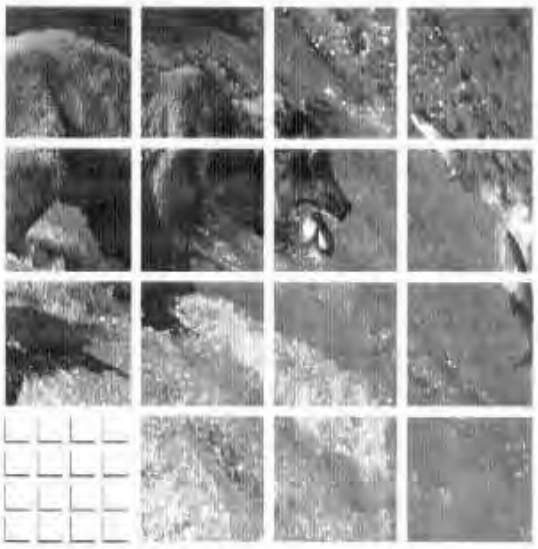
ENTRIX

EXPOSURE OF OPIHI TO SPM HOSE SPILL ON KAUAI, HAWAII

Prepared by:

Judith A. Nedoff, M.S.
Andrew E. Jahn, Ph.D.
Robert I. Haddad, Ph.D.
ENTRIX, Inc.
Walnut Creek, CA



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Prepared by:

ENTRIX, INC.
590 Ygnacio Valley Road, Suite 200
Walnut Creek, California 94596

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The purpose of this study is to estimate the extent and nature of exposure of limpets (opihi) to petroleum from the SPM Hose Spill in August/September 1998. The overall approach is to compare petroleum-derived hydrocarbon concentrations in opihi from areas oiled with weathered fuel oil from the Tesoro SPM Hose Spill with those measured in opihi from non-oiled or reference areas.

The opihi tissue was analyzed for the amounts and distributions of polycyclic aromatic hydrocarbons (PAHs). The rationale behind using PAHs rather than other measures of hydrocarbon (e.g., total petroleum hydrocarbons) is that PAHs are not produced biogenically and thus are unambiguous indicators of exposure to petroleum-derived material.

Tar balls associated with the SPM Hose Spill began washing ashore at the eastern end of a north-facing beach in the southern Kipu Kai area of Kauai in early September 1998, resulting in a visible coating of oil on the boulders. In this area of the Kipu Kai South Beach, the blackfoot opihi species (*Cellana exarata*) was seen. The yellowfoot species, *C. sandwicensis*, could only be found by venturing into the low intertidal zone.

The Kipu Kai North Beach, just north of Molehu Point, had a sandy beach strand about 5 to 10 meters wide that ended on the seaward side in a limestone bench, apparently at or just above high water.

Two opihi sampling events were conducted. The first event occurred on 23 September 1998 at the oiled boulder area of Kipu Kai South Beach, during which seven blackfoot opihi samples and one yellowfoot opihi sample were collected. The second event occurred on 2 and 3 November 1998 and focused on the blackfoot opihi, *C. exarata*. In November, opihi were collected from Ahukini and two Kipu Kai shores that were possibly or known to be impacted by the SPM Hose Spill. Reference samples were collected from Ninini (near Ahukini), from the Kipu Kai area, and at Haena. Haena was chosen for reference sample collection because it was outside the Kauai area that was impacted by the spill.

ADL laboratory analyzed four of the eight opihi samples collected on 23 September 1998 and all 14 samples collected on 2 and 3 November 1998 for alkylated polycyclic aromatic hydrocarbons (PAHs). Total PAH concentrations were adjusted for interferences in the procedural blank prior to interpretation of the data.

Opihi samples collected on 23 September in the oiled boulder area at Kipu Kai showed adjusted total PAH concentrations ranging from 140 to 410 µg/kg (parts per billion - ppb) dry weight (dw) for three blackfoot opihi samples, and 14 µg/kg-dw for the yellowfoot opihi sample. Three blackfoot opihi samples collected on 2 November from the same area contained 13 to 67 µg/kg adjusted total PAH. Two blackfoot opihi samples collected on 2 November from the limestone outcropping area of Kipu Kai (possibly lightly oiled)

contained 7.6 and 14 µg/kg adjusted total PAH. The four blackfoot opihi samples collected from non-oiled areas of Kipu Kai on 2 November contained adjusted total PAH concentrations ranging from 15 to 40 µg/kg.

Two blackfoot opihi samples collected in November from a formerly oiled area at Ahukini showed adjusted total PAH concentrations of 13 and 180 µg/kg. The higher value appeared to derive from a combustion source, not from weathered petroleum. Two opihi samples collected from a non-oiled area near Ahukini contained 6.3 and 8 µg/kg adjusted total PAH. The sample collected from Haena contained 10 µg/kg adjusted total PAH.

Based on the PAH distribution in samples collected at Kipu Kai in September 1998 and on a comparison of the PAH tissue concentrations measured in opihi from reference sites in November (Table 6-1), a qualitative case can be made for exposure of the blackfoot species (*C. exarata*) to petroleum at this location at this time. This conclusion is based on levels of total adjusted PAH in these samples that were approximately 10 times greater than total adjusted PAH concentrations measured in the Kipu Kai reference areas. In addition, the PAH distribution in the blackfoot samples is dominated by phenanthrene, dibenzothiophene, and their highly alkylated homologues, which though not conclusive in itself, is consistent with exposure to weathered oil. A typical PAH distribution derived from non-petroleum sources (e.g., air-borne particulates, creosote, etc.) is dominated by higher molecular weight PAHs (e.g., chrysene, benzo[a]pyrene).

The differences in PAH concentrations between the September and November samples collected from the oiled boulder area in Kipu Kai (South Beach) suggest that exposure to petroleum from the SPM Hose Spill had diminished to near-background levels by November 1998. Further, based on review of all results presented, there is no indication of exposure to petroleum from the SPM Hose Spill in the November 1998 opihi samples from Ahukini.

1.1 PURPOSE

The purpose of this study is to estimate the extent and nature of exposure of limpets (opihi) to petroleum from the SPM Hose Spill in August/September 1998.

1.2 SPILL EVENT

The Single Point Mooring (SPM) Hose Spill of August 24, 1998, off Barber's Point, Oahu, released IFO-380 (Intermediate Fuel Oil, 380 centistokes) fuel oil. This material is a viscous black oil, with little or no light material in the composition and is considered and used as a bunker fuel. Oil was recovered offshore of Oahu in the two days following the spill. Some of the unrecovered oil was carried by ocean currents to Kauai and washed up on several beaches in the form of tar balls in early September.

Most of the oil stranding occurred in scattered pockets on the east side of Kauai from Kaipu Kai to just north of Kealia. The distance between these points is approximately 31 kilometers. Outside of this area there was a 45 meter beach very lightly oiled with tarballs at Barking Sands on the west side of the island. At Kipu Kai, SCAT reports indicated 250 meters of boulder beach heavily oiled with a SCAT oil character designation of "tar coating" and another 250 meters of very lightly oiled sandy beach. At Ahukini, 160 meters of supratidal basalt bench were recorded to have a 70 percent covering of oil with SCAT character designation "fresh oil". Between Ahukini and Kealia Beach, another 2.8 kilometers of beach were at times designated as very lightly oiled with small tar balls.

1.3 APPROACH

In order to evaluate exposure of the transported oil from the SPM Hose spill to organisms found in the intertidal areas of the impacted Kauai beaches, a study was conducted to measure petroleum-derived hydrocarbons in limpets (opihi). The study included the collection of opihi samples during the beach cleanup (September 23, 1998), as well as six weeks later (November 2 and 3, 1998).

To estimate the extent and nature of exposure of opihi to petroleum derived from the SPM Hose Spill, it was necessary to first compare petroleum-derived hydrocarbon concentrations in opihi from oiled areas with those measured in opihi collected from non-oiled or reference areas. Toward this end, the opihi tissue was analyzed for the amounts and distributions of polycyclic aromatic hydrocarbons (PAHs). The rationale behind using PAHs rather than other measures of hydrocarbon (e.g., total petroleum hydrocarbons, etc.) is that PAHs are not produced biogenically and are unambiguous indicators of exposure to petroleum-derived material. These compounds are also used in

the National Status & Trends Mussel Watch program as an indicator of petroleum-derived pollution in coastal environments (National Oceanic and Atmospheric Administration/National Oceanic Service (NOAA/NOS)). Because of other possible sources of hydrocarbons in Kauai (such as other oil spills and various unknown chronic or episodic releases of petroleum products in both oceanic and nearshore waters), we evaluated and compared the distribution of PAH compounds measured in the opihi tissue with the PAH compounds found in the source oil.

The purpose of and approach to the study were developed in conjunction with representatives of trustee agencies (NOAA/Damage Assessment Center (DAC)), Hawaii Department of Land and Natural Resources (DLNR), United States Fish and Wildlife Service (USFWS), and Hawaii Department of Health (DOH)). This report describes the two sampling events, sampling procedures, chemical analyses, laboratory results, and interpretation of the results.

Tar balls associated with the SPM Hose Spill began washing ashore at the eastern end of a north-facing beach in the Kipu Kai area of Kauai in early September 1998 (Figure 2-1). Cleanup crews were dispatched to the area and collected tar balls by hand and through the use of snares in the surf zone. It appeared that some tar balls had been stranded among the boulders at the eastern end of the beach and had melted from heating by the sun during exposure at low tide, resulting in a coating of oil on approximately 250 meters of the boulders.

On 21 September 1998, representatives of Tesoro and trustee agencies visited the Kipu Kai area to survey the extent of oiling and observe wildlife present. Members of the party included John Cubit and Frank Csulak (NOAA/DAC); Chris Jansen (Tesoro); Gordon Robilliard, Andy Jahn, and Judy Nedoff (ENTRIX); and Lee Ann Woodward (USFWS). Nominal low tide of 0.4 feet MLLW on 21 September was at 0930. The following observations were recorded by Andy Jahn and Gordon Robilliard between 0950 and 1300.

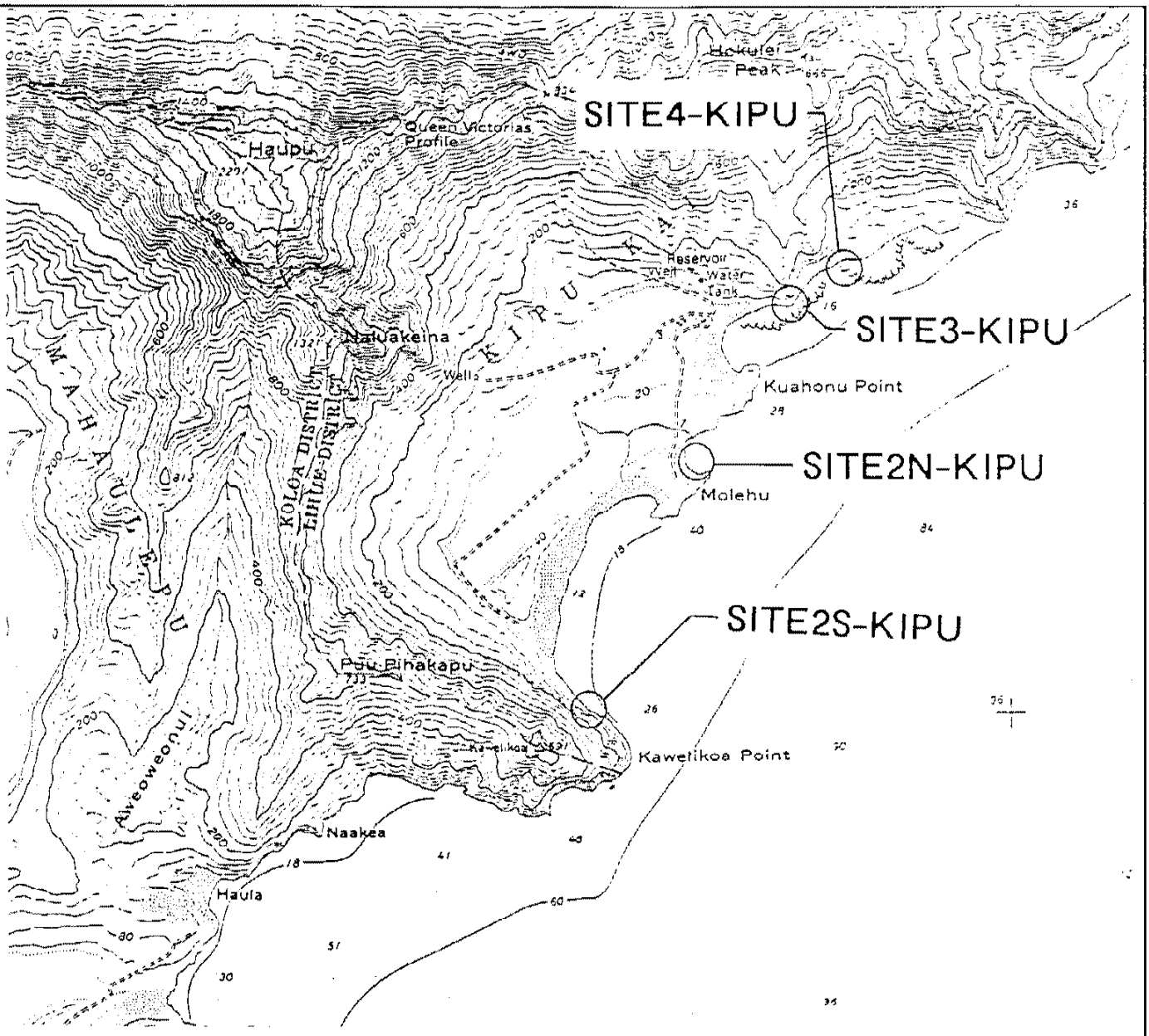
2.1 SOUTH BEACH AREA OF KIPU KAI

This beach is a north-facing boulder slope (Figure 2-1), grading from a sand beach on the west to cliffs at the eastern end (Kawelikoa Point), with a total length of approximately 600 meters. Approximately the western 400 meters were explored, and approximately the western 250 meters appeared partially oiled. The boulders were a mixture of very smooth, dense basalt and rougher volcanic material that had cooled while retaining gas bubbles. Some boulders had depressions formed by short-spine urchins at low intertidal or subtidal depths and these boulders had probably been washed ashore by large waves.

Correlated with the eastward change from sand-boulder to steep cliff, the intertidal habitat grades from drier to wetter; white water run-up (west) to breaking wave (east); and high suspended sand load on the west end to very low suspended load near the eastern end. Corresponding increases in algal coating of mid-intertidal rocks, as well as apparent abundance of grapsid crabs, limpets (opihi), helmet urchins, short-spine urchins, and macroalgae were noted (all more abundant toward the eastern portion of the beach). Nerites (small gastropod snails) appeared to be abundant along the entire stretch.

2.1.1 OILING OF BOULDER AREA

Besides some staining of boulders near the western end of the explored area, it was possible to find a thicker coating of oil and occasional tar balls under boulders when they were rolled over. Observations under boulders also revealed the presence of opihi, small (< 1 cm carapace width) grapsid crabs, nerites (some oiled), moderate numbers of a raspberry-colored anemone (6 to 10 under larger boulders), one light-colored nerite,



Basemap taken from U.S.G.S. 1983,
Lihue quadrangle, Hawaii, 7.5 minute series (topographic).
Topography from aerial photographs taken in 1960. Field checked in 1963.
Revised from photographs taken in 1978. Limited field check in 1981.

N

Scale 1:24 000

1 1/2 0 1 Mile

1000 0 1000 2000 3000 4000 5000 6000 7000 Feet

Figure 2-1 Kipu Kai Sampling Locations	Opihi Sampling Sites at Kipu Kai, Kauai, Hawaii	
	SPM Hose Spill Incident	Tesoro Hawaii Corporation

tubicolus polychaetes, and flatworms. In clean sand beneath the oil, porcellanid crabs, a sipunculid (peanut worm), and amphipods were also observed, all in apparently normal condition. No dead animals were observed.

2.1.2 OPIHI

The majority of opihi seen were the green-mantled/black-foot species, *Cellana exarata.* Only by venturing into the low intertidal could specimens of the yellow-foot species, *C. sandwicensis,* be obtained. The latter were large (>1.5 inches) and covered with turf-like algae. Few of the opihi appeared to be oiled and those that were had a relatively light coating scattered on the shell. Many of the *C. exarata* in the low intertidal were abraded, some so much that the outer protein layer (periostracum) was present only on the last margin of shell growth. This condition was common at the west (sandy) end of the beach, but rare to non-existent toward the east (rocky, high-energy) end.

In parallel with the natural gradient of increasing wave exposure from west to east along this stretch, rocky intertidal organisms become more diverse and abundant with increasing distance from the sandy, non-vegetated beach area. The ease of human access also decreases with increasing distance from the sandy beach, a factor that could also contribute to the perceived gradient of increasing opihi abundance. At some point (estimated by SCAT teams as 250 m from the sand beach), the oiling of the shoreline became little or non-existent toward the east (i.e., Kawelikoa Point).

2.2 NORTH BEACH

The northern beach is just north of Molehu Point (Figure 2-1). This beach had a non-vegetated, sandy stretch about 5 to 10 meters wide that ended on the seaward side in a limestone bench, apparently at or just above high water. This is a high wave energy area, such that a tide pool, or splash pool, occupied much of the lower-elevation areas of the bench. The upper part of the bench was covered by a black-green, felt-like mat, apparently of cyanobacteria ("blue-green algae"). Two oil samples were collected at this beach on 21 September. However, oil was not observed washing up on the beach at the time.

Two sampling events were conducted. The first event occurred on 23 September 1998 at the oiled boulder area of Kipu Kai South Beach. The second event occurred on 2 and 3 November 1998, and encompassed sampling at Kipu Kai South Beach, North Beach, and reference locations; Ahukini (previously oiled) and Ninini Point (reference); and Kee Beach at Haena (reference). Both events included representatives of Tesoro and trustee agencies (Table 3-1).

3.1 OPIHI SAMPLING IN SEPTEMBER 1998

On 23 September 1998, personnel from ENTRIX, NOAA, USFWS, and DLNR obtained tissue samples from two species of limpet (opihi, *Cellana exarata* [blackfoot] and *C. sandwicensis* [yellowfoot]) as well as the helmet urchin (Ha uke uke, *Colobocentrotus atrata*) from an oiled section of South Beach at Kipu Kai. A summary of these samples is shown in Table 3-2. Observations of the sampling team indicated that the blackfoot opihi species (*C. exarata*) was by far the more common at the mid-intertidal level accessible to the collection team. This species scrapes algal film off the mid-intertidal rocks. The yellowfoot species, *C. sandwicensis*, is said to graze macroalgae in the lower intertidal zone.

These species are all consumed by humans in the recreational fishery. Both opihi species are important in the Hawaiian culture. Opihi are potentially exposed to hydrocarbons through absorption from the water, dermal contact, and through feeding by rasping oil and oil-coated algae off the rocks. These samples were collected for analysis of the amount of petroleum hydrocarbons in the tissue. The sampling on 23 September 1998 was done to get an indication of the potential exposure of these intertidal animals to petroleum hydrocarbons while oil was still present on the upper beach at Kipu Kai.

A wooden post on the slope above the North Beach area was chosen by the field team as a landmark above the reach of common winter storm waves. Collection of opihi samples from the largest boulders began at this point and proceeded approximately west toward the sandy beach area. A total of seven blackfoot opihi samples and one yellowfoot opihi sample were collected. Opihi sampling methods are described in Section 4.0.

Table 3-1. Participants at 23 September 1998 Sampling Event

Name of Personnel	Organization
Dr. John Cubit	NOAA/DAC
Mr. Don Heacock	DLNR
Dr. Lee Ann Woodward	USFWS
Ms. Liz Galvez	Hawaii Department of Health
Ms. Kathy Ho	Hawaii Attorney General's Office
Dr. Andy Jahn	ENTRIX
Ms. Judy Nedoff	ENTRIX
Mr. Chris Jansen	Tesoro Hawaii Corporation

Table 3-2. Sample Collected at Kipu Kai South Beach 23 September 1998

Sample ID	Date Collected	Area - Location	Sample Type	Sample Analyzed?	Jars Filled
BLACKFOOT1	9/23/98	Kipu Kai - South Beach	Oiled	YES	1
BLACKFOOT2	9/23/98	Kipu Kai - South Beach	Oiled	NO	1
BLACKFOOT3	9/23/98	Kipu Kai - South Beach	Oiled	NO	1
BLACKFOOT4A/B	9/23/98	Kipu Kai - South Beach	Oiled	YES	2
BLACKFOOT5	9/23/98	Kipu Kai - South Beach	Oiled	NO	1
BLACKFOOT6	9/23/98	Kipu Kai - South Beach	Oiled	YES	1
YELLOWFOOT1	9/23/98	Kipu Kai - South Beach	Oiled	YES	1
KKCRAB-092398	9/23/98	Kipu Kai - South Beach	Oiled	NO	1
KKURCHIN1	9/23/98	Kipu Kai - South Beach	Oiled	NO	1
KKURCHIN2	9/23/98	Kipu Kai - South Beach	Oiled	NO	1
KKURCHIN3	9/23/98	Kipu Kai - South Beach	Oiled	NO	1

3.2 OPIHI SAMPLING IN NOVEMBER 1998

The objective of the November 1998 sampling was to collect opihi both at Kipu Kai and at other beaches that had been oiled by the SPM Hose Spill as well as at non-oiled sites. Results would allow the following:

1. Comparison of PAH levels present in opihi over time, i.e., levels in opihi collected in September when oil was present at Kipu Kai vs. levels in opihi collected six weeks later from the same location; and

2. Comparison of PAH levels in previously exposed opihi with the natural or chronic background hydrocarbon levels seen in opihi collected from locations out of the area impacted by the SPM Hose Spill (i.e., reference sites).

