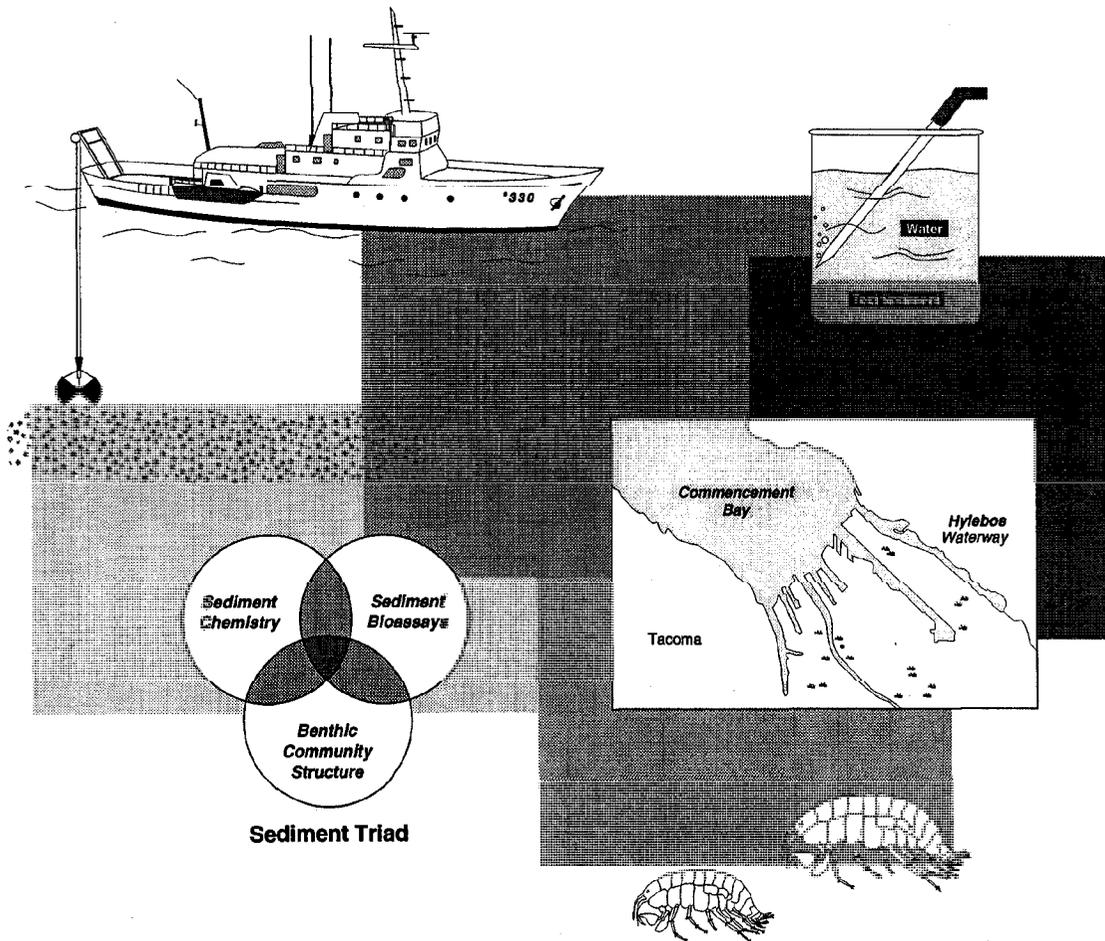


# COMMENCEMENT BAY DAMAGE ASSESSMENT STUDIES

# HYLEBOS WATERWAY DATA AND DATA ANALYSIS REPORT



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# **HYLEBOS WATERWAY DATA AND DATA ANALYSIS REPORT**

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## LIST OF ACRONYMS

ARI	Analytical Resources, Inc.
CBDAS	Commencement Bay Damage Assessment Study
COC	contaminant of concern
DGPS	differential global positioning system
DNR	Washington Department of Natural Resources
DOI	Department of the Interior
DW	dry weight
Ecology	Washington State Department of Ecology
ER	enrichment ratio
EVS	EVS Environment Consultants, Inc.
HCC	Hylebos Cleanup Committee
HPAH	high molecular weight polycyclic aromatic hydrocarbons
LOEL	lowest observed effects level
LPAH	low molecular weight polycyclic aromatic hydrocarbons
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OC	organic carbon
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PSDDA	Puget Sound Dredged Disposal Analysis
PSEP	Puget Sound Estuary Program
QA/QC	quality assurance/quality control
QAPP/LAP	quality assurance project plan/laboratory analysis plan
RI	remedial investigation
ROD	record of decision
SAP	sampling and analysis plan
SMS	sediment management standards
SQO	sediment quality objective
SQS	sediment quality standards
SVOC	semivolatile organic compound
TOC	total organic carbon
Trustees	Commencement Bay Natural Resources Trustee Council

VOC  
U.S. EPA

volatile organic compound  
U.S. Environmental Protection Agency

## 1.0 INTRODUCTION

The Hylebos Waterway (Figure 1-1) is one of the many waterways that compose the Commencement Bay Superfund site. During the Commencement Bay Near Shore/Tideflats remedial investigation (RI) conducted in 1985, the degree and spatial extent of chemical contamination, adverse biological effects, and potential threats to natural resources were assessed (Tetra Tech 1985). Subsequent efforts included a feasibility study that identified alternatives for sediment remedial action (Tetra Tech 1988) and development of sediment quality objectives (SQOs) based on sediment clean up goals (P11 1989). The results of past studies (Tetra Tech 1985; Striplin et al. 1995) indicate that sediments in the Hylebos Waterway are contaminated with a number of hazardous substances. Based on results of laboratory bioassay tests, these sediments may be toxic to natural resources. These previous data also indicate that the benthic community may be impacted. When compared to reference areas, statistically significant reductions in the abundance of various taxonomic groups, including crustaceans, polychaetes, and molluscs were apparent for many stations in the Hylebos Waterway (Tetra Tech 1985).

The Commencement Bay Natural Resource Trustee Council (Trustees) is concerned that hazardous substances present in the sediments of the Hylebos Waterway have caused and are continuing to injury to natural resources. Members of this council include the National Oceanic and Atmospheric Administration (NOAA), the U.S. Department of the Interior, including the U.S. Fish and Wildlife Service; the Washington Department of Ecology (Ecology), Washington Department of Natural Resources (DNR), the Puyallup Tribe of Indians, and the Muckelshoot Indian Tribe. The Trustees cooperatively initiated the Commencement Bay Damage Assessment Study (CBDAS) to assess natural resource injury for Commencement Bay. Between May 23 and June 1, 1994, as part of the CBDAS, the Trustees conducted an investigation that specifically addressed the natural resource injury issues for the Hylebos Waterway. The purpose of this investigation was to verify and further define the presence of hazardous substances in Hylebos Waterway sediments, to determine the potential toxicity associated with surficial sediments based on standardized bioassays, and to assess the status of benthic infauna communities. During this investigation, chemical analyses were used to further delineate the magnitude and extent of chemical contaminants within the upper strata of soft-bottom sediments, and laboratory bioassays were used to estimate the degree of toxicity associated with exposure to these surficial sediments.

Abundance and enumeration data were used to assess the status of benthic infaunal communities and to determine the extent to which benthic community structure may be injured from continued exposure to hazardous substances. The data generated in this investigation were interpreted as per the sediment quality triad methodology, an approach that utilizes a weight-of-evidence type analysis of sediment chemistry, toxicity results from laboratory bioassays, and benthic species abundance data to identify potential effects.

This report summarizes the data obtained during the Hylebos Waterway investigation conducted in the summer of 1994. The methods used during all phases of the project (i.e., field collection, chemical analyses, laboratory bioassays, and data analysis) will be reviewed. There were no deviations from the sampling and analysis plan (SAP; EVS 1994a).

## **2.0 SUMMARY OF THE STUDY DESIGN AND METHODS**

A detailed account of the study design can be found in the SAP (EVS 1994a), the combined quality assurance project plan/laboratory analysis plan (QAPP/LAP; EVS 1994b), and the laboratory procedures of the NOAA/National Marine Fisheries Service (NMFS) Montlake Laboratory (NOAA 1995). The SAP identifies the potential sampling locations for both the Hylebos Waterway and reference stations, methods of sample collection and handling, procedures for the chemical analysis of volatile organic compounds (VOCs) in sediments samples, laboratory bioassay procedures, benthic community analysis procedures, and proposed methods for data reduction, validation, and analysis. The QAPP/LAP contains explicit information for each procedure that was used during the investigation, as well as procedures to ensure that the data are of sufficient quality to be used in support of any litigation that might ensue from a natural resource damage assessment. NOAA and NMFS were the primary agencies involved in this investigation; technical support was provided by EVS Environment Consultants (EVS).

The surface sediment samples were collected from the Hylebos Waterway, Carr Inlet, and Commencement Bay between May 23 and June 1, 1994, and processed in accordance with the SAP and QAPP/LAP. Sections 2.1 through 2.6 of this data analysis report summarize the major aspects of the methods as provided in the SAP.

### **2.1 SAMPLING STATIONS**

A total of 32 stations were sampled for this study. Twenty-eight stations were in the Hylebos Waterway (Figure 2-1), two reference stations were in Carr Inlet (Figure 1-1), and two reference stations were along the north shore of Commencement Bay (Figure 1-1). Latitude and longitude coordinates for the sampling stations were established using the differential global positioning system (DGPS; Table 2-1).

## 2.1.1 Hylebos Waterway Stations

The Hylebos Waterway stations were selected on the basis of the following project objectives:

- To verify the presence and further delineate the distribution of contaminants of concern (COCs) and sediment problem areas. A sediment problem area is defined as an area in which the concentration of one or more hazardous substances is causing injury to natural resources, thereby reducing the level of services provided to other resources.
- To supplement the sediment chemistry studies undertaken by the Hylebos Cleanup Committee (HCC; Striplin et al. 1995), a consortium of responsible parties. Studies were conducted at the direction of the U.S. Environmental Protection Agency (U.S. EPA). Station locations were chosen to accomplish the following objectives: 1) to increase the spatial resolution of sediment quality by decreasing the distances among adjacent sampled sediment locations; 2) to collect bioassessment/injury data from areas not sampled previously; and 3) to further delineate the extent of previously identified problem areas.

The Hylebos Waterway was divided into six approximately equal-sized segments based on reach length (Figure 2-1). The segments are numbered 1 through 6, with Segment 1 located at the head of the waterway and Segment 6 located at the mouth. In general, these segments are comparable with those used in the RI.

Five stations were located in Segment 1 (Figure 2-1). All five stations were located near areas identified by historical data as exhibiting resource injuries based on toxicity and impacted benthic communities as documented in the RI (Tetra Tech 1985).

Five stations were located in Segment 2 (Figure 2-1). Stations were located near areas of known resource injury, as documented in RI data, or in areas where resource injury was suspected. Stations DAC-HY-21, DAC-HY-20, and DAC-HY-19 were located near the Elf Atochem facility; Stations DAC-HY-23 and DAC-HY-22 were located near the General Metals of Tacoma facility.

Four stations were located in Segment 3 (Figure 2-1) near areas of known resource injury, based on historical data. Station DAC-HY-18 was adjacent to the Hylebos Marina. Stations DAC-HY-18, DAC-HY-17, and DAC-HY-16 increased the spatial resolution of the data on

sediment quality; Station DAC-HY-15 was co-located with a station proposed by the HCC (Striplin 1994).

Two stations were located in Segment 4 (Figure 2-1). This portion of the waterway has historically contained relatively low concentrations of contaminants in surface sediment, and previous assessment of biological resources has indicated little adverse impact (Tetra Tech 1985). Station DAC-HY-14 was located near the area identified by historical data as an area of potential resource injuries (Tetra Tech 1985).

Six stations were located in Segment 5 (Figure 2-1), all near the Occidental Chemical Company facility. These stations were located near areas that were identified in the RI as exhibiting resource injuries, or in locations that would increase the spatial resolution of sediment quality in the segment. Station DAC-HY-09 was co-located with a station proposed by the HCC (Striplin et al. 1994).

Six stations were located in Segment 6 (Figure 2-1), where little historical data have been generated. All six stations were located near potential nearshore sources of contamination, including AK-WA Shipbuilding, Ole & Charlie's Marina, and the Commencement Bay Marina. Stations DAC-HY-03, DAC-HY-04, and DSC-HY-05 are co-located with stations utilized by the HCC (Striplin et al. 1994).

### **2.1.2 Reference Stations**

Reference sediment samples were collected from two stations in Carr Inlet and two stations on the north shore of Commencement Bay (Figure 1-1). Latitude and longitude coordinates for the reference stations are provided in Table 2-1. The Carr Inlet sediments were used as reference sediment for the toxicity tests. The Commencement Bay sediments were used as the reference benthic community and as the comparative basis for the abundance of major taxa found in Hylebos Waterway.

The two Carr Inlet reference stations were within 200 m of each other, located on the north side of Raft Island. Carr Inlet was chosen for reference sediment collection because it was recommended and approved by local regulatory agencies as a reference station for sediment bioassays. In addition, there is a substantial amount of historical data for this area that could be used in analysis of the chemical and biological test results. Only Carr Inlet sediments

were used as reference sediments in the laboratory toxicity tests. Reference sediments were used to account for bioassay test responses that may be due to natural characteristics of the sediment, such as sediment grain size or total organic carbon (TOC) content.

The Commencement Bay stations were located along the southern shore of Browns Point (Figure 1-1). Sediments were collected from two areas because each was predominated by different sediment grain-size characteristics. Grain size, TOC, and water depth were used to select the appropriate Commencement Bay reference stations for analysis of benthic abundance data. Sediments from the Commencement Bay reference stations were not used in the laboratory toxicity tests because they have been neither recommended nor approved by local regulatory agencies for that use.

## **2.2 SAMPLING METHODS**

A 0.1-m<sup>2</sup> van Veen grab sampler was used to collect all sediment samples submitted for chemical analysis and toxicity tests; a 0.06-m<sup>2</sup> van Veen was used for sediments submitted for benthic community analysis. A minimum of nine grab samples of surficial sediments was collected from each test and reference station. The uppermost 10 cm of surface sediment was removed from each sample with a stainless-steel spoon. Samples were placed into the appropriate containers and processed as specified in the SAP and QAPP/LAP. Four replicates were collected at each station for samples submitted for chemical analysis and bioassay testing; seven replicates were collected at each station for samples submitted for benthic community analysis. The sediment samples collected for benthic analyses were sieved through 1-mm screens while aboard the sampling platform. Organisms retained on the screen were placed into a jar and preserved with 10 percent buffered formalin. They were later identified to the lowest practical taxonomic level and enumerated at the laboratory.

## **2.3 LABORATORY ANALYSIS**

### **2.3.1 Sediment Conventional**

All sediment samples were analyzed for the following parameters: grain size, TOC, total solids, total volatile solids, ammonia, and sulfides. Analytical Resources Incorporated (ARI)

of Seattle, Washington, conducted these analyses in accordance with the procedures identified in the project plans (EVS 1994a,b; NOAA 1995).

### **2.3.2 Hazardous Substance Analysis**

The primary COCs included 12 trace elements, polychlorinated biphenyls (PCBs), 4 VOCs, and 18 semivolatile organic compounds (SVOCs) that were identified as COCs in the Commencement Bay Damage Assessment Phase I Report (EVS 1995). The substances measured in the current Hylebos Waterway study extended beyond these 35 compounds. Table 2-2 lists all analytes included in the CBDAS and the laboratory that performed the analyses. Analyses of the VOCs and selected chlorinated hydrocarbons were performed by ARI following the procedures specified in the QAPP/LAP (EVS 1994b). The NOAA/NMFS Northwest Fisheries Center in Seattle, Washington, analyzed the sediments for all analytes except VOCs. Analytical procedures used by the NMFS laboratory were specified by NOAA (1995). PCBs were analyzed by congener and were reported as total PCBs as well as by "chlorobiphenyl A/B," where A equals the number of chlorines and B equals the typical BZ number.

#### **2.3.2.1 Method Comparison**

Trace elements were analyzed by the NMFS laboratory using two different methods: strong acid digestion and total acid digestion. A discussion of both methods appears in the Puget Sound Estuary Program (PSEP) protocols (PSEP 1989). Because data in the past have been collected by both methods, these samples were used as an opportunity to determine whether the methods yielded substantial differences in results for the COCs for Commencement Bay. Only results based on the total acid digestion method were used in this study. Because the total acid digest is considered to provide a more exhaustive recovery of the metals and metalloids, the Trustees determined that only the results using this method would be used in the report. (The results of measurements made using both strong acid and total acid digests on the same samples are compared in Section 3.2.1.1.)

### **2.3.3 Toxicity Testing**

Three standardized sediment toxicity tests were conducted: a 10-day amphipod mortality test using *Rhepoxynius abronius*; a 20-day juvenile polychaete growth test using *Neanthes*

*arenaceodentata*; and a 48-hour echinoderm larval combined mortality test using *Dendraster excentricus*. Toxicity testing was conducted by EVS. PSEP (1991) and ASTM (1993) guidelines were followed for all bioassays, except for the deviations as noted in the project plans (EVS 1994a,b). Two of the toxicity tests used in the present study, the amphipod and the echinoderm larval test, are similar to the tests conducted during the RI (Tetra Tech 1985). Although the bivalve larval test was used in the RI, the echinoderm larval test was used in the current study because bivalve larvae were not available when the tests were performed. Comparable results from these two tests are expected for two reasons. First, local regulatory agencies consider the tests interchangeable, and review of the LC<sub>50</sub> data generated from reference toxicity tests indicates that the two groups have similar sensitivities. The LC<sub>50</sub> value is a tool used within the scientific community that allows the relative toxicities of contaminants to be compared. It represents the concentration of contaminant in water that is estimated to be lethal to 50 percent of the test organisms. The LC<sub>50</sub> is usually expressed as a time-dependent value (i.e., 96-hour or 10-day) to provide an estimate of toxicity at both the acute and chronic levels. The juvenile polychaete growth test was not used during RI, but was added to the CBDAS to be consistent with present requirements of the Washington State Sediment Management Standards (SMS; Ecology 1991).

Testing was conducted in two series for each bioassay to ensure that sediment holding times were not exceeded. For amphipod and polychaete bioassays, the first test series was conducted on sediment collected from 12 Hylebos Waterway stations; the second test series was conducted on sediment from the remaining 16 Hylebos Waterway stations and the two Carr Inlet reference stations. For the echinoderm larval tests, each test series was conducted on sediment from 15 stations. The two test series overlapped (i.e., the second test series was initiated before completion of the first test series), and the toxicity response data for the two reference sediments were used in all statistical comparisons for both test series.

Sediment from Carr Inlet served as the reference sediment for all laboratory toxicity tests. Control sediment was collected from West Beach, Whidbey Island, Washington.

### **2.3.4 Benthic Organism Identification and Abundance**

After preliminary processing in the field, the benthic infauna samples were delivered to the EVS Benthic Laboratory, Seattle, Washington, for identification and enumeration. Biota were sorted, identified, and enumerated according to the project plans (EVS 1994a,b). Of

the seven replicate samples collected at each station, four samples were randomly selected for analyses and the remaining three samples were archived.

Upon arrival in the laboratory, all samples were reinventoried and checked against the chain of custody forms. Samples were rinsed with fresh water to remove formalin and then rescreened with a 0.5-mm mesh to retain smaller organisms and fragments. All biota retained on the screen were stored in 70 percent ethanol until further processing. Taxonomists counted and identified all organisms to the lowest practical taxonomic level, which was generally species. Only the anterior portions of fragments were identified and counted.

The enumeration data were entered into a computerized database. Numeric abundance for the major classes of benthos (i.e., crustaceans, polychaetes, and molluscs) and total abundance data were determined for each station.

Quality assurance and quality control (QA/QC) was conducted for both sorting and taxonomy. In compliance with the methods provided in the SAP and QAPP/LAP (EVS 1994a,b), 20 percent of the samples were resorted by an independent processor to check for sorting efficiency and accuracy. Taxonomic QA/QC was achieved by independent re-identification of 5 percent of all samples.

## **2.4 DATA QUALITY AND STATUS SUMMARY**

EcoChem, Inc., Seattle, Washington, performed QA/QC review of all data. EcoChem provided validation reports for each of the categories of analyses conducted for this project. These validation reports (Appendix A) are the source for the data quality and status information presented in Appendix B. All data, as qualified, were found to be acceptable for use.

## **2.5 DATA ANALYSIS AND USE**

The data analysis approaches used during this study were similar to those used in the RI (Tetra Tech 1985). This approach permits direct comparison of data generated as part of this

study with results obtained during the RI, and evaluation of the status of resource conditions relative to those observed in 1984. Sediment chemistry data from each station were used with the sediment toxicity data and the benthic species abundance data to perform a sediment quality triad analysis, using a weight-of-evidence approach.

### **2.5.1 Hazardous Substances**

Concentrations of analytes were compared with the SQOs identified in the Commencement Bay Nearshore/Tideflats Record of Decision (ROD; EPA 1989). The data were also compared with the sediment quality standards (SQS) as defined in the Washington State sediment management standards (SMS). Exceedance of the SQS was considered indicative of injury to the sediment as defined by the U.S. Department of Interior (DOI) Natural Resource Damage Assessment regulations (43 CFR Part 11).

To allow comparison with SQS and SQO, the concentrations of organic compounds were normalized to both dry weight (DW) and organic carbon (OC) content. Two enrichment ratios (ERs), in which both the SQS and SQO were used as the criteria concentration, were calculated for each analyte detected at each station, according to the following equation:

$$ER = \frac{\text{normalized contaminant concentration}}{\text{criteria concentration}}$$

### **2.5.2 Toxicity Data**

Laboratory toxicity data were analyzed by the following process:

1. The results for each sample from the Hylebos Waterway was matched, on the basis of sediment grain size, to results for an appropriate Carr Inlet reference sediment.
2. Homogeneity of variance for these two data sets was tested using an F-test.
3. Based on the results of the test for homogeneity of variance, the appropriate *t*-test, which tests for equal or unequal variances, was used to determine the statistical significance between the Hylebos Waterway data set and the data set for the selected reference station.

This approach is consistent with that used for analysis of the RI data (Tetra Tech 1985).

### **2.5.3 Benthic Data**

Benthic taxonomic and abundance data were analyzed by the following process:

1. The results for each sample from the Hylebos Waterway was matched, on the basis of sediment grain size, TOC, and water depth, to the results for an appropriate Commencement Bay reference sediment.
2. Abundance data for the major classes of benthos as well as total abundance data were log-transformed.
3. Numeric abundance for major classes of benthos and total abundance data for the Hylebos Waterway and the appropriate reference stations were statistically compared with a *t*-test.

The approach used to analyze the benthic data is consistent with that used for analysis of the RI data (Tetra Tech 1985).

### **2.5.4 Sediment Quality Triad Analysis**

The sediment quality triad analysis was used to evaluate the impact of chemical contamination in the Hylebos Waterway. The sediment quality triad uses a weight-of-evidence approach to assess the effects of contamination by combining chemical and biological measurements (Chapman 1992). Three complementary measures are used to identify pollution-induced degradation: sediment chemistry to determine contamination, sediment bioassays to determine toxicity, and *in situ* bioeffects (e.g., benthic infaunal community structure) to determine alteration of resident communities. The combination of these three separate measures allows for the differentiation of effects related to contamination from natural variability and/or laboratory artifacts. In general, impacted or degraded habitats are those which have positive "hits" for all of the three measures. Summary statistics for the triad approach commonly include rankings or an index of severity for the respective measurement parameters, ratio-to-reference values, and generation of triaxial plots for the different indices. This process permits a station-by-station analysis to establish whether conditions at the station are degraded and whether the degradation is consistent among the independent measures.

In conducting the triad analysis for the CBDAS, stations were placed into one of three classifications — adversely affected, potentially adversely affected, or not adversely affected — based on a qualitative evaluation of the data from each station. The following definitions were used; a classification matrix is shown in Table 2-3:

- **Adversely Affected** — The data from a station included contaminants at concentrations that were elevated above the SQS, the sediments were toxic in at least one of the three tests, and there were significant reductions in at least one of the abundance indices.
  
- **Potentially Adversely Affected** —
  - A) The data from a station included contaminants at concentrations that were elevated above the SQS and exhibited either toxicity in at least one of the toxicity tests or significant reduction in at least one of the abundance indices.
  
  - B) The data from a station did not include any contaminants at concentrations above the SQS, but exhibited either toxicity in at least one of the toxicity tests or significant reduction in at least one of the abundance indices. This status is assigned to stations that exhibited impact but whose measured contaminants did not exceed the SQS, because not all potential contaminants are analytically measured, and the responses measured during toxicity testing or analysis of benthic abundance data may be due to one of these unmeasured contaminants.
  
- **Not Adversely Affected** — The data from a station includes contaminants at concentrations above or below the SQS or SQO, but there were no significant responses observed in any of the toxicity tests, nor any significant reduction in any of the benthic abundance indices.

## 3.0 RESULTS

The results are summarized separately for each parameter measured, beginning with the analytical data. Because of the vast amount of data generated during this study, summary tables have been prepared and are presented in this section. Detailed data reports are presented in Appendices C, D, and E.

### 3.1 SEDIMENT: CONVENTIONAL PARAMETERS

The highest fractions of silt and clay were found in sediments from the head of the Hylebos Waterway; the mouth of the waterway was predominantly sand (Table 3-1). Sediments at the four reference stations covered a wide range of grain-size composition; sediments with high fractions of silt and clay (i.e., fines, consisting of particles which pass through a 62.5  $\mu$  mesh) were found in both Carr Inlet and Commencement Bay. A summary of all conventional parameters measured is provided in Table 3-2 for surface sediments from the Hylebos Waterway, and Table 3-3 for surface sediments from Carr Inlet and Commencement Bay.

### 3.2 HAZARDOUS SUBSTANCES

Analytical results for trace elements and organotin compounds measured in sediments from the reference stations are provided in Table 3-4; comparable results for organic compounds measured in the reference sediment samples are provided in Table 3-5. None of the analytes exceeded their respective SQS or SQO concentrations at either the Carr Inlet or Commencement Bay reference stations. Monobutyltin and tetrabutyltin were not detected at any of the reference stations. Dibutyltin (19.9  $\mu\text{g}/\text{kg}$ ) and tributyltin (25.5  $\mu\text{g}/\text{kg}$ ) were both detected at Reference Station DAC-HY-30 (Table 3-4). There are no SQS or SQO for organotin compounds. Nearly all of the SVOCs were detected in the reference station sediments, but none of these compounds were found at concentrations that exceeded SQS or SQO concentrations. None of the VOCs were detected in any of the reference stations sediments (Table 3-5).

Analytical results for trace elements and organotin compounds for the Hylebos Waterway sediment samples are summarized in Table 3-6 and Table 3-7. Table 3-6 presents results obtained by the total acid digestion method; Table 3-7 presents results obtained by the strong acid digestion method. These tables provide information on the frequency of detection; minimum, median, and maximum concentration normalized to both dry weight and organic carbon content; the SQO and SQS concentrations, and the frequency of exceeding these values. Comparable data for organic compounds in the Hylebos Waterway sediment samples are presented in Table 3-8. Figure 3-1 shows which analytes were detected at concentrations exceeding the SQS and SQO on a station-by-station basis. No reference stations are depicted in Figure 3-1 because there were no exceedances at these stations.

Detailed results for each sediment sample, along with appropriate qualifiers are provided in Appendix C. No significant data quality issues were identified by the QA/QC review of the data (see Appendix B).

### **3.2.1 Trace Elements and Organotin Compounds: Comparison to Criteria**

In the Hylebos Waterway samples, mercury was detected at 1 of 28 stations (Table 3-6), but the measured concentration was below both the SQS and SQO. However, the detection limits for mercury exceeded the SQS in eight samples and the SQO in six samples (Appendix C); all of these samples were collected from Segments 1 and 2. Cadmium was detected at 21 of the 28 stations, but none of the measured concentrations exceeded the SQS and SQO. The remainder of the trace elements were detected at all 28 Hylebos Waterway stations, but only arsenic and zinc were found at concentrations exceeding the criteria concentrations. Arsenic exceeded both the SQS and SQO at three stations in Segment 1; zinc exceeded both the SQS and SQO at one station in Segment 2 and one station in Segment 3 (Figure 3-1).

Neither monobutyltin nor tetrabutyltin were detected in sediments from any of the Hylebos Waterway stations. Dibutyltin was detected at 24 of the 28 stations, and tributyltin was detected at all 28 stations (Table 3-6). Concentrations of tributyltin ranged from 14.9 to 238  $\mu\text{g}/\text{kg}$  DW. There is no SQS or SQO for tributyltin, although concentrations at 26 of 28 Hylebos Waterway stations exceeded the Puget Sound Dredged Disposal Analysis (PSDDA) screening concentration of 30  $\mu\text{g}/\text{kg}$  DW.

### **3.2.1.1 Trace Element Method Comparison**

Total-to-strong acid ratios calculated for the trace elements analyzed in this study are presented in Appendix C. For most trace elements the concentrations generated by the total acid method were higher than that generated by the strong acid method by a factor of about 1.2, as shown below:

#### **Average of total to strong acid ratios:**

- Antimony — 5.85
- Arsenic — 0.82
- Cadmium — 1.07
- Chromium — 1.14
- Copper — 1.09
- Lead — 1.32
- Mercury — 0.85
- Nickel — 1.49
- Silver — 0.75
- Zinc — 1.17

As measured by total acid digestion, arsenic concentrations exceeded the SQS at three stations and exceeded the SQO at three stations; zinc concentrations exceeded the SQS at two stations and exceeded the SQO at two stations (Table 3-6). In comparison, as measured by strong acid digestion, arsenic and zinc concentrations exceeded SQS at one station and the SQO at one station (Table 3-7). These data indicate that for most elements analyzed, both methods yield comparable results.

### **3.2.2 Organic Compounds: Comparison to Criteria**

Table 3-8 summarizes the concentrations of organic compounds in surface sediments collected from the Hylebos Waterway. All polycyclic aromatic hydrocarbons (PAHs) on the analyte list were detected at all 28 of Hylebos Waterway stations, but none of the concentrations exceeded SQS. However, the concentrations of anthracene and phenanthrene exceeded their SQO. There was at least one exceedance of SQO for each of the high molecular weight PAHs (HPAHs), but no exceedances of SQS. All exceedances occurred in Segments 1 and 2 (Figure 3-1). All HPAH compounds were detected at Station DAC-HY-24 (Segment 1) at concentrations exceeding the SQO.

All of the measured phenols except 2-methylphenol were detected at all of the Hylebos Waterway stations. Only pentachlorophenol exceeded the SQS and SQO, at one station in Segment 5 (DAC-HY-09).

Concentrations of 1,4-dichlorobenzene exceeded the SQS at two stations, and concentrations of 1,2,4-trichlorobenzene exceeded the SQS at 15 stations and the SQO at 4 stations (Figure 3-1). The concentration of neither 1,3- nor 1,2-dichlorobenzene exceeded SQS or SQO at any station.

Hexachlorobutadiene was detected at all 28 Hylebos Waterway stations. Concentrations exceeded both the SQS and SQO at five stations in Segments 5 and 6 (DAC-HY-06 through -10). With the exception of Station DAC-HY-17, the concentration of hexachlorobutadiene exceeded the SQO at all stations in Segments 2 through 6 (Figure 3-1).

Concentrations of bis(2-ethylhexyl)phthalate exceeded the SQS at Station DAC-HY-09, and the SQO at Station DAC-HY-24 (Figure 3-1). Concentrations of butylbenzylphthalate exceeded the SQS at Station DAC-HY-23 in Segment 2 (Figure 3-1). No other phthalates exceeded SQS or SQO concentrations.

