project vicinity will be understood at the time of the final assessment of eelgrass impacts resulting from the East Span Project.



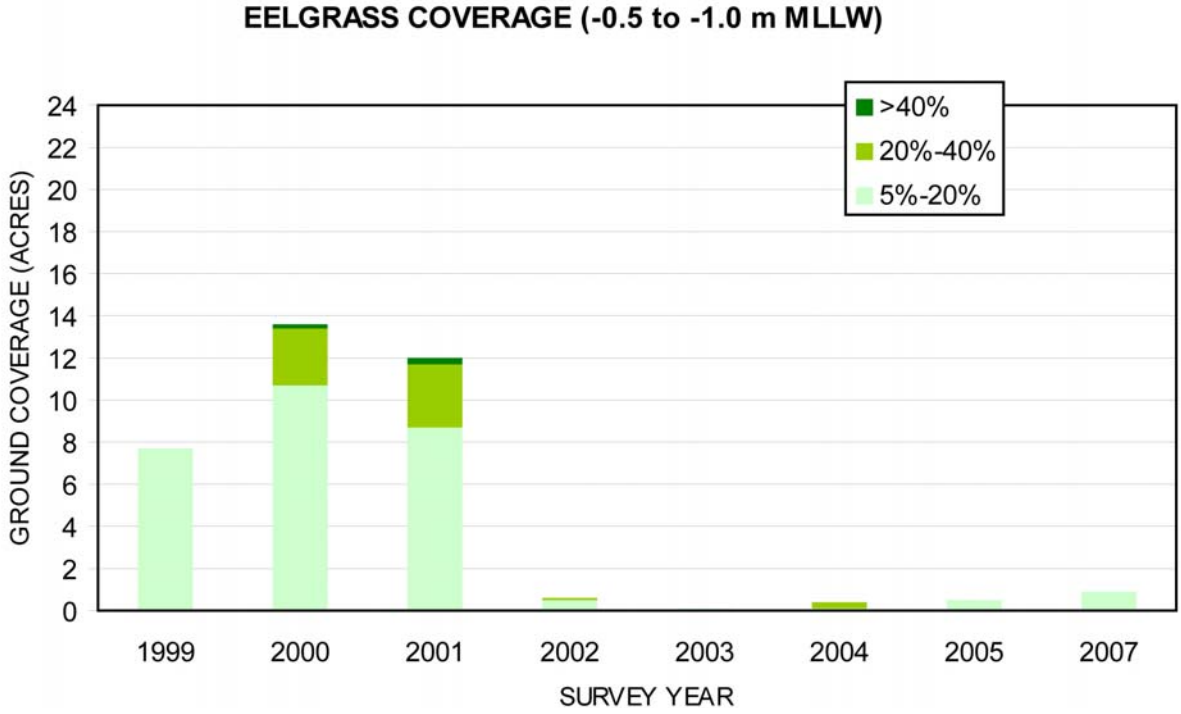


Figure 6. Eelgrass coverage within two depth ranges at Emeryville Flats

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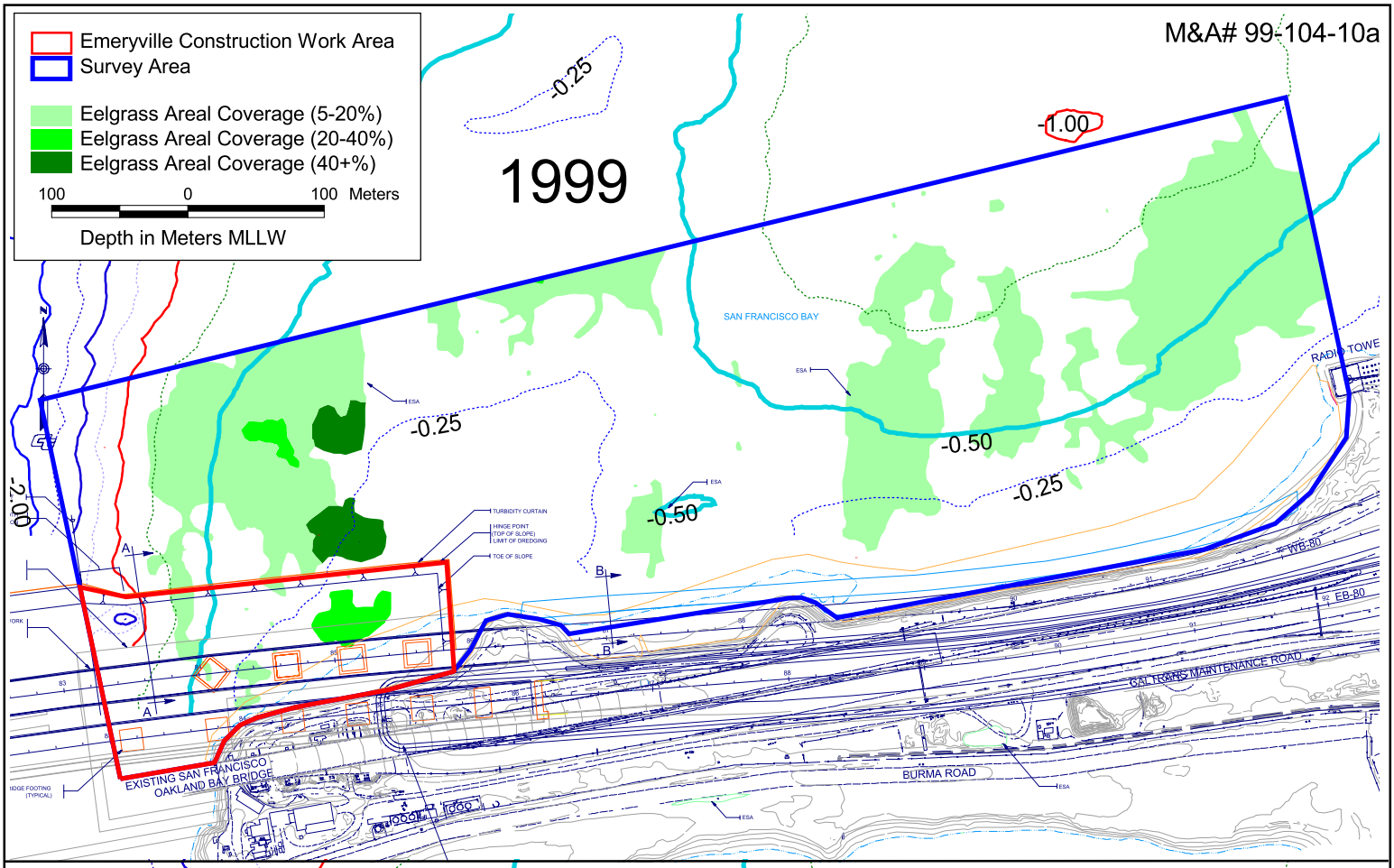
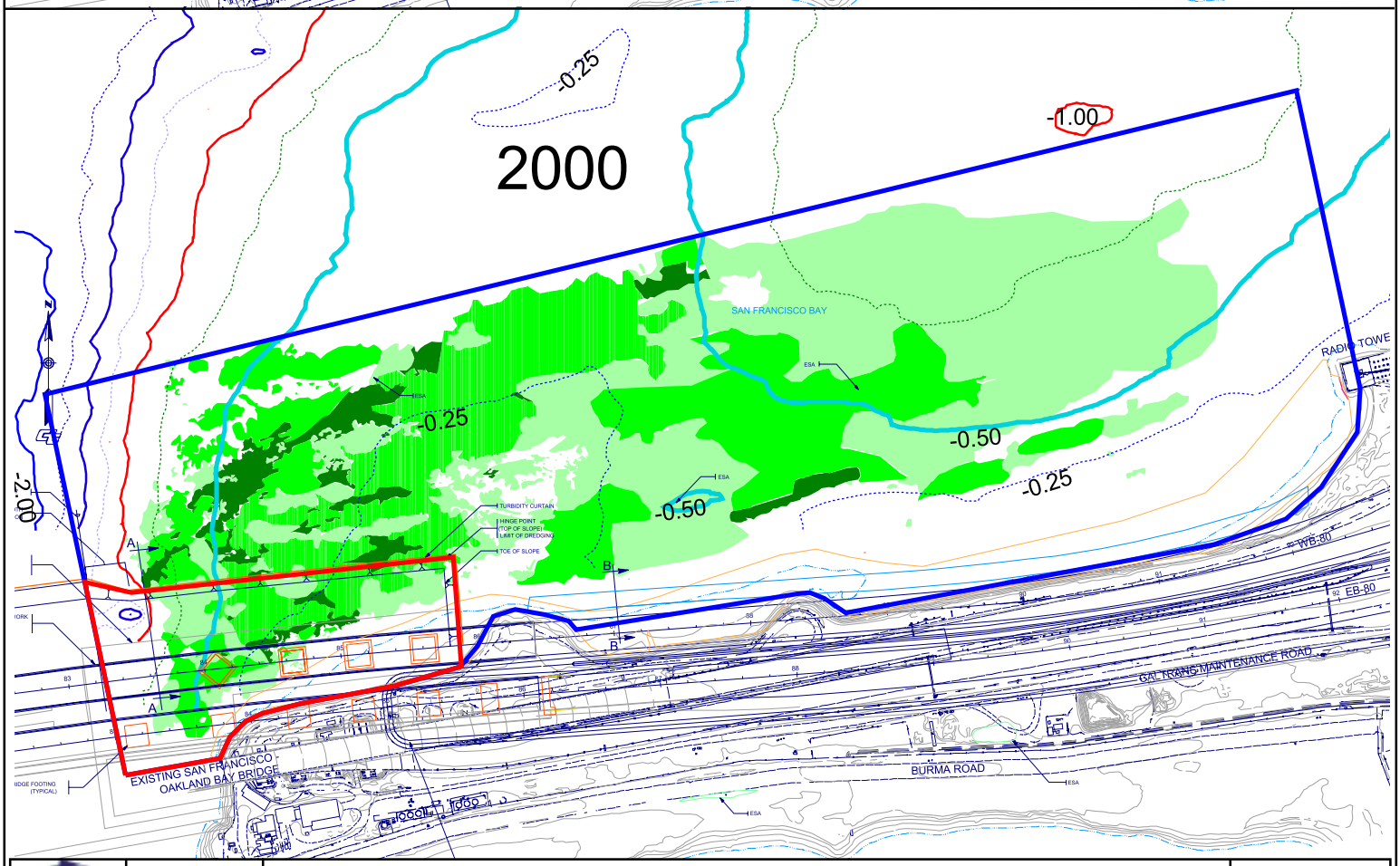
APPENDIX A.

