Are Clipper Cove's Sediments Suitable For Redevelopment?

Blaine Pedlow

Abstract: Concentrations of inorganic and organic mercury were studied as part of an overall assessment of soil sediments and their levels of contamination using mercury as an indicator. Testing was configured in order to pinpoint levels of mercury contamination due to runoff and wharf usage on the perimeter of the cove as well as dispersion from these sites to the center of the cove. Time scale data was collected at sixteen sites to determine relative changes in contamination over time. No significant differences were detected between sites associated with runoff and those in the center of the cove. Additionally, no statistical differences were found between each site and the background level of San Francisco Bay mercury concentration. There was no meaningful difference in concentration between different layers of sediment, indicating that there is little or no change in the flux of mercury to the cove during the time period corresponding to the depths sampled. Additional investigation is required to assess the exact impacts of redevelopment, specifically dredging and piling, in Clipper Cove.

Introduction

Clipper Cove is a shallow harbor located between Treasure Island (TI), a manmade landfill, and Yerba Buena Island (YBI) in San Francisco Bay. Since Clipper Cove's creation in the 1930s it has served a variety of purposes, including being a terminal for the Pan-American Clipper Line, an anchorage for smaller US Navy (USN) ships being repaired and a commercial and public marina. TI and Clipper Cove were both deeded to San Francisco after the USN closed the base in 1997. Since the creation of the island until the closure of the base in 1997, Clipper Cove was exposed to significant levels of industrial pollution, both from Navy sources and from commercial uses (Nichols, 2001).

