

Using the Tri△d Approach in Sediment Quality Monitoring Near a Wastewater Outfall

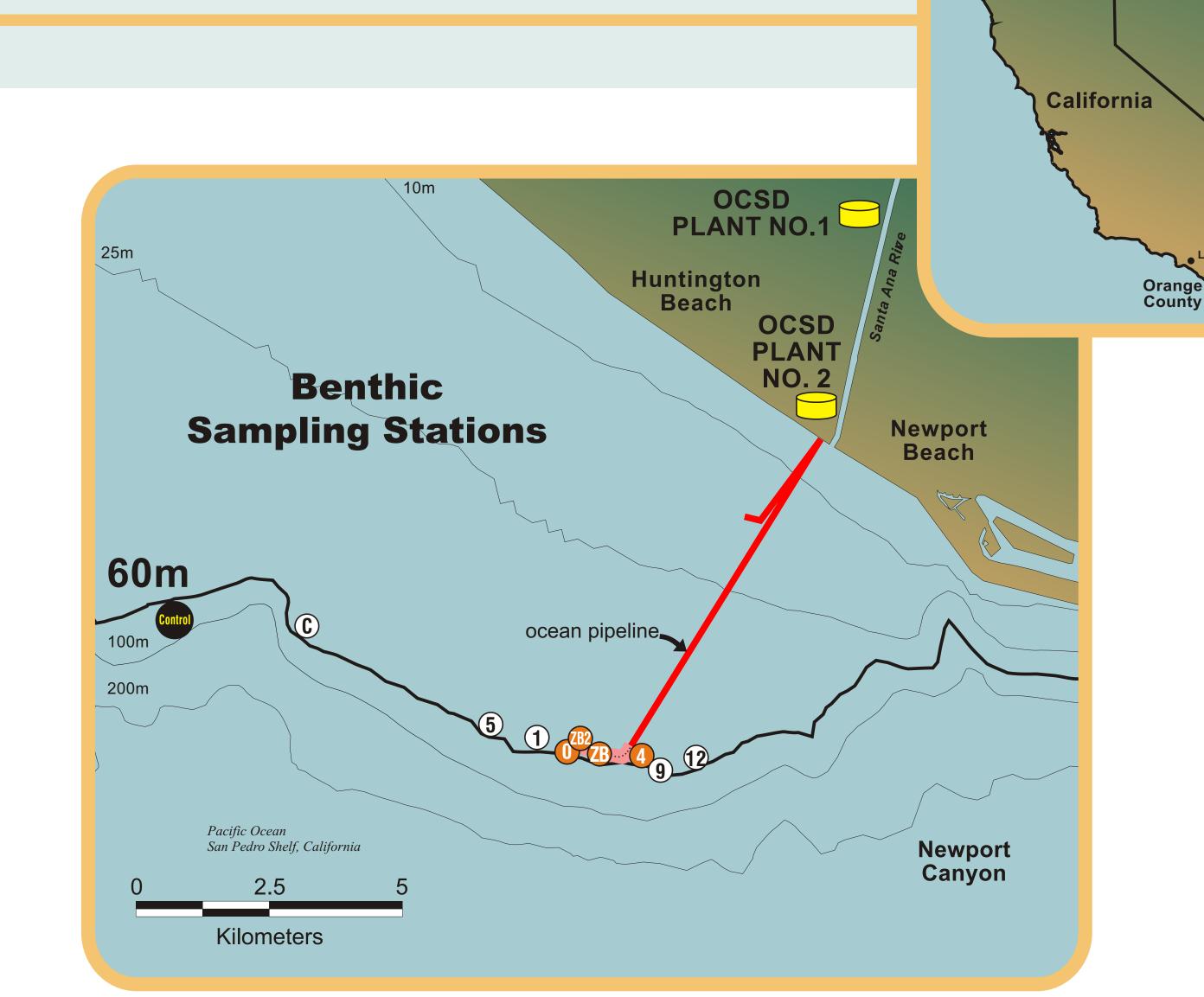
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Abstract

