SAN FRANCISCO BAY CREOSOTE PILING REMOVAL AND PACIFIC HERRING HABITAT RESTORATION PROJECT

TECHNICAL MEMORANDUM 3:

HABITAT RESTORATION SUITABILITY AND PILING REMOVAL:
TIER III FIELD INVESTIGATIONS AND SITE SELECTION RECOMMENDATIONS

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Merkel & Associates, Inc.

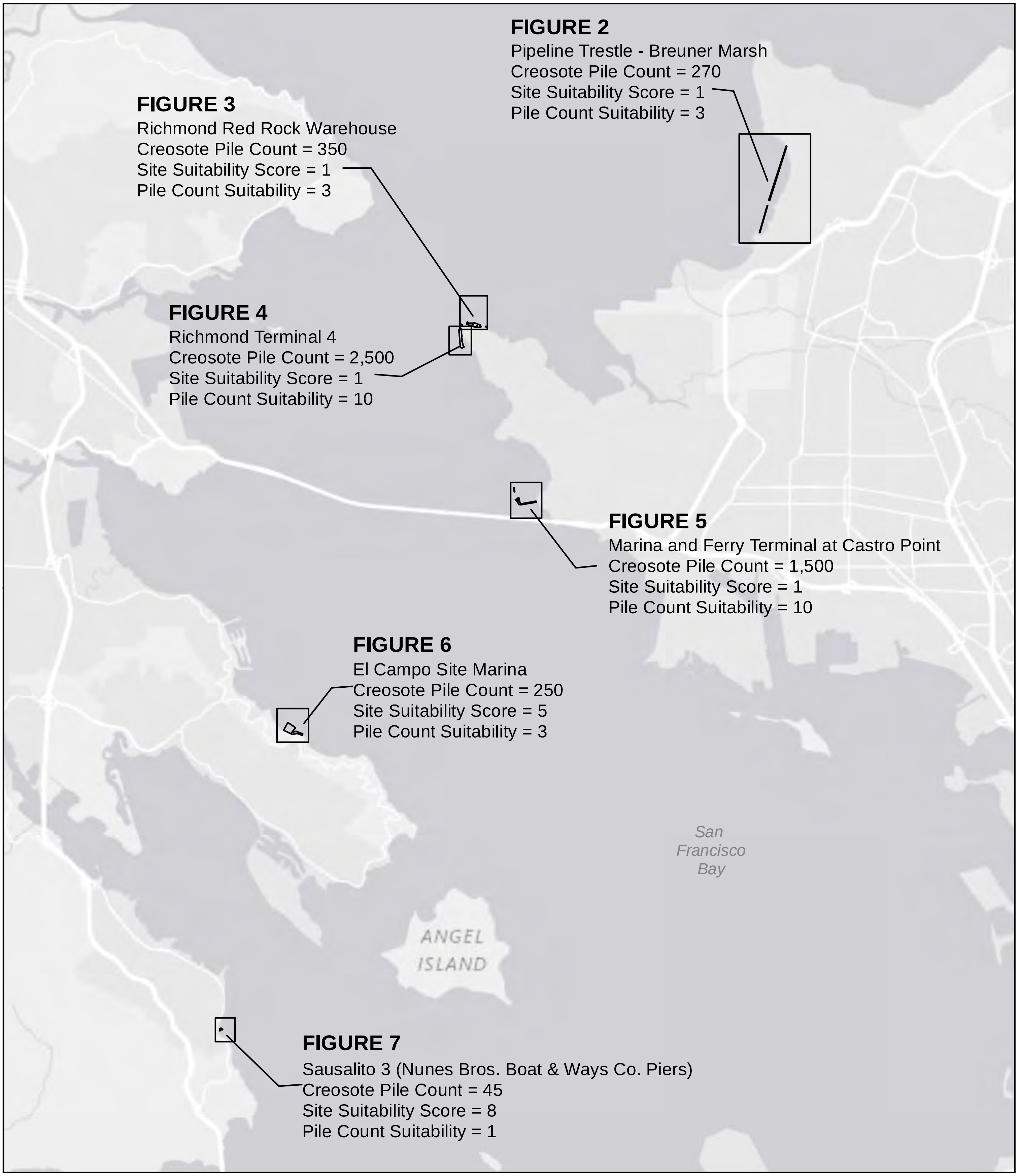
INTRODUCTION

This is the third technical memorandum prepared in support of the San Francisco Bay Creosote Piling Removal and Pacific Herring Habitat Restoration Project being undertaken by the California Coastal Conservancy (Conservancy) with funding from the National Fish & Wildlife Foundation (NFWF). The three technical memoranda, including the present document, outline the process for selection of a project site(s) to implement a creosote pile removal project for the benefit of Pacific herring (*Clupea pallasii*) spawning success.

The goal of the screening process was to identify pile clusters that best fit objectives of removing creosote piling from herring spawning habitat where restoration of native habitats, including, but not limited to, eelgrass (*Zostera marina*) and Olympia oyster beds (*Ostrea lurida*) may be accomplished to replace the lost physical structure of the pilings for spawning herring. For the current effort, the project targets the removal of 1,200 individual pilings or 180 tons of creosote pilings. As such, identifying sites with high pile counts is an important element of the screening process. A related goal is to provide the benefits of the implemented habitat restoration over an area of at least one acre. The one-acre target does not require or intend that the physical footprint of the restoration treatments (e.g., transplanted eelgrass beds, reef balls, shell bag mounds, etc.) cover a full acre of substrate, but rather that the benefits and improved ecological functions or services would extend over at least one acre.

Technical Memorandum 1 (Merkel & Associates 2014a) outlined a process for screening the approximately 630 identified creosote pile clusters supporting over 30,000 pilings identified in Appendix 6-1 of the Subtidal Goals Report (Conservancy et al. 2010) titled *Removal of Creosote Treated Pilings and Structures from San Francisco Bay* (Werme et al 2010). Technical Memorandum 2 (Merkel & Associates 2014b) outlined the process for development and application of a GIS screening model to narrow potential candidate sites for project implementation using available and prepared regional spatial data sets (Tier I). The memorandum subsequently reviewed the application of non-spatial desktop tools, including aerial imagery and map reviews, to assist in final selection of a small number of sites to be subjected to field review and additional screening data collection (Tier II).

From the Tier I and Tier II screening, six sites were selected to advance through Tier III screening. The selected sites range from very high pile counts resulting in high "Pile Count Suitability" scores to low pile counts and commensurate low "Pile Count Suitability" scores. In addition, the sites ranged from high to low "Site Restoration Suitability Scores" based on the combined effects of historic herring spawning frequency in the site region and the predicted restoration potential based on baywide habitat suitability models (Merkel & Associates 2014b). The selected sites for Tier III screening are distributed along the east and west shoreline of the northern portion of the Bay (Figure 1) and include the following:



Sites Reviewed During the Tier 3 Screening Process

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Figure 1

- **Pipeline –Trestle Breuner Marsh** is the furthest north and eastward site located on the westerly flank of Point Pinole in San Pablo Bay;
- **Richmond Red Rock Warehouse** is located on the northeastern side of Point San Pablo in San Pablo Bay;
- **Richmond Terminal 4** has the greatest pile count of the sites present within historic herring spawning region of the Bay. This site is located on the northwester tip of the San Pablo Peninsula;
- **Marina and Ferry Terminal at Castro Point** is located north of the eastern touchdown of the Richmond-San Rafael Bridge just south of the newly opened Point Molate Beach Park;
- **El Campo Site Marina** is located along the Tiburon Peninsula north of Paradise Beach Park in Marin County, and;
- **Sausalito 3 (Nunes Brothers Boat & Ways Company Piers)** is located at the south end of the City of Sausalito within a semi-protected easterly facing cove.

This current document summarizes the investigations conducted on these six Tier III sites and makes a recommendation for the ultimate project site selection. This is the final step in the site selection screening. With this final memorandum complete, the Conservancy, in consultation with NFWF, will make a final site selection, which will initiate coordination with property owners regarding the desired project and commencement of design, environmental review, and permitting.

METHODS

Following completion of the Tier II screening, the six sites selected to be advanced through Tier III screening were subjected to further investigation in order to evaluate conditions that could not be assessed from the regional data and remote sensing tools applied to earlier screening. The investigations included limited field reviews of physical and biological characteristics and more in depth research into factors that may promote or detract from a site, such as historic resource concerns and ownership.

Merkel & Associates (M&A) conducted field investigation between October 16 and October 20, 2014. Investigations included both high tide and low tide visits by boat to all of the Tier III sites. The vessel used for the work was M&A's 24-foot hydrographic survey equipped Ocean King. A three-person vessel crew completed the surveys.

View from Ocean King survey vessel showing interferometric sidescan sonar data collection windows of bathymetry, sidescan backscatter, navigation/coverage chart plotter, and signal/noise and other data collection status indicators.

PHYSICAL ENVIRONMENT

Bathymetry

The bathymetry of the project areas was determined by conducting a comprehensive mapping of the sites using interferometric sidescan sonar. The hull-mounted sonar is rigidly coupled with a ship motion sensor and GPS position and heading antennae. The interferometric sonar uses sound pulses generated at a 468 kHz frequency to ensonify the water around the vessel and then listens for and interprets the returning reflected acoustic signals from the surrounding environment. Acoustic returns are collected on port and starboard facing transducer heads that collect high density bathymetric and acoustic reflectivity data from swaths on both sides of the vessel.

Surveys were conducted at high tides in order to allow survey access into the intertidal zones at each site. As operated for the current survey, the port and starboard swath widths were each 31 meters (102 feet) wide for a total swath width of 62 meters (203 feet). The vessel was navigated along tracklines at a speed of approximately 7.3 kilometers per hour (4.0 knots), with tracklines being positioned to provide 60 percent overlap in swath coverage by adjacent lines. The non-overlap density of data points with these operating parameters is approximately 36 square centimeters per point. The equipment provided a precise positioning and orientation of the sonar equipment. For the present investigations, surveys relied on no location specific position correction or reference, and equipment provided a ±1.6-meter (±5.2-foot) horizontal accuracy and ±0.3-meter (±1.0-foot) vertical accuracy. Data are not to be used for navigation purposes and were intended for the very specific site screening use.

Following field data collection, bathymetric data were processed within Swathplus Grid Processor software. Bathymetric data were then merged with 2010 Coastal Mapping LiDAR data (NOAA NOS 2010) to provide a continuous bathymetric and topographic surface at each of the investigated sites.

Substrate Characteristics

The capacity to support habitat restoration of various types within the investigated sites is partially dependent upon the surface sediment characteristics and the sediment's foundation bearing capacity. Sandy and non-gelatinous unconsolidated sediments are well suited to support eelgrass habitat restoration, and the depth of soft sediment is relatively unimportant to eelgrass restoration potential. Conversely, support of habitat structures such as reefs is strongly dependent upon sediment depth and bearing capacity as well as erosion potential. To explore these conditions, limited field investigations were undertaken at each site. The objectives of the investigations were to garner a sense of potential restoration opportunities rather than to complete a comprehensive design analysis for a particular restoration proposal. As such, depending upon the site selected and restoration proposed, additional geotechnical investigations may be required. This would be particularly true if a reef or other heavy structure were proposed at a site. It may not be required for other restoration options.

Static sediment evaluation was performed at 3 or 4 locations within each site based on accessibility given tidal conditions as well as variability of the sediment across the site based on more widespread sediment probing and acoustic data review during collection. Sediment sampling sites are illustrated on maps for each of the investigated sites (below). To position the vessel for sediment sampling, a single spud was lowered through the spud collar within the transom of the survey vessel. The forward thruster and main drive engine were then put into gear to create a dynamic three-point anchoring system capable of maintaining the vessel in a static position at the sampling point. Where multiple sampling was performed, this was done by moving around the gunnels of the vessel such that all samples at a given sampling point were located within approximately 3 meters of the sample point.

Surface sediment characteristics were evaluated by collecting grab samples from the top 6 centimeters of the sediment and completing a field classification under the Unified Soil Classification System (USCS). Classification used a number of field assessment methods including tactile evaluation of texture, settlement rate, and volumetric fraction when suspended in a shaken tube. In addition, any surface algae or other material was noted.

Shear strength measurements are performed in cohesive sediments to determine their stress-strain-time behavior. In clayey marine sediments, shear stress decreases as the sediment is strained beyond a peak stress where it fails. While slope stability, typically evaluated using shear strength measurements, is of little interest to the present evaluation, critical shear stress (the stress required to initiate surface erosion) provides insights into the sediment's resistance to erosion by flowing water. This is important where hydrodynamics are expected to be modified by pile removal or structure additions such as contemplated under this project. Highly cohesive sediments with high shear strength are less erosive than non-cohesive sediments.

To assess shear strength, a submersible shear vane was used to measure shear *in situ* in accordance with methods described by Hauton & Paterson (2003). Three shear measurements were taken at each sediment sampling point within each site. Where non-cohesive sediments or matrix cobble and substantial shell hash were present, shear vane measurements were not collected, as the results are not meaningful.

Subsurface conditions were investigated in order to evaluate the likely bearing capacity of sediments and to determine if greater or lesser strength bearing strata were present in the near surface sediments at each site. Measurement of true bearing capacity requires sediment loading over time and is not conducive to rapid assessment of multiple candidate sites. For this reason, sediment probing was completed using a high-density graduated probe with a circular concave penetrating tip that was of a greater diameter than the following graduated rod. This design follows that of most cone penetrometers in order to minimize skin friction and tactile sensations felt along the rod. The graduated probe was pushed into the sediment, and the pressure required to advance the rod was recorded along with the depth of penetration beneath the sediment surface. A constant rate of advance of approximately 1 meter per minute was used to drive the rod. As the rod was advanced, the vibrations from the advancement of the tip propagated up the dense rod to the hands of the rod-driver and the tactile sensation was relayed to the data recorder. This methodology allows for rapid stratum characterization and thickness.

For example, unconsolidated silts and clays create a viscous, smooth, vibrationless sensation as the probe is advanced while sands generate gritty high frequency vibrations on the rod when comprising a significant fraction of the sediment matrix. Where sands do not have high clay or silt content that allow for lubricated flow of sand around the probe tip, the sands are resistant to probe advancement and may require a light tapping to liquefy sand layers and allow the probe to advance. This produces a dull thud rather than a sharp ping of rock. Gravel creates a lower frequency vibration than sand due to the fewer contacts on the probe tip and may have an uneven pressure requirement to advance the probe as gravels are moved off the probe tip and the probe drops to the next gravel barrier. Shell hash has a distinctive crunch as the probe passes through it. The data recorded from this methodology is generally fairly accurate but is both less accurate and precise than extracting cores for inspection and laboratory characterization. In addition, like any boring or coring, this method only provides localized information that may or may not be extrapolated across broader areas depending upon the uniformity of the geologic and sediment strata.

To evaluate the complexity of underlying sediment layers, a roving probing was conducted within the investigated sites. This included slowly navigating the vessel around the sites, typically in systematic shoreward to deeper water and deeper to shallower motion, while probing the bottom to depths of approximately 1-1.5 meters (3-5 feet). For this effort, the pressure to advance the probe and recording of substrate characteristics was omitted. Major strata were noted and the depth of probe refusal was noted where this occurred. If refusal was due to rock impact or consolidated sediment (ping or thud), this was noted. If the refusal appeared to be due to something else (e.g. wood), this was noted as well. Roving data collection was done over a large area and does not have specific coordinate points. As such, it provides no specific mappable data. Rather, it was intended to assist in developing a narrative description of the site subsurface conditions, including its consistency or variability. For highly variable subsurface conditions, it would be appropriate to conduct further quantitative, geographically registered, and spatially intense investigations using tools such as sub-bottom acoustic profilers if reefs or other structural enhancement features were ultimately desired.

BIOLOGICAL ENVIRONMENT

Existing Spawning Habitat Resources

As indicated previously, the interferometric sidescan sonar system collects both bathymetric data as well as acoustic reflectivity data typical of standard sidescan sonar systems. However, because of the greater positional, directional, and pitch, heave, and roll correction possible with the rigid hull mounted interferometric system, data collection is both more accurate and precise than standard sidescan sonar. Further, because the data are integrated with bathymetry, there is also greater informational value that may be garnered from the interferometric system. This includes obtaining depth distribution of resources detected within the sidescan record.

Sidescan sonar data are processed to create a spatially rectified mosaic of reflectivity of features on the seafloor. The imagery presents similar to monochromatic photography with objects, casting shadows and having differing reflectivity or transparency. In addition, features have characteristic shapes and patterns, while sediments have differential sound absorption or reflectivity characteristics that can be used to interpret bottom conditions. The native pixel resolution of the image is approximately 6 cm x 6 cm (2.4 inch x 2.4 inch), thus allowing very small features, such as depressions generated by burrowing organisms in mud, to be observed depending on contrast and noise in the area.