All pesticides, except for aldrin, were detected at most of the Hylebos Waterway stations. Concentrations of hexachlorobenzene exceeded the SQS at 21 of 28 stations, and the SQO at 12 of 28 stations. The exceedances of the SQS occurred at every station mouthward of and including Station DAC-HY-21, which is midway in Segment 2 (Figure 3-1). Sediments from all stations in Segment 5 contained hexachlorobenzene at concentrations exceeding the SQO. The remaining exceedances occurred at various stations throughout the Hylebos Waterway.

Concentrations of p,p'-DDE exceeded the SQO at three stations, and concentrations of p,p'-DDD exceeded the SQO at two stations. All five exceedances occurred in Segment 1 (Figure 3-1). p,p'-DDT was detected at nearly all Hylebos Waterway stations, but none of the measured concentrations exceeded the SQO criterion. There are no SQS criteria for DDT or its metabolites. No SQS or SQO criteria exist for the other pesticides. The only comparison criteria available are the PSDDA screening guidelines; there were no exceedances of these concentrations for other pesticides.

PCBs were detected in all sediment samples from the Hylebos Waterway. Total PCBs were determined by measuring the concentrations of 17 chlorobiphenyl congeners, summing the concentrations, and multiplying by 2, as specified in NOAA (1995). The concentration of total PCBs determined in this manner exceeded the SQS at 19 of the 28 Hylebos Waterway stations, but did not exceed the SQO at any station (Figure 3-1). Segment 1 was the only segment that had no samples with total PCB concentrations exceeding the SQS.

Trichloroethene was the only VOC detected in any sample. It was measured in sediments from one station, but the SQO was not exceeded. Currently no SQS concentrations exist for VOCs.

### 3.3 TOXICITY TESTING

Sufficient sediment was collected from all 28 Hylebos Waterway stations and the two Carr Inlet reference stations to conduct the three standardized laboratory toxicity tests. Sediment from Carr Inlet Station DAC-CR-2 was used as reference sediment in all bioassay tests conducted on sediments collected from Hylebos Waterway Stations DAC-HY-01, -02, -06, -07, -13, -14, and -22. Sediment from Carr Inlet Station DAC-CR-2A was used as reference sediment in all bioassay tests for the remaining Hylebos Waterway stations. Sediment grain size was the criterion used to select the appropriate reference station for each Hylebos Waterway station. The tests proceeded without incident, and no major data quality issues were identified by the QA/QC review of the data (see Appendix B). Those stations at which toxicity was observed, following the criteria of Section 2.6.2 and the SAP, are summarized in Figure 3-2. No stations had sediments that were toxic in all three laboratory bioassays. Sediments from Stations DAC-HY-04, -05, -10, and -24 were toxic in both the amphipod mortality and echinoderm larval tests. The laboratory bioassay data sheets are provided in Appendix D.

#### 3.3.1 Amphipod Mortality Test

Results of the 10-day mortality test with the amphipod *Rhepoxynius abronius* are presented in Table 3-9 for Carr Inlet reference stations and the control stations and in Table 3-10 for Hylebos Waterway stations. Mean mortality in the West Beach control sediment (Table 3-9) was 3 and 7 percent for the two test series, respectively. Mortality in the controls was below

the acceptability limit of 10 percent. Therefore, the amphipod bioassay tests were considered successful.

Mean mortality in the two Carr Inlet reference sediment samples was 14 and 15 percent, for Stations DAC-CR-2 and DAC-CR-2A, respectively. The percent mortality determined for reference sediment sample DAC-CR-2A is based on only four replicate samples rather than five as were used in all other tests, because an unusually high mortality of 90 percent was observed in one of the five replicates when compared to the mortality observed in the other four replicates (i.e.,  $\bar{x}$  = 15 percent). For this report, the one replicate with high mortality was considered an outlier datum and was not included when calculating the mean mortality for Station DAC-CR-2A, nor subsequently when making statistical comparisons with Hylebos Waterway sediment toxicity test data.

Table 3-10 summarizes mean percent mortality measured for each Hylebos Waterway station, the reference station used in the statistical comparison, and whether mortalities were significantly different than reference. Mean mortality for all tests conducted with Hylebos Waterway sediment ranged from 3 percent for sediments from Station DAC-HY-14 to 44 percent for sediments from Station DAC-HY-10. Sediments from six stations exhibited statistically significant mortality when compared to results from reference sediments. Most of these stations are located in Segments 5 and 6.

### **3.3.2 Echinoderm Larval Combined Mortality Test**

Results of the 48-hour echinoderm larvae (*Dendraster excentricus*) combined mortality test are presented in Table 3-9 for Carr Inlet reference stations and control stations, and Table 3-11 for Hylebos Waterway stations. Combined mortality in the seawater control ranged from approximately -20 percent to -6 percent, while the combined mortality in the sediment control ranged from -1 percent to approximately -17 percent (Table 3-9). Negative mortality results when the number of larvae counted at the end of the exposure period is greater than the number of fertilized eggs that were estimated to have been originally placed into the exposure chamber. Larval density was estimated at the start of the test by counting the number of larvae in a well-mixed sample from the batch of fertilized eggs used to initiate the test exposures. Established protocols do not address the issue of overseeding; according to the acceptability criteria, these echinoderm larval tests were successful.

Table 3-11 summarizes mean percent combined mortality measured for each Hylebos Waterway station, the reference station used in the statistical comparison, and whether combined mortalities were significantly different than reference. Combined mortality for all tests conducted with Hylebos Waterway sediment ranged from -28 percent for Station DAC-HY-21 to 57 percent for Station DAC-HY-20. Of the 28 Hylebos Waterway sediment samples tested, 10 samples were found to exhibit a statistically significant increase in combined mortality when compared to the appropriate reference sediment. Significant mortalities were found for sediments collected from all segments of the Hylebos Waterway.

### **3.3.3 Juvenile Polychaete Growth Test**

Results of the 20-day juvenile polychaete (*Neanthes arenaceodentata*) growth test for Carr Inlet reference stations are presented in Table 3-9; data for the Hylebos Waterway stations are presented in Table 3-12. Table 3-12 summarizes mean individual biomass measured for each Hylebos Waterway station, the reference station used in the statistical comparison, and whether measured mortalities were significantly different than reference. Mean end-of-test biomass of juvenile worms maintained in control sediment ranged from 9.7 to 11.7 mg DW, while the end-of-test biomass of worms from the reference sediments ranged between 9 and 10 mg DW. Mean biomass of juvenile worms exposed to Hylebos Waterway sediments ranged from 7 to 14 mg DW. There were no statistical differences in the biomass of worms exposed to in Hylebos Waterway sediment when compared to the appropriate reference sediment.

## **3.4 BENTHIC ABUNDANCE**

### **3.4.1 Total Abundance**

The total abundances of benthic organisms in sediment from the Hylebos Waterway stations and Commencement Bay reference stations are presented in Table 3-13. The occurrence of statistically significant depressions in total benthic abundances are also summarized in Table 3-13. A complete listing of the species found and their densities is provided in Appendix E. Table 3-14 provides the data for grain size, TOC, and depth, which were used to pair the Hylebos Waterway station with the appropriate Commencement Bay reference station, and the results of the pairing process. Sediments from Commencement Bay Station DAC-HY-35

were used as reference sediments in the benthic invertebrate analysis for Hylebos Waterway Stations DAC-HY-01, -02, -03, -04, -05, -06, -07, -09, -12, -13, -14, -17, and -23. Sediments from Commencement Bay Station DAC-HY-30 were used as reference sediment for the remaining Hylebos Waterway stations. Statistical comparisons for individual abundances of crustaceans, molluscs, and polychaetes are tabulated in Tables 3-15, 3-16, and 3-17, respectively.

When compared to the appropriate Commencement Bay reference station, the total abundances of benthic organisms were statistically lower at 22 of the 28 stations located in Hylebos Waterway. Stations where total abundance exceeded the total abundance at the reference station are shown in Figure 3-3. Of the six stations at which the total benthic abundance was not significantly depressed, one station was in Segment 1, four stations were in Segment 2, and one station was in Segment 3. Total benthic abundance was statistically lower than reference at all stations in Segments 4 and 5.

### 3.4.2 Crustacean Abundance

The mean abundance of crustaceans at the Commencement Bay reference stations were approximately 1,083 and 1,466 individuals per m<sup>2</sup> (Table 3-15), while the mean abundance at Hylebos Waterway stations ranged from approximately 33 to 1,229 per m<sup>2</sup> (Table 3-15). Crustaceans represented between 5 and 18 percent of the total abundance of benthic organisms in reference area samples, whereas crustaceans were less abundant, ranging from >1 percent to approximately 9 percent in the Hylebos Waterway benthic communities.

Numerically abundant benthic crustaceans found at the reference stations include the ostracods *Euphilomedes carcharodonta* and *E. producta*, the amphipod *Rhepoxynius abronius*, and the pinnotherid crab *Pinnixa schmitti*. Numerically abundant benthic crustaceans found in the Hylebos Waterway include the ostracods *Euphilomedes carcharodonta* and *E. producta*, the tanaid *Leptochelia savignyi*, and the cumacean *Eudorella pacifica*.

Results of the statistical comparisons for abundance of crustaceans found in Hylebos Waterway sediments relative to reference sediments are found in Table 3-15. The abundance of crustaceans was statistically lower at 23 of the 28 stations located in the Hylebos

Waterway. Stations where abundance of crustaceans exceeded that of the reference stations are shown in Figure 3-3.

### 3.4.3 Molluscan Abundance

The mean abundance of molluscs for the Commencement Bay reference stations were approximately 937 and 2,087 per m<sup>2</sup> (Table 3-16). The mean abundance of molluscs from the Hylebos Waterway stations ranged from approximately 125 to 4,204 per m<sup>2</sup> (Table 3-16). Molluscs represented between 3 and 50 percent of the total abundance of benthic organisms in reference area samples. Molluscs in the Hylebos Waterway samples accounted for approximately 2 to 39 percent of the total abundance of benthic organisms.

Numerically abundant benthic molluscs found in the Hylebos Waterway include the bivalve molluscs *Axinopsida serricata*, *Lyonsia californica*, and *Psephidia lordi* and the gastropod *Turbonilla* sp. Numerically abundant molluscs found at the reference stations include *Crepidatella lingulata*, *Parvilucina tenuisculpta*, and *Turbonilla* sp.

Results of the statistical comparisons for abundance of molluscs found in Hylebos Waterway sediments relative to reference sediments are found in Table 3-16. The abundance of molluscs was statistically lower at 14 of the 28 stations located in the Hylebos Waterway. Stations where abundance of molluscs exceeded reference are shown in Figure 3-3.

### 3.4.4 Polychaete Abundance

The mean abundance of polychaetes for the Commencement Bay reference stations was approximately 13,970 and 16,012 per m<sup>2</sup> (Table 3-17). The mean abundance of polychaetes from the Hylebos Waterway stations ranged from approximately 1,575 to 17,496 per m<sup>2</sup> (Table 3-17). Polychaetes represented between 30 and 86 percent of the total abundance of benthic organisms in reference area samples. Polychaetes in the Hylebos Waterway samples accounted for approximately 55 to 98 percent of the total abundance of benthic organisms.

Numerically abundant polychaetes found at the reference stations include the cirratulid *Aphelochaeta* sp., the spionid *Prionospio steenstrupi*, and the lumbrinerid *Scoletoma luti*. Numerically abundant polychaetes found in the Hylebos Waterway include the cirratulids

*Aphelochaeta* sp. and *Chaetozone acuta*, the spionids *Polydora socialis* and *Prionospio steenstrupi*, the lumbrinerids including *Scoletoma luti*, and the sabellid *Euchone limnicola*.

Results of the statistical comparisons for abundance of polychaetes found in Hylebos Waterway sediments relative to reference sediments are found in Table 3-17. The abundance of polychaetes was statistically lower at 21 of the 28 stations located in the Hylebos Waterway. Stations where abundance of polychaetes exceeded reference are shown in Figure 3-3.

## 4.0 DATA ANALYSIS

The chemistry, toxicity, and benthic abundance data for Hylebos Waterway sediments were analyzed using the sediment quality triad approach. The first step in the analysis was to calculate ERs for each compound that exceed either the SQS or the SQO criteria (Table 4-1). Using the sediment chemistry data which consist of exceedances of SQS and SQO criteria and ER values, laboratory bioassay results, and benthos data, the stations were placed into one of three classifications — adversely affected, potentially adversely affected, or not adversely affected — as defined in Section 2.5.4. The results of this classification, based on the sediment quality triad rankings (Table 4-2), indicate that one station was classified as not adversely affected, 15 stations were classified as potentially adversely affected, and 12 stations were classified as adversely affected. The majority of stations that were classified as adversely affected were located in Segments 1 and 5.

## 5.0 SUMMARY

Between May 23 and June 1, 1994, surface sediment samples were collected from 28 locations in Hylebos Waterway, 2 reference stations in Carr Inlet, and 2 reference locations in Commencement Bay. Sediment samples were submitted for chemical analysis, laboratory toxicity testing, and benthic invertebrate enumeration. Results were compared with chemical and biological SQS, and with chemical criteria presented in the ROD (U.S. EPA 1989). Chemical, bioassay, and benthic data were used to perform a sediment quality triad analysis. Data quality evaluations were performed on all data. No significant data quality issues were found for either the chemical or biological data. All data, as qualified, were acceptable for use.

### 5.1 TRACE ELEMENTS AND ORGANOTIN

Arsenic concentrations exceeded both SQS and SQO concentrations at three stations in Segment 1, at the head of the waterway. Zinc concentrations exceeded the SQS and SQO at one station in Segment 2 and at one station in Segment 3. Mercury was detected at one station, but the concentration did not exceed either the SQS or SQO. Detection limits for mercury exceeded the SQS for eight samples and exceeded the SQO for five samples. No other trace elements were detected at concentrations exceeding either SQS or SQO concentrations.

Monobutyltin and tetrabutyltin were not detected at any Hylebos Waterway stations; dibutyltin was detected at 24 of 28 stations; tributyltin was detected at all 28 stations. Tributyltin concentrations exceeded the PSDDA screening level of 30  $\mu\text{g}/\text{kg}$  dry weight at 26 of the 28 stations.

None of the trace elements or organotin compounds in sediments collected from either the Carr Inlet or Commencement Bay reference stations exceeded the SQS or SQO.

## 5.2 ORGANIC COMPOUNDS

PAHs were detected at all 28 Hylebos Waterway stations. No concentrations exceeded respective SQS concentrations. LPAH concentrations exceeded the SQO concentrations at two stations in Segment 2, and HPAH concentrations exceeded the SQO concentrations at eight stations in Segments 1 and 2. All ERs were less than 2, except for fluoranthene, which was 2.44 at Station DAC-HY-22.

Exceedances of SQS and SQO concentrations by phthalates and phenols were limited to a small number of compounds at a few stations. SQO concentrations of p,p'-DDD and p,p'-DDE were exceeded at four stations in Segment 5, and all exceedance ratios were less than 1.5.

Hexachlorobenzene concentrations exceeded the SQS at 21 stations: from Station DAC-HY-1, located at the mouth of Hylebos Waterway, through Station DAC-HY-21, located midway in Segment 2. Hexachlorobenzene concentrations exceeded the SQO at 12 Hylebos Waterway stations; these included six stations in Segment 5 and six stations throughout the remaining segments of the waterway. Concentrations of 1,2,4-trichlorobenzene exceeded the SQS at 15 stations and exceeded the SQO at four stations. Concentrations of 1,4-dichlorobenzene exceeded the SQS at two stations.

Hexachlorobutadiene concentrations exceeded both the SQS and SQO at Stations DAC-HY-06 through DAC-HY-10. Hexachlorobutadiene concentrations exceeded only the SQO at all other stations mouthward of DAC-HY-24, with the exception of DAC-HY-17.

Although total PCBs did not exceed the SQO concentration at any Hylebos Waterway station, the SQS was exceeded at 19 of the 28 stations, distributed in all segments except Segment 1.

None of the organic compounds in sediments collected from either the Carr Inlet or Commencement Bay reference stations exceeded the SQS or SQO.

### **5.3 TOXICITY TESTING**

In amphipod mortality bioassays, statistically different percent mortalities were observed for the following six stations: DAC-HY-04, -05, -08, -10, -12, and -24. Station DAC-HY-24 was near the head of the waterway; the remainder were near the mouth.

Statistical differences in echinoderm combined mortality was observed at 10 of the 28 Hylebos Waterway stations. There were no statistical differences in growth of juvenile polychaete worms exposed to Hylebos sediments when compared to the appropriate reference sediment.

### **5.4 BENTHIC ABUNDANCE**

Total benthic abundance was statistically lower at 22 of the 28 stations when compared to the appropriate reference station. Total benthic abundance was not depressed in Segments 4, 5, and 6, which are located near the head of the waterway.

Numerically, crustaceans accounted for up to 9 percent of the Hylebos Waterway benthic community. Crustacean abundance was statistically lower at 23 of the 28 Hylebos stations when compared to the appropriate reference station. The five stations where abundance of crustaceans was not depressed were distributed irregularly throughout the Hylebos Waterway.

Polychaetes accounted for approximately 55 percent to 98 percent of the Hylebos Waterway benthic population. Polychaete abundance was statistically lower at 21 of the 28 Hylebos stations when compared to the appropriate reference station. These 21 stations were distributed among all of the waterway segments.

Molluscs represented up to 50 percent of the Hylebos Waterway benthic population. Molluscs abundance was statistically less at 14 of the 28 Hylebos stations when compared to the appropriate reference station. Significant depressions of molluscan abundance occurred primarily in Segment 1, at the head of the waterway, and in Segments 5 and 6, at the mouth of the waterway.

## 5.5 SEDIMENT QUALITY TRIAD ANALYSIS

Sediment quality at each of the Hylebos Waterway stations was evaluated by a triad approach that took into account the results of chemical analyses, toxicity tests, and benthic enumeration. Stations were classified as adversely affected, potentially adversely affected, or not adversely affected. The results of this classification were as follows: one station was classified as not adversely affected, 15 stations were classified as potentially adversely affected, and 12 stations were classified as adversely affected. Each of the 6 waterway segments contained at least one station that was classified as adversely affected.

## 6.0 REFERENCES

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## FIGURES

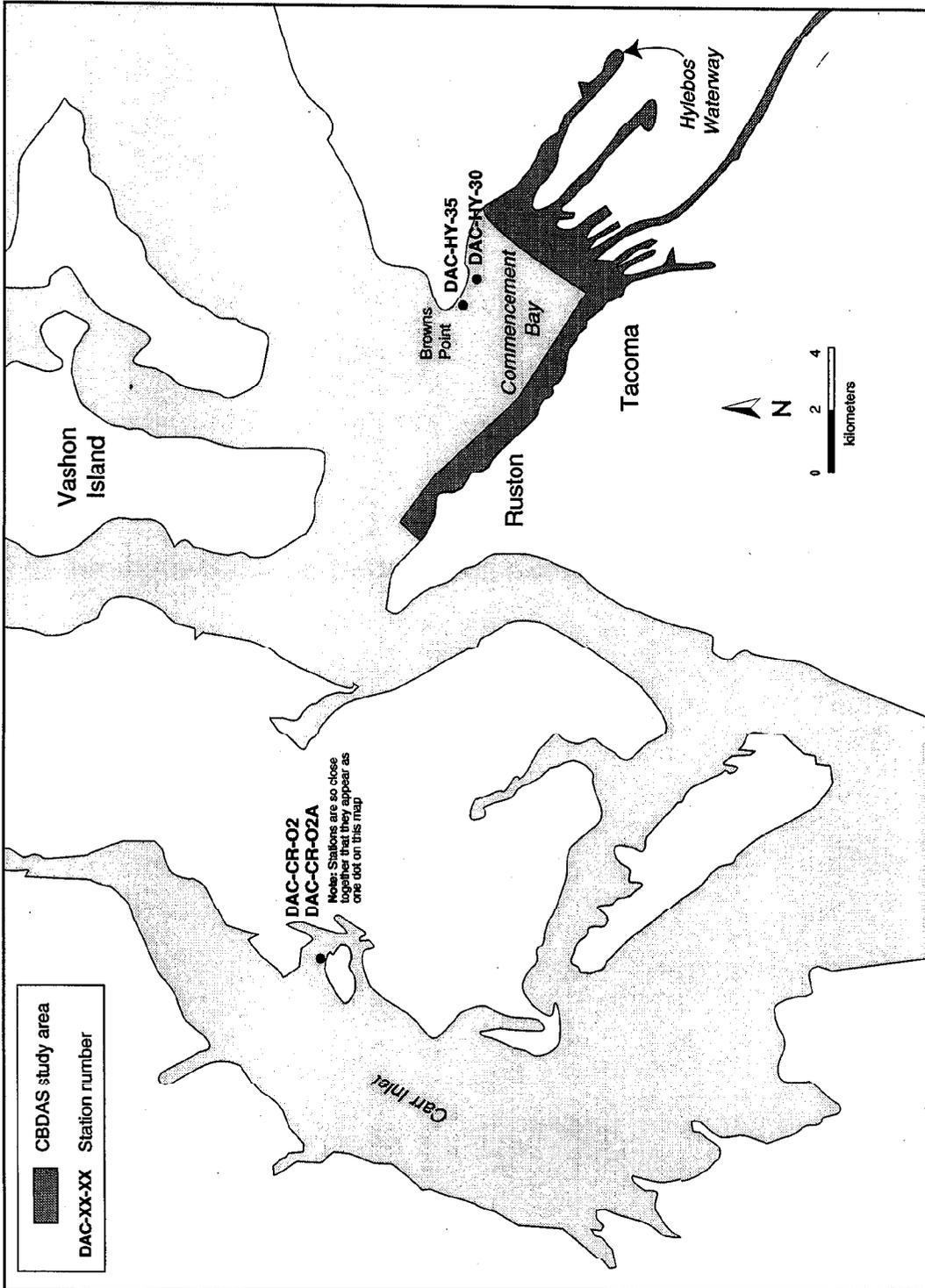


Figure 1-1. South and southcentral Puget Sound; locations of the CBDAS, the Hylebos Waterway, and reference stations in Carr Inlet and Commencement Bay.

Figure 2-1. Approximate station locations and locations of selected industries in Hylebos Waterway.

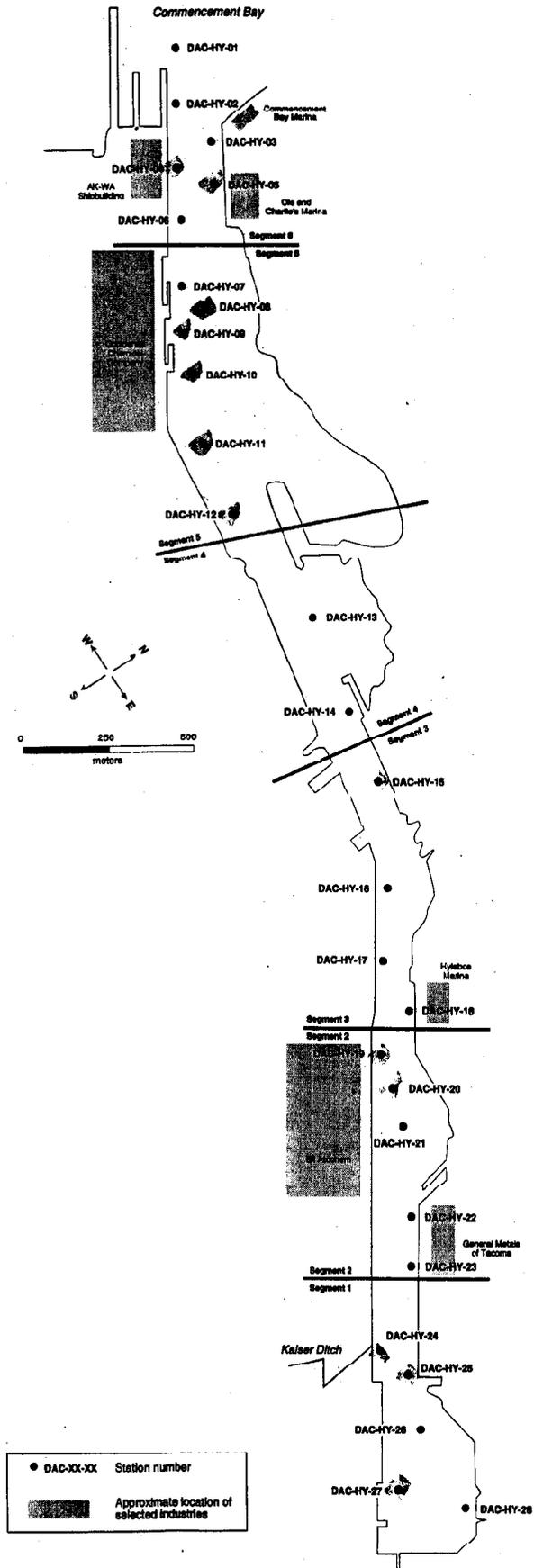


Figure 3-1. Contaminants of concern that exceeded SOS and/or SOO concentrations at Hybeos Waterway stations.

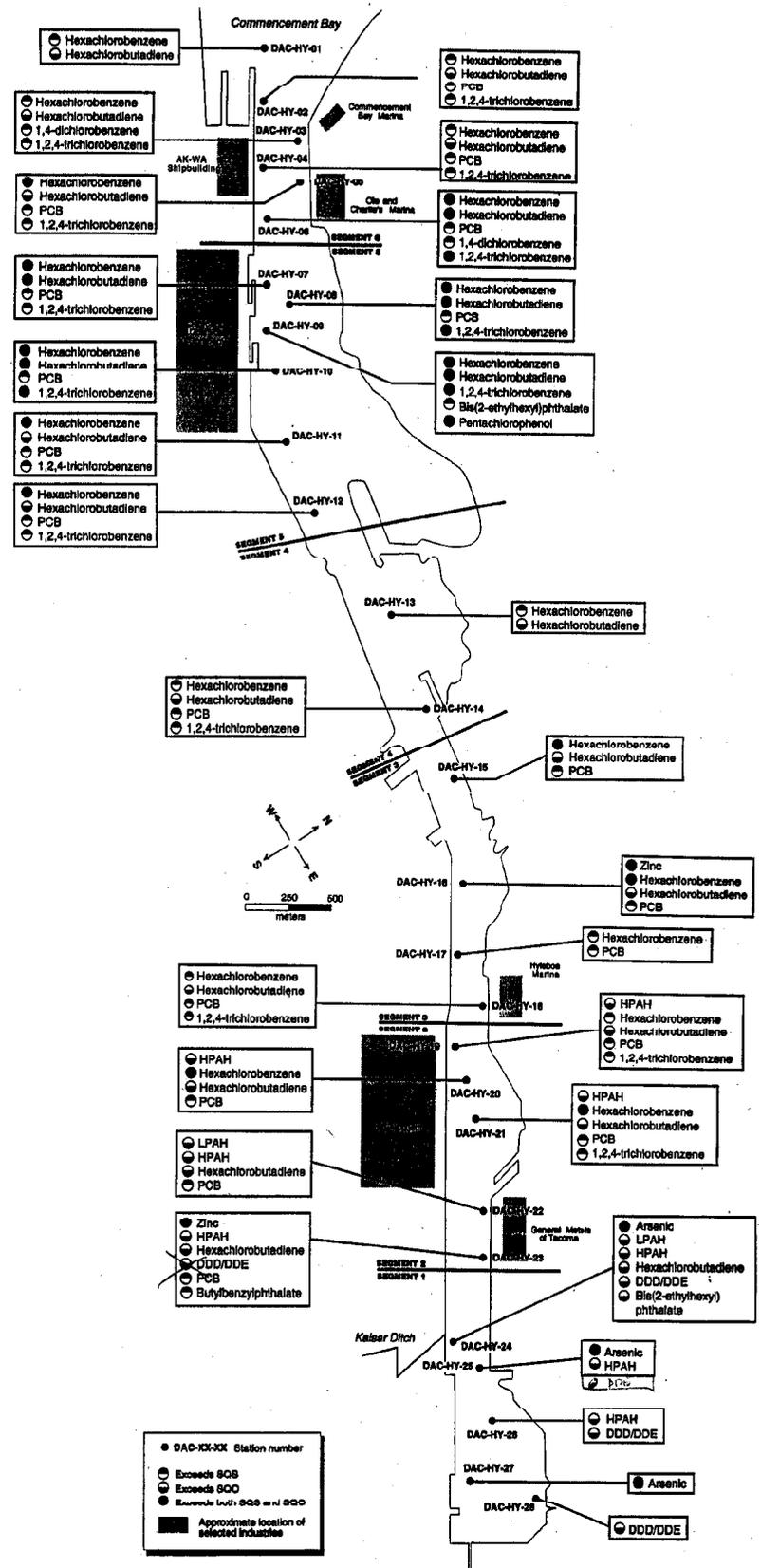


Figure 3-2. Summary of toxicity test results and locations of selected industries in Hylebos Waterway.