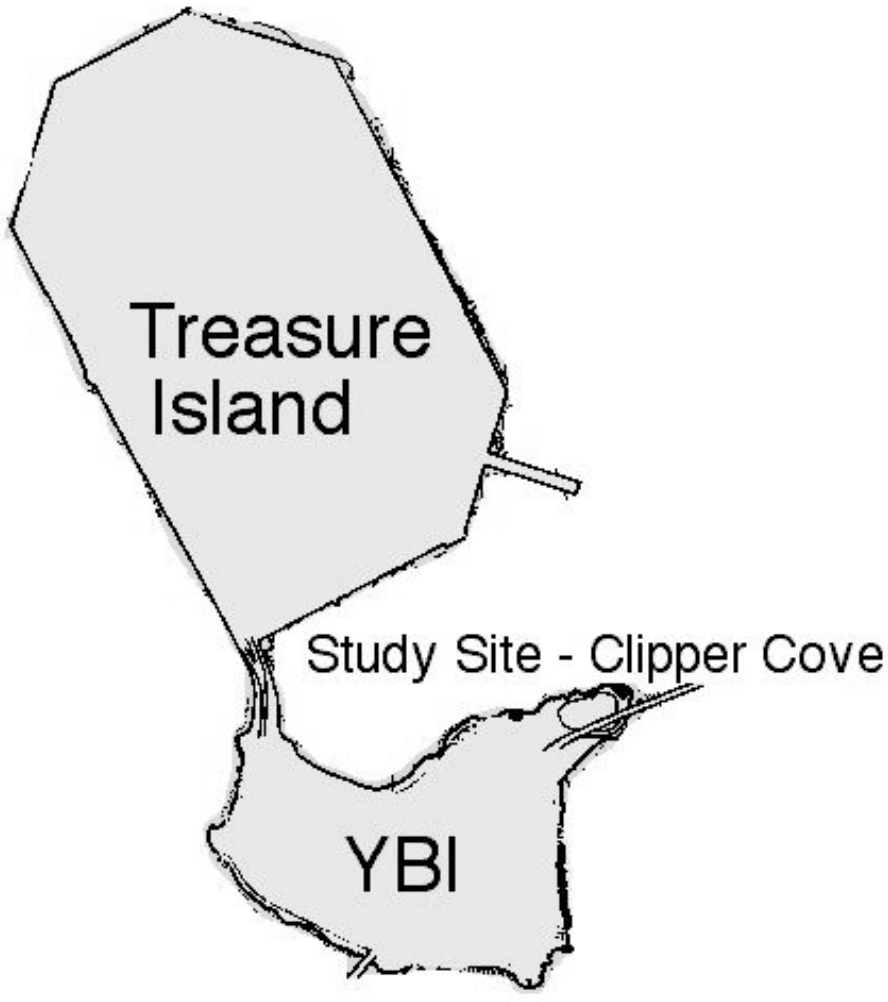

Figure 1. Treasure Island, Yerba Buena Island and Clipper Cove

In 1998 the City of San Francisco created the Treasure Island Development Authority (TIDA), which was to oversee the reuse of the Island and Clipper Cove. Less than a year later, they announced their vision for the new Treasure Island, including a 1-mile promenade along the northern shore of the cove, dredging of the cove to make a deep-water anchorage, and construction of an extensive marina facility along the northern and western edges of the cove (TIDA, 2002).

While the reuse of Clipper Cove and TI may be of great value to the people of the Bay Area, it may pose a significant risk to the environment. Studies show that Naval activities lead to extensive contamination of sediments by leaching off of ships hulls, over spray from painting operations and runoff from industrial sources (Colin et al, 1997 and Page, Ozbal and Lanphear, 1996). It is also suggested that dredging may lead to considerable re-release of mercury and other toxins from the sediments (Miller et al, 2000 and Tack et al, 1995). Miller et al (2000) also indicate that there may be significant amounts of debris on the cove floor due to USN activities, putting the cove at additional risk for re-suspension of contaminants by perturbation of the sediments during the removal of the objects. Furthermore, USN facilities are not required to follow US Environmental Protection Authority (EPA) regulations, implying that there is a considerable possibility that there is additional contamination in excess of that found in commercial facilities (Colin et al, 1997). This is of particular concern as the City of San Francisco aims to turn the cove into a largely recreational area. No known sediment impact studies have ever been conducted in Clipper Cove and it is unknown whether there are considerable pollutants in the cove's sediments.

The goal of this study is to conduct a preliminary analysis of the sediments of Clipper Cove. The study will use mercury concentration as an indicator of overall sediment contamination as suggested by Carr et al (1999), as it is commonly associated with industrial, shipyard and marine wastes (Carr et al, 1999). Time scale data will be used to determine what depth of sediments is the most contaminated. With this information I can determine the minimum amount of sediment that must be removed so that contaminated sediment is not left exposed on the cove floor after dredging. Using the data on mercury contamination and the core analysis, I can make several suggestions to the Treasure Island Development Authority regarding Clipper Cove's reuse, including a recommendation of where to build to minimize the re-suspension and release of contaminants.

Methods

Study Site and Data Collection My study site was located inside Clipper Cove, an area that includes an old US Navy anchorage, debris from demolished piers and an existing marina in the northwest corner. Preexisting Navy and Pan American Clipper launch ramps as well as wastewater outfall pipes also surround the cove. The easternmost 50 meters at the exposed end of the cove are subjected to substantial currents daily and are much deeper and scoured that the inner parts of the cove. This area was excluded, as it will not need to be altered in order to redevelop the area.

A visual inspection of the area and historical research of the cove's usage determined sampling sites inside the cove. Four point sources were determined around the cove, including a boat launching ramp on the northern shore (site A), two large outflow pipes in the southeastern

