ENTRIX
ENVIRONMENTAL CONSULTANTS

APPENDIX D
METHOD 3 RISK CHARACTERIZATION

BARGE B120 OIL SPILL
BUZZARDS BAY, MASSACHUSETTS

RTN 4-17786

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1.0 INTRODUCTION

On behalf of Bouchard Transportation Company, Inc. ("Bouchard" or "RP) and under the direction of Richard Wozmak, P.E., the Licensed Site Professional (LSP)-of-record for the release, ENTRIX, Inc. ("ENTRIX") and GeoInsight, Inc. ("GeoInsight") characterized the risk of harm to human health, safety, public welfare, and the environment associated with potential exposures to residual Number 6 ("No. 6") fuel oil and associated constituents from the April 27, 2003 release from Bouchard Barge B120, affecting approximately 84 miles of Massachusetts shoreline (the "Site"). The Site is listed with the Massachusetts Department of Environmental Protection (MADEP) under Release Tracking Numbers (RTN) 4-17786.

Oil from the release stranded discontinuously along the Buzzards Bay shoreline. Multiple towns in southeastern Massachusetts were affected, including Bourne, Dartmouth, Fairhaven, Falmouth, Gosnold, Marion, Mattapoisett, New Bedford, Wareham, and Westport. The shoreline was divided into 149 segments for assessment purposes, and 120 of the segments were considered oiled to some degree.[1] A Partial Class A-2 Response Action Outcome (RAO) Statement, dated May 21, 2004, was achieved for the 57 intertidal zones of these 120 of shoreline segments. The maximum degree of initial oiling was characterized as "light" or "very light" at these 57 segments. Three of these 57 segments were sandy beaches where the maximum degree of initial oiling was characterized as "moderate." The remaining 63 intertidal shoreline segments consist of locations where, with few exceptions[2], the maximum degree of initial oiling was characterized as "moderately to heavily" oiled.

As described in the conceptual site model (CSM), significant residual oil impacts are not likely to be present in the subtidal zone. If subtidal residual oil were present, it would be located in nearshore subtidal quiescent areas downcurrent of heavily oiled shoreline segments. The subtidal area is considered to be one "segment", because it is entirely submerged underwater at all times. Thus, the Site currently consists of the 63 remaining intertidal shoreline segments (Table 1) and the subtidal zone in Buzzards Bay.

The purpose of the risk characterization is to evaluate whether a condition of No Significant Risk (NSR), as defined in the Massachusetts Contingency Plan (MCP; 310 CMR 40.0006)[3], exists at the Site under current and foreseeable future uses and activities. The conservative characterization focused upon evaluating worst-case conditions at intertidal shoreline segments and subtidal areas where the greatest degree of residual oil was expected to be present. To characterize intertidal shoreline conditions, twelve segments representing worst-case conditions of the primary intertidal shoreline types (e.g., sandy beach, rocky, marshes, mixed sand and gravel) were selected for evaluation and approved by MADEP. Potential residual oil in the subtidal zone was characterized by evaluating areas downcurrent of eight shoreline segments where the degree of initial oiling was classified moderate to heavy.

The characterization approach outlined above and described in more detail in the Phase II Scope of Work (SOW) and the Phase II Comprehensive Site Assessment (CSA) has been approved by the MADEP and conducted in accordance with the MCP (1995; 1996; 2006), technical updates (2002; 2006) and MCP Guidance (MADEP, 1995).

This risk characterization was developed in accordance with the limitations included in Attachment I. Tables,

[1] *The remaining 29 segments were not oiled.*

[2] *Two salt marsh segments were categorized as very light, and five mixed sand and gravel beach segments were categorized as light.*

[3] *As defined by the MCP (310 CMR 40.0006): "<u>No Significant Risk</u> means a level of control of each identified substance of concern at a site or in the surrounding environment such that no such substance of concern shall present a significant risk of harm to health, safety, public welfare, or the environment during any foreseeable period of time."*

Figures, and Attachments referenced in this risk characterization are presented at the end of this Appendix.

1.1 SITE DESCRIPTION

The released No. 6 fuel oil stranded in discontinuous areas along the Buzzards Bay shoreline. Currently, the subtidal zone and 63 intertidal segments of various shoreline types (sandy beaches, sand and gravel beaches, rock and man-made structure, and salt marsh) remain to be evaluated for potential risks to human health, safety, public welfare, and the environment. The primary constituents of concern (COC) are Extractable Petroleum Hydrocarbon (EPH) fractions and polynuclear aromatic hydrocarbons[4] (PAH) associated with the No. 6 fuel oil released from Barge B120.

Section 3 of the Phase II Comprehensive Site Assessment (CSA) report presents a complete Site description with detailed descriptions of each segment. Individual segment descriptions are summarized in Section 7 of the Phase II CSA, and are provided in detail in Appendix B (Segment Packages). Table 2 summarizes the extensive sampling and field efforts that have occurred over the last three years at each of the 63 segments.

Approximately 20 percent of the 63 intertidal shoreline segments (Table 1) not addressed in the 2004 Partial Class A-2 RAO were selected to represent worst-case, current conditions for the multiple shoreline types described above. As described in the Updated CSM and the Phase II CSA reports, characterization of the selected intertidal shoreline segments focused upon segments with mixed sand and gravel substrates and salt marshes because the greatest degree of residual oil was expected to be present at these locations. These segments are as follows:

Segment Name	Segment Identification	Town
Aucoot Cove	W1D-01	Mattapoisett
Strawberry Cove	W1E-02	Mattapoisett
Crescent Beach	W1E-04	Mattapoisett
Brandt Island West	W1F-02	Mattapoisett
Mattapoisett Neck West	W1F-05	Mattapoisett
Harbor View	W2A-02	Fairhaven
Pope's Beach	W2A-03	Fairhaven
Long Island and Causeway South	W2A-10	Fairhaven
West Island West	W2A-11	Fairhaven
Round Hill Beach West	W3A-05	Dartmouth
Barney's Joy (West of Barbed Wire)	W3C-03	Dartmouth
Barney's Joy (East of Barbed Wire)	W3C-04	Dartmouth

These intertidal segments were selected based on the following criteria:

- maximum degree of initial oiling;
- oil ranking assigned during the initial Shoreline Cleanup Assessment Team (SCAT) surveys;
- extent and magnitude of current residual oiling; and
- degree of environmental sensitivity as indicated by extent of Massachusetts National Heritage & Endangered Species Program (NHESP) priority habitat coverage, percent area classified as salt marsh, and whether threatened or endangered species were expected to be present.

[4] *Polynuclear aromatic hydrocarbons are hydrocarbon compounds with multiple benzene rings and are also known as polycyclic aromatic hydrocarbons.*

Subtidal areas that were selected for quantitative sediment sampling included areas offshore of the following segments: W1C-02 – Planting Island Causeway; W1E-02 – Strawberry Cove; W1E-03 – Strawberry Point West; W1F-02 – Brandt Island West; W2A-03-Pope's Beach; W2A-10-Long Island and Causeway South; W3C-03 – Barney's Joy (west of the barbed wire); and W3C-06 - Demarest Lloyd State Park Marsh. These areas were selected based upon:

- areas immediately offshore of where initial oil slick stranded on moderately to heavily oiled segments;
- areas adjacent to moderately or heavily oiled shorelines where natural processes would scour and possibly resuspend oil particles from intertidal areas; and
- quiescent areas adjacent to moderately oiled or heavily oiled areas where sand-grain sized particles would be expected to be deposited.

In addition, shellfish were collected from subtidal areas offshore of numerous segments including but not limited to: W1D01-Aucoot Cove; W1F-02 – Brandt Island West; W2A-03 – Pope's Beach; W2A-10 – Long Island and Causeway South; and W3C-03 – Barney's Joy (west of the barbed wire).

As explained in Section 7 of the Phase II CSA, residual oil in the form of hardened splatter, tarmats, or tarballs were observed intermittently at a limited number of shoreline segments. The most recent discovery of residual oil was at segment W2A-02 (Harbor View) in the summer of 2005, where a tarball approximately four inches in diameter was found hidden by an overhanging marsh hummock, and additional residual oil had congregated by a decaying railroad tie, partially buried in the sand. Upon determining the oil was related to the B120 release, the observed oil was removed from this segment. Because this tarball had a relatively sticky interior compared to other tarballs, it was selected to represent the worst-case current conditions.

Since most volatile PAH compounds have long since dissipated, air is not an environmental medium of concern. Similarly, surface water is not a primary environmental medium of concern because concentrations of dissolved hydrocarbons decreased to below detection limits within weeks of the spill. As explained in the CSM, ground water is not an environmental medium of concern because hydrologically it flows towards the bay, not inland. In addition, as demonstrated by the trend in surface water, the nature of No. 6 fuel oil is such that its constituents do not readily dissolve in water.

1.2 RISK CHARACTERIZATION METHOD

A Method 3 Risk Characterization was conducted to assess potential risks posed by residual oil and related constituents. This assessment approach is consistent with the following relevant state and federal risk assessment guidance:

- Massachusetts Contingency Plan (MCP), Subpart I, (310 CMR 40.0900);
- MADEP, Guidance For Disposal Site Risk Characterization – In Support of the Massachusetts Contingency Plan (WSC/ORS-95-141); and
- U.S. Environmental Protection Agency (U.S. EPA), *Risk Assessment Guidance for Superfund, Volume 1 (Parts A, B, and E)*, Office of Emergency and Remedial Response, Washington, D.C. (EPA/540/R-89/002; EPA/540/R-92/003; EPA/540/R-99/005).

The risk characterization also includes assessment of impacts to identified human and ecological receptors, as well as characterization of the risk of harm to safety and public welfare, as established in Subpart I of the MCP (310 CMR 40.0900). A Method 3 Risk Characterization was conducted for this Site because sediment, surface water, and weathered oil were identified as potential primary environmental media of concern. Shellfish tissue was identified as a potential secondary environmental medium of concern.

1.2.1 Method 3 Human Health Risk Characterization

Due to the nature of the release and the potential need to evaluate numerous individual shoreline segments, screening benchmarks for evaluation of potential human health risks were developed based on threshold concentrations that would trigger potential non-cancer or carcinogenic risks based on the MCP risk limits. These benchmarks were intended to screen many non-contiguous areas throughout the coastline, both currently or if a future need arises. In order to demonstrate the conservative nature of the human health screening benchmarks, a traditional, forward-progressing Method 3 Human Health Risk Characterization (HHRC) was conducted using maximum detected concentrations from across the entire Site for each identified environmental media of concern. In a traditional Method 3 HHRC, a site- and receptor-specific Hazard Index (HI) for potential non-cancer risks, and an Excess Lifetime Cancer Risk (ELCR) for potential carcinogenic risks are calculated from exposure point concentrations (EPC), exposure assumptions, and toxicological information. These site- and receptor-specific estimates are then compared to MCP risk limits (non-cancer risk limit HI = 1, carcinogenic risk limit ELCR = 1×10^{-5}). Using the forward-progressing calculations resulted in Hazard Indices (HI) that were less than these MCP risk limits.

Screening or risk-based threshold concentrations (RBTC) for relevant environmental media were developed relying on the basic structure outlined for Method 3 Risk Assessments and recommended by U.S. EPA. Using conservative exposure assumptions, appropriate toxicity and carcinogenicity information and target MCP cumulative risk limits for carcinogenic and non-carcinogenic effects, RBTC for environmental media were "back-calculated". These were used as screening benchmarks to which EPC for each environmental medium of concern were compared to determine the potential for human health risk. RBTC represent media-specific maximum acceptable concentration thresholds for COC below which a condition of NSR to human health exists. A condition of NSR to human health was concluded to exist for worst-case representative segments with EPC that are less than the conservative RBTC, and the same was assumed true for all remaining segments of that shoreline type that are considered to be less impacted (i.e., not "worst-case"). If EPC exceeded these RBTC, indicating the presence of potential risks to human receptors for that shoreline segment type or the subtidal area, a more refined segment-specific risk characterization would be conducted to better define specific areas within individual segments that might need additional response actions.

1.2.2 Method 3 Environmental Risk Characterization

A Stage I Environmental Screening (ES) was conducted according to the MCP (310 CMR 40.0995) to assess potential risks to ecological receptors. Constituent concentrations detected in affected environmental media (surface water, sediments) were compared to relevant ecological screening benchmarks (i.e., ambient water quality criteria [U.S. EPA, 2004b] and Effects Range-Low [ER-L] sediment values [Long and Morgan, 1990]). Additionally, each shoreline segment was evaluated for the presence of potentially stressed vegetation, persistent sheens on surface water, or significant areas of exposed oil residue. For those segments where constituent concentrations in media are not detected or do not exceed screening ecological benchmarks and where evidence of stressed vegetation, persistent sheens, and/or residual oil is not present or does not present potential adverse physical effects, it was concluded that a condition of NSR exists.

1.2.3 Method 3 Safety and Public Welfare Risk Characterization

In accordance with the MCP, separate, qualitative assessments were conducted to determine the potential for risks to safety (310 CMR 40.0960) and public welfare (310 CMR 40.0994).

2.0 SITE ANALYTICAL DATA

Analytical data from subtidal sediment samples, intertidal sediment samples, marsh sediment samples, surface water samples, shellfish tissue, and the most representative worst-case weathered oil sample were reviewed. This assessment relied on analytical data available for these environmental media of concern collected at the selected intertidal segments and the subtidal zone. A list of samples collected at each of the 12 intertidal segments and the subtidal zone is provided in Table 3. Analytical data that were representative of current spill-related conditions at the Site were retained in the risk characterization dataset.

2.1 DATA RETAINED IN RISK CHARACTERIZATION DATASET

Sediment data (Attachment II) used in this risk characterization are summarized in Tables 4a through 4c, and include samples collected between January 2004 and October 2005. The locations of subtidal, intertidal, and marsh sediment samples used in the risk characterization are presented in segment-specific figures following this report (Figures 1 through 14).

Surface water data for samples collected between April 29, 2003 and May 12, 2003 were evaluated and are presented in Table 5. Weathered residual oil data (Table 6) from a sample collected in Fairhaven (segment W2A02, Harbor View) on June 29, 2005 was used to characterize residual (bulk) oil characteristics for this risk characterization. A summary of shellfish data used in this risk characterization is provided in Table 7. The shellfish tissue dataset consisted of the most recent sample collected at each location[5] from segments between June 2003 and May 2004. Individual shellfish tissue sample results for analytical data evaluated in this risk characterization are provided in Attachment II.

2.2 DATA NOT RETAINED IN RISK CHARACTERIZATION DATASET

Samples of environmental media determined to be unrepresentative of current conditions were eliminated from the risk assessment dataset. Samples considered not to be representative of current conditions include those surface water samples collected during the initial stage of the spill response or during IRA cleanup activities, surficial sediment samples collected from areas that were subsequently excavated or remediated during IRA activities, and those samples that originated from sources other than B120 fuel as determined by fingerprint analyses (e.g., the pattern of PAH indicates the source was due to combustion such as beach wood fires or non-B120 petroleum).[6] Any samples that met these criteria were not retained in the risk characterization dataset.

2.3 DISCUSSION OF DETECTED CONSTITUENTS

As discussed previously, the primary constituents detected in Site environmental media are EPH fractions and individual PAH compounds. A brief summary of the analytical results for each environmental medium is presented below. Data tables are provided in Attachment II along with laboratory analytical data for shellfish, and sediment sample results from B&B Laboratories. All other laboratory analytical data for

[5] *Although shellfish samples were collected during the emergency response in May 2003, these data were not retained in the dataset because they are not considered representative of conditions that exist after initial emergency response actions. Subsequent shellfish samples were collected in June, August, and October 2003, as well as May 2004. Since not every sampling location was revisited during each of these sampling rounds, the most recent shellfish tissue data collected from each sampling location was retained in the dataset.*

[6] *Appendix G provides detailed forensic evaluation of each sample that contained constituents determined to be unrelated to the B120 release.*

sediment collected are either presented in Appendix B or in previous IRA reports.

2.3.1 Sediment

Sediment samples were collected from the subtidal zone and the intertidal zone (including samples collected in intertidal marshes). For the purposes of this assessment, the subtidal zone is the entire portion of the seafloor that remains underwater at low tide. The intertidal zone extends from the mean low water mark to the mean high water mark (generally where the wrack line is present). Marsh areas are found throughout the Buzzards Bay shoreline ranging in size from back-barrier expanses located in sheltered bays, to limited areas of rugged, fringing marsh grass occurring on limited portions of exposed shoreline. Sediment composition can vary substantially between these zones within a single segment. For example, marsh sediments typically have higher organic content and finer-grained sediment particles than sediments in the intertidal zones of mixed sand and gravel beaches. Since multiple shoreline types (e.g., beach, marsh, gravel, etc.) occur in most segments, and the sediment composition varies widely, the sediment samples collected in this investigation were classified functionally using one of the three categories described above (subtidal, intertidal, and marsh).

2.3.1.1 Subtidal Sediment

Fifty-nine subtidal sediment samples collected between July 2004 and September 2005 were included in the risk characterization dataset and summary statistics for detected compounds are presented in Table 4a. With the exception of W2A10-ST samples which were collected individually as "grabs," each subtidal sediment sample represents a composite of three grab samples collected approximately within 15 feet of each another. Results for duplicate samples and samples that were analyzed by more than one laboratory were averaged and were included in the summary statistics (Table 4a). Average PAH and EPH concentrations were calculated by using the detected concentrations and one-half the detection limit of any non-detected results. If an analytical result was qualified with a "J," this indicates that the concentration is estimated but below the detection limit. This result was included in the average, rather than one-half the detection limit. Total PAH represents the sum total of all detected PAH, as well as one-half of the detection limit of PAH compounds that were not detected.

Detected concentrations of individual PAH in subtidal sediments ranged from 0.0031 mg/kg (acenaphthene and fluorene) to 0.35 mg/kg (chrysene; average of sample W2A10-ST-S07 and its duplicate W2A10-ST-XXX collected in subtidal area adjacent to the boat ramp at Hoppy's Landing, segment W2A-10). Concentrations of C_{19}-C_{36} aliphatics ranged from 47 to 93 mg/kg. However, this hydrocarbon fraction was only detected in five of the 59 samples. C_{11}-C_{22} aromatic hydrocarbon fractions were detected once in the sample collected adjacent to the boat ramp (W2A10-ST-S07). A trace sheen was observed in this sample when it was collected.[7] Total PAH in subtidal sediments ranged from 0.062 to 1.8 mg/kg.

Compounds detected in subtidal sediment samples included the following: C_{19}-C_{36} aliphatic hydrocarbons, C_{11}-C_{22} aromatic hydrocarbons naphthalene, 2-methylnaphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo (a) anthracene, benzo (b) fluoranthene, chrysene, benzo (k) fluoranthene, benzo (a) pyrene, indeno (1,2,3-cd) pyrene, dibenzo (a,h) anthracene, and benzo(g,h,i)perylene.

2.3.1.2 Intertidal Sediment

Seventy-one intertidal samples were included in the risk characterization dataset and summary statistics for

[7] *More detailed information regarding sampling conditions and observations were provided in the IRA Status Report by GeoInsight, dated September 16, 2004.*

detected EPH and PAH compounds are presented in Table 4b. Nearly all intertidal sediment sample represent a composite of three grab samples collected within 30 feet of each another. There were a few samples that represent a discrete grab sample: the HB-SED series collected at Brandt Island West (W1F-02) in December 2004, and a few samples collected at Harbor View in the summer of 2005 (W2A02-82905-01 and W2A02-82905-02, and W2A02-092905-01 and W2A02-092905-02). Intertidal samples in the risk characterization dataset were collected between January 2004 and September 2005 and best represent current conditions in the segments. Although no EPH fractions were detected in the intertidal samples, 17 individual PAH were detected at frequencies ranging from 4% (acenaphthylene) to 68% (naphthalene). Total PAH concentrations ranged from 0.003 mg/kg to 1.7 mg/kg.

The compounds detected in intertidal sediment samples includes the following: naphthalene, 2-methylnaphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthrancene, and benzo(g,h,i)perylene.

2.3.1.3 Marsh Sediment

Thirty-one marsh sediment samples were included in the risk characterization dataset and summary statistics for detected compounds are presented in Table 4c. With the exception of four marsh samples (W2A10-C01 through W2A10-C04) collected from the same general area at segment W2A-10, marsh sediment samples represent a composite of three grab samples collected within 15 feet of each another. Results for duplicate samples were averaged with the original samples, and these values are also included in the summary statistics. These marsh sediment samples were collected between January 2004 and October 2005 and best represent current conditions at the segments. Two EPH fractions, C_{19}-C_{36} aliphatics and C_{11}-C_{22} aromatics, were detected in one and two of these 31 samples, respectively. PAH compounds were detected at frequencies ranging from 3% (acenaphthene, acenaphthylene, and fluorene) to 52% (naphthalene). Total PAH concentrations ranged from 0.088 mg/kg to 0.9 mg/kg.

The constituents detected in marsh sediments includes the following: C_{19}-C_{36} aliphatic and C_{11}-C_{22} aromatic hydrocarbons, naphthalene, 2-methylnaphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.

2.3.2 Surface Water

Surface water samples were collected in close proximity to the oil slick within 48 hours of the April 27, 2003 release. Samples were subsequently collected from the same locations at intervals several weeks following the spill. As demonstrated in Table 5, surface water concentrations of dissolved hydrocarbons were at ambient concentrations less than one month after the release. With the exception of two surface water samples collected in pools adjacent to active IRA remedial operations at Long Island (W2A-10) in August 2004, dissolved hydrocarbons were not detected in additional surface water samples. The absence of dissolved hydrocarbons in a water sample collected at the same time in an area not affected by clean-up operations indicates that the dissolved oil components were highly localized and limited to the area proximal to active clean-up operations.

Because release-related constituent concentrations in surface water were reduced to detection limits less than one month after the spill and were only subsequently detected in pools adjacent to active remediation, release-related constituents are not expected to be present in surface water under current and future conditions. Surface water is currently not affected by the release, therefore it is not considered further in the risk assessment.

2.3.3 Residual Weathered Oil

Significant remedial efforts and natural attenuation (i.e., weathering) have eliminated much of the oil that was stranded ashore following the spill. The small amount of residual oil at the shoreline that is present occurs as dried "splatter" on rocks or as dime to quarter-size tarballs or tar patties on the shoreline. This residual oil is heavily weathered and has a consistency similar to that of roadway asphalt. The chemical composition of residual oil that may be present at the shoreline was characterized using the laboratory analysis of a softball-sized localized deposit of weathered oil encountered at the Harbor View (W2A-02) in the summer of 2005. The oil was tacky and was mixed with fine gravel and sediment particles (Photo 1). The oil sample was analyzed for fingerprint analysis and a summary of the analytical results of this residual oil sample is presented in Table 6. This residual weathered oil sample is considered to be worst-case because its tacky nature suggests more constituents from the oil are likely to adhere to skin.

Concentrations of PAH compounds, including the presence of a number of alkylated PAH homologs, were detected. The compounds detected in the weathered residual oil include: naphthalene, benzothiophene, biphenyl, acenaphthylene, acenaphthene, dibenzofuran, fluorene, anthracene, phenanthrene, dibenzothiophene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(e)pyrene, benzo(a)pyrene, perylene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, benzo(g,h,i)perylene, 2-methylnaphthalene, plus alkylated PAH compounds.

2.3.4 Shellfish Tissue

Consumption of shellfish represents a potentially important pathway for human receptors to be exposed to spill-related constituents. Rather than using mathematical models to estimate bioaccumulation of spill constituents in shellfish tissues, PAH concentrations in shellfish tissue were measured directly. In cooperation with the Massachusetts Department of Marine Fisheries (MADMF) staff and Town Shellfish Constables, ENTRIX sampled five species of bivalves based on their recreational and commercial importance and abundance: blue mussels (*Mytilus edulis*); oysters (*Crassostrea virginica*); quahogs (*Mercenaria mercenaria*); scallops (*Argopecten irradians*); and softshell clams (*Mya arenaria*). Shellfish beds in the vicinity of oiled beaches where recreational shellfishing commonly occurs were identified and shellfish samples were collected for tissue analysis. Shellfish were collected from these locations beginning on May 5, 2003. These locations were re-sampled on five subsequent occasions to document depuration of PAH concentrations in shellfish tissue to baseline levels. Between May 5, 2003 and May 13, 2004, a total of 153 composite shellfish tissue samples[8] were collected from intertidal and shallow subtidal areas along unoiled, lightly oiled, moderately oiled, and heavily oiled beaches. Shellfish sampling locations are featured in Figure 15. Shellfish tissue analytical data used in the risk characterization are summarized in Table 7 and presented in more detail in Attachment II.

PAH are present in the environment due to various sources (e.g., fossil fuels, cigarette smoke, combustion sources) and some concentrations of PAH are normally present in shellfish tissue. To characterize concentrations of ambient PAH concentrations in shellfish tissue, fifteen samples were collected between May 5 to May 7, 2003 from subtidal areas adjacent to segments that were not oiled in order to establish a baseline for PAH concentrations in unoiled Buzzards Bay shellfish. Total PAH concentrations in these baseline samples ranged from 32 to 209 µg/kg (micrograms per kilogram, or parts per billion), with an average of 82 µg/kg.

Additional shellfish tissue samples were collected in June, July, August, and October 2003, as well as May 2004 from beds offshore of oiled shoreline segments. Total PAH concentrations in shellfish tissue from these

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[8] *A total of 12 to 15 specimens of each available species were collected, yielding one composite sample per species at each station. The shells of each specimen were cleared of debris, sediment or visible oil using bay water before being sent to the laboratory for analysis.*

affected segments ranged from 24 µg/kg to 186 µg/kg, with an average of 95 µg/kg. Statistical analysis[9] of the samples from "oiled" and "unoiled" areas revealed that the total PAH mean concentrations of the two data sets do not differ significantly (Attachment III).

The total PAH concentration represents a sum of all detected concentrations; constituents not detected are included as one-half the detection limit, consistent with general risk assessment practice. Many alkylated PAH compounds were detected and included in this total value. In addition, the concentrations of PAH compounds that have associated toxicity equivalency factors (TEF; MADEP, 1995) were used to normalize concentrations based on benzo(a)pyrene (BaP) toxicity equivalent concentrations. Alkylated PAH were summed with their parent compound prior to calculating toxic equivalent values. BaP equivalents ranged from 1.5 to 13 µg/kg, with an average of 5 µg/kg. BaP equivalents in "baseline" shellfish tissue ranged from 1.2 to 7.8 µg/kg, with an average of 3 µg/kg.

Since total PAH concentrations in shellfish from previously oiled segments declined to similar concentrations as those detected in baseline shellfish samples, this medium is no longer considered to be affected by the spill. To demonstrate that this potential exposure pathway is insignificant, this pathway was included in the forward-calculating risk tables (Attachment IV). Because this potential exposure pathway is an insignificant contributor to risk estimates and constituent concentrations are similar to concentrations found in shellfish from unoiled areas, this pathway was not included in the development of risk-based threshold concentrations protective of human health. Portions of two shellfish beds remain closed to shellfishing because of the possibility of further remediation at adjacent segments (W1F-02 and W2A010), not because existing conditions pose a potential human health risk.

Since 1986, the National Status & Trends Program of the National Oceanic and Atmospheric Administration (NOAA) has monitored chemical contaminants in sediments and bivalve mollusks (e.g., mussels and oysters) in an international Mussel Watch Project (Mussel Watch). Mussel Watch sites are selected to be representative of large coastal areas and to avoid small scale areas of contamination, or "hot spots." For this reason, Mussel Watch data can be used as reference data to compare constituent concentrations and evaluate environmental quality in coastal regions. Table 8 presents total PAH data collected between 1989 to 2002 from six Mussel Watch sites in Buzzards Bay (Naushon Island, West Falmouth, Cape Cod Canal, Angelica Point, Angelica Rock, Round Hill; no data was available from Gooseberry Neck). Concentrations of total PAH ranged between 75 and 1,125 µg PAH/kg tissue wet weight (parts per billion), and the average total PAH in these samples was 275 µg/kg wet weight (NOAA, 2006). These data indicate that total PAH concentrations in shellfish measured between June 2003 and May 2004 are similar to pre-spill PAH concentrations documented in the Mussel Watch data set.

2.4 DATA USABILITY

In general, data are selected for inclusion in the risk characterization in order to provide a conservative estimate of potential risks at the Site. Specifically, data were included (or excluded) in this assessment based on the following criteria:

- Sediment data collected in 2003 was not included in the risk characterization dataset because these samples have been replaced with samples collected in 2004 and 2005, which are more recent;
- Several sediment samples were analyzed by two laboratories using different analytical methods. Ground water Analytical Inc. (GWA) analyzed samples using MADEP EPH with PAH by method 8270C modified selected ion mode (SIM) which yields results for the three EPH fractions and 17 priority PAH

[9] *The null hypothesis of the t-test that the means are equal could not be rejected with p-values of 0.550 for the non-transformed case, and 0.828 for the transformed case. Therefore, the means are not statistically different. The test has sufficient power to detect a medium to large difference in the means at a 90% confidence level.*

compounds. B&B Laboratories Inc. has developed a method also using gas chromatography in selected ion mode, but detects very low concentrations for more than 50 PAH compounds, including alkylated PAH homologs. These results were presented in the analytical data tables in Attachment II, but averaged with GWA results for the purposes of calculating summary statistics. One half of the detection limit was used to calculate average concentrations if the constituent was not detected by one laboratory. If the constituent was not detected in either set of results, the value presented is "<" (i.e., less than) minimum detection limit of the two sets of results.

- The results for duplicate samples were presented in the analytical data tables, but were averaged with the original composite results for the purposes of the summary statistics.

- Because there is limited, if any, toxicity information for individual alkylated PAH compounds, these compounds were conservatively added to the concentration of their parent compound for the human health characterization and the cumulative concentration was used to characterize risks (e.g., concentration of C1-naphthalene was summed with the concentration of naphthalene). In the environmental screening, alkylated PAH were not added to their parent compounds. This difference in how alkylated PAH were carried through the characterization is based on the benchmarks by which they were evaluated. Increasing the parent compound concentration of carcinogenic PAH compounds results in a higher benzo(a)pyrene equivalent concentration to be compared to the derived human health carcinogenic risk-based threshold, resulting in a more conservative evaluation. Ecological screening benchmarks are not differentiated as carcinogenic or non-carcinogenic, but were derived based on whole sediment (including alkylated PAH). Therefore, comparing total PAH concentrations in sediment to the ecological screening benchmark for total PAH captures parent PAH and alkylated PAH compounds.

- For samples that were not analyzed for alkylated PAH, EPH were quantified, which includes various aliphatic and aromatic compounds within fractional ranges of C9-C18 aliphatics, C19-C36 aliphatics, and C11-C22 aromatics. Although there are limited toxicological data available for alkylated PAH, MADEP has developed human health non-cancer reference doses (RfD) for EPH fractions (MADEP 2003; 2002a). By developing the human health non-cancer risk-based threshold concentrations using the RfD for C11-C22 aromatics (which incorporates most of the alkylated PAH), the potential non-cancer human health risks posed by alkylated PAH homologs were also addressed in samples that did not have quantified alkylated PAH results. There are no applicable ecological benchmarks for EPH fractions. However, EPH fractions were detected very infrequently at the Site (in two marsh sediment samples, five subtidal sediment samples, out of a total 167 sediment samples); and

- In order to calculate the total PAH concentration in shellfish tissue, detected concentrations (and one-half detection limits for undetected compounds) were summed. As described in the "Evaluation of Appropriate Criteria and Technical Approaches for Re-Opening Shellfish Areas" (ENTRIX, 2003), shellfish eliminate PAH tissue residues over time when exposed to uncontaminated water, a process called "depuration." In fact, concentrations of total PAH in shellfish declined rapidly over a period of four months such that even the highest concentrations were reduced to less than 200 μg/kg in this time period. Because of this process, shellfish tissue data collected from oiled segments within one month of the spill (i.e., May 2003) were not included in the shellfish data set.

2.4.1 Comparison to Background and Local Conditions

In order to determine whether constituents detected in environmental media of concern should be considered in the risk characterization, detected constituent concentrations are typically compared to concentrations considered to be representative of background conditions. Background is defined as "those levels of oil and hazardous material that would exist in the absence of the disposal site of concern which are either:

(a) ubiquitous and consistently present in the environment at and in the vicinity of the disposal site of concern; and attributable to geologic or ecological conditions, or atmospheric deposition of industrial process or engine emissions;

(b) attributable to coal ash or wood ash associated with fill material;

(c) releases to ground water from a public water supply system; or

(d) petroleum residues that are incidental to the normal operation of motor vehicles." (MCP, 310 CMR 40.0006)

In general, if concentrations for a given constituent are below published MADEP background concentrations for air, soil, or sediment (MADEP, 2002a, 2002b, 2002c) and its presence is not attributed to the release, then the constituents should not be retained in the risk characterization. The same principle applies in comparison to local conditions. Local conditions are concentrations of constituent(s) that are greater than background, but are attributable to conditions other than the release (e.g., PAH associated with wood ash material from local burning).

At this Site, it was conservatively assumed that background concentrations of spill-related constituents are not detectable in environmental media. As discussed in the Conceptual Site Model (CSM; GeoInsight, 2005b), surface water concentrations were detected at or below laboratory detection limits within weeks of the release. Therefore, conditions in this environmental medium are considered to be consistent with pre-spill conditions. Because the boundaries of the Site incorporate many towns and shoreline types, it is not feasible to identify local conditions in sediment that represent pre-spill conditions for all shoreline segments.

PAH compounds are widely distributed in the environment due to generation from combustion ("pyrogenic") sources such as vehicular emissions and wood-fueled bonfires or because they are natural constituents of fossil fuels such as petroleum or coal ("petrogenic"). The mixture and proportion of PAH compounds convey a chemical signature such that the source can be identified as pyrogenic, petrogenic, or a combination of the two. Because PAH compounds from sources other than the release could be present at detectable concentrations at any segment, sediment samples with concentrations of PAH two to three times higher than other samples from the same segments were evaluated by a forensic chemist. This evaluation included a review of proportion and distribution of PAH compounds in order to determine the source contribution of PAH. Samples that contained PAH from a source other than B120 oil were not included in the sediment dataset for this risk characterization.

Nine of 167 sediment samples[10] were removed from the risk characterization dataset because detected PAH were not related to the release, including the following:

Sample ID	Segment Name	PAH source	Sediment Type
W2A-02-092905-01	Harbor View	Pyrogenic	Intertidal
W2A-02-MS01	Harbor View	Combination pyrogenic /alternative petrogenic	Marsh
W2A-02-MS02	Harbor View	Combination pyrogenic /alternative petrogenic	Marsh
W2A-02-P2-M01	Harbor View	Combination pyrogenic /alternative petrogenic	Marsh
W2A-02-P2-M02	Harbor View	Combination pyrogenic /alternative petrogenic	Marsh
W2A-02-P2-M03	Harbor View	Combination pyrogenic /alternative petrogenic	Marsh
W2A-03-P2-M03	Pope's Beach	Combination pyrogenic /alternative petrogenic	Marsh

[10] *The total of 167 sediment samples includes duplicates.*

Sample ID	Segment Name	PAH source	Sediment Type
W2A-03-LIT-02	Pope’s Beach	Pyrogenic	Intertidal
W3A-05-P2-LIT-02	Round Hill	Pyrogenic	Intertidal

Summaries of the forensic evaluation of these samples are included in Appendix G.

Because PAH in several sediment samples from two adjacent segments located in Fairhaven, Pope’s Beach (W2A-03) and Harbor View (W2A-02) were determined to be from an alternative source, limited research on surrounding Sites was conducted that revealed that two Superfund Sites (Atlas Tack and New Bedford Harbor) at which PAH are considered COC occur in the vicinity of affected shoreline segments. Detailed discussion on these sites is provided in Section 8.2.1.1 of the Phase II CSA.

3.0 METHOD 3 HUMAN HEALTH RISK CHARACTERIZATION

This section provides details on the approach used for evaluating potential risks to human health, including identification of constituents of concern, exposure assessment including potential pathways, assumptions, exposure points, exposure point concentrations, dose-response assessment, and the human health risk characterization.

3.1 HAZARD IDENTIFICATION

The Hazard Identification identifies COC and provides information on their toxicological nature. COC are those constituents that are both identified at the Site and are associated with a release of oil and/or hazardous material (OHM). Unless specific justification is provided for eliminating a constituent from the risk characterization, the constituents detected in each environmental medium at a site are considered to be COC and are carried through the risk characterization process. A constituent may be eliminated as a COC for the following reasons;

- it is present at concentrations that are consistent with "background" for the area and there is no evidence that the constituent is related to activities at a site;
- it is detected with low frequency and low concentrations; or
- its presence may be attributable to field sampling or laboratory contamination.

The primary spill-related constituents detected in site environmental media were PAH and EPH fractions associated with No. 6 fuel oil. In addition to the carcinogenic PAH compounds commonly detected in environmental media, there were numerous aliphatic and aromatic petroleum hydrocarbons which are included in the C_{11}-C_{22} aromatic and the C_{19}-C_{36} aliphatic fractions, as well as dozens of alkylated naphthalene, phenanthrene, fluorene, and chrysene homologs[11] that are common constituents of No. 6 fuel oil.

3.1.1 Constituents of Concern

As discussed in Section 2.1, the following constituents were detected in Site environmental media:

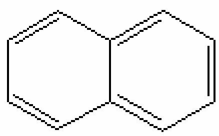
C_{19}-C_{36} aliphatic and C_{11}-C_{22} aromatic hydrocarbons, naphthalene, 2-methylnaphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, benzo(g,h,i)perylene, and alkylated PAH. No hydrocarbon fractions were detected in intertidal sediment, but both fractions mentioned above were detected in marsh and subtidal sediment. The residual weathered oil sample was "fingerprinted" by B&B Laboratories in order to determine whether patterns and distribution of PAH identified it as B120 oil. This analysis yielded results for more than 50 PAH compounds. Several sediment samples also have analytical results for this suite of PAH compounds. Table 9 presents constituents that were retained as COCs for the human health evaluation.

[11] *Alkylated PAH homolog is defined as the parent PAH compound (e.g. naphthalene) that has an additional methyl group (a carbon with three hydrogen atoms) attached to one of the carbon atoms (e.g., C1-naphthalenes).*

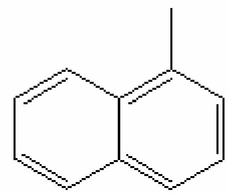
3.1.2 Toxicological Effects of PAH

PAH compounds are complex molecules consisting of multiple 5- to 6-carbon ring structures. Some of these structures are alkylated, meaning one or more additional alkyl groups (i.e., one to four saturated carbons) are substituted on the ring structure, forming daughter compounds. An example of a parent compound (naphthalene) and alkylated daughter compound is presented below.

Two 6-carbon rings combined to form naphthalene.



One alkyl group substituted at the first carbon of a parent PAH (e.g., naphthalene), creates C-1 naphthalene.



While there are more than 100 different PAH, the following seventeen PAH are commonly evaluated in human health and ecological risk assessments:

- acenaphthene;
- acenaphthylene;
- anthracene;
- benzo[a]anthracene;
- benzo[a]pyrene;
- benzo[b]fluoranthene;
- benzo[g,h,i]perylene;
- benzo[k]fluoranthene;
- chrysene;
- dibenzo[a,h]anthracene;
- fluoranthene;
- fluorene;
- indeno[1,2,3-c,d]pyrene;
- 2-methylnaphthalene;
- naphthalene;
- phenanthrene; and

- pyrene.

These 17 individual PAH are considered priority pollutants by the U.S. EPA, and toxicity information is available for these constituents.

3.1.3 Toxicity Profiles

Toxicity profiles of COC provide summaries of acute and chronic toxicological effects, potential carcinogenicity, and toxicity mechanisms of action, as well as data on physicochemical properties and transport and fate processes. These profiles provide general information and do not necessarily relate directly to potential effects associated with exposures to constituents identified at the Site. The primary COC for the Site are EPH fractions and PAH compounds. Information regarding the toxicity of specific PAH compounds are available at http://risk.lsd.ornl.gov/tox/rap_toxp.shtml and http://www.atsdr.cdc.gov/toxprofiles/tp69.html. Information on toxicity of EPH fractions is available in the EPH/VPH guidance (MADEP 2002a). Toxicity information on petroleum hydrocarbons is available at http://www.atsdr.cdc.gov/toxprofiles/tp123.html.

In cases of occupational exposure to No. 6 fuel oil, it may be a skin, eye, and respiratory irritant. If skin is frequently in contact with No. 6 fuel oil for extended periods of time, dermatitis may result with symptoms of dryness and cracking. In addition, chronic effects of some of the constituents in No. 6 fuel oil (such as naphthalenes) may impact the liver and kidney (Irwin, 1997a). However, naphthalene concentrations in environmental samples of B120 oil are currently very low (less than 0.07 mg/kg) due to the volatilization, dissolution, and weathering of this low molecular weight PAH. Because these effects have been observed after occupational exposure, they may not be relevant to the conditions of potential exposure that currently exist along shoreline segments.

PAH compounds suspected to be human carcinogens are as follows:

- benzo(a)anthracene;
- benzo(a)pyrene;
- benzo(b)flouranthene;
- benzo(k)fluoranthene;
- chrysene;
- dibenzo(a,h)anthracene; and
- indeno(1,2,3-cd)pyrene.

3.1.4 Toxicity Equivalency Factors (TEF)

PAH compounds typically occur in mixtures with variable toxicity. As described by Nisbet and LaGoy (1992), the toxicity equivalency factor (TEF) approach assumes benzo(a)pyrene (BaP) as the benchmark compound, since it is the most well-studied of the PAH compounds, and it is assigned a TEF of one. Relative potencies were developed for the other carcinogenic PAH compounds, which are equally toxic or less toxic than benzo(a)pyrene. For example, benzo(a)anthracene is considered to be one-tenth as toxic, so it is assigned a TEF of 0.1. Non-carcinogenic PAH compounds are assigned a TEF of zero. Concentrations of individual PAH compounds are converted into benzo(a)pyrene equivalent concentrations by multiplying the concentration by the TEF. Then, mixtures of PAH can be evaluated as BaP equivalents. TEF values promulgated in MADEP guidance (Table 7-4, 1995) were used to convert the detected PAH concentrations in sediment and residual oil to BaP equivalents for calculating potential carcinogenic risks (Table 9).

3.2 HUMAN HEALTH CONCEPTUAL EXPOSURE MODEL

The conceptual exposure model provides a qualitative framework for presenting assumptions, exposure pathways, potential receptors, and data that are used to characterize risks at a site. The core of the risk characterization process is the exposure assessment, which identifies the receptors and pathways that may result in contact with constituents at the Site. The risk characterization combines exposure pathways, analytical data, and toxicity information for the COC to estimate exposure levels and risks for receptors at the Site.

Potential exposures of human receptors to spill-related constituents are variable for each shoreline classification and also for specific locations within that shoreline classification. The most sensitive human receptor group was identified as annual (i.e., year-round) residents who frequent the shore and walk along the coastline, wade and swim in the water, dig in the sand, and eat locally-caught shellfish. Exposures to the different shoreline types are described in greater detail in the following sections. A summary of the human health exposure scenarios evaluated in this risk characterization is presented in Table 10.

3.2.1 Human Receptors

The people most likely to come into contact with the residues associated with the B120 release of No. 6 fuel oil are annual residents of the coast. These individuals may use the shore recreationally on a regular basis (e.g., beach use, wading, swimming, shellfishing) throughout their lifetime. Both adult and child residents were evaluated in this risk assessment. This “lifetime resident recreational beach-goers” receptor group is considered to be the most sensitive because of the frequency and duration of contact, and extent of potential dermal exposure to oil residue in the intertidal zone or subtidal sediment. This group will serve as the benchmark for human health risks associated with the residual contamination of the Site. That is, this most sensitive receptor group is assumed to be exposed to “worst-case” conditions. If it is determined that a condition of NSR exists for this human receptor group, then the other receptor groups, which experience a lesser degree of exposure to COC, would also be protected. This includes residents who do not live year-round near the coast and/or do not frequent the beach on a regular basis (i.e., summer-only residents, or short-term vacationers).

3.2.1.1 Contact with Surficial Sediment at the Site

<u>Intertidal Sediment</u>

Residents may visit the beach, salt marsh, or other shoreline types located within the intertidal zone throughout the year, but primarily during the summer months. Exposure is expected to be substantially reduced in the early spring, late fall, and winter months when the air and water temperatures are typically too cold for extensive skin contact. If spill-related COC were present in the sediment, digging and playing in wet sand or sediment could provide opportunities for exposure to COC. Sediment may adhere to exposed skin and some sediment particles may subsequently be ingested during the time spent on the beach.

<u>Subtidal Sediment</u>

Beach goers are less likely to spend as much time in contact with subtidal sediment as they would intertidal sediment because subtidal sediment is, by definition, submerged at all times. In addition, since only the soles of one’s feet are likely to contact the subtidal sediment while wading in the water or swimming, exposure to any potential spill-related COC would be considerably less than that predicted for intertidal sediment.

Marsh Sediment

Similar to predicted subtidal sediment exposures, the extent of contact with marsh sediment is likely to be limited to the soles of feet, since marsh sediment is usually well-covered by marsh grasses during the summer season and marshes are not used for recreational uses to the same extent as sandy beaches.

3.2.1.2 Contact with Surface Water at the Site

Although recreational beach goers may ingest small amounts of surface water while swimming in Buzzards Bay, concentrations of spill-related COC were either below or near detection limits in the water column within weeks of the spill (i.e., mid-May 2003). Therefore, there is not a complete exposure pathway between release-related constituents and receptors. This pathway is not considered further in the assessment.

3.2.1.3 Contact with Weathered Residual Oil at the Site

Weathered oil is present on some rocks or hard surfaces and as small pieces adhered to marsh peat. The highly weathered oil on the surfaces of some rocks and manmade structures is typically characterized as “splatter,” which does not come off on skin when touched. Small pieces of weathered oil, identified as tarmats or tarballs (depending upon their physical shape), have been found sporadically on the marsh fringe in a few shoreline segments. These can be touched without resulting in observable transfer of oil to the skin, although vigorous disturbance can result in a very small amount of oil on the skin. If oil residue adheres to their skin, individuals could incidentally ingest some portion of the oil. Because the splatter, tarmats, and tarballs are only present in limited areas and is the consistency of pavement it is unlikely that even local residents encounter these pieces of weathered oil on a frequent basis.[12] To be conservative, this assessment assumes that the residual oil may be somewhat “tacky,” as observed at segment W2A-02 (Harbor View) in the summer of 2005.[13] Because the possibility of a chance encounter with weathered oil does exist, dermal contact and incidental ingestion of weathered residual oil are included in this assessment.

3.2.1.4 Contact with Shellfish at the Site

Because it is likely that local residents might consume locally harvested shellfish, shellfish beds were closed immediately following the initial spill in 2003. By May 2004, the Massachusetts Department of Public Health determined that residual contamination levels in shellfish in the spill area were below levels of concern (i.e., concentrations of petroleum-related compounds that were presumably associated with the spill). The concentrations of PAH measured in shellfish collected from unoiled areas in May 2003 are considered to be representative of baseline concentrations. Based on the comparison in Section 2.1.4, total PAH concentrations in shellfish collected immediately offshore from segments initially classified as oiled to some degree are comparable to total PAH concentrations in shellfish collected in unaffected areas. Since Site-related constituent concentrations are not statistically greater than background concentrations (see Attachment III), consumption of shellfish is not considered to be a significant exposure pathway to Site-related constituents. To demonstrate this, maximum detected PAH concentrations in shellfish were carried through the traditional forward-calculating tables (Attachment IV). The contribution of this pathway was negligible to overall cumulative risk, and was not considered further in the risk characterization.

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[12] *Whenever tarballs, tarmats, or pavement were encountered or reported, they were removed from the Site.*
[13] *Note that this “tacky” weathered oil was removed from this location during a clean up operation.*

3.3 HUMAN HEALTH EXPOSURE ASSESSMENT

The exposure assessment identifies the receptors and pathways that may result in contact with constituents at or near the Site, as well as quantifies the magnitude of that potential exposure. A qualitative evaluation of the identified sensitive receptor groups for the risk characterization components (e.g., year-round residents for human health characterization) and potential exposure pathways present at the Site was provided in Table 10 and is discussed further in Section 4.1. The exposure assessment identifies potential exposure points and estimates exposure point concentrations (Section 3.3.3) and estimates potential doses to human receptors (Section 3.3.4) for quantitative evaluation.

3.3.1 Potential Exposure Pathways

Potentially complete exposure pathways were quantitatively evaluated as part of the human health risk characterization. A complete exposure pathway consists of the following elements:

- the presence of COC derived from the release in an environmental medium;
- a location of potential human contact (exposure point) to this environmental medium; and
- an exposure route (e.g., dermal contact or ingestion).

Complete exposure pathways were identified for the annual residents, based on Site activities and uses and the presence of COC in environmental media. Exposure scenarios evaluated include:

- Residents directly contacting release-related constituents in sediment in marshes and in the intertidal and subtidal zones of the Buzzards Bay shoreline. The routes of exposure may include dermal contact and incidental ingestion; and
- Residents directly contacting release-related constituents in residual weathered oil located either in the intertidal sediment, as rock splatter, or tarmats found in marshes. The routes of exposure may include dermal contact and incidental ingestion.

As recommended by MCP Guidance (1995), subchronic non-cancer exposures should be evaluated using the most sensitive age group for residents, which is a young child (2 years old), because there is a higher exposure potential during developmental stages. Chronic non-cancer exposures are generally between two and seven years in duration, and a young child (aged 1 to 8 years) developing in a coastal residential environment during this time period would experience the greatest degree of exposure during these growth years. Cancer risk is typically conservatively evaluated by assuming the most sensitive age ranges and lowest body weight to surface area ratio over a 30-year period (i.e., a resident exposed to release-related constituents from ages 1 to 31 years). In summary, subchronic non-cancer effects are evaluated for a young child (1<2 years old), chronic non-cancer effects are evaluated for a young child (1<8 years old), and carcinogenic effects are evaluated for a resident that has grown from a young child to an adult (1<31 years), while living in the same area.

3.3.2 Human Health Exposure Points

The geographic location where contact with COC occurs is referred to as the exposure point. From a risk assessment perspective, an exposure point should not be considered a discrete physical location, but rather an area that provides an equal likelihood of exposure, such as an area where people might come into contact with release related constituents in sediment. For receptors to be exposed to constituents at the Site, a realistic exposure pathway must be established leading from the source to the receptor. According to MCP

Guidance (1995), "an exposure point for soil, sediment or surface water should be delineated by the distribution of oil or hazardous material in the environmental medium." However, the residual contamination from the oil spill is not homogeneously distributed along the shoreline. Because of this uncertainty, this assessment assumes the worst-case conditions known to exist, and these are considered to be exposure points in this assessment.

3.3.2.1 Sediment Exposure Points

The most sensitive human receptors that come into contact with the Site are year-round residents. These receptors were assumed to have the potential to contact constituents in surficial sediments from the marsh, intertidal and subtidal sediments. Thus, the exposure points used to evaluate potential risks to residents are marsh, intertidal, and subtidal surficial sediments. Because the Site encompasses many miles of shoreline, and nearly all sediment sample represents a composite of three grab samples, each composite sample is assumed to represent one exposure point. There were a few sediment samples that were collected as a grab samples; these are discussed in more detail in Section 3.3.3.1.

3.3.2.2 Residual Weathered Oil Exposure Point

While the presence of weathered oil is limited to only a few areas, residents may occasionally contact this media. Weathered oil exists in several forms including; small floating particles ("flecks") on tidal pools, small tarmats or tarballs on marsh surfaces, and splatter on rocks. The greatest degree of exposure to residual weathered oil would occur with direct contact to a pocket of oily sediment or small tarball (Photo 1).