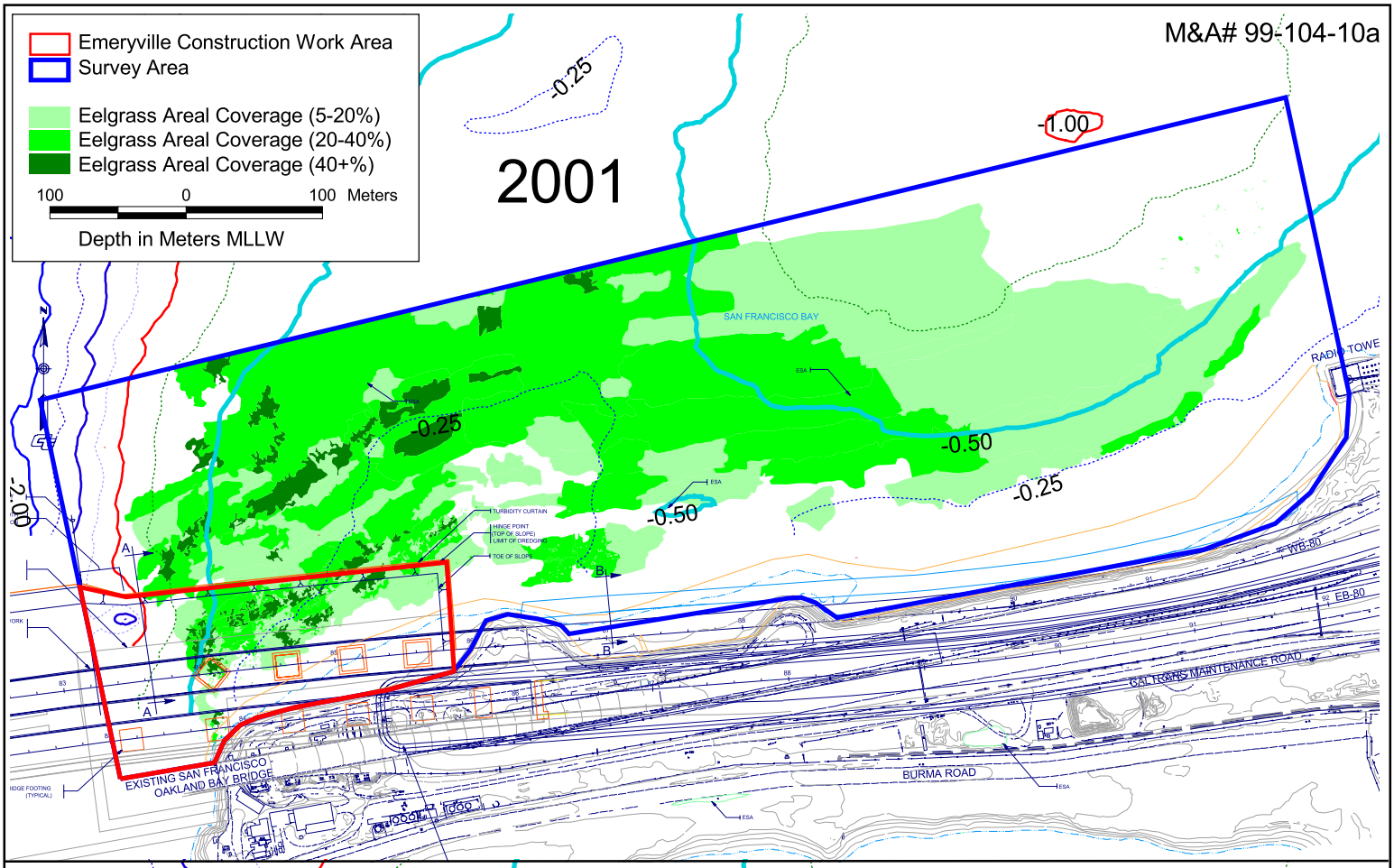
Cumulative Eelgrass Maps of Previous Surveys at Emeryville Flats, Clipper Cove, and Coast Guard Cove

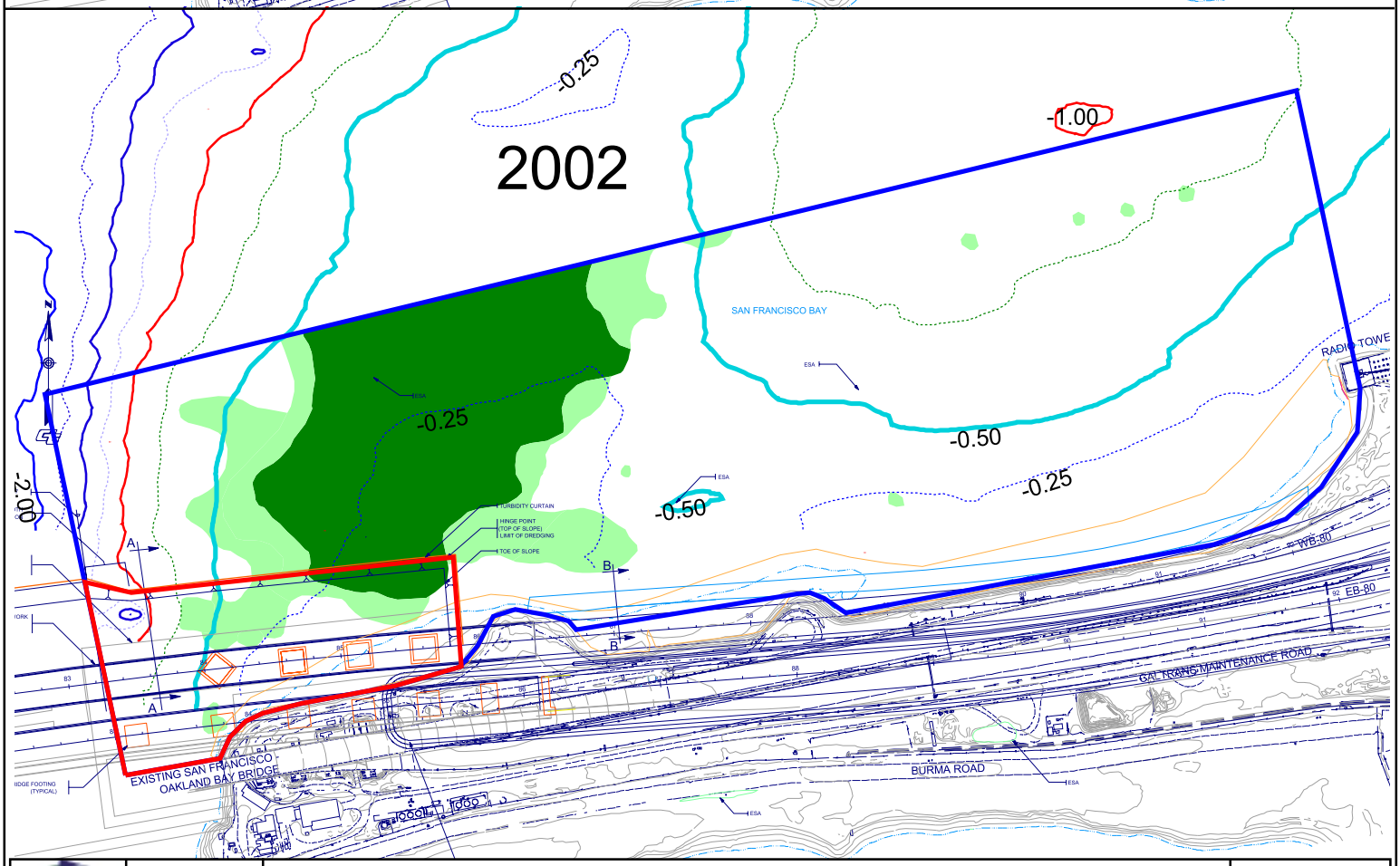




Eelgrass Distribution within the Oakland Touchdown Area, Emeryville Flats (1999 and 2000)