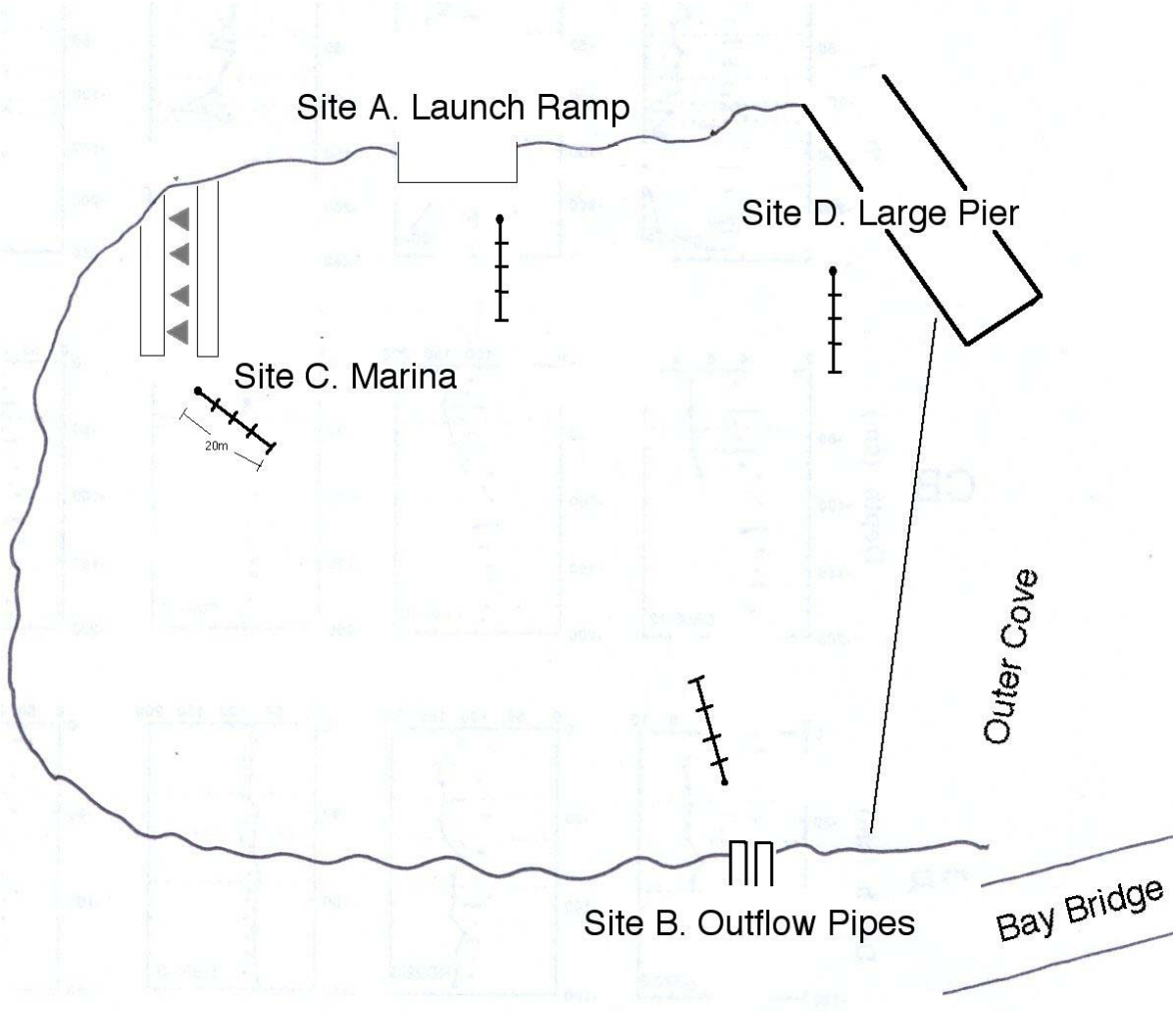

Figure 2. Clipper Cove Map and Site Layout

portion of the cove (Site B), the existing marina (Site C) and a large pier on the northeastern shore (Site D). Four samples were taken at each location, each sample lying on a transect at five-meter intervals as suggested by Nichols (2002). Four additional samples from the center of the cove were analyzed to determine the background levels of contamination in the cove.

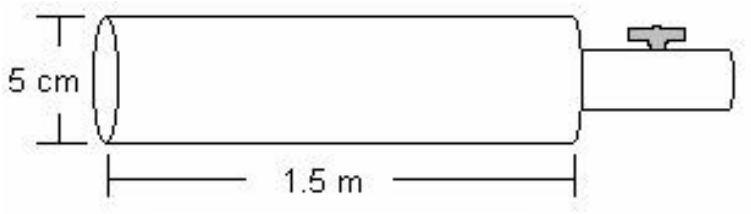

Figure 3 Corer and extension

Cores were collected using a 1.5-meter corer of 5-centimeter diameter (Figure 3). The PVC corer has two 5-meter attachments that allow sampling through all depths of the cove. Samples were taken by inserting the corer into the sediment until it reaches the stainless steel plate. By closing the valve at the end of the attachments, the sediment is trapped inside the corer and may be taken to the surface. Opening the valve releases the stratified sediment. Sediment samples were immediately separated into 40-centimeter increments and placed into sealed sterile bags. Samples were stored on ice and kept below 4˚ Celsius until testing.