Photo 1. Weathered oil beneath marsh sediment overhang.
(Photograph taken on June 29, 2005 at Harbor View, Fairhaven)

3.3.2.3 Hot Spot Evaluation

As defined in the MCP (40.0006), a Hot Spot refers to "a discrete area where the concentrations of oil or hazardous material or the thickness of Nonaqueous Phase Liquid ("NAPL") are substantially higher than those present in the surrounding area." The definition also includes quantitative benchmarks to determine a hot spot; that is, if the average concentration of a discrete area is between 10 and 100 times the average concentration of the immediate surrounding area and the discrete area may pose a higher degree of exposure than the surrounding area. Regardless of exposure, if the average concentrations are 100 times greater in a discrete area, it is considered a hot spot. Also, an area where the thickness of NAPL is 10 times greater than the surrounding area is considered a hot spot.

Tarballs are primarily composed of weathered oil with grains of sand and gravel embedded in the surface.. Tarballs do fit the definition of "a discrete area" needed for a "hot spot". However, for the purposes of this risk characterization, exposure to weathered oil in tarballs is evaluated as a potential worst-case "hot spot" condition.

3.3.3 Human Health Exposure Point Concentrations

Exposure point concentrations (EPC) represent the concentration of each constituent within a given exposure point that the receptor may contact over a given exposure period. Typically average concentrations of samples within an exposure point are used as EPC; in this case, each intertidal composite sediment sample data point was conservatively used as EPC for this Site. Sediment and weathered residual oil exposure point concentrations were estimated as described below.

3.3.3.1 Sediment EPC

Each of the 12 selected intertidal shoreline segments and the subtidal zone was characterized by multiple samples during the field efforts over the last three years. Unless otherwise noted, each sediment sample is a composite of three grab samples, collected at approximate 20-foot intervals. There are a few samples that were collected as discrete or grab samples; the HB-SED intertidal series from segment W1F-02 (Brandt Island West) collected in December 2004, the subtidal samples W2A10-ST series and the marsh core samples W2A10-C01 through W2A10-C04 collected from segment W2A-10 (Long Island) in July and August 2004. Total PAH concentrations were determined by summing detected concentrations and one-half detection limits when a constituent was not detected. Results qualified by a "J," indicating the concentration is estimated but below the detection limit, were used in calculating the total PAH, rather than using one-half the detection limit, which is considered to be conservative as one-half of estimated values are typically used in most risk characterizations. If alkylated PAH compounds were analyzed, these were summed with their parent compounds, and all PAH were summed to result in the total PAH concentration. In order to incorporate EPH fractions for comparison to non-cancer RBTC, detected EPH concentrations were also included in the total PAH value.[14] This total PAH value was used in evaluating potential non-cancer risk estimates. The COC concentrations for carcinogenic PAH compounds were converted to BaP equivalents using MADEP TEF values and summed for a total BaP equivalent value that was used in evaluating potential carcinogenic risk estimates.

3.3.3.2 Weathered Residual Oil EPC

The weathered residual oil collected from segment W2A-02 (Harbor View) was used to represent worst-case conditions for potential exposure to residual weathered oil. Alkylated PAH homologs were summed with parent compounds including the carcinogenic PAH concentrations, which were converted to BaP equivalent

[14] *Evaluating the EPH fractions with the total PAH value adds more conservativism because there is some duplication of individual compounds in these analyses.*

concentrations. Total BaP equivalents summed to 456 mg/kg and total PAH concentrations summed to 45,340 mg/kg (Table 6).

Although oil exposed to natural scouring and weathering processes results in a change in composition (i.e., low molecular weight PAH concentrations decline), it is very conservative to assume that concentrations will remain constant over a 30-year exposure period. In addition, this sample has been characterized as relatively fresh (i.e., sticky to the touch) because the protected location where it was discovered inhibited the natural weathering process. Thus, this sample is considered representative of the worst-case exposure point concentration to which receptors could be exposed.

3.3.4 Human Health Exposure Dose Calculation

The exposure dose is an estimate of the amount of a COC that an individual receptor may contact and take into his/her body given the conditions specified in the risk assessment. Exposure dose is a function of receptor-specific exposure assumptions and constituent-specific exposure parameters. The material that reaches a receptor's absorption barrier (such as skin, lung, or gastrointestinal tract) is referred to as the applied dose, while the absorbed (or internal) dose is defined as the amount of material that actually gets into the person's bloodstream from whence it can be distributed to target organs.

Exposure doses are calculated as the daily amount of constituent taken into the body per unit body weight per unit time (mg/kg-day). The general equation used to estimate Average Daily Dose (ADD) and Lifetime Average Daily Dose (LADD) is:

$$\text{ADD (or LADD)} = \frac{\text{Total Amount of OHM Contacted/Ingested * Relative Absorption Factor}}{\text{Body Weight * Averaging Period}}$$

The specific equations used to calculate the ADDs and LADDs for each exposure pathway are presented on Table 11. These equations incorporate receptor-specific exposure variables and pathway-specific contact rates, along with constituent-specific media exposure point concentrations and relative absorption factors to estimate the constituent-specific doses or exposures for each receptor and pathway.

Subchronic ADDs were calculated for the evaluation of non-cancer effects associated with short-term exposures (i.e., less than 2 years). Chronic ADDs were calculated for the evaluation of non-cancer effects that occur over a time period up to seven years, and LADDs were estimated for evaluation of cancer effects (i.e., over a 30 year period).

3.3.5 Human Health Receptor-Specific Exposure Assumptions

Receptor-specific exposure assumptions incorporated in the equations used to calculate ADDs and LADDs, include parameters such as body weight, skin surface area affected, soil ingestion rate, frequency of exposure, duration of the exposure event, duration of the exposure period, and averaging period. Receptor-specific exposure assumptions for the exposure scenarios are presented in Table 12a and 12b. The exposure assumptions were based on conservative exposure assumptions and factors developed in accordance with MADEP (2002a, 2002d, 2002e, 1995; 1994; 1992) and U.S. EPA (2004a, 2005a) guidelines. Key exposure assumptions are discussed below.

3.3.5.1 Sediment Exposure Parameters

Residents and frequent visitors have the potential to engage in outdoor activities (digging, walking, sunbathing) along the shoreline. The more sensitive age range (children between the ages of 1 and 8 years old) is used to calculate chronic risk estimates,[15] while young children between the ages of 1 and 2 years is used to calculate subchronic risk estimates.[16] Cancer risks are estimated over the lifetime of the receptor, and in this evaluation the exposure parameters (skin surface area and body weight) are age-weighted to reflect ages between 1 and 31 years.[17] Residents are assumed to be using the shoreline for 4 days per week during the non-winter months (May through September or 87 events/year).

For lifetime residential sediment exposures, dermal contact exposure is based upon an affected skin surface area of faces, hands, forearms, lower legs, and feet, according to MADEP default values (MADEP, 2002d). The sediment adherence factor accepted by MADEP is 1 mg/cm^2, regardless of body part (MADEP, 2002d). The adherence factors and skin surface areas for contacting sediment is used to calculate the sediment dermal contact rate (DCR) of 5,657 mg/day for adults aged 18-30 years. Lifetime DCR and body weight values are age-weighted to include seven years of intermediate size (1 to 8 years, or youth), and 23 years of adulthood. Thus, the lifetime DCR is 4,905 mg/day (Table 12a). An incidental ingestion rate of 60 mg/day is assumed (MADEP 2002e). Ingestion rates were not altered to include ingestion of soil-borne fugitive dust through nasal passages because intertidal sediment is by nature wet, and not expected to become airborne, except on particularly blustery days which would correspondingly discourage outdoor activities (Table 12b).

Non-cancer sediment exposures were evaluated for the most sensitive age group among residents (i.e., children). Children were assumed to have the typical soil ingestion rate of 100 mg/day, and youth (1-8 years) have an age-weighted ingestion rate calculated using 100 mg/day for ages 0-6 years, and 50 mg/day for ages 7 and older during each exposure event (MADEP, 2002e). The dermal contact exposure for sediment is based upon the skin surface area for face, hands, forearms, lower legs, and feet. The sediment adherence factor is 1 mg/cm^2, according to MADEP (2002d). Skin surface areas for face, hands, forearms, lower legs, and feet of young children (ages 1-2 years) are calculated from values representative of the 50th percentile skin surface area by ages (U.S. EPA, 2004a). Skin surface areas for children (ages 1-8 years) were obtained from the Child Resident and Child Recreational profile presented in MADEP Technical Update (2002d). The adherence factor and skin surface areas for contacting sediment are used to calculate the sediment DCR of 1,914 mg/day (child) and 2,563 mg/day (youth). Tables 12a and 12b present the exposure factors for this receptor group.

3.3.5.2 Weathered Oil Exposure Parameters

For weathered oil exposures, children on the beach for one summer (i.e., subchronic) were assumed to contact a tacky tarball once during the summer. It is important to reiterate that this is a very conservative estimate because the small amounts of residual oil present on the shoreline are generally weathered and hard to the touch (i.e., not tacky). In addition, the sample used (collected from Harbor View) was collected from a sheltered location and this sample was relatively fresh despite its age.

The frequency of exposure is based on a conservative estimate of the number of beaches that actually have had recent reports of a tacky tarball (discovered at segment W2A02, Harbor View), which has subsequently been removed. However, the frequency of encountering a B120 tarball is likely to decrease over a 30-year exposure period, therefore it is assumed that children or adults may encounter tarballs once per summer for the next 5 years, and may encounter a tarball once every other summer for the remaining 25 years. This results in a lifetime exposure frequency of 0.58 events/year. It is assumed that children may expose the entire surface of both hands to the weathered oil, but that adults would only expose the distal pad of three fingers on one hand (approximate area 4.5 cm^2 x 3 fingers = 13.5 cm^2).

[15] *An exposure period of seven (7) years is used to evaluate chronic exposure.*
[16] *An exposure period of two (2) years is used to evaluate subchronic exposure.*
[17] *Thirty years is used to evaluate a lifetime exposure; 33 years is the 90th percentile of occupying the same residence (U.S. EPA 1997).*

3.4 HUMAN HEALTH DOSE-RESPONSE ASSESSMENT

In order to characterize the potential adverse impact that an estimated daily dose of a COC might have on an exposed individual, an expression of the dose-response relationship for the COC must be applied to that dose estimate. The expression of the dose-response relationship for a chemical is called its Toxicity Factor. There are two basic types of Toxicity Factors: 1) non-carcinogenic and 2) carcinogenic. Those toxicity factors that pertain to non-cancer or threshold toxicity endpoints of a constituent are primarily the Reference Dose (RfD) and Reference Concentrations (RfCs). The Toxicity Factors that represent the dose-response relationship for constituents that cause cancer are termed Cancer Slope Factors (CSFs), and Unit Risks (UR). Toxicity Factors are constituent-specific and often exposure route-specific. Toxicity Factors published by U.S. EPA (and some of the U.S. EPA Regional Offices) have been derived through a rigorous review of relevant animal, and if available, human toxicological data. Because inhalation pathways are not complete (i.e., an inhalation exposure pathway does not exist) in this assessment, RfCs and Unit Risks are not presented.

In accordance with the U.S. EPA (2003), toxicity values were obtained from the following sources:

(1) U.S. EPA, Integrated Risk Information System (IRIS, December, 2005) (http://www.epa.gov/iris/);

(2) MADEP, Characterizing Risks Posed by Petroleum Contaminated Sites: Implementation of the MADEP VPH/EPH Approach, Final Policy (#WSC-02-411). Table 4-13. October 2002.

(3) U.S. EPA, *Health Effects Assessment Summary Tables* (HEAST, July 1997a); and

(4) MADEP, Background Documentation for the Development of the MCP Numerical Standards, Bureau of Waste Site Cleanup, Office of Research and Standards, April 1994.

3.4.1 Non-Cancer Effects

Regulatory guidance assumes that a threshold level exists at or below which no adverse health effects would be expected. Any given chemical may produce a number of threshold toxic effects. The reference dose for use in human health risk assessments is conservatively derived from the controlled exposure study (usually laboratory animals) involving the most sensitive species and most sensitive effect. If multiple studies are available for a toxic agent, the study using the lowest doses that produced an adverse effect would be selected as the basis for deriving the reference dose. The lowest dose where no ill effects occurs is termed the No-Observed-Adverse-Effect-Level (NOAEL). The lowest dose at which an adverse effect occurs is identified as a Lowest-Observed-Adverse-Effect-Level (LOAEL). The NOAEL is the preferred starting point for deriving the RfD, but the LOAEL may be used if the selected study did not identify the NOAEL. U.S. EPA derives constituent-specific RfDs for non-cancer effects by applying uncertainty factors to a NOAEL or LOAEL obtained from studies of dose-response relationships. The purpose of these uncertainty factors is to establish conservative exposure levels that are protective of human health, even for sensitive subpopulations. Some examples of the conservative assumptions are:

- uncertainty factors of 10 are often used to account for interspecies variability between humans and other mammals used in dose-response studies;
- use of a NOAEL derived from a subchronic rather than a chronic study;
- uncertainty when extrapolating from LOAELs to NOAELs; and
- variation in the general population with the intent to protect sensitive subpopulations (e.g. elderly, children).

A modifying factor (MF) is an additional uncertainty factor that allows for "professional judgment," relative to confidence in the studies, in the estimation of allowable levels. The default MF is 1 (no modification).

The chronic (oral) RfDs, which may incorporate MFs and uncertainty factors, are conservative estimates of levels for humans. These doses indicate the level below which no adverse non-cancer health effects are expected to occur over long periods of exposure. The units of the RfD are mg/kg-day (mg constituent/kg body weight per day). The subchronic RfDs are calculated in a manner analogous to the chronic benchmarks; however, they are designed to be protective of shorter duration exposures (generally defined as representing exposures lasting from several days to less than seven years).

Non-cancer dose-response information for COC is provided in Table 13 for the oral exposure routes. This table also provides information on the target organ/system that was affected in the toxicity study upon which the reference dose or concentration is based. This table indicates that many PAH do not have chronic and subchronic RfDs, but that the RfD for pyrene is assigned as a surrogate where appropriate. The subchronic and chronic RfDs for pyrene are 0.3 and 0.03 mg/kg-day, respectively. These values are the same as those for C_{11}-C_{22} aromatic hydrocarbons, which are the most protective and therefore conservative RfDs of the EPH fractions. The non-cancer toxicity information for C_{11}-C_{22} aromatic hydrocarbons was selected for use in estimating an acceptable concentration of total PAH, a value which includes petroleum fractions and alkylated PAH concentrations, if present.

3.4.2 Cancer Effects

Consistent with U.S. EPA guidance (2005a), chemical carcinogenicity is conservatively assumed to have a non-threshold dose response. In other words, any exposure, no matter how small, poses some level of cancer risk, the magnitude of which increases with the dose. The metric of chemical carcinogenicity is the Cancer Slope Factor (CSF) and is derived from the slope of the dose-response curve rather than from a single dose level (Table 14). Cancer Slope Factors are expressed as the inverse of dose and consequently, the estimated daily intake of a carcinogenic chemical is multiplied by the Cancer Slope Factor to yield a unitless estimate of risk. The risk is an estimate of the number of cancer cases that may arise in a population given the circumstances of exposure specified in the risk assessment. Cancer risk estimates are expressed as a frequency of theoretical occurrence per unit population (e.g., Y cases per 100,000 people exposed (Y x 10^{-5}); Y cases per 10,000 people exposed (Y x 10^{-4})).

CSFs are derived by the U.S. EPA Carcinogen Assessment Group (CAG) typically using the linearized multistage model (for animal data) to extrapolate from high experimental doses to low environmental doses. The dose-response curve indicates the relationship between the dose of a particular constituent and the probability of developing cancer over a lifetime. U.S. EPA utilizes the 95 percent upper confidence limit of the slope of the dose-response curve from the multistage model, expressed in $(mg/kg\text{-}day)^{-1}$. Use of a CSF assumes that the calculated dose received is expressed as a lifetime average. The CSF for BaP is 7.3 $(mg/kg\text{-}day)^{-1}$. There are no CSFs for EPH since none of the fractions are considered to be carcinogenic.

3.4.3 Relative Absorption Factors

Relative absorption factors (RAFs) are necessary to account for differences in the absorption of a constituent in a given environmental medium relative to that in the dose-response study. Absorption differences can result from matrix attenuation effects as well as differences in the route of administration (e.g., oral versus dermal exposures). The RAF is used to convert the dose-response value to an absorbed dose, if necessary.

RAFs derived by MADEP (MADEP, 1992; 2002a) were used when available. For constituents without MADEP-derived values, applicable surrogate values were substituted. For constituents that did not have adequate information to establish a RAF value, MCP guidance suggests a default of 1. These are summarized in Table 15. The carcinogenic oral and dermal RAF for benzo(a)pyrene are 1 and 0.2, respectively. A value of 1 was used for the oral and dermal RAF for C_{11}-C_{22} aromatics, which was used to evaluate non-carcinogenic effects of total PAH. A value of 1 was used to estimate daily doses for exposure to weathered oil.

3.5 HUMAN HEALTH RISK CHARACTERIZATION

The risk characterization ties together the estimate of daily intake with the toxicity factors for each COC, environmental medium, route of exposure and receptor to generate unitless estimates of non-cancer hazard and cancer risk. In a traditional Method 3 risk characterization, the potential risk of harm to human health posed by the Site is assessed by comparing calculated cumulative non-cancer and cancer risks to:

(1) MCP Cumulative Non-cancer Risk Limit which is a Hazard Index (HI) equal to one; and

(2) MCP Cumulative Cancer Risk Limit which is an Excess Lifetime Cancer Risk (ELCR) of one in one hundred thousand (1×10^{-5}).

In this characterization, risk-based threshold concentrations were developed using a target risk limit, receptor-specific exposure parameters, and toxicity factors. These risk-based threshold concentrations are then compared to EPC developed for each segment and environmental media (sediment and weathered oil).

Typically, EPC are usually compared to applicable or suitably analogous public health standards; however, these public health standards are not available for sediment or residual oil. For this human health risk characterization, a condition of NSR to human health exists if exposure point concentrations are less than or equal to the risk-based threshold concentrations derived from MCP risk limits (1.0 for noncancer risks, and 1×10^{-5} for excess lifetime carcinogenic risks), and EPC are less than or equal to any applicable health standards.

3.5.1 Calculation of Risk-Based Threshold Concentrations

The methodology used to calculate risk-based threshold concentrations for exposure to COC in sediment and residual weathered oil is described in the following sections.

3.5.1.1 Methodology

Developing risk-based threshold concentrations essentially is a back-calculation from target risk limits to exposure point concentrations that triggers the risk limit; the opposite of forward-progressing, Method 3 risk calculations (as shown in Attachment IV). The RBTC or threshold EPC is estimated from the receptor-specific exposure factors and the daily dose for each constituent in each media. This average daily dose (ADD) was calculated by dividing the hazard quotient by the RfD. The HQ for each constituent for each pathway is a portion of the cumulative hazard index (HI). An HI less than one indicates that the cumulative exposure to the EPC is very unlikely to cause health effects for the receptor group under the conditions specified in the risk assessment.[18]

By developing RBTC that are specific to each environmental medium, any future detected concentrations of release-related constituents could readily be screened to evaluate the potential for human health risks and/or be used as an aid for risk managers to determine if additional mitigation measures are needed.

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[18] This approach assumes that toxic effects by different constituents are additive within a target organ system. In reality, different constituents often affect different organ systems.

Deriving Risk Based Threshold Concentration

The concentration for a constituent that corresponds to a non-cancer Hazard Index of 1.0 is calculated as follows:

Eq. 1 $$\text{Target Dose} = \text{Target HI} * \text{RfD}$$

Eq. 2 $$\text{RBTC} = \frac{\text{BW} * \text{AP} * \text{Target Dose}}{\text{Rate of Contact} * \text{EF} * \text{ED} * \text{EP} * \text{RAF} * \text{C1}}$$

Where:

Target Dose	= average daily dose (ADD) or lifetime average daily does (LADD)
Target HI	= target hazard index (HI =1)
RfD	= Reference Dose (constituent-specific)
RBTC	= Risk-based threshold concentration
BW	= body weight
AP	= averaging period
Rate of contact	= ingestion rate, dermal contact rate
EF	= exposure frequency
ED	= exposure duration
EP	= exposure period
RAF	= relative absorption factor
C1	= unit conversion factor

These calculations are completed for each of the four pathways evaluated in this assessment: dermal contact with sediment; incidental ingestion of sediment; dermal contact with weathered residual oil; and incidental ingestion of weathered residual oil. An RBTC is calculated for each pathway, using the conservative RfD for C_{11}-C_{22} aromatic hydrocarbons. The minimum non-cancer RBTC calculated for each media is selected as the overall screening benchmark to which segment EPC for each media are compared. The non-cancer RBTC is in units of total PAH, providing a relative benchmark to compare total PAH concentrations at each segment. The RBTC or minimum EPC for resident subchronic and chronic non-cancer exposures are calculated in Table 16 and Table 17, respectively.

The RBTC for cancer are calculated similarly, except that the excess lifetime cancer risk (ELCR) represents the upper bound probability of the likelihood of developing cancer over a lifetime as a result of exposure to each Site-related constituent. In the traditional Method 3 risk assessment, potential excess lifetime cancer risks are assessed by multiplying each constituent-specific LADD by the appropriate CSF to yield a COC-specific lifetime cancer risk estimate. In order to calculate the RBTC, the target cancer risk level is set at the MCP risk limit (1×10^{-5}). The LADD is calculated for each exposure pathway as follows:

Eq 3. $$\text{Target Dose} = \frac{\text{ELCR}}{\text{CSF}}$$

The RBTC is then calculated using Equation 2. These calculations are completed for each of the four pathways mentioned above, using the CSF for benzo(a)pyrene. The RBTC is a screening benchmark for comparison to BaP equivalents concentration. The RBTC or minimum EPC for residential carcinogenic exposures is presented in Table 18.

3.5.1.2 Pathway-Specific Risk Estimates

RBTC for each of the exposure pathways for each media were calculated based on equal partitioning the MCP non-cancer target risk limit of 1.0 between the four pathways (i.e., 0.25) for non-cancer exposures, and dividing the carcinogenic target risks evenly between the two environmental media of concern. The majority of the target risk was allocated to the exposure pathways demonstrated to contribute most to cumulative ELCR (i.e., incidental ingestion of weathered oil exposure pathway contributed more than 50% to overall carcinogenic risk estimates). The minimum RBTC was then chosen as a benchmark for each environmental media.

Receptor Group:		**Child (<2 yrs)**	**Child (1-8 yrs)**		**Adult (1-31 yrs)**
Exposure Pathway	Target Risk (non-cancer)	$RBTC_{subchronic}$ total PAH (mg/kg)	$RBTC_{chronic}$ total PAH (mg/kg)	Target Risk (cancer)	$RBTC_{cancer}$ BaP (mg/kg)
Dermal Contact with Sediment	0.25	1,833	**222**	5×10^{-6}	**0.35**
Ingestion of Sediment	0.25	35,084	5,828	1×10^{-6}	1.1
Dermal Contact of Weathered Oil	0.25	940,739	**124,235**	1×10^{-6}	**757**
Ingestion of Weathered Oil	0.25	3,052,313	506,290	5×10^{-6}	852
MCP Risk Limits	1.0			1×10^{-5}	

Sediment EPC for total PAH were compared to the minimum sediment non-cancer RBTC (i.e., 222 mg/kg). Sediment EPC for BaP equivalents were compared to the minimum sediment cancer RBTC (0.35 mg/kg). Similarly, the minimum non-cancer and cancer RBTC (i.e., 124,235 mg/kg total PAH and 757 mg/kg BaP) calculated for weathered oil were compared to the weathered oil results collected from Harbor View in June 2005.

In Table 19 the total PAH concentration and BaP equivalents for each sediment sample is compared to the RBTC calculated above. The total PAH and BaP equivalents EPC for all sediment samples were less than the calculated non-cancer and cancer RBTC. The total PAH and BaP equivalents EPC for the weathered oil sample were 46,354 mg/kg and 465 mg/kg, respectively, which are also less than the calculated RBTC for weathered oil. For perspective, the non-cancer RBTC estimated for ingestion of weathered oil is approximately 3 million parts per million, or 3 percent PAH.

These calculations demonstrate that occasional contact with residual oil and associated constituents in sediment is not a concern with respect to non-cancer risks. The cancer RBTC are considerably less than the RBTC calculated for non-cancer exposures due to the known carcinogenic PAH that are present in No. 6 fuel oil. Because B120 oil has been removed from the majority of shorelines, most of the beach-going population will not contact spill-related constituents. This HHRC has been designed to estimate potential risks to the fraction of the population that may encounter spill-related COCs because they frequent the beaches where spill-related constituents have been detected or where residual oil has been observed. The calculations presented in this HHRC indicate that there is No Significant Risk to human health for even this fraction of the population.

3.5.2 Comparison To Applicable or Suitably Analogous Standards

Typically, applicable or suitably analogous standards refers to standards such as state and federal drinking water standards that are protective of human health. However, no such sediment standards that are applicable in a Method 3 Risk Characterization have been promulgated. Therefore, no comparison of sediment constituent concentrations to public health standards could be made.

3.6 CONCLUSION

The MCP indicates that a condition of NSR of harm to human health exists if:

- the Cumulative Receptor Non-cancer Risk is less than 1.0;
- the Cumulative Excess Lifetime Cancer Risk is less than 1 x 10^{-5}; and
- Exposure Point Concentration of OHM are less than an applicable or suitably analogous public health standard (where applicable).

Based on the assessment and comparisons described in this assessment, none of the total PAH or BaP sediment or weathered oil EPC exceeded the applicable RBTC. This method of calculating a screening risk-based threshold concentration in order to facilitate the assessment of each exposure point is supported by the traditional forward calculations that are presented in Attachment IV. These calculations are based on the maximum COC concentrations detected in sediment, shellfish tissue, and the relatively fresh weathered oil sample collected during the summer of 2005. The cumulative risk estimates from these forward-progressing calculations do not exceed MCP risk limits of 1.0 for non-cancer and 1 x10^{-5} for excess lifetime cancer risks, thereby further supporting a conclusion of NSR to human health at this Site. Because the RBTC represent concentrations at which cumulative non-cancer and cancer risks for current and future residential exposures do not exceed applicable MCP risk limits, and there are no applicable public health standards, a condition of NSR of harm to human health exists at the Site.

4.0 STAGE I ENVIRONMENTAL SCREENING

An Environmental Risk Characterization (ERC) was conducted for the 63 remaining shoreline segments and subtidal zone (Table 1) that comprise the Site in order to determine whether any concentrations of residual oil constituents detected in those segments might pose a potential current or future risk to ecological receptors or habitats. An ERC evaluates the potential that adverse ecological effects may occur or are occurring as a result of exposure to one or more biological, chemical, or physical stressors (U.S. EPA, 1992). As described in the MCP (310 CMR 40.0995), "Characterization of the risk of harm to the environment shall include an assessment of chemical data, potential contaminant migration pathways, and an evaluation of biota and habitats at and in the vicinity of the disposal site, as described in 310 CMR 40.0995(2), as well as through the application of Upper Concentration Limits, as described in 310 CMR 40.0995(5)." (310 CMR 40.0995). The "risk of harm" standard relies upon available evidence to determine the likelihood of actual, or potential impacts. "Habitats and biota exposed" refers to ecological subpopulations and communities that, under current and foreseeable future conditions, may or could experience potentially adverse levels of exposures.

An ERC is used to methodically evaluate and organize information, data, assumptions, and uncertainties for the purpose of understanding and predicting the relationships between stressors and ecological effects in a way that is useful for environmental decision making. Risk managers can then use the information from an ERC to determine if recommendations for MCP response actions are necessary. As specified by the MCP (310 CMR 40.0995), an ERC is conducted in a two-step iterative manner. First, a Stage I Environmental Screening (ES) is conducted to determine whether there are any potentially complete exposure pathways between ecological receptors and OHM at the Site, as well as whether those exposures might have the potential to adversely impact sensitive receptors. In the event that the Stage I ES concludes that potentially complete exposure pathways might pose a hazard to ecological receptors, one of two paths is followed: implementation of remedial measures to mitigate the potential site hazards to acceptable levels or to further evaluate Site conditions in a quantitative Stage II ERC. In this latter path, a site-specific evaluation of the potential for adverse exposure to ecological receptors at the Site would be conducted.

The following is the Stage I ES of potential spill-related risks at the remaining affected segments in Buzzards Bay. This was accomplished by characterizing the spill-related constituents of potential ecological concern (COPEC) detected in the affected environmental media, identifying potential environmentally-sensitive receptors (ESR), characterizing potential constituent migration pathways between the COPEC with ESR, and comparing constituent concentrations found in environmental media to protective "benchmark" concentrations.

4.1 METHODOLOGY

As described in the CSA-SOW (GeoInsight, 2005) and subsequent addendum letter (Wozmak, 2006), a characterization of the potential risk of harm to the environment at the Site was conducted. In brief, an ES was conducted in the following iterative steps:

Initially, background concentrations of spill-related COPEC, specifically PAH, were assumed to be absent in Site environmental media. Constituent concentrations detected in affected environmental media (surface water, sediments) were compared to relevant ecological screening benchmarks (i.e., ambient water quality criteria [U.S. EPA, 2004b] and Effects Range-Low [ER-L] sediment values [Long and Morgan, 1990]). Additionally, each shoreline segment was evaluated for the presence of potentially stressed vegetation, persistent sheens on surface water, or significant areas of exposed oil residue. For those segments where COPEC concentrations in media are not detected or do not exceed screening ecological benchmarks and where evidence of stressed vegetation, persistent sheens, and/or residual oil is not present or does not present potentially adverse physical effects, it was concluded that a condition of NSR exists.

For segments where detected COPEC concentrations exceed ecological screening benchmarks, an evaluation of potential contribution from pre-existing local conditions (i.e., sources of PAH which are not attributable to the B120 spill) was conducted to determine whether the exceedance of ecological benchmarks might be readily attributable to that local condition. For those segments where PAH concentrations are consistent with local conditions, NSR was concluded unless there is physical evidence suggesting potential stressed vegetation, persistent sheens, or exposed oil residue associated with the B120 spill.

A Stage II ERC would be conducted only for those remaining segments where COPEC concentrations in environmental media exceed ecological screening benchmarks and may be attributed to the spill event (i.e., not to local conditions or background) or where habitat evaluation reveals physical evidence of potential habitat impacts (stressed vegetation, residual oil, and/or persistent sheen). If additional measures were implemented that reduced COPEC concentrations to below those screening benchmarks or to mitigate adverse impacts to affected habitat, no additional risk characterization would be warranted.

This assessment approach is consistent with relevant state and federal risk assessment guidance, including:

- MADEP, 2006a. *Massachusetts Contingency Plan*. BWSC, 310 CMR 40.0000;
- MADEP, 2006b. Technical Updates: Ecological Risk Assessment Guidance, BWSC/ORS;
- U.S. EPA, 1997b. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. EPA/540-R-97-006. Washington, D. C.;
- MADEP, 1996. Guidance of Disposal Site Risk Characterization, Chapter 9: Method 3 Environmental Risk Characterization, Interim Final Policy, BWSC/ORS-95-141; and
- U.S. EPA, 1995b. *Guidelines for Ecological Risk Assessment*. EPA/630/R-95/002F, Washington, D.C.

4.2 ECOLOGICAL SITE DESCRIPTION

The Site primarily consists of multiple shoreline types within Buzzards Bay, including salt marshes, sandy beaches, mixed sand and gravel beaches, and rocky or man-made structures (piers, jetties, walls), and associated subtidal zones. The Site extends across multiple municipalities, including Bourne, Dartmouth, Fairhaven, Falmouth, Gosnold, Marion, Mattapoisett, New Bedford, Wareham, and Westport. A discussion of shoreline type classifications is presented in the Updated Conceptual Site Model (CSM; GeoInsight, 2005). Detailed descriptions of the individual segments being evaluated as part of the Phase II CSA are presented in Section 3.0 of that report and Appendix B. A discussion of the potentially affected habitats and ecological communities in Buzzards Bay is presented below.

4.2.1 Habitat Characterization

Buzzards Bay is bounded by mainland Massachusetts to the north and northwest, and by Cape Cod and the Elizabeth Islands to the east and southeast. The bay opens to the Atlantic Ocean to the southwest and connects with Cape Cod Bay via the Cape Cod Canal at the northeastern end of the bay. Because of the location and circulation patterns of the Bay, many migratory aquatic and avian species frequent its productive waters. Its ecosystem contains a diversity of shoreline habitats, ranging from sand dunes and estuarine wetlands to weathered rock and man-made structured shoreline. Typical habitats include salt marshes, tidal flats, eel grass beds, barrier beaches, rocky shores, and tidal rivers and streams. Each smaller-scale habitat provides a diversity of functions to the species that inhabit or visit Buzzards Bay. This includes spawning, nursery, and feeding areas for fish, birds, crustacea, molluscs, as well as providing conditions suitable for a multitude of plant and algae species. Howes and Goehringer (1996) compiled a detailed monograph of the Buzzards Bay ecosystem, wherein a fairly comprehensive characterization of habitats and biota is presented.

Since the areas most affected by the release were the intertidal zones and, to a lesser degree, the subtidal zone, additional characterization of these areas is provided below. For the purpose of this ES, the intertidal and subtidal zones evaluated are considered to represent current worst-case conditions for the entire Buzzards Bay ecosystem associated with the B120 spill.

4.2.1.1 Characteristics of Intertidal and Subtidal Zones

The intertidal zone is the transitional shoreline area that is regularly inundated by tides twice daily and extends from the mean low water to the mean high water mark. The subtidal zone is the area below mean low water, and extends toward the sea. These zones include combinations of one or more substrate types, such as sand, gravel, cobble, and marsh peat. The grain size and organic content of the substrate influence the abundance and diversity of aquatic plants and benthic community that inhabit these areas.

Fringing and back barrier salt marshes occur in the intertidal zones of some of the Buzzards Bay shoreline. Fringing salt marsh are areas of shoreline that are regularly exposed to rough wind and wave conditions, and generally consist of sparse patches of marsh grass. Larger salt marshes generally form in low-energy, protected environments such as coves or behind barrier beaches. The low-wave energy in these protected areas results in the deposition of fine particles, which eventually leads to colonization by marsh plants. Salt marshes consist of two zones; low and high marsh. The low marsh is inundated daily by the tides (i.e., located between mean low water and mean high water), and the high marsh lies between mean high water and spring high water, and so is rarely inundated. Only some of the fringing marshes and low salt marsh areas in Buzzards Bay were affected by the B120 release.

Benthic Community[19]

Benthic communities commonly occur in intertidal and subtidal soft-sediment habitats where sediment accumulates, and often are present as tidal flats along the margins of estuaries. Organisms that generally comprise the benthic community are Bivalvia, Polychaeta, Gastropoda, Crustacea, Tunicata, Phaeophyta, and Rhodophyla.[20] Typically, deposit feeders (such as segmented worms, amphipods, sea cucumbers, snails) dominate the soft-bottom sediments, while filter feeders dominate the benthic community in sandy substrate, which may have a stronger correlation with the moderate currents that provide a constant supply of food in the water column.

Buzzards Bay salt marshes typically are located in intertidal areas behind barrier beaches, bordering pools, quiescent water, or along the banks of tidal rivers. Salt marshes support populations of marine life (e.g., snails, crabs, mussels, amphipods, small fish) and terrestrial wildlife (e.g., field mice, various bird species) that commonly forage in the marsh during low tides. Mosquitoes and biting flies breed in stagnant pools on the surface of salt marshes, providing a food source for birds and small fish. As discussed by Howes and Goehringer (1996) and Werme (1981), 90 percent of the resident fish population in the Great Sippewissett marsh in Falmouth was comprised of two species, Atlantic silverside (*Menidia menidia*) and mummichog (*Fundulus heteroclitus*).

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[19] Information provided in this section was obtained from several reports regarding the intertidal habitats of Buzzards Bay, including Howes and Goehringer (1996) and Sarda et al. (1995a,b).
[20] The Ecology of Buzzards Bay (Table 4.1; Howes and Goehringer 1996) provides a more comprehensive list of species than is listed here.

Biotic diversity depends on the size and location of substrate in rocky, coarse cobble, and mixed sand and gravel habitats. For example, large boulders or pilings provide stability to allow for colonization by barnacles. Smaller, lighter cobbles are moved more frequently by wave action, and tend to be more biologically barren than larger boulders. Generally, the upper intertidal rocky areas are dominated by barnacles (*Semibalanus balanoides* and *Balanus balanus*). Mid-intertidal areas are dominated by small mussels, green crabs (*Carcinus maenas*), dog whelks (*Nucella lapillus*), and periwinkles (*Littorina littorea*). Lower intertidal areas exhibit considerable free space with patchy mussel beds.

The subtidal areas of Buzzards Bay support populations of various shellfish species that are harvested for commercial and recreational purposes. Hard- and soft-shelled clams, scallops, and oysters are filter feeders. Hard-shelled clams or quahogs (*Mercenaria mercenaria*) inhabit sandy to mud/sand bottoms and, in addition to being the most widespread shellfishery in Buzzards Bay, are the most tolerant of short periods of stress such as low oxygen or deep burial. Soft-shell clams (*Mya arenaria*) are more susceptible to such stresses because they are not able to close their shells completely. As indicated by their name, the shells are also more fragile. This species is typically found in soft-bottom, organic sediments, and low-energy environments (such as protected harbors and inlets, and salt marsh creeks). Scallops (*Argopecten irradians*) live on top of the sediment ("benthic epifauna") rather than buried in the sediment ("infauna") like the aforementioned clams. Adult bay scallops are capable of moving by expulsion of water through the rapid contraction of their shells, and are most abundant in shallow embayments. Scallops have a relatively short life span (2 years) and spawn only once, typically in early summer. In order to grow, young oysters (*Crassostrea virginica*) require a hard substrate to settle, such as rocks or pilings. This species is not as abundant as the others mentioned here, but is found along the eastern shores of Buzzards Bay.

Aquatic Plant Community

The composition of aquatic plant communities in marine or estuarine habitats of the Buzzards Bay is dictated to a large degree by its hydrologic regime. Low marsh intertidal habitats are dominated by salt or heavily brackish water, and conditions favor one dominant species, the smooth cord grass (*Spartina alterniflora*). Since the high marsh is less frequently flooded, a wider variety of plants are established, including marsh hay (*Spartina patens*), spike grass, (*Distichlis spicata*), black needle rush (*Juncus gerardi*), and marsh elder (*Iva frutescens*).

The intertidal and shallow subtidal zone where marsh is not present is largely barren of aquatic plant cover. In some areas of the soft-bottom subtidal zone where sediments are constantly submerged and light penetrates to the bottom, aquatic plants such as eel grass (*Zostera marina*), widgeon grass (*Ruppia maritima*), green algae (Chlorophyta), brown algae (Phaeophyta), and red algae (Rhodophyta) may be present. Along shorelines with coarse substrate, macroalgae rather than rooted vascular plants may occur.

Wildlife Community

The intertidal and subtidal zones of Buzzards Bay ecosystem support a diversity of vertebrate terrestrial and semi-aquatic biota. Shorebirds dominate this group. The table below summarizes representative bird species that utilize shoreline habitats of Buzzards Bay. This summary is based upon project-specific wildlife reconnaissance surveys, general information from Christmas Bird Counts, SEANET Marine Bird Summaries, and published technical literature (Howes and Goehringer, 1996).

Since PAH and petroleum hydrocarbons do not biomagnify through the foodweb, their direct effect is to first order consumers (Eisler, 1987). Consequently, upper trophic level biota, including mammals and birds such as osprey and roseate terns, are unlikely to be affected by spill constituents through biomagnification under current conditions. These species are relatively uncommon in the sand/cobble beach and low marsh habitats. Theoretically, the bird species that would have the greatest potential exposure via sediment and/or shellfish ingestion pathways would be those that obtain the majority of their diet foraging in intertidal habitats, have relatively small foraging ranges, and have relatively high ingestion rates. Therefore, smaller shorebirds would have the greatest potential exposure compared to larger species such as great blue herons, common loons and common terns. Representative bird species that may be found in or along Buzzards Bay are listed below.

NAME		**SEASON**	**PRIMARY SHORELINE HABITATS**			
Common	**Scientific**	**B**reeding **M**igration **W**intering	**Sandy / Cobble Beach**	**Open Water**	**Rocky**	**Marsh**
American Black Duck	*Anas rubripes*	B/M/W		X		X
Brant	*Branta bernicla*	M/W		X		X
Bufflehead	*Bucephala albeola*	M/W		X		X
Canvasback	*Aythya valisineria*	M/W		X		X
Cormorant, Double-crested	*Phalacrocorax auritus*	B/M/W		X	X	
Cormorant, Great	*Phalacrocorax carbo*	M/W		X	X	
Dunlin	*Calidris alpina*	M	X			
Eider, Common	*Somateria mollissima*	M/W		X		X
Egret, Great	*Ardea alba*	B/M	X			X
Egret, Snowy	*Egretta thula*	B/M	X			X
Gadwall	*Anas strepera*	B/M/W		X		X
Gannet, Northern	*Morrus bassanus*	M/W		X		
Goose, Canada	*Branta canadensis*	B/M/W		X		X
Grebe, Horned	*Poduceps auritus*	M/W		X		X
Grebe, Red-necked	*Podiceps grisegena*	M/W		X		X
Gull, Bonapartes	*Larus philadelphia*	M/W	X	X	X	
Gull, Great Black-backed	*Larus marinus*	B/M/W	X	X	X	
Gull, Herring	*Larus argentatus*	B/M/W	X	X	X	
Gull, Ring-billed	*Larus delawarensis*	B/M/W	X	X	X	
Goldeneye, Common	*Bucephala clangula*	M/W		X		X
Heron, Black-crowned Night	*Nycticorax nycticorax*	B/M/W	X			X
Heron, Great Blue	*Ardea herodias*	B/M/W	X			X
Heron, Green	*Butorides virescens*	B/M/W				X
Killdeer	*Charadrius vociferus*	B/M	X			
Long-tailed Duck	*Clangula hyemalis*	M/W		X	X	
Loon, Common	*Gavia immer*	M/W		X		
Loon, Red-throated	*Gavia stellata*	M/W		X		
Mallard	*Anas platyrhynchos*	B/M/W		X		X
Merganser, Common	*Mergus merganser*	M/W		X		X
Merganser, Hooded	*Lophodytes cucullatus*	B/M/W		X		X
Merganser, Red-breasted	*Mergus serrator*	M/W		X		X
Oystercatcher, American	*Haematopus palliatus*	B/M	X		X	
Plover, Black-bellied	*Pluvialis squatarola*	M	X		X	
Plover, Piping	*Charadrius melodus*	B/M	X			
Plover, Semipalmated	*Charadrius semipalmatus*	M	X			
Razorbill	*Alca torda*	M/W		X	X	
Sanderling	*Calidris alba*	M	X			

NAME		SEASON	PRIMARY SHORELINE HABITATS			
Common	**Scientific**	**B**reeding **M**igration **W**intering	**Sandy / Cobble Beach**	**Open Water**	**Rocky**	**Marsh**
Sandpiper, Least	*Calidris minutilla*	M	X			X
Sandpiper, Purple	*Calidris maritima*	M/W			X	
Sandpiper, Semipalmated	*Calidris puscilla*	M	X			
Scaup, Greater	*Aythya marila*	M		X		X
Scoter, Black	*Melanitta nigra*	M/W		X		
Scotor, Surf	*Melanitta perspicillata*	M/W		X		
Scoter, White-winged	*Melanitta fusca*	M/W		X		
Shearwater, Sooty	*Piffinus griseus*	M*		X		
Swan, Mute	*Cygnus olor*	B/M/W		X		X
Tern, Common	*Sterna hirundo*	B/M	X	X		X
Tern, Least	*Sterna antillarum*	B/M	X	X		
Tern, Roseate	*Sterna dougallii*	B/M	X	X	X	X
Turnstone, Ruddy	*Arenaria interpres*	M	X		X	
Yellowlegs, Greater	*Tringa melanoleuca*	M/W	X		X	X
Willet	*Catoptrophorus semipalmatus*	B/M	X		X	X

* Sooty Shearwater breeds in Southern Hemisphere but is seen here during summer as migrant.

Upland species of small rodents might be expected to browse along the high marsh fringe foraging for various common insect species, with larger omnivorous mammals such as raccoons (*Procyon lotor*) and coyotes (*Canis latrans*) occasionally foraging for carrion along the water margin. Reptiles, such as northern diamondback terrapin (*Malaclemys terrapin*), do not commonly frequent the intertidal and nearshore subtidal habitats and consequently have little, if any, exposure to weathered oil.

4.2.2 Shoreline Segment Characterization

Because a mixture of shoreline and habitat types occurs within each study segment, a system of categorizing the relative environmental sensitivity of each segment was established. Segments with high proportions of state-designated priority habitats were identified as more environmentally sensitive segments. The presence and extent of priority habitats was an important criterion in selecting segments for further characterization in the Phase II CSA.

According to the MCP, environmentally sensitive areas include wetlands, surface water bodies, or marine habitats. Since the release occurred in the marine/estuarine ecosystem of Buzzards Bay and oil primarily stranded in salt marshes, beaches, and other marine habitats, the entire Site is considered an environmentally sensitive area. To determine whether distinctive environmental values might be present, such as salt marsh or habitat of rare or endangered wildlife, the following sources were consulted:

- Massachusetts Natural Heritage and Endangered Species Program (NHESP), Priority Habitats for State-Protected Species Data layer, (MASSGIS, 2006a);
- Massachusetts Wetlands Data layer (MASSGIS, 2006b); and
- Massachusetts Areas of Critical Environmental Concern (ACEC; MADCR, 2003).

It was confirmed that Priority Habitat of State-Protected Rare Species and/or Estimated Habitat of Rare

Wildlife occur on or are closely associated with many of the shoreline segments that comprise the current Site. Figures 1 through 14 identify the areas of individual shoreline segments that are designated as Priority Habitat. Priority habitat and/or salt marshes are associated with all segments selected for assessment in this ES. The approximate percentages of area designated as NHESP priority habitat are listed for the following segments.[21]

Approximate Percent of Shoreline Designated as Environmentally Sensitive Habitat (Approximation based on shoreline length)

Segment Name	Segment ID	Priority NHESP Habitat	Salt Marsh
Aucoot Cove	W1D-01	60%	60%
Strawberry Cove	W1E-02	100%	80%
Crescent Beach	W1E-04	<1%	20%
Brandt Island West	W1F-02	<1%	<10%
Mattapoisett Neck West	W1F-05	<1%	90%
Harbor View	W2A-02	<1%	80%
Pope's Beach	W2A-03	<1%	30%
Long Island and Causeway South	W2A-10	80%	<10%
West Island West	W2A-11	25%	<1%
Round Hill Beach West	W3A-05	100%	<1%
Barney's Joy (W of barbed)	W3C-03	100%	<1%
Barney's Joy (E of barbed)	W3C-04	100%	<1%

According to the ACEC Statewide Map (MADCR, 2003), no ACEC occur in the 63 shoreline and subtidal zone currently under review.

4.3 READILY APPARENT HARM DETERMINATION

In accordance with the MCP (310 CMR 40.0995(3)(b)(1)), an evaluation was conducted to determine whether conditions at the Site associated with the presence of spill-constituents represent "Readily Apparent Harm" to the environment. Those conditions evaluated were as follows:

1. Visual evidence of stressed biota attributable to the release at the disposal site, including, without limitation, fish kills or abiotic conditions;
2. The existence of oil and/or hazardous material attributable to the disposal site in concentrations which exceed Massachusetts Surface Water Standards promulgated in 314 CMR 4.00, which include U.S. EPA Ambient Water Quality Criteria applied pursuant to 314 CMR 4.05(5)(e); and
3. Visible presence of oil, tar, or other non-aqueous phase hazardous material in soil within three feet of the ground surface over an area equal to or greater than two acres, or over an area equal to or greater than 1,000 square feet in sediment within one foot of the sediment surface.

[21] *The percentages are based on the fraction of linear shoreline occurring within approximately 100 feet of these habitats. These segments have been selected for characterization and are considered to be representative of all other segments in the current Site. See Section 1.1 of this Appendix.*

The segments have been monitored and inspected since the B120 spill. No visual evidence of stressed biota or abiotic conditions attributable to the release have been observed following the completion of Unified Command cleanup activities. No fish kills occurred because of the release, and as of the end of June 2003, no oiled birds or other die-offs have been reported. No abiotic conditions exist currently or are expected to exist in the future at the shoreline segment being evaluated.

Spill-related constituents were detected in surface water immediately following the release. Constituent concentrations in surface water declined to near or below laboratory detection limits within weeks of the spill. Currently, spill-related constituents are undetectable in the surface waters of Buzzards Bay.

While residual weathered oil may be encountered sporadically at segments in the form primarily of limited rock splatter, with some highly localized discontinuous pavement/tarmats (approximately 4 inch pieces) and occasional small dime-sized tarballs, there are no areas of contiguous oiling equal to 1,000 square feet in sediment. Discontinuous surficial deposits of weathered oil have recently been observed at Segments W2A-03 (Pope's Beach) and W2A-10 (Long Island and Causeway South) in Fairhaven. Both segments have been the subject of recent IRA activities, as described below.

- Pope's Beach Intertidal Marsh. An IRA was conducted in the marsh area of this segment in early April 2006 to remove limited deposits of discontinuous surficial pavement/tarmats observed in the mid-intertidal zone of the marsh area. The weathered oil deposits were removed in such a manner so as to minimize damage to the underlying peat. On April 26, 2006, the LSP-of-Record, a senior ecologist, and representative of MADEP visited the area of cleanup and confirmed that the removal was successful and only scant remnants of residual weathered oil remain; and

- Long Island and Causeway South. A limited IRA cleanup consisting of exposing residual oil located beneath intertidal cobble to weathering was conducted in December 2005 size. This area was also subject previously to clean up activities conducted in 2004 and the area of remaining weathered oil is substantially less than 1,000 ft^2. Further clean up activities are planned for this segment as part of a Phase 3 program. The limited remnant weathered oil that remains in the intertidal cobble area tends to be fairly viscous, but is capable of being transferred by direct contact. Small foci of persistent sheen were encountered in tide pools in one of the areas targeted for further mitigation. While the potential for wildlife receptors to be exposed to these oil residuals exists, the hazard posed by these materials is likely to be minimal due to limited extent of areal distribution and the restricted access wildlife would have to these deposits. That notwithstanding, additional mitigation measures are planned to remove much of the remaining oil residue from this segment.

Based on the field work conducted at the Site and observations made over the last three years, it is concluded that a condition of Readily Apparent Harm does not exist.

4.4 CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERN

The COPEC associated with the B120 spill are PAH and extractable petroleum hydrocarbon (EPH) fractions that comprise No. 6 fuel oil. A detailed discussion of No. 6 fuel oil is presented in Section 3.2 of the Phase II CSA, Section 2.3 of this Appendix, as well as in the CSM (GeoInsight, 2005).

4.4.1 Identified COPEC

EPH fractions and PAH compounds identified as consistent with B120 oil were retained as COPEC in this assessment. COPEC include: C_{19}-C_{36} aliphatic hydrocarbons, C_{11}-C_{22} aromatic hydrocarbons, naphthalene, 2-methylnaphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.