For the current surveys, the principal spawning resources of interest are submerged aquatic vegetation (eelgrass and algae) and consolidated or stable hard substrate that may support algae or direct substrate spawning use by herring. Soft bottom habitats do not provide spawning substrate due to mobility of the sediments and lack of structure to retain adhered eggs. Further, sediment that is typically semi-stable, except during large storms or very high currents, may become unstable if herring spawning occurs and increases the hydrodynamic roughness and drag. As such, unconsolidated sand and gravel beaches are typically not suitable spawning substrate.

During the investigations, habitats within the investigated sites were mapped up to the +1.2 meter MLLW (+4 foot MLLW) contour to fully encompass tidal elevations potentially suited to herring spawning as well as habitat elevations for rockweed (*Fucus distichus*) and Olympia oysters. All topography and bathymetry charts are presented in feet MLLW rather than metric units. Habitats were mapped as follows and are listed in order of diminishing value as herring spawning habitat:

- **Eelgrass** – Surveys were limited to eelgrass habitat occurring within and adjacent to the sites. Other submerged vegetation within the project areas was limited to minor accumulations of acoustically transparent macroalgae. While this habitat in abundance may often be mapped, algal occurrence on soft bottoms was too limited to provide confidence in mapping;
- **Consolidated/Stable Hard Bottom** – This habitat includes bedrock formations such as occurring on headlands south of Richmond Terminal 4, cemented cobble and boulders, rip rap and shoreline concrete rubble;
- **Sunken Vessels/Structures** – This includes a number of features ranging from sunken ship and barge hulls and/or structural ribs (found at the Richmond Red Rock Warehouse, Richmond Terminal 4, and Marina and Ferry Terminal at Castro Point) to lattice debris and ship ways rails (found at the Richmond Red Rock Warehouse and Sausalito 3 (Nunes Bros. Boat & Ways Co. Piers) sites). Other non-woody structural debris was also mapped under this category;
- **Unconsolidated Sand/Cobble Bottom** – This habitat type includes sand, gravel, and non-cemented cobble beaches. Subtidally, this habitat also includes active sand scour and transport areas, typically found where water velocities are increased such as at the tips of structures, and;
- **Unconsolidated Soft Bottom** – This habitat includes subtidal and intertidal mud bottom habitats. This habitat is the dominant subtidal habitat throughout all sites and occurs as intertidal habitat only at the Pipeline Trestle – Breuner Marsh site.

Avian/Marine Mammals

During the course of field investigations, observations were made of the piles and structures within and near the sites to determine if intensive or unique avian roosting, nesting, or marine mammal use occurred at the sites. Observations included examination of the avian use at the time of the survey as well as consideration of the scale of guano deposits, presence of maintained or deteriorated nests, and potential for structures to support extensive avian use and not leave substantive evidence (e.g., narrow cross beams that would not result in considerable guano collection, even if there were heavy use).

Marine mammal investigations focused on potential haul out locations and any evidence of haul out use. In addition, the presence of marine mammals was noted during the surveys.

Herring Spawning History

The California Department of Fish and Wildlife (DFW) maintains data on annual herring spawning locations within San Francisco Bay, and estimated tonnage of spawn dating back to the 1973-1974 (DFW 2014a). In what has been largely attributed to the prolonged drought reducing freshwater barriers to herring spawing in the northern portions of the Bay, 2014 marked the most northerly herring spawned in Marin County in at least 40 years (DFW 2014b, R. Bartling, pers. comm.). Through tabular data interpretation and collaboration with Ryan Bartling of the DFW herring program, historic spawning records were converted to spatial regional spawning frequency data by shoreline segments. These historic spawning frequency data were used during the Tier I screening process (Merkel & Associates 2014a).

The frequency of spawning provided a good tool for regional assessment of past herring occurrence. However, this metric does not examine the temporal distribution of herring spawn or other factors that may affect the records of spawning history. These include herring survey intensity or frequency, or availability of potential spawning habitat that may or may not be altered by habitat restoration. As such, for the six sites advanced to Tier III review, the occurrence of spawning in the region was examined from CDFW data (DFW 2014 a and b) by survey year to evaluate the potential presence of trends in spawning regional distribution through time (Table 1). Because the conditions at individual sites are discussed separately in this document and the trends in spawning history are best viewed collectively, the results of this analysis are presented in this section and discussed by site within the subsequent analyses section of this report.

The data suggest recent expansion of the herring spawning range within the last few years since the 2008-2009 spawning season (Table 1). It is likely that this expanded use is reflective of drought conditions over the past several years as well as potential increase in the intensity of monitoring and awareness of herring use at more peripheral areas of the spawning area.

Table 1. Regional herring spawning history reflected for the Tier III sites.

	SPAWNING SEASON																																								
SITE WITHIN SPAWNING REGION	1973-1974	1974-1975	1975-1976	1976-1977	1977-1978	1978-1979	1979-1980	1980-1981	1981-1982	1982-1983	1983-1984	1984-1985	1985-1986	1986-1987	1987-1988	1988-1989	1989-1990	1990-1991	1991-1992	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
Pipe Trestle - Breuner Marsh																																				■				■	
Richmond Red Rock Warehouse																																				■				■	
Richmond Terminal 4																																				■				■	
Marina and Ferry Terminal at Castro Point																																					■	■	■	■	■
Marina at El Campo Site						■	■			■												■						■	■	■	■		■	■	■	■	■	■	■	■	■
Sausalito 3 (Nunes Bros. Boat & Ways Co. Piers)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■			■	■	■	■	■	■		■	■	■	■		■					■	■	

As expected, overall spawning frequency increases with distance from the river delta and what would normally be significant freshwater inputs. Notably, however, spawning reports for Sausalito have diminished with increasing spawning further into the Bay. This may suggest that there is more to spawning distribution than relaxation of hypersalinity constraints. In the years leading up to 2008 Sausalito had a spawning frequency of 82.8 percent, however since the 2008-2009 spawning season, the Sausalito spawning frequency has only been 33.3 percent. Conversely, all other Tier III sites occur within regions that have exhibited an increase in spawning frequency in more recent years. This includes increases from a 31.4 percent spawning occurrence prior to 2008-2009 along the Paradise Cove and Paradise Cay shoreline that supports the El Campo site to a recent frequency of 100 percent for the past 6 years. None of the other sites supported recorded herring spawning prior to recent years; and now the shoreline segment supporting the Castro Point site has supported spawning during the last 5 years or 83.3 percent of the years since 2008-2009. It should be noted that the extent of spawning within the specific site is not known since the navigational hazards of this area have generally precluded sampling by CDFW. The Point San Pablo region that encompasses the Richmond Terminal 4, Richmond Red Rock Warehouse, and Pipeline Trestle –

Breuner Marsh sites had no recorded spawning until recently and have had a 33.3 percent spawning history since the 2008-2009 season.

The relatively recent expansion of spawning distribution into other areas of the Bay from the historic core areas is extremely notable; and as indicated previously, may be a transitory effect of reduced delta discharges over the past several years. Conversely, water export from the delta has been increasing over time such that the average outflows to the bay have been diminishing with time, even though extreme discharges remain substantially unaffected by water withdraws. The relevance of extraction on herring spawning is unknown and certainly dwarfed by the prevailing drought. Of potentially greater importance to site selection is that the recent geographic expansion of spawning does not appear to occur with herring making more diffuse levels of use over a broader number of shoreline regions, but rather involves actual site switching. This makes year-to-year site selection of outlier areas very important to the individual spawning events and potentially the population at large.

Further, consideration with respect to herring use frequency and trends relates to availability of preferred spawning habitat at each of the investigated sites as it pertains to the proportional distribution of desirable non-toxic spawning substrate (e.g., eelgrass hard bottom substrates) relative to creosote pile substrates. This is discussed later for each site individually.

OTHER CONSIDERATIONS

Historic Resources

During the course of Tier III investigations, consideration has been given to the potential for historic resources to exist at each of the sites. This has included noting the condition and uniqueness of the resource within the Bay, searching easily accessible references and on-line historic society information, and reviewing photographs of the bay for timelines for the development or decommissioning of piers and pile structures.

This work was not conducted by a qualified historian, and as such, it should not be relied on as a formal historic resource review. Information is presented for each site as a starting point for historic evaluation should a site be selected for project development. In some cases, there is an overwhelming amount of information that the site is either historic or interpreted to be of a historic nature by the surrounding community. In these cases, the Tier III screening used this information as a detractor from proceeding with the site. In other instances, observations of potential historic features are noted, but not explicitly used to eliminate sites. It should be noted that the Richmond Ferry Terminal within the Miller-Knox Shoreline was eliminated during Tier II screening due to its early identification as a historic site.

Bottom Debris and Navigation Hazards

Within the various Tier III sites, there are a number of navigational hazards ranging from partially submerged to fully submerged derelict vessels to broken pile butts. Often, the presence of vertical piles provides the only indication of likely subsurface hazards in the area. For this reason, removal of piles could result in either an increase in navigation hazards at the site, or the necessity to remove or monument the non-creosote hazards as a matter of public safety. In most instances, the hazards have been mapped within the site and are discussed under the habitat features. Where hazards would create a cost or logistical constraint to the pile removal project, this is discussed.

Current and Wave Energy

The removal of dense pile fields or structures that affect water movement will result in changing the wave and current environments at the project sites. In many instances, it is clear to see where piles have altered the hydrodynamic characteristics within and adjacent to the sites or there is a high potential for pile removal to affect flow, scour, and deposition patterns.

No specific hydrodynamic monitoring or modeling has been conducted at any of the sites. As a result, current and wave energy is discussed qualitatively based on secondary data sources including bathymetry and surface sediment characterization, current and historic aerial photographs, and visual observations of waves and vessel wakes as they propagate through the sites. In all instances, the investigated sites were occupied by the study team for a period long enough to experience wake environments from large vessels passing in the nearby channels. In the case of the Pipeline Trestle – Breuner Marsh, it was possible to observe a significant wind wave storm event as it propagated through the site at high tide.

Pile Conditions

The condition of piles is important in assessing both the potential environmental harm they pose due to chemical leaching, as well as likely complexity of pile removal. Pile condition was assessed in multiple ways. First, where information exists, the approximate age of piles was estimated based on historic documents and photographs. Second, piles were reviewed in the field for such factors as degree of weathering of the piles, presence of creosote on the pile surface both above and below the waterline, growth of marine organisms on the pile surface (suggesting lower levels of toxicity), and pile wrapping that would reduce toxicity by sequestering some of the leachate beneath the wrapping.

In addition to reduction of toxicity levels, pile wrapping can increase or decrease the difficulty of pile removal, depending upon the method and quality of wrapping. This was evaluated in the field and is discussed for each site.

Property Ownership

Property owner approval for completion of a creosote pile removal project will ultimately be required for the selected site. As such, the ownership of the various sites is very important to the screening of candidate sites. Deteriorating and unused piles pose a long-term liability to property owners who may be at fiscal or litigation risk due to unsafe site condition, developing navigation hazards, or potential future contamination liability. As such, it is expected that willing property owners will be identifiable. However, where piles provide protection against future shoreline erosion, hold potential for vesting or resurrecting a waterside use, owners may be reluctant to allow pile removals. Further, it is anticipated that public owners may be more willing to cooperate than private owners due to greater familiarity with process and public benefit interests. Multiple ownerships or ownerships by trusts create complexity due to the necessity to coordinate with multiple parties, any one of which may significantly affect the project scope or viability.

For this reason, ownership information was sought for all of the Tier III sites using regional data sets and inquires at municipal agencies and the State of California. The ownership data as it is presently known is presented within the discussion on each site. In some instances, ownership information was not located but can be surmised with a high likelihood of being accurate. This includes the street right-of-ways between paper lots laid out in Sausalito that are presumed to be owned by the City of Sausalito and offshore portions of the Bay that are presumed to be owned by the State of California, and most commonly by the State Lands Commission.

Construction Access/Staging

Using the site bathymetry, review of shoreline features and land uses, and previously reviewed aerial photographs greater insights into construction constraints including access and staging area opportunities have been gained. These are discussed individually by site.

RESULTS

PIPELINE TRESTLE – BREUNER MARSH

Physical Environment

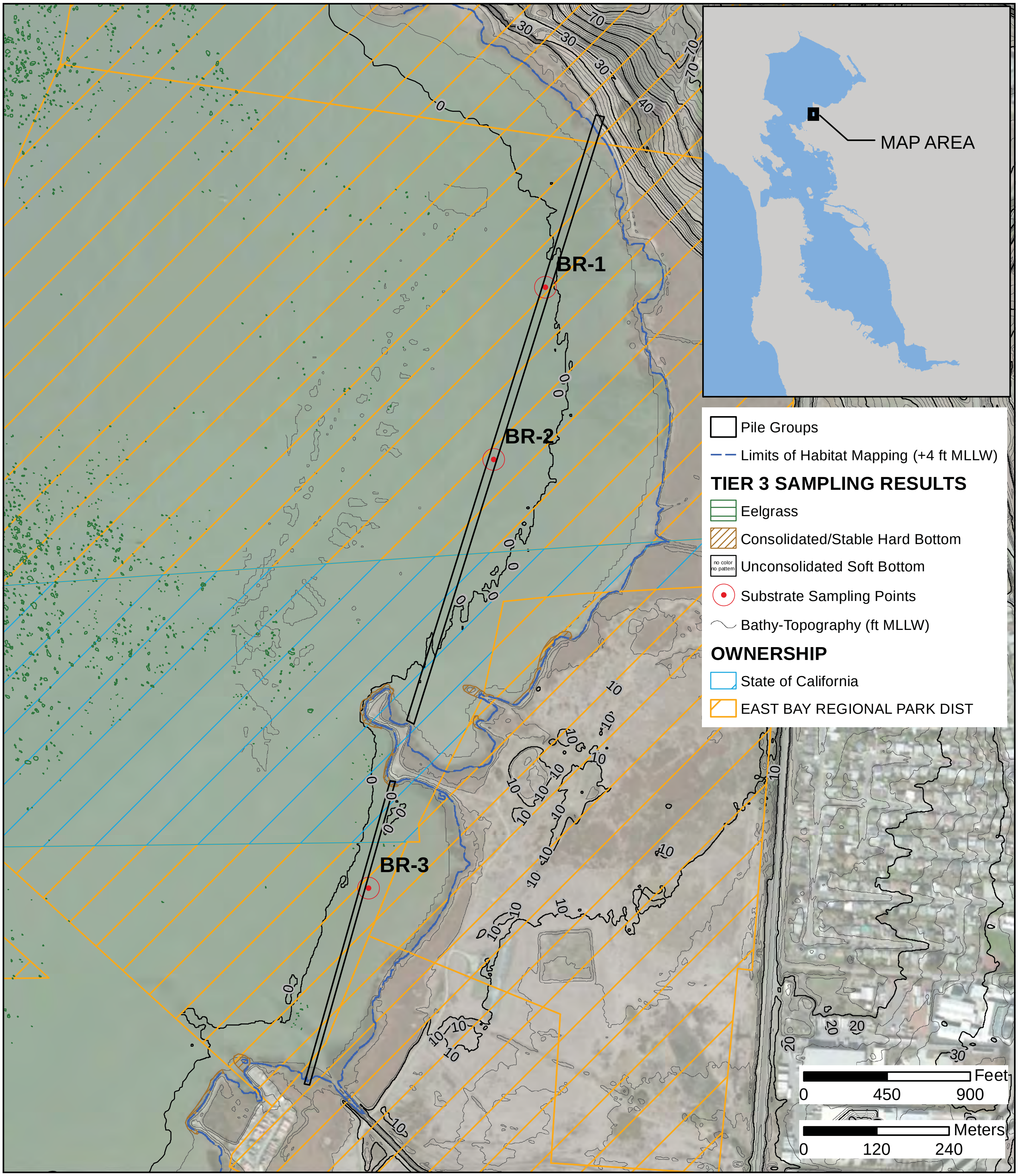
Location and History

The Pipeline Trestle-Breuner Marsh is a 270-pile linear trestle that held a long-retired pipeline along the shoreline margins of San Pablo Bay between Point San Pablo and Point Pinole (Figure 2). It is the furthest north and east of all of the Tier III sites. Despite its relatively low pile count, this site has the greatest length of all of the sites, covering just over one mile from south to north as a single row of piles having a nominal even inter-pile spacing of 20 feet. The pile alignment is believed to have once buttressed an on-grade petroleum pipeline of the Standard Oil Company. The pipeline was present on the bay flats in photographs from 1938 and was likely put in place between 1901, when the Richmond Standard Oil Refinery was constructed, and December 1938, when it is clearly present in a photograph. The 1938 photograph would tend to indicate the pipeline is on the mudflats not suspended on the top of the trestle as would be the case for modern pipeline construction. This may indicate that the piles were used as a buttress to hold an on-grade pipeline in position, or it may indicate that the pipeline was defunct by 1938 and had fallen off the trestle.

The pipeline trestle on flats offshore of Breuner Marsh in December 1938 photograph. The Standard Oil refinery built in 1901 is located to the south of this photograph and oil was stored in hundreds of tanks dotting the hillsides around the refinery.