The objectives of the November opihi sampling were to obtain (up to three) replicate samples of *Cellana exarata* (blackfoot opihi) from three oiled beaches (Kipu Kai South, Kipu Kai North, and Ahukini), from three non-oiled beaches nearby the oiled beaches, and from a beach that was out of the area impacted by oil. Based on observations concerning animal locations, greater availability, and potential exposure to spilled oil, this sampling focused on the blackfoot opihi, *C. exarata*.

The sampling team for the 2 and 3 November 1998 effort is provided in Table 3-3.

3.2.1 NOVEMBER SAMPLING LOCATIONS

Samples were collected from Ahukini (Figure 3-1) and two Kipu Kai shores (Figure 2-1) that were known to be impacted by the SPM Hose Spill. In addition, samples were collected from reference or "non-oiled" shores. One reference site was near Ahukini (Figure 3-1), two reference sites were in the Kipu Kai area (Figure 2-1), and one reference site, at Haena (Figure 3-2), was chosen because it was outside the Kauai area that was impacted by the spill. Table 3-4 describes the sampling locations and associated photographs. Photographs can be found in Appendix A. A summary of samples collected on 2 and 3 November 1998 is shown in Table 3-5.

At the time of sample collection, it was observed that there was a scarcity of relatively large opihi. None of the opihi appeared to be oiled and no oil was observed in the sample collection areas. It should be noted that at the Kipu Kai - North Beach, the yellowfoot and blackfoot opihi were found in the same intertidal area. Therefore, the samples collected from this site contained a few yellowfoot opihi (*C. sandwicensis*). It is not expected that this had any effect on the analytical results.

Table 3-3. Personnel Present at 2 and 3 November 1998 Sampling Event

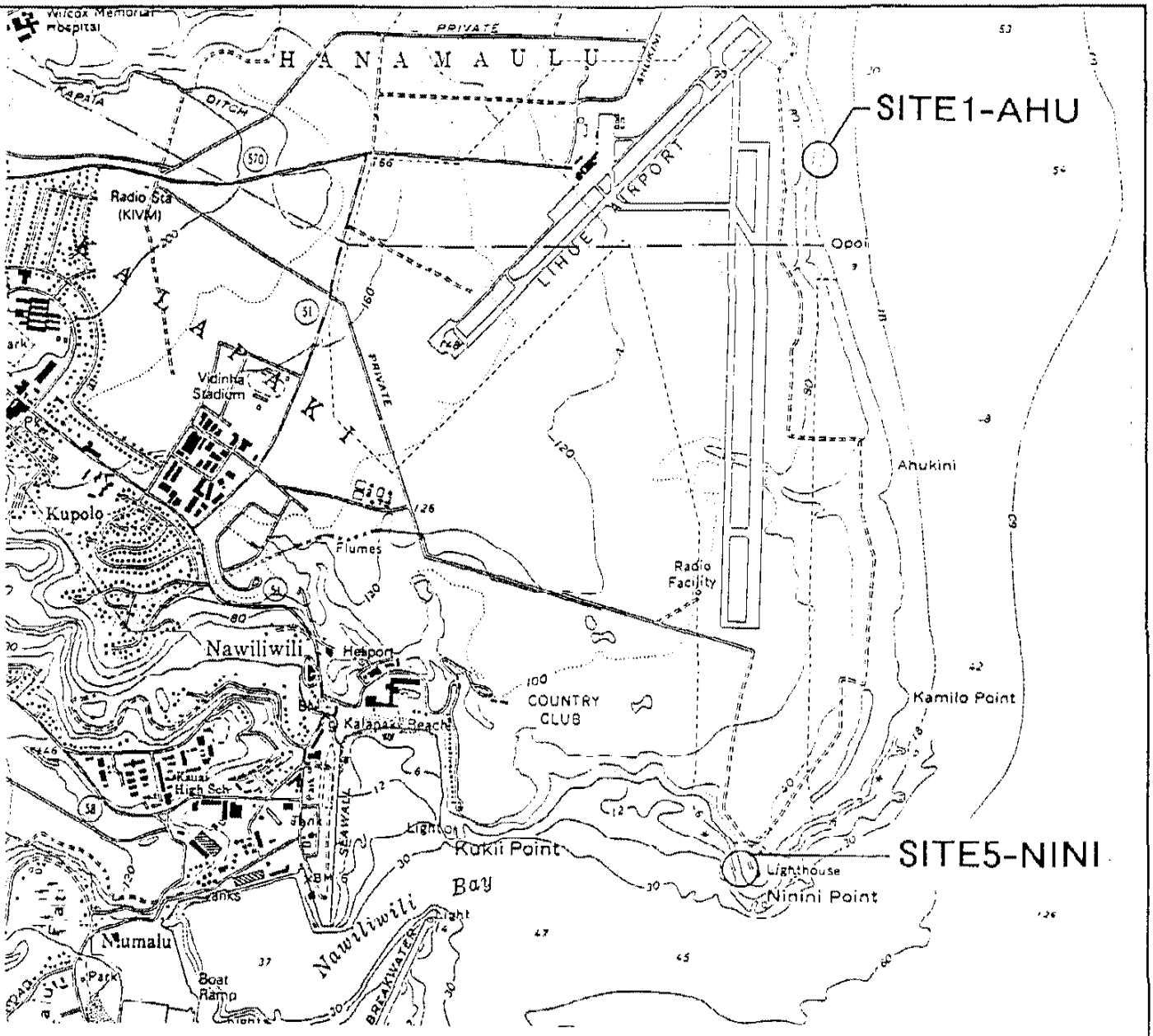
Name of Personnel	Organization
Ms. Stephanie Sakurai	Clayton Environmental Consultants
Mr. Stan Souza	Clean Islands Council (CIC)
Mr. Don Heacock	DLNR
Ms. Rose Chu	Tesoro Hawaii Corporation
Mr. Richard Rosen	Tesoro Hawaii Corporation
Ms. Regie Kawamoto	University of Hawaii, Zoology Department
Dr. Alison Kay	University of Hawaii
Mr. Dwayne Minton	University of Hawaii

Table 3-4. November Opihi Sample Locations

Area - Sample Type	Location	Landmark	Photo No.
Ahukini - Oiled	Ahukini	East of drainage ditch at end of airport	1 through 6
Ahukini - Reference	Ninini Point near Lighthouse	Western side of the lighthouse	7 through 9
Kipu Kai - Oiled	South Beach	Approx. 25 m north of wooden post	10 through 14
Kipu Kai - Oiled	North Beach	Southwest side of beach near limestone overhang and from northeastern side of beach near limestone shelf	15 and 16
Kipu Kai - Reference	North of Kuahonu Point	Basalt boulder beach	17 and 18
Kipu Kai - Reference	Further North of Kuahonu Point	Basalt boulder beach	19 and 20
Haena - Reference	Kee Beach	Basalt boulders west of Haena State Park	21 and 22

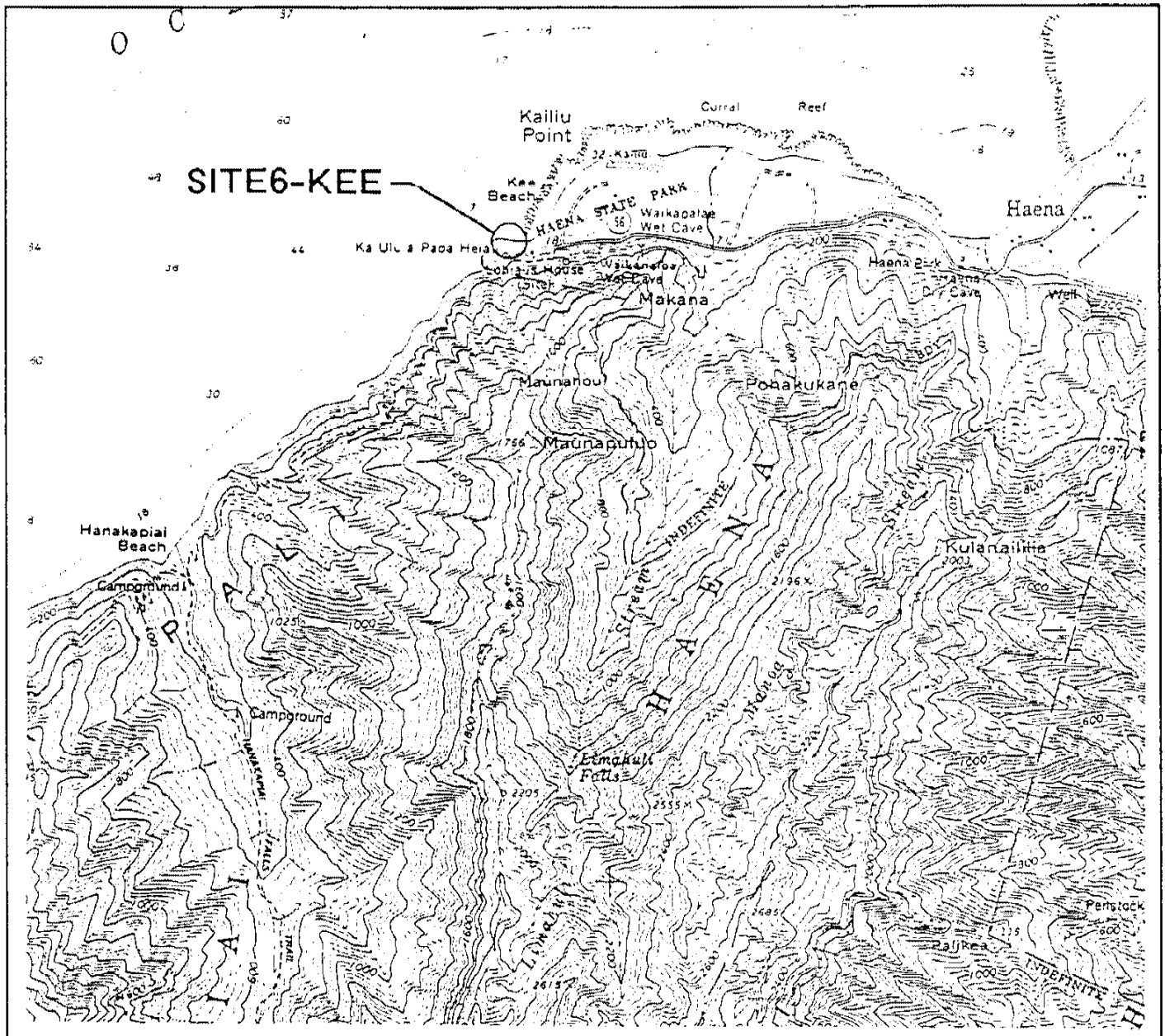
Table 3-5. Sample Locations and Replicates Collected November 1998

Sample ID	Date Collected	Area - Location	Sample Type	Jars Filled	Approximate No. Per Jar
SITE1-AHU	11/2/98	Ahukini	Oiled	2	Jar 1: 51 Jar: 2: 38
SITE5-NINI	11/3/98	Ahukini - Ninini Point near Lighthouse	Reference	2	Jar 1: 58 Jar 2: 83
SITE2S-KIPU	11/2/98	Kipu Kai - South Beach	Oiled	3	Jar 1: 45 Jar: 2: 48 Jar 3: 58
SITE2N-KIPU	11/2/98	Kipu Kai - North Beach	Oiled	2	Jar 1: 28 Jar: 2: 13
SITE3-KIPU	11/2/98	Kipu Kai - North of Kuahonu Point	Reference	2	Jar 1: 41 Jar: 2: 52
SITE4-KIPU	11/2/98	Kipu Kai - Further North of Kuahonu Point	Reference	2	Jar 1: 32 Jar: 2: 41
SITE6-KEE	11/3/98	Haena - Kee Beach	Reference	1	Jar 1: 53



Basemap taken from U.S.G.S. 1983,
Lihue quadrangle, Hawaii, 7.5 minute series (topographic).
Topography from aerial photographs taken in 1960. Field checked in 1963.
Revised from photographs taken in 1978. Limited field check in 1981.

Figure 3-1 Ahukini Sampling Locations	Opihi Sampling Sites at Ahukini, Lihue, Kauai, Hawaii	
	SPM Hose Spill Incident	Tesoro Hawaii Corporation



Basemap taken from U.S.G.S. 1983,
Haena quadrangle, Hawaii, 7.5 minute series (topographic).
Topography from aerial photographs taken in 1960. Field checked in 1965.
Revised from photographs taken in 1977. Limited field check in 1981.

N

Scale 1:24 000

1 1/2 0 1 Mile

1000 0 1000 2000 3000 4000 5000 6000 7000 Feet

Figure 3-2 Haena Sampling Location	Opihi Sampling Site at Kee Beach, Haena, Kauai, Hawaii	
	SPM Hose Spill Incident	Tesoro Hawaii Corporation

Animals were popped off the rocks with a clean stainless steel blade using a quick twisting motion to minimize the amount of substrate scraped up with the animal. Animals were transferred to personnel for shucking. The animals were handled with Nitrile gloves, and the whole body tissue samples were scraped into clean glass jars using a clean knife for each sample. Any opihi in which a foot contacted the shell of another opihi, was not used for the sample. The 30-gram sample size required for the PAH analysis was estimated as approximately 30 cubic centimeters. Samples were placed on ice in a cooler immediately upon collection. Samples collected in September were placed in a freezer upon return to the command center on Kauai at the Outrigger Hotel, and were shipped on dry ice to Arthur D. Little (ADL) laboratory in Cambridge, Massachusetts.

Samples were collected in November in a similar way, according to the "Sampling and Analysis Plan, Opihi Samples," October 2, 1998, prepared by ENTRIX, Inc. The opihi were placed, shell side down, on clean aluminum trays and the animals were carried to a central area for processing as described above.

To prevent the misidentification of samples collected, each jar was labeled after collection with a unique sample identification number. The shells were placed in ZipLok™ bags for later measuring. In September, shells were segregated according to opihi species. In November, shells were segregated according to respective samples/jars. The shells were sent to John Cubit at NOAA, where they were measured.

A chain of custody record was completed to accompany each shipment of samples to the laboratory. The chain of custody form was used to establish the documentation necessary to trace sample possession from the time of collection until laboratory analysis. The samples collected during the November sampling event were stored in a cooler with frozen ice packs and dry ice under custody of Clayton Environmental Consultants until shipment to the laboratory. The samples and the chain of custody form were then shipped to ADL laboratory in Cambridge, Massachusetts, by overnight delivery on 3 November 1998. The laboratory received the samples frozen and intact on 4 November 1998.

4.1 DECONTAMINATION PROCEDURES

Nitrile gloves were used for handling the opihi and were changed between samples to prevent cross-contamination. The stainless steel knives that were reused were decontaminated after the collection of each sample by washing with water, rinsing with distilled water, and wiping with isopropyl alcohol. The sampling equipment was then air dried or wiped with paper towels.

5.1 LABORATORY ANALYSES

ADL laboratory analyzed four of the eight opihi samples collected on 23 September 1998 and all 14 samples collected on 2 and 3 November 1998 for alkylated PAHs according to modified EPA Method 8270 using gas chromatography/mass spectrometry in the selective ion monitoring mode (GC/MS-SIM). The laboratory was requested to retain all tissue residues. ADL laboratory analyzed a sample of the oil released in the SPM Hose Spill with the tissue batch for comparison. Quality control samples analyzed and reported by the laboratory included a procedural blank, matrix spike, matrix spike duplicate, and standard reference material, as well as surrogate spike results for each sample. A copy of the laboratory data report is included in Appendix B.

5.2 DATA QUALITY REVIEW

An ENTRIX chemist (Judy Nedoff) reviewed the laboratory results for compliance with quality criteria. Data validation includes but is not limited to a review of sample integrity (information from chain of custody form), review of detection and reporting limits, appropriate significant figures, and completeness of report. In addition, quality control data reported by the laboratory are reviewed to determine whether precision and accuracy criteria were achieved. In this opihi data report, results for the procedural blank, surrogate spikes, matrix spike samples, and standard reference material samples were reviewed as indicators of the laboratory's ability to measure sample concentrations accurately. Results for the matrix spike duplicate pair were compared to precision criteria and indicate the laboratory's ability to produce consistent results.

Results of the data quality review indicate that the data can be accepted for use with some qualifications. Naphthalene was detected in the procedural blank at 25 µg/kg (parts per billion - ppb) on a dry weight basis, which is higher than the concentration of naphthalene detected in many of the opihi samples. Benzo(ghi)perylene was detected in the blank at 14 µg/kg. This indicates the analytical system (e.g., reagents) contains interferences that may impact the accuracy of some sample results. In the data validation process, when a constituent is detected in a sample that is also detected in the associated procedural blank, qualification of the sample result is necessary unless the concentration in the sample is five times greater than the level in the blank (USEPA 1994). In this data set, naphthalene was detected in all the opihi samples at levels less than five times the level in the blank. One opihi sample contained benzo(ghi)perylene at a level less than five times that in the blank. A "U" qualifier was added to these results during validation, indicating that the constituent concentrations are equivalent to not detected.

Results for surrogate spike, matrix spike and duplicate matrix spike analyses met acceptance criteria for accuracy in all samples. However, as the report narrative explains, results for the tissue standard reference material (SRM) did not meet acceptance criteria. ADL analyzed the SRM a second time and obtained similar results. During the same period, the SRM was analyzed in triplicate for an interlaboratory study, and these analyses met the acceptance criteria. The SRM failed because six of the thirteen PAHs were detected at elevated concentrations relative to expected levels, indicating that levels of these compounds measured in opihi samples may be biased high. Of the six PAHs that failed the criteria, one was detected in two opihi samples, and four were detected in only one opihi sample. Five were detected in a sample from Ahukini which had an anomalous PAH distribution compared to the other opihi samples, as described in Section 6.2.2. A Standard Reference Material is prepared by an independent source and used by the laboratory to check the accuracy of its measurements. Generally, accuracy of analytical data is not considered questionable based on results of the SRM alone when sufficient other accuracy measurements have been made and meet acceptance criteria, such as in this case.

Total PAH concentrations for opihi samples are summarized in Table 6-1. Total PAH as reported by the laboratory and total PAH adjusted for blank contamination (values qualified with a U subtracted) are shown.

Opihi samples collected on 23 September in the oiled boulder area at Kipu Kai showed total PAH (adjusted) concentrations ranging from 140 to 340 µg/kg (parts per billion) dry weight for the three blackfoot opihi samples, and 14 µg/kg for the one yellowfoot opihi sample. Three blackfoot opihi samples collected on 2 November from the same area contained 13 to 67 µg/kg total PAH (adjusted). Two blackfoot opihi samples collected on 2 November from the limestone outcropping area of Kipu Kai (formerly lightly oiled) contained 7.6 and 14 µg/kg total PAH (adjusted). Two blackfoot opihi samples were collected from each of two non-oiled areas of Kipu Kai on 2 November. Total PAH (adjusted) concentrations in these four samples ranged from 15 to 40 µg/kg.

Two blackfoot opihi samples were collected from an area at Ahukini that had been oiled in September. Total PAH (adjusted) concentrations in these samples were 13 and 180 µg/kg. Two opihi samples collected from Ninini Point (a non-oiled area near Ahukini) contained 6.3 and 8 µg/kg total PAH (adjusted).

In addition, one opihi sample was collected from Haena, which was outside the area of Kauai coastline known to have been oiled as a result of the SPM Hose Spill. Only one sample could be collected due to dangerous surf conditions at the time of sampling. This sample contained 10 µg/kg total PAH (adjusted).