4.4.2 Toxicological Effects of COPEC

PAH are a family of compounds that consist of a base structure of 2 to 7 fused 6-carbon rings onto which a variety of functional groups are substituted. The number of base rings and the variations in functional groups dictate the physicochemical behavior of the individual compounds. Generally, PAH compounds with fewer rings (less than 4), fewer substituted functional groups, and corresponding lower molecular weights tend to have greater water solubility and acute toxicity. They also tend to be noncarcinogenic. High molecular weight PAH (HPAH), those with 4 or more fused rings and more substituted functional groups, tend to be less acutely toxic, less soluble, but more highly carcinogenic (Eisler, 1987). MADEP has not established ecological screening benchmarks for EPH fractions in sediment. EPH fractions include groups of compounds and are divided by ranges and structure. For example, C_{11}-C_{22} aromatic hydrocarbons include hydrocarbon compounds with 11 to 22 carbons in an aromatic formation, which includes many of the target 17 PAH for which there are benchmarks. Because EPH fractions include oil spill-related PAH, total PAH screening benchmarks were used to evaluate potential risk associated with residual oil.

4.4.2.1 PAH Toxicity to Sediment Macroinvertebrates

Toxic effects of petroleum on sediment macroinvertebrates are attributed largely to the presence of low molecular weight PAH (LPAH) compounds, primarily in the C_8 to C_{14} carbon range. In addition to adversely affecting reproduction and survival, PAH compounds are known to affect emergence, mobility, behavior, growth, and respiration rates of various species of aquatic organisms. There are vast differences in the magnitude of toxicity to PAH among species. For example, crustacea are relatively sensitive, polychaete worms are moderately sensitive, and fish are relatively insensitive to PAH exposure (Neff, 1979; Eisler, 1987). PAH are known to bioaccumulate in shellfish tissues, because these organisms cannot readily metabolize these compounds (Eisler, 1987).

4.4.2.2 PAH Toxicity to Vertebrate Wildlife

Fish, birds, and mammals do not bioaccumulate PAH because they are able to metabolize these compounds quickly (Eisler, 1987). However, exposure at high doses can be lethal. In fish, sublethal toxicity is often manifested in retarded growth and development, impaired reproduction, reduced immunocompetence, and an increased frequency of tissue lesions and noncancerous and cancerous tumors. Sublethal PAH exposure in birds has been demonstrated to result in impaired reproduction and growth, as well as a variety of metabolic effects. Information on avian impacts is largely based on bird embryo studies. The effects of PAH on mammals have been well documented in laboratory animals. Target organs adversely affected by PAH exposure include the blood, skin, intestine and mammary gland. Certain PAH are also known carcinogens in mammals (Eisler, 1987; Albers, 1995). There is limited information on biological effects of PAH on marine reptiles. However, PAH exposure has been linked to depressed reproduction and growth, and increased incidence of tumors and cancer.

4.4.2.3 PAH Toxicity to Plants

Plants are known to be sensitive to PAH. Plants have the ability to absorb PAH through their roots and translocate the chemicals to shoots or leaves (Greenberg, 2003). Accumulation of PAH in plant tissue may result in limited primary productivity, and impaired growth and development. PAH absorb sunlight and can act as photosensitizing agents, thereby increasing toxicity dramatically in the host plant. However, PAH are generally only phytotoxic at high concentrations, and the LPAH compounds, such as naphthalene, are mostly acutely toxic. A key mitigating factor in plant uptake and toxicity is the presence of humic acids in the soil. Humic acids present in organic-rich soils tend to bind PAH, limiting its bioavailability and mitigating PAH toxicity. Low concentrations of PAH in No. 6 oil as well as minimal solubility of these compounds also help mitigate these concerns under the current circumstances.

4.4.2.4 Toxicity of Oil Sheens to Aquatic Life

The sea-surface microlayer (SML) provides a habitat for a diverse neuston population, including bacteria, protozoa, microalgae, small metazoa, and certain marine biota lifestages, mainly fish/shellfish eggs and larvae (Hardy, 1999; Wurl and Obbard, 2004). It also represents an entry point, as well as a sink, for pollutants in the marine environment. The soluble fraction of residual oil that spreads across surface water in thin films is known as a sheen. The thickness, viewing angle, and sunlight all contribute to the color of the sheen, but in general, lighter compounds spread into the sheen that is typically a few microns thick.

Oil sheens have the potential to be toxic to some aquatic life. Price et al. (1994) demonstrated this in a study of oil released to the Persian Gulf during the 1991 Gulf War. In that report, concentrations of spill-related constituents in the SML proved to be significantly toxic to aquatic receptors, whereas underlying subsurface water was not toxic. The authors hypothesized that the SML toxicity was likely due to a combination of petroleum hydrocarbons and heavy metals occurring in the SML.

4.5 CONCEPTUAL EXPOSURE MODEL

In the context of an ecological screening, a conceptual exposure model (CEM) may best be defined as a written description of the known, expected, and/or predicted relationships between COPEC detected at a site and the ecological receptors. A CEM depicts the current knowledge of the Site under evaluation. The model identifies the environmental media of concern, ecological receptors and the exposure pathways between them.

4.5.1 Environmental Media of Concern

In the three years following the B120 release, significant remedial and monitoring efforts have been completed, resulting in a substantial reduction in the nature and extent of residual oil left along the shoreline. These mitigation measures are described in Section 4.0 of the Phase II CSA. This, combined with natural scouring and weathering processes of the wind, sun, weather, and tidal action, have further degraded any oil remaining in these segments (GeoInsight, 2005). Residual B120 oil at the Site is best characterized as highly sporadic. Remnant residual oil is visible at only a few segments, and only within very limited areas of those segments. The weathered oil observable along shoreline segments primarily occurs in the form of small (quarter-size to 4 x 4 inch) hardened splatter on rocks, with some fragmented remnants of pavement/tarmats in a couple of intertidal marsh areas, and occasional small tarballs.

Surface Water. COPEC in surface water were studied intensively in the weeks following the B120 spill. As shown in Table 5, COPEC concentrations in surface water declined to near or below laboratory detection limits within weeks of the spill. Currently, there are no detectable concentrations of spill-related constituents in surface water. Therefore, the surface water of Buzzards Bay is not an environmental media of concern.

Intertidal and Subtidal Sediments. The bulk of the oil that washed ashore stranded in the intertidal regions of the coast, particularly on southwest facing sides of peninsulas. A minor portion of the oil stranded along the intertidal zone may have become entrained with sand or silt, resuspended by wave action and tidal movement, and deposited in the sediments in the nearshore subtidal zone immediately adjacent to the shoreline. Therefore, sediments within the intertidal and subtidal zones are environmental media of concern.

While much of the oil stranded ashore has degraded and only residual components (e.g., PAH) remain in sediment, highly localized deposits of residual highly weathered oil has also been encountered sporadically in the intertidal zone of a limited number of shoreline segments. This weathered oil occurs primarily in the form of limited rock splatter (one to two centimeter diameter), discontinuous pavement/tarmat remnants, or infrequent small tarballs may be encountered sporadically in the intertidal zone. Typical rock splatter occurs as thin dime-sized deposits of hardened weathered oil on protected rock surfaces. Splatter is difficult to chip loose and does not adhere to the skin. Tarmats, tarballs, and pavement are mostly weathered and hardened pieces of oil with grains of sand mixed into the outer matrix. When broken up, some pieces may have a tacky interior. Given the highly limited distribution of these materials and lack of bioavailability, weathered oil is not considered an environmental medium of concern, but rather a component of the intertidal sediments of an affected segment. Separate phase lightly weathered deposits of viscous residual oil has been encountered in interstices of intertidal cobble in a limited portion of Hoppy's Landing (Long Island and Causeway South segment). Occasional persistent sheening has been observed in a limited number of small tidal pools where the viscous residual oil has been occurs.

Biota Tissue. Vertebrate wildlife, such as American oystercatchers, frequent the intertidal zone of Buzzards Bay to forage for a variety of macroinvertebrate prey. It is not feasible to conduct a comprehensive analysis of COPEC in intertidal prey species in this Stage I ES. For the purposes of this screening, shellfish were selected to serve as a reasonable and representative prey item for an avian wildlife species that forage in the intertidal zone. As discussed in Section 2.1.4, PAH are known to bioaccumulate in shellfish tissues because these organisms cannot readily metabolize these compounds. Therefore, total PAH concentrations detected in shellfish collected along shoreline segments affected by the B120 release serve as reasonable worst-case exposure points for these wildlife species.

The most current total PAH concentrations detected in shellfish collected along shoreline segments affected by the B120 release did not differ statistically from those collected in unaffected areas as discussed in Section 2.1.4 (see also Attachment III, Table 7). Further, these data indicate that total PAH levels in these shellfish were comparable to pre-spill PAH residue concentrations as documented in the Mussel Watch data set for the region (NOAA, 2006, see Table 8). On this basis, it is concluded that shellfish and other aquatic macroinvertebrates do not represent a significant exposure risk to aquatic and semi-aquatic receptors. To be conservative, a screening of potential exposure via the food web on two prominent intertidal foraging shorebirds was conducted (Section 4.6.1.3) in order to confirm this conclusion.

4.5.1.1 COPEC in Environmental Media of Concern

COPEC have been detected primarily in intertidal sediments. Visible, weathered oil in the form of splatter, tarballs, or tarmat is sporadically found within the intertidal zone. However, based on its physical condition and very sparse distribution, it is not considered an environmental medium of concern. COPEC have not been detected in surface water since shortly after the actual spill in 2003. Intertidal/subtidal sediments and deposits of weathered oil have been identified as environmental media of concern. The presence of all detected PAH were conservatively assumed to be attributable to the B120 oil spill except for those sediment samples eliminated from further evaluation based on forensic analysis as discussed below.

4.5.1.2 Local Conditions

The technical literature is replete with documentation of natural and anthropogenic sources of PAH to the environment, particularly to aquatic sediments (Brown and Weiss, 1979; Eisler, 1987; McElroy et al., 1989). Likewise, petroleum hydrocarbons are also common constituents encountered in coastal waters, particularly in areas used by maritime shipping and other commercial and recreational vessels. Numerous other regional and local sources also contribute COPEC to the ecosystem. Major anthropogenic sources of these constituents to maritime sediments include direct discharges from oil spills, municipal water treatment plants, industrial facilities, and stormwater runoff, as well atmospheric deposition from stationary and mobile combustion sources.

Buzzards Bay has a well-documented maritime, industrial, and municipal development history. In additional to Buzzards Bay being a major coastal maritime shipping lane, it is bounded by numerous municipalities, as well as a number of current and historical industrial facilities. It is important to understand that not all PAH and petroleum hydrocarbons detected in environmental media of Buzzards Bay are attributable to the B120 fuel oil spill.

Advances in forensic chemical analysis have made it possible to identify sources of petroleum, as well as sources of petroleum and non-petroleum PAH, based on detailed compositional analysis. The pattern and proportion of PAH compounds convey a chemical signature (fingerprint) such that the source can be identified as pyrogenic (combustion), petrogenic (petroleum), or a combination of the two. It is also possible to differentiate petroleum sources using PAH patterns between sources, as well as differentiate various pyrogenic sources as well. B120 fuel oil has a distinct PAH and petroleum hydrocarbon fingerprint (Appendix G).

Several sediment samples collected at shoreline segments were found to exceed screening benchmarks (Effects Range-Low [ER-L]; Long and Morgan, 1990; Long et al., 1995) and were submitted for forensic analysis to assess the presence of B120 oil. If the source of PAH in the sample was determined to be petrogenic, and with a signature consistent to B120 oil, then that sample was retained in the risk characterization dataset. If analysis determined that the PAH are present due to pyrogenic sources or petroleum sources inconsistent with the B120 fingerprint, that sample was excluded from the risk characterization dataset. A detailed forensic evaluation of the sediment samples evaluated in the assessment is provided in Appendix G.

4.5.1.3 Exposure Point Concentrations of COPEC

Sediment samples from the intertidal and subtidal zones of selected shoreline segments have been analyzed and results have been compiled in Table 20.

4.5.2 Ecological Receptors

Intertidal and subtidal sediments were identified as the environmental media of concern. The most sensitive ecological receptors that directly contact COPEC in that medium are marine macroinvertebrates living in (infauna) and/or on top of the sediment (epibenthic fauna). These receptors include molluscs (e.g., clams, snails), marine worms (e.g., polychaetes), and crustacea (e.g., crabs), among others. These organisms inhabit the intertidal and subtidal zones.

Salt marsh grass (*Spartina alterniflora*) is considered potentially exposed and therefore a sensitive receptor due to the fact that the root systems of these plants may come in direct contact with COPEC in the sediments of the intertidal zone.

Small shorebirds that frequent the intertidal zone of affected shoreline segments are not considered to be sensitive ecological receptors at affected segments on the basis that COPEC concentrations detected in local shellfish are consistent with ambient levels found elsewhere in Buzzards Bay. A simplistic screening was performed to ensure that these receptors are not likely to be affected by spill-related constituents.

4.5.3 Exposure Pathways

Benthic and epibenthic macroinvertebrates are exposed to sediments (and thus potential PAH in sediment) via direct contact and through incidental ingestion. COPEC can be taken up by the root systems of marsh plants through direct contact with sediment. If comparisons of suitable ecological screening benchmarks with COPEC sediment concentrations indicate that these constituents might pose a hazard to benthic or epibenthic organisms or semi-aquatic plants, then the potential risk to higher trophic levels will be evaluated in a Stage II ERC.

4.6 ECOLOGICAL RISK CHARACTERIZATION

As stated previously, the purpose of a Stage I ES is to eliminate from further evaluation those situations in which either: (1) the exposures are unlikely to result in environmental harm; or (2) those exposures where environmental harm is readily apparent. In Section 4.3, it was determined that there are no areas of Readily Apparent Harm. Therefore, this screening-level ecological risk characterization is focused on determining whether any spill-related COPEC exposures are likely occurring that have the potential to cause environmental harm.

In previous sections of this Stage I ES, available evidence was evaluated to determine if ecological receptors are likely to be currently exposed to B120 release-related COPEC. It was determined that a potentially complete exposure pathway exists between the COPEC detected in the intertidal and subtidal sediments and two sensitive ecological receptor groups (benthic macroinvertebrates and salt marsh grasses). The following sections present the ecological effects-based screening that was conducted to determine whether those identified pathway(s) might pose an unacceptable risk of harm to the ecological receptors.

The effects-based screening involves comparison of sediment constituent concentrations to appropriate benchmarks to determine whether complete exposure pathways may need more defined quantification of risks in a Stage II ERC. The potential that COPEC detected in Site environmental media may pose unacceptable risks to sensitive ecological resources under existing conditions were qualitatively evaluated using an environmental effects quotient (EEQ) approach. This method allows the risk manager to determine whether the presence of a COPEC in a given environmental medium within specific areas of interest at a site poses a potential risk to ecological receptors. Further, it allows one to consider the relative level of that potential risk using a numeric index.

An EEQ is calculated by dividing a media-specific exposure point COPEC concentration by its associated constituent- and media-specific ecotoxicity benchmark concentration. EEQ values were calculated for environmental media and a representative wildlife species using the following equations:

$$EEQ = \frac{\text{Media Concentration (mg/kg)}}{\text{Benchmark Screening Value (mg/kg)}}$$

In each case, the calculated EEQ was evaluated according to the following protocol: an EEQ of less than 1.0 is considered to be of "no significant risk," an EEQ greater than 1.0 indicates some potential ecological risk to the average individual within the local population. When the EEQ indicates that the average individual is not at significant risk, then it is considered likely that adverse effects on the local population are unlikely (NRC, 2001).

4.6.1 Effects-Based Screening

Exposure point concentrations (EPC) represent the concentration of a COPEC at a given location where an ecological receptor might be exposed while in contact with environmental media at the Site. Since this Site is comprised of miles of shoreline, composite samples representative of small intertidal and subtidal areas (<1,000 ft^2) were used to conservatively represent individual EPC. Two different types of sediments were collected; intertidal (including marsh) and subtidal. These analytical data are summarized in Tables 4a through 4c. In the effects-based screening analysis, these EPC were compared to conservative receptor-specific screening benchmarks, which are discussed below.

4.6.1.1 Screening Benchmarks

The environmental media of concern in this Stage I ES are intertidal and subtidal sediments. Consistent with U.S. EPA (2005c) and MADEP (2006b) guidance, these regularly-inundated, tidally-influenced hydric soils were evaluated using screening benchmarks appropriate for marine/estuarine habitats. The following benchmarks were used to assess whether ecological receptors exposed to spill-related constituents are at potential risk of harm. These benchmarks were developed by Long and Morgan (1990) represent the 10th percentile of concentrations at which exposure resulted in some measurable or observable effect in benthic organisms. Therefore, these benchmarks are considered conservative measures of potential ecological risk.

Phytotoxicity Benchmark for *Spartina*

Currently there are no established ecological benchmarks to estimate the toxicity of B120 spill-related compounds in sediment on marine wetland salt grasses (e.g., *Spartina alterniflora*). *Spartina* is a hardy, robust plant that thrives under highly stressful (physical and chemical) conditions. Use of available phytotoxicity benchmarks based on the available laboratory literature (i.e., fragile lettuce seed germination/root elongation test model) is inappropriate for evaluating potential chemical toxicity for this native grass. MADEP (2006b) has recently recommended using the ER-L sediment benchmark as a suitable value for the evaluation of potential adverse impacts of PAH on marine/estuarine aquatic and semiaquatic plants. There are no published phytotoxicity screening values for EPH fractions.

In an effort to confirm the suitability of using ER-Ls to screen for potential phytotoxic effects on salt marsh grasses and to derive a suitable screening tool for EPH, relevant literature was reviewed to characterize the sensitivity of this plant species to oil-spill related COPEC. The objective of the studies cited below was to evaluate the efficacy of using *Spartina* in oil-contaminated wetland restoration/phytoremediation. Although these studies do not provide a highly refined toxicity threshold benchmark, they do provide a realistic and reasonably conservative tool to evaluate potential impacts to shoreline grasses affected by the B120 spill.

Lin et al. (2002) conducted studies to evaluate the potential for using Spartina to phytoremediate oil-contaminated sediments. *Spartina* seedlings were grown in soil spiked with varying concentrations of No. 2

fuel oil. Performance metrics including plant stem density, shoot height, evapo-transpiration (ET) rate, above-ground biomass, and below-ground biomass were measured. The investigators concluded that S. alterniflora could be transplanted in oil-contaminated sediments containing up to 171,000 parts per million (mg/kg; ppm) total petroleum hydrocarbons (TPH) of No. 2 fuel oil for the purpose of phytoremediation and habitat restoration. While overall restoration efficiency may be reduced at these levels, lower concentrations of No. 2 fuel oil (7,000 - 14,000 ppm TPH; 368 - 735 ppm total PAH) actually stimulated plant growth and increased ET rates.

Bergen et al. (1996, 2000) conducted field studies in conjunction with a large-scale restoration of *Spartina* in salt marshes heavily impacted by No. 2 fuel oil. In the study, *Spartina* seedlings were planted in salt marsh soils with a mean TPH concentration of 17,534 ppm; percent plant cover, stem height, stem density, flower density, rhizome spread, basal area of individual plants, above-ground biomass and below-ground biomass were measured. Bergen et al. (1996) reported that vegetation monitoring parameters increased at restored sites in the two years following the planting and both studies report that oil concentrations did not limit the survival or growth of S. alterniflora seedlings. While these studies did not report PAH values for the No. 2 fuel oil used, it is reasonable to assume that PAH concentrations were comparable with the Lin et al. (2000) study.

Although the OHM at this Site is No. 6 fuel oil and the studies discussed above evaluated No. 2 fuel oil, the results are considered applicable because No. 2 fuel oil is considered to be more acutely toxic to plants due to its relatively higher concentrations of LPAH, particularly naphthalene. The minimum concentrations of oil constituents in sediment cited in the above studies are 7,000 ppm TPH and 368 ppm total PAH, which are higher than concentrations detected in sediment samples collected from Buzzards Bay. At these concentrations, no inhibition of growth or survival of *Spartina* was observed. Based on this evaluation, it is concluded that the use of the ER-L for total PAH as a screening benchmark for potential phytotoxicity to salt marsh grasses is highly conservative. The derived screening value for TPH (7,000 ppm) will be used to assess potential risks to these intertidal plants for all other B120 spill related constituents.

Toxicity Benchmark for Intertidal/Nearshore Subtidal Sediment Macroinvertebrate Biota

NOAA's National Status and Trends Program developed sediment screening benchmarks in the early 1990s. The Effects Range approach developed using the results of an extensive database of whole sediment toxicity studies (Long and Morgan, 1990). These sediments were collected from major waterbodies around the U.S. where a range of chemical contaminants co-occurred in the samples. A variety of benthic infaunal and epibenthic test organisms were evaluated, including various amphipods and bivalve larvae. These species are sensitive to the dissolved chemicals in porewater. Effects Range – Median (ER-M) and Effects Range – Low (ER-L) benchmarks are screening values developed by that program that have been widely accepted in the scientific and regulatory community as benchmarks used to screen constituent concentrations in sediment. To be conservative, the ER-L benchmark was used to assess potential risk. These values represent the 10^{th} percentile of concentrations at which exposure resulted in some measurable or observable effect in benthic organisms. Because ER-Ls were developed for many types of organisms exposed to whole sediment, including porewater, potential toxicity associated with COPEC concentrations in sediment porewater is directly addressed using this benchmark. The ER-L benchmark is recommended by MADEP as a conservative screening for marine and estuarine sediments and MADEP considers ER-Ls to be a suitable threshold below which there is little potential for biologically significant harm to benthic receptors (MADEP, 2006b).

Besides the major PAH compounds typically evaluated in sediments, there are dozens of alkylated naphthalene, phenanthrene, fluorene, chrysene, benzothiophene homologs that commonly occur in petroleum distillates, including No. 6 fuel oil. Many of these derivatives have not been well characterized toxicologically. It is important to note that, while other alkylated PAH homologs are present in No. 6 fuel oil, these other alkylated PAH will not be specifically evaluated because the risk-based toxicity benchmarks were established for 13 PAH using data from "whole oil" release sites. At the release sites where the toxicological benchmarks were established, analyses of these target PAH were conducted to quantify the threshold for observed ecological risk. These PAH are considered to be indicators of potential risk for the range of PAH that are likely to be present in a fuel oil release. Risk-based toxicity benchmarks are not established for the other alkylated PAH, therefore direct evaluation of these alkylated PAH will not be conducted in this assessment. It is appropriate and suitably conservative to use the ER-L for total PAH as the screening benchmark to address these B120 oil constituents.

Toxicity Reference Value (TRV) for Avian Receptors

A TRV is the concentration of a chemical in water, food, or the tissues of a receptor that will not cause toxicity to receptors of concern. Ideally, TRVs are derived from chronic toxicity studies in which an ecologically relevant endpoint was assessed in the species of concern, or a closely related species.

For avian species, two relevant studies on toxicity of PAH were found in the literature. In the first study, mallard ducks were exposed to graded dose concentrations of No. 2 fuel oil (0%, 0.25%, 0.5%, 1.0%, and 1.5% in feed) for 100 days, with the additional stresses of saline drinking water and cold (3°C) for 50 of the 100 days (Holmes et al., 1979). The authors reported that aromatic hydrocarbons comprised 38% of the No. 2 fuel oil. Therefore, the TRV for birds is calculated based on the amount of aromatic hydrocarbons in the diet. At 1% No. 2 fuel oil, adverse effects were observed including an increase in mortality. The NOAEL was 0.5% No. 2 fuel oil (or 380 mg PAH/kg/d).

In the second study, mallard ducks were exposed to diets containing either 400 or 4,000 mg/kg of aromatic hydrocarbons, including PAH for 210 days (Patton and Dieter, 1980). Conversion of concentrations in diet to a daily dose in this mallard study was based on a body weight of 1 kg and a food consumption rate of 0.1 kg/d (Sample et al., 1996). The No-Observed-Adverse-Effects-Levels (NOAEL) for the feeding study occurred in the 400 mg/kg in feed (or 40 mg/kg/d) treatment in the 210 day study. At 4,000 mg/kg in feed (or 400 mg/kg/d), mild adverse effects were observed including increased liver weight and an increase in hepatic blood flow.

Since the No. 2 fuel oil study primarily evaluated mortality and was not carried out for as long as the study by Patton and Dieter (1980), the latter study was used as the basis for the chronic NOAEL (40 mg/kg/d). It is recognized that the results from these studies are confounded by the unknown contribution of toxicity from chemicals other than PAH. For the purpose of this screening, a TRV for PAH derived for avian receptors of concern is based on a chronic toxicity to mallards (40 mg/kg/d). In order to address the uncertainty associated with extrapolating toxicity effects from the mallards used in the study to shorebird species, an uncertainty factor of 5 was applied, resulting in a TRV for avian receptors of 8 mg/kg/d.

4.6.1.2 Benchmark Screening of Environmental Media

Salt Marsh Grasses

Shoreline segments under evaluation were inspected for visual signs of stressed vegetation. No evidence of spill-related stressed vegetation was observed. Recently implemented IRA field programs have removed most of the known residual deposits of weathered oil from the intertidal salt marsh grass areas. The phytotoxicity threshold concentration at which no observable effect occurred in studies described in Section 4.6.1.1.1 is 7,000 ppm TPH and 368 ppm total PAH. The benchmark recommended by MADEP to screen for potential phytotoxic effects of PAH is the ER-L (4.022 ppm, total PAH). The maximum total PAH concentrations detected in marsh sediment collected from the Site are less than 4 ppm. Petroleum hydrocarbon fractions were detected in marsh sediment at a maximum concentration of less than 300 ppm (Table 4c).

EEQ for TPH = $\dfrac{\text{Media Concentration at the Site}}{\text{Benchmark Value}} = \dfrac{300\text{ ppm}}{7{,}000\text{ ppm}} = \ll 1$

EEQ for total PAH ER-L = $\dfrac{\text{Media Concentration at the Site}}{\text{Benchmark Value}} = \dfrac{1.7\text{ ppm}}{4.022\text{ ppm}} = <1$

EEQ for total $PAH_{Spartina}$ = $\dfrac{\text{Media Concentration at the Site}}{\text{Benchmark Value}} = \dfrac{1.7\text{ ppm}}{368\text{ ppm}} = \ll 1$

The threshold for adverse impacts to salt marsh grasses are not exceeded as evidenced by EEQ's for that ecological receptor of less than 1. This indicates that concentrations of COPEC detectable in shoreline sediment do not pose a toxicological hazard to the growth or survival of marsh grasses. Since the majority of deposits of surficial weathered oil in salt grass areas along the shoreline segments have also been removed, no spill-related physical barriers to plant growth currently exist in the shoreline segments. Therefore, based on this analysis and on extensive field reconnaissance, current and future foreseeable conditions do not pose a risk of harm to this receptor group.

Aquatic Macroinvertebrates and Fish

Since concentrations of spill-related constituents are currently below detection limits in the water column (i.e., detection limits are significantly below U.S. EPA Marine Ambient Water Quality Criteria [2004b]), this exposure pathway is considered incomplete.

Benthic and Epibenthic Macroinvertebrates

ER-L screening benchmarks for individual PAH compounds and total PAH were used to evaluate potential sediment toxicity associated with spill-related PAH constituents. Individual ER-L values have been developed for 13 PAH compounds.

The concentrations of PAH compounds in the sediment samples presented in Table 20 were less than ER-L values and many were below detection limits. Because these PAH concentrations were less than the ER-L values, all EEQ are less than 1, demonstrating that concentrations of COPEC in the intertidal and subtidal sediments of Buzzards Bay do not pose a hazard to benthic and epibenthic invertebrates. Therefore, current and future foreseeable conditions do not pose a risk of harm to this receptor group.

4.6.1.3 Higher Trophic Level Biota

PAH do not bioaccumulate in upper trophic level biota because those species have sufficient enzyme systems to degrade those compounds. Shellfish collected in initially oiled reaches of shoreline do not have PAH body burdens of PAH that differ significantly from samples collected in unaffected areas of Buzzards Bay. Likewise, since stranded oil deposited on the intertidal zone of affected segments of the shoreline has been removed during the IRAs implemented subsequent to the spill, risk of exposure by vertebrate biota due to direct contact with the sporadic remnant weathered oil that might remain is and will be minimal.

To be conservative, an additional screening was conducted to confirm that local semi-aquatic bird species are not currently (or in the foreseeable future) at risk of harm as a result of the B120 spill. Based on the current distribution of residual oil, the primary exposure pathway into the food web would be through benthic or epibenthic invertebrates in intertidal habitats associated with measurable concentrations of COPEC. Assessment of this exposure route focused on shorebirds since they may heavily utilize the intertidal zone, are secondary consumers in the Site area and have relatively high ingestion rates relative to body size. These attributes contribute to a conservative estimate of exposure for these ecological receptors. Since birds and mammals metabolize PAH relatively quickly, the greatest potential exposure from the food web would be to the secondary consumers that feed directly on prey in contact with oil. The exposure route to tertiary consumers would be reduced relative to secondary consumers due to the varied feeding strategies, extensive foraging ranges, and the relatively rapid metabolism of PAH in higher trophic levels.

Therefore, this assessment focused on relatively small shorebirds that frequently occur along Buzzards Bay shorelines and feed on intertidal benthic invertebrates (Piping plover) or shellfish (American oystercatcher). Critical parameters necessary for calculating the potential exposure risk for these organisms are body weight (BW) and food ingestion (FI) rate. Previous studies of Piping plovers (Wilcox, 1959) and American oystercatchers (Nol et al., 1984) were used to estimate mean BW values of 0.06 kg and 0.60 kg, respectively. FI rates were calculated based on previously described allometric scaling equations (Nagy, 1987). FI rates for Piping plovers and American oystercatchers were estimated to be 0.0065 kg/day and 0.0367 kg/day, respectively.

Assessment of the exposure route to shorebirds focused specifically on sediment concentrations in sand or sand/gravel habitats, and shellfish concentrations to assess ecological exposure via the food web. The birds were assumed to obtain 100% of their diet from the intertidal habitat of the affected shoreline segment with the highest measured sediment concentrations of spill-related COPEC (Popes Beach, W2A-03; Table 20). To be conservative, the maximum detected concentration (1.682 mg/kg total PAH) was used as the exposure point concentration (EPC) to evaluate exposures to the plovers. The highest total PAH residue concentration detected in shellfish (0.186 mg/kg total PAH; Table 7) during the most recent surveys was used as the EPC in the evaluation of potential oystercatcher exposures. Since site-specific tissue concentrations were not available for intertidal benthic invertebrates, tissue concentrations were extrapolated from measured sediment concentrations using a literature-based bioaccumulation factor (BAF). Specifically, the BAF was calculated as the upper 95% confidence limit of the maximum observed BAF from four pertinent studies on PAH concentrations in sediments and benthic invertebrates (Klosterhaus et al., 2002; Landrum et al., 2002, Schuler et al., 2003; Weston and Mayer, 1998). This resulted in a BAF of 9.4, which was multiplied by the sediment concentration to estimate the intertidal macroinvertebrate tissue concentration of 15.81 mg/kg. It should be apparent from the methodology used to calculate the BAF that this estimate is extremely conservative and should not be used to estimate benthic invertebrate tissue concentrations in more sensitive analyses. However, the conservative nature of this estimate is appropriate for the current analysis.

The PAH concentration in the diet was converted to a daily dose based on the daily ingestion rate relative to body weight (Sample et al. 1996). A summary of the input parameters used for this screening assessment is presented in the table below.

EEQs for both avian receptor species, calculated using the maximum daily dose and TRV values, are well below one, indicating that the maximum modeled exposures to spill-related COPEC do no exceed toxicity thresholds. On this basis, it is concluded that the B120 spill poses no increased risk of harm to avian biota that inhabit or frequent Buzzards Bay.

Summary Of Input Parameters For PAH Risk Screening Of Shorebirds

PARAMETER	VALUE	
	Piping Plover	**American Oystercatcher**
Mean body weight (kg)	0.060	0.600
Daily ingestion rate (kg)[1]	0.0065	0.0037
Literature-based Chronic NOAEL (mg/kg-day)	40	40
Uncertainty factor (Interspecies)	5	5
Project-specific NOAEL (mg/kg-day)	8	8
Maximum concentration in prey item (mg/kg)	15.81[2]	0.186[3]
Estimated maximum daily dose (mg/kg-day)[4]	1.71	0.001
EEQ	0.2	<0.1

[1]*Food ingestion rates estimated using allometric scaling recommended by Nagy (1987).*

[2]*Incorporates bioaccumulation factor of 9.4 and upper 95% CL total PAH concentration for shoreline segment where highest PAH detections were encountered (Popes Beach, W2A-03).*

[3]*Maximum shellfish tissue total PAH concentration detected in recent shellfish survey of shoreline segments (Table 7).*

[4]*Estimated maximum daily dose =* $\dfrac{\textit{daily ingestion rate * maximum concentration in prey}}{\textit{body weight}}$

4.6.2 Potential for Direct Contact with Separate Phase Residual Oil

Due to the highly weathered nature of residual oil that occurs in the form of rock splatter, small tar balls, and fractured pavement/tarmats, the potential for direct contact exposure by ecological receptors with COPEC in these materials is limited. The potential for direct contact exposure does exist where less weathered deposits of viscous residual oil or persistent oil sheens might occur in the intertidal zone. Viscous oil has been observed in a limited area of intertidal cobble at the tip of Hoppy's Landing (a portion of Long Island and Causeway South segment W2A-10). Occasional small foci of persistent sheening has been observed in association with those deposits of viscous residual oil. On this basis, a condition of NSR to the environment cannot be concluded for this shoreline segment at this time.

Current conditions in Buzzards Bay do not support the generation of significant spontaneous B120-related oil sheens elsewhere. While sheening has been observed in a highly localized area of Leisure Shores (a portion of the Brandt Island West segment W1F-2), this condition does not spontaneously occur. Rather, it arises only when the sediment of limited area of gravel beach is vigorously agitated. The sheen dissipates when it contacts a rising tide. Bulk sediment chemistry analyses of these sediments intertidal sediments confirms that the concentrations of PAH are below ER-L screening levels. On this basis, a condition of NSR to the environment is concluded for this shoreline segment.

4.6.3 Comparison To Applicable or Suitably Analogous Standards

4.6.3.1 Massachusetts Surface Water Quality Standards

Massachusetts Surface Water Quality Standards (314 CMR 4.00) designates the most sensitive uses (such as swimming, shellfishing) for each waterbody, and prescribes the minimum water quality criteria required to support the designated uses. The coastal waters of southeastern Massachusetts are designated as Class SA, indicating that these waters are "excellent habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation." Also, when shellfish beds are approved for harvesting, the shellfish can be collected without depuration.

The primary qualities typically attributed to waters designated as Class SA are summarized below:

- Dissolved oxygen levels not less than 6.0 mg/L;
- Maximum temperature should not exceed 85°F (29.4°C) or a daily mean of 80°F (26.7°C);
- pH levels range between 6.5 through 8.5 standard units;
- No floating, suspended and settleable solids, color, or turbidity at levels that would impair use, cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom;
- No oil and grease and petrochemicals; and
- No taste or odor other than of natural origin.

None of these water quality parameters are compromised due to the release of B120 oil either currently or in the foreseeable future.

4.6.3.2 Massachusetts Wetlands Protection Act

The Massachusetts Wetlands Protection Act (M.G.L. ch.131, s. 40) was enacted in 1963 with the purpose of protecting wetlands and associated areas from the pressure of development. The act prohibits filling, excavation, or other alteration of the land surface, water levels, or vegetation in wetland resource areas without a permit from the local Conservation Commission. Although mitigation measures to remove stranded oil have been implemented in intertidal areas of coastal marshes, no significant removal of marsh peat or sediment has occurred under the MCP IRA. Tarmats, pavement, and other stranded oil deposits were removed from the marshes by hand as part of ongoing IRA activities in order to minimize impacts to the marsh peat layer. Heavy construction equipment, chemical solvents, or high pressure water were not used during the IRA phase of the marsh cleanup in order to preserve this sensitive natural resource.

4.6.3.3 Upper Concentration Limits

The Upper Concentration Limits (UCL) presented in the MCP have been promulgated for soil and ground water for a number of OHM substances. UCL that are potentially applicable for this release is the UCL for non-aqueous phase liquid (NAPL) thickness of ½ inch in an environmental media. Although small amounts of weathered residual oil splatter may be present in some shoreline areas, the splatter is discontinuous, less than ½ inch thick, and does not constitute a UCL exceedence.

4.6.4 Discussion of Criteria

The following criteria were addressed briefly in the discussion of methodology. According to the MCP (310 CMR 40.0995), these criteria must be met in order to conclude that a condition of No Significant Risk of harm to the environment exists or has been achieved.

4.6.4.1 No evidence of a continuing release of oil to surface waters and/or wetlands which significantly affects environmental receptors

Extensive cleanup has been conducted to remove the residual oil that stranded on Buzzards Bay shorelines in April 2003. These efforts have been described fully in the multiple status reports from 2003 through 2006, Phase I Initial Site Assessment (GeoInsight, 2004), the Phase II CSA Scope of Work (GeoInsight, 2005), and in the Phase II CSA itself, to which this report is appended. Currently, scant residual oil remains after three years of cleanup and monitoring efforts. What residual oil does remain is typically present as highly weathered splatter, and small sporadic deposits of hardened weathered oil in the form of tarballs, broken pieces of tarmats, and remnant pavement. As a result of the weathering, the material has been largely depleted of the lower molecular weight, mobile constituents found in the parent oil. There is no on-going release to surface water or wetlands at 62 of the 63 shoreline segments and subtidal zone.

The presence of small oil sheens was observed in some tide pools adjacent to areas where localized deposits of viscous residual oil occurs in the interstices of cobble at the southern tip of Hoppy's Landing (a portion of segment W2A-10). Based on this, the condition of no continuing release cannot be concluded for this segment at this time.

4.6.4.2 No evidence of biologically significant harm associated with current or foreseeable future exposure of wildlife, fish, shellfish or other aquatic biota to oil

Current conditions at the Site have been well documented. Citizen reports of residual oil were investigated and (if proven to be B120 oil) remediated where feasible. Based on the knowledge of existing current conditions described in this report and the Stage I ES findings, it is concluded that there is no evidence that existing conditions at 62 of the 63 shoreline segments and subtidal zone would result in biologically significant harm to wildlife, fish, shellfish, or other aquatic biota from exposure to spill-related oil..

The presence of small oil sheens was observed in some tide pools adjacent to areas where localized deposits of viscous residual oil occurs in the interstices of cobble at the southern tip of Hoppy's Landing (a portion of segment W2A-10). Therefore, it cannot be concluded that there is no evidence of biologically significant harm associated with current or foreseeable future exposure of wildlife, fish, shellfish or other aquatic biota to oil in that segment at this time.

4.6.4.3 Concentrations of oil do not exceed Massachusetts Surface Water Quality Standards

As described previously, the coastal waters of southeastern Massachusetts are designated as Class SA, indicating that these waters are "excellent habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation." The water quality parameters that are typical of Class SA waterbodies are not currently (nor will be) compromised due to the release of B120 oil at the Site in the foreseeable future.

4.6.4.4 No indication of the potential for biologically significant harm to environmental receptors

Given the discussion in previous sections of the Stage I ES, there are no complete exposure pathways between the constituents of residual oil and ecological receptors that would cause biologically significant harm to receptors at 62 of the 63 shoreline segments and subtidal zone. The condition of no potential for biologically significant harm to ecological receptors cannot be concluded for the southern tip of Hoppy's Landing (a portion of segment W2A-10) at this time because small foci of oil sheens in some tide pools and localized deposits of viscous residual oil occurring in the interstices of in that area pose potentially complete exposure pathways to ecological receptors

4.7 CONCLUSIONS

This Stage I ES has determined that, at this time, no areas of Readily Apparent Harm exist and a condition of No Significant Risk to the environment is concluded for 62 of the 63 shoreline intertidal segments and the subtidal area under consideration in this Phase II CSA. This conclusion is based on the following:

The effects-based screening of potentially affected surface water and sediments has demonstrated that all EPCs are below applicable ecological screening benchmarks;

Extensive observations have been made of the Buzzards Bay ecosystem in general and the 63 shoreline segments and the subtidal zone in particular. There is no visible evidence of stressed vegetation or adverse effects to other ecological receptors that might be linked to deposits of residual oil from the B120 spill;

Due to the highly weathered nature of residual oil that occurs in the form of rock splatter, small tar balls, and fractured pavement/tarmats, the potential for direct contact exposure by ecological receptors with COPEC in these materials is negligible. The presence of these limited deposits of weathered oil does not represent a significant risk to the Buzzards Bay ecosystem, the subtidal zone, or to intertidal shoreline segments evaluated in the Phase II CSA;

The potential for direct contact exposure with less weathered deposits of viscous residual oil exists in a limited area of intertidal cobble at the tip of Hoppy's Landing (a portion of Long Island and Causeway South segment W2A-10). Occasional small foci of persistent sheening have also been observed in this area in association with those deposits of viscous residual oil, which also presents a potential direct contact exposure pathway for ecological receptors. On this basis, a condition of NSR to ecological receptors cannot be concluded for this portion of shoreline segment W2A-10 at this time; and

Substantial deposits of viscous residual oil do not occur in the other 62 intertidal shoreline segments and the subtidal zone under consideration in the Phase II CSA. Current conditions at these segments and the subtidal zone do not support the generation of significant spontaneous B120-related oil sheens. On this basis, a condition of NSR to ecological receptors is concluded for these 62 intertidal shoreline segments and the subtidal zone.

In accordance with the MCP (310 CMR 40.0995), the following four criteria have been met at 62 of the 63 shoreline and the subtidal zone under consideration in the Phase II CSA. It is concluded that a condition of No Significant Risk of harm to the environment exists at these segments because:

1. There is no physical evidence of a continuing release of oil and/or hazardous material at or from the Site to surface waters and/or wetlands which significantly affects environmental receptors;

2. There is no evidence of biologically significant harm known or believed to be associated with current or foreseeable future exposure of wildlife, fish, shellfish or other aquatic biota to oil and/or hazardous material at or from the Site;

3. Concentrations of oil and/or hazardous material at or from the Site do not and are not likely to exceed Massachusetts Surface Water Quality Standards as promulgated at 314 CMR 4.00 (and as amended) at current and reasonably foreseeable exposure points; and

4. There is no indication of the potential for biologically significant harm to environmental receptors, considering their location and the fate and transport characteristics of the oil and/or hazardous material at or from the Site, currently or for any foreseeable period of time.

A condition of No Significant Risk to the environment cannot be concluded at this time for a limited area of intertidal cobble at the southern tip of Hoppy's Landing (a portion of Long Island and Causeway South segment W2A-10) due to the presence of viscous residual oil and foci of persistent sheen in some small tidal pools.

5.0 UNCERTAINTY ANALYSIS

The evaluation of uncertainty involves identifying sources of uncertainty associated with the ERC process that may potentially affect the conclusions of the assessment. According to U.S. EPA (1996), "uncertainty analyses increase credibility by explicitly describing the magnitude and direction of uncertainties, and they provide that basis for efficient data collection of or application of refined methods." To reduce the potential for uncertainty resulting in underestimates of actual risks at this Site, conservative methods and procedures were used throughout the assessment.

5.1 METHOD 3 HUMAN HEALTH RISK

The results of the human health risk characterization are dependent on a number of assumptions. Among these are the representativeness and quality of the data collected to describe Site conditions, the nature and extent of release-related constituents, and the assumptions made to evaluate potential risks for receptors potentially exposed to OHM in environmental media. Uncertainty may be introduced in each step of the risk characterization process. Although the magnitude of uncertainty has not been quantified for this Site, the primary sources of uncertainty in the above sections (i.e., hazard identification, exposure assessment, dose-response assessment, and risk characterization) are qualitatively discussed below.

5.1.1 Hazard Identification

A subset of segments that comprise the Site were used to represent the other segments that were not as well characterized. This subset of segments was selected because it was considered to be representative of worst-case conditions for each shoreline type. Data from segments that were not selected as representative worst case were not included in the risk characterization dataset.

Analytical data for sediment samples collected from January 2004 through October 2005, and the weathered oil sample collected in June 2005 were used to characterize potential health risks for residents under current and reasonably foreseeable land use activities. Sediment data collected in 2003 were not included in the risk characterization because they were not considered representative of current conditions. Although only one weathered oil sample was used in the risk characterization, its condition was such that it was very tacky and more similar to fresh oil than other samples, since it had been protected inside and underneath an overhanging piece of marsh.

Although detected PAH were generally assumed to be related to the B120 spill, several samples were eliminated from the dataset based on forensic analysis confirming alternative sources of PAH (Appendix G). PAH are generated from combustion such as wood fires, vehicle or industrial emissions or are present in other commonly used petroleum products such as diesel. At least two segments (Pope's Beach and Harbor View) are located proximal to the Atlas Tack Superfund Site in Fairhaven, at which PAH had been previously identified as constituents of concern. Essentially, because forensic evaluations were not conducted for each sample that contained detected concentrations of PAH to determine its source, many samples with detected concentrations were retained on the assumption that all are attributable to the B120 release, when in fact it is likely that at least some of these detections are not related to the release.

5.1.2 Exposure Assessment

Estimating EPC, characterizing current and reasonably foreseeable land activities and uses, and calculating daily doses contribute most to the uncertainty in the exposure assessment. To counter this uncertainty, health-protective exposure assumptions based on either Site-specific information or conservative default values provided in U.S. EPA and MADEP guidance were used to quantitatively evaluate potential risks. For example, contact and ingestion rates were obtained from MADEP and U.S. EPA guidance, which are intended to err on the side of protecting human health. If default assumptions were inappropriate or not available, realistic but conservative assumptions were made based on Site-specific information.

Because each composite intertidal sediment sample was considered to be an exposure point, the results were compared directly to RBTC, and no EPC exceeded these site-specific non-cancer or cancer RBTC, the uncertainty associated with estimating EPC is considerably reduced. However, there is still uncertainty related to whether each sample point truly represents concentrations throughout the segment from which it was collected. All efforts were made to collect samples from the areas identified as most likely to harbor residual contamination or at least from areas that represented the same conditions found throughout the segment.

5.1.3 Dose-Response Assessment

The primary sources of uncertainty associated with the toxicity values used to quantify risks include:

- extrapolation of dose-response information from effects observed at high doses to predict adverse effects at low levels anticipated for human exposure to environmental constituents;
- use of toxicity information compiled from short-term exposure studies to predict the effects associated with long-term exposures (and visa -versa);
- use of dose-response information from animal studies to predict likely effects in humans; and
- use of toxicity information based on homogeneous animal populations or healthy human populations to predict the effects that are likely to be observed in the general population (including sensitive subgroups).

The dose-response values used in the calculation of HIs and cancer risk estimates are conservative values. Since RfDs and RfCs are derived using a number of safety factors and are developed to protect sensitive subpopulations, the actual dose or concentration associated with a health effect is likely to be more health-protective than the dose or concentration established by U.S. EPA or the MADEP for most groups in the general population. In addition, the CSFs and unit risks are derived based on the upper 95 percent confidence limit and assume that no threshold level exists for exposure to carcinogens. To be conservative, when no subchronic dose-response value was available, the chronic value was used. Although no values have been established for dermal contact exposures, it is standard practice to use values derived from studies based on oral exposures to evaluate dermal contact exposures. This technique is health-protective since it has been demonstrated that the most significant exposures for most constituents occur via the oral and inhalation route.

5.1.4 Risk Characterization

Important sources of uncertainty in the risk characterization include:

- equal weighting given to constituents whose RfDs have different confidence levels in estimating HIs;
- assumption of simple additivity of ELCRs and HIs across COC, despite differences in toxicological endpoints; and
- assumption of TEFs are appropriate when converting to BaP equivalents.

The use of conservative assumptions and parameters in developing risk estimates have been conservatively incorporated to err on the side of protecting human health. Thus, calculated HIs and risk estimates are likely to result in upper bound estimates of the hazard resulting from exposure to COC present in environmental media at the Site. Consequently, the estimates should be used to highlight areas of potential concern and to assist in providing practical risk management information, rather than as absolute estimates of health risks.

5.2 STAGE I ENVIRONMENTAL SCREENING

The results of the Stage I ES depend on a number of simplifying assumptions that contribute to the uncertainty of the ecological screening. To protect sensitive environmental resources, conservative assumptions are commonly made which tend to overestimate potential risks to ecological receptors. To place the results of the Stage I ES in perspective, it is important to identify the key sources of uncertainty and their potential impact on the ES. There are 3 primary sources of uncertainty in this ES, in addition to the considerations related to background discussed in the preceding section.

5.2.1 Biased Sampling Strategy

The primary driver for the site investigation/IRA conducted following the B120 spill was to identify and eliminate deposits of oil wherever it might become stranded. While qualitative site investigation activities (viz., sediment chain drag, SCAT survey) were broad-based and comprehensive, sampling of environmental media focused on worst-case situations (surface water sampling immediately below oil slicks, sediment sampling in intertidal and subtidal areas where substantial oil strandings occurred, and collection of shellfish in areas most likely to be affected by oil deposition). Chemical analyses of samples collected from these areas likely resulted in a biased overestimation of impacts to environmental media than actually occurred on a habitat-wide basis.

While there are 63 shoreline segments plus the subtidal area under consideration in the Phase II CSA, a subset of those segments was selected for critical and detailed evaluation for potential human health and ecological risks. Not evaluating each segment individually imparts a degree of uncertainty into the assessment. The shoreline segments selected for detailed assessment in the Phase II CSA were intentionally biased toward worst-case conditions. Risk estimates developed based on assessment of these segments overpredicts any potential hazards posed by residual B120 oil to the Buzzards Bay ecosystem as a whole. That said, demonstration of “no risk of harm” to these worst-case shoreline segments provides high confidence that concern that ecological receptors and sensitive habitats that occur at the remaining lesser-impacted segments might be adversely affected by residual B120 constituents is unwarranted.

5.2.2 Exposure Assumptions

EPC values selected for use in the Stage I ES were based primarily on composite samples, and to a limited degree, discrete grab samples. Each sample or composite was treated as an exposure point and was compared with applicable ecological benchmarks. No attempt was made to area-average site data so as to more accurately reflect habitat-scaled exposures. This was especially important in the assessment of potential exposures to avian receptors. Exposure estimates for these receptors were based on the maximum EPC for sediment and/or shellfish tissue residue detected in the study segments. This approach grossly overestimated potential risks to vertebrate consumers via the foodweb exposure pathway.

The exposure assessment also assumes steady-state conditions relative to COPEC residue concentrations in environmental media. As described in detail in the CSM, spill-related constituents undergo substantial weathering. The result will be a continued decline in spill residual concentrations in Site sediments and prey tissues.

5.2.3 Ecological Screening Benchmarks

A key source of uncertainty in ecological risk assessment lies in the use of ecological screening benchmarks as threshold risk tools. A number of factors come to bear on this issue. Ecological toxicity benchmarks are intentionally conservative. Their purpose is to exclude or screen out only those contaminants in a given environmental medium that pose no potential ecological concern (Efroymson et al., 1997). As such, they tend to overestimate risk potential.

Screening benchmarks used in this Stage I ES are consistent with this approach. ER-Ls developed by NOAA were used as the basis for screening sediments for potential COPEC risks in that medium. MADEP (2006b) indicated during its Winter 2006 training seminar that this is a suitable and conservative tool for screening marine and estuarine sediments for potential risks to benthic biota. MADEP further indicated that this metric is suitable for screening for potential phytotoxicity in aquatic and semi-aquatic plants. The conservatism of this benchmark for screening potential oil spill-related risks to estuarine plant life was demonstrated in Section 4.6.1.1.1 where a literature review confirmed that salt marsh grasses were largely refractory to PAH and petroleum hydrocarbons.

