Memorandum

To: Hunters Point Restoration Advisory Board

From: Tom Lanphar, Senior Hazardous Substance Scientist
Department of Toxic Substances Control, Office of Military Facilities

Date: May 11, 2004

RE: HUNTERS POINT AMBIENT LEVELS (HPALS)

At the May 1, 2004 special meeting of between some members of the Hunters Point Restoration Advisory Board, the Navy, US EPA, City of San Francisco, DTSC, and the RWQCB, I received a specific action item to determine what the current status of agreement is between the DTSC and the Navy in regards to HPALs.

Currently there is no dispute with the concentration of metals found in the HPALs. The following chronology tracks the development of HPALs and the resolution of specific issues related to the use of HPALs.

1. During the early 1990's the Navy, US EPA, DTSC and the RWQCB began discussing background metal concentrations at Hunters Point.

2. At a meeting on January 17, 1995 the Navy, US EPA, DTSC and the RWQCB agreed to a methodology for calculating Hunters Point Ambient Levels by using a statistical method that calculates the 95% upper confidence level (UCL) of the 95 percentile for all metals except Nickel (Ni), Chromium (Cr) and Cobolt (Co). For Ni, Cr, and Co the parties agree to use regression analysis to determine ambient levels. Dr. Frampton of DTSC actually proposed both the 95%UCL/95 percentile and the regression equations. The regression compares Ni, Cr, and Co concentrations against the concentration of Magnesium (Mg). This means that no specific concentration will establish ambient for Ni, Cr, and Co. Instead an HPAL for these metals will be calculated using regression coefficients at each site.

3. On April 11, 1995 Navy issues a draft document proposing HPALs using 95% UCL of the 95 percentile and regression coefficients for Ni, Cr, and Co. A draft final of this document is released on August 17, 1995.

4. On October 2, 1995 DTSC accepts the Navy's HPALs and regression coefficients for Ni, Cr, and Co found in the August 17, 1995 Navy document.

5. The ROD for Parcel A is signed on November 16, 1995. The Parcel A ROD references the draft HPALs presented in a draft memorandum dated April 11, 1995. These HPALs are the same as those in the August 17, 1995 document. The ROD does not establish a HPAL for Manganese (Mn). It is unclear why an HPAL for Mn is not included in the ROD. Both the April 11, 1995 and August 17, 1995 document identify the HPAL for Mn as 1431 mg/kg.

6. During the Parcel B remedial action Navy finds elevated levels (outside the expected range based on Ni regression with Mg) of Nickel and suspects that these levels are naturally occurring. In an October 22, 1998 document the Navy proposes a new Nickel regression equation. The Navy and DTSC agree that in weathered serpentine, or soils developed over serpentinite parent material, it would be expected that magnesium (Mg) would leach from soil while Ni and Co would be retained. Using the reduced Mg concentrations in a regression equation with Ni would incorrectly label naturally occurring Ni

concentrations as above HPALs. Therefore the Ni to Mg regression is not appropriate for weathered serpentine. Because Co would be retained along with the Ni, Dr. Frampton of DTSC proposed that a new Ni-Co regression equation be used. An August 4, 1999 Technical Memorandum by the Navy established a new Nickel to Cobalt regression based on Dr. Frampton's recommendations.

7. In 2001 the Navy proposed establishing Supplemental Manganese Ambient Level in a Technical Memorandum dated February 28, 2001. The new Manganese (Mn) level was proposed because high levels of Mn can be found in chert, a rock found at Hunters Point in the bedrock and fill. DTSC did not agree with the Navy's proposal and the issue went to dispute resolution in 2002. A Supplemental Manganese Ambient Level was never established and the Mn HPAL remains at 1431 mg/kg.