Low tide view of the pipeline trestle crossing intertidal mudflats

Since its construction, it is not clear if the pipeline trestle has been altered. Nearly all piles are present within the alignment. There have been two episodes of bay fill that now cover portions of the pipeline alignment at the western end and approximately one third of the way down the trestle from west to east.



Pipeline Trestle - Breuner Marsh

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Figure 2

Bathymetry

The Pipeline Trestle – Breuner Marsh is the shallowest of the sites investigated, with approximately half of the alignment occurring above 0 feet MLLW. The site occurs on a broad mud and sand flat with a very gradual slope to the west. The mudflat slope ranges between 1:500 and 1:2,000 (rise:run) making it extremely difficult to access the site by water at all but the highest tides with very shallow draft vessels. The site over a mile from the -5ft MLLW contour.

Sediment Characteristics

The site sediment characteristics were investigated at three locations, identified as BR-1 to BR-3 located along the trestle alignment (Figure 2). Additional sediment probing was performed bayward of the trestle as water was too shallow during the low tide to hazard a passage through the trestle piles, which were nearly fully submerged at the time of sampling.

Surface sediments throughout the site were characterized as unconsolidated soft sediments (Table 2). Subsurface sediments consisted of distinct strata of primarily silts and clays with some sand and shell hash layers. It was surprising to find some clean sands on the site given the broad shallow flats and the present lack of highly suitable mechanisms for sandy sediment transport past the broad eelgrass expanse to the west of the site. Surface sediment shear strength was not high, and it is anticipated that the site would be fairly erosive if acted on by large waves.

Throughout the wide-ranging subsurface probing, no stiff strata were located that would support extensive surface loading, and no probe refusal was noted to sediment depths exceeding 150 cm (59 inches). This suggests that if reef habitat were desired, it may be required to build up a spread footing foundation to support the reef structure. This may be accomplished by placement of interlocking gravel or shell base material prior to reefs to expand the loading of reefs.

Waves and Currents

The shallow and flat nature of the bathymetry combined with the offshore eelgrass bed likely provides considerable protection against scouring the mudflats at this site. The same cannot be said for the shoreline marsh that rises abruptly between the +2 and +4 feet MLLW beyond the flats. This shoreline was not closely inspected but appears from a distance to be weathered clays and potentially organic interbedded sediments. The marsh face is eroding as a result of high tide wave impacts. During the high tide survey conducted at this site, extreme wind waves were encountered. These waves ran unmitigated across the flats and through the pile trestle where they broke against the marsh shoreline. The single pile alignment with gaps of 6 meters (20 feet) between piles renders the short period wind waves that reach this shoreline at high tides unaffected by the trestle. Further, the piles do not extend to high tidal elevations and are fully submerged at even moderate tides below mean sea level. The moderate to high accumulation of macroalgae on the surface near the northeastern end of the pipeline suggests that current velocities are low in the area of the trestle and wave transport of algae to the site may be occurring at a greater rate than current export. These factors further reduce the effect of the trestle on hydrodynamics and geomorphology and it is unlikely that the removal or retention of the piles would substantially affect flow characteristics in the area.

Table 2. Surface and subsurface sediment characteristics at Pipeline Trestle – Breuner Marsh Site.

Site	Pipeline Trestle - Breuner Marsh					
Station	**BR-1**		**BR-2**		**BR-3**	
Latitude: Longitude	37.99258	-122.36171	37.99002	-122.36272	37.98366	-122.36511
Surface Characteristics	abundant algae (Ulva)		some algae (Ulva)		no algae	
(USCS)	sandy clay		sandy clay		silt	
Shear Strength (kPA)	Shear was sampled at 15 cm below sediment surface					
1	5.21		4.04		NA	not cohesive
2	4.17		5.92		NA	sediment
3	5.81		3.23		NA	
Mean	**5.06**		**4.40**		**NA**	
Sediment Depth (cm)						
0	sandy clay		sandy clay		silt	
5			shell hash		clean sand	
10						
15					shell hash	
20					silty sand	
25						
30	silty clay					
35			silty clay			
40					silt	
45						
50						
55					stiff	
60					clay	
65						
70						
75						
80	silt				silt	
85			clay			
90						
95	clay					
100						
105						
110						
115						
120						
125						
130						
135						
140						
145						
150						

Biological Environment

Herring Spawning History

At 4.9 percent spawning frequency, this site occurs within a region of low herring spawn frequency over the 41 year DFW recorded spawning site history. However, the shoreline region has a 33.3 percent history over the recent 6 years. While DFW herring biologist, Ryan Bartling, has reported herring spawning within the large Point San Pablo-Point Pinole eelgrass bed occurring bayward of the site, there is no specific information to suggest herring have spawned on the site itself, and it is anticipated that this is a case where the DFW shoreline regional data over-predicts specific site use.

Existing Spawning Habitat Resources

The Point San Pablo-Point Pinole eelgrass bed supports approximately half of the eelgrass present within San Francisco Bay and extends for nearly 4 miles in length to the north and west of the site. Eelgrass within this bed would be ideally suited for spawning by herring during periods of low delta outflows. Within the investigated site, the majority of the bottom supports bare mudflats and macroalgae at the northern end of the trestle. The shoreline is principally unconsolidated with minor rubble revetment occurring on fills near the southwestern end of the trestle. The trestle piles provide the most stable and predictable habitat at the site; however, the prolific presence of eelgrass bayward of the site would be preferred by herring over the piles at the site.

In addition to the piles being a very limited and unlikely spawning habitat given the abundance of eelgrass in the area, the piles are also not likely to be significant contributors to free creosote contaminants in the Bay. The piles along the trestle have been historically concrete wrapped and have been weathering in the intertidal zone of the bay for at least 76 years and likely over a century. At present, most of the wood in the piles is gone leaving the square section concrete pile wraps standing and a hollow void where the wood has rotted away. Piles support some marine invertebrates, particularly barnacles but coverage is not as dense as would be expected within a different physical environment.

Avian/Marine Mammals

The low elevation of piles means they are submerged during most tides and exposed for only a limited portion of most days. Further, the piles provide limited surface area available for roosting during low tide when most birds are foraging not roosting. During the course of investigation, birds observed roosting on the piles were limited to an observation of three western gulls and a great blue heron that was foraging from a pile as it became exposed with the falling tide. No significant roosting or loafing on the piles is expected and no nesting is possible.

The areas provide no suitable loafing or haul out areas for marine mammals and none were observed at the site during the investigation.

Other Considerations

Ownership

The Pipeline Trestle – Breuner Marsh site is fully within public ownership. The northern and southern ends of the alignment occurring within East Bay Regional Park District lands while the central portion of the alignment occur within property owned by the State of California (Figure 2).

Construction Access/Staging

The Breuner Marsh site is located at elevations ranging between +2 feet MLLW and -1 foot MLLW. This makes the site the shallowest of all of the Tier III sites and difficult to access by water on all but extreme high tides. The site is also located over a mile from waters deeper than -5 feet MLLW that are typically considered to be not substantially tidally encumbered for this type of construction work. Access to the site requires crossing a broad shallow shoal that is fully covered by eelgrass, making access risky without damaging existing habitat resources. Upland staging opportunities are not available at the site and the only landside access is through the presently under construction Breuner Marsh restoration site, or pedestrian trails within the Point Pinole Regional Shoreline. Neither of these offer suitable shoreside water depths or upland conditions to support construction access or land side staging.

Site Analysis

The Pipeline Trestle – Breuner Marsh site has very little if anything to support its continued evaluation as a candidate project site. The pile count falls well below the targeted project scale. The site has a low history of herring spawning; and although the shoreline region in which it occurs has experienced a marked increase in herring spawning in recent drought years, it is unlikely that spawning occurs at this particular site. Further, it is unlikely that the remnant pilings continue to leach significant creosote toxicity to the bay based on the wrapping of the piles and the deteriorated or even absent wood in most piles.

Upland access conditions to the pipeline trestle are not suitable through the Breuner Marsh (foreground) or Point Pinole Regional Shoreline (background).

In addition to the lack of merit for piling removal, the site poses significant logistical challenges due to its shallow nature and great distance from deep water. In full consideration of the site conditions, the pipeline trestle may serve better to assist in developing a support for a "living shoreline" reef structure to assist in protecting the marsh frontage at Breuner Marsh and Giant Marsh from the continuing and exacerbated erosion presently occurring and anticipated with sea level rise. While sediment probing was not attempted directly adjacent to the piles due to concern about vessel impact on undetected submerged piles, it is highly likely that the remnants of the prior pipeline remain buried at a shallow depth along this alignment and would further provide support for reef structures placed on this axis.

This site is recommended for dismissal as a candidate site for a creosote pile and herring habitat restoration project.

Richmond Red Rock Warehouse

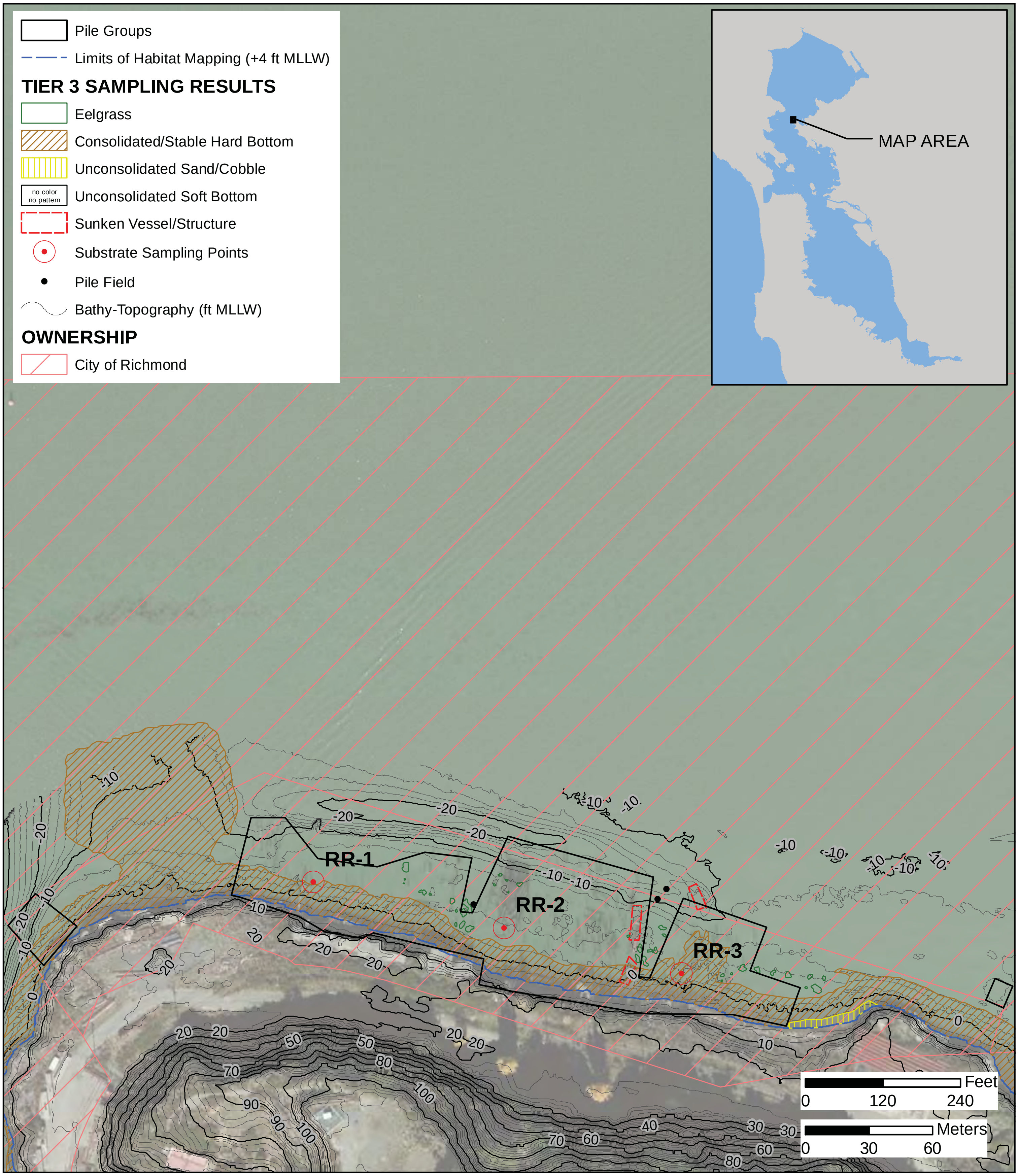
Physical Environment

Location and History

The Richmond Red Rock Warehouse site is located on the northeastern tip of the San Pablo Peninsula within San Pablo Bay (Figure 3). The site supports an estimated 350 creosote piles and further supports a minor amount of collapsing decking that is also creosote treated and will eventually drop to the bay and be exported from the site by bay currents.

The Richmond Red Rock Warehouse was constructed at some point after 1938 and may have integrated some of the pile support structures from a number of smaller overwater warehouses and piers that occupied this shoreline early in the century. In addition to a reconstruction of the overwater structures during the middle of the 20th century, there has also been an expansion of shoreline fills post-1938 that pushed the banks of the peninsula shoreward in several areas. The Del Monte Richmond Whaling Station was constructed on one such fill pad and operated on the site from 1956 to 1971. The station burned to the ground and waterline after it closed and was dismantled in 1998. Only subtidal remnants of the station persist where the lower portion of the hoisting ramp that was used to slide whales into the building was spared the fire. This is located on the far right side of Figure 3. As the last whaling station in America, a substantially intact facility would likely be considered a historically significant building. However, the loss of the structure to fire and ultimate removal removed most of the historic value of the site. The remnants of the warehouse piles show some fire charring along the upper portions of the piles and on the bottom of some of the remnant decking wood. Little of the original post-1938 warehouse complex structures remain on the site.

Photographic history of changes at the Richmond Red Rock Warehouse and Terminal 4 sites



Richmond Red Rock Warehouse

SAN FRANCISCO BAY CREOSOTE PILING REMOVAL
AND PACIFIC HERRING HABITAT RESTORATION PROJECT

Figure 3

N W E S

Bathymetry

The Richmond Red Rock Warehouse complex is located at the tip of Point San Pablo where water flowing past the point is accelerated and has maintained a moderately deep scoured channel just north of the warehouse site. Historically, this channel allowed short piers to reach depths suited to navigation by moderate draft vessels. Within the piling field, the site slopes gently to the north from an elevation of 0 feet MLLW at the toe of a rubble armored bank down to an elevation of -6 feet MLLW at the edge of the scoured channel cut (Figure 3). The slope through the piling site is relatively even and gradual at approximately 1:25 (rise:run). The adjacent deeper water would provide ready access for pile removal and restoration activities. Further, disturbed flat pads at +14 to +16 feet MLLW occur in the uplands adjacent to the candidate site. These pads are presently being used for *ad hoc* storage by a tenant of the City of Richmond. These pads would provide both accessible and ideally suited areas for storing, drying, mustering and trucking piles out for disposal.

Sediment Characteristics

The site sediment characteristics were investigated at three locations identified as RR-1 to RR-3 located within the warehouse piling site (Figure 3), with additional sediment probing being performed throughout the site at areas close to the shoreline, mid-distance to the channel, and near the channel edge.

Surface sediments throughout the site were characterized as shell hash, sandy silt, and silty gravel. In general, the surface sediment collections and probing indicates that mollusk shell rubble and gravels are common constituents of the surface sediment within a cementing matrix of silt in some instances exposed silty sand surface substrate was identified on the surface through probing. Subsurface sediments consisted of narrow distinct strata of primarily silts and clays with some areas exhibiting layers of shell hash (Table 3). Probe refusal was met at very shallow depths throughout the site, suggesting that the Point San Pablo formation extends out into the bay just below the sloping bench that extends to the channel. The refusal was met by a dampened resonance rather than a sharp ping, suggesting the underlying resistant layer is not hard rock.

Waves and Currents

The location of the Red Rock Warehouse on the east flank of Point San Pablo protects the site from most of the prevailing storms from the west and northwest. However the site is exposed to a 10-mile fetch from the north and longer fetches to the northeast. During strong northerly winds, significant waves impact the rubble armored shoreline at the Richmond Red Rock Warehouse. The site is also exposed to wakes from vessels traveling along the channel, most specifically in a southward direction past Point San Pablo. The Red Rock Warehouse site has a moderate influence on wave energy passing through the field this is evidenced by observing the morphing and dampening of ferry wakes as they pass through the pile field.

While the majority of the current flows that pass the site travel within the scoured channel located off the edge of the site, there is evidence of elevated flow velocities through portions of the pile field. This evidence includes scour around the bases of piles at the northern tip of the site and even at the channel edge piles further to the south.

Table 3. Surface and subsurface sediment characteristics at Richmond Red Rock Warehouse.