Sample Testing All five incremented cores from the bag were tested for mercury concentrations using the guidelines established by the National Oceanic and Atmospheric Administration (NOAA). JNE Associates in San Diego, California performed this testing. Sediment samples were analyzed for metallic mercury by digestion in Teflon bombs, using nitric and sulfuric acids. Mercury concentrations were determined by cold vapor atomic absorption spectrophotmetry, using a Perkin-Elmer 3030 spectrophotometer (modified EPA method 245.5).

Statistical Analysis Concentrations of mercury at each depth were compared by linear regression with depth as the predictor variable. Analysis of variance was used to compare the sixteen total samples using core depth and distance from point source of comparison factors. Mean concentrations at each of the four point sources were compared to the mean of the 4 background samples using ANOVA. Additionally, the mean of the background samples was compared to the known overall concentration of mercury in San Francisco Bay by a t-test to analyze the difference between background levels inside of the cove and those of the entire Bay.

Results

Concentrations of mercury in Clipper Cove were found to be consistent with the overall concentrations of mercury throughout San Francisco Bay. Hornberger et al (1999) e stablish the average mercury concentration in the top 1 meter of sediment to be .38 μg/g dry weight. The background value of mercury in Clipper Cove was tested to be .36 μg/g, yielding a p-value of 0.14 and indicating that they are nearly statistically identical.