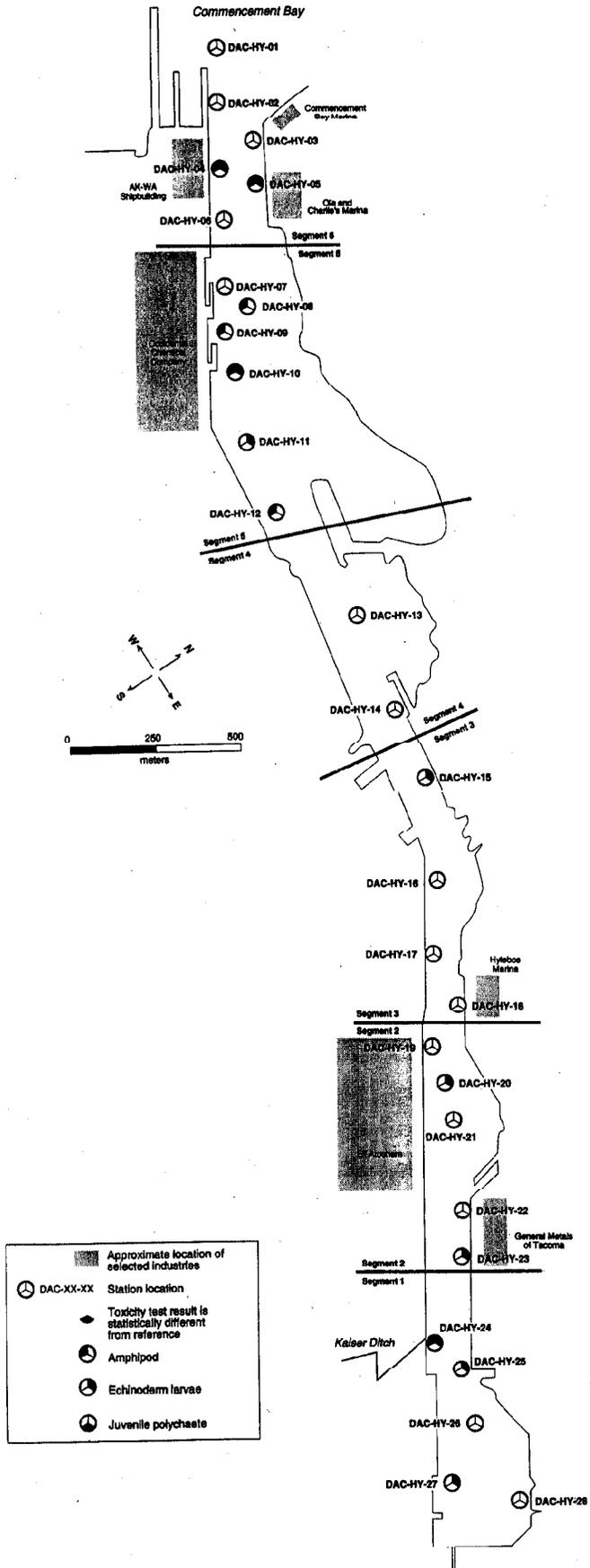
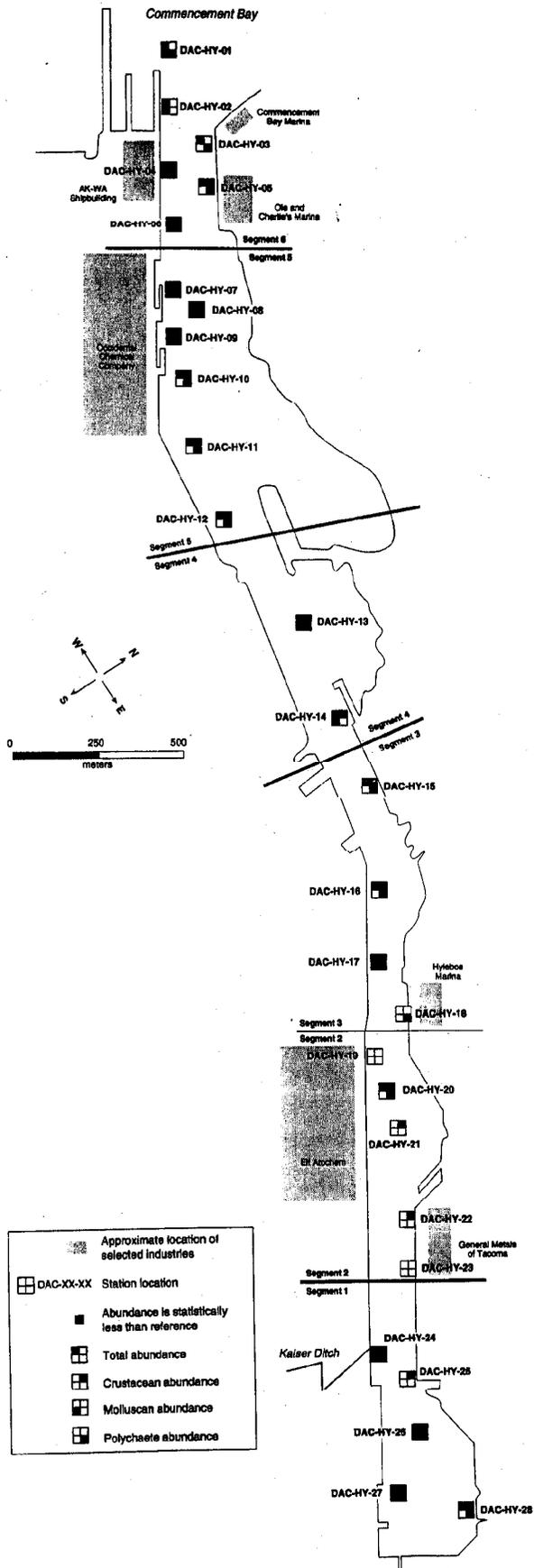
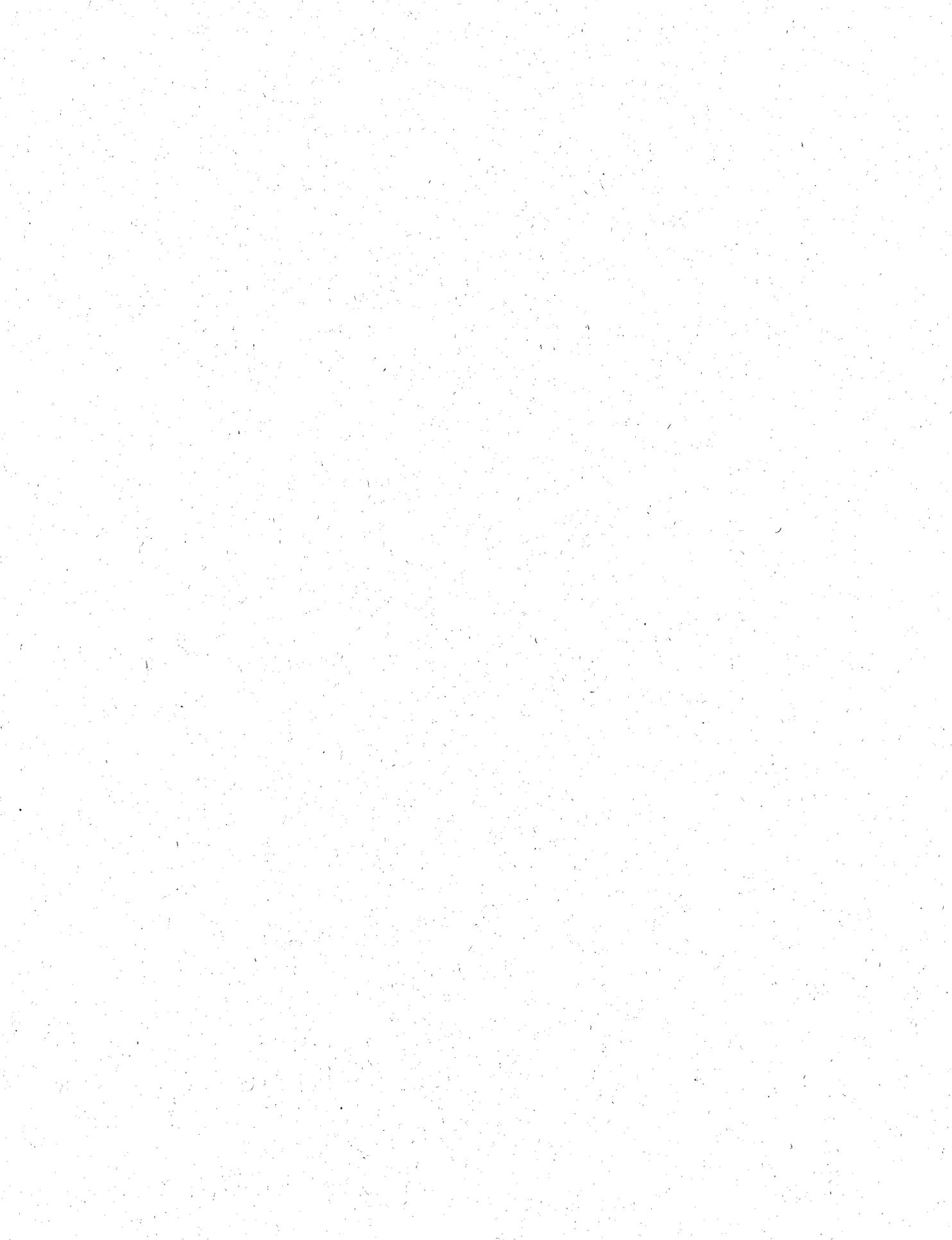


Figure 3-3. Summary of benthic abundance results and locations of selected industries in Hylebos Waterway.



Approximate location of selected industries  
+ DAC-XX-XX Station location  
 Abundance is statistically less than reference  
 Total abundance  
 Crustacean abundance  
 Molluscan abundance  
 Polychaete abundance

## **TABLES**



**TABLE 2-1. HYLEBOS WATERWAY AND REFERENCE STATION COORDINATES<sup>a</sup>**

<b>Station</b>	<b>Latitude (N)</b>	<b>Longitude (W)</b>
<b>Reference</b>		
DAC-CR-02	47°20'00.0"	122°40'00.0"
DAC-CR-02A	47°20'06.0"	122°39'54.0"
DAC-HY-30	47°17'50.0"	122°25'42.5"
DAC-HY-35	47°17'54.5"	122°26'22.5"
<b>Hylebos Waterway</b>		
DAC-HY-01	47°17'08.0"	122°24'54.0"
DAC-HY-02	47°17'06.1"	122°24'38.0"
DAC-HY-03	47°17'02.0"	122°24'30.5"
DAC-HY-04	47°17'01.0"	122°24'31.0"
DAC-HY-05	47°16'58.0"	122°24'22.0"
DAC-HY-06	47°16'58.0"	122°24'25.0"
DAC-HY-07	47°16'52.0"	122°24'17.5"
DAC-HY-08	47°16'52.0"	122°24'13.0"
DAC-HY-09	47°16'49.5"	122°24'12.5"
DAC-HY-10	47°16'45.0"	122°24'07.0"
DAC-HY-11	47°16'43.5"	122°23'53.5"
DAC-HY-12	47°16'40.0"	122°23'45.5"
DAC-HY-13	47°16'36.5"	122°23'32.0"
DAC-HY-14	47°16'35.0"	122°23'21.0"
DAC-HY-15	47°16'32.0"	122°23'07.0"
DAC-HY-16	47°16'27.5"	122°22'52.5"
DAC-HY-17	47°16'21.0"	122°22'46.5"
DAC-HY-18	47°16'18.0"	122°22'37.5"
DAC-HY-19	47°16'14.5"	122°22'36.0"
DAC-HY-20	47°16'12.5"	122°22'28.0"
DAC-HY-21	47°16'06.0"	122°22'23.0"
DAC-HY-22	47°16'06.5"	122°22'18.5"
DAC-HY-23	47°15'59.5"	122°22'08.0"
DAC-HY-24	47°15'55.0"	122°22'04.0"
DAC-HY-25	47°15'51.5"	122°21'55.0"
DAC-HY-26	47°15'49.5"	122°21'45.0"
DAC-HY-27	47°15'45.5"	122°21'44.0"
DAC-HY-28	47°15'45.0"	122°21'40.0"

<sup>a</sup> Coordinates positioned using the North American Datum (NAD) of 1983.

**TABLE 2-2. CURRENT ANALYTES VERSUS ORIGINAL CONTAMINANTS OF CONCERN, AND LABORATORY RESPONSIBLE FOR ANALYSIS**

Analyte	Original Contaminant of Concern	Analytical Laboratory	Analyte	Original Contaminant of Concern	Analytical Laboratory	Analyte	Original Contaminant of Concern	Analytical Laboratory
<b>Trace Elements</b>			<b>Semivolatile Organic Compounds (continued)</b>			<b>Semivolatile Organic Compounds (continued)</b>		
Antimony	✓	NMFS	Phenanthrene		NMFS	1,2-Dichlorobenzene	✓	ARI & NMFS
Arsenic	✓	NMFS	Total LPAHs	✓	NMFS	1,2,4-Trichlorobenzene		ARI & NMFS
Cadmium	✓	NMFS	Benz(a)anthracene		NMFS	1,3-Dichlorobenzene	✓	ARI & NMFS
Chromium	✓	NMFS	Benzo(a)pyrene		NMFS	1,4-Dichlorobenzene	✓	ARI & NMFS
Copper	✓	NMFS	Benzo(g,h,i)perylene		NMFS	Hexachlorobutadiene	✓	NMFS
Lead	✓	NMFS	Chrysene		NMFS	Dibenzofuran	✓	Not Analyzed
Mercury	✓	NMFS	Dibenz(a,h)anthracene		NMFS	Di-n-octylphthalate		NMFS
Nickel	✓	NMFS	Fluoranthene		NMFS	Bis(2-ethylhexyl)phthalate	✓	NMFS
Silver	✓	NMFS	Indeno(1,2,3-c,d)pyrene		NMFS	Butylbenzylphthalate	✓	NMFS
Zinc	✓	NMFS	Pyrene		NMFS	Diethyl phthalate		NMFS
<b>Organotin</b>			Total benzofluoranthenes	✓	NMFS	Dimethyl phthalate	✓	NMFS
<b>Semivolatile Organic Compounds</b>			Total HPAHs			Di-n-butyl phthalate	✓	NMFS
2-Methylnaphthalene		NMFS	2-Methylphenol	✓	NMFS	Gamma-HCH (Lindane)		NMFS
Acenaphthene		NMFS	2,4-Dimethylphenol	✓	NMFS	Hexachlorobenzene	✓	NMFS
Acenaphthylene		NMFS	4-Methylphenol	✓	NMFS	Aldrin		NMFS
Anthracene		NMFS	Pentachlorophenol	✓	NMFS	Alpha-chlordane		NMFS
Fluorene		NMFS	Phenol	✓	NMFS	Gamma-chlordane		NMFS
Naphthalene		NMFS						

TABLE 2-2. (CONTINUED)

Analyte	Original Contaminant of Concern	Analytical Laboratory	Analyte	Original Contaminant of Concern	Analytical Laboratory	Analyte	Original Contaminant of Concern	Analytical Laboratory
<b>Semivolatile Organic Compounds (continued)</b>			<b>Semivolatile Organic Compounds (continued)</b>					
Chlordane		NMFS	Total PCBs	✓	NMFS	Trichloroethene		ARI
Dieldrin		NMFS	p,p'-DDD	✓	NMFS	Tetrachloroethane	✓	Not Analyzed
Heptachbr		NMFS	p,p'-DDE	✓	NMFS	Tetrachloroethene		ARI
Chlorobiphenyl 10/209*		NMFS	p,p'-DDT		NMFS	Ethylbenzene		ARI
Chlorobiphenyl 3/18*		NMFS	Benzyl alcohol	✓	Not Analyzed	Total Xylenes		ARI
Chlorobiphenyl 3/28*		NMFS	Benzoic acid	✓	Not Analyzed			
Chlorobiphenyl 4/44*		NMFS						
Chlorobiphenyl 4/52*		NMFS						
Chlorobiphenyl 4/66*		NMFS						
Chlorobiphenyl 5/101*		NMFS						
Chlorobiphenyl 5/105*		NMFS						
Chlorobiphenyl 5/118*		NMFS						
Chlorobiphenyl 6/128*		NMFS						
Chlorobiphenyl 6/138*		NMFS						
Chlorobiphenyl 6/153*		NMFS						
Chlorobiphenyl 7/170*		NMFS						
Chlorobiphenyl 7/180*		NMFS						
Chlorobiphenyl 7/187*		NMFS						
Chlorobiphenyl 8/195*		NMFS						
Chlorobiphenyl 9/206*		NMFS						

NOTES: NMFS = National Marine Fisheries Service  
ARI = Analytical Resources, Inc.

\* PCB congeners reported as chlorobiphenyl A/B, where A = the number of chlorines and B = typical BZ number

**TABLE 2-3. CRITERIA FOR STATION CLASSIFICATION UNDER THE  
SEDIMENT QUALITY TRIAD APPROACH**

Contaminants of Concern Exceeding Chemistry Objectives		Laboratory Toxicity Test				Depressed Benthic Abundance Indices				Classification
SQS	SQO	A	E	LP		C	M	P	T	
✓		Fail at least 1			and	Fail at least 1				Adversely affected
✓		Fail at least 1			or	Fail at least 1				Potentially adversely affected
	none	Fail at least 1			or	Fail at least 1				Potentially adversely affected
Exceed SQS or SQO		Pass all laboratory bioassays			and	No significant depressions in benthos				Not adversely affected

**NOTES:** A = Amphipod mortality toxicity test  
 E = Echinoderm combined mortality test  
 LP = Larval Polychaete growth test  
 C = Crustacean abundance  
 M = Molluscan abundance  
 P = Polychaete abundance  
 T = Total abundance

**TABLE 3-1. GRAIN SIZE DISTRIBUTION FOR  
HYLEBOS WATERWAY STATIONS AND REFERENCE STATIONS**

Station	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	Percent Fines <sup>a</sup>
<b>Reference</b>					
DAC-CR-02	4	59	32	5	37
DAC-CR-02A	0	25	66	9	73
DAC-HY-30	1	16	47	36	83
DAC-HY-35	3	32	36	29	65
<b>Hylebos Waterway</b>					
DAC-HY-01	4	42	38	16	54
DAC-HY-02	19	37	30	14	44
DAC-HY-03	0	32	43	25	68
DAC-HY-04	1	36	40	23	63
DAC-HY-05	0	39	39	22	61
DAC-HY-06	1	45	36	18	54
DAC-HY-07	1	48	32	19	51
DAC-HY-08	0	13	56	31	87
DAC-HY-09	1	31	45	23	68
DAC-HY-10	1	24	49	26	75
DAC-HY-11	1	31	46	22	68
DAC-HY-12	0	34	44	22	66
DAC-HY-13	28	38	23	11	34
DAC-HY-14	2	55	27	16	43
DAC-HY-15	0	19	52	29	81
DAC-HY-16	0	12	58	30	88
DAC-HY-17	1	36	47	16	63
DAC-HY-18	0	21	51	28	79
DAC-HY-19	0	24	49	27	76
DAC-HY-20	0	7	57	36	93
DAC-HY-21	0	10	57	33	90
DAC-HY-22	1	51	29	19	48
DAC-HY-23	1	32	39	28	67
DAC-HY-24	2	23	52	23	75
DAC-HY-25	0	15	52	33	85
DAC-HY-26	1	10	60	29	89
DAC-HY-27	2	11	57	30	87
DAC-HY-28	0	10	53	37	90

<sup>a</sup> Percent fines is the sum of the percentages of silt and clay.

**TABLE 3-2. CONCENTRATIONS OF CONVENTIONAL PARAMETERS MEASURED IN  
SURFACE SEDIMENTS FROM HYLEBOS WATERWAY STATIONS**

<b>Parameter</b>	<b>Units</b>	<b>No. Stations (Detections/Total)</b>	<b>Minimum Concentration</b>	<b>Median Concentration</b>	<b>Maximum Concentration</b>
Ammonia - Nitrogen	mg/kg	28/28	1.8	19.1	30.7
Total Sulfide	mg/kg	28/28	9.44	670	5,650
Total Volatile Solids	%	28/28	2.19	2.91	6.15
Total Solids	%	28/28	35.5	50.8	65.1
Total Organic Carbon	%	28/28	1.47	2.53	6.32

**TABLE 3-3. CONCENTRATIONS OF OTHER CONVENTIONAL PARAMETERS MEASURED IN  
SURFACE SEDIMENT FROM CARR INLET AND COMMENCEMENT BAY  
REFERENCE STATIONS**

Parameter	Units	Carr Inlet		Commencement Bay	
		DAC-CR-02	DAC-CR-02A	DAC-HY-30	DAC-HY-35
Ammonia - Nitrogen	mg/kg	5.49	2.50	9.66	3.53
Total Sulfide	mg/kg	1.46U	4.03	961	172
Total Volatile Solids	%	1.37	1.61	3.90	2.78
Total Solids	%	68.8	61.1	49.36	55.0
Total Organic Carbon	%	0.981	0.740	2.42	1.71

**NOTES:** U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

**TABLE 3-4. CONCENTRATIONS OF TRACE ELEMENTS AND ORGANOTIN COMPOUNDS MEASURED IN SURFACE SEDIMENTS FROM REFERENCE STATIONS IN CARR INLET AND COMMENCEMENT BAY, DETERMINED BY THE TOTAL ACID DIGESTION METHOD**

Parameter	Carr Inlet Stations			Commencement Bay Stations			SQS	SQO
	DAC-CR-02	DAC-CR-02A	DAC-CR-02A	DAC-HY-30	DAC-HY-35	DAC-HY-35		
<b>Trace Elements (mg/kg DW)</b>								
Antimony	1.22U	1.22U	1.22U	1.22U	1.22U	1.22U	na	150
Arsenic	3.06	1.87	6.41	6.41	6.61	6.61	57	57
Cadmium	0.348	0.180	0.295	0.295	0.217	0.217	5.1	5.1
Chromium	61.4	45.8	27.7	27.7	20.9	20.9	260	na
Copper	16.0	9.80	71.4	71.4	52.1	52.1	390	390
Lead	10.4	8.49	28.7	28.7	40.9	40.9	450	450
Mercury	0.038UJ	0.024UJ	0.251UJ	0.251UJ	0.169UJ	0.169UJ	0.41	0.59
Nickel	33.9	27.5	26.1	26.1	24.6	24.6	na	140
Silver	0.076	0.043	0.240	0.240	0.217	0.217	6.1	6.1
Zinc	17.2	15.7U	75.5	75.5	64.6	64.6	410	410
<b>Organotin Compounds (µg/kg DW)</b>								
Monobutyltin	5.75U	7.26U	10.5U	10.5U	7.14U	7.14U	na	na
Dibutyltin	5.75U	7.26U	19.9	19.9	7.14U	7.14U	na	na
Tributyltin	5.75U	7.26U	25.5	25.5	7.14U	7.14U	na	na
Tetrabutyltin	5.75U	7.26U	10.5U	10.5U	7.14U	7.14U	na	na

**NOTES:** None of the measured trace elements or organotin compounds exceeded the SQS or SQO concentrations at any of the reference stations. DW - Dry weight

na - Not applicable

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.  
 UJ - The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

**TABLE 3-5. CONCENTRATIONS OF ORGANIC COMPOUNDS MEASURED IN SURFACE SEDIMENTS FROM REFERENCE STATIONS IN CARR INLET AND COMMENCEMENT BAY**

Parameter	Carr Inlet Stations					Commencement Bay Stations				
	DAC-CR-02 ( $\mu\text{g/kg DW}$ )	DAC-CR-02A ( $\mu\text{g/kg DW}$ )	DAC-HY-30 ( $\mu\text{g/kg DW}$ )	DAC-HY-35 ( $\mu\text{g/kg DW}$ )	SQO ( $\mu\text{g/kg DW}$ )	DAC-CR-02 ( $\mu\text{g/kg OC}$ )	DAC-CR-02A ( $\mu\text{g/kg OC}$ )	DAC-HY-30 ( $\mu\text{g/kg OC}$ )	DAC-HY-35 ( $\mu\text{g/kg OC}$ )	SQS ( $\mu\text{g/kg OC}$ )
<b>Semivolatile Organic Compounds</b>										
2-Methylnaphthalene	0.700 U	2.30	68.0	99.0	670	71.4 UJ	311	2,810	5,790	38,000
Acenaphthene	0.820 U	1.90 U	66.0	100	500	83.6 U	257 U	2,730	5,850	16,000
Acenaphthylene	0.480 U	1.10 U	12.0	23.0	1,300	48.9 U	149 U	496	1,350	66,000
Anthracene	0.420 U	1.40	190	230	960	42.8 U	189	7,850	13,500	220,000
Fluorene	0.660 U	1.50 U	82.0	110	540	67.3 U	203 U	3,390	6,430	23,000
Naphthalene	1.30	4.00	94.0	170	2,100	133	541	3,880	9,940	99,000
Phenanthrene	2.90	7.00	550	J 820	1,500	296	946	22,700 J	48,000	100,000
Total LPAHs	<6.58	<16.9	1,062	J 1,450	5,200	<671	<2,280	41,100 J	85,000	370,000
Benz(a)anthracene	0.570 U	3.50	240	340	1,600	58.1 U	473	9,920	19,900	110,000
Benzo(a)pyrene	0.550 U	3.50	260	250	1,600	56.1 U	473	10,700	14,600	99,000
Benzo(g,h,i)perylene	0.680 U	4.90	170	150	720	69.3 U	662	7,020	8,770	31,000
Chrysene	2.10	6.40	340	370	2,800	214	865	14,000	21,600	110,000
Dibenz(a,h)anthracene	0.720 U	1.10 U	43.0	34.0	230	73.4 U	149 U	1,780	1,990	12,000
Fluoranthene	6.10	15.0	670	780	2,500	622	2,030	27,700 J	45,600	160,000
Indeno(1,2,3-c,d)pyrene	0.720 U	3.70	180	140	690	73.4 U	500	7,440	8,190	34,000
Pyrene	4.90	12.0	750	890	3,300	499	1,620	31,000	52,000	1,000,000
Total benzofluoranthrenes	1.10	12.0	530	460	3,600	112	1,620	21,900	26,900	230,000
Total HPAHs	<17.4	<62.1	3,183	J 3,410	17,000	<1,780	<8,390	132,000 J	200,000	950,000

TABLE 3-5. (CONTINUED)

Parameter	Carr Inlet Stations				Commencement Bay Stations				Carr Inlet Stations				Commencement Bay Stations			
	DAC-CR-02		DAC-CR-02A		DAC-HY-30		DAC-HY-35		DAC-HY-30		DAC-CR-02A		DAC-HY-30		DAC-HY-35	
	( $\mu\text{g}/\text{kg DW}$ )	( $\mu\text{g}/\text{kg OC}$ )														
2-Methylphenol	2.00 U	1.90 U	4.60 U	4.50 U	63	na										
2,4-Dimethylphenol	0.410	1.50	4.40	6.00	29	na										
4-Methylphenol	3.90	4.00	25.0	32.0	670	na										
Pentachlorophenol	0.760 J	0.700 J	13.0 J	7.80 J	360	na										
Phenol	21.0	16.0 U	31.0	31.0	420	na										
1,2-Dichlorobenzene	0.300 U	0.400 U	1.60	1.80	50	30.6 U	54 U	66.1	105	2,300	na	na	na	na	na	na
1,2,4-Trichlorobenzene	0.270 U	0.320 U	2.50	2.00	51	27.5 U	43.2 U	103	117	810	na	na	na	na	na	na
1,3-Dichlorobenzene	0.260 U	0.380 U	1.00	0.690	170	na										
1,4-Dichlorobenzene	1.20 U	1.80 U	10.0	7.70 U	110	122 U	243 U	413	450 U	3,100	na	na	na	na	na	na
Hexachlorobutadiene	1.10 U	1.50 U	3.30	3.20	11	112 U	203 U	196	187	3,900	na	na	na	na	na	na
Din-octyl phthalate	0.190 U	0.350 U	7.80	1.80	6,200	19.4 U	47.3 U	322	105	58,000	na	na	na	na	na	na
Bis(2-ethylhexyl)phthalate	7.90 U	18.0 UJ	150 J	97.0 J	1,300	805 U	2,430 UJ	6,200 J	5,670 J	47,000	na	na	na	na	na	na
Butylbenzyl phthalate	0.970 UJ	1.90 U	13.0	5.70 UJ	900	98.9 UJ	257 U	537	333 UJ	4,900	na	na	na	na	na	na
Diethyl phthalate	2.10 UJ	2.50 U	3.20 UJ	2.70 UJ	200	214 UJ	338 U	132 UJ	158 UJ	61,000	na	na	na	na	na	na
Dimethyl phthalate	0.210 J	0.420 UJ	20.0	5.50 J	160	21.4 J	56.8 UJ	826	322 J	53,000	na	na	na	na	na	na
Di-n-butyl phthalate	2.70 UJ	5.40 UJ	11.0 UJ	6.80 UJ	1,400	275 UJ	730 UJ	455 UJ	398 UJ	220,000	na	na	na	na	na	na
Gamma-HCH (Lindane)	0.070	0.110 U	0.530	0.210	na											
Hexachlorobenzene	0.110 U	0.180	4.60	4.30	22	11.2 U	24.3	190	251	380	na	na	na	na	na	na

TABLE 3-5. (CONTINUED)

Parameter	Commencement Bay Stations					Commencement Bay Stations				
	Carr Inlet Stations		Commencement Bay Stations			Carr Inlet Stations		Commencement Bay Stations		
	DAC-CR-02 ( $\mu\text{g/kg DW}$ )	DAC-CR-02A ( $\mu\text{g/kg DW}$ )	DAC-HY-30 ( $\mu\text{g/kg DW}$ )	DAC-HY-35 ( $\mu\text{g/kg DW}$ )	SQO ( $\mu\text{g/kg DW}$ )	DAC-CR-02 ( $\mu\text{g/kg OC}$ )	DAC-CR-02A ( $\mu\text{g/kg OC}$ )	DAC-HY-30 ( $\mu\text{g/kg OC}$ )	DAC-HY-35 ( $\mu\text{g/kg OC}$ )	SQS ( $\mu\text{g/kg OC}$ )
Alkrlin	0.100	0.082 U	0.090 U	0.120 U	na	na	na	na	na	na
Alpha-chlordane	0.130	0.390	0.540	0.350	na	na	na	na	na	na
Gamma-chlordane	0.110	0.550	0.097 U	1.80	na	na	na	na	na	na
Chlordane	0.240	0.940	0.540	2.20	na	na	na	na	na	na
Dieldrin	0.054	0.086 U	0.570	0.340	na	na	na	na	na	na
Heptachlor	0.100	0.103 U	0.300	0.100	na	na	na	na	na	na
Chlorobiphenyl 10/209 <sup>a</sup>	0.055 U	0.150	3.90	1.50	na	na	na	na	na	na
Chlorobiphenyl 3/18 <sup>b</sup>	0.190 U	0.283 U	2.30	2.60	na	na	na	na	na	na
Chlorobiphenyl 3/28 <sup>b</sup>	0.180 U	0.223 U	0.770 U	0.980 U	na	na	na	na	na	na
Chlorobiphenyl 4/44 <sup>a</sup>	0.530 U	0.563 U	2.00 U	1.20 U	na	na	na	na	na	na
Chlorobiphenyl 4/52 <sup>a</sup>	0.180	0.210	2.10	1.70	na	na	na	na	na	na
Chlorobiphenyl 4/66 <sup>a</sup>	0.080 U	0.200	0.200 U	0.100 U	na	na	na	na	na	na
Chlorobiphenyl 5/101 <sup>a</sup>	0.200 U	0.270	2.50	2.90	na	na	na	na	na	na
Chlorobiphenyl 5/105 <sup>a</sup>	0.160	0.075 U	0.520	1.30	na	na	na	na	na	na
Chlorobiphenyl 5/118 <sup>a</sup>	0.250	0.390	2.70	5.10	na	na	na	na	na	na
Chlorobiphenyl 6/126 <sup>a</sup>	0.077	0.071 U	0.710	0.500	na	na	na	na	na	na
Chlorobiphenyl 6/138 <sup>a</sup>	0.340 U	0.510 U	2.80	4.10	na	na	na	na	na	na
Chlorobiphenyl 6/153 <sup>a</sup>	0.310 U	0.380	3.10	5.40	na	na	na	na	na	na
Chlorobiphenyl 7/170 <sup>a</sup>	0.460 U	0.190 U	1.20	0.930	na	na	na	na	na	na
Chlorobiphenyl 7/180 <sup>a</sup>	0.160	0.210	2.20	1.70	na	na	na	na	na	na
Chlorobiphenyl 7/187 <sup>a</sup>	0.066 U	0.100	2.00	1.10	na	na	na	na	na	na
Chlorobiphenyl 8/195 <sup>a</sup>	0.050 U	0.059	0.320	0.087	na	na	na	na	na	na
Chlorobiphenyl 9/206 <sup>a</sup>	0.110	0.079	2.30	0.710	na	na	na	na	na	na

**TABLE 3-5. (CONTINUED)**

Parameter	Carr Inlet Stations				Commencement Bay Stations				Commencement Bay Stations					
	DAC-CR-02 ( $\mu\text{g/kg DW}$ )		DAC-CR-02A ( $\mu\text{g/kg DW}$ )		DAC-HY-30 ( $\mu\text{g/kg DW}$ )		DAC-HY-35 ( $\mu\text{g/kg DW}$ )		DAC-CR-02 ( $\mu\text{g/kg OC}$ )		DAC-HY-30 ( $\mu\text{g/kg OC}$ )		DAC-HY-35 ( $\mu\text{g/kg OC}$ )	
	DW	OC	DW	OC	DW	OC	DW	OC	DW	OC	DW	OC	DW	OC
Total PCBs	6.00	8.00	64.0	63.0	1,000 <sup>a</sup>				612	1,080	2,640	3,680	12,000	
p,p'-DDD	0.140	0.180	1.30	1.70	16				na	na	na	na	na	
p,p'-DDE	0.110	0.210	0.380	0.190	9				na	na	na	na	na	
p,p'-DDT	0.057 U	0.140 U	0.210	0.200	34				na	na	na	na	na	
<b>Volatile Organic Compounds</b>														
Trichloroethene	1.20 U	1.00 U	1.70 U	1.60 U	na				na	na	na	na	na	
Tetrachloroethene	1.20 U	1.00 U	1.70 U	1.60 U	57				na	na	na	na	na	
Ethylbenzene	1.20 U	1.00 U	1.70 U	1.60 U	10				na	na	na	na	na	
Xylenes	2.40 U	2.00 U	3.30 U	3.20 U	40				na	na	na	na	na	

**NOTES:** None of the measured concentrations of organic compounds exceeded the SQO or SQS concentrations at any of the reference stations.