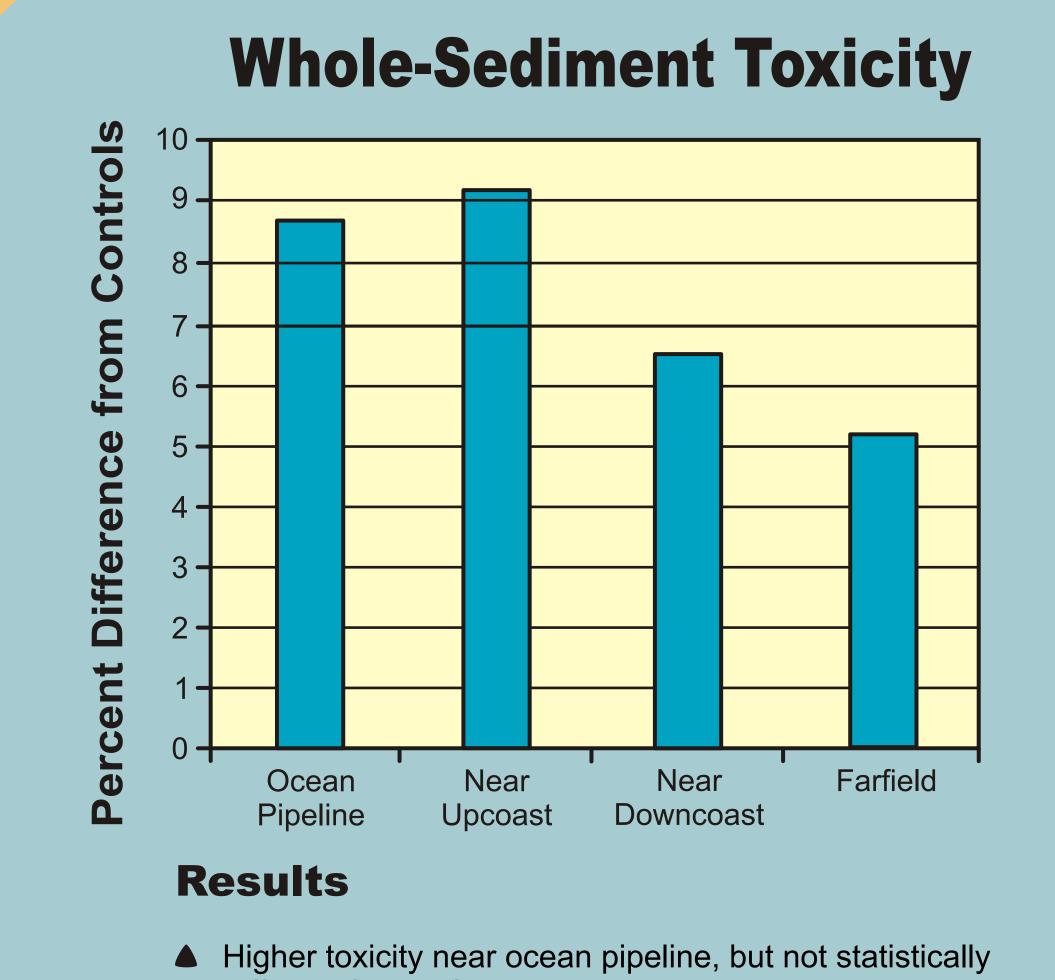
sediment quality near the Orange County Sanitation District (OCSD) ocean pipeline in southern California. Samples were collected quarterly from October 1999 through July 2001 at 10 sites for sediment geochemistry, infaunal community, and sediment toxicity analysis. Whole sediment toxicity was tested with the 10-day amphipod (*Eohaustorius estuarius*) test and porewater toxicity was tested using Microtox®. Sediment toxicity changed over time both spatially and in magnitude. Whole sediment test results correlate to the overall good health of the infaunal populations in the monitoring area, while Microtox results suggest that porewater toxicity is increasing both spatially and temporally in the monitoring area. ERM-quotients ranged from 0.06-0.13 with a relationship to the ocean pipeline suggested. No ERM values were exceeded at any station for metal or organic compounds. ERL exceedances for tDDT, tPAH, and tPCB were generally localized near the ocean pipeline. Community analysis indicates overall enhancement of the infauna near the ocean pipeline, with a gradient of decreasing diversity moving away from the ocean pipeline. Seventy-six percent of the individual station analyses conclude that low levels of toxicants are present in the sediments, but that toxicity is a laboratory artifact and a normal infaunal community is present. Seventeen percent showed chemicals in the sediment were not bioavailable and there was no evidence of environmental degradation. Four percent indicated that unmeasured chemicals or conditions exist with the potential to cause degradation. Strong evidence for no pollution-induced degradation occurred in only one station analysis. Similarly, strong evidence for pollution-induced degradation occurred in only one analysis.