6.1 INTERPRETATION OF PAH RESULTS

6.1.1 SEPTEMBER 1998 OPIHI RESULTS

Based on the samples collected in September 1998 and on a comparison of the PAH tissue concentrations measured in opihi from reference sites in November (Table 6-1), a qualitative case can be made for exposure of the blackfoot species (*C. exarata*) to petroleum. This conclusion is based on two points of evidence:

- The total adjusted PAH concentration measured in these samples (140 to 410 µg/kg dry wt.) is approximately 10 times greater than total adjusted PAH concentrations measured six weeks later in the Kipu Kai reference areas (15 to 40 µg/kg dry wt.);

Table 6-1. Summary of Total PAH Results in Opihi Samples Collected September 23 and November 2 and 3 1998

Location	Sample Name	Minimum Reporting Limit	Total PAH	Total PAH adjusted*
		ug/Kg dry wt.	ug/Kg dry wt.	ug/Kg dry wt.
Kipu Kai, oiled boulders	Blackfoot 1	35	150	140
September 23, 1998	Blackfoot 4A/4B	35	440	410
	Blackfoot 6	29	350	340
	Yellow Foot 1	34	38	14
	Average Value			**226**
Kipu Kai, oiled boulders	SITE2S-KIPU	29	80	67
November 2, 1998	SITE 2S KIPU - Jar 2	23	47	29
	SITE 2S KIPU - Jar 3	24	25	13
	Average Value			**36**
Kipu Kai,	SITE2N-KIPU	25	26	14
oiled limestone	SITE 2N KIPU - Jar 2	20	25	7.6
November 2, 1998	**Average Value**			**11**
Kipu Kai,	SITE3-KIPU	35	38	21
reference areas	SITE 3 KIPU - Jar 2	28	39	19
November 2, 1998	SITE4-KIPU	34	32	15
	SITE 4 KIPU - Jar 2	34	81	40
	Average Value			**24**
Ahukini, oiled boulders	SITE1-AHU	31	220	180
November 2, 1998	SITE 1 AHU - Jar 2	28	29	13
	Average Value			**97**
Ahukini, reference	SITE5-NINI	23	17	8
November 3, 1998	SITE 5 NINI - Jar 2	21	20	6.3
	Average Value			7.2
Haena, control				
November 3, 1998	SITE 6-KEE	28	25	10

- The distribution of PAHs measured in the blackfoot samples (Table 6-2, Figure 6-1) indicates that the PAHs in these samples are dominated by phenanthrenes and dibenzothiophenes (all samples also contained naphthalene, however, not at levels above those found in the method blanks). Within these homologous families, most of the blackfoot samples are characterized by higher concentrations of the more highly alkylated PAHs. While there is not enough information in the PAH suite to make defensible conclusions regarding the specific source of these PAHs, the distribution is consistent with exposure to weathered oil. A probable source of the weathered oil is the SPM Hose Spill. If the PAH concentrations found in these samples were derived from non-petroleum sources (e.g., PAHs associated with post-combustion air-borne particulates, creosote, etc.), one would expect to see PAH distributions dominated by detectable levels of higher molecular weight PAHs (e.g., chrysenes, benzo[a]pyrene, etc.) and low levels of the alkylated homologues.

Total PAH concentration (14 µg/kg dry wt.) and the PAH distribution (see Table 6-2) measured in the yellowfoot sample from Kipu Kai in September 1998 are similar to those measurements in the blackfoot opihi collected from the Kipu Kai reference areas in November 1998. This observation is consistent with the hypothesis that the intertidal animals collected and analyzed as part of the Yellowfoot 1 sample were exposed to little if any petroleum from the Tesoro release.

6.1.2 November 1998 Opihi Results

6.1.2.1 Reference and Control Site Samples

A total of six reference and one control site samples were collected and analyzed for alkylated PAHs. At Kipu Kai, the total adjusted PAH concentrations for the four reference samples ranged from 15 to 40 µg/kg dry wt. (Table 6-1). PAH distributions for these samples (presented in Table 6-2) indicate that minor amounts of phenanthrene are present in the these tissue samples. As discussed above, the naphthalene concentrations are below those found in the method blanks. The Ahukini reference and the Haena control samples (see Tables 6-1 and 6-2) have total adjusted PAH concentrations in the range 10 to 6.3 µg/kg dry wt., and distributions similar to those seen in the reference samples from Kipu Kai. Based on the similarities in total adjusted PAH concentrations (6.3 to 40 µg/kg dry wt.; mean 17±11 µg/kg dry wt.) and on the relative similarity in distributions of PAH homologues within these samples, it appears that these results represent background levels of PAHs in the local environment.

6.1.2.2 Kipu Kai Samples

A review of Table 6-1 shows that the total adjusted PAH concentrations measured in opihi samples collected from the possibly oiled limestone area (14 and 7.6 µg/kg dry wt.) and in most samples collected from the oiled boulder area (13 to 67 µg/kg dry wt.; mean 36±28 µg/kg dry wt.) largely overlap the results from the Kipu Kai reference sites and indicate a close approach to background levels of tissue PAHs measured in the local

Table 6-2. PAH Distribution in Opihi Samples Collected September and November 1998

Field ID			Blackfoot 1		Blackfoot 4A/4B		Blackfoot 6		Yellow Foot 1		SITE2S-KIPU		SITE 2S KIPU - JAR 2		SITE 2S KIPU - JAR 3	
Field Date			09/23/98		09/23/98		09/23/98		09/23/98		11/02/98		11/01/98		11/02/98	
Min Reporting Limit			35		35		29		34		29		23		24	
Units			ug/Kg dry wt.		ug/Kg dry wt.		ug/Kg dry wt.		ug/Kg dry wt.		ug/Kg dry wt.		ug/Kg dry wt.		ug/Kg dry wt.	
PAH Compounds	# Rings	Abbr.														
Naphthalene	2	N	13	JB U	32	JB U	16	JB U	24	JB U	13	JB U	18	JB U	12	JB U
C1-Naphthalenes	2	N1	ND		ND		ND		ND		14	J	16	J	ND	
C2-Naphthalenes	2	N2	ND		ND		ND		ND		ND		ND		ND	
C3-Naphthalenes	2	N3	ND		ND		ND		ND		ND		ND		ND	
C4-Naphthalenes	2	N4	ND		ND		ND		ND		ND		ND		ND	
Acenaphthylene	2	ACY	ND		ND		ND		ND		ND		ND		ND	
Acenaphthene	3	ACE	ND		ND		ND		ND		ND		ND		ND	
Biphenyl	3	B	ND		ND		ND		ND		ND		ND		ND	
Fluorene	3	F	ND		ND		ND		ND		ND		ND		ND	
C1-Fluorenes	3	F1	ND		ND		ND		ND		ND		ND		ND	
C2-Fluorenes	3	F2	ND		ND		ND		ND		ND		ND		ND	
C3-Fluorenes	3	F3	ND		ND		ND		ND		ND		ND		ND	
Anthracene	3	A	ND		50		ND		ND		ND		ND		ND	
Phenanthrene	3	P	29	J	43		39		14	J	20	J	13	J	13	J
C1-Phenanthrenes/Anthracenes	3	PA1	42		97		95		ND		19	J	ND		ND	
C2-Phenanthrenes/Anthracenes	3	PA2	65		91		80		ND		ND		ND		ND	
C3-Phenanthrenes/Anthracenes	3	PA3	ND		ND		ND		ND		ND		ND		ND	
C4-Phenanthrenes/Anthracenes	3	PA4	ND		ND		ND		ND		ND		ND		ND	
Dibenzothiophene	3	DBT	ND		ND		11	J	ND		ND		ND		ND	
C1-Dibenzothiophenes	3	DBT1	ND		55		55		ND		ND		ND		ND	
C2-Dibenzothiophenes	3	DBT2	ND		76		56		ND		ND		ND		ND	
C3-Dibenzothiophenes	3	DBT3	ND		ND		ND		ND		ND		ND		ND	
Fluoranthene	4	FL	ND		ND		ND		ND		7	J	ND		ND	
Pyrene	4	PY	ND		ND		ND		ND		6.9	J	ND		ND	
C1-Fluoranthenes/Pyrenes	4	FLPY1	ND		ND		ND		ND		ND		ND		ND	
C2-Fluoranthenes/Pyrenes	4	FLPY2	ND		ND		ND		ND		ND		ND		ND	
C3-Fluoranthenes/Pyrenes	4	FLPY3	ND		ND		ND		ND		ND		ND		ND	
Benzo(a)anthracene	4	BaA	ND		ND		ND		ND		ND		ND		ND	
Chrysene	4	C	ND		ND		ND		ND		ND		ND		ND	
C1-Chrysenes	4	C1	ND		ND		ND		ND		ND		ND		ND	
C2-Chrysenes	4	C2	ND		ND		ND		ND		ND		ND		ND	
C3-Chrysenes	4	C3	ND		ND		ND		ND		ND		ND		ND	
C4-Chrysenes	4	C4	ND		ND		ND		ND		ND		ND		ND	
Benzo(b)fluoranthene	5	BbF	ND		ND		ND		ND		ND		ND		ND	
Benzo(k)fluoranthene	5	BkF	ND		ND		ND		ND		ND		ND		ND	
Benzo(e)pyrene	5	BeP	ND		ND		ND		ND		ND		ND		ND	
Benzo(a)pyrene	5	BaP	ND		ND		ND		ND		ND		ND		ND	
Perylene	5	Per	ND		ND		ND		ND		ND		ND		ND	
Indeno(1,2,3-c,d)pyrene	6	Ind	ND		ND		ND		ND		ND		ND		ND	
Dibenzo(a,h)anthracene	5	DahA	ND		ND		ND		ND		ND		ND		ND	
Benzo(g,h,i)perylene	6	BghiP	ND		ND		ND		ND		ND		ND		ND	
Sum PAHs			150		440		350		38		80		47		25	
Adjusted Sum PAHs*			140		410		340		14		67		29		13	

* These values do not include values for those PAHs (primarily naphthalene) which are less than 5 times the level in the blank.

Only 2 significant figures used.

Table 6-2. PAH Distribution in Opihi Samples Collected September and November 1998

Field ID			SITE2N-KIPU	SITE 2N KIPU-JAR 2	SITE3-KIPU	SITE 3 KIPU-JAR 2	SITE4-KIPU	SITE 4 KIPU-JAR 2	SITE1-AHU
Field Date			11/02/98	11/02/98	11/02/98	11/02/98	11/02/98	11/02/98	11/02/98
Min Reporting Limit			25	20	35	28	34	34	31
Units			ug/Kg dry wt.	ug/Kg dry wt.	ug/Kg dry wt.	ug/Kg dry wt.	ug/Kg dry wt.	ug/Kg dry wt.	ug/Kg dry wt.
PAH Compounds	#Rings	Abbr.							
Naphthalene	2	N	2 JB U	17 JB U	17 JB U	20 JB U	17 JB U	41 B U	31 B U
C1-Naphthalenes	2	N1	ND	ND	ND	10 J	ND	25 J	ND
C2-Naphthalenes	2	N2	ND	ND	ND	ND	ND	ND	ND
C3-Naphthalenes	2	N3	ND	ND	ND	ND	ND	ND	ND
C4-Naphthalenes	2	N4	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	2	ACY	ND	ND	ND	ND	ND	ND	14 J
Acenaphthene	3	ACE	ND	ND	ND	ND	ND	ND	18 J
Biphenyl	3	B	ND	ND	ND	ND	ND	ND	ND
Fluorene	3	F	ND	ND	ND	ND	ND	ND	ND
C1-Fluorenes	3	F1	ND	ND	ND	ND	ND	ND	ND
C2-Fluorenes	3	F2	ND	ND	ND	ND	ND	ND	ND
C3-Fluorenes	3	F3	ND	ND	ND	ND	ND	ND	ND
Anthracene	3	A	ND	ND	ND	ND	ND	ND	8.1 J
Phenanthrene	3	P	4 J	7.6 J	21 J	8.7 J	15 J	15 J	26 J
C1-Pheranthrenes/Anthracenes	3	PA1	ND	ND	ND	ND	ND	ND	ND
C2-Pheranthrenes/Anthracenes	3	PA2	ND	ND	ND	ND	ND	ND	ND
C3-Pheranthrenes/Anthracenes	3	PA3	ND	ND	ND	ND	ND	ND	ND
C4-Pheranthrenes/Anthracenes	3	PA4	ND	ND	ND	ND	ND	ND	ND
Dibenzothiophene	3	DBT	ND	ND	ND	ND	ND	ND	ND
C1-Dibenzothiophenes	3	DBT1	ND	ND	ND	ND	ND	ND	ND
C2-Dibenzothiophenes	3	DBT2	ND	ND	ND	ND	ND	ND	ND
C3-Dibenzothiophenes	3	DBT3	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	4	FL	ND	ND	ND	ND	ND	ND	15 J
Pyrene	4	PY	ND	ND	ND	ND	ND	ND	14 J
C1-Fluoranthenes/Pyrenes	4	FLPY1	ND	ND	ND	ND	ND	ND	ND
C2-Fluoranthenes/Pyrenes	4	FLPY2	ND	ND	ND	ND	ND	ND	ND
C3-Fluoranthenes/Pyrenes	4	FLPY3	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	4	BaA	ND	ND	ND	ND	ND	ND	ND
Chrysene	4	C	ND	ND	ND	ND	ND	ND	15 J
C1-Chrysenes	4	C1	ND	ND	ND	ND	ND	ND	ND
C2-Chrysenes	4	C2	ND	ND	ND	ND	ND	ND	ND
C3-Chrysenes	4	C3	ND	ND	ND	ND	ND	ND	ND
C4-Chrysenes	4	C4	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	5	BbF	ND	ND	ND	ND	ND	ND	16 J
Benzo(k)fluoranthene	5	BkF	ND	ND	ND	ND	ND	ND	14 J
Benzo(e)pyrene	5	BeP	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	5	BaP	ND	ND	ND	ND	ND	ND	13 J
Perylene	5	Per	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-c,d)pyrene	6	Ind	ND	ND	ND	ND	ND	ND	16 J
Dibenzo(a,h)anthracene	5	DahA	ND	ND	ND	ND	ND	ND	10 J
Benzo(g,h,i)perylene	6	BghiP	ND	ND	ND	ND	ND	ND	15 JB U
Sum PAHs			26	25	38	39	32	81	220
Adjusted Sum PAHs*			14	7.6	21	19	15	40	180

* These values do not include values for those PAHs (primarily naphthalene) which are less than 5 times the level in the blank

Only 2 significant figures used.

Table 6-2. PAH Distribution in Opihi Samples Collected September and November 1998

Field ID			SITE 1 AHU - JAR 2		SITE5-NINI		SITE 5 NINI - JAR 2		SITE6-KEE		SPM HOSE001	
Field Date			11/02/98		11/03/98		11/03/98		11/03/98		10.1	
Min Reporting Limit			28		23		21		28		5	
Units			ug/Kg dry wt.		ug/Kg dry wt.		ug/Kg dry wt.		ug/Kg dry wt.		mg/Kg	
PAH Compounds	# Rings	Abbr										
Naphthalene	2	N	16	JB U	9.1	JB U	14	JB U	15	JB U	300	
C1-Naphthalenes	2	N1	ND		ND		ND		ND		820	
C2-Naphthalenes	2	N2	ND		ND		ND		ND		1300	
C3-Naphthalenes	2	N3	ND		ND		ND		ND		1400	
C4-Naphthalenes	2	N4	ND		ND		ND		ND		950	
Acenaphthylene	2	ACY	ND		ND		ND		ND			ND
Acenaphthene	3	ACE	ND		ND		ND		ND		26	
Biphenyl	3	B	ND		ND		ND		ND		66	
Fluorene	3	F	ND		ND		ND		ND		110	
C1-Fluorenes	3	F1	ND		ND		ND		ND		300	
C2-Fluorenes	3	F2	ND		ND		ND		ND		380	
C3-Fluorenes	3	F3	ND		ND		ND		ND		330	
Anthracene	3	A	ND		ND		ND		ND		27	
Phenanthrene	3	P	13	J	8	J	6.3	J	10	J	300	
C1-Pheranthrenes/Anthracenes	3	PA1	ND		ND		ND		ND		570	
C2-Pheranthrenes/Anthracenes	3	PA2	ND		ND		ND		ND		540	
C3-Pheranthrenes/Anthracenes	3	PA3	ND		ND		ND		ND		300	
C4-Pheranthrenes/Anthracenes	3	PA4	ND		ND		ND		ND		160	
Dibenzothiophene	3	DBT	ND		ND		ND		ND		120	
C1-Dibenzothiophenes	3	DBT1	ND		ND		ND		ND		250	
C2-Dibenzothiophenes	3	DBT2	ND		ND		ND		ND		300	
C3-Dibenzothiophenes	3	DBT3	ND		ND		ND		ND		250	
Fluoranthene	4	FL	ND		ND		ND		ND		5.2	
Pyrene	4	PY	ND		ND		ND		ND		15	
C1-Fluoranthenes/Pyrenes	4	FLPY	ND		ND		ND		ND		51	
C2-Fluoranthenes/Pyrenes	4	FLPY2	ND		ND		ND		ND		69	
C3-Fluoranthenes/Pyrenes	4	FLPY3	ND		ND		ND		ND		67	
Benzo(a)anthracene	4	BaA	ND		ND		ND		ND			ND
Chrysene	4	C	ND		ND		ND		ND		12	
C1-Chrysenes	4	C1	ND		ND		ND		ND		29	
C2-Chrysenes	4	C2	ND		ND		ND		ND		49	
C3-Chrysenes	4	C3	ND		ND		ND		ND		58	
C4-Chrysenes	4	C4	ND		ND		ND		ND		56	
Benzo(b)fluoranthene	5	BbF	ND		ND		ND		ND		2.9	J
Benzo(k)fluoranthene	5	BkF	ND		ND		ND		ND			ND
Benzo(e)pyrene	5	BeP	ND		ND		ND		ND		6.7	
Benzo(a)pyrene	5	BaP	ND		ND		ND		ND		2.3	J
Perylene	5	Per	ND		ND		ND		ND		2.2	J
Indeno(1,2,3-c,d)pyrene	6	Ind	ND		ND		ND		ND			ND
Dibenzo(a,h)anthracene	5	DahA	ND		ND		ND		ND			ND
Benzo(g,h,i)perylene	6	BghiF	ND		ND		ND		ND		3.5	J
Sum PAHs			29		17		20		25		9200	
Adjusted Sum PAHs*			13		8		6.3		10			

* These values do not include values for those PAHs (primarily naphthalene) which are less than 5 times the level in the blank.
Only 2 significant figures used.

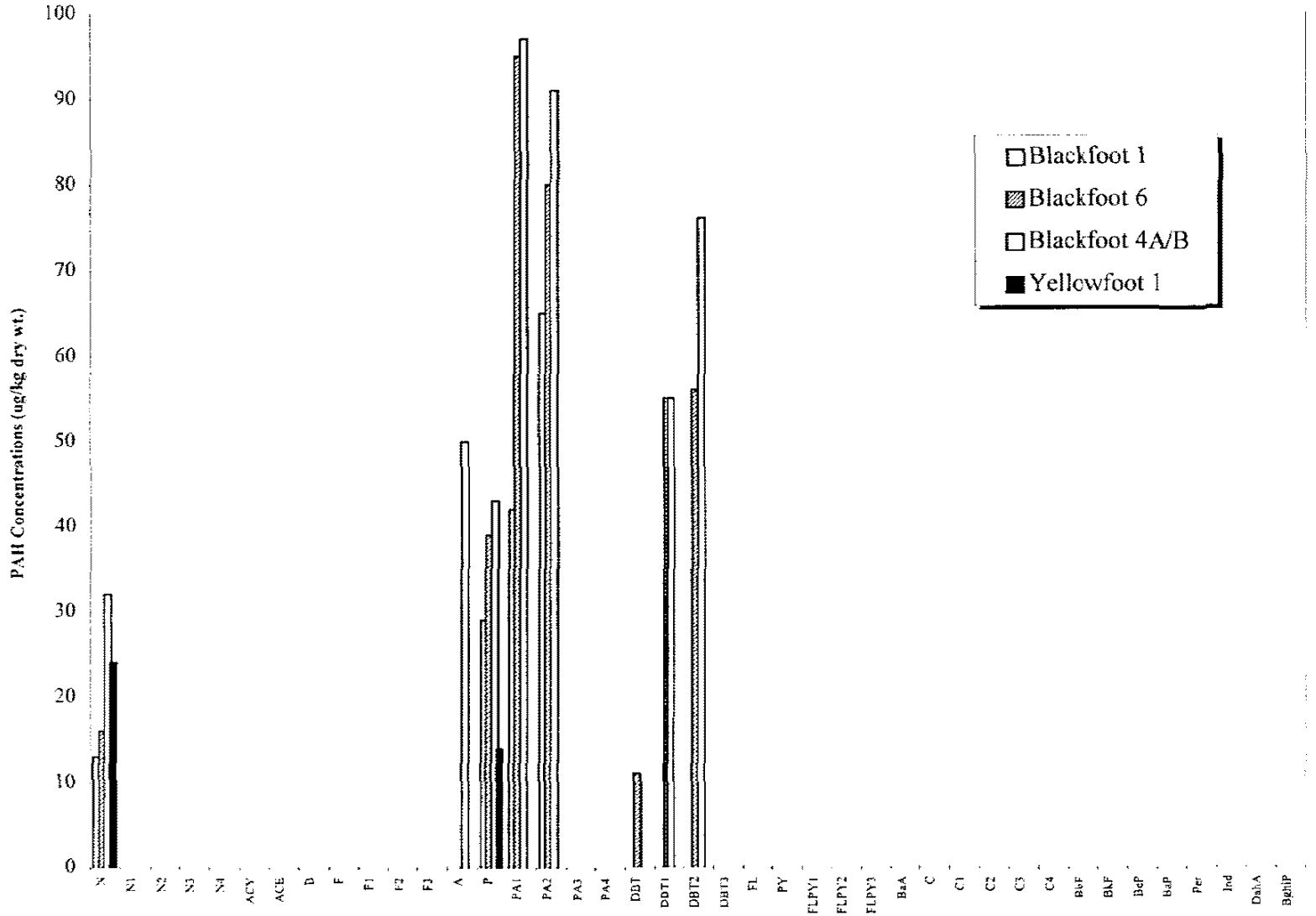


Figure 6-1. PAHs in Opihi Tissue Collected on September 23, 1998 from Oiled Boulders at Kipu Kai, Kauai

environment. The PAH distributions measured in the opihi from the oiled locations are also similar to those measured from the reference locations. The implications of these distributions have been discussed above (Section 6.2.1). While the degree of replication was not sufficient for powerful statistical tests, these results support the conclusion that either: (1) the opihi sampled in November from this location were much less exposed to petroleum from the Tesoro spill than those sampled in September; or (2) depuration diminished or removed any measurable effect of petroleum exposure. The latter explanation, if correct, suggests that above-background petroleum exposure in these intertidal animals was temporally restricted to a period of **approximately** two months.