Site	Richmond Red Rock Warehouse					
Station	**RR-1**		**RR-2**		**RR-3**	
Latitude: Longitude	37.96569	-122.42746	37.96549	-122.42644	37.96529	-122.42549
Surface Characteristics	sandy silt		shell hash		silty gravel	
(USCS)	shell hash		silt interbedded		shell hash	
Shear Strength (kPA)	Shear was sampled at 15 cm below sediment surface					
1	11.23		NA	shell hash	10.875	
2	9.22		NA	precluded	9.435	
3	11.57		NA	clear vane	7.492	
Mean	**10.67**		**NA**	rotation	**9.27**	
Sediment Depth (cm)						
0	shell hash		shell hash		graded gravel	
5	silty clay		silt		stiff	
10	stiff		shell hash		clay	
15	clay		stiff		silt	
20	refusal		clay		refusal	
25			refusal			
30						

Biological Environment

Herring Spawning History

At 4.9 percent spawning occurrence, this site occurs within a region of low herring spawn frequency over the 41 year DFW recorded spawning site history. However, the shoreline region has a 33.3 percent history over the recent 6 years. The expansion of spawning into the San Pablo Peninsula region is a relatively recent phenomenon and may reverse following return of more typical delta outflows.

Existing Spawning Habitat Resources

As indicated previously, the Point San Pablo-Point Pinole eelgrass bed supports approximately half of the eelgrass present within San Francisco Bay. This bed occurs approximately a quarter mile to the north of the site. Within the Red Rock Warehouse site, eelgrass is found in scattered patches at depths from -1 foot MLLW to -6 feet MLLW. Eelgrass in this site may be restricted by the lack of availability of suitable soft sediment at suitable depth ranges given the abundance of shell hash, cobble and gravels within the depth range occupied by eelgrass at the site. In addition to eelgrass, the site supports an abundance of hard substrate including bank armoring comprised of rubble and hard bottom consisting of consolidated or semi-stable rubble, cobble, shell hash and debris. The shoreline includes a moderately sloping low intertidal and shallow subtidal rubble revetment slope that supports macroalgae as well as a well-developed community of encrusting invertebrates including Olympia oysters. There is a sunken vessel within the pile field along with a large broken steel lattice structure and fine gravelly rubble that may be the remnants of an asphalt floor that collapsed when the warehouses burned. These hard features provide additional shallow surfaces suitable to support herring spawning.

In addition to the horizontal substrate, the site has extensive vertical pile surface. These piles have considerable exposed surface creosote in areas above the mean high tide line and less obvious surface creosote below the mean high tide line. The piles support a good coverage of ephemeral algae, but very little in the way of encrusting invertebrates. None of the piles at this site are wrapped and given the anticipated age, condition of piles, and lack of marine fouling community development, it is believed that these piles likely are leaching creosote derivatives at a moderately toxic level and the piles pose a moderate risk to herring spawning.

Pile field at Richmond Red Rock Warehouse. The rubble shoreline and submerged debris that provide potential preferred spawning substrate over vertical piles can be seen in this low tide photograph.

Avian/Marine Mammals

The piles at the Red Rock Warehouse site provide undisturbed overwater structures suitable for roosting use by a number of avian species that are commonly associated with such structures. These include double-crested cormorant and a number of gulls. During the multiple visits made to the site, a surprisingly low level of avian activity was observed and guano deposits on piles and remaining decking materials suggest the site receives limited roosting use. Two cormorants were observed on the piles during one of the visits made to the site.

The areas provide no suitable loafing or haul out areas for marine mammals and none were observed at the site during the investigation.

Other Considerations

Ownership

The Red Rock Warehouse site is owned by the City of Richmond. The City has expressed interest in the demolition and removal of both the warehouse and the larger Richmond Terminal 4 in order to reduce the hazards and liability of the site and make way for expanding public shoreline park access to the area and could be instrumental in expanding partnerships for creosote removal and habitat restoration.

Construction Access/Staging

The City property extends over the surrounding uplands in addition to the waters supporting the pile sites. Because the uplands have substantial flat pads, controlled access, and are of a disturbed nature, this area provides both a willing landowner participant and an ideal staging area. Deep water extends very close to the shoreline at a few locations at the site and it is likely that a floating barge and causeway could be temporarily positioned to provide a temporary offloading pier to remove piles from barges supporting the pile removal. Alternatively, a land based crane could be used to pull piles from deck barges positioned near the shoreline.

Site Analysis

The Richmond Red Rock Warehouse site has potential benefits for herring, especially if the more recent increased spawning on the San Pablo Peninsula continues. The site provides easy access for pile removal, good opportunities for pile handling on site, and has reasonable opportunities for expanding spawning habitat by transplanting eelgrass on site into soft sediment locations after pile removal or construction of oyster reefs in areas of deeper rubble in order to increase surface relief. However, it is not clear that spawning habitat is limited at the site given the significant extent of hard bottom, the presence of some eelgrass, and the great extent of eelgrass just a quarter mile to the north.

In terms of the project goals, what the site lacks is a large number of creosote piles, although those present likely retain moderate levels of residual toxicity. The lack of pile wrapping and relatively younger age of piles than several other sites makes pile removal here of greater benefit than piles that are either well aged or wrapped in a manner that reduces leaching. At 350 piles, the site falls well short of the desired 1,200-pile goal. Given the length and girth of some of the piles, however, it would not be surprising for the dried piles to weigh between 600 and 1,000 pounds each coming much closer to the 180-ton alternative removal objective. This makes the Red Rock Warehouse site a reasonable candidate for consideration if coupled with pile removals at a second site of similar scale.

Richmond Terminal 4

Physical Environment

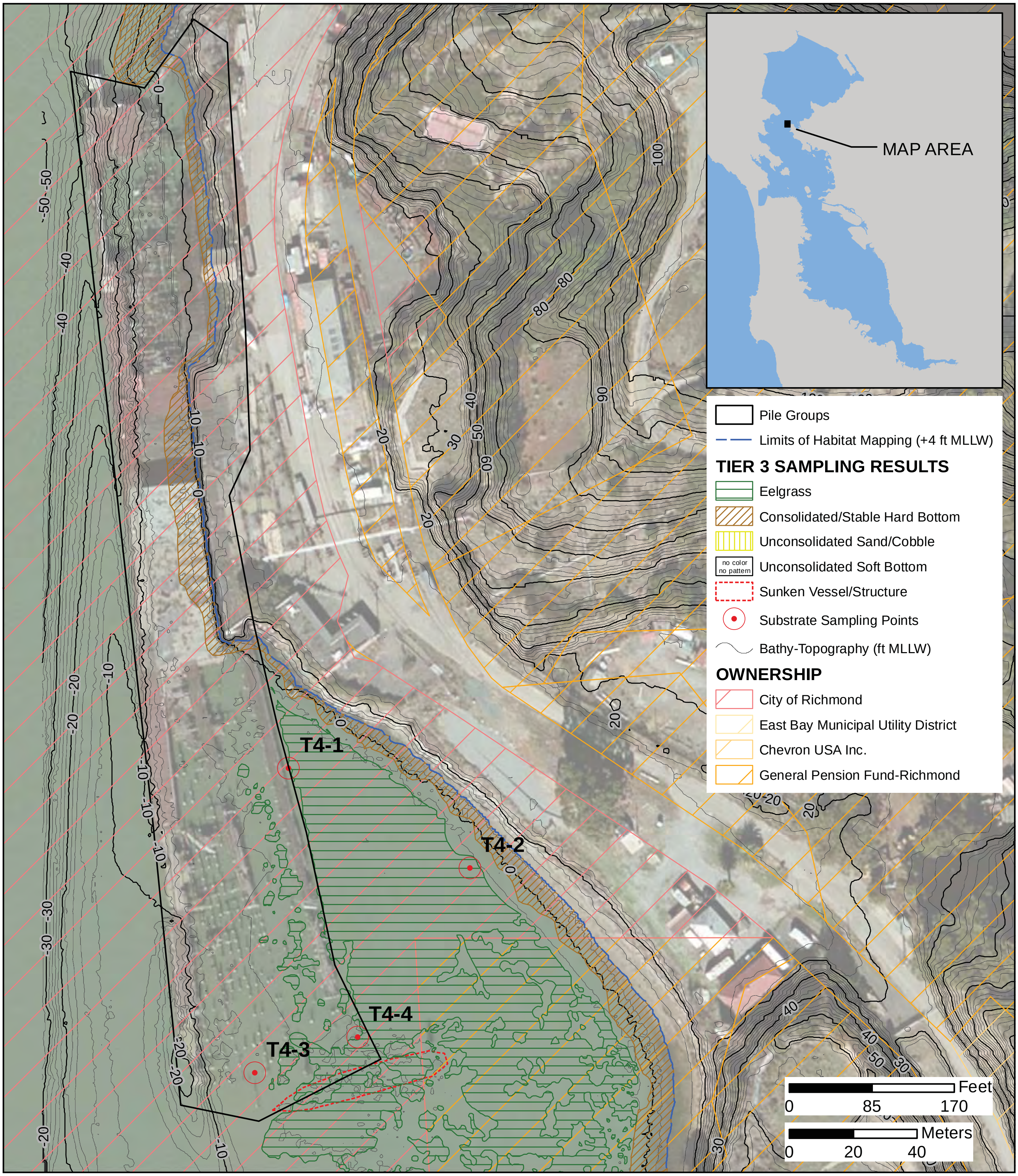
Location and History

The Richmond Terminal 4 site is located on the northwestern tip of the San Pablo Peninsula within San Pablo Bay (Figure 4). The site supports an estimated 2,500 creosote piles and further supports a significant extent of partially collapsed deck and a collapsing warehouse over the central portion of the terminal.

Based on a review of historic bay charts, the Richmond Terminal 4 structures were built sometime between 1850 and 1915. Historic aerial photographs show the terminal in heavy operation in December 1938 when there were four ships berthed at the southern end of the terminal (see photographs from prior discussion of the Richmond Red Rock Warehouse). This berthing pattern indicates that significantly deeper water once occurred on the east side of the southern pier are in an area that is now intertidal flats.

While being at least 100 years old, the pile support structure for the pier were designed and constructed for prolonged life. Most of the piles that support the pier are concrete wrapped creosote treated wood piles. The concrete wrapping appears to be original construction rather than being associated with later retrofit action. This is based on the uniformity of the encasement even well under the pier in areas that what would have been all but inaccessible if decking had been present. Further, the concrete pours around the piles were completed in short lifts using tubular forms to contain the concrete. Close inspection of several piles revealed no evidence of form seams in the cast concrete, suggesting that the casting was conducted prior to installing the wooden pier substructure that attaches to each pile by a pin set in the core of the wooden pile upon which wooden posts were set to hold large joist beams and cross member framing. It is suspected that the concrete was poured in situ and thus does not extend far below the mud line at each pile. Further, movement of some of the piles in response to passing vessel wakes suggests that the concrete encasement may currently be suspended above the mudline on several of the piles. The bearing piles and batter piles beneath the pier appear much older than the non-wrapped creosote treated fender piles along the western face of the pier. These piles show signs of creosote leaching where most of the older piles no longer show significant physical evidence of creosote except when looking closely above the area of regular inundation.

It is not clear when Terminal 4 ceased full operations. By 1987, however, the pier had fallen into a state of significant disrepair and much of the structure and decking at the north end of the terminal had been damaged or lost. Between 1997 and 2002, a substantial portion of the pier north of the overwater warehouse was redecked and considerable investment was made to bolster some of the structural support members beneath the deck. Continued reliance on the failing support beams and piles, however, ultimately has resulted in the new decking buckling and failing with most of this redecking project now being unsafe to walk or drive on. The pier is presently in a condemned and likely unsalvageable state.



Richmond Terminal 4

SAN FRANCISCO BAY CREOSOTE PILING REMOVAL
AND PACIFIC HERRING HABITAT RESTORATION PROJECT

Figure 4

Failed northern section of the Richmond Terminal 4 pier revealing the principal construction of the pier to be short concrete wrapped wood piles supporting a lattice work of beams and cross members that held the pier deck. Deck support beams and encased piles both show evidence of creosote treatment.

Bathymetry

The Richmond Terminal 4 site is located at the northwestern tip of Point San Pablo and extends along the face of a relatively straight segment of rubble armored shoreline at the north and central portions of the pier and extends in front of a small cove at the southern end of the pier. As indicated previously, the 1938 berthing of ships, stern into the cove, would indicate that the cove was at one time substantially deeper than it is today. In fact, today the remnants of a sunken ship rest in the mud in the approximate position of the northerly of the two ships that are side tied at the end of the Terminal 4 southern pier in the 1938 photograph of Point San Pablo on page 18. Only some frame ribs and the top of the propulsion unit of the ship continue to protrude above the surface of the sediment.

At present, the bathymetry in this cove ranges from 0 feet MLLW along the toe of a rubble revetted shoreline and gravel beach to a depth of approximately -4 feet MLLW through the center of the pier. At the outer edge of the pier, the bottom drops away to a scour hole at -20 feet at the southern corner of the pier and a depths of -44 feet MLLW at the northwestern tip of the pier ruins where water scours the face of the slope supporting the pier as it passes around the tip of Point San Pablo through the gap between the point and East Brothers Island (Figure 4). This northern scour pit has excavated several piles from their embedment enough to free the pile or allow it to be snapped off below the wrapping. This is verified by numerous piles lying at the bottom of the scour hole between -54 and -66 feet MLLW outside of the project area.

As was noted for the Richmond Red Rock Warehouse, the landside topography rises up a short rubble protected bank to a flat pad near the elevation of the Terminal 4 Pier at about +14 feet

MLLW. This pad would be an ideal candidate site for processing piles for disposal from either the Terminal 4 site or any of the other sites under consideration.

Sediment Characteristics

The site sediment characteristics were investigated at four locations identified as T4-1 to T4-4. Sites were distributed within the cove at the south end of Terminal 4 and within accessible areas of the southern end of the pier (Figure 4). The sampling was conducted both near shore and further removed from the rocky shoreline and cobble beach environment.

Surface sediments throughout the site were silts with one site supporting sandy silt and another site supporting clayey silt (Table 4). Silty sediment is typical of protected depositional environments and reflects the accretion of sediment that has occurred in the cove over the years. Along the shoreline above the sampling locations, surface conditions are dominated by rubble revetment and cobble and gravel beach to the south of the pier.

Table 4. Surface and subsurface sediment characteristics at Richmond Terminal 4.

Site	Richmond Terminal 4							
Station	**T4-1**		**T4-2**		**T4-3**		**T4-4**	
Latitude: Longitude	37.96270	-122.42876	37.96241	-122.42811	37.96184	-122.42889	37.96194	-122.42852
Surface Characteristics	sandy silt		silts		clayey silt		Silt	
(USCS)			silt in eelgrass mat					
Shear Strength (kPA)	Shear was sampled at 15 cm below sediment surface							
1	4.13		8.134	eelgrass root	3.741		4.436	
2	3.34		9.945	interference	4.454		7.631	
3	<2.643		6.572		3.523		6.008	
Mean	**3.37**		**8.22**		**3.91**		**6.03**	
Sediment Depth (cm)								
0								
5								
10	silt		silt		silt		silt	
15								
20								
25	silty clay							
30			silty clay		silty clay			
35								
40							stiff clay	
45								
50			graded gravel		soft clay			
55	soft clay							
60								
65								
70								
75								
80			stiff clay					
85							soft clay	
90								
95								
100								
105					stiff clay			
110								
115								
120								
125								
130								
135								
140							stiff clay	
145								
150								

As with the surface sediments, the subsurface sediments on the site supported principally fine sediments identified as clays due to stickiness on the probe. In the sampling station located nearest the shoreline, a narrow band of gravel was encountered at approximately 45 cm (18 inches) depth. This gravel was rapidly passed back into the clayey sediments. The gravels crossed in this probing are not represented on the shoreline above the sampling area and may reflect the historic slope that occurred at this cove location prior to sediment burial. It should be noted that there is good anecdotal evidence that the cove was once deeper and has shallowed since at least 1938. However, it is not known whether there has been historic or recurrent dredging to maintain cove depths for terminal use. There was no evidence observed in the probing strata to suggest dredging has been performed, however, given the relatively shallow nature of the probing, encountering a prior maintenance dredging interface would be unexpected.

Waves and Currents

The shear stress values noted in surface silts indicate a weak cohesion of the sediment and potential for high erosion in the event wave or current energy is increased at the site. Similar risk does not exist at the central and northern ends of the Terminal where the underlying conditions are comprised of rubble revetment and cobble matrix based on observations from the surface. Within the cove, there is risk that removal of the dense field of pier pilings would allow for significantly more wave, wake, and current energy to enter the cove and potentially scour out the accreted sediment that now supports fairly dense eelgrass habitat.

The dense presence of eelgrass in the cove to moderate depths just beyond -4 feet MLLW would be expected to stabilize the cove against erosion under most conditions. However, as beds thin or contract, sediment scour would be expected to eat away at the lower fringes of the bed and eventually remove the eelgrass along with sediment. Over time, it is expected that the eelgrass in this cover would contract in distribution absent protection against increased energy environments. To combat the potential for damaging wave penetration into the cover, consideration should be given to retaining some of the outer piles to continue to serve as a wave barrier and/or integration of an elevated armored sill along the outer alignment of the existing piles. A combination may be prudent to retain navigational aids, anchors for enhancement features, and improved habitat component designs over the existing piles.