Updated Table E-15
Cancer Risks and Hazard Index, With Ambient Screen
IR-59 JAI

COPC	EPC (mg/kg)	HPS PRG (mg/kg)		Cancer Risk	Hazard Index
		Cancer	Noncancer		
Metals					
Aluminum	1.6E+04	—	7.2E+04	—	2.2E-01 *
Antimony	1.4E+00	—	1.0E+01	—	1.3E-01
Barium	1.4E+02	—	2.7E+03	—	5.3E-02 *
Chromium[a]	3.4E+02	1.2E+02	1.3E+03	2.8E-06	2.7E-01 *
Cobalt	3.5E+01	9.0E+02	9.7E+02	3.9E-08	3.6E-02 *
Iron[b]	3.0E+04	—	2.2E+04	—	1.3E+00
Lead[c]	1.6E+01	—	—	—	—
Manganese	5.7E+02	—	5.9E+02	—	9.6E-01 *
Nickel	5.9E+02	9.7E+03	3.0E+02	6.1E-08	2.0E+00
Zinc	6.2E+01	—	3.7E+02	—	1.7E-01
Semivolatile Organic Compounds					
Benzo(a)anthracene	4.1E-02	3.7E-01	—	1.1E-07	—
Benzo(a)pyrene	5.0E-02	3.7E-02	—	1.3E-06	—
Benzo(b)fluoranthene	6.7E-02	3.4E-01	—	2.0E-07	—
Benzo(k)fluoranthene	4.9E-02	3.4E-01	—	1.4E-07	—
Chrysene	1.8E-01	3.3E+00	—	5.5E-08	—
Fluoranthene	2.0E-01	—	2.0E+03	—	9.7E-05 *
Indeno(1,2,3-cd)pyrene	2.4E-02	3.5E-01	—	6.9E-08	—
Phenanthrene	2.4E-02	—	2.2E+04	—	1.1E-06
Pyrene	1.9E-01	—	2.3E+03	—	8.3E-05 *
Pesticides/PCBs					
4,4'-DDD	6.4E-03	2.1E+00	—	3.0E-09	—
4,4'-DDE	3.2E-02	1.6E+00	—	2.1E-08	—
4,4'-DDT	1.5E-01	1.2E+00	2.9E+01	1.2E-07	5.2E-03 *
Aldrin	3.8E-04	2.4E-02	1.6E+00	1.6E-08	2.3E-04 *
Heptachlor	3.7E-02	8.3E-02	2.6E+01	4.5E-07	1.4E-03
Heptachlor epoxide	1.2E-03	2.7E-02	4.8E-01	4.5E-08	2.4E-03
alpha-Chlordane	4.4E-03	4.3E-01	3.5E+01	1.0E-08	1.2E-04
gamma-Chlordane	4.2E-03	4.3E-01	3.5E+01	9.8E-09	1.2E-04
			Total	5.6E-06	4.9E+00

Notes:

a The HPS PRG for chromium assumes hexavalent chromium and trivalent chromium are present in a 1:6 ratio.

b Iron is considered by EPA to be an essential nutrient. Since the time of the Parcel A RI, EPA has developed an oral reference doses for iron. Accordingly, iron is evaluated in quantitatively in the table. No HPALs have been developed for iron. The range of detected iron concentrations at IR-59 JAI (15,062 - 44,472 mg/kg) is within the range of ambient iron concentrations found in California soils.

c Lead is evaluated separately from other COPCs. The EPC for lead is below the PRG of 150 mg/kg.

nisee *National Information Service for Earthquake Engineering*
University of California, Berkeley

Key Geotechnical Aspects of the 1989 Loma Prieta Earthquake
Jonathan Stewart

Assistant Professor, Civil and Environmental Engineering
UCLA

Introduction

The Loma Prieta Earthquake of October 17, 1989 occurred at 5:05 p.m. (local time) when a segment of the San Andreas fault in the mountains northeast of Santa Cruz, California ruptured over a length of approximately 28 miles (45 km). The Seismographic Station at the University of California, Berkeley determined the earthquake to have a *local magnitude* of ML = 7.0. The location of the fault rupture zone and the earthquake *epicenter* are shown in Fig. 1.

While damage from the Loma Prieta Earthquake was severe in counties near the epicenter, more than 80 percent of the fatalities (50 out of 62 deaths) and 70 percent of the $5.9 billion in monetary losses occurred in San Francisco and Alameda Counties, approximately 50 miles (80 km) from the epicenter. Indeed, some of the most vivid and widely publicized examples of damage were the collapsed section of the Interstate 880 Cypress Street Viaduct in Oakland, the partial collapse of a section of the San Francisco-Oakland Bay Bridge, and the structural failures and fires in the Marina District of San Francisco. (Fig. 2)

Much of the damage to result from the Loma Prieta Earthquake, especially in the central San Francisco Bay area, occurred at sites underlain by thick deposits of soft clayey soils. The concentration of damage in a few distinct areas having these soil conditions resulted from amplification of relatively moderate levels of "bedrock" shaking to much stronger levels of ground surface shaking. This ground motion amplification at "soft" soil sites was the most significant geotechnical aspect of the Loma Prieta Earthquake. Another significant geotechnical feature was a form of ground failure known as *soil liquefaction*. Liquefaction of loose, saturated cohesionless soils in a number of coastal areas near the Monterey and San Francisco Bays caused extensive damage to waterfront facilities, structures, and buried pipelines.