6.1.2.3 Ahukini Samples

As noted above and in Table 6-1, replicate samples of opihi tissue were collected from oiled boulders in the Ahukini area. These two replicates have very different total adjusted PAH concentrations (13 and 180 µg/kg dry wt.) and PAH distributions (Table 6-2 and Figure 6-2). A review of the PAH distributions presented in Figure 6-2 shows that the Site 1 Jar 2 sample distribution is characterized by high molecular weight PAHs and an absence of alkylated homologues. As discussed above, exposure of biological tissues to petroleum would tend to result in a relative dominance of lower molecular weight compounds and in the uptake of alkylated compounds. This is due to the higher relative concentrations of these compounds in petroleum products (see SPM Hose oil PAH distribution in Figure 6-3) and their ability to more easily move through the environment and be available for uptake. Conversely, PAHs derived from pyrogenic sources such as combustion of petroleum products or creosote, have a PAH distribution dominated by the more stable non-alkylated PAHs (i.e., parent PAHs) and by the larger molecular weight PAHs (Burns 1997 #4).

The PAH distribution measured in the Ahukini Site 1 Jar 2 sample appears to be indicative of a pyrogenic source. The discrepancy between this sample and the other Ahukini Site 1 sample suggests that the pyrogenic source may be derived from a localized input (or from sample contamination). A review of the PAH concentration and distribution in the Ahukini Site 1 sample compared with the total adjusted PAH concentrations measured at the Ahukini reference site (8 and 6.3 µg/kg dry wt., respectively) indicates that there is no current exposure of these intertidal animals to either petroleum or pyrogenic PAH sources.

6.1.3 Interpretation Summary

Total adjusted PAH concentrations for all Kipu Kai opihi samples are comparatively illustrated in Figure 6.4. This presentation emphasizes the differences between the PAH tissue concentrations measured in the September 1998 blackfoot samples, the November samples from both the oiled boulder area and oiled limestone area, and the samples collected from the reference locations. As discussed above, the difference noted between the September and November samples collected from the oiled boulder area clearly suggests that continued exposure to petroleum from the SPM Hose spill is no longer present at levels sufficient to elevate tissue concentrations over background levels.

Further, based on review of all results presented in Tables 6-1 and 6-2, exposure to petroleum from the SPM Hose spill is not indicated in the November 1998 opihi samples collected and analyzed from Ahukini.

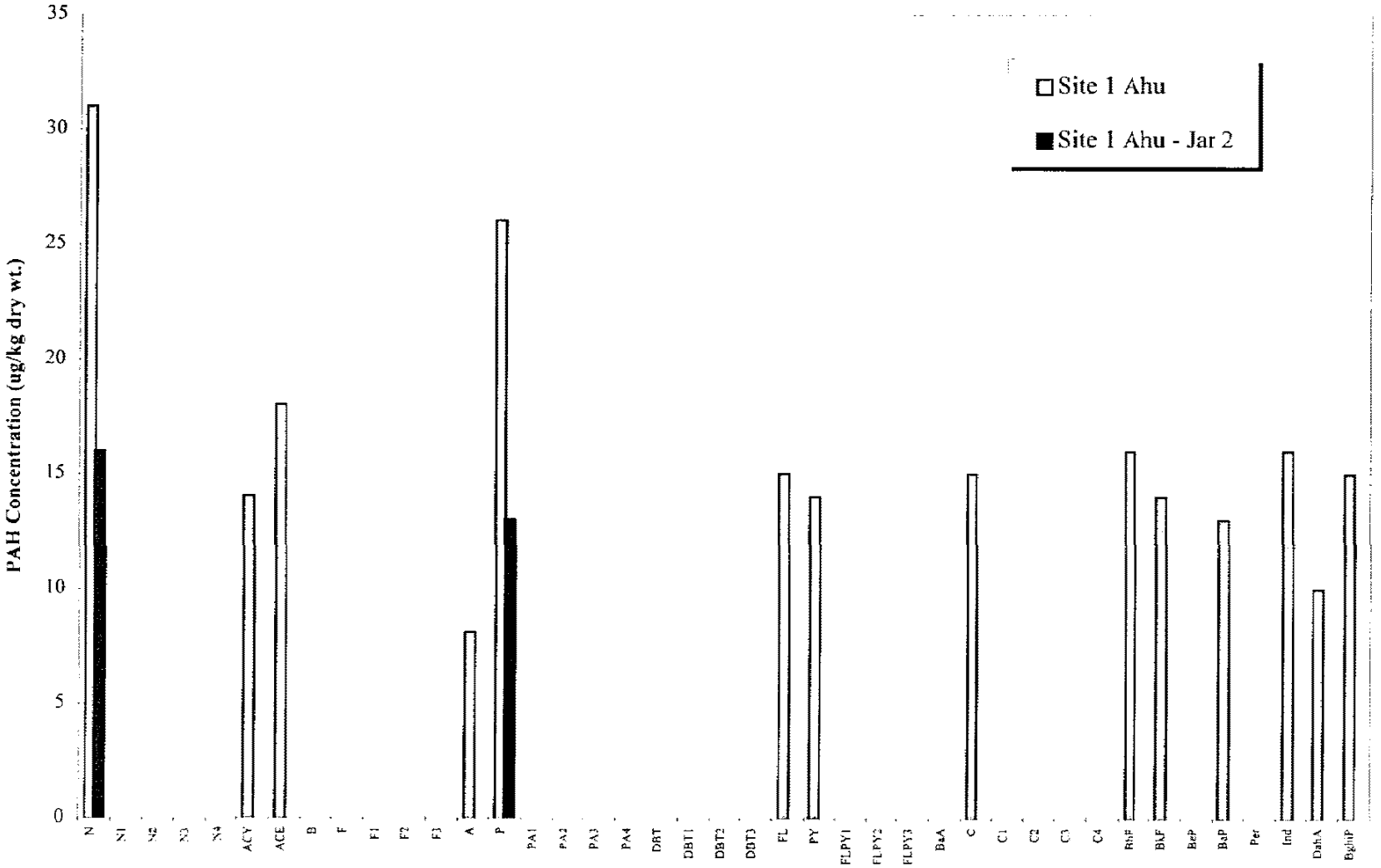


Figure 6-2. Comparison of PAH Concentrations Measured in Site 1 Ahukini Opihi Replicates Collected on November 2, 1998

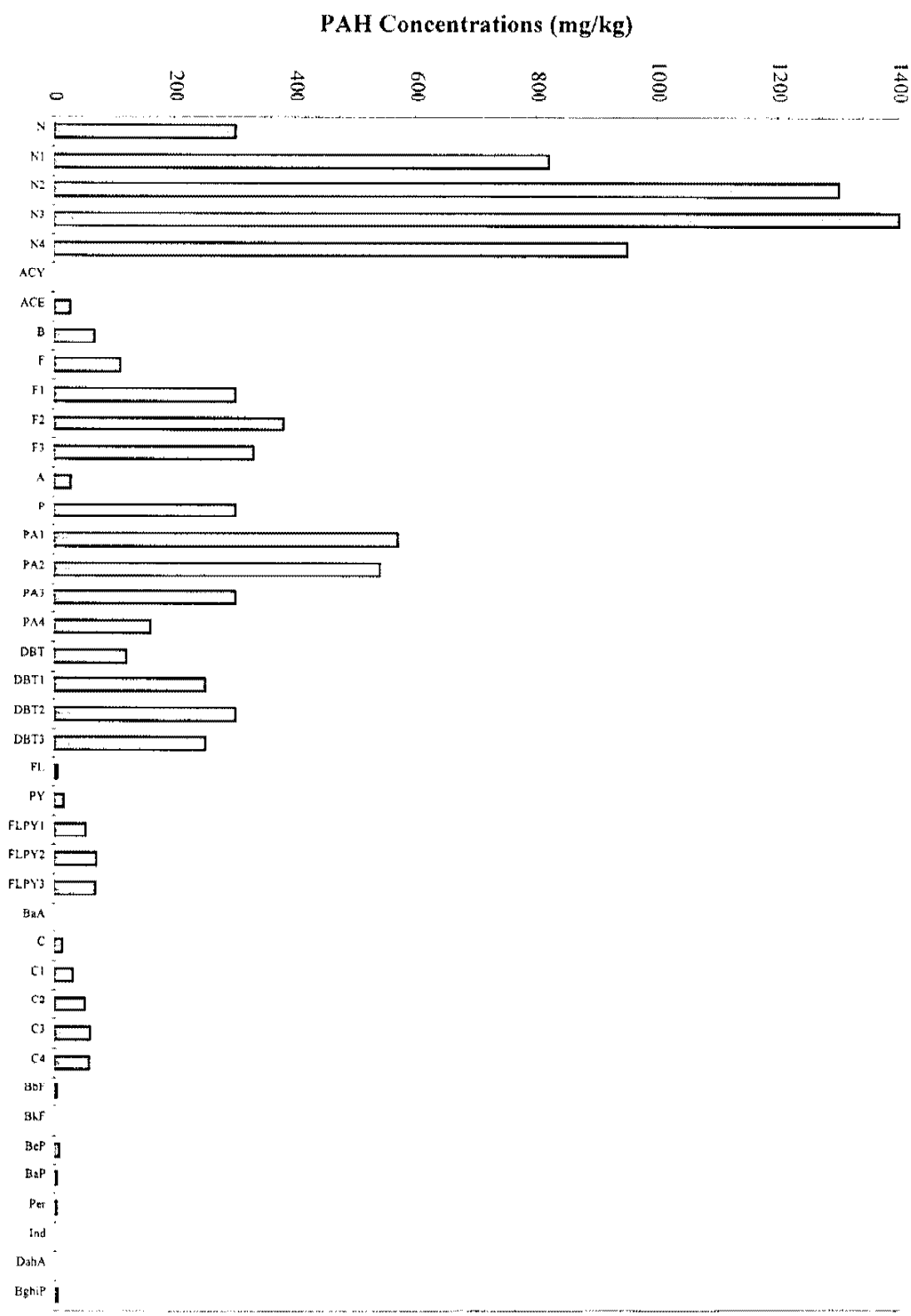


Figure 6-3. PAH Concentrations in the SPM Hose Oil

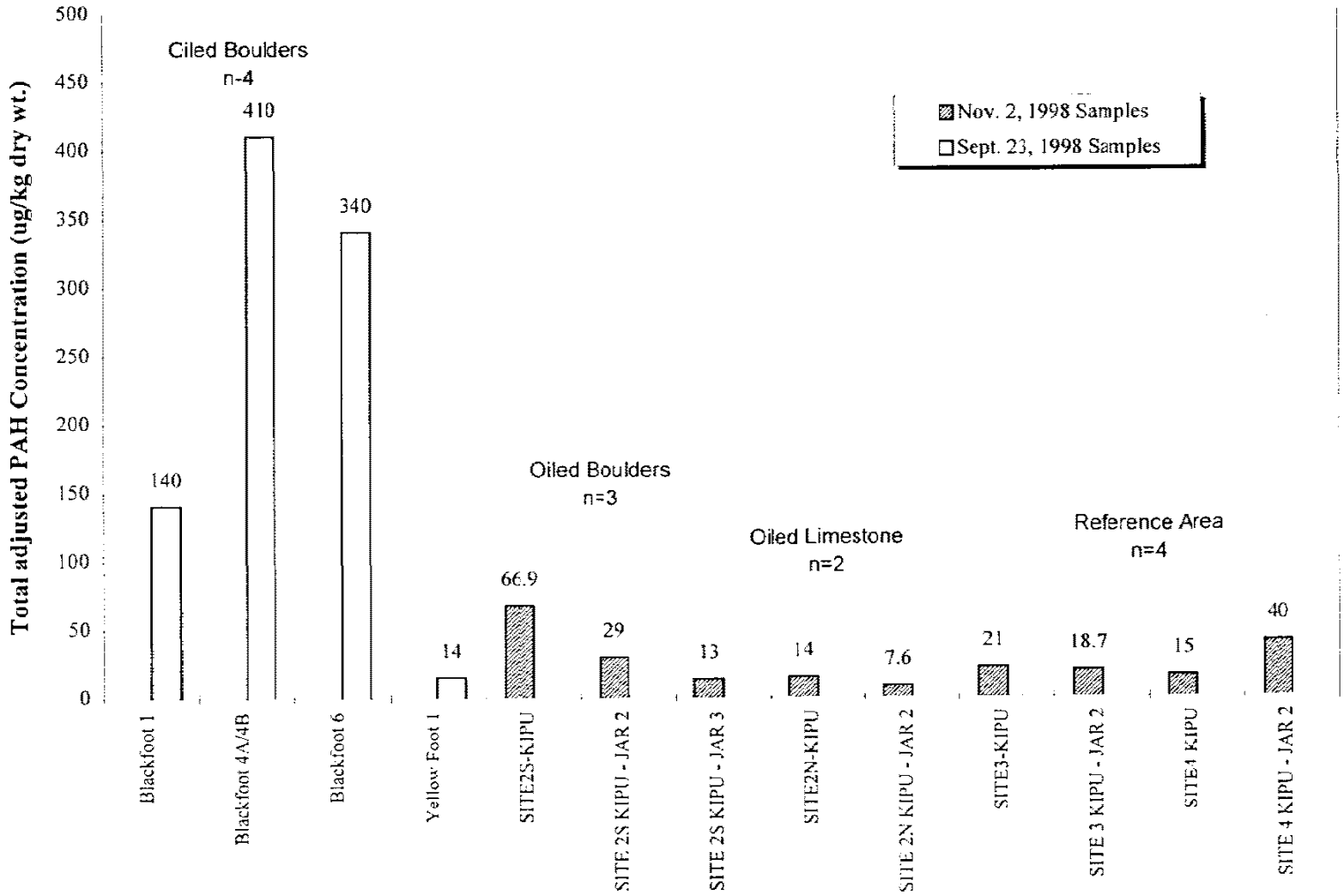


Figure 6-4. Comparison of Total PAHs in Kipu Kai Opihi Samples, September and November 1998

7.0
REFERENCES

Burns, WA, Mankiewiez, PJ, Bence, AE, Page, DS, and Parker, KR. 1997. A Principal Component and Least-Squares Method for Allocating Polycyclic Aromatic Hydrocarbons in Sediment to Multiple Sources. Environ. Tox. & Chem. 16:1119-1131.

USEPA 1994. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. EPA 540/R-94/012. February 1994.

APPENDIX A

PHOTOGRAPHS

SPM Hose Spill Incident	Description	Ahukini "Oiled" Site, looking east	Photo 1
	Project	Opihi Tissue Sampling, Kauai, Hawaii	Photo Date
	Client	Tesoro Hawaii Corporation	Nov. 2, 1998

SPM Hose Spill Incident	Description	Ahukini "Oiled" Site, looking east	Photo 2
	Project	Opihi Tissue Sampling	Photo Date
	Client	Tesoro Hawaii Corporation	Nov. 2, 1998

SPM Hose Spill Incident	Description	Ahukini "Oiled" Site, looking northeast	Photo 3
	Project	Opihi Tissue Sampling	Photo Date Nov. 2, 1998
	Client	Tesoro Hawaii Corporation	

SPM Hose Spill Incident	Description	Ahukini "Oiled" Site, looking south	Photo 4
	Project	Opihi Tissue Sampling	Photo Date Nov. 2, 1998
	Client	Tesoro Hawaii Corporation	

SPM Hose Spill Incident	Description	Ahukini "Oiled" Site, looking west	Photo 5
	Project	Opihi Tissue Sampling	Photo Date
	Client	Tesoro Hawaii Corporation	Nov. 2, 1998

SPM Hose Spill Incident	Description	View of debris on rocks at Ahukini	Photo 6
	Project	Opihi Tissue Sampling	Photo Date
	Client	Tesoro Hawaii Corporation	Nov. 2, 1998

SPM Hose Spill Incident	Description	Ahukini "Reference" Site at Ninini Point, looking west	Photo 7
	Project	Opihi Tissue Sampling	Photo Date Nov. 3, 1998
	Client	Tesoro Hawaii Corporation	

SPM Hose Spill Incident	Description	Ahukini "Reference" Site at Ninini Point, looking southwest	Photo 8
	Project	Opihi Tissue Sampling	Photo Date Nov. 3, 1998
	Client	Tesoro Hawaii Corporation	

SPM Hose Spill Incident	Description	Ahukini "Reference" Site at Ninini Point, looking southwest	Photo 9
	Project	Opihi Tissue Sampling	Photo Date Nov. 3, 1998
	Client	Tesoro Hawaii Corporation	

SPM Hose Spill Incident	Description	Overview of Kipu Kai South Beach, looking southeast	Photo 10
	Project	Opihi Tissue Sampling	Photo Date Nov. 2, 1998
	Client	Tesoro Hawaii Corporation	

SPM Hose Spill Incident	Description	Kipu Kai South Beach "Oiled" Site, looking northeast	Photo 11
	Project	Opihi Tissue Sampling	Photo Date Nov. 2, 1998
	Client	Tesoro Hawaii Corporation	

SPM Hose Spill Incident	Description	Kipu Kai South Beach "Oiled" Site, looking east	Photo 12
	Project	Opihi Tissue Sampling	Photo Date Nov. 2, 1998
	Client	Tesoro Hawaii Corporation	

SPM Hose Spill Incident	Description	Kipu Kai South Beach "Oiled" Site, looking southeast	Photo 13
	Project	Opihi Tissue Sampling	Photo Date Nov. 2, 1998
	Client	Tesoro Hawaii Corporation	

SPM Hose Spill Incident	Description	Kipu Kai South Beach "Oiled" Site, looking northwest	Photo 14
	Project	Opihi Tissue Sampling	Photo Date Nov. 2, 1998
	Client	Tesoro Hawaii Corporation	

SPM Hose Spill Incident	Description	Kipu Kai North Beach "Oiled" Site, looking southeast	Photo 15
	Project	Opihi Tissue Sampling	Photo Date Nov. 2, 1998
	Client	Tesoro Hawaii Corporation	

SPM Hose Spill Incident	Description	Kipu Kai North Beach "Oiled" Site, looking north	Photo 16
	Project	Opihi Tissue Sampling	Photo Date Nov. 2, 1998
	Client	Tesoro Hawaii Corporation	

SPM Hose Spill Incident	Description	Kipu Kai "Reference" Site (SITE3), looking northeast	Photo 17
	Project	Opihi Tissue Sampling	Photo Date Nov. 2, 1998
	Client	Tesoro Hawaii Corporation	

SPM Hose Spill Incident	Description	Kipu Kai "Reference" Site (SITE3), looking southwest	Photo 18
	Project	Opihi Tissue Sampling	Photo Date Nov. 2, 1998
	Client	Tesoro Hawaii Corporation	

SPM Hose Spill Incident	Description	Kipu Kai "Reference" Site (SITE4), looking northeast	Photo 19
	Project	Opihi Tissue Sampling	Photo Date Nov. 2, 1998
	Client	Tesoro Hawaii Corporation	

SPM Hose Spill Incident	Description	Kipu Kai "Reference" Site (SITE4), looking southwest	Photo 20
	Project	Opihi Tissue Sampling	Photo Date Nov. 2, 1998
	Client	Tesoro Hawaii Corporation	

SPM Hose Spill Incident	Description	Haena "Control" Site at Kee Beach, looking west	Photo 21
	Project	Opihi Tissue Sampling	Photo Date Nov. 3, 1998
	Client	Tesoro Hawaii Corporation	

SPM Hose Spill Incident	Description	Haena "Control" Site at Kee Beach, looking east	Photo 22
	Project	Opihi Tissue Sampling	Photo Date Nov. 3, 1998
	Client	Tesoro Hawaii Corporation	

ARTHUR D. LITTLE
Environmental Monitoring and Analysis Unit
Polynuclear Aromatic Hydrocarbons in Tissue Samples
Project Narrative

Client:	Tesoro Hawaii Corporation	Batch No.	B0301
Project No.:	39650	Package No.:	1529
Entered By:	Richard Purdy	Date:	January 11, 1999

Polynuclear Aromatic Hydrocarbons in Tissue Samples

Sample Receipt

Twenty-two (22) tissue samples were received intact and in good condition by Arthur D. Little, Inc. on September 28 and November 4, 1998 on behalf of Tesoro Hawaii Corporation. All pertinent sample receipt information is noted on the chain of custody records included as part of this deliverable. Data for the following samples are reported in this package:

Blackfoot 1	Yellowfoot 1	Blackfoot 4A [2]	Site 2N Kipu Jar 2
Blackfoot 2 [1]	KK Crab 092398 [1]	Blackfoot 4B [2]	Site 3 Kipu Jar 2
Blackfoot 3 [1]	KK Urchin 1 [1]	Site 1 Ahu Jar 2	Site 4 Kipu Jar 2
Blackfoot 5 [1]	KK Urchin 2 [1]	Site 2S Kipu Jar 2	Site 5 Nini Jar 2
Blackfoot 6	KK Urchin 3 [1]	Site 2S Kipu Jar 3	Site 1 Ahu
Site 2S Kipu	Site 2N Kipu	Site 3 Kipu	Site 4 Kipu
Site 5 Nini	Site 6 Kee		

[1] – Sample not analyzed

[2] – Samples combined, prepared and analyzed together

Laboratory Methods

These samples were prepared and analyzed for Parent and Alkyl Homologue Polynuclear Aromatic Hydrocarbons in accordance with the laboratory procedures described in the quality assurance workplan for the project. Quality control samples include a preparation blank, matrix spike/matrix spike duplicate (MS/MSD), and reference material samples.