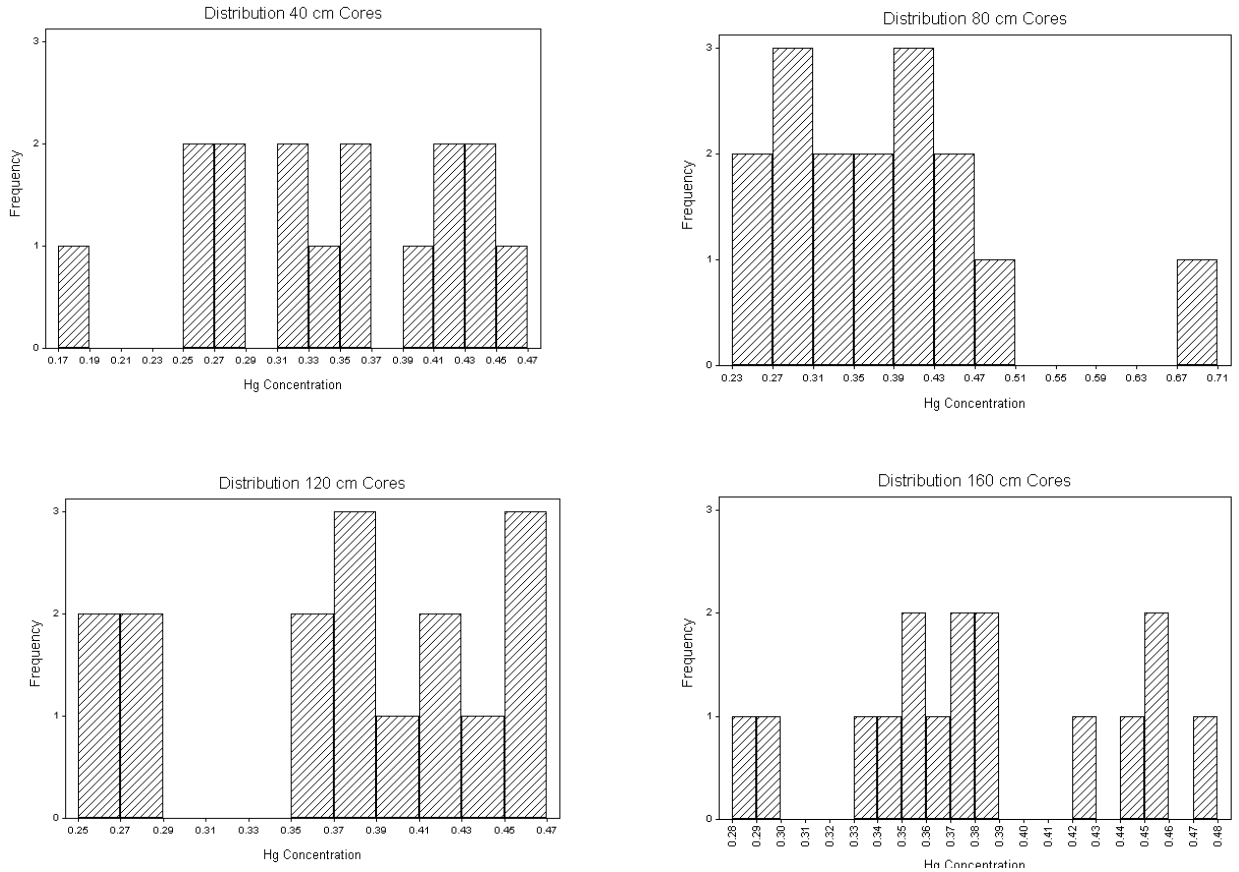

Figure 4. Distributions of Mercury Concentrations at 40-, 80-, 120- and 160-cm depths

Cored samples further supported the fact that Clipper Cove is not especially more contaminated than San Francisco Bay as a whole. Of the sixteen samples taken from the point-source areas, only two contained mercury concentrations that were remarkably different than the background level of concentration in the cove of San Francisco Bay. The first of these samples, taken from the second level (depth of 80 cm) of a core 10 meters from site A, yielded a concentration of 0.69 μg/g. However, the 5-meter radius and 15-meter radius cores from site A

returned the lowest average concentrations (.21 µg/g and .26 ug/g, respectively). The other exceptional sample was from Site D at a radius of 15 meters, and had a value of .59 µg/g at the very top level of the core (40 cm depth). These two outliers may indicate pockets of high Hg

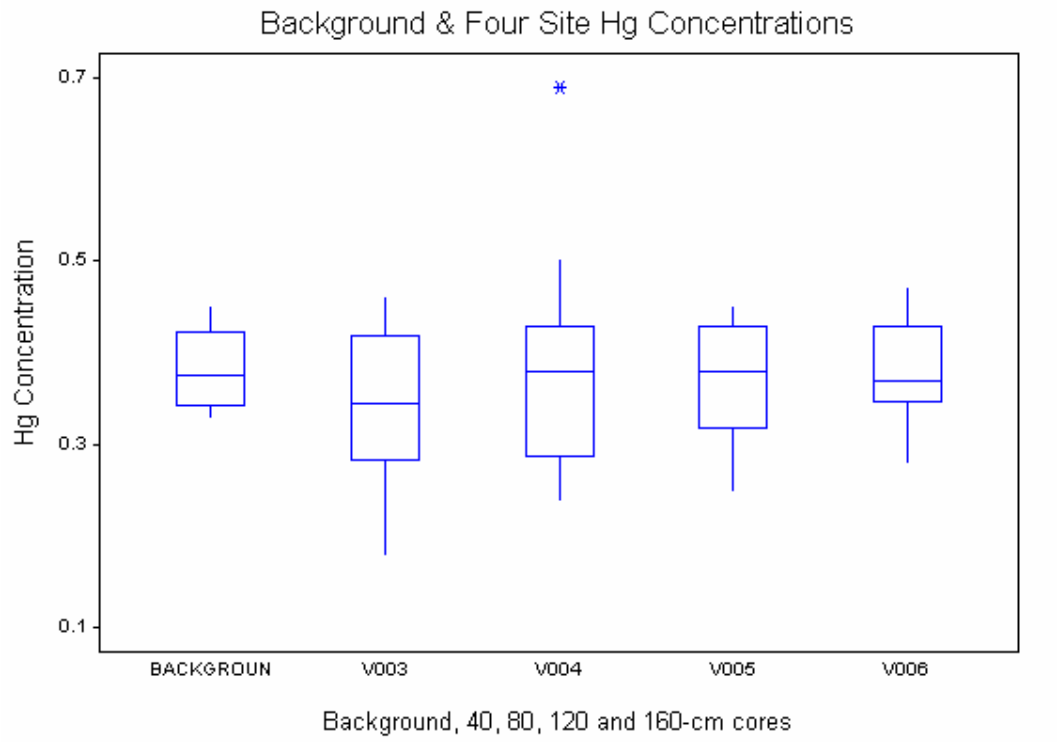

Figure 5. Means and Errors of Cores at all four depths.

concentration, but most clearly indicate the lack of trend in distribution from a point source or increase of Hg concentration with depth.