The effects of high currents that pass the cove may be seen by the development of the deep scour pit at the southwestern corner of the Terminal 4 pier and the very deep pit off the northern tip of the Terminal pier. The southerly pit has been excavated by the acceleration of water resulting from a flow constraint pinch point at the tip of the pier where water flowing into the cove is forced back out around the end of the pier. The removal of portions in this location would allow the scour pit to migrate shoreward following the pier removal. Conversely, the removal of the southerly pier or portions thereof would also reduce the flow constraint and would reduce the velocities in this area thus also reducing the depth of scour in the developing pinch point. It is not clear whether the reduction in flow constraint would fully offset the migration of scour into the cove. While flow scour in the southern portion of the pier is a concern, it is not as great a concern as wave erosion; and this issue would be satisfied by addressing wave scour issues.

At the north end of the pier, scour is a greater concern as the developing scour pit has a steep encroachment bank adjacent to the pier piles and several piles have already been lost and migrated to the bottom of the scour pit. It is not known what if any role the pier piles play in curbing the erosion of the east bank of the scour pit. It can be speculated, however, that full removal of the piles along this slope edge would allow greater erosion cut migration into the bank and may eventually encroach on the revetment toe at the tip of the Terminal 4 wharf.

Biological Environment

Herring Spawning History

As was discussed for the two sites presented above, the Richmond Terminal 4 site occurs within the San Pablo Peninsula region of the bay and spawning is known to have occurred in this area twice in the past 41 years. Those events occurred very recently during the 2008-2009 and 2012-2013 seasons with similar patterns of expanding occurrence occurring elsewhere where depressed salinities have generally been identified as the factor limiting herring spawn distribution. For the most recent 6 years this regional reach of shoreline had a 33.3 percent spawning frequency.

The Terminal 4 site differs from the other Point San Pablo shoreline segment sites under consideration, as it is the most proximate site to the regular spawning areas in the central bay of all sites. As such, it is expected that this area would be more suited to continued use than sites located closer to the Delta should normal freshwater discharge patterns return.

Existing Spawning Habitat Resources

Approximately 0.9 hectares (2.2 acres) of eelgrass occurs within and adjacent to the southern end of the Terminal 4 pier. The eelgrass habitat is bounded at the upper elevation of approximately -2 feet MLLW by an unconsolidated sand/cobble beach along much of the cove and a steeper consolidated rubble shoreline as the banks steepens as it approaches Terminal 4. Along the shoreline beneath Terminal 4, the shoreline is a rubble revetted shore that wraps around the northern end of the site and the tip of Point San Pablo. Away from the armored bank, the pier inner pier piles likely provide moderately suitable spawning habitat, while the outer piles are likely to be subject to currents of too high a velocity to support spawning. The high flow velocities around the Brothers Islands has been speculated by Ryan Bartling (Pers. Comm. 2014) to be the reason herring have never spawned on these islands.

The aged and wrapped piles of Terminal 4 comprise over 90 percent of all of the piles at the site. Newer non-wrapped creosote treated fender piles and what appear to be scattered replacement piles comprise the remaining pile substrates along with partially fallen beams. The wrapped piles support a good coverage of encrusting invertebrates including barnacles and Olympia oysters, and it is anticipated that residual leaching from these piles is relatively low. Conversely, the fender pile leaching is likely much higher as these piles were likely replaced in the late 1980s or 1990s. These piles, however, are located within the swiftest current environment affecting the pier and may not be conducive to herring spawning use.

Avian/Marine Mammals

The Richmond Terminal 4 site supports extensive use by rock doves (domestic pigeons) which nest within the warehouse and under the pier. This species is not protected at its nest sites and may be removed during demolition work. Terminal 4 also supports day and night roosting by double-crested cormorant, black-crowned night herons, western gull, and a few brown pelicans. No nesting by these species was noted on the pier; however, nesting by some species would not be unexpected and any removal should be initiated outside of the breeding season or pre-demolition surveys may be done to ensure that nesting is not occurring within the work area. There is one significant nesting activity on the Terminal 4 site and that is by an osprey, which has used a nest at the southwestern tip of the pier. It is not known if this nest remains active as osprey were never observed at or around the site during field investigations although these were well outside of the nesting season and lack of bird occurrence is not unexpected. Osprey nests can generally be relocated during the non-breeding season with a high degree of success, and it would be reasonable to attempt to retain this nesting use at the site under any project by retaining the piles supporting the nest or moving the nest to a more stable dolphin away from the pier demolition work.

The pier was reviewed during both daylight and nighttime hours. The review revealed a moderate amount of night roosting and daytime loafing on the structure. Guano accumulation indicates that roosting is generally fairly limited in both area and intensity with the ends of the pier away from the warehouse being utilized more extensively than other areas. The extent of use by avifauna is not atypically high or low compared to most overwater structures.

The areas provide no suitable loafing or haul out areas for marine mammals and none were observed at the site during the investigation.

Other Considerations

Ownership

Richmond Terminal 4 is owned by the City of Richmond. The City has expressed interest in the demolition and removal of Terminal 4 in order to reduce the hazards and liability of the site and make way for expanding public shoreline park access to the area. The interest in the removal of the terminal by the City and the control the City exercises over the site and surrounding uplands that may serve makes the removal of Terminal 4 highly desirable from a logistic and potential partnering perspective. Further, restoration of habitats including eelgrass and hard bottom habitat would be possible within the footprint of the removed southern end of the terminal in an area that would not be expected to conflict with the City's future goals and uses for the site.

Construction Access/Staging

As previously discussed, the City property extends over the surrounding uplands in addition to the waters supporting the pile sites. These uplands are prime candidates for staging the pile removal and having little if any adverse effect on third parties. Whether this site or another site is advanced to final selection, the uplands at Terminal 4 should be pursued as a project staging and operational area.

Site Analysis

The Richmond Terminal 4 site is a large site that exceeds the project's creosote-removal goal by more than two hundred percent. However, the project could be completed in multiple phases with the present project implementing one element of the work.

Terminal 4 has a relatively low herring spawning frequency at 4.9 percent over a 41-year history. Conversely, all of the spawning in this area has been recent with a regional expansion of spawning to areas outside of the core of historic uses and even a shifting of spawning away from the historic core spawning grounds over the past few years. There is no guarantee this trend will continue under more normal Delta flow conditions.

Assuming that spawning will continue to develop within the San Pablo region, it is important to consider the return value on pile removal at this site as a means to reduce spawning impact due to creosote toxicity and for the purpose of promoting habitat restoration. With over 90 percent of the piles being very aged and wrapped in concrete, it is unlikely that residual creosote leachate toxicity from piles remains high. Further, removal and disposal of wrapped piles would be much more costly than removal and disposal of unwrapped piles. For this reason, it is expected that targeting non-wrapped piles would provide an opportunity to remove a greater number of higher toxicity piles for equal or lesser cost.

The Terminal 4 site provides opportunity for expanding eelgrass habitat and constructing oyster reefs and subtidal shoals suited to use by spawning herring. This would be accomplished within the footprint of the existing Terminal 4 pier by removal of piles and decking to open the site up to greater light to support eelgrass and integrating hard bottom habitat features to create a barrier shoal to protect against wave and current damage to the site. While the work would be expected to have a high likelihood of success, the actual area of direct habitat restoration yield would be approximately 0.3 to 0.5 acre without raising bottom elevation. The ecological benefits of this area of direct habitat restoration would likely extend over a larger area and would thus have a good chance of meeting the one-acre goal described in the Introduction.

With all factors considered, The Richmond Red Rock Warehouse is expected to provide a greater toxicity reduction and habitat enhancement opportunity than the Richmond Terminal 4 site with less complexity of work and lower risk of unforeseen issues. For this reason, it is recommended that Terminal 4 not be pursued over the Red Rock Warehouse; however, depending upon the scale of the project and overall budget considerations, removal of unwrapped creosote fender piles at Terminal 4 could be reasonably added to the Red Rock Warehouse project to increase the net overall pile removal and garner the maximum toxicity reductions at Terminal 4 possible on a per pile basis.

MARINA AND FERRY TERMINAL AT CASTRO POINT

Physical Environment

Location and History

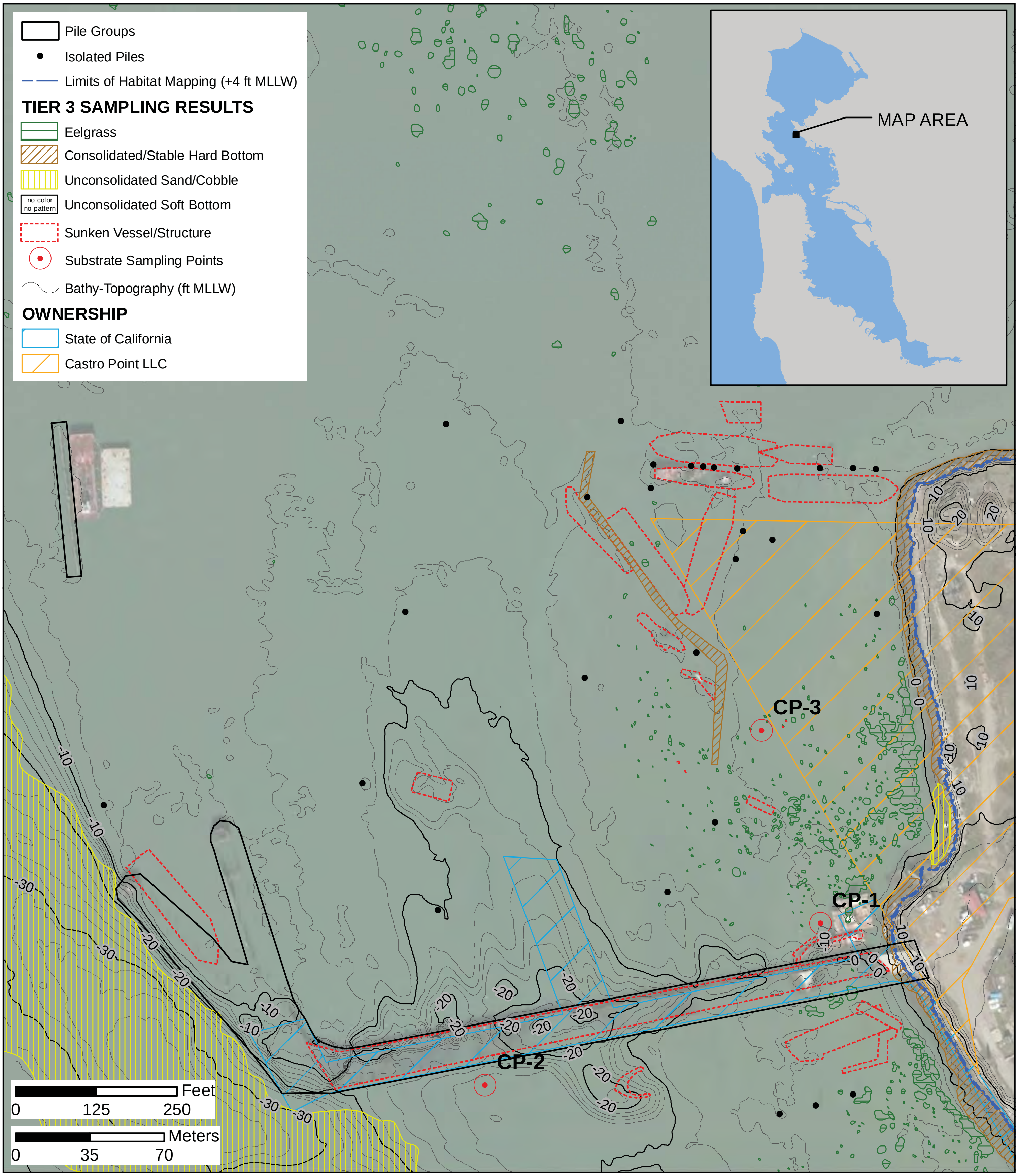
The Marina and Ferry Terminal at Castro Point is located at the end of Castro Point just north of the Richmond side of the Richmond-San Rafael Bridge and just south of the City of Richmond's recently opened Point Molate Beach Park (Figure 5). The site is the location of the now defunct and deteriorating ferry terminal that was operated by the Richmond-San Rafael Ferry and Transportation Company that subsequently became the Richmond-San Rafael Ferry Company. Ferries were operated from the site starting in approximately 1924, after a move of the operation from Quarry Point (an area that is now the location of the Richmond touchdown for the Richmond-San Rafael Bridge). The ferry operations were conducted through at least 1938 from short piers off the tip of Castro Point and not from the larger ferry dock that exists in a principally deteriorated and partially submerged state today.

Photograph of the Castro Point terminal of the Richmond-San Rafael Ferry Company. The ferry docks in the foreground were located near the shoreline while the background pier is the present deteriorating ferry dock

Between 1938 and 1952, the new longer ferry dock with a concrete deck was constructed and served the larger automobile ferries through the Richmond-San Rafael Ferry Terminal until the opening of the bridge in September 1956. After the bridge opening, the terminal shut down.

Later, the ferry pier became the southerly breakwater for the Red Rock Marina and Fishing Resort, which operated on the site until the late 1970s. As part of the marina development, a collection of derelict vessels were brought to the site and oriented along the northern boundary where they were scuttled to create a makeshift breakwaters. In total, there are twelve submerged or partially submerged vessels on the site (Figure 5). A rock jetty was also constructed along the westerly exposure to protect the marina against waves. This jetty was present as a supratidal feature in 1987 but has subsequently sunk into the bay muds to the point that the jetty is now fully subtidal. A book published in 2011 documents the use of the ferry pier as the San Francisco Bay landing point for major marijuana smuggling operation that operated from 1979 through 1983 bringing boats into the Y-berth at the tip of the pier for unloading to trucks (Douglas 2011).

While the site supports a considerable amount of vessel and other debris, for purposes of this analysis the focus is on the creosote treated wood structures. These include the ferry dock, a wave attenuation wall located to the north of the dock, and scattered piles. Other debris is considered in this document as potential constraints or liabilities on the site.



Marina and Ferry Terminal at Castro Point

SAN FRANCISCO BAY CREOSOTE PILING REMOVAL AND PACIFIC HERRING HABITAT RESTORATION PROJECT

Figure 5

Bathymetry

The Marina and Ferry Terminal at the Castro Point site extends from the intertidal shoreline out to the edge of a scour hole developed by concentrated flow between Castro Rocks and the Richmond shoreline headlands, including the ferry dock at Castro Point (Figure 5). The general site topology slopes from east to west from -2 feet MLLW to -6 feet MLLW adjacent to the scour hole at a 1:333 (rise:run) gradient. Because of the numerous scour features and submerged material at the site, the overall shallow slope is not readily apparent. From the outer edge of the ferry dock, a steep slope falls away to the bottom of the scour hole at -36 feet MLLW. In addition to this bathymetric low point at the end of the pier, the ferry terminal is designed with a solid piling bulkhead wall along the northern edge of the pier. However, a portion of this wall has been undermined creating a flow path through the bulkhead that has resulted in a smaller scour hole extending linearly through the wall and to a maximum depth of -24 feet MLLW. There are also indications that even smaller breaches through the pile wall are occurring based on scouring immediately adjacent to the wall.

While the site has an overall very shallow bathymetry, the depths at the pile bulkhead wall and ferry pier are nearly all below -5 feet MLLW and would thus provide good access for barges and equipment required for pile removal with limited depth constraint.

Sediment Characteristics

The site sediment characteristics were investigated at three locations identified as CP-1 to CP-3 located adjacent to existing eelgrass on the site where restoration potential may exist and adjacent to the ferry pier where current and wave energy may be substantially modified with the removal of the ferry terminal pier (Figure 5). Additional sediment probing was performed throughout the site.

Surface sediments near shore were characterized by sandy clay, while sediments further offshore were generally comprised of silts. Accumulations of macroalgae occurred near shore within the sheltered areas behind the ferry pier. These areas also supported considerable eelgrass. Subsurface sediments throughout the site revealed the presence of multiple strata consisting of narrow distinct layers of clays, silts, and shell hash suggesting differing periods of sedimentation under variable energy regimes (Table 5). Near shore, the probes met refusal in clays at depths between 125 and 140 cm (49 to 55 inches); however, it is not clear whether the probe actually hit a solid formation or the clays just got too stiff for the manual advancement of the probe. While not reached by the probing conducted, the scour hole off the end of the ferry dock has exposed sand deposits that are obvious in the sidescan sonar record. Because sands in this area are actively being moved around, it is not possible to determine the depth of sand layers that generated the sands in the first place.

The nearshore sediment layers reveal multiple thin layers of shell hash and silty sediments near the surface, with stiffer clays not occurring until about 70 cm (28 inches) below the probed sediment surface. In the surface layers, the shear vane measurements identified weak and very weak shear strengths in clay and silt. This suggests that the bearing capacity for the material is low above the clay layers and would likely require some foundation to support reefs or other hard habitat enhancement features. The continued sinking of the marina rock breakwater from supratidal to subtidal levels suggests that heavier features would require deep foundations.