Preparation

These tissue samples were prepared by homogenizing portions of each sample and serially extracting with methylene chloride. The extracts were cleaned-up using size exclusion chromatography and alumina columns to remove non-target matrix

Approved By: _____ Date: 1/11/99

Arthur D Little

interferences. The solvent extracts were then concentrated to a known volume and submitted for analysis.

Analysis

The sample extracts were analyzed for Parent and Alkyl Homologue Polynuclear Aromatic Hydrocarbons using gas chromatography/mass spectrometry in the selected ion monitoring mode (GC/MS/SIM). The GC/MS is tuned using PFTBA at the start of each analytical sequence, before the calibration. Continuing calibration standards are analyzed after every fifteen to eighteen samples and at the end of the sequence. Target compounds are quantified from the average response factor (RRF) of the calibration curve. Alkyl homologues are quantified using the RRF of the parent compound.

Quality Assurance/Quality Control

Quality assurance and quality control procedures for the analyses are documented in the laboratory quality assurance plan and standard operating procedures (SOPs). The preparation and analysis data are contained in ADL packages 1529. Quality assurance audits were performed on all data generated as part of this deliverable. Please note the following:

- Initial and continuing calibration standards met control limit requirements.
- All surrogate and matrix spike compound recoveries met control limit requirements.
- Target compound recoveries in the standard reference materials (SRM) exceeded quality control requirements for six of the thirteen certified recoveries. Re-analysis of the sample confirmed these results. Triplicate analyses of this SRM analyzed as part of an interlaboratory comparison study during the same time period yielded results for all compounds within acceptable limits. The data are accepted without further qualification but associated results may be biased high.

Data Report

The final report includes the following components:

- Narrative – includes project discussion, sample listing, report qualifiers
- Chain of Custody – includes all signed chain of custody records and observation forms for the reported field samples.
- Data Tables – includes data summary, surrogate recovery summary and quality control results for all analyses

Approved By: _____ Date: 1/11/99

ARTHUR D. LITTLE
Environmental Monitoring and Analysis Unit
Polynuclear Aromatic Hydrocarbons in Tissue Samples
Project Narrative

The method detection limit (MDL) and minimum reporting limits (MRL) were adjusted for sample size, sample split and pre-injection volume (PIV). The minimum reporting limits (MRL) were calculated based on the low calibration standard, 25 µg/mL.

Qualifiers used in reporting of the analytical data are described in the following table.

Table 1: Report Qualifiers

Qualifier	Explanation
J	Concentration between the adjusted minimum reporting limit (MRL) and the adjusted method detection limit (MDL)
U	Concentration below MDL
D	Concentration quantitated from dilution analysis
B	Detected in the associated procedural blank
DO	Diluted out; result could not be measured

Additional qualifiers may be used as defined in the individual data reports or project narrative

Approved By: _____ Date: 1/11/99

Arthur D Little

Clayton
ENVIRONMENTAL CONSULTANTS

REQUEST FOR LABORATORY ANALYTICAL SERVICES

Page ___ of ___

IMPORTANT
Date Results Requested: ___
Rush Charges Authorized? ☐ Yes ☐ No
☐ Phone or ☐ Fax Results

For Clayton Use Only
Clayton Lab Project No.

REPORT RESULTS TO		
Name	RICH ROSEN (TESORO)	Client Job No.
Company	Tesoro Hawaii Corp	Dept.
Mailing Address	P.O. BOX 3379	
City, State, Zip	Honolulu, HI 96842	
Telephone No.	(808) 547-3795	FAX No.

SEND INVOICE TO	
Purchase Order No.	
Name	
Company	Dept.
Address	
City, State, Zip	

Special Instructions and/or specific regulatory requirements: (method, limit of detection, etc.)
HOLD FOR FURTHER INSTRUCTIONS
* Explanation of Preservative

Samples are: (check if applicable)
☐ Drinking Water
☐ Groundwater
☐ Wastewater

ANALYSIS REQUESTED (Enter an 'X' in the box below to indicate request; Enter a 'P' if Preservative added.*)

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	MATRIX/MEDIA	AIR VOLUME (specify units)	Number of Containers	MS/MSD	FOR LAB USE ONLY
~~Kipu Kai 1~~ BLACKFOOT 1	9/23/98	10:30	Tissue		1		✓ 98D3047
~~Kipu Kai 2~~ BLACKFOOT 2	↓	10:20	↓		1		98D3048
BLACKFOOT 3		10:45			1		98D3049
~~BLACKFOOT 4~~		~~11:10~~			~~2~~	~~X~~	
BLACKFOOT 5		11:00			1		98D3050
BLACKFOOT 6		11:15		USE for MS/MSD	1		✓ 98D3051
YELLOW FOOT 1	↓	11:20			1		✓ 98D3052
KK CRAB-092398	9/23/98	9:30			1		98D3053
KK URCHIN 1	9/23/98	10:45			1		98D3054
KK URCHIN 2	9/23/98	11:00	↓		1		98D3055

Does COC match samples? (Y) or N
Broken container: Y or (N)
Received within holding time (Y) or N
COC seal intact (Y) or N / None
Any other problems: Y or (N)
If problems, Client contacted: Y or N
Date contacted: __/__/__
Temperature (°C): 5.6

CHAIN OF CUSTODY

Collected by: Wendy Sanseinesono, Judy Kodetts (print)		Collector's Signature: [signature]		
Relinquished by: Judy Kodetts	Date/Time 9/23/98 1700	Received by: [signature]	Date/Time 9-23-98 1705	
Relinquished by: [signature]	Date/Time 9/24/98 1030	Received by: Stephanie Sakurai	Date/Time 9/24/98 1030	
Method of Shipment: Team Air w/ Dry Ice		Received at Lab by: [signature]	Date/Time 9/28/98 9:45	

Authorized by: ______ Date ______
(Client Signature MUST Accompany Request)

Sample Condition Upon Receipt: ☑ Acceptable ☐ Other (explain)

Please return completed form and samples to one of the Clayton Environmental Consultants, Inc. labs listed below:

Detroit Regional Lab
22345 Roethel Drive
Novi, MI 48375
(800) 806-5887
(810) 344-1770
FAX (810) 344-2655

Atlanta Regional Lab
400 Chastain Center Blvd., N.W., Suite 490
Kennesaw, GA 30144
(800) 252-9919
(770) 499-7500
FAX (770) 423-4990

San Francisco Regional Lab
1252 Quarry Lane
Pleasanton, CA 94566
(800) 294-1755
(510) 426-2657
FAX (510) 426-0106

Seattle Regional Lab
4636 E. Marginal Way S., Suite 215
Seattle, WA 98134
(800) 568-7755
(206) 763-7364
FAX (206) 763-4189

DISTRIBUTION:
White = Clayton Laboratory
Yellow = Clayton Accounting
Pink = Client Copy

11/95 20K

Relinquished by: Stephanie Sakurai 9/24/98 1500

Clayton ENVIRONMENTAL CONSULTANTS

REQUEST FOR LABORATORY ANALYTICAL SERVICES

IMPORTANT
Date Results Requested: _____
Rush Charges Authorized? ☐ Yes ☐ No
☐ Phone or ☐ Fax Results

Page 1 of 1

For Clayton Use Only
Clayton Lab Project No.

REPORT RESULTS TO
Name: Rick Rosen (Tesoro)
Company: Tesoro Hawaii Corp
Dept.
Mailing Address
City, State, Zip
Telephone No.: (808) 547-3795 FAX No.

Client Job No.
Purchase Order No.

SEND INVOICE TO
Name
Company
Dept.
Address
City, State, Zip

Special instructions and/or specific regulatory requirements: (method, limit of detection, etc.)
HOLD FOR FURTHER INSTRUCTIONS

Explanation of Preservative:

Samples are: (check if applicable)
☐ Drinking Water
☐ Groundwater
☐ Wastewater

ANALYSIS REQUESTED
(Enter an "X" in the box below to indicate request; Enter a "P" if Preservative added.)

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	MATRIX/ MEDIA	AIR VOLUME (specify units)	Number of Containers	FOR LAB USE ONLY
KRUECHIN 3	9/23/98	11:00	Tissue	Tyvek	2	98D3056
Blackfoot 4C	9/23/98	11:00	Tissue	Tyvek	2	
Blackfoot 4A	9-23-98	11:00	Tissue		1	98D3057
Blackfoot 4B	9-23-98	11:00	tissue		1	98D3058

Does COC match samples? Y or N
Broken container: Y or N
Received within holding time: Y or N
COC seal intact: Y or N / None
Any other problems: Y or N
If problems, Client contacted: Y or N
Date contacted:
Temperature (°C): 5.6

CHAIN OF CUSTODY

Collected by:	Stephanie Sakurai/Judy Nedoff (print)	Collector's Signature:	Stephanie Sakurai/Judy Nedoff
Relinquished by: Judy Nedoff	Date/Time 9/23/98 1700	Received by: Stephanie Sakurai	Date/Time 9-23-98 1705
Relinquished by: Stephanie Sakurai	Date/Time 9-24-98 1030	Received by: Stephanie Sakurai	Date/Time 9/24/98 10:30
Method of Shipment: Team Air w/ Dry Ice		Received at Lab by: Lynn T. Lee	Date/Time 9/28/98 9:25
Authorized by: _____ Date _____ (Client Signature MUST Accompany Request)		Sample Condition Upon Receipt: ☑ Acceptable	☐ Other (explain)

Please return completed form and samples to one of the Clayton Environmental Consultants, Inc. labs listed below:

Detroit Regional Lab
22345 Roethel Drive
Novi, MI 48375
(800) 805-6867
(248) 344-1770
FAX (248) 344-2555

Atlanta Regional Lab
400 Chastain Center Blvd., N.W., Suite 402
Kennesaw, GA 30144
(800) 252-9919
(770) 499-7530
FAX (770) 423-4990

San Francisco Regional Lab
1252 Quarry Lane
Pleasanton, CA 94566
(800) 284-1155
(510) 426-2557
FAX (510) 426-0106

Seattle Regional Lab
4030 E. Marginal Way S., Suite 215
Seattle, WA 98134
(800) 508-7755
(206) 763-7364
FAX (206) 763-4189

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11/95 20K

Relinquished by Stephanie Sakurai 9/24/98 1030

Clayton LABORATORY SERVICES

REQUEST FOR LABORATORY ANALYTICAL SERVICES

IMPORTANT
Date Results Requested: _____
Rush Charges Authorized? ☐ Yes ☐ No
☐ Phone or ☐ Fax Results

Page ___ of ___

For Clayton Use Only
Clayton Lab Project No.

REPORT RESULTS TO
Name: Richard Rosen | Client Job No.: SPM HOSE
Company: Tesoro Hawaii Corporation | Dept.:
Mailing Address: P.O. Box 3379
City, State, Zip: Honolulu, HI 96842
Telephone No.: (808) 547-3795 | FAX No.: (808) 547-3044

SEND INVOICE TO
Purchase Order No.:
Name:
Company: | Dept.:
Address:
City, State, Zip:

Special instructions and/or specific regulatory requirements: (e.g. detect. limit of detection, etc.)
Please call Judy Vedoff (Entrix) and Rich Rosen to confirm analyses

Samples are: (check if applicable)
☐ Drinking Water
☐ Groundwater
☐ Wastewater

Explanation of Preservative:

ANALYSIS REQUESTED
(Enter an "X" in the box below to indicate request. Enter a "P" if Preservative added.)

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	MATRIX/ MEDIA	AIR VOLUME (specify units)	Number of Containers	PAHs	FOR LAB USE ONLY
SITE1-AHU	11/2/98	8:25	Tissue		2	X	9804265
SITE2S-KIPU	11/2/98	12:00	"		3	X	9804266
SITE2N-KIPU	11/2/98	11:30			2	X	9804267
SITE3-KIPU	11/2/98	2:15			2	X	9804268
SITE4-KIPU	11/2/98	3:15			2	X	9804269
SITE5-NINI	11/3/98	9:10			2	X	9804270
SITE6-KEE	11/3/98	12:00	V		1	X	9804271
END							

Does COC match all containers? Y or N
Custody seals on containers: Y or N
Received within holding time: Y or N
COC tape intact: Y or N
Any other problems: Y or N
If problems, Client contacted: Y or N
Date contacted: __/__/__
Temperature (°C): 20°C

CHAIN OF CUSTODY

Collected by: Stephanie G. Sakurai (Clayton) (print) | Collector's Signature: Stephanie G. Sakurai on behalf of sampling team
Relinquished by: Stephanie G. Sakurai | Date/Time: 11/4/98
Received by: | Date/Time:
Relinquished by: | Date/Time:
Received by: | Date/Time:
Method of Shipment: ~~FED EX~~ TeamAir Express
Received at Lab by: JP Nay | Date/Time: 11-4-98 / 1500
Authorized by: _____ Date: _____ (Client Signature MUST Accompany Request)
Sample Condition Upon Receipt: ☐ Acceptable ☐ Other (explain)

Please return completed form and samples to one of the Clayton Group Services, Inc. labs listed below:

Detroit Regional Lab
22345 Roethel Drive
Novi, MI 48375
(800) 405-6867
(248) 344-1770
FAX (248) 344-2655

Atlanta Regional Lab
400 Chamblee Center Blvd., N.W., Suite 490
Kennesaw, GA 30144
(800) 252-9810
(770) 499-7500
FAX (770) 423-4990

San Francisco Regional Lab
1252 Quarry Lane
Pleasanton, CA 94566
(800) 294-1755
(510) 426-2937
FAX (510) 426-0106

Seattle Regional Lab
4636 E. Marginal Way S., Suite 215
Seattle, WA 98134
(800) 568-7755
(206) 763-7364
FAX (206) 763-1189

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Cooler Number: _____ of _____

Arthur D. Little, Inc.
CHAIN OF CUSTODY RECORD

Page 1 of 1

PROJ. NO.	PROJECT NAME	ANALYSES	REMARKS
	Tesoro	PAHs	

SAMPLERS: (Signature)

Field Sample Number	DATE	TIME	*SAMPLE MATRIX	# of CONTAINERS	PRESERVATION
Site 1 - Akiu Jar 1		8:25	Tissue	1	Frozen
Site 2S - Kipu Jar 1		12:00		1	
" " Jar 3		11:30		1	
Site 2N - Kipu Jar 1		8:15		1	
Site 3 - Kipu Jar 1		3:15		1	
Site 4 - Kipu Jar 1		9:10		1	
Site 5 - ~~Kipu~~ NIDI Jar 1		12:00		1	

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Date	Time	Ship To:
		[signature]	11-4-98	18:00	
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Date	Time	
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date	Time	
			Date	Time	Carrier / Airbill #:

Arthur D. Little, Inc. Acorn Park Cambridge, MA 02140
Tel: (617) 498-5000 FAX: (617) 498-7200

* Soil, SED-Sediment, W-Water T-Tissue

Arthur D. Little
Environmental Monitoring and Analysis Unit

Project Title : Tesoro
Data Package: B0301
Data Table: PAH - Main - Surrogate Corrected

Field ID	SRM 1491	North Slope Crude	SPM HOSE001	Procedural Blank	1974a
Lab ID	BN18	BN14	98D2604RE	CA-S-20PB PCA	CA-S-21SRM PCA
Lab Batch	B0301	B0301	B0301	B0301	B0301
File	DZ5473.D	DZ5474.D	DZ5500.D	DZ5476.D	DZ5477.D
Sample Type	QC	QC	QC	QC	SAMP
Weight Basis	VOLUME	OIL	OIL	DRY	DRY
Matrix	SRM	OIL	OIL	TISSUE	TISSUE
Sample Size	0.1 mL	5 mg	10.1 mg	2 g	1.68 g
Percent Moisture	NA	NA	NA	NA	88.6
Associated Blank	NA	NA	NA	NA	CA-S-20PB PCA
Field Date	NA	NA	NA	NA	NA
Extract Date	NA	NA	NA	NA	12/08/98
Analysis Date	12/17/98	12/17/98	12/18/98	12/17/98	12/17/98
Min Reporting Limit	250	5	5	25	30
Units	ug/L	mg/Kg	mg/Kg	ug/Kg	ug/Kg
Naphthalene	6600	760	300	25	18 JB
C1-Naphthalenes	ND	1700	820	ND	13 J
C2-Naphthalenes	ND	2000	1300	ND	ND
C3-Naphthalenes	ND	1500	1400	ND	ND
C4-Naphthalenes	ND	860	950	ND	ND
Acenaphthylene	6400	ND	ND	ND	14 J
Acenaphthene	6200	ND	26	ND	7 J
Biphenyl	7000	220	66	ND	5.6 J
Fluorene	6200	95	110	ND	6.3 J
C1-Fluorenes	ND	220	300	ND	ND
C2-Fluorenes	ND	330	380	ND	ND
C3-Fluorenes	ND	370	330	ND	ND
Anthracene	7800	ND	27	ND	26 J
Phenanthrene	6800	280	300	ND	30
C1-Phenanthrenes/anthracenes	ND	630	570	ND	68
C2-Phenanthrenes/anthracenes	ND	700	540	ND	140
C3-Phenanthrenes/anthracenes	ND	540	300	ND	200
C4-Phenanthrenes/anthracenes	ND	410	160	ND	220
Dibenzothiophene	ND	230	120	ND	8.5 J
C1-Dibenzothiophenes	ND	480	250	ND	36
C2-Dibenzothiophenes	ND	640	300	ND	120
C3-Dibenzothiophenes	ND	590	250	ND	160
Fluoranthene	5900	ND	5.2	ND	150
Pyrene	6000	12	15	ND	140
C1-Fluoranthenes/pyrenes	ND	85	51	ND	160
C2-Fluoranthenes/pyrenes	ND	150	69	ND	140
C3-Fluoranthenes/pyrenes	ND	180	67	ND	100
Benzo[a]anthracene	3500	ND	ND	ND	52
Chrysene	6500	44	12	ND	94
C1-Chrysenes	ND	80	29	ND	110
C2-Chrysenes	ND	100	49	ND	100
C3-Chrysenes	ND	110	58	ND	ND
C4-Chrysenes	ND	84	56	ND	ND
Benzo[b]fluoranthene	5100	6	2.9 J	ND	80
Benzo[k]fluoranthene	5600	ND	ND	ND	19 J
Benzo[e]pyrene	5700	12	6.7	ND	110
Benzo[a]pyrene	7100	ND	2.3 J	ND	37
Perylene	7200	ND	2.2 J	ND	9 J
Indeno[1,2,3,-c,d]pyrene	6000	ND	ND	ND	23 J
Dibenzo[a,h]anthracene	5100	ND	ND	ND	18 J
Benzo[g,h,i]perylene	5100	ND	3.5 J	14 J	51 B
Total PAH	120000	13000	9200	39	2500
			96		
%d8-Naphthalene	105	110	89	85	82
%d10-Acenaphthene	99	104	91	80	87
%d10-Phenanthrene	95	100	95	91	89
%d12-Benzo[a]pyrene	95	99	95	86	79

Arthur D. Little
Environmental Monitoring and Analysis Unit

Project Title : Tesoro
Data Package: B0301
Data Table: PAH - Main - Surrogate Corrected

