Appendix 3-3

Geoarchaeological Assessment

Memorandum

Date:	May 2, 2016
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Cc:	Devyani Jain, Senior Planner
From:	J. Tait Elder, MA, Geoarchaeologist Erin Efner, Project Manager
Subject:	**Geoarchaeological Assessment for the Seawall Lot 337/Pier 48 Mixed-Use Project**

Introduction

Seawall Lot 337 Associates, LLC (project sponsor) of the Seawall Lot 337 and Pier 48 Mixed-Use Project (proposed project) proposes a mixed-use, multi-phase waterfront development of Seawall Lot 337, rehabilitation and reuse of Pier 48, and construction of approximately 5.4 acres of net new open spaces, for a total of 8.0 acres of open space on the site. In addition, approximately 1.1 million gsf of parking would be provided in two public parking garages, one above grade and one underground. The proposed project would also include public access areas, assembly areas, and an internal grid of public streets, shared streets, and utilities infrastructure. Overall, the proposed project would involve construction of up to 2.7 to 2.8 million gross square feet (gsf) of residential, commercial, production, and active/retail uses on 11 proposed development blocks on Seawall Lot 337, plus rehabilitation of 263,000 gsf of Pier 48 for reuse. The project site is in the Mission Bay neighborhood of the City and County of San Francisco (City).

Seismic upgrades, which would occur over an approximately 16-month period, are necessary in order to support the proposed uses at Pier 48. The scope of the seismic upgrade consists of 106 new pile piles located below a new heavily reinforced concrete apron. The apron would be approximately 12 feet wide, 6 feet deep, and 40 feet long, and would be located at both the north and south perimeter of Pier 48, replacing the exterior pier deck in these locations.

In conformance with the provisions of the California Environmental Quality Act (CEQA) and State CEQA guidelines, the proposed project's Lead Agency, the City of San Francisco, is preparing a Draft Environmental Impact Report (EIR) for the proposed project. One of the elements of the affected environment considered in the Draft EIR is historic resources. This technical memorandum is designed to supplement existing documentation related to historic resources by considering the proposed project's potential for encountering precontact archaeological resources for the purpose of integrating this information into the Draft EIR.

The goal of this memorandum is to use existing shoreline research and geotechnical data to assess the potential for encountering buried archaeological resources (hereafter referred to as archaeological sensitivity) resulting from development of the proposed project. This memorandum focuses on assessing archaeological sensitivity below the fill deposits that cover the project site, and does not consider archaeological sensitivity associated with historic era use of fill landforms. A review of historic era archaeological sensitivity within the project site is provided in the proposed project's Environmental Planning Preliminary Archaeological Review Checklist.

This document is divided into the following sections:

- **Analytical Framework –** Discusses the relationship between the environment and archaeological site distributions and preservation.
- **Methods –** Describes the methods used to perform the geoarchaeological assessment, including historical map analysis and geotechnical bore analysis.
- **Results –** Presents the results of the historical map and geotechnical bore analysis.
- **Summary and Conclusions –** Summarizes the results of the geoarchaeological assessment.

Analytical Framework

It is outside of the scope of this memorandum to provide a detailed description of the geologic landscape history of the project site. A detailed summary can be found in the *Archaeological Research Design and Treatment Plan for the Transit Center District Plan Area, San Francisco, California.*[1]

This document uses *landforms* as the unit by which the current and past landscape is segmented to reflect patterns in the attributes of the physical environment. Landforms are physical landscape features with discrete attributes such as shape, lithology, and stratigraphy. They can range from very large (e.g., an estuary) to very small (e.g., a tidal channel) and large landforms are often comprised of a combination of smaller landforms (e.g., an estuary contains tide flats, salt marshes, and tidal channels).

The age and environment in which a landform is created has direct bearing on when it becomes accessible for human use, how humans interact with it once it becomes accessible, and how the material remains of these activities are preserved. Landforms are useful analytical units for considering the relationship between landscape history and human activities because each type has a unique set of physical attributes (e.g., age, depositional environment, stability, accessibility,

[1] Byrd, B.F., P. Kaijankoski, J. Meyer, A. Witaker, R. Allen, M. Bunse, and B. Larson. 2010. *Archaeological Research Design and Treatment Plan for the Transit Center District Plan Area, San Francisco, California*. Prepared for Major Environmental Analysis, San Francisco Planning Department.

resources) that condition how humans use them and they can be recognized and contrasted at the macroscopic scale.