Table 5. Surface and subsurface sediment characteristics at Marina and Ferry Terminal at Castro Point.

Site	Marina and Ferry Terminal at Castro Point					
Station	**CP-1**		**CP-2**		**CP-3**	
Latitude: Longitude	37.93639	-122.41383	37.93571	-122.41563	37.93721	-122.41414
Surface Characteristics	abundant algae (Ulva)		No surface algae		sparse algae (Ulva)	
(USCS)	sandy clay		silt		sandy clay	
Shear Strength (kPA)	Shear was sampled at 15 cm below sediment surface					
1	8.23		<2.64		NA	not cohesive
2	9.13		<2.64		NA	sediment
3	5.76		<2.64		NA	shell hash
Mean	**7.71**		**<2.64**		**NA**	interference
Sediment Depth (cm)						
0	sandy clay				sandy clay	
5					shell hash	
10			silt			
15					silty clay	
20	clay					
25			shell hash		shell hash	
30						
35						
40	shell hash		silt			
45					silty clay	
50						
55	silty clay		stiff			
60			clay		shell hash	
65	shell hash		shell hash		silty clay	
70	stiff					
75	clay					
80	shell hash		clay		clay	
85						
90	stiff					
95	clay				shell hash	
100					stiff	
105					clay	
110	shell hash				shell hash	
115	stiff					
120	clay				stiff	
125	refusal				clay	
130						
135						
140					refusal	
145						
150						

Waves and Currents

As discussed somewhat in the bathymetry section, the currents through this area are mediated to a large degree by the presence of the 300-meter (1,000 foot) long ferry pier that forces tidal flows away from the shore. In addition, flows are constricted by the presence of Castro Rocks beneath the Richmond-San Rafael Bridge. This has resulted in a deep scour hole at the tip of the pier and smaller scour holes where gaps beneath the pier have allowed water through the pier.

The pier and wooden bulkhead wall reduce wave energy entering the small cove created by the pier, as do many of the scuttled vessels that were set to provide a protected marina. The removal of the creosote pier and bulkhead wall would expose the area to an increase in wave energy. This would spread the current flows over a broader portion of the shallow flats than currently receive flow, thus dropping the velocity in areas of present flow and increasing velocities elsewhere. This would be expected to result in some infill of the deeper scour holes and potentially limit erosion of the silts from the more shallow areas at the outer ends of the jetty. The increase in wave and current exposure would not be expected to result in substantial changes in eelgrass distribution in this area, as the protected portion of the site that supports eelgrass have similar bayward extents and depth ranges as occur within the larger Point Molate beds located immediately to the north of the site outside of the direct influence of the pier.

The existing shoreline at the site is armored with rubble in a manner that would be expected to provide similar levels of protection from wave erosion with or without the presence of the creosote pile wall and ferry pier.

Biological Environment

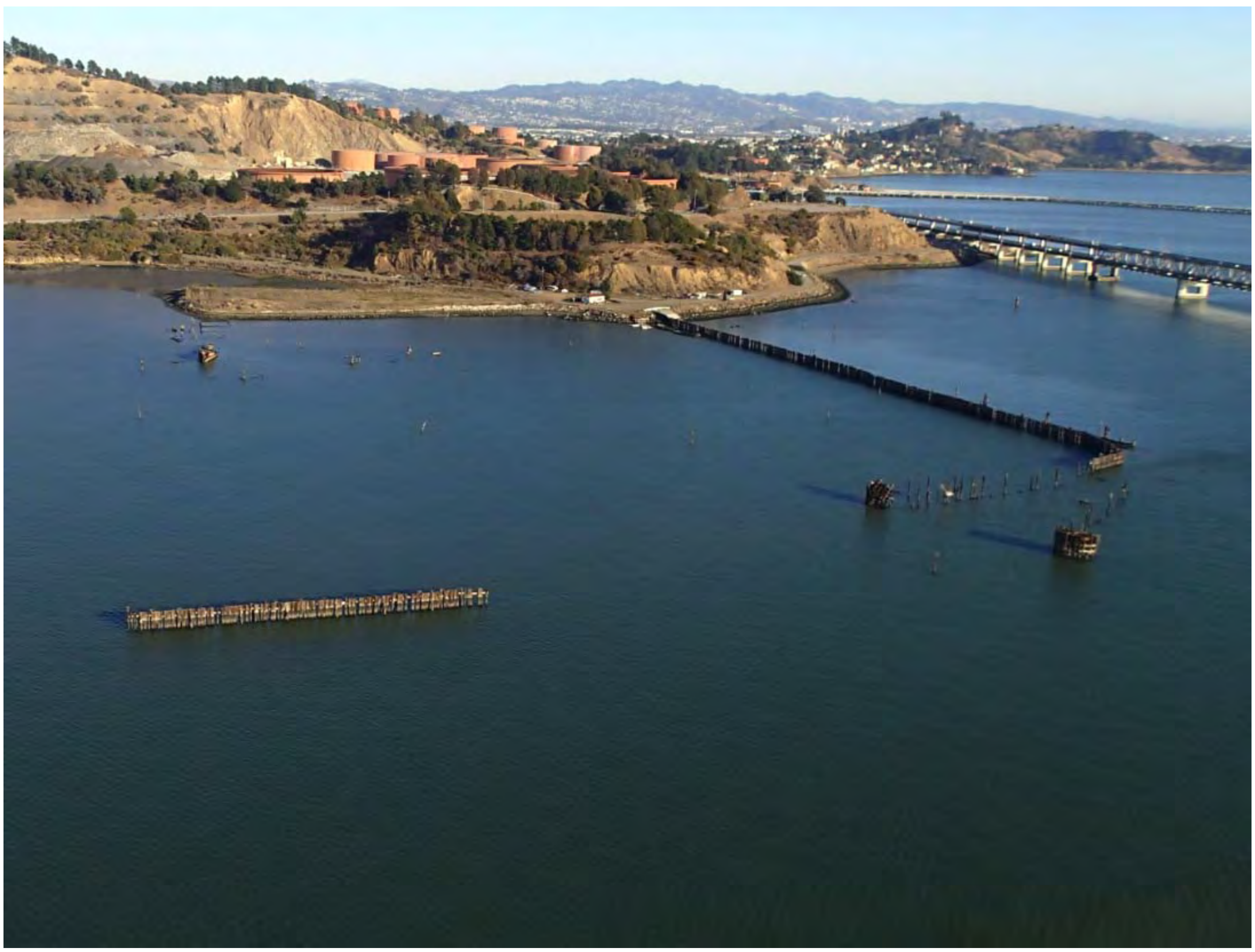
Herring Spawning History

The Castro Point site occurs within a shoreline region that has historically had herring spawning occurrence at a 12.2 percent frequency of occurrence over the 41-year history of DFW monitoring. However, the area inside the ferry terminal itself has not been investigated in many years due to the numerous unmarked navigation hazards present in this site (R. Bartling, pers. comm.). As such, the site specific use of the site by spawning herring is unknown. However, of particular interest in evaluating herring use along the broader shoreline region, within which the site occurs, is that there were no records of spawning use until the 2009-2010 season, with spawning occurring in every year since this season. Over the past 6 years, which were discussed for other sites in this report, this represents an 83.3 percent use frequency. As has been noted previously, the general expansion of spawning use beyond the core historic spawning areas is a relatively recent phenomenon and may reverse following return of more typical delta outflows.

Existing Spawning Habitat Resources

The site supports a minor presence of eelgrass beds along the shoreward edge of the site with a very sparse occurrence of single season plants extending outward to depths of approximately -6 feet MLLW. These deeper plants likely do not persist through the winter season. In addition to eelgrass, other potential spawning habitat at the site includes the submerged rock jetty and shoreline rubble revetment, the scuttled ship hulls, other minor debris on the shallow bottom, and the concrete decking of the ferry pier that has generally fallen below the water surface and which is now suspended on collapsed pile infrastructure.

Because of the pier and wall scale, the creosote piles of the ferry terminal pier and the bulkhead wall provide a significant portion of the potentially suitable spawning structure available at the site. None of the piles at this site are wrapped and they have an anticipated age range between 76 and 62 years. The piles are generally in good condition and there is considerable surface creosote both above and below the waterline. There was a notable lack of well-developed marine fouling communities on the piles, although other rubble on site supported dense occurrences of barnacle and Olympia oysters, as well as attached macroaglae. Based on the age and conditions of the piles, it is anticipated that these piles continue to leach creosote derivatives at a moderately toxic level, and the piles pose a moderate risk to herring spawning. At the northern tip of the pile bulkhead wall, a minor oil sheen was noted clinging to the piles and trailing off in the current. It is not known, however, if this oil originated at the wall or was simply trapped by the wall from another source.



Pile field at Richmond Red Rock Warehouse. The rubble shoreline and submerged debris that provide potential preferred spawning substrate over vertical piles can be seen in this low tide photograph.

Avian/Marine Mammals

The piles at the Marina and Ferry Terminal at Castro Point site provide undisturbed overwater structures suitable for roosting use by a number of avian species that are commonly associated with such structures. These include double-crested cormorant and a number of gulls. During multiple visits made to the site, both gulls and cormorants were observed making use of the pier and bulkhead wall as well as the exposed portions of the vessels. The intensity of avian use on the structures was typical of overwater structures, and extensive accumulations of guano were not noted. It is anticipated that nocturnal roosting occurs on the structures, but not at an intensive level.

The area provides some suitable loafing or haul out areas for marine mammals on the derelict vessels; however, no mammals were observed in the area during the surveys and no indications of extensive use (such as animal waste). A thousand feet to the south of the pier, Castro Rocks hosts the second largest harbor seal rookery in San Francisco Bay and is sometimes used by California sea lions as a haul out as well. This is heavily used by harbor seals and lesser presence of sea lions in the immediate area suggests that some use of the site is likely, despite the lack of physical evidence at the time of the investigations.

Other Considerations

Ownership

The ferry terminal pier is owned by the State of California and it is believed that waters surrounding the site are owned by the state as well under the control of the California State Lands Commission. The shoreline and former marina basin area of the Red Rock Marina and Fishing Resort is privately owned by Castro Point, LLC. The upland areas that make up a large portion of the private holdings are primarily on bay fill that was place after 1938 and which was expanded substantially between 1987 and 1993. The private site has been on the market since July 2013 with an advertised price of $2.9M for the approximately 3.4 hectare (8.44 acre) site.

Construction Access/Staging

The site has adequate water depth to access the vast majority of the creosote piles from the water without being substantially constrained by tides. The large shoreline pad within the private ownership of Castro Point LLC is potentially accessible as a dewatering and land based haul out site for the pile. It is serviced by an adequate road system for large trucks and is far enough removed from residential or other sensitive noise and odor receptor sites to be suited to the long-term drying, cutting or possibly mulching, and trucking operations required for pile disposal.

Public Visibility

The site has a significant potential public relations and outreach benefit of being highly visible from a distance with viewpoints from the Richmond-San Rafael Bridge and Point Molate Beach Park. At the same time, the site is not readily accessed by land by the public. This provides for good construction period site control for safety and security.

Historic Resources

The site's history in the ferry business is notable, but the relatively recent and short-lived nature of the present ferry pier structure (post-1938 to 1956), the lack of any particular events of interest, and the highly deteriorated and nearly unrecognizable condition of the structure makes it unlikely that the remains of the ferry pier hold much historic significance. The multiple vessels that were scuttled (likely in the 1950s) to serve as breakwaters are all fairly young, steel hulled vessels, that have little potential for being of historic consequence.

There is one sunken vessel feature of potential historic interest on the site, both because of its apparent construction and its location within the sediment strata. Immediately south of the ferry pier, the scour hole that formed where flows breached the pier wall, has excavated sediment to a depth of -20 feet MLLW from a starting depth of approximately -8 feet MLLW. This scouring has exposed the bow of what appears to be a wooden vessel that was buried at least 1.2 meters (4 feet) below the bay mud prior to the scouring. This vessel is not of the construction, nor placement age of the other derelict vessels on the site. Work to remove the pier could be accomplished in a manner that completely avoids this vessel and the scour pit would likely reaccrete sediment over some or all of the vessel. In the event this site were to advance to design and planning, an evaluation of the potential historic resource importance of this vessel ship should be made and, if required, measures taken to protect the vessel from damage undertaken.

Interferometric sidescan sonar image of ship ribs at bow emerging from the bottom within a scour hole generated where the piling wall of the ferry pier has been breached. The vessel is a minimum of 4 feet below the sediment surface and may have been buried in the sediment prior to pier construction.

Site Analysis

The Marina and Ferry Terminal at Castro Point has high potential benefits for herring, especially with recent increased spawning on the east bay along the shoreline region that includes this site. The site meets the desired pile count of 1,200, with approximately 1,500 piles being located primarily in two well defined structures. The adequate working water depth and adjacent pile-to-pile construction used for development of bulkheads would substantially benefit the efficiency of pile removals; however, a failed concrete deck on top of the ferry platform creates some complexity of removal that would dictate the use of large equipment to grapple this deck up for removal. Offloading potential exists on site but is under private ownership control. Given that there appear to be no present uses of this site at the present time and the site is up for sale, a short-term construction period lease of the site may be possible for material handing for upland disposal.

There do not appear to be any substantial biological constraints present on site and, while historic resources are not verified at this time, the wooden ship that is partially exposed from the bottom could be avoided with the pile removal work.

Good, however limited in scale, restoration potential exists on the site, particularly with the removal of a small floating dock to create a space in which to restore eelgrass, and by constructing oyster reefs and shoals outboard of the eelgrass. This may potentially use the submerged rock breakwater as a base to avoid subsidence into the mud. Ship hulk removal would free up more potential eelgrass restoration area, however this would be expected to yield only limited additional habitat area while removing substantial navigation hazards. The removal of these ships and other debris is not contemplated as a part of the creosote removal project, but is not required to conduct some restoration at the site.

The site is publically visible providing good opportunities for notable public outreach benefits, while its physical inaccessibility fosters good construction site control.

The Castro Point site is considered to have the best stand-alone potential to achieve the project objectives as outlined. If it were to be selected, some actions would likely be required to monument the remaining navigational hazards that are presently tucked away behind and shoreward of the prominent pier. Some habitat restoration of eelgrass would be possible through debris removal, however, for significant resource expansion, placement of reefs or shoals would likely be required. Conversely, approximately an acre of bay bottom suitable for eelgrass restoration could be generated by removal of some or the entire fill placed on site in the late 1980s-early 1990s to create an expanded pad on the private parcel.