DW - dry weight

OC - organic carbon normalized

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

J - The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

UU - The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

<sup>a</sup> PCB congeners reported as chlorobiphenyl A/B, where A = the number of chlorines and B = the typical BZ number.

<sup>b</sup> This table indicates the SQO for PCBs is 1,000  $\mu\text{g/kg}$ . The ROD for the RI selected the human health-based PCB SQO of 150  $\mu\text{g/kg}$  as the PCB decision criterion.

**TABLE 3-6. CONCENTRATIONS OF TRACE ELEMENTS AND ORGANOTIN COMPOUNDS MEASURED IN SURFACE SEDIMENTS FROM HYLEBOS WATERWAY, DETERMINED BY THE TOTAL ACID DIGESTION METHOD**

Parameter	No. Stations (Detections/Total)	Minimum Concentration	Median Concentration	Maximum Concentration	SQS	No. Stations Exceeding SQS	SQO	No. Stations Exceeding SQO
<b>Trace Elements (mg/kg DW)</b>								
Antimony	28/28	1.73	6.29	16.5	na	na	150	0
Arsenic	28/28	5.45	16.6	120	57	3	57	3
Cadmium	21/28	0.202	0.477	1.95	5.1	0	5.1	0
Chromium	28/28	28.7	33.6	91.7	260	0	na	na
Copper	28/28	53.6	117	230	390	0	390	0
Lead	28/28	23.4	73.8	207	450	0	450	0
Mercury	1/28	0.16	0.16	0.16	0.41	0	0.59	0
Nickel	28/28	24.8	33.6	43.7	na	na	140	0
Silver	28/28	0.095	0.29	0.398	6.1	0	6.1	0
Zinc	28/28	99.4	174	579	410	2	410	2
<b>Organotin Compounds (<math>\mu\text{g/kg DW}</math>)</b>								
Monobutyltin	0/28	<5.78	<9.26	<12.8	na	na	na	na
Dibutyltin	24/28	10.8	46.75	82.8	na	na	na	na
Tributyltin	28/28	14.9	134.5	238	na	na	na	na
Tetrabutyltin	0/28	<5.78	<9.26	<12.8	na	na	na	na

**NOTES:** DW - dry weight

**TABLE 3-7. CONCENTRATIONS OF TRACE ELEMENTS MEASURED IN SURFACE SEDIMENTS FROM HYLEBOS WATERWAY, DETERMINED BY THE STRONG ACID DIGESTION METHOD**

Parameter	No. Stations (Detections/Total)	Minimum Concentration	Median Concentration	Maximum Concentration	SQS	No. Stations Exceeding SQS	SQO	No. Stations Exceeding SQO
<b>Trace Elements (mg/kg DW)</b>								
Antimony	10/28	1.12	1.46	2.27	na	na	150	0
Arsenic	23/28	13.9	34.6	63.4	57	1	57	1
Cadmium	27/28	0.184	0.343	1.35	5.1	0	5.1	0
Chromium	28/28	20.3	32.55	50.2	260	0	na	na
Copper	28/28	43.4	112.00	184	390	0	390	0
Lead	28/28	21.5	68.55	176	450	0	450	0
Mercury	0/28	<0.207	<0.427	<0.997	0.41	0	0.59	0
Nickel	28/28	14.6	21.70	39.5	na	na	140	0
Silver	28/28	0.112	0.40	0.507	6.1	0	6.1	0
Zinc	28/28	63.4	131.00	530	410	1	410	1

**NOTE:** DW - dry weight



TABLE 3-8. (CONTINUED)

Parameter	No. Stations (Detections/Total)	Concentration (µg/kg DW)					Concentration (µg/kg OC)				
		Minimum Conc.	Median Conc.	Maximum Conc.	SQO Conc.	No. Exceeding SQS	Minimum Conc.	Median Conc.	Maximum Conc.	SQS Conc.	No. Exceeding SQO
2-Methylphenol	16/28	2	8.8	23	63	0	na	na	na	na	0
2,4-Dimethylphenol	28/28	4	8.1	18	29	0	na	na	na	na	0
4-Methylphenol	28/28	16	36.5	120	670	0	na	na	na	na	0
Pentachlorophenol	28/28	13	55	790	360	1	na	na	na	na	1
Phenol	28/28	27	44	68	420	0	na	na	na	na	0
1,2-Dichlorobenzene	28/28	1	4.05	13	50	0	39.5	152	637	2,300	0
1,2,4-Trichlorobenzene	28/28	7	22	110	51	4	163	862	5,390	810	15
1,3-Dichlorobenzene	26/28	1	3.95	14	170	0	na	na	na	na	na
1,4-Dichlorobenzene	21/28	10	23	81	110	0	197	1,060	4,200	3,100	2
Hexachlorobutadiene	28/28	6	24.5	260	11	23	109	890	14,900	3,900	5
Di-n-octylphthalate	28/28	2	7.7	14	6,200	0	83.3	244	686	58,000	0
Bis(2-ethylhexyl)phthalate	27/28	89	520	1,400	1,300	1	4,940	16,600	54,500	47,000	1
Butylbenzylphthalate	24/28	10	54	580	900	0	451	1,610	15,300	4,900	1
Diethyl phthalate	0/28	<0.52	<3.15	<8.30	200	0	<16.2	<135.71	<250	61,000	0
Dimethyl phthalate	28/28	1	16.5	75	160	0	42.1	676	2,300	53,000	0
Di-n-butyl phthalate	2/28	72	74	76	1,400	0	3,860	4,330	4,800	220,000	0
Gamma-HCH (Lindane)	28/28	0	1.05	4.8	na	na	na	na	na	na	na
Hexachlorobenzene	28/28	8	21.5	120	22	12	177	738	5,940	380	21
Aldrin	9/28	1	5.3	8	na	na	na	na	na	na	na

TABLE 3-8. (CONTINUED)

Parameter	No. Stations (Detections/ Total)	Conc. (µg/kg DW)				Conc. (µg/kg OC)						
		Minimum	Median	Maximum	SQO Conc.	Minimum	Median	Maximum	SQS Conc.			
Alpha-chlordane	28/28	1	1.9	5.1	na	na	na	na	na	na	na	na
Gamma-chlordane	19/28	0	2.5	5.9	na	na	na	na	na	na	na	na
Chlordane	28/28	1	3.15	8.3	na	na	na	na	na	na	na	na
Dieldrin	24/28	0	1.4	3.5	na	na	na	na	na	na	na	na
Heptachlor	28/28	0	0.75	4.1	na	na	na	na	na	na	na	na
Chlorobiphenyl 10/209 <sup>a</sup>	28/28	6	18.5	140	na	na	na	na	na	na	na	na
Chlorobiphenyl 3/18 <sup>a</sup>	28/28	2	6.05	22	na	na	na	na	na	na	na	na
Chlorobiphenyl 3/28 <sup>a</sup>	25/28	1	4.8	12	na	na	na	na	na	na	na	na
Chlorobiphenyl 4/44 <sup>a</sup>	13/28	3	10	13	na	na	na	na	na	na	na	na
Chlorobiphenyl 4/52 <sup>a</sup>	28/28	1	9.05	31	na	na	na	na	na	na	na	na
Chlorobiphenyl 4/66 <sup>a</sup>	21/28	0	7	13	na	na	na	na	na	na	na	na
Chlorobiphenyl 5/101 <sup>a</sup>	27/28	2	18	50	na	na	na	na	na	na	na	na
Chlorobiphenyl 5/105 <sup>a</sup>	24/28	1	7.2	27	na	na	na	na	na	na	na	na
Chlorobiphenyl 5/118 <sup>a</sup>	28/28	2	29.5	63	na	na	na	na	na	na	na	na
Chlorobiphenyl 6/128 <sup>a</sup>	23/28	1	5.1	12	na	na	na	na	na	na	na	na
Chlorobiphenyl 6/138 <sup>a</sup>	28/28	3	21.5	52	na	na	na	na	na	na	na	na
Chlorobiphenyl 6/153 <sup>a</sup>	26/28	3	25	61	na	na	na	na	na	na	na	na
Chlorobiphenyl 7/170 <sup>a</sup>	24/28	0	2.45	6.2	na	na	na	na	na	na	na	na
Chlorobiphenyl 7/180 <sup>a</sup>	28/28	4	18	42	na	na	na	na	na	na	na	na
Chlorobiphenyl 7/187 <sup>a</sup>	28/28	2	5.9	14	na	na	na	na	na	na	na	na
Chlorobiphenyl 8/195 <sup>a</sup>	28/28	1	1.7	5.2	na	na	na	na	na	na	na	na
Chlorobiphenyl 9/206 <sup>a</sup>	28/28	5	11	66	na	na	na	na	na	na	na	na

**TABLE 3-8. (CONTINUED)**

Parameter	No. Stations (Detections/Total)	Minimum Conc. ( $\mu\text{g/kg DW}$ )	Median Conc. ( $\mu\text{g/kg DW}$ )	Maximum Conc. ( $\mu\text{g/kg DW}$ )	SQO Conc. ( $\mu\text{g/kg DW}$ )	No. Exceeding SQS	Minimum Conc. ( $\mu\text{g/kg OC}$ )	Median Conc. ( $\mu\text{g/kg OC}$ )	Maximum Conc. ( $\mu\text{g/kg OC}$ )	SQS Conc. ( $\mu\text{g/kg OC}$ )	No. Exceeding SQO
Total PCBs	28/28	94	410	790	1,000 <sup>b</sup>	0	6,270	15,450	28,500	12,000	19
p,p'-DDD	28/28	1	6.6	21	16	2	na	na	na	na	na
p,p'-DDE	27/28	0	2.1	13	9	3	na	na	na	na	na
p,p'-DDT	25/28	0	2.5	19	34	0	na	na	na	na	na
<b>Volatile Organic Compounds</b>											
Trichloroethene	1/28	2	2.4	2.4	na	na	na	na	na	na	na
Tetrachloroethene	0/28	<1.00	<1.60	<2.30	57	0	na	na	na	na	na
Ethylbenzene	0/28	<1.00	<1.60	<2.30	10	0	na	na	na	na	na
Xylenes	0/28	<2.00	<3.20	<4.70	40	0	na	na	na	na	na

**NOTES:** DW - Dry weight  
OC - Organic carbon

<sup>a</sup> PCB congeners reported as chlorobiphenyl A/B, where A = the number of chlorines and B = the typical BZ number.

<sup>b</sup> This table indicates the SQO for PCBs is 1,000  $\mu\text{g/kg}$ . The ROD for the RI selected the human health-based PCB SQO of 150  $\mu\text{g/kg}$  as the PCB decision criterion.

**TABLE 3-9. SUMMARY OF BIOASSAY PERFORMANCE FOR CONTROL STATIONS  
AND CARR INLET REFERENCE STATIONS**

Station	Test Series	Mean Percent Mortality <sup>a</sup> ( <i>Rhepoxynius abronius</i> )	Mean Percent Combined Mortality <sup>a</sup> ( <i>Dendraster excentricus</i> )	Mean Individual Biomass (mg) <sup>a</sup> ( <i>Neanthes arenaceodentata</i> )
<b>Control</b>				
Sediment 1	1	3 ± 1.8	-14.4 ± 4.3	10.9 ± 0.8
	2	4 ± 1.7	-1.2 ± 2.5	10.2 ± 0.2
Seawater 1	1	na	-9.6 ± 4.0	na
	2	na	-7.1 ± 3.7	na
Sediment 2	1	3 ± 1.1	-17.3 ± 4.3	11.7 ± 1.2
	2	7 ± 2.7	-3.2 ± 4.0	9.7 ± 0.7
Seawater 2	1	na	-20.1 ± 3.7	na
	2	na	-5.8 ± 3.1	na
<b>Carr Inlet</b>				
DAC-CR-02	2	14 ± 4.3	39.4 ± 1.3	9.9 ± 0.6
DAC-CR-02A	2	15 ± 0.0 <sup>b</sup>	4.8 ± 2.6	9.0 ± 0.5

**NOTE:** na - not applicable.

<sup>a</sup> Mean and standard error based on five replicate samples.

<sup>b</sup> Mean and standard error based on four replicate samples.

**TABLE 3-10. MEAN PERCENT MORTALITY IN *RHEPOXYNIUS ABRONIUS* BIOASSAYS AND SIGNIFICANT RESULTS FOR HYLEBOS WATERWAY STATIONS**

Hylebos Waterway Station	Reference Station <sup>a</sup>	Test Series	Mean Percent Mortality <sup>b</sup>	Significant t-Test <sup>c</sup>
DAC-HY-01	DAC-CR-2	2	23 + 3.0	No
DAC-HY-02	DAC-CR-2	2	12 ± 2.3	No
DAC-HY-03	DAC-CR-2A	2	14 ± 2.6 <sup>d</sup>	No
DAC-HY-04	DAC-CR-2A	2	21 ± 1.7 <sup>d</sup>	Yes
DAC-HY-05	DAC-CR-2A	2	23 ± 3.3 <sup>d</sup>	Yes
DAC-HY-06	DAC-CR-2	2	13 ± 1.8	No
DAC-HY-07	DAC-CR-2	2	6 ± 2.9	No
DAC-HY-08	DAC-CR-2A	2	26 ± 1.7	Yes
DAC-HY-09	DAC-CR-2A	2	16 ± 2.6	No
DAC-HY-10	DAC-CR-2A	2	44 ± 3.3	Yes
DAC-HY-11	DAC-CR-2A	2	14 ± 5.0	No
DAC-HY-12	DAC-CR-2A	2	23 ± 4.1	Yes
DAC-HY-13	DAC-CR-2	1	11 ± 3.6	No
DAC-HY-14	DAC-CR-2	1	3 ± 1.1	No
DAC-HY-15	DAC-CR-2A	1	14 ± 1.7	No
DAC-HY-16	DAC-CR-2A	1	12 ± 2.3	No
DAC-HY-17	DAC-CR-2A	1	16 ± 2.6	No
DAC-HY-18	DAC-CR-2A	1	14 ± 1.7	No
DAC-HY-19	DAC-CR-2A	1	9.5 ± 1.6	No
DAC-HY-20	DAC-CR-2A	1	16 ± 3.8	No
DAC-HY-21	DAC-CR-2A	1	27 ± 8.2	No
DAC-HY-22	DAC-CR-2	1	15 ± 5.1	No
DAC-HY-23	DAC-CR-2A	1	16 ± 1.7	No
DAC-HY-24	DAC-CR-2A	1	33 ± 4.1	Yes
DAC-HY-25	DAC-CR-2A	2	13 ± 1.8	No
DAC-HY-26	DAC-CR-2A	2	19 ± 3.8	No
DAC-HY-27	DAC-CR-2A	2	14 ± 3.3	No
DAC-HY-28	DAC-CR-2A	2	28 ± 6.1	No

<sup>a</sup> Corresponding reference station with similar grain size.

<sup>b</sup> Mean percent mortality and standard error for five replicate samples.

<sup>c</sup> Statistically significant increases in mean percent mortality compared to the reference as determined by a t-test at the  $\alpha=0.05$  level.

<sup>d</sup> Percent mortality determined for the reference sediment sample DAC-CR-2A is based on four replicates. See Section 3.1.1 for details.

**TABLE 3-11. MEAN PERCENT COMBINED MORTALITY IN *DENDRASTER EXCENTRICUS* BIOASSAYS AND SIGNIFICANT RESULTS FOR HYLEBOS WATERWAY STATIONS**

Hylebos Waterway Station	Reference Station <sup>a</sup>	Test Series	Mean Percent Combined Mortality <sup>b</sup>	Significant t-Test <sup>c</sup>
DAC-HY-01	DAC-CR-2	2	-0.5 ± 2.1	No
DAC-HY-02	DAC-CR-2	2	2.8 ± 3.2	No
DAC-HY-03	DAC-CR-2A	2	14.7 ± 4.8	No
DAC-HY-04	DAC-CR-2A	2	21.3 ± 3.7	Yes
DAC-HY-05	DAC-CR-2A	2	14.6 ± 3.0	Yes
DAC-HY-06	DAC-CR-2	2	13.2 ± 4.9	No
DAC-HY-07	DAC-CR-2	2	13.5 ± 3.2	No
DAC-HY-08	DAC-CR-2A	1	11.0 ± 2.6	No
DAC-HY-09	DAC-CR-2A	1	7.5 ± 2.6	No
DAC-HY-10	DAC-CR-2A	1	32.9 ± 2.8	Yes
DAC-HY-11	DAC-CR-2A	1	20.5 ± 3.3	Yes
DAC-HY-12	DAC-CR-2A	1	12.3 ± 4.4	No
DAC-HY-13	DAC-CR-2	1	26.5 ± 3.4	No
DAC-HY-14	DAC-CR-2	2	12.1 ± 4.7	No
DAC-HY-15	DAC-CR-2A	1	15.2 ± 2.8	Yes
DAC-HY-16	DAC-CR-2A	1	9.4 ± 3.7	No
DAC-HY-17	DAC-CR-2A	1	-13.9 ± 3.2	No
DAC-HY-18	DAC-CR-2A	1	8.7 ± 1.8	No
DAC-HY-19	DAC-CR-2A	1	-20.8 ± 3.5	No
DAC-HY-20	DAC-CR-2A	1	57.1 ± 2.8	Yes
DAC-HY-21	DAC-CR-2A	1	-28.6 ± 4.8	No
DAC-HY-22	DAC-CR-2	1	7.5 ± 2.8	No
DAC-HY-23	DAC-CR-2A	1	28.1 ± 2.6	Yes
DAC-HY-24	DAC-CR-2A	2	30.5 ± 3.0	Yes
DAC-HY-25	DAC-CR-2A	2	36.7 ± 1.7	Yes
DAC-HY-26	DAC-CR-2A	2	2.7 ± 3.3	No
DAC-HY-27	DAC-CR-2A	2	33.1 ± 3.0	Yes
DAC-HY-28	DAC-CR-2A	2	10.9 ± 8.1	No

<sup>a</sup> Corresponding reference station with similar grain size.

<sup>b</sup> Mean percent combined mortality and standard error based on five replicate samples.

<sup>c</sup> Statistically significant increases in mean percent combined mortality compared to the reference as determined by a t-test at the  $\alpha=0.05$  level.

**TABLE 3-12. BIOMASS MEASUREMENTS FOR *NEANTHES ARENACEODENTATA* BIOASSAYS, AND SIGNIFICANT RESULTS FOR HYLEBOS WATERWAY STATIONS**

Hylebos Waterway Station	Reference Station <sup>a</sup>	Test Series	Mean Individual Biomass (mg) <sup>b</sup>	Significant t-Test <sup>c</sup>
DAC-HY-01	DAC-CR-2	2	10.1 ± 0.3	No
DAC-HY-02	DAC-CR-2	2	7.4 ± 0.6	No
DAC-HY-03	DAC-CR-2A	2	10.4 ± 0.7	No
DAC-HY-04	DAC-CR-2A	2	10.1 ± 0.6	No
DAC-HY-05	DAC-CR-2A	2	12.6 ± 0.5	No
DAC-HY-06	DAC-CR-2	2	11.4 ± 0.4	No
DAC-HY-07	DAC-CR-2	2	12.8 ± 0.4	No
DAC-HY-08	DAC-CR-2A	2	11.5 ± 0.5	No
DAC-HY-09	DAC-CR-2A	2	10.0 ± 1.6	No
DAC-HY-10	DAC-CR-2A	2	9.3 ± 0.4	No
DAC-HY-11	DAC-CR-2A	2	9.1 ± 0.4	No
DAC-HY-12	DAC-CR-2A	2	10.7 ± 1.0	No
DAC-HY-13	DAC-CR-2	1	12.6 ± 0.9	No
DAC-HY-14	DAC-CR-2	1	12.6 ± 0.5	No
DAC-HY-15	DAC-CR-2A	1	12.1 ± 1.0	No
DAC-HY-16	DAC-CR-2A	1	9.4 ± 0.9	No
DAC-HY-17	DAC-CR-2A	1	13.3 ± 0.3	No
DAC-HY-18	DAC-CR-2A	1	11.3 ± 0.8	No
DAC-HY-19	DAC-CR-2A	1	11.8 ± 0.6	No
DAC-HY-20	DAC-CR-2A	1	10.6 ± 0.9	No
DAC-HY-21	DAC-CR-2A	1	13.1 ± 0.4	No
DAC-HY-22	DAC-CR-2	1	10.9 ± 1.5	No
DAC-HY-23	DAC-CR-2A	1	11.5 ± 0.4	No
DAC-HY-24	DAC-CR-2A	1	14.2 ± 0.5	No
DAC-HY-25	DAC-CR-2A	2	9.2 ± 0.6	No
DAC-HY-26	DAC-CR-2A	2	10.1 ± 1.1	No
DAC-HY-27	DAC-CR-2A	2	7.7 ± 0.5	No
DAC-HY-28	DAC-CR-2A	2	10.0 ± 0.7	No

<sup>a</sup> Corresponding reference station with similar grain size.

<sup>b</sup> Mean individual biomass and standard error based on five replicate samples.

<sup>c</sup> Statistically significant decreases in mean individual biomass compared to the reference as determined by a t-test at the  $\alpha=0.05$  level.

**TABLE 3-13. TOTAL BENTHIC ABUNDANCE FOR HYLEBOS WATERWAY STATIONS AND COMMENCEMENT BAY REFERENCE STATIONS**

Station	Reference Station <sup>a</sup>	Mean Abundance <sup>b</sup> (per m <sup>2</sup> )	Significant t-Test <sup>c</sup>
<b>Hylebos Waterway</b>			
DAC-HY-01	DAC-HY-35	11,091.7 ± 854.5	Yes
DAC-HY-02	DAC-HY-35	9,362.5 ± 1,081.0	Yes
DAC-HY-03	DAC-HY-35	13,354.2 ± 1,230.4	Yes
DAC-HY-04	DAC-HY-35	6,837.5 ± 901.8	Yes
DAC-HY-05	DAC-HY-35	14,633.3 ± 1,236.7	Yes
DAC-HY-06	DAC-HY-35	7,200.0 ± 844.1	Yes
DAC-HY-07	DAC-HY-35	8,445.8 ± 2,036.0	Yes
DAC-HY-08	DAC-HY-30	5,370.8 ± 1,159.6	Yes
DAC-HY-09	DAC-HY-35	4,883.3 ± 2,329.6	Yes
DAC-HY-10	DAC-HY-30	8,358.3 ± 2,131.8	Yes
DAC-HY-11	DAC-HY-30	5,883.3 ± 1,083.3	Yes
DAC-HY-12	DAC-HY-35	7,512.5 ± 1,052.2	Yes
DAC-HY-13	DAC-HY-35	2,679.2 ± 869.6	Yes
DAC-HY-14	DAC-HY-35	8,570.8 ± 1,215.7	Yes
DAC-HY-15	DAC-HY-30	5,770.8 ± 511.8	Yes
DAC-HY-16	DAC-HY-30	8,633.3 ± 1,064.7	Yes
DAC-HY-17	DAC-HY-35	1,854.2 ± 265.8	Yes
DAC-HY-18	DAC-HY-30	11,583.3 ± 2,145.2	No
DAC-HY-19	DAC-HY-30	15,708.3 ± 2,105.4	No
DAC-HY-20	DAC-HY-30	9,391.7 ± 1,400.0	Yes
DAC-HY-21	DAC-HY-30	14,516.7 ± 2,328.1	No
DAC-HY-22	DAC-HY-30	21,200.0 ± 2,163.6	No
DAC-HY-23	DAC-HY-35	18,895.8 ± 2,666.7	No
DAC-HY-24	DAC-HY-30	11,662.5 ± 560.2	Yes
DAC-HY-25	DAC-HY-30	13,541.7 ± 1,062.2	No
DAC-HY-26	DAC-HY-30	7,745.8 ± 910.3	Yes
DAC-HY-27	DAC-HY-30	6,012.5 ± 149.8	Yes
DAC-HY-28	DAC-HY-30	7,991.7 ± 440.9	Yes
<b>Commencement Bay</b>			
DAC-HY-30	na	16,312.5 ± 824.0	na
DAC-HY-36	na	21,112.5 ± 519.2	na

<sup>a</sup> Corresponding reference station with similar grain size, TOC, and depth.

<sup>b</sup> Mean abundance for four samples.

<sup>c</sup> Statistically significant depressions of abundance compared to the reference as determined by a t-test at the  $\alpha=0.05$  level.

**TABLE 3-14. RESULTS USED TO SELECT REFERENCE STATIONS  
FOR HYLEBOS WATERWAY STATIONS FOR BENTHIC ABUNDANCE**

	Grain Size (percent fines)	Total Organic Carbon (percent)	Depth (ft)	Selected Reference Station
<b>Reference Station</b>				
DAC-HY-35	60	0.0171	23	na
DAC-HY-30	82	0.0242	26	na
<b>Hylebos Waterway Station</b>				
DAC-HY-1	53	0.0150	40	DAC-HY-35
DAC-HY-2	44	0.0180	39	DAC-HY-35
DAC-HY-3	68	0.0192	37	DAC-HY-35
DAC-HY-4	61	0.0175	28	DAC-HY-35
DAC-HY-5	58	0.0197	21	DAC-HY-35
DAC-HY-6	53	0.0193	28	DAC-HY-35
DAC-HY-7	48	0.0175	31	DAC-HY-35
DAC-HY-8	84	0.0288	26	DAC-HY-30
DAC-HY-9	66	0.0202	37	DAC-HY-35
DAC-HY-10	72	0.0204	30	DAC-HY-30
DAC-HY-11	67	0.0209	28	DAC-HY-30
DAC-HY-12	64	0.0250	26	DAC-HY-35
DAC-HY-13	34	0.0189	41	DAC-HY-35
DAC-HY-14	39	0.0147	31	DAC-HY-35
DAC-HY-15	75	0.0255	25	DAC-HY-30
DAC-HY-16	85	0.0312	25	DAC-HY-30
DAC-HY-17	59	0.0228	30	DAC-HY-35
DAC-HY-18	77	0.0337	30	DAC-HY-30
DAC-HY-19	73	0.0385	34	DAC-HY-30
DAC-HY-20	91	0.0404	31	DAC-HY-30
DAC-HY-21	87	0.0392	29	DAC-HY-30
DAC-HY-22	46	0.0321	27	DAC-HY-30
DAC-HY-23	65	0.0378	24	DAC-HY-35
DAC-HY-24	71	0.0585	32	DAC-HY-30
DAC-HY-25	82	0.0632	38	DAC-HY-30
DAC-HY-26	86	0.0608	34	DAC-HY-30
DAC-HY-27	86	0.0376	32	DAC-HY-30
DAC-HY-28	87	0.0492	28	DAC-HY-30

**TABLE 3-15. BENTHIC ABUNDANCE FOR CRUSTACEA FOR HYLEBOS WATERWAY STATIONS AND COMMENCEMENT BAY REFERENCE STATIONS**

Station	Reference Station <sup>a</sup>	Mean Abundance <sup>b</sup> (per m <sup>2</sup> )	Significant t-Test <sup>c</sup>
<b>Hylebos Waterway</b>			
DAC-HY-01	DAC-HY-35	970.8 ± 213.5	No
DAC-HY-02	DAC-HY-35	779.2 ± 37.4	No
DAC-HY-03	DAC-HY-35	879.2 ± 125.7	No
DAC-HY-04	DAC-HY-35	112.5 ± 30.3	Yes
DAC-HY-05	DAC-HY-35	654.2 ± 79.1	Yes
DAC-HY-06	DAC-HY-35	558.3 ± 164.8	Yes
DAC-HY-07	DAC-HY-35	491.7 ± 102.3	Yes
DAC-HY-08	DAC-HY-30	195.8 ± 41.4	Yes
DAC-HY-09	DAC-HY-35	300.0	Yes
DAC-HY-10	DAC-HY-30	475.0 ± 110.3	Yes
DAC-HY-11	DAC-HY-30	300.0 ± 78.4	Yes
DAC-HY-12	DAC-HY-35	591.7 ± 151.9	Yes
DAC-HY-13	DAC-HY-35	279.2 ± 122.1	Yes
DAC-HY-14	DAC-HY-35	91.7 ± 9.3	Yes
DAC-HY-15	DAC-HY-30	266.7 ± 42.5	Yes
DAC-HY-16	DAC-HY-30	429.2 ± 112.5	Yes
DAC-HY-17	DAC-HY-35	95.8 ± 25.3	Yes
DAC-HY-18	DAC-HY-30	837.5 ± 71.0	No
DAC-HY-19	DAC-HY-30	662.5 ± 171.7	No
DAC-HY-20	DAC-HY-30	237.5 ± 22.3	Yes
DAC-HY-21	DAC-HY-30	191.7 ± 47.7	Yes
DAC-HY-22	DAC-HY-30	708.3 ± 90.0	Yes
DAC-HY-23	DAC-HY-35	1,229.2 ± 526.1	No
DAC-HY-24	DAC-HY-30	341.7 ± 94.7	Yes
DAC-HY-25	DAC-HY-30	175.0 ± 23.9	Yes
DAC-HY-26	DAC-HY-30	37.5 ± 32.5	Yes
DAC-HY-27	DAC-HY-30	33.3 ± 15.6	Yes
DAC-HY-28	DAC-HY-30	133.3 ± 21.2	Yes
<b>Commencement Bay</b>			
DAC-HY-30	na	1,083.3 ± 133.6	na
DAC-HY-35	na	1,466.7 ± 304.7	na

<sup>a</sup> Corresponding reference station with similar grain size, TOC, and depth.

<sup>b</sup> Mean abundance for four replicate samples.

<sup>c</sup> Statistically significant depressions of abundance compared to the reference as determined by a t-test at the  $\alpha=0.05$  level.

**TABLE 3-16. BENTHIC ABUNDANCE FOR MOLLUSCA FOR HYLEBOS WATERWAY STATIONS AND COMMENCEMENT BAY REFERENCE STATIONS**

Station	Reference Station <sup>a</sup>	Mean Abundance <sup>b</sup> (per m <sup>2</sup> )	Significant t-Test <sup>c</sup>
<b>Hylebos Waterway</b>			
DAC-HY-01	DAC-HY-35	1,045.8 ± 158.4	Yes
DAC-HY-02	DAC-HY-35	845.8 ± 55.7	Yes
DAC-HY-03	DAC-HY-35	2,254.2 ± 208.1	No
DAC-HY-04	DAC-HY-35	379.2 ± 61.3	Yes
DAC-HY-05	DAC-HY-35	1,845.8 ± 221.8	No
DAC-HY-06	DAC-HY-35	1,091.7 ± 175.4	Yes
DAC-HY-07	DAC-HY-35	729.2 ± 186.0	Yes
DAC-HY-08	DAC-HY-30	275.0 ± 91.4	Yes
DAC-HY-09	DAC-HY-35	891.7 ± 90.8	Yes
DAC-HY-10	DAC-HY-30	1,354.2 ± 267.3	No
DAC-HY-11	DAC-HY-30	2,191.7 ± 387.2	No
DAC-HY-12	DAC-HY-35	1,550.0 ± 362.7	No
DAC-HY-13	DAC-HY-35	350.0 ± 81.9	Yes
DAC-HY-14	DAC-HY-35	525.0 ± 41.9	Yes
DAC-HY-15	DAC-HY-30	2,233.3 ± 256.5	No
DAC-HY-16	DAC-HY-30	2,616.7 ± 301.6	No
DAC-HY-17	DAC-HY-35	158.3 ± 31.5	Yes
DAC-HY-18	DAC-HY-30	2,437.5 ± 311.3	No
DAC-HY-19	DAC-HY-30	4,204.2 ± 268.4	No
DAC-HY-20	DAC-HY-30	1,550.0 ± 103.6	No
DAC-HY-21	DAC-HY-30	2,487.5 ± 445.4	No
DAC-HY-22	DAC-HY-30	2,608.3 ± 496.3	No
DAC-HY-23	DAC-HY-35	2,129.2 ± 385.8	No
DAC-HY-24	DAC-HY-30	312.5 ± 63.6	Yes
DAC-HY-25	DAC-HY-30	483.3 ± 137.8	No
DAC-HY-26	DAC-HY-30	125.0 ± 32.5	Yes
DAC-HY-27	DAC-HY-30	325.0 ± 112.2	Yes
DAC-HY-28	DAC-HY-30	470.8 ± 91.5	No
<b>Commencement Bay</b>			
DAC-HY-30	na	937.5 ± 179.5	na
DAC-HY-35	na	2,087.5 ± 276.2	na

<sup>a</sup> Corresponding reference station with similar grain size, TOC, and depth.