Introduction

The sediment quality Triad (TRIAD) method uses a weight of evidence approach to determine sediment quality. The TRIAD method allows a synoptic evaluation of sediment chemistry, sediment toxicity, and benthic infaunal community characteristics to assess relative sediment quality (Chapman et al. 1997). There are many ways to interpret TRIAD data, including comparison of the data to a response matrix listing the possible outcomes for each response scenario (Chapman 1990).

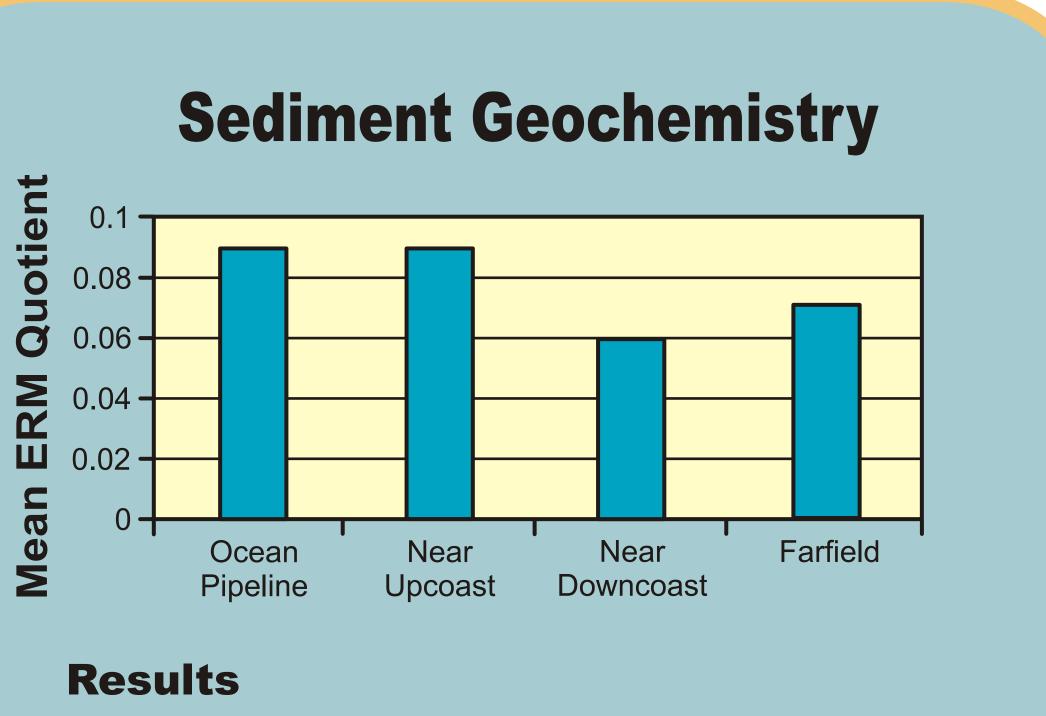
To better characterize sediment conditions near the ocean pipeline, the OCSD supplemented the NPDES permit-required sediment geochemistry and benthic infaunal community analyses already performed in their Ocean Monitoring Program with sediment toxicity testing, thus providing the third TRIAD element. The purpose of this project was to provide a three-year assessment of sediment quality near OCSD's ocean pipeline relative to a reference area, including the determination of the existence of a spatial gradient of effects and seasonal patterns in sediment quality. This paper presents the results of the 12 quarterly sampling events scheduled for this project.