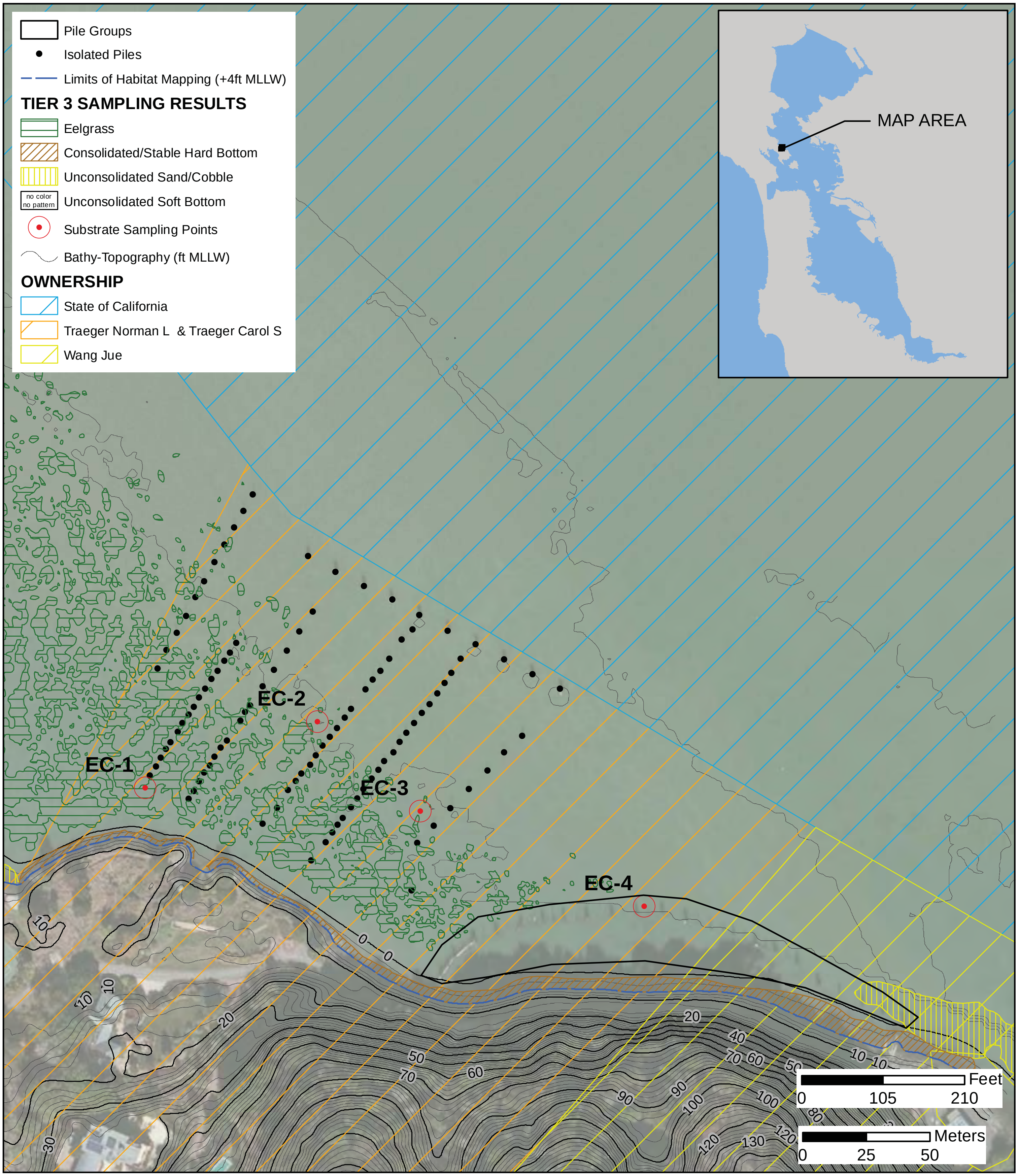
EL CAMPO SITE MARINA

Physical Environment

Location and History

The El Campo Marina site is located north of Paradise Beach County Park in Marin County along the eastern side of the Tiburon Peninsula (Figure 6). The site supports an estimated 250 creosote piles that are arranged in rows to support marina docks. Along the northeastern edge of the site, piles are cabled together with a division between piles that suggest that breakwater panels of some type were held in place by this line of pile dolphins. A similar arrangement of pile dolphins extends to the south along the shoreline in what appears to have been a buttress structure that retains many horizontal and vertical piles. Between these pile dolphins there are vertical rusted I-beam piles that also suggest that a buttress wall historically existed at this location. This buttress may have been designed to extend the shoreline outward, but other than the pile structure itself there is no indication of a prior fill. Subtidally, there are numerous piles amassed in a parallel alignment to the vertical pile dolphin arrangement. The horizontal subtidal piles include concrete wrapped and non-wrapped piles with a few piles being visible on the shoreline. The piles scattered along the base of the shoreline dolphin alignment are not visible from the surface and add significantly to the previously estimated 250 piles at this site. However, the relative proportion of these piles that are wrapped and unwrapped and the total number are not known or easily estimated at this time do to their being piled on top of each other. There are at least 65 piles that were noted in the interferometric sidescan record and undoubtedly many more that were not detectable past the first pile layers.

Aerial overview of the El Campo marina site illustrating the larger dolphin pile clusters along the shoreline and outboard of the marina pile field.



El Campo Site Marina

SAN FRANCISCO BAY CREOSOTE PILING REMOVAL
AND PACIFIC HERRING HABITAT RESTORATION PROJECT

Figure 6

The marina was constructed in about 1963 and was defunct by 1968, making this site the youngest of the six Tier III sites. It is not clear whether a marina ever went into full operation at this site although docks and gangways from the shore were present at one time with the docks being removed some time ago and the gangways remaining present through at least 1987. The history of the marina is spotty and but does not appear to be noteworthy. However, the history of the El Campo Site itself is fairly rich as a destination recreational area in San Francisco Bay that was established in 1891 by the San Francisco & North Pacific Railroad. Piers were constructed to bring guests to the site by ferry, and the uplands of the site once held band stands and a dance pavilion. The structures have long-since disappeared.

Bathymetry

The El Campo Site Marina ranges from intertidal to slightly subtidal elevations with a gradual gradient sloping downward to the northeast at a 1:125 slope. The marina pilings occur in waters from near 0 feet MLLW down to a shallow depth of approximately -3 feet MLLW (Figure 3). At the water's edge the site abuts a generally well-constructed rock-reveted slope that rises up to a bench notched into the hillside during the 1891 construction of the original El Campo facilities. The rock was undoubtedly added much later.

Sediment Characteristics

The site sediment were characteristics at four locations identified as EC-1 to EC-4 located within piling field (Figure 6) with additional sediment probing being performed throughout the site at areas close to the shoreline, mid-distance to the channel, and near the channel edge.

Surface sediments throughout the site were characterized as silts with only one site (EC-4) supporting a grittier sandy silt (Table 6). Eelgrass was found at EC-1 through EC-3. Shear strengths in near surface sediments were very low in all cases falling below the measurable shear of 2.64 kPA at two stations, slightly above this limit at one station and was not measurable do to shell hash at one station. Broad ranging surface probing suggested similar conditions occur throughout the site.

Subsurface sediments to 200 cm (79 inches) consisted of similar deep silt deposits at three of the stations with occasional layers of limited shell hash. At the EC4 site near the shoreline parallel pile wall, sediments supported stiffer materials classified as stiff and soft clay with a layer beginning at 155 cm (61 inches) of depth that was classified as sandy clay (Table 6). None of the probes ever met refusal, but were limited at approximately 175-200 cm (69-79 inches) of penetration depth by the equipment and tidal elevations during sampling.

From the perspective of placing reefs or other enhancement features on the site, there does not appear to be a suitable foundation to support a heavy structure without considerable evaluation and design of a floating foundation.

Waves and Currents

The location of the El Campo Site is generally well protected against the prevailing wind wave patterns. Wakes generated by passing vessels are typically low due to the nearly half mile separation between the site and the closest navigation channel that is used principally by high speed ferries and not by deep draft vessels.

The site is tucked into mainland coves far from deeper waters of the bay, and it is not subject to high current velocities. The lack of significant scour at pile bases even though the upper sediment is comprised of soft silts is indicative of the low current and wave environment at the site.

Table 6. Surface and subsurface sediment characteristics at El Campo Site Marina.

Site	El Campo Site Marina							
Station	**EC-1**		**EC-2**		**EC-3**		**EC-4**	
Latitude: Longitude	37.89846	-122.46588	37.89869	-122.46511	37.89838	-122.46465	37.89803	-122.46365
Surface Characteristics	silt		silts		silt		sandy silt	
(USCS)			silt in eelgrass mat					
Shear Strength (kPA)	Shear was sampled at 15 cm below sediment surface							
1	<2.64		<2.64		NA	shell hash	5.23	
2	<2.64		<2.64		NA	interference	3.35	
3	<2.64		<2.64		Na		<2.64	
Mean	**<2.64**		**<2.64**		**NA**		**3.74**	
Sediment Depth (cm)								
0					silt			
5					shell hash			
10							silt	
15								
20			silt					
25								
30								
35								
40							stiff clay	
45			shell hash					
50								
55								
60								
65								
70								
75								
80								
85							soft clay	
90								
95	silt		silt		silt			
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140							stiff clay	
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160					stiff clay			
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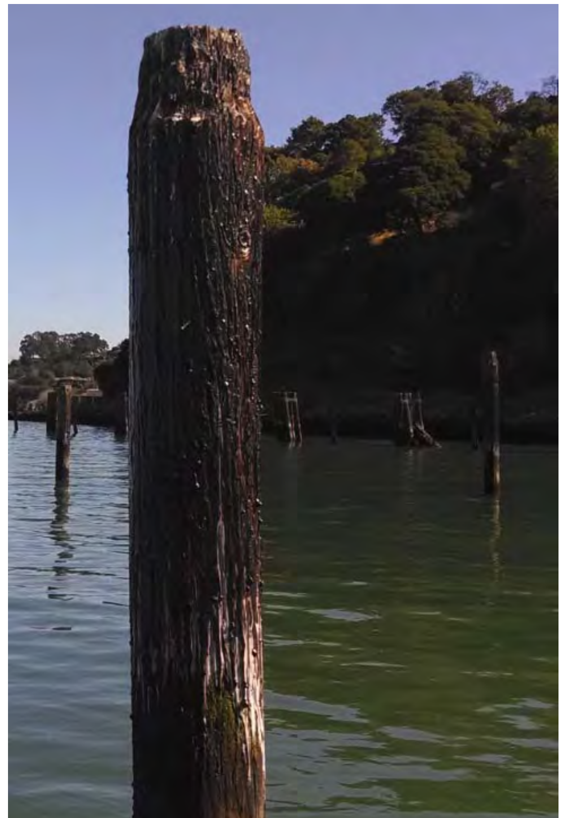
Biological Environment



Creosote condition on marina piles. Shoreline pile dolphins in the background support horizontal submerged pilings as well.

Herring Spawning History

The El Campo Marina site occurs in a shoreline region with a 41.5 percent spawning occurrence over the past 41 years of DFW recorded spawning site history. Notably 13 of the last 14 years have had herring spawning along this shoreline region and spawning has occurred 100 percent of the time over the last 6 years within this region of the bay. This makes the El Campo Marina site second only to Sausalito 3 in terms of frequency of spawning over the 41 year DFW monitoring history and higher in spawning history than Sausalito 3 over the past 23 years following the 1991-1992 season, as shown in Table 1.

Existing Spawning Habitat Resources

The El Campo Site Marina supports a healthy eelgrass bed and a stable shoreline revetment suitable for use by spawning herring. There is some limited potential for eelgrass habitat expansion at this site following removal of the shoreline parallel piles, which presently isolate waters of suitable depth to support eelgrass from full flushing and cover potential eelgrass restoration areas with horizontal piles.

Unconsolidated sand and gravel beach areas may also receive some use by herring but success in these areas may be low due to sediment mobility with increased drag caused by herring roe.

The creosote pile field on site includes both vertical and horizontal piles. Within the marina proper, all of the piles stand vertically; however, horizontal piles are present within the shoreline oriented dolphins in a mix of wooden and some concrete piles that exist within subtidal portions of this feature. The presence of horizontal plies within this well flushed but low energy environment provide highly selectable, but unsuited creosote impregnated substrate.

As indicated previously, the piles at this site are the youngest of any of the Tier III sites investigated dating back to approximately 51 years of age. The piles above the high tide line all show heavy creosote presence at the surface, while piles below the high tide line are more weathered but continue to show creosote on the surface and within the cracks in the wood. The piles themselves are in generally good shape suggesting continued protection against borers by the creosote treatment.

Given the high frequency of herring spawning in this area, combined with the abundance and condition of creosote piles at this site, it is anticipated that creosote pile toxicity poses a high threat to spawning herring at the El Campo Site Marina.

Avian/Marine Mammals

The piles at the El Campo Site Marina support night roosting and loafing use by a number of bird species. Most of the pile tops were observed to be coated in guano and several birds were present roosting on the piles both at night and during daylight visits to the site. Birds roosting on the piles included double-crested and pelagic cormorants, brown pelican, elegant tern, and western gulls. There are no areas suitable for nesting and the limited pile top space limits the available roosting space to a relatively few number of birds.

The areas provide no suitable loafing or haul out areas for marine mammals and none were observed at the site during the investigation.

Other Considerations

Ownership

The marina site is located principally within a private trust with a small portion of the easterly end of the shoreline pile alignment being within a separate ownership. Bayward of the marina pile field, the waters are owned by the State of California. The limited number of owners is a positive condition that favors suitability of the site. The piles presently provide no function and are a potential navigation and environmental liability for the property. The presence of eelgrass and shallow waters through the site suggest that the area is unlikely to be suitable for future marina development, thus minimizing the potential value of retaining any portions of the piles on the water.

Construction Access/Staging

The site has poor construction access and staging opportunities. There is no available land access for staging, drying, or haulout and all of the piles occur in waters shallower than -4 feet MLLW. This means that construction access will be tidally constrained. Many of the piles also occur within dense shallow eelgrass beds that have a high potential to be damaged if piles are removed by barge and crane. Conversely, it may be possible to hand cut piles at the mudline with a pneumatic or hydraulic saw and float them out of the eelgrass to deeper water for removal.

The spacing of the marina piles and the shallow water will adversely impact the cost of removal due to limiting the time of operation and due to the many moves of the barge required. Further, an offsite staging area would be required for this site.

Site Analysis

The El Campo Site Marina has high herring spawning use, considerable creosote piling substrate for spawning, and some potential for eelgrass restoration following piling removal. The young age of piles, the extensive presence of creosote on the surface of piles, and the good structural condition of piles suggests that creosote leachate toxicity remains high at this site. The approximately 250 piles identified at this site total only 21 percent of the targeted 1,200 piles and thus would require combination with pile removal at another site to meet that goal. As noted previously, there is a very minimum of 65 additional piles laying horizontally below the surface adjacent to the shoreline and it is likely there are many more in the mounds of piles observed, bringing the pile count up somewhat.

The El Campo site has benefits of having limited ownership interests and uncomplicated wave and current environments. The eelgrass resources on site are a concern that will require protection during pile removal, but there is little risk of harm following pile removal. The shallow nature of the site and the lack of upland staging area create increased complexity during removals and will add to the cost of pile removal at this site over sites in deeper water with available upland staging.

With all factors considered, the El Campo Site Marina is a highly favorable pile removal site with anticipated high benefits to herring spawning, with or without integration of eelgrass-based restoration at the site. However, after removal of the shoreward pile bulkhead remnants, approximately 0.1 hectare (0.25 acre) of eelgrass restoration is expected to be possible in areas exposed by horizontal pile removal. Again, however, the ecological benefits of that restoration would extend over a larger area than the footprint of the actual restoration designs.

SAUSALITO 3 (NUNES BROTHERS BOAT AND WAYS CO. PIERS)

Physical Environment

Location and History

The Sausalito 2 (Nunes Brothers Boat & Ways Company Piers) site is located in a shallow cove at the southern end of Sausalito, south of Richardson's Bay (Figure 7). With an estimate of only 45 piles, this site is substantially smaller than any of the other Tier III sites and was included in the Tier III evaluation due to its historically high spawning frequency relative to other sites which have high pile counts, but a historically lower frequency of spawning use. It also scored well in the Tier I and II evaluation due to its high restoration potential,l based on modeling results.

Nunes Brothers Boat & Ways Company piers circa 1928.

The piles remaining in the cove are the remnants of the Nunes Brothers Boat & Ways Company. The Nunes brothers, moved onto the site in 1925 taking over the Reliance Boat and Ways Co., which already operated piers and shipways at this site. The company operated on the site for the next 35 years. Pleasure boat construction continued on site until the beginning of World War II when the operations shifted to construction of vessels for the Coast Guard and U.S. Army. After the War, the yard returned to private vessel building, including rental of space and tools for private boat building. A small boat harbor was constructed in the cove in the mid-1950s but was gone by 1962. The Nunes Brothers Boat & Ways Company closed down in 1959 and the shoreline buildings were demolished for the development of the Portofino apartment complex.

Signage posted on the piles within the cove at the end of Main Street, Sausalito. The signage, although faded reads "Historic Piles and Cove No Tieups or Mooring City of Sausalito Min. Fine $148.00 PC 81044.

