

9. DATA ANALYSIS

9.1 SEDIMENT INVESTIGATION

Analysis of the data collected as part of the sediment investigation will be conducted by the Sediment Technical Lead. Laboratory results will be evaluated by providing general descriptions of the sediment chemistry data and any biological data generated during the investigation. Stations exhibiting exceedances of applicable sediment quality criteria (e.g., SQS or CSL numerical criteria for individual chemicals or SQS or CSL biological effects criteria) will be clearly identified. The areas exhibiting such exceedances will be indicated on a map.

9.1.1 Sediment Chemistry Data

Sediment chemistry data will be tabulated for all measured analytes (including conventional sediment variables), whether or not there are applicable numerical criteria for evaluating the data. For those chemicals whose numerical criteria are TOC-normalized, separate tables will be prepared for the dry-weight and TOC-normalized concentrations. The latter tables will allow direct comparison with the numerical criteria, whereas the former tables may be useful in cases where TOC values are either very high or very low. In these cases, the data may be compared with the dry-weight apparent effects threshold (AET) values (Barrick et al., 1988). Ancillary data that will be reported in these tables include station numbers, sample identification numbers (corresponding to those on laboratory data sheets), the date of sample collection, and the sampling interval (upper and lower depths within the sediments relative to the sediment-water interface). The results for field duplicate samples will be identified as such and reported separately (i.e., not averaged). Appropriate data qualifiers will be reported with the chemical concentrations. Detection limits will be included for undetected analytes. To facilitate comparisons with applicable numerical criteria (e.g., SQS, CSL), the data tables will include one or more columns with the criteria and an indicator that identifies individual values in the other columns that exceed the criteria.

Some of the applicable numerical criteria (e.g., SQS, CSL) are for the sum of individual compounds (e.g., total low molecular weight polynuclear aromatic hydrocarbons [total LPAHs], total high molecular weight polynuclear aromatic hydrocarbons [total HPAHs]),

isomers (e.g., total benzofluoranthenes), or groups of congeners (e.g., total PCBs). For these chemicals, the following rules will be used in generating the sums:

- Under the SMS, if a chemical analysis identifies an undetected value for every individual compound, isomer, or group of congeners, the highest individual chemical detection limit in a group is used to represent the sum of the respective compounds/isomers. When one or more individual compound/isomer in a group are detected, only the detected concentrations are included in the sum.
- Total LPAH should represent the sum of the concentrations of the following LPAH compounds: naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. 2-Methylnaphthalene is not included in the LPAH definition under the SMS.
- Total HPAH should represent the sum of the concentrations of the following HPAH compounds: fluoranthene, pyrene, benz[a]anthracene, chrysene, total benzofluoranthenes, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, dibenz[a,h]anthracene, and benzo[ghi]perylene
- Total benzofluoranthenes should represent the sum of concentrations of the b, j, and k isomers of benzofluoranthenes
- Total PCBs should represent the sum of the concentrations of individual Aroclor® mixtures.

9.1.2 Biological Test Data

Statistical analyses of any biological test data will be conducted.

For each toxicity test endpoint measured, the mean response for each sediment sample (i.e., averaged over five subsamples tested from each station) will be compared with the mean response for the reference area sample (also averaged over five subsamples) using a *t*-test and a one-tailed probability level of $\alpha=0.05$ for the amphipod and polychaete tests, and an $\alpha = 0.1$ for the larval test. A one-tailed test will be used because only statistically significant adverse effects (e.g., increased mortality relative to reference results) are considered relevant.

data, the biological test results will be tabled by station and by test, with columns representing individual stations and rows representing individual biological tests. The tabled values will represent the mean response at each station for toxicity tests. Biological test results found to exceed the applicable biological effects criteria will be identified within the table. For toxicity test data, the responses in each replicate treatment will be reported in an appendix. For toxicity test data, the results for reference area samples will be included. All other pertinent test data listed under *Data Reporting Requirements* in the protocols for each sediment toxicity test (PSEP, 1995) will also be included in an appendix to the data report.

9.1.3 Data Interpretation

The procedures for interpreting sediment chemistry and biological data in the context of the sediment cleanup process of the SMS will be followed and are described in Chapters 2, 3, and 4 of the Sediment Cleanup Users Manual, Volumes 1 and 2 (SCUM 1 and SCUM 2) (Ecology, 1991). Example worksheets presented in SCUM 2 (Ecology, 1991) may be completed as aids to interpreting the data in light of the sediment cleanup standards of the SMS, as appropriate for the specific sediment investigation.

9.2 MARINE BIOTA

Chemistry data from the tissues of marine organisms will be tabulated for all measured analytes. In addition, ancillary data that will be reported in these tables include station numbers, sample identification numbers (corresponding to those on laboratory data sheets), the date of sample collection, age of organism, and the sampling interval (upper and lower depths within the sediments relative to the sediment-water interface). The results for field duplicate samples will be identified as such and reported separately (i.e., not averaged). Appropriate data qualifiers will be reported with the chemical concentrations. Detection limits will be included for undetected analytes.

9.2.1 Statistical Summary

To evaluate risks posed by marine biota to human health and ecological receptors as discussed in Volume I, it is necessary to develop descriptive statistics to describe the data set's central tendency and variability. In some cases, comparisons of data sets using inferential statistics can provide risk assessment with the ability to quantify exposure

differences among species, sites, or temporal periods. However, the risk assessment proposed for the former Rayonier Mill Site in Port Angeles relies primarily on the use of descriptive statistics to characterize the data set.

9.2.2 Calculation of Descriptive Statistics

EPA (1989) indicates risk assessments should be developed that represent a range of possible exposures that are based on the average of a data set. This is because the carcinogenic and noncarcinogenic toxicity criteria are based on lifetime average exposure, and thus, the average concentration is most representative of the concentrations that would be contacted at a site over time.

For example, if one assumes an exposed individual moves randomly across an exposure area, the spatially averaged soil concentration can be used to estimate true average concentrations contacted over time. While an individual may not actually exhibit a truly random pattern of movement across an exposure area, EPA notes the assumption that equal time spent in different parts of the area is a simple and reasonable approach.

Currently, two types of exposure estimates are typically calculated under a site-specific risk assessment. The average exposure is defined as the best estimate based on the existing data as to the long-term average concentration that a receptor may come into contact with. For this value, the arithmetic mean is proposed as the best estimate of exposure to a receptor randomly using the site. The second exposure scenario is referred to as the reasonable maximum estimate (RME) of the average concentrations. Because the average of the data set is only an estimate of the true population mean, the estimate has an error associated with it. This error can be quantified if the distribution of the data set is known. Thus, with typical data sets, a statistical distributional test is performed to identify the likely distribution of the data, and then a likely upper bound estimate of the average is developed.

With tissue data sets, the largest individual sample that can be collected is often too small for conclusive chemical analyses. Measurement of chemicals in tissue samples from certain species of crab is one example of this situation. Tissue collected from a total of four crabs must be composited to obtain a sample large enough for measurement of chemical concentrations in the tissue. If the mixing process is thorough, a physical averaging process takes place, and the concentration of the composited sample will accurately represent the average of the concentration of the individual crabs. However, extreme values in the data

set made up of composite samples are closer to the average than extremes of concentrations that were present in the original population of crab samples. Because each sample is an average, the 95th percentile of a data set of averages should approximate the 95 percent upper confidence limit. Because the sample size proposed for each species is small, the maximum concentration found for each chemical for a set of composite samples will be used as an approximation of the upper bound of the estimated average.