Figure A-1

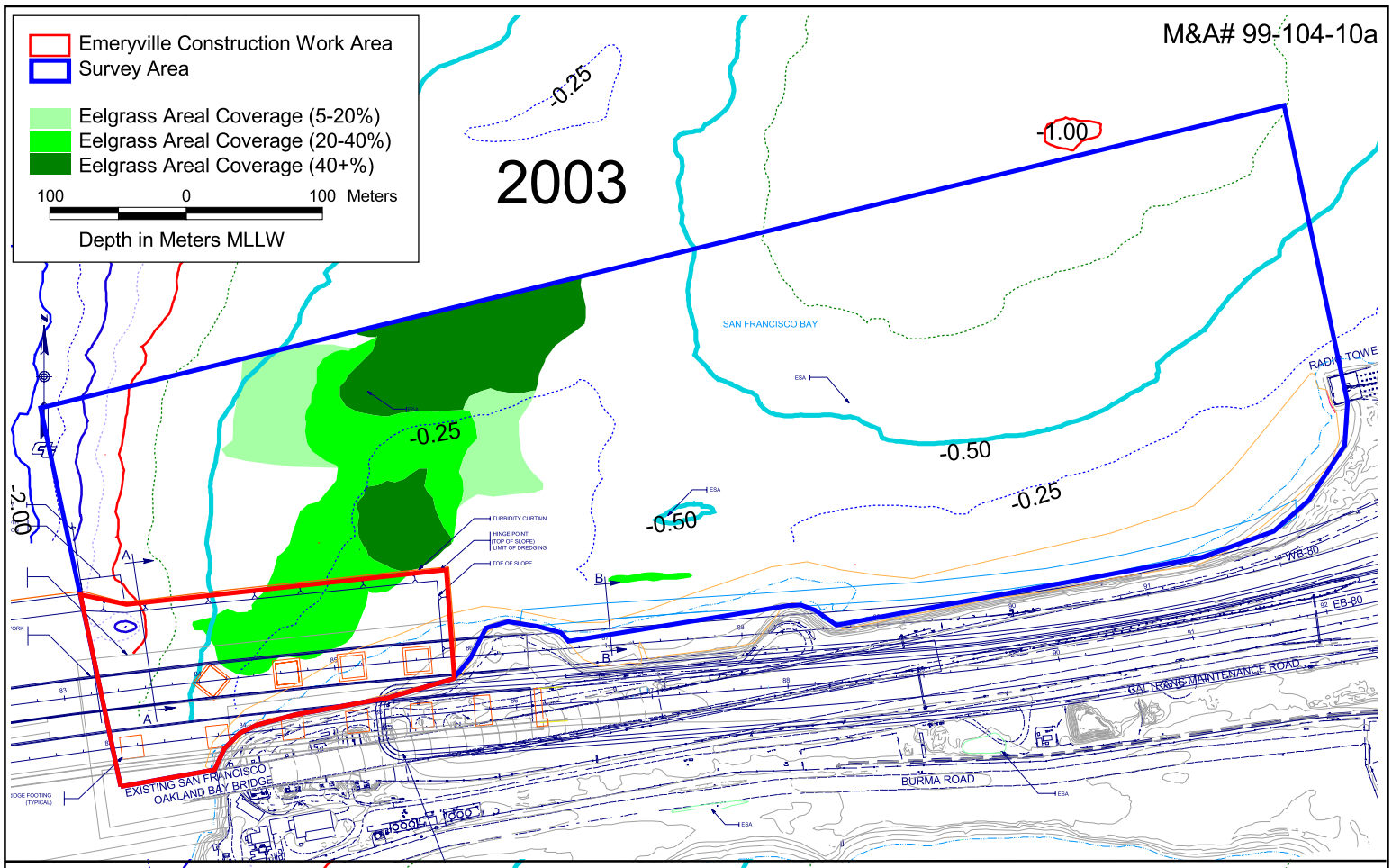


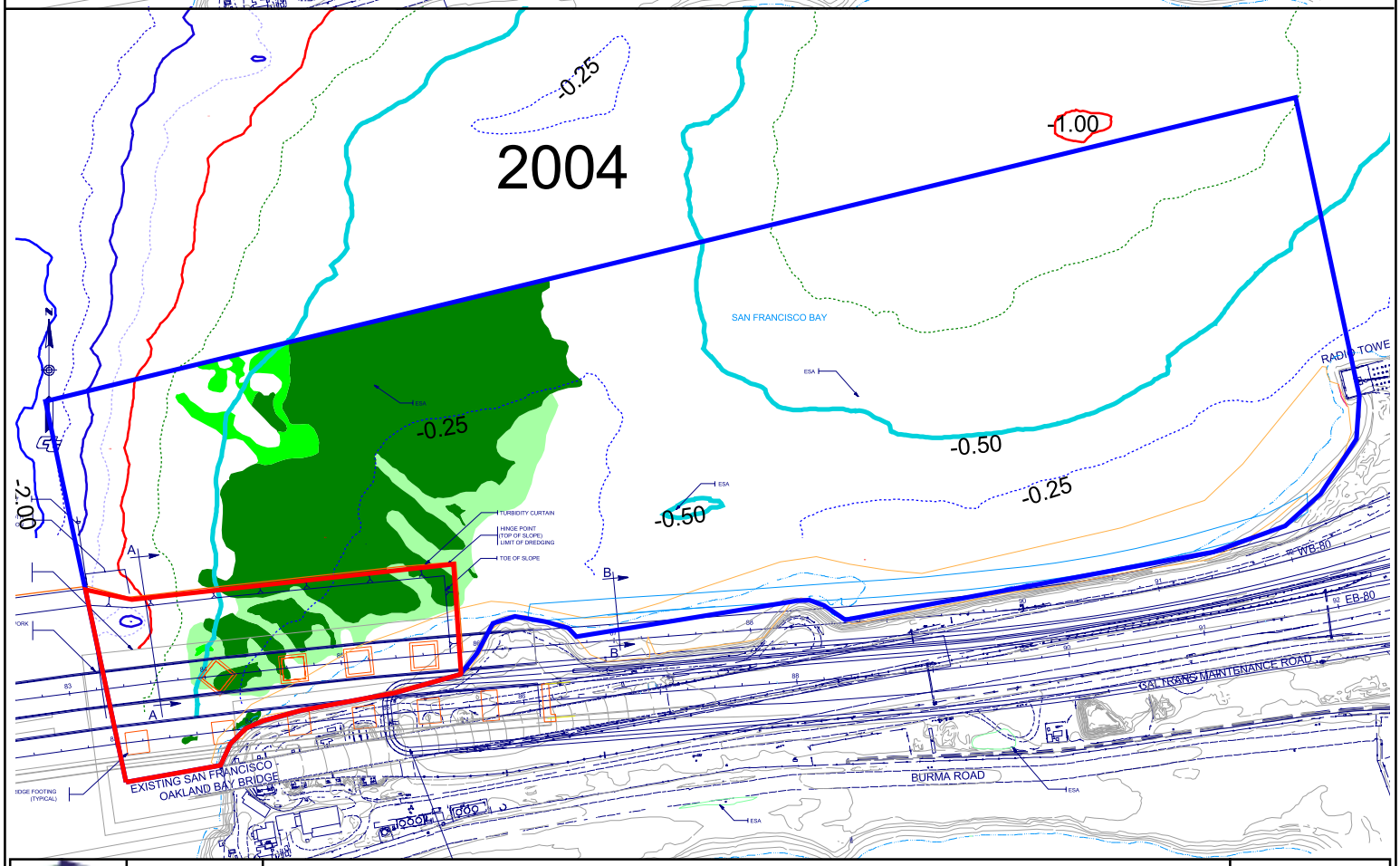


N W E S

Eelgrass Distribution within the Oakland Touchdown Area, Emeryville Flats (2001 and 2002)

Figure A-2

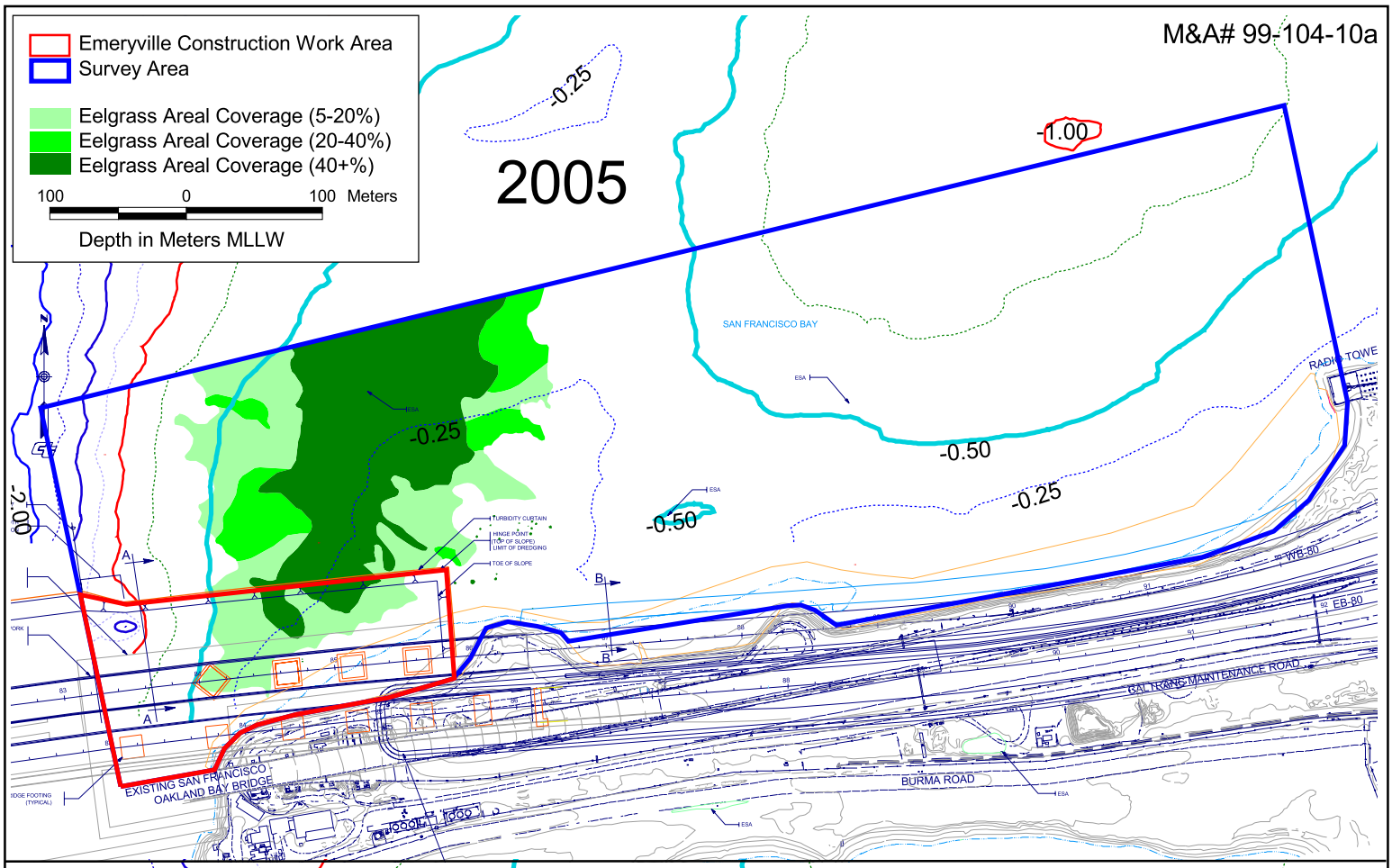


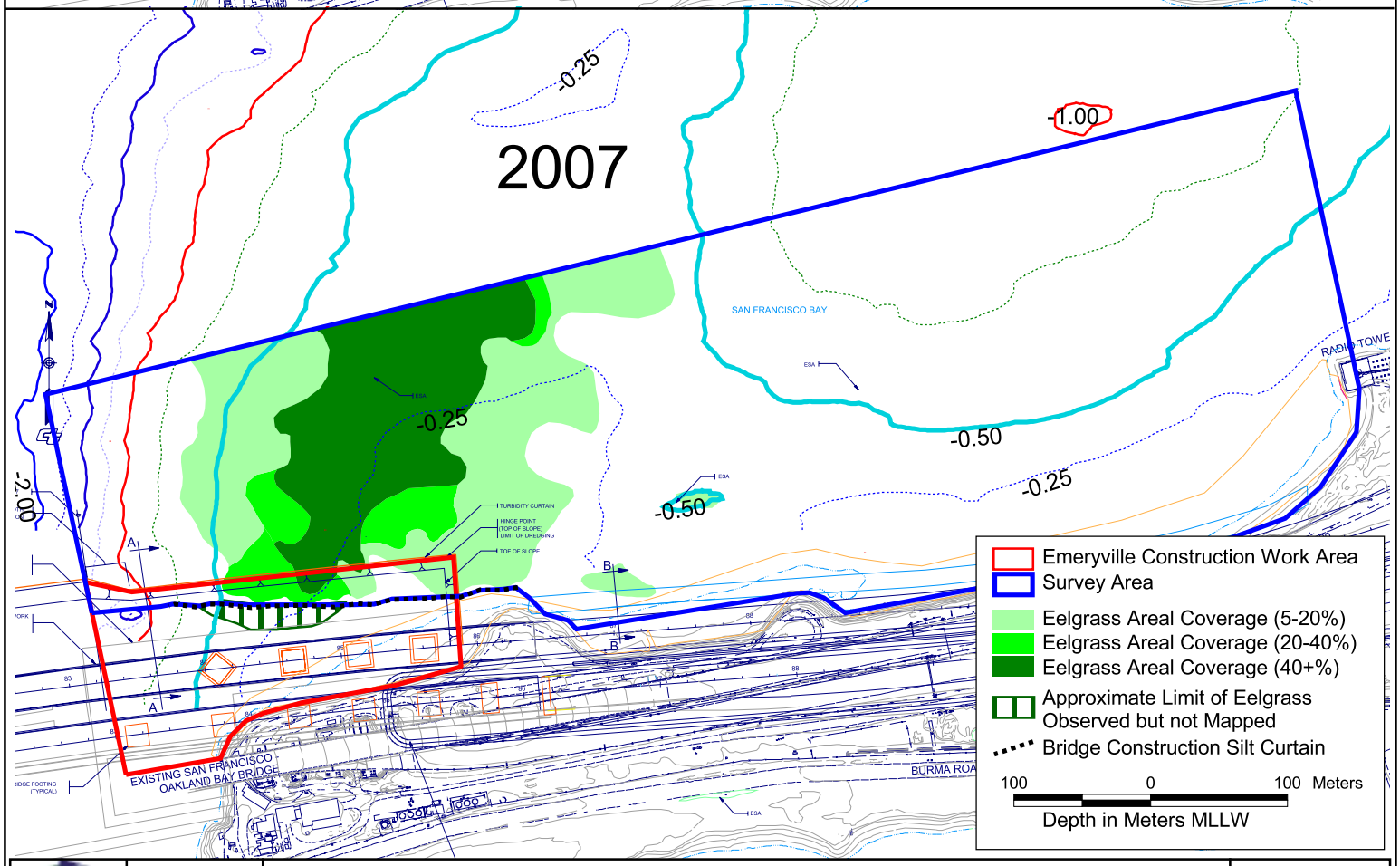


N W E S

Eelgrass Distribution within the Oakland Touchdown Area, Emeryville Flats (2003 and 2004)