Samples taken from the same core depth showed relatively little variability in their concentration or in their difference from the mean of the cove. Apart from the two outlying values, there was little or no difference in contamination in sediments associated with potential point sources or those located towards the middle of the cove. Additionally there is no statistical difference between any of the core depths and the background level inside of the cove.

Discussion

The results indicate that Clipper Cove has not been exposed to any mercury contamination apart from that found in the rest of San Francisco Bay. This surprising result indicates that naval and industrial pollution are not important factors in Clipper Cove sediment contamination when

compared to many years of mine leaching and runoff (Hornberger et al, 1999), the cause of the majority of SF Bay's mercury pollution (Hornberger et al, 1999). The uniformity of contamination in the cove also speaks to this point, indicating that point sources of runoff from Treasure Island are not dramatically increasing the concentration of pollutants in Clipper Cove. This is great news, as mercury is an excellent indicator of other industrial wastes and contaminated runoffs. While my study does not say that Clipper Cove is safe, it does indicate that there is minimal industrial contamination over the time period sampled in the cores.

This study also leaves many questions to be answered about the deposition of sediments in the cove. Measured mercury concentration may have been lower than anticipated because sedimentation rate was dramatically underestimated and the core depth sampled were not adequately deep to see any historical trends. Further in-depth study is required to determine the actual sedimentation rate inside of Clipper Cove before the relative rate of contamination of the sediments can be tested. In order to improve this study, it may also be worthwhile to use another contaminant, such as butyltins or lead, as an indicator of sediment contamination.

Acknowledgements

I would like to thank Jean Nichols of JNE Associates in San Diego, California for providing the background knowledge and know-how to undertake this project. Justin Remais, Matt Orr, John Latto and Manish Desai were all very helpful in pointing me in the right direction and helping narrow my focus. Lastly, I would like to thank my mom for baking me cookies that were so tasty to eat while sampling and Café Milano, which provided the coffee to keep me warm during two very cold sampling mornings.

References

Carr, R.S., Biedenbach, J.M. and R.L. Hooten. Sediment Quality Assessment Survey and Toxicity Identification Evaluation Studies in Lavaca Bay, Texas, A Marine Superfund Site. Environmental Pollution, 1999, 20-30.

Chau, Y.k., Zhang, S. and R.J. Maguire. Determination of Butyltin species in sewage and sludge by gas chromatography-atomic absorption spectroscopy. Analyst, col 117, 1992, p. 1161-1164.

Colin R., Chaumery, C.J. and Guermer E. Organo-tin Concentrations in Brest Naval Port in 1993 and 1994. Annales del Institut Oceanograpique, 1997, 73, 17-24.

Fent, K. and Muller, M.D. Occurrence of Organotins in municipal wastewater and sewage sludge and behavior in a treatment plant. Environmental Science Technology, 1991, 25, 489-493.

Horvat, M. and Covelli, S. Mercury in Contaminated Coastal Environments; a Case Study: The Gulf of Trieste. The Science of the Total Environment, 1999, 237, 43-56.

Miller, B.S., Pirie, D.J. and C.J. Redshaw. An Assessment of the Contamination and Toxicity of Marine Sedminents in the Holy Loch, Scotland. Marine Pollution Buletin, 2000, 40, 22-35.

Nichols, Jean. Personal interview, October 12, 2001.

Page, D.S., Ozbal, C.C. and M.E. Lanphear. Concentrations of Butyltin Species in Sediments Associated with Shipyard Activity. Environmental Pollution, 1996, 91, 237-243.

Thompson, J.A., Sheffer, M.G. and R.C. Pierce. Organotin Compounds in the Aquatic Environment: Scientific Criteria for assessing their Effects on Environmental Quality. National Research Council Canada, 1985.

Treasure Island Development Authority, http://www.ci.sf.ca.us/treasureisland/, February 18, 2002.