Ecological toxicity screening benchmarks have not been derived for a number of B120 spill constituents, namely alkylated PAH compounds and other petroleum hydrocarbons contained in N0. 6 fuel oil. MADEP had developed benchmarks for its EPH fraction for human health screening, but has not done so for ecological receptors. This uncertainty was addressed in this ES through the use of NOAA ER-L benchmarks for PAH. As described in greater detail in Section 4.6.1.1.2, these benchmarks were derived using co-occurrence data from a wide variety of sources where oil spills had occurred. As a consequence, the occurrence of constituents in the sediment samples contributed to the toxicity that provided the basis for the individual and total PAH ER-L values. On this basis, the uncertainty associated with the lack of specific benchmarks for these constituents was minimized.

6.0 SAFETY AND PUBLIC WELFARE RISK CHARACTERIZATIONS

6.1 RISK OF HARM TO SAFETY

The MCP lists the following as examples of potential safety hazards:

- the presence of rusted or corroded drums or containers, open pits, lagoons, or other dangerous structures;
- any threat of fire or explosion, including the presence of explosive vapors resulting from a release of OHM; and
- any uncontained materials that exhibit the characteristics of corrosivity, reactivity, or flammability as described in 310 CMR 40.0347.

Neither slipping nor any of the safety hazards listed above were observed at the Site, and they are not anticipated to occur in the future. Therefore, a condition of NSR of harm to safety was concluded for the Site.

6.2 RISK OF HARM TO PUBLIC WELFARE

The risk of harm to public welfare was evaluated using two criteria: 1) comparing concentrations of detected constituents to appropriate Upper Concentration Limits (UCLs) defined in the MCP, and 2) evaluating the potential for the existence of a nuisance condition to the degree that would limit the use of the shoreline under current and reasonably foreseeable future uses that is directly attributable to the release of OHM. UCLs that are potentially applicable for this release are the UCLs in soil published for individual COC and the UCL for non-aqueous phase liquid (NAPL) thickness of ½ inch in an environmental media. Concentrations of EPH fractions and PAH in sediment samples were compared to the applicable UCLs in soil (although it is recognized that the soil UCLs are not directly applicable to sediment concentrations), and these concentrations were below soil UCLs for those analytes. Although small amounts of weathered residual oil splatter may be present in some shoreline areas, the splatter is discontinuous, less than ½ inch thick, and does not constitute a UCL exceedence.

The risk to public welfare was also evaluated for the potential for residual oil to create a nuisance condition (such as rubbing off on skin when touched) to the degree that limits public or community use (active or passive) of the shoreline segment. For the purposes of this risk characterization, segments that contain restricted areas (e.g., private beaches) were considered to be publicly accessible (i.e., community or public use was assumed to be present at each segment). Shoreline uses for both children and adults considered for this evaluation included:

- Walking along the shoreline (barefoot or with shoes);
- Digging in the sediment;
- Recreational clamming in the intertidal or subtidal zone;
- Recreational fishing;
- Sunbathing; and
- Bird watching.

A condition of No Significant Risk to public welfare was concluded for the subtidal area and at all but two localized areas within the intertidal segments. Although isolated splatter may be present in some intertidal locations, the splatter is weathered and hard to the touch, and contact with this splatter would not create a nuisance condition. The localized areas where residual oiling has been characterized as a potential nuisance condition (and therefore different from residual oil in other areas) are the Leisure Shores portion of segment W1F-02 and the southern tip of Hoppy's Landing in segment W2A-10. Cleanup activities were conducted at these localized areas during the previous summer (W1F-02) and winter (W2A-10) and recent field observations indicate that residual oiling does not easily rub off upon contact. Additional field surveys will be conducted during the warm summer months to determine whether residual oil may be more readily available during warmer periods. Therefore, a condition of No Significant Risk to public welfare cannot be concluded for these portions of these segments at this time.

At Leisure Shores, the primary shoreline uses were considered to include walking along the shoreline, digging in sediment (both adults and children playing along the shoreline), recreational clamming, and sunbathing. Residual oil observed at Leisure Shores after cleanup operations conducted in the summer of 2005 consisted of small, sand-size particles (identified as "flecks") that appear on the water surface in trenches excavated in some areas in Leisure Shores. Although the particles are small and difficult to encounter, it is possible that residents digging or playing in the sand at Leisure Shores could contact some of these particles and this could create a nuisance condition to the degree that might limit the use of the shoreline under current and reasonably foreseeable uses. In addition, it is possible that residents walking barefoot along the shoreline may step on a small amount of residual oil that could come off on the skin, although this is not considered to be as likely because exposed oil is typically hard to the touch.

Hoppy's Landing is primarily a cobble beach with fringing marsh, and the primary shoreline uses were considered to be walking along the shoreline, recreational clamming, recreational fishing, and bird watching. Residual oil at the southern tip of Hoppy's Landing consists of splatter and small areas of pavement that are weathered on the outer surface, but may be tacky below the weathered layer. Residual oil pavement in sheltered locations (e.g., under rocks) can also be tacky to the touch when exposed. Although this area is primarily a cobble shoreline and is not heavily used, it is possible that a person walking in this area could contact residual oil that would come off on the skin or clothing causing a nuisance condition. In addition, the residual oil splatter and pavement that remains may be considered to impact visual aesthetics for people walking along the shoreline.

The potential risk of harm to public welfare was also evaluated for the potential for residual oil to create a nuisance condition (such as rubbing off on skin when touched) to the degree that could significantly limit public or community use (active or passive) of each intertidal shoreline segment. In a memorandum attached to the MADEP June 27, 2006 Phase II SOW Addendum approval letter, MADEP provided additional Site-specific guidance on evaluating potential risks to public welfare, which included the visual and/or olfactory evidence of oil residuals that may discourage use of otherwise publicly accessible shoreline due to the potential for contact and adherence to their skin, or if residual oil would adversely impact the economic interest of a region. It is important to note that while there may be a risk of contact to a small amount of oil, this does not necessarily constitute a significant risk. In accordance with the MADEP guidance, a condition of No Significant Risk to public welfare exists in the subtidal zone and at all but the two localized intertidal areas discussed above. Although isolated splatter may be present in some intertidal locations, the splatter is weathered and hard to the touch, and contact with this splatter would not create a nuisance condition.
In summary, a condition of No Significant Risk to public welfare exists at 61 of the remaining 63 shoreline segments, as well as the subtidal zone. Residual oil at portions of segments W1F-02 and W2A-10 could potentially create a nuisance condition if the residual oil was encountered by residents, and, therefore, a condition of No Significant Risk to public welfare has not been demonstrated at this time.

7.0 RISK CHARACTERIZATION CONCLUSIONS

Results of the human health, safety, public welfare, and environmental risk characterizations are summarized below.

7.1 HUMAN HEALTH RISK CHARACTERIZATION

As described, cumulative risk-based threshold benchmarks were developed to represent a streamlined process to determine if EPC represent a potential risk to human health. All sediment EPC and the worst case weathered oil EPC were well below the RBTC, therefore a condition of No Significant Risk to human health was concluded for the Site.

7.2 ENVIRONMENTAL RISK CHARACTERIZATION

Based on observations made and information collected during environmental investigations of the Site, conditions at the Site that are related to a release of OHM do not currently pose a threat of adverse impacts to ecological receptors at 62 out of 63 intertidal shoreline segments and the subtidal area. Therefore, a condition of NSR of harm to the environment was concluded for these segments. A condition of NSR could not be concluded for the southern tip of Hoppy's Landing (portion of segment W2A-10) at this time.

7.3 SAFETY RISK CHARACTERIZATION

Based on observations made and information collected during environmental investigations of the Site, conditions that are related to a release of OHM do not currently and will not in the foreseeable future pose a threat of physical harm or bodily injury to people. Therefore, a condition of No Significant Risk of harm to safety was concluded for the Site.

7.4 PUBLIC WELFARE RISK CHARACTERIZATION

Based on observations made and information collected during environmental investigations of the Site, no community in the vicinity of the Site experiences adverse impacts to public welfare under current or anticipated future conditions. Two small portions of segments W2A-10 and W1F-02 have localized residual oiling that may pose a nuisance condition during warm weather. However, with the exception of these two areas, a condition of NSR to public welfare was concluded for all other areas of the Site.

ENTRIX
ENVIRONMENTAL CONSULTANTS

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TABLES

TABLE 1

SHORELINE SEGMENTS TO BE ADDRESSED IN RISK CHARACTERIZATION

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	Segment Name	Town	Dominant IRAC- ESI Code	Maximum Degree of Initial Oiling	Oil Ranking
E1-11	Scraggy Neck South	Bourne	1C	Moderate	1.00
E1-13	Nye's Neck	Falmouth	1C	Heavy	2.92
E1-14	New Silver Beach	Falmouth	1A/1B	Moderate	<1.00
E1-15	Crow Point	Falmouth	1D	Heavy	<1.00
E3-06	Uncatena Island	Gosnold	1C	Moderate	2.00
W1B-12	Warren Point	Wareham	1C	Moderate	3.00
W1B-15	Wareham River East Shore	Wareham	1F	Moderate	1.80
W1B-31	Great Hill Point	Marion	1C	Moderate	3.00
W1B-33	Piney Point South	Marion	1A/1B	Moderate	3.00
W1C-01	Butler's Point	Marion	1D	Moderate	3.00
W1C-02	**Planting Island Causeway**	**Marion**	**1D**	**Heavy**	**3.00**
W1C-04	Blankinship Cove	Marion	1F	Moderate	1.46
W1C-05	Sippican Harbor East	Marion	1D	Moderate	3.00
W1C-10	Silver Shell Beach	Marion	1A/1B	Moderate	<1.00
W1C-11	Sippican Harbor West	Marion	1F	Very Light	<1.00
W1C-12	Converse Point East	Marion	1C	Moderate	2.63
W1D-01	**Aucoot Cove**	**Mattapoisett**	**1F**	**Moderate**	**1.46**
W1D-03	Holly Woods / Hiller Cove	Mattapoisett	1C	Moderate	2.00
W1D-04	Holly Woods / Peases Point	Mattapoisett	1D	Moderate	2.23
W1D-05	Point Connett Beach	Mattapoisett	1A/1B	Heavy	2.00
W1E-01	Nye Cove / Strawberry Cove	Mattapoisett	1C	Light	1.33
W1E-02	**Strawberry Cove**	**Mattapoisett**	**1C**	**Light**	**1.46**
W1E-03	**Strawberry Point West**	**Mattapoisett**	**1F**	**Moderate**	**2.28**
W1E-04	**Crescent Beach**	**Mattapoisett**	**1C**	**Heavy**	**3.92**
W1E-05	Mattapoisett Harbor East	Mattapoisett	1D	Moderate	1.26
W1E-06	Mattapoisett Town Beach	Mattapoisett	1D	Moderate	3.00
W1F-01	Brandt Beach	Mattapoisett	1D	Heavy	2.49
W1F-02	**Brandt Island West (Howards Beach)**	**Mattapoisett**	**1D**	**Heavy**	**3.34**
W1F-03	Brandt Island East	Mattapoisett	1D	Heavy	3.07
W1F-04	Brandt Island Cove	Mattapoisett	1F	Heavy	2.19
W1F-05	**Mattapoisett Neck West**	**Mattapoisett**	**1F**	**Heavy**	**3.77**
W1F-06	Mattapoisett Neck South	Mattapoisett	1C	Heavy	2.74
W1F-07	Mattapoisett Shores	Mattapoisett	1A/1B	Moderate	2.94
W1F-08	Mattapoisett Neck East	Mattapoisett	1C	Heavy	1.08
W1F-09	Mattapoisett Harbor North	Mattapoisett	1F	Moderate	1.00
W1G-00	Ram Island (1)	Mattapoisett	1C	Heavy	4.00
W2A-01	Fort Phoenix	Fairhaven	1C	Moderate	1.79
W2A-02	**Harbor View**	**Fairhaven**	**1F**	**Heavy**	**3.00**
W2A-03	**Pope's Beach**	**Fairhaven**	**1C**	**Moderate**	**3.00**
W2A-04	Manhattan Ave	Fairhaven	1C	Heavy	3.65
W2A-05	Sunset Beach	Fairhaven	1C	Moderate	2.00
W2A-06	Silver Shell Beach	Fairhaven	1C	Light	2.00
W2A-07	Sconticut Neck West	Fairhaven	1C	Heavy	2.17
W2A-08	Wilbur Point	Fairhaven	1D	Moderate	2.40
W2A-09	Sconticut Neck East	Fairhaven	1D	Heavy	3.00
W2A-10	**Long Island and Causeway South**	**Fairhaven**	**1C**	**Heavy**	**3.44**
W2A-11	**West Island West**	**Fairhaven**	**1C**	**Heavy**	**3.95**
W2A-12	Rocky Point to East Cove (Town Beach)	Fairhaven	1A/1B	Heavy	1.19
W2A-13	East Cove	Fairhaven	1A/1B	Light	1.00
W2A-14	Pine Creek to North Point	Fairhaven	1C	Moderate	3.00
W2A-19	Shaw Cove	Fairhaven	1F	Heavy	2.23
W2B-05	Fort Taber	New Bedford	1D	Moderate	1.44
W3A-01	Mishaum Point East	Dartmouth	1C	Heavy	1.05
W3A-02	Salters Point West	Dartmouth	1A/1B	Moderate	3.00
W3A-03	Pier Beach (Salter's Point)	Dartmouth	1D	Moderate	2.44
W3A-04	Salters Point East	Dartmouth	1A/1B	Light	2.00
W3A-05	**Round Hill Beach West**	**Dartmouth**	**1A/1B**	**Heavy**	**2.14**
W3A-06	Round Hill Beach East	Dartmouth	1A/1B	Heavy	2.77
W3B-02	Mishaum Point West	Dartmouth	1C	Heavy	3.65
W3C-03	**Barney's Joy (W of barbed)**	**Dartmouth**	**1A/1B**	**Heavy**	**4.00**
W3C-04	**Barney's Joy (E of barbed)**	**Dartmouth**	**1C**	**Heavy**	**2.60**
W3C-06	Demarest Lloyd State Park Marsh	Dartmouth	1F	Very Light	1.00
W3D-07	Gooseberry Neck West	Westport	1C	Moderate	2.05

Notes:
1. Ram Island was not selected for characterization to avoid disturbing the sensitive Roseate Terns colony.
2. Shaded and bolded segments were selected for characterization and represent all other segments that were less impacted by the release.
3. IRAC - ESI code = Immediate Response Action Completion Criteria and Environmental Sensitivity Index. The codes correspond to the following shoreline types:
- 1A/B Heavily Utilized Public Recreational Sand Beaches/Less-utilized Semi-public and Private Sand Beaches
- 1C Mixed Sand and Gravel, Gravel (pebble to boulder) and Rip Rap Groins (jetties)
- 1D Rip Rap Seawalls, Bulkheads, Piers, Docks and Pilings
- 1E Rocky Point to East Cove (Town Beach)
- 1F Salt Marshes

4. The maximum degree of oiling and oil ranking were determined as explained in detail of Section 2.2 of the Partial RAO (GeoInsight 2004).

TABLE 2

SUMMARY OF DATA AVAILABLE BY SEGMENT

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	Water Samples	Subtidal Sediment	Intertidal Sediment	Marsh Core	Marsh Sediment	Shellfish Bed Raking	Chain Drags	Dive Survey	Lobster Pot	Shellfish	Absorbent Pad
E1-11						19 Locations (7/04)				Oyster MHRS-A and B (5/03) Quahog MHRS-A and B (5/03) Softshell Clam MHRS-A,B, and C (5/04) Softshell Clam MHRS-A,B, and C (Dup) (5/03)	MHRS - MRAI - DP -1 (5/03) MHRS - LI - DP - 1 (5/03) MHRS - MHLI - DP -1 (5/03)
E1-13											
E1-14		WH-SED-S-1 (5/03) WH-SED-S-2 (5/03) WH-SED-S-3 (5/03)									
E1-15											
E3-06											
W1B-12											
W1B-15										Quahog LNGB-A and B (5/03) Softshell Clam LNGB-A and B (5/03, 6/03)	LNGB - DP - 1 (5/03) LNGB- DP - 2 -N (5/03) LNGB - DP -2 (6/03)
W1B-31											
W1B-33											
W1C-01											
W1C-02*	W1C02-TP01 (8/04) W1C02-TP02 (8/04)	W1C02-P2-SUB01 W1C02-P2-SUB02			W1C02-MS01 (8/04)						
W1C-04			AP-SED-UI-01 (5/03) AP-SED-LI-01 (5/03)								
W1C-05											
W1C-10											
W1C-11										Quahog BVMA-A,B, and C (5/03)	BVMA - DP - 1 (5/03)
W1C-12										Softshell Clam MOMA-A,B, and C (5/03)	MOMA - DP (5/03)
W1D-01*				W1D01-P2-M-01 W1D01-P2-M-02 W1D01-P2-M-03	W1D01-M-01 (1/04) W1D01-M-02 (1/04) W1D01-M-03 (1/04)						
W1D-03											
W1D-04			W1D04-UIT-01 (1/04) W1D04-LIT-01 (1/04) W1D04-UIT-02 (1/04) W1D04-LIT-02 (1/04) W1D04-UIT-03 (1/04) W1D04-MID-03 (1/04) W1D04-LIT-03 (1/04) DDD2-UIT-03 (1/04) DDD2-MID-03 (1/04) DDD2-LIT-03 (1/04) PP-SED-UI-01 (5/03) PP-SED-LI-01 (5/03)								
W1D-05											
W1E-01				W1E-01-C05		7 Locations (7/04)				Quahog PCMA-A,B, and C (5/03, 6/03)	PCMA - DP - 1 - D (5/03) PCMA - DP - 2 - D (6/03)
W1E-02*		W1E02-P2-SUB-01 W1E02-P2-SUB-02 DDD-P2-03		W1E02-P2-M-01 W1E02-P2-M-02 W1E02-P2-M-03 W1E02-P2-M-04 W1E02-P2-M-05							

Notes:
1. Shaded rows indicate no data was collected for these segments.
2. Segment IDs marked with an asterisk "*" were selected for characterization.

TABLE 2

SUMMARY OF DATA AVAILABLE BY SEGMENT

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	Water Samples	Subtidal Sediment	Intertidal Sediment	Marsh Core	Marsh Sediment	Shellfish Bed Raking	Chain Drags	Dive Survey	Lobster Pot	Shellfish	Absorbent Pad
W1E-03*		W1E03-P2-SUB-01 W1E03-P2-SUB-02	W1E03-UIT-01 (1/04) W1E03-UIT-02 (1/04) W1E03-UIT-03 (1/04)								
W1E-04*			W1E04-UIT-01 (1/04) W1E04-LIT-01 (1/04) W1E04-UIT-02 (1/04) W1E04-LIT-02 (1/04) W1E04-UIT-03 (1/04) W1E04-LIT-03 (1/04) DDD01-UIT-01 (1/04) DDD01-LIT-01 (1/04) W1E04-P2-UIT-01 W1E04-P2-LIT-01 W1E04-P2-UIT-02 W1E04-P2-LIT-02								
W1E-05											
W1E-06			W1E06-UIT-01 (1/04) W1E06-LIT-01 (1/04) W1E06-UIT-02 (1/04) W1E06-LIT-02 (1/04) W1E06-UIT-03 (1/04) W1E06-LIT-03 (1/04)								
W1F-01						8 Locations (7/04)					
W1F-02*		WMN-SED (offshore of W1F-01 & W1F-02) W1F02-P2-SUB-01 W1F02-P2-SUB-02 W1F02-P2-SUB-03 W1F02-P2-SUB-04 W1F02-P2-SUB-05 W1F02-P2-SUB-06 W1F02-P2-SUB-07 W1F02-P2-SUB-08	BI-SED-UI-01 (5/03) BI-SED-LI-01 (5/03) HB-SED-01 (12/04) HB-SED-02 (12/04) HB-SED-03 (12/04) HB-SED-04 (12/04) HB-SED-05 (12/04) HB-SED-06 (12/04) HB-SED-07 (12/04) HB-SED-08 (12/04) HB-SED-09 (12/04) HB-DUP-01 (12/04) W1F02-P2-UIT-01 W1F02-P2-LIT-01 W1F02-P2-UIT-02 W1F02-P2-LIT-02 HB-SED-01 MS/MSD		W1F02-P2-M-01 DDD-P2-06	8 Locations (7/04)				BIMT-OY-1-A,B, and C (5/03,6/03,7/03,8/03) BIMT-QH-1-A,B, and C(5/03,6/03,7/03)	
W1F-03										Quahog BIMT-A,B, and C (5/03, 6/03, 7/03) Oyster BIMT-A,B, and C (5/03, 6/03, 7/03, 8/03)	BIMT - DP - 1 (5/03) Brandt Island (6/03)
W1F-04	W1F04-W01 (8/04)		W1F-UIT-01 (1/04) W1F-UIT-02 (1/04) W1F-UIT-03 (1/04)		W1F04-S01 (8/04)						
W1F-05*	W1F05-TP-1 (8/04)				W1F05-MS01 (8/04) W1F05-P2-M-01 W1F05-P2-M-02 W1F05-P2-M-03 DDD-P2-05						
W1F-06						6 Locations (7/04)				Scallop MONB-A and B (5/03, 7/03, 8/03)	
W1F-07						8 Locations (7/04)					
W1F-08						inadvertent overlap 2 locations (1 shellfish)					

Notes:
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TABLE 2

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Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	Water Samples	Subtidal Sediment	Intertidal Sediment	Marsh Core	Marsh Sediment	Shellfish Bed Raking	Chain Drags	Dive Survey	Lobster Pot	Shellfish	Absorbent Pad
W1F-09										Oyster EEHH-N (5/03, 6/03, 7/03, 8/03, 10/03) Oyster EEHH-N (Dup) (5/03) Quahog MHHH-A,B, and C (5/03, 6/03) Softshell Clam MEHH-A (5/03, 7/03)	MHHH - DP - 1 - A (5/03) MEHH - DP - 1 - A (5/03) EEHH - DP - 1 - N (5/03) MHHH - QH - 2 (5/03) EEHH - OY - 2 (5/03)
W1G-00											
W2A-01										Quahog FTPH-A,B, and C (5/03, 7/03, 5/04)	FTPH - PD (5/03)
W2A-02*	W2A02-TP01 (8/04)		Turner Ave-1 (Weathered Oil) W2A02-82905-01 W2A02-82905-02		W2A02-MS01 (8/04) W2A02-MS02 (8/04) W2A02-P2-M-01 W2A02-P2-M-02 W2A02-P2-M-03 W2A02-P2-M-04						
W2A-03*		PB-SS-S01 (8/04) PB-DS-S01 (8/04) PB-SS-S02 (8/04) PB-DS-S02 (8/04) PB-SS-S03 (8/04) PB-DS-S03 (8/04) PB-SS-S04 (8/04) PB-DS-S04 (8/04) BSS-01 (8/04)	W2A03-UIT-01 (1/04) W2A03-LIT-01 (1/04) W2A03-UIT-02 (1/04) W2A03-LIT-02 (1/04) W2A03-UIT-03 (1/04) W2A03-LIT-03 (1/04) PB-SED-UI-01 (5/03) PB-SED-LI-01 (5/03)		W2A-03-P2-M01 W2A-03-P2-M02 W2A-03-P2-M03 W2A-03-P2-M04 W2A-03-P2-M05 W2A-03-P2-M06		5 Drags (8/04)			Oyster FHHS-A,B, and C (5/03, 7/03, 8/03, 10/03, 5/04) Quahog FHHS-A,B, and C (5/03, 7/03, 8/03, 5/04) Softshell Clam FHHS-A,B, and C (5/03, 7/03, 8/03, 10/03, 5/04) Quahog SNNW-A,B, and C (5/03) Softshell Clam SNNW-A,B, and C (5/03)	FHHS - DP - 1 - N (5/03) SNNW - PD (5/03)
W2A-04			W2A04-UIT-01 (1/04) W2A04-LIT-01 (1/04) W2A04-UIT-02 (1/04) W2A04-LIT-02 (1/04) W2A04-UIT-03 (1/04) W2A04-LIT-03 (1/04)								
W2A-05					W2A05-MS01 (8/04) W2A05-MS02 (8/04)						
W2A-06										Quahog WCSN-A,B, and C (5/03, 7/03, 5/04)	WCSN - DP - 1 (5/03)
W2A-07	SWWP-1 (4/29/03) SWWP-1a (4/30/03) SWWP-1b (5/01/03) SWWP-1c (5/05/03) SWWP-1d (5/12/03)	SN-DS-S01 (8/04) SN-SS-S01 (8/04) SN-DS-S02 (8/04) SN-SS-S02 (8/04) SN-DS-S03 (8/04) SN-SS-S03 (8/04) SN-SS-S04 (8/04) SS-DS-S04 (8/04) BSS-S02 (8/04)					4 Drags (8/04)			Softshell Clam WCSN-A,B, and C (5/03, 7/03, 5/04)	WCSN - DP - 1 (5/03)
W2A-08											

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TABLE 2

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Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	Water Samples	Subtidal Sediment	Intertidal Sediment	Marsh Core	Marsh Sediment	Shellfish Bed Raking	Chain Drags	Dive Survey	Lobster Pot	Shellfish	Absorbent Pad
W2A-09			W2A09-UIT-01 (1/04) W2A09-LIT-01 (1/04) W2A09-UIT-02 (1/04) W2A09-LIT-02 (1/04) W2A09-UIT-03 (1/04) W2A09-LIT-03 (1/04)				4 Drags Southwest of West Island (6/03)		Southwest of West Island (6/2/03, 6/5/03)		
W2A-10*	W2A10-SW1 (6/04) W2A10-SW2 (6/04) W2A10-SW3 (6/04)	W2A10-ST-S01 (7/04) W2A10-ST-S02 (7/04) W2A10-ST-S03 (7/04) W2A10-ST-S04 (7/04) W2A10-ST-S05 (7/04) W2A10-ST-S06 (7/04) W2A10-ST-S07 (7/04) W2A10-ST-S08 (7/04) W2A10-ST-S09 (7/04) W2A10-ST-XXX (7/04) ACD-S01 (8/04) LI-DS-S01 (8/04) LI-DS-S02 (8/04) LI-DS-S03 (8/04) LI-DS-S04 (8/04)	W2A-10-P2-UIT-01 W2A-10-P2-LIT-01 W2A-10-P2-UIT-02 W2A-10-P2-LIT-02 W2A-10-P2-UIT-03 W2A-10-P2-LIT-03 W2A-10-P2-UIT-05 W2A-10-P2-LIT-05	W2A10-C01 (8/04) W2A10-C02 (8/04) W2A10-C03 (8/04) W2A10-C04 (8/04)	W2A10-P2-M-01 W2A10-P2-M-02 W2A10-P2-M-03 W2A10-P2-M-04		3 Drags (8/04)			Quahog MNHH-A (5/03, 7/03, 8/03, 5/04) Softshell Clam MNHH-A (5/03, 8/03, 10/03, 5/04) Quahog SWLI-A,B, and C (5/03, 7/03, 8/03, 10/03, 5/04) Quahog SWLI-A,B, and C (Dup) (5/03)	MNHH - DP - 1 - A (5/03) SWLI - DP - 1 - D (5/03)
W2A-11*		WI-SED-S-1 (5/03) offshore WI-SED-S-2 (5/03) offshore WI-SED-S-3 (5/03) offshore	W2A11-UIT-01 (1/04) W2A11-LIT-01 (1/04) W2A11-UIT-02 (1/04) W2A11-LIT-02 (1/04) W2A11-UIT-03 (1/04) W2A11-LIT-03 (1/04) WI-SED-UI-01 (5/03) WI-SED-LI-01 (5/03) W2A11-P2-UIT-01 W2A11-P2-LIT-01 W2A11-P2-UIT-02 W2A11-P2-LIT-02 DDD-P2-01 DDD-P2-02								SWWI - DP - 1 - D (5/03)
W2A-12											
W2A-13	SWWI-2 (4/29/03) SWWI-2a (4/30/03) SWWI-2b (5/01/03) SWWI-2c (5/05/03) SWWI-2d (5/12/03)				W2A13-M-02 (1/04) W2A13-M-03 (1/04)					Oyster BASS-A,B, and C (5/03, 7/03) Blue Mussel BASS-A,B, and C (5/03, 7/03) Quahog BASS-A,B, and C (5/03, 7/03) Softshell Clam BASS-A (5/03, 7/03)	BASS - DP - 1 - N (5/03) BASS - DP - 2 - N (5/03)

Notes:
1. Shaded rows indicate no data was collected for these segments.
2. Segment IDs marked with an asterisk "*" were selected for characterization.

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SUMMARY OF DATA AVAILABLE BY SEGMENT

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	Water Samples	Subtidal Sediment	Intertidal Sediment	Marsh Core	Marsh Sediment	Shellfish Bed Raking	Chain Drags	Dive Survey	Lobster Pot	Shellfish	Absorbent Pad
W2A-14			W2A14-UIT-02 (1/04) W2A14-UIT-03 (1/04)		W2A14-MS01 (8/04) W2A14-M-01 (1/04)		3 Drags Northeast of West Island (6/03)			Quahog NEWI-A,B, and C (5/03) Softshell Clam NEWI-A,B, and C (5/03)	NEWI - PD (5/03)
W2A-19										Softshell Clam SHCV-A,B, and C (5/03, 6/03, 7/03) Quahog SHCV-A,B, and C (5/03, 6/03)	
W2B-05											
W3A-01											
W3A-02			W3A02-UIT-01 (1/04) W3A02-LIT-01 (1/04) W3A02-UIT-02 (1/04) W3A02-LIT-02 (1/04) W3A02-UIT-03 (1/04) W3A02-LIT-03 (1/04)			4 Locations (7/04)					
W3A-03			W3A03-UIT-02 (1/04) W3A03-LIT-02 (1/04) W3A03-UIT-03 (1/04) W3A03-LIT-03 (1/04) SB-SED-UI-01 (5/03) SB-SED-LI-01 (5/03)								
W3A-04						7 Locations (7/04)					
W3A-05*			W3A05-P2-UIT-01 W3A05-P2-LIT-01 W3A05-P2-UIT-02 W3A05-P2-LIT-02 W3A05-P2-UIT-03 DDD-P2-04 W3A05-P2-LIT-03			5 Locations (7/04)					
W3A-06						5 Locations (7/04)					
W3B-02										Quahog MPDA-A,B, and C (5/03, 6/03, 7/03)	MPDA - DP - 1 - D (5/03) MPDA - DP - 2 - D (6/03)
W3C-03*	SWAP-1 (4/29/03) SWAP-1a (4/30/03) SWAP-1b (5/01/03) SWAP-1c (5/05/03) SWAP-1d (5/12/03)		W3C03-UIT-01 (1/04) W3C03-MIT-01 (1/04) W3C03-LIT-01 (1/04) W3C03-UIT-02 (1/04) W3C03-MIT-02 (1/04) W3C03-LIT-02 (1/04) W3C03-UIT-03 (1/04) W3C03-MIT-03 (1/04) W3C03-LIT-03 (1/04) DDD-P2-04			11 Locations 7/04)				Surf Clam BJB-A (5/03) Surf Clam BJB-B (5/03) Surf Clam BJB-A,B, and C (7/03, 8/03)	

Notes:
1. Shaded rows indicate no data was collected for these segments.
2. Segment IDs marked with an asterisk "*" were selected for characterization.

TABLE 2

SUMMARY OF DATA AVAILABLE BY SEGMENT

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	Water Samples	Subtidal Sediment	Intertidal Sediment	Marsh Core	Marsh Sediment	Shellfish Bed Raking	Chain Drags	Dive Survey	Lobster Pot	Shellfish	Absorbent Pad
W3C-04*	SWBJP-1 (4/29/03) SWBJP-1a (4/30/03) SWBJP-1b (5/01/03) SWBJP-1c (5/05/03) SWBJP-1d (5/12/03)	BJP-SED-S-1 (5/03) BJP-SED-S-2 (5/03) BJP-SED-S-3 (5/03) BJ-DS-S01 BJ-DS-S02 BJ-DS-S03 BJ-DS-S04 BJ-SS-S01 BJ-SS-S02 BJ-SS-S03 BJ-SS-S04	BJ-SED-UI-01 (5/03) BJ-SED-LI-01 (5/03) W3C04-P2-UIT-01 W3C04-P2-LIT-01 W3C04-P2-UIT-02 W3C04-P2-LIT-02 W3C04-P2-UIT-03 W3C04-P2-LIT-03			8 Locations (7/04)	7 Drags (9/04) 4 Drags off of Barney's Joy (5/03) (3 oiled) 7 Drags off of Barneys Joy Point (6/03) (2 oiled) 3 Drags Barneys Joy Point (6/03) 3 Drags Barneys Joy Point (6/03)	6 Bay Locations 7/03, 8/03)	Barneys Joy Point (5/30/03, 6/2/03, 6/5/03, 6/11/03, 6/13/03)		
W3C-06		DL-SS-S03 (8/04) DL-SS-S04 (8/04)			W3C06-M-01 (1/04) W3C06-M-02 (1/04) W3C06-M-03 (1/04)		same 5 drags as w3c-05				
W3D-07										Quahog GBWP-A, B, and C (5/03, 7/03)	GBWP -DP - 1 (5/03)

Notes:
1. Shaded rows indicate no data was collected for these segments.
2. Segment IDs marked with an asterisk "*" were selected for characterization.

TABLE 3

8/1/2006

SAMPLE INVENTORY BY SEGMENT SELECTED FOR CHARACTERIZATION

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	SAMPLE ID	COLLECTION DATE	MATRIX	ANALYSIS	PURPOSE	Segment to be included in 2006 RAO?	Data used in Phase II Risk Characterization?
W1C02	W1C02-MS01	8/25/04	SED	EPH, PAH	Marsh Assessment	Yes	Yes
W1C02	W1C02-P2-SUB-1A	9/13/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1C02	W1C02-P2-SUB-1B	9/13/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1C02	W1C02-P2-SUB-1C	9/13/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1C02	W1C02-P2-SUB-2A	9/13/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1C02	W1C02-P2-SUB-2B	9/13/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1C02	W1C02-P2-SUB-2C	9/13/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1C02	W1C02-TP01	8/23/-8/26/04	Water	EPH, PAH	Marsh Assessment	Yes	Incomplete Exposure Pathway
W1C02	W1C02-TP02	8/23/-8/26/04	Water	EPH, PAH	Marsh Assessment	Yes	Incomplete Exposure Pathway

TABLE 3

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SAMPLE INVENTORY BY SEGMENT SELECTED FOR CHARACTERIZATION

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	SAMPLE ID	COLLECTION DATE	MATRIX	ANALYSIS	PURPOSE	Segment to be included in 2006 RAO?	Data used in Phase II Risk Characterization?
W1D01	MOMA-SS-1-A, B and C	5/20/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W1D01	WID01-M-01-A, B and C	1/21/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W1D01	WID01-M-02-A, B and C	1/21/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W1D01	WID01-M-03-A, B and C	1/21/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W1D01	W1D01-P2-M-01A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1D01	W1D01-P2-M-01B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1D01	W1D01-P2-M-01C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1D01	W1D01-P2-M-02A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1D01	W1D01-P2-M-02B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1D01	W1D01-P2-M-02C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1D01	W1D01-P2-M-03A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1D01	W1D01-P2-M-03B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1D01	W1D01-P2-M-03C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes

TABLE 3

8/1/2006

SAMPLE INVENTORY BY SEGMENT SELECTED FOR CHARACTERIZATION

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	SAMPLE ID	COLLECTION DATE	MATRIX	ANALYSIS	PURPOSE	Segment to be included in 2006 RAO?	Data used in Phase II Risk Characterization?
W1E02	DDD-P2-03A	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes - duplicate of W1E02-P2-M-01A
W1E02	DDD-P2-03B	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes - duplicate of W1E02-P2-M-01B
W1E02	DDD-P2-03C	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes - duplicate of W1E02-P2-M-01C
W1E02	W1E02-P2-M-01A	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-M-01B	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-M-01C	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-M-02A	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-M-02B	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-M-02C	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-M-03A	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-M-03B	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-M-03C	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-M-04-A	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-M-04-B	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-M-04-C	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-M-05-A	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-M-05-B	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-M-05-C	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-SUB-01A	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-SUB-01B	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-SUB-01C	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-SUB-02-A	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-SUB-02-B	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E02	W1E02-P2-SUB-02-C	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes

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TABLE 3

SAMPLE INVENTORY BY SEGMENT SELECTED FOR CHARACTERIZATION

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	SAMPLE ID	COLLECTION DATE	MATRIX	ANALYSIS	PURPOSE	Segment to be included in 2006 RAO?	Data used in Phase II Risk Characterization?
W1E03	WIE03-UIT-01-A, B and C	1/21/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W1E03	WIE03-UIT-02-A, B and C	1/21/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W1E03	WIE03-UIT-03-A, B and C	1/21/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W1E03	W1E03-P2-SUB-01A	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E03	W1E03-P2-SUB-01B	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E03	W1E03-P2-SUB-01C	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E03	W1E03-P2-SUB-02A	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E03	W1E03-P2-SUB-02B	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E03	W1E03-P2-SUB-02C	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes

TABLE 3 8/1/2006

SAMPLE INVENTORY BY SEGMENT SELECTED FOR CHARACTERIZATION

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	SAMPLE ID	COLLECTION DATE	MATRIX	ANALYSIS	PURPOSE	Segment to be included in 2006 RAO?	Data used in Phase II Risk Characterization?
W1E04	DDD01-LIT-01-A, B and C	1/21/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes - duplicate of W1E04-LIT-01
W1E04	DDD01-UIT-01-A, B and C	1/21/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes - duplicate of W1E04-UIT-01
W1E04	WIE04-LIT-01-A, B and C	1/21/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W1E04	WIE04-LIT-02-A, B and C	1/21/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W1E04	WIE04-LIT-03-A, B and C	1/21/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W1E04	WIE04-UIT-01-A, B and C	1/21/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W1E04	WIE04-UIT-02-A, B and C	1/21/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W1E04	WIE04-UIT-03-A, B and C	1/21/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W1E04	W1E04-P2-LIT-01-A	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E04	W1E04-P2-LIT-01-B	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E04	W1E04-P2-LIT-01-C	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E04	W1E04-P2-UIT-01-A	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E04	W1E04-P2-UIT-01-B	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E04	W1E04-P2-UIT-01-C	8/31/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E04	W1E04-P2-LIT-02-A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E04	W1E04-P2-LIT-02-B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E04	W1E04-P2-LIT-02-C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E04	W1E04-P2-UIT-02-A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E04	W1E04-P2-UIT-02-B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1E04	W1E04-P2-UIT-02-C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes

TABLE 3

SAMPLE INVENTORY BY SEGMENT SELECTED FOR CHARACTERIZATION

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	SAMPLE ID	COLLECTION DATE	MATRIX	ANALYSIS	PURPOSE	Segment to be included in 2006 RAO?	Data used in Phase II Risk Characterization?
W1F02	HB-DUP-01	12/9/04	SED	EPH, PAH	Discovery of new oiling condition	Yes	Yes - duplicate of HB-SED-01
W1F02	HB-SED-01	12/9/04	SED	EPH, PAH	Discovery of new oiling condition	Yes	Yes
W1F02	HB-SED-01 (MS/MSD)	12/9/04	SED	EPH, PAH	Discovery of new oiling condition	Yes	No - QA/QC purposes
W1F02	HB-SED-02	12/9/04	SED	EPH, PAH	Discovery of new oiling condition	Yes	Yes
W1F02	HB-SED-03	12/9/04	SED	EPH, PAH	Discovery of new oiling condition	Yes	Yes
W1F02	HB-SED-04	12/9/04	SED	EPH, PAH	Discovery of new oiling condition	Yes	Yes
W1F02	HB-SED-05	12/9/04	SED	EPH, PAH	Discovery of new oiling condition	Yes	Yes
W1F02	HB-SED-06	12/9/04	SED	EPH, PAH	Discovery of new oiling condition	Yes	Yes
W1F02	HB-SED-07	12/9/04	SED	EPH, PAH	Discovery of new oiling condition	Yes	Yes
W1F02	HB-SED-08	12/9/04	SED	EPH, PAH	Discovery of new oiling condition	Yes	Yes
W1F02	HB-SED-09	12/9/04	SED	EPH, PAH	Discovery of new oiling condition	Yes	Yes
W1F02	LS-OS-S01	8/31/04	SED	FINGERPRINT	Howard Beach-Fingerprint	Yes	No, oiled Sand - more product than sediment
W1F02	LS-OS-S02	8/31/04	SED	FINGERPRINT	Howard Beach-Fingerprint	Yes	No, oiled Sand - more product than sediment
W1F02	BIMT-OY-1-A, B and C	5/20/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W1F02	BIMT-QH-1-A, B and C	5/20/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W1F02	BIMT-OY-2-A, B and C	6/10/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W1F02	BIMT-QH-2-A, B, C and D	6/10/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W1F02	BIMT-OY-3-A, B and C	7/10/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W1F02	BIMT-QH-3-A, B and C	7/10/03	TISSUE	PAH	Pre-Assessment	Yes	Yes
W1F02	BIMT-OY-4-A, B, and C	8/27/03	TISSUE	PAH	Pre-Assessment	Yes	Yes
W1F02	HB-092704	9/27/04	SED/TARBALL	PAH, TPH	Weathered oil	Yes	No - Sample not field preserved, fingerprintin
W1F02	HB-110904	11/9/04	SED/TARBALL	PAH, TPH	Weathered oil; depletion analysis	Yes	No - more product than sediment
W1F02	W1F02-P2-SUB-02A	9/13/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-02B	9/13/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-02C	9/13/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-03A	9/13/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-03B	9/13/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-03C	9/13/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-04A	9/13/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-04B	9/13/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-04C	9/13/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-05A	9/13/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-05B	9/13/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-05C	9/13/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	DDD-P2-06A	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes - duplicate of W1F02-P2-M-01A
W1F02	DDD-P2-06B	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes - duplicate of W1F02-P2-M-01B
W1F02	DDD-P2-06C	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes - duplicate of W1F02-P2-M-01C
W1F02	W1F02-P2-LIT-01A	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-LIT-01B	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-LIT-01C	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-LIT-02A	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-LIT-02B	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-LIT-02C	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-M-01A	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-M-01B	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-M-01C	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-01A	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-01B	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-01C	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-06A	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-06B	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-06C	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-07A	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-07B	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-07C	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-08A	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-08B	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-SUB-08C	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-UIT-01A	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-UIT-01B	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-UIT-01C	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-UIT-02A	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-UIT-02B	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	W1F02-P2-UIT-02C	9/14/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F02	BI-SED-LI-01	5/7/03	SED	PAH, TPH	Pre-Assessment	Yes	Not representative of current conditions
W1F02	BI-SED-UI-01	5/7/03	SED	PAH, TPH	Pre-Assessment	Yes	Not representative of current conditions
W1F02	WMN-Sed-S	5/13/03	SED	PAH	Pre-Assessment	Yes	Not representative of current conditions

TABLE 3

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SAMPLE INVENTORY BY SEGMENT SELECTED FOR CHARACTERIZATION

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	SAMPLE ID	COLLECTION DATE	MATRIX	ANALYSIS	PURPOSE	Segment to be included in 2006 RAO?	Data used in Phase II Risk Characterization?
W1F05	W1F05-MS01	8/23/-8/26/04	SED	EPH, PAH	Marsh Assessment	Yes	Yes
W1F05	DDD-P2-05-A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes - duplicate of W1F05-P2-M-05A
W1F05	DDD-P2-05-B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes - duplicate of W1F05-P2-M-05B
W1F05	DDD-P2-05-C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes - duplicate of W1F05-P2-M-05C
W1F05	W1F-05-P2-M-01-A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F05	W1F-05-P2-M-01-B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F05	W1F-05-P2-M-01-C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F05	W1F-05-P2-M-02-A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F05	W1F-05-P2-M-02-B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F05	W1F-05-P2-M-02-C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F05	W1F-05-P2-M-03-A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F05	W1F-05-P2-M-03-B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F05	W1F-05-P2-M-03-C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W1F05	W1F05-TP01	8/23/-8/26/04	Water	EPH, PAH	Marsh Assessment	Yes	Incomplete Exposure Pathway

TABLE 3

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SAMPLE INVENTORY BY SEGMENT SELECTED FOR CHARACTERIZATION

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	SAMPLE ID	COLLECTION DATE	MATRIX	ANALYSIS	PURPOSE	Segment to be included in 2006 RAO?	Data used in Phase II Risk Characterization?
W2A02	W2A02-92905-01	9/29/05	SED	--	DEP visit - Black sediment	Yes	Not analyzed
W2A02	W2A02-92905-02	9/29/05	SED	EPH, PAH	DEP visit - Black sediment	Yes	No - alternative PAH source
W2A02	W2A02-MS01	8/26/04	SED	EPH, PAH	Marsh Assessment	Yes	No - alternative PAH source
W2A02	W2A02-MS02	8/24/04	SED	EPH, PAH	Marsh Assessment	Yes	No - alternative PAH source
W2A02	W2A02-82905-01	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A02	W2A02-82905-02	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A02	W2A02-82905-03	8/29/05	SED	--	Phase II Sampling	Yes	Not analyzed
W2A02	W2A02-82905-04	8/29/05	SED	--	Phase II Sampling	Yes	Not analyzed
W2A02	W2A02-P2-M-01A	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	No - alternative PAH source
W2A02	W2A02-P2-M-01B	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	No - alternative PAH source
W2A02	W2A02-P2-M-01C	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	No - alternative PAH source
W2A02	W2A02-P2-M-02A	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	No - alternative PAH source
W2A02	W2A02-P2-M-02B	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	No - alternative PAH source
W2A02	W2A02-P2-M-02C	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	No - alternative PAH source
W2A02	W2A02-P2-M-03A	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	No - alternative PAH source
W2A02	W2A02-P2-M-03B	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	No - alternative PAH source
W2A02	W2A02-P2-M-03C	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	No - alternative PAH source
W2A02	W2A02-P2-M-04A	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A02	W2A02-P2-M-04B	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A02	W2A02-P2-M-04C	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A02	W2A02-TP01	8/24/04	Water	EPH, PAH	Marsh Assessment	Yes	Incomplete Exposure Pathway

TABLE 3

SAMPLE INVENTORY BY SEGMENT SELECTED FOR CHARACTERIZATION

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	SAMPLE ID	COLLECTION DATE	MATRIX	ANALYSIS	PURPOSE	Segment to be included in 2006 RAO?	Data used in Phase II Risk Characterization?
W2A03	FHHS-OY-1-A, B and C	5/7/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W2A03	FHHS-QH-1-A, B and C	5/7/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W2A03	FHHS-SS-1-A, B and C	5/7/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W2A03	SNNW-QH-1-A, B and C	5/21/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W2A03	SNNW-SS-1-A, B and C	5/21/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W2A03	FHHS-OY-2-A, B and C	7/8/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W2A03	FHHS-QH-2-A, B and C	7/8/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W2A03	FHHS-SS-2-A, B and C	7/8/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W2A03	W2A03-LIT-01-A, B and C	1/19/04	SED	EPH, PAH	MCP-Phase I Initial Site Investigation	Yes	Yes
W2A03	W2A03-LIT-02-A, B and C	1/19/04	SED	EPH, PAH	MCP-Phase I Initial Site Investigation	Yes	No - alternative PAH source
W2A03	W2A03-LIT-03-A, B and C	1/19/04	SED	EPH, PAH	MCP-Phase I Initial Site Investigation	Yes	Yes
W2A03	W2A03-UIT-01-A, B and C	1/19/04	SED	EPH, PAH	MCP-Phase I Initial Site Investigation	Yes	Yes
W2A03	W2A03-UIT-02-A, B and C	1/19/04	SED	EPH, PAH	MCP-Phase I Initial Site Investigation	Yes	Yes
W2A03	W2A03-UIT-03-A, B and C	1/19/04	SED	EPH, PAH	MCP-Phase I Initial Site Investigation	Yes	Yes
W2A03	FHHS-OY-3-A, B, and C	8/27/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W2A03	FHHS-QH-3-A, B, and C	8/27/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W2A03	FHHS-SS-3-A, B, and C	8/27/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W2A03	FHHS-OY-4-A, B and C	10/23/03	TISSUE	PAH	Shellfish Bed Reopening	Yes	Not representative of current conditions
W2A03	FHHS-SS-4-A, B and C	10/23/03	TISSUE	PAH	Shellfish Bed Reopening	Yes	Not representative of current conditions
W2A03	FHHS-OY-5	5/13/04	TISSUE	PAH	Shellfish Bed Reopening	Yes	Yes
W2A03	FHHS-QH-5	5/13/04	TISSUE	PAH	Shellfish Bed Reopening	Yes	Yes
W2A03	FHHS-SS-5	5/13/04	TISSUE	PAH	Shellfish Bed Reopening	Yes	Yes
W2A03	W2A03-P2-M-01A	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A03	W2A03-P2-M-01B	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A03	W2A03-P2-M-01C	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A03	W2A03-P2-M-02A	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A03	W2A03-P2-M-02B	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A03	W2A03-P2-M-02C	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A03	W2A03-P2-M-03A	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	No - alternative PAH source
W2A03	W2A03-P2-M-03B	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	No - alternative PAH source
W2A03	W2A03-P2-M-03C	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	No - alternative PAH source
W2A03	W2A03-P2-M-04A	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A03	W2A03-P2-M-04B	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A03	W2A03-P2-M-04C	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A03	W2A03-P2-M-05A	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A03	W2A03-P2-M-05B	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A03	W2A03-P2-M-05C	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A03	W2A03-P2-M-06A	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A03	W2A03-P2-M-06B	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A03	W2A03-P2-M-06C	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A03	PB-SED-LI-01	5/8/03	SED	PAH, TPH	Pre-Assessment	Yes	Not representative of current conditions
W2A03	PB-SED-UI-01	5/8/03	SED	PAH, TPH	Pre-Assessment	Yes	Not representative of current conditions
W2A03	W2A03-LIT-02A	1/19/04	SED	EPH, PAH	Reanalysis of aliquot	Yes	Yes
W2A03	W2A03-LIT-02B	1/19/04	SED	EPH, PAH	Reanalysis of aliquot	Yes	Yes
W2A03	W2A03-LIT-02C	1/19/04	SED	EPH, PAH	Reanalysis of aliquot	Yes	Yes
W2A03	W2A03-LIT-02A (MS/MSD)	1/19/04	SED	EPH, PAH	Reanalysis of aliquot	Yes	No - QA/QC purposes only
W2A03	PB-DS-S01	8/11/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes
W2A03	PB-DS-S02	8/11/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes
W2A03	PB-DS-S03	8/11/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes
W2A03	PB-DS-S04	8/11/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes
W2A03	PB-SS-S01	8/11/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes
W2A03	PB-SS-S02	8/11/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes
W2A03	PB-SS-S03	8/11/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes
W2A03	PB-SS-S04	8/11/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes

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SAMPLE INVENTORY BY SEGMENT SELECTED FOR CHARACTERIZATION

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	SAMPLE ID	COLLECTION DATE	MATRIX	ANALYSIS	PURPOSE	Segment to be included in 2006 RAO?	Data used in Phase II Risk Characterization?
W2A10	MNHH-QH-1-A	5/7/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W2A10	MNHH-SS-1-A	5/7/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W2A10	MNHH-QH-2-A, B and C	7/9/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W2A10	SWLI-QH-2-A, B and C	7/9/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W2A10	MNHH-QH-3-A, B, and C	8/27/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W2A10	MNHH-SS-2-A, B, and C	8/27/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W2A10	SWLI-QH-3-A, B, and C	8/27/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W2A10	MNHH-SS-3-A, B and C	10/23/03	TISSUE	PAH	Shellfish Bed Reopening	Yes	Not representative of current conditions
W2A10	SWLI-QH-4-A, B and C	10/23/03	TISSUE	PAH	Shellfish Bed Reopening	Yes	Not representative of current conditions
W2A10	W2A10-P2-M-01-A	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-M-01-B	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-M-01-C	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-M-02-A	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-M-02-B	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-M-02-C	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-M-03-A	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-M-03-B	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-M-03-C	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-M-04-A	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-M-04-B	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-M-04-C	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	MNHH-QH-5	5/13/04	TISSUE	PAH	Shellfish Bed Reopening	Yes	Yes
W2A10	MNHH-SS-5	5/13/04	TISSUE	PAH	Shellfish Bed Reopening	Yes	Yes
W2A10	SWLI-QH-5	5/13/04	TISSUE	PAH	Shellfish Bed Reopening	Yes	Yes
W2A10	W2A10-P2-LIT-01-A	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-LIT-01-B	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-LIT-01-C	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-LIT-02-A	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-LIT-02-B	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-LIT-02-C	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-LIT-03-A	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-LIT-03-B	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-LIT-03-C	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-LIT-05-A	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-LIT-05-B	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-LIT-05-C	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-UIT-01-A	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-UIT-01-B	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-UIT-01-C	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-UIT-02-A	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-UIT-02-B	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-UIT-02-C	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-UIT-03-A	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-C01	8/24/04	CORE	ARCHIVE/EPH	Top 2" sent to Groundwater Analytical	Yes	Yes
W2A10	W2A10-C02	8/24/04	CORE	ARCHIVE/EPH	Top 2" sent to Groundwater Analytical	Yes	Yes
W2A10	W2A10-C03	8/24/04	CORE	ARCHIVE/EPH	Top 2" sent to Groundwater Analytical	Yes	Yes
W2A10	W2A10-C04	8/24/04	CORE	ARCHIVE/EPH	Top 2" sent to Groundwater Analytical	Yes	Yes
W2A10	W2A10-P2-UIT-03-B	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-UIT-03-C	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-UIT-05-A	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-UIT-05-B	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	W2A10-P2-UIT-05-C	8/30/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A10	LI-DS-S01	8/11/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes
W2A10	LI-DS-S02	8/11/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes
W2A10	LI-DS-S03	8/11/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes
W2A10	LI-DS-S04	8/11/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes
W2A10	W2A10-ST-S01	7/22/04	SED	PAH, TPH, ALI/EPH	Subtidal-Diver Observed Oil	Yes	Yes
W2A10	W2A10-ST-S02	7/22/04	SED	PAH, TPH, ALI/EPH	Subtidal-Diver Observed Oil	Yes	Yes
W2A10	W2A10-ST-S03	7/22/04	SED	PAH, TPH, ALI/EPH	Subtidal-Diver Observed Oil	Yes	Yes
W2A10	W2A10-ST-S04	7/22/04	SED	PAH, TPH, ALI/EPH	Subtidal-Diver Observed Oil	Yes	Yes
W2A10	W2A10-ST-S05	7/22/04	SED	PAH, TPH, ALI/EPH	Subtidal-Diver Observed Oil	Yes	Yes
W2A10	W2A10-ST-S06	7/22/04	SED	PAH, TPH, ALI/EPH	Subtidal-Diver Observed Oil	Yes	Yes
W2A10	W2A10-ST-S07	7/22/04	SED	PAH, TPH, ALI/EPH	Subtidal-Diver Observed Oil	Yes	Yes
W2A10	W2A10-ST-S08	7/22/04	SED	PAH, TPH, ALI/EPH	Subtidal-Diver Observed Oil	Yes	Yes
W2A10	W2A10-ST-S09	7/22/04	SED	PAH, TPH, ALI/EPH	Subtidal-Diver Observed Oil	Yes	Yes
W2A10	W2A10-ST-XXX	7/22/04	SED	PAH, TPH, ALI/EPH	Subtidal-Diver Observed Oil	Yes	Duplicate of W2A10-ST-S07
W2A10	ACD-S01	8/11/04	SED	EPH, PAH	Town of Fairhaven Dredge Project	Yes	No - not collected for segment characterization purposes
W2A10	ACD-S02	8/11/04	SED	EPH, PAH	Town of Fairhaven Dredge Project	Yes	No - not collected for segment characterization purposes
W2A10	ACD-S03	8/11/04	SED	EPH, PAH	Town of Fairhaven Dredge Project	Yes	No - not collected for segment characterization purposes

TABLE 3

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SAMPLE INVENTORY BY SEGMENT SELECTED FOR CHARACTERIZATION

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	SAMPLE ID	COLLECTION DATE	MATRIX	ANALYSIS	PURPOSE	Segment to be included in 2006 RAO?	Data used in Phase II Risk Characterization?
W2A11	W2A11-LIT-01-A, B and C	1/20/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W2A11	W2A11-LIT-02-A, B and C	1/20/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W2A11	W2A11-LIT-03-A, B and C	1/20/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W2A11	W2A11-UIT-01-A, B and C	1/20/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W2A11	W2A11-UIT-02-A, B and C	1/20/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W2A11	W2A11-UIT-03-A, B and C	1/20/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W2A11	DDD-P2-01-A	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes - duplicate of W2A11-P2-UIT-02
W2A11	DDD-P2-01-B	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes - duplicate of W2A11-P2-UIT-02
W2A11	DDD-P2-01-C	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes - duplicate of W2A11-P2-UIT-02
W2A11	DDD-P2-02-A	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes - duplicate of W2A11-P2-LIT-02
W2A11	DDD-P2-02-B	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes - duplicate of W2A11-P2-LIT-02
W2A11	DDD-P2-02-C	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes - duplicate of W2A11-P2-LIT-02
W2A11	W2A11-P2-LIT-01-A	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A11	W2A11-P2-LIT-01-B	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A11	W2A11-P2-LIT-01-C	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A11	W2A11-P2-LIT-02-A	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A11	W2A11-P2-LIT-02-B	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A11	W2A11-P2-LIT-02-C	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A11	W2A11-P2-UIT-01-A	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A11	W2A11-P2-UIT-01-B	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A11	W2A11-P2-UIT-01-C	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A11	W2A11-P2-UIT-02-A	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A11	W2A11-P2-UIT-02-B	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A11	W2A11-P2-UIT-02-C	8/29/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W2A11	WI-SED-LI-01	5/8/03	SED	PAH, TPH	Pre-Assessment	Yes	Not representative of current conditions
W2A11	WI-SED-UI-01	5/8/03	SED	PAH, TPH	Pre-Assessment	Yes	Not representative of current conditions

TABLE 3

8/1/2006

SAMPLE INVENTORY BY SEGMENT SELECTED FOR CHARACTERIZATION

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	SAMPLE ID	COLLECTION DATE	MATRIX	ANALYSIS	PURPOSE	Segment to be included in 2006 RAO?	Data used in Phase II Risk Characterization?
W3A05	DDD-P2-04-A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes - duplicate of W3A05-P2-UIT-03
W3A05	DDD-P2-04-B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes - duplicate of W3A05-P2-UIT-03
W3A05	DDD-P2-04-C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes - duplicate of W3A05-P2-UIT-03
W3A05	W3A05-P2-LIT-01-A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3A05	W3A05-P2-LIT-01-B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3A05	W3A05-P2-LIT-01-C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3A05	W3A05-P2-LIT-02-A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	No - alternative PAH source
W3A05	W3A05-P2-LIT-02-B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	No - alternative PAH source
W3A05	W3A05-P2-LIT-02-C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	No - alternative PAH source
W3A05	W3A05-P2-LIT-03-A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3A05	W3A05-P2-LIT-03-B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3A05	W3A05-P2-LIT-03-C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3A05	W3A05-P2-UIT-01-A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3A05	W3A05-P2-UIT-01-B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3A05	W3A05-P2-UIT-01-C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3A05	W3A05-P2-UIT-02-A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3A05	W3A05-P2-UIT-02-B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3A05	W3A05-P2-UIT-02-C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3A05	W3A05-P2-UIT-03-A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3A05	W3A05-P2-UIT-03-B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3A05	W3A05-P2-UIT-03-C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes

TABLE 3

8/1/2006

SAMPLE INVENTORY BY SEGMENT SELECTED FOR CHARACTERIZATION

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	SAMPLE ID	COLLECTION DATE	MATRIX	ANALYSIS	PURPOSE	Segment to be included in 2006 RAO?	Data used in Phase II Risk Characterization?
W3C03	BJB-SC-1-A	5/6/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W3C03	BJB-SC-1-B	5/6/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W3C03	BJB-SC-2-A, B and C	7/10/03	TISSUE	PAH	Pre-Assessment	Yes	Not representative of current conditions
W3C03	BJB-SC-3-A, B, and C	8/28/03	TISSUE	PAH	Pre-Assessment	Yes	Yes
W3C03	W3C03-LIT-01-A, B and C	1/22/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W3C03	W3C03-LIT-02-A, B and C	1/22/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W3C03	W3C03-LIT-03-A, B and C	1/22/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W3C03	W3C03-MIT-01-A, B and C	1/22/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W3C03	W3C03-MIT-02-A, B and C	1/22/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W3C03	W3C03-MIT-03-A, B and C	1/22/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W3C03	W3C03-UIT-01-A, B and C	1/22/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W3C03	W3C03-UIT-02-A, B and C	1/22/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W3C03	W3C03-UIT-03-A, B and C	1/22/04	SED	ARCHIVE	MCP-Phase I Initial Site Investigation	Yes	Yes
W3C03	BJ-DS-S01	9/2/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes
W3C03	BJ-DS-S02	9/2/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes
W3C03	BJ-DS-S03	9/2/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes
W3C03	BJ-DS-S04	9/2/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes
W3C03	BJ-SS-S01	9/2/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes
W3C03	BJ-SS-S02	9/2/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes
W3C03	BJ-SS-S03	9/2/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes
W3C03	BJ-SS-S04	9/2/04	SED	EPH, PAH	Subtidal Sediment Assessment	Yes	Yes

TABLE 3 8/1/2006

SAMPLE INVENTORY BY SEGMENT SELECTED FOR CHARACTERIZATION

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Segment ID	SAMPLE ID	COLLECTION DATE	MATRIX	ANALYSIS	PURPOSE	Segment to be included in 2006 RAO?	Data used in Phase II Risk Characterization?
W3C04	W3C04-P2-LIT-01A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3C04	W3C04-P2-LIT-01B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3C04	W3C04-P2-LIT-01C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3C04	W3C04-P2-LIT-02A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3C04	W3C04-P2-LIT-02B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3C04	W3C04-P2-LIT-02C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3C04	W3C04-P2-LIT-03A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3C04	W3C04-P2-LIT-03B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3C04	W3C04-P2-LIT-03C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3C04	W3C04-P2-UIT-01A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3C04	W3C04-P2-UIT-01B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3C04	W3C04-P2-UIT-01C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3C04	W3C04-P2-UIT-02A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3C04	W3C04-P2-UIT-02B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3C04	W3C04-P2-UIT-02C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3C04	W3C04-P2-UIT-03A	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3C04	W3C04-P2-UIT-03B	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3C04	W3C04-P2-UIT-03C	9/1/05	SED	EPH, PAH	Phase II Sampling	Yes	Yes
W3C04	BJ-SED-LI-01	5/8/03	SED	PAH, TPH	Pre-Assessment	Yes	Not representative of current conditions
W3C04	BJ-SED-UI-01	5/8/03	SED	PAH, TPH	Pre-Assessment	Yes	Not representative of current conditions
W3C04	BJP-Sed-S	5/13/03	SED	PAH	Subtidal	Yes	Not representative of current conditions

TABLE 4a

SUMMARY OF SUBTIDAL SEDIMENT ANALYTICAL DATA

Buzzards Bay, Massachusetts

Analyte	Frequency of Detection # detected	/	Total analyzed	Range of Detected Concentrations (mg/kg) Min	Max	Maximum Concentration Location	Date	Average mg/kg	Median mg/kg
Extractable Petroleum Hydrocarbons (EPH)									
C19-C36 Aliphatic Hydrocarbons	5	/	59	47	92.5	W2A10-ST-S07 & -XXX	7/22/04	23	19
C11-C22 Aromatic Hydrocarbons	1	/	59	110	110	W2A10-ST-S07 & -XXX	7/22/04	21	19
Polycyclic Aromatic Hydrocarbons (PAH)									
Naphthalene	13	/	59	0.0043	0.023	W2A10-ST-S07 & -XXX	7/22/04	0.008	0.0069
2-Methylnapthalene	7	/	59	0.0033	0.019	W2A10-ST-S07 & -XXX	7/22/04	0.007	0.0065
Acenaphthylene	4	/	59	0.0033	0.019	W2A10-ST-S07 & -XXX	7/22/04	0.007	0.0065
Acenaphthene	4	/	59	0.0031	0.011	W2A10-ST-S07 & -XXX	7/22/04	0.007	0.0065
Fluorene	4	/	59	0.0031	0.015	W2A10-ST-S07 & -XXX	7/22/04	0.007	0.0065
Phenanthrene	13	/	59	0.0032	0.087	W2A10-ST-S07 & -XXX	7/22/04	0.012	0.0065
Anthracene	5	/	59	0.0033	0.029	W2A10-ST-S07 & -XXX	7/22/04	0.008	0.0065
Fluoranthene	15	/	59	0.0036	0.21	W2A10-ST-S07 & -XXX	7/22/04	0.020	0.0065
Pyrene	17	/	59	0.0038	0.26	W2A10-ST-S07 & -XXX	7/22/04	0.020	0.0065
Benzo(a)anthracene	13	/	59	0.0039	0.26	W2A10-ST-S07 & -XXX	7/22/04	0.016	0.0065
Chrysene	14	/	59	0.0041	0.35	W2A10-ST-S07 & -XXX	7/22/04	0.018	0.0065
Benzo(b)fluoranthene	9	/	59	0.0043	0.15	W2A10-ST-S07 & -XXX	7/22/04	0.012	0.0065
Benzo(k)fluoranthene	9	/	59	0.0035	0.068	PB-DS-S01	8/11/04	0.010	0.0065
Benzo(a)pyrene	14	/	59	0.0043	0.17	W2A10-ST-S07 & -XXX	7/22/04	0.014	0.0065
Indeno(1,2,3-cd)pyrene	8	/	59	0.0040	0.065	W2A10-ST-S07 & -XXX	7/22/04	0.010	0.0065
Dibenzo(a,h)anthracene	5	/	59	0.0032	0.026	W2A10-ST-S07 & -XXX	7/22/04	0.007	0.0065
Benzo(g,h,i)perylene	8	/	59	0.0038	0.062	W2A10-ST-S07 & -XXX	7/22/04	0.010	0.0065
Total PAH	22	/	59	0.062	1.8	W2A10-ST-S07 & -XXX	7/22/04	0.32	0.17

Notes:
1. These summary statistics are for the following samples collected in:
   July 2004: W2A10-ST-S01 through S09
   August 2004: PB-SS-S01 through -S04, PB-DS-S01 through -S04, LI-DS-S01 through -S04, DL-SS-S01 through -S04, DL-DS-S01 through -S04, SN-DS-S01 through -S04, SN-SS-S01 through -S04.
   September 2004: BJ-SS-S01 through -S04, BJ-DS-S01 through -S04
   August 2005: W1E02-P2-SUB-01, W1E02-P2-SUB-02, W1E03-P2-SUB-01, W1E03-P2-SUB-02
   September 2005: W1C02-P2-SUB-01, W1C02-P2-SUB-02, W1F02-P2-SUB-01 through SUB-08
2. All concentrations are presented in milligrams per kilogram (mg/kg) or parts per million.
3. For samples that were analyzed by more than one lab (i.e., B&B Laboratory and Groundwater Analytical), the results were averaged and this average was included in the summary statistics.
4. Average and median concentrations were calculated using one-half the detection limit for results that were reported as non-detected.
5. Results for duplicate samples were averaged with original sample and this value was included in the summary statistics.
   BSS-S01 & SN-SS-S03
   BSS-S02 & PB-SS-02
   W2A10-ST-S07 & W2A10-ST-XXX

TABLE 4b

SUMMARY OF INTERTIDAL SEDIMENT ANALYTICAL DATA

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	Frequency of Detection			*Range of Detected Concentrations (mg/kg)*		*Maximum Concentration*		*Average*	*Median*
Analyte	*# detected*	*/*	*Total analyzed*	*Min*	*Max*	*Location*	*Date*	*mg/kg*	*mg/kg*
Extractable Petroleum Hydrocarbons (EPH)	*No constituents were detected.*								
Polycyclic Aromatic Hydrocarbons (PAH)									
Naphthalene	48	/	71	0.0001	0.016	W3C03-MIT-01	1/22/04	0.007	0.01
2-Methylnapthalene	21	/	71	0.0001	0.018	W3C03-MIT-01	1/22/04	0.006	0.01
Acenaphthylene	3	/	71	0.0001	0.011	W2A03-UIT-03	1/19/04	0.005	0.01
Acenaphthene	7	/	71	0.0001	0.010	W3C03-UIT-01	1/22/04	0.005	0.01
Fluorene	9	/	71	0.0001	0.011	W2A03-UIT-03	1/19/04	0.005	0.01
Phenanthrene	29	/	71	0.0001	0.16	W2A03-UIT-03	1/19/04	0.012	0.01
Anthracene	13	/	71	0.0001	0.026	W3A05-P2-LIT-03	9/1/05	0.006	0.01
Fluoranthene	33	/	71	0.0002	0.31	W2A03-UIT-03	1/19/04	0.021	0.01
Pyrene	34	/	71	0.0003	0.30	W2A03-UIT-03	1/19/04	0.019	0.01
Benzo(a)anthracene	27	/	71	0.0001	0.11	W2A03-UIT-03	1/19/04	0.011	0.01
Chrysene	29	/	71	0.0004	0.13	W2A03-UIT-03	1/19/04	0.012	0.01
Benzo(b)fluoranthene	25	/	71	0.0004	0.11	W2A03-UIT-03	1/19/04	0.010	0.01
Benzo(k)fluoranthene	24	/	71	0.0001	0.095	W2A03-UIT-03	1/19/04	0.009	0.01
Benzo(a)pyrene	23	/	71	0.0003	0.17	W2A03-UIT-03	1/19/04	0.011	0.01
Indeno(1,2,3-cd)pyrene	29	/	71	0.0001	0.097	W2A03-UIT-03	1/19/04	0.009	0.01
Dibenzo(a,h)anthracene	16	/	71	0.0001	0.025	W3A05-P2-UIT-01	9/1/05	0.006	0.01
Benzo(g,h,i)perylene	23	/	71	0.0002	0.12	W2A03-UIT-03	1/19/04	0.009	0.01
Total PAH	50	/	70	0.0030	1.7	W2A03-UIT-03	1/19/04	0.17	0.10

Notes:
1. These summary statistics are for the following samples collected in:
   January 2004: W2A03-UIT-01 through -03, W2A03-LIT-01, W2A03-LIT-03, W2A11-UIT-01 through -03, W2A11-LIT-01 through -03, W1E03-UIT-01 through -03, W1E04-UIT-01 through -03, W1E04-LIT-01 through -03, W3C03-UIT-01 through -03, W3C03-MIT-01 through -03, W3C03-LIT-01 through -03
   December 2004: HB-SED-01 through -09
   August 2005: W2A02-82905-01, W2A02-82905-02, W2A11-P2-UIT-01, W2A11-P2-UIT-02, W2A11-P2-LIT-01, W2A11-P2-LIT-02, W2A10-P2-UIT-01 through -03, W2A10-P2-LIT-01 through -03, W2A10-P2-UIT-05, W2A10-P2-LIT-05 W1E04-UIT-01, W1E04-LIT-01
   September 2005: W1E04-P2-UIT-02, W1E04-P2-LIT-02, W3A05-P2-UIT-01 through -03, W3A05-P2-LIT-01, W3A05-P2-LIT-03 W3C04-P2-UIT-01 through -03, W3C04-P2-LIT-01 through -03, W1F02-P2-UIT-01, W1F02-P2-LIT-01, W1F02-P2-UIT-02, W1F02-P2-LIT-02
2. All concentrations are presented in milligrams per kilogram (mg/kg) or parts per million.
3. Results for duplicate samples were averaged with original sample and this value was included in the summary statistics.
   HB-SED-DUP-01 & HB-SED-01
   DDD01-UIT-01 & W1E04-UIT-01
   DDD01-LIT-01 & W1E04-LIT-01
   DDD-P2-01 & W2A11-P2-UIT-02
   DDD-P2-02 & W2A11-P2-LIT-02
   DDD-P2-04 & W3A05-P2-UIT-03
4. Average and median concentrations were calculated using one-half the detection limit for results that were reported as non-detected.

TABLE 4c

SUMMARY OF MARSH SEDIMENT ANALYTICAL DATA

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	Frequency of Detection			*Range of Detected Concentrations (mg/kg)*		*Maximum Concentration*		*Average*	*Median*
Analyte	*# detected*	*/*	*Total analyzed*	*Min*	*Max*	*Location*	*Date*	*mg/kg*	*mg/kg*
Extractable Petroleum Hydrocarbons (EPH)									
C19-C36 Aliphatic Hydrocarbons	1	/	31	110	110	W2A10-C01	8/24/04	26	20
C11-C22 Aromatic Hydrocarbons	2	/	31	62	180	W2A10-C01	8/24/04	29	20
Polycyclic Aromatic Hydrocarbons (PAH)									
Naphthalene	16	/	31	0.006	0.063	W1E02-P2-M-01	average with DDD-P2-03	0.010	0.009
2-Methylnapthalene	5	/	31	0.006	0.037	W2A10-C01	8/24/04	0.009	0.008
Acenaphthylene	1	/	31	0.007	0.007	W2A03-P2-M05	8/30/05	0.008	0.007
Acenaphthene	1	/	31	0.014	0.014	W2A10-C01	8/24/04	0.008	0.007
Fluorene	1	/	31	0.026	0.026	W2A10-C01	8/24/04	0.009	0.007
Phenanthrene	11	/	31	0.005	0.12	W2A10-C01	8/24/04	0.014	0.009
Anthracene	4	/	31	0.007	0.021	W2A10-C01	8/24/04	0.009	0.008
Fluoranthene	13	/	31	0.006	0.13	W2A03-P2-M05	8/30/05	0.020	0.009
Pyrene	14	/	31	0.0068	0.17	W2A10-C01	8/24/04	0.023	0.009
Benzo(a)anthracene	9	/	31	0.009	0.098	W2A10-C01	8/24/04	0.015	0.009
Chrysene	12	/	31	0.006	0.13	W2A10-C01	8/24/04	0.019	0.009
Benzo(b)fluoranthene	9	/	31	0.006	0.075	W2A03-P2-M05	8/30/05	0.015	0.008
Benzo(k)fluoranthene	6	/	31	0.005	0.030	W2A03-P2-M05	8/30/05	0.009	0.008
Benzo(a)pyrene	7	/	31	0.005	0.093	W2A10-C01	8/24/04	0.015	0.008
Indeno(1,2,3-cd)pyrene	13	/	31	0.0095	0.044	W2A03-P2-M05	8/30/05	0.013	0.010
Dibenzo(a,h)anthracene	9	/	31	0.012	0.031	W2A10-P2-M-01	8/30/05	0.011	0.009
Benzo(g,h,i)perylene	7	/	31	0.008	0.042	W2A10-P2-M-01	8/30/05	0.011	0.008
Total PAH	23	/	31	0.088	0.89	W2A10-C01	8/24/04	0.25	0.18

Notes:
1. These summary statistics are for the following samples collected in:
   January 2004: W1D01-M-01 through -03
   August 2004: W1C02-MS-01, W1F05-MS01, W2A10-C01 through -C04,
   W2A02-P2-M-04, W2A03-P2-M01, W2A03-P2-M02, W2A03-P2-M04 through -M06, W2A10-P2-M-01 through -04,
   W1E02-P2-M-01 through -05
   September 2005: W1D01-P2-M-01, W1D01-P2-M-02, W1F05-P2-M-01 through -03, W1F02-P2-M-01
   October 2005: W1D01-P2-M-03
2. All concentrations are presented in milligrams per kilogram (mg/kg) or parts per million.
3. Results for duplicate samples were averaged with original sample and this value was included in the summary statistics.
   DDD-P2-03 & W1E02-P2-M-01
   DDD-P2-05 & W1F05-P2-M-03
   DDD-P2-06 & W1F02-P2-M-01
4. Average and median concentrations were calculated using one-half the detection limit for results that were reported as non-detected.

TABLE 5
SUMMARY OF 2003 SURFACE WATER SAMPLES
Barge B120 Oil Spill
BUZZARDS BAY, MASSACHUSETTS

ANALYTE	SWAP-1: Near inlet of Allen's Pond					SWBJP-1: North end of Barney's Joy Point					Ambient Water Quality Criteria
Sampling Date:	4/29/2003	4/30/2003	5/1/2003	5/5/2003	5/12/2003	4/29/2003	4/30/2003	5/1/2003	5/5/2003	5/12/2003	Critieria Maximum Concentration
Naphthalene	ND (<0.0094) U	**0.012**	ND (<0.0095) U	**0.011**	ND (<0.013) U	**0.085**	ND (<0.0097) U	ND (<0.01) U	ND (<0.011) U	ND (<0.014) U	**2,350**
Methylnaphthalene, 2-	**0.019**	**0.030**	**0.022**	**0.024**	**0.021**	**0.28**	**0.019**	**0.025**	**0.025**	ND (<0.014) U	**300**
Acenaphthylene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.0095) U	ND (<0.011) U	ND (<0.013) U	ND (<0.0093) U	ND (<0.0097) U	ND (<0.01) U	ND (<0.011) U	ND (<0.014) U	**300**
Acenapthene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.0095) U	ND (<0.011) U	ND (<0.013) U	**0.020**	ND (<0.0097) U	ND (<0.01) U	ND (<0.011) U	ND (<0.014) U	**970**
Fluorene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.0095) U	ND (<0.011) U	ND (<0.013) U	**0.024**	ND (<0.0097) U	ND (<0.01) U	ND (<0.011) U	ND (<0.014) U	**300**
Phenanthrene	ND (<0.0094) U	**0.012**	**0.012**	ND (<0.011) U	ND (<0.013) U	**0.076**	ND (<0.0097) U	**0.014**	**0.014**	ND (<0.014) U	**7.7**
Anthracene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.0095) U	ND (<0.011) U	ND (<0.013) U	ND (<0.0093) U	ND (<0.0097) U	ND (<0.01) U	ND (<0.011) U	ND (<0.014) U	**300**
Fluoranthene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.0095) U	ND (<0.011) U	ND (<0.013) U	ND (<0.0093) U	ND (<0.0097) U	ND (<0.01) U	ND (<0.011) U	ND (<0.014) U	**40**
Pyrene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.0095) U	ND (<0.011) U	ND (<0.013) U	**0.024**	ND (<0.0097) U	ND (<0.01) U	ND (<0.011) U	ND (<0.014) U	**300**
Benzo[a]anthracene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.0095) U	ND (<0.011) U	ND (<0.013) U	**0.010**	ND (<0.0097) U	ND (<0.01) U	ND (<0.011) U	ND (<0.014) U	**300**
Chrysene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.0095) U	ND (<0.011) U	**0.026**	**0.030**	ND (<0.0097) U	ND (<0.01) U	ND (<0.011) U	ND (<0.014) U	**300**
Benzo[b]fluoranthene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.0095) U	ND (<0.011) U	**0.033**	ND (<0.0093) U	ND (<0.0097) U	ND (<0.01) U	ND (<0.011) U	ND (<0.014) U	**300**
Benzo[k]fluoranthene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.0095) U	ND (<0.011) U	ND (<0.013) U	ND (<0.0093) U	ND (<0.0097) U	ND (<0.01) U	ND (<0.011) U	ND (<0.014) U	**300**
Benzo[a]pyrene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.0095) U	ND (<0.011) U	ND (<0.013) U	ND (<0.0093) U	ND (<0.0097) U	ND (<0.01) U	ND (<0.011) U	ND (<0.014) U	**300**
Indeno[1,2,3-cd]pyrene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.0095) U	ND (<0.011) U	ND (<0.013) U	ND (<0.0093) U	ND (<0.0097) U	ND (<0.01) U	ND (<0.011) U	ND (<0.014) U	**300**
Dibenzo[a,h]anthracene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.0095) U	ND (<0.011) U	ND (<0.013) U	ND (<0.0093) U	ND (<0.0097) U	ND (<0.01) U	ND (<0.011) U	ND (<0.014) U	**300**
Benzo[g,h,i]perylene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.0095) U	ND (<0.011) U	ND (<0.013) U	ND (<0.0093) U	ND (<0.0097) U	ND (<0.01) U	ND (<0.011) U	ND (<0.014) U	**300**
Other PAH	**0.078**	**0.126**	**0.116**	**0.175**	**0.160**	**2.151**	**0.067**	**0.121**	**0.131**	**0.015**	**NA**
Total PAH	**0.097**	**0.180**	**0.150**	**0.210**	**0.240**	**2.700**	**0.086**	**0.160**	**0.170**	**0.015**	**300**

Notes:

1. All concentrations in ug/l (equivalent to parts per billion).
2. C1-Naphthalene reported value was used as a substitute for 2-Methylnaphthalene.
3. ND( ) = constituent not detected at practical quantitation limit noted in parentheses.

Notes from lab's validation report:

4. Samples with undetected PAHs can be considered as undetected ("U" qualifier) above the reporting method detection limit.
5. Concentrations with positive results below target reporting method detection limit can be considered as estimated ("J" qualifier).
6. "Other PAH" is the sum of other PAH (excluding those listed above) detected in the laboratory analysis.
7. "Total PAH" is the sum of all PAH detected in the laboratory analysis.

TABLE 5
SUMMARY OF 2003 SURFACE WATER SAMPLES
Barge B120 Oil Spill
BUZZARDS BAY, MASSACHUSETTS

ANALYTE	SWCC-1: Near Entrance of Clark's Cove					SWWP-1: Southwest of Wilbur's Point					Ambient Water Quality Criteria
Sampling Date:	4/29/2003	4/30/2003	5/1/2003	5/5/2003	5/12/2003	4/29/2003	4/30/2003	5/1/2003	5/5/2003	5/12/2003	Critieria Maximum Concentration
Naphthalene	ND (<0.0089) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.01) U	ND (<0.014) U	**0.018**	ND (<0.011) U	ND (<0.01) U	**0.013**	ND (<0.013) U	**2,350**
Methylnaphthalene, 2-	ND (<0.0089) U	ND (<0.0092) U	ND (<0.011) U	**0.011**	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	**0.011**	**0.015**	ND (<0.013) U	**300**
Acenaphthylene	ND (<0.0089) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.01) U	ND (<0.0099) U	ND (<0.013) U	**300**
Acenapthene	ND (<0.0089) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.01) U	ND (<0.0099) U	ND (<0.013) U	**970**
Fluorene	ND (<0.0089) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.01) U	ND (<0.0099) U	ND (<0.013) U	**300**
Phenanthrene	ND (<0.0089) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.01) U	ND (<0.014) U	**0.010**	ND (<0.011) U	**0.014**	**0.011**	ND (<0.013) U	**7.7**
Anthracene	ND (<0.0089) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.01) U	ND (<0.0099) U	ND (<0.013) U	**300**
Fluoranthene	ND (<0.0089) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.01) U	ND (<0.0099) U	ND (<0.013) U	**40**
Pyrene	ND (<0.0089) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.01) U	ND (<0.0099) U	ND (<0.013) U	**300**
Benzo[a]anthracene	ND (<0.0089) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.01) U	ND (<0.0099) U	ND (<0.013) U	**300**
Chrysene	ND (<0.0089) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.01) U	ND (<0.0099) U	ND (<0.013) U	**300**
Benzo[b]fluoranthene	ND (<0.0089) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.01) U	ND (<0.0099) U	ND (<0.013) U	**300**
Benzo[k]fluoranthene	ND (<0.0089) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.01) U	ND (<0.0099) U	ND (<0.013) U	**300**
Benzo[a]pyrene	ND (<0.0089) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.01) U	ND (<0.0099) U	ND (<0.013) U	**300**
Indeno[1,2,3-cd]pyrene	ND (<0.0089) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.01) U	ND (<0.014) U	**0.011**	ND (<0.011) U	ND (<0.01) U	ND (<0.0099) U	ND (<0.013) U	**300**
Dibenzo[a,h]anthracene	ND (<0.0089) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.01) U	ND (<0.0099) U	ND (<0.013) U	**300**
Benzo[g,h,i]perylene	ND (<0.0089) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.01) U	ND (<0.0099) U	ND (<0.013) U	**300**
Other PAH	**0.009**	**0.011**	ND	**0.012**	ND	**0.071**	**0.014**	**0.435**	**0.061**	**0.028**	**NA**
Total PAH	**0.009**	**0.011**	ND	**0.023**	ND	**0.110**	**0.014**	**0.460**	**0.1**	**0.028**	**300**

Notes:

1. All concentrations in ug/l (equivalent to parts per billion).
2. C1-Naphthalene reported value was used as a substitute for 2-Methylnaphthalene.
3. ND( ) = constituent not detected at practical quantitation limit noted in parentheses.

Notes from lab's validation report:

4. Samples with undetected PAHs can be considered as undetected ("U" qualifier) above the reporting method detection limit.
5. Concentrations with positive results below target reporting method detection limit can be considered as estimated ("J" qualifier).
6. "Other PAH" is the sum of other PAH (excluding those listed above) detected in the laboratory analysis.
7. "Total PAH" is the sum of all PAH detected in the laboratory analysis.

TABLE 5
SUMMARY OF 2003 SURFACE WATER SAMPLES
Barge B120 Oil Spill
BUZZARDS BAY, MASSACHUSETTS

ANALYTE	SWWI-1: One and a Half Miles South of West Island					SWWI-2: North of West Island					Ambient Water Quality Criteria
Sampling Date:	4/29/2003	4/30/2003	5/1/2003	5/5/2003	5/12/2003	4/29/2003	4/30/2003	5/1/2003	5/5/2003	5/12/2003	Critieria Maximum Concentration
Naphthalene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.018) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0095) U	**0.013**	ND (<0.011) U	ND (<0.011) U	ND (<0.012) U	**2,350**
Methylnaphthalene, 2-	**0.027**	**0.028**	**0.029**	ND (<0.01) U	ND (<0.013) U	**0.0097**	**0.047**	**0.024**	**0.014**	**0.014**	**300**
Acenaphthylene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.018) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0095) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.011) U	ND (<0.012) U	**300**
Acenapthene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.018) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0095) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.011) U	ND (<0.012) U	**970**
Fluorene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.018) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0095) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.011) U	ND (<0.012) U	**300**
Phenanthrene	**0.025**	**0.015**	**0.012**	ND (<0.01) U	ND (<0.013) U	ND (<0.0095) U	**0.027**	**0.016**	ND (<0.011) U	ND (<0.012) U	**7.7**
Anthracene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.018) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0095) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.011) U	ND (<0.012) U	**300**
Fluoranthene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.018) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0095) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.011) U	ND (<0.012) U	**40**
Pyrene	**0.014**	ND (<0.0094) U	ND (<0.018) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0095) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.011) U	ND (<0.012) U	**300**
Benzo[a]anthracene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.018) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0095) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.011) U	ND (<0.012) U	**300**
Chrysene	**0.013**	ND (<0.0094) U	ND (<0.018) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0095) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.011) U	ND (<0.012) U	**300**
Benzo[b]fluoranthene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.018) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0095) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.011) U	ND (<0.012) U	**300**
Benzo[k]fluoranthene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.018) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0095) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.011) U	ND (<0.012) U	**300**
Benzo[a]pyrene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.018) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0095) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.011) U	ND (<0.012) U	**300**
Indeno[1,2,3-cd]pyrene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.018) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0095) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.011) U	ND (<0.012) U	**300**
Dibenzo[a,h]anthracene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.018) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0095) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.011) U	ND (<0.012) U	**300**
Benzo[g,h,i]perylene	ND (<0.0094) U	ND (<0.0094) U	ND (<0.018) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0095) U	ND (<0.0092) U	ND (<0.011) U	ND (<0.011) U	ND (<0.012) U	**300**
Other PAH	**0.771**	**0.227**	**0.079**	**0.039**	**0.014**	**0.047**	**0.553**	**0.250**	**0.065**	**0.049**	**NA**
Total PAH	**0.850**	**0.270**	**0.120**	**0.039**	**0.014**	**0.057**	**0.640**	**0.290**	**0.079**	**0.063**	**300**

Notes:

1. All concentrations in ug/l (equivalent to parts per billion).
2. C1-Naphthalene reported value was used as a substitute for 2-Methylnaphthalene.
3. ND( ) = constituent not detected at practical quantitation limit noted in parentheses.

Notes from lab's validation report:

4. Samples with undetected PAHs can be considered as undetected ("U" qualifier) above the reporting method detection limit.
5. Concentrations with positive results below target reporting method detection limit can be considered as estimated ("J" qualifier).
6. "Other PAH" is the sum of other PAH (excluding those listed above) detected in the laboratory analysis.
7. "Total PAH" is the sum of all PAH detected in the laboratory analysis.

TABLE 5
SUMMARY OF 2003 SURFACE WATER SAMPLES
Barge B120 Oil Spill
BUZZARDS BAY, MASSACHUSETTS

ANALYTE	SWCL-1: Cleveland Ledge Lighthouse					SWCL-2: Three Mile South of Cleveland Ledge Lighthouse					Ambient Water Quality Criteria
Sampling Date:	4/29/2003	4/30/2003	5/1/2003	5/5/2003	5/12/2003	4/29/2003	4/30/2003	5/1/2003	5/5/2003	5/12/2003	Critieria Maximum Concentration
Naphthalene	ND (<0.011) U	**0.016**	ND (<0.0091) U	**0.015**	ND (<0.012) U	ND (<0.0095) U	ND (<0.0094) U	ND (<0.0093) U	ND (<0.01) U	ND (<0.013) U	**2,350**
Methylnaphthalene, 2-	ND (<0.011) U	**0.036**	**0.011**	ND (<0.01) U	ND (<0.012) U	ND (<0.0095) U	**0.015**	**0.016**	ND (<0.01) U	ND (<0.013) U	**300**
Acenaphthylene	ND (<0.011) U	ND (<0.0097) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.012) U	ND (<0.0095) U	ND (<0.0094) U	ND (<0.0093) U	ND (<0.01) U	ND (<0.013) U	**300**
Acenapthene	ND (<0.011) U	ND (<0.0097) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.012) U	ND (<0.0095) U	ND (<0.0094) U	ND (<0.0093) U	ND (<0.01) U	ND (<0.013) U	**970**
Fluorene	ND (<0.011) U	ND (<0.0097) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.012) U	ND (<0.0095) U	ND (<0.0094) U	ND (<0.0093) U	ND (<0.01) U	ND (<0.013) U	**300**
Phenanthrene	ND (<0.011) U	**0.020**	**0.0095**	ND (<0.01) U	ND (<0.012) U	**0.017**	**0.014**	**0.012**	ND (<0.01) U	ND (<0.013) U	**7.7**
Anthracene	ND (<0.011) U	ND (<0.0097) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.012) U	ND (<0.0095) U	ND (<0.0094) U	ND (<0.0093) U	ND (<0.01) U	ND (<0.013) U	**300**
Fluoranthene	ND (<0.011) U	ND (<0.0097) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.012) U	ND (<0.0095) U	ND (<0.0094) U	ND (<0.0093) U	ND (<0.01) U	ND (<0.013) U	**40**
Pyrene	ND (<0.011) U	ND (<0.0097) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.012) U	**0.013**	ND (<0.0094) U	ND (<0.0093) U	ND (<0.01) U	ND (<0.013) U	**300**
Benzo[a]anthracene	ND (<0.011) U	ND (<0.0097) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.012) U	ND (<0.0095) U	ND (<0.0094) U	ND (<0.0093) U	ND (<0.01) U	ND (<0.013) U	**300**
Chrysene	ND (<0.011) U	ND (<0.0097) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.012) U	**0.013**	ND (<0.0094) U	ND (<0.0093) U	ND (<0.01) U	ND (<0.013) U	**300**
Benzo[b]fluoranthene	ND (<0.011) U	ND (<0.0097) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.012) U	ND (<0.0095) U	ND (<0.0094) U	ND (<0.0093) U	ND (<0.01) U	ND (<0.013) U	**300**
Benzo[k]fluoranthene	ND (<0.011) U	ND (<0.0097) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.012) U	ND (<0.0095) U	ND (<0.0094) U	ND (<0.0093) U	ND (<0.01) U	ND (<0.013) U	**300**
Benzo[a]pyrene	ND (<0.011) U	ND (<0.0097) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.012) U	ND (<0.0095) U	ND (<0.0094) U	ND (<0.0093) U	ND (<0.01) U	ND (<0.013) U	**300**
Indeno[1,2,3-cd]pyrene	ND (<0.011) U	ND (<0.0097) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.012) U	ND (<0.0095) U	ND (<0.0094) U	ND (<0.0093) U	ND (<0.01) U	ND (<0.013) U	**300**
Dibenzo[a,h]anthracene	ND (<0.011) U	ND (<0.0097) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.012) U	ND (<0.0095) U	ND (<0.0094) U	ND (<0.0093) U	ND (<0.01) U	ND (<0.013) U	**300**
Benzo[g,h,i]perylene	ND (<0.011) U	ND (<0.0097) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.012) U	ND (<0.0095) U	ND (<0.0094) U	ND (<0.0093) U	ND (<0.01) U	ND (<0.013) U	**300**
Other PAH	ND	**0.378**	**0.060**	**0.065**	ND	**0.667**	**0.131**	**0.102**	**0.130**	ND	**NA**
Total PAH	ND	**0.450**	**0.080**	**0.080**	ND	**0.710**	**0.160**	**0.130**	**0.130**	ND	**300**

Notes:

1. All concentrations in ug/l (equivalent to parts per billion).
2. C1-Naphthalene reported value was used as a substitute for 2-Methylnaphthalene.
3. ND( ) = constituent not detected at practical quantitation limit noted in parentheses.

Notes from lab's validation report:

4. Samples with undetected PAHs can be considered as undetected ("U" qualifier) above the reporting method detection limit.
5. Concentrations with positive results below target reporting method detection limit can be considered as estimated ("J" qualifier).
6. "Other PAH" is the sum of other PAH (excluding those listed above) detected in the laboratory analysis.
7. "Total PAH" is the sum of all PAH detected in the laboratory analysis.

TABLE 5
SUMMARY OF 2003 SURFACE WATER SAMPLES
Barge B120 Oil Spill
BUZZARDS BAY, MASSACHUSETTS

ANALYTE	SWPI-1: Just North of Penikese Island				SWQH-1: Quicks Hole				Ambient Water Quality Criteria
Sampling Date:	4/30/2003	5/1/2003	5/5/2003	5/12/2003	4/30/2003	5/1/2003	5/5/2003	5/12/2003	Critieria Maximum Concentration
Naphthalene	ND (<0.0096) U	ND (<0.0096) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.011) U	ND (<0.013) U	**2,350**
Methylnaphthalene, 2-	**0.017**	ND (<0.0096) U	ND (<0.01) U	ND (<0.014) U	**0.0093**	ND (<0.011) U	ND (<0.011) U	ND (<0.013) U	**300**
Acenaphthylene	ND (<0.0096) U	ND (<0.0096) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.011) U	ND (<0.013) U	**300**
Acenapthene	ND (<0.0096) U	ND (<0.0096) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.011) U	ND (<0.013) U	**970**
Fluorene	ND (<0.0096) U	ND (<0.0096) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.011) U	ND (<0.013) U	**300**
Phenanthrene	**0.014**	ND (<0.0096) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.011) U	ND (<0.013) U	**7.7**
Anthracene	ND (<0.0096) U	ND (<0.0096) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.011) U	ND (<0.013) U	**300**
Fluoranthene	ND (<0.0096) U	ND (<0.0096) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.011) U	ND (<0.013) U	**40**
Pyrene	ND (<0.0096) U	ND (<0.0096) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.011) U	ND (<0.013) U	**300**
Benzo[a]anthracene	ND (<0.0096) U	ND (<0.0096) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.011) U	ND (<0.013) U	**300**
Chrysene	ND (<0.0096) U	ND (<0.0096) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.011) U	**0.023**	**300**
Benzo[b]fluoranthene	ND (<0.0096) U	ND (<0.0096) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.011) U	**0.014**	**300**
Benzo[k]fluoranthene	ND (<0.0096) U	ND (<0.0096) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.011) U	**0.021**	**300**
Benzo[a]pyrene	ND (<0.0096) U	ND (<0.0096) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.011) U	**0.016**	**300**
Indeno[1,2,3-cd]pyrene	ND (<0.0096) U	ND (<0.0096) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.011) U	ND (<0.013) U	**300**
Dibenzo[a,h]anthracene	ND (<0.0096) U	ND (<0.0096) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.011) U	**0.021**	**300**
Benzo[g,h,i]perylene	ND (<0.0096) U	ND (<0.0096) U	ND (<0.01) U	ND (<0.014) U	ND (<0.0093) U	ND (<0.011) U	ND (<0.011) U	**0.017**	**300**
Other PAH	**0.119**	**0.024**	**0.024**	ND	**0.015**	ND	ND	**0.018**	**NA**
Total PAH	**0.150**	**0.024**	**0.024**	ND	**0.024**	ND	ND	**0.130**	**300**

Notes:

1. All concentrations in ug/l (equivalent to parts per billion).
2. C1-Naphthalene reported value was used as a substitute for 2-Methylnaphthalene.
3. ND( ) = constituent not detected at practical quantitation limit noted in parentheses.

Notes from lab's validation report:

4. Samples with undetected PAHs can be considered as undetected ("U" qualifier) above the reporting method detection limit.
5. Concentrations with positive results below target reporting method detection limit can be considered as estimated ("J" qualifier).
6. "Other PAH" is the sum of other PAH (excluding those listed above) detected in the laboratory analysis.
7. "Total PAH" is the sum of all PAH detected in the laboratory analysis.

TABLE 5
SUMMARY OF 2003 SURFACE WATER SAMPLES
Barge B120 Oil Spill
BUZZARDS BAY, MASSACHUSETTS

ANALYTE	SWCH-1: Cuttyhunk Island				DUP-1	Ambient Water Quality Criteria
Sampling Date:	4/30/2003	5/1/2003	5/5/2003	5/12/2003	4/30/2003	Critieria Maximum Concentration
Naphthalene	ND (<0.01) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.013) U	**0.010**	**2,350**
Methylnaphthalene, 2-	ND (<0.01) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.013) U	**0.039**	**300**
Acenaphthylene	ND (<0.01) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0088) U	**300**
Acenapthene	ND (<0.01) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0088) U	**970**
Fluorene	ND (<0.01) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0088) U	**300**
Phenanthrene	**0.011**	ND (<0.0091) U	ND (<0.01) U	ND (<0.013) U	**0.017**	**7.7**
Anthracene	ND (<0.01) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0088) U	**300**
Fluoranthene	**0.014**	ND (<0.0091) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0088) U	**40**
Pyrene	**0.047**	ND (<0.0091) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0088) U	**300**
Benzo[a]anthracene	ND (<0.01) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0088) U	**300**
Chrysene	ND (<0.01) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0088) U	**300**
Benzo[b]fluoranthene	ND (<0.01) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0088) U	**300**
Benzo[k]fluoranthene	ND (<0.01) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0088) U	**300**
Benzo[a]pyrene	ND (<0.01) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0088) U	**300**
Indeno[1,2,3-cd]pyrene	ND (<0.01) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0088) U	**300**
Dibenzo[a,h]anthracene	ND (<0.01) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0088) U	**300**
Benzo[g,h,i]perylene	ND (<0.01) U	ND (<0.0091) U	ND (<0.01) U	ND (<0.013) U	ND (<0.0088) U	**300**
Other PAH	**0.000**	ND	ND	ND	**0.314**	**NA**
Total PAH	**0.072**	ND	ND	ND	**0.380**	**300**

Notes:

1. All concentrations in ug/l (equivalent to parts per billion).
2. C1-Naphthalene reported value was used as a substitute for 2-Methylnaphthalene.
3. ND( ) = constituent not detected at practical quantitation limit noted in parentheses.

Notes from lab's validation report:

4. Samples with undetected PAHs can be considered as undetected ("U" qualifier) above the reporting method detection limit.
5. Concentrations with positive results below target reporting method detection limit can be considered as estimated ("J" qualifier).
6. "Other PAH" is the sum of other PAH (excluding those listed above) detected in the laboratory analysis.
7. "Total PAH" is the sum of all PAH detected in the laboratory analysis.

TABLE 6

WEATHERED RESIDUAL OIL ANALYTICAL DATA USED IN RISK CHARACTERIZATION

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Sample ID Matrix Collection Date **Analyte**	Turner Ave-1 Product 06/29/05	TEF	BaP equivalents
Naphthalene	1.5J	--	--
C1-Naphthalenes	14J	--	--
C2-Naphthalenes	684J	--	--
C3-Naphthalenes	1860J	--	--
C4-Naphthalenes	1360J	--	--
Benzothiophene	0.9	--	--
C1-Benzothiophenes	7.2	--	--
C2-Benzothiophenes	49J	--	--
C3-Benzothiophenes	142J	--	--
Biphenyl	2.6	--	--
Acenaphthylene	<10	--	--
Acenaphthene	59.8	--	--
Dibenzofuran	11.7	--	--
Fluorene	49.0	--	--
C1-Fluorenes	385	--	--
C2-Fluorenes	1100	--	--
C3-Fluorenes	1320	--	--
Carbazole	<10	--	--
Anthracene	77.0	--	--
Phenanthrene	271	--	--
C1-Phenanthrene/Anthracenes	2470	--	--
C2-Phenanthrene/Anthracenes	6340	--	--
C3-Phenanthrene/Anthracenes	6760	--	--
C4-Phenanthrene/Anthracenes	3320	--	--
Dibenzothiophene	39.0	--	--
C1-Dibenzothiophenes	439	--	--
C2-Dibenzothiophenes	1020	--	--
C3-Dibenzothiophenes	1120	--	--
Fluoranthene	91.3	--	--
Pyrene	413	--	--
C1-Fluoranthenes/Pyrenes	2310	--	--
C2-Fluoranthenes/Pyrenes	3500	--	--
C3-Fluoranthenes/Pyrenes	2250	--	--
Benz(a)anthracene	446	0.1	45
Chrysene[3]	560	0.01	6
C1-Chrysenes	2570	--	--
C2-Chrysenes	2370	--	--
C3-Chrysenes	1100	--	--
C4-Chrysenes	27.4	--	--
Benzo(b)fluoranthene	154	0.1	15
Benzo(k)fluoranthene	27.9	0.01	0.28
Benzo(e)pyrene	129	--	--
Benzo(a)pyrene	288	1	288
Perylene	88.0	--	--
Indeno(1,2,3-c,d)pyrene	23.1	0.1	2.3
Dibenzo(a,h)anthracene	39.2	1	39
Benzo(g,h,i)perylene	44.8	--	--
2-Methylnaphthalene	5.5J	--	--
	45,340		395
	tPAH		BaP Equivalents
Non-cancer RBTC:	**124,235**	**Carcinogenic RBTC:**	**757**

Notes:
1. Concentrations are in milligrams per kilogram (mg/kg).
2. This sample represents the most recent analytical data for residual weathered oil. The presence of this oil was reported for the first time in 2005. All known occurrences of oil (including this one) have been remediated.
3. Value of chrysene + alkylated chrysenes = 6627 mg/kg prior to conversion to BaP eq.
4. "<" = less than detection limit; "J" - estimated value less than the detection limit
5. The RBTC is the calculated risk-based threshold concentration.