<sup>b</sup> Mean abundance for four replicate samples.

<sup>c</sup> Statistically significant depressions of abundance compared to the reference as determined by a t-test at the  $\alpha=0.05$  level.

**TABLE 3-17. BENTHIC ABUNDANCE FOR POLYCHAETA FOR HYLEBOS WATERWAY STATIONS AND COMMENCEMENT BAY REFERENCE STATIONS**

Station	Reference Station <sup>a</sup>	Mean Abundance <sup>b</sup> (per m <sup>2</sup> )	Significant t-Test <sup>c</sup>
<b>Hylebos Waterway</b>			
DAC-HY-01	DAC-HY-35	8,591.7 ± 555.2	Yes
DAC-HY-02	DAC-HY-35	7,441.7 ± 1,111.2	No
DAC-HY-03	DAC-HY-35	9,937.5 ± 950.9	Yes
DAC-HY-04	DAC-HY-35	6,229.2 ± 899.5	Yes
DAC-HY-05	DAC-HY-35	11,908.3 ± 1,139.5	Yes
DAC-HY-06	DAC-HY-35	5,362.5 ± 542.4	Yes
DAC-HY-07	DAC-HY-35	7,095.8 ± 1,805.3	Yes
DAC-HY-08	DAC-HY-30	4,795.8 ± 983.0	Yes
DAC-HY-09	DAC-HY-35	3,579.2 ± 2,172.7	Yes
DAC-HY-10	DAC-HY-30	6,154.2 ± 1,750.9	Yes
DAC-HY-11	DAC-HY-30	3,275.0 ± 777.6	Yes
DAC-HY-12	DAC-HY-35	5,287.5 ± 672.8	Yes
DAC-HY-13	DAC-HY-35	1,983.3 ± 758.0	Yes
DAC-HY-14	DAC-HY-35	7,887.5 ± 1,210.7	No
DAC-HY-15	DAC-HY-30	3,183.3 ± 434.1	Yes
DAC-HY-16	DAC-HY-30	5,500.0 ± 1,011.2	Yes
DAC-HY-17	DAC-HY-35	1,575.0 ± 277.2	Yes
DAC-HY-18	DAC-HY-30	8,179.2 ± 1,915.9	Yes
DAC-HY-19	DAC-HY-30	10,175.0 ± 1,651.8	No
DAC-HY-20	DAC-HY-30	7,575.0 ± 1,310.1	Yes
DAC-HY-21	DAC-HY-30	11,395.8 ± 1,779.4	No
DAC-HY-22	DAC-HY-30	17,495.8 ± 1,632.1	No
DAC-HY-23	DAC-HY-35	14,141.7 ± 1,745.1	No
DAC-HY-24	DAC-HY-30	10,970.8 ± 515.8	Yes
DAC-HY-25	DAC-HY-30	12,870.8 ± 979.3	No
DAC-HY-26	DAC-HY-30	7,583.3 ± 889.0	Yes
DAC-HY-27	DAC-HY-30	5,645.8 ± 168.0	Yes
DAC-HY-28	DAC-HY-30	7,366.7 ± 472.5	Yes
<b>Commencement Bay</b>			
DAC-HY-30	na	13,970.8 ± 665.3	na
DAC-HY-35	na	16,012.5 ± 441.2	na

<sup>a</sup> Corresponding reference station with similar grain size, TOC, and depth.

<sup>b</sup> Mean abundance for four replicate samples.

<sup>c</sup> Statistically significant depressions of abundance compared to the reference as determined by a t-test at the  $\alpha=0.05$  level.

**TABLE 4-1. STATION BY STATION CONTAMINANTS OF CONCERN THAT EXCEED SQS AND SQO CONCENTRATIONS, AND ENRICHMENT RATIOS FOR SURFACE SEDIMENTS OF HYLEBOS WATERWAY**

Station	Parameter	Concentration ( $\mu\text{g}/\text{kg OC}$ )	SQS ( $\mu\text{g}/\text{kg OC}$ )	ER	Concentration ( $\mu\text{g}/\text{kg DW}$ )	SQO ( $\mu\text{g}/\text{kg DW}$ )	ER
DAC-HY-01	Hexachlorobenzene	733	380	1.93			
	Hexachlorobutadiene				14	11	1.27
DAC-HY-02	1,2,4-Trichlorobenzene	1,610	810	1.99			
	Hexachlorobenzene	1,110	380	2.92			
	Hexachlorobutadiene				49	11	4.45
	Total PCBs	18,300	12,000	1.53			
DAC-HY-03	1,2,4-Trichlorobenzene	833	810	1.03			
	1,4-Dichlorobenzene	3,180	3,100	1.03			
	Hexachlorobenzene	1,150	380	3.03			
	Hexachlorobutadiene				25	11	2.27
DAC-HY-04	1,2,4-Trichlorobenzene	1,260	810	1.56			
	Hexachlorobenzene	1,260	380	3.32			
	Hexachlorobutadiene				37	11	3.36
	Total PCBs	12,600	12,000	1.05			
DAC-HY-05	1,2,4-Trichlorobenzene	1,570	810	1.94			
	Hexachlorobenzene	2,080	380	5.47	41	22	1.86
	Hexachlorobutadiene				75	11	6.82
	Total PCBs	17,800	12,000	1.48			
DAC-HY-06	1,2,4-Trichlorobenzene	5,030	810	6.21	97	51	1.9
	1,4-Dichlorobenzene	4,200	3,100	1.35			
	Hexachlorobutadiene	7,770	3,900	1.99	150	11	13.64
	Hexachlorobenzene	3,260	380	8.58	63	22	2.86
	Total PCBs	26,400	12,000	2.2			
DAC-HY-07	1,2,4-Trichlorobenzene	2,570	810	3.17			
	Hexachlorobutadiene	14,900	3,900	3.82	260	11	23.64
	Hexachlorobenzene	3,660	380	9.63	64	22	2.91
	Total PCBs	16,000	12,000	1.33			
DAC-HY-08	1,2,4-Trichlorobenzene	2,570	810	3.17	74	51	1.45
	Hexachlorobutadiene	8,330	3,900	2.14	240	11	21.82
	Hexachlorobenzene	1,880	380	4.95	54	22	2.45
	Total PCBs	27,400	12,000	2.28			

**TABLE 4-1. (CONTINUED)**

Station	Parameter	Concentration ( $\mu\text{g}/\text{kg OC}$ )	SQS ( $\mu\text{g}/\text{kg OC}$ )	ER	Concentration ( $\mu\text{g}/\text{kg DW}$ )	SQO ( $\mu\text{g}/\text{kg DW}$ )	ER
DAC-HY-09	Pentachlorophenol	790	360	2.19	790 J	360	2.19
	1,2,4-Trichlorobenzene	2,920	810	3.6	59	51	1.16
	Hexachlorobutadiene	10,900	3,900	2.79	220	11	20
	Bis(2-ethylhexyl)phthalat	54,500	47,000	1.16			
	Hexachlorobenzene	5,940	380	15.63	120	22	5.45
DAC-HY-10	1,2,4-Trichlorobenzene	5,390	810	6.65	110	51	2.16
	Hexachlorobutadiene	5,880	3,000	1.51	120	11	10.91
	Hexachlorobenzene	3,140	380	8.26	64	22	2.91
	Total PCBs	23,000	12,000	1.92			
DAC-HY-11	1,2,4-Trichlorobenzene	2,000	810	2.47			
	Hexachlorobenzene	1,900	380	5	40	22	1.82
	Hexachlorobutadiene				66	11	6
	Total PCBs	18,600	12,000	1.55			
DAC-HY-12	1,2,4-Trichlorobenzene	1,400	810	1.73			
	Hexachlorobenzene	1,800	380	4.74	45	22	2.05
	Hexachlorobutadiene				62	11	5.64
	Total PCBs	16,000	12,000	1.33			
DAC-HY-13	Hexachlorobenzene	635	380	1.67			
	Hexachlorobutadiene				16	11	1.45
DAC-HY-14	1,2,4-Trichlorobenzene	1,020	810	1.26			
	Hexachlorobenzene	1,090	380	2.87			
	Hexachlorobutadiene				23	11	2.00
	Total PCBs	15,600	12,000	1.3			
DAC-HY-15	Hexachlorobenzene	1,100	380	2.89	28	22	1.27
	Hexachlorobutadiene				25	11	2.27
	Total PCBs	16,100	12,000	1.34			
DAC-HY-16	Zinc	579 <sup>a</sup>	410	1.41	579	410	1.41
	Hexachlorobenzene	737	380	1.94	23	22	1.05
	Hexachlorobutadiene				25	11	2.27
	Total PCBs	19,200	12,000	1.6			
DAC-HY-17	Hexachlorobenzene	434	380	1.14			
	Total PCBs	28,500	12,000	2.38			

**TABLE 4-1. (CONTINUED)**

Station	Parameter	Concentration ( $\mu\text{g}/\text{kg OC}$ )	SQS ( $\mu\text{g}/\text{kg OC}$ )	ER	Concentration ( $\mu\text{g}/\text{kg DW}$ )	SQO ( $\mu\text{g}/\text{kg DW}$ )	ER
DAC-HY-18	1,2,4-Trichlorobenzene	890	810	1.1			
	Hexachlorobenzene	623	380	1.64			
	Hexachlorobutadiene				24	11	2.18
	Total PCBs	17,200	12,000	1.43			
DAC-HY-19	Benzo(g,h,i)perylene				940	720	1.31
	Indeno(1,2,3-c,d)pyrene				800	690	1.16
	Pyrene				3,800	3,300	1.15
	1,2,4-Trichlorobenzene	1,040	810	1.28			
	Hexachlorobenzene	545	380	1.43			
	Hexachlorobutadiene				27 UJ	11	2.45
	Total PCBs	17,400	12,000	1.45			
DAC-HY-20	Benzo(g,h,i)perylene				870	720	1.21
	Indeno(1,2,3-c,d)pyrene				720	690	1.04
	Hexachlorobenzene	569	380	1.5	23	22	1.05
	Hexachlorobutadiene				19	11	1.73
	Total PCBs	14,900	12,000	1.24			
DAC-HY-21	Benzo(g,h,i)perylene				880	720	1.22
	Indeno(1,2,3-c,d)pyrene				780	690	1.13
	1,2,4-Trichlorobenzene	944	810	1.17			
	Hexachlorobenzene	740	380	1.95	29	22	1.32
	Hexachlorobutadiene				24	11	2.18
	Total PCBs	15,300	12,000	1.28			
DAC-HY-22	Total PCBs	12,800	12,000	1.07			
	Phenanthrene				2,000	1,500	1.33
	Fluoranthene				2,900	2,500	1.16
	Hexachlorobutadiene				17	11	1.55
DAC-HY-23	Zinc	434 <sup>a</sup>	410	1.06	434	410	1.06
	Butylbenzyl phthalate	15,300	4,900	3.12			
	Total PCBs	14,000	12,000	1.17			
	Benzo(g,h,i)perylene				870	720	1.21
	Indeno(1,2,3-c,d)pyrene				750	690	1.09
	Total				3,900	3,600	1.08
	Hexachlorobutadiene				12	11	1.09

TABLE 4-1. (CONTINUED)

Station	Parameter	Concentration ( $\mu\text{g}/\text{kg OC}$ )	SQS ( $\mu\text{g}/\text{kg OC}$ )	ER	Concentration ( $\mu\text{g}/\text{kg DW}$ )	SQO ( $\mu\text{g}/\text{kg DW}$ )	ER
DAC-HY-24	Arsenic	120 <sup>a</sup>	57	2.11	120	57	2.11
	Anthracene				990	960	1.03
	Dibenz(a,h)anthracene				340	230	1.48
	Benz(a)anthracene				1,900	1,600	1.19
	Benzo(a)pyrene				1,800	1,600	1.13
	Benzo(g,h,i)perylene				1,300	720	1.81
	Chrysene				3,700	2,800	1.32
	Fluoranthene				6,100	2,500	2.44
	Total HPAHs				28,500	17,000	1.68
	Indeno(1,2,3-c,d)pyrene				1,100	690	1.59
	Pyrene				5,700	3,300	1.73
	Total				6,600	3,600	1.83
	Hexachlorobutadiene				12	11	1.09
	Bis(2-ethylhexyl)phthalat				1,400	1300	1.08
p,p'-DDD				16	16	1	
DAC-HY-25	Arsenic	61.4 <sup>a</sup>	57	1.08	61.4	57	1.08
	Dibenz(a,h)anthracene				280	230	1.22
	Benzo(g,h,i)perylene				1,000	720	1.39
	Indeno(1,2,3-c,d)pyrene				900	690	1.35
	Pyrene				3,400	3,300	1.03
	Total				4,800	3,600	1.33
	p,p'-DDE				9.6	9	1.07
DAC-HY-26	Dibenz(a,h)anthracene				240	230	1.04
	Benzo(g,h,i)perylene				870	720	1.21
	Indeno(1,2,3-c,d)pyrene				800	690	1.16
	Total				3,900	3,600	1.08
	p,p'-DDE				13	9	1.44
DAC-HY-27	Arsenic	97.6 <sup>a</sup>	57	1.71	97.6	57	1.71
DAC-HY-28	p,p'-DDD				21	16	1.31
	p,p'-DDE				12	9	1.33

## TABLE 4-1. (CONTINUED)

- NOTES:** na - Not applicable; the detection limit for this analyte exceeded the SQS.  
OC - Organic carbon  
ER - Enrichment ratio  
DW - Dry weight  
J - The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.  
UJ - The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- <sup>a</sup> Metals are in mg/kg dry weight.

**TABLE 4-2. CLASSIFICATION OF HYLEBOS WATERWAY STATIONS  
BASED ON SEDIMENT QUALITY TRIAD ANALYSIS**

Station	Number of Contaminants of Concern That Exceed Chemistry Objectives		Failed Laboratory Toxicity Test			Depressed Benthic Abundance Indices				Classification
	SQS (ER) <sup>a</sup>	SQO (ER) <sup>a</sup>	A	E	LP	C	M	P	T	
DAC-HY-01	1 (1.9)	1 (1.3)					✓	✓	✓	Potentially adversely affected
DAC-HY-02	3 (2.9)	1 (4.5)					✓		✓	Potentially adversely affected
DAC-HY-03	3 (3.0)	1 (2.3)						✓	✓	Potentially adversely affected
DAC-HY-04	3 (3.3)	1 (3.4)	✓	✓		✓	✓	✓	✓	Adversely affected
DAC-HY-05	3 (5.5)	2 (6.8)	✓	✓		✓		✓	✓	Adversely affected
DAC-HY-06	5 (8.6)	3 (13.6)				✓	✓	✓	✓	Potentially adversely affected
DAC-HY-07	4 (9.6)	2 (23.6)				✓	✓	✓	✓	Potentially adversely affected
DAC-HY-08	4 (5.0)	3 (21.8)	✓			✓	✓	✓	✓	Adversely affected
DAC-HY-09	5 (15.6)	4 (2.2)	✓			✓	✓	✓	✓	Adversely affected
DAC-HY-10	4 (8.3)	3 (10.9)	✓	✓		✓		✓	✓	Adversely affected
DAC-HY-11	3 (2.5)	2 (6.0)		✓		✓		✓	✓	Adversely affected
DAC-HY-12	3 (4.7)	2 (5.6)	✓			✓		✓	✓	Adversely affected
DAC-HY-13	1 (1.7)	1 (1.5)				✓	✓	✓	✓	Potentially adversely affected
DAC-HY-14	3 (2.9)	1 (2.1)				✓	✓		✓	Potentially adversely affected
DAC-HY-15	2 (2.9)	2 (2.3)		✓		✓		✓	✓	Adversely affected
DAC-HY-16	3 (1.9)	3 (2.3)				✓		✓	✓	Potentially adversely affected
DAC-HY-17	2 (2.4)	0				✓	✓	✓	✓	Potentially adversely affected
DAC-HY-18	3 (1.6)	1 (2.18)						✓		Potentially adversely affected
DAC-HY-19	3 (1.5)	4 (2.5)								Not adversely affected
DAC-HY-20	2 (1.5)	4 (1.7)		✓		✓		✓	✓	Adversely affected
DAC-HY-21	3 (2.0)	3 (2.2)				✓				Potentially adversely affected
DAC-HY-22	1 (1.1)	3 (1.6)				✓				Potentially adversely affected
DAC-HY-23	3 (3.1)	5 (1.2)		✓						Potentially adversely affected
DAC-HY-24	1 (2.1)	15 (2.4)	✓	✓		✓	✓	✓	✓	Adversely affected
DAC-HY-25	1 (1.1)	7 (1.4)		✓		✓				Adversely affected
DAC-HY-26	0	5 (1.4)				✓	✓	✓	✓	Potentially adversely affected
DAC-HY-27	1 (1.7)	1 (1.7)		✓		✓	✓	✓	✓	Adversely affected
DAC-HY-28	0	2 (1.3)				✓		✓	✓	Potentially adversely affected

## TABLE 4-2. (CONTINUED)

**NOTES:** ER - Enrichment ratio  
A - Amphipod mortality toxicity test  
E - Echinoderm mortality/abnormality test  
LP - Larval Polychaete growth test  
C - Crustacean abundance  
M - Molluscan abundance  
P - Polychaete abundance  
T - Total abundance

<sup>a</sup> Maximum enrichment ratio measured for contaminants exceeding the SQS for each station.

## **APPENDIX A**

### **CHEMISTRY DATA VALIDATION REPORTS**



EcoChem, Inc.

Environmental Science and Chemistry

**TRANSMITTAL**

**DATE:** March 13, 1995  
**PROJECT NO.:** 10201-1  
**VIA:** Federal Express  
**TO:** Mr. Rob Wolotira  
NOAA  
Damage Assessment Office  
7600 Sand Point Way  
Seattle, WA 98115-0070

**THE FOLLOWING MATERIALS ARE ENCLOSED:**

Hylebos Data Validation Report.

Please call if you have any questions.

Sincerely,

Ann K. Bailey  
President  
EcoChem, Inc.

**COPIES TO:** Chron  
Project Files  
Carol Ann Manen, NOAA

Enclosure(s)



EcoChem, Inc.

Environmental Science and Chemistry

## DATA VALIDATION REPORT

**Prepared for:**

U.S. Department of Commerce, NOAA  
Damage Assessment Center 102  
1305 East-West Highway  
N/ORCAx1, SSMC4  
Station 10218  
Silver Spring, MD 20910

**Prepared by:**

EcoChem, Inc.  
1401 Norton Building  
801 Second Avenue  
Seattle, Washington 98104

EcoChem Project Number: 10201-03

March 13, 1995

**Approved for Release**

Ann K. Bailey  
Project Director  
EcoChem, Inc.

**CONFIDENTIAL: ATTORNEY/CLIENT WORK PRIVILEGE**

## **BASIS FOR THE DATA PACKAGE REVIEW**

This report summarizes results from a review of analytical data packages from the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) laboratory. The Sample Index (TABLE 1) lists the samples and analytical fractions reviewed.

Data packages received from the laboratory consisted of a laboratory case narrative, sample results, and associated quality control (QC) information. Raw data from instrument read-outs were not reviewed.

The cursory data review was based on procedures and QC criteria documented in the laboratory standard operating procedures (SOPs), analytical methods listed in TABLE 2, and the following documents: NOAA/NMFS/Environmental Conservation Division, *Commencement Bay Damage Assessment Quality Assurance Plan* (June 7, 1994); U.S.EPA, *National Functional Guidelines for Organic Data Review* (February 1994); U.S.EPA, *National Functional Guidelines for Inorganic Data Review* (February 1994); and TetraTech, Inc., *Puget Sound Estuary Program Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound* (1986-1989).

## **OVERALL ASSESSMENT**

Results for each analytical fraction were reviewed and QC criteria were met, with the following exceptions:

### **Organic Analyses**

The calibrations associated with pentachlorophenol and the phthalates did not meet the percent difference criteria; phenol was detected in the method blanks at concentrations greater than three times the method detection limit (MDL), several compounds had calculated MDL that were greater than the target MDL; and a sample specific reporting limit was used instead of the calculated MDL. There were also several discrete non-compliances, such as low surrogate recoveries. None of these items were judged to significantly affect data usability

### **Inorganic Analyses**

Cadmium, mercury and nickel were observed in the method blank samples for both the strong acid and total acid digestion procedure data sets; SRM recoveries were low for arsenic (total acid set) and antimony (strong acid set) data; CBDA QAP specified target MDLs were not met for various metals in one or both digestion data sets; laboratory MDLs were not adjusted on a sample-by-sample basis to account for varying sample weights or percents solids, but were calculated using an average sample weight. Although specifically not a CBDA QAP requirement mercury results in the strong acid and total acid digestion analytical procedures were qualified as

estimated due to exceedences of the PSEP recommended 28 day holding time. None of these items were judged to significantly affect inorganic data usability.

The above items are discussed in detail in the following technical review narratives. All data, as qualified, are acceptable for use. The percent completeness for each fraction is 100%, meeting the CBDA QAP specified data quality objective of 90%.

**TABLE 1**  
**SAMPLE INDEX -- ORGANIC ANALYSES**

Client: National Oceanic & Atmospheric Administration  
Laboratory: Environmental Conservation Division, Northwest Fisheries Science Center  
EcoChem Project No.: 10201-03

Lab ID	Site	Matrix	SVOC	CH	AH
110-063	HY-02C-REF	Sediment	✓	✓	✓
110-064	HY-35C-REF	Sediment	✓	✓	✓
110-065	HY-01C	Sediment	✓	✓	✓
110-066	HY-02C	Sediment	✓	✓	✓
110-067	HY-03C	Sediment	✓	✓	✓
110-182	HY-03C REP 1	Sediment	✓	✓	✓
110-183	HY-03C REP 2	Sediment	✓	✓	✓
110-068	HY-04C	Sediment	✓	✓	✓
110-069	HY-05C	Sediment	✓	✓	✓
110-070	HY-06C	Filter	✓	✓	✓
110-071	HY-22FB	Sediment	✓	✓	✓
110-081	HY-08C	Sediment	✓	✓	✓
110-082	HY-09C	Sediment	✓	✓	✓
110-083	HY-10C	Sediment	✓	✓	✓
110-084	HY-11C	Sediment	✓	✓	✓
110-085	HY-12C	Sediment	✓	✓	✓
110-086	HY-13C	Sediment	✓	✓	✓
110-087	HY-14C	Sediment	✓	✓	✓
110-088	HY-11C	Air	✓	✓	✓
110-089	HY-16C	Sediment	✓	✓	✓
110-184	HY-16C REP 1	Sediment	✓	✓	✓
110-101	HY-17C	Sediment		✓	✓
110-102	HY-18C	Sediment		✓	✓
110-103	HY-19C	Sediment		✓	✓
110-104	HY-22C	Air		✓	✓
110-105	HY-21C	Sediment		✓	✓
110-106	HY-22C	Sediment		✓	✓
110-107	HY-07C	Sediment		✓	✓
110-120	HY-25C	Sediment	✓	✓	✓
110-121	HY-26C	Sediment	✓	✓	✓
110-122	HY-17C	Sediment	✓	✓	✓
110-123	HY-28C	Sediment	✓	✓	✓
110-186	HY-28C REP 1	Sediment	✓	✓	✓
110-187	HY-28C REP 2	Sediment	✓	✓	✓
110-124	HY-30C	Sediment	✓	✓	✓
110-125	HY-5CCB	Filter	✓	✓	✓
110-126	HY-32C	Sediment	✓	✓	✓
110-127	HY-33C	Sediment	✓	✓	✓
110-136	HY-17C	Sediment	✓		
110-137	HY-18C	Sediment	✓		
110-138	HY-19C	Sediment	✓		
110-139	HY-21C	Sediment	✓		
110-140	HY-22C	Sediment	✓		
110-141	HY-07C	Sediment	✓		
110-148	HY-23C	Sediment	✓	✓	✓
110-149	HY-24C	Sediment	✓	✓	✓
110-150	HY-20C	Sediment	✓	✓	✓
110-151	HY-34C	Sediment	✓	✓	✓
110-152	HY-31C	Sediment	✓	✓	✓
110-153	HY-15C	Sediment	✓	✓	✓
110-154	HY-2AC-REF	Sediment	✓	✓	✓

**TABLE 1**

**SAMPLE INDEX -- INORGANIC ANALYSES**

**Client:** National Oceanic & Atmospheric Administration

**Laboratory:** Environmental Conservation Division, Northwest Fisheries Science Center

**EcoChem Project No.:** 10201-03

Container ID	Site	Matrix	TMET	Butylins	Strong Acid
00455	HY-01C	Sediment	✓	✓	✓
00442	HY-02C	Sediment	✓	✓	✓
00428	HY-03C	Sediment	✓		✓
00428 Rep	HY-03C Rep	Sediment	✓		✓
00428 Replicate A	HY-03C Rep A	Sediment		✓	
00428 Replicate B	HY-03C Rep B	Sediment		✓	
00418	HY-04C	Sediment	✓	✓	✓
00383	HY-05C	Sediment	✓	✓	✓
00390	HY-05CCB	Filter	✓		✓
00364	HY-06C	Sediment	✓	✓	✓
00351	HY-07C	Sediment	✓	✓	✓
00351 Rep	HY-07C Rep	Sediment	✓		
00318	HY-08C	Sediment	✓	✓	✓
00350	HY-09C	Sediment	✓	✓	✓
00338	HY-10C	Sediment	✓	✓	✓
00297	HY-11C	Sediment	✓	✓	✓
00279	HY-12C	Sediment	✓	✓	✓
00010	HY-13C	Sediment	✓	✓	✓
00019	HY-14C	Sediment	✓	✓	✓
00019 Rep	HY-14C Rep	Sediment	✓		✓
00033	HY-15C	Sediment	✓		✓
0033 Replicate A	HY-15C Rep A	Sediment		✓	
0033 Replicate B	HY-15C Rep B	Sediment		✓	
00043	HY-16C	Sediment	✓	✓	✓
00061	HY-17C	Sediment	✓	✓	✓
00077	HY-18C	Sediment	✓	✓	✓
00092	HY-19C	Sediment	✓	✓	✓
00130	HY-20C	Sediment	✓	✓	✓
00141	HY-21C	Sediment	✓	✓	✓
00159	HY-22C	Sediment	✓	✓	✓
00176	HY-23C	Sediment	✓	✓	✓
00194	HY-24C	Sediment	✓		✓
00194 Replicate A	HY-24C Rep A	Sediment		✓	
00194 Replicate B	HY-24C Rep B	Sediment		✓	
00207	HY-25C	Sediment	✓	✓	✓
00222	HY-26C	Sediment	✓	✓	✓
00268	Field Blank	Sediment		✓	
00269	HY-26FB	Filter	✓		✓
00243	HY-27C	Sediment	✓	✓	✓
00270	HY-28C	Sediment	✓	✓	✓
00480	HY-30C	Sediment	✓	✓	✓
00117	HY-31C	Sediment	✓	✓	✓
00120	HY-32C	Sediment	✓	✓	✓
00398	HY-33C	Sediment	✓	✓	✓
00406	HY-34C	Sediment	✓	✓	✓
00529	HY-35C REF	Sediment	✓	✓	✓
00522	HY-CR-2AC REF	Sediment	✓		✓
00490	HY-CR-2C REF	Sediment	✓	✓	✓

## TABLE 2 ANALYTICAL METHOD REFERENCES

- NOAA Technical Memorandum, NOS ORCA 71: Sampling and Analytical Methods of the National Status and Trends Program, National Benthic Surveillance and Mussel Watch Projects, 1984-1992, *Vol IV, Comprehensive Descriptions of Trace Organics Analytical Methods*. July 1993.
- NOAA Technical Memorandum, NOS ORCA 71: Sampling and Analytical Methods of the National Status and Trends Program, National Benthic Surveillance and Mussel Watch Projects, 1984-1992, *Vol III, Comprehensive Descriptions of Elemental Analytical Methods*. July 1993.
- Krone, C.A., Brown, D.W., Burrows, D.G., Chan, S.-L. & Varanasi, U. (1989). A method for analysis of butyltin species and measurement of butyltins in sediment and English sole livers from Puget Sound. *Marine Environ.*, 26: 1-18.
- Krone, C.A., Chan, S.-L. and Varanasi, U. (1991) Butyltins in sediments and benthic fish tissues from the East, Gulf and Pacific coasts of the United States. In: *Oceans '91 Conference Proceedings Vol. 2.*, New York, New York, IEEE, p. 1054-1059.

### TABLE 3 DATA QUALIFIER DEFINITIONS

#### *Validation Qualifiers*

The following definitions provide brief explanations of the qualifiers assigned to results in the data review process.

---

U	The material was analyzed for, but was not detected. The associated numerical value is the sample detection limit; or the sample concentration was determined to be potentially affected by blank contamination.
J	The associated numerical value is an estimated quantity.
UJ	The material was analyzed for, but was not detected. The sample detection limit is an estimated quantity.

---

**DATA VALIDATION REPORT**  
**CURSORY DATA REVIEW**  
**PHthalates, PHenols, CHLORINATED BENZENES, AND**  
**HEXACHLOROBUTADIENE**

Analytical data for 36 sediment samples, one bottle blank sample, and two field (filter) blank samples were reviewed using quality control (QC) criteria documented in the laboratory standard operating procedures (SOP) and the Commencement Bay Damage Assessment Quality Assurance Plan (CBDA QAP). The samples were analyzed by National Marine Fisheries Service Laboratory. Refer to the Sample Index (Organic Analyses) for a complete listing of samples analyzed.

**I. COMPLETENESS**

Analytical results and results for associated quality control (QC) samples were received for the samples analyzed. The laboratory followed the QAP requirements for QC sample frequency of analysis, acceptance criteria, and corrective action processes. All anomalies were discussed in the case narrative.

**II. TECHNICAL DATA VALIDATION**

The quality control (QC) requirements that were reviewed are listed below. All criteria were met for all quality control requirements, except for those marked with an asterisk (\*). Those items marked with an asterisk are discussed below. A summary of qualified data is presented in **TABLE 4-SV**.

- \* Initial Calibration
- \* Calibration Verification
- \* Method Blanks
- \* Surrogate Spikes
- \* Laboratory Replicates
- \* Standard Reference Materials
- \* Matrix Spikes/Matrix Spike Duplicates
- \* Target Analyte List
- \* Reported Detection Limits

**Initial Calibration**

Initial calibrations were performed at the required frequency. A correlation coefficient was calculated for each compound. All correlation coefficients were greater than the QAP specified minimum of 0.990, with the exception of the di-n-octyl phthalate correlation coefficient for laboratory batch number H183 (at 0.9824). All positive results for di-n-octyl phthalate in batch H183 were qualified as estimated (J). Qualified data are summarized in **TABLE 4-SV**.