At some point, the City of Sausalito declared the remnant piers to be a historic site and the remains of the piers are posted with faded signage noting "Historic Piles and Cove No Tieups or Mooring". Remnants of the original piers remain as isolated piles and piles with limited cross beams and bracing. Two hulks of the old ways or target barges that were used to create wave breaks for the harbor remain just below the low tide line offshore of the remnants of the piers and scattered piles that may have been part of the original piers or the subsequent harbor development. The majority of the creosote piles within the cove likely date back to the Reliance

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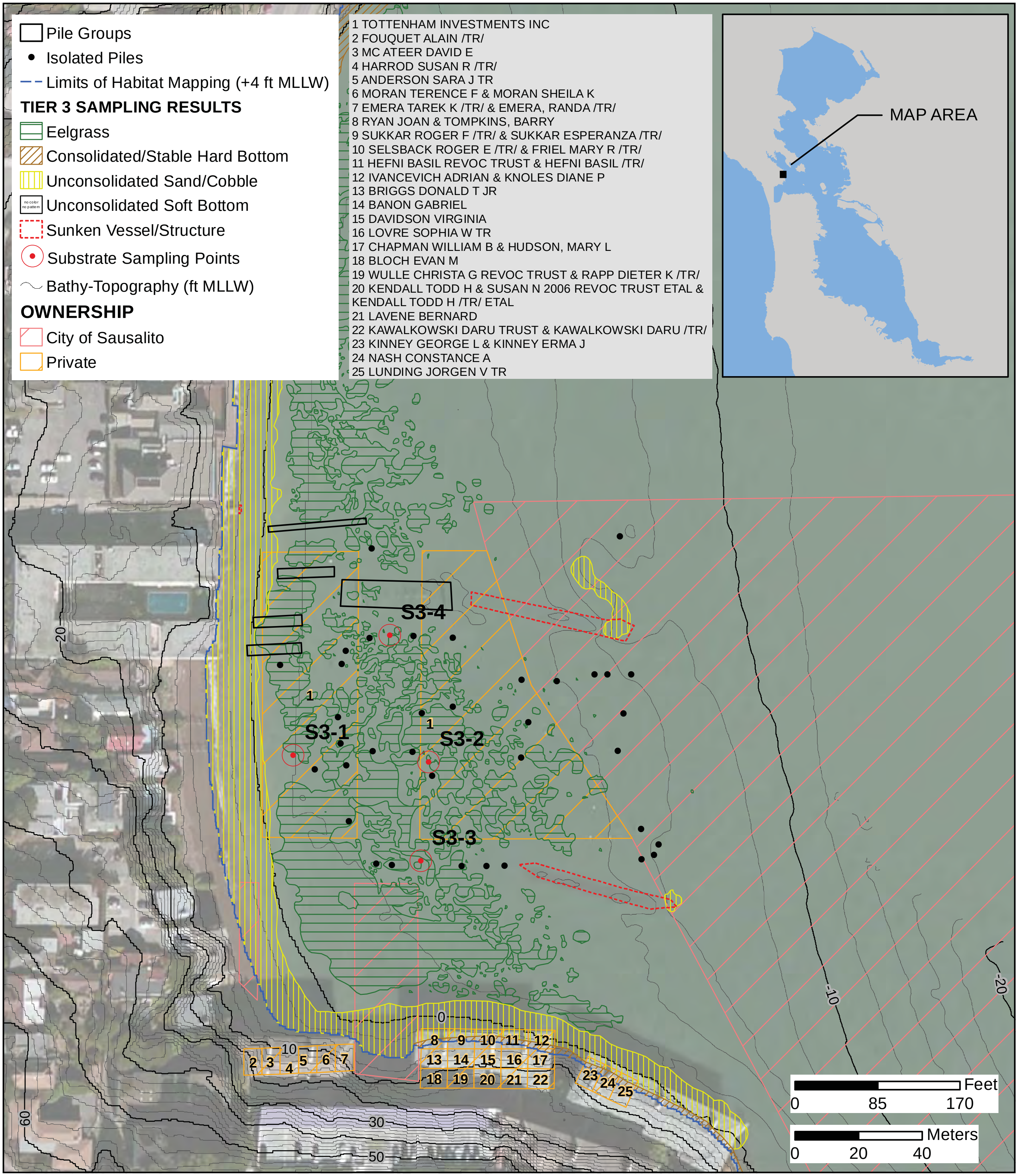


Sausalito 3 (Nunes Bros. Boat & Ways Co. Piers)

SAN FRANCISCO BAY CREOSOTE PILING REMOVAL AND PACIFIC HERRING HABITAT RESTORATION PROJECT

Figure 7

Merkel & Associates, Inc.

Boat and Ways Co. and are about a century old. The wood is heavily weathered both above and below the waterline.

Bathymetry

The Sausalito 3 site extends across a gently sloping cove with pile remains extending from approximately 0 feet MLLW down to approximately -6 feet MLLW (Figure 7). The gradient of the bottom is approximately 1:60 sloping downward to the east.

The majority of the piles at this site occur in waters shallower than -5 feet MLLW indicating that access for pile removal would likely be tidally constrained.

Sediment Characteristics

The site sediment characteristics were investigated at four locations identified as S3-1 to S3-4 (Figure 7) with additional sediment probing being performed throughout the site at areas close to the shoreline, and at midway through the pile field. Waters were too deep to probe at the outer edge of the site during the period of low tide sampling.

Surface sediments throughout the site were highly variable and ranged from gravels to silts. The site supported layers of shell hash at many locations that may have been debris from the prior piers or boat cleaning at the site. Below surface layers, sediments were characterized primarily by shallow clays with harder clay or formational sediment layers resulting in refusal of the probe within a maximum of 125 cm (49 inches) below the surface. This suggests the site has experience limited sediment accumulation over the recent past.

Table 7. Surface and subsurface sediment characteristics at Sausalito 3 (Nunes Brothers Boat & Ways Co.).

Site	Sausalito 3 (Nunes Brothers Boat & Ways Co. Piers)							
Station	**S3-1**		**S3-2**		**S3-3**		**S3-4**	
Latitude: Longitude	37.84825	-122.47968	37.84823	-122.47919	37.84795	-122.47922	37.84859	-122.47933
Surface Characteristics	gravel		sandy silt		silty sand		Silt	
(USCS)			eelgrass mat					
Shear Strength (kPA)	Shear was sampled at 15 cm below sediment surface							
1	NA	Not cohesive	7.493	eelgrass root	7.443		NA	shell hash
2	NA	sediment	5.929	interference	5.885		NA	interference
3	NA		8.726		6.798		NA	
Mean	**NA**		**7.38**		**6.71**		**NA**	
Sediment Depth (cm)								
0								
5	graded gravel						shell hash	
10			sandy silt		sandy silt		sandy silt	
15	clean sand							
20	stiff clay				shell hash		shell hash	
25	silty clay						sandy silt	
30	stiff clay		silty clay		silty clay			
35	refusal						shell hash	
40					stiff clay		stiff clay	
45								
50			graded gravel		soft clay			
55								
60			refusal					
65								
70								
75					stiff clay			
80								
85							soft clay	
90								
95					refusal			
100								
105								
110								
115							stiff clay	
120								
125							refusal	
130								

Waves and Currents

The location of the site is relatively protected from most prevailing weather patterns, but it can be very exposed to storms from the northeast that propagate through Raccoon Straits. The westerly shoreline of the cove is a coarse sand and gravel beach with small headlands between beach runs being armored by concrete rubble revetment. To the south of the cove, a combination of near vertical native formation and scattered rock rubble characterizes the intertidal bank. The shoreline conditions suggest the area does not see extensive wave erosion energy.

The site is outside of the primary channel system and protected from high current velocities that occur jut to the north of the site in the channel that runs into Richardson's Bay. Limited scour evidence occurs around the piles on site with the most prominent evidence of current scour being depressions with sandy pockets being found at the easterly tips of the submerged steel structures that are either parts of the original ways or Navy target barges placed at the edge of the cove in the 1950s to create a breakwater.

Biological Environment

Herring Spawning History

At 75.6 percent spawning occurrence, this site occurs in the shoreline region with the highest herring spawn frequency recorded over the 41 year DFW recorded spawning site history. In recent years, the utilization of this shoreline has fallen below that of the eastern edge of the Tiburon Peninsula with only a 33.3 percent spawning frequency over the most recent 6 years, equal to that observed on the San Pablo Peninsula over the same period.

Existing Spawning Habitat Resources

The Sausalito 3 site supports a solid eelgrass bed from approximately -1 foot MLLW out to approximately -3 feet MLLW with some scattered eelgrass extending out to greater than -4 feet MLLW. Given the present distribution of eelgrass there is little expectation that substantial additional eelgrass expansion is possible in this cove without improved water clarity.

In addition to eelgrass, the cove supports two moderately large hulks of steel framework that would be expected to provide spawning habitat. The shoreline is predominantly unconsolidated sand and gravel beach and vertical to near vertical formation and boulders. This intertidal surface likely provides some, limited spawning substrate.

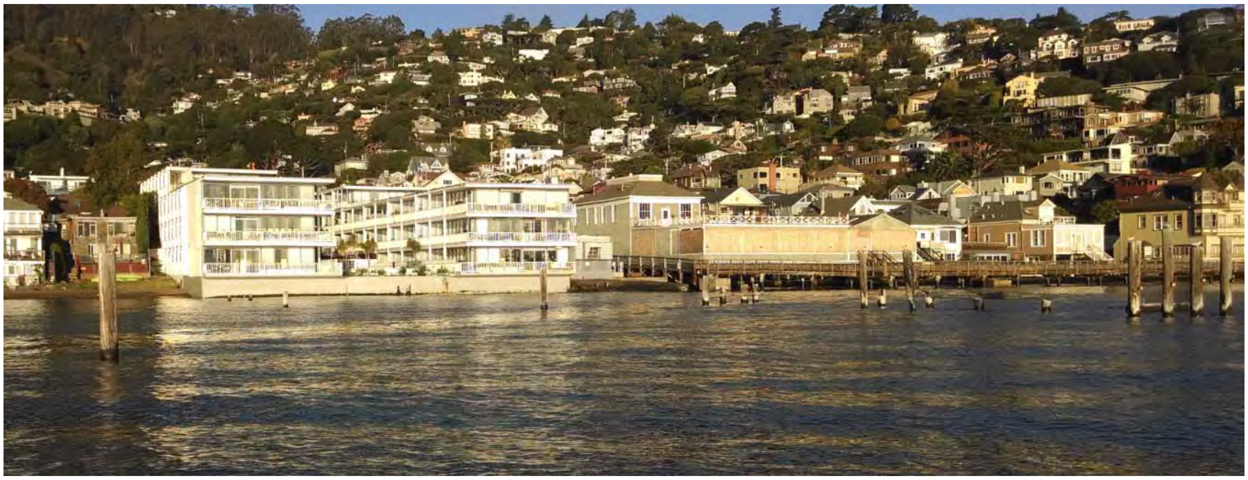
The less desirable spawning habitat of vertical piles make up a relatively minor amount of the total substrate available to spawning fish and is dwarfed in overall area by the more highly selected eelgrass habitat.

Given the limited extent of piles compared to other more selected for habitats and the advanced age of the piles it is expected that the limited spawning by herring on these piles has an insignificant population level effect on herring in San Francisco Bay.

Avian/Marine Mammals

The piles at Sausalito 3 receive some night roosting and regular daylight loafing use by a number of birds. During the field investigations, the majority of birds using the pile tops were western gulls with three double-crested cormorants also being observed. Guano deposits on the pile tops and cross beams suggest that regular, but not extensive, roosting occurs on these piles.

The areas provide no suitable loafing or haul out areas for marine mammals and none were observed at the site during the investigation. Both harbor seals and California sea lions have been observed on a regular basis within the channel area offshore of this site by Merkel & Associates biologists, so it would not be unexpected for occasional use by either species to occur on the site, especially during herring spawning periods.



Current condition of the pile field at Sausalito 3 (Nunes Brothers Boat & Ways Company piers.

Other Considerations

Ownership

The Sausalito 3 site has a complicated ownership pattern that is a mosaic of public and private lands (Figure 7). This portion of the bay was historically laid out in rectangular lots that were sold off with the anticipation of future bay fills. As such, the parcels consist of "paper streets" (presumed to be the property of the City of Sausalito), parcels owned by the City, and lots owned by a private party (Tottenham Investments, Inc).

Construction Access/Staging

The site has poor construction access and staging opportunities. There is no available land access for staging, drying, or haulout and all but 9 of the 45 piles occur in waters shallower than -4 feet MLLW. This means that construction access will be tidally constrained. Many of the piles also occur within dense shallow eelgrass beds that have a high potential to be damaged if piles are removed by barge and crane. Conversely, it may be possible to hand cut piles at the mudline and float them out of the eelgrass to deeper water for removal.

The site is bounded on two sites by closely spaced residential units in condominiums apartment complexes and single family homes the configuration of the cove creates an amphitheater like setting that would likely result in significant but short-term noise impacts during the removal process. The small number of piles in this area, would however limited the duration of noise generation to only a week or two, depending upon equipment draft and tides during the work period.

Site Analysis

The Sausalito 3 (Nunes Brothers Boat & Ways Company Piers) was originally rated high for herring use and habitat restoration potential and low for pile count relative to the project scale objectives. The current Tier III review has identified some constraints that affect this initial ranking. First, there is limited, if any restoration potential because the site presently supports eelgrass at or near capacity without increases in water clarity. Second the abundance of eelgrass as a spawning substrate at the site lowers the relative importance of creosote piles as herring spawning habitat; the herring would be far more likely to spawn in the greatest proportion on the eelgrass than the few piles that are present. Third, while the site overall occurs in the region of highest spawning frequency, the El Campo Site occurs in a regional of shoreline that, over the past 23 years has had more frequent herring use than Sausalito as measured by annual spawning events. Even the other east bay Tier III sites have shown an increase in spawning frequency over the Sausalito 3 site over the recent several years, with the Castro Point Marina and Ferry Terminal site occurring on a shoreline segment with higher frequency of occurrence than Sausalito 3 over the past decade. If bias were given to recent spawning history over older events, Sausalito 3 would fall significantly down in preference over either El Campo or Castro Point sites.

As with some of the other sites, the shallow nature of the site, lack of upland staging area, and potential for damage to existing eelgrass from creosote pile removal detract from the site desirability for a creosote pile removal project. However, one of the most substantial non-biological factors in opposition to the selection of this site is the designation of the area as historic by the City of Sausalito.

The detracting factors, combined with the expected low biological benefit of this site makes it unsuited to selection for the present project.

SUMMARY RECOMMENDATION

A matrix has been prepared to compare the six Tier III sites using additional information garnered in the present review (Table 8).

Table 8. Summary matrix supporting site selection recommendations.

FACTOR CONSIDERED	Pipeline Trestle Breuner Marsh	Richmond Red Rock Warehouse	Richmond Terminal 4	Marina and Ferry Terminal at Castro Point	El Campo Site Marina	Sausalito 3 (Nunes Bros. Boat & Ways Co. Piers)
41 Year Herring Spawning Frequency	4.9%	4.9%	4.9%	12.2%	41.5%	75.6%
Last 6 Year Herring Spawning Frequency	33.3%	33.3%	33.3%	83.3%	100.0%	33.3%
Creosote Pile Count	270	350	2,500	1,500	250	45
Creosote Piles Wrapped	Yes		Yes			
Creosote Pile Estimated Age (Years)	76-113	58-76	99-164	62-76	51	89-100+
Likely Leachate Toxicity Levels	Low	Moderate	Low	Moderate	Mod-High	Low
Availability of desirable spawning habitat	High	Mod-High	Moderate	Mod-High	Moderate	Moderate
Spawning Habitat Restoration Potential	Low	Low-Mod	Moderate	Moderate	Moderate	Low
Biological Resource Constraints	None	Low	Moderate	Low	Low	Low
Historic Resource Constraints				Maybe		Yes
Ownership Suitability	High	High	High	High	Moderate	Low
Implementation Unit Cost and Risk	Very High	Low	Very High	Mod-High	Mod-High	Moderate
Public Visibility	Low	Low	Low	High	Low	High
Elimination Recommendations	**Yes**		**Yes**			**Yes**
Potential Use Option		**Combine with El Campo**		**Stand Alone Site**	**Combine with Red Rock**	

FIRST RECOMMENDED OPTION – MARINA AND FERRY TERMINAL AT CASTRO POINT

Out of the three sites remaining, only the Marina and Ferry Terminal at Castro Point site, on its own, would meet the full scale of creosote removal desired. The pile count exceeds the 1,200-pile goal by 25 percent. This excess in piles may be a cost issue, however the adjacent alignment of piles would reduce the on-water construction costs in a manner that may adequately offset greater handling and disposal costs, allowing for completion of a larger project than initially targeted. This site could achieve all of the pile removal objectives on lands owned by the State and having a very high likelihood of landowner support. Restoration opportunity on the site is more complicated, limited in scale, and would likely require property owner approval from the private ownership of the landside parcel. It is possible that excavation of upland fills could be used to restore eelgrass habitat on the site; however, this would likely be expensive and not easily accomplished without partnering. This site has high visibility, potential for on-site material handling, and possible partnership opportunities or phasing opportunities involving other parties to remove the non-creosote debris for the purpose of generating more habitat restoration potential.

SECOND RECOMMENDED OPTION – RICHMOND RED ROCK WAREHOUSE AND THE EL CAMPO SITE MARINA

The second recommendation is for a combination of two sites that have high potential to benefit herring spawning habitat by removal of toxic creosote piles. These sites are the Richmond Red Rock Warehouse and the El Campo Site Marina. These two sites combined only achieve 50 percent of the pile count objective for the project (600 of 1,200 piles), however would likely be close to meeting the alternative 180-tons of creosote pile objectives given the large size of the piles at both of these sites. The combined sites would make use of the Richmond site for upland staging, drying, and pile haul out. Collectively, these sites have greater habitat restoration potential at a reasonable level of effort than does the Castro Point site. While it is unlikely that a project with a full acre footprint of restored or enhanced habitat would be achieved on these combined sites, the area of ecological benefits and enhanced habitat function is likely to be greater than the goal of one acre. This recommendation has the complexity of more property owners and greater risk of damage to existing eelgrass habitat than does the first recommendation; however, it is possible to protect eelgrass at these sites by implementing protective measures during the work.

SITES RECOMMENDED FOR DISMISSAL - PIPELINE TRESTLE - BREUNER MARSH, RICHMOND TERMINAL 4, AND SAUSALITO 3 B (NUNES BROTHERS BOAT & WAYS PIERS)

The results of the Tier III site review and additional site investigations can readily be used to reduce six potential sites to three sites with the Pipeline Trestle - Breuner Marsh, Richmond Terminal 4, and Sausalito 3 (Nunes Brothers Boat & Ways Piers) having substantially less appeal for the present project than the other three sites. As such, these sites are recommended for dismissal as candidates for the present work. The recommendation for dismissal of these sites is based on multiple factors and the general poor alignment of the sites with the identified goals of the project. This does not mean other projects with differing goals would not be better aligned with the conditions of these sites.

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