TABLE 7

TOTAL PAH CONCENTRATIONS IN COMPOSITE SHELLFISH SAMPLES
SAMPLES COLLECTED FROM PREVIOUSLY OILED SEGMENTS
June 2003 - May 2004

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Sample ID	Date Collected	Species	Location Collected	Total PAH (µg/kg)	BaP equivalents (µg/kg)
MDWI-OY	June 9 - 10, 2003	Oyster	Meadow Island in Sippican Harbor	122	3.0
MHHH-QH	June 9 - 10, 2003	Quahog	Mattapoisett Harbor	133	5.9
PCMA-QH	June 9 - 10, 2003	Quahog	Near Angelica Point, Mattapoisett	170	7.4
SHCV-QH	June 9 - 10, 2003	Quahog	Shaw's Cove, Fairhaven	180	8.4
LNGB-SS	June 9 - 10, 2003	Softshell Clam	Long Beach Point, North side of Long Beach near Indian Neck	46	3.8
MDWI-SS	June 9 - 10, 2003	Softshell Clam	Meadow Island in Sippican Harbor	90	5.5
Swift-SS	June 9 - 10, 2003	Softshell Clam	Swift's Beach, Wareham	186	10
BASS-BM	July 8-10, 2003	Blue Mussel	Bass Creek, East side of West Island of Nasketucket Bay	145	4.0
SLOC-OY	July 8-10, 2003	Oyster	Slocum	120	5.0
BASS-OY	July 8-10, 2003	Oyster	Bass Creek, East side of West Island of Nasketucket Bay	175	4.1
GBWP-QH	July 8-10, 2003	Quahog	East side of Gooseberry Island, Westport	38	3.1
BASS-QH	July 8-10, 2003	Quahog	Bass Creek, East side of West Island of Nasketucket Bay	59	2.6
NBOHFR-QH	July 8-10, 2003	Quahog	New Bedford Outer Harbor, Frederick Street	69	5.2
COWY-QH	July 8-10, 2003	Quahog	Cow Yard, Dartmouth	72	3.1
MPDA-QH	July 8-10, 2003	Quahog	East of Mishaum Point	107	5.0
BIMT-QH	July 8-10, 2003	Quahog	Brandt Island, Mattapoisett	108	4.5
BASS-SS	July 8-10, 2003	Softshell Clam	Bass Creek, East side of West Island of Nasketucket Bay	73	4.7
FHSB-SS	July 8-10, 2003	Softshell Clam	Fairhaven Sandy Beach, Northeastern side of Sconticut Neck near Little Bay of Nasketucket Bay	41	3.9
MEHH-SS	July 8-10, 2003	Softshell Clam	Mouth of East Pond in Mattapoisett Harbor	148	7.1
SHCV-SS	July 8-10, 2003	Softshell Clam	Shaw's Cove, Fairhaven	76	4.4
FHIN-BS	Aug 27 - 28, 2003	Bay Scallop	Fairhaven Inner Harbor in Nasketucket Bay, north of West Island	57	8.4
MONB-BS	Aug 27 - 28, 2003	Bay Scallop	Mattapoisett Outer Nasketucket Bay, Middle of mouth of Bay	79	6.6
FHIN-OY	Aug 27 - 28, 2003	Oyster	Fairhaven Inner Harbor in Nasketucket Bay, north of West Island	35	2.4
BIMT-OY	Aug 27 - 28, 2003	Oyster	Brandt Island, Mattapoisett	161	5.3
WHBR-QH	Aug 27 - 28, 2003	Quahog	Wild Harbor Basin, Falmouth	107	6.4
BJB-SC	Aug 27 - 28, 2003	Surf Clam	Barneys Joy Beach ¾ mile west	52	3.9
EEHH-OY	Oct 23 - 24, 2003	Oyster	Eastern mouth of Eel Pond	126	7.3
MDWI-QH	Oct 23 - 24, 2003	Quahog	Meadow Island in Sippican Harbor	24	2.7
FHHS-OY	May 13, 2004	Oyster	Fairhaven Hacker Street Upper reach of New Bedford/ Fairhaven Bay, not in New Bedford Harbor	101	3.6
FHHS-QH	May 14, 2004	Quahog	Fairhaven Hacker Street Upper reach of New Bedford/ Fairhaven Bay, not in New Bedford Harbor	49	2.3
FTPH-QH	May 16, 2004	Quahog	Fort Phoenix, Fairhaven	50	2.6
MNHH-QH	May 17, 2004	Quahog	Mouth of Nakata Creek, Southeast side of Sconticut Neck	31	1.6
SWLI-QH	May 19, 2004	Quahog	The Southwest side of Long Island in Fairhaven	172	7.2
WCSN-QH	May 20, 2004	Quahog	West Central side of Sconticut Neck	27	1.5
FHHS-SS	May 15, 2004	Softshell Clam	Fairhaven Hacker Street Upper reach of New Bedford/ Fairhaven Bay, not in New Bedford Harbor	139	13
MNHH-SS	May 18, 2004	Softshell Clam	Mouth of Nakata Creek, Southeast side of Sconticut Neck	79	5.5
WCSN-SS	May 21, 2004	Softshell Clam	West Central side of Sconticut Neck	68	5.0
			Site Shellfish Average	**95**	**5.0**
			Standard Deviation	*49*	*2.5*

TABLE 7

TOTAL PAH CONCENTRATIONS IN COMPOSITE SHELLFISH SAMPLES
SAMPLES COLLECTED FROM UNOILED SEGMENTS (EXISTING CONDITIONS)
May 2003

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Sample ID	Date Collected	Species	Location Collected	Total PAH (µg/kg)	BaP equivalents (µg/kg)
Rt88-BM	May 5 - 7, 2003	Blue Mussel	Route 88 Bridge at Westport Point in Westport Harbor	209	6.7
Brook-OY	May 5 - 7, 2003	Oyster	Great Island, Northeastern part of Great Island	85	1.9
MHRS-OY	May 5 - 7, 2003	Oyster	Megansett Harbor	99	1.6
PPBR-OY	May 5 - 7, 2003	Oyster	Plow Penny Road, Back River	37	1.2
WFHRS-OY	May 5 - 7, 2003	Oyster	West Falmouth Harbor	75	1.9
BRM-QH	May 5 - 7, 2003	Quahog	Back River Mouth	32	1.5
LNGB-QH	May 5 - 7, 2003	Quahog	Long Beach Point, North side of Long Beach near Indian Neck	68	1.9
MHRS-QH	May 5 - 7, 2003	Quahog	Megansett Harbor	53	2.1
RI-QH	May 5 - 7, 2003	Quahog	Ram Island, South side of Big Ram Island in Eastern Branch of Westport River	51	1.4
WFHRS-QH	May 5 - 7, 2003	Quahog	West Falmouth Harbor	83	2.0
EPBR-SS	May 5 - 7, 2003	Softshell Clam	Eel Pond Back River	88	7.8
Great-SS	May 5 - 7, 2003	Softshell Clam	Great Island, Southeastern part of island, Island is in the middle of Eastern Branch of Westport River	107	5.3
MHRS-SS	May 5 - 7, 2003	Softshell Clam	Megansett Harbor	102	2.5
WFHRS-SS	May 5 - 7, 2003	Softshell Clam	West Falmouth Harbor	109	4.0
			Background Average	**85**	**3.0**
			Standard Deviation	*43*	*2.1*

Notes:
1. Concentrations of tPAH in shellfish tissue are in micrograms per kilogram (µg/kg) or parts per billion.
2. Total PAH concentrations include all 54 individual PAH reported by B&B Lab, including substituted alkylated PAHs. Total PAH is the sum of detected PAH compounds plus one-half the detection limit of non-detected compounds.
3. Benzo(a)pyrene (BaP) equivalents were calculated based on USEPA (1993) Toxicity Equivalency Factors (TEF) recommended in MADEP Guidance (1995). Alkylated PAH were summed with their parent compound before BaP equivalents were calculated.

TABLE 8 8/28/2006

Total PAH Concentrations (in ng/dry g) for *Mytilus edulis* in Buzzards Bay Mussel Watch Sites

Year	Location						
	Angelica Rock	***Anglelica Point***	***Gooseberry Neck***	***West Falmouth***	***Naushon Island***	***Cape Cod Canal***	***Round Hill***
1989	NA	NA	NA	NA	NA	133.7	279.1
1990	507.5	NA	NA	109.6	102.1	145.7	289.8
1991	598.9	NA	NA	160.3	137.9	163.7	NA
1992	NA	NA	NA	252.7	221.37	231.7	NA
1993	461.4	NA	NA	NA	NA	NA	NA
1994	NA	NA	NA	118.5	157.44	151.4	1125.8
1996	463.2	168.5	NA	156.3	133.4	NA	621.1
1998	216.6	NA	NA	111.8	84.5	143.5	654.7
2000	NA	NA	NA	104.4	75.4	97.5	355.9
2002	NA	NA	NA	250	250.6	305.6	655.8

Data Source: NOAA Mussel Watch as of May 26, 2006

NA - Not Available

TABLE 9

SUMMARY OF CONSTITUENTS OF CONCERN AND TOXICITY EQUIVALENCY FACTORS
Barge B120 Oil Spill
Buzzards Bay, Massachusetts

ANALYTE	Subtidal Sediment	Intertidal Sediment	Marsh Sediment	Residual Weathered Oil	TEF[3]
2-Methylnaphthalene	COC	COC	COC	COC	
Acenaphthene	COC	COC	COC	COC	
Acenaphthylene	COC	COC	COC	--	
Anthracene	COC	COC	COC	COC	
Benzo(a)Anthracene	COC	COC	COC	COC	0.1
Benzo(a)Pyrene	COC	COC	COC	COC	1
Benzo(b)Fluoranthene	COC	COC	COC	COC	0.1
Benzo(g,h,i)Perylene	COC	COC	COC	COC	
Benzo(k)Fluoranthene	COC	COC	COC	COC	0.01
Chrysene	COC	COC	COC	COC	0.01
Dibenzo(a,h)anthracene	COC	COC	COC	COC	1
Fluoranthene	COC	COC	COC	COC	
Fluorene	COC	COC	COC	COC	
Indeno(1,2,3-cd)Pyrene	COC	COC	COC	COC	0.1
Naphthalene	COC	COC	COC	COC	
Phenanthrene	COC	COC	COC	COC	
Pyrene	COC	COC	COC	COC	
C11-C22 Aromatic Fraction	COC	--	COC	--	
C19-C36 Aliphatic Fraction	COC	--	COC	--	

Notes:
1. Detected constituents for each media were identified as Constituents of Concern (COC). If a constituent was not analyzed or reported as not detected, a "--" indicates this is not a COC.
2. Samples sent for "fingerprinting" were analyzed for alkylated PAH compounds. Since there is limited or no toxicity information available for these constituents, they are grouped with their parent PAH compounds for evaluation of potential risks to human health.
3. Toxicity Equivalency Factors (MADEP, 1995) were used to convert carcinogenic constituents into equivalent concentrations of benzo(a)pyrene ("BaP").

TABLE 10

HUMAN HEALTH EXPOSURE ASSESSMENT SUMMARY

Barge B120 Oil Spill
Buzzard's Bay, Massachusetts

Receptor Group	Media	Route of Exposure	Complete Exposure Pathway?	Description
Child/Adult Resident	Sediment (Subtidal, Intertidal & Marsh)	Dermal Contact	Yes	People residing along the shoreline may visit the beach or different shoreline types throughout the summer. Digging and playing in wet sand may facilitate exposure to COCs in sediment. Sediment may adhere to exposed skin and some sediment particles may be ingested during the time spent on the beach.
		Incidental Ingestion	Yes	
	Surface Water	Dermal Contact	No	Because release-related constituent concentrations declined to detection limits in a matter of weeks after the spill, there are no release-related COC to evaluate. Therefore these exposure pathways were not evaluated in the human health risk assessment.
		Incidental Ingestion	No	
	Shellfish	Consumption	No	It is not uncommon for local residents to harvest and consume shellfish from nearby beds. These shellfish may reside in sediment and filter seawater that contains small organic particulates, to which oil-related constituents adhere. Although concentrations of COC were comparable to samples collected from unoiled areas, quantifiable risk estimates are provided in Attachment IV which demonstrates this pathway is not a signficant contributor to overall risk estimates.
	Weathered Product	Dermal Contact	Yes	Children and adults digging below the surface of the sediment in the intertidal zones may encounter flecks of oil. If this occurs, oil may adhere to their skin. This receptor group may also rarely contact tacky tarballs or tarmats resulting in direct contact.
		Incidental Ingestion	Yes	If oil is deposited on their skin, children and possibly adults may ingest some portion of the oil.

TABLE 11

HUMAN HEALTH RISK EQUATIONS

Barge B120 OIl Spill
Buzzards Bay, Massachusetts

Dermal Contact with Sediment

$$\text{ADD or LADD}_{sed\text{-}dermal} = \frac{EPC_{sed} * DCR_{sed} * EF * ED * EP * RAF_{dermal} * C1}{BW * AP}$$

Incidental Ingestion of Sediment

$$\text{ADD or LADD}_{sed\text{-}oral} = \frac{EPC_{sed} * IR_{sed} * EF * ED * EP * RAF_{oral} * C1}{BW * AP}$$

Dermal Contact with Tarball/Weathered Oil

$$\text{ADD or LADD}_{oil\text{-}dermal} = \frac{EPC_{oil} * DCR_{oil} * EF * ED * EP * RAF_{dermal} * C1}{BW * AP}$$

Incidental Ingestion of Tarball/Weathered Oil

$$\text{ADD or LADD}_{oil\text{-}oral} = \frac{EPC_{oil} * IR_{oil} * EF * ED * EP * RAF_{oral} * C1}{BW * AP}$$

Where:

LADD:	mg/kg-day	Lifetime Average Daily Dose (Cancer)
ADD:	mg/kg-day	Average Daily Dose (non-cancer)
EPC:	mg/kg	Exposure Point Concentration
DCR:	mg/day	Dermal Contact Rate
IR:	mg/day	Ingestion Rate
EF:	events/yr	Exposure Frequency
ED:	days/event	Exposure Duration
EP:	years	Exposure Period
RAF:	unitless	Relative Absorption Factor
C1:	kg/mg	Unit Conversion Factor
BW:	kg/mg	Body Weight
AP:	days	Averaging Period
RfD:	mg/kg-day	Reference Dose
CSF:	(mg/kg/day)-1	Cancer Slope Factor
Rate of Contact	mg/day	ingestion rate or dermal contact rate

Non-Cancer Hazard Quotient (HQ)

HQ = ADD/RfD
Hazard Index (HI) = Σ HQs
HI is compared to the MCP Risk Limit (1.0)

Excess Lifetime Cancer Risk (ELCR)

ELCR = LADD * CSF
HI = Σ ELCR
HI is compared to the MCP Cancer Risk Limit (1.0×10^{-5})

In order to estimate the EPC, these equations must be rearranged algebraically and include a Target Risk level.

$$TR * RfD = \text{Dose}$$
non-cancer

or

$$\frac{TR}{CSF} = \text{Dose}$$
cancer

$$\rightarrow \quad EPC = \frac{BW * AP * (\text{ADD or LADD})}{\text{Rate of Contact} * EF * ED * EP * RAF * C1}$$

TABLE 12a

DERMAL CONTACT EXPOSURE ASSUMPTIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	Sediment		*Weathered Oil*		*General*					
	DCR mg/d	**EF** events/yr	**DCR** mg/d	**EF** events/yr	**ED** days/event	**EP** years	**CF** kg/mg	**BW** kg	**AP_{nc}** days	**AP_c** days
Child (1<2 years)	1,914	87	324	1	1	1	1.00E-06	11.15	365	--
Youth (1<8 years)	2,434	87	379	1	1	7	1.00E-06	17.2	2,555	--
Adult (1<31 years)	4,905	87	13.5	0.58	1	30	1.00E-06	47.7	--	27,375

Dermal Contact Rate (DCR)

	Child (ages 1-2)			**Youth (ages 1-8)**			**Adult (ages 18-30)**		
Body Part	SA (cm2/day)	AF (mg/cm2)	DCR_{sed} (mg/day)	SA (cm2/day)	AF (mg/cm2)	DCR_{sed} (mg/day)	SA (cm2/day)	AF (mg/cm2)	DCR_{sed} (mg/day)
Face:	342	1	342	329	1	329	370	1	370
Hands:	324	1	324	379	1	379	817	1	817
Forearms:	355	1	355	472	1	472	1150	1	1,150
Lower Legs	514	1	514	754	1	754	2180	1	2,180
Feet:	379	1	379	500	1	500	1140	1	1,140
		Total DCR:	1,914		Total DCR:	2,434		Total DCR:	5,657

Notes:

Dermal Contact Rate	DCR	(MADEP, 2002; USEPA, 2004) Lifetime DCR is age weighted = [(youth DCR * 7 years) + (adult DCR * 23 years)] / 30 years. The dermal contact rates were based on the average of skin surface area for face hands, forearms, lower legs, and feet for females within the specified age range multiplied by the sediment adherence factor of 1 mg/cm2. The sediment adherence factor and the skin surface areas for youths and adults was obtained from MADEP (2002d). The skin surface areas for young children are from USEPA (2004). The DCR for oil includes both hands for childhood (non-cancer) exposures, and the approximate skin surface area of the distal pad of three fingers for lifetime exposures. [(5,657 mg/day * 22 years) + (2,434 mg/day * 8 years)]/30 years
Exposure Frequency	EF	4 days/week from May through September for sediment. Children and youths are expected to contact tarballs once per year on average. Over a 30-year period, adults are less likely to encounter tarballs every year. See text, Section 3.2.5.2.
Exposure Duration	ED	MADEP, 1995.
Exposure Period	EP	Age interval
Relative Absorption Factor	RAF_{dermal}	MADEP, 1995; MADEP, 1994; MADEP, 1992.
Conversion Factor	CF	Constant ($1x10^{-6}$ kg/mg)
Body Weight	BW	MADEP, 1995 (Table B-1); average for age range
Averaging Period (non-cancer)	AP_{nc}	equals EP * 365 days/year
Averaging Period (cancer)	AP_c	equals average lifetime, 75 years * 365 days/year

TABLE 12b

INCIDENTAL INGESTION EXPOSURE ASSUMPTIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	Sediment		*Weathered Oil*		*General*						
	IR mg/d	**EF** events/yr	**IR** mg/d	**EF** events/yr	**ED** days/event	**EP** years	**CF** kg/mg	**BW** kg	**AP_{nc}** days	**AP_c** days	
Child (1<2 years)	100	87	100	1	1	1	1.00E-06	11.15	365	--	
Youth (1<8 years)	93	87	93	1	1	7	1.00E-06	17.2	2,555	--	
Adult (1<31 years)	60	87	60	0.58	1	30	1.00E-06	47.7	--	27,375	

Notes:

Ingestion Rate	IR	MADEP, 1995. A child aged 1-6 has an ingestion rate of soil of 100mg/d; older than 6 years has an ingestion rate of 60 mg/d. The Youth ingestion rate is age-weighted accordingly.
Exposure Frequency	EF	4 days/week from May through September for sediment. Children and youths are expected to contact tarballs once per year on average. Over a 30-year period, adults are less likely to encounter tarballs every year. See text, Section 3.2.5.2.
Exposure Duration	ED	MADEP, 1995
Exposure Period	EP	Age interval
Relative Absorption Factor	RAF_{dermal}	MADEP, 1995; MADEP, 1994; MADEP, 1992
Conversion Factor	C1	Constant ($1x10^{-6}$ kg/mg)
Body Weight	BW	MADEP, 1995 (Table B-1); average for age range
Averaging Period (non-cancer)	AP_{nc}	equals EP * 365 days/year
Averaging Period (cancer)	AP_c	equals average lifetime, 75 years * 365 days/year

TABLE 13

SUMMARY OF DOSE-RESPONSE INFORMATION - NONCARCINOGENIC EFFECTS - ORAL

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

COC	Oral Subchronic Reference Dose (mg/kg-day)		Oral Chronic Reference Dose (mg/kg-day)		Chronic Oral RfD UF X MF	Target Organ/System	Critical Effect	Study Animal	Study Method
Semi-Volatile Organic Compounds									
1-Methylnaphthalene	0.004	e	0.004	f					
2-Methylnaphthalene	0.004	e	0.004	a		lungs	Pulmonary alveolar proteinosis.		
Acenaphthene	0.6	c	0.06	a	3000 x 1	liver	hepatoxicity	mouse	oral-gavage
Acenaphthylene	0.3	g	0.03	g					
Anthracene	3	b	0.3	a	3000 x 1	NA	no observed effects	mouse	oral-gavage
Benzo(a)Anthracene	0.3	h	0.03	g					
Benzo(a)Pyrene	0.3	h	0.03	g					
Benzo [e] Pyrene									
Benzo(b)Fluoranthene	0.3	h	0.03	g					
Benzo(g,h,i)Perylene	0.3	h	0.03	g					
Benzo(k)Fluoranthene	0.3	h	0.03	g					
Benzothiophene									
Biphenyl	0.05	c	0.05	a	100x10	kidney	kidney damage	rat	oral-diet
Carbazole									
Chrysene	0.3	h	0.03	g					
Dibenzo(a,h)anthracene	0.3	h	0.03	g					
Dibenzofuran									
Dibenzothiophene									
Fluoranthene	0.4	b	0.04	a	3000 x 1	kidney, liver	nephropathy, increased liver weights, hematologica	mouse	oral-gavage
Fluorene	0.4	b	0.04	a	3000 x 1	blood	decreased RBC and hemoglobin	mouse	oral-gavage
Indeno(1,2,3-cd)Pyrene	0.3	h	0.03	g					
Naphthalene	0.02	e	0.02	a	3000 x 1	whole body	decreased body weight	rat	oral-gavage
Perylene									
Phenanthrene	0.3	h	0.03	g					
Phenol	0.6	c	0.3	a	100 x 1	whole body	decreased maternal weight	rat	oral-gavage
Pyrene	0.3	c	0.03	a	3000 x 1	kidney	tubular pathology, decreased organ weight	mouse	oral-gavage
VPH/EPH									
C9-C18 Aliphatic Fraction	1	b	0.1	b					
C19-C36 Aliphatic Fraction	6	b	2	b					
C11-C22 Aromatic Fraction	0.3	b	0.03	b					
Total Petroleum Hydrocarbons	0.3	i	0.03	i					

Hierarchy of Sources: a. US EPA Integrated Risk Information System (IRIS), http://www.epa.gov/IRIS, December 2005.
b. MADEP, Characterizing Risks Posed by Petroleum Contaminated Sites: Implementation of the MADEP VPH/EPH Approach, Final Policy (#WSC-02-411). Table 4-13. October 2002.
c. US EPA, Health Effects Assessment Summary Tables (HEAST), Office of Solid Waste and Emergency Response/Office of Emergency and Remedial Response, Annual FY 1997.
d. MADEP, Revisions to Dose-Response Values Used in Human Health Risk Assessment, August 2004.
e. In the absence of an agency-derived subchronic RfD, the chronic value was used.

Notes on Values Used:
f. Value from IRIS for 2-methylnaphthalene was used for 1-methylnaphthalene.
g. Value from IRIS for pyrene was used for PAHs for which a chronic RfD is not available.
h. Value from HEAST for pyrene was used for PAHs for which a subchronic RfD is not available.
i. Value for C11-C22 Aromatic Hydrocarbons used for Total Petroelum Hydrocarbons.

Notes: 1. A blank space indicates no data found.

Abbreviations: COC = Constituent of Concern; MADEP = Massachusetts Department of Environmental Protection;
MF= Modifying Factor; NA= Not Applicable; RBC = Red blood count; RfD = Reference Dose; UF= Uncertainty Factor.

TABLE 14

SUMMARY OF DOSE-RESPONSE INFORMATION - CARCINOGENIC EFFECTS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

COC	Weight of Evidence Class		Oral Cancer Slope Factor $(mg/kg/day)^{-1}$		Target Organ/System (oral)	Study Animal	Study Method
Semi-Volatile Organic Compounds							
1-Methylnaphthalene							
2-Methylnaphthalene							
Acenaphthene							
Acenaphthylene	D	a					
Anthracene	D	a					
Benzo(a)Anthracene	B2	a	7.30E-01	c			
Benzo(a)Pyrene	B2	a	7.30E+00	a	forestomach	mouse	oral-diet
Benzo [e] Pyrene							
Benzo(b)Fluoranthene	B2	a	7.30E-01	c			
Benzo(g,h,i)Perylene	D	a					
Benzo(k)Fluoranthene	B2	a	7.30E-02	c			
Benzothiophene							
Biphenyl							
Carbazole	B2	b	2.00E-02	b	liver	mouse	oral-diet
Chrysene	B2	a	7.30E-02	c			
Dibenzo(a,h)anthracene	B2	a	7.30E+00	c			
Dibenzofuran							
Dibenzothiophene							
Fluoranthene	D	a					
Fluorene	D	a					
Indeno(1,2,3-cd)Pyrene	B2	a	7.30E-01	c			
Naphthalene	C	a					
Perylene							
Phenanthrene	D	a					
Phenol	D	a					
Pyrene	D	a					
VPH/EPH							
C9-C18 Aliphatic Fraction							
C19-C36 Aliphatic Fraction							
C11-C22 Aromatic Fraction							
Total Petroleum Hydrocarbons							

Hierarchy of Sources: a. US EPA Integrated Risk Information System (IRIS), http://www.epa.gov/IRIS, December, 2005.
b. US EPA, 1997. Health Effects Summary Tables (HEAST), Office of Solid Waste and Emergency Response/Office of Emergency and Remedial Response, Annual FY 1997.

Notes on Values Used:
c. MADEP, 2001 (MCP Toxicity.xls). Conversion of the oral Cancer Slope Factor to the inhalation Unit Risk, using the equation: Slope Factor x Ventilation Rate x Constant / Body Weight
(CSF x V x C)/BW = (CSF x 20 m3/day x 0.001 mg/µg) / 70 kg

Notes:
1. Weight of evidence classification:
A: Human carcinogen
B: Probable human carcinogen
- B1: Limited evidence of carcinogenicity in humans from epidemiological studies
- B2: Sufficient evidence of carcinogenicity in animals, inadequate evidence in humans

C: Possible human carcinogen
D: Not classified
E: No evidence of carcinogenicity

2. Inhalation unit risk is defined as the risk per concentration unit in air, e.g. risk per $\mu g/m^3$.

3. Blank space indicates no data available.

Abbreviations: COC = Constituent of Concern; MADEP = Massachusetts Department of Environmental Protection; NA = Not Applicable/Not Available

TABLE 15

RELATIVE ABSORPTION FACTORS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

COC	Oral Soil/Sediment				Dermal Soil/Sediment			
	Carcinogen		Non-Carcinogen		Carcinogen		Non-Carcinogen	
Semi-Volatile Organic Compounds								
1-Methylnaphthalene								
2-Methylnaphthalene			1	a			0.10	a
Acenaphthene	1.00	a	1.00	a			0.20	a
Acenaphthylene			0.91	a			0.18	a
Anthracene			1	a			0.29	a
Benzo [a] Anthracene	1.00	a	0.91	a	0.20	a	0.18	a
Benzo [a] Pyrene	1.00	a	0.91	a	0.20	a	0.18	a
Benzo [e] Pyrene						a		
Benzo [b] Fluoranthene	1.00	a	0.91	a	0.20	a	0.18	a
Benzo [g,h,i] Perylene			0.91	a			0.18	a
Benzo [k] Fluoranthene	1.00	a	0.91	a	0.20	a	0.18	a
Benzothiophene								
Biphenyl			1.00	a			0.08	a
Carbazole								
Chrysene	1	a	0.91	a	0.2	a	0.18	a
Dibenzo(a,h)anthracene	1	a	1	a	0.09	a	0.08	a
Dibenzofuran								
Dibenzothiophene								
Fluoranthene			1.00	a			0.20	a
Fluorene			1.00	a			0.20	a
Indeno [1,2,3-cd] Pyrene	1.00	a	0.91	a	0.20	a	0.18	a
Naphthalene			1.00	a			0.1	a
Perylene								
Phenanthrene			0.91	a			0.18	a
Phenol			1	a			0.26	a
Pyrene			1	a			0.2	a
VPH/EPH								

TABLE 16

SUBCHRONIC NON-CANCER RISK ESTIMATES

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	HI	RfD	ADD	EPC_{tPAH} (mg/kg)
Dermal Contact with Sediment	0.25	0.3	7.50E-02	1,833
Incidental Ingestion of Sediment	0.25	0.3	7.50E-02	35,084
			Min EPC	**1833**
Dermal Contact with Tarball/Weathered Oil	0.25	0.3	7.50E-02	940,739
Incidental Ingestion of Tarball/Weathered Oil	0.25	0.3	7.50E-02	3,052,313
			Min EPC	**940,739**

Assumes all COCs are C11-C22 aromatics

Dermal Contact with Sediment

	value	units
ADD:	7.50E-02	mg/kg-day
EPC:	1833	mg/kg
DCR:	1914	mg/day
EF:	87	events/year
ED:	1	days/event
EP:	1	years
RAF:	1	unitless
C1:	0.000001	kg/mg
BW:	11.15	kg
AP_{nc}	365	days

Incidental Ingestion of Sediment

	value	units
ADD:	7.50E-02	mg/kg-day
EPC:	35084	mg/kg
IR:	100	mg/day
EF:	87	events/year
ED:	1	days/event
EP:	1	years
RAF:	1.00	unitless
C1:	0.000001	kg/mg
BW:	11.15	kg
AP_{nc}	365	days

Dermal Contact with Tarball/Weathered Oil

	value	units
ADD:	7.50E-02	mg/kg-day
EPC:	940,739	mg/kg
DCR:	324	mg/day
EF:	1	events/year
ED:	1	days/event
EP:	1	years
RAF:	1	unitless
C1:	0.000001	kg/mg
BW:	11.15	kg
AP_{nc}	365	days

Incidental Ingestion of Tarball/Weathered Oil

	value	units
ADD:	7.50E-02	mg/kg-day
EPC:	3,052,313	mg/kg
IR:	100	mg/day
EF:	1	events/year
ED:	1	days/event
EP:	1	years
RAF:	1	unitless
C1:	0.000001	kg/mg
BW:	11.15	kg
AP_{nc}	365	days

Tox input		
RfD	Subchronic Reference Dose for C11-C22	0.3
RAF_{oral}	Relative Absorption Factor (non-cancer)	1
RAF_{der}	Relative Absorption Factor (non-cancer)	1

See Tables 12a and 12b for exposure assumptions.

TABLE 17

CHRONIC NON-CANCER RISK ESTIMATES

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	HI	RfD	ADD	EPC_{tPAH} (mg/kg)
Dermal Contact with Sediment	0.25	0.03	7.50E-03	222
Incidental Ingestion of Sediment	0.25	0.03	7.50E-03	5,828
			Min EPC	**222**
Dermal Contact with Tarball/Weathered Oil	0.25	0.03	7.50E-03	124,235
Incidental Ingestion of Tarball/Weathered Oil	0.25	0.03	7.50E-03	506,290
			Min EPC	**124,235**

Assumes all COCs are C11-C22 aromatics

Dermal Contact with Sediment

	value	units
ADD:	7.50E-03	mg/kg-day
EPC:	222	mg/kg
DCR:	2434	mg/day
EF:	87	events/year
ED:	1	days/event
EP:	7	years
RAF:	1	unitless
C1:	0.000001	kg/mg
BW:	17.2	kg
AP_{nc}	2,555	days

Incidental Ingestion of Sediment

	value	units
ADD:	7.50E-03	mg/kg-day
EPC:	5828	mg/kg
IR:	93	mg/day
EF:	87	events/year
ED:	1	days/event
EP:	7	years
RAF:	1	unitless
C1:	0.000001	kg/mg
BW:	17.2	kg
AP_{nc}	2,555	days

Dermal Contact with Tarball/Weathered Oil

	value	units
ADD:	7.50E-03	mg/kg-day
EPC:	124,235	mg/kg
DCR:	379	mg/day
EF:	1	events/year
ED:	1	days/event
EP:	7	years
RAF:	1	unitless
C1:	0.000001	kg/mg
BW:	17.2	kg
AP_{nc}	2,555	days

Incidental Ingestion of Tarball/Weathered Oil

	value	units
ADD:	7.50E-03	mg/kg-day
EPC:	506,290	mg/kg
IR:	93	mg/day
EF:	1	events/year
ED:	1	days/event
EP:	7	years
RAF:	1	unitless
C1:	0.000001	kg/mg
BW:	17.2	kg
AP_{nc}	2,555	days

Tox input		
$RfD_{c11-c22}$	Reference dose for C11-C22 Aromatics	0.03
$RAF_{oral\_c11-c22}$	Relative Absorption Factor (noncancer)	1
$RAF_{der\_c11-c22}$	Relative Absorption Factor (noncancer)	1

See Tables 12a and 12b for exposure assumptions.

TABLE 18

CANCER RISK ESTIMATES

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	Target ELCR	CSF	LADD	EPC_{bap} (mg/kg)	
Dermal Contact with Sediment	5.00E-06	7.3	6.85E-07	0.35	0.34931166
Incidental Ingestion of Sediment	1.00E-06	7.3	1.37E-07	1.1	
			Min EPC	**0.35**	
Dermal Contact with Tarball/Weathered Oil	1.00E-06	7.3	1.37E-07	757	
Incidental Ingestion of Tarball/Weathered Oil	5.00E-06	7.3	6.85E-07	852	
			Min EPC	**757**	

Dermal Contact with Sediment

	value	units
LADD:	6.85E-07	mg/kg-day
EPC:	0.35	mg/kg
DCR:	4905	mg/day
EF:	87	events/year
ED:	1	days/event
EP:	30	years
RAF:	0.2	unitless
C1:	0.000001	kg/mg
BW:	47.7	kg
AP_c	27375	days

Incidental Ingestion of Sediment

	value	units
LADD:	1.37E-07	mg/kg-day
EPC:	1.14	mg/kg
IR:	60	mg/day
EF:	87	events/year
ED:	1	days/event
EP:	30	years
RAF:	1	unitless
C1:	0.000001	kg/mg
BW:	47.7	kg
AP_c	27375	days

Dermal Contact with Tarball/Weathered Oil

	value	units
LADD:	1.37E-07	mg/kg-day
EPC:	757	mg/kg
DCR:	13.5	mg/day
EF:	0.58	events/year
ED:	1	days/event
EP:	30	years
RAF:	1	unitless
C1:	0.000001	kg/mg
BW:	47.7	kg
AP_c	27375	days

Incidental Ingestion of Tarball/Weathered Oil

	value	units
LADD:	6.85E-07	mg/kg-day
EPC:	852	mg/kg
IR:	60	mg/day
EF:	0.58	events/year
ED:	1	days/event
EP:	30	years
RAF:	1	unitless
C1:	0.000001	kg/mg
BW:	47.7	kg
AP_c	27375	days

Tox input		
CSF_{bap}	Cancer slope factor for benzo(a)pyrene	7.3
RAF_{oral_bap}	Relative Absorption Factor (cancer)	1
RAF_{der_bap}	Relative Absorption Factor (cancer)	0.2

See Tables 12a and 12b for exposure assumptions.

TABLE 19

HUMAN HEALTH SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Analyte (mg/kg)	TEF[2] Sediment Type: Sample ID: Date Sampled:	Maximum EPC	*subtidal* W1C02-P2-SUB-01 9/13/05	*subtidal* W1C02-P2-SUB-02 9/13/05	*subtidal* W1E02-P2-SUB-01 8/31/05	*subtidal* W1E02-P2-SUB-02 8/31/05	*subtidal* W1E03-P2-SUB-01 8/31/05	*subtidal* W1E03-P2-SUB-02 8/31/05	*subtidal* W1F02-P2-SUB-01 9/14/05	*subtidal* W1F02-P2-SUB-02 9/13/05	*subtidal* W1F02-P2-SUB-03 9/13/05	*subtidal* W1F02-P2-SUB-04 9/13/05	*subtidal* W1F02-P2-SUB-05 9/13/05	*subtidal* W1F02-P2-SUB-06 9/14/05	*subtidal* W1F02-P2-SUB-07 9/14/05
Extractable Petroleum Hydrocarbons (EPH)															
C9-C18 Aliphatic Hydrocarbons	NA	ND	<40	<39	<36	<52	<35	<33	<38	<36	<35	<36	<34	<35	<36
C19-C36 Aliphatic Hydrocarbons	NA	78	<40	<39	<36	<52	<35	<33	<38	<36	<35	<36	<34	<35	<36
C11-C22 Aromatic Hydrocarbons	NA	73	<40	<39	<36	<52	<35	<33	<38	<36	<35	<36	<34	<35	<36
Polycyclic Aromatic Hydrocarbons (PAH)															
Naphthalene	NA	0.063	<0.017	<0.017	<0.012	<0.019	<0.012	0.01	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
2-Methylnapthalene	NA	0.019	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Acenaphthylene	NA	0.012	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Acenaphthene	NA	0.013	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Fluorene	NA	0.11	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Phenanthrene	NA	1.1	<0.017	<0.017	<0.012	<0.019	<0.012	0.01	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Anthracene	NA	0.026	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Fluoranthene	NA	0.31	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Pyrene	NA	1.2	<0.017	<0.017	<0.012	<0.019	<0.012	0.006	0.009	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Benzo(a)anthracene	0.1	0.19	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Chrysene	0.01	1.4	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Benzo(b)fluoranthene	0.1	0.11	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Benzo(k)fluoranthene	0.01	0.10	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Benzo(a)pyrene	1	0.17	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Indeno(1,2,3-cd)pyrene	0.1	0.10	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	0.01	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Dibenzo(a,h)anthracene	1	0.031	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	0.014	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Benzo(g,h,i)perylene	NA	0.12	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Other PAH[3]	NA	0.17	--	--	--	--	--	--	--	--	--	--	--	--	--
EPH + Total PAH RBTC[2]:	**222**	148	ND	ND	ND	ND	ND	0.103	0.152	ND	ND	ND	ND	ND	ND
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No	No

BaP Equivalents	TEF[2]	Maximum EPC	W1C02-P2-SUB-01 9/13/05	W1C02-P2-SUB-02 9/13/05	W1E02-P2-SUB-01 8/31/05	W1E02-P2-SUB-02 8/31/05	W1E03-P2-SUB-01 8/31/05	W1E03-P2-SUB-02 8/31/05	W1F02-P2-SUB-01 9/14/05	W1F02-P2-SUB-02 9/13/05	W1F02-P2-SUB-03 9/13/05	W1F02-P2-SUB-04 9/13/05	W1F02-P2-SUB-05 9/13/05	W1F02-P2-SUB-06 9/14/05	W1F02-P2-SUB-07 9/14/05
Extractable Petroleum Hydrocarbons (EPH)															
C9-C18 Aliphatic Hydrocarbons	NA		--	--	--	--	--	--	--	--	--	--	--	--	--
C19-C36 Aliphatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C11-C22 Aromatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAH)															
Naphthalene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylnapthalene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	0.1	0.019	--	--	--	--	--	--	--	--	--	--	--	--	--
Chrysene	0.01	0.014	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	0.1	0.011	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	0.01	0.001	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	1	0.17	--	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.1	0.010	--	--	--	--	--	--	0.001	--	--	--	--	--	--
Dibenzo(a,h)anthracene	1	0.031	--	--	--	--	--	--	0.014	--	--	--	--	--	--
Benzo(g,h,i)perylene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other PAH	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BaP equivalents RBTC[2]:	**0.35**	0.22	--	--	--	--	--	--	0.015	--	--	--	--	--	--
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Notes:
1. Benzo(a)pyrene or "BaP" equivalents were calculated for detectecd concentrations of constituents with toxicity equivalent factors (TEF). The detected concentration and the TEF were multiplied to yield a BaP equivalent.
2. The risk-based screening benchmaker (RBTC) for Total PAH and BaP equivalent risk-based threshold benchmark is derived (Tables 16 through 18).
3. Other PAH refer to constituents detected in samples analyzed by B&B laboratories for fingerprinting purposes. Other PAH include:benzothiphene, biphenyl, dibenzofuran, carbazole, dibenzothiphene, benzo(e)pyrene, and perylene. Concentrations of alkylated PAH compounds were summed with the concentration of the parent PAH compound and presented in this table.
4. EPH + Total PAH refers to the sum of all detected EPH fractions and the total PAH value, including alkylated PAH compounds which are summed with parent PAH.
5. NA = not available; "<" = less than detection limit; "--" = not analyzed/not converted to BaP eqivalents; mg/kg = milligrams per kilogram

TABLE 19

HUMAN HEALTH SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Analyte (mg/kg)	TEF[2]													
	Sediment Type:	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*
	Sample ID:	W1F02-P2-SUB-08	PB-SS-S01	PB-SS-S02	PB-SS-S03	PB-SS-S04	PB-DS-S01	PB-DS-S02	PB-DS-S03	PB-DS-S04	W2A10-ST-S01	W2A10-ST-S02	W2A10-ST-S03	W2A10-ST-S04
	Date Sampled:	9/14/05	8/11/04	averaged with BSS-S01	8/11/04	8/11/04	8/11/04	8/11/04	8/11/04	8/11/04	7/22/04	7/22/04	7/22/04	7/22/04
Extractable Petroleum Hydrocarbons (EPH)														
C9-C18 Aliphatic Hydrocarbons	NA	<37	<39	<38	<33	<36	<45	<49	<48	<40	<35	<35	<37	<35
C19-C36 Aliphatic Hydrocarbons	NA	<37	<39	<38	<33	<36	47	78	53	<40	<35	<35	<37	<35
C11-C22 Aromatic Hydrocarbons	NA	<37	<39	<38	<33	<36	<45	<49	<48	<40	<35	<35	<37	<35
Polycyclic Aromatic Hydrocarbons (PAH)														
Naphthalene	NA	<0.017	<0.013	<0.013	<0.011	<0.012	<0.015	<0.016	<0.016	<0.014	0.009	0.011	0.009	0.009
2-Methylnapthalene	NA	<0.017	<0.013	<0.013	<0.011	<0.012	<0.015	<0.016	<0.016	<0.014	<0.012	<0.012	<0.012	<0.012
Acenaphthylene	NA	<0.017	<0.013	<0.013	<0.011	<0.012	<0.015	<0.016	<0.016	<0.014	<0.012	<0.012	<0.012	<0.012
Acenaphthene	NA	<0.017	<0.013	<0.013	<0.011	<0.012	<0.015	<0.016	<0.016	<0.014	<0.012	<0.012	<0.012	<0.012
Fluorene	NA	<0.017	<0.013	<0.013	<0.011	<0.012	<0.015	<0.016	<0.016	<0.014	<0.012	<0.012	<0.012	<0.012
Phenanthrene	NA	<0.017	<0.013	<0.013	<0.011	<0.012	0.067	0.035	0.023	0.023	<0.012	<0.012	<0.012	<0.012
Anthracene	NA	<0.017	<0.013	<0.013	<0.011	<0.012	0.025	<0.016	<0.016	<0.014	<0.012	<0.012	<0.012	<0.012
Fluoranthene	NA	<0.017	<0.013	<0.013	0.011	<0.012	0.19	0.077	0.058	0.05	<0.012	<0.012	<0.012	<0.012
Pyrene	NA	<0.017	<0.013	<0.013	<0.011	<0.012	0.14	0.064	0.05	0.051	<0.012	0.009	<0.012	<0.012
Benzo(a)anthracene	0.1	<0.017	<0.013	<0.013	<0.011	<0.012	0.075	0.033	0.025	0.026	<0.012	<0.012	<0.012	<0.012
Chrysene	0.01	<0.017	<0.013	<0.013	<0.011	<0.012	0.072	0.03	0.027	0.026	<0.012	0.012	<0.012	<0.012
Benzo(b)fluoranthene	0.1	<0.017	<0.013	<0.013	<0.011	<0.012	0.058	0.025	0.021	0.021	<0.012	<0.012	<0.012	<0.012
Benzo(k)fluoranthene	0.01	<0.017	<0.013	<0.013	<0.011	<0.012	0.068	0.025	0.02	0.02	<0.012	<0.012	<0.012	<0.012
Benzo(a)pyrene	1	<0.017	<0.013	<0.013	<0.011	<0.012	0.087	0.034	0.028	0.029	<0.012	0.008	<0.012	<0.012
Indeno(1,2,3-cd)pyrene	0.1	<0.017	<0.013	<0.013	<0.011	<0.012	0.043	0.019	<0.016	0.015	<0.012	<0.012	<0.012	<0.012
Dibenzo(a,h)anthracene	1	<0.017	<0.013	<0.013	<0.011	<0.012	<0.015	<0.016	<0.016	<0.014	<0.012	<0.012	<0.012	<0.012
Benzo(g,h,i)perylene	NA	<0.017	<0.013	<0.013	<0.011	<0.012	0.045	0.02	0.017	0.017	<0.012	<0.012	<0.012	<0.012
Other PAH[3]	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
EPH + Total PAH RBTC[2]:	**222**	ND	ND	ND	0.099	ND	92.915	127.418	101.333	0.327	0.105	0.118	0.105	0.105
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No

BaP Equivalents	TEF[2]	W1F02-P2-SUB-08	PB-SS-S01	PB-SS-S02	PB-SS-S03	PB-SS-S04	PB-DS-S01	PB-DS-S02	PB-DS-S03	PB-DS-S04	W2A10-ST-S01	W2A10-ST-S02	W2A10-ST-S03	W2A10-ST-S04
		9/14/05	8/11/04	averaged with BSS-S01	8/11/04	8/11/04	8/11/04	8/11/04	8/11/04	8/11/04	7/22/04	7/22/04	7/22/04	7/22/04
Extractable Petroleum Hydrocarbons (EPH)														
C9-C18 Aliphatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
C19-C36 Aliphatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
C11-C22 Aromatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAH)														
Naphthalene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylnapthalene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	0.1	--	--	--	--	--	0.0075	0.0033	0.0025	0.0026	--	--	--	--
Chrysene	0.01	--	--	--	--	--	0.00072	0.0003	0.00027	0.00026	--	0.00012	--	--
Benzo(b)fluoranthene	0.1	--	--	--	--	--	0.0058	0.0025	0.0021	0.0021	--	--	--	--
Benzo(k)fluoranthene	0.01	--	--	--	--	--	0.00068	0.00025	0.0002	0.0002	--	--	--	--
Benzo(a)pyrene	1	--	--	--	--	--	0.087	0.034	0.028	0.029	--	0.008	--	--
Indeno(1,2,3-cd)pyrene	0.1	--	--	--	--	--	0.0043	0.0019	--	0.0015	--	--	--	--
Dibenzo(a,h)anthracene	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Other PAH	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
BaP equivalents RBTC[2]:	**0.35**	--	--	--	--	--	0.106	0.04225	0.03307	0.03566	--	0.00812	--	--
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No

Notes:
1. Benzo(a)pyrene or "BaP" equivalents were calculated for detectecd concentrations of constituents with toxicity equivalent factors (TEF). The detected concentration and the TEF were multiplied to yield a BaP equivalent.
2. The risk-based screening benchmaker (RBTC) for Total PAH and BaP equivalent risk-based threshold benchmark is derived (Tables 16 through 18).
3. Other PAH refer to constituents detected in samples analyzed by B&B laboratories for fingerprinting purposes. Other PAH include:benzothiphene, biphenyl, dibenzofuran, carbazole, dibenzothiphene, benzo(e)pyrene, and perylene. Concentrations of alkylated PAH compounds were summed with the concentration of the parent PAH compound and presented in this table.
4. EPH + Total PAH refers to the sum of all detected EPH fractions and the total PAH value, including alkylated PAH compounds which are summed with parent PAH.
5. NA = not available; "<" = less than detection limit; "--" = not analyzed/not converted to BaP eqivalents; mg/kg = milligrams per kilogram

TABLE 19

HUMAN HEALTH SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Analyte (mg/kg)	TEF[2]													
	Sediment Type:	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*
	Sample ID:	W2A10-ST-S05	W2A10-ST- S06, S07 & XXX, S08	W2A10-ST-S09	LI-DS-S01	LI-DS-S02	LI-DS-S03	LI-DS-S04	BJ-SS-S01	BJ-SS-S02	BJ-SS-S03	BJ-SS-S04	BJ-DS-S01	BJ-DS-S02
	Date Sampled:	7/22/04		7/22/04	8/11/04	8/11/04	8/11/04	8/11/04	9/2/04	9/2/04	9/2/04	9/2/04	9/2/04	9/2/04
Extractable Petroleum Hydrocarbons (EPH)														
C9-C18 Aliphatic Hydrocarbons	NA	<39	<32	<36	<52	<44	<34	<38	<37	<46	<36	<40	<40	<38
C19-C36 Aliphatic Hydrocarbons	NA	<39	42	<36	<52	<44	<34	<38	<37	<46	<36	<40	<40	<38
C11-C22 Aromatic Hydrocarbons	NA	<39	48	<36	<52	<44	<34	<38	<37	<46	<36	<40	<40	<38
Polycyclic Aromatic Hydrocarbons (PAH)														
Naphthalene	NA	0.011	0.0596	0.0018	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	0.005	<0.013
2-Methylnapthalene	NA	<0.013	0.0057	0.0005	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	0.005	<0.013
Acenaphthylene	NA	<0.013	0.0119	0.0006	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	<0.013	<0.013
Acenaphthene	NA	<0.013	0.0058	0.0001	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	<0.013	<0.013
Fluorene	NA	<0.013	0.108	0.0001	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	<0.013	<0.013
Phenanthrene	NA	0.032	1.13	0.0059	<0.018	<0.015	<0.011	<0.012	<0.012	0.007	<0.012	<0.013	0.007	<0.013
Anthracene	NA	<0.013	0.0234	0.0006	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	<0.013	<0.013
Fluoranthene	NA	0.017	0.169	0.0012	0.033	0.018	<0.011	<0.012	<0.012	0.007	<0.012	<0.013	0.008	<0.013
Pyrene	NA	0.025	1.18	0.0087	0.032	0.024	<0.011	<0.012	<0.012	0.011	<0.012	<0.013	0.006	<0.013
Benzo(a)anthracene	0.1	0.012	0.193	0.0017	<0.018	0.016	<0.011	<0.012	<0.012	0.006	<0.012	<0.013	0.005	<0.013
Chrysene	0.01	0.014	1.45	0.0129	0.019	0.016	<0.011	<0.012	<0.012	0.006	<0.012	<0.013	<0.013	<0.013
Benzo(b)fluoranthene	0.1	<0.013	0.103	0.0026	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	<0.013	<0.013
Benzo(k)fluoranthene	0.01	<0.013	0.0281	0.0009	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	<0.013	<0.013
Benzo(a)pyrene	1	0.01	0.0981	0.0025	0.019	0.017	<0.011	<0.012	<0.012	0.005	<0.012	<0.013	<0.013	<0.013
Indeno(1,2,3-cd)pyrene	0.1	<0.013	0.0662	0.0019	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	<0.013	<0.013
Dibenzo(a,h)anthracene	1	<0.013	0.0153	0.0003	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	<0.013	<0.013
Benzo(g,h,i)perylene	NA	<0.013	0.0510	0.0016	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	<0.013	<0.013
Other PAH[3]	NA	--	0.172	0.0008	--	--	--	--	--	--	--	--	--	--
EPH + Total PAH RBTC[2]:	**222**	0.186	111	0.0439	0.22	0.181	ND	ND	ND	0.13	ND	ND	0.1075	ND
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No