## Calibration Verification

Continuing calibration standards were analyzed before (labeled S1), during (S2), and after (S3) each analytical batch consisting of ten or less field samples. A concentration was calculated for each target analyte in each continuing calibration standard. The continuing calibration standard analyzed at the midpoint of the analytical sequence (S2) was used to assess the initial (S1) and final (S3) continuing calibration standards, in that the percent difference (%D) values were calculated for S1 as compared to S2, and the %D values for S3 were also compared to S2. All reported %D (percent difference) results were less than the control limit of 25% D. However, from the reported data, the S2 standard response (as compared to the initial calibration) cannot be assessed.

The following compounds had one or more %D values greater than 25%: pentachlorophenol, dimethyl phthalate, diethyl phthalate, di-n-butyl phthalate, benzylbutyl phthalate, bis (2-ethylhexyl) phthalate, and di-n-octyl phthalate, as well as surrogate compounds d5-phenol and dibenzyl phthalate. The average %D values for pentachlorophenol, dimethyl phthalate, diethyl phthalate, di-n-butyl phthalate, and the surrogate compound dibenzyl phthalate were also greater than 25%. The laboratory states in the case narrative that analysis of these compounds was affected by the high degree of contamination in the samples.

The following action was taken due to %D values greater than 25%: if one or more of the continuing calibrations associated with a set of samples (laboratory batch) had a %D value greater than 25%, the results for the compound with the %D outlier are estimated (J, positive results, UJ for the reporting limits for non-detected compounds). Qualified data are summarized in TABLE 4-SV.

## Method Blanks

Method blanks were analyzed at the required frequency. At least 7 of the 16 target compounds were detected in all of the method blanks. With the exception of phenol, the reported concentrations were less than three times the MDL, as specified in the QAP. To assess the affect of contamination sources on the reported sample data, action levels were established at 10 times the concentration detected in the method blanks. All associated sample results that are less than the action levels were qualified as not detected (U) at the reported concentrations (elevation of MDL). Qualified data are summarized in TABLE 4-SV.

As noted in the case narrative, phenol was present in all method blanks at concentrations greater than three times the MDL. Phenol was also detected in all field samples, including bottle blank and filter blank samples. The laboratory suggests that the surrogate spike solution used contained phenol as an impurity, and phenol was inadvertently spiked into all analyses. It is recommended that that an action level be determined at 10 times the average concentration found in the method blanks. All positive results reported for the samples less than this action level would then be qualified as undetected at the reported concentration. As the concentration of phenol in the blanks was so high (average is 15.1 ng/g), an action level of 10 times the blank concentration would result in the loss of all phenol results in the samples and the matrix spike analyses. The percent relative standard deviation for the phenol results in the blanks was 7.95%.

indicating that the level of phenol contamination was consistent. To assess the affect of contamination sources on the reported sample data, action levels were established using a criterion similar to that used to assess the standard reference material. A 95% confidence level was calculated, and the action level was established as the 95% confidence level (of the average concentration) plus 35%. This gave an action level of 18.3 ng/g for phenol. All associated sample phenol results that are less than this action level were qualified as not detected (U) at the reported concentrations (elevation of MDL). Qualified data are summarized in TABLE 4-SV.

Two filter blanks (HY-5CCB and HY-22FB) and one bottle blanks (HY-11C) were received at the laboratory. The filter and bottle blanks each contained from nine to eleven target compounds. All associated samples were either qualified based upon the method blanks, or had concentrations greater than the action levels, with the exception of the phthalate concentrations in the filter blanks. The filter blanks had very high levels of phthalates, up to 2900 ng/g. As it is not possible to determine if the phthalate contamination was present at such high levels in the filter blanks, or if the contamination represents carry over from some of the high level samples, no qualifiers were issued based upon the filter blank phthalate levels.

### Surrogate Spikes

Surrogate recovery values were within the control limits specified in the QAP, with one exception. The surrogate compound dibenzyl phthalate was less than the lower control limit at 35% in Sample HY-24C (laboratory number 110-149). Dibenzyl phthalate is used to calculate the concentrations of all of the phthalate target compounds. The phthalate target compounds in Sample HY-24C are qualified as estimated (J positive results, UJ for reporting limits of non-detected compounds) due to the low recovery.

### Laboratory Replicates

Samples HY-03C (three replicates), HY-16C (two replicates), and HY-28C (three replicates) were analyzed by the laboratory. Relative standard deviations were evaluated for each analyte. Most analytes met the criterion of  $\leq 50\%$  relative standard deviation (RSD) as specified in the QAP, with the following exceptions:

Analyte	Sample	Replicate 1	Replicate 1	Replicate 3	RSD Value
Di-n-octyl phthalate	HY-16C	4 ng/g	9 ng/g	not performed	54.4%
Diethyl phthalate	HY-28C	2 ng/g	5 ng/g	7 ng/g	53.9%

The high %RSD values for the compounds listed in the table above may be the result of matrix interferences, a poorly homogenized sample, or due to the presence of high levels of non-target compounds. For these reasons, qualification of data due to laboratory replicate precision outliers will apply only to the samples used for replicate analyses. Positive results for the compounds with high %RSD values are estimated (J) in the replicate samples. Qualified data are summarized in TABLE 4-SV.

## Standard Reference Material

Five replicate SRM samples were prepared and analyzed. No published concentrations exist for the target analytes; therefore, no evaluation of recovery was made.

## Matrix Spikes/Matrix Spike Duplicates

Two pairs of matrix spike/matrix spike duplicate (MS/MSD) sets were prepared and analyzed for the sediment matrix, meeting the frequency requirement. Percent recovery (%R) values were within control limits, with several exceptions. In one pair (laboratory batch H186), pentachlorophenol is greater than the 125% upper control limit at 193% and 187%, respectively. For laboratory batch H186, the %R value for bis (2-ethylhexyl) phthalate is at 136% and 139%, respectively, and is 140% in the MSD for batch H239. All pentachlorophenol results were previously estimated due to continuing calibration outliers, and no additional action was required. All positive bis (2-ethylhexyl) phthalate results not previously qualified due to calibration outliers are estimated (J). Qualified data are summarized in TABLE 4-SV.

Dimethyl phthalate had a %R value of 1% for both the MS and MSD in batch H239. The %R values were acceptable in batch H186. Although dimethyl phthalate is not a certified compound, dimethyl phthalate is present in the SRM, and had acceptable recovery values in all five replicates. The low recovery values in batch H239 were judged to be an isolated occurrence, possibly due to a spiking error. No data were qualified based upon the low dimethyl phthalate recovery values.

## Target Analyte List

The laboratory analyzed for hexachlorobutadiene. According to Table 1.2 of the QAP, this compound is not a target analyte. No action is required.

## Reported Detection Limits

The laboratory calculated MDL according to Appendix B of 40CFR, Part 136. However, the concentrations used for the seven replicate standards are significantly greater than the calculated MDL, ranging from a factor of 3 to a factor of 20 times greater than the MDL. The calculated MDL may not accurately reflect the instrument response at concentrations near the MDL. All calculated MDL are less than the target MDL specified in Table 6.1 of the QAP, with the exception of the dimethyl phthalate MDL of 6.83 ng/g (target MDL is 4 ng/g).

For analytes that were not detected, the laboratory did not report the MDL, but calculated a sample specific reporting limit based upon the response of the lowest standard and the sample weight and percent moisture. This method of reporting detection limits does not agree with the MDL reporting method specified in Table 6.1 of the QAP. However, most reported positive results are greater than the reporting limit and calculated MDL, or were qualified as not detected (U) due to blank contamination. No action was taken.

## Overall Assessment

Accuracy was acceptable, as demonstrated by the percent recovery values of most of the surrogate and matrix spiking compounds. Precision, as demonstrated by the RPD of the MS/MSD pairs, was acceptable.

Data were qualified based upon calibration outliers, method blank contamination, a low surrogate compound percent recovery value, poor laboratory replicate precision, and MS/MSD %R outliers.

The data, as qualified, are acceptable for use.

**TABLE 4-SVOC**  
**PHTHALATES, PHENOLS, HEXACHLOROBUTADIENE, CHLORINATED BENZENES**

Analyte	Sample ID	Site ID	Qualifier	QC Criteria
pDCB	110-065	HY-01C	U	Sample concentration < 10 x method blank concentration
MP2	110-065	HY-01C	U	Sample concentration < 10 x method blank concentration
DEPH	110-065	HY-01C	U	Sample concentration < 10 x method blank concentration
MP2	110-066	HY-02C	U	Sample concentration < 10 x method blank concentration
DEPH	110-066	HY-02C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-066	HY-02C	U	Sample concentration < 10 x method blank concentration
BBPH	110-066	HY-02C	U	Sample concentration < 10 x method blank concentration
pDCB	110-063	HY-02C-REF	U	Sample concentration < 10 x method blank concentration
MP2	110-063	HY-02C-REF	U	Sample concentration < 10 x method blank concentration
DMPH	110-063	HY-02C-REF	U	Sample concentration < 10 x method blank concentration
DEPH	110-063	HY-02C-REF	U	Sample concentration < 10 x method blank concentration
DnBPH	110-063	HY-02C-REF	U	Sample concentration < 10 x method blank concentration
BBPH	110-063	HY-02C-REF	U	Sample concentration < 10 x method blank concentration
bEHP	110-063	HY-02C-REF	U	Sample concentration < 10 x method blank concentration
DOPH	110-063	HY-02C-REF	U	Sample concentration < 10 x method blank concentration
MP2	110-067	HY-03C	U	Sample concentration < 10 x method blank concentration
DEPH	110-067	HY-03C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-067	HY-03C	U	Sample concentration < 10 x method blank concentration
DEPH	110-182	HY-03C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-182	HY-03C	U	Sample concentration < 10 x method blank concentration
DEPH	110-183	HY-03C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-183	HY-03C	U	Sample concentration < 10 x method blank concentration
MP2	110-068	HY-04C	U	Sample concentration < 10 x method blank concentration
DEPH	110-068	HY-04C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-068	HY-04C	U	Sample concentration < 10 x method blank concentration
MP2	110-069	HY-05C	U	Sample concentration < 10 x method blank concentration
DEPH	110-069	HY-05C	U	Sample concentration < 10 x method blank concentration
MP2	110-070	HY-06C	U	Sample concentration < 10 x method blank concentration
DEPH	110-070	HY-06C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-070	HY-06C	U	Sample concentration < 10 x method blank concentration
DEPH	110-141	HY-07C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-141	HY-07C	U	Sample concentration < 10 x method blank concentration
BBPH	110-141	HY-07C	U	Sample concentration < 10 x method blank concentration
DEPH	110-081	HY-08C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-081	HY-08C	U	Sample concentration < 10 x method blank concentration
DEPH	110-082	HY-09C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-082	HY-09C	U	Sample concentration < 10 x method blank concentration
DEPH	110-083	HY-10C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-083	HY-10C	U	Sample concentration < 10 x method blank concentration
pDCB	110-088	HY-11C	U	Sample concentration < 10 x method blank concentration
Phenol	110-088	HY-11C	U	Sample concentration < 10 x method blank concentration
PCP	110-088	HY-11C	U	Sample concentration < 10 x method blank concentration
DMPH	110-088	HY-11C	U	Sample concentration < 10 x method blank concentration
DEPH	110-088	HY-11C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-088	HY-11C	U	Sample concentration < 10 x method blank concentration
BBPH	110-088	HY-11C	U	Sample concentration < 10 x method blank concentration
bEHP	110-088	HY-11C	U	Sample concentration < 10 x method blank concentration

**TABLE 4-SVOC**  
**PHTHALATES, PHENOLS, HEXACHLOROBUTADIENE, CHLORINATED BENZENES**

Analyte	Sample ID	Site ID	Qualifier	QC Criteria
DOPH	110-088	HY-11C	U	Sample concentration < 10 x method blank concentration
DEPH	110-084	HY-11C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-084	HY-11C	U	Sample concentration < 10 x method blank concentration
DEPH	110-085	HY-12C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-085	HY-12C	U	Sample concentration < 10 x method blank concentration
mDCB	110-086	HY-13C	U	Sample concentration < 10 x method blank concentration
pDCB	110-086	HY-13C	U	Sample concentration < 10 x method blank concentration
PCP	110-086	HY-13C	U	Sample concentration < 10 x method blank concentration
DEPH	110-086	HY-13C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-086	HY-13C	U	Sample concentration < 10 x method blank concentration
BBPH	110-086	HY-13C	U	Sample concentration < 10 x method blank concentration
mDCB	110-087	HY-14C	U	Sample concentration < 10 x method blank concentration
PCP	110-087	HY-14C	U	Sample concentration < 10 x method blank concentration
DEPH	110-087	HY-14C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-087	HY-14C	U	Sample concentration < 10 x method blank concentration
pDCB	110-153	HY-15C	U	Sample concentration < 10 x method blank concentration
MP2	110-153	HY-15C	U	Sample concentration < 10 x method blank concentration
DEPH	110-153	HY-15C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-153	HY-15C	U	Sample concentration < 10 x method blank concentration
DEPH	110-089	HY-16C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-089	HY-16C	U	Sample concentration < 10 x method blank concentration
DEPH	110-184	HY-16C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-184	HY-16C	U	Sample concentration < 10 x method blank concentration
pDCB	110-136	HY-17C	U	Sample concentration < 10 x method blank concentration
DEPH	110-136	HY-17C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-136	HY-17C	U	Sample concentration < 10 x method blank concentration
BBPH	110-136	HY-17C	U	Sample concentration < 10 x method blank concentration
bEHP	110-136	HY-17C	U	Sample concentration < 10 x method blank concentration
DEPH	110-137	HY-18C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-137	HY-18C	U	Sample concentration < 10 x method blank concentration
DEPH	110-138	HY-19C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-138	HY-19C	U	Sample concentration < 10 x method blank concentration
DEPH	110-138	HY-19C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-138	HY-19C	U	Sample concentration < 10 x method blank concentration
pDCB	110-150	HY-20C	U	Sample concentration < 10 x method blank concentration
MP2	110-150	HY-20C	U	Sample concentration < 10 x method blank concentration
DEPH	110-150	HY-20C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-150	HY-20C	U	Sample concentration < 10 x method blank concentration
DEPH	110-139	HY-21C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-139	HY-21C	U	Sample concentration < 10 x method blank concentration
DEPH	110-140	HY-22C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-140	HY-22C	U	Sample concentration < 10 x method blank concentration
pDCB	110-071	HY-22FB	U	Sample concentration < 10 x method blank concentration
Phenol	110-071	HY-22FB	U	Sample concentration < 10 x method blank concentration
MP2	110-071	HY-22FB	U	Sample concentration < 10 x method blank concentration
DMPH	110-071	HY-22FB	U	Sample concentration < 10 x method blank concentration
DEPH	110-071	HY-22FB	U	Sample concentration < 10 x method blank concentration

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**TABLE 4-SVOC**  
**PHTHALATES, PHENOLS, HEXACHLOROBUTADIENE, CHLORINATED BENZENES**

Analyte	Sample ID	Site ID	Qualifier	QC Criteria
pDCB	110-148	HY-23C	U	Sample concentration < 10 x method blank concentration
DEPH	110-148	HY-23C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-148	HY-23C	U	Sample concentration < 10 x method blank concentration
pDCB	110-149	HY-24C	U	Sample concentration < 10 x method blank concentration
DEPH	110-149	HY-24C	U	Sample concentration < 10 x method blank concentration
MP2	110-120	HY-25C	U	Sample concentration < 10 x method blank concentration
DEPH	110-120	HY-25C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-120	HY-25C	U	Sample concentration < 10 x method blank concentration
MP2	110-121	HY-26C	U	Sample concentration < 10 x method blank concentration
DEPH	110-121	HY-26C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-121	HY-26C	U	Sample concentration < 10 x method blank concentration
MP2	110-122	HY-27C	U	Sample concentration < 10 x method blank concentration
DEPH	110-122	HY-27C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-122	HY-27C	U	Sample concentration < 10 x method blank concentration
MP2	110-123	HY-28C	U	Sample concentration < 10 x method blank concentration
DEPH	110-123	HY-28C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-123	HY-28C	U	Sample concentration < 10 x method blank concentration
DEPH	110-186	HY-28C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-186	HY-28C	U	Sample concentration < 10 x method blank concentration
DEPH	110-187	HY-28C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-187	HY-28C	U	Sample concentration < 10 x method blank concentration
pDCB	110-154	HY-2AC-REF	U	Sample concentration < 10 x method blank concentration
Phenol	110-154	HY-2AC-REF	U	Sample concentration < 10 x method blank concentration
MP2	110-154	HY-2AC-REF	U	Sample concentration < 10 x method blank concentration
DMPH	110-154	HY-2AC-REF	U	Sample concentration < 10 x method blank concentration
DEPH	110-154	HY-2AC-REF	U	Sample concentration < 10 x method blank concentration
DnBPH	110-154	HY-2AC-REF	U	Sample concentration < 10 x method blank concentration
BBPH	110-154	HY-2AC-REF	U	Sample concentration < 10 x method blank concentration
bEPH	110-154	HY-2AC-REF	U	Sample concentration < 10 x method blank concentration
DOPH	110-154	HY-2AC-REF	U	Sample concentration < 10 x method blank concentration
MP2	110-124	HY-30C	U	Sample concentration < 10 x method blank concentration
DEPH	110-124	HY-30C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-124	HY-30C	U	Sample concentration < 10 x method blank concentration
MP2	110-152	HY-31C	U	Sample concentration < 10 x method blank concentration
DEPH	110-152	HY-31C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-152	HY-31C	U	Sample concentration < 10 x method blank concentration
MP2	110-126	HY-32C	U	Sample concentration < 10 x method blank concentration
DEPH	110-126	HY-32C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-126	HY-32C	U	Sample concentration < 10 x method blank concentration
MP2	110-127	HY-33C	U	Sample concentration < 10 x method blank concentration
DEPH	110-127	HY-33C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-127	HY-33C	U	Sample concentration < 10 x method blank concentration
BBPH	110-127	HY-33C	U	Sample concentration < 10 x method blank concentration
MP2	110-151	HY-34C	U	Sample concentration < 10 x method blank concentration
DMPH	110-151	HY-34C	U	Sample concentration < 10 x method blank concentration
DEPH	110-151	HY-34C	U	Sample concentration < 10 x method blank concentration
DnBPH	110-151	HY-34C	U	Sample concentration < 10 x method blank concentration

# TABLE 4-SVOC

## PHTHALATES, PHENOLS, HEXACHLOROBUTADIENE, CHLORINATED BENZENES

Analyte	Sample ID	Site ID	Qualifier	QC Criteria
BBPH	110-151	HY-34C	U	Sample concentration < 10 x method blank concentration
pDCB	110-064	HY-35C-REF	U	Sample concentration < 10 x method blank concentration
MP2	110-064	HY-35C-REF	U	Sample concentration < 10 x method blank concentration
DEPH	110-064	HY-35C-REF	U	Sample concentration < 10 x method blank concentration
DnBPH	110-064	HY-35C-REF	U	Sample concentration < 10 x method blank concentration
BBPH	110-064	HY-35C-REF	U	Sample concentration < 10 x method blank concentration
pDCB	110-125	HY-5CCB	U	Sample concentration < 10 x method blank concentration
DMPH	110-125	HY-5CCB	U	Sample concentration < 10 x method blank concentration
DEPH	110-125	HY-5CCB	U	Sample concentration < 10 x method blank concentration
DnBPH	110-065	HY-01C	J	ICAL correlation coefficient < 0.990
DnBPH	110-066	HY-02C	J	ICAL correlation coefficient < 0.990
DnBPH	110-067	HY-03C	J	ICAL correlation coefficient < 0.990
DnBPH	110-068	HY-04C	J	ICAL correlation coefficient < 0.990
DnBPH	110-069	HY-05C	J	ICAL correlation coefficient < 0.990
DnBPH	110-070	HY-06C	J	ICAL correlation coefficient < 0.990
DnBPH	110-071	HY-22FB	J	ICAL correlation coefficient < 0.990
DnBPH	110-064	HY-35C-REF	J	ICAL correlation coefficient < 0.990
PCP (detects)	ALL	SAMPLES	J	CCAL individual and average %D values > 25%
PCP (non-detects)	ALL	SAMPLES	UJ	CCAL individual and average %D values > 25%
DMPH	110-065	HY-01C	J	CCAL %D values > 25%
DMPH	110-066	HY-02C	J	CCAL %D values > 25%
DMPH	110-063	HY-02C-REF	J	CCAL %D values > 25%
DMPH	110-067	HY-03C	J	CCAL %D values > 25%
DMPH	110-068	HY-04C	J	CCAL %D values > 25%
DMPH	110-069	HY-05C	J	CCAL %D values > 25%
DMPH	110-070	HY-06C	J	CCAL %D values > 25%
DMPH	110-064	HY-35C-REF	J	CCAL %D values > 25%
DMPH	110-153	HY-15C	J	CCAL %D values > 25%
DMPH	110-150	HY-20C	J	CCAL %D values > 25%
DMPH	110-148	HY-23C	J	CCAL %D values > 25%
DMPH	110-149	HY-24C	J	CCAL %D values > 25%
DMPH	110-154	HY-24C-REF	J	CCAL %D values > 25%
DMPH	110-152	HY-31C	J	CCAL %D values > 25%
DMPH	110-151	HY-34C	J	CCAL %D values > 25%
DMPH	110-141	HY-07C	J	CCAL %D values > 25%
DMPH	110-136	HY-17C	J	CCAL %D values > 25%
DMPH	110-137	HY-18C	J	CCAL %D values > 25%
DMPH	110-138	HY-19C	J	CCAL %D values > 25%
DMPH	110-139	HY-21C	J	CCAL %D values > 25%
DMPH	110-140	HY-22C	J	CCAL %D values > 25%
DMPH	110-182	HY-03C	J	CCAL %D values > 25%
DMPH	110-183	HY-03C	J	CCAL %D values > 25%
DMPH	110-184	HY-16C	J	CCAL %D values > 25%
DMPH	110-186	HY-28C	J	CCAL %D values > 25%
DMPH	110-187	HY-28C	J	CCAL %D values > 25%
DMPH	110-071	HY-22FB	UJ	CCAL %D values > 25%
DEPH	110-065	HY-01C	UJ	CCAL %D values > 25%

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**TABLE 4-SVOC**  
**PHTHALATES, PHENOLS, HEXACHLOROBUTADIENE, CHLORINATED BENZENES**

Analyte	Sample ID	Site ID	Qualifier	QC Criteria
DEPH	110-066	HY-02C	UJ	CCAL %D values > 25%
DEPH	110-063	HY-02C-REF	UJ	CCAL %D values > 25%
DEPH	110-067	HY-03C	UJ	CCAL %D values > 25%
DEPH	110-068	HY-04C	UJ	CCAL %D values > 25%
DEPH	110-069	HY-05C	UJ	CCAL %D values > 25%
DEPH	110-070	HY-06C	UJ	CCAL %D values > 25%
DEPH	110-064	HY-35C-REF	UJ	CCAL %D values > 25%
DEPH	110-071	HY-22FB	UJ	CCAL %D values > 25%
DEPH	110-120	HY-25C	UJ	CCAL %D values > 25%
DEPH	110-121	HY-26C	UJ	CCAL %D values > 25%
DEPH	110-122	HY-27C	UJ	CCAL %D values > 25%
DEPH	110-123	HY-28C	UJ	CCAL %D values > 25%
DEPH	110-124	HY-30C	UJ	CCAL %D values > 25%
DEPH	110-126	HY-32C	UJ	CCAL %D values > 25%
DEPH	110-127	HY-33C	UJ	CCAL %D values > 25%
DEPH	110-125	HY-5CCB	UJ	CCAL %D values > 25%
DEPH	110-153	HY-15C	UJ	CCAL %D values > 25%
DEPH	110-150	HY-20C	UJ	CCAL %D values > 25%
DEPH	110-148	HY-23C	UJ	CCAL %D values > 25%
DEPH	110-149	HY-24C	UJ	CCAL %D values > 25%
DEPH	110-154	HY-2AC-REF	UJ	CCAL %D values > 25%
DEPH	110-152	HY-31C	UJ	CCAL %D values > 25%
DEPH	110-151	HY-34C	UJ	CCAL %D values > 25%
DEPH	110-141	HY-07C	UJ	CCAL %D values > 25%
DEPH	110-136	HY-17C	UJ	CCAL %D values > 25%
DEPH	110-137	HY-18C	UJ	CCAL %D values > 25%
DEPH	110-138	HY-19C	UJ	CCAL %D values > 25%
DEPH	110-139	HY-21C	UJ	CCAL %D values > 25%
DEPH	110-140	HY-22C	UJ	CCAL %D values > 25%
DEPH	110-182	HY-03C	UJ	CCAL %D values > 25%
DEPH	110-183	HY-03C	UJ	CCAL %D values > 25%
DEPH	110-184	HY-16C	UJ	CCAL %D values > 25%
DEPH	110-186	HY-28C	UJ	CCAL %D values > 25%
DEPH	110-187	HY-28C	UJ	CCAL %D values > 25%
DnBPH	110-065	HY-01C	J	CCAL %D values > 25%
DnBPH	110-069	HY-05C	J	CCAL %D values > 25%
DnBPH	110-071	HY-22FB	J	CCAL %D values > 25%
DnBPH	110-125	HY-5CCB	J	CCAL %D values > 25%
DnBPH	110-066	HY-02C	UJ	CCAL %D values > 25%
DnBPH	110-063	HY-02C-REF	UJ	CCAL %D values > 25%
DnBPH	110-067	HY-03C	UJ	CCAL %D values > 25%
DnBPH	110-068	HY-04C	UJ	CCAL %D values > 25%
DnBPH	110-070	HY-06C	UJ	CCAL %D values > 25%
DnBPH	110-064	HY-35C-REF	UJ	CCAL %D values > 25%
DnBPH	110-120	HY-25C	UJ	CCAL %D values > 25%
DnBPH	110-121	HY-26C	UJ	CCAL %D values > 25%
DnBPH	110-122	HY-27C	UJ	CCAL %D values > 25%

# TABLE 4-SVOC

## PHTHALATES, PHENOLS, HEXACHLOROBUTADIENE, CHLORINATED BENZENES

Analyte	Sample ID	Site ID	Qualifier	QC Criteria
DnBPH	110-123	HY-28C	UJ	CCAL %D values > 25%
DnBPH	110-124	HY-30C	UJ	CCAL %D values > 25%
DnBPH	110-126	HY-32C	UJ	CCAL %D values > 25%
DnBPH	110-127	HY-33C	UJ	CCAL %D values > 25%
DnBPH	110-153	HY-15C	UJ	CCAL %D values > 25%
DnBPH	110-150	HY-20C	UJ	CCAL %D values > 25%
DnBPH	110-148	HY-23C	UJ	CCAL %D values > 25%
DnBPH	110-149	HY-24C	UJ	CCAL %D values > 25%
DnBPH	110-154	HY-2AC-REF	UJ	CCAL %D values > 25%
DnBPH	110-152	HY-31C	UJ	CCAL %D values > 25%
DnBPH	110-151	HY-34C	UJ	CCAL %D values > 25%
DnBPH	110-141	HY-07C	UJ	CCAL %D values > 25%
DnBPH	110-136	HY-17C	UJ	CCAL %D values > 25%
DnBPH	110-137	HY-18C	UJ	CCAL %D values > 25%
DnBPH	110-138	HY-19C	UJ	CCAL %D values > 25%
DnBPH	110-139	HY-21C	UJ	CCAL %D values > 25%
DnBPH	110-140	HY-22C	UJ	CCAL %D values > 25%
DnBPH	110-182	HY-03C	UJ	CCAL %D values > 25%
DnBPH	110-183	HY-03C	UJ	CCAL %D values > 25%
DnBPH	110-184	HY-16C	UJ	CCAL %D values > 25%
DnBPH	110-186	HY-28C	UJ	CCAL %D values > 25%
DnBPH	110-187	HY-28C	UJ	CCAL %D values > 25%
BBPH	110-065	HY-01C	J	CCAL %D values > 25%
BBPH	110-067	HY-03C	J	CCAL %D values > 25%
BBPH	110-068	HY-04C	J	CCAL %D values > 25%
BBPH	110-069	HY-05C	J	CCAL %D values > 25%
BBPH	110-070	HY-06C	J	CCAL %D values > 25%
BBPH	110-071	HY-22FB	J	CCAL %D values > 25%
BBPH	110-137	HY-18C	J	CCAL %D values > 25%
BBPH	110-138	HY-19C	J	CCAL %D values > 25%
BBPH	110-139	HY-21C	J	CCAL %D values > 25%
BBPH	110-140	HY-22C	J	CCAL %D values > 25%
BBPH	110-066	HY-02C	UJ	CCAL %D values > 25%
BBPH	110-063	HY-02C-REF	UJ	CCAL %D values > 25%
BBPH	110-064	HY-35C-REF	UJ	CCAL %D values > 25%
BBPH	110-141	HY-07C	UJ	CCAL %D values > 25%
BBPH	110-136	HY-17C	UJ	CCAL %D values > 25%
bEPH	110-065	HY-01C	J	CCAL %D values > 25%
bEPH	110-066	HY-02C	J	CCAL %D values > 25%
bEPH	110-067	HY-03C	J	CCAL %D values > 25%
bEPH	110-068	HY-04C	J	CCAL %D values > 25%
bEPH	110-069	HY-05C	J	CCAL %D values > 25%
bEPH	110-070	HY-06C	J	CCAL %D values > 25%
bEPH	110-064	HY-35C-REF	J	CCAL %D values > 25%
bEPH	110-071	HY-22FB	J	CCAL %D values > 25%
bEPH	110-141	HY-07C	J	CCAL %D values > 25%
bEPH	110-136	HY-17C	J	CCAL %D values > 25%

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**TABLE 4-SVOC**  
**PHTHALATES, PHENOLS, HEXACHLOROBUTADIENE, CHLORINATED BENZENES**

Analyte	Sample ID	Site ID	Qualifier	QC Criteria
bEPH	110-137	HY-18C	J	CCAL %D values > 25%
bEPH	110-138	HY-19C	J	CCAL %D values > 25%
bEPH	110-139	HY-21C	J	CCAL %D values > 25%
bEPH	110-140	HY-22C	J	CCAL %D values > 25%
bEPH	110-182	HY-03C	J	CCAL %D values > 25%
bEPH	110-183	HY-03C	J	CCAL %D values > 25%
bEPH	110-184	HY-16C	J	CCAL %D values > 25%
bEPH	110-186	HY-28C	J	CCAL %D values > 25%
bEPH	110-187	HY-28C	J	CCAL %D values > 25%
bEPH	110-063	HY-02C-REF	UJ	CCAL %D values > 25%
DOPH	110-182	HY-03C	J	CCAL %D values > 25%
DOPH	110-183	HY-03C	J	CCAL %D values > 25%
DOPH	110-184	HY-16C	J	CCAL %D values > 25%
DOPH	110-186	HY-28C	J	CCAL %D values > 25%
DOPH	110-187	HY-28C	J	CCAL %D values > 25%
DMPH	110-149	HY-24C	J	Dibenzyl phthalate surrogate %R 35% (LCL 50%)
DnBPH	110-149	HY-24C	J	Dibenzyl phthalate surrogate %R 35% (LCL 50%)
BBPH	110-149	HY-24C	J	Dibenzyl phthalate surrogate %R 35% (LCL 50%)
bEHP	110-149	HY-24C	J	Dibenzyl phthalate surrogate %R 35% (LCL 50%)
DOPH	110-149	HY-24C	J	Dibenzyl phthalate surrogate %R 35% (LCL 50%)
DEPH	110-149	HY-24C	UJ	Dibenzyl phthalate surrogate %R 35% (LCL 50%)
DOPH	110-184	HY-16C	J	Laboratory replicate %RSD > 50%
DOPH	110-089	HY-16C	J	Laboratory replicate %RSD > 50%
DEPH	110-186	HY-28C	J	Laboratory replicate %RSD > 50%
DEPH	110-187	HY-28C	J	Laboratory replicate %RSD > 50%
DEPH	110-123	HY-28C	J	Laboratory replicate %RSD > 50%
bEPH	110-081	HY-08C	J	MS/MSD %R values > 125%
bEPH	110-082	HY-09C	J	MS/MSD %R values > 125%
bEPH	110-083	HY-10C	J	MS/MSD %R values > 125%
bEPH	110-084	HY-11C	J	MS/MSD %R values > 125%
bEPH	110-085	HY-12C	J	MS/MSD %R values > 125%
bEPH	110-086	HY-13C	J	MS/MSD %R values > 125%
bEPH	110-087	HY-14C	J	MS/MSD %R values > 125%
bEPH	110-153	HY-15C	J	MS/MSD %R values > 125%
bEPH	110-089	HY-16C	J	MS/MSD %R values > 125%
bEPH	110-150	HY-20C	J	MS/MSD %R values > 125%
bEPH	110-148	HY-23C	J	MS/MSD %R values > 125%
bEPH	110-120	HY-25C	J	MS/MSD %R values > 125%
bEPH	110-121	HY-26C	J	MS/MSD %R values > 125%
bEPH	110-122	HY-27C	J	MS/MSD %R values > 125%
bEPH	110-123	HY-28C	J	MS/MSD %R values > 125%
bEPH	110-124	HY-30C	J	MS/MSD %R values > 125%
bEPH	110-152	HY-31C	J	MS/MSD %R values > 125%
bEPH	110-126	HY-32C	J	MS/MSD %R values > 125%
bEPH	110-127	HY-33C	J	MS/MSD %R values > 125%
bEPH	110-151	HY-34C	J	MS/MSD %R values > 125%
bEPH	110-125	HY-5CCB	J	MS/MSD %R values > 125%

# DATA VALIDATION REPORT

## CURSORY DATA REVIEW

### AROMATIC HYDROCARBONS

Analytical data for 36 sediment samples, two bottle blank samples, and two field (filter) blank samples were reviewed using quality control (QC) criteria documented in the laboratory standard operating procedures (SOP) and the Commencement Bay Damage Assessment Quality Assurance Plan (CBDA QAP). The samples were analyzed by National Marine Fisheries Service Laboratory. Refer to the Sample Index (Organic Analyses) for a complete listing of samples analyzed.