- Higher toxicity near ocean pipeline, but not statistica different from reference
- ▲ Toxicity showed a decreasing gradient moving away from the ocean pipeline

Sediment Quality Assessment

- ▲ Based on the assessment criteria in Chapman (1990), sediment quality within the OCSD's area is generally good. There is some loading of organic contamiants localized near the ocean pipeline, but they do not appear to cause toxicity or benthic community degradation.
- ▲ There was a pattern of elevated toxicity near the ocean pipeline that also increased over time, but it did not correlate to sediment geochemistry measurements.
- ▲ Sediment toxicity returned to low levels by the end of the three-year project.
- ▲ Benthic communities at the ocean pipeline showed higher diversity than reference sediments throughout the project period.



▲ mERMq higher at ocean pipeline, but less than toxic threshold

No clear ocean pipeline gradient evident

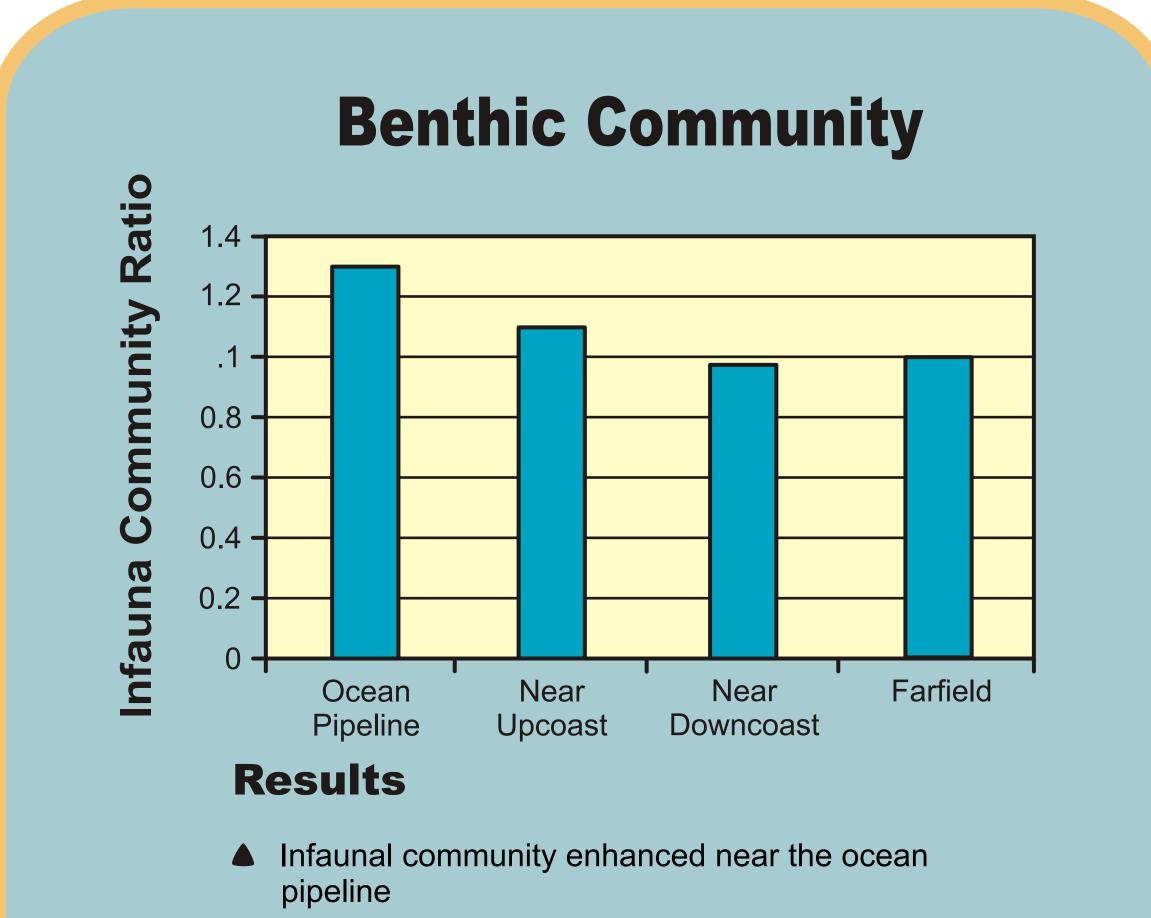
Conclusions

- ▲ Sediments in the OCSD's monitoring area are not degraded and support a healthy benthic community, while the near-ocean pipeline community is enhanced relative to reference areas.
- ▲ The sediments near the ocean pipeline show some degree of impact due to organic contaminant loading. However, these chemicals may not be bioavailable *in situ* based on the health of the benthic community.
- ▲ The cause of the increase in whole-sediment toxicity near the ocean pipeline is not known, but appears to be due to some unmeasured compound or condition.
- Seasonal variability was not detected in any of the TRIAD elements.

Methods

- Sediments were collected quarterly from a total of ten stations (4 ocean pipeline, 4 intermediate, 2 reference) using tandem, modified 0.1 m² VanVeen grab samplers.
- ▲ Sediment geochemistry analyses were performed using performance-based methods and a list of analytes similar to NOAA National Status and Trends methods (NOAA 1993). The chemical characterization of the sediment included total organic carbon (TOC), acid volatile sulfides (AVS), metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Ag, Zn), chlorinated pesticides (e.g., total DDT, dieldrin, aldrin), total polychlorinated biphenyl (PCB), and total polycyclic aromatic hydrocarbon (PAH).
- ▲ Sediment collected for infaunal analysis are screened through a 0.5 mm sieve. The animals collected are returned to the laboratory, identified to the lowest possible taxon, and the data used to calculate baenthic community diversity measures for each sampling station.