BaP Equivalents	TEF[2]	W2A10-ST-S05	0-ST- S06, S07 & XXX	W2A10-ST-S09	LI-DS-S01	LI-DS-S02	LI-DS-S03	LI-DS-S04	BJ-SS-S01	BJ-SS-S02	BJ-SS-S03	BJ-SS-S04	BJ-DS-S01	BJ-DS-S02
		7/22/04	1/0/00	7/22/04	8/11/04	8/11/04	8/11/04	8/11/04	9/2/04	9/2/04	9/2/04	9/2/04	9/2/04	9/2/04
Extractable Petroleum Hydrocarbons (EPH)														
C9-C18 Aliphatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
C19-C36 Aliphatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
C11-C22 Aromatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAH)														
Naphthalene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylnapthalene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	0.1	0.0012	0.01927	0.00017	--	0.0016	--	--	--	0.0006	--	--	0.0005	--
Chrysene	0.01	0.00014	0.01449	0.000129	0.00019	0.00016	--	--	--	0.00006	--	--	--	--
Benzo(b)fluoranthene	0.1	--	0.01034	0.00026	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	0.01	--	0.00028	0.000009	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	1	0.01	0.09813	0.0025	0.019	0.017	--	--	--	0.005	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.1	--	0.00662	0.00019	--	--	--	--	--	--	--	--	--	--
Dibenzo(a,h)anthracene	1	--	0.01533	0.0003	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
Other PAH	NA	--	--	--	--	--	--	--	--	--	--	--	--	--
BaP equivalents RBTC[2]:	**0.35**	0.01134	0.1644635	0.003558	0.01919	0.01876	--	--	--	0.00566	--	--	0.0005	--
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No

Notes:
1. Benzo(a)pyrene or "BaP" equivalents were calculated for detectecd concentrations of constituents with toxicity equivalent factors (TEF). The detected concentration and the TEF were multiplied to yield a BaP equivalent.
2. The risk-based screening benchmaker (RBTC) for Total PAH and BaP equivalent risk-based threshold benchmark is derived (Tables 16 through 18).
3. Other PAH refer to constituents detected in samples analyzed by B&B laboratories for fingerprinting purposes. Other PAH include:benzothiphene, biphenyl, dibenzofuran, carbazole, dibenzothiphene, benzo(e)pyrene, and perylene. Concentrations of alkylated PAH compounds were summed with the concentration of the parent PAH compound and presented in this table.
4. EPH + Total PAH refers to the sum of all detected EPH fractions and the total PAH value, including alkylated PAH compounds which are summed with parent PAH.
5. NA = not available; "<" = less than detection limit; "--" = not analyzed/not converted to BaP eqivalents; mg/kg = milligrams per kilogram

TABLE 19

HUMAN HEALTH SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	TEF[2]																		
Analyte (mg/kg)	Sediment Type:	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*
	Sample ID:	BJ-DS-S03	BJ-DS-S04	SN-SS-S01	SN-SS-S02	SN-SS-03	SN-SS-S04	SN-DS-S01	SN-DS-S02	SN-DS-S03	SN-DS-S04	DL-SS-S01	DL-SS-S02	DL-SS-S03	DL-SS-S04	DL-DS-S01	DL-DS-S02	DL-DS-S03	DL-DS-S04
	Date Sampled:	9/2/04	9/2/04	8/12/04	8/12/04	averaged with BSS-S02	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04
Extractable Petroleum Hydrocarbons (EPH)																			
C9-C18 Aliphatic Hydrocarbons	NA	<38	<42	<38	<37	<35	<37	<37	<36	<34	<43	<35	<36	<38	<38	<36	<40	<38	<39
C19-C36 Aliphatic Hydrocarbons	NA	<38	<42	<38	<37	<35	<37	<37	<36	<34	65	<35	<36	<38	<38	<36	<40	<38	<39
C11-C22 Aromatic Hydrocarbons	NA	<38	<42	<38	<37	<35	<37	<37	<36	<34	<43	<35	<36	<38	<38	<36	<40	<38	<39
Polycyclic Aromatic Hydrocarbons (PAH)																			
Naphthalene	NA	<0.012	<0.014	<0.013	<0.013	0.0105	<0.013	<0.013	<0.012	<0.012	0.016	<0.012	<0.012	<0.013	<0.013	<0.012	<0.013	<0.012	<0.013
2-Methylnapthalene	NA	<0.012	<0.014	<0.013	<0.013	0.0105	<0.013	<0.013	<0.012	<0.012	0.015	<0.012	<0.012	<0.013	<0.013	<0.012	<0.013	<0.012	<0.013
Acenaphthylene	NA	<0.012	<0.014	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	<0.014	<0.012	<0.012	<0.013	<0.013	<0.012	<0.013	<0.012	<0.013
Acenaphthene	NA	<0.012	<0.014	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	<0.014	<0.012	<0.012	<0.013	<0.013	<0.012	<0.013	<0.012	<0.013
Fluorene	NA	<0.012	<0.014	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	<0.014	<0.012	<0.012	<0.013	<0.013	<0.012	<0.013	<0.012	<0.013
Phenanthrene	NA	<0.012	<0.014	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	0.015	<0.012	<0.012	<0.013	<0.013	<0.012	<0.013	<0.012	<0.013
Anthracene	NA	<0.012	<0.014	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	<0.014	<0.012	<0.012	<0.013	<0.013	<0.012	<0.013	<0.012	<0.013
Fluoranthene	NA	<0.012	<0.014	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	0.04	<0.012	<0.012	<0.013	<0.013	<0.012	<0.013	<0.012	<0.013
Pyrene	NA	<0.012	<0.014	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	0.04	<0.012	<0.012	<0.013	<0.013	<0.012	<0.013	<0.012	<0.013
Benzo(a)anthracene	0.1	<0.012	<0.014	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	0.023	<0.012	<0.012	<0.013	<0.013	<0.012	<0.013	<0.012	<0.013
Chrysene	0.01	<0.012	<0.014	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	0.025	<0.012	<0.012	<0.013	<0.013	<0.012	<0.013	<0.012	<0.013
Benzo(b)fluoranthene	0.1	<0.012	<0.014	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	0.019	<0.012	<0.012	<0.013	<0.013	<0.012	<0.013	<0.012	<0.013
Benzo(k)fluoranthene	0.01	<0.012	<0.014	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	0.024	<0.012	<0.012	<0.013	<0.013	<0.012	<0.013	<0.012	<0.013
Benzo(a)pyrene	1	<0.012	<0.014	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	0.03	<0.012	<0.012	<0.013	<0.013	<0.012	<0.013	<0.012	<0.013
Indeno(1,2,3-cd)pyrene	0.1	<0.012	<0.014	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	<0.014	<0.012	<0.012	<0.013	<0.013	<0.012	<0.013	<0.012	<0.013
Dibenzo(a,h)anthracene	1	<0.012	<0.014	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	<0.014	<0.012	<0.012	<0.013	<0.013	<0.012	<0.013	<0.012	<0.013
Benzo(g,h,i)perylene	NA	<0.012	<0.014	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	<0.014	<0.012	<0.012	<0.013	<0.013	<0.012	<0.013	<0.012	<0.013
Other PAH[3]	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EPH + Total PAH RBTC[2]:	**222**	ND	ND	ND	ND	0.111	ND	ND	ND	ND	108.296	ND	ND	ND	ND	ND	ND	ND	ND
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

BaP Equivalents		BJ-DS-S03	BJ-DS-S04	SN-SS-S01	SN-SS-S02	SN-SS-03	SN-SS-S04	SN-DS-S01	SN-DS-S02	SN-DS-S03	SN-DS-S04	DL-SS-S01	DL-SS-S02	DL-SS-S03	DL-SS-S04	DL-DS-S01	DL-DS-S02	DL-DS-S03	DL-DS-S04
	TEF[2]	9/2/04	9/2/04	8/12/04	8/12/04	averaged with BSS-S02	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04
Extractable Petroleum Hydrocarbons (EPH)																			
C9-C18 Aliphatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C19-C36 Aliphatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C11-C22 Aromatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAH)																			
Naphthalene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylnapthalene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	0.1	--	--	--	--	--	--	--	--	--	0.0023	--	--	--	--	--	--	--	--
Chrysene	0.01	--	--	--	--	--	--	--	--	--	0.00025	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	0.1	--	--	--	--	--	--	--	--	--	0.0019	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	0.01	--	--	--	--	--	--	--	--	--	0.00024	--	--	--	--	--	--	--	--
Benzo(a)pyrene	1	--	--	--	--	--	--	--	--	--	0.03	--	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzo(a,h)anthracene	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other PAH	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BaP equivalents RBTC[2]:	**0.35**	--	--	--	--	--	--	--	--	--	0.03469	--	--	--	--	--	--	--	--
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Notes:
1. Benzo(a)pyrene or "BaP" equivalents were calculated for detectecd concentrations of constituents with toxicity equivalent factors (TEF). The detected concentration and the TEF were multiplied to yield a BaP equivalent.
2. The risk-based screening benchmaker (RBTC) for Total PAH and BaP equivalent risk-based threshold benchmark is derived (Tables 16 through 18).
3. Other PAH refer to constituents detected in samples analyzed by B&B laboratories for fingerprinting purposes. Other PAH include:benzothiphene, biphenyl, dibenzofuran, carbazole, dibenzothiphene, benzo(e)pyrene, and perylene. Concentrations of alkylated PAH compounds were summed with the concentration of the parent PAH compound and presented in this table.
4. EPH + Total PAH refers to the sum of all detected EPH fractions and the total PAH value, including alkylated PAH compounds which are summed with parent PAH.
5. NA = not available; "<" = less than detection limit; "--" = not analyzed/not converted to BaP eqivalents; mg/kg = milligrams per kilogram

TABLE 19

HUMAN HEALTH SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	TEF[2]	W1C02 Planting Island Causeway	W1D01 Aucoot Cove						W1E02 Strawberry Cove					W1E03 Strawberry Point West		
Analyte (mg/kg)	Sediment Type:	*marsh*	*marsh*	*marsh*	*marsh*	*marsh*	*marsh*	*marsh*	*marsh*	*marsh*	*marsh*	*marsh*	*marsh*	*intertidal*	*intertidal*	*intertidal*
	Sample ID:	W1C02-MS01	W1D01-M-01	W1D01-M-02	W1D01-M-03	W1D01-P2-M-01	W1D01-P2-M-02	W1D01-P2-M-03	W1E02-P2-M-01 average with DDD-P2-03	W1E02-P2-M-02	W1E02-P2-M-03	W1E02-P2-M-04	W1E02-P2-M-05	WIE03-UIT-01	WIE03-UIT-02	WIE03-UIT-03
	Date Sampled:	8/24/04	1/21/04	1/21/04	1/21/04	9/1/05	9/1/05	10/19/05		8/31/05	8/31/05	8/31/05	8/31/05	1/21/04	1/21/04	1/21/04
Extractable Petroleum Hydrocarbons (EPH)																
C9-C18 Aliphatic Hydrocarbons	NA	<47	<30	<42	<30	<36	<36	<61	<77	<33	<35	<34	<32	<36	<33	<30
C19-C36 Aliphatic Hydrocarbons	NA	<47	<30	<42	<30	<36	<36	<61	<77	<33	<35	<34	<32	<36	<33	<30
C11-C22 Aromatic Hydrocarbons	NA	<47	<30	<42	<30	<36	<36	<61	<77	<33	<35	<34	<32	<36	<33	<30
Polycyclic Aromatic Hydrocarbons (PAH)																
Naphthalene	NA	0.006	0.008	0.011	0.009	0.006	<0.012	<0.02	0.0625	<0.011	<0.017	<0.011	<0.013	0.013	0.011	0.008
2-Methylnapthalene	NA	0.006	<0.010	<0.014	<0.010	<0.012	<0.012	<0.02	<0.026	<0.011	<0.017	<0.011	<0.013	0.01	0.008	0.006
Acenaphthylene	NA	<0.016	<0.010	<0.014	<0.010	<0.012	<0.012	<0.02	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Acenaphthene	NA	<0.016	<0.010	<0.014	<0.010	<0.012	<0.012	<0.02	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Fluorene	NA	<0.016	<0.010	<0.014	<0.010	<0.012	<0.012	<0.02	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Phenanthrene	NA	0.006	<0.010	<0.014	<0.010	<0.012	<0.012	<0.02	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Anthracene	NA	<0.016	<0.010	<0.014	<0.010	<0.012	0.007	<0.02	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Fluoranthene	NA	0.014	<0.010	<0.014	<0.010	<0.012	0.006	<0.02	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	0.007
Pyrene	NA	0.008	<0.010	<0.014	<0.010	<0.012	0.011	0.011	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	0.007
Benzo(a)anthracene	0.1	<0.016	<0.010	<0.014	<0.010	<0.012	0.01	<0.02	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Chrysene	0.01	0.006	<0.010	<0.014	<0.010	<0.012	0.01	<0.02	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Benzo(b)fluoranthene	0.1	0.006	<0.010	<0.014	<0.010	<0.012	0.01	<0.02	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Benzo(k)fluoranthene	0.01	0.005	<0.010	<0.014	<0.010	<0.012	<0.012	<0.02	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Benzo(a)pyrene	1	0.005	<0.010	<0.014	<0.010	<0.012	0.01	<0.02	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Indeno(1,2,3-cd)pyrene	0.1	<0.016	<0.010	<0.014	<0.010	<0.012	0.013	<0.02	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Dibenzo(a,h)anthracene	1	<0.016	<0.010	<0.014	<0.010	<0.012	0.018	<0.02	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Benzo(g,h,i)perylene	NA	<0.016	<0.010	<0.014	<0.010	<0.012	0.008	<0.02	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Other PAH[3]	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EPH + Total PAH RBTC[2]:	**222**	0.126	0.088	0.123	0.089	0.102	0.145	0.171	0.2705	ND	ND	ND	ND	0.113	0.1015	0.093
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

BaP Equivalents	TEF[2]	W1C02-MS01	W1D01-M-01	W1D01-M-02	W1D01-M-03	W1D01-P2-M-01	W1D01-P2-M-02	W1D01-P2-M-03	W1E02-P2-M-01 average with DDD-P2-03	W1E02-P2-M-02	W1E02-P2-M-03	W1E02-P2-M-04	W1E02-P2-M-05	WIE03-UIT-01	WIE03-UIT-02	WIE03-UIT-03
		8/24/04	1/21/04	1/21/04	1/21/04	9/1/05	9/1/05	10/19/05		8/31/05	8/31/05	8/31/05	8/31/05	1/21/04	1/21/04	1/21/04
Extractable Petroleum Hydrocarbons (EPH)																
C9-C18 Aliphatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C19-C36 Aliphatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C11-C22 Aromatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAH)																
Naphthalene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylnapthalene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	0.1	--	--	--	--	--	0.001	--	--	--	--	--	--	--	--	--
Chrysene	0.01	0.00006	--	--	--	--	0.0001	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	0.1	0.0006	--	--	--	--	0.001	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	0.01	0.00005	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	1	0.005	--	--	--	--	0.01	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.1	--	--	--	--	--	0.0013	--	--	--	--	--	--	--	--	--
Dibenzo(a,h)anthracene	1	--	--	--	--	--	0.018	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other PAH	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BaP equivalents RBTC[2]:	**0.35**	0.00571	--	--	--	--	0.0314	--	--	--	--	--	--	--	--	--
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Notes:
1. Benzo(a)pyrene or "BaP" equivalents were calculated for detectecd concentrations of constituents with toxicity equivalent factors (TEF). The detected concentration and the TEF were multiplied to yield a BaP equivalent.
2. The risk-based screening benchmaker (RBTC) for Total PAH and BaP equivalent risk-based threshold benchmark is derived (Tables 16 through 18).
3. Other PAH refer to constituents detected in samples analyzed by B&B laboratories for fingerprinting purposes. Other PAH include:benzothiphene, biphenyl, dibenzofuran, carbazole, dibenzothiphene, benzo(e)pyrene, and perylene. Concentrations of alkylated PAH compounds were summed with the concentration of the parent PAH compound and presented in this table.
4. EPH + Total PAH refers to the sum of all detected EPH fractions and the total PAH value, including alkylated PAH compounds which are summed with parent PAH.
5. NA = not available; "<" = less than detection limit; "--" = not analyzed/not converted to BaP eqivalents; mg/kg = milligrams per kilogram

TABLE 19

HUMAN HEALTH SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	TEF[2]	W1E04 Crescent Beach									
Analyte (mg/kg)	Sediment Type:	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*
	Sample ID:	W1E04-UIT-01 average with DDD-01 UIT-1	WIE04-LIT-01 average with DDD01-LIT-01	WIE04-UIT-02	WIE04-LIT-02	WIE04-UIT-03	WIE04-LIT-03	W1E04-P2-UIT-01	W1E04-P2-LIT-01	W1E04-P2-UIT-02	W1E04-P2-LIT-02
	Date Sampled:			1/21/04	1/21/04	1/21/04	1/21/04	8/31/05	8/31/05	9/1/05	9/1/05
Extractable Petroleum Hydrocarbons (EPH)											
C9-C18 Aliphatic Hydrocarbons	NA	<31	<31	<32	<30	<31	<30	<30	<37	<31	<34
C19-C36 Aliphatic Hydrocarbons	NA	<31	<31	<32	<30	<31	<30	<30	<37	<31	<34
C11-C22 Aromatic Hydrocarbons	NA	<31	<31	<32	<30	<31	<30	<30	<37	<31	<34
Polycyclic Aromatic Hydrocarbons (PAH)											
Naphthalene	NA	0.01	0.0105	0.011	0.01	0.01	0.009	0.005	0.007	<0.013	0.006
2-Methylnapthalene	NA	0.0065	0.0075	0.007	0.006	0.006	0.007	<0.01	<0.012	<0.013	<0.011
Acenaphthylene	NA	<0.01	<0.01	<0.011	<0.010	<0.010	<0.010	<0.01	<0.012	<0.013	<0.011
Acenaphthene	NA	<0.01	<0.01	<0.011	<0.010	<0.010	<0.010	<0.01	<0.012	<0.013	<0.011
Fluorene	NA	<0.01	<0.01	<0.011	<0.010	<0.010	<0.010	<0.01	<0.012	<0.013	0.006
Phenanthrene	NA	0.00575	<0.01	0.011	0.018	0.015	0.012	<0.01	0.008	<0.013	0.037
Anthracene	NA	<0.01	<0.01	<0.011	<0.010	<0.010	<0.010	<0.01	<0.012	<0.013	<0.011
Fluoranthene	NA	0.01225	<0.01	0.016	0.024	0.03	0.026	0.006	0.023	<0.013	0.023
Pyrene	NA	0.01125	<0.01	0.02	0.028	0.027	0.023	0.005	0.02	<0.013	0.025
Benzo(a)anthracene	0.1	0.00675	<0.01	0.006	0.008	0.014	0.008	<0.01	0.014	<0.013	0.011
Chrysene	0.01	0.00775	<0.01	0.013	0.014	0.014	0.013	<0.01	0.015	<0.013	0.011
Benzo(b)fluoranthene	0.1	0.00675	<0.01	0.006	0.007	0.012	0.01	<0.01	0.007	<0.013	<0.011
Benzo(k)fluoranthene	0.01	0.00625	<0.01	0.006	0.008	0.012	0.009	<0.01	0.007	<0.013	<0.011
Benzo(a)pyrene	1	0.00675	<0.01	0.006	0.007	0.014	0.011	<0.01	<0.012	<0.013	<0.011
Indeno(1,2,3-cd)pyrene	0.1	<0.01	<0.01	<0.011	<0.010	0.008	0.008	0.007	0.013	<0.013	0.008
Dibenzo(a,h)anthracene	1	<0.01	<0.01	<0.011	<0.010	<0.010	<0.010	<0.01	<0.012	<0.013	<0.011
Benzo(g,h,i)perylene	NA	0.00575	<0.01	<0.011	0.005	0.009	0.009	<0.01	0.007	<0.013	<0.011
Other PAH[3]	NA	--	--	--	--	--	--	--	--	--	--
EPH + Total PAH RBTC[2]:	**222**	0.116	0.093	0.1405	0.165	0.196	0.17	0.088	0.163	ND	0.1765
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No

BaP Equivalents	TEF[2]	W1E04-UIT-01 average with DDD-01 UIT-1	WIE04-LIT-01 average with DDD01-LIT-01	WIE04-UIT-02 1/21/04	WIE04-LIT-02 1/21/04	WIE04-UIT-03 1/21/04	WIE04-LIT-03 1/21/04	W1E04-P2-UIT-01 8/31/05	W1E04-P2-LIT-01 8/31/05	W1E04-P2-UIT-02 9/1/05	W1E04-P2-LIT-02 9/1/05
Extractable Petroleum Hydrocarbons (EPH)											
C9-C18 Aliphatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--
C19-C36 Aliphatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--
C11-C22 Aromatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAH)											
Naphthalene	NA	--	--	--	--	--	--	--	--	--	--
2-Methylnapthalene	NA	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	NA	--	--	--	--	--	--	--	--	--	--
Acenaphthene	NA	--	--	--	--	--	--	--	--	--	--
Fluorene	NA	--	--	--	--	--	--	--	--	--	--
Phenanthrene	NA	--	--	--	--	--	--	--	--	--	--
Anthracene	NA	--	--	--	--	--	--	--	--	--	--
Fluoranthene	NA	--	--	--	--	--	--	--	--	--	--
Pyrene	NA	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	0.1	0.000675	--	0.0006	0.0008	0.0014	0.0008	--	0.0014	--	0.0011
Chrysene	0.01	0.0000775	--	0.00013	0.00014	0.00014	0.00013	--	0.00015	--	0.00011
Benzo(b)fluoranthene	0.1	0.000675	--	0.0006	0.0007	0.0012	0.001	--	0.0007	--	--
Benzo(k)fluoranthene	0.01	0.0000625	--	0.00006	0.00008	0.00012	0.00009	--	0.00007	--	--
Benzo(a)pyrene	1	0.00675	--	0.006	0.007	0.014	0.011	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.1	--	--	--	--	0.0008	0.0008	0.0007	0.0013	--	0.0008
Dibenzo(a,h)anthracene	1	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	NA	--	--	--	--	--	--	--	--	--	--
Other PAH	NA	--	--	--	--	--	--	--	--	--	--
BaP equivalents RBTC[2]:	**0.35**	0.00824	--	0.00739	0.00872	0.01766	0.01382	0.0007	0.00362	--	0.00201
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No

Notes:
1. Benzo(a)pyrene or "BaP" equivalents were calculated for detectecd concentrations of constituents with toxicity equivalent factors (TEF). The detected concentration and the TEF were multiplied to yield a BaP equivalent.
2. The risk-based screening benchmaker (RBTC) for Total PAH and BaP equivalent risk-based threshold benchmark is derived (Tables 16 through 18).
3. Other PAH refer to constituents detected in samples analyzed by B&B laboratories for fingerprinting purposes. Other PAH include:benzothiphene, biphenyl, dibenzofuran, carbazole, dibenzothiphene, benzo(e)pyrene, and perylene. Concentrations of alkylated PAH compounds were summed with the concentration of the parent PAH compound and presented in this table.
4. EPH + Total PAH refers to the sum of all detected EPH fractions and the total PAH value, including alkylated PAH compounds which are summed with parent PAH.
5. NA = not available; "<" = less than detection limit; "--" = not analyzed/not converted to BaP eqivalents; mg/kg = milligrams per kilogram

TABLE 19

HUMAN HEALTH SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	TEF[2]	W1F02 Brandt Island West						W1F05 Mattapoisett Neck West						W2A03 Pope's Beach				
Analyte (mg/kg)	Sediment Type:	*intertidal*	*intertidal*	*intertidal*	*intertidal*		*marsh*	*marsh*	*marsh*	*marsh*	*marsh*	*intertidal*	*marsh*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*
	Sample ID:	W1F02-P2-UIT-01	W1F02-P2-LIT-01	W1F02-P2-UIT-02	W1F02-P2-LIT-02	average of HB-SED-01 & dup through 09	W1F02-P2-M-01 average with DDD-P2-06	WIF05-MS01	W1F05-P2-M-01	W1F05-P2-M-02	W1F05-P2-M-03 average with DDD-P2-05	W2A02-82905 average -01 and -02	W2A02-P2-M-04	W2A03-UIT-01	W2A03-LIT-01	W2A03-UIT-02	W2A03-UIT-03	W2A03-LIT-03
	Date Sampled:	9/14/05	9/14/05	9/14/05	9/14/05			8/24/04	9/1/05	9/1/05			8/29/05	1/19/04	1/19/04	1/19/04	1/19/04	1/19/04
Extractable Petroleum Hydrocarbons (EPH)																		
C9-C18 Aliphatic Hydrocarbons	NA	<30	<34	<31	<32	<33	<48	<59	<47	<44	<34	<33	<35	<31	<38	<34	<37	<35
C19-C36 Aliphatic Hydrocarbons	NA	<30	<34	<31	<32	<33	<48	<59	<47	<44	<34	<33	<35	<31	<38	<34	<37	<35
C11-C22 Aromatic Hydrocarbons	NA	<30	<34	<31	<32	<33	<48	<59	<47	<44	<34	<33	<35	<31	<38	<34	<37	<35
Polycyclic Aromatic Hydrocarbons (PAH)																		
Naphthalene	NA	<0.017	<0.017	<0.017	<0.017	0.01011	<0.017	<0.020	<0.016	<0.015	0.00675	<0.011	0.007	0.009	0.014	0.008	0.014	0.012
2-Methylnapthalene	NA	<0.017	<0.017	<0.017	<0.017	0.000	<0.017	<0.020	<0.016	<0.015	<0.011	<0.011	<0.012	<0.010	<0.013	<0.011	<0.012	<0.012
Acenaphthylene	NA	<0.017	<0.017	<0.017	<0.017	0.000	<0.017	<0.020	<0.016	<0.015	<0.011	<0.011	<0.012	<0.010	<0.013	<0.011	0.011	<0.012
Acenaphthene	NA	<0.017	<0.017	<0.017	<0.017	0.000	<0.017	<0.020	<0.016	<0.015	<0.011	<0.011	<0.012	<0.010	<0.013	<0.011	<0.012	<0.012
Fluorene	NA	<0.017	<0.017	<0.017	<0.017	0.009	<0.017	<0.020	<0.016	<0.015	<0.011	<0.011	<0.012	<0.010	<0.013	<0.011	0.011	<0.012
Phenanthrene	NA	<0.017	<0.017	<0.017	<0.017	0.059	0.00925	0.009	<0.016	<0.015	<0.011	0.0305	0.01	0.006	<0.013	0.041	0.16	0.072
Anthracene	NA	<0.017	<0.017	<0.017	<0.017	0.000	<0.017	<0.020	<0.016	<0.015	<0.011	<0.011	<0.012	<0.010	<0.013	0.009	0.025	0.012
Fluoranthene	NA	<0.017	<0.017	<0.017	<0.017	0.001	0.01575	0.02	<0.016	<0.015	0.00775	0.0715	0.028	0.01	<0.013	0.06	0.31	0.16
Pyrene	NA	<0.017	<0.017	<0.017	<0.017	0.041	0.01375	0.01	<0.016	<0.015	0.00675	0.0795	0.029	0.009	<0.013	0.048	0.3	0.13
Benzo(a)anthracene	0.1	<0.017	<0.017	<0.017	<0.017	0.002	0.00925	0.009	<0.016	<0.015	<0.011	0.0345	0.012	<0.010	<0.013	0.021	0.11	0.06
Chrysene	0.01	<0.017	<0.017	<0.017	<0.017	0.039	0.00925	0.011	<0.016	0.008	<0.011	0.038	0.012	0.006	<0.013	0.025	0.13	0.079
Benzo(b)fluoranthene	0.1	<0.017	<0.017	<0.017	<0.017	0.001	<0.017	0.011	<0.016	<0.015	<0.011	0.0345	0.006	0.006	<0.013	0.022	0.11	0.064
Benzo(k)fluoranthene	0.01	<0.017	<0.017	<0.017	<0.017	0.000	<0.017	<0.020	<0.016	<0.015	<0.011	0.0165	<0.012	<0.010	<0.013	0.019	0.095	0.061
Benzo(a)pyrene	1	<0.017	<0.017	<0.017	<0.017	0.001	<0.017	<0.020	<0.016	<0.015	<0.011	0.0245	<0.012	<0.010	<0.013	0.029	0.17	0.08
Indeno(1,2,3-cd)pyrene	0.1	<0.017	<0.017	<0.017	<0.017	0.000	0.01175	<0.020	<0.016	0.012	0.0095	0.024	0.013	<0.010	<0.013	0.016	0.097	0.042
Dibenzo(a,h)anthracene	1	<0.017	<0.017	<0.017	<0.017	0.000	<0.017	<0.020	<0.016	0.019	<0.011	0.0115	0.013	<0.010	<0.013	<0.011	0.019	0.012
Benzo(g,h,i)perylene	NA	<0.017	<0.017	<0.017	<0.017	0.000	<0.017	<0.020	<0.016	<0.015	<0.011	0.0175	0.008	<0.010	<0.013	0.02	0.12	0.046
Other PAH[3]	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EPH + Total PAH RBTC[2]:	**222**	ND	ND	ND	ND	0.165	0.1625	0.18	ND	0.144	0.10225	0.416	0.18	0.101	0.118	0.3455	1.69	0.854
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

BaP Equivalents		W1F02-P2-UIT-01	W1F02-P2-LIT-01	W1F02-P2-UIT-02	W1F02-P2-LIT-02		W1F02-P2-M-01	WIF05-MS01	W1F05-P2-M-01	W1F05-P2-M-02	W1F05-P2-M-03	W2A02-82905	W2A02-P2-M-04	W2A03-UIT-01	W2A03-LIT-01	W2A03-UIT-02	W2A03-UIT-03	W2A03-LIT-03
	TEF[2]	9/14/05	9/14/05	9/14/05	9/14/05	average of HB-SED-01 & dup through 09	average with DDD-P2-06	8/24/04	9/1/05	9/1/05	average with DDD-P2-05	average -01 and -02	8/29/05	1/19/04	1/19/04	1/19/04	1/19/04	1/19/04
Extractable Petroleum Hydrocarbons (EPH)																		
C9-C18 Aliphatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C19-C36 Aliphatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C11-C22 Aromatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAH)																		
Naphthalene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylnapthalene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	0.1	--	--	--	--	0.00020	0.00093	0.0009	--	--	--	0.0035	0.0012	--	--	0.0021	0.011	0.006
Chrysene	0.01	--	--	--	--	0.00039	0.00009	0.00011	--	0.00008	--	0.0004	0.00012	0.00006	--	0.00025	0.0013	0.00079
Benzo(b)fluoranthene	0.1	--	--	--	--	0.00012	--	0.0011	--	--	--	0.0035	0.0006	0.0006	--	0.0022	0.011	0.0064
Benzo(k)fluoranthene	0.01	--	--	--	--	0.00000	--	--	--	--	--	0.0002	--	--	--	0.00019	0.00095	0.00061
Benzo(a)pyrene	1	--	--	--	--	0.00149	--	--	--	--	--	0.0245	--	--	--	0.029	0.17	0.08
Indeno(1,2,3-cd)pyrene	0.1	--	--	--	--	0.00003	0.00118	--	--	0.0012	0.00095	0.0024	0.0013	--	--	0.0016	0.0097	0.0042
Dibenzo(a,h)anthracene	1	--	--	--	--	0.00023	--	--	--	0.019	--	0.0115	0.013	--	--	--	0.019	0.012
Benzo(g,h,i)perylene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other PAH	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BaP equivalents RBTC[2]:	**0.35**	--	--	--	--	0.00247	0.00219	0.00211	--	0.02028	0.00095	0.0458	0.0162	0.00066	--	0.03534	0.223	0.11
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Notes:
1. Benzo(a)pyrene or "BaP" equivalents were calculated for detectecd concentrations of constituents with toxicity equivalent factors (TEF). The detected concentration and the TEF were multiplied to yield a BaP equivalent.
2. The risk-based screening benchmaker (RBTC) for Total PAH and BaP equivalent risk-based threshold benchmark is derived (Tables 16 through 18).
3. Other PAH refer to constituents detected in samples analyzed by B&B laboratories for fingerprinting purposes. Other PAH include:benzothiphene, biphenyl, dibenzofuran, carbazole, dibenzothiphene, benzo(e)pyrene, and perylene. Concentrations of alkylated PAH compounds were summed with the concentration of the parent PAH compound and presented in this table.
4. EPH + Total PAH refers to the sum of all detected EPH fractions and the total PAH value, including alkylated PAH compounds which are summed with parent PAH.
5. NA = not available; "<" = less than detection limit; "--" = not analyzed/not converted to BaP eqivalents; mg/kg = milligrams per kilogram

TABLE 19

HUMAN HEALTH SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	TEF[2]	**W2A03** Pope's Beach					**W2A10** Long Island and Causeway South								**W2A10** Long Island and Causeway South				
Analyte (mg/kg)	Sediment Type:	*marsh*	*marsh*	*marsh*	*marsh*	*marsh*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*marsh*	*marsh*	*marsh*	*marsh*	*marsh*
	Sample ID:	W2A03-P2-M01	W2A03-P2-M02	W2A03-P2-M04	W2A03-P2-M05	W2A03-P2-M06	W2A-10-P2-UIT-01	W2A-10-P2-LIT-01	W2A-10-P2-UIT-02	W2A10-P2-LIT-02	W2A-10-P2-UIT-03	W2A-10-P2-LIT-03	W2A-10-P2-UIT-05	W2A-10-P2-LIT-05	average of W2A10-C01 through C04	W2A10-P2-M-01	W2A10-P2-M-02	W2A10-P2-M-03	W2A10-P2-M-04
	Date Sampled:	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05		8/30/05	8/30/05	8/30/05	8/30/05
Extractable Petroleum Hydrocarbons (EPH)																			
C9-C18 Aliphatic Hydrocarbons	NA	<40	<39	<62	<39	<41	<35	<34	<30	<36	<32	<36	<32	<35	<39	<49	<38	<56	<38
C19-C36 Aliphatic Hydrocarbons	NA	<40	<39	<62	<39	<41	<35	<34	<30	<36	<32	<36	<32	<35	55.5	<49	<38	<56	<38
C11-C22 Aromatic Hydrocarbons	NA	<40	<39	<62	<39	<41	<35	<34	<30	<36	<32	<36	<32	<35	73	62	<38	<56	<38
Polycyclic Aromatic Hydrocarbons (PAH)																			
Naphthalene	NA	0.01	0.01	0.011	0.013	0.009	<0.016	<0.018	<0.012	0.015	<0.012	<0.014	<0.012	0.006	0.0075	0.01	<0.018	0.01	<0.014
2-Methylnapthalene	NA	<0.013	<0.013	<0.021	0.009	<0.014	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	0.018625	<0.016	<0.018	<0.019	<0.014
Acenaphthylene	NA	<0.013	<0.013	<0.021	0.007	<0.014	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	<0.013	<0.016	<0.018	<0.019	<0.014
Acenaphthene	NA	<0.013	<0.013	<0.021	<0.013	<0.014	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	0.01275	<0.016	<0.018	<0.019	<0.014
Fluorene	NA	<0.013	<0.013	<0.021	<0.013	<0.014	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	0.01575	<0.016	<0.018	<0.019	<0.014
Phenanthrene	NA	0.009	0.032	<0.021	0.053	0.016	<0.016	<0.018	<0.012	0.007	<0.012	<0.014	<0.012	<0.012	0.038875	0.012	<0.018	<0.019	<0.014
Anthracene	NA	<0.013	0.007	<0.021	0.013	<0.014	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	0.0145	<0.016	<0.018	<0.019	<0.014
Fluoranthene	NA	0.011	0.099	<0.021	0.13	0.042	<0.016	<0.018	<0.012	0.024	0.011	<0.014	<0.012	<0.012	0.02	0.031	<0.018	0.015	<0.014
Pyrene	NA	0.015	0.094	<0.021	0.12	0.039	<0.016	<0.018	<0.012	0.022	0.009	<0.014	<0.012	<0.012	0.05175	0.033	<0.018	0.017	<0.014
Benzo(a)anthracene	0.1	<0.013	0.047	<0.021	0.065	0.021	<0.016	<0.018	<0.012	0.012	<0.012	<0.014	<0.012	<0.012	0.03375	0.016	<0.018	<0.019	<0.014
Chrysene	0.01	0.007	0.048	<0.021	0.07	0.024	<0.016	<0.018	<0.012	0.01	<0.012	<0.014	<0.012	<0.012	0.04175	0.09	<0.018	<0.019	<0.014
Benzo(b)fluoranthene	0.1	<0.013	0.045	<0.021	0.075	0.022	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	0.02675	0.049	<0.018	<0.019	<0.014
Benzo(k)fluoranthene	0.01	<0.013	0.02	<0.021	0.03	0.011	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	0.01275	0.009	<0.018	<0.019	<0.014
Benzo(a)pyrene	1	<0.013	0.035	<0.021	0.053	0.012	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	0.0325	0.066	<0.018	<0.019	<0.014
Indeno(1,2,3-cd)pyrene	0.1	0.01	0.032	0.012	0.044	0.019	<0.016	<0.018	<0.012	0.011	0.008	<0.014	<0.012	<0.012	0.01225	0.034	<0.018	0.016	<0.014
Dibenzo(a,h)anthracene	1	<0.013	0.017	<0.021	0.02	0.016	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	0.01225	0.031	<0.018	0.021	<0.014
Benzo(g,h,i)perylene	NA	<0.013	0.025	<0.021	0.036	0.013	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	0.013	0.042	<0.018	<0.019	<0.014
Other PAH[3]	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EPH + Total PAH RBTC[2]:	**222**	0.1335	0.537	0.1805	0.751	0.279	ND	ND	ND	0.161	0.112	ND	ND	0.102	148.37125	111.463	ND	0.193	ND
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

BaP Equivalents	TEF[2]	W2A03-P2-M01	W2A03-P2-M02	W2A03-P2-M04	W2A03-P2-M05	W2A03-P2-M06	W2A-10-P2-UIT-01	W2A-10-P2-LIT-01	W2A-10-P2-UIT-02	W2A10-P2-LIT-02	W2A-10-P2-UIT-03	W2A-10-P2-LIT-03	W2A-10-P2-UIT-05	W2A-10-P2-LIT-05	W2A10-C01 t	W2A10-P2-M-01	W2A10-P2-M-02	W2A10-P2-M-03	W2A10-P2-M-04
		8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	1/0/00	8/30/05	8/30/05	8/30/05	8/30/05
Extractable Petroleum Hydrocarbons (EPH)																			
C9-C18 Aliphatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C19-C36 Aliphatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C11-C22 Aromatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAH)																			
Naphthalene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylnapthalene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	0.1	--	0.0047	--	0.0065	0.0021	--	--	--	0.0012	--	--	--	--	0.003375	0.0016	--	--	--
Chrysene	0.01	0.00007	0.00048	--	0.0007	0.00024	--	--	--	0.0001	--	--	--	--	0.0004175	0.0009	--	--	--
Benzo(b)fluoranthene	0.1	--	0.0045	--	0.0075	0.0022	--	--	--	--	--	--	--	--	0.002675	0.0049	--	--	--
Benzo(k)fluoranthene	0.01	--	0.0002	--	0.0003	0.00011	--	--	--	--	--	--	--	--	0.0001275	0.00009	--	--	--
Benzo(a)pyrene	1	--	0.035	--	0.053	0.012	--	--	--	--	--	--	--	--	0.0325	0.066	--	--	--
Indeno(1,2,3-cd)pyrene	0.1	0.001	0.0032	0.0012	0.0044	0.0019	--	--	--	0.0011	0.0008	--	--	--	0.001225	0.0034	--	0.0016	--
Dibenzo(a,h)anthracene	1	--	0.017	--	0.02	0.016	--	--	--	--	--	--	--	--	0.01225	0.031	--	0.021	--
Benzo(g,h,i)perylene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other PAH	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BaP equivalents RBTC[2]:	**0.35**	0.0011	0.0651	0.0012	0.0924	0.03455	--	--	--	0.0024	0.0008	--	--	--	0.05257	0.10789	--	0.0226	--
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Notes:
1. Benzo(a)pyrene or "BaP" equivalents were calculated for detectecd concentrations of constituents with toxicity equivalent factors (TEF). The detected concentration and the TEF were multiplied to yield a BaP equivalent.
2. The risk-based screening benchmaker (RBTC) for Total PAH and BaP equivalent risk-based threshold benchmark is derived (Tables 16 through 18).
3. Other PAH refer to constituents detected in samples analyzed by B&B laboratories for fingerprinting purposes. Other PAH include:benzothiphene, biphenyl, dibenzofuran, carbazole, dibenzothiphene, benzo(e)pyrene, and perylene. Concentrations of alkylated PAH compounds were summed with the concentration of the parent PAH compound and presented in this table.
4. EPH + Total PAH refers to the sum of all detected EPH fractions and the total PAH value, including alkylated PAH compounds which are summed with parent PAH.
5. NA = not available; "<" = less than detection limit; "--" = not analyzed/not converted to BaP eqivalents; mg/kg = milligrams per kilogram

TABLE 19

HUMAN HEALTH SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	TEF[2]	W2A11 West Island West										W3A05 Round Hill Beach West				
Analyte (mg/kg)	Sediment Type:	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*
	Sample ID:	W2A11-UIT-01	W2A11-LIT-01	W2A11-UIT-02	W2A11-LIT-02	W2A11-UIT-03	W2A11-LIT-03	W2A11-P2-LIT-01	W2A11-P2-LIT-02 average with DDD-P2-02	W2A11-P2-UIT-01	W2A11-P2-UIT-02 average with DDD-P2-01	W3A05-P2-UIT-01	W3A05-P2-LIT-01	W3A05-P2-UIT-02	W3A05-P2-UIT-03 average with DDD-P2-04	W3A05-P2-LIT-03
	Date Sampled:	1/20/04	1/20/04	1/20/04	1/20/04	1/20/04	1/20/04	8/29/05		8/29/05		9/1/05	9/1/05	9/1/05		9/1/05
Extractable Petroleum Hydrocarbons (EPH)																
C9-C18 Aliphatic Hydrocarbons	NA	<33	<35	<30	<36	<35	<35	<36	<30	<30	<31	<30	<35	<30	<30	<32
C19-C36 Aliphatic Hydrocarbons	NA	<33	<35	<30	<36	<35	<35	<36	<30	<30	<31	<30	<35	<30	<30	<32
C11-C22 Aromatic Hydrocarbons	NA	<33	<35	<30	<36	<35	<35	<36	<30	<30	<31	<30	<35	<30	<30	<32
Polycyclic Aromatic Hydrocarbons (PAH)																
Naphthalene	NA	0.01	0.011	0.009	0.01	0.01	0.01	<0.012	<0.01	<0.01	<0.012	0.006	<0.012	<0.01	<0.01	0.006
2-Methylnapthalene	NA	<0.011	0.007	<0.010	<0.012	0.006	<0.012	<0.012	<0.01	<0.01	<0.012	<0.01	<0.012	<0.01	<0.01	<0.011
Acenaphthylene	NA	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012	<0.01	<0.012	<0.01	<0.01	<0.011
Acenaphthene	NA	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012	<0.01	<0.012	<0.01	<0.01	<0.011
Fluorene	NA	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012	0.006	<0.012	<0.01	<0.01	0.006
Phenanthrene	NA	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012	0.019	<0.012	0.032	0.017	0.061
Anthracene	NA	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012	0.013	<0.012	0.006	0.0055	0.026
Fluoranthene	NA	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012	0.035	<0.012	0.065	0.0345	0.13
Pyrene	NA	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	0.006	<0.012	0.029	<0.012	0.047	0.0265	0.097
Benzo(a)anthracene	0.1	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012	0.027	<0.012	0.02	0.017	0.053
Chrysene	0.01	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012	0.027	<0.012	0.023	0.015	0.044
Benzo(b)fluoranthene	0.1	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012	0.02	<0.012	0.022	0.0155	0.05
Benzo(k)fluoranthene	0.01	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012	0.023	<0.012	0.012	0.0095	0.023
Benzo(a)pyrene	1	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012	0.016	<0.012	0.009	0.0095	0.035
Indeno(1,2,3-cd)pyrene	0.1	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	0.007	<0.012	0.025	<0.012	0.017	0.0125	0.03
Dibenzo(a,h)anthracene	1	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	0.011	<0.012	0.025	<0.012	<0.01	0.0095	0.015
Benzo(g,h,i)perylene	NA	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012	0.021	<0.012	0.011	0.0095	0.023
Other PAH[3]	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EPH + Total PAH RBTC[2]:	**222**	0.098	0.108	0.089	0.106	0.106	0.106	ND	ND	0.094	ND	0.307	ND	0.294	0.2065	0.6155
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

BaP Equivalents		W2A11-UIT-01	W2A11-LIT-01	W2A11-UIT-02	W2A11-LIT-02	W2A11-UIT-03	W2A11-LIT-03	W2A11-P2-LIT-01	W2A11-P2-LIT-02	W2A11-P2-UIT-01	W2A11-P2-UIT-02	W3A05-P2-UIT-01	W3A05-P2-LIT-01	W3A05-P2-UIT-02	W3A05-P2-UIT-03	W3A05-P2-LIT-03
	TEF[2]	1/20/04	1/20/04	1/20/04	1/20/04	1/20/04	1/20/04	8/29/05	average with DDD-P2-02	8/29/05	average with DDD-P2-01	9/1/05	9/1/05	9/1/05	average with DDD-P2-04	9/1/05
Extractable Petroleum Hydrocarbons (EPH)																
C9-C18 Aliphatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C19-C36 Aliphatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C11-C22 Aromatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAH)																
Naphthalene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylnapthalene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	0.1	--	--	--	--	--	--	--	--	--	--	0.0027	--	0.002	0.0017	0.0053
Chrysene	0.01	--	--	--	--	--	--	--	--	--	--	0.00027	--	0.00023	0.00015	0.00044
Benzo(b)fluoranthene	0.1	--	--	--	--	--	--	--	--	--	--	0.002	--	0.0022	0.00155	0.005
Benzo(k)fluoranthene	0.01	--	--	--	--	--	--	--	--	--	--	0.00023	--	0.00012	0.000095	0.00023
Benzo(a)pyrene	1	--	--	--	--	--	--	--	--	--	--	0.016	--	0.009	0.0095	0.035
Indeno(1,2,3-cd)pyrene	0.1	--	--	--	--	--	--	--	--	0.0007	--	0.0025	--	0.0017	0.00125	0.003
Dibenzo(a,h)anthracene	1	--	--	--	--	--	--	--	--	0.011	--	0.025	--	--	0.0095	0.015
Benzo(g,h,i)perylene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other PAH	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BaP equivalents RBTC[2]:	**0.35**	--	--	--	--	--	--	--	--	0.0117	--	0.0487	--	0.0153	0.0237	0.0640
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Notes:
1. Benzo(a)pyrene or "BaP" equivalents were calculated for detectecd concentrations of constituents with toxicity equivalent factors (TEF). The detected concentration and the TEF were multiplied to yield a BaP equivalent.
2. The risk-based screening benchmaker (RBTC) for Total PAH and BaP equivalent risk-based threshold benchmark is derived (Tables 16 through 18).
3. Other PAH refer to constituents detected in samples analyzed by B&B laboratories for fingerprinting purposes. Other PAH include:benzothiphene, biphenyl, dibenzofuran, carbazole, dibenzothiphene, benzo(e)pyrene, and perylene. Concentrations of alkylated PAH compounds were summed with the concentration of the parent PAH compound and presented in this table.
4. EPH + Total PAH refers to the sum of all detected EPH fractions and the total PAH value, including alkylated PAH compounds which are summed with parent PAH.
5. NA = not available; "<" = less than detection limit; "--" = not analyzed/not converted to BaP eqivalents; mg/kg = milligrams per kilogram

TABLE 19

HUMAN HEALTH SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	TEF[2]	**W3C03** Barney's Joy (W of barbed)									**W3C04** Barney's Joy (E of barbed)					
Analyte (mg/kg)	Sediment Type:	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*
	Sample ID:	W3C03-UIT-01	W3C03-MIT-01	W3C03-LIT-01	W3C03-UIT-02	W3C03-MIT-02	W3C03-LIT-02	W3C03-UIT-03	W3C03-MIT-03	W3C03-LIT-03	W3C04-P2-UIT-01	W3C04-P2-LIT-01	W3C04-P2-UIT-02	W3C04-P2-LIT-02	W3C04-P2-UIT-03	W3C04-P2-LIT-03
	Date Sampled:	1/22/04	1/22/04	1/22/04	1/22/04	1/22/04	1/22/04	1/22/04	1/22/04	1/22/04	9/1/05	9/1/05	9/1/05	9/1/05	9/1/05	9/1/05
Extractable Petroleum Hydrocarbons (EPH)																
C9-C18 Aliphatic Hydrocarbons	NA	<32	<30	<31	<33	<31	<31	<31	<31	<31	<39	<33	<32	<37	<30	<33
C19-C36 Aliphatic Hydrocarbons	NA	<32	<30	<31	<33	<31	<31	<31	<31	<31	<39	<33	<32	<37	<30	<33
C11-C22 Aromatic Hydrocarbons	NA	<32	<30	<31	<33	<31	<31	<31	<31	<31	<39	<33	<32	<37	<30	<33
Polycyclic Aromatic Hydrocarbons (PAH)																
Naphthalene	NA	0.008	0.016	0.007	0.007	0.008	0.008	0.007	0.007	0.006	<0.013	0.007	<0.011	0.013	0.006	<0.011
2-Methylnapthalene	NA	<0.011	0.018	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.013	<0.011	<0.011	<0.012	<0.01	<0.011
Acenaphthylene	NA	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.013	<0.011	<0.011	<0.012	<0.01	<0.011
Acenaphthene	NA	0.01	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.013	<0.011	<0.011	<0.012	<0.01	<0.011
Fluorene	NA	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.013	<0.011	<0.011	<0.012	<0.01	<0.011
Phenanthrene	NA	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.013	0.013	<0.011	<0.012	0.031	<0.011
Anthracene	NA	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.013	0.01	<0.011	<0.012	0.007	<0.011
Fluoranthene	NA	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.013	0.025	<0.011	0.009	0.061	<0.011
Pyrene	NA	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.013	0.021	<0.011	0.008	0.045	<0.011
Benzo(a)anthracene	0.1	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.013	<0.011	<0.011	<0.012	0.026	<0.011
Chrysene	0.01	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.013	0.012	<0.011	<0.012	0.025	<0.011
Benzo(b)fluoranthene	0.1	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.013	<0.011	<0.011	<0.012	0.022	<0.011
Benzo(k)fluoranthene	0.01	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.013	<0.011	<0.011	<0.012	0.012	<0.011
Benzo(a)pyrene	1	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.013	<0.011	<0.011	<0.012	0.011	<0.011
Indeno(1,2,3-cd)pyrene	0.1	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.013	0.01	<0.011	0.008	0.019	<0.011
Dibenzo(a,h)anthracene	1	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.013	<0.011	<0.011	<0.012	0.014	<0.011
Benzo(g,h,i)perylene	NA	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.013	<0.011	<0.011	<0.012	0.012	<0.011
Other PAH[3]	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EPH + Total PAH RBTC[2]:	**222**	0.1005	0.109	0.087	0.095	0.088	0.088	0.087	0.087	0.086	ND	0.153	ND	0.116	0.311	ND
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

BaP Equivalents	TEF[2]	W3C03-UIT-01	W3C03-MIT-01	W3C03-LIT-01	W3C03-UIT-02	W3C03-MIT-02	W3C03-LIT-02	W3C03-UIT-03	W3C03-MIT-03	W3C03-LIT-03	W3C04-P2-UIT-01	W3C04-P2-LIT-01	W3C04-P2-UIT-02	W3C04-P2-LIT-02	W3C04-P2-UIT-03	W3C04-P2-LIT-03
		1/22/04	1/22/04	1/22/04	1/22/04	1/22/04	1/22/04	1/22/04	1/22/04	1/22/04	9/1/05	9/1/05	9/1/05	9/1/05	9/1/05	9/1/05
Extractable Petroleum Hydrocarbons (EPH)																
C9-C18 Aliphatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C19-C36 Aliphatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C11-C22 Aromatic Hydrocarbons	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAH)																
Naphthalene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylnapthalene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0026	--
Chrysene	0.01	--	--	--	--	--	--	--	--	--	--	0.00012	--	--	0.00025	--
Benzo(b)fluoranthene	0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0022	--
Benzo(k)fluoranthene	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00012	--
Benzo(a)pyrene	1	--	--	--	--	--	--	--	--	--	--	--	--	--	0.011	--
Indeno(1,2,3-cd)pyrene	0.1	--	--	--	--	--	--	--	--	--	--	0.001	--	0.0008	0.0019	--
Dibenzo(a,h)anthracene	1	--	--	--	--	--	--	--	--	--	--	--	--	--	0.014	--
Benzo(g,h,i)perylene	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other PAH	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BaP equivalents RBTC[2]:	**0.35**	--	--	--	--	--	--	--	--	--	--	0.00112	--	0.0008	0.03207	--
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Notes:
1. Benzo(a)pyrene or "BaP" equivalents were calculated for detectecd concentrations of constituents with toxicity equivalent factors (TEF). The detected concentration and the TEF were multiplied to yield a BaP equivalent.
2. The risk-based screening benchmaker (RBTC) for Total PAH and BaP equivalent risk-based threshold benchmark is derived (Tables 16 through 18).
3. Other PAH refer to constituents detected in samples analyzed by B&B laboratories for fingerprinting purposes. Other PAH include:benzothiphene, biphenyl, dibenzofuran, carbazole, dibenzothiphene, benzo(e)pyrene, and perylene. Concentrations of alkylated PAH compounds were summed with the concentration of the parent PAH compound and presented in this table.
4. EPH + Total PAH refers to the sum of all detected EPH fractions and the total PAH value, including alkylated PAH compounds which are summed with parent PAH.
5. NA = not available; "<" = less than detection limit; "--" = not analyzed/not converted to BaP eqivalents; mg/kg = milligrams per kilogram

TABLE 20

ECOLOGICAL SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Analyte (mg/kg)	Effects Range Low (ER-L[1])														
	Sediment Type:		*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*
	Sample ID:	Maximum EPC	W1C02-P2-SUB-01	W1C02-P2-SUB-02	W1E02-P2-SUB-01	W1E02-P2-SUB-02	W1E03-P2-SUB-01	W1E03-P2-SUB-02	W1F02-P2-SUB-01	W1F02-P2-SUB-02	W1F02-P2-SUB-03	W1F02-P2-SUB-04	W1F02-P2-SUB-05	W1F02-P2-SUB-06	W1F02-P2-SUB-07
	Date Sampled:		9/13/05	9/13/05	8/31/05	8/31/05	8/31/05	8/31/05	9/14/05	9/13/05	9/13/05	9/13/05	9/13/05	9/14/05	9/14/05
Extractable Petroleum Hydrocarbons (EPH)															
C9-C18 Aliphatic Hydrocarbons	NA	ND	<40	<39	<36	<52	<35	<33	<38	<36	<35	<36	<34	<35	<36
C19-C36 Aliphatic Hydrocarbons	NA	78	<40	<39	<36	<52	<35	<33	<38	<36	<35	<36	<34	<35	<36
C11-C22 Aromatic Hydrocarbons	NA	62	<40	<39	<36	<52	<35	<33	<38	<36	<35	<36	<34	<35	<36
Polycyclic Aromatic Hydrocarbons (PAH)															
Naphthalene	0.160	0.063	<0.017	<0.017	<0.012	<0.019	<0.012	0.01	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
2-Methylnapthalene	0.070	0.018	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Acenaphthylene	0.044	0.011	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Acenaphthene	0.016	0.010	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Fluorene	0.019	0.011	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Phenanthrene	0.240	0.160	<0.017	<0.017	<0.012	<0.019	<0.012	0.01	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Anthracene	0.085	0.026	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Fluoranthene	0.600	0.310	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Pyrene	0.665	0.300	<0.017	<0.017	<0.012	<0.019	<0.012	0.006	0.009	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Benzo(a)anthracene	0.261	0.127	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Chrysene	0.384	0.162	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Benzo(b)fluoranthene	NA	0.110	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Benzo(k)fluoranthene	NA	0.095	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Benzo(a)pyrene	0.430	0.170	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Indeno(1,2,3-cd)pyrene	NA	0.097	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	0.01	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Dibenzo(a,h)anthracene	0.063	0.031	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	0.014	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Benzo(g,h,i)perylene	NA	0.120	<0.017	<0.017	<0.012	<0.019	<0.012	<0.011	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Total PAH:	4.022	1.7	ND	ND	ND	ND	ND	0.103	0.152	ND	ND	ND	ND	ND	ND
	Exceeds benchmark?		No	No	No	No	No	No	No	No	No	No	No	No	No

Notes:

1. Effects Range-Low (ER-L) values represent the constituent concentration at which approximately 10% of studies found threshold effects to test species (Long and Morgan 1991).
2. Concentrations are in milligrams per kilogram (mg/kg).
3. Total PAH is the sum of all detected PAH, plus one-half any non-detected PAH compounds.
4. ND = not detected; "--" = not analyzed, "<" = below detection limit.