Field ID	Blackfoot 1	Blackfoot 6	Yellow Foot 1	Blackfoot 4A/4B	Blackfoot 4A/4B
Lab ID	98D3047 PCA	98D3051 PCA	98D3052 PCA	98D3057 PCA	98D3057MS PCA
Lab Batch	B0301	B0301	B0301	B0301	B0301
File	DZ5478.D	DZ5479.D	DZ5480.D	DZ5481.D	DZ5482.D
Sample Type	SAMP	SAMP	SAMP	SAMP	QC
Weight Basis	DRY	DRY	DRY	DRY	DRY
Matrix	TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
Sample Size	1.42 g	1.7 g	1.45 g	1.44 g	1.34 g
Percent Moisture	83.8	81.7	81.5	82.5	82.5
Associated Blank	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA
Field Date	09/23/98	09/23/98	09/23/98	09/23/98	09/23/98
Extract Date	12/08/98	12/08/98	12/08/98	12/08/98	12/08/98
Analysis Date	12/17/98	12/17/98	12/17/98	12/17/98	12/17/98
Min Reporting Limit	35	29	34	35	37
Units	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
Naphthalene	~~43 JB~~ 35 U	~~16 JB~~ 29 U	~~24 JB~~ 34 U	~~32 JB~~ 35 U	730
C1-Naphthalenes	ND	ND	ND	ND	ND
C2-Naphthalenes	ND	ND	ND	ND	ND
C3-Naphthalenes	ND	ND	ND	ND	ND
C4-Naphthalenes	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	680
Acenaphthene	ND	ND	ND	ND	700
Biphenyl	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	730
C1-Fluorenes	ND	ND	ND	ND	ND
C2-Fluorenes	ND	ND	ND	ND	ND
C3-Fluorenes	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	50	530
Phenanthrene	29 J	39	14 J	43	760
C1-Phenanthrenes/anthracenes	42	95	ND	97	88
C2-Phenanthrenes/anthracenes	65	80	ND	91	95
C3-Phenanthrenes/anthracenes	ND	ND	ND	ND	ND
C4-Phenanthrenes/anthracenes	ND	ND	ND	ND	ND
Dibenzothiophene	ND	11 J	ND	ND	12 J
C1-Dibenzothiophenes	ND	55	ND	59	35 J
C2-Dibenzothiophenes	ND	56	ND	76	65
C3-Dibenzothiophenes	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	760
Pyrene	ND	ND	ND	ND	720
C1-Fluoranthenes/pyrenes	ND	ND	ND	ND	ND
C2-Fluoranthenes/pyrenes	ND	ND	ND	ND	ND
C3-Fluoranthenes/pyrenes	ND	ND	ND	ND	ND
Benzo[a]anthracene	ND	ND	ND	ND	790
Chrysene	ND	ND	ND	ND	730
C1-Chrysenes	ND	ND	ND	ND	ND
C2-Chrysenes	ND	ND	ND	ND	ND
C3-Chrysenes	ND	ND	ND	ND	ND
C4-Chrysenes	ND	ND	ND	ND	ND
Benzo[b]fluoranthene	ND	ND	ND	ND	790
Benzo[k]fluoranthene	ND	ND	ND	ND	790
Benzo[e]pyrene	ND	ND	ND	ND	ND
Benzo[a]pyrene	ND	ND	ND	ND	780
Perylene	ND	ND	ND	ND	ND
Indeno[1,2,3,-c,d]pyrene	ND	ND	ND	ND	720
Dibenzo[a,h]anthracene	ND	ND	ND	ND	710
Benzo[g,h,i]perylene	ND	ND	ND	ND	690
Total PAH	150	350	38	440	12000
%d8-Naphthalene	78	58	68	48	75
%d10-Acenaphthene	81	62	68	52	75
%d10-Phenanthrene	82	67	69	55	79
%d12-Benzo[a]pyrene	82	63	64	53	78

Arthur D. Little
Environmental Monitoring and Analysis Unit

Project Title : Tesoro
Data Package: B0301
Data Table: PAH - Main - Surrogate Corrected

Field ID	Blackfoot 4A/4B	SITE1-AHU	SITE2S-KIPU	SITE2N-KIPU	SITE3-KIPU
Lab ID	98D3057MSD PCA	98D4265 PCA	98D4266 PCA	98D4267 PCA	98D4268 PCA
Lab Batch	B0301	B0301	B0301	B0301	B0301
File	DZ5483.D	DZ5484.D	DZ5486.D	DZ5487.D	DZ5488.D
Sample Type	QC	SAMP	SAMP	SAMP	SAMP
Weight Basis	DRY	DRY	DRY	DRY	DRY
Matrix	TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
Sample Size	1.3 g	1.62 g	1.72 g	1.99 g	1.43 g
Percent Moisture	82.5	78.7	80.5	78.2	79.1
Associated Blank	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA
Field Date	09/23/98	11/02/98	11/02/98	11/02/98	11/02/98
Extract Date	12/08/98	12/08/98	12/08/98	12/08/98	12/08/98
Analysis Date	12/17/98	12/17/98	12/17/98	12/17/98	12/17/98
Min Reporting Limit	38	31	29	25	35
Units	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
Naphthalene	730	31 B ~~J~~	~~13 JB~~ 29 ~~J~~	~~12 JB~~ 25 ~~J~~	~~17 JB~~ 36 ~~J~~
C1-Naphthalenes	25 J	ND	14 J	ND	ND
C2-Naphthalenes	ND	ND	ND	ND	ND
C3-Naphthalenes	ND	ND	ND	ND	ND
C4-Naphthalenes	ND	ND	ND	ND	ND
Acenaphthylene	710	14 J	ND	ND	ND
Acenaphthene	710	18 J	ND	ND	ND
Biphenyl	ND	ND	ND	ND	ND
Fluorene	750	ND	ND	ND	ND
C1-Fluorenes	ND	ND	ND	ND	ND
C2-Fluorenes	ND	ND	ND	ND	ND
C3-Fluorenes	ND	ND	ND	ND	ND
Anthracene	530	8.1 J	ND	ND	ND
Phenanthrene	790	26 J	20 J	14 J	21 J
C1-Phenanthrenes/anthracenes	150	ND	19 J	ND	ND
C2-Phenanthrenes/anthracenes	220	ND	ND	ND	ND
C3-Phenanthrenes/anthracenes	130	ND	ND	ND	ND
C4-Phenanthrenes/anthracenes	ND	ND	ND	ND	ND
Dibenzothiophene	18 J	ND	ND	ND	ND
C1-Dibenzothiophenes	50	ND	ND	ND	ND
C2-Dibenzothiophenes	130	ND	ND	ND	ND
C3-Dibenzothiophenes	140	ND	ND	ND	ND
Fluoranthene	770	15 J	7 J	ND	ND
Pyrene	750	14 J	6.9 J	ND	ND
C1-Fluoranthenes/pyrenes	69	ND	ND	ND	ND
C2-Fluoranthenes/pyrenes	84	ND	ND	ND	ND
C3-Fluoranthenes/pyrenes	64	ND	ND	ND	ND
Benzo[a]anthracene	800	ND	ND	ND	ND
Chrysene	740	15 J	ND	ND	ND
C1-Chrysenes	40	ND	ND	ND	ND
C2-Chrysenes	31 J	ND	ND	ND	ND
C3-Chrysenes	34 J	ND	ND	ND	ND
C4-Chrysenes	ND	ND	ND	ND	ND
Benzo[b]fluoranthene	820	16 J	ND	ND	ND
Benzo[k]fluoranthene	790	14 J	ND	ND	ND
Benzo[e]pyrene	ND	ND	ND	ND	ND
Benzo[a]pyrene	790	13 J	ND	ND	ND
Perylene	ND	ND	ND	ND	ND
Indeno[1,2,3,-c,d]pyrene	710	16 J	ND	ND	ND
Dibenzo[a,h]anthracene	720	10 J	ND	ND	ND
Benzo[g,h,i]perylene	640	~~15 JB~~ 31 ~~J~~	ND	ND	ND
Total PAH	13000	220	80	26	38
%d8-Naphthalene	89	65	88	72	76
%d10-Acenaphthene	93	66	88	74	74
%d10-Phenanthrene	97	70	89	76	78
%d12-Benzo[a]pyrene	97	67	85	73	78

Arthur D. Little
Environmental Monitoring and Analysis Unit

Project Title : Tesoro
Data Package: B0301
Data Table: PAH - Main - Surrogate Corrected

Field ID	SITE4-KIPU	SITE5-NINI	SITE6-KEE	SITE 1 AHU - JAR 2	SITE 2S KIPU - JAR 2
Lab ID	98D4269 PCA	98D4270 PCA	98D4271 PCA	98D4411 PCA	98D4412 PCA
Lab Batch	B0301	B0301	B0301	B0301	B0301
File	DZ5489.D	DZ5490.D	DZ5491.D	DZ5492.D	DZ5493.D
Sample Type	SAMP	SAMP	SAMP	SAMP	SAMP
Weight Basis	DRY	DRY	DRY	DRY	DRY
Matrix	TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
Sample Size	1.47 g	2.14 g	1.78 g	1.76 g	2.17 g
Percent Moisture	80	79.6	80.3	80.1	79.7
Associated Blank	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA
Field Date	11/02/98	11/03/98	11/03/98	11/02/98	11/02/98
Extract Date	12/08/98	12/08/98	12/08/98	12/08/98	12/08/98
Analysis Date	12/17/98	12/17/98	12/17/98	12/18/98	12/18/98
Min Reporting Limit	34	23	28	28	23
Units	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
Naphthalene	~~17 JB~~ 34	~~9.1 JB~~ 23	~~15 JB~~ 28	~~19 JB~~ 28	~~18 JB~~ 23
C1-Naphthalenes	ND	ND	ND	ND	16 J
C2-Naphthalenes	ND	ND	ND	ND	ND
C3-Naphthalenes	ND	ND	ND	ND	ND
C4-Naphthalenes	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND
Biphenyl	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND
C1-Fluorenes	ND	ND	ND	ND	ND
C2-Fluorenes	ND	ND	ND	ND	ND
C3-Fluorenes	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND
Phenanthrene	15 J	8 J	10 J	13 J	13 J
C1-Phenanthrenes/anthracenes	ND	ND	ND	ND	ND
C2-Phenanthrenes/anthracenes	ND	ND	ND	ND	ND
C3-Phenanthrenes/anthracenes	ND	ND	ND	ND	ND
C4-Phenanthrenes/anthracenes	ND	ND	ND	ND	ND
Dibenzothiophene	ND	ND	ND	ND	ND
C1-Dibenzothiophenes	ND	ND	ND	ND	ND
C2-Dibenzothiophenes	ND	ND	ND	ND	ND
C3-Dibenzothiophenes	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND
C1-Fluoranthenes/pyrenes	ND	ND	ND	ND	ND
C2-Fluoranthenes/pyrenes	ND	ND	ND	ND	ND
C3-Fluoranthenes/pyrenes	ND	ND	ND	ND	ND
Benzo[a]anthracene	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND
C1-Chrysenes	ND	ND	ND	ND	ND
C2-Chrysenes	ND	ND	ND	ND	ND
C3-Chrysenes	ND	ND	ND	ND	ND
C4-Chrysenes	ND	ND	ND	ND	ND
Benzo[b]fluoranthene	ND	ND	ND	ND	ND
Benzo[k]fluoranthene	ND	ND	ND	ND	ND
Benzo[e]pyrene	ND	ND	ND	ND	ND
Benzo[a]pyrene	ND	ND	ND	ND	ND
Perylene	ND	ND	ND	ND	ND
Indeno[1,2,3,-c,d]pyrene	ND	ND	ND	ND	ND
Dibenzo[a,h]anthracene	ND	ND	ND	ND	ND
Benzo[g,h,i]perylene	ND	ND	ND	ND	ND
Total PAH	32	17	25	29	47
%d8-Naphthalene	75	83	80	67	69
%d10-Acenaphthene	75	81	82	68	72
%d10-Phenanthrene	79	81	84	69	76
%d12-Benzo[a]pyrene	81	80	86	68	73

Arthur D. Little
Environmental Monitoring and Analysis Unit

Project Title : Tesoro
Data Package: B0301
Data Table: PAH - Main - Surrogate Corrected

	SITE 2S KIPU -	SITE 2N KIPU -	SITE 3 KIPU - JAR	SITE 4 KIPU - JAR	SITE 5 NINI - JAR
Field ID	JAR 3	JAR 2	2	2	2
Lab ID	98D4413 PCA	98D4414 PCA	98D4415 PCA	98D4416 PCA	98D4417 PCA
Lab Batch	B0301	B0301	B0301	B0301	B0301
File	DZ5494.D	DZ5495.D	DZ5496.D	DZ5497.D	DZ5499.D
Sample Type	SAMP	SAMP	SAMP	SAMP	SAMP
Weight Basis	DRY	DRY	DRY	DRY	DRY
Matrix	TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
Sample Size	2.06 g	2.48 g	1.78 g	1.49 g	2.35 g
Percent Moisture	80.1	77.2	80.4	82.2	79.6
Associated Blank	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA
Field Date	11/02/98	11/02/98	11/02/98	11/02/98	11/03/98
Extract Date	12/08/98	12/08/98	12/08/98	12/08/98	12/08/98
Analysis Date	12/18/98	12/18/98	12/18/98	12/18/98	12/18/98
Min Reporting Limit	24	20	28	34	21
Units	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
Naphthalene	~~12 JB~~ 24 J	~~17 JB~~ 20 J	~~20 JB~~ 28 J	41 B J	~~44 JB~~ 21 J
C1-Naphthalenes	ND	ND	10 J	25 J	ND
C2-Naphthalenes	ND	ND	ND	ND	ND
C3-Naphthalenes	ND	ND	ND	ND	ND
C4-Naphthalenes	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND
Biphenyl	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND
C1-Fluorenes	ND	ND	ND	ND	ND
C2-Fluorenes	ND	ND	ND	ND	ND
C3-Fluorenes	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND
Phenanthrene	13 J	7.6 J	8.7 J	15 J	6.3 J
C1-Phenanthrenes/anthracenes	ND	ND	ND	ND	ND
C2-Phenanthrenes/anthracenes	ND	ND	ND	ND	ND
C3-Phenanthrenes/anthracenes	ND	ND	ND	ND	ND
C4-Phenanthrenes/anthracenes	ND	ND	ND	ND	ND
Dibenzothiophene	ND	ND	ND	ND	ND
C1-Dibenzothiophenes	ND	ND	ND	ND	ND
C2-Dibenzothiophenes	ND	ND	ND	ND	ND
C3-Dibenzothiophenes	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND
C1-Fluoranthenes/pyrenes	ND	ND	ND	ND	ND
C2-Fluoranthenes/pyrenes	ND	ND	ND	ND	ND
C3-Fluoranthenes/pyrenes	ND	ND	ND	ND	ND
Benzo[a]anthracene	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND
C1-Chrysenes	ND	ND	ND	ND	ND
C2-Chrysenes	ND	ND	ND	ND	ND
C3-Chrysenes	ND	ND	ND	ND	ND
C4-Chrysenes	ND	ND	ND	ND	ND
Benzo[b]fluoranthene	ND	ND	ND	ND	ND
Benzo[k]fluoranthene	ND	ND	ND	ND	ND
Benzo[e]pyrene	ND	ND	ND	ND	ND
Benzo[a]pyrene	ND	ND	ND	ND	ND
Perylene	ND	ND	ND	ND	ND
Indeno[1,2,3,-c,d]pyrene	ND	ND	ND	ND	ND
Dibenzo[a,h]anthracene	ND	ND	ND	ND	ND
Benzo[g,h,i]perylene	ND	ND	ND	ND	ND
Total PAH	25	25	39	81	20
%d8-Naphthalene	77	67	85	77	73
%d10-Acenaphthene	75	67	86	78	78
%d10-Phenanthrene	77	67	88	80	79
%d12-Benzo[a]pyrene	75	66	87	81	81

Arthur D. Little
Environmental Monitoring and Analysis Unit

Project Title : Tesoro
Data Package: B0301
Data Table: PAH - MS-MSD - Surrogate Corrected

Field ID	Blackfoot 4A/4B		Blackfoot 4A/4B				
Lab ID	98D3057 PCA		98D3057MS PCA				
Lab Batch	B0301		B0301				
File	DZ5481.D		DZ5482.D				
Sample Type	SAMP		QC				
Weight Basis	DRY		DRY				
Matrix	TISSUE		TISSUE				
Sample Size	1.44 g		1.34 g				
Percent Moisture	82.5		82.5				
Associated Blank	CA-S-20PB PCA		CA-S-20PB PCA				
Field Date	09/23/98		09/23/98				
Extract Date	12/08/98		12/08/98				
Analysis Date	12/17/98		12/17/98				
Min Reporting Limit	35		37				
Units	ug/Kg		ug/Kg		T	%R	Q
Naphthalene	32	JB	730		746	94	
C1-Naphthalenes	ND		ND				
C2-Naphthalenes	ND		ND				
C3-Naphthalenes	ND		ND				
C4-Naphthalenes	ND		ND				
Acenaphthylene	ND		680		746	91	
Acenaphthene	ND		700		746	94	
Biphenyl	ND		ND				
Fluorene	ND		730		746	98	
C1-Fluorenes	ND		ND				
C2-Fluorenes	ND		ND				
C3-Fluorenes	ND		ND				
Anthracene	50		530		746	64	
Phenanthrene	43		760		746	96	
C1-Phenanthrenes/anthracenes	97		88				
C2-Phenanthrenes/anthracenes	91		95				
C3-Phenanthrenes/anthracenes	ND		ND				
C4-Phenanthrenes/anthracenes	ND		ND				
Dibenzothiophene	ND		12	J			
C1-Dibenzothiophenes	55		35	J			
C2-Dibenzothiophenes	76		65				
C3-Dibenzothiophenes	ND		ND				
Fluoranthene	ND		760		746	102	
Pyrene	ND		720		746	97	
C1-Fluoranthenes/pyrenes	ND		ND				
C2-Fluoranthenes/pyrenes	ND		ND				
C3-Fluoranthenes/pyrenes	ND		ND				
Benzo[a]anthracene	ND		790		746	106	
Chrysene	ND		730		746	98	
C1-Chrysenes	ND		ND				
C2-Chrysenes	ND		ND				
C3-Chrysenes	ND		ND				
C4-Chrysenes	ND		ND				
Benzo[b]fluoranthene	ND		790		746	106	
Benzo[k]fluoranthene	ND		790		746	106	
Benzo[e]pyrene	ND		ND				
Benzo[a]pyrene	ND		780		746	105	
Perylene	ND		ND				
Indeno[1,2,3,-c,d]pyrene	ND		720		746	97	
Dibenzo[a,h]anthracene	ND		710		746	95	
Benzo[g,h,i]perylene	ND		690		746	92	
%d8-Naphthalene	48		75				
%d10-Acenaphthene	52		75				
%d10-Phenanthrene	55		79				
%d12-Benzo[a]pyrene	53		78				

Arthur D. Little
Environmental Monitoring and Analysis Unit

Project Title : Tesoro
Data Package: B0301
Data Table: PAH - MS-MSD - Surrogate Corrected

Field ID	Blackfoot 4A/4B					
Lab ID	98D3057MSD PCA					
Lab Batch	B0301					
File	DZ5483.D					
Sample Type	QC					
Weight Basis	DRY					
Matrix	TISSUE					
Sample Size	1.3 g					
Percent Moisture	82.5					
Associated Blank	CA-S-20PB PCA					
Field Date	09/23/98					
Extract Date	12/08/98					
Analysis Date	12/17/98					
Min Reporting Limit	38					
Units	ug/Kg		T	%R	Q RPD	Q
Naphthalene	730		769	91	3.2	
C1-Naphthalenes	25	J				
C2-Naphthalenes	ND					
C3-Naphthalenes	ND					
C4-Naphthalenes	ND					
Acenaphthylene	710		769	92	1.1	
Acenaphthene	710		769	92	2.2	
Biphenyl	ND					
Fluorene	750		769	98	0	
C1-Fluorenes	ND					
C2-Fluorenes	ND					
C3-Fluorenes	ND					
Anthracene	530		769	62	3.2	
Phenanthrene	790		769	97	1	
C1-Phenanthrenes/anthracenes	150					
C2-Phenanthrenes/anthracenes	220					
C3-Phenanthrenes/anthracenes	130					
C4-Phenanthrenes/anthracenes	ND					
Dibenzothiophene	18	J				
C1-Dibenzothiophenes	50					
C2-Dibenzothiophenes	130					
C3-Dibenzothiophenes	140					
Fluoranthene	770		769	100	2	
Pyrene	750		769	98	1	
C1-Fluoranthenes/pyrenes	69					
C2-Fluoranthenes/pyrenes	84					
C3-Fluoranthenes/pyrenes	64					
Benzo[a]anthracene	800		769	104	1.9	
Chrysene	740		769	96	2.1	
C1-Chrysenes	40					
C2-Chrysenes	31	J				
C3-Chrysenes	34	J				
C4-Chrysenes	ND					
Benzo[b]fluoranthene	820		769	107	0.94	
Benzo[k]fluoranthene	790		769	103	2.9	
Benzo[e]pyrene	ND					
Benzo[a]pyrene	790		769	103	1.9	
Perylene	ND					
Indeno[1,2,3,-c,d]pyrene	710		769	92	5.3	
Dibenzo[a,h]anthracene	720		769	94	1	
Benzo[g,h,i]perylene	640		769	83	10	
%d8-Naphthalene	89					
%d10-Acenaphthene	93					
%d10-Phenanthrene	97					
%d12-Benzo[a]pyrene	97					