This article will describe some of the lessons that have been learned from the Loma Prieta Earthquake about the important geotechnical phenomena of ground motion amplification in "soft" soils and soil liquefaction. Extensive research has been conducted on both of these topics in the years since the earthquake which has affected the ways engineers design for the effects of earthquakes. This article is only intended to be a cursory introduction to these topics; several reports have been prepared which examine these issues in greater detail such as Seed et al. (1990), Benuska (1990), Baldwin and Sitar (1991), and Borcherdt (1994).

It should also be noted that there are other significant geotechnical aspects to this earthquake which are not discussed here. These include landsliding in hillside areas and coastal bluffs, the performance of geotechnical structures such as earth dams and retaining structures, and the resistance of improved ground to soil liquefaction. Information on these topics can be found in Seed et al. (1990), Harder

(1991), Hudson (1990), and Mitchell and Wentz (1991).

Effects of Local Soil Conditions on Ground Motions

Shown in Fig. 1 are geologic units and *peak ground accelerations* in the central and southern San Francisco Bay and northern Monterey Bay regions. The geologic units are broadly classified as (1) bedrock and stiff, shallow soils, (2) alluvium, and (3) areas near the margins of the San Francisco Bay underlain by a soft marine clay known locally as *Bay Mud*.

The peak accelerations shown in Fig. 1 are seen to be relatively large near the fault rupture zone, and to generally decrease with distance from this zone.

Fig. 3 (Seed et al., 1990) plots the variations of peak ground acceleration with distance from the fault rupture surface for recordings made on different geologic units. It is clear from the figure that the decrease in peak acceleration with distance is significantly less pronounced for "soft" soil sites than for all other site conditions. These relatively high accelerations on soft soil sites occurred in the central San Francisco Bay Area and appear to be the result of localized amplification of seismic waves as they propagate upwards from the bedrock towards the ground surface through soil.

Perhaps the best example of the influence of local soil conditions on ground shaking characteristics is provided by sets of strong motion recordings from two stations on the adjacent Yerba Buena and Treasure Islands in the San Francisco Bay. Yerba Buena Island is a rocky outcrop near the center of the bay which anchors the Bay Bridge.Treasure Island was man-made from loose dredged *hydraulic fill* and is underlain by natural, soft bay sediments. Both islands are approximately 45 miles (72 km) north of the fault rupture surface. Thus, the strong motions recorded at these locations represent a pair of recordings with nearly the same location relative to the fault plane, but for rock and deep soft soil conditions.

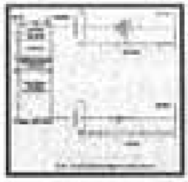
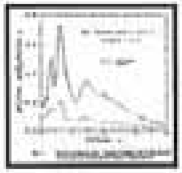


Fig. 4 presents a schematic illustration of the soil column underlying the Treasure Island recording station alongwith the *seismograms* for the N-S direction from the Treasure Island and Yerba Buena sites represented as "soil" and "rock" shaking, respectively.

It is clear from the figure that the Treasure Island record has a significantly higher amplitude of shaking, and a longer *predominant period*. This amplification phenomena can be quantified by examining peak accelerations and *acceleration response spectra*. The three recorded components of shaking had peak accelerations as follow (CSMIP, 1991):

	N-S Comp.	E-W Comp.	Vertical Comp.
Treasure Island	max=0.10g	max=0.16g	max=0.02g
Yerba Buena Island	max=0.03g	max=0.07g	max=0.03g



These data illustrate the amplification of shaking in the horizontal directions; no significant amplification typically occurred in the vertical direction. The amplification of Treasure Island motions across a range of periods can be represented by acceleration response spectra as shown in Fig. 5.