#### I. COMPLETENESS

Analytical results and results for associated quality control (QC) samples were received for the samples analyzed. The laboratory followed the QAP requirements for QC sample frequency of analysis, acceptance criteria, and corrective action processes. All anomalies were discussed in the case narrative.

#### II. TECHNICAL DATA VALIDATION

The quality control (QC) requirements that were reviewed are listed below. All criteria were met for all quality control requirements, except for those marked with an asterisk (\*). Those items marked with an asterisk are discussed below. A summary of qualified data is presented in **TABLE 4-AH**.

Technical Holding Times

Initial Calibration

- \* Continuing Calibration
- \* Blanks (Method and Field)
- \* Surrogate Spikes
- \* Laboratory Replicates
- \* Standard Reference Materials
- \* Matrix Spikes/Matrix Spike Duplicates
- Target Analyte List
- \* Method Detection Limits (MDL) and Reported Detection Limits

#### Continuing Calibration

Continuing calibration standards were analyzed before (labeled S1), during (S2), and after (S3) each analytical batch consisting of ten or less field samples. A concentration was calculated for each target analyte in each continuing calibration standard. The continuing calibration standard analyzed at the midpoint of the analytical sequence (S2) was used to assess the initial (S1) and final (S3) continuing calibration standards, in that the percent difference (%D) values were

calculated for S1 as compared to S2, and the %D values for S3 were also compared to S2. All reported %D (percent difference) results were less than the control limit of 25% D. However, from the reported data, the S2 standard response (as compared to the initial calibration) cannot be assessed.

As an initial calibration was analyzed for each sample batch, and as the average of the %D values for all continuing calibration standards analyzed during a batch were acceptable (all are less than 12%), instrument drift can be judged as not significant, and there is no impact on the reported data. From the data provided, the midpoint calibration response factors could not be compared to the initial calibration response factors. However, as almost all matrix spike and standard reference material (SRM) recovery values are acceptable, the calibration is also assumed to be acceptable, and no data qualification was made.

### **Blanks (Method and Field)**

Method blanks were analyzed at the required frequency. No target compounds were detected in the method blanks, with the exception of the method blank extracted with laboratory batch H186. This method blank (laboratory number 110-131) contained naphthalene, fluoranthene, and pyrene at low levels. The reported concentrations were less than three times the MDL, as specified in the QAP. To assess the affect of contamination sources on the reported sample data, action levels were established at 10 times the method blank concentration for naphthalene, fluoranthene, and pyrene. All associated sample results were greater than the action levels, with the exception of naphthalene in one of the filter blanks, Sample HY-5CCB (laboratory number 110-125). The naphthalene result in Sample HY-5CCB was qualified as not detected (U) at the reported concentration (elevation of MDL). Qualified data are summarized in TABLE 4-AH.

Two filter blanks (HY-5CCB and HY-22FB) and two bottle blanks (HY-22C and HY-11C) were received at the laboratory. Both bottle blanks and filter blank HY-5CCB contained low levels of naphthalene. The HY-5CCB result was qualified as not detected, as discussed above. All sample results were significantly greater than 10 times the bottle blank concentrations, so no action was taken.

### **Surrogate Spikes**

Surrogate recovery values were within the control limits specified in the QAP, with one exception. The surrogate compound benzo(a)pyrene-d12 was slightly greater than the 125% upper control limit (at 128%) in Sample HY-15C (laboratory sample number 110-153, batch H237). As all other surrogate values were acceptable in all samples and QC analyses, and as the SRM associated with batch H237 had no outliers, the slightly elevated surrogate recovery in Sample HY-15C was judged to have no significant impact on the reported data, and no action was taken.

### **Laboratory Replicates**

Several sets of laboratory replicates, Samples HY-03C (three replicates), HY-16C (two replicates), and HY-28C (three replicates) were analyzed by the laboratory. Relative standard

deviations for each analyte were evaluated. Most analytes met the criterion of  $\leq 50\%$  relative standard deviation (RSD) as specified in the QAP, with the following exceptions:

Analyte	Sample	Replicate 1	Replicate 2	Replicate 3	%RSD Value
2-Methylnaphthalene	HY-03C	150 ng/g	110 ng/g	310 ng/g	55.7%
Fluorene		310 ng/g	260 ng/g	1600 ng/g	105%
Phenanthrene		1400 ng/g	2100 ng/g	6100 ng/g	79.2%
Anthracene		740 ng/g	690 ng/g	3600 ng/g	99.4%
Fluoranthene		2400 ng/g	3800 ng/g	9000 ng/g	68.6%
Pyrene		1900 ng/g	3100 ng/g	5400 ng/g	51.3%
Fluorene	HY-16C	66 ng/g	160 ng/g	not performed	58.8%
Anthracene		160 ng/g	740 ng/g		91.1%

The high %RSD values for the compounds listed in the table above may be the result of matrix interferences, or due to the presence of high levels of non-target compounds. For these reasons, qualification of data due to laboratory replicate precision outliers will apply only to the samples used for replicate analyses. Positive results for the compounds with high %RSD values are estimated (J) in the replicate samples. Qualified data are summarized in TABLE 4-AH.

### Standard Reference Material

Five replicate SRM samples were prepared and analyzed. The concentrations are certified for all analytes except the following: naphthalene, 2-methylnaphthalene, acenaphthylene, acenaphthene, fluorene, chrysene, and dibenz(a,h)anthracene. These analytes were evaluated for recovery with the matrix spike/matrix spike duplicate samples.

Analyte recovery values met the acceptance criteria for both the average concentration and the individual concentration of the certified analytes. Individual certified analyte outliers are: phenanthrene and fluoranthene in laboratory batches H185 and H186, and pyrene in batch H237 had concentrations greater than the upper control limit. At least 70% of the individual analytes (analytes with concentrations 10 times the reported method detection limit) were within 35% of either end of the 95% confidence interval range of the reference value. The relative standard deviation (RSD) of the concentration results were calculated for each analyte from the five replicates. All %RSD values were less than 15%, indicating acceptable precision.

For laboratory batch H186, a matrix spike/matrix spike duplicate (MS/MSD) set were also submitted. Although phenanthrene and fluoranthene are certified analytes in the SRM, these compound were included in the MS/MSD set, and had recovery values greater than the 125% upper control limit. As both the SRM and MS/MSD results were greater than the control limits for phenanthrene and fluoranthene in batch H186, these compounds were judged to have a possible high bias, and all positive results for these compounds in the associated samples were qualified as estimated (J). Qualified data are summarized in TABLE 4-AH.

## Matrix Spikes/Matrix Spike Duplicates

Two pairs of matrix spike/matrix spike duplicate (MS/MSD) sets were prepared and analyzed for the sediment matrix, meeting the frequency requirement. All analyte recovery values and the relative percent differences between the analyte pairs were within the control limits specified in the QAP, with the exception of phenanthrene and fluoranthene in the MS/MSD set analyzed with laboratory batch H186. These compounds were evaluated by the SRM results, as discussed above.

## Method Detection Limits (MDL) and Reported Detection Limits

The laboratory calculated MDL according to Appendix B of 40CFR, Part 136. However, the concentrations used for the seven replicate standards are significantly greater than the calculated MDL, ranging from a factor of 2 to a factor of 20 times greater than the MDL. The calculated MDL may not accurately reflect the instrument response at concentrations near the MDL.

The MDL listed by the laboratory for four analytes (2-methylnaphthalene at 5.22 ng/g, acenaphthene at 4.51 ng/g, fluorene at 5.20 ng/g and dibenz(a,h)anthracene at 4.64 ng/g), were greater than the target MDL specified in Table 6.1 of the QAP. With the exception of the 2-methylnaphthalene result for Sample HY-2AC-REF (laboratory number 110-154) at 2 ng/g, all reported results for these compounds are significantly greater than the calculated MDL, so no action was required. Although the 2-methylnaphthalene result for Sample HY-2AC-REF was less than the calculated MDL, the result was two times greater than the sample specific reporting limit established for this sample.

For analytes that were not detected, the laboratory did not report the MDL, but calculated a sample specific reporting limit based upon the response of the lowest standard and the sample weight and percent moisture. This method of reporting detection limits does not agree with the MDL reporting method specified in Table 6.1 of the QAP. However, the only analyses that do not have positive results for all compounds are the bottle and filter blanks, and Samples HY-02C-REF, HY-2AC-REF, and HY-35C-REF. As all field sample results are significantly greater than the reporting limit and calculated MDL (except as noted above), sample results were judged to be not affected.

## Overall Assessment

On the basis of this evaluation, the laboratory followed the general analytical methodology as outlined in the QAP and laboratory SOP.

Accuracy, as demonstrated by the recovery values of most of the surrogate, matrix spike, and standard reference material (SRM) compounds was acceptable. Precision, as demonstrated by the relative standard deviation (RSD) of the replicate concentrations of the SRM and the RPD of the MS/MSD pairs, was acceptable.

The data, as qualified, are acceptable for use.

**TABLE 4-AH**  
**AROMATIC HYDROCARBONS**

Analyte	Sample ID	Site ID	Qualifier	QC Criteria
Naphthalene	110-125	HY-5CCB	U	Sample concentration < 10x method blank level
Phenanthrene	110-120	HY-25C	J	Recovery above UCL in SRM and MS/MSD sets
Phenanthrene	110-121	HY-26C	J	Recovery above UCL in SRM and MS/MSD sets
Phenanthrene	110-122	HY-27C	J	Recovery above UCL in SRM and MS/MSD sets
Phenanthrene	110-123	HY-28C	J	Recovery above UCL in SRM and MS/MSD sets
Phenanthrene	110-124	HY-30C	J	Recovery above UCL in SRM and MS/MSD sets
Phenanthrene	110-126	HY-32C	J	Recovery above UCL in SRM and MS/MSD sets
Phenanthrene	110-127	HY-33C	J	Recovery above UCL in SRM and MS/MSD sets
Fluoranthene	110-120	HY-25C	J	Recovery above UCL in SRM and MS/MSD sets
Fluoranthene	110-121	HY-26C	J	Recovery above UCL in SRM and MS/MSD sets
Fluoranthene	110-122	HY-27C	J	Recovery above UCL in SRM and MS/MSD sets
Fluoranthene	110-123	HY-28C	J	Recovery above UCL in SRM and MS/MSD sets
Fluoranthene	110-124	HY-30C	J	Recovery above UCL in SRM and MS/MSD sets
Fluoranthene	110-126	HY-32C	J	Recovery above UCL in SRM and MS/MSD sets
Fluoranthene	110-127	HY-33C	J	Recovery above UCL in SRM and MS/MSD sets
2-Methylnaphthalene	110-067	HY-03C	J	Laboratory replicate %RSD > 50%
Fluorene	110-067	HY-03C	J	Laboratory replicate %RSD > 50%
Phenanthrene	110-067	HY-03C	J	Laboratory replicate %RSD > 50%
Anthracene	110-067	HY-03C	J	Laboratory replicate %RSD > 50%
Fluoranthene	110-067	HY-03C	J	Laboratory replicate %RSD > 50%
Pyrene	110-067	HY-03C	J	Laboratory replicate %RSD > 50%
2-Methylnaphthalene	110-182	HY-03C	J	Laboratory replicate %RSD > 50%
Fluorene	110-182	HY-03C	J	Laboratory replicate %RSD > 50%
Phenanthrene	110-182	HY-03C	J	Laboratory replicate %RSD > 50%
Anthracene	110-182	HY-03C	J	Laboratory replicate %RSD > 50%
Fluoranthene	110-182	HY-03C	J	Laboratory replicate %RSD > 50%
Pyrene	110-182	HY-03C	J	Laboratory replicate %RSD > 50%
2-Methylnaphthalene	110-083	HY-03C	J	Laboratory replicate %RSD > 50%
Fluorene	110-083	HY-03C	J	Laboratory replicate %RSD > 50%
Phenanthrene	110-083	HY-03C	J	Laboratory replicate %RSD > 50%
Anthracene	110-083	HY-03C	J	Laboratory replicate %RSD > 50%
Fluoranthene	110-083	HY-03C	J	Laboratory replicate %RSD > 50%
Pyrene	110-083	HY-03C	J	Laboratory replicate %RSD > 50%
Fluorene	110-089	HY-16C	J	Laboratory replicate %RSD > 50%
Anthracene	110-089	HY-16C	J	Laboratory replicate %RSD > 50%
Fluorene	110-084	HY-16C	J	Laboratory replicate %RSD > 50%
Anthracene	110-084	HY-16C	J	Laboratory replicate %RSD > 50%

# DATA VALIDATION REPORT

## CURSORY DATA REVIEW

### CHLORINATED HYDROCARBONS

Analytical data for 36 sediment samples, two bottle blank samples, and two field (filter) blank samples were reviewed using quality control (QC) criteria documented in the laboratory standard operating procedures (SOP) and the Commencement Bay Damage Assessment Quality Assurance Plan (CBDA QAP). The samples were analyzed by National Marine Fisheries Service Laboratory. Refer to the Sample Index (Organic Analyses) for a complete listing of samples analyzed.

#### I. COMPLETENESS

Analytical results and results for associated quality control (QC) samples were received for the samples analyzed. The laboratory followed the QAP requirements for QC sample frequency of analysis, acceptance criteria, and corrective action processes. All anomalies were discussed in the case narrative.

#### II. TECHNICAL DATA VALIDATION

The quality control (QC) requirements that were reviewed are listed below. All criteria were met for all quality control requirements, except for those marked with an asterisk (\*). Those items marked with an asterisk are discussed below. A summary of qualified data is presented in **TABLE 4-CII**.

- Initial Calibration
- \* Calibration Verification
- Blanks (Method and Field)
- \* Surrogate Spikes
- \* Laboratory Replicates
- \* Standard Reference Materials
- Matrix Spikes/Matrix Spike Duplicates
- Target Analyte List
- \* Method Detection Limits (MDL) and Reported Detection Limits

#### Calibration Verification

Continuing calibration standards were analyzed before (labeled S1), during (S2), and after (S3) each analytical batch consisting of ten or less field samples. A concentration was calculated for each target analyte in each continuing calibration standard. The continuing calibration standard analyzed at the midpoint of the analytical sequence (S2) was used to assess the initial (S1) and final (S3) continuing calibration standards, in that the percent difference (%D) values were

calculated for S1 as compared to S2, and the %D values for S3 were also compared to S2. All reported %D (percent difference) results were less than the control limit of 25% D. However, from the reported data, the S2 standard response (as compared to the initial calibration) cannot be assessed.

As an initial calibration was analyzed for each sample batch, and as the average of the %D values for all continuing calibration standards analyzed during a batch were acceptable (all are less than 10%), instrument drift was not significant, and there is no impact on the reported data. From the data provided, the midpoint calibration response factors could not be compared to the initial calibration response factors. However, as almost all matrix spike and standard reference material (SRM) recovery values are acceptable, the calibration is also assumed to be acceptable, and no data qualification was made.

### **Blanks (Method and Field)**

Method blanks were analyzed at the required frequency. Hexachlorobenzene was detected at a low concentration in the method blank extracted with laboratory batch H183 (laboratory number 110-073). The reported concentration was less than three times the MDL, as specified in the QAP. To assess the affect of contamination sources on the reported sample data, action levels were established at 10 times the concentration detected in the method blank. All associated sample results were greater than the hexachlorobenzene action levels, with the exception of Sample HY-02C-REF. The hexachlorobenzene result in this sample was qualified as not detected (U) at the reported concentration (elevation of MDL). Qualified data are summarized in **TABLE 4-CH**.

Chlorobiphenyl congeners (PCB) were detected in all of the method blanks, at low levels. At least four of the 17 congeners were detected in each method blank. All of the reported chlorobiphenyl congener results were less than three times the MDL. To assess the affect of contamination sources on the reported sample data, action levels were established at 10 times the concentration detected in the method blank. All associated sample results that are less than the action levels were qualified as not detected (U) at the reported concentrations (elevation of MDL). Qualified data are summarized in **TABLE 4-CH**.

Two filter blanks (HY-5CCB and HY-22FB) and two bottle blanks (HY-22C and HY-11C) were received at the laboratory. Filter blank HY-5CCB contained low levels of alpha and gamma chlordanes, and filter blank HY-22FB contained a low level of hexachlorobenzene. All bottle and filter blanks contained five to ten of the 17 chlorobiphenyl congeners. All associated samples were either qualified based upon the method blanks, or had concentrations greater than the action levels. No further action was taken.

### **Surrogate Spikes**

Surrogate recovery values were within the control limits specified in the QAP, with one exception. Recovery of the surrogate compound (dibromooctafluorobiphenyl) was less than the lower control limit at 39% in Sample HY-34C (laboratory number 110-151). All positive results

in this sample are qualified as estimated (J), and the detection limits for non-detected compounds are qualified as estimated (UJ). Qualified data are summarized in TABLE 4-CH.

### Laboratory Replicates

Several sets of laboratory replicates, Samples HY-03C (three replicates), HY-16C (two replicates), and HY-28C (three replicates) were analyzed by the laboratory. Relative standard deviation values for each analyte were evaluated. Most analytes met the criterion of  $\leq 50\%$  relative standard deviation (RSD) as specified in the QAP, with the following exceptions:

Analyte	Sample	Replicate 1	Replicate 1	Replicate 3	%RSD Value
alpha & gamma-Chlordane	HY-16C	6 ng/g	2 ng/g	not performed	70.7%
Congener 153		61 ng/g	28 ng/g		52.4%
p,p'-DDT	HY-28C	2 ng/g	1 ng/g	4 ng/g	65.5%
Congener 195		3 ng/g	0.8 ng/g	1 ng/g	76.0%

The high %RSD values for the compounds listed in the table above may be the result of matrix interferences, a poorly homogenized sample, or due to the presence of high levels of non-target compounds. For these reasons, qualification of data due to laboratory replicate precision outliers will apply only to the samples used for replicate analyses. Positive results for the compounds with high %RSD values are estimated (J) in the replicate samples. Qualified data are summarized in TABLE 4-CH.

### Standard Reference Material

Five replicate SRM samples were prepared and analyzed. There are no certified concentrations for any of the target analytes. Non-certified concentrations are available for all compounds except the following: hexachlorobenzene, heptachlor, lindane, aldrin, alpha and gamma chlordane, and Congeners 44 and 128. All analytes were evaluated for recovery using the matrix spike/matrix spike duplicate analyses.

### Reported Detection Limits

The laboratory calculated MDL according to Appendix B of 40CFR, Part 136. However, the concentrations used for the seven replicate standards are significantly greater than the calculated MDL, ranging from a factor of 3 to a factor of 24 times greater than the MDL. The calculated MDL may not accurately reflect the instrument response at concentrations near the MDL. All calculated MDL are less than the target MDL specified in Table 6.1 of the QAP.

For analytes that were not detected, the laboratory did not report the MDL, but calculated a sample specific reporting limit based upon the response of the lowest standard and the sample weight and percent moisture. This method of reporting detection limits does not agree with the MDL reporting method specified in Table 6.1 of the QAP. However, most reported positive results are greater than the reporting limit and calculated MDL. No data were qualified.

## Overall Assessment

On the basis of this evaluation, the laboratory followed the general analytical methodology as outlined in the QAP.

Accuracy, as demonstrated by the recovery values of most of the surrogate and matrix spike compounds was acceptable. Precision, as demonstrated by the RPD of the MS/MSD pairs, was acceptable.

Data qualifiers were issued due to blank contamination, a low surrogate recovery, and poor laboratory replicate precision.

The data, as qualified, are acceptable for use.

**TABLE 4-CH**  
**CHLORINATED HYDROCARBONS**

Analyte	Sample ID	Site ID	Qualifier	QC Criteria
All positive result	110-151	HY-34C	J	Surrogate recovery (39%) below LCL (50%)
All non-detects	110-151		UJ	Surrogate recovery (39%) below LCL (50%)
Alpha & gamma chlordanes	110-089	HY-16C	J	Laboratory replicate %RSD > 50%
PCB Congener 153	110-089		J	Laboratory replicate %RSD > 50%
Alpha & gamma chlordanes	110-184	HY-16C	J	Laboratory replicate %RSD > 50%
PCB Congener 153	110-184		J	Laboratory replicate %RSD > 50%
p,p'-DDT	110-123	HY-28C	J	Laboratory replicate %RSD > 50%
PCB Congener 195	110-123		J	Laboratory replicate %RSD > 50%
p,p'-DDT	110-186	HY-28C	J	Laboratory replicate %RSD > 50%
PCB Congener 195	110-186		J	Laboratory replicate %RSD > 50%
p,p'-DDT	110-187	HY-28C	J	Laboratory replicate %RSD > 50%
PCB Congener 195	110-187		J	Laboratory replicate %RSD > 50%
Hexachlorobenzene	110-063	HY-02C-REF	U	Sample concentration < 10x Method blank level
PCB Congener 28	110-065	HY-01C	U	Sample concentration < 10x Method blank level
PCB Congener 28	110-063	HY-02C-REF	U	Sample concentration < 10x Method blank level
PCB Congener 28	110-071	HY-22FB	U	Sample concentration < 10x Method blank level
PCB Congener 28	110-064	HY-35C-REF	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-065	HY-01C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-066	HY-02C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-063	HY-02C-REF	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-067	HY-03C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-069	HY-05C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-071	HY-22FB	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-064	HY-35C-REF	U	Sample concentration < 10x Method blank level
PCB Congener 66	110-067	HY-03C	U	Sample concentration < 10x Method blank level
PCB Congener 66	110-071	HY-22FB	U	Sample concentration < 10x Method blank level
PCB Congener 101	110-063	HY-02C-REF	U	Sample concentration < 10x Method blank level
PCB Congener 101	110-071	HY-22FB	U	Sample concentration < 10x Method blank level
PCB Congener 138	110-063	HY-02C-REF	U	Sample concentration < 10x Method blank level
PCB Congener 138	110-071	HY-22FB	U	Sample concentration < 10x Method blank level
PCB Congener 153	110-063	HY-02C-REF	U	Sample concentration < 10x Method blank level
PCB Congener 153	110-071	HY-22FB	U	Sample concentration < 10x Method blank level
PCB Congener 170	110-065	HY-01C	U	Sample concentration < 10x Method blank level
PCB Congener 170	110-066	HY-02C	U	Sample concentration < 10x Method blank level
PCB Congener 170	110-063	HY-02C-REF	U	Sample concentration < 10x Method blank level
PCB Congener 170	110-070	HY-06C	U	Sample concentration < 10x Method blank level
PCB Congener 170	110-064	HY-35C-REF	U	Sample concentration < 10x Method blank level
PCB Congener 209	110-071	HY-22FB	U	Sample concentration < 10x Method blank level
PCB Congener 209	110-071		U	Sample concentration < 10x Method blank level
PCB Congener 28	110-088	HY-11C	U	Sample concentration < 10x Method blank level
PCB Congener 28	110-086	HY-13C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-082	HY-09C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-083	HY-10C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-088	HY-11C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-084	HY-11C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-085	HY-12C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-086	HY-13C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-087	HY-14C	U	Sample concentration < 10x Method blank level
PCB Congener 138	110-088	HY-11C	U	Sample concentration < 10x Method blank level
PCB Congener 209	110-088	HY-11C	U	Sample concentration < 10x Method blank level
PCB Congener 28	110-104	HY-22C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-107	HY-07C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-102	HY-18C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-104	HY-22C	U	Sample concentration < 10x Method blank level

**TABLE 4-CH**  
**CHLORINATED HYDROCARBONS**

Analyte	Sample ID	Site ID	Qualifier	QC Criteria
PCB Congener 44	110-106	HY-22C	U	Sample concentration < 10x Method blank level
PCB Congener 52	110-104	HY-22C	U	Sample concentration < 10x Method blank level
PCB Congener 66	110-104	HY-22C	U	Sample concentration < 10x Method blank level
PCB Congener 118	110-104	HY-22C	U	Sample concentration < 10x Method blank level
PCB Congener 138	110-104	HY-22C	U	Sample concentration < 10x Method blank level
PCB Congener 153	110-104	HY-22C	U	Sample concentration < 10x Method blank level
PCB Congener 209	110-104	HY-22C	U	Sample concentration < 10x Method blank level
PCB Congener 28	110-124	HY-30C	U	Sample concentration < 10x Method blank level
PCB Congener 28	110-125	HY-5CCB	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-122	HY-27C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-123	HY-28C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-124	HY-30C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-126	HY-32C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-127	HY-33C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-125	HY-5CCB	U	Sample concentration < 10x Method blank level
PCB Congener 66	110-125	HY-5CCB	U	Sample concentration < 10x Method blank level
PCB Congener 209	110-125	HY-5CCB	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-154	HY-2AC-REF	U	Sample concentration < 10x Method blank level
PCB Congener 138	110-154	HY-2AC-REF	U	Sample concentration < 10x Method blank level
PCB Congener 170	110-154	HY-2AC-REF	U	Sample concentration < 10x Method blank level
PCB Congener 28	110-183	HY-03C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-182	HY-03C	U	Sample concentration < 10x Method blank level
PCB Congener 44	110-183	HY-03C	U	Sample concentration < 10x Method blank level
PCB Congener 66	110-182	HY-03C	U	Sample concentration < 10x Method blank level
PCB Congener 66	110-183	HY-03C	U	Sample concentration < 10x Method blank level

# DATA VALIDATION REPORT

## CURSORY DATA REVIEW

### METALS ANALYSIS USING TOTAL ACID DIGESTION

Analytical data for 36 sediment and two field blank (filter) samples were reviewed using quality control (QC) criteria documented in the analytical method and the Commencement Bay Damage Assessment Quality Assurance Plan (CBDA QAP). Refer to the Sample Index (Inorganic Analyses) for a complete listing of samples analyzed.

#### I. COMPLETENESS

Analytical results and associated QC samples were received for samples analyzed. The laboratory followed the CBDA QAP requirements for QC sample frequency of analysis, acceptance criteria, and corrective action processes. All anomalies were discussed in the case narrative.

#### II. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below. All criteria were met for all quality control requirements, except those marked with an asterisk (\*) and are discussed below. A summary of qualified data is presented in TABLE 4-MET.

- \* Technical Holding Times
  - Initial Calibration
  - Initial and Continuing Calibration Verification
- \* Blanks (Method and Field)
- \* Standard Reference Materials (SRM)
  - Matrix Spike Sample Analysis
  - Duplicate Sample Analysis
- \* Reported Method Detection Limits (MDLs)

#### Technical Holding Times

Chain-of-Custody forms indicated that all samples were received by the National Marine Fisheries Service (NMFS) laboratory using custody procedures as specified in the CBDA QAP. NMFS reported in their SOP that an interlaboratory Chain-of-Custody was used, and that samples were locked in a freezer with security tape-type seals. Since holding times were not specified in the CBDA QAP, the advisory holding times of 1 year for metals, and 28 days for mercury samples were used (*Puget Sound Estuary Program Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound*, March, 1986). All metals analyses, except for mercury, were completed within these recommended holding times. Mercury results for all samples were qualified as estimated. Qualified data are summarized in TABLE 4-MET.

## Blanks (Method and Field)

Cadmium results for nine samples, including the filter wipes HY-05CCB and HY-26FB, were qualified as non-detected (U) due to the presence of cadmium in the associated method blanks ranging from 0.004 to 4.14 µg/g.

Mercury was detected in 5 of 12 method blanks ranging from 0.025 to 0.088µg/g. Eight field samples had mercury concentrations less than five times the amount detected in their associated method blank and were qualified as not-detected (U) with elevated MDLs. Qualified data are summarized in TABLE 4-MET.

## Standard Reference Materials (SRM)

The CBDA QAP requirement of 1 SRM per 10 field samples and more than 70% of the analytes within 35% of either end of the 95% confidence interval range of the reference values was met. Results outside the confidence interval were as follows:

Analyte	SRM ID	Result (µg/g)	Range (µg/g)	MDL (µg/g)	Action Taken
Silver	MESS-2 4	0.075	0.10-0.27	0.007	None. All other 14 SRM values in control limits.
	MESS-2 6B	0.099	0.10-0.27		
Arsenic	NIST2704 6A	12.9	14.7-32.7	0.136	All samples qualified as estimated.
	NIST2704 6B	13.3	14.7-32.7		
	MESS-2 6A	9.05	12.9-29.0		
	MESS-2 6B	9.05	12.9-29.0		
Cadmium	NIST2704 6A	1.77	2.10-4.95	0.004	None. All 15 other SRM values in control limits.
Chromium	BCSS-1 1A	68.7	71-185	1.75	None. All 13 other SRM values in control limits.
	PACS-1 3	66.6	68-163		
	PACS-1 6	61.0	68-163		
Mercury	MESS-2 5	0.053	0.054-0.136	0.024	None. Results just slightly low, and within 3 times the MDL.
	MESS-2 6A	0.050	0.054-0.136		
	MESS-2 6B	0.042	0.054-0.136		
	PACS-1 6	6.43	2.87-5.95		None. Conc. of this SRM significantly higher than associated samples.
Antimony	NIST2704 6B	<1.22	2.37-5.32	1.22	None. Affect on data cannot be determined. SRM values lower than MDL or reported values within 3 times the MDL.
	BCSS-1 5	1.25	0.34-0.88		
	MESS-1 2	<1.22	0.42-1.09		
	MESS-1 4	<1.22	0.42-1.09		
	BCSS-1 1A	<1.22	0.34-0.88		
	BCSS-1 1C	<1.22	0.34-0.88		
Antimony	BCSS-1 2	<1.22	0.34-0.88	1.22	None. Affect on data cannot be determined. SRM values lower than MDL or reported values within 3 times the MDL.
	MESS-2 5	<1.22	0.62-1.65		
	MESS-2 6A	<1.22	0.62-1.65		
	MESS-2 6B	<1.22	0.62-1.65		

Qualified data are summarized in TABLE 4-MET.