Arthur D. Little
Environmental Monitoring and Analysis Unit

Project Title : Tesoro
Data Package: B0301
Data Table: PAH - IRM - Surrogate Corrected

Field ID	SRM 1491			
Lab ID	BN18			
Lab Batch	B0301			
File	DZ5473.D			
Sample Type	QC			
Weight Basis	VOLUME			
Matrix	SRM			
Sample Size	0.1 mL			
Percent Moisture	NA			
Associated Blank	NA			
Field Date	NA			
Extract Date	NA			
Analysis Date	12/17/98			
Min Reporting Limit	250			
Units	ug/L	T	%D	Q
Naphthalene	6600	6890	-4.2	
C1-Naphthalenes	ND			
C2-Naphthalenes	ND			
C3-Naphthalenes	ND			
C4-Naphthalenes	ND			
Acenaphthylene	6400	6960	-8	
Acenaphthene	6200	7280	-15	
Biphenyl	7000	7000	0	
Fluorene	6200	7270	-15	
C1-Fluorenes	ND			
C2-Fluorenes	ND			
C3-Fluorenes	ND			
Anthracene	7800	7820	-0.3	
Phenanthrene	6800	7010	-3	
C1-Phenanthrenes/anthracenes	ND			
C2-Phenanthrenes/anthracenes	ND			
C3-Phenanthrenes/anthracenes	ND			
C4-Phenanthrenes/anthracenes	ND			
Dibenzothiophene	ND			
C1-Dibenzothiophenes	ND			
C2-Dibenzothiophenes	ND			
C3-Dibenzothiophenes	ND			
Fluoranthene	5900	5910	-0.2	
Pyrene	6000	5890	1.9	
C1-Fluoranthenes/pyrenes	ND			
C2-Fluoranthenes/pyrenes	ND			
C3-Fluoranthenes/pyrenes	ND			
Benzo[a]anthracene	3500	3590	-2.5	
Chrysene	6500	7030	-7.5	
C1-Chrysenes	ND			
C2-Chrysenes	ND			
C3-Chrysenes	ND			
C4-Chrysenes	ND			
Benzo[b]fluoranthene	5100	5250	-2.8	
Benzo[k]fluoranthene	5600	5570	0.54	
Benzo[e]pyrene	5700	5620	1.4	
Benzo[a]pyrene	7100	6790	4.6	
Perylene	7200	7120	1.1	
Indeno[1,2,3,-c,d]pyrene	6000	6290	-4.6	
Dibenzo[a,h]anthracene	5100	5180	-1.5	
Benzo[g,h,i]perylene	5100	5290	-3.6	
%d8-Naphthalene	105			
%d10-Acenaphthene	99			
%d10-Phenanthrene	95			
%d12-Benzo[a]pyrene	95			

Arthur D. Little
Environmental Monitoring and Analysis Unit

Project Title : Tesoro
Data Package: B0301
Data Table: PAH - NSC - Surrogate Corrected

Field ID	North Slope Crude				
Lab ID	BN14				
Lab Batch	B0301				
File	DZ5474.D				
Sample Type	QC				
Weight Basis	OIL				
Matrix	OIL				
Sample Size	5 mg				
Percent Moisture	NA				
Associated Blank	NA				
Field Date	NA				
Extract Date	NA				
Analysis Date	12/17/98				
Min Reporting Limit	5				
Units	mg/Kg		T	%D	Q
Naphthalene	760		750	1.3	
C1-Naphthalenes	1700		1700	0	
C2-Naphthalenes	2000		2400	-17	
C3-Naphthalenes	1500		2000	-25	
C4-Naphthalenes	860		1200	-28	
Acenaphthylene	ND				
Acenaphthene	ND				
Biphenyl	220		220	0	
Fluorene	95		94	1.1	
C1-Fluorenes	220		240	-8.3	
C2-Fluorenes	330		350	-5.7	
C3-Fluorenes	370		400	-7.5	
Anthracene	ND				
Phenanthrene	280		260	7.7	
C1-Phenanthrenes/anthracenes	630		600	5	
C2-Phenanthrenes/anthracenes	700		740	-5.4	
C3-Phenanthrenes/anthracenes	540		540	0	
C4-Phenanthrenes/anthracenes	410		330	24	
Dibenzothiophene	230		240	-4.2	
C1-Dibenzothiophenes	480		500	-4	
C2-Dibenzothiophenes	640		740	-14	
C3-Dibenzothiophenes	590		660	-11	
Fluoranthene	ND				
Pyrene	12		14	-14	
C1-Fluoranthenes/pyrenes	85		83	2.4	
C2-Fluoranthenes/pyrenes	150		150	0	
C3-Fluoranthenes/pyrenes	180		170	5.9	
Benzo[a]anthracene	ND				
Chrysene	44		49	-10	
C1-Chrysenes	80		84	-4.8	
C2-Chrysenes	100		110	-9.1	
C3-Chrysenes	110		92	20	
C4-Chrysenes	84		75	12	
Benzo[b]fluoranthene	6	J	6.6	-9.1	
Benzo[k]fluoranthene	ND				
Benzo[e]pyrene	12		12	0	
Benzo[a]pyrene	ND				
Perylene	ND				
Indeno[1,2,3,-c,d]pyrene	ND				
Dibenzo[a,h]anthracene	ND				
Benzo[g,h,i]perylene	ND				
%d8-Naphthalene	110				
%d10-Acenaphthene	104				
%d10-Phenanthrene	100				
%d12-Benzo[a]pyrene	99				

Arthur D. Little
Environmental Monitoring and Analysis Unit

Draft

Project Title : Tesoro
Data Package: B0301
Data Table: PAH - Main - Surrogate Corrected

Field ID	SRM 1491	North Slope Crude	SPM HOSE001	Procedural Blank	1974a
Lab ID	BN16	BN14	98D2604RE	CA-S-20PB PCA	CA-S-21SRM PCA
Lab Batch	B0301	B0301	B0301	B0301	B0301
File	DZ5473.D	DZ5474.D	DZ5500.D	DZ5476.D	DZ5477.D
Sample Type	QC	QC	QC	QC	SAMP
Weight Basis	VOLUME	OIL	OIL	DRY	DRY
Matrix	SRM	OIL	OIL	TISSUE	TISSUE
Sample Size	0.1 mL	5 mg	10.1 mg	2 g	1.68 g
Percent Moisture	NA	NA	NA	NA	88.6
Associated Blank	NA	NA	NA	NA	CA-S-20PB PCA
Field Date	NA	NA	NA	NA	NA
Extract Date	NA	NA	NA	NA	12/08/98
Analysis Date	12/17/98	12/17/98	12/18/98	12/17/98	12/17/98
Min Reporting Limit	250	5	5	25	30
Units	ug/L	mg/Kg	mg/Kg	ug/Kg	ug/Kg
Naphthalene	6600	760	300	25	18 JB
C1-Naphthalenes	ND	1700	820	ND	13 J
C2-Naphthalenes	ND	2000	1300	ND	ND
C3-Naphthalenes	ND	1500	1400	ND	ND
C4-Naphthalenes	ND	860	950	ND	ND
Acenaphthylene	6400	ND	ND	ND	14 J
Acenaphthene	6200	ND	26	ND	7 J
Biphenyl	7000	220	66	ND	5.6 J
Fluorene	6200	95	110	ND	8.3 J
C1-Fluorenes	ND	220	300	ND	ND
C2-Fluorenes	ND	330	380	ND	ND
C3-Fluorenes	ND	370	330	ND	ND
Anthracene	7800	ND	27	ND	26 J
Phenanthrene	6800	280	300	ND	30
C1-Phenanthrenes/anthracenes	ND	630	570	ND	68
C2-Phenanthrenes/anthracenes	ND	700	540	ND	140
C3-Phenanthrenes/anthracenes	ND	540	300	ND	200
C4-Phenanthrenes/anthracenes	ND	410	160	ND	220
Dibenzothiophene	ND	230	120	ND	8.5 J
C1-Dibenzothiophenes	ND	480	250	ND	36
C2-Dibenzothiophenes	ND	640	300	ND	120
C3-Dibenzothiophenes	ND	590	250	ND	160
Fluoranthene	5900	ND	5.2	ND	150
Pyrene	6000	12	15	ND	140
C1-Fluoranthenes/pyrenes	ND	85	51	ND	160
C2-Fluoranthenes/pyrenes	ND	150	69	ND	140
C3-Fluoranthenes/pyrenes	ND	180	67	ND	100
Benzo[a]anthracene	3500	ND	ND	ND	52
Chrysene	6500	44	12	ND	94
C1-Chrysenes	ND	80	29	ND	110
C2-Chrysenes	ND	100	49	ND	100
C3-Chrysenes	ND	110	58	ND	ND
C4-Chrysenes	ND	84	56	ND	ND
Benzo[b]fluoranthene	5100	6	2.9 J	ND	80
Benzo[k]fluoranthene	5600	ND	ND	ND	19 J
Benzo[e]pyrene	5700	12	6.7	ND	110
Benzo[a]pyrene	7100	ND	2.3 J	ND	37
Perylene	7200	ND	2.2 J	ND	9 J
Indeno[1,2,3,-c,d]pyrene	6000	ND	ND	ND	23 J
Dibenzo[a,h]anthracene	5100	ND	ND	ND	18 J
Benzo[g,h,i]perylene	5100	ND	3.5 J	14 J	51 B
Total PAH	120000	13000	(96)	39	2500
%d8-Naphthalene	105	110	89	85	82
%d10-Acenaphthene	99	104	91	80	87
%d10-Phenanthrene	95	100	95	91	89
%d12-Benzo[a]pyrene	95	99	95	86	79

Project Title : Tesoro
Data Package: B0301
Data Table: PAH - Main - Surrogate Corrected

Field ID	Blackfoot 1	Blackfoot 8	Yellow Foot 1	Blackfoot 4A/4B	Blackfoot 4A/4B
Lab ID	98D3047 PCA	98D3051 PCA	98D3052 PCA	98D3057 PCA	98D3057MS PCA
Lab Batch	B0301	B0301	B0301	B0301	B0301
File	DZ5478.D	DZ5479.D	DZ5480.D	DZ5481.D	DZ5482.D
Sample Type	SAMP	SAMP	SAMP	SAMP	QC
Weight Basis	DRY	DRY	DRY	DRY	DRY
Matrix	TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
Sample Size	1.42 g	1.7 g	1.45 g	1.44 g	1.34 g
Percent Moisture	83.8	81.7	81.5	82.5	82.5
Associated Blank	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA
Field Date	09/23/98	09/23/98	09/23/98	09/23/98	09/23/98
Extract Date	12/08/98	12/08/98	12/08/98	12/08/98	12/08/98
Analysis Date	12/17/98	12/17/98	12/17/98	12/17/98	12/17/98
Min Reporting Limit	35	29	34	35	37
Units	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
Naphthalene	13 JB	16 JB	24 JB	32 JB	730
C1-Naphthalenes	ND	ND	ND	ND	ND
C2-Naphthalenes	ND	ND	ND	ND	ND
C3-Naphthalenes	ND	ND	ND	ND	ND
C4-Naphthalenes	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	680
Acenaphthene	ND	ND	ND	ND	700
Biphenyl	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	730
C1-Fluorenes	ND	ND	ND	ND	ND
C2-Fluorenes	ND	ND	ND	ND	ND
C3-Fluorenes	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	50	530
Phenanthrene	29 J	39	14 J	43	760
C1-Phenanthrenes/anthracenes	42	95	ND	97	88
C2-Phenanthrenes/anthracenes	60	80	ND	91	95
C3-Phenanthrenes/anthracenes	ND	ND	ND	ND	ND
C4-Phenanthrenes/anthracenes	ND	ND	ND	ND	ND
Dibenzothiophene	ND	11 J	ND	ND	12 J
C1-Dibenzothiophenes	ND	55	ND	55	35 J
C2-Dibenzothiophenes	ND	56	ND	76	65
C3-Dibenzothiophenes	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	760
Pyrene	ND	ND	ND	ND	720
C1-Fluoranthenes/pyrenes	ND	ND	ND	ND	ND
C2-Fluoranthenes/pyrenes	ND	ND	ND	ND	ND
C3-Fluoranthenes/pyrenes	ND	ND	ND	ND	ND
Benzo[a]anthracene	ND	ND	ND	ND	790
Chrysene	ND	ND	ND	ND	730
C1-Chrysenes	ND	ND	ND	ND	ND
C2-Chrysenes	ND	ND	ND	ND	ND
C3-Chrysenes	ND	ND	ND	ND	ND
C4-Chrysenes	ND	ND	ND	ND	ND
Benzo[b]fluoranthene	ND	ND	ND	ND	790
Benzo[k]fluoranthene	ND	ND	ND	ND	790
Benzo[e]pyrene	ND	ND	ND	ND	ND
Benzo[a]pyrene	ND	ND	ND	ND	780
Perylene	ND	ND	ND	ND	ND
Indeno[1,2,3,-c,d]pyrene	ND	ND	ND	ND	720
Dibenzo[a,h]anthracene	ND	ND	ND	ND	710
Benzo[g,h,i]perylene	ND	ND	ND	ND	690
Total PAH	190	350	30	440	12000
%d8-Naphthalene	78	58	68	48	75
%d10-Acenaphthene	81	62	68	52	75
%d10-Phenanthrene	82	67	69	55	79
%d12-Benzo[a]pyrene	82	63	64	53	78

Project Title : Tesoro
Data Package: B0301
Data Table: PAH - Main - Surrogate Corrected

Field ID	Blackfoot 4A/4B	SITE1-AHU	SITE2S-KIPU	SITE2N-KIPU	SITE3-KIPU
Lab ID	98D3057MSD PCA	98D4265 PCA	98D4266 PCA	98D4267 PCA	98D4268 PCA
Lab Batch	B0301	B0301	B0301	B0301	B0301
File	DZ5483.D	DZ5484.D	DZ5486.D	DZ5487.D	DZ5488.D
Sample Type	QC	SAMP	SAMP	SAMP	SAMP
Weight Basis	DRY	DRY	DRY	DRY	DRY
Matrix	TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
Sample Size	1.3 g	1.62 g	1.72 g	1.99 g	1.43 g
Percent Moisture	82.5	76.7	80.5	78.2	79.1
Associated Blank	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA
Field Data	09/23/98	09/23/98	09/23/98	09/23/98	09/23/98
Extract Date	12/08/98	12/08/98	12/08/98	12/08/98	12/08/98
Analysis Date	12/17/98	12/17/98	12/17/98	12/17/98	12/17/98
Min Reporting Limit	38	31	29	25	35
Units	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
Naphthalene	730	31 B	13 JB	12 JB	17 JB
C1-Naphthalenes	25 J	ND	14 J	ND	ND
C2-Naphthalenes	ND	ND	ND	ND	ND
C3-Naphthalenes	ND	ND	ND	ND	ND
C4-Naphthalenes	ND	ND	ND	ND	ND
Acenaphthylene	710	14 J	ND	ND	ND
Acenaphthene	710	18 J	ND	ND	ND
Biphenyl	ND	ND	ND	ND	ND
Fluorene	750	ND	ND	ND	ND
C1-Fluorenes	ND	ND	ND	ND	ND
C2-Fluorenes	ND	ND	ND	ND	ND
C3-Fluorenes	ND	ND	ND	ND	ND
Anthracene	530	8.1 J	ND	ND	ND
Phenanthrene	790	26 J	20 J	14 J	21 J
C1-Phenanthrenes/anthracenes	150	ND	19 J	ND	ND
C2-Phenanthrenes/anthracenes	220	ND	ND	ND	ND
C3-Phenanthrenes/anthracenes	130	ND	ND	ND	ND
C4-Phenanthrenes/anthracenes	ND	ND	ND	ND	ND
Dibenzothiophene	18 J	ND	ND	ND	ND
C1-Dibenzothiophenes	50	ND	ND	ND	ND
C2-Dibenzothiophenes	130	ND	ND	ND	ND
C3-Dibenzothiophenes	140	ND	ND	ND	ND
Fluoranthene	770	15 J	7 J	ND	ND
Pyrene	750	14 J	6.9 J	ND	ND
C1-Fluoranthenes/pyrenes	69	ND	ND	ND	ND
C2-Fluoranthenes/pyrenes	84	ND	ND	ND	ND
C3-Fluoranthenes/pyrenes	64	ND	ND	ND	ND
Benzo[a]anthracene	800	ND	ND	ND	ND
Chrysene	740	15 J	ND	ND	ND
C1-Chrysenes	40	ND	ND	ND	ND
C2-Chrysenes	31 J	ND	ND	ND	ND
C3-Chrysenes	34 J	ND	ND	ND	ND
C4-Chrysenes	ND	ND	ND	ND	ND
Benzo[b]fluoranthene	820	16 J	ND	ND	ND
Benzo[k]fluoranthene	790	14 J	ND	ND	ND
Benzo[e]pyrene	ND	ND	ND	ND	ND
Benzo[a]pyrene	790	13 J	ND	ND	ND
Perylene	ND	ND	ND	ND	ND
Indeno[1,2,3,-c,d]pyrene	710	16 J	ND	ND	ND
Dibenzo[a,h]anthracene	720	10 J	ND	ND	ND
Benzo[g,h,i]perylene	640	15 JB	ND	ND	ND
Total PAH	13000	220	60	26	38
%d8-Naphthalene	89	65	88	72	76
%d10-Acenaphthene	93	66	88	74	74
%d10-Phenanthrene	97	70	89	76	78
%d12-Benzo[a]pyrene	97	67	85	73	78

Project Title : Tesoro
Data Package: B0301
Data Table: PAH - Main - Surrogate Corrected

Field ID	SITE4-KIPU	SITE5-NINI	SITE6-KEE	SITE 1 AHU - JAR 2	SITE 2S KIPU - JAR 2
Lab ID	98D4269 PCA	98D4270 PCA	98D4271 PCA	98D4411 PCA	98D4412 PCA
Lab Batch	B0301	B0301	B0301	B0301	B0301
File	DZ5489.D	DZ5490.D	DZ5491.D	DZ5492.D	DZ5493.D
Sample Type	SAMP	SAMP	SAMP	SAMP	SAMP
Weight Basis	DRY	DRY	DRY	DRY	DRY
Matrix	TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
Sample Size	1.47 g	2.14 g	1.78 g	1.76 g	2.17 g
Percent Moisture	80	79.6	80.3	80.1	79.7
Associated Blank	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA	CA-S-20PB PCA
Field Date	09/23/98	09/23/98	09/23/98	09/23/98	09/23/98
Extract Date	12/08/98	12/08/98	12/08/98	12/08/98	12/08/98
Analysis Date	12/17/98	12/17/98	12/17/98	12/18/98	12/18/98
Min Reporting Limit	34	23	28	28	23
Units	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
Naphthalene	17 JB	9.1 JB	15 JB	16 JB	18 JB
C1-Naphthalenes	ND	ND	ND	ND	16 J
C2-Naphthalenes	ND	ND	ND	ND	ND
C3-Naphthalenes	ND	ND	ND	ND	ND
C4-Naphthalenes	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND
Biphenyl	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND
C1-Fluorenes	ND	ND	ND	ND	ND
C2-Fluorenes	ND	ND	ND	ND	ND
C3-Fluorenes	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND
Phenanthrene	15 J	8 J	10 J	13 J	13 J
C1-Phenanthrenes/anthracenes	ND	ND	ND	ND	ND
C2-Phenanthrenes/anthracenes	ND	ND	ND	ND	ND
C3-Phenanthrenes/anthracenes	ND	ND	ND	ND	ND
C4-Phenanthrenes/anthracenes	ND	ND	ND	ND	ND
Dibenzothiophene	ND	ND	ND	ND	ND
C1-Dibenzothiophenes	ND	ND	ND	ND	ND
C2-Dibenzothiophenes	ND	ND	ND	ND	ND
C3-Dibenzothiophenes	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND
C1-Fluoranthenes/pyrenes	ND	ND	ND	ND	ND
C2-Fluoranthenes/pyrenes	ND	ND	ND	ND	ND
C3-Fluoranthenes/pyrenes	ND	ND	ND	ND	ND
Benzo[a]anthracene	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND
C1-Chrysenes	ND	ND	ND	ND	ND
C2-Chrysenes	ND	ND	ND	ND	ND
C3-Chrysenes	ND	ND	ND	ND	ND
C4-Chrysenes	ND	ND	ND	ND	ND
Benzo[b]fluoranthene	ND	ND	ND	ND	ND
Benzo[k]fluoranthene	ND	ND	ND	ND	ND
Benzo[e]pyrene	ND	ND	ND	ND	ND
Benzo[a]pyrene	ND	ND	ND	ND	ND
Perylene	ND	ND	ND	ND	ND
Indeno[1,2,3,-c,d]pyrene	ND	ND	ND	ND	ND
Dibenzo[a,h]anthracene	ND	ND	ND	ND	ND
Benzo[g,h,i]perylene	ND	ND	ND	ND	ND
Total PAH	32	17	25	29	47
%d8-Naphthalene	75	83	80	67	68
%d10-Acenaphthene	75	81	82	68	72
%d10-Phenanthrene	79	81	84	69	76
%d12-Benzo[a]pyrene	81	80	86	68	73