The landforms presented below were selected from a range of hierarchical coastal landform classes developed by Shipman,[2] based on the extent to which they affect resource distribution, landform stability, and site preservation. Based on a review of previous geotechnical and geoarchaeological reports of the project site and the areas adjacent to it, it is anticipated that it has been primarily shaped by coastal and anthropogenic processes, likely resulting in the formation of three common landform types: *anthropogenic*, *tidal flats*, *and intertidal beaches*.[3][4] Descriptions of these landform types, their attributes, and archaeological potential are presented below. Deposits associated with intertidal beaches were not identified during the geotechnical bore analysis. It is included in the discussion below; however, to provide a means with which to recognize the differential physical attributes commonly associated with each anticipated landform type.

Anthropogenic

Human-induced (i.e., anthropogenic) modifications to the landscape result in the creation of new landforms that are anthropogenic, rather than natural, in origin. The project area has been extensively filled during the historic era (after around 1850).[5] Filling is used to raise the elevation of the ground surface and to provide structurally suitable materials for construction. The process of filling can bury the pre-development ground surface, which—when cutting has not removed deposits that retain archaeological potential—can result in the burial of archaeological sites. Depending on the fill material's source of origin, it may contain accumulations of precontact, historical, and/or modern items that have been displaced from the location of their primary deposition. Such items would not be in primary depositional context and, therefore, would not represent intact archaeological deposits.

Tidal Flats

In this memorandum, the term tidal flats will collectively be used to refer to three landform types that have similar physical attributes, but differ in their position relative to the intertidal zone (i.e., the area that is above water during low tide and submerged during high tide). These landforms include salt marshes, intertidal flats, and subtidal flats. All three landform types are relatively flat plains incised by sinuous or winding tidal channels.[6] They form along coasts or in lagoons, estuaries, and embayments where the depositional effects of tidal action are the dominant landscape formation processes. Although all three types of low-energy intertidal landforms occur within or

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[2] Shipman, H. 2008. *A Geomorphic Classification of Puget Sound Nearshore Landforms, Technical Report 2008-01*. Prepared for the Puget Sound Nearshore Partnership.

[3] Simpson, L.A. 2006. *Case Studies in Mission Bay, San Francisco: Deep Foundations in Challenging Soil Conditions*. Presented at the 31st Annual Conference on Deep Foundations.

[4] Byrd, B.F., P. Kaijankoski, J. Meyer, A. Witaker, R. Allen, M. Bunse, and B. Larson. 2010. *Archaeological Research Design and Treatment Plan for the Transit Center District Plan Area, San Francisco, California*. Prepared for Major Environmental Analysis, San Francisco Planning Department.

[5] Simpson, L.A. 2006. *Case Studies in Mission Bay, San Francisco: Deep Foundations in Challenging Soil Conditions*. Presented at the 31st Annual Conference on Deep Foundations.

[6] Reading, H. G., and J. D. Collinson. 1996. Clastic Coasts. Pages 154–231 in H. G. Reading (ed.), *Sedimentary Environments: Processes, Facies, and Stratigraphy*. Blackwell Publishing, Malden, MA.

below the intertidal zone, they occur at different elevations within these zones. Salt marshes, for example, occur at the interface between the supratidal (i.e., the zone that extends above normal high tide, but is regularly splashed by waves and storm events) and upper intertidal zone (i.e., the zone that is only submerged during the highest tides) in locations where soil, salinity, and nutrient content is ideal for the growth of salt-tolerant vegetation. Intertidal flats occur throughout the intertidal zone, while subtidal flats occur below the intertidal zone. Although all three are formed by the same processes, each can exhibit minor variations in sedimentary composition relative to each other. All three landforms are typically comprised of finely laminated clays, silts, and fine sands; but salt marshes may contain a higher concentration of decomposed organics and subtidal flats may contain a slightly higher concentration of coarser sediments.[7]

Tidal flats have been forming in the within and in the project area during the period for which there is documented evidence of human occupation of North America (starting at the Pleistocene/Holocene transition - around 12,000 years ago[8]); however, the conditions in which they form reduce their potential to contain archaeological deposits. For example, although salt marshes and intertidal flats are rich in floral and faunal resources, they are regularly inundated and cannot be used for habitation or resource processing activities that require long periods of time – although salt marshes are typically inundated less frequently than intertidal flats. Since the ground surface associated with subtidal flats is permanently inundated, human activities would not have occurred directly on the surface. As a result of the limited ground surface accessibility for all three landforms, it is anticipated that any evidence of human use of the landscape would be limited to occasional isolated tools and intertidal resource capture facilities (i.e., weirs and traps).

In some instances, rapid coseismic subsidence may result in previously stable terrestrial surfaces dropping to an elevation at which they can be buried by fine sediments that ultimately result in the formation of tidal flats.[9][10][11] Coseismic subsidence, however, is a process associated with convergent plate boundaries – like those found in northern California, Oregon, and Washington. Although the project site is located in a tectonically active region, it is located near a transform fault boundary, which is primarily associated with lateral – rather than vertical – coseismic movement.[12] In the absence of vertical coseismic movement, such as a rapid drop in ground surface elevation, the

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[7] Reading, H. G., and J. D. Collinson. 1996. Clastic Coasts. Pages 154–231 in H. G. Reading (ed.), *Sedimentary Environments: Processes*, *Facies*, *and Stratigraphy*. Blackwell Publishing, Malden, MA.

[8] Meltzer, D. J. 2004. Peopling of North America. In A. R. Gillespie, S. C. Porter, and B. F. Atwater (eds.), *Developments in Quaternary Science 1: The Quaternary Period in the United States*. Elsevier, Amsterdam, The Netherlands.

[9] Atwater, B.F. 1987. Evidence for great Holocene earthquakes along the outer coast of Washington State. *Science* 236(4804):942-944.

[10] Atwater, B.F. and A.L. Moore. 1992. A tsunami about 1000 years ago in Puget Sound, Washington. *Science* 258:1614-1617.

[11] Atwater, B.F., A.R. Nelson, J.J. Clague, G.A. Carver, D.K. Yamaguchi, P.T. Bobrowsky, J. Bourgeois, M.E. Darienzo, W.C. Grant, E. Hemphill-Haley, H.M. Kelsey, G.C. Jacoby, S.P. Nishenko, S.P. Palmer, C.D. Peterson, and M. A. Reinhart. 1995. Summary of coastal geologic evidence for past great earthquakes at the Cascadia subduction zone. *Earthquake Spectra* 11(1):1-18.

[12] For discussion of coseismic uplift and crustal warping along the San Andreas fault see: Anderson, R.S. and K.M. Menking. 1994. The Quaternary Marine Terraces of Santa Cruz, California: Evidence for Coseismic Uplift on Two Faults. *GSA Bulletin* 106 (5): 649-664.

likelihood for encountering buried terrestrial surfaces within deposits associated with intertidal flats in areas subject to tectonic forces associated with transform fault boundaries is low.

Intertidal Beach

Intertidal beaches include the beach face and low-tide terrace, and can be found in areas primarily shaped by wave action. Such landforms are unstable and are frequently reworked by wave action, creating seaward-dipping or cross-bedded structure.[13] As sea level transgresses (increases in elevation), sediments associated with these landform components remain, and are subsequently buried under fine sediments as high energy wave action is replaced by lower energy tidal forces.

Like tidal flats, intertidal beaches have been forming within and directly adjacent to the project site during the period for which there is documented evidence of human occupation of North America. While in the active intertidal zone, these landform components are in a constant state of erosion and deposition. Once they pass below the intertidal zone, they become inaccessible for human use. Although intertidal beach landforms can contain shellfish and lithic material, their frequent inundation combined with near-constant erosion and deposition results in limited potential for the preservation of archaeological deposits in primary depositional context.

Methods

The proposed project would occur in an area that was extensively filled during the late nineteenth and early twentieth centuries.[14] To reconstruct the landscape prior to filling, and to thus evaluate the proposed project's sensitivity for encountering buried archaeological deposits, two methods were used: Historical Map Analysis and Geotechnical Bore Analysis. Since these methods analyze two different datasets, they can be cross-verified to establish a stronger basis for assessing archaeological sensitivity within the project site.

Historical Map Analysis

The purpose of historical map analysis was to determine the historical pre-development setting of the project site. ICF archaeologist J. Tait Elder, MA, reviewed historical maps and previously completed shoreline studies that encompass the project site to determine where the predevelopment shoreline was located relative to the project site. To do this, portable document format (PDF) files of historic shoreline data were obtained and imported into ArcGIS and geo-referenced against the project site.

Geotechnical Bore Analysis

The purpose of geotechnical bore analysis was to assess the pre-development landscape history within the project site. To perform this analysis, ICF geoarchaeologist J. Tait Elder, MA, analyzed logs from geotechnical bores that were previously excavated within the project site. Using sedimentary descriptions and inferred depositional origins described in the geotechnical bore logs, a series of

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[13] Waters, M. R. 1992. *Principles of Geoarchaeology: A North American Perspective*. University of Arizona Press, Tucson, AZ.

[14] Simpson, L.A. 2006. *Case Studies in Mission Bay, San Francisco: Deep Foundations in Challenging Soil Conditions*. Presented at the 31st Annual Conference on Deep Foundations.

stratigraphic fence diagrams of the project site were developed. These diagrams were used to reconstruct the local pre-development landscape history.

Although all of the analyzed bores were excavated to depths in excess of 200 feet, it was decided that geoarchaeological analysis of geotechnical bore data would cease approximately 160 feet below the current mean sea level, which would have been approximately 30 feet below sea level during the Pleistocene/Holocene transition.[15] This was done to focus the analysis on sediments that were most likely deposited during the period for which there is evidence for human occupation of North America.

Results

The following are the results of the historical map and geotechnical bore analyses.

Historical Map Analysis

Review of previous shoreline studies that encompass the project site reveal that it is located seaward of the pre-development shoreline. Figure 1 depicts the location of the project site relative to the pre-development shoreline. This indicates that the ground surface within the project site would have been regularly or permanently inundated prior to historic shoreline development. The results of a previous paleoshoreline analyses (i.e., an analysis of how the San Francisco Bay shoreline location and elevation changed over the last 12,000 years) suggest that the project site is likely to have been subaerially exposed between around 4500 and 7800 years ago when sea levels were between 16 and 30 feet lower than they are currently.[16] As the geotechnical bore analysis below will emphasize; however, the depth of the lower-most interface of the tidal flat deposits within the project site indicates that it has been a tidal flat since at least 7,800 to 8,700 years ago. Thus, it is likely that the ground surface within the project site has stayed within or below the intertidal zone for much of the Holocene epoch, but has been slowly accreting (growing upward) with sea level rise.

Geotechnical Bore Analysis

Review of logs of geotechnical bores that were previously excavated within the project site reveal widespread anthropogenic fill deposits underlain by tidal flat deposits, underlain by silts and sands of various origins.[17] Figure 1 shows the location of the bores within the project site. As depicted in Figure 2, anthropogenic fill deposits range from 14 to 35 feet in thickness across the portion of the project site located west of the seawall and exhibit a north-facing, or seaward dipping, slope. Fill

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[15] Byrd, B.F., P. Kaijankoski, J. Meyer, A. Witaker, R. Allen, M. Bunse, and B. Larson. 2010. *Archaeological Research Design and Treatment Plan for the Transit Center District Plan Area, San Francisco, California*. Prepared for Major Environmental Analysis, San Francisco Planning Department.

[16] Byrd, B.F., P. Kaijankoski, J. Meyer, A. Witaker, R. Allen, M. Bunse, and B. Larson. 2010. *Archaeological Research Design and Treatment Plan for the Transit Center District Plan Area, San Francisco, California*. Prepared for Major Environmental Analysis, San Francisco Planning Department.

[17] Treadwell & Rollo. 2011. *Preliminary Geotechnical Investigation, Seawall Lot 337 - Mission Bay, San Francisco, California.* Prepared for Mission Rock Development.

deposits do not appear to be present east of the seawall.[18] Below the anthropogenic fill deposits and in areas where fill deposits are not present, intertidal flat deposits extend to depths ranging from 50 to 85 feet below mean sea level. Below the intertidal flat deposits, sands and silts inferred to be of multiple depositional origins were encountered. Based on the results of other geotechnical investigations in the project site vicinity, these deposits are thought to be Colma formation (i.e., terrestrial sediments deposited during the Wisconsin glaciation – around 85,000 to 11,000 year ago) and Old Bay Mud (i.e., estuarine sediments deposited during the Sangamon interglacial period – before 85,000 years ago).[19][20] Both previous studies and the geotechnical bores reviewed for this memorandum indicate that Colma formation overlies Old Bay Mud within the project site. Both of these deposits predate the period for which there is documented evidence of human occupation of North America, so the depth of the contact between Colma formation and Old Bay Mud were not considered in this memorandum. All geotechnical bores reviewed for this study were terminated in bedrock, which was encountered between 190 and 260 feet below mean sea level.

Based on the information presented above, it appears that the ground surface in the project area was 50 to 85 feet lower than its current elevation prior to the the post-Wisconsin infilling of the San Francisco Bay, which began approximately 10,000 years ago. Using the sea level curve generated by Atwater et al.[21], a ground surface at this range of elevations would have been sub-aerially exposed (i.e., terrestrial) until between 7,800 and 8,700 years ago. Since then, and until the nineteenth century, the project area was a tidal flat.

Although geotechnical bore log analysis was based on interval sediment samples (i.e., collected at regularly spaced intervals with regular spacing between samples) rather than continuous samples (i.e., samples collected in sequence with spacing between samples), the lack of a documented mechanism for rapid coseismic subsidence in the project area would indicate a low likelihood for encountering buried terrestrial surfaces within tidal flat deposits.

Summary and Conclusions

Review of historical maps that depict the Project area reveal that the project site was located seaward of the historic pre-development shoreline and would have been regularly or permanently inundated prior to historic shoreline development. Logs from geotechnical bores that were excavated within the project site corroborate this, revealing deep tidal flat deposits underlying anthropogenic fill. The tidal flat deposits extend to depths ranging from 50 to 85 feet below mean sea level, indicating that it has been a tidal flat since around 8,700 years ago. Prior to 8,700 years

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[18] Treadwell & Rollo. 2001. Geotechnical Memorandum to Bo Jensen. Prepared for the San Francisco Planning Department.

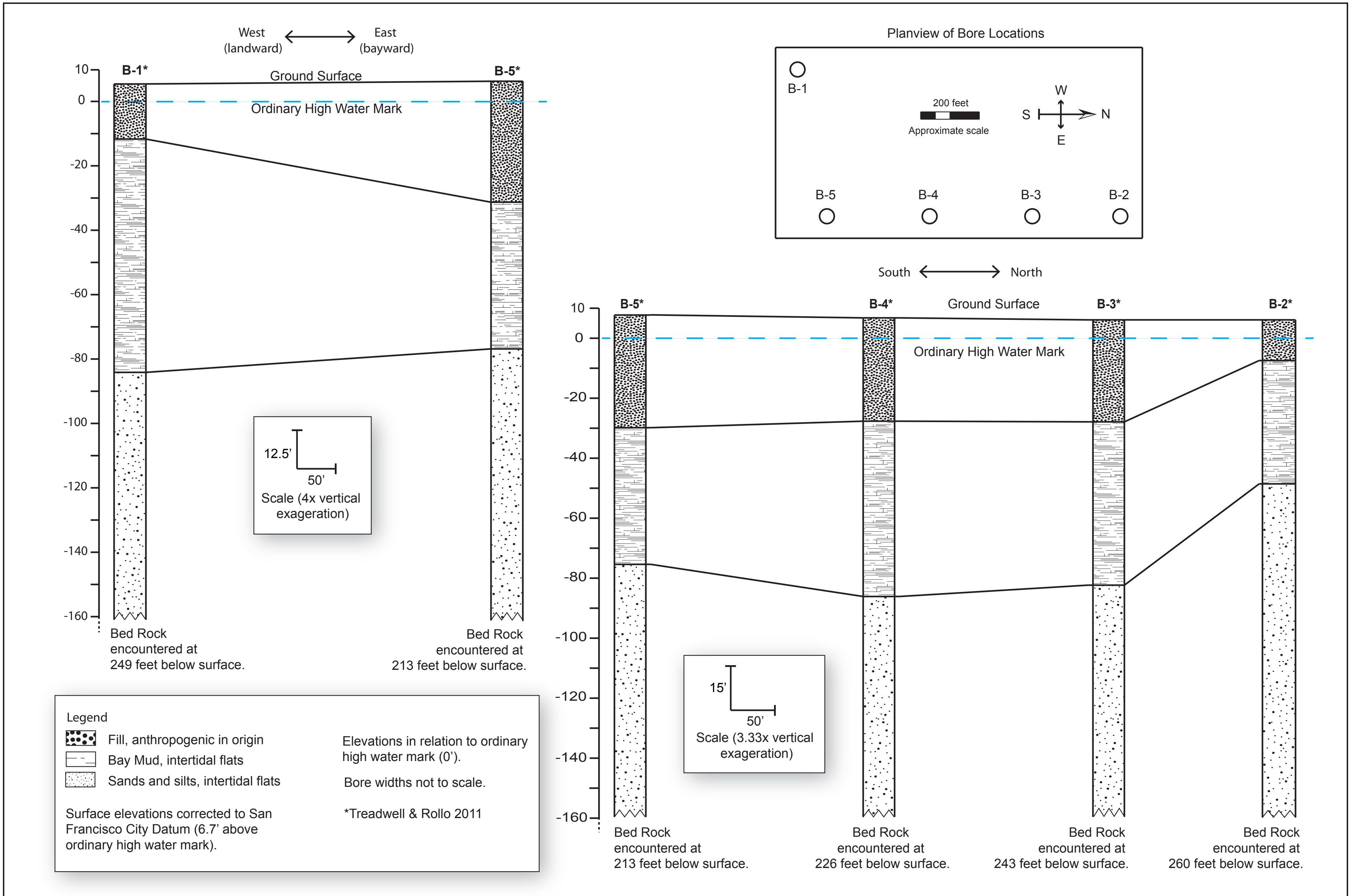
[19] Treadwell & Rollo. 2008. *Geotechnical Consultation EIR Preparation Downtown San Francisco Developments, San Francisco, California*. Prepared for Reubens and Junis, LLP, San Francisco, California.

[20] Simpson, L.A. 2006. Case Studies in Mission Bay, San Francisco: Deep Foundations in Challenging Soil Condition. Presented at the 31st Annual Conference on Deep Foundations, Washington, DC.

[21] Atwater, B.F., C.W. Hedel, and E.J. Helley. 1977. *Late Quaternary Depositional History, Holocene Sea-Level Changes, and Vertical Crustal Movement, Southern San Francisco Bay, California.* Geological Survey Professional Papers 1014. U.S. Geological Survey, Washington DC.

ago, the project site would have been sub-aerially exposed – making it suitable for human habitation and resource processing. All deposits located at depths greater than 50 to 85 feet below mean sea level appear to predate the period for which there is documented evidence of human occupation of North America.

As outlined in the Analytical Framework section of this memorandum, tidal flat deposits have limited archaeological sensitivity, save for rare occurrences of precontact intertidal fishing facilities and isolated fishing gear, as well as historic sunken vessels. Deposits that predate the period for which there is documented evidence of human occupation of North America also have limited archaeological sensitivity. Therefore, only the interface between the intertidal flat deposits and the underlying Colma Formation/Old Bay Mud retains sensitivity for archaeological resources - an interface that ranges from 50 to 85 feet below mean sea level. Importantly, only the proposed driving of piles would occur at this depth, an activity that would not result the removal of sediments. Given the great depth at which an archaeologically sensitive interface could be encountered, the limited range of methods that could be used to further sample this interface (all of which would a very limited sample), and the fact that no sediments will be removed during the activity that could encounter the archaeologically sensitive interface (e.g., pile driving), no additional archaeological studies are recommended at this time.



Source: Treadwell & Rollo 2011, ICF 2013.