In addition to the amplification of peak ground accelerations (i.e. spectral accelerations at T=0), as is shown Fig. 5, deep soft soils at Treasure Island also amplified long-period components of the motion (i.e. spectral accelerations at T = 1.5 sec).

This amplification of motions at soft soil sites was also evident at a number of other locations in the central San Francisco Bay Area, including Emeryville, Oakland, San Francisco, and portions of the west San Francisco bayshore from South San Francisco to Redwood City.

A large percentage of the significant damage in the central San Francisco Bay Area occurred at sites underlain by soft Bay Mud soils similar to those encountered at Treasure Island. As shown in Fig. 6 the collapsed section of the I-880 Cypress Street Viaduct in Oakland was underlain by 0 to 25 feet of Bay Mud deposits which in turn overlie older and stiffer soils which extend to great depth (> 500 feet). In contrast, the southern section of the viaduct, which was damaged but did not collapse, is underlain by deep alluvium but without surficial Bay Mud deposits. Amplification of shaking through the soft Bay Mud soils at the northern end of the viaduct may have contributed to the collapse. These amplification effects also appeared to affect the patterns of structural damage and ground failure in San Francisco (e.g., the Marina District, Embarcadaro shoreline, old Mission Bay Marsh), Richmond Harbor, the Emeryville and Port of Oakland shorelines, West Oakland, and South San Francisco along the bay shoreline (Seed, et al., 1990).

Studies on site effects conducted since the Loma Prieta earthquake have developed recommendations to guide engineers in their selection of ground motions for use in engineering design (Dickenson, 1994, Borcherdt, 1994, Idriss, 1991). These recommendations enable engineers to estimate ground surface motions given the site condition (i.e., the characteristics of the geologic media underlying the site) and the level of shaking that would be expected "on rock" in the vicinity of the site. Some of these recommendations have been incorporated into building codes (e.g., Building Seismic Safety Council, 1995).

Soil liquefaction occurred over a widespread area including sites as far as 70 miles (112 km) from the epicenter. The principal areas affected were northern and eastern San Francisco, Treasure Island, the east San Francisco bayshore from Richmond to Alameda, Santa Cruz, and the east Monterey Bay region. A detailed discussion of liquefaction and its effects in these regions is provided in Seed et al. (1990), O'Rourke (1992), and Kropp and Thomas (1991). Hence, only a brief summary is presented here.

Liquefaction in the central San Francisco Bay Area (e.g., San Francisco, Treasure Island, Oakland, Emeryville, Alameda) primarily occurred in bayshore fills. These sites typically had 10 to 30 feet of loose, sandy fill which was underlain by deep cohesive soils which amplified ground shaking sufficiently to trigger liquefaction. The extent of liquefaction and its consequences were limited, however, due to the short duration of strong shaking in this earthquake (8 to 10 seconds). Many of these same areas suffered much more severe liquefaction during the 1906 San Francisco Earthquake due to the higher amplitude and longer duration of the shaking during that event.

Strong shaking in the Santa Cruz/East Monterey Bay region produced widespread liquefaction within natural alluvial and coastal beach and dune deposits. However, damage resulting from this ground failure was limited as a result of sparse development in many of the affected areas. Also interesting was the non-occurrence (for the most part) of liquefaction in the south San Francisco Bay Area. Many of the saturated alluvial soils in these areas liquefied during the 1906 San Francisco Earthquake, but the lesser amplitude and duration of shaking in these areas during the Loma Prieta Earthquake was not sufficient to trigger liquefaction again.

One of the principal lessons to be learned from the liquefaction which occurred in the San Francisco Bay

Area during the Loma Prieta Earthquake was that a significant ground failure hazard exposure from future earthquakes remains. This earthquake, which was centered far south of the Bay Area in the Santa Cruz Mountains, represents an inadequate test of the Bay Area's ability to withstand the larger and longer duration shaking sure to occur in future seismic events. However, the technology is available to identify the sites most at risk to liquefaction, and to mitigate against liquefaction hazards (Mitchell and Wentz, 1991). Whether such mitigation actually takes place is a matter of economics and public policy, and many developed areas remain at risk.

Conclusions

This article has presented a brief overview of two key geotechnical aspects of the Loma Prieta Earthquake: ground motion amplification at "soft" soil sites in the central San Francisco Bay Area and soil liquefaction. Much more detail on these topics and other geotechnical aspects of this earthquake are presented in other reports previously cited.