- ▲ Sediment toxicity was tested two ways:
- Whole-Sediment Testing: Whole-sediment toxicity was assessed with the 10-day amphipod survival test using *Eohaustorius estuarius*.
- Interstitial (Porewater) Testing: Porewater toxicity was assessed using the MicrotoxTM comparison test method.

- ▲ Differential TRIAD Response Analysis: For each station per survey, the collective responses of each TRIAD component were evaluated using the Differential TRIAD Response Matrix and the following criteria:
- Sediment geochemistry values were evaluated against published effects range-low (ERL) and effects range-Median (ERM) values (Long et al. 1995). Any exceedance of an ERM was considered a positive potential impact.
- Four parameters were used to characterize benthic community diversity: (1) total abundance, (2) number of species, (3) Shannon-Wiener Diversity Index (H'), and (4) Margalef Diversity Index (d). Each of the four parameters was converted to a ratio to the control condition, the four parameters summed, and then normalized to the control condition assumed equal to 1.00. Variability in the "normal condition" was based on the variability at the control stations (cv = 17%).
- A toxic response in the whole-sediment toxicity test was considered a positive response. The porewater test was used for trend assessment only.



Community measured showed a decreasing gradient

moving away from the ocean pipeline

TRIAD Analysis Results

- The benthic community was balanced within the monitoring area and showed enhancement near the ocean pipeline relative to the reference area. Presence of pollution-tolerant organisms (e.g., *Capitella capitata*) was low and localized near the ocean pipeline, while pollution-sensitive animals (e.g., *Amphiodia* complex) have recovered throughout the monitoring area.
- ▲ No ERM values were exceeded for any single compound, but elevated mean ERM quotients were found near the ocean pipeline. These were driven by high total DDT and total PCB concentrations. Metal contaminants were generally below ERL values.
- ▲ Whole sediment toxicity was generally low, though elevated near the ocean pipeline compared to the reference area. Due to good infaunal community health, this indicates that while some chemicals reside in the sediments capable of causing degradation, they are not bioavailable *in situ*.

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