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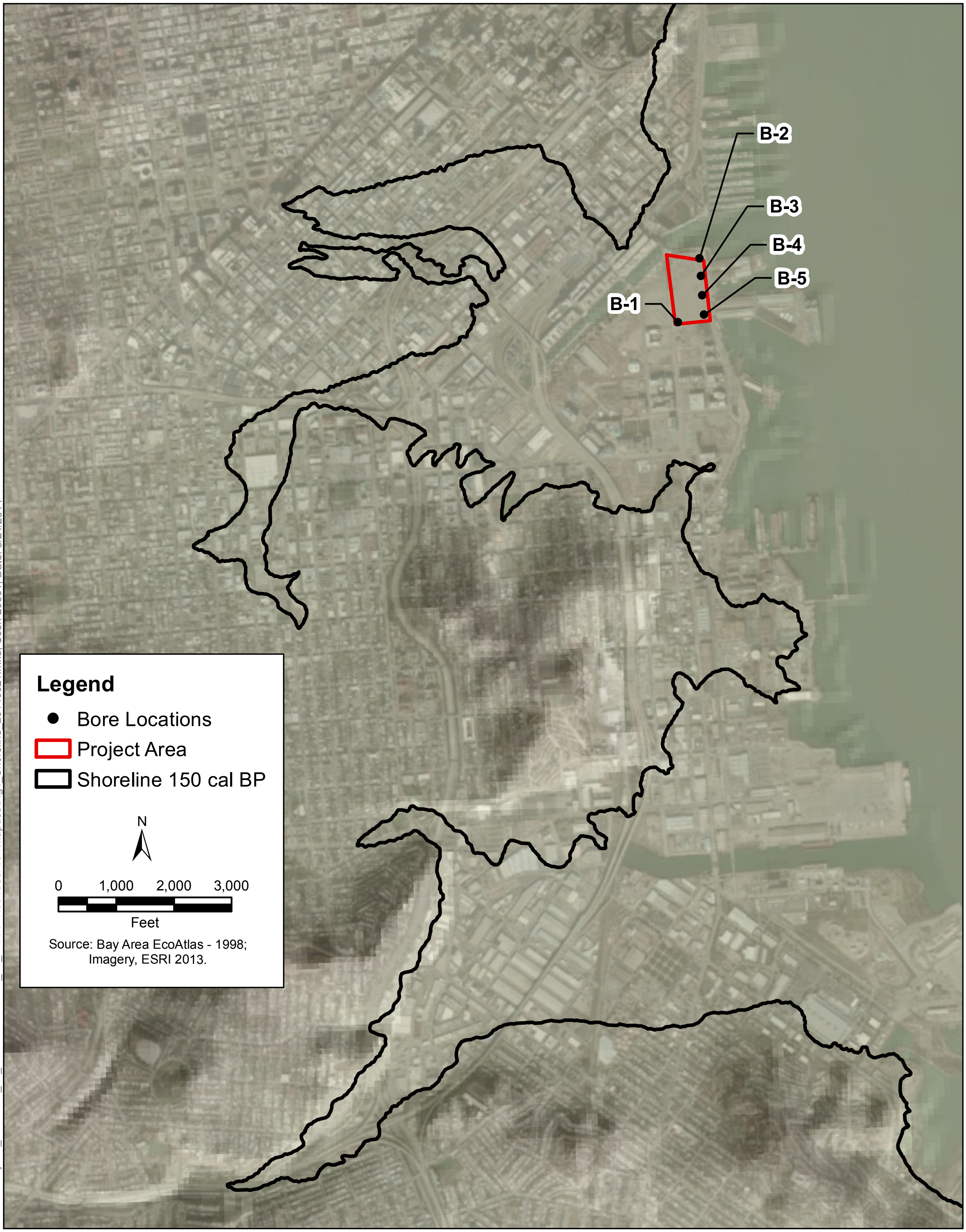
Seawall Lot 337/Pier 48 Mixed-Use Project
Case No. 2013.0208E
Geoarchaeological Assessment

Figure 2
Content of Borings



Path: K:\Projects_3\Seawall_37_Associates\00336_16_MissionRockGeoArch\mapdoc\Fig1_Shoreline_20140321.mxd; User: 29391; Date: 3/21/2014

Seawall Lot 337/Pier 48 Mixed-Use Project
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Figure 1
Project Are Vicinity, Pre-Development Shoreline, and Geotechnical Boreholes