TABLE 20

ECOLOGICAL SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	Effects Range Low (ER-L[1])														
Analyte (mg/kg)	Sediment Type:	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*
	Sample ID:	W1F02-P2-SUB-08	PB-SS-S01	PB-SS-S02 averaged with BSS-S01	PB-SS-S03	PB-SS-S04	PB-DS-S01	PB-DS-S02	PB-DS-S03	PB-DS-S04	W2A10-ST-S01	W2A10-ST-S02	W2A10-ST-S03	W2A10-ST-S04	W2A10-ST-S05
	Date Sampled:	9/14/05	8/11/04		8/11/04	8/11/04	8/11/04	8/11/04	8/11/04	8/11/04	7/22/04	7/22/04	7/22/04	7/22/04	7/22/04
Extractable Petroleum Hydrocarbons (EPH)															
C9-C18 Aliphatic Hydrocarbons	NA	<37	<39	<38	<33	<36	<45	<49	<48	<40	<35	<35	<37	<35	<39
C19-C36 Aliphatic Hydrocarbons	NA	<37	<39	<38	<33	<36	47	78	53	<40	<35	<35	<37	<35	<39
C11-C22 Aromatic Hydrocarbons	NA	<37	<39	<38	<33	<36	<45	<49	<48	<40	<35	<35	<37	<35	<39
Polycyclic Aromatic Hydrocarbons (PAH)															
Naphthalene	0.160	<0.017	<0.013	<0.013	<0.011	<0.012	<0.015	<0.016	<0.016	<0.014	0.009	0.011	0.009	0.009	0.011
2-Methylnapthalene	0.070	<0.017	<0.013	<0.013	<0.011	<0.012	<0.015	<0.016	<0.016	<0.014	<0.012	<0.012	<0.012	<0.012	<0.013
Acenaphthylene	0.044	<0.017	<0.013	<0.013	<0.011	<0.012	<0.015	<0.016	<0.016	<0.014	<0.012	<0.012	<0.012	<0.012	<0.013
Acenaphthene	0.016	<0.017	<0.013	<0.013	<0.011	<0.012	<0.015	<0.016	<0.016	<0.014	<0.012	<0.012	<0.012	<0.012	<0.013
Fluorene	0.019	<0.017	<0.013	<0.013	<0.011	<0.012	<0.015	<0.016	<0.016	<0.014	<0.012	<0.012	<0.012	<0.012	<0.013
Phenanthrene	0.240	<0.017	<0.013	<0.013	<0.011	<0.012	0.067	0.035	0.023	0.023	<0.012	<0.012	<0.012	<0.012	0.032
Anthracene	0.085	<0.017	<0.013	<0.013	<0.011	<0.012	0.025	<0.016	<0.016	<0.014	<0.012	<0.012	<0.012	<0.012	<0.013
Fluoranthene	0.600	<0.017	<0.013	<0.013	0.011	<0.012	0.19	0.077	0.058	0.05	<0.012	<0.012	<0.012	<0.012	0.017
Pyrene	0.665	<0.017	<0.013	<0.013	<0.011	<0.012	0.14	0.064	0.05	0.051	<0.012	0.009	<0.012	<0.012	0.025
Benzo(a)anthracene	0.261	<0.017	<0.013	<0.013	<0.011	<0.012	0.075	0.033	0.025	0.026	<0.012	<0.012	<0.012	<0.012	0.012
Chrysene	0.384	<0.017	<0.013	<0.013	<0.011	<0.012	0.072	0.03	0.027	0.026	<0.012	0.012	<0.012	<0.012	0.014
Benzo(b)fluoranthene	NA	<0.017	<0.013	<0.013	<0.011	<0.012	0.058	0.025	0.021	0.021	<0.012	<0.012	<0.012	<0.012	<0.013
Benzo(k)fluoranthene	NA	<0.017	<0.013	<0.013	<0.011	<0.012	0.068	0.025	0.02	0.02	<0.012	<0.012	<0.012	<0.012	<0.013
Benzo(a)pyrene	0.430	<0.017	<0.013	<0.013	<0.011	<0.012	0.087	0.034	0.028	0.029	<0.012	0.008	<0.012	<0.012	0.01
Indeno(1,2,3-cd)pyrene	NA	<0.017	<0.013	<0.013	<0.011	<0.012	0.043	0.019	<0.016	0.015	<0.012	<0.012	<0.012	<0.012	<0.013
Dibenzo(a,h)anthracene	0.063	<0.017	<0.013	<0.013	<0.011	<0.012	<0.015	<0.016	<0.016	<0.014	<0.012	<0.012	<0.012	<0.012	<0.013
Benzo(g,h,i)perylene	NA	<0.017	<0.013	<0.013	<0.011	<0.012	0.045	0.02	0.017	0.017	<0.012	<0.012	<0.012	<0.012	<0.013
Total PAH:	4.022	ND	ND	ND	0.099	ND	0.915	0.418	0.333	0.327	0.105	0.118	0.105	0.105	0.186
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Notes:

1. Effects Range-Low (ER-L) values represent the constituent concentration at which approximately 10% of studies found threshold effects to test species (Long and Morgan 1991).

2. Concentrations are in milligrams per kilogram (mg/kg).

3. Total PAH is the sum of all detected PAH, plus one-half any non-detected PAH compounds.

4. ND = not detected; "--" = not analyzed, "<" = below detection limit.

TABLE 20

ECOLOGICAL SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Analyte (mg/kg)	Effects Range Low (ER-L[1])														
	Sediment Type:	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*
	Sample ID:	W2A10-ST- S06, S07 & XXX, S08	W2A10-ST-S09	LI-DS-S01	LI-DS-S02	LI-DS-S03	LI-DS-S04	BJ-SS-S01	BJ-SS-S02	BJ-SS-S03	BJ-SS-S04	BJ-DS-S01	BJ-DS-S02	BJ-DS-S03	BJ-DS-S04
	Date Sampled:		7/22/04	8/11/04	8/11/04	8/11/04	8/11/04	9/2/04	9/2/04	9/2/04	9/2/04	9/2/04	9/2/04	9/2/04	9/2/04
Extractable Petroleum Hydrocarbons (EPH)															
C9-C18 Aliphatic Hydrocarbons	NA	<32	<36	<52	<44	<34	<38	<37	<46	<36	<40	<40	<38	<38	<42
C19-C36 Aliphatic Hydrocarbons	NA	42	<36	<52	<44	<34	<38	<37	<46	<36	<40	<40	<38	<38	<42
C11-C22 Aromatic Hydrocarbons	NA	48	<36	<52	<44	<34	<38	<37	<46	<36	<40	<40	<38	<38	<42
Polycyclic Aromatic Hydrocarbons (PAH)															
Naphthalene	0.160	0.0123	0.0043	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	0.005	<0.013	<0.012	<0.014
2-Methylnapthalene	0.070	0.0093	0.0033	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	0.005	<0.013	<0.012	<0.014
Acenaphthylene	0.044	0.0106	0.0033	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	<0.013	<0.013	<0.012	<0.014
Acenaphthene	0.016	0.0076	0.0031	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	<0.013	<0.013	<0.012	<0.014
Fluorene	0.019	0.0088	0.0031	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	<0.013	<0.013	<0.012	<0.014
Phenanthrene	0.240	0.0509	0.0032	<0.018	<0.015	<0.011	<0.012	<0.012	0.007	<0.012	<0.013	0.007	<0.013	<0.012	<0.014
Anthracene	0.085	0.0164	0.0033	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	<0.013	<0.013	<0.012	<0.014
Fluoranthene	0.600	0.1201	0.0036	0.033	0.018	<0.011	<0.012	<0.012	0.007	<0.012	<0.013	0.008	<0.013	<0.012	<0.014
Pyrene	0.665	0.1373	0.0038	0.032	0.024	<0.011	<0.012	<0.012	0.011	<0.012	<0.013	0.006	<0.013	<0.012	<0.014
Benzo(a)anthracene	0.261	0.1270	0.0039	<0.018	0.016	<0.011	<0.012	<0.012	0.006	<0.012	<0.013	0.005	<0.013	<0.012	<0.014
Chrysene	0.384	0.1624	0.0041	0.019	0.016	<0.011	<0.012	<0.012	0.006	<0.012	<0.013	<0.013	<0.013	<0.012	<0.014
Benzo(b)fluoranthene	NA	0.0814	0.0043	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	<0.013	<0.013	<0.012	<0.014
Benzo(k)fluoranthene	NA	0.0332	0.0035	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	<0.013	<0.013	<0.012	<0.014
Benzo(a)pyrene	0.430	0.0861	0.0043	0.019	0.017	<0.011	<0.012	<0.012	0.005	<0.012	<0.013	<0.013	<0.013	<0.012	<0.014
Indeno(1,2,3-cd)pyrene	NA	0.0429	0.0040	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	<0.013	<0.013	<0.012	<0.014
Dibenzo(a,h)anthracene	0.063	0.0143	0.0032	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	<0.013	<0.013	<0.012	<0.014
Benzo(g,h,i)perylene	NA	0.0385	0.0038	<0.018	<0.015	<0.011	<0.012	<0.012	<0.016	<0.012	<0.013	<0.013	<0.013	<0.012	<0.014
Total PAH:	4.022	0.959	0.0616	0.22	0.181	ND	ND	ND	0.13	ND	ND	0.1075	ND	ND	ND
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Notes:

1. Effects Range-Low (ER-L) values represent the constituent concentration at which approximately 10% of studies found threshold effects to test species (Long and Morgan 1991).
2. Concentrations are in milligrams per kilogram (mg/kg).
3. Total PAH is the sum of all detected PAH, plus one-half any non-detected PAH compounds.
4. ND = not detected; "--" = not analyzed, "<" = below detection limit.

TABLE 20

ECOLOGICAL SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	Effects Range Low (ER-L[1])													
Analyte (mg/kg)	Sediment Type:	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*	*subtidal*
	Sample ID:	SN-SS-S01	SN-SS-S02	SN-SS-03 averaged with BSS-S02	SN-SS-S04	SN-DS-S01	SN-DS-S02	SN-DS-S03	SN-DS-S04	DL-SS-S01	DL-SS-S02	DL-SS-S03	DL-SS-S04	DL-DS-S01
	Date Sampled:	8/12/04	8/12/04		8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04	8/12/04
Extractable Petroleum Hydrocarbons (EPH)														
C9-C18 Aliphatic Hydrocarbons	NA	<38	<37	<35	<37	<37	<36	<34	<43	<35	<36	<38	<38	<36
C19-C36 Aliphatic Hydrocarbons	NA	<38	<37	<35	<37	<37	<36	<34	65	<35	<36	<38	<38	<36
C11-C22 Aromatic Hydrocarbons	NA	<38	<37	<35	<37	<37	<36	<34	<43	<35	<36	<38	<38	<36
Polycyclic Aromatic Hydrocarbons (PAH)														
Naphthalene	0.160	<0.013	<0.013	0.0105	<0.013	<0.013	<0.012	<0.012	0.016	<0.012	<0.012	<0.013	<0.013	<0.012
2-Methylnapthalene	0.070	<0.013	<0.013	0.0105	<0.013	<0.013	<0.012	<0.012	0.015	<0.012	<0.012	<0.013	<0.013	<0.012
Acenaphthylene	0.044	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	<0.014	<0.012	<0.012	<0.013	<0.013	<0.012
Acenaphthene	0.016	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	<0.014	<0.012	<0.012	<0.013	<0.013	<0.012
Fluorene	0.019	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	<0.014	<0.012	<0.012	<0.013	<0.013	<0.012
Phenanthrene	0.240	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	0.015	<0.012	<0.012	<0.013	<0.013	<0.012
Anthracene	0.085	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	<0.014	<0.012	<0.012	<0.013	<0.013	<0.012
Fluoranthene	0.600	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	0.04	<0.012	<0.012	<0.013	<0.013	<0.012
Pyrene	0.665	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	0.04	<0.012	<0.012	<0.013	<0.013	<0.012
Benzo(a)anthracene	0.261	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	0.023	<0.012	<0.012	<0.013	<0.013	<0.012
Chrysene	0.384	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	0.025	<0.012	<0.012	<0.013	<0.013	<0.012
Benzo(b)fluoranthene	NA	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	0.019	<0.012	<0.012	<0.013	<0.013	<0.012
Benzo(k)fluoranthene	NA	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	0.024	<0.012	<0.012	<0.013	<0.013	<0.012
Benzo(a)pyrene	0.430	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	0.03	<0.012	<0.012	<0.013	<0.013	<0.012
Indeno(1,2,3-cd)pyrene	NA	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	<0.014	<0.012	<0.012	<0.013	<0.013	<0.012
Dibenzo(a,h)anthracene	0.063	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	<0.014	<0.012	<0.012	<0.013	<0.013	<0.012
Benzo(g,h,i)perylene	NA	<0.013	<0.013	<0.012	<0.013	<0.013	<0.012	<0.012	<0.014	<0.012	<0.012	<0.013	<0.013	<0.012
Total PAH:	4.022	ND	ND	0.111	ND	ND	ND	ND	0.296	ND	ND	ND	ND	ND
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No

Notes:

1. Effects Range-Low (ER-L) values represent the constituent concentration at which approximately 10% of studies found threshold effects to test species (Long and Morgan 1991).
2. Concentrations are in milligrams per kilogram (mg/kg).
3. Total PAH is the sum of all detected PAH, plus one-half any non-detected PAH compounds.
4. ND = not detected; "--" = not analyzed, "<" = below detection limit.

TABLE 20

ECOLOGICAL SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	Effects Range Low (ER-L[1])				**W1C02** Planting Island Causeway	**W1D01** Aucoot Cove					
Analyte (mg/kg)	Sediment Type:	*subtidal*	*subtidal*	*subtidal*	*marsh*	*marsh*	*marsh*	*marsh*	*marsh*	*marsh*	*marsh*
	Sample ID:	DL-DS-S02	DL-DS-S03	DL-DS-S04	W1C02-MS01	W1D01-M-01	W1D01-M-02	W1D01-M-03	W1D01-P2-M-01	W1D01-P2-M-02	W1D01-P2-M-03
	Date Sampled:	8/12/04	8/12/04	8/12/04	8/24/04	1/21/04	1/21/04	1/21/04	9/1/05	9/1/05	10/19/05
Extractable Petroleum Hydrocarbons (EPH)											
C9-C18 Aliphatic Hydrocarbons	NA	<40	<38	<39	<47	<30	<42	<30	<36	<36	<61
C19-C36 Aliphatic Hydrocarbons	NA	<40	<38	<39	<47	<30	<42	<30	<36	<36	<61
C11-C22 Aromatic Hydrocarbons	NA	<40	<38	<39	<47	<30	<42	<30	<36	<36	<61
Polycyclic Aromatic Hydrocarbons (PAH)											
Naphthalene	0.160	<0.013	<0.012	<0.013	0.006	0.008	0.011	0.009	0.006	<0.012	<0.02
2-Methylnapthalene	0.070	<0.013	<0.012	<0.013	0.006	<0.010	<0.014	<0.010	<0.012	<0.012	<0.02
Acenaphthylene	0.044	<0.013	<0.012	<0.013	<0.016	<0.010	<0.014	<0.010	<0.012	<0.012	<0.02
Acenaphthene	0.016	<0.013	<0.012	<0.013	<0.016	<0.010	<0.014	<0.010	<0.012	<0.012	<0.02
Fluorene	0.019	<0.013	<0.012	<0.013	<0.016	<0.010	<0.014	<0.010	<0.012	<0.012	<0.02
Phenanthrene	0.240	<0.013	<0.012	<0.013	0.006	<0.010	<0.014	<0.010	<0.012	<0.012	<0.02
Anthracene	0.085	<0.013	<0.012	<0.013	<0.016	<0.010	<0.014	<0.010	<0.012	0.007	<0.02
Fluoranthene	0.600	<0.013	<0.012	<0.013	0.014	<0.010	<0.014	<0.010	<0.012	0.006	<0.02
Pyrene	0.665	<0.013	<0.012	<0.013	0.008	<0.010	<0.014	<0.010	<0.012	0.011	0.011
Benzo(a)anthracene	0.261	<0.013	<0.012	<0.013	<0.016	<0.010	<0.014	<0.010	<0.012	0.01	<0.02
Chrysene	0.384	<0.013	<0.012	<0.013	0.006	<0.010	<0.014	<0.010	<0.012	0.01	<0.02
Benzo(b)fluoranthene	NA	<0.013	<0.012	<0.013	0.006	<0.010	<0.014	<0.010	<0.012	0.01	<0.02
Benzo(k)fluoranthene	NA	<0.013	<0.012	<0.013	0.005	<0.010	<0.014	<0.010	<0.012	<0.012	<0.02
Benzo(a)pyrene	0.430	<0.013	<0.012	<0.013	0.005	<0.010	<0.014	<0.010	<0.012	0.01	<0.02
Indeno(1,2,3-cd)pyrene	NA	<0.013	<0.012	<0.013	<0.016	<0.010	<0.014	<0.010	<0.012	0.013	<0.02
Dibenzo(a,h)anthracene	0.063	<0.013	<0.012	<0.013	<0.016	<0.010	<0.014	<0.010	<0.012	0.018	<0.02
Benzo(g,h,i)perylene	NA	<0.013	<0.012	<0.013	<0.016	<0.010	<0.014	<0.010	<0.012	0.008	<0.02
Total PAH:	4.022	ND	ND	ND	0.126	0.088	0.123	0.089	0.102	0.145	0.171
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No

Notes:

1. Effects Range-Low (ER-L) values represent the constituent concentration at which approximately 10% of studies found threshold effects to test species (Long and Morgan 1991).
2. Concentrations are in milligrams per kilogram (mg/kg).
3. Total PAH is the sum of all detected PAH, plus one-half any non-detected PAH compounds.
4. ND = not detected; "--" = not analyzed, "<" = below detection limit.

TABLE 20

ECOLOGICAL SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	Effects Range Low (ER-L[1])	**W1D01** Aucoot Cove					**W1E03** Strawberry Point West		
Analyte (mg/kg)	Sediment Type:	*marsh*	*marsh*	*marsh*	*marsh*	*marsh*	*intertidal*	*intertidal*	*intertidal*
	Sample ID:	W1E02-P2-M-01	W1E02-P2-M-02	W1E02-P2-M-03	W1E02-P2-M-04	W1E02-P2-M-05	WIE03-UIT-01	WIE03-UIT-02	WIE03-UIT-03
	Date Sampled:	average with DDD-P2-03	8/31/05	8/31/05	8/31/05	8/31/05	1/21/04	1/21/04	1/21/04
Extractable Petroleum Hydrocarbons (EPH)									
C9-C18 Aliphatic Hydrocarbons	NA	<77	<33	<35	<34	<32	<36	<33	<30
C19-C36 Aliphatic Hydrocarbons	NA	<77	<33	<35	<34	<32	<36	<33	<30
C11-C22 Aromatic Hydrocarbons	NA	<77	<33	<35	<34	<32	<36	<33	<30
Polycyclic Aromatic Hydrocarbons (PAH)									
Naphthalene	0.160	0.0625	<0.011	<0.017	<0.011	<0.013	0.013	0.011	0.008
2-Methylnapthalene	0.070	<0.026	<0.011	<0.017	<0.011	<0.013	0.01	0.008	0.006
Acenaphthylene	0.044	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Acenaphthene	0.016	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Fluorene	0.019	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Phenanthrene	0.240	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Anthracene	0.085	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Fluoranthene	0.600	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	0.007
Pyrene	0.665	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	0.007
Benzo(a)anthracene	0.261	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Chrysene	0.384	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Benzo(b)fluoranthene	NA	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Benzo(k)fluoranthene	NA	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Benzo(a)pyrene	0.430	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Indeno(1,2,3-cd)pyrene	NA	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Dibenzo(a,h)anthracene	0.063	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Benzo(g,h,i)perylene	NA	<0.026	<0.011	<0.017	<0.011	<0.013	<0.012	<0.011	<0.010
Total PAH:	4.022	0.2705	ND	ND	ND	ND	0.113	0.1015	0.093
	Exceeds benchmark?	No	No	No	No	No	No	No	No

Notes:

1. Effects Range-Low (ER-L) values represent the constituent concentration at which approximately 10% of studies found threshold effects to test species (Long and Morgan 1991).
2. Concentrations are in milligrams per kilogram (mg/kg).
3. Total PAH is the sum of all detected PAH, plus one-half any non-detected PAH compounds.
4. ND = not detected; "--" = not analyzed, "<" = below detection limit.

TABLE 20

ECOLOGICAL SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	Effects Range Low (ER-L[1])	W1E04 Crescent Beach										W1F02 Brandt Island West					
Analyte (mg/kg)	Sediment Type:	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*marsh*
	Sample ID:	W1E04-UIT-01 average with DDD-01-UIT-1	WIE04-LIT-01 average with DDD01-LIT-01	WIE04-UIT-02	WIE04-LIT-02	WIE04-UIT-03	WIE04-LIT-03	W1E04-P2-UIT-01	W1E04-P2-LIT-01	W1E04-P2-UIT-02	W1E04-P2-LIT-02	W1F02-P2-UIT-01	W1F02-P2-LIT-01	W1F02-P2-UIT-02	W1F02-P2-LIT-02	average of HB-SED-01 & dup through 09	W1F02-P2-M-01 average with DDD-P2-06
	Date Sampled:			1/21/04	1/21/04	1/21/04	1/21/04	8/31/05	8/31/05	9/1/05	9/1/05	9/14/05	9/14/05	9/14/05	9/14/05		
Extractable Petroleum Hydrocarbons (EPH)																	
C9-C18 Aliphatic Hydrocarbons	NA	<31	<31	<32	<30	<31	<30	<30	<37	<31	<34	<30	<34	<31	<32	<33	<48
C19-C36 Aliphatic Hydrocarbons	NA	<31	<31	<32	<30	<31	<30	<30	<37	<31	<34	<30	<34	<31	<32	<33	<48
C11-C22 Aromatic Hydrocarbons	NA	<31	<31	<32	<30	<31	<30	<30	<37	<31	<34	<30	<34	<31	<32	<33	<48
Polycyclic Aromatic Hydrocarbons (PAH)																	
Naphthalene	0.160	0.01	0.0105	0.011	0.01	0.01	0.009	0.005	0.007	<0.013	0.006	<0.017	<0.017	<0.017	<0.017	0.00016	<0.017
2-Methylnapthalene	0.070	0.0065	0.0075	0.007	0.006	0.006	0.007	<0.01	<0.012	<0.013	<0.011	<0.017	<0.017	<0.017	<0.017	0.00016	<0.017
Acenaphthylene	0.044	<0.01	<0.01	<0.011	<0.010	<0.010	<0.010	<0.01	<0.012	<0.013	<0.011	<0.017	<0.017	<0.017	<0.017	0.00010	<0.017
Acenaphthene	0.016	<0.01	<0.01	<0.011	<0.010	<0.010	<0.010	<0.01	<0.012	<0.013	<0.011	<0.017	<0.017	<0.017	<0.017	0.00010	<0.017
Fluorene	0.019	<0.01	<0.01	<0.011	<0.010	<0.010	<0.010	<0.01	<0.012	<0.013	0.006	<0.017	<0.017	<0.017	<0.017	0.00012	<0.017
Phenanthrene	0.240	0.00575	<0.01	0.011	0.018	0.015	0.012	<0.01	0.008	<0.013	0.037	<0.017	<0.017	<0.017	<0.017	0.00036	0.00925
Anthracene	0.085	<0.01	<0.01	<0.011	<0.010	<0.010	<0.010	<0.01	<0.012	<0.013	<0.011	<0.017	<0.017	<0.017	<0.017	0.00017	<0.017
Fluoranthene	0.600	0.01225	<0.01	0.016	0.024	0.03	0.026	0.006	0.023	<0.013	0.023	<0.017	<0.017	<0.017	<0.017	0.00063	0.01575
Pyrene	0.665	0.01125	<0.01	0.02	0.028	0.027	0.023	0.005	0.02	<0.013	0.025	<0.017	<0.017	<0.017	<0.017	0.00246	0.01375
Benzo(a)anthracene	0.261	0.00675	<0.01	0.006	0.008	0.014	0.008	<0.01	0.014	<0.013	0.011	<0.017	<0.017	<0.017	<0.017	0.00201	0.00925
Chrysene	0.384	0.00775	<0.01	0.013	0.014	0.014	0.013	<0.01	0.015	<0.013	0.011	<0.017	<0.017	<0.017	<0.017	0.00428	0.00925
Benzo(b)fluoranthene	NA	0.00675	<0.01	0.006	0.007	0.012	0.01	<0.01	0.007	<0.013	<0.011	<0.017	<0.017	<0.017	<0.017	0.00122	<0.017
Benzo(k)fluoranthene	NA	0.00625	<0.01	0.006	0.008	0.012	0.009	<0.01	0.007	<0.013	<0.011	<0.017	<0.017	<0.017	<0.017	0.00018	<0.017
Benzo(a)pyrene	0.430	0.00675	<0.01	0.006	0.007	0.014	0.011	<0.01	<0.012	<0.013	<0.011	<0.017	<0.017	<0.017	<0.017	0.00149	<0.017
Indeno(1,2,3-cd)pyrene	NA	<0.01	<0.01	<0.011	<0.010	0.008	0.008	0.007	0.013	<0.013	0.008	<0.017	<0.017	<0.017	<0.017	0.00030	0.01175
Dibenzo(a,h)anthracene	0.063	<0.01	<0.01	<0.011	<0.010	<0.010	<0.010	<0.01	<0.012	<0.013	<0.011	<0.017	<0.017	<0.017	<0.017	0.00023	<0.017
Benzo(g,h,i)perylene	NA	0.00575	<0.01	<0.011	0.005	0.009	0.009	<0.01	0.007	<0.013	<0.011	<0.017	<0.017	<0.017	<0.017	0.00048	<0.017
Total PAH:	4.022	0.11575	0.093	0.1405	0.165	0.196	0.17	0.088	0.163	ND	0.1765	ND	ND	ND	ND	0.01445	0.1625
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Notes:

1. Effects Range-Low (ER-L) values represent the constituent concentration at which approximately 10% of studies found threshold effects to test species (Long and Morgan 1991).
2. Concentrations are in milligrams per kilogram (mg/kg).
3. Total PAH is the sum of all detected PAH, plus one-half any non-detected PAH compounds.
4. ND = not detected; "--" = not analyzed, "<" = below detection limit.

TABLE 20

ECOLOGICAL SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	Effects Range Low (ER-L[1])	W1F05 Mattapoisett Neck West				W2A02 Harbor View			W2A03 Pope's Beach					W2A03 Pope's Beach			
Analyte (mg/kg)	Sediment Type:	*marsh*	*marsh*	*marsh*	*marsh*	*intertidal*	*intertidal*	*marsh*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*marsh*	*marsh*	*marsh*	*marsh*
	Sample ID:	WIF05-MS01	W1F05-P2-M-01	W1F05-P2-M-02	W1F05-P2-M-03 average with DDD-P2-05	W2A02-82905-01	W2A02-82905-02	W2A02-P2-M-04	W2A03-UIT-01	W2A03-LIT-01	W2A03-UIT-02	W2A03-UIT-03	W2A03-LIT-03	W2A03-P2-M01	W2A03-P2-M02	W2A03-P2-M04	W2A03-P2-M05
	Date Sampled:	8/24/04	9/1/05	9/1/05		8/29/05	8/29/05	8/29/05	1/19/04	1/19/04	1/19/04	1/19/04	1/19/04	8/30/05	8/30/05	8/30/05	8/30/05
Extractable Petroleum Hydrocarbons (EPH)																	
C9-C18 Aliphatic Hydrocarbons	NA	<59	<47	<44	<34	<33	<36	<35	<31	<38	<34	<37	<35	<40	<39	<62	<39
C19-C36 Aliphatic Hydrocarbons	NA	<59	<47	<44	<34	<33	<36	<35	<31	<38	<34	<37	<35	<40	<39	<62	<39
C11-C22 Aromatic Hydrocarbons	NA	<59	<47	<44	<34	<33	<36	<35	<31	<38	<34	<37	<35	<40	<39	<62	<39
Polycyclic Aromatic Hydrocarbons (PAH)																	
Naphthalene	0.160	<0.020	<0.016	<0.015	0.00675	<0.011	<0.012	0.007	0.009	0.014	0.008	0.014	0.012	0.01	0.01	0.011	0.013
2-Methylnapthalene	0.070	<0.020	<0.016	<0.015	<0.011	<0.011	<0.012	<0.012	<0.010	<0.013	<0.011	<0.012	<0.012	<0.013	<0.013	<0.021	0.009
Acenaphthylene	0.044	<0.020	<0.016	<0.015	<0.011	<0.011	<0.012	<0.012	<0.010	<0.013	<0.011	0.011	<0.012	<0.013	<0.013	<0.021	0.007
Acenaphthene	0.016	<0.020	<0.016	<0.015	<0.011	<0.011	<0.012	<0.012	<0.010	<0.013	<0.011	<0.012	<0.012	<0.013	<0.013	<0.021	<0.013
Fluorene	0.019	<0.020	<0.016	<0.015	<0.011	<0.011	<0.012	<0.012	<0.010	<0.013	<0.011	0.011	<0.012	<0.013	<0.013	<0.021	<0.013
Phenanthrene	0.240	0.009	<0.016	<0.015	<0.011	0.042	0.019	0.01	0.006	<0.013	0.041	0.16	0.072	0.009	0.032	<0.021	0.053
Anthracene	0.085	<0.020	<0.016	<0.015	<0.011	<0.011	<0.012	<0.012	<0.010	<0.013	0.009	0.025	0.012	<0.013	0.007	<0.021	0.013
Fluoranthene	0.600	0.02	<0.016	<0.015	0.00775	0.11	0.033	0.028	0.01	<0.013	0.06	0.31	0.16	0.011	0.099	<0.021	0.13
Pyrene	0.665	0.01	<0.016	<0.015	0.00675	0.13	0.029	0.029	0.009	<0.013	0.048	0.3	0.13	0.015	0.094	<0.021	0.12
Benzo(a)anthracene	0.261	0.009	<0.016	<0.015	<0.011	0.055	0.014	0.012	<0.010	<0.013	0.021	0.11	0.06	<0.013	0.047	<0.021	0.065
Chrysene	0.384	0.011	<0.016	0.008	<0.011	0.063	0.013	0.012	0.006	<0.013	0.025	0.13	0.079	0.007	0.048	<0.021	0.07
Benzo(b)fluoranthene	NA	0.011	<0.016	<0.015	<0.011	0.063	<0.012	0.006	0.006	<0.013	0.022	0.11	0.064	<0.013	0.045	<0.021	0.075
Benzo(k)fluoranthene	NA	<0.020	<0.016	<0.015	<0.011	0.027	<0.012	<0.012	<0.010	<0.013	0.019	0.095	0.061	<0.013	0.02	<0.021	0.03
Benzo(a)pyrene	0.430	<0.020	<0.016	<0.015	<0.011	0.043	<0.012	<0.012	<0.010	<0.013	0.029	0.17	0.08	<0.013	0.035	<0.021	0.053
Indeno(1,2,3-cd)pyrene	NA	<0.020	<0.016	0.012	0.0095	0.036	0.012	0.013	<0.010	<0.013	0.016	0.097	0.042	0.01	0.032	0.012	0.044
Dibenzo(a,h)anthracene	0.063	<0.020	<0.016	0.019	<0.011	0.017	<0.012	0.013	<0.010	<0.013	<0.011	0.019	0.012	<0.013	0.017	<0.021	0.02
Benzo(g,h,i)perylene	NA	<0.020	<0.016	<0.015	<0.011	0.029	<0.012	0.008	<0.010	<0.013	0.02	0.12	0.046	<0.013	0.025	<0.021	0.036
Total PAH:	4.022	0.18	ND	0.144	0.10225	0.648	0.186	0.18	0.101	0.118	0.3455	1.694	0.854	0.1335	0.537	0.1805	0.751
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Notes:

1. Effects Range-Low (ER-L) values represent the constituent concentration at which approximately 10% of studies found threshold effects to test species (Long and Morgan 1991).

2. Concentrations are in milligrams per kilogram (mg/kg).

3. Total PAH is the sum of all detected PAH, plus one-half any non-detected PAH compounds.

4. ND = not detected; "--" = not analyzed, "<" = below detection limit.

TABLE 20

ECOLOGICAL SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	Effects Range Low (ER-L[1])		W2A10 Long Island and Causeway South												
Analyte (mg/kg)	Sediment Type:	*marsh*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*marsh*	*marsh*	*marsh*	*marsh*	*marsh*
	Sample ID:	W2A03-P2-M06	W2A-10-P2-UIT-01	W2A-10-P2-LIT-01	W2A-10-P2-UIT-02	W2A10-P2-LIT-02	W2A-10-P2-UIT-03	W2A-10-P2-LIT-03	W2A-10-P2-UIT-05	W2A-10-P2-LIT-05	average of W2A10-C01 through C04	W2A10-P2-M-01	W2A10-P2-M-02	W2A10-P2-M-03	W2A10-P2-M-04
	Date Sampled:	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05	8/30/05		8/30/05	8/30/05	8/30/05	8/30/05
Extractable Petroleum Hydrocarbons (EPH)															
C9-C18 Aliphatic Hydrocarbons	NA	<41	<35	<34	<30	<36	<32	<36	<32	<35	<39	<49	<38	<56	<38
C19-C36 Aliphatic Hydrocarbons	NA	<41	<35	<34	<30	<36	<32	<36	<32	<35	55.5	<49	<38	<56	<38
C11-C22 Aromatic Hydrocarbons	NA	<41	<35	<34	<30	<36	<32	<36	<32	<35	73	62	<38	<56	<38
Polycyclic Aromatic Hydrocarbons (PAH)															
Naphthalene	0.160	0.009	<0.016	<0.018	<0.012	0.015	<0.012	<0.014	<0.012	0.006	0.0075	0.01	<0.018	0.01	<0.014
2-Methylnapthalene	0.070	<0.014	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	0.018625	<0.016	<0.018	<0.019	<0.014
Acenaphthylene	0.044	<0.014	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	<0.013	<0.016	<0.018	<0.019	<0.014
Acenaphthene	0.016	<0.014	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	0.01275	<0.016	<0.018	<0.019	<0.014
Fluorene	0.019	<0.014	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	0.01575	<0.016	<0.018	<0.019	<0.014
Phenanthrene	0.240	0.016	<0.016	<0.018	<0.012	0.007	<0.012	<0.014	<0.012	<0.012	0.038875	0.012	<0.018	<0.019	<0.014
Anthracene	0.085	<0.014	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	0.0145	<0.016	<0.018	<0.019	<0.014
Fluoranthene	0.600	0.042	<0.016	<0.018	<0.012	0.024	0.011	<0.014	<0.012	<0.012	0.02	0.031	<0.018	0.015	<0.014
Pyrene	0.665	0.039	<0.016	<0.018	<0.012	0.022	0.009	<0.014	<0.012	<0.012	0.05175	0.033	<0.018	0.017	<0.014
Benzo(a)anthracene	0.261	0.021	<0.016	<0.018	<0.012	0.012	<0.012	<0.014	<0.012	<0.012	0.03375	0.016	<0.018	<0.019	<0.014
Chrysene	0.384	0.024	<0.016	<0.018	<0.012	0.01	<0.012	<0.014	<0.012	<0.012	0.04175	0.09	<0.018	<0.019	<0.014
Benzo(b)fluoranthene	NA	0.022	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	0.02675	0.049	<0.018	<0.019	<0.014
Benzo(k)fluoranthene	NA	0.011	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	0.01275	0.009	<0.018	<0.019	<0.014
Benzo(a)pyrene	0.430	0.012	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	0.0325	0.066	<0.018	<0.019	<0.014
Indeno(1,2,3-cd)pyrene	NA	0.019	<0.016	<0.018	<0.012	0.011	0.008	<0.014	<0.012	<0.012	0.01225	0.034	<0.018	0.016	<0.014
Dibenzo(a,h)anthracene	0.063	0.016	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	0.01225	0.031	<0.018	0.021	<0.014
Benzo(g,h,i)perylene	NA	0.013	<0.016	<0.018	<0.012	<0.012	<0.012	<0.014	<0.012	<0.012	0.013	0.042	<0.018	<0.019	<0.014
Total PAH:	4.022	0.279	ND	ND	ND	0.161	0.112	ND	ND	0.102	0.37125	0.463	ND	0.193	ND
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Notes:

1. Effects Range-Low (ER-L) values represent the constituent concentration at which approximately 10% of studies found threshold effects to test species (Long and Morgan 1991).
2. Concentrations are in milligrams per kilogram (mg/kg).
3. Total PAH is the sum of all detected PAH, plus one-half any non-detected PAH compounds.
4. ND = not detected; "--" = not analyzed, "<" = below detection limit.

TABLE 20

ECOLOGICAL SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	Effects Range Low (ER-L[1])	**W2A11** West Island West									
Analyte (mg/kg)	Sediment Type: Sample ID: Date Sampled:	*intertidal* W2A11-UIT-01 1/20/04	*intertidal* W2A11-LIT-01 1/20/04	*intertidal* W2A11-UIT-02 1/20/04	*intertidal* W2A11-LIT-02 1/20/04	*intertidal* W2A11-UIT-03 1/20/04	*intertidal* W2A11-LIT-03 1/20/04	*intertidal* W2A11-P2-LIT-01 8/29/05	*intertidal* W2A11-P2-LIT-02 average with DDD-P2-02	*intertidal* W2A11-P2-UIT-01 8/29/05	*intertidal* W2A11-P2-UIT-02 average with DDD-P2-01
Extractable Petroleum Hydrocarbons (EPH)											
C9-C18 Aliphatic Hydrocarbons	NA	<33	<35	<30	<36	<35	<35	<36	<30	<30	<31
C19-C36 Aliphatic Hydrocarbons	NA	<33	<35	<30	<36	<35	<35	<36	<30	<30	<31
C11-C22 Aromatic Hydrocarbons	NA	<33	<35	<30	<36	<35	<35	<36	<30	<30	<31
Polycyclic Aromatic Hydrocarbons (PAH)											
Naphthalene	0.160	0.01	0.011	0.009	0.01	0.01	0.01	<0.012	<0.01	<0.01	<0.012
2-Methylnapthalene	0.070	<0.011	0.007	<0.010	<0.012	0.006	<0.012	<0.012	<0.01	<0.01	<0.012
Acenaphthylene	0.044	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012
Acenaphthene	0.016	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012
Fluorene	0.019	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012
Phenanthrene	0.240	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012
Anthracene	0.085	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012
Fluoranthene	0.600	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012
Pyrene	0.665	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	0.006	<0.012
Benzo(a)anthracene	0.261	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012
Chrysene	0.384	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012
Benzo(b)fluoranthene	NA	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012
Benzo(k)fluoranthene	NA	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012
Benzo(a)pyrene	0.430	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012
Indeno(1,2,3-cd)pyrene	NA	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	0.007	<0.012
Dibenzo(a,h)anthracene	0.063	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	0.011	<0.012
Benzo(g,h,i)perylene	NA	<0.011	<0.012	<0.010	<0.012	<0.012	<0.012	<0.012	<0.01	<0.01	<0.012
Total PAH:	4.022	0.098	0.108	0.089	0.106	0.106	0.106	ND	ND	0.094	ND
	Exceeds benchmark?	No	No	No	No	No	No	No	No	No	No

Notes:

1. Effects Range-Low (ER-L) values represent the constituent concentration at which approximately 10% of studies found threshold effects to test species (Long and Morgan 1991).
2. Concentrations are in milligrams per kilogram (mg/kg).
3. Total PAH is the sum of all detected PAH, plus one-half any non-detected PAH compounds.
4. ND = not detected; "--" = not analyzed, "<" = below detection limit.

TABLE 20

ECOLOGICAL SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

	Effects Range Low (ER-L[1])	**W3A05** Round Hill Beach West					**W3C03** Barney's Joy (W of barbed)								
Analyte (mg/kg)	Sediment Type:	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*
	Sample ID:	W3A05-P2-UIT-01	W3A05-P2-LIT-01	W3A05-P2-UIT-02	W3A05-P2-UIT-03 average with DDD-P2-04	W3A05-P2-LIT-03	W3C03-UIT-01	W3C03-MIT-01	W3C03-LIT-01	W3C03-UIT-02	W3C03-MIT-02	W3C03-LIT-02	W3C03-UIT-03	W3C03-MIT-03	W3C03-LIT-03
	Date Sampled:	9/1/05	9/1/05	9/1/05		9/1/05	1/22/04	1/22/04	1/22/04	1/22/04	1/22/04	1/22/04	1/22/04	1/22/04	1/22/04
Extractable Petroleum Hydrocarbons (EPH)															
C9-C18 Aliphatic Hydrocarbons	NA	<30	<35	<30	<30	<32	<32	<30	<31	<33	<31	<31	<31	<31	<31
C19-C36 Aliphatic Hydrocarbons	NA	<30	<35	<30	<30	<32	<32	<30	<31	<33	<31	<31	<31	<31	<31
C11-C22 Aromatic Hydrocarbons	NA	<30	<35	<30	<30	<32	<32	<30	<31	<33	<31	<31	<31	<31	<31
Polycyclic Aromatic Hydrocarbons (PAH)															
Naphthalene	0.160	0.006	<0.012	<0.01	<0.01	0.006	0.008	0.016	0.007	0.007	0.008	0.008	0.007	0.007	0.006
2-Methylnapthalene	0.070	<0.01	<0.012	<0.01	<0.01	<0.011	<0.011	0.018	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010
Acenaphthylene	0.044	<0.01	<0.012	<0.01	<0.01	<0.011	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010
Acenaphthene	0.016	<0.01	<0.012	<0.01	<0.01	<0.011	0.01	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010
Fluorene	0.019	0.006	<0.012	<0.01	<0.01	0.006	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010
Phenanthrene	0.240	0.019	<0.012	0.032	0.017	0.061	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010
Anthracene	0.085	0.013	<0.012	0.006	0.0055	0.026	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010
Fluoranthene	0.600	0.035	<0.012	0.065	0.0345	0.13	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010
Pyrene	0.665	0.029	<0.012	0.047	0.0265	0.097	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(a)anthracene	0.261	0.027	<0.012	0.02	0.017	0.053	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010
Chrysene	0.384	0.027	<0.012	0.023	0.015	0.044	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(b)fluoranthene	NA	0.02	<0.012	0.022	0.0155	0.05	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(k)fluoranthene	NA	0.023	<0.012	0.012	0.0095	0.023	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(a)pyrene	0.430	0.016	<0.012	0.009	0.0095	0.035	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010
Indeno(1,2,3-cd)pyrene	NA	0.025	<0.012	0.017	0.0125	0.03	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010
Dibenzo(a,h)anthracene	0.063	0.025	<0.012	<0.01	0.0095	0.015	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(g,h,i)perylene	NA	0.021	<0.012	0.011	0.0095	0.023	<0.011	<0.010	<0.010	<0.011	<0.010	<0.010	<0.010	<0.010	<0.010
Total PAH:	4.022	0.307	ND	0.294	0.2065	0.6155	0.1005	0.109	0.087	0.095	0.088	0.088	0.087	0.087	0.086
	Exceeds benchmark?	No	No	No		No	No	No	No	No	No	No	No	No	No

Notes:

1. Effects Range-Low (ER-L) values represent the constituent concentration at which approximately 10% of studies found threshold effects to test species (Long and Morgan 1991).

2. Concentrations are in milligrams per kilogram (mg/kg).

3. Total PAH is the sum of all detected PAH, plus one-half any non-detected PAH compounds.

4. ND = not detected; "--" = not analyzed, "<" = below detection limit.

TABLE 20

ECOLOGICAL SEDIMENT EXPOSURE POINT CONCENTRATIONS

Barge B120 Oil Spill
Buzzards Bay, Massachusetts

Analyte (mg/kg)	Effects Range Low (ER-L[1])	W3C04 Barney's Joy (E of barbed)					
	Sediment Type:	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*	*intertidal*
	Sample ID:	W3C04-P2-UIT-01	W3C04-P2-LIT-01	W3C04-P2-UIT-02	W3C04-P2-LIT-02	W3C04-P2-UIT-03	W3C04-P2-LIT-03
	Date Sampled:	9/1/05	9/1/05	9/1/05	9/1/05	9/1/05	9/1/05
Extractable Petroleum Hydrocarbons (EPH)							
C9-C18 Aliphatic Hydrocarbons	NA	<39	<33	<32	<37	<30	<33
C19-C36 Aliphatic Hydrocarbons	NA	<39	<33	<32	<37	<30	<33
C11-C22 Aromatic Hydrocarbons	NA	<39	<33	<32	<37	<30	<33
Polycyclic Aromatic Hydrocarbons (PAH)							
Naphthalene	0.160	<0.013	0.007	<0.011	0.013	0.006	<0.011
2-Methylnapthalene	0.070	<0.013	<0.011	<0.011	<0.012	<0.01	<0.011
Acenaphthylene	0.044	<0.013	<0.011	<0.011	<0.012	<0.01	<0.011
Acenaphthene	0.016	<0.013	<0.011	<0.011	<0.012	<0.01	<0.011
Fluorene	0.019	<0.013	<0.011	<0.011	<0.012	<0.01	<0.011
Phenanthrene	0.240	<0.013	0.013	<0.011	<0.012	0.031	<0.011
Anthracene	0.085	<0.013	0.01	<0.011	<0.012	0.007	<0.011
Fluoranthene	0.600	<0.013	0.025	<0.011	0.009	0.061	<0.011
Pyrene	0.665	<0.013	0.021	<0.011	0.008	0.045	<0.011
Benzo(a)anthracene	0.261	<0.013	<0.011	<0.011	<0.012	0.026	<0.011
Chrysene	0.384	<0.013	0.012	<0.011	<0.012	0.025	<0.011
Benzo(b)fluoranthene	NA	<0.013	<0.011	<0.011	<0.012	0.022	<0.011
Benzo(k)fluoranthene	NA	<0.013	<0.011	<0.011	<0.012	0.012	<0.011
Benzo(a)pyrene	0.430	<0.013	<0.011	<0.011	<0.012	0.011	<0.011
Indeno(1,2,3-cd)pyrene	NA	<0.013	0.01	<0.011	0.008	0.019	<0.011
Dibenzo(a,h)anthracene	0.063	<0.013	<0.011	<0.011	<0.012	0.014	<0.011
Benzo(g,h,i)perylene	NA	<0.013	<0.011	<0.011	<0.012	0.012	<0.011
Total PAH:	4.022	ND	0.153	ND	0.116	0.311	ND
	Exceeds benchmark?	No	No	No	No	No	No

Notes:

1. Effects Range-Low (ER-L) values represent the constituent concentration at which approximately 10% of studies found threshold effects to test species (Long and Morgan 1991).
2. Concentrations are in milligrams per kilogram (mg/kg).
3. Total PAH is the sum of all detected PAH, plus one-half any non-detected PAH compounds.
4. ND = not detected; "--" = not analyzed, "<" = below detection limit.