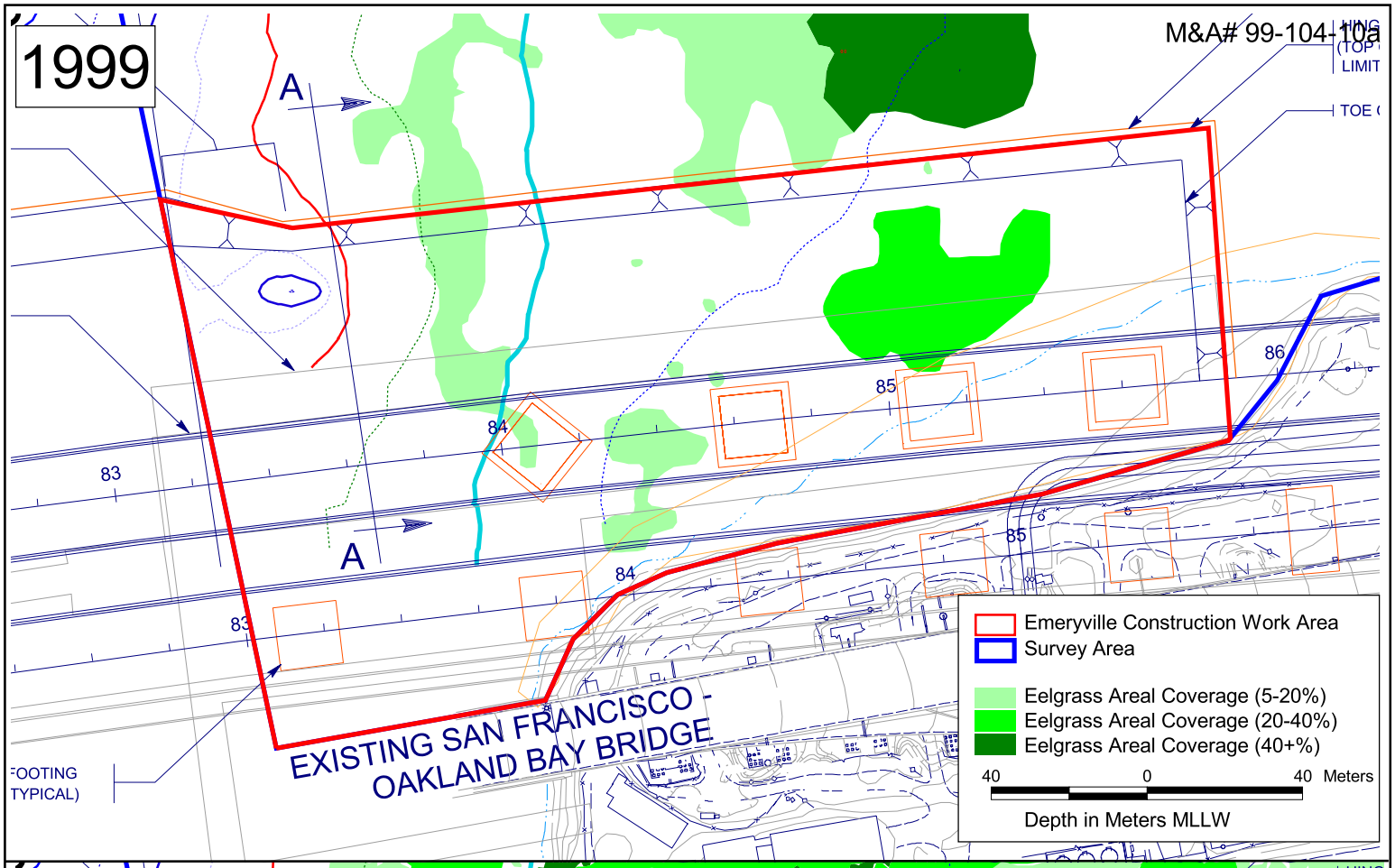
Figure A-3

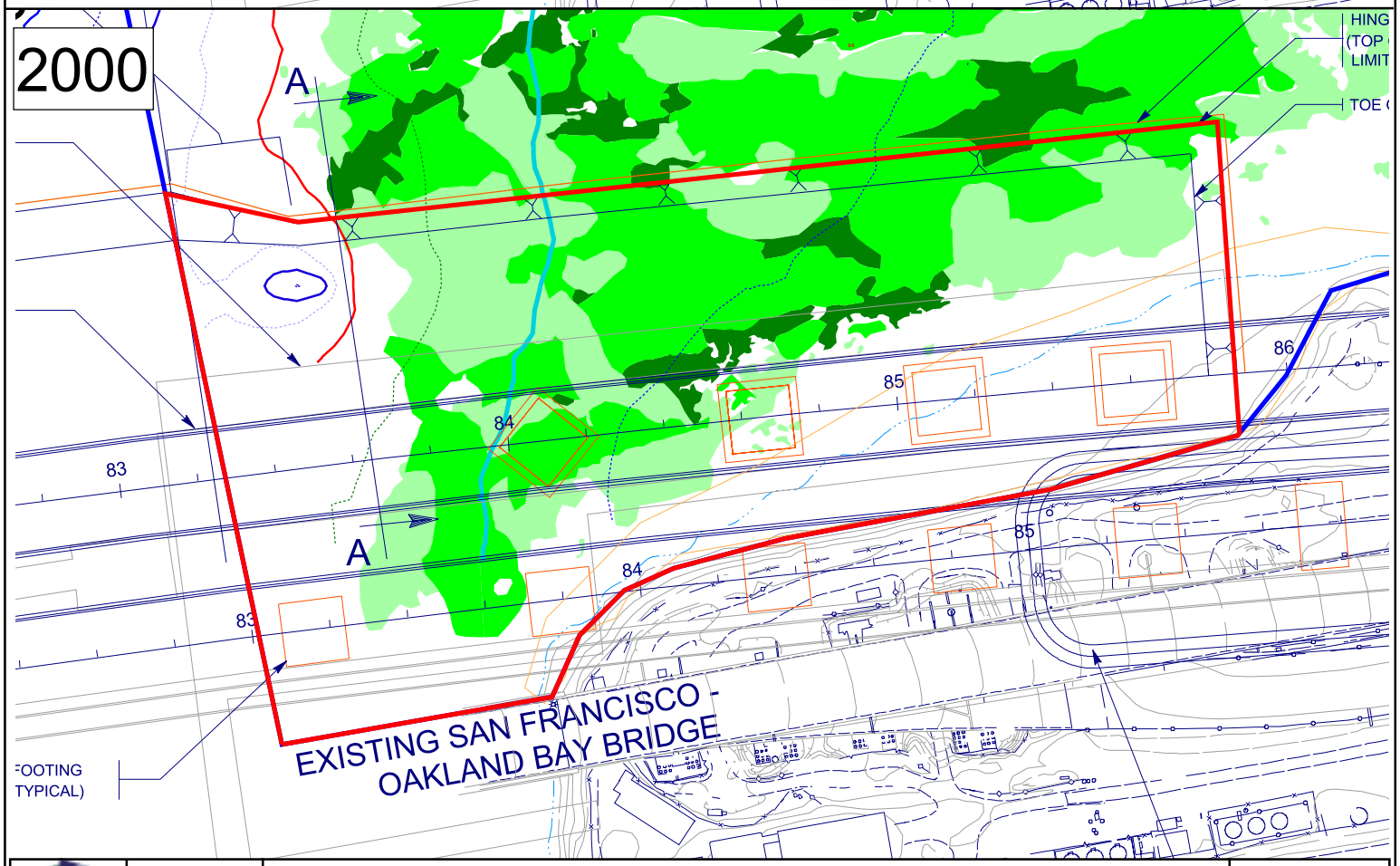


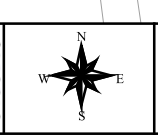


Eelgrass Distribution within the Oakland Touchdown Area, Emeryville Flats (2005 and 2007)

Figure A-4

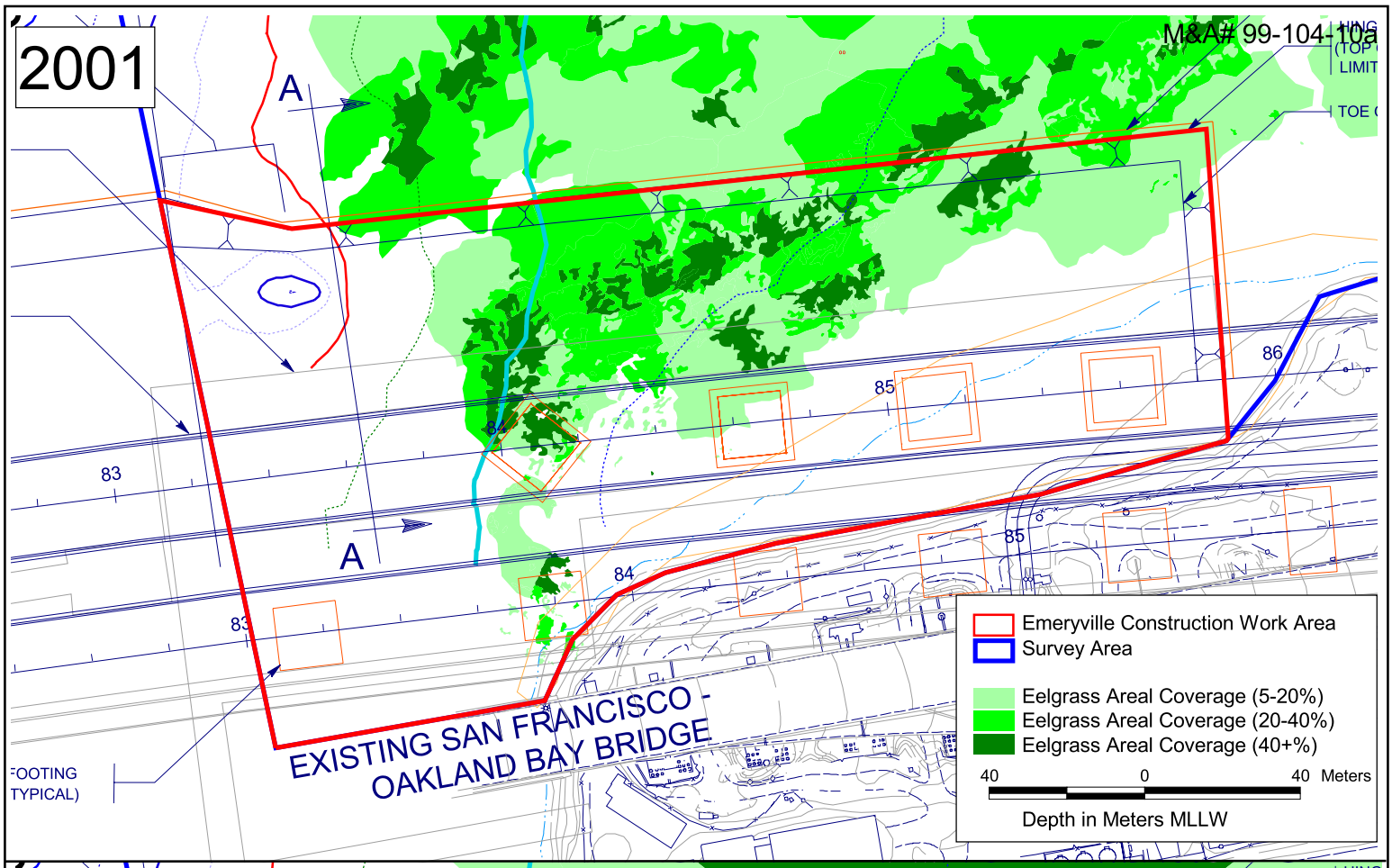


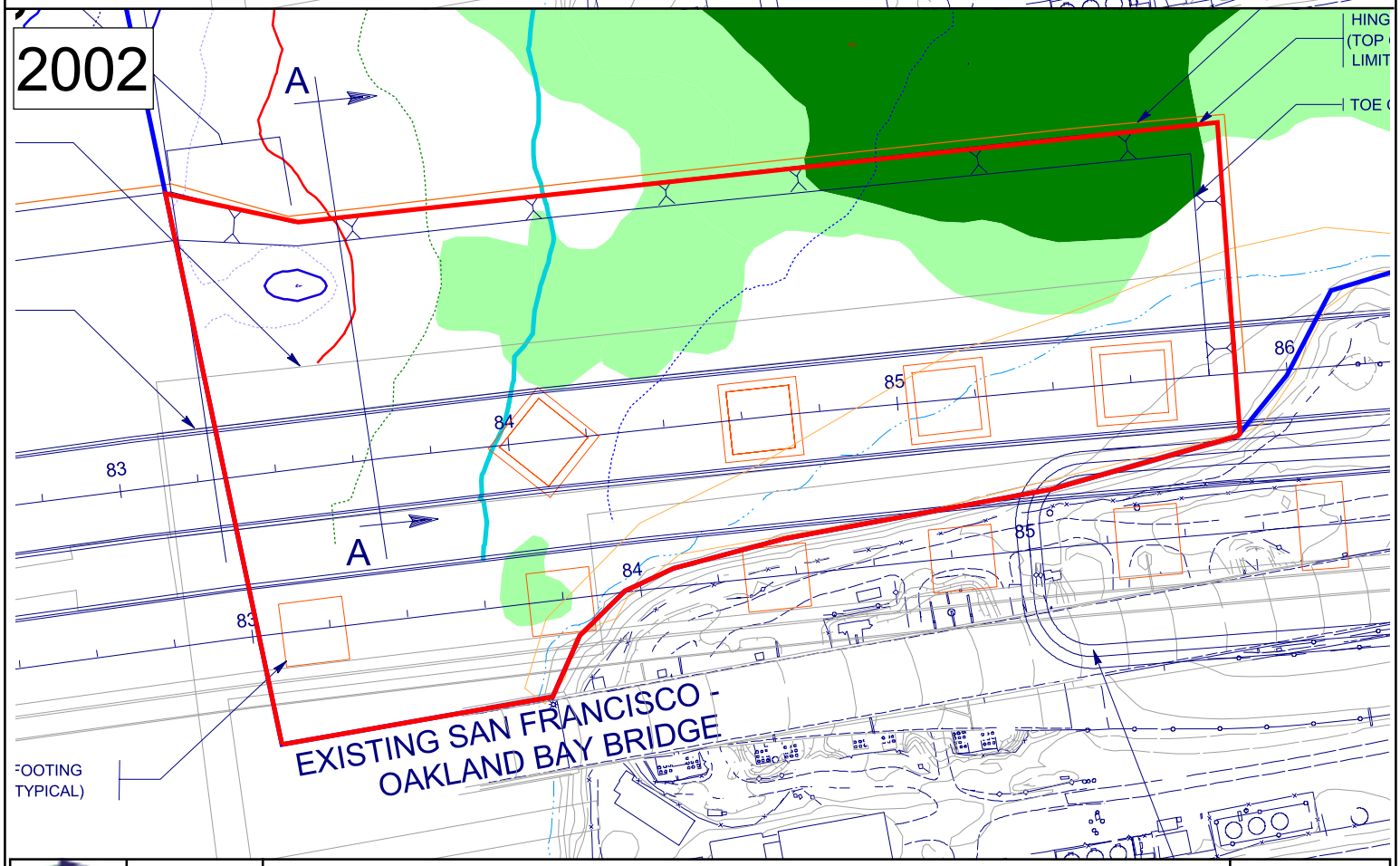


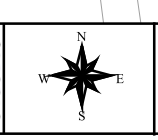


Eelgrass Distribution within the Emeryville Flats Construction Work Area (1999 and 2000)

Figure A-5

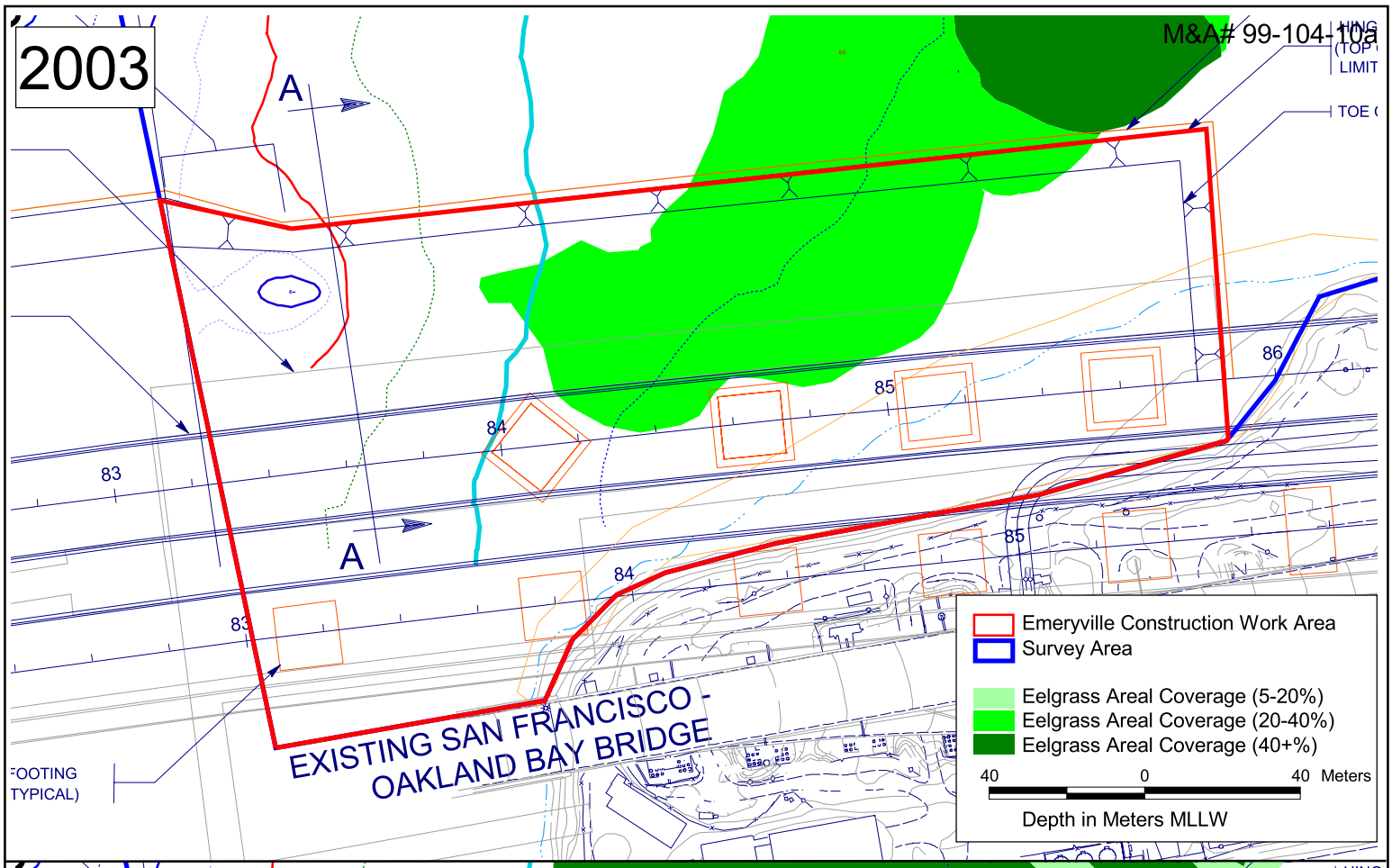


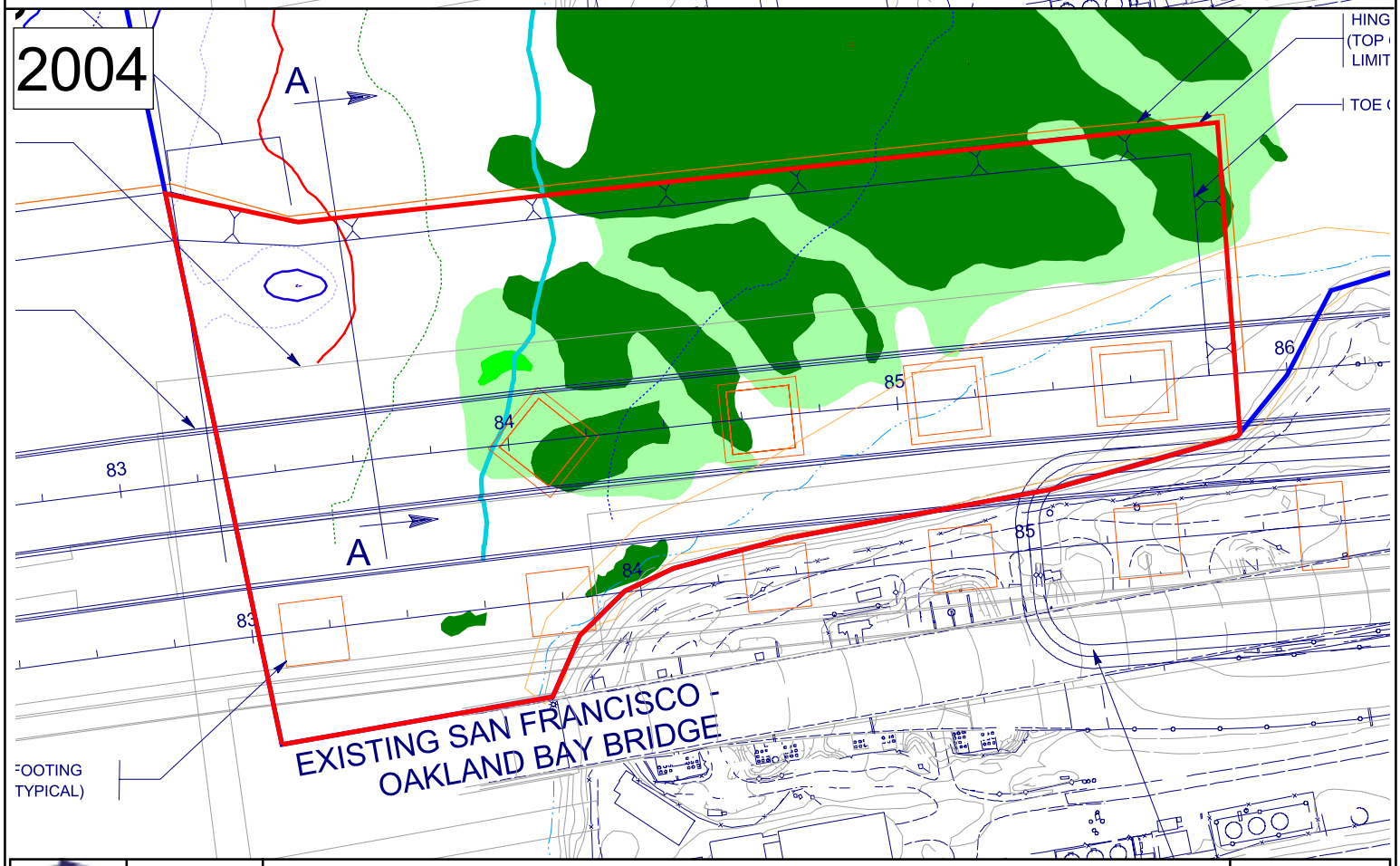




Eelgrass Distribution within the Emeryville Flats Construction Work Area (2001 and 2002)

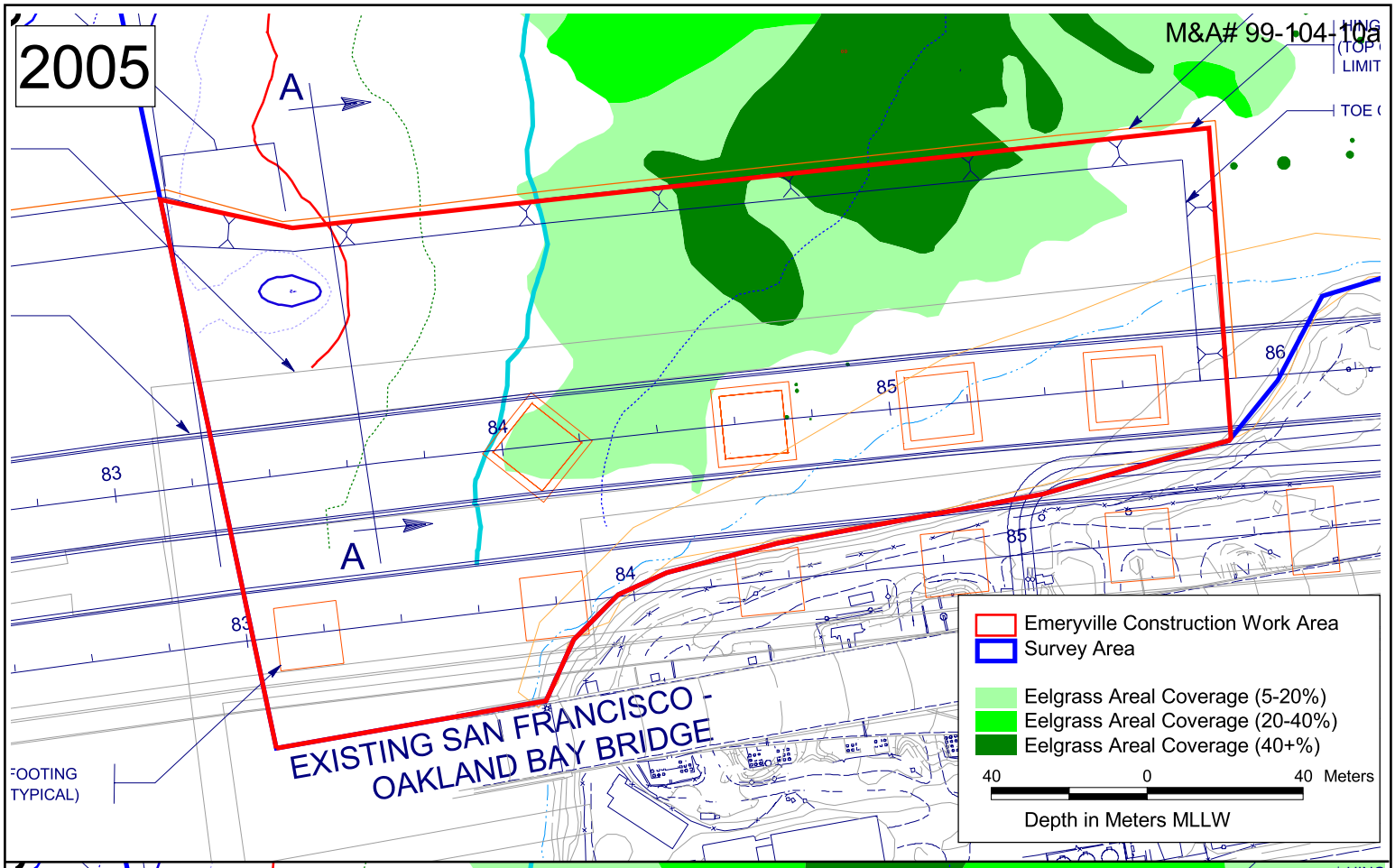
Figure A-6

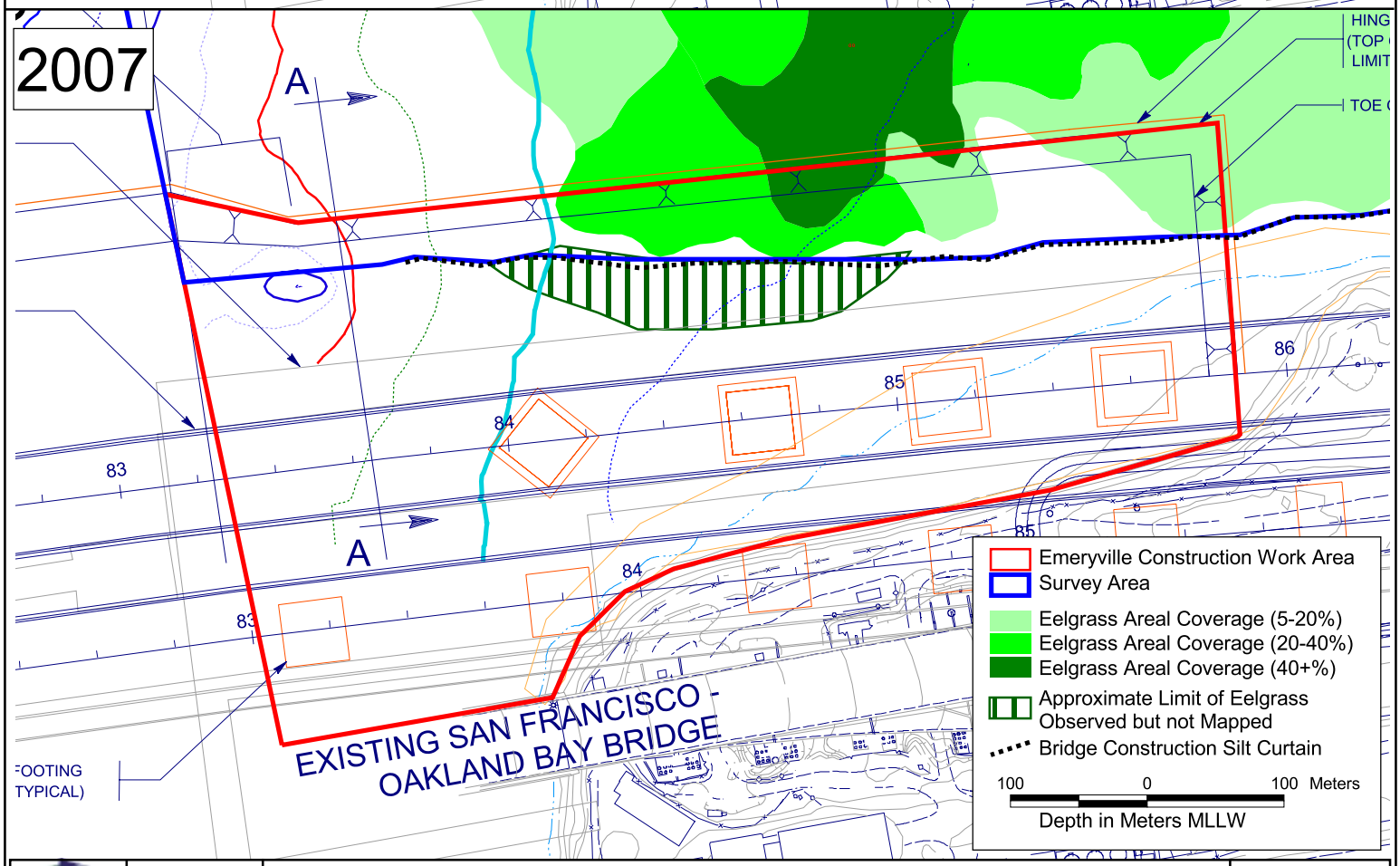


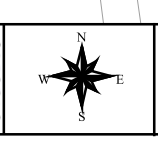


Eelgrass Distribution within the Emeryville Flats Construction Work Area (2003 and 2004)

Figure A-7

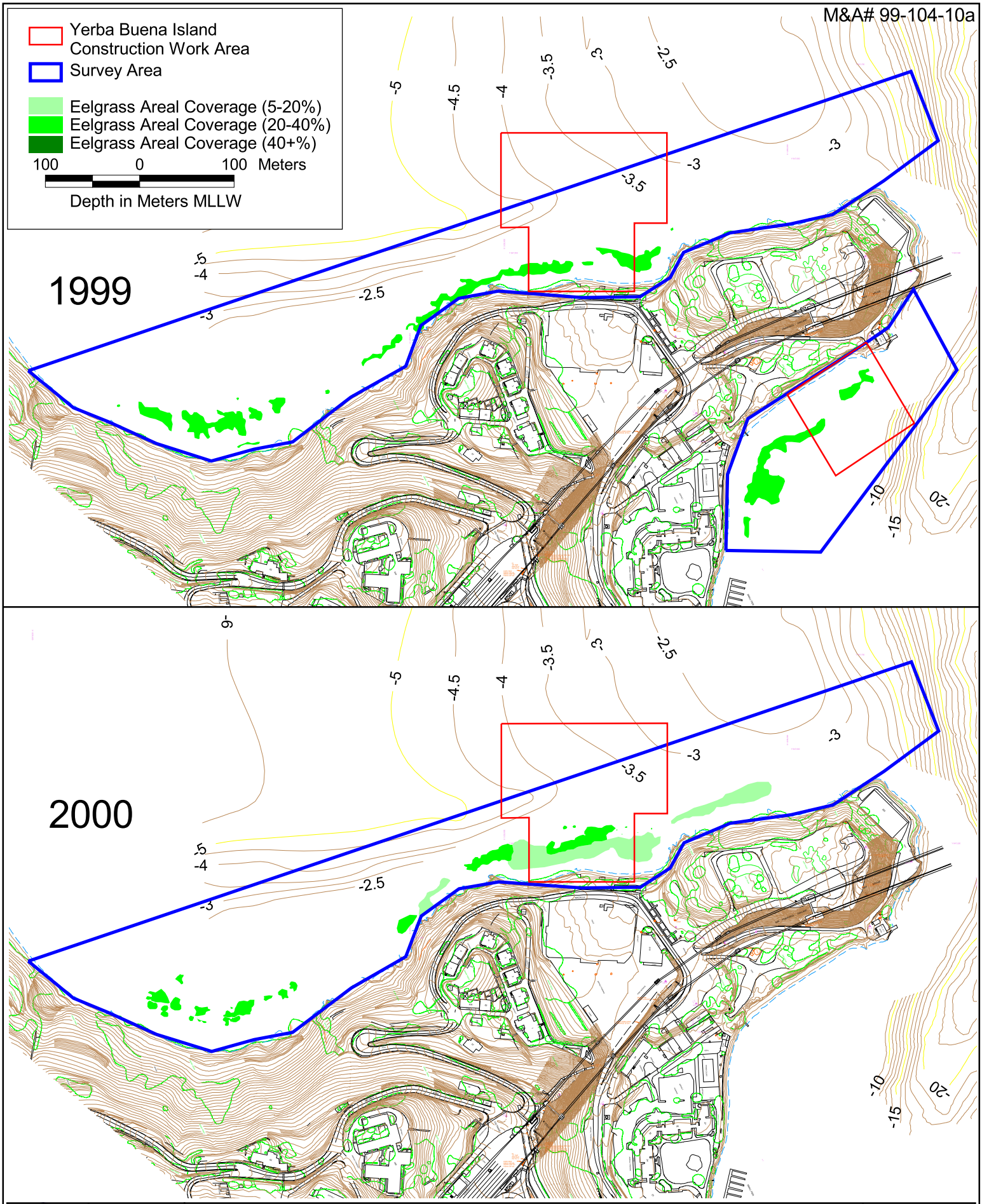






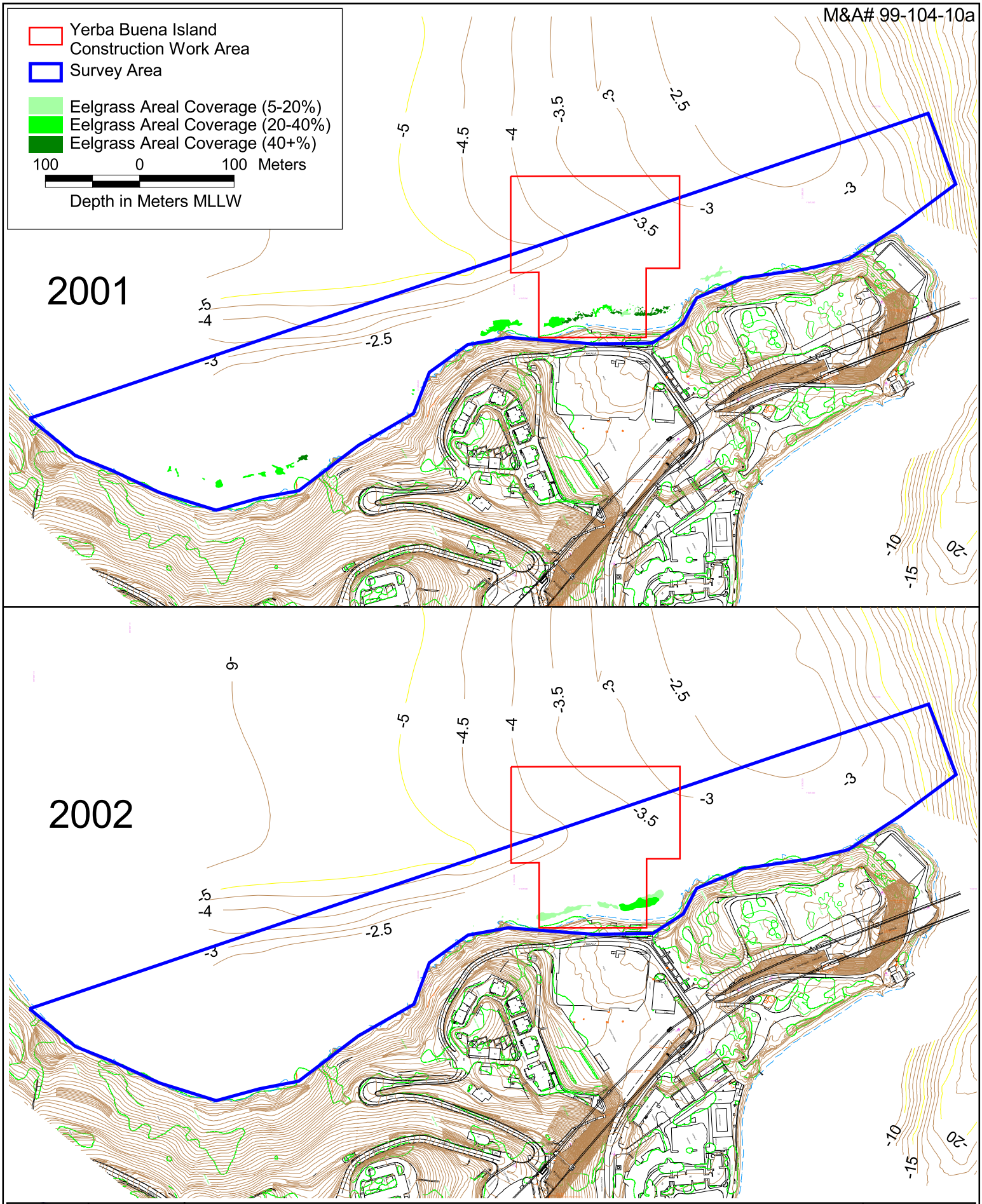
Eelgrass Distribution within the Emeryville Flats Construction Work Area (2005 and 2007)

Figure A-8



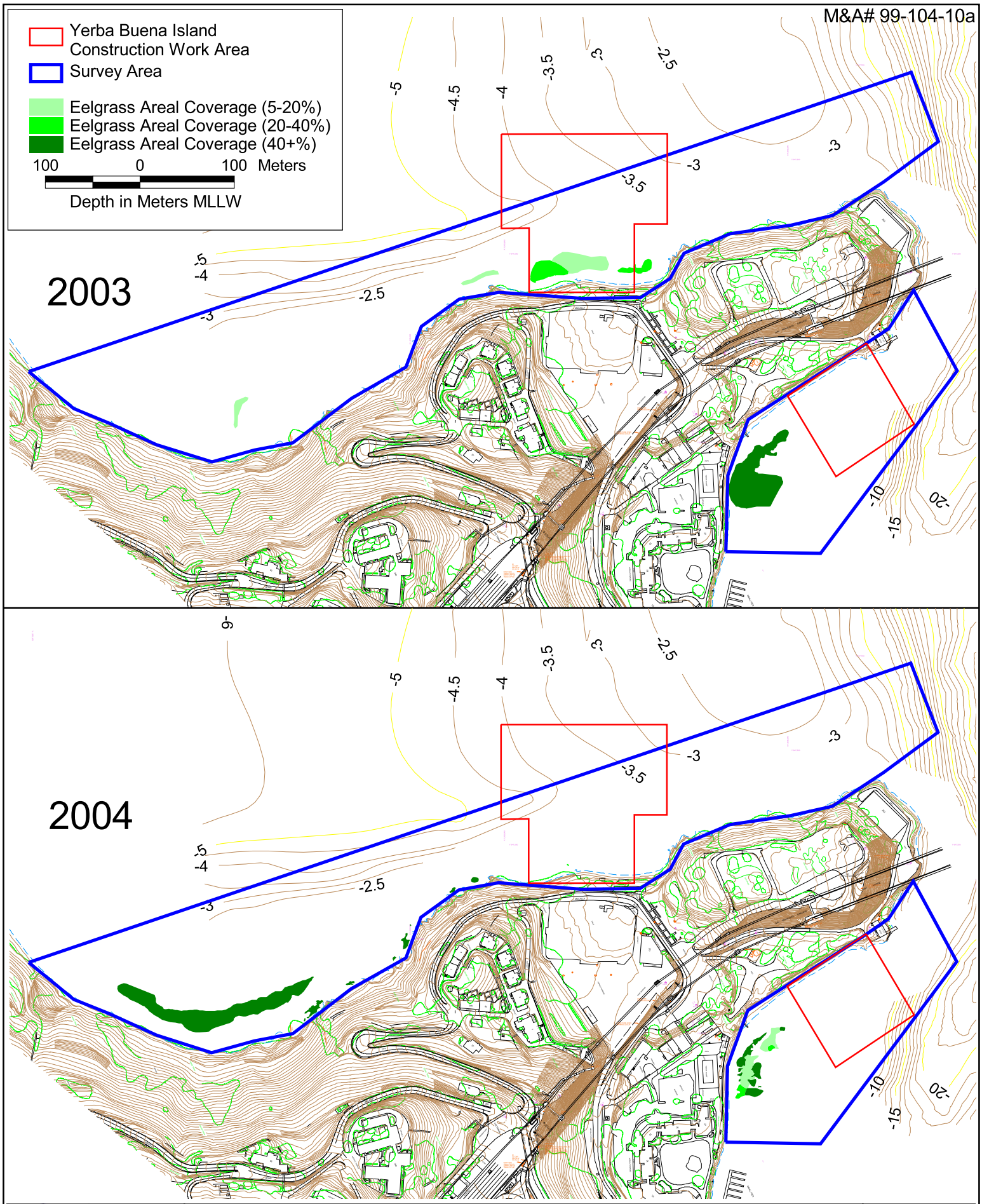
Eelgrass Distribution within the Yerba Buena Island, Clipper Cove Survey Area (1999-2000)

Figure A-9



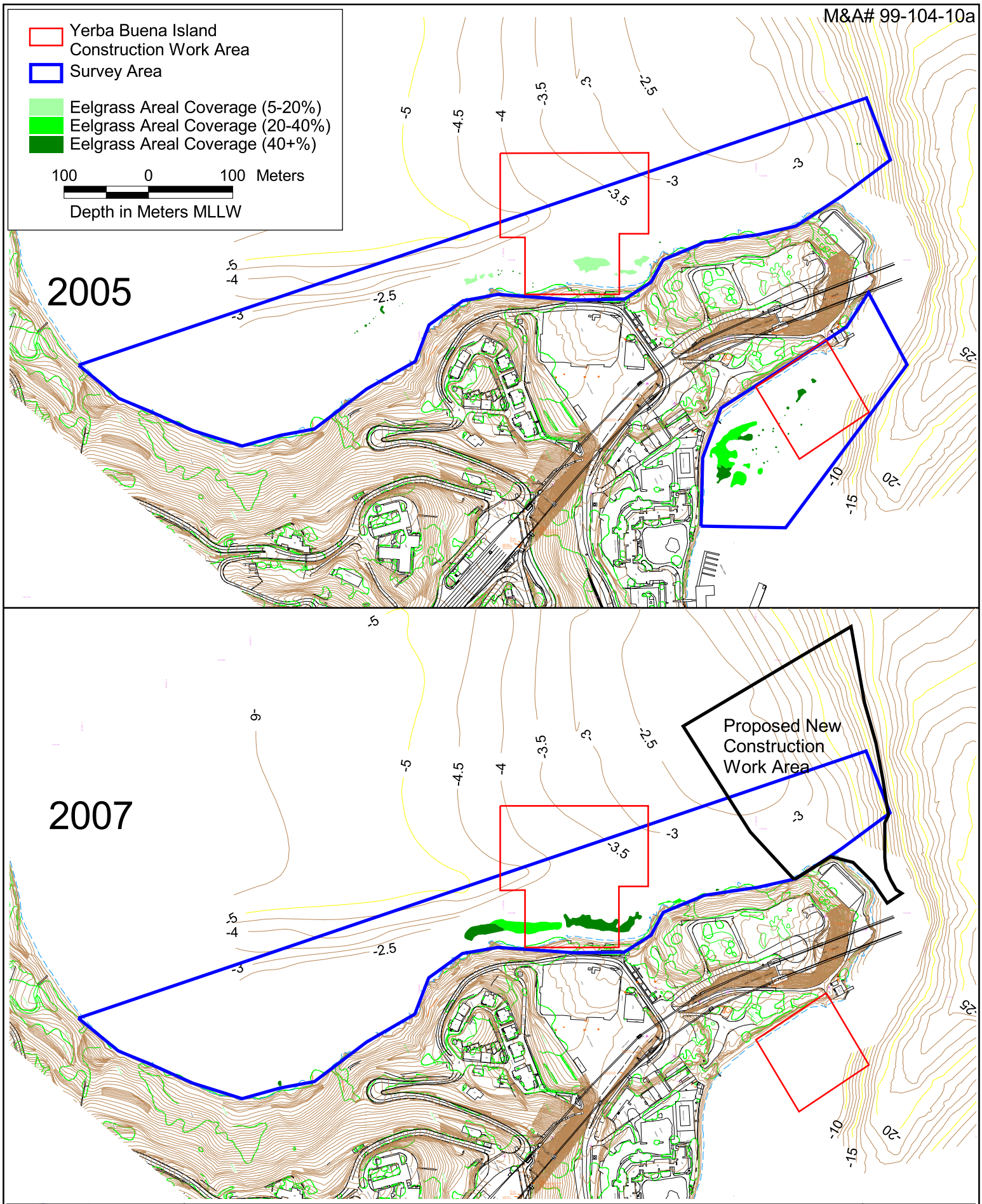
Eelgrass Distribution within the Yerba Buena Island, Clipper Cove Survey Area (2001-2002)

Figure A-10



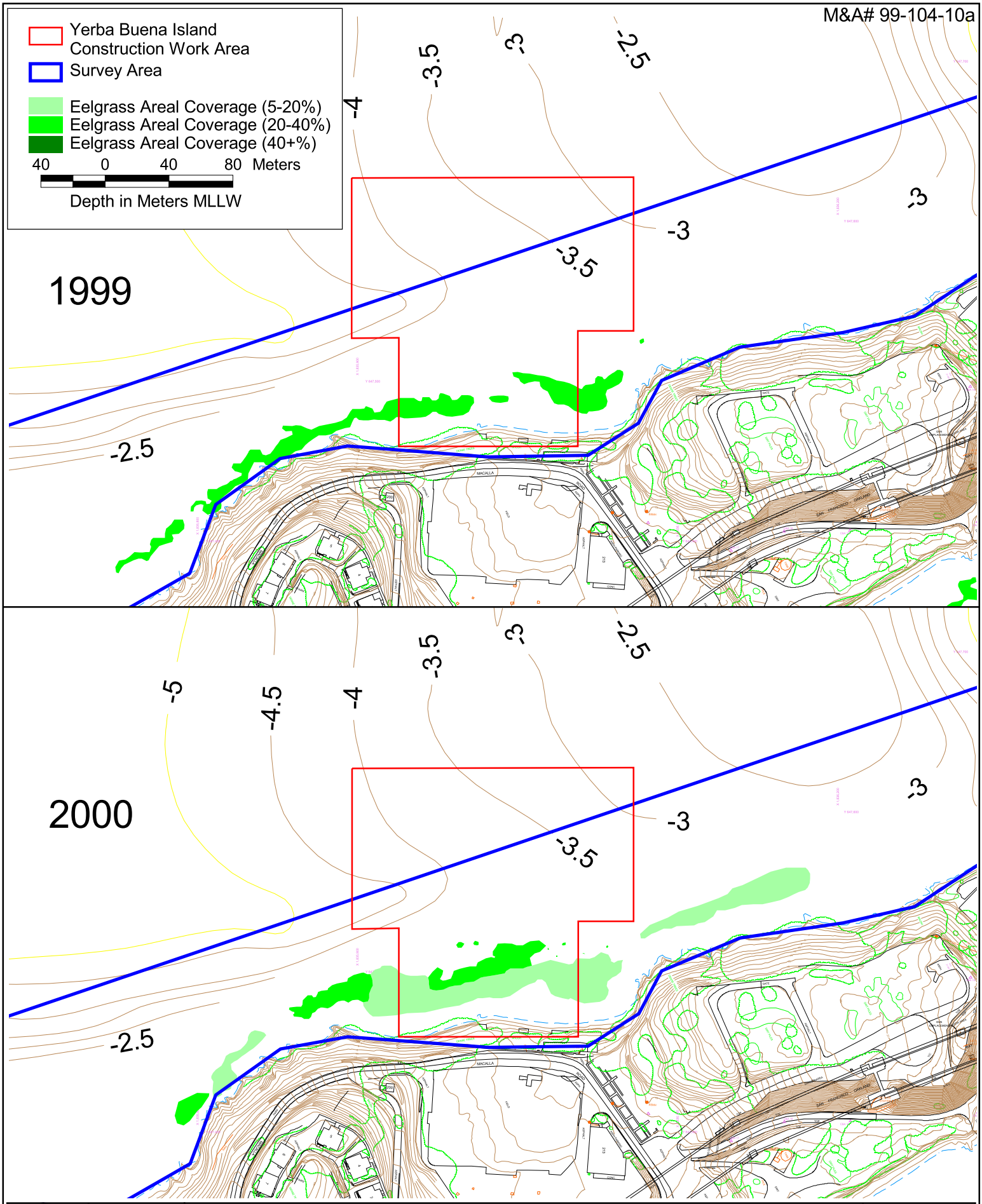
Eelgrass Distribution within the Yerba Buena Island, Clipper Cove Survey Area (2003-2004)

Figure A-11



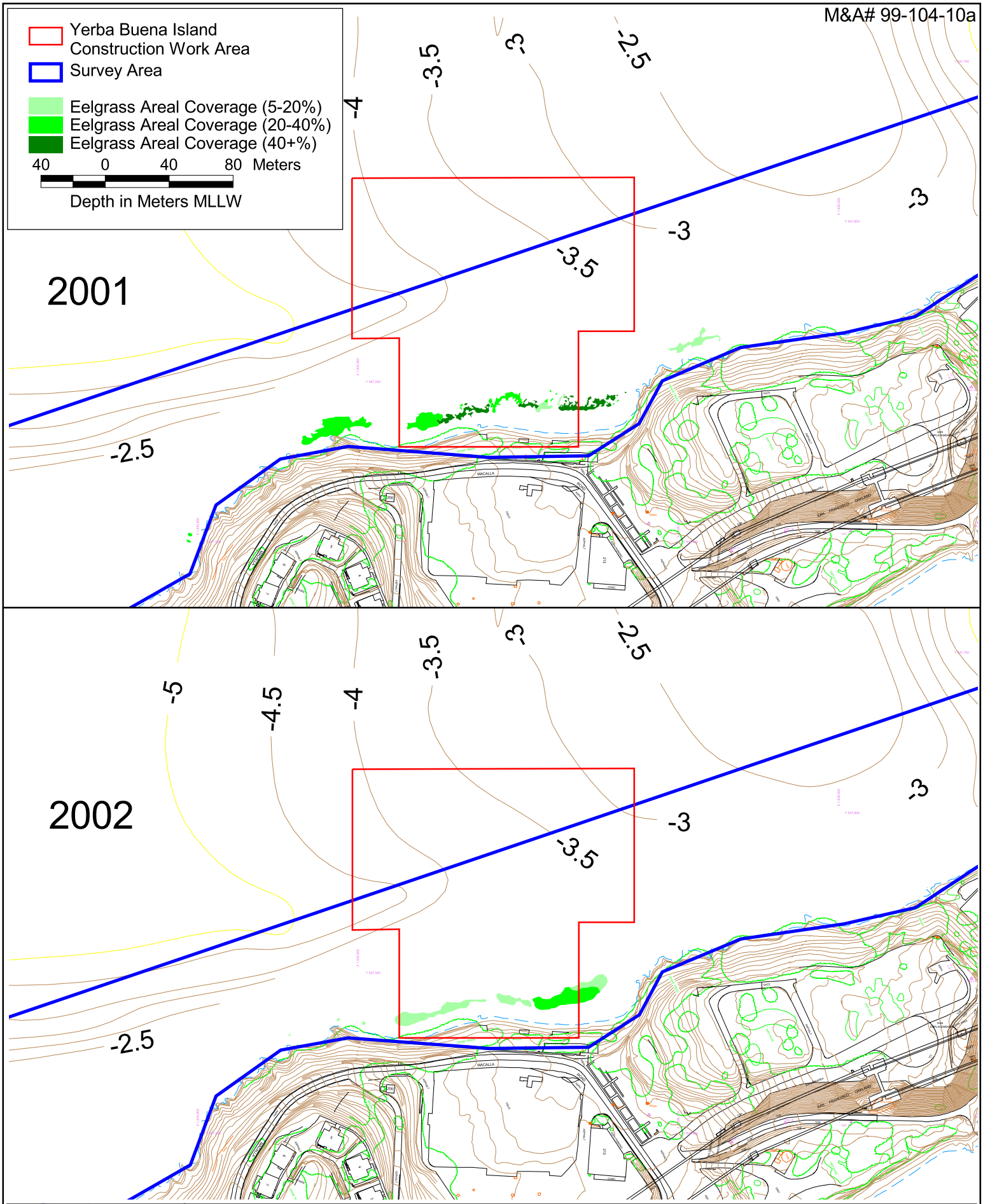
Eelgrass Distribution within the Yerba Buena Island, Clipper Cove Survey Area (2005-2007)

Figure A-12



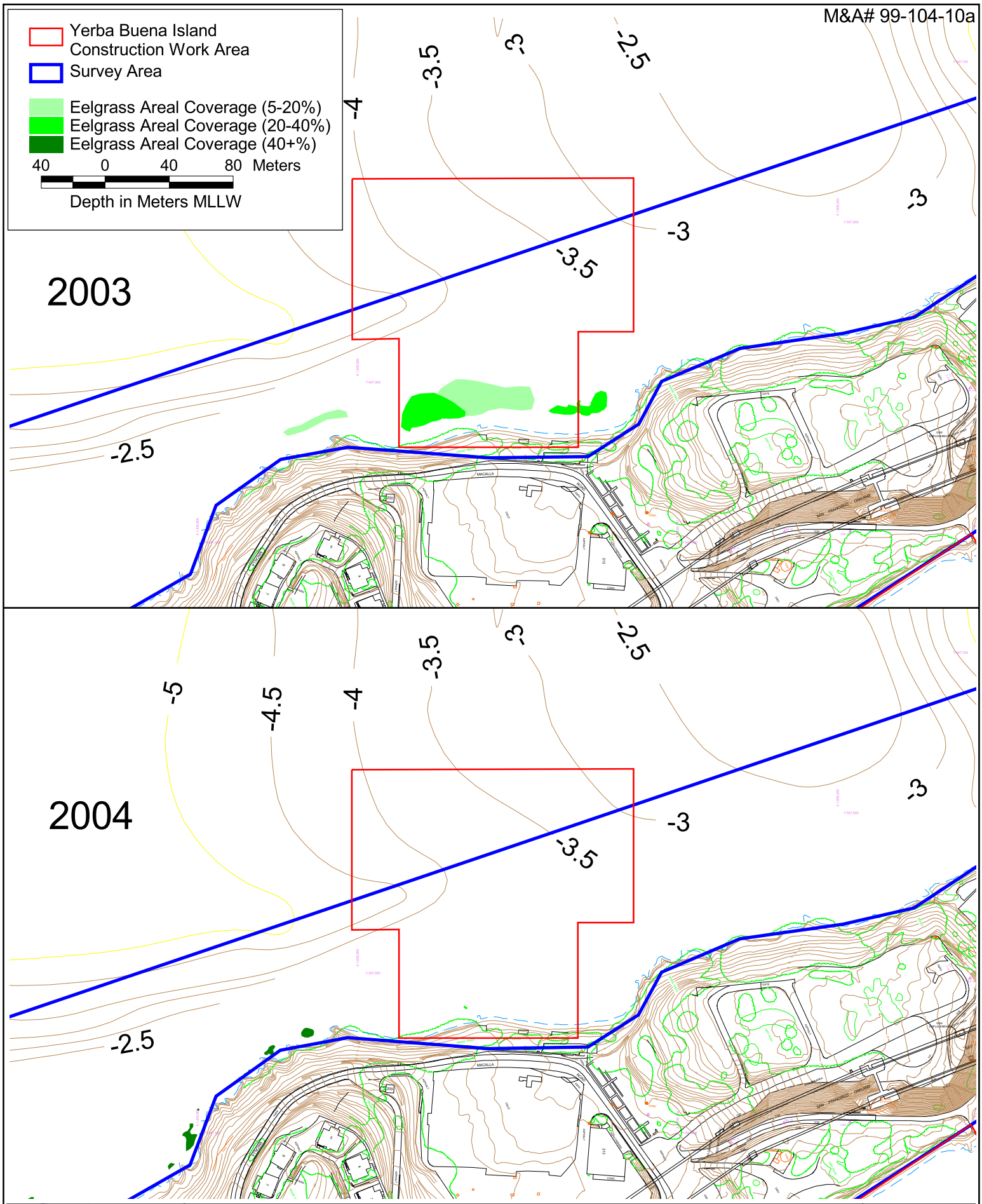
Eelgrass Distribution within the Yerba Buena Island, Construction Work Area (1999-2000)

Figure A-13



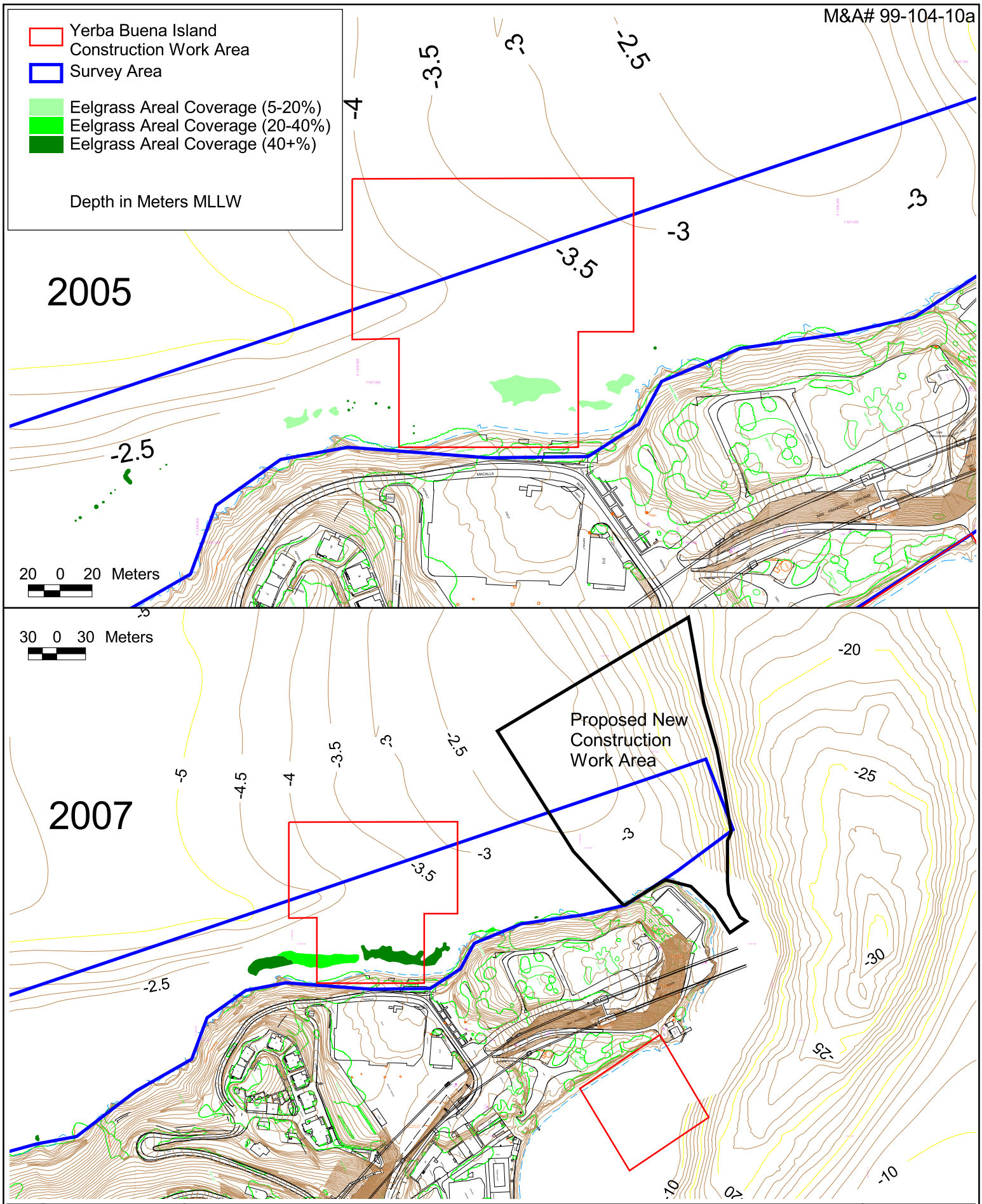
Eelgrass Distribution within the Yerba Buena Island, Construction Work Area (2001-2002)

Figure A-14



Eelgrass Distribution within the Yerba Buena Island, Construction Work Area (2003-2004)

Figure A-15



Eelgrass Distribution within the Yerba Buena Island, Construction Work Area (2005-2007)

Figure A-16