### Reported Method Detection Limits (MDLs)

Results for the metals analyses were significantly greater than the detection limit, except for the filter blanks, the blind reference material samples (REF), and in Sample HY-30c (antimony only). These results did not meet the target MDLs in the CBDA QAP as follows:

Analyte	Target MDL ( $\mu\text{g/g}$ )	Reported MDL ( $\mu\text{g/g}$ )	Affected Samples (non-detects only)
Antimony	0.1	1.22	HY-05CCB, HY-26FB, HY-30C, HY-35C REF, HY-CR-2AC REF, HY-CR-2C REF
Arsenic	0.1	0.136	HY-05CCB, HY-26FB
Chromium	1.0	1.75	HY-05CCB, HY-26FB
Lead	0.1	0.486	HY-05CCB, HY-26FB
Mercury	0.01	0.024	HY-05CCB, HY-26FB, HY-CR-2C REF
Nickel	0.1	0.783	HY-05CCB, HY-26FB
Zinc	5.0	15.75	HY-05CCB, HY-26FB, HY-CR-2C REF

Laboratory MDLs were not adjusted to account for varying sample weights or percent solids, but were calculated using an average sample weight. Data usability was judged not to be affected and results were not qualified.

### Overall Assessment

Mercury results for all samples were qualified as estimated due to holding time exceedences. Results may be biased low. Cadmium results in nine samples and mercury results in eight samples were qualified as not-detected due to their presence in the method blank samples.

All arsenic results were qualified as estimated due to SRM recoveries that were less than the certified lower control limit. Arsenic may be biased low. For the analysis of antimony, accuracy could not be determined as all SRM certified values were less than the laboratory MDL or the measured values were less than three times the MDL.

Target MDLs were not met for antimony, arsenic, chromium, lead, mercury, nickel and zinc. Laboratory MDLs were not adjusted to account for varying sample weights or percent solids, but were calculated using an average sample weight. No qualification of data was necessary, and data usability was determined not to be affected.

**TABLE 4-MET**  
**TOTAL ACID DIGESTION**

Analyte	Container ID	Site ID	Qualifier	QC Criteria
Mercury	00455	HY-01C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00442	HY-02C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00428 Rep	HY-03C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00418	HY-04C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00383	HY-05C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00364	HY-06C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00351	HY-07C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00351	HY-07C Rep	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00243	HY-27C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00480	HY-30C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00117	HY-31C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00120	HY-32C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00428	HY-03C Rep	J	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	0390/0269	HY-05CCB	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	0390/0269	HY-26FB	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00318	HY-08C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00350	HY-09C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00338	HY-10C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00297	HY-11C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00010	HY-12C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00010	HY-13C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00019	HY-14C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00019	HY-14C Rep	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00033	HY-15C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00043	HY-16C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00061	HY-17C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00077	HY-18C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00092	HY-19C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00130	HY-20C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00141	HY-21C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00159	HY-22C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00176	HY-23C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00194	HY-24C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00207	HY-25C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00222	HY-26C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00270	HY-28C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00398	HY-33C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00406	HY-34C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00529	HY-35C REF	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00522	HY-CR-2AC REF	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00490	HY-CR-2C REF	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Cadmium	00455	HY-01C	U	MDL < sample result < 10 x blank value
Cadmium	00442	HY-02C	U	MDL < sample result < 10 x blank value
Cadmium	00428	HY-03C	U	MDL < sample result < 10 x blank value
Cadmium	00418	HY-04C	U	MDL < sample result < 10 x blank value
Cadmium	00383	HY-05C	U	MDL < sample result < 10 x blank value
Cadmium	0390/0269	HY-05CCB	U	MDL < sample result < 10 x blank value

TABLE 4-MET  
TOTAL ACID DIGESTION

Analyte	Container ID	Site ID	Qualifier	QC Criteria
Cadmium	0390/0269	HY-26FB	U	MDL < sample result < 10 x blank value
Cadmium	00364	HY-06C	U	MDL < sample result < 10 x blank value
Cadmium	00351	HY-07C	U	MDL < sample result < 10 x blank value

**DATA VALIDATION REPORT**  
**CURSORY DATA REVIEW**  
**METALS ANALYSIS USING STRONG ACID DIGESTION**

Analytical data for 36 sediment and two field blank (filter) samples were reviewed using quality control (QC) criteria documented in the analytical method and the Commencement Bay Damage Assessment Quality Assurance Plan (CBDA QAP). Refer to the Sample Index (Inorganic Analyses) for a complete listing of samples analyzed.

**I. COMPLETENESS**

Analytical results and associated QC samples were received for samples analyzed. The laboratory followed the CBDA QAP requirements for QC sample frequency of analysis, acceptance criteria, and corrective action processes. All anomalies were discussed in the case narrative.

**II. TECHNICAL DATA VALIDATION**

The quality control (QC) requirements that were reviewed are listed below. All criteria were met for all quality control requirements, except those marked with an asterisk (\*) and are discussed below. A summary of qualified data is presented in **TABLE 4-MET**.

- \* Technical Holding Times
  - Initial Calibration
  - Initial and Continuing Calibration Verification
- \* Blanks (Method and Field)
- \* Standard Reference Materials (SRM)
  - Matrix Spike Sample Analysis
  - Duplicate Sample Analysis
- \* Reported Method Detection Limits (MDLs)

**Technical Holding Times**

Chain-of-Custody forms indicated that all samples were received by the National Marine Fisheries Service (NMFS) laboratory using custody procedures as specified in the CBDA QAP. NMFS reported in their SOP that an interlaboratory Chain-of-Custody was used, and that samples were locked in a freezer with security tape-type seals. Since holding times were not specified in the CBDA QAP, the advisory holding times of 1 year for metals, and 28 days for mercury samples were used (*Puget Sound Estuary Program Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound*, March, 1986). All metals analyses, except for mercury, were completed within these recommended holding times. Mercury results for all samples were qualified as estimated. Qualified data are summarized in **TABLE 4-MET**.

## Blanks (Method and Field)

Cadmium results for Samples HY-30c, HY-31c, and HY-32c were qualified as not-detected (U) due to the presence of cadmium at 0.207 µg/g in the associated method blank.

Nickel was detected in 9 of 12 method blanks ranging from 0.21 to 1.06µg/g. All samples except HY-05CCB and HY-26FB had concentrations greater than five times the amount detected in their associated method blank, so no action was required. Samples HY-05CCB and HY-26FB were qualified as not-detected (U) with elevated MDLs.

Mercury was detected in 12 of 12 method blanks ranging from 0.037 to 0.0626µg/g. Ten field samples had mercury concentrations less than five times the amount detected in their associated method blank and were qualified as not-detected (U) with elevated MDLs. Qualified data are summarized in TABLE 4-MET.

## Standard Reference Materials (SRM)

The CBDA QAP requirement of 1 SRM per 10 field samples and more than 70% of the analytes within 35% of either end of the 95% confidence interval range of the reference values, does not apply to samples digested by the strong acid method or those results less than ten times the MDL. However, the data were evaluated using these criteria for the purpose of this technical review.

The above criteria were met, except for the analyte antimony. In these SRMs (NIST 2704, BCSS-1, MESS-1, MESS-2), certified analyte levels were less than the MDL, thus recoveries could not be determined. The remaining antimony SRM results (3 measurements of SRM PACS-1) were less than the lower control limit. The certified value for this SRM is 171 µg/g while associated samples ranged from <0.995 to 5.37 µg/g. As sample results are at least an order of magnitude below the SRM material value and the other SRM data cannot be evaluated, all antimony results were qualified as estimated.

Cadmium and mercury each had one SRM recovery outside of recovery criteria. As the other SRMs for these two metals were within criteria, no qualification of data was performed. SRM recoveries for the remaining analytes were within acceptance criteria. Qualified data are summarized in TABLE 4-MET.

## Reported Method Detection Limits (MDLs)

Results for the metals analyses were significantly greater than the detection limit, for the following analytes. These results did not meet the target MDLs in the CBDA QAP as follows:

Analyte	Target MDL (µg/g)	Reported MDL (µg/g)	Affected Samples (non-detects only)
Antimony	0.1	0.995	20 samples
Arsenic	0.1	13.0	11 samples
Copper	1.0	2.28	None (all samples detected)
Lead	0.1	0.179	HY-5CCB, HY-26FB

Analyte	Target MDL ( $\mu\text{g/g}$ )	Reported MDL ( $\mu\text{g/g}$ )	Affected Samples (non-detects only)
Mercury	0.01	0.0139	None (all samples detected)
Nickel	0.1	0.20	None (all samples detected)
Silver	0.01	0.018	HY-5CCB, HY-26FB

Laboratory MDLs were not adjusted to account for varying sample weights or percent solids, but were calculated using an average sample weight. Data usability was judged not to be affected and no results were qualified.

### Overall Assessment

Mercury results for all samples were been qualified as estimated due to holding time exceedences. Results may be biased low. Cadmium results in three samples, nickel results in two samples, and mercury results in 10 samples were qualified as not-detected due to their presence in the method blank samples.

All antimony results were qualified as estimated due to SRM recoveries that were less than the certified lower control limit. Additionally, for the analysis of antimony, accuracy could often not be determined as most SRM certified values were less than the laboratory MDL.

Target MDLs were not met for antimony, arsenic, copper, lead, mercury, nickel and silver. Laboratory MDLs were not adjusted to account for varying sample weights or percent solids, but were calculated using an average sample weight. No qualification of data was necessary, and data usability was determined not to be affected.

## TABLE 4-MET

## STRONG ACID DIGESTION

Analyte	Container ID	Site ID	Qualifier	QC Criteria
Cadmium	00270	HY-28C	U	MDL < sample result < 10 x blank value
Cadmium	00480	HY-30C	U	MDL < sample result < 10 x blank value
Cadmium	00447	HY31C	U	MDL < sample result < 10 x blank value
Cadmium	00120	HY-32C	U	MDL < sample result < 10 x blank value
Nickel	00390	HY-05CCB	U	MDL < sample result < 10 x blank value
Mercury	00455	HY-01C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00442	HY-02C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00428 Rep	HY-03 Rep	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00418	HY-04C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00383	HY-05C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00390	HY-05CCB	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00364	HY-06C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00351	HY-07C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00318	HY-08C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00350	HY-09C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00338	HY-10C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00297	HY-11C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00279	HY-12C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00010	HY-13C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00019	HY-14C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00019 Rep	HY-14 Rep	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00033	HY-15C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00043	HY-16C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00061	HY-17C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00077	HY-18C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00269	HY-26FB	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00480	HY-30C	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00529	HY-35 REF	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00522	HY-CR-2AC REF	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00490	HY-CR-2C REF	UJ	MDL < sample result < 10 x blank value and holding time > 28 days
Mercury	00428	HY-03C	J	Holding time > 28 days
Mercury	00092	HY-19C	J	Holding time > 28 days
Mercury	00130	HY-20C	J	Holding time > 28 days
Mercury	00141	HY-21C	J	Holding time > 28 days
Mercury	00159	HY-22C	J	Holding time > 28 days
Mercury	00176	HY-23C	J	Holding time > 28 days
Mercury	00194	HY-24C	J	Holding time > 28 days
Mercury	00207	HY-25C	J	Holding time > 28 days
Mercury	00222	HY-26C	J	Holding time > 28 days
Mercury	00243	HY-27C	J	Holding time > 28 days
Mercury	00270	HY-28C	J	Holding time > 28 days
Mercury	00117	HY-31C	J	Holding time > 28 days
Mercury	00120	HY-32C	J	Holding time > 28 days
Mercury	00398	HY-33C	J	Holding time > 28 days
Mercury	00406	HY-34C	J	Holding time > 28 days

# DATA VALIDATION REPORT

## CURSORY DATA REVIEW

### BUTYLINS

Analytical data for 36 sediment and one field blank samples were reviewed using quality control (QC) criteria documented in the analytical method and the Commencement Bay Damage Assessment Quality Assurance Plan (CBDA QAP). Refer to the Sample Index (Inorganic Analyses) for a complete listing of samples analyzed.

#### I. COMPLETENESS

Analytical results and associated QC samples were received for samples analyzed. The laboratory followed the QAP requirements for QC sample frequency of analysis, acceptance criteria, and corrective action processes. All anomalies were discussed in the case narrative.

#### II. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below. All criteria were met for all quality control requirements, except those marked with an asterisk (\*) and are discussed below.

- \* Technical Holding Times
  - Initial Calibration
  - Initial and Continuing Calibration Verification
  - Blanks (Method and Field)
  - Surrogate Spike Sample Analysis
  - Standard Reference Materials (SRM)
  - Matrix Spike Sample Analysis
  - Duplicate Sample Analysis
  - Reported Method Detection Limits (MDLs)

#### Technical Holding Times

Chain-of-Custody forms indicated that all samples were received by the National Marine Fisheries Service (NMFS) laboratory using custody procedures as specified in the CBDA QAP. NMFS reported in their SOP that an interlaboratory Chain-of-Custody was used, and that samples were locked in a freezer with security tape-type seals. Since holding times were not specified in the CBDA QAP, the advisory holding time of 1 year for butyltins (the holding time for semivolatile organics and metals) was used (*Puget Sound Estuary Program Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound*, March, 1986). All analyses were completed within this holding time.

## Overall Assessment

Precision, as measured by the RPD between duplicate sample pairs was acceptable. Accuracy, as measured by the percent recovery of the SRMs was acceptable for all tributyltin species. QA/QC requirements of the CBDA QAP were met. All data, as reported, are acceptable for use.

**DATA VALIDATION REPORT**  
**Volatile Organic Analyses**  
**Method: 8260**  
**Laboratory No.: H342**

**I. DELIVERABLES AND DOCUMENTATION**

All necessary data and documentation for volatile organic analyses were provided by the laboratory. Good documentation practices were observed by the laboratory in the following areas: changes and corrections were struck out by a single line and the entry initialed and dated by the analyst; correction fluid or tape was not found on any of the raw data, and proper units for numerical values were used.

**II. CHAIN-OF-CUSTODY**

Field Chain-of-Custody forms were present and complete. All forms were signed and dated. The field Chain-of-Custody forms indicate no problems with sample receipt conditions. The air blank and PE (CLP quality control standard) samples were not listed on the Chain-of-Custody form. All samples listed on the Chain-of-Custody forms were analyzed as requested.

**III. FIELD QUALITY CONTROL**

One air blank (DAC-HY-22AB) was collected and analyzed for volatile organic compounds. No volatile organic compounds were detected in the air blank. No field duplicate samples were submitted with this SDG.

**IV. TECHNICAL ASSESSMENT**

**1.0 Sample Holding Times: ACCEPTABLE/All criteria met**

The analytical holding time criterion for sediment matrices is 14 days from date of collection to date of analysis. All samples were analyzed within seven days of sampling.

**2.0 GC/MS instrument performance Check: ACCEPTABLE/All criteria met.**

Bromofluorobenzene (BFB) was analyzed at the beginning of each twelve hour calibration period as required. All appropriate BFB data were provided, and all results were within the specified control limits.

**3.0 Initial and Continuing Calibrations:** ACCEPTABLE/All criteria met.

All relative response factor (RRF) in the initial and continuing calibrations were above the 0.05 lower control limit. All percent relative standard deviation (%RSD) values in the initial calibration and percent difference (%D) values in the continuing calibrations were within the control limits.

**4.0 Method Blank Analyses:** ACCEPTABLE/All criteria met.

The frequency requirement of one method blank for every 20 samples was met. No target compounds were detected in the method blanks.

**5.0 Surrogate Recovery:** ACCEPTABLE/All criteria met.

Surrogate spiking compound recovery values were reviewed by recalculation. No transcription or calculation errors were noted. All percent recovery values were within the control limits.

**6.0 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Sample Analyses:**  
ACCEPTABLE/All criteria met.

MS/MSD analyses were performed on Sample DAC-HY-21C. The percent recovery values in this set of MS/MSD analyses ranged from 70.0% to 95.8%. The RPD values in this set of MS/MSD analyses ranged from 1.0% to 14%. All MS/MSD percent recovery and RPD values were acceptable.

**7.0 Laboratory Control Sample (LCS) Analyses:** ACCEPTABLE/All criteria met.

One laboratory control sample was analyzed and reviewed. The percent recovery values ranged from 90.2% to 97.8%, and are within acceptable ranges.

**8.0 Internal Standards Performance:** ACCEPTABLE/All criteria met.

All internal standard areas were within the technical acceptance window (50% to 200% of associated continuing calibration internal standard area). All internal standard retention times were within plus or minus 30 seconds of the associated continuing calibration internal standard relation time for the samples.

**9.0 Compound Identification:** ACCEPTABLE/With the following discussion.

**Qualified Data:** None.

**Discussion:**

All compound identifications were reviewed and were found to be acceptable. One target compound (1,2,4-trichlorobenzene) was not listed on the submitted sample results summary form (Form I) for the water sample (DAC-HY-22AB). The laboratory was contacted, and a corrected Form I was submitted. No further action was taken.

**10.0 Compound Quantitation and Quantitation Limits (QL):** ACCEPTABLE/With the following discussion.

**Qualified Data:** None.

**Discussion:**

Sample target compound concentrations were recalculated to verify results. No errors were found. Compound quantitation was acceptable.

All reported quantitation limits were adjusted correctly for sample size and dilution factors. The percent moisture content was greater than 50% in several samples. Due to the high percent moisture content, the reported results may have a high bias for these samples. However, as bias cannot be clearly established, no action was taken.

**11.0 System Performance:** ACCEPTABLE/All criteria met.

No signs of degraded instrument performance were observed. The analytical systems were judged to have been in tune, within control, and stable during the course of these analyses.

**V. OVERALL ASSESSMENT OF THE DATA**

Based on this review, the laboratory followed the specified method. One PE sample (CLP quality control standard) was analyzed and reviewed. The percent recovery values were acceptable.

Precision is acceptable, as demonstrated by the RPD values of the MS/MSD analyses. Accuracy is acceptable, as demonstrated by MS/MSD and LCS recovery values.

All data, as reported, are acceptable for use.

**DATA VALIDATION REPORT**  
**Volatile Organic Analyses**  
**Method: 8260**  
**Laboratory No.: H373**

**I. DELIVERABLES AND DOCUMENTATION**

All necessary data and documentation for volatile organic analyses were provided by the laboratory. Good documentation practices were observed by the laboratory in the following areas: changes and corrections were struck out by a single line and the entry initialed and dated by the analyst; correction fluid or tape was not found on any of the raw data, and proper units for numerical values were used.

**II. CHAIN-OF-CUSTODY**

Field Chain-of-Custody forms were present and complete. All forms were signed and dated. The field Chain-of-Custody forms indicate no problems with sample receipt conditions. Three of six containers for Sample DAC-HY-5C were incorrectly labeled as DAC-HY-5T. The rinsate blank (DAC-HY-30VB) was incorrectly labeled as DAC-HY-30C. The trip blank and PE (CLP quality control standard) sample were not listed on Chain-of-Custody. All samples listed on the Chain-of-Custody forms were analyzed.

**III. FIELD QUALITY CONTROL**

Two field rinsate blanks (DAC-HY-30VB and DAC-HY-19VB) and one trip blank were collected and analyzed for volatile organic compounds. No volatile organic compound was detected in any of the blanks.

Two sets of field replicates (DAC-HY-6C/DAC-HY-34C/DAC-HY-33C and DAC-HY-19C/DAC-HY-32C/DAC-HY-31C) were analyzed and reviewed. One compound (1,4-Dichlorobenzene) was detected in Sample DAC-HY-34C at a concentration of 11 µg/kg, but was not detected in the replicate analysis. Trichloroethene was detected in Sample DAC-HY-33C at a concentration of 3.2 µg/kg, but was not detected in the replicate. No other volatile organic compounds were detected in any of the field replicate samples. The relative percent difference (RPD) values are not calculable.

#### IV. TECHNICAL ASSESSMENT

##### 1.0 Sample Holding Times: ACCEPTABLE/With the following exceptions.

###### Qualified Data:

Compound	Qualifier	Sample ID	Holding Times	QC Criteria
All target compounds	UJ	DAC-HY-19VB Trip Blank	17 days 22 days	14 days

###### Discussion:

The analytical holding time criterion for preserved water and sediment matrices are 14 days from date of collection to date of analysis. All samples were analyzed within 14 days of sampling with the exceptions of Samples DAC-IYY-19VB (17 days) and Trip Blank (22 days). No target compounds were detected in either sample. Due to a possible low bias, the detection limits were qualified as estimated (UJ). Qualified data are summarized in the table above.

##### 2.0 GC/MS instrument performance Check: ACCEPTABLE/All criteria met.

Bromofluorobenzene (BFB) was analyzed at the beginning of each twelve hour calibration period as required. All appropriate BFB data were provided, and all results were within the specified control limits.

##### 3.0 Initial and Continuing Calibrations: ACCEPTABLE/All criteria met.

All relative response factor (RRF) in the initial and continuing calibrations were above the 0.05 lower control limit. All percent relative standard deviation (%RSD) values in the initial calibration and percent difference (%D) values in the continuing calibrations were within the control limits.

##### 4.0 Blank Analyses: ACCEPTABLE/All criteria met.

The frequency requirement of one method blank for every 20 samples, or extraction batch of similar matrix, was met. No target compounds were detected in the method blanks.

##### 5.0 Surrogate Recovery: ACCEPTABLE/All criteria met.

Surrogate spiking compound percent recovery values were reviewed by recalculation. No transcription or calculation errors were noted. All percent recovery values were within the control limits.

**6.0 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Sample Analyses:**  
ACCEPTABLE/All criteria met.

MS/MSD analyses were performed on Samples DAC-HY-6C and DAC-HY-12C. The percent recovery values in these two sets of MS/MSD analyses ranged from 42.8% to 91.2%. The RPD values ranged from 6.3% to 16%. All MS/MSD percent recovery and RPD values were acceptable.

**7.0 Laboratory Control Sample (LCS) Analyses:** ACCEPTABLE/All criteria met.

Three laboratory control samples were analyzed and reviewed. The percent recovery values ranged from 92.4% to 101%. The LCS percent recovery values were acceptable.

**8.0 Internal Standards Performance:** ACCEPTABLE/All criteria met.

All internal standard areas were within the technical acceptance window (50% to 200% of associated continuing calibration internal standard area). All internal standard retention times were within plus or minus 30 seconds of the associated continuing calibration internal standard relation time for the samples.

**9.0 Compound Identification:** ACCEPTABLE/With the following discussion.

**Qualified Data:** None.

**Discussion:**

All compound identifications were reviewed and are found to be acceptable. One target compound (1,2,4-trichlorobenzene) was not listed on the sample results summary forms (Form I) for any of the water samples. The laboratory was contacted, and corrected Forms I were submitted. No further action was taken.

**10.0 Compound Quantitation and Quantitation Limits (QL):** ACCEPTABLE/With the following discussion.

**Qualified Data:** None.

**Discussion:**

Sample target compound concentrations were recalculated to verify results. No errors were found. Compound quantitation was acceptable.

All reported quantitation limits were adjusted correctly for sample size and dilution factors. The percent moisture content was greater than 50% in several samples. Due to the high percent moisture content, the reported results may have a high bias for these samples. However, as bias cannot be clearly established, no action was taken.

**11.0 System Performance:** ACCEPTABLE/All criteria met.

No signs of degraded instrument performance were observed. The analytical systems were judged to have been in tune, within control, and stable during the course of these analyses.

**V. OVERALL ASSESSMENT OF THE DATA**

Based on this review, the laboratory followed the specified method.

Precision is acceptable, as demonstrated by the RPD values of the MS/MSD analyses. Accuracy is acceptable, as demonstrated by MS/MSD and LCS recovery values.

All data, as qualified, are acceptable for use.

**DATA VALIDATION REPORT**  
**Conventionals Analyses**  
**Laboratory Nos.: H342, H373, H423, and H439**

**I. DELIVERABLES AND DOCUMENTATION**

The technical review of 35 sediment samples and one water blank for conventionals (ammonia, sulfide, total organic carbon, total solid, total volatile solid, and total purged solid) and grain size analyses, and 35 deep water sediment samples for grain size analyses has been completed. The samples were analyzed by Analytical Resources, Incorporated and Soil Technology, Incorporated.

Good documentation practices were observed by the laboratory the following areas: Changes were struck out by a single line and the entry was initialed and dated by the analyst; correction fluid or tape was not found on any of the raw data and proper units for numerical values were used.

**II. CHAIN OF CUSTODY/SAMPLE IDENTIFICATION**

Field chain of custody forms were present and complete for all samples with conventional analyses in SDGs H342, H373, H423, and H439. The forms were signed and dated. There was a delay of up to nine days between sample collection and receipt by the laboratory for part of SDG H373. It was confirmed that the samples were stored in locked freezers at NOAA/NMFS Northwest Fisheries during this time. In addition, the samples were received by the laboratory with chain of custody seals intact as noted on the chain of custody.

**III. FIELD QUALITY CONTROL**

Field quality control was accomplished by use of a field blank (SDG H373, DAC-HY-19BB) for sulfide analysis; two sets of triplicate samples (DAC-HY-19C/DAC-HY-32C/DAC-HY-31C and DAC-HY-6C/DAC-HY-34C/DAC-HY-33C) for conventional parameters; and one set of triplicate samples (DAC-CB-21C/DAC-CB-35C/DAC-CB-36C) for grain size analysis.

Sulfide was not detected in the field blank at or above the detection limit. Field replicates for sulfide had percent relative standard deviation (%RSD) out of control limits. The lack of precision was attributed to sample heterogeneity and also possible low bias since some sulfide samples were received after the hold time had expired.

The initial analysis of ammonia for Sample DAC-HY-19C was 11.4 mg/kg. The ammonia results in Samples DAC-HY-32C and DAC-HY-31C (two field replicates of DAC-HY-19C) were 28.9 mg/kg and 25.3 mg/kg, respectively. Sample DAC-HY-19C was reanalyzed for ammonia, past hold time; the result was 28.0 mg/kg.

Field triplicate analyses for grain size was performed on SDGs H373 and H439. The precision was excellent for SDG H373. SDG H439 results showed some variability in the mid-range between 15.6 and 125 microns; precision was excellent above and below this range.

Field replicate analyses for all other analyses were within control limits. No qualifiers were assigned based on field QC results.

#### IV. TECHNICAL ASSESSMENT

##### 1.0 Sample Holding Times: ACCEPTABLE/With the following exceptions.

###### Qualified Data:

Analyte	Qualifier	Sample ID	QC Value	QC Criteria
Sulfide	J	DAC-HY-11C	8 days	7 days
		DAC-HY-12C	8 days	
		DAC-HY-13C	11 days	
		DAC-HY-14C	10 days	
		DAC-HY-15C	10 days	
		DAC-HY-16C	10 days	
		DAC-HY-17C	10 days	
		DAC-HY-18C	10 days	
		DAC-HY-19C	10 days	
		DAC-HY-19BB	10 days	
		DAC-HY-27C	8 days	
		DAC-HY-31C	10 days	
		DAC-HY-32C	10 days	

###### Discussion:

The holding time criteria applied for sediment samples were based on PSEP protocol. Thirteen samples in SDG H373 analyzed for sulfide exceeded the holding time criterion by one to four days. The laboratory received the samples more than seven days after collection. The affected samples were qualified as estimated (J).

Sample DAC-HY-19C was reanalyzed beyond the holding time to confirm the field replicate results for ammonia. Since the reanalysis was used for confirmation only, no qualifier was assigned.

All other analyses were performed within the holding time limits.

##### 2.0 Initial and Continuing Calibration: ACCEPTABLE/All criteria met.

The minimum number of standards required for the initial calibration were analyzed. All correlation coefficients were equal to or greater than 0.995.

The laboratory analyzed continuing calibration verification (CCV) standard at the required frequency of one-in-every ten samples. The percent recovery values of the CCV standards were within the control limits of 90% to 110%.

### **3.0 Blank Analyses:** ACCEPTABLE/With the following discussion.

**Qualified Data:** None.

#### **Discussion:**

Two types of blanks were evaluated for possible contamination effects. These blanks are: initial calibration and continuing calibration blanks (ICB and CCB) and preparation blanks (PB).

The frequency for calibration blank analyses of one at the beginning and one every ten samples was met by the laboratory. The laboratory analyzed one method blank with each 20 samples digested or one per batch, for each digestion procedure, as required.

Ammonia and purged total solids were detected in one method blank (SDG H342) at concentrations of 0.021 mg/L and 1.30 mg residue, respectively. All ammonia and purged total solid results in SDG H342 were greater than the action level; no action was taken.

In SDG H373, only one method blank was analyzed for sulfide per 27 field samples. The frequency of one method blank per 20 field samples requirement was not met. No samples were qualified based on the frequency of method blank analysis. Sulfide was not detected in the method blank at or above the detection limit.

All other analytes in the blanks were below the detection limits.

### **4.0 Check Standard Analyses/Standard Reference Materials (SRMs):** ACCEPTABLE/All criteria met.

Check standards were analyzed for sulfide and ammonia. The percent recovery values for sulfide and ammonia were within the ARI control limits.

SRMs were analyzed for Total Organic Carbon (TOC) at a frequency of one per SDG. All SRM values were within the control limits.

### **5.0 Matrix Spike/Matrix Spike Duplicates (MS/MSD) Analyses:** Acceptable/All criteria met.

Matrix spike analyses were performed on Samples DAC-HY-3C and DAC-HY-15C for ammonia and on Samples DAC-CR-2AC and DAC-HY-13C for sulfide. MS/MSD analyses were performed on Samples DAC-CR-2AC, DAC-HY-14C, DAC-HY-21C for total organic carbon and on Sample DAC-HY-21C for sulfide.

The percent recovery values and RPD values were within ARI control limits for ammonia, sulfide and TOC analyses.

**6.0 Laboratory Replicate Sample Analyses:** ACCEPTABLE/ With the following exceptions.

**Qualified Data:**

Analyte	Qualifier	Sample ID			RPD	QC Criteria
Sulfide	J	DAC-CR-2AC, DAC-HY-35C, DAC-HY-1C, DAC-HY-2C, DAC-HY-3C,	DAC-HY-30C, DAC-HY-5C, DAC-HY-7C, DAC-HY-10C, DAC-HY-9C,	DAC-HY-6C, DAC-HY-4C, DAC-HY-34C, DAC-HY-33C	95.1%	50%

**Discussion:**

Laboratory triplicate analyses were performed at the frequency required. All %RSD and RPD values were within the control limits with one exception of sulfide in SDG H373 at 95.1%. This was attributed to sample heterogeneity and the fact that the some samples were received after the hold time had expired. Thirteen sulfide results in SDG H373 have been qualified as estimated due to holding time criteria not met. No further action was taken. All other positive sulfide results in SDG H373 were qualified as estimated. Qualified data are summarized in the table above.

**7.0 Sample Result Verification:** ACCEPTABLE/With the following discussion.

**Qualified Data:** None.

**Discussion:**

QC results and sample results were verified for calculation and transcription errors. Transcription errors were found in SDG H373 for percent solid results. Laboratory was contacted and corrected benchsheet was resubmitted from the laboratory. All other reported results are acceptable. The laboratory met the reporting limit levels for all analytes.

**V. OVERALL ASSESSMENT OF THE DATA**

Based on this review, the laboratory followed the specified methods.

Precision was acceptable, as demonstrated by the RPD values in the MS/MSD sets. Accuracy was acceptable, as demonstrated by the %R values of MS/MSD, SRMs and check standards recovery values.

Qualifications were required for sulfide results in SDG H373 due to holding time criterion and high RPD value of laboratory triplicate analyses.

The data, as qualified, are acceptable for use.