It is important to realize that neither of these geotechnical phenomena which so significantly influenced the damage patterns from the Loma Prieta Earthquake came as a surprise to the geotechnical engineering community. Ground motion amplification effects had been previously observed in the September 19, 1985 Mexico City Earthquake (Seed et al., 1987), and the implications of these effects for the Bay Area had been recognized (Seed and Sun, 1989). Widespread liquefaction had been identified during the 1964 Niigata and Alaska Earthquakes as well the 1971 San Fernando Earthquake, and subsequent research led to analysis procedures capable of predicting the combination of ground shaking and soil conditions under which liquefaction is likely to occur (e.g., Seed et al., 1983).

Though there were few geotechnical surprises from the Loma Prieta Earthquake, it was nonetheless a seminal event. From a geotechnical standpoint, its principal legacies are twofold: (1) it increased public awareness of earthquake hazards in general and of geotechnical factors such as soil liquefaction in particular, and (2) it provided researchers with a significant amount of data on geotechnical phenomena such as site amplification and soil liquefaction, which in turn has prompted studies to improve our analytical capabilities for predicting these effects. This combination of political will and technical knowledge has led to improvements in the ways engineers design structures to resist earthquake loading. However, as subsequent events like the Northridge earthquake in Los Angeles, California and the Hyogoken Nanbu earthquake near Kobe, Japan have illustrated, there remains much to be accomplished before these seismic hazards can be considered to have been appropriately mitigated.

Definitions

Magnitude is a qualitative measure of the energy released by an earthquake.The *local magnitude* is a particular measure defined as the logarithm of the maximum amplitude on a Wood-Anderson torsion seismogram located at a distance of 100 km from the earthquake source (Richter, 1958). (Back)

Earthquakes result from ruptures of the earth's crust along discontinuities, or faults. The rupture has a point of origin called a focus, and then spreads out across a certain area on the fault. The larger the rupture area on the fault, the larger the earthquake magnitude. The *epicenter* is the point on the surface of the earth which is directly above the focus. (Back)

Bray (1995) defines *soil liquefaction* as phenomena resulting when the pore-pressure within saturated particulate media increases dramatically, resulting in a severe loss of strength. The following qualitative description of soil liquefaction has been given by Seed and Idriss (1982): "If a saturated sand is subjected to ground vibrations, it tends to compact and decrease in volume; if drainage is unable to

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Updated December 8, 1997.
Send comments or questions to EERC Library.

Office of the Mayor
City & County of San Francisco

Gavin Newsom

February 7, 2005

Dear Community Resident:

I am happy to announce that the U.S. Navy has transferred the first 75 acres of the Hunters Point Naval Shipyard to the San Francisco Redevelopment Agency. The transfer was made possible after more than a decade of careful consideration by federal and state environmental regulatory agencies, local environmental advocates, the Bayview Hunters Point community, the City and the San Francisco Redevelopment Agency.

As a result, after years of community outreach and planning, development at the Shipyard is finally about to begin. Together, we will be able to transform an area that has been a blight on the community for more than 30 years into a new source of jobs, parks, and affordable housing, and a great economic engine for Southeastern San Francisco. Construction on the first phase of development is scheduled to begin as early as next month, and is slated to include an unprecedented level of community benefits, including:

- 1,600 residential units, 32% - 44% will be affordable;
- A first-time home buyers assistance program;
- 35 acres of new parks and open space;
- An annual average of over 430 construction jobs per year over the initial 5-year construction period, with many more jobs to follow;
- Priority programs for community residents in the areas of job training, hiring, and contracting, and priority leasing, small business assistance and incubator space programs for existing local companies;
- Earmarking land for community facilities and more than 30% of all of the land available for market-rate development for community builders; and
- Reinvesting an estimated $30-40 million in land sales revenues directly in the Bayview Hunters Point community after an extensive community input process.

I sincerely thank you for your continued efforts to ensure a smooth and proper transition. Everyone in southeast San Francisco will feel the positive effects of this redevelopment.

Sincerely,

Gavin Newsom
Mayor

1 Dr. Carlton B. Goodlett Place, Room 200, San Francisco, California 94102-4641
gavin.newsom@sfgov.org • (415) 554-6141