Project Title : Tesoro
Data Package: B0301
Data Table: PAH - MS-MSD - Surrogate Corrected

Field ID	Blackfoor 4A/4B	Blackfoot 4A/4B			
Lab ID	98D3057 PCA	98D3057MS PCA			
Lab Batch	B0301	B0301			
File	DZ5481.D	DZ5482.D			
Sample Type	SAMP	QC			
Weight Basis	DRY	DRY			
Matrix	TISSUE	TISSUE			
Sample Size	1.44 g	1.34 g			
Percent Moisture	82.5	82.5			
Associated Blank	CA-S-20PB PCA	CA-S-20PB PCA			
Field Date	09/23/98	09/23/98			
Extract Date	12/08/98	12/08/98			
Analysis Date	12/17/98	12/17/98			
Min Reporting Limit	35	37			
Units	ug/Kg	ug/Kg	T	%R	Q
Naphthalene	32 JB	730	746	94	
C1-Naphthalenes	ND	ND			
C2-Naphthalenes	ND	ND			
C3-Naphthalenes	ND	ND			
C4-Naphthalenes	ND	ND			
Acenaphthylene	ND	680	746	91	
Acenaphthene	ND	700	746	94	
Biphenyl	ND	ND			
Fluorene	ND	730	746	98	
C1-Fluorenes	ND	ND			
C2-Fluorenes	ND	ND			
C3-Fluorenes	ND	ND			
Anthracene	50	530	746	64	
Phenanthrene	43	760	746	96	
C1-Phenanthrenes/anthracenes	97	88			
C2-Phenanthrenes/anthracenes	91	95			
C3-Phenanthrenes/anthracenes	ND	ND			
C4-Phenanthrenes/anthracenes	ND	ND			
Dibenzothiophene	ND	12 J			
C1-Dibenzothiophenes	55	35 J			
C2-Dibenzothiophenes	76	65			
C3-Dibenzothiophenes	ND	ND			
Fluoranthene	ND	760	746	102	
Pyrene	ND	720	746	97	
C1-Fluoranthenes/pyrenes	ND	ND			
C2-Fluoranthenes/pyrenes	ND	ND			
C3-Fluoranthenes/pyrenes	ND	ND			
Benzo[a]anthracene	ND	790	746	106	
Chrysene	ND	730	746	98	
C1-Chrysenes	ND	ND			
C2-Chrysenes	ND	ND			
C3-Chrysenes	ND	ND			
C4-Chrysenes	ND	ND			
Benzo[b]fluoranthene	ND	790	746	106	
Benzo[k]fluoranthene	ND	790	746	106	
Benzo[e]pyrene	ND	ND			
Benzo[a]pyrene	ND	780	746	105	
Perylene	ND	ND			
Indeno[1.2.3.-c.d]pyrene	ND	720	746	97	
Dibenzo[a,h]anthracene	ND	710	746	95	
Benzo[g,h,i]perylene	ND	690	746	92	
%d8-Naphthalene	48	75			
%d10-Acenaphthene	52	75			
%d10-Phenanthrene	55	79			
%d12-Benzo[a]pyrene	53	78			

Project Title : Tesoro
Data Package: B0301
Data Table: PAH - MS-MSD - Surrogate Corrected

Field ID	Blackfoot 4A/4B					
Lab ID	98D3057MSD PCA					
Lab Batch	B0301					
File	DZ5483.D					
Sample Type	QC					
Weight Basis	DRY					
Matrix	TISSUE					
Sample Size	1.3 g					
Percent Moisture	82.5					
Associated Blank	CA-S-20PB PCA					
Field Date	09/23/98					
Extract Date	12/08/98					
Analysis Date	12/17/98					
Min Reporting Limit	38					
Units	ug/Kg		T	%R	Q	RPD	Q
Naphthalene	730		769	91		3.2	
C1-Naphthalenes	25	J					
C2-Naphthalenes		ND					
C3-Naphthalenes		ND					
C4-Naphthalenes		ND					
Acenaphthylene	710		769	92		1.1	
Acenaphthene	710		769	92		2.2	
Biphenyl		ND					
Fluorene	750		769	98		0	
C1-Fluorenes		ND					
C2-Fluorenes		ND					
C3-Fluorenes		ND					
Anthracene	530		769	62		3.2	
Phenanthrene	790		769	97		1	
C1-Phenanthrenes/anthracenes	150						
C2-Phenanthrenes/anthracenes	220						
C3-Phenanthrenes/anthracenes	130						
C4-Phenanthrenes/anthracenes		ND					
Dibenzothiophene	18	J					
C1-Dibenzothiophenes	50						
C2-Dibenzothiophenes	130						
C3-Dibenzothiophenes	140						
Fluoranthene	770		769	100		2	
Pyrene	750		769	98		1	
C1-Fluoranthenes/pyrenes	69						
C2-Fluoranthenes/pyrenes	84						
C3-Fluoranthenes/pyrenes	64						
Benzo[a]anthracene	800		769	104		1.9	
Chrysene	740		769	96		2.1	
C1-Chrysenes	40						
C2-Chrysenes	31	J					
C3-Chrysenes	34	J					
C4-Chrysenes		ND					
Benzo[b]fluoranthene	820		769	107		0.94	
Benzo[k]fluoranthene	790		769	103		2.9	
Benzo[e]pyrene		ND					
Benzo[a]pyrene	790		769	103		1.9	
Perylene		ND					
Indeno[1,2,3,-c,d]pyrene	710		769	92		5.3	
Dibenzo[a,h]anthracene	720		769	94		1	
Benzo[g,h,i]perylene	640		769	83		10	
%d8-Naphthalene	89						
%d10-Acenaphthene	93						
%d10-Phenanthrene	97						
%d12-Benzo[a]pyrene	97						

Project Title : Tesoro
Data Package: B0301
Data Table: PAH - IRM - Surrogate Corrected

Field ID	**SRM 1491**				
Lab ID	**BN18**				
Lab Batch	**B0301**				
File	**DZ5473.D**				
Sample Type	**QC**				
Weight Basis	**VOLUME**				
Matrix	**SRM**				
Sample Size	**0.1**	**mL**			
Percent Moisture	**NA**				
Associated Blank	**NA**				
Field Date	**NA**				
Extract Date	**NA**				
Analysis Date	**12/17/98**				
Min Reporting Limit	**250**				
Units	**ug/L**		**T**	**%D**	**Q**
Naphthalene	6600		6890	-4.2	
C1-Naphthalenes		ND			
C2-Naphthalenes		ND			
C3-Naphthalenes		ND			
C4-Naphthalenes		ND			
Acenaphthylene	6400		6960	-8	
Acenaphthene	6200		7280	-15	
Biphenyl	7000		7000	0	
Fluorene	6200		7270	-15	
C1-Fluorenes		ND			
C2-Fluorenes		ND			
C3-Fluorenes		ND			
Anthracene	7800		7820	-0.3	
Phenanthrene	6800		7010	-3	
C1-Phenanthrenes/anthracenes		ND			
C2-Phenanthrenes/anthracenes		ND			
C3-Phenanthrenes/anthracenes		ND			
C4-Phenanthrenes/anthracenes		ND			
Dibenzothiophene		ND			
C1-Dibenzothiophenes		ND			
C2-Dibenzothiophenes		ND			
C3-Dibenzothiophenes		ND			
Fluoranthene	5900		5910	-0.2	
Pyrene	6000		5890	1.9	
C1-Fluoranthenes/pyrenes		ND			
C2-Fluoranthenes/pyrenes		ND			
C3-Fluoranthenes/pyrenes		ND			
Benzo[a]anthracene	3500		3590	-2.5	
Chrysene	6500		7030	-7.5	
C1-Chrysenes		ND			
C2-Chrysenes		ND			
C3-Chrysenes		ND			
C4-Chrysenes		ND			
Benzo[b]fluoranthene	5100		5250	-2.8	
Benzo[k]fluoranthene	5600		5570	0.54	
Benzo[e]pyrene	5700		5620	1.4	
Benzo[a]pyrene	7100		6790	4.6	
Perylene	7200		7120	1.1	
Indeno[1,2,3,-c,d]pyrene	6000		6290	-4.6	
Dibenzo[a,h]anthracene	5100		5180	-1.5	
Benzo[g,h,i]perylene	5100		5290	-3.6	
%d8-Naphthalene	105				
%d10-Acenaphthene	99				
%d10-Phenanthrene	95				
%d12-Benzo[a]pyrene	95				

Project Title : Tesoro
Data Package: B0301
Data Table: PAH - NSC - Surrogate Corrected

Field ID	North Slope Crude				
Lab ID	BN14				
Lab Batch	B0301				
File	DZ5474.D				
Sample Type	QC				
Weight Basis	OIL				
Matrix	OIL				
Sample Size	5 mg				
Percent Moisture	NA				
Associated Blank	NA				
Field Date	NA				
Extract Date	NA				
Analysis Date	12/17/98				
Min Reporting Limit	5				
Units	mg/Kg		T	%D	Q
Naphthalene	760		750	1.3	
C1-Naphthalenes	1700		1700	0	
C2-Naphthalenes	2000		2400	-17	
C3-Naphthalenes	1500		2000	-25	
C4-Naphthalenes	860		1200	-28	
Acenaphthylene	ND				
Acenaphthene	ND				
Biphenyl	220		220	0	
Fluorene	95		94	1.1	
C1-Fluorenes	220		240	-8.3	
C2-Fluorenes	330		350	-5.7	
C3-Fluorenes	370		400	-7.5	
Anthracene	ND				
Phenanthrene	280		260	7.7	
C1-Phenanthrenes/anthracenes	630		600	5	
C2-Phenanthrenes/anthracenes	700		740	-5.4	
C3-Phenanthrenes/anthracenes	540		540	0	
C4-Phenanthrenes/anthracenes	410		330	24	
Dibenzothiophene	230		240	-4.2	
C1-Dibenzothiophenes	480		500	-4	
C2-Dibenzothiophenes	640		740	-14	
C3-Dibenzothiophenes	590		660	-11	
Fluoranthene	ND				
Pyrene	12		14	-14	
C1-Fluoranthenes/pyrenes	85		83	2.4	
C2-Fluoranthenes/pyrenes	150		150	0	
C3-Fluoranthenes/pyrenes	180		170	5.9	
Benzo[a]anthracene	ND				
Chrysene	44		49	-10	
C1-Chrysenes	80		81	-1.8	
C2-Chrysenes	100		110	-9.1	
C3-Chrysenes	110		92	20	
C4-Chrysenes	84		75	12	
Benzo[b]fluoranthene	6	J	6.6	-9.1	
Benzo[k]fluoranthene	ND				
Benzo[e]pyrene	12		12	0	
Benzo[a]pyrene	ND				
Perylene	ND				
Indeno[1,2,3,-c,d]pyrene	ND				
Dibenzo[a,h]anthracene	ND				
Benzo[g,h,i]perylene	ND				
%d8-Naphthalene	110				
%d10-Acenaphthene	104				
%d10-Phenanthrene	100				
%d12-Benzo[a]pyrene	99				

Project Title : Tesoro
Data Package: B0301
Data Table: PAH - SRM - Surrogate Corrected

Field ID	1974a				
Lab ID	CA-S-21SRM PCA				
Lab Batch	B0301				
File	DZ5477.D				
Sample Type	SAMP				
Weight Basis	DRY				
Matrix	TISSUE				
Sample Size	1.68 g				
Percent Moisture	NA				
Associated Blank	CA-S-20PB PCA				
Field Date	NA				
Extract Date	12/08/98				
Analysis Date	12/17/98				
Min Reporting Limit	30				
Units	ug/Kg		T	%D	Q
Naphthalene	18	J	23.5	-23	
C1-Naphthalenes	13	J			
C2-Naphthalenes	ND				
C3-Naphthalenes	ND				
C4-Naphthalenes	ND				
Acenaphthylene	14	J			
Acenaphthene	7	J			
Biphenyl	5.6	J			
Fluorene	6.3	J			
C1-Fluorenes	ND				
C2-Fluorenes	ND				
C3-Fluorenes	ND				
Anthracene	26	J	6.1	330	&
Phenanthrene	30		22.2	35	
C1-Phenanthrenes/anthracenes	68				
C2-Phenanthrenes/anthracenes	140				
C3-Phenanthrenes/anthracenes	200				
C4-Phenanthrenes/anthracenes	220				
Dibenzothiophene	8.5	J			
C1-Dibenzothiophenes	36				
C2-Dibenzothiophenes	120				
C3-Dibenzothiophenes	160				
Fluoranthene	150		164	-8.4	
Pyrene	140		152	-7.6	
C1-Fluoranthenes/pyrenes	160				
C2-Fluoranthenes/pyrenes	140				
C3-Fluoranthenes/pyrenes	100				
Benzo[a]anthracene	52		32.5	60	&
Chrysene	94		94.9	-1	
C1-Chrysenes	110				
C2-Chrysenes	100				
C3-Chrysenes	ND				
C4-Chrysenes	ND				
Benzo[b]fluoranthene	80		46.4	72	&
Benzo[k]fluoranthene	19	J	20.2	-5.8	
Benzo[e]pyrene	110		84	31	
Benzo[a]pyrene	37		15.6	140	&
Perylene	9	J	7.68	17	
Indeno[1,2,3,-c,d]pyrene	23	J	14.2	62	&
Dibenzo[a,h]anthracene	18	J			
Benzo[g,h,i]perylene	51		22	130	&
%d8-Naphthalene	82				
%d10-Acenaphthene	87				
%d10-Phenanthrene	89				
%d12-Benzo[a]pyrene	79				

ENTRIX

Chemistry Data Quality Review Form
Revision 3.2
May 18, 1998

PROJECT NAME: SPM Hose Spill - Tesoro SAMPLING EVENT: 9/23/98 & 11/2-3/98 Opihi

PROJECT NUMBER: 304201 TASK NUMBER: 2000

LABORATORY: ADLittle REPORT ID: B0301

ENTRIX CONTACT: Judy Nedoff REVIEWER: Judy Nedoff

DATE COMPLETED: 1/12/98 SIGNATURE: Judy Nedoff

SAMPLE INVENTORY

ANALYSIS	Method	Matrix	Instrumentation	Data units reported	Total # of samples	# of trip blanks	Date(s) collected	Total # of samples analyzed	# trip blanks analyzed
Alkylated PAH	EPA 8270	tissue	GC/MS	µg/kg	18	NA	9/23, 11/2-3/98	18	NA

Notes:

REPORT CONTENT

	Yes	No	NA
1) Is there a signature and title of the person accepting responsibility for the report?	☒	☐	
2) Has the laboratory submitted an electronic copy of the data?	☒	☐	
3) Are all report pages numbered (including total number of pages or indication of last report page)?	☒	☐	
4) Are all pages of the report legible?	☒	☐	
5) Is there a legend for sample data qualifiers?	☐	☒	☐
6) Is chain of custody documentation included in the report?	☒	☐	
7) Was a laboratory sample receiving/integrity report included in the report? *Any noted problems?*	☒	☐	
8) Were samples properly preserved for the particular matrices and analyses?	☒	☐	☐
9) Were sample collection procedures performed as described in project documents?	☒	☐	☐
10) Do receipt dates match chain of custody documentation?	☒	☐	

	Yes	No	NA
11) Have all requested analyses been conducted?	☒	☐	
12) Have all analyses been conducted by this laboratory? *If No, which?*	☒	☐	
13) Are all dates (i.e., collection date(s), ~~receipt date(s),~~ extraction date(s) analysis date(s), ~~reporting dates, etc.~~), listed for all samples and consistent throughout the report? *Identify omissions and inconsistencies on page(s)*	☒	☐	
14) Were all specified sample holding times met? *If no, which?*	☒	☐	
15) Is sample identification consistent throughout the report? *Circle inconsistencies and identify pages*	☒	☐	
16) Are test methods listed for each analysis?	☐	☒	
17) Are the test methods listed appropriate for the requested analysis?	☒	☐	☐
18) Were the test methods project specific or (lab specific) or standard? *Circle Choice*			
19) Are complete results reported for each analysis?	☒	☐	
20) Are results reported with a consistent and appropriate number of significant figures?	☒	☐	
21) Are results reported using appropriate concentration units?	☒	☐	
22) Are MDLs or PQLs reported (or on record) for each analysis?	☒	☐	
23) Have data below MDL or PQL been correctly qualified? *If not, Identify data with a check mark (✓)*	☒	☐	☐
24) Have data above the MDL or PQL been correctly left unqualified? *Identify data with asterisks (*)*	☒	☐	☐
25) Have the required Matrix QC samples been analyzed?			
A. One trip blank per sample set?	☐	☐	☒
B. One field blank per sample set?	☐	☐	☒
C. One field replicate per 20 samples or sample set?	☒	☐	☐
D. One equipment rinsate blank per 20 samples or batch, whichever is more frequent?	☐	☐	☒
E. One lab reagent or procedural blank per extraction batch or change in reagents?	☒	☐	☐
F. One Matrix Spike (MS) or Blank Spike sample per 20 samples or batch, whichever is more frequent?	☒	☐	☐
G. One Matrix Spike Duplicate (MSD) or Blank Spike Duplicate per 20 samples or batch, whichever is more frequent?	☒	☐	☐
H. One laboratory duplicate per 20 samples or batch, whichever is more frequent?	☐	☐	☒
I. One SRM or QC check standard per 20 samples or batch, whichever is more frequent?	☒	☐	☐
J. One Continuing calibration standard per 20 samples or batch, whichever is more frequent?	☐	☐	☒
K. Other (Define)	☐		
26) Do the concentrations of all analytes in blanks fall below IDL, MDL, or (PQL) (circle applicable) for all parameters? If no, explain Naphthalene = RQL at 25 ug/kg	☐	☒	☐

	Yes	No	NA
27) Were surrogates used where appropriate? *Identify analyses* All field and all lab QC samples	☒	☐	☐
28) Do surrogate recoveries meet acceptance criteria (accuracy)? *Acceptance criteria* d8-Naph: 35-125%; d10-Ace & d10-Phe: 40-125%; d12 BaP: 40-135% *If no, note exceptions and qualify appropriately*	☒	☐	☐
29) Do percent recoveries for Matrix Spike/ Matrix Spike Duplicate (MS/MSD) meet acceptance criteria (accuracy) for the test method/sample matrix? *Acceptance criteria* 40-150 % recovery	☒	☐	☐
30) Do the Relative Percent Differences (RPDs) for MS/MSD meet acceptance criteria (precision) for the test method/sample matrix? *Acceptance criteria* ≤ 35	☒	☐	☐
31) Do percent recoveries for laboratory control spikes (LCS) meet acceptance criteria (accuracy) for the test method/sample matrix? *Acceptance criteria*	☐	☐	☒
32) Do the Relative Percent Difference (RPDs) for laboratory duplicate pairs meet acceptance criteria (precision) for the test method/sample matrix? *Acceptance criteria*	☐	☐	☒
33) Do the Relative Percent Difference (RPDs) for field (blind) duplicate pairs meet acceptance criteria (precision) for the test method/sample matrix? *Acceptance criteria*	☐	☐	☒
	SRM1491	1974a	
34) Are SRM/Laboratory check standard recoveries within acceptance criteria for the test method/sample matrix? *Acceptance criteria* SRM 1491: ±15% ; SRM 1974a (tissue) ± 35% *Circle exceptions*	☒	☒	☐
35) Is the discussion of any report variance consistent with the data reported?	☒	☐	☐
36) Is the data package free of deviations from, additions to, or exclusions from the test method, and any other information relevant to a specific test? *Notes*	☒	☐	☐
37) Have all qualified data been completely/correctly identified? *If not, data on which page*	☒	☐	☐
38) Is the quality of the data package acceptable without revisions by the laboratory? *If no, attach corrective action summary*	☒	☐	☐

QUALIFIERS ASSIGNED BY ENTRIX

Data qualified with a U indicates that the value reported for the sample is less than 5 times the amount of that analyte detected in the blank. The U qualifier was applied to the data according to USEPA Contract Laboratory Program (CLP) protocol as follows:

1. If the level of an analyte reported in the sample is greater than the MDL for that analyte in that sample, a U is placed next to the sample result if it is less than 5 times the level in the blank.
2. If the level reported in the sample is less than the MDL (qualified by the laboratory with a J) and less than 5 times the level in the blank, the sample result and J qualifier are crossed out and replaced with the MDL for that analyte in that sample followed by U.

Sample results that exceed the MDL and are greater than 5 times the level in the blank are